Biomass Energy Solutions for Federal Institutions Presented to GovEnergy

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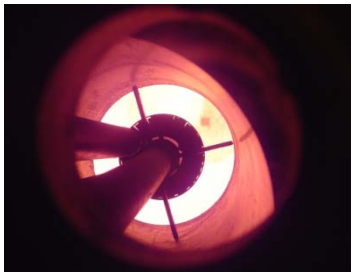


Agenda

- Drivers for Biomass Energy in the Federal Government
- Applications of Biomass Technology
- Oak Ridge National Labs Case Study
- Project Considerations

Nexterra Overview

Company

- Global leader in biomass gasification technology and systems
- Supplies turnkey biomass gasification systems for public institutions and industrial customers
- Enables customers to generate, clean renewable energy from low cost biomass
- Ultra low emissions, high efficiency and solution package ideally suited to urban environments
- World class partners, well capitalized with an experienced team

Strategic Relationships

GE – Advanced power systems

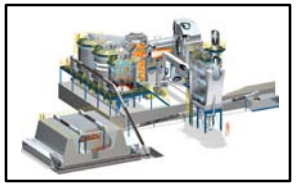
Johnson Controls – institutions

Andritz – WWT/municipal partner

Tolko Industries – Kamloops
- 38 MMBtu/hr plywood plant heating system
- Displaces natural gas
- CO2e reduction: 12,000 tpy
- Commissioned 2006

University of South Carolina
- 72 MMBtu/hr campus heat & power
- CO2e reduction 20,000 tpy
- Commissioned 2008

Dockside Green, Victoria
- 7 MMBtu/hr district heating system
- Heating & Hot Water for residential complex
- CO2e reduction 3,400 tpy
- Commissioned May 2009



US DOE Oak Ridge National Labs
- 60 MMBtu/hr steam system
- JCI/Nexterra selected by DOE
- CO2e reduction: 23,000 tpy
- Startup: 2011

Kruger Products (Scott Paper)
- 40 MMBtu/hr steam system
- Gas displacement in a boiler
- Commissioned: Q4/2009
- CO_2e Reduction: 22,000 tpy

UNBC, Prince George
- 15 MMBtu/hr campus heat
- CO2e reduction: 3,500tpy
- Startup: 2010

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Drivers for Biomass in the Federal Government

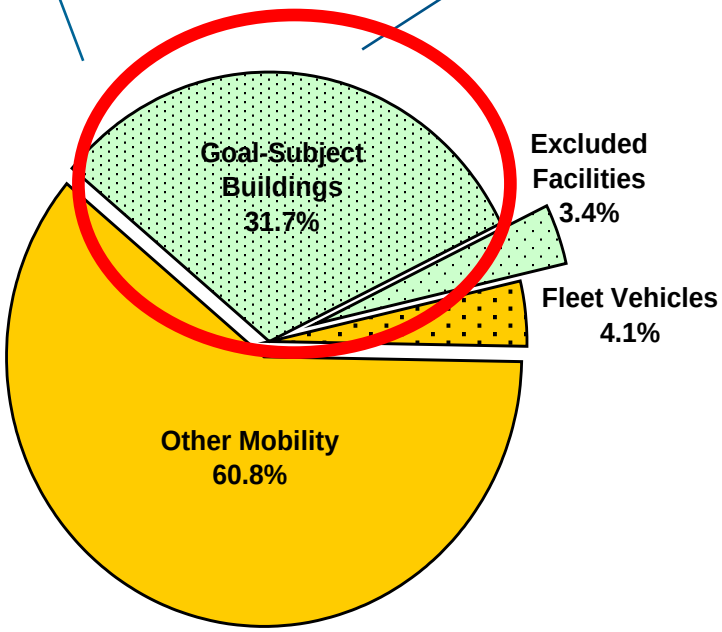
Federal Government – Renewable Energy

- **All Federal Agencies**
  - E.O. 13514 – Federal Agencies to reduce 28 % GHG reduction by 2020
- **Department of Veterans Affairs Energy Sustainability Act of 2009**
  - Not less than 7.5% renewables by FY 2013
- **Department of Energy – TEAM Initiative**
  - Reduce energy intensity by over 30% by 2015
  - Acquire at least 7.5% of all energy from renewable sources by 2010
- **Department of Defence**
  - 25% of all energy utilized by branches must be from renewable sources by 2025
  - Bonus for generation on-site

