Biomass Design & Potential

Mark Froling

President

FROLING ENERGY

BIOMASS BOILERS • SERVICE • FUEL

Office & PDC Production Facility:

590 Hancock Road, Peterborough, NH

Biomass Design & Potential

This course covers:
The considerations one should make
when designing and planning
an automated biomass heating system

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A Self-Performing Contractor

What We Do:

- **Biomass Boiler System Installations**

  with Integration into Existing Boiler Systems

- **Complete Project Management**
- **Biomass Boiler Servicing & Maintenance**
- **Manufacture & Delivery of PDCs**

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Our Experience:

145 Biomass Boilers Installed

Fuel: Mostly wood pellet & dry wood chip

at over 100 Customer Sites

Plus Cleaning, Maintenance & Repairs

PART 1:

Biomass Fuel Choices:

- ***Wood Pellets***
- ***PDCs***
- ***Green Wood Chips***

3 BIOMASS FUELS TO CONSIDER

DEPENDING ON FUEL CONSUMPTION AT YOUR BUILDING!

PELLETS — **3000 to 30,000 gallons of oil**

PDCs — **20,000 to 70,000 gallons of oil**
(Precision Dry Wood Chips)

GREEN CHIPS — **40,000 gallons of oil to Huge**

Wood Pellets

7% moisture content

Precisely controlled small size

Flows like water—easy to store & move

Compact BTU storage (by weight & volume)

PDCs

"Precision Dry Wood Chips"

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25% moisture content

Screened: Nothing bigger than a matchbook

Stacks—does not flow. 90% hardwood

PDCs: A Value Added Product

PDCs

- 25% Moisture Content
- Made from bole wood (the main trunk of a tree)
- Wood quality is similar to wood pellets (Bole wood)
- Screened to eliminate sticks, oversized chunks, rocks and “Tramp metal”
- Able to be blown into a bin through a 5” pipe as long as 150 feet
- Produced with quality control standards
- Does not require a large pit-type bin with roof, garage doors, live floor, etc…

Green Wood Chips

35% to 50% moisture content (varies by season)

Many Variables: Size, hard/soft wood, % bark

Price is determined by Quality

GREEN CHIPS

Wood Chips—In General

The more selectively produced = More expensive

- Whole Tree Chips
- Hardwood / Softwood
- Bole Wood—Main tree trunk with bark

Comparing PDCs and Green Chips

PDCs

GREEN CHIPS

- **Green Chips are more readily available**
- **Green Chips cost less**
- **Green chips require larger initial investments due to larger infrastructure requirements:**
  - Chip delivery & storage systems are bigger and more costly
  - Fuel material handling systems are more robust/costly
  - Green Chip systems usually employ single large boilers
  - The Larger the Load: the more Green Chips make sense!

- **Boilers over 2 million BTU/hr output are regulated in NH and must prove compliance with technical standards**
  - PDC boilers are usually less than 2 Million BTU/hr

- **Green Chips can compost, generating heat or get moldy**
  - Must be managed—bins emptied in summer

3 BIOMASS FUELS TO CONSIDER

Volume per Ton

PELLETS

50 cubic feet per Ton

(Delivery: Blown into silo)

PDCs

133 cubic feet per Ton

(Delivery: Blown into bin)

GREEN CHIPS

83 cubic feet per Ton

(Delivery: Dumped into bin)

Calculations use HHV energy content of hardwood burned at 84% Efficiency

3 BIOMASS FUELS TO CONSIDER

Net (burned) Heat Content of Fuel

PELLETS

120.5 Gal Oil per Ton

13.370 Million BTU per Ton

PDCs

93.5 Gal Oil per Ton

10.392 Million BTU per Ton

GREEN CHIPS

66 Gal Oil per Ton

7.335 Million BTU per Ton

Calculations use HHV energy content of hardwood burned at 84% Efficiency

EXAMPLE:

To Offset 30,000 Gallons of Oil …

PELLETS

Need 249 Tons

Total Biomass Boiler Output: 1.3 Million BTU
Storage: 28 ton steel silo 9 fillings

PDCs

Need 321 Tons

Total Biomass Boiler Output: 1.3 Million BTU
Storage: 23 ton bin (Min) w/3100 cu ft
14 fillings using 15 ton truck

GREEN CHIPS

Need 486 Tons

Total Biomass Boiler Output: 1.75 Million BTU
Storage: 41 ton bin (Min) w/4000 cu ft
20 fillings using 25 ton truck

Calculations use HHV energy content of hardwood burned at 84% Efficiency

3 BIOMASS FUELS TO CONSIDER

Net Cost of Delivered Fuels……$ per Million BTU

Propane at $2.75/gal = $35.95

Oil at $3.00/gal = $27.02

Propane at $2.00/gal = 26.14

Oil at $2.50/gal = $22.52

Propane at $1.50/gal = $19.61

Oil at $2.00/gal = $18.02

PELLETS

…at $240/ton = $17.95

Oil at $1.50/gal = $13.59

Propane at $1.00/gal = $13.07

PDCs

…at $120/ton = $11.55

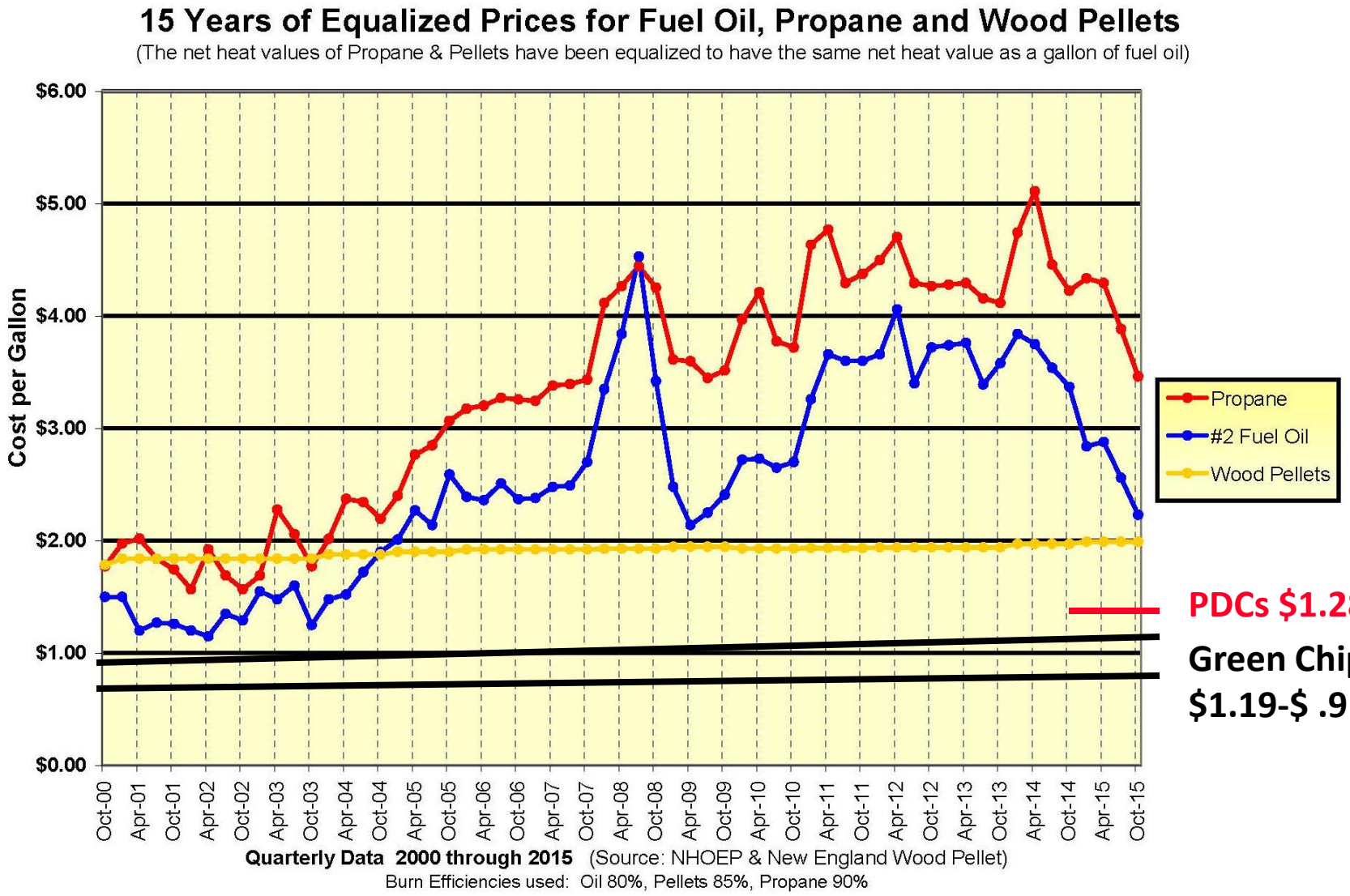
…at $75/ton = $10.22

GREEN CHIPS

Oil at $1.00/gal = $9.06

…at $60/ton = $8.18

HISTORICAL FUEL PRICES FOR OIL Propane or BIOMASS:



