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# Coal future of China and the World

**Peak coal is coming!**



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# Uppsala Hydrocarbon Depletion Study Group,

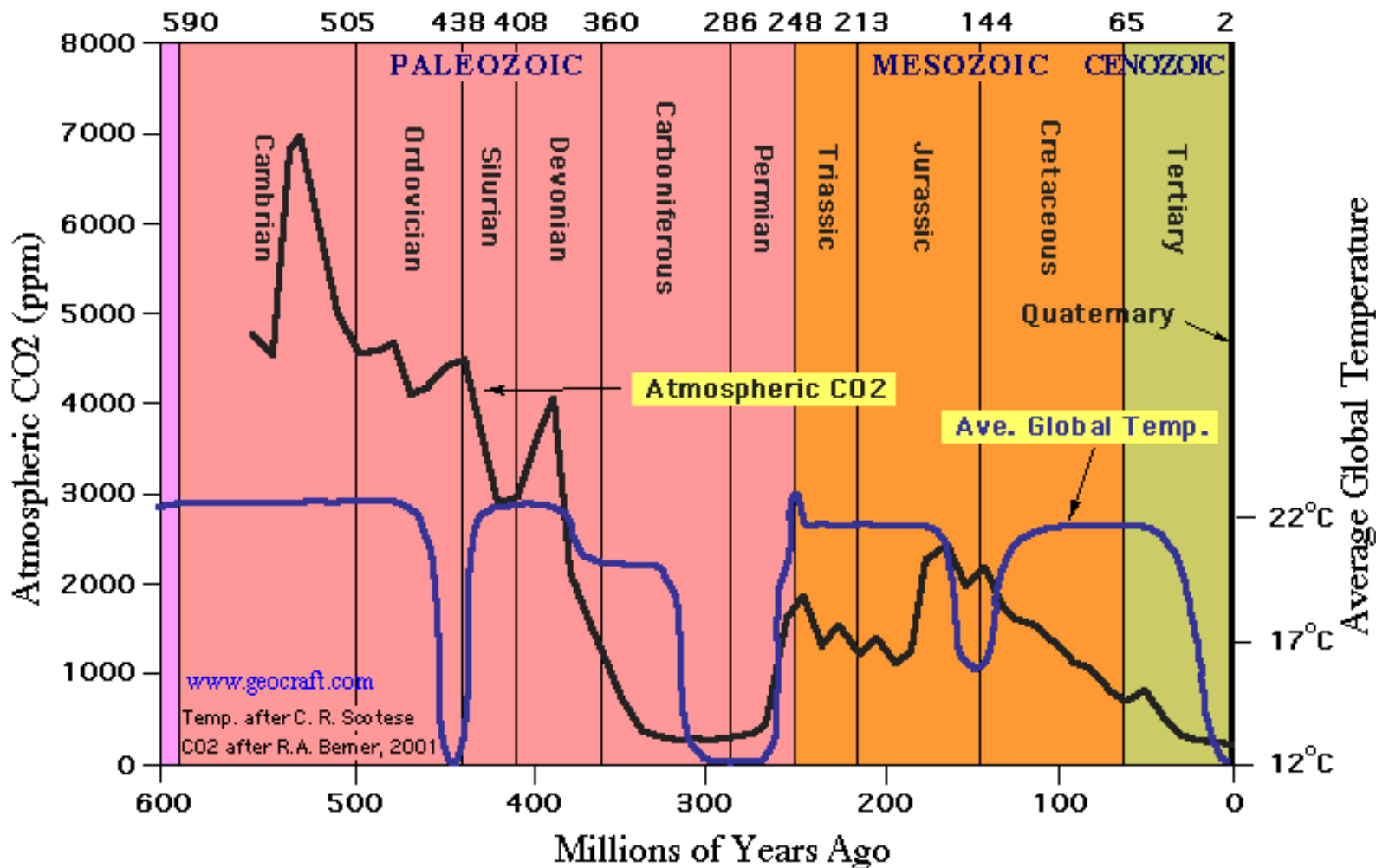
Uppsala University

## Research areas:

- Resource Physics
- Energy systems
- Energy and technology  
in the society



# Origin of fossil fuels





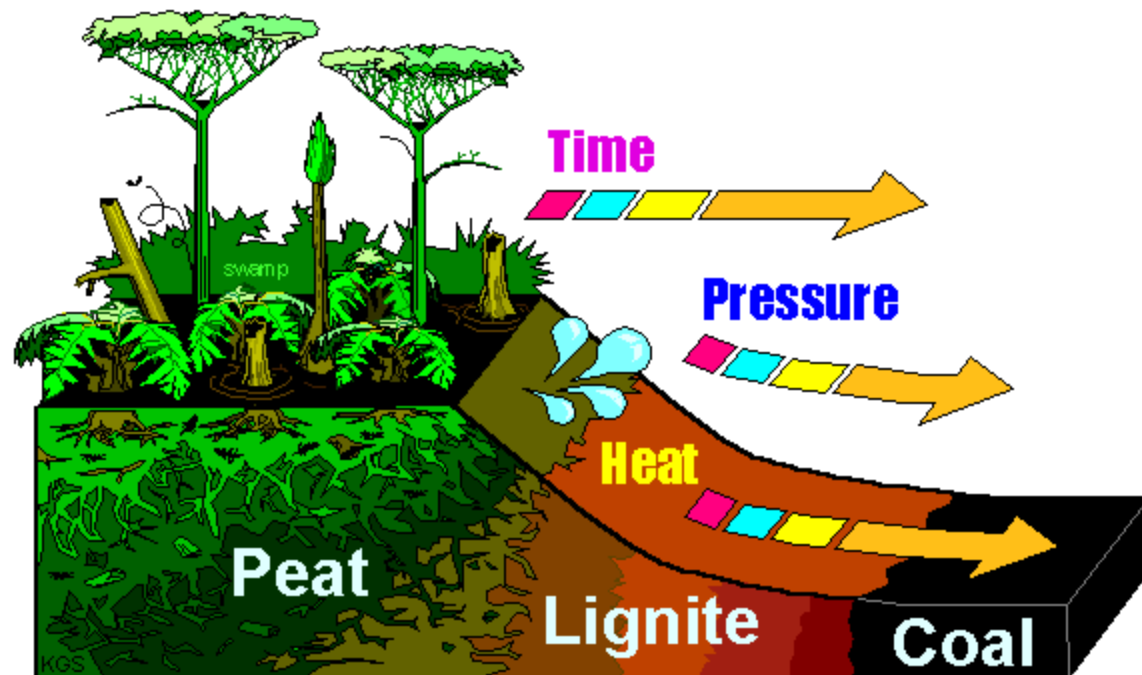
# Coal basics

- Coal makes up around 50% of all known fossil fuel reserves
- Contains four subclasses, depending on energy content
- Anthracite, bituminous, subbituminous and lignite
- Anthracite is the finest, while lignite has the lowest quality



