Ground Energy Support LLC
2 Washington Street, Suite 217
Dover NH 03820
(603) 867-9762
www.groundenergy.com

DE 14-237

September 15, 2014

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

NHPUC 16SEP'14AM10:36

Dear Ms. Howland:

Please find enclosed the application for Rolling Dog Farm located at to become registered as a Class-I Thermal generating facility pursuant to Proposed Puc 2500. Rolling Dog Farm will be using the services of Ground Energy Support as an independent monitor and Revolution Energy Aggregators LLC as an aggregator.

The contact information for the applicant:

Steven Smith
Rolling Dog Farm
PO Box 150
Lancaster NH 03584
(603) 788-2218
elmridgefarm@gmail.com

As part of the application, we have included several attachments: (1) an attestation by the owner that the facility is installed and operating according the relevant building codes, (2) a copy of the AHRI Certificate of Product Ratings for the geothermal heat pump installed, (3) a memo regarding our service as Independent Monitor and the interpretation of Proposed Puc 2509(g), (4) the report of our on-site inspection of both the heat pump and metering equipment being use, and (5) the datasheet summarizing the heat pump runtime metering equipment, methodology, and accuracy.

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,

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

Cc: Steven Smith

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 150,000 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.

* 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.

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

Is this facility part of a Commission approved aggregation?
Yes X No _____
Aggregator's Company Name: Revolution Energy Aggregation LLC
Aggregator Contact Information: Mike Behrmann

Contents

Part 1. General Application Information 3
Part 2. Technology Specific Data 4
Part 3. Metering and Measurement of Thermal Energy and REC Calculations 5
Part 4. Affidavits 9
Application Checklist 10
Appendix A. Excerpt from Puc 2500 – Certain Thermal Metering Provisions 11

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: Rolling Dog Farm

Mailing Address: P.O. Box 150

Town/City: Lancaster State: NH Zip Code: 03584

Primary Contact: Steven Smith

Telephone: (603) 788-2218 Cell: (603) 631-5190

Email Address: elmridgefarm@gmail.com

Facility

Name: Rolling Dog Farm

Physical Address: 44 Whitney Rd

Town/City: Lancaster State: NH Zip Code: 03584

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

Installer

Name: Appalachian Green Builders LLC

Installer License Number: IGSPHA Accredited Installer, in good standing

Mailing Address: 63 Lehan Rd

Town/City: Bethlehem State: NH Zip Code: 03574

Primary Contact: Peter Duguay

Telephone: 603-728-8166 Cell: _____

Email Address: peter@nhlovesgeothermal.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 Washington St, Suite 217

Town/City: Dover State: NH Zip Code: 03820

Primary Contact: Matthew 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 thermal 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

Mr. Webb will assist you in obtaining a GIS facility code and an ISO-New England asset ID number. GIS Facility Code # NON42866 Asset ID #

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

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

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

Part 2. Technology Specific Data

All Technologies

Fuel type (solar, geothermal, or biomass): Geothermal

Rated Thermal Capacity (Btu/hr): 72,000 Btu/hr (0.021MW$_t$)

Date of initial operation using renewable fuels: October 11, 2013

Biomass

- If a thermal biomass facility, provide proof of New Hampshire Department of Environmental Services approval that the facility meets the emissions requirements set forth in Puc 2500, as Attachment 2-1.

Solar Thermal

- If a solar thermal facility, please provide the Solar Rating and Certification Corporation rating based on Mildly Cloudy C (kBtu/day): N/A

Geothermal

- If a geothermal facility, please provide the following:

The coefficient of performance (COP): 4.1

The energy efficiency ratio of the system: 23.1

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

This section deals with 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.** 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.

Metering based on Energy

- Using the table below, identify the thermal metering 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.
N/A			
Total System Accuracy (Percent)		%	

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

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

- 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: N/A

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. ☐

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 ±5.0% or better, ☐

C Use of an alternative metering method approved pursuant to Puc 2506.06. ☐

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

D Installation and use of meters with accuracy of ±3.0% or better. ☐

E Installation and use of meters with system accuracy that do not meet D but are ±5% or better. ☐

F Use of an alternative metering method approved pursuant to Puc 2506.06. ☐

- 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 for meter accuracy. (Enter 0 if no discount is required): 0 %

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 ±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.

Run Time Metering

The useful energy produced by a facility may also be calculated using simpler run time measurements. Please fill out the section appropriate to your type of resource.

