NAVIGANT

DISTRIBUTED GENERATION— COMBINED HEAT AND POWER DEMONSTRATION PROGRAM

Market Characterization and Assessment Report

Prepared for:

New York State Energy Research and Development Authority

nyserda Energy. Innovation. Solutions

Nicole Wobus
Charlie Bloch
Pace Goodman
Brent Barkett, Director

Navigant Consulting, Inc.
1375 Walnut Street
Suite 200
Boulder, CO 80302

303.728.2500
www.navigant.com

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ES Executive Summary

ES.1 Introduction and Background

This report presents the results of Navigant Consulting, Inc.'s (Navigant's) Market Characterization and Assessment (MCA) evaluation of the New York State Energy Research and Development Authority (NYSERDA) Distributed Generation-Combined Heat and Power Demonstration Program (DG-CHP Demonstration Program), a component of the **New York Energy $mart℠** Program. The MCA evaluation results can be used to assess progress towards meeting the New York State Public Service Commission's public policy goals under which NYSERDA operates, as well as the institutional goals NYSERDA has established to move markets towards improved energy efficiency. In addition, the evaluation results can be used by NYSERDA program staff and managers to adjust program offerings as needed to ensure continual improvement of the programs and increase market interest and uptake of existing program offerings.

The goal of the New York System Benefits Charge (SBC)-funded DG-CHP Demonstration Program is to contribute to the growth of combined heat and power capacity installed as distributed generation in New York. The program provides funding for single-site and multi-site (fleet) demonstrations and seeks to improve end users' and project developers' awareness and knowledge of CHP. The program uses a competitive review process to select and fund projects that are expected to provide lessons learned for dissemination throughout the market. The program also seeks to address related issues such as distributed-generation permitting, standard interconnection requirements, utility standby service tariffs, technology risk, renewable fuel options such as biomass and landfill gas, and the impact of fluctuating natural gas prices.

The 2006–2011 SBC 3 DG-CHP Demonstration Program budget was $37.5 million. An additional $6 million initially budgeted for a different program was ultimately made available to support DG-CHP Demonstration projects as well.[1]

ES.2 Data Sources and Methods

Primary data collection for this study consisted of 104 in-depth interviews with market actors spanning seven categories: 1) participating developers, 2) non-participating developers, 3) participating facility owners, 4) non-participating facility owners, 5) partially participating facility owners, 6) other market participants, and 7) program staff. Target populations included participants in three Program Opportunity Notices (PONs) issued during the SBC 3 funding period, facilities owners involved with projects not funded by the DG-CHP Demonstration Program, utility representatives, and trade association representatives, and other market experts.

[1] The DG/CHP Incentive Program was the precursor to other NYSERDA CHP deployment programs. In an effort to jump-start CHP activity within deployment programs that initially had no funds budgeted to support CHP, funds were redirected from DG-CHP demonstration activity and allocated to a "DG/CHP Incentive Program." Funds not spent under that incentive program ($6 million) were then returned for use by the DG/CHP Demonstration Program.

The MCA team reviewed many secondary data sources, first as part of an initial literature review conducted to inform the market characterization component of the study, and later as a means of researching the context around certain comments made by interviewees.

Program data included in the analysis of market activity dates back to 2000. However, the majority of the analysis of market activity focuses on the SBC 3 funding period (2006-2010).[2]

ES.3 Market Characterization

This section provides a contextual overview of the DG-CHP market in New York, drawing primarily on secondary research and a review of program records.

ES.3.1 Technology Summary

The term "CHP," sometimes called "cogeneration," describes a single system capable of generating both electricity and thermal energy. CHP systems can achieve much higher levels of efficiency than conventional energy systems. These efficiency gains, coupled with the fact that CHP is typically located close to the point of energy use, account for the numerous and varied benefits of CHP systems. CHP systems consist of a variety of components including the prime mover (heat engine), generator, and heat recovery elements. The systems are typically categorized according to prime mover type. These include steam turbines, reciprocating engines, combustion gas turbines, microturbines, and fuel cells. Steam turbines, reciprocating engines and combustion gas turbines are all well-established technologies, while microturbines and fuel cells are still gaining a foothold in the market.

ES.3.2 Market Activity

Overview of Market Activity (2000-2010)

CHP systems identified as "program-funded projects" are those funded by the NYSERDA DG-CHP Demonstration Program. CHP systems identified as "non-program funded projects" are those projects for the U.S. Department of Energy (DOE) database of installed capacity that did not also appear in the DG-CHP Demonstration Program tracking records. Approximately 20 of the "non-program funded" systems (38 MW) dating back to 2000 were funded by other NYSERDA programs. This includes six systems (9.4 MW) installed during the SBC3 funding period. Note that other financial incentives besides NYSERDA and federal incentives (e.g., Investment Tax Credit, PURPA qualifying facility status) have been available to support CHP project development in the past.[3]

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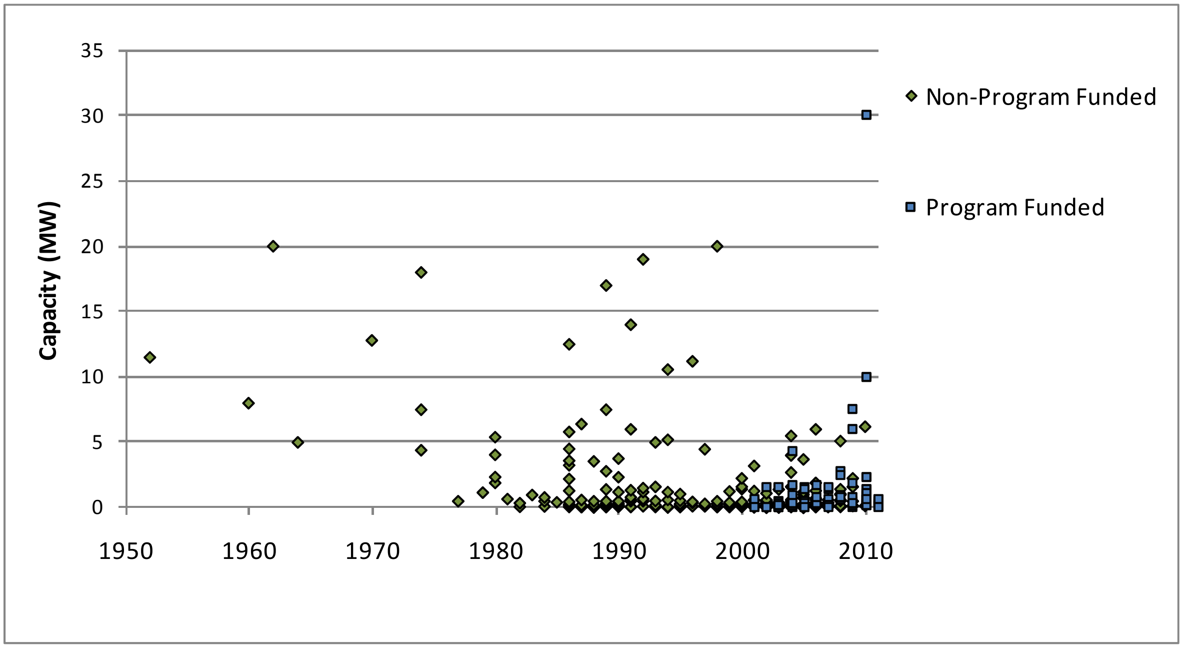
[2] Three Program Opportunity Notices (PONs) were issued by the Demonstration Program during the SBC3 funding period: 1043, 1178 and 1241. Projects funded under PON 1931 are outside the evaluation scope due to the timing of that PON. In addition, some projects from PON 914 (which was issued prior to SBC 3) ultimately received SBC3 funds and were included in the set of SBC 3 funded projects analyzed.

[3] For example, National Fuel Gas Distribution Company, a natural gas distribution company serving customers in western New York, made approximately $3 million in loans available to support CHP project development in its service territory. The loans were part of a 3-year pilot program approved by the Public Service Commission. The program ran from 2003 to 2006. DG Monitor. Volume III, Issue 1. January/February 2003. Obtained November 7, 2011. Available at: http://www.distributed-generation.com/Library/Monitor_Feb03.pdf.

As shown in Figure 1, the majority of program-funded projects installed during the last decade have been smaller than 5 megawatts (MW), and only one system larger than 10 MW has been built.[4] A period of steady growth in CHP installation activity has occurred since the NYSERDA DG-CHP Demonstration Program was launched in 2001.

Figure 1. Scatter Plot of Installed Capacity and Time for Program- and Non-Program-Funded Projects, Dating Back to Start of DOE Record Keeping



Source: NYSERDA DG-CHP Demonstration Program tracking files, DOE's Energy and Environmental Analysis, Inc., database of installed capacity, and Navigant analysis.

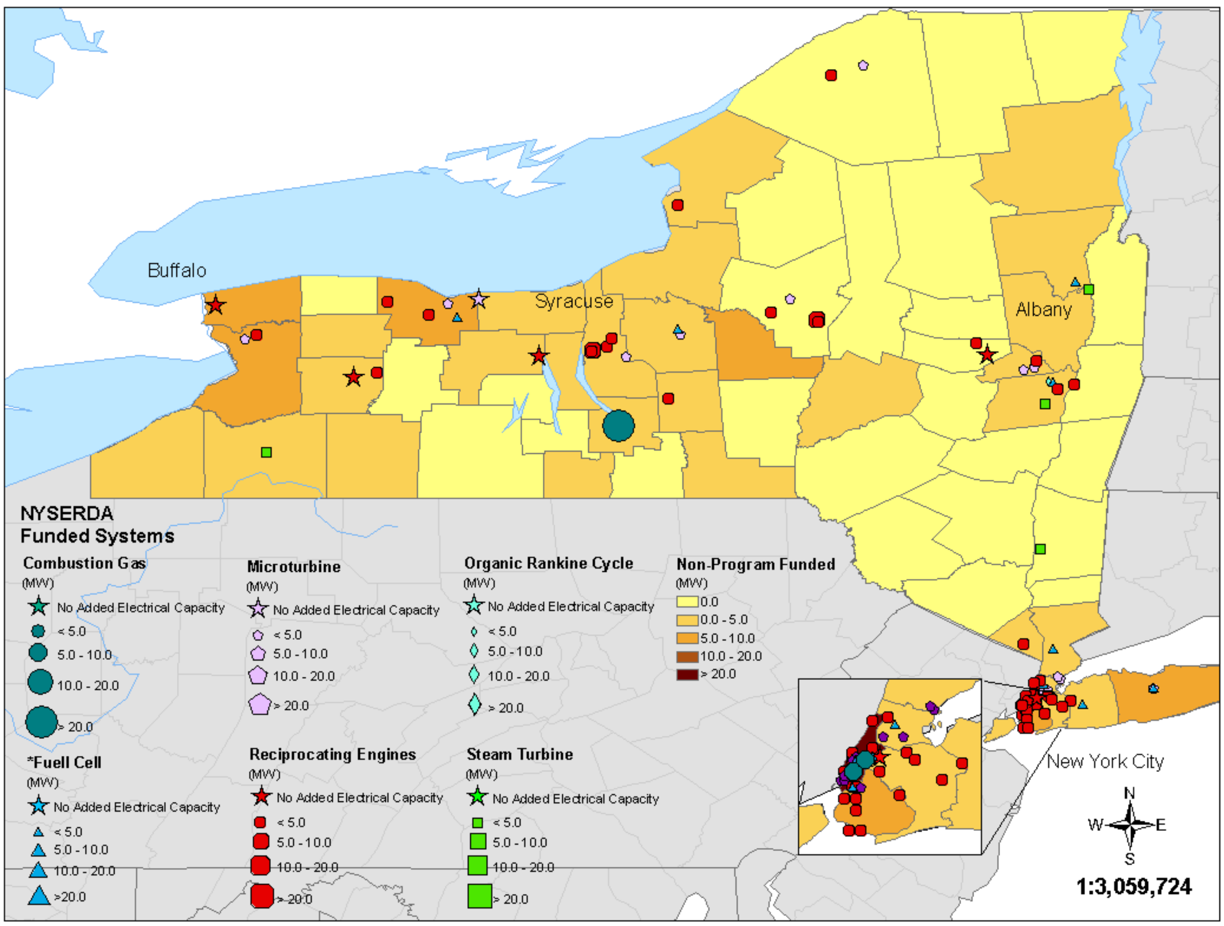
Non-program-funded DG-CHP systems exceed program-funded systems in terms of number of systems, but not in terms of installed capacity. During the 2000–2010 time frame, 95 program-funded projects (111 MW) were completed, compared with 147 non-program-funded projects completed (92 MW).

For the period since the program's inception (2000), reciprocating engines make up the vast majority of non-program-funded project activity both in terms of installed capacity and number of systems. In terms of number of projects, reciprocating engines also stand out as a leader among program-funded systems (51 percent). However, combustion gas turbine systems account for the largest share of program-funded project activity in terms of installed capacity (43 percent), followed closely by reciprocating engines (39 percent).

[4] That one large system is a 30-MW combustion gas turbine that was installed at Cornell University in 2010. That system is included in data presented in Figures 2 and 5, but it is excluded from some analysis presented later in this report, as it is considered an outlier and skews the trends otherwise apparent in the analysis of CHP activity by building type, fuel type, and prime mover type.

In Figure 2, the counties of the state are shaded to represent the amount of installed capacity of non-program-funded DG-CHP systems, and program-funded projects overlay these shaded areas to provide a high-level comparison of where funded and non-funded project activity is occurring. The majority of DG-CHP activity, both program-funded and non-program-funded, has occurred in the central and western parts of the state surrounding Syracuse and Buffalo, and in the metropolitan New York City area. Compared to non-program-funded projects, program-funded projects are more concentrated in urban areas.

Figure 2. New York State Map of Program-Funded Projects by Prime Mover Overlaying Non-Program-Funded Project Installed Capacity by County



*Suffolk State Office Building in Hauppauge, NY is a hybrid system (200 kW fuel cell / 500 kW reciprocating engine)

Source: NYSERDA DG-CHP Demonstration Program tracking files, DOE's Energy and Environmental Analysis, Inc., database of installed capacity, and Navigant analysis.

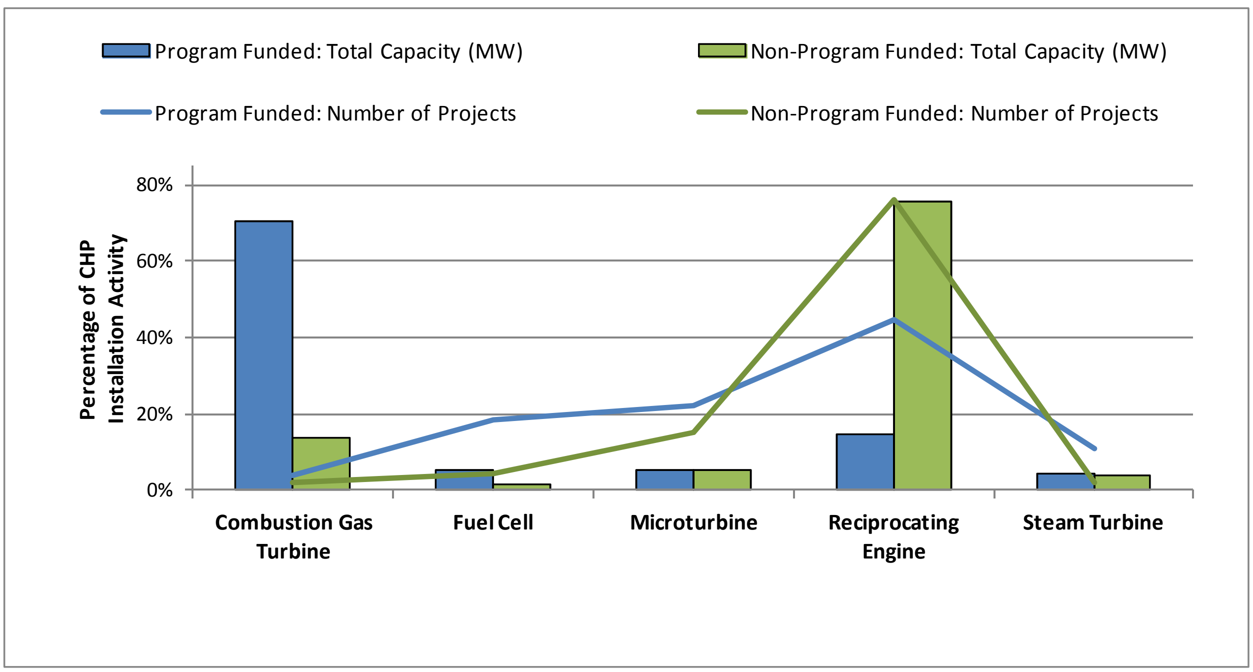
Considering project activity from an upstate versus downstate perspective, the number of program-funded projects is evenly split across the two regions. However, reviewing project activity in terms of installed capacity, the majority exists in the upstate region. For non-program-funded projects, both installed capacity and total number of projects are greater in the upstate region, but the regional difference is minimal.

Market Activity During the SBC3 Funding Period (2006–2010)

CHP activity is occurring across a wide range of building types. Projects in the apartment/hospitality sector are most numerous among program-funded systems (11 projects). However, schools are by far the leading sector in terms of installed capacity (33 MW), due largely to the 30-MW system at Cornell University. The greatest numbers of non-program-funded projects have occurred in the hospital/nursing home and multifamily housing sectors, with 26 projects having occurred in each of the two sectors. Though projects in those sectors were numerous, their installed capacity (5 MW and 2 MW, respectively) was relatively small compared with projects in the commercial office sector (15 MW). Another sector with a notable amount of activity among non-program-funded projects is the apartment/hospitality sector, with 6 MW of installed capacity.

Figure 3 presents market activity during the SBC 3 funding period by prime mover type. For program-funded projects, systems have been installed across all prime mover types, though reciprocating engines account for the greatest number of systems (twelve systems). Combustion gas turbines are the dominant category in terms of installed capacity (30 MW), though this only represents the single 30 MW project. Among non-program-funded projects, reciprocating engines account for 75 percent of total installed capacity, and 76 percent of projects (Figure 3).

Figure 3. Percentage of Installed Capacity and Number of Projects by Prime Mover Type for Program-Funded and Non-Program-Funded Projects, 2006–2010



Source: NYSERDA DG-CHP Program tracking files, DOE's Energy and Environmental Analysis, Inc., database of installed capacity, and Navigant analysis.

The sizes of DG-CHP systems installed during this period have been relatively small when compared with systems installed in New York during earlier periods (see Figure 8). The average system capacity per project for program-funded projects is 0.5 MW, and 0.6 MW for non-program-funded projects.[5]

ES.3.3 Market Structure

The skill sets required for DG-CHP project development generally span three areas of expertise—financial, regulatory, and technical issues. Key market actors in the CHP value chain include Original Equipment Manufacturers (OEMs) and distributors, Energy Service Companies (ESCOs) and developers, engineers and owners' agents, contractors, and installers, operations and maintenance (O&M) contractors, the New York Independent System Operator (NYISO), policymakers, NYSERDA, and third-party financiers. Some firms, especially ESCOs and developers, may offer host customers some degree of integrated services for delivering a project, including contractual arrangements where the firm owns and operates the system for the customer. Others may just specialize in a particular discipline related to system design or installation (e.g., a mechanical contractor).[6]

ES.3.4 Policy Framework

Wide-ranging factors including federal tax policies, utility purchasing and emissions regulations, state interconnection requirements, and local building codes all affect the viability of installing DG-CHP systems. According to the American Council for an Energy-Efficient Economy (ACEEE), New York State has some of the most favorable policies and incentives in the nation, ranking best in the area of financial incentives.[7]

Interconnection is one of the most critical policy-related issues for CHP. In 2009, New York simplified interconnection requirements for systems 2 MW and smaller, significantly reducing barriers to the development of smaller CHP systems. Issues surrounding interconnection of CHP in urban spot networks remain significant.

Standby rates are another key area of policy focus for the CHP market. Standby rates are the utility tariffs that apply to those customers with on-site generation that rely on the utility for supplemental power supply. New York's standby rates, revised in 2003, address the need for CHP system owners to contribute to system-wide costs associated with ensuring that adequate generating capacity exists to serve load in the event that CHP systems cannot.[8] While New York's standby rates are less onerous than some other

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[5] This average excludes the 30-MW system installed at Cornell University due to the outlier effect of that data point.
[6] Casten, S. Recycled Energy Development. 2008. "Opportunity and Pitfall Trends Identified through NYSERDA's Involvement in a Large Portfolio of Projects." NYSERDA CHP in NYS: Past, Present, and Future Conference.
[7] Molina et al. 2010. *The 2010 State Energy Efficiency Scorecard*. American Council for an Energy-Efficient Economy.
[8] The following orders established standby rates for New York utilities: Case 02-E-1108, Central Hudson Gas & Electric Corporation (issued December 4, 2003); Case 02-E-0551, Rochester Gas & Electric Corporation (issued July 29, 2003); Cases 02-E-0780 and 02-E-0781, Orange & Rockland Utilities, Inc. and Consolidated Edison Company of New York, Inc. (issued July 29, 2003); and Case 02-E-0779, New York State Electric & Gas Corporation (issued July 30, 2003). National Grid's standby rates were set as part of the utility's general rate proceeding in Case 01-E-0075, Niagara Mohawk Power Corporation - Merger and Rate Plan, Opinion No. 01-6 (issued December 3, 2001). These rates differ from those that apply to other utilities.

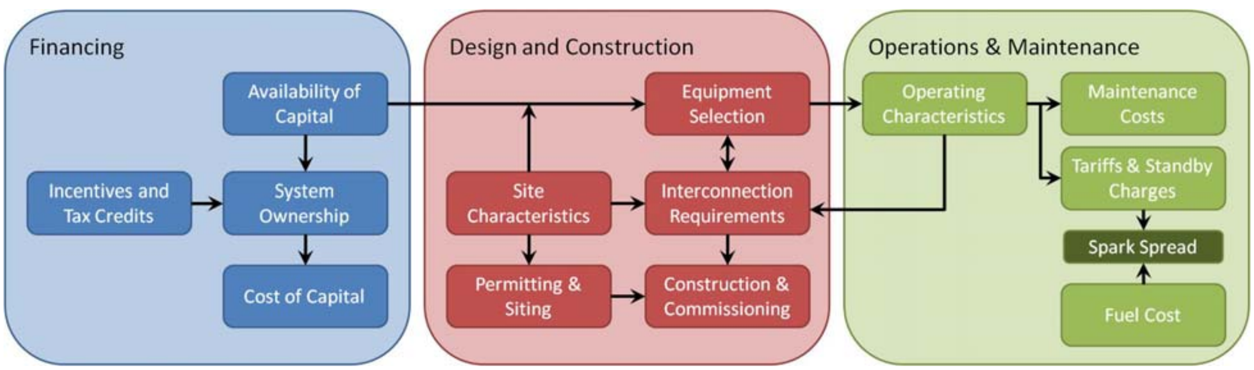
states when it comes to issues like demand ratchets, the rates can still hurt the economic viability of some CHP systems. Certain clean DG systems are exempt from the standby rates through 2015.[9]
The City of New York has taken a number of policy-related steps to improve market conditions for CHP, including setting an 800-MW target for clean DG development by 2030, requiring a review of CHP viability for larger new construction, and passing laws requiring efficiency upgrades in existing commercial buildings.

ES.3.5 Project Economics and Economic Drivers

The economic viability of a CHP project stems largely from the financial benefits of cogenerating all or part of a facility's thermal and electrical energy on-site rather than purchasing electricity from the grid and/or generating thermal loads separately (e.g., from a boiler). The difference between the costs of grid electricity and the natural gas that fuels many CHP systems—commonly referred to as the "spark spread"—is an underlying factor in the operational cost-benefit comparison.[10]

Numerous other factors also contribute to the final installed cost and long-term operational costs of any CHP system. These drivers can be grouped into three general categories along the CHP value chain: Financing, Design and Construction, and O&M. Figure 4 illustrates the drivers in each category and some of the relationships among them.

Figure 4. Key Drivers in CHP System Economics



Source: Navigant analysis.

ES.4 Market Assessment

This section discusses findings from market actor interviews and relates these findings to topics discussed in the market characterization section of the report. The section highlights key observations about the current status of the market, recent changes that have occurred, and developments that appear likely to unfold in years to come.

[9] NY PSC Case 09-E-0109. *Order Continuing and Modifying in Part the Standby Rate Exemption*. Effective May 18, 2009.
[10] Brooks, S., et al. ACEEE. 2006. "Combined Heat and Power: Connecting the Gap Between Markets and Utility Interconnection and Tariff Practices (Part I)." Proceedings of the Twenty-Eighth Industrial Energy Technology Conference.

ES.4.1 Market Structure-Related Trends

Firms Offering DG-CHP Products and Services
Driven largely by New York's attractive spark spread and the availability of incentives, the number of active firms pursuing CHP activity is slowly increasing. Various types of market actors (e.g., engineering firms and ESCOs) have either introduced or strengthened their focus on CHP-related offerings. Despite this increase in attention and activity, the field of companies completing the majority of project work has only grown slightly and remains relatively limited.

Many firms are finding ways to offer more integrated approaches to project development, design, and delivery. For example, some developers have begun partnering with specific equipment manufacturers, design engineers, and contractors. In addition, several firms are starting to tailor their offerings to target specific segments of the New York CHP market. Building a strong reputation for successful project completion appears to play an important role in winning work, and several firms rely on this as a key strategy for growing their businesses.

End-User Participation in the Market
Green image, reliable energy supply, and energy savings ranked among the top reasons for installing CHP systems. Recent CHP activity is concentrated in the New York City area. Key features of the downstate market that make it so favorable include economic conditions (higher electricity pricing), demographics, local government support for the CHP market (e.g., New York City CHP Task Force), and greater demand for reliability. The DG-CHP Demonstration Program has also encouraged program-funded project activity in the downstate region. The types of facilities that have always been good candidates for CHP (e.g., hospitals and universities) continue to see a significant amount of activity. However, there appears to be an increase in interest and installation activity at facilities that place a high premium on reliable power (e.g., banks and data centers).

Initiation of CHP Project Activity
Based on interviewee comments it appears that facility owners play a fairly active role in the process of initiating CHP projects, though on the whole, developers are more likely to take the lead in proposing a project.

Ownership and Financing Arrangements
Many customers lack the risk profile or balance sheet capacity to directly own a CHP system, making them good candidates for third-party ownership. However, most interviewed developers and system hosts indicated that the majority of CHP projects installed in the past several years have been owned outright by the energy end user.

The continued trend toward direct system ownership reflects many host customers' desire to capture the full benefits of their investments. Also, it appears that system host customers still have not made the paradigm shift required to accept a third party owning and operating a system at their facility. Some developers and owners attribute the limited use of third-party ownership models to several practical barriers that may be difficult for the market to overcome. These include the added complexity and costs of third-party ownership arrangements, as well as some owners' concerns over the long-term solvency of third-party owners. While some developers focus their sales efforts on energy service agreements (ESA), the few projects actually installed under third-party ownership arrangements primarily utilized equipment leases.

ES.4.2 Economic Trends

Project Economics
Project payback requirements vary widely among current and potential CHP system users. Several developers suggested that industrial end users maintained a strict project payback threshold of three years or less for any capital improvement project. Payback thresholds cited for commercial energy users ranged widely. Some developers suggested that commercial customers require a two-year minimum payback; however, some owners discussed projects with paybacks between five and ten years. Public institutions such as hospitals and colleges will generally accept projects with longer payback periods than those in the private sector. Market actors suggested payback expectations ranging from 7 to 15 years in this sector.

The most important factors currently affecting project economics include appropriate system design, commodity cost uncertainty, and increased payback complexity for systems in New York City.

Economic Performance of Recent CHP Systems
Half of the respondents claimed that their CHP systems were meeting expectations for economic performance and payback. The other half provided a variety of reasons for their projects failing to meet payback projections. The majority attributed systems' poor performance to improper system design, equipment malfunctions, and other technical issues. In addition, some owners continue to experience less-than-expected performance as a result of commodity price volatility, standby tariffs, and other unexpected operating costs.

Economic Risks Facing CHP Projects
There is risk and uncertainty associated with virtually every factor that drives CHP project economics. Risk factors most commonly cited by market actors include commodity price uncertainty, regulatory risk, persistent economic recession and reduced incentives, and infrastructure-related barriers in New York City. Across the board, market actors expressed concerns about the economic recession's toll on the CHP market. While projects continue to move forward, the recession has slowed the overall pace of installations at a time when spark spreads and other factors would otherwise encourage greater activity. Key risk mitigation strategies include: long-term contracting for gas supply, increasing participation in political and regulatory dialogue, and transferring risk through contractual relationships with other market actors.

ES.4.3 Policy and Regulatory-Related Trends

On the whole, the team found that policy and regulatory conditions are improving though some barriers remain. New York City's laws and other initiatives supporting the CHP market (e.g., the Greener Greater Buildings Laws, setting a clean DG installation target, and the creation of a Cogeneration Task Force) are reducing barriers to project development and facilitating market growth in the downstate region. New York City's phase-out of No. 6 heating oil also presents a growth opportunity for CHP. However, any increase in demand for natural gas in New York City that might result from the phase-out would exacerbate what appears to be a significant shortage of natural gas supply infrastructure within the city.

New York's passage of simplified interconnection processes for systems 2 MW or less in 2009 (SIR) has significantly diminished interconnection barriers that previously existed in the state. The ten percent Investment Tax Credit (ITC) available to many CHP projects has helped the market, though it appears that it is not enough to drive significant project activity. When the Treasury Department cash grant option offered in lieu of the ITC expires at the end of the year the ITC will be of more limited value to the market because many companies have insufficient taxable income to which they can apply a credit.

ES.4.4 Awareness and Knowledge

Based on findings from interviews with market actors, it appears that the majority of participants in the DG-CHP market in New York are aware of NYSERDA's DG-CHP Demonstration Program, and they either have already participated in the past or would seek to participate in the future for some, if not all of their projects. While NYSERDA is well known in the market as a source of funding for CHP projects, there is confusion about the differences between the various NYSERDA programs that provide support for CHP, in particular the differences between the Existing Facilities Program and the Demonstration Program. Program staff members have taken a number of steps to address this issue, but confusion persists. Staff members note that any confusion does not appear to be having a deleterious effect on the Demonstration Program, as the program is consistently over-subscribed. Nonetheless, further clarification about the differences between the two programs would reduce barriers to participation by making both programs more user-friendly.

A more fundamental issue with regard to market awareness is the low level of awareness about CHP in general. Several interviewees indicated that a lack of understanding of CHP opportunities is a key barrier in the marketplace. Several interviewees noted that awareness has increased in recent years, in part as a result of NYSERDA's DG-CHP Program efforts, while others pointed out that more efforts are needed to inform a broader range of potential players in the CHP market (e.g., large property owners and managers).

ES.4.5 System Performance and Technology-Related Trends

Technical System Performance and Maintenance Practices

The scope of this evaluation did not include an in-depth performance investigation of CHP systems that have received program funding. However, during its interviews the team did inquire with CHP developers and system owners about the technical performance of their systems. Most technical problems cited occurred during system construction and commissioning and were therefore covered by manufacturers and developers. However, several market actors also described long-term or persistent technical issues that have caused some systems to perform outside of their expected payback thresholds. No clear themes emerged based on the technical issues reported.

Almost every CHP system owner interviewed relies to some degree on external resources for ongoing system maintenance. These arrangements might involve any combination of equipment manufacturers, project developers, or third-party maintenance service providers, as well as in-house maintenance staff.

Some maintenance contracts cover entire CHP systems, while others apply only to the generating units, excluding heat exchange and other auxiliary equipment.

System Sizes

System sizes are smaller than they have historically been. Limited development activity is occurring at large industrial facilities where there has historically been a great deal of focus on CHP. A key factor contributing to this change is that less favorable conditions exist for selling electricity back to utilities. This is largely a result of changes in the Public Utilities Regulatory Policy Act (PURPA) rules. Limited development activity at industrial facilities also reflects uncertainty in the economy and reservations about making capital improvements at facilities that are at risk of being shut down.

A gap exists in the availability of mid-sized CHP systems. Gap Exists in Availability of Mid-Sized CHP Systems. This gap may be filled by growth in the market for modular systems within the next few years.

Emergence of Modular and Packaged Systems

Given NYSERDA staff and other CHP program administrators' level of interest in modular and prepackaged systems' potential benefits, the evaluation team specifically inquired about market actors' perceptions of this emerging trend. In such systems, manufacturers offer pre-engineered configurations of CHP generating units that also include standardized features such as integrated heat exchange systems, advanced controls and remote monitoring capabilities, interconnection equipment, and other auxiliary equipment. Such packaged systems may help some system owners achieve lower project costs through economies of scale and reduced custom engineering requirements.

The majority of respondents provided positive feedback about the trend and would support NYSERDA's increased focus on such systems. Several commented that market awareness of and demand for packaged systems is growing, particularly to address the challenges of installing systems in existing buildings in urban settings. However, some market actors expressed doubts about the scope of market benefits that packaged systems will provide. While packaged system configurations may help reduce the engineering work associated with system selection, respondents believed that most systems will still require significant customization and engineering.

Anticipated Future Technological Advancements

Market actors provided a wide range of ideas regarding potential technological advancements in the CHP market. In addition to expected incremental improvements in prime mover efficiencies, several market actors mentioned the possibility of alternative or dual-fuel systems, with a particular focus on systems that would be classified as renewable energy technologies. Comments about the future of fuel cells were split between those who saw either high potential for the technology or significant added risks and costs. Additional technological advancements of mention include improved interconnection technologies for addressing fault current issues; widespread implementation of building management systems and tenant sub-meters; and improved heat exchange equipment.

ES.4.6 Market Barriers

Market barriers to CHP development generally fall into the following categories: financial, policy and regulatory, knowledge and awareness, infrastructure, and logistics.

The most common barrier identified by interviewees of all types is that the simple payback on CHP projects (i.e., the number of years it takes for a project to generate cumulative savings that equal the project investment) is often too long to attract investment. As noted previously, other financial barriers include poor economic conditions, commodity price volatility and perceived risks associated with CHP technology.

Policy and regulatory barriers span a broad spectrum. They include utility-related issues such as interconnection and standby charges, air emissions permitting, building and fire code issues in the City of New York, and uncertainty about the future of regulations and the availability of financial incentives. Interconnection was the barrier most commonly cited by interviewees. Despite the marked improvements on issues related to interconnection, many interviewees had strong opinions about the need for utilities and regulators to do more to improve interconnection conditions in the market. The primary concerns raised by interviewees pertained to costs and time frames associated with interconnection processes, particularly for those systems larger than 2 MW, and those planned for locations within the spot networks that exist in urban areas.

Interviewees noted that standby rates are less onerous than they once were. In general, New York's standby tariffs are believed to expose CHP projects to less risk of long-term demand ratchets than in other states.[11] However, the issue of demand ratchets and overall costs associated with standby rates are still perceived by some in the market to be a barrier in New York. Certain clean DG systems are currently exempt from standby rates through the end of 2015. When the exemption expires, standby rates may become a greater area of concern among CHP market actors.

Emissions permitting was also cited as a barrier by market actors, primarily due to the risk that permitting introduces to the development process, as well as the administrative burdens associated with regulatory compliance. Fire and related building code issues in New York City are another perceived barrier to certain CHP applications. Like other barriers, interviewees reported that permitting and regulatory barriers are less substantial than they have been in the past.

Other barriers include:

» Low levels of knowledge and awareness

» Siting, infrastructure, and logistical barriers

» The fact that CHP is a non-essential investment

» Complexity of the CHP market and development process

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[11] Molina et al. 2010. *The 2010 State Energy Efficiency Scorecard*. American Council for an Energy-Efficient Economy. American Council for an Energy-Efficient Economy. State Energy Efficiency Policy Database: New York Clean Distributed Generation. Available at http://www.aceee.org/energy-efficiency-sector/state-policy/New%20York/204/all/195. Accessed August 10, 2011.

ES.4.7 DG-CHP Demonstration Program's Interaction with the Market

The New York CHP market appears to still be relatively immature and in need of financial incentives to enable it to proceed rapidly toward achieving its potential. This is apparent based on the low level of market penetration of CHP overall, the fact that awareness of CHP opportunities is still low, and the fact that CHP product and service providers generally lack the resources to effectively educate and market to the population of target sites. NYSERDA incentives are speeding the development of projects, and turning some projects with borderline project economics into viable investments.

When asked about reasons an eligible project may opt not to submit a proposal to compete for the NYSERDA DG-CHP Demonstration Program, reasons stated included an unwillingness to wait for program funding to materialize to begin realizing savings from the project, burdensome program requirements, and project size. Timing issues associated with the PON structure were noted by several other interviewees as burdensome, though not specifically as a reason for non-participation. A number of market actors believe that the program's requirements are too onerous, including the requirement that systems maintain the capability to operate with stand-alone capability during power grid outages. Program staff recognizes that the program's requirement for stand-alone operability is challenging for participants to fulfill, but they hold that it is a worthwhile requirement that improves the overall quality and value of Demonstration Program installations. Furthermore, staff points out that there are enough projects capable of meeting the requirement to fully allocate program funding, and therefore it is not necessary to require any less of program proposers. Additionally, the Existing Facilities Program's (EFP) CHP Performance Program does not impose a requirement for stand-alone capability. Therefore, there is an alternative NYSERDA source of funds for projects eligible for the EFP if project proponents find the Demonstration Program's stand-alone operability requirement to be too onerous.

Through project funding and staff support, as well as through broader efforts to break down barriers in the market, the program is playing an important role in helping to advance the CHP market in the state. On the whole, interviewees view project funding as the program's most important offering to the market. Other direct benefits that market actors report receiving from program participation include the credibility and symbolic value that comes with having been selected to receive NYSERDA funding, the support and engagement of program staff during the project development process, and a better understanding of unique CHP applications. The program also provides indirect benefits to the market as a whole; it leverages the real-world experiences of demonstration program participants as opportunities to bring market barriers to the attention of policy makers.

The two primary sources of funding for CHP projects in New York at this time are two NYSERDA programs: NYSERDA's DG-CHP Demonstration Program and its EFP. The two programs have different underlying programmatic goals; the Demonstration Program focuses on building market experience with unique CHP applications, and breaking down market barriers, while the EFP focuses on deploying more advanced applications of CHP. However, the difference that matters to most market actors is which program will provide their project(s) with the greatest amount of funding. Given the somewhat nuanced differences between the features of the incentives offered, it could be difficult for a CHP developer or facility owner to readily assess which program is best suited to the needs of a given project.

Many developers active in New York are also engaging in CHP markets in other states, most commonly New Jersey, Massachusetts, and Connecticut. When developers were asked how they decide which CHP markets they will pursue, most remarked that they go where the best financial opportunities exist in terms of overall project financial viability. For companies also engaged in other energy-related services, the existing location of their company had a strong bearing on their choice to pursue the New York market, as it is where their resources and experience already reside.

ES.4.8 Market Outlook

It appears that the prospects for growth in the CHP market are strong, and that they are greatest in the downstate region of the state where electricity prices are highest, and where CHP receives support from local policies. Specifically, several interviewees expect to see an increase in the use of modular or packaged CHP systems, as well as an increase in the number of new construction projects incorporating CHP. Interest in power supply reliability and energy security are also likely to drive growth in the CHP market. Microgrids hold promise for addressing interconnection and siting-related barriers to CHP, though substantial use of microgrids appears unlikely to occur for several years. The barriers that currently stand in the way of CHP development (e.g., volatility in commodity costs, an inability for synchronous generators to interconnect in much of the downstate region, and identifying ideal sites for CHP) are likely to remain challenges into the future. A barrier that may come into play in a more significant way in the future is limited natural gas supply infrastructure.

ES.5 Key Findings and Recommendations

ES.5.1 Key Findings

Market Activity
A period of steady growth in CHP installation activity has occurred since the NYSERDA DG-CHP Demonstration Program was launched in 2001. The majority of program-funded projects installed during the last decade have been smaller than 5 MW. Reciprocating engines and gas turbines are the most common types of CHP systems in use in New York. Non-program-funded DG-CHP systems exceed program-funded systems in terms of number of systems, but not in terms of installed capacity. It appears that a market shift has occurred; installation activity was once focused on industrial facilities located in central and western parts of the state, but now a strong concentration of activity exists in the New York City area. Favorable economic conditions which exist for CHP development downstate relative to other parts of the state are likely the key factor driving the concentration of project activity in the downstate region, but it may also reflect the City of New York’s pro-DG policies and the Demonstration program’s efforts to increase the amount of development activity in New York City.

Market Structure and Firm Strategies
The number of firms developing and completing projects in New York is slowly increasing. This growth is driven by existing firms in the building and energy sectors expanding their services to include CHP-specific offerings. Firms are pursuing strategies to offer customers more integrated CHP-related services. Opportunities exist for project developers willing to aggregate multiple projects to help reduce equipment purchase costs, facilitate project financing, and mitigate costs related to the construction of new natural gas supply infrastructure (i.e., for adjacent properties in New York City).

Policy Framework
New York State's policies related to clean DG are considered to be some of the strongest in the nation.[12] Changes in policies related to interconnection and standby rates during the past several years have reduced, but not eliminated market barriers in these areas. Policies introduced in New York City during the last five years demonstrate a strong commitment to CHP market growth.

Project Economics and Drivers
Key factors currently affecting project economics include appropriate system design, commodity cost uncertainty, and increased payback complexity for systems in New York City. Commodity price volatility is the greatest perceived risk to CHP's economic viability. The economic recession has sharply reduced the pace of installations in New York State and has exacerbated concerns about economic risk which have always existed for DG-CHP projects. Any near-term policy or regulatory changes that detract from the economic viability of DG-CHP projects would threaten an already fragile market. Project payback thresholds for investment decision-making vary widely among current and potential CHP system users. Half of the respondents claimed that their CHP systems were meeting expectations for economic performance and payback.

System Performance and Technological Trends
Most technical issues arise during construction, commissioning, or early-stage system operations when manufacturers' warranties cover repair and replacement costs. Market actors are generally supportive of NYSERDA increasing its focus on smaller prepackaged and modular systems. Building owners and ESCOs are increasing installation of sub-meters and building management systems to enhance control and operations of their facilities.

Market Barriers
The most substantial market barrier is the long simple payback on some CHP projects. Despite the improvements on issues related to interconnection, the costs and time frames associated with interconnection processes are still problematic. Demand costs associated with standby rates are still perceived by some in the market to be a barrier in New York. For projects in New York City, uncertain and often unexpectedly high costs for Con Edison to upgrade the natural gas line serving a facility have prevented several otherwise viable CHP projects from moving forward. Other barriers include: uncertainty about future market conditions; low levels of knowledge and awareness; siting, infrastructure, and logistical barriers; competing investment priorities; and the complexity of the CHP market and development process.

Awareness and Knowledge
Awareness and knowledge of CHP opportunities in general is relatively low. Awareness about NYSERDA DG funding opportunities is strong, though there is some confusion about the differences between incentives offered by the DG-CHP Demonstration Program and those offered by the Existing Facilities Program.

[12] Molina et. al. 2010. *The 2010 State Energy Efficiency Scorecard*. American Council for an Energy-Efficient Economy.

DG-CHP Demonstration Program's Interaction with the Market

The New York CHP market appears to still be relatively immature and the continuation of financial incentives will accelerate the pace at which it can proceed toward achieving its potential. While projects possessing strong characteristics can move forward without incentives, NYSERDA incentives are speeding the development of projects, and turning some projects with borderline project economics into solidly viable investments. Through project funding and staff support, as well as through broader efforts to break down barriers in the market, the program is playing an important role in helping to advance the CHP market in the state.

Market Outlook

It appears that the prospects for growth in the CHP market are strong, and that they are greatest in the downstate region where electricity prices are highest, and where CHP receives support from local policies. Volatile commodity costs and siting barriers are likely to remain substantial barriers. Gas supply infrastructure in New York City may take on greater significance as a barrier as demand for natural gas grows.

ES.5.2 Recommendations

- Strive to maintain a consistent policy and incentive structure over time
- Consider offering additional / alternative strategies for assisting CHP systems on the margin of economic viability
- Publish case studies highlighting experience of systems that have participated in the program
- Expand outreach and education activities
- Update website and provide clearer explanation of the differences in incentive offerings provided by the DG-CHP Demonstration Program and EFP
- The PSC should explore the impacts of raising system size caps on streamlined interconnection requirements and the clean DG system exemption from standby rates
- Consider supporting pilot projects that demonstrate innovative CHP-related technology applications but that fall outside standard program eligibility criteria
- Continue drawing on lessons learned from program participant experiences to highlight necessary changes in the market

1 Introduction and Background

This report presents the results of Navigant Consulting, Inc.'s (Navigant's) Market Characterization and Assessment (MCA) evaluation of the New York State Energy Research and Development Authority (NYSERDA) Distributed Generation-Combined Heat and Power Demonstration Program (DG-CHP Demonstration Program), a component of the **New York Energy $mart**℠ Program.

1.1 Program Overview

The goal of the New York System Benefits Charge (SBC)-funded DG-CHP Demonstration Program is to contribute to the growth of combined heat and power installed as distributed generation in New York. The program provides funding for single-site and multi-site (fleet) demonstrations and seeks to improve end users' and project developers' awareness and knowledge of CHP. In particular, the program selects projects through a competitive review process, and projects that are funded are expected to provide lessons learned for dissemination throughout the market. The program also seeks to address related issues such as distributed-generation permitting, standard interconnection requirements (SIRs), utility standby service tariffs, technology risk, renewable fuel options such as biomass and landfill gas, and the impact of fluctuating natural gas prices.

In general, projects selected for funding under the DG-CHP Demonstration Program are those that: 1) increase end-user awareness, 2) document performance (for example, hours of operation, or thermal and electrical power output), 3) provide learning or other benefits, 4) address institutional impediments, or 5) support the expansion of the industry.

According to program staff, the DG-CHP Demonstration Program functions as a "market path-breaker."[13] The program funds projects that demonstrate leading-edge technological features or address market barriers. The program provides financial incentives to facility owners to demonstrate and validate customer-sited combined heat and power using: (1) commercially available technologies using advanced features such as flicker-free transition to stand-alone operation in the case of a grid outage, and (2) emerging distribution-system technologies such as microturbines, fuel cells, and organic Rankine cycle systems. Once they are validated, commercial combined heat and power technologies are ready for support by NYSERDA through resource acquisition-focused programs such as the Existing Facilities Program (EFP) and the Renewable Portfolio Standard's (RPS's) Customer-Sited Tier programs.

The DG-CHP Demonstration Program was initiated in 2001 and has evolved significantly in recent years in order to continue to take advantage of new and important learning opportunities. The program previously funded feasibility studies and issued joint solicitations in conjunction with other programs that support power generation product development. Those activities are now funded through stand-alone programs (e.g., Flex Tech). As noted earlier, the current use of the Demonstration Program funding is primarily for supporting installation of demonstration projects. Program funds are also spent on technology transfer activities (for example, conferences, and performance-data collection and dissemination), and efforts to address market barriers (for example, staff communications with policymakers and coordination with trade associations).

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[13] NYSERDA DG-CHP staff input provided during kickoff meeting.

The 2006–2011 SBC 3 funding for the Distributed Energy Resources (DER) program as a whole is $72.5 million, which includes both the Power Systems Product Development Program and the DG-CHP Demonstration Program. The SBC 3 DG-CHP Demonstration portion of the budget was $37.5 million. In addition to this figure, about $6 million of the $10 million budgeted for the DG-CHP Incentive Program was used for the DG-CHP Demonstration Program projects, the remaining $4 million having been absorbed into projects in NYSERDA's Multifamily Performance Program and EFP.[14]

1.2 *Evaluation Objectives and Challenges*

As specified in the New York State Energy Research and Development Authority Energy Public Benefits Program Evaluation Plan,[15] the primary objectives of the MCA evaluation effort are: (1) to develop a comprehensive understanding of current and emerging markets (e.g., market structure and actors); (2) to provide baseline and background information required by NYSERDA to define and deliver programs to target markets; and (3) to track changes in markets over time, with a specific focus on market indicators that are likely to be impacted by program offerings. When accomplished, these objectives support the ultimate goals of the MCA evaluation effort, which are: (1) to conduct credible and transparent evaluations of the **New York Energy $mart℠** Program portfolio and individual program offerings and (2) to provide NYSERDA program staff and managers, as well as the System Benefits Charge Advisory Group, the New York State Public Service Commission (PSC), Department of Public Service (DPS) staff, and other stakeholders with timely and unbiased information regarding the implementation of **New York Energy $mart℠** Program offerings.

This MCA study was planned to address researchable issues and indicators identified in a March 2011 logic model report prepared for the program, as well as areas of specific interest to program staff.[16] A select set of researchable issues identified in the logic model report that were explored through this research effort includes:

- Have the program approaches resulted in effective DG-CHP system demonstrations being installed?
- How effective has the program been at graduating technologies to the deployment programs?
- Is the program funding a range of promising technology applications? Are certain technology applications worthy of merit having difficulty obtaining funding?
- Has increased awareness resulting from program activities led to DG/CHP system refinements in existing projects and innovative new demonstration projects?
- Are policies and standards being developed to support DG-CHP systems?
- To what extent are external influences helping or hindering achievement of NYSERDA's DG-CHP Demonstration Program goals?

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[14] The DG/CHP Incentive Program was the precursor to other NYSERDA CHP deployment programs. In an effort to jump-start CHP activity within deployment programs that initially had no funds budgeted to support CHP, funds were redirected from DG-CHP demonstration activity and allocated to a "DG/CHP Incentive Program." Funds not spent under that incentive program ($6 million) were then returned for use by the DG/CHP Demonstration Program.

[15] NYSERDA, *Energy Public Benefits Program Evaluation Plan*, December 2007.

[16] GDS Associates. *Systems Benefits Charge Distributed Generation / Combined Heat and Power Program: Program Logic Model Report*. March 2011.

While all of these researchable issues were taken into consideration in developing interview guides and carrying out secondary research, practical considerations and resource constraints limited the team's ability to address all of the topics at the same level of depth. An important factor to consider when reviewing this report is that the DG-CHP Demonstration Program's goals are different than those of resource acquisition-focused programs. As a research and development (R&D) program, the program strives to pave the way for the CHP market in the state by taking steps to address barriers and by supporting projects with unique features that will provide lessons learned and serve as models for future CHP market participants.

1.3 Report Format

This report first presents the data sources and methods used to complete the MCA analysis. A market characterization section follows. That section introduces the CHP technologies being installed through the program, presents a summary of market activity, and provides an overview of market structure, policies affecting the market, and project economics. The section draws primarily on secondary research and a review of program records.

The market assessment section follows. The section discusses findings from market actor interviews, and highlights ways in which the market has changed since the program was last evaluated in 2005.

Finally, the report highlights key findings and provides suggested actions for program staff consideration.

2 Data Sources and Methods

This section describes primary and secondary data sources and methods used by the MCA team to evaluate the DG-CHP Demonstration Program. Section 2.1 details the primary data collection efforts, and Section 2.2 highlights the secondary data sources used.

The primary and secondary data sources described in this section were components of a comprehensive research approach that consisted of the following activities:

- Planning meetings with NYSERDA evaluation and DG-CHP Demonstration Program staff
- Review of programmatic documentation including Program Opportunity Notices (PONs) issued during the SBC 3 funding period, program tracking databases, and information and tools available on NYSERDA's website
- Review of secondary data sources including literature from industry trade journals, market studies, and previous evaluations of the DG-CHP Demonstration Program
- Review of the DG-CHP Demonstration Program logic model to identify specific researchable issues, market barriers, and outcome measurement indicators for use in the evaluation
- Coordination with other NYSERDA evaluation contractors to maximize the efficiency of data collection, research, and reporting efforts
- In-depth interviews with the following market actor groups:
  - Program staff
  - Participating developers
  - Participating facility owners
  - Partially participating facility owners
  - Non-participating developers
  - Non-participating facility owners
  - Other market actors (e.g., utility and industry association representatives, representatives from regulatory agencies, and financiers)

2.1 *Primary Data Collection*

Primary data collection activities consisted of in-depth interviews with seven market actor groups. Because a process evaluation of the program was simultaneously underway during the study period, interview efforts were coordinated across the MCA team and the process team. The two teams jointly developed interview guides in collaboration with NYSERDA staff, and staff or affiliates of the MCA and process teams conducted all interviews. Interview guides were designed to address researchable issues and measurement indicators identified in the program logic model, as well as topics of interest to program staff. A sample interview guide is presented in Appendix A. This guide is representative of topics addressed in the other six guides. NYSERDA sent advance letters to sample contacts notifying them of the survey effort.

