Acts 2014, Ch. 251 - 225 CMR 16.00
Renewable Thermal Technologies in the Alternative Portfolio Standard
FINAL DESIGN
Stakeholder Meeting 12/16/2014
Westborough, MA
Agenda

1:00 – 3:00 – General meeting
• Technologies
• Metering
• Minting
• Biomass/gas/fuels

3:00 – 3:30 – Break and building visit

3:30 – 5:00 – Metering subgroup
• Air Source Heat Pumps
Technologies – per the Statute

• **Add** any facility that generates useful thermal energy using:
  - Sunlight, biomass, biogas, liquid biofuel or naturally occurring temperature differences in ground, air or water
• **Strike** carbon capture and storage, gasification, paper derived fuel
• Additionally **exclude** construction & demolition debris
Specifications in the Statute

1 credit (MWh) shall be earned for every 3,412,000 Btu of net useful thermal energy produced and verified through an on-site utility grade meter or other means satisfactory to the department.

- Non-emitting on-site renewable thermal technologies can get a credit for less than 3,412,000 Btu, or in essence, a credit multiplier.

DOER has to establish for biomass, biogas and liquid biofuel technologies (with MassDEP):

- Air emission performance standards for PM2.5 and CO;
- A requirement of 50% reduction in life-cycle GHG emissions;
- Requirements for thermal storage or other means to minimize deterioration of efficiency or emissions due to boiler cycling, if feasible;
- Fuel conversion efficiency performance standards;
- Requirements that fuel shall be provided by means of sustainable forestry practices (with DCR).

Enters into force 1/1/2015
DOER Regulatory Process

• Stakeholder/industry engagement
  ➢ Meetings preceding formal regulatory process
  ➢ Formal public hearing and comment period
  ➢ Subgroups on metering, biomass, biofuels
  ➢ Final Design Presentation on 12/16/2014

• Regulatory proceeding
  ➢ Draft regulation and commence rulemaking in Jan/Feb 2015
  ➢ Final regulations by summer 2015

• Use guidelines according to RPS/APS custom
Technologies
Commercial Operation Date

• Eligible systems to be put in service on or after 1/1/2015 (date the statute enters into effect)
  ➢ DOER will provide retroactivity for systems installed after 1/1/2015 but prior to the finalization of the regulations (expected summer 2015)
  ➢ Project that received MassCEC rebate prior to finalization of APS regulations cannot qualify
Eligible Technologies

• Active solar thermal using evacuated tubes or flat plate collectors
  - Space heating, domestic & process hot water
  - Further analysis needed for guideline (performance & metering)
    - Transpired solar collectors
    - Glazed solar thermal air-heating
    - Hybrid solar thermal and PV
    - Solar active sludge dryer

• Heat pumps delivering space and/or water heating
  - Air source, ground source, water source
    - Climate weighted annual average COP > 2.5
    - COP @5°C F ≥ 1.75 (at maximum capacity operation) / EER @95°F > 12
  - Gas engine ASHP
    - Climate weighted annual average COP > 2
Eligible Technologies (ctd.)

- Woody biomass heating
  - Automatically fed biomass boilers and furnaces using wood pellets, chips, cordwood
  - Pyrolysis oil
- Biogas/methane from anaerobic digestion, landfill gas or biomass gasification
  - Used on site or off site (transported in natural gas distribution network)
- Liquid advanced biofuels meeting ASTM Standard D6751, produced from organic waste feedstocks, so as to support the MassDEP commercial food waste ban
Net Energy Generation

\[ E_{\text{net}} = E_{\text{thermal, out}} - E_{\text{non-renewable, in}} \]

- Non-renewable energy input is calculated as primary energy, so for electricity:
  - Assume average heat rate and electric transmission/distribution losses (ISO-NE)
  - Established as 41% factor (DOER will reassess periodically)
  - \( E_{\text{non-renewable, in}} = \frac{\text{Electricity input}}{0.41} \)
  - \( E_{\text{thermal, out}} = \text{heat load served (heat transferred to a useful load)} \)
Consideration of Cooling

• Cooling from heat pumps will not be credited
  ➢ Heat pumps in cooling mode deliver heating energy from the conditioned space to the environment, rather than bring energy in from the environment

• Renewable heat can be used to provide cooling through absorption chillers
  ➢ In commercial & industrial uses
  ➢ Thermal energy delivered as process heat to the absorption chiller will be credited as useful thermal energy
Non-emitting AEC Multiplier

Purpose of multiplier = stimulate development of certain new on-site non-emitting renewable thermal technologies

