Combined Heat and Power (CHP)

A Guide to Submitting CHP Applications for Incentives in Massachusetts

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Disclaimer: *Please acquire and review the latest version of this document before submitting a project for pre-approval of an incentive.*

Ongoing consultation with the applicable Program Administrator during development of a project is essential to maximize the chances for receiving an incentive. There may be circumstances where additional requirements are necessary for the customer to receive an incentive. Similarly, there may be projects where some of the requirements listed herein can be waived by the Program Administrator. Please note that for the reasons discussed within the document, an incentive pre-approval letter should be received prior to initiating the purchase of a CHP system. Projects which proceed prior to receiving an incentive pre-approval letter may be disqualified from receiving an incentive.

Cape Light Compact

EVERSOURCE

nationalgrid

Unitil

mass save
Savings through energy efficiency

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Purpose of this Guide

The purpose of this document is to describe Massachusetts' Combined Heat and Power Program (CHP) initiative including available incentives, the application process, requirements for post-installation assessment and regulatory evaluations. Complying with the recommendations of this Guide will increase the likelihood that a CHP project is eligible for incentives from Massachusetts' Program Administrators (PAs).

The incentive levels for successful CHP projects are significant. However, the application process for receiving these incentives is fairly involved in order to achieve program objectives. CHP developers and engineering consultants who are assisting customers in preparing an incentive application should familiarize themselves with the overall process. The goal of this Guide is to shorten that learning curve and encourage the installation of CHP systems in Massachusetts.

Introduction

As a result of the Massachusetts Green Communities Act of 2008, CHP projects are eligible for funding as an electric energy efficiency measure by Electric. PAs responsible for administering incentives for CHP projects in their respective service territories are:

- Cape Light Compact
- Eversource
- National Grid
- Unitil Corporation

What is CHP?

CHP is the simultaneous generation of electric and thermal energy from a single fuel source such as natural gas. For example, when coupled with a generator a natural gas-fired engine produces electric energy. The engine also produces waste heat via engine exhaust gas as well as heat rejected through the radiator to keep the engine and the lubricant at the optimal temperature. This normally wasted heat can be captured to produce steam or hot water for space heating, domestic hot water, or manufacturing processes. The steam or hot water produced by the CHP unit will lower the amount of fuel otherwise used in the facility's boiler for these end uses. The overall efficiency of a CHP system can be as high as 80-85%, exceeding the efficiency of power generation, transmission and distribution system of a central power plant (typically 40 to 45% electric efficiency) combined with on-site production of thermal energy.

The increased efficiency of CHP mostly leads to a lower carbon footprint because of reduced greenhouse gas emissions.

Other significant benefits of the CHP system may include standby power capability at the facility and better control of power factor, depending on type of generator and controls used

in the CHP system. If these capabilities are of interest, discuss options and costs with your CHP supplier.

In addition, federal, state and electric energy efficiency program incentives for CHP systems can significantly improve project economics.

Successful CHP Projects

In order to derive the maximum benefit from a CHP installation, thermal energy generated by the CHP unit should be fully utilized by the host facility. The best CHP applications are facilities with high annual hours of operation and continuous thermal load. Facilities in which electrical and thermal loads coincide to a large degree are ideal.

Examples of such applications include industrial processes that need heat and electricity during the same time period (particularly those with 24/7 operation), and commercial applications such as hotels, hospitals, nursing homes, schools, colleges, laundries, health facilities, assisted living facilities and multi-unit apartments. Round-the-clock thermal and electrical loads are of key importance in allowing a return on the CHP capital investment within an acceptable amount of time.

Thermal Load is Key

Even the best CHP application marginally passes the Benefit Cost Ratio (BCR) test and requires rigorous examination to determine whether it meets the necessary requirements for receiving an incentive.

A successful CHP project typically utilizes nearly all of the thermal energy being produced by the system and uses a prime mover with an attractive heat rate and with minimal parasitic load (less than or equal to 5%). CHP projects with substantial thermal dumping of the load, high parasitic requirements, and few thermal following run hours are far less likely to achieve an acceptable BCR.

Use of thermal storage (especially for domestic hot water) to more evenly spread the thermal load over a greater numbers of hours may boost the BCR and increase the chances for being awarded an incentive. A reciprocating engine genset installation in which the electric and thermal outputs of the system can be utilized simultaneously within the facility for at least 5,000 hours per year has a good chance of satisfying the BCR test. There are projects with more than 5,000 hours that have failed the test due to excessive thermal dumping, resulting in less efficient operation, while other ones have passed with fewer than 5,000 hours, due to better overall efficiency.

Projects using small combustion turbines or microturbines usually require substantially more than 5,000 hours, since these systems are more typically more expensive than reciprocating engines and have a lower electrical efficiency. However, maintenance costs are typically lower for turbines than reciprocating engines which provide some offset to the higher installed cost and lower turbine electrical efficiency.

It is unlikely that a building with minimal summertime thermal use would pass the BCR test as it would not have enough run hours to justify the capital expenditure.

Care should be taken not to propose an oversized system. An oversized system will cost more to install than a properly sized system and will result in a reduced number of equivalent full load operating hours compared to a correctly sized system. This will substantially reduce the likelihood of the project going forward (and will also reduce the likelihood of passing the BCR test) since the over-sized unit presents more financial risk.

Typical CHP System Types

The table below compares different CHP prime mover types and feasibility considerations. These are general comments which an application with special circumstances may disprove.

Prime Mover	Prospect	Remarks
Reciprocating engine generator	More Likely	Requires gas, i.e. natural, propane or landfill or #2-fuel oil. Highest electric conversion efficiency; lower installed cost; higher maintenance cost. Life expectancy is greater for larger units.
Gas turbine generator	Less Likely	Requires gas, i.e. natural, propane, landfill or #2-fuel oil. Higher installed cost but lower maintenance cost. Booster compressor increases parasitic load which reduces net CHP kWh production. Potential use of a duct burner for increased thermal efficiency and thermal production.
Microturbine generator	Less Likely	Requires gas, i.e. natural, propane or landfill. Booster compressor increases parasitic load which reduces net CHP kWh production; higher installed cost but lower maintenance cost.
Back pressure (BP) steam turbine	Most Likely	Applicable only in high pressure steam systems. Steam systems using pressure reducing valves with significant flow and pressure drop should consider BP turbines. Lowest installed cost as boiler is usually in place. No or minor emissions permit required. Lower maintenance cost.
Fuel cell with thermal output	Least Likely	Requires gas, i.e. natural, propane or landfill. Least efficient; low grade waste heat is available; high equipment cost.

*Note: Fuel Cells that produce electric **only** are not qualified as CHP and therefore the discussion of CHP incentive consideration in these pages does not apply.*

CHP Program Description

Equipment Eligible for CHP Funding

Generally, equipment qualifying for CHP incentives include reciprocating engines, gas turbines (also called combustion turbines), and back pressure steam turbines. A CHP system can use any type of fuel.

Retrofit and New Construction

It is important to note that for the purposes of receiving an incentive under this program, a CHP system must directly produce electricity and not simply offset the use of electricity. An example of equipment that would not qualify is a gas-fired engine directly coupled to a compressor, which indirectly reduces electricity by reducing or eliminating the use of a motor to drive that compressor. The application for an incentive requires submission of a filled-out Retrofit or New Construction Application form

CHP equipment is required to have an annual combined electric and thermal efficiency equal to or greater than 60% with fuel input being expressed on a higher heating value (HHV) basis. High system efficiency is encouraged in order to shorten payback period, increase societal benefits, and improve the BCR for incentive eligibility discussed below.

a. Electrical Efficiency = $kW_{nameplate}$ X 3,412 Btu/kWh ÷ Fuel Input $(Btu/Hr)_{HHV}$
b. Thermal Efficiency = Btu/Hr useful thermal energy ÷ Fuel Input $(Btu/Hr)_{HHV}$
c. Combined Efficiency = a + b
   If an absorber is used for waste heat utilization, consider the chilled water produces as the useful thermal energy

Please note that many CHP engine manufacturers list their rated natural gas fuel input on a lower heating value (LHV) basis. For natural gas, HHV Fuel Input = 1.1 LHV Fuel Input. Other fuel types have different conversion factors.