2.1.1 Sample

Target Population
Program participants in three PONs issued for the DG-CHP Demonstration Program during the SBC3 funding period (PONs 1043, 1178, and 1241) comprised the target population for interviews involving program participants (participating developers and facility owners, and partially participating facility owners). Participants in PON 1931 were excluded due to the fact that the award decision-making was still underway while samples were being developed, and participants in that PON were less likely to possess experience working with projects funded through the program.

For interviews with non-participants, the target population was developers or facility owners involved with CHP projects developed in New York during the SBC3 funding period which did not receive funding from the DG-CHP Demonstration Program.

For the “other market actors” interview category, the target population included industry experts, representatives from utilities, and state and local agencies that play a role in the CHP market within the state (e.g., the Department of Environmental Conservation, and the New York City Department of Buildings).

The target population for staff interviews was NYSERDA staff members who manage the DG-CHP Demonstration Program or projects funded by the program.

Sample Frames and Sample Selection
For interviews with market actor groups involving program participants, the sample frame consisted of program tracking records for the DG-CHP Demonstration Program. Tracking records for the four relevant PONs included 31 unique participating facility owners and 28 unique participating project developers who represented 35 unique projects approved for funding under one of the four SBC3, demonstration-program PONS, that were completed or underway.

For interviews with non-participating market actors, sample frames included the U.S. Department of Energy’s (DOE)’s Energy and Environmental Analysis (EEA) database of installed CHP capacity in New York, the U.S. Environmental Protection Agency’s (EPA’s) CHP Partnership participant contact lists for New York and Northeastern states, distribution lists for PSC proceedings pertaining to CHP, and program tracking records for NYSERDA’s Flex Tech Program. Participants in the Flex Tech program who conducted feasibility studies of CHP systems were the focus within the NYSERDA Flex Tech Program tracking records.. In some cases, interviewees also provided suggestions for additional relevant interviewees.

Due to the limited sizes of the sample frames, all records in each frame were screened for relevance, and included in the sample if deemed relevant. For developers, the screening process included a review of company websites and other Internet sources to confirm that the company is active in the CHP market in New York or other Northeastern states. For facility owners, the screening process included a telephone call to confirm that the company or facility hosts a CHP system.

Target Completes

Initial estimated sample sizes were included in the DG-CHP Demonstration Program Evaluation Plan. Those values were estimated by MCA and process team staff based on a preliminary assessment of population sizes. Completion targets were adjusted for program participant populations to reflect an effort to reach all companies that participated in the program during the SBC 3 funding period. In the case of non-participant facility owners and other market participants, a combined target of 21 completes across the two groups (approximately 12 non-participant facility owners and 9 other market participants) replaced an initial target of 21 completes for non-participant facility owners, and 4 completes for "other market participants." This adjustment was made after the MCA team experienced difficulty identifying contact data for a sufficient number of non-participant facility owners. The team was also concerned that non-participant facility owners may demonstrate a low level of CHP market awareness and that the interviews may provide limited value.

2.1.2 Data Collection

Interview Procedures and Time Frames

The MCA team conducted all interviews with non-participants and other market actors. The process team conducted interviews with program participants and partial participants. Interviews were conducted by telephone, and were recorded when deemed appropriate and when interviewees agreed to be recorded. Detailed interview notes were shared across both the MCA and process teams, and access to recorded interviews was provided.

Interviews with participating and non-participating developers were conducted during April and May of 2011. Interviews with all other market actor groups were conducted during June and July of 2011.

Sample Disposition and Experience with Sample Populations

Table 1 presents a summary of interview targets and completions by category. As shown, a total of 102 in-depth interviews were conducted with interviewees from seven different market actor categories.

Table 1. Interview Sample Disposition

Interview Category	Target Completes	Actual Completes	% of Target Completed
Participating Developers	29	23	79%
Participating Facility Owners	25	19	76%
Partially Participating Facility Owners	20	13[a]	65%
Non-Participant Developers	21	20	95%
Non-Participant Facility Owners	12	12	100%
Other Market Actors	9	13	144%
Program Staff	4	4	100%
Total	**120**	**104**	**86%**

[a]Includes four contacts identified as project developers rather than as owners. Two of these four developer interviews used the interview guide for participants, and one of them used the interview guide for nonparticipants.

Source: Navigant and Research Into Action, Inc.

Categorization of interviewees proved challenging. Part of the challenge stems from the fact that market actor roles within the CHP market are not clearly demarcated. Some interviewees whose companies are ultimately manufacturers or engineers were placed in the broad category of "developer" because they play a role in project development.

Categorization of non-participant interviewees was particularly challenging because the interviewees' assumed categories were assigned during the sample development phase based on available data, but the team's understanding of the interviewees' actual circumstances changed based on input provided during the interviews. Therefore, in three cases, interviewees were interviewed using an interview guide that wasn't specifically geared toward the category within which they were ultimately placed. Another challenge of non-participant interviewee categorization was that most interviewees (all but seven) had some relationship with a NYSERDA program; however, several could not recall which program they had participated in.

2.2 *Secondary Data Sources*

The MCA team reviewed many secondary data sources, first as part of an initial literature conducted to inform the market characterization component of the study, and later as a means of researching the context around certain comments made by interviewees. Secondary data sources included, but were not limited to:

- PlaNYC reports
- EPA CHP Partnership website
- Northeast Clean Energy Application Center website
- American Council for an Energy-Efficient Economy reports and website
- Database of State Incentives for Renewables and Efficiency
- PACE Energy and Climate Center website
- U.S. Department of Energy and Energy Information Administration (EIA) data
- Additional literature addressing CHP markets in the U.S., with a focus on states in the Northeastern and Mid-Atlantic regions

In addition, the MCA Team reviewed and analyzed NYSERDA Demonstration program tracking records dating back to 2000. The majority of the market activity discussed in this report focuses on the SBC-3 funding period (2006-2010) as this time period comprises the scope of this evaluation. Three Program Opportunity Notices (PONs) were issued by the Demonstration Program during the SBC-3 funding period: 1043, 1178 and 1241. Projects funded under PON 1931 are outside the evaluation scope due to the timing of that PON. In addition, some projects from PON 914 (which was issued prior to SBC-3) ultimately received SBC-3 funds and were included in the set of SBC-3 funded projects analyzed.

3 Market Characterization

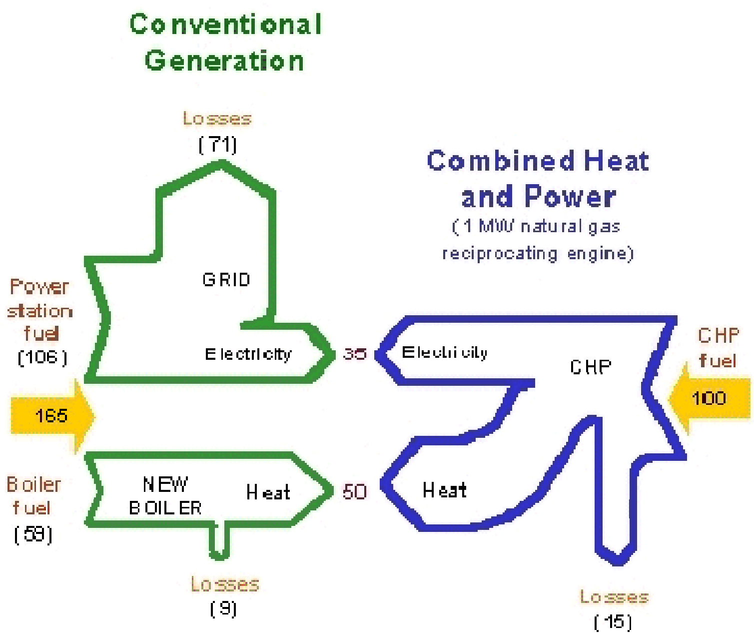
3.1 Introduction

This section provides a contextual overview of the DG-CHP market in New York. It starts with a summary of the various CHP technologies being installed through the program, noting key features of each. The section then presents a summary of program activity that has occurred with SBC 3 funding, and how this activity compares with market potential. This is followed by a discussion of the market structure, which identifies key market actors and highlights the roles they play in the New York market for CHP. Next, the report discusses relevant federal, state, and local policies, and concludes with a discussion of project economics and other factors influencing the market. This section draws primarily on secondary research and a review of program records.

3.2 Description of Technologies and Grid Interconnection Options

The term "CHP," sometimes called "cogeneration," describes a single system capable of generating both electricity and thermal energy. In contrast, conventional energy infrastructure relies on separate systems to produce electricity and heat. CHP systems capture heat that would otherwise be wasted in the electricity generation process. As a result, CHP systems offer substantial efficiency gains when compared with traditional energy production. As shown in Figure 5, CHP systems can achieve much higher levels of efficiency than conventional energy systems. These efficiency gains, coupled with the fact that CHP is typically located close to the point of energy use, account for the numerous and varied benefits of CHP systems.

Figure 5. CHP vs. Conventional Generation Process Flow Diagram



Source: DOE. Northeast Clean Energy Application Center.

Because CHP systems are deployed close to energy loads, line losses associated with electricity distribution are reduced and overall efficiency is improved. As a form of distributed generation, CHP also reduces the strain on congested power grids, and improves energy security. CHP is particularly beneficial to the electric infrastructure in places like New York City that suffer from a shortage of local generating capacity, while seeing rapid growth in demand for electricity. By producing the same amount of energy with less fuel input, CHP systems also deliver important environmental benefits at a relatively low cost compared with other clean energy technologies.[17]

From the point of view of the system owner, CHP systems can deliver substantial cost savings and address power supply reliability concerns. As will be discussed in a later section, the amount of cost savings resulting from a CHP installation is heavily dependent on utility rate design, as well as proper sizing of the CHP system to meet the needs of a given facility, and the amount and type of energy produced by the system. CHP systems are typically most cost effective when designed to meet a facility's baseload thermal demand. As a result, the majority of power produced by CHP systems is used on-site rather than being sold back to the power grid.

CHP systems consist of a variety of components including the prime mover (heat engine), generator, and heat recovery elements. The systems are typically categorized according to prime mover type. These include steam turbines, reciprocating engines, combustion gas turbines, microturbines, and fuel cells.

Steam turbines are one of the oldest prime mover technologies and they operate by producing steam with some combustible fuel source, such as coal, solid waste, wood or natural gas, and then using the

[17] Shipley, Anna, A. Hampson, B. Hedman, P. Garland, and P. Bautista. 2008. *Combined Heat and Power: Effective Energy Solutions for a Sustainable Energy Future*. Oak Ridge National Laboratory.

steam to turn a turbine.[18] This technology is common in large-scale commercial power generation and its capacity ranges from 50 kilowatts (kW) up to 250 megawatts (MW).[19] Steam turbines typically have relatively low power efficiency; however, in CHP applications, their overall efficiency can reach 80 percent.[20]

Reciprocating internal combustion engines are a common DG-CHP prime mover because of their low initial costs, their small yet flexible capacity range (10 kW to 5 MW), and the market's relative familiarity with the technology. This technology ignites an air and fuel source mix in an enclosed chamber where the resulting expansion is mechanically applied to turn a turbine. These engines are primarily fueled by natural gas, but can also run on propane, landfill gas, and biogas. The technology is characterized by accurate load following and high partial load efficiency.[21]

Combustion gas turbines are another established technology that primarily use natural gas, but can also run on petroleum fuels, landfill gas, and biogas. In order to produce electric power in a combustion gas turbine, an air and fuel source mixture is first combusted in a high pressure environment, then passed through a nozzle to further increase velocity, and finally passed through the turbine blades, which produce mechanical and ultimately electric power.[22] System capacities range from 500 kW to over 100 MW, and their high-temperature exhaust heat contains enough thermal energy to create usable steam (Shipley et al. 2008). Like steam turbines, combustion gas turbines are also common in large-scale commercial electricity generation.[23]

Microturbines essentially use the same technology as combustion gas turbines; however, their capacity range is limited, with system sizes ranging from 30 kW to 250 kW.[24] Benefits of microturbines include low water consumption (they rely on air cooling) and the negligible fault current they produce when interconnected as an inverter-based generator. Microturbines also have a limited number of moving parts, which should reduce the risk of equipment failure.[25] [26] In general, microturbines are still in the early entry phase of market maturity.[27]

Fuel cells are distinct from other prime movers available for DG-CHP production, as they use chemical energy to produce electricity, and are the most immature of the available technologies. This technology is currently limited in commercial application due to high initial costs and a lack of market familiarity with

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[18] Shipley, Anna, A. Hampson, B. Hedman, P. Garland, and P. Bautista. 2008. *Combined Heat and Power: Effective Energy Solutions for a Sustainable Energy Future*. Oak Ridge National Laboratory.
[19] Shipley, Anna, A. Hampson, B. Hedman, P. Garland, and P. Bautista. 2008. *Combined Heat and Power: Effective Energy Solutions for a Sustainable Energy Future*. Oak Ridge National Laboratory.
[20] EPA. 2008. *EPA Catalog of CHP Technologies*.
[21] Shipley, Anna, A. Hampson, B. Hedman, P. Garland, and P. Bautista. 2008. *Combined Heat and Power: Effective Energy Solutions for a Sustainable Energy Future*. Oak Ridge National Laboratory.
[22] US DOE. 2011. How Gas Turbine Power Plants Work. Fossil Energy Office of Communications, http://fossil.energy.gov/programs/powersystems/turbines/turbines_howitworks.html.
[23] Hammer, S. and Mitchell, J., eds. 2007. *CHP in NYC: A Viability Assessment*. Columbia University.
[24] EPA. 2008. *EPA Catalog of CHP Technologies.*
[25] Shipley, Anna, A. Hampson, B. Hedman, P. Garland, and P. Bautista. 2008. *Combined Heat and Power: Effective Energy Solutions for a Sustainable Energy Future*. Oak Ridge National Laboratory.
[26] Hammer, S. and Mitchell, J., eds. 2007. *CHP in NYC: A Viability Assessment*. Columbia University.
[27] EPA. 2008. *EPA Catalog of CHP Technologies.*

the technology, but they do have great potential in the market looking forward. Fuel cells generally use inverter-based interconnection, which produces little fault current, and they generate electricity with low emissions, low noise, and at high efficiencies.[28]

Table 2 presents a summary of key features of the CHP prime mover types. As shown, steam turbines, reciprocating engines and combustion gas turbines are all well-established technologies, while microturbines and fuel cells are still gaining a foothold in the market.

Table 2. Summary of Key Features of CHP Prime Mover Types

	Steam Turbine	Reciprocating Engines	Combustion Gas Turbines	Microturbines	Fuel Cells
Technology Status[29]	Commercial	Commercial	Commercial	Early Entry	Early Entry/ Development
Overall Efficiency (HHV)	80%	70-80%	50-70%	50-70%	55-80%
Typical Capacity (MWe)	0.5-250	0.01-5	0.5-250	0.03-0.25	0.005-2
Common Generation Type	Synchronous or Induction	Synchronous or Induction	Synchronous or Induction	Synchronous, Induction or Inverter Based	Inverter Based

Sources: EPA. 2008. Catalog of CHP Technologies. EPA Combined Heat and Power Partnership; Hedman, Bruce, Darrow, Ken, and Bourgeois, Tom. 2002. CHP Market Potential for New York State. NYSERDA. All but the "technology status" data is sourced from the EPA Catalog of CHP Technologies.

3.2.1 Grid Interconnection

This section provides a brief overview of issues related to CHP system interconnection to the electric grid. This information is presented here to provide the reader with a basic understanding of key topics and terminology, as interconnection-related issues are some of the most pressing barriers to CHP market development and are discussed throughout later sections of the report.

[28] Hammer, S. and J. Mitchell, eds. 2007. *CHP in NYC: A Viability Assessment*."Columbia University.
[29] Hedman. B. and K. Darrow. 2002 *Combined Heat and Power Market Potential for New York State*. New York State Energy Research and Development Authority.

Types of Configuration

Electricity customers are generally connected to either a radial or network type of grid. Radial configurations have a single line delivering energy to customers in series, while network configurations, as the name implies, consist of multiple feeders supplying energy in parallel. The power flow for network systems is much more complex than radial systems, and as a result, interconnection is more challenging in network configurations. Network configurations are more common in urban areas, like the boroughs of New York City, whereas radial configurations dominate suburban and rural areas.

Technical Issues

Distributed generation can lead to a variety of system management issues for utilities including voltage changes, harmonic distortion, islanding, and increased fault current levels. The issue of fault current levels is a key challenge for interconnection in urban areas like New York City.

Con Edison summarizes the fault current issue on its DG website:

> *"When a fault or short-circuit occurs in an electric power system, all synchronous generators contribute current directly to that fault until protective equipment acts to either isolate the fault or trip (switch off) the generators. The Consolidated Edison system has been designed to operate successfully for the isolation of these faults at the highest levels of current that can be anticipated for the electric power system. If the fault current exceeds the ability of the equipment to protect the system, the result could be a catastrophic failure of the protective equipment as well as significant portions of the electric system infrastructure."*[30]

The type of generation employed by a particular DG system plays an important role in determining whether it will put the distribution system at risk of fault current issues. The three main types of generation are synchronous, induction, and inverter-based. Synchronous generators, referred to in the statement above, are the most challenging when it comes to interconnection and fault current issues.

Synchronous generators are rotating energy conversion machines that can operate either as stand-alone power sources (independent of the grid), or in parallel with the utility electric grid. Unlike other types of generation, synchronous generators must be precisely synchronized with the grid from the instant that they are connected. Frequency, phase angle and voltage magnitude of the generator must be carefully matched with that of the utility system to avoid damaging the generator or utility system equipment. Due to the nature of these generators, they are capable of sustaining fault currents for much longer periods than induction generators. Therefore, fault current protection is a much greater concern for this type of generation than it is for either induction or inverter-based generators. Most commercially-available DG-CHP systems are synchronous generators.

Induction generators also use a rotating conversion mechanism, but their configuration is such that they pose much less fault current risk than do synchronous generators. However, induction generators are not capable of operating independent of the utility grid because they must draw power from the grid in order to sustain functionality. Because they are not capable of stand-alone operability during a grid outage, they are ineligible for participation in the DG-CHP Demonstration Program.

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[30] Consolidated Edison. *Distributed Generation: Synchronous Generation and Fault Current Limitations*. Available at: http://www.coned.com/dg/configurations/synFaultLimitations.asp. Obtained August 25, 2011.

Inverter-based generators, or "static power converters," make use a rapid on/off switching of solid state transistors instead of the rotating conversion mechanisms used in synchronous and induction generators. Therefore, this type of generator poses a low fault current risk. However, inverter-based generation is most commonly used by PV and wind power systems. They are relatively uncommon among commercially-available DG-CHP systems.[31]

To avoid the possibility of having a CHP system cause a fault that would exceed the capacity of protective equipment installed in a particular part of the network, Con Edison carefully reviews interconnection applications proposing synchronous generators to assess whether installation of the system would introduce fault current risk. In cases where the proposed system is deemed problematic (e.g., the calculated fault current exceeds the rated capacity of protective equipment at the proposed location on the network), risk mitigation measures would need to be taken, such as reducing the installed capacity of the system, switching to an alternative type of CHP system that is not synchronous generation (e.g., induction or DC inverted generators), using an "AC to DC link" to minimize fault current contribution, or using a "fast fuse" to enable the system to trip when needed. All of these risk mitigation strategies would come at a cost, or would compromise the design intent of a proposed synchronous system.

In addition to the limitations on synchronous generation in high voltage interface network areas, this form of generation is prohibited from connecting to the low-voltage interface network that serves most customers in the urban boroughs of New York (Table 3) due to concerns that the generation could cause the power flow on network feeders to shift (reverse), thus causing network protectors within the network grid to trip open. Con Edison may allow small induction- and inverter-based generators to connect to the secondary voltage grid networks on a case-by-case basis.[32]

As highlighted in Figure 6, data provided by Con Edison shows that a plurality of CHP systems currently connected to the grid in its services territory are induction generators (44 percent). This type of generation is ineligible to participate in the DG-CHP Demonstration Program due to the fact that it cannot operate with stand-alone capability during power grid outages.

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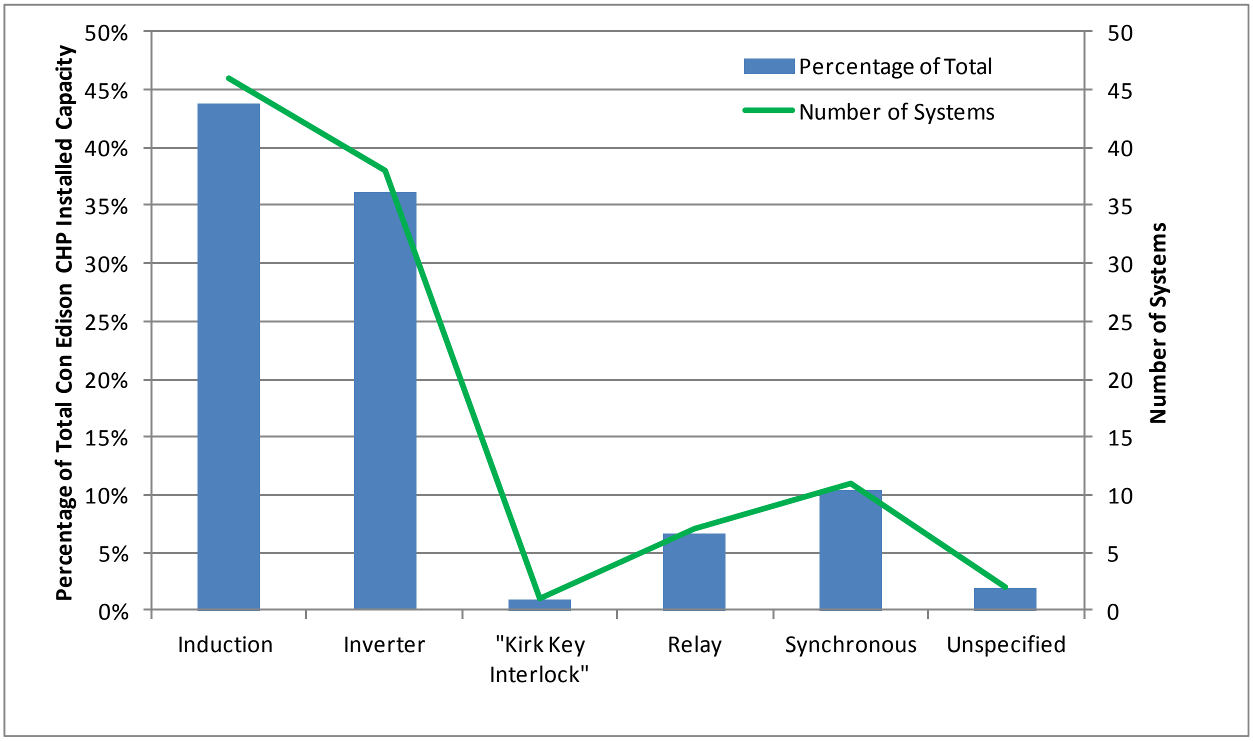
[31] Consolidated Edison. *Distributed Generation: Concepts for Generation*. Available at: http://www.coned.com/dg/configurations/generation.asp. Obtained November 14, 2011.

[32] Consolidated Edison. *Distributed Generation: Protected Systems- Connecting to the System*. Available at: http://www.coned.com/dg/_CommonLib/Dialog.asp?url=/dg/configurations/connectingSystem.asp. Obtained August 25, 2011.

Figure 6. Type of Generation or Fault Current Mitigation Employed by CHP Systems in Con Edison Service Territory, 2000–2010



Source: Con Edison CHP installed capacity data provided August, 2011. Navigant analysis.

In Con Edison's service territory, any CHP system between 2 and 20 MW in capacity, and some smaller systems, must conduct a Coordinated Energy System Interconnection Review (CESIR) in order to determine the severity of system impacts and whether any system upgrades will need to take place. Generally, any generation on a low-voltage distribution system is limited to 10 MW, and a total of 20 MW per network substation.[33]

National Grid also requires detailed studies of proposed CHP systems that it believes could pose a threat to service reliability and worker safety. Systems seeking to connect to National Grid's network systems which exist in downtown districts of Albany, Buffalo, Cortland, Glens Falls, Niagara Falls, Schenectady, Syracuse, Troy, Utica, and Watertown, must go through a more complex study process than systems proposing to connect to radial distribution systems.[34]

[33] Con Edison Distributed Generation website, http://www.coned.com/dg/. Obtained May 1, 2011.
[34] National Grid. DG Installation Process Guide. Available at: http://www.nationalgridus.com/niagaramohawk/home/energyeff/DG%20InstallProcessGuide-0711_ver1_0.pdf. Obtained: August 25, 2011.

Service Categories

The rate structure that applies to a facility that operates a CHP system depends on the extent to which the facility chooses to have access to the power grid as a form of additional power supply. In Con Edison's service territory, non-residential CHP systems can interconnect and receive electricity service under the Standby, Stand-Alone, or Buy Back service categories. Standby systems enable energy generators to purchase supplemental energy from the grid, but they cannot sell power back to the grid or generate power for on-site consumption when the grid is down unless they are on another version of the service category: "Standby with Stand-Alone" service. Stand-Alone systems are very similar, except that they do enable on-site consumption when the grid is down. Lastly, Buy Back service allows energy generators to sell their power directly to the utility.[35] Table 3 shows the applicable service categories for various generator types and grid configurations for Con Edison's service territory. These service categories are representative of the options available in other utility service territories in the state.

Table 3. Con Edison Service Categories

Distribution System Configuration	Synchronous	Induction	Inverter Based
Radial Configuration	Standby or Stand-Alone	Standby	Net Metered, Standby or Stand-Alone
Low-Voltage Network Configuration	Not Available	Standby	Net Metered, Standby or Stand-Alone
Spot Network Configuration	Standby or Stand-Alone	Standby	Standby or Stand-Alone
High-Voltage Feeders	Standby, Stand-Alone or Buy Back	Standby or Buy Back	Standby, Stand-Alone or Buy Back

Source: Con Edison.

According to DG-CHP Demonstration Program staff, approximately 90 percent of systems installed with program funding are grid interconnected. A few systems that were initially configured as stand-alone or "islanded" ultimately connected to the grid.

3.3 *Market Activity*

This section describes the CHP installation activity that has occurred with funding from NYSERDA's DG-CHP Demonstration Program, and compares this program activity with overall CHP activity occurring

[35] Con Edison Distributed Generation website, http://www.coned.com/dg/. Obtained May 1, 2011.

across New York State. Market activity is also compared with findings presented in a report on CHP market potential in New York State prepared for NYSERDA in 2002.

The sources of data presented in this analysis include DOE's EEA statewide installed capacity data, and NYSERDA's program tracking records for the DG-CHP Demonstration Program from program inception through December 31, 2010. CHP systems identified as "program funded projects" are those funded by the NYSERDA DG CHP Demonstration Program. CHP systems identified as "non-program-funded projects" are those projects from the DOE database that did not also appear in the DG-CHP Demonstration Program tracking records. Note that other NYSERDA programs (e.g., Existing Facilities Program, Multifamily Housing Program, or RPS Customer Sited Tier) provided funding for approximately 20 of these systems (38 MW) dating back to 2000, including six systems (9.4 MW) installed during the SBC3 funding period.

In addition, other financial incentives besides NYSERDA and federal incentives (Investment Tax Credit, PURPA qualifying facility status, etc.) have been available to support CHP project development in the past. When reviewing the market activity summary in this section it is important note that although there is a substantial population of non-program funded projects, this should not be interpreted as an indicator that the market is mature.[36] The issue of market maturity is discussed further in Section 4.10.

In general, only systems 20 MW or less are included in this analysis, as this is consistent with the scale of projects that have been funded by the program.[37] The one exception is a 30-MW program-funded system at Cornell University. This system is significantly larger than other systems installed through the program.

Because this analysis compares program-funded activity with non-program-funded *installed capacity* in the state, projects in the earliest stages of program participation (with phases identified as "contract" and "out to signature" in program tracking records) are excluded from the set of program-funded projects discussed here.[38]

This section first provides an overview of statewide DG-CHP project activity for the period since the DG-CHP Demonstration Program's inception. Figures used in that initial overview discussion of market activity include project activity from 2000 through 2010.[39]

The section then hones in on key features of DG-CHP project activity occurring in New York during the SBC 3 funding period (2006–2010), as that funding period comprises the scope of this evaluation.

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[36] For example, National Fuel Gas Distribution Company, a natural gas distribution company serving customers in western New York, made approximately $3 million in loans available to support CHP project development in its service territory. The loans were part of a 3-year pilot program approved by the Public Service Commission. The program ran from 2003 to 2006. DG Monitor. Volume III, Issue 1. January/February 2003. Obtained November 7, 2011. Available at: http://www.distributed-generation.com/Library/Monitor_Feb03.pdf.

[37] The 20-MW size threshold is also consistent with Con Edison's definition of distributed generation. Con Edison Distributed Generation website, http://www.coned.com/dg/. Obtained April 28, 2011.

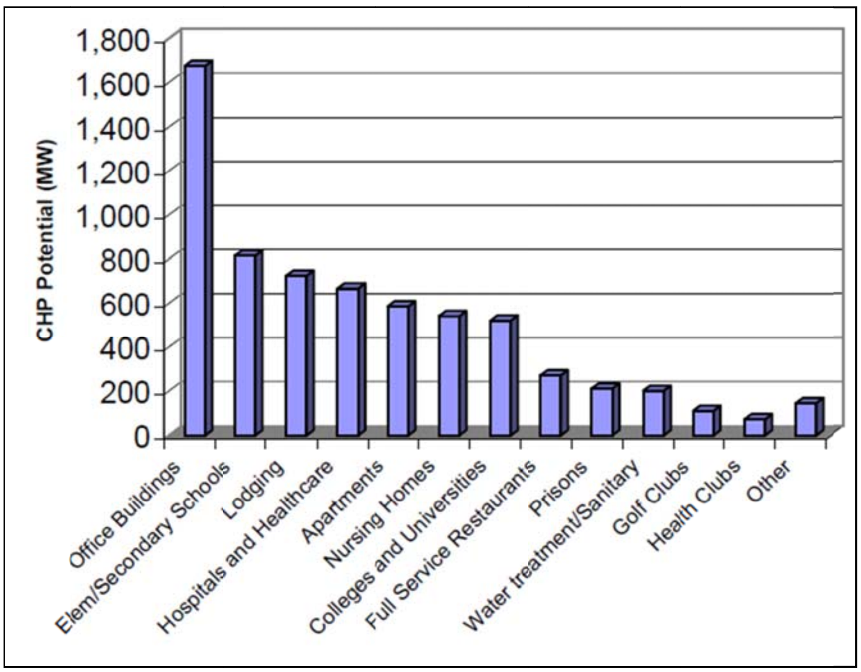
[38] Eight Demonstration Program-funded projects that received SBC-3 funding were excluded from the analysis and discussion here because they were too early in the project development cycle to be included (e.g., project status in program tracking records was either "contract" or "out for signature"). This equates to 5 MW of planned installed capacity.

[39] The one exception is the scatter plot presenting all project activity, with non-program-funded projects dating back to the earliest records kept in the DOE Energy and Environmental Analysis, Inc. database.

3.3.1 New York DG-CHP Market Activity Overview (2000-2010)

ACHP market potential study was conducted for NYSERDA in 2002. Although this study is dated, DG-CHP Demonstration program staff indicate that it is still a reliable and relevant source, and is the best available source of market potential data. The study found that the state's technical potential for CHP development is 8,500 MW. Assuming favorable policy and market developments, the market potential (the amount that is actually likely to be developed given market conditions) is 2,200 MW during the 2002–2012 timeframe. The study found that the market potential for larger CHP systems has, for the most part, been realized already. The majority of the remaining CHP market potential in the state exists in smaller commercial systems, primarily in office buildings, as well as elementary and secondary schools, lodging, hospitals, apartments, nursing homes, and colleges and universities (Figure 7).[40]

Figure 7. Potential Capacity by Business Sector



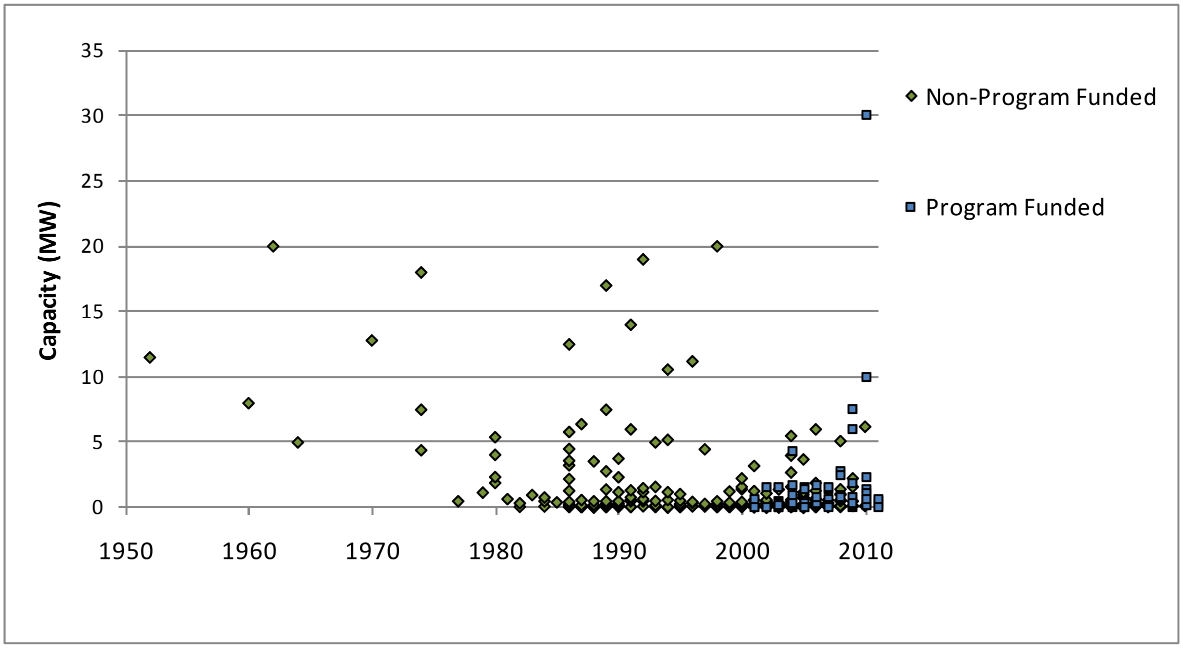
Source: B. Hedman and K. Darrow. 2002. Combined Heat and Power Market Potential for New York State. New York State Energy Research and Development Authority.

CHP development that has occurred in recent years supports the study's findings that system sizes would likely trend downward in the state; the frequency of smaller capacity non-program- funded projects is increasing, and program-funded DG-CHP projects have generally remained in the smaller capacity size range as well. As shown in Figure 8, the majority of program-funded projects installed during the last decade have been smaller than 5 MW, and only one system larger than 10 MW has been

[40] B. Hedman and K. Darrow. 2002. *Combined Heat and Power Market Potential for New York State*. New York State Energy Research and Development Authority.

developed.[41] Though difficult to discern from Figure 8, a period of steady growth in CHP installation activity has occurred since the NYSERDA DG-CHP Demonstration Program was launched in 2001.

Figure 8. Scatter Plot of Installed Capacity and Time for Program- and Non-Program-Funded Projects, Dating Back to Start of DOE Record Keeping



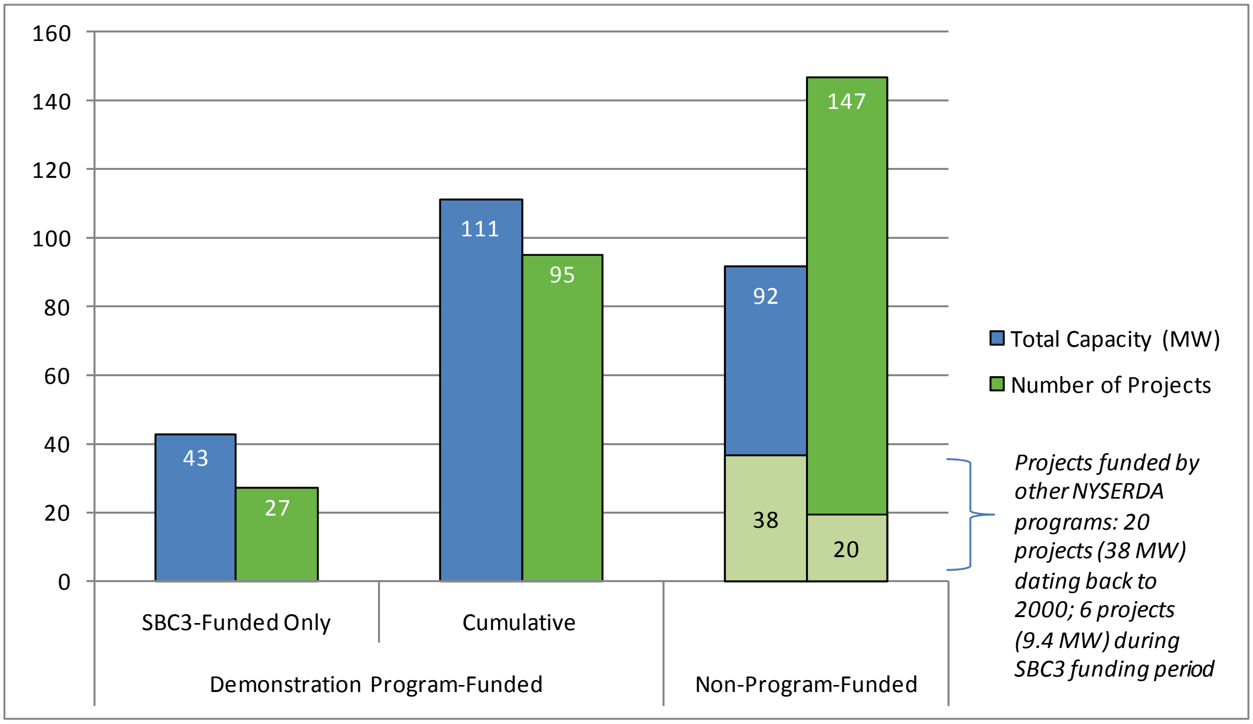
Source: NYSERDA DG-CHP Demonstration Program tracking files, DOE's Energy and Environmental Analysis, Inc., database of installed capacity, and Navigant analysis.

Looking at the statewide DG-CHP installed capacity as a whole, non-program-funded DG-CHP systems exceed those installed with program funding, in terms of number of systems, but not in terms of installed capacity (Figure 9). Note that the program-funded projects overlay the non-program-funded projects in Figure 8 for the period from 2000–2010 so that they are easier to identify. However, as shown in Figure 9, the number of non-program-funded projects during that period (147 projects) exceeds the program-funded projects during that period (95 projects).[42] The total amount of program-funded CHP activity during the period 2000–2010 is 111 MW, while the non-program-funded DG-CHP capacity installed during that period is approximately 92 MW.

[41] That one large system is a 30-MW combustion gas turbine that was installed at Cornell University in 2010. That system is included in data presented in Figures 2 and 5, but it is excluded from some analysis presented later in this report, as it is considered an outlier and skews the trends otherwise apparent in the analysis of CHP activity by building type, fuel type, and prime mover type.

[42] Two additional projects were awarded funding but were ultimately decommissioned. These projects included a 0.12 MW reciprocating engine system and a 0.18 MW microturbine system.

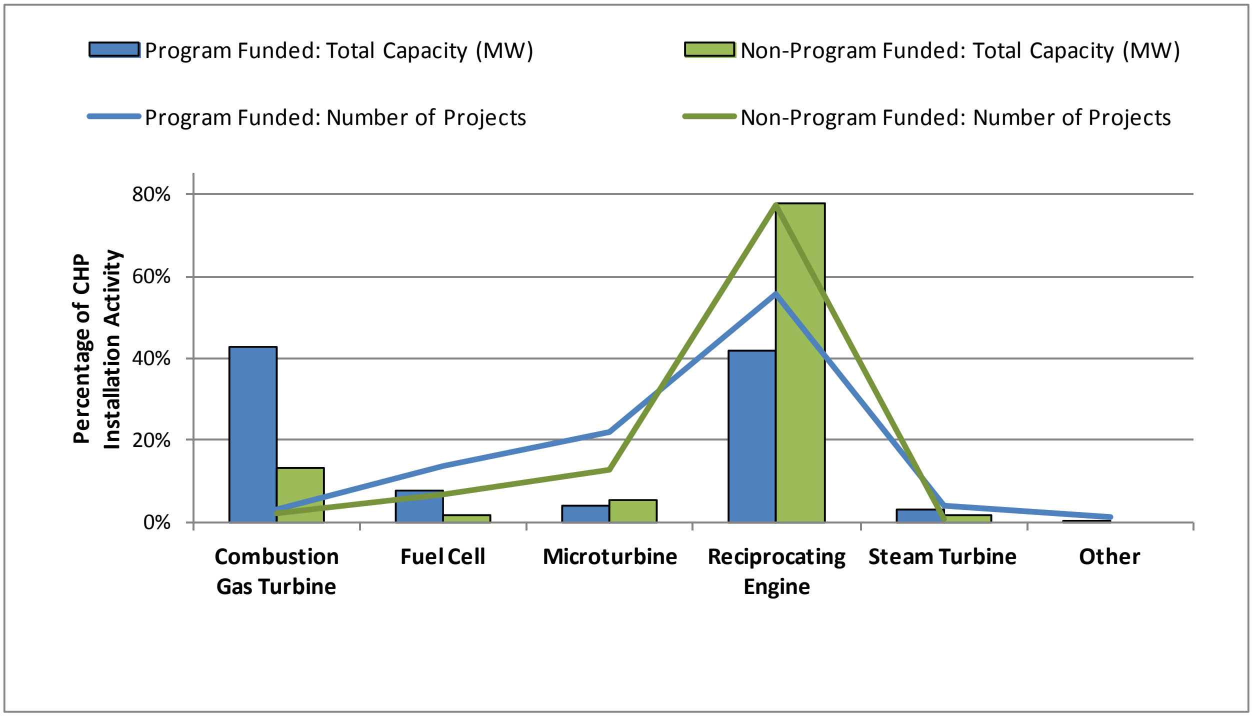
Figure 9. Statewide Activity for Program-Funded and Non-Program-Funded Projects by Capacity and Number of Projects, 2000–2010



Source: NYSERDA DG-CHP Demonstration Program tracking files, DOE's Energy and Environmental Analysis, Inc., database of installed capacity, and Navigant analysis.
Note: For non-program-funded projects, this includes only projects meeting the DG definition of being 20 MW or less in capacity. Note: The 2002 market potential study prepared for NYSERDA identified total CHP installed capacity in the state at 5,000 MW spread across approximately 210 sites.

Figure 10 summarizes program-funded and non-program-funded project activity in terms of total capacity and number of projects for each prime mover. As shown, for the period since the program's inception (2000), reciprocating engines make up the vast majority of non-program-funded project activity both in terms of installed capacity and number of systems. In terms of number of projects, reciprocating engines also stand out as a leader among program-funded systems (56 percent). However, combustion gas turbine systems account for the largest share of program-funded project activity in terms of installed capacity (43 percent), followed closely by reciprocating engines (42 percent).

Figure 10. Statewide Activity by Prime Mover Type for Program-Funded and Non-Program-Funded Projects, 2000–2010



Source: NYSERDA DG-CHP Demonstration Program tracking files, DOE's Energy and Environmental Analysis, Inc., database of installed capacity, and Navigant analysis.
Note: The one system included in the "other" category is an organic rankine cycle system.

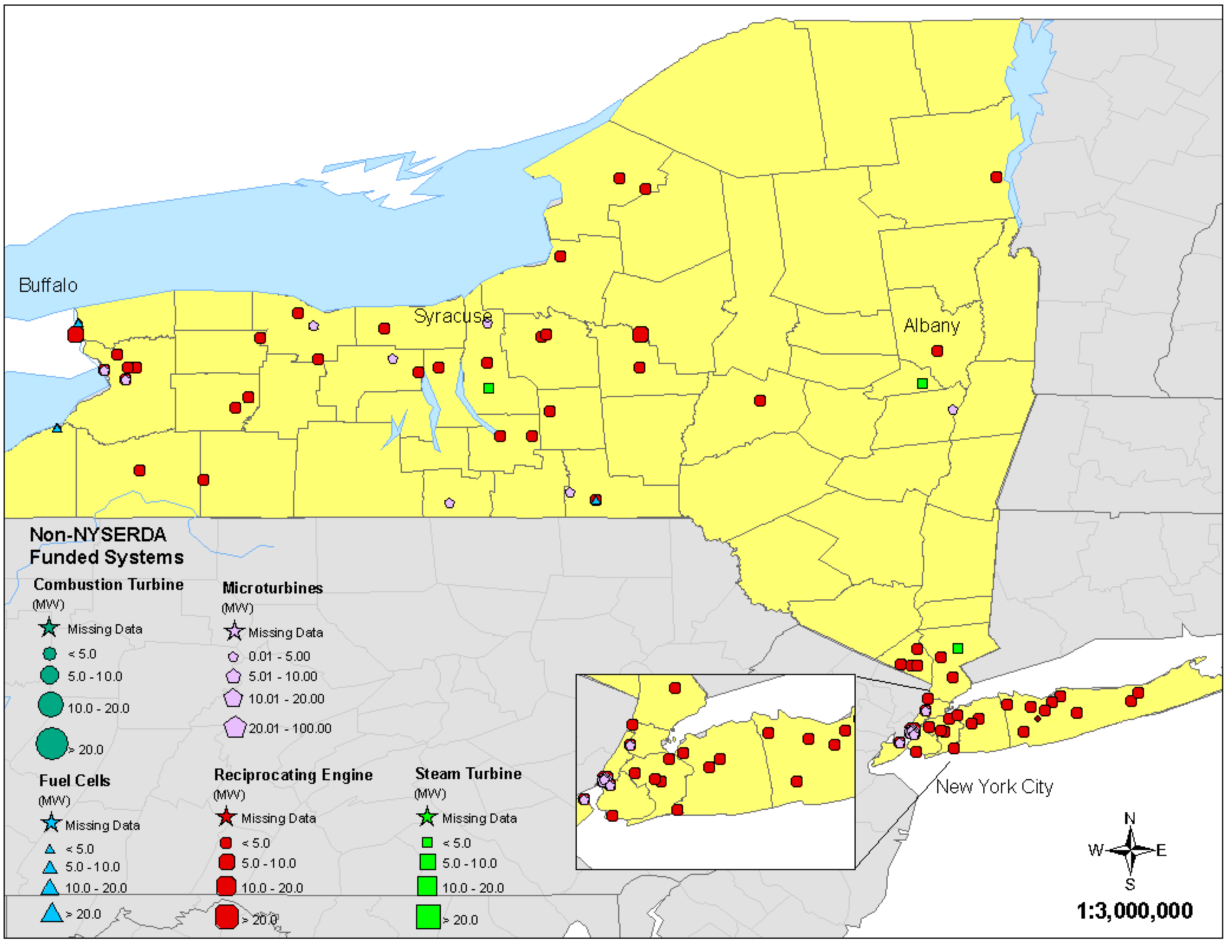
For mapping purposes, all program-funded projects and non-program-funded DG-CHP projects installed from 2000 through 2010 are included in the analysis in order to depict the DG-CHP market in New York State as a whole for the general time frame during which NYSERDA has played a role in the market.[43] Figure 11 displays the relevant non-program-funded projects to provide a snapshot of CHP market activity occurring prior to, and outside of, program-funded DG-CHP activity. In Figure 12, the counties of the state are shaded to represent the amount of installed capacity of non-program-funded DG-CHP systems, and program-funded projects overlay these shaded areas to provide a high-level comparison of where funded and non-funded project activity is occurring.

The majority of DG-CHP activity, both program funded and non-program funded, has occurred in the central and western parts of the state surrounding Syracuse and Buffalo, and in the metropolitan New York City area (Figure 11 and Figure 12). Reciprocating engines are the most common prime mover type overall, and there is a concentration of these systems on Long Island (Figure 11). Several microturbines are located across the state, both in urban and rural locations. A handful of steam turbines are scattered across more rural parts of the state, and two combustion turbines are located in the Syracuse and New

[43] NYSERDA-funded projects that have a status of "installed and commissioned," "operational," or "undergoing installation" in program tracking records as of December 31, 2010, are included in the analysis.

York City areas. A small number of fuel cells are installed in the downstate area, and one is located in the Syracuse area.

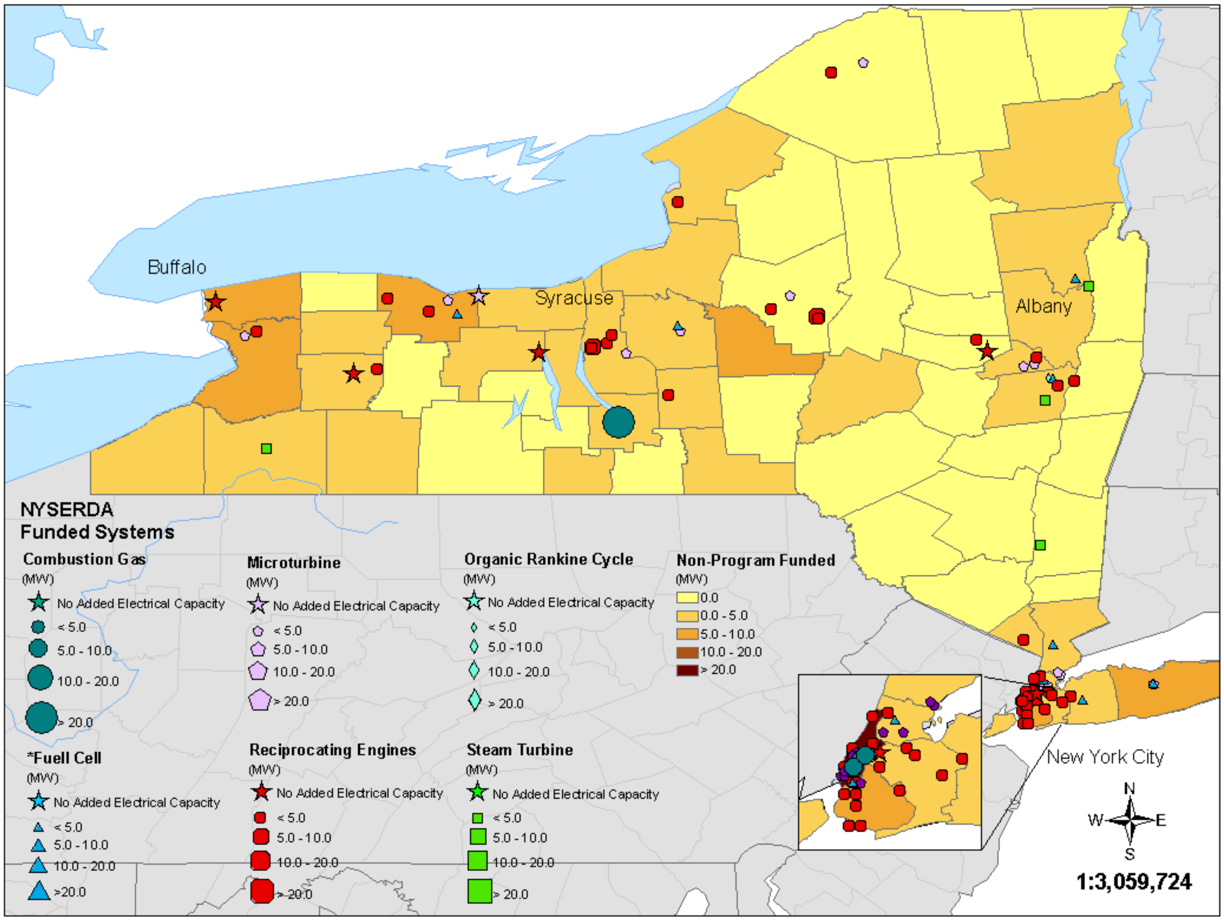
Figure 11. New York State Map of Non-Program-Funded Projects by Prime Mover, 2000–2010



Source: DOE's Energy and Environmental Analysis, Inc., database of installed capacity, and Navigant analysis.

