The Future of Biomass Thermal Energy: Advanced Technologies

This Webinar is brought to you by:

Biomass Thermal Energy Council (BTEC)

With the generous support of the
U.S. Forest Service
Wood Education Resource Center

1 PM ET, December 14, 2011

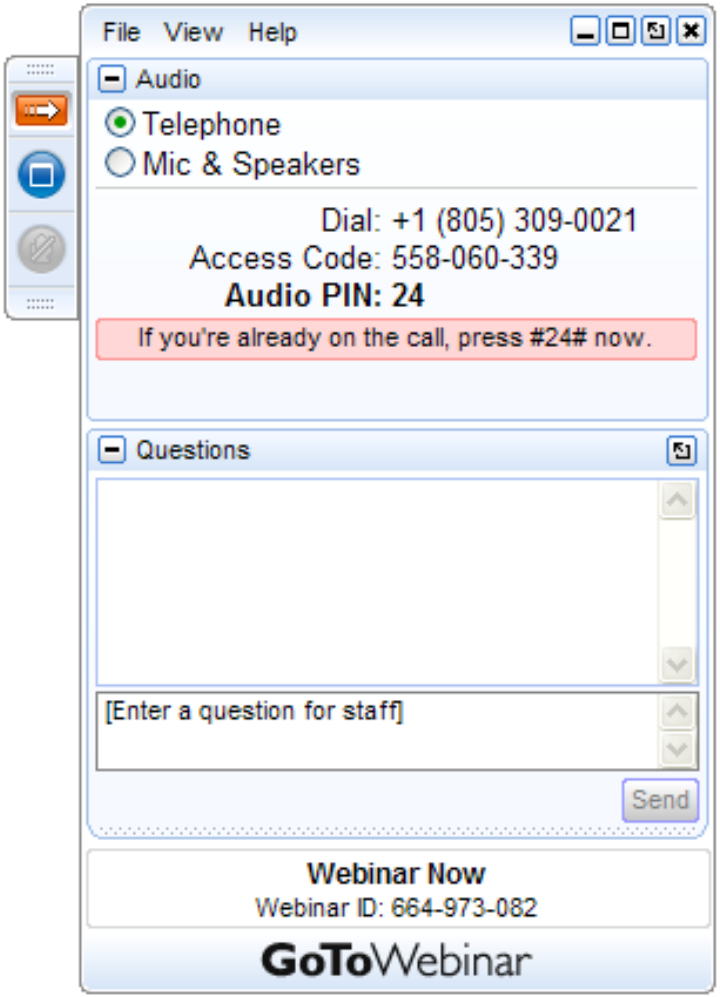
"The work upon which this publication is based was funded in whole or in part through a grant awarded by the Wood Education and Resource Center, Northeastern Area State and Private Forestry, U.S. Forest Service. This institution is an equal opportunity provider."

Joseph Seymour - Introductions

- Executive Director - Biomass Thermal Energy Council (BTEC)

Quick notes

- Two Audio Options: Streaming Audio and Dial-In.
  1. Streaming Audio/Computer Speakers (Default)
  2. Dial-In: Use the **Audio Panel** (right side of screen) to see dial-in instructions. Call-in separately from your telephone.
- Ask questions using the **Questions Panel** on the right side of your screen.
- The recording of the webinar and the slides will be available after the event. Registrants will be notified by email.



Speakers

- **Dave O'Connor**, Project Manager, Electric Power Research Institute
- **David Frank**, Co-founder, Sunwood Biomass
- **Tom Miles**, Principal, TR Miles Technical Consultants Inc.

Moderator

- **Joseph Seymour**, Executive Director, Biomass Thermal Energy Council

Presentation Outline

I. **Introduction** – Joe Seymour
II. **Advanced Fuels** – Dave O'Connor
III. **Residential and Commercial Systems** – David Frank
IV. **Advanced Commercial Technologies** – Tom Miles
V. **Q&A** – Joe Seymour
VI. **Resources and Future Events** - Joe Seymour

[Full presentation will be available online, www.biomassthermal.org/resource/webinars.asp]

Introduction to BTEC

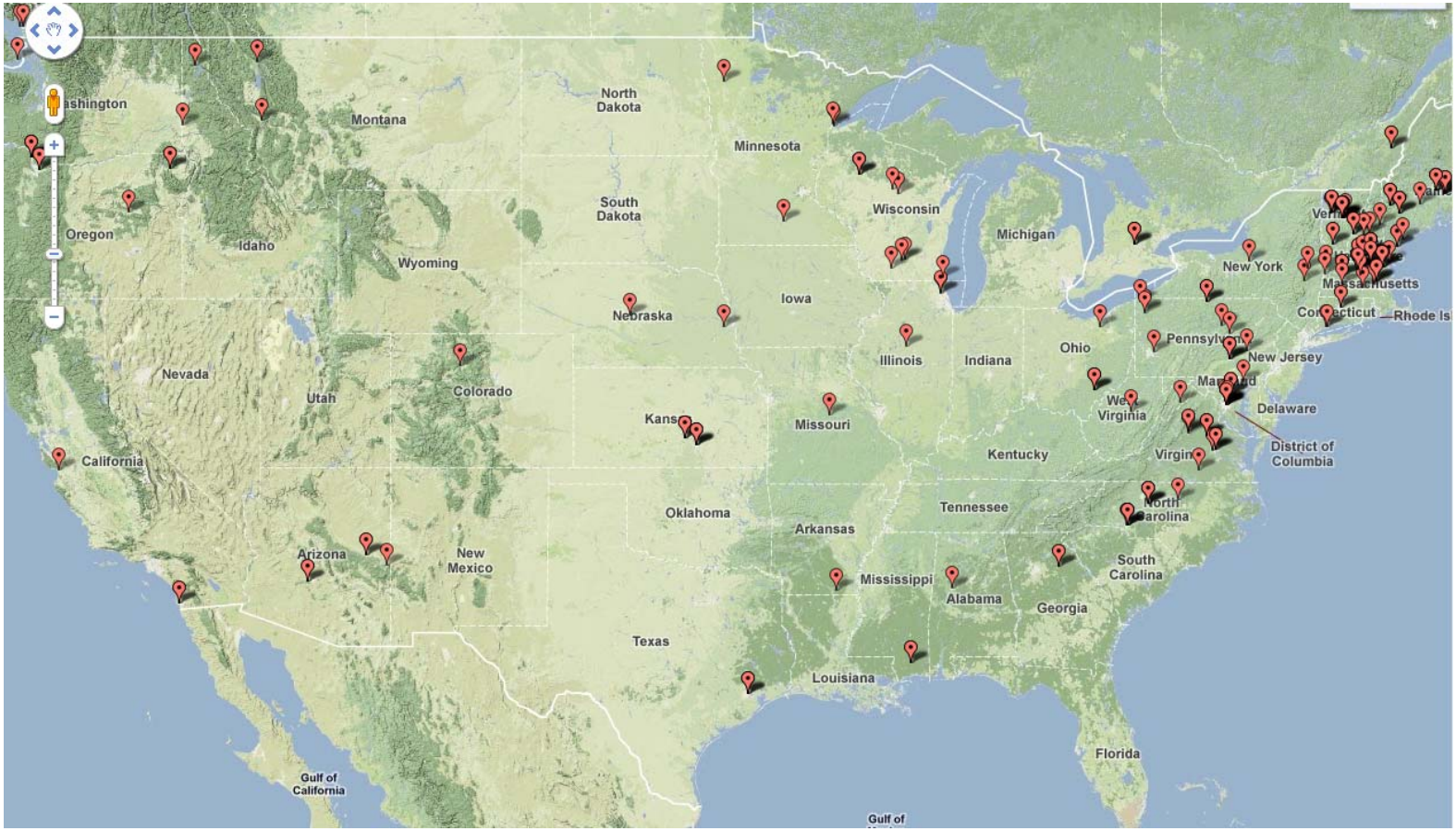
The Biomass Thermal Energy Council (BTEC) is the industry trade association dedicated to advancing the use of biomass for heat and other thermal energy applications.

Why was BTEC established?

1. To **advocate for and promote** the industry in the national energy policy debate
2. To **reach out** to and **educate** the public and decision makers on the benefits and advantages of using biomass for heat
3. To develop biomass energy **research and analysis** that enables sound investment and policy decisions

BTEC's membership*

* As of November 13, 2011



BTEC Membership

Abundant Power
ACT Bioenergy
AFS Energy Systems
Alliance for Green Heat
Alternative Energy Solutions International
American Agriculture Movement
American Biomass
American Wood Fibers
APEX
Bear Mountain Forest Products
Biomass Combustion Systems
Biomass Commodities Corporation
Biomass Energy Resource Center
Biomass Energy Works
Bionera Resources
Biowood Energy
Chip Energy
Clean Power Development
Comact Equipment
Confluence Energy
Continental Biomass Industries
Control Labs
Corinth Wood Pellet
Cousineau Forest Products
Dejno's
Ecostrat
Enviva Materials
Ernst Biomass
Forest Energy
FutureMetrics
Green Clean Heat
Indeck Ladysmith
Innovative Natural Resource Solutions
Integrated Biomass Resources
International Renewable Energy Technology Institute
International WoodFuels
Jesse E. Lyman Pellets
Lignetics of Virginia
Maine Energy Systems
Maine Pellet Fuels Association
Marth
Missouri Corn Merchandising Council
Montana Community Development Corporation
National Network of Forest Practitioners
New England Wood Pellet
New Horizon
Northeast Mill Services
PA Pellets
Pellet Technology USA
Pelletco
Piney Wood Pellets
Plum Creek
Pratt & Whitney Power Systems - Turboden
Proe Power Systems
Public Policy Virginia
Rainforest Alliance
Ray Albright
Recast Energy
Renewable Energy Resources
Resource Professionals Group
Richmond Energy Associates
Sandri Companies
Santa Energy Corporation
Sewall Company
Skanden Energy
State University of New York - Environmental Science and Forestry
Tarm Biomass
Twin Ports Testing
University of British Columbia
Vapor Locomotive Company
Vecoplan
Vermont Sustainable Jobs Fund
Vermont Wood Pellet
Viessmann
West Oregon Wood Products
Western Ag Enterprises
Westervelt Renewable Energy
Wilson Engineering Services
Wisconsin Energy Conservation Corporation
Woodmaster
Zilkha Biomass Energy

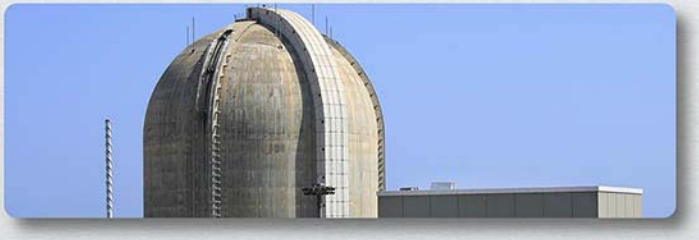
Project made possible by the USDA FS WERC

- BTEC awarded a grant from the USDA Forest Service's Wood Education and Resource Center (WERC) in June 2010 to advance education and outreach on biomass thermal energy
- The Center's mission is to work with the forest products industry toward sustainable forest products production for the eastern hardwood forest region.
- Previous webinars available at: www.biomassthermal.org/resource.
- All questions and attendee feedback will help form future activities.

