The Case for Fuel Delivery System Upgrades on Utility Boilers

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ASME Research Committee on Energy, Environment and Waste

- 1960s - Industrial Waste
- 1970s - Municipal Solid Waste
- 1980s - Hazardous Waste & Medical Waste
- 2000s - Energy, and other environmental issues
- 2011 - Renaissance

Fuel Delivery System Upgrades for Utility Boilers Subcommittee

- Subcommittee deals with coal-fired boilers and the fuel delivery system evaluating upgrades & benefits; costs & savings

Roster of the Fuel Delivery Systems Upgrade Subcommittee

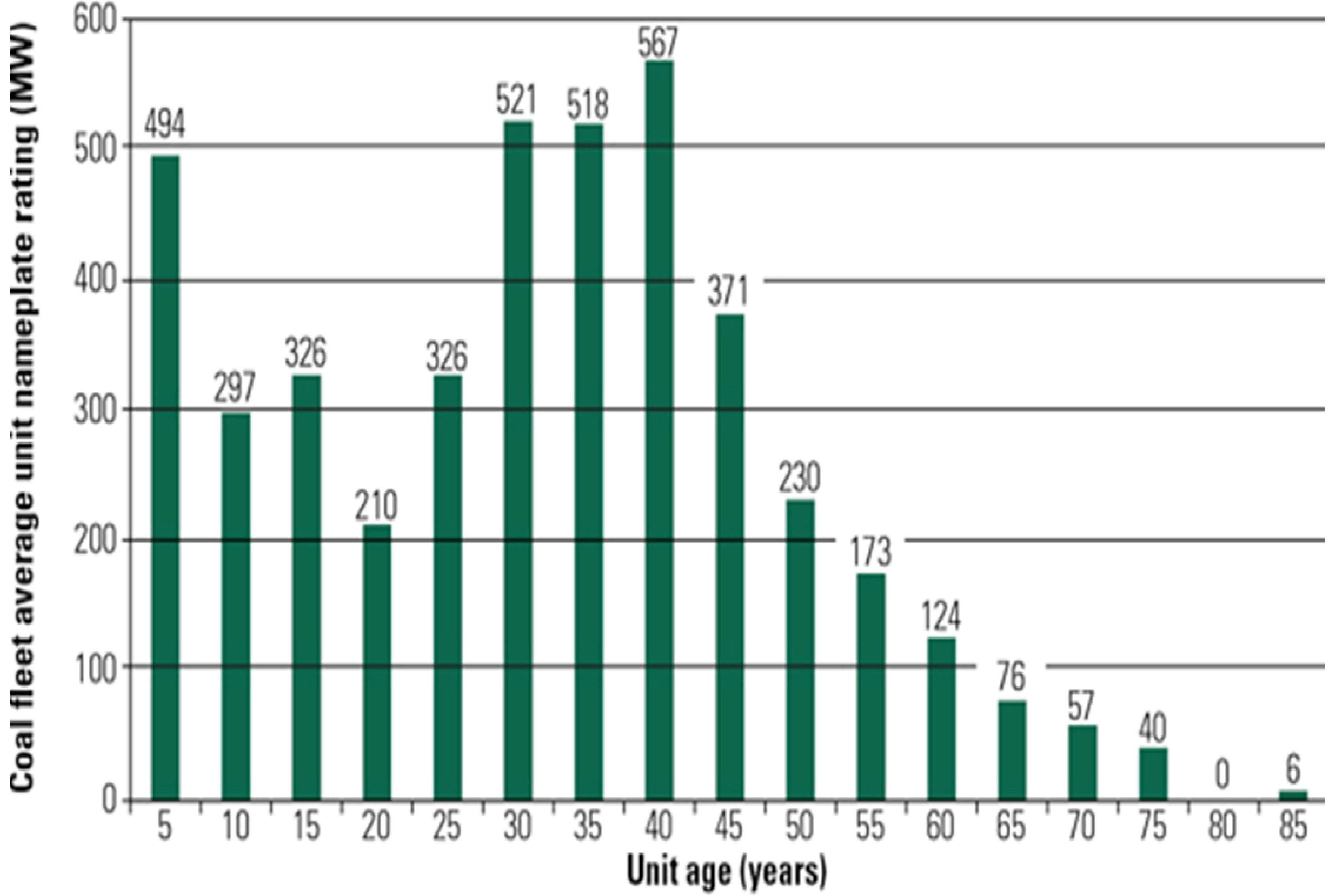
- Robert Chase, Terrasource (Supplier)
- Blaz Jurko, Gebr. Pfeiffer, Inc. (Supplier)
- David J. Stopek, Consultant, Sargent & Lundy LLC (Consultant)
- Grant E. Grothen, Principal, Burns & McDonnell (Consultant)
- Steve McCaffrey, President, Greenbank Energy (Supplier)
- Melanie Green, Director, CPS Energy (User)
- Don B. Pearson, Babcock & Wilcox (Retired) (Supplier)
- Richard Himes, EPRI (User)
- Tony Licata, Licata EEC & Chair RC EEW (Supplier)
- Robert E. Sommerlad, Consultant & Chair, FDS Subcommittee (Consultant)
- Todd Melick, Vice President, Promecon USA (Supplier)
- Joe Von der Haar, Plant Manager, East Kentucky Power (User)