Compared to non-program-funded projects, program-funded projects are more concentrated in urban areas (Figure 12).

Figure 12. New York State Map of Program-Funded Projects by Prime Mover Overlaying Non-Program-Funded Project Installed Capacity by County, 2000–2010

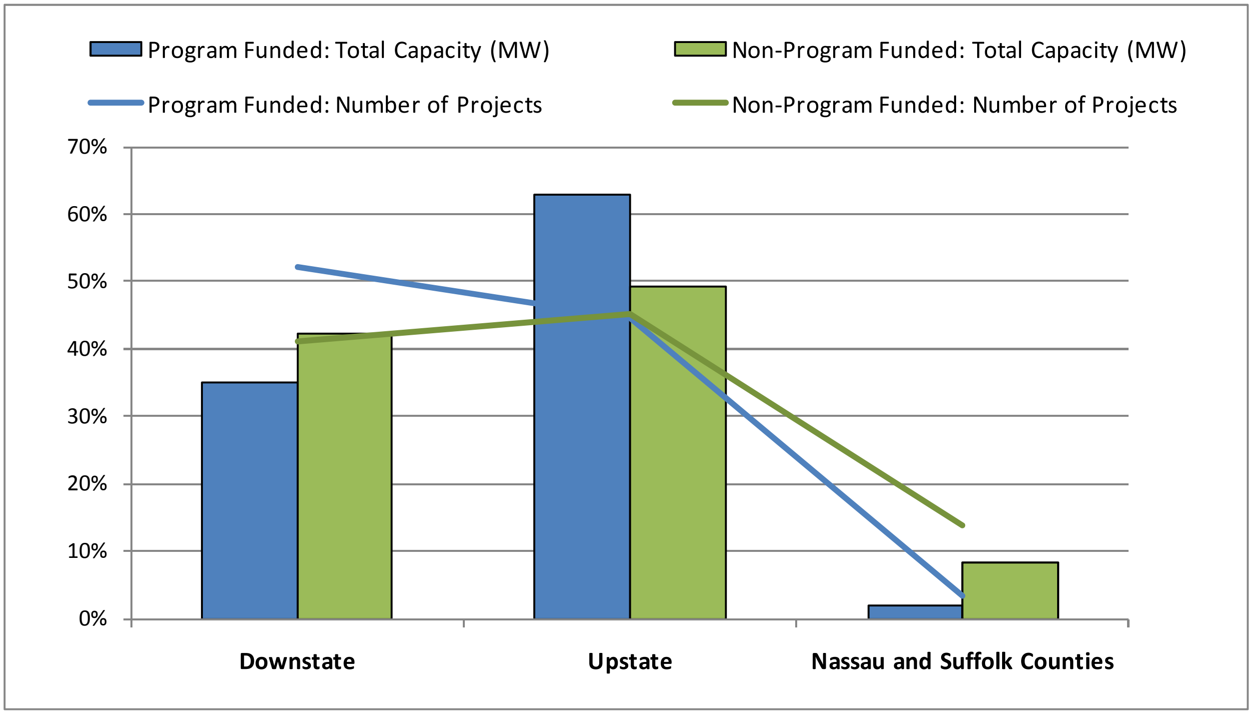


*Suffolk State Office Building in Hauppauge, NY is a hybrid system (200 kW fuel cell / 500 kW reciprocating engine)

Source: NYSERDA DG-CHP Demonstration Program tracking files, DOE's Energy and Environmental Analysis, Inc., database of installed capacity, and Navigant analysis.

Considering project activity from an upstate versus downstate perspective, the number of program-funded projects is evenly split across the two regions. However, reviewing project activity in terms of installed capacity, the majority exists in the upstate region. For non-program-funded projects, both installed capacity and total number of projects are greater in the upstate region, but the regional difference is minimal (Figure 13).

Figure 13. Percentage of Installed Capacity and Number of Projects by Region for Program-Funded and Non-Program-Funded Projects, 2000–2010



Source: NYSERDA DG-CHP Demonstration Program tracking files, DOE's Energy and Environmental Analysis, Inc., database of installed capacity, and Navigant analysis.

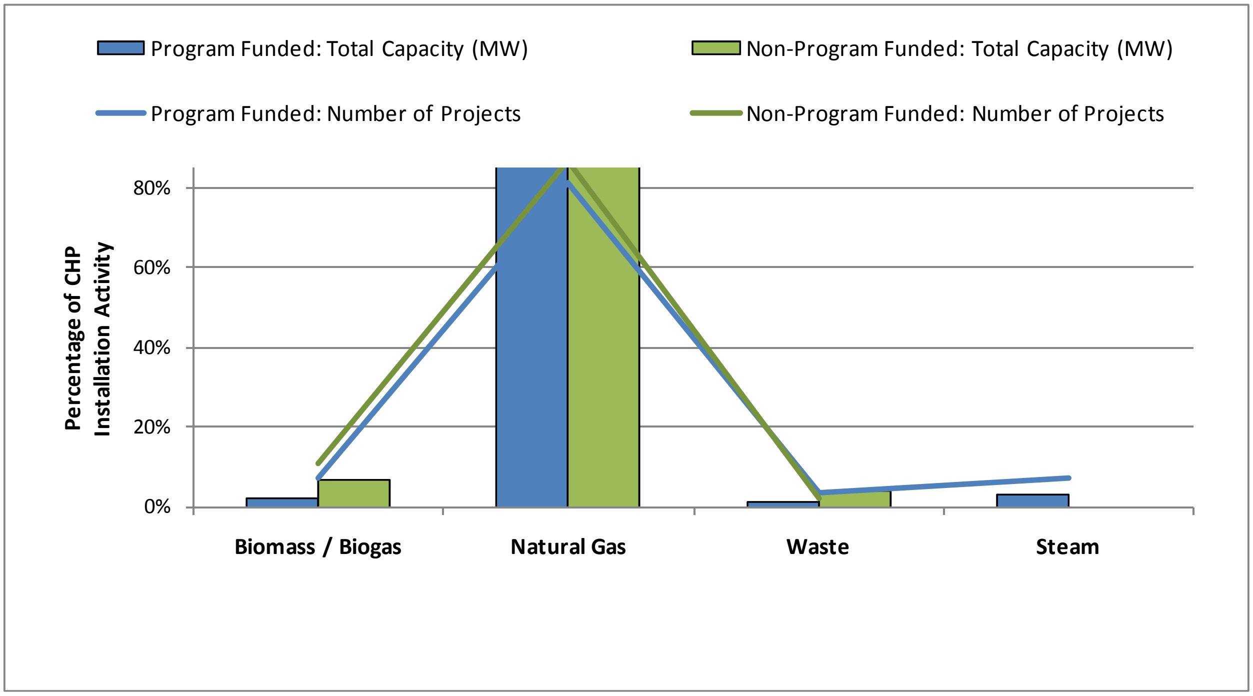
3.3.2 Market Activity During the SBC 3 Funding Period (2006-2010)

This section examines some more detailed characteristics of DG-CHP market activity that has occurred in New York during the SBC 3 funding period (2006–2010). As noted earlier, data for program-funded systems excludes those in the earlier stages of program participation, and the analysis is limited to systems 20 MW and under, with the exception of the 30-MW Cornell system. While that system received program funding, its capacity is three times greater than the next largest program-funded system. Given these parameters, the data presented in this section includes 27 program-funded projects totaling 43 MW of capacity, and 47 non-program-funded projects totaling 37 MW of capacity.[44]

Natural gas is the dominant fuel source across both program-funded and non-program-funded systems (Figure 14). Other fuel sources identified in records analyzed include biogas, biomass, and waste (including waste heat and waste energy more broadly).

[44] The non-program-funded data for the SBC 3 time period includes six systems installed with funding from NYSERDA programs other than the DG-CHP Demonstration Program. These other NYSERDA-funded systems total 9.4 MW.

Figure 14. Percentage of Installed Capacity and Number of Projects by Fuel Type for Program-Funded and Non-Program-Funded Projects, 2006–2010



Source: NYSERDA DG-CHP Demonstration Program tracking files, DOE's Energy and Environmental Analysis, Inc., database of installed capacity, and Navigant analysis.

As shown in Figure 15, DG-CHP activity is occurring across a wide range of building types. The greatest numbers of non-program-funded projects have occurred in the hospital/nursing home and multifamily housing sectors, with 26 projects having occurred in each of the two sectors. Though projects in those sectors were numerous, their installed capacity (5 MW and 2 MW, respectively) was relatively small compared with projects in the commercial office sector (15 MW). Another sector with a notable amount of activity among non-program-funded projects is the apartment/hospitality sector, with 6 MW of installed capacity.

Projects in the apartment/hospitality sector are most numerous among program-funded systems (11 projects). However, schools are by far the leading sector in terms of installed capacity (33 MW), due largely to the 30-MW system at Cornell University. The next most active sectors in the program-funded category are the hospital/nursing home sector with one project sized at 2 MW, and the industrial sector with three projects totaling 2 MW.[45]

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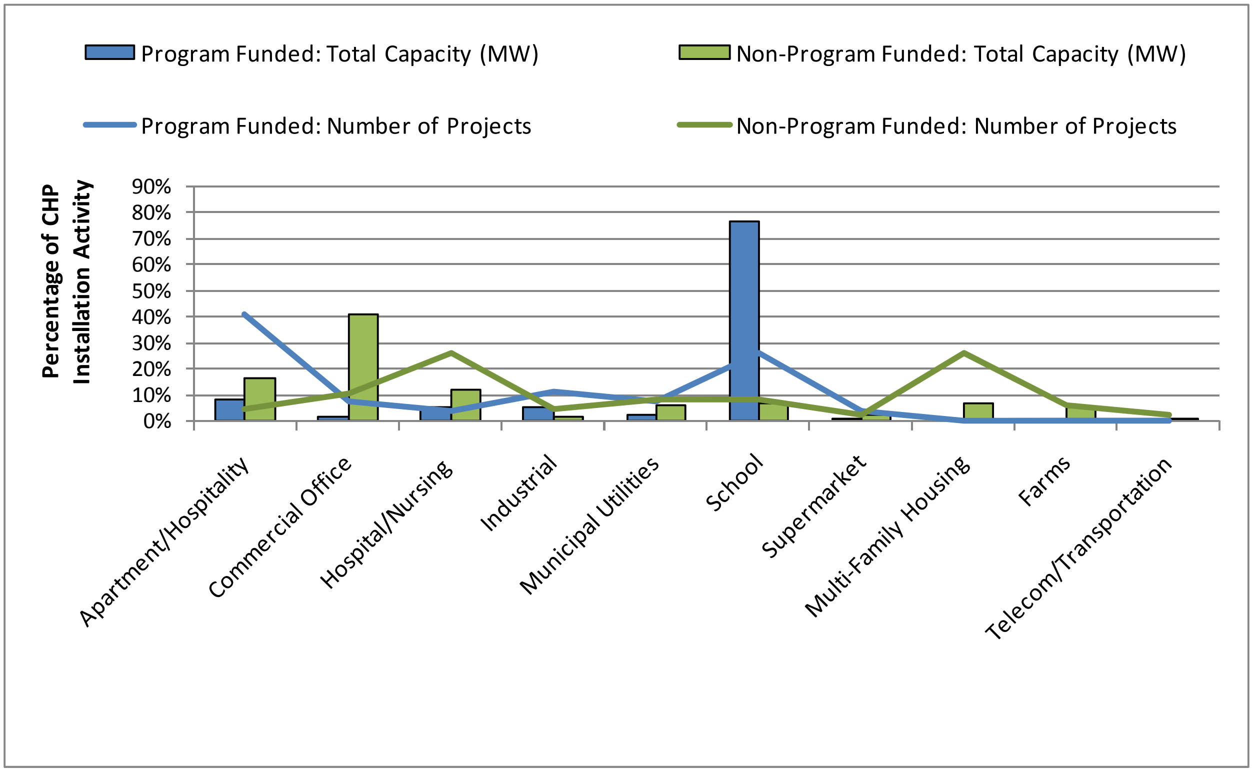
[45] This is a project at the St. Elizabeth's Medical Center.

Figure 15. Percentage of Installed Capacity and Number of Projects by Building Type for Program-Funded and Non-Program-Funded Projects, 2006–2010

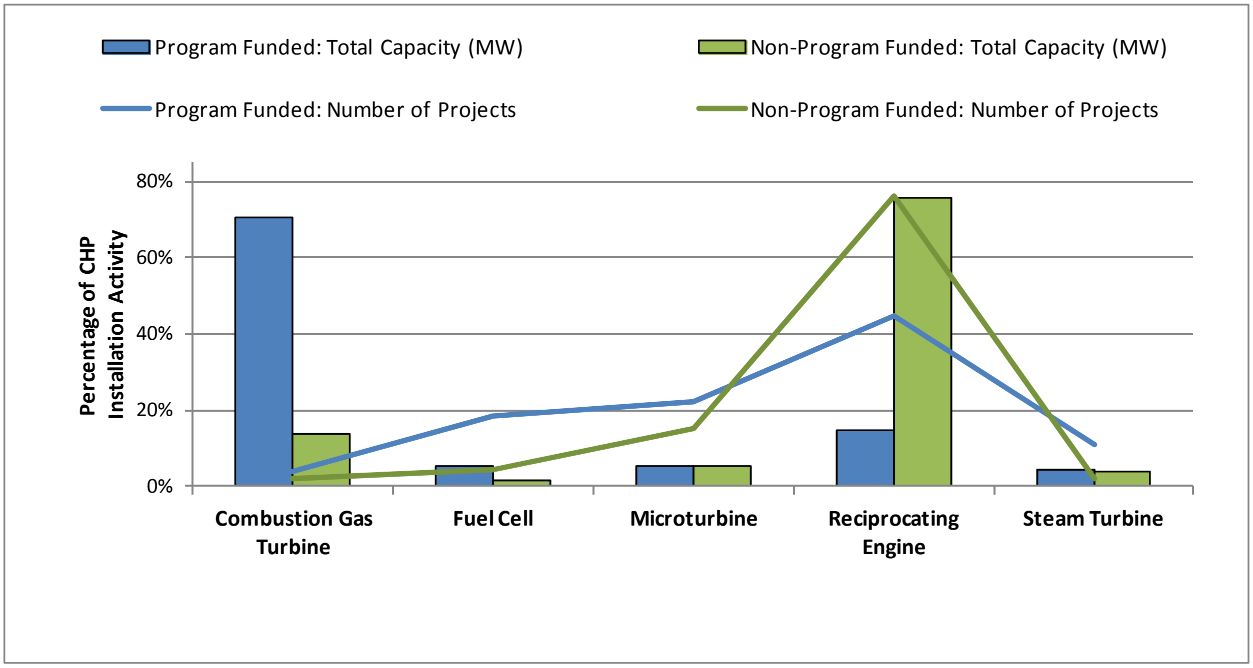


Source: NYSERDA DG-CHP Demonstration Program tracking files, DOE's Energy and Environmental Analysis, Inc., database of installed capacity, and Navigant analysis.

Figure 16 presents market activity during the SBC 3 funding period by prime mover type. For program-funded projects, systems have been installed across all prime mover types, though reciprocating engines account for the greatest number of systems (twelve systems). Combustion gas turbines are the dominant category in terms of installed capacity (30 MW). However, a single project, the 30-MW Cornell University system, accounts for the entire installed capacity in this prime mover category.

Among non-program-funded projects, reciprocating engines have comprised the vast majority of project activity, accounting for 75 percent of total installed capacity, and 76 percent of projects (Figure 16).

Figure 16. Percentage of Prime Movers by Installed Capacity and Project Frequency for Program-Funded and Non-Program-Funded Projects, 2006–2010



Source: NYSERDA DG-CHP Demonstration Program tracking files, DOE's Energy and Environmental Analysis, Inc., database of installed capacity, and Navigant analysis.

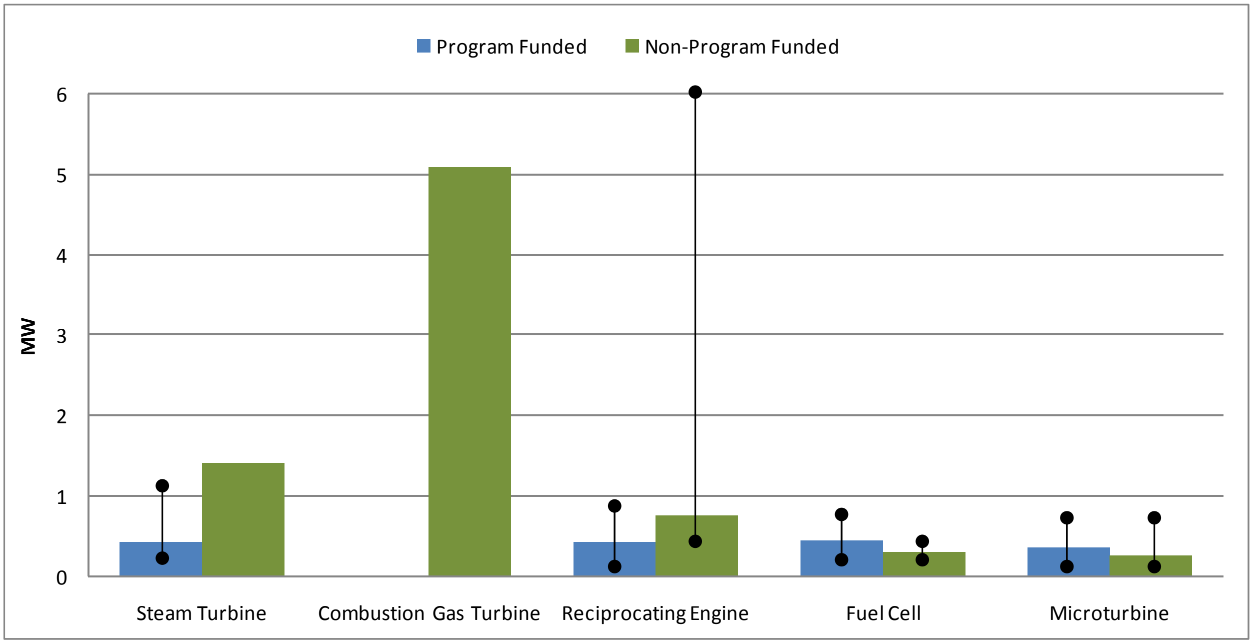
Figure 17 presents the average size of systems installed during the SBC 3 funding period.[46] The sizes of DG-CHP systems installed during this period have been relatively small when compared with systems installed in New York during earlier periods (see Figure 8). Among program-funded systems, average system sizes fall below 1 MW for each individual prime mover type, and the average system size across all prime mover types is 0.5 MW.[47]

Among non-program-funded systems, the average system size is greatest for combustion gas turbines. The one system of this type that was installed is 5 MW. Steam turbines follow; the one system of this type that was installed is 1.4 MW. The average system size across all non-program-funded systems is 0.6 MW.

[46] The 30-MW Cornell University system has been removed from the data set for the system size analysis presented in Figure 17 because it is an outlier.

[47] This average excludes the 30-MW system installed at Cornell University due to the outlier effect of that data point.

Figure 17. Average Systems Sizes for Program-Funded and Non-Program-Funded Systems, 2006–2010

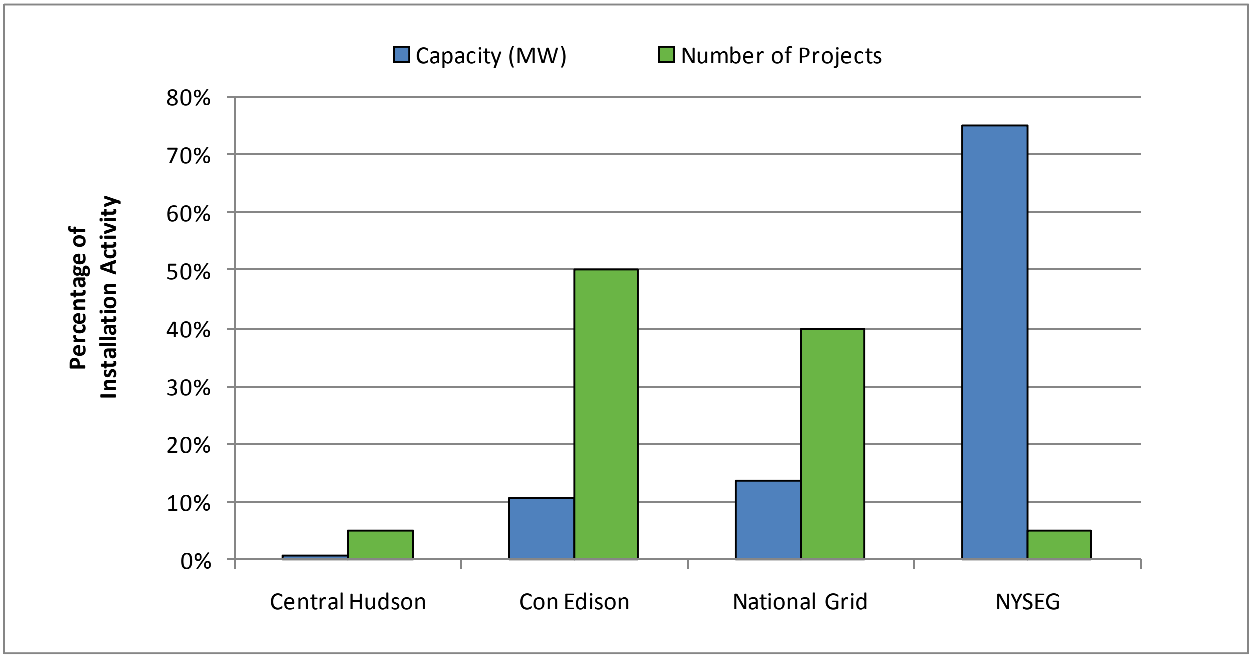


Source: NYSERDA DG-CHP Demonstration Program tracking files, DOE's Energy and Environmental Analysis, Inc., database of installed capacity, and Navigant analysis.

Figure 18 presents market activity by utility territory for program-funded systems.[48] New York State Electric & Gas (NYSEG) leads in terms of installed capacity (30 MW) because the 30-MW Cornell University system is located in NYSEG territory. Con Edison leads in terms of installed number of systems (ten systems), followed by National Grid (eight systems).

[48] Data by utility territory were not readily available for non-program-funded systems. Please see maps of installed capacity presented in the previous section for more comprehensive representation of the geographic distribution of systems across the state.

Figure 18. Market Activity by Utility Territory for Program-Funded Projects, Years 2006–2010

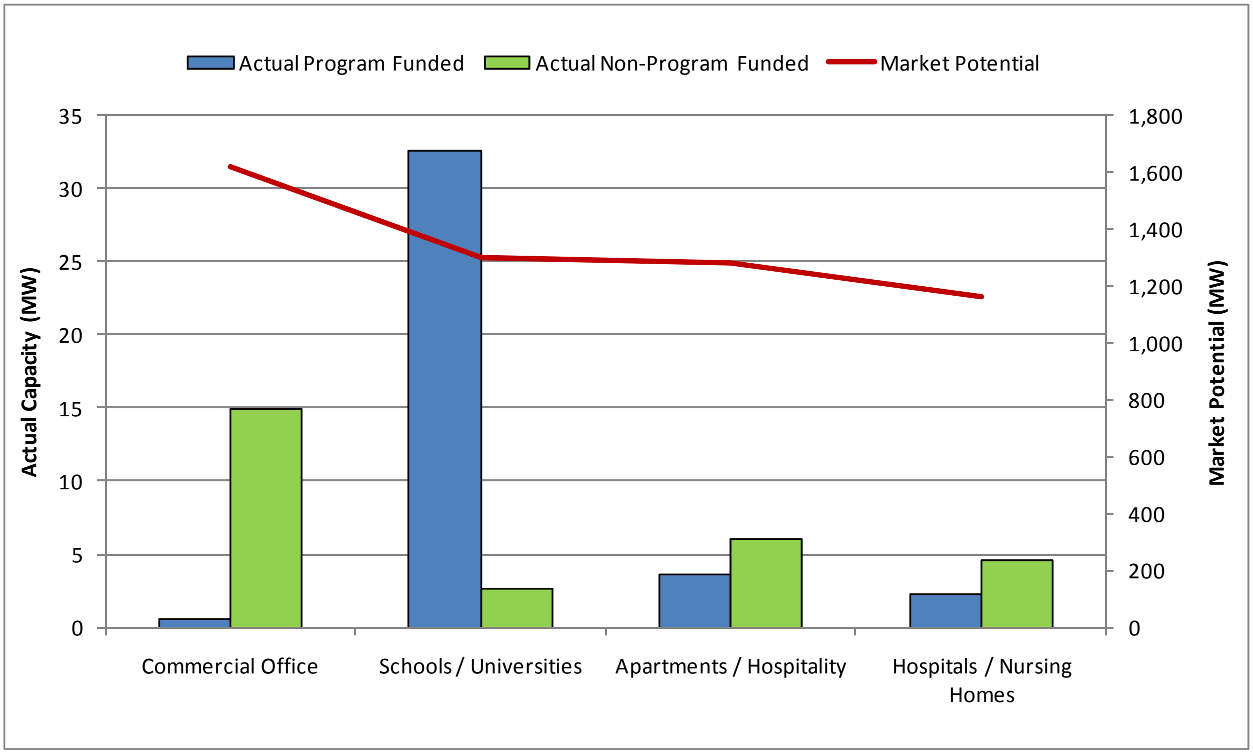


Source: NYSERDA DG-CHP Demonstration Program tracking files.

As indicated previously, the goal of the program is not resource acquisition. However, for purposes of understanding the status of the DG-CHP market in the state, it is worth noting that the market activity described above represents a small fraction of the market potential identified for these sectors in the 2002 market potential study prepared for NYSERDA.[49] Figure 19 presents market potential relative to actual market activity; market potential is represented by a red line with values presented on the right axis.

[49] Hedman, B. and K. Darrow. 2002. *Combined Heat and Power Market Potential for New York State*. New York State Energy Research and Development Authority.

Figure 19. Actual Market Activity Compared with Market Potential, 2006–2010



Source: NYSERDA DG-CHP Demonstration Program tracking files, DOE's Energy and Environmental Analysis, Inc., database of installed capacity, and Navigant analysis. Hedman, B. and K. Darrow. 2002. Combined Heat and Power Market Potential for New York State. New York State Energy Research and Development Authority.

3.4 Market Structure

Installing a CHP system falls beyond most host customer organizations' core competencies, and a diverse set of market actors can help navigate the complexities of evaluating and completing a project. The required skill sets generally span three areas of expertise—financial, regulatory, and technical issues. Some firms, such as an energy service companies (ESCOs), may offer host customers some degree of integrated services for delivering a project, while others may specialize in a particular discipline related to system design or installation (e.g., a mechanical contractor).[50] In either of these cases, CHP may only represent a portion of the firm's energy-related expertise and revenue-generating activity. This section identifies and briefly describes the numerous market actors who participate in the CHP market in New York.

Figure 20 illustrates the value chain for CHP systems, highlighting the key market actors likely to fulfill each step in a project's delivery. A brief summary of the roles and interactions between market actors follows.

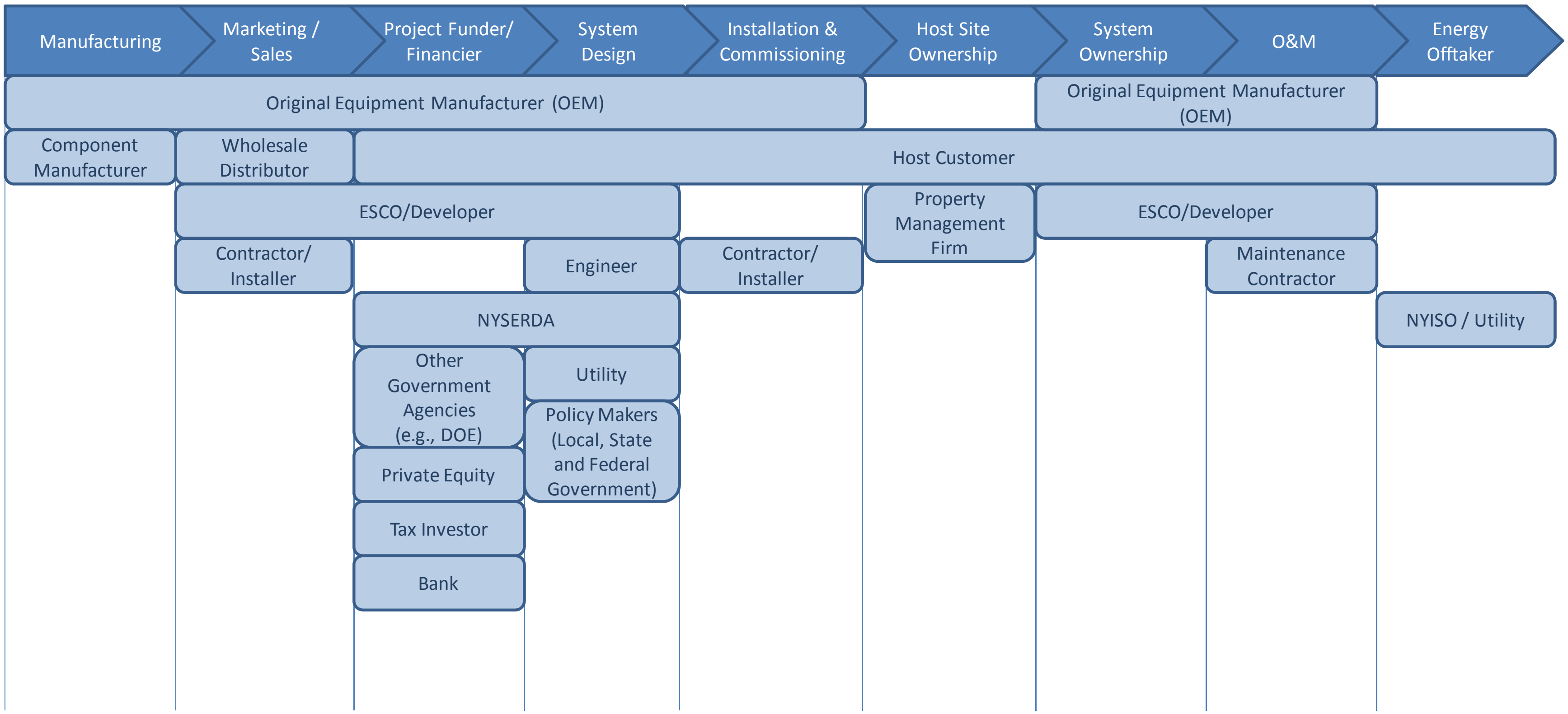
[50] Casten, S. Recycled Energy Development. 2008. "Opportunity and Pitfall Trends Identified through NYSERDA's Involvement in a Large Portfolio of Projects." NYSERDA CHP in NYS: Past, Present, and Future Conference.

Host Customers. Depending on the degree of in-house expertise, the host customer organization (i.e., the building owner/occupant and energy end user) may take on a range of responsibilities in conceiving of and implementing a CHP project. Those with more knowledgeable staff or a greater comfort level with the issues surrounding CHP may take the lead role in equipment selection and system design, financing, and interacting with the utility and NYSERDA staff. Others will rely heavily on a project developer or engineering partner to help navigate the myriad decisions and potential roadblocks to completing a project.

Regardless of whether the customer initiates the project internally or is approached by a developer, the host will likely contract for third-party assistance at some point in the process. Many owners are not prepared to take on the responsibilities of detailed system engineering, construction or maintenance, while others may prefer to avoid the risks inherent in owning the system directly.

Original Equipment Manufacturers (OEMs) and Distributors. Many of the key equipment manufacturers are well-established players in the national CHP market. Some interact directly with host customers, developers, and engineering firms, while others supply the market through wholesale distributors. OEMs are increasingly offering customers additional services related to system ownership, financing, commissioning, and long-term maintenance. Through various arrangements (discussed later in this section), an OEM may retain ownership of a system and either lease the system or sell power to the host customer. In addition, the manufacturer can offer considerable added value to the host customer by providing commissioning services (to ensure the installed system performs as designed) and system maintenance services that help reduce the customer's risk profile for the project.

Figure 20. Key Market Actors and Roles in the CHP Value Chain



Source: Navigant analysis.

Energy Service Companies and Developers. Some host customers choose to work closely with a project developer or ESCO to help manage a project from its initiation through completion. Such firms may offer services ranging from technical and economic modeling, equipment selection, installation, and, as with manufacturers, financing and operating the system through power purchase agreements (PPAs) or Energy Service Agreement (ESA) contracts.

Engineers and Owners Agents. Instead of contracting with a developer or ESCO to manage most of the project, some host customers hire an engineering firm to provide only specific services such as equipment selection, system design, or construction management. These firms are unlikely to take an ownership stake in the projects, instead acting on the host customer's behalf to supplement the capabilities and expertise of its own staff. In some cases, a host customer may hire one of these firms to help its own staff evaluate options presented by developers or ESCOs (e.g., in response to a Request for Proposals issued by the host customer). Many of these firms focus generally on the building and energy engineering markets, while others may offer more specialized CHP-related services.

Contractors and Installers. Regardless of whether a host customer manages a project independently or has a developer, ESCO, or engineering firm oversee the process, one or several contractors will likely perform the actual construction and installation of a CHP system. Whether contracted directly by the host customer or under subcontract to the ESCO or developer, their participation is often solicited through a competitive bidding process. CHP projects typically involve modifications to numerous building-related systems at the host customer site—including heating, ventilating, and air conditioning (HVAC), plumbing, electric, and often structural elements—and require specialized contractors to complete each type of work. In addition, an engineer or other contractor may provide commissioning services if not provided by the equipment manufacturer or developer.

Operations and Maintenance (O&M) Contractors. As mentioned at the beginning of this section, operating and maintaining a power-generating system falls outside of most host customers' primary missions and the expertise of in-house staff. Therefore, many system owners outsource ongoing system maintenance to the equipment manufacturer or a third-party service provider. Maintenance contracts are often offered for a set, long-term period (e.g., ten years). Depending on the system, the contract may cover only specific components or the entire CHP system.

Utilities. No matter which type of party manages a project, coordination with the host customer's utility represents one of the key interactions in the implementation of a CHP system. While SIRs exist for systems up to 2 MWs in New York, the related equipment specifications (and subsequent costs to the system owner) may vary based on the site, type, and size of the equipment as well as the utility. In addition, the gas, steam, and standby electricity tariffs imposed by the utility (and approved by the PSC) exert significant influence on the economic viability of a project.[51]

New York Independent System Operator (NYISO). The NYISO manages and operates the state's wholesale electricity markets and system reliability, both of which can affect CHP system economics. In addition to setting regional electricity supply charges, the NYISO oversees the state's electricity capacity market that enables some host customers to participate in demand response (DR) activities.

Policy makers. Local, state, and federal government agencies influence the CHP market primarily through policies and regulations related to financial incentives, building codes, and environmental

[51] Hammer, S. and J. Mitchell, eds. 2007. "CHP in NYC: A Viability Assessment." Columbia University.

permitting requirements (e.g., air pollution and noise). Permitting and code requirements and processes may vary from one municipality or region to the next, as well as among different CHP technologies. Aside from interconnection, the permitting process represents one of the greatest sources of uncertainty for a CHP system host customer or developer.

NYSERDA. NYSERDA plays a substantial role in the CHP market, educating market actors about CHP technologies, seeking to reduce barriers to system implementation, and communicating the needs of the market to regulators (e.g., the PSC) and policymakers. In addition, NYSERDA offers ratepayer-funded financial incentive programs to support CHP system development (e.g., DG-CHP Demonstration Program, Existing Facilities Program, and Flex Tech).

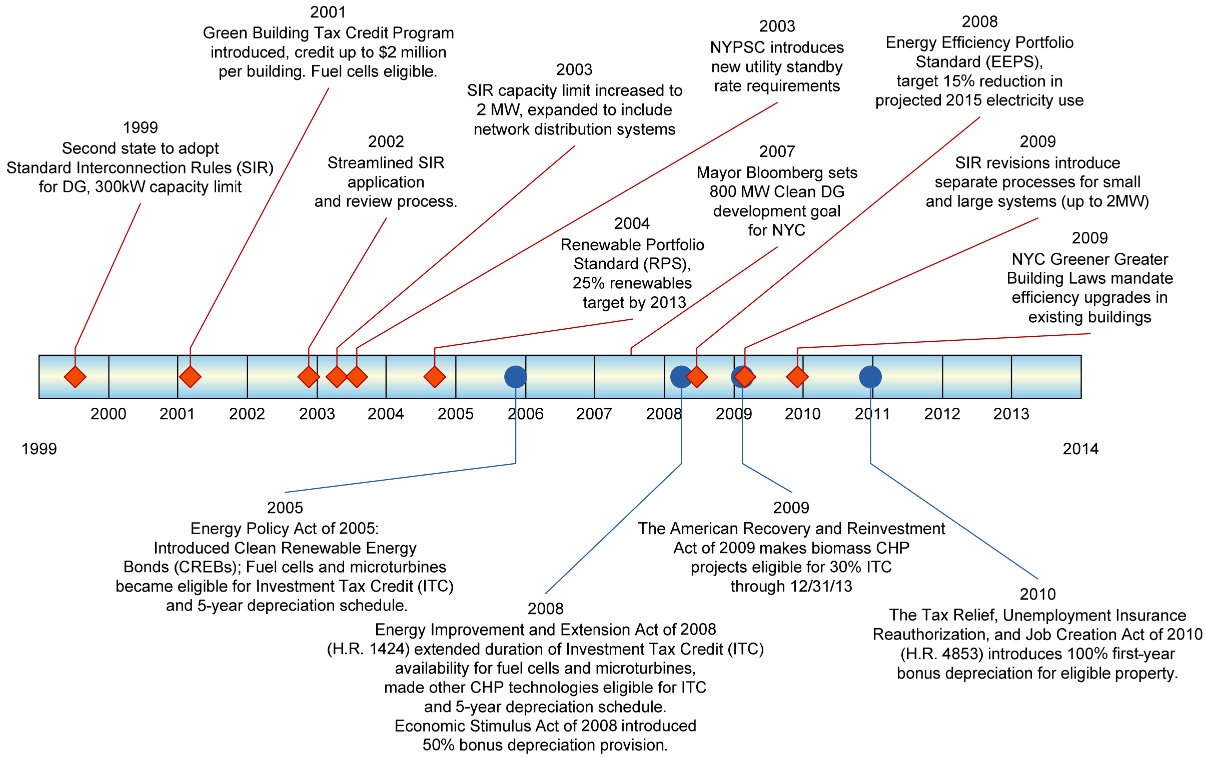
Third-Party Financiers. While sometimes not considered a primary market actor, the banks, tax investors, and other lenders that often provide the capital necessary to complete a CHP installation play an important role in the market. These firms may lend funds directly to the host customer or invest in the developers and ESCOs who operate under long-term contracts with the host.

3.5 Policy Framework

In order for the substantial efficiency benefits and development potential of CHP to be realized, a favorable regulatory and policy environment must exist. Factors ranging from federal tax policy to state interconnection requirements all affect the viability of installing DG-CHP systems. This section provides an overview of the federal, state, and local policies and regulations of relevance to the CHP market in New York State.

Figure 21 is a time line of policy milestones affecting the market for CHP in New York State. The figure provides a high-level overview of the range of key policies discussed throughout this section.

Figure 21. Time Line of Policy Milestones Affecting New York CHP Market



Sources: Database of State Incentives for Renewables and Efficiency, EPA Combined Heat and Power Partnership, Northeast Clean Heat Application Center, PlaNYC Reports on Energy, 2007 and 2011.

3.5.1 Federal Policies

For many years, federal tax policy has provided critical financial support for the development of a wide range of clean energy technologies, primarily in the form of investment tax credits, production incentives, and accelerated depreciation schedules. CHP technologies have lagged behind solar and other clean energy technologies in becoming beneficiaries of these tax policies. With passage of the Energy Policy Act of 2005, fuel cells and microturbines became the first CHP technologies to be eligible for the corporate investment tax credit (often referred to as the Investment Tax Credit or "ITC") and an accelerated five-year depreciation schedule ("Modified Accelerated Cost Recovery System").[52] Amidst the heightened political emphasis on advancing energy efficiency that arose in 2008, more mature CHP technologies became eligible for the ITC and accelerated depreciation schedule as well as a result of the Energy Improvement and Extension Act of 2008.

The 10 percent ITC available to all CHP technologies except fuel cells is less than that available to most other ITC-eligible technologies due to the comparatively more favorable economics of CHP. Fuel cells,

[52] Database of State Incentives for Renewables and Efficiency.

often categorized as a renewable energy technology even when fueled with natural gas, are eligible for a 30 percent ITC.

With the passage of the American Recovery and Reinvestment Act (ARRA) in February 2009, project investors gained the ability to take a cash grant in lieu of the ITC. The grant option is attractive to project investors because: (1) the full value of the grant is paid out quickly; and (2) though the applicant must be a tax-paying entity, the value of the grant is not limited by the applicant's tax liability. The grant option is only available to projects that begin construction before the end of 2011, and that are placed in service before January 1, 2017.

The incentives described above, as well as additional incentives (Modified Accelerated Cost Recovery System [MACRS] and Clean Renewable Energy Bonds), are highlighted in Table 4. The incentives summarized here are available to CHP systems operating with natural gas as a fuel source, as this is the fuel source used by the vast majority of CHP systems operating today. Additional incentives are available to CHP systems operating with biomass as a fuel source.[53]

[53] For additional details on grants and financial incentives available to all CHP, including biomass-fueled CHP, see the EPA CHP Partnership website: http://www.epa.gov/chp/incentives/.

Table 4. Summary of Federal Financial Incentives for CHP Development[54]

Policy / Incentive	Features	Limitations
Investment Tax Credit	» Defrays costs by providing credit value during the first year of operation » 10% tax credit for all natural gas-fueled CHP except fuel cells, which are eligible for 30% tax credit. Biomass-fueled CHP also eligible for 30% tax credit.	» Requires involvement of tax equity investors with tax appetite » Value vests over 5 years so sale of project during that time frame may cause complications » Microturbines: capped at $20/kW and 2 MW of capacity, and must exceed 26% electricity-only generation efficiency; Fuel cells: capped at $1,500/0.5 kW; Other CHP: capped at 50 MW of capacity, and must exceed 60% efficiency
Cash Grant	» Can be taken in lieu of ITC » Funds available quickly providing balance sheet benefits » No need to secure investors with significant tax appetite	» Short-term availability » Same technology-specific limitations as ITC
Modified Accelerated Cost Recovery System (MACRS)	» Depreciating the asset over a 5-year period as opposed to its full life provides investors with financial benefits » Available indefinitely	» Insufficient to drive project development on its own
Qualified Energy Conservation Bonds	» State, local, and tribal governments can issue bonds, and bondholders receive tax credit in lieu of interest; thus, provides access to capital for project owners that are not tax-paying entities. » Bond issuer can receive direct payment from Department of Treasury.	» Bondholders must have tax appetite.

Source: Database of State Incentives for Renewables and Efficiency, EPA Combined Heat and Power Partnership website: http://www.epa.gov/chp/incentives/.

Another change brought about by EPACT 2005 that had an impact on the CHP market relates to the Public Utilities Regulatory Policy Act (PURPA). When PURPA was adopted by Congress in 1978 it paved the way for development of non-utility owned power generation by requiring utilities to purchase electricity from "qualifying facilities" (QFs) at a set price. QFs are cogeneration projects or other small

[54] Database of State Incentives for Renewables and Efficiency. Federal Incentives and Policies for Renewables and Efficiency. URL: http://www.dsireusa.org/incentives/index.cfm?state=us&re=1&EE=1. Accessed May 9, 2010.

power producers that meet certain criteria.[55] PURPA was introduced around the same time as a 10 percent ITC, and as new larger-scale efficient CHP technologies were coming online. This combination of factors contributed to a surge in development of large-scale (>100 MW projects) CHP projects in the U.S., many of which were at industrial facilities.[56]

EPACT 2005 scaled back PURPA significantly. In response to provisions in EPACT 2005, FERC no longer requires utilities to purchase electricity from new QFs less than 10 MW in markets that have competition (RTOs / ISO) such as New York.[57] As noted later in the report (Section 4.6), some market actors attribute the decrease in CHP project sizes to these PURPA changes.

3.5.2 State Policies

The types of state policies most important to the advancement of CHP markets include:

- Standard interconnection rules
- Status of CHP-friendly standby rates
- Presence of CHP financial incentive programs
- Inclusion of CHP/waste heat recovery in a state renewable or energy efficiency portfolio standard
- Presence of output-based emissions regulations
- Net metering regulations

As shown in Table 5, according to the American Council for an Energy-Efficient Economy (ACEEE), New York State is among the leading states for favorable CHP policy, ranking best in the area of financial incentives.[58] NYSERDA's DG-CHP Demonstration Program staff have actively communicated with policymakers about market needs and the lessons learned from program experience. This staff activity has likely contributed significantly to the positive CHP policy framework that exists and continues to take shape in New York.

This section provides an overview of New York's key CHP-related policies.

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[55] Bosselman, F. et al. 2006. *Energy, Economics and the Environment: Cases and Materials*. Second Edition. Foundation Press.
[56] IEA. 2008. *CHP/DHC Country Scorecard: United States*. The International CHP/DHC Collaborative, Advancing Near-Term Low Carbon Technologies.
[57] Ibid.
[58] Molina et al. 2010. *The 2010 State Energy Efficiency Scorecard*. American Council for an Energy-Efficient Economy.

Table 5. Comparison of State Policies Important to CHP Development

	Inter connection	Standby Rates	Incentives	Output Based Emissions Regulations	RPS or EERS	Net Metering	Overall Score
Connecticut	●	◔	◑	●	●	○	5
Ohio	●	◔	◑	◕	●	○	5
California	●	◑	◑	●	○	○	5
Texas	◕	◑	○	●	●	○	5
Massachusetts	◕	◔	◔	●	●	◑	5
New York	◕	◔	●	◕	◔	◑	5
North Carolina	◕	◔	●	○	●	●	5
Illinois	●	◑	◔	●	○	○	5
Pennsylvania	◕	◑	◑	○	●	●	5
Maine	○	●	○	●	●	◑	4

Source: Adapted from Molina et al. 2010. The 2010 State Energy Efficiency Scorecard. American Council for an Energy-Efficient Economy.

Standard Interconnection Requirements

New York was one of the first states in the nation to develop SIRs. These requirements established uniformity and predictability in the procedures, cost structures, and time lines that govern the process through which prospective DG owners apply to the utility to interconnect with the electric grid. When first introduced in 1999, the SIR applied to projects up to 300 kW, but revisions since that time have raised the size limit to 2 MW.

The SIRs enable many projects up to 2 MW in capacity to navigate the interconnection process with relative ease. However, projects interconnecting in urban network grid areas, and projects larger than 2 MW, may still face substantial interconnection challenges, depending on the project circumstances. In the case of systems interconnecting to network grids, the utility may deem their system unable to accommodate additional interconnected generating capacity within the area the applicant wishes to interconnect, or the applicant may need to pay for additional equipment to achieve the levels of safety required by the utility.

For projects larger than 2 MW, the interconnection process lacks the standardization that exists for smaller projects. As a result, there is less transparency and utilities have greater latitude to impose equipment upgrade charges and fees on an interconnection applicant, or to slow down the interconnection process for a given project by requiring additional studies or by being slow to issue approvals.

In Con Edison territory, synchronous generators are also subject to more restrictions and a more involved interconnection process than other types of generators. [59] This is significant because a CHP system must employ either a synchronous or inverter-based generator in order to fulfill the DG-CHP Demonstration Program's requirement that it be capable of operating stand-alone during power grid outages. Only fuel cells and some microturbines have integrated inverters.[60] Therefore, CHP systems using other technologies must add an inverter, or undergo a more complex interconnection process in order to be eligible for the DG-CHP Demonstration Program. Market participant views on interconnection issues were previously discussed in this section.

Standby Rates

Standby rates are the utility tariffs that apply to those customers with on-site generation that rely on the utility for supplemental power supply. The New York PSC approved new standby rates for most of the state's major utilities in 2003.[61]

From the perspective of a DG customer, the most favorable rate structure is one based on energy usage that rewards the customer for drawing less power from the grid. However, utilities still must provide capacity and grid infrastructure to serve standby DG customers in times of need. Therefore, the standby rates introduced in 2003 are based on the principle that standby rates should enable utilities to recover their costs associated with serving those customers. The rates consist of three different types of charges: the *customer charge* recovers certain fixed costs; the *contract demand charge* varies based on total demand at a given site, but remains the same regardless of whether the customer reaches the set demand level; and the *daily as-used demand charge* varies based on actual metered demand during peak periods.

Given the mix of charges included in the standby rates introduced in 2003, and given the varying circumstances of different DG customers, the NY PSC estimated that some existing DG systems would suffer under the new rates, while others would benefit. Customers with existing DG systems, and those in the development phase, were given the opportunity to opt out of the standby rates and remain on the standard applicable rate structure. [62] Furthermore, the NY PSC granted an exemption from standby rates for renewably fueled DG and environmentally beneficial CHP sized at 1 MW or less, and NYSERDA-funded projects that were built within a specified timeframe.[63] This exemption was initially set to expire

[59] According to a Con Edison representative, synchronous generation cannot connect to the 120/208 secondary system due to islanding concerns. Connection to spot network is ok if anti-islanding (no export) protection is installed. Personal communication with Con Edison representative, August 11, 2011.

[60] Hammer, Stephen and Jeanene Mitchell. (2007) CHP in NYC: A Viability Assessment. Urban Energy Program, Center for Energy, Marine Transportation and Public Policy, Columbia University.

[61] The following orders established standby rates for New York utilities: Case 02-E-1108, Central Hudson Gas & Electric Corporation (issued December 4, 2003); Case 02-E-0551, Rochester Gas & Electric Corporation (issued July 29, 2003); Cases 02-E-0780 and 02-E-0781, Orange & Rockland Utilities, Inc. and Consolidated Edison Company of New York, Inc. (issued July 29, 2003); and Case 02-E-0779, New York State Electric & Gas Corporation (issued July 30, 2003). National Grid's standby rates were set as part of the utility's general rate proceeding in Case 01-E-0075, Niagara Mohawk Power Corporation - Merger and Rate Plan, Opinion No. 01-6 (issued December 3, 2001). These rates differ from those that apply to other utilities.

[62] NY PSC Cases 02-E-0780 and O2-E-0781. *Order Establishing Electric Standby Rates*. Effective July 29, 2003.

[63] NY PSC Cases 02-E-0551, 02-E-0079, 02-E-0780, 02-E-0781, 02-E-1108. *Order Directing Modification to Standby Service Tariffs*. Effective January 23, 2004.

in 2009, but was later extended through 2015.[64] The phase-in period has now passed, and new CHP systems that do not qualify for the technology-related exemption are subject to the standby rates offered in their utility service territory.

The issue of standby rates is complex and the subject of debate across the country. A number of states have introduced standby rates that are considered to be more favorable to CHP than those in place in New York (see Table 5). Market participant views on the issue of standby rates were previously discussed in this section.

