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## Summary:

Climate Energy has partnered with the Propane Education & Research Council to demonstrate the energy conservation benefits of Micro-Combined Heat & Power (Micro-CHP) through the Propane Warm Air **freewatt**™ System Demonstration Program. The Propane **freewatt** Demonstration Program began in the Fall of 2007 with the identification and confirmation of a candidate residential home. Installation subsequently occurred at the site in Dover, Massachusetts, and the **freewatt** Systems began operation in December 2007. Overall, the results were consistent with energy performance expectations and the Propane Warm Air **freewatt** Micro-CHP System was well received by both the system installers and the homeowner. Climate Energy's unique **freewatt** micro-CHP system was shown to have important residential energy conservation and environmental benefits at levels comparable to those of renewable energy alternatives. This program has demonstrated the benefits of the Warm Air **freewatt** System. These benefits and more will be incorporated into the Propane Warm Air **freewatt** Plus System, which becomes commercially available in 2010. All **freewatt** products are marketed and sold under the ECR International, Inc. brand name.

## System Description:

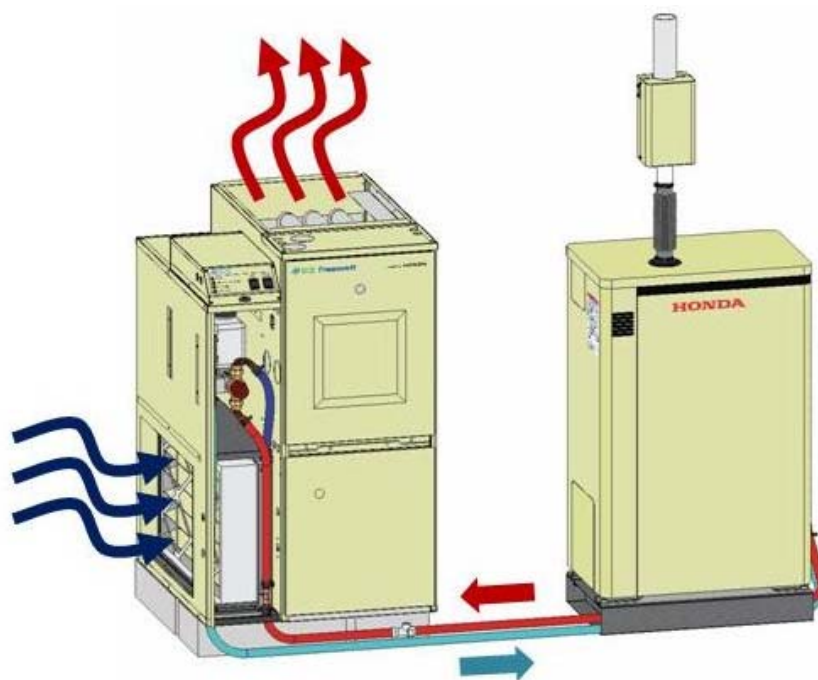
The Warm Air **freewatt** System is designed to replace an existing warm air furnace or install in the place of a conventional warm air furnace in a new home. Each **freewatt** Micro-CHP system has four primary parts: a furnace module with a high-efficiency auxiliary burner and ECM blower motor, a Honda MCHP module, a hybrid integration module (HI Module), and a microprocessor based system controller.



Whenever heat is demanded by

the room thermostat the Honda MCHP unit turns on and begins to generate heat and 1.2 kW<sup>1</sup> of electricity. The MCHP unit is a natural gas driven, liquid-cooled, internal combustion engine-generator set specifically developed by Honda for the home cogeneration application. A similar MCHP product is in widespread use in Japan. The heat that is produced by the Honda MCHP is captured and delivered to a heat exchanger in the HI -Module. The heat is transferred into the return air stream from the building and then delivered into the home by the furnace module blower operating in low air flow mode. The **freewatt** System runs in this mode for many thousands of hours per year, maximizing the benefits of combined heat and power as well as improving the comfort of the home by maintaining a more constant temperature.

If more heat is required than can be provided by the MCHP unit alone, the auxiliary burners in the furnace module are automatically operated. This can occur on very cold days or when the thermostat calls for a quick re-warming of the building after a period of night-time temperature setback.



The above illustration shows the heat flow in the system during the normal combined heat and power mode of operation. Heat from the Honda MCHP is transferred to the HI Module via a liquid coolant circulating loop. Return air from the home is heated by engine coolant in the heat exchanger in the HI Module and the heated air is supplied to the home by use of the furnace blower.

The furnace module is manufactured for Climate Energy by ECR International and is based on well-established condensing warm air furnace design practices. The HI Module is manufactured by ECR International and incorporates mechanical components widely used in the HVAC industry. The Honda MCHP 1.2 kW modules are manufactured by Honda to Climate Energy specifications for the North American market and are largely based on an existing production model now widely used in Japan. The system controller is structured around a high

capability Rabbit BL2600 micro-processor controller and communicates digitally with the Honda MCHP and the thermostat, while also controlling the main air blower, the auxiliary burners, and coolant pump and receiving inputs from various sensors.

## Installation:

The Warm Air **freewatt** Micro-CHP System was designed with the heating and air conditioning trades in mind. The system requires no additional skills to install beyond those already represented in a typical heating system installation crew of electrician, plumber, and duct fitter. The installation of each Warm Air **freewatt** System was completed by KeySpan Home Energy Services in about 2 days, including removal of the old heating system.



Furnace & HI Module



Honda MCHP Unit, Model YM2A

The project site is located in Dover, MA and is at an approximate elevation of 500 ft. above sea level. Average daily temperatures range from 23° F in January to 78° F in July. Electric service is provided by NSTAR at 240 VAC and propane fuel gas is supplied by Eastern Propane Gas. The residence is about 3,400 sq. ft. and had two heating systems to ensure proper heat delivery to a new addition. The home has adequate electrical power usage and heat loss for the operation of two Warm Air **freewatt** Systems. . The demo home, at 3,400 square feet, is close to twice the size of the average American home of 2,000 square feet. A typical sized home between 1,300 to 2,000 sq. ft. would only require one **freewatt** system.

The residence had two existing oil-fired furnaces located in the basement at two separate ends of the basement. These were replaced with two Propane Warm Air **freewatt** Systems. Photos of the furnace/HI module and Honda MCHP unit are found in the figures above and the Propane Warm Air **freewatt** Systems are found on the next page. Each system required slightly more floor space than the existing furnaces and also



Warm Air **freewatt** System #1  
(Side View)

required PVC venting for the high efficiency appliances. The installation also included new dedicated 240 VAC circuits for the Honda MCHPs.

System #1 supplies heat to the main house. System #2 supplies heat to the second floor addition of approximately 900 sq. ft.

## Grid Interconnection:

The Propane Warm Air **freewatt** System connects to the electric grid using the Honda MCHP's on-board electronic inverter and utility-grade relays. The inverter is UL 1741 certified and therefore is approved for grid interconnection in Massachusetts. Permission to connect to the grid for this class of system is obtained using a one-page Simplified Grid Interconnect permit application in Massachusetts. Most systems were installed by hard wiring a dedicated 240v AC line to a location near the Honda MCHP unit and extending flexible metal conduit to the Honda MCHP unit. Since the electric utility was NSTAR, an outside disconnect switch was required. Most electric utilities do not require the outdoor disconnect switch. Please find the permit application in the Appendix.

## Net Metering:

The Propane Warm Air **freewatt** system produces electrical power as it operates to meet the space heating demand. Electric power is not produced in response to specific, instantaneous on-site electrical power demands. In the net metering mode of operation, when more power is being produced by **freewatt** than can be used in the home, excess power flows back out to the electric grid. A customer receives an instantaneous "credit" during such occurrences as his electric meter spins backwards. Later, when the customer has a greater power demand than can be supplied by the Propane Warm Air **freewatt** System, the extra power needed is drawn from the power grid and that "credit" is redeemed as the meter spins forward again. At the end of the month, the net excess power produced, if any, is typically credited to the homeowner's monthly bill. If the homeowner uses more power during the billing month than is generated by the **freewatt**, he simply pays for that net amount of power drawn from the grid. The **freewatt** electric generation capacity is sized such that the amount of power generation during the winter months would be about equal to the level of consumption of a typical home. Typical home power consumption is, on a 24-hour average, just over 1 kWh. With the **freewatt** system operating nearly continuously in the cogen heating mode during the winter months, the ability to meet much of the power needs of a typical home during the heating season is demonstrated. A number of homeowners received net zero electric bills during the coldest months of the heating season. One site experienced no electrical use charges for six months.