In order to qualify for Federal Tax Credits and Federal Grants[1], a proposed CHP system has to have a minimum 60% annual combined electric and thermal efficiency with fuel input expressed on a HHV basis.

Other Eligible CHP System Applications

CHP System Replacement or Expansion Having Received an Incentive: Replacement of an existing operable CHP system with remaining measure life or a capacity expansion of an existing CHP system with a remaining measure life may be eligible for incentives. Provided the proposed system passes the BCR test, the incentive calculation will be based on the following steps:

a. Determine the salvage value of the existing unit;

[1] The applicant, not the PA, is solely responsible to determine applicable requirements pertaining to tax credits, grants, latest rules and regulations. These credits expire Dec. 2016 unless Congress changes the current regulations

b. Determine the cost of installing the new unit;
c. Determine the incremental cost (cost of installing the new unit minus salvage value of the existing unit);
d. Determine the incremental annual kWh generation, incremental kW during winter and summer peak and off-peak periods[2], incremental thermal savings, and incremental fuel usage;
e. Submit information for PA to run BCR model;
f. Incentive will be paid on the new unit based on as outlined later in this guidebook **minus** any incentive paid for the original unit

Replacement of "End of Life" CHP System: Customers with an existing CHP system exceeding the accepted measure life, listed in the table below, and has not received an energy efficiency program incentive for the existing unit may be eligible for incentives. Provide the following:

a. Describe the base case scenario, i.e. typically a non-operating CHP system;
b. Quantify the base case cost of the necessary mechanical and electrical system infrastructure upgrades to meet the facility electric and thermal needs if the current CHP becomes non-operational;
c. For the proposed case, quantify the cost of the CHP system and follow the New Construction Custom Measure Application Process documentation requirements and provide all information

Replacement of prime mover with same size prime mover but with higher electrical efficiency: If the existing CHP that was incentivized under the EE program is replaced with an engine with higher electrical efficiency, the project will consider the gas savings under custom gas project for the remaining measure life for the original project (no electrical savings) and the rest of the measure life of CHP for electrical savings under the CHP project guide lines. Two separate applications will be required in this case. One for gas savings and the other for electrical savings.

Replacement of de-commissioned CHP plant but was in service for less than measure life: If the plant is more than 2 years out of service, the replacement plant will be considered under as a new construction project.

Rebuilding of a plant that was mothballed for more than 2 years: This project can be considered as a new construction CHP project, but the measure life will be determined by the useful life of the remaining components.

[2] Winter and summer peak and off-peak periods as defined in the Custom Application form

CHP System Measure Life[3]	
Technology	**Years**
Fuel Cell *	5
Combustion Gas Turbine	17
IC Small <= 200 KW*	17
IC Large > 200 KW*	20
Micro Turbine	15
Steam Turbine	25

* Size of individual prime-mover, not the overall system. For example, a project -with three 75kW internal combustion engines should be assigned a seventeen-year measure life for small systems. Fuel Cell installation may consider a longer measure life for projects with a long term maintenance contract that includes cell replacement as required to claimed measure life.

Qualifying Criteria

Following is a discussion of the kinds of issues that should be considered during initial planning stages for a CHP project.

Benefit/Cost Analysis: The CHP equipment must undergo a Benefit/Cost Analysis utilizing a methodology prescribed by the Department of Public Utilities (DPU). This methodology considers:

a. The net power (kW) output of the CHP system (net of any incremental parasitic load to operate the CHP system's auxiliary equipment),
b. Annual net kWh generated,
c. Installed cost of the equipment,
d. Ongoing annual maintenance costs,
e. Quantity of fuel and type of fuel being fired in the CHP system as well as fuel displaced by the CHP system,
f. Timing of the power production, such as winter/summer and peak versus off-peak as defined in the Custom Project application.

Above are the inputs to the Benefit/Cost model used to determine the BCR. In order to receive incentive funding for CHP projects, the lifetime benefits must exceed the lifetime cost. In other words, the BCR must be greater than or equal to 1.0.

Benefit/Cost Analysis vs. ROI /Payback: It is important to understand that the BCR model used to determine whether a project is eligible for incentive funding is a different methodology than the analysis a customer would perform to determine whether project economics are attractive enough to move forward. Some of the key differences are as follows:

[3] CHP System Measure Life includes balance of plant, i.e. equipment required to enable the recovery and use of waste heat.

a. The BCR model utilizes marginal values of fuel and electricity as well as the value of deferred transmission and distribution. Also, the value of capacity used in the BCR model is determined according to the ISO-New England Peak Period definitions.
b. In contrast, a customer's economic model will utilize retail costs for fuel and electric power. Also, a customer will consider the cost of project financing, the value of APS credits, tax credits, depreciation, value of avoided electric demand charges determined according to the periods defined in the rate tariffs (instead of the ISO-NE period definitions) etc.
c. O&M costs annualized over the life of the CHP unit are also included in the BCR calculations.

The federal Modified Accelerated Cost Recovery System corporate depreciation and Massachusetts Alternative Portfolio Standard (APS) credits are not included in the BCR inputs. Under the terms of the Green Communities Act (2009), Massachusetts retail electric companies must purchase a certain quantity of Alternative Energy Credits (AECs) per year (or make an Alternative Compliance Payment. The value of APS credit is subject to change so it is advisable to visit DOER website for current information (https://www.mass.gov/alternative-energy-portfolio-standard).

The number of credits earned by cogeneration projects is calculated as follows:

$$\#\text{Credits} = \frac{Electricity\ Generated}{0.33} + \frac{Useful\ thermal\ energy\ output}{0.80} - (\text{total fuel input to CHP}),$$

Where all quantities are expressed in MWh

APS Credit Example		
Electrical Efficiency	36	%
Thermal Efficiency	35	%
Annual EFL Hours	7,000	
Unit Size	500	kW
APS Credit (estimated at)	2	$ per MWh
Credit per Year Calculation		
Electrical Generation per year divide by 0.33	10,606	MWh
Therms Utilized per year divided by 0.80	4,253	MWh
Fuel In per year	9,722	MWh
MWh for Credit	5,137	MWh
APS Credit per year	10,274	$
APS Credit per kWh based on above assumptions	0.29	Cents per kWh

As there are differences in the economic modeling methodology between the two perspectives, a CHP project may make economic sense for the customer, but fail the BCR test and therefore not be eligible for an incentive.

Determining CHP System Cost: The total cost paid for the CHP system, subtracting any federal credits or grants, but not subtracting any MA-related program funding, shall be used as the input into the BCR model. Qualifying ***Federal Tax Credits and Federal Grants*** which effectively reduce the installed cost of the CHP system are allowed to be included as a reduction in installed cost of the CHP system for the purpose of calculating BCR. Sufficient documentation will need to be provided for the availability of these grants or tax credits to the extent consideration of these grants and tax credits are essential to achieving the required BCR. Federal regulations change over time so please check for current regulations before making any assumptions. (https://programs.dsireusa.org/system/program/detail/676)

When providing the PA with the total cost of the system, a breakdown of overall installed cost, equipment cost, and federal tax credits/federal grants should be provided.[4] Providing this level of detail is advantageous to the applicant as some of the listed costs may not necessarily be attributable to the incremental costs of the CHP project. Any costs related to load shifting controls, facilitate exporting of power, etc. which are not associated with the generation of power and utilization of heat for the CHP projects should not be included in the project cost. This will allow the PA to work with the applicant to exclude those costs which are not directly part of the CHP system. This could enhance the likelihood that the project BCR is greater than or equal to 1.0.

Tax credits and grants, etc., which are specific to Massachusetts are not permitted to be included in a reduction of installed cost for purposes of the BCR analysis. For example, the value of a customer's participation in the Massachusetts Alternative Portfolio Standard, i.e. sale of Alternative Energy Certificates, cannot be used to reduce customer costs for the purposes of the BCR analysis.

Maintenance Contract: CHP systems eligible for an incentive must have in place a maintenance agreement covering a minimum of (3) three years.

Wider Facility Energy Efficiency: A building or process materially lacking in implementation of cost-effective energy efficiency measures may be ineligible to receive any CHP incentive payment. Specific requirements shall be determined by the applicable Program Administrator.

