

ENV 6932

Special Problems in Environmental Engineering

Course will focus on complexities of treating water for inorganic compounds using physical/chemical/biological treatment

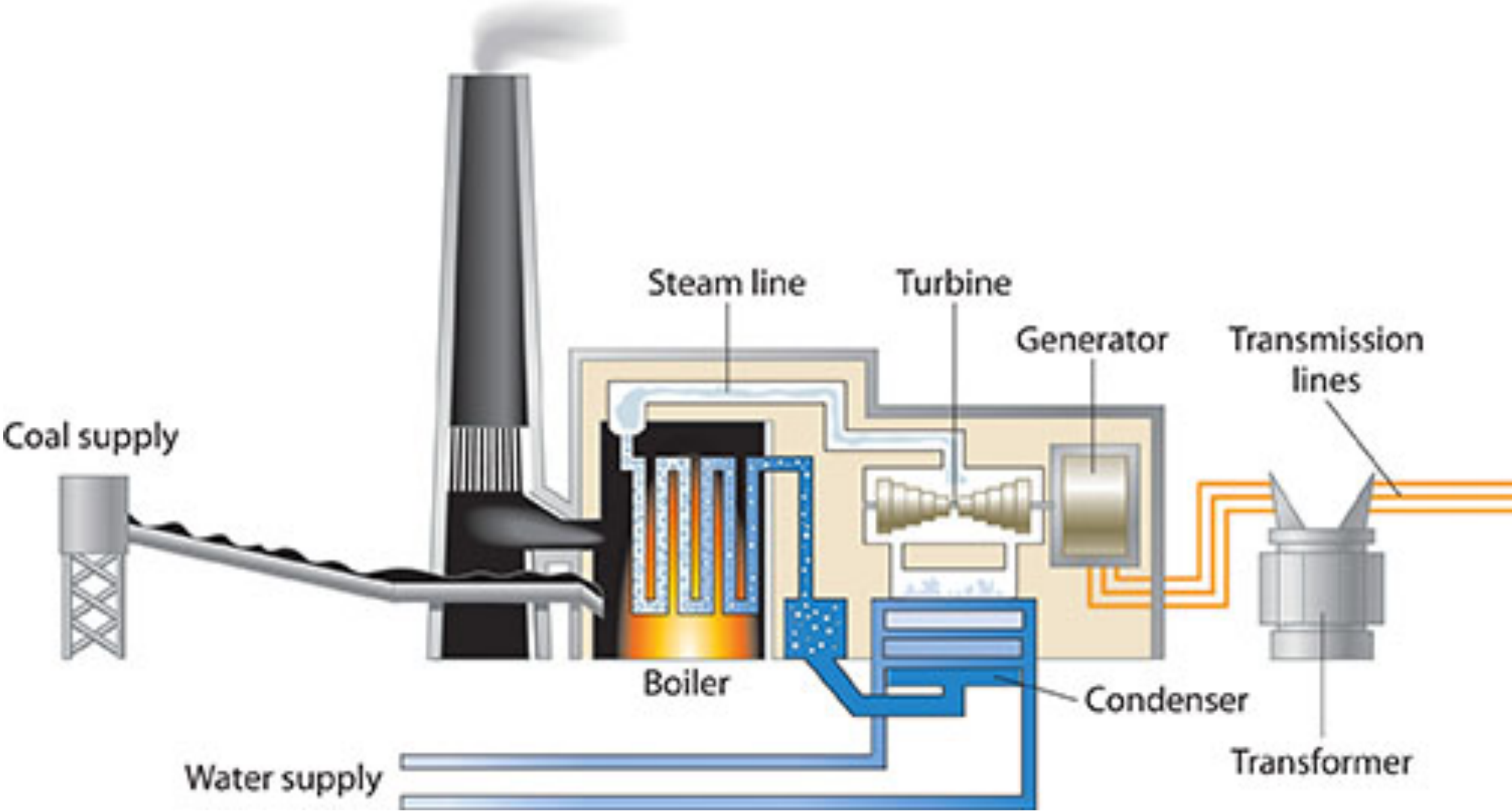
Professor: Dr. David W. Mazyck

How is Electricity Produced?

