



U.S. DEPARTMENT OF ENERGY
Northeast Clean Energy Application Center

Promoting CHP, District Energy, and Waste Heat Recovery

Award Number:
DE-EE0001104

Award Recipient:
Pace University

Principal Investigator:
Tom Bourgeois, (914) 422-4126, tbourgeois@law.pace.edu

Reporting Period:
October 1, 2009 through September 30, 2013

Submission Date:
December 31, 2013

Submitted to:
U.S. DOE / NETL / OSTI
Joseph Renk, (412) 386-6406, Joseph.Renk@NETL.DOE.GOV

Mr. Joe Renk
Project Manager
Power and Vehicle Technology Division
NETL
PO Box 10940
Pittsburgh, PA 15236-0940

Dear Mr. Renk,

Please find attached our Final Technical Report for award number DE-EE0001104 – “Northeast Clean Energy Application Center.”

Below you will find a brief synopsis of our activities for the four-year contract period beginning October 1, 2009 and ending September 30, 2013. If you have any questions, please do not hesitate to contact Tom Bourgeois (914-422-4013, tbourgeois@law.pace.edu) or Nicholas Martin (914-422,4221, nmartin2@law.pace.edu).

Thank you,

Tom Bourgeois
Nicholas Martin

NORTHEAST CLEAN ENERGY APPLICATION CENTER MANAGEMENT REPORTING

The final scientific/technical report must include the following information and any other information identified under Special Instructions on the Federal Assistance Reporting Checklist:

- 1. Identify the DOE award number; name of recipient; project title; name of project director/principal investigator; and consortium teaming members.*

Award Number: DE-EE0001104

Recipient: Pace University

Project title: Northeast Clean Energy Application Center

Name of project director/principal investigator: Tom Bourgeois (PI) and Beka Kosanovic

Consortium/team members: Nicholas Martin, Jordan Gerow, Jordan Stutt, Tom Kelly, Tim Banach, Bill Pentland, Marck Gerrish

- 2. Display prominently on the cover of the report any authorized distribution limitation notices, such as patentable material or protected data. Reports delivered without such notices may be deemed to have been furnished with unlimited rights, and the Government assumes no liability for the disclosure, use or reproduction of such reports.*

This report does not contain patentable material or protected data.

- 3. Provide an executive summary, which includes a discussion of 1) how the research adds to the understanding of the area investigated; 2) the technical effectiveness and economic feasibility of the methods or techniques investigated or demonstrated; or 3) how the project is otherwise of benefit to the public. The discussion should be a minimum of one paragraph and written in terms understandable by an educated layman.*

From October 1, 2009 through September 30, 2013 (“contract period”), the Northeast Clean Energy Application Center (“NE-CEAC”) worked in New York and New England (Connecticut, Rhode Island, Vermont, Massachusetts, New Hampshire, and Maine) to create a more robust market for the deployment of clean energy technologies (CETs) including combined heat and power (CHP), district energy systems (DES), and waste heat recovery (WHR) systems through the provision of technical assistance, education and outreach, and strategic market analysis and support for decision-makers. CHP, DES, and WHR can help reduce greenhouse gas emissions, reduce electrical and thermal energy costs, and provide more reliable energy for users throughout the United States.

The NE-CEAC's efforts in the provision of technical assistance, education and outreach, and strategic market analysis and support for decision-makers helped advance the market for CETs in the Northeast thereby helping the region move towards the following outcomes:

- Reduction of greenhouse gas emissions and criteria pollutants
- Improvements in energy efficiency resulting in lower costs of doing business
- Productivity gains in industry and efficiency gains in buildings
- Lower regional energy costs
- Strengthened energy security
- Enhanced consumer choice
- Reduced price risks for end-users
- Economic development effects keeping more jobs and more income in our regional economy

Over the contract period, NE-CEAC provided technical assistance to approximately 56 different potential end-users that were interested in CHP and other CETs for their facility or facilities. Of these 56 potential end-users, five new CHP projects totaling over 60 MW of install capacity became operational during the contract period. The NE-CEAC helped host numerous target market workshops, trainings, and webinars; and NE-CEAC staff delivered presentations at many other workshops and conferences. In total, over 60 different workshops, conferences, webinars, and presentation were hosted or delivered during the contract period. The NE-CEAC also produced publically available educational materials such as CHP project profiles. Finally, the NE-CEAC worked closely with the relevant state agencies involved with CHP development. In New York, the NE-CEAC played an important role in securing and maintaining funding for CHP incentive programs administered by the New York State Energy Research Development Authority. NE-CEAC was also involved in the NYC Mayor's Office DG Collaborative. The NE-CEAC was also named a strategic resource for the Connecticut Department of Energy and Environmental Protection's innovative Microgrid Pilot Program.

