Biomass Power & CHP Systems

What Are They & What Makes Them Work?

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Power for the 21st Century
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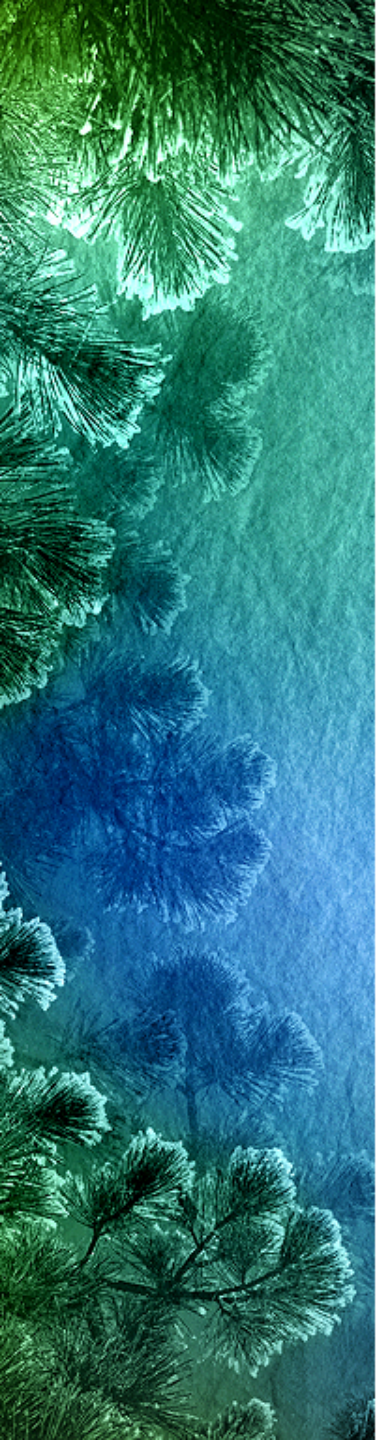


Definition of Terms

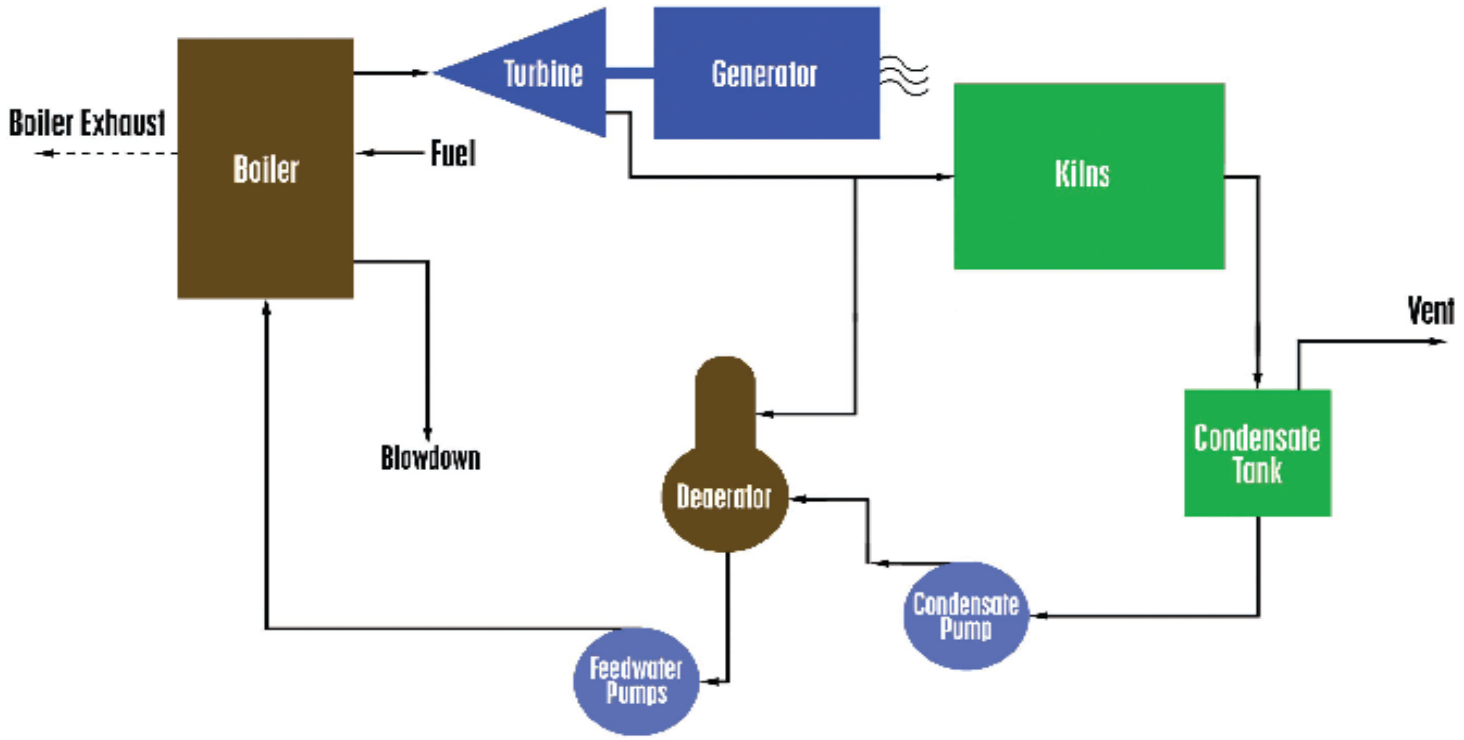
- Biomass-any form of organic material, in this case a subset consisting of:
  - **Mill residual material**
  - **Forest waste**
  - **Urban wood**
  - **Agricultural residual material**
  - **Energy crops**

- Combined Heat & Power (CHP)

  Simultaneous production of thermal and electrical energy from a single fuel source (e.g. power and district heating)

How Do They Work?

