Comprehensive Feasibility Assessments for Biomass Thermal and CHP Projects

Heating the Midwest Conference

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Energy · Environment · Enterprise

Presentation Overview

- Key steps in feasibility study process
  - Establishing owner goals
  - Solving the thermal puzzle
    - Annual fuel use / cost
    - Thermal systems / energy demand
  - Option development & analysis
    - Fuels, technologies, economics
- Study is a decision document allowing owner to seek financing or higher a designer/contractor

Biomass thermal benefits / Owner goals

- **Environmental and Social**
  - Renewable energy
  - Replace fossil fuel
  - Energy security
  - Markets for low-use wood (waste, forest residues)
  - Thermal/CHP is most efficient use of limited biomass resource
  - Considered carbon neutral
- **Economic**
  - Energy dollars stay local
  - Energy savings to owner

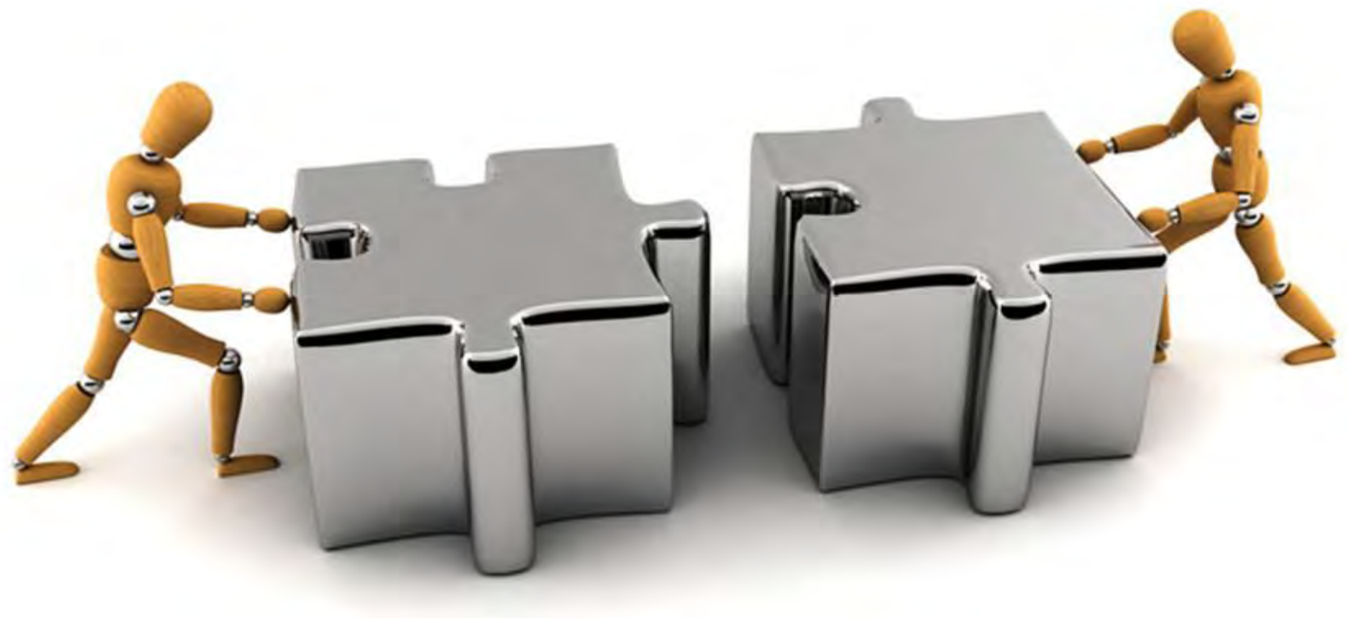
Discussion of what is realistic up front – back of envelope

- Establish realistic goals with the owner and narrow down the list of options
  - Example: "I would like to generate all my electricity from biomass."

- ~Potential Budget = Savings * Acceptable Payback
  - How much is spent now on heating?
  - How much can be saved?
  - What simple payback is needed?

Piecing together the thermal puzzle, basis for feasibility study

- Annual fuel use and cost
- Heat generation, distribution, and use
- Thermal load modeling



Fossil fuel use and cost – key to economics

- Establish facility's baseline fossil fuel usage from records or projections (modeling)
  - Consider past impacts to records such as weather data and future changes such as efficiency projects, facility expansion, etc.
- Establish baseline fossil fuel cost from historical data and future projections
- Baseline usage and cost drives project economics – vet with the owner

How is the heat used? – Generation, Distribution, and Quality

Steam

- Temperature
- Pressure
- Uses (heating, humidification, etc.)
- Building or process operating schedule
- Allowable variance