PDCs $1.28

Green Chips $1.19-$ .91

All prices noted in Net Oil Price Per Gallon Equivalents

3 BIOMASS FUELS TO CONSIDER

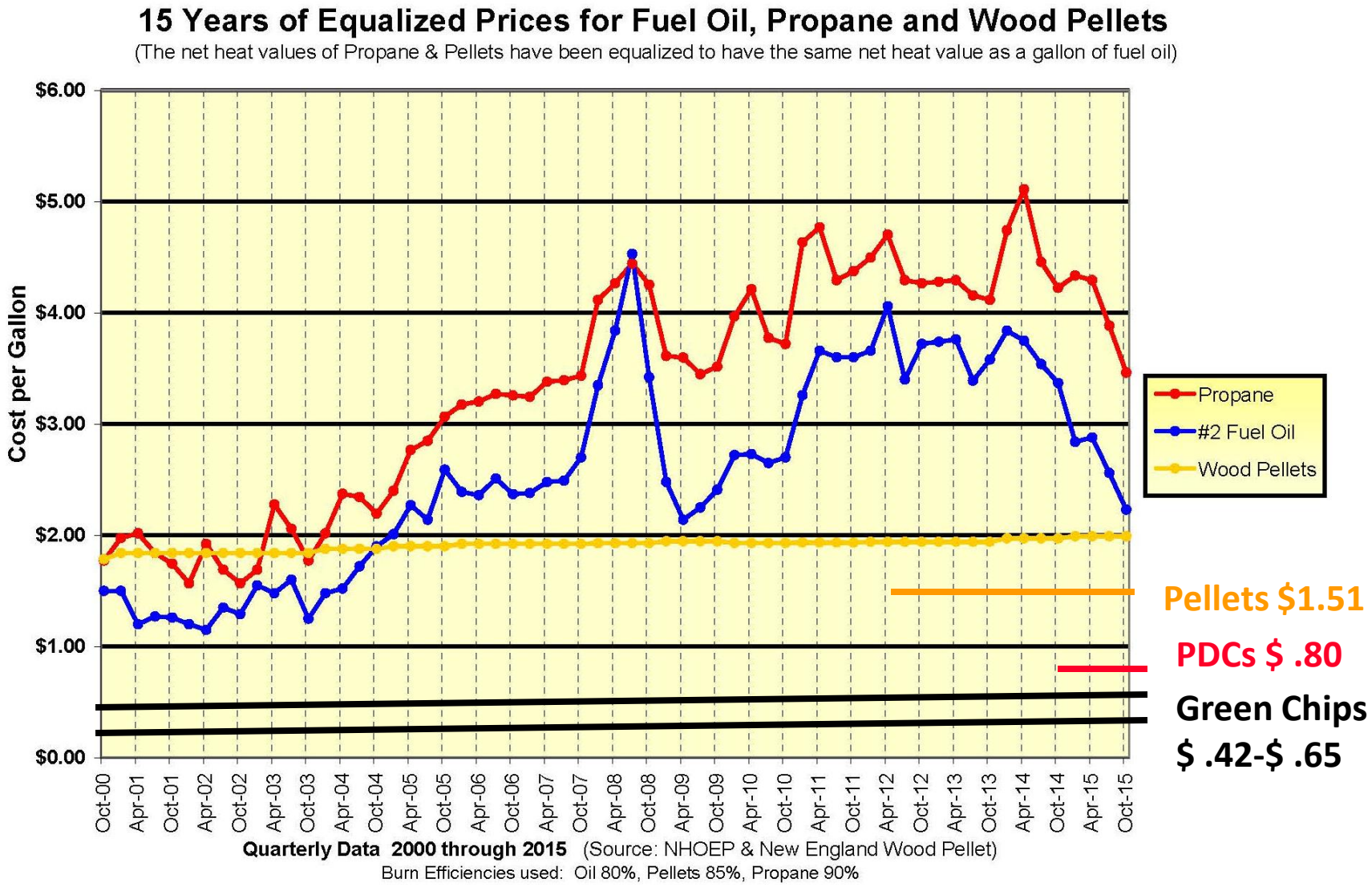
Fuel Cost in Oil Equivalent ***with THERMAL RECs***

PELLETS **Costs the same as $1.51/Gal Oil**

PDCs **Costs the same as $ .80/Gal Oil**

GREEN CHIPS **Costs the same as $ .42 to $ .65/Gal**

FUEL PRICES: BIOMASS With Thermal RECs!!



All prices noted in Net Oil Price Per Gallon Equivalents

PART 2:

Biomass Heating Systems

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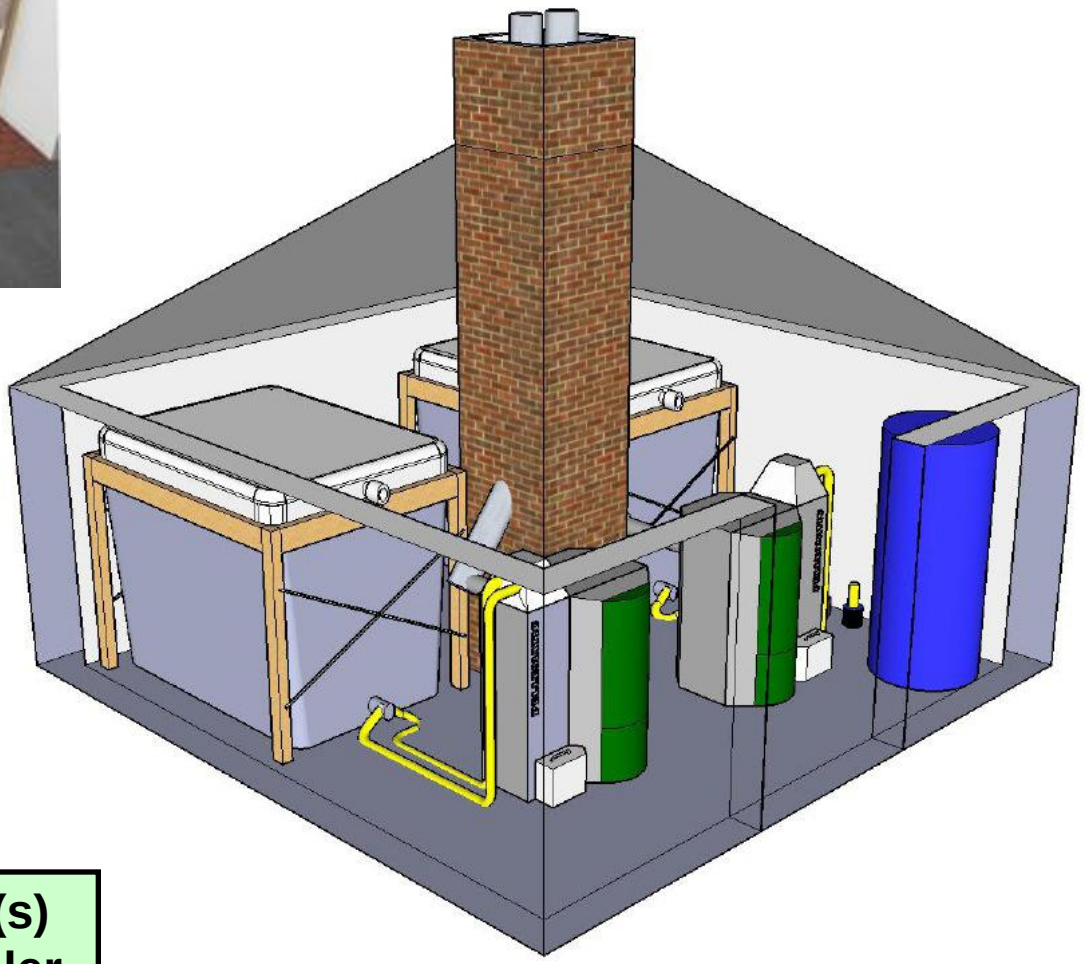
A Few Basic Biomass Boiler System Designs