- 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 pump 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 Mildly Cloudy Class C Conditions	N/A	Thousands of Btu per day
L	Orientation and shading losses	N/A	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.

- 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 pump at your facility.

Product Name Envision Series Geothermal Heat Pump

Product Manufacturer WaterFurnace International, Inc.

Model Number NDV-072

In order to calculate the useful energy produced by a solar thermal facility, please fill out the following information:

Variable	Definition	Value	Units
HC	Air Conditioning, Heating and Refrigeration Institution (AHRI) certified heating capacity at part load	45,000	Btu/hour
COP	AHRI Certified Coefficient of Performance	4.1	--

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.

- 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 biomass 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	N/A	Per hour
V	Auger feed volume 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	N/A	Cubic inches per auger revolution
EC	Default energy content of the fuel pellet	7870	Btu/lb
ASE	Default thermal efficiency *Based on the manufacturer's warranty or average seasonal thermal efficiency or a default value of 65%*	N/A	Percentage converted to a decimal

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.

Interim Alternative Metering Method

Until such time as the Puc 2500 rule is finalized applicants may utilize an alternative method as described in the draft rule 2505.02(e)(2):

> *In lieu of the information required by Puc 2505.02 (d) (11) through (13), a thermal source may submit a detailed explanation of the methodology used to measure and calculate thermal energy and an attestation by a professional engineer that is licensed in New Hampshire and in good standing that the methodology for measuring useful thermal energy and calculating certificates is sound.*

Part 4. Affidavits

Owners Affidavit

The following affidavit must be completed by the owner attesting to the accuracy of the contents of the application pursuant to PUC 2505.02 (b) (14).

AFFIDAVIT

I, STEVEN P. SMITH have reviewed the contents of this application and attest that it is accurate and is signed under the pains and penalties of perjury.

Applicant's Signature _____ Date 9/12/14

Applicant's Printed Name STEVEN P. SMITH

Subscribed and sworn before me this 12th Day of Sept. (month) in the year 2014

County of Coos State of New Hampshire

Notary Public/~~Justice of the Peace Seal~~

My Commission Expires 2/20/2018

NH Professional Engineer Affidavit

AFFIDAVIT

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 09/15/14

Professional Engineer's Printed Name Timothy M. Roos

NH Professional Engineer License Number 13296

PE Stamp

STATE OF NEW HAMPSHIRE
TIMOTHY M. ROOS
No. 13296
LICENSED
PROFESSIONAL ENGINEER

Application Checklist				
Application Section		Item Description	Attachment Required	Check box
Part 1-1		Applicant Information		☒
Part 1-2		Facility Location Information		☒
Part 1-3		Installer Contact Information		☒
Part 1-4		Equipment Seller Information		☒
Part 1-5		Facility Monitor Information		☒
Part 1-6		Regulatory Approvals for REC Requirements	Yes	☐
Part 1-7		Other REC Certifications		☐
Part 1-8		Facility Output Information		☒
Part 1-9		Facility Operator Information		☐
Part 1-10		Additional Facility Classification Information		☐
Part 1-11		Attestation that Building Codes are Met		☒
Part 2-1		Rated Thermal Capacity		☒
Part 2-2a		Thermal Biomass Facility, 3-99 MMBTu/hour Output		☐
Part 2-2b		Thermal Biomass Facility, 100+ MMBTu/hour Output		☐
Part 2-3		Solar Thermal Facility Solar Rating and Certification Corporation Rating		☐
Part 2-4a		Geothermal Facility Coefficient of Performance		☒
Part 2-4b		Geothermal Facility Energy Efficiency Ratio		☒
Part 3-1		Equipment and Meter Description		☒
Part 3-2		Recommended Methods for Meter Calibration		☐
Part 3-3		Attestation that Meters meet PUC 2506 Requirements		☒
Part 3-4		Guaranteed Accuracy of Meters		☐
Part 3-5a		Small Thermal Source- Calculating Useful Thermal Out		☒
Part 3-5b		Large Thermal Source- Calculating Useful Thermal Out		☐
Part 3-6		Meter Accuracy Discount Factor		☐
Part 3-7a		PUC 2506 Operating Energy and Thermal Loss Discount Factor		☐
Part 3-7b		Determining Operating Energy and Thermal Loss Discount Factor		☐
Part 4-1		Owner Affidavit		☒
Part 4-2		Professional Engineer Affidavit		☒