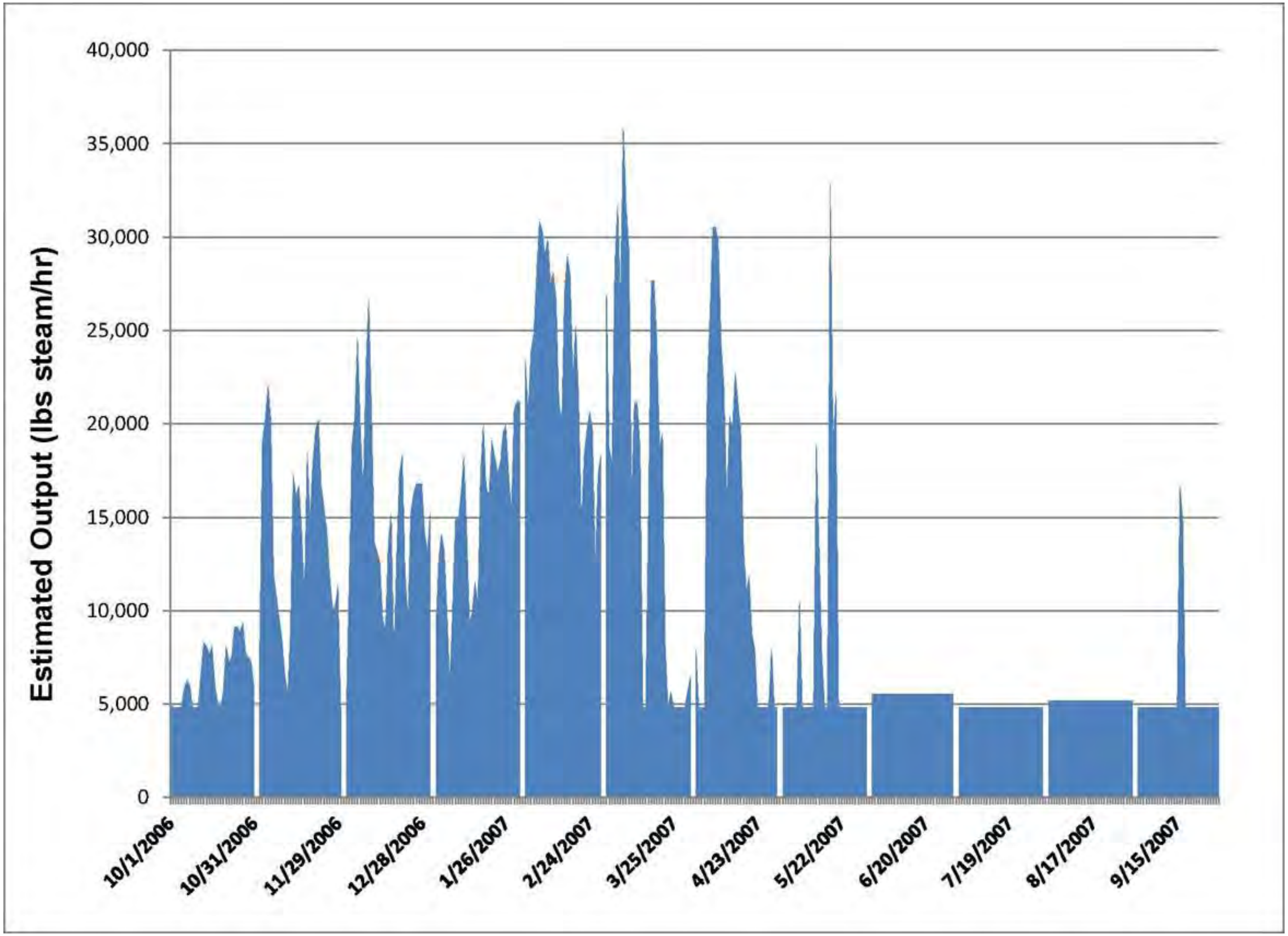
Hot Water

- Required temperature
- Uses (pool, DHW, heating, laundry, drying, etc.)
- Building or process operating schedule
- Allowable variance

Forced Air

- Required temperature
- Required air flow
- Uses (heating, drying, etc.)
- Building or process operating schedule
- Allowable variance

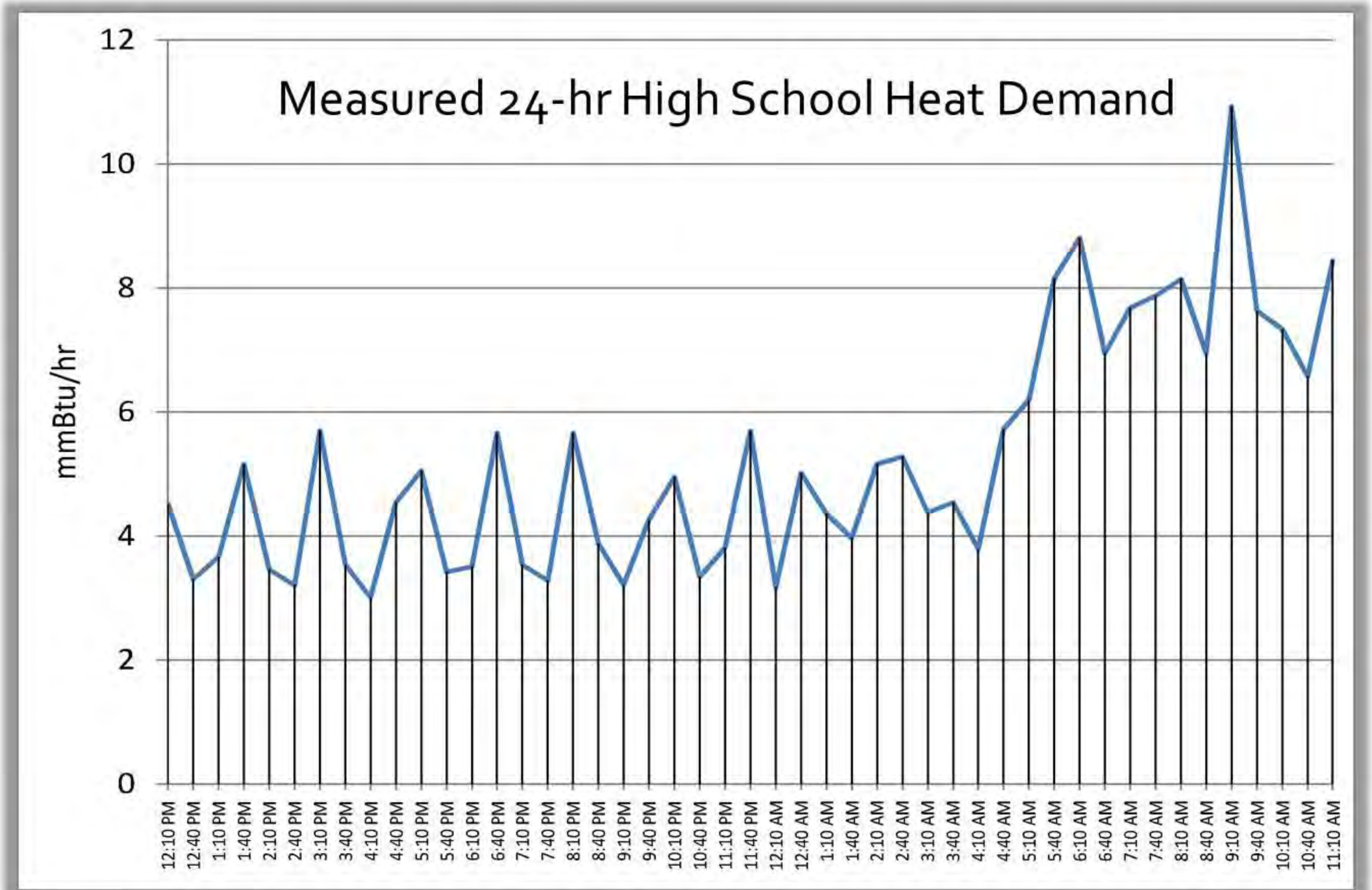
Model the loads using all the puzzle pieces available – demand curve



