FEASIBILITY ANALYSIS FOR INSTALLING A CIRCULATING FLUIDIZED BED BOILER FOR COFIRING MULTIPLE BIOFUELS AND OTHER WASTES WITH COAL AT PENN STATE UNIVERSITY

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Project Kick-Off Meeting

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The Energy Institute

PROJECT OBJECTIVE

- Perform a feasibility analysis on installing a state-of-the-art CFB boiler and ceramic filter emission control device for cofiring multiple biofuels and other wastes with coal or coal refuse.

- Develop a test program to evaluate cofiring multiple biofuels and coal-based feedstocks.

PROJECT PARTICIPANTS

- Penn State University
  - The Energy Institute
  - Office of Physical Plant
  - College of Agricultural Sciences
    - Farm Operations
    - Agricultural & Biological Engineering Department
    - Horticulture Department
- Foster Wheeler
- Cofiring Alternatives

CFB BOILER SYSTEM WILL BE UNIQUE:

1) be compact vs. traditional design

2) include modules for ceramic filters

3) contain an advanced instrumentation package including temperature and pressure sensors, deposition and slagging probes, heat flux meters, and corrosion/erosion panels

4) contain multi-fuel capabilities

5) be a commercial facility in a rural, agricultural setting that contains an engineering and agricultural-based university

THE STATE-OF-THE-ART CFB BOILER SYSTEM WILL ALLOW THE UNIVERSITY TO:

- more economically supply heat to the University Park Campus
- reduce the amount of air-borne pollutants (NO_X, SO_2, fine PM, and potentially trace elements), thus helping to reduce the overall emissions from the University's central heating plant
- reduce the amount of agricultural and other waste products produced by the University
- help reduce the amount of CO_2 emissions by combusting waste biofuels
- serve as a commercial demonstration-size test facility for federally and other outside source-funded R&D projects

THE FEASIBILITY ANALYSIS WILL ASSESS:

- the economics of producing steam
- the economics of off-sets such as utilizing multiple biomass and other wastes
- the value of a unique CFB test facility to perform research for industry and government agencies
- the environmental aspects of the CFB boiler
- the availability of funding from multiple sources including University, state, and federal sources

The feasibility study will also include developing a multi-year program to test biofuels in a boiler system that is heavily instrumented and able to handle multiple fuels.