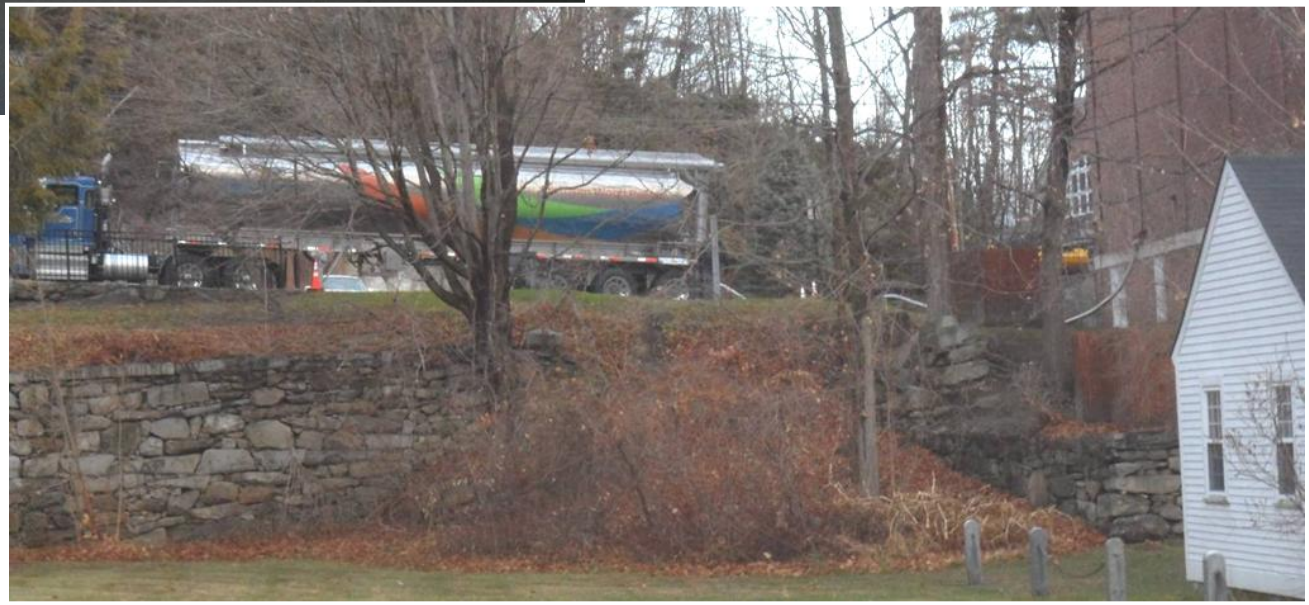
PELLETS



Interior Pellet Storage Bag(s) with Pneumatic Feed to Boiler

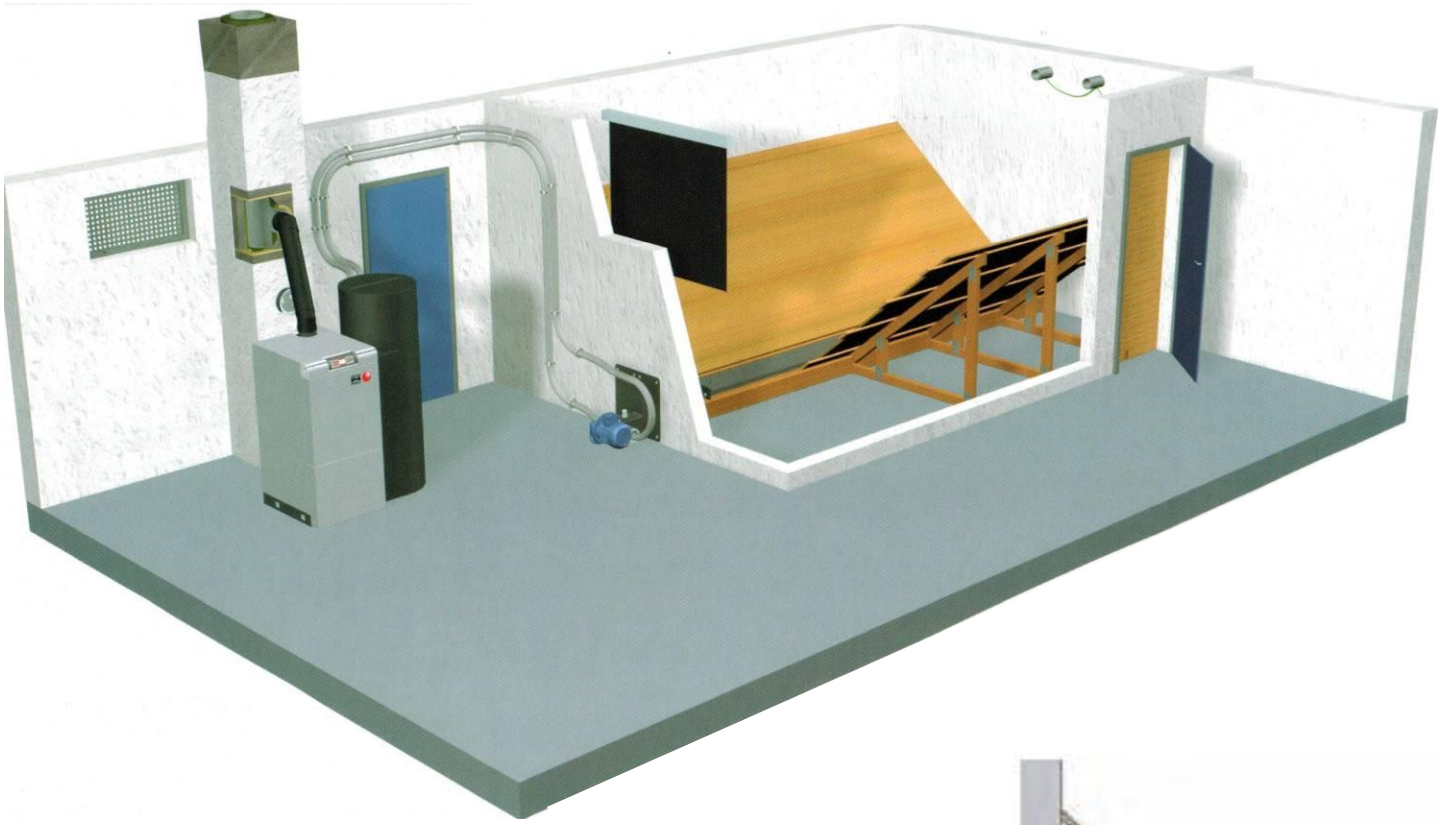
Pneumatic Pellet delivery trucks—Quick & Easy

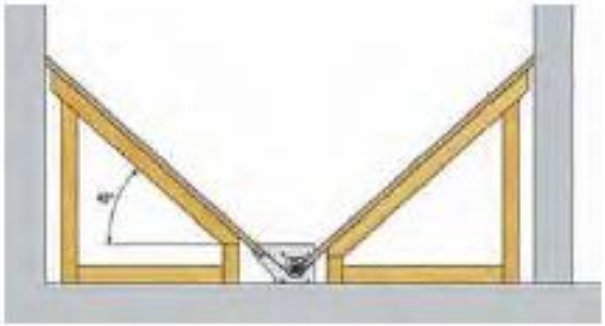
15 ton tanker



30 Ton Trailer

PELLETS





Interior Pellet Storage Bin with Augur and Pneumatic Feed to Boiler

PELLETS

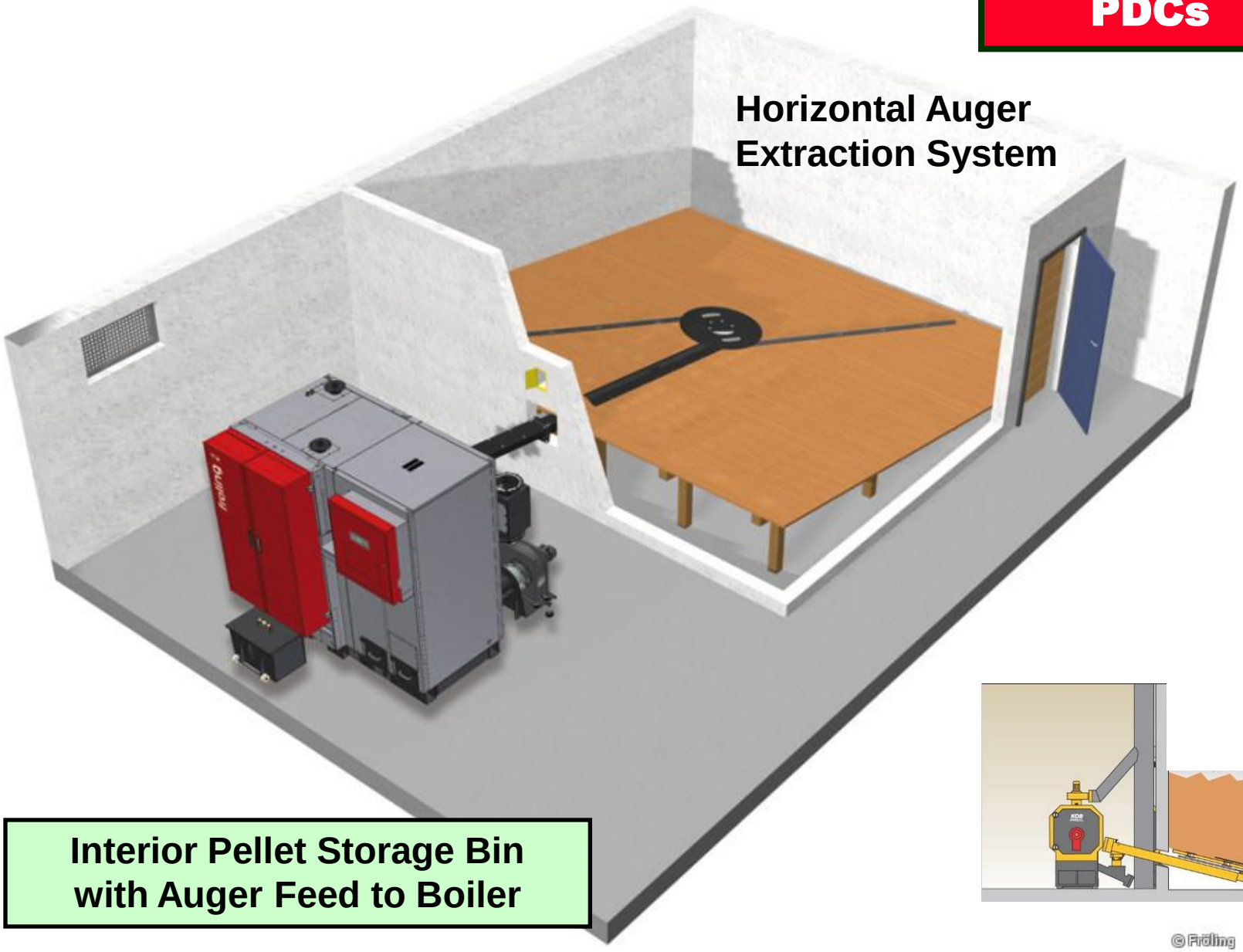
Exterior Pellet Storage Silo with Pneumatic Feed to Boiler

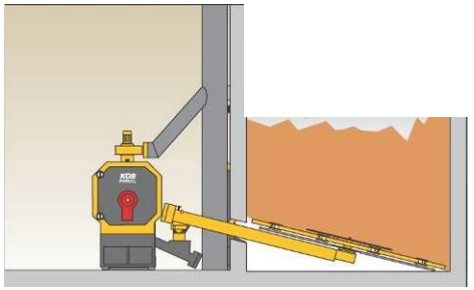
PELLETS

Exterior Pellet Storage Silo with Auger Feed to Boiler

PDCs

Horizontal Auger
Extraction System





© Fröling

Interior Pellet Storage Bin
with Auger Feed to Boiler

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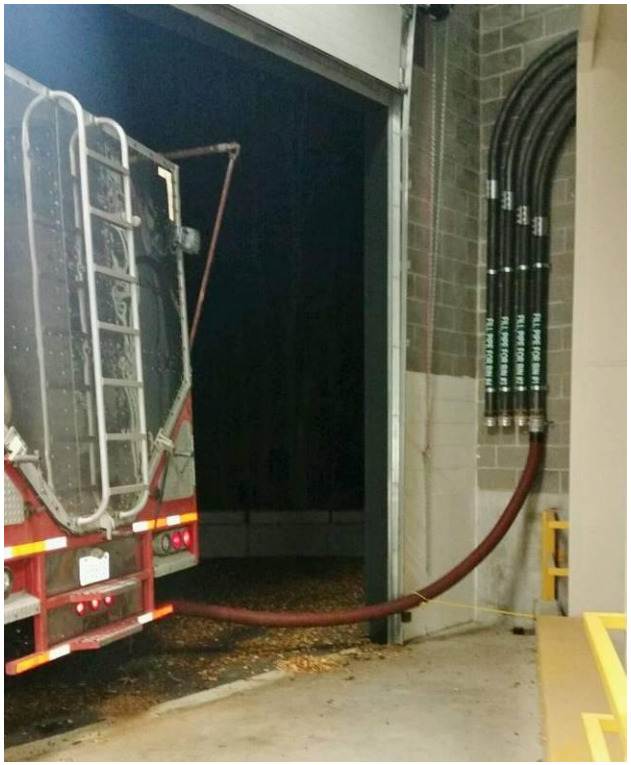
Our New Biomass Fuel: PDCs

Made at our facility in Peterborough



Delivered in our Box Truck and *BLOWN* into customer storage bins

DESIGN PARAMETERS for PDCs

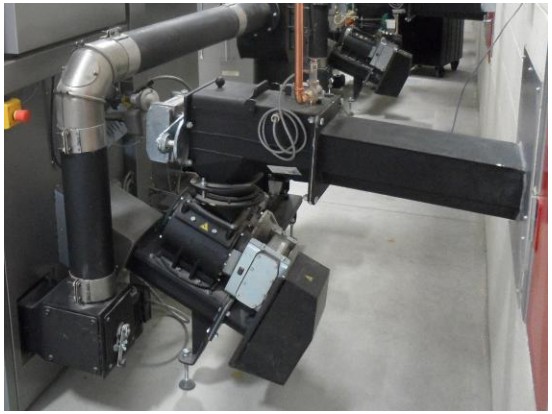
For 20,000 to 70,000 Gallons per year Consumption