Federal Government – Energy Footprint

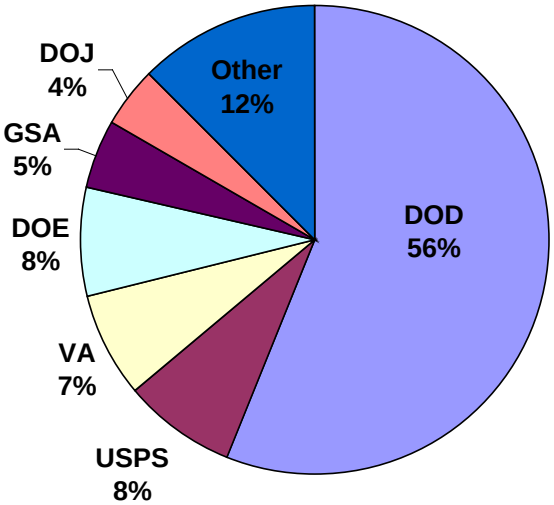
***Building Energy Usage by Type*:**

50% Electricity
34% Natural Gas
7% Fuel Oil
5% Coal
4% Other



Facility Energy Usage by agency

Total: 389 trillion Btu



***Mobility Energy Usage by Type*:**

70% Jet Fuel
14% Navy Special
7% Diesel
7% Auto Gas
2% Other

A source of baseload renewable energy is required for Federal facilities to meet renewable and GHG reduction targets

Source: FEMA

Biomass: Carbon Neutral Solution

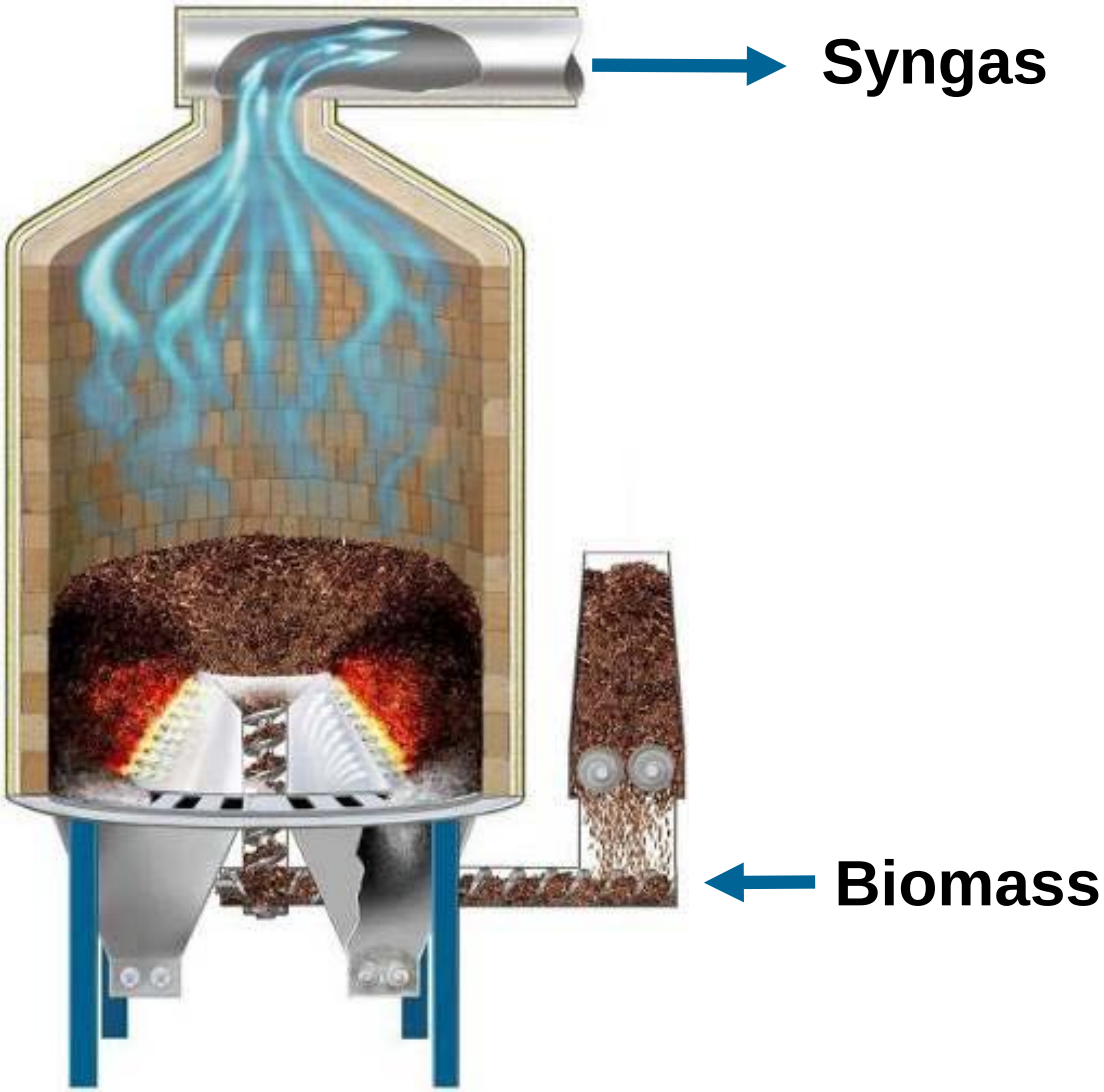
- Biomass is a carbon neutral energy resource that can help reduce greenhouse gas emissions and reduce reliance on conventional fossil fuels
- Biomass is the only widely available, firm, load following renewable
- Sources of biomass can include locally produced wood residue, municipal tree trimmings, recycled construction and demolition waste, etc.