4. Provide a comparison of the actual accomplishments with the goals and objectives of the project.

The Statement of Project Objectives (SOPO) listed five main objectives—policy support, technology transfer, promote energy efficiency and carbon emission reduction benefits, regional activities to educate stakeholders on clean energy technology benefits, provide valuable feedback to DOE and industry regarding future program needs. The following table compares the actual accomplishments with these objectives.

Goal and objective	Accomplishment
Policy support	<ul style="list-style-type: none">• The NE-CEAC engaged in the design and execution of New York's SBC IV, Technology and Market Development Plan (T&MD) components that provide \$75 Million in support to CHP.• The NE-CEAC was appointed Co-Chair of NYC Mayor's Office Cogen (DG) Collaborative. Tom Bourgeois Co-Chaired one of the two

	<p>committees of NYC Cogen Working Group. Committees drafted strategic regulatory improvements to effectively facilitate CHP deployment in NYC and move the city towards achieving the PlaNYC goal of 800 MW of new CHP by 2030. New York State is promoting CHP through many venues, including financial support via the New York State Energy Research and Development Authority (NYSERDA) Industrial R&D program, policy support at the NY PSC as evidenced by the Standardized Interconnection Requirements (SIR) process, the special DG CHP gas rates, waivers of standby tariffs for certain qualifying systems, and other activities.</p> <ul style="list-style-type: none"> • Connecticut is supporting new incentive programs aimed at promoting CHP and clean DER such as CEFIA's Commercial Property Assessed Clean Energy (C-PACE) program. C-PACE allows Connecticut building owners to finance energy upgrades (including CHP, efficiency measures and renewable generation) by adding an additional charge to their property tax bill. This enables building owners to make long-term clean energy investments without a large capital outlay. The C-PACE program is a reflection of Gov. Malloy and CT DEEP Commissioner Esty's commitment to increasing CHP deployment by developing innovative financing mechanisms for target CHP markets. • Connecticut also has instituted a nationally innovative Microgrids Pilot program, via Public Law 12-148 Section 7. The NE-CEAC has been listed as a resource for program participants to help them consider CHP and DES for their microgrid designs. • Massachusetts has enacted an Alternative Portfolio Standard (APS) that stands in some ways as a model for the nation. Additionally they have designed other instruments that should have a significant influence on future CHP, DES, and WHR developments in that state, including one of the handful of states that permit CHP to participate as an eligible measure in the utilities' energy efficiency portfolio program. • In 2012, Massachusetts Department of Public Utilities (Mass DPU) established a collaborative Distributed Generation Working Group and approved a Smart Grid pilot program. • The NE-CEAC worked with key stakeholders to improve & refine CHP market incentive packages, resulting in NYSERDA PONs 2568 (CHP Acceleration Program) and 2701 (CHP Performance Program). • The NE-CEAC played a central role in highlighting the value of strategically sited CHP as a substitute for distribution system capital. This idea is now imbedded in some of the incentive mechanisms to support CHP and is being tested in utility pilot programs. The "Non-Wires Alternatives" work that the NE-CEAC has engaged in as part of activities with National Grid (NY and New England) and Con Edison (NY) represents a nationally innovative initiative. National Grid agreed to a "NON-WIRES ALTERNATIVES" Pilot to put forward in rate case. Con Edison revised CHPs role in distribution congestion. NYSERDA eventually included a 10% bonus payment for "strategically sited" CHP in critical zones identified by Con Ed (2013).
Technology transfer	<ul style="list-style-type: none"> • The NE-CEAC targeted the healthcare industry through a conference jointly developed with EPA Region 1 and National Grid, and meetings with the Dormitory Authority of New York (DASNY). This meeting featured discussions of new and innovative financing mechanisms applicable to CHP and energy efficiency capital investments. • The NE-CEAC drafted a white paper outlining hospital financing of CHP.

