Summary of Revisions

March 2016

The CHP Program – CHP Module/Vendor Qualification RFI 2568 has undergone significant changes since the last update. You are encouraged to read the entire RFI in order to get a full understanding of the Program requirements going forward.

Major changes include the following:

1. The minimum system size limit has been eliminated and the maximum size limit has been increased to 3MW.
2. CHP Systems fueled by propane and compresses natural gas are now eligible in addition to pipeline natural gas.
3. Non-black-start capable induction-based modules 50kW and smaller are now eligible.
4. Both black-start capable and non-black-start capable back pressure steam turbines and organic Rankine cycle (ORC) generators are now eligible.
5. A vendor qualification application section has been added.
6. Program gap-filling CHP equipment 1MW and smaller that does not have the operating history to qualify under the general terms of this RFI can apply under a new “CHP Equipment Demonstration” option.
7. Several sections have been rewritten to improve readability and to provide clarity.

CHP Program – CHP Module/Vendor Qualification
Request for Information (RFI) 2568

Applications accepted through November 30, 2018 at 5:00 PM Eastern Time*

The Combined Heat and Power (CHP) Program provides incentives for the installation of CHP systems through PON 2568, which supports an accelerated procurement process where customers select from a set of pre-approved, pre-engineered CHP modules supplied by approved CHP Vendors (the Catalog Approach) or the more traditional design/build procurement process specifically for larger customers that are not adequately met by the Catalog Approach (the Custom Approach).

Under the Catalog Approach, a CHP System consisting of one or more pre-approved Catalog Modules is installed with the approved Vendor acting as a single point of responsibility for the entire project and providing a minimum 5-year maintenance/warranty agreement on the CHP System. Under this approach, NYSERDA will only accept applications from, and will only contract with, approved Vendors.

Through this RFI 2568, NYSERDA is accepting applications from vendors of packaged CHP equipment that wish to become eligible to receive incentives under PON 2568's Catalog Approach (approved Vendor) through the installation of pre-approved CHP equipment (Catalog Module).

NYSERDA is seeking to pre-qualify Catalog Modules that have been completely pre-engineered and pre-tested, with the approved Vendor providing a single point of responsibility for design, installation, service and warranty including all system components. The Catalog Modules must be capable of acquiring proper air permits, transitioning from grid interconnected to grid islanding mode (except as allowed for systems 50kW and smaller, or certain back pressure steam turbines or certain ORC devices that do not have black-start capability), and capable of interconnecting to New York State electric utilities using radial distribution systems, secondary network distribution systems and/or spot network distribution systems. Catalog Modules that cannot pre-qualify because they do not meet the pre-tested requirement for pre-qualification may be considered for conditional-qualification provided performance test data is available for the major components and acceptable calculations showing proper sizing of the components is provided.

Approved Vendors must have demonstrated experience designing, installing and maintaining CHP equipment, either alone or with partners.

Packaged Catalog Modules may consist of one or more prime movers and can be up to and including 3 MW in total size. Vendors must submit a separate application for each different system design. Pre-approved Vendors will be able to receive incentives only for installation of pre-approved equipment.

Application Submission: Applicants must submit one (1) hard copy and one (1) digital copy on CD-ROM of the application and supporting documentation, including a completed Application Cover Sheet (Attachment A). Applications must be clearly labeled and submitted to:

CHP Program, RFI 2568
NYS Energy Research and Development Authority
17 Columbia Circle
Albany, NY 12203-6399

If you have questions concerning this Request for Information, contact Edward Kear at (518) 862-1090, ext. 3269 or edward.kear@nyserda.ny.gov.

*Faxed or emailed applications will not be accepted. Applications will not be accepted at any other NYSERDA location other than the address above. If changes are made to this Request for Information, notification will be posted on NYSERDA's web site at www.nyserda.ny.gov.

Introduction

NYSERDA's CHP Program PON 2568's Catalog Approach provides incentives for the installation of appropriately sized, packaged Catalog Modules that meet specified criteria in terms of system design and component integration; capability to meet a threshold of performance; and sales, installation and service support. Only CHP installations using pre-qualified, or conditionally qualified, packaged Catalog Modules will be eligible for incentives under PON 2568's Catalog Approach. The purpose of this RFI is to invite applications to pre-qualify/conditionally-qualify packaged CHP equipment and to become pre-approved CHP Vendors. In addition, as NYSERDA's interest in CHP evolves, compiling, and maintaining a list of vetted CHP systems and vendors might have value for a variety of market nurturing efforts beyond support of PON 2568.

The term "packaged" is not necessarily limited to, or defined as, a physically integrated prime mover, heat recovery and controls product on a single skid, but more broadly defined to include:

- An integrated Catalog Module design that includes one or more prime mover/generator(s) and matched heat recovery, interconnection, controls, and monitoring components with demonstrated performance,
- The module is pre-engineered and major components and assemblies are factory pre-tested prior to shipment to the site,
- A single point of responsibility for equipment, installation, service and warranty, and
- A single warranty for the module including all components.

Two categories of Catalog module pre-approval will be used based on the level of documented system performance:

- Pre-qualified CHP Modules – pre-engineered systems with a single point of responsibility for installation, service and warranty, and **demonstrated performance as an integrated system based on one of the three ASERTTI CHP Testing Protocols or equivalent**.

- Conditionally-qualified CHP Modules – pre-engineered systems of matched components and a single point of responsibility for installation service and warranty. **Components and subsystems must have been individually performance tested and the complete system must have been designed and performance rated using accepted engineering methods**. Conditionally qualified modules can be upgraded to pre-qualified status once integrated system performance is demonstrated and documented to NYSERDA's satisfaction.

A hallmark of this program is NYSERDA's emphasis to principally provide consumer protection. In that regard, this program supports only commercially-mature products (this program is not intended to assist inventors with developing or demonstrating prototypes or other pre-commercial activities for bringing a new product to market).

Program Requirements

Applicants (i.e., Respondents to this RFI) must be fully responsible for all aspects of vending/installing/maintaining/warranting the package and may be an original equipment manufacturer, a system integrator, or any other entity that offers to install packaged Catalog Modules at sites in New York State.

The Applicant must provide a single point of responsibility for site integration, installation, all warranties (defect and performance), maintenance and service activities related to packaged Catalog Modules offered by the Applicant (including all components) for a period of not less than five (5) years from the date of electric grid interconnection approval. The Applicant may use subcontracted teams to fulfill these obligations. Regardless of the teaming arrangement, however, the Applicant remains fully responsible for all aspects.

Applicants, or an applicant team, must have demonstrated experience designing, installing and maintaining CHP equipment.

The aggregate generator nameplate electric output rating of the packaged Catalog Module must not be greater than 3 MW.

Packaged Catalog Modules that utilize thermal energy to power the prime mover are eligible. For example, back pressure steam turbines and organic Rankine cycle generators. For those Catalog Modules that utilize a fuel to power the prime mover, only pipeline natural gas, propane or compressed natural gas are eligible fuels. Prime movers fueled directly by low BTU or adulterated fuels, such as biogas, landfill gas, and gasifier gas, or using liquid fuels, such as diesel or gasoline, are not eligible under this Program. Fuel cell systems are not eligible.

Eligible packaged Catalog Modules must be capable of operating in parallel with the utility electric grid. Catalog Modules greater than 50 kW that use fuel to power the prime mover(s) must also be capable of operating in stand-alone mode during a grid outage.

Eligible packaged CHP equipment may be configured to provide hot water, steam, chilled water, or any combination as thermal outputs. Eligible CHP equipment may also incorporate one or more organic Rankine cycle (ORC) generators in a combined cycle configuration, one or more ORC generators configured to use waste heat, or one or more back pressure steam turbines.

Packages selected for admittance into the Program will be listed in catalog-format in the CHP Catalog (CHP Program PON 2568 Attachment C) when it is updated. Excerpts from the materials submitted by the Applicant in response to this RFI will be used to create the “catalog entry” and thus the Applicant must work in good faith with NYSERDA to distinguish between confidential/proprietary materials which the Applicant may submit in order to convince NYSERDA of the merits of their packages, versus materials which NYSERDA would be allowed to publish in order to create a catalog that adequately describes the package.

Catalog Modules installed at a customer’s site via PON 2568 may be subject to re-commission activities, at NYSERDA’s expense, during the system’s sophomore-year of operation. The Applicant will be expected to facilitate NYSERDA’s re-commissioning agent’s access to the site, the Catalog Module, and information regarding its legacy of performance. Additionally, the Applicant is expected to thoughtfully consider the merits of any recommendations for improvement of the CHP System and/or its operational dispatch that may result from such re-commissioning effort.