- One of the most complex waters requiring treatment is that from coal-fired power plants.
- US Environmental Protection Agency has implemented new regulations to remove inorganic compounds from "contaminated" water generated during electricity production.
- Need to have an appreciation for how electricity is produced.
- Need to have an appreciation for origin of contaminants.

<https://www.youtube.com/watch?v=20Vb6hLQsG>

Simplistic Overview of Electricity Production: Missing Air Pollution Control Devices



Introduction to Coal

Credited: Kenneth M. Klemow, Ph.D.
at Wilkes University



What is coal?

- A form of rock rich in organic carbon
- Able to be burned as a source of energy
- Contains
 - Organic carbon (rings and straight chains)
 - Inorganic elements (Fe, Al, clay, CaCO₃, trace metals – for example, As, Hg, Se)
 - Form ash
 - Water
- Elemental analysis
 - Bituminous: C₁₃₇H₉₇O₉NS
 - Anthracite: C₂₄₀H₉₀O₄NS

Different forms of coal



Anthracite



Bituminous



Sub-bituminous



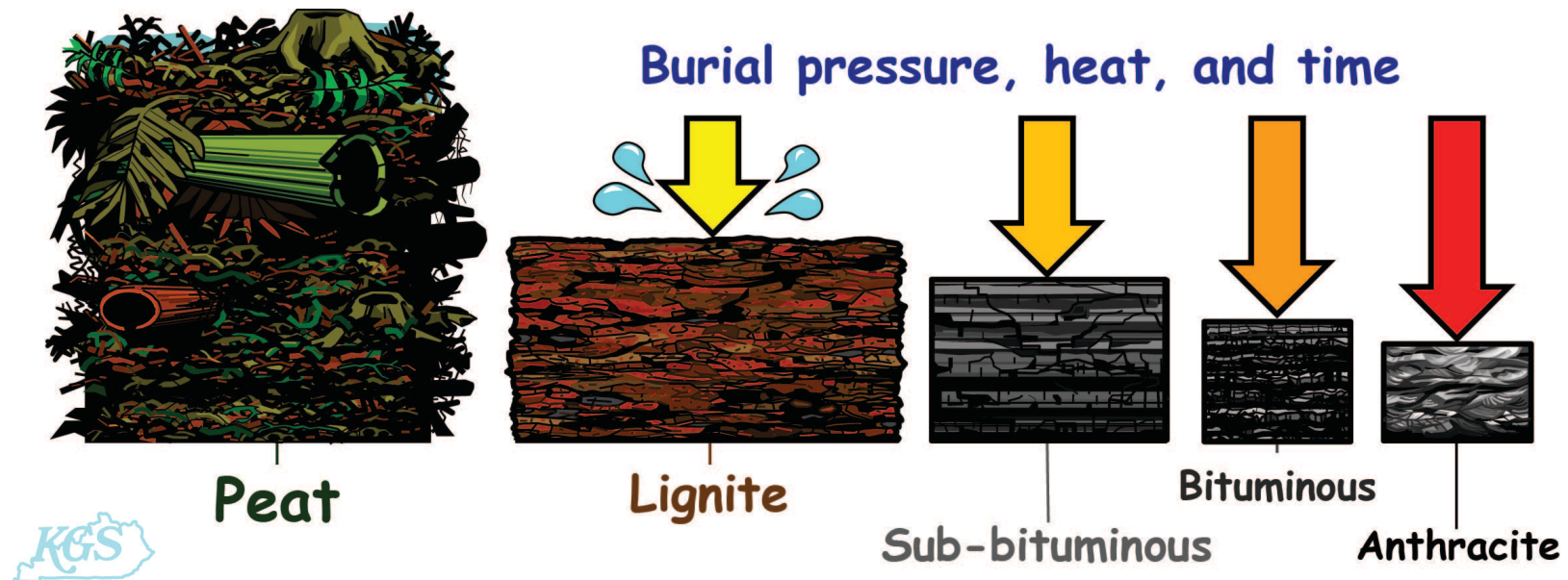
Lignite



Peat

How is coal created?