Ground Energy Support LLC
2 Washington Street, Suite 217
Dover NH 03820
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Part 1-5

MEMO

To: Barbara Bernstein
NH Public Utilities Commission
From: Matthew Davis
Date: September 15, 2014
Re: Ambiguity of the meaning of "equipment" in Proposed Puc 2505.09(g)

In agreeing to provide Independent Monitoring services to Rolling Dog Farm, we recognize the prohibition cited in Proposed Puc 2505.09(g) for the Independent Monitor to not have sold or installed "equipment used by the source"[1]. We interpret "equipment used" in Proposed Puc 2505.09(g) to indicate the "thermal equipment" and not the metering equipment. The ambiguity of "equipment" in 2505.09(g) has been noted in the rulemaking process[2] and we elaborate on its interpretation here.

The ambiguity of "equipment" in 2505.09(g) arises because it can be interpreted as: (1) thermal energy producing equipment, (2) metering equipment, or (3) both energy producing and metering equipment. Because 2505.09(g) refers specifically to the independent monitor for sources producing useful thermal energy, we focus on the use of the term "equipment" in the corresponding application requirements for sources producing useful thermal energy.

In Proposed Puc 2505.02(d), when "equipment" is not specifically qualified as "thermal equipment", it is either used distinctly from metering equipment or has an unambiguous interpretation as "thermal equipment".

- In 2505.02(d)(3), "equipment" is used separately from "meters used to measure useful thermal energy" and therefore refers to equipment used for production of thermal energy.

  > *2505.02(d)(3) A description of the equipment and meters used to measure useful thermal energy including the manufacturer, model, placement of the sensors in the energy production system, temperature operating range, flow operating range, thermal energy operating range, and pressure operating range, if applicable;*

- In 2505.02(d)(7), information is requested for the installer of the "thermal biomass facility, solar thermal technology, or geothermal system". In this instance, "equipment" is used to include any of the three types of energy producing equipment.

  > *2505.02(d)(7) The name, license number, if applicable, and contact information of the installer of thermal biomass facility, solar thermal technology, or geothermal system, or a statement that the equipment was installed directly by the owner;*

---

[1] 2505.09(g). "No customer-site source or source producing useful thermal energy shall use an independent monitor who is a member of the immediate family of the owner of the source, holds a direct or indirect ownership interest in the source, or who sold or installed the equipment used by the source."

[2] See written testimony submitted by the New England Geothermal Professionals Association pertaining to Docket DRM14-095.

- In 2505.02(d)(8), "equipment" is specifically referred to as ''thermal equipment".

2505.02(d)(8) The name and contact information of the seller of the thermal equipment;

The intent of Proposed Puc 2505.09(g) is to prohibit the independent monitor from having interests that may conflict with the independent monitor's responsibility to report accurate and unbiased energy production to the NEPOOL-GIS, and specifically prohibits the independent monitor from having "sold or installed the equipment used by the source". As noted above, it is reasonable to interpret the seller of "equipment" as the seller of "thermal equipment", as referenced in 2505.02(d)(8). Similarly, it is reasonable to interpret the installer of equipment as the installer of the energy producing equipment, as referenced in 2505.02(d)(7).

While interpreting "equipment" in Proposed Puc 2505.09(g) as "thermal equipment" would be consistent with the remainder of Proposed Puc 2505, it is also important to note that such an interpretation does not violate the intent of Proposed Puc 2505.09(g). While the seller or installer of energy producing equipment may make claims of energy production which could create a potential conflict of interest in reporting such production, the seller or installer of metering equipment makes no such claims of energy production. Instead, the seller/installer of metering equipment warrants that the meter(s) will operate according to specifications, thus supporting the veracity of energy production reported by the Independent Monitor.

Finally, other states do not prohibit the independent monitors from selling or installing metering equipment. For example, several of the Independent Verifiers in Massachusetts (e.g. Deck Monitoring, Also Energy, Locus Energy) also sell the metering equipment.

In conclusion, the word "equipment" in Proposed Puc 2505.09(g) should mean only thermal equipment, and not include metering equipment. Such an interpretation would be consistent with language of the rest of the chapter and would not be counter to the intent of the regulation.