All CHP Systems larger than 50kW installed under PON 2568 must be instrumented with a performance monitoring system that, at a minimum, conforms to NYSERDA’s Monitoring and Data Collection Standard (RFI 2568 Attachment C). The Standard requires that CHP System performance (including thermal use) be measured on 15 minute intervals, and be automatically uploaded to NYSERDA’s DG Performance Website (http://chp.nyserda.ny.gov) on a daily basis for at least 3 years, where such performance data will be available to the public. All Catalog Modules larger than 50kW must include a performance monitoring system consistent with Attachment C.

For CHP Systems 50kW and smaller, NYSERDA intends to sample the performance of small CHP Systems by accessing any monitoring system included within the CHP System by the Vendor, or by installing monitoring equipment at NYSERDA’s expense at select CHP project sites. In any case, the site owner must provide a communications route (phone line or internet connection).

NYSERDA may require that each conditionally-qualified Catalog Module, and the first unit of a pre-qualified Catalog Module design supported under PON 2568, be factory witness tested prior to shipment to the site. If required, the witness test must be conducted with the system fully assembled. The witnesses shall include NYSERDA staff or designated representative. If the witness testing of the first pre-qualified unit proves acceptable then NYSERDA may allow subsequent units to be factory tested as a disaggregation of individual subsystems so as to assess the quality of workmanship.

NYSERDA may limit the number of simultaneous installations projects from any one Vendor. Vendors installing their first project under PON 2568 may be limited to as few as the single project. The number of projects using new system designs may be limited until performance can be verified. NYSERDA may also limit further applications from a Vendor if, in the view of NYSERDA, the Vendor may not have sufficient resources to adequately serve the projects.

CHP Equipment Demonstration

Vendors with commercially available CHP equipment 1MW and smaller that does not have sufficient operating history to meet RFI 2568 requirements, and that fills a hole in the CHP Catalog, can apply for a CHP Equipment

Demonstration Project at a test site to show that the equipment is robust and properly designed. Contact the NYSERDA contact person listed on page 1 of this RFI before applying. All information required for an equipment application under this RFI and for a site application under PON 2568 will need to be provided along with a letter from the site stating that it is understood that the proposed project is a demonstration and that the equipment has not been vetted by NYSERDA. If approved, the award for such a demonstration project will be the same as the incentive for a similarly sized project through PON 2568.

Applications for Equipment Demonstration Projects will be evaluated based on the qualifications of the proposing team, the relative technical risks of the project, whether a successful outcome would result in acceptance into the CHP Catalog, the suitability of the test site including tolerance for failure, the perceived market desirability of the proposed system relative to other Catalog equipment if the project is successful, and any unique or technically interesting features of the proposed equipment.

Qualification Requirements for Pre-Approved CHP Modules

Qualification Table		
Category	**Minimum Requirements**	**Required Documentation**
CHP Module submitted for pre-qualification	Completed	CHP Program – CHP Module Qualification Data Form (Attachment B)
Overall CHP efficiency Overall CHP Efficiency = (Net CHP Electric Output + CHP Thermal Output Available @ Temperature)/CHP Fuel Input; all calculated in Higher Heating Value (HHV). Operating conditions must be stated.	60% HHV	Documentation should provide confidence that annual efficiencies in the field will meet the 60% minimum requirement. Pre-qualified: Third party laboratory results based on one of the three ASERTTI CHP Testing Protocols or Equivalent. Field tested data such as data at chp.nyserda.org may be acceptable. Conditionally-qualified: Overall CHP Efficiency (HHV) based on accepted engineering methods.
NOx Emissions (Expressed as generator-out emissions, engine-out calculation should be based on 95% efficient generator)	Less than 1.6 lb/MWhe	Certified third party emissions measurements in accordance with latest EPA test requirements. Emissions data provided for full and part load (100%, 75%, 50%, 25% if appropriate).
Warranty/Service	Five year parts and labor for the complete CHP system[1] for both planned and unplanned events.	Written warranty language and description of warranty/service plan.
Performance Monitoring System (required for systems >50 kW, optional for systems 50kW and smaller)	Conforming to NYSERDA Data Monitoring Standard	Written compliance. Coordination with NYSERDA's CHP Data Agent (CDH Energy Corp.) is recommended.
Installation and Commissioning Manual	Complete CHP system including heat recovery and intertie	Written manual
Operating Manual		Written manual
Maintenance and Repair Manual		Written manual

[1] A critical factor in qualification is single point responsibility for the entire system. This includes a single warranty covering all elements that make the CHP system function including prime mover, generator, waste heat recovery system, heat dump radiator (if required), supplemental heating (if required), valves, dampers, piping, ductwork, controls, monitoring and data export, etc. Single point responsibility also includes CHP system level drawings, part lists, installation, operation and maintenance manuals, and service and maintenance program.

Certifications	IEEE 1547 compliant UL 1741 certification	Written compliance with IEEE 1547 Written UL 1741certification (if applicable)
Grid-parallel & stand-alone (required for systems >50kW, optional for systems 50kW and smaller. Systems 50kW and smaller will receive a reduced incentive if not capable of stand-alone operation)	Capable of operation in both grid-parallel and stand-alone configurations	Written description of capability and operational transition sequence from grid-parallel to stand-alone, and then back to grid-parallel
Interconnection	IEEE 1547 compliant	Description of interconnection and protective equipment and demonstrated compliance with minimum specifications.

Application Requirements

Approved Vendor Application

Applicants for Approved Vendor status must provide documentation showing experience designing, installing and maintaining CHP equipment. If the Applicant does not have sufficient experience in one of these areas, the Applicant may team with other entities to submit a joint application. If an Applicant team is approved by NYSERDA to become an Approved Vendor, the Applicant will be held responsible for meeting all program requirements. Changes to a key member of an Approved Vendor team will require review and approval by NYSERDA.

Applicants seeking Approved Vendor status are required to submit the following information at a minimum:

- Description of the company including its structure.
- If you operate an Operation Center that monitors CHP system telemetry, a description of its capabilities. what types of parameters are you monitoring and what level of system control do you have.
- Description of the form of the relationships with OEMs and other members of the Applicant's team.
- List of markets (locations) where the Applicant is actively selling, installing, and/or servicing CHP equipment.
- Total number of employees involved in CHP activities.
- Locations of your primary CHP manufacturing and warehousing facilities.
- Indicate locations of your CHP sales and service offices.
- Number of employees performing CHP functions that directly support the New York state market broken down by function (sales, equipment design and manufacturing, site integration design, project management, installation, and service).
- Types of relevant certifications held by your service staff, and the number of service staff holding such certifications.
- Descriptive list of CHP systems installed.
- Number of CHP systems that the Applicant is currently servicing through a maintenance agreement.
- A copy of the Warrant/Maintenance Agreement that the Applicant intends to use for CHP Systems installed under the CHP Program showing a minimum 5-year term (cost and financial information may be redacted).

Pre-Approved Catalog Module Application

Applicants must submit a separate application under this RFI for each different packaged CHP system design where qualification is requested.

Pre-qualified CHP systems
These systems are pre-engineered, pre-tested with single or multiple integrated prime movers, or matched components that have been previously integrated and performance tested as a complete system including controls, monitoring system, any interconnecting piping, ductwork and/or wiring as supplied by the manufacturer/developer.

Conditionally-qualified CHP systems
This category includes pre-engineered systems comprised of matched components and subsystems that have been individually tested. The complete systems including interconnecting piping, ductwork and or wiring which have been designed by the manufacturer/developer. Individual components and subsystems have been performance tested, and the complete system including all interconnecting equipment has been engineered, designed and performance rated using accepted engineering methods.

Applicants seeking Pre-approval of their packages are required to submit the following materials:

- System piping and instrumentation drawing (P&ID).
- System layout (configuration) drawing.
- Single line wiring diagram.
- Complete bill of materials that includes major system components, controls and piping, ductwork and wiring integral to the system.
- **<u>Those applying for Conditional-Qualification status</u>. System component and subsystems performance test documentation, and calculations combining the components and subsystems into a complete CHP system including: net electric output, useful thermal output(s) (form, flows, temperature, pressure, and energy - see data form for details), fuel requirements (flow, temperature, pressure, and energy in HHV), as well as the method of testing utilized and uncertainty analysis.**
- **<u>Those applying for Pre-Qualification status.</u> System performance test documentation including: net electric output, useful thermal output(s) (form, flows, temperature, pressure, and energy - see data form for details), fuel requirements (flow, temperature, pressure and energy in HHV), as well as testing entity, the method of testing utilized and uncertainty analysis.**
- All system performance and emissions data must be provided at full and part load conditions; Part load is defined as 75%, 50% and 25% of full load capacity.
- System monitoring and data export configuration and mechanisms (if applicable).
- System performance guarantees including net power and thermal outputs (temperature and energy) shall be provided at part and full loads.
- System installation and commissioning requirements to maintain system warranty including (as applicable) qualification requirements to be used to select subcontractors that will act as installers and associated quality control measures, training and responsibilities.
- System operation requirements including services provided and responsibilities.
- System warranty and service plan including information on parts and labor coverage, length of coverage, and warranty/service providers (Five-year term is mandatory, ten-year term is optional).
- System service requirements including parts, labor and maintenance requirements during the first ten years of operation.
- Factory test protocols for each major component and assembly, and the complete system.
- Description of the operational transition from grid-parallel to stand-alone, and then back to grid-parallel (if applicable), as well as black start while in stand-alone mode.
- <u>Those applying for Pre-Qualification status</u>. List (with photos) of existing installations of the packaged CHP system.
- A completed CHP System Qualification Data Form.