Note that on average, non-CHP energy efficiency measures such as upgrading lighting and HVAC equipment have a higher BCR or lower payback period than CHP and should be implemented as the first choice. This is especially significant given that interactions may exist between other building energy efficiency measures and operation of the CHP system. For instance, replacing an older boiler with a more efficient one may result a lower CHP system thermal benefit than if the existing boiler were to remain in place. Quantification of CHP benefits must consider any contemplated changes in baseline conditions. This avoids overstating the thermal efficiency benefits from a CHP project.

In general, CHP systems which are sized without taking into account available electrical and thermal energy efficiency measures may ultimately end up being oversized relative to the

[4] At a minimum, the breakdown between major components, other materials and labor costs must be provided.

eventual building electric and thermal load if standard building energy efficiency measures are implemented after a CHP system is installed. Sizing of the CHP system should consider these EE measures.

Timing of CHP System Order: Customers who have already placed an order for a CHP system may be denied an incentive offer if there is a strong likelihood they would be considered a free rider, i.e. they would have moved forward without an incentive. Customers who are relying on an incentive must defer ordering CHP equipment until a pre-approval letter has been received from their PA.

Incentive Levels

Assuming a project qualifies for a CHP incentive, as discussed in the preceding section, the specific incentive award will vary depending on the efficiency of a project and other project attributes described in more detail below. These incentives are ***not guaranteed***. Each PA will approve the incentive for the project based on their budgets and other criteria to administer their specific program efficiently.

Incentive levels are based on the annual electrical and thermal efficiency, annual electrical power generation, kW generated during the ISO co-incidental peak period and the Tier levels as described in the following sections. The incentive structure is for CHP projects that meet all program requirements under the Retrofit Program and shall consist of the implementation of CHP projects in support of an existing facility.

Payment Schedule:

80% of the incentive may be paid upon installation of the CHP system as described in the MRD and all PA interconnect requirements have been completed by the customer and, therefore, the remaining 20% of the incentive shall be paid after commissioning of the CHP system in accordance with the MRD issued by the PA. Per the requirements listed above, metered M&V data displaying the 60% annual efficiency shall be required.

Failure to meet Efficiency Expectations: If the initial plant operation indicates that the expected efficiency levels are not achieved, the project incentive will be reduced based on the new tier level during the release of the remaining 20% of the incentive. It is very important that the Minimum Requirements Document is shared with the design and construction team by the customer early on in the project cycle so that the plant performance will meet the requirement of MRD and not jeopardize the incentive expected.

New Construction

CHP systems included in qualifying new construction projects, as determined and defined by the PA, shall receive the aforementioned Tier 1 CHP incentive. At the discretion of the PA, and dependent on available PA funding, additional incentives may be considered on a case by case basis provided that:

a. significant total site energy savings (after all agreed to EE measures excluding the CHP are implemented) is expected over the base case, which is defined as a building meeting the energy efficiency requirements of the Massachusetts Building Code (or industry standard practice) at the time of the issuance of construction permit (if the MA stretch code is applicable to the CHP site then it will be considered the base code). Savings calculations for the project will use the regular building code and not the stretch code as the base line.
b. The CHP system shall have an estimated total annual efficiency **greater than 65%**.
c. The final incentive amount shall be subject to the discretion of the associated PA.

d. The incentive level shall not exceed the 75% of the incremental cost of the CHP project (heating and cooling plant).

New Construction Payment Schedule:

80% of the Tier 1 incentive shall be paid upon the installation of the system as described in the MRD and all PA interconnect requirements have been completed by the customer and, therefore, the remaining 20% of the Tier 1 incentive shall be paid after commissioning of the CHP system in accordance with the MRD. Per the requirements listed above, metered M&V data displaying the 65% annual efficiency shall be required. In the event that additional customer incentives are negotiated, the incremental incentive may be paid after all agreed upon additional EE measures have been implemented and commissioned by the agreed upon schedule.

Advanced Payment of Approved Incentive

Applicable to all incentives for new construction and retrofit projects, at the discretion of the PA the customer may receive an incentive advance of $150/kW by placing the order for the system within ninety days of receiving a pre-approval letter. The incentive advance shall be deducted from the initial 80% incentive payment. If the CHP system installation fails to meet the agreed upon schedule, then the customer shall return the incentive to the PA.

Estimated Potential Incentive

Level based on total efficiency

Level 1	Level 2	Level 3	Level 4
60-66	66-72	72-78	78+

Note: If an absorber is used for waste heat utilization, consider the chilled water BTUs produced as the useful thermal energy. The BTU's going into the absorber should not be used as useful thermal energy.

Tiering by prior usage reductions

Tier 1: No energy efficiency work

Tier 2: 5% of site total electric usage reduced prior to CHP installation, based on highest use year in the past 5 years (can include current projects in the works)

	Available Incentive per Annual kWh Saved			
Level	L1	L2	L3	L4
Tier 1	.075	.09	.11	.13
Tier 2	.85	.10	.12	.14

*Benefits of the CHP system are maximized during ISO Peak hours and the incentive can be affected if the unit is not modeled to produce kW reduction during summer months.

Interconnection Approval

Timing is critical when trying to install a CHP project especially on the interconnect side. With a huge inundation of Solar projects, the Distributed Generation (DG) on the utility feeders has been significantly increased triggering upgrades in our substations and distribution lines sooner than in past years. When an application is submitted, a snapshot of current DG and proposed DG already submitted on the feeder are collected. The impact of this new CHP project is then evaluated to the worst case scenario, including minimum loading and maximum loading. It is determined how the DG interacts at those load points on the feeder and the protections needed to protect the utility grid system.

Process summary:

- Application is submitted and evaluated to ensure correct documentation is given.
- Application captures current and future DG on the feeder and is summarized with rule of thumb checks at a high level and determines if a further study is required.
- If an Impact study is required, this study determines what protections are necessary to protect the grid utility system from this new CHP and potential hazards caused by this unit. Upgrade costs and scheduling are also returned with that report.

- An Interconnect Service Agreement (ISA) is signed, stating the cost and protections required and operationally how the utility and the customer will interact.
- Distribution Design is started after first payment is collected.
- Construction is started after Design is complete and second payment is received.
- Once construction is complete and customer is ready with all the required documentation; a witness test is scheduled to ensure all the protection schemes were implemented. (Witness test is a time when utility completes an on-site test of the protection scheme, as agreed in the ISA).
- Once all protections are tested and verified, authorization to Interconnect is issued.

One other item to note is that once the ISA is signed and if a phone line is required, it is critical to begin the phone line process as soon as possible. Get agreement from the phone line folks that their process is started and an order is being processed. Keep tabs on this process throughout the construction phase.

Please note that approval of an incentive payment for CHP shall not constitute approval of a project's utility interconnection. There is a separate application process for receiving approval to interconnect a CHP system with the local electric utility. Please contact the interconnection department of your distribution company to learn how to apply for interconnection. Attachment 4 lists the links to the various utilities for the interconnection process. Often there are significant costs associated with interconnection studies and implementation of the upgrades necessary to interconnect with the utility infrastructure. Also the time required to obtain the interconnection approval from the local utility could be significant and should be considered during the planning process for the project.

Electric utilities conduct Distributed Generation Interconnection seminars several times a year. The following link is provided for dates of previous and upcoming seminars and presentations.
https://ngus.force.com/s/article/MA-Seminars

CHP Incentive Application Process

Early Engagement with the Program Administrator

It is highly recommended that the customer establish a dialogue with the PA during the early stages of developing a CHP project. By doing so, feedback can be given to the customer in the early stages of the development process regarding the likely cost-effectiveness of the proposed project. If one or more configurations for a CHP are NOT going to meet the minimum criteria for an incentive, it's best for everyone involved to receive early feedback on this result.

A critical path item that should be determined early in the process is to affirm that the electric utility circuit is compatible with a CHP project, i.e. not on an area network. Please note that a circuit compatibility check is not the same as receiving approval to interconnect a CHP project with the electric utility. Please contact the applicable electric account executive to determine compatibility. Since the electric utility interconnection

application process and installation may be time consuming and costly, in the early project development stage please contact the applicable electric utility account executive.