# Coal is a fossil fuel

- Coal is formed from biological matter in geological processes.
- Similar to oil and gas





# Coal in history

- Coal was the first fossil fuel that was used on a large scale
- It was more convenient and practical to use compared to firewood and biomass
- Important in the development of metallurgy
- Laid the foundation of the industrial society and drove its development



# Coal mining

Coal has been known and used since the bronze age.

Romans used coal for household heating in Britannia.

But the use was small until the industrial revolution



*Chinese coal mine during the Ming dynasty*



# Charcoal

- By combusting wood with limited available oxygen, charcoal can be formed.
- Charcoal contains more energy per mass unit than wood and is thus a higher quality fuel for combustion.
- Hard coal is even better...



*Charcoal production*



# Understanding depletion

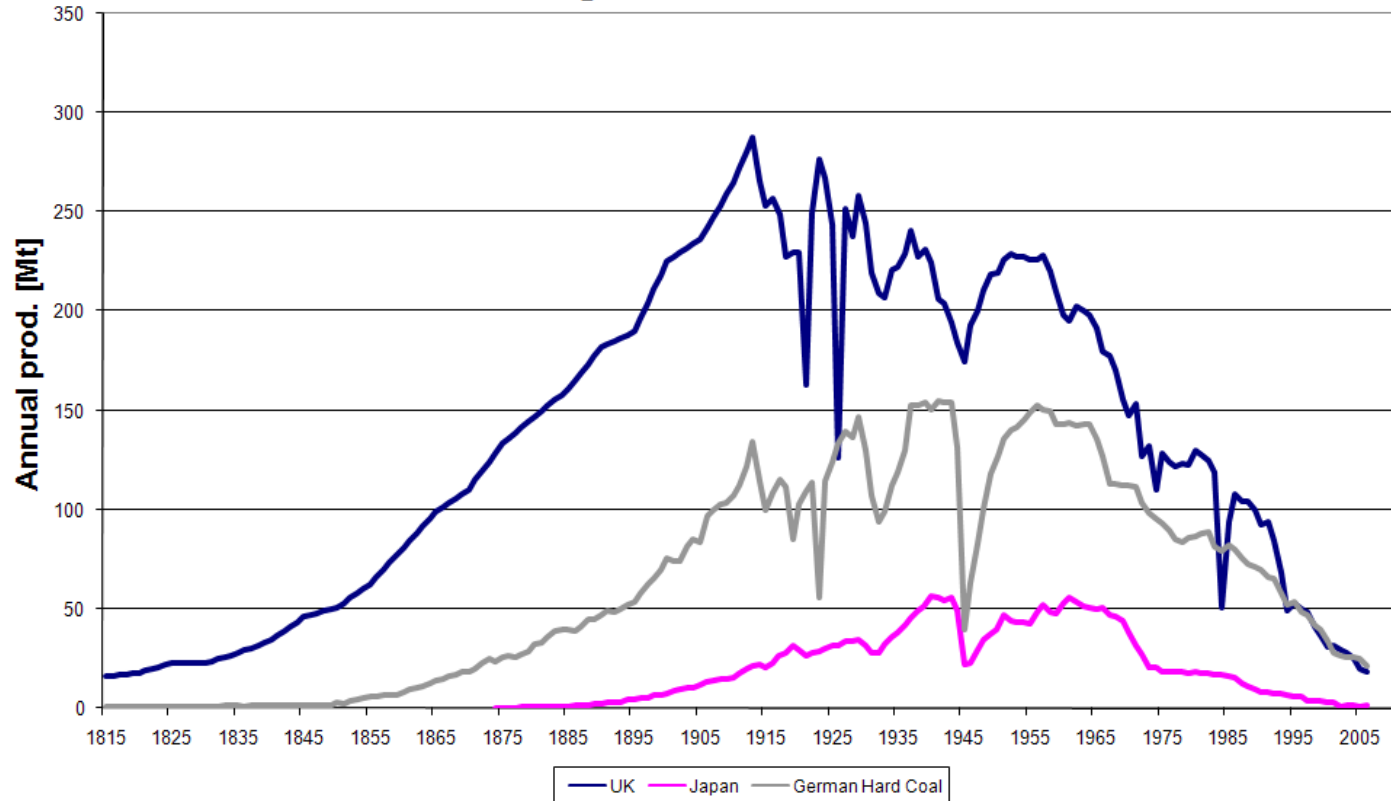


**Coalín Campbell:** "Understanding depletion is simple. Think of an Irish pub. The glass starts full and ends empty. There are only so many more drinks to closing time. It's the same with oil. We have to find the bar before we can drink what's in it."



# Learning from history

Post peak coal countries



United Kingdom, Japan & Germany have all passed peak coal and depleted their coal reserves.



# Global coal distribution

1.	USA	27.1 %
2.	Russia	17.3 %
3.	<u>China</u>	<u>12.6 %</u>
4.	India	10.2 %
5.	Australia	8.6 %
6.	South Africa	5.4 %
7.	Ukraine	3.8 %
8.	Kazakhstan	3.4 %
9.	Poland	1.5 %



*90 % of the worlds  
coal reserves are  
located in just 9  
countries!*

...

*but coal is present  
in 70 countries and  
mined in 50 of those*



# Coal Production

## Top Six Coal Producers 2006 [Mt]

<u>Country</u>	<u>Production</u>	<u>Share of world</u>
<b>1. China</b>	<b>2 380</b>	<b>38,4 %</b>
2. USA	1 054	17.1 %
3. India	447	7,2 %
4. Australia	374	6.0 %
5. Russia	309	4.9 %
6. South Africa	257	4.7 %



# Importance of China

China is by far the worlds most important coal producer and among the largest coal reserve holders.