- From special form of fossilization of plants that lived hundreds of millions of years ago.
- Carbon in bodies not decomposed



Coal seams in Alaska



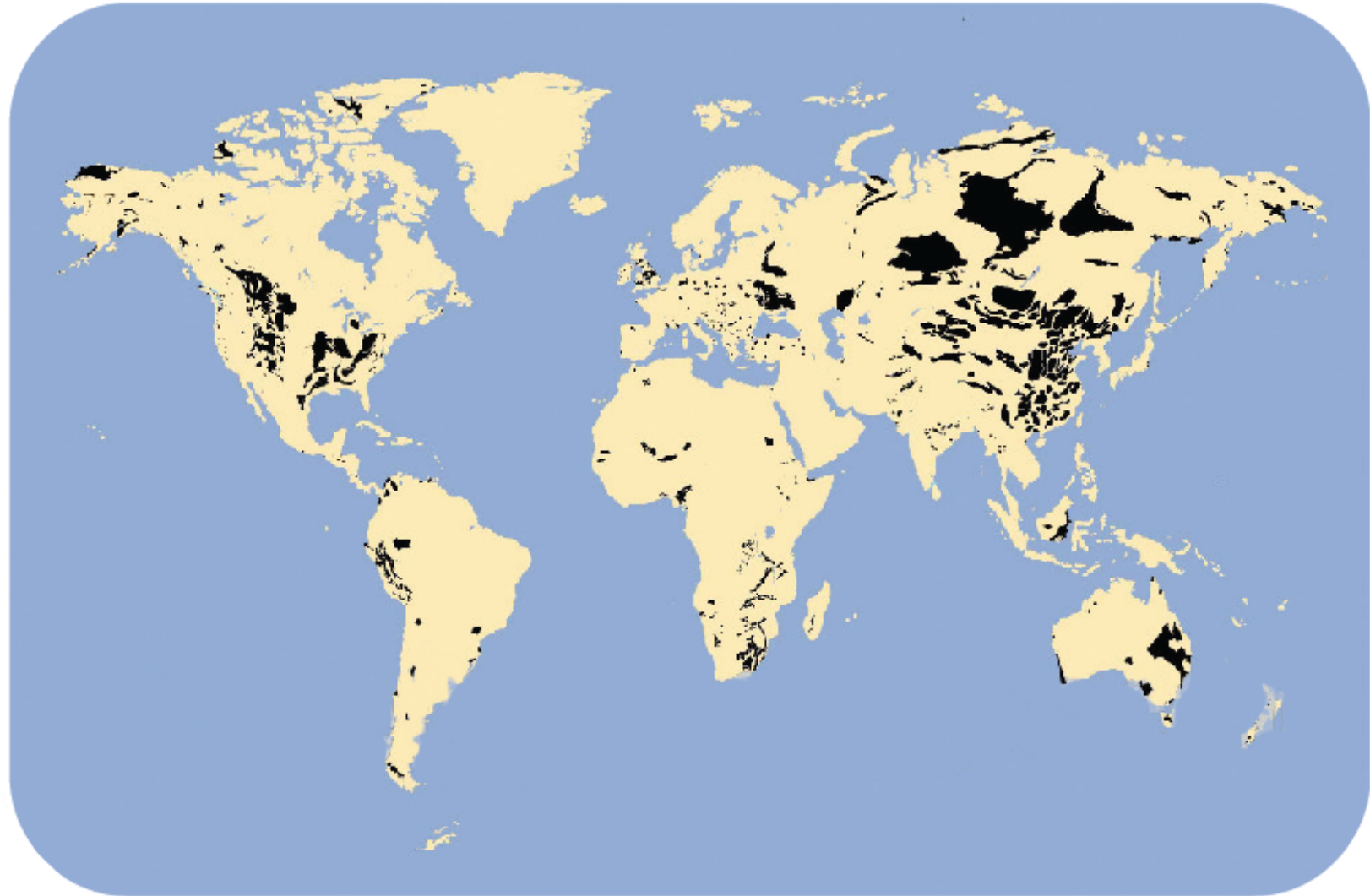
Coal seams in Colorado



Coal seams in Pennsylvania