1 Alternative Energy Credit
= 1 MWh = 3.412 MMBtu

- Multiplier: 1 AEC = 3.412 MMBtu / X
- Basis for X = align levelized cost of energy of renewable thermal technologies
- DOER will re-evaluate periodically based on market uptake
Non-emitting AEC Multiplier

- Non-emitting technologies with higher levelized cost of energy:
  - Solar: DHW & combi systems
  - Ground source heat pumps

<table>
<thead>
<tr>
<th>Technology</th>
<th>AEC Multiplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar DHW</td>
<td>5</td>
</tr>
<tr>
<td>Solar Combi</td>
<td>2</td>
</tr>
<tr>
<td>Ground Source Heat Pumps</td>
<td>3</td>
</tr>
</tbody>
</table>

These are proposed initial multipliers, values will be re-evaluated periodically.
# Example Residential Installation

**Building characteristics**

<table>
<thead>
<tr>
<th></th>
<th>BIO</th>
<th>ccASHP</th>
<th>GSHP</th>
<th>Solar Combi</th>
<th>Solar DHW</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Heat Load</strong> MMBtu/y</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Cool Load</strong> MMBtu/y</td>
<td></td>
<td>3</td>
<td>4</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Domestic Hot Water Load</strong> MMBtu/y</td>
<td>15</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Efficiency/COP**

<table>
<thead>
<tr>
<th></th>
<th>BIO</th>
<th>ccASHP</th>
<th>GSHP</th>
<th>Solar Combi</th>
<th>Solar DHW</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Load served</strong> %</td>
<td>100</td>
<td>80%</td>
<td>100%</td>
<td>40%</td>
<td>60%</td>
</tr>
<tr>
<td><strong>AEC/year</strong></td>
<td>34</td>
<td>4</td>
<td>34</td>
<td>27</td>
<td>13</td>
</tr>
<tr>
<td><strong>Pre-minted AEC value</strong></td>
<td>$</td>
<td>$633</td>
<td>$5,078</td>
<td>$4,045</td>
<td>$1,978</td>
</tr>
</tbody>
</table>

Illustrative example, including multiplier, actual calculation will depend on final regulations

Calculation assumes 10 years pre-minted AECs are sold at $15/AEC
Metering
- Large Systems
Goal of Metering

- Determine the credits generated by the specific system performance
- Ensure long-term and optimal operation
- Avoid rebound effect

- Right (accurate), Reliable, Replicable, Reported
  - Metering heat, steam, fuel
  - Standards
- Reasonable (cost, effort)

Heating and Cooling in the Massachusetts Alternative Portfolio Standard, Report to the Legislature, EEA/DOER with assistance from Meister Consultants Group and MassCEC, 2012
Creating A Cleaner Energy Future For the Commonwealth

Metering Approach

• Large systems: continuous accurate **metering** and **automatic reporting** to independent verifier
  - Available equipment / standards / industry best practice

• Small systems: **calculate** projected output
  - Meant to cover residential, small multi-family and small commercial
  - Verification of ongoing operation through spot checks and run-time monitoring
## Large Systems

<table>
<thead>
<tr>
<th>Thermal technology</th>
<th>Large system threshold (total system capacity)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar</td>
<td>Collector surface &gt; <strong>660 sq ft</strong> (20 panels)</td>
</tr>
<tr>
<td>Biomass, Heat Pumps</td>
<td>Rated capacity &gt; <strong>340 kBtu/h</strong> (100 kW; 28 ton)</td>
</tr>
<tr>
<td>Biogas/fuels</td>
<td>Heat Pump capacity rated at 47°F (dry bulb)</td>
</tr>
<tr>
<td></td>
<td><strong>N/A</strong></td>
</tr>
</tbody>
</table>
Large System Metering - General Principles

- Boundary for thermal measurement (Btus)
  - Before delivery to distribution or rejection of excess heat systems
- Measuring the net renewable thermal energy transferred to a facility’s heating or cooling thermal load:
  - Air/Water Systems: based on flow, temperature, and specific heat
  - Steam systems: based on flow and specific enthalpy (temp. & pressure)
Accuracy of Metering

• For liquid or air based systems:
  ➢ Must meet accuracy of EN1434 standard; or
  ➢ Must meet accuracy of ±5% (AECs discounted)

• For steam systems:
  ➢ Must meet accuracy of ±3%; or
  ➢ Must meet accuracy of ±5% (AECs discounted)
Upfront Minting
- Small Systems
## Small Systems

