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TO: MA Department of Energy Resources August 4, 2017

FROM: Mitsubishi Electric Cooling and Heating

Subject: APS – 225 CMR 16 Comments

The MA APS has provided a unique opportunity for the State of Massachusetts to continue its national leadership in energy policy. By incorporating Renewable Thermal into the APS, this regulation will help to further establish a thriving market for GHG reductions and energy efficient heating and cooling systems. The entire value chain will benefit because it will serve to bring more awareness to thermal technologies that are just beginning to thrive, and accelerate them to mainstream. Manufacturers, Distributors, Contractors, Architects, Engineers, Builders, and building owners will all benefit as the pathway and economic model is established through higher volume of renewable thermal projects.

One important recognition that we have experienced via the utility efficiency programs is the need for simplification. While those of us who have been working to establish, revise, and improve the APS Renewable Thermal regulations understand this need for simplicity in concept, the importance of constantly keying in on simplification is paramount to the programs' success. Our experience has shown that even slightly complicated programmatic offerings will not be adopted by building owners, in particular in the commercial space. For instance, the current utility *Custom* program is often ignored by building owners due to its perceived complexity. This results in significant consequences – the utilities do not capture the required energy efficiency savings, the beneficial technology doesn't get the benefit of raising its awareness, and other issues. In comparison, the MA CEC has launched simplified clean energy programs that are prescriptive in form, incentivizing at a $/ton basis. In the case of the APS, we feel that an overly restrictive and complicated qualification process will again lead the program to be underutilized, having impacts down the line including the utilities not reaching their allocated APS requirement. We highly recommend that the MA DOER respectfully consider simplifying the programs as much as possible, and have made some suggestions below as to areas to consider.

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Comments and Questions: (Small Category)

Page 12, Section b, ii: Determination of APS Alternative Attributes:

> 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 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*.

Comment: What documentation do you require to prove that a building meets the definition in the document that you refer to on page 12, Section b: "A Common Definition for Zero Energy Buildings".

Recommendation: You may want to provide this link, and refer them to the important part of the document, unless it is all important.

NOTE: Here is the link to "A Common Definition for Zero Energy Buildings":
https://energy.gov/sites/prod/files/2015/09/f26/A%20Common%20Definition%20for%20Zero%20Energy%20Buildings.pdf

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Page 13, Section e: Combination of Funding:

> e. Combination of Funding. 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 a grant or incentive program administered by the Department or any other state agency prior to [**the Effective Date of this Subsection**], the Generation Unit shall not be eligible to qualify in the APS.

Question: Provide better clarification whether a project can qualify for APS and the MassCEC rebates, as long as they are after the effective date?

Question: Clarify if a project did not receive a MassCEC rebate in the past, can it be submitted?

Page 19, Section e: Eligibility Criteria for Small Air Source Heat Pumps:

> (e) Eligibility Criteria for Small Air Source Heat Pumps. All small air source heat pump Renewable Thermal Generation Units, as prescribed in 225 CMR 16.05(4)(a), must:
>
> 1. be ENERGY STAR™ certified;
>
> 2. meet the Cold Climate Air Source Heat Pump Specification (Version 2.0) published by Northeast Energy Efficiency Partnerships effective January 1, 2017;
>
> 3. have a variable speed compressor; and
>
> 4. be part of an Air-Conditioning, Heating, & Refrigeration Institute matched system.
>
> For new construction, the small air source heat pump Renewable Thermal Generation Unit must supply 100% of the building's total annual heating and cannot have any supplemental, non-renewable heating sources. In retrofit construction or existing buildings, all small air source heat pump Renewable Thermal Generation Units that do not meet the above requirement must be used as the primary source of heat, supply at least 90% of the total annual heating, be integrated to a heating distribution system, capable of distributing produced heat to all conditioned areas of the building, and have a heat-rate capacity at five degrees Fahrenheit that is at least 50% of the nameplate capacity of the existing heating source equipment.

