Preventing Green House Gas Emissions through Biomass Substitution

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Like wind and solar, anytime biomass is used to produce energy that otherwise would have been produced by fossil fuels we have done a good thing.

CO_2 CH_4 SO_x Hg NO_x

Types of Biomass

- **Harvest only – typical forest**
- **Plant/farm – hybrid poplars**
- **Crops -miscanthus, sugarcane switchgrass, hemp, corn,**
- **Municipal solid waste -**

And the fossil fuel needs

Fuel to harvest and transport

+ Fuel to prepare site and plant

+ Fuel to fertilize and cultivate;
Corn ethanol -> distill

+ Costs to separate, need better boiler
- Save from landfill

Woody Biomass Energy

Can help reduce dependence on foreign oil

Help provide outlet for thinnings from hazardous fuel treatments

Reduce cost for hazardous fuel treatments

Can be cost effective alternative

Electricity generally costs eight to ten times more per unit of energy than wood chips; oil and natural gas cost roughly two to two and one-half times as much as wood chips

Fuel Calculator

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Biomass Power

Combined heat and power plant in St Paul, MN

25MW of power

District heating and cooling to downtown

Fuel is urban wood waste less than 25 miles

MN has two more 25MW plants (2007) Mandate = 125MW

Biomass Power

Combined heat and power

5KW of electrical power
Heat for space and water

That's 1/5000 the size of St Paul

Today, the average house uses less than 1kw (average)

Woody Biomass Energy

When it comes to making electricity,
What size is right for you?

ElectricalPower.xls

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Grinders, Chippers

Initial cost vs. maintenance

Size and production

Advantages and disadvantages…..