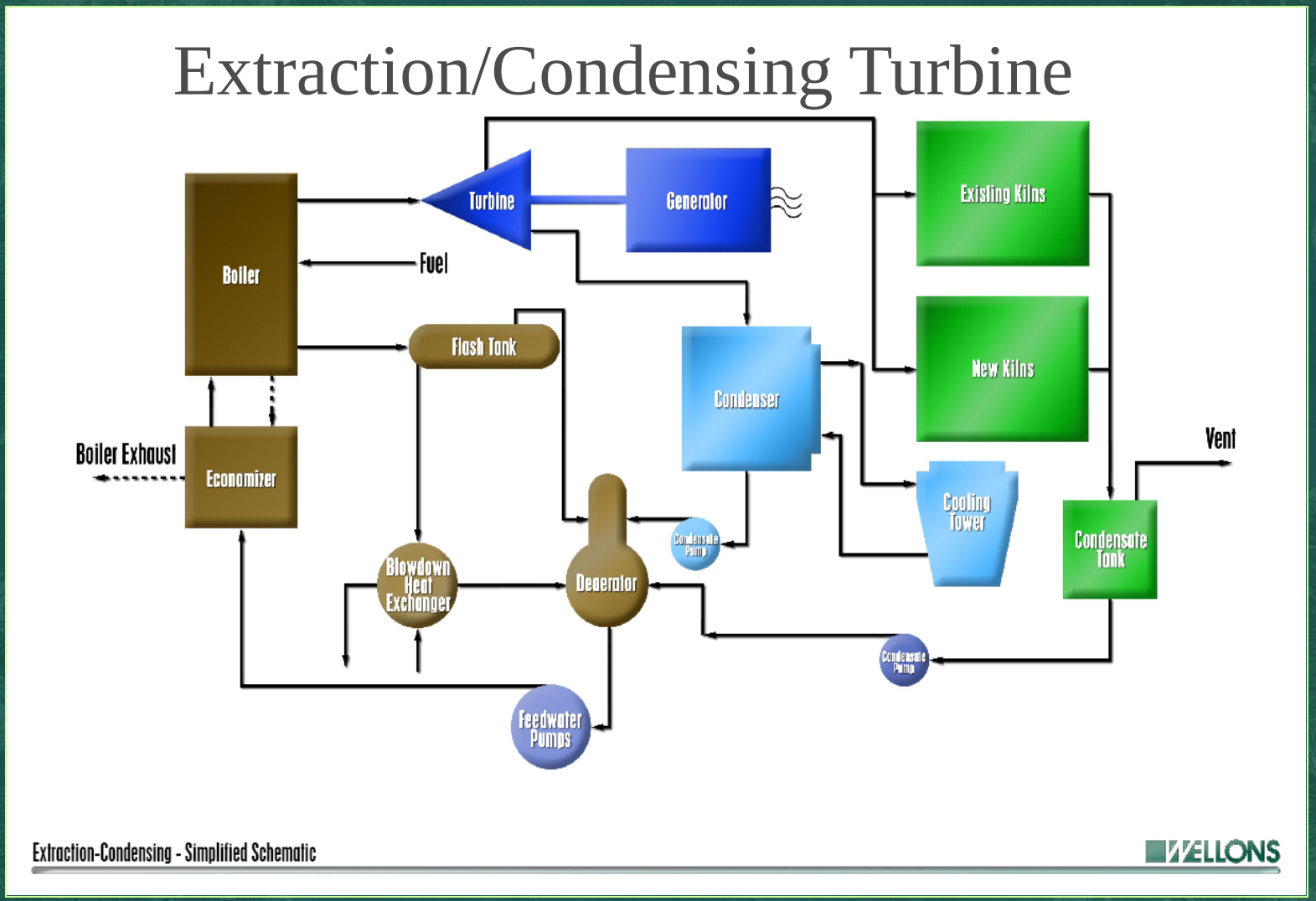
Backpressure Turbine



Backpressure - Simplified Schematic

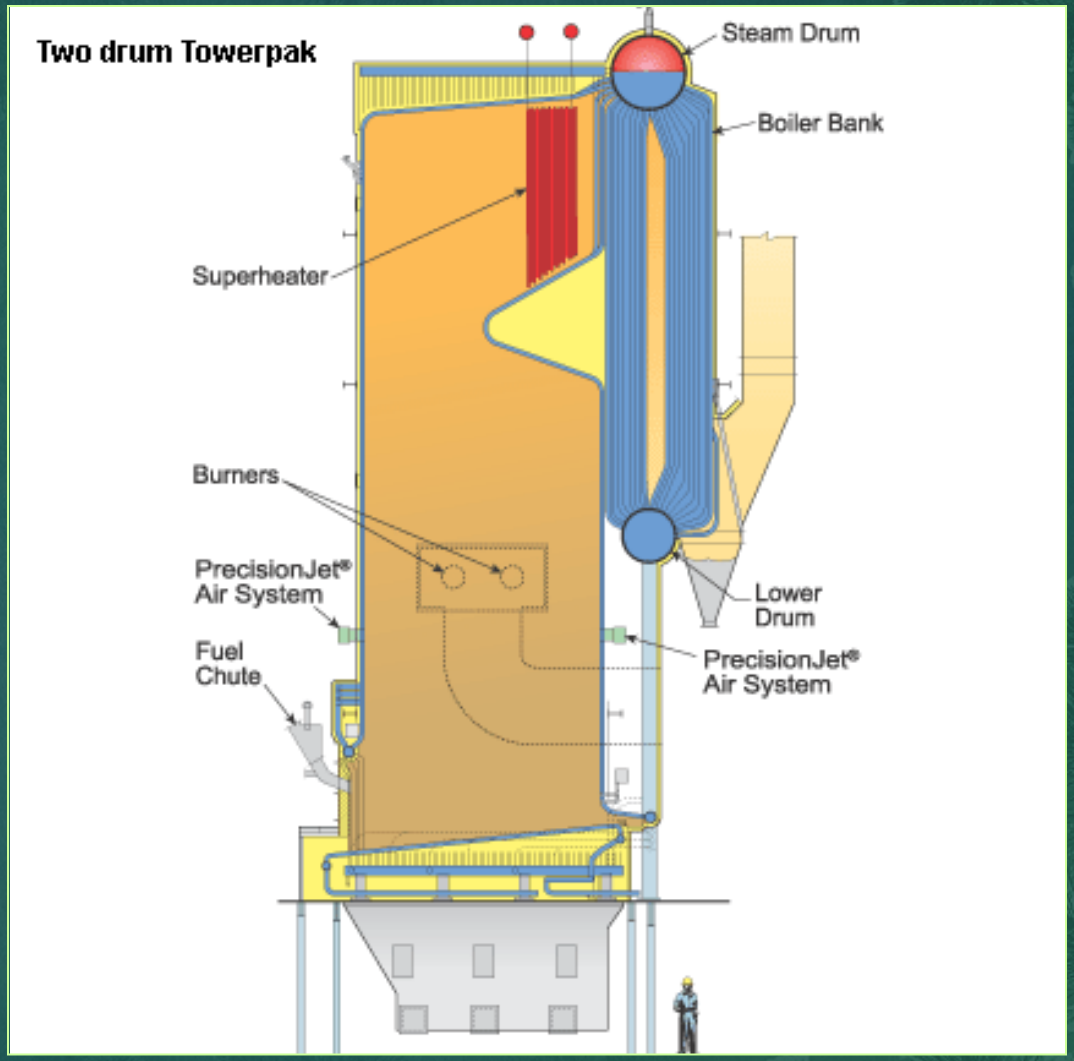
WELLONS

How Do They Work?



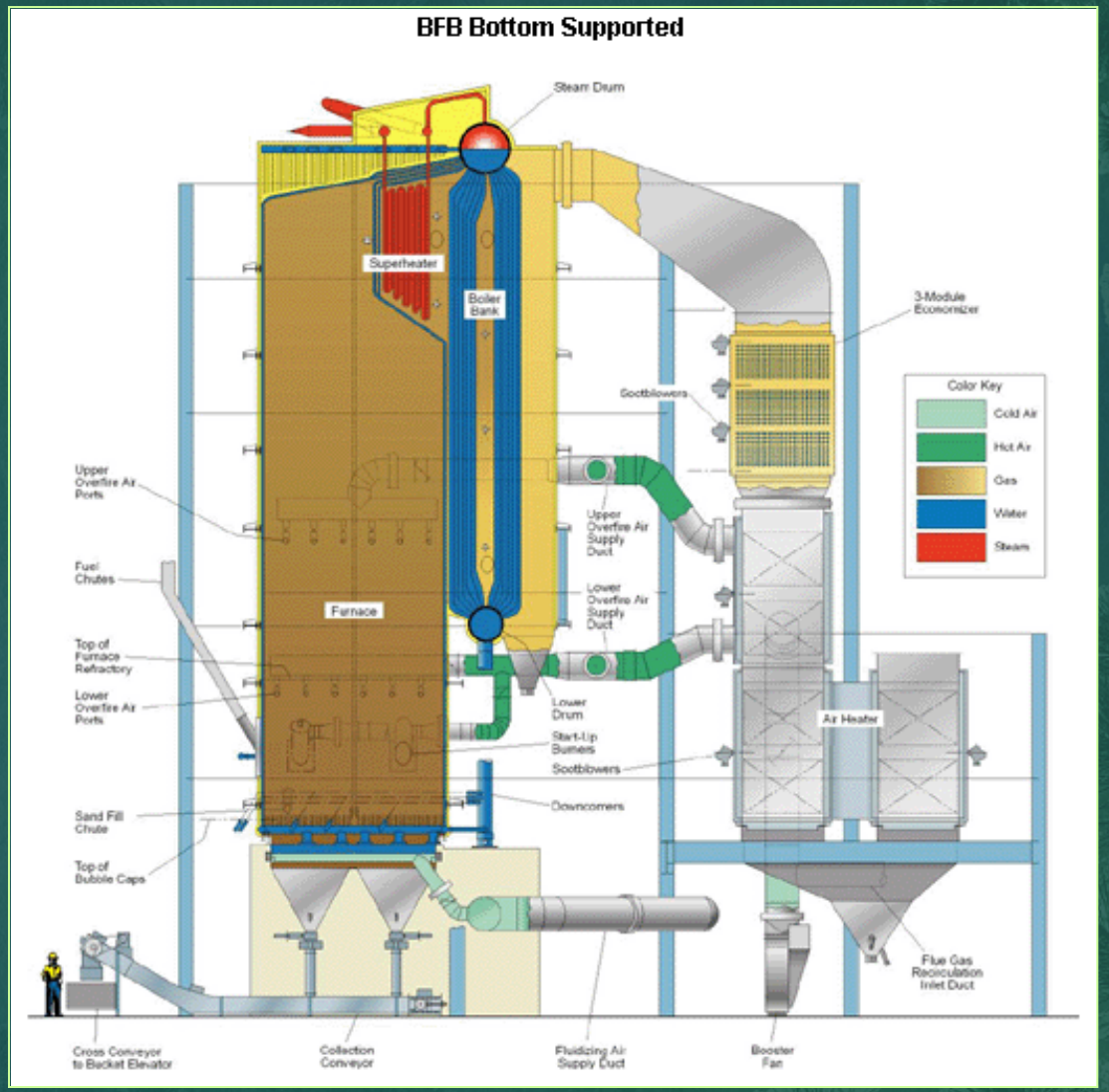
What Are the Technologies?

Stoker fueled grate boiler



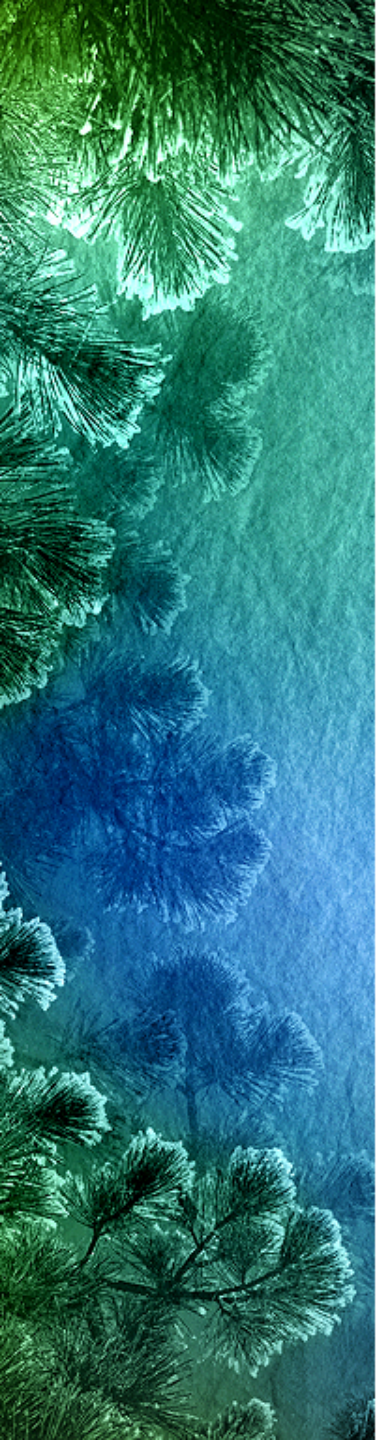
What Are the Technologies?

Fluidized Bed Boiler



What Are the Technologies?