Gas Rates for CHP Systems

In 2002 the PSC ordered gas utilities to consider DG systems as an alternative to conventional grid infrastructure improvements.[65] The PSC also ordered the creation of a separate rate class for DG users. This action was initiated out of a recognition of the fact that DG systems' higher natural gas usage would result in these systems covering a greater percentage of the utilities' fixed costs than other customers.[66]

Utilities offer gas customers with CHP systems an option to select a different natural gas rate, though opting to use this alternative rate may result in a need for the facility to install some additional equipment.

Incentive Programs and Clean Energy Targets

Financial incentives for CHP are one of the policy features that put New York in the forefront among states working to advance CHP markets. Depending on project circumstances, CHP developers can obtain funding from a variety of different financial incentive programs offered by NYSERDA, including the DG-CHP Demonstration Program, the Existing Facilities Program, the New Construction Program, and the RPS-Customer Sited Tier.

The DG-CHP Demonstration Program is funded by the SBC. The SBC was established by the NY PSC in 1996 to support a range of energy efficiency-related efforts including outreach and education, R&D, and low-income energy efficiency programs. The SBC is collected through a surcharge on electric bills of customers of the state's investor-owned utilities (IOUs). The SBC has been extended a number of times, and at the time of this writing, it is in effect through the end of 2011. A total of $1.98 billion will have been collected through SBC from 1998 through 2011.[67]

A host of additional programs and activities are underway in New York aimed at achieving target levels of clean energy usage established through the Energy Efficiency Portfolio Standard (EEPS), and the RPS. The EEPS, established through a PSC order in 2008, set a target to reduce electric sales by 15 percent relative to baseline consumption levels projected for 2015.[68] Gas efficiency targets were added to the

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[64] NY PSC Case 09-E-0109. *Order Continuing and Modifying in Part the Standby Rate Exemption*. Effective May 18, 2009.
[65] NY PSC Case 02-M-0515. Proceeding on Motion of the Commission to Establish Gas Transportation Rates for Distributed Generation Technologies. Effective May 14, 2002.
[66] EPA Combined Heat and Power Partnership. Utility Rates. Available at: http://www.epa.gov/chp/state-policy/utility.html. Obtained August 23, 2011.
[67] Database of State Incentives for Efficiency and Renewables. *New York System Benefits Charge*. Accessed at http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=NY07R&state=NY&CurrentPageID=1&RE=1&EE=1 on May 5, 2011.
[68] NY PSC Order, Case 07-M-0548. June 23, 2003.

EEPS in 2009. New York's RPS, established through a PSC order in 2004, initially set a target to achieve 25 percent renewable energy usage in the state by 2013.[69] This goal was later increased to 30 percent by 2015. The Customer-Sited Tier component of the RPS provides funding to eligible fuel cells, a form of CHP.[70] Funding for the EEPS and RPS is collected through separate charges on utility bills of the customers of IOUs.

New York also offers a green building tax credit program that offers up to $2 million per building for implementing whole-building efficiency improvements. Buildings using fuel cells are eligible for a credit through the program.[71]

Net Metering

Net metering policies enable DG facilities in some states to be compensated for the excess generation they produce. Net metering policies must be evaluated based on a number of design details, and in the context of broader rate design in a given state. Therefore, it is difficult to compare states on net metering policies. Non-residential CHP systems are not eligible for net metering in New York.[72] However, New York receives a moderate ranking on ACEEE's 2010 State Energy Efficiency Scorecard for CHP policies.[73]

3.5.3 Local Policies

Over 118 MW of CHP capacity already exists in New York City, but further development is limited by a number of barriers. New York City sustainability planning efforts, spurred by the PlaNYC initiative, recognize the importance of encouraging the development of clean DG such as CHP. PlaNYC is an interagency planning effort working to achieve environmental sustainability across a number of areas including land use, transportation, and energy. Drawing on findings of the PlaNYC efforts, in 2007 Mayor Bloomberg announced new targets and rules aimed at increasing CHP and other clean DG development. Passage of a set of Greener Greater Buildings Laws in 2009 introduced several measures focused on increasing energy efficiency in existing buildings; monitoring of building energy performance resulting from implementation of these laws will help buildings identify opportunities for CHP.

PlaNYC and related policies and initiatives likely to advance CHP development in New York City include:

- Target of 800 MW of clean DG capacity by 2030[74]
- Requirement that new developments larger than 350,000 square feet analyze CHP feasibility[75]

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[69] NY PSC Order, Case 03-E-0188. September, 24, 2004.

[70] The Main Tier component of the RPS provides financial support to biomass projects, though the program targets central-scale generation, not DG.

[71] Database of State Incentives for Efficiency and Renewables. *New York Green Building Tax Credit*. Accessed at http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=NY05F&re=1&ee=1 on May 5, 2011.

[72] Database of State Incentives for Renewables and Efficiency. New York Net Metering. Accessed at http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=NY05R&re=1&ee=1 on May 5, 2011.

[73] Molina et al. 2010. *The 2010 State Energy Efficiency Scorecard*. American Council for an Energy-Efficient Economy.

[74] PlaNYC. 2011. *PlaNYC: A Greener Greater New York*.

[75] Simpson.T. *PlaNYC Perspective on CHP and DG*. Presented March 19, 2009. New York City Economic Development Corporation.

» Requirement that City-owned facilities with demand greater than 500 kW assess CHP, and subsequent screening of CHP feasibility at 300 City-owned facilities[76]

» Incentives for CHP at evacuation shelters[77]

» Promotion of opportunities to develop district energy at appropriate sites[78]

» Encouragement of Con Edison to make infrastructure improvements that will increase the amount of clean DG that can safely be connected to the grid[79]

» New York City Department of Buildings' issuance of a guide to CHP development[80]

» Phase-out of No. 6 heating oil[81]

Given the substantial opportunity for CHP development in New York City, issues surrounding the CHP market in the city have been well studied as part of the PlaNYC efforts, and by other thought leaders. Interconnection has been identified as a major hurdle to CHP development in the city due to presence of network grids and problems related to fault current levels. Other city-specific challenges include a permitting process that is slow and difficult to navigate. PlaNYC reports that the City will work with Con Edison and city agencies to address interconnection and permitting issues.

3.5.4 Emissions Regulations

CHP systems introduce new sources of local air emissions. Emissions permitting can pose a development challenge, particularly in states that base emissions regulations solely on fuel inputs. Conventional input-based emissions standards do not recognize the efficiency benefits provided by CHP, and they can encourage use of emissions controls at less efficient plants, rather than investment in more efficient equipment and processes. In contrast, output-based emissions standards calculate emissions based on the amount of emissions per unit of output (lb emissions per megawatt-hour [MWh]). Because output-based emissions reflect and reward the higher levels of efficiency of CHP relative to conventional power generation, they represent a key policy tool for advancing the market for CHP.

During the last decade, awareness of the importance of output-based emissions standards has increased, and a variety of federal and state air emissions rules introduced in recent years have included output-based emissions components.[82]

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[76] Ibid.
[77] Ibid.
[78] Ibid.
[79] Ibid.
[80] New York City Department of Buildings. 2010. Installing Natural Gas-Fueled Combined Heat and Power Systems: A Guide to Required Permits and Inspections and Available Incentive Programs for Property Owners and the Construction Industry. Available at http://www.nyc.gov/html/dob/downloads/pdf/combined_heat_and_power_systems.pdf. Accessed August 11, 2011.
[81] Environmental Defense Fund. *Cleaning Up New York's Dirty Heating Oil*. Available at: http://www.edf.org/climate/cleaning-new-york-dirty-heating-oil. Accessed August 22, 2011.
[82] Changes introduced to the EPA's New Source Performance Standards in 2006 included output-based emissions standards for utility and industrial boilers, stationary combustion turbines, and reciprocating internal combustion engines. Naik-Dhungel, N. *Output Based Emissions Regulations: Best Practices Option for CHP*. Presented July 13, 2011.

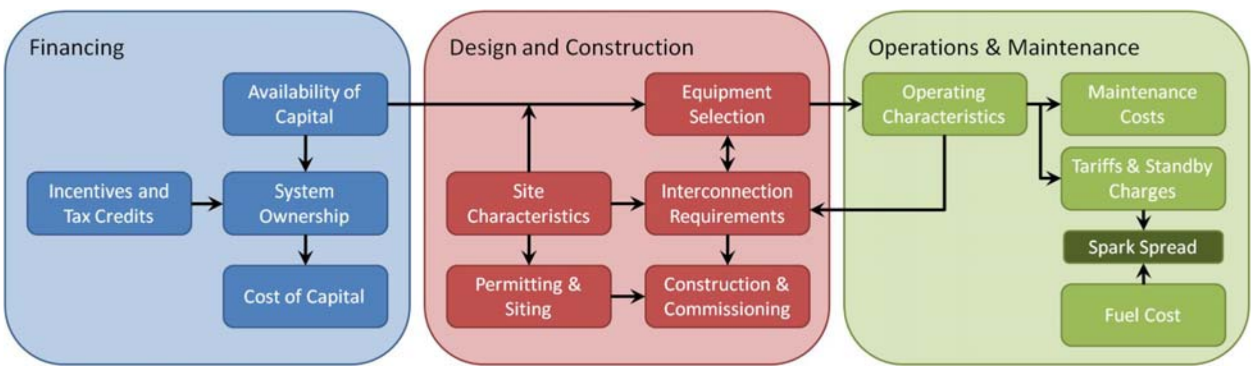
As part of its State Implementation Plan required as a result the state's non-attainment status under the Clean Air Act, New York includes output-based emissions regulations in its NOx Budget Trading Program.[83]

3.6 *Project Economics and Economic Drivers*

In broad terms, the economic viability of a CHP project stems largely from the financial benefits of cogenerating all or part of a facility's thermal and electrical energy on-site rather than purchasing electricity from the grid and/or generating thermal loads separately (with either natural gas or electricity). The difference between the costs of grid electricity and the natural gas that fuels many CHP systems—commonly referred to as the "spark spread"—is an underlying factor in the operational cost-benefit comparison.[84]

Numerous other factors also contribute to the final installed cost and long-term operational costs of any CHP system. Several market assessments and research papers describe the factors affecting a project's economic viability in varying levels of detail.[51,85,86] This assessment groups these drivers into three general categories along the CHP value chain: Financing; Design and Construction; and Operations and Maintenance. Figure 22 illustrates the drivers in each category and some of the relationships among them.

Figure 22. Key Drivers in CHP System Economics



Source: Navigant analysis.

Available at: http://www.intermountaincleanenergy.org/events/2011-07-13/Output-Based_Regulations.pdf. Accessed August 11, 2011.

[83] New York allocation of NOx allowances recognizes the efficiency benefits of "cogeneration systems" and takes into consideration the useful thermal output of a system. American Council for an Energy-Efficient Economy. State Energy Efficiency Policy Database. Accessed at http://www.aceee.org/energy-efficiency-sector/state-policy/New%20York/204/all/195 on May 5, 2011.

[84] Brooks, S., et al. ACEEE. 2006. "Combined Heat and Power: Connecting the Gap Between Markets and Utility Interconnection and Tariff Practices (Part I)." Proceedings of the Twenty-Eighth Industrial Energy Technology Conference.

[85] Hedman, B. et al. October 2002. "Combined Heat and Power Market Potential for New York State." NYSERDA.

[86] Kaufman, N. and R. Elliott. 2010. "The Role of Incentives in Promoting CHP Development." 2010 ACEEE Summer Study on Energy Efficiency in Buildings.

This section describes the economic drivers within each of these three categories and concludes with a discussion of the role of different system ownership models in project finance.

3.6.1 Financing Costs

The system ownership model is the key factor affecting CHP project finance as it relates to project economics. As described in more detail in Section 4.3, the host customer's willingness to accept a greater degree of project ownership and risk can greatly increase the overall project payback and financial rate of return. On the other hand, a host customer that lacks the technical capability, upfront capital or risk profile to directly own a CHP system outright may pursue an ESA or joint ownership model to help defer some or all of those deficiencies.

Regardless of which ownership model a project employs, other secondary financial factors will influence the ultimate cost of a CHP system to a particular host customer. The first of these factors is the system owner's cost of capital, which comprises both the organization's cost of debt (e.g., interest rate on loans) and its cost of equity (i.e., investors' expected rate of return on invested capital). The cost of capital determines the organizations' internal hurdle rate—the rate of return the organization requires for capital investments to gain approval. For the host customer, this often translates into a calculation of the project's simple payback period, or the amount of time required before the project's benefits return the amount initially invested. For a third-party owner, this cost of capital factors into the borrowing costs and profit margins reflected in the ESA price charged to the host customer. In either case, such financial factors help the system owner compare the CHP project to other potentially profitable investments.

The second underlying set of financial drivers comprises the various incentives and tax credits available to the organization financing the CHP project. As described in Section 3.5, the CHP system owner may benefit from various federal (e.g., the ITC and accelerated depreciation) and state or local incentives (e.g., NYSERDA funding).

3.6.2 Design and Construction

While design and construction represent distinct stages in the CHP value chain, the overlap and interdependence of the two phases allow them to be considered under a shared category. Each of the below issues related to system design and engineering directly affects the complexity, duration, and cost of the construction process and plays a significant role in determining a project's ultimate viability.

» ***System Selection and Sizing.*** As described in Section 3.2, each potential CHP technology provides distinct costs and benefits that must be considered by a potential host customer. Beyond the differential capital costs of each technology, the host customer should ensure it has sufficient on-site demand for the system's thermal and electrical output. Insufficient or irregular demand, especially for thermal energy, increases the likelihood of installing an improperly sized system, potentially leading to inefficient operation and lost benefits.

  In addition to site characteristics and intended power uses, the host customer must also consider the specific utility tariffs (e.g., for electricity, gas, and/or standby steam and electricity) that will apply once it installs its CHP system. These tariffs frequently vary based on the host customer's energy consumption and/or the size of the CHP system, and in some cases may cause an otherwise viable project to be unattractive.[51]

- ***Interconnection Requirements.*** As discussed in Section 3.5, substantial improvements have been made to interconnection rules in recent years, including the improvements to the SIRs. However, uncertainties often remain, and utilities may specify unanticipated (and often costly) requirements for a project that can lead to additional engineering studies or equipment not included in the original project budget. The NYSERDA DG-CHP Demonstration Program's current requirement for stand-alone capability during power grid outages may further increase a project's exposure to such design risk. As with the above-mentioned tariffs, unforeseen interconnection expenses can often derail a project completely.[87,88]

- ***Permitting and Siting.*** Similar to the uncertainties surrounding interconnection, the requirements and processes for acquiring air permits and meeting local building codes are often unclear or inconsistent. Permitting costs and requirements may also vary depending on the type, size, and location of a project. With the potential for these requirements to change as a result of a design decision, host customers and engineers may have difficulty anticipating the full scope of permitting costs, or may run into expensive delays as a result of unclear communications with permitting agencies.

- ***Construction and Commissioning.*** The type, size, and complexity of a project and the characteristics of the host customer site can have a wide-ranging effect on the overall upfront cost of a CHP system. Projects often require significant structural work on top of the substantial electrical and mechanical construction that must be completed.[89] In addition, an owner's ability and cost to connect their system to natural gas supplies and the electric grid will vary depending on the condition of the building's existing infrastructure. As with any construction project, any one of these elements is susceptible to unforeseen conditions, delays, and change orders. Following construction, the commissioning process may also uncover design or construction errors or other costly problems that must be corrected before a CHP system can become operational.

3.6.3 Operations and Maintenance

The final category of economic factors comprises the operational aspects of the CHP system, including fuel costs, characteristics of system use, tariffs and standby charges, and maintenance requirements.

- ***Fuel Costs.*** As mentioned above, one of the key operational drivers for installing a CHP system arises from the opportunity to generate less expensive electricity on-site than what a host customer can purchase from the utility. The "spark spread," or difference between the costs of grid electricity and the natural gas that fuels many CHP systems, is a critical factor in determining a project's economic viability. As both natural gas and electricity prices rose

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[87] Hammer, S. and J. Mitchell., eds. 2007. "CHP in NYC: A Viability Assessment." Columbia University.

[88] Brooks, S., et al. ACEEE. 2006. "Combined Heat and Power: Connecting the Gap Between Markets and Utility Interconnection and Tariff Practices (Part I)." Proceedings of the Twenty-Eighth Industrial Energy Technology Conference.

[89] Gas Technology Institute (GTI). 2008. "Opportunities for the Development of Distributed Generation/Combined-Heat-and-Power Systems in New York City Commercial Buildings." NYSERDA.

starting in 2002, spark spreads diminished, making gas-fired CHP systems less profitable than many system owners had forecast.[90] Natural gas wellhead prices have subsequently been in steady decline since July 2008, but it is yet unclear what long-term effect this may have on renewing interest in gas-fired CHP systems. [91]

Some system owners seek to offset the risks associated with natural gas price volatility through long-term gas supply contracts. However, as with any hedging activity, this may periodically result in the system owner paying above market cost should rates end up below the owner's contracted price.

» ***Operating Characteristics.*** The decisions the system owner makes regarding the operation of a CHP system greatly affect the project's overall economics. These decisions are driven by a combination of the host customer's needs regarding facility operating hours and their utility tariffs. In addition, participation in either NYISO or utility demand response programs may offer system owners additional incentives for operating their systems during peak demand events.

» ***Tariffs and Standby Charges.*** Closely linked to the operating characteristics of the system are the standby demand charges the utility imposes on the CHP system owner. From an operational perspective, the impact of such charges depends on the degree to which the host customer relies more heavily on the utility for electricity than he anticipated when the system was installed (e.g., during unexpected CHP system outages).

» ***Maintenance Costs.*** As previously mentioned, ongoing maintenance represents a significant factor in the operating costs of any CHP system. For the more conventional CHP technologies—gas turbines, gas engines, and steam turbines—operations and maintenance costs are fairly comparable, while costs for microturbines and fuel cells are slightly and substantially higher, respectively.[92]

3.6.4 The Role of Ownership Models in Project Economics

As described above, the role of system ownership generally falls among one of three types of market actor: the host customer, the equipment manufacturer, or the project developer (e.g., ESCO). Most host customers in New York opt to directly own their CHP system, either borrowing funds from banks or other typical lending institutions, or purchasing it outright with capital on hand.[93] This model bestows all of the system's financial benefits directly to the host customer, providing the highest rate of return and quickest payback when compared to other third-party-financed models. However, direct ownership burdens the host customer with the majority of project risk, including volatile energy prices, regulatory and permitting challenges, and the costs of downtime that result from equipment malfunction and maintenance.

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[90] Hammer, S. and J. Mitchell, eds. 2007. "CHP in NYC: A Viability Assessment." Columbia University.

[91] U.S. Energy Information Administration (EIA). "U.S. Natural Gas Wellhead Price (Dollars per Thousand Cubic Feet)." Accessed May 9, 2011. http://www.eia.doe.gov/dnav/ng/hist/n9190us3M.htm.

[92] U.S. EPA. December 2008. "Catalog of CHP Technologies." U.S. Environmental Protection Agency Combined Heat and Power Partnership.

[93] Interview with Dana Levy, NYSERDA Program Manager for Manufacturing, Technology, Development and On-Site Power Applications. March 14 and March 24, 2011.

Contracting with other market actors can help reduce these project risks. Risks can be reduced through relationships as simple as a long-term maintenance contract with the manufacturer, albeit at a cost to the host customer's bottom line. Alternatively, the host customer may avoid virtually all project risk by contracting with a third party who takes ownership of the system.

For host customers that lack the willingness or ability to fully fund, operate or maintain a CHP system, two primary third-party ownership models provide opportunities to reduce a project's risk profile. The first uses an ESA, wherein a developer installs, owns, and operates the CHP system at the host customer's facility and then signs a long-term (i.e., ten-year) contract to sell the generated power to the host customer. The cost for this power is usually offered at a discounted rate compared to what the customer would otherwise pay their utility. While this model removes a great deal of the risk to the host customer, it also subtracts the third-party firm's cost of capital and profit margin from the financial benefits realized by the host customer. In a "lease-to-own" variation of this model, the customer makes modest lease payments on top of any power purchased from the third-party system owner. The third-party firm will eventually transfer ownership of the system to the customer or may offer an option to buy out the system before the ESA term expires. In either case, the full benefits (and risks) of operating the system would then revert to the host customer.

The second third-party ownership model takes a hybrid approach, dividing the costs and benefits of the CHP system among the host customer and the ESCO. This "joint-ownership" model might utilize a limited liability corporation or similar joint-venture structure that enables both parties to finance the system. As with the ESA model, the ESCO provides installation, operations, and maintenance services for the system; however, it also shares a portion of the system's financial benefits with the host customer proportional to the customer's equity stake in the project.[94] Alternately, some manufacturers offer simple equipment lease options for owners who wish to own the majority of their CHP system, but would like some risk protection and financing assistance with the generating unit.

3.7 Additional Market Forces

A number of trade ally networks and partnerships play a strong role in advancing the market for CHP in New York and elsewhere, including EPA's CHP Partnership, the DOE-funded Northeast Clean Energy Application Center, and the Northeast Clean Heat and Power Initiative (NCHPI), a joint effort of individuals, organizations, and state and federal agencies. These initiatives provide valuable educational information to the public about the benefits of CHP, and through websites and conferences they serve as a platform for peers within the industry to exchange ideas and lessons learned. The Northeast Clean Energy Application Center provides in-depth support to those interested in understanding whether CHP is appropriate for their facility. NCHPI advocates for policies that help facilitate CHP development.

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[94] Hammer, S. and J. Mitchell, eds. 2007. "CHP in NYC: A Viability Assessment." Columbia University.

4 Market Assessment

4.1 Introduction

This section discusses findings from market actor interviews and relates these findings to topics discussed in the market characterization section of the report. The section highlights key observations about the current status of the market, recent changes that have occurred, and developments that appear likely to unfold in years to come.

4.2 Market Structure-Related Trends

This section highlights key observations about the structure of the CHP market in New York today, highlighting changes in market conditions that have occurred in recent years. The section first describes trends relating to firms offering DG-CHP-related projects and services, then discusses trends related to end-user participation in the market. Discussion of which parties are initiating project activity, and ownership and financing arrangements follows.

4.2.1 Firms Offering DG-CHP Products and Services

Interviewees noted only minor changes in the nature of firm participation in New York's CHP market during the past five years. These changes include a small increase in the number of firms active in the market, an increase in integrated approaches to project development and delivery, and increased specialization or segment focus by market actors. Interviewees also commented on the importance a solid reputation plays in winning work.

Number of Active Firms Slowly Increasing
Several respondents described an overall increase in the number of firms attempting to serve New York's CHP market. Driven largely by New York's attractive spark spread and the availability of incentives, various types of market actors have either introduced or strengthened their focus on CHP-related offerings. For example, some engineering firms and mechanical contractors that serve the building, energy efficiency, and renewable energy markets have added offerings and expertise to capture a portion of the CHP market opportunity.

Similarly, some of the more traditional ESCOs have begun to deliberately pursue CHP projects on a one-off basis versus including a CHP system in conjunction with a larger energy efficiency retrofit. While ESCOs' cost structures and margins may make such a focus more difficult, their ability to offer a performance guarantee may appeal to both project investors and potential system owners. On the other hand, some start-up developers are having trouble securing commitments from host customers and investors based on the firms' lack of both balance sheet security and evidence of past project experience.

A handful of respondents also addressed the perception that under-qualified or underperforming project developers and contractors had oversaturated the market. Some respondents maintained that such firms remain active in the market, overstating potential returns or delivering poorly designed systems to facility owners. Others, while admitting that bad installations had occurred, suggest that the market has successfully shaken out those poorly performing firms. Regardless of whether such firms remain active, respondents agree that the effects of those low-quality projects continue to cause hesitation among facility owners considering CHP systems.

Despite this increase in attention and activity, several respondents agreed that the core group of firms that deliver most projects in New York has grown only slightly and remains relatively limited. Given the complexity of CHP systems, the long lead time for developing a project, and the persistent economic recession, some market actors felt that few opportunities remain for new entrants to gain experience.

Focus on Integrated Delivery Approaches

While respondents could not recall any significant changes in terms of firm ownership, mergers, or acquisitions, several indicated that many firms are finding ways to offer more integrated approaches to project development, design, and delivery. For example, some developers pursuing the design-build or design-build-own-operate (i.e., ESA) models have begun partnering (informally and formally) with specific equipment manufacturers, design engineers, and contractors. Such an approach can enhance the learning curve efficiencies of working repeatedly with similar equipment or designs rather than starting each project from scratch. As discussed below, this trend may also contribute to some degree of segmentation among market actors. In a step toward vertical integration, some manufacturers and distributors are also offering their own design-build services in addition to equipment supply and service contracts.

One building owner mentioned a unique business model for a development firm that had approached him about a system. This developer's approach focused on integrating CHP systems with building management systems and mobile communications networks across several locations, with the intent of aggregating several CHP systems for remote operations. Such aggregated approaches could help facilitate bulk purchases of equipment and attract project financing through the distribution of risk across several projects. Similarly, another market actor commented on the potential for a firm to aggregate several potential CHP systems in a particular area to help divide the costs of any new gas infrastructure that might need to be installed.

Firm Specialization

As mentioned above, several firms indicated that they have begun to tailor their offerings to target specific segments of New York's CHP market. The primary segmentation approach mentioned by market actors focuses on specific types of host customers and facilities. For example, ten responding firms focus their CHP development efforts on the institutional and public-sector markets (e.g., hospitals and schools). Another ten firms focus their efforts on various subcategories of commercial and industrial customers, including high-rise office buildings, multifamily residential properties, and industrial facilities. In addition, seven firms specifically mentioned that their company focuses exclusively on New York City. Finally, most interviewed respondents were more likely to focus their efforts on systems below 2-MW capacity.

Reputation and Word of Mouth Play Key Roles in Winning Work

Six developers explained that they win CHP work by up-selling to existing clients to whom they provide other energy-related services. Five developers expressed that they rely on their reputation and word of mouth to win work.

These perspectives are well captured in one developer's comment,

> *"[CHP project development] is a people and relationships business."*

Experience and reputation play an important role when it comes to "selling" CHP within an organization as well. Two facility owners commented that their leadership approved a second CHP project at a different facility within the organization after the organization had a positive experience with the first.

Since interviewee input indicates that the majority of CHP projects are still initiated by developers as opposed to facility owners, there must be a substantial amount of targeted marketing taking place in the market. However, comments about these marketing channels were relatively rare. One manufacturer explained that his company takes its products to the end users by attending the industry-specific conferences that will be attended by their target audiences, not just clean energy-related conferences. A representative from a large commercial property owner explained that ESCOs and other developers are approaching the company seeking to establish ESAs and use its properties as CHP host sites.

4.2.2 End-User Participation in the Market

This section highlights observations related to end user participation in the market, including reasons for participating, geographic trends in participation, and the types of facilities most interested in participating.

Green Image, Reliability, and Energy Savings Key Reasons for Installing CHP
Facility owners were asked to comment on their reasons for installing CHP. Nine interviewees explained that efforts to reduce greenhouse gas emissions, or to "be green" in general, contributed significantly to their decision to install CHP. An additional four interviewees commented that they installed CHP in an effort to achieve Leadership in Energy and Environmental Design (LEED) certification.

An interest in improving power supply reliability was cited by eight interviewees as a key reason for installing CHP. A representative for a commercial real estate management firm commented,

> *"After the 2003 blackout, customers were asking how [our company] planned to address reliability issues, and we saw lots of increased use of emergency backup generation."*

Six facility owners cited energy cost savings as a key reason for installing CHP, and one interviewee explained that the project enabled his organization to hedge against volatile future energy prices by locking in natural gas supply contracts. It is somewhat surprising that so few facility owners identified costs savings as the key driver behind their CHP installation; a review of interviewee comments as a whole seems to indicate that cost savings is, in fact, a more fundamental driver behind the decision to install CHP. It may be that interviewees did not specifically mention cost savings because they considered it to be a given.

Four facility owners cited reasons related to load growth. Two of these interviewees explained that their tenants expect access to a certain amount of energy per square foot of leased space, and distribution system infrastructure serving older buildings can limit a facility's ability to meet these tenant demands. CHP can function as an alternative to paying for costly distribution system upgrades that a facility owner would otherwise incur to satisfy tenant load.
Two facility owners representing colleges and universities explained that a key reason for their CHP installations was to use CHP as a tool for educating students. Two interviewees cited an interest in making use of waste heat. Two other interviewees explained that they installed CHP because they were approached by a developer and it sounded like a good idea.

Recent CHP Activity is Concentrated in New York City
Despite the fact that interconnection and logistical hurdles are many, and the costs of real estate and construction are high in New York City, interviewee comments demonstrate that this area is the focus of the majority of CHP development activity in the state. This observation reflects a shift in the market; during earlier periods of CHP development in New York, industrial facilities located in the central and western parts of the state accounted for much of the CHP development activity.

While several interviewees specifically commented on the fact that the CHP market is much more favorable in the downstate area than the upstate area of New York, most interviewees simply focused their comments on the downstate market because that is their area of focus. One developer explained,

> *"New York City has many factors supporting CHP, [including congestion pricing and other factors]. We do energy efficiency work in other states, but for CHP, we work in New York City only."*

An industry expert remarked,

> *"[The upstate and downstate markets] are two different universes…. Downstate you have an incredibly ripe market for CHP."*

This interviewee identified key features of the downstate market that make it so much more favorable than the upstate market, including economic conditions (higher electricity pricing), demographics, local government support for the CHP market (e.g., New York City CHP Task Force), and greater demand for reliability.

As described in Section 3.5, New York City has taken a proactive stance in supporting CHP development (e.g., setting a clean DG development target, and producing a developer's guide to CHP development). Furthermore, the Demonstration program has made an effort to encourage CHP development in the New York City area by offering projects located in that area with bonus points in the proposal review process. While these efforts help reduce barriers to development in NYC, the most powerful force driving development in the downstate area is favorable project economics. Electricity prices in the Con Edison service territory are substantially higher than in other utility territories.

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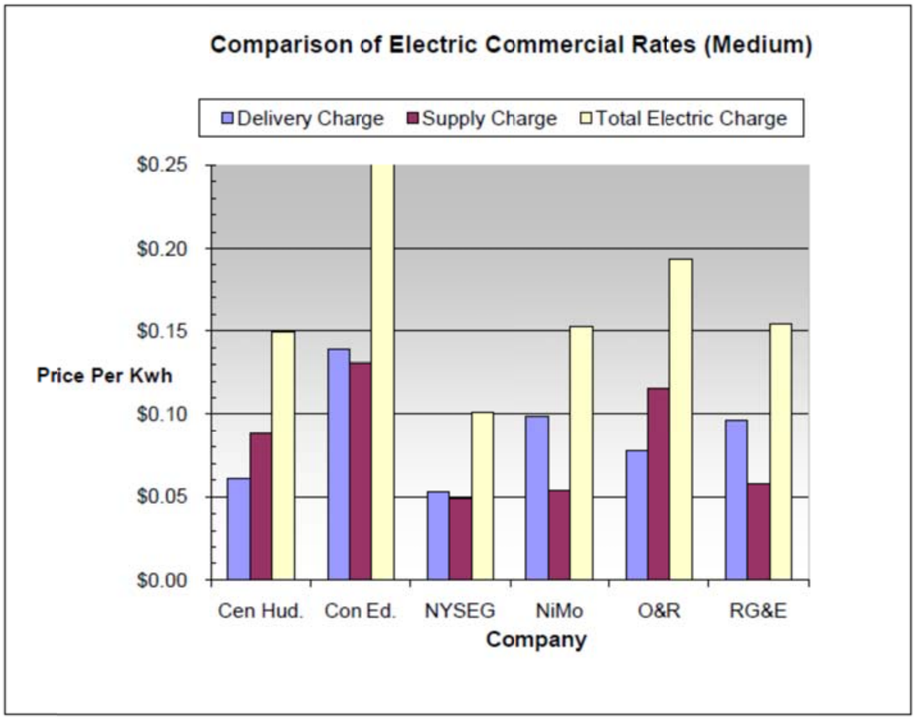
Table 6. Comparison of Commercial Electric Rates Across Utility Service Territories, January 2011



Source: New York Department of Public Service. Monthly Commercial Bills Including State GRT, Major Electric Companies. January, 2011.

As a few interviewees noted, transmission congestion issues contribute to the high electricity pricing in the downstate region. For purposes of achieving economic efficiency and system reliability, the New York Independent System Operator (NYISO) uses a Location-Based Marginal Pricing (LBMP) structure. LBMP is the marginal cost of the next unit of energy at a specific location in the grid at a given point in time. It reflects the costs of electricity, transmission congestion, and transmission-related energy losses. NYISO sets LBMPs for each geographic zone in New York State based on the prices bid into its markets by electricity generators and load-serving entities.[95] These LBMPs are ultimately reflected in retail electricity prices. Because transmission congestion is a significant constraint in the downstate electric grid, LBMPs, and thus retail electricity prices, are much higher in the downstate area.

Installation Activity Increasing at Facilities Seeking Reliable Power

The types of facilities that have always been good candidates for CHP (e.g., hospitals and universities) continue to see a significant amount of activity. However, there appears to be an increase in interest and installation activity at facilities that place a high premium on reliable power (e.g., banks and data centers). Other types of facilities that interviewees reported are seeing an uptick in activity include

[95] New York Independent System Operator. "Location Based Marginal Pricing: The Cornerstone of the NYISO Market Operation." Available at: http://www.nyiso.com/public/services/market_training/online_resources/lbmp_online.pdf. Obtained August 21, 2011.

facilities with continuous operations that can also benefit greatly from reliable power (e.g., nursing homes and supermarkets).

4.2.3 Initiation of CHP Project Development

Based on interviewee comments it appears that facility owners play a fairly active role in the process of initiating CHP projects, though on the whole, developers are more likely to take the lead in proposing a project. One interviewee commented,

> *"Often a project is initiated from the outside, then that makes a light bulb go off for a prospective internal champion, and things go from there."*

Seven developers explained that about 50 percent of projects are initiated by clients contacting them, and the remaining 50 percent of projects are initiated by the developer. Five developers indicated that they initiate most, but not all projects. Two of these developers reported that they are responsible for initiating about 60 percent of their work, and the other 40 percent are initiated by clients. Another developer described a 75 percent/25 percent split, in which his company is typically the party proposing a CHP installation to prospective clients.

4.2.4 Ownership and Financing Arrangements

Most interviewed developers and system hosts indicated that the majority of CHP projects installed in the past several years have been owned outright by the energy end user. While some developers focus their sales efforts on ESAs, the few projects actually installed under third-party ownership arrangements primarily utilized equipment leases. This trend toward direct ownership holds across all prime movers and systems sizes. Several developers indicated that such third-party ownership arrangements are geared toward larger system sizes that were underrepresented in this study.[96]

This section discusses these ownership and financing trends in greater detail. The first subsection discusses a few notable sources of financing for host-owned systems. The second explores the trends identified for the few projects, owners, and developers using third-party ownership models. The final subsection focuses on the continued barriers to wider adoption of such third-party ownership arrangements.

Trends in Direct System Ownership

Several market actors explained that the continued trend toward direct system ownership indicates host customers' desire to capture the full benefits of their investments. Most host customers who ultimately decide to install a system take the time to truly understand the project's economics. Based on that knowledge, they prefer to capture the full economic value of the system themselves rather than sharing benefits with a third party. One owner of a reciprocating engine CHP system explained it this way:

> *"We had a lot of people who came in…to pitch their companies. Most of them were PPA structures. We convinced ourselves, correctly I think, that we had the balance sheet to carry it. And if there was*

[96] The majority of interviews (owners and developers) referenced projects with capacities below 1.0 MW.

economic value on paper, that rather than do a PPA with someone else, we'd rather own the facility outright, because we've thought of the revenue generating activity for us."

The financial modeling required to understand a system's economics arms host customers with enough information to make a case to self-finance the project through existing channels. This may involve asking boards of directors for access to cash or capital reserves, issuing bonds, or seeking loans directly from banks or other investment partners. In most cases, the third-party ownership option only comes into play for institutional customers (e.g., hospitals and schools) who have limitations on adding debt or other liabilities to their balance sheets.

Sources of Capital for Self-Financed Systems

Self-financed system owners can draw on diverse resources to help fund investments in CHP projects. Outside of cash or reserves, several system owners mentioned one of the following financing sources as playing an important role in funding their projects.

» **Grants and Incentives.** Owners and developers both agreed that few projects were likely to move forward without the financial assistance available through various grants and incentive programs. Many specifically mentioned NYSERDA programs, including the DG-CHP Demonstration Program and others such as the Existing Facilities Program. In addition, the 10 percent federal ITC and grants from organizations like DOE and the City of New York have played a key role in several projects.

» **Commercial Bank Loans and Interest Buy-down Programs.** Once a system owner factors available grants and incentives into their financial model, many seek to fill any remaining funding gap with commercial loans. Several owners and developers mentioned the helpfulness of NYSERDA's former Energy Smart loan program in buying down the interest rate for loans.

» **Equity Partner Contributions.** On the private-sector side, many system owners draw upon equity contributions from either directly vested or third-party partners. For example, a building owner may contribute to a system installed by a tenant, or each co-owner of a larger property may invest a share proportional to their overall equity stake in the property. In other cases, the system owner may simply seek outside private equity investment.

» **Conduit Bond Issuances.** Three CHP system owners from institutional organizations mentioned drawing upon conduit bond issuances to help finance their projects. A conduit bond is one "sold by a public authority to benefit a third party, generally non-governmental."[97] For example, the New York Dormitory Authority could issue a conduit bond to provide funds for a project at a private university. The repayment of the bond is tied to the recipient of the bond proceeds rather than the issuing agency.

[97] For more on conduit bonds in New York, see "What is non-State-Funded Debt?" at http://www.osc.state.ny.us/press/debtfaq.htm

Trends in Third-Party System Ownership

Several market actors advocated the potential benefits of third-party ownership arrangements and their use in other projects (mostly outside of New York). However, few of the specific systems covered by the team's interviews involved such ownership models. Long-term equipment leasing agreements were more common than ESAs, but in most cases host customers owned and financed their systems independently. The remainder of this section presents trends for projects that used some form of third-party ownership, while the section following further explores potential barriers to more projects using such arrangements.

Awareness and Use of Energy Service Agreements

Market actors have high levels of awareness of the various third-party ownership models, and several interviewed system owners had considered such arrangements before ultimately settling on a direct ownership model. As previously mentioned, actual implementation of projects using third-party ownership models was very limited among the interviewed populations. Only two of the more than forty interviewed system hosts used an ESA for a financed project.

Most market actors agreed that the model generally appeals to institutional energy users such as schools or hospitals that lack the balance sheet strength to self-finance a CHP project. In addition, ESAs and other performance contracts can help a public institution finance a project without taking on additional debt, which may require voter approval. Three institutional customers (two schools and one hospital) with stalled or canceled projects discussed their intention to use ESAs or performance contracts; however, their projects had been unable to proceed for various reasons. Notably, both of the interviewed project owners that had installed projects with ESAs are private-sector organizations.

Several developers similarly commented that the ESA model is more appropriate for larger capacity CHP systems like those used in campus applications. One developer stated that developers' narrow profit margins generally do not provide for attractive enough returns on projects below 1.5 MW without substantial upfront incentives. Other developers confirmed this perspective, suggesting that the lower upfront costs for smaller systems are more geared toward direct ownership, as the host customer has a higher likelihood of independently financing the project.

While few interviewed host customers used the ESA model, several project developers discussed using the model in past projects or systems installed in other states. This apparent disconnect could indicate a general trend toward direct ownership of CHP systems. However, based on developers' sense that ESAs occur more with larger systems, the trend may also simply reflect the increasing frequency of smaller capacity systems as discussed in Section 3.3.

Awareness and Use of Equipment Leases

Among interviewed market actors, most of the installed projects that used third-party ownership arrangements involved equipment leases. As discussed in Section 3.6, a long-term equipment lease provides a host customer another opportunity to finance a CHP system without a large upfront cost. In the case of an operating lease, such agreements may also allow a customer to keep monthly lease payments from appearing on its balance sheet. Such off-balance-sheet financing may be a particular concern for organizations (e.g., hospitals) with limited debt capacity.

Unlike ESAs and performance contracts, equipment leases are a commonly understood and applied financing mechanism for both private- and public-sector organizations. Notably, an equipment lease may cover only a portion of the overall CHP system, typically the core generating technology (i.e., the turbine or fuel cell itself). The host customer retains ownership of the balance of the system. Market actors did not indicate any notable differences in the types of customers or systems likely to use an equipment lease.

The team spoke with owners and developers from three projects that are using different types of long-term lease arrangements. The details of each lease vary, as do the projects to which they apply. The systems involved range from approximately 200 kW to 600 kW, and include a fuel cell, microturbines, and reciprocating engines. Two of the leasing agreements are structured as capital leases, essentially lease-to-own arrangements where equipment ownership will transfer to each of the host customers after a set term (e.g., ten years) of monthly payments. Both of these projects involved institutional organizations. The other lease—with a private-sector host customer—was a component of an ESA and effectively served as a monthly operating lease.

While generally less complicated than ESAs, equipment leases also involve potentially confusing accounting issues that may discourage some organizations from using them. The next section discusses these issues and other barriers to broader acceptance of third-party ownership arrangements.

Barriers to Expanding Third-Party Ownership

While many customers lack the risk profile or balance sheet capacity to directly own a CHP system, potential projects involving third-party ownership arrangements continue to falter. Several developers explained that system host customers still have not made the paradigm shift required to accept a third party owning and operating a system at their facility. Other developers and owners, however, attributed the lack of uptake to several practical barriers that may be difficult for the market to overcome.

Adding Confusion to a Complicated Decision

As discussed in Section 3.4, owning and operating a cogeneration system falls well beyond most energy end users' core organizational competencies. The decision to install a CHP system involves a complex set of technical and economic considerations that can easily overwhelm an organization. Adding complicated financing arrangements to the equation can increase the uncertainty surrounding potential paybacks, and raises important questions about accounting rules that may be unclear to decision makers.

Some developers discussed the difficulty in selling the ESA model to institutional customers who have concerns about the balance sheet, depreciation, and tax impacts of such agreements. Unfortunately, the accounting rules for treating these arrangements lack clarity. The International Accounting Standards Board (IASB) and Financial Accounting Standards Board (FASB) are in the middle of a process of updating accounting standards to bring U.S. accounting practices more in-line with international principles. One key change will affect accounting for operating leases, essentially requiring that they appear on the leasing organization's balance sheet.[98] Until the IASB and FASB finalize these proposed

[98] Price Waterhouse Coopers. July 2010. "The overhaul of IFRS lease accounting: Catalyst for change in corporate real estate." Accessed August 22, 2011. Available at: http://www.pwc.com/gx/en/asset-management/ifrs/ifrs-lease-accounting-0710.jhtml.

changes (which is expected by the end of 2011), organizations may approach new long-term leasing arrangements with caution.

Added Costs of Financing

ESA and ESCO-type ownership arrangements also suffer from host customers' recognition that transferring risk to a third party raises overall project costs. In addition to the profit margin earned by the developer or ESCO, any parties financing that developer also require a certain rate of return. Whether that financing comes from commercial loans or private equity, the additional required returns and loan interest pass through to the project. Developers noted the effects of less favorable financing since the economic downturn in 2008, including shortened loan terms (e.g., 8 years versus 15) and higher interest rates. One developer explained that a five-year payback on an owner-financed project can increase to eight years based on the current financing terms available to most ESCOs and developers. In many cases, host customers may feel that the increased costs to cover this risk transfer are simply not justified or that they would be better off finding financing on their own.

Third-Party Solvency Concerns

Another concern cited (though less frequently) by host customers considering third-party ownership arrangements involved uncertainty about the solvency of the developers pushing ESA or performance contracts. With the increase in awareness and perceived opportunity in New York's DG-CHP market, new market entrants are seeking to develop, finance, and own CHP systems on behalf of host customers. However, some host customers have expressed concerns about their risk exposure should the third-party owner face bankruptcy, especially in the face of a persistent recession.

Mitigating Capital Issues Through Loan Programs

While the above issues may prove difficult for developers to mitigate, some indicated that the barriers stemming from increased capital costs could be partly mitigated through various loan programs. Several system owners and developers mentioned the importance of interest rate buy-down programs, such as the former NYSERDA Energy Smart Loan Program, in helping projects move forward in the past. One developer mentioned that several projects were shelved when funding for this program ceased in 2007. When the economic downturn hit a year later, those projects were essentially forgotten.

One potential policy option for helping faltering projects move forward could involve the provision of either a similar interest-rate buy-down program or a revolving loan-guarantee fund for qualifying projects. Whether made available through state or federal channels, such funds would reduce the capital constraints facing many CHP projects.

4.3 Economic Trends

This section presents a discussion of market trends pertaining specifically to projects' economic viability, as well as economic conditions as a whole. Because such a diverse set of factors affects project economics, some topics addressed in this section are discussed elsewhere in the report as well; discussion in this section focuses specifically on the ways in which these factors affect project economics.

4.3.1 Project Economics

This section discusses findings from interviews as they relate to the various facets of CHP system economics. Following a general introduction to payback expectations among different types of system owners, it describes the leading factors that contribute to a project's viability. Subsequent sections examine how the economic recession has affected project economics since 2008, and how recently installed systems have performed against owner and developer expectations. The section concludes with a discussion of the risks market actors perceive to future CHP project economics.

Project Payback Expectations

Project payback requirements vary widely among current and potential CHP system users. Generally speaking, public-sector system owners will accept a longer payback period (e.g., 5-10 years) than that of their industrial or commercial counterparts. However, even within a particular market segment (e.g., hospitals or colleges), owner expectations lack consistency. A key contributor to this variation stems from the increasing influence of the sustainability, energy efficiency, and green-building movements in the market. Many energy end users will consider a CHP system that falls outside of their usual payback threshold if that project contributes to their perceived competitive advantage or other intangible benefits such as a green image.

Based on interview responses, the team could not infer any meaningful variation in payback expectations for different prime movers or system capacities.[99] The number and complexity of factors contributing to a project's payback calculation—equipment costs, contracting arrangements, fuel costs, financing—are simply too extensive to allow simple comparisons.

Industrial Energy Users

Several developers suggested that industrial end users maintained a strict project payback threshold of three years or less for any capital improvement project. Other potential investments than can help lower costs or raise productivity can create high opportunity costs for capital in a manufacturing setting. Despite some indications that opportunities to install large (>2 MW) CHP systems at industrial facilities in New York have diminished, other developers feel confident that potential for such systems remains. As will be discussed more in subsequent sections, uncertainty caused by the ongoing economic recession has effectively stopped any nonessential capital improvement projects for many industrial organizations. The possibility of missed revenue targets or facilities closing altogether has many organizations hesitating to make plant and equipment investments.

Commercial Energy Users

Payback expectations cited for commercial energy users ranged widely. Some developers suggested that commercial customers require a two-year minimum payback; however, some owners discussed projects with paybacks between five and ten years. Market actors explained this greater leniency in two ways. First, the project's contribution to a commercial business or property owner's sustainability efforts (e.g., LEED certification) enables many organizations to accept a longer than usual payback. Secondly, those who have installed (or are considering) CHP systems in New York City have come to recognize the

[99] The majority of interviews (owners and developers) referenced projects with capacities below 1.0 MW, making economic comparisons with larger systems difficult.

added complexities and costs of implementing a project there. To some degree, many system owners have accepted these effects as an added cost of doing business in New York City. These issues—gas infrastructure, permitting, interconnection, emissions, opportunity costs of space—are discussed in more detail in the next section.

Institutional Energy Users
Public institutions such as hospitals and colleges will generally accept projects with longer payback periods than those in the private sector. Market actors suggested payback expectations ranging from 7 to 15 years in this sector. This willingness primarily stems from a combination of these organizations' not-for-profit missions and long-term planning horizons. CHP projects can provide institutions with greater long-term certainty surrounding energy costs, critical infrastructure support (particularly for hospitals), and enhanced sustainability profile. Further, unlike an industrial or commercial energy user, hospitals and colleges are unlikely to abandon or divest a particular property.

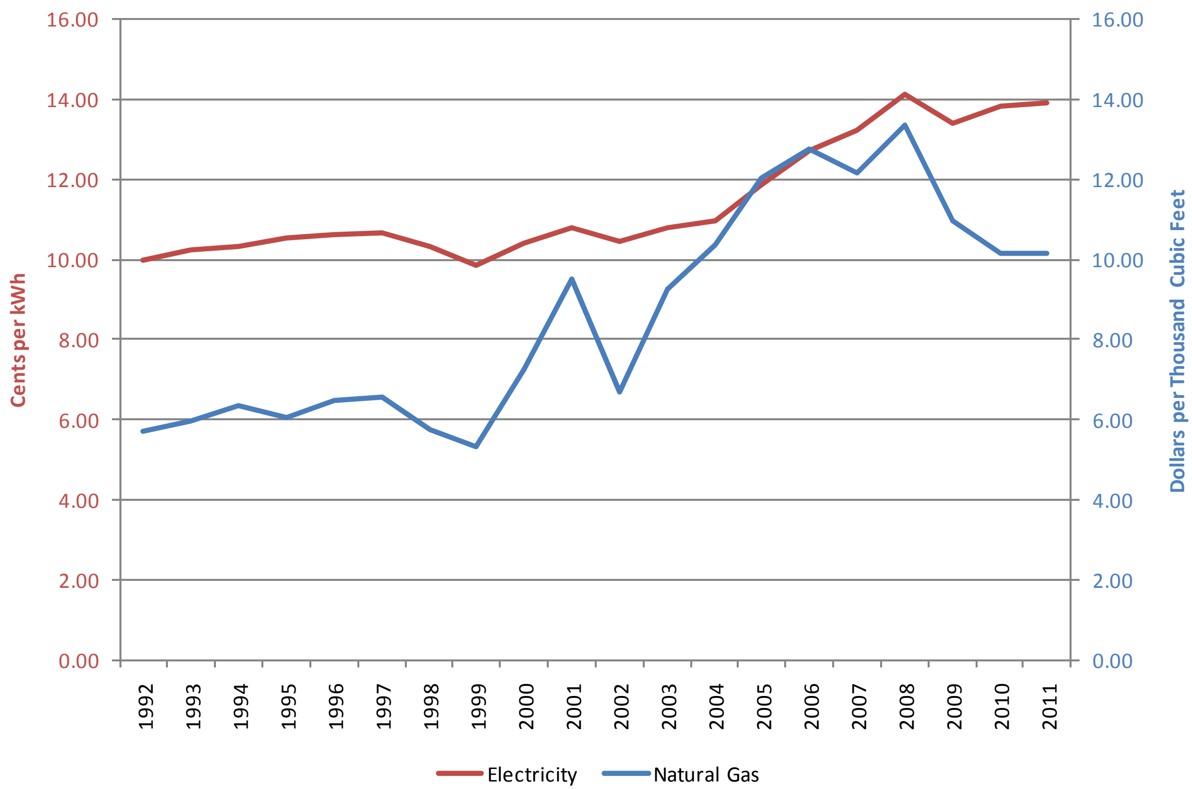
Leading Factors in Project Economics
The economics of a CHP system can vary widely based on several factors. These include the nature of the host customer's thermal load, ownership and financing arrangements, and site-specific design- and construction-related issues. While different energy users may have unique goals and payback thresholds when considering a CHP system, most referred to a common set of economic factors that affect a project's viability. This section summarizes those considerations.

Appropriate System Design
Every system's payback equation begins at the initial technology selection and design phase. Both developers and system owners echoed the core principle that CHP systems should be designed around the end user's thermal load, not their electric demand. Depending on the nature of the end user's thermal load (i.e., steady versus variable) and their intended use of the system (i.e., baseload versus peaking), the design engineer can recommend an optimal system capacity. Technology selection and system sizing must also account for the physical site constraints of the host facility. A well-designed system will address natural gas line and exhaust stack access, noise and visibility considerations, and structural support requirements as key issues that may affect the system's installed cost. As discussed in subsequent sections, a poorly designed system will likely fail to meet the owner's payback expectations, whether from poor thermal load matching or other key design omissions.