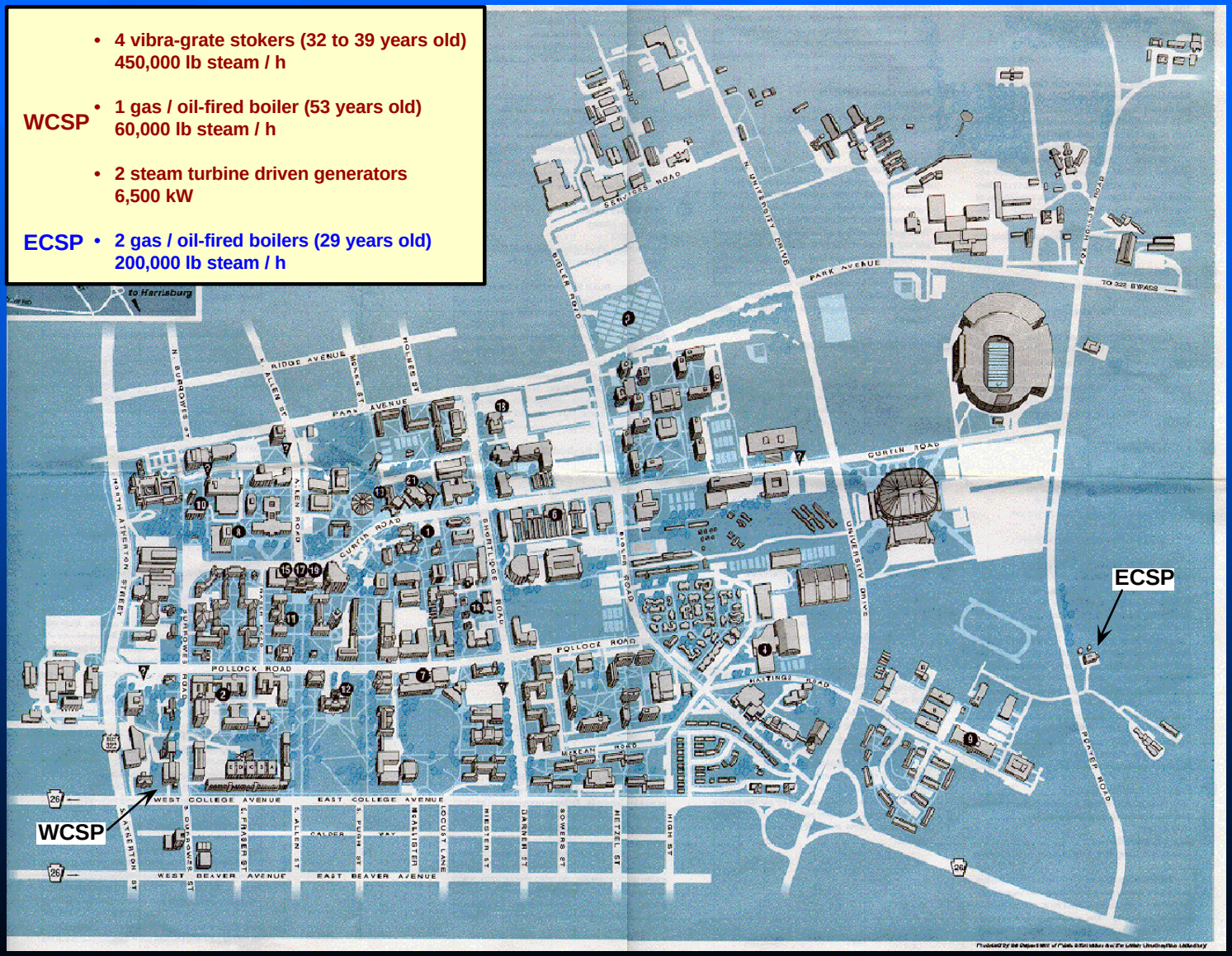
PENN STATE'S WEST CAMPUS AND EAST CAMPUS STEAM PLANTS

WCSP

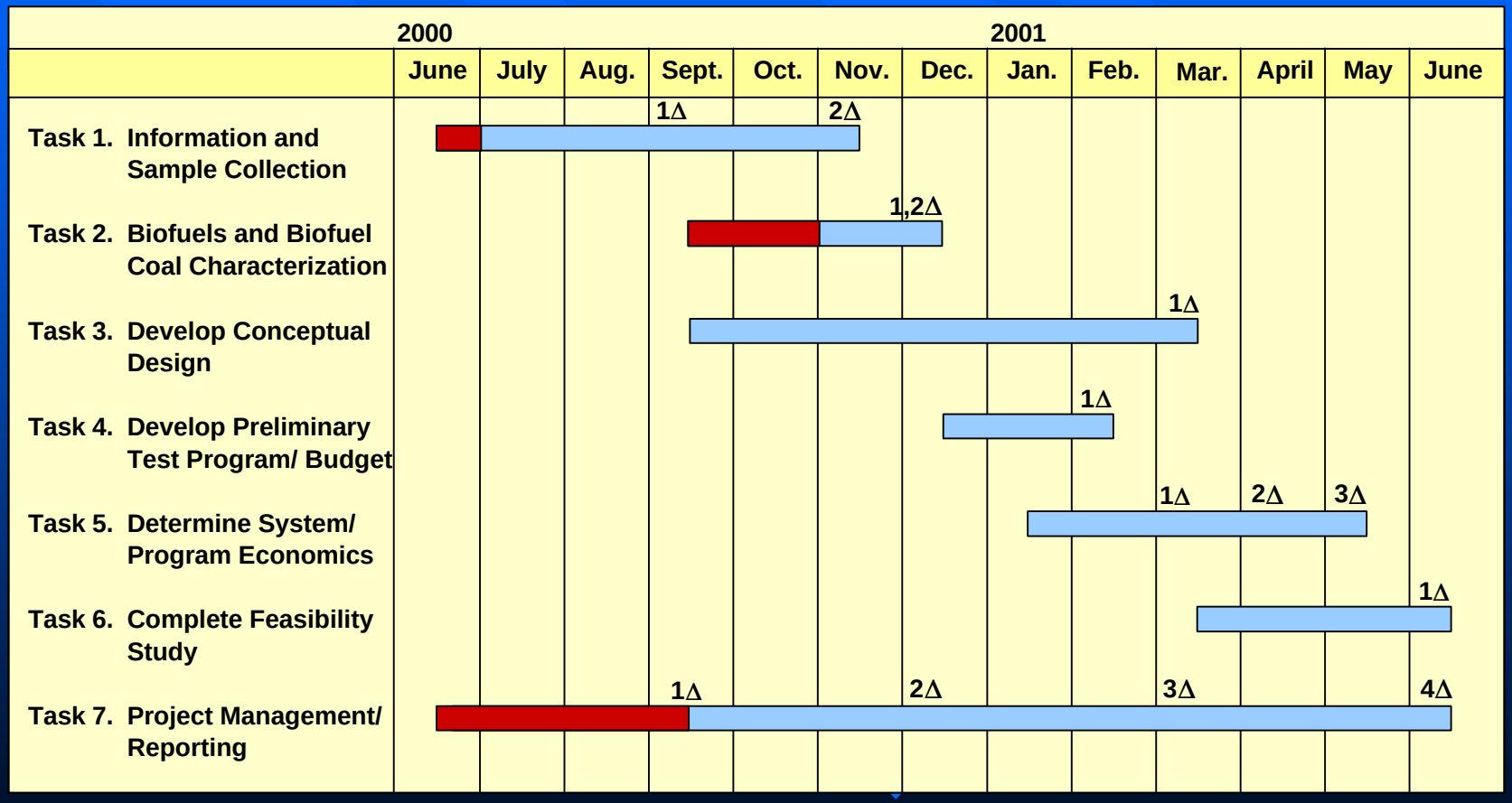
- 4 vibra-grate stokers (32 to 39 years old)
  450,000 lb steam / h
- 1 gas / oil-fired boiler (53 years old)
  60,000 lb steam / h
- 2 steam turbine driven generators
  6,500 kW

ECSP

- 2 gas / oil-fired boilers (29 years old)
  200,000 lb steam / h



MILESTONE SCHEDULE



SUMMARY OF ACTIVITIES

Task 1. Information and Sample Collection

- Assemble system requirements and infrastructure requirements
- Collect representative samples of biofuel, coal, and coal refuse

Task 2. Characterize Biofuels and Biofuel/Coal Combinations

- Analyze samples
- Assess issues such as materials handling, deposition, and emissions

Task 3. Develop Conceptual Design

- Design a state-of-the-art CFB boiler system to address objectives

SUMMARY OF ACTIVITIES (continued)

Task 4. Develop Preliminary Test Program/Budget

- Develop and cost a 3-5 year test program to use the CFB boiler system

Task 5. Determine System/Program Economics

- Determine capital and operating costs
- Assess availability of funding for the system and test program