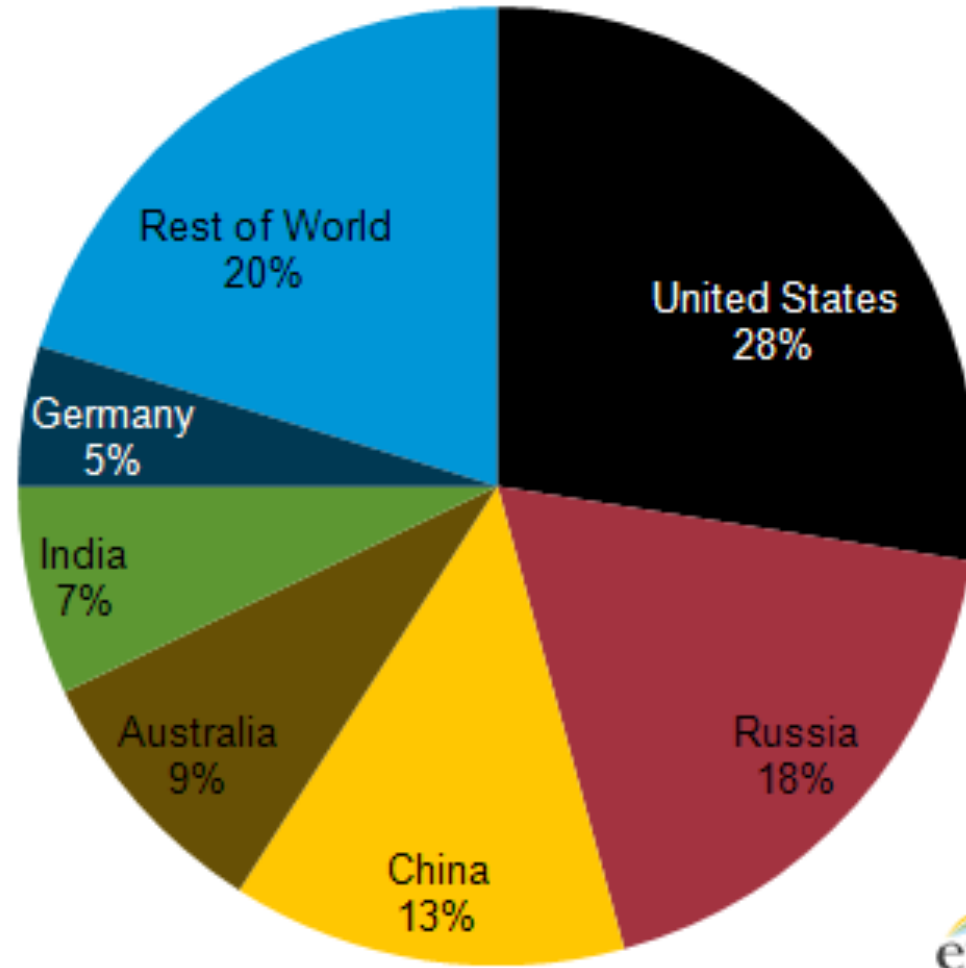


Coal deposits worldwide

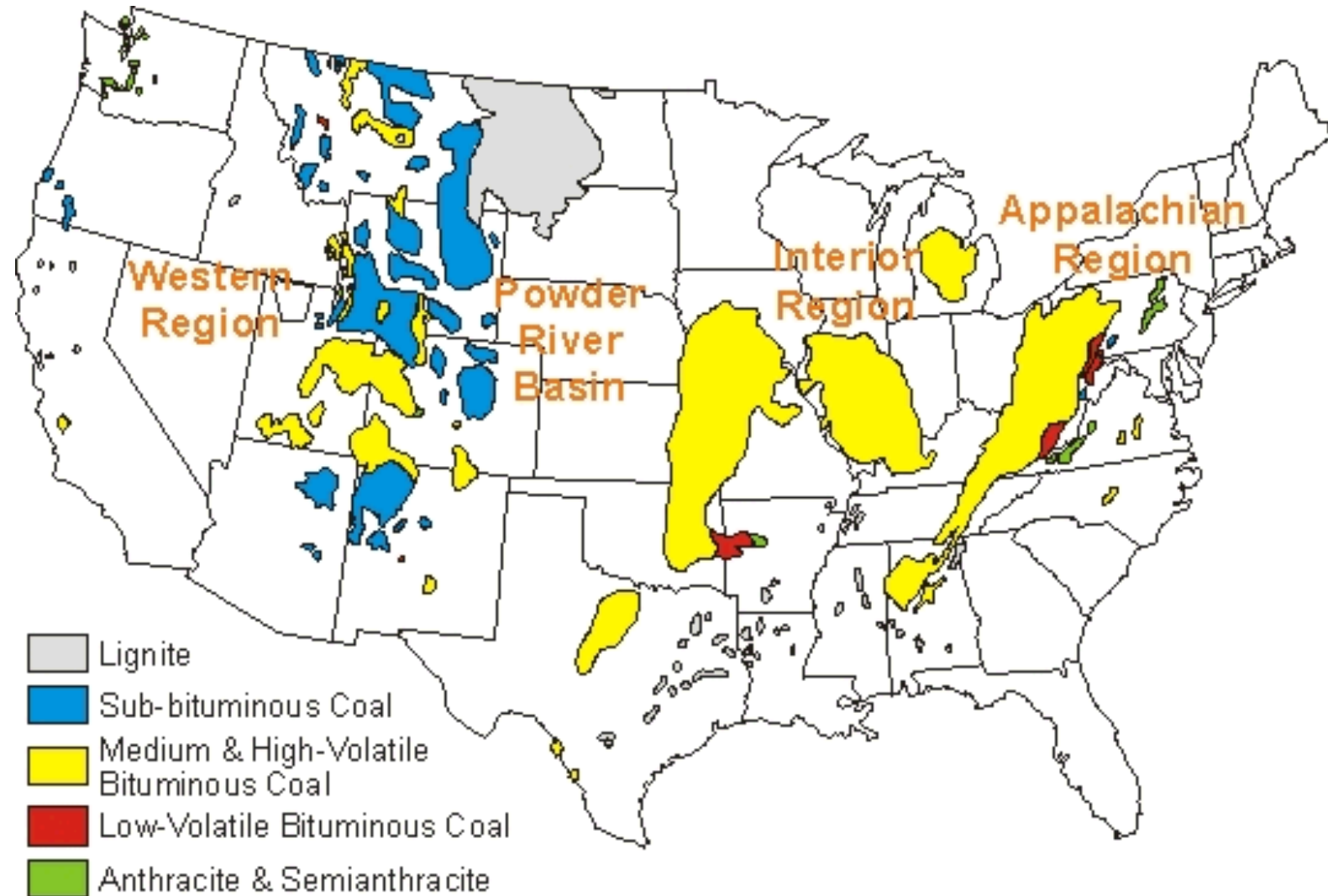


Recoverable coal reserves worldwide

Global share of recoverable coal reserves

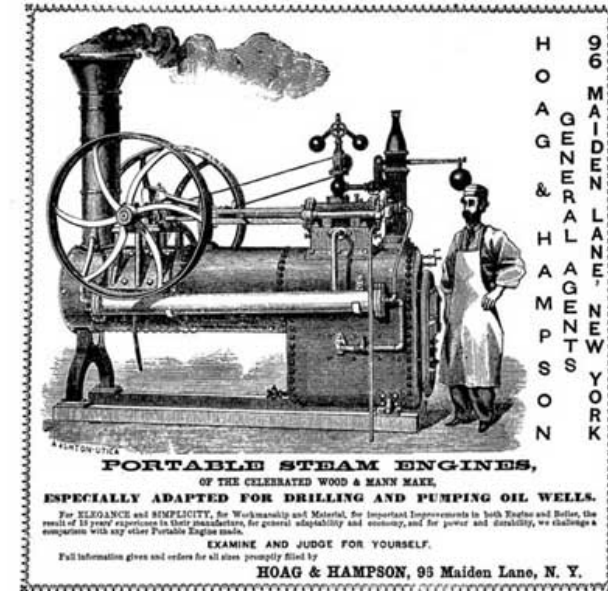


Coal deposits in United States



Coal fueled the industrial revolution

- Powered steam generators, locomotives, and eventually electric generators.
- Made industrialization possible.
- First in British Isles (18th Century), then continental Europe and US by 19th Century.