## Demonstration System Operating Results

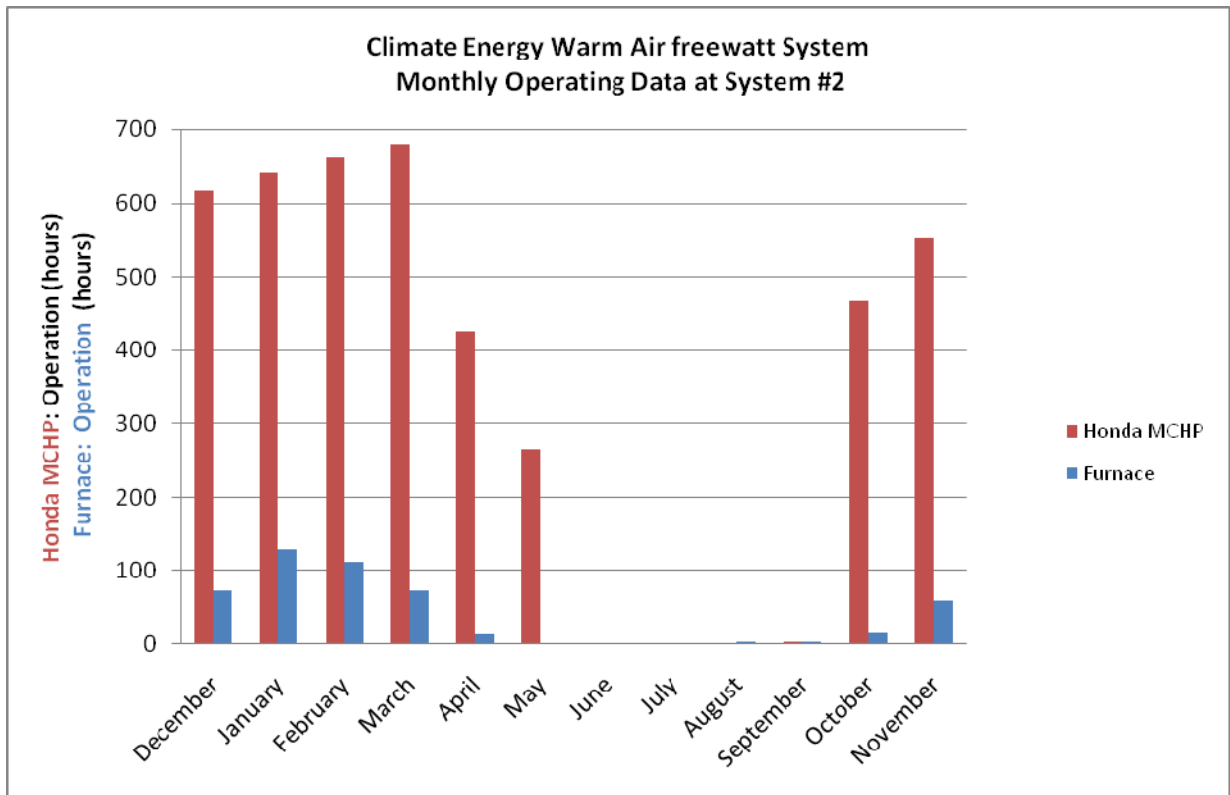
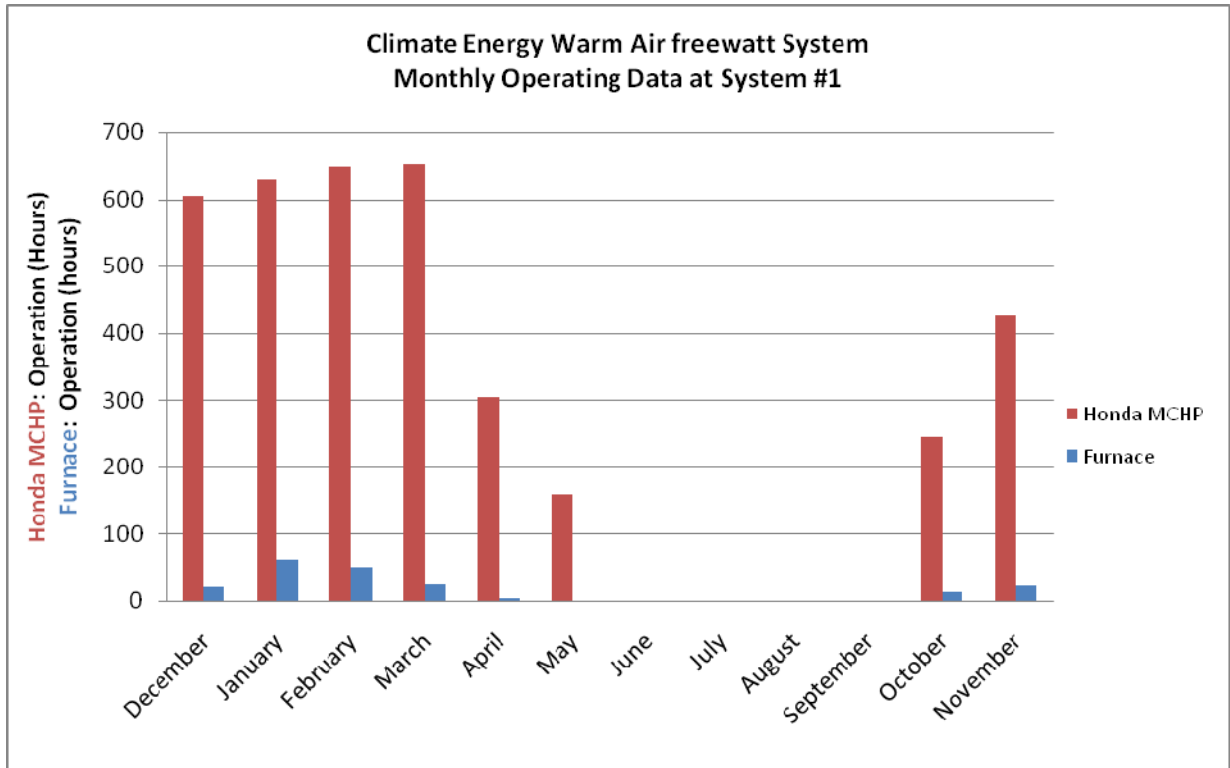
Since December 2007, the two demonstration Propane Warm Air **freewatt** Systems have been operating in the Dover home and have been sending operating data to the Climate Energy Data Center. This data has been inspected and reduced to provide the following results for the one year test period from December 2007 to November 2008.

**Table 1: Operating Results for Propane freewatt Demonstration Systems**

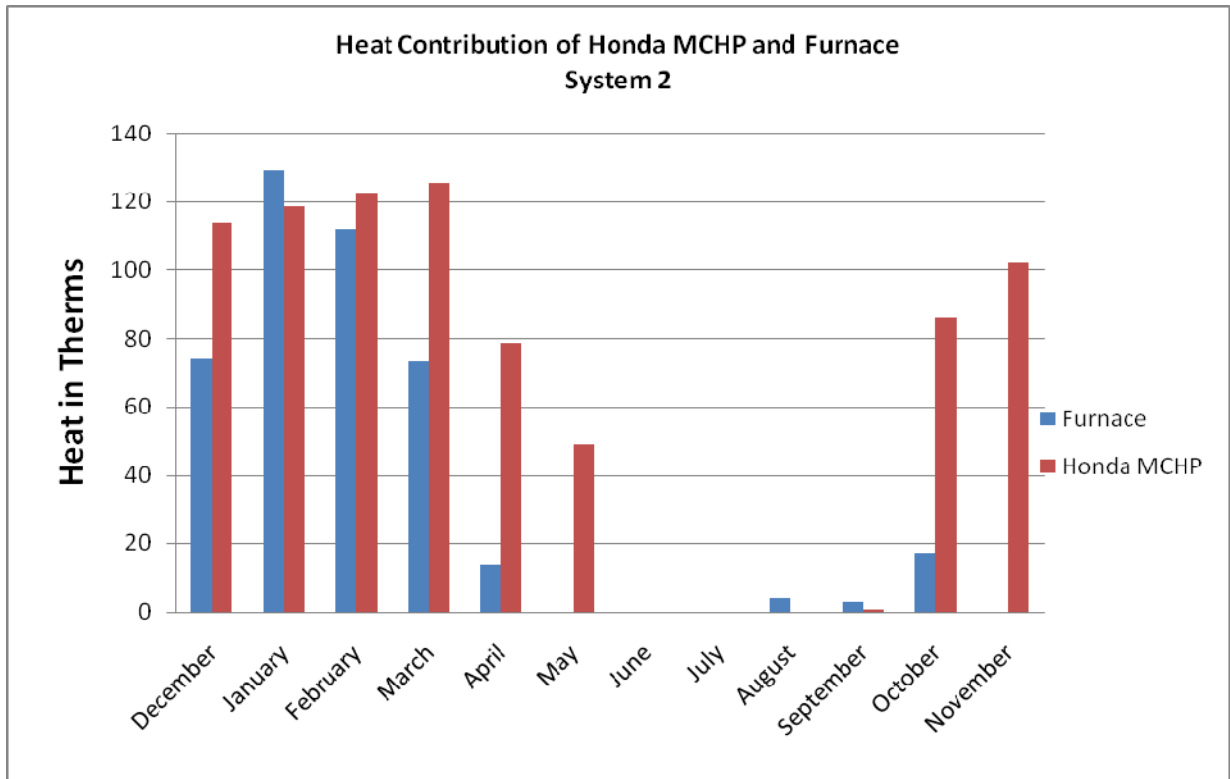
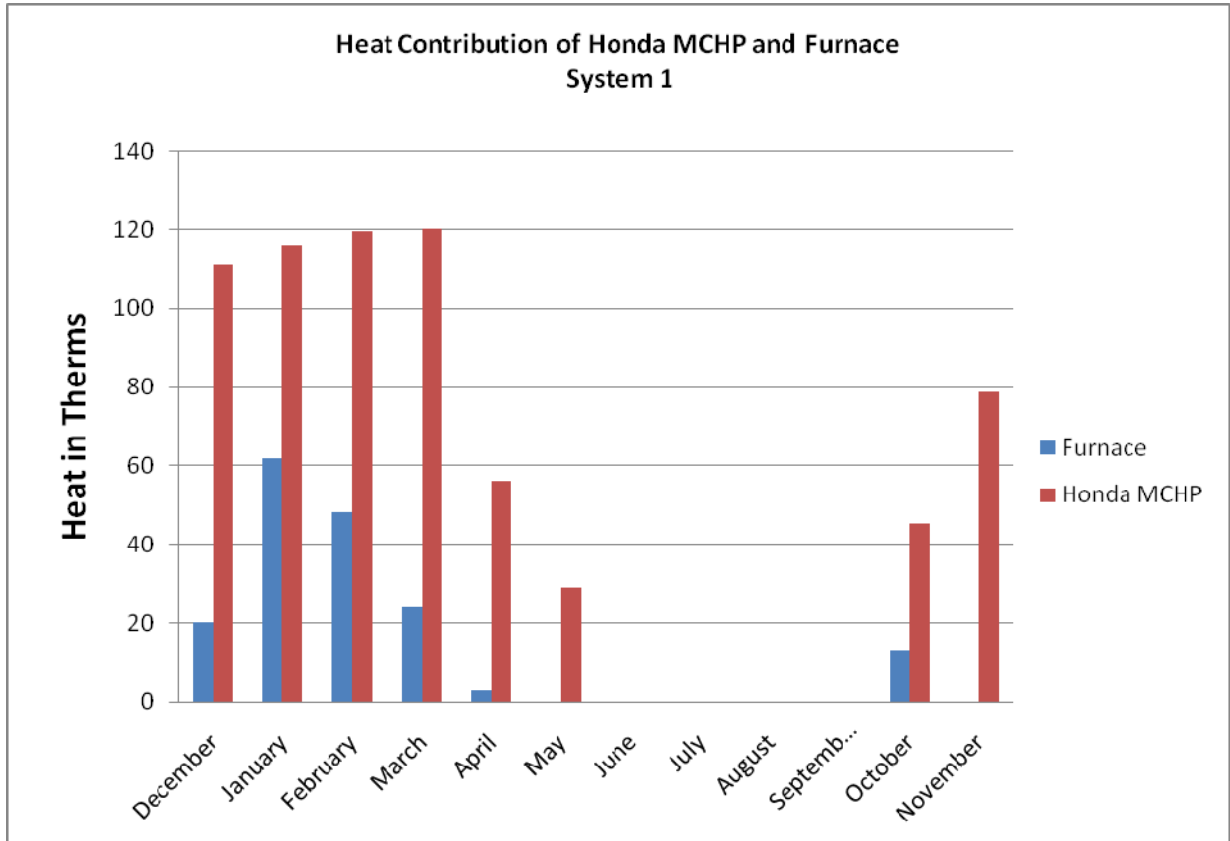
<b>Annual Operating Results</b>	<b>System 1</b>	<b>System 2</b>	<b>Total</b>
<b>Freewatt Propane Fuel Consumption (Therms)</b>	830	1097	1,927
<b>Electric Power Production (kwh)</b>	4,401	5,176	9,577
<b>Useful Heat Production (Therms)</b>	604	820	1,424
<b>Expected Fuel Consumption of Replaced Oil Furnace (Therms)</b>	775	1,029	1804
<b>Expected Fuel Consumption of High-Efficiency Propane Furnace (Therms) (for comparison)</b>	671	914	1585
<b>Value of Electric Generation</b>	\$836	\$983	\$1,819
<b>Total Cost of Propane Fuel For freewatt System</b>	\$1,983	\$2,621	\$4,604
<b>Expected Fuel Cost with Original Oil Furnace</b>	\$2,043	\$2,963	\$5,006
<b>Expected Fuel Cost for Hypothetical High Efficiency Propane Furnace (for comparison)</b>	\$1,604	\$2,184	\$3,788
<b>Freewatt Energy Cost Saving over Original Heating System (@ then current energy costs, fuel and electric)</b>	\$1,069	\$1,454	\$2,523
<b>Freewatt System Total Carbon Emissions Reduction (Compared to Original System) (lbs)</b>	16,653	15,369	32,022

