

Coal

Basics

Oldest form of fossil fuels, both in age (up to 350 million years) and in use

Largest reserves of the fossil fuels

We know coal supplies well, both globally and in US... most coal is within a few hundred feet of the surface... easily mapped.

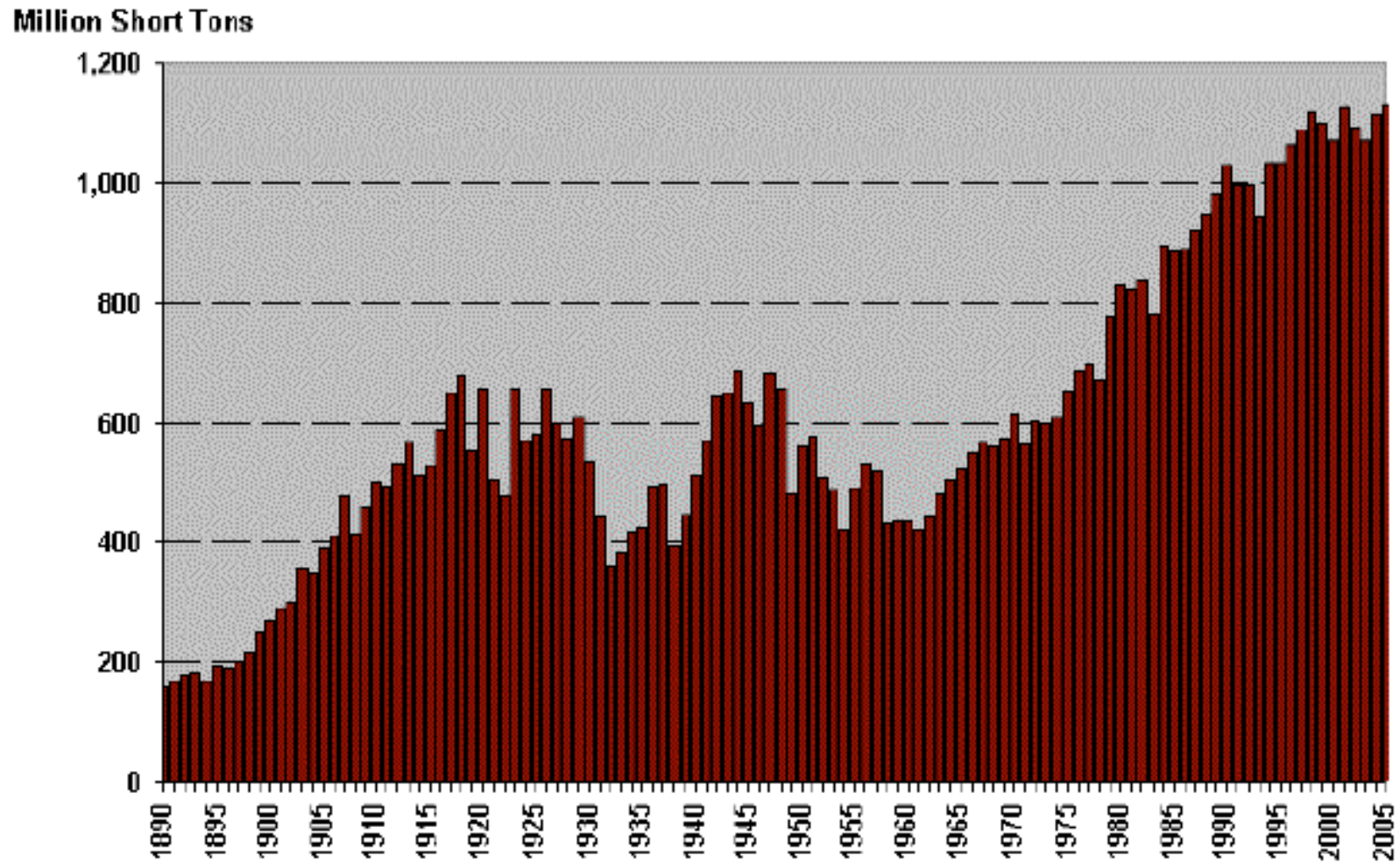
Current R/P is about 400 years.

Types of coal

Types of coal, age (millions of years) and purity

<u>Type</u>	<u>age</u>	<u>% carbon</u>
Anthracite	350	95
Bituminous	300	50-80
Lignite	150	up to 50

Figure 1. United States Coal Production, 1890 – 2005



Sources: Annual Coal Report, (and predecessor report titles), DOE/EIA-0584 (years 1993-2003) and DOE/EIA-0118 (years 1976-1992); Energy Information Administration: Washington, DC. In-house file data from U.S. Bureau of Mines, Annual Coal Production surveys by Bureau of Mines and by U.S. Geological Survey (years 1890-1975): Washington, DC.

World coal reserves

<u>Country</u>	<u>% of total</u>
Former USSR	56
United States	20
Asia (mostly China)	10
Canada	8
Western Europe	5

Everywhere else less than 1% per country

Issues

Russia, US and China have most of the coal (about 85%)... poorly distributed

Russia has natural gas and nuclear, has been using relatively little coal... but that is changing as nuclear energy becomes more unreliable.

