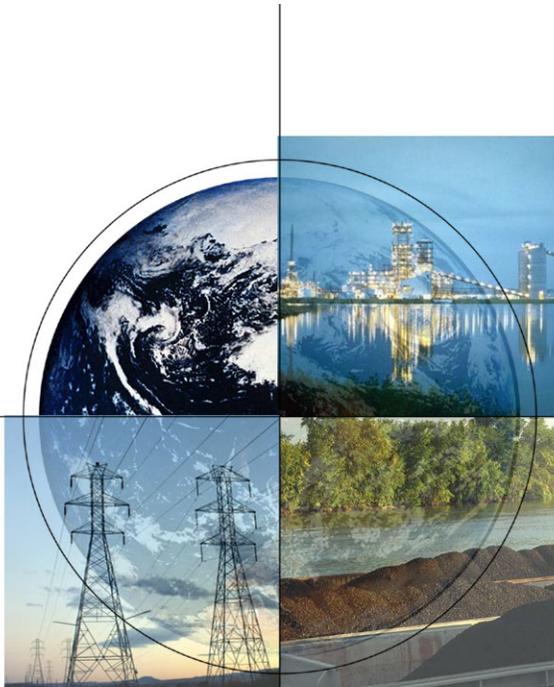


NETL Combustion Systems R&D Program



**Combustion Technologies
University Alliance
Workshop II**

**Columbus, Ohio
August 4, 2003**

**Donald L Bonk, Product Manager
National Energy Technology Laboratory**



Combustion

- **Over three quarters of all electricity in US is produced by combustion (coal, gas, oil, syngas and bio-mass) based power plants**
- **Over half US electricity is produced by solid fuel (coal-fired) combustion power plants**
- **Advanced combustion systems will remain the cheapest, most direct way to produce electricity for at least next 20 years**
- **Improvement, expansion and repowering of the combustion power plant fleet are opportunities for today's and tomorrow's power generators**



Combustion Technologies

Performance Goals

Dedicated to FE's Strategic & Vision 21 Goals, Clear Skies and Climate Change Initiatives

Performance	Conv'l System	LEBS (2004)	Advanced Systems (2009)	Advanced Systems (2013)
Emissions: (lb/10⁶Btu)				
SO₂	0.6	0.1	0.06	0.06
NOx	0.6	0.1	0.06	0.06
Particulate Matter	0.03	0.01	0.003	0.003
Thermal Efficiency: (Net, based on fuel HHV)	35%	42–45%	47–50%	55%
Cost of Electricity: (Relative)	100%	90%	85%	80%