Detailed monthly data and analysis are provided in the attached tables at the end of this report. Performance and cost assumptions incorporated into these findings are detailed in these attached tables. Fuel use results for the freewatt system are based on the measured consumption rate of the freewatt MCHP and furnace units and the accumulated run time. Fuel use results for the original oil furnace and the hypothetical high-efficiency propane furnace (only) are calculated using the observed total heat generation (supply) of the freewatt system and the efficiency and fuel costs of these two comparison systems.

The systems operated routinely over the year and there were no operational abnormalities or equipment failures. The homeowners found that the low noise level of the system was acceptable, causing no concerns. The figures below present the Honda MCHP and furnace operating run time data for System #1 and #2.



Below the relative contributions of the MCHP unit and the Auxiliary Furnace Burners to the heating of the demo home are shown for System #1 and System #2.



# Demonstration System Performance Review and Assessment

The operating results provided in Table 1 correspond well with expectations for the actual in-field performance of the freewatt system. While the demonstration home is about twice the size of the average American home, the application of two freewatt systems yields general performance characteristics that would be typical of a smaller, average home with one freewatt system.

Total annual electric generation of the two freewatt warm air systems, at 9,577 kwh, is exactly in line with the expected 5,000 kwh per system when applied in the climate zone of the demo home. Other important observations regarding the demo system are as follows:

- 1) Total annual energy cost savings for this particular application, at the prevailing energy costs of the time of the test, are found to be about \$2,500 per year total, or about \$1,250 per freewatt system. This cost savings is due to the inherent efficiency of the freewatt system, but is also dependent on the assumed/actual fuel and energy costs. Savings can be expected to be higher or lower for other climate zone applications and other energy cost scenarios. For example, at identical energy costs (\$/therm) for propane and oil, the total cost savings for the demonstration system would have been about \$1,700 per year. Nonetheless, with the good thermal and electrical performance demonstrated by the freewatt system, significant cost savings can be expected in most applications. In high cost electric areas in the Northeast, like where the demo unit is located, annual energy savings of about \$1,000 per year per freewatt system would be typical.
- 2) In comparison to a high-efficiency propane furnace, the freewatt system results in an increased propane fuel consumption of about 22%. However, for the demo home and many other application situations, the electric power cost savings substantially outweigh the additional fuel cost.
- 3) The carbon emission reduction in switching from an oil fired furnace with supply of all electricity from the grid to a freewatt home energy system is dramatic. While propane is inherently a lower carbon fuel than oil, the freewatt system further builds upon this good characteristic of propane due to the significant reduction in primary energy used for electric power production. For the demonstration home the annual carbon reduction is 16 tons. This is equivalent to the annual carbon emissions of about 3 automobiles or 1.5 automobiles per installed freewatt system. This highlights the great practicality of micro-CHP as a strategy for significant carbon emission reductions. A propane fueled freewatt will result in a greater carbon emissions reduction than the application of a large, and much more expensive, solar PV electric array to a home that continues to heat with oil.
- 4) The performance of the freewatt system as cost reduction, energy use reduction, and carbon emissions reduction system in comparison to other alternative energy strategies does depend on the amount of expected use of the system. Use will be approximately proportional to heating demand or amount of "heating degree days". With the demo system operating in a climate with about 6,500 degree days (F), and providing the performance shown in Table 1, annual saving in other areas will be approximately proportional to the local "heating degrees days".

## Commercialization Status

This project used a Propane Warm Air **freewatt** System to determine the operating characteristics of the system in Micro-CHP mode. This model will not be commercially available, though the Propane Warm Air **freewatt** Plus System will be formally released in the first quarter of 2010 and embody two additional modes of operation: Back-Up Power and Grid Boost. Climate Energy is also planning the installation of several demonstration Propane Warm Air **freewatt** Systems in the Northeast in 2009.

The Propane Warm Air **freewatt** Plus System is currently finishing certification and being prepared for production. Our current schedule has the Propane Warm Air **freewatt** Plus System product being commercially available through certified **freewatt** dealers in 2010 with a focus in the Northeast portion of the United States. The Propane Warm Air **freewatt** Plus System will have two models available: WAJ and WDJ. The base model, WAJ, has four modes of operation: MCHP mode, MCHP & Heat mode, Grid Boost mode and Back-Up Power mode. MCHP mode has the MCHP delivering heat and power to the home. MCHP & Heat mode has the MCHP delivering heat and power to the home, while the furnace augments the MCHP's heat delivery. Grid Boost mode allows the electric utility to operate the MCHP unit to assist in a Demand Response mode of operation. The electric utility will need to set up an agreement with the homeowner to perform this act. Back-Up Power mode will be automatic for up to six circuits configured into the system.

The WDJ model will have the same modes as the WAJ and will add Domestic Hot Water (DHW) Mode. DHW mode will allow the MCHP's heat to be transferred into the water contained in a direct fired water heater. This will allow for significantly higher power generation during the summer months.

## Economic Analysis

The price for an installed Propane Warm Air **freewatt** Plus System to the homeowner is expected to be in the \$25,000 range. This price includes the equipment, installation, commissioning, extended warranty, and grid interconnection. Since the price includes the installation of a high efficiency two-stage furnace with ECM motor, the incremental cost for cogeneration and backup power production of the Plus system is under \$20,000. This price does not include any incentives available through Energy Star programs or electric/gas utilities, so the potential for lowering this price is high.

Our analysis of operating expenses for the Propane Warm Air **freewatt** Plus System compared with the existing oil furnace include the value of the electric power generated by the Propane Warm Air **freewatt** Plus System. Depending on the installation location, the electric rate can vary from \$0.06 to \$0.27/kW-hr. Consequently, the value of electric power generation can vary, though the major Massachusetts's electric utilities have electric power rates of about \$0.18/kW-hr. Another important aspect of power generation is the grid interconnection agreement and metering requirements. Massachusetts requires all investor-owned electric utilities to allow net-metering for distributed generation. Depending on incentives, electric power rate (\$/kW-hr) and the final installed price of the Propane Warm Air **freewatt** Plus System, the payback period can vary dramatically.

As the Propane Warm Air **freewatt** Plus System is a micro-combined heat and power system or home energy system, a direct comparison to other systems in this product category cannot be performed because no other companies provide a completely integrated home energy solution. However, a fair comparison can be

performed on a home with a high efficiency furnace with an ECM motor that also has a Solar PV array installed to provide about 5,000 kW-hrs of green power for the home. We will assume that the Solar PV system will operate at about 10% utilization in the Northeast and therefore require about a 5 kW system to generate about 5,000 kW-hrs annually. Using industry pricing from Massachusetts Technology Collaborative’s Commonwealth Solar Program, the cost to install the system is about \$8,000/kW, therefore making the price for the Solar PV system about \$40,000. The table below shows the economic comparison for these two home energy systems:

	<b>freewatt</b>	<b>Solar PV</b>
System Cost and Installation	\$25,000	\$40,000
High Efficiency Furnace w/ ECM motor & Installation	Included	\$6,000
Automatic Back-Up Power Capability	Included	\$5,000
Remote Diagnostic Capability	Included	\$1,000
Total Installed Cost	\$25,000	\$52,000

Before Federal and State incentives, the **freewatt** heating, cogeneration, and backup power system is over 50% less than the installed cost of a comparable Solar – PV-based home energy system, while providing a near similar level of environmental benefits.