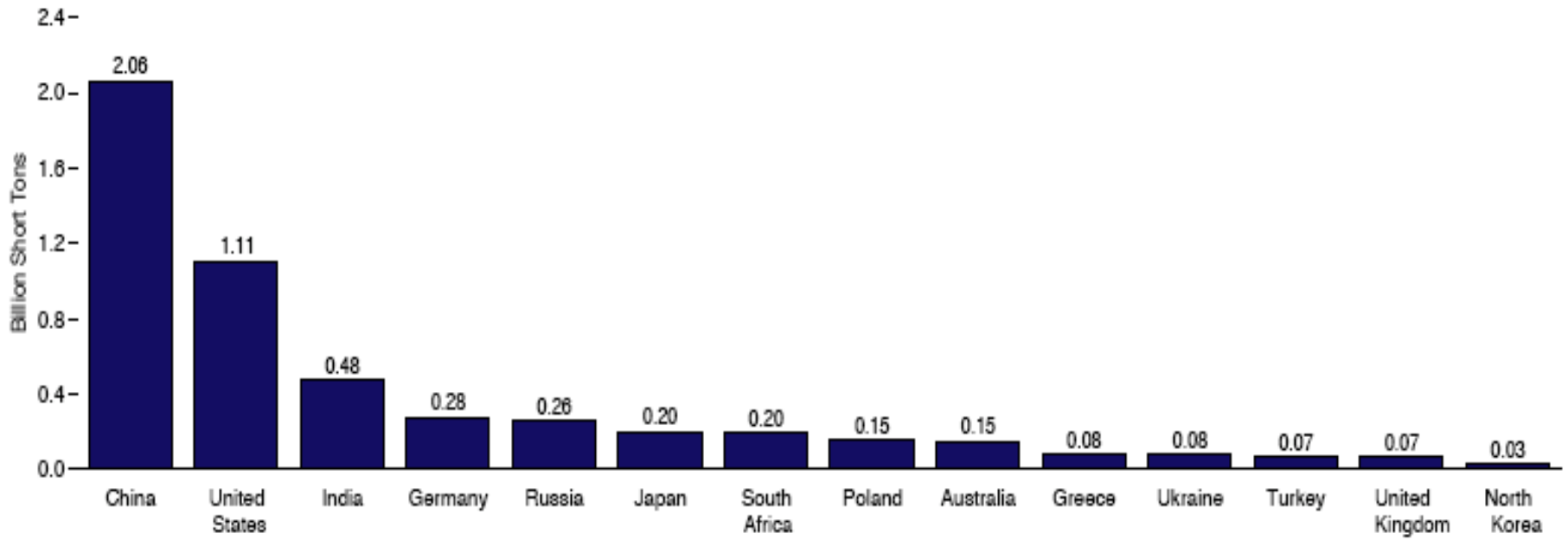
Issues

China relies heavily on coal...

- 75% of energy from coal
- is 2rd largest energy consumer worldwide
- produces 10 to 15% of CO₂ emissions, 2nd only to United States (will be 1st in a few years)
- most coal burned locally (home fires)... very hard to clean up

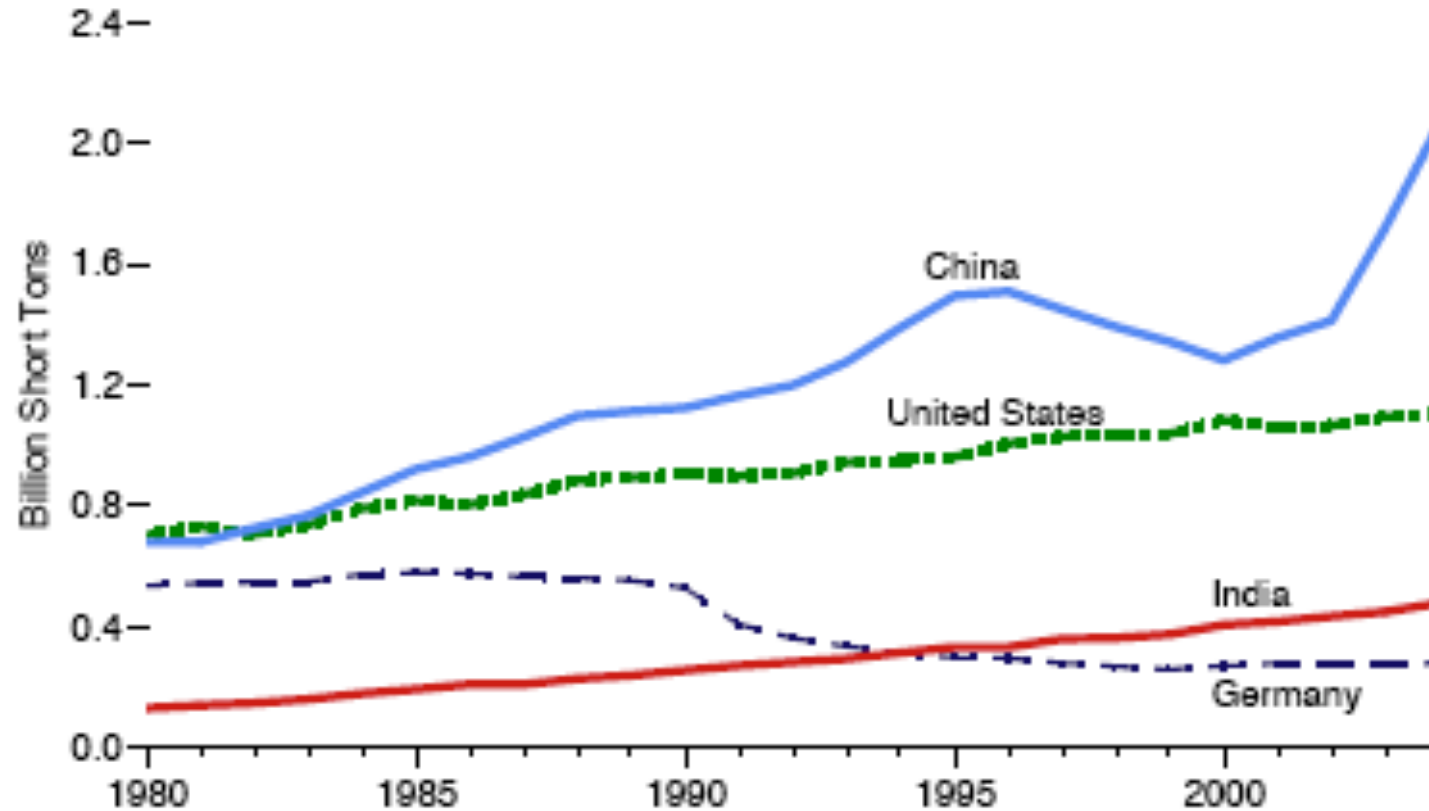
Coal consumption and rapidly developing economies

