Presentation
for the
Energy Development and Transmission Committee
October 3, 2010

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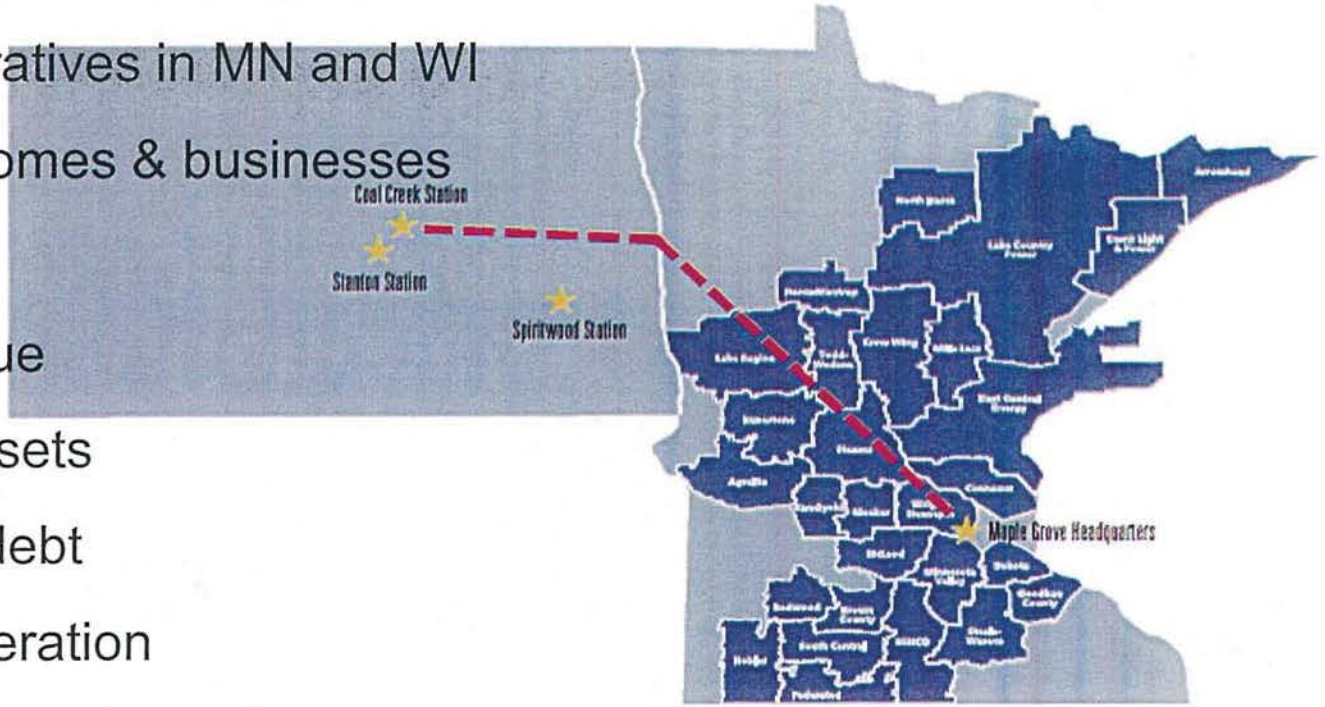
GREAT RIVER ENERGY®
A Touchstone Energy® Cooperative

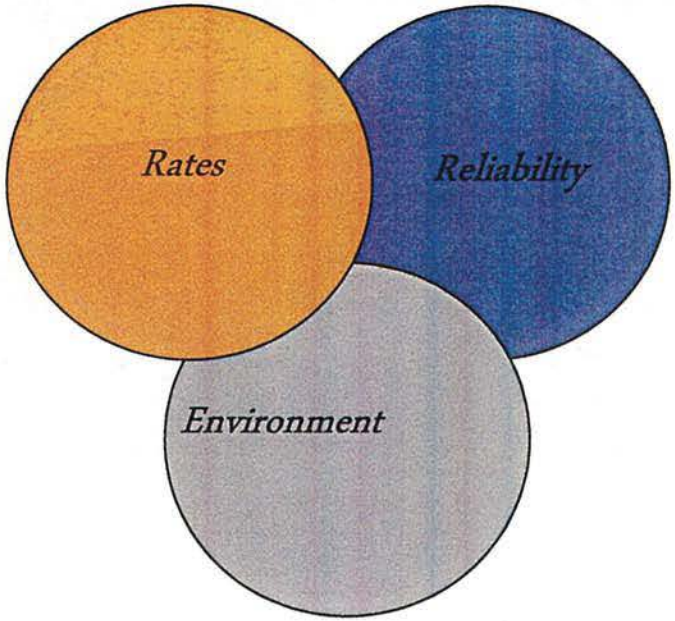
Great River Energy

- Generation & transmission cooperative
- 28 member cooperatives in MN and WI
- Serving 645,000 homes & businesses
- 850 employees
- $850 million revenue
- $3.3 billion total assets
- Investment grade debt
- 2,800+ MW of generation
- 4,500+ miles of transmission lines



Background - The "Triple Bottom Line"

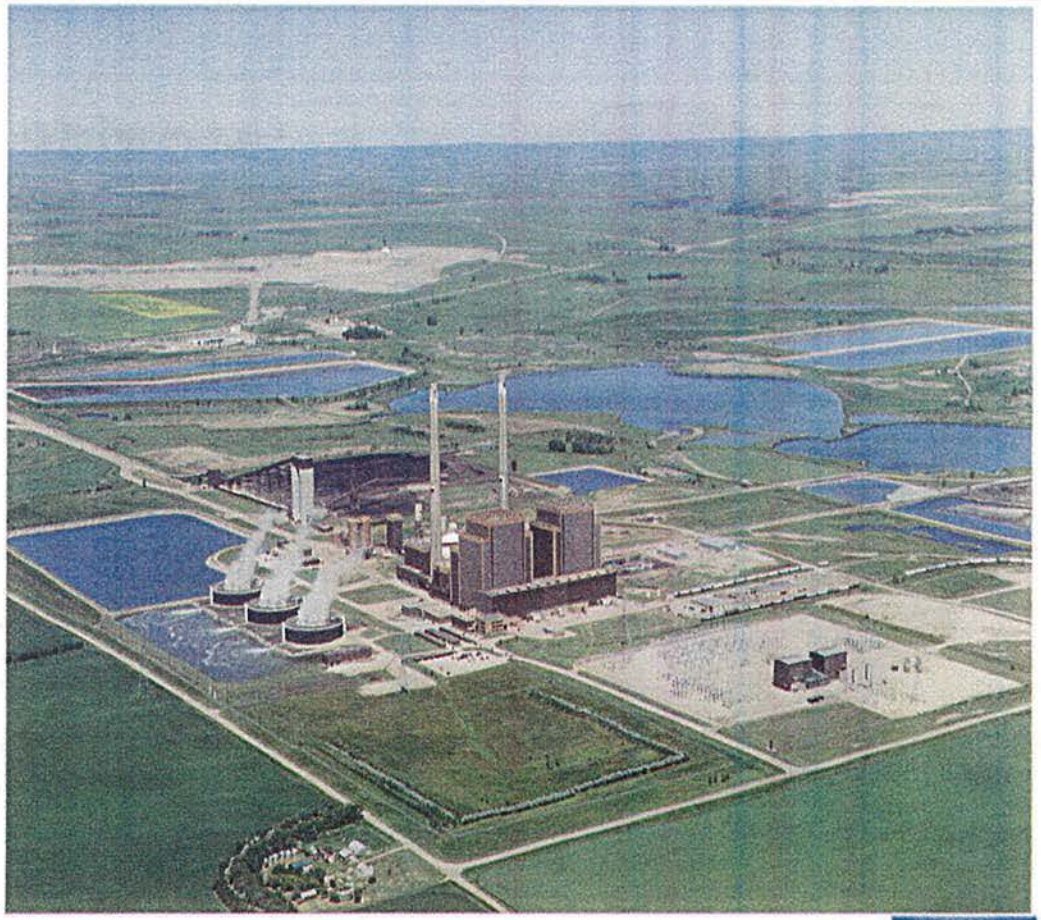
- **Great River Energy has a commitment to provide customers with:**
  - Stable rates
  - Reliable electricity
  - Environmental stewardship



- **Members annually approve:**
  - **Rates**
  - **New projects**
  - **Environmental investments**

Coal Creek Station

- Coal Creek Units #1 and #2…
  - 2 X 600 MW Natural Circulation
  - Tangentially Fired, Dual Furnace
  - 8 X 8 burners, plus SOFA
  - Eight Pulverizers per Unit
  - Mine Mouth, ND Lignite
    - 6,200 BTU/lb (14.4 MJ/kg)
    - 38% moisture
  - Commissioned 1979, 1981
  - Base Loaded
  - Wet FGD's, No SCR's
  - Closed Loop Cooling



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DryFining™

FUEL ENHANCEMENT PROCESS

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Problem Statement:

- Plant performance is based on 6,800 BTU/lb (15.8 MJ/kg) fuel (with normal margins), but delivered fuel HHV has rarely exceeded 6,200 BTU/lb (14.4 MJ/kg)
- As a result….
    - Lost Boiler And Cycle Efficiency
        - **9% Higher Coal Flow Rate Than Design**
        - **20 MW Of Station Service Power**
        - **20% Higher Flue Gas Flow Rate Than Design**
        - **High Exit Gas Temperature**
    - Lost Spare Mill Capability
    - Increased Operating And Maintenance Costs
    - **Flue Gas Flow Limited Scrubbers!**

Partnership Development Effort

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LEHIGH UNIVERSITY

North Dakota Industrial Commission

LIGNITE ENERGY COUNCIL

FALKIRK
THE FALKIRK MINING COMPANY

BARR

HEYL&PATTERSON

Lignite Fuel Enhancement

EPRI | ELECTRIC POWER RESEARCH INSTITUTE

U.S. DEPARTMENT OF ENERGY

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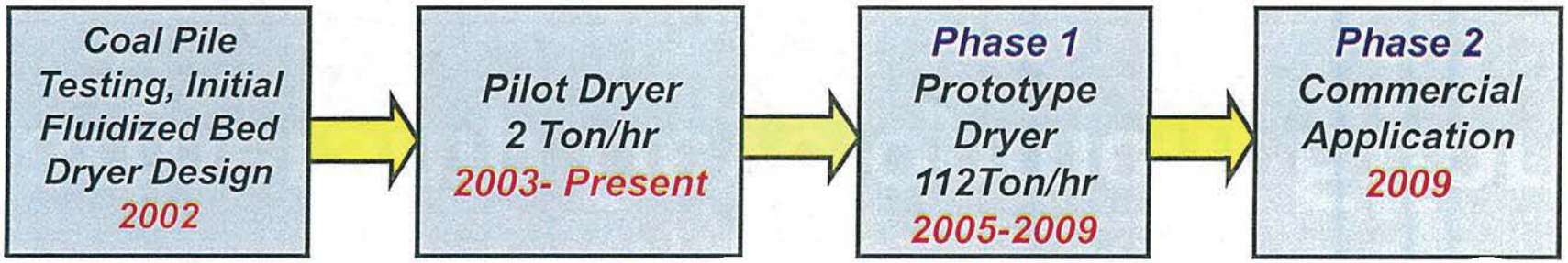
Solution

- Objective….
  - Restore lost performance by removing moisture in the incoming fuel stream just prior to bunkering
- How….
  - Employ waste heat to reduce moisture content of the lignite conveyed to the bunkers
- Approach….
  - Demonstrate and Select Basic Drying Process Concept
  - Develop "Proof Of Concept" Pilot Plant
  - Develop Dryer Design And Predictive Performance Modeling
  - Prototype Full Scale Dryer Design
  - Integrate Full Scale Commercial Demonstration Into Existing Plant Project