China will therefore be the most important factor in the future world coal production and situation

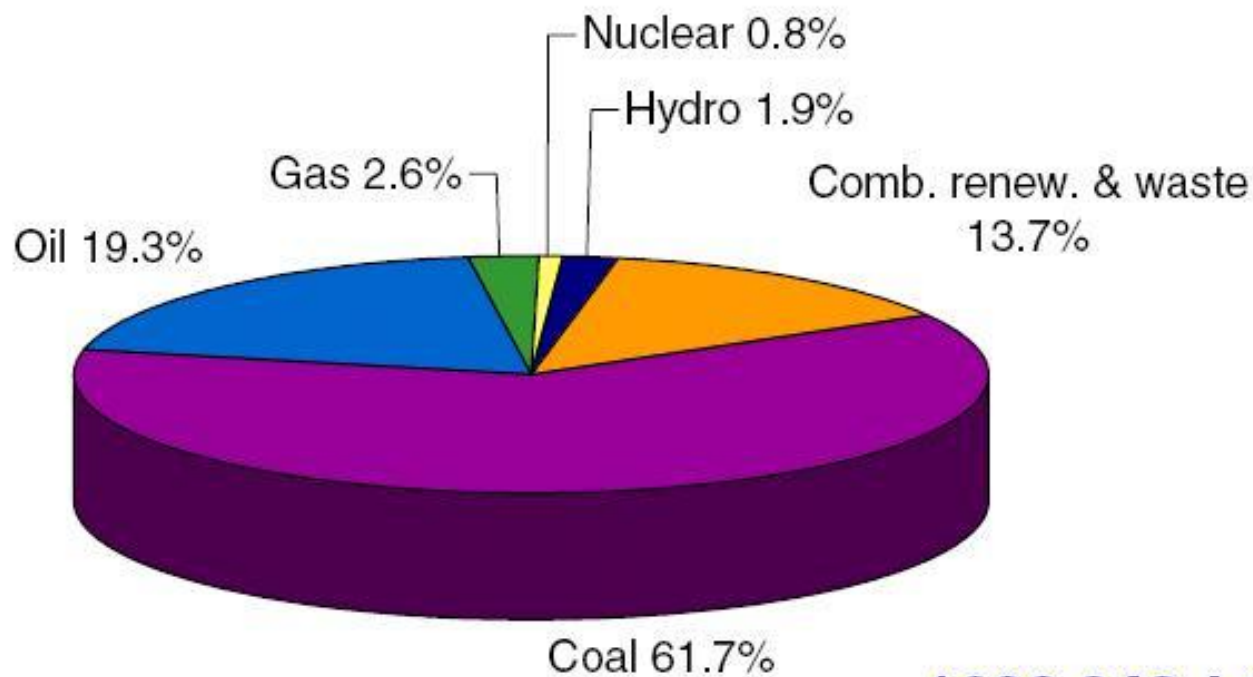
Coal is also the driving force behind Chinese economy and society