Commodity Cost Uncertainty
The core economic argument favoring distributed CHP installations stems from the increased efficiency of generating both thermal and electrical energy at the point of consumption. Therefore, long-term natural gas and electricity price trends represent key variable costs for CHP system owners. Most market actors cited New York's attractive spark spread as a key driver for the state's CHP market. However, the spark spread is highly variable. While the economic model used to predict a system's payback should account for a range of possible natural gas and electricity costs, an inability to predict future pricing introduces an inherent investment risk.

Figure 23 shows the variability in natural gas and electricity prices that has existed over the last two decades. One can see that an analysis conducted in 2006 would indicate a narrowing of spark spread, and thus, a much less favorable outlook for CHP than one would find if focusing on the trend in spark spread that has been unfolding since 2008.

Figure 23. U.S. Mid-Atlantic Regional Commercial Electricity and Gas Prices, 1992–2011



Sources: *EIA Natural Gas Monthly*, August, 2011; *EIA Electric Power Monthly*, August 9, 2011.

Deciding to install an on-site CHP system involves difficult assumptions about the likely behavior of commodity markets. The long-term trends in the above figure demonstrate why developers and host customers have so much trouble settling on those assumptions, even when current spark spreads are so attractive. A project's payback equation may also vary as a result of the different strategies system owners employ for commodity purchasing and risk management. For example, trading in natural gas futures contracts or using other hedging strategies can help reduce cost variability, but also involve significant transaction costs.

Increased Payback Complexity for CHP Systems in New York City

Most CHP projects involve some level of cost uncertainty related to issues like interconnection and commodity costs. However, several market actors expressed particular difficulty in anticipating the various costs of designing and installing a system in New York City. Factors such as the density and age of buildings, the structure and capacity of gas and electrical distribution systems, and regulations from various state and local agencies add a layer of complexity to such projects. The following describes sources of unpredictable costs likely to affect the economics of a project in New York City.

- **Insufficient Natural Gas Supply Infrastructure.** In some cases, the existing natural gas line serving a facility may not have sufficient capacity to provide the volume of gas required for the specified CHP system. Unfortunately, the facility owner cannot reasonably predict their expected share of the cost estimate that Con Edison provides for upgrading the supply line. Furthermore, when Con Edison will supply such estimates is also uncertain, potentially leaving significant project costs unknown until late in the design process. Developers and system owners provided anecdotes of projects being canceled when Con Edison provided higher-than-anticipated gas infrastructure cost estimates.

- **Complexity and Age of Electric Distribution System.** Similarly, the age and complexity of ConEd's electrical distribution system makes it more difficult for market actors to anticipate interconnection requirements and costs. Many developers recognize the legitimate safety and reliability concerns that the utility must address before agreeing to interconnect a CHP system. However, such technical issues (and resulting costs) may not be well understood by less experienced market actors.

- **Permitting.** Several market actors discussed the potential costs that may result from the myriad permitting requirements for a CHP project in New York City. Projects require permits from the Buildings Department, Fire Department, and the Department of Environmental Protection, with specific requirements differing based on the size and type of system.[100]

In addition to the unknown costs surrounding permitting and electrical and gas infrastructure, each of these issues also creates schedule risk for a potential CHP project. As project time lines drag on, commodity forecasts may change or host customers may find other capital investment opportunities.

Effects of the Recession on Project Economics
Across the board, market actors expressed concerns about the economic recession's toll on the CHP market. While projects continue to move forward, the recession has slowed the market through several interrelated factors, as described below.

General Economic Uncertainty
Most market actors commented on the general tightening of capital budgets within organizations that might invest in a CHP system. A down economy decreases revenues for both public and private organizations, leading to cutbacks in capital improvements. As stated elsewhere in this report, a CHP system is a nonessential investment for most energy users. When the economic crisis struck in late 2008, many potential projects were postponed indefinitely. Even an industrial energy user for whom a planned project may show a modeled payback of 2-3 years faces enough uncertainty to prevent the project from moving forward. As previously mentioned, a particular facility for a manufacturing company could significantly scale back or even close in that short time frame.

[100] New York City Department of Buildings. (2010) "Installing Natural Gas-fueled Combined Heat and Power (CHP) Systems: A Guide to Required Permits, Inspections and Available Incentive Programs for Property Owners and the Construction Industry."

Availability and Cost of Capital
In addition to reduced internal funds at most organizations, the availability of attractively termed external financing has also decreased. Market actors cited stricter lending requirements, shorter lending periods, and higher interest rates as factors contributing to higher costs and stalled projects. In addition, the usefulness of the 10 percent federal ITC depends on the size of the tax equity market. During a recession, tax equity investors have lower revenues and pay lower taxes, decreasing their overall appetite for such tax credits. Competition for the remaining tax equity among other projects (e.g., wind farms) eligible for such credits drives up the cost of financing projects with the ITC. This tightening of credit markets affects financing for direct- and third-party ownership models alike.

Developers provided conflicting views of the attractiveness of CHP projects to potential investors. One developer suggested that investors have turned their attention to energy projects due to the continued lack of opportunities in the real estate market. As a counterpoint, however, another developer suggested that private equity is flowing more to projects that can secure long-term contracts with more predictable revenues. This might include large-scale renewable energy installations with long-term power purchase agreements and access to markets for selling renewable energy credits (RECs).

A representative from the financial industry noted, "[NYSERDA's] loan fund program ended a year before the financial crisis, and at that time a number of projects were put on hold indefinitely, and ultimately not picked up because of the later downturn in the economy."

Commodity Price Volatility
With CHP project economics so closely tied to spark spread, most market actors commented on the changing trends in both gas and electric prices over the past several years. As previously discussed (see Figure 23), natural gas prices have declined sharply in the past three years to below 2004 levels. Just as electricity rates began decreasing in response to lower gas costs, the recession was also leading consumers to reduce their electricity consumption. While the drop in gas prices is driving substantial interest in CHP, some developers continue to cite lower-than-expected retail electric rates as a barrier to some projects moving forward.

In addition, the interest in CHP driven by lower natural gas prices is tempered by investors' and host customers' wariness of that market's historic volatility. One developer recounted how past periods of such volatility have also caused projects to be shelved.

Economic Performance of Recent CHP Systems
The proceeding sections described key economic considerations and effects of the economic downturn on CHP system economics. This section explores market actors' responses regarding the economic performance of installed systems within that context. Note that responses in this section represent only 16 individual developers and system owners. Several projects were still in the construction or commission stages, or had not been operating long enough for the owner or developer to comfortably discuss the system's overall economic performance.

Half of the respondents claimed that their CHP systems were meeting expectations for economic performance and payback. These responses comprised each major type of prime mover, and responses did not vary noticeably between program participants and nonparticipants. While some respondents reported minor variations from their modeled paybacks based on standby charges or early technical issues, all were satisfied that their systems were generally on track economically. The other half of the respondents provided a variety of reasons for their projects failing to meet payback projections. Again, no clear patterns existed in regards to prime movers or participation in NYSERDA's program. The reasons cited for poor economic performance of systems fell into one of the following four categories.

Improper System Design
In several cases where system owners or developers discussed poor design, systems had been improperly sized (generally oversized) based on the end user's thermal or electrical loads. In one case, the developer cited miscommunication about tenant occupancy rates between a property owner and its management company, leading to an oversized system. Other design errors involved poorly designed or improper specification of auxiliary equipment such as heat exchangers or pumps.

Equipment Malfunction and Other Technical Issues
Several market actors explained that most technical issues arise either during commissioning or early on in a system's operation. Manufacturers' warranties cover repair and replacement of most affected equipment, and system owners seemed satisfied with the responses of manufacturers and developers in solving these early-stage problems. On the other hand, some system owners reported persistent, unexplained, or later-stage equipment issues that have resulted in unexpected and unacceptably long system downtimes. In one case, an owner reported his system was down for 1.5 months while the manufacturer dealt with a repeated problem. While warranties cover equipment repair costs, they may not account for the owner's lost savings or exposure to standby power charges during downtime events. Additional discussion of specific types of technical issues appears in Section 874.6.

Changing Spark Spread
As previously mentioned, the economic performance of most systems can vary greatly with changes in the spark spread. While many system owners hedge this risk through long-term gas supply contracts or futures contract trading, these mechanisms cannot fully protect owners from such variations. Conversely, gas or electricity prices can periodically result in better-than-expected project economics; however, market actors may be more likely to report the downside of such changes. Several developers and system owners reported cases where paybacks have fallen short due to commodity price shifts (both gas and electricity) outside of the ranges they expected. Two developers also mentioned potential long-term performance implications for owners who stop running (and maintaining) their CHP systems when the spark spread is less favorable.

Standby Tariffs and Other Unexpected Operating Costs
A handful of system owners and developers attributed their projects' poor economic performance to higher-than-expected demand charges and standby rates. While such charges could stem from inaccurate modeling assumptions, exceeding agreed-upon demand could also be symptomatic of system design errors or unexpected downtime. On top of higher standby charges, one developer reported that increased property taxes on a facility with a newly installed CHP system also affected the project's overall payback.

Economic Risks Facing the CHP Market

Unsurprisingly, the issues that market actors perceive as posing the greatest risks to system performance and future project viability have appeared repeatedly in previous sections. Each of the following risk factors—listed in order of decreasing emphasis by respondents—was mentioned by multiple market actors. The final subsection describes the mitigation strategies owners and developers discussed using to address these risks.

Commodity Price Uncertainty

One in every three market actors responding to questions about market risk discussed the uncertainty surrounding energy markets, particularly in regard to natural gas prices. Both developers and system owners expressed cautious optimism about gas prices remaining low. However, most reiterated that a sudden uptick in prices would have severe, negative consequences for the CHP market. Specifically, respondents have concerns about potential environmental regulations aimed at hydraulic fracturing and the chemicals used to produce natural gas from shale. In addition, recent media reports have questioned the validity of commodities futures forecasts for natural gas based on the role of the technology.[101]

Regulatory Risk

Market actors also perceive a relatively high degree of risk from unanticipated changes in utility and regulatory agency policies. For example, changes in utility tariffs and standby rates can harm CHP project economics by increasing the potential demand charges projects face for unexpected downtime. In addition, continued (or increasingly) strict permitting requirements can create unintended barriers or costs for installing CHP systems. This includes not only air permitting, but also various building and safety codes. One developer suggested that agencies should simplify permitting requirements for smaller systems. He explained that imposing the same requirements that apply to an 8-MW system onto a 1-MW (or smaller) system creates unnecessary costs and complexities that discourage mid- and small-sized CHP installations.

In addition to potentially significant added costs for projects, market actors also indicate that inconsistent or varying policies simply create too much uncertainty among project owners and investors. Lead times between the initial design and actual construction and commissioning of CHP systems often exceed two years. Developers fear that future policy changes could ruin projects in which they have invested significant time and money. One developer stated that state governments often deter activity by creating uncertainty in the market. He then explained that his company had canceled hiring a new manager for the New York market in 2010 when NYSERDA staff expressed uncertainty about the future direction of the CHP program.

Persistent Economic Recession and Reduced Incentives

Several market actors expressed concerns about the effects of a prolonged economic recession, particularly as it applies to the availability of capital. Continued tightening of public- and private-sector capital improvement budgets could threaten projects currently in their planning stages. Other respondents feared that incentives for CHP projects will disappear as decreased revenues and spending cuts continue to pinch state and federal budgets. In addition, financial market uncertainty and reduced

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[101] Urbina, Ian. 2011. "Insiders Sound an Alarm Amid a Natural Gas Rush." *The New York Times*. June 25, 2011. Accessed August 22, 2011. http://www.nytimes.com/2011/06/26/us/26gas.html?pagewanted=all.

tax equity may make private equity investors and banks less willing to provide reasonably termed project financing. As summarized by one equipment distributor, even the most beneficial of CHP projects cannot move forward without affordable access to capital.

Infrastructure-related Barriers in New York City

Speaking specifically about the New York City market, several respondents perceived significant risks related to existing buildings and gas distribution infrastructure. For the former, respondents cited the relative lack of existing chimneys to provide for exhaust from new CHP systems. As mentioned earlier, code requirements for installing new stacks or gas lines in existing buildings may also add significant costs to an otherwise viable project.

A few additional market actors expressed concerns over the state of Con Edison's existing natural gas distribution system. Previously planned CHP projects have been canceled based on the utility's cost estimates for installing the larger capacity gas lines required to supply proposed systems. The demand for and cost of such gas infrastructure improvements may be further heightened by the City's recently announced regulation requiring the phase out of No. 6 and No. 4 heating oil by 2015 and 2030, respectively. The new regulations, combined with currently low natural gas prices, may encourage some building owners to convert their buildings' heating systems to natural gas ahead of the deadlines. [102]

4.3.2 Economic Risk Mitigation Strategies

In light of the market threats posed by the above described risks, several market actors shared their intended strategies for reducing the potential scope or impact of issues on existing and future CHP projects. Most commonly, developers and system owners rely on long-term (e.g., three-year) gas supply contracts or, less commonly, trading in commodity futures to mitigate their exposure to price volatility. As previously discussed, such contracts could also reduce potential savings if gas prices decrease below a system owner's contracted rate; however, the main focus of such contracts is to reduce the owner's exposure to significant downside.

Avoiding project ownership, and instead entering into energy services agreements or performance contracts with developers or ESCOs is another strategy facility owners use to limit exposure to financial risk. However, the underlying market risk must still be borne by other market actor(s), such as a developer, manufacturer, ESCO or some combination of the three. An inability or unwillingness for market actors to bear this risk makes market volatility an unavoidable barrier to the CHP market as a whole.

In response to regulatory risk, incentive reductions, and infrastructure barriers, market actors' primary mitigation strategy focused on increased political and regulatory involvement. Whether working independently or through lobbyists, some developers and owner organizations suggested they actively seek to influence policymakers and regulatory decision makers on these key issues. This included pressing the utility and the PSC for changes to steam and electricity tariffs that might limit the size of certain projects.

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[102] Toy, Vivian S. 2011. "Going Green in New York: One Co-ops Story." *The New York Times.* July 22, 2011. Accessed August 22, 2011. http://www.nytimes.com/2011/07/24/realestate/10000-buildings-get-the-word-on-dirty-fuel.html.

In the shorter term, system owners discussed alleviating some of these risks through various contractual relationships with other market actors. Common project risks related to system design, equipment failures, and fuel supply are quantifiable. Project developers and other service contractors, who are better positioned than owners to address those risks, can price those risks into the various contracts they offer system owners.

4.4 Policy and Regulatory Trends

On the whole, the team found that policy and regulatory conditions are improving though some barriers remain. Policy and regulatory ***barriers*** are discussed later in Section 4.7. This section highlights overall policy and regulator trends.

Four interviewees reported that regulatory challenges are less of a burden than in the past, and several interviewees pointed to a stronger commitment to CHP among policymakers in New York City as a positive market development.

Three interviewees highlighted the importance of New York City's laws and other initiatives launched to facilitate the growth in CHP (e.g., the Greener Greater Buildings Laws, setting a clean DG installation target, and the creation of a Cogeneration Task Force). Two developers cited New York City's phase-out of No. 6 heating oil usage as a growth opportunity for CHP. In April 2011, Mayor Bloomberg announced new rules for the dirtiest of heating fuels, No. 6 heating oil. Starting in 2015, facilities seeking permits for the installation of new boilers will no longer be able to secure a permit to burn No. 6 heating oil.[103] No. 4 heating oil permits will stop being issued in 2030. The failure of existing boilers will present a strong opportunity for buildings to consider conversion to natural gas, and installation of a CHP system.[104] Any increase in demand for natural gas in New York City that might result from the No. 6 heating oil phase-out would exacerbate what appears to be a significant shortage of natural gas supply infrastructure within the city, as discussed further in Section 4.10.

Several interviewees commented that New York's passage of simplified interconnection processes for systems 2 MW or less in 2009 (SIR) has significantly diminished interconnection barriers that previously existed in the state. One interviewee reported that standby issues are less of an issue than they have been in the past, though this was not a commonly held view. Interviewees also pointed to other states, particularly Massachusetts, as examples of places where policies favorable to CHP are driving an increase in CHP market activity. (See Section 4.9. for further discussion of CHP policies and markets in other states.)

Four developers and three other market actors noted that the ten percent Investment Tax Credit (ITC) available to many CHP projects has helped the market. One of these interviewees cited the tax credit as a key component in the market, while the others said it helps somewhat, but that it is not enough to drive significant project activity. A Treasury Department cash grant option that systems have been able to take

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[103] Environmental Defense Fund. *Cleaning Up New York's Dirty Heating Oil*. Available at: http://www.edf.org/climate/cleaning-new-york-dirty-heating-oil. Accessed August 22, 2011.

[104] Toy, V. "Going Green in New York: One Co-Op's Story." *The New York Times*. July 22, 2011.

advantage of in lieu of the ITC in recent years will expire at the end of the year. A representative from a financial institution explained that while this tax credit option will remain, it will be of limited value to the market because many companies have insufficient taxable income to which they can apply a credit. One developer noted that changes in accelerated depreciation that were introduced as part of the economic stimulus package have helped the market as well.

Although policy and regulatory barriers appear to be less burdensome than in the past, interviewee comments indicate that several policy and regulatory barriers still remain, as described in Section 4.6.

4.5 Awareness and Knowledge

Awareness of the DG-CHP Demonstration Program, and of CHP opportunities in general, are key factors in gauging the state of the market served by the program. This section describes awareness-related findings based on interviews with market actors. The section of the report that addresses market barriers also includes discussion of the issue of awareness.

Based on findings from interviews with market actors, it appears that the majority of participants in the DG-CHP market in New York are aware of NYSERDA's DG-CHP Demonstration Program, and they either have already participated in the past or would seek to participate in the future for some, if not all of their projects.

While NYSERDA is well known in the market as a source of funding for CHP projects, there is confusion about the various programs that provide support for CHP. NYSERDA's Existing Facilities Program (EFP) is the one most commonly confused with the DG-CHP Demonstration Program. Some interviewees made reference to minimum-size thresholds for participation in the DG-CHP Demonstration Program, and noted ineligibility of microturbines. Both of these issues pertain to the EFP and not to the DG-CHP Demonstration Program. Many program non-participants stated directly that they were confused about which NYSERDA program dealt with which types of projects, and several interviewees who had received funding from a NYSERDA program could not recall which program had provided funding for their project.

The key difference between the DG-CHP Demonstration Program and the EFP is that the Demonstration Program focuses on funding projects that offer something innovative or unique to the market (e.g., using a newer technology, or including rare features like black-start capabilities), with the EFP is a "deployment" program, meaning that its primary goal is to produce energy savings.

The Demonstration Program pays out its incentive in milestone increments. Projects receive the full amount of their incentive shortly after the project becomes operational. In addition, the projects benefit from significant support from program staff to help them address challenges that may arise during the development process.

The EFP incentive available is significant ($0.10/kWh plus up to $750/kW). However, the incentive is performance-based, so there is a risk that the system may under-perform and receive less funding than anticipated. That risk may make it more difficult for a project to secure financing.

Table 7. Comparison of NYSERDA's DG-CHP Demonstration Program and Existing Facilities Program

Program Features	DG-CHP Demonstration Program	Existing Facilities Program
Maximum Award per Site	$2 million, not to exceed 50% of project costs	$2 million, not to exceed 50% of project costs
Payment Time Frame	Milestone basis, final milestone payment follows certification of system as operational (i.e., incentive payment not affected by system performance)	40% after installation and commissioning, and 30% after each year of M&V (Anticipated incentive amount may be reduced if performance is poor.)
Incentive Formula	30% of project costs base incentive; up to 50% for projects meeting key criteria (10% extra for each criteria)	Upstate: $0.10/kWh + $600/kW Downstate: $0.10/kWh + $750/kW Based on first-year savings estimates; not to exceed 50% of project costs
Minimum System Size	N/A	250 kW
Performance Monitoring	» 4 years » Must report 15-minute interval performance data to NYSERDA contractor » Emissions and electricity generation tracked	» 2 years » Conducted in coordination with NYSERDA M&V contractor » Emissions and electricity generation tracked
Key Eligibility Criteria	» Must be capable of stand-alone operation during power grid outages » 60% minimum annual fuel conversion efficiency based on higher heating value, with limited exceptions » NOx emission rate < 1.6 lbs/MWh » Fuel cells and Anaerobic Digester Gas projects eligible. Other NYSERDA programs are ineligible for this program.	» Reciprocating engines or gas turbines that produce peak demand reduction during summer » 60% minimum annual fuel conversion efficiency based on higher heating value » Use ≥ 75% of generated electricity on-site » NO_x emission rate < 1.6 lbs/MWh » Fuel cells ineligible

Source: NYSERDA program PONs, and program websites.

NYSERDA staff is well aware that many market participants confuse the DG-CHP Demonstration Program with the EFP and they have taken steps to address the issue. A few years ago staff developed a brochure that was designed to summarize all the different NYSERDA programs that have a CHP-related component. Staff also makes an effort to emphasize the programmatic differences at every opportunity. Staff attributes some of the confusion to the fact that the EFP program has implementation contractors actively conducting program outreach across the state, so that program's message is reaching a larger volume of market actors across the state than is information about the DG-CHP Demonstration Program. Staff continues to make efforts to resolve confusion about NYSERDA's CHP-related program offerings, highlighting the differences in program goals and format. Staff points out that the EFP is a prescriptive program that funds a limited range of CHP applications that are more mature and well established in the market. In contrast, the DG-CHP Demonstration Program aims to break down barriers in the market and to fund innovative CHP applications.

Program staff highlights that the EFP has undergone a number of changes in eligibility criteria over the years, and this may be a significant contributor to market actor confusion about NYSERDA offerings to the CHP market. They highlight that any confusion that does exist does not appear to be having a deleterious effect on the DG-CHP Demonstration Program, as that program is consistently over-subscribed.

A NYSERDA CHP conference, to be held in NYC in June 2012, will focus on clarifying and distinguishing the purposes and formats of NYSERDA's two CHP program elements.

A more fundamental issue with regard to market awareness is the low level of awareness about CHP in general. Several interviewees indicated that a lack of understanding of CHP opportunities is a key barrier in the marketplace. Specifically, a number of interviewees noted that decision makers at prospective CHP sites are typically not technically oriented and they have a hard time understanding how CHP could benefit their facilities. Some interviewees noted that in certain cases, facility managers recognize the opportunities for CHP at their facilities, but they are not able to effectively communicate those opportunities to decision makers in their organization. One interviewee indicated that engineers specifying mechanical systems for new construction lack an understanding of CHP opportunities, resulting in numerous missed opportunities to integrate CHP into a building at the opportune construction phase.

Compared with the markets for other efficiency-related technologies, the CHP market is immature, and developers and manufacturers have limited resources to spend on getting the word out about CHP. Furthermore, these market actors may be ill equipped to effectively communicate the benefits of CHP to an audience of chief financial officers (CFOs) and other key decision makers. Despite these limitations, it is incumbent on manufacturers and developers to approach potential project hosts and educate them about the benefits of CHP. This process of educating decision makers requires substantial resources, and it puts a strain on many participants in this developing market, especially considering that most sites will not actually go on to install a CHP system.

Several interviewees noted that awareness has increased in recent years, in part as a result of NYSERDA's DG-CHP Demonstration Program efforts, while others pointed out that they always see the same faces at conferences and that an effort needs to be made to inform a broader range of potential players in the CHP market (e.g., large property owners and managers). A number of interviewees expressed confidence that state-sponsored efforts to document and publicize CHP success stories, and to increase awareness about CHP opportunities in general, would help move the market forward.

Another awareness-related issue of note is that a few interviewees demonstrated a low level of understanding about the current status of some CHP market conditions, particularly on the issue of standby charges. Some market actors complained of issues with standby rates that are actually not relevant to the New York market. For example, one interviewee noted that if his project exceeded a certain demand threshold he would be locked into a different demand ratchet for the entire year, which is an often-cited problem with standby rates in other states, but is not an issue in New York given the changes in standby rates that occurred in 2003. This confusion reflects the overall complexity of understanding opportunities that exist within the CHP market.

4.6 System Performance and Technology-Related Trends

This section describes trends observed in the market related to technology performance, maintenance practices, and the market for modular or packaged CHP systems. Anticipated technological advancement that may affect the CHP market is also discussed.

4.6.1 Technical System Performance and Maintenance Practices

This section provides an overview of market participants' experiences with system performance and maintenance practices.

NYSERDA's DG-CHP Integrated Data System (IDS)
As a condition for receiving NYSERDA program funds, participating CHP system owners must enable digital reporting of their systems' performance data to an Integrated Data System. The IDS primarily serves to enable NYSERDA's measurement and verification (M&V) requirements for systems that receive program funds. However, the database also provides market actors a key source of demonstration system data. As stated in the IDS User Guide, an underlying goal of the database is to:

> *"provide meaningful site-level and portfolio-level information that enhances understanding of the technical, economic and environmental performance of DG/CHP systems. The database is intended to allow individual facility managers to better understand reliability, availability, and performance of their particular units and also determine how their facilities compare with other units."*[105]

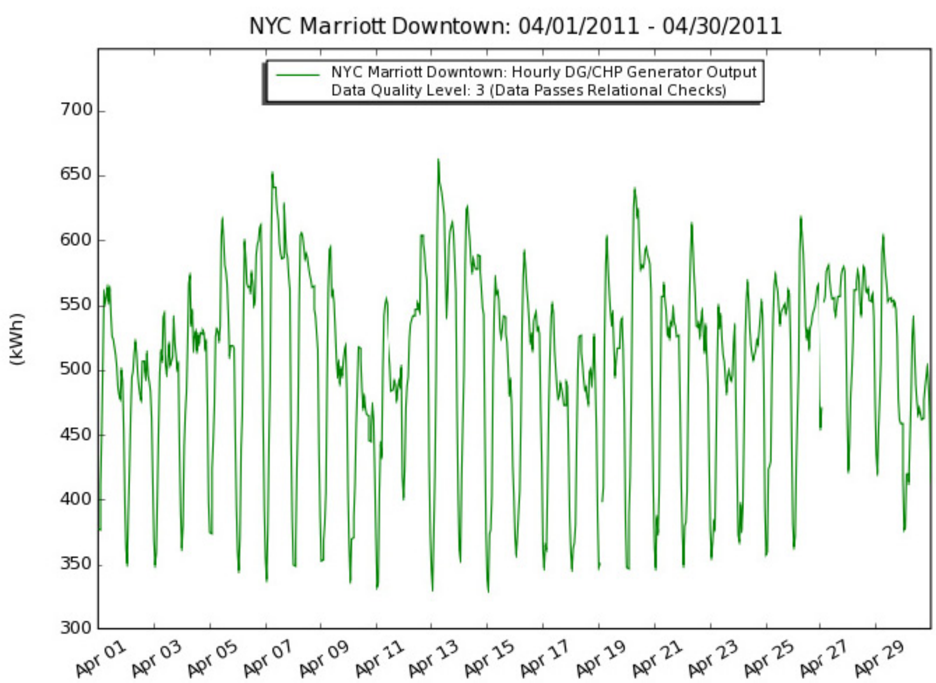
A performance investigation of the systems included in the IDS is beyond the scope of this evaluation. However, the study team did use the IDS as a supplementary resource to inform its interviews with participating system owners and developers. This section describes how market actors might use the IDS for additional research into system performance, along with a few caveats regarding the data it contains.

[105] CDH Energy. "NYSERDA Distributed Generation / Combined Heat and Power Integrated Data System: Data Integrator User Guide." NYSERDA. Available at http://cdhnrgy1.user.openhosting.com/Documentation/NYSERDA%20DG-CHP%20Data%20Integrator%20Training%20Manual.pdf

Site-Level and Comparative Analyses
With some basic training and understanding of the web-based user interface, developers as well as current or potential system owners can find useful information about their own or other similar CHP systems. For a particular system configuration, the IDS provides insights into system run times, efficiency, and power production, as well as operational reliability reports that help explain the reasons for system outages.

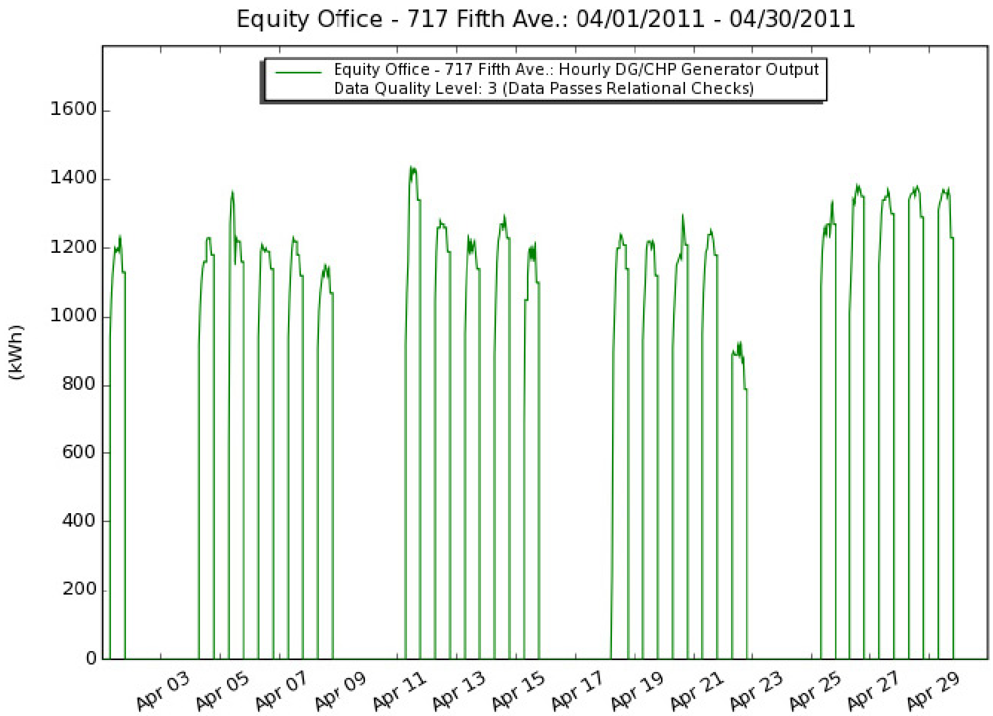
Potential system purchasers can use such data to identify specific performance trends or issues for further investigation as they consider equipment options for their own facilities. However, anyone using the IDS to make comparisons among systems with differing capacities or prime movers should take particular care to understand different system owners' intended uses of and operating characteristics for their systems. In some cases this information may not be fully apparent in the IDS. Figure 24 and Figure 25 provide an example of one such side-by-side comparison of two microturbine systems in the IDS.

Figure 24. Sample IDS Output – System 1



Source: Sample output, NYSERDA CHP Integrated Data System reporting.

Figure 25. Sample IDS Output – System 2



Source: Sample output, NYSERDA CHP Integrated Data System reporting.

These two preceding figures demonstrate how differences in system operating characteristics can make simple comparisons more difficult. The operating characteristics listed in the IDS for System 1 reveal that the system is intended to run a full 168 hours per week. While the IDS lists similar characteristics for System 2, the data reveals that the system instead runs only five days per week for ten-hour periods. Potential CHP owners should consider such differences in facilities' usage patterns, load demands, and owner goals before drawing conclusions.

Furthermore, those considering a CHP system should practice due diligence when relying on this data to make key decisions. Systems included in the IDS exhibit wide variation in the scope of specific data collected and uploaded from each site, with few sites consistently providing all the data requested. Conferring with a referenced system's owner about trends, downtime, or any data anomalies could help potential owners better understand the complexities and unexpected issues that may arise when installing and operating a system. In some cases, what appears as underperformance for a particular system may have an unexpected explanation that could better inform a potential owner's decisions.

NYSERDA staff and its technical consultant have undertaken various efforts, including required M&V, to examine the performance of systems in the IDS. However, little processed or summary information about their findings has been published or otherwise been made available to the public. One developer highlighted the potential usefulness of detailed case studies of some of the systems in the IDS. In particular, the developer suggested that market actors could learn as much, if not more, from case studies of underperforming CHP systems as from systems that have performed as expected. Such in-depth analyses of systems in the IDS would require a significant allocation of resources, as well as extensive discussions with system owners and operators to identify and explain performance trends. However, NYSERDA might consider conducting a few pilot studies and reports to gauge their effectiveness in informing the market about particular issues or misconceptions of CHP system performance.

Summary of Technical Issues Reported by Market Actors

The scope of this evaluation did not include an in-depth performance investigation of CHP systems that have received program funding. However, during its interviews the team did inquire with CHP developers and system owners regarding the technical performance of their systems. As previously mentioned, most technical problems cited occurred during system construction and commissioning and were therefore covered by manufacturers and developers. However, several market actors also described long-term or persistent technical issues that have caused some systems to perform outside of their expected payback thresholds.

This section provides additional details about the nature of those technical problems and the types of systems they affected. Notably, many respondents' systems were still in construction or commissioning phases, with several encountering problems that owners dismissed as minor issues that would be resolved. This section focuses not on these initial commissioning adjustments, but on the longer-term technical issues mentioned. With a relatively small sample size and the low number of useful responses to this issue, the team did not identify any overarching trends related to specific system configurations, capacities, or prime movers. As such, the discussion here provides paraphrased versions of market actor comments about system problems for each type of prime mover.

Microturbines

Owners and developers of systems using microturbines reported few technical problems. Among 23 respondents (some discussing the same system), only four respondents mentioned significant technical problems. One developer that works with both microturbines and fuel cells specifically described microturbines as easier to install, more cost effective, and less risky than fuel cells. Three participating system owners and one participating developer mentioned the following problems with microturbine systems:

- **Microturbine System 1.** The system is generating as planned, with no noise or emissions problems. However, thunderstorms can cause a shutdown and the unit will not reset automatically. The owner has had to restart it manually. In addition, the machine had a couple of seal failures early on that have since been rectified.

- **Microturbine System 2.** This recently commissioned system is already having some problems that the manufacturer says are unusual. Some of these issues are too premature to discuss. However, the system is putting too much heat into the room, and it will require additional mechanical equipment to resolve the problem. The ambient heat issue impairs the system's performance. In addition, the circulating pumps have been leaking, but the owner is working with the manufacturer to resolve the issue. The system is covered under a full manufacturer's warranty.

- » **Microturbine System 3.** While the owner of this system reports that it has generally performed well, the system frequently shuts down inexplicably. Since the system has demonstrated no major mechanical issues, the owner suspects the problem relates to the controls systems.

Fuel Cells
As with microturbines, few respondents reported any significant technical problems with fuel cell CHP systems. Of the nine respondents (again, some respondents discussed the same system), two participating owners reported on the following issues:

- » **Fuel Cell System 1.** This system has performed very well to date. It did experience some minor problems early on due to water quality issues, which were resolved with the addition of extra filtration.

- » **Fuel Cell System 2.** For the first 2.5 to 3 years, the system was very reliable. However, within the last 1 to 1.5 years the system has experienced several glitches and prolonged shutdowns lasting up to 1.5 months. The fuel cell performed very well for three years; but after that it started having problems that even the manufacturer had difficulty troubleshooting. On the worst one, the unit was down for five weeks before the manufacturer discovered a problem with a relay. The system has had myriad smaller problems (e.g., relays, bad connectors, pumps, and valves) that were not covered by the manufacturer's fuel cell warranty. The owner cited that a key lesson learned was to purchase a maintenance plan that covers *everything*.

Reciprocating Engines
A handful of respondents reported both minor and significant technical performance issues for reciprocating engine CHP systems.[106] Of the 30 respondents discussing systems with reciprocating engines, three participating and one nonparticipating owner mentioned the following issues:

- » **Reciprocating Engine System 1.** These systems (the owner has multiple systems based on the same technology) have missed performance projections due to technical issues that arose during the past two years [the system was commissioned in 2001]. Prior to that, they ran smoothly. In the past 1-2 years, the systems have started to have a lot of problems with plate and frame heat exchangers. The owner suspects this might result from hot-to-cold temperature transitions when they turn the units off at night. They have also experienced problems with dry frame coolers, which they believe stem from a design flaw. That problem may require $400,000 in repairs. Finally, the systems' pump seals have become problematic, likely due to continuous usage and heat. The owner suggested that a significant infusion of funds may be needed to keep the systems running.

- » **Reciprocating Engine System 2**. This system experienced early problems with its generators involving failures with the fasteners that hold the magnets onto the rotors as well as the generator bearings. Everything was replaced under the manufacturer's warranty.

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[106] Reciprocating engines also had the largest interview sample (n=30) of any prime mover, potentially contributing to the higher number of reported problems.

- **Reciprocating Engine System 3.** This system has had problems since its commissioning in 2008. It finally began running smoothly in early 2011. The owner explained that the system's design probably contributed to its poor performance. They were unable to fully load the system because it could not be connected in parallel with the utility. Although this required the owner to rebuild the system, they proceeded with the project because they were facing mandatory hourly pricing from their utility. They anticipated the utility would upgrade the local distribution and substation equipment in the near future, allowing them to upgrade the system for parallel connection.

- **Reciprocating Engine System 4.** While this system has performed close to expectations, it has experienced some design and technical issues. Primarily, these issues have involved complications with absorption chillers and AC services that have failed to meet expectations for pushing the output of the engine. With the system exceeding the facility's hot water load, the owner recently replaced their cooling towers to try to resolve cooling issues. The system was currently running at 65 percent efficiency, but the owner expected to reach 80 percent or better before the end of 2011.

Other Prime Mover Systems
A handful of both participants and nonparticipants discussed their experiences with other alternative prime mover technologies such as larger combustion gas turbines and backpressure steam turbines. Of the six specific such projects referred to by respondents, two (both participating system owners) reported technical problems.

- **Gas Turbine System 1.** This system's owner (a non-participant) reported 95-percent reliability over the system's first 1.5 years of operation, expressing a desire for better performance. The owner mentioned "sorting out issues" with duct burners and heat recovery systems, as well as a turbine gearbox malfunction. The manufacturer replaced the gearbox, and subsequently replaced the power turbines as a proactive measure based on prior experience with other plants.

- **Back Pressure Steam Turbine System 1.** This system owner expressed overall satisfaction with his system, but reported a couple of unexplained problems. Aside from a bearing failure on the turbine, he also reported a recent generator failure and an event where the generator "arced and sparked." At the time of the interview, neither of the later two issues had been explained.

As mentioned, the relatively low number of detailed responses about this issue makes it difficult to draw any meaningful conclusions about the collective performance of CHP systems in New York or in NYSERDA's DG-CHP Demonstration program. A robust performance investigation effort, using statistical sampling and multiple regression analysis, could help uncover specific trends and causes of any variations in systems' performance. In one recent such evaluation focusing on systems installed in California, the CHP systems examined demonstrated a 5.9 percentage point annual decrease in capacity factor across all prime mover types. The decrease arose from a combination of increasing system downtimes and decreasing electrical and thermal efficiencies.[107] As with the data provided by NYSERDA's IDS, such analysis could further inform potential system owners' economic modeling assumptions.

Maintenance Practices

Almost every CHP system owner interviewed relies to some degree on external resources for ongoing system maintenance. These arrangements might involve any combination of equipment manufacturers, project developers, or third-party maintenance service providers, as well as in-house maintenance staff. Some maintenance contracts cover the entire CHP systems, while others apply only to the generating units, excluding heat exchange and other auxiliary equipment.

The evaluation team did not specifically probe system owners regarding their satisfaction rates with maintenance providers. However, several owners expressed approval of their contracted service providers' efforts (particularly those of manufacturers) in working to resolve any problems that arose. While few owners commented negatively about their service providers specifically, some suggested that, given the chance, they would have chosen more inclusive contracting arrangements.

Several respondents commented positively on the reduced economic and operating risk such maintenance contracts have provided for their systems. System owners demonstrated a high awareness of the risks associated with self-performing CHP system maintenance, including one program participant who recounted NYSERDA's encouragement in his seeking a long-term maintenance agreement. The remainder of this section describes additional trends in the relationships and contracting mechanisms owners use to procure maintenance services.

Manufacturer Warranties and Service Agreements

In many cases, the equipment manufacturer provides complete, "bumper-to-bumper" system maintenance through an equipment warranty or long-term service agreement. The system owner is not responsible for any of the maintenance costs or requirements. Contract terms range from three to ten years, with most owners signing five- or ten-year agreements. Such agreements are particularly common for microturbines and fuel cells.

As mentioned previously, manufacturers are increasingly involved in project development and long-term operations and/or maintenance roles. One manufacturer offers system owners a performance guarantee if they enter into a standard service contract. Similarly, two other respondents mentioned that their maintenance contracts were part of an ESA signed with an equipment manufacturer.

Third-Party Service Providers

A handful of system owners contracted not with the equipment manufacturer, but with another third-party service provider to maintain their CHP systems. In some cases, the project developer will offer

[107] Barnes, J., R. Firestone, and K. Cooney. Navigant 2010. "Self-Generation Incentive Program: Combined Heat and Power Performance Investigation." SGIP Working Group. April 1, 2010. Available at: http://www.cpuc.ca.gov/PUC/energy/DistGen/sgip/.

these services under an ESA or as a stand-alone service contract. In these cases, the developer or service contractor will usually administer any equipment warranties provided by manufacturers.

In what may indicate an emerging trend in the market, one developer described that some firms are willing to offer O&M contracts without having been involved in a system's design. Such O&M services have previously been offered by ESCOs and project developers in combination with design and construction services; however, free-standing O&M contracts have been less common. The developer continued:

> *"We're seeing more outsourcing of that O&M to someone who has a service lead and the ability to financially stand behind whatever performance guarantees they are providing. And then they are taking responsibility for all the subcomponents of that – the warranties, long-term service agreements, preventative maintenance, whatever else needs to be done – and they allow for it in the pricing of that contract. The thinking is that to the extent that the plant was built properly, the third party can come in and take responsibilities for O&M, and they're going to price their contract based on their perception of how that plant was designed and built."*

Another developer explained that some owners may combine manufacturer service contracts and warranties with an additional service agreement with a local mechanical contractor. In such cases, the manufacturer's service contracts may only cover the generating units themselves, and the owner contracts with another service provider to maintain heat exchange and other balance of system (BOS) components.

Role of In-House Maintenance Staff
Only a single owner responded that the organization performs all required maintenance using in-house staff. In what represented the majority of responses, most system owners pursue some combination of in-house staff assistance, and a long-term service agreement with the manufacturer, developer, or another third-party provider. Some of these respondents reported performing most regular maintenance with in-house staff, but relying on service contractors for periodic inspections and equipment rebuilds. In a handful of cases, owners expressed regrets in having taken on the level of maintenance responsibility required in their service contracts. In two cases where owners' service contracts with manufacturers only covered the generating units, the systems experienced problems with auxiliary equipment (e.g., pumps and valves) that fell on the owner to repair or replace. These owners suggested that having the manufacturer or another service provider maintain those systems would have been more cost effective. In another case, a public-sector system owner had planned to use in-house staff for much of his system's required maintenance. However, budget cuts required his organization to trim staff, and they now require more third-party assistance than expected.

4.6.2 System Sizes

System Sizes Are Smaller Than They Have Historically Been
A few interviewees explained that not much new development activity is occurring at large industrial facilities where there has historically been a great deal of focus on CHP. A key factor contributing to this decrease in CHP development at industrial facilities is that less favorable conditions exist for selling electricity back to utilities; it no longer makes sense to build a CHP facility for the purpose of selling

power. One interviewee highlighted the importance of changes in Public Utilities Regulatory Policy Act (PURPA) rules that previously provided independent power producers with favorable terms when selling power back to utilities,

> *"The PURPA amendments in the 2005 Energy Bill were a big change. Utilities no longer have an obvious incentive to establish long-term contracts with energy producers."*

Another factor contributing to the limited development activity at industrial facilities is uncertainty in the economy and reservations about making capital improvements at facilities that are at risk of being shut down. A few interviewees also noted that most of the ideal sites for industrial CHP applications have already been developed, though one interviewee challenged that perspective and reported that plenty of potential remains for development at industrial sites. The 2-MW cap on eligibility for use of streamlined interconnection procedures also supports the installation of systems under this size threshold.

Gap Exists in Availability of Mid-Sized CHP Systems
Two developers and a staff member noted that there is a gap in the commercial availability of CHP systems in the mid-size range. They expressed optimism that manufacturers will fill this gap in the coming years. One developer explained,

> *"You can get commercially available units up to 100 kW, then you jump to 750 kW. I think somebody is going to find a sweet spot in the middle."*

As discussed in Section 4.6, many market participants expect to see growth in the market for modular systems within the next few years. The majority of interviewees commenting on the future of modular systems explained that they think the market holds promise, but that it also faces a number of challenges (e.g., the logistics associated with CHP can be complex even for small projects), and they will be interested to see how the market unfolds for modular systems in the years to come.

4.6.3 Emergence of Modular and Packaged Systems

Two system owners mentioned an increase in the number of prepackaged CHP system designs as a notable trend. In such systems, manufacturers offer pre-engineered configurations of CHP generating units that also include standardized features such as integrated heat exchange systems, advanced controls and remote monitoring capabilities, interconnection equipment, and other auxiliary equipment. Some manufacturers of generating units may also partner with manufacturers of heat exchange systems or other equipment to offer a co-branded packaged CHP system. Such packaged systems may help some system owners achieve lower project costs through economies of scale and reduced custom engineering requirements.

Given NYSERDA staff and other CHP program administrators' level of interest in such systems' potential benefits, the evaluation team specifically inquired about market actors' perceptions of the trend. The remainder of this section explores those findings.

Perceptions of the Shift to Packaged Systems

The majority of market actors commenting on the emergence of packaged CHP systems (15 of 23 respondents) provided positive feedback about the trend. These respondents commented that evidence of demand for packaged systems exists in the market, particularly to address the challenges of installing systems in existing buildings in urban settings. This perceived demand has driven manufacturers to offer more options in terms of packaged system capacities and heat recovery configurations. Many manufacturers' websites and marketing materials tout new pre-packed and modular system configurations that allow for "plug-and-play" capabilities. In addition, one developer also mentioned making such systems a focus of his firm's business.

Improved Project Economics

Respondents discussed a wide range of potential benefits from the increased focus on packaged and modular systems. Several actors perceived that standardized designs for these systems would improve project economics through increased efficiencies and reduced engineering and labor costs. In addition, smaller system capacities and modularity enables system owners the flexibility to add additional capacity in the future if desired. Maybe most importantly, respondents suggested that the trend toward standardized system configurations would reduce perceived risks among potential system owners. Those considering a CHP project may be more likely to install a system identical to one they know to be performing well for a similar organization. One owner of a packaged microturbine system stated that the modularity and flexibility it provided was a key contributor to the project's overall economics.

Flexibility for Existing Buildings and Urban Settings

Several market actors stressed the additional benefits smaller packaged systems provide to host customers in a densely developed urban environment. Owners of existing buildings face considerable space and structural constraints when considering a CHP system. Respondents discussed a desire for equipment that could fit through doorways and be easily rigged in areas with limited space. Another respondent cited the potential for such systems to help address point-needs in higher stories of high-rise buildings. Smaller packaged systems that also provide for modular assembly can help address these issues.

Ability to Replicate System Configuration, and Large-Scale Procurement

Respondents also cited the potential for packaged systems to create opportunities for large-scale CHP system procurements by organizations with multiple similar facilities (e.g., commercial real estate developers). Once potential system owners see evidence that a particular packaged system performs at consistently high levels, they may consider purchasing several of those systems for multiple properties. While owners would still face some cost uncertainty for integrating the system into each unique building, such aggregate purchases could help drive down overall costs. In addition, owners of multiple systems could likely procure umbrella service contracts to address system maintenance at each of their facilities.

Potential Drawbacks of Smaller Packaged Systems

While most comments focused on the potential benefits of packaged systems, several expressed doubts about the scale of those benefits' impact on the market, particularly for smaller capacity systems. At the heart of these comments, market actors shared a sense that prepackaged system configurations will not equate to a "plug-and-play" approach to system design and installation. As a result, some questioned the likelihood that any significant increase in demand would emerge to drive cost reductions in CHP systems.

While packaged system configurations may help reduce the engineering work associated with system selection, respondents believed that most systems will still require significant customization and engineering. Each host facility has unique infrastructure constraints as well as thermal and electric load characteristics. Locations of gas lines, exhaust flues, and electrical distribution equipment can all create project-specific challenges that require a custom approach. Another developer pointed out that a smaller system still requires as much development and permitting oversight as a large CHP system, reducing economies of scale in recovering associated costs.

Packaged Systems Among Different Prime Mover Technologies

Respondents provided few comments indicating any common perceptions regarding the types of prime mover technologies most likely to contribute to or benefit from a shift to prepackaged CHP systems. The few comments on this issue revealed more about respondents' specific facility characteristics and experiences with different prime mover technologies, and less about how each technology might leverage packaged configurations. One system owner believed that microturbines best serve the perceived demand for packaged systems based on the relatively small amount of space they require. However, another system owner proclaimed that microturbines remain too expensive and generate too much heat (for his specific purposes).

Reactions to NYSERDA Promoting Packaged Systems

Only 12 of the interviewed system owners and developers provided comments regarding the results they would expect should NYSERDA shift the program's focus to packaged systems. Two-thirds of those comments suggested a favorable perception, with the remaining comments suggesting a negative perception of the proposed shift.

Those in favor of NYSERDA's increased focus on smaller, packaged systems cited several of the perceived benefits already discussed above, particularly that of system adoption across several similar facilities. In addition, one respondent commented on the present lack of feedback from the market regarding the availability of packaged systems. He felt that NYSERDA's focus on the systems, and subsequent sharing of lessons learned, would enhance and accelerate the pace of learning in the market. Another respondent felt that shifting incentives toward smaller systems would make program funds more available to potential system owners with smaller loads who may have felt excluded from past funding opportunities.

The few comments expressing unfavorable views of NYSERDA's potential shift to smaller systems focused on the fact that it would lessen the incentives available for the application of more proven technologies. Two respondents suggested that the potential benefits of focusing on smaller, packaged systems failed to offset the drawbacks. Specifically, by taking incentives away from proven, commercially viable systems, the program would be shifting funds to less economical systems with poorer per-unit paybacks. Another system owner believed that the packaged systems would not have a significant impact for commercial building owners due to the unique needs and requirements of each facility. Of course, the point of the Demonstration program is to provide growth opportunities for technologies and system applications that are not yet firmly established in the market, so these comments must be considered within that context.

4.6.4 Recent and Anticipated Future Technological Advancements

When asked about recent improvements in CHP technologies, most respondents replied that manufacturers continue to make incremental improvements to their systems, resulting in higher overall efficiencies. One respondent specifically mentioned the rapid pace of improvement in fuel cell efficiency. However, relatively few respondents offered evidence or details about specific improvements in technologies. Two market actors cited recent improvements in controls and diagnostic systems and integration with building systems as enhancing the cost-effectiveness of system operations and maintenance.

In addition to current technology trends, the evaluation team sought to identify areas of emerging opportunity and interest related to technological advancements in the CHP market. These comments generally fell into one of the following technology categories, listed in order of frequency of mentions from respondents.

- **Prime Movers and Alternative Fuels**. A relatively large number of respondents discussed potential advancements in prime mover technologies. In addition to incremental improvements in prime mover efficiencies, several market actors mentioned the possibility of new options for alternative fuel sources. In particular, respondents demonstrated interest in systems that could be classified as renewable energy technologies, including gasification systems or solar/CHP hybrid systems. Other technologies mentioned included multiple-fuel devices and Rankine or Sterling engines.

- **Fuel Cells.** While several respondents mentioned fuel cells, the comments were evenly divided between those in favor and those opposed to the technology. Advocates for the technology claimed that fuel cells are competing effectively against microturbines in the market, and that they will continue to scale more rapidly. Conversely, an equal number of respondents claimed that fuel cells entail greater risks and costs than microturbines. Several expressed dismay that the technology continues to take funding opportunities away from more proven technologies (especially microturbines).