For systems firing natural gas, confirmation should be received from the gas account executive that sufficient gas volume and pressure is available to supply a facility's total gas requirements for the proposed CHP system and other existing or new gas equipment and appliances. Some early study work may be necessary to determine the range of systems being considered and the gas firing rate for each CHP option under consideration. Find your gas provider using the map and contract your provider for details (https://docs.digital.mass.gov/dataset/massgis-data-public-utility-service-providers)

Authorization to Share Customer Data

Because there are usually multiple parties involved in the analysis and implementation of a CHP system, it is essential for a customer to give permission to share data with third parties involved in the development of the project. Attachments 5 and 6 allow the customer to grant permission for the utility or third party energy suppliers to share electrical data with third parties. Please consult with your natural gas utility representative to determine if gas interval data is available and how to obtain it.

CHP Application Form

Applications for CHP incentives are submitted using the Custom Application form:

- For Retrofit projects: Retrofit
- For New Construction Projects: New Construction

The following clarifications might be helpful:

Page 1 of the application seeks information from the customer and requires the customer's signature. Please note that the customer is defined as the entity responsible for paying the electric utility bill and whose name is on the electric bills with the listed account number. In some cases, the customer may not actually own the CHP equipment. For example, the equipment may be owned by a third party and the customer simply purchases the electric and thermal output from the system. The customer may receive the incentive payment directly either in the form of a check or a credit on their electric bill or may choose to assign the incentive payment to the vendor who is installing the CHP system. The entity receiving the incentive payment, i.e. customer or vendor, shall list their Tax ID number on this sheet.

Page 4 of the application summarizes the key information needed by the PA to perform a BCR analysis.

> *Table 1* of the form requests a summary of electric energy (kWh) and demand reductions (kW) according to the time periods defined in the notes below the table. Note that these peak and off-peak periods are different from those defined in a customer's rate tariff.

Table 2 requests cost information for the project. Most projects will involve a new CHP system installation at an existing facility, in which case the cost is defined as the total installation cost of the CHP system including any balance of plant work directly associated with the CHP installation.

If a project involves a new building or facility in which CHP is part of the proposed construction, consult with your PA to determine the details of how to develop costs associated with a "baseline" case.

Table 3 requests information pertaining to Non-Electric Benefits. Since CHP usually trades additional fuel costs for electricity, fuel and O&M costs will be a net cost *increase* rather than a net benefit and should therefore be entered as negative values.

For example, the MMBtu impact in this table would be:

Boiler fuel savings - CHP system fuel consumption, where

Annual boiler fuel savings = annual thermal energy displaced by the CHP system ÷ existing boiler efficiency

Page 5 of the application is the Minimum Requirements Document -see Attachment 7 Sample Minimum Requirements Document for CHP Projects.

Hourly Simulation: As electric and thermal loads for most facilities vary both daily and seasonally, it is essential that a simulation be conducted to project CHP system performance for each hour of the year. Attachment 3 describes the level of data detail that must be included in the Custom Application. At least one year of electric and heating fuel data is required in order to create this simulation.

The simulation model supporting this data will also need to be provided with the application.

Electricity Data: Electric interval data is available from the PA for time of use customers to use in establishing the baseline conditions. The data is available in either 15 minute or hourly increments. Attachment 4 is a standard request form for electric interval data. This data can be adjusted as necessary for weather normalization and/or other possible load changes such as improvements in building energy efficiency, planned process expansions, etc.

Gas Interval Data: In some instances, gas interval data may also be available to provide assistance in establishing the quantity and profile of gas being consumed for the facility prior to the installation of a CHP system. Please consult with your natural gas utility representative to determine if gas interval data is available and how to obtain it.

In some cases additional analysis will be necessary if, for example, fuel data includes other loads which will *not* be offset by the thermal output of a CHP system. The applicable PA will review the methodology for estimating thermal loads which can be offset by a CHP system, and will determine whether it is acceptable. Generally, pre-installation thermal

metering will be required on larger systems. For smaller systems, engineering estimation methodology may be acceptable in lieu of pre-installation thermal metering.

Columns A and B in Attachment 3 represent the purchased electricity and fuel to meet the facility loads pre-CHP. This is also referred to as the baseline conditions.

Columns C and D describe the facility's requirement for useful thermal energy (steam and hot water). As mentioned above, it may be necessary to adjust these values if building energy efficiency measures are envisioned. Weather normalization of these loads will be required.

Columns E to N describe the performance of the CHP system and the incremental impact that operation of the system will have on electric and thermal loads in the facility.

Columns O and P describe purchased electric and fuel requirements following completion of the CHP system. In this example, this CHP system produces both hot water and steam. Many applications will produce only one or the other.

In projects where some of the CHP system's thermal output drives an absorption chiller, additional columns will be needed to show how this impacts the electric chiller's kW and kWh consumption.

Typical Approval Path

Attachment 1 is a flow chart describing the approval path for a CHP incentive.

Note: If desired, a list of CHP suppliers and engineering consultants can be provided by the PA. Contact your PA for more information.

A CHP custom application can be submitted whether or not a specific developer or piece of equipment has been chosen. For example, if a customer has engaged an engineer who is studying the feasibility of a CHP system, referred to as a "CHP Technical Assessment," the study itself could provide enough information to allow the PA to offer a CHP incentive, providing the study deliverables include the information requested herein, and the project meets all qualifying requirements. The level of detail required in the application implies that a detailed equipment specification has been developed to the point where equipment quotes can be obtained, and these in turn are necessary to determine costs, benefits, and BCR. This approach can be taken if, for example, the customer desires to receive a commitment from the PA regarding the availability of funding before spending additional time and resources to obtain detailed engineering design.

Similarly, a CHP incentive offer can be made and a contract signed whether or not a specific piece of equipment has been selected, as long as the project passes the BCR test and a Minimum Requirements Document has been completed and accepted by the PA.

Minimum Requirements Document (MRD): The MRD will accompany the Incentive Pre-Approval package. This document is developed in consultation with the PA and cites specific system attributes and performance. In general the MRD is written around a fairly rigorous

system specification. As long as the eventual project design and operation is in compliance with the MRD, no additional approvals are necessary. Please request the latest copy of a sample MRD from your PA. In general the MRD is a more detailed version of the information requested in Page 5 of the Custom Application Form.

There is a downside to writing an MRD around a particular manufacturer's CHP system, as the CHP pre-approval offer may lock the customer into actually installing that system. If the customer later issues a request for proposals, and the successful bidder's system is not in compliance with the MRD, it may be necessary to reapply. There's also a risk that a different system may not satisfy the benefit/cost ratio. In general the MRD should avoid being tied to a specific manufacturer and model of equipment unless the customer is sure of the system that will be installed.

Allocation of Energy Benefits

Other than the energy cost savings realized by the Customer, the PA is entitled to 100% of the benefits and rights associated with the CHP installation. This is described in Section 19 of the Terms and Conditions of the Custom Application form.

However, upon request the PA may waive rights to pursue and retain APS Generation Attributes associated with the Massachusetts Alternative Energy Portfolio Standard ("APS"). In that case the customer shall be solely responsible for all costs associated with the reporting requirements of the APS. The APS program, administered by the Commonwealth of Massachusetts, is an optional program and participation is not required to receive a CHP incentive. Please contact the Massachusetts Department of Energy Resources for more information.

Co-funding of Engineering Technical Assessments

PAs may offer partial funding for engineering feasibility studies that provide the deliverables described in Attachment 2 of the Appendix, "CHP Technical Assessments."

Co-funding of Engineering Services for CHP studies is limited to the deliverables listed in Attachment 2. Detailed design work as required to actually install the CHP system is NOT eligible for co-funding. Co-funding is usually limited to 50% of the reasonable costs of performing the study, as determined solely by the PA. Please contact your PA to request a co-payment of a Technical Assessment.

If the customer decides to install a CHP system, the entity, parent company or affiliate of that entity performing the Technical Assessment is precluded from performing detailed design or any other post-feasibility engineering work on the CHP system and non-CHP energy efficiency measures.

A more limited scope for co-funding of engineering services may be approved under certain circumstances. An example of this would be services to obtain metered data on existing loads, in order to more accurately establish the thermal load profile which may be available for offset by a CHP system.