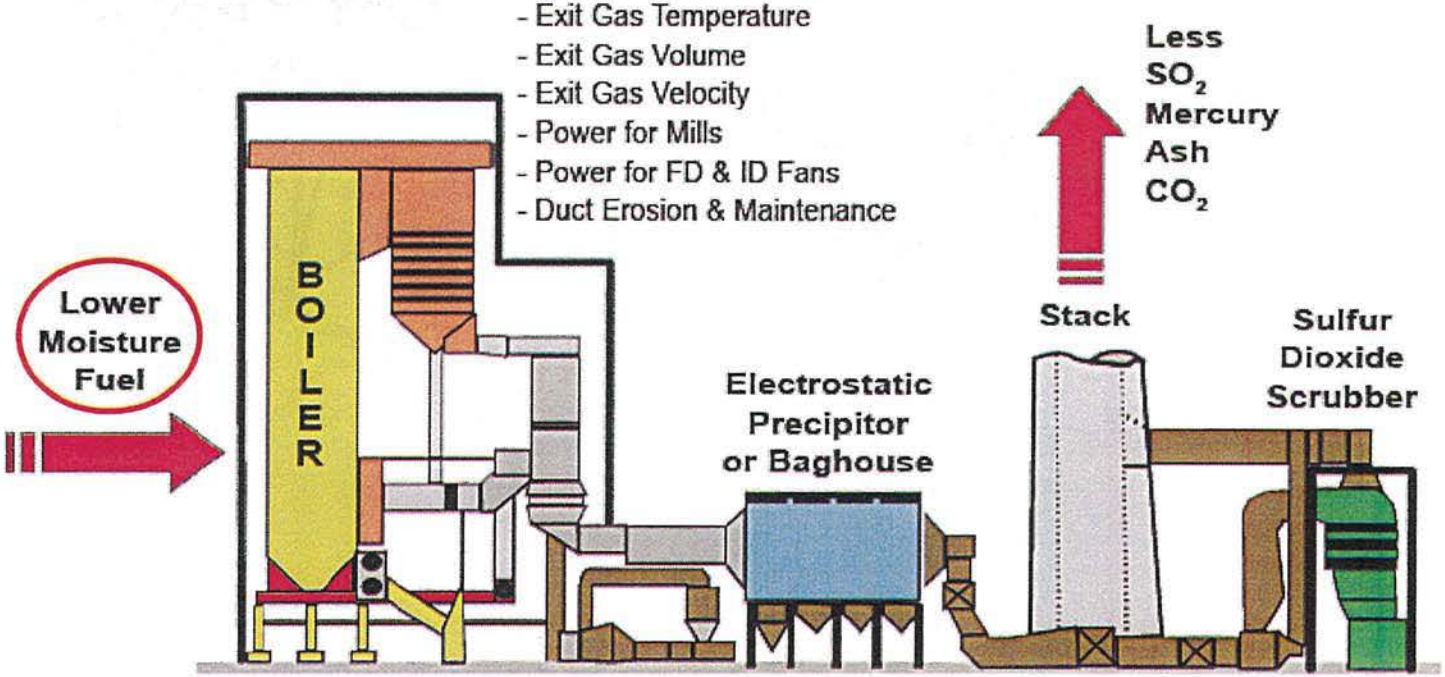


DryFining™ Process

DryFining Technology

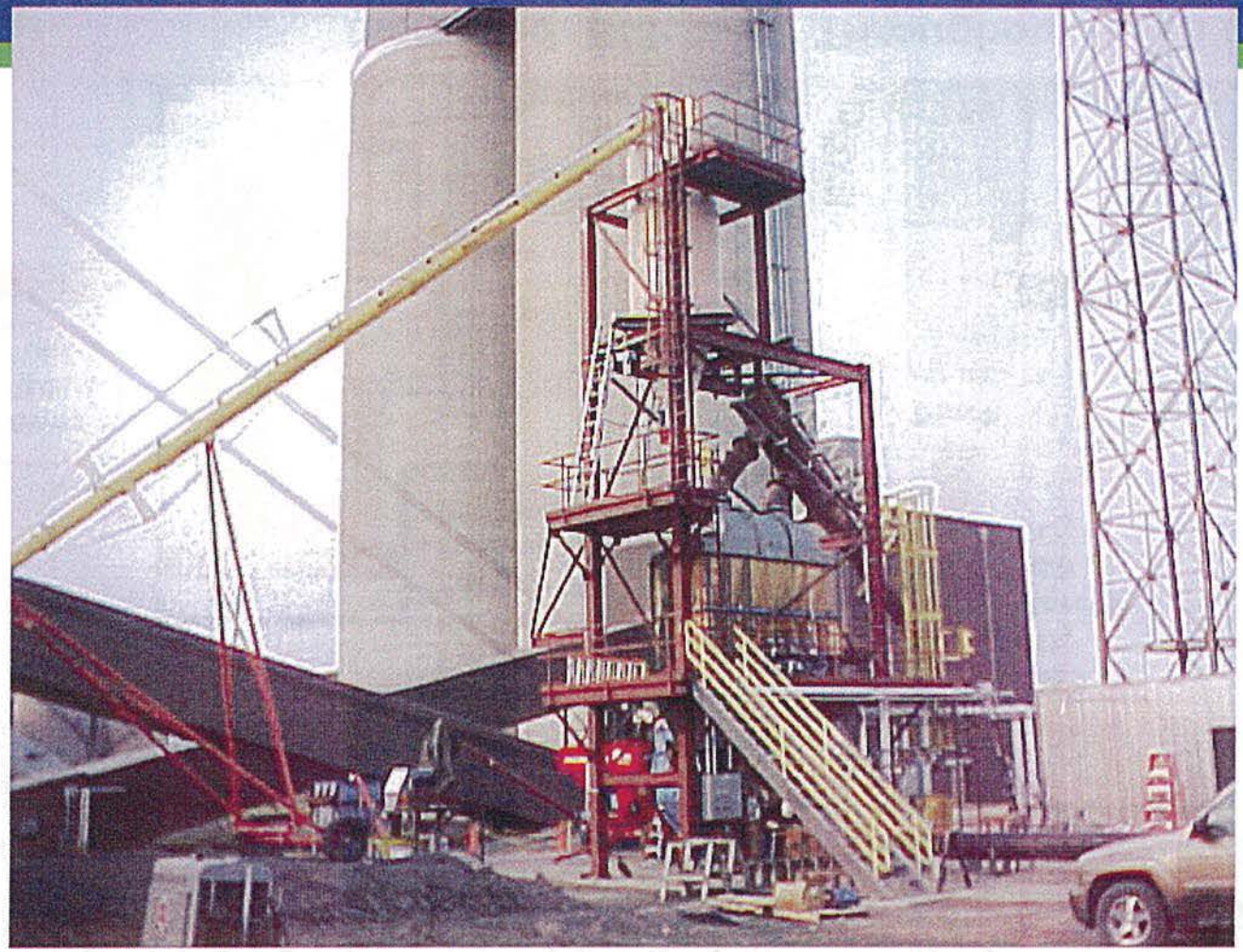
Less Moisture Lowers:

- Exit Gas Temperature
- Exit Gas Volume
- Exit Gas Velocity
- Power for Mills
- Power for FD & ID Fans
- Duct Erosion & Maintenance

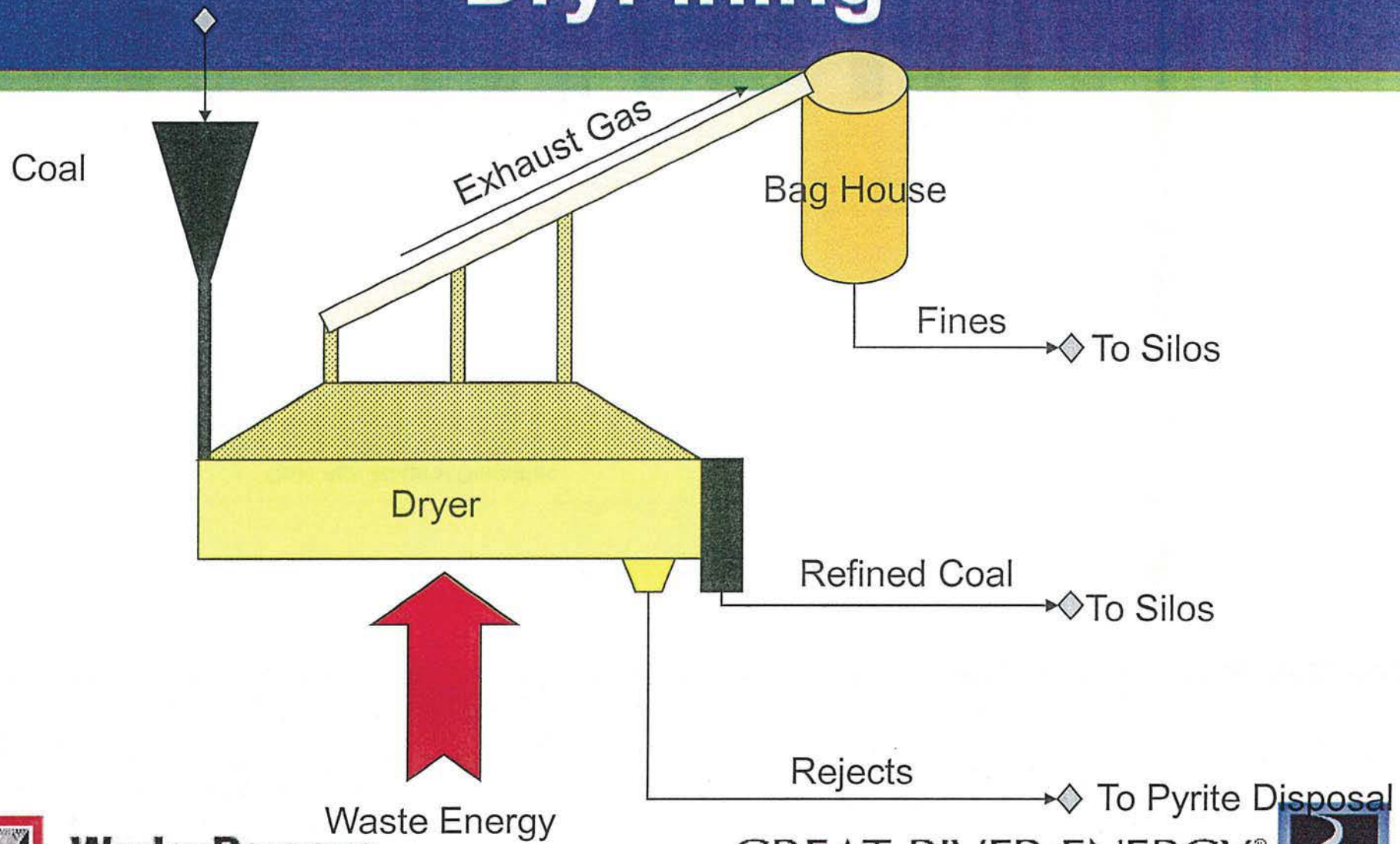


Increased Efficiency Throughout

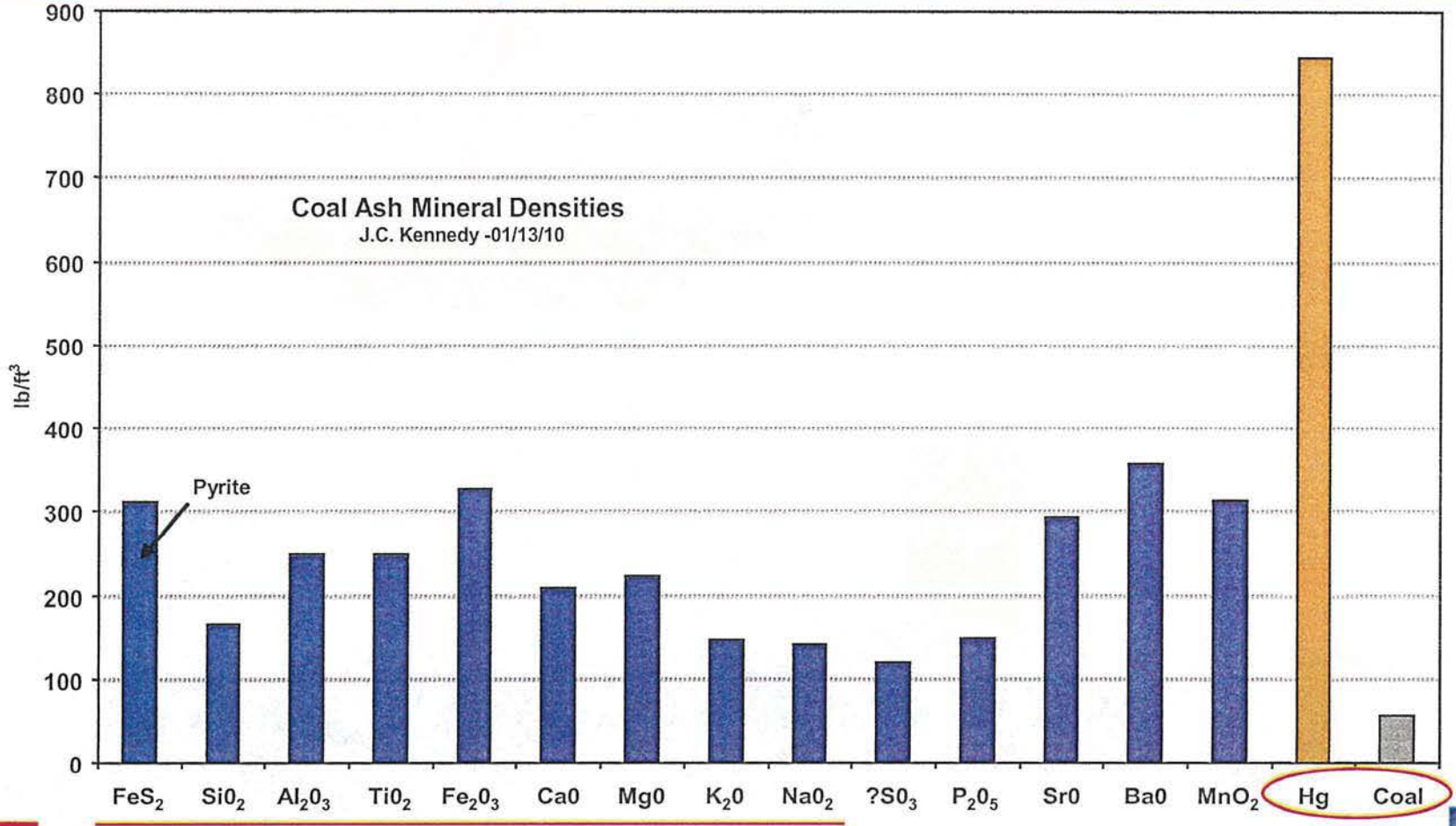
2 Ton/Hr Pilot Coal Drying



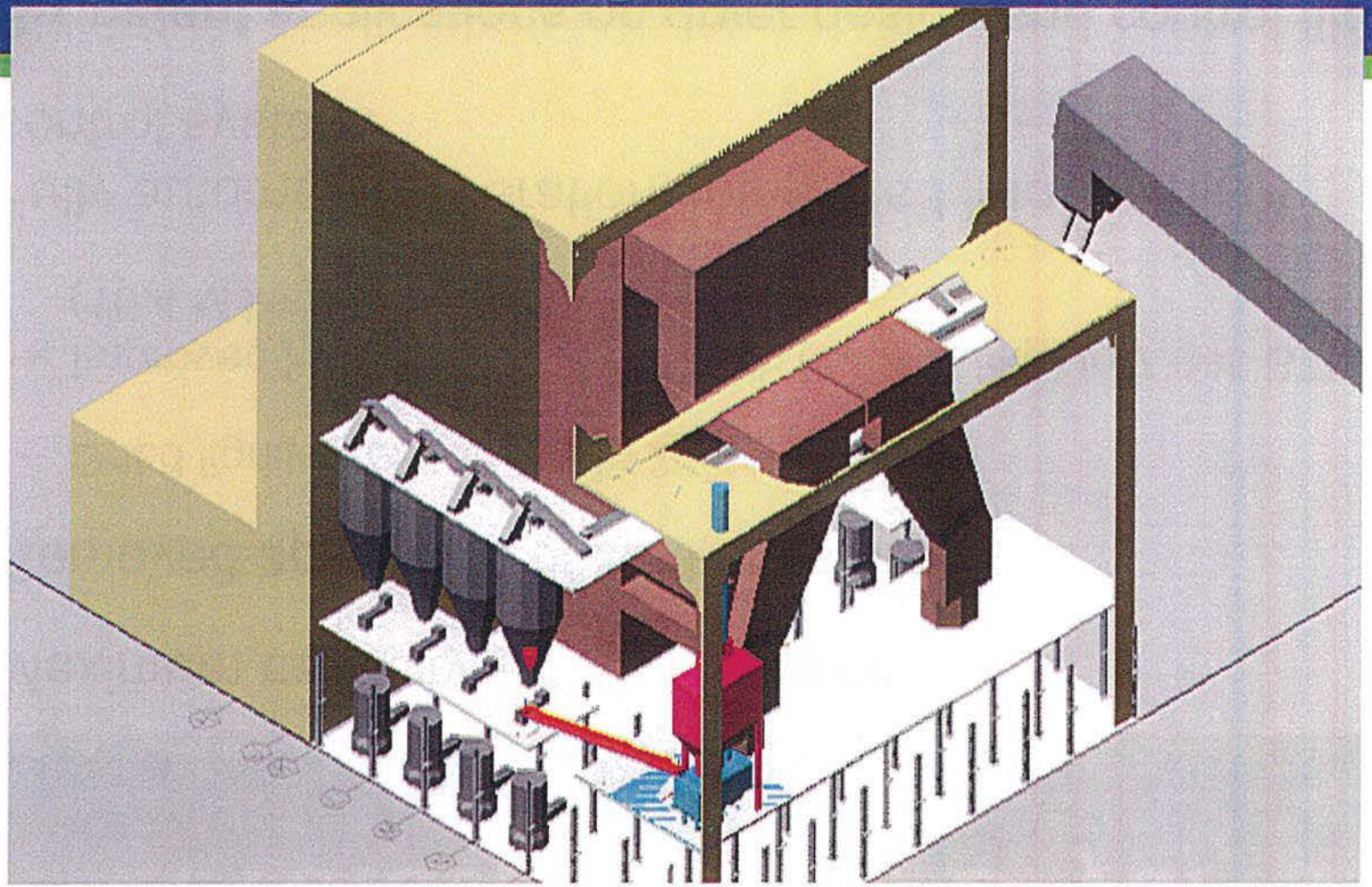
DryFining


Coal
Exhaust Gas
Bag House
Fines
To Silos
Dryer
Refined Coal
To Silos
Rejects
To Pyrite Disposal
Waste Energy

Ash Segregation



Prototype Dryer: Unit 2 East



Prototype Coal Dryer

- Maximum capacity - **112.5 tons/hr**
- Removed approx. ¼ of coal moisture.
  - Dried lignite from **38.5%** to **29.5%** moisture
  - Improved HHV from **6,200** BTU/lb (14.4 MJ/kg) to **7,045** BTU/lb (16.4 MJ/kg)
- Fully automated operation, integrated into the plant control system.
- Six patent applications on dryer design and control filed by GRE (two awarded).