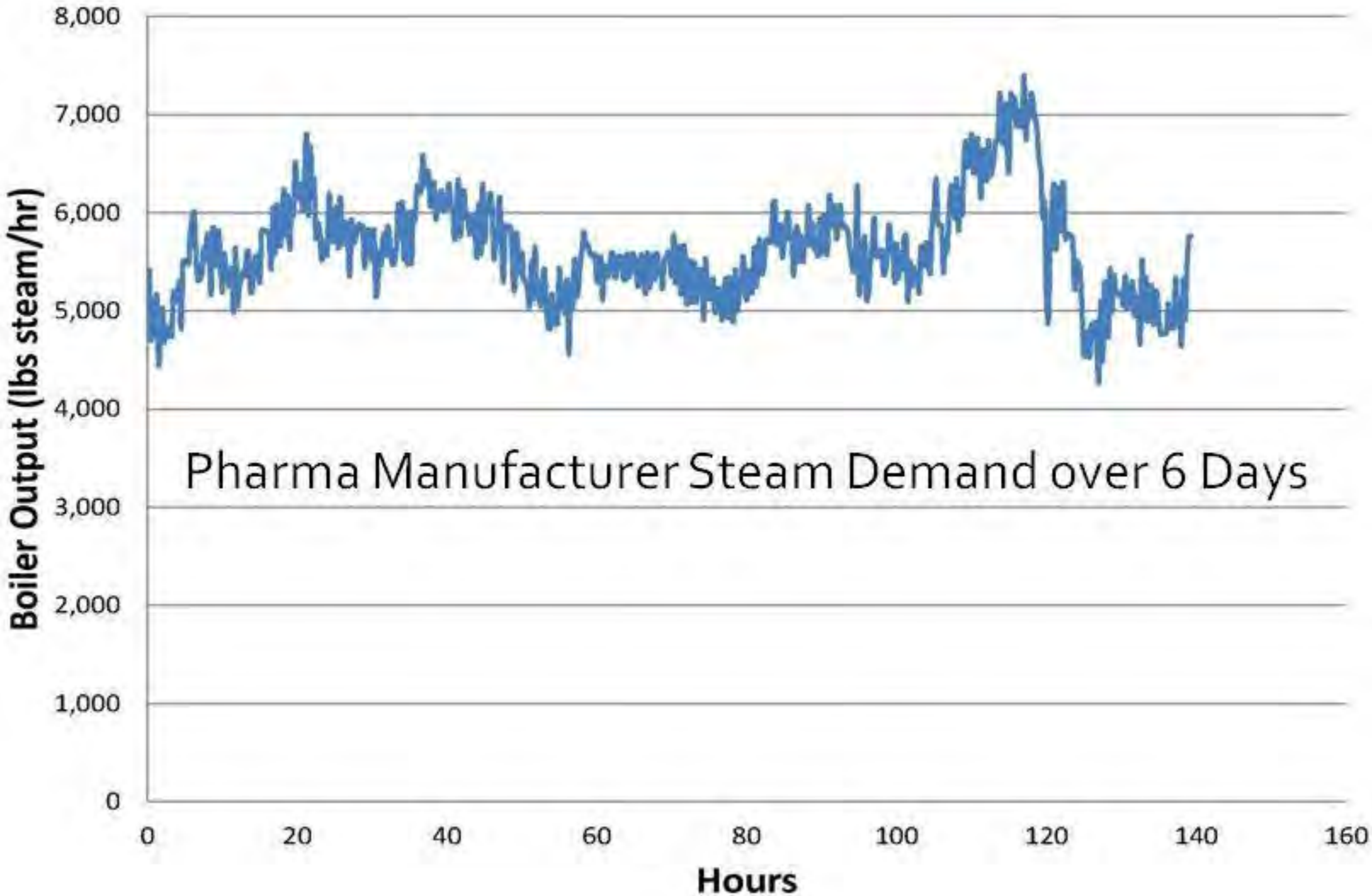
Pieces:

- Fuel use records/bills
- Recorded heat production
- Portable Btu meter
- Building or process model
- Operating Parameters
- Local weather data

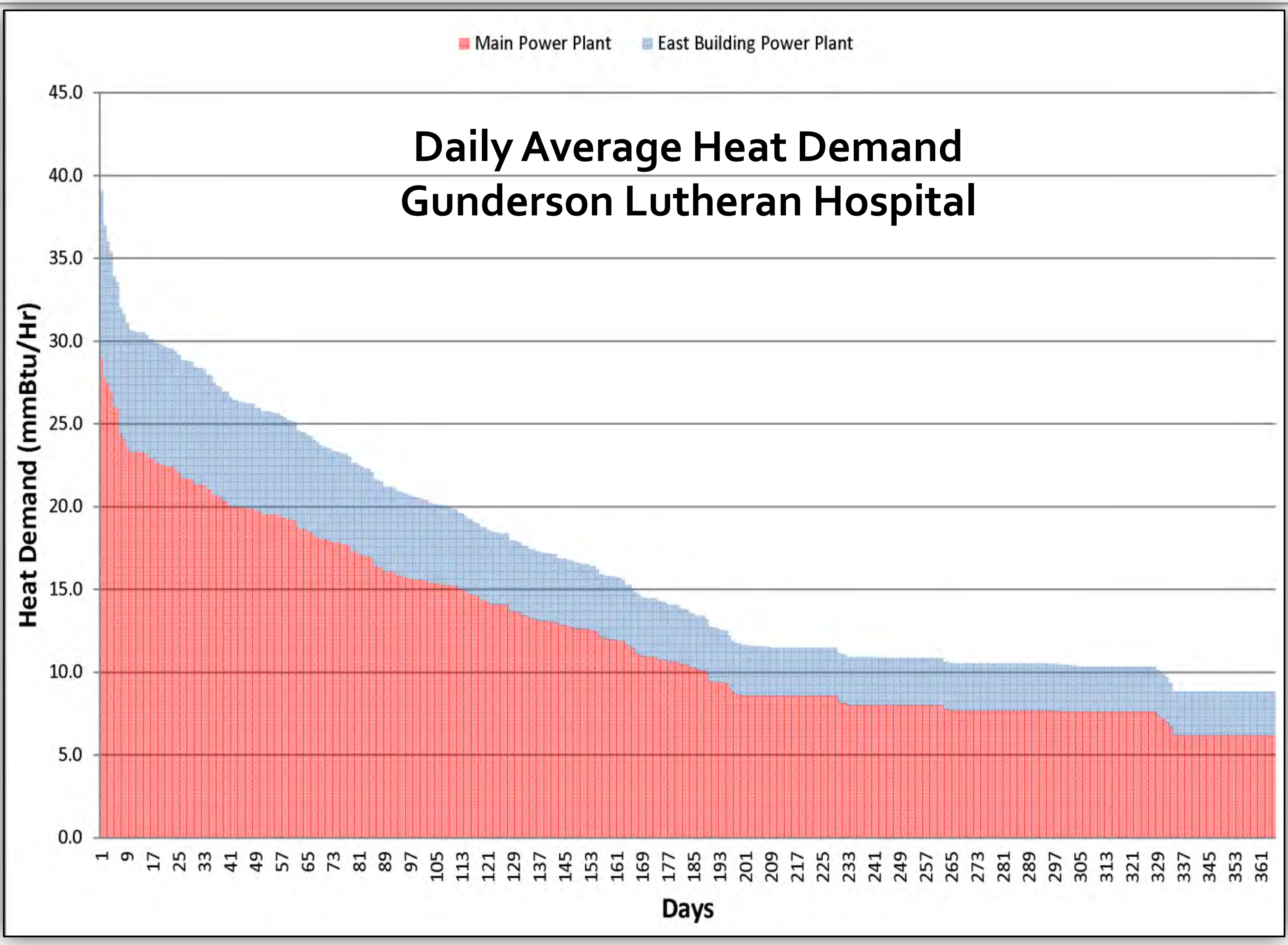
Use portable metering equipment to help complete the puzzle



Use portable metering equipment to help complete the puzzle



Load duration curve



Easy to develop once the load model is completed & is useful for system sizing.