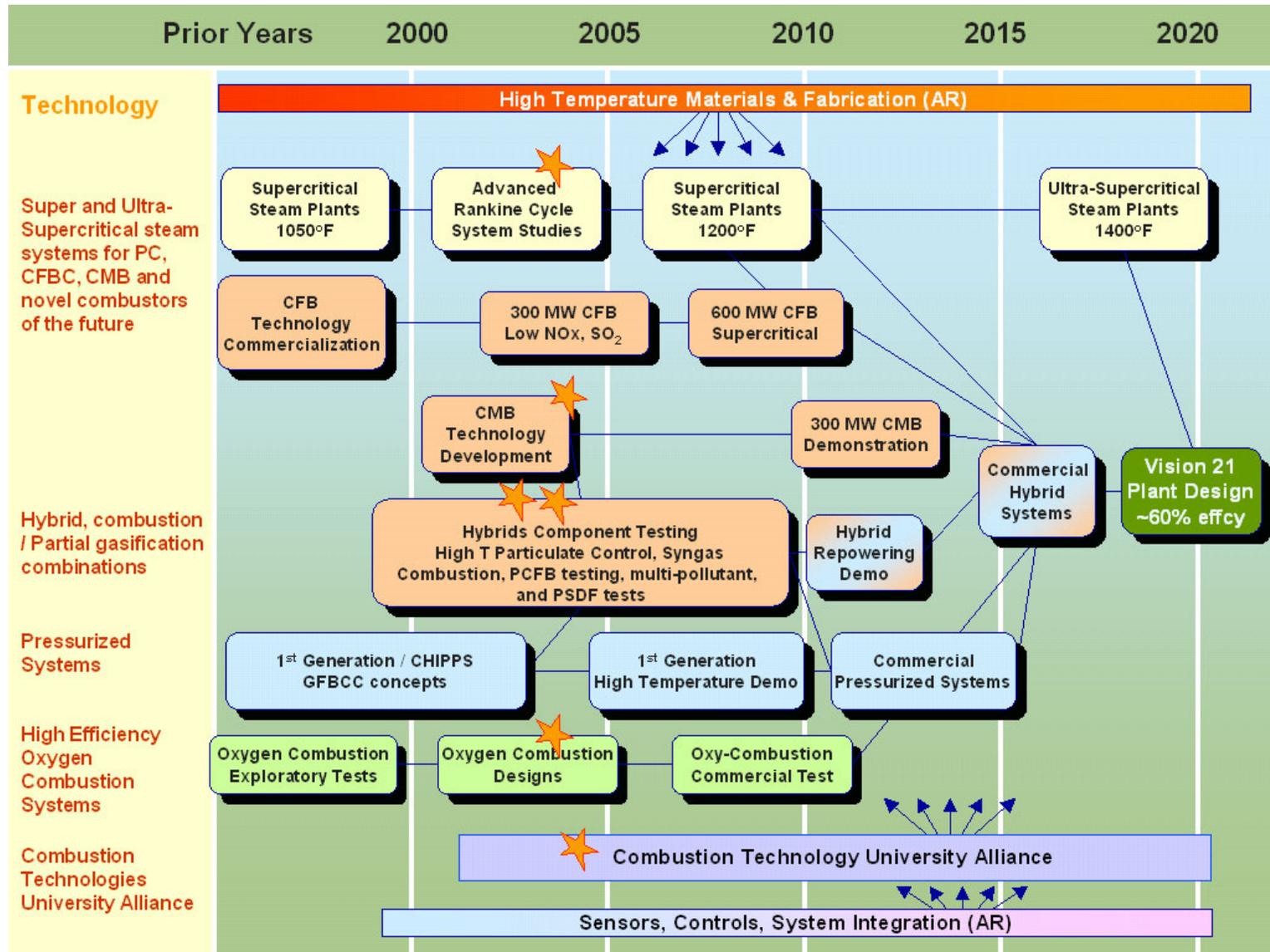
Combustion Technologies

Program Components

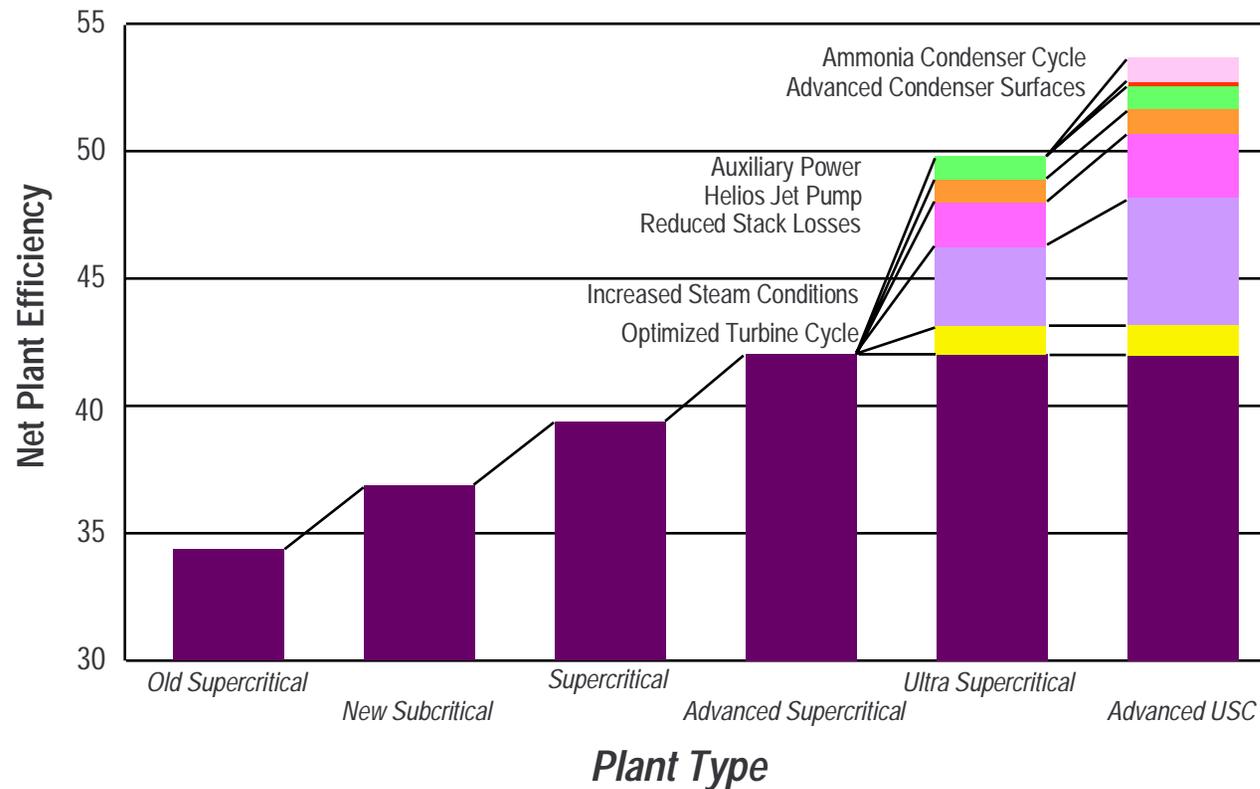
- **Super and ultra supercritical steam systems for PC, CFBC, CMB and novel combustors of the future**
- **Hybrid, combustion/partial gasification combinations**
 - CHIPPS and FBGCC
 - Educational interactive NETL/utility repowering studies
- **Pressurized systems**
 - Feeders and ash letdown
 - Hot gas filtration and multi-contaminant control
 - Coal-fired peaker
- **High efficiency oxygen combustion systems**
- **Combustion technologies university alliance**
 - Power reliability improvement & emissions reductions (PRIER)



Combustion Technologies Roadmap



Potential for PC Rankine Cycle Efficiency Improvement



Source: Babcock & Wilcox



ALSTOM Advanced CFB - “Circulating Moving Bed [CMB]”