Overview

- Plant Retirements
- Focus on 35- to 45- year old coal-fired units
- Fuel Delivery System
- Potential Upgrades
- Methodology – Present status; Determine Upgrades & Benefits: Costs & Savings; Breakevens
- Case Studies – 500-MW units converted to PRB Coal
    1. Opposed Wall
    2. Tangential
    3. Cyclone
- Results

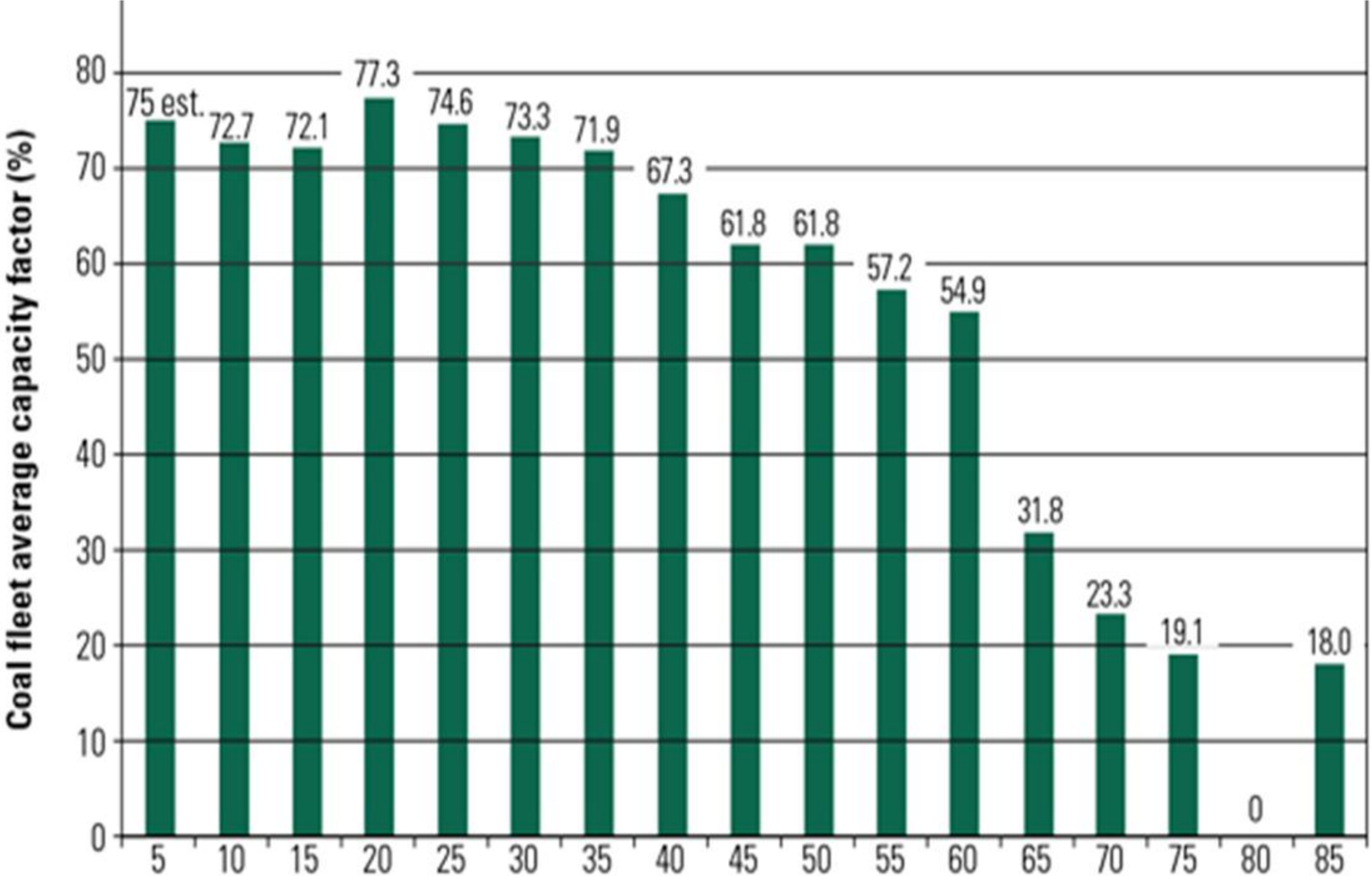
Analogy to Plane Geometry Theorems

- Given: A group of boilers will be retired putting increased performance requirements on the next younger boilers.
