University of Iowa
Biomass Fuel Project
Chicago Climate Exchange

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UI Biomass Project

- Co-fire oat hulls with coal in circulating fluidized bed (CFB) boiler.
- Oat hull fuel displaces coal fuel.
- Oat hulls are a byproduct of the cereal making process at Quaker Oats, Cedar Rapids Facility.

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Why biomass combustion?

- Renewable / Sustainable
- Emissions Reductions
- UI / Industry Partnership
- Lowest Cost Energy Source
- Educational Value

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Major Challenges:

The feather-weight oat hulls required – without having a negative impact on the existing coal systems:

- Special materials handling solutions,
- Boiler control system modifications,
- New procedures to make this fuel work
- And …

The Iowa DNR & US EPA

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Business Aspects

- Quaker Oats is a large production facility, employing ~1,200 Iowans.
- Oat hulls are purchased
  - ~ ½ the cost of coal.
  - Source of revenue for Quaker
  - Purchased energy savings for UI
- Stable fuel supply for UI.
- Stable byproduct outlet for Quaker.

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What did we do?

- Converted a coal-fired boiler to burn a combination of coal and oat hulls.
- Two years of effort to find out how to do it and obtain regulatory permits for operation.
- Project operational since 2003.

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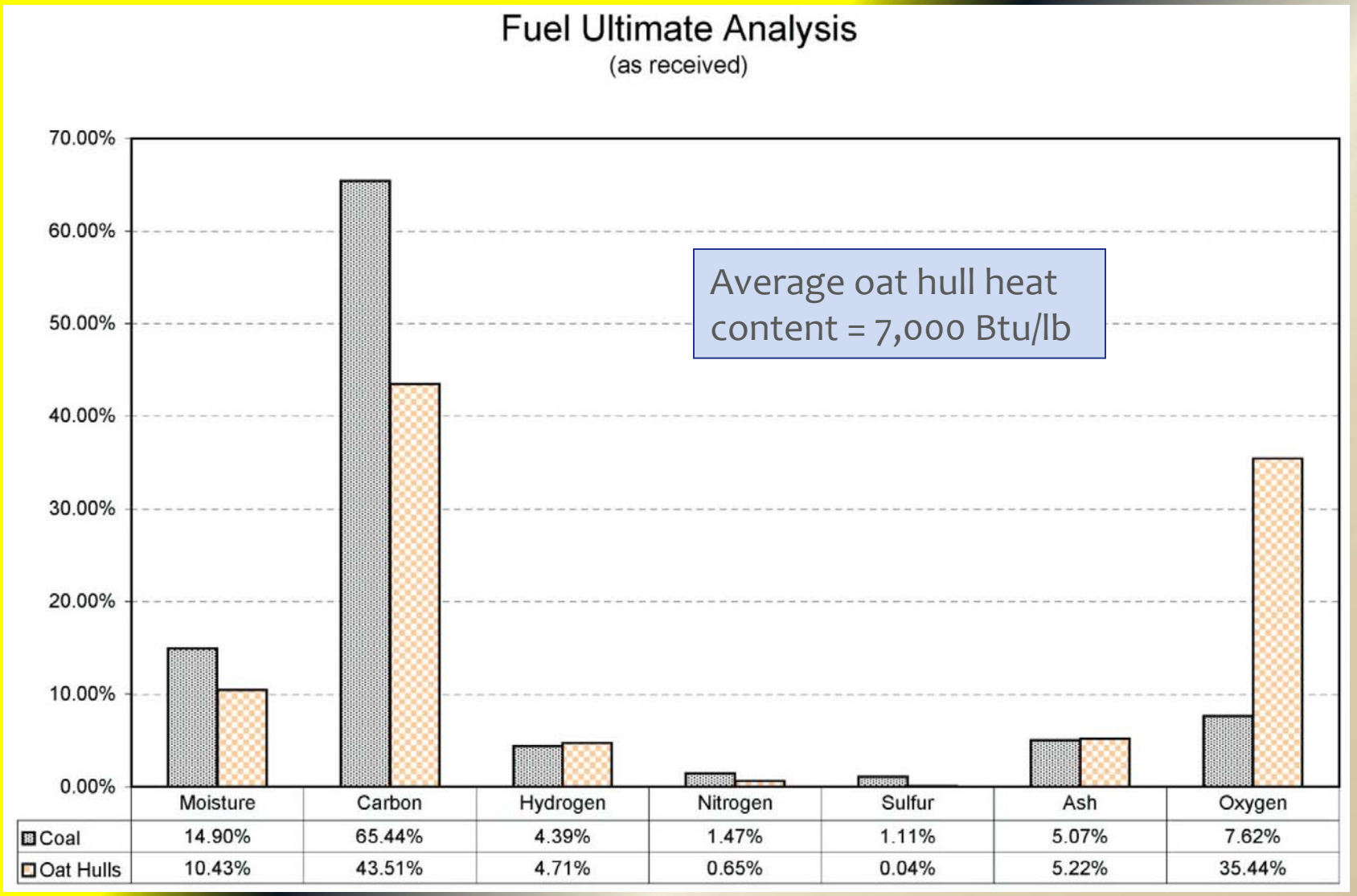
Oat Hull & Coal Comparison



	Moisture	Carbon	Hydrogen	Nitrogen	Sulfur	Ash	Oxygen
Coal	14.90%	65.44%	4.39%	1.47%	1.11%	5.07%	7.62%
Oat Hulls	10.43%	43.51%	4.71%	0.65%	0.04%	5.22%	35.44%

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Boiler Conversion

- Circulating Fluidized Bed Boiler
  - Pyroflow process
  - 170,000 lbs/hr
  - Washed bituminous coal (3.0 to 3.5% S)
  - 90% SO_2 removal