Other benefits provided by the Propane Warm Air **freewatt** Plus System that are not shown in this comparison include:

- Using the established home heating professional for installation, service and maintenance
- Clean emissions of back-up power provided by the Honda MCHP’s 3-way catalytic converter
- Quiet operation of automatic back-up power system
- Optimize energy conservation and emissions in back-up power mode
- Indoor installation and can be installed in most existing and all new homes.
- No aesthetic changes to property and no need for special home siting or orientation.

Of course, operating and maintenance (O&M) costs will be required for the Propane Warm Air **freewatt** Plus System, but our annual estimates are about \$250 - \$300. However, a comparable Home Energy system with back-up power capability will also have an annual check-up (~\$150), so the incremental annual O&M costs for the Propane Warm Air **freewatt** Plus System should be about \$100 - \$150).

## Conclusion

The Propane Warm Air **freewatt** Plus System performed according to its technical specifications and offers a practical and environmentally responsible distributed generation technology for the propane residential market.

## Questions

If you have any questions about the Propane Warm Air **freewatt** Plus System or about this report, feel free to contact Eric Guyer or Mark Macaulay at 508-359-4500.

# **Appendix A**

Grid Interconnection Paperwork



## **Simplified Process Interconnection Application Instructions**

### **General Information**

If you wish to submit an application to interconnect your generating Facility using the Simplified Process (10KW or less 1-Phase or up to 25 kW 3-Phase, inverter-based, IEEE 1547 / UL1741-listed) please fill out the attached application form down to the space for your signature. Once complete, please sign and attach any documentation provided by the generator manufacturer describing the IEEE 1547 / UL1741 listing for the generator. The process is as follows:

1. Application process:
  - a. Interconnecting Customer submits a Simplified Application filled out properly and completely.
  - b. The electric utility Company acknowledges to the Interconnecting Customer receipt of the application within three business days of receipt.
  - c. Company evaluates the application for completeness and notifies the Interconnecting Customer within 10 days of receipt that the application is or is not complete and, if not, advises what is missing.
2. Company verifies Facility equipment can be interconnected safely and reliably. Company signs application approval line and sends to Customer. In certain rare circumstances, the Company may require the Interconnecting Customer to pay for minor System Modifications, if so, an estimate will be sent back with the approved application requiring the Interconnecting Customer's consent to pay for the modifications.
3. After installation, customer returns Certificate of Completion. Prior to parallel operation Company may inspect Facility for compliance with standards which may include a witness test, and schedules appropriate metering replacement, if necessary.

Company notifies Interconnecting Customer in writing that interconnection of the Facility is authorized. If the witness test is not satisfactory, the Company has the right to disconnect the Facility. The Interconnecting Customer has no right to operate in parallel until a witness test has been performed or previously waived on the Application Form. The Company is obligated to complete this witness test within 10 days of the receipt of the Certificate of Completion. If the Company does not inspect in 10 days or by mutual agreement of the Parties, the Witness Test is deemed waived.

**Contact Information:** You must provide the contact information for the legal applicant (i.e. the Interconnecting Customer). If another party is responsible for interfacing with the Company (utility), you should provide his/her/its contact information as well.

**Ownership Information:** Please enter the legal names of the owner or owners of the Facility. Include the percentage ownership (if any) by any Company or public utility holding company, or by any entity owned by either.



## **Simplified Process - Interconnection Application Instructions, cont'd**

**Confidentiality Statement:** In an ongoing effort to improve the interconnection process for Interconnecting Customers, the information you provide and the results of the application process will be aggregated with the information of other applicants and periodically reviewed by a DG Collaborative of industry participants that has been organized by the Massachusetts Department of Telecommunications and Energy (DTE). The aggregation process mixes the data together so that specific details for one Interconnecting Customer are not revealed. In addition to this process, you may choose to allow the information specific to your application to be shared with the Collaborative by answering “Yes” to the Confidentiality Statement question on the first page. Please note that even in this case your identification information (contact data) and specific Facility location will not be shared.

**Facility Information - UL1741 Listed?:** This standard (“Inverters, Converters, and Controllers for Use in Independent Power Systems”) addresses the electrical interconnection design of various forms of generating equipment. Many manufacturers choose to submit their equipment to a Nationally Recognized Testing Laboratory (NRTL) that verifies compliance with UL1741. This “listing” is then marked on the equipment and supporting documentation.

**DEP Air Quality Permit Needed?** A Facility may be considered a point source of emissions of concern by the Massachusetts Department of Environmental Protection (DEP). Therefore, when submitting this application, please indicate whether the proposed Facility will require an Air Quality Permit. You must answer these questions, however, your specific answers will not affect whether your application is deemed complete. Please contact the DEP to determine whether the generating technology planned for your Facility qualifies for a DEP waiver or requires a permit.



**SIMPLIFIED INTERCONNECTION APPLICATION AND SERVICE AGREEMENT FOR FACILITIES WITH INVERTER CAPACITY OF 10KW OR LESS SINGLE-PHASE OR UP TO 25 KW THREE-PHASE**

Date Prepared: \_\_\_\_\_

**Contact Information**

Legal Name and address of Interconnecting Customer applicant (or, if an Individual, Individual's Name)

Company Name: \_\_\_\_\_ Contact Person: \_\_\_\_\_

Mailing Address: \_\_\_\_\_

City: \_\_\_\_\_ State: \_\_\_\_\_ Zip Code: \_\_\_\_\_

Telephone (Daytime): \_\_\_\_\_ (Evening): \_\_\_\_\_

Facsimile Number: \_\_\_\_\_ E-Mail Address: \_\_\_\_\_

**Alternative Contact Information (if different from Applicant)**

Name: \_\_\_\_\_

Mailing Address: \_\_\_\_\_

City: \_\_\_\_\_ State: \_\_\_\_\_ Zip Code: \_\_\_\_\_

Telephone (Daytime): \_\_\_\_\_ (Evening): \_\_\_\_\_

Facsimile Number: \_\_\_\_\_ E-Mail Address: \_\_\_\_\_

Ownership (include % ownership by any electric utility): \_\_\_\_\_

**Confidentiality Statement:** "I agree to allow information regarding the processing of my application (without my name and address) to be reviewed by the Massachusetts DG Collaborative that is exploring ways to further expedite future interconnections." Yes\_\_\_ No\_\_\_

**Facility Information**

Location (if different from above): \_\_\_\_\_

Electric Service Company: \_\_\_\_\_

Account Number (if available): \_\_\_\_\_

Inverter Manufacturer: \_\_\_\_\_ Model \_\_\_\_\_

Nameplate Rating: \_\_\_\_\_ (KW) \_\_\_\_\_ (kVA) \_\_\_\_\_ (AC Volts) Single\_\_\_ or Three\_\_\_ Phase

System Design Capacity: \_\_\_\_\_ (KW) \_\_\_\_\_ (kVA)

Prime Mover: Photovoltaic  Reciprocating Engine  Fuel Cell  Turbine   
Other \_\_\_\_\_

Energy Source: Solar  Wind  Hydro  Diesel  Natural Gas  Fuel Oil   
Other \_\_\_\_\_



IEEE 1547.1 (UL 1741) Listed Yes \_\_\_ No \_\_\_

Need an air quality permit from DEP? Yes \_\_\_ No \_\_\_ Not Sure \_\_\_

If "yes", have you applied for it? Yes \_\_\_ No \_\_\_

Estimated Install Date: \_\_\_\_\_ Est. In-Service Date: \_\_\_\_\_

**Customer Signature (attach manufacturer's cutsheet showing IEEE 1547.1/ UL1741 listing & sign here)**

I hereby certify that, to the best of my knowledge, all of the information provided in this application is true and I agree to the Terms and Conditions on the following page:

Interconnecting Customer Signature: \_\_\_\_\_ Title: \_\_\_\_\_ Date: \_\_\_\_\_

**Please attach any documentation provided by the inverter manufacturer describing the inverter's IEEE 1547 / UL 1741 listing.**

**Approval to Install Facility (For Company use only)**

Installation of the Facility is approved contingent upon the terms and conditions of this Agreement, and agreement to any system modifications, if required (Are system modifications required? Yes \_\_\_ No \_\_\_):

Company Signature: \_\_\_\_\_ Title: \_\_\_\_\_ Date: \_\_\_\_\_

Application ID number: \_\_\_\_\_ Company waives inspection/witness test? Yes \_\_\_ No \_\_\_



## **TERMS AND CONDITIONS FOR SIMPLIFIED INTERCONNECTIONS**

1. Construction of the Facility. The Interconnecting Customer may proceed to construct the Facility once the Approval to Install the Facility has been signed by the Company.
2. Interconnection and operation. The Interconnecting Customer may operate Facility and interconnect with the Company's system once the following has occurred:
  - 2.1. Municipal Inspection: Upon completing construction, the Interconnecting Customer will cause the Facility to be inspected or otherwise certified by the local electrical wiring inspector with jurisdiction.
  - 2.2. Certificate of Completion: The Interconnecting Customer returns the Certificate of Completion appearing as Attachment 2 to the Agreement to the Company at address noted.
  - 2.3. Company has completed or waived the right to inspection.
3. Company Right of Inspection. Within ten (10) business days after receipt of the Certificate of Completion, the Company may, upon reasonable notice and at a mutually convenient time, conduct an inspection of the Facility to ensure that all equipment has been appropriately installed and that all electrical connections have been made in accordance with the Tariff. The Company has the right to disconnect the Facility in the event of improper installation or failure to return Certificate of Completion. If the Company does not inspect in 10 days or by mutual agreement of the Parties, the Witness Test is deemed waived.
4. Safe Operations and Maintenance. The Interconnecting Customer shall be fully responsible to operate, maintain, and repair the Facility.
5. Access. The Company shall have access to the disconnect switch (if required) of the Facility at all times.
6. Disconnection. The Company may temporarily disconnect the Facility to facilitate planned or emergency Company work.
7. Metering and Billing. All Facilities approved under this Agreement qualify for net metering, as approved by the Department from time to time, and the following is necessary to implement the net metering provisions:
  - 7.1. Interconnecting Customer Provides Meter Socket. The Interconnecting Customer shall furnish and install, if not already in place, the necessary meter socket and wiring in accordance with accepted electrical standards.
  - 7.2. Company Installs Meter. The Company shall furnish and install a meter capable of net metering within ten (10) business days after receipt of the Certificate of Completion if inspection is waived, or within 10 business days after the inspection is completed, if such meter is not already in place.