Part 1-11

AFFIDAVIT

PERSONALLY came and appeared before me, the undersigned Notary, the within named STEVEN P. SMITH, who is a resident of COOS County in the State of NEW HAMPSHIRE and makes his/her statement and Affidavit upon oath and affirmation of belief and personal knowledge that the following matters, facts and things set forth are true and correct to the best of his/her knowledge:

The geothermal heat pump system installed at 44 Whitney Road, Lancaster NH is installed and operating in compliance with applicable building codes.

DATED this the 12th day of SEPTEMBER, 2014

Signature of Affiant

SWORN to subscribed before me, this 12th day of Sept., 2014

NOTARY PUBLIC

My Commission Expires: 2/20/2018

Part 2-4

AHRI CERTIFIED®
www.ahridirectory.org

This combination qualifies for a Federal Energy Efficiency Tax Credit when placed in service between Jan 1, 2006 and Dec 31, 2016 and used in GLHP or GWHP application point.

Certificate of Product Ratings

AHRI Certified Reference Number: 5696565 Date: 9/13/2014 †Status: Active

Product: Water/Brine to Air Heat Pump Packaged Unit

Model Number: NDV/NDH072G1*(1,4)

Manufacturer: WATERFURNACE INTERNATIONAL, INC.

Trade/Brand name: 5 SERIES

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:

Cooling Air Flow Rate:	2000.0 / 2000.0	Cooling Air Flow Rate - Part Load:	1500.0 / 1500.0
Heating Air Flow Rate:	2000.0 / 2000.0	Heating Air Flow Rate - Part Load:	1500.0 / 1500.0

WLHP (Water-Loop Heat Pumps)	**Full Load**	**Part Load**
Cooling Capacity(Btuh)	69000 / 69000	52800 / 52800
Cooling EER Rating(Btuh/watt)	15.00 / 15.00	16.00 / 16.00
Cooling Fluid Flow Rate(gpm)	18.00 / 18.00	16.00 / 16.00
Heating Capacity(Btuh)	81900 / 81900	61400 / 61400
Heating COP(watt/watt)	4.80 / 4.80	5.20 / 5.20
Heating Fluid Flow Rate(gpm)	18.00 / 18.00	16.00 / 16.00
GWHP (Ground-Water Heat Pumps)		
Cooling Capacity(Btuh)	78500 / 78500	61000 / 61000
Cooling EER Rating(Btuh/watt)	22.00 / 22.00	27.00 / 27.00
Cooling Fluid Flow Rate(gpm)	18.00 / 18.00	16.00 / 16.00
Heating Capacity(Btuh)	67500 / 67500	49400 / 49400
Heating COP(watt/watt)	4.30 / 4.30	4.40 / 4.40
Heating Fluid Flow Rate(gpm)	18.00 / 18.00	16.00 / 16.00
GLHP (Ground-Loop Heat Pumps)		
Cooling Capacity(Btuh)	71600 / 71600	59000 / 59000
Cooling EER Rating(Btuh/watt)	17.00 / 17.00	23.40 / 23.40
Cooling Fluid Flow Rate(gpm)	18.00 / 18.00	16.00 / 16.00
Heating Capacity(Btuh)	54200 / 54200	45000 / 45000
Heating COP(watt/watt)	3.70 / 3.70	4.10 / 4.10
Heating Fluid Flow Rate(gpm)	18.00 / 18.00	16.00 / 16.00

* 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 NO.: 130550812808730998

Part 3

NH Independent Monitor:

Name: Matt Davis

Facility Contact:

Name: Steve Smith

Facility Location:

Street: 44 Whitney Rd

Date: 9/12/14

City/Town: Lancaster

County: Coos

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)

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	Water Furnace	NDV072	☑	4.10	45,000	23.4	54,200
2			☐				
3			☐				

Monitoring Equipment Inspection

Meter Manufacturer: Ground Energy Support Model: GXT - Power

HP	EWT Sensor	LWT Sensor	Runtime Sensor	Heating Cycle	✓
1	Type: OMP	Type: OMP	Type: CT	Start: 3:25	☑
	ID: G11253	ID: G11026	ID: 10157-2	End: 3:27	
2	Type:	Type:	Type:	Start:	☐
	ID:	ID:	ID:	End:	
3	Type:	Type:	Type:	Start:	☐
	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:

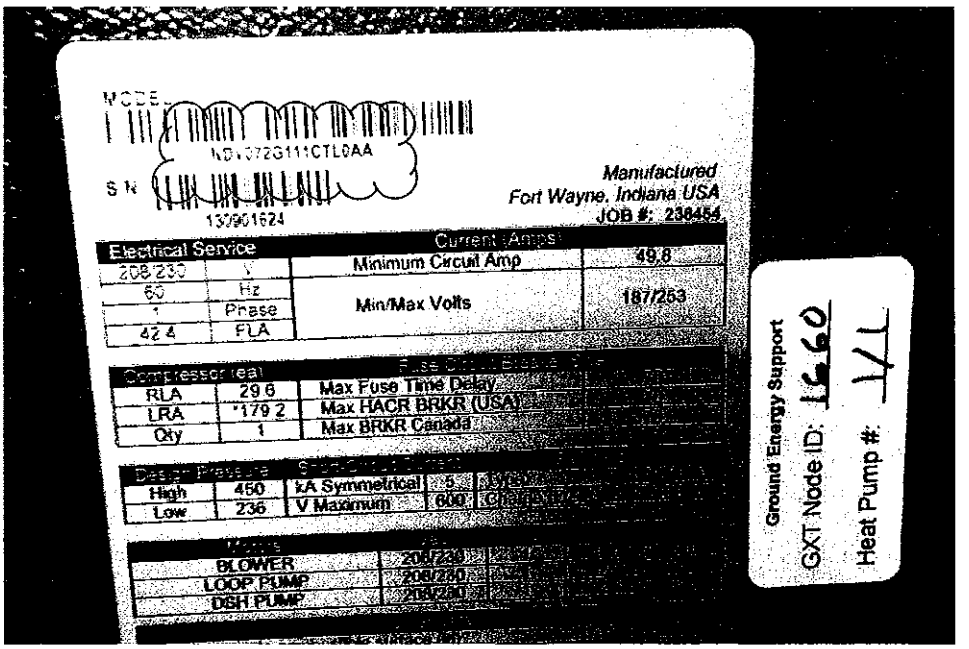
Description of Use(s): Space Conditioning

Conditioned Space (Square Feet): 3600 SF

Unusual circumstances, if any: None

Total System Heating Capacity (sum of Full Load HC on previous page): 54,200

Nameplate Photographs:



Independent Monitor Signature: [signature] Date: 9/12/14

Part 3-5a

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"

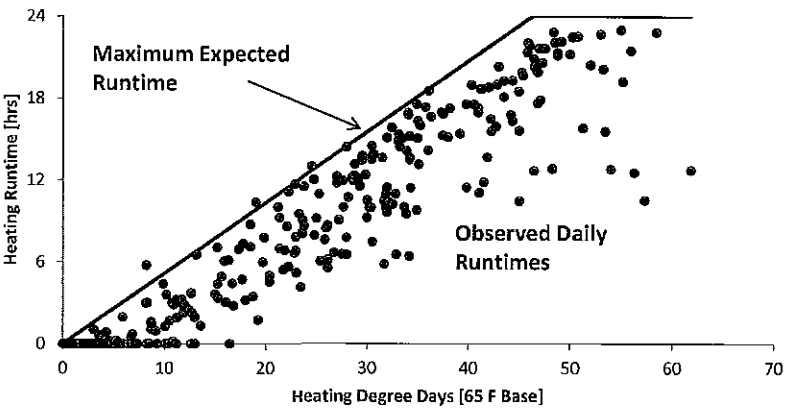
4. **Thermal Energy Produced (*Q*)** is calculated daily using the AHRI Certified COP and Heating Capacity (*HC*) and the metered heating runtime (*t*).

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

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%.



Appendix A. Excerpt from Puc 2500 – Certain Thermal Metering Provisions

For complete rules and requirements related to the RPS and REC eligibility, please refer to Puc 2500.

Puc 2506.04 Metering of Sources that Produce Useful Thermal Energy

(a) Sources producing useful thermal energy shall comply with this part in metering production of useful thermal energy.

(b) Sources shall retain an independent monitor to verify the useful thermal energy produced.

(c) Sources shall take data readings for the measurement of useful thermal energy at least every hour. The useful thermal energy produced shall be totaled for each 24 hour period, each monthly period, and each quarter.

(d) Sources shall install meters to measure thermal energy output in compliance with the manufacturer's recommendations and as noted in this part.