Engineering Firms Contracted to Perform Technical Reviews for Program Administrators

The engineering firm (or parent, or affiliate of that engineering firm) contracted directly by the PA to perform a technical review of a third party proposal and/or study for a CHP project is precluded from seeking compensation for any CHP or other non-CHP energy efficiency work with that customer for a period of two years following the date that such firm is contracted by the PA to perform that work. Also, this two year limitation applies to the engineering firm being contracted directly by that customer as well as indirectly through an entity contracted by that customer.

Post-Installation Requirements

Installation: Installation of the CHP system must comply with all the local, state and federal requirements and satisfy the permitting requirements including but not limited to air emissions. Meters are installed, in compliance with the governing MRD – see Attachment 7.

Sample Metering/Monitoring Requirements: The following table is a general illustration of the types of hardware and information that could be collected from installed meters. This example is for a single reciprocating-engine unit providing hot water to a customer's space heating and domestic hot water systems. This may not be indicative of the requirements for more complicated systems.

Equipment	Data Gathered	Used to calculate
(Qty) Temperature Probes	Temperatures (describe)	Percentage of recovered heat that serves domestic hot water, building heat, or is rejected
BTU meter, using flow and ΔT sensors, with pulse adapter	Total BTU/hr of net heat recovery by time/date	Heat utilized for process/heating loads
Three-phase electric meter with pulse adapter	Generated electricity output by time/date	Electricity generated, system efficiency
Natural gas meter with pulse adapter	Natural gas flow rate by time-of-use	Corrected natural gas input to system
(Qty) Current Transducers	Current draw of CHP system components	Parasitic pump/fan loads

Metering Requirements: Metering/monitoring should capture 15 minute interval data for control inputs and outputs, electricity produced, and thermal energy recovered. The monitoring system should provide hourly trends for gas input and engine run hours. For larger CHP systems, collection of data for auxiliary equipment such as secondary pumps, radiator fans etc., supporting the CHP plant should also be collected. From a cost standpoint, it may not be practical to collect continuous data for all auxiliary equipment. Other means of approximating these loads, such as engineering estimates or spot measurements may be more appropriate. However, Regulatory Evaluation activities may require additional metering which surpasses what the customer might feel is essential to meet operational needs.

Monitoring and metering is an important discussion to have with the PA at the time the MRD is being developed.

During the post-installation inspection, the PA shall confirm that the data collection system is properly installed, including proper metering, calibration, reporting and archiving of data.

Post-Operational Assessment

As described in the MRD, documentation similar to that listed below should be available during commissioning and post operational assessment by the PA. The requested information will generally be limited to those items which are integral to the design and operation of the system and are produced by the installing contractor(s) and/or engineer(s) in the course of their normal activities. The listed items DO NOT need to be received prior to the PA issuing an incentive pre-approval letter. This list is typical of larger projects; smaller projects may have fewer requirements.

a. Design specifications, data sheets and O&M manuals for the following equipment:
    1. Prime mover and generator set
    2. Cooling system(s)
    3. Electric Motors and Variable Frequency Drives
    4. Heat Exchangers – Exhaust Gas, Primary Water/Hot Water
    5. Control Systems
    6. Metering and Monitoring Equipment
b. Plant layout drawings, flow and PID diagrams
c. Controls Drawings, Final Sequence of Operations programming, O&M Manuals, Instrumentation List and Datasheets
d. Demonstration of ability to provide CHP plant performance data for one hour intervals
e. Gross and Net kW output after parasitic loads are deducted
f. Fuel input to CHP system
g. Heat energy exported from CHP plant
h. Heat energy provided to process/heating system
i. Cumulative data as needed to measure seasonal and annual overall plant efficiency
j. CHP system components status
k. Any other points that are necessary to determine the net plant efficiency based on the final plant design
l. Ability to export weekly data electronically to third party during the Commissioning process
m. Provide meter calibration data and provide Testing and Balancing (“TAB”) reports for all applicable CHP equipment.

Post-Installation Evaluation

PAs are required to evaluate their energy efficiency programs to determine the percentage of predicted energy savings which are actually realized and to utilize those results to make program improvements. Typically, evaluations of such energy efficiency projects are performed on a subset of projects each year.

Due to typical facility load variations, a full (or nearly full) year of data is often needed in order to perform a meaningful evaluation. Some proposed CHP systems already include the necessary meters to gather some or all of the essential data for performing regulatory evaluations. This is especially the case when:

a. Systems are part of a performance-based contract;
b. The customer plans to participate in the APS program (most typically systems exceeding 150 kW in size), or
c. A third party will own and operate the system and sell the electric and thermal outputs to the customer.

To the extent that metering/monitoring that meets the requirements for regulatory evaluation is already included in proposed CHP systems, such metered data must be provided at no cost to the PA.

In those few instances where metered data is not being collected for all of the necessary inputs and outputs (or is of insufficient precision), then the PA may subsidize the cost of equipment and/or installation services.

Note that meters installed for evaluation purposes may only be in place temporarily and may have different specifications from those more appropriate to permanent use and/or those normally installed with a given CHP system.

Prior to the issue of a pre-approval incentive letter, the PA in consultation with a third party evaluation consultant, will discuss the specific metering requirements and determine which party is responsible for equipment and/or installation costs. This is an evolving area so specific metering requirements are not listed within the current version of this document. Please contact your PA with any questions.

Appendix

Attachment 1 – Typical CHP Approval Path

Attachment 2 – Combined Heat and Power Technical Assessments

Attachment 3 – Example of Hourly Data - Before and After CHP

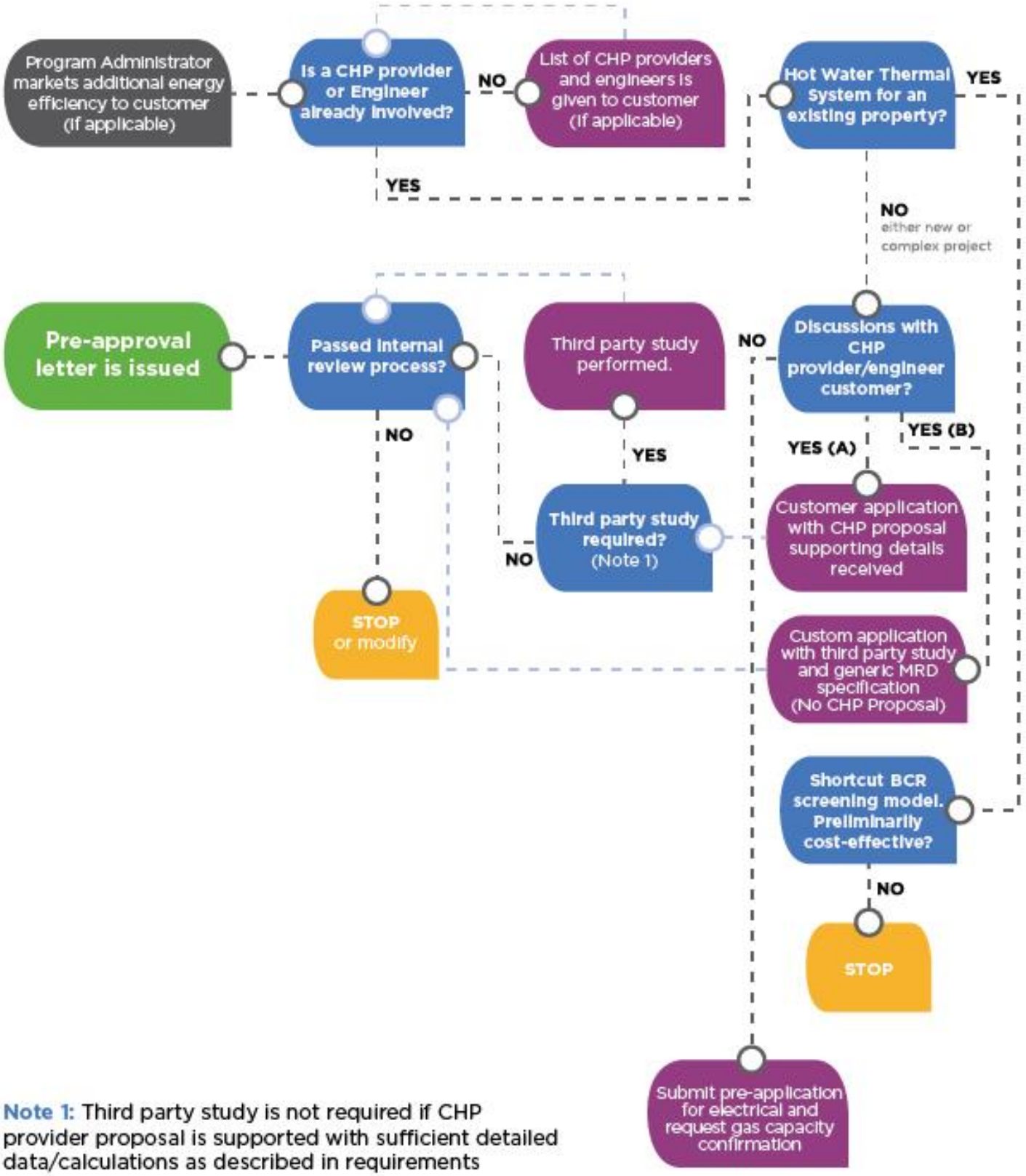
Attachment 4 – Links to Interconnection Requirements