- **Interconnection and Distribution Technologies.** A few respondents mentioned specific advancements in equipment related to utility interconnection and electricity distribution that they expect to help reduce associated barriers. Specifically, fast-fuse systems and improved inverter technologies were mentioned as having potential to help address fault current issues while improving overall system efficiencies. One utility respondent also discussed ongoing improvements to address the fault current issue, including substation-level fault current mitigation that may have subsequent applications for generator-level fault current mitigation.

- **Building Management Systems and Sub-Metering.** A few respondents also mentioned the benefits building owners and ESCOs are expecting to see from increased implementation of building control systems and tenant sub-metering. Many building owners are installing pulse or interval-type meters to provide additional systems monitoring capabilities (e.g., knowing when their chillers turn on and off). These technologies allow building owners and energy consultants to better understand opportunities to improve a facilities energy use, including potential CHP systems. In addition, CHP system engineers and developers will have access to improved load data to help determine optimal system size and operating characteristics.

» **Heat Exchange.** Two respondents mentioned the likelihood of general improvements in heat recovery and exchange equipment, citing demand for improvements in size and efficiency.

Beyond the comments about specific technology categories, other respondents were evenly split between expectations for rapid improvements in systems and those who felt that little would change beyond incremental efficiency improvements.

4.7 Market Barriers

Numerous barriers stand in the way of CHP market development in New York. Many of the barriers fall into the following categories: financial, policy and regulatory, knowledge and awareness, and infrastructure and logistics. This section describes interviewees' perspectives on these barriers, as well as other barriers that do not fit well within the categories outlined here.

4.7.1 Financial Barriers

The most common barrier identified by interviewees of all types is that the simple payback on CHP projects is often too long to attract investment. As noted in Section 4.3, private-sector property owners and investors are looking for paybacks in the range of two to three years at most, but CHP project paybacks typically exceed this investment threshold.

As discussed previously, each item in the list of economic factors driving project feasibility is affected by overall conditions in the economy, as well as site-specific issues. The volatility of the spark spread in particular is a real concern for investors, and is seen as the greatest risk to future growth in the CHP market. Project investors can attempt to limit the risk associated with market volatility through strategies such as securing long-term gas contracts.

Technology performance risk and lack of knowledge also contribute to the difficulty CHP project proponents experience when attempting to secure project funding. CHP technologies such as reciprocating engines and gas turbines have a long track record for performance and are considered well-proven technologies among those knowledgeable of the CHP market. Meanwhile, microturbines, Rankine cycle engines, and fuel cells have a less proven track record and are considered to carry greater performance risk than more established technologies. Unfortunately, CHP solutions on the whole are still generally unfamiliar to potential investors, resulting in a perceived risk that deters investment.

Twenty-four interviewees spanning nearly all interviewee categories cited recent economic conditions as a significant barrier to the CHP market. As discussed in Section 4.3, access to capital has been severely limited since the economic downturn began in 2008. During a time when equity is hard to come by across all sectors of the economy, many CHP projects are viewed as too complex and risky to warrant investment. Facility owners are often unwilling or unable to make any capital expenditures in this economic climate, regardless of the long-term financial gains that may result from a CHP investment. A few interviewees noted that, in those cases in which a facility owner decides to make energy-related capital expenditures in this economy, they are more likely to invest in well-proven, low-hanging fruit such as lighting upgrades.

4.7.2 Policy and Regulatory Barriers

Policy and regulatory barriers span a broad spectrum. They include utility-related issues such as interconnection and standby charges, air emissions permitting, building and fire code issues in the City of New York, and uncertainty about the future of regulations and the availability of financial incentives.

Interconnection

Interconnection is one of the most often-cited barriers to the CHP market as a whole, and is definitely the most contentious policy and regulatory-related barrier. Many interviewees (15) prefaced any critique related to interconnection issues by noting that interconnection is much less of a barrier than it was in the past. These market actors cited the introduction of Standard Interconnection Requirements for systems under 2 MW as a key contributor to a more streamlined and predictable interconnection process than existed prior to passage of these rules in 2009. A few market actors reported that roughly a decade ago utilities would take steps to derail the interconnection process for prospective DG projects, and that those efforts to deliberately block interconnection of DG systems are now a thing of the past.

Some applauded Con Edison for the progress the utility has made in addressing the inherent challenges of interconnection and planning for a future grid infrastructure that can accommodate significantly greater amounts of DG capacity. Interviewees also noted that utility representatives in general, and particularly those from Con Edison, are more willing to engage in interconnection discussions (e.g., reviewing project materials and providing feedback) early on in the project planning phase than they were in the past. A few interviewees remarked that their communications with the utility were positive even though the outcomes were not necessarily favorable for the CHP project; the utility representatives made a clear case for why the projects needed to bear certain costs.

Despite the marked improvements on issues related to interconnection, many interviewees had strong opinions about the need for utilities and regulators to do more to improve interconnection conditions in the market. The primary concerns raised by interviewees pertained to costs and time frames associated with interconnection processes. Most interviewees noted that interconnection on radial networks that exist outside of densely populated urban areas, and for systems falling below the 2-MW SIR threshold, was generally not a challenge. However, projects larger than 2 MW, and those planned for locations within the spot networks that exist in urban areas, often encounter significant barriers.

As part of the interconnection process, utility representatives review project details and determine whether and to what extent grid infrastructure improvements must be made (e.g., transformer or substation upgrades) in order to accommodate the introduction of new DG capacity in a particular location. These infrastructure investments are typically borne by the DG owner rather than the utility since changes at the DG owner's facility are triggering the investment. Interviewees complained that interconnection-related costs were too high, and did not always have a clear basis. One interviewee noted that utility representatives had quoted one cost early on in the project planning phase, but then came back with a much higher cost later in the process, and the rationale for the increase was not clear. Many interviewees complained that the interconnection process took an unnecessarily long amount of time.

A number of interviewees recognized that there are legitimate safety and reliability-related concerns associated with interconnection in spot networks. These fault current issues are described in Section 3.5. Depending on the nature of the existing electric grid infrastructure in a given location within a spot network, the location may be significantly limited in its ability to safely accommodate additional DG capacity. Con Edison is generally credited with being more proactive than National Grid in defining which areas of its spot networks are capable of accepting additional DG capacity. For example, Con Edison's website provides a map indicating which areas are "red zones" (those that are off-limits to added DG capacity) and "green zones" (those areas capable of accommodating more DG capacity). In early 2011, Con Edison announced changes in the way it conducts fault current studies which, according to interviewees, will effectively delay Con Edison's ability to accommodate a significant increase in DG for another decade.

As noted in Section 3.5, there are strict restrictions around the installation of synchronous generation in Con Edison's service territory. One interviewee highlighted that this, coupled with the NYSERDA DG-CHP Demonstration Program's requirement that systems be able to run stand-alone during power grid outages, significantly limits the CHP technology options available to buildings located in Con Edison's service territory, the region of the state possessing the bulk of CHP market potential.

Standby Rates

As with interconnection issues, interviewees noted that standby rates are less onerous than they once were. Several interviewees reported that standby rates are not a market barrier. However, two interviewees in each of four different market actor interviewee categories, along with one interviewee in each of the remaining two categories, expressed that standby rates remain a significant barrier to further CHP market development in New York. As noted in 3.5, CHP systems sized at 1 MW or less and meeting certain emissions and efficiency criteria qualify for an exemption from standby rates.
One interviewee explained that he is working to increase the exemption size threshold from 1 MW to 2 MW.

Several respondents made general comments about the fact that demand ratchets hurt project economics; if a CHP system unexpectedly goes offline during a period of high demand, it would be required to pay higher demand charges for a period of time following the event. Interviewees indicated that this is particularly problematic because CHP system operators cannot always predict when their system will be taken out of service. In general, New York's standby tariffs are believed to expose CHP projects to less risk of long-term demand ratchets than in other states.[108] However, the issue of demand

[108] Molina et al. 2010. *The 2010 State Energy Efficiency Scorecard*. American Council for an Energy-Efficient Economy. American Council for an Energy-Efficient Economy. State Energy Efficiency Policy Database: New York Clean Distributed Generation. Available at http://www.aceee.org/energy-efficiency-sector/state-policy/New%20York/204/all/195. Accessed August 10, 2011.

ratchets and overall costs associated with standby rates are still perceived by some in the market to be a barrier in New York.

One interviewee explained that if a site has characteristics that make it a strong candidate for CHP (e.g., continuous operation, large and well-matched electric and thermal demands), the standby rates should not pose a barrier. However, at sites that have more marginal characteristics, the standby rates would likely present a greater barrier. This interviewee expressed that it would be an unwise public policy decision to modify standby rates to accommodate sites that are not ideal candidates for CHP. In contrast, other interviewees argued that public policies need to be modified in order to broaden the spectrum sites for which CHP can be deemed economically viable.

One interviewee reported that an overarching "asymmetry of information" exists that makes it difficult for market actors to accurately project both standby rates and interconnection costs for a given project. The market actor noted that the tariffs are written such that it is difficult to determine how they apply across a broad range of possible circumstances. The resulting uncertainty contributes to the difficulty of securing funding commitments for CHP projects.

Emissions Permitting Requirements

Compared with other barriers discussed, a relatively small number of interviewees expressed concerns about emissions permitting-related issues. Emissions-related issues were identified as a barrier by eight interviewees distributed across developer, facility owner, and "other market actor" interviewee categories. A few of these market actors noted that emissions permitting requirements are getting more difficult to comply with as EPA introduces more stringent emissions requirements. Both the required emissions levels and the reporting requirements pose challenges.

A few interviewees explained that emissions regulations continue to become stricter, increasing market uncertainty and making it that much more difficult to successfully complete CHP projects that are already burdened by many challenges. One developer commented that the emissions permitting process exposes project proponents to significant financial risk and general anxiety, as they don't know when they dive into the costly permitting process whether or not it will result in a positive outcome.
Two interviewees suggested that New York should have more streamlined permitting processes for smaller projects, or projects that have more familiar and well-documented emissions profiles. One of these interviewees commented,

> *"The whole regulatory climate needs to be simplified in terms of permitting. We permit a 1 MW plant like we permit an 8 MW plant."*

These interviewees may have been referring to the New York Department of Environmental Conservation's (DEC's) plans to introduce provisions for DG into its air regulations, and the fact that these rules have not yet been put into effect. The DEC planned to make draft DG rules effective in 2008, but the rules were never approved by the State Environmental Board. According to a representative from the New York Department of Environmental Conservation, revised rules are expected to go before the governor during the fall of 2011. At the time this report was written, the proposed revised rules were not yet publicly available. Under the proposed rules, a system's permitting requirements would depend on its level of annual emissions, and New York's regulations would still be dictated by the framework of its State Implementation Plan under EPA. However, the proposed rules will include provisions that recognize the efficiency benefits of CHP systems.[109]

Another interviewee complained that environmental regulators at both the state level and within the City of New York have not put forth clear enough definitions of "clean" DG. This lack of clarity contributes to the overall uncertainty and difficulty associated with planning for a CHP investment. Guidance on air permitting in New York City is provided in a Department of Buildings guidebook for CHP development in the city tailored for facility owners and the construction industry.[110]

Fire and Building Code Requirements

Fire and building code requirements associated with use of CHP systems were identified by five developers and two facility owners as a significant impediment to CHP development in New York City. Specific concerns related to the time it takes to obtain permits, a lack of communication between the Department of Buildings and utilities, and requirements related to the pressure at which natural gas can be supplied to a CHP system. A study of CHP opportunities in New York City conducted by Columbia University in 2007 also identified fire code issues related to high-pressure natural gas use for microturbine projects as a barrier to CHP in the city, and noted that the Fire Department task force was working to address the issue.[111]

Based on interviewee comments, it appears that at least some market actors still perceive fire and related building code issues to be a barrier to certain CHP applications. However, the New York City Department of Buildings has taken steps to clarify the code requirements and processes a CHP project must go through to obtain necessary permits by issuing a guidebook for CHP development.[112]

Uncertainty About Future Changes in Incentives and Regulations

Uncertainty about the availability of financial incentives and the nature of regulatory requirements that may exist in the future were cited by many as a barrier to CHP market development (nine developers, two facility owners, and two other market actors).

A few of these interviewees' comments highlighted the importance of long-term policy certainty to build investors' confidence in the CHP market, and to enable CHP market participants to carry out effective project and business planning. Two interviewees noted that there had been mid-stream changes in policies or program requirements that caused them to redesign their system, or to purchase new

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[109] Navigant staff communication with John Barnes, New York Department of Environmental Conservation. August 11, 2011.

[110] New York City Department of Buildings. 2010. Installing Natural Gas-Fueled Combined Heat and Power Systems: A Guide to Required Permits and Inspections and Available Incentive Programs for Property Owners and the Construction Industry. Available at http://www.nyc.gov/html/dob/downloads/pdf/combined_heat_and_power_systems.pdf. Accessed August 11, 2011.

[111] Hammer, Stephen and Jeanene Mitchell. 2007. "CHP in NYC: A Viability Assessment." Urban Energy Program, Center for Energy, Marine Transportation and Public Policy, Columbia University.

[112] New York City Department of Buildings. 2010. "Installing Natural Gas-Fueled Combined Heat and Power Systems: A Guide to Required Permits and Inspections and Available Incentive Programs for Property Owners and the Construction Industry." Available at http://www.nyc.gov/html/dob/downloads/pdf/combined_heat_and_power_systems.pdf. Accessed August 11, 2011.

equipment that had not initially been included in their financial planning. Other interviewees noted that New York's definitions of "clean" and "renewable" are not clear enough, and that it is difficult to predict the potential value that RECs might hold for a project. Two interviewees commented that planned decreases in NYSERDA DG-CHP Demonstration Program funding were diminishing the potential for CHP market growth. One interviewee explained that changes in the way Con Edison defines its fault current issues will defer the utility's infrastructure improvement activities by nearly a decade, resulting in a major setback for the CHP market.

On a related note, six interviewees (three developers and three facility owners) explained that timing issues related to the PON structure used by the DG-CHP Demonstration Program present challenges. A few interviewees suggested that it would help provide greater market certainty to have an incentive program that is consistently available for projects to submit a proposal to compete for funding.

4.7.3 Knowledge and Awareness Barriers

As discussed previously, a lack of knowledge and awareness of CHP opportunities presents a major barrier to the CHP market in New York. Fifteen developers, five facility owners and one other market participant identified low awareness levels as a key barrier to CHP development.

Many interviewee comments focused on the unique challenges the CHP market faces due to the conceptual complexity of CHP from a technical standpoint, noting the difficulties they encounter selling a very complex concept to nontechnical decision makers. A few interviewees explained that competing clean energy-related technologies (e.g., photovoltaics [PV]) are much easier for nontechnical decision makers to understand and support. Several market actors commented on the significant resources they must invest in educating potential decision makers about the CHP opportunity, and they suggested that much more substantial efforts should be made by NYSERDA, the utilities, and others to increase awareness levels about CHP.

4.7.4 Siting, Infrastructure, and Logistical Barriers

Some of the most burdensome barriers to CHP market development include siting, infrastructure, and logistical issues. Unfortunately, little can be done to diminish these barriers.

Siting Barriers

Siting CHP projects is a major, fundamental challenge. A site must possess several key characteristics in order to result in favorable project economics. These characteristics include, but are not limited to, large and well-matched thermal and electric loads, continuous operation (ideally 24 hours per day, seven days per week), ready access to sufficient natural gas supply, and a location in which the distribution system can accommodate additional DG capacity. These features only exist in a relatively small segment of buildings. A CHP developer commented,

> *"This technology has a well defined role in the energy landscape and without a significant technological breakthrough is limited to a fairly small population of sites."*

This interviewee explained that the ideal sites for CHP development today are, to a large extent, the same types of facilities that have been targeted for CHP development for decades. Hospitals, universities, and industrial facilities are some of the most often-targeted facility types for CHP. Some report that development potential at industrial facilities has been mostly exhausted at this point, though one interviewee challenged that notion, stating that a great deal of industrial CHP development potential still exists. Other types of facilities identified by interviewees as favorable for CHP include data centers, nursing homes, grocery stores, and multifamily housing.

A common and often overlooked problem with many facilities is that they lack an ability to use the waste heat produced by the CHP system. In some cases, an inability to use waste heat, even for a few months of the year, can destroy a project's financial success.

Infrastructure Barriers
A few market actors described experiences in which the cost of adding sufficient gas supply to support a CHP installation makes a project cost prohibitive. Gas supply costs can be an issue for a project in any location if the location that makes most sense for a CHP system is not readily accessible to an existing gas distribution line. A more pressing concern, in the opinion of some market actors, is the fact that insufficient natural gas distribution infrastructure exists in New York City, and that this poor infrastructure will limit CHP market growth.

A representative from a large commercial property holder expressed concern that insufficient natural gas distribution infrastructure will limit the amount of CHP development that can occur in New York City in the future. The interviewee described an experience in which a CHP system had been in the planning stages of development for some time, and the facility owner had sought confirmation from Con Edison that it could secure sufficient access to natural to support the system. The facility owner was ultimately told by Con Edison that sufficient gas supply could not be made available to support the project. An upgrade to the infrastructure would cost approximately four million dollars, ruining the financial viability of the project. The interviewee explained,

> *"The greatest risk [to CHP market growth] is that the gas infrastructure in the City currently does not support a huge deployment of [CHP]. We've already learned that the hard way… If you're trying to move the needle in the City, you can't get enough gas supply in the short run to make a real substantial jump."*

This interviewee urged the PSC to take action to address this issue.

Concerns expressed by interviewees are supported by comments the Northeast Gas Association submitted to the PSC on the Draft Scope of the 2013 New York State Energy Plan,

> *"New York and the Northeast have one of the oldest energy delivery networks in the nation. The expansion and upgrade of natural gas utilities' distribution systems is a critical and necessary investment to ensure energy security and reliability, as well as to improving economic development and environmental quality."*[113]

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[113] Kiley, T. *Comments on Draft Scope 2013 New York State Energy Plan*. Northeast Gas Association. April 28, 2011.

Logistical Barriers

The fact that so much CHP potential exists in New York City means that the challenges of development in an urban area are unavoidable. The challenges of working in New York City were noted by a substantial number of interviewees (nine developers, three property owners, and one other market participant). Urban challenges include space and building layout constraints, competing uses for high-value real estate, high property taxes, potential for noise complaints, and the fire and building code issues that were described previously. A few interviewees noted that the only place where they could fit a CHP system would be on the roof, making the overall logistics infeasible, as demonstrated by projects that had similar attempts in the past.

Space and building layout related issues affect more than just urban buildings. These issues reside among a broader category of challenges facing existing buildings that seek to install CHP. For example, many existing buildings do not possess the structural integrity to support the installation of a CHP system on an upper level or rooftop. Projects at these locations would require significant structural improvements in order for a CHP installation to move forward. Whether a facility is located in New York City or a rural area, if the existing structure would need to be remodeled or if an addition to the facility would be necessary in order to accommodate a CHP system, these modifications to the facility can often make a CHP project cost prohibitive.

A few interviewees highlighted that the logistics of incorporating CHP into new facilities are much simpler than installing a system into an existing facility. They noted that the engineering challenges and capital expenditures are much greater when integrating a CHP system into a building's existing mechanical, electrical, and plumbing systems.

4.7.5 Other Barriers

Several of the barriers that stand in the way of CHP market development cannot fit easily into the categories previously outlined. These "other" barriers are described here.

Thirteen market actors spanning all interviewee categories noted that the CHP market suffers from the fact that an investment in CHP is simply not a priority. One developer commented, "No matter how you slice it, CHP is always an add-on to the owner's mission, therefore, if there's not a really good payback it's hard to get their attention." An interviewee from the investment community highlighted the added difficulty of funding CHP given current economic conditions, explaining,

> *"If it's a non-essential business asset, it goes to the back of the line in terms of which capital projects get funded first."*

A few developers commented that competing energy-related investments that are simpler to understand, less complicated to implement, and more well known for producing favorable returns on investment are more likely to attract the attention and support of a facility's decision makers.

The general perception about the overall complexity of completing a CHP installation is a barrier in and of itself. One engineer stated,

> *"I'd like to propose CHP, but there are 8 million obstacles to overcome in order for a project to succeed."*

A facility owner and a developer also commented on the cumulative impact of the many complexities and barriers that many CHP projects encounter, and one referred to the combined effect as "deal fatigue."

4.8 DG-CHP Demonstration Program's Interaction with the Market

This section includes discussion of the role of NYSERDA funding in the New York DG-CHP market, challenges of participating in the DG-CHP Demonstration Program, and benefits of DG-CHP Demonstration Program participation.

4.8.1 Role of NYSERDA Funding in the New York DG-CHP Market

Thirteen interviewees representing developers, facility owners, and other market actors remarked that NYSERDA funding plays an essential role in the market for CHP in New York State at this time, and that the market is not yet ready to stand on its own without the support of financial incentives.[114]
A number of interviewees who had participated in the program stated that their projects would not have been completed had they not received the NYSERDA funding. One facility owner commented,

> *"There's a misconception that all owners are rich. A lot of these building owners are overleveraged on their properties. There's no way they can pay the money for a system outside of the grant."*

An additional three interviewees explained that the program turns projects with marginal financial footing into more solid and comfortable investments, thus speeding the pace of market development. A facility owner reported,

> *"The NYSERDA incentives were a big part of why we moved quickly. It really did enhance the economics of the project and make it so that we went from an unknown scenario, or borderline investment to a more comfortable investment for everybody. We're not making a killing on this thing by any means, but it took it from a grey area to a more solidly comfortable area for us."*

[114] Interviewers explained that the questioning referred specifically to the DG-CHP Demonstration Program. However, as noted previously, a number of respondents were confused about the distinction between the DG-CHP Demonstration Program and other programs that currently, or have in the past provided funding to CHP systems (e.g., the EFP). Most of the interviewees who identified NYSERDA funding as critical to the advancement of the CHP market had actually received funding from the DG-CHP Demonstration Program, so it is likely that their comments were referring to that program.

Most interviewees remarked that NYSERDA's funding for CHP projects is essential to market growth, and that virtually all projects that are eligible to compete for program funding are submitting proposals to compete for funds. However, six interviewees reported that there is a substantial amount of CHP development activity occurring outside of NYSERDA program funding. According to interviewees who commented on the topic, the projects getting built without NYSERDA funding include:

- » Small projects (e.g., under 300 kW)
- » Projects not eligible for SBC funding (e.g., those that do not meet stand-alone operability criteria, those initiated by New York Power Authority [NYPA] customers, or those on Long Island)
- » Projects with favorable economic prospects and eager project proponents who do not wish to wait for program funding to materialize, or to adhere to program participation requirements (e.g., monitoring system performance)

One interviewee who described this non-NYSERDA-funded CHP development activity identified a small subset of developers that actively pursue CHP development without program funding. All three of those developers identified as active in building CHP systems without the assistance of NYSERDA funding were interviewed as part of this study.

Two of those developers reported that the majority of their CHP development activity is not funded by NYSERDA; one reported that 50 to 65 percent of CHP projects being built in New York are not pursuing NYSERDA program funding, while the other stated that approximately 85 percent of his projects are built without NYSERDA funding. Both of these developers projects' are typically relatively small systems (e.g., under 300 kW). The developers explained that the burden of submitting a proposal to compete for funding and complying with program requirements is not worth the effort, and that participation in the program interferes with their sales cycle. They report that most of their projects can achieve economic viability without program funding.[115]

One of these developers stated,

> *"NYSERDA should be playing a role. But I'm not sure that incentivizing a customer up to 30 – 50% of costs is creating the most economic outcome. A better role for the program to play in the market would be for it to provide a smaller percentage of total project funding, with fewer strings attached. We just need a little icing on the cake to close the deal; if we can present a 3 to 5 year simple payback on project- that's enough to make a project go."*

This same interviewee explained that the types of CHP projects that are most in need of financial support are those incorporating absorption cooling, as that can be a capital intensive feature, but one that is needed in order to make CHP applicable to certain facility types.

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[115] This perspective on the issues facing smaller CHP systems runs counter to comments made by four other developers and facilities owners who reported that it is particularly challenging for small CHP projects to achieve economic viability.

Another developer identified as active in building CHP systems without the assistance of NYSERDA funding reported,

> *"Most projects in NYSERDA territory choose to pursue funding even though they need to postpone the project (and savings) to receive the funding."*

This developer identified the postponement of initiating project savings as the main reason his clients would choose not to pursue NYSERDA funding. The developer reported having built CHP systems at 50 sites in New York, and explained that projects at 7 of those sites had received NYSERDA funding (14 percent). This developer learned of NYSERDA's programs when a client brought the DG-CHP Demonstration Program to his attention, having found information about the program on NYSERDA's website. Now that the developer is familiar with NYSERDA's programs, he is encouraging projects to pursue program funding. However, the developer built many projects before becoming aware of the program.

All three companies identified as having developed a significant number of projects without NYSERDA funding have actually participated in and been awarded funds through NYSERDA's DG-CHP Demonstration Program at some point in time. According to these interviewees, while projects possessing favorable characteristics and can move forward without the assistance of program funding, the market for CHP as a whole is still immature and is still in need of financial and other support to enable it to grow in a timely manner. According to these interviewees the program helps facilitate the completion of projects that would otherwise have marginal economic viability.

Recent comments by a company active in the CHP market in the Northeast that were published in a trade journal shed light on the role of financial incentive programs in the market. The developer indicated that grant and incentive programs speed the development of the CHP market, but that project development can still occur without incentives in cases for which the system owner can accept a longer payback period.[116]

Interviewee reports that only a limited number of companies are building projects without pursuing NYSERDA funding are supported by the MCA team's experience developing non-participant sample frames. The team was not able to identify any companies that are actively developing CHP projects in New York that are not in some way engaged with NYSERDA CHP funding programs currently, or plan to participate in the programs in the future.

A review of the CHP project activity taking place in New York without the support of NYSERDA funding can inform the assessment of the role of the DG-CHP Demonstration Program in the market for CHP. As discussed in Section 3.3, 147 CHP projects totaling 111 MW of capacity was installed in New York State from 2000–2010 that did not receive funding from the DG CHP Demonstration Program. This excludes capacity installed on Long Island where customers do not pay into the SBC and are, therefore, ineligible for participation in the DG-CHP Demonstration Program. The data includes systems installed

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[116] Brzozowski, C. "Harnessing Heat." *Distributed Energy*. January-February, 2011.

with funding from other NYSERDA programs; those 20 projects total 38 MW of capacity. Therefore, the total non-NYSERDA funded CHP capacity installed from 2000–2010 is 73 MW.[117]

An overall review of interviewee comments indicates that market actors believe the New York CHP market is still immature and can benefit significantly from continued financial incentives, particularly given current economic conditions. While projects possessing strong characteristics can move forward without incentives, NYSERDA incentives are speeding the development of projects, and turning some projects with borderline project economics into solidly viable investments.

4.8.2 Challenges of Participation in DG-CHP Demonstration Program

When asked about reasons an eligible project may opt not to submit a proposal to compete for the NYSERDA program, reasons stated included an unwillingness to wait for program funding to materialize to begin realizing savings from the project, burdensome program requirements, and project size.

The respondent who spoke of clients' unwillingness to wait for program funding explained,

> *"In Con Ed territory, customers know that getting funding could be a one to two year process, so the customer has to wait to realize savings if pursuing funding. If they postpone the project a year, they will postpone savings, and a single cogen unit nets anywhere from $65,000 to $85,000 per year."*

This developer explained that most clients still opt to submit a proposal to compete for program funding, but not all.
Timing issues associated with the PON structure were noted by several other interviewees as burdensome to the market in general, though not specifically as a reason for non-participation. One interviewee commented that both the sales cycle and the PON approval time frame are lengthy, and that the timing structure was only well suited to cases in which a champion at the host site is fully committed to installing CHP and is willing to wait a great deal of time to move forward. He explained that this level of commitment and patience on the part of decision makers at a host site is rare.

Ten interviewees spanning a range of market actor types noted that the program's requirements are too onerous. Seven of these interviewees referred specifically to the program's requirement that systems maintain the capability to operate stand-alone during power grid outages. Others spoke more generally of the program's requirements, in some cases making note of reporting and monitoring requirements. One of the interviewees who commented on the challenges associated with the requirement for stand-alone operability during power grid outages suggested that it would be more appropriate to make stand-alone capability an option rather than a requirement in New York City since the levels of grid

[117] The non-program-funded installed capacity value also includes any CHP systems that may have been installed at facilities served by the New York Power Authority (NYPA). Based on communications with a NYPA representative, it appears likely that a great deal of CHP capacity exists at its customers sites, though NYPA does not track this. NYPA customers receive significantly lower electric rates than other electricity consumers in New York, making CHP project economics less favorable, and NYPA does not offer any financial incentives to support CHP installations. Personal communication with NYPA representative, August 25, 2011.

reliability are so high there, and a CHP system would not likely need to run stand-alone due to a grid outage more than one time in ten years. This interviewee noted that making a system capable of stand-alone operation in New York City is particularly expensive given the interconnection requirements that exist there. According to this interviewee, given the reliability of the grid in New York City, stand-alone operability may not be worth the added investment. And if the program requirement is limiting the development potential of otherwise favorable CHP project opportunities in the city, the requirement may be worth reconsidering for projects in that location.

Program staff recognizes that the program's requirement for stand-alone operability is challenging for participants to fulfill, but they hold that it is a worthwhile requirement that improves the overall quality and value of Demonstration Program installations. Furthermore, staff points out that there are enough projects capable of meeting the requirement to fully allocate program funding, and therefore it is not necessary to require any less of program participants. Additionally, the EFP does not impose a requirement for stand-alone capability. Therefore, there is an alternative NYSERDA source of funds for projects that qualify for the EFP whose proponents find the Demonstration Program's stand-alone operability requirement to be too onerous.

As noted in the previous section, a developer who installs CHP projects without program funding commented that for small projects (e.g., nursing homes) it is sometimes not worth the effort of submitting a proposal to compete for program funds.

4.8.3 Benefits of DG-CHP Demonstration Program Other than Project Funding

On the whole, interviewees view project funding as the program's most important offering to the market. However, several interviewees noted additional attributes of the program that help advance the market for CHP.

Five developers, two staff members, and one other market actor made comments related to the important symbolic impact of securing project funding from NYSERDA. One developer noted that the NYSERDA funding provides a project with credibility. Another developer remarked that having the NYSERDA "brand" behind a particular project helps it leverage additional funding from other sources. On a similar note, two staff members referenced a case in which the NYSERDA funding was small relative to the scale of the project as a whole, but that NYSERDA's funding commitment signaled to other key decision makers that the project was worthy of supporting.

One facility owner applauded program staff for providing important support to projects during the design phase. Several other interviewees remarked about how actively engaged NYSERDA staff are in the projects they fund. Two staff members also highlighted the fact that program staff engage extensively in discussions with project team members throughout the design and development processes, including attending meetings at key milestones throughout the process.

A CHP market expert who has played an active role in designing CHP systems in New York and other states for a number of years noted that NYSERDA is in a unique position to alleviate project risk at a critical point in the project life cycle by providing funding to explore project feasibility. Funding for feasibility studies of CHP systems is now provided by the Flex Tech Program. However, this was an active component within the DG-CHP Demonstration Program for a number of years.

This same market actor commented,

> *"The role that NYSERDA plays in educating facility operators and demonstrating new technologies at select locations is valuable in promoting new ideas and awareness."*

Aside from this comment, few other interviewees recognized NYSERDA for playing a role in building market awareness for CHP, and several interviewees suggested specific ways in which NYSERDA could do more in the area of education and awareness in the future (Section 4.11). It is possible that NYSERDA's existing education and awareness-related efforts (e.g., conferences and speaking engagements at industry association meetings within target market sectors) are simply less well recognized in the market than the funding provided by the program. However, it appears education and awareness-building activity is an area the program should consider expanding upon in the future.

One facility owner and a program staff member noted that the program encourages facilities to equip themselves to offer emergency-related services, (e.g., functioning as emergency shelters), thus promoting energy security and disaster preparedness. The program accomplishes this by taking into consideration during the proposal evaluation process the extent to which facilities offer strategic services in response to local emergencies. The program's requirement that systems be capable of operating during a grid outage also enhances energy security.

A developer who has only participated in CHP incentive programs in other states to date, but has thoroughly researched the market opportunity in New York, remarked that when it comes to advocating for CHP, NYSERDA's DG-CHP Demonstration Program stands out as a leader compared with programs in other states.

Program staff highlighted the role the program plays in paving a path forward for the DG-CHP market in the state, noting several specific attributes, including:

- Holding projects to higher standard of quality than they might otherwise achieve
- Engaging in discussions with industry experts and policymakers to address market barriers
- Facilitating the development of unique and innovative CHP applications
- Assisting projects in overcoming a wide range of challenges that arise during the development process
- Collaborating with other CHP-focused initiatives, such as the Northeast Clean Energy Application Center, and EPA's CHP Partnership, to inform the market about the benefits of CHP development

These program benefits reflect the fact that the DG-CHP Demonstration Program's primary goal is to facilitate advancement of the CHP market as a whole; the program is not designed to achieve the greatest amount of energy production at the lowest cost. While CHP systems funded under the EFP receive financial support only, systems funded under the DG-CHP Demonstration Program receive extensive support from program staff throughout the development process. One staff member explained that the EFP is strictly a "pay for performance" program, while the DG-CHP Demonstration Program is a "shared risk" program.

Program staff leverage the real-world experiences of demonstration program participants as opportunities to bring market barriers to the attention of policymakers. For example, staff members observed several years ago that after receiving program funding commitments, some project proponents would receive offers from their utilities to start taking advantage of "flex rates" that were not previously made available to them. Staff explained that these flex rates existed for the purpose of providing an incentive to keep a facility in New York State if it appeared the company planned to relocate to a different state. However, the flex rates were instead being used as a disincentive for facilities to install CHP. Staff brought this matter to the attention of the PSC and, according to staff, the Commission ultimately ordered that the practice be discontinued.

Staff also described having used two projects that had encountered serious challenges with standby charges as an opportunity to highlight to policymakers the market barrier posed by standby charges prior to their revision in 2003. Staff explained that they assist program participants in navigating interconnection challenges as well.

DG-CHP Demonstration Program funding recipients must successfully demonstrate their merits to NYSERDA during the proposal phase, but once they secure a funding commitment from the program, they benefit from a high level of engagement and assistance from program staff. Given the complexity and numerous challenges associated with developing CHP projects, the assistance NYSERDA staff provide to projects, both directly and indirectly, appears to be of great importance as the market is not yet well established enough to stand on its own.

4.8.4 Summary

Based on market actor interviews and secondary research, it appears that NYSERDA's funding is not essential to the success of certain projects that possess characteristics making them ideal candidates for CHP (e.g., well-matched thermal and electric loads, and a large, continuous demand for energy), and that link up with a savvy developer capable of putting together a project financing package. However, ideal candidate sites for CHP are relatively rare, and many developers report difficulty putting together project financing in the current economic climate. Therefore, the program funding helps speed the pace at which projects are completed, it helps overcome the significant limitations on access to capital in a poor economy, and it helps turn projects with marginal economic characteristics into more comfortable investments. Through project funding and staff support, as well as through broader efforts to break down barriers in the market, the program is playing an important role in helping the CHP market in the state realize its potential.

4.9 *Relationship to Other Related Programs and Markets*

This section includes discussion of the DG-CHP Demonstration Program's relationship to other programs supporting DG-CHP development in New York, as well as a comparison of the New York DG-CHP market with markets in other states.

4.9.1 DG-CHP Demonstration Program Relationship to Other Programs Supporting CHP Development in New York

The primary source of financial incentives for CHP project development in New York State is NYSERDA. Additional potential sources of funding have, in recent years, included a grant opportunity offered by DOE, demand response programs offered by utilities and the NYISO.

In 2009 DOE offered a grant program drawing on funds from the economic stimulus package.[118] However, that opportunity was limited in duration. Some CHP projects can also benefit from the demand response programs available in New York, though only a limited number of facilities with CHP systems are configured in such a way that they can adjust operating conditions in response to peak demand events. According to interviewees, in most cases, favorable DG-CHP project economics depend on sizing a system to serve on-site loads, without building in excess electricity generating capacity. Since facilities typically depend on all the power production available in their CHP system to support on-site load, it is rare that a facility would reconfigure its operations for the purpose of participating in a demand response program.

Within NYSERDA, two programs are the primary sources of funding for CHP projects, the DG-CHP Demonstration Program and the EFP. The customer-sited tier of the RPS also funds fuel cell projects. Details regarding the differences between the DG-CHP Demonstration Program and the EFP are presented in Section 4.5.

Based on comments from interviewees, it appears that most project developers and facility owners are not selective about the sources of their funding; all else being equal, they will seek the opportunity that provides the greatest financial support for their project. It is possible that a project could meet the eligibility criteria for both the EFP and the Demonstration Program. In such cases, determining the program that offers the greatest amount of funding will depend on a variety of project characteristics. One developer explained that for cases in which a project is eligible for both programs, his team will run a cost-benefit analysis to determine which program is more beneficial. Factors taken into consideration include incentive formulas, likelihood of receiving an award, and the additional hurdles and risks of participating in the program (e.g., performance monitoring requirements, or possibility that award amount will be reduced as a result of under-performance).

The two programs have different underlying programmatic goals, as highlighted in a NYSERDA brochure summarizing the various programs that include some CHP component. However, the confusion between the two programs observed in interviews with market actors is not surprising given

[118] U.S. Department of Energy. American Recovery and Reinvestment Act of 2009 (ARRA) - Industrial Energy Efficiency. Available at: http://www.grants.gov/search/search.do?mode=VIEW&oppId=47763. Obtained August 20, 2011.

the somewhat nuanced differences between the features of the incentives offered. It could be difficult for a CHP developer or facility owner to readily assess which program is best suited to the needs of a given project.

A few interviewees across a variety of market actor groups highlighted that developing a CHP project is complex and requires a great deal of site-specific analysis; comparatively, assessing the details and applicability of NYSERDA funding opportunities is a minor challenge. Nonetheless, making it easier for market actors to easily identify relevant programs and assess which program best suits a given project's characteristics would make CHP market opportunities more accessible to a broader range of market actors (e.g., CEOs and nontechnical decision makers seeking to understand market opportunities).

4.9.2 Comparison of New York Market with Other States

Developers and facility owners were asked about their experiences with CHP markets in other states. A number of these interviewees indicated that they are active in states other than New York, and a few interviewees are only active in other states at this time. Conversations with these market actors helped provide perspective on the similarities and differences between New York's market for CHP and those markets in other jurisdictions.

As shown in Table 8, more interviewees cited New Jersey (15) as another state where they develop CHP than any other state. Connecticut and Massachusetts were the next most common states mentioned; each state was cited by 11 developers. Some of the other more frequently noted states include California (7), Pennsylvania (7), Florida (4), Maryland (4), New Hampshire (4) and Texas (4).

Table 8. Other States Where Interviewees Develop CHP[119]

Location	Number Active
New Jersey	15
Connecticut	11
Massachusetts	11
California	7
Pennsylvania	7
Florida	4
Maryland	4
New Hampshire	4
Texas	4
Vermont	3
Hawaii	2
Indiana	2
Maine	2
Michigan	2
Ohio	2

Source: MCA and Process team market actor interviews.

When developers were asked how they decide which CHP markets they will pursue, ten developers remarked that they go where the best market opportunities exist in terms of overall project financial viability. Developers who work in New York commented that high electricity prices, and the Location-Based Marginal Pricing that exists to address grid congestion in downstate New York, make that region a particularly favorable market. One respondent explained that his company had relocated to New York from the Midwest because,

> *"The utility rate climate is so much more advantageous in New York than in the Midwest."*

Market conditions in downstate New York are further enhanced by the fact that there is such a high concentration of commercial buildings in the area. Several interviewees also cited the availability of

[119] States listed include only those states for which more than one interviewee reported working in the state. Additional states noted by just one interviewee each include: Alaska, Delaware, Tennessee, Virginia, Washington, Wisconsin, and Wyoming.

financial incentive programs as another factor that contributes to the favorable economic outlook for project development in New York.

An interviewee commented about the favorability of the CHP market in downstate New York relative to other markets,

> *"The NYC market is more robust because of the higher cost of delivered utility services- so systems have better economics. Also the end-users and facility managers have a higher level of sophistication. An institution in New Jersey or upstate New York or Pennsylvania, would have a harder time achieving economic viability than the same institution in New York City. New York is also at the front of the pack in terms of grants, support, and interest from organizations like NYSERDA, as well as advancements in interconnection policies, and environmental regulations."*

Six developers explained that their decision about where to pursue CHP projects was driven mostly by geography and experience. A few interviewees commented that their company provides a broad range of energy services including CHP, and that they pursue work in areas close to their existing office locations. One interviewee explained that the key staff who formed his company lived in a particular area and that they were most familiar with the market in that area.

Comments about experiences with other CHP markets varied widely. Due to the diversity of the comments, few trends were observed. On the whole, interviewees appear to hold New York's CHP market in high regard, though several features of CHP programs and markets in other states were noted.

Figure 26. Favorable Features of New York and Other CHP Markets Noted by Interviewees

Favorable Features of CHP Markets in Other Jurisdictions	Favorable Features of New York's CHP Market
• New Jersey (PSE&G) has favorable standby rates, and a stable distribution system capable of accommodating substantial DG capacity. • Feed-in tariffs are available in California and Nova Scotia. • Construction costs are lower in other states than in New York. • Robust policies and incentives are supporting CHP in Connecticut and Massachusetts. • Interconnection is easier in spot networks in Texas than in Con Edison territory.	• High delivered cost of electricity • Dense population of buildings, and sophisticated building owners in downstate region • Staff of NYSERDA's programs are more responsive and more engaged in advancing the market than program staff in other states. • NYSERDA programs are more stable than in other states. • Standby Rates: Demand ratchets limited to 30 days • CHP development process is more mature than in other states (e.g., utilities and building officials familiar with CHP projects).

Source: MCA and Process team market actor interviews.

Six interviewees pointed to Massachusetts as a market with particularly favorable policies and market features. The Green Communities Act that was passed in Massachusetts in 2008 includes several elements designed to jump-start the state's markets for energy-efficient technologies such as CHP, and to ensure an energy-efficient future for the state. The act introduced an innovative policy called an "Alternative Energy Portfolio Standard" focused specifically on advancing markets for CHP and other "alternative" technologies not typically captured in state energy portfolio standards.[120] The Alternative Energy Portfolio Standard requires investor-owned utilities and retail suppliers to meet 5 percent of their load with "alternative energy sources" by 2020. This requirement is distinct from the state's Renewable Portfolio Standard and its "Energy Efficiency First Fuel Requirement," an energy efficiency resource standard.[121]

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[120] Other technologies included in the state's Alternative Energy Portfolio Standard include gasification with capture and permanent sequestration of carbon dioxide, flywheel energy storage, paper-derived fuel sources, or energy-efficient steam technology.

[121] Database of State Incentives for Renewables and Efficiency. Massachusetts Incentives / Policies for Renewables and Efficiency. Available at:

Three interviewees highlighted Connecticut as a state with model market and policy features. State policies and incentive programs that benefit the CHP in Connecticut include an energy efficiency component in the state's Renewable Energy Portfolio Standard, and a state loan fund that offers long-term fixed interest rates.[122]

Therefore, the states touted by interviewees for having positive policy and market features are places that rely primarily on portfolio standards (i.e., percentage-based minimum procurement thresholds for utilities) to support CHP market development.

Although only one developer highlighted New Jersey as a state with strong policies or incentives, the fact that 15 interviewees reported having developed projects in New Jersey clearly indicates that developers view the state as a location with significant opportunity for CHP development. Interviewees cited favorable standby rates and distribution system infrastructure in PSE&G's service territory as attractive features of the market there. The state also offers grant and loan programs to support CHP project development.[123]

One developer commented that New Jersey's solar market provides a great example of how policies can make a market work. This interviewee explained that his company develops a range of clean distributed generation technologies and is currently focusing on developing PV in New Jersey because that is the most opportune market in the region.

4.10 Market Outlook

This section provides an overview of the trajectory New York's DG-CHP market appears likely to follow based on research conducted by the MCA team.

4.10.1 Prospects for Market Growth are Generally Positive

Looking ahead, a number of interviewees anticipate seeing substantial growth in the CHP market in New York. Nine developers and two other market actors expressed optimism for the future of the CHP market in the state. A few of these interviewees noted that expectations of continued low natural gas prices favor project development. One developer stated,

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http://www.dsireusa.org/incentives/index.cfm?getRE=1?re=undefined&ee=1&spv=0&st=0&srp=1&state=MA. Obtained August 20, 2011.

[122] Database of State Incentives for Renewables and Efficiency. Connecticut Incentives / Policies for Renewables and Efficiency. Available at: http://www.dsireusa.org/incentives/index.cfm?getRE=1?re=undefined&ee=1&spv=0&st=0&srp=1&state=MA. Obtained August 20, 2011. And American Council for an Energy Efficient Economy. State Energy Efficiency Policy Database: Connecticut Clean Distributed Generation. Available at: http://www.aceee.org/energy-efficiency-sector/state-policy/connecticut/180/all/195. Obtained August 20, 2011.

[123] American Council for an Energy Efficient Economy. State Energy Efficiency Policy Database: New Jersey Clean Distributed Generation. Available at: http://www.aceee.org/energy-efficiency-sector/state-policy/connecticut/180/all/195. Obtained August 20, 2011.

> *"The market is bubbling right now… the ability to secure 5-year gas contracts helps underwrite risks."*

Other reasons interviewees cited as the basis for their anticipation that the market will experience near-term growth include:

» New developers are entering the market

» Facility owners are expressing interest in emergency power

» Increased awareness for CHP opportunities, and an increase in the number of facilities owners contacting developers with interest in CHP

» Installation activity has recently increased in the New York City area

» Policies are more favorable to CHP development than they have been in the past

A few market actors offered less optimistic views of the market. Three interviewees indicated that they did not expect to see much growth in the CHP market in the near-term. Reasons for this pessimism about the potential for market growth include the fact that CHP development is complex, and that there are not that many facility types that are well-suited to using CHP. One developer stated,

> *"The New York market is not likely to grow significantly in the next 5 years as air permitting, local siting issues, and interconnection costs all present major challenges, and most of the suitable host facilities have already been fairly well 'picked through,'"*

One facility owner whose organizations have facilities located across the state noted that electricity prices of electricity are pretty hard to beat right now, so only the parts of the state most vulnerable to the pricing effects of transmission congestion are likely to find promising CHP opportunities (e.g., New York City and Long Island).

4.10.2 Growth in Market for Modular or Packaged Systems is Likely

As noted in Section 4.2, and discussed further in Section 4.6, many interviewees expect to see growth in the market for modular or packaged systems, though the level of optimism expressed by interviewees varied. Several interviewees indicated a strong belief in the market growth potential, three other interviewees said that the potential for growth was there in theory, but they would need to wait and see how circumstances unfold.

4.10.3 CHP May Become More Common in New Construction

Two interviewees expressed optimism that CHP will become a fixture in new construction occurring in New York City as a result of improving market conditions and policy support for CHP in the city. One of these interviewees, a representative of a major commercial property holder, explained,

> *"I think the real inflection point in the City is making it the norm. I think you will be hard pressed to see any new construction in the City without [a CHP system] built in. The question is what will happen with the existing building fleet."*

Unlike existing buildings, new construction suffers from many fewer logistical barriers than do existing buildings. Although new facilities would still need to possess key load and operations characteristics in order to make them viable projects, the logistical and upfront investment barriers would be significantly reduced if CHP was incorporated during initial construction. A New York City requirement that new developments larger than 350,000 square feet analyze CHP feasibility is another key factor supporting growth in CHP within the new construction market.[124]

4.10.4 Increased Emphasis on CHP for Purposes of Reliability and Critical Infrastructure Support

As noted in Section 4.2, increased interest in reliability by banks and data centers is an important driver for CHP installation today. In addition, a wide range of commercial and public property owners are interested in equipping their facilities to serve as emergency shelters, or simply to continue operations during emergency events. It appears that these drivers will only increase in importance over time, as our economy becomes even more dependent on computer networking and data storage, and as energy security concerns remain significant.

4.10.5 Microgrids Hold Promise for Expanding CHP Markets

Microgrids consist of a grouping of electrical generation, storage and loads. The grouping is often connected with the mainstream electric grid, but can also operate autonomously.[125] This approach offers strong potential benefits; it would improve reliability for facilities operating within the microgrid, enable facilities to build larger CHP systems without worrying about limitations related to interconnecting with the utility, and could possibly increase flexibility in CHP system design since electrical and thermal energy generation could serve more than just one facility.

Two interviewees reported that microgrids or other forms of district energy hold great promise for expanding the market for CHP, and one of these interviewees noted that a pilot microgrid project is already in the development phase in New York City. Another interviewee commented that microgrid development of any substantial scale is at least five years off, and that pilot programs occurring during the next few years will provide a better understanding of the challenges and opportunities associated with microgrids.

4.10.6 Electric Distribution System Improvements Will Expand Opportunities for CHP Development, Though Timing is Uncertain

Areas of Con Edison's spot network systems that are ill-suited to support added DG are identified as "red zones," meaning that additional DG cannot be added unless it uses fault current mitigation elements are included in the DG system. Upgrades to Con Edison's electric delivery infrastructure would help turn "red zones" into "green zones," where it is less likely that costly fault current mitigation tools would need to be used by CHP systems. Con Edison announced changes to its fault current

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[124] Simpson.T. *PlaNYC Perspective on CHP and DG.* Presented March 19, 2009. New York City Economic Development Corporation.

[125] Stan Mark Kaplan, Fred Sissine. (2009) *Smart grid: modernizing electric power transmission and distribution.* The Capitol Net Inc.

calculations in February 2011that make the calculation more stringent.[126] These changes are expected to extend the amount of time it will take for areas of the spot networks to change from "red zones" to "green zones." This issue is not yet well-defined, as Con Edison has not yet defined all the details of its new approach to fault current calculations.

4.10.7 Natural Gas Supply Infrastructure May Limit CHP Growth Potential

As noted in Section 4.6, insufficient gas supply infrastructure to support the addition of CHP in certain locations within New York City has already proven to be a problem for some projects. It is likely that CHP installation activity, and overall demand for natural gas supply will increase with the phase-out of No. 6 and No. 4 heating oil in New York City in the coming years. These and other factors will indicate that gas supply infrastructure deficiencies could become a much more significant limitation to CHP market growth in the future.

4.10.8 Availability of Qualified Technicians to Maintain Systems May Become Limited

Two staff members and one other industry expert expressed concern about the availability of qualified technicians to perform system maintenance. Although manufacturers can provide maintenance services, if competition to supply the services is limited there will be no downward pressure on pricing. This issue of sparse competition to supply services appears to be a factor for microturbines and fuel cells. Recognizing the need for more companies to offer CHP system maintenance services, NYSERDA is supporting a company that will provide maintenance services to CHP systems in the New York City area. Looking ahead, it is not clear whether a competitive field of maintenance providers will exist in the market. Given the extent to which system performance depends on proper maintenance, this is an issue that deserves close attention in the future.

4.10.9 Additional Factors That May Affect the CHP Market in the Future

» *Power Quality*: There is an increased interest in power quality (in addition to reliability) by banks and the commercial sector, and this interest may drive additional CHP project activity;

» *Tri-generation*: Use of CHP, or "tri-generation" at facilities relying upon utility supplied steam for producing chilled water offers particularly favorable economics and may be an area of growth in the coming years;

4.10.10 Summary

It appears that the prospects for growth in the CHP market are strong, and that they are greatest in the downstate region of the state where electricity prices are highest, and where CHP receives support from local policies. Specifically, several interviewees expect to see an increase in the use of modular or packaged CHP systems, as well as an in increase in the number of new construction projects incorporating CHP. Interest in power supply reliability and energy security are also likely to drive growth in the CHP market. Microgrids hold promise for addressing interconnection and siting-related barriers to CHP, though substantial use of microgrids appears unlikely to occur for several years. The barriers that currently stand in the way of CHP development (e.g. volatility in spark spread, and

[126] Personal communication with Con Edison representative, August 2011.

identifying ideal sites for CHP) are likely to remain challenges into the future. A barrier that may come into play in a more significant way in the future is limitations on natural gas supply infrastructure.