<table>
<thead>
<tr>
<th>Thermal technology</th>
<th>Small system threshold (total system capacity)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar</td>
<td>Collector surface &lt; $660 \text{ sq ft}$ (20 panels)</td>
</tr>
<tr>
<td>Biomass, Heat Pumps</td>
<td>Rated capacity &lt; $340 \text{ kBtu/h}$ (100 kW; 28 ton)</td>
</tr>
<tr>
<td>Biogas/fuels</td>
<td>Heat Pump capacity rated at 47°F (dry bulb)</td>
</tr>
<tr>
<td></td>
<td>N/A</td>
</tr>
</tbody>
</table>
Small system monitoring/verification

- Small systems: **calculate** projected output
  - Meant to cover residential, small multi-family and small commercial
    - No upfront minting for biogas/fuels
  - Verification of ongoing operation through spot checks and run-time monitoring
    - Integration with smart thermostat and connected devices
Upfront Minting of AECs

• Upfront minting will be default for non-metered (small) systems

• In lieu of lifetime AECs, systems will receive a one-time strip of AECs, equivalent to 10 years projected output
  - AECs will be year of APS qualification vintage
  - Upfront minting allowed as far as APS minimum standard can accommodate
  - Combination with MassCEC rebate can not exceed 50% of capital cost of project
    ▪ AEC award will be adjusted to not exceed this cap, if necessary
    ▪ Project that received MassCEC rebate prior to finalization of APS regulations cannot qualify
Upfront Minting of AECs

• DOER contracts with Third Party (Agent)
  ➢ Default AEC aggregator to transact AECs and return revenue to owner
  ➢ System verification

• DOER is considering market options to enable forward purchase of pre-minted AECs to provide up-front project capital (not for inclusion in regulations)
Output Projections for Pre-Minted AECs

- Based on thermal load served in building and rated capacity and performance of system
- Verify against building load (cannot exceed)

\[
\text{AEC/y} = \frac{E_{\text{th, net}}}{\text{HC} \times t \times P \times O_{\text{source}}}
\]

- $E_{\text{th, net}}$ = net useful thermal energy output
- HC = seasonal average heating capacity
- t = time (hours/y)
- P = performance factor
- $O_{\text{source}}$ = operating energy factor (source energy)
Output Projections – Factors to consider

• Technologies

- Solar Thermal: calculation (eg. RETscreen), using SRCC OG100/300 rating, taking into account shading/orientation losses
- ASHP/GSHP: operating hours of pump, seasonal heat capacity and seasonal COP
- Biomass: operating hours, average thermal efficiency, heat capacity
Biomass
Biogas
Biofuels
Biomass Sustainability

• Options to demonstrate sustainable forest management:
  ➢ Licensed forester attests
    ▪ Long term forest management plan, Best Management Practices, Forest Guild biomass guidelines
  ➢ Independent certification of forest resource
    ▪ Sustainable Forestry Initiative, Forest Stewardship Council, Tree Farm
    ▪ Commonwealth Quality Program (MA only)
      Incl. provisions for downed wood and soil condition
  ➢ Use non-forest derived residues (as defined in MA RPS Class I woody biomass regulations)

• Chain of custody from forest to fuel supplier
Biomass Sustainability

- DOER will provide list of qualified pellet suppliers that demonstrate meeting biomass sustainability criteria
- DOER will require wood chip systems users to provide chain of custody records from suppliers that demonstrate biomass sustainability criteria
- Verification
  - Qualified biomass system owners required to keep record of invoices to demonstrate eligible fuel is used
    - Spot audits by DOER or Agent
  - DOER tracks and reports average aggregate share of residues/thinnings from pellet & chip producers/suppliers
    - Includes information to demonstrate sustainable forest management practices were used
      Forester attestation
      Independent certification
Biomass GHG Balance

• Need to demonstrate 50% lifecycle GHG savings compared to default traditional heating source
  ➢ Time horizon: 20 years
  ➢ DOER calculation, no individual reporting
    ▪ Based on representative reported mix of residues and thinnings
    ▪ Include in sustainability criteria
  ➢ Residue versus thinnings share in pellet feedstock should be about 50/50

(Indicative results based on the MA RPS Class I GHG Calculation Guideline)
### Air Emissions

