



Coal Combustion Inc.

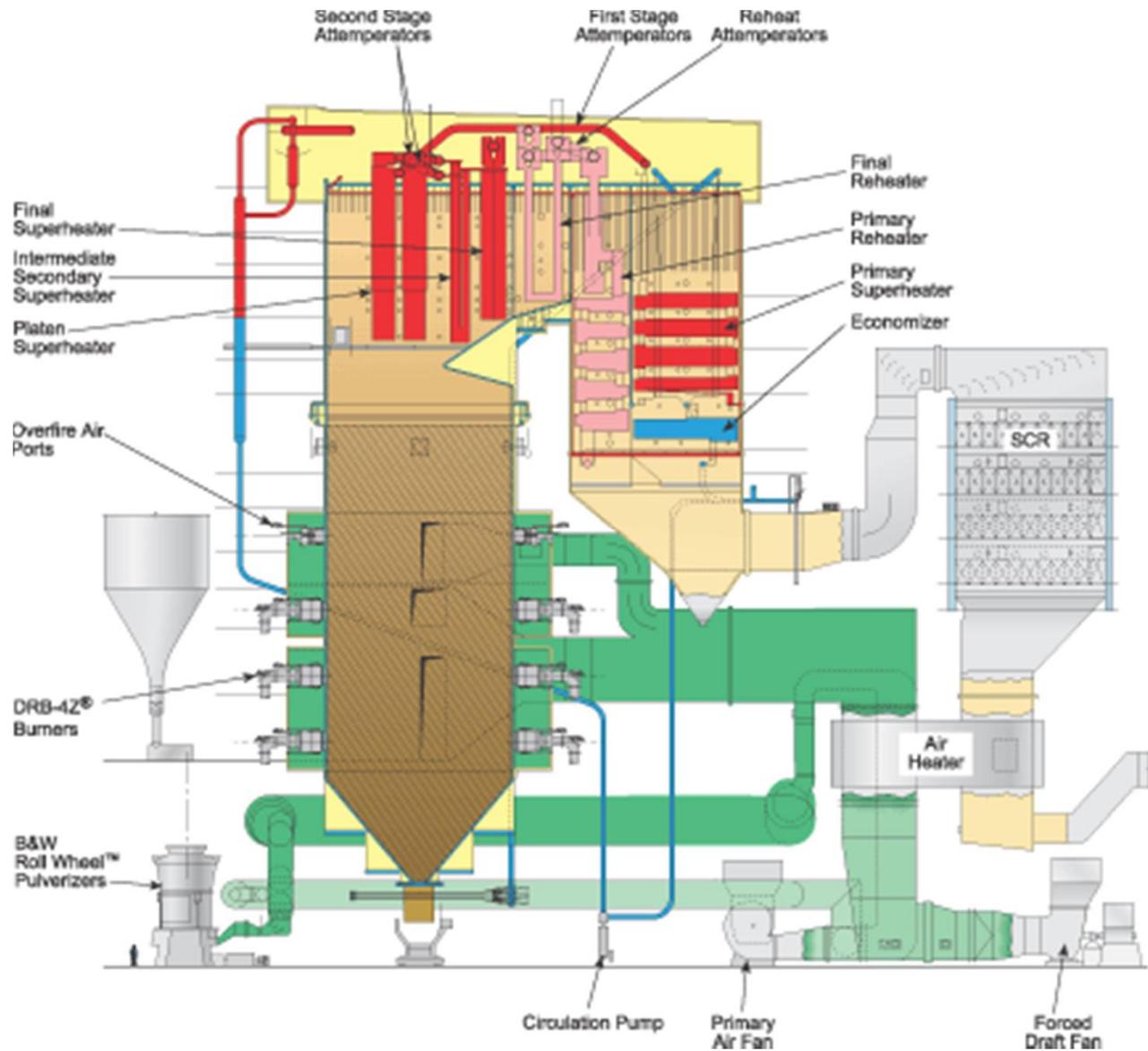
Understanding the business of coal

CAPP Coal Future?

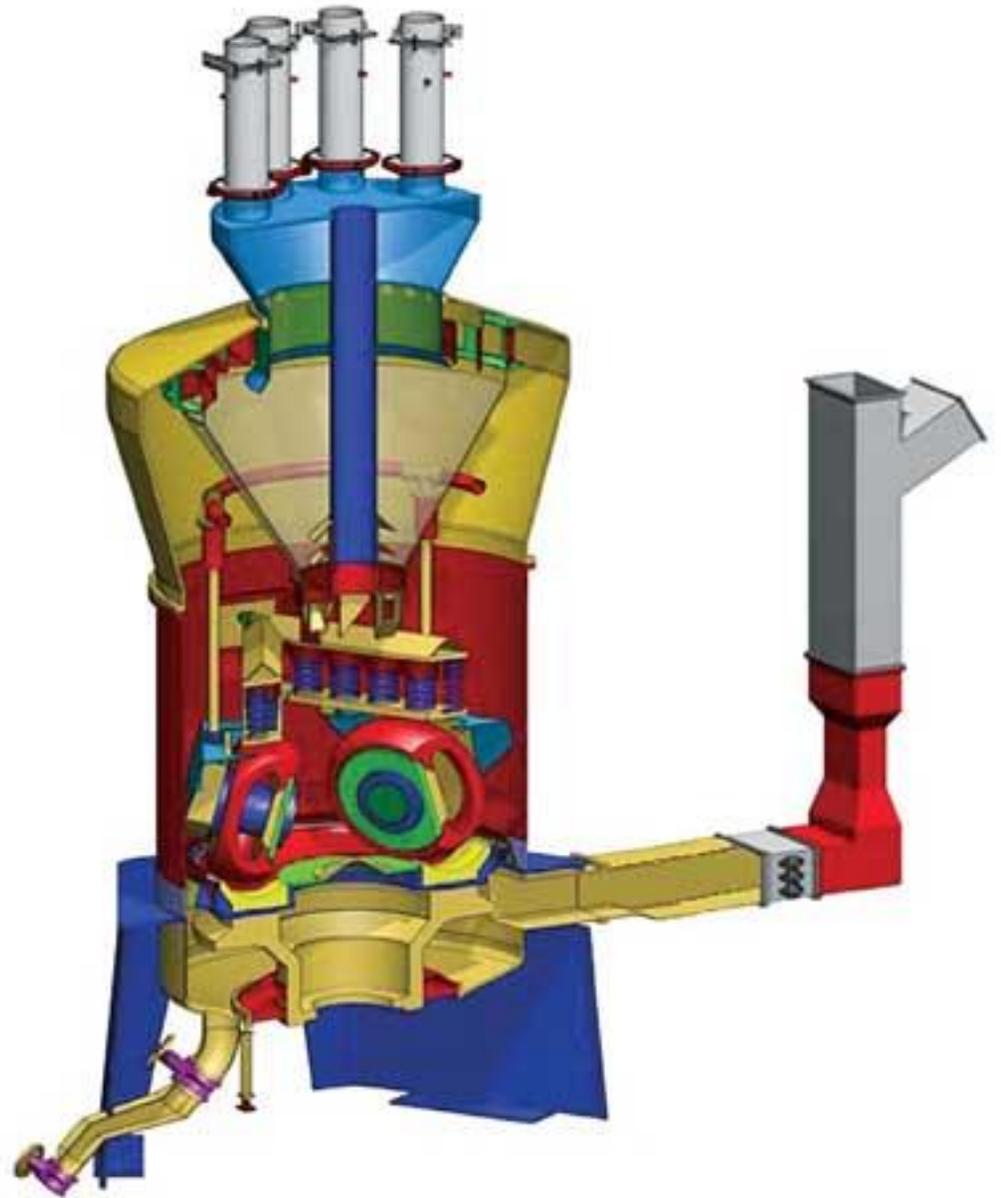
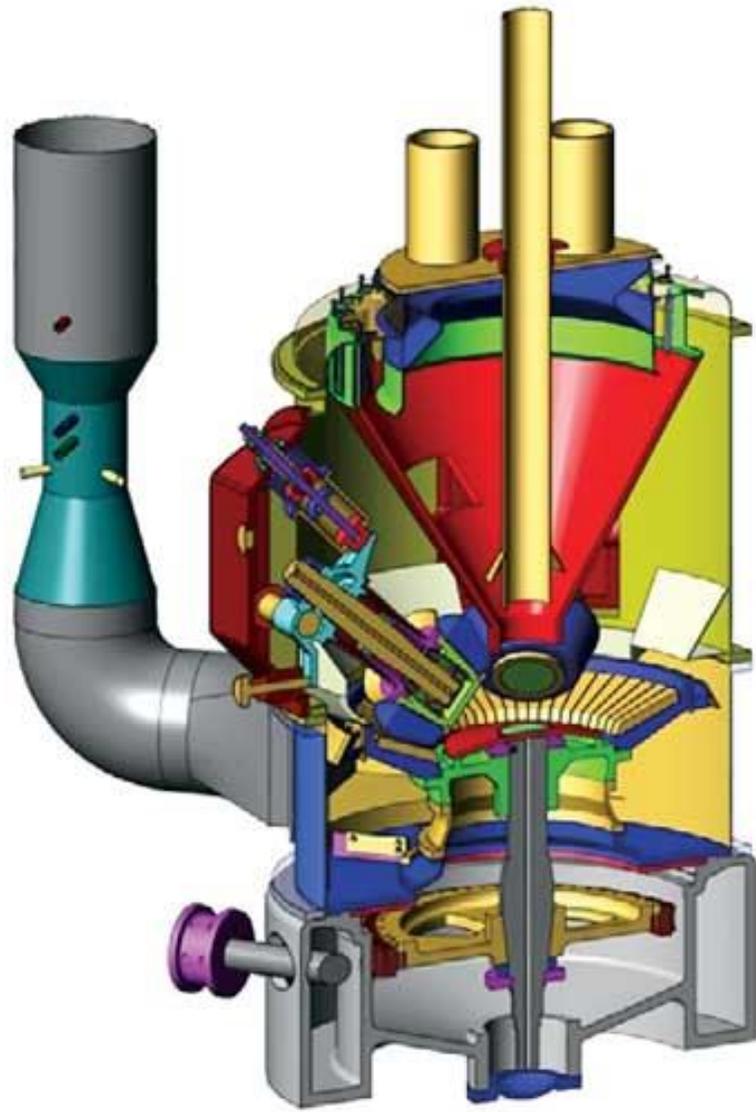
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Pulverized Coal Plant



