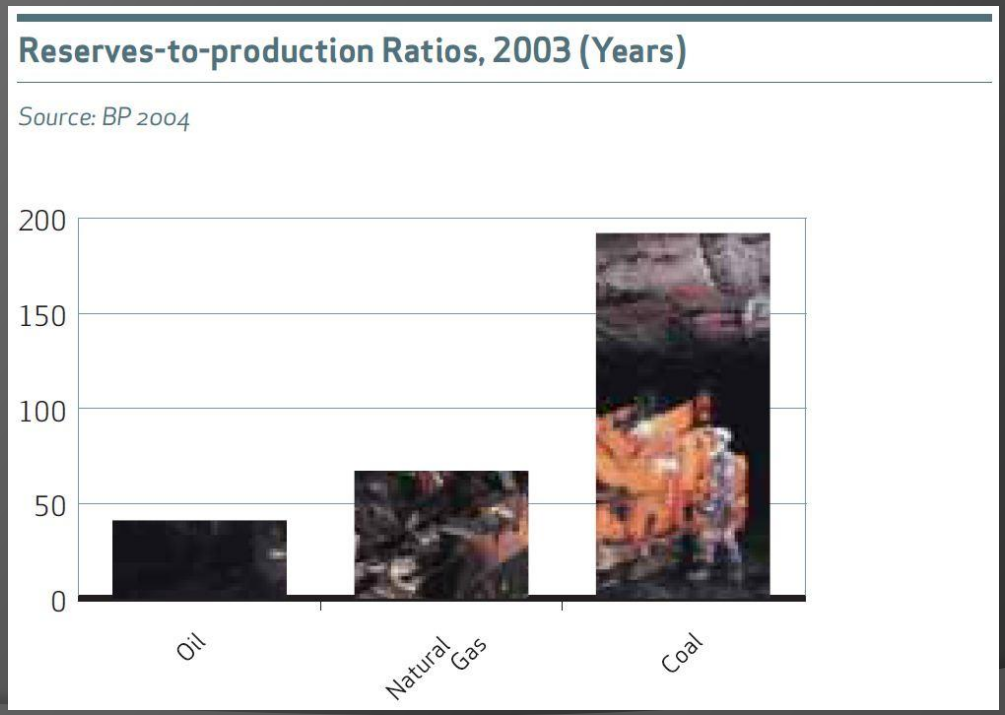
COAL: FOSSIL FUEL OF THE PAST, PRESENT, AND FUTURE



World Coal Institute – The Coal Resource – A Comprehensive Overview of Coal - 2005

By Rob Warren

March 1, 2010

A Quick Outline!

- Brief history of coal
- What is coal?
- Coal as an energy source
- Current usage
- What's the catch?
  - Environment issues
  - Example: Issues in China
  - Possible solutions

Things I will not be going over:

☹ Carbon sequestration

☹ Gasification and Liquefaction

☹ Powerplant efficiency and ways to make coal power plants more efficient and more environmentally friendly

Very Brief History of Coal

- First commercial use in China, ~1000 BC
- Romans used energy from coal before 400 AD
- Mining & trading in Europe, Middle Ages
- Industrial Revolution, 18th – 19th centuries
- Electric power, 19th century

Schweinfurth, Stanley. An Introduction to Coal Quality. The National Coal Resource Assessment Overview, Chapter C. USDI, USGS. 2009

Coalification (formation of Coal)

PEAT

http://upload.wikimedia.org/wikipedia/commons/9/90/Peat_Lewis.jpg

LIGNITE

http://www.justsaynotolignite.co.uk/

SUB-BITUMINOUS

Sorry… no good picture here…

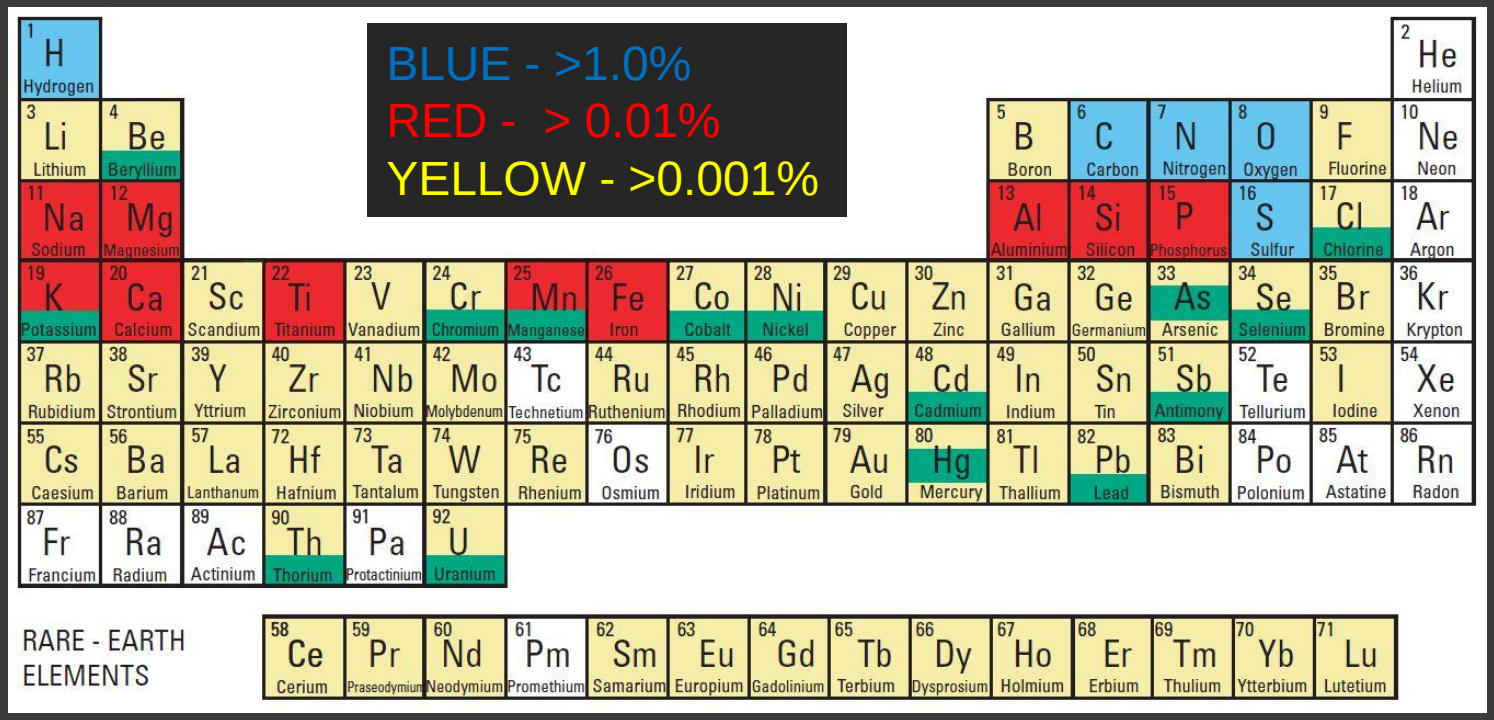
BITUMINOUS

http://www.dkimages.com/discover/previews/1245/16407.JPG

ANTHRACITE

http://upload.wikimedia.org/wikipedia/commons/7/72/Coal_anthracite.jpg

Composition of Coal



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Composition of Coal, cntd

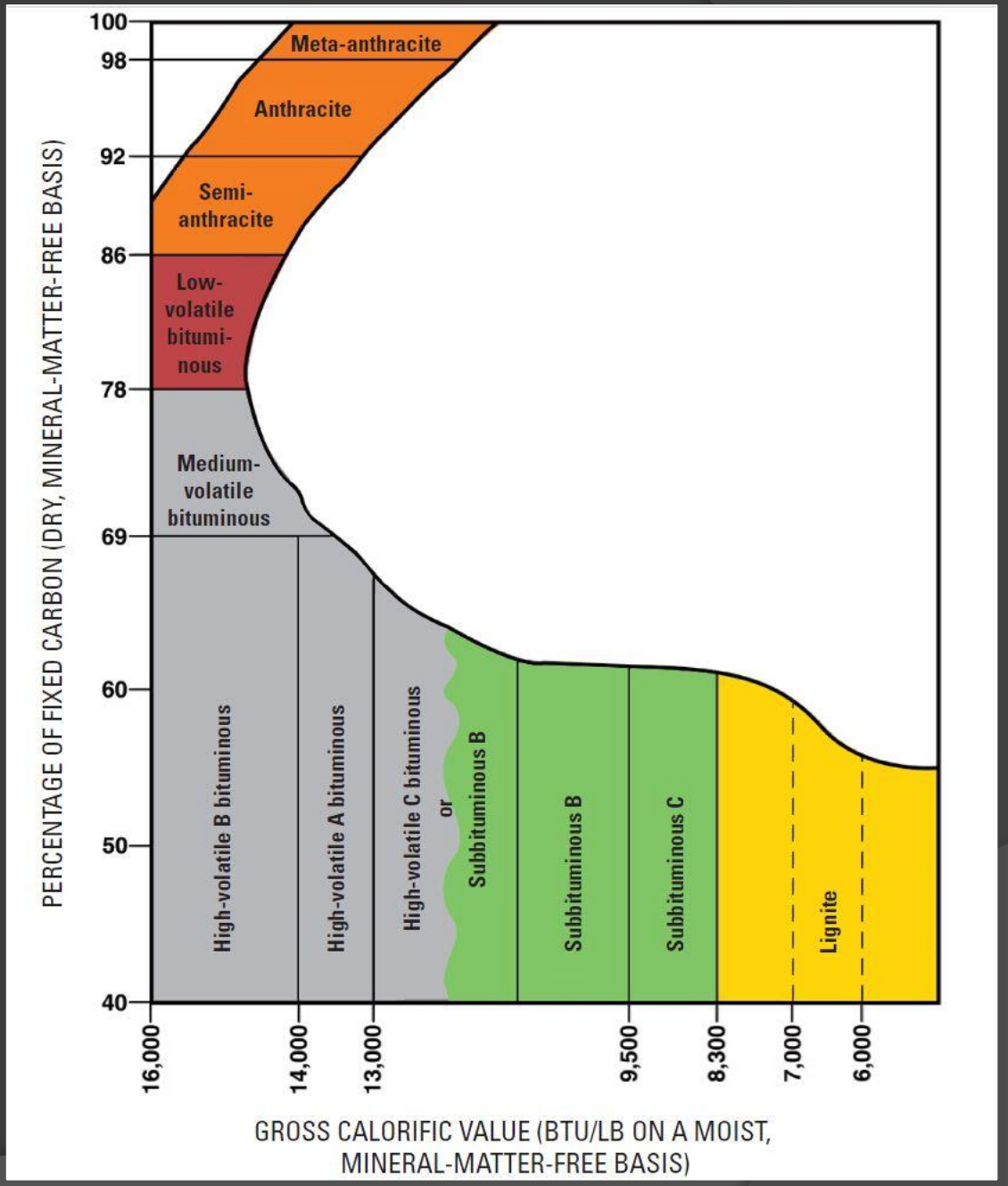
- Mixture of inorganic and organic compounds
- Minerals, common ones being:
  - Illite clay
  - Pyrite
  - Quartz
  - Calcite
- Macerals
  - Vitrinite
  - Liptinite
  - Inertinite

Take away point… Complexity.

- Plants, plant remains, other organisms
- Biological & chemical processes
- Location of mire
- Mineral matter
- Coalification

… all of these affect the **RANK** of coal

% of Carbon in coal types



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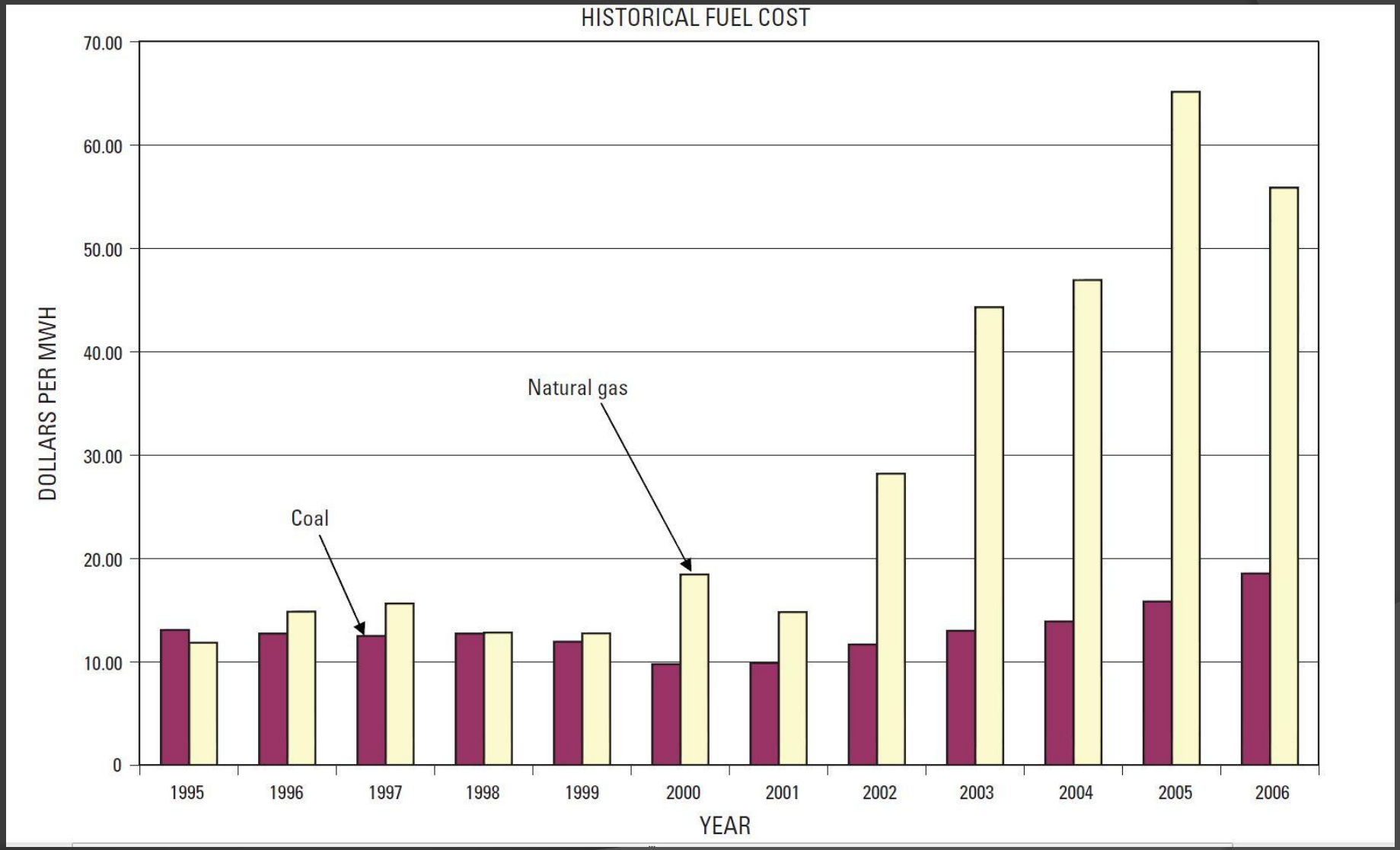
Why use coal?



Attanasi, ED and PA Freeman. Coal Marketability: Current and Future Conditions. The National Coal Resource Assessment Overview, Chapter E. USDI, USGS. 2009

Current Usage

- Electricity
- Steel production
- Liquefaction
- Cement
- Chemical by-product production
- Lots of other industries

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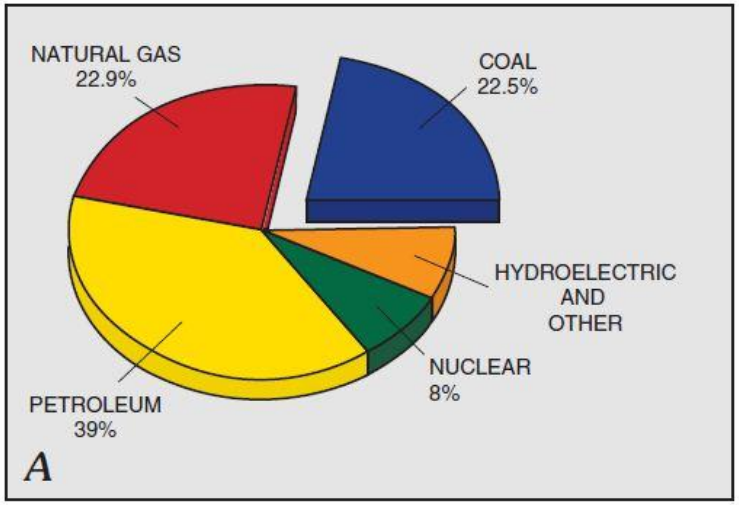
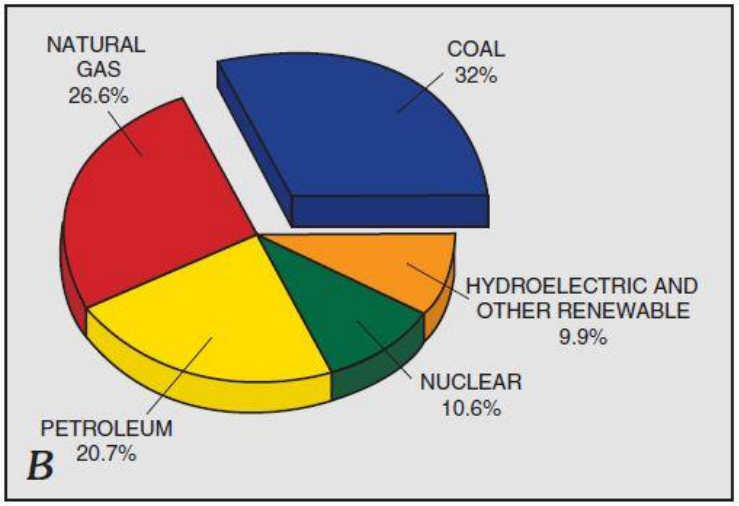
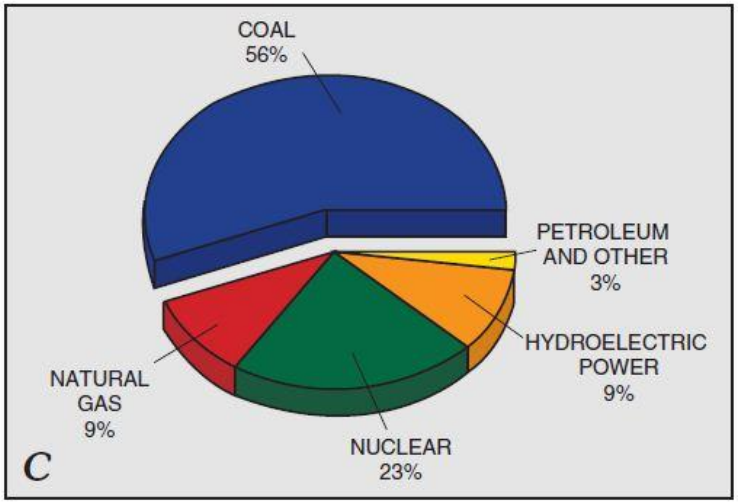
United States Usage in 1999



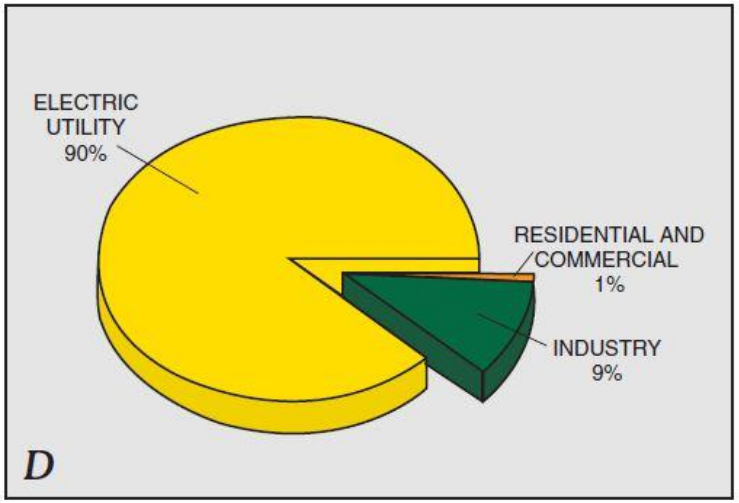
Total energy consumption



Total energy production



Electricity generation



Coal consumption by sector

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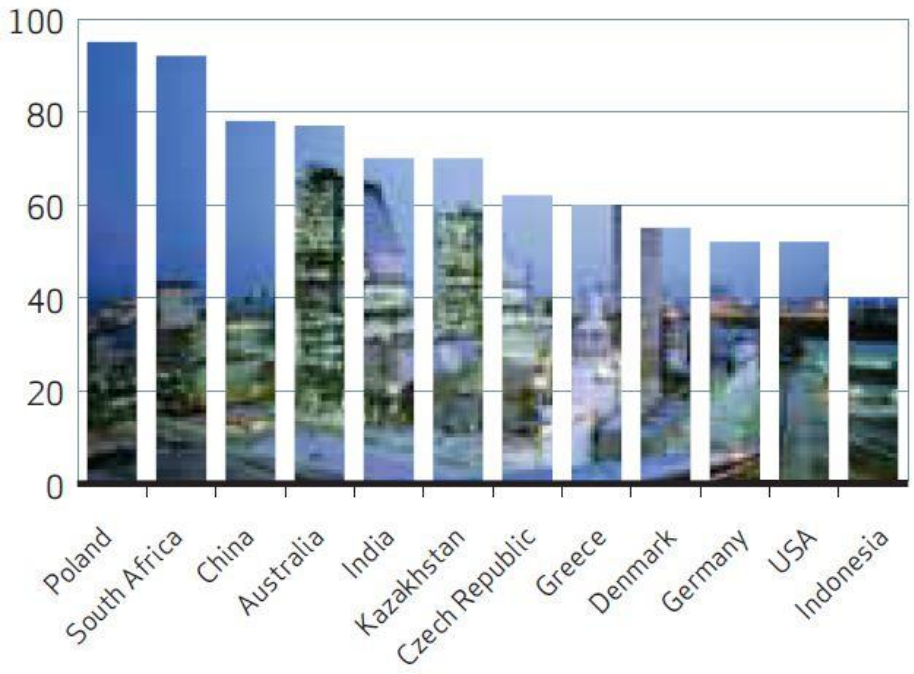
Electricity

Percentage of Electricity Generated from Coal in Selected Countries (mixture of 2003 & 2002 data)

Source: IEA 2004



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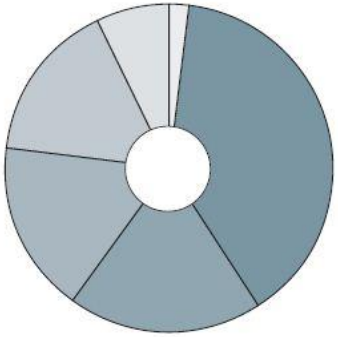
More Shocking Electricity Stats

Total World Electricity Generation (% by Fuel, 2002)

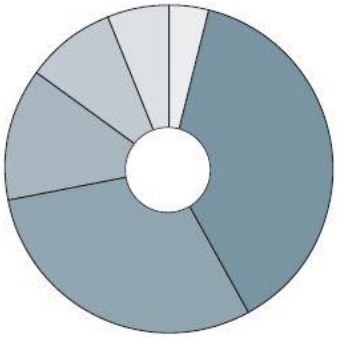


Coal	39%
Gas	19%
Nuclear	17%
Hydro	16%
Oil	7%
Other*	2%

**Other includes solar, wind, combustible renewables, geothermal and waste*

Source: IEA 2004

Total World Electricity Generation (% by Fuel, projected for 2030)



Coal	38%
Gas	30%
Hydro	13%
Nuclear	9%
Other*	6%
Oil	4%

**Other includes solar, wind, combustible renewables, geothermal and waste*

Source: IEA 2004

Environmental Effects

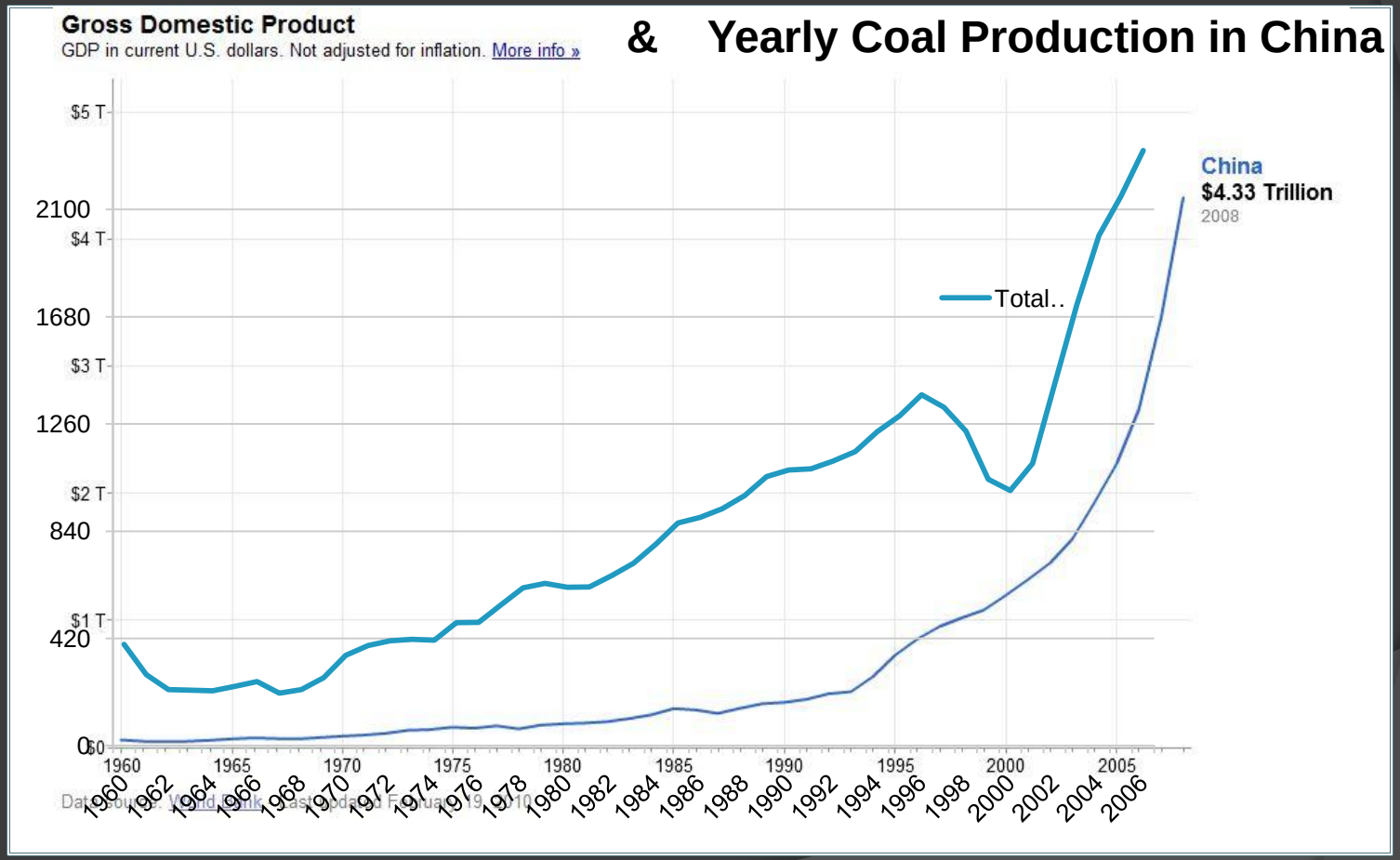
- Mining
  - Soil erosion
  - Dust
  - Noise
  - Water pollution
- Usage
  - Release of SOx, NOx and mercury
  - CO_2 release

Another issue...

- BBC stories on Chinese coal mines:
  - "Rising demand for energy and fuel means that owners and local officials often ignore safety issues in pursuit of profits."[1]
  - "… many accidents are allegedly covered up in order to avoid costly mine shutdowns."[2]
  - "…miners are still dying at a rate of **six a day**…"[3]

1. http://news.bbc.co.uk/2/hi/asia-pacific/7132017.stm
2. http://news.bbc.co.uk/2/hi/asia-pacific/8243175.stm
3. http://news.bbc.co.uk/2/hi/asia-pacific/8371789.stm

China: GDP & Coal Production



Possible Solutions

The Coal-fired Route to CO_2 Reductions

Up to 5% CO_2 Reductions

Coal Upgrading
Includes coal washing/drying, briquetting. Widespread use throughout the world.

Up to 22% CO_2 Reductions

Efficiency Improvements of Existing Plant
Conventional coal-fired subcritical generation has improved significantly in its efficiency (38-40%) so reducing emissions. Supercritical and ultrasupercritical plant offer even higher efficiencies (already up to 45%). Improved efficiency subcritical plant operate around the world. Supercritical and ultrasupercritical plant operate successfully in Japan, USA, Europe, Russia and China.

Up to 25% CO_2 Reductions

Advanced Technologies
Very high efficiencies and low emissions from innovative technologies such as integrated gasification combined cycle (IGCC). pressurised fluidised bed combustion (PFBC) and in the future integrated gasification fuel cells (IGFC). IGCC and PFBC operational in USA, Japan and Europe, IGFC at R&D stage.

Up to 99% CO_2 Reductions

Zero Emissions
Carbon capture and storage. Significant international R&D efforts ongoing. FutureGen project aims to have demonstration plant operational within 10 years.

Schweinfurth, Stanley. An Introduction to Coal Quality. The National Coal Resource Assessment Overview, Chapter C. USDI, USGS. 2009

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- BBC News, Deadly mine blast traps dozens in north-eastern China. http://news.bbc.co.uk/2/hi/asia-pacific/8371789.stm
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Abbreviations Mentioned or Shown

- EIA – Energy Information Administration
- DOE – Department of Energy
- IEA – International Energy Annual
- USGS – US Geological Survey
- USDI – US Department of the Interior