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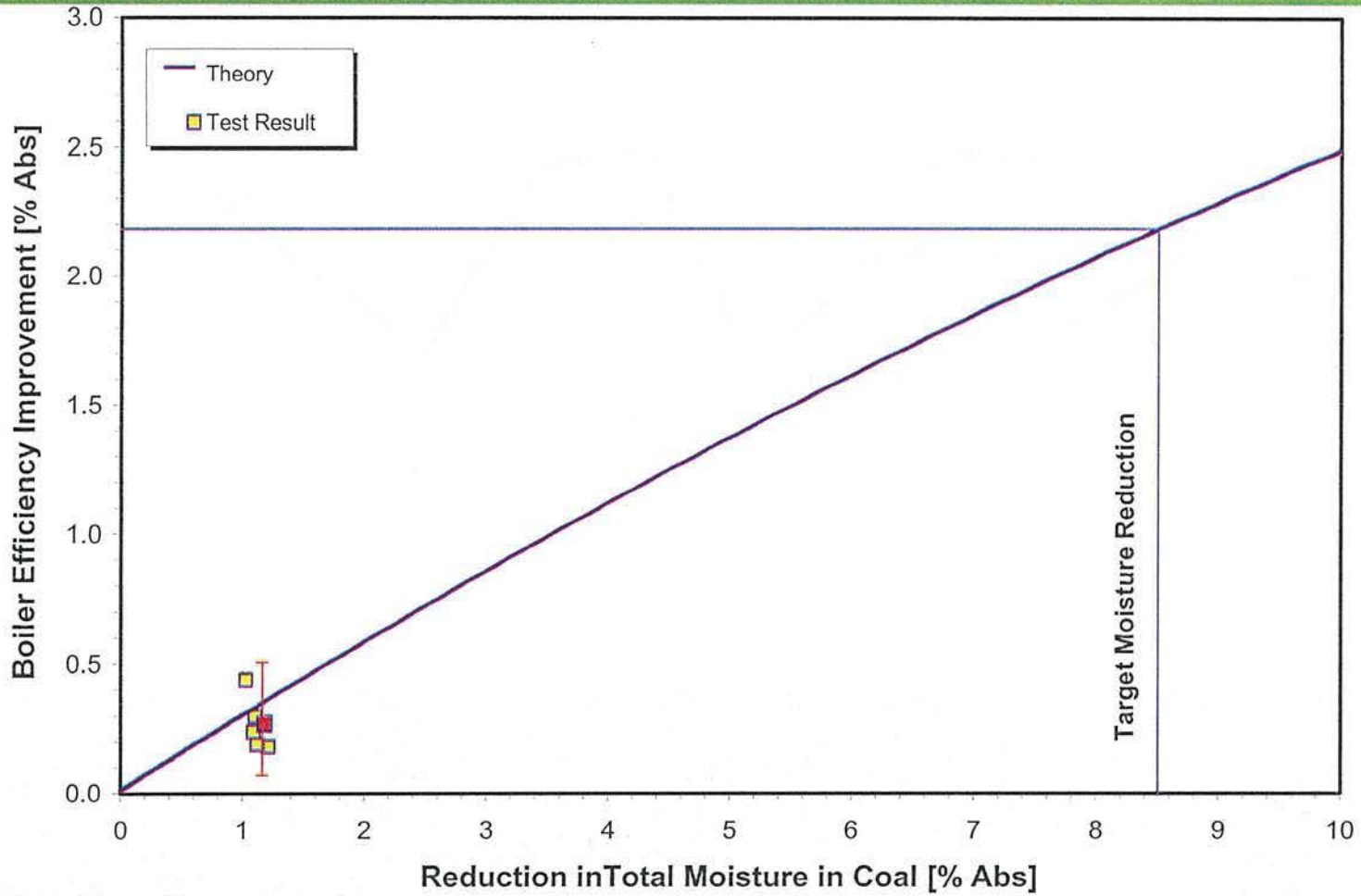
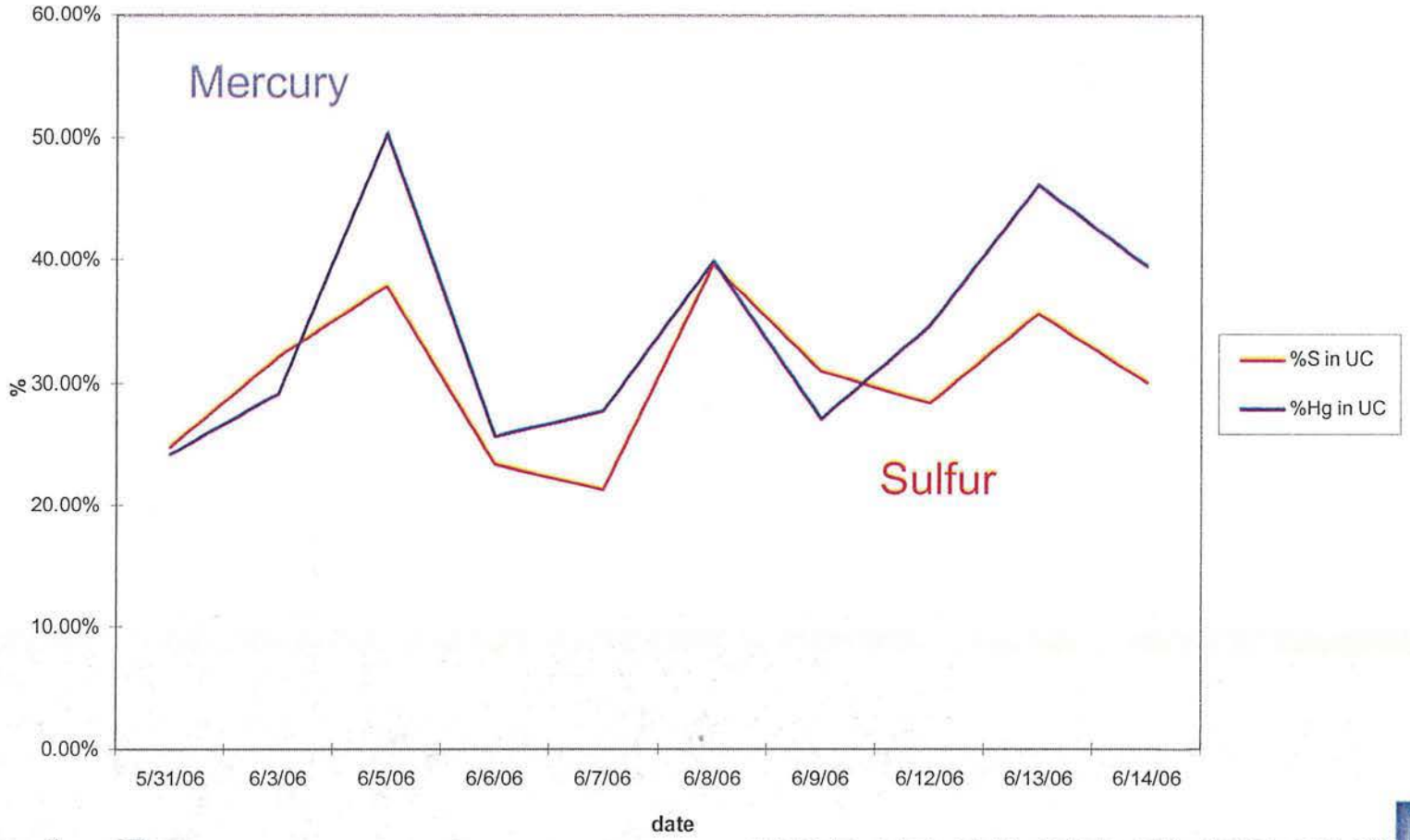
Boiler Efficiency Improvement

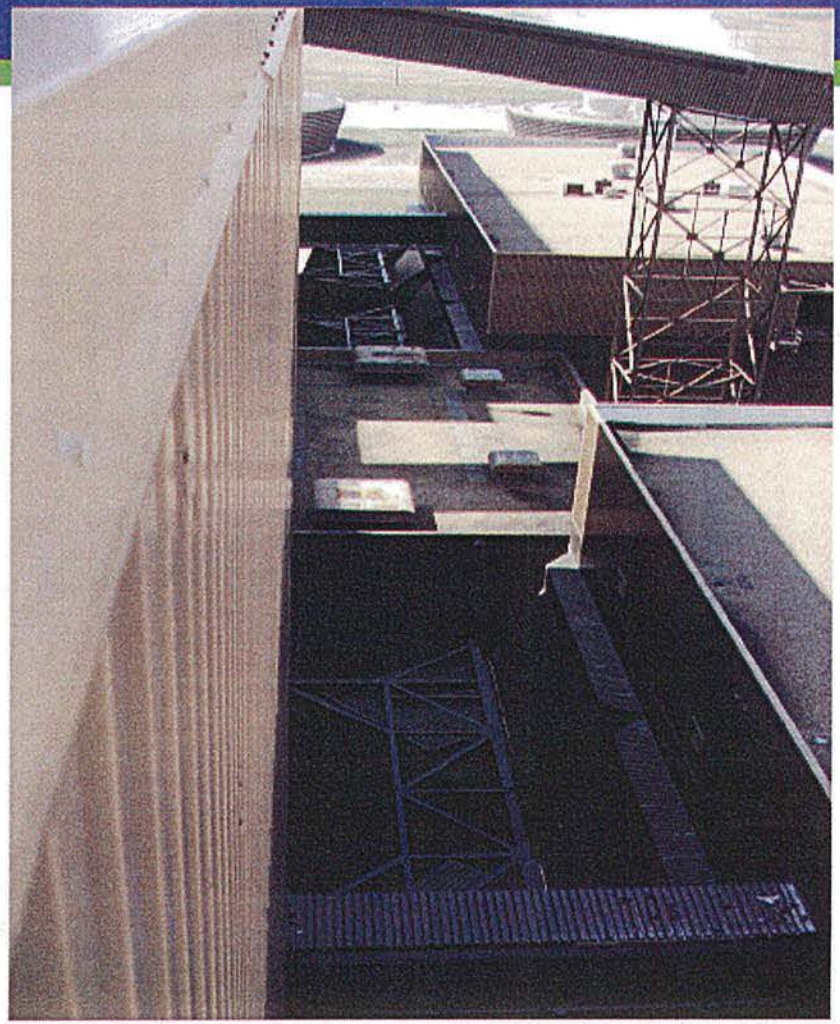


Segregation Stream

Sulfur and Hg in Segregation Stream



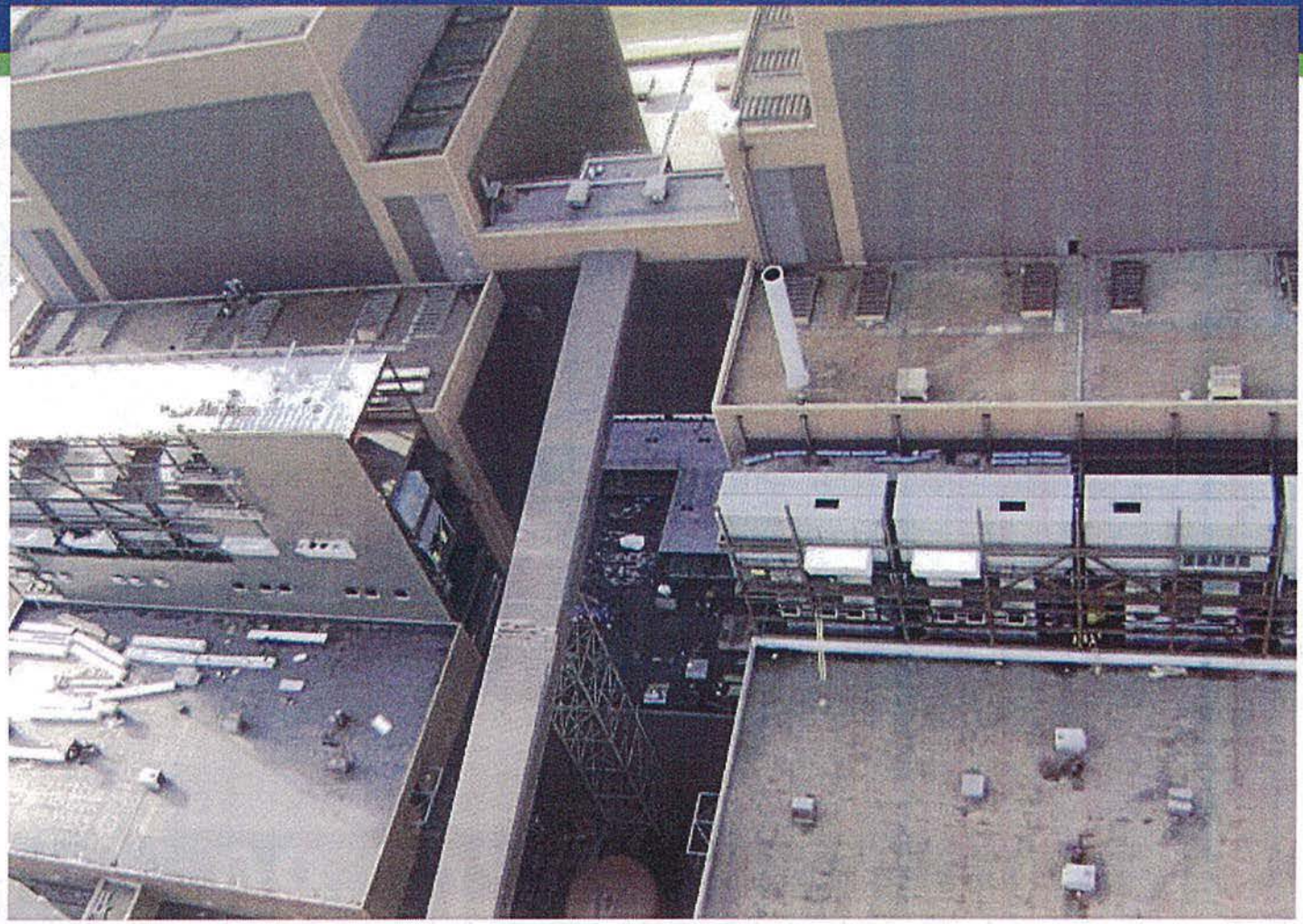
Commercial Dryer Location



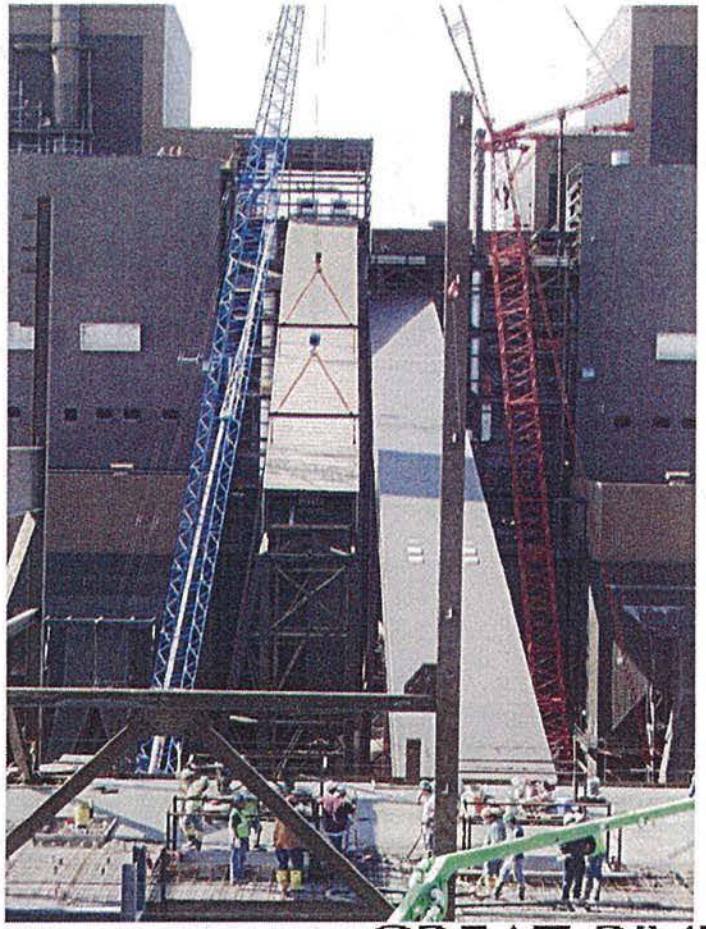
Unit #2 "Complete" April '08

July '08: U2 (left), U1 (right)

