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August 7, 2017

Samantha Meserve
Commonwealth of Massachusetts
Department of Energy Resources
100 Cambridge Street, Suite 1020
Boston, MA 02114

Via Electronic Mail: thermal.doer@state.ma.us

Subject: Comments on Second Draft of APS Regulations

Dear Ms. Meserve:

The New England Geothermal Professionals Association (NEGPA) has reviewed the second public comment draft of revisions to 225 CMR 16.00 and associated draft Guidelines that were published June 2nd 2017. We believe we have identified substantive issues with the draft documents. Our comments on the draft documents are presented herein.

NEGPA provided detailed comments on the first draft revisions that were published in 2016. Upon review of the second draft of the regulations and guidelines, some of our members noted that many of our previous comments were not addressed. This included comments that included significant analysis as well as comments that identified simple typographical errors. We have attached and include herein by reference our comments on the 2016 draft as many of our recommendations and concerns remain valid.

Our members are again expending significant personal time to provide comments and we are hopeful that DOER will consider the items we present. We understand that in finalizing the documents DOER will balance a number of factors. As such, we do not expect that each comment we make will result in a change to the draft documents but we wish to understand that our comments have been heard. Some of our members have experience commenting on draft regulations from other Massachusetts Departments. In those cases, a master list of

comments has been developed by the department and published with a response to and outcome associated with each comment. We are hopeful that DOER will provide some similar form of feedback on the various comments received for the 2017 draft of 225 CMR 16.00 and associated Guidelines so that it is clear that all public comments have been considered.

Our comments on the 2017 draft documents are presented in Table 1, below. Our comments on the 2016 draft documents, many of which remain applicable, are presented as Attachment 1. As you will see from both versions of comments, NEGPA has significant concerns regarding the accuracy of the equations used to calculate the number of AECs earned by operation of GSHPs. We also note that the manner in which non-renewable energy corrections are applied is not consistent between technologies resulting in potential bias. For example correcting ASHPs and GSHPs for electric grid inefficiency in apparent effort to adjust for GHG emissions at the generating facility does not appear to have an analogue for biomass installations where there is no correction for GHG emissions during fuel harvesting, processing, and transportation.

Should you have any questions regarding our comments, please contact Mr. Lessard at 978-338-5548 ext. 102 or llessard@achieverenewable.com and he will relay your question to the appropriate individual.

Sincerely,
New England Geothermal Professionals Association

NEGPA™
New England Geothermal Professional Association

Lawrence Lessard, Vice President

Matthew Davis, Director

Timothy Roos, Standards Committee

Table 1: NEGPA Comments on Draft Documents

Note: Where regulations or guidance have been cited, we have copied text from the redline version of the document. Typically, this results in unchanged text being black and blue or red text depicting edits in the public comment draft.

Document	Location in Document	Text Associated with Comment	NEGPA Comment
225 CMR 16.00	16.02 Definitions	**Commercial Operation Date**. The date that a Generation Unit first produces electrical energy for sale within the ISO-NE Control Area. In the case of a Generation Unit that is connected to the End-use Customer's side of the electric meter or produces Off-grid Generation, the date that such Generation Unit first produces electrical energy. In the case of an APS Renewable Thermal Generation Unit, the Commercial Operation Date is the date that such APS Renewable Thermal Generation Unit first produces Useful Thermal Energy.	NEGPA believes that this definition should be modified to clearly exclude periods of testing and commissioning. It is common for renewable thermal systems to be tested and commissioned at a date substantially in advance of regular operation. It would not be appropriate for metering of renewable thermal energy to begin prior to regular operation.
	16.02 Definitions	**Useful Thermal Energy**. Energy (a) in the form of direct heat, steam, hot water, hot air, or other thermal form that is used in the production and beneficial measures of for heating, cooling, humidity control, process use, or other valid thermal end use energy requirements, and (b) for which fuel or electricity would otherwise be consumed.	Why are cooling and other uses not allowed for ASHP and GSHP? There are numerous installations that have cooling-dominated loads. These can include, but are not limited to, cooling of manufacturing processes, data centers, and environmental remediation systems. These facilities will be cooled with less efficient conventional equipment if there is no benefit to using renewable thermal installations. NEGPA believes that cooling should be considered part of the APS when the renewable thermal installation and that there should be additional incentive for instances where there is a meaningful attempt to store or utilize the thermal energy for a beneficial purpose.
	16.05 (1) (a) 6. a. ii.	Ground or water-source heat pumps are provided APS Alternative Energy Attributes only when operating in a heating mode; that is, when transferring thermal energy from the ambient underground or water environment to a thermal load.	Why is APS eligibility limited to heating mode given definition of Useful Thermal Energy? Cooling and process uses are as necessary as heating. As stated above, NEGPA believes there are substantial cooling loads from various processes and buildings that will be addressed using less-efficient, more GHG-intensive technologies in the absence of financial incentive for renewable thermal technologies.
	16.05 (1) (a) 6. b. ii.	In addition to the applicable APS Renewable Thermal Generation Unit multiplier, any small ground source heat pump or air source heat pump installed in a residential building shall be given two APS Alternative Energy Attributes per MWh of net Useful Thermal Energy generated, if the home achieves a Home Energy Rating System Index rating of 50 or less as defined by the Residential Energy Services Network system, and as documented by a certified Residential Energy Services Network professional. In addition to the applicable APS Renewable Thermal Generation Unit multiplier, any eligible ground source heat pump or air source heat pump installed in a non-residential building shall be given two APS Alternative Energy Attributes per MWh of net Useful Thermal Energy generated, if the building meets the definition of "Zero Energy" as defined by the United States Department of Energy	NEGPA strongly supports additional incentives being available when renewable thermal technologies are combined with conservation measures such as highly efficient buildings. We suggest that this section be expanded to allow for different thresholds for new construction and renovation. We support the new construction thresholds as written. We respectfully suggest that for building renovations, the threshold for additional APS incentive be based on the degree of improvement of