- To Prove: Younger group of boilers can be upgraded and achieve significant benefits
- Analogies:
  - Analyze critical parts of typical coal-fired power plant
  - Select Fuel Delivery System as the carburetor of the system
  - Consider, select potential upgrades, and cost same
  - Determine potential benefits, and savings
  - Evaluate, review, rereview, and report
  - “To Prove” proven



Coal fleet average unit rating

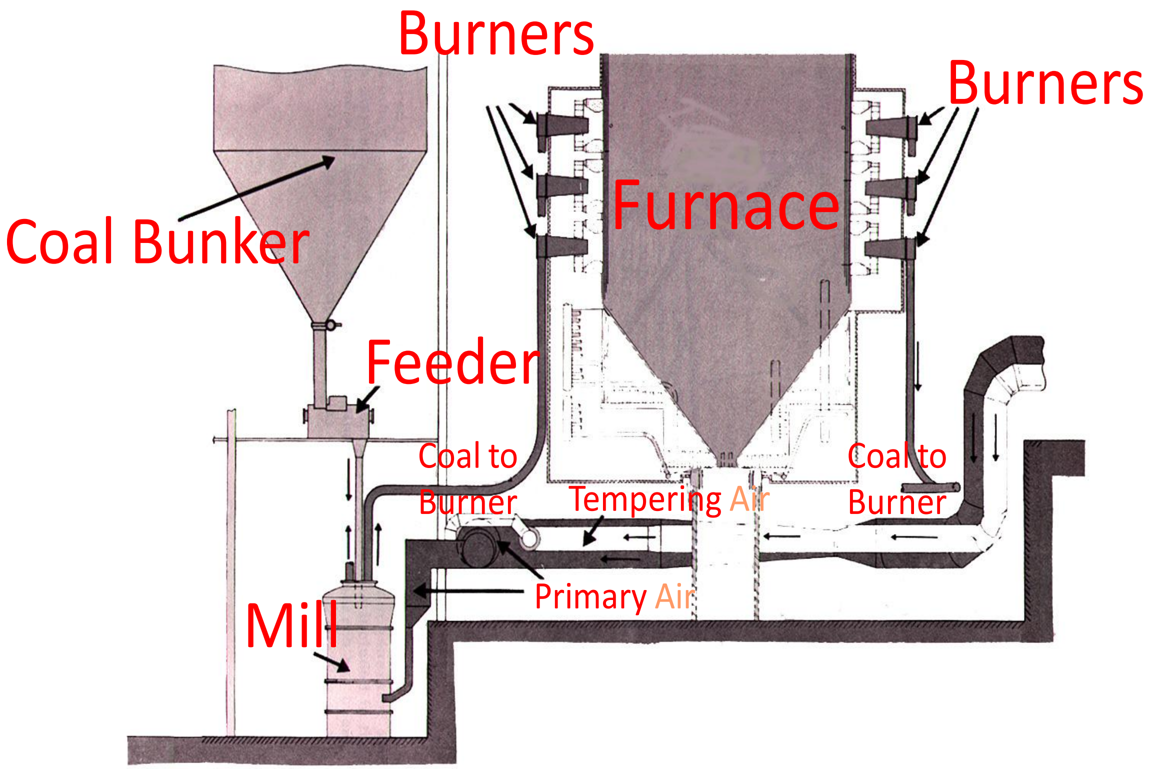
- Greater than 50 years – 53 GW or 20% of fleet
- 30 to 45 year old units – 216 GW or 63% ~ 500 MW