Top Consuming Countries, 2004

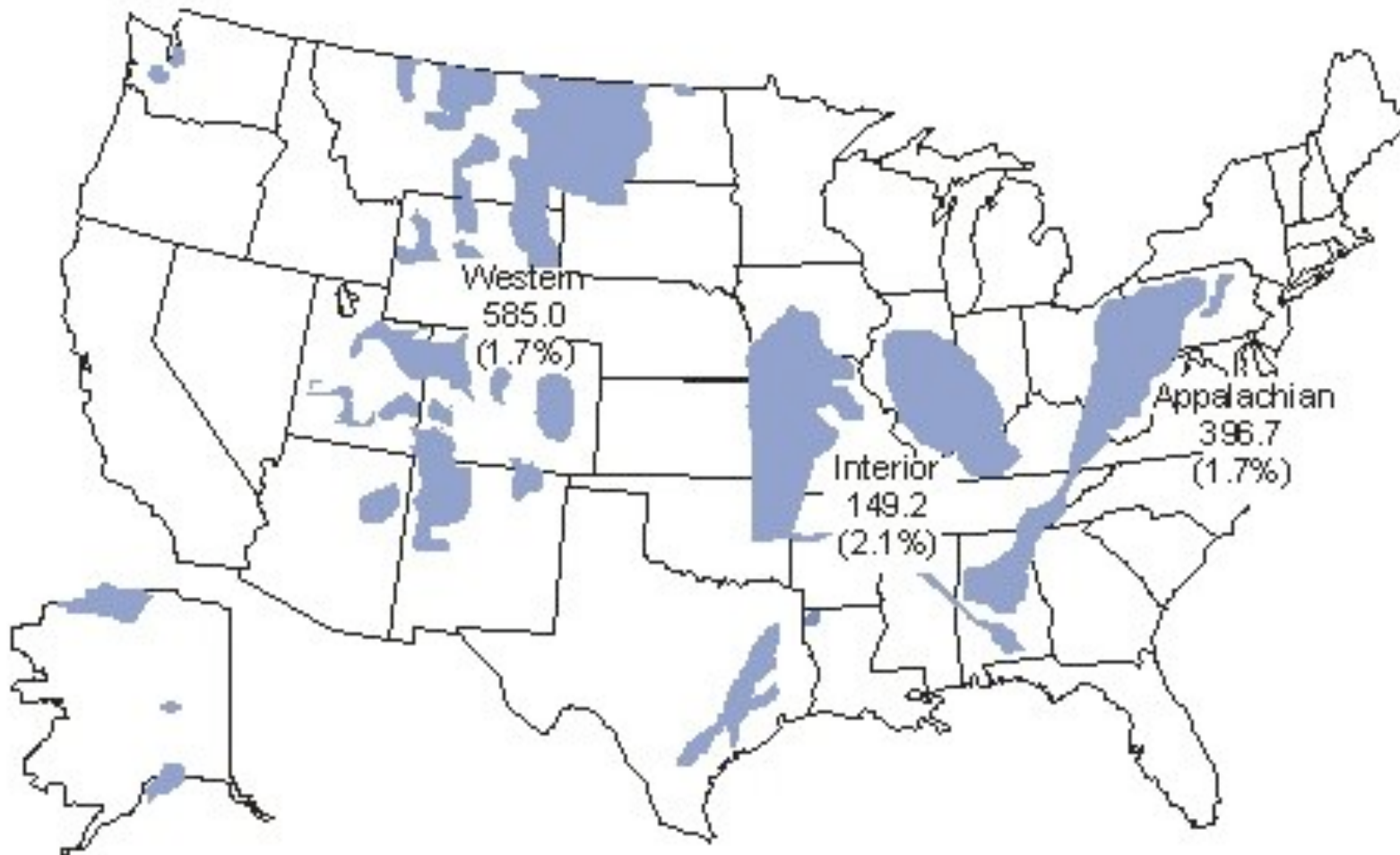


Coal by country time trends

Selected Countries, 1980-2004



US coal reserves



US coal reserves

Appalachian Coal Region:

- Annually produces about 35% of total U.S. coal production.
- Large underground mines and small surface mines.
- Coal mined in the Appalachian coal region is primarily used for steam generation for electricity, metal production, and for export.