		publication "A Common Definition for Zero Energy Buildings," dated 15 September 2015, and as documented for the Statement of Qualification application by a Massachusetts licensed professional engineer. More information on how to apply the APS Renewable Thermal Generation Unit multipliers can be found in the Department's *Guideline on AEC Multipliers for Renewable Thermal Generation Units*.	the building structure. Frequently, structure limitations such as wall thickness preclude reaching the levels of insulation that are possible in new construction. Since many more buildings are renovated than constructed new, it is important policy to reward efforts to improve renovated buildings. NEGPA recommends that percentages of building efficiency gain and minimum standards for absolute efficiency be adopted. NEGPA also suggests that an additional AEC Multiplier be provided for ASHP and GSHP installations that are offset by an associated Solar PV array.
	16.05 (1) (a) 6. e.	e. Combination of F~~f~~unding. If a Generation Unit receives any funding through a grant or incentive program administered by MassCEC or funding in an amount exceeding 50% of the Generation Unit's total construction and installation costs, from through one or more a grant or incentive programs administered by the Department or any other state agency, MassCEC, or both prior to [**the Effective Date of this Subsection**], the Generation Unit shall not be eligible to qualify in the APS.	NEGPA opposes this limitation on the grounds that this a retroactive elimination of incentive for entities that could not have foreseen these circumstances. Entities that accepted funding from state agency(ies) and/or MassCEC in the past had no ability at that time to evaluate the potential value of the incentives received vs. maintaining eligibility for the APS. Given that this section effectively penalizes entities that did not have benefit of final (or even draft) APS regulations in their decision-making process, NEGPA suggests that this limitation be removed from the draft regulations. The rationale for this restriction should be explicitly stated.
	16.05 (1) (a) 6. b. ii.	The APS Renewable Thermal Generation Unit may~~shall~~ have all of the APS Alternative Generation Attributes in 225 CMR 16.05(4)(c)(i) pre-minted as APS Alternative Generation Attributes, and may~~shall~~ be minted in the first quarter after the APS Alternative Generation Unit's Statement of Qualification or Commercial Operation Date, whichever is later. The volume of pre-minted APS Alternative Generation Attributes shall be equal to 40 times the quarterly volume of the monthly forward minted Attributes determined in 225 CMR 16.05(4)(c)(i). And Generation Units that are eligible for forward minting or pre-minting may choose at the start of their qualification period to forgo forward minting or pre-minting and instead meter their Useful Thermal Load and receive Generation Attributes quarterly. All small Generation Units that forgo their right to forward minting or pre-minting must meet all eligibility criteria of an intermediate or large system as defined in the Department's Guideline on Metering and Calculating the Useful Thermal Output of Eligible Renewable Thermal Generation Units.	NEGPA supports small generation units having a choice of calculation method. The change from 'shall' to 'may' provides important flexibly to system owners.
	16.05 (4) (f) 3.	3. be installed by licensed contractors and/or plumbers in accordance with the National Electric Code and manufacturer's specifications and must conform to all applicable municipal, state, and federal	NEGPA opposes the requirement that GSHPs be installed by licensed Plumbers. Tasks associated with GSHP