Application Format
The format of the qualification submittal is left to the Applicant. However, NYSERDA suggests that the submitted materials be organized in the following order:

- System drawings, schematics and diagrams must be of sufficient detail to fully understand the complete system that is being submitted for qualification. With respect to pre-qualification this includes all interconnecting piping, ductwork, valves wiring and controls including configuration and dimensions. Keep in mind that only the submitted system configuration will be pre-qualified. Conditionally-qualified systems must include design and physical limitations with respect to interconnecting piping, ductwork, valves wiring and controls including configuration and dimensions.

- The Bill of Materials should be at a level of detail where major components are identified including prime mover, generator, heat recovery devices, thermally activated technologies, emissions abatement equipment, system level controls, monitoring equipment, interconnection paralleling, transfer and protective equipment, interconnecting piping, ductwork and valving.
- System energy and emissions performance documentation as requested above.
- Certifications as requested above.
- The installation manual should include:
  - Safety instructions
  - Principles of operation
  - System description and technical data
  - Installation requirements
  - Thermal system connections
  - Fuel connections
  - Intake and exhaust information
  - Electric connections
  - Controls
  - Initial operation and commissioning
  - Maintenance
  - Spare parts
- The operating manual should include:
  - Application/Operating modes
  - Sub-system descriptions
    - Prime mover
    - Heat recovery systems
    - Controls and monitoring systems
    - Grid interconnection and protective systems
    - Other
  - System operation
  - Operator interface
  - Maintenance
  - Troubleshooting
- The maintenance and service manual should include:
  - General overview of maintenance requirements
  - Routine service requirements and procedures
  - Troubleshooting
  - Service parts list
- The warranty description should include:
  - Length and limits of coverage
  - Service plans and options

Application Evaluation

Applications that meet Application Requirements will be reviewed using the evaluation criteria below:

<u>Applications to become an Approved Vendor</u>

- Does the application meet the RFI requirements?

- Does the application show single-point responsibility, with adequate resources and experience to engender confidence of the ability to manage the equipment packaging, installation, commissioning, and maintenance, either directly or through subcontracted teaming arrangements? (Regardless of the teaming arrangement, the Applicant remains fully responsible for all aspects).

Applications for CHP equipment pre-approval

- Does the application meet the RFI requirements?
- Does the application contain sufficient information to provide an understanding of how the system was engineered and designed, why specific components were selected, how they were integrated into the package, and how the integrated package and controls will operate in the field?
- Does the application demonstrate that the equipment and individual components have a history of durability, quality, and reliability?
- Does the application demonstrate that the equipment and individual components are well-matched to work in harmony with each other as a “system”?

NYSERDA may utilize outside evaluators to assist in the review of applications. NYSERDA may request supplemental materials as reasonably necessary to facilitate review.

GENERAL CONDITIONS

Proprietary Information - Careful consideration should be given before confidential information is submitted to NYSERDA as part of your application. Review should include whether it is critical for evaluating a application, and whether general, non-confidential information, may be adequate for review purposes. The NYS Freedom of Information Law, Public Officers law, Article 6, provides for public access to information NYSERDA possesses. Public Officers Law, Section 87(2)(d) provides for exceptions to disclosure for records or portions thereof that "are trade secrets or are submitted to an agency by a commercial enterprise or derived from information obtained from a commercial enterprise and which if disclosed would cause substantial injury to the competitive position of the subject enterprise." Information submitted to NYSERDA that the applicant wishes to have treated as proprietary, and confidential trade secret information, should be identified and labeled "Confidential" or "Proprietary" on each page at the time of disclosure. This information should include a written request to exempt it from disclosure, including a written statement of the reasons why the information should be exempted. See Public Officers Law, Section 89(5) and the procedures set forth in 21 NYCRR Part 501
http://nyserda.ny.gov/~/media/Files/About/Contact/NYSERDARegulations.ashx
However, NYSERDA cannot guarantee the confidentiality of any information submitted.

Omnibus Procurement Act of 1992 - It is the policy of New York State to maximize opportunities for the participation of New York State business enterprises, including minority- and women-owned business enterprises, as bidders, subcontractors, and suppliers on its procurement Agreements.

Information on the availability of New York subcontractors and suppliers is available from:

Empire State Development
Division For Small Business
30 South Pearl Street
Albany, NY 12245

A directory of certified minority- and women-owned business enterprises is available from:

Empire State Development
Minority and Women's Business Development Division
30 South Pearl Street
Albany, NY 12245

Limitation - This Request for Information does not commit NYSERDA to award a contract, pay any costs incurred in preparing an application, or to procure or contract for services or supplies. NYSERDA reserves the right to accept or reject any or all applications received, or to cancel in part or in its entirety the solicitation when it is in NYSERDA's best interest.

Disclosure Requirement - The applicant shall disclose any indictment for any alleged felony, or any conviction for a felony within the past five years, under the laws of the United States or any state or territory of the United States, and shall describe circumstances for each. When an applicant is an association, partnership, corporation, or other organization, this disclosure requirement includes the organization and its officers, partners, and directors or members of any similarly governing body. Applicants must also disclose if they have ever been debarred or suspended by any agency of the U.S. Government or the New York State Department of Labor.

Attachments

Attachment A - Application Cover Sheet
Attachment B - CHP System Qualification Data Form
Attachment C - Monitoring and Data Collection Standard

CHP System Model Identifier
Applicant (Company Name)
Contact Person
Address
Phone Number
Email Address

Attachment A – RFI 2568 Application Cover Sheet

Attachment B - CHP Program – CHP Module Qualification Data Form		
Category	**Units**	**Information Required***
Prime Mover		Provide data for 100%, 75%, 50% and 25% load where appropriate
Manufacturer		
Model		
Capacity	kW	
Fuel required	scfm	
Fuel pressure	inches water or psia (please indicate)	
Fuel Booster compressor power (if required)	kW	
Exhaust temperature	°F	
Exhaust flow rate	scfm	
Exhaust pressure available for external use (e.g. HRSG if applicable)	psig	
NOx emissions	lb/MWhe	
PM10 emissions	lb/MWhe	
PM2.5 emissions	lb/MWhe	
CO emissions	lb/MWhe	
VOC emissions	lb/MWhe	
Noise	dBA	
Generator/Inverter		☐ Synchronous ☐ Inverter ☐ Other
Manufacturer		
Model		
Power output rating	kW	
Power output rating	kVA	
Rated voltage	V	
Rated efficiency	%	
Rated current	Amps	
Minimum operation frequency/time	Hz/sec.	
Connection		☐ Delta ☐ Wye ☐ Wye grounded
Total system type tested		☐ Yes ☐ No Provide documentation
Equipment type tested (inverter, protection system)		☐ Yes ☐ No Provide documentation
Synchronous		☐ Salient ☐ Non-salient Attach copies of saturation and Vee curves
Rated speed	RPM	
Torque	ft-lbs	
Field amps at rated voltage and current	Amps	

Field power factor over-excited	%	
Type of exciter		
Output power of exciter	W	
Type of voltage regulator		
Locked rotor current	Amps	
Direct-axis synchronous reactance (X_d)	ohms	
Direct-axis transient reactance (X'_d)	ohms	
Direct-axis sub-transient reactance (X''_d)	ohms	
Inverter		☐ Forced commutated ☐ Line commutated
Heat Recovery		
Hot Water		
Manufacturer		
Model		
Maximum continuous HW supply temperature	°F	
Minimum return HW temperature (excluding dump radiator heat transfer)	°F	
Maximum energy available at the HW supply temperature	Btu/h	
Maximum energy available given the above HW supply and return temperatures	Btu/h	
Chilled Water		☐ Exhaust ☐ Hot water ☐ Hybrid
Manufacturer		
Model		
Minimum continuous chilled water supply temperature	°F	
Maximum supply/return temperature differential	°F	
Maximum energy available at the minimum chilled water supply temperature	Btu/h	
Chiller Coefficient of Performance		
Useful thermal energy required from the prime mover to deliver the maximum energy available at the minimum chilled water	Btu/h per thermal stream including required supply temperatures	
Steam (HRSG)		
Input (e.g. turbine exhaust at HRSG inlet) temperature	°F	
Input (e.g. turbine exhaust at HRSG inlet) flow rate	scfm	

HRSG pressure drop	psig	
Feed water inlet temperature	°F	
Steam output pressure	psig	
Steam output flow rate	lb/hr	
Steam output temperature	°F	
Steam output energy	Btu/h	
System Performance		
Net Electric Efficiency[1] (HHV)	%	
Thermal Energy Available Efficiency[1] (HHV)	%	
CHP Efficiency[1] (HHV)	%	

***Note:** All system performance, fuel consumption and emissions data must be provided at full and part load conditions. Part load is defined as 75%, 50% and 25% of full load capacity. If the CHP Module consists of multiple prime mover/generators, complete a data form for the prime mover/generator and for the CHP Module as a whole.