Attachment 5 - Request for Hourly Electric Interval Data

Attachment 6 - Customer Authorization for Release of Data to Third Parties

Attachment 7 – Sample Minimum Requirements Document for CHP Projects

Attachment 1 – Typical CHP Approval Path



Note 1: Third party study is not required if CHP provider proposal is supported with sufficient detailed data/calculations as described in requirements

Attachment 2 – Combined Heat and Power Technical Assessments

The following should be included in a CHP technical assessment:

- A description of the existing facility including pertinent equipment and existing processes/loads.
- Identification of cost and estimated savings of potential building energy efficiency measurements likely to be cost-effective derived from an energy review of the building/facility.
- Description of the proposed CHP system and how it will fit into the existing building or facility process.
- CHP manufacturer's descriptions and specifications (a detailed quote is ideal).
- Estimate of parasitic loads associated with the CHP system.
- All relevant electric and fuel data including consumption and billing information
- Hourly or daily data for existing thermal loads to the extent feasible (or data estimated by alternative means). The more accurate and detailed this information, the better.
- Confirmation of available gas supply and pressure requirements.
- A draft Minimum Requirements Document for the proposed CHP system and sequence of operations (obtain sample MRD from the PA and work with them to tailor it to a specific project).
- Description of methodology used to estimate the expected performance of the CHP system including a list of all assumptions and support of such assumptions.
- Hourly model showing the expected performance of the CHP system
- Profile showing facility kWh, kW, and thermal needs prior to and after the installation of a CHP system summarized monthly and annually according to peak- and off-peak periods.
- Detailed cost estimates for the CHP system for installation, commissioning, operation, routine and major maintenance.
- Customer financial analysis considering all variables which impact economics.
- Completed custom application form (ready for a customer's signature).

Attachment 3 – Example of Hourly Data – Before and After CHP

Figure 4

CHP Incentive Application - Hourly Summary Detail to be included with Custom Application (Note 1)

Note 1: Include excel model showing all assumptions and formulas which produces this summary.

			Total Facility Pre-CHP				CHP System										Total Facility Post CHP	
			A	B	C	D	E	F	G	H	I = G - H	J	K	L = J - K	M = (H + K)/Boiler Efficiency	N = E - M	O = A - F	P = B + N
Month	Day	Hour	kWh	Fuel (Btus)	Steam (Btus)	Hot Water (Btus)	Fuel Fired to CHP (Btus)	kWh produced net of parasitics	Steam Produced (Btus)	Steam Energy Used (Btus)	Steam Energy Dumped (Btus)	Hot Water Energy Produced (Btus)	Hot Water Used (Btus)	Hot Water Energy Dumped (Btus)	Boiler Fuel Saved (Btus)	Incremental Facility Fuel Increase (Btus)	kWh	Fuel (Btus)
Jan	1	1																
Jan	1	2																
Jan	1	3																
Jan	1	4																
Jan	1	5																
Jan	1	6																
Jan	1	7																
Jan	1	8																
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Jan	2	22																
Jan	2	23																
Jan	2	24																
Repeat for each hour of each day for all months																		

Attachment 4 - Links to Interconnection Requirements

Eversource

https://www.eversource.com/Content/ema-c/about/doing-business-with-us/builders-contractors/interconnections

Eversource MA Interconnection Application:
https://www.eversource.com/content/ct-c/about/about-us/doing-business-with-us/builders-contractors/interconnections/massachusetts/application-to-interconnect

National Grid

http://www.nationalgridus.com/masselectric/business/energyeff/4_interconnect.asp

https://ngus.force.com/s/

Pre-Application
Pre-applications are required for all CHP installations over 500 kw. Any interconnecting customer can request a pre-application. The pre-application report will give the customer the feeder and sub, pending and connected DG on said feeder, insight into whether there is an ASO study hold, pending system modifications, or improvement efforts that might delay interconnection.

Network Maps
Check ESB756C, Exhibit 2, for maps of the Area Networks.

- Lynn
  https://ngus.force.com/servlet/servlet.FileDownload?file=0150W00000CqjXq
- Worcester
  https://ngus.force.com/servlet/servlet.FileDownload?file=0150W00000CqjY0
- Brockton:
  https://ngus.force.com/servlet/servlet.FileDownload?file=0150W00000CqjY5

Non-Effectively Grounded Circuits
There are feeders outside the Network systems which are not effectively grounded, known as NEG Circuits. These networks will potentially require greater levels of system protection. A pre-application will identify whether this is an issue for the customer's specific site. Contact National Grid for assistance in identifying your network status.

Electrical Interconnection Useful Links
National Grid nCAP Portal - https://ngus.force.com/s/
MA System Data Portal General Information - https://ngus.force.com/s/article/Massachusetts-System-Data-Portal
MA System Data Portal - https://ngrid.apps.esri.com/NGSysDataPortal/MA/index.html
(Hosting Capacity, Heat Map, etc…)
Pre-application Report Request - https://ngus.force.com/s/article/MA-Complex-Pre-Application-Report-Request
ASO Study - https://ngus.force.com/s/article/DG-Stakeholder-Updates

ESB 756 - https://ngus.force.com/servlet/servlet.FileDownload?file=0150W00000E6sFh
DG Links List - https://ngus.force.com/s/article/MA-BUSINESS-Useful-Links

Unitil

http://www.unitil.com/energy-for-businesses/electric-information/tariffs

DOER site on interconnection and heat map:
https://sites.google.com/site/massdgic/home/interconnection

Attachment 5 – Request for Hourly Electric Interval Data

Following is a request form for Electric Interval Data from the customer's distribution company.

Please note that the "Supplier/Broker" can be any third-party that may need this information in order to perform a Technical Assessment or prepare a CHP Application. The customer must sign this document to authorize releasing electric interval data to a third party (the customer can also request this data directly).

Contact your applicable natural gas account executive to determine whether such hourly gas interval data is available and the mechanism for requesting this data.

MASSACHUSETTS INTERVAL DATA REQUEST FORM

Distribution Company (circle one): NGRID EVERSOURCE UNITIL

• Customer Name (as it appears on the bill): _____

Account Number	Service Address	Billing Name	Billing Address	City/State/Zip

Please attach additional accounts as needed, and reference accordingly in the table above with "see attached".

• Supplier/Broker Name: _____
• Supplier/Broker Contact: _____
• Supplier/Broker Contact Telephone Number: _____
• Supplier/Broker Contact Email Address: _____

***CHECK ONE □ Invoice the customer OR □ Invoice the supplier/broker as follows:
(Not applicable to NSTAR)

Supplier/Broker Signature: _____ Date: _____
Supplier Billing Address _____

This section is to be completed by the Customer
I authorize the above distribution company to share my interval data with the above supplier/broker until I or my supplier/broker notifies you otherwise. The tariff allows for one request per account per calendar year for historical data at no charge. I understand that a fee will be assessed for any subsequent request made within the calendar year. Please accept this request for information under the authority of this form as if the request was made directly to you. You are permitted to accept this form as authentic whether it is the original executed document or a copy thereof. My signature affirms that I have the authority to make and sign this request on behalf of my company.