		codes, standards, regulations, and certifications, as well as program requirements;	installation such as closed-loop piping are not required to be conducted by Plumbers under the Building Code. It is not appropriate for DOER to require licensure not required by applicable code. This appears to be a 'power grab' by the Plumbers' Lobby. The only GSHP tasks that require a plumber by code are related to potable water connections for devices such as a desuperheater.
	16.05 (4) (f) 5.	5. use compressors that are two-stage, multi-speed, or variable-speed drives, unless they are water-to-water units. Single-stage water-to-water systems are eligible, provided they include accumulator tanks with the greater of ten gallons of capacity per heating ton or industry/manufacturer recommended best practice;	NEGPA believes the requirement for compressors with two or more speeds is generally desirable. However, there should be an exemption for small GSHPs that are only available with single-stage compressors. This includes ductless 'console' units, which are generally less than 2-tons capacity. Single-stage units less than 2-tons should be exempt from the multiple-speed compressor requirement of 225 CMR 16.05 (4) (f) 5.
	16.05 (4) (f) 6.	6. for vertically bored closed-loop systems, Generation Units must have a minimum depth of 150 feet per 12,000 Btu per hour of heating load served by the system;	NEGPA opposes the use of rules-of-thumb for design purposes, including the specification of 150'/ton for closed-loop installations. It is not appropriate to have this requirement for the following reasons: 1.) This requirement quashes innovation in loop design. With geologic conditions typical in Massachusetts and the availability of innovative piping designs and high Thermal Conductivity grout materials, many closed-loop systems can be designed with significantly less than 150'/ton. 2.) Having such a requirement in the regulations does not allow for current or future innovative designs or evolution of new GSHPs utilizing new refrigerants that can be supported by smaller ground sources. Changes to regulations are much less easily accomplished than changes to guidance documents. If there must be a prescribed minimum amount of closed-loop installed, NEGPA recommends that the specification be limited to the guidance not the regulations. NEGPA also notes that other metrics, such as minimum Coefficient of Performance (COP_{min}) or Minimum Entering Water temperature EWT_{min}, have more technical basis than an arbitrary amount of loop per ton.
	16.05 (4) (f) 13.	13. all systems must supply 100% of a building's total annual heating; non-renewable supplemental heat sources are prohibited.	The requirement that all systems supply 100% of a building's total annual heating without use of supplemental heat sources is impractical and not consistent with industry practice or good engineering design. Also, MassCEC has previously approved installation of many systems that provide less than 100% of a building's load. It

			is inappropriate for those installations to loose eligibility when designs were complete and approved well in advance of the availability of the final (or even draft) APS regulations. Further, the requirement as written precludes the renewable thermal conversion of portions of buildings (perhaps due to different uses or different tenancies).
Guideline on Metering – Part 1	3. E) (1) (a) (iii)	(iii) All GSHP RTGUs must be installed by licensed contractors and/or plumbers in accordance with the National Electric Code and manufacturer's specifications and must conform to all applicable municipal, state, and federal codes, standards, regulations, and certifications, as well as program requirements.	NEGPA opposes the requirement that GSHPs be installed by licensed Plumbers. Tasks associated with GSHP installation such as closed-loop piping are not required to be conducted by Plumbers under the Building Code. It is not appropriate for DOER to require licensure not required by applicable code. The only GSHP tasks that require a plumber are related to potable water connections for devices such as a desuperheater.
	3. E) (1) (a) (v)	(v) All compressors must use two-stage, multi-speed, or variable-speed drives, unless they are water-to-water units. Single-stage water-to-water systems are eligible, provided they include accumulator tanks with the greater of ten gallons of capacity per heating ton or industry/manufacturer recommended best practice.	NEGPA believes the requirement for compressors with two or more speeds is generally desireable. However, there should be an exemption for small GSHPs that are only available with single-stage compressors. This includes ductless 'console' units which are generally less than 2-tons capacity. Single-stage units less than 2-tons should be exempt from the Guideline on Metering.
	3. E) (1) (b) (i)	(i) Vertically bored closed-loop GSHP RTGUs must have a minimum depth of 150 feet per 12,000 BTU/hr of heating load served by the system (i.e., the lesser of capacity and peak load).	NEGPA opposes the use of rules-of-thumb for design purposes, including the specification of 150'/ton for closed-loop installations. It is not appropriate to have this requirement for the following reasons: 1.) This requirement quashes innovation in loop design. With geologic conditions typical in Massachusetts and the availability of innovative piping designs and high Thermal Conductivity grout materials, many closed-loop systems can be designed with significantly less than 150'/ton. 2.) Having such a requirement in the regulations does not allow for current or future innovative designs or evolution of new GSHPs utilizing new refrigerants that can be supported by smaller ground sources. Changes to regulations are much less easily accomplished than changes to guidance documents. If there must be a prescribed minimum amount of closed-loop installed, NEGPA recommends that the specification be limited to the guidance not the regulations. NEGPA also notes that other metrics, such as minimum Coefficient of Performance (COP_{min}) or Minimum Entering Water temperature EWT_{min}, have more technical basis than an arbitrary amount of loop per ton.