Roll-Off Containers-

Whole tree processing at landing

Minimizes handling costs

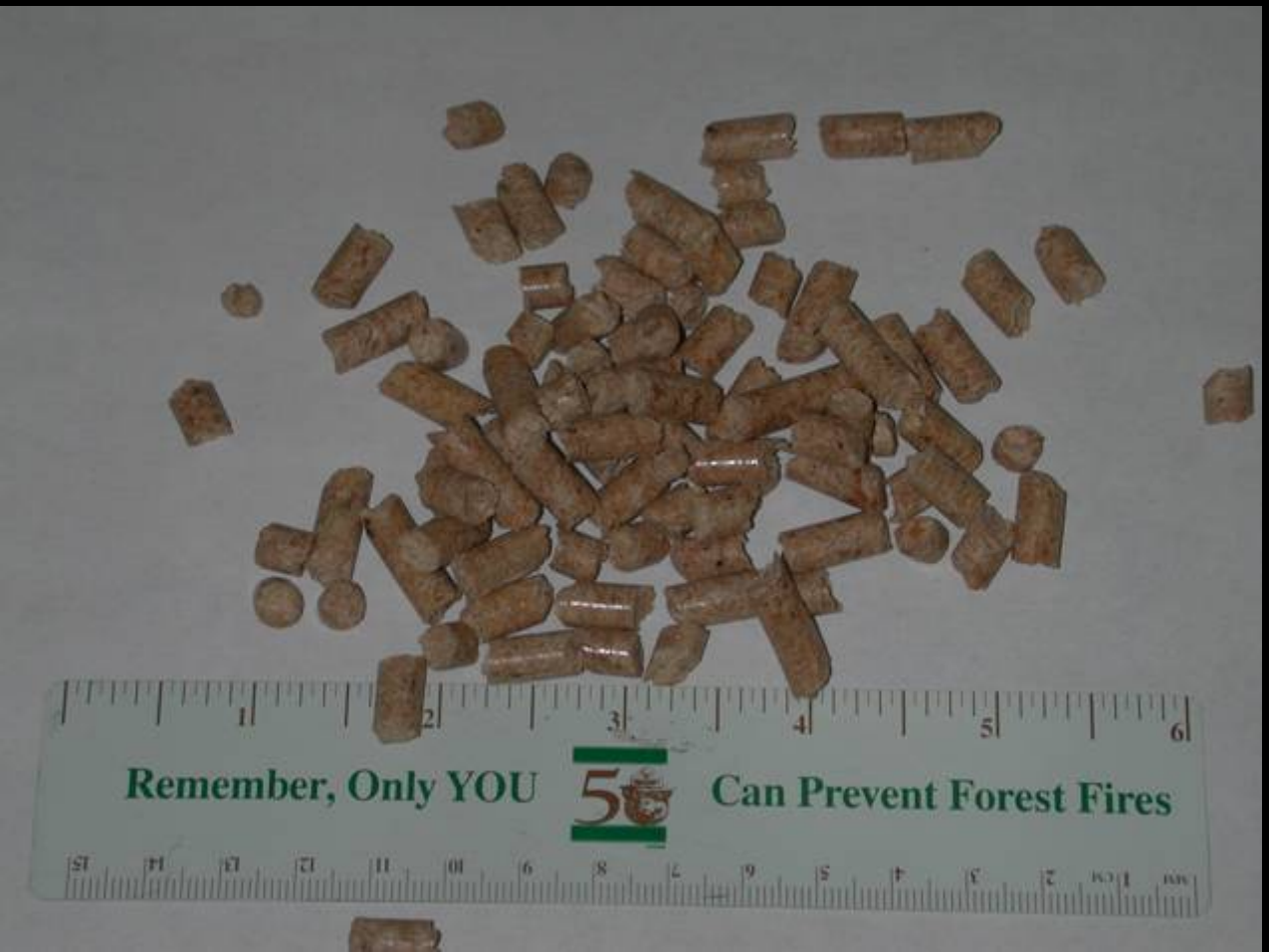
Less Move-in cost for grinder

movie

f g

Wood Pellets

If transportation is more than 30-60 miles it can be cost effective to go through the expense of making pellets!



- **Sawdust**
- **Large export market**
- **Shortage**
- **Hit 1 million tons production**
- **Bagged or bulk**
- **Pellet furnaces**

	1 TPH	2.5 TPH	4 TPH
Hammermill & Feeder	$40,644 (30 hp)	$43,114 (75 hp)	$56,007 (150 hp)
Air assist discharge system	$20,373	$21,480	$23,804
Pellet Mill, Conditioner, Feeder	$119,613 (100 hp)	$178,570 (250 hp)	$277,519 (400hp)
Cooler, Air system	$45,949	$45,949	$45,949
Rotex Screener	$7,831	$9,554	$13,999
TOTAL	$234,410	$298,667	$441,082
Electrical cost (max)	$9.70	$24.25	$41.00

2.5T x 24 hr x 7 day
x 50 weeks x $150
= $3 million
- $200,000 electrical

(Free dry wood)

Production Cost per Ton (15-18 Jobs at the Plant, plus in-woods)

Expense Category	*Total $*	*$/ton*
Payroll	$638,550	$30.37
Feedstock cost	$540,317	$25.70
Packaging	$510,924	$24.30
Utilities	$325,645	$15.49
Debt repayment	$212,178	$10.09
Front-end loader operation	$109,601	$5.21
Advertising and sales	$77,100	$3.67
Dyes and rollers	$41,120	$1.96
Dryer fuel	$25,052	$1.19
Repairs and maintenance	$10,280	$0.49
Insurance	$2,570	$0.12
Legal	$2,570	$0.12
Total	$2,495,907	$118.72

Source: McNeil Technologies

Pellet Systems

170 k btu system

- Fuel more costly
- Storage smaller, cheaper
- Boiler smaller, cheaper

Pellet stoves, efficient, automatic
Easier to burn clean because dry and controlled feed