Plant Basics

Boilers are Btu machines

Pulverizers are ton machines
Pulverizers grind and DRY coal

Higher moisture lower Btu coals
impact pulverizer performance

Pulverizers

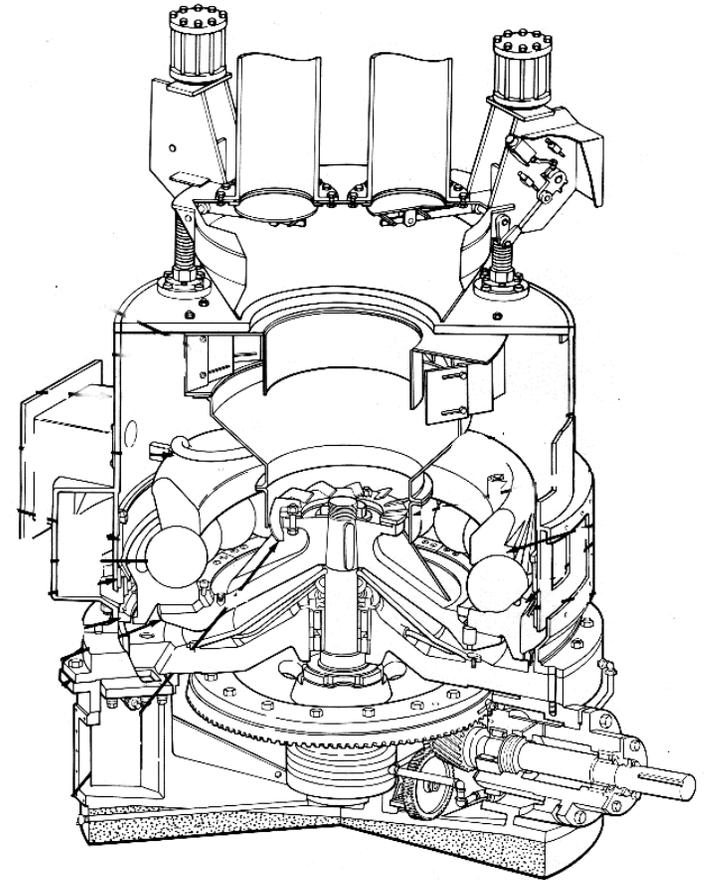
Have to grind and Dry

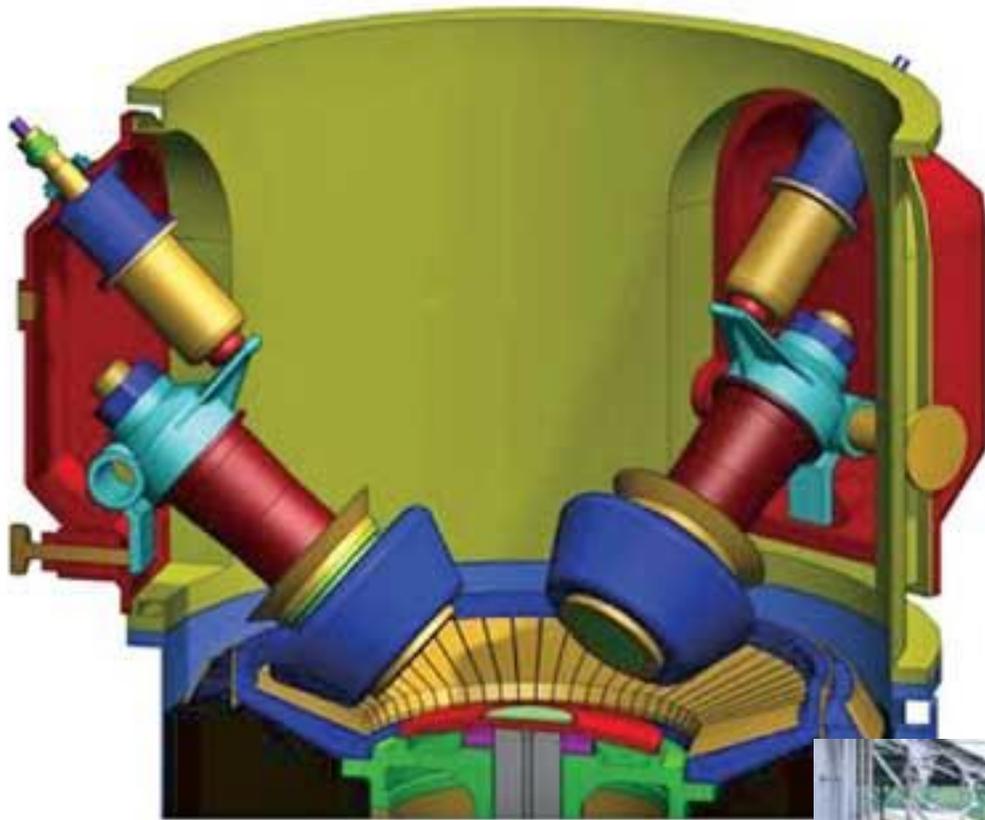
Ash Wears Them Out

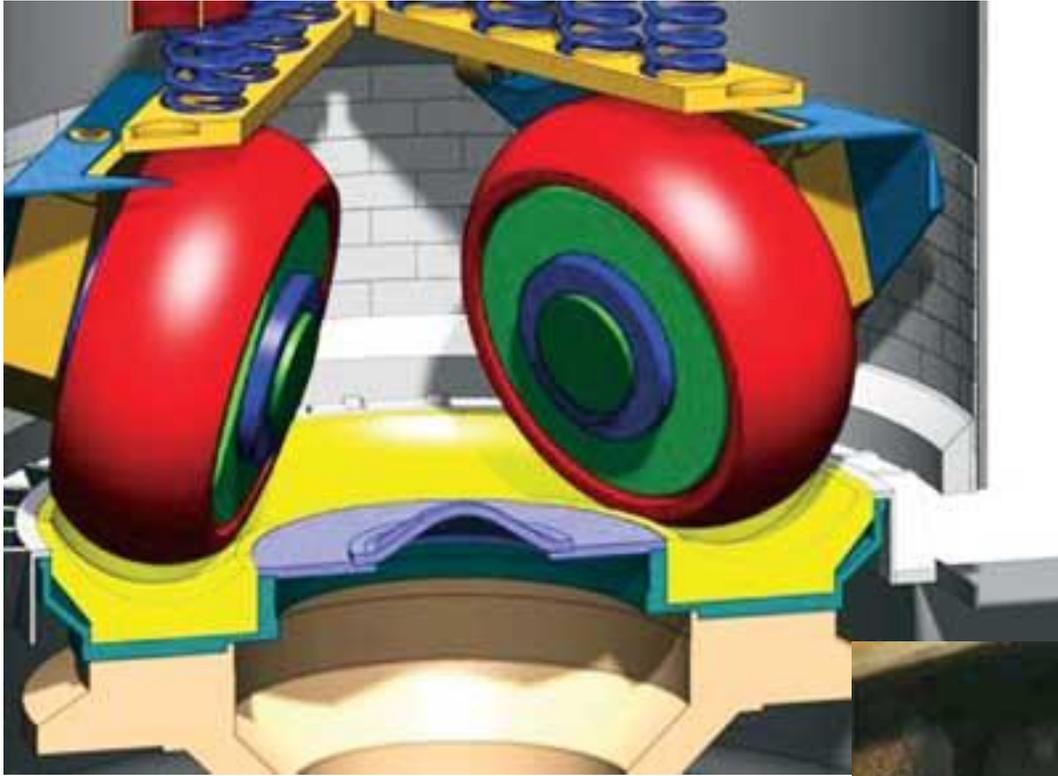
Impacts load

High Maintenance

Performance Testing









Scrubber remove SO₂ from flue gas

CAPP is easiest coal to use:

Easy to Low NOx

Little to no Slag

Little to no Corrosion

Easy on Operators

NAPP is easier coal to use:

High Btu

High HGI Grind

Low ash =Less Slag

Can be Easy Operators

High Sulfur Issues

PRB Coal:

Handling Issues

Low Sulfur

Good Low NOX

Slagging & Fouling

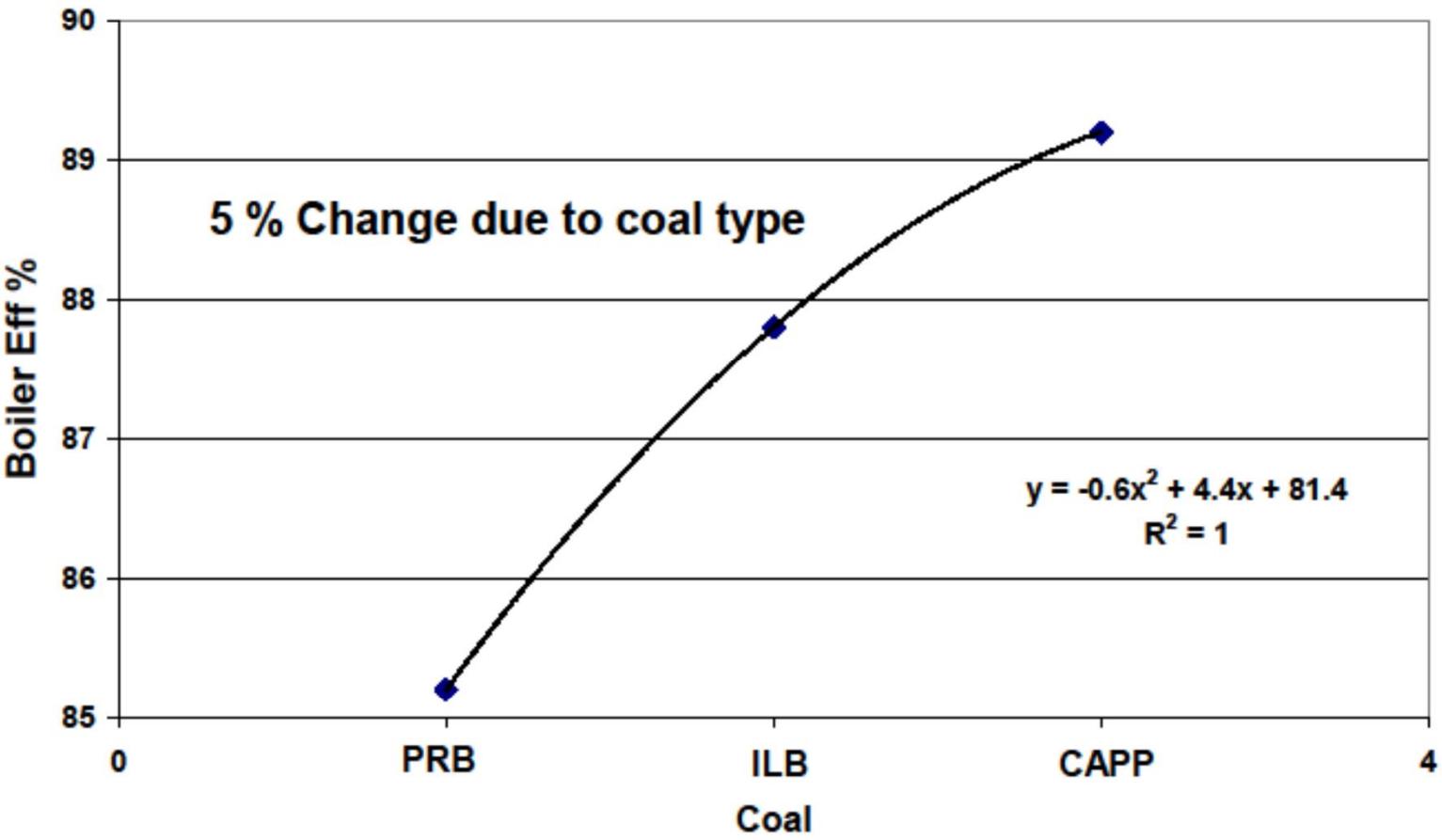
Low Btu/Low Price



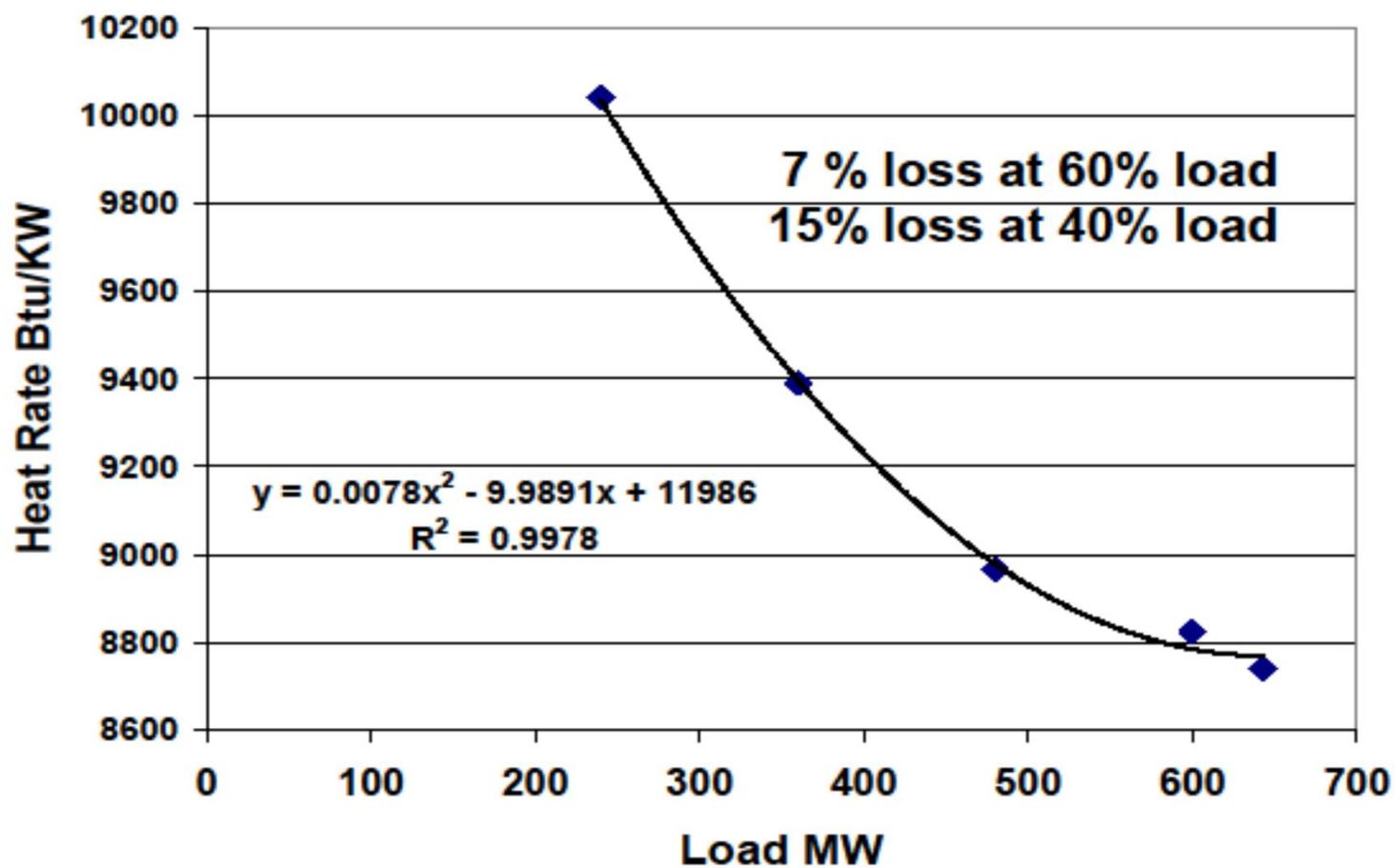
Illinois Basin:

**Plant Operators have
to stay on top of their game
Not low NOX friendly
Slagging & Fouling
High Sulfur Issues
Best Value?**

Boiler Efficiency w Coal Type



Low Load Kills Efficiency



Compounding Efficiency Losses

Conversion from CAPP to PRB
and operation at partial load

10 to 20 % loss in efficiency
10 to 20 % more CO₂ per MW

Coal Basics

CAPP, NAPP-High rank (Btu) Coals are low moisture
and high MAF Btu/lb
Oil like and do not mix with water

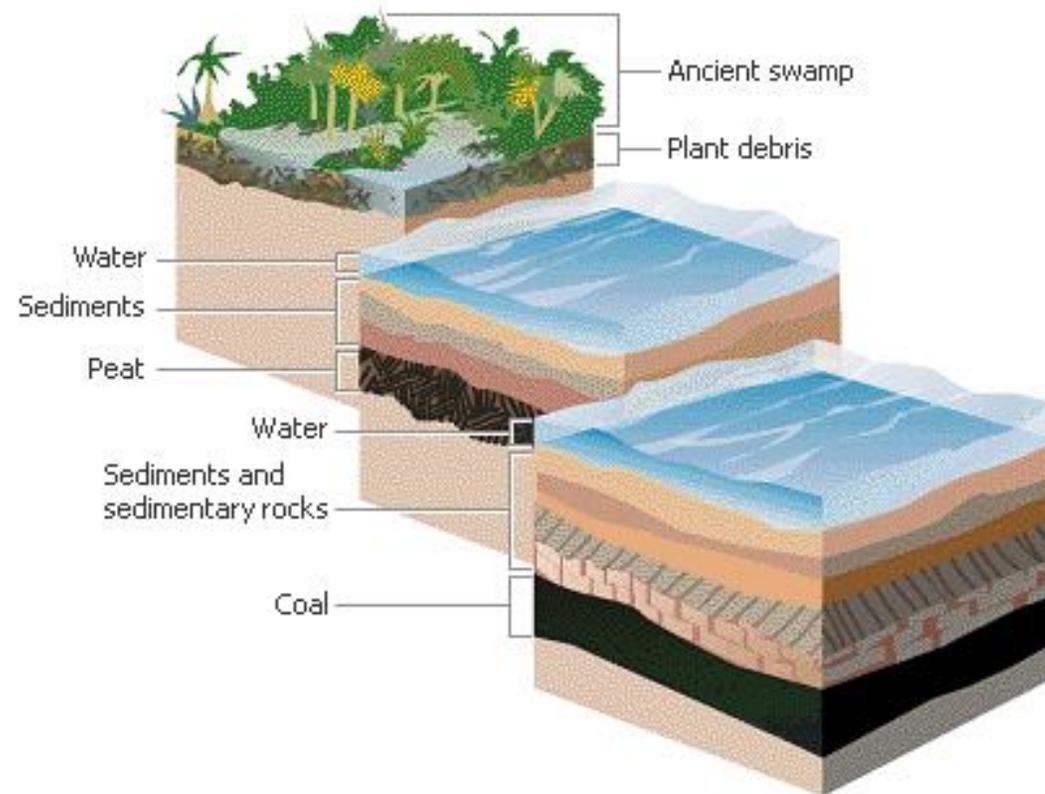
PRB-Low rank coals are low MAF Btu/lb due to high
oxygen in ultimate test
High oxygen materials like water, Whiskey and water

