Small-scale Wood Biomass Gasification

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Alaska Wood Energy Conference
November 14-15
Fairbanks, Alaska

Gasification CHP Systems

• Origins: engines in WWII
• Adapted to Stationary Power in 1970's
• Publically funded demonstration projects- many attempts, few successes
• Research Development and Demonstration Programs Stimulate New Interest: Small Modular Biopower Program
  – US Department of Energy
  – US Forest Service

www.vedbil.se
What is Gasification?

- Conversion of solid (biomass) to a combustible gas
- Add air/oxygen to
  - burn part of fuel to provide heat to
  - pyrolyze wood to gas and charcoal
  - gasify charcoal.
- Make smoke
- Burn up the smoke in an engine

Small Commercial Wood Gasifiers

- **Community/Industry**
  - Nexterra, Canada 500 kWe-10 MWe
  - Condens Oy Finland, 1-3 MWe,
- **Sawmill Industry/Small Community**
  - Biomass Engineering Ltd., UK 250 kWe
  - Ankur Scientific, India 4 kWe-425 kWe
  - Aruna, India 10-100 kWe
  - Fluidyne, NZ, 10-35, 100, 500 kWe
  - Ngen Eco5 5 kW wood pellet gasifier
Nexterra, Canada

Nexterra Gasifiers and Boiler at Hefley Plywood, Tolko, BC
1. Wood Fuel Bin
2. Gasification Hearth
3. Ash removal
4. Gas exit

Condens Oy Novel Power Plant
Kokemaki, Finland

condens.fi
Biomass Engineering Ltd
Gasification Systems

Module design

- 250kwe gasifier and filter module leaving the factory
- Module design enables flexible site layout and ease of installation for multi unit sites
- Units cold tested at the factory
FUEL SIZING AND DRYING IS REQUIRED FOR DOWNDRAFT GASIFIERS

Supplied with Laimet chipper.
www.laimet.net/eng/chippers.html

ANKUR SCIENTIFIC ENERGY TECHNOLOGIES, PTY LTD.
200 KWe GASIFIER WITH GAS FILTERS, FLARE AND COOLER.

Energy and Environmental Research Center, University North Dakota
www.undeerc.org/centersofexcellence/biomass
EERC Gasification Development and Demonstration for BERC/USFS/Mt. Wachusett Community College

- Operational Tests
- Environmental Tests
WOOD CUBES IN COMBUSTION ZONE OF GASIFIER AS SEEN THROUGH AIR NOZZLE

GAS IS COOLED AND CLEANED WITH A WET VENTURI SCRUBBER AND DRY FILTERS
ANKUR SCIENTIFIC ENERGY TECHNOLOGIES LTD
www.ankurscientific.com

4 kW Ankur Gasifier in Rural Cambodia

ARUNA Electrical Works (P) Ltd. Tamilnadu, India
10-100 kWe
www.arunabiomass.com

50% Cost Savings with subsidy
FLUIDYNE (NZ) Gasifiers
www.fluidynenz.250x.com

Wood Block Fuel
10 kW Pioneer Class
35 kW Pacific Class
100 kW Atlantic Class
Innovation Technologies/Fluidyne
www.innovation-tech.co.uk

WOOD PELLET GASIFIERS 5 kW

Ngen Eco5 5 kW Pellet Gasifier,
Colorado  www.ngenpower.com

Fludyne (NZ) Micro Class
Gasifier
Gas out 12 m3/h ~ 3-5 kW
www.fluidynenz.250x.com

Eleca 10+ kW pellet gasifier
France  www.eleceau.com

Community Power Corporation
Pre-commercial 5 kW for USFS
Small Modular Biopower Program
www.gocpc.com
Demonstration and Pre-commercial Gasifiers

- Pudhas Energy/Connecticut Clean Energy Fund
  - Tallon Lumber, CT 300 kWe
- Community Power Corporation
  - Mt. Wachusett Community College, MA 50 kWe
  - Shasta Opportunity Center, CA 25 kWe

Tallon Lumber 300 kWe CHP

- Chipper at Sawmill
- Dryer and Fuel Bin
- Pudhas Energy Gasifier
- Schmitt Enertec 300 kWe CHP+kilns

www.puhdasenergia.com
Auxiliary Systems and Equipment
Fuel Dryer
Diesel tank
Radiator
Hot Water System and Kiln
Transformer, Switchgear
Building, Services

Community Power Corporation
50 kWe Gasifier-Generator

Baghouse-Gasifier-Chip Screen-Dryer
Engine-Generator
50 kWe CPC Gasifier at Mount Wachusett Community College, Gardner, MA, February 2007