# Energy Situation in China

Share of Total Primary Energy Supply\* in 2004

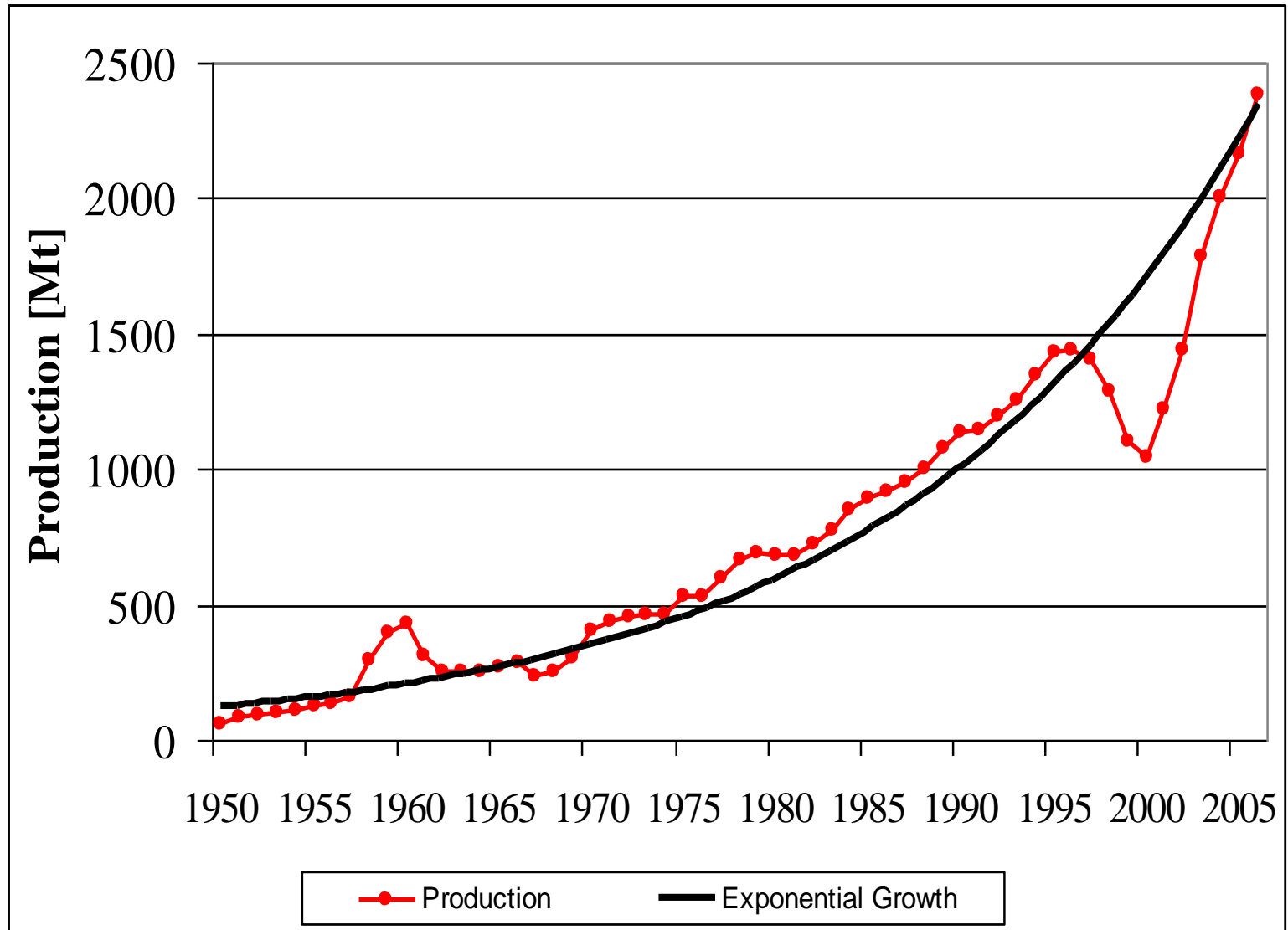
## *People's Republic of China*



**1609 348 ktoe**



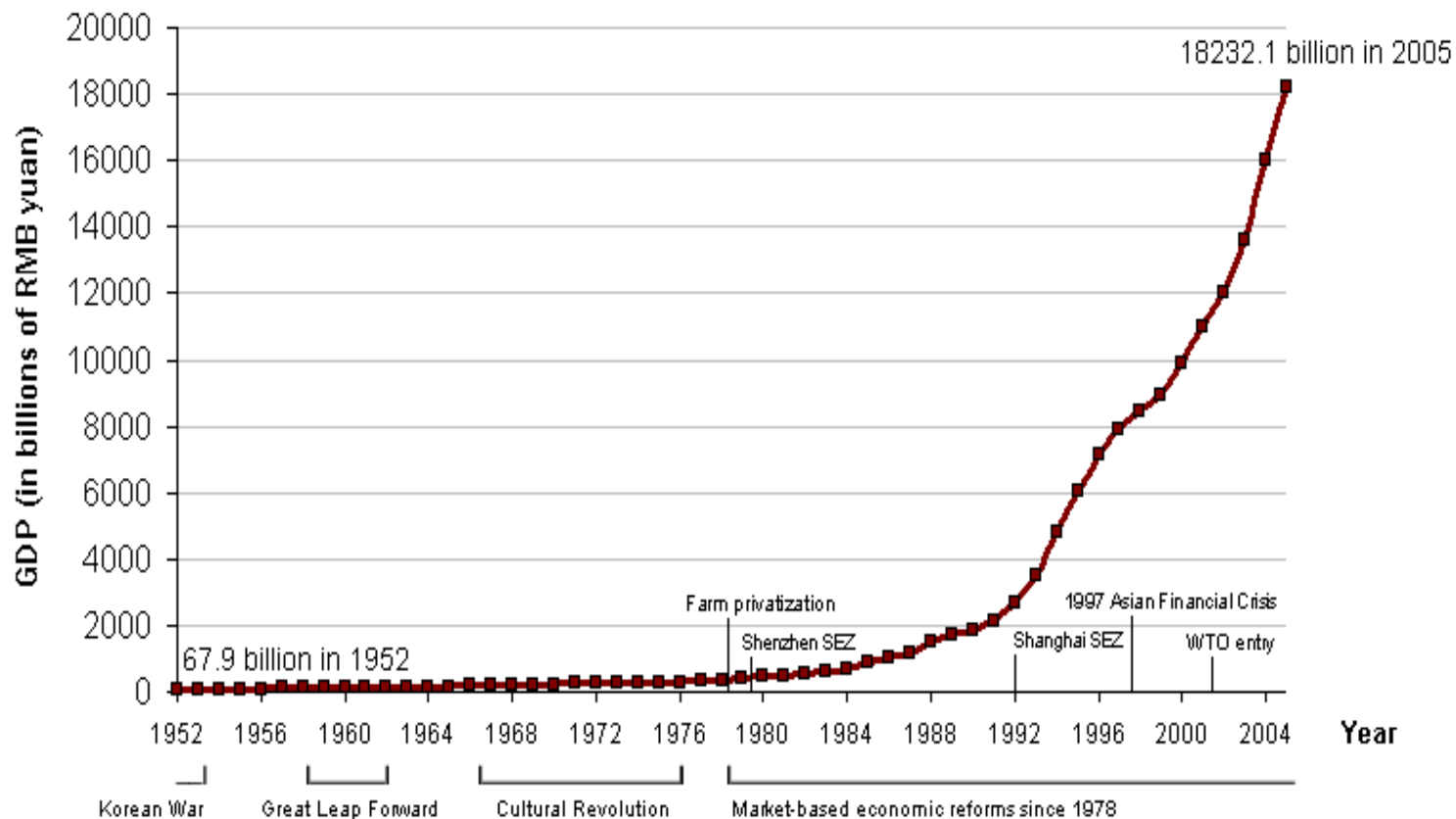
# Coal Production of China





# Chinas GDP growth

People's Republic of China's Nominal Gross Domestic Product (GDP) Between 1952 to 2005





# Energy and economy

Energy = the ability to do work

Without doing work it is impossible to have a economy

1 barrel of oil is equivalent to 25 000 hours of human physical labour

~12 people working a year

Oil can be pulled out of the ground for about 1 dollar/barrel.

**Virtually free energy!!!**



# Cost of energy

1 barrel of oil (=159 litres) contain 6.12 GJ and cost around 80 dollars

Gasoline is the cheapest liquid you can buy in USA

*300 kg of coal will give the same amount of energy as 1 barrel of oil and will cost about 18 dollars.*

156 cubic meters of natural gas gives the same amount of energy as 1 barrel of oil and will cost about 40 dollars



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# Coal in China





# Closer look on Chinese coal

- China will have the largest impact on the future coal production due to its dominance

## Important factors

- Reserve issues
- Export and import problems
- Future mining depths
- (New technology)