Some Problems Now

Cold jacket & Low load = smolder

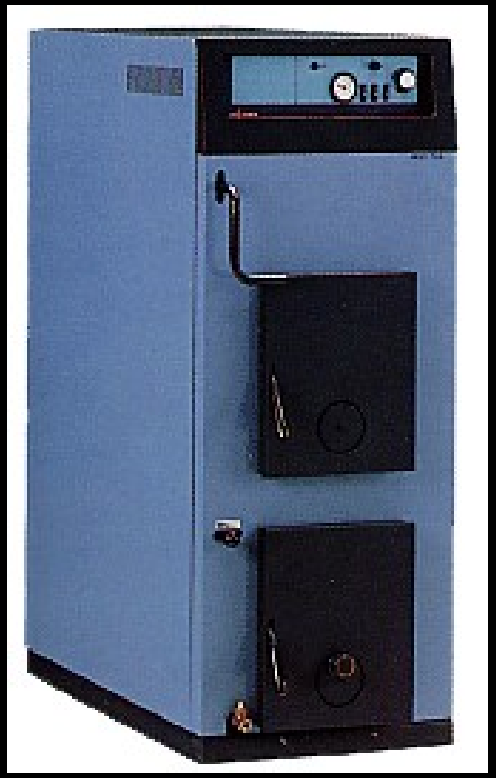
Incomplete Combustion
= Inefficient & Polluting

New designs = better

Two efficient wood boilers

Tarm

100,000-200,000 BTU/hr



Garn

350,000 - 950,000 BTU/hr

Called gasification units although the time as a gas is very short

Fire at optimal intensity and heat up to 2000 gallons of water & then burn out, never smolder.

Useable Energy Forms

- Electricity
- Heat (steam, exhaust gas, hot water)
- Cooling (air-conditioning)
- Producer (wood) gas (crop drying, duel-fuel)
- Bio-fuels
  - Bio-ethanol
  - Bio-oil
  - Bio-methanol
  - Bio-diesel...

} Partial breakdown of wood

Soybeans, rapeseed, algae…

- Syn-fuels …. Breakdown to H_2 and CO and rebuild

Liquid fuels

Biological

Partially break down the wood with enzymes and microorganisms to a level similar to corn and then use the corn process to make ethanol.

Disadvantage is transportation

Pyrolysis

Partially break down the wood with heat. Try to stop at a usable oil. Make sort of a crude oil that with additives can be used as fuel oil or added to a refinery.