	<ul style="list-style-type: none"> The NE-CEAC placed on a list of qualified organizations to provide technical assistance for NYSERDA's CHP programs and incentives.
Promote energy efficiency and carbon emission reduction benefits	<ul style="list-style-type: none"> During the contract period, states became increasingly concerned with reducing GHG emissions. States and cities (e.g., PlaNYC and the 80 x 50 process in New York, MA Green Communities, CT Clean Energy Communities) set CO₂ reduction targets and encouraging other large end user sectors to take on similar goals. NE-CEAC worked with these entities to incorporate CHP and other CETs into their energy plans. NE-CEAC established itself as a center for high quality and unbiased information on Microgrids and District Energy Systems with CHP. The NE-CEAC acted to insure that the discussion of Microgrids emphasized the importance of high efficiency, environmentally superior, CHP as a centerpiece of a Microgrid project through work with regional microgrid initiatives such as Connecticut's Microgrid Pilot Program.
Regional activities to educate stakeholders on clean energy technology benefits	<ul style="list-style-type: none"> The NE-CEAC hosted or presented at over 60 different events throughout the contract period. The NE-CEAC has addressed industry associations, hospital associations, associations of facility managers, nursing home associations, multi-family building interests, environmental interest groups, financial interests, associations of large commercial office buildings, brownfield developers and others. The NE-CEAC has prepared briefings for city and state policymakers on the benefits of CETs. The NE-CEAC has done media spots including interviews on CHP with National Public Radio and the New York Times in the wake of Superstorm Sandy (November 2012). The NE-CEAC has worked closely with the New York City Mayor's Office of Long-term Planning and Sustainability and other stakeholders on achieving the City's 800 MW CHP goal.
Provide valuable feedback to DOE and industry regarding future program needs	<ul style="list-style-type: none"> NE-CEAC directors participated in monthly conference calls with DOE to relay information obtained from working in the field. By spearheading the development of the Northeast CHP Initiative (NECHPI), the NE-CEAC had the distinct advantage of close connection to a regional industry association. NE-CEAC was regularly in touch with issues from the field via our monthly meetings and the frequent calls we take from those familiar with NECHPI. Other information regularly communicated included cumulative experiences of project developers, A&E firms, others in the CET marketplace and motivated end users who are currently using, or have intent to use, CHP, DES, or WHR.

Please also view the attached metrics report for FY 2013 that provides a more granular comparison of yearly goals and objectives and their comparison to actual accomplishments.

5. Summarize project activities for the entire period of funding, including original hypotheses, approaches used, problems encountered and departure from planned methodology, and an assessment of their impact on the project results. Include, if

applicable, facts, figures, analyses, and assumptions used during the life of the project to support the conclusions.

The NE-CEAC Statement of Project Objectives (SOPO) outlined five main objectives to be achieved over the course of the four-year planning period that included activities on several fronts. Although the activities were diverse, they were planned to operate as a comprehensive and cohesive whole. The five main objectives were as follows:

1. **Policy support.** Market rules and the regulatory environment under which CETs operate were identified as strong influencers on the market for clean energy development and the advancement of greater CET business opportunities. For this reason, a primary objective of the NE-CEAC was to provide decision-makers with information, education, and outreach materials regarding CHP, DES, and WHR.
2. **Technology transfer.** To support the technology transfer of CHP, DES, WHR, and other CETs, the NE-CEAC's second objective was to provide essential support through a coordinated education and outreach program. The program plan included the production of case studies, workshops, brochures, briefings, and media events; the expansion of web-based tools; and presentations at relevant events attended by target audiences.
3. **Promote energy efficiency and carbon emission reduction benefits.** CHP, DES, and WHR applications were identified as critical components of any energy efficiency and carbon reduction strategies. For this reason, the third objective of the NE-CEAC was to integrate the message that these CETs are indispensable components of efficiency and carbon reduction plans through all NE-CEAC activities.
4. **Regional activities to educate stakeholders on clean energy technology benefits.** The NE-CEAC's fourth objective was build upon the track record compiled by the Northeast Regional Application Center (NERAC) in education stakeholders through the Northeast by delivering presentations, addressing industry and end-user associations, and engaging media.
5. **Provide valuable feedback to DOE and industry regarding future program needs.** The final objective of the NE-CEAC was to convey critical feedback from the field to DOE via regular progress reports, national team meetings, and the preparation and dissemination of lessons learned and best practices observations.