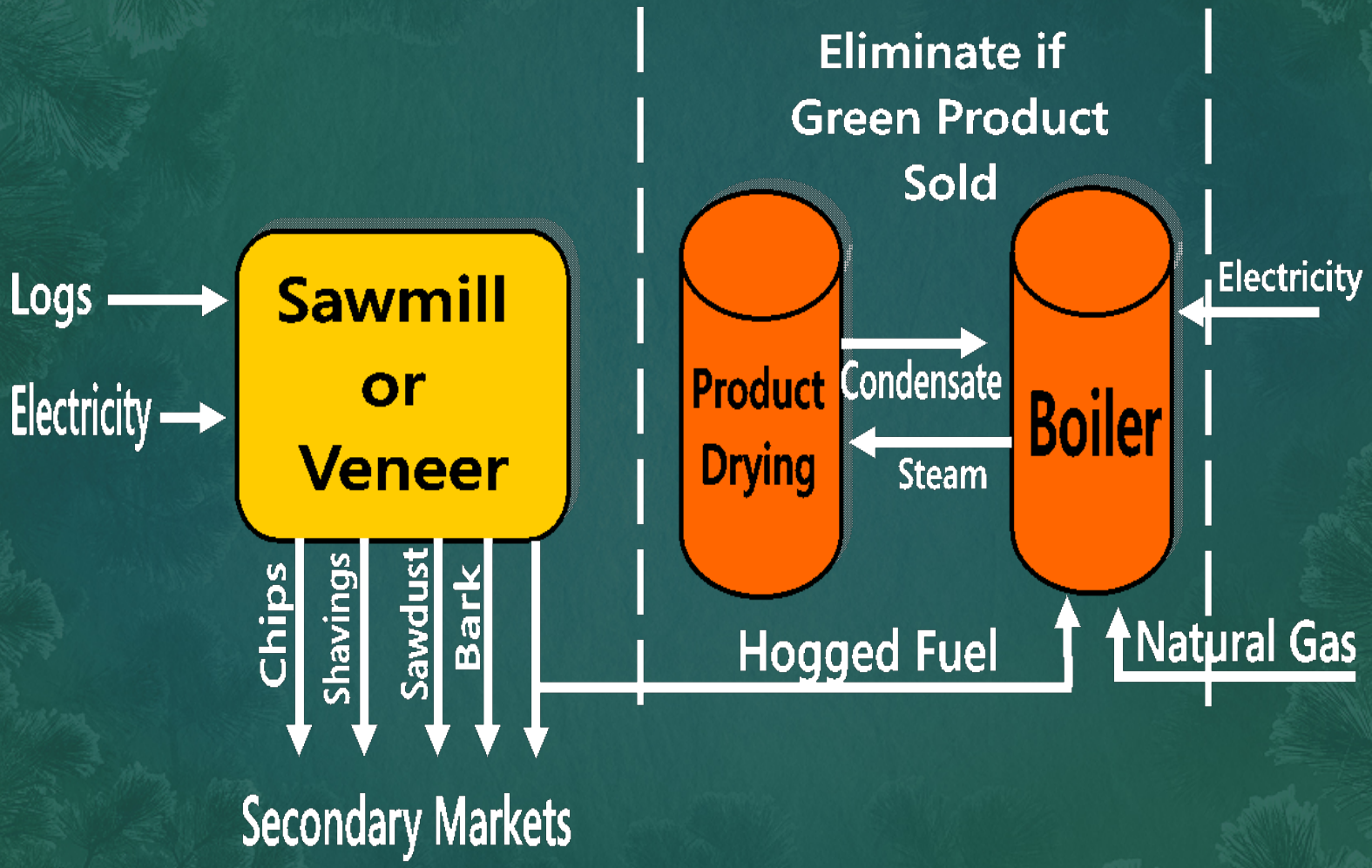
Biomass Gasification



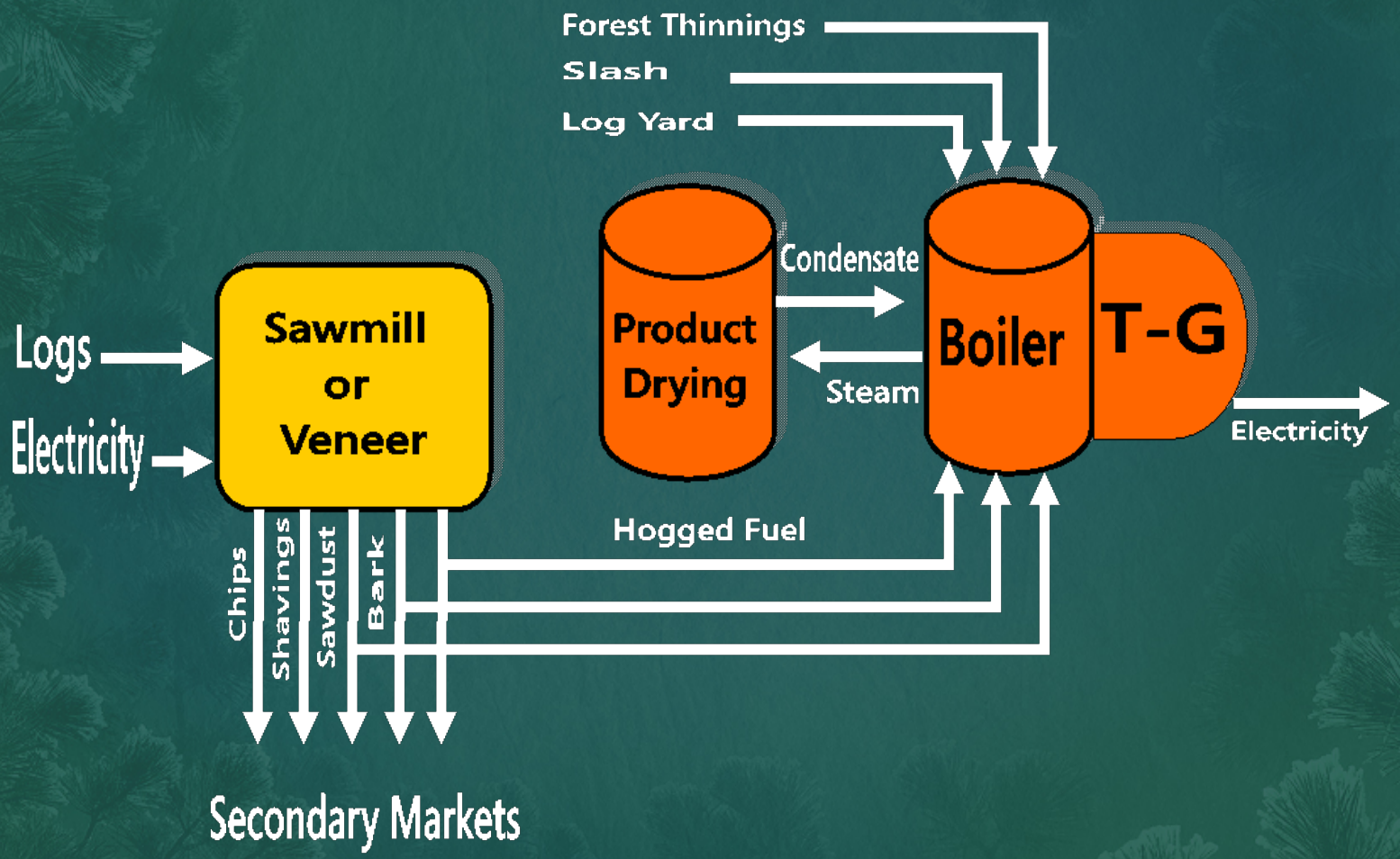
Offshoots of These Technologies

- Biochar
  - **Energy plus a fertilizer and carbon sequestration agent**
- Torrefaction
  - **Production of a coal substitute from biomass with similar hauling/processing/combustion characteristics**