Customer Signature/Date _____
Printed Name/Title _____
Company Name _____

NOTE: Massachusetts Tariff allows for one request per account per calendar year for historical data at no charge. If available, I would like to exercise that option now: □ YES □ NO

Specify desired data interval: □ 1 hour □ 15 minute
Specify time period for which data is desired: From: Hour_____ Day____ Month_____ Year _____
To: Hour_____ Day____ Month_____ Year _____

INTERVAL DATA REQUEST FEE SCHEDULE

National Grid

Please scan the completed form into PDF format and email to: IntervalDataRequests@us.ngrid.com

Historical request for Interval Data:

- Initial Request – covering a single calendar year ☐ **No Charge**

Subsequent historical request within same calendar year

- Single Retail delivery service account ☐ **$83.00**
- Additional retail delivery service account – requested at same time
  $6.41 per account x # of accounts (_____) ☐ _____

Subscription Service for Interval Data over the Internet:

- Single retail delivery service account ☐ **$154.00**
- Additional retail delivery service account – requested at same time
  $76.89 per account x # of accounts (_____) ☐ _____

*****CIRCLE ONE 1 Year Contract OR Automatic Yearly Renewal**

Total Charges $_____

EVERSOURCE

Energy Profiler Online (EPO) information

https://www.eversource.com/content/ct-c/business/save-money-energy/energy-efficiency-tips/energy-profiler-online

Application:
Request Form

UNITIL

Fax To (603) 227-4543

Historical request for Interval Data:	
Initial Request – covering a single calendar year	**No Charge**
Subsequent historical request within same calendar year	
Single Retail delivery service account	**$49.26 per meter**
Additional retail delivery service account	
(Please attach list of accounts)	
$**49.26 per meter** x # of accounts	$_____
Annual Subscription	
Single retail delivery service account	$346.92 per meter
Total Charges	$_____

Attachment 6 - Customer Authorization for Release of Data

I authorize the following utilities and/or energy suppliers to release billing information and other data being collected regarding my facility to third parties in order to determine the feasibility of a potential energy efficiency measure and/or to facilitate the preparation of an energy efficiency incentive application.

Name:_____ Title: _____

Signature: _____ Date: _____

Utility or Energy Supplier Name	Account Number	Billing Name	Service Address

Please indicate the third parties which are allowed to receive this information:

Third Party Allowed to Receive Data	Contact Person	Email Address	Telephone Number

After completing this form, please forward to the applicable utility or energy supplier with a copy to the third party requesting such data.

Attachment 7 - Sample Minimum Requirements Document for CHP Projects

Minimum Requirements Document

Customer Name		**EI or D2**	
Location		**Application**	
ECM:			

This document specifies the agreed upon minimum equipment specifications and operational requirements of the proposed system. These requirements shall address the criteria necessary to be met to achieve the demand and energy savings estimated in the engineering analysis for this project. (Use additional sheets if necessary).

Pre-Construction	**SEQUENCE OF OPERATION**: Provide a description of equipment operating sequences, set points, operating schedules, balancing requirements (flow, velocity, head, etc.) or any other required operating parameters **Submittals:** Provide major equipment data sheets
Yes □ No □	Milestone 1. Equipment submittal and approval of Sequence of Operation (SOO). Required Completion Date: Before the start of the combined heat and power (CHP) installation at the site and prior to approving submittals for the major equipment. 1. The **XXXX** CHP plant shall be controlled to follow **ELEC/Thermal** loads. (Thermal "following" is defined as limiting the engine output such that the heat output does not exceed that required to satisfy the connected heating loads.) Accordingly, sustained use of radiators for heat rejection should not be required. The thermal loads connected to the engines shall be as follows: a. XXXXX b. XXXXX c. XXXXX 2. The Generator shall connect to the XXX heating source via the Piping and instrument Diagram (P&ID) titled XXXXX, dated XXXXX drawings attached to this MRD. P&ID will show all the sensors and meter locations as required for measuring thermal and electrical efficiency. Line out how the unit will be connected here, unique to every installation. 3. The electrical output of the generator should not exceed the demand of the connected electrical loads. That is, should the thermal-following approach yield a combined electrical output that exceeds the electrical demand of the connected buildings, the output of the generator(s) shall be reduced such that the generator(s) do not back-feed the grid. 4. The remaining load of the boiler plants shall provide heating water when the CHP thermal output is not able to satisfy the facility thermal demands, either because the generator is at its maximum output or because the electrical demands limit the generator output.

	5. Btu meters will be utilized to quantify the total useful thermal output (engine thermal output- dump radiator) of the generator. 6. Provide a process and instrument diagram showing all CHP plant equipment, fuel gas and hot water piping, and instruments including Btu meters. 7. All meters shall be utility grade. 8. The XXXX kW CHP Plant is designed to meet the following performance criteria for the year: a. Annual Production of x,xxx,xxx kWh (accounting for parasitics; see Milestone 2a below) b. Facility fuel increase x,xxx,xxx therms (fuel fired for cogen minus boiler fuel saved) HHV c. Boiler fuel offset of x,xxx,xxx therms d. Electrical efficiency XX% (accounting for parasitics) e. Thermal efficiency XX% (accounting for parasitics) f. Plant overall efficiency XX% g. X,XXX,XXX ton hours of chilled water production.

Post Inspection	**Installation Completion**: Provide a list of equipment or materials installed as part of this project. Include mfg, model, HP, kW, efficiency ratings, etc. and confirm completion
Yes □ No □	**<u>Milestone 2a. Installation Completion</u>** 1. Install X,XXX kW, Type of Generator and heat recovery system. Engine shall be XXXXX model or equal. 2. CHP unit shall meet the following criteria derived from the product data sheet: a. electric output: X,XXX kW, not including parasitic loads (pumps and radiator fans) b. thermal output, main hot water: X,XXX MBH with XXX°F jacket water c. thermal output, oil cooler: XXX MBH d. thermal output, exhaust: X,XXX MBH based on exhaust gas cooled to XXX°F e. overall efficiency: XX% at full load based on XXX,XXX Btu/min (X,XXX MBH) of fuel input (using HHV) f. part-load HHV performance as follows:

	100%	80%	60%
Electrical output*	1,016 kW	813 kW	610 kW
Fuel input (HHV)	10,626 MBH	8,722 MBH	6,851 MBH
Main hot water output	2,719 MBH	2,231 MBH	1,760 MBH
Oil cooler output	365 MBH	351 MBH	334 MBH
Exhaust output	1,976 MBH	1, 658 MBH	1,339 MBH
Total recoverable heat	5,060 MBH	4,240 MBH	3,433 MBH
Electrical efficiency*	36.5%	35.6	33.9

	<table><tr><td>Thermal efficiency*</td><td>47.6%</td><td>48.6%</td><td>50.1%</td></tr></table> *not accounting for parasitic loads; based on HHV g. Thermal output delivered to heating system: X,XX MBH at XXX°F supply, XXX°F return hot water accounting for exhaust heat recovery heat exchanger, oil cooler heat exchangers, and final heat exchanger as per P&ID. h. Parasitic loads: estimated at XX kW during full-load operation; inclusive of all pumps and fans; accounting for expected parasitic equipment loading at these conditions. 3. Install three 15 hp circulation pumps to circulate water from the primary cogeneration loop to the new Building 3 hot water loop. 4. Install three new, 322-ton absorption chillers, based on 195 deg. F entering hot water temperature, Thermax model 5G 5L C, or equal, serving the Building 3 and 4 chilled water system. The unit shall have a coefficient of performance of at least 0.7 at AHRI conditions. 5. Install a Btu meter to measure the thermal output of the CHP unit(s). 6. Install Btu meters to measure the hot water and chilled water connections to the absorption chiller. 7. Provide meters as required to monitor energy output, waste heat utilization and electrical power production. Both electric meters and gas meters shall have accuracy equal to utility grade meters. 8. Thermal energy monitoring accuracy shall meet Massachusetts alternative portfolio standard (APS) requirements. a. As a minimum the system shall be able to capture 15-minute interval data for electricity produced, waste heat utilization, fuel input and power consumed by all auxiliary equipment, including domestic hot water system and space heating boiler system. b. Fifteen-minute trends for gas input and engine run hours shall be provided. c. The control system should be capable of trending and archiving this data for a period of one year before overwriting. d. Archived data shall be capable of being exported to a designated ftp server via CSV compatible electronic files. 9. "1. In addition to the above requirements, the CHP plant will meet all the requirements of (a) Section III.2(C) in the **Massachusetts APS Statement of Qualification Application Form** (which is in the "Generation Unit Technical Details" section of the Web-based application) and (b) Section 2 of the **APS Guideline for CHP,** June 14, 2011 Edition (or most recent version), both of which can be found at the **APS Statement of Qualification Applications** page of the Massachusetts DOER website: http://www.mass.gov/eea/energy-utilities-clean-tech/renewable-energy/rps-aps/rps-aps-sqa/aps-statement-of-qualification-applications.html 10. During post inspection confirm that data collection system is installed, connected to properly calibrated metering and reporting and archiving data properly.
Yes ☐ No ☐	**Milestone 2b. Demonstration of Operability** **(Completion of Milestone 2A and 2b is required for the payment of 80% of the incentive)**