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It is our interpretation that the small category is too restrictive in its eligibility criteria. The result will be very few installations that qualify for the program. This is primarily due to the multiple competing requirements favoring whole home renewable thermal installations for retrofits, which are infrequent in today's market. This will lead to very low enrollment in the small category, which is the highest volume category and thus has the biggest impact on awareness building. Some details follow.

Comment: In sub-bullet 2 above, you specify Cold Climate Heat Pump Specification (Version 2.0) published by Northeast Energy Efficiency Partnerships effective January 1, 2017. If a Version 3.0 is released, do you only apply Version 2.0? Perhaps you should change Version 2.0 language to "meet the Cold Climate Heat Pump Specification (current version) published by Northeast Energy Efficiency Partnerships." Alternatively you could say Version 2.x.

This becomes even more important as NEEP considers further integration of ducted heat pumps into their specification. At this time, the efficiency metrics required to qualify for the Cold Climate specification are high, which causes most *ducted* systems to be disqualified. One of the most important points to consider: because of the above requirements, it is clear that the program is aimed at whole home conversions. The first point is that whole home conversions to ASHPs are a rare event, which will cause extremely low enrollment in this program. Second, without qualifying ducted equipment, it becomes nearly impossible to serve most whole home situations unless there is a head put in every room – which is highly cost prohibitive. It may be possible that NEEP addresses this through creating a separate ducted specification. However, as currently construed, this program will NOT succeed if retrofits (not New Construction) are required to heat the entire home, because that is the exception rather than the rule at this time.

Comment: In sub-bullet 4 above, please clarify how you would handle multi-zone systems. A matched system in the AHRI Data-base for multi-zones says non-ducted, mixed, or ducted. There is not a specific indoor unit that matches up with these individual combinations.

Comment: We recommend that you allow non-renewable emergency heat. Many homes that would qualify, will be disqualified if they have a gas fireplace. Perhaps you could specifically prohibit certain types of emergency heat.

Comment: Please define New Construction vs retrofit/existing buildings. There are varying definitions, and it is important to know what a gut rehab is classified as.

Comment: Please define how to calculate the requirement "supply at least 90% of the total annual heating". Please see our recommendation below to eliminate this provision.

Comment How do you handle hot water as a portion of the heating requirements for a home? Boilers that heat hot water are using energy, even when they aren't heating the home.

Comment: Please define what an integrated heating distribution system is. If a home has baseboard heat, how is a ductless heat pump going to integrate into it? If a home has ductwork, but ductless systems are installed, how do

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they integrate into the heating distribution system? Please see our recommendation below to eliminate this provision.

Comment: The retrofit application seems impossible to meet.

To illustrate the problem, we describe an actual home:

1. Used 800 gallons of oil in 2016
2. Heats house and hot water with an existing boiler that has a name plate capacity of 135,000 BTU's.
3. Has 3 bedrooms upstairs, 2 bedrooms downstairs, family room, kitchen, dining room

The requirements of the program include:

1. Be primary source of heat
2. **AND** Supply at least 90% of total annual heating
    a. How can this be determined? What is the source that a contractor or homeowner will use to determine what their annual heating is?
    b. According to the owner of this home, actual oil usage for 2016 was 800 gallons. How would a homeowner determine what size system to put in to offset 90% of 800 gallons?
    c. The system has an integrated tankless hot water coil. How do you back out the portion of that usage that is to heat the hot water, or for boiler standby?
3. **AND** Integrated to a heating distribution system, capable of distributing produced heat to all conditioned spaces
    a. How do you integrate a ductless mini-split into an existing heating distribution system? This home uses hydro-air with 3 air handlers. The homeowner would only have two options:
        i. Option 1: Remove all existing air handlers and install single zone air handlers for each one. Likely cost prohibitive
        ii. Option 2: Remove existing air handles and ductwork and install ductless mini-splits with 8 indoor units capable of covering each room mentioned above. Definitely cost prohibitive.
4. **AND**, Have a heat rate capacity at 5°F that is at least 50% of the name plate capacity of existing heating source equipment.
    a. This home has a boiler with a name plate capacity of 135,000 BTU's. To comply with this program, they would need to install 67,500 BTU's worth of heat pumps. The largest ccASHP that is sold by Mitsubishi can produce 48,000 BTU's at 5°F. The only way to get to 67,500 would be to install an additional 3 zone system. Again, likely cost prohibitive.