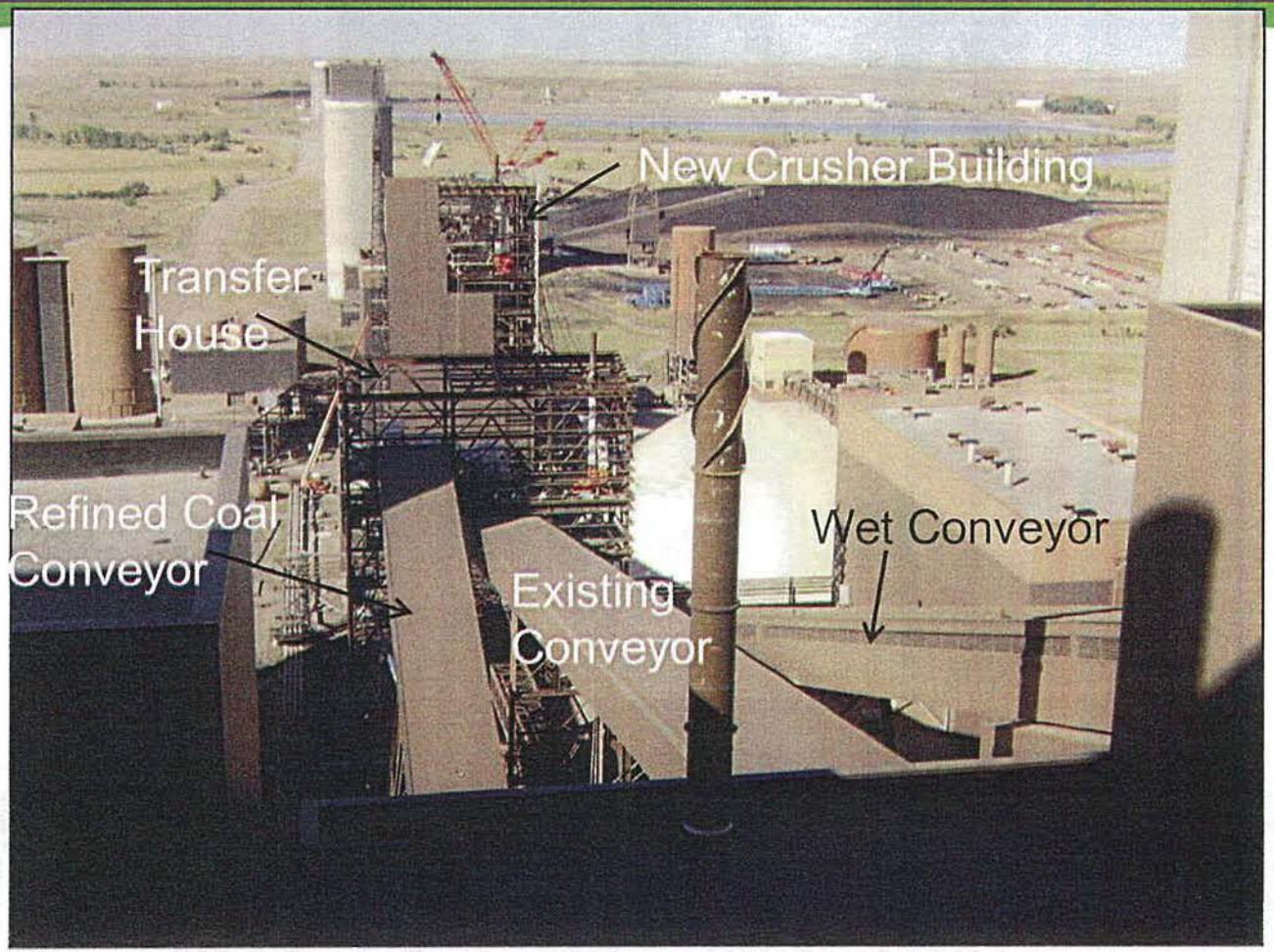
Summer 2009 Installation



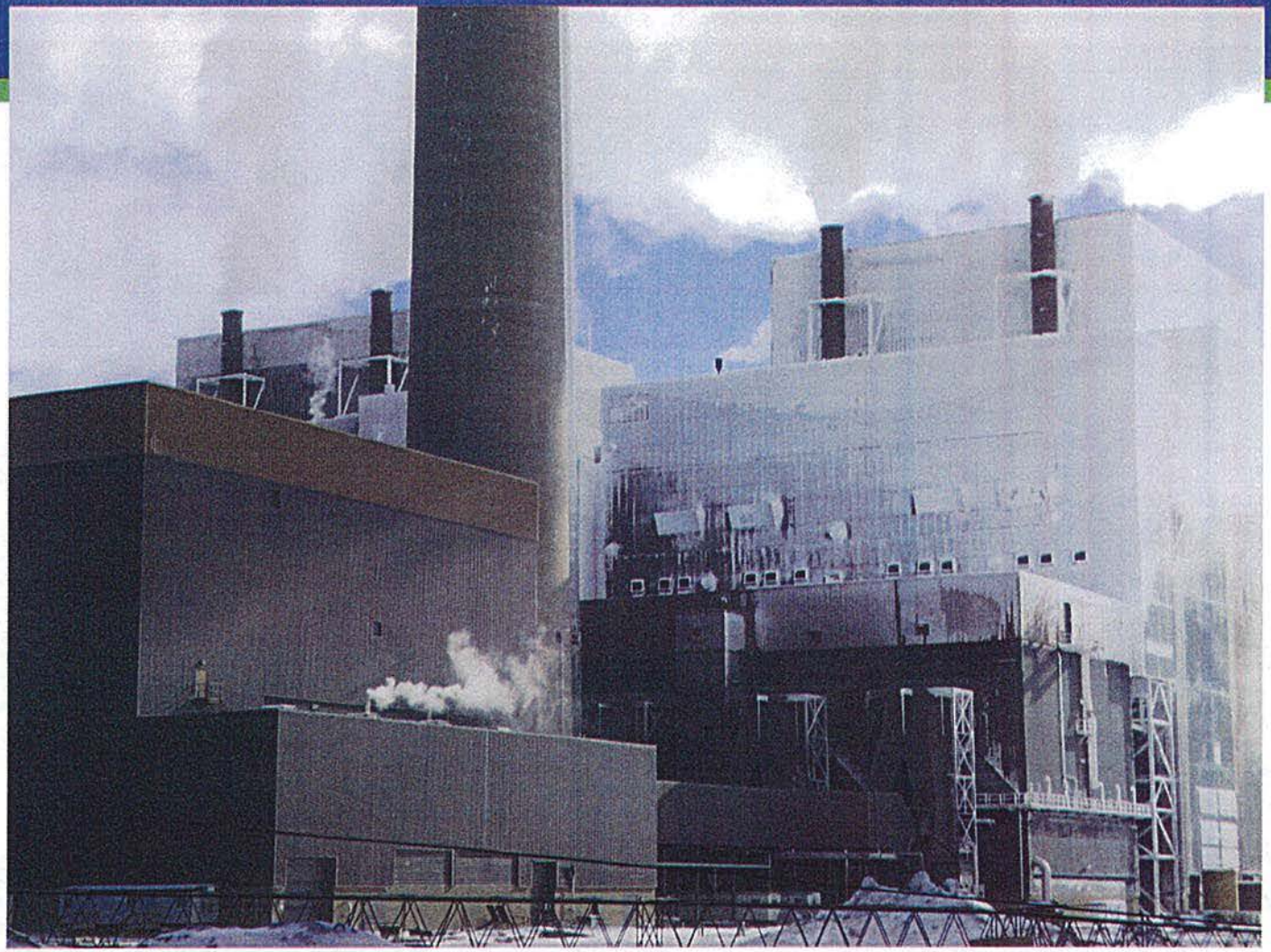
Install "wet" Conveyor



DryFining Conveying System



January 2010



DryFining™ Performance

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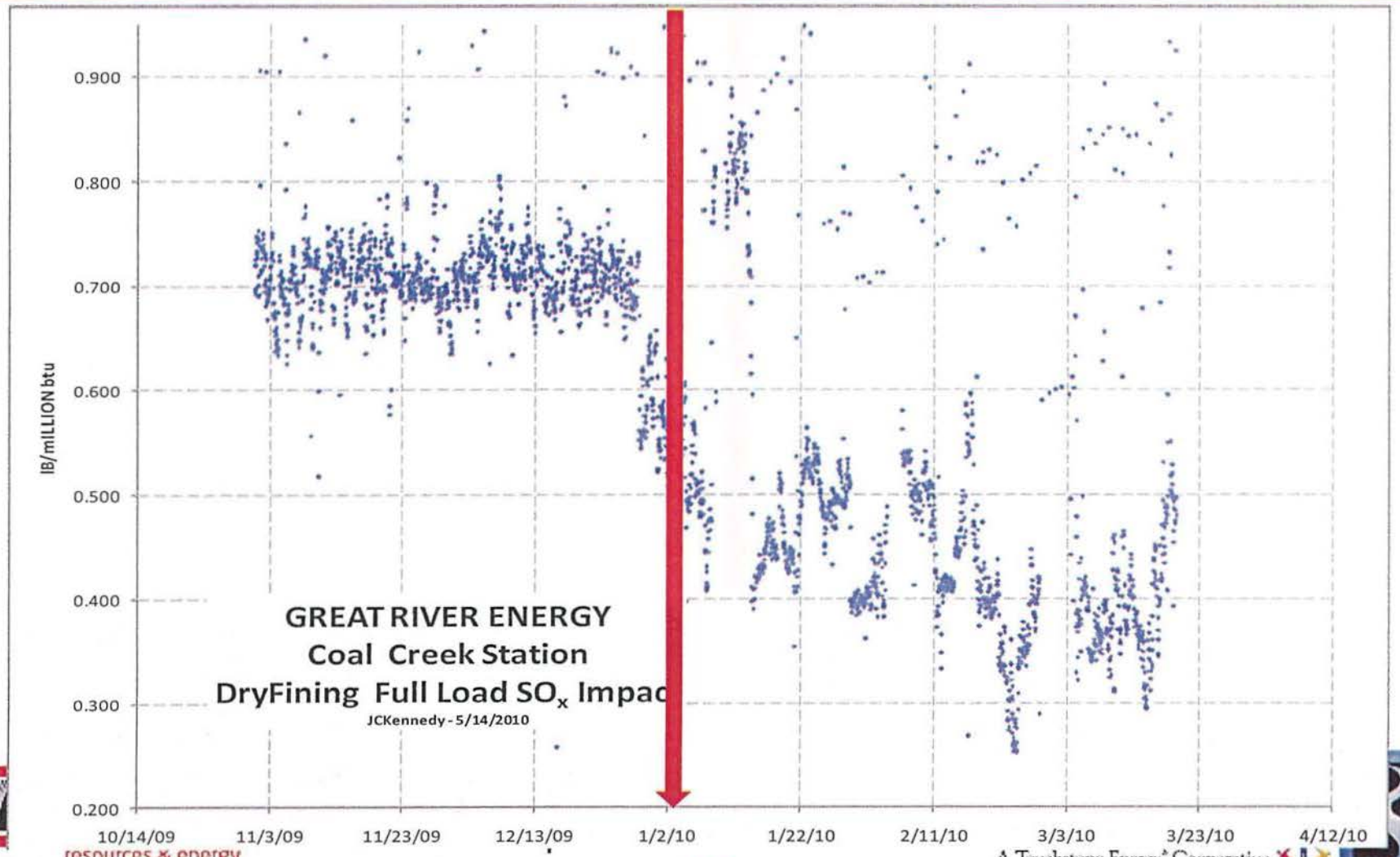
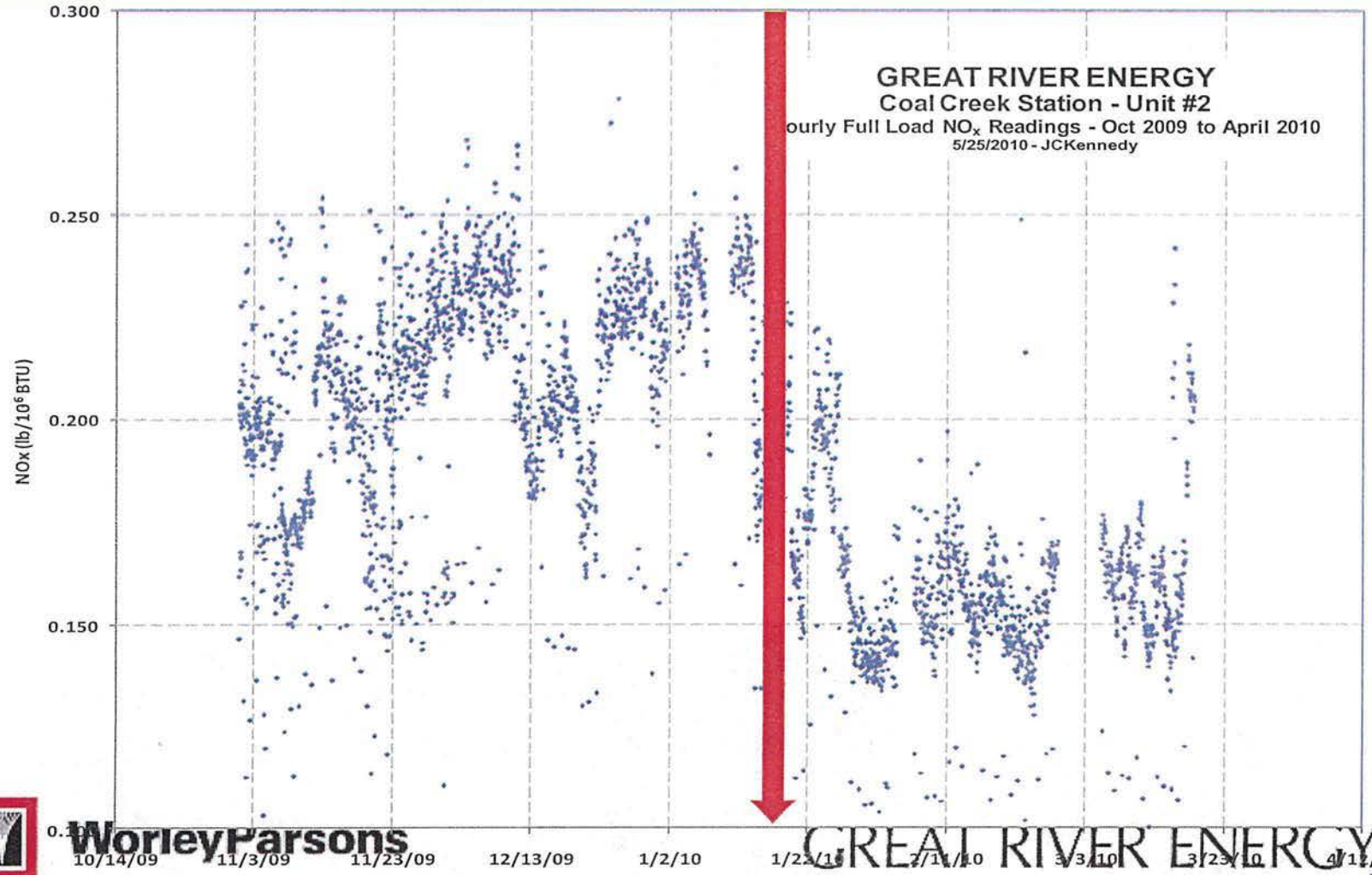
SO_2 Reduction