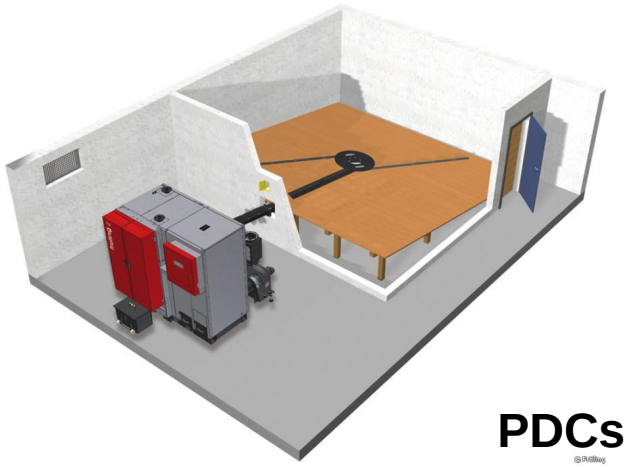
Storage Bin: Interior Sweeper Arm Type:
15, 23 or 34 tons each (Min/Max) 144/225/324 sq ft

- Each Bin supplies one or two Boilers
- Boilers are direct fed with rigid auger from Bin
- Bin must be close to Boiler (back to back)
- Boiler and Bin also able to handle pellets (Dual Fuel)
- New building often needed due to larger footprint

HIGH MOWING SCHOOL
Wilton, NH

PDCs



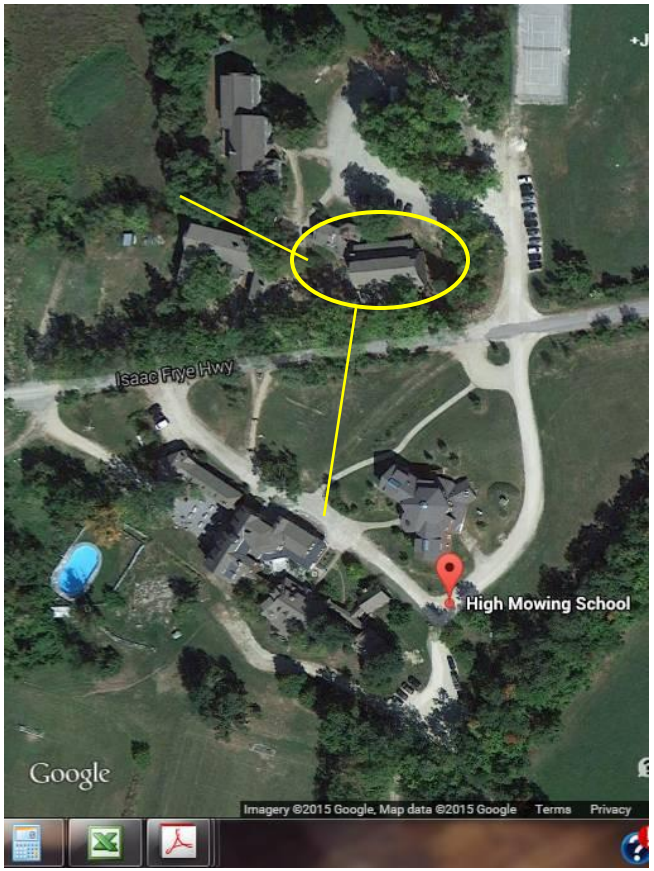


PDCs are blown into the silos from our blower truck

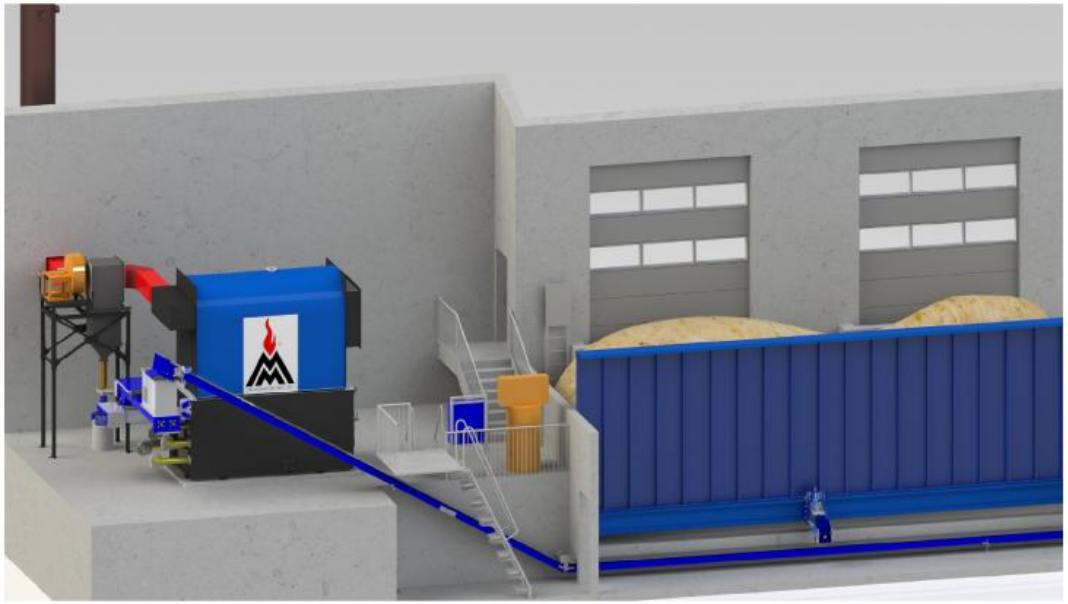
HIGH MOWING SCHOOL
Wilton, NH

PDCs

2 Froling TX-150 Boilers = 1 Million BTU/hr
Propane Back up = 1.5 million BTU/hr



9 Building District Heating System
with Central Biomass Boiler Building
Prior fuel use: 30,000 Gal Oil



GREEN CHIPS

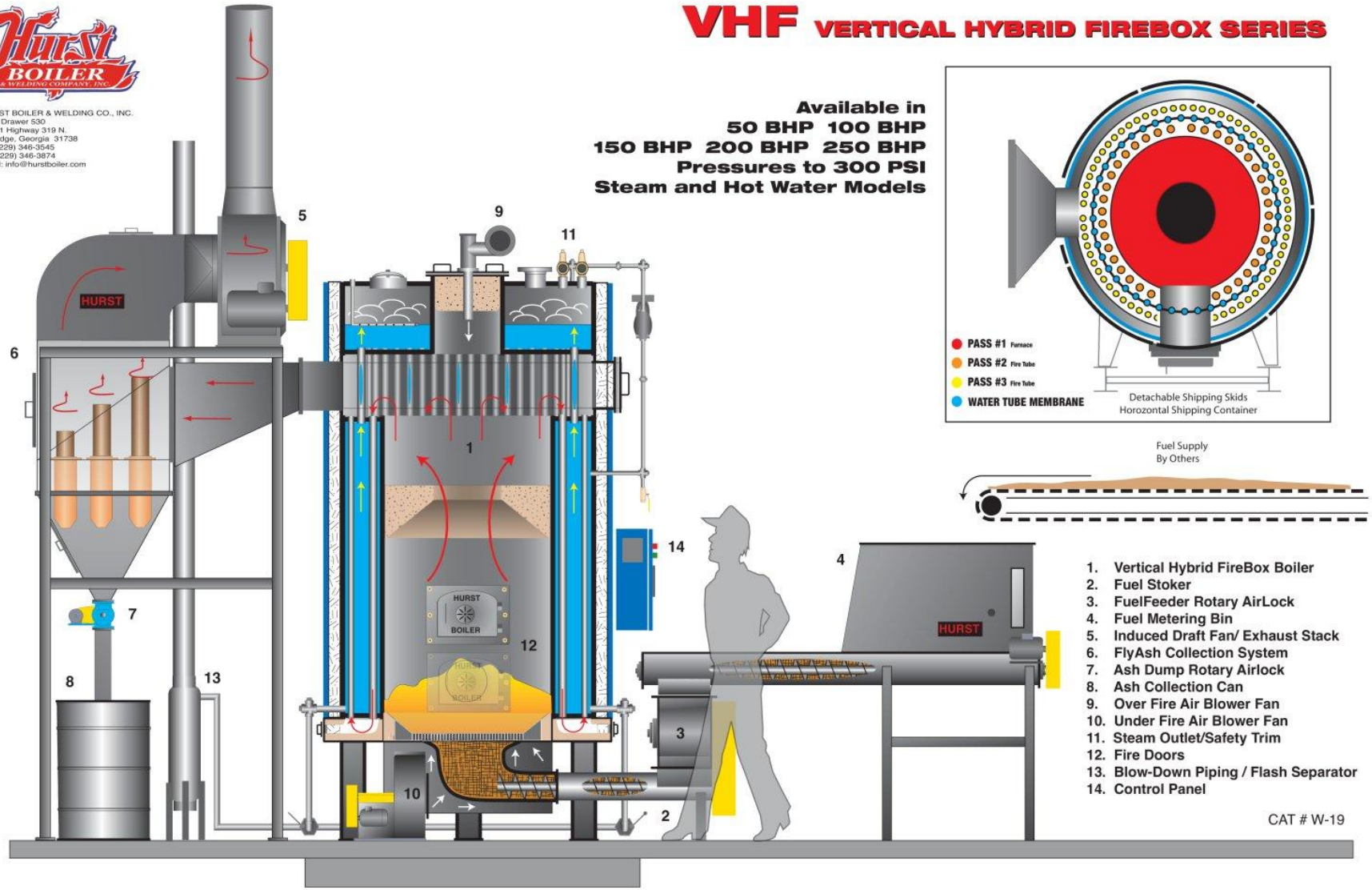
Shown: A Typical Messersmith System

GREEN CHIPS

HURST BOILER & WELDING CO., INC.
P. O. Drawer 530
21971 Highway 319 N.
Coolidge, Georgia 31738
Tel: (229) 346-3545
Fax.(229) 346-3874
email: info@hurstboiler.com

VHF VERTICAL HYBRID FIREBOX SERIES

Available in
50 BHP 100 BHP
150 BHP 200 BHP 250 BHP
Pressures to 300 PSI
Steam and Hot Water Models