Technology & Applications

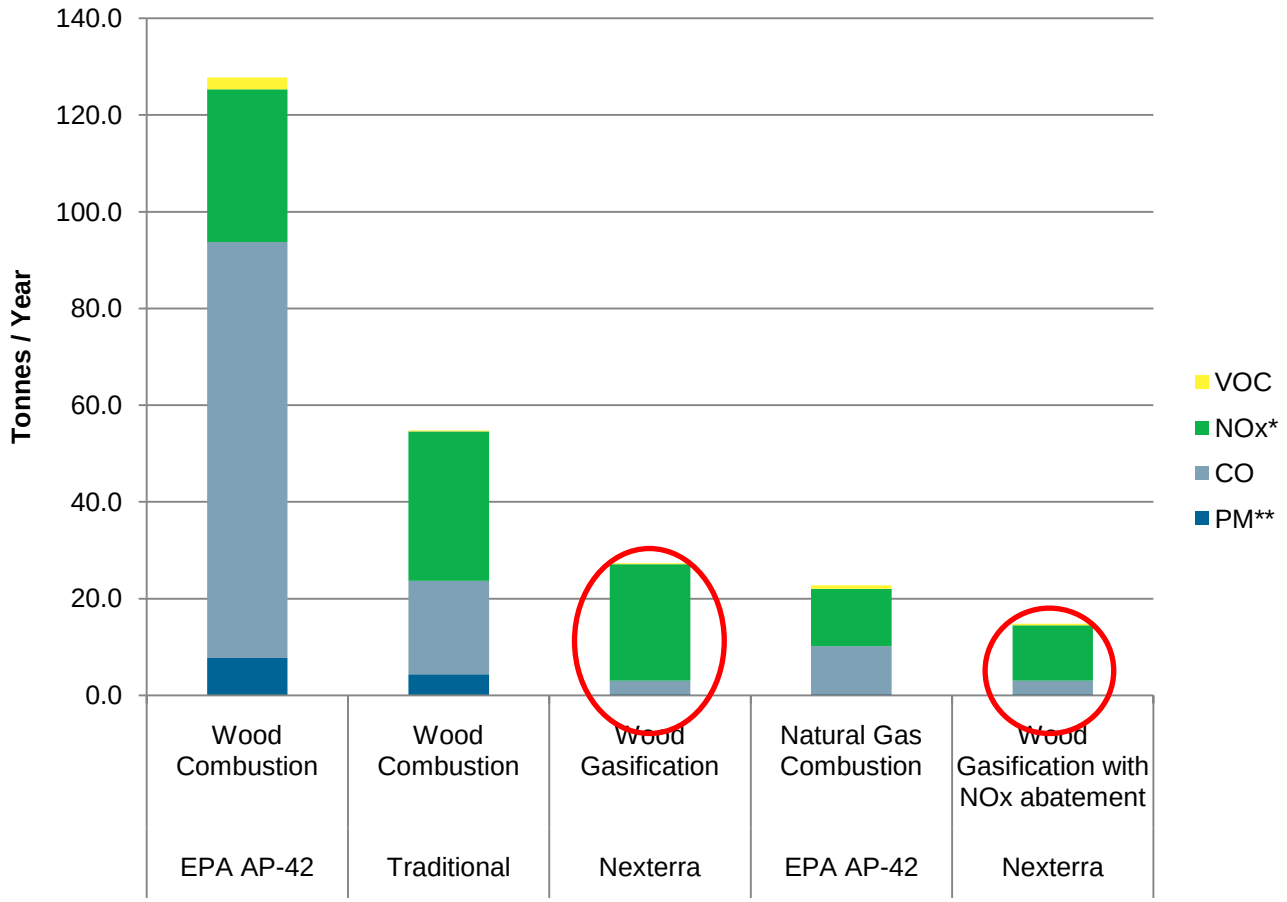
Core Technology

Advantages:

- Simple, proven, reliable
- Low emissions for particulate matter, NOx, VOC, CO , TOC
- Fuel flexibility
- Syngas versatility
- High system efficiency
- User friendly, fully automated
- Low lifecycle cost
- Economic at small-scale



Air Emissions: Comparisons



Notes:

Tonnes per year based upon typical 24 MMBtu/hr system, 45% mc fuel
* NOx depends on nitrogen in biomass fuel
** PM with baghouse or ESP