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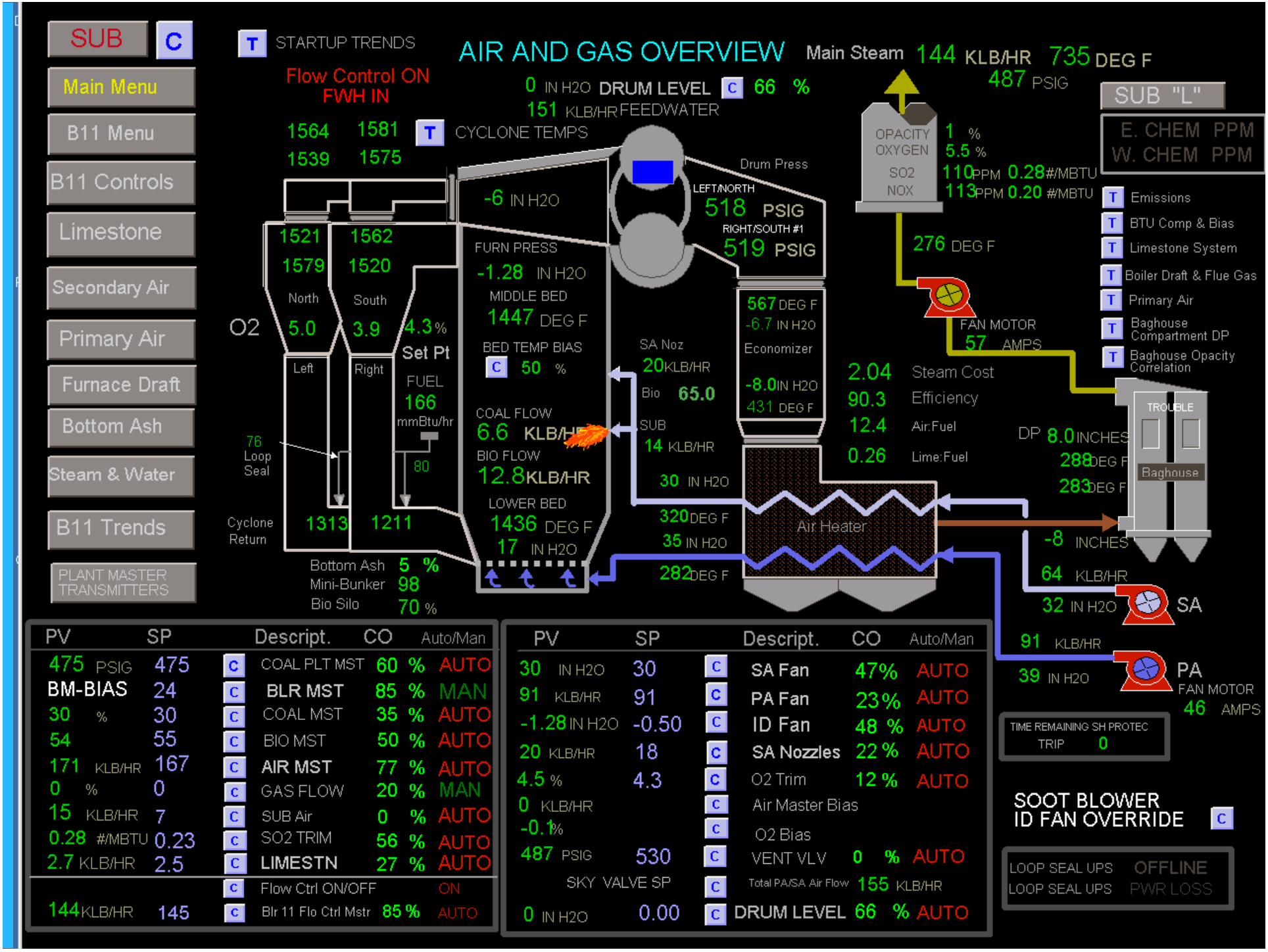
