



REC 16-692  
Ground Energy Support LLC  
2 Maple St  
Durham NH 03824  
(603) 867-9762  
www.groundenergy.com

NHPUC 27 JUN 16 PM 12:08

24 June 2016

Debra Howland  
Executive Director  
State of New Hampshire  
Public Utilities Commission  
21 S. Fruit St, Suite 10  
Concord, NH 03301-2429

Dear Ms. Howland:

Please find enclosed the application for the geothermal heat pump system at 23 Country Side Dr, Nashua NH to become registered as a Class-I Thermal generating facility pursuant to Puc 2500.

The contact information for the owner is:

Eric Christian  
23 Country Side Dr.  
Nashua NH 03062  
eric678@gmail.com

Mr. Christian will be using Revolution Energy Aggregation LLC as the Aggregator. Mr. Christian also seeks approval of using Ground Energy Support (GES) as the Independent Monitor even though he is also using metering equipment sold by GES, as approved for Rolling Dog Farm in DE 14-237.

As per the instructions, I have enclosed the originals and two copies and will forward electronic versions to yourself and Ms. Bernstein. Please let me know if you have any questions or need any additional information.

Respectfully,

A handwritten signature in blue ink, appearing to read "J. Matthew Davis".

J. Matthew Davis, Ph.D.  
Vice President, CTO

Cc: Eric Christian



**Revolution Energy Aggregation, LLC**  
208 Market Street, Suite 30  
Portsmouth, NH 03801

February 10, 2016

New Hampshire Public Utilities Commission  
21 South Fruit Street  
Suite 10  
Concord, NH 03301-2429  
Tel: 603-271-2431  
Fax: 603-271-3878  
executive.director@puc.nh.gov

**Re: Revolution Energy Aggregation (REA) Facilities – Eric Christian NON 70949**

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To Whom It May Concern,

Thank you for your consideration on this matter.

Revolution Energy Aggregation, LLC (REA) respectfully requests to add the below noted generating facility(s) to REA's aggregator serve of renewable energy facilities in New Hampshire. REA will provide the service of aggregating the Renewable Energy Credits (RECs) generated from the generating facility(s) for sale in the ISO- NE REC market. The Unit name for each facility is listed below. The NEPOOL GIS Account name for REA is: REAg ID - 15299.

Facility To Be Aggregated:

Eric Christian, 23 Country Side Drive, Nashua, NH 03060 - NON70949

Please do not hesitate to contact us regarding any questions or concerns you may have with this request.

Sincerely,

A handwritten signature in black ink, appearing to read 'Michael Behrmann', with a long horizontal flourish extending to the right.

Michael Behrmann  
Revolution Energy Aggregation, LLC

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State of New Hampshire  
 Public Utilities Commission  
 21 S. Fruit Street, Suite 10, Concord, NH 03301-2429



**DRAFT**

APPLICATION FORM FOR  
**RENEWABLE ENERGY SOURCE ELIGIBILITY FOR  
 CLASS I THERMAL SOURCES WITH RENEWABLE THERMAL ENERGY CAPACITY  
 200,000 BTU/HR OR LESS**

*Pursuant to New Hampshire Administrative Code [PUC 2500](#) Rules*

- Please submit one (1) original and two (2) paper copies of the completed application and cover letter\* to:  
 Debra A. Howland  
 Executive Director  
 New Hampshire Public Utilities Commission  
 21 South Fruit Street, Suite 10  
 Concord, NH 03301-2429
- Send an electronic version of the completed application and the cover letter electronically to [executive.director@puc.nh.gov](mailto:executive.director@puc.nh.gov).

\* The cover letter must include complete contact information and identify the renewable energy class for which the applicant seeks eligibility. Pursuant to PUC 2505.01, the Commission is required to render a decision on an application within 45 days of receiving a completed application.

If you have any questions please contact Barbara Bernstein at (603) 271-6011 or [Barbara.Bernstein@puc.nh.gov](mailto:Barbara.Bernstein@puc.nh.gov).

**Only facilities that began operation after January 1, 2013 are eligible.**

Is this facility part of a Commission approved aggregation?

Yes  No

Aggregator's Company Name: Revolution Energy Aggregation LLC

Aggregator Contact Information: Mike Berhmann (mike@rev-en.com)

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## Attachment Labeling Instructions

Please label all attachments by Part and Question number to which they apply (e.g. Part 3-7). For electronic submission, name each attachment file using the Owner Name and Part and Question number (e.g. Pearson Part 3-7).