Interior Coal Region:

- Annually produces approximately 13% of total U.S. coal production.
- Mid-sized surface mines.
- Mid- to large-sized companies.

Western Coal Region:

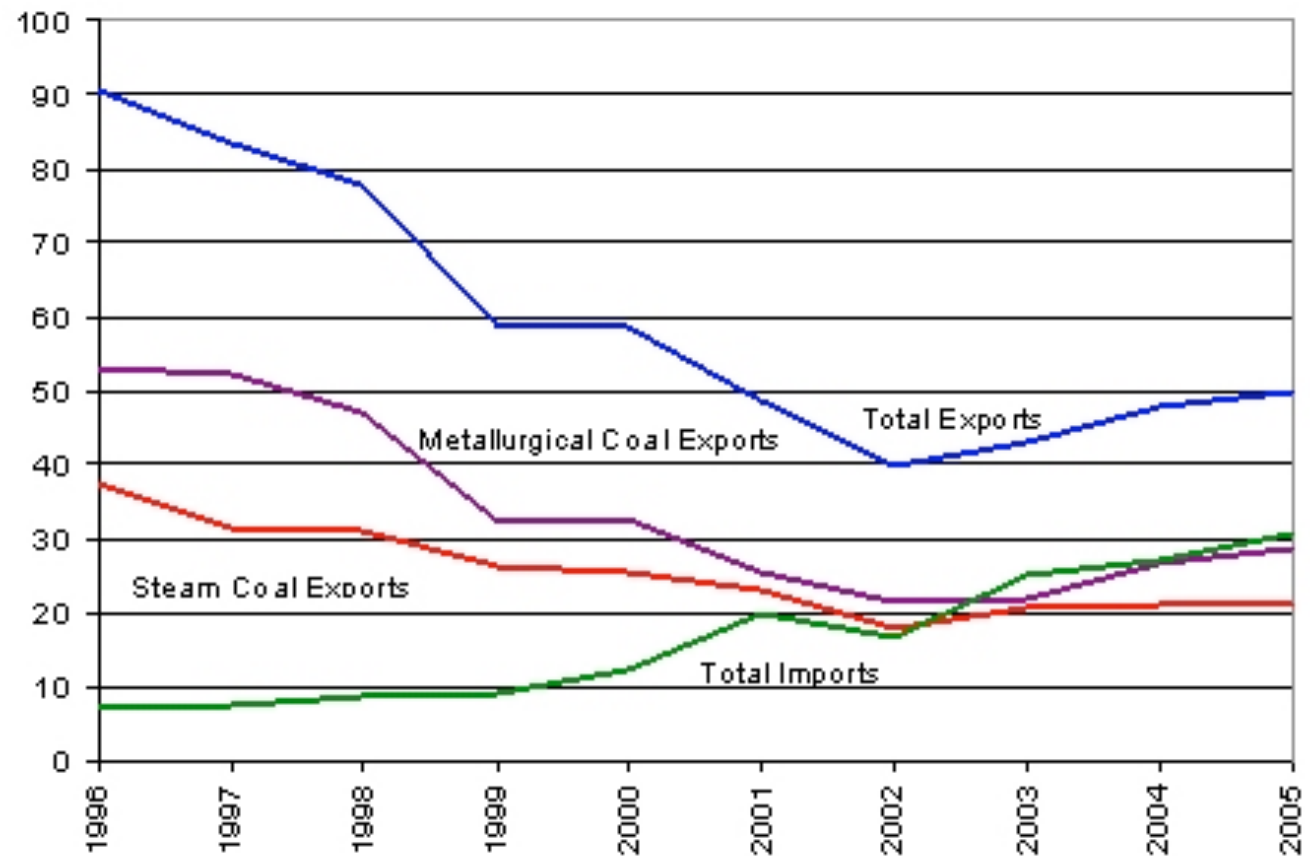
- Annually produces about 52% of total U.S. coal production.
- The State of Wyoming (number one coal state) accounts for over 30% of total U.S. coal production.
- Large surface mines.
- Largest coal mines in the world.

US coal: exports and imports

Exports
dropping

And imports
increasing

Figure 8. U.S. Coal Export and Imports, 1996-2005
(Million Short Tons)



Source: U.S. Department of Commerce, Bureau of the Census, "Monthly Report EM 545" and "Monthly Report IM 145."