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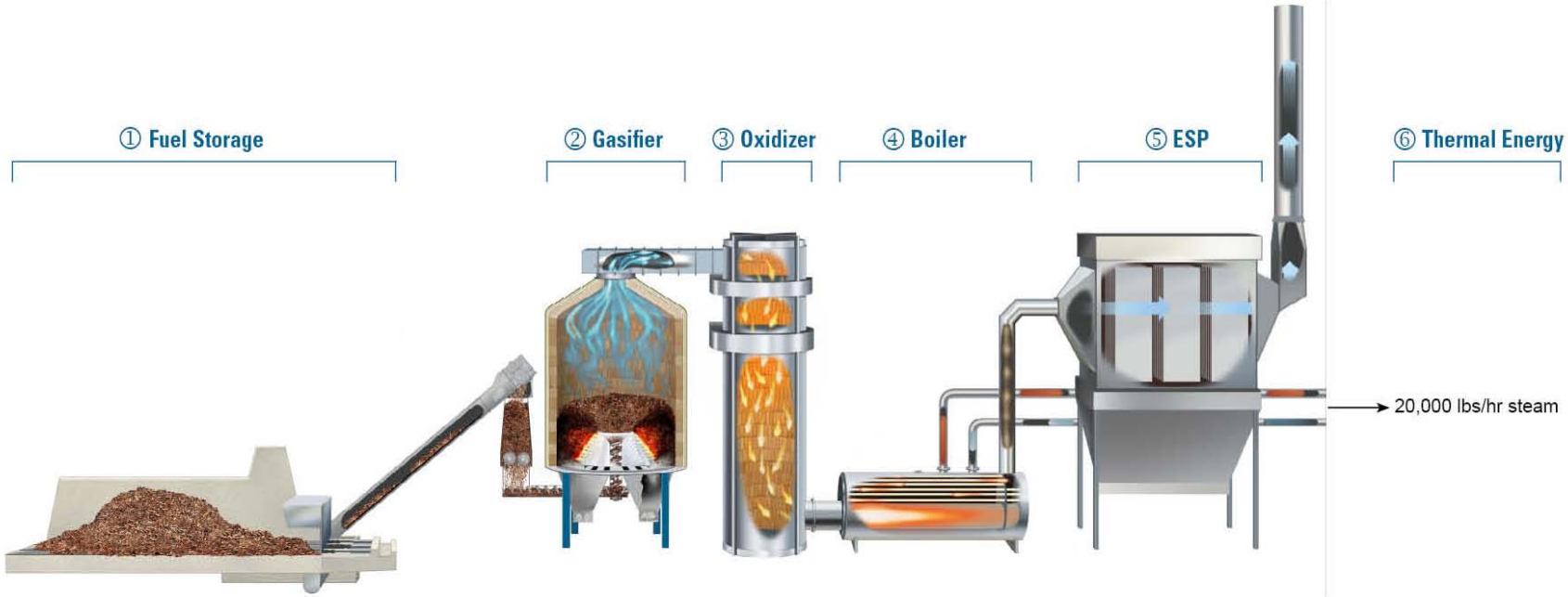
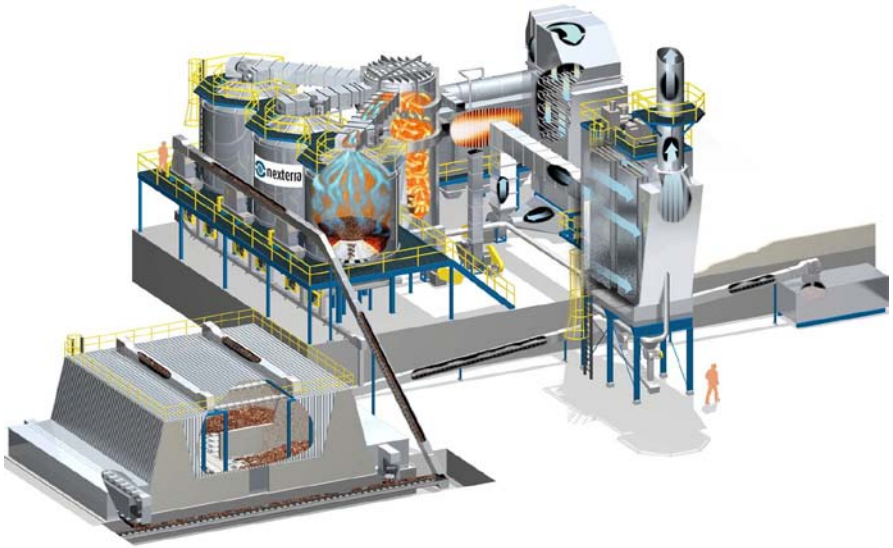
Biomass Energy for District Energy



- Convert biomass into heat or steam for process or district energy
- Displaces fossil fuel usage
- Significantly reduces energy costs
- Reduces greenhouse gas emissions

Oak Ridge National Labs

- 60,000 lbs/hr steam plant
- Annual Savings: $4.0 MM
- GHG Reduction: 22,000 tpy
- Operational Q2/2011



ORNL Project Drivers

- TEAM Initiative requires all of DOE's national facilities to:
  - Reduce energy intensity by 30% and water intensity by 16% by the end of fiscal year 2015
  - Maximize the installation of on-site renewable energy generation and acquire at least 7.5% of all energy from renewable sources by the end of fiscal year 2010
  - Develop best practice models for the use of third party financing for energy saving projects