Task 6. Complete Feasibility Study

- Integrate results from Tasks 1 through 5

PROJECT STATUS

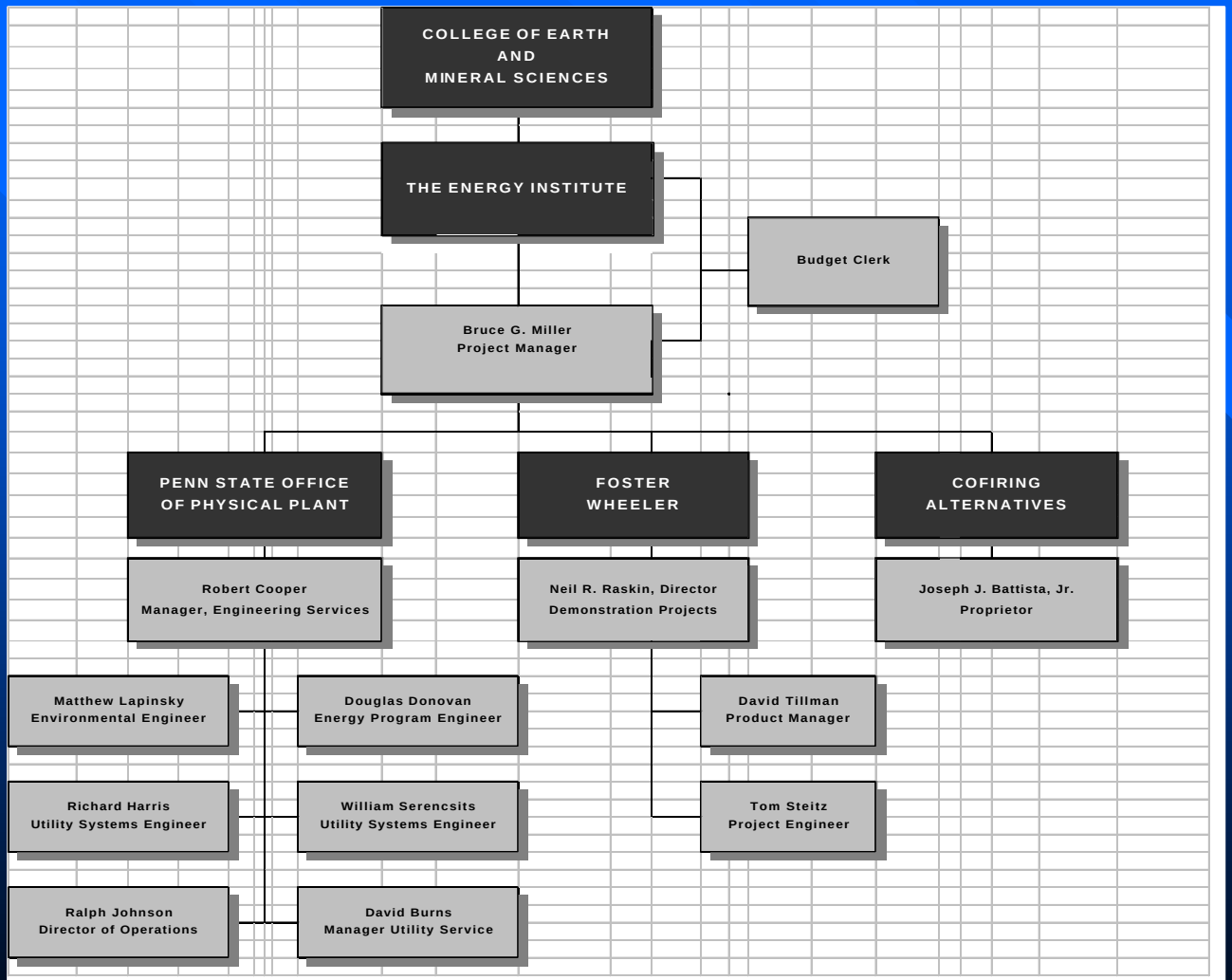
- Contract signed 06/15/00
- Subcontract executed with Cofiring Alternatives 09/25/00
- Subcontract still being negotiated with Foster Wheeler
- Assessment of the types and quantities of potential feedstocks has started
- Preliminary list of potential feedstocks developed

PROJECT STATUS (continued)

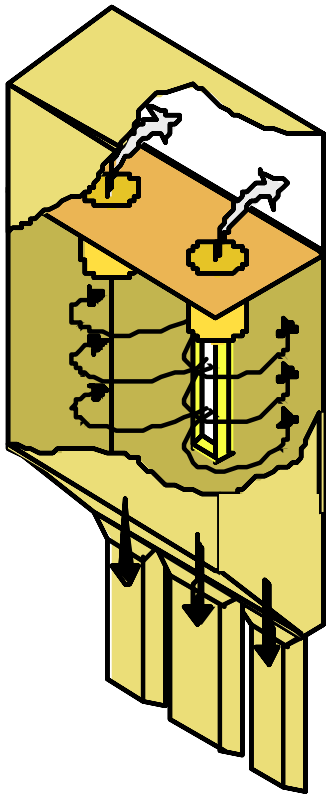
Sample collection and analyses have started