ILB coals are medium rank with moderate moisture

Low sulfur coals are low in pyrite

All coal has sulfur

It comes from sea water vs. fresh water environment



Sea salts

Sea water

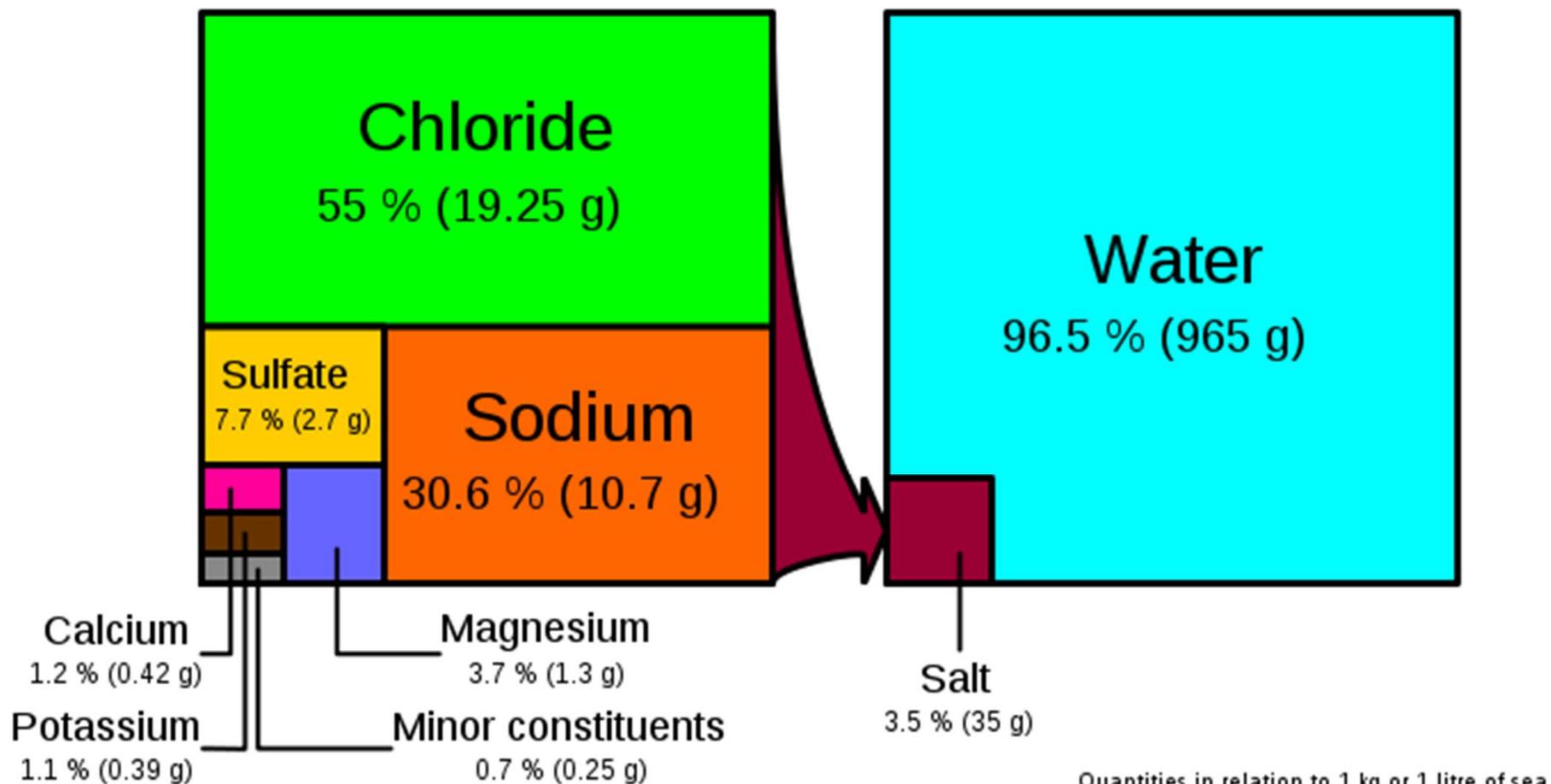


Table of Top 14 Out of 70 Trace Elements in Natural Sea Water

Parts per million (ppm) and milligrams per liter (mg/l) are relatively the same in sea water, therefore the measurements shown are used synonymously.

Chromium (Cr) 0.00005

Cobalt (Co) 0.0005

Copper (Cu) 0.003

Fluorine/Fluoride (F) 1.3

Iodine/Iodide (I) 0.05

Iron (Fe) 0.01

Manganese (Mn) 0.002

Molybdenum (Mo) 0.01

Nickel (Ni) 0.0005

Phosphorus/Phosphate (P) 0.07

Selenium (Se) 0.0002

Tin (Sn) 0.003

Vanadium (V) 0.002

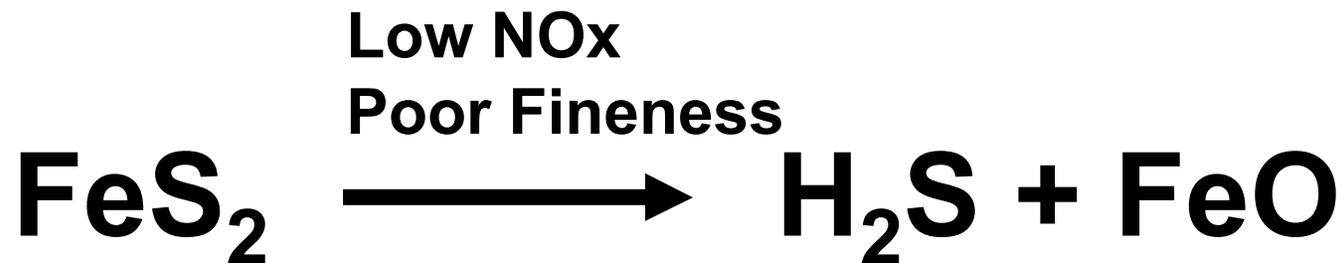
Zinc (Zn) 0.01

Pyritic



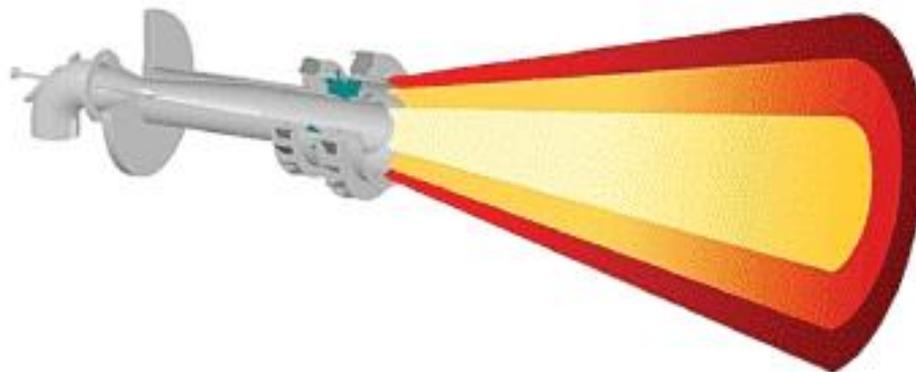
**sulfur is attached
to iron in
fool's gold**

Chemistry Issues



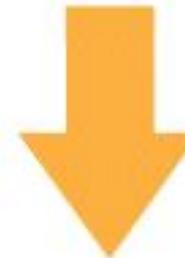
High Sulfur Coal

Corrosion and Slag

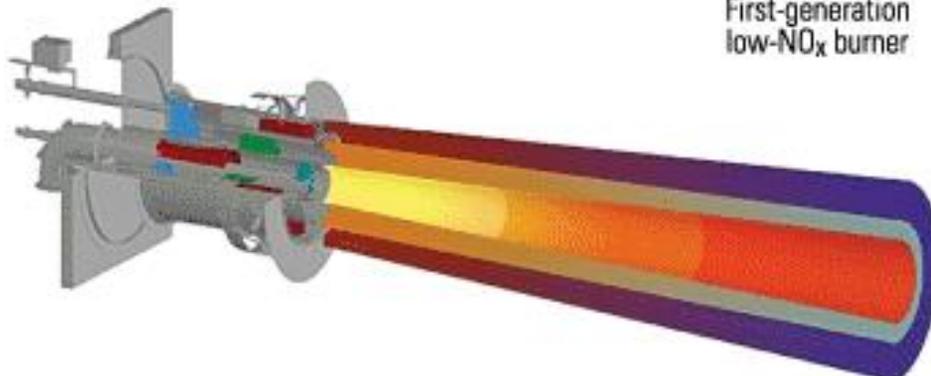


First-generation low- NO_x burner

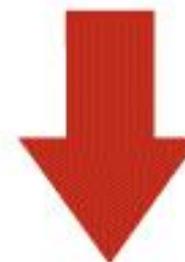
Sensitive



Unforgiving



Second- and third-generation low NO_x burners with overfire air/staged combustion



Challenging!

Fusion Spread Ox-Red

Low NOx Conditions

Iron Level

delta Temp F.