## Part 1. General Application Information

Please provide the following information:

### Applicant

Name: ERIC CHRISTIAN

Mailing Address: 23 COUNTRY SIDE DR

Town/City: NASHUA State: NH Zip Code: 03062

Primary Contact: ERIC CHRISTIAN

Telephone: 603-864-6811 Cell: 603-557-5553

Email Address: eric678@gmail.com

### Facility

Name: COUNTRY SIDE GEOTHERMAL

Physical Address: 23 COUNTRY SIDE DR

Town/City: NASHUA State: NH Zip Code: 03062

If the facility does not have a physical address, the Latitude: \_\_\_\_\_ & Longitude \_\_\_\_\_

### Installer

Name: QUEST GEOTHERMAL

Installer License Number, if applicable: N/A

Mailing Address: 164 NH-108

Town/City: Somersworth State: NH Zip Code: 03878

Primary Contact: Stuart Smith

Telephone: 603-434-4278 Cell: 603 833 6240

Email Address: stuart@questgeothermal.com

If the equipment was installed by the facility owner, check here:

If the facility operator is different from the owner, please provide the following:

Facility Operator Name: \_\_\_\_\_

Facility Operator Telephone Number: \_\_\_\_\_

## Independent Monitor

Name: GROUND ENERGY SUPPORT LLC  
Mailing Address: 2 MAPLE ST  
Town/City: DURHAM State: NH Zip Code: 03824  
Primary Contact: Matt Davis  
Telephone: (603) 867-9762 Cell: \_\_\_\_\_  
Email Address: mdavis@groundenergysupport.com

## NEPOOL/GIS Asset ID and Facility Code

***In order to qualify your facility's electrical production for RECs, you must register with the NEPOOL – GIS. Contact information for the GIS administrator follows:***

**James Webb**  
**Registry Administrator, APX Environmental Markets**  
224 Airport Parkway, Suite 600, San Jose, CA 95110  
Office: 408.517.2174  
[jwebb@apx.com](mailto:jwebb@apx.com)

Mr. Webb will assist you in obtaining a GIS facility code and an ISO-New England asset ID number.

GIS Facility Code # NON70949 Asset ID # \_\_\_\_\_

Has the facility been certified under another non-federal jurisdiction's renewable portfolio standards?  
Yes  No

If you selected yes, please provide proof of certification in the form of an attached document as **Attachment 1-8**.

Attach any supplementary documentation that will help in classification of the facility as **Attachment 1-9**.

## Part 2. Technology Specific Data

### All Technologies

Renewable energy source: Solar  Geothermal  Biomass

Rated Thermal Capacity :

Btu/hr 29,700 MW equivalent 0.009

Please show your calculation here: 27,700/3,412,000

Date of initial operation using renewable source: December 2014

### Part 3. Metering and Measurement of Thermal Energy and REC Calculations

This section covers the thermal metering system including methods for calculation and reporting useful thermal energy. **A copy of PUC 2506.04 of the RPS rules is included as Appendix A of this application.** Applicants for small thermal systems may choose to meter the thermal energy generated (Part 3A) or use a simplified approach employing run time meters (Part 3B) coupled with calculations to estimate energy production based on operating time.

Indicate method used and complete corresponding section of the application:

Select one	Attachment Number	Description
<input type="checkbox"/>	3A (see page 5 – 6)	Metering with a Heat Meter pursuant to 2506.04(g)(1)
<input type="checkbox"/>	3B-Solar (see page 7)	Runtime metering of solar thermal pursuant to 2506.04(h)
<input checked="" type="checkbox"/>	3B-Geothermal (see page 7)	Runtime metering of geothermal pursuant to 2506.04(i)
<input type="checkbox"/>	3B-Biomass (see page 8)	Runtime metering of biomass pursuant to 2506.04(j)

**Only complete the section of the application that corresponds with the attachment number checked above.**

#### 3A. Metering with a Heat Meter

Using the table below, identify the thermal metering system packaged system or custom components (e.g., heat meters, flow meters, pressure and temperature sensors) used to measure the useful thermal energy and enter the accuracy of measurement for the entire system:

System or Component	Product name	Product Manufacturer	Model No.	Product Seller
N/A				
Total System Accuracy (Percent)			%	

Attach component specification sheets (Accuracy, Operating Ranges) as **Attachment 3A-1.**

Attach a simple schematic identifying the location of each sensor that is part of the metering system as **Attachment 3A-2.**

Check the applicable standard for meter accuracy prescribed in Puc 2506.04 among the six choices below (compliance with Puc 2506.04 shall be certified by a professional engineer licensed by the state of New Hampshire and in good standing):