With the thermal puzzle solved, now you need some biomass

- Biomass availability
  - What (type & quality), how much, what cost, sustainably available?
    - Opportunity fuels?
- Ask vendors and local/state resource agencies:
  - Fuel, quality, how much, what cost, sustainable?
- Where appropriate, perform a detailed resource assessment
  - Depends on system size and owner comfort with long-term availability

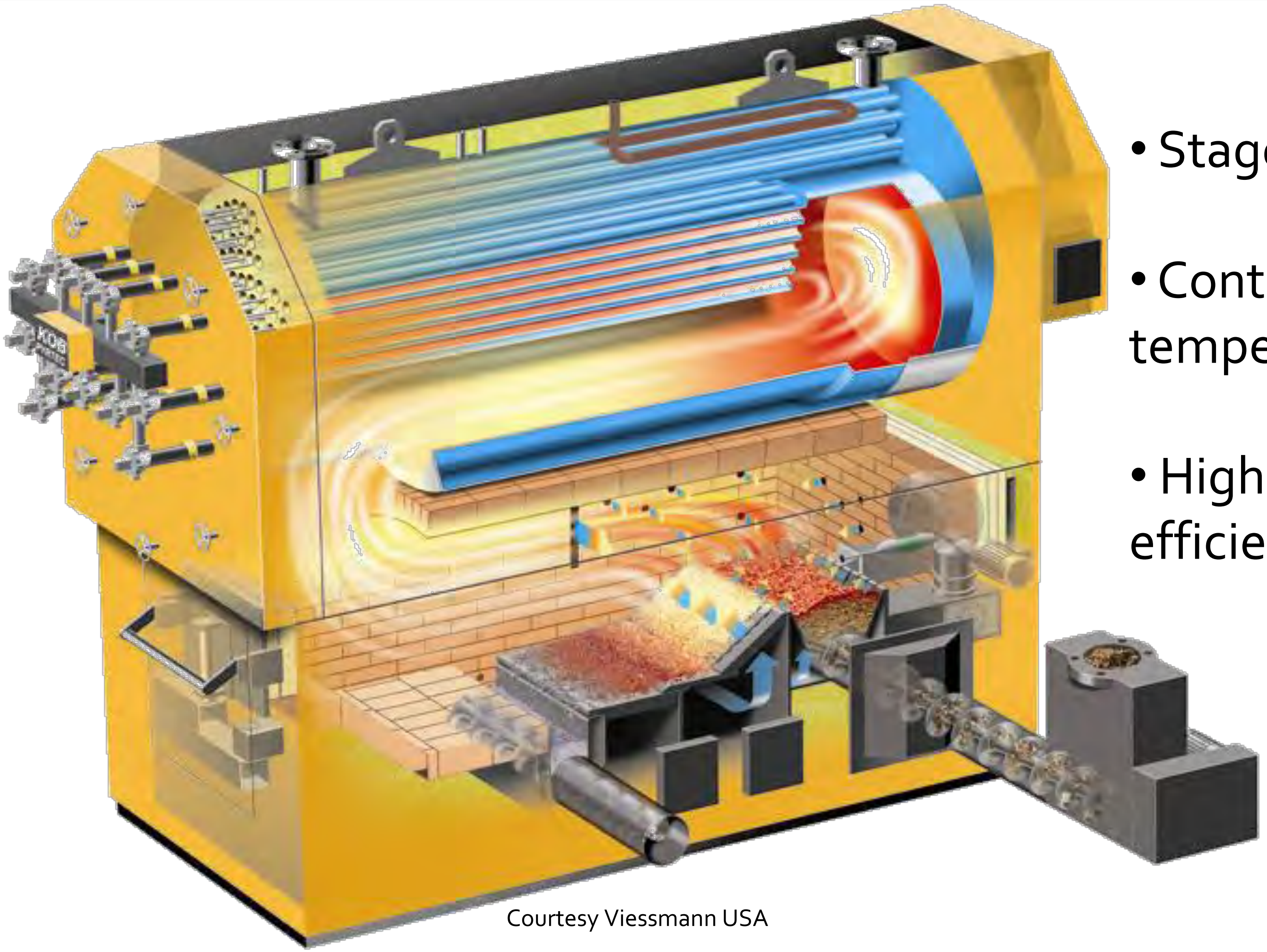
Mill Chips

Pellets

Whole-Tree Chips

Switchgrass Briquettes

Conversion technology – Advanced Biomass Combustion Units



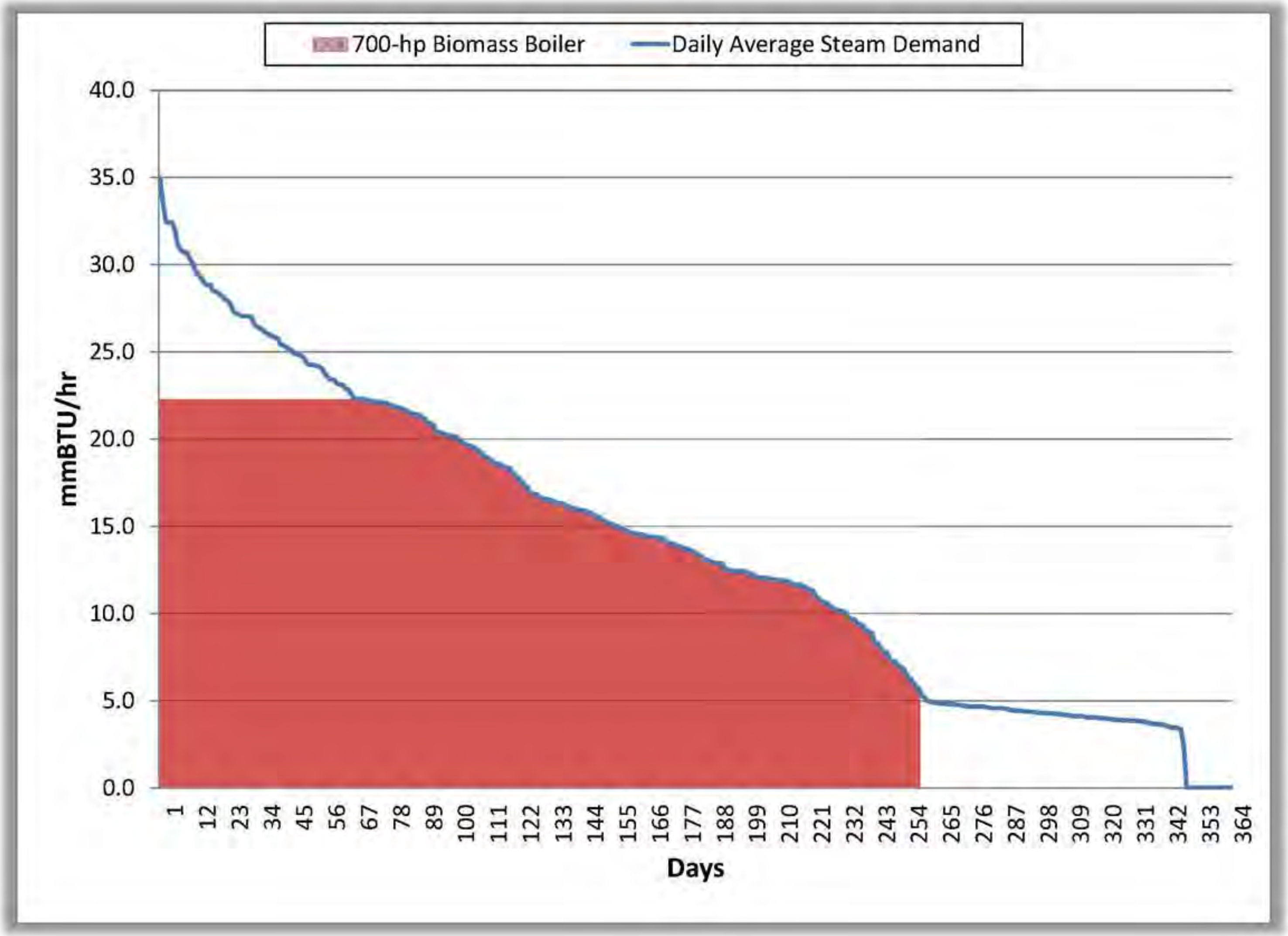
Courtesy Viessmann USA

- Staged combustion