- Separate heat transfer from combustion
- More effective surface allows supercritical steam conditions at lower cost
- Lower cost than ordinary CFB for conventional duty
- Lower auxiliary power
- Potential pathway to in situ CO₂ capture

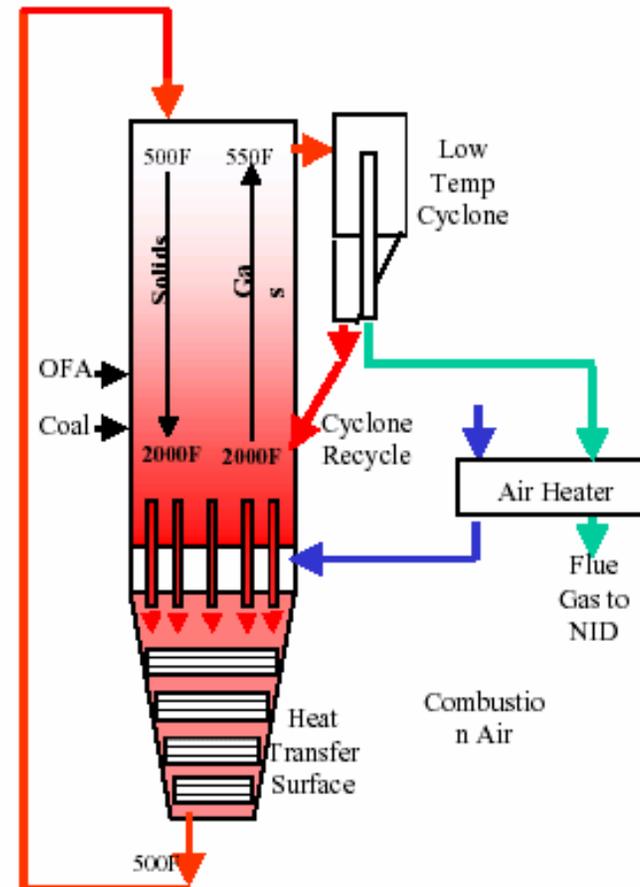


Image courtesy of ALSTOM

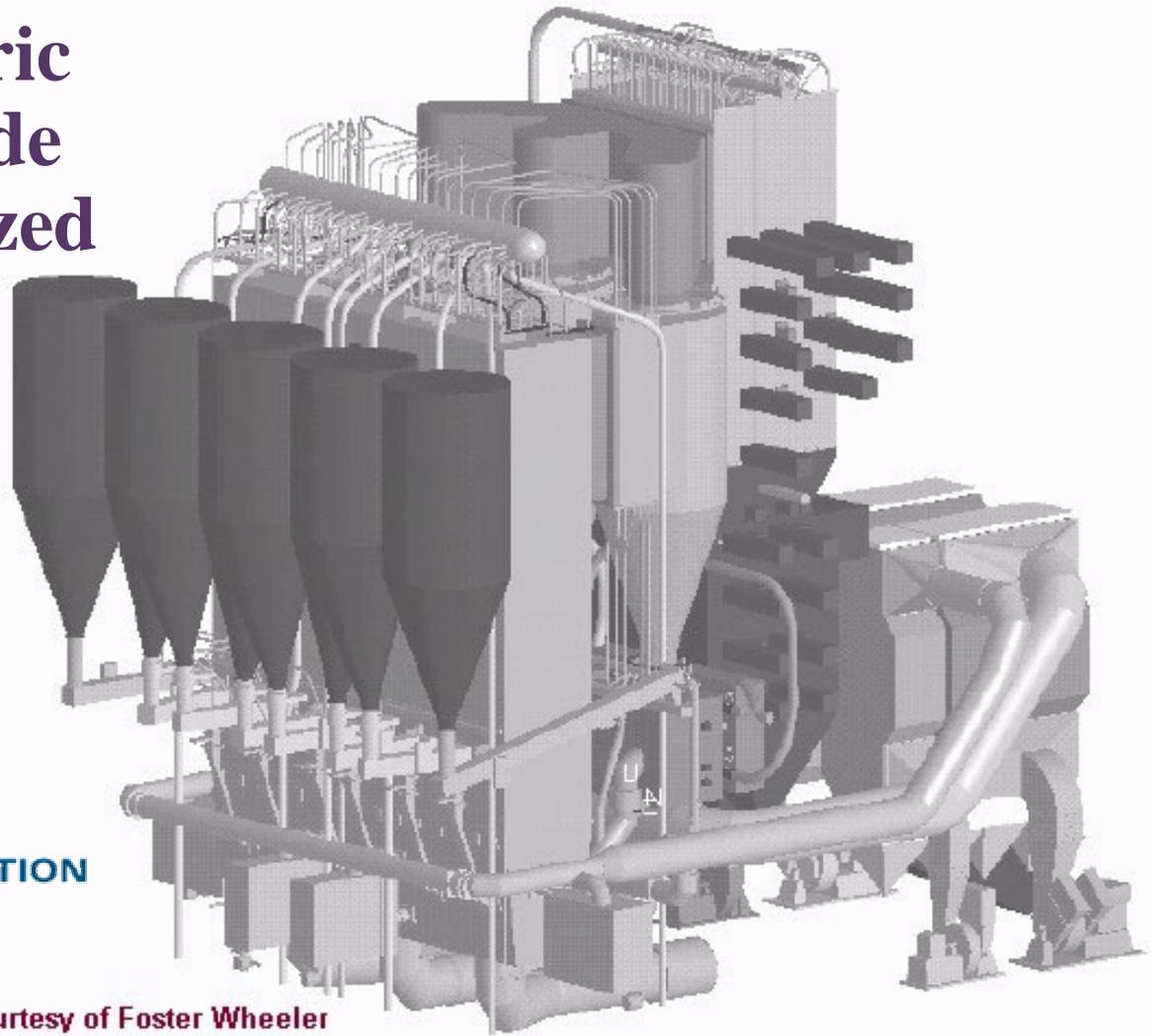


CTUA Awards In Supercritical Steam Systems

- **“Novel Burner and Turbine Proof of Concept Testing”**
 - Iowa State University
 - Total Award and FY02 Funding = \$25,000
- **No FY03 Proposals Received for Components, Welding and Manufacturing**