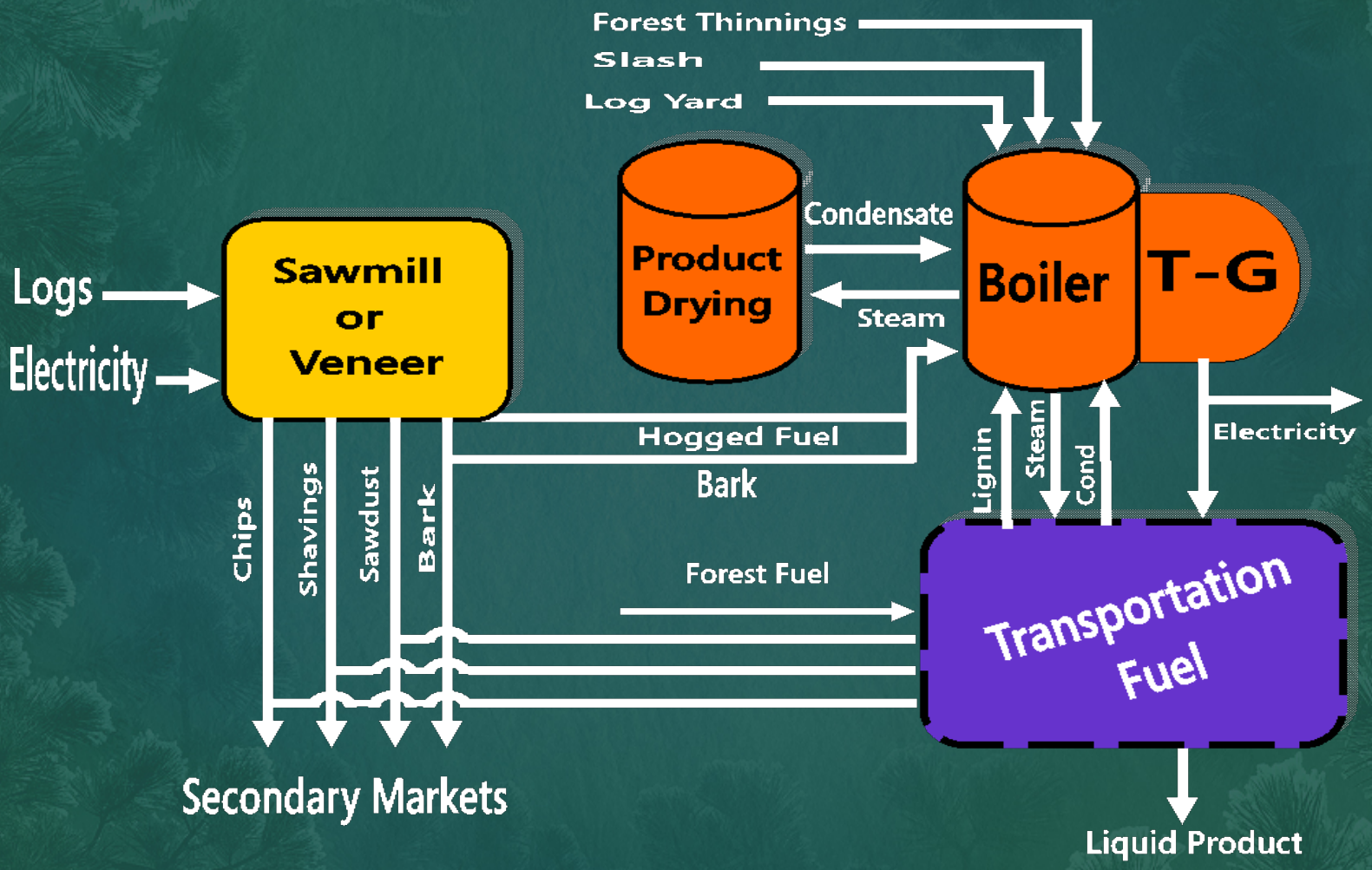
Traditional Mill

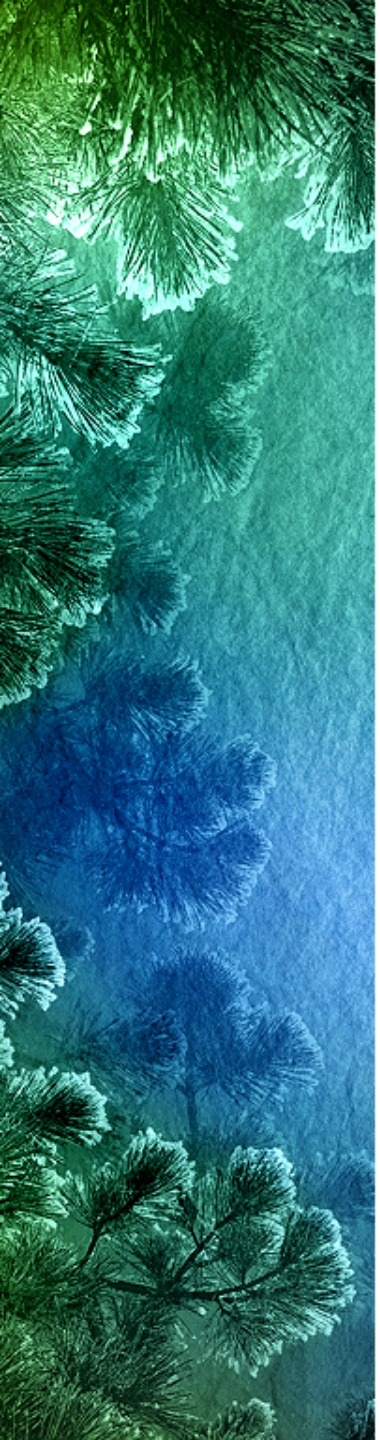


Addition of Combined Heat & Power



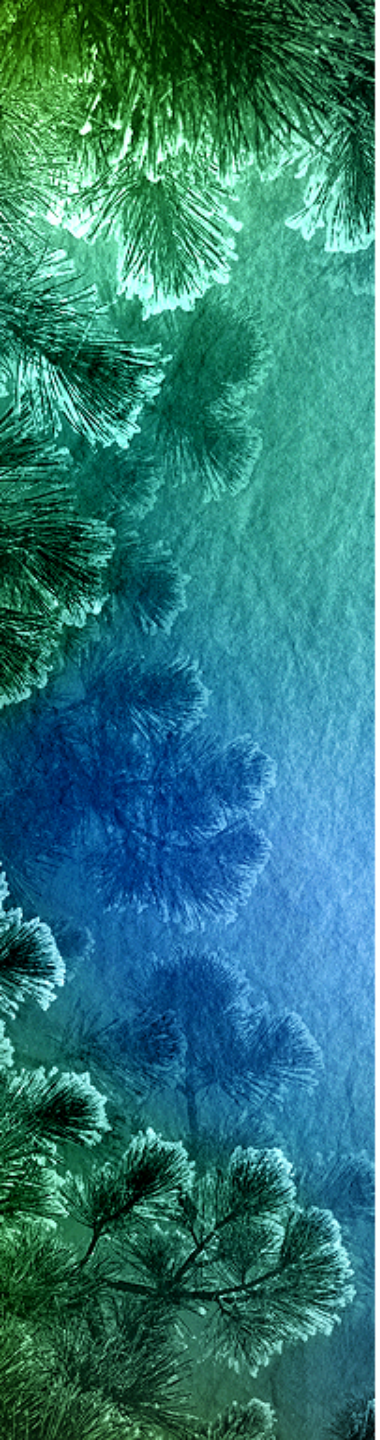
Final Arrangement (Another User)





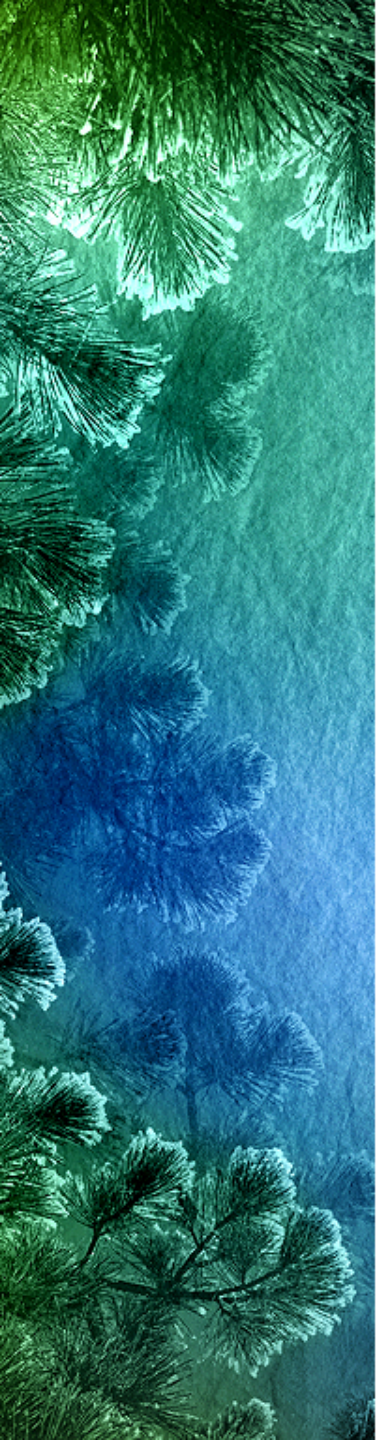
What Situations Are You Looking For?

- Heavy fossil fuel use for heating/cooling/drying
- Excess fuel availability/no serious competition
- Existing distribution network such as district heating/aging steam facilities
- Enlightened regulatory environment that values renewables, firm generation, fossil fuel displacement
- Available state/federal incentives that significantly boost revenues, avoid taxes
- A utility that actually wants your power/heat.



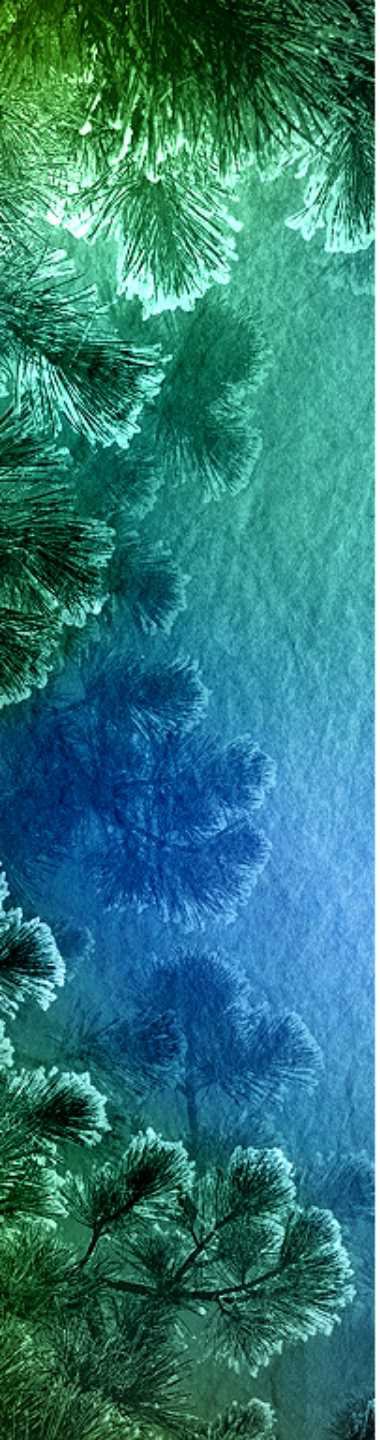
What Situations Do You Seek to Avoid?