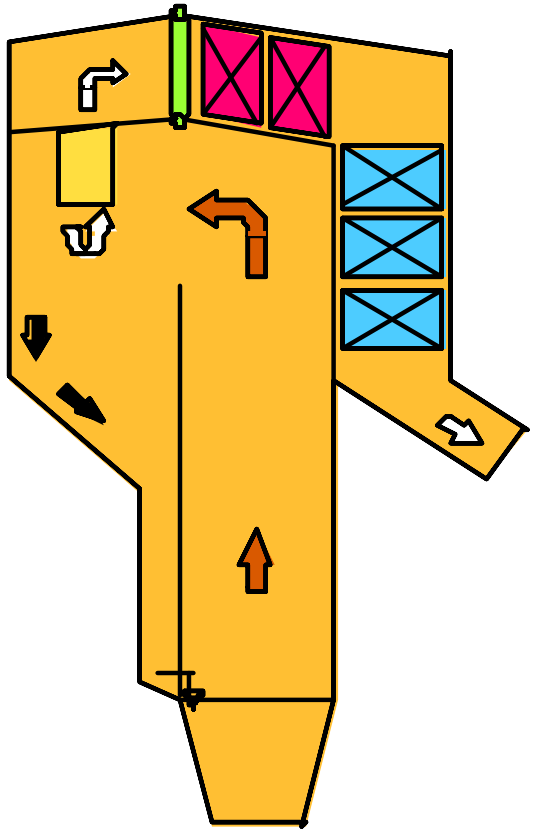
- Waste Water Treatment Plant Sludge
- WWTP Digester Effluent
- Pine Chips
- Pine Shavings
- Red Oak Shavings
- Stoker boiler fly ash
- Stoker boiler bottom ash
- Hard Plastic (Horticulture Dept.)
- Plastic Bags
- Miscellaneous Manure from Covered Manure Barn
- Dairy Tie-Stall Manure
- Dairy Free-Stall Manure
- Mulch Hay
- Mulch Leaves
- Bale Tarp
- Silo Bunker Cover
- Sheep Manure
- Beef Barn Manure
- Swine Waste