Coal fleet average Capacity Factor

- 30 to 45 year old with >50 year old gone,
- 75% of fleet and Capacity Factor near 80%

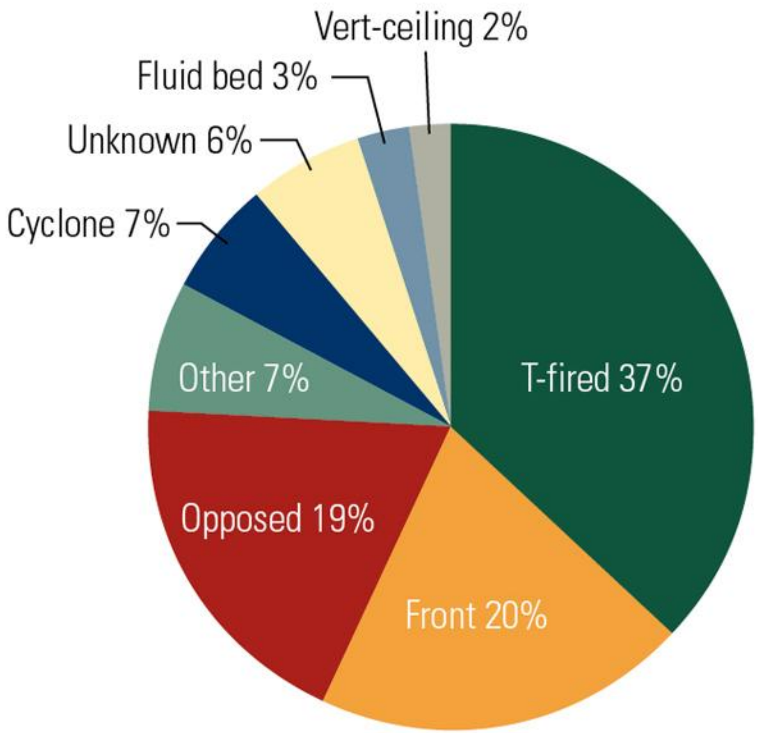
Fuel Delivery System



Potential Upgrades for FDS

Component	Upgrade	Benefit
Feeders	Metering	Flow control
Pulverizers	Dynamic Classifier	Fineness/Capacity
Coal Pipes	Coal-air flow Metering	Flow & Air/Fuel Ratio
Burners	Metering	Improved combustion
Boiler Control System	Neural Networks	Improved performance

Case Studies



Coal fleet boiler design.

- Based on real 35- to 45-year old 500-MW boilers now firing PRB coal & derated
- No Air Quality Control System Upgrades
- No increase in emissions to avoid NSR & PSD