NO_x Reduction



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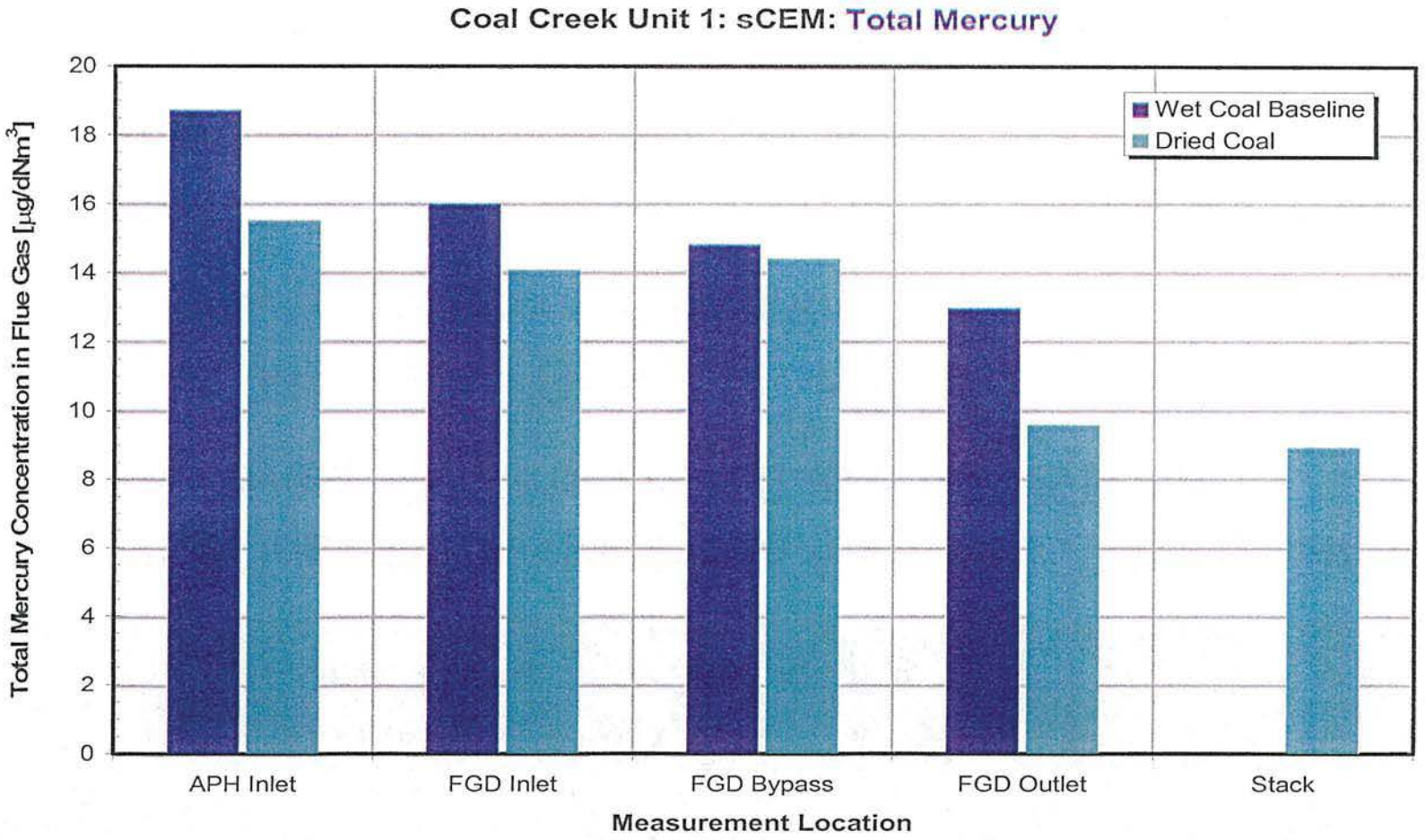
Summary: Hg^T


Coal Creek Unit 1: sCEM: Total Mercury
Total Mercury Concentration in Flue Gas [µg/dNm3]
20
18
16
14
12
10
8
6
4
2
0
Wet Coal Baseline
Dried Coal
APH Inlet
FGD Inlet
FGD Bypass
FGD Outlet
Stack
Measurement Location

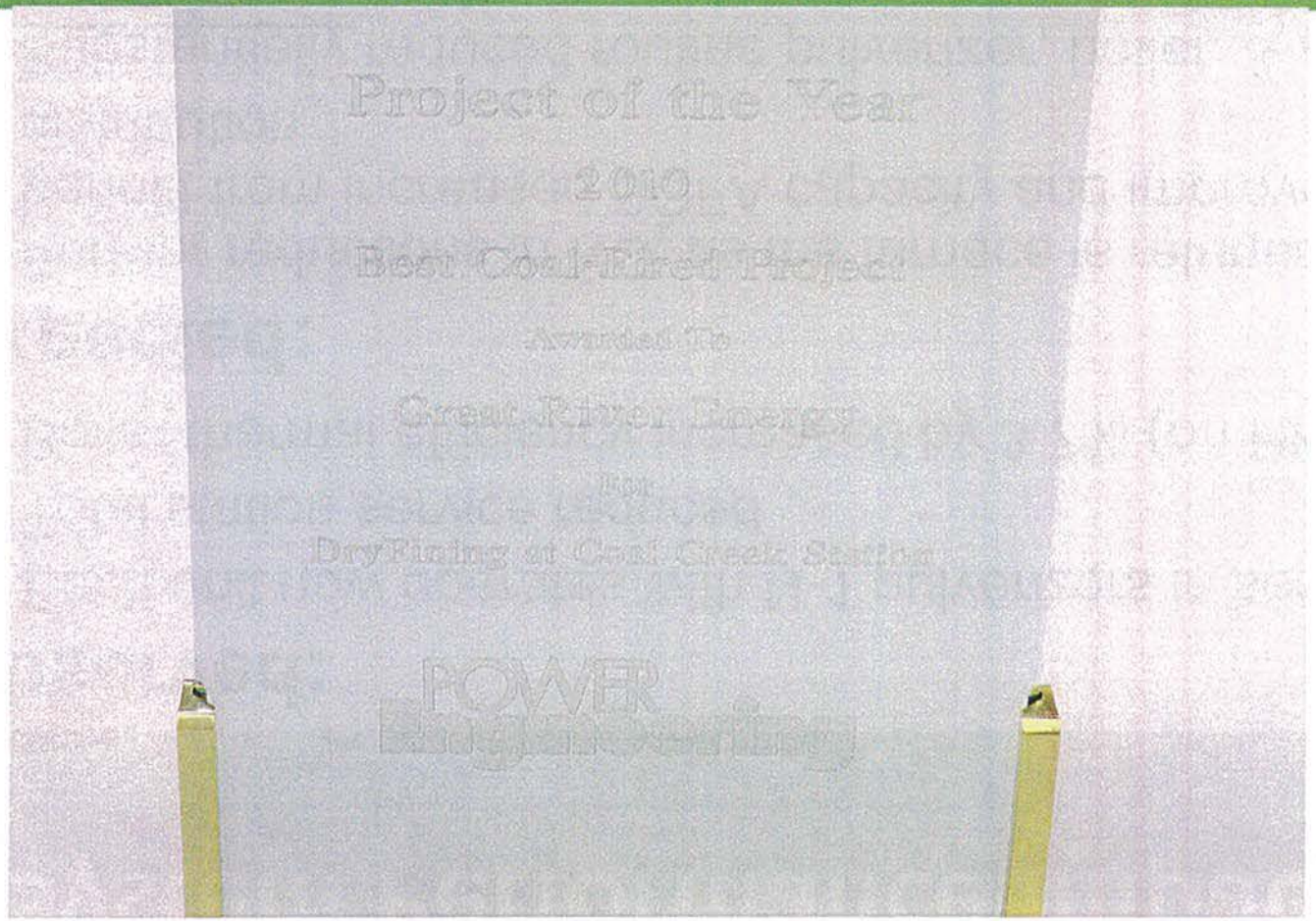
DryFining Results

- **25% less H_2O** - dry lignite from 38 to 29% moisture, improving HHV from 6,100 to 6,800 BTU/lb
- **54% less SO_2** - Segregation of ash minerals, plus improved collection efficiency
- **40% less Hg** - Segregation of ash minerals, plus improved collection efficiency
- **32% less NO_X**- Reduced volumetric release rate, improved fineness and air & fuel distribution to furnace
- **4% less CO_2** - 4% improved cycle efficiency

System Performance Impacts:

- **Observed:**
  - Each unit now operates with N-1 pulverizers in service
  - Total station service reduced
  - Boiler thermal efficiency increased by 3.7% (on HHV basis)
- **Expected:**
  - Further reductions in NO_x as the furnace is retuned to benefit from increased SOFA capacity and improved fuel distribution
  - Substantially reduced routine pulverizer, boiler, & AQCS maintenance costs

2010 Coal-fired Project of the Year

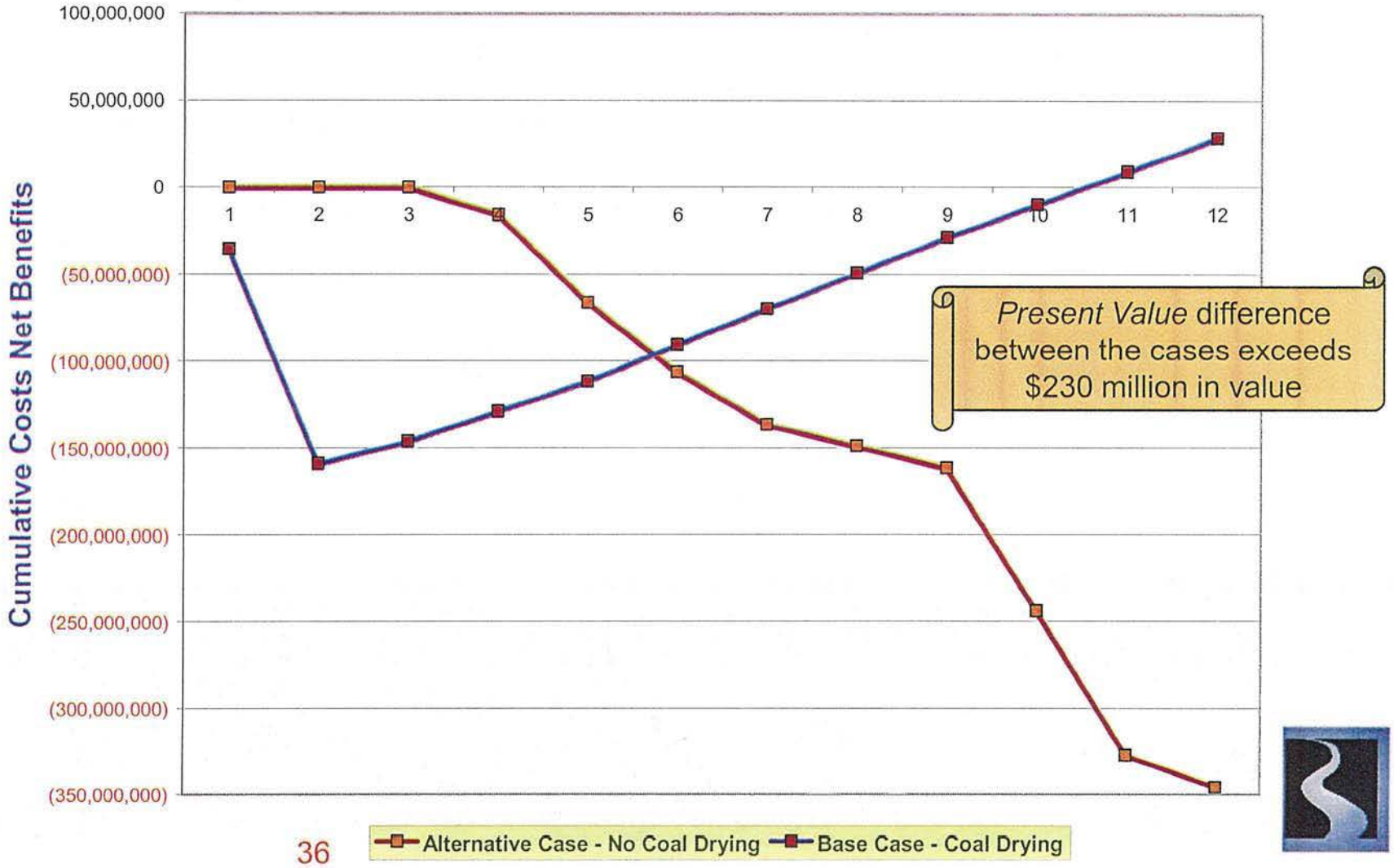


Process integrations

- Gasifiers
  - IGCC
  - Coal to Liquids
- SCPC
- Activated Carbon
- Oxy-fuel firing
- Confidentiality agreements
  - 50% Global reserves

Financial Justification

DryFining is the clear choice



IRS Section 45

- Refined Coal Tax Credits for electric generation
  - 20% reduction in NO_X
  - AND
  - 40% reduction in SO_2 OR Hg
- Economic Stabilization Act of 2008
  - $6.27 per ton tax credit for 10 years
  - In service by 12/31/2009 – Extended to 12/31/2011
- $420 million tax credits produced by 1200 MW of DryFining at Coal Creek Station

Introducing EPRI…

EPRI is a company that…

…brings together great people…

…with new and exciting ideas…

…to help energize the world!

"Together…Shaping the Future of Electricity"

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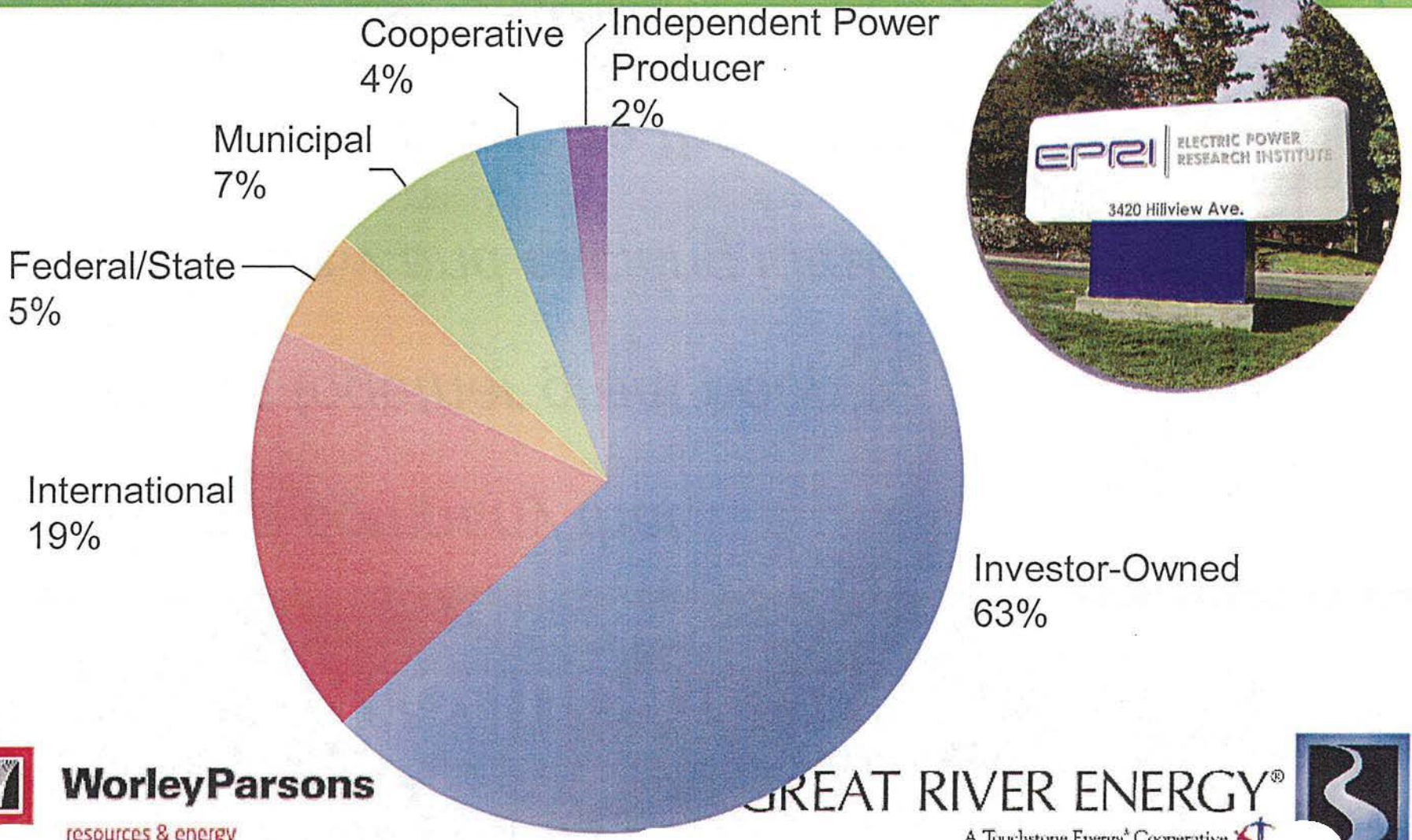
EPRI Members Breakdown By 2010 Annual Research Portfolio Funding