- Controlled air and temperature
- High combustion efficiency

Selecting the appropriate advanced combustion unit / storage / handling

- From the thermal puzzle
  - Heat transfer medium, quality
  - Sizing with demand curve and load duration curve
- Given available fuels – maximize flexibility
  - Storage and handling flexibility (if possible)
  - Combustion unit covering range of fuels (if possible)
- Many quality vendors will fit your needs
  - Make your study vendor neutral
  - Owner visits to different installations/vendors
  - The more qualified bidders, the better for the owner

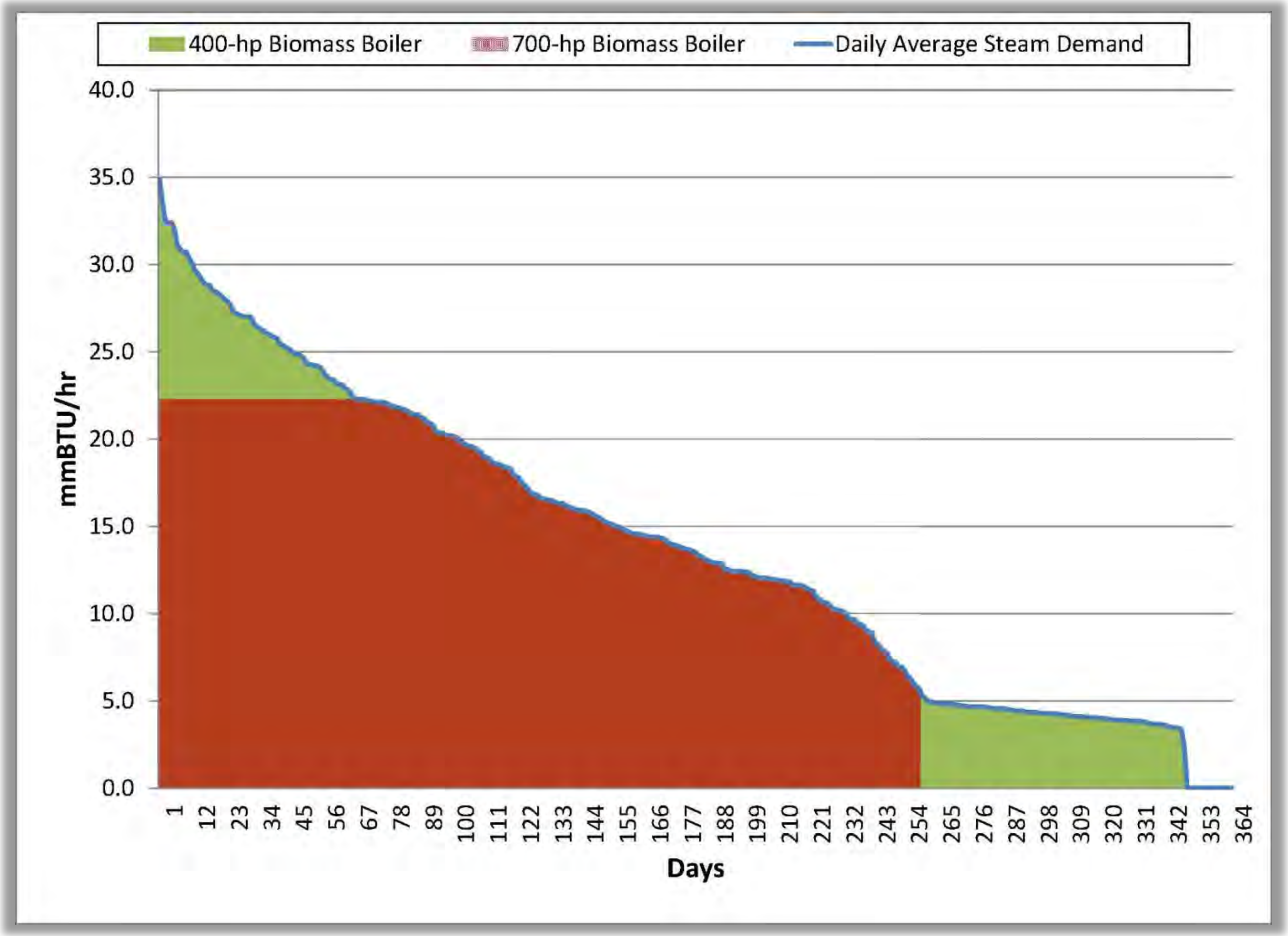
Boiler Sizing – Maximize coverage with one boiler