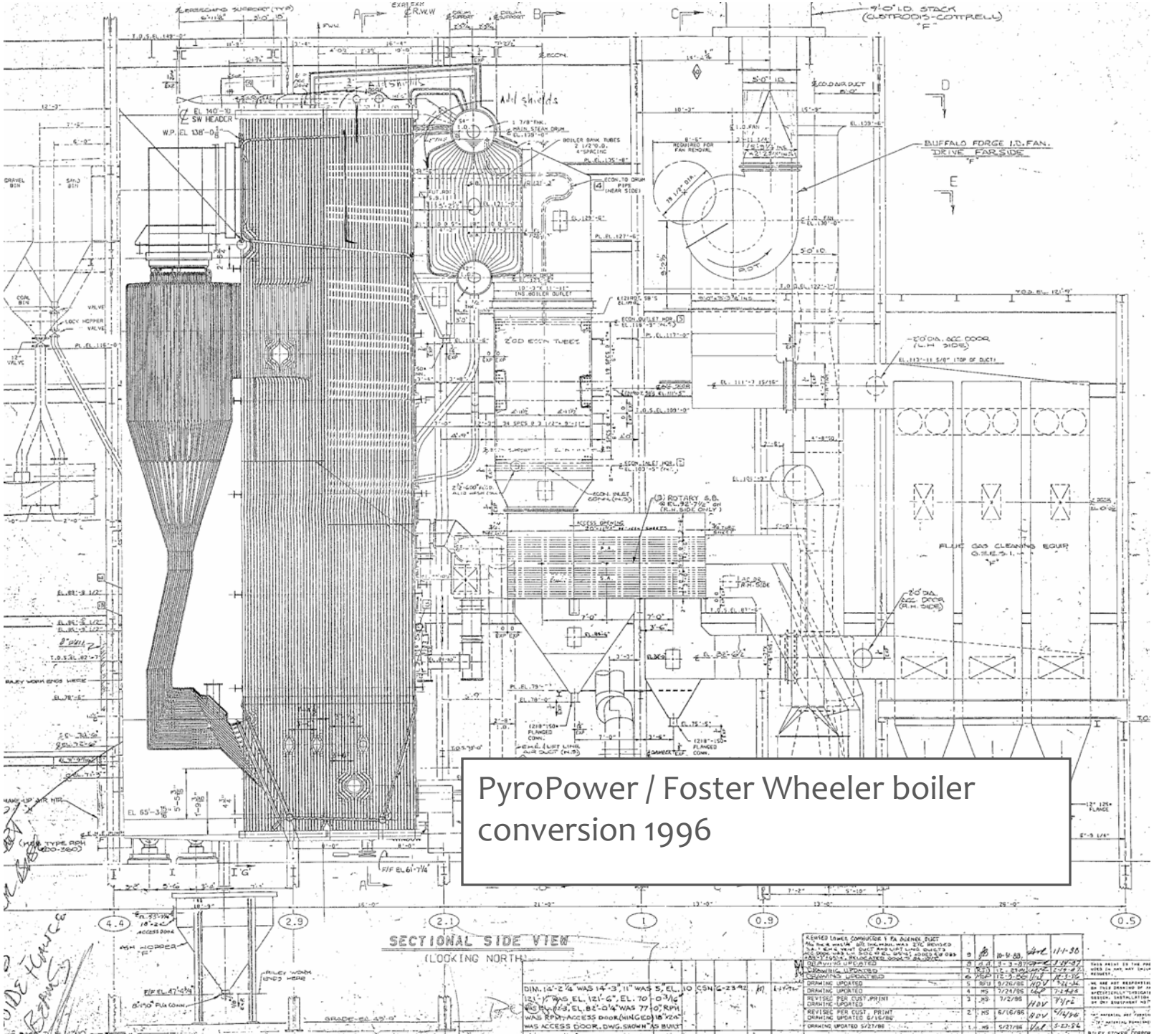
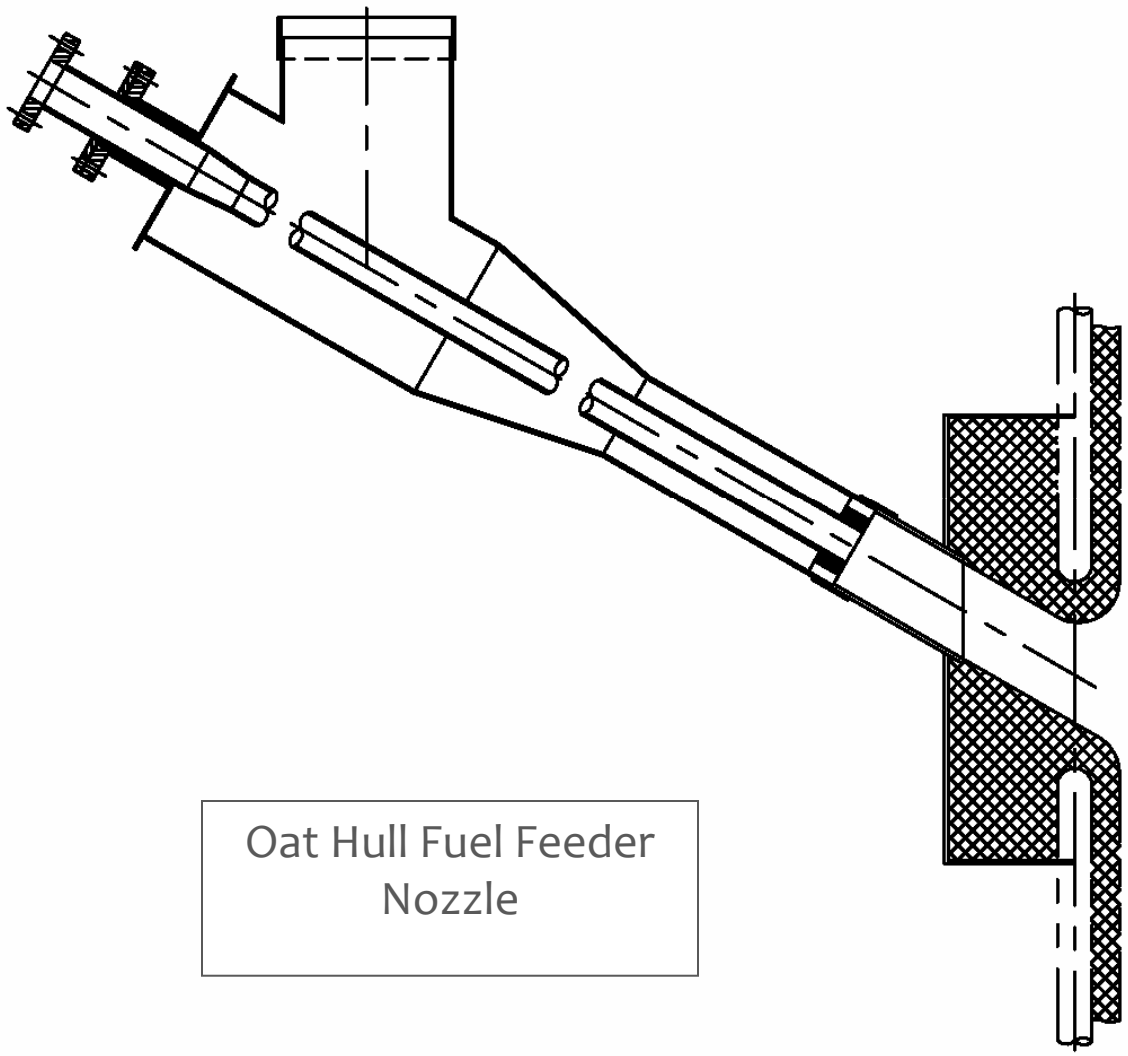