# Coal regions of China

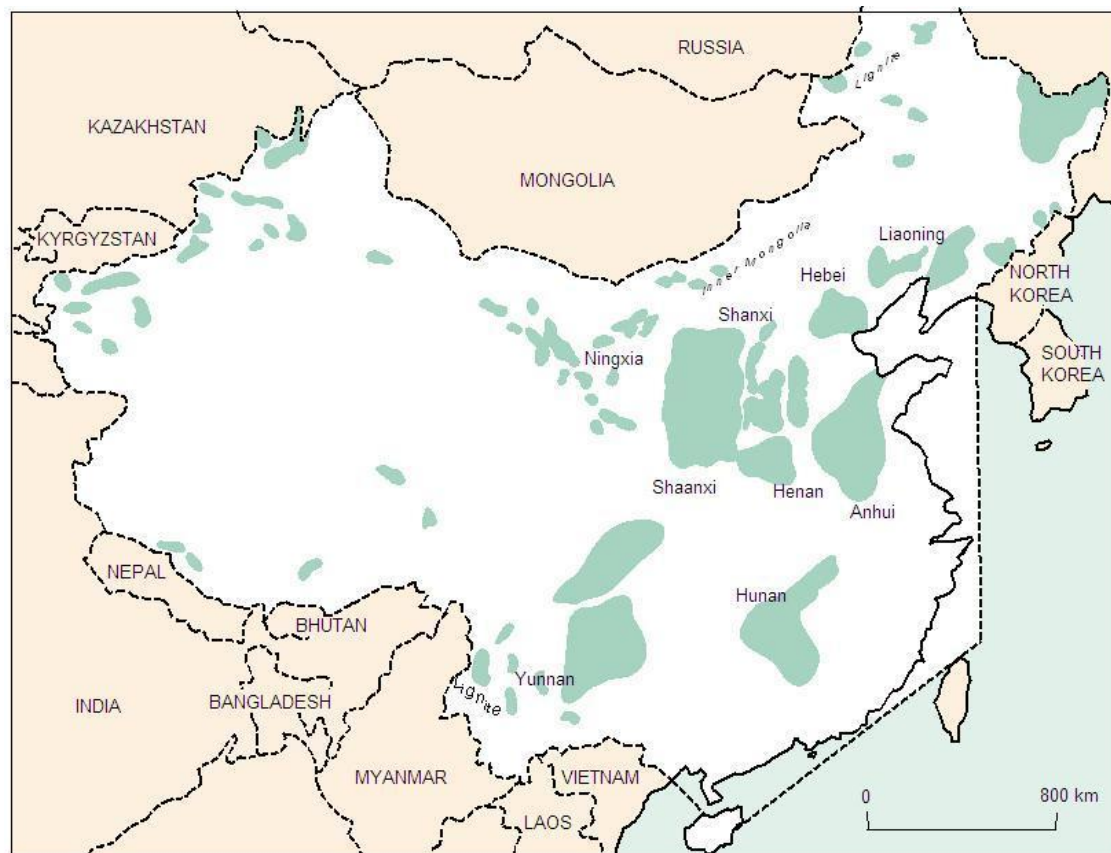


Figure 11: *Distribution of coal deposits in China. Source: IEA Clean Coal Center, Coal Online*



# Hard coal reserve issues

Year	USA	China	India	FSU	Australia	S. Africa	Germany	Poland	UK
1987	131,971	156,400	12,610	108,800	29,138	58,404	23,919	28,300	9,000
1988	131,971	156,400	12,610	108,800	29,138	58,404	23,919	28,300	9,000
1989	131,971	156,400	12,610	108,800	29,138	58,404	23,919	28,300	9,000
1990	129,543	152,831	60,098	102,496	44,893	54,811	23,698	28,182	8,602
1991	129,543	<b>152,831</b>	60,098	102,496	44,893	54,811	23,698	28,182	8,602
1992	112,668	62,200	60,648	104,000	45,340	55,333	23,698	29,600	3,300
1993	112,668	62,200	60,648	104,000	45,340	55,333	23,919	29,600	3,300
1994	106,495	62,200	60,047	104,000	45,340	55,333	23,919	29,100	2,000
1995	106,495	62,200	60,047	104,000	45,340	55,333	24,000	29,100	2,000
1996	106,495	62,200	60,047	104,000	45,340	55,333	24,000	29,100	2,000
1997	106,495	62,200	60,047	104,000	45,340	55,333	24,000	29,100	2,000
1998	111,338	62,200	72,733	96,476	47,300	55,333	24,000	12,113	1,000
1999	111,338	62,200	72,733	96,476	47,300	55,333	24,000	12,113	1,000
2000	115,891	62,200	72,733	96,476	47,300	55,333	24,000	12,113	1,000
2001	115,891	62,200	82,396	96,476	42,550	49,520	23,000	20,300	1,000
2002	115,891	62,200	82,396	96,476	42,550	49,520	23,000	20,300	1,000
2003	115,891	62,200	82,396	96,476	42,550	49,520	<b>23,000</b>	<b>20,300</b>	<b>1,000</b>
2004	111,338	62,200	90,085	93,513	38,600	48,750	183	14,000	220
2005	111,338	62,200	<b>90,085</b>	93,513	38,600	48,750	183	14,000	220
2006	112,261	62,200	52,240	92,609	37,100	48,000	152	6,012	155



# Reserve issues

- Chinas coal reserve haven't been updated since 1992
- Similar behaviour can be seen in brown coal & lignite
- Completely ignoring the fact that almost 30% of the reserves should have been produced
- Many other countries show dramatic decreases in coal reserves



# Export and Import

- China used to be a large coal exporter.
- Export have been dropping for a long time.
- This year China have been a net importer of coal...