[1] Show complete calculation

Net Electrical Efficiency

Net electrical energy output is a calculated value that indicates the usable electrical power a system (in contrast to a product) delivers and accounts for the energy required in operating the system. The external parasitic loads shall be identified during test plan development prior to testing and included in the test report.

The net electrical output is calculated based on the total electrical energy out of the system, integrated over the test duration, less all external parasitic losses, such as heat transfer fluid pumps and fans that are outside the product boundary, but inside the system boundary. The net electrical energy produced is given by:

$E_n = E_g - E_a$

Where:

E_a = total auxiliary electrical energy requirements
E_g = total (gross) electrical energy measured
E_n = net electrical energy in kW/h

Net electrical efficiency is the indication of fuel to electricity conversion efficiency of the DG product considering internal and external parasitic losses and accounting for the actual fuel required to operate the CHP product and is based on Higher Heating Value (HHV).

$$\eta_{ne} = \frac{E_n \times 3412}{Q_i}$$

Where:

η_{ne} = net electrical efficiency based on HHV
Q_i = total fuel into the system (Btu) based on HHV
3,412 = conversion factor from kWe to Btu/hr (Btu/kW·hr)

Thermal Efficiency

Hot Water Supply System

Thermal efficiency is a measure of energy utility; that is, the percentage of total fuel input which is captured and put to useful service by conversion to thermal energy and is based on Higher Heating Value (HHV).

$Q_{hw} = m \times C_p \times \Delta T$

or,

$Q_{hw} = F_{hw} \times K \times \Delta T$

Where:

Q_{hw} = hot water supply in Btu/h
m = mass flow rate of water in lb/h
F_{hw} = hot water flow rate in gpm
ΔT = temperature differential (supply temperature – required return temperature)
K = conversion factor from gpm to lb/h [2]
C_p = for water = 1 Btu/lb

$$\eta_{hw} = \frac{Q_{hw}}{Q_i}$$

Where:

η_{hw} = net thermal hot water efficiency based on HHV
Q_i = total fuel into the system (Btu/h) based on HHV

Chilled Water Supply System

Thermal efficiency is a measure of energy utility; that is, the percentage of total energy input, which is captured and put to useful service by conversion to thermal energy and is based on Higher Heating Value (HHV).

$Q_{cw} = m \times C_p \times \Delta T$

or,

$Q_{cw} = F_{cw} \times K \times \Delta T$

Where:

Q_{cw} = chilled water supply in Btu/hr
m = mass flow rate of chilled water in lb/h
F_{cw} = chilled water flow rate in gpm
ΔT = temperature differential (supply temperature – required return temperature)
K = conversion factor from gpm to lb/h [3]
C_p = for water = 1 Btu/lb °F

$$Q_{cwthermal} = \frac{Q_{cw}}{COP}$$

[2] K is 488 for water at 180 °F, need to adjust accordingly for other fluids
[3] K = 500 for chilled water

Where:

$Q_{cwthermal}$ = the useful thermal energy (Btu/h) from the prime mover required by the chiller to deliver Q_{cw}
COP = measured Coefficient of Performance of the chiller (hot water, exhaust gas or hybrid) to deliver the measured Q_{cw}

$$\eta_{cwthermal} = \frac{Q_{cwthermal}}{Q_i}$$

Where:

$\eta_{cwthermal}$ = net thermal chilled water efficiency based on HHV
$Q_{cwthermal}$ = the useful thermal energy (Btu/h) from the prime mover required by the chiller to deliver Q_{cw}
Q_i = total fuel into the system (Btu/h) based on HHV

Steam Supply System

Thermal efficiency is a measure of energy utility; that is, the percentage of total energy input, which is captured and put to useful service by conversion to thermal energy and is based on Higher Heating Value (HHV).

$$Q_{steam} = F_{steam} \times \Delta H$$

Where:

Q_{steam} = steam supply in Btu/h
F_{steam} = steam flow rate in pounds per hour
ΔH = increase in steam enthalpy in Btu/pound (enthalpy of steam output – enthalpy of feed water input)[4]

$$\eta_{steam} = \frac{Q_{steam}}{Q_i}$$

Where:

η_{steam} = net thermal steam efficiency based on HHV
Q_i = total fuel into the system (Btu/h) based on HHV (including fuel used in duct burners or auxiliary boilers integrated into the system)

[4] Enthalpy is a function of the pressure and temperature of steam or feed water

ATTACHMENT C

MONITORING AND DATA COLLECTION STANDARD

FOR

DISTRIBUTED GENERATION/COMBINED HEAT AND POWER (DG/CHP) SYSTEMS

December 29, 2004

Revised

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Attachment No. 1 to Appendix A-2 - Suggested Convention for Naming Data Points

GLOSSARY

DG/CHP System. The units, components, equipment and subsystems that make up the Distributed Generation/Combined Heat and Power system at a facility.

Data Acquisition System (DAS). The controllers, instrumentation and other equipment at the site to measure and record data related to the facility or DG/CHP system. Can be a dedicated data logger, a direct digital control (DDC) system for controlling facility operation, an industrial control system, or an on-board controller for the DG/CHP equipment. Generally, the DAS is located on-site near the DG/CHP System.

Data Collection, Logging, or Recording Interval. The time interval at which data are recorded or saved into memory in the on-site DAS.

Data Retrieval Interval. The time interval at which data are transferred from the on-site DAS to an off-site computer system for storage and analysis.

Data Point. The measured value or reading provided by a sensor or instrument installed as part of the on-site DAS or from other handheld instruments.

Demonstration Site. A facility or building where a DG/CHP system has been installed with financial support from NYSERDA.

Displaced Fuel Use. The natural gas or other fuels that would have been consumed if the DG/CHP system had not been installed/operating at the site.

Load. The equipment and systems in a facility or building that consume or use heat, power, or cooling that is produced by a DG/CHP system. In the absence of the DG/CHP equipment, the thermal load would be met with boilers, furnaces, chillers, or other fuel consuming equipment at the site. The electric load would have been met by the local electric utility.

Log or Logfile. The file or memory locations where control systems save or record time stamped data. This term is commonly used by building direct digital control systems.

Monitoring Plan. A document describing the sensors and equipment to be installed as part of the DAS. The plan explains the purpose and use of each sensor or data point.

Monitoring System. Same as Data Acquisition System (DAS).

Parasitic Power. Electric power consumed by the DG/CHP system. Can be power use internal to the DG/CHP unit (internal parasitics) or power use by pumps, fans, compressors and other components that are required to deliver heat, power or cooling to the load (external parasitics).

Scan or Sampling Interval. The time interval at which each sensor or instrument is read by the on-site DAS.

Introduction

This document describes the requirements and desirable attributes of an automated data collection system designed to monitor the performance of a distributed generation/combined heat and power (DG/CHP) system. This standard is intended to provide guidance to demonstration sites that are part of NYSERDA's DG/CHP program. Specifically, this document seeks to guide demonstration sites through the process of developing a monitoring system and preparing a Monitoring Plan for their DG/CHP site.

DG/CHP demonstration sites that receive funding from NYSERDA are generally required to collect key performance data at 15-minute intervals over the first year of operation. The monitored data are intended to quantify facility load profiles, generator power output, fuel consumption, useful thermal outputs, parasitic loads and equipment runtimes. These data provide the means to confirm electrical and CHP efficiencies over the year, determine equipment availability, and verify system economics.