Mount Wachusett Community College
http://www.mwcc.mass.edu/renewable

Wood Fuel Delivery to MWCC Boiler House

50 kW Engine-Generator
Gas to Flare - Gas Inlet - Exhaust
Piloted Flare for Gasifier

FACILITIES DIRECTOR ROB RIZZO AT 50 kW ENGINE-GENERATOR OUTSIDE BOILER HOUSE
WOOD CHIPS ARE RECLAIMED FROM WOOD BIN AND CONVEYED TO BOILER

MESSERSMITH CHIP RECLAIMER
FUEL CHIPS FROM COMMERCIAL SUPPLIER

CHIPS DELIVERED TO BOILER METER BIN
8,000 PPH MESSERSMITH BOILER AT LEFT
BOILER METER BIN WITH AUGER TO DELIVER CHIPS TO GASIFIER

CHIPS AUGERED THROUGH WALL TO GASIFIER CHIP SCREEN
CHIPS DISCHARGE TO VIBRATING SCREEN ACCEPTS DISCHARGED TO MOVING BELT DRYER

SCREEN DISCHARGE TO DRYER, OVERSIZE, MOVING BELT DRYER

HEAT FROM GAS COOLER USED TO DRY CHIPS
OVERSIZED CHIPS REMOVED BY SCREEN

MOVING BELT DRYER
DISCHARGE FROM DRYER TO HOPPER

AUGER ELEVATES CHIPS TO GASIFIER
CHIPS DROP INTO GASIFIER
HOOD EXHAUSTS TOXIC GAS FROM GASIFIER THOUGH POWERED ROOF VENT

SOLID WOOD CHIPS CONVERT TO GAS AS THEY FLOW DOWN THROUGH VERTICAL REACTOR AT RIGHT

HOT GAS EXITS TO BOTTOM LEFT COOLED IN HEAT EXCHANGER
ASH DISCHARGED AT BOTTOM RIGHT
MOTOR CONTROLS (ABOVE)
HOT GAS COOLER (BELOW)

HEAT FROM GAS COOLER PIPED TO CHIP DRYER
COOLED GAS CLEANED IN FILTER

TO ENGINE

FABRIC FILTERS
CHAR FROM FILTER REMOVED TO DRUM FOR DISPOSAL

CLEAN GAS BURNED ON ENGINE TO DRIVE 50 KW GENERATOR
ENGINE EXHAUST AND ENGINE JACKET COOLING WATER HEAT CAMPUS WATER

WATER BY WASTE HEAT FROM ENGINE JOINS CAMPUS HEATING LOOP FROM WOOD BOILER
FIRE SUPPRESSION SYSTEM AND BIOMAX50 CONTROL COMPUTER
CPC Biomax 25
Siskiyou Opportunity Center, Mt. Shasta, CA
March 31, 2007

Fuel: Peeler Cores from veneer plant

Bandit Model 95 chipper
Dryer, Gasifier, 25 kWe Genset

Fuel Dryer Open Vent to Building
Heat inlet, vibratory screen outlet

Chip screen and gasifier feed auger
Gasifier Feed Auger

Gasifier, heat exchanger and filter enclosure
Engine bypass and intake

Engine exhaust and gas flare
Is Gasification Suitable for Rural Alaska?

1. Cost (if you have to ask, you can’t afford one)
2. Operation and Maintenance
3. Repair
4. Cold climate
5. Remote area
6. Potential savings?
Challenges for Small Scale Wood Gasifiers

- High Cost $5,000-$10,000/kW
  - 50 kW $500,000-$1,000,000
  - 300 kW $1.5-$2 million
- Fuel Size
  - Chunks, dense fuel
- Similar in efficiency to small scale steam engine: 3 lb dry wood/kWh
- Better efficiency than Organic Rankine Cycle at 6 lb dry wood/kWh.
- High Labor Cost
- Automation needed
- Must Demonstrate Reliability for 5,000 hrs/year

Short Term Prospects

- Gasification for Development, Demonstration or Education – Research Centers, Sites with Suitable Support
- Direct heat substitution for high cost liquid and gaseous fuels.
- Use with other energy conversion – Stirling engines and ORC.
Acknowledgements

- Fluidyne Ltd. [www.fluidynenz.250x.com](http://www.fluidynenz.250x.com) – Doug Williams
- Biomass Energy Foundation [www.woodgas.com](http://www.woodgas.com) – Tom Reed – Agua Das
- Gasification Discussion List [Gasifiers.bioenergylists.org](http://Gasifiers.bioenergylists.org)
- Renewable Energy Policy Project [www.repp.org](http://www.repp.org)