5

20

10

70

20

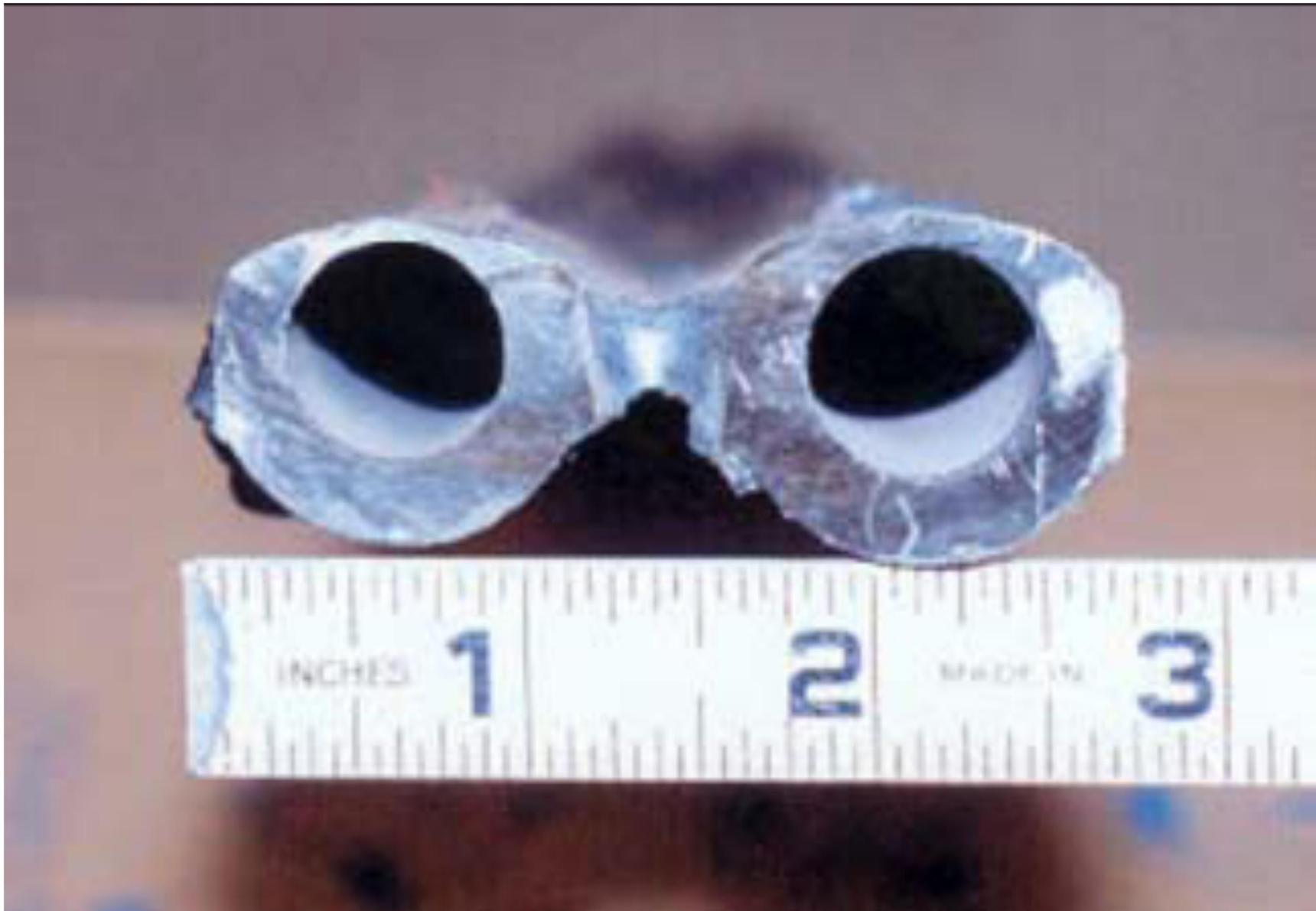
200

25

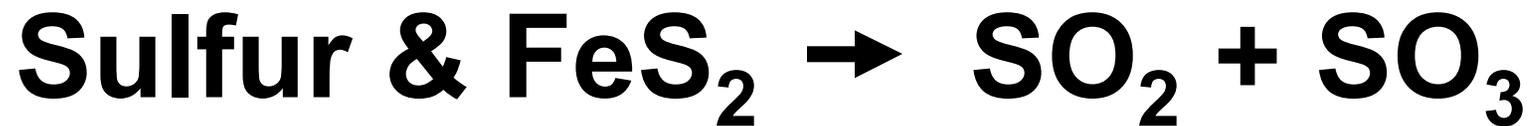
300



With low NO_x Waterwall Corrosion – Tube Leaks

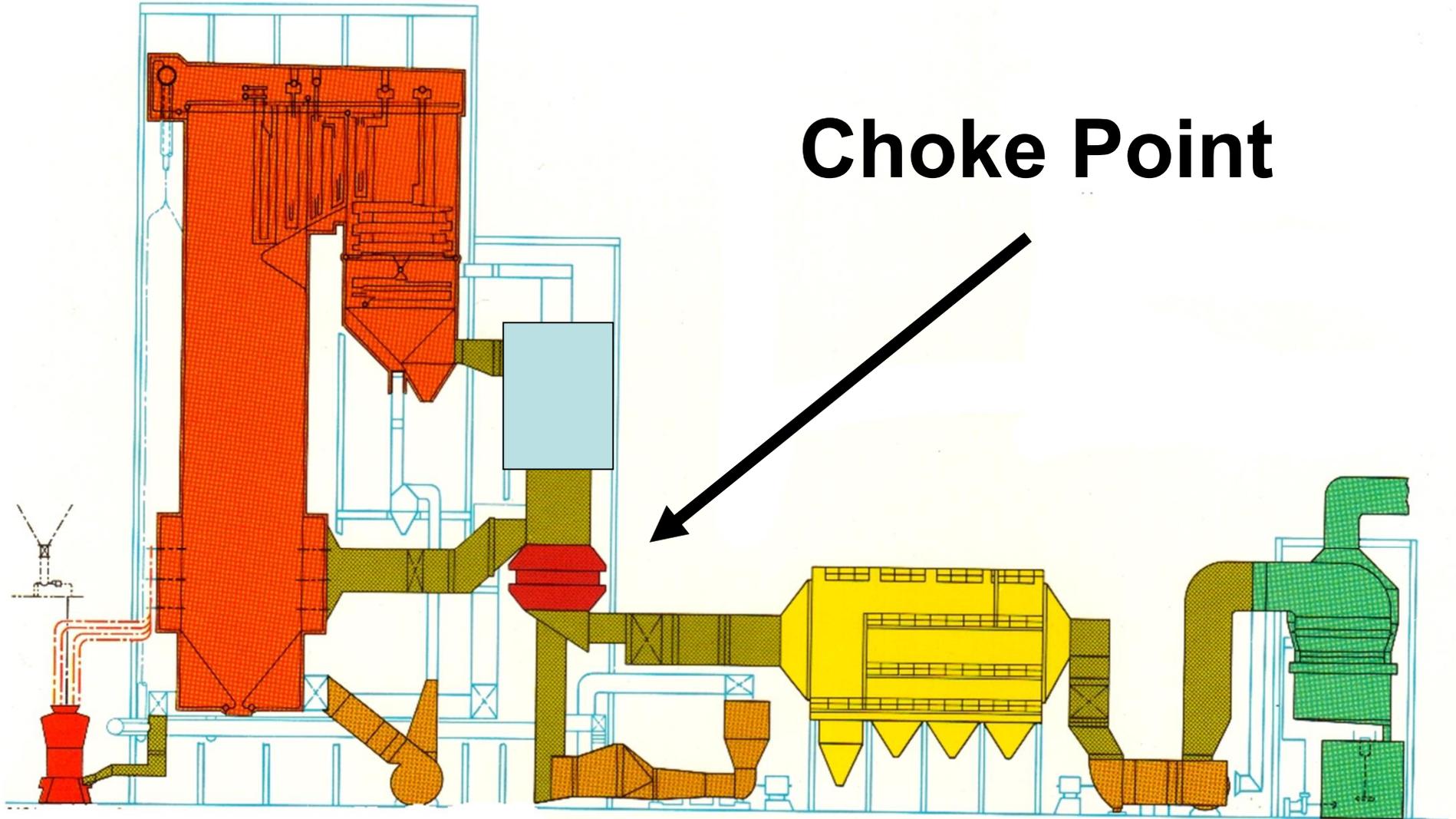


Chemistry Issues



Air Heater Pluggage

Choke Point





Corrosion Issues

Plant corrosion rates increase with higher sulfur coals

Lower operating load minimizes slag and

maximizes corrosion

Acid Oxides Basic Oxides

SiO₂

Al₂O₃

TiO₂