PROJECT ORGANIZATIONAL CHART

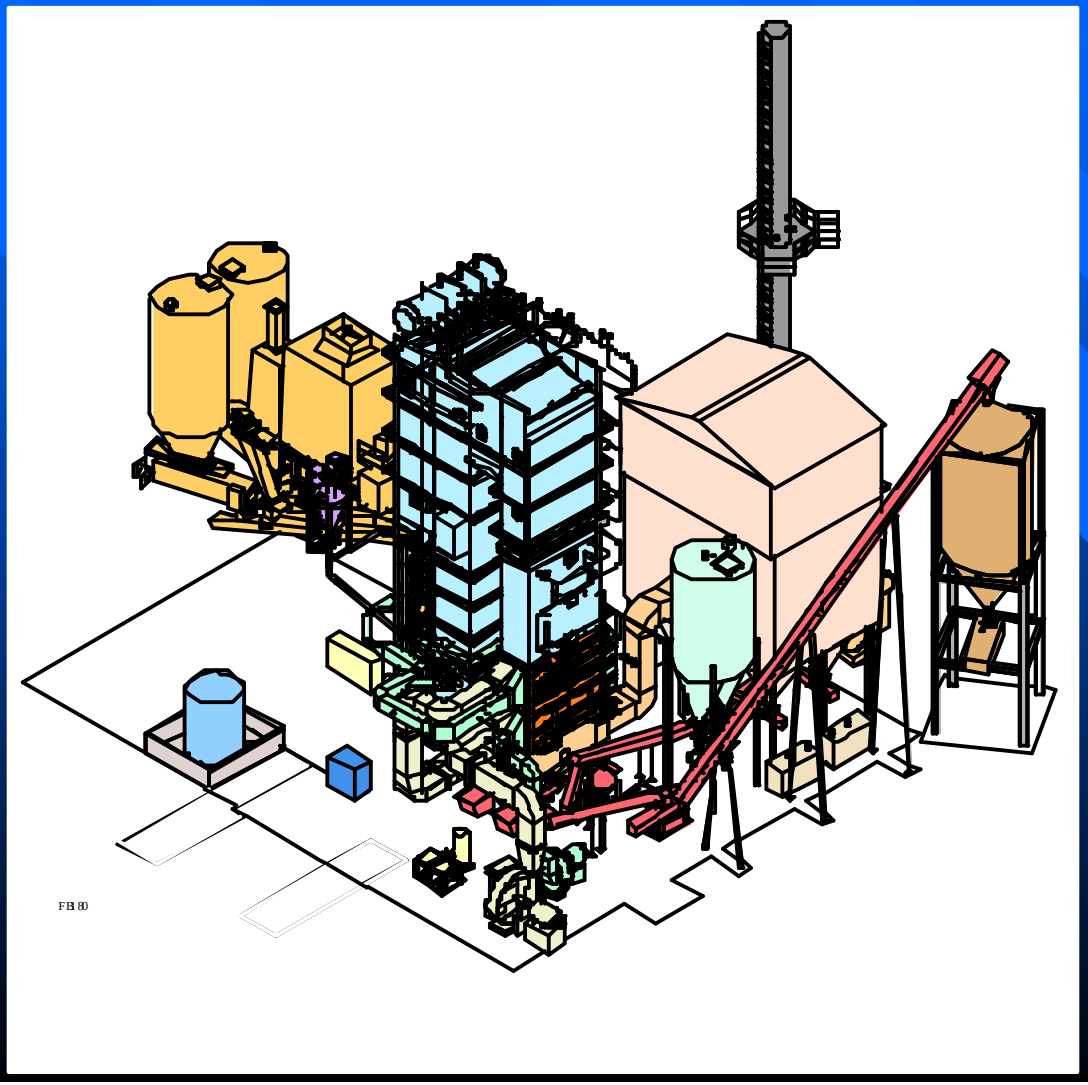


STATE-OF-THE-ART ACFB BOILER





CONCEPTUAL DESIGN



POTENTIAL CFB FEEDSTOCKS

Material	Quantity (tons/yr)
Biomass/Biomass Waste at University Park	
Animal Wastes:	
Dairy manure (tie stall and free stall mixed with leaves)	**13,200**
Manure from covered manure barn (poultry litter, horse barn, misc.)	**1,180**
Beef manure	**1,033**
Sheep manure	**265**
Swine waste	**2,505 (@ 2.2% solids)**
Woodwaste/brush	**150**
Pallets	**92**
Reed Canary Grass	**600**
Other Wastes at University Park	
Sewage sludge	**2,708 (@ 12% solids)**
Bottom ash	**6,990**
Fly ash	**1,445**
Plastics - total	**2.1**
Horticulture hard plastics	**0.2**
Horticulture plastic bags	**1.0**
Bale tarps	**0.5**
Silo bunker covers	**0.4**
Used oil	**14**
Tires	**5**
Biomass from Surrounding Region	
Wood products (chips/shavings)	**20,000**

WASTE AND BY-PRODUCT STREAMS THAT WERE PRODUCED AT THE UNIVERSITY PARK CAMPUS DURING 1998

Material	Quantity (tons)
Biomass Waste/ By-Products	
Bedding/ manure	10,000
Wood waste/ brush	150
Leaves – Penn State	150
Pallets	92
Spoiled hay	small amount
Spoiled feed	small amount
Grass clippings	small amount
Excess lumber	unknown small amount
Woodchips/ sawdust	unknown small amount
Chicken litter	unknown small amount
Other Wastes	
Garbage	6,719
Bottom ash	6,394
Fly ash	1,400
Paper	736
Cardboard	472
Sewage sludge	360
Newspaper	200
Dead animals	95
Food waste	93
Used oil	14
Tires	5
Agricultural plastics – animal feed bags	5
Agricultural plastics – horticulture use	2