The sections that follow discuss the types of on-site measurements that are required or recommended to meet the goals and monitoring requirements. First, this document describes the need to fully document the salient details of the DG/CHP system and to develop a simple system schematic. Next, the process of setting monitoring objectives and goals for a CHP project are described. Then, the process of selecting monitoring hardware and instrumentation to meet the project goals is demonstrated by an example. Finally, the advantages and disadvantages of various communications and web presentation options are compared.

Documenting System Details

The first step in developing a monitoring plan is to define the key components and equipment as well as to provide the basic layout of the components in the DG/CHP system. This step is critical because it helps to determine the data points and measured parameters that must be monitored to quantify system operation.

<u>Describing DG\CHP Equipment</u>

At a minimum, the monitoring plan should include the basic equipment and system details listed in Table 1.

Table 1. Documenting DG/CHP Equipment and Site Details

System overview	• Generator size and type • Is power exported to the grid? • standby power functionality • heat recovery used to meet facility loads; describe loads and displaced fuels
Power generating equipment	• Nameplate data such as output, operating voltage, generator type, fuel input • Basic nameplate data on standby power/auto transfer components • protective relay functions and settings
Heat recovery system and displaced thermal equipment	• Rated performance and corresponding operating temperatures of heating/ cooling systems • Size and Nameplate data on boilers, chillers and other equipment that are displaced by (or provide backup for) heat recovery operation
Facility load details	• Facility size, use, and other application details • Electric utility details: number of meters, original and current electric and gas tariff info

System Schematic

An important step to describing and understanding a DG/CHP system is to develop a simple schematic representation of the system. Unlike detailed engineering drawings that show the physical layout of all components in a system, a simple schematic conveys the functional layout of the system in order to understand the energy flows and thermodynamic boundaries. The key concepts conveyed by the schematic are the flow of fuel, electricity, and thermal energy between the DG/CHP system and the facility. The number of heat exchange steps, the direction of fluid flow, the operating temperature of each loop, the net power supplied to the building, and exported power are all shown.

Figure 1 shows a simple schematic of a CHP system that supplies heat recovery to a building via a hot water loop. Hot water from the CHP unit is supplied at 180°F. A heat exchanger (HX) is required to separate the building hot water loop from the CHP system loop. The extra heat exchange step lowers the fluid temperature that can be delivered to the load. A dump radiator rejects heat from the loop when it cannot be used to meet building thermal loads. The system supplies generated power into the main electric bus for the facility. This power is consumed internally (no power export to the utility). Some external parasitic power is required to run the pumps and dump radiator. The net purchases from the utility are also monitored at the main meter.

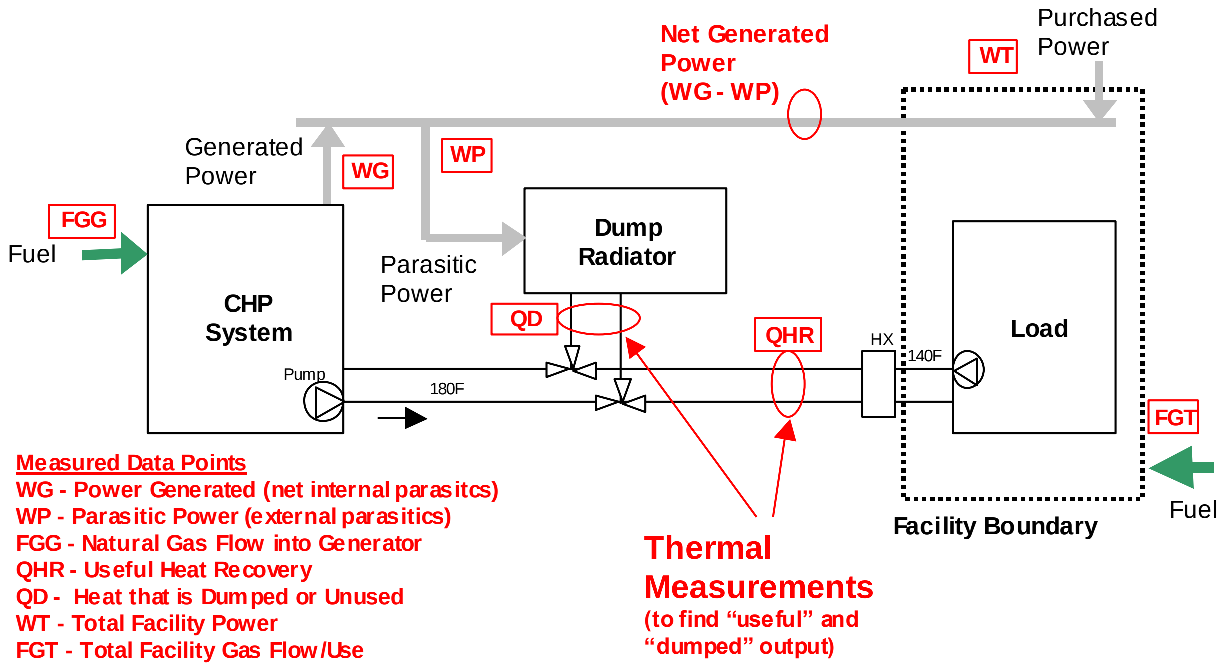


Figure 1. Simple Schematic CHP System

Figure 1 also shows the location of monitored data points that would be included to measure DG/CHP system performance. The data point name or tag corresponding to each sensor is shown as the red, box-enclosed text on the schematic[1]. A key purpose of the schematic is to show the location of each measured point in order to demonstrate that meaningful data are being collected. The next section talks about process and rationale for selecting these points.

<u>Feasibility Study and Estimated Annual Performance</u>

In most cases a DG/CHP System is installed and built after a detailed engineering feasibility study has been completed to evaluate the cost effectiveness of the system. Generally this study would have assumed or calculated sizes and performance characteristics for key equipment and predicted annual power production, daily or monthly load profiles, annual heat recovery savings, parasitic power use, etc. The key results of the feasibility study should be briefly summarized in the monitoring plan. The original feasibility study could also be attached as an appendix or provided as a reference.

[1] Appendix A explains the naming convention that was used for selecting the data point names shown in Figure 1.

Data Collection and Monitoring

<u>Monitoring Objectives</u>

In order to select the necessary monitored data points the project objectives should first be clearly stated, since they drive the monitoring and data collection requirements. The primary monitoring objectives (listed in Table 2) are usually required for NYSERDA DG/CHP sites. Other optional objectives are listed in Table 3. The data points necessary to meet these objectives are listed in each table.

Table 2. Primary (NYSERDA Required) Monitoring Objectives

No	Objective	Data Necessary to Meet Objective
1	Quantify the variation of DG/CHP system power output, gas consumption, and efficiency over wide range of annual operating conditions.	WG[1], FGG, TAO
2.	Quantify external parasitic loads (e.g., gas compressors, pumps, dump radiators, etc.).	WP
3.	Quantify the daily, weekly monthly, and annual variation of total facility power use (or power purchased from the utility) so that actual utility costs can be determined.	WT
4.	Determine the thermal loads imposed on the CHP system by the facility (or the useful thermal output supplied to the facility) to measure the total CHP efficiency of the system on a daily, monthly and annual basis; quantify the variation of these loads with ambient conditions and operating schedules so the findings from this site can be extended to other climates.	QHR (or integrated flows & temperatures), TAO
5.	Quantify the displaced fuel use on auxiliary equipment and systems to confirm the benefit of heat recovery.	Boiler fuel use, total facility fuel use (FGT), chiller electric consumption
6.	Quantify the amount of available thermal energy that is unused or "dumped" by the CHP system in order to demonstrate a system heat balance.	QD (or integrated flows & temperatures)

1 - The data point names correspond to the points listed in Figure 1 and Attachment No. 1 to Appendix A-2.

Table 3. Optional Monitoring Objectives

No	Objective	Data Necessary to Meet Objective
7.	Determine the impact of generator operation on power quality in the facility (power factor, kVAR, frequency, total harmonic distortion); measure at generator output and/or main service entrance.	Volts, amps, kVA, hz, THD, etc (total and/or per phase)
8.	Collect diagnostic data to confirm the DG/CHP system operates as expected and/or support of maintenance and operation activities.	Component statuses, intermediate temperatures, pressures
9.	Develop performance maps of CHP equipment and components to verify manufacturer specifications.	QHR, flows, temperatures, statuses, etc.
10.	Determine environmental emissions from DG/CHP equipment to quantify net emissions impacts of the system.	CO, NO_x, THC, etc

The primary objectives listed in Table 2 require the relatively small set of monitored data points shown on Figure 1. The optional objectives would require a more extensive monitoring system. Generally all these data would be captured and recorded at 15-minute intervals. Though in some cases one-time readings with handheld meters will sufficient to quantify operation (e.g., one time readings of parasitic power for a constantly operating pump; one-time flow readings for loop flow rates that are constant). Some data, such as local weather data, can also be purchased instead of measured (www.ncdc.noaa.gov).