*If the facility is using a liquid or air based system, check the method that applies:*

A	Installation and use of heat meters capable of meeting the accuracy provisions of European Standard EN 1434 published by CEN, the European Committee for Standardization. The heat meter shall have the highest Class flow meter that will cover the design flow range at the point of measurement and a temperature sensor pair of Class 5K or lower.	<input type="checkbox"/>
B	Installation and use of meters that do not comply with European Standard EN 1434, provided that the manufacturers' guaranteed accuracy of the meters is $\pm 5.0\%$ or better,	<input type="checkbox"/>
C	Use of an alternative metering method approved pursuant to Puc 2506.06.	<input type="checkbox"/>

*If the facility is using a steam-based system, check the method that applies:*

A	Installation and use of meters with accuracy of $\pm 3.0\%$ or better.	<input type="checkbox"/>
B	Installation and use of meters with system accuracy that do not meet 2.b.1) but are $\pm 5\%$ or better.	<input type="checkbox"/>
C	Use of an alternative metering method approved pursuant to Puc 2506.06.	<input type="checkbox"/>

Please summarize the manufacturer's recommended methods and frequency for metering system calibration and provide reference for source document (e.g. owners/operators manual):

**REC Calculation Discount Factor**

REC Calculation Discount factor for meter accuracy. (Enter 0 if no discount is required): \_\_\_\_\_ %

If the meters used to measure useful thermal energy comply with the accuracy of the European Standard EN 1434 for liquid systems or use of meters with accuracy of  $\pm 3.0\%$  or better for steam systems enter zero, for all other systems enter the sum total of the manufacturer's guaranteed accuracy of the meters used or the accuracy of the alternative method approved pursuant to Puc 2506.06. \_\_\_\_\_ %

### 3B-Solar for Systems Using Solar Technologies

This method for calculating useful thermal energy is based on the run time of the collector system's circulating pump. Please fill out the following information regarding the meter at your facility.

Product Name   N/A  

Product Manufacturer \_\_\_\_\_ Model Number \_\_\_\_\_

In order to calculate the useful energy produced by a solar thermal facility, please fill out the following information on variables determined one time for the calculations:

Variable	Definition	Value	Units
R	SRCC OG100 rating on Medium Radiation C Conditions		Thousands of Btu per day
L	Orientation and shading losses		Percentage as a decimal < 1
h	Conversion factor from SRCC OG100 to hourly basis	11	Hours per day

Please refer to Appendix A, Puc 2506.04 Metering of Sources that Produce Useful Thermal Energy subpart H to determine the useful thermal energy of your facility.

### 3B-Geothermal for Systems Using Geothermal Thermal Technologies

This method for calculating useful thermal energy is based on the run time of the system's ground loop pump. Please fill out the following information regarding the meter at your facility.

Product Name   GxTracker  

Product Manufacturer   Ground Energy Support  

Model Number   GxT-Power  

In order to calculate the useful energy produced by a geothermal thermal facility, please fill out the following information for each heat pump installed at facility:

AHRI Certified Heat Pump Performance Ratings					
N	Manufacturer	Series/Model	Part Load		Full Load
			COP [ - ]	HC [MBtuH]	HC [MBtuH]
1	ClimateMaster	TEV038B	4.80	23,800	29,700

Total system heating capacity (sum of Full Load HC):

Please refer to Appendix A, Puc 2506.04 Metering of Sources that Produce Useful Thermal Energy Subpart I to determine the useful thermal energy of your facility.

### 3B-Biomass for Systems Using Thermal Biomass Technologies

This method for calculating useful thermal energy is based on the run time of the system's fuel auger. Please fill out the following information regarding the auger at your facility.

Product Name   N/A  

Product Manufacturer \_\_\_\_\_

Model Number \_\_\_\_\_

In order to calculate the useful energy produced by a solar thermal facility, please fill out the following information unless it is already given:			
Variable	Definition	Value	Units
D	Default pellet density	0.0231	Pounds
R	Auger revolutions		Per hour
V	<b>Auger feed volume</b> Assume one of the following: a. 5 cubic inches per revolution for augers with a 2" inside diameter; b. 20 cubic inches per revolution for augers with a 3" inside diameter; c. 50 cubic inches per revolution for augers with a 4" inside diameter; d. 95 cubic inches per revolution for augers with a 5" inside diameter; or e. 150 cubic inches per revolution for augers with a 6" inside diameter		Cubic inches per auger revolution
EC	Default energy content of the fuel pellet	7870	Btu/lb
ASE	Default thermal efficiency (choose one):		Percentage converted to a decimal
	<input type="checkbox"/> <i>Based on the manufacturer's warranty</i>		
	<input type="checkbox"/> <i>Based on average seasonal thermal efficiency</i>		
	<input type="checkbox"/> <i>Based on default value of 65%</i>	0.65	
<i>Please refer to Appendix A, Puc 2506.04 Metering of Sources that Produce Useful Thermal Energy Subpart J to determine the useful thermal energy of your facility.</i>			