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Recommendation:

1. Change "Be primary source of heat" to "be used as the primary source of heat for conditioned zone".
2. Eliminate "Supply at least 90% of total annual heating". There doesn't seem to be a very easy way of completing these calculations, plus how do you handle a house that heats their hot water with a boiler.
3. Eliminate: "Integrated to a heating distribution system, capable of distributing produced heat to all conditioned spaces". This is extremely confusing and ductless mini-splits generally can't be integrated into a heating distribution system.
4. Eliminate "Have a heat rate capacity at 5°F that is at least 50% of the name plate capacity of existing heating source equipment". If you can't eliminate this, then change "name plate capacity" to "heating design load". Requiring "name plate capacity" of the existing heating system assumes that the existing system is properly sized. Many boilers in homes are 200 – 300% oversized. Back when they were put in, oil was only $.25 per gallon and right sizing was not required or even a priority.
    a. Our concern with requiring 50% is that this eliminates the majority of jobs that are actually completed. As an example, since November 2014, only 25% of the over 5,000 rebates paid by the MassCEC on Mitsubishi Electric equipment would meet this requirement. We understand that the goal of this program is "whole home", but we feel that the success of the program may hinge on this requirement.

We strongly suggest that an alternative be considered. Rather than require 50% of heating design load, we suggest qualifying everything and adjust the number of AEC's that the installation would qualify for. Perhaps something like the table below. This would provide access to the program for nearly everyone. If a home has a load of 72,000 BTU's, then a 9,000 BTU system would qualify for a multiplier of .5 (12.5%). Other models could be developed, but this simplified model still incentivizes the smaller amount of whole home installations, but also picks up the much more common partial-load installation that is being seen in the market today.

Heating Design Load	AEC Multiplier
100%	3
50%	2
37.5%	1.5
25%	1
12.5%	.5

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Page 20: Eligibility Criteria for Ground Source Heat Pumps

> 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 codes, standards, regulations, and certifications, as well as program requirements;

Question: #3 states that a Ground Source Heat Pump must be installed by a licensed contractor. There should be a similar requirement in the Air Source Heat Pump section. We would recommend that you include something similar to this in the ASHP section. Specifically an EPA Section 608 Technician Certification.

Typo for AEC Multipliers in Documents

From page 12 of CMR 16.00

Technology	APS Renewable Thermal Generation Unit multiplier		
System size	Small	Intermediate	Large
Active solar hot water systems used for domestic hot water	3	3	3
Active solar hot water systems used for domestic hot water and/or space heating	1	1	1
Active solar hot air systems	-	5	5
Solar sludge dryer	-	-	1
Ground source heat pumps	5	5	5
Deep geothermal	-	-	1
Air source heat pumps (electric or engine driven) – partial system	2	1	1
Air source heat pump (electric or engine driven) – all other	3	3	3
Biomass, biofuels, biogas	N/A	N/A	N/A

From page 2: AEC Multiplier for RTGU

Technology	APS Renewable Thermal Generation Unit multiplier		
System size[1]	Small	Intermediate	Large
Active solar hot water systems used for domestic hot water	3	3	3
Active solar hot water systems used for domestic hot water and/or space heating	1	1	1
Active solar hot air systems	-	5	5
Solar sludge dryer	-	-	1
Ground source heat pumps	5	5	5
Deep geothermal	-	-	1
Air source heat pumps (electric or engine driven) – partial system[2]	2	2	2
Air source heat pump (electric or engine driven) – all other	3	3	3
Biomass, biofuels, biogas	N/A	N/A	N/A

Question: Above are two tables that we believe are supposed to be the same. The 1st is from the CMR 16.00, the 2nd is from the Guideline on AEC Multipliers. The numbers for the "Air source heat pumps – partial system" are different. Please clarify.

Question: Clarify details around calculating and reporting on Net CO2 Emissions rates. Who is responsible for this calculation, and at who's expense?