During the contract period, NE-CEAC worked in New York and New England to achieve these objectives through three main core strategies. These strategies were as follows:

1. **Education and Outreach.** NE-CEAC will encourage deployment of CET throughout the Northeast by developing and distributing informational materials, using both general and targeted information materials and many of the same marketing methods previously used successfully by NERAC, including target market workshops, seminars, webinars, and local and national conferences and educational activities to stakeholders and end users.
2. **Identification of High Impact Projects and Implementation Assistance.** NE-CEAC will identify high profile candidates for clean energy deployment, and

provide and coordinate onsite assessments for those considering deploying CET. NE-CEAC will build upon procedures used successfully by NERAC for providing and coordinating onsite assessments.

3. **Strategic Market Analysis and Support for Decision-makers.** NE-CEAC will conduct in-depth strategic market analysis, and assist organizations developing CET to overcome barriers to deployment. Analysis will be informed by trade ally relationships, close consultation with state energy planning objectives, use of data from such sources as ES-202 databases, state permitting data on usage and stack temperature, and leveraging targeted industrial and sector outreach programs of public and private economic development organizations.

Throughout the contract period, slight variations to strategies were made to reflect changing market conditions and relevant events and/or policy changes within the region. The core strategies, however, were followed throughout the contract period. The following section briefly outlines some of the key accomplishments of the NE-CEAC resulting from the three core strategies discussed above.

Education and Outreach

The NE-CEAC conducted extensive market development and end-user educational outreach during the four-year contract period. The NE-CEAC helped host numerous target market workshops, trainings, and webinars; and NE-CEAC staff delivered presentations at many other workshops and conferences. In total, over 60 different workshops, conferences, webinars, and presentation were hosted or delivered during the contract period. The audiences for these events ranged from broad segments of the market to targeted groups including healthcare facilities, universities and colleges, government buildings, industrial facilities, and other groups.

The NE-CEAC made a concerted effort in targeting the healthcare sector. Hospitals and related facilities are prime candidates for CHP because of their large thermal and electric loads as well as for the importance of having resilient power for such critical facilities. NE-CEAC staff played prominent role in organizing events that examined financing bottlenecks and new and innovative mechanisms to free up more capital for CHP investment in hospitals. For example, the NE-CEAC hosted a CHP training session at a Health Care Association of New York State event in the spring of 2011 and gave several other presentations that highlighted CHP opportunities for healthcare facilities to key stakeholder groups. Through relationships formed through these activities, the NE-CEAC held continuing conversations with key healthcare groups like Healthcare Without Harm to explore the potential and barriers to CHP in hospitals. From these endeavors, the NE-CEAC has developed a report on the unique issues regarding financing CHP projects in the healthcare sector.

The NE-CEAC co-convened several major CHP conferences and workshops across the Northeast Region. In January 2012 at the Hotel Pennsylvania in New York City, the NE-CEAC was host to an event that drew more than 150 participants. The event featured speakers from the U.S Department of Energy, NYS Energy Research and Development Authority, MA Department of Energy Resources, utilities, project developers and key end

user representatives. A similar event was held March 21, 2013 in Boston MA, that again drew a full house, for a conference co-convened with MA Department of Energy Resources. The conference featured speakers from the U.S Department of Energy, US CHP Association, ICF International, NYS Energy Research and Development Authority, MA Department of Energy Resources, utilities, project developers and key end user representatives.