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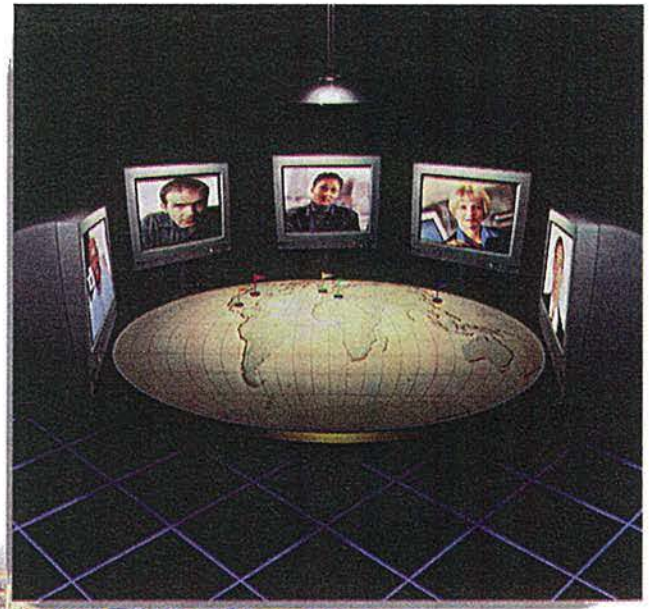
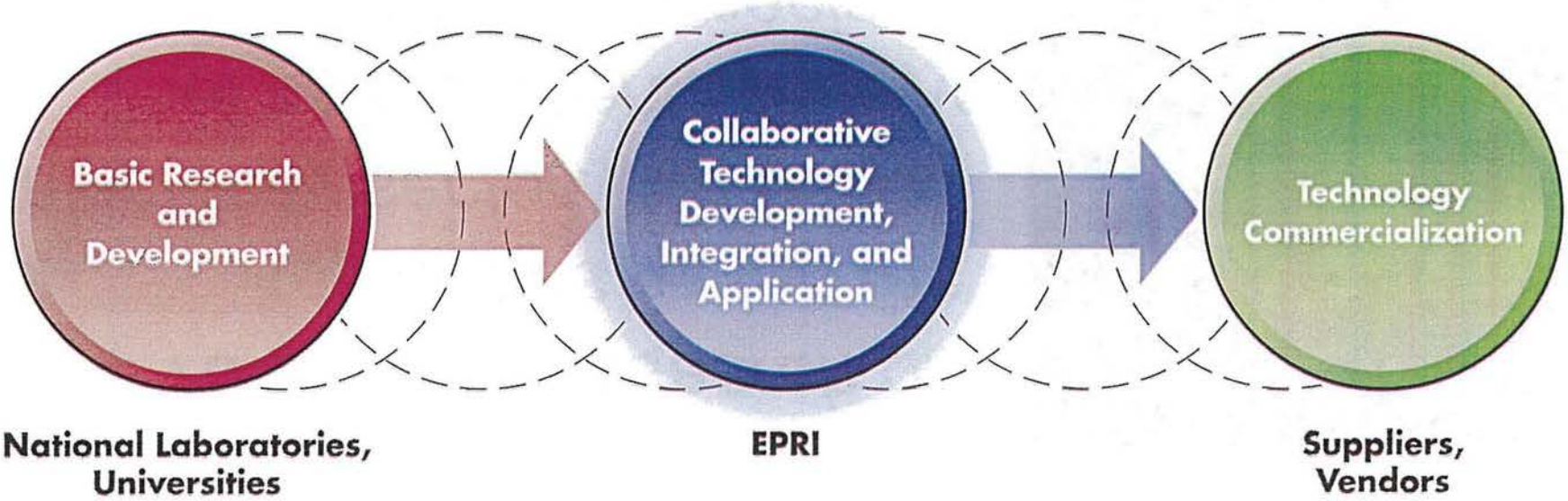
Our Mission…

To conduct research on key issues facing the electricity sector…on behalf of its members, energy stakeholders, and society.



Our Role…

Help Move Technologies to the Commercialization Stage…



Technology Accelerator!

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EPRI...the Power of Collaboration...

Delivering greater value for our members' investment...

- Helps reduce the associated costs and risks of technology development, delivery, and commercialization
- Collaborative model shares the ideas, expertise, and valued experiences of EPRI membership
- Costs and benefits are shared among EPRI members
- Ultimate goal is to ensure society's energy needs are met cleanly, efficiently, and economically

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GR...

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Sector Research Area Roadmaps

- Advanced Coal Generation
- Flexible Operation of Fossil Fleet
- Gas Generation Technology
- Generation Fleet Transition
- Long Term Operation
- Near-Zero Emissions
- Renewable Generation Technology
- Water Management.

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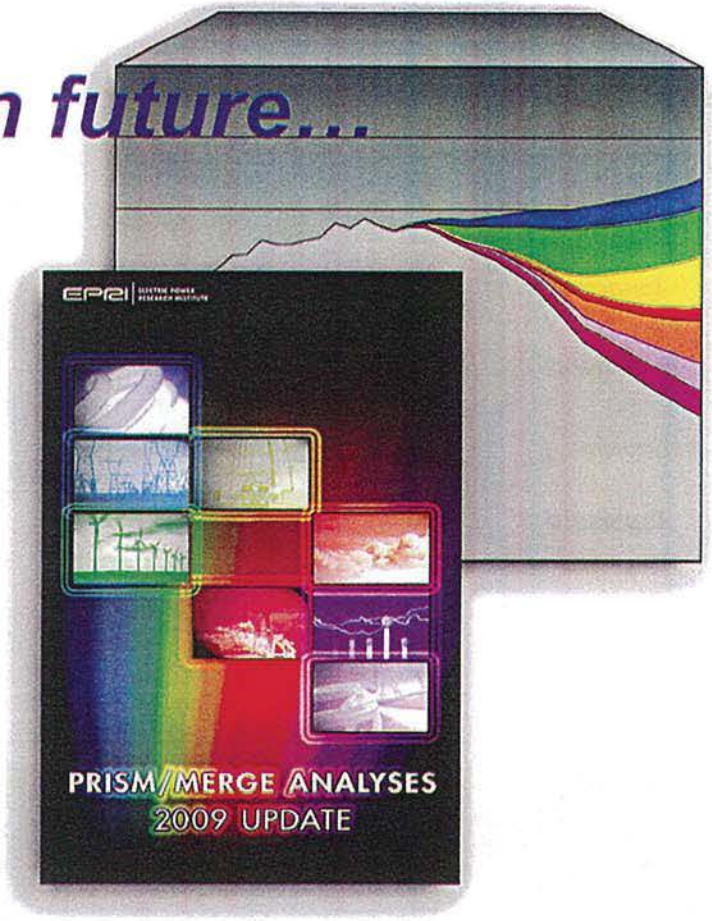
EPRI's Prism / MERGE Analysis...

Roadmap for a low-carbon future...

- Detailed analysis of the pathway to reducing CO_2 emissions across the electricity sector
- Provides guidance on the needed generation mix to slow, stop and reverse global CO_2 emissions
- Cited in numerous national and international publications as pre-eminent work on global climate and energy



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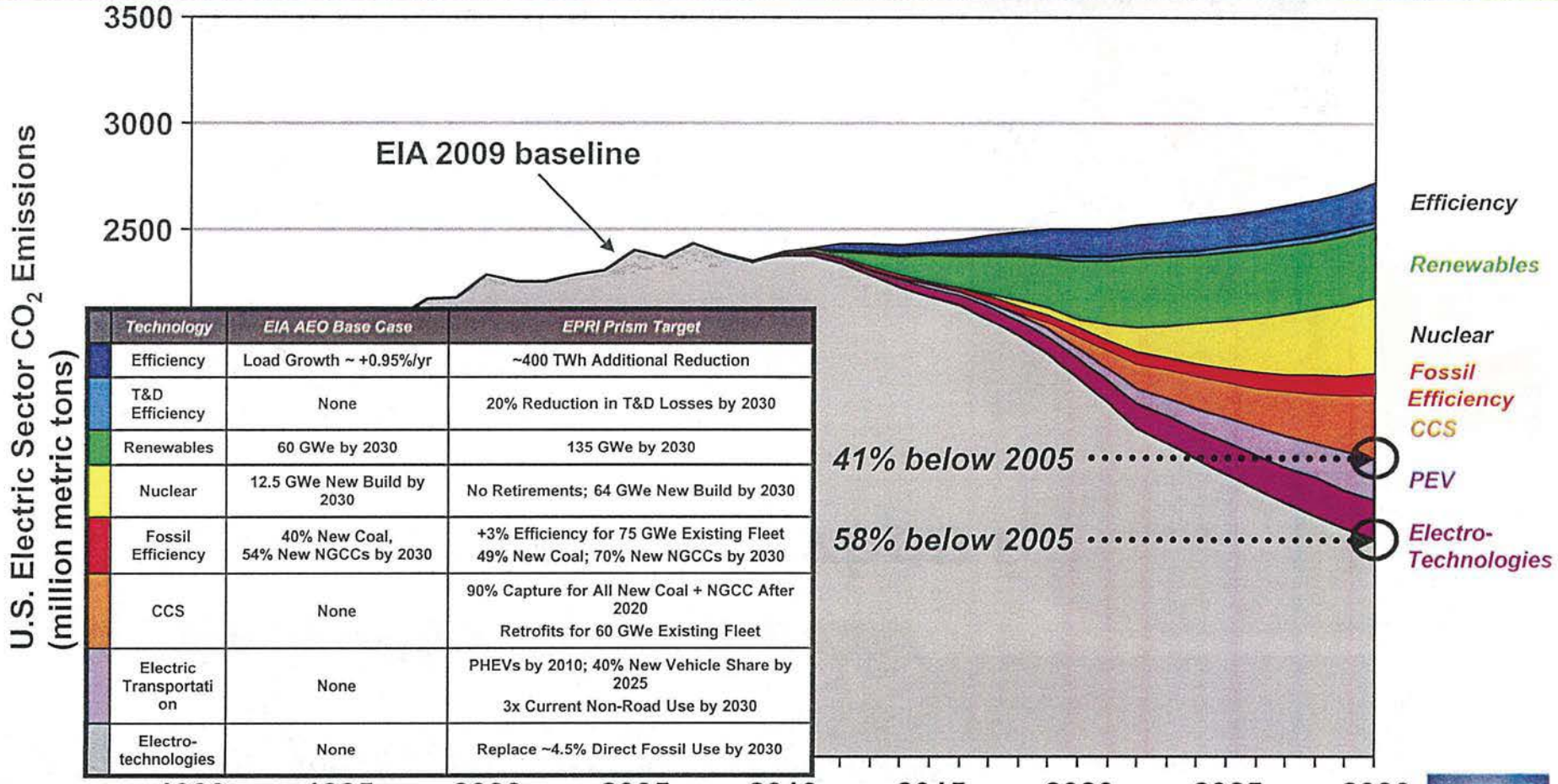
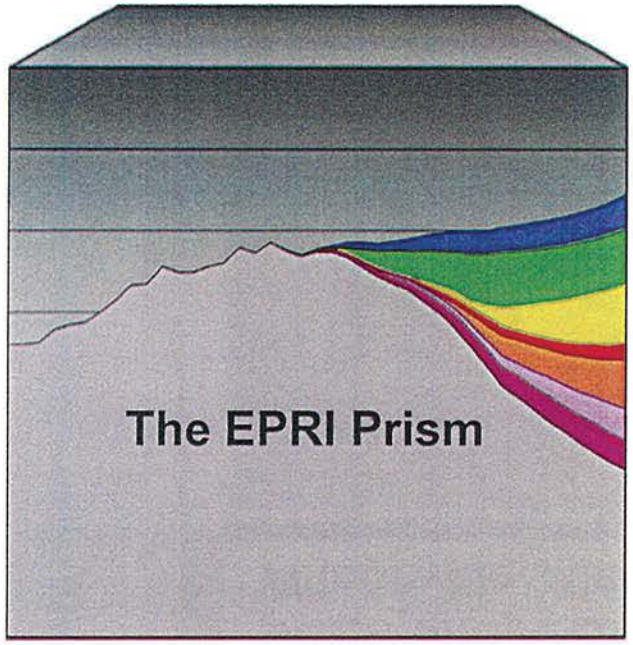
Analysis Framework…2009 Prism



Technology	EIA AEO Base Case	EPRI Prism Target
Efficiency	Load Growth ~ +0.95%/yr	~400 TWh Additional Reduction
T&D Efficiency	None	20% Reduction in T&D Losses by 2030
Renewables	60 GWe by 2030	135 GWe by 2030
Nuclear	12.5 GWe New Build by 2030	No Retirements; 64 GWe New Build by 2030
Fossil Efficiency	40% New Coal, 54% New NGCCs by 2030	+3% Efficiency for 75 GWe Existing Fleet 49% New Coal; 70% New NGCCs by 2030
CCS	None	90% Capture for All New Coal + NGCC After 2020 Retrofits for 60 GWe Existing Fleet
Electric Transportation	None	PHEVs by 2010; 40% New Vehicle Share by 2025 3x Current Non-Road Use by 2030
Electro-technologies	None	Replace ~4.5% Direct Fossil Use by 2030

Industry Demonstration Projects… From Analysis to Action



Demonstration Projects
Energy efficiency projects
Smart grids
Compressed air energy storage projects
Pulverized coal with CCS
IGCC with CCS
Low cost oxygen (O_2)
Solar and biomass projects

Goal is to help develop large-scale demonstration projects in multiple areas required to provide the full portfolio of technologies

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National Carbon Capture Center

DOE-Funded CO_2 Capture Test Facilities in Wilsonville, Alabama

Power Systems Development Facility (PSDF) started combustion testing June 1996 and gasification September 1999.

In May 2009 PSDF transitioned to the National Carbon Capture Center (NCCC).

Existing facilities used to support development of pre-combustion CO_2 capture.

Additional facility, the Post-Combustion CO_2 Capture Center (PC4), built and started testing March 2011.

Located at adjacent power plant, Alabama Power's Plant Gaston

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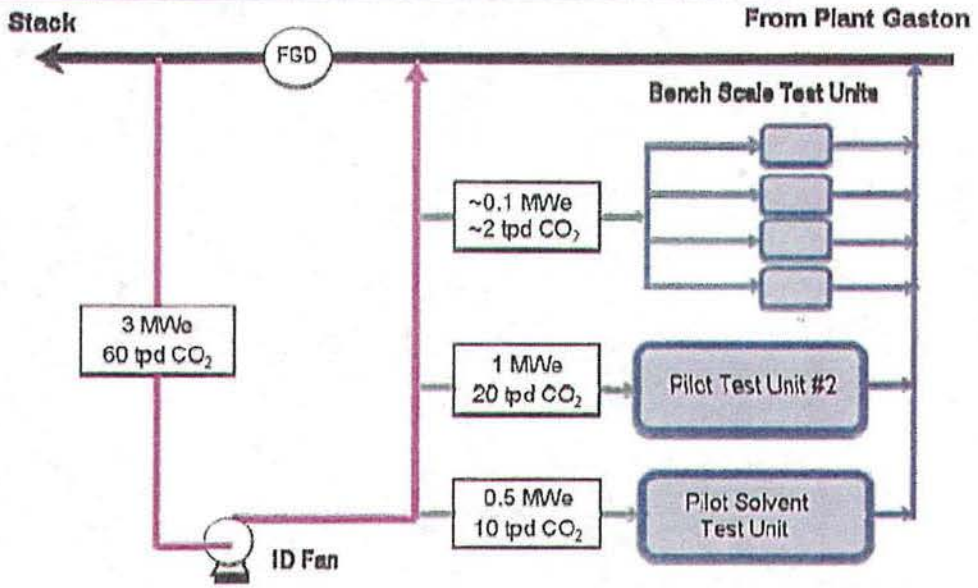
NCCC: PC4

Layout of PC4



Flue gas drawn from downstream of FGD and returned upstream so any contaminants introduced are removed by FGD before passing to stack

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Coal Generation Plans for Canadian Utilities

- Alberta – new units coming on line (Keephills 3 just became commercial)
- Saskatchewan – no decision on new units; run existing units beyond EOL if feasible
- Manitoba – one unit left; operate on emergency basis only until 2020
- Ontario – retire all units by 2014
- New Brunswick – run existing units until EOL and then retire
- Nova Scotia – run existing units until EOL and **then retire**

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Proposed Canadian Coal Plant CO_2 Regulations (cont.)