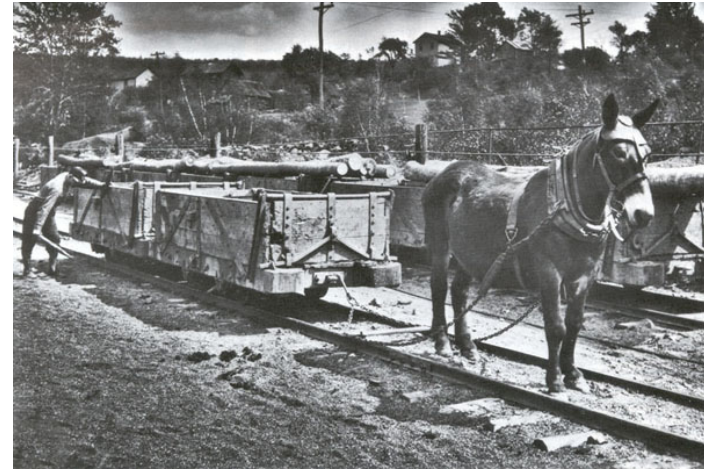
<http://blogs.cas.suffolk.edu/adlane/>



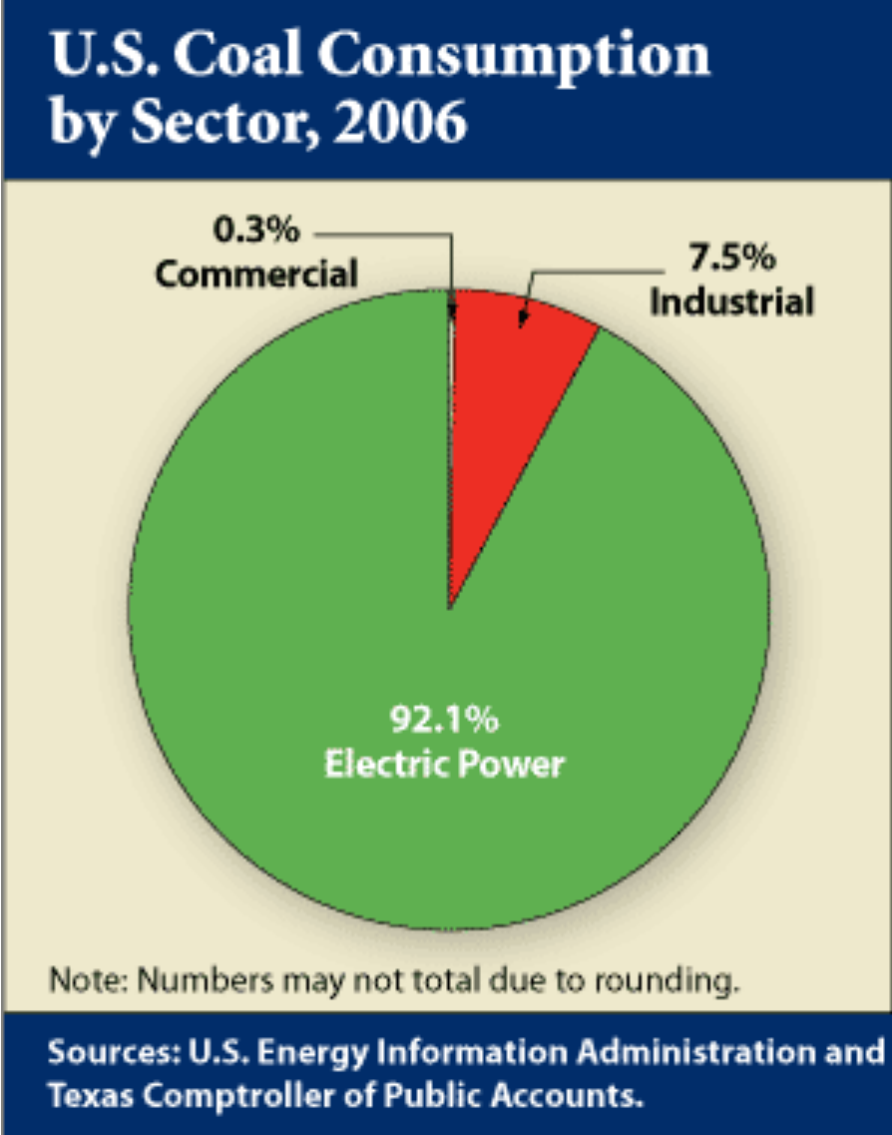
<http://www.bbc.co.uk/history/0/20979973>

Coal important in US

- Anthracite from NE Pennsylvania thought to be worthless in 18th Century.
- Technique for burning discovered in 1808.
- Became mined extensively by 1850, replacing wood.
 - Used for heating, transportation, industrial
 - Scranton, Wilkes-Barre, Hazleton, Pottsville, and surrounding towns grew greatly
 - Railroads preferred way of getting coal to market.



Coal consumption



Benefits of coal

- High energy density
- Abundant fuel
- Relatively inexpensive
- Employs many thousands of workers
- Often found where energy needed
- Reliable
- Easy to transport



Drawbacks

- Terrestrial impacts
 - Habitat destruction
- Aquatic impacts
 - Abandoned mine drainage
- Atmospheric impacts
 - Particulates
 - Sulfur
 - Greenhouse gases
 - Heavy metals