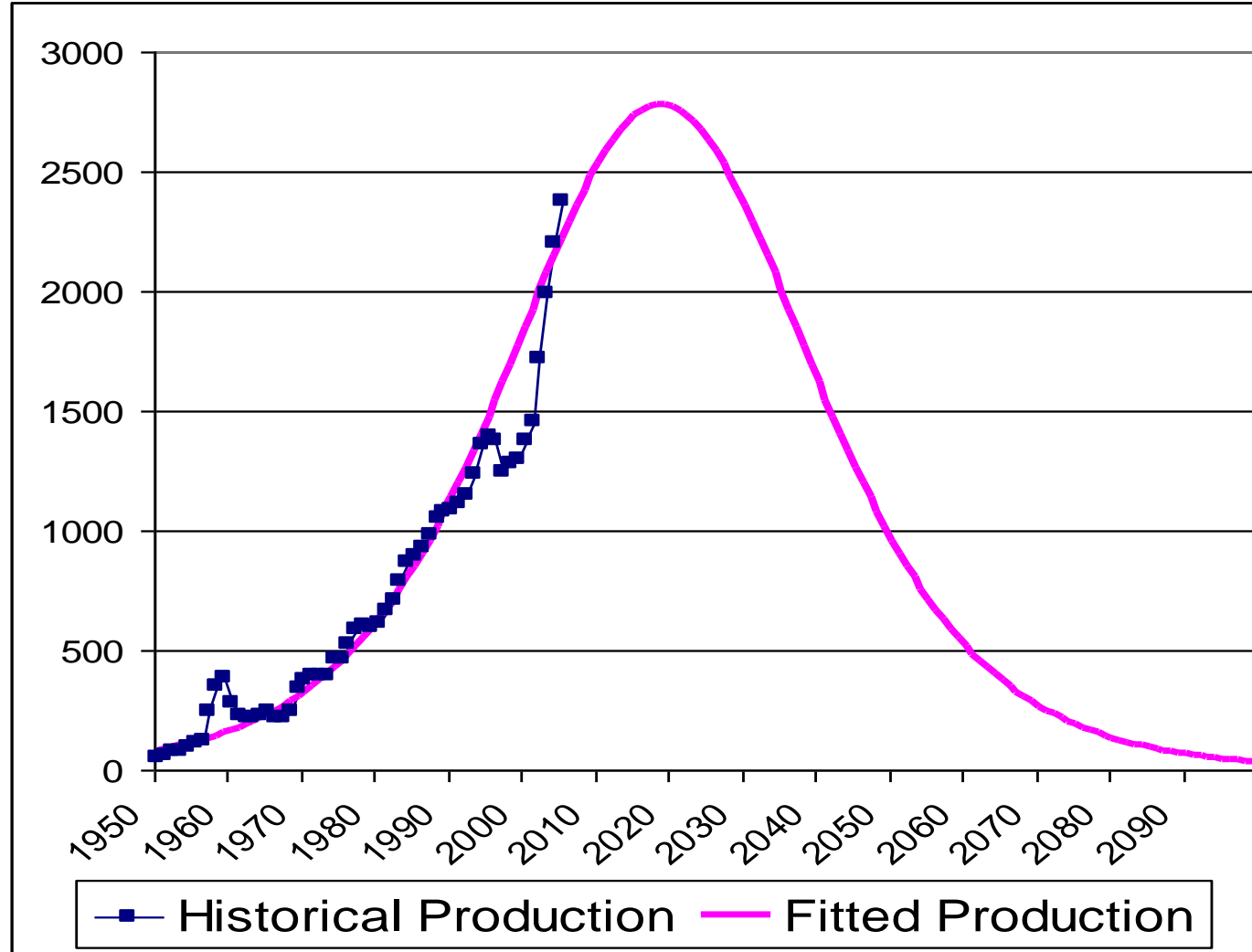


# Future mining depths

- Chinese coal reserves below 150 meters are small
- Most of the coal is located between 150-300 meters
- Coal resources are located even deeper
- Mining at huge depths is more costly, complicated and energy consuming