- **New and old units 375 tonnes of CO_2/GWh**
  - Deemed equivalent to combined cycle natural gas
  - No provision for credits, off-sets or trading
- **New unit – commissioned after July 1, 2015**
- **Old unit – operating after end of useful life**
  - Useful life – 45 years after commissioning or determined by end of power purchase agreement
- **Existing unit – neither new or old**

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BD3 CCS Rendering

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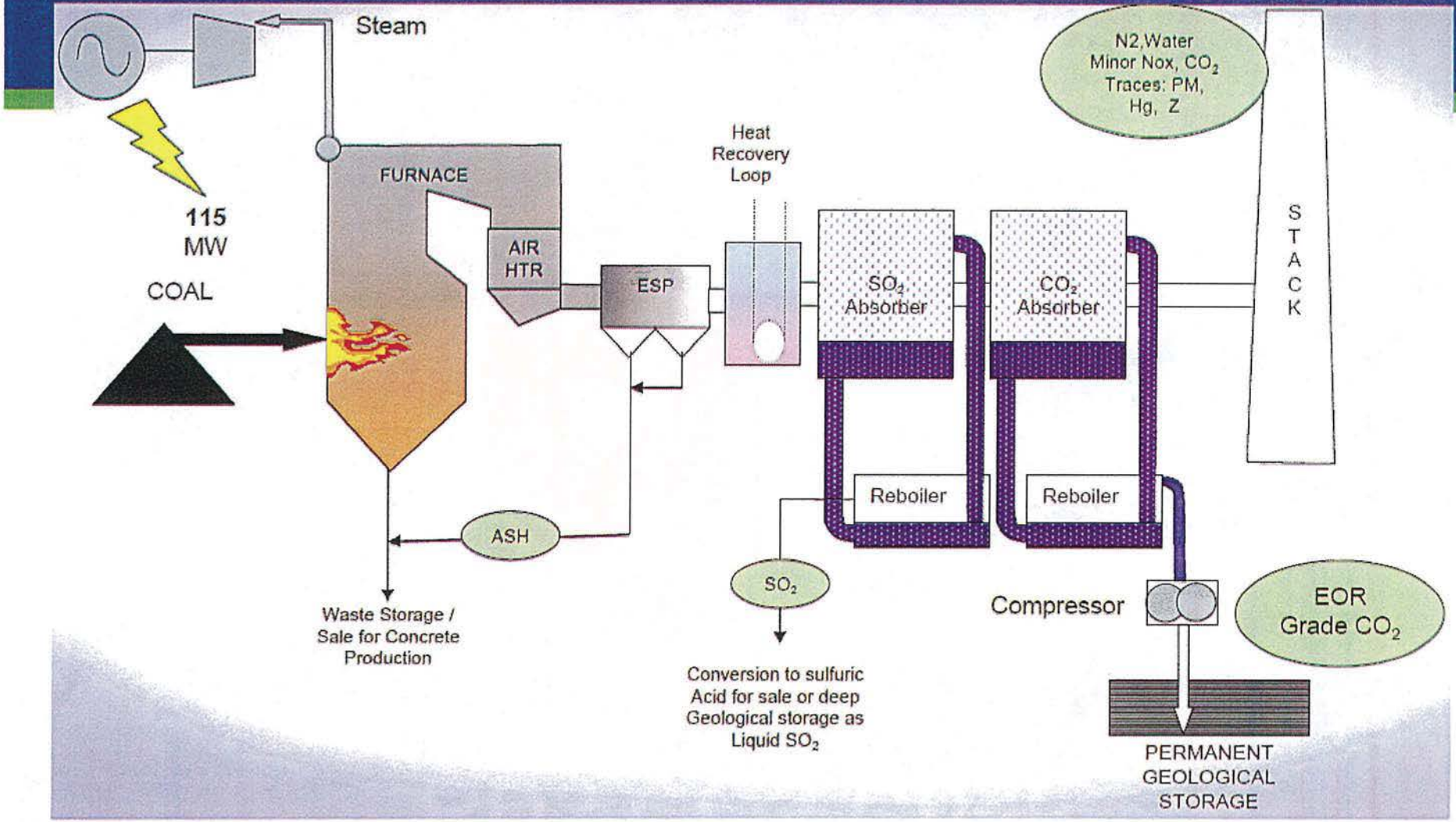
BD3 CCS Schematic



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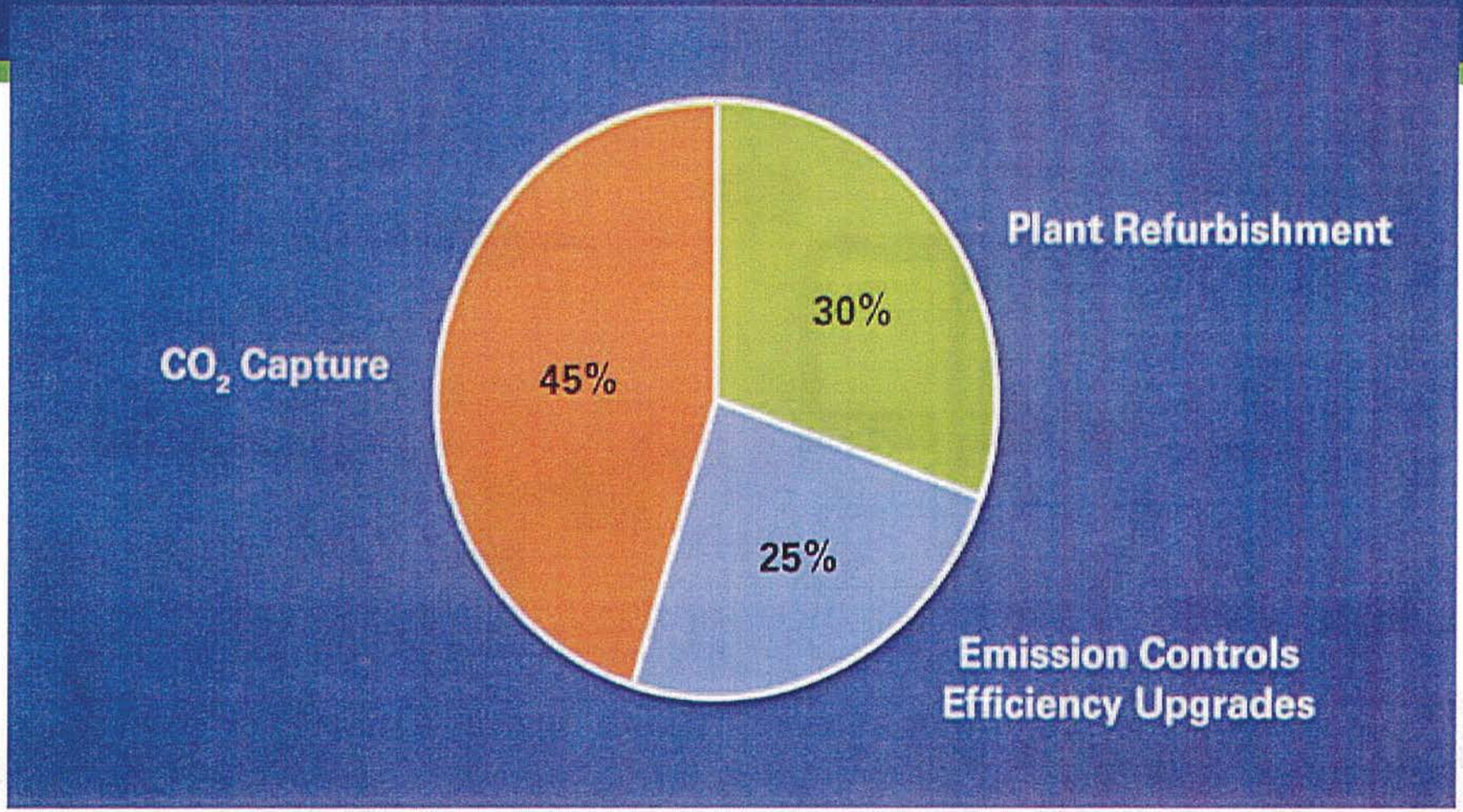
BD3 CCS Costs



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Magnitude!

Chemicals from CO_2 – Global

Rank	Chemical	2002 Production Mt *	Estimate +13% for 2007 Mt	Gmol	GWe if equimolar rxn with CO2 90% capture
1	Sulfuric Acid	36.65	41.54	423.54	2.74
2	Nitrogen	30.76	34.87	1244.65	8.06
3	Ethylene	23.67	26.83	838.44	5.43
4	Oxygen	22.04	24.98	890.27	5.76
5	Lime	18.42	20.87	372.24	2.41
6	Polyethylene	16.06	18.20	568.91	3.68
7	Propylene	14.46	16.38	380.27	2.46
8	Ammonia, Anydrous	13.20	14.96	878.51	5.69
9	Chlorine	11.39	12.91	182.02	1.18
10	Phosphoric Acid	10.81	12.26	125.06	0.81
95	Sodium Bicarbonate	0.54	0.61	7.24	0.05
96	Cyclohexanone	0.54	0.61	6.19	0.04
97	Propylene Glycol	0.53	0.60	7.92	0.05
98	Phthalic Anhydride	0.53	0.60	4.03	0.03
99	Sodium Sulfate	0.51	0.58	4.06	0.03
100	Potassium Hydroxide	0.47	0.54	9.55	0.06
	TOTAL	443.08	502.16	10339.12	66.95

Global top 100 chemicals production total ~ 0.5 Gt/yr; CO_2 Emissions ~ 30 Gt/yr

$A + CO_2 \rightarrow ACO_2$

Limited supplies of A & limited sales of ACO_2

Need to regenerate A or make A with CO_2 constraints

* Source: American Chemistry Council

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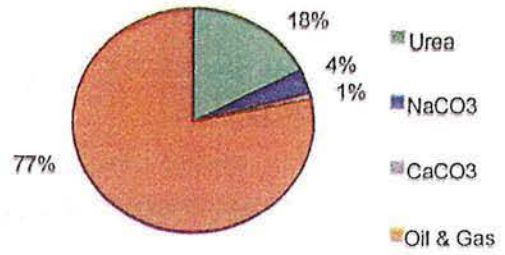
USA CO2 Usage

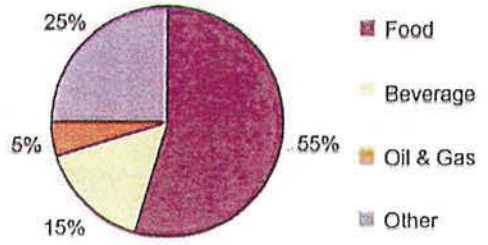
CO_2 Usage – United States

Gaseous Consumption = 30.9 million metric tons



Mainly EOR

Liquid/Solid Consumption = 7.1 million metric tons



Mainly Food

~40M Tonnes of Use vs. 6B Tonnes Currently Emitted (2.5B Tonnes from US Utility Sector)

Source: Howard Herzog / MIT Laboratory for Energy and the Environment

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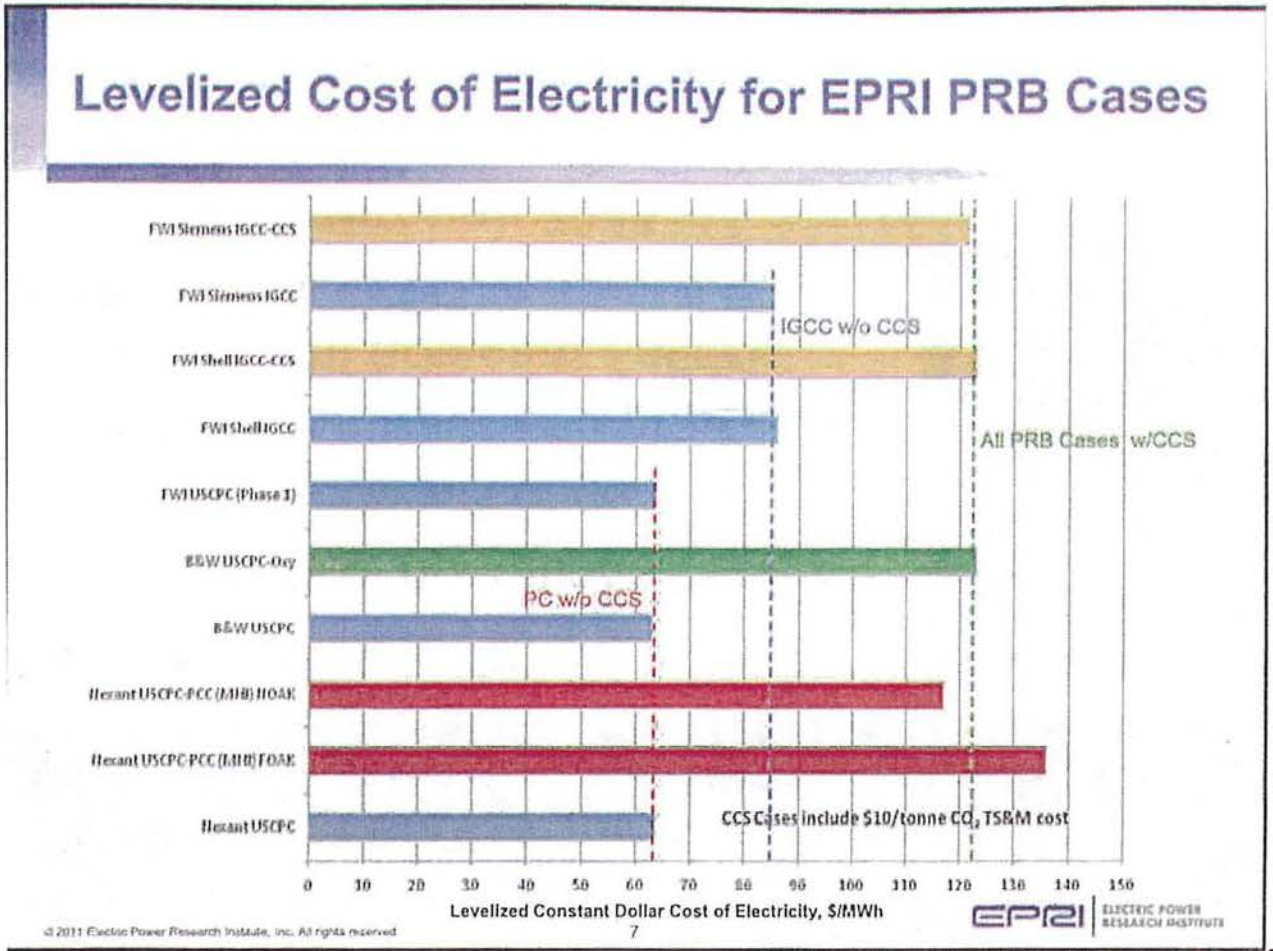
COE



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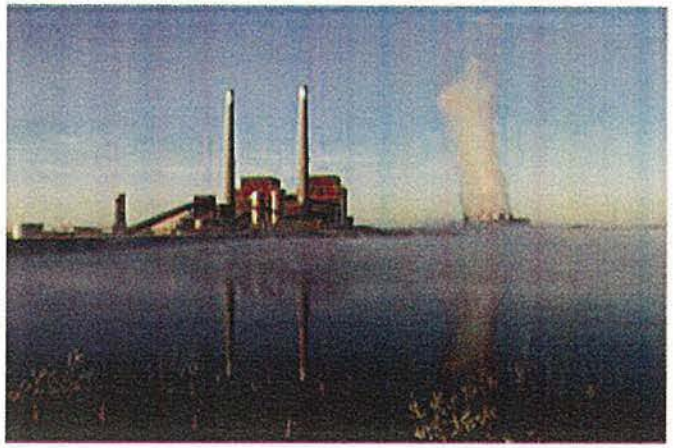
Coal Creek Station