Primary advantage is transportation

Gasification

Completely break down the wood with heat to CO and H_2

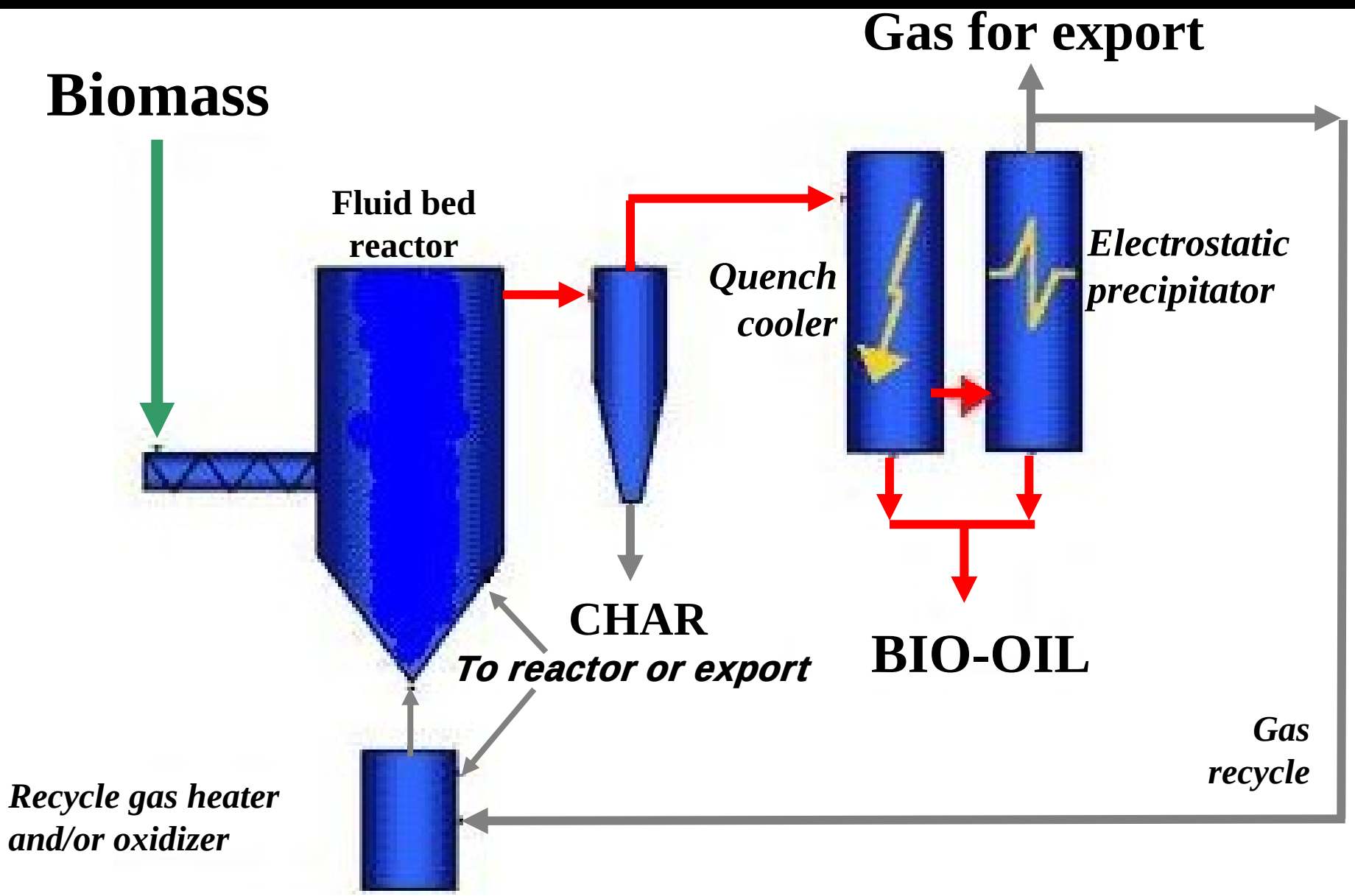
Then rebuild to make many types of liquid fuels

Probably the future of renewable liquid fuels.

Ethanol - Fermentation

- Mostly made from corn
- Current yield 65 gallons/bone dry ton
- Steps include:
  - Pretreatment of chips
  - Enyzmatic treatment
  - Fermentation
  - Distillation
- Yield to 80% with enzymes for 5-carbon sugars

Bio Oil


Gas for export
Biomass
Fluid bed
reactor
Quench
cooler
Electrostatic
precipitator
CHAR
To reactor or export
BIO-OIL
Gas
recycle
Recycle gas heater
and/or oxidizer

Liquid Fuel - Thermochemical

- Thermal treatment to produce a synthesis gas (mostly H_2 and CO)
- Fischer-Tropsch reaction with catalyst (also a fermentation process)
- Convert low BTU gas into methanol, diesel, gasoline, etc
- Pilot plant stage in US

Flambeau River Bioenergy

Park falls WI

20 million gallons of cellulosic ethanol per year

Low hanging fruit, just using the free sugars of spent pulping liquor

Now trying to make Jet A fuel (gasification and Fischer-Tropsch)

Public Policy is Creating More Biomass

- Thin the Forests!
  - NFP,
  - HFI,
  - HFRA,
  - TFPA
  - DOE, USDA, USDI
  - Energy bill

What do we do with the biomass?