8. Indemnification. Interconnecting Customer and Company shall each indemnify, defend and hold the other, its directors, officers, employees and agents (including, but not limited to, Affiliates and contractors and their employees), harmless from and against all liabilities, damages, losses, penalties, claims, demands, suits and proceedings of any nature whatsoever for personal injury (including death) or property damages to unaffiliated third parties that arise out of, or are in any manner connected with, the performance of this Agreement by that party, except to the extent that such injury or damages to unaffiliated third parties may be attributable to the negligence or willful misconduct of the party seeking indemnification.
9. Limitation of Liability. Each party's liability to the other party for any loss, cost, claim, injury, liability, or expense, including reasonable attorney's fees, relating to or arising from any act or omission in its performance of this Agreement, shall be limited to the amount of direct damage actually incurred. In no event shall either party be liable to the other party for any indirect, incidental, special, consequential, or punitive damages of any kind whatsoever.
10. Termination. This Agreement may be terminated under the following conditions:
  - 10.1. By Mutual Agreement. The Parties agree in writing to terminate the Agreement.
  - 10.2. By Interconnecting Customer. The Interconnecting Customer may terminate this Agreement by providing written notice to Company.
  - 10.3. By the Company. The Company may terminate this Agreement (1) if the Facility fails to operate for any consecutive 12 month period, or (2) in the event that the Facility impairs the operation of the electric distribution system or service to other customers or materially impairs the local circuit and the Interconnecting Customer does not cure the impairment.
11. Assignment/Transfer of Ownership of the Facility: This Agreement shall survive the transfer of ownership of the Facility to a new owner when the new owner agrees in writing to comply with the terms of this Agreement and so notifies the Company.
12. Interconnection Tariff: These Terms and Conditions are pursuant to the Company's Tariff for the Interconnection of Interconnecting Customer-Owned Generating Facilities, as approved by the Department of Telecommunications and Energy and as the same may be amended from time to time ("Interconnection Tariff"). All defined terms set forth in these Terms and Conditions are as defined in the Interconnection Tariff (see Company's website for complete tariff).



ATTACHMENT 2

CERTIFICATE OF COMPLETION
SIMPLIFIED PROCESS INTERCONNECTION

Installation Information

Check if owner-installed

Interconnecting Customer: Contact Person:

Mailing Address:

Location of Facility (if different from above):

City: State: Zip Code:

Telephone (Daytime): (Evening):

Facsimile Number: E-Mail Address:

Electrician:

Name:

Mailing Address:

City: State: Zip Code:

Telephone (Daytime): (Evening):

Facsimile Number: E-Mail Address:

License number:

Date Approval of Install Facility granted by the Company:

Application ID number:

Inspection:

The system has been installed and inspected in compliance with the local Building/Electrical Code of

(City/County)

Signed:

Local Electrical Wiring Inspector, or attach signed electrical inspection

Name (printed): Date:

As a condition of interconnection you are required to send/fax a copy of this form along with a copy of the signed electrical permit to the following person at NSTAR Electric:

Name: Joe Feraci
Company: NSTAR Electric
Mail 1: One NSTAR Way
Mail 2: Mailstop: SW360
City, State ZIP: Westwood, MA 02090
Fax No.: 781-441-8721

## **Appendix B**

Operating Data

Comparison of Warm Air freewatt System Performance Compared to Replaced Heating System for System #1

Summary

Test Period December 2007 through November 2008

	Cost of Operation	Total Primary Fuel Used (Therms)	Electricity Generated (kWhr)	CO2 (lbs)
freewatt Micro-CHP System	\$1,229.28	874.44	4,401	11,311
Old Furnace*	\$2,298.80	1,201.77	---	22,362
<b>Savings</b>	<b>\$1,069.52</b>	<b>327.33</b>	<b>4,401</b>	<b>11,051</b>

\* Includes cost of Electricity otherwise supplied by Micro-CHP System

Results for Test Period based on data recorded by freewatt System Control and Transmitted to Climate Energy over Internet (data interval is 10 minutes - 24/7)

<b>Annual Savings:</b>	<b>\$1,069.52</b>
<b>Operating Cost Savings</b>	<b>47%</b>
<b>Electric Generation CO2 Reduction Compared to Power Plant</b>	<b>63%</b>

Estimated Annual Costs based on Actual Gas Usage calculated by freewatt System's operating data

Equipment and Building Characteristics and Utility Rat

ECR freewatt System

Micro-CHP Mode Gas Consumption Rate (BTU/hr):	18,450
Micro-CHP Mode Heat Output Rate (BTU/hr):	12,500
Furnace Input Rate (BTU/hr):	80,000
Furnace Burner Efficiency:	95%
Micro-CHP Mode Electric Power Usage (Watts):	85
Furnace Electric Power Usage (Watts):	600
MCHP Power Production (kW):	1.2

Utility Costs and Grid Energy Efficiency

Cost of Heating Fuel (\$/therm Propane):	\$2.39
Cost of Cogeneration Fuel (\$/therm Propane):	\$2.39
Cost of Electricity (\$/kWhr):	\$0.19
Power Station Delivery Efficiency:	33%

Old Heating System Characteristics

Old Furnace Gas Consumption Rate (BTU/hr):	140,000
Old Furnace AFUE:	80%
Old Furnace with ECM Motor (Yes/No):	No
Old Furnace Electric Power Usage (Watts):	1200
Cost of Heating Fuel (\$/therm Oil):	\$2.88

CO2 Production

Average CO2 production for electric generation (lbs./kWhr):	1.21
CO2 production for propane combustion (lbs./therm propane):	13.00
CO2 production for oil combustion (lbs./therm Oil):	21.50

All Site Specific Inputs in this Color (Blue) Fields

Actual Runtime Data and Calculated Operating Costs and Fuel Use for Test Period

Month	MCHP Run Time (Hours)	MCHP Gas Usage (Therms)	Furnace Run Time (Hours)	Furnace Gas Usage (Therms)	Total Electrical Generation (kWhr)	Total Gas Used (Therms)	freewatt System Electrical Consumption (kWhr)	Operating Cost of freewatt System	Total Energy Cost	Total Primary Fuel Used (Therms)	Total Heat Generation (million BTU)	CO2 (lbs)	CO2 (lbs) for electrical generation	Electric Bill Savings
Dec-09	604	111.44	20	16.00	725	127.44	63.34	\$316.61	\$316.61	133.99	9.07	1,733	347	\$137.71
Jan-09	629	116.05	62	49.60	755	165.65	90.67	\$413.13	\$413.13	175.03	12.57	2,263	337	\$143.41
Feb-09	648	119.56	48	38.40	778	157.96	83.88	\$393.45	\$393.45	166.63	11.75	2,155	356	\$147.74
Mar-08	651	120.11	24	19.20	781	139.31	69.74	\$346.20	\$346.20	146.52	9.96	1,896	372	\$148.43
Apr-08	305	56.27	3	2.40	366	58.67	27.73	\$145.50	\$145.50	61.54	4.04	796	179	\$69.54
May-08	158	29.15	0	0.00	190	29.15	13.43	\$72.22	\$72.22	30.54	1.98	395	94	\$36.02
Jun-08	0	0.00	0	0.00	0	0.00	0.00	\$0.00	\$0.00	0.00	0.00	0	0	\$0.00
Jul-08	0	0.00	0	0.00	0	0.00	0.00	\$0.00	\$0.00	0.00	0.00	0	0	\$0.00
Aug-08	0	0.00	0	0.00	0	0.00	0.00	\$0.00	\$0.00	0.00	0.00	0	0	\$0.00
Sep-08	0	0.00	0	0.00	0	0.00	0.00	\$0.00	\$0.00	0.00	0.00	0	0	\$0.00
Oct-09	245	45.20	13	10.40	294	55.60	28.63	\$138.33	\$138.33	58.56	4.05	758	138	\$55.86
Nov-09	428	78.90	22	17.60	513	96.50	49.55	\$240.06	\$240.06	101.63	7.02	1,315	241	\$97.50
<b>Totals</b>	<b>3667.64</b>	<b>676.68</b>	<b>192.01</b>	<b>153.60</b>	<b>4401.16</b>	<b>830.28</b>	<b>426.95</b>	<b>\$2,065.50</b>	<b>\$2,065.50</b>	<b>874.44</b>	<b>60.44</b>	<b>11311</b>	<b>2063.77</b>	<b>\$836.22</b>