Fe₂O₃

CaO

MgO

K₂O

Na₂O

Glass Formers

Fluxes

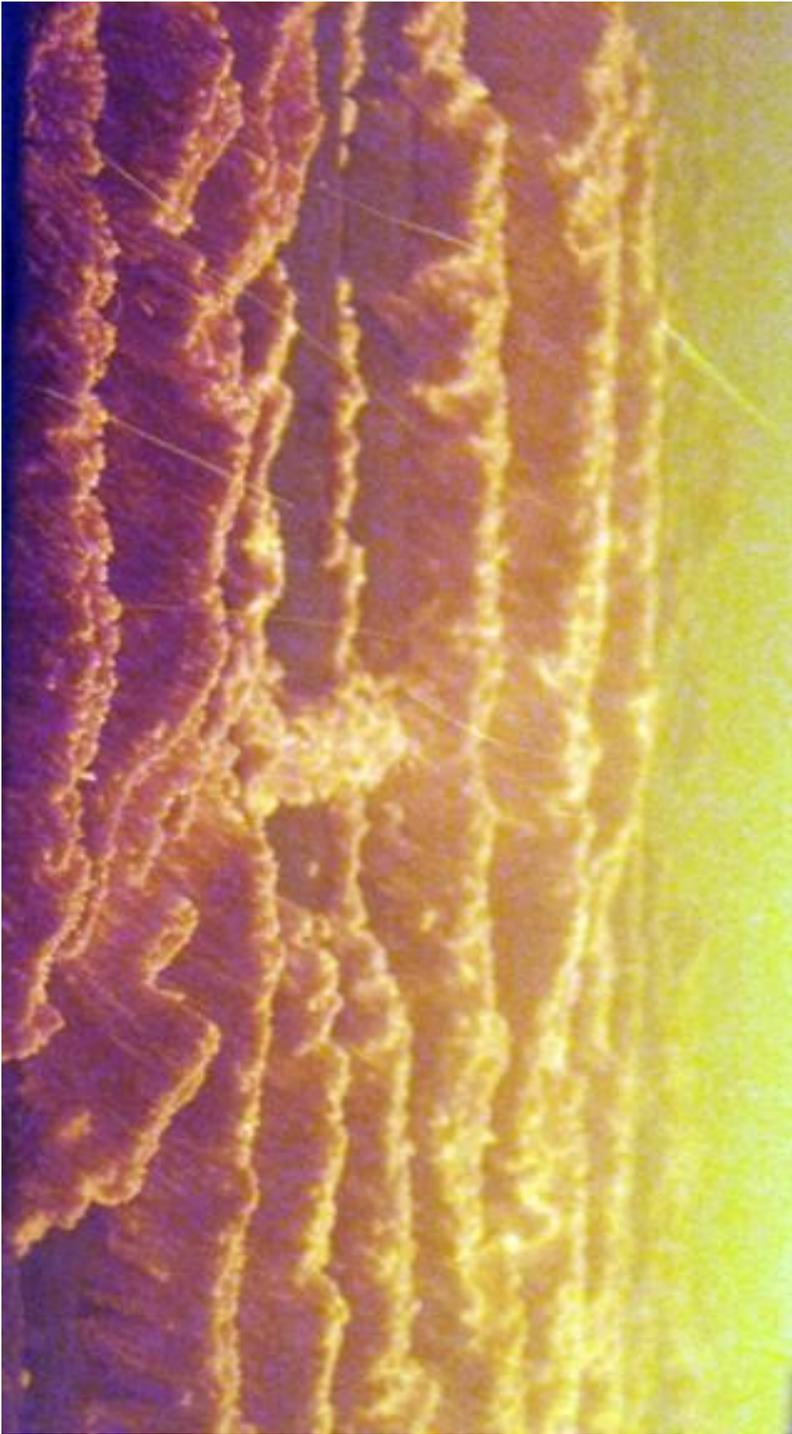
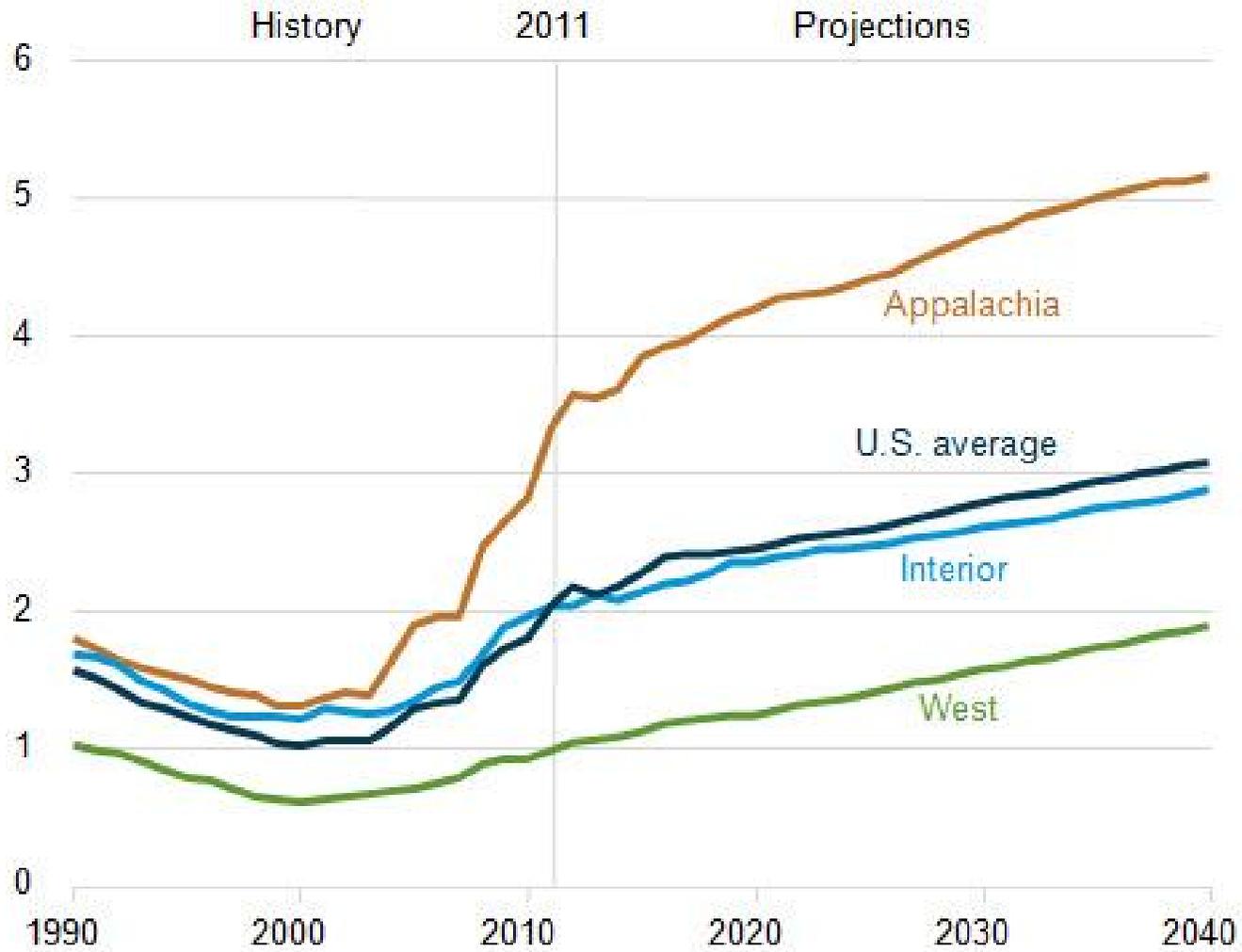
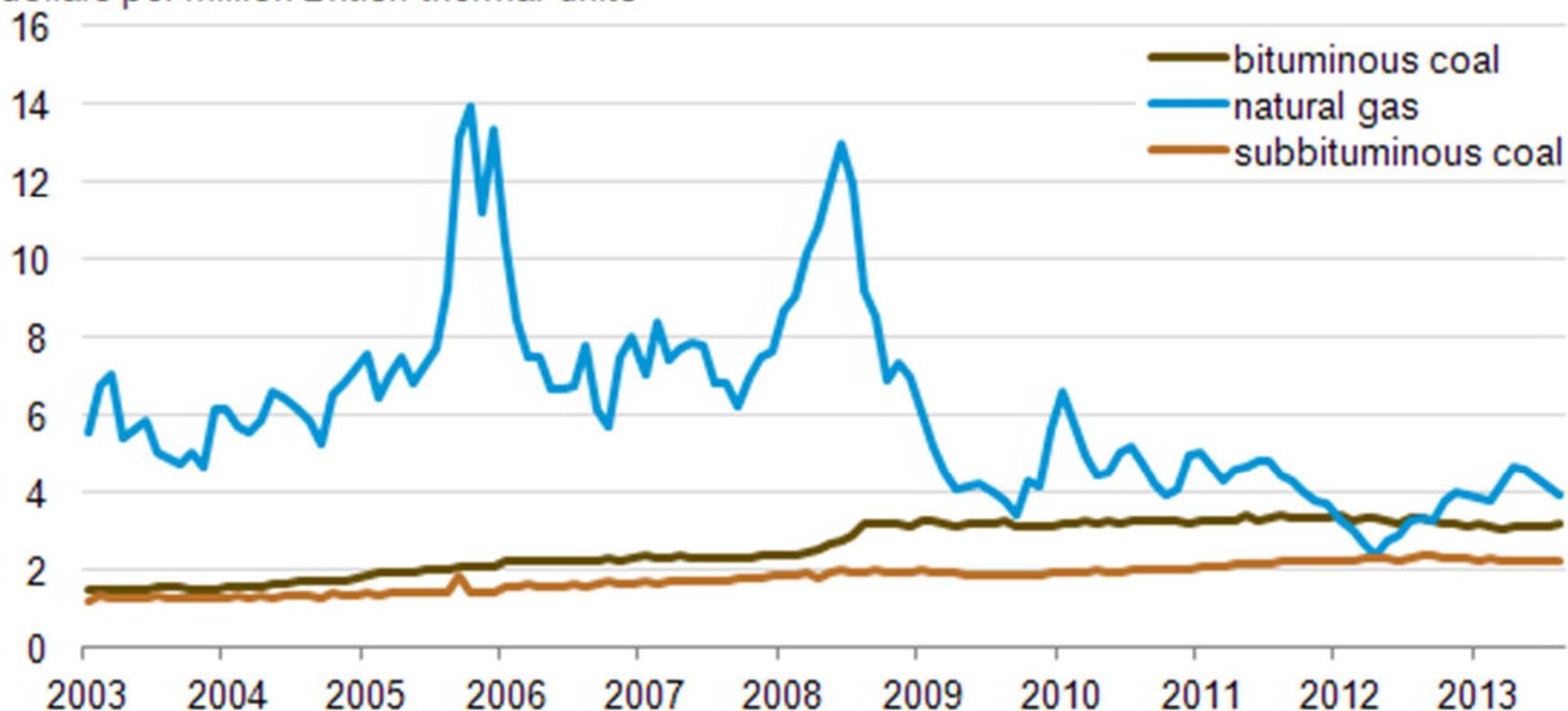


Figure 106. Average annual minemouth coal prices by region, 1990-2040 (2011 dollars per million Btu)

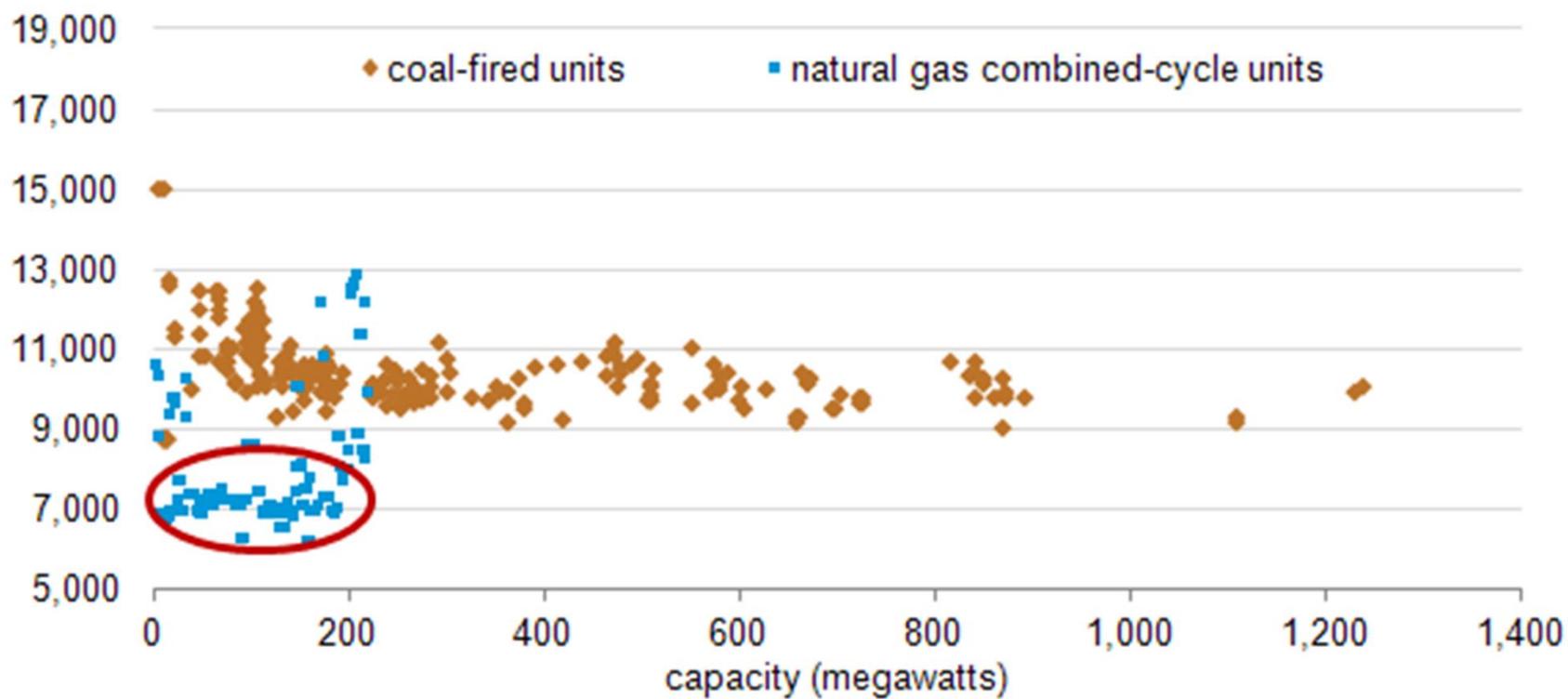


Delivered cost of coal and natural gas to electric power plants in the Southeast
dollars per million British thermal units