Remember to answer the survey at the webinar's conclusion!

Dave O'Connor

- Project Manager, Electric Power Research Institute
- **Advanced Fuel Technologies**





ELECTRIC POWER RESEARCH INSTITUTE

Upgraded Biomass Fuels

Dave O'Connor
Senior Manager, Biomass Projects
doconnor@epri.com 650/855-8970

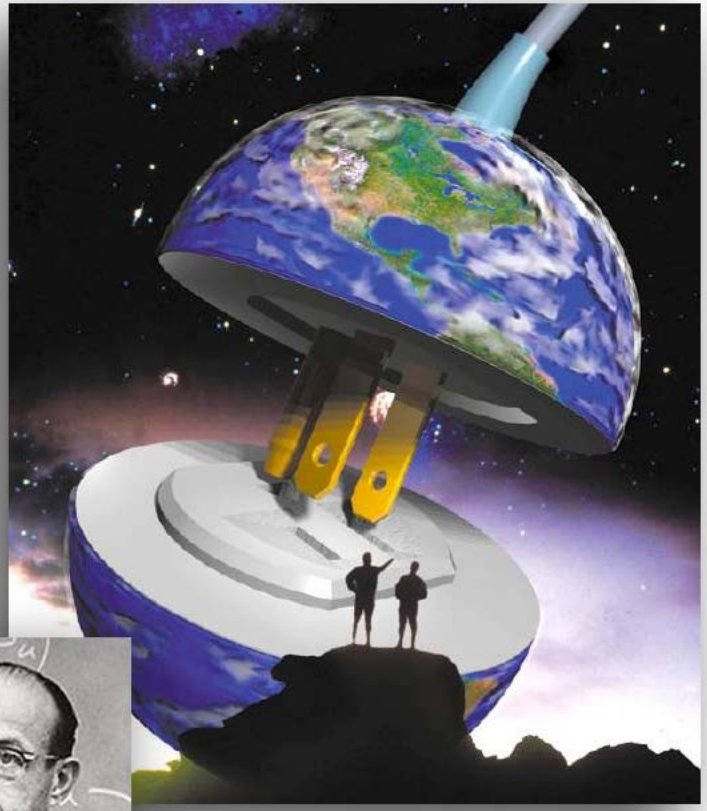
Biomass Thermal Energy Council Webcast
December 14, 2011

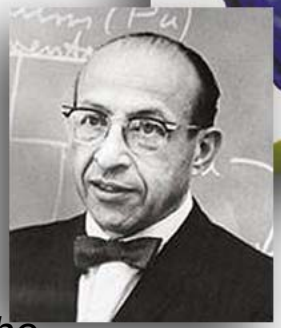
Overview

- About EPRI
- About Biomass
- About Upgraded Biomass
  - Advantages
  - Disadvantages
  - Prospects
- Conclusions

About EPRI

- Founded in 1973
- Independent, nonprofit center for public interest energy and environmental research
- **Collaborative** resource for the electricity sector
- Major offices in Palo Alto, CA; Charlotte, NC; Knoxville, TN
  - Laboratories in Knoxville, Charlotte and Lenox, MA
- Our Mission:
  - *To conduct research on key issues facing the electricity sector…on behalf of its members, energy stakeholders, and society.*





Chauncey Starr
EPRI Founder

Biomass: A Mixed Blessing

YEAH!!!

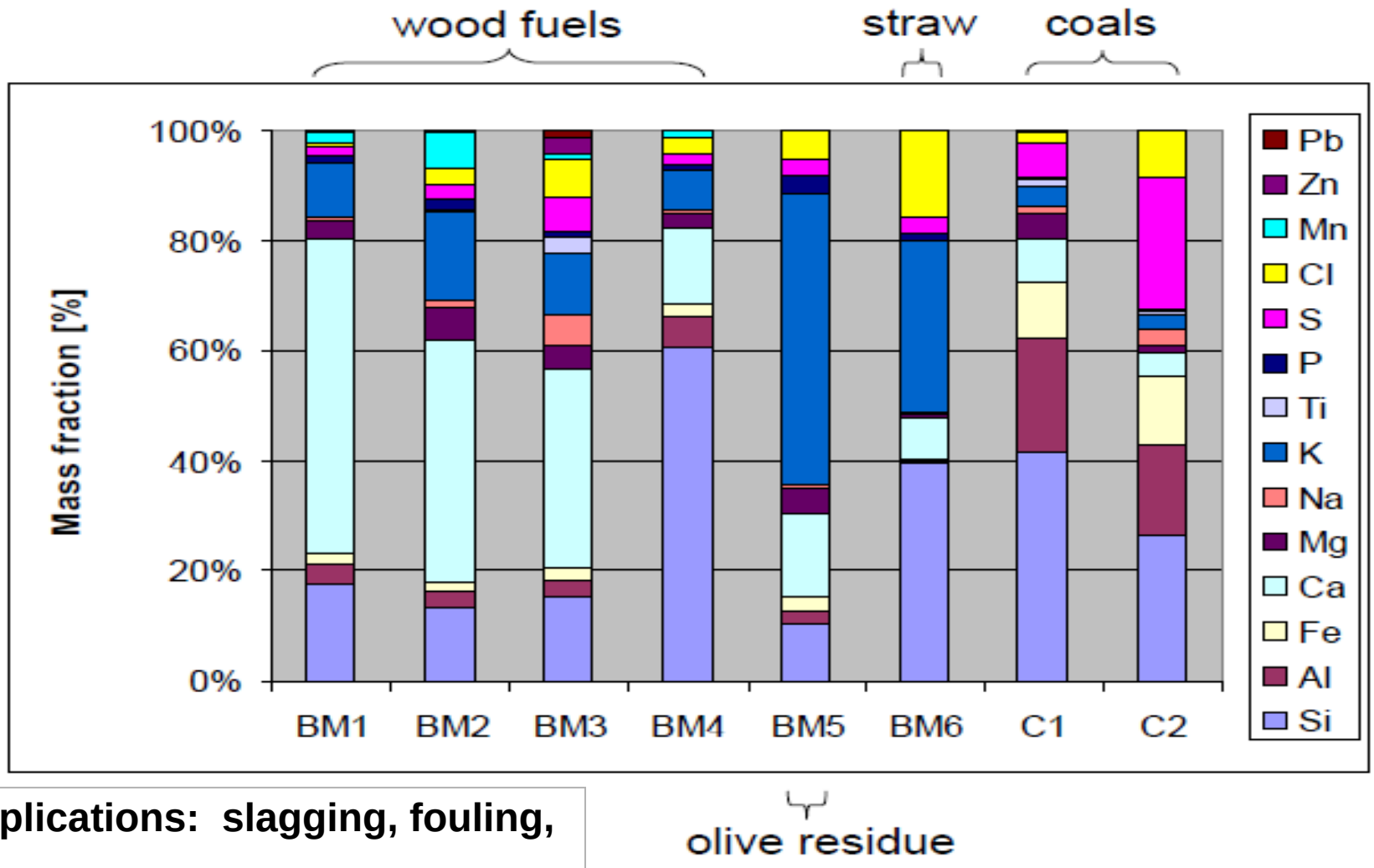
- Low ash
- Low sulfur
- Low levels of key pollutants

BOO!!!