If a thermal biomass facility, provide the New Hampshire Department of Environmental Services approval letter that the facility meets the provisions set forth in Puc 25005.02(d)15d as **Attachment 3-A**. (See the proposed best management practices that are consistent with the recommendations in the report entitled "Emission Controls for Small Wood-Fired Boilers" prepared for the US Forest Service, Western Forestry Leadership Coalition, by RSG, Inc., May 6, 2010 available at, [http://www.wflcenter.org/news\\_pdf/361\\_pdf.pdf](http://www.wflcenter.org/news_pdf/361_pdf.pdf), as specified in Appendix B.

## Part 4. Statements

The following statements must be completed by the owner/application preparer and a NH Professional Engineer attesting to the accuracy of the contents of the application pursuant to PUC 2505.02 (b) (14). An electronic signature is permitted pursuant to RSA 294-E.

### Owner/Preparer Statement

#### STATEMENT

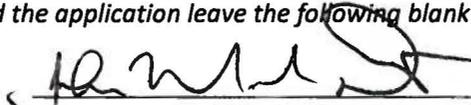
1. I, Eric Christian have reviewed the contents of this application and attest that it is accurate and is signed under the pains and penalties of perjury.

2. I, Eric Christian attest that the system is installed and operating in compliance with applicable building codes.

Applicant's Signature  Date 2/7/16

Applicant's Printed Name Eric Christian

If the applicant prepared the application leave the following blank

Preparer's Signature  Date 2/12/16

Preparer's Printed Name Matthew Davis

Subscribed and sworn before me this 12<sup>th</sup> Day of February (Month) in the year 2016

County of Stratford State of New Hampshire

Notary Public/Justice of the Peace Seal

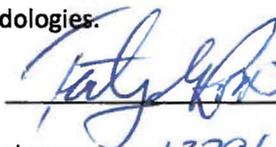
My Commission Expires: September 28, 2016 (Date)



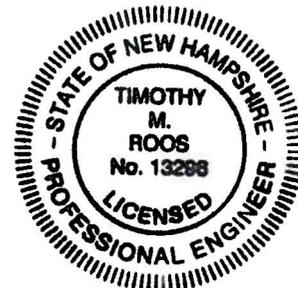
### NH Professional Engineer Affidavit

#### STATEMENT

I, Timothy M. Roos attest that this facility meets the requirements of the thermal REC eligibility requirements of Puc 2500, including the thermal metering and measurement methodologies and standards and REC calculation methodologies.

Professional Engineer's Signature  Date 6/15/16

NH Professional Engineer License Number 13296  
PE Stamp



## Attachment Checklist

Application Section	Item Description	Check box
<b>Part 1</b>		<input type="checkbox"/>
Attachment 1-A	If the facility has been certified under another non-federal jurisdiction's renewable portfolio standard, provide proof thereof.	<input type="checkbox"/>
	Please note that GIS operating rules REQUIRE an independent monitor. Applications will not be fully certified unless an independent monitor is identified.	<input type="checkbox"/>
Attachment 1-B	Attach any supplementary documentation that will help in the classification of this facility.	<input type="checkbox"/>
<b>Part 3</b>		
Attachment 3A -1	Attach component specification sheets (Accuracy, Operating Ranges)	<input type="checkbox"/>
Attachment 3A -2	Attach a simple schematic identifying the location of each sensor that is part of the metering system.	<input type="checkbox"/>
<b>Part 3B-1</b>		
<b><i>Biomass only!</i></b>	<b><i>Biomass – best management practices approval from DES</i></b>	<input type="checkbox"/>

**NH Independent Monitor:**

Name: Matt Davis

**Facility Contact:**

Name: Eric Christian

**Facility Location:**

Street: 23 County Side Dr

Date: 2/7/16

City/Town: Nashua

County: Hillsborough

**Heat Pump System Specifications**

**Ground Loop Supply Line:** Pressure Tank [Y/N] | Water Filter [Y/N] | Flow Center (Y/N)

**Source Type (check one):**  Ground Water (GWHP) or  Ground Loop (GLHP) *Internal*

**Non-Ground Sources:** Do any of the heat pumps have a supply other than ground loop? [Y/N]

N	Manufacturer	Model Series-Capacity	Name plate Photo	COP	HC	EER	Full Load HC
				Part Load, GWHP or GLHP			
1	ClimateMaster	TEV038B	<input checked="" type="checkbox"/>	4.8	23,800	<del>28.5</del>	29,700
2			<input type="checkbox"/>			29.6	
3			<input type="checkbox"/>				