	3. E) (1) (c)	(c) Whole Building Heating Requirement All GSHP RTGUs must be designed to supply 100% of a building's total annual heat load heat load; with no nnon-renewable supplemental heat sources are prohibited.	The requirement that all systems supply 100% of a building's total annual heating without use of supplemental heat sources is impractical and not consistent with industry practice or good engineering design. Also, MassCEC has previously approved installation of many systems that provide less than 100% of a building's load. It is inappropriate for those installations loose eligibility when designs were complete and approved well in advance of the availability of final (or even draft) APS regulations. Further, the requirement as written precludes the renewable thermal conversion of portions of buildings (perhaps due to different uses or different tenancies).
	3. E) (2)	**If conditioned building area is less than or equal to 1,500 sf:** $$\mathbf{E_{net,out} = 4.5}$$ **If conditioned building area is greater than 1,500 sf:** $$\mathbf{E_{net,out} = \left(4.5 + (2.9 * (\frac{A-1{,}500}{1{,}000})\right)}$$	1.) Background documentation for development of these equations are not provided. This precludes NEGPA from being able to validate the results. 2.) The equations give no benefit for high-efficiency equipment. This provides incentive to owners and installers to utilize equipment that meets but is no better than program required COPs. This is not appropriate when the goal is to reduce GHG emissions. DOER should not inadvertently support the use of lower-efficiency equipment.
Guideline on Metering – Part 2	Table 3	Metering accuracy	NEGPA believes that the stated accuracy requirements are greater than necessary given the use of BTU look-up tables. Potential interpolation error from the use of look-up tables may greatly exceed the meter accuracy. As such, it is appropriate to allow electric metering options that are of similar accuracy as use of the look-up tables. Multiplying measured amps times line voltage would suffice.
	Figure 12	Metering flow chart	1.) Why is there a BTU Computer if incentive is based upon electrical use? 2.) COP Lookup System does not exist. 3.) The flow chart is poorly drawn and confusing. A more professional flow chart is desirable.
	Unlabeled figure (continuation of #12 with an undesireable page break or new #13?)	Metering flow chart	Generally the figures are poorly done. Graphics must be clearer if to be used for regulatory compliance. The flow chart is confusing and may be split on multiple pages. A more professional flow chart is desirable.
		Formula for Intermediate, GSHPs	1.) Lookup table for COP_{EWT} does not exist from any

		The COPEWT for each five minute interval will be determined by the use of a lookup table provided by the RTGU's original equipment manufacturer (OEM) on their letterhead. The table will show the COP of the RGTU for each 10 degree increment in the entering water temperature between 32 and 80 deg. F. The table is to be constructed as follows: i) The AHRI rating performance data is to be used. ii) The AHRI rating data is subdivided into 15 deg. intervals using a linear interpolation. iii) The AHRI rating data is extended to 80 deg. F by linear interpolation. iv) Extension of the table below the lowest entering water temperature shown in the AHRI rating cannot be done by linear interpolation but must instead be developed and submitted by the OEM along with sufficient narrative detail to permit a review	manufacturer known to NEGPA. 2.) Why should design of the lookup table be so prescriptive? 3.) NEGPA believes that interpolation error from the look-up table adds more error to the metering than the meters themselves. It is appropriate to allow electric metering options that are of similar accuracy as use of the look-up tables. Multiplying measured amps times line voltage would suffice.
	Formula for Large GSHPs		1.) For the same installation, Intermediate and Large approaches do not yield close to the same number of AECs. 2.) The lack of consistency between the calculation methods may provide undesirable bias to the APS.
Guideline on AEC Multipliers	4.	**4. Additional Multipliers for Efficient Buildings Utilizing Heat Pumps** Per CMR 16.05(1)(b)(ii), Any any small ground source heat pump or air source heat pump installed in a residential building will be given an additional multiplier of 2 (added to the base multiplier) if the home achieves a Home Energy Rating System (HERS) Index rating of 50 or less as defined by the Residential Energy Services Network (RESNET) system, and as documented by a Certified RESNET Professional. Additionally, a Any eligible ground source heat pump or air source heat pump installed in a non-residential building will be given an additional multiplier of 2 (added to the base multiplier) if the building meets the definition of "Zero Energy" as defined by the United States Department of Energy DOE) publication "A Common Definition for Zero Energy Buildings," dated 15 September 2015, and as documented for the application by a Massachusetts licensed Professional Engineer.	NEGPA strongly supports additional incentives being available when renewable thermal technologies are combined with highly efficient buildings. We suggest that this section be expanded to allow for different thresholds for new construction and renovation. We support the new construction thresholds as written. We respectfully suggest that for building renovations, the threshold for additional APS incentive be based on the degree of improvement of the building structure. Frequently, structure limitations such as wall thickness preclude reaching the levels of insulation that are possible in new construction. Since many more buildings are renovated than constructed new, it is important policy to reward efforts to improve renovated buildings. NEGPA recommends that percentages of building efficiency gain and minimum standards for absolute efficiency be adopted.