- High moisture
- Fibrous
- Has difficult ash
- Low energy density

Upgrading Biomass Offers the Opportunity to Remove or Modify Technical Barriers

Ash elements in biomass and coal



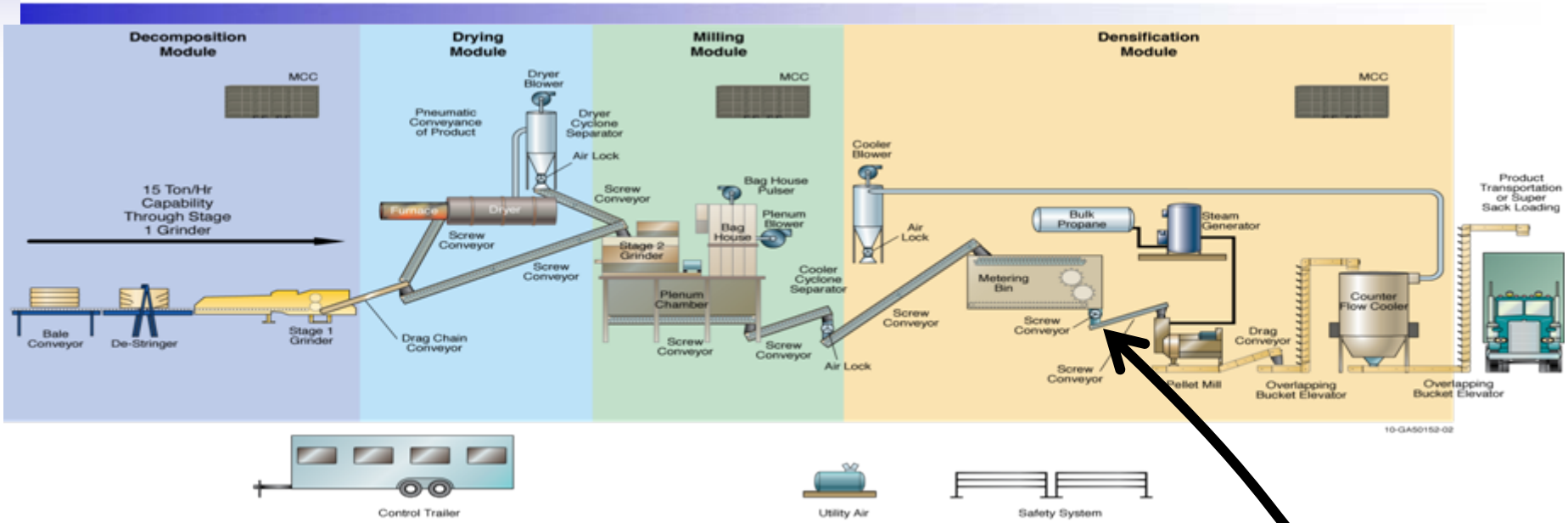
Implications: slagging, fouling, corrosion, catalyst degradation

Upgrading in a Nutshell

Heat-based Upgrading Briefly

- Grind raw biomass
  - Purpose is to increase heat transfer/reaction speed
- Torrefaction
  - Subject biomass to elevated heat for extended time under controlled conditions, lose moisture and some volatiles (volatiles are used to generate process heat)
- Steam explosion
  - Subject biomass to elevated heat and pressure for a short period of time, decompress rapidly, lose moisture, some volatiles
- Densify if desired

Small Modular Upgrading Plants



- Pilot test AGP-1 Basic Torrefaction Module (2.5t/h capacity) using PDU Auxiliary equipment
- Test with woody, grasses and Agricultural waste feedstock, to assess performance
- Produce enough chips and pellets to support co-firing burning tests in 2012-2013

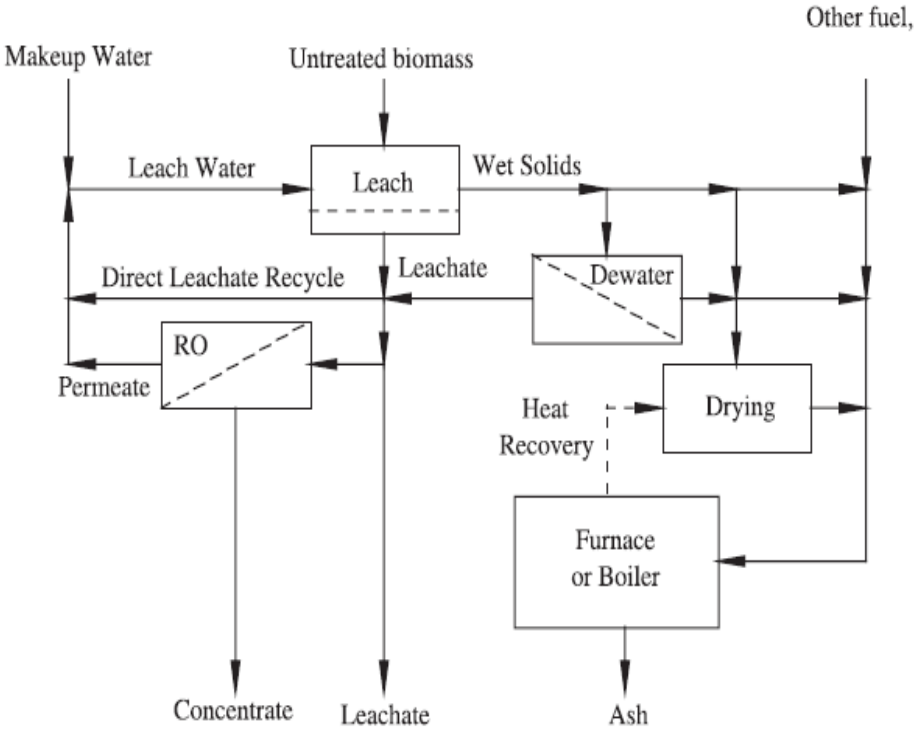
Biomass Washing-leaching Bench Testing

Benefits of washing-leaching

- *Removes >90%alkali, >95% Cl, heavy metals…*
- *Increases ash fusion temperatures/reduces volatility*
- *Decreases slag/fouling and corrosion in boilers*
- *Improves combustion properties*

Bench Test scope

- *6 feedstock (Wheat straw, DDGS, Switch grass, Rice Straw, Sugar cane trash, Olive residue)*
- *Matrix>350 tests to optimize key process parameters (solid/ liquid ratio, contact time, temperature, solvents, particle size…)*
- *Mechanical dewatering options*
- *Water recycling and treatment options*
- *Leachate/concentrate characterization*
- *Concept engineering for a pilot continuous process plant*



Process can be used as a first step before biomass torrefaction or to clean the solid char after torrefaction

EPRI ELECTRIC POWER RESEARCH INSTITUTE

Conclusions: Status of Biomass Upgrading

- Pellets—low moisture, higher heat density
  - Wood Pelletization—Commercial, robust business
  - Pelletizing other biomass—Commercial, specialty business
- Torrefaction/Steam Explosion—friable, low moisture, hydrophobic, high heat density
  - Approaching commercial status: two plants have commercial-size equipment
- Cleaned Biomass—low levels of alkali/alkaline earths
  - Approaching pilot scale
- Costs are higher than raw biomass, and each case must determine if the benefits exceed the increase in fuel cost

Together…Shaping the Future of Electricity

David Frank

- Co-founder, Sunwood Biomass
- **Residential and Commercial Technologies**

Advanced Biomass Heating Systems

Residential & Commercial Technology

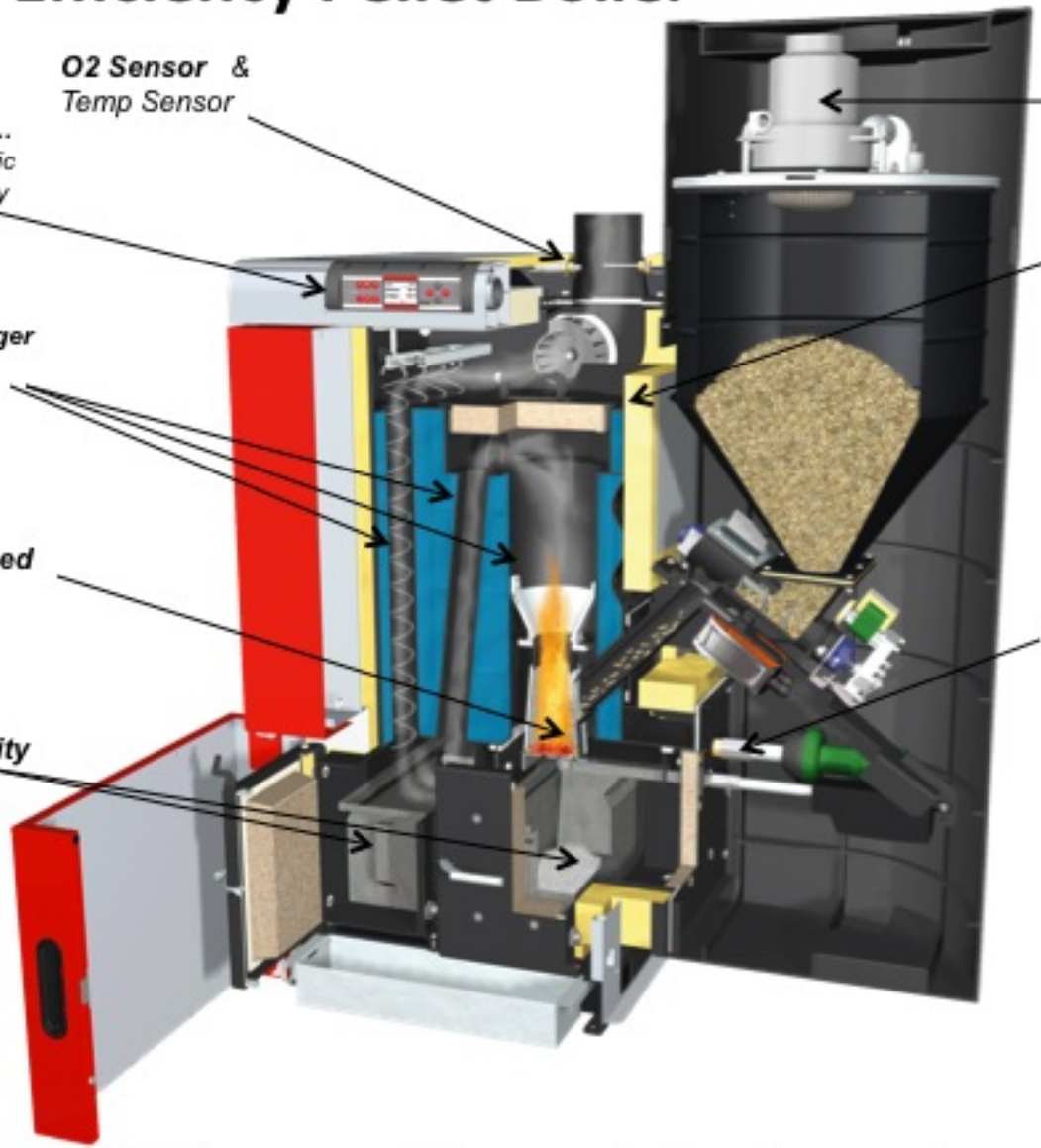
Dave Frank of *SunWood Biomass*

Innovation in Biomass Heating®

Planning for Equipment
Cost vs. Value of all Equipment

- Durability…..Quality of components = WARRANTY
- Reliability
- Efficiency
- Ease of Operator Use
- Maintenance: frequency & difficulty of regular maintenance
- Parts & Mfg. Support availability
- **User Experience talk to owner operators visit installs**