- » Burn It — smoke?
- » Chip It — paper?
- » Leave It — methane?
- » Use It — Best

Disposal Problem

We have a lot of Forest biomass

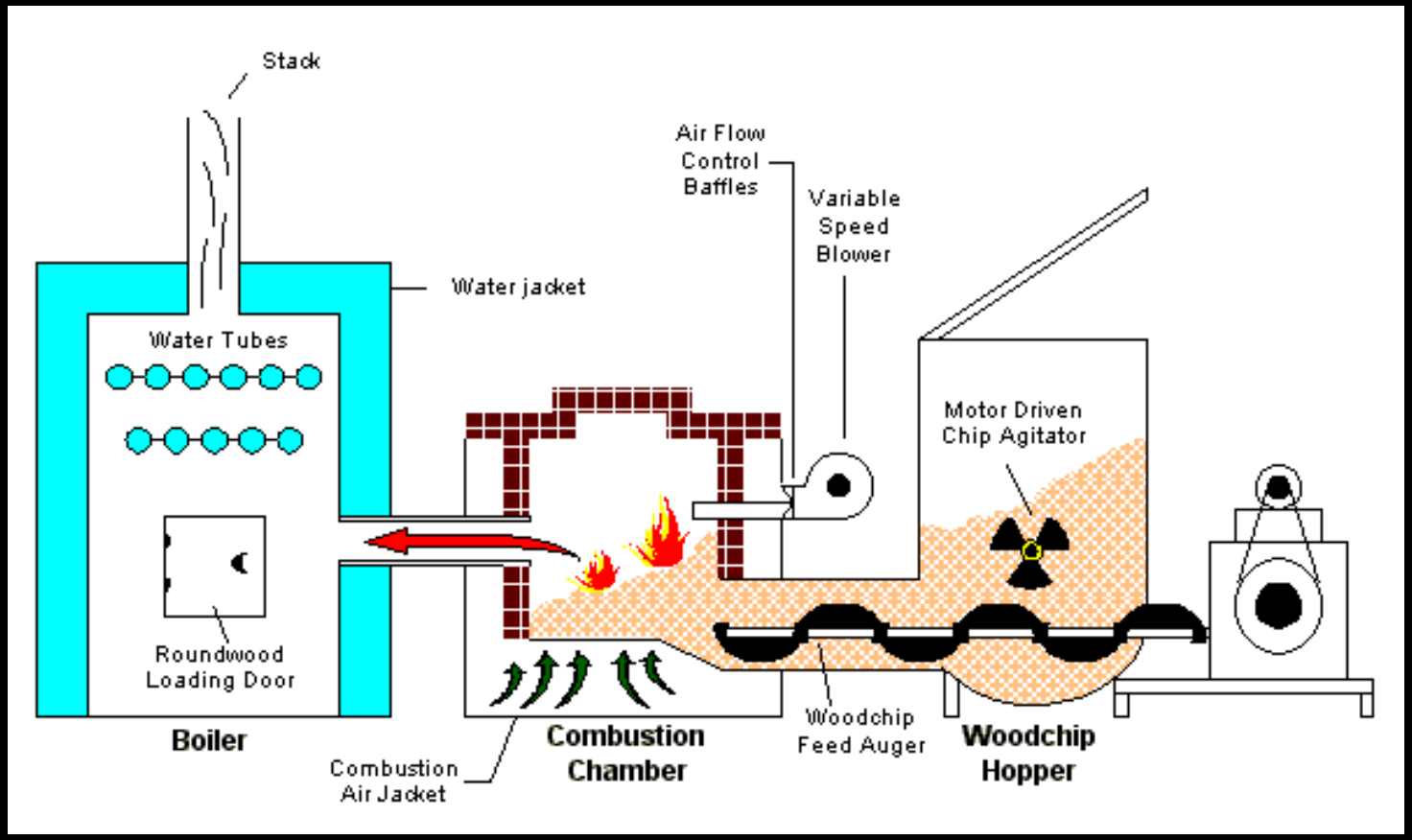
Problem or Opportunity?

- **USDA-DOE Billion Ton Report**
  - **368 mill dry tons of forest biomass**
  - **998 mill dry tons of ag biomass**
  - **Equivalent of >30% of USA oil use**

Why “Use It”?