(e) Large thermal sources using a liquid or air based system shall measure the useful thermal energy produced using one of the following methods:

(1) Installation and use of heat meters with an accuracy that complies with European Standard EN 1434 published by CEN, the European Committee for Standardization, and that complies with paragraph (k), (l) or (m). 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. Compliance shall be certified by a professional engineer licensed by the state of New Hampshire and in good standing;

(2) Installation and use of meters that do not comply with subparagraph (e) (1), provided that the manufacturers' guaranteed accuracy of the meters is ±5.0% or better, and provided that a professional engineer licensed by the state of New Hampshire and in good standing certifies that the meters were installed and operate according to the manufacturers' specifications and in accordance with paragraph (k), (l) or (m); or

(3) Use of an alternative metering method approved pursuant to Puc 2506.06, provided that the accuracy of any such method is ±5.0% or better, and provided that a professional engineer licensed by the state of New Hampshire and in good standing certifies that the source implemented the alternative method as approved by the commission and certifies that the alternative method achieves the stated accuracy of ±5.0% or better.

(f) Large thermal sources using a steam-based system shall measure the useful thermal energy produced using one of the following methods:

(1) Installation and use of meters with accuracy of ±3.0% or better, which compliance shall be certified by a professional engineer licensed by the state of New Hampshire and in good standing and in accordance with paragraph (m);

(2) Installation and use of meters that do not comply with the accuracy of subparagraph (f) (1), provided that the manufacturer's guaranteed accuracy of the meters is ±5.0% or better, and provided that a professional engineer licensed by the state of New Hampshire and in good standing certifies that

the meters were installed and operate according to the manufacturer's specifications and in accordance with paragraph (m); or

(3) Use of an alternative metering method approved pursuant to this section, provided that the accuracy of any such method is ±5.0% or better, and provided that a professional engineer licensed by the state of New Hampshire and in good standing certifies that the source implemented the alternative method as approved by the commission and certifies that the alternative method achieves the stated accuracy of ±5.0% or better.

(g) Small thermal sources shall measure useful thermal energy produced using one of the following methods:

(1) For any small thermal sources, the methods described in paragraphs (e) or (f);

(2) For small thermal sources using solar thermal technologies, the method described in paragraph (h);

(3) For small thermal sources using geothermal technologies, the method described in paragraph (i); or

(4) For small thermal sources using thermal biomass technologies, the method described in paragraph (j).

(h) Calculation of useful thermal energy produced by small thermal sources using solar technologies.

(1) "Q" means thermal energy generated, stated in Btu's.

(2) "R" means the Solar Rating and Certification Corporation (SRCC) OG100 rating on Mildly Cloudy C Conditions, stated in thousands of Btu's per day.

(3) "L" means the orientation and shading losses calculated based on solar models such as Solar Pathfinder, T-sol, Solmetric, or another model approved by the Commission, converted from a percentage to the equivalent number less than 1.

(4) "t" means the total operating run time of the circulating pump as metered, stated in hours.

(5) "h" means 11 hours per day to convert the SRCC OG100 rating to an hourly basis (conversion factor).

(6) To calculate Q, the useful thermal energy produced by small thermal sources using solar technologies, the source shall compute the product of R, t and the result of 1 minus L, and divide the result by the product of h and 1,000, as in the formula below:

$$Q = [R * t * (1 - L)] / (h * 1{,}000)$$

(i) Calculation of useful thermal energy produced by small thermal sources using geothermal technologies.

(1) "Q" means thermal energy generated, stated in Btu's.

(2) "HC" means the Air Conditioning, Heating and Refrigeration Institute (AHRI) certified heating capacity at part load, stated in Btu's per hour.

(3) "COP" means the AHRI Certified Coefficient of Performance.

(4) "t" means total operating run time of the pump when the entering water temperature is greater than the leaving water temperature, stated in hours.

(5) Small thermal sources using geothermal technologies may calculate Q, the useful thermal energy produced, by multiplying HC by the difference between COP and 1, multiplying the result by t, and dividing the result by COP, as in the formula below:

$$Q = [HC * (COP - 1) * t] / COP$$

(j) Calculation of useful thermal energy produced by small thermal sources using thermal biomass renewable energy technologies.

(1) "Q" means the thermal energy generated, stated in Btu's.

(2) "D" means the default pellet density, which shall be 0.0231 pounds per cubic inch.

(3) "R" means the auger revolutions per hour.

(4) "V" means auger feed volume, stated in cubic inches per auger revolution. Small thermal sources shall assume that V equals 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.