Uses of coal

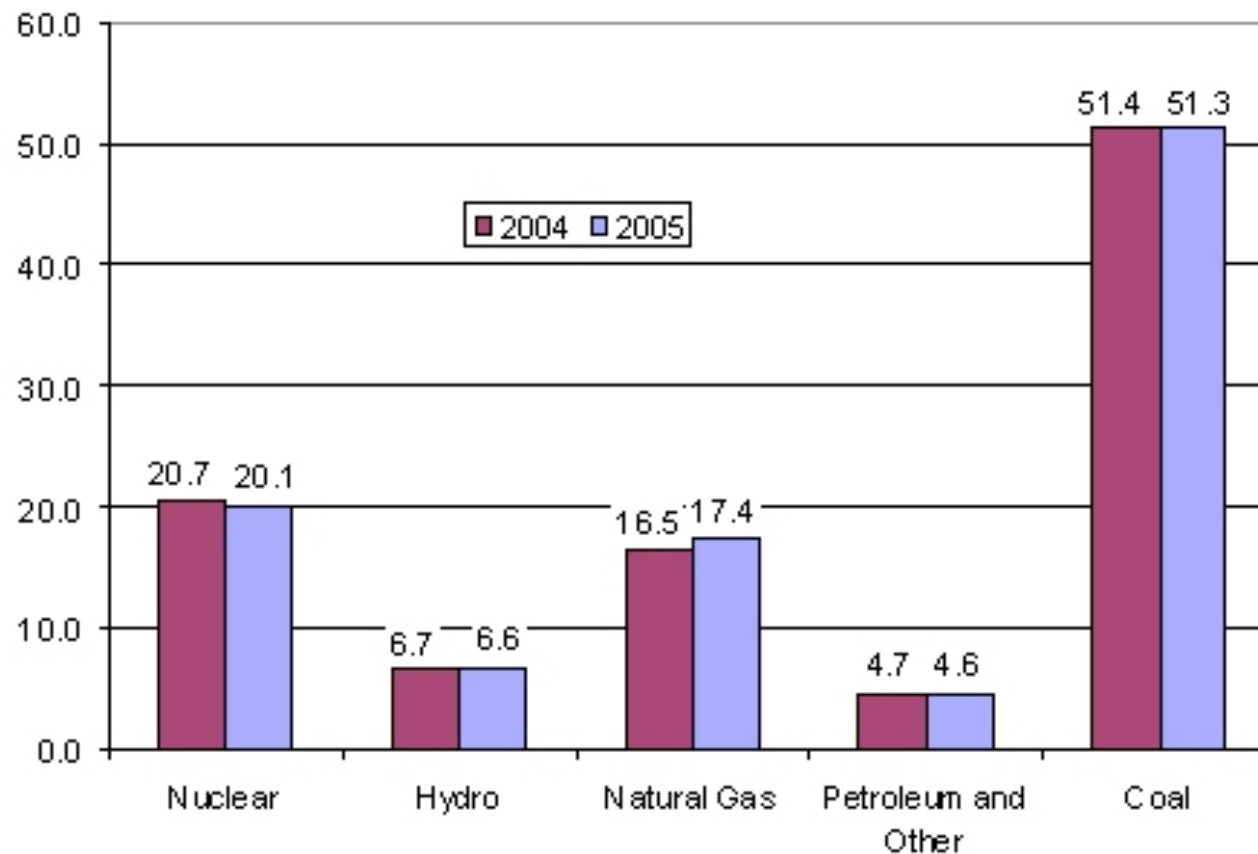
In industrialized countries coal is mostly used in industry and in the generation of electricity

Not very useful in transportation today
Electric cars?