Biomass boilers operate between 100 and 25% of rated capacity

85% replacement with 23 mmBtu/hr wood boiler

Boiler Sizing – Two boilers to cover nearly 100% of load



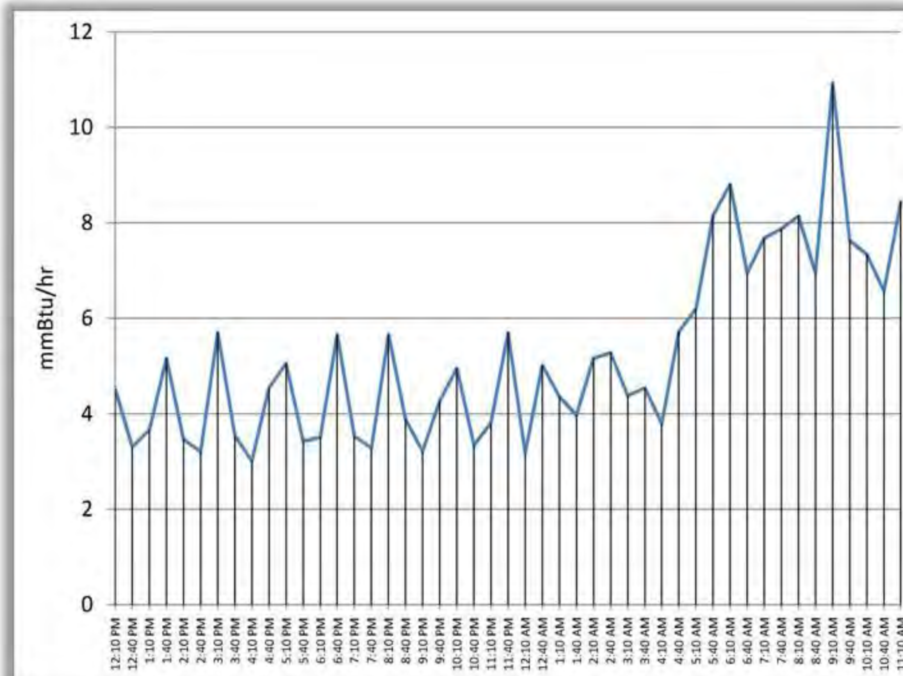
Biomass boilers operate between 100 and 25% of rated capacity

~100% replacement with 23 mmBtu/hr & 13 mmBtu/hr wood boilers

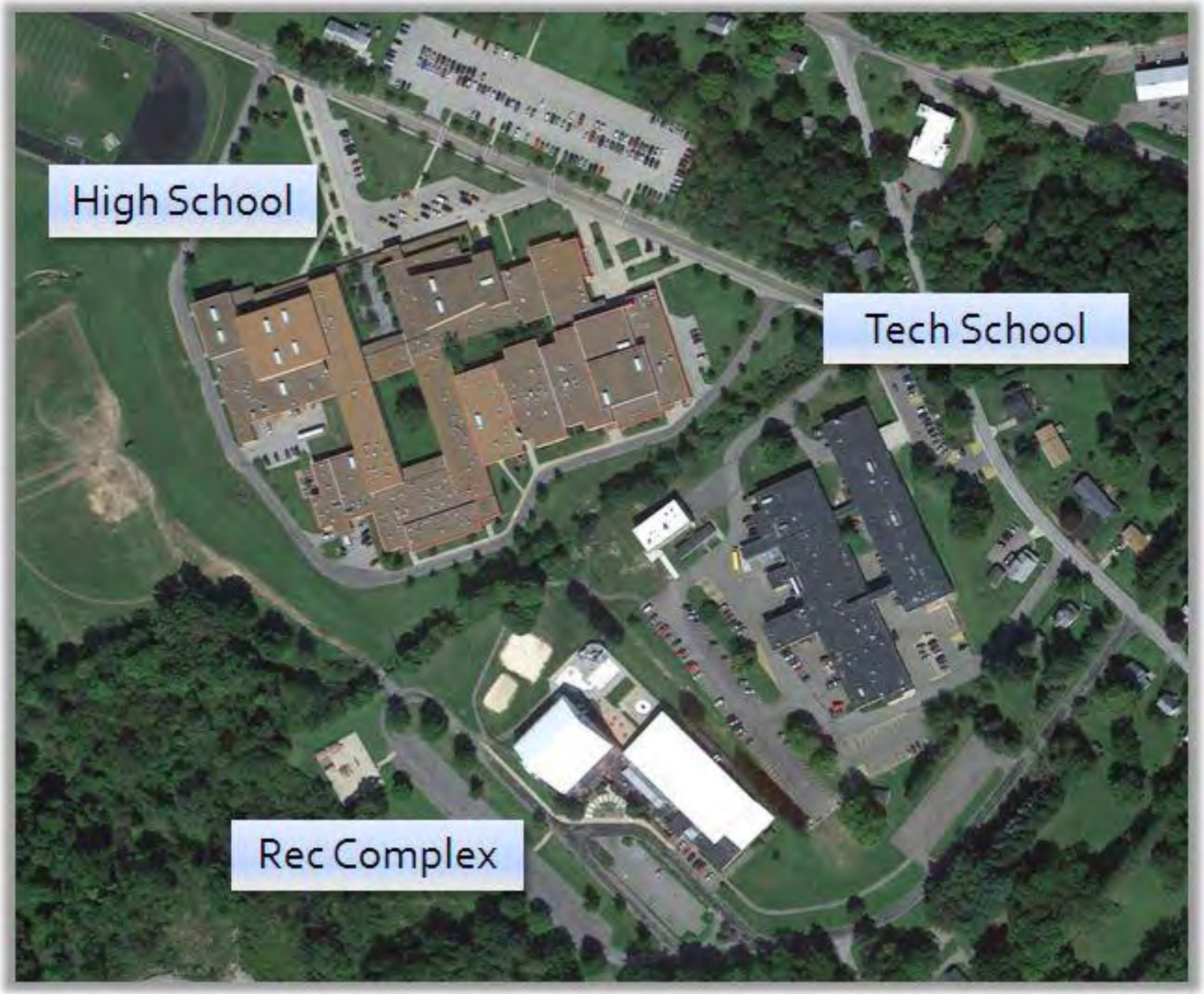
Thermal storage increases biomass thermal efficiency

Buffer between fluctuating load and biomass unit

Allows operation further into the shoulder months for space heating applications

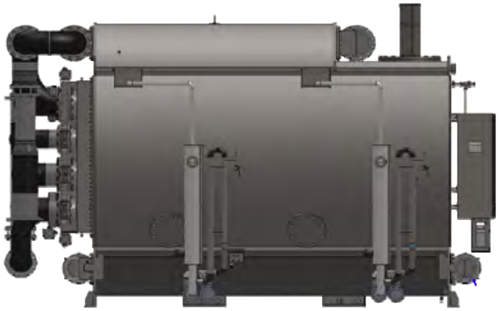


Look to add load (savings) without major increases in capital cost



Cooling - low cost heat / high electric cost

- Air Conditioning w/ Heat COPs (energy output / energy input)
  - Steam Turbine compressor = ~1.8
  - Absorption Chiller
    - Single-Stage (hot water or steam) = ~0.7
    - Two-Stage (steam) = ~1.3
  - Adsorption (hot water or steam) = ~0.7
  - Desiccant cooling (hot water or steam) = varies depending on climate [consumes water]



Eco-Max Adsorption Chiller

- Electric water cooled chiller COP = ~7
- Electric air cooled chiller COP = ~4

COP values presented are approximate for illustration purposes. Actual values vary widely depending on actual conditions.