Site Solution

- In August 2008, JCI and DOE signed an agreement to provide $89M of Energy Conservation Measures (ECMs) to ORNL
- Measures range from the anchor Biomass Gasification System to an educational program advising staff to turndown the thermostat and wear sweaters
- Biomass gasification system was chosen by ORNL because of:
  - JCI and Nexterra experience with the technology, viewed as a low risk project
  - Research group at ORNL recognized the opportunity to use a full-scale plant of this leading edge technology for research
  - Ultra low emissions

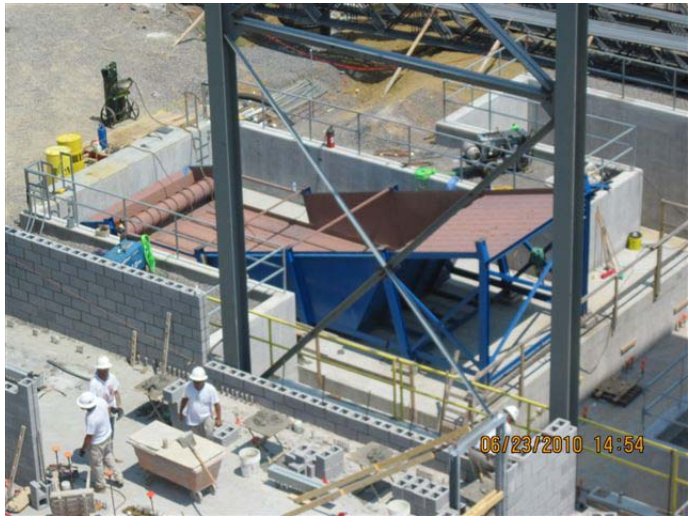
ORNL: Biomass Gasification Benefits

- Shut down 4 fossil fuel fired boilers (WWII vintage marine steam boilers)
- Stabilize fuel costs and reduce by $3–4M/year
- Lowers GHG emissions by 23,000 tons per year
- Reduces reliance on fossil fuel by 85% and will use locally procured biomass
- Adds a valuable research tool for ORNL BioEnergy Science Center