- Fuels that are questionable or require additional pollution control equipment (treated, contaminated wood)
- Unreasonable air regulatory environment that unnecessarily raises capital/operating costs
- Lack of reasonable long term offtake or fuel agreements
- Significant early public opposition that cannot be changed by public education



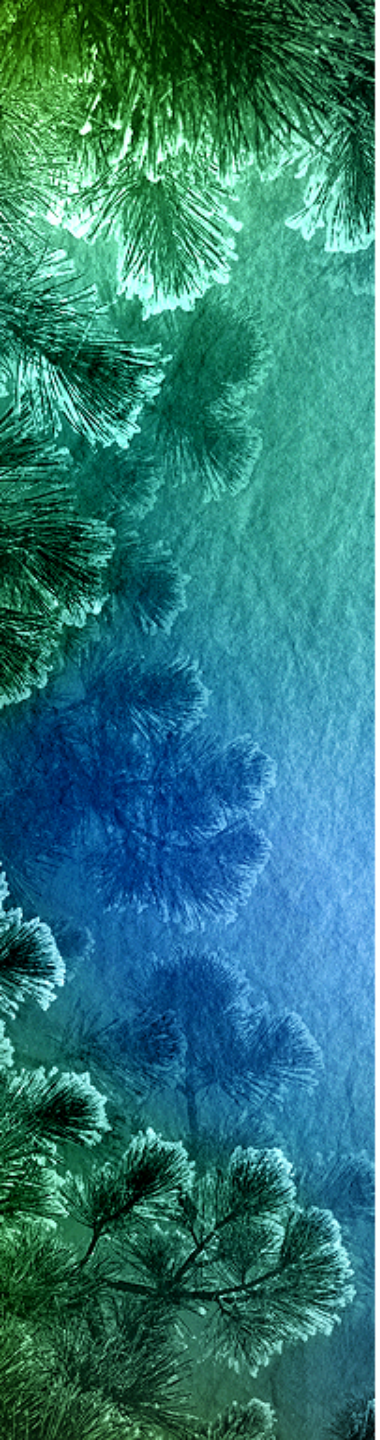
In What Sequence Do We Evaluate the Opportunity?

1. Potential steam/hot water/hot gas/chilled water customers
2. Available fuel supply/cost
3. Should electrical generation be part of the project?
4. What are the available incentives
5. What ownership structure can create most value in this circumstance



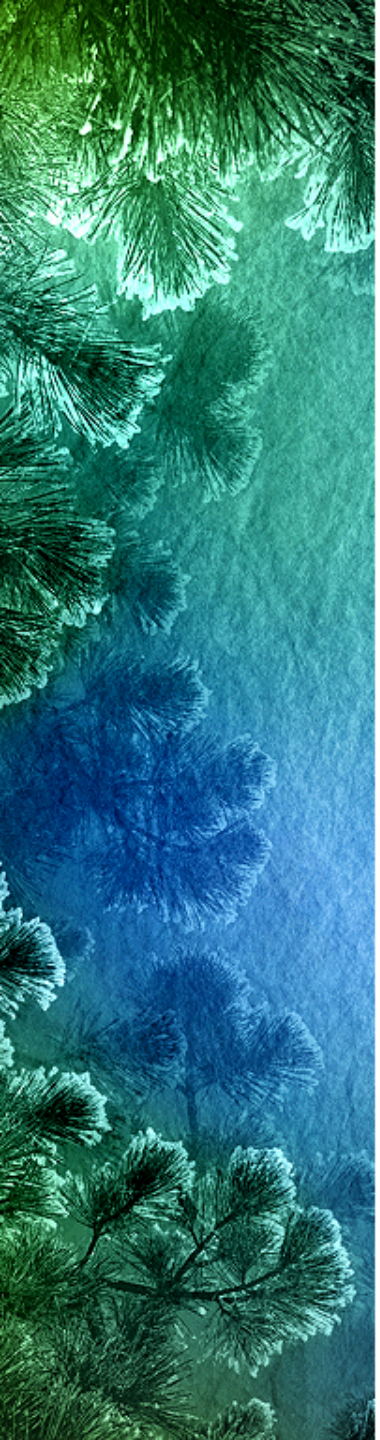
Potential Heating/Cooling Customers

- Size, seasonality, concentration, stability
- Fuels currently used
  - **Fossil fuel displacement generates carbon credits**
- Low pressure/temperature use generates greater cogeneration opportunity
- Size heat source substantially larger than peak customer load
  - **Allow customer growth**
  - **Allow new customers**



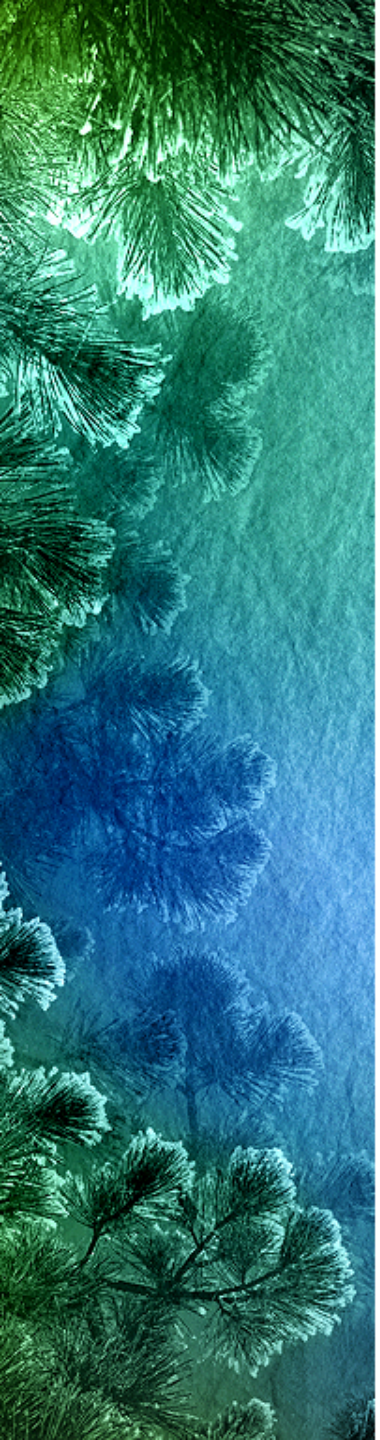
Available Fuel Supply

- Quantities and types of fuels available
- Estimated gathering/processing/delivery costs
- Ability to get long term commitments to deliver
- Try not to size project for greater than 50% of available fuel unless you control it
- Situation with competitors for fuel
- How do fuels mesh with regulatory environment?



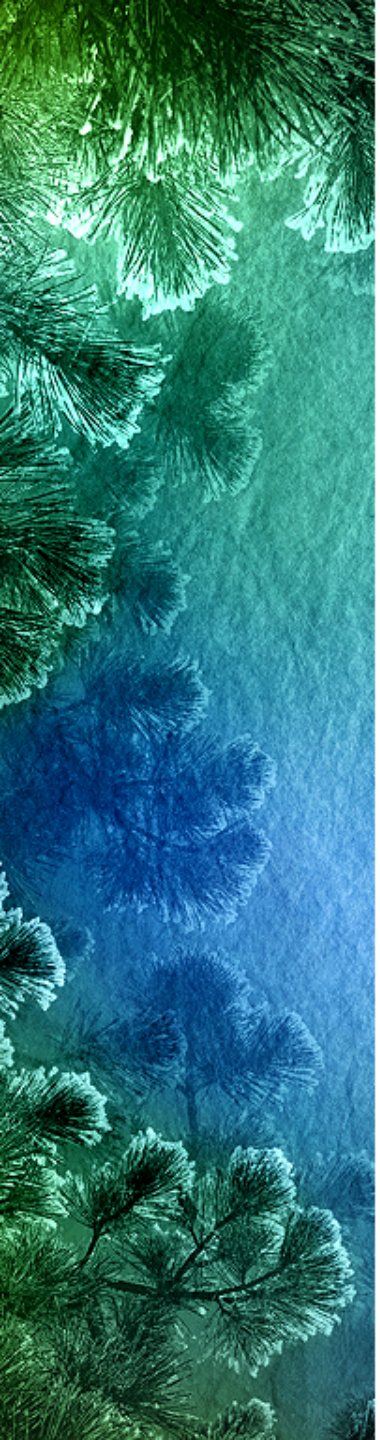
To Generate or Not to Generate

- Varying seasonal customer heat loads encourages generation to fully utilize equipment, fuel
  - **Marginal generation cost only slightly above marginal fuel cost**
- Steady heat loads encourage backpressure generation
- Varying heat loads encourage extraction/condensing generation
- Evaluate local power sales opportunities and wheeling options to other RPS states
- Typically would not supply heat customer its electrical load



Available Incentives

- Check available front end grant funds, loan guarantees, low cost loan pools
- Check carbon credit markets and possibility of national cap & trade legislation
- Check availability of Federal Production Tax Credit, state tax incentives, continuation of federal grant
- Check smaller programs such as Enterprise Zone, New Market Tax Credits



Project Ownership Structure

- Public ownership typically cannot use tax credits, accelerated depreciation, federal grant
- Tax equity partners available for good solid projects
- Tax equity partners will exit once target return is reached
- Utility purchase option after 5 years increasingly popular