(5) "EC" means the default energy content of pellet fuel, which shall be 7870 Btu per pound.

(6) "ASE" means the default thermal efficiency expressed as a percentage based on the manufacturer's warranty of average seasonal thermal efficiency, or based on a default thermal efficiency of 65%.

(7) "t" means the total auger run time in hours as metered.

(8) The estimated amount of fuel burned (the product of D, R, V and t) shall be verified by the fuel purchase records and fuel inventory.

(9) Small thermal sources using thermal biomass renewable energy technologies with wood pellets as the fuel source may calculate Q, the useful thermal energy produced, by computing the product of D, R, V, EC, ASE and t, as in the formula below:

$$Q = (D * R * V * EC * ASE * t)$$

(k) Thermal sources using solar thermal technologies.

(1) "Q_g" means the heat generated in the collector loop, stated in Btu's.

(2) "dm/dt" means the mass flow of the collector working fluid measured near the inlet to the solar storage tank, stated in pounds per hour.

(3) "c_p" means the specific heat of the collector fluid, stated in Btu's per pound (mass), degrees Fahrenheit (BTU/lbm-°F).

(4) "Ti" means the collector loop inlet temperature measured near the outlet of the solar storage tank, stated in degrees Fahrenheit.

(5) "To" means the collector loop outlet temperature measured near the inlet to the solar storage tank, stated in degrees Fahrenheit.

(6) "t" means the frequency at which data readings are recorded, stated in hours.

(7) Meter sensors shall be installed on the collector loop as close to the water storage tank as practical and in accordance with the meter manufacturer's guidance.

(8) Thermal sources using solar thermal technologies shall calculate Q, the useful thermal energy produced, by calculating the product of dm/dt, c_p, the difference between To and Ti, and t, as stated in the formula below:

$$Q_g = (dm/dt)*c_p*(To - Ti) * t$$

(l) Thermal sources using geothermal technologies.

(1) "Q_g" means heat generated in the ground loop, stated in BTU's.

(2) "dm/dt" means mass flow measured near the outlet of the ground loop, stated in pounds per hour.

(3) "c_p" means specific heat of the working fluid, stated in BTU/lbm-°F.

(4) "t" means the frequency at which data readings are recorded, stated in hours.

(5) "Ti" means ground loop inlet temperature measured at the inlet to the ground loop, stated in degrees Fahrenheit.

(6) "To" means ground loop outlet temperature measured at the outlet from the ground loop, stated in degrees Fahrenheit.

(7) Bleed points, supplemental boilers and cooling towers shall be excluded from the calculation.

(8) Meter sensors shall be installed on the ground loop as close to the ground loop inlet and outlet as practical and in accordance with the manufacturer's recommendation.

(9) Thermal sources using geothermal technologies shall calculate Q, the useful thermal energy produced, by calculating the product of dm/dt, c_p, the difference between To and Ti, and t, as stated in the formula below:

$$Q_g = (dm/dt) * c_p * (To - Ti) * t$$

(m) Thermal sources using thermal biomass renewable energy technologies.

(1) "Q_g" means the thermal energy generated from biomass, stated in Btu.

(2) "dm_{out}/dt" means mass flow metered upstream of distribution and downstream of parasitic loads, stated in pounds per hour.

(3) "h_{out}" means the specific enthalpy at the metering point determined by temperature data and, for superheated steam, by pressure data, stated in Btu's per pound.

(4) "dm_{in}/dt" means mass flow of water into the feedwater or condensate pumps, stated in pounds per hour.

(5) "h_{in}" means the specific enthalpy at the metering point which will be a function of the enthalpy of incoming condensate and make-up water prior to the first condensate or feedwater pumps, stated in Btu's per pound.

(6) "t" means the frequency at which data readings are recorded, stated in hours.
(7) All metering systems shall measure boiler feedwater flow, pressure and temperature as close to the first feedwater pump inlet as possible, thereby excluding the deaerator.

(8) Metering for systems that produce hot water shall include sensors for temperature and hot water mass flow placed as close as possible to the boiler hot water distribution header inlet.

(9) Metering for systems that produce steam shall include sensors for temperature, pressure and steam flow placed as close as possible to the steam distribution header inlet and thereby prior to distribution to process loads.

(10) For saturated steam systems, pressure and temperature shall be measured to verify the absence of superheat at the measurement point.