As part of education and outreach, the NE-CEAC developed publically available materials to help inform end-users, policymakers, CHP developers, and other stakeholders on key CHP issues and events. For example, the NE-CEAC developed 20 different CHP Project Profiles that highlight innovative and high profile CHP installation in the Northeast region. These materials were hosted on the NE-CEAC website that was maintained by NE-CEAC staff. Over the course of the four-year contract period, the website garnered approximately 11,000 unique visitors and 51,000 total visitors.

Identification of High Impact Projects and Implementation Assistance

Over the course of four years, NE-CEAC provided technical assistance to approximately 56 different potential end-users that were interested in CHP for their facility or facilities. Of these 56 potential end-users, approximately 23 end-users were provided recommendations to consider efficient and economically viable CHP installations. 19 of these end-users indicated serious consideration of NE-CEAC's recommendations and six ultimately moved to the development stage during the four-year contract period. Finally, five new CHP projects totaling over 60 MW of install capacity that received NE-CEAC technical assistance became operational during the contract period¹. Additional CHP projects that received NE-CEAC technical assistance are expected to come online in the near future.

Among the different CHP end-users to which the NE-CEAC provided technical assistance, several different CHP projects merit further discussion for their unique impact or high visibility.

We provided technical assistance to industrial, commercial and institutional facilities in our region. For example, technical assistance was provided to an industrial facility in Fitchburg, MA that manufactures saw blades. The facility installed a system with three 600-kW MWM engines running on natural gas. In order to reduce emissions, they installed selective catalytic reduction (SCR) and a 400-ton Carrier absorption chiller. The president & CEO of the plant stated that "The installation of the CHP co-generation system at our plant has changed our competitive cost position dramatically, enabling the company to retain energy intensive manufacturing operations and to consider adding new operations in the future. The project is a win-win as it is good for the company, our employees and the economic health of North Central Massachusetts."

¹ The majority of the additional CHP capacity resulted from a 57 MW project at the Nassau County District Energy, Garden City, NY.

The NE-CEAC specifically targeted industrial facilities impacted by the federal boiler MACT regulations. Our center contacted 58 facilities in the northeast that are subject to this rule. Most of them were already either in compliance or working toward it. Several facilities expressed interest in learning more about CHP, and we have provided requested information. Some outreach is still ongoing and one facility, Newark America in Fitchburg, MA, is in the final phase of implementing a project to install a 14 MW gas turbine with an HRSG system.

The NE-CEAC also began providing technical assistance for potential district energy utilizing CHP systems in the Northeast during the contract period—a new activity for the program. We provided technical support to several municipalities interested in district heating. Examples include Ithaca, NY, Kennebunk, ME and Nassau County District Energy System in Garden City, NY.

In addition to providing technical assistance to potential end-users, the NE-CEAC accomplished other significant achievements relating to technical assistance. We assisted in development of the IDEA/CEAC District Energy Tool and implemented it for several high profile evaluations including the 57 MW Nassau County District Energy System in collaboration with Nassau County staff, and in Ithaca, NY on behalf of Energize Ithaca and with the support of the Mayor and Business Alliance.

Strategic Market Analysis and Support for Decision-makers

New York State is one of the nation's leading states in incentivizing and supporting CHP at the state level, and the NE-CEAC has played a large role in CHP related state policy in New York. NE-CEAC has supported and played an advisory role for the multiple different CHP incentive programs administered by the New York State Energy Research Development Authority (NYSERDA). In 2011, the NE-CEAC successfully assisted in securing \$75 million in CHP incentive funds through the NY Systems Benefits Charge IV five-year plan. These funds helped support key state CHP incentive programs such the CHP Acceleration Program and the CHP Performance Program.

The CHP Acceleration Program (PON 2568) provides an incentive to pre-qualified CHP systems that are 1.3 MW and smaller and have the capability of operating during grid outages. PON 2568 includes a bonus incentive for CHP that serves a facility of refuge, as well as a bonus incentive for CHP in targeted zones of strategic grid value. This PON has served to significantly increase the deployment of small-scale CHP in New York's small commercial sector, which has been an underserved market.