SUB
C
Main Menu
B11 Menu
B11 Controls
Limestone
Secondary Air
Primary Air
Furnace Draft
Bottom Ash
Steam & Water
B11 Trends
PLANT MASTER TRANSMITTERS
T STARTUP TRENDS
Flow Control ON
FWH IN
AIR AND GAS OVERVIEW
Main Steam 144 KLB/HR 735 DEG F
487 PSIG
0 IN H2O DRUM LEVEL C 66 %
151 KLB/HR FEEDWATER
SUB "L"
E. CHEM PPM
W. CHEM PPM
1564 1581 T CYCLONE TEMPS
1539 1575
Drum Press
LEFT/NORTH
518 PSIG
RIGHT/SOUTH #1
519 PSIG
-6 IN H2O
OPACITY 1 %
OXYGEN 5.5 %
SO2 110 PPM 0.28 #/MBTU
NOX 113 PPM 0.20 #/MBTU
T Emissions
T BTU Comp & Bias
T Limestone System
T Boiler Draft & Flue Gas
T Primary Air
T Baghouse Compartment DP
T Baghouse Opacity Correlation
276 DEG F
FAN MOTOR
57 AMPS
1521 1562
1579 1520
North South
O2
5.0 3.9 4.3 %
Set Pt
FUEL
166 mmBtu/hr
80
Left Right
76 Loop Seal
Cyclone Return
1313 1211
FURN PRESS
-1.28 IN H2O
MIDDLE BED
1447 DEG F
BED TEMP BIAS
C 50 %
COAL FLOW
6.6 KLB/HR
BIO FLOW
12.8 KLB/HR
LOWER BED
1436 DEG F
17 IN H2O
SA Noz
20 KLB/HR
Bio 65.0
SUB
14 KLB/HR
30 IN H2O
320 DEG F
35 IN H2O
282 DEG F
567 DEG F
-6.7 IN H2O
Economizer
-8.0 IN H2O
431 DEG F
2.04 Steam Cost
90.3 Efficiency
12.4 Air:Fuel
0.26 Lime:Fuel
Air Heater
DP 8.0 INCHES
288 DEG F
283 DEG F
TROUBLE
Baghouse
-8 INCHES
64 KLB/HR
32 IN H2O
SA
91 KLB/HR
39 IN H2O
PA
FAN MOTOR
46 AMPS
Bottom Ash 5 %
Mini-Bunker 98
Bio Silo 70 %
TIME REMAINING SH PROTEC
TRIP 0
SOOT BLOWER
ID FAN OVERRIDE
C
LOOP SEAL UPS OFFLINE
LOOP SEAL UPS PWR LOSS
PV SP Descript. CO Auto/Man
475 PSIG 475 C COAL PLT MST 60 % AUTO
BM-BIAS 24 C BLR MST 85 % MAN
30 % 30 C COAL MST 35 % AUTO
54 55 C BIO MST 50 % AUTO
171 KLB/HR 167 C AIR MST 77 % AUTO
0 % 0 C GAS FLOW 20 % MAN
15 KLB/HR 7 C SUB Air 0 % AUTO
0.28 #/MBTU 0.23 C SO2 TRIM 56 % AUTO
2.7 KLB/HR 2.5 C LIMESTN 27 % AUTO
C Flow Ctrl ON/OFF ON
144 KLB/HR 145 C Blr 11 Flo Ctrl Mstr 85 % AUTO
PV SP Descript. CO Auto/Man
30 IN H2O 30 C SA Fan 47% AUTO
91 KLB/HR 91 C PA Fan 23% AUTO
-1.28 IN H2O -0.50 C ID Fan 48 % AUTO
20 KLB/HR 18 C SA Nozzles 22 % AUTO
4.5 % 4.3 C O2 Trim 12 % AUTO
0 KLB/HR C Air Master Bias
-0.1% C O2 Bias
487 PSIG 530 C VENT VLV 0 % AUTO
SKY VALVE SP C Total PA/SA Air Flow 155 KLB/HR
0 IN H2O 0.00 C DRUM LEVEL 66 % AUTO