Construction Photos of ORNL

Demolition

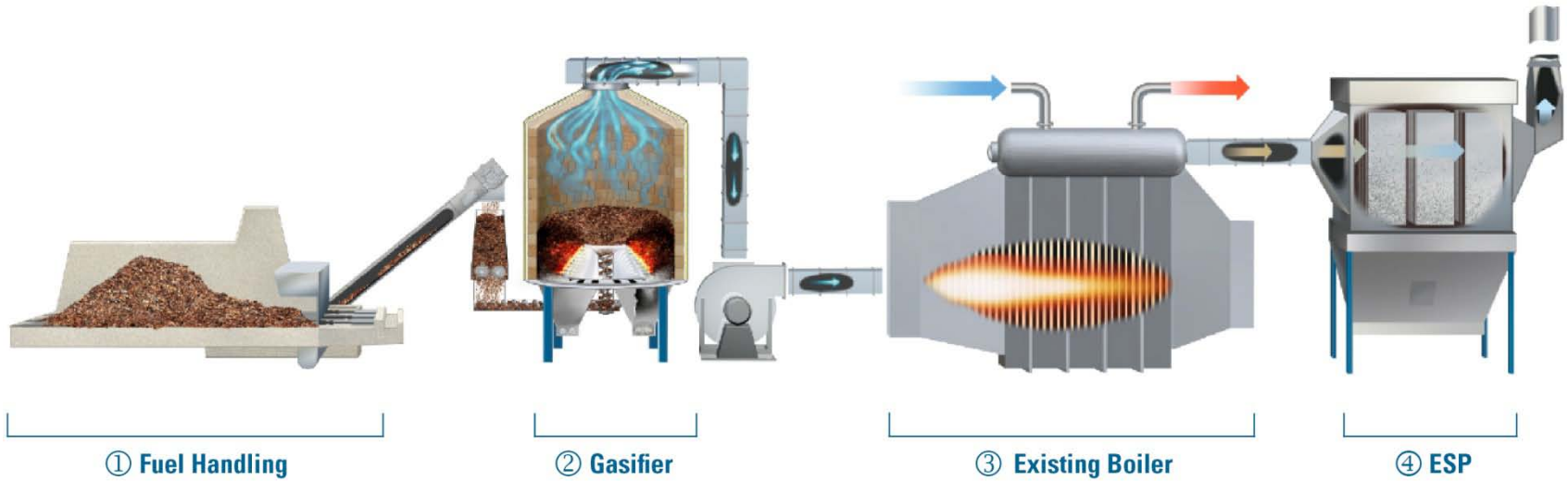
Foundations



Fuel Handling

ESP

Biomass Gasification for Existing Boilers



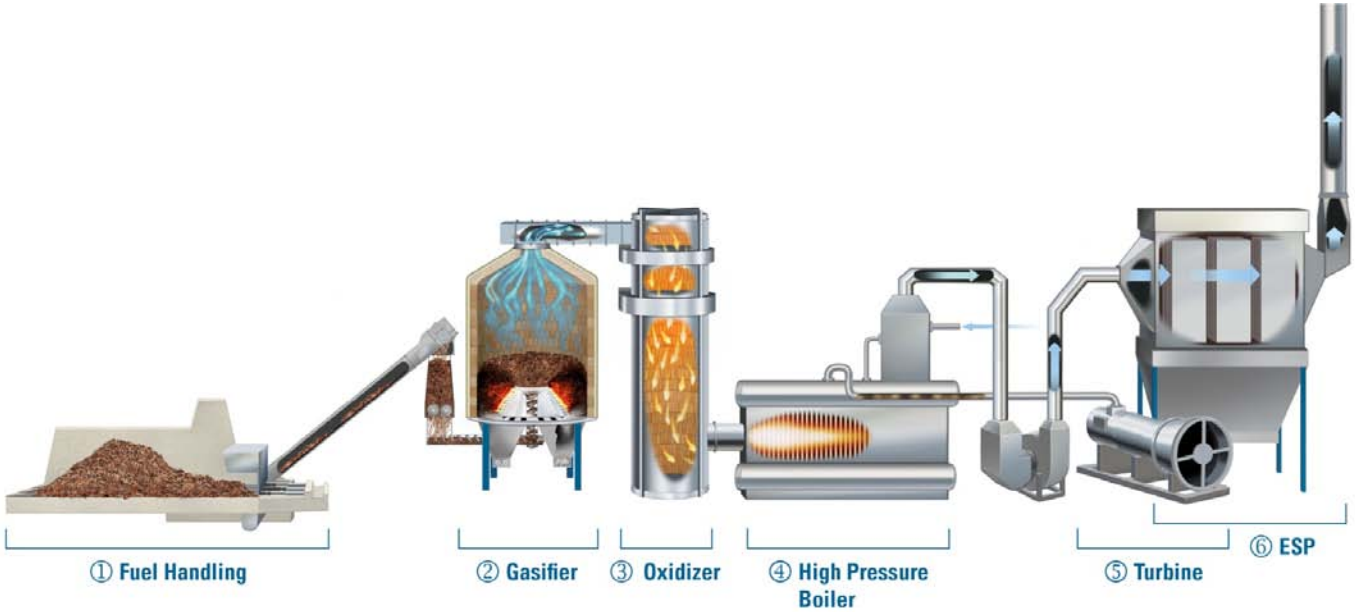
- Use syngas in existing boiler for steam for process or district energy
- Potential to utilize existing infrastructure (boiler, ESP, building)
- Displaces fossil fuel usage
- Reduce energy costs
- Reduce greenhouse gas emissions

Kruger

Kruger Products Tissue Mill – Vancouver, BC

- 40,000 lbs/hr gasification system
- Displaces 400,000 GJ/yr of NG
- Lowers GHGs by 20,000 tonnes/yr
- Operational December 2009

Biomass Cogeneration – Steam Driven

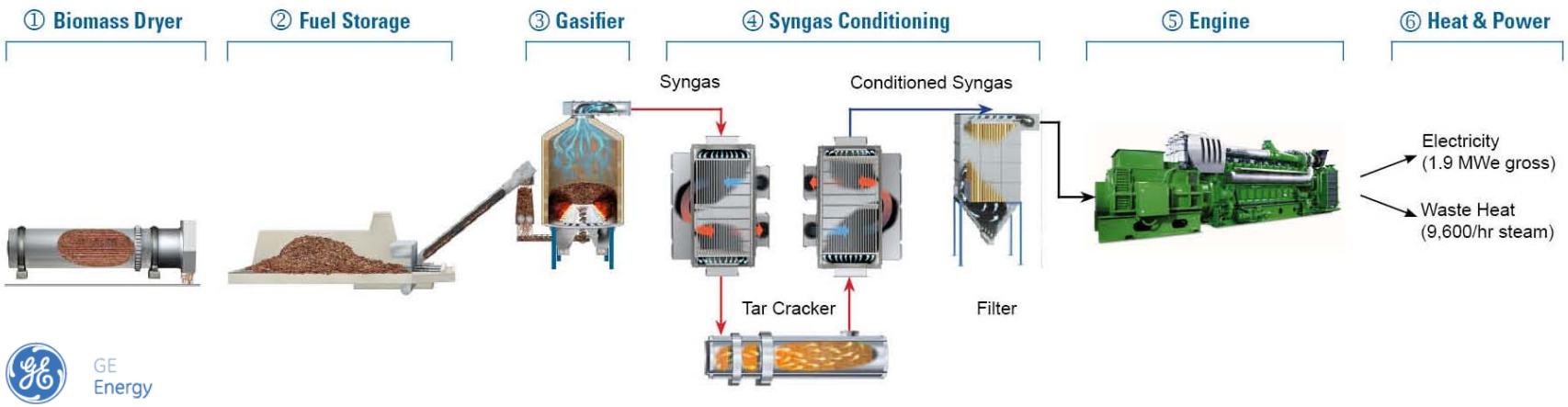


- Gasification or Combustion
- Produce high pressure steam and then power through turbine
- Helps meet renewable power goals
- Displaces fossil fuel usage
- Reduce energy costs and greenhouse gas emissions
- Often not economic due to high operator costs, low efficiencies (condensing and extraction) and low power rates
- BP turbine offers higher efficiency but poor electrical to thermal ratio