**Monitoring Equipment Inspection**

Meter Manufacturer Green Energy Support Model: GXT-Power

HP	EWT Sensor	LWT Sensor	Runtime Sensor	Run Cycle	✓
1	Type: <u>OMP</u>	Type: <u>OMP</u>	Type: <u>CT</u>	Start: <u>11:21</u>	<input checked="" type="checkbox"/>
	ID: <u>G11377</u>	ID: <u>G11375</u>	ID: <u>G1019-1</u>	End: <u>11:20</u>	
2	Type:	Type:	Type:	Start:	<input type="checkbox"/>
	ID:	ID:	ID:	End:	
3	Type:	Type:	Type:	Start:	<input type="checkbox"/>
	ID:	ID:	ID:	End:	

Temp sensors: OMP=on metal pipe; OPP=on plastic pipe; TW=thermal well, HP= inside heat pump

Runtime sensors: CS= current switch; CT = current transducer; FM = Flowmeter.

✓ indicates heat pump cycle was correctly recorded by meter.

**Meter Readings:**

- ONLINE:** Connection type:  Direct Ethernet    Powerline Adapter    Wireless
- MANUAL:** Photograph meter display and note location of heating runtime [hrs].

**Useful Thermal Energy:**

Description of Use(s): Residential

Conditioned Space (Square Feet): 2000 SF

Unusual circumstances, if any: None

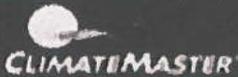
Total System Heating Capacity (sum of Full Load HC on previous page): 29,700 Btu/hr

**Nameplate Photographs:**

see attached

Independent Monitor Signature: [Signature]   Date: 4/7/16

MEMBER



Replacement Parts  
(405)745-6000 7300 NW 44th  
Oklahoma City, OK 73179  
www.climatemaster.com

The equipment complies with the 1999  
requirements of ASHRAE standard 90.1



Model: **TEV038BGD02CLTS**

Serial: **S14523531**

Electrical Service		Current (Amps)		Fuse/Circuit Breaker Size	
208/240	V	Min. CKT Ampacity	45 2R	Max. Time Delay Fuse	40R
60	Hz	Branch CKT		Max. HACR CT Breaker	40R
	Ph	Selection Current	NR	Max. CKT BRK-CPA	40R
197	Min. V	Rated Current	NR		

SCCH **NR**



ISO Capacity Ratings		Compressor (E.a)		Blower Motor (E.a)	
Cooling	Heating	FLA	LS	HP	LS
12.2-13.0 NLS B35	12.0-12.0 B10 B0	FLA	57.0	FLA	8.9
11.8-11.1 kW	13.1-1.9 kW	Qty		Qty	1

Factory Charged	Unit Pump Max
Refrigerant <b>R410A</b>	<b>NR</b>
<b>5.5</b> lbs. CKT	



Design Pressure PSIG High **650** Low **550**



Ground Energy Support  
 GXT Node ID: **1303**  
 Heat Pump # **1**

# Certificate of Product Ratings

**AHRI Certified Reference Number: 7212557**

Date: 5/24/2016

†Status: Active

**Product: Water/Brine to Air Heat Pump Packaged Unit**

**Model Number: TEV/H/D038B**

**Manufacturer: CLIMATE MASTER, INC.**

**Trade/Brand name: TRANQUILITY 30 DIGITAL**

**Rated as follows in accordance with ANSI/AHRI/ASHRAE/ISO Standard 13256-1 for Water-to-Air and Brine-To-Air Heat Pumps and subject to verification of rating accuracy by AHRI-sponsored, independent, third party testing:**

Air Flow Rate - Cooling:	1250 / 1250	Air Flow Rate - Cooling - Part Load	1000 / 1000
Air Flow Rate - Heating:	1250 / 1250	Air Flow Rate - Heating - Part Load	1000 / 1000