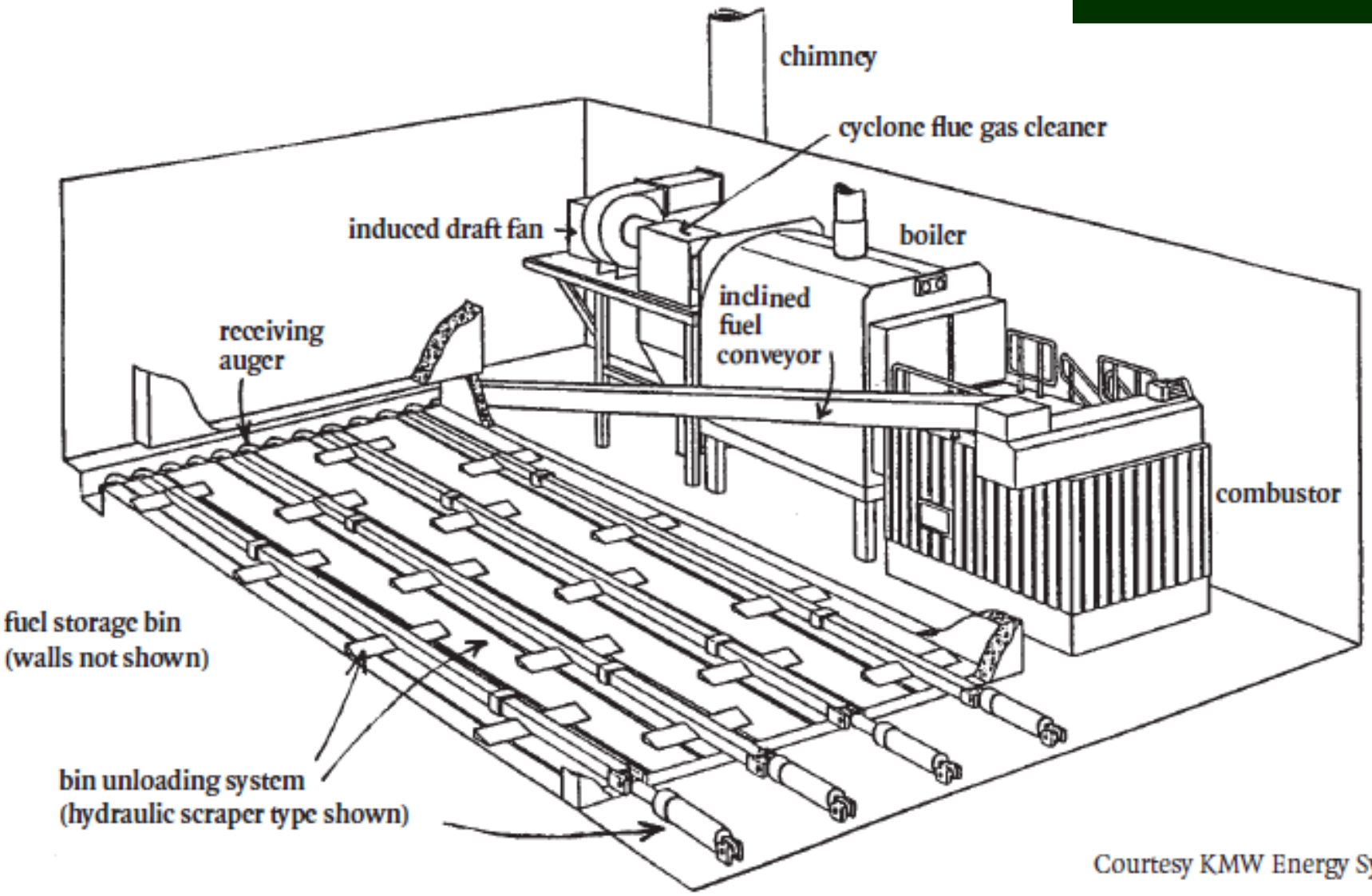


1. Vertical Hybrid FireBox Boiler
2. Fuel Stoker
3. FuelFeeder Rotary AirLock
4. Fuel Metering Bin
5. Induced Draft Fan/ Exhaust Stack
6. FlyAsh Collection System
7. Ash Dump Rotary Airlock
8. Ash Collection Can
9. Over Fire Air Blower Fan
10. Under Fire Air Blower Fan
11. Steam Outlet/Safety Trim
12. Fire Doors
13. Blow-Down Piping / Flash Separator
14. Control Panel

CAT # W-19

GREEN CHIPS

Figure 3.1
A Typical Biomass System



Courtesy KMW Energy Systems

Photo of Green Chip Delivery Truck (Live

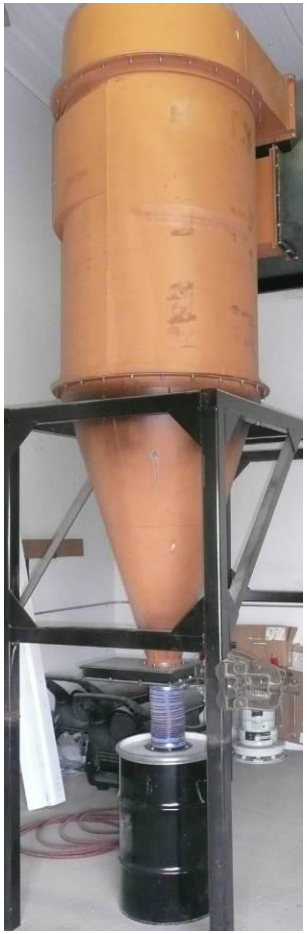
GREEN CHIPS

Example: Hanover High School
Green Wood Chip Boiler System

5 Million BTU Max Output

GREEN CHIPS

GREEN CHIPS



A Cyclone is often required to remove particulates from the exhaust.

Example: Hanover High School
Green Wood Chip Boiler System

SCHEUCH ESP

In some cases an ESP is required in the exhaust stream (Electrostatic Precipitator)

DESIGN PARAMETERS for Green Chips

For over 40,000 Gallons per year Consumption

Interior Bin: 37 tons minimum (400 sq ft)

Design: Live Floor or Rake / Auger & conveyors

- Bin must be fairly close Boiler so conveyor system can get the chips up to the boiler
- Typically installed in new boiler room/house due to large footprint
- Usually employs one large boiler (100% Design Load)
- Boilers are fed by conveyors, pushers & augers

PART 3:

Sizing for Financial Viability

When to switch to Biomass?

PELLETS

PDCs

GREEN CHIPS

- ☑ **Oil Boilers need to be replaced**
- ☑ **Oil Tank Inspection Results need repairs or replacement**
- ☑ **Green Initiative (Sets Green Example for Students and the Community)**
- ☑ **New Addition / New Building**
- ☑ **Performance Contract**

Design Criteria

PELLETS

PDCs

GREEN CHIPS

- ☑ **How much fuel is consumed each year? (3-5 yr avg)**
- ☑ **What conservation steps reduce the heat load?**
- ☑ **Are other buildings close that could be in a District system?**
- ☑ **What physical constraints do the property present?**
- ☑ **Are other issues forcing a need to replace current equipment?**

Issues & Challenges of Conversion

PELLETS

PDCs

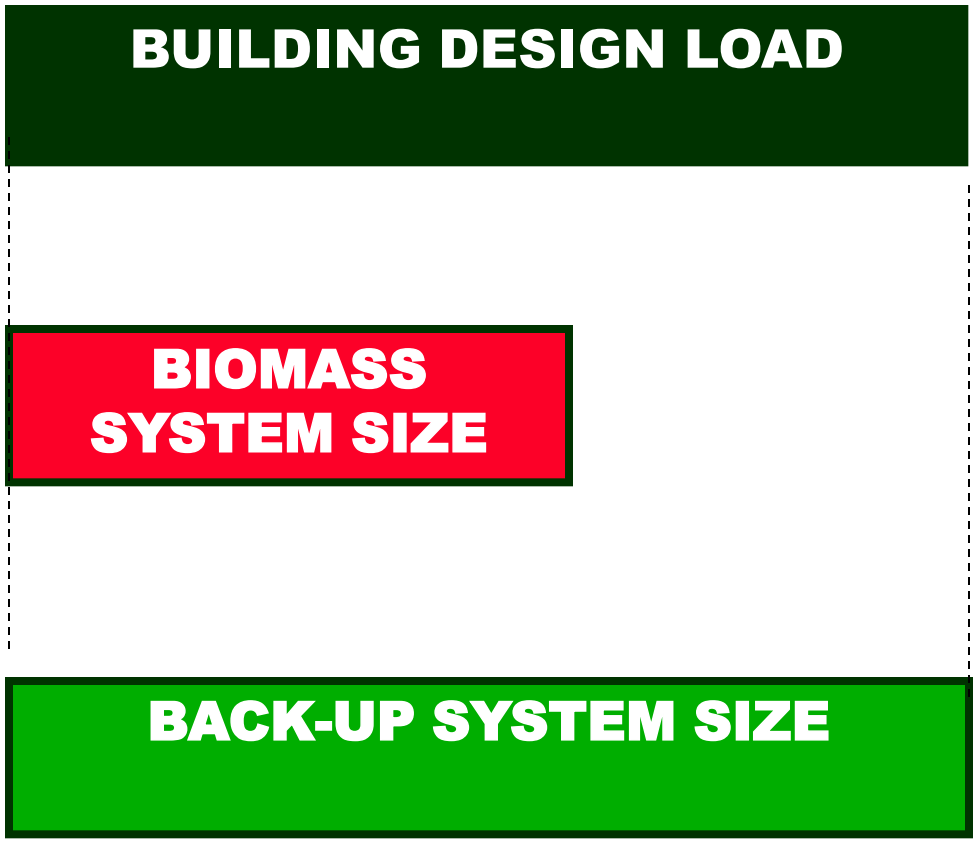
GREEN CHIPS

- ☑ **Boiler room too small**
- ☑ **New Boiler House is necessary**
- ☑ **Difficulty locating fuel storage silo/bin near boiler**
- ☑ **Difficult access to silo/bin for Fuel Delivery Truck**
- ☑ **Steam Heat (Convert to FHW?)**
- ☑ **Availability of Natural Gas!**

PELLETS

PDCs

Don't Oversize the System



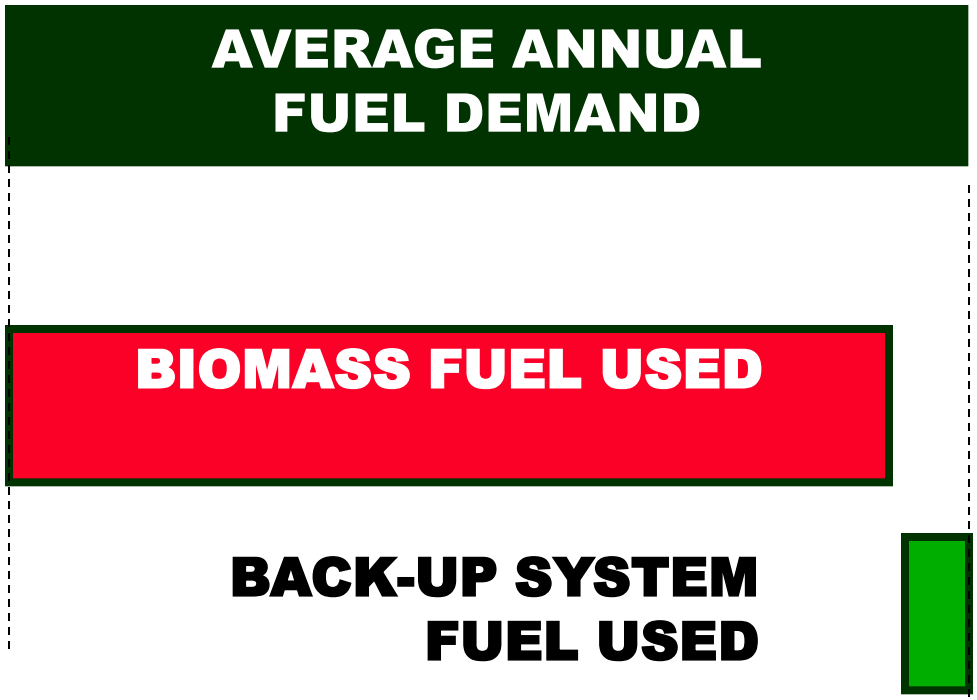
Size the Biomass System to be 65% to 75% of Design Load…

And cover 90% to 95% of annual heat needs.