Thermally-led CHP can provide electric at <$0.02/kWh (energy cost)

Commercially Available Closed Cycle Biomass Power Generation Options

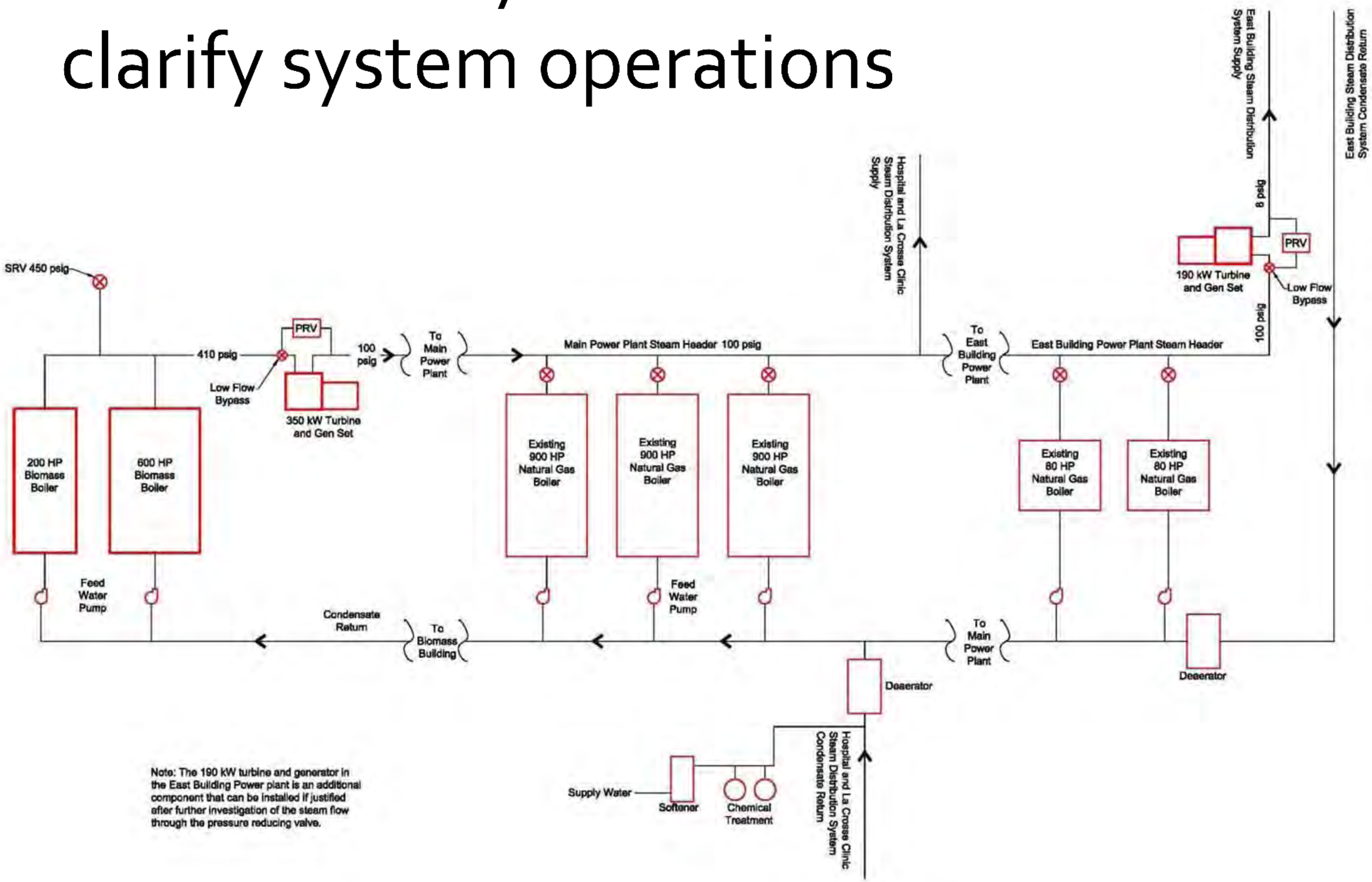
- Backpressure steam (~5-10% electrical efficiency)
- Organic Rankine Cycle (~15-20%)

Courtesy Turboden

Tips:

- Use onsite to maximize value of electric generated
- Year-round load helpful to economics
- Lower quality heat needed onsite = better CHP potential