PyroPower / Foster Wheeler boiler conversion 1996



Oat Hull Fuel Feeder Nozzle

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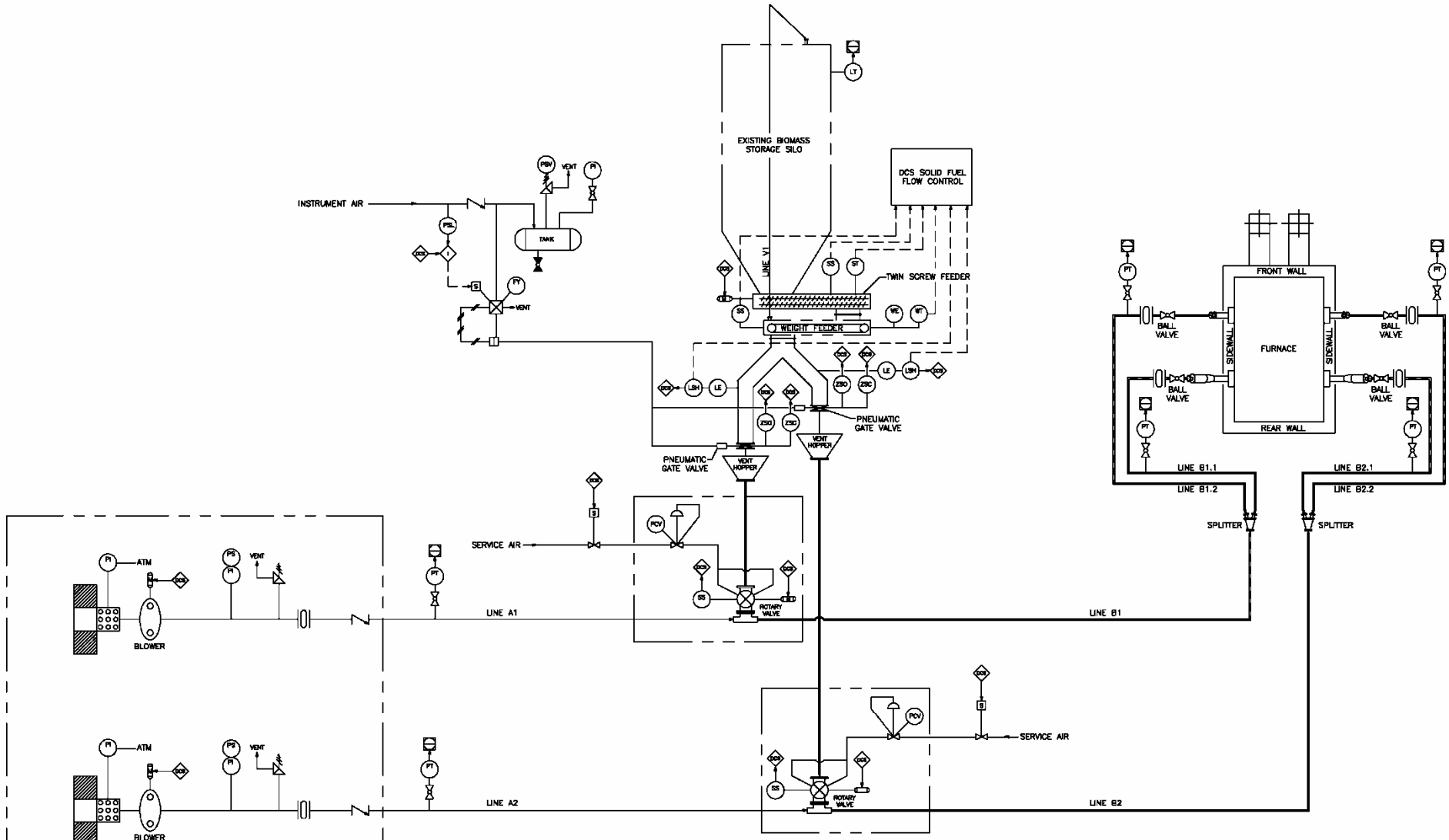

Oat Hull Fuel Feed System PID

Oat Hull Transport System

Auto Fuel Block Valves

Air Locks

Transport Air

Dust Recovery

Twin Screw Feeder

Lean Phase Transport

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Emission (stack) Testing Results

	SO2 (lb/MMBtu)	NOx (lb/MMBtu)	PM (lb/hr)	CO (lb/MMBtu)	VOC (lb/MMBtu)
Permit Limit	1.0	0.40	6.69	0.30	N/A
100% Coal	0.21	0.22	2.51	0.06	0.33
50% Oat Hulls	0.13	0.18	1.57	0.03	0.11
80% Oat Hulls	0.08	0.18	1.32	0.20	0.18

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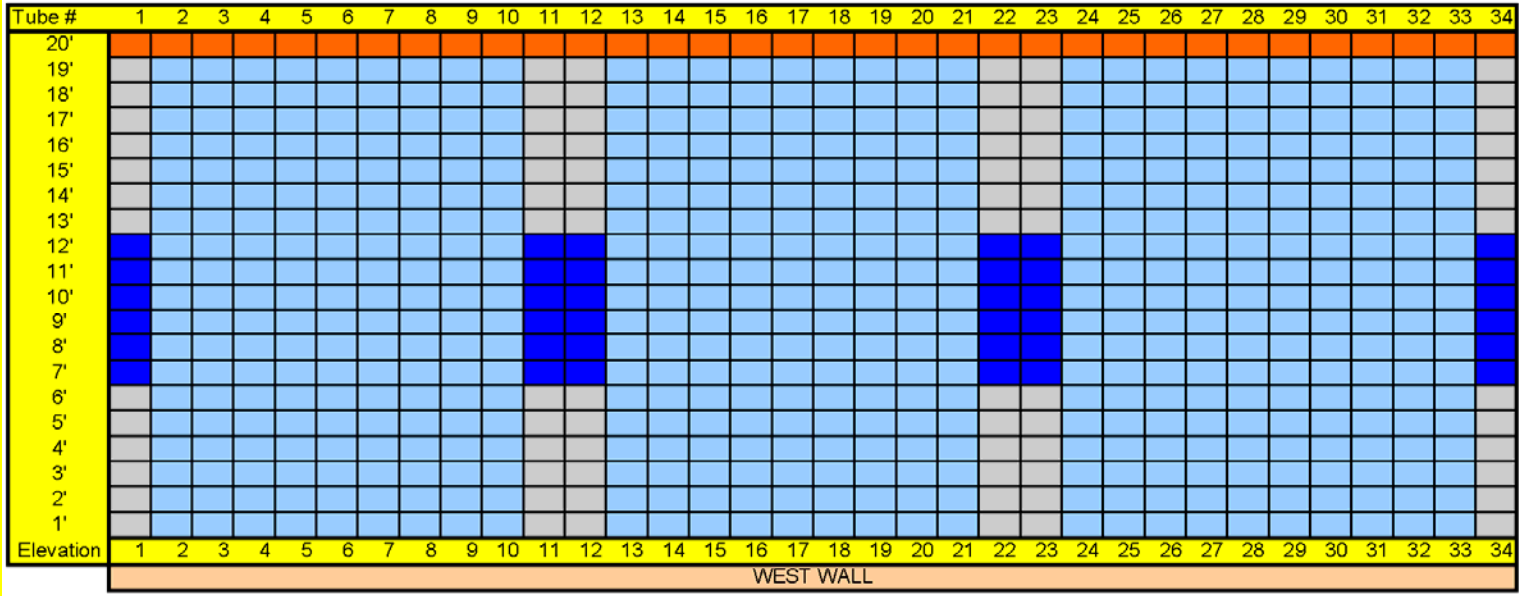
Flame Spray Layout