- Reduce smoke from disposal burning
  - Human/Enviro Health – SO_X, NO_X, GHG
  - Airshed Aesthetics – “Smokey Air”
  - Airshed space for Prescribed Burns
- Reduce cost to treat land
- Save on heat & power bills
- Energy independence - Renewable
- Engage communities in solutions
  - » Create jobs
  - » Small business opportunities

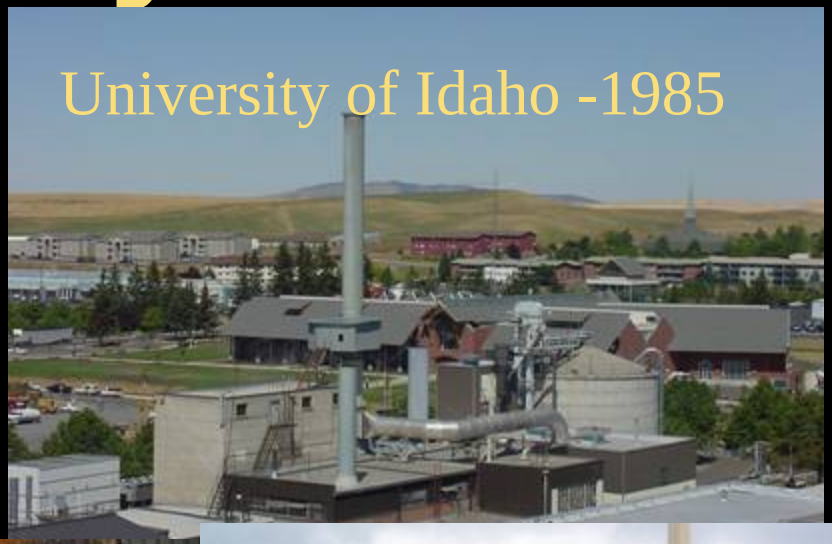
Small Commercial Bioenergy System



School Heating System

Hot and not O_2 starved

Existing Systems



Darby, MT

Wood Products

Industry

Heating With Wood:

Three Options:

- Fully automated – large facilities
- Surge Bin – small facilities
- Pellet systems

Combined Heat and Power

Thompson Falls

Surge - bin System (2-5 days)

Smaller, Simpler, Cheaper

Large Facility

Darby, MT

Darby school 3rd year

Source	Tons	Price	Cost
Soil Tech, Inc. (original chip stockpile contractor. Usage terminated due to composting of stockpile and other problems.)	274	$24.00	$6,576
Hayes Creek donation ($10 cost due to requiring contractor to chip slash rather than grind, as original agreement called for.)	192	$10.00	$1,920
Bass siding DF/L tops (Thomas)	56	$41.00	$2,296
Porterbilt Post and Pole (combined cost of material, hauling, and some chipping.)	103	$29.16	$3,003
Pine Products, Inc. (mostly clean DF/LPP chips)	135	$32.41	$4,375
TOTALS	**760**	**23.91**	**$18,171**