<b>WLHP (Water-Loop Heat Pumps)</b>	<b>Full Load</b>	<b>Part Load</b>
Cooling Capacity(Btuh)	37700 / 37700	27400 / 27400
Cooling EER Rating(Btuh/watt)	17.90 / 17.90	20.10 / 20.10
Cooling Fluid Flow Rate(gpm)	9.50 / 9.50	8.50 / 8.50
Heating Capacity(Btuh)	45700 / 45700	32600 / 32600
Heating COP(watt/watt)	5.80 / 5.80	6.50 / 6.50
Heating Fluid Flow Rate(gpm)	9.50 / 9.50	8.50 / 8.50

<b>GWHP (Ground-Water Heat Pumps)</b>		
Cooling Capacity(Btuh)	42100 / 42100	30700 / 30700
Cooling EER Rating(Btuh/watt)	26.10 / 26.10	34.40 / 34.40
Cooling Fluid Flow Rate(gpm)	9.50 / 9.50	8.50 / 8.50
Heating Capacity(Btuh)	37900 / 37900	27300 / 27300
Heating COP(watt/watt)	5.20 / 5.20	5.50 / 5.50
Heating Fluid Flow Rate(gpm)	9.50 / 9.50	8.50 / 8.50

<b>GLHP (Ground-Loop Heat Pumps)</b>		
Cooling Capacity(Btuh)	39000 / 39000	29700 / 29700
Cooling EER Rating(Btuh/watt)	20.30 / 20.30	29.60 / 29.60
Cooling Fluid Flow Rate(gpm)	9.50 / 9.50	8.50 / 8.50
Heating Capacity(Btuh)	29700 / 29700	23800 / 23800
Heating COP(watt/watt)	4.40 / 4.40	4.80 / 4.80
Heating Fluid Flow Rate(gpm)	9.50 / 9.50	8.50 / 8.50

**Indoor Blower Motor Fan Type:**

**Sold In: USA;**

\* Ratings followed by an asterisk (\*) indicate a voluntary rerate of previously published data, unless accompanied with a WAS, which indicates an involuntary rerate.

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**CERTIFICATE VERIFICATION**