Panel Tie-in

Field applied Nanosteel to panel Tie-ins (Instead of HV Armacor)

Shop applied HVOF

Shop applied Nanosteel

06C Applied at Weld Line

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Spring 2007 Outage

Screen tubes in front of superheater, downstream of cyclone outlet

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Spring 2007 Outage

Loop seal

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UI Biomass Fuel Project Results

Calendar Year	Tons of Coal Displaced	Avoided Emissions Tons CO2	Boiler Bio Heat Input	Avoided Fuel Cost
2003	11,511	28,385	18%	$ 391,299
2004	16,636	41,024	24%	$ 415,273
2005	24,290	59,899	36%	$ 765,471
2006	27,424	67,627	41%	$ 1,017,780
2007	23,324	57,518	43%	$ 872,136
2008	17,929	44,213	41%	$ 712,672
6-Yr Total	121,113	298,666		$ 4,174,630

Avoided costs include fuel cost difference, lower limestone consumption, less ash disposal, and less coal system maintenance

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Chicago Climate Exchange (CCX)

CCX is a cap and trade system whose Members make a legally binding emission reduction commitment.

Members are allocated annual emission allowances in accordance with their emissions Baseline and the CCX Emission Reduction Schedule.

Members who reduce beyond their targets have surplus allowances to sell or bank; those who do not meet the targets comply by purchasing CCX Carbon Financial Instrument® (CFI®) contracts.

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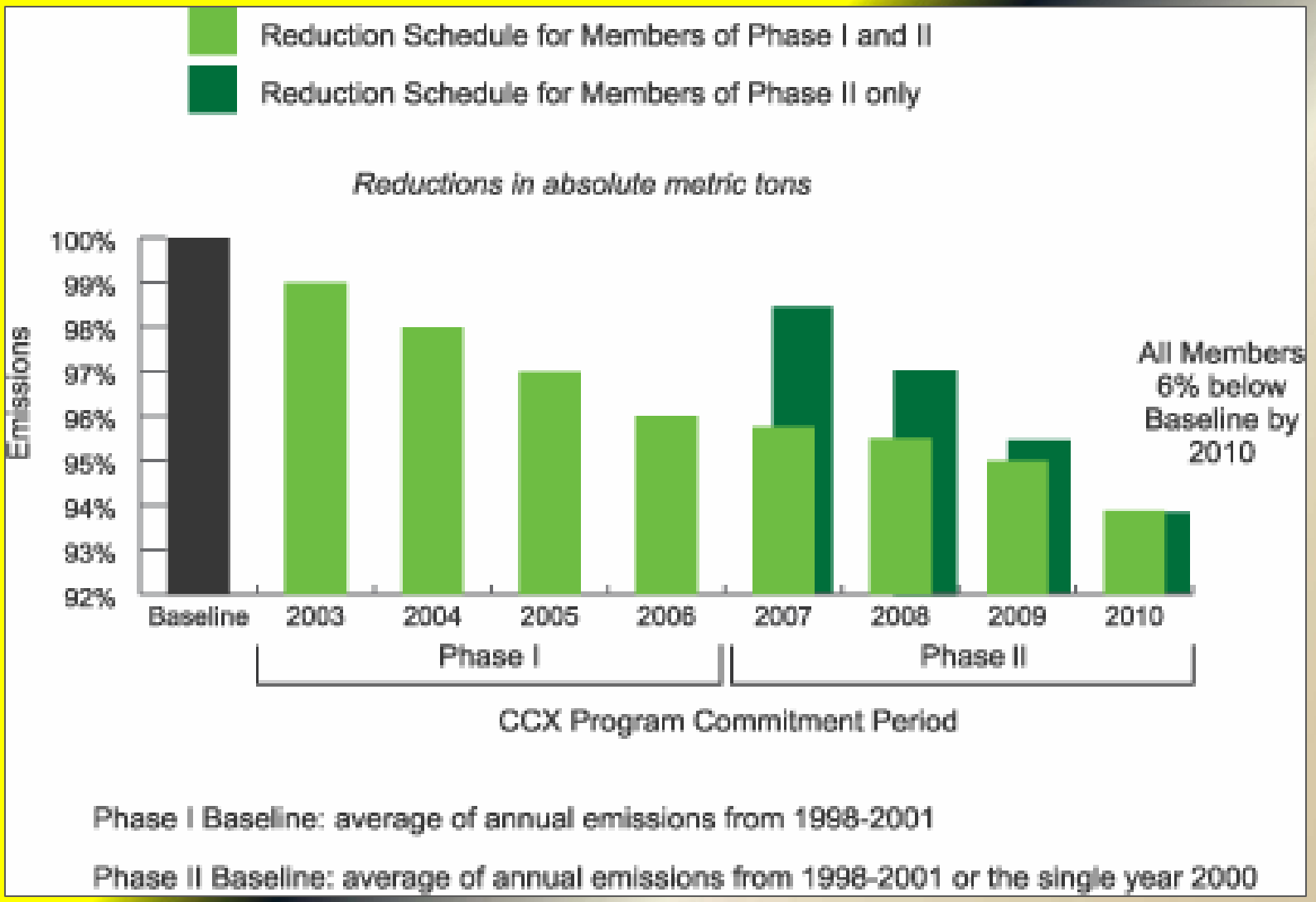
CCX Required Reductions



Phase I Baseline: average of annual emissions from 1998-2001

Phase II Baseline: average of annual emissions from 1998-2001 or the single year 2000

