Biomass Thermal Energy

Metering Principals
A Few Other Thoughts

- Principals generally applicable regardless of system size or whether steam/hot water
- Small-scale systems
  - More likely to use hot water as working fluid
  - Less instrumentation needed for operation
  - Less likely to be CHP
- Large-scale systems
  - More likely to use steam for working fluid
  - More likely to include power generation
  - Industrial process heat
  - More instrumentation—ideally
Thermal Metering – Net Useful Energy

- Net Useful biomass energy delivered to distribution
  - Gross renewable thermal energy production continuously metered at the inlet of boiler and prior to distribution
  - Adjustments applied to determine net useful thermal energy
- General Equation for Net Useful Thermal Energy ($U_{th}$)

$$U_{th} = Q_{out} - Q_{ret} - Q_{rps} - Q_{adj} - Q_{par} + Q_{wh}; \text{ where}$$

- $U_{th}$ = useful thermal energy
- $Q_{out}$ = energy leaving BECD
- $Q_{ret}$ = energy returned from process
- $Q_{adj}$ = energy adjustment for non-renewable energy inputs
- $Q_{par}$ = energy adjustment for parasitic loads downstream of $Q_{out}$ metering point
- $Q_{rps}$ = thermal energy used to produce RPS compensated electricity
- $Q_{wh}$ = waste heat recovered from exhaust gas
Gross Thermal Production

- Continuous Metering: Boiler input and output
  - Temperature, flow and pressure sensors installed after feedwater pumps and at inflow to main steam header
- Thermal Generation formula

\[
Q_{th} = Q_{out} - Q_{ret}
\]
where

\[
\begin{align*}
Q_{th} &= \text{biomass thermal energy produced (Btu/hr)} \\
Q_{out} &= \text{energy leaving BECD (Btu/hr)} \\
Q_{ret} &= \text{energy returned from process (Btu/hr)}
\end{align*}
\]
Adjustment for Parasitic Loads

- Parasitic Thermal Loads
  - Feedwater heaters, deaerators, plant heating/cooling, etc.
- Not all loads will require adjustments, only those that may result in overstatement of useful thermal energy
  - Those outside of metering boundaries, or cross metering boundaries
- Adjustment process
  - Identify relevant parasitic thermal loads;
  - Use plant energy audit techniques to quantify these loads ($P_{load}$)
- Calculate parasitic load coefficient as percentage of gross thermal output

$$Q_{par} = Q_{out} \times P_{load}$$
RPS Power Deduction

- Deduction for RPS Power Generation
  - Deduction excludes thermal energy used to produce Electric RECs (avoids double counting)
- Calculation of energy extracted for electricity will depend on type of turbine.
  - Back pressure turbine
  - Extraction turbine, back pressure
  - Extraction turbine, condensing
  - Hybrids (multi-turbine)
General formula

- $Q_{RPS}$ is the adjustment factor

\[
Q_{RPS} = Q_{Tin} - Q_{process} - Q_{Tout}; \quad \text{where}
\]

- $Q_{RPS}$ = total energy generate RPS electricity;
- $Q_{Tin}$ = total energy to the turbine inlet;
- $Q_{process}$ = total energy from turbine to process
- $Q_{Tout}$ = the total energy in condensate; and
Waste Heat Recovery Adjustment

- Addition for Waste Heat – Case by Case
  - Addition credits the recovery of useful process energy from exhaust gases
  - Assumes that waste heat is used to add value to a product that is not consumed at the plant
    - Drying lumber = OK
    - Drying wood fuel = parasitic use
Methodology ensures that RECs created by power generation for the RPS do not overlap RECs created by thermal energy production.

Adjustment must be made if fossil boiler operated in parallel – case by case, but methodology does accommodate this:
- \( Q_{adj} \) = energy adjustment for non-renewable energy inputs

Meter choices have a big impact and freedom for proper specification for each application must be provided. An overall accuracy adjustment factor seems appropriate to be fair to all parties.