4.11 Interviewee Lessons Learned, and Suggested Changes to Advance the CHP Market

Interviewee's were asked to share their most valuable lessons learned based on past experience developing CHP projects in New York. They were also asked to provide suggestions for ways the market for CHP could be improved through changes in program and policy design. Interviewee feedback on these topics is summarized in this section.

4.11.1 Interviewee Lessons Learned

A summary of key market-related lessons learned expressed by interviewees is presented in Table 9. As shown, the most common lessons learned that were noted by interviewees pertained to the interconnection process. The market actors interviewed emphasized the importance of initiating the interconnection process early, carefully monitoring progress over time, and engaging in frequent communications with the utility. Another topic highlighted by several interviewees is the importance of engaging in careful analysis and due diligence when assessing project feasibility, and during the project planning phase. A third topic that received a noteworthy number of comments from interviewees is the importance of ensuring that waste heat from a CHP system can be sufficiently utilized.

Table 9. Summary of Interviewee Lessons Learned

Lesson Learned	Number Commenting
Interconnection issues can be reduced through careful attention to detail and frequent communications: » Initiate utility interconnection agreements early-on in the development process » Carefully monitor progress toward interconnection process milestones » Promptly address issues as they arise through regular communications with utility	12
Due diligence during the feasibility analysis and planning stages is important: » Obtain cost estimates from multiple sources to verify accuracy (4 interviewees) » Obtain independent engineering analysis to check accuracy of manufacturer claims about system performance (4 interviewees)	8
Utilization of waste heat is key to project economics: » During the design phase, careful consideration should be give to a facility's ability to make use of waste heat	5
Small projects can encounter the same level of complexity as larger projects, often making it difficult to achieve favorable project economics for small systems	4
Hire an experienced team	3
Obtain warranty / maintenance contracts to ensure that all system components are covered	3
Emissions permitting tends to take longer than expected: » Permitting tasks should be initiated early on in the project planning process » Sufficient time should be built into the development schedule	2

Source: MCA and Process Team market actor interviews.

The topics highlighted in Table 9 are those that were noted by more than one interviewee. Additional noteworthy lessons learned that were mentioned by a single interviewee include:

» Consider standby rate-related demand charges when timing maintenance work

» It is difficult to avoid demand charge problems due to unplanned system downtime

- It is hard to keep clients engaged in energy-related matters since it is not their core business
- Building relationships with suppliers can help expedite the development process
- Remote monitoring of system performance is a significant challenge
- Facility owners should have the system manufacturer or a project integrator conduct a turnkey installation rather than attempting to sub-contract out components of the work
- Fuel cells require less maintenance than reciprocating engines or gas turbines

4.11.2 Interviewee Suggested Changes to Advance the New York Market for CHP

Interviewee offered a number of suggestions for program and policy changes that could advance the market for CHP in New York. Several interviewees provided program process-related suggestions (e.g., recommendations for improving the CHP website, and changes to program participation requirements). Those process-specific topics are discussed the Process Evaluation Report. Recommendations that pertain to broader market-related topics are summarized here.

The majority of comments pertained to a desire for additional funding for CHP project development. Interviewees also recommended increasing education and awareness activities, funding equipment R&D, and making programs more prescriptive in nature.

Table 10. Interviewee Suggested Program and Policy Changes

Interviewee Suggestions	Number Commenting
Increase Funding for CHP Programs and Projects	
Expand program / secure additional program funding	15
Raise cap on project funding	5
Total	*20*
Conduct More Education / Awareness Activities	
Provide better, more accurate education about benefits of CHP drawing on latest system data	9
Provide more education and awareness about program	6
Total	*15*
Add / Change Types of Incentives Available	
Fund equipment R&D	5
Make more prescriptive- Provide standard offer incentive to all that meet minimum criteria- abandon the current timing format	4
Put more money into CHP performance program rather than demonstration program (more support to tried and true technologies rather than cutting edge projects)	4
Total	*13*
Provide More Technical Tools to Assist Market Actors	
Provide tools to help evaluate whether a site is a good candidate for CHP to reduce cost burden on others in the market	4
NYSERDA should be more proactive about identifying good target sites	5
Total	*9*
NYSERDA Should Continue Role as Market Facilitator	
NYSERDA should take lead in facilitating communications to resolve issues in market	5
NYSERDA should do more to push utilities on interconnection and advocate for CHP	2

Interviewee Suggestions	Number Commenting
Total	*7*
Ensure Long-Term Policy and Incentive Program Stability	
Maintain incentive offerings for long periods of time so that market actors can count on incentive availability in business and project-specific planning	8
Total	*8*
Changes to Interconnection Policies and Processes	
State should oversee interconnection rather than utilities so that utilities do not have ability to stand in the way of project success	2
Total	*2*
Other	
Promote modular systems	6
Provide opportunities for participation by a wide range of potential players- e.g., microgrids	2
Support power storage technologies	2
Total	*10*

Source: MCA and Process Team market actor interviews.

Suggestions highlighted in Table 10 include topics addressed by more than one interviewee. A few additional noteworthy suggestions were offered by just a single interviewee. These include:

» Interviewee-recommended actions for NYSERDA
  - Reinstate Smart Energy Loan Program
  - Develop a guidebook to clarify the steps in the process, and provide guidance on navigating potential issues that may arise during the development process
  - Provide funds to help keep struggling existing systems running
  - Identify areas of resistance in the market and address them
  - Coordinate with banks to ensure financing available for projects
  - Pay incentives directly to end-users to avoid potential abuses by installer
  - Market to end-users
  - Limit support of fuel cells to niche applications

» Interviewee-recommended actions for state policy-makers

- Raise cap on Standard Interconnection Requirements to something greater than 2MW
- Ensure that properties with CHP are not taxed as though they are power plants
- Allow to CHP owners to sell across rights of way without being considered a utility
- Allow net metering for non-residential CHP systems
- Don't extend net metering to CHP
- Change standby rate exemption criteria so broader
- Harmonize program with efforts at federal level (EPA)
- More clearly define "clean" energy

5 Key Findings and Actions for Consideration by Program Staff

The most significant findings resulting from the evaluation study are summarized in the bulleted lists included in this section.

5.1 *Key Findings*

5.1.1 Overall Market Trends

- » Economic conditions have slowed development activity
- » Most systems being installed are owned and financed directly by the host customer
- » Firms are pursuing strategies to offer customers more integrated CHP-related services and are beginning to focus on sub-segments of the market
- » Both developers and facility owners play a role in initiating CHP project development
- » The policy and regulatory climate is improving, though significant barriers remain
- » Commodity price volatility is the greatest perceived risk to CHP's economic viability
- » Green image, reliability, and energy savings are key reasons for installing CHP
- » Most projects are engaging in long-term maintenance contracts
- » Recent CHP development activity is concentrated in the New York City area
- » Installation activity is increasing at facilities seeking reliable power
- » System sizes are smaller than they have historically been, driven by factors such as a shift away from new installation activity at large industrial sites, and the 2 MW cap on streamlined interconnection rules
- » There is a gap in the commercial availability of mid-sized CHP systems
- » Reputation and word-of-mouth play keys role in winning work
- » Awareness of and demand for modular or packaged systems is growing, particularly for applications in existing buildings and urban settings

5.1.2 Market Activity

- » A period of steady growth in CHP installation activity has occurred since the NYSERDA DG-CHP Demonstration Program was launched in 2001
- » The majority of program-funded projects installed during the last decade have been smaller than 5 MW. The average system capacity per project for program-funded projects is 0.5 MW, and 0.6 MW for non-program funded projects.[127]

[127] This average excludes the 30 MW system installed at Cornell University due to the outlier effect of that data point.

- Non-program-funded DG-CHP systems exceed program-funded systems in terms of number of systems, but not in terms of installed capacity. During the 2000-2010 timeframe, 95 program-funded projects (111 MW) were completed, compared with 147 non-program funded projects were completed (92 MW).
- The majority of DG-CHP activity, both program funded and non-program funded, has occurred in the central and western parts of the state surrounding Syracuse and Buffalo, and in the metropolitan New York City area. It appears that a market shift has occurred; installation activity was once focused at industrial facilities located in central and western parts of the states, but now a strong concentration of activity exists in the New York City area.
- During the SBC3 funding period (2006-2010) reciprocating engines accounted for the greatest number of systems installed, both among program-funded and non-program funded projects. For program-funded projects, combustion gas turbines exceeded reciprocating engines in terms of installed capacity, though this was driven by a single 30 MW gas turbine installation.

5.1.3 Market Structure and Firm Strategies

- The number of firms developing and completing projects in New York is slowly increasing. This growth is driven by existing firms in the building and energy sectors expanding their services to include CHP-specific offerings. A number of less experienced development firms continue to try to break into in the market; however, economic conditions and customers wary of reportedly poor-performing systems make it difficult for them to gain traction.
- Firms are pursuing strategies to offer customers more integrated CHP-related services. This includes vertical integration of manufacturers into the design-build space, as well as informal partnerships between developers, engineers, and contractors. Firms are also increasingly specializing by focusing their CHP market activities on particular customer segments (e.g., high-rise office buildings) and technologies.
- Opportunities exist for project developers willing to aggregate multiple projects to help reduce equipment purchase costs, facilitate project financing, and mitigate costs related to the construction of new natural gas supply infrastructure (i.e., for adjacent properties in New York City).

5.1.4 Policy Framework

- New York State's policies related to clean DG are considered to be some of the strongest in the nation.[128]
- Changes in policies related to interconnection and standby rates during the past several years have reduced, but not eliminated market barriers in these areas. A key interconnection-related developments include passage of Standard Interconnection Requirements, and streamlining of requirements for systems 2 MW or smaller. Revised standby rates were introduced in 2003, and exemptions to standby rates will remain in place for certain clean DG systems through 2015.

[128] Molina et al. 2010. *The 2010 State Energy Efficiency Scorecard*. American Council for an Energy-Efficient Economy.

» Policies introduced in New York City during the last five years demonstrate a strong commitment to CHP market growth on the part of city policy-makers. These favorable policies, coupled with high delivered electricity rates make the New York City area one of the most attractive places in the country for CHP development.

5.1.5 Project Economics and Drivers

» Most host customers continue to own and finance systems directly rather than relying on third-party ownership arrangements. System owners cite a desire to capture the full economic value of the system themselves rather than sharing benefits with a third party.

» Third-party ownership arrangements (e.g., energy service agreements or ESAs) have gained limited traction in the market. In addition to added complexity, host customers have concerns about the added financing costs and the long-term solvency of third-party owners.[129]

» The International Accounting Standards Board (IASB) and Financial Accounting Standards Board (FASB) are in the middle of a process of updating accounting standards to bring U.S. accounting practices more in-line with international principles. One key change will affect accounting for operating leases, essentially requiring that they appear on the leasing organization's balance sheet.[130] The institutional customers for whom ESAs and leases are most appealing have concerns about the balance sheet, depreciation, and tax impacts of such agreements. Until the IASB and FASB finalize these proposed changes (which is expected by the end of 2011), organizations may approach new long-term leasing arrangements with caution.

» The economic recession has sharply reduced the pace of installations in New York State. A combination of uncertainty and risk aversion; lack of capital and acceptable financing terms; and flattening energy prices due to reduced consumption have some potential project owners hesitating or unable to move projects forward.

» Roughly half of installed CHP systems fail to meet owners' expectations for economic performance. The leading reasons for lower-than-expected performance, in order of frequency, include: improper system design; equipment malfunctions and other technical issues; commodity price volatility; and standby tariffs and other unexpected operating costs.

» Commodity price volatility is the greatest perceived risk to CHP's economic viability. While market actors express cautious optimism about natural gas prices remaining low, most agree that a sudden uptick in prices would have severe, negative consequences for the CHP market.

» Inconsistent or negative policy and regulatory changes will threaten an already fragile market. Frequent changes in utility tariffs, standby rates, and permitting requirements can create unintended barriers and costs for installing CHP systems.

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[129] Several developers indicated that such third-party ownership arrangements are better geared toward systems with larger capacities, which were underrepresented in this study.

[130] Pricewaterhouse Coopers. July 2010. "The overhaul of IFRS lease accounting: Catalyst for change in corporate real estate." Accessed August 22, 2011. Available at: http://www.pwc.com/gx/en/asset-management/ifrs/ifrs-lease-accounting-0710.jhtml.

5.1.6 System Performance and Technological Trends

- Most technical issues arise during construction, commissioning, or early-stage system operations when manufacturers' warranties cover repair and replacement costs. However, some systems experience long-term or persistent technical issues that can cause them to perform outside of expected payback thresholds.
- Market actors are generally supportive of NYSERDA increasing its focus on smaller prepackaged and modular systems. Several commented that market awareness of and demand for packaged systems is growing, particularly to address the challenges of installing systems in existing buildings in urban settings. However, some market actors expressed doubts about the scope of market benefits that packaged systems will provide.
- Building owners and ESCOs are increasing installation of sub-meters and building management systems to enhance control and operations of their facilities. These technologies allow building owners and energy consultants to better understand opportunities to improve a facility's energy use, including installation of a CHP system. Such systems will also provide CHP design engineers and developers with improved data to help determine optimal system size and operating characteristics of potential CHP systems.

5.1.7 Market Barriers

- The most substantial market barrier is the long simple payback on some CHP projects; if the simple payback period is longer than 3 to 5 years, it will likely be difficult for the project to attract investment. Numerous economic and system performance factors drive a project's simple payback. Many of these factors are difficult to estimate and difficult to control making system planning challenging.
- Despite the improvements on issues related to interconnection, the costs and timeframes associated with interconnection processes are still problematic, particularly for those systems larger than 2 MW. There are also significant restrictions on projects seeking to interconnect within the spot networks that exist in urban areas.
- Demand costs associated with standby rates are still perceived by some in the market to be a barrier in New York. Certain clean DG systems are currently exempt from standby rates through the end of 2015. When the exemption expires, standby rates may become a greater area of concern among CHP market actors.
- Policy and regulatory barriers are less significant than in the past. However, market actors expressed concern about regulatory risk, and about administrative burdens associated with regulatory compliance.
- For projects in New York City, uncertain and often unexpectedly high costs for Con Edison to upgrade the natural gas line serving a facility have prevented several otherwise viable CHP projects from moving forward.
- Other barriers include: uncertainty about future market conditions; low levels of knowledge and awareness; siting, infrastructure and logistical barriers; competing investment priorities; and the complexity of the CHP market and development process.

5.1.8 Awareness and Knowledge

- Awareness and knowledge of CHP opportunities in general is relatively low.
- Among CHP market actors in New York, awareness about the presence of NYSERDA DG funding opportunities is strong, though there is some confusion about the differences between incentives offered by the DG-CHP Demonstration Program and those offered by the Existing Facilities Program.

5.1.9 DG-CHP Demonstration Program's Interaction with the Market

- The New York CHP market appears to still be relatively immature, and continued financial incentives will accelerate the pace at which it can proceed toward achieving its potential. While projects possessing strong characteristics can move forward without incentives, NYSERDA incentives are speeding the development of projects, and turning some projects with borderline project economics into solidly viable investments.
- Challenges associated with participating in the DG-CHP Demonstration Program include timing issues related to the PON structure, and program requirements. It appears that some smaller projects with favorable project characteristics do not submit a proposal to compete for program funding because they do not believe the benefit to be worth the burden of participating.
- Through project funding and staff support, as well as through broader efforts to break down barriers in the market, the program is playing an important role in helping to advance the CHP market in the state.

5.1.10 Market Outlook

- It appears that the prospects for growth in the CHP market are strong, and that they are greatest in the downstate region of the state where electricity prices are highest, and where CHP receives support from local policies.
- The market for modular or packaged systems is likely to grow.
- Other market developments that may occur include: an increase in CHP systems in new construction, growth in power supply reliability as a driver for CHP investment, development of microgrids that will provide greater flexibility in identifying potential sites suitable for CHP, improvements to utility distribution system infrastructure that will expand opportunities for CHP to interconnect, and a shortage of qualified technicians to perform system maintenance.
- Volatile commodity costs and siting barriers are likely to remain substantial barriers. Gas supply infrastructure in New York City may take on greater significance as a barrier as demand for natural gas grows.

5.2 Recommendations

- ***Strive to maintain a consistent policy and incentive structure over time.***
  - When incentives offered through a particular program vary in structure from year to year it makes it difficult for market actors to conduct effective planning and business activity.

NYSERDA and the PSC should consider the importance of maintaining policy and market stability over time when making decisions about program and policy changes in the future. Building a history of policy and incentive stability helps reduce perceived regulatory risk among investors, thus attracting CHP investment to the state.

» ***Consider offering additional / alternative strategies for assisting CHP systems on the margin of economic viability.***
  – One potential policy option for helping faltering projects move forward could involve the provision of either an interest-rate buy-down program or a revolving loan-guarantee fund for qualifying projects. Whether made available through state or federal-channels, such funds would reduce the capital constraints facing many CHP projects.

» ***Publish case studies highlighting experience of systems that have participated in the program***.
  – NYSERDA staff and its technical consultant have undertaken various efforts, including required M&V, to examine the performance of systems in the Integrated Data System (IDS). However, little processed or summary information about their findings have been published or otherwise made available to the public. Publication of detailed case studies of experiences of some of the systems in the IDS would be a valuable tool to support NYSERDA's efforts to inform the market. The case studies would provide real data to help the market better understand system performance characteristics, and address misconceptions related to CHP system performance.

» ***Expand outreach and education activities***.
  – Low awareness about CHP opportunities is a significant market barrier. Raising awareness about CHP is part of the program's mandate; thus staff should consider allocating additional program resources and attention to education and awareness activities. A few types of activities to consider include:
  – Conduct studies to identify favorable potential CHP sites and provide targeted outreach to those facilities.
  – Increase efforts to educate end-users in sectors most favorable for CHP (e.g., attend conferences targeting decision-makers at hospitals, nursing homes, and facilities requiring reliable power; and hold CHP information workshops geared toward facility decision-makers in New York City and other regions with strong CHP potential).
  – Inform market actors about services offered by the Northeast Clean Energy Application Center, EPA's CHP Partnership, and other similar initiatives. A few interviewees who were otherwise fairly informed about the CHP market in New York were unaware of technical services offered through the Northeast Clean Energy Application Center, and requested that NYSERDA provide tools to help prospective sites assess the viability of CHP. Continued efforts to coordinate activities across various CHP market-building initiatives will help maximize the cumulative impact of these initiatives.

» ***Update website and provide clearer explanation of the differences in incentive offerings provided by DG-CHP Demonstration Program and EFP.***
    – To address concerns about the difficulty of navigating NYSERDA's DG-CHP Demonstration Program, and confusion between the Demonstration Program and EFP,

staff should consider taking steps to make it easier for readers to easily navigate to the websites of the different programs funding DG-CHP systems. In addition, a side-by-side comparison of how incentive and program features would affect a sample project would help viewers readily assess differences in the incentive offerings and other features of the two programs.

» ***The PSC should explore the impacts of raising system size caps on streamlined interconnection requirements and the clean DG system exemption from standby rates***.
  – The current size limits on SIR and the clean DG system exemption from standby rates are somewhat arbitrary. However, they are encouraging system design choices that result in smaller systems that fit within the size thresholds of these policies. A thorough assessment of appropriate system size thresholds would inform sound policy decision-making.

» ***Consider supporting pilot projects that demonstrate innovative CHP-related technology applications but that fall outside standard program eligibility criteria***.
  – The program should consider supporting efforts to demonstrate unique and developing CHP technology applications (e.g., microgrids, innovative remote data monitoring approaches, new interconnection-related technologies, etc.)

» ***Continue drawing on lessons learned from program participant experiences to highlight necessary changes in the market***.
  – The Demonstration Program has a history of using participant experiences as examples for changes that could be made to improve market conditions. This type of activity is within the program mandate, and staff members hold strong market expertise that should be utilized. Therefore, staff should continue to engage in activities that inform dialogue among industry thought leaders and policy-makers.

6 Appendix A. Sample Interview Guide

DG-CHP Participating Developer Interview Guide

» **Introduction**

My name is _________________ . NYSERDA (the NY State Energy Research and Development Authority) has contracted with us to conduct an evaluation and market assessment for its Distributed Generation-Combined Heat and Power Demonstration program. As part of that work, we are interviewing developers of CHP projects that have received funding through the program. According to the information NYSERDA provided to us, you have worked on a project(s) for __________________ using a _____________________ generation device(s) (prime mover). [Note: the previous sentence will need to be modified as appropriate to reflect whether the individual developer contact has worked on multiple SBC3-funded projects or only on a single project.]
Are you the person at your company who is most familiar with that project? [If not, ask for the name and phone number of the better contact.]

» **Project Processes**

1. According to the records we received from NYSERDA, your project is in the ____________ phase. Is that correct? [If not obtain update.]
2. What project-related activities have you had responsibility for? [Ask only about those steps which have occurred for this project]
    a. Proposal development
    b. Contracting with NYSERDA
    c. Project design
    d. Equipment acquisition
    e. Project installation
    f. Project commissioning
3. [If **proposal-development**] Please describe your experience with the proposal process. [Probe for ease or difficulty, unexpected steps, perception of amount of time required, areas for improvement]
4. [If **contracting**] What was the contract negotiation process like? [Probe for ease or difficulty, unexpected steps, perception of amount of time required, areas for improvement]
5. [If project **design**] What were the reasons for the selection of the technology and design approach used for this project?
6. [If project **design**] What was most challenging about designing this project? [Probe for reasons]

7. [If **equipment acquisition**] Was the equipment required for this project readily available? [Probe for customized versus off-the-shelf equipment, unforeseen delays and reasons for them, unexpected cost, perception of amount of time required for equipment delivery]
8. [If project **installation**] Did the installation go as expected? [If not, probe for details]
9. [If project **commissioning**] Were there any surprises that arose during commissioning? [If so, probe for details]
10. What has been your experience with the system's operation and performance? [Probe for generation performance, noise, emissions, operating cost, reliability, meeting payback projections]
11. How does the performance of this system compare to the performance of the other systems you've installed? [If other projects fell short of expectations, ask following subset]
    a. Could you briefly describe technical challenges you've encountered in your other projects? [Probe: Are these problems isolated to a particular type of equipment?]
    b. How have actual project payback results been comparing to expectations for your projects overall [Probes: What have the paybacks typically been (# of years)? How carefully is this being tracked?]
12. What is your firm's role in providing system maintenance?
13. Have there been any unexpected maintenance issues? [If so, probe for details of maintenance issues and responses to them]
14. Have your other CHP installations had the same approach to maintenance responsibilities as this demonstration project? [If not] What types of maintenance plans are in place at your other clients' sites? [Probes: Are they under long-term maintenance contracts with your company, another company, or do their clients' in-house staff maintain the systems?]
15. Did you or your client communicate with the utility about this demonstration project at any points during your involvement with it? [If so, probe for the stages during which the communications occurred, who communicated, purposes of communications, and the utility's responses]
16. Did your client have previous involvement with any distributed-generation systems that you know of? [If so, probe for technologies, when installed, and client's satisfaction with them]

» **Other Program Processes**

17. How would you characterize your communications with NYSERDA staff? [Probe for staff availability, responsiveness, and contact's satisfaction]
18. [If system is operational] Were you involved in setting the project up with NYSERDA's DG-CHP Integrated Data System? [If so, probe for ease or difficulty, satisfaction]
19. What (have you/do you) or your client (learned/expect to learn) from this project?

» **Company Background**

20. Could you describe how CHP fits into your company's broader business structure (e.g., does the company install EE measures or other DG technologies as well)?
21. Could you briefly summarize the nature of the CHP work you've done in New York? That is, do you typically install a certain type or size of system, or work mostly in a certain region of the state, or with certain types of clients or buildings?
22. [If firm has a particular focus] Why have you chosen to focus on this particular subset of the CHP market?

» **Firm's CHP Experience and Processes**

23. For how many years has your company been installing CHP systems in New York?
24. Roughly how many systems have you installed in New York during that time?
25. Why did your company decide to make New York a focus for CHP business activity?
26. Does your company install CHP systems in states other than New York? [If yes, ask following sub-set]
    a. In what other states do you install CHP?
    b. For how long have you been installing CHP in those states?
    c. How does your experience working in New York differ from your experience working in other states? [Probe for differences in areas of standby charges, grid-interconnect or off-grid-operability requirements, experience working with funding agency]
    d. Are there any CHP funding programs in other states that you think could serve as a good model for NYSERDA?
27. What changes have you noticed in the New York CHP market in the past five years in terms of competition among project developers and installers? [Probe for mergers, acquisitions, bankruptcies, sector/equipment specialization]. What do you think has primarily contributed to those changes?
28. Are your clients typically the ones who approach you with an interest in CHP, or is it more common for you to take the lead and propose CHP to potential clients?
29. [If not addressed] For this project, did you inform your client about the NYSERDA opportunity, or did your client come to you with the project idea?
30. What strategies does your company use to gain a competitive advantage in the market? [Probe for repeated work with the same sub-contractors, offering packaged units, having long-term procurement contracts with certain equipment suppliers, or offering unique contract terms]

» **Economic / Finance / Policy Issues**

31. Please describe the project financing for your demonstration project. To what extent did the site owner or equity investors play a role in project finance? [Probe for participation in obtaining financing, reasons for using a particular financing arrangement, its advantages and drawbacks]

32. Please describe the ownership structure for your demonstration project. [Probe for reasons for ownership structure, its advantages and drawbacks. If party other than the site host owns the system, ask if ownership will revert to the site owner in the future. Note: In some cases, the ownership question may be answered in the response to the previous question. It's possible developers are taking initial ownership of the systems and selling power / thermal energy back to the site host.]
33. [If not addressed] Are this project's financing and ownership arrangements are generally consistent with other CHP projects you've completed, and other similar CHP projects in New York in general? [If not] In what ways are they different?
34. Have you observed any changes in the market during the last five years with regard to ownership and financing arrangements? [If so] What changes? [Note: This question could be skipped if time constrained.]
35. What are the most critical economic drivers for the CHP market as a whole? [Not inquiring about project economics specifically, as much as about equipment costs, availability of financing, volatility of natural gas and electricity prices, financial health of end-user companies, etc.]
36. In the past five years, have there been any notable changes in federal, state, or local policies or regulations that have improved the CHP market in New York? [Probe for changes to interconnection requirements, standby charges, NYC initiatives, and federal investment tax credits]
37. What about any changes that have hurt the market?

» **Technology and System Performance Trends**

38. What refinements are you making in your CHP installations to address lessons learned from past experiences?
39. Are there other technology-related developments that are changing the CHP market, or that you expect will come about in the next few years? [Probe: Are you seeing technology solutions to help facilitate grid interconnection and make it easier for systems to operate independently during grid outages?]
40. What steps do you think the NYSERDA DG-CHP program should take to prepare to address these changes in the market?

» **Market Barriers to the DG-CHP Program and the Market**

41. The number of CHP installations in New York falls far short of the estimated market potential despite the fact that the state is considered one of the strongest in the nation for CHP policies and financial incentives. Why do you think this is the case?
42. Looking ahead, what other risks to CHP project development in New York do you see over the next five years?
43. [If not addressed] How would you rank those risks and reasons in terms of their relative importance in discouraging CHP development?

44. How do you plan to address those risks for your projects? [Probe for possible long-term natural gas contracting, other hedging strategies.]
45. Do you think NYSERDA's Demonstration program has been effective at advancing the market for combined heat and power in the state, specifically in the areas of increasing awareness among target markets, addressing market barriers, and documenting system performance?
46. [If not previously addressed] Are there certain types of DG-CHP systems that you think could help advance the CHP market in New York but that have had difficulty securing funding through the program? [Probe: Is the program's requirement that systems be capable of operating independently during a grid outage an impediment?]

» **Relationship to Other Programs**

47. Do you think there's confusion about the differences between NYSERDA's DG-CHP demonstration program (a research and development program) and other NYSERDA programs that fund proven CHP installations (e.g., the Existing Facilities Program and the Flex Tech Program)? [If yes] What steps could NYSERDA take to minimize this confusion?

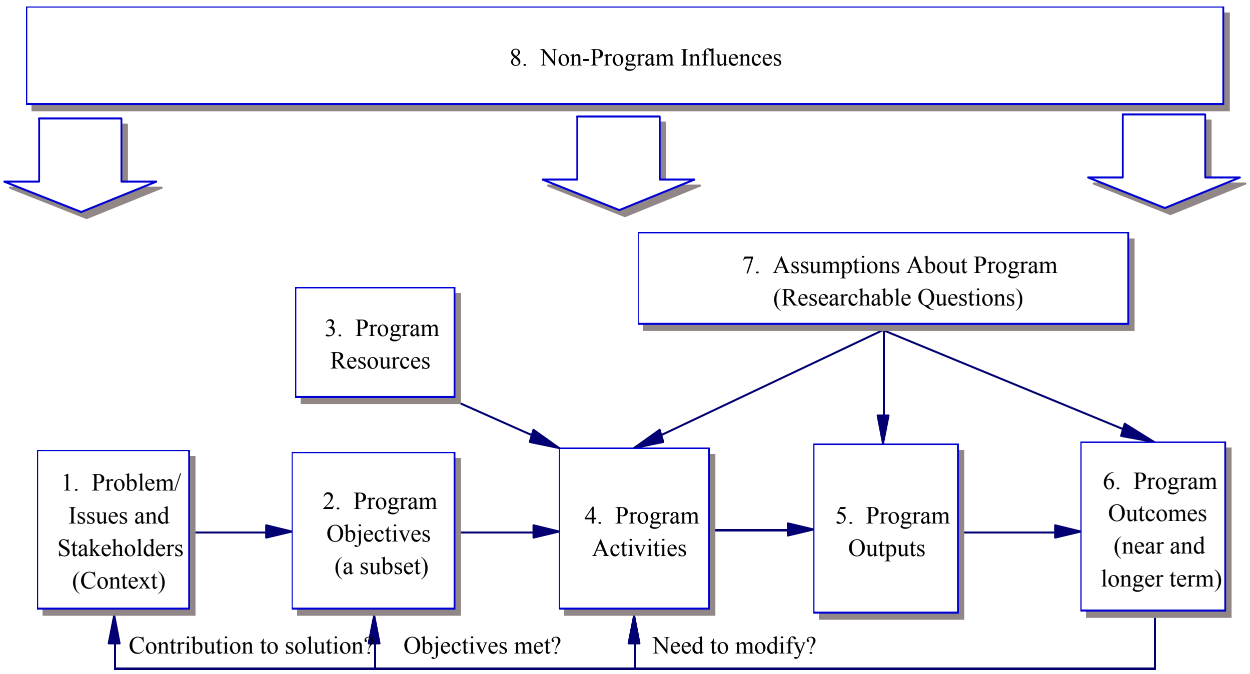
» **Closing**

48. Have you and your client discussed installing any additional CHP systems? [If yes, probe for type of system, prospective project date, facility type, and location]
49. [If not addressed earlier] What, if any, changes should NYSERDA's DG-CHP program make to serve the market better in the future?
50. Do you have any other thoughts or comments you think might be useful to NYSERDA staff in developing more effective CHP programs?

Thank you for your time.

7 Appendix B. Logic Model

Figure 27. Program Logic Model



Source: New York State Energy Research and Development Authority. (2007) Distributed Energy Resources Program: Program Logic Model Report.

8 Appendix C. Non-Demonstration Program-Funded CHP Project List

Data in the following table were obtained from the U.S. Department of Energy's Energy and Environmental Analysis, Inc., database of installed capacity. The table includes only systems installed in parts of the state of New York in which the majority of customers pay into the Systems Benefit Fund (i.e., utility customers are eligible to participate in NYSERDA programs). Records pertaining to systems that may be owned by customers of the New York Power Authority (i.e., those public entities that may not pay into the Systems Benefit Fund), and systems that may have received funding from other NYSERDA programs have not been excluded from the table.

ID	City	Organization Name	Facility Name	Application	SIC4	NAICS	Op Year	Prime Mover	Capacity (mw)	Fuel Type
1		Beechhurst Multifarm	Beechhurst Multifarm	Multi-Family Building	6513	53111	2004	ERENG	0.12	NG
2		Bus Garage	Bus Garage	Unknown	9900	.	2001	ERENG	0.17	NG
3		Byron Bergen School District	Byron Bergen Campus	Schools	8211	61111	2001	ERENG	1.28	NG
4		Crowne Plaza Holiday Inn	Crowne Plaza Holiday Inn	Hotels	7011	72111	1989	ERENG	0.185	NG
5		Red Hook Stores	Red Hook Stores	Food Stores	5411	44511	2005	ERENG	1	NG
6	Albany	Maplewood Manor Nursing Home	Maplewood Manor Nursing Home	Nursing Homes	8051	62311	2002	MT	1.1	NG
7	Alden	Alden School District	Alden High School	Schools	8211	61111	1999	ERENG	0.3	NG
8	Alden	Alden School District	Alden Middle School	Schools	8211	61111	1999	ERENG	0.225	NG
9	Allegany	Big Wheel Machinery, Inc.	Big Wheel Machinery, Inc.	Machinery	3500	333	1990	ERENG	0.2	NG
10	Allegany	Greenhouse Project	Greenhouse Project	Agriculture	182	111419	1984	ERENG	0.79	WAST
11	Allegany	Hydrocarbon Generation	Hydrocarbon Generation	Oil/Gas Extraction	1311	211111	1990	ERENG	0.5	NG
12	Amherst	Delta Sonic Carwash	Delta Sonic Carwash-Amherst	Carwashes	7542	811192	1997	ERENG	0.3	NG
13	Amherst	National Fuel Gas	Energy Company	Utilities	4931	221112	2006	ERENG	1.3	NG

NAVIGANT

ID	City	Organization Name	Facility Name	Application	SIC4	NAICS	Op Year	Prime Mover	Capacity (mw)	Fuel Type
14	Amityville	Long Island Home, Ltd	South Oaks Hospital	Hospitals/Healthcare	8062	62211	1990	ERENG	1.2	NG
15	Arverne	Alliant Energy / EUA/FRC II Energy Associates	Resort Health Related Facility	Amusement/Recreation	7997	71394	1993	ERENG	0.12	NG
16	Arverne	Alliant Energy / EUA/FRC II Energy Associates	Resort Nursing Home	Nursing Homes	8051	62311	1993	ERENG	0.075	NG
17	Auburn	Auburn High School	Auburn High School	Schools	8211	61111	2000	ERENG	0.225	NG
18	Babylon	Babylon Town Hall	Babylon Town Hall	General Gov't	9100	92119	2002	FCEL	0.005	NG
19	Baldwin	FDR Services	FDR Services	Misc. Services	8900	514199	1987	ERENG	0.205	OIL
20	Baldwinsville	Anheuser-Busch	Baldwinsville Cogen Project	Food Processing	2082	31212	1998	CT	20	NG
21	Ballston Spa	Ballston Spa High School	Ballston Spa High School	Schools	8211	61111	2000	ERENG	0.225	NG
22	Batavia	Seneca Power Partners LP	O-At-Ka Milk Producers Coop	Food Processing	2026	311511	1992	CC	61.5	NG
23	Batavia	Genesee County Nursing Home	Genessee County Nursing Home	Nursing Homes	8051	62311	2000	ERENG	0.45	NG
24	Batavia	Genesee Memorial Hospital	Genesee Memorial Hospital	Hospitals/Healthcare	8062	62211	2000	ERENG	0.3	NG
25	Bay Shore	Tecogen Inc.	Brightwaters Racquet & Spa, Inc.	Amusement/Recreation	7997	71394	1988	ERENG	0.03	NG
26	Bayport	All Systems Cogeneration	Fairway Manor Apartments	Multi-Family Building	6513	53111	1994	ERENG	0.062	NG
27	Bayshore	Private Energy Partners, Inc.	Entenmanns Bakery Project	Food Processing	2051	311812	1994	ERENG	5.2	NG
28	Bayside	Ozanam Hall of Queens Nursing Home	Ozanam Hall of Queens Nursing Home	Nursing Homes	8051	62311	2004	MT	0.6	NG

NAVIGANT

ID	City	Organization Name	Facility Name	Application	SIC4	NAICS	Op Year	Prime Mover	Capacity (mw)	Fuel Type
29	Beaver Falls	Kamine/Besicorp Beaver Falls LP	Specialty Paperboard/Boise Cascade	Pulp and Paper	2631	32213	1995	CC	100	NG
30	Bethpage	Calpine -TBG Cogen / General Electric Company	Grumman Aerospace Company	Transportation Equip.	3721	336411	1989	CC	57	NG
31	Binghamton	Binghamton Cogeneration LP	Anitec Image Technology	Instruments	3861	325992	1992	CC	55	NG
32	Binghamton	Binghamton City Schools	High School	Schools	8211	61111	2002	ERENG	0.35	NG
33	Binghamton	Binghamton City Schools	East Middle	Schools	8211	61111	2002	ERENG	0.35	NG
34	Binghamton	Binghamton City Schools	West Middle	Schools	8211	61111	2002	ERENG	0.35	NG
35	Binghamton	New York State Dept. of Transportation	NYS DOT	General Gov't	9100	92119	2006	MT	0.06	NG
36	Boces	BOCES Regional Information center	Onondaga-Courtland-Madison BOCES	Colleges/Univ.	8221	61131	1997	FCEL	0.2	NG
37	Bohemia	Connetquot Central School District	Connetquot High School Facility	Schools	8211	61111	1995	ERENG	0.12	NG
38	Brentwood	Multifamily Building	Multifamily Building	Multi-Family Building	6513	53111	2009	ERENG	0.15	NG
39	Briarcliff Manor	Health Club	Health Club	Amusement/Recreation	7997	71394	2007	ERENG	0.15	NG
40	Bronx	Montefiore Medical Center	Montefiore Medical Center	Hospitals/Healthcare	8062	62211	1994	CT	10.57	NG
41	Bronx	Aegis Energy Services Inc.	Regeis Care Center	Nursing Homes	8051	62311		ERENG	0.3	NG
42	Bronx	AES NJ Cogen Inc. / American DG	Hermany Farms	Food Processing	2026	311511	2003	ERENG	0.225	NG
43	Bronx	All Systems Cogeneration	Manhattanville Nursing Center	Nursing Homes	8051	62311	2003	ERENG	0.12	NG
44	Bronx	Apartments	Apartments	Multi-Family Building	6513	53111	2006	ERENG	0.075	NG

ID	City	Organization Name	Facility Name	Application	SIC4	NAICS	Op Year	Prime Mover	Capacity (mw)	Fuel Type
45	Bronx	CRM Inc.	Bronx Center for Rehabilitation and Health Care	Hospitals/Healthcare	8062	62211	2001	ERENG	0.15	NG
46	Bronx	Flex O Tex	Flex O Tex Laundry	Laundries	7211	81232	1998	ERENG	0.5	NG
47	Bronx	Multifamily Building	Multifamily Building	Multi-Family Building	6513	53111	2007	ERENG	0.375	NG
48	Bronx	Nursing Center	Nursing Center	Nursing Homes	8051	62311	2005	ERENG	0.15	NG
49	Bronx	Nursing Center	Nursing Center	Nursing Homes	8051	62311	2005	ERENG	0.15	NG
50	Bronx	South Bronx Community Management Company	OUB Houses Housing Company, Inc.	Multi-Family Building	6513	53111	1989	ERENG	0.12	NG
51	Brookhaven	State University of New York	Suny Stonybrook	Colleges/Univ.	8221	61131	1995	CT	40	NG
52	Brooklyn	Domino Corporation	Amstar Corporation	Food Processing	2062	311312	1952	B/ST	11.5	NG
53	Brooklyn	Starrett City, Inc.	Starrett & Spring Creek	Multi-Family Building	6513	53111	1974	B/ST	18	NG
54	Brooklyn	Brooklyn Navy Yard Cogeneration Partners	Brooklyn Navy Yard Cogen Project	Military/National Security	9711	92811	1996	CC	322	NG
55	Brooklyn	Warbasse-Cogeneration Technologies, LP	Amalgamated Warbasse Houses, Inc.	Multi-Family Building	6513	53111	1965	CC	37.7	NG
56	Brooklyn	Admiral Plastics	Admiral Plastics	Rubber/Plastics	3085	32616	1980	ERENG	2.35	NG
57	Brooklyn	All Systems Cogeneration	Seacrest Healthcare Facility	Nursing Homes	8051	62311	2003	ERENG	0.12	NG
58	Brooklyn	American DG/AES New Jersey Cogen	Aishel Avraham Nursing Home	Nursing Homes	8051	62311	1991	ERENG	0.075	NG
59	Brooklyn	Bakery	Bakery	Food Processing	2051	311812	2008	ERENG	0.525	NG
60	Brooklyn	Bay Park Associates	Bay Park 1 Associates	Multi-Family Building	6513	53111	1988	ERENG	0.145	NG
61	Brooklyn	Bay Park Associates	Bay Park 2	Multi-Family Building	6513	53111	1988	ERENG	0.145	NG

ID	City	Organization Name	Facility Name	Application	SIC4	NAICS	Op Year	Prime Mover	Capacity (mw)	Fuel Type
62	Brooklyn	Chromium Plating & Polishing Corporation	Chromium Plating Plant	Fabricated Metals	3471	332813	1993	ERENG	0.525	NG
63	Brooklyn	Cogen Power Company, Inc.	Paeizdegat Boat & Raquet Club	Amusement/Recreation	7997	71394	1991	ERENG	0.6	OIL
64	Brooklyn	Cogeneration Power Company, Inc.	Rjr Health & Swim Club	Amusement/Recreation	7997	71394	1991	ERENG	0.6	OIL
65	Brooklyn	Commercial Building	Commercial Building	Office Buildings	6512	53112	2009	ERENG	0.5	NG
66	Brooklyn	Epner Technology	25 Division Place Project	Misc. Services	8900	514199	1993	ERENG	0.2	NG
67	Brooklyn	Fairway Market	Fairway Market Redhook	Food Stores	5411	44511	2008	ERENG	1	NG
68	Brooklyn	Glenmore Plastics	Glenmore Plastics Facility	Chemicals	2821	325211	1977	ERENG	0.5	NG
69	Brooklyn	Golten's Marine Co. Inc.	Golten's Marine Facility	Transportation Equip.	3731	336611	1993	ERENG	0.1	NG
70	Brooklyn	International Cogeneration Corporation	YMCA Of Greater New York-Prospect Park	Amusement/Recreation	7991	71394	1988	ERENG	0.075	NG
71	Brooklyn	Keyspan Energy Corp / Brooklyn Union Gas Company	Brooklyn Union Gas Company	Utilities	4924	22121	1986	ERENG	0.06	NG
72	Brooklyn	Kings Plaza	Kings Plaza Shopping Center	General Merch. Stores	5311	45299	1970	ERENG	12.8	NG
73	Brooklyn	Kingsbrook Jewish Medical Center	Kingsbrook Jewish Medical Center	Hospitals/Healthcare	8062	62211	1991	ERENG	0.5	NG
74	Brooklyn	Linden Plaza Associates	Linden Plaza Apartments	Multi-Family Building	6513	53111	1990	ERENG	0.15	NG
75	Brooklyn	Lucky Mcmxcvi, L.L.C.	Lucky Mcmxcvi, L.L.C.	Unknown	9900	999	2000	ERENG	1.42	NG
76	Brooklyn	Lutheran Medical Center	Lutheran Medical Center Hospital	Hospitals/Healthcare	8062	62211	1993	ERENG	1.6	NG
77	Brooklyn	Magnolia Industries	Magnolia Industries	Rubber/Plastics	3069	326299	1979	ERENG	1.16	NG

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ID	City	Organization Name	Facility Name	Application	SIC4	NAICS	Op Year	Prime Mover	Capacity (mw)	Fuel Type
78	Brooklyn	N.Y.C. Dept. Of Environmental Protection	Coney Island Plant	Wastewater Treatment	4952	22132	1987	ERENG	6.4	NG
79	Brooklyn	N.Y.C. Dept. Of Environmental Protection	Owl's Head Plant	Wastewater Treatment	4952	22132	1991	ERENG	6	NG
80	Brooklyn	New York Methodist Hospital	Methodist Hospital	Hospitals/Healthcare	8062	62211	1990	ERENG	3.76	NG
81	Brooklyn	New York Telephone	New York Telephone	Communications	4813	51331	1986	ERENG	3.25	NG
82	Brooklyn	Nursing Home	Nursing Home	Nursing Homes	8051	62311	2006	ERENG	0.075	NG
83	Brooklyn	NYSERDA	SeaRise I & II Apartments	Multi-Family Building	6513	53111	2003	ERENG	0.22	NG
84	Brooklyn	Oceangate Associates	29th Street	Multi-Family Building	6513	53111	1987	ERENG	0.06	NG
85	Brooklyn	Oceangate Associates	24th Street	Multi-Family Building	6513	53111	1987	ERENG	0.06	NG
86	Brooklyn	Private Brands	50 Wallabout Street Project	Food Processing	2000	311	1995	ERENG	0.545	NG
87	Brooklyn	Sea Park East	Sea Park East	Multi-Family Building	6513	53111	2009	ERENG	0.15	NG
88	Brooklyn	Sea Park West	Sea Park West	Multi-Family Building	6513	53111	2009	ERENG	0.15	NG
89	Brooklyn	St. Mary's Hospital	St. Mary's Hospital	Hospitals/Healthcare	8062	62211	1994	ERENG	1.2	NG
90	Brooklyn	Superior Fiber Mills, Inc.	Superior Fiber Mills, Inc.	Textiles	2299	313113	1999	ERENG	0.25	NG
91	Brooklyn	Surf 21 Associates	Surf 21 Associates	Multi-Family Building	6513	53111	1987	ERENG	0.06	NG
92	Brooklyn	United States Of America	Louis Food Service	Food Processing	2000	311	2000	ERENG	0.194	NG
93	Brooklyn	Alpha Plastics	Alpha Plastics	Rubber/Plastics	3089	326199	2005	MT	0.18	NG
94	Brooklyn	Aviator Sports Complex	Aviator Sports Complex	Amusement/Recreation	7990	71399	2006	MT	0.24	NG
95	Brooklyn	City Facility - Brooklyn	City Facility	General Gov't	9100	92119	2004	MT	0.12	NG
96	Brooklyn	Multi-Family Building	Multi-Family Building	Multi-Family Building	6513	53111	2006	MT	0.6	NG

ID	City	Organization Name	Facility Name	Application	SIC4	NAICS	Op Year	Prime Mover	Capacity (mw)	Fuel Type
97	Buffalo	Roswell Park Cancer Institute	Roswell Park Cancer Institute	Hospitals/Healthcare	8069	62231	2008	B/ST	1.418	WAST
98	Buffalo	Star Mark Energy Systems, Inc.	National Fuel's Mineral Springs Works	Utilities	4922	48621	1989	B/ST	2.789	OTR
99	Buffalo	General Mills, Inc.	General Mills, Inc.	Food Processing	2041	311211	1988	CT	3.55	NG
100	Buffalo	Cohen Bakery	Cohen Bakery	Food Processing	2051	311812	2003	ERENG	0.21	NG
101	Buffalo	Delta Sonic Carwash	Delta Sonic Carwash-Buffalo	Carwashes	7542	811192	1995	ERENG	0.3	NG
102	Buffalo	Mod-Pac Inc.	Mod-Pac Inc.	Printing/Publishing	2741	511199	2000	ERENG	2.25	NG
103	Canton	St Lawrence University	St Lawrence University	Colleges/Univ.	8221	61131	1982	B/ST	0.35	OIL
104	Carthage	Carthage High School	Carthage High School	Schools	8211	61111	2000	ERENG	0.375	NG
105	Castleton-On-Hudson	Transcanada Power Services	Ft. Orange Paper Company	Pulp and Paper	2621	322121	1992	CC	68	NG
106	Cato	Cato Meridian High School	Cato Meridian High School	Schools	8211	61111	2000	ERENG	0.225	NG
107	Centereach	Meat Farms	Meat Farms	Food Stores	5411	44511	1987	ERENG	0.12	NG
108	Cheektowaga	Cheektowaga Central High School	Cheektowaga Central High School	Schools	8211	61111	2003	ERENG	0.3	NG
109	Cheektowaga	Cleveland Hill School	Cleveland Hill School	Schools	8211	61111	2003	ERENG	0.3	NG
110	Cheektowaga	Delta Sonic Carwash	Delta Sonic Carwash-Cheektowaga	Carwashes	7542	811192	1998	ERENG	0.3	NG
111	Clarence	Delta Sonic Carwash	Delta Sonic Carwash-Clarence	Carwashes	7542	811192	1998	ERENG	0.3	NG
112	Clifton Springs	Clifton Springs High School	Clifton Springs High School	Schools	8211	61111	2000	ERENG	0.375	NG
113	Clifton Springs	Clifton Springs Hospital	Clifton Springs Hospital	Hospitals/Healthcare	8062	62211	1994	ERENG	0.6	NG
114	Clymer	Ridgeline Farm / RCM International, Inc.	Ridgeline Farm	Agriculture	241	11212	2001	ERENG	0.13	BIOMASS

ID	City	Organization Name	Facility Name	Application	SIC4	NAICS	Op Year	Prime Mover	Capacity (mw)	Fuel Type
115	Commack	Nursing & Rehabilitation Center	Nursing & Rehabilitation Center	Nursing Homes	8051	62311	2010	ERENG	0.14	NG
116	Coney Island	New York Aquarium	New York Aquarium	Museums/Zoos	8421	71213	2001	FCEL	0.2	NG
117	Cooperstown	Cooperstown Holstein Dairy	Cooperstown Holstein Dairy	Agriculture	241	11212	2002	ERENG	0.065	BIOMASS
118	Corinth	Indeck Energy Services, Inc.	International Paper	Pulp and Paper	2621	322121	1995	CC	122	NG
119	Cuba	Cuba High School	Cuba High School	Schools	8211	61111	2002	ERENG	0.45	NG
120	Cuba	Cuba Rushford Elementary School	Cuba Rushford Elementary School	Schools	8211	61111	2000	ERENG	0.3	NG
121	Cuba	Cuba Rushford Middle School	Cuba Rushford Middle School	Schools	8211	61111	2003	ERENG	0.3	NG
122	Deer Park	Deer Park Union Free School District	Deer Park High School	Schools	8211	61111	1999	ERENG	0.12	NG
123	Deer Park	Deer Park Union Free School District	John F. Kennedy Intermediate School	Schools	8211	61111	1999	ERENG	0.06	NG
124	Deer Park	Deer Park Union Free School District	Robert Frost Middle School	Schools	8211	61111	1999	ERENG	0.06	NG
125	Deferiet	Champion International Corporation	Deferiet Mill	Pulp and Paper	2621	322121	1945	B/ST	8.107	COAL
126	Depew	Depew School District	Depew School District	Schools	8211	61111	2005	ERENG	0.8	NG
127	Dryden	Dryden High School	Dryden High School	Schools	8211	61111	2000	ERENG	0.18	NG
128	East Northport	Oak Tree Dairy	Oak Tree Dairy	Agriculture	241	11212	1986	ERENG	1.3	OIL
129	East Syracuse	Carr Street Generating Station / East Syracuse Generating Co. LP	Bristol-Myers Squibb Plant	Chemicals	2834	325412	1993	CC	105	NG
130	Eastover	McEntire ANG Fire Station	McEntire ANG Fire Station	Military/National Security	9711	92811	2005	FCEL	0.005	NG
131	Eden	Eden School District	Eden School District	Schools	8211	61111		ERENG	0.8	NG