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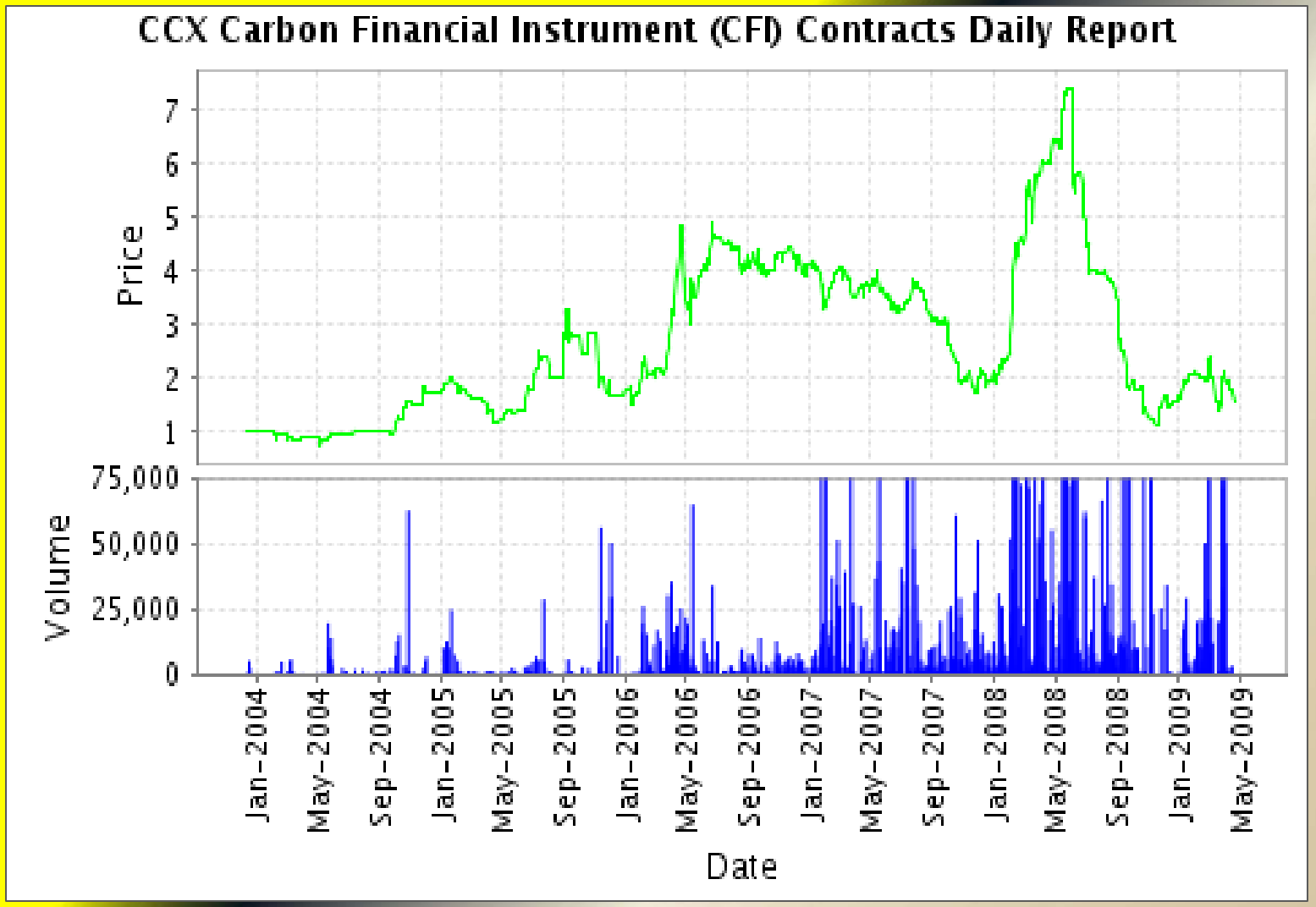
CCX CO2 Cost History



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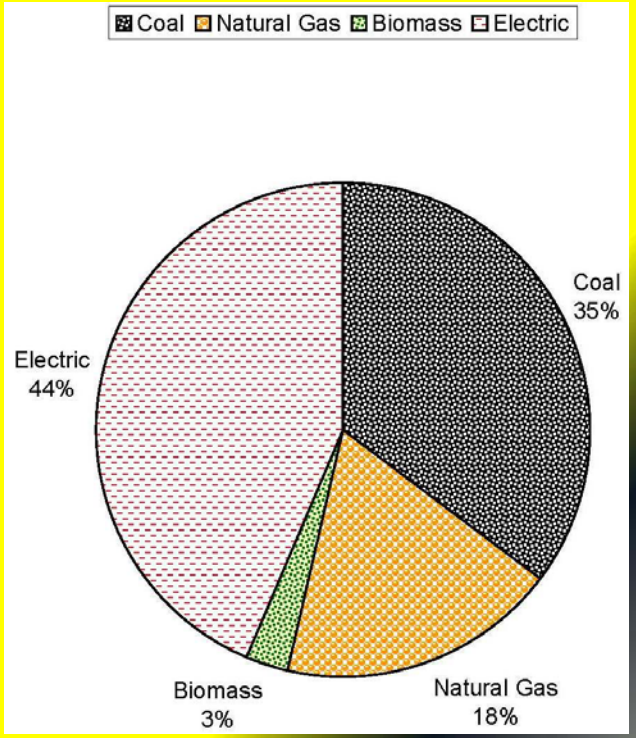
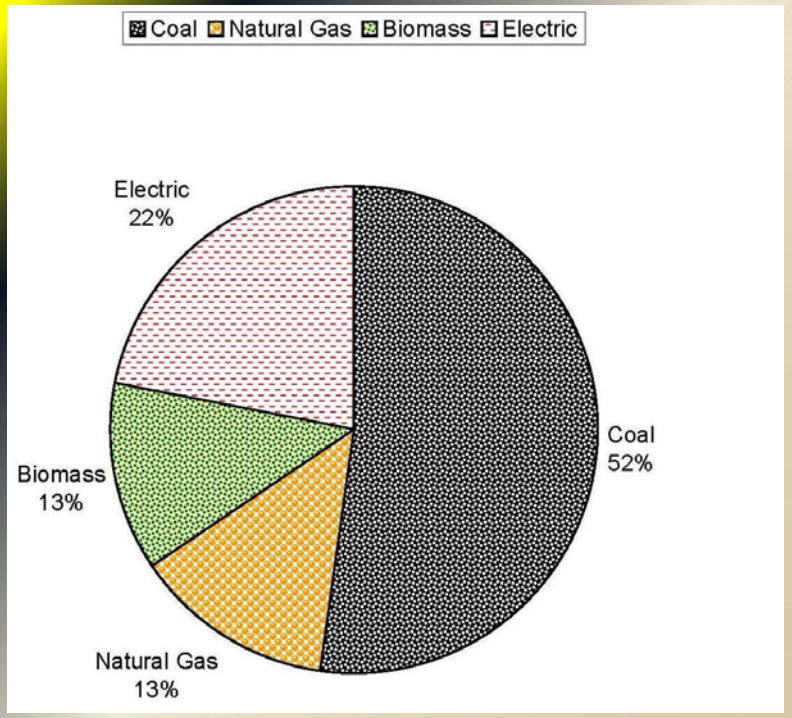
Purchased Energy Type and Cost