<table>
<thead>
<tr>
<th>Pollutants</th>
<th>Pellets</th>
<th>Chips</th>
<th>Cordwood</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Small Scale &lt; 3 MMBtu/hr heat input)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PM$_{2.5}$</td>
<td>0.08 lb/MBBtu heat input</td>
<td>0.10 lb/MBBtu heat input</td>
<td>reserved</td>
</tr>
<tr>
<td>CO</td>
<td>270 ppm @ 7% O$_2$</td>
<td>270 ppm @ 7% O$_2$</td>
<td>reserved</td>
</tr>
<tr>
<td><strong>Large Scale (equal to or &gt;3MMBtu/hr heat input)</strong></td>
<td>MassDEP permit required</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NOx, CO, PM$_{2.5}$</td>
<td>MassDEP permit required</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

DOER will review air emission requirements every 2 years, with MassDEP
Biomass System Performance

• Requirements for **thermal storage** or other means to minimize deterioration of efficiency or emissions due to boiler cycling:
  - Properly insulated buffer tank (min. R12)
  - Demonstrate to DOER the heating system (incl. distribution) is designed to match fluctuating load
    ▪ Air emission requirements met down to 20% of max. capacity
    ▪ Will include monitoring requirements

• Fuel conversion **efficiency performance standards**
  - Min. thermal efficiency: 80% (HHV)
Biomass Fuel Quality

• Combine sustainability with fuel quality requirements
  ➢ Dimension (length, diameter)
  ➢ Heating value
  ➢ Moisture content
  ➢ Ash content
  ➢ Contaminants
• Available standards
  ➢ ENplus (EN 14961-2, ISO 17225-2) > PFI
# Biomass Fuel Quality

<table>
<thead>
<tr>
<th>Pellet fuel standards</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Calorific value</td>
<td>&gt; 8,000 Btu/lb</td>
</tr>
<tr>
<td>Moisture</td>
<td>&lt; 10%</td>
</tr>
<tr>
<td>Ash</td>
<td>&lt; 1%</td>
</tr>
<tr>
<td>Chlorine</td>
<td>&lt; 0.03% (dry)</td>
</tr>
<tr>
<td>Source materials</td>
<td>Only wood</td>
</tr>
<tr>
<td></td>
<td>&gt; 50% wood residues</td>
</tr>
<tr>
<td></td>
<td>Chain of custody for forest management</td>
</tr>
<tr>
<td>Excluded</td>
<td>Grass, construction &amp; demolition waste</td>
</tr>
</tbody>
</table>

DOER will consider chip quality requirements for inclusion in Guideline
Biogas

- Biogas from landfills, anaerobic digestion or biomass gasification
  - Used for thermal energy generation
  - Need to reduce lifecycle GHG emissions by 50%
  - When using woody biomass as feedstock: demonstrate implementation of sustainable forest management
- Allow for blending of biogas with natural gas in distribution system
  - Similar to RPS Class I
    - Physical deliverability into MA (document with contracts)
    - Biogas produced entirely within the ISO-NE Control Area or an adjacent Control Area
  - AEC calculation for delivered energy, taking into account transmission and distribution losses and qualified units’ conversion efficiency
Eligible Biofuels

• Biofuels need to be “advanced” biofuels
  ➢ 50% lifetime GHG savings per unit of delivered energy, in comparison to the petroleum distillate fuel displaced

  *An Act Relative to Clean Energy Biofuels, M.G.L. 94, § 295G1/2 2008*

• Biofuels eligible to qualify in the APS: organic waste derived biodiesel
  ➢ In support of the commercial food waste disposal ban (MassDEP)
  ➢ Other fuels considered case by case
Biofuels Qualification

• The facility (user) qualifies
  - Information about oil furnace/boiler
  - Demonstrates purchase of advanced biofuel
    ▪ Tracked with Renewable Identification Number
    ▪ Suppliers participate in EPA Quality Assurance Plan
    ▪ Share of advanced biofuel needs to be significant
  - Administrative burden for residential/small customers
    ▪ Fuel supplier could act as aggregator

• Only AECs for energy *generation* with advanced biofuel
  - Takes into account conversion efficiency
Upstream Qualification

• Upstream qualification: supplier of fuel used in eligible renewable thermal technology qualifies portfolio of (customer) installations

  ➢ Would result in much lower administrative burden for biogas/fuel/mass participation in APS
    ▪ Supplier qualifies and receives credits, leading to lower fuel price point
    ▪ Tracking through supply contracts and delivery receipts
    ▪ Average efficiency of furnaces/boilers

  ➢ Legal basis uncertain, therefore **not included**
    ▪ Facility has to qualify
    ▪ Potential solution: suppliers act as aggregators
Logistics
Stakeholder Comments

• Stakeholders invited to provide written feedback on this presentation
  ➢ Comments, suggestions, information resources
  ➢ E-mail before 12/31/2014 to bram.claeys@state.ma.us
Enjoy the Holidays