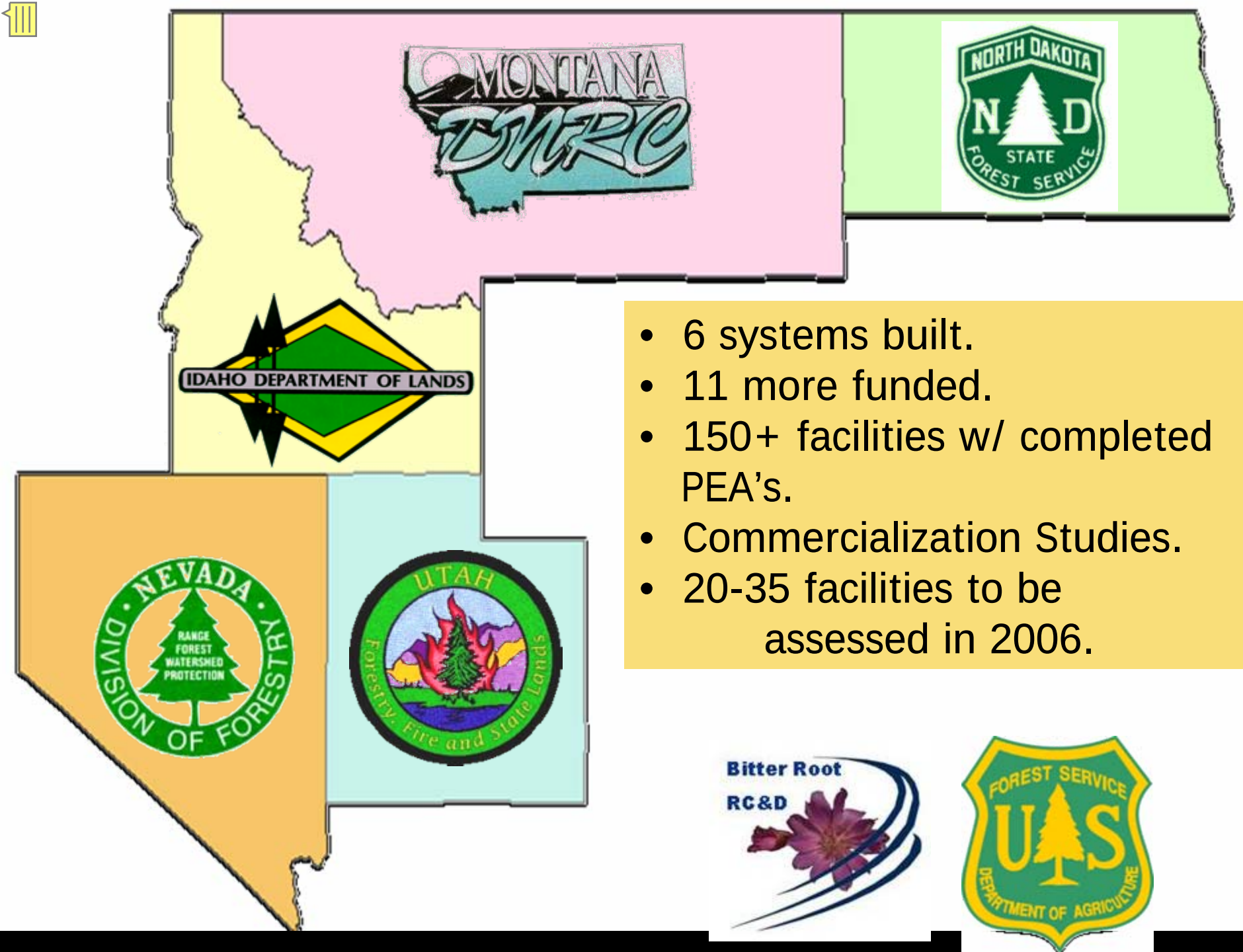
Darby school 3rd year

Cost of wood chips (760 tons)	$18,170.00
Cost of operating boiler and participating in fuels study (approximately $9.00 per ton of fuel used)	$4,700.00
Supplemental fuel oil	$1,935.00
2005/6 Cost	**$24,805.00**

Comparison of projected cost had the school heated with fuel oil: Historic usage cost of fuel oil (50,000 gal @ $2.30/gal, avg. cost winter 2005/6	$115,000.00
Estimated 2005-2006 cost savings	**$90,195.00**

Complex, 3 buildings, retrofit…$900k installation = 10 yr payback

New construction – boiler 300k, building 130k, fees 40k, gas backup 60k



- 6 systems built.
- 11 more funded.
- 150+ facilities w/ completed PEA's.
- Commercialization Studies.
- 20-35 facilities to be assessed in 2006.