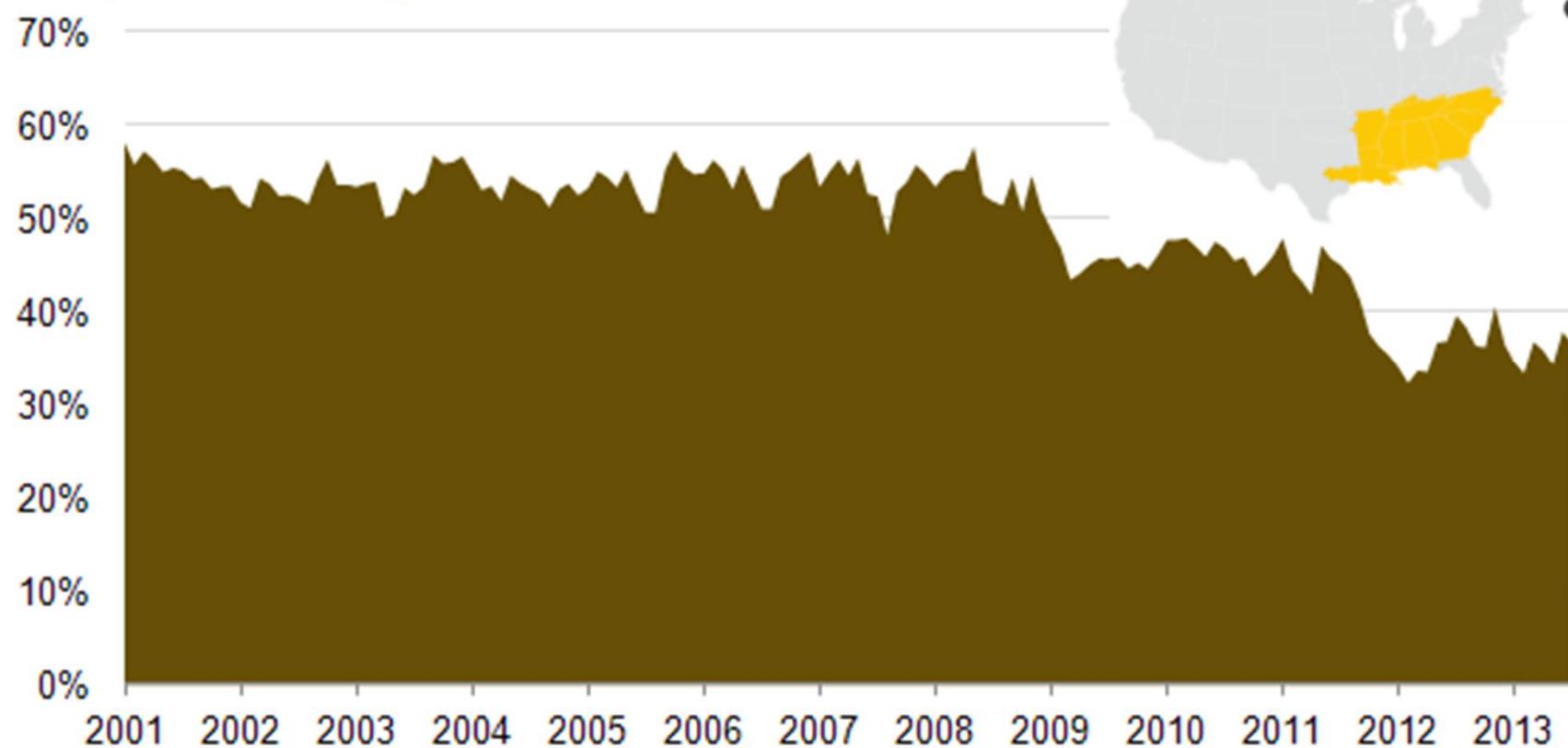


Tested heat rates, Southeast

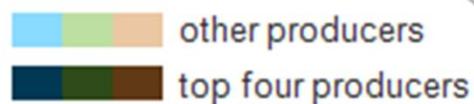
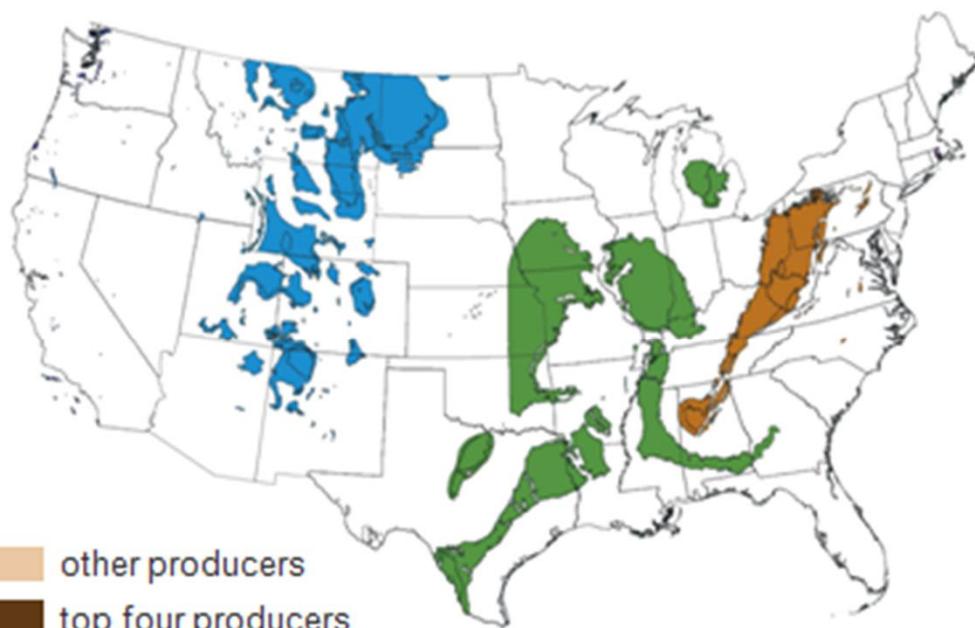
Btu/kilowatthour



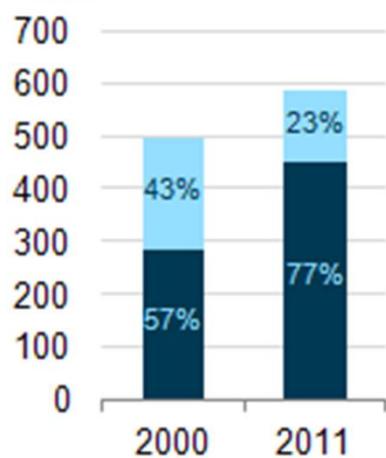
Coal percent of total generation in the Southeast



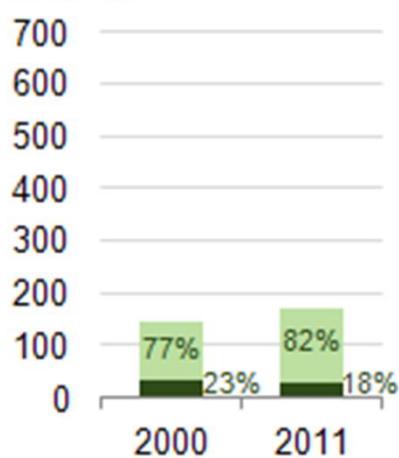
Regional production for top four U.S. producers
million short tons