# Forecasting the future



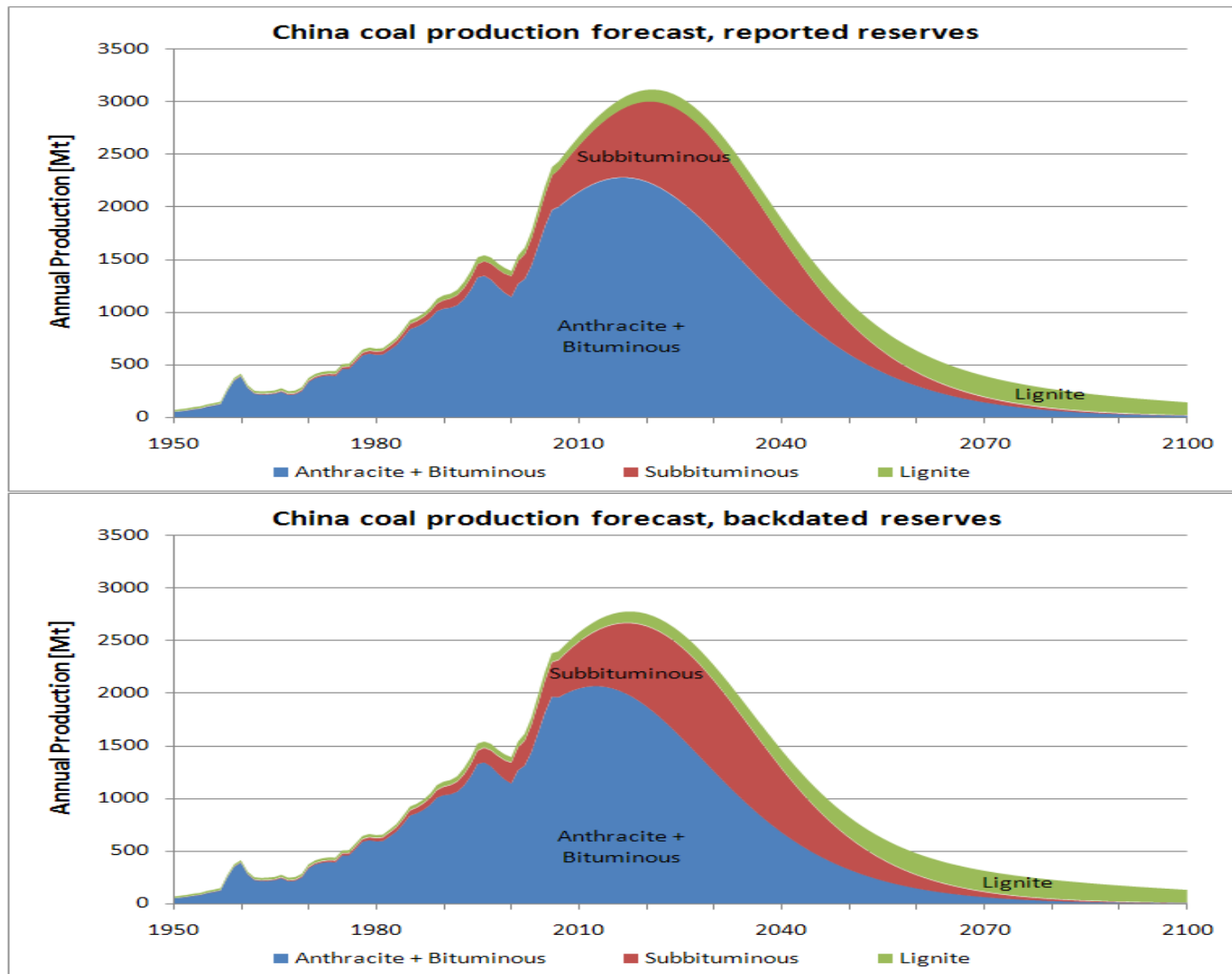


# Why logistic model?

- It is simple and very general
- It fits very well with the historic data
- Useful for predicting the peak
- Disadvantage regarding tail production, but not a real problem



# Chinese coal forecast





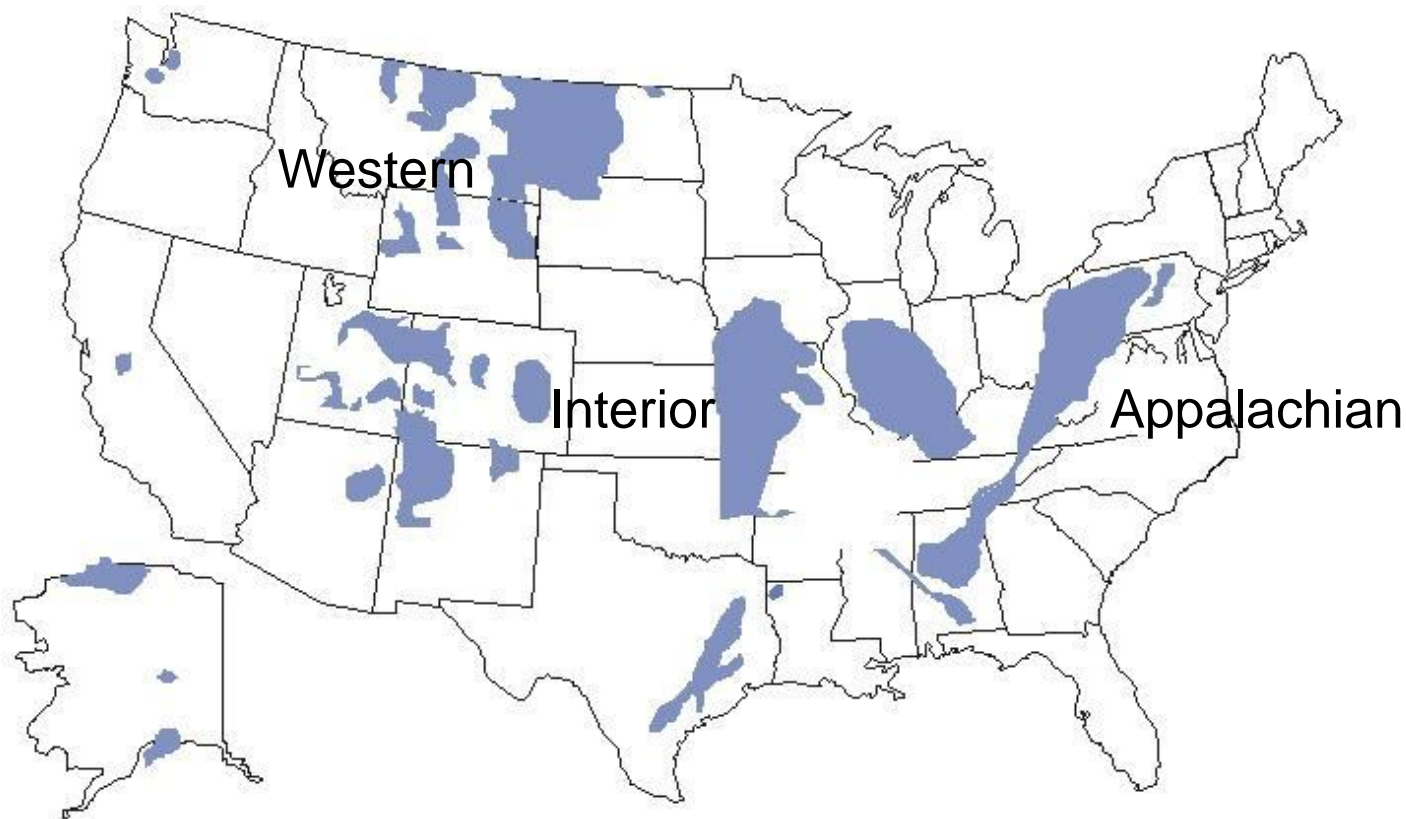
# USA



- USA is the worlds second largest coal producer
- Shows many signs of coming problems
- Many regions are in decline

