The Economics of Biomass Combined Heat & Power

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CHP Basics

Generating electric power and useful energy from a single fuel source

35% Efficient
70% Efficient
80% Efficient
Minnesota CHP Facility Count

- Coal: 3
- Natural Gas: 13
- Oil: 1
- Waste: 3
- Biomass: 18

Source: ICF CHP Database

Minnesota CHP Capacity (kW)

- Natural Gas: 323,865
- Oil: 3,900
- Waste: 63,700
- Coal: 238,250
- Biomass: 196,217
- Biomass-boiler: 188,500
- Biomass-reciprocating engine: 185

Source: ICF CHP Database
CHP Benefits: Economic

Lower cost  Less price variability

Minnesota Electricity Rates, 2001-2015

Source: Energy Information Administration
CHP Benefits: Efficiency

Recover otherwise wasted thermal energy

Takes place closer to energy consumer—lower losses to transmission & distribution
CHP Benefits: Environmental

More efficient energy use
Lower carbon fuels

→ Lower greenhouse gas emissions!
For those businesses whose operations depend on reliable power

-Adobe Biogas Fuel Cells
Why Biomass?

Energy cost savings

Greenhouse gas reductions

Local economic development

Reduced supply risk
When does CHP work best?

High electricity prices
Deregulated electricity markets
Firms with
  - Regular operations
  - Regular thermal loads
  - Existing central plant
  - Central plant equipment replacement or major construction planned
  - Reliability concerns
  - Environment
Determining Feasibility: The Spark Spread
Spark Spread = Industry + Demand - Supply
Spark Spread = Avoided cost of power ($/kWh) + Avoided cost of thermal fuel ($/MMBtu) - CHP fuel price ($/MMBtu) ÷ Boiler efficiency (%) x CHP heat rate (MMBtu/kWh) ÷ Power-to-heat ratio ÷ 3,413 MMBtu/kWh
Spark Spread = \$0.08/kWh \div 80\% \div 0.1 \div 3,413 \text{ MMBtu/kWh} = \$0.03/kWh

\$0.08/kWh \div \$6/\text{MMBtu} \times 0.0141 \text{ MMBtu/kWh} = \$0.0705/kWh
You **may** have a CHP project if

the spark spread is **positive**

...we didn’t account for capital costs and O&M.
Adding the Cost of Capital

Assumptions
- Electric Capacity (MW) 3
- Annual Operating Hours 8,000
- Capital Cost $18,000,000
- Cost of Capital 8%

Calculations
- Cost per kW $6,000
- Cost per kWh $0.06
+ O&M from $0.02 to $0.10+/kWh
Sensitivity Analysis

Prices: electricity, boiler fuel, CHP fuel, capital, O&M

Technology: boiler efficiency, power to heat ratio, CHP heat rate

Project scale and scope

Alternative fuels
What about risk?

Price risk
Supply risk
Policy risk
Operating risk
What about emissions?

Calculate the spark spread using carbon instead of financial accounting

Price using a carbon price (eg $20 MT/CO$_2$e)
Green Spark Spread

\[
\text{Green Spark Spread} = \frac{\text{Avoided GHG emissions of power (g CO}_2\text{e/kWh)}}{\text{Boiler efficiency (\%)} - \frac{\text{Avoided GHG emissions of thermal fuel (g CO}_2\text{e/MMBtu)}}{\text{CHP heat rate (MMBtu/kWh)}} \cdot \frac{\text{CHP GHG emissions (g CO}_2\text{e/MMBtu)}}{3,413 \text{ MMBtu/kWh}}}.
\]
Someone needs to get EPA better biomass carbon emissions values for their CHP emissions calculator ASAP!
CHP Policy

Federal
- Tax Incentives
- Financing (§ 1703)
- Boiler MACT
- § 111(d)

State
- Next Generation Energy Act (MN)
- RPS
- CIP
- Net metering
- Standby
- Incentives/financing
Summary

Know the basics
Calculate the spark
Follow policy developments
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