PELLETS

PDCs

Don't Oversize the System!

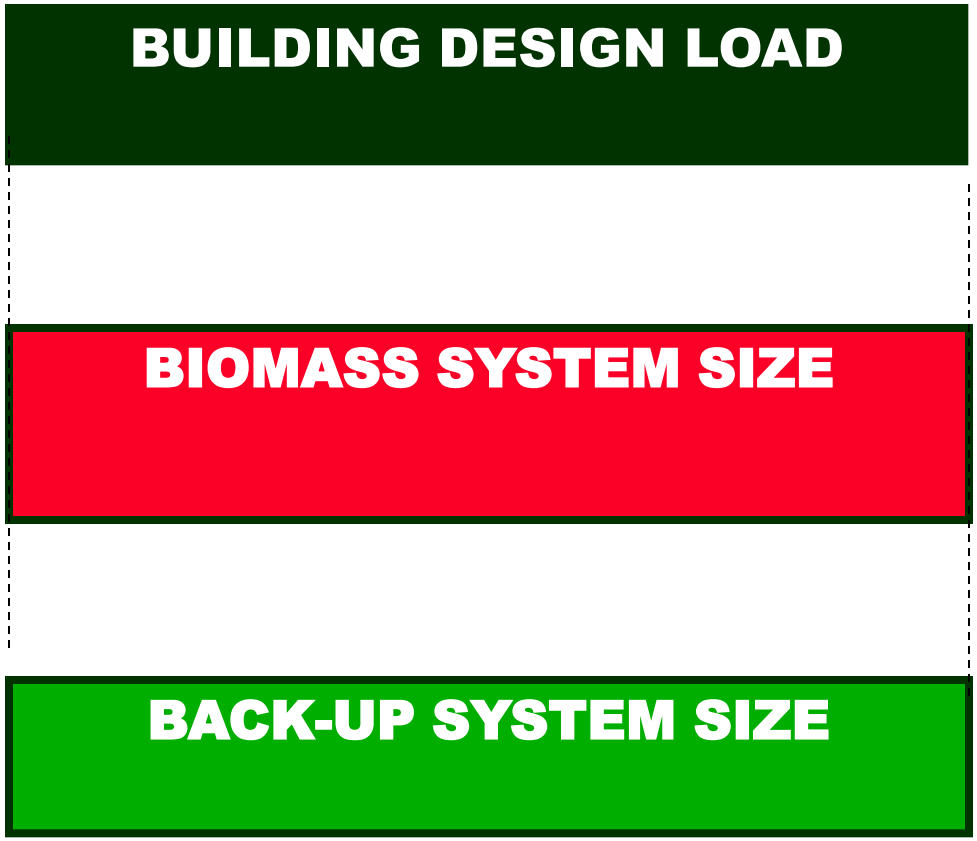


Smaller Boiler Systems Cost Less.

An average of only 7 days per year get close to Design Load.

GREEN CHIPS

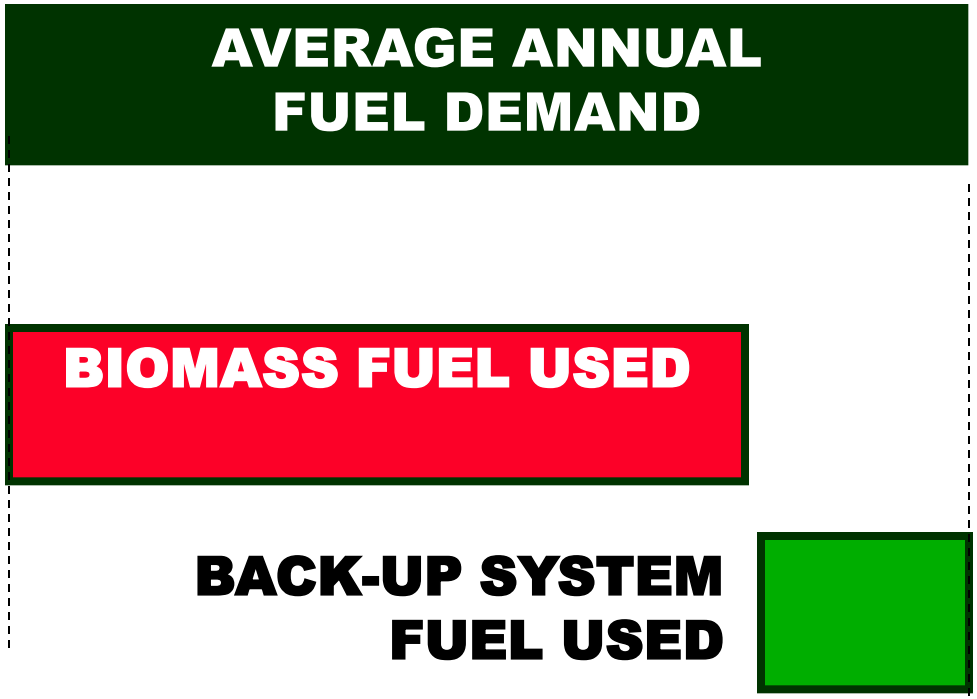
For BIG Fuel Users



Size the Biomass System to be 100% of Design Load…

GREEN CHIPS

For BIG Fuel Users



And cover 80% of annual heating needs.

WHY?

When loads are too small these systems are turned off:

Start Up in October

& Turn Off in March

The 95% vs 80% Coverage Dilemna

If you are burning 50,000 gallons of oil per year…

	PDCs	GREEN CHIPS
System Cost Estimate:	**$350,000**	**$500,000**
Net Average Oil offset:	95% or 47,500 Gal	80% or 40,000 Gal
Average Biomass use:	507 tons per year	605 tons per year
Biomass Cost:	at $120/Ton = $60,840	at $60/Ton = $36,300
Average Thermal RECs:	1542 @ $15 = $23,130	1542 @ $15 = $23,130
Net Average Oil Use:	2,500 gallons	10,000 gallons
Net Average Oil Cost:	@ $3.00 = $7,500	@ $3.00 = $30,000
TOTAL Average Annual Fuel Cost:	**$45,210**	**$43,170**

At $40 a ton for Green Chips…

Fuel costs cut by $12,100

Economics of a Biomass Conversion

PELLETS

PDCs

GREEN CHIPS

A simple economic analysis is tempting:

Total System Cost

Divided by

Projected Average Annual Savings

HOWEVER: Other important factors may be pivotal.

- **Buried Oil Tank is failing**
- **Existing Oil Boilers need replacement**
- **Energy Conservation Measures planned**
- **New Addition is being planned**
- **Switching from Steam to FHW**

Making the Case for a Biomass System

ROI and "Payback" models don't tell the Whole Story!

- **A more realistic method is costing out "Alternate Futures"**
  - PLAN A: Stick with Oil—Replace oil boiler in year X. Replace buried oil tank. Upgrade other components. + 10 Yrs Fuel Costs
  - PLAN B: Convert to wood pellet boiler system. Remove buried oil tank. Back up with Propane boilers. + 10 Yrs Fuel Costs
  - PLAN C: Convert to PDC boiler system + 10 Yrs Fuel Costs
  - PLAN D: Convert to Green Chip boiler system + 10 Yrs Fuel Costs
- **Include Rebates, RECs, Grants, etc… in Each PLAN**
- **Include 10 to 20 years of projected future fuel costs in each PLAN**
  - Agree upon reasonable future fuel prices in projections ($3 Oil?)
  - Keep fuel costs flat over the 10 to 20 year period

NH Pellet Boiler 30% Rebate

PELLETS

PDCs

- **Rebate comes from NHPUC**
- **Wood Pellet systems ONLY**
- **Cap of $50,000 (+ $5,000 max for Buffer Tank)**
- **Apply in advance > Funds earmarked for you.**
    - **Funds paid out when project is complete**
- **Best to apply before a public vote**
- **Must use recognized equipment and trained installers**

NH Thermal RECs

(Renewable Energy Credits)