Estimated Operating Costs and Fuel Use for Old Furnace During Test Period

Month	Estimated Oil Usage for Old Furnace (Therms)	Old Furnace Electric Consumption (kWhr)	Operating Cost of Old Furnace	Electricity Made by Old Furnace	Total Energy Cost	Total Primary Fuel Used (Therms)	Fuel to Deliver Equivalent Electricity from Power Station (Therms)	CO2 (lbs)	CO2 (lbs) produced by power plant
Dec-07	113.38	97.18	\$344.98	\$0.00	\$344.98	185.89	62.47	3,434	919.47
Jan-08	157.18	134.73	\$478.28	\$0.00	\$478.28	236.17	65.05	4,458	968.22
Feb-08	146.85	125.87	\$446.84	\$0.00	\$446.84	226.89	67.02	4,252	993.34
Mar-08	124.52	106.73	\$378.89	\$0.00	\$378.89	202.89	67.33	3,753	991.65
Apr-08	50.51	43.29	\$153.68	\$0.00	\$153.68	86.53	31.54	1,582	462.46
May-08	24.69	21.16	\$75.12	\$0.00	\$75.12	43.22	16.34	786	239.16
Jun-08	0.00	0.00	\$0.00	\$0.00	\$0.00	0.00	0.00	0	0.00
Jul-08	0.00	0.00	\$0.00	\$0.00	\$0.00	0.00	0.00	0	0.00
Aug-08	0.00	0.00	\$0.00	\$0.00	\$0.00	0.00	0.00	0	0.00
Sep-08	0.00	0.00	\$0.00	\$0.00	\$0.00	0.00	0.00	0	0.00
Oct-08	50.63	43.40	\$154.06	\$0.00	\$154.06	80.46	25.34	1,497	374.23
Nov-08	87.72	75.19	\$266.93	\$0.00	\$266.93	139.73	44.23	2,599	653.03
<b>Totals</b>	<b>755.47</b>	<b>647.55</b>	<b>\$2,298.80</b>	<b>\$0.00</b>	<b>\$2,298.80</b>	<b>1201.77</b>	<b>379.32</b>	<b>22,362</b>	<b>5601.57</b>

Comparison of Warm Air freewatt System Performance Compared to Replaced Heating System for System #2

Summary

Test Period December 2007 through November 2008				
	Cost of Operation	Total Primary Fuel Used (Therms)	Electricity Generated (kWhr)	CO2 (lbs)
freewatt System	\$1,809.29	1,165.52	5,176	15,064
Old Furnace*	\$3,263.65	1,647.69	---	22,940
<b>Savings</b>	<b>\$1,454.36</b>	<b>482.17</b>	<b>5,176</b>	<b>7,876</b>

\* Includes cost of Electricity otherwise supplied by Micro-CHP System

Results for Test Period based on data recorded by freewatt System Control and Transmitted to Climate Energy over Internet (data interval is 10 minutes - 24/7)

<b>Annual Savings:</b>	<b>\$1,454.36</b>
<b>Operating Cost Savings</b>	<b>45%</b>
<b>Electric Generation CO2 Reduction Compared to Power Plant</b>	<b>68%</b>

Estimated Annual Costs based on Actual Gas Usage calculated by freewatt System's operating data

Equipment and Building Characteristics and Utility Rates

ECR freewatt System

Micro-CHP Mode Gas Consumption Rate (BTU/hr):	18,500
Micro-CHP Mode Heat Output Rate (BTU/hr):	12,500
Furnace Input Rate (BTU/hr):	60,000
Furnace Burner Efficiency:	95%
Micro-CHP Mode Electric Power Usage (Watts):	85
Furnace Electric Power Usage (Watts):	600
MCHP Power Production (kW):	1.2

CO<sub>2</sub> Production

Average CO <sub>2</sub> production for electric generation (lbs./kWhr)	1.21
CO <sub>2</sub> production for propane combustion (lbs./therm propane)	13.00
CO <sub>2</sub> production for oil combustion (lbs./therm Oil)	21.50

Utility Costs and Grid Energy Efficiency

Cost of Heating Fuel (\$/therm Propane):	\$2.39
Cost of Cogeneration Fuel (\$/therm Propane):	\$2.39
Cost of Electricity (\$/kWhr):	\$0.18
Power Station Delivery Efficiency:	33%

Old Heating System Characteristics

Old Furnace Gas Consumption Rate (BTU/hr):	40,000
Old Furnace AFUE:	80%
Old Furnace with ECM Motor (Yes/No):	No
Old Furnace Electric Power Usage (Watts):	650
Cost of Heating Fuel (\$/therm Oil):	\$2.88

All Site Specific Inputs in this Color (Blue) Fields

Actual Runtime Data and Calculated Operating Costs and Fuel Use for Test Period

Month	MCHP Run Time (Hours)	MCHP Gas Usage (Therms)	Furnace Run Time (Hours)	Furnace Gas Usage (Therms)	Total Electrical Generation (kWhr)	Total Gas Used (Therms)	freewatt System Electrical Consumption (kWhr)	Operating Cost of freewatt System	Total Energy Cost	Total Primary Fuel Used (Therms)	Total Heat Generation (million BTU)	CO <sub>2</sub> (lbs)	CO <sub>2</sub> (lbs) for electrical generation
Dec-09	617.00	114.15	74.00	44.40	740	158.55	96.85	\$396.35	\$396.35	168.56	11.93	2,178	338
Jan-09	642.00	118.77	129.00	77.40	770	196.17	131.97	\$492.60	\$492.60	209.82	15.38	2,710	329
Feb-09	662.00	122.47	112.00	67.20	794	189.67	123.47	\$475.54	\$475.54	202.44	14.66	2,615	348
Mar-08	679.00	125.62	73.00	43.80	815	169.42	101.52	\$423.17	\$423.17	179.91	12.65	2,325	375
Apr-08	425.00	78.63	14.00	8.40	510	87.03	44.53	\$216.00	\$216.00	91.63	6.11	1,185	249
May-08	266.00	49.21	0.00	0.00	319	49.21	22.61	\$121.68	\$121.68	51.55	3.33	667	159
Jun-08	0.00	0.00	0.00	0.00	0	0.00	0.00	\$0.00	\$0.00	0.00	0.00	0	0
Jul-08	0.00	0.00	0.00	0.00	0	0.00	0.00	\$0.00	\$0.00	0.00	0.00	0	0
Aug-08	0.00	0.00	4.00	2.40	0	2.40	2.40	\$6.17	\$6.17	2.65	0.23	34	-2
Sep-08	4.00	0.74	3.00	1.80	5	2.54	2.14	\$6.46	\$6.46	2.76	0.22	36	1
Oct-08	466.00	86.21	17.00	10.20	559	96.41	49.81	\$239.39	\$239.39	101.56	6.79	1,314	272
Nov-09	552.00	102.12	72.00	43.20	662	145.32	90.12	\$363.54	\$363.54	154.64	11.00	1,998	300
<b>Totals</b>	<b>4313.00</b>	<b>797.91</b>	<b>498.00</b>	<b>298.80</b>	<b>5175.60</b>	<b>1096.71</b>	<b>665.41</b>	<b>\$2,740.90</b>	<b>\$2,740.90</b>	<b>1165.52</b>	<b>82.30</b>	<b>15063.64</b>	<b>2369.60</b>

Estimated Operating Costs and Fuel Use for Old Furnace During Test Period

Month	Estimated Oil Usage for Old Furnace (Therms)	Old Furnace Electric Consumption (kWhr)	Operating Cost of Old Furnace	Electricity Made By Old Furnace	Total Energy Cost	Total Primary Fuel Used (Therms)
Dec-07	149	242	\$473.12	\$0.00	\$473.12	238
Jan-08	192	312	\$609.83	\$0.00	\$609.83	291
Feb-08	183	298	\$581.32	\$0.00	\$581.32	283
Mar-08	158	257	\$501.59	\$0.00	\$501.59	255
Apr-08	76	124	\$242.32	\$0.00	\$242.32	133
May-08	42	68	\$131.86	\$0.00	\$131.86	76
Jun-08	0	0	\$0.00	\$0.00	\$0.00	0
Jul-08	0	0	\$0.00	\$0.00	\$0.00	0
Aug-08	3	5	\$9.04	\$0.00	\$9.04	3
Sep-08	3	4	\$8.76	\$0.00	\$8.76	4
Oct-08	85	138	\$269.42	\$0.00	\$269.42	147
Nov-08	138	224	\$436.38	\$0.00	\$436.38	218
<b>Totals</b>	<b>1,029</b>	<b>1,672</b>	<b>\$3,263.65</b>	<b>\$0.00</b>	<b>\$3,263.65</b>	<b>1,648</b>

Fuel to Deliver Equivalent Electricity from Power Station (Therms)	CO <sub>2</sub> (lbs)	CO <sub>2</sub> (lbs) produced by power plant
63.81	4,397	1,074
66.40	3,811	1,152
68.47	3,706	1,174
70.23	3,354	1,176
43.96	1,762	715
27.51	1,009	441
0.00	0	0
0.00	0	0
0.00	43	3
0.41	47	9
48.20	1,949	785
57.09	2,862	965
446.07	22,940	7,492

## Climate Energy Micro-CHP Comparison Analysis

### **Definitions:**

#### **Inputs:**

Micro-CHP Mode Gas Consumption Rate (BTU/hr): measured gas input rate for the Honda module

Micro-CHP Mode Heat Output Rate (BTU/hr): measured Honda module heat output into the house

Auxiliary Burner Input Rate (BTU/hr): measured auxiliary burner gas consumption

Auxiliary Burner Efficiency: manufacturer reported AFUE

Micro-CHP Mode Electric Power Usage (Watts): measured power usage for Honda module operation, Climate Energy Hi-Module (including pump and system controller), and furnace fan on low speed when operating in first stage Micro-CHP mode.

Auxiliary Burner Electric Power Usage (Watts): measured power usage in addition to the Micro-CHP Mode Electric Power Usage to operate the auxiliary burner combustion blower and furnace fan in high speed when operating in second stage Micro-CHP mode.