Residential and commercial use can be met via electricity

Coal and electricity

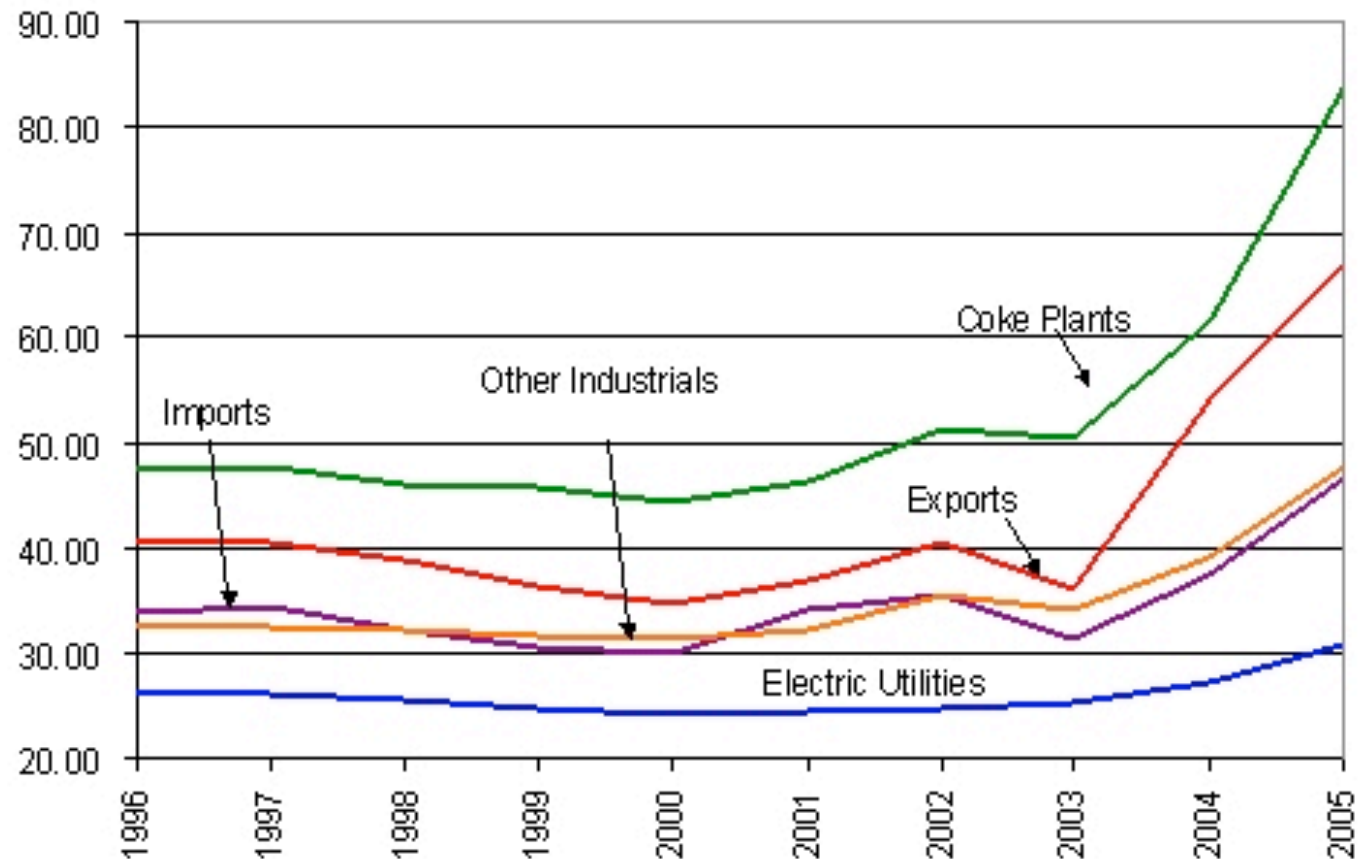
Figure 4. Share of Electric Power Sector Net Generation by Energy Source, 2004 vs. 2005



Source: Energy Information Administration, Form EIA-906, "Power Plant Report."

Coal prices are increasing as demand rises

Figure 6. Delivered Coal Prices, 1996-2005
(Nominal Dollars)



Source: Energy Information Administration, *Quarterly Coal Report*, October-December 2005, DOE/EIA-0121(2005/Q4) (Washington, DC March 2006); *Coal Industry Annual*, DOE/EIA-0584, various issues; and *Annual Coal Report 2002*, DOE/EIA-0584(2002), (Washington, DC, November 2003); *Annual Coal Report 2004*, DOE/EIA-0584(2004), (Washington, DC November 2005); *Electric Power Monthly*, March 2006, DOE/EIA-0226 (2006/03), (Washington, DC); and U.S. Department of Commerce, Bureau of the Census, "Monthly Report EM 545" and "Monthly Report IM 145."

Coal and pollution

**Purer coal has fewer impurities (like sulfur),
so it pollutes less**

Abundance in US does not match purity:

<u>Type</u>	<u>% abundance</u>
Anthracite	1
Bituminous	71
Lignite	28

Coal and pollution

Other than CO₂, which we will discuss later..

Sulfur oxides

Sulfur oxides yield **sulfuric acid** when exposed to vapor in the atmosphere..

- Acid rain
- Sulfur oxides are the primary cloud-condensing nucleus in the atmosphere...