http://republicanherald.com/polopoly_fs/

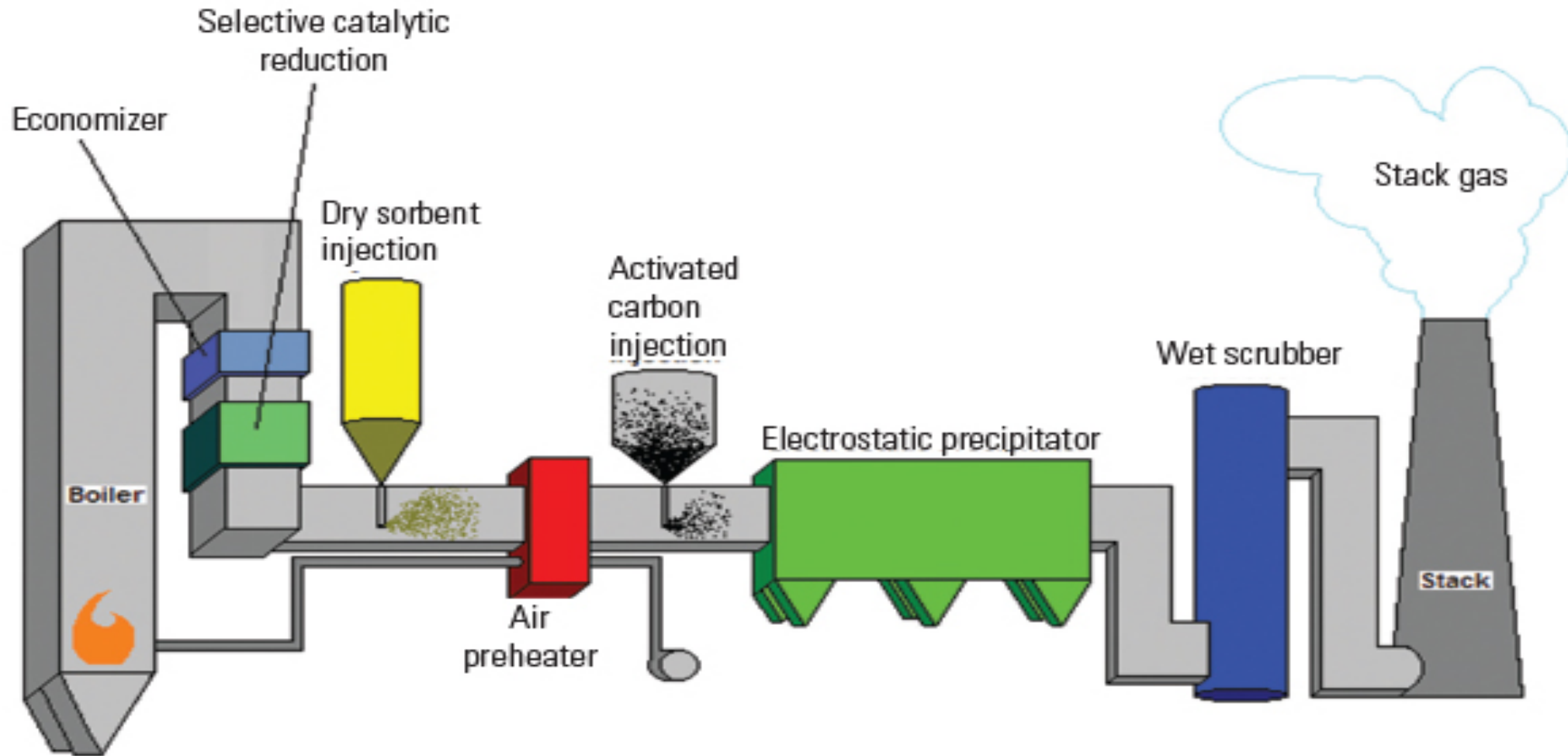


http://klemow.wilkes.edu/images/AMD_stream.gif

Contaminants Generated/Released During Coal Combustion

- Particulate matter – also referred to as flyash
- NO_x – coal requires air (79% of which is nitrogen) for combustion
- SO_x – coal has sulfur (% varies based on type and region of coal)
- Heavy metals (e.g., arsenic, Hg, selenium)

Air Pollution Control Devices for Power Plants



EPA Regulations

- MATS – Mercury and Air Toxics Standards
 - ~ 90% Hg removal from coal-fired power plants (April 2015)
 - Many utilities requested and received one-year extension (April 2016)
- ELGs – Effluent Limitation Guidelines
 - Beginning November 1, 2018
 - No later than December 31, 2023 (NPDES Renewals)
- Air-phase/liquid-phase regulations require holistic solution, but timing of legislation varies

Pollutant (units)	Monthly Average	Daily Maximum
Mercury, Hg (ppb)	0.356	0.788
Arsenic, As (ppb)	8	11
Selenium, Se (ppb)	12	23
Nitrate-Nitrite (ppb)	4,400	17,000

Final Rule FGD Wastewater Discharge Limits for existing sources of electric generating units

MATS Technology Options

- Coal additive (CaBr_2) – oxidization
- Powdered activated carbon (PAC) - adsorption
- Wet flue gas desulfurization (WFGD) - absorption