A Renewable Future Creates Great Opportunities

Drivers

Global Warming

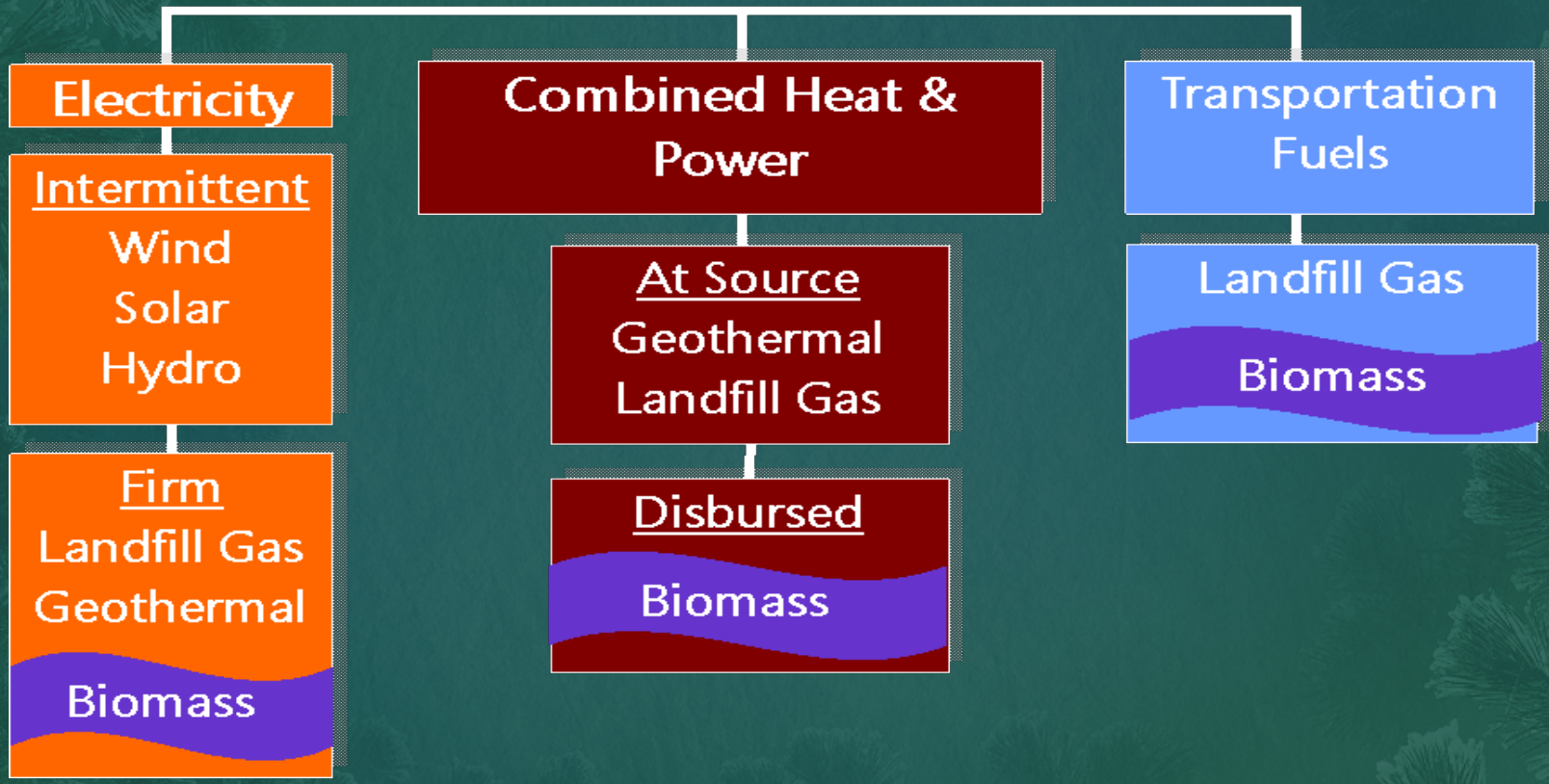
- Warming real/cause uncertain
- Dire consequences
- Fossil fuel use driven
- Can't hurt to lower GHG emissions

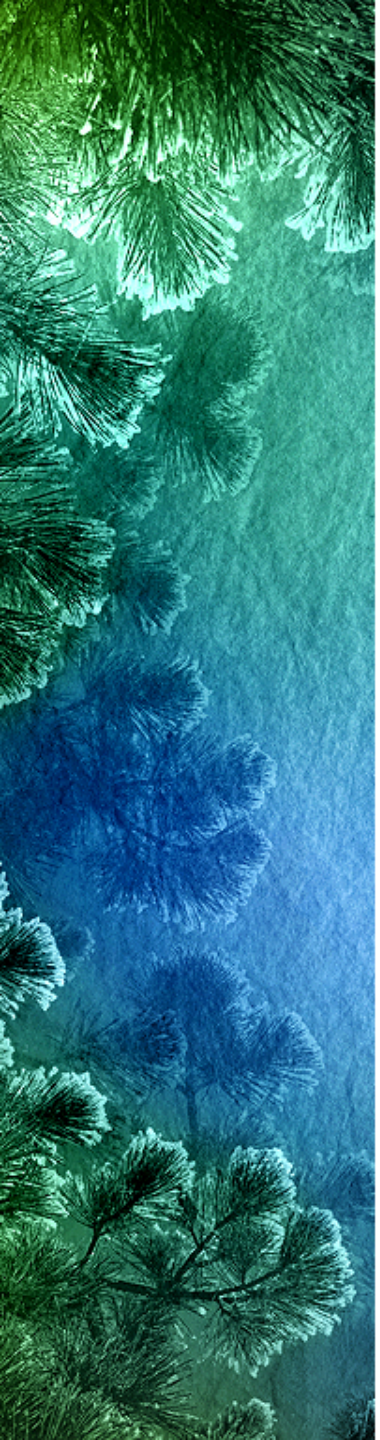
Weaning from Fossil Fuels

- Imported from unstable regions
- Balance of payment issues
- Unsustainable
- Military intervention to protect
- High cost for oil/gas

Renewable Energy

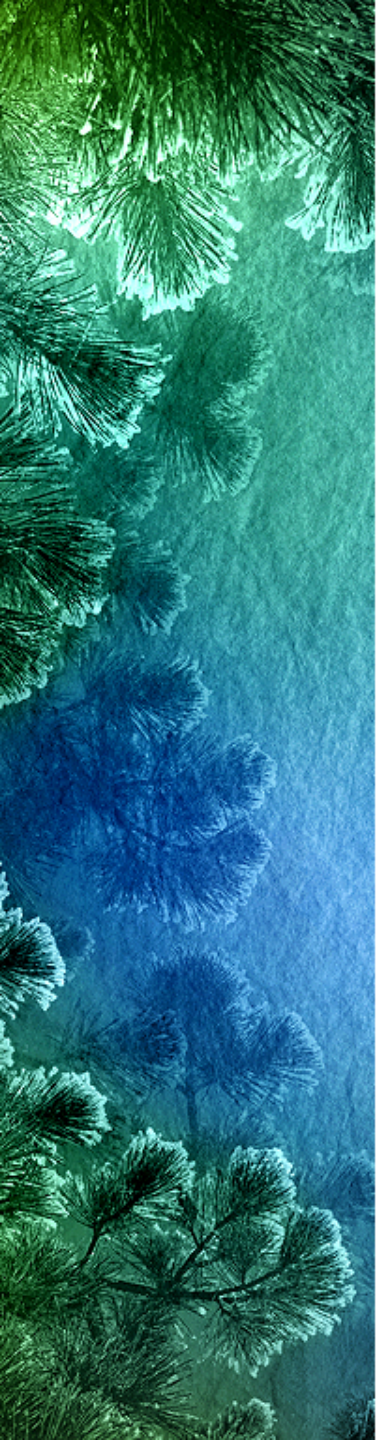
Renewable Energy





Biomass Energy in a Renewable Energy/Carbon Constrained World

- All renewables offset fossil fuel emissions
- Biomass power assumed to be “carbon neutral” by various scientific bodies
  - **Biogenic vs. anthropogenic carbon**
- “Sustainability” key to carbon neutrality of biomass