Attachment 1: 2016 NEGPA Comments

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Events
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30 June 2016

Ms. Samantha Meserve
Department of Energy Resources
100 Cambridge Street
Suite 1020
Boston MA 02114

Delivered via email to: Samantha.Meserve@state.ma.us

Dear Ms. Meserve,

On behalf of the New England Geothermal Professional Association Board of Directors, I have attached our comments regarding the revisions to the Massachusetts Alternative Energy Portfolio Standard (APS) and associated metering guidelines.

While these comments focus on the ground-source heat pump technology, we also point out some inconsistencies in the treatment of different technologies, that, if unaddressed, may lead to further delay in adoption of these rules and associated guidelines.

We have tried to be clear and constructive in our comments. If you have any questions or would like any clarifications, please don't hesitate to contact us.

Sincerely,

J. Matthew Davis, PhD
Board of Directors, Member

cc: NEGPA Board of Directors

New England Geothermal Professional Association (NEGPA) comments on 225 CMR 16.00 and associated metering guidelines

The New England Geothermal Professional Association commends the Commonwealth of Massachusetts on incorporating renewable thermal energy into the APS and value the opportunity to provide comments on the draft rules (225 CMR 16.00) and associated metering guidelines that bring the Acts of 2014, Chapter 251 ("the Act") into practice.

Our main points of concern revolve around the following three themes.

- The definition of 'net useful thermal energy' and proper accounting thermal energy from non-renewable sources of useful thermal energy.
- The consistency in the application of the Acts to different renewable technologies.
- Use of a 2.27 multiplier on electricity used by an RTGU is inconsistent with the Act, unjustified, and results in erroneous calculations of AECs.
- Requirement to exclude air-conditioning but without a practical methodology to do so.

The specifics of these concerns are detailed below and we offer recommendations where appropriate.

A. Comments on 225 CMR 16.00

1. On the definition of "net useful thermal energy"

Section 1 of the Act defines "Useful thermal energy" as:

> *energy in the form of direct heat, steam, hot water or other thermal form that is used in production and beneficial measures for heating, cooling, humidity control, process use or other valid thermal end use energy requirements and for which fuel or electricity would otherwise be consumed.*

As defined in the Act, the definition of Useful thermal energy does not stipulate that it be generated entirely from a renewable source but instead stipulates (Section 2(a)) that "alternative energy credit shall be earned for … net useful thermal energy produced".

The language in the Act differentiates between 'Useful thermal energy' as the total energy that is produced and the 'net useful thermal energy' that is renewable and thus eligible for alternative energy credits.[1]

225 CMR 16.05(1)6.a defines the eligible APS renewable thermal generation unit technologies and, in paragraphs (i) and (ii), correctly characterize heat pumps as technologies that use compression and evaporation to transfer thermal energy from the environment (air, ground, and/or water) to a thermal load as Useful Thermal Energy. The electricity used for the operation

[1] In contrast, the State of New Hampshire defines useful thermal energy as "renewable energy that is delivered from a Class I source…." where Class I source can include thermal energy from the ground, but not energy from a compressor.

of a heat pump is converted to thermal energy and included in the definition of Useful thermal energy.

However, in determining the Earned APS Alternative Energy Attributes, 225 CMR 16.05(1)6.b.iii is ambiguous in that it stipulates that "any fossil fuel energy and electrical input to the APS Renewable Thermal Generation Unit necessary for its operation" shall be subtracted from the generated Useful Thermal Energy. 225 CMR 16.02 defines Generation Units as: "A facility that converts a fuel or an energy resource into electrical energy or thermal energy, or both." Furthermore, 225 CMR 16.05(4)a envisions Generation Units as potentially having more than one eligible technology. The definitions and usage of "a Generation Unit" through 225 CMR 16.00 suggest a property, building, or complex with many energy uses, both renewable and non-renewable. Electrical and fossil fuel energy may well be necessary to operate a Generation Unit but may not be at all related to the production of Useful thermal energy.

Recommendation: Calculation of net useful thermal energy as stipulated in the Acts should only subtract the portion of total Useful thermal energy that is directly attributable to non-renewable source; for example, the electrical energy that is converted to thermal energy by a heat pump compressor.

2. On the exclusion of cooling from the calculation of AECs

Per the Act, "Useful thermal energy" is defined as "energy in the form of direct heat, steam, hot water or other thermal form that is used in production and beneficial measures for heating, **cooling, humidity control**, process use or other valid thermal end use energy requirements **and for which fuel or electricity would otherwise be consumed**." 225 CMR 16.05(1)6.a.i and ii state that "heat pumps are provided APS Alternative Energy Attributes only when operating in a heating mode". The Department should provide justification for this contradiction from the Acts.