1. Opposed-Wall
2. Tangential
3. Cyclone

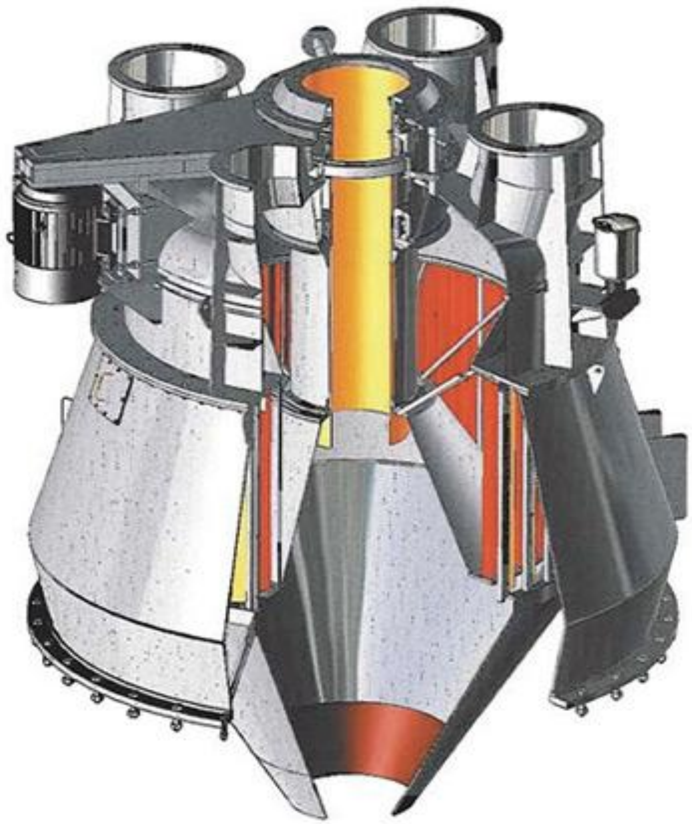
Case Study 1 – Opposed Wall

Component	Upgrade
Feeder	New Feeder
Pulverizer	Dynamic Classifier
Coal Pipes	Coal-air flow
Burner Modernization	LNBs & OFA
Boiler Control System	Neural Network

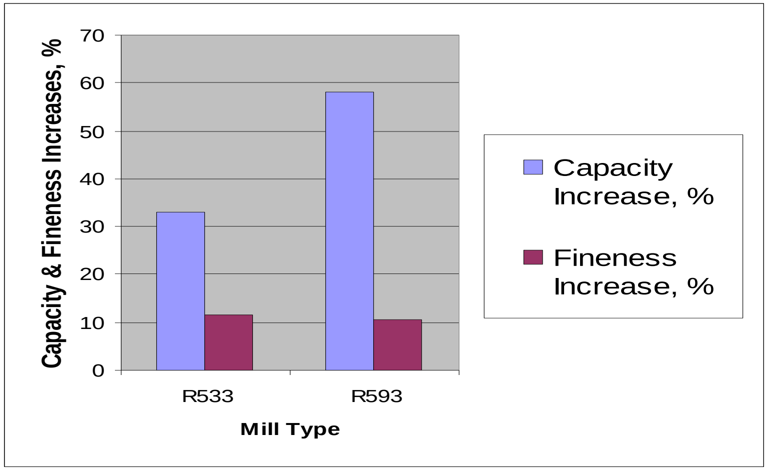
Case Study 1 – Opposed Wall

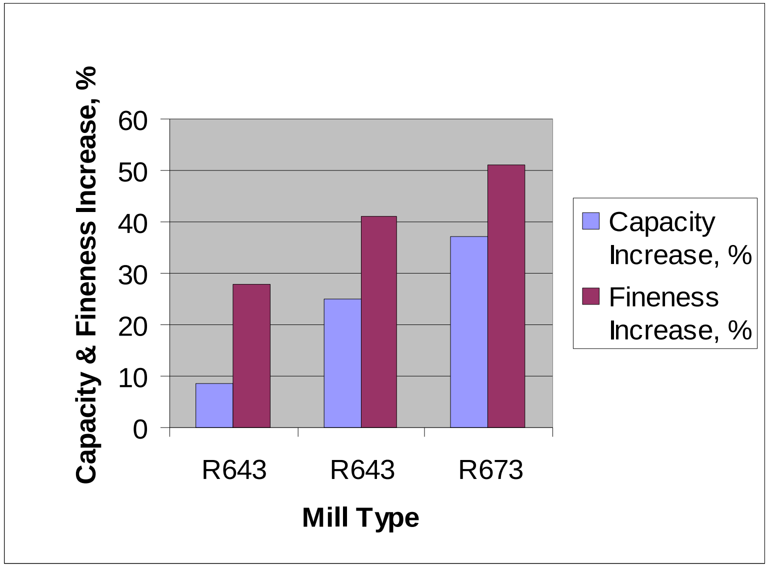
Component	Upgrade	Benefits
Feeder	New Feeders	Improved Flow Control
Pulverizer	Dynamic Classifiers	Increase Fineness (X50 Mesh) & Capacity (~5%)
Coal Pipes	Coal-air flow	Improved Flow Control
Burner Modernization	LNBs & OFA	NOx and UBC; <NH3
Boiler Control System	Neural Network	Improve Boiler Efficiency & Fan Power; <NH3