Micro-CHP Power Production (kW): rated electrical output of Honda module (Beta units are 1.0 kW, production units will be 1.2 kW)

Average CO<sub>2</sub> production for electric generation (lbs./kWhr): CO<sub>2</sub> production for local aggregate electric production source profile. Source – DOE Energy Information Administration, Massachusetts Electricity Profile 2004 Edition (*DOE/EIA-0629*)

CO<sub>2</sub> production for gas combustion (lbs./therm Nat. Gas): CO<sub>2</sub> production per therm of natural gas burned

Cost of Heating Fuel (\$/therm natural gas): Approximate current cost of natural gas for use in space heating

Cost of Cogeneration Fuel (\$/therm natural gas): Approximate current cost of natural gas for use in distributed generation

Cost of Electricity (\$/kWhr): Approximate current cost of electricity

Power Station Delivery Efficiency: Electrical energy delivered to the home divided by the fuel energy it took to produce that electricity at a central power station; this number is typically an aggregate average for a region

Old Furnace Gas Consumption Rate (BTU/hr): Input rating on furnace being replaced

Old Furnace Combustion Efficiency: AFUE rating on furnace being replaced

Old Furnace with ECM Motor (Yes/No): Indicate whether the old furnace has an ECM motor

Old Furnace Electric Power Usage (Watts): Steady-state electrical power consumption of furnace being replaced

Estimated Annual Percentage of Heat Delivered in Micro-CHP Mode: Percentage of heat delivered solely by Micro-CHP module (used to estimate annual savings beyond test period)

Percentage of Heat Delivered in Micro-CHP Mode during test period: Amount of heat delivered by Micro-CHP module divided by the total amount of heat delivered to the house from the system

Estimated Heat Required for entire heating season (million BTU): Total amount of heat required to keep the house warm through the duration of the heating season; derived using Wrightsoft Manual-J heat loss analysis software

CE Micro-CHP Run Time (Hours): Number of hours that the Micro-CHP module operated for a given duration

Auxiliary Burner Run Time (Hours): Number of hours that the system auxiliary burner ran

### **Calculations:**

CE Micro-CHP Gas Usage (Therms): CE Micro-CHP Run Time times Micro-CHP Mode Gas Consumption Rate

Auxiliary Burner Gas Usage (Therms): Auxiliary Burner Run Time times Auxiliary Burner Input Rate

Total Electrical Generation (kWhr): CE Micro-CHP Run Time times Micro-CHP Power Production

Total Gas Used (Therms): Sum of the CE Micro-CHP and Auxiliary Burner Gas Usage

CE Micro-CHP System Electrical Consumption (kWhr): CE Micro-CHP Run Time times Micro-CHP Mode Electric Power Usage plus Auxiliary Burner Run Time times Auxiliary Burner Electric Power Usage

Operating Cost of CE Micro-CHP System: Sum of the Electrical Consumption times the Cost of Electricity and the Total Gas Used times the Cost of Heating Fuel

Total Energy Cost: Operating Cost of System plus the cost to purchase electricity; there is no purchase of electricity other than what is required to operate the system for the CE Micro-CHP system

Total Primary Fuel Used (Therms): Total Gas Used plus electricity purchased from a central power station divided by the Power Station Delivery Efficiency

Total Heat Generation (million BTU): CE Micro-CHP Run Time times Micro-CHP Mode Heat Output Rate plus Auxiliary Burner Run Time times Auxiliary Burner Input Rate times Auxiliary Burner Efficiency

CO<sub>2</sub> (lbs): Total Gas Used times CO<sub>2</sub> Production for Gas Combustion plus System Electrical Consumption times Average CO<sub>2</sub> Production for Electric Generation

CO<sub>2</sub> (lbs) for electrical generation: Total Gas Used minus the product of the Total Heat Generation and the inverse of 90% (efficiency of furnace used as a basis of comparison) all times CO<sub>2</sub> production for gas combustion

Estimated Gas Usage for Old Furnace (Therms): Estimated Heat Required for entire heating season divided by Old Furnace Combustion Efficiency

Old Furnace Electric Consumption (kWhr): Estimated Gas Usage for Old Furnace divided by Old Furnace Gas Consumption Rate times Old Furnace Electric Power Usage

Operating Cost of Old Furnace: Estimated Gas Usage for Old Furnace times Cost of Heating Fuel plus Old Furnace Electric Consumption times Cost of Electricity

Cost to Replace Electricity Otherwise Made by CE Micro-CHP: Total Electrical Generation times Cost of Electricity

Total Energy Cost: Operating Cost of System plus the cost to purchase of electricity; there is no purchase of electricity other than what is required to operate the system for the CE Micro-CHP system

Total Primary Fuel Used (Therms): Total Gas Used plus electricity purchased from a central power station divided by the Power Station Delivery Efficiency

Fuel to Deliver Equivalent Electricity from Power Station (Therms): Total Electrical Generation divided by Power Station Delivery Efficiency

CO<sub>2</sub> (lbs): Total Gas Used times CO<sub>2</sub> Production for Gas Combustion plus the sum of System Electrical Consumption and Total Electrical Generation times Average CO<sub>2</sub> Production for Electric Generation

CO<sub>2</sub> (lbs) produced by power plant: Total Electrical Generation (kWhr) times Average  
CO<sub>2</sub> production for electric generation

## **Appendix C**

Technical Specification  
Warm Air freewatt System

(Natural Gas Model currently on Market)

**COMBINED HEAT AND POWER FOR THE HOME**

Climate Energy's **freewatt** System combines two technologies, an advanced warm air furnace and a natural gas-fired engine-generator. This hybrid heat and power generation package provides unrivaled total energy efficiency in combined heat and power delivery to the home. The **freewatt** system is designed to be installed in the place of a typical furnace and uses the same ductwork system to deliver the heat to the home.


**freewatt SYSTEM FEATURES**

- **Honda MCHP Power Generation Technology**
  - Honda Reliable
  - Quiet (47 dBA)
  - Efficient (85%+ = Heat And Power)
  - 1.2 kW of Electric Power Production
  - UL 1741 Certified for Grid Interconnection
  - Proven Technology
  - PVC Exhaust Venting
- **Advanced Warm Air Furnace**
  - Energy-Star Qualified
  - High Efficiency (93% AFUE)
  - ECM Blower Motor: Low Power Consumption
- **Hybrid Integration Module**
  - Permanent Magnet Pump
  - Custom Air Coil Heat Exchanger
  - High Efficiency Air Filter (MERV 8)
- **Supervisory Control System**
  - **freewatt** System Controller
  - Advanced Heat And Power Algorithm
  - Communicating Thermostat
  - Internet Connection
- **Simple Installation**
- **Compatible with Conventional Air Conditioning Systems**


**freewatt SYSTEM BENEFITS**

- Reliable Power Generation, Powered by Honda™
- Significantly Reduces:
  - Home's Carbon Footprint Using Energy Conservation
  - Monthly Electric Bill by Net-Metering Power Generation & Use
- Enhanced Comfort
  - Low Level of Continuous Heat Delivery
- Indoor Air Quality – MERV 8 Air Filtration
- Increases house value by \$5,000 to \$20,000 (National Appraiser's Institute)
- Return on Investment (ROI) of up to 20% annually
- System Monitoring through the Internet Connection
- Breakthrough Home Energy Technology
- Simplified Grid Interconnection






The Furnace and HI Module assembly is design certified in the US and Canada by the Canadian Standards Association.



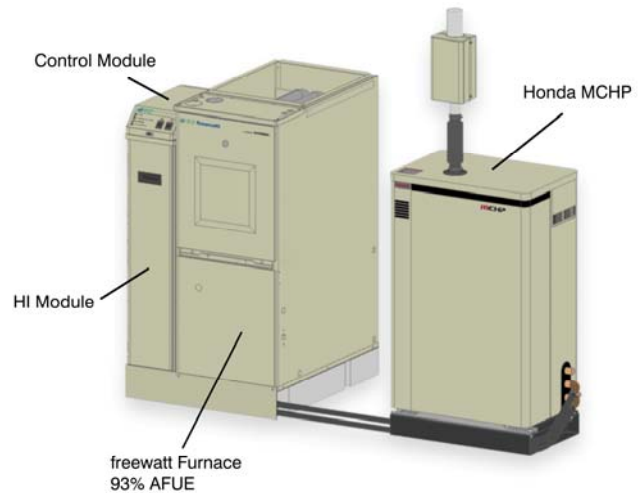
As an Energy Star partner, Climate Energy has determined that the furnace included as part of the **freewatt** system meets Energy Star guidelines for energy efficiency.



The Honda MCHP is an Underwriter's Laboratory (UL) Listed, "Utility Interactive, Cogeneration, Stationary Engine-Generator Assembly, File Number FTSR.AU2004 (U.S.) and FTSR7.AU2004 (Canada)."

## Engineered for High Efficiency

1. Honda MCHP
  - Delivers a steady-state efficiency of 85%+ while producing power and heat, thereby reducing the amount of energy consumed to generate your power
  - Delivers exhaust through PVC Venting
2. **freewatt** Furnace
  - Delivers 93% AFUE with a corrosion resistant heavy gauge aluminized-steel tubular triple-pass heat exchanger coupled with a stainless steel heat recovery coil
  - Reduces electric power consumption by 20% over conventional blower motors using an electronically commutated motor (ECM) in High Heat mode and over 80% in Low Heat Mode
3. Hybrid Integration (HI) Module
  - Consumes under 30 watts to deliver heat from Honda MCHP unit to air coil heat exchanger
4. Control Module
  - Advanced heat and power algorithm optimizes power production of Honda MCHP unit



## Warm Air freewatt System

## Advanced Technology

5. Onboard Inverter
  - Integrated inverter delivers high quality power to the home's main circuit panel
  - UL 1741 Certified for Grid Interconnection
6. Exhaust Heat Exchanger
  - High efficiency heat exchanger reduces exhaust products to 140° F, allowing use of PVC venting
  - Three-way catalytic converter significantly reduces emissions
7. Combustion Control System
  - Oxygen sensor feedback allows for excellent emissions control
  - Stepping gas valve offers almost unlimited control of gas:air mixture

## Quiet Operation & Comfort

### Honda MCHP

- Generates heat & power at a noise level of only 47 dBA

### Advanced Warm Air Furnace

- Low Heat mode drastically reduces temperature swings, increases overall comfort and lowers the unit's noise

### freewatt System

- Low Heat mode – MCHP operates
- High Heat mode – MCHP and furnace operate



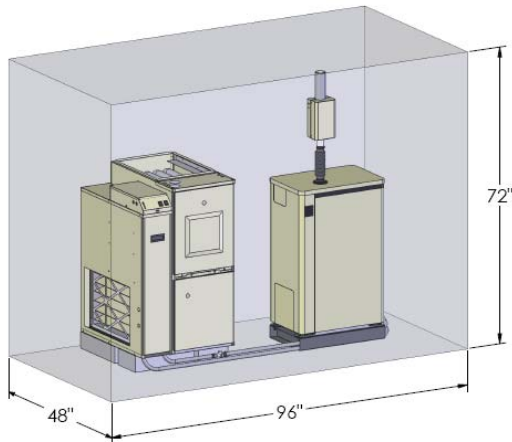
## Honda MCHP Unit

## Reliability

Honda's commitment to bringing products to market that improve the quality of people's life goes well beyond cars and motorcycles. Since 1953, Honda has manufactured over 40 million power products worldwide and continues as a leader in the development of low-emission, fuel efficient, environmentally friendly 4-stroke engines for use in numerous power equipment applications. Now Honda's unwavering reliability, quality, durability and environmentally conscious efficiency combines with Climate Energy's **freewatt** System to bring micro-combined heat and power to the home.