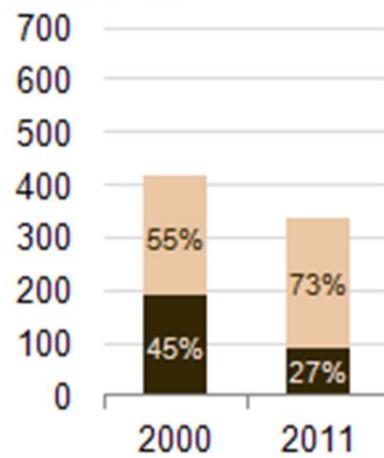
West



Interior

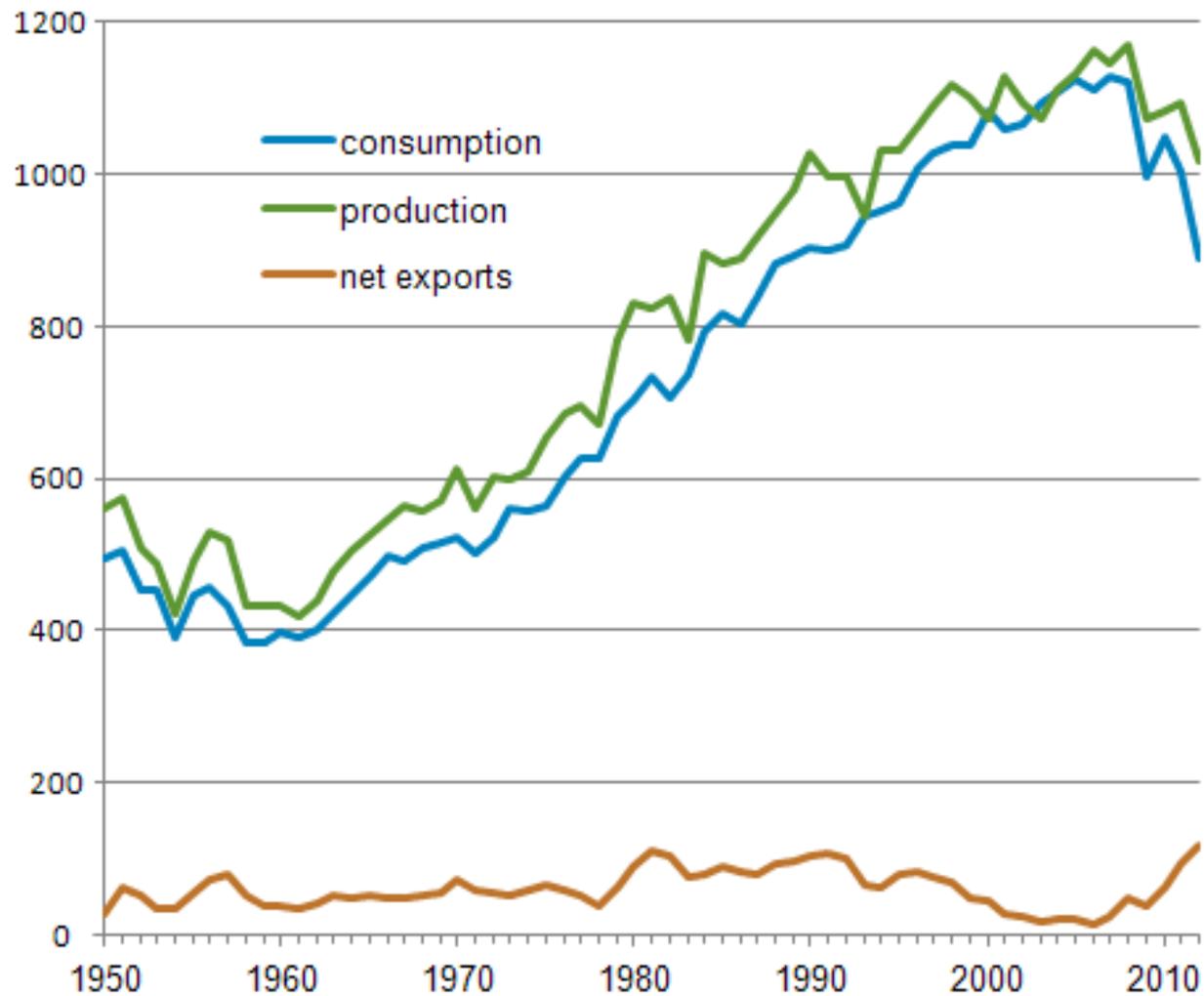


Appalachia



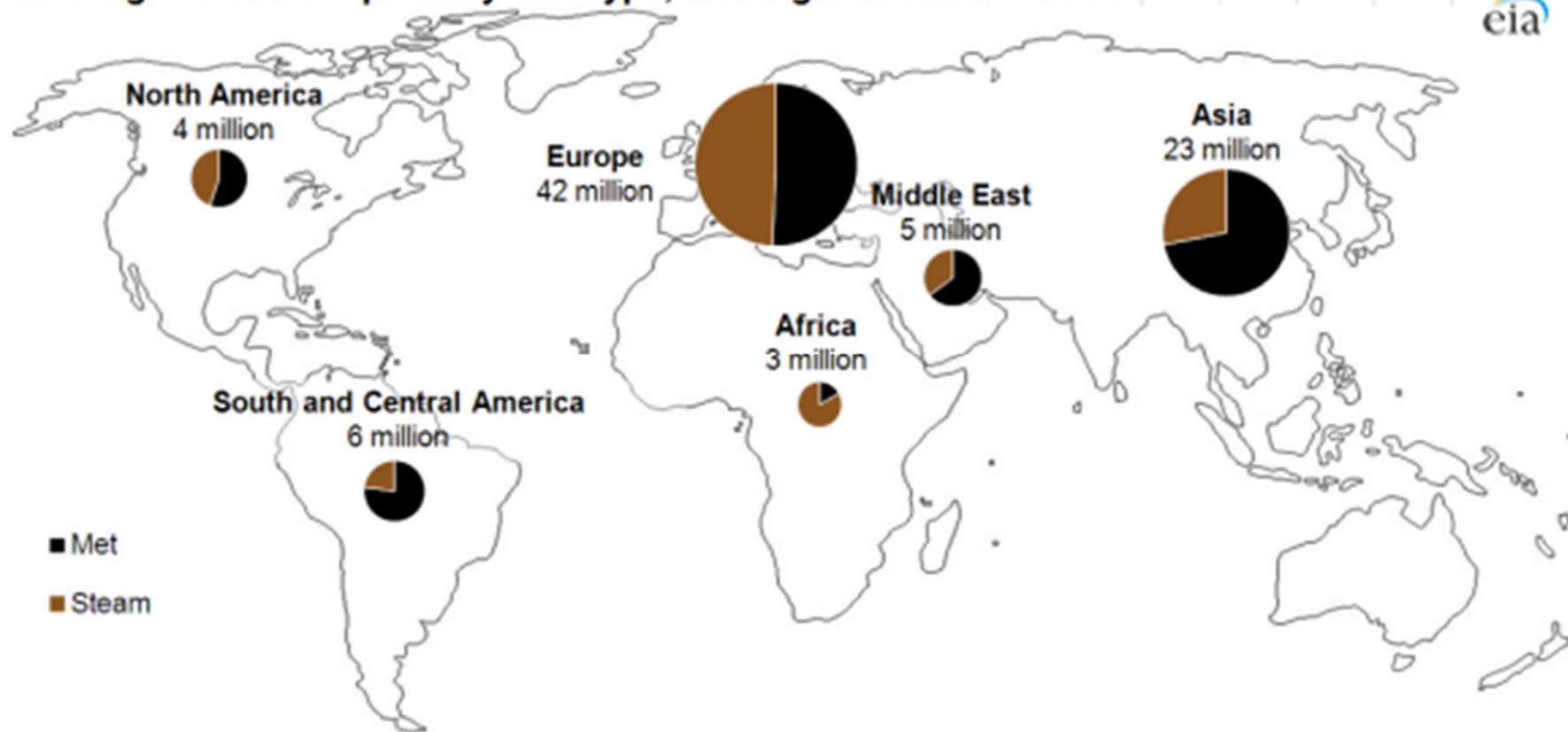
U.S. coal production, consumption, and net exports (1950-2012)

million short tons



Source: U.S. Energy Information Administration, *Quarterly Coal Report* (March 2013), preliminary 2012 data, and *Annual Energy Review* (August 2012).

U.S. regional coal exports by coal type, first eight months of 2012

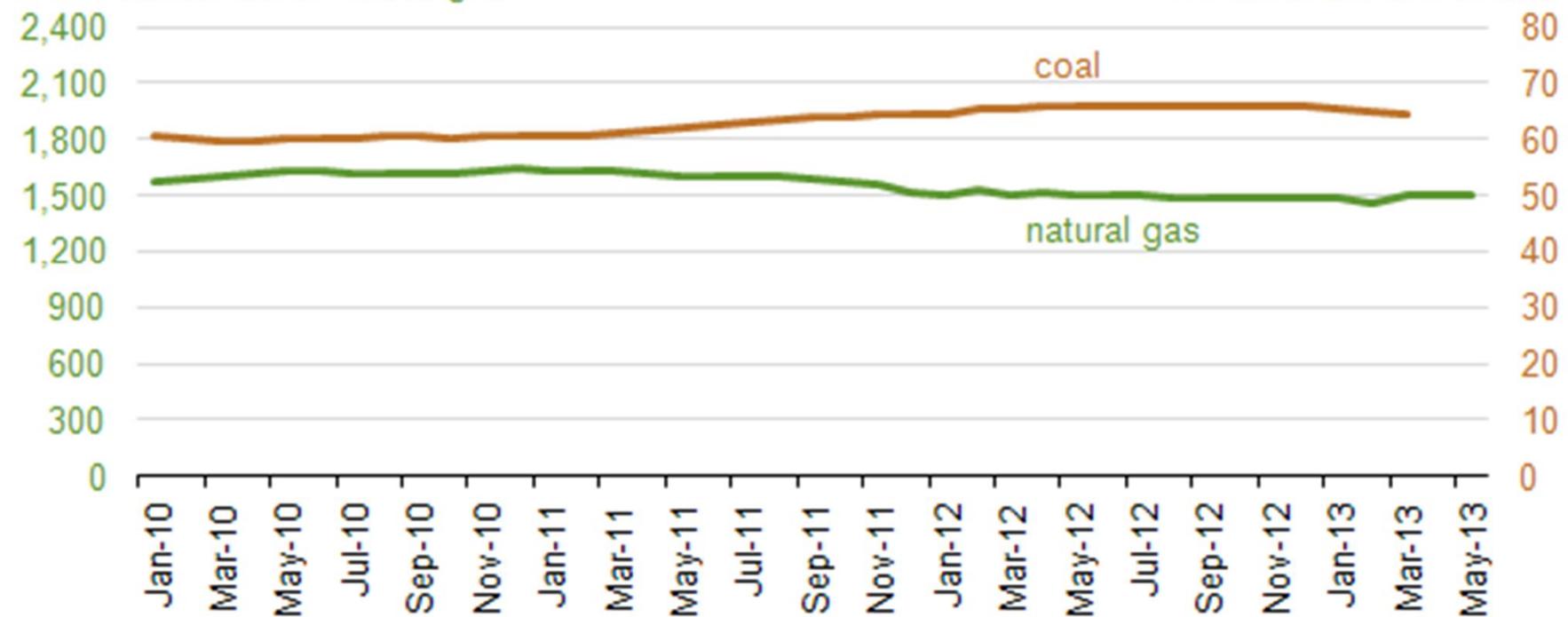


OECD-Europe natural gas and coal consumption, 12-month moving averages (Jan 2010-May 2013)



million cubic feet of natural gas

million short tons of coal



Conclusion

**High value product, use high quality coal
to maximize production**

Low value product, change to participate in market

**US – regions with low electric demand and gas units
Switch to low value coals**

**Europe – Higher value electric product, potential for CAPP
Lots of competition from other bituminous coals**



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Thank you!