University of South Carolina – Columbia

- 60,000 pph steam/1.4 MWe (BP turbine)
- Annual Savings: $2 - 3 MM/yr
- GHG Reduction: 20,000 tpy
- Operational 2008

Cogeneration – Biomass to IC Engine



- **Gasification Only**
- Clean syngas is fuel for IC Engine
- Heat captured from waste heat – good electrical to thermal ratio (~40/60)
- High electrical and CHP efficiency (up to 65% in CHP mode)
- No steam operator required
- No water requirement
- Reduces energy costs and greenhouse gas emissions
- Meets renewable power objectives

Game Changing CHP System

- Nexterra's CHP System represents a step change over conventional biomass systems. Developed with GE Energy over the past 3 years
  - **Superior performance**: up to 60%+ efficiency in co-generation mode
  - **Small scale**: minimal fuel requirements not disruptive to local biomass markets
  - **Modular design**: short construction time, allowing rapid deployment
  - **Improved environmental profile**: natural gas equivalent particulate emissions

Will enable a paradigm shift in the biomass power market: Evolution from large centralized facilities to distributed networks of small-scale plants

Comparison – Biomass Combustion vs. Nexterra CHP

30 MW ABB/Zurn biomass plant, CA

2 MW Nexterra biomass CHP plant

	Old Paradigm	New Paradigm
Model	Centralized	Distributed
Efficiency (power only)	Low (20 - 22%)	High (30%)
Efficiency (CHP)	System dependent	High (60%+)
Scale (economic)	Large (>30 MW)	Small (2–10 MW)
Fuel Footprint	High (30 MW = 250,000 bdtpy)	Low (2 MW = 13,000 bdtpy)
Fuel Truck Traffic	High (30 MW = 30 trucks/day)	Low (2 MW = 2 trucks/day)
Steam Plant Operators	Yes	No
PM Emissions	High volume	Ultra Low – natural gas for particulate
Permitting/Public Risk	Higher	Lower
Construction Time	Long : 24 – 36 months	Short: 12 months
Grid Connection Costs	Higher	Minimal – inside the fence
Urban Friendly	No – scale, traffic, emissions	Yes – scale, traffic, emissions

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Standard, Modular CHP Systems

2 MW

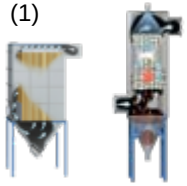
- Net Power: 1.7 MW
- Total Avail Heat Energy: 10 MMBtu/hr
- Wood Fuel Req't: 12,500 Bdt

Fuel Handling (1)

Gasifier (1 x 16 ft)

Gas Clean-up (1)

Syngas Conditioning (1)



Engines (1)

Heat Exchanger (1)

4 MW

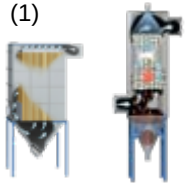
- Net Power: 3.4 MW
- Total Avail Heat Energy: 10 MMBtu/hr
- Wood Fuel Req't: 25,000 Bdt

Fuel Handling (1)

Gasifiers (1 x 20 ft)

Gas Clean-up (1)

Syngas Conditioning (1)



Engines (2)

Heat Exchanger (1)

8 MW

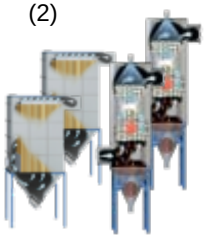
- Net Power: 6.8 MW
- Total Avail Heat Energy : 20 MMBtu/hr
- Wood Fuel Req't: 50,000 Bdt

Fuel Handling (1)

Gasifiers (2 x 20 ft)

Gas Clean-up (2)

Syngas Conditioning (2)



Engines (4)

Heat Exchanger (2)