In some cases it may be more convenient to measure power at different locations in the system. For instance:

- measure total facility power use instead of net utility purchases,
- separately measure generator gross output and internal parasitics instead of net busbar power output.

These variations are acceptable but must be documented in the monitoring plan tables and schematic. The Monitoring Plan must include equations defining how the values shown in Figure 1 can be calculated from the measured data.

Monitoring Hardware Issues

The necessary sensors and equipment are driven by monitoring objectives as well as the type of monitoring system hardware and software that will be used. For instance, if the monitoring system is capable of counting pulses, then a utility-grade KYZ (or Form C) output can often be added to main electric meter at a relatively low cost. Otherwise an additional power meter with a more compatible output (e.g., a 4-20 ma output proportional to kW) might have to be installed on the building main. Similar issues are true for the gas meter installed on the CHP unit.

Another monitoring system issue is the type of software used to sample, record, and save the monitored data. Building control systems have historically had the ability to sample data at specified interval and then save that information in a "log". In contrast data loggers and other more flexible control systems can usually scan or read sensors at relatively fast interval (e.g., every few seconds) and then average or totalize the readings over the recording interval (e.g., every 15-minutes). This distinction can become very important when aggregating the data to daily, monthly, or annual values. The relative impact depends on how much the outputs, inputs, or loads fluctuate in time. Generally, monitoring systems than can average or totalize over the recording interval will provide more accurate and useful data.

Key examples are the electric power output from a generator or total power use of a facility. The goal is usually to determine the overall energy production (kWh) as well as the average demand (kW) for each recording interval (e.g., 15-minutes). With a pulse output meter, the total energy use (kWh) is explicitly determined. However, the average demand (kW) in time interval can also be determined if the pulse resolution is sufficiently small. In this case the average demand is:

KW_{avg} = (measured kWh per interval) / (time interval)

The other metering option would be to use a power meter that measures power (kW) and provides an analog output (e.g., 4-20 mA). This meter explicitly measures power demand. However, the overall energy use can also be inferred:

KWh_{total} = (measured kW) x (time interval)

For systems were the measured value changes faster than the time interval, the error in determining the inferred kWh value can be large. This is especially true for monitoring systems that only take one sample in the recording interval. Scanning and averaging the power transducer at a faster rate can generally alleviate these concerns.

Other more expensive types of power meters solve this problem by independently providing a kWh and kW reading via a serial connection (e.g., MODBUS) for each interval.

Generally we believe that priority should be on explicitly determining energy use (kWh) with a high-resolution, pulse-emitting meter since this reading is most important to overall economics. The average demand in any interval can be closely inferred by the method described above.

Determining the thermal outputs from a CHP system has similar issues. Determining the thermal output generally requires that the flow and delta temperature be measured. The product of flow and delta temperature must be integrated (or summed) to determine the energy content:

$$q = k \cdot \Sigma\{gpm_i \cdot (Tin_i - Tout_i)\} \cdot \text{(time interval)}$$

Where i corresponds the readings at each scan interval. The factor "k" depends on the specific heat and density of the actual fluid at the site. The summation is completed for all the scans to find the total value "q" for the recording or logging interval (i.e., 15 minutes). The integration can be done by a control system/data logger or by using a dedicated electronic device known as a BTU Meter. If the flow is known to be constant throughout the year, then a one-time flow reading can be combined with continuous temperature measurements. In all cases, care should be taken to properly integrate the flow-temperature product at small intervals if the flow varies (or cycles on and off) to meet the needs of the load.

If a constant flow is assumed, then the Monitoring Plan must explicitly make the case that no pumps or valves in the loop will vary. At a minimum, a one-time flow measurement is required to verify the flow rate. Design flow values from drawings or engineering design calculations are not acceptable.

Monitored Data Points

The monitored data points that are ultimately selected need to specified in tabular and graphic form. The tabular summary needs to specify or provide:

- the data point name or tag
- a description of the measured value
- the engineering units of the measured/recorded value
- the type of sensor or transducer and key manufacturer information

Separate tables should be provided for continuous or automatically-collected data points and for measurements that a taken periodically or one-time with handheld or temporary meters.

The DG/CHP system schematic should be used to show the location of each data point in the system. The schematic must include sufficient detail to explain why and how the measurement location was selected.

Finally, the rationale and intended purpose for each data point should be described in the text. The description should explain how the measured point would be used to analyze and understand DG/CHP system performance. The description can be bulleted text or in narrative format. The next subsection shows an example of how the monitored data points could be presented and defined.

Selecting Monitoring Points for and EXAMPLE CHP SITE….

The continuously-monitored data points in Table 4 were selected to quantify the performance of the CHP system. Figure 2 shows the location of each monitored point in the system. The CHP system includes two 60 kW microturbines with integrated heat recovery. Hot water produced by the microturbines is used to provide space heating to the building. Hot water is also provided to an absorption chiller that can meet the space cooling loads in the summer. Heat recovery provided for space heating will displace boiler operation. Hear recovery used by the chiller will displace operation of the original electric chiller.

The monitoring system will use a Campbell Scientific CR-10x data logger that samples and integrates every 10 seconds and records data at 15-minute intervals.

Table 4. Continuous or Automatically Collected Monitoring Points for EXAMPLE CHP System

Channel Type	Data Pt Name	Description	Eng Units	Sensor Type
Analog-1		Thermocouple reference		
Analog-2	TAO	Ambient Temperature	F	type-T TC
Analog-3	TCHL	Chilled Water Supply - system	F	type-T TC
Analog-4	TCHE	Chilled Water Return - system	F	type-T TC
Analog-5	THXL	Hot Water from microturbines	F	type-T TC
Analog-6	THXE	Hot Water to microturbines	F	type-T TC
Analog-7	TBXL	Hot Water Supply on Boiler-Side of HX	F	type-T TC
Analog-8	TCWE	Cooling Water Entering Abs. Chiller	F	type-T TC
Analog-9				
Analog-10	FHW	Heat Recovery Flow	gpm	Onicon F-1110
Analog-11	FCH	Chilled Water Flow	gpm	Onicon F-1110
Analog-12	RHO	Ambient RH	%	Vaisala RH
Pulse-1	FGB	Building Gas Use	cu ft	Gas meter[1]
Pulse-2	FGT	Microturbine Gas Use	cu ft	Gas meter[1]
Pulse-3	WCH	Electric Chiller Power	kWh	Veris H-6010
Status-1	SCH	ABS Chiller Status	min	Veris 800
Status-2	SHV	Boiler/Abs CH Valve Status	min	Veris 800
Status-3	SCT	Cooling Tower Status	min	Veris 800
Status-4	SHP	Heat Exchanger Pump Status	min	Veris 800
MODBUS	WT1	Power Microturbine #1	kW/V/A	Veris Modbus
MODBUS	WT2	Power Microturbine #2	kW/V/A	Veris Modbus

Notes: 1- Gas meters are utility-grade, temperature- and pressure-compensated meters.