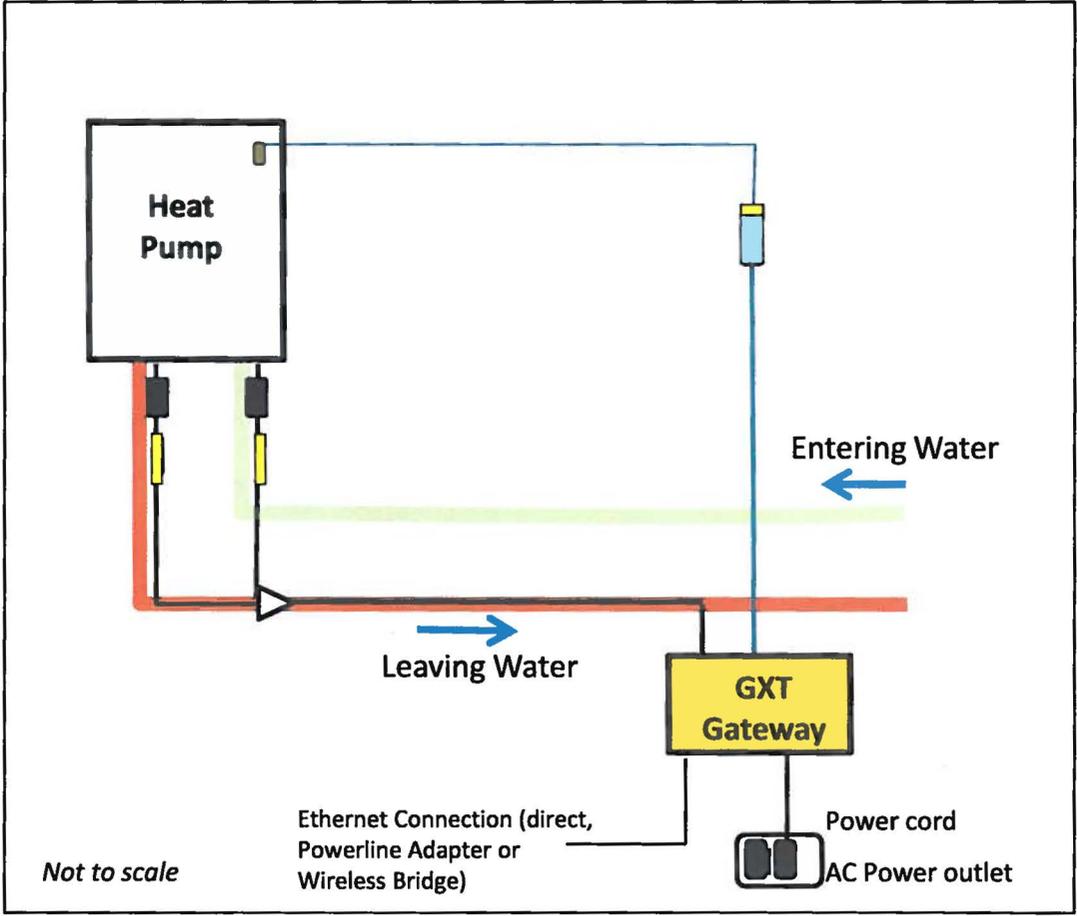
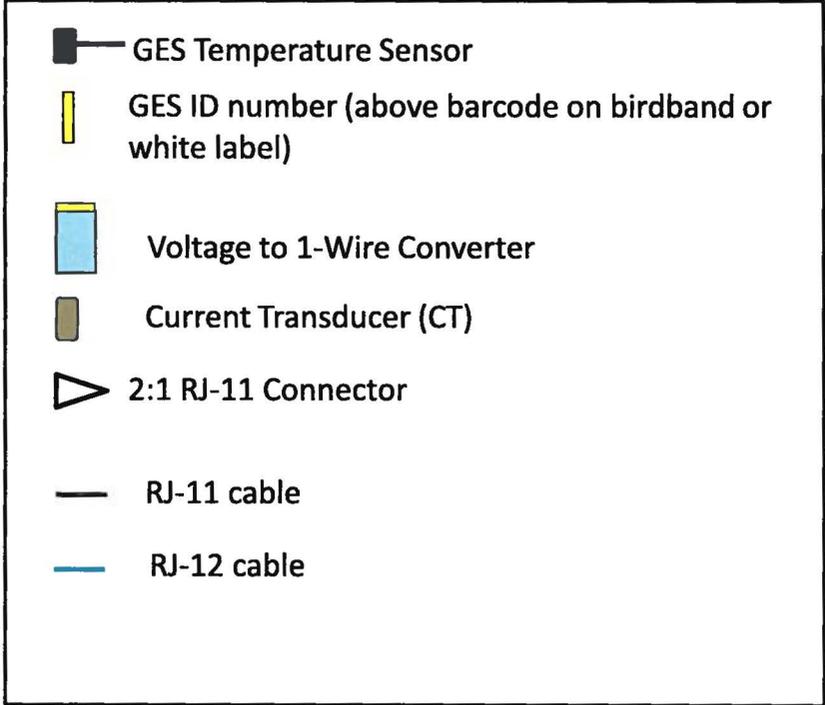
The information for the model cited on this certificate can be verified at [www.ahrirectory.org](http://www.ahrirectory.org), click on "Verify Certificate" link and enter the AHRI Certified Reference Number and the date on which the certificate was issued, which is listed above, and the Certificate No., which is listed at bottom right.

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**CERTIFICATE NO.:** 131085768592518688



GXT-Power



# Geothermal Heat Pump Runtime Metering

## Document applies to:

- GxTracker-Basic
- GxTracker-Power
- GxTracker-PowerPlus

The GxTracker™ is an easy-to-install web-based monitoring system that displays ground source heat pump (GSHP) system operating data an online data portal.

Heat Pump runtimes are stored in separate heating- and cooling-runtime registers and can be used to compute Useful Thermal Energy produced in compliance with New Hampshire Public Utilities Commission (Proposed) Rule 2500.

**System Components:** Each GxTracker Monitoring System consists of three essential components to measure heating runtime:

- Ethernet gateway to transmit data to GES server
- On-pipe temperature sensor pair to measure entering and leaving water temperatures (EWT and LWT)
- Current or flow sensing device to detect heat pump activity

## System Requirements:

- Always-on internet connection.\*
- Exposed entering and leaving water pipes.
- Up to three geothermal heat pumps.

\* Thermal energy produced when GxTracker is offline will not be reported and Thermal RECs are forfeited.

## Operating Algorithm:

1 Heat Pump data is posted to GES server once per minute using local internet connection.

2 Heat Pump On/Off status determined from electric input to compressor (current switch, current transducer, or watt meter) or inline flowmeter.