ID	City	Organization Name	Facility Name	Application	SIC4	NAICS	Op Year	Prime Mover	Capacity (mw)	Fuel Type
132	Edgemere	EUA/FRCII Energy Associates	Rockaway Care Center	Nursing Homes	8051	62311	1993	ERENG	0.15	NG
133	Ellicottville	Fitzpatrick & Weller	Fitzpatrick & Weller	Wood Products	2421	321113	1996	B/ST	0.45	WAST
134	Ellicottville	Holimont Ski Resort	Holimont Ski Resort	Hotels	7011	72111	2000	ERENG	1.6	NG
135	Elmhurst	Cogenic Energy Systems, Inc.	Holiday Inn-La Guardia	Hotels	7011	72111	1984	ERENG	0.1	NG
136	Elmira	Chemung County Health Center	Chemung County Health Center	Hospitals/Healthcare	8062	62211	2006	ERENG	0.3	NG
137	Elmsford	Cogenic Energy Systems, Inc.	Coke Of New York Bottling Plant	Food Processing	2086	312111	1989	ERENG	1.4	NG
138	Far Rockaway	American DG/AES New Jersey Cogen	Resort Nursing Home / West Lawrence Care Center	Nursing Homes	8051	62311	1989	ERENG	0.06	NG
139	Far Rockaway	American DG/AES New Jersey Cogen	Park Nursing Home	Nursing Homes	8051	62311	1989	ERENG	0.06	NG
140	Far Rockaway	American DG/AES New Jersey Cogen / Synergics Inc	Rockaway Care Center	Nursing Homes	8051	62311	1989	ERENG	0.12	NG
141	Far Rockaway	Haven Manor Health Facility	Haven Manor Health Facility	Nursing Homes	8051	62311	2000	ERENG	0.06	NG
142	Far Rockaway	Rockaway One	Wavecrest Gardens	Multi-Family Building	6513	53111	1989	ERENG	0.06	NG
143	Far Rockaway	Synergics, Inc.	Resort Health Related Facility	Nursing Homes	8051	62311	1989	ERENG	0.12	NG
144	Floral Park	Three Towers Asssociates	North Shore Towers	Multi-Family Building	6513	53111	1974	ERENG	7.5	NG
145	Flushing	Aguilar Gardens, Inc.	Aguilar Gardens Apartments	Multi-Family Building	6513	53111	1990	ERENG	0.1	NG
146	Fort Drum	U.S. Army	Dort Drum NY, Army CHP Demo	Military/National Security	9711	92811	2002	MT	0.03	NG
147	Fulton	Oswego County	Oswego County Energy Recovery	Solid Waste Facilities	4953	562212	1986	B/ST	3.6	WAST

ID	City	Organization Name	Facility Name	Application	SIC4	NAICS	Op Year	Prime Mover	Capacity (mw)	Fuel Type
148	Fulton	Fulton Cogeneration Associates	Nestle Foods Corporation	Food Processing	2066	31133	1991	CT	50	NG
149	Genessee	Genesee High School	Genesee High School	Schools	8211	61111	2000	ERENG	0.225	NG
150	Geneva	Geneva High School	Geneva High School	Schools	8211	61111	2000	ERENG	0.225	NG
151	Glendale	ICC Technologies, Inc.	First National Supermarket-Glendale	Food Stores	5411	44511	1990	ERENG	0.15	NG
152	Glens Falls	Finch, Pruyn & Company, Inc.	Finch-Pruyn & Co.	Pulp and Paper	2621	322121	1987	B/ST	21	WOOD
153	Great Neck	Aegis Energy Services Inc.	Wedgewood	Multi-Family Building	6513	53111	2003	ERENG	0.06	NG
154	Great Neck	All Systems Cogeneration	Grace Plaza of Great Neck	Nursing Homes	8051	62311	2003	ERENG	0.12	NG
155	Great Neck	Great Neck Park Ice Rink	Great Neck Park Ice Rink	Amusement/Recreation	7997	71394	2005	ERENG	0.075	NG
156	Great Neck	North Hempstead Housing Authority	Spinny Hill	Multi-Family Building	6513	53111	2003	FCEL	0.33	NG
157	Greece	Greece Schools	Arcadia	Schools	8211	61111	2002	ERENG	0.6	NG
158	Greece	Greece Schools	Athena	Schools	8211	61111	2002	ERENG	0.525	NG
159	Greece	Greece Schools	Olympia	Schools	8211	61111	2002	ERENG	0.225	NG
160	Greece	Greece Schools	Odyssey	Schools	8211	61111	2002	ERENG	0.15	NG
161	Greece	Greece Schools	Apollo	Schools	8211	61111	2002	ERENG	0.3	NG
162	Hastings-On-The-Hudson	Technical Centers, Inc.	Toys For Special Children, Inc.	Community Services	8322	62419	1994	ERENG	0.012	NG
163	Hauppauge	Alliant Energy / EUA Cogenex Corporation	Arkay Packaging Facility	Pulp and Paper	2631	32213	1990	ERENG	0.45	OIL
164	Hauppauge	Cogenic Energy Systems, Inc.	Colease Inc	Chemicals	2800	325	1986	ERENG	0.456	NG
165	Hauppauge	The Rinx	The Rinx Ice Skating Rink	Amusement/Recreation	7999	71399	2004	ERENG	0.25	NG

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ID	City	Organization Name	Facility Name	Application	SIC4	NAICS	Op Year	Prime Mover	Capacity (mw)	Fuel Type
166	Hauppauge	Local 25 International Brotherhood of Electrical Workers headquarters	Local 25 International Brotherhood of Electrical Workers headquarters	Unknown	9900	99999	2005	FCEL	0.005	NG
167	Hauppauge	Suffolk County	William Rogers Legislative Building	General Gov't	9100	92119	2003	FCEL	0.015	NG
168	Hauppauge	Suffolk County Medical Examiner	Suffolk County Medical Examiner	Health Clinics	8011	622	2006	MT	0.06	NG
169	Haverstraw	CRM Inc.	Norther Riverview	Nursing Homes	8051	62311	2003	ERENG	0.3	NG
170	Hempstead	American Ref-Fuel Company	Hempstead Industrial Development Authority	Solid Waste Facilities	4953	562212	1990	B/ST	72	WAST
171	Hempstead	Hofstra University	Hofstra University Facility	Colleges/Univ.	8221	61131	1990	ERENG	2.338	NG
172	Hicksville	Hicksville Public Schools	Hicksville High School	Schools	8211	61111	1997	ERENG	0.12	NG
173	Hicksville	Hicksville Public Schools	Hicksville Middle School	Schools	8211	61111	1997	ERENG	0.12	NG
174	Highland	All Systems Cogeneration	Hudson Valley Nursing Center	Nursing Homes	8051	62311	1998	ERENG	0.06	NG
175	Homer	New Hope View Farm / RCM International, Inc.	New Hope View Farm	Agriculture	241	11212	2001	ERENG	0.07	BIOMASS
176	Honeoye Falls	Honeoye Falls-Lima School	Honeoye Falls-Lima School	Schools	8211	61111	2000	ERENG	0.225	NG
177	Hudson Falls	Adirondack RRA/Foster Wheeler Resources	Adirondack Resource Recovery Associates	Solid Waste Facilities	4953	562212	1991	B/ST	14	WAST
178	Huntington	All Systems Cogeneration	Carillon House Nursing Home Facility	Nursing Homes	8052	623311	1998	ERENG	0.06	NG
179	Huntington	Nursing Home	Nursing Home	Nursing Homes	8051	62311	2003	ERENG	0.075	NG
180	Huntington	Tecogen, Inc.	Huntington Township YMCA	Amusement/Recreation	7991	71394	1988	ERENG	0.06	NG

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181	Huntington Station	All Systems Cogeneration	Birchwood Nursing Home Facility	Nursing Homes	8051	62311	1997	ERENG	0.12	NG
182	Huntington Station	All Systems Cogeneration	Hillside Manor Nursing Center	Nursing Homes	8051	62311	1997	ERENG	0.12	NG
183	Ilion	Indeck Energy Services, Inc.	E.I. Dupont - Remington Arms Ilion Plant	Fabricated Metals	3484	332994	1993	CC	56	NG
184	Ithaca	Ithaca Car Wash	740 S. Meadow Street	Carwashes	7542	811192	1991	ERENG	0.06	WAST
185	Jamaica	York Research Corporation	Rochdale Village Houses	Multi-Family Building	6513	53111	1962	B/ST	20	NG
186	Jamaica	Honeywell Farms, Inc.	Honeywell Farms, Inc.	Food Processing	2026	311511	1974	ERENG	4.4	NG
187	Jamaica	Nursing Home	Nursing Home	Nursing Homes	8051	62311	2006	ERENG	0.225	NG
188	Jamaica	St. John's University (Cogen Financial)	St. John's University	Colleges/Univ.	8221	61131	1989	ERENG	0.225	OIL
189	Jamaica	Utility Systems Corporation /Cogenic	Continental Baking Company	Food Processing	2051	311812	1988	ERENG	0.5	NG
190	Jamestown	City of Jamestown	S A Carlson	Communications	4861	51312	1951	B/ST	84	COAL
191	Lakeland	Lakeland Schools	Lakeland Schools	Schools	8211	61111	2005	ERENG	0.3	NG
192	Lansing	Hardie Farms	Hardie Farms	Agriculture	241	11212	2006	ERENG	0.125	BIOMASS
193	Le Ray	Black River LP	Fort Drum Army Base	Military/National Security	9711	92811	1989	B/ST	50	COAL
194	Lewiston	Town of Lewiston	Water Pollution Control Center	Wastewater Treatment	4952	22132	2003	MT	0.06	BIOMASS
195	Little Falls	Cogent Little Falls, G.P.	Burrows Paper Plant	Pulp and Paper	2621	322121	1986	CC	4.5	NG
196	Liverpool	Liverpool High School	Liverpool High School	Schools	8211	61111	2000	FCEL	0.2	NG
197	Lockport	Buffalo Paperboard	Buffalo Paperboard Corp	Pulp and Paper	2600	322	1992	B/ST	1.5	NG
198	Lockport	Lockport Energy Associates L.P.	Harrison Radiator Division/General Motors	Transportation Equip.	3714	336399	1992	CC	184	NG

ID	City	Organization Name	Facility Name	Application	SIC4	NAICS	Op Year	Prime Mover	Capacity (mw)	Fuel Type
199	Long Island City	Fink Baking Corporation	Fink Baking Corporation	Food Processing	2051	311812	1980	ERENG	1.9	OIL
200	Long Island City	Four Starr Dairy	Four Star Dairy	Agriculture	241	11212	1987	ERENG	0.595	OIL
201	Lynbrook	Nathan Hale Housing Company, Inc.	Nathan Hale Housing Company, Inc.	Multi-Family Building	6513	53111	1989	ERENG	0.12	NG
202	Lyonsfalls	Lyonsdale Energy LP	Burrows Paper Corporation	Pulp and Paper	2621	322121	1992	B/ST	19	WOOD
203	Manhattan	Consolidated Edison Co NY	East River	District Energy	4961	221112	1951	B/ST	500	NG
204	Manhattan	Grand Central Station	Grand Central Station	General Gov't	9100	99999	2006	FCEL	0.4	NG
205	Marion	Marion High School	Marion High School	Schools	8211	61111	2000	ERENG	0.225	NG
206	Maspeth	J&J Farms Creamery	J&J Farms Creamery Facility	Food Processing	2026	311511	2000	ERENG	0.375	NG
207	Massapequa	ICC Technologies, Inc.	J.C. Penny #1192	General Merch. Stores	5311	45299	1990	ERENG	0.3	NG
208	Mcconnellsville	Harden Furniture, Inc.	Harden Furniture, Inc.	Furniture	2511	337112	1981	B/ST	0.665	WOOD
209	Medford	ICC Technologies, Inc.	First National Supermarket-Medford	Food Stores	5411	44511	1990	ERENG	0.15	NG
210	Medford	Nursing Home	Nursing Home	Nursing Homes	8051	62311	2005	ERENG	0.15	NG
211	Messena	Power City Generating/Sithe Energies	Alcoa Project	Primary Metals	3341	331314	1992	CC	79	NG
212	Mineola	Restaurant	Restaurant	Restaurants	5812	72232	2008	MT	0.12	NG
213	Monsey	CRM Inc.	Northern Metropolitan	Nursing Homes	8051	62311	2003	ERENG	0.3	NG
214	Monsey	CRM Inc.	Fountainview at College Road	Nursing Homes	8051	62311	2002	MT	0.5	NG
215	Moriah	Moriah School District	School	Schools	8211	61111	2007	ERENG	0.6	NG
216	Morrisville	SUNY at Morrisville	SUNY at Morrisville	Colleges/Univ.	8221	61131	2007	ERENG	0.05	BIOMASS
217	Mount Kisco	Saw Mill River Courts	Saw Mill River Courts	Multi-Family Building	6513	53111	1983	ERENG	0.975	OIL
218	Mt. Kisco	A&P Fresh Market	A&P Fresh Market	Food Stores	5411	44511	2005	MT	0.24	NG

ID	City	Organization Name	Facility Name	Application	SIC4	NAICS	Op Year	Prime Mover	Capacity (mw)	Fuel Type
219	Nanuet	CRM Inc.	Northern Manor	Nursing Homes	8051	62311	2003	ERENG	0.3	NG
220	Nesconset	All Systems Cogeneration	Nesconset Nursing Home	Nursing Homes	8051	62311	1996	ERENG	0.12	NG
221	New York	St. Lukes/Roosevelt Hospital Center	St. Lukes/Roosevelt Hospital Center	Hospitals/Healthcare	8062	62211	1993	B/ST	0.15	OTR
222	New York	Kiak Partners /Airport Cogen Corporation	John F. Kennedy International Airport	Air Transportation	4581	488119	1994	CC	109	NG
223	New York	Bank of America Headquarters	Bank of America One Bryant Park	Office Buildings	6512	53112	2008	CT	5.1	NG
224	New York	Rockefeller University	University Boiler House	Colleges/Univ.	8221	61131	1991	CT	0.8	OIL
225	New York	Archstone Apartments	Archstone Midtwon West	Multi-Family Building	6513	53111	2008	ERENG	0.15	NG
226	New York	Archstone Apartments	Archstone Chelsea	Multi-Family Building	6513	53111	2008	ERENG	0.075	NG
227	New York	Archstone Apartments	Archstone East 39th Street	Multi-Family Building	6513	53111	2008	ERENG	0.075	NG
228	New York	Commercial Building	Commercial Building	Office Buildings	6512	53112	2009	ERENG	2.25	NG
229	New York	Commercial Building	Commercial Building	Office Buildings	6512	53112	2008	ERENG	0.15	NG
230	New York	CRM Inc.	25 Tudor City	Multi-Family Building	6513	53111	2004	ERENG	0.15	NG
231	New York	Equity Office Properties / 717 5th Avenue	717 5th Avenue	Office Buildings	6512	53112	2004	ERENG	1.6	NG
232	New York	Home Depot	Ozone Park	General Merch. Stores	5211	44411	2005	ERENG	0.75	NG
233	New York	Home Depot	Baychester	General Merch. Stores	5211	44411	2005	ERENG	0.75	NG
234	New York	Home Depot	Woodhaven	General Merch. Stores	5211	44411	2005	ERENG	0.75	NG
235	New York	Hudson Hotel	Hudson Hotel	Hotels	7011	72112	2003	ERENG	0.3	NG
236	New York	International Cogeneration Corporation	West Side YMCA	Amusement/Recreation	7991	71394	1988	ERENG	0.225	NG
237	New York	Multi-Family Building	Multi-Family Building	Multi-Family Building	6513	53111	2007	ERENG	0.225	NG

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ID	City	Organization Name	Facility Name	Application	SIC4	NAICS	Op Year	Prime Mover	Capacity (mw)	Fuel Type
238	New York	Mutual Redevelopment Houses - Penn South	Penn South	Multi-Family Building	6513	53111	2001	ERENG	3.2	NG
239	New York	New Yorker Hotel	New Yorker Hotel	Hotels	7011	72111	2001	ERENG	0.6	NG
240	New York	Tishman Building	11 West 42nd Street Building	Office Buildings	6512	53112	1980	ERENG	5.4	OIL
241	New York	United States Of America	125 116th Food Corp	Food Processing	2000	311	2000	ERENG	0.42	NG
242	New York	Vornado Realty Trust	One Penn Plaza	Office Buildings	6512	53112	2010	ERENG	6.2	NG
243	New York	Four Times Square Associates, LLC	Conde Nast Building - Times Square	Office Buildings	6512	53112	1999	FCEL	0.4	NG
244	New York	State University of New York	College of Environmental Science and Forestry	Colleges/Univ.	8221	61131	2003	FCEL	0.25	NG
245	New York	Battery Park City	Battery Park City Residential Building	Multi-Family Building	6513	53111	2006	MT	0.06	NG
246	New York	NYSERDA	160 West End Avenue Condominium	Multi-Family Building	6513	53111	2004	MT	0.3	NG
247	New York	OfficePower 1350 Avenue of the Americas	1350 Avenue of the Americas	Office Buildings	6512	53112	2006	MT	0.72	NG
248	New York City	Corona Yard	Rail Transit	Railroads	4111	485112	2006	FCEL	0.2	NG
249	Newark	Newark-Wayne Hospital	Newark-Wayne Hospital	Hospitals/Healthcare	8062	62211	1995	ERENG	0.29	NG
250	Newton Falls	Stora Papyrus Newton Falls, Inc.	Newton Falls Paper Ml, Inc.	Pulp and Paper	2621	322121	1964	B/ST	5	OIL
251	Niagara Falls	American Ref-Fuel Company	Hooker Chemicals & Plastics Corp	Chemicals	2821	325211	1980	B/ST	50	WAST
252	Niagara Falls	Delta Sonic Carwash	Delta Sonic Carwash-Niagara Falls	Carwashes	7542	811192	1998	ERENG	0.3	NG
253	Niagara Falls	Seneca Casino Resort	Seneca Casino Resort	Hotels	7011	72112	2006	ERENG	6	NG

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ID	City	Organization Name	Facility Name	Application	SIC4	NAICS	Op Year	Prime Mover	Capacity (mw)	Fuel Type
254	North Tonawanda	Oxbow Power Of North Tonawanda NY Inc.	Greenhouse/Village Farms Of Wheatfield	Agriculture	182	111419	1993	CC	55.3	NG
255	Oakdale	Lasalle Military Academy	Lasalle Military Academy	Schools	8211	61111	1994	ERENG	0.06	NG
256	Oakfield	U.S. Gypsum Company	U.S. Gypsum Company	Stone/Clay/Glass	3275	32742	1986	CT	5.8	NG
257	Ogdensburg	Ag-Energy, L.P.	St. Lawrence Psychiatric Center	Hospitals/Healthcare	8063	62221	1993	CC	83	NG
258	Old Westbury	SUNY Old Westbury	State University of New York Old Westbury	Colleges/Univ.	8221	62231	2006	ERENG	1.9	NG
259	Olean	Indeck Energy Services, Inc.	Olean-Dresser Rand Energy Center	Misc. Manf.	3900	339999	1994	CC	86	NG
260	Oneida	Turning Stone Casino and Resort	Turning Stone Casino and Resort	Hotels	7011	72112	2004	CT	5.5	NG
261	Oneida	City Of Oneida	City Of Oneida	Misc. Services	8900	514199	1995	ERENG	0.08	NG
262	Oswego	Indeck Energy Services, Inc.	Hammermill Paper/Oswego Energy Center	Pulp and Paper	2621	322121	1990	CC	57.4	NG
263	Pearl River	Lederle Laboratories/American Home Products / Cyanamid	Pearl River Plant	Chemicals	2834	325412	1990	CC	23.4	NG
264	Penfield	Penfield High School	Penfield High School	Schools	8211	61111	1996	ERENG	0.375	NG
265	Perry	Emerling Farms / RCM International, Inc.	Emerling Farms	Agriculture	241	11212	2006	ERENG	0.23	BIOMASS
266	Perry	Town of Perry	Town of Perry	Utilities	4939	22131	2006	ERENG	0.39	BIOMASS
267	Plainview	AES/CGH Company LP	Central General Hospital	Hospitals/Healthcare	8062	62211	1990	ERENG	0.15	NG
268	Plattsburgh	Saranac Energy Company, Inc.	Saranac Energy / Georgia Pacific	Pulp and Paper	2621	322121	1994	CC	241	NG

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ID	City	Organization Name	Facility Name	Application	SIC4	NAICS	Op Year	Prime Mover	Capacity (mw)	Fuel Type
269	Pleasanton	Reader's Digest Association	Reader's Digest Building--Pleasantown	Office Buildings	6512	53112	2003	CT	1.4	NG
270	Port Jefferson	Holmes Engineering, P.C.	St. Charles Hospital	Hospitals/Healthcare	8062	62211	1992	ERENG	0.67	NG
271	Portlandville	Wightman Lumber	Wightman Lumber	Wood Products	2421	321113	1999	B/ST	0.096	WAST
272	Poughkeepsie	Pennsylvania Resource Systems, Inc.	Dutchess County Resource Recovery	Machinery	3571	334111	1989	B/ST	7.5	WAST
273	Pulaski	Pulaski School	Pulaski School	Schools	8211	61111	2000	ERENG	0.225	NG
274	Queens	Keyspan Corp	Ravenswood Powerplant / Consolidated Edison	District Energy	4961	22133	2004	CC	250	NG
275	Queens	CRM Inc.	Berkeley Cooperative Towers	Multi-Family Building	6513	53111	2001	ERENG	0.3	NG
276	Queens	Keyspan Energy Corp / Brooklyn Union Gas Company	JFK International Airport	Air Transportation	4581	488119	1988	ERENG	0.075	NG
277	Queens	Multi-family Building	Multi-family Building	Multi-Family Building	6513	53111	2004	ERENG	0.085	NG
278	Queens	Parman Corporation	Cogen Parker Towers	Office Buildings	6512	53112	2005	ERENG	1.2	NG
279	Queens	Atlantis Marine World Aquarium	Atlantis Marine World Aquarium	Museums/Zoos	8421	71213	2001	MT	0.03	NG
280	Rensselaer	LG&E-Westmoreland	LGPE Power 15/ BASF Corporation	Chemicals	2865	325132	1994	CC	80	NG
281	Richmond Hill	Cogenic Energy Systems, Inc.	Uniforms For Industry, Inc.	Laundries	7213	812331	1984	ERENG	0.5	NG
282	Riverdale	Multi-Family Building	Multi-Family Building	Multi-Family Building	6513	53111	2007	ERENG	0.375	NG
283	Riverdale	Nursing Home	Nursing Home	Nursing Homes	8051	62311	2008	ERENG	1.05	NG
284	Riverhead	Motel	Motel	Hotels	7011	72112	2006	ERENG	0.075	NG
285	Rochester	Kodak Park	Eastman Kodak Company	Chemicals	2843	325613	1937	B/ST	198.6	COAL
286	Rochester	University of Rochester	University of Rochester	Colleges/Univ.	8221	61131	2006	B/ST	25	NG

ID	City	Organization Name	Facility Name	Application	SIC4	NAICS	Op Year	Prime Mover	Capacity (mw)	Fuel Type
287	Rochester	Iola Health Facility	Iola Health Facility	Hospitals/Healthcare	8062	62211	2004	ERENG	2.7	NG
288	Rochester	Monroe County Community College	Monroe County Community College	Colleges/Univ.	8222	61121	2004	ERENG	4	NG
289	Rochester	Rochester Commercial	Empire Returns, Inc.	Misc. Services	8900	514199	1989	ERENG	0.125	OIL
290	Rockaway Park	EUA/FRCII Energy Associates	Park Nursing	Nursing Homes	8051	62311	1993	ERENG	0.06	NG
291	Rockville Center	Holmes Engineering, P.C.	Mercy Medical Center	Hospitals/Healthcare	8062	62211	1991	ERENG	1.34	NG
292	Rondout	Rondout School District	Rondout High School	Schools	8211	61111	1997	ERENG	0.18	NG
293	Rondout	Rondout School District	Rondout Middle School	Schools	8211	61111	1997	ERENG	0.18	NG
294	Ronkonkoma	Islip Resource Recovery Agency	Mac Arthur Waste to Energy	Solid Waste Facilities	4953	562212	1986	B/ST	12.5	WAST
295	Ronkonkoma	Connetquot Central School District	Ronkonkoma Jr. High School Facility	Schools	8211	61111	1996	ERENG	0.12	NG
296	Rushford	Rushford Kiln & Milling Limited	Rushford Kiln & Milling Limited	Wood Products	2421	321113	1985	ERENG	0.416	NG
297	Schenectady	Encotech Engineering PC	Ellis Hospital Facility	Hospitals/Healthcare	8062	62211	2001	ERENG	0.56	NG
298	Scipio Center	Sunnyside Farms / GHD, Inc.	Sunnyside Farms	Agriculture	241	11212	2009	ERENG	1.6	BIOMASS
299	Scriba	Sithe Independence Power Partners Lp	Alcan Rolled Products Company	Primary Metals	3353	331315	1994	CC	1042	NG
300	Seaford	Energy Dynamics, Inc.	Massapequa General Hospital	Hospitals/Healthcare	8062	62211	1990	ERENG	0.12	NG
301	Sherrill	Sterling Power Partners, LP	Oneida, Ltd	Misc. Manf.	3914	332999	1991	CC	57	NG
302	Silver Creek	Lake Shore Hospital	Lake Shore Hospital	Hospitals/Healthcare	8062	62211	2003	ERENG	0.4	NG

ID	City	Organization Name	Facility Name	Application	SIC4	NAICS	Op Year	Prime Mover	Capacity (mw)	Fuel Type
303	Silver Springs	Indeck Energy Services, Inc.	Morton Salt/Silver Spring Energy Center	Chemicals	2899	325998	1991	CC	55	NG
304	Silver Springs	Noblehurst Farms Dairy	Noblehurst Farms Dairy	Agriculture	241	11212	2002	ERENG	0.13	BIOMASS
305	Smithtown	Smithtown Central School District	Smithtown High School	Schools	8211	61111	1995	ERENG	0.12	NG
306	Somers	Pepsi Cola Company	Pepsi Cola Company	Food Processing	2086	312111	1995	ERENG	1.05	OIL
307	South Glens Falls	South Glens Falls Energy LLC	South Glens Falls Energy LLC	Pulp and Paper	2621	322121	1999	CC	59.7	NG
308	South Huntington	American DG/AES New Jersey Cogen	Huntington Lodge	Nursing Homes	8051	62311	1991	ERENG	0.075	NG
309	South Setauket	Nursing Home	Nursing Home	Nursing Homes	8051	62311	2007	ERENG	0.225	NG
310	Southampton	Holmes Engineering, P.C.	Southampton Hospital	Hospitals/Healthcare	8062	62211	1992	ERENG	0.5	NG
311	St. James	All Systems Cogeneration	St. James Plaza Nursing Center	Nursing Homes	8051	62311	2003	ERENG	0.12	NG
312	Staten Island	Brooklyn Union Gas Company/GRI	Staten Island Hospital	Hospitals/Healthcare	8062	62211	1988	ERENG	0.022	NG
313	Staten Island	Community Health Sys Of Staten Island	Staten Island Univ Hospital South	Hospitals/Healthcare	8062	62211	1992	ERENG	1.2	NG
314	Staten Island	CRM Inc.	Golden Gate Rehab Center	Hospitals/Healthcare	8062	62211	2003	ERENG	0.15	NG
315	Staten Island	Home Depot	Staten Island	General Merch. Stores	5211	44411	2005	ERENG	0.75	NG
316	Staten Island	Staten Island University Hospital	Staten Island University Hospital / North Shore	Hospitals/Healthcare	8062	62211	1997	ERENG	4.475	NG
317	Staten Island	Sun Chemical Corporation	Sun Oil Corporation	Chemicals	2869	325199	1982	ERENG	0.075	NG
318	Staten Island	Vanbro Asphalt	Vanbro Asphalt	Stone/Clay/Glass	3271	327331	1999	ERENG	1.25	NG
319	Staten Island	Sun Chemical Corporation	Fuel Cell Cogeneration Project	Chemicals	2869	325199	1996	FCEL	0.4	NG

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ID	City	Organization Name	Facility Name	Application	SIC4	NAICS	Op Year	Prime Mover	Capacity (mw)	Fuel Type
320	Suffolk	William Floyd School District	School District	Schools	8211	61111	2005	ERENG	3.7	NG
321	Syosset	Dominion Construction Corp.	St. Mary's Children & Family Services	Community Services	8300	62419	1998	ERENG	0.06	NG
322	Syracuse	Trigen Energy Corp	Trigen Syracuse Energy Corp	Pulp and Paper	2679	322299	1991	B/ST	101.1	COAL
323	Syracuse	Syracuse University	Syracuse University & Local Hospitals	Colleges/Univ.	8221	61131	1992	CT	96	NG
324	Syracuse	Central Hudson Enterprises Corporation	Dr. Weeks Elementary School	Schools	8211	61111	1995	ERENG	0.225	NG
325	Syracuse	Central Hudson Enterprises Corporation	Lincoln Junior High School	Schools	8211	61111	1995	ERENG	0.225	NG
326	Syracuse	Central Hudson Enterprises Corporation	Henninger High School	Schools	8211	61111	1995	ERENG	0.225	NG
327	Syracuse	Syracuse City School District	Dr. Weeks Elementary /Lincoln Junior High/ Henninger High School	Schools	8211	61111	1995	ERENG	0.05	NG
328	Syracuse	Syracuse City School District	Nottingham High School	Schools	8211	61111	1986	ERENG	0.2	NG
329	Syracuse	Syracuse City School District	Corcoran High School	Schools	8211	61111	1989	ERENG	0.24	NG
330	Syracuse	Syracuse City School District	Fowler High School	Schools	8211	61111	1989	ERENG	0.325	NG
331	Syracuse	Syracuse Power Company	Purity Water Distillation Plant	Food Processing	2086	312111	1993	ERENG	5	NG
332	Ticonderoga	International Paper Company	Ticonderoga Mill	Pulp and Paper	2621	322121	1971	B/ST	37.8	OIL

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ID	City	Organization Name	Facility Name	Application	SIC4	NAICS	Op Year	Prime Mover	Capacity (mw)	Fuel Type
333	Tonawanda	Indeck Energy Services, Inc.	E. I. Du Pont De Nemours, Yerkes Plant	Chemicals	2821	325211	1990	CC	53.9	NG
334	Town Of Geddes	Fiberteck Energy, LLC / Onondaga Cogeneration	Solvay Paper Board, General Chemical	Pulp and Paper	2631	32213	2000	CC	90.6	NG
335	Union	Nursing Home	Nursing Home	Nursing Homes	8051	62311	2008	ERENG	0.075	NG
336	Uniondale	Nassau District Energy Corporation	Nassau County Central Utilities Plant	District Energy	4961	22133	1991	CC	57	NG
337	Utica	U.S. Air Force / Oneida County Department Of Public Works	Griffiss Air Force Base	Military/National Security	9711	92811	1986	B/ST	2.2	WAST
338	Utica	Grace Petroleum Company	Grace Petroleum	Wholesale Trade	5172	42272	1992	ERENG	0.113	OIL
339	Waterloo	Seneca Energy	Seneca Energy	Utilities	4939	221112	1996	ERENG	11.2	BIOMASS
340	Waterloo	Waterloo Schools	Waterloo Schools	Schools	8211	61111	2004	ERENG	0.45	NG
341	Watervliet/Colonie	Albany Cogeneration Associates	Norton Company-Coated Abrasives Division	Stone/Clay/Glass	3291	32791	1991	CT	25	NG
342	Watkins Glen	Akzo Nobel Salt, Inc.	Watkins Glen Refinery	Chemicals	2899	325998	1960	B/ST	8	NG
343	Waverly	Waverly Central Schools	Waverly Jr-Sr High School	Schools	8211	61111	1990	ERENG	0.3	NG
344	West Babylon	Ogden Projects Inc-Babylon	Babylon Resource Recovery Facility	Solid Waste Facilities	4953	562212	1989	B/ST	17	WAST
345	West Babylon	All Systems Cogeneration	East Neck Nursing Center	Nursing Homes	8051	62311	1998	ERENG	0.12	NG
346	West Nyack	Felix V. Festa Middle School	School	Schools	8211	61111	2006	ERENG	0.075	NG
347	West Point	U.S. Army	West Point Military Academy	Colleges/Univ.	8221	61131		B/ST	5	NG

ID	City	Organization Name	Facility Name	Application	SIC4	NAICS	Op Year	Prime Mover	Capacity (mw)	Fuel Type
348	West Seneca	Mineral Springs Service Center	Mineral Springs Service Center	Office Buildings	6512	53112	2004	MT	0.06	NG
349	West Seneca	Westwood Village	Westwood Village	Multi-Family Building	6513	53111	2004	MT	0.06	NG
350	White Plains	Burke Rehabilitation Hospital	Burke Rehabilitation Hospital	Hospitals/Healthcare	8062	62211	2008	ERENG	0.6	NG
351	White Plains	Metropolitan Energy Management Consult.	Yarp Restaurant, Inc.	Restaurants	5812	72211	1986	ERENG	0.27	OIL
352	Woodside	BEI Energy Corporation	BQE Health Club	Amusement/Recreation	7991	71394	1990	ERENG	0.072	NG
353	Woodside	National Urban Energy Corporation	Big Six Towers	Multi-Family Building	6513	53111	1980	ERENG	4.05	NG
354	Yonkers	Buena Vista Associates	Ocean Gate - 33Rd Street	Multi-Family Building	6513	53111	1987	ERENG	0.06	NG
355	Yonkers	Cogenic Energy Systems, Inc.	Yonkers General Hospital	Hospitals/Healthcare	8062	62211	1989	ERENG	0.5	OIL
356	Yorktown	Utility Systems Corporation/Cogenic	Field Home - Holy Comforter	Nursing Homes	8051	62311	1990	ERENG	0.102	NG
357	Youngstown	Lewiston Porter High School	Lewiston Porter High School	Schools	8211	61111	1997	ERENG	0.2	NG

9 Appendix D. Demonstration Program-Funded CHP Project List

The list presented here includes all projects funded by the DG-CHP Demonstration Program.[131] Those projects that received SBC3 funding are noted.

ID	Location	Participating Organization	Site Name	Application	Date Operational	Prime Mover	Installed Capacity MW	Fuel Type	PON #	SBC3 (Y/N)
6539	Hauppauge	CDH Energy Corporation	Waldbaums-A&P Supermarket	Supermarket	4/18/2003	Microturbine	0.06	Natural gas	554	N
6540	Brooklyn	Keyspan Utility Services, LLC	ShopRite Supermarket	Supermarket	10/11/2007	Reciprocating Engine	0.14	Natural Gas	554	N
6541	Brooklyn	Landsberg Engineering, P.C.	Floyd Bennett Field	Other	6/17/2005	Microturbine	0.18	Natural gas	554	N
6543	Garden City	Verizon Communications, Inc	Verizon - Garden City Office	Telecom/ Transportation	9/15/2005	Fuel Cell	1.4	Natural gas	554	N
6545	Williamsville	Oakwood Health Care Center, Inc.	Oakwood Health Care Center	Hospital/Nursing Home	12/19/2001	Reciprocating Engine	0.6	Natural gas	554	N
6546	New York	DSM Engineering Associates, P.C.	10 West 66th Street	Apartment/ Hospitality	12/1/2003	Microturbine	0.07	Natural gas	554	N
6548	Bronx	Herbert E. Hirschfeld, P.E.	Stevenson Commons	Apartment/ Hospitality	6/30/2007	Microturbine	0.07	Natural gas	554	N
6551	Warsaw	Wyoming County Community Hospital	Wyoming County Community Hospital	Hospital/Nursing Home	4/1/2002	Other: Chilled water absorption project	0	Other	554	N

[131] Note that two projects were decommissioned (Project IDs: 6541 and 6826). Those two projects are included in this list but are excluded from the set of projects referenced in the main body of the report. Three projects listed here produce mechanical power rather than electrical power (Project IDs: 6839, 6848, 7858). Three other projects listed here (Project IDs: 8571, 6551 and 6846) were existing CHP systems that received program funding to facilitate efficiency improvements or other measures to keep them in operation.

ID	Location	Participating Organization	Site Name	Application	Date Operational	Prime Mover	Installed Capacity MW	Fuel Type	PON #	SBC3 (Y/N)
6741	Skaneateles	Twin Birch Dairy, LLC	Twin Birch Farm	Farms	1/27/2007	Microturbine	0.12	Biogas	578	N
6825	Rochester	Siemens Building Technologies, Inc.	Greater Rochester International Airport	Telecom/ Transportation	6/21/2002	Reciprocating Engine	1.5	Natural gas	536	N
6826	Bronx	Herbert E. Hirschfeld, P.E.	Hazel Towers	Apartment/ Hospitality	5/18/2004	Reciprocating Engine	0.12	Natural gas	536	N
6827	Maspeth	Compudye, Inc.	Compudye, Inc.	Industry	1/15/2003	Reciprocating Engine	0.45	Natural gas Diesel	536	N
6829	Brooklyn	Paradise Plastics	Paradise Plastics LLP	Industry	1/1/2004	Reciprocating Engine	1	Natural gas	536	N
6833	Cortland	Cortland Memorial Hospital	Cortland Memorial Hospital	Hospital/Nursing Home	10/13/2006	Reciprocating Engine	1.65	Natural gas	536	N
6839	Geneva	Geneva General Hospital	Geneva General Hospital	Hospital/Nursing Home	9/15/2003	Reciprocating Engine	0	Natural gas	536	N
6841	New Rochelle	Allied Converters, Inc.	Allied Converters, Inc.	Industry	7/7/2003	Microturbine	0.06	Natural gas	536	N
6842	Fonda	Fonda-Fultonville Central School District	Fonda-Fultonville Central School District	School	3/13/2004	Reciprocating Engine	1.66	Natural gas	536	N
6845	Amherst	Gerster Trane/SUNY Buffalo	University at Buffalo	School	12/22/2004	Microturbine	0.12	Natural gas	536	N
6846	Ontario	Northern Development/Harbec Plastics (note:this line also accounts for previous project)	Harbec Plastics	Industry	7/1/2001	Microturbine	0	Natural gas	536	N

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ID	Location	Participating Organization	Site Name	Application	Date Operational	Prime Mover	Installed Capacity MW	Fuel Type	PON #	SBC3 (Y/N)
6848	Queens	LaGuardia Corporate/Bulova Building	Bulova Corporate Center	Commercial Office	4/1/2002	Reciprocating Engine	0	Natural gas	536	N
6853	Brooklyn	Grenadier Realty Corp.	Coney Island Site 4A II Houses	Apartment/ Hospitality	4/2/2004	Reciprocating Engine	0.12	Natural gas	536	N
6854	Brooklyn	Grenadier Realty Corp.	Coney Island Site 4A I Houses	Apartment/ Hospitality	4/2/2004	Reciprocating Engine	0.12	Natural gas	536	N
6937	Brooklyn, Queens, Staten Island	NYPA	26th Ward WWTF/Red Hook WWTF/Oakwood Beach WWTF/Hunts Point WWTF	Municipal Utilities	7/31/2003	Fuel Cell	1.6	Biogas	536	N
7282	College Point	Consolidated Edison Solutions, Inc.	Pepsi Cola Bottling Co.	Industry	4/1/2007	Reciprocating Engine	1.46	Natural gas	669	N
7286	Brooklyn	Shoreview Nursing Home	Shore View Nursing Home	Hospital/Nursing Home	5/30/2004	Reciprocating Engine	0.08	Natural gas	669	N
7288	Adams	Sheland Farms, Inc.	Sheland Farms	Farms	9/15/2007	Reciprocating Engine	0.1	Biogas	669	N
7291	Troy	Siemens Building Technologies Inc.	Hudson Valley Community College	School	4/1/2004	Reciprocating Engine	4.27	Natural gas, biogas, diesel	669	N
7293	Brooklyn	Clinton Hill Apartment Owners' Corporation	Clinton Hill Apartments (North Campus)	Apartment/ Hospitality	6/14/2006	Microturbine	0.54	Natural gas	669	N
7296	Syracuse	SUNY-ESF	SUNY-ESF	School	1/1/2006	Fuel Cell	0.25	Natural gas	669	N

ID	Location	Participating Organization	Site Name	Application	Date Operational	Prime Mover	Installed Capacity MW	Fuel Type	PON #	SBC3 (Y/N)
7298A	Nanuet	Rockland Bakery Inc.	Rockland Bakery Inc.	Industry	7/15/2006	Reciprocating Engine	0.846	Natural gas	669	N
7306	New Rochelle	VIP Country Club	VIP Country Club	Other	12/24/2004	Microturbine	0.18	Natural gas	669	N
7307	Flushing	AES-NJ Cogen Co.,Inc.	Rego Park Nursing Home	Hospital/Nursing Home	9/29/2003	Reciprocating Engine	0.075	Natural gas	669	N
7311	New York	PPL Energy Services Holdings, LLC	Sheraton New York Hotel & Towers	Apartment/ Hospitality	6/14/2005	Fuel Cell	0.25	Natural gas	669	N
7312	South Glens Falls	Borden Chemical, Inc	Borden Chemical	Industry	1/1/2004	Steam Turbine	0.343	Other	669	N
7313	Perry	Town of Perry	Sunny Knoll Farm; Emerling Farms, LLC	Farms	7/1/2006	Reciprocating Engine	0.39	Biogas	669	N
7314	Hollis	AES-NJ Cogen Co.,Inc.	Holliswood Care Center	Hospital/Nursing Home	8/31/2004	Reciprocating Engine	0.15	Natural gas	669	N
7318	Brooklyn	Arrow linen Supply Company	Arrow Linen Supply Company	Industry	8/1/2004	Reciprocating Engine	0.3	Natural gas	669	N
7320	Brooklyn	4C Foods Corporation	4C Foods Corporation	Industry	6/24/2004	Reciprocating Engine	0.38	Natural gas	669	N
7321	Brooklyn	AES-NJ Cogen Co.,Inc.	Greenpark Care Center	Hospital/Nursing Home	5/20/2003	Reciprocating Engine	0.15	Natural gas	669	N
7322	Bronx	The Jewish home and hospital/Bronx Division	Jewish Home and Hospital Bronx Facility Nursing Home	Hospital/Nursing Home	9/1/2005	Reciprocating Engine	0.4	Natural gas	669	N
7324	Queens	Flack & Kurtz, Inc.	Long Island Jewish Medical Center	Hospital/Nursing Home	7/30/2008	Reciprocating Engine	2.8	Natural gas	669	N

ID	Location	Participating Organization	Site Name	Application	Date Operational	Prime Mover	Installed Capacity MW	Fuel Type	PON #	SBC3 (Y/N)
7325A	New York	206 West End Avenue Owner's Corporation	205 West End Avenue Condominium	Apartment/ Hospitality	9/29/2003	Reciprocating Engine	0.3	Natural gas	669	N
7326	New York	Aegis Energy Services, Inc.	Tudor City Place	Apartment/ Hospitality	4/1/2005	Reciprocating Engine	0.15	Natural gas	669	N
7854	New York	New York University	New York University	School	10-Dec	Combustion Gas Turbine	10	Natural gas	750	N
7855A	Brockport	Allied Frozen Storage, Inc.	Allied Frozen Storage, Inc.	Industry	Winter 2008	Reciprocating Engine	2.5	Natural gas	750	N
7857	Utica	Burrstone Energy, LLC	St. Lukes Hospital & Utica College	Hospital/Nursing Home	Fall 2009	Reciprocating Engine	6.018	Natural gas	750	N
7858	Florida	Power Pallet, Inc.	Power Pallet	Industry	9/30/2005	Reciprocating Engine	0	Diesel	750	N
7861	East Rochester	East Rochester Central School	East Rochester School District	School	3/30/2007	Fuel Cell	0.2	Natural gas	750	N
7862	Auburn	Patterson Farms, Inc.	Patterson Farms, Inc.	Farms	10/27/2005	Reciprocating Engine	0.25	Biogas	750/762	N
7866	Bronx	NYPA	The Wildlife Conservation Society- Bronx Zoo	Other	Spring 2010	Fuel Cell	0.2	Natural gas	750	N
7868	Albany	Pine Bush Energy, LLC	Avila Senior Living Center	Apartment/ Hospitality	3/30/2007	Reciprocating Engine	0.674	Natural gas	750	N
7988	Hauppauge	NYS Office of General Serrvices	Suffolk State Office building	Commercial Office	Spring 2010	Hybrid Fuel Cell / Reciprocating Engine	0.7	Natural gas	750	N
8571	Model City	Modern Landfill Inc.	Model City Energy, LLC/H2Gro	Municipal Utilities	1/1/2005	Reciprocating Engine	0	Landfill Gas	800	N
8574	Ellicotville	Laidlaw Energy Group, Inc.	Laidlaw Energy & Environmental, Inc.	Other	Spring 2009	Steam Turbine	1.8	Biomass	800	N

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8576	New York	The New York Times Company	The New York Times Company	Commercial Office	Summer 07	Reciprocating Engine	1.5	Natural gas	800	N
8577	Brooklyn	Blue Point Energy	Macy's East	Other	Fall 08	Reciprocating Engine	0.875	Natural gas	800	N
8580A	New York	The New York Racquet and Tennis Club	The New York Racquet and Tennis Club	Other	Fall 2010	Microturbine	0.14	Natural gas	800	N
8583	New York	BPC Green, LLC	Tribeca Green	Apartment/ Hospitality	Spring 2011	Microturbine	0.06	Natural Gas	800	N
8586	Schenectady	Art Center and Theater of Schenectady, NY	Proctors Theatre	Other	Fall 2010	Microturbine	0.24	Natural gas	800	N
8590	New York	Northern Power Systems	Black Stone Realty	Commercial Office	12/12/2005	Reciprocating Engine	1.6	Natural gas	800	N
9171	Auburn	Global Common, LLC	Oakwood Dairy Farm	Farms	Difficult to Forecast	Reciprocating Engine	5.25	Biogas	914	N
9172	New York	NY Presbyterian Hospital	NY Presbyterian Hospital	Hospital/Nursing Home	Spring 09	Combustion Gas Turbine	7.5	Natural gas	914	N
9173	Auburn	City of Auburn	City of Auburn Waste Water Treatment Plant	Municipal Utilities	Spring 2010	Reciprocating Engine	1.4	Biogas	914	N
9175	Auburn	Cayuga County Soil and Water Conservation District	Natural Resource Center	Other	Fall/Winter 2010	Reciprocating Engine	0.625	Biogas	914	N
9178	Canton	SUNY Canton Farm Digester	SUNY Canton	School	Difficult to Forecast	Reciprocating Engine	0.5	Biogas	914	Y
9180	New York	Cooper Union	Cooper Union (New Academic Building)	School	10-Dec	Reciprocating Engine	0.25	Natural gas	914	Y

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9181	Verona	Madison Oneida BOCES	Madison Oneida BOCES	School	7/15/2008	Reciprocating Engine	0.6	Natural gas	914	Y
9186	New York	Hilton New York Fuel Cell project	The New York Hilton	Apartment/ Hospitality	10/15/2007	Fuel Cell	0.2	Natural gas	914	Y
9187	New York	11 Riverside Drive Corporation	Schwab House	Apartment/ Hospitality	10/17/2009	Reciprocating Engine	0.24	Natural gas	914	Y
9188	New York	M. Plaza L.P.	Manhattan Plaza	Apartment/ Hospitality	4/1/2010	Reciprocating Engine	0.96	Natural gas	914	Y
9190	Poughkeepsie	Vassar College	Vassar College	School	Winter 2009	Steam Turbine	0.25	Natural gas	914	Y
9920	Ithaca			School		Combustion Gas Turbine	30	Natural gas	1043	Y
9921	Schenectady	City of Schenectady	City of Schenectady Waste Water Treatment Plant	Municipal Utilities	Winter 10/11	Reciprocating Engine	0.4	Biogas	1043	Y
9923	Manhattan	UTC Power, LLC	New York Marriott Financial Center Hotel	Apartment/ Hospitality	10/1/2008	Microturbine	0.715	Natural gas	1043	Y
9924	Manhattan	The Cooper Union for the Advancement of Science and Art	Cooper Union Foundation Building	School	Difficult to Forecast	Reciprocating Engine	0.15	Natural gas	1043	Y
9926	Manhattan	Flatbush Owners Company, LLC/Integrated Energy Concepts Engineering, PC	Myrtle Avenue Condominiums	Apartment/ Hospitality	10/1/2009	Reciprocating Engine	0.5	Natural gas	1043	Y
10799	Albany, NY	UTC Power Corp.	Price Chopper in Colonie Plaza	Supermarket	12/15/2009	Fuel Cell	0.4	Natural Gas	1178	Y

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10800	Potsdam, NY	Clarkson University	Technology Advancement Center (TAC)	School	1/1/2009	Microturbine	0.195	Natural Gas	1178	Y
10801	Albany, NY	Albany County	Albany County Sewer District - North Plant	Municipal Utilities	Fall 2011	Organic Rankine Cycle	0.57	other-Waste Heat	1178	Y
10802	Selkirk, NY	Sabic Innovative Plastics US, LLC	Sabic Innovative Plastics - Selkirk	Industry	11/1/2010	Steam Turbine	1.108	other-Steam	1178	Y
10805	Bronx, NY	Steven Winter Associates, Inc.	Melrose Commons Site 5	Apartment/ Hospitality	11/1/2009	Microturbine	0.009	Natural Gas	1178	Y
11083	Elmsford, NY	UTC Power Corp.	CocaCola Enterprises	Industry	Oct. 2010	Fuel Cell	0.8	Natural Gas	1241	Y
11085	New York, NY	Cabrini Terrace Owners Corp.	Cabrini Terrace	Apartment/ Hospitality	Fall 2010	Reciprocating Engine	0.11	Natural Gas	1241	Y
11086	Brooklyn, NY	Grenadier Realty Corp.	Glen Gardens	Apartment/ Hospitality	Difficult to Forecast	Reciprocating Engine	0.16	Natural Gas	1241	Y
11088	Queensbury, NY	UTC Power Corp.	Price Chopper in Queensbury	Supermarket	Difficult to Forecast	Fuel Cell	2	Natural Gas	1241	Y
11183	Schenectady, NY	UTC Power Corporation	Golub Headquarters Building	Commercial Office	5/1/2010	Microturbine	0.2	Natural Gas	1241	Y
11184	New York, NY	Printing House Fitness Center Limited	The Printing House Fitness Center	Multi-family/mixed-use	Winter 10/11	Reciprocating Engine	0.24	Natural gas	1241	Y
11185	New York, NY	Octagon, L.P.	Octagon Park Apartments	Apartment/ Hospitality	Difficult to Forecast	Fuel Cell	0.4	Natural Gas	1241	Y
11186	Syracuse, NY	Syracuse University	South Campus Data Center	School	Winter 2009	Microturbine	0.78	Natural Gas	1241	Y

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11187	New York, NY	Brookfield Financial Properties	World Trade Financial Center	Industry	Difficult to Forecast	Microturbine	0.275	Steam	1241	Y
15913	Rome, NY	Rome Memorial Hospital	Rome Memorial Hospital	Hospital/Nursing Home	Late fall 2010	Microturbine	0.26	Natural gas	1241	Y
15914	New York, NY	Fountain House, Inc.	Fountain House, Inc.	Other	Difficult to Forecast	Microturbine	0.065	Natural Gas	1241	Y
15917	Rochester	East Irondequoit Central School District	East Ridge High School	School	Difficult to Forecast	Microturbine	0.325	Natural Gas	1241	Y
15918	New York	MP Freedom LLC	Liberty Green	Apartment/ Hospitality	Difficult to Forecast	Reciprocating Engine	0.085	Natural Gas	1241	Y
15919	New York	MP Liberty LLC	Liberty Luxe	Apartment/ Hospitality	Difficult to Forecast	Reciprocating Engine	0.17	Natural Gas	1241	Y
15920	New York	1211 6th Ave Property Owner, LLC	1211 6th Ave	Commercial Office	Fall 2011	Fuel Cell	0.4	Natural Gas	1241	Y
15923	Utica	St. Elizabeth Medical Center	St. Elizabeth Medical Center	Hospital/Nursing Home	Fall 2010	Reciprocating Engine	2.31	Natural Gas	1241	Y