Dynamic Classifiers



Courtesy of Loesche Energy Systems.





Case Study 1 – Opposed Wall

Component	Upgrade	Cost, $k	Savings, $k/y
Feeder	New Feeders	900	Combine with DCs
Pulverizer	Dynamic Classifiers	3,600	5% "Recovery" 8,760 2 Days Op 960 Subtotal 9,720
Coal Pipes	Coal-air flow	700	Combine with BCS
Burner Mods	LNBs & OFA	5,400	NH_3 210
Boiler Control System	Neural Network	300 Subtotal 10,900	Efficiency 596 Fan 314 NH_3 85 Subtotal 995
PM&ES	25%	2,725	
Total		13,625	10,925

Breakeven 15 months

Case Study 2 - Tangential

Component	Upgrade	Cost, $k	Savings, $k/y
Feeder	New Feeders	750	Combine with DCs
Pulverizer	Dynamic Classifiers	3,000	5% "Recovery" 8,760 2 Days Op 960 Subtotal 9,720
Coal Pipes	Coal-air flow	584	Combine with BCS
Burner Mods (Burners & SOFA)	New Burners & SOFA & Other	4,800	Some NO_x, UBC but no significant savings 0
Boiler Control System Subtotal	Neural Network	300 9,434	Efficiency 596 Fan 314 Subtotal 910
PM & ES	25%	2,359	
Total		11,763	10,630

Breakeven 13 months

Case Study 3 - Cyclone

Component	Upgrade	Cost, $k	Savings, $k/y
Feeder/Crusher "Island"	New Feeders & Instrumentation	1,200	Combine with Cyclone Modernization
Cyclone Modernization	Cyclone upgrades and new "Split" air damper	2,880	Regain 7 days full load oper-ation due to slagging 3,360
Boiler Control System	Update Boiler Control System	400 Subtotal 4,480	Efficiency 268 Fan 57 Subtotal 455
PM & ES	25%	1,120	
Total		5,600	3,815

Breakeven 18 months

Summary of Case Study Costs, Savings, and Breakevens

Case Study	Type	Cost, $k	Savings, $k/y	Breakeven, Months
1	Opposed Wall	13,625	10,925	15
2	Tangential	11,697	10,630	13
3	Cyclone	5,600	3,815	18

500 MW, 80% Capacity Factor

Impact of Capacity Factor on Savings and Breakevens

Capacity Factor, %			60	70	80
Case Study	**Boiler Type**				
1	Opposed Wall	Savings, $k	8,295	9,096	10,925
		Breakeven, Months	20	18	15
2	Tangential	Savings, $k	7,973	9,301	10,630
		Breakeven, Months	18	15	13
3	Cyclone	Savings, $k	2,861	3.331	3,815
		Breakeven, Months	23	20	18

Other Considerations

- Redoing Case Studies for Eastern Coal
  - Price of eastern coal has increased
- Market Size - approximate
  - Opposed Wall – 226
  - Tangential – 143
  - Cyclone - 15
- Next steps
  - Presentations, feedback

Conclusions & Footnote

This Research Subcommittee came together with concerns by some that this effort could not be done, but with some considerable give and take the Subcommittee succeeded. Most were surprised by the short breakevens or short payback periods. The costs and savings were revisited and largely remain unchanged. Clearly the Dynamic Classifier and Neutral Network upgrades provided some amazing savings.

The Subcommittee is to be applauded for its enthusiastic efforts over a 20-month effort in monthly one-hour conference calls. As its Chair, it was an honor and pleasure to work with them.