B. Comments on Guidelines on Metering and Calculations

1. Part I (Formulas for Small Generation Units)

1. On p. 4, the Guidelines put forth the "General Formula for Output Projections for All Small RTGUs"

$$\frac{\text{AECs}}{\text{yr}} = \text{Eth, net} = \text{M} * \text{HC} * \text{t} * \text{P} * \text{O}_{\text{source}}$$

This equation is confusing as it lumps the multiplier (M) into the calculation of net useful thermal energy load (Eth,net). The multiplier, M, should be included explicitly with Eth,net.

Clarification of the equation notwithstanding, the formula is then applied inconsistently to develop specific equations for the difference RTGU technologies.

a. For solar thermal, the Guidelines develop an equation based on equipment capacity, surface orientation, and solar access for the specific location. The Guidelines go on to assume that solar panels are operating at full capacity at all times (t=365 days). It is simply not realistic to assume that a solar hot water system is operating at full output capacity at all times.

b. For heat pump technologies (both ASHP and GSHP), the General formula is applied so that, for buildings less than or equal to 1,500 square feet, the $HC*t*P*O_{source}$ is equal to 2.5 and 4.5, respectively. The rationale for the different multipliers is clearly justified as GSHP will operate at a higher average COP and thus deliver a greater proportion of renewable thermal energy than similarly sized ASHP systems. However, the justification for the value of 4.5 $MWh_{thermal}$ per year for GSHP is not clear. Based on available data, it appears to be low.

Recommendation: To insure that equations being used appropriately reflect renewable thermal energy production, the Department should document the studies on which these equations are based and compare projected production with actual data.

*2. Part II (Metering for Intermediate and Large Generation Units_*

1. On p. 5, it is stated that "The Department has determined that is appropriate, practical, and non-burdensome to require that Large RTGUs be fully and directly metered and that a reduced level of direct metering combined with indirect metering is required for Intermediate sized RTGUs". While we agree that direct metering in itself may not be burdensome, *there are several aspects of the Guidelines that are burdensome.* These will be pointed out below. NEGPA agrees that indirect metering is an attractive solution for Intermediate systems and will meet the objectives with appropriate level of on-site verification.

2. The DRAFT of 225 CMR 16 (Alternative Energy Portfolio Standards), that is also currently open for comment, has the provision (16.05(1)(a)6.b.iii) for the Department to net 'fossil fuel energy and electrical energy input' that is necessary to operate the renewable energy generation unit[2]. There are three major concerns related to this provision. In the Draft Guidelines, the netting of non-renewable fuels

    a. is applied inconsistently to different technologies,

    b. appears to be applied towards GSHP's in a manner that is not the intent of the 225-CMR-16, nor per 3. A) (4) of these guidelines. An example of this is apparent in the Large GSHP AEC formula where the RH (renewable heat) directly from the ground is measured and the NRF (non-renewable fuel energy) is subtracted. In this example, it would be appropriate to subtract the NRF from the **total heat energy** supplied to the building, but NOT from the RH as defined in the guideline. The NRF should be subtracted from the 'net useful heat' transferred to the facility, but not from the RH (renewable heat) which already does not account for the NRF of the system.

[2] 16.05(1)(a)6.b.iii. Earned APS Alternative Energy Attributes shall be for the generation of Useful Thermal Energy, net of any fossil fuel energy and electrical energy input to the APS Renewable Thermal Generation Unit necessary for its operation, however, the Department may exclude small energy uses, including but not limited to, fans, pumps, meters, controls, and data collection. The Department shall prescribe the calculations for netting energy input from the Useful Thermal Energy in the Department's *Guideline on Metering and Calculating the Useful Thermal Output of Eligible Renewable Thermal Generation Units*.

c. as written in the Guidelines, the 'netting' inappropriately devalues the AECs that may be earned for the production of useful thermal energy from the ground for large geothermal systems.

3. Definition of "Net useful heat" (p. 7) uses the concept of enthalpy to define heat transfer with the Net useful heat being the difference between the thermal energy (enthalpy) supplied to the load minus the thermal energy (enthalpy) returned to the source[3]. The definition of Net useful energy, as stated, does not indicate whether the difference in enthalpies shall be positive or negative. In addition, the definition of 'load' is unclear. Is it delivery upstream of the heat pump (as suggested in metering diagrams) or downstream of the heat pumps (as suggested in the description of Net Useful Heat in 3. A) (4))? This apparent inconsistency seems to be the root of the concern mentioned above in 2. b. of these comments. Also, the term Renewable Heat (RH) in sections 3. I) (12), (17) & (21) seems to intend the same as the 'Net useful heat' in some circumstances, but not in others.