- **No FY03 Proposals for Additional Novel Systems Received**



Jacksonville Electric Authority Northside Circulating Fluidized Bed (CFB)



 FOSTER WHEELER CORPORATION

image courtesy of Foster Wheeler

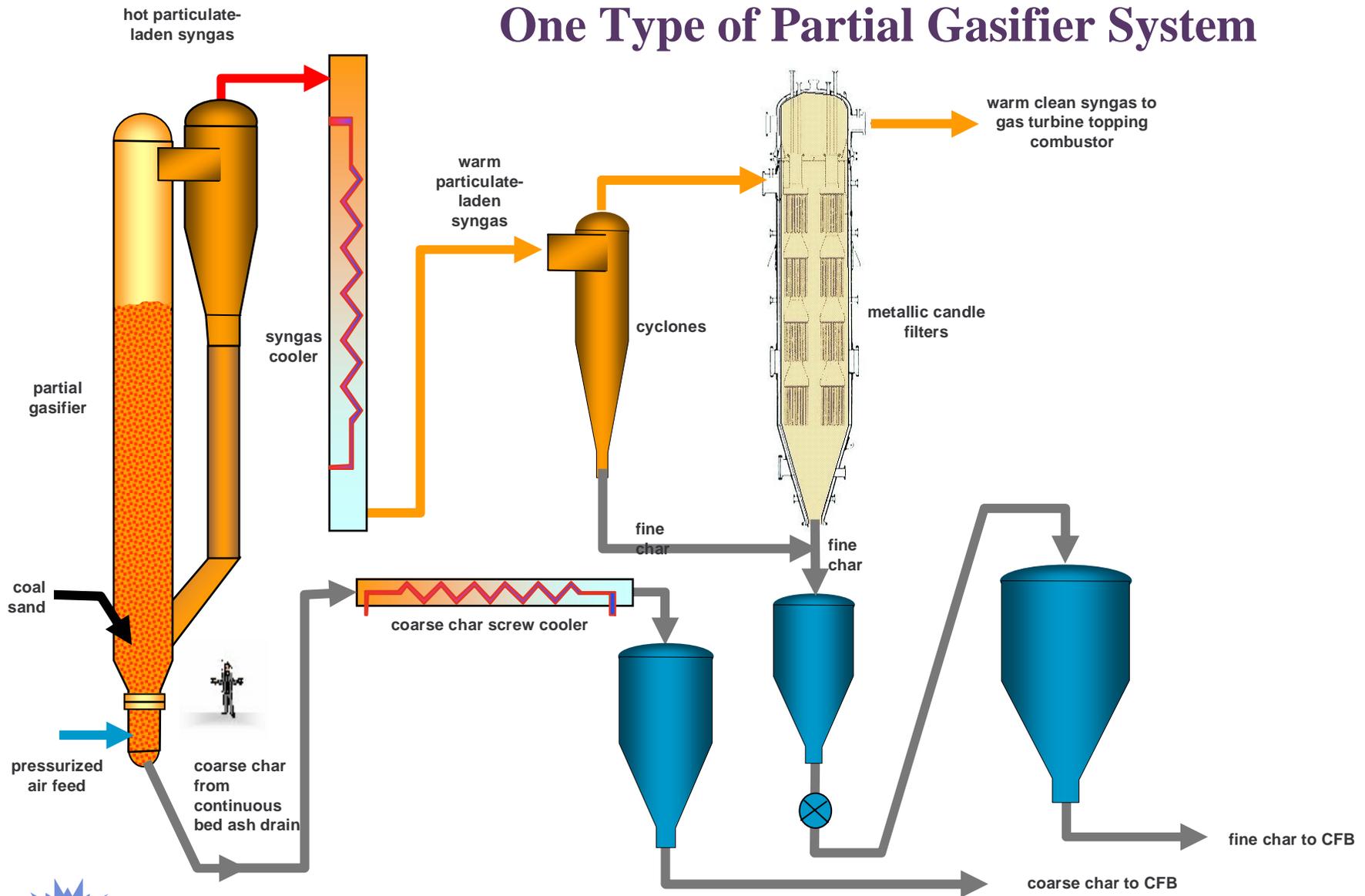


CTUA Awards In FBC Technology Commercialization Area

- **“Review of Need for CFB Environmental Controls”**
 - Western Kentucky University Research Foundation
 - Total Award and FY02 Funding = \$25,000
- **“Establishment of Environmental Control Technology with a CFB”**
 - Western Kentucky University Research Foundation
 - Total FY03 Award = \$2,000,000
 - FY03 Funding \$ 600,634