**Model WAA**

**Typical Warm Air freewatt System Footprint**



**Model WAA**

**Connections**

**Furnace/Hi Module**

**Electrical:** 120 Volts AC, 60 Hz, 1 phase, Less than 12 amps

**Air Intake/Vent:** 2" / 3" Sch 40 PVC

**Natural Gas:** 1/2" NPT

**Condensate Drain:** 1/2" PVC

**Internet Connection:** RJ45

**Honda MCHP**

**Electrical:** 240 Volts AC, 60 Hz, 1 phase, Less than 5 amps

**Vent:** 2" Sch 40 PVC

**Natural Gas:** 1/2" NPT w/ flexible connector

**Condensate Drain:** 1/2" Tube

**Consult Installation Manuals for more details.**

**Model WAA**

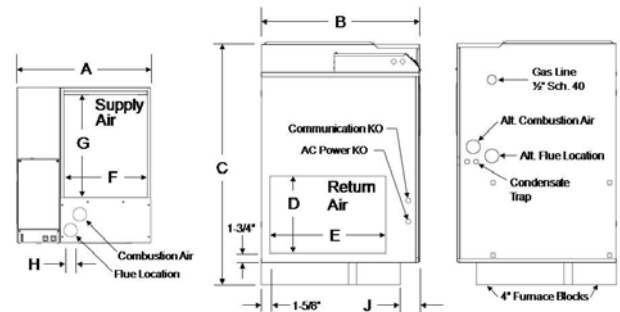
**System Clearances**

Dimensions	Furnace/ HI Module	Honda MCHP	Service
Top	1"	20"	8"
Left Side	0"	12"	24"
Right Side	0"	12"	-
Base	C - Note 1	B - Note 2	-
Front	0"	21"	24"
Back	0"	2"	-
Intake/Vent Piping	0"	0"	-

- Note: 1. Combustible floor (but not carpet or non-ceramic tile).  
 2. MCHP is attached to base that is anchored to concrete floor.  
 3. All dimensions are inches and are measured from cabinet.

**Model WAA**

**Integrated Furnace and HI Module Dimensions**



Model	Width A	Depth B	Height C	Vents H	Supply Air (F x G)	Return Air (D x E)	Overhang J
60	25	29	44	2	15-7/8 x 20	14-1/4 x 21-1/4	3-1/2 to 5
80	26-1/2	29	44	2	17-1/2 x 20	14-1/4 x 21-1/4	3-1/2 to 5
100	28-1/2	29	44	2	19-1/2 x 20	14-1/4 x 21-1/4	3-1/2 to 5

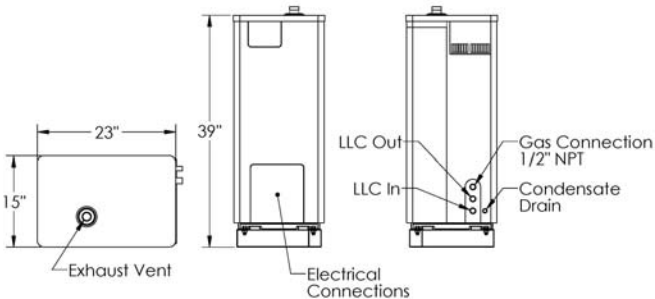
**Model WAA**

**Honda MCHP Unit - Standard YM2A Model**

**CONCRETE FLOOR REQUIREMENTS:**  
 THICKNESS: 3" MINIMUM  
 FLATNESS: 1/2" IN 10 FEET CLASS CX  
 DROP-IN ANCHOR: 3/8" OD x 1.75" LONG (5/16"-18 THREAD) QUANTITY 4

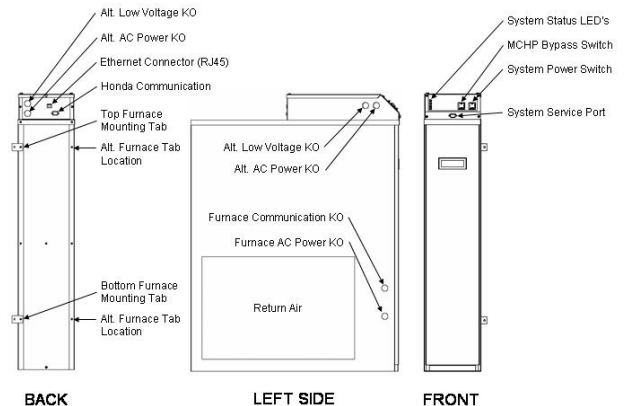
**Clearance to Combustibles**

Top: 20 Inches  
 Front: 21 Inches + Service  
 Sides: 12+ Inches  
 Rear: 2 Inches  
 Bottom: Concrete Floor



**Model WAA**

**Hybrid Integration Module Details**



### freewatt HEATING CAPACITIES – NATURAL GAS

Model	WAA060N00A	WAA080N00A	WAA100N00A
Honda MCHP			
Input (BTU) 0-2,000'	18,500	18,500	18,500
Output (BTU) 0-2,000'	12,000	12,000	12,000
Furnace			
Input (BTU) 0-2,000'	60,000	80,000	100,000
Output (BTU) 0-2,000'	55,800	74,400	93,000
Furnace Efficiency (AFUE)	93%	93%	93%

### AIRFLOW AND COOLING

Cooling Capacity (tons)	3	4	4
Heating - Max cfm @ 0.20" WC	1,200	1,700	1,800
Cooling - Max cfm @ 0.50" WC	1,200	1,600	1,700
Motor – ECM Direct Drive	½ hp	½ hp	¾ hp

### DUCTWORK CONNECTION DIMENSIONS

Supply Air (F x G)	16 x 20	17.5 x 20	19.5 x 20
Return Air (D x E)	14 x 22	14 x 22	14 x 22

### MAXIMUM VENTING LENGTHS (EACH ELBOW EQUALS FIVE FEET)

Venting Length (ft.) – Furnace (3")	100 ft.	100 ft.	100 ft.
Venting Length (ft.) – Honda MCHP (2")	90 ft.	90 ft.	90 ft.

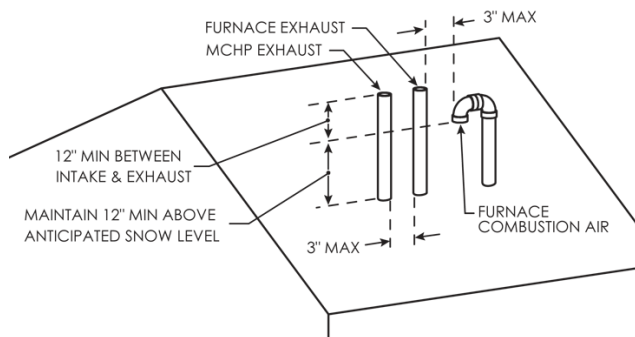
### Model WAA

#### freewatt Air Filter Details

MERV Rating: 8  
 Air Flow Rating:  
 Medium: 1,400 cfm  
 High: 1,750 cfm  
 Resistance:  
 Medium: 0.19 W.G  
 High: 0.29 W.G.  
 Face Area: 18.6 sq. ft.  
 Media Area/Face Area: 1.0 sq. ft.  
 The filter is Class 2 Approved and Listed.

### Model WAA

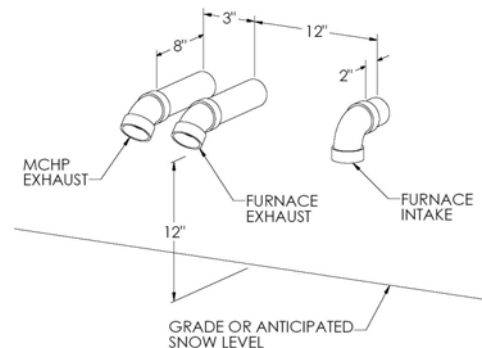
#### Typical Roof Vent/Intake Terminations



**Consult Installation Manuals for more details.**

### Model WAA

#### Typical Sidewall Vent/Intake Terminations



**Consult Installation Manuals for more details.**

### Model WAA

#### Grid Interconnection

The Honda MCHP unit must be grid interconnected in order to operate properly. Depending on the state's regulations and the electric utility, different grid interconnection application processes are required. Climate Energy is actively educating state governments and electric utilities about the benefits of Micro-CHP and how the **freewatt** system can be a critical component in their energy conservation portfolio. If any questions surface during the grid interconnection process, please contact your Climate Energy product technician or Climate Energy at 508-359-4500.



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## **Appendix D**

Product Brochure

Warm Air freewatt System

(Natural Gas Model currently on Market)