   The definition of Non Useful Heat (p. 9), however, uses the concept of heat transfer (difference in enthalpy) in that it states that energy rejected to a heat sink (e.g. cooling mode of GSHP system?) is not considered Useful Thermal Energy. As defined, the "Net useful heat" will be negative when heat is being rejected to the ground. This can be a large problem in the practical aspects of installing the metering devices for both GSHP and ASHP systems. This is mainly due to the fact that both of these system types can change their operation from heating to cooling at the individual heat pump level. Furthermore, a multi heat pump system could have some heat pumps operating in cooling mode while others are operating in heating mode.

   For a geothermal system with equal heating and cooling loads, the total annual "Net useful heat" will be zero unless the energy transferred during operation of heat pumps during cooling mode is not totalized. While rejecting heat to a ground loop is arguably not qualified for renewable energy credits, the beneficial heating should not be discounted for also operating the system in cooling mode. The currently unclear definition of "Net useful heat" combined with the explicit discounting of "Non useful heat" *would result in most geothermal systems resulting in negative AECs.* According to equation used to calculate AECs (p. 10).

$$AEC = \left(UH - NUH - P_e - P_{th} - \frac{G}{0.44}\right) * M$$

   Where the heat of rejection (NUH) is subtracted from the "Net useful energy", which is already near zero for a geothermal system with an annual balanced load. Even if UH only counted for heating (as was likely intended), the subtraction of NUH (rejected heat) offsets benefits of heat extracted during heating mode.

   Recommendation: 1) Clarify the definitions of 'Net Useful Heat' and RH (Renewable Heat), which appear to be the same concept at times, but different in others, 2) Define UH as energy

[3] Use of the word 'source' here is intended to help clarify definition of net useful heat where 'source' is the source of the renewable energy (ground, air, biomass). The Guidelines actually use RTGU which, as discussed in Comments A.1, above is ambiguous.

transfer during heating mode only (entering temperature > leaving temperature), and 2) do not meter or subtract NUH.

This recommendation would also alleviate the confusion arising from the requirement to install a separate meter to record heat rejected to a sink (p. 9). Such a requirement is highly impractical (and burdensome) for a geothermal system that uses a single pair of supply return pipes.

As noted above, the so-called "netting of energy use" by subtracting G/0.44 is inconsistent with the Acts. Its impact on AEC calculations is discussed in comments below.

4. General Guidance for Locating Btu Meters (p. 9). NEGPA concurs with clause (a) that states that meters should be located on the RTGU side and not on the load side. This clause indicates that the metered heat energy from the RTGU does not include the NRF component of the total energy delivered to the building, therefore the NRF should not be subtracted from the RH for the large geothermal system AEC calculations in 3. I) (21) For a geothermal system, this would be interpreted as metering geoexchange (heat of extraction) on the ground-loop side of any and all heat pumps. Such placement of a meter would prevent it from recording any thermal energy produced by the heat pumps as well as the need for "netting of energy use" (more on this below).

5. Figure 1 is unclear, particularly as it relates to "General Guidance for Location Btu meter" as no meters are shown.

6. Use of Non-Renewable Fuels which are blended (3(B)(3). It is unclear how a geothermal system that uses a gas-fired boiler as emergency backup would use the equation provided. There is no 'renewable fuel' used in such a system. We suggest that the location of the injection of the boiler heat, in conjunction with the location of the electricity meter (for intermediate systems) or heat meter (for large systems) is located, impacts whether the non-renewable fuel needs to be factored out of the net useful heat. It would only need to be factored out if the measurement of the electricity to the heat pump or the heat meter from the RTGU included the heat injected by the boiler. In most GSHP systems, the boiler heat would be on the load side of the heat pumps or the heat meter from the RTGU, so the non-renewable fuel should not need to be factored out in those cases.

7. Thermal (Btu) Energy Meters for "Hot Water". It appears that Table 3 applies to geothermal systems though fluid is typically not "hot".

    a. What is the justification for excluding turbine meters? The Onicon F-1100 and F-1200 are high quality highly accurate flow meters that maintain excellent accuracy over a wide range of flows. They meet the requirements for heat meters in Europe and Canada and are not excluded from ASTM standards. They are highly appropriate for closed loop geothermal systems and should be permitted.

    b. How are accuracies of Btu meters to be documented? Because accuracy depends on operating conditions, most heat meter manufacturers only report the accuracy of individual components and not the entire meter. *Recommendation: Specify accuracy of*

individual components so they are consistent with ENE 1425 (Class 5K temperature sensors, Class 2 flow meters, etc.).

8. Electric (kWh) Meters (p. 15). The Guidelines require that electric meters be 'revenue grade'. However, the Guidelines also use 'indirect metering' for intermediate systems. The benefit of 'revenue grade' kWh is unclear when an indirect method is used to compute AECs. Given the inherent errors in indirect metering for intermediate systems, measurement of volt-amps is sufficient when indirect metering is used. As noted below, one of the most practical ways to discern Useful Heat from heat being rejected is to measure the entering and leaving water temperatures on a heat pump. Currently, the Guidelines require the exclusion of rejected heat but don't provide mechanism for doing so.