Super High Efficiency Pellet Boiler



O2 Sensor *&*
Temp Sensor

Beyond Computer Control....
Must have extensive diagnostic capabilities that is user friendly to all consumers

"true" ***Triple pass Heat Exchanger***
Optional Condensing unit

Drop Feed vs. Under Feed

Extensive Ash Holding Capacity

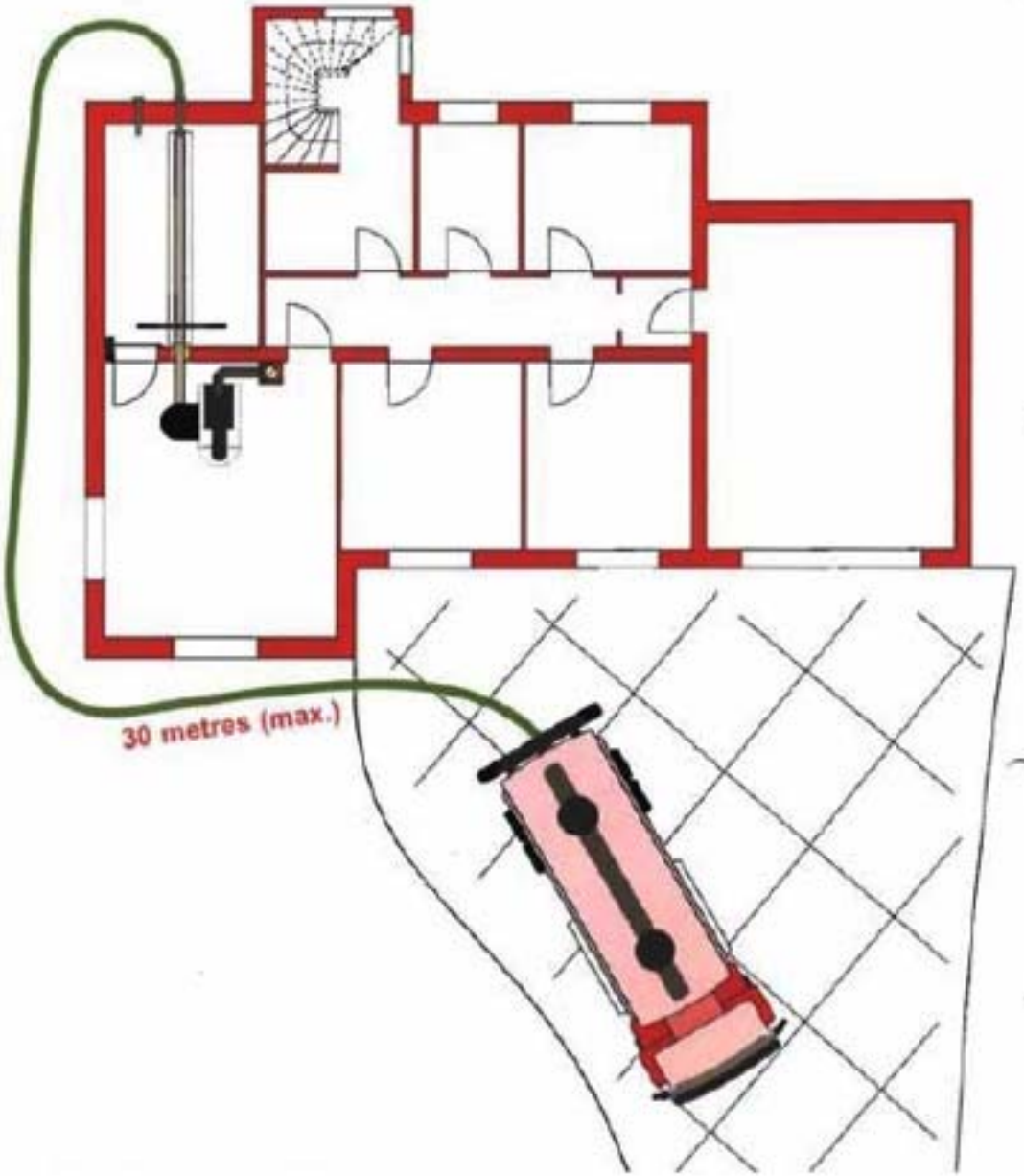
Installer Friendly
User Friendly
Pneumatic Pellet
Feed

Built for Long Service Life
- *HD Boiler Body Construction*
- *HD Motors and Components*

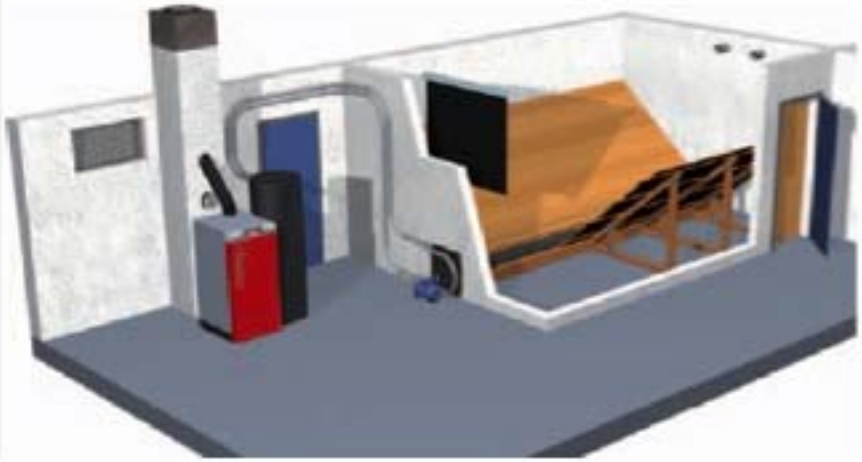
Auto Ignition

The Future of Biomass Thermal Equipment
1.Reliability 2.Durability 3.Ease of Use

Bulk Pellet Delivery & Storage Systems



Screw suction system



The Froling screw delivery system is the ideal solution for rectangular rooms with front-end removal. The deep and horizontal position of the delivery screw means the space in the room is used optimally and complete emptying of the store is guaranteed. Combined with a suction system from Froling it also enables flexible boiler setup.

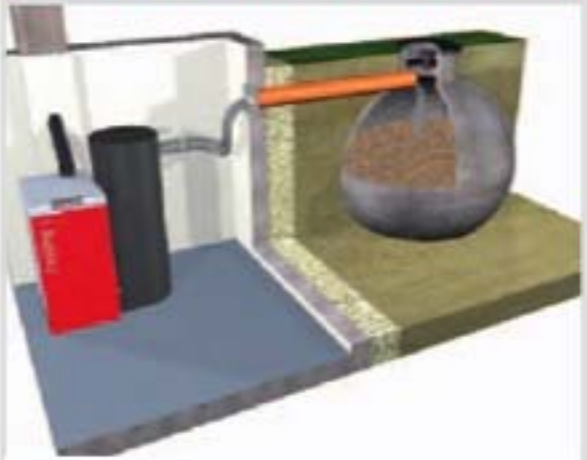
Pellet Storage Systems

Bag silo system

The bag silo system is a flexible, simple way of storing pellets.

There are other advantages to using a bag silo. It is easy to assemble and store. It is dustproof and flood proof. You can fit rainproof and sun proof covers and install the silo outside.