One Type of Partial Gasifier System



Performance Improvements at Sheldon Station Unit 1 with GFBC Repowering

- increased output
- increased energy efficiency

	NPPD	
	Existing Sheldon Unit 1 §	Sheldon Unit 1 Repowered with GFBC
Gas turbine gross, kWe	--	83,080
Steam turbine gross, kWe	110,097	112,150
Auxiliary steam turbine gross, kWe	--	16,600
Total Gross, kWe	110,097	211,830
Syngas airfeed steam turbine drive	--	15,900
Syngas airfeed compressor load	--	-15,900
Auxiliary losses, kWe	-4,447	-9,500
Net plant output, kWe	105,650	202,330
Net plant HHV efficiency	30.9%	36.5%
Net plant HHV heat rate, Btu/kWh	11,040	9,347

Output Almost Doubles

15% Less Fuel Needed per kW

§ these are the conditions used as baseline for the comparisons, not the rated output of the unit. Unit 1 rated output is 109,000 kWe

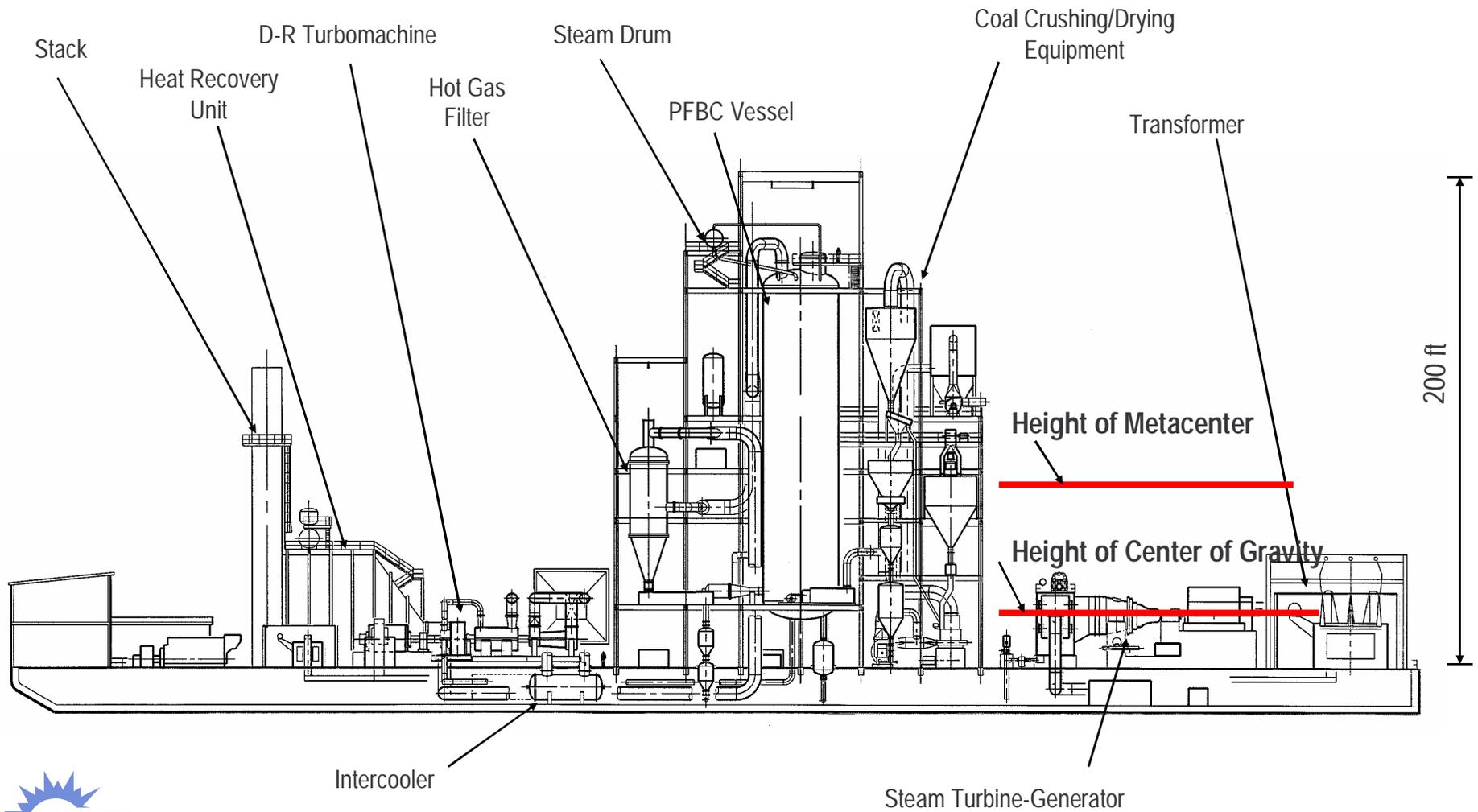


CTUA Awards In Hybrid Systems Area

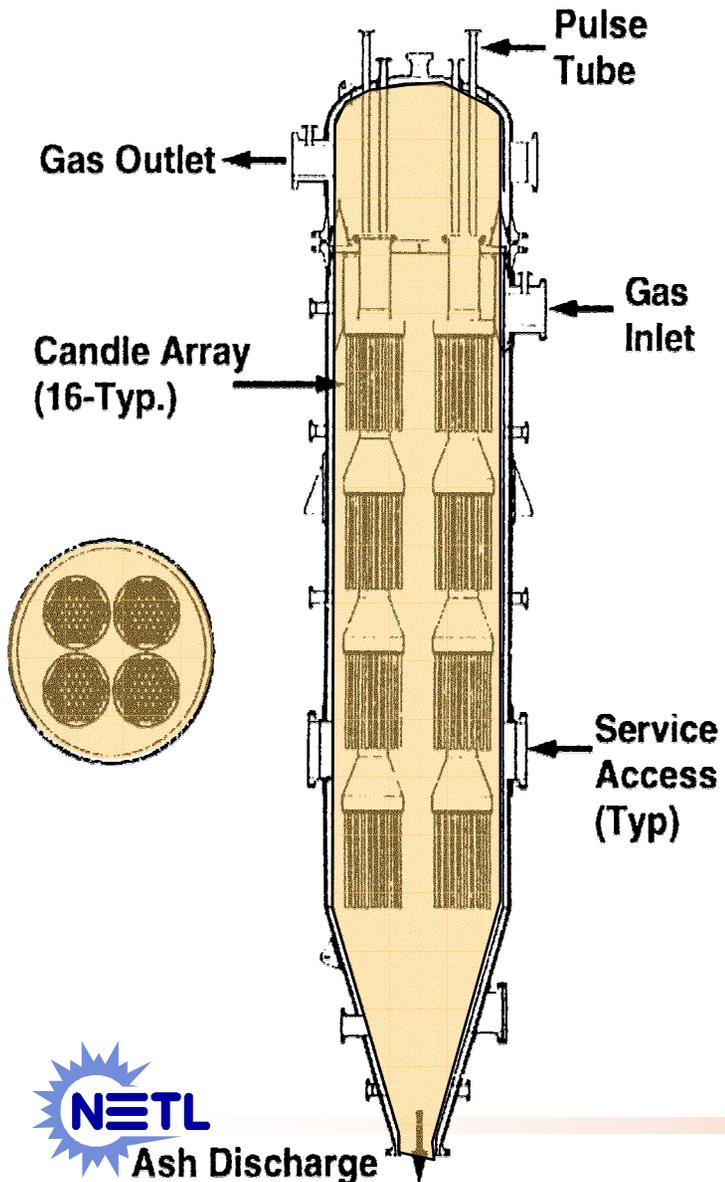
- **“Capacitance Probe for Cold Modeling of Fluidized Solids”**
 - Ohio State University
 - Total Award and FY03 Funding = \$25,000
- **No FY03 Proposals Received for Components**
- **No FY03 Proposals for Additional Novel Systems Received**



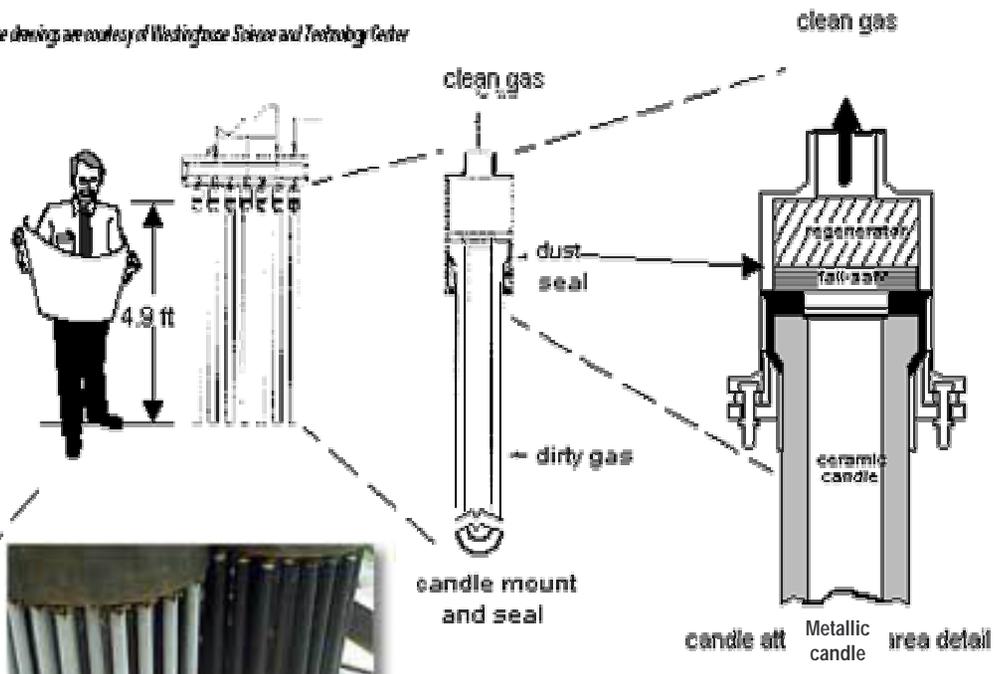
PFBC Elevation View-Broadside (140 MWe/Bituminous Coal/Barge)