Add a basic system schematic to clarify system operations



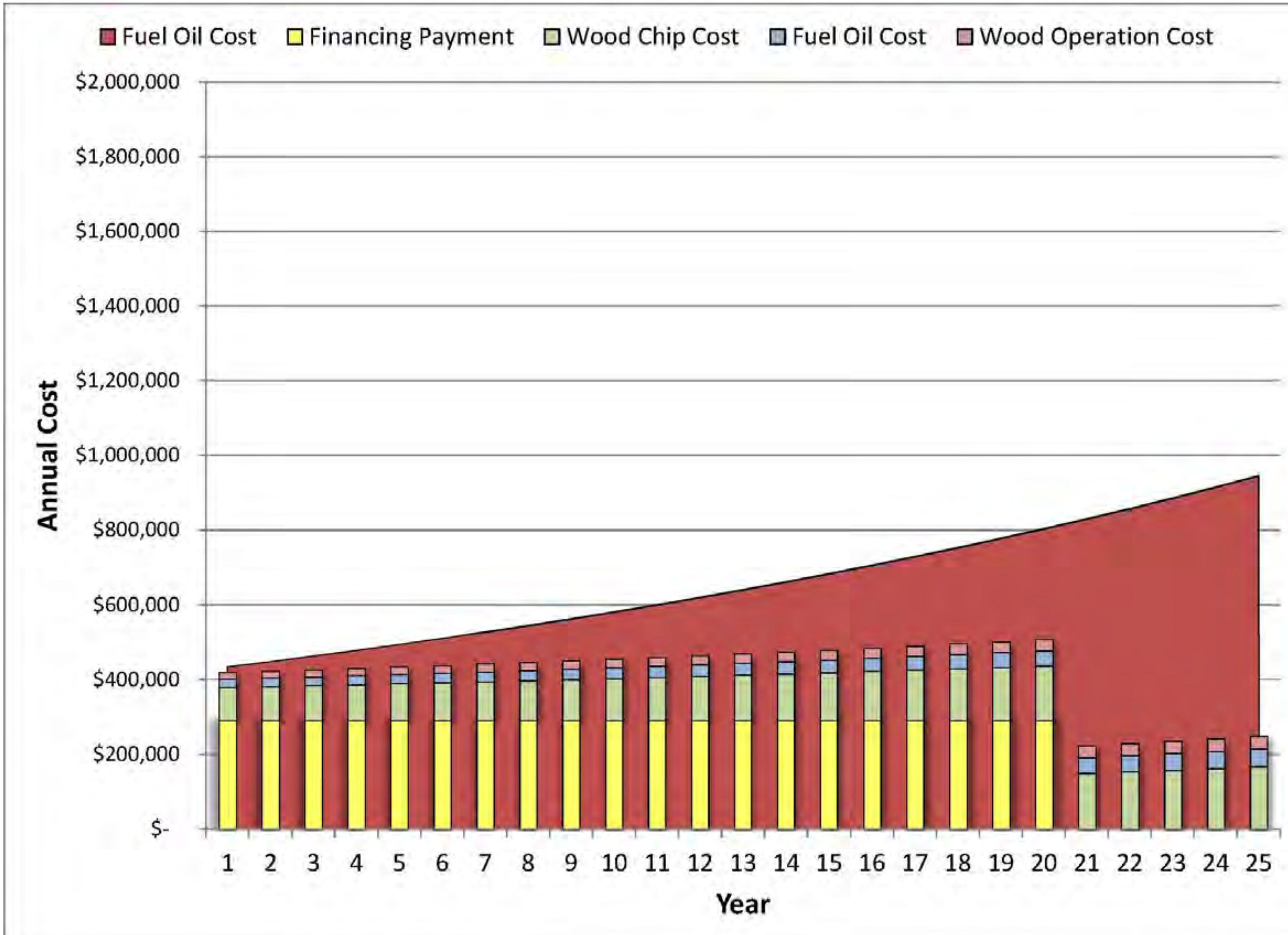
Ensure owner understands escalation assumptions

Escalation Rates:

Oil – 3.3%

Wood – 2.7%

General
Inflation – 2.7%



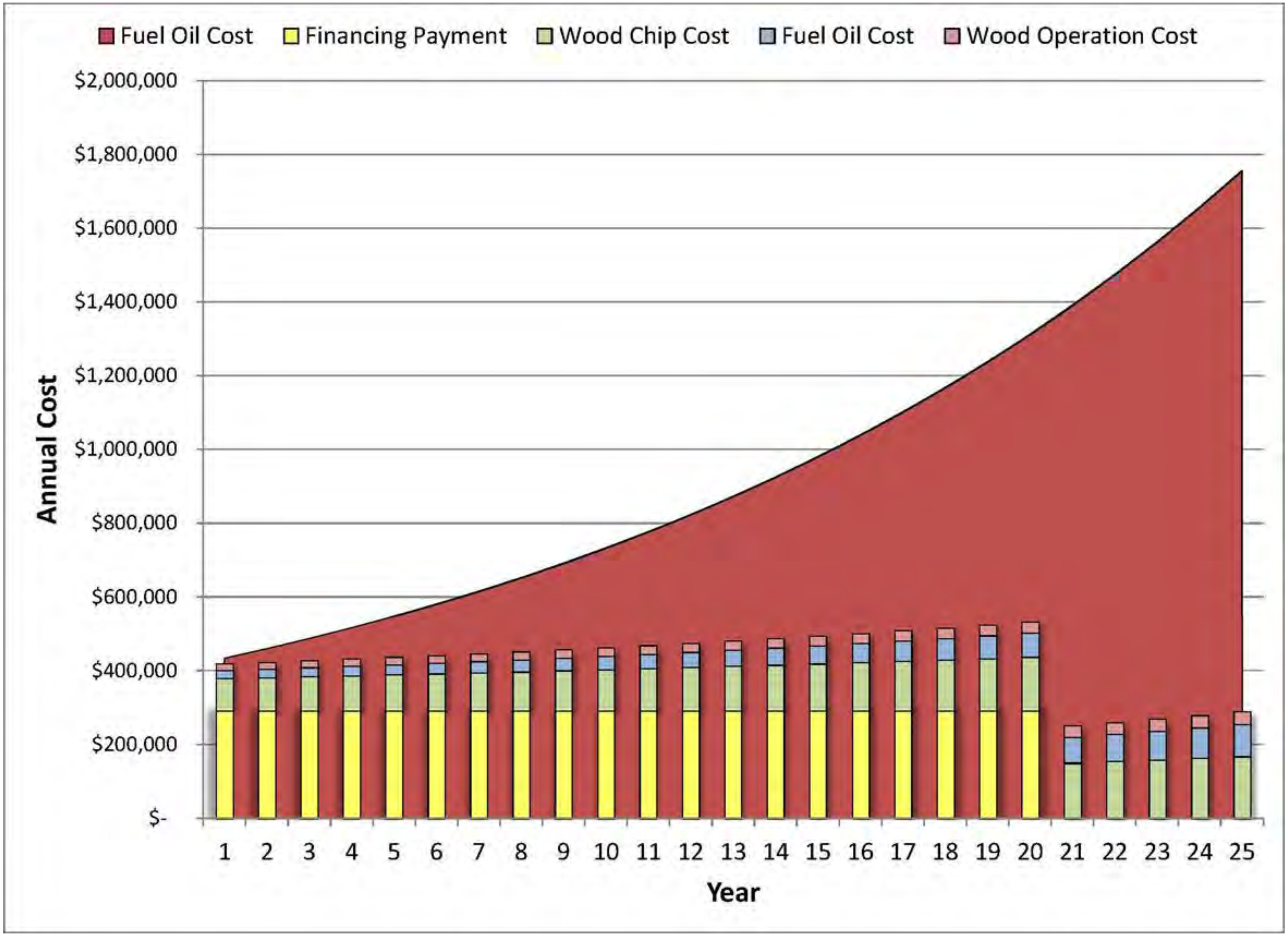
Ely, MN - Cash Flow Analysis

Escalation Rates:

Oil – 6.0%

Wood – 2.7%

General Inflation – 2.7%



Summary

- Establish owner goals
- Solving the thermal puzzle is the key to biomass thermal studies
- Focus study on most viable options, keep it short and to the point