Humans and SO₂

Humans make more SO₂ than do ocean plants, the non-anthropogenic source

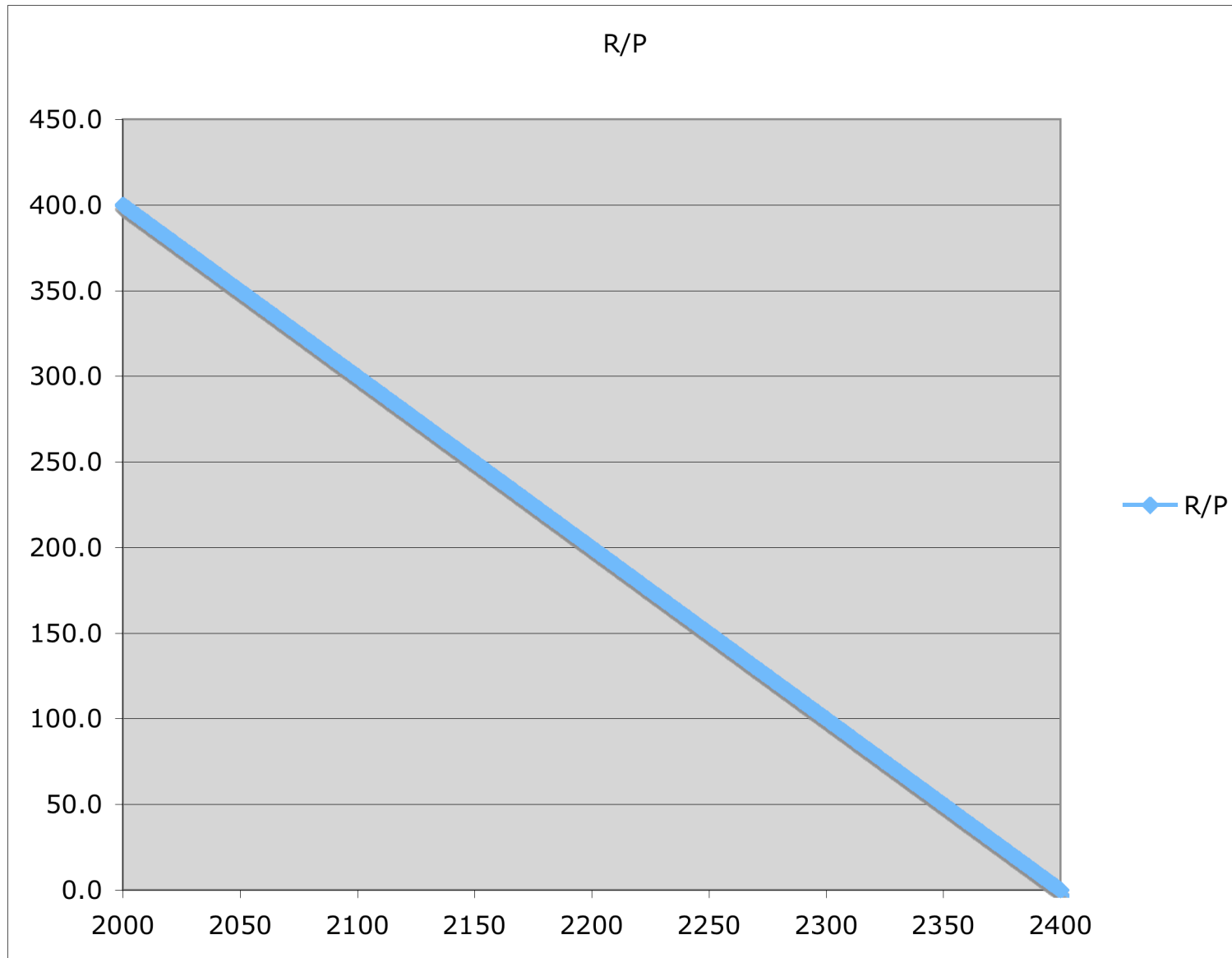
Human SO₂ dominates on the continents (more than 90% of all SO₂ over continents comes from humans)

SO₂ regulation

Sulfur oxides emissions in North America are slightly decreasing even though coal burning is increasing... **sulfur trading emissions** scheme in North America...

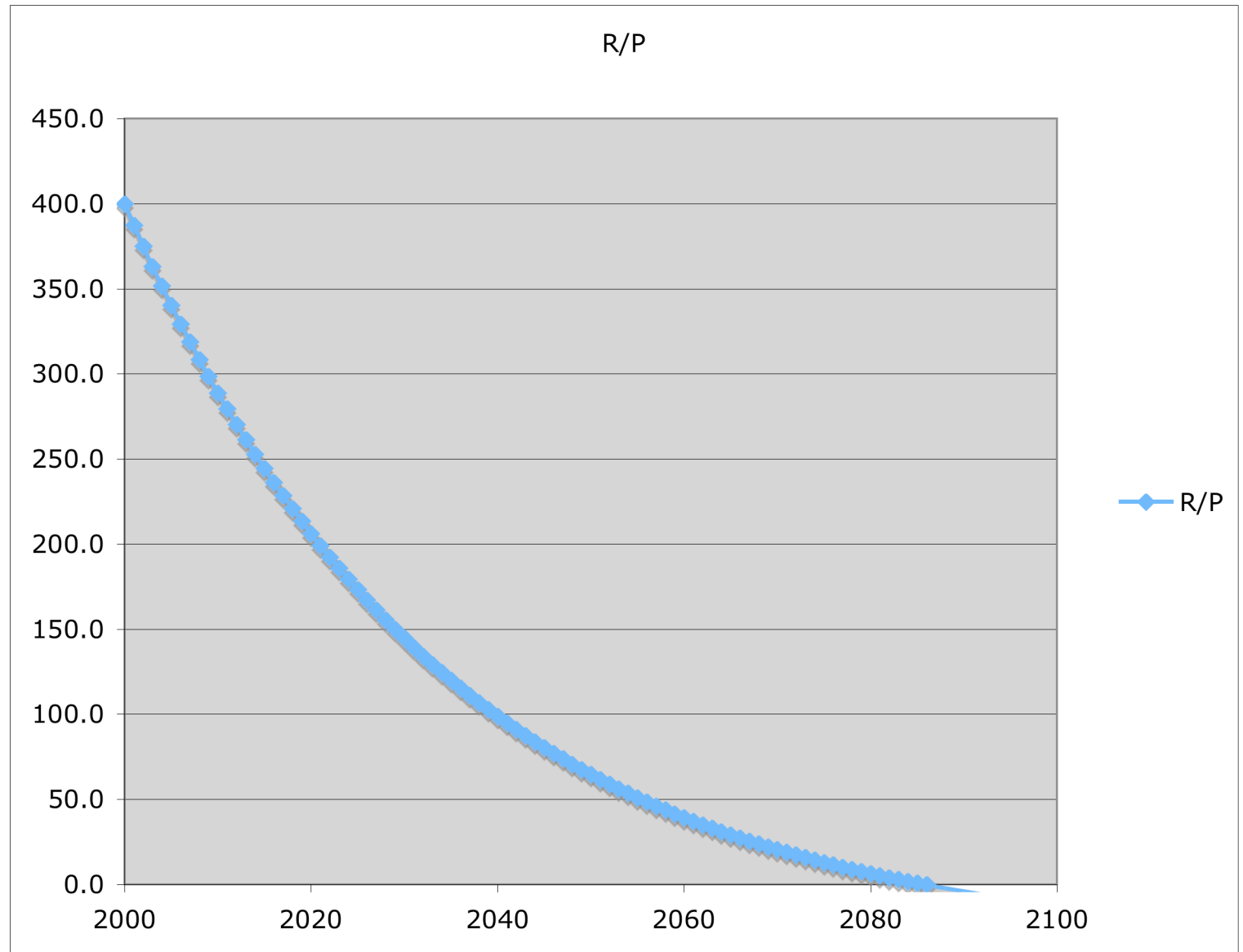
can this work for CO₂ worldwide?... what are the differences?...the similarities?