Bitter Root RC&D

FOREST SERVICE
US
DEPARTMENT OF AGRICULTURE

Financing

- Grants
  - Federal, State, Foundations
- USDA Rural Development
  - Rural Economic Development Loans and Grants (REDLG)
  - Community Facilities
  - Rural Business Enterprise Grants (RBEG)
- Carbon Trading
- Municipal Leases
- Fuel SAVINGS

Project Viability Factors

- Community Enthusiasm and Support
- Proximity to Biomass Fuel
- Processing and Delivery Infrastructure
- Fuel type/volume, Use Profile, and Unit Costs
- Site Access and space
- Existing System Age, Condition, Adequacy
- Construction and Integration Costs
- Air Quality Permitting

Expansion Beyond Schools

10% of nations needs or
30% of transportation fuels

Commercialization

- MT Assessment
  - State boiler data base - >7300
  - Age, size, fuel type
  - Distance to forests
  - 3100 in the .5-5 mill BTU
- Economic analysis
  - 2,567 boilers < 15 yr payback
  - 367 > 30 yr old
- Available at www.fuelsforschools.org

Growth Potential

- Many small bites vs. a few large bites i.e. school vs. pulp mill
- UT – >14,000 boilers 0 pulp mills
- N. Dakota – over 6,000 boilers
- College campus, prison or hospital
- Need an “Anchor Tenant”
- UI = 42,000 tons Darby=750 tons

Fuel Supply Considerations

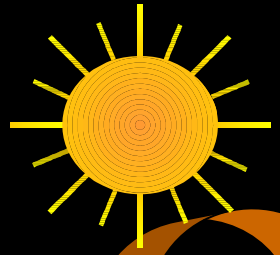
- Sources
- Processing, Delivery and Storage
  - Clustering
- Fuel Quality
  - Moisture Management
  - Ash – clinkers management
- Chips vs. pellets

Sources of Fuel

- Slash from forest management
- Local landfill?
- Residues from manufacturers
  - Post and Pole
  - Sawmills
  - House logs
  - Secondary manufacturers
- Power line clearing

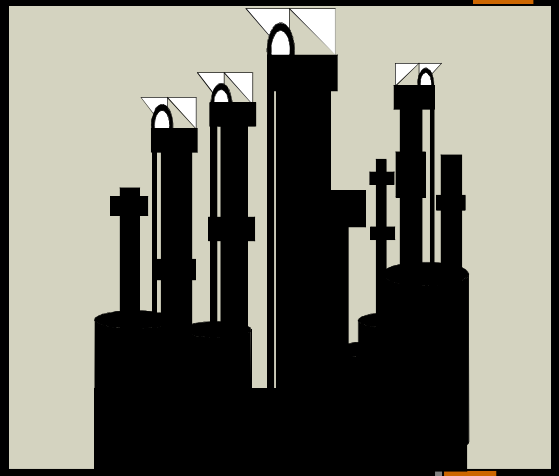
Where can I get more Info

- www.fuelsforschools.org links to:
  - Manufacturers - consultants;
  - Biomass Energy Resource Center – BERC's publication:
    Wood-Chip Heating Systems
- Monitoring reports
- Pre-Assessment form



66×10^6 MT CO_2

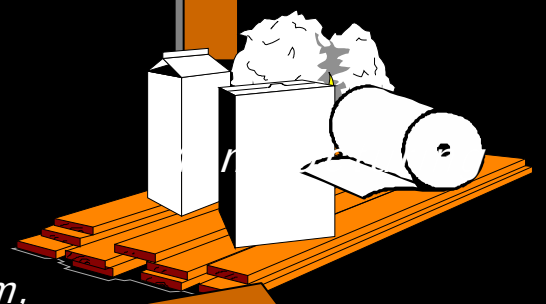
O_2



Syngas

Power Export
$3.8 Billion
or
Liquid Fuels/Chemicals
$5.5. Billion

Black Liquor
& Residuals



Steam, Power & Chemicals

➥Extract Hemicelluloses
➥New Products
Chemicals Polymers
$3.3 Billion

➥BL Gasifier
➥Wood Residual Gasifier
➥Combined Cycle System
➥Process to Manufacture
Liquid Fuels and Chemicals

➥Pulp
$5.5 Billion

The Forest Biorefinery

Net Revenue Assumptions:

Acetic Acid - $1.73/gallon	Purchased Electricity - $43.16/MWH
Ethanol - $1.15/gallon	Exported Electricity - $40.44/MWH
Pulp - $100/ton net profit	Renewable Fisher Tropsch Fuel - $57/bbl

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