(11) For superheated systems, both pressure and temperature measurements shall be required.

(12) Regardless of phase, the enthalpy under the measured conditions shall either be calculated using International Association for the Properties of Water and Steam (IAPWS) Industrial Formulation 1997 (IF97) formulas or taken from IAPWS or derivative steam tables.
(13) Thermal sources using thermal biomass renewable energy technologies shall calculate Q, the useful thermal energy produced, by calculating the product of dm_{out}/dt, (h_{out}), and t, and subtract from that number the product of dm_{in}/dt, h_{in} and t, as stated in the formula below:

$$Q_g = [dm_{out}/dt * (h_{out}) * t] - [dm_{in}/dt * (h_{in}) * t]$$

Puc 2506.05 <u>Calculation of Certificates for Production of Useful Thermal Energy</u>

(a) Sources producing useful thermal energy, the independent monitor or the designated representative shall report to GIS the useful thermal energy produced and the amount of RECs calculated pursuant to this part, as verified by the source's independent monitor.

(b) Useful thermal energy shall be expressed and reported in megawatt-hours where each 3,412,000 Btu's of useful thermal energy is equivalent to one megawatt-hour.

(c) Small thermal sources shall receive certificates based on the useful thermal energy produced as metered pursuant to Puc 2506.04(e) or (f) and discounted, as applicable, by the discount for meter accuracy pursuant to paragraph (e) or as calculated pursuant to Puc 2506.04(h), (i), or (j).

(d) Large thermal sources shall receive certificates based on the useful thermal energy calculated pursuant to Puc 2506.04(e) or (f), discounted by the sum of the percentage discount for meter accuracy pursuant to paragraph (e) and the percentage discount for operating energy and thermal storage losses, or parasitic load, pursuant to paragraph (f).

(e) The discount factor for meter accuracy referenced in paragraphs (c) and (d) shall be one of the following:

(1) If the meters used to measure useful thermal energy output comply with the accuracy of the European Standard EN 1434 as provided in Puc 2506.04(e)(1) or the accuracy pursuant to Puc 2506.04(f)(1), there shall be no meter accuracy discount; or

(2) If the meters used to measure useful thermal energy output do not comply with the accuracy of the European Standard EN 1434 as provided in Puc 2506.04(e)(1) or the accuracy pursuant to Puc 2506.04(f)(1), the applicable meter discount shall be the manufacturer's guaranteed accuracy of the meters used or the accuracy of the alternative method approved pursuant to Puc 2506.06.

(f) The discount factor for large thermal sources for parasitic load referenced in paragraph (d) shall be one of the following:

(1) For sources using solar thermal technology, the discount factor shall be 3.0% of the useful thermal energy produced as measured pursuant to Puc 2506.04;

(2) For sources using geothermal technology, the discount factor shall be 3.6% of the useful thermal energy produced as measured pursuant to Puc 2506.04;

(3) For sources using thermal biomass renewable energy technology, the discount factor shall be 2.0% of the useful thermal energy produced as measured pursuant to Puc 2506.04; or

(4) The discount factor shall be the source's actual metering of the parasitic load.

Puc 2506.06 Request for Alternative Method for Measuring Thermal Energy

(a) A source shall not use an alternative metering method until that alternative method is approved by the commission.

(b) A source seeking approval of an alternative method shall submit an application to the commission that includes the following information:

(1) The name, mailing address, daytime telephone number, and e-mail address of the person requesting approval for the alternative method;

(2) The name and location of the source at which the alternative method will be implemented;

(3) A description of the metering method otherwise required by these rules and the reasons it cannot be used with the applicant's facility;

(4) A description of the proposed alternative method;

(5) Technical data and information demonstrating that the accuracy of the method otherwise required by these rules will be substantially achieved by the proposed alternative method (such data and information may include third party data such as product test results from independent test laboratories, performance data based on nationally recognized product test/certification programs, published

resource data for use in calculations, and examples of the use of the method by other organizations for similar purposes); and

(6) Certification by a professional engineer licensed by the state of New Hampshire and in good standing of the meter accuracy rate that will be achieved by the alternative metering method and that the proposed alternative method is technologically sound.

(a) Electricity generation in megawatt-hours and useful thermal energy expressed in megawatt-hours shall be measured and verified in accordance with ISO-NE and GIS operating rules and this Part.

(c) The commission shall approve an alternative metering method that satisfies the requirements of paragraph (b).