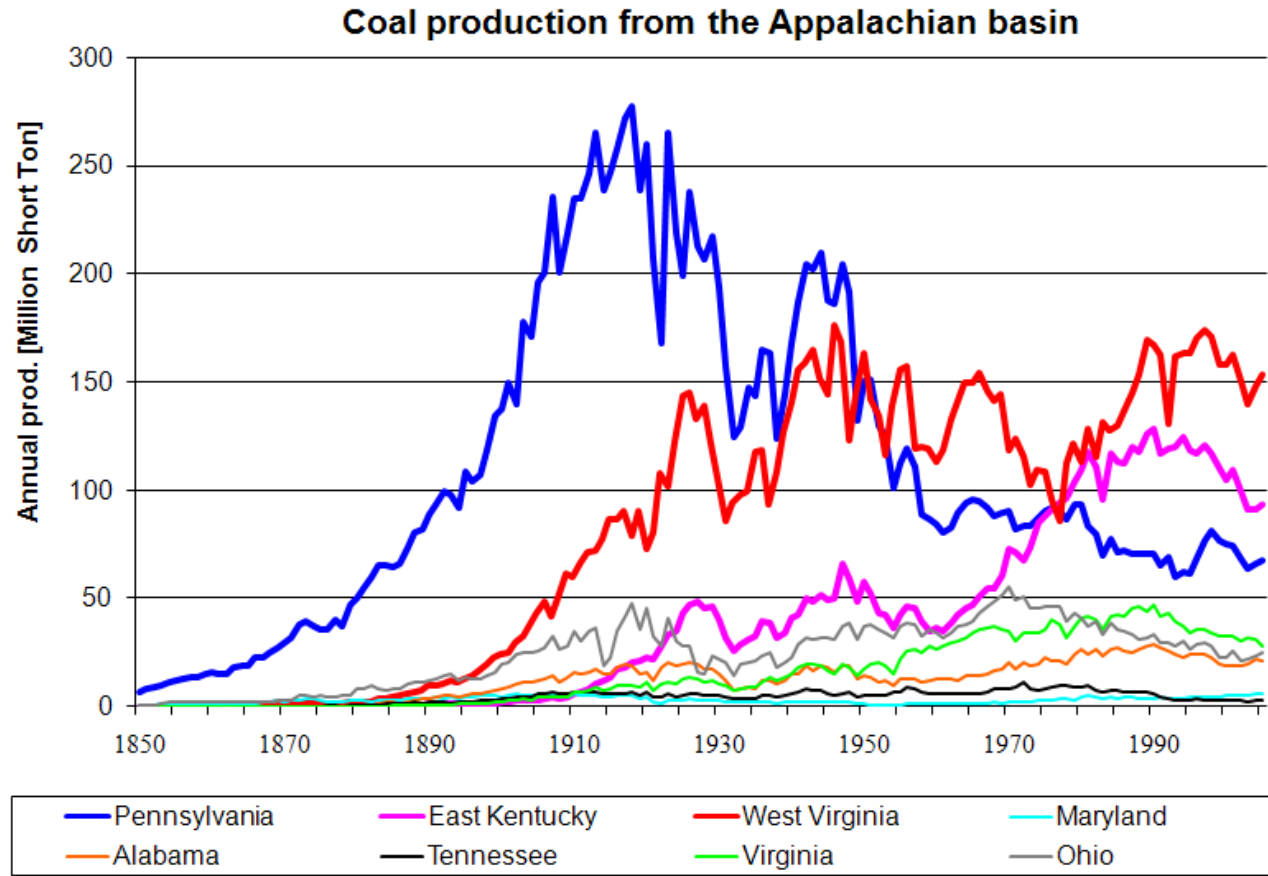


# Coal regions of USA



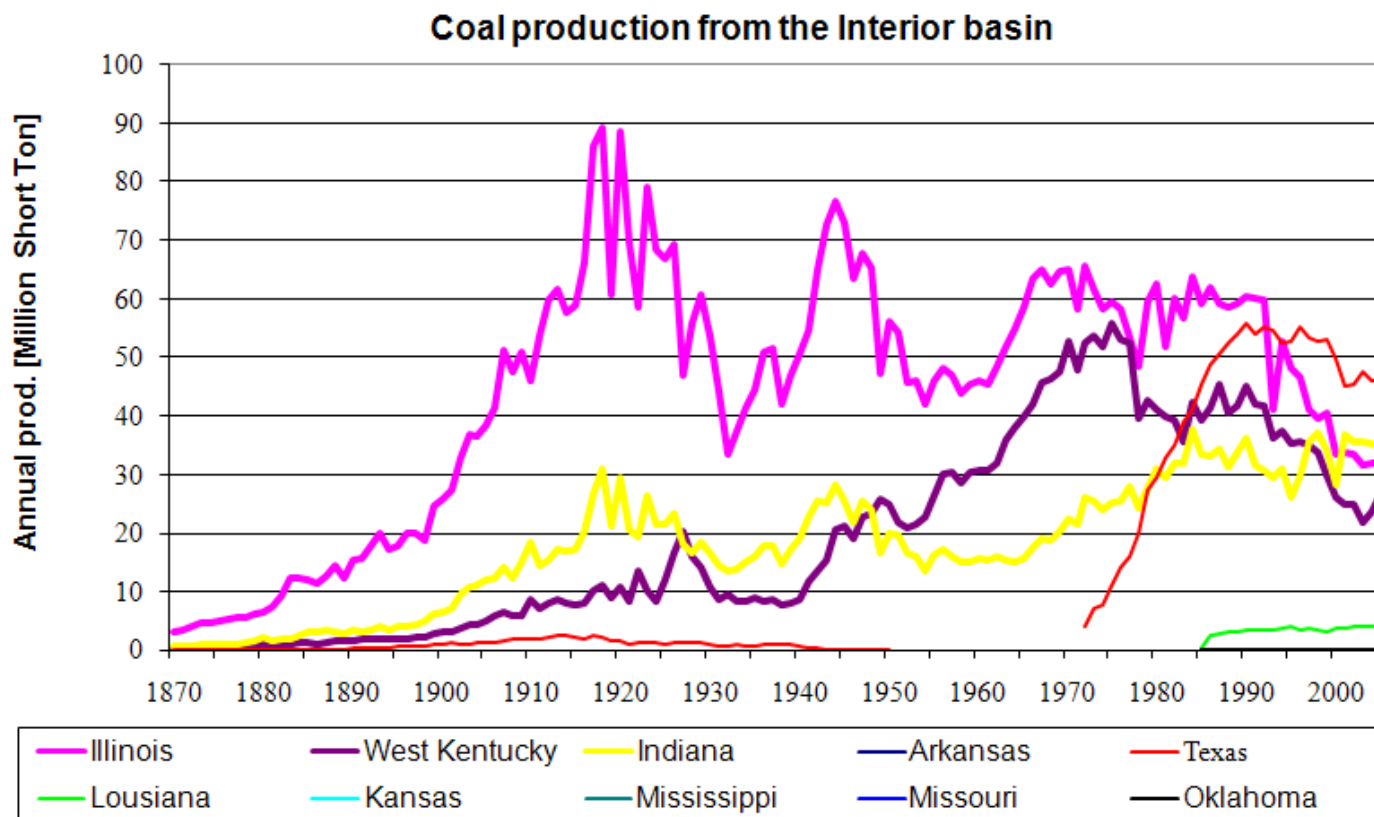


# Appalachian basin