3 **If EWT > LWT**, time interval is registered as "HEATING"  
**If EWT < LWT**, time interval is registered as "COOLING"

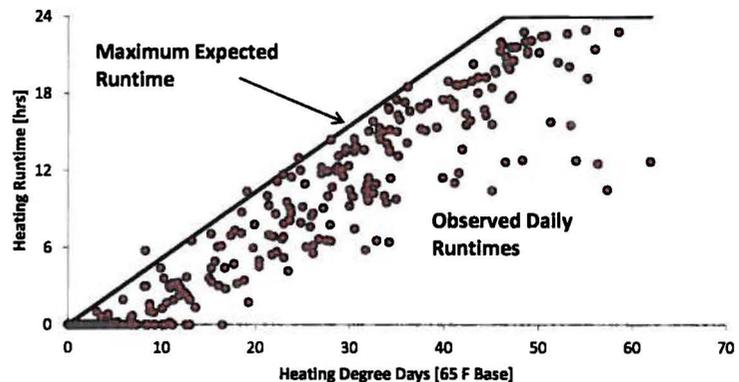
4 **Thermal Energy Produced (Q)** is calculated daily using the AHRI Certified COP and Heating Capacity (HC) and the metered heating runtime (t).

$$Q = \frac{HC \cdot (COP - 1) \cdot t}{COP}$$


**Quality Assurance:** AHRI Certified COP and Heating Capacity and the continuous heat pump operating data are stored in a centralized and secure database, insuring reliable calculation of runtimes and the corresponding thermal energy production. Raw data is backed-up daily to an offsite location and stored for at least 90 days, allowing for independent verification, if necessary.

**Quality Control:** For geothermal heat pumps that are providing building heating and cooling, GES develops a characteristic usage profile for each facility based on average outdoor air temperatures. GES staff are alerted to significant departures from the profile, enabling a check of meter operation and accuracy.

**Runtime Accuracy:** The nominal 1-minute sampling interval used by the GxTracker devices result in a typical daily runtime error of less than 0.5%.



**Calibration Requirements:** Metering of heating-mode runtimes uses amperage and temperature thresholds that exceed the sensor and drift errors of any sensors used; therefore no calibration is required.

# On-pipe Temperature Sensor

1-Wire® temperature sensor sold exclusively with the  
GxTracker™ monitoring system

## DESCRIPTION:

- ◆ Utilizes DS18B20 digital temperature sensor
- ◆ Parasite powered
- ◆ Encapsulation for durability and water resistance
- ◆ Low thermal mass, rapid response
- ◆ Bird-band with barcode and human-readable ID
- ◆ RJ-11 termination
- ◆ 6 ft. nominal lead of CAT3 Cable, 2 Pair/24 AWG
- ◆ Thermal pad for thermal connection with pipe
- ◆ Pin assignments (6-Position RJ-11):

Pin 3: Data

Pin 4: GRD

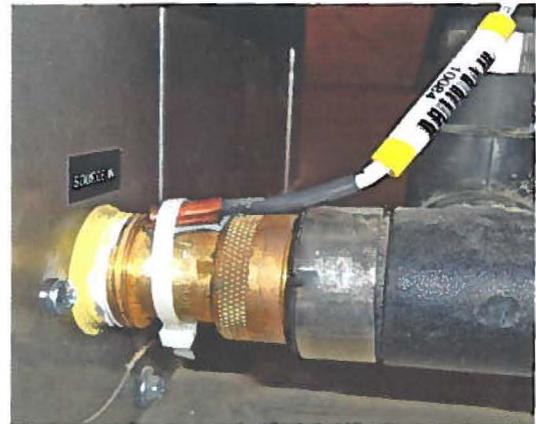
- ◆ Rapid Response
- ◆ Indoor use only

## OPTIONS:

- ◆ Can be sold in matched pairs with  $\Delta T < 0.10$  °C at standard conditions
- ◆ Custom lead lengths (2-12 ft) available

## REQUIREMENTS:

- ◆ For best results, install on thin-walled metal pipes.



PARAMETER	SYMBOL	MIN	TYP	MAX	UNITS
Temperature Range	TR	- 10	-	+85	Degrees C
Accuracy (-10 to +85 Deg. C)	ACM	-0.5	-	+0.5	Degrees C
Resolution		9		12	BITS
Pull-up supply voltage	V <sub>PU</sub>	+3.0		+5.5	Volts
Active Current (DS18B20)	I <sub>dd</sub>		1000	1500	MicroAmps
Standby Current (DS18B20)	I <sub>q</sub>		100	150	NanoAmps
Thermal time constant (installed)	$\tau_c$	20	30	45	seconds
Housing length	HLength	18	20	22	Millimeters
Housing width	HWidth	12	15	18	Millimeters
Thermal Pad thickness	Pthick	3.0	3.2	3.3	Millimeters
Thermal Pad conductivity	K <sub>pad</sub>	.8	1	1.2	W/m-K

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