Sketch of the Siemens Westinghouse Filter System



note: hot gas filter line drawings are courtesy of Westinghouse Science and Technology Center



Note: illustrations courtesy of Siemens Westinghouse

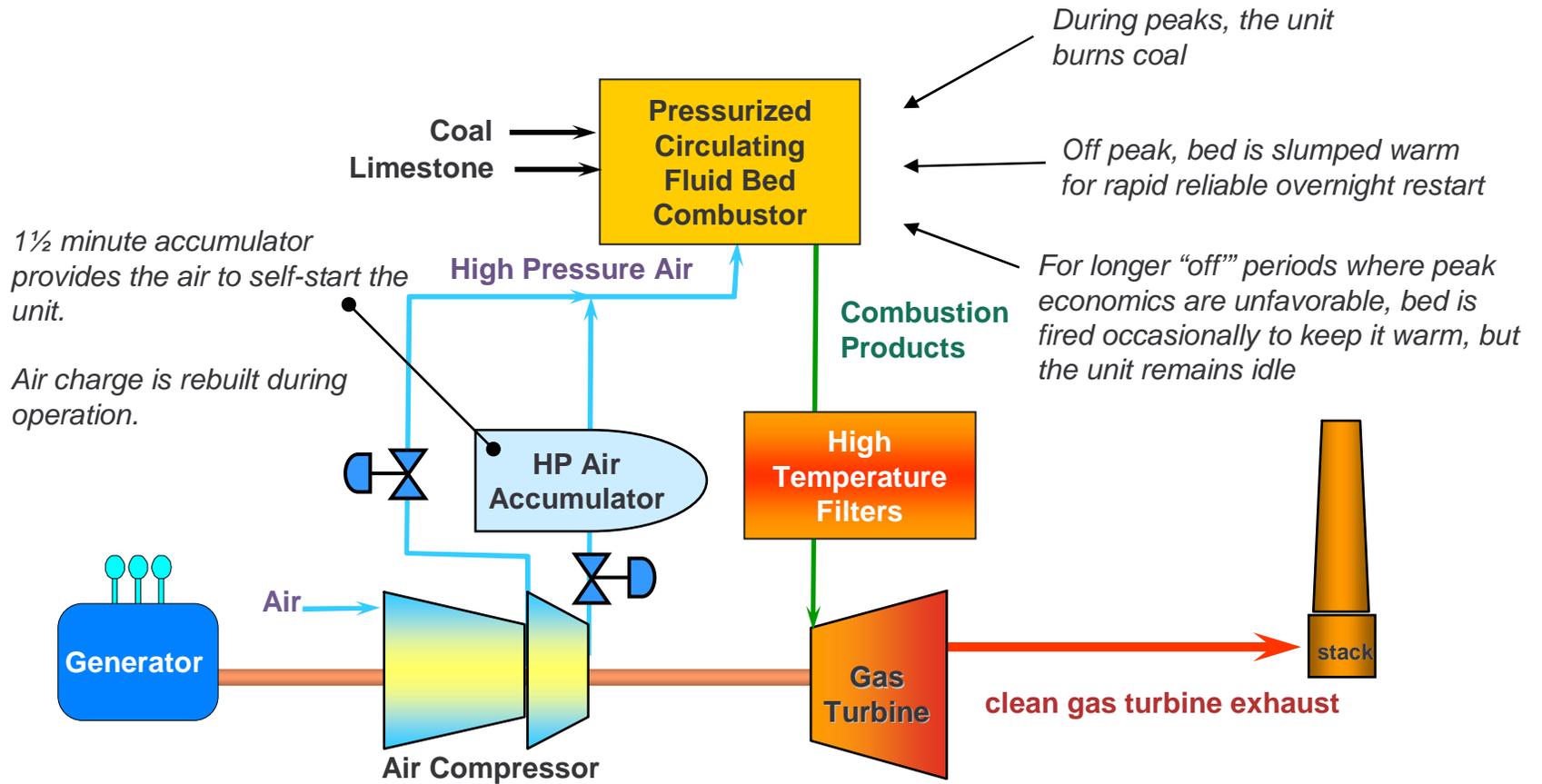


Siemens Westinghouse Candle Filter Assembly



Descriptor - include initials, /org#/date

Coal Peaker "A"?



13 ft outside diameter vessel	
1650°F bed	1750°F bed
16 atm operating pressure	21 atm operating pressure
20,300 kW	27,300 kW