Cost ($)



Type (MMBtu basis)

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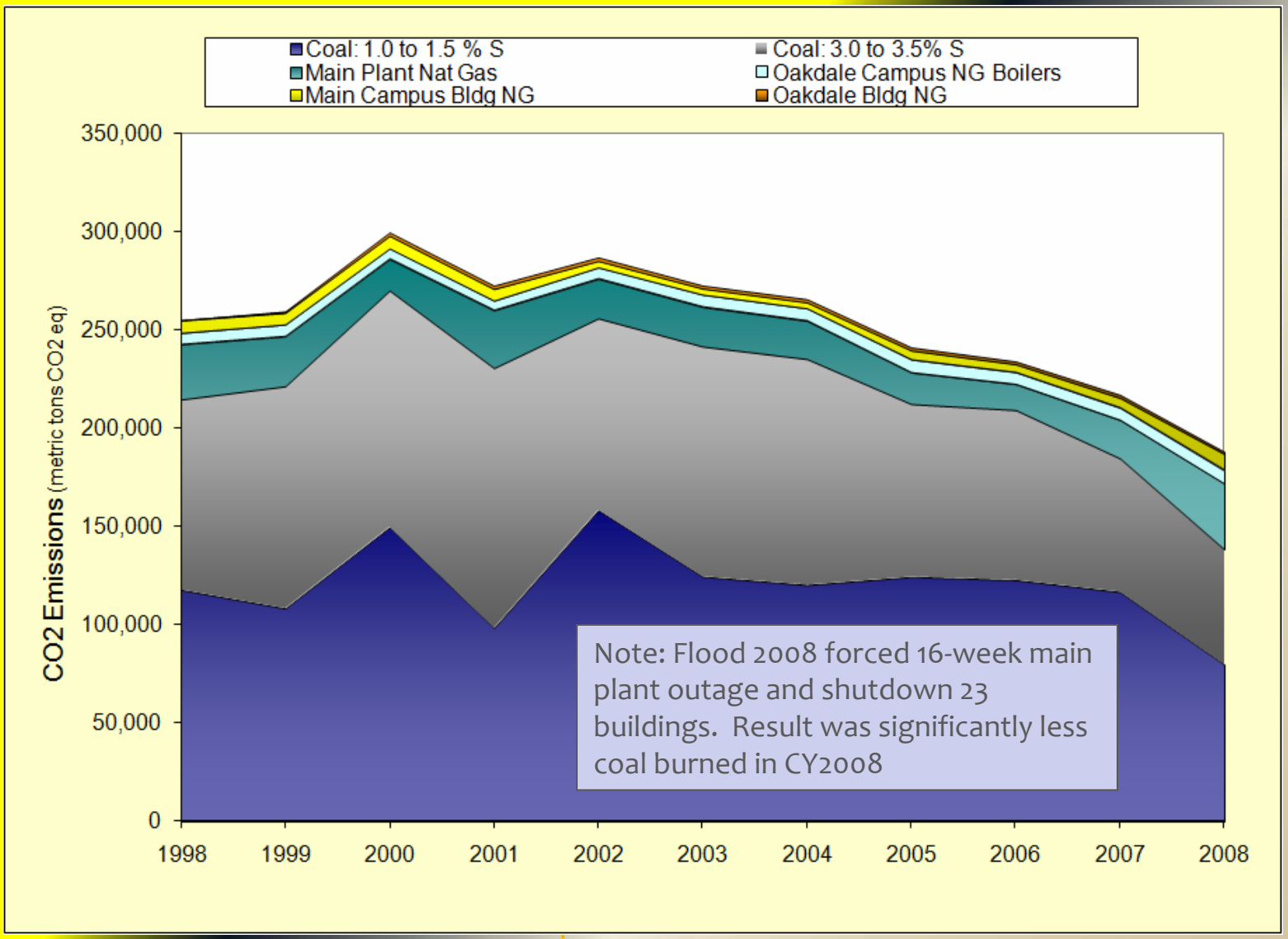
UI Purchased Fuel CO2 Emissions



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Questions / Discussion

http://ui.media.uiowa.edu/btn/iowamag4.html

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