PELLETS

PDCs

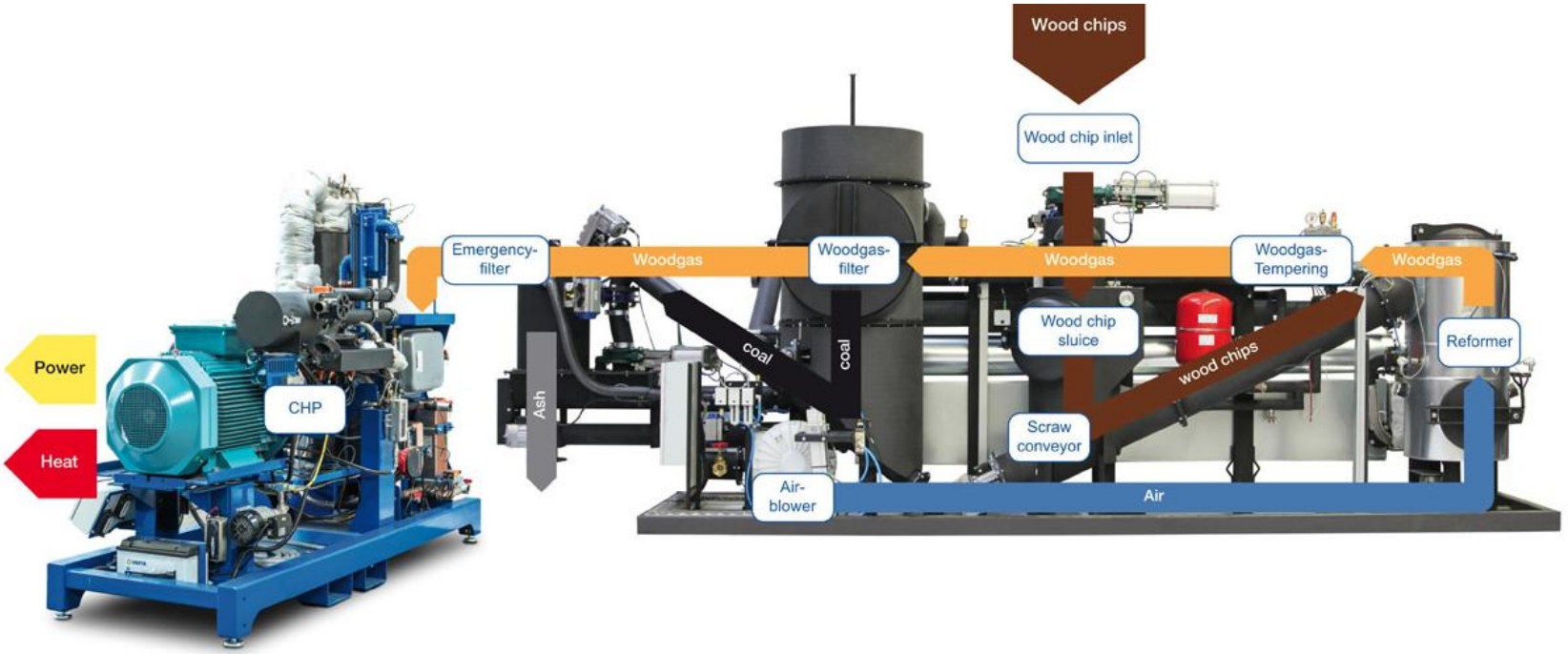
GREEN CHIPS

- **T-RECs available for any Biomass boiler system installed after January 1, 2013**
- **Must have site approved by NHPUC**
- **Pellets get *approximately* 4 T-RECs per ton**
  - **PDCs: 3/ton** **Green Chips 2/ton**
  - **Generally: .0325 RECs per Offset gallon of Oil**
- **Requires Monitoring Equipment**
  - **BTU Meter & Data Accumulator**
- **Requires Qualified Verification**
- **Sell T-RECs in NEPOOL System Directly or by Agent.**
  - **Value varies approx $10-$25 each**

PART 5:

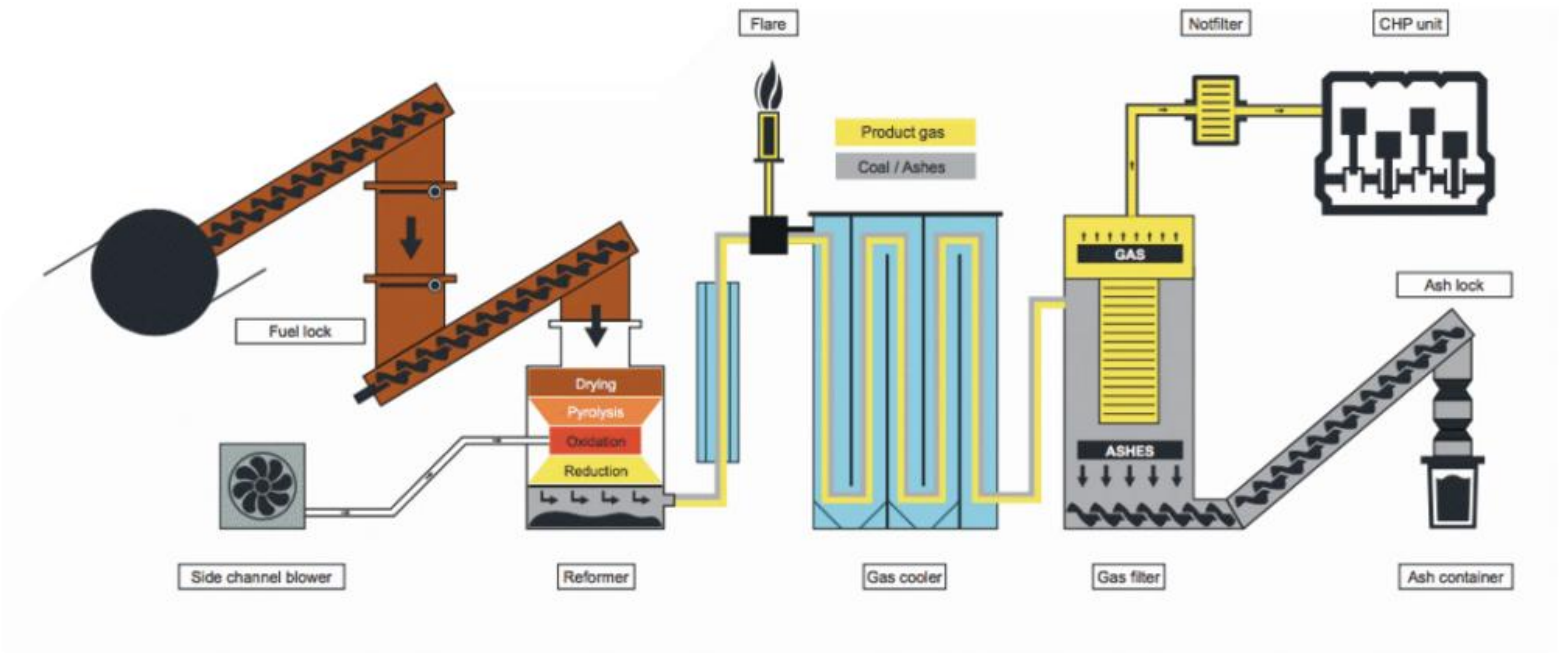
The Near Future and Cogeneration Options

Spanner CHP
45KW Electrical Power
108KW Thermal Power
81% overall efficiency
Cost installed app. $300K



Froeling CHP 50

50KW Electrical Power
107KW Thermal Power
83% Overall Efficiency
Installed Cost $350K

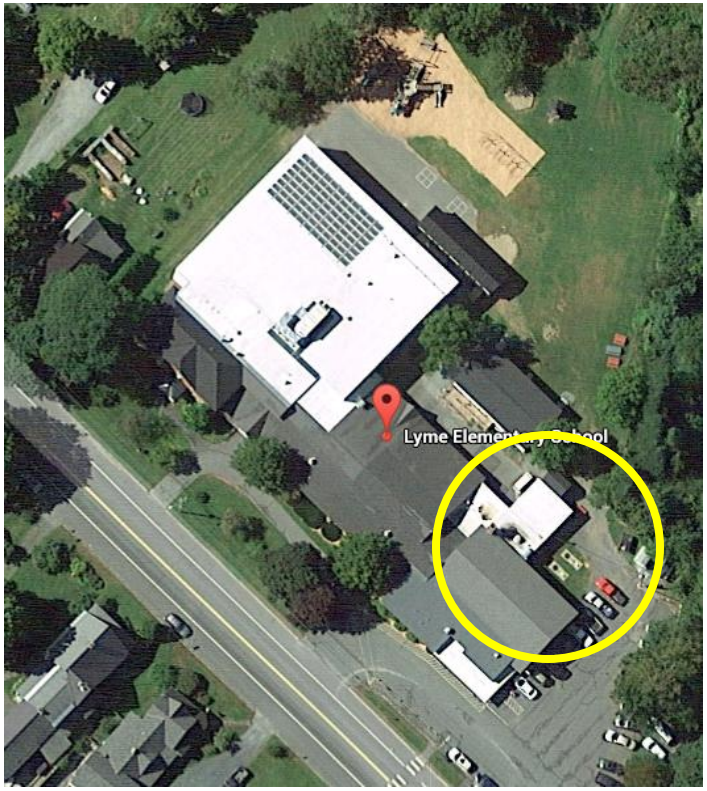

Flare
Notfilter
CHP unit
Product gas
Coal / Ashes
Fuel lock
Drying
Pyrolysis
Oxidation
Reduction
GAS
ASHES
Ash lock
Side channel blower
Reformer
Gas cooler
Gas filter
Ash container

PART 6:

Three Biomass Heating Projects

LYME ELEMENTARY SCHOOL
Lyme, NH

PELLETS



LYME ELEMENTARY SCHOOL
Lyme, NH

PELLETS

Prior Oil Use: 10,000 Gallons/yr

2 - 340,000 BTU boilers do 95% coverage

28 ton Silo

Propane back up can cover 100%

FROLING ENERGY

Projects

CORNISH ELEMENTARY SCHOOL

Cornish, NH

PELLETS

FROLING ENERGY

Projects

CORNISH ELEMENTARY SCHOOL

Cornish, NH

PELLETS

Containerized Boiler Rooms

Built at our shop—dropped into place by crane

FROLING ENERGY

Projects

CORNISH ELEMENTARY SCHOOL

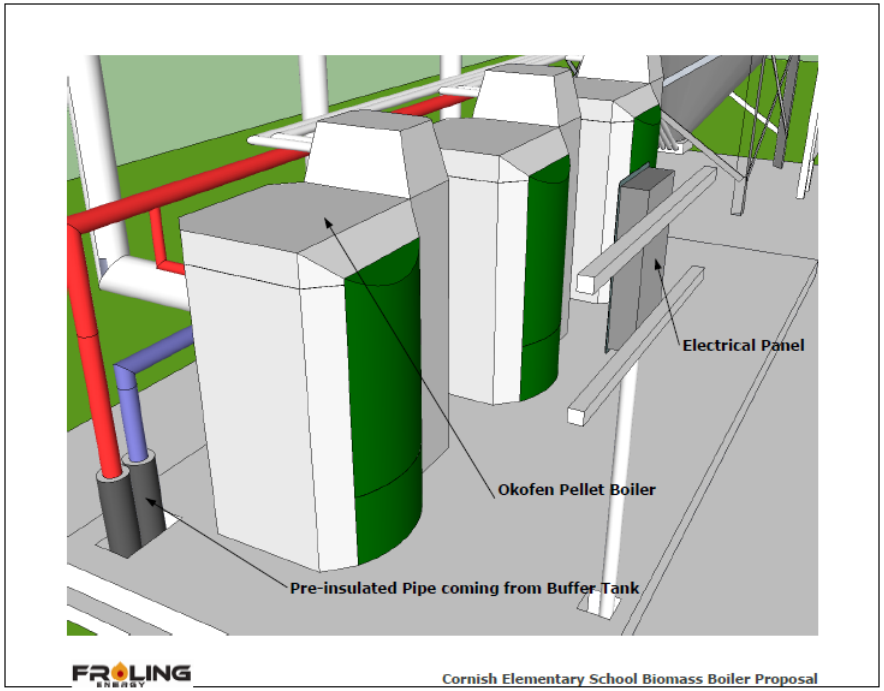
Cornish, NH

PELLETS

CORNISH ELEMENTARY SCHOOL

Cornish, NH

PELLETS



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Projects

STEVENS HIGH SCHOOL

Claremont, NH

PELLETS

PDCs

FROLING ENERGY

Projects

STEVENS HIGH SCHOOL

Claremont, NH

PELLETS

PDCs

Before

A large scale renovation was done in 2014

After

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Projects

STEVENS HIGH SCHOOL

Claremont, NH

PELLETS

PDCs

PELLETS

PDCs

STEVENS HIGH SCHOOL

Claremont, NH

2 Froling TX-150
Pellet/PDC Boilers
500,000 BTU/Hr Each

Steel Interior Silo can hold
70 tons of Pellets
Or 35 tons of PDCs

FROLING ENERGY

Projects

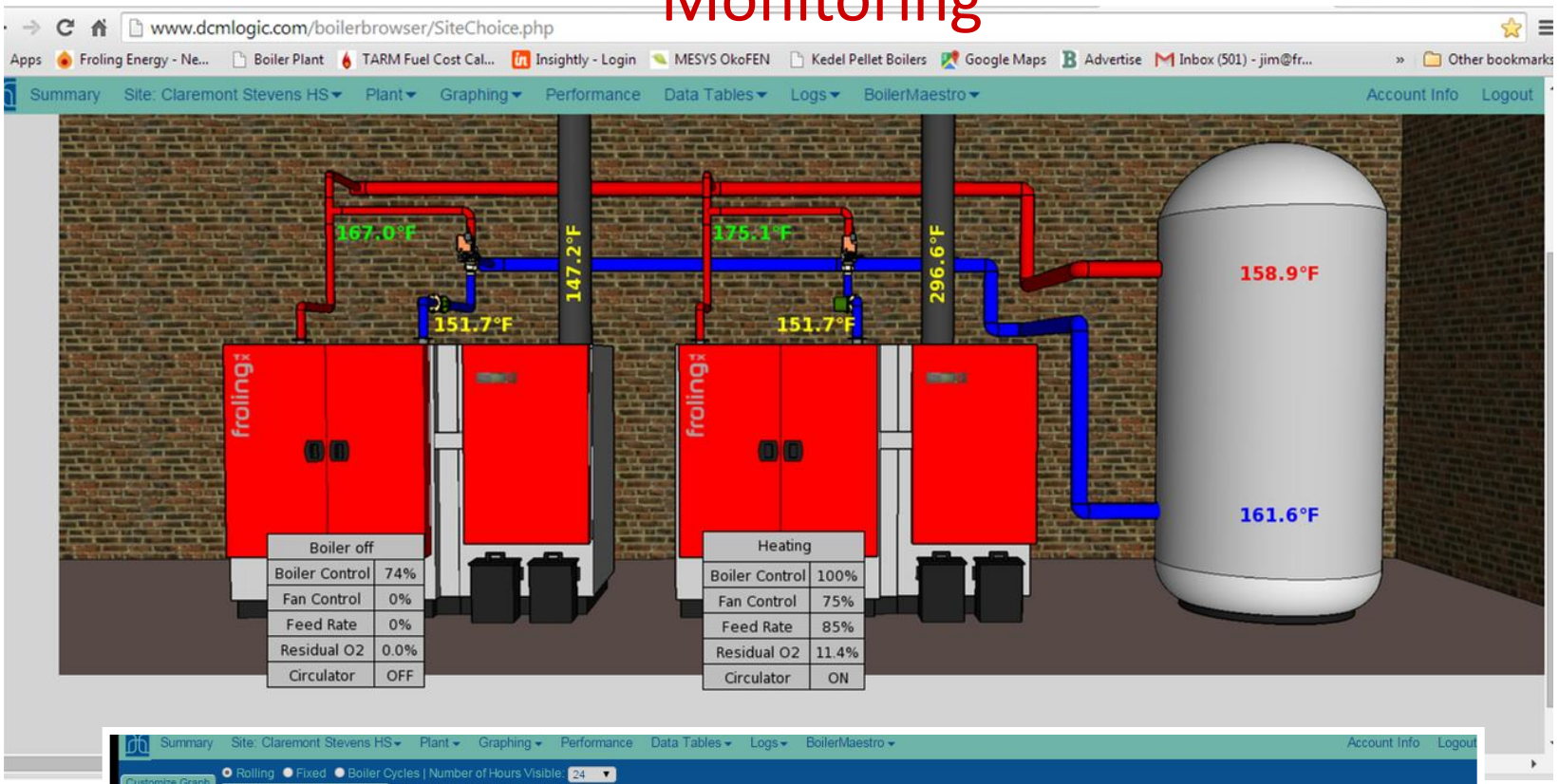
STEVENS HIGH SCHOOL

Claremont, NH

PELLETS

PDCs

"Constant Monitoring"



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Questions?

Jim@FrolingEnergy.com 603-924-1001 *www.FrolingEnergy.com*

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Thank You!

Jim@FrolingEnergy.com 603-924-1001 *www.FrolingEnergy.com*

A 30% Rebate is available now from the NHPUC for

Commercial
Bulk-Fed Wood Pellet
Central Heating Systems

(Schools & Municipal Buildings Included)

For installation of bulk-fuel fed wood pellet boilers and furnaces of 2.5 million BTU Output or less

Provides 30% of the cost of the boilers with installation, up to a maximum of $50,000.

Must be operational before December 18, 2013.

RENEWABLE ENERGY CREDITS FROM THE NHPUC

FOR CLASS I THERMAL SOURCES
WITH RENEWABLE THERMAL ENERGY CAPACITY
GREATER THAN 150,000 BTU/HR

- The Biomass boiler system installation must be completed with an approved energy production metering system in place
- A Registered Engineer must affirm that the installation meets the standards
- The official Application is completed, submitted and accepted by the NHPUC

RENEWABLE ENERGY CREDITS FROM THE NHPUC

Current Values

- For each ton of biomass (wood pellets) burned you get about 4 Thermal RECs
- Thermal RECs can be sold each year at a set rate
- We expect them to trade for between $12 and $25 each year
- RECS were sold for $22 in the most recent sale

PART 7:

More Biomass Heating Projects

NORTHWEST ELEMENTARY SCHOOL
Rutland, VT

PELLETS

PUTNEY SCHOOL Putney, VT

PELLETS

CANAAN ELEMENTARY Canaan, NH

PELLETS

RUTLAND HIGH SCHOOL
& STAFFORD TECHNICAL CENTER
Rutland, VT

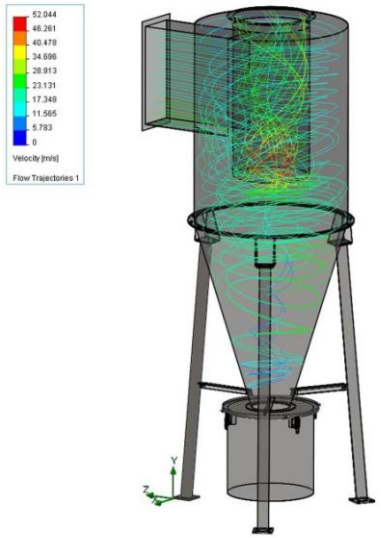
PELLETS

PART 4:

Emissions Implications of Biomass Fuels

Proven Emissions Control Equipment

- **Electro Static Precipitator (ESP)**
- **Metal Mesh Filter**
- **Bag House**
- **Ceramic filter Baghouse**
- **Cyclone**



Massachusetts Emissions Limits so you can get Grants (200,000-3,000,000BTU)

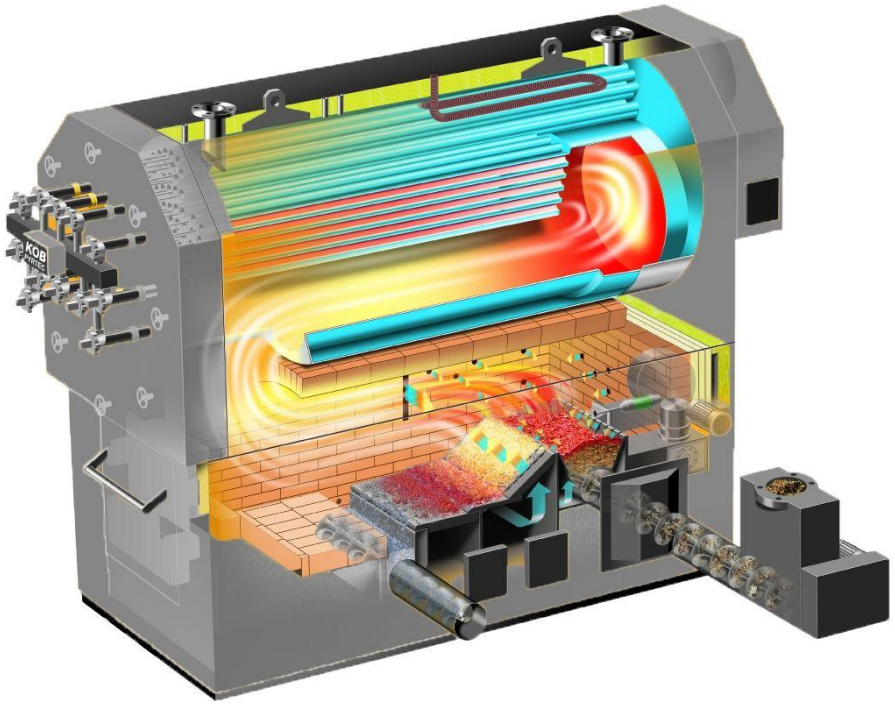
- Sensitive Receptor Sites (Hospitals, Schools, Nursing Homes, Daycare Centers)
- PM 2.5 < .03 lbs/MMBTU/hr
- Nox < .22 lbs/MMBTU/hr
- CO < .18 lbs/MMBTU/hr
- General Sites
- PM 2.5 < .08 lbs/MMBTU/hr
- Nox < .22 lbs/MMBTU/hr
- CO < .18 lbs/MMBTU/hr

Equipment that will comply with regulations
Complies in MA and NH with Pellets

Fröling P4
Fröling T4
Fröling TX
Fröling TM

Needs ESP with Chips

Viessmann KRT and KPT Boilers Complies in MA and NH with Pellets



350MBH to 4300MBH

Needs ESP with Chips