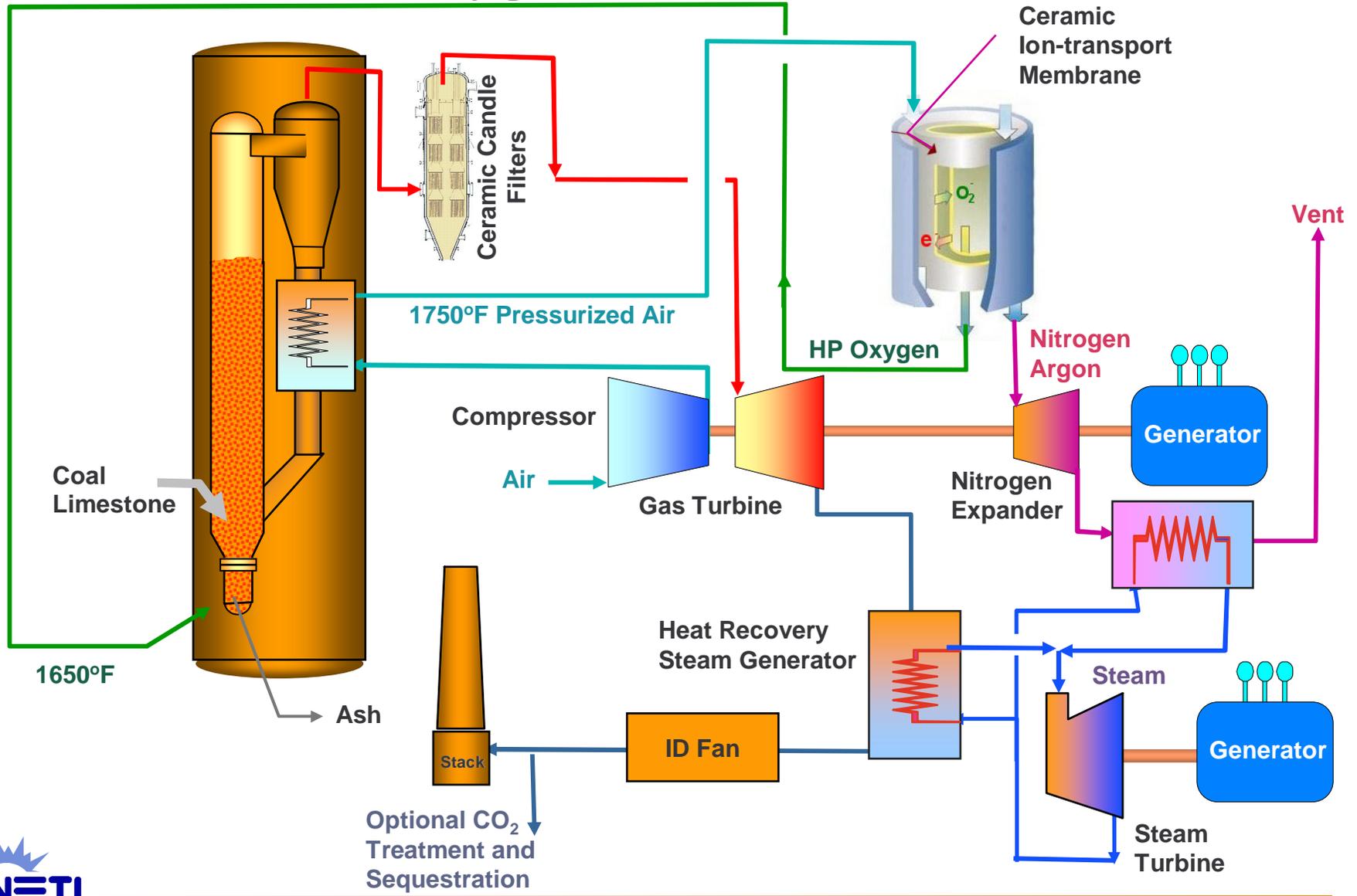


CTUA Awards In Pressurized Combustion Technology Area

- **“Qualifications of Candle Filters for Pressurized Applications”**
 - Southern Illinois University – Carbondale
 - Total FY03 Award = \$2,031,757
 - FY03 Funding = \$513,757
- **“Support of Atmospheric Coal Fired Peaker Tests”**
 - Ohio State Agricultural College and ENERCON
 - Total and FY03 Funding = \$25,000
- **Mercury Modeling, Multi-contaminate Study**
 - Western Kentucky University
 - Total Value and FY03 Funding = \$25,000



Oxygen-Fired PCFB



CTUA Awards In Oxygen Based Combustion Technology Area

- **“ Chemical Looping For Advanced Combustion”**
 - Ohio State University
 - Total and FY03 Funding = \$25,000



PRIER Program Goals

1. Increase Existing Coal Generating Reliability & Availability without increasing emissions by
 - Improving Overall Plant Performance
 - Reducing Effective Forced Outage Rate (EFOR)
2. Help Mitigate Projected Near-Term Power Shortages - accomplishments in 3 to 12 months.
3. Reduce Environmental Impact by Improving Overall Plant Performance.



CTUA Awards In PRIER Technology Area

- **“Balancing of PC Flows to Burners in Boilers with Pressurized Vertical Spindle Mills”**
 - Leigh University
 - Total FY03 Award = \$ 75,172
 - FY03 Funding \$ 22,273
- **“FBC Ash Cooler System Improvement Study”**
 - Penn State University
 - Total Award and FY02 Funding = \$25,000



CTUA Summary

- **FY 02**
 - Three Projects
 - Total Awards and Funding = \$75,000
- **FY 03**
 - Seven Awards
 - Total Awards = \$ 2,206,757
 - Funding = \$ 1,236,664
- **FY 04**
 - Budget Request = \$0
 - House Marks = \$5,000,000 for Base Combustion Program
 - Senate Marks = \$ 3,000,000 for Combustion Alliance



Combustion Technologies University Alliance

The Fast Track

Advanced Combustion Technologies can be developed SOON, your help is needed to develop data and experience base. They can be employed to repower existing plants or as greenfield units. The sooner the better