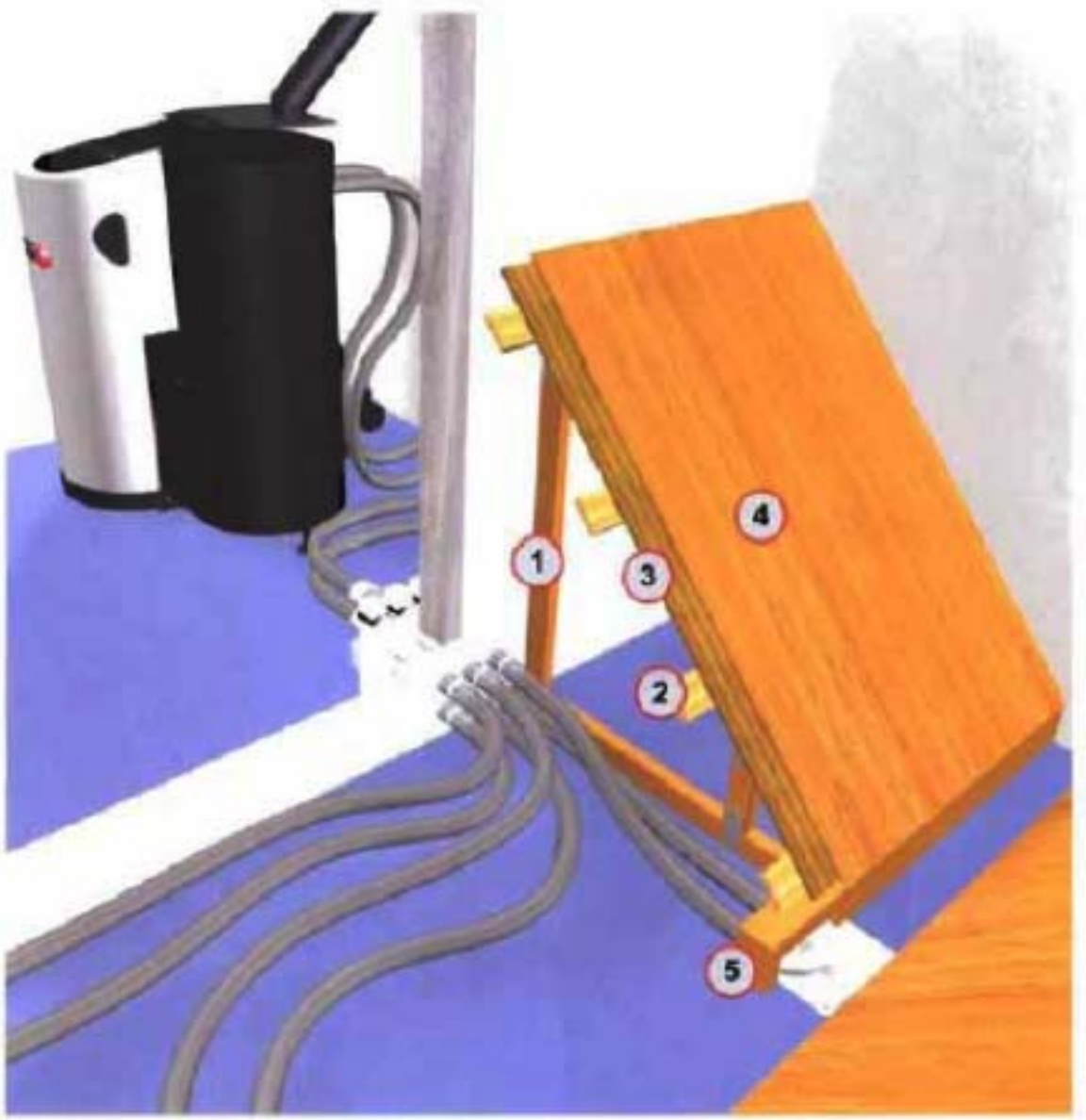
Underground feeder tank system



If you have no storage space indoors then the underground tank is a good alternative. The underground tank is buried outdoors and feeds pellets to the boiler via a suction pipe. The suction pipes should be laid inside a hollow pipe from the underground tank to the building.

Pellet Home Storage Flexibility

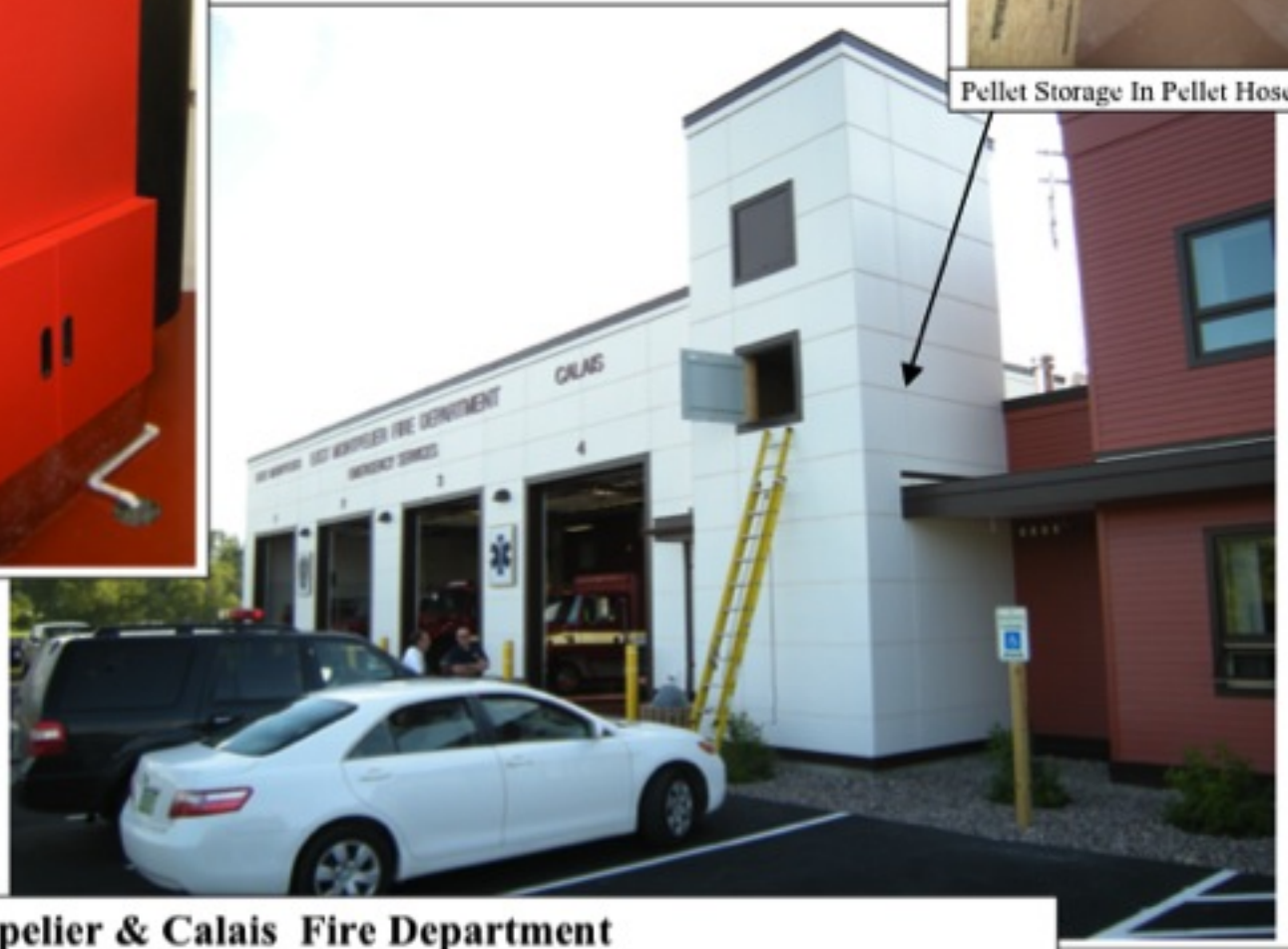
Suction Trough Systems



East Montpelier Fire Department

New Super Insulated Fire Department

Pellet Storage In Pellet Hose Tov

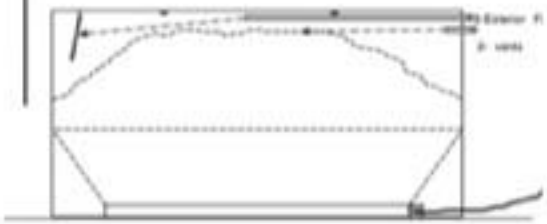


East Montpelier & Calais Fire Department
200,000btu/hr Fröling P4 Pellet Boiler with custom pellet storage

VERMONT TECHINAL COLLEGE

Biomass Educational Installation & Historical Preservation

Basement Pellet Storage & VTC's Applied Biomass Educational Curriculum

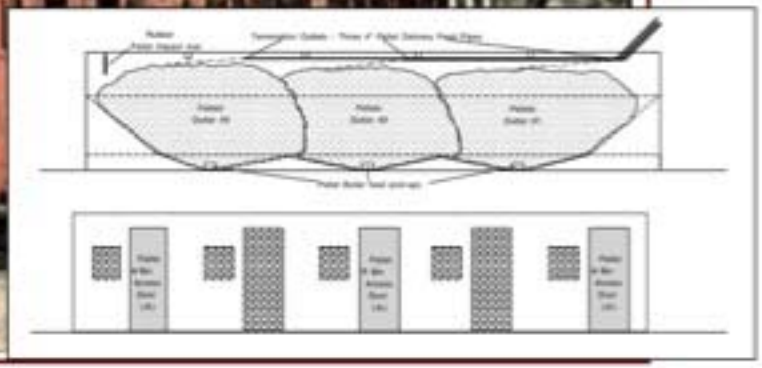


- 164,000btu/hr Fröling Pellet Boiler System
- Interior Trough Auger System Designed by SunWood Biomass
- Switch Grass Pellet Combustion Testing will be conducted
- VTC's Red School House in Randolph Center Vermont

Elderly Housing -Windsor Village

Historical Preservation for Housing Utilizing Biomass

- 77 units of Elderly Housing
- 400,000 btu/hr Fröling(s) P4 w/440gal Heat Storage
- **50 Tons Pellet Storage utilizing 10 old Prison Cells**



State Prison, Windsor,

High Efficiency Gasification Log Boiler

(85+% efficient)

Von TRAPP Farmstead

Small Scale District Heating…..*makes cheese*

von Trapp Home
(Martin & Kelly)