Similar to PON 2568, NYSERDA's CHP Performance Program (PON 2701) applies to CHP systems that are 1.3 MW or larger and provide summer peak demand reduction. PON 2701 includes a bonus incentive for CHP that serves a facility of refuge, as well as a bonus incentive for CHP in zones of strategic grid value. After Superstorm Sandy, NE-CEAC urged the state and NYSERDA to take advantage of CHP as a means to rebuild the state's energy infrastructure with an eye towards resiliency and sustainability.

In 2012, Thomas Bourgeois was appointed Co-Chair of the NYC Mayor's Office DG Collaborative. Tom Bourgeois Co-Chaired one of the two committees of the NYC Cogen Working Group within the DG Collaborative. Through the DG Collaborative, NE-CEAC provided input for the drafting of strategic regulatory improvements to effectively facilitate CHP deployment in NYC and move the city towards achieving the PlaNYC goal of 800 MW of new CHP by 2030.

The NE-CEAC was named as a strategic resource for the Connecticut Department of Energy and Environmental Protection's innovative Microgrid Pilot Program. The Microgrid Pilot Program's goal is to encourage the development of resilient microgrids that serve critical infrastructure in an economic and efficient manner. CT DEEP recognizes the ability of CHP to provide affordable, efficient, and reliable energy for microgrids and thus worked with NE-CEAC to help provide assistance to municipalities as they developed proposals for the pilot program.

Throughout the contract period, the NE-CEAC played a central role in highlighting the value of strategically sited CHP as a substitute for distribution system capital. The Northeast is particularly suitable for the value of strategically sited CHP. This idea is now imbedded in some of the incentive mechanisms to support CHP and is being tested in utility pilot programs. The "Non-Wires Alternatives" work that the NE-CEAC has engaged in as part of activities with National Grid (NY and New England) and Con Edison (NY) represents a nationally innovative initiative.

Impact on project objectives

6. Identify products developed under the award and technology transfer activities, such as:

a. Publications (list journal name, volume, issue), conference papers, or other public releases of results. If not provided previously, attach or send copies of any public releases to the DOE Program Manager identified in Block 15 of the Assistance Agreement Cover Page;

"Energy and Exergy Analysis of a 16-MW Combined Cycle District Heating System with Performance Improvements" International Journal of Exergy, Vol. 13, No. 3, 2013 (S. Suresh and D. Kosanovic)

"Real-Time Thermodynamic Performance Monitoring and Optimum Thermo-economic Operation of Power Plants" ASME Power 2011 Conference, Denver, CO July 12-14, 2011, Power Technical Publication: POWER2011-55018 (H. Gopalakrishnan and D. Kosanovic).

"Energy and Exergy Analysis of a University Power Plant" 2011 ACEEE Summer Study on Energy Efficiency in Industry, Niagara Falls, NY July 2011 (H. Gopalakrishnan, S. Suresh, and D. Kosanovic)

"Thermodynamic Analysis of Combined Cycle District Heating System" 33rd National Industrial Energy Technology Conference, New Orleans, LA, May 2011 (S. Suresh, H. Gopalakrishnan and D. Kosanovic)

"Evaluation of the Contribution of On-Site Generation to Grid and Customer Reliability" 2011 SAE World Congress, Detroit, MI, April 2011. (T. Kanitkar and D. Kosanovic)

b. Web site or other Internet sites that reflect the results of this project;

The NE-CEAC's website was located at www.northeastcleanenergy.org during the contract period. It has now migrated to www.northeastchptap.org.

c. Networks or collaborations fostered;

The NE-CEAC continued to help foster the Northeast Clean Heat and Power Initiative (NECHPI), which is an organization that "strives to promote policies and practices conducive to the deployment of clean heat and power in applications where high over-all efficiency and associated economic and environmental benefits can be achieved." During the contract period, Tom Bourgeois served as the treasurer and on the executive board of NECHPI.

d. Technologies/Techniques;

No technologies or techniques were developed during the contract period.

e. Inventions/Patent Applications, licensing agreements; and

No inventions/patent applications or licensing agreements were produced during the contract period.

f. Other products, such as data or databases, physical collections, audio or video, software or netware, models, educational aid or curricula, instruments or equipment.

No other products were developed during the contract period.

7. For projects involving computer modeling, provide the following information with the final report:

The NE-CEAC did not develop any computer modeling during the contract period.