Provide guidance on what a third party meter reader is.

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Comments and Questions: (Large Category)

Our team has significant comments to share on the Large Category, with strong reference back to earlier comments about **simplification** and maximizing participation. The intermediate category is currently the model category, and will likely see the most activity. **We would recommend altering the LARGE category to also a simplified watt-hour metering protocol,** [perhaps with a potential requirement for random sites around Massachusetts to be fully metered to serve as baseline validation.]

Ultimately our recommendation would be to simplify the entire process by reducing down to a simplified simulated feed-in tariff or some type of cost-based compensation to renewable thermal producers. A simplified $/kwh would provide price certainty that would help finance renewable thermal investments, rather than the system being proposed that is fraught with uncertainty and complexity. [Similar to the current MA CEC prescriptive incentive].

Issues with Proposed Protocol

The **existing metering protocol** presents several challenges that are not easily solved, so program participation will not even be possible unless these requirements are modified. Potentially and likely it will cost tens of thousands of dollars for equipment, setup, protection, and monitoring, if appropriate equipment can be sourced.

1. **SRF: measurement of lbs/hr of refrigerant flow will be difficult for VRF systems because:**
    - Mass flow rate measurement equipment is intended for AHRI compliance testing in a laboratory setting and is therefore not suitable for field installation.
    - Not only would this equipment lack cost effectiveness, but the complexity involved in operating mass flow meters makes it difficult to use in the field since test engineers won't be available to calibrate and operate the devices.

2. **RST/RRT: the only place in the system to measure RST with accuracy where we can ensure 100% vapor is at the compressor discharge, the only place in the system that we can measure RRT with accuracy where we can ensure 100% vapor is between the accumulator and compressor inlet.**
    - Even if we were able to accurately measure RRT and RST for use in the formula to calculate the renewable heat, this formula would actually be capturing the amount of work done by the compressor, NOT the renewable energy exchanged with ambient.

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- This formula doesn't account for the energy transferred by the phase change of the R410a refrigerant as it condenses from a superheated gas to a subcooled liquid as it delivers heat to the occupied spaces within the building. The energy transferred by refrigerant phase change at the VRF fan coil represents the majority of heating BTU's delivered to the space.

Rate of Renewable Heat Transferred = (SRF) * (Cp) * (RST-RRT) / 3.412E6 (Btu/MWh)

Where:

SRF = Supply refrigerant flow (lbs/hr)

Cp = Specific heat of the refrigerant supply (Btu/lb-deg F)

RST = Refrigerant supply temperature (°F)

RRT = Refrigerant return temperature (°F)

Recommended Method:

The recommended method is for an established $/kWh be set for reasons highlighted previously. Representative measured and verified buildings for verification can follow the following protocol:

Use the method for "Metering Large, DX ASHPs", which basically amounts to measuring airflow and Delta T at the outdoor unit and using this data to calculate heat absorbed from ambient in real time.

- Calculating the renewable heat can be captured by measuring airflow and Delta T at the outdoor unit as this would represent the actual heat absorbed from the ambient air into the refrigerant stream, which is then distributed to indoor fan coils for use in heating the occupied spaces within the building.

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- BTU/H = 1.08 * CFM * Delta T
- CFM can be calculated by measuring amperage to the outdoor unit fan in real time using current transducers. Manufacturers can provide condenser fan curve data showing amp draw graphed against airflow.
- Delta T can be measured using 2 sensors, one for outside air temperature and the other for discharge air temperature from the outdoor unit. An enthalpy sensor would need to be added to capture specific heat per the APS formula.
- A typical VRF condenser moves 1,000 CFM per ton with a 10°F Delta T at full load.

Rate of Renewable Heat Transferred = (EAF) * (Cp) * (ETA-LTA) / 3.412E6 (Btu/MWh)

Where:

EAF = Outside air flow rate (lbs/hr) through the Evaporator(s)

Cp = Specific heat of the outside air (Btu / lb-deg F)

ETA = Temperature of the outside air entering the evaporator section (°F)

LTA = Temperature of the outside air leaving the evaporator section (°F)

Thank you,

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