425,000 BTU
GARN
Gasfication Boiler

GARN

Garn Boiler building nearing completion 2009

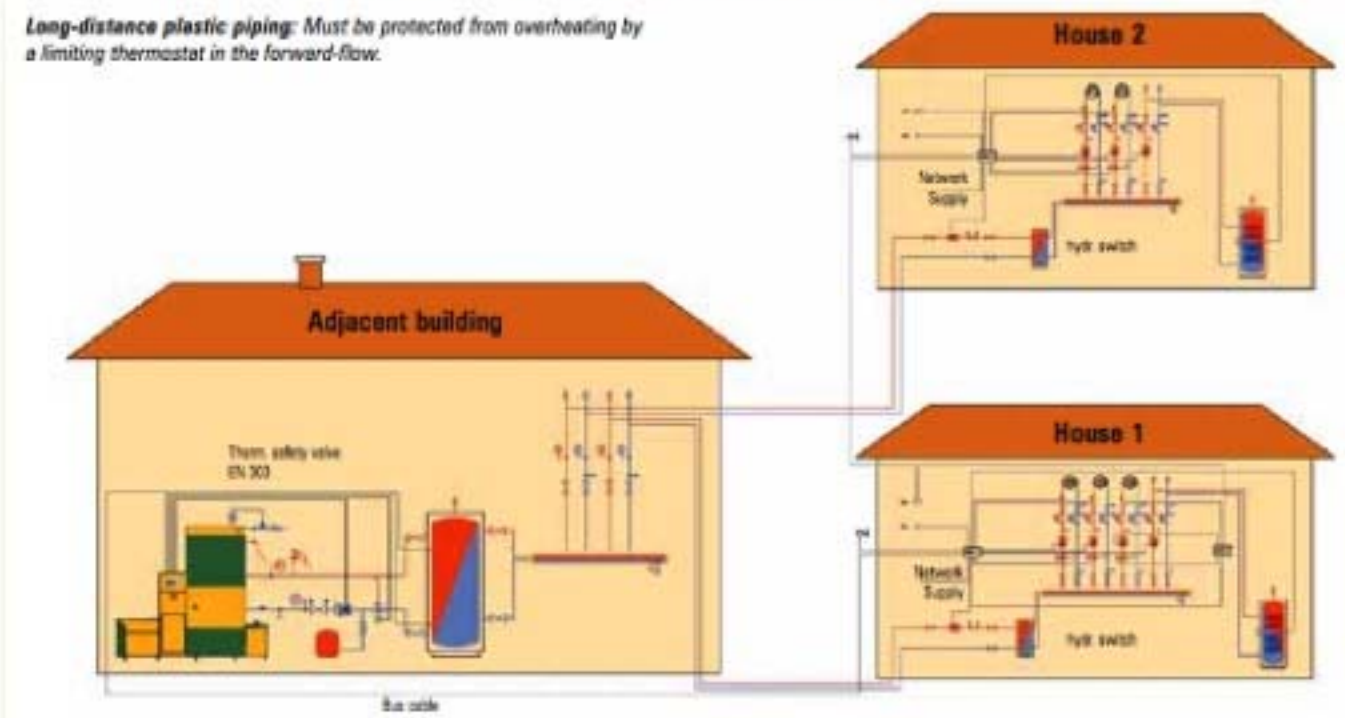
VON TRAPP FARMSTEAD

Cheese Making Facility

Milking Parlor

Milk House

Pellet *or* Chip Boiler in a Small / Micro Scale District Heating Network



Shared Capitol Cost makes this more Affordable

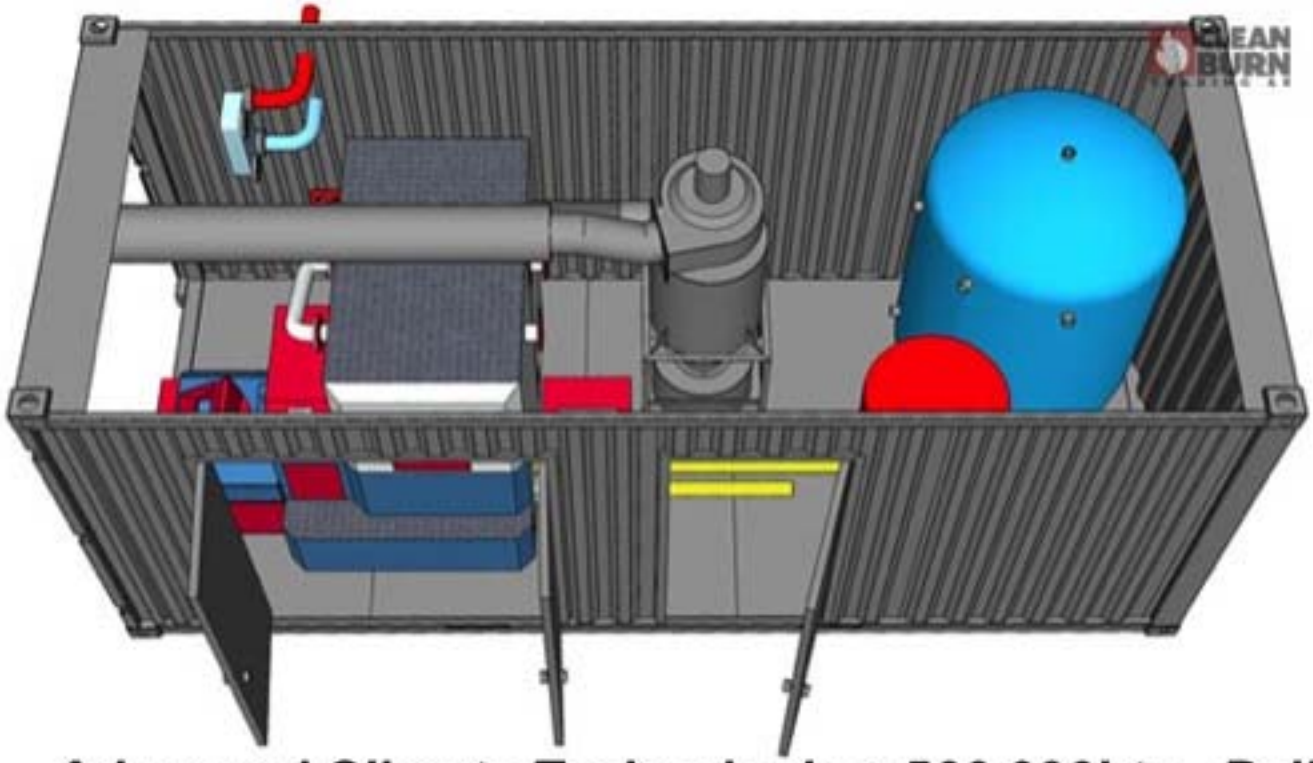
Legislative action for incentives

Education & Successful Site Examples

Containerized Pellet or Chip System

BioBox®

100,000btu -to- 3MM/btu



Advanced Climate Technologies 500,000btu Pellet/Chip Boiler

Craftsbury Academy

Craftsbury Common ~ Vermont

ACT's Combination Wood Chip Pellet & Boiler

- Offset of **25,000+ gallons** annually of Heating oil
- Heating **26,000sq.ft** School & Gym
- **Annual savings to exceed $18,000.**
- Craftsbury Academy and it's community are committed to being carbon natural…
- Deep Energy retrofit underway as well.

850,000 Btu ACT Boiler
Advanced Climate Technologies
Wood Chip / Pellet Boiler

BAST & ROOD ARCHITECTS
187 WINDROW LANE
PO BOX 220
HINESBURG, VT 05461

TEL : 802 - 482 - 5200
FAX : 802 - 482 - 3453
EMAIL : bastrood@gmavt.net

The Moulton Story…

a Vermont family with Strong values

Thank You !

SunWood Biomass

Innovation in Biomass Heating®

Waitsfield - Vermont SunWoodBiomass.com

Dave Frank – Marc DiMario

BERC
Biomass Energy
Resource Center

Renewable Energy Vermont

Vermont Sustainable Jobs Fund

Tom Miles

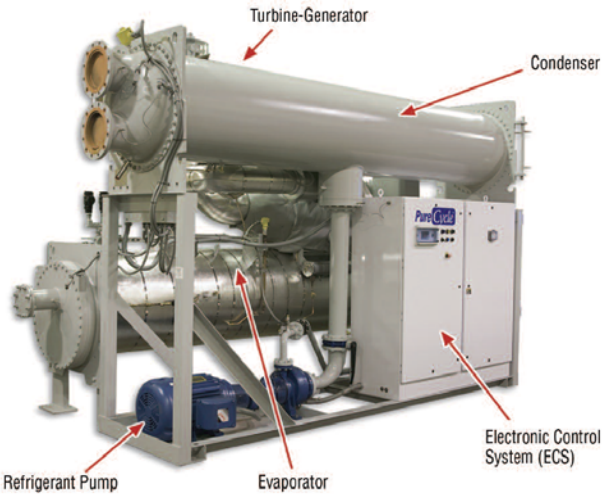
- Principal, TR Miles Technical Consultants Inc.

- **Advanced Commercial Technologies**

Advanced Commercial Technologies

BTEC Webinar, December 14, 2011

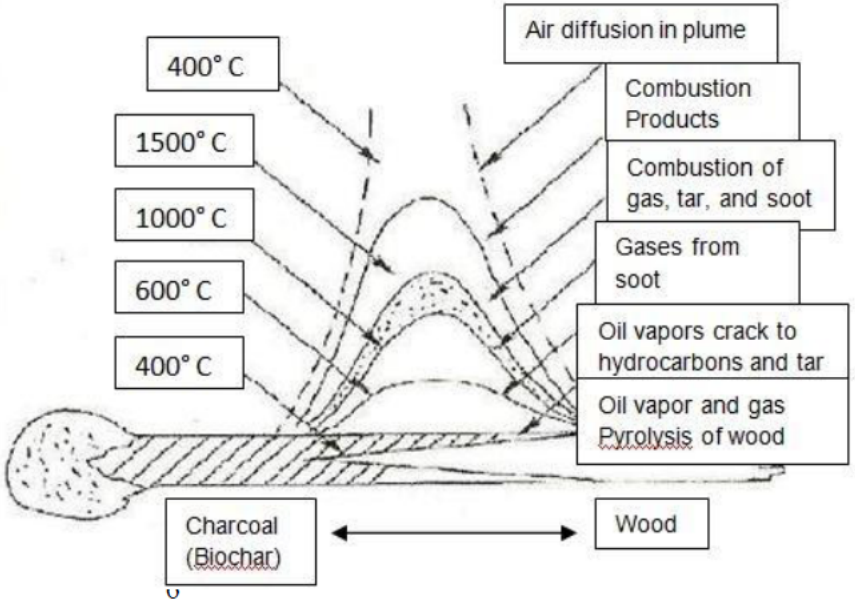
- Carbonization (torrefaction, pyrolysis)
- Improved combustion
- Gasification
- Combined heat and biochar



Improved conversion technologies increase product recovery

- Improve fuel to heat and power efficiency
- Enable use of low quality (low cost) fuels
- Improve emissions
- Reduce operating costs
- Make co-products like biochar and power