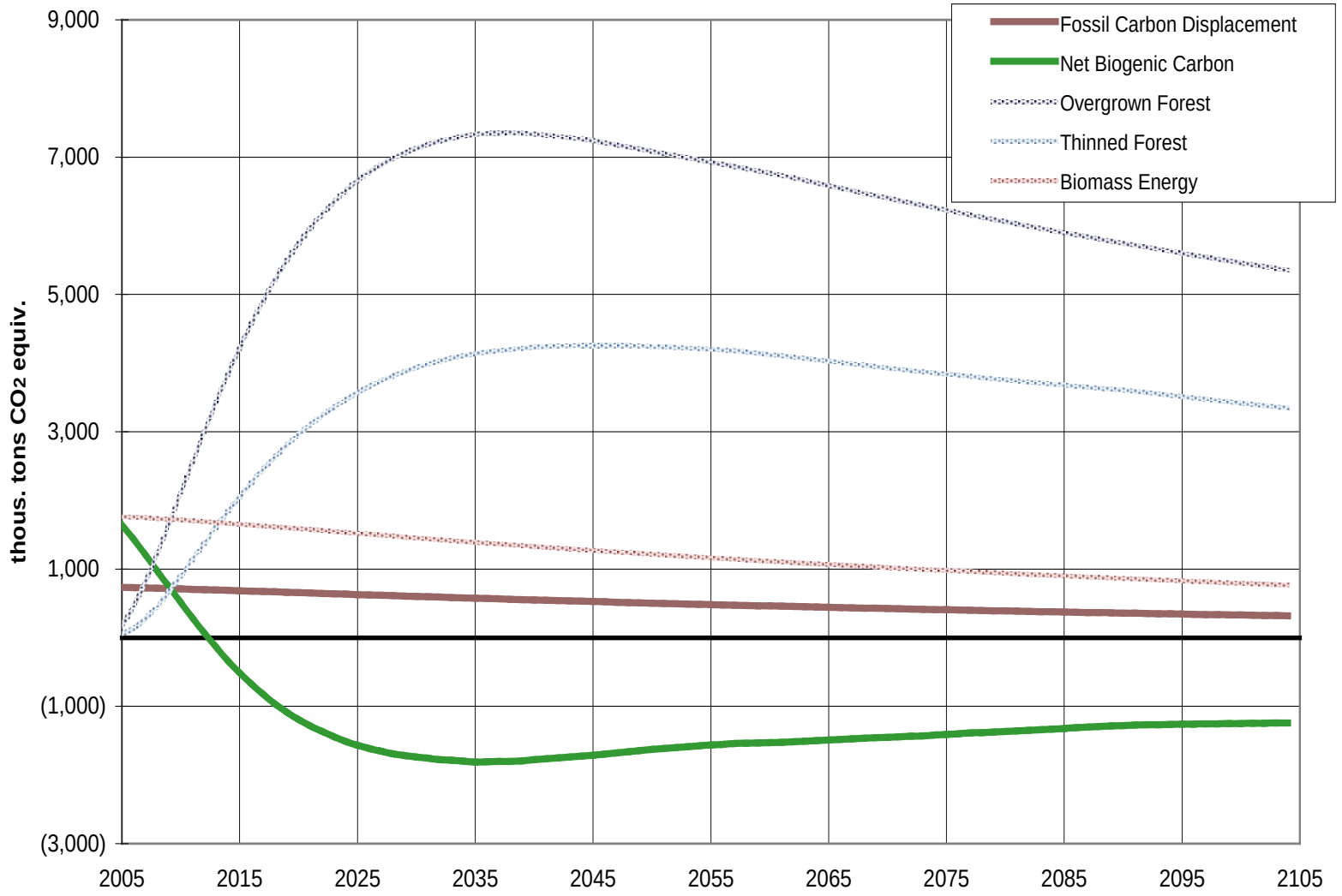


Biopower and GHG Emissions

- Depending on fuels used, biopower can be a source of negative greenhouse gas emissions (less than zero)

- Typical forest residue or urban wood disposal generates a portion of carbon released as methane rather than CO_2 (methane 25 times more damaging)
  - **Open burning** **5% C as CH4**
  - **Surface decomposition** **12.5% C as CH4**
  - **Landfilling** **50% C as CH4**

Atmospheric GHG Burden Associated with Production of 1 million bdt of Forest Fuels



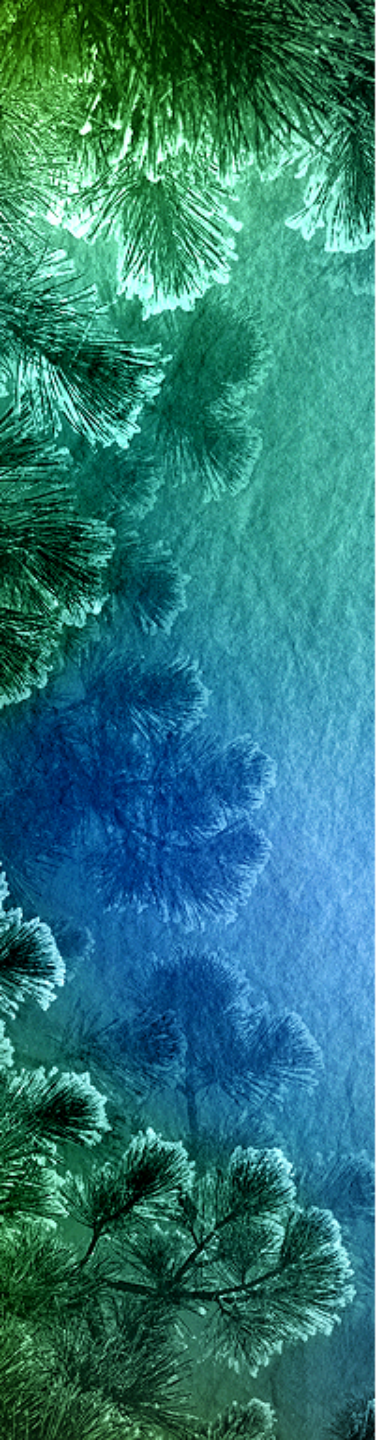
Biomass for CHP Applications

- Has typically revolved around forest products facility (lumber, plywood, pulp & paper) as they have fuel, steam need, electric need

Potential Applications in Midwest

- Any forest products facility
  - **Drying need (lumber, veneer, paper)**
  - **On site biomass fuel**

- College/University/Hospital Complex
  - **Seasonal heating/cooling load**
  - **Maximize power generation in summer**

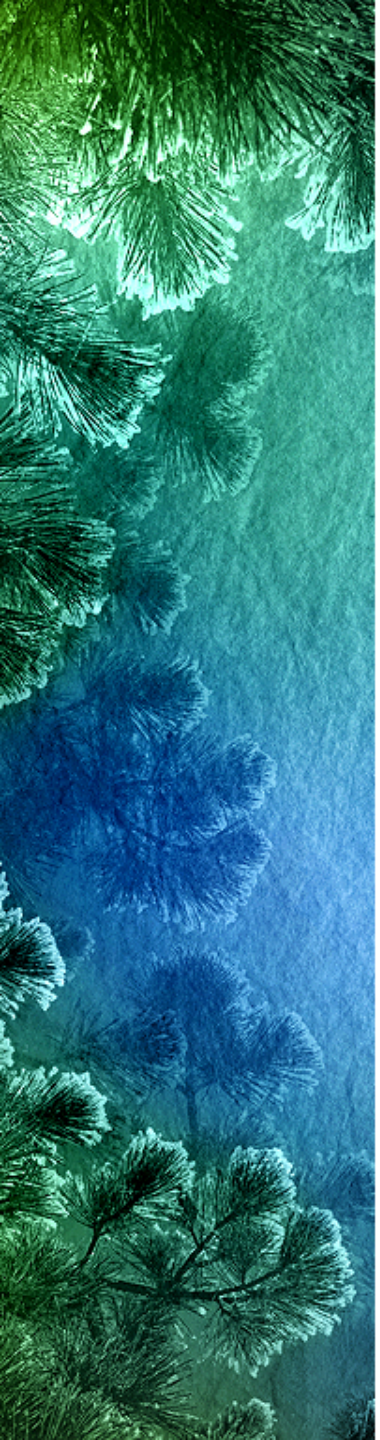


Potential Applications in Midwest (Cont.)

- District Heating System
  - **Collection of Offices/commercial buildings**
  - **Steam or hot water**
- Other Industrial Applications
  - **Food processing**
  - **Large consumer of fossil fuels**
- Ethanol Industry
  - **Now depend on natural gas for process heat**

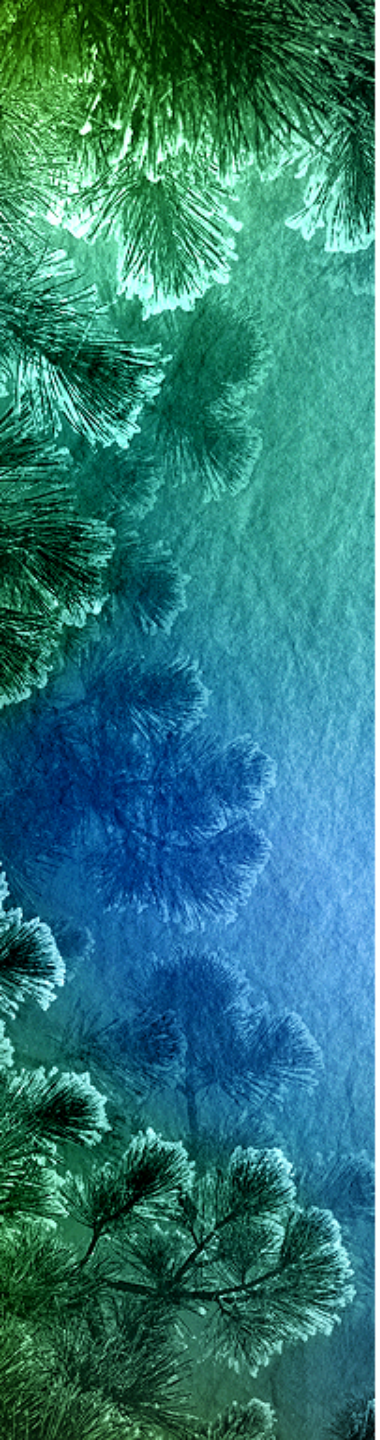
Why Add Power Generation to Simple Boiler Heating/Cooling System?