- **Two units built in 1979 & 1981**
  - 25+ years of operation
  - 1,180 megawatts of generation
- **Uses 8 million tons of lignite coal annually from adjacent Falkirk Mine**
  - **Contract through 2045**
- **Electricity delivered to customers via high voltage direct current transmission system**



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Efficiency Improvements

- Turbine blades
  - Future upgrades
- Cooling Towers
- Simulator
- Ventilation
- Variable packing
- Fans/VFD's
- Controls
- Leak detection
- Compressed air
- 605,771 tons total

- DryFining
  - beneficiation
- 4%, 800,000 tons total

Over $316,000,000 invested in environmental and efficiency improvements since 1979

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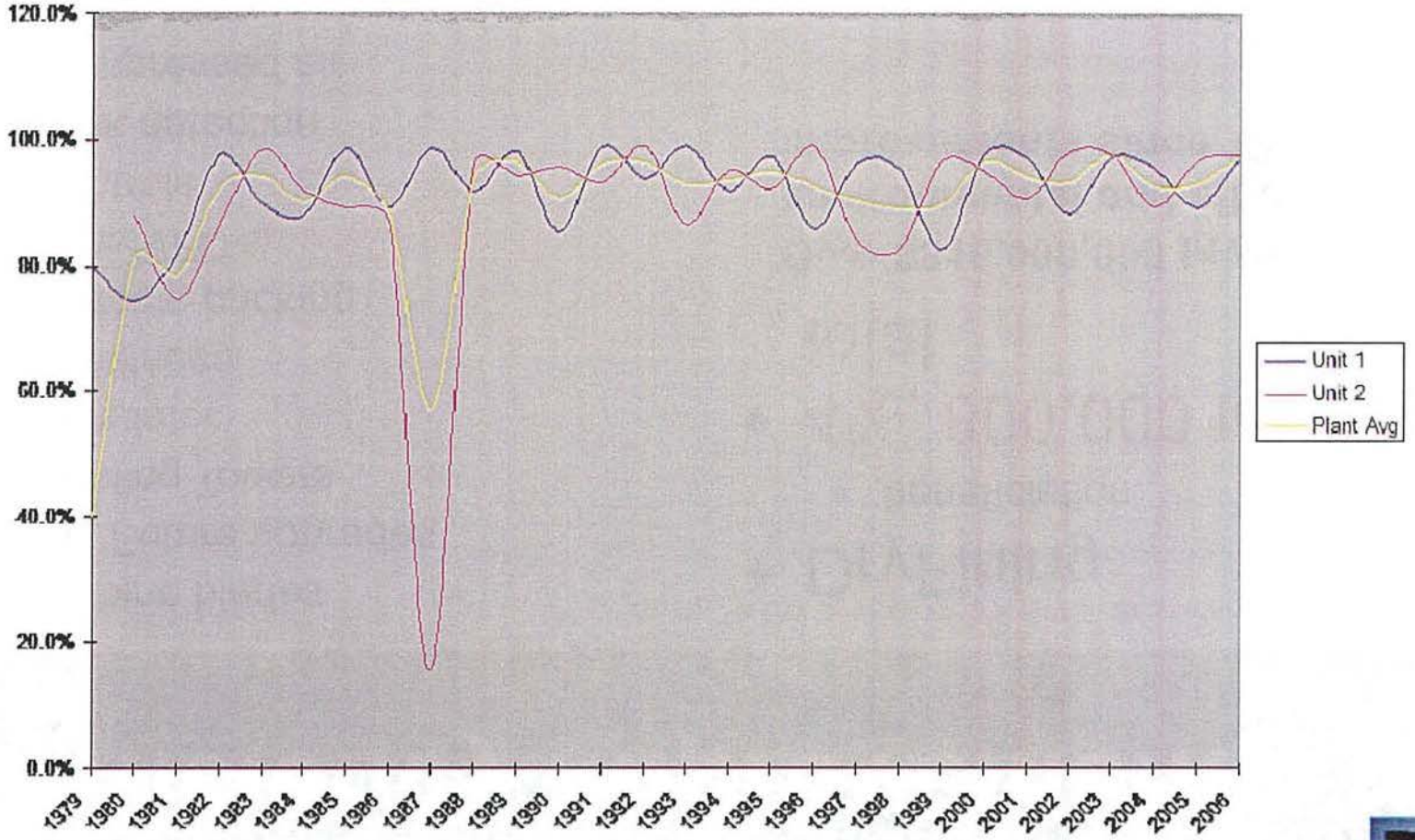
Availability



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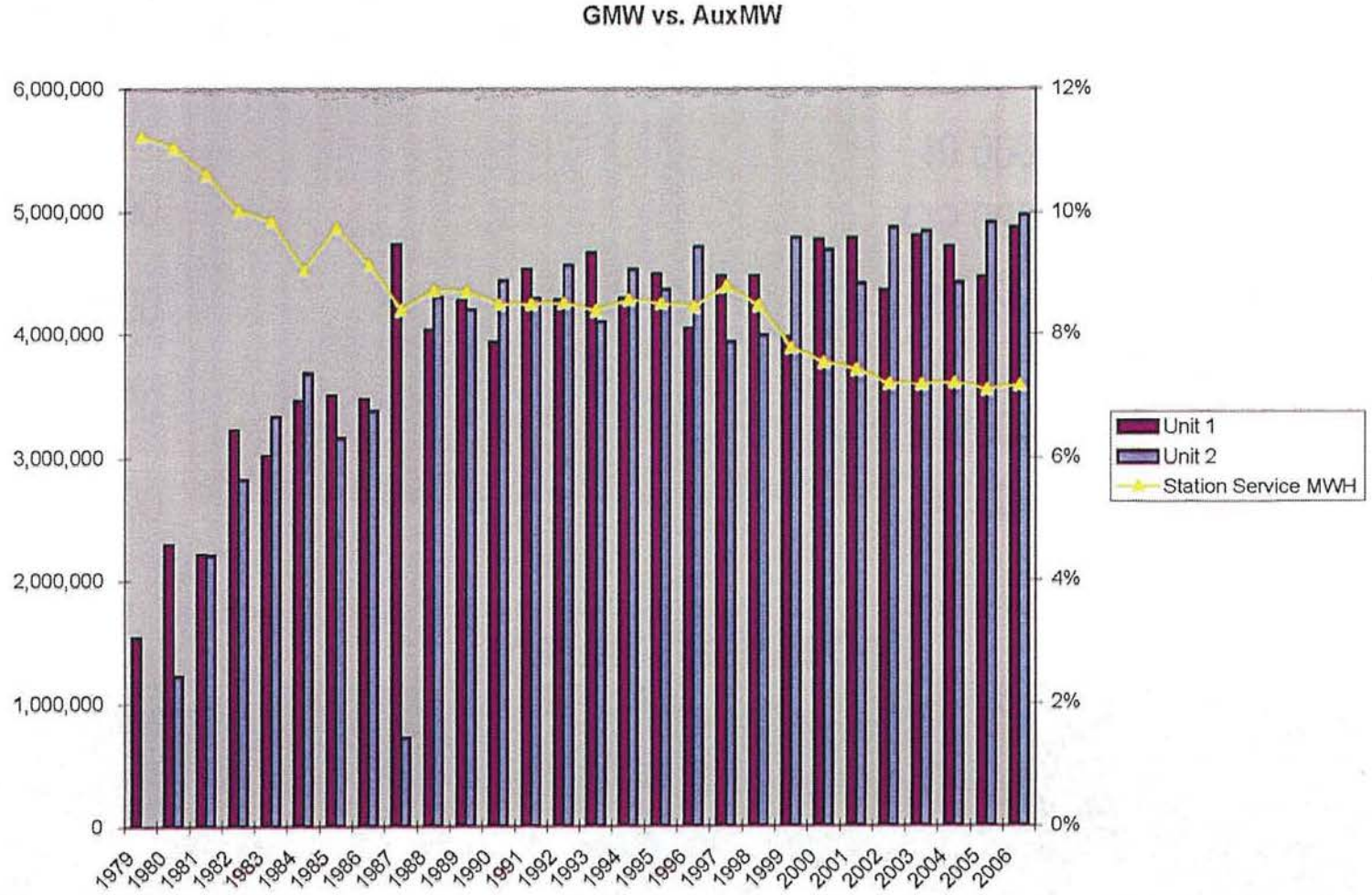
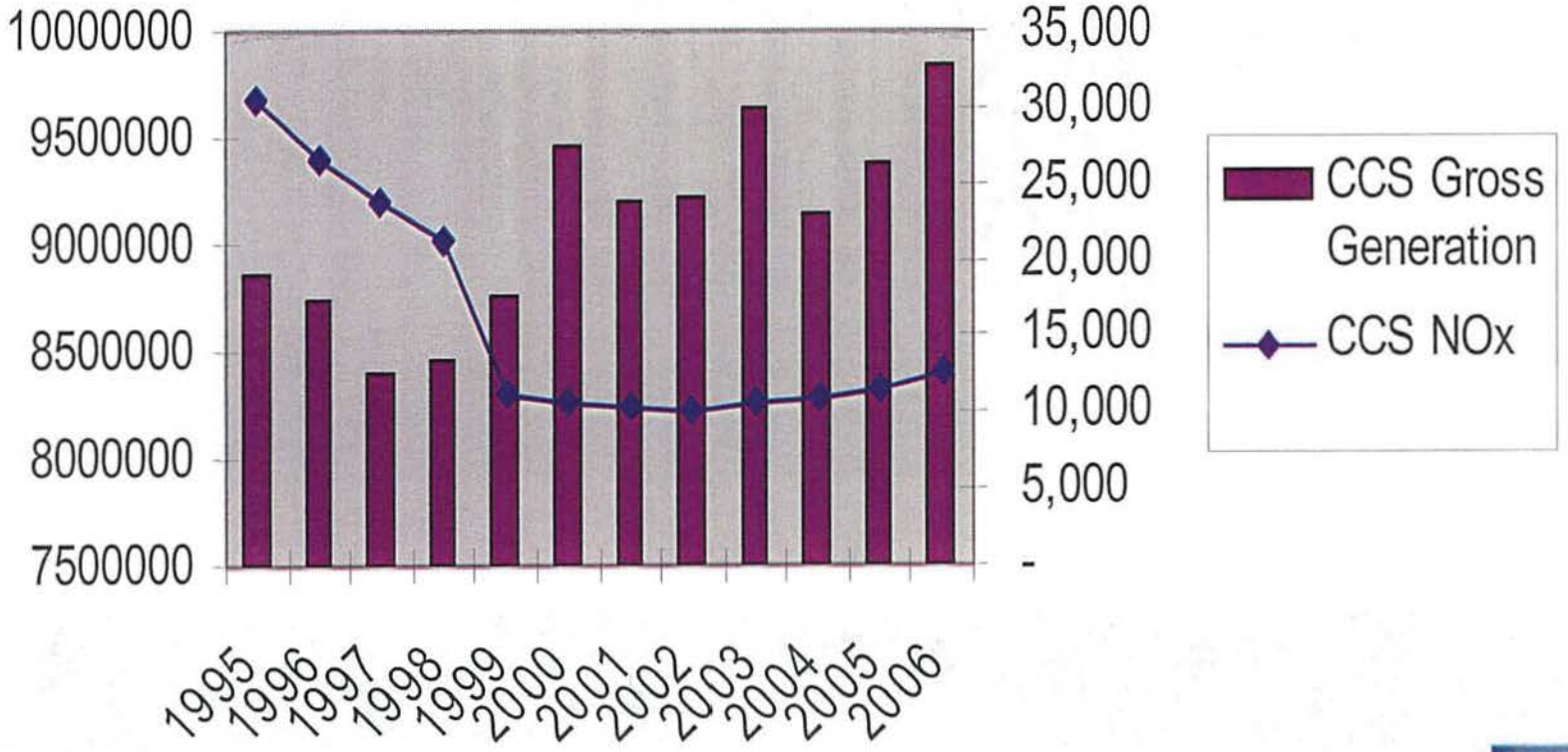
Aux power


GMW vs. AuxMW
6,000,000
5,000,000
4,000,000
3,000,000
2,000,000
1,000,000
0
12%
10%
8%
6%
4%
2%
0%
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
Unit 1
Unit 2
Station Service MWH

NOx vs. Generation



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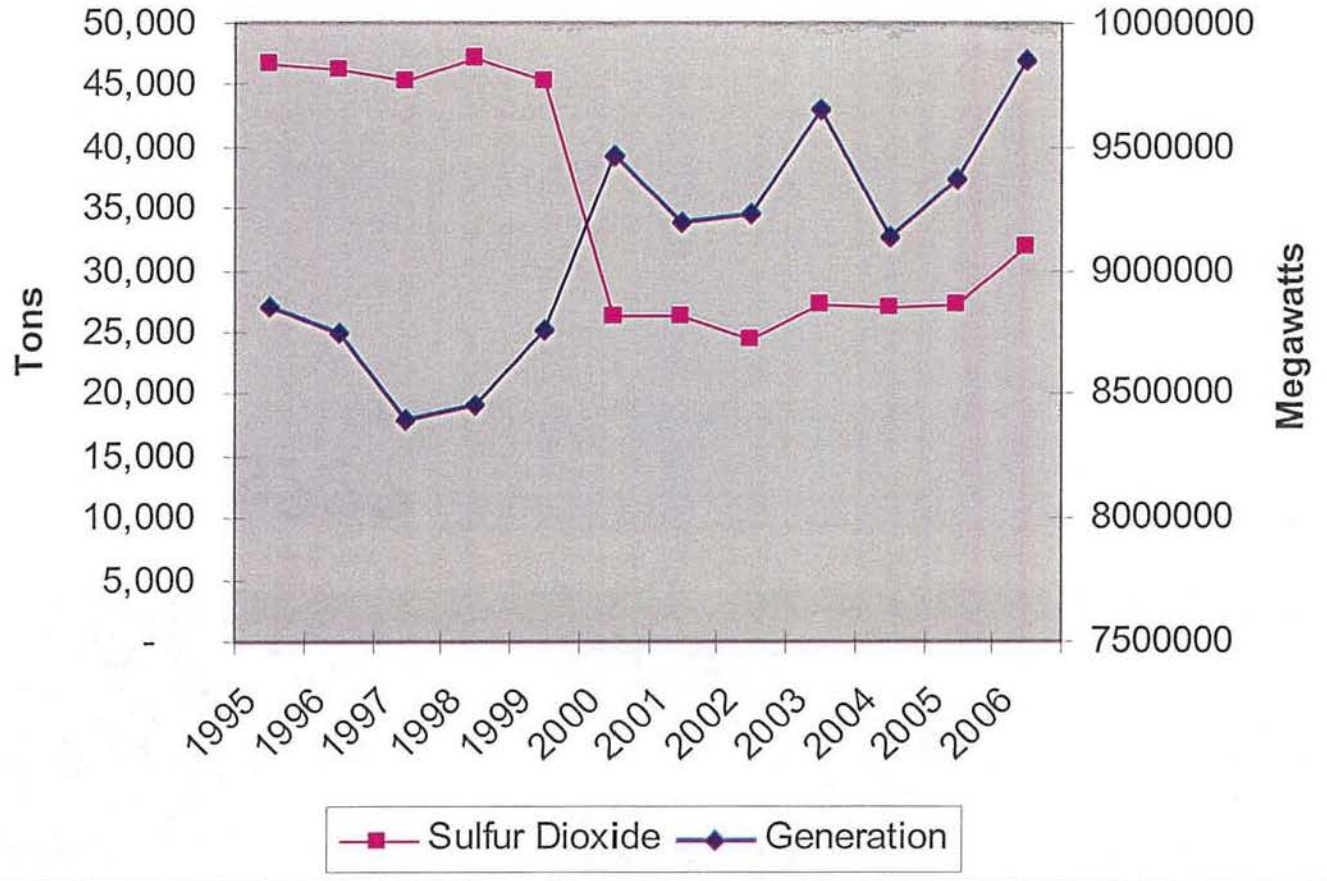
Coal Creek Station
Sulfur Dioxide Emission vs Generation



Any questions???

- Questions???

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