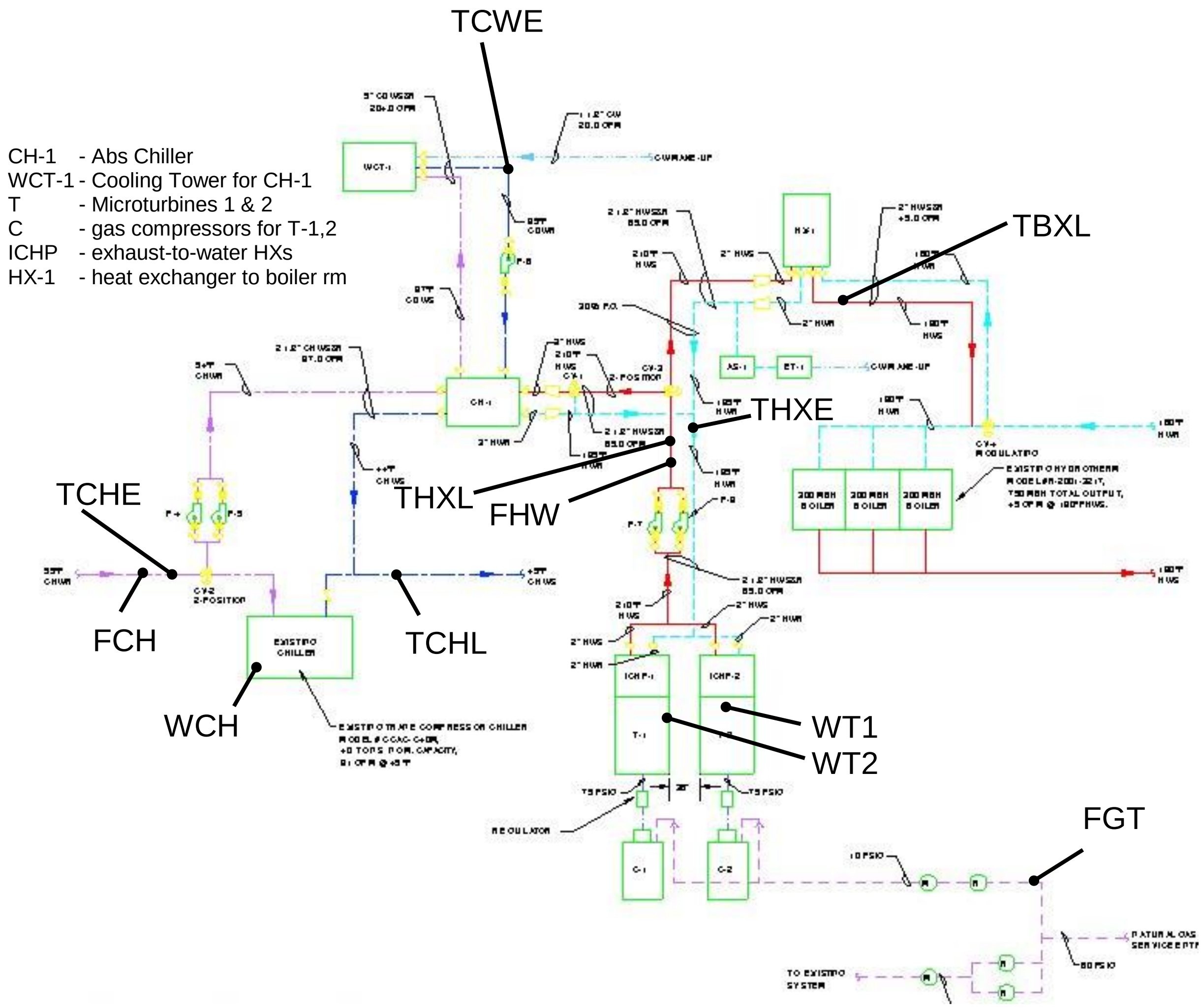


Figure 2. System Schematic Showing Sensor Locations in EXAMPLE CHP System

The electrical output of the microturbines (**WT1 & WT2**) will be measured with a MODBUS power transducer than can also measure volts, amps and true power for each phase (Objectives 1 & 7). The gas input to the turbines (**FGT**) will be measured by a single gas meter with pulse output (supplied by local utility) (Objective 1). The parasitic power use of the DC-powered gas compressors will be captured in the turbine power (so a separate power transducer is no longer needed) (Objective 2). A valve status sensor (**SHV**) will determine when the heat recovery output is going to the boiler load or to the chiller (Objectives 4, 6 & 8). The runtimes of the absorption chiller, constant-speed tower fans, and heat recovery pump will also be monitored (**SCH, SCT, SHP**) (Objectives 2 & 8).

The thermal output from the heat recovery unit will be determined from the flow and temperature difference (**FHW, THXL, THXE**) (Objectives 4 & 9). The data logger will integrate these readings every 10 seconds to determine the thermal output. We will also measure the temperature of the hot water supplied to the boiler loop after the boiler HX (**TBXL**) to determine how effectively the heat is being transferred into the boiler loop (Objective 8 & 9). Total gas use for the building (**FGB**) will be continuously monitored to provide an indication of how much boiler gas use is displaced by heat recovery (Objective 5).

The output of the total chiller system (electric and absorption) will be measured (**FCH, TCHL, TCHE**) along with the condenser water temperature (**TCWE**) entering the absorption chiller (Objectives 4, 5 & 9). This data will allow us to confirm that the COP and capacity of the chiller is consistent with the manufacturer's performance specifications. Absorption chiller and cooling tower parasitic power will also be determined by combining one-time power measurements (**WABS, WCTF, WCTP**) with the continuously recorded component runtimes (**SCH, SCT, SHP**) (Objective 2). The total power for the electric chiller (**WCH**) will be continuously monitored with a power transducer (Objective 5).

Table 5. One-Time Measured Data Collected for EXAMPLE CHP System

Name	Description	Eng Units	Sensor Type
WCH	ABS Chiller Parasitic Power	kWh	Handheld Pwr Meter
SCT	Cooling Tower Fan Power	kWh	Handheld Pwr Meter
SHP	Heat Exchanger Pump Power	kWh	Handheld Pwr Meter

Communications, Data Retrieval Procedures, and Web Presentation

Communications with the monitoring system can range from manual data retrieval to fully automated broadband connections that allow for real-time (or near real-time) display of measured values on a web page. The type of communication link needed for a project depends on:

- the type of DG/CHP equipment,
- how the system is operated, maintained, or dispatched, and
- the reporting needs for monitoring.

Strictly speaking, it might be fully rational to provide a complex monitoring system with no communications capability if on-site staff are available to operate/maintain the system and to periodically transfer monitored data from a computer to a CD or memory stick. Conversely, a very simple monitoring system may require a direct broadband connection if system operation were critical and responsible personnel were remotely located. NYSERDA's DG/CHP sites are generally encouraged to have some form of communication connection so that system status and periodic reporting can be provided on the web.

Table 6. Communications Options for Data Retrieval and Monitoring

Type of Communications for Data Collection	Description / Example
None / Manual download	Data is manually downloaded or transferred to a CD or memory stick on a periodic basis (monthly, weekly, daily).
Phone	Data are automatically (or manually) retrieved via phone-modem link using dedicated software. Data retrieval rates can be hourly, daily, weekly or monthly.
Broadband	A DSL or Ethernet connection allows continuous automated data retrieval. The operating state and performance of the DG/CHP system can be displayed in real or near-real time. A web connection can be established directly with the unit controller or via an intermediate server capable of aggregating data from many sites.

The system that displays DG/CHP operating data and performance history on the web can be implemented with a variety of communications options. The key question is whether the web site is intended to present a real time snapshot of system operation (such as Figure 3 and Figure 4) or present a higher-level summary of recent and historic performance (Figure 5). Real time control and monitoring of the DG/CHP system clearly require a DSL or Ethernet connection (though an phone-modem connection polled hourly can approach real time functionality). Requirements for monitoring alone can be less stringent so that a phone-modem connection is sufficient. The choice of the communications option is often driven by the cost or difficulty of providing either a phone or broadband connection in the facility.

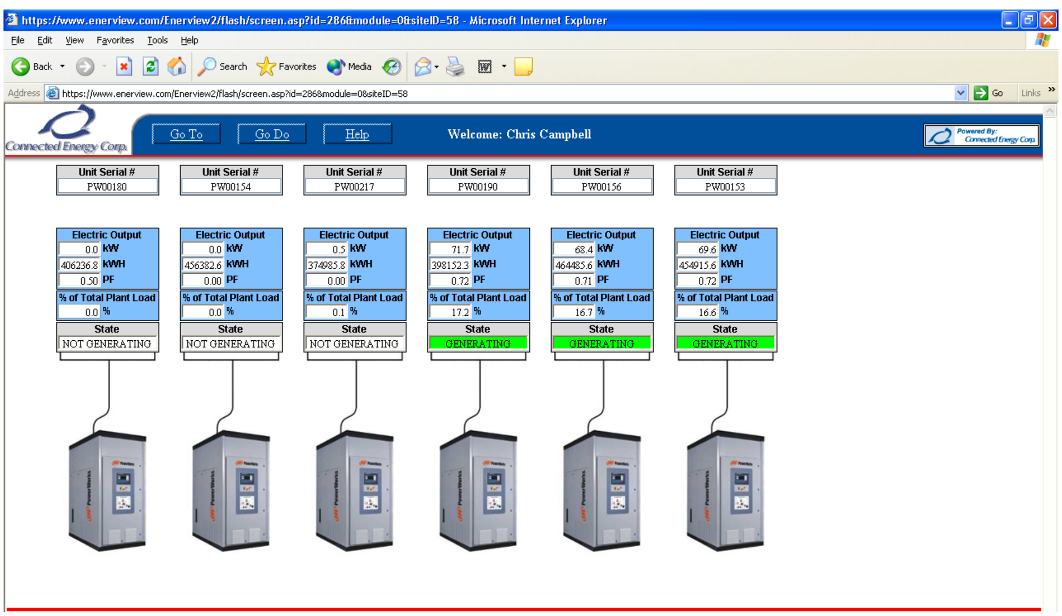


Figure 3. Example of a Real time Web Page Showing System Status (Served from Intermediate Site)