[1] *20 ft Gasifier is in development.*

University of British Columbia CHP Project

GE Energy

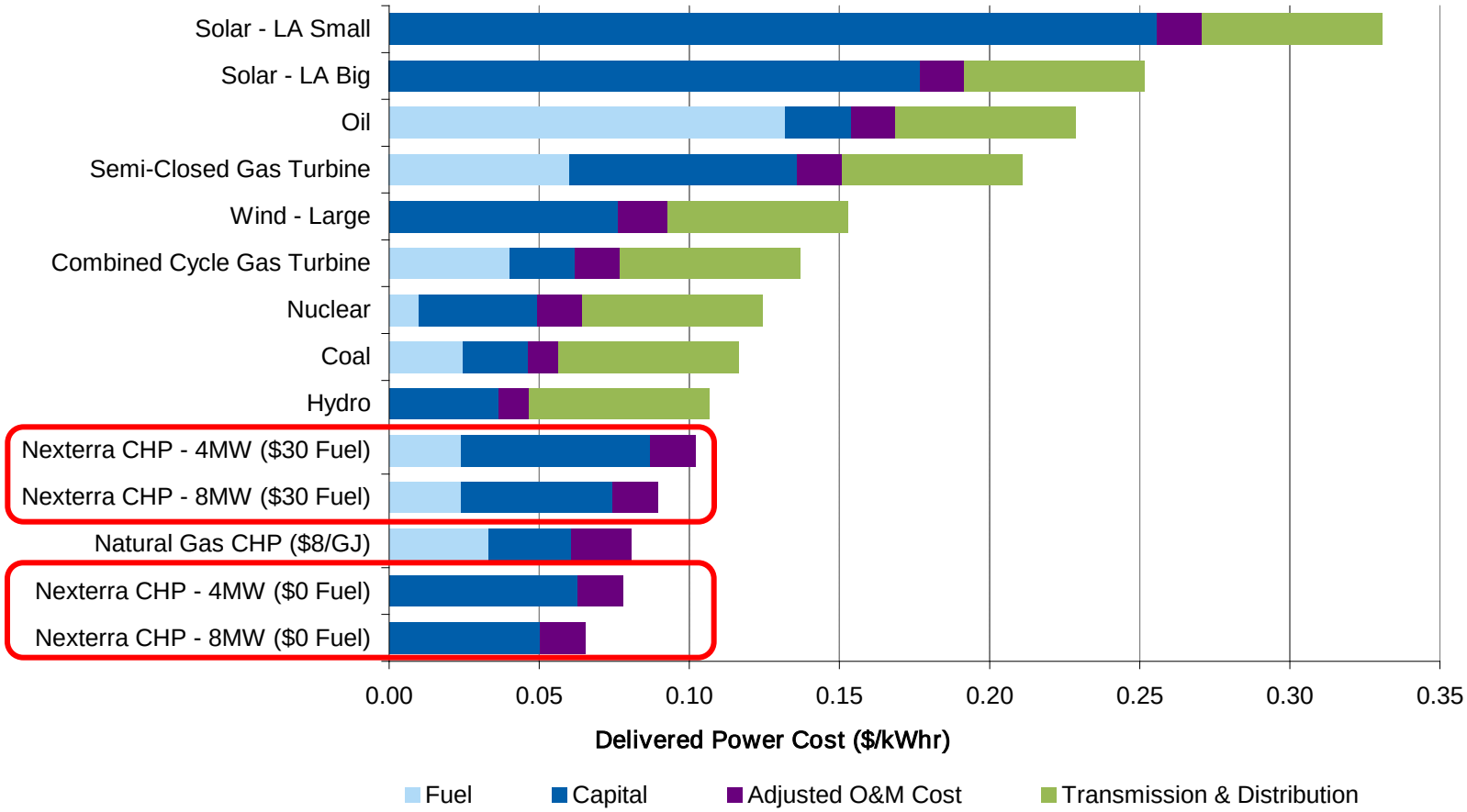
UBC – 2 MW Biomass CHP Project

- Fuel Req'd: 12,500 BDMT/year (2/3 trucks/day)
- Gross Power: 1.95 MW
- Net Thermal: 10 MMBTU/hr (80,000 MMBTU/yr)
- CO2 Red: 4,000 tpy (thermal only)
- Footprint: 180' X 90'

Levelized Cost-of-Energy

- Nexterra's CHP system is able to deliver one of the lowest levelized cost-of-energy solutions

Levelized Cost of Power Alternatives[1]



[1] *Management estimates; assumes projected 2012 capital costs for Nexterra CHP systems.*

Project Considerations

Biomass Project Considerations

A number of considerations need to go into designing a successful biomass project including:

- Economics
  - Fossil fuel pricing, electricity pricing and CO2 credits
  - Does power and/or heat displacement make economic sense at a particular site?
  - Focus on baseload, not peak
- Business Model
  - Direct
  - ESCO
  - DBOO
- Biomass availability
  - Target fuel < 50 miles to enable reasonable cost
    - Preferably delivered for less than ~$35/Green Ton (critical for condensing or extraction turbines)
  - Fuel flexibility of biomass system critically important
  - Larger the system the more significant the fuel risk
- System location
  - Site layout
  - Air quality/emissions environment

System Location

- Sufficient space for system footprint
  - Rule of thumb: 1000 sq. ft./10MMBTU/hr net useable heat capacity
- Accessible by truck
- Neighborhood acceptability
  - Public consultation will normally be required
- Air emissions requirements
  - Can the system be permitted in the jurisdiction?
  - Increasingly challenging for wood fired combustion systems

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Thank You

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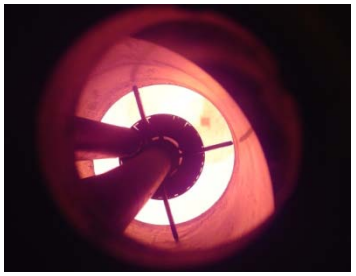
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