- Maximize use of invested capital by adding insatiable electric market
- Dramatic improvement in efficiency of electric production (20→50/60%)
- Many incentives only available for electric production or CHP, not heating
- Lower cost of heating/cooling application



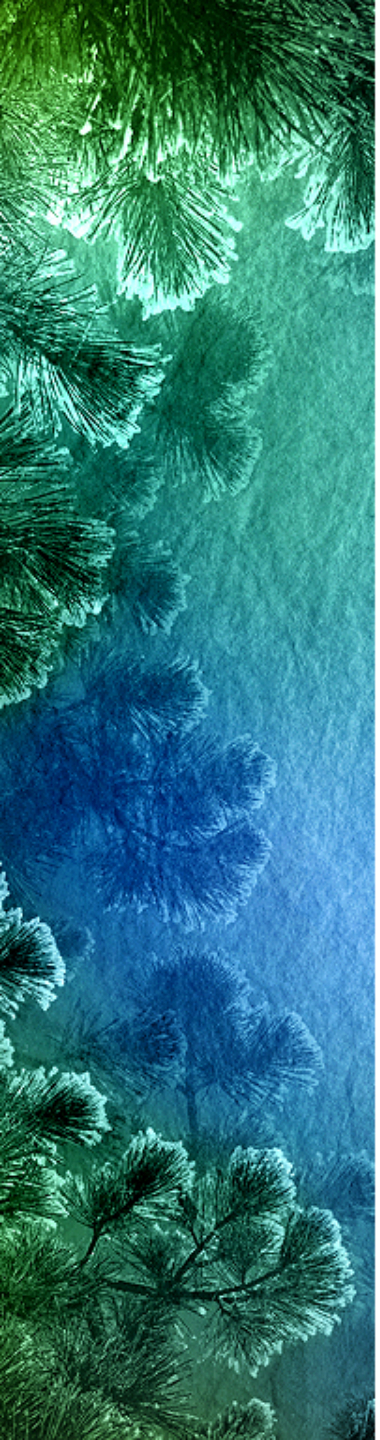
What Do Utilities Think of Biomass Power?

- It is renewable power that meets their Portfolio Standard (RPS) Requirements
- It is a firm, base load resource as opposed to intermittent wind/solar
- It is available in small, disbursed increments
- It is typically end of line, providing valuable voltage control/reliability
- It typically does not require transmission upgrades
- It offers local economic development, assistance with forest restoration, potential carbon offsets



Potential Utility Co-firing With Coal

- Can be used to reduce emissions of coal plants
- Difficult in pulverized coal units as wood cannot be “pulverized”
- Totally compatible with stoker fed grate boilers or fluidized beds
- Torrefaction attempts to duplicate coal’s handling characteristics with biomass
- Good retrofit opportunity for smaller, older coal boilers



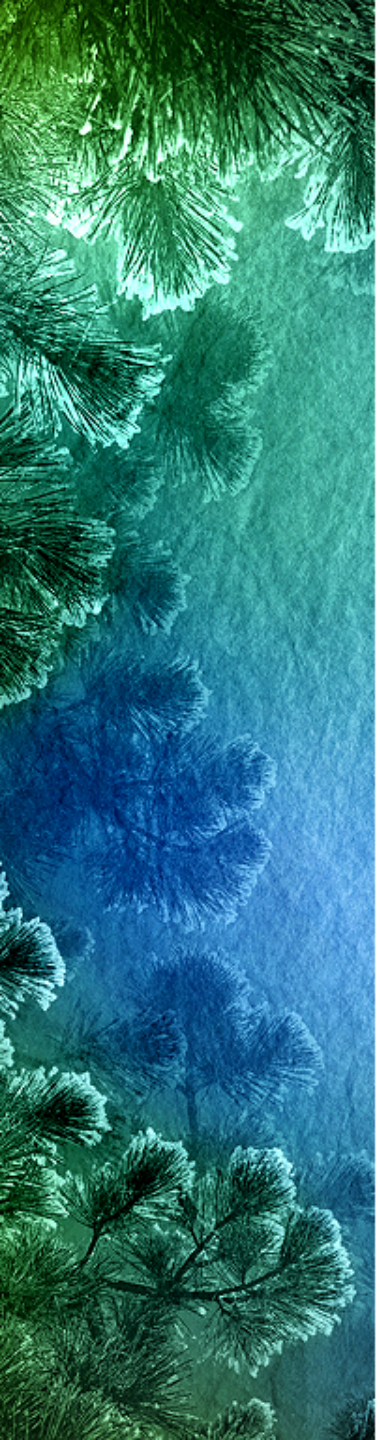
A Closer Look - Size

- Big enough to be economic
- Small enough to not stress fuel supply or sustainability
- Big enough to be steam supplier to multiple future businesses/green industrial park
- Small enough to not stress existing infrastructure
  - **Transmission, roads, water/sewer**

A Closer Look At A 25 MW Project Investment

- $80 million Project
  - **70% materials and equipment**
  - **30% local construction**

- 60 construction jobs over 18 months
  - **$¾ million in upfront studies, permitting, design**



A Closer Look - Jobs

- 18 permanent jobs at plant
  - **4 Admin/fuel**
  - **9 Operations**
  - **5 Maintenance**

- 40+ fuel supply jobs
  - **5 chipping/grinding “sides”**
    - 8 Jobs each
    - Additional drivers for mill byproducts, urban wood

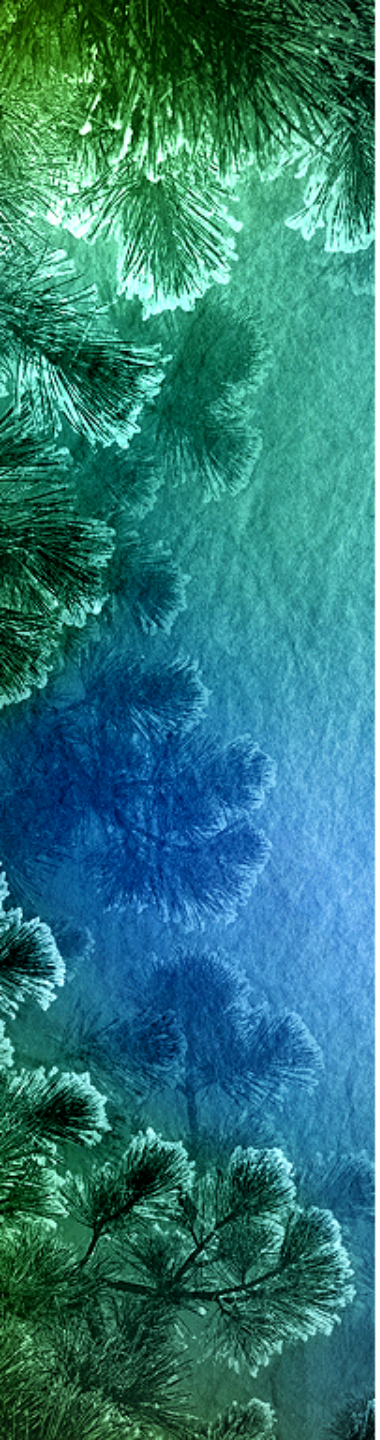
A Closer Look – Operations & Maintenance

- $800,000 annual property tax
- $1.2 Million annual payroll & benefits
- $1.3 Million annual local O&M purchases
- $5 Million annual local fuel purchase

A Closer Look – Fuel Supply

- Home for harvest residues, precommercial thinnings now burned/piled
- Outlet for local green waste, urban wood fraction, right-of-way thinnings
- Reverse loss of markets when pulp mills left
- New markets for low valued wood help “keep forests as forests”



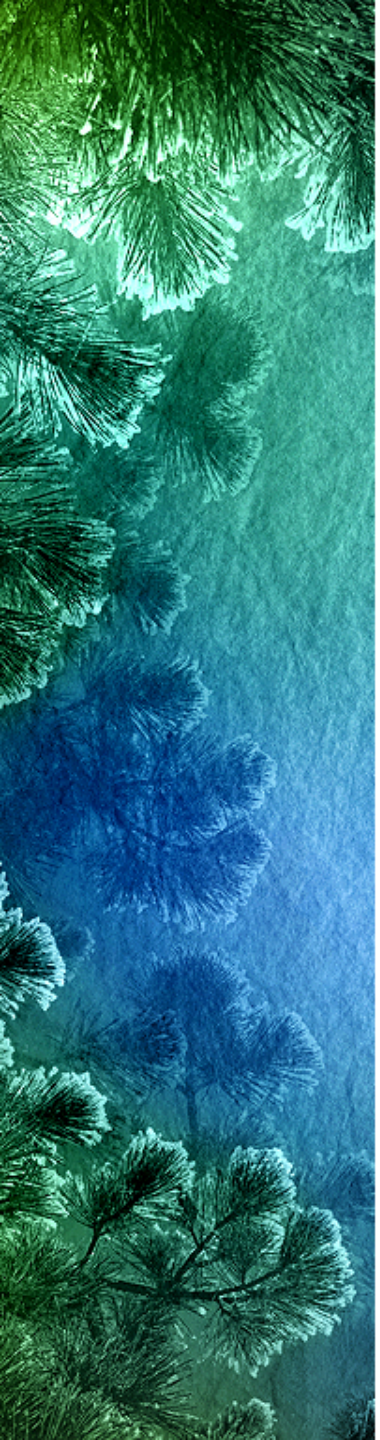


Environment – Local

- Eliminate much slash pile burning/open burning (97% reduction in emissions)
- Potential to lower fire risk around communities
- Fuel hauled to central site for combustion
  - **BACT required for pollution controls**
  - **Electrostatic precipitator**
  - **Multiple levels of heated overfire air**
  - **Probable selective non catalytic removal (SNCR) for NOx**
  - **Local ash disposal/use as fertilizer**
  - **Water consumption/sewer use**

Environment – State/Region

- Displace fossil fuel use for generation
- Help Holland and Michigan meet Renewable Portfolio Standards (RPS)
- Help retain “forests as forests” by creating markets for low valued wood



Bottom Line

Done correctly, biomass CHP plant is:

- Complement to local forest industry
- Catalyst to improve forest health, lower fire risk, keep “forests as forests”
- Place for community to safely dispose of woody materials
- Local source of thermal and electrical green energy for Holland
- Minor source of emissions, use of other resources
- Economic engine for community