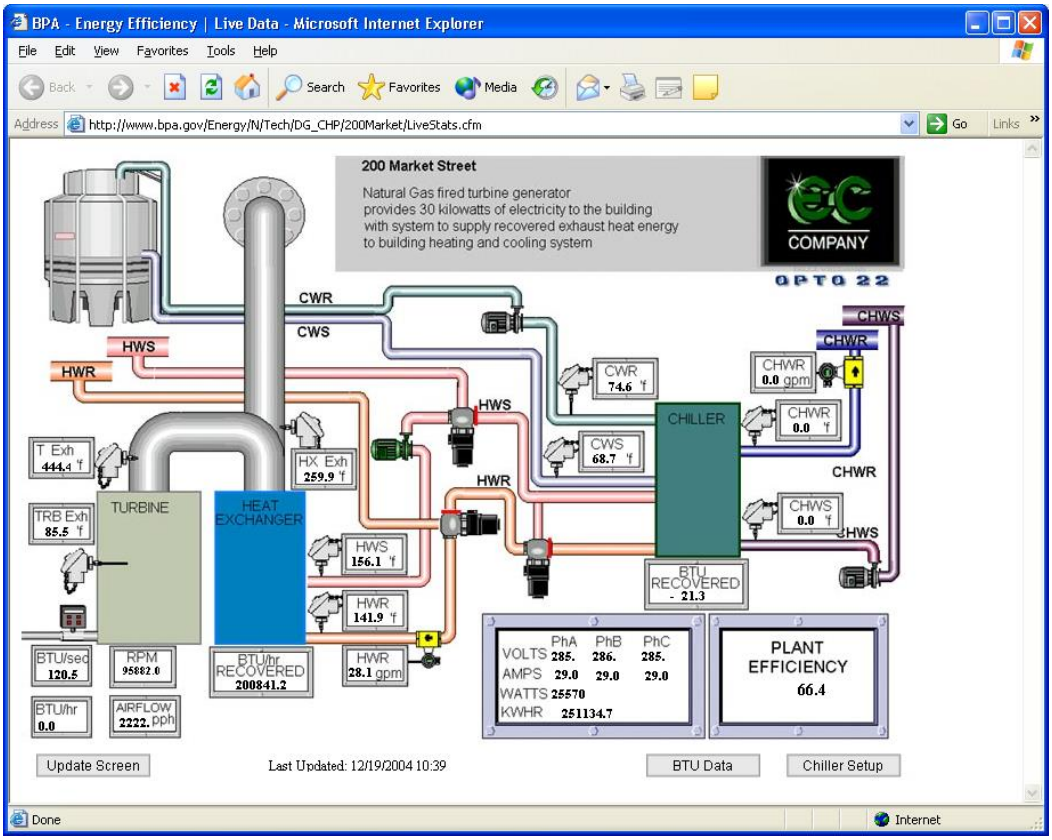


Figure 4. Example of a Real time Web Page Showing System Status (Served by Site-level PLC/computer)

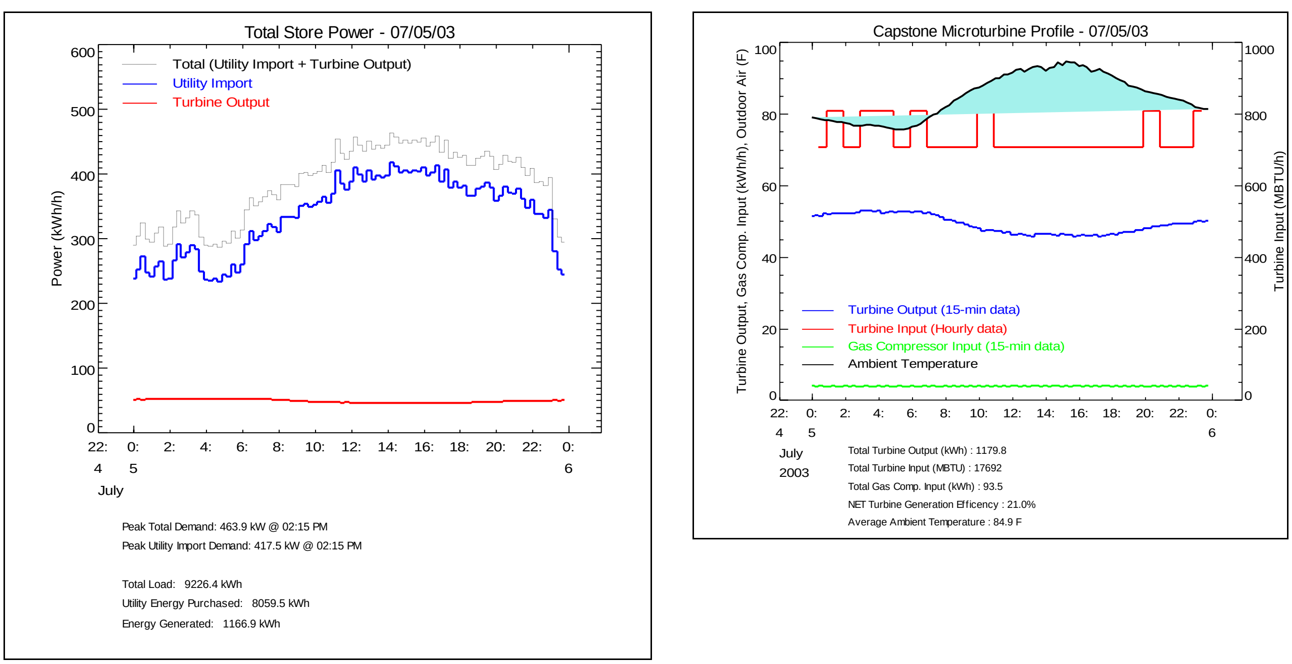


Figure 5. Example of a Web Page Showing Recent System Performance (Served from an Intermediate Site)

The frequency of data retrieval from a monitoring system can vary based on the project needs. For monitoring systems with a broadband connection, data retrieval rates can take place every few seconds. For phone-modem systems, data retrieval can take place as quickly as once every hour.

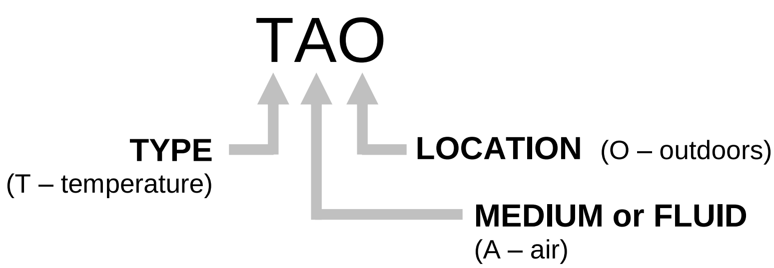
Even more important than the rate of data retrieval is the need for a robust system for archiving and capturing all the data regardless of the communications status. Data loggers generally are most robust at this task since data logging and recording is the highest priority function (i.e., data logging continues even when communications with the remote host are taking place). Even if the communication connection is lost, the on-board memory can continue to record data for several days or weeks until communications are reestablished. PLCs (programmable logic controllers) are at the other end of the spectrum since they can only save the most recent readings and a loss of communications typically results in a loss of data.

A robust monitoring system must place as much emphasis on reliably storing the collected data in the local controller as it does on the real time display of those values.

Attachment No. 1 to Appendix A-2
Suggested Convention for Naming Data Points or Tags in a Monitoring System

An important but often overlooked aspect of developing a monitoring system is to select rational and easily-understood naming conventions for each data point. Consistent naming helps communications within the project team as well as with outside entities. The following is one possible convention.

Each data point should be named according a hierarchy, for instance:



Suggested designations for the type, medium, or location are given in the table below. One or more letters can be used for each designation. The actual letter designations can change based on project needs and preferences. The important aspect is the hierarchy of the naming convention. Each site or monitoring entity is encouraged to develop and use their own consistent naming conventions.

Data Point "TYPE"	Data Point "MEDIUM"	Data Point "LOCATION"
T – temperature	A – air	O – outdoor
P – pressure	G – gas (natural)	I – indoor
RH – relative humidity	CH – chilled water	E – entering
W – Power (watts/watt-hr)	CW – cooling water	L – leaving
F – flow	HW – hot water	
S – status/runtime	CT – cooling tower	
V – volts	B – boiler	
I – current/amps		
HZ - frequency		

Examples

TCHL: temperature – chilled water – leaving
TBXL: temperature – boiler heat exchanger – leaving
WT1: watts/power – turbine #1
FGT: flow – gas – turbines
FCH: flow – chilled water
VAT1: volts – phase A – turbine 1