9. AECs for Intermediate GSHP systems.

    a. Figure 10.

        i. What is the Btu Computer? Is it computing AECs? If so, shouldn't the NRF meter be input to the Btu Computer? What is the meaning of arrows and dashed lines.

        ii. Should time stamped "q/o" should be "I/O"?

        iii. Typo on circulating pumps (two l's)

        iv. The NRF meter states to include the circulating pumps. We feel that including the circulator pumps is inappropriate due to the method of calculating the AEC's based on the COP_w of the heat pump by the manufacturer. Adding the energy from the circulating pumps with falsely inflate the AEC for the intermediate geothermal system.

    b. The equation to calculate AECs for Intermediate GSHP systems uses the heat pump COP and the energy consumed (NRF = G/0.44):

$$AEC = \left((COP_w * NRF) - NRF\right) * M$$

While the Guidelines require that heat of rejection be excluded for AEC calculations, the equation provided has no mechanism for doing so. The metered electricity usage (G) will include both heating and cooling, unless somehow the cooling mode usage is subtracted out or ignored. In order to determine whether a heat pump is producing Useful or Non-useful thermal energy, it is necessary to measure the entering and leaving water temperature on each heat pump, as is currently done for New Hampshire Thermal RECs (small systems).

    c. COPw is defined as being provided by the equipment manufacturer. We are not aware of any such rating for ground source heat pumps. *Recommendation: Use ANSI/AHRI*

13256-1 and -2 COP ratings that use conservative (minimum) ground loop temperatures COP and consider both closed- and open-loop systems.

10. AECs for large systems.

    a. It is unclear why there are differences in the calculation of AECs for large ASHP and large GSHP systems – two systems which are very similar in setup except that one extracts heat from air, the other from the ground. In the calculation of AECs for Large DX ASHP systems (p. 24) and large VRF ASHPs (p. 28) there is no 'netting' of non-renewable fuel. However, for large GSHP systems (p. 31) there is. What is the justification for the different formulas for ASHP and GSHP technologies? For both, the metering in the figures shown is on the 'source' side and the metered thermal energy does not include any thermal energy from non-renewable fuels.

    b. Furthermore, the inconsistent 'netting' of non-renewable energy between renewable thermal technologies results in the equation for AECs for large GSHP system assuring that a large GSHP system will generate negligible AECs. The equation for large GSHPs (p. 31) is:

$$AEC = (RH - NRF) * M)$$

Renewable Heat (RH) is the metered renewable component of the thermal energy. Given the equation for RH and the recommended placement of the meter (Figure 11), RH is equivalent to the Heat of Extraction (HE) of a geothermal system. NRF is the adjusted non-renewable fuel calculated from the electricity consumed (G) by the RTGU and is calculated as NRF= G/0.44.

Given the wording in the Guidelines and the manner in which the electric meter is shown to be connected to the heat pump in Figure 11, it appears that G (and NRF) include the electricity consumed by the heat pump. If this is correct, the result is that **a GSHP system with a COP of 3.27 (meeting the minimum requirements for Part 1) would result in a total annual generation 0 AECs.**

$$COP = \frac{RH + G}{G}$$

$$If\ COP = 3.27, \qquad RH = 2.27G$$

$$AEC = \left(2.27G - \frac{G}{0.44}\right) * M = 0$$

It is quite clear that the 'netting' of renewable energy, as shown in the guidelines, is inappropriate and erroneous for the Large GSHP systems, especially when compared to how it is or isn't applied to ASHP and other technologies.

If 'netting' of non-renewable energy is used in the calculation of AECs, it should be done uniformly, for all renewable thermal technologies. Furthermore, as stipulated in the Draft of 225 CMR 16, it should include non-renewable energy other than electricity[4]. For example, the harvesting, processing, and delivery of biomass to an RTGU consumes fossil fuel energy, is necessary for its operation, and should be 'netted' out. However, our recommendation is that it is applied appropriately for all technologies but not for the Large GSHP, therefore the AEC formula for Large GSHP should be

$$AEC = RH * M$$

c. Typo on bottom of p. 31. Should be 'renewable heat transferred from the _ground_' instead of '_air_'.

d. Typo on top of p. 32. SGWF in equation should be GSWF, and the units of GSWF should be (lbs/hr) instead of (lbs)

Recommendation: Remove the definition of NRF in the AEC Formula for Large GSHP section if the formula is modified as suggested above in comment 10. B.

[4] "any fossil fuel energy and electrical energy input to the APS Renewable Thermal Generation Unit necessary for its operation".