	Confirm that the above noted equipment is installed and operational for completing Milestone 2b. Installed and operational is defined as : ○ All components of the new XXXX kW CHP and XXX ton absorption chillers including all meters are installed and connected to their respective building systems. ○ All equipment, piping (including flushing), electrical and control wiring is completed, so that all CHP units can run in an automatic mode. The minimum performance shall be the following: a. Annual Production of X,XXX,XXX kWh (accounting for parasitics; see Milestone 2a below) b. Boiler fuel offset of XX,XXX therms (based on XX% overall boiler efficiency) c. Plant overall efficiency XX% ○ Interconnection facilities are completed and accepted by Retail Connections Engineering, and insurance certificates are in place. This does not absolve the customer from meeting any other jurisdictional permits or other regulatory requirements. ○ All instrumentation and meters required are installed and are working properly and porting data to remote website. ○ 15-minute interval data shall be made available and exported to remote website for access to PA in CSV format for a 2 week period. ○ Customer and its vendors have completed their own commissioning with reports on major pieces of equipment provided.

Post Operational Assessment	**DOCUMENTATION:** List written documentation required to train, verify, operate, or maintain the equipment being installed or controlled. This may include specification sheets, test reports, construction drawings, etc.**:** Provide a list of Trending Requirements required to verify proper system operation. Trends should document operational sequences, set points and scheduling of equipment as described in TA Study
Yes □ No □	**<u>Milestone 3. (Completion of Milestone 3 & 4 is required for the payment of the remaining 20% of the incentive.)</u>** Validate the following items: (a) O&M manuals and documentation on site 1. All equipment catalogs and performance specifications for the one, XXX kW CHP units. O&M manuals for the following equipment: a. Engine/generator sets b. Pumps c. Electric motors d. Heat exchangers e. Absorption chillers f. Metering equipment (gas, electric, hot water) 2. Design Drawings (Process and & Instrument Diagrams and Mechanical Piping Drawings, Instrumentation List and equipment Data Sheets) are available on site. *(b)* Waterside economizer sequence is implemented and operational *(c)* Availability of trend data and confirming of its exportability.

1. Provide 15-minute interval data for the following points as a minimum. Provide the capacity for and enable trend data archiving for a period of at least one year.
    a. Gross and net (after parasitics) kW and kWh electrical output – including parasitic consumption measurements
    b. Fuel input to CHP plant (therms or MMBtu)
    c. Hot water generated and utilized by CHP plant (therms or MMBtu)
    d. Flow/temperature on heat recovery supply/return
    e. Any point necessary to determine other parasitic loads, based on the final plant design
    f. Absorption chiller Btu meter readings, and water temperatures (inlet and outlet) and flows, for both the hot water and chilled water connections
2. Provide ability to export weekly data electronically to third party via email or FTP at all times.
3. Post operational assessment process will require functional testing of the CHP and the thermal and electrical interface to the buildings, a minimum 2 weeks and up to 6 months of concurrent 15 minute interval data for all points noted above. If equipment fails to meet expected sequences of operations and corrections are needed, additional trend data shall be provided to confirm any seasonal changes in operations.
4. Provide meter calibration data.
5. Install, maintain, and calibrate measurement, monitoring and data recording equipment for the lifetime of the project in compliance with ISO-New England's Manual for Measurement and Verification of Demand Resources, including:
    a. Meet or exceed the relevant American National Standard Institute or equivalent standard for the equipment.
    b. Meet the relevant Institute of Electrical and Electronics Engineers standards for equipment installed and measuring electric demand on electric circuits with significant harmonics and have a digital sampling rate of at least 2.6 kHz.
    c. Utilize a pulse rate within the resolution capabilities of the recorder, if recording pulses from measurement and monitoring devices.
    d. Have an accuracy of no less than +/-2% using a true Root Mean Square measurement device to measure electrical demand or using any measurement or monitoring equipment for proxy variables to calculate electrical demand.
    e. Install measurement or monitoring devices that direct measure electrical demand from three-phase devices such that measurements are taken on all three-phases to account for any phase imbalance or an equivalent method that can measure electrical demand using two phases.
    f. Include the power factor of the end-uses in the demand calculations if measuring current and nominal voltage to calculate electrical demand.
    g. Synchronize data recorders with the National Institute of Standards and Technology to an accuracy of +/- 2 minutes per month.
    h. Calibrate to meet or exceed Federal Energy Management Program Measurement and Verification Guidelines, applicable American Society of Heating, Refrigeration and Air Conditioning Engineers standards, National

	Institute of Standards and Technology, or equivalent standard for the equipment and provide meter calibration data. i. Ensure all measurement, monitoring and data logging equipment is maintained to meet or exceed industry and manufacturer maintenance standards and maintain documentation on all such calibration activities. j. Collect electricity usage data at a frequency of 15 minute intervals or less. (d) Sequence of operation is working as outlined in MRD, TA report and supporting energy saving calculations.
Post Inspection	**OTHER REQUIRMENTS:** Describe any requirements for demolition, removal, etc. of existing equipment.
Yes □ No □	**Milestone 4** 1. Customer will have a minimum 3 year or first major overhaul maintenance contract to help achieve long term proposed operational strategies and energy cost savings. Normal planned /routine maintenance shall be conducted where possible during National Grid off-peak billing periods. 2. Provide detailed project cost breakdown by major system components. Provide copies of paid invoices to support the project costs. 3. If the annual kWh productions, kW, thermal production, electrical and thermal efficiencies as outlined in above milestones are not met, the final payment will be adjusted to reflect the actual as built efficiencies and may result in lower final incentive amount. A reasonable time will be granted for the customer to make improvements to system so that they can meet the efficiency and energy production criteria set by this MRD

The PA signature below indicates the PA engineer, or their representative, has reviewed and agrees to the requirements stated in this MRD. The customer signature below indicates the customer also agrees with the requirements of this MRD and will implement as stated. The customer should only sign below if this MRD has been signed by PA or its representative.

The pre-approved incentive is subject to Retail Companies' POST INSPECTION of final specifications, drawings and operation of the proposed equipment. In the event the proposed system is altered from the above description, notify the Company of the change prior to the equipment purchase and installation as the change in design and operation may impact the available incentive.

PA Engineer or Representative	Date	Customer Agreement Signature	Date

Once the installation is complete and the equipment is operational, the post inspector will sign below, confirming all requirements of this MRD have been met, and/or any discrepancies have been noted. PA will review any discrepancies to determine their impact on energy savings or incentive. The final customer

signature indicates that they agree with the findings of the post inspector, including any discrepancies noted, and are satisfied with the installation.

Milestone 1 (Pre-installation) Signatures

PA Engineer or Representative	Date	Customer Agreement Signature	Date

Milestone 2 (Post-installation) Signatures

PA Engineer or Representative	Date	Customer Agreement Signature	Date

Milestone 3 and 4 (Post-operational Assessment) Signatures

PA Post Engineer or Representative	Date	Customer Certification of Installation	Date

Attachment: P&ID dated x/x/20xx