FIGURE 3: A MATCH CONVERTS WOOD INTO CHAR AS IT BURNS



H. McGlaughlin All biochars are not created equal. . . V2. Oct 2009, Biochar 2009

Staged Combustion of Wet, Fine, Dirty, Fuels Reduces Emissions

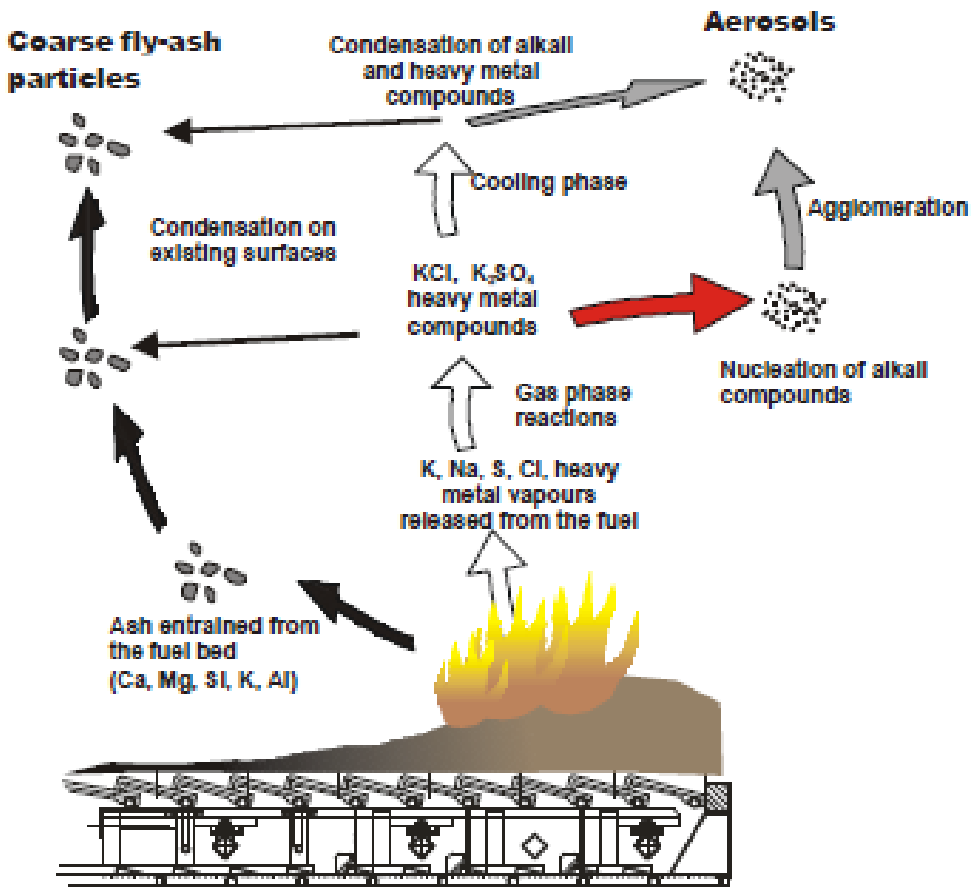


Figure 7: Aerosol formation during fixed-bed combustion of chemically untreated wood chips

Obernberger, Bios-AT 2010

Modular Chip and Pellet Boilers Control Emissions Through Staged Combustion

John Day, OR

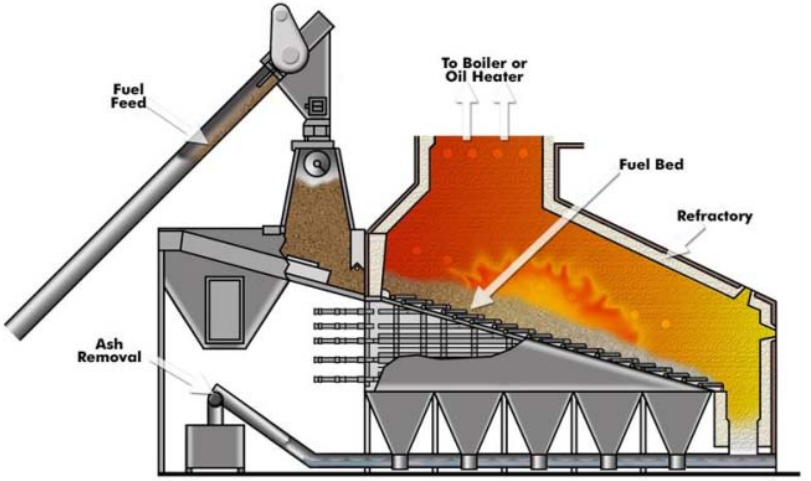
www.viessmann.com

Secondary Chamber Burns Gas
Heat Exchanged to Water – Flue Gas Recycled

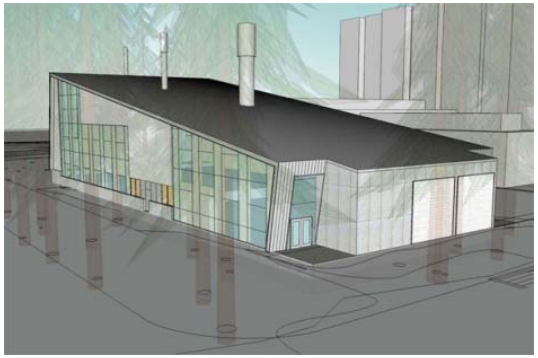
Moving Grate Primary Chamber
Gasifies Pellets or Chips

Staged Combustion and Gasification Improves Large Biomass Systems

Large Institutions (>10 MMBtuh): Schools, Military installations, Community Facilities
Commercial and small industrial (>10 MMBtuh<60 MMBtuh): Greenhouses



www.wellonsfei.ca



Process:
- Gasify wood
- Condition gas, remove impurities
- Burn gas in engine to produce heat and electricity

UBC 2 MW electricity and 9,600 lbs/hr steam

www.nexterra.ca

Pyrolysis and gasification enable conversion of wood, grasses and marginal fuels

- Characteristics of low quality fuels
  - High ash with low melting temperatures
  - Low bulk density
- Combustion requirements
  - Low peak temperatures
  - Pyrolysis, staged combustion or gasification
- Recover heat, char and power
  - Combined heat and power
  - Combined heat and biochar

- Pyrolysis
  - Whitfield Biochar Burner
  - Pacpyrolysis,
- Gasification
  - Kansai (rice husk)
  - DK Stirling
  - All Power Labs
  - Fluidyne NZ
  - Pratt & Whitney

Heat and Kuntan (Rice Husk Char)

Aito Nanohana EcoProject, Higashi-Omi City, Shiga

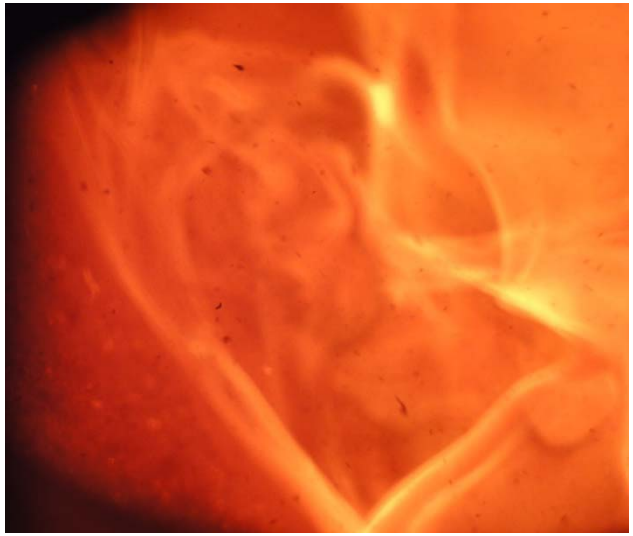
Kansai Corp 200 kilns 150 kg/hr, 1.2 MMBtu, 50 kg char/hr

主成分　炭素分　４０％
　　ケイ酸分　５０％

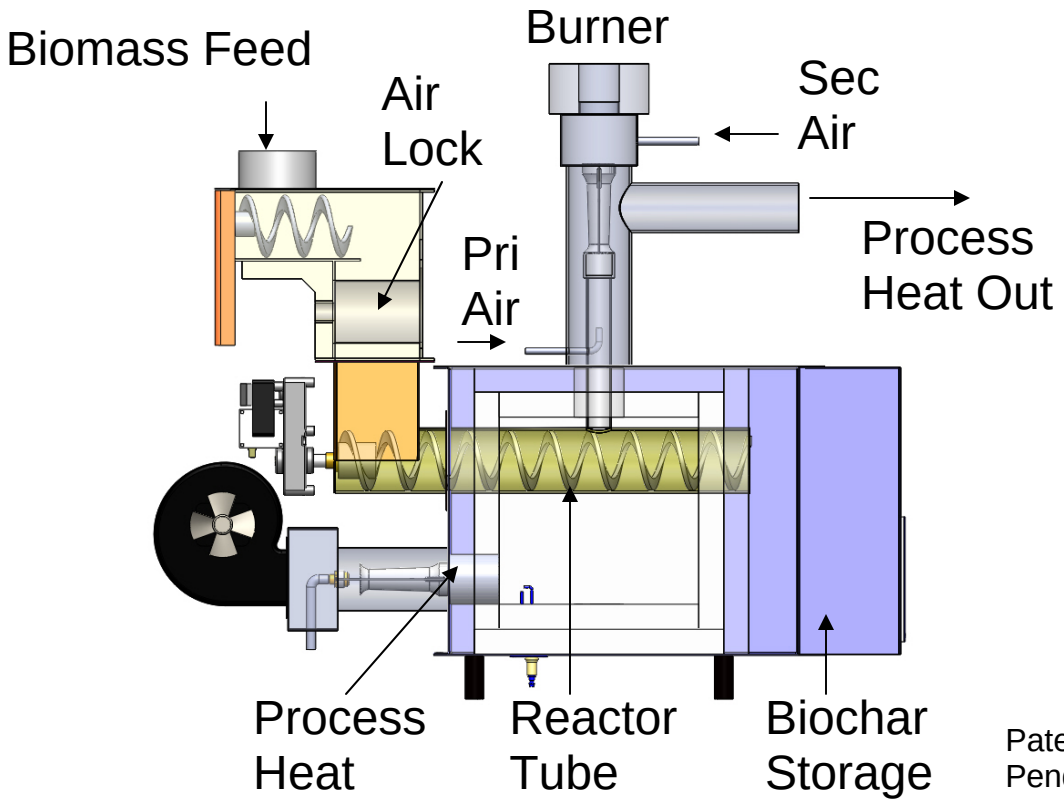
炭成分中の微量要素
（バイオ炭１ｋｇ中）

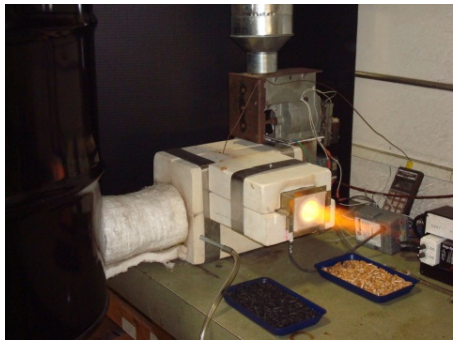
カリウム	K	11,000mg
カルシウム	Ca	5,700mg
ナトリウム	Na	1,700mg
マンガン	Mn	790mg
鉄	Fe	190mg
亜鉛	Zn	110mg
銅	Cu	微量

700Y/10 kg
$0.41/lb



Combined Heat and Biochar: Whitfield Biochar Furnace

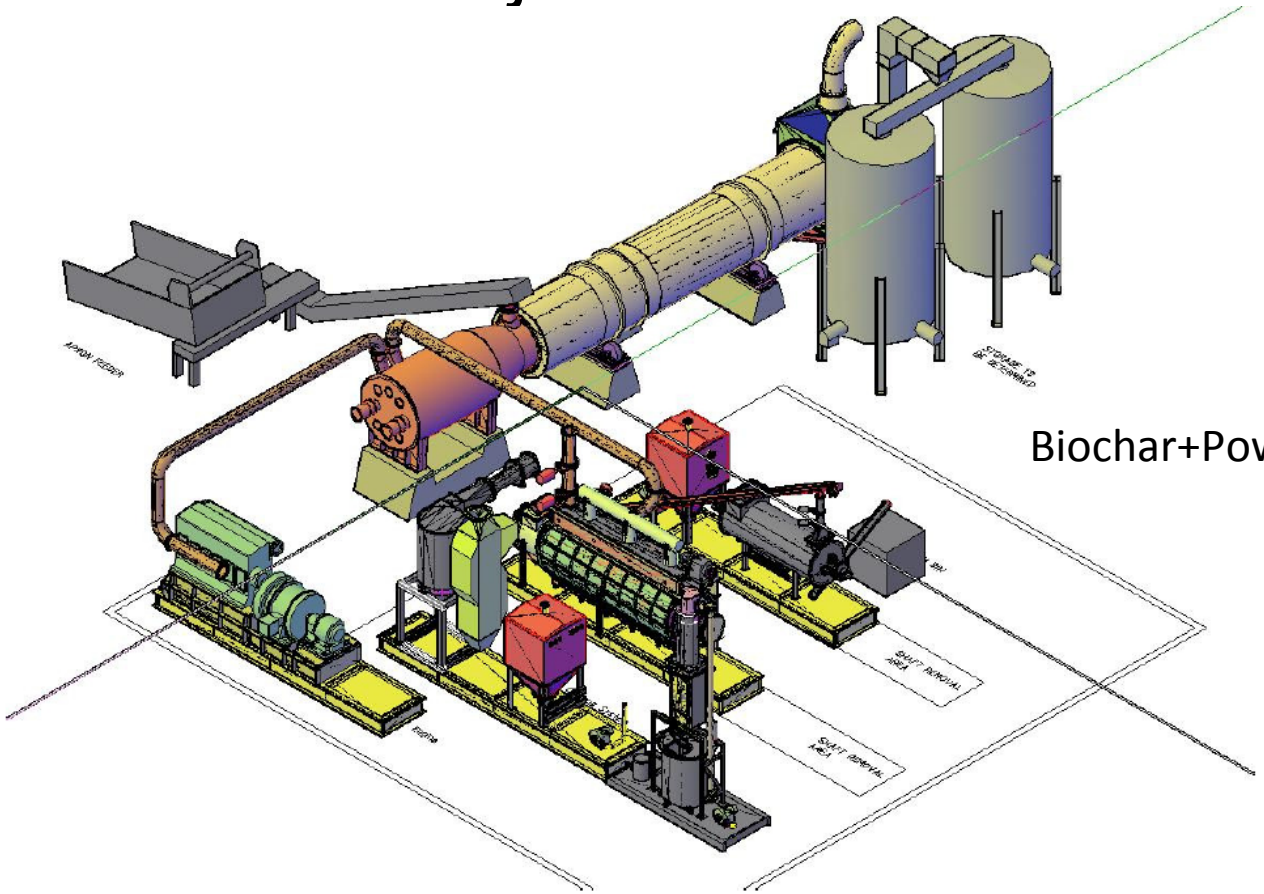




20,000 Btuh and 700,000 Btuh Prototypes
Up to 350,000 Btuh and 50 lb/hr biochar

J. Whitfield, Heating the Northeast 2011

Pyrolysis Enables Commercial Greenwaste Project in Australia



Biochar+Power

PacPyro has been offered $4.5 million dollars by the Victorian State Government to assist in building a project for the conversion of waste organics to renewable energy and biochar.

pacificpyrolysis.com 2011

PACIFIC PYROLYSIS

Pyrolysis and Gasification Power Stirling Engines for Small Scale Combined heat and Biochar

All Heat and 60% of Power and biochar to Danish Organic Farm

Engine and Combustion Chamber

Gasifier

Combined heat and power modules with an output of 35-140 kWe power and 140-560 kWth heat.

www.blackcarbon.dk

www.stirling.dk

200 Hr Test All Power Labs 10 kWe Power Pallet Genset

Engines and Energy Conversion Laboratory, Colorado State University, April 2011

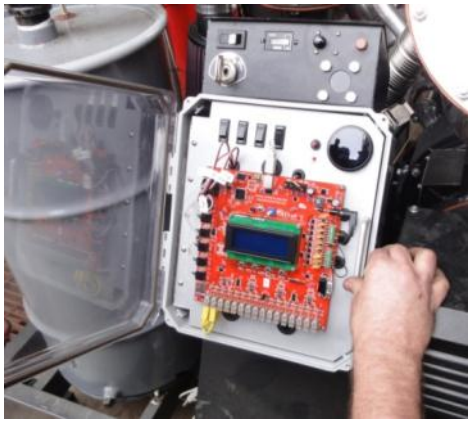
www.eecl.colostate.edu

Hopper-Dryer-Gasifier-Char

Engine Exhaust Pyrolyzes Chips

Chipped Fuel

Filter-Engine Intake



Computer Control

www.gekgasifier.com

40 kWe CHP Development Gasifier Heats California Greenhouse Biochar Used as Growing Media

www.fluidynenz.250x.com

ORC Systems Recover Small Scale Combined Heat and Power 1000 kWe Turboden (Viessman, GER)

www.viessmann.de/de/Industrie-Gewerbe/Produkte/Holzfeuerungsanlagen.html

Market development in this field can be maintained through:

- Fiscal incentives: Renewable Portfolio Standards or Thermal RPS; Carbon offsets.
- Feasibility Studies to create awareness
- Design studies to identify real opportunities
- Develop public projects for demonstration and to offset risk
- Develop private projects to realize benefits.

We have many options. Let's use them!

www.info.bioenergylists.org

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Design and development of energy and environmental processes

Industries

- **Biomass energy**
- **Pollution control**
- **Materials handling**
- **Feed, Food and Fuels**

Q & A

Ask questions using the **Questions Panel** on the right side of your screen.

All questions and comments will be recorded and incorporated in the webinar summary report.

Also, please take a few moments to answer the survey questions after the conclusion of the webcast.

Other Resources

- Interviews with key industry leaders (10+, also on iTunes Podcasts)

BTEC B-TALK

- Factsheets (biomass background, job data, technology, etc.)
- Presentation (comprehensive program information)

All Resources are available here: biomassthermal.org/resources

Upcoming Webinars

Last Webinar:

Biomass Thermal Markets – Outlook 2012-2015

- December 20, 2011

Featuring:

- Jeffrey Eppink, President, Enegis, Inc.
- William Perritt, Executive Editor, RISI Inc.

Attendees of today's webinar will receive timely notification of our final webinar.

Upcoming Events

- **Northeast Biomass Heating Expo** – March 21 - 23, 2012 in Saratoga Springs, New York
  - Come see what Biomass Heat can do for your customers, your clients, and your community!
  - Increased space for exhibitors, registration open.
  - More information is available at: www.nebiomassheat.com

Upcoming Events

- **Heating the Midwest with Renewable Biomass Conference and Expo** – April 25-27, 2012 in Eau Claire, WI
  - Join us for this inaugural event!
  - More information is available at: www.heatingthemidwest.org

More Information

- **This Webinar will be available** by Friday, Dec. 16.
- **Sign up** to receive BTEC news at on our website.
- **Join BTEC for:**

  -- Frequent and timely regulatory, policy and market intelligence updates

  -- Business Development opportunities and networking with other biomass leaders

  -- Visibility as a supporter of the market's growth

  -- Discounts to nearly all major biomass industry events in the U.S.

For more info or to join, go to: www.biomassthermal.org/membership

Thank you!

If you want to learn more about the biomass thermal industry, BTEC, or membership, visit www.biomassthermal.org