Coal R/P: 400 yrs, no growth in use



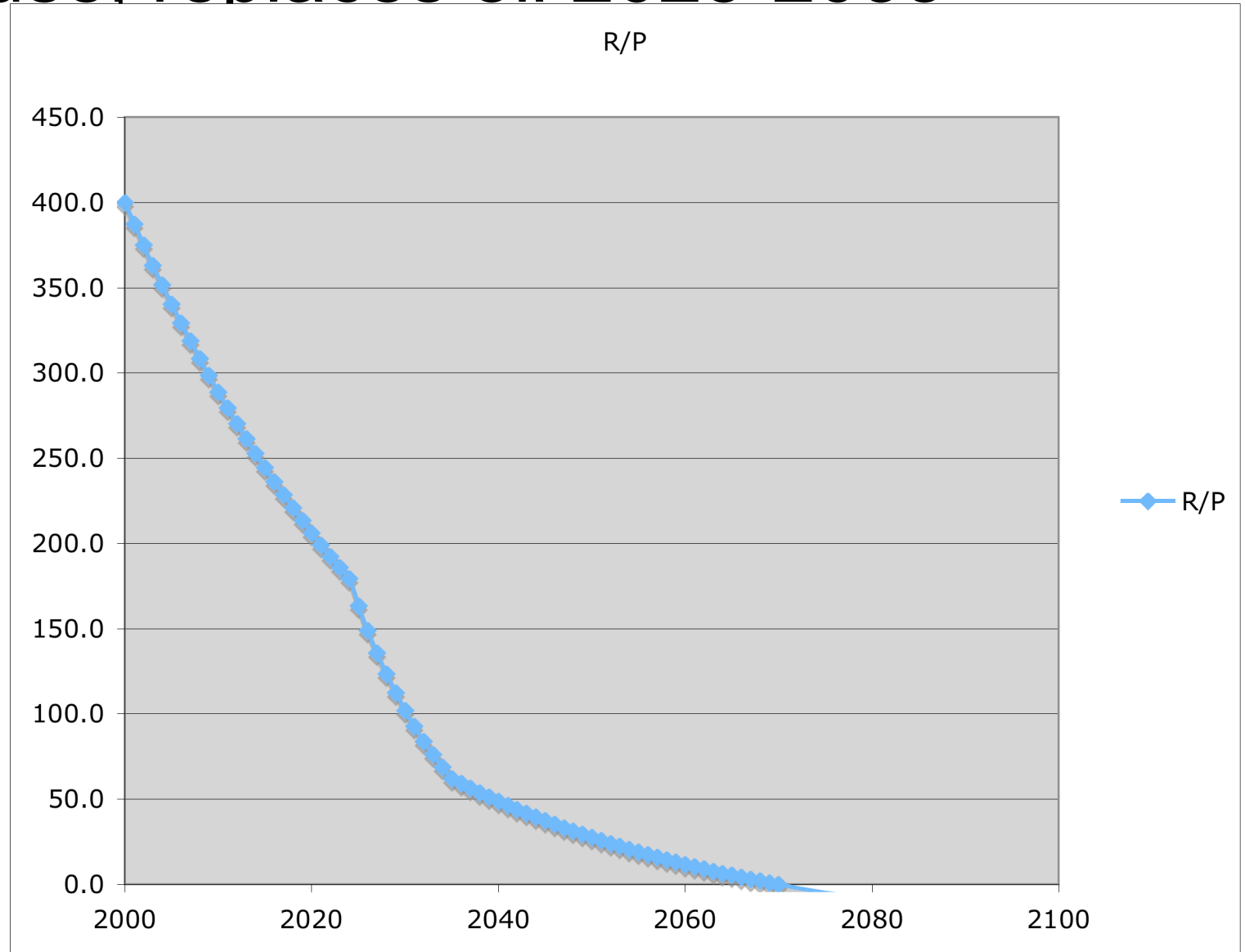
Coal R/P: 400 yrs, 3% growth in use

Note the
scale
change!



Coal R/P: 400 yrs, 3% growth in use, replaces oil 2025-2035

Note the scale!



Coal... the bottom line

Even coal, our most abundant fossil fuel, cannot withstand growth in energy demand

Options:

- Reduce demand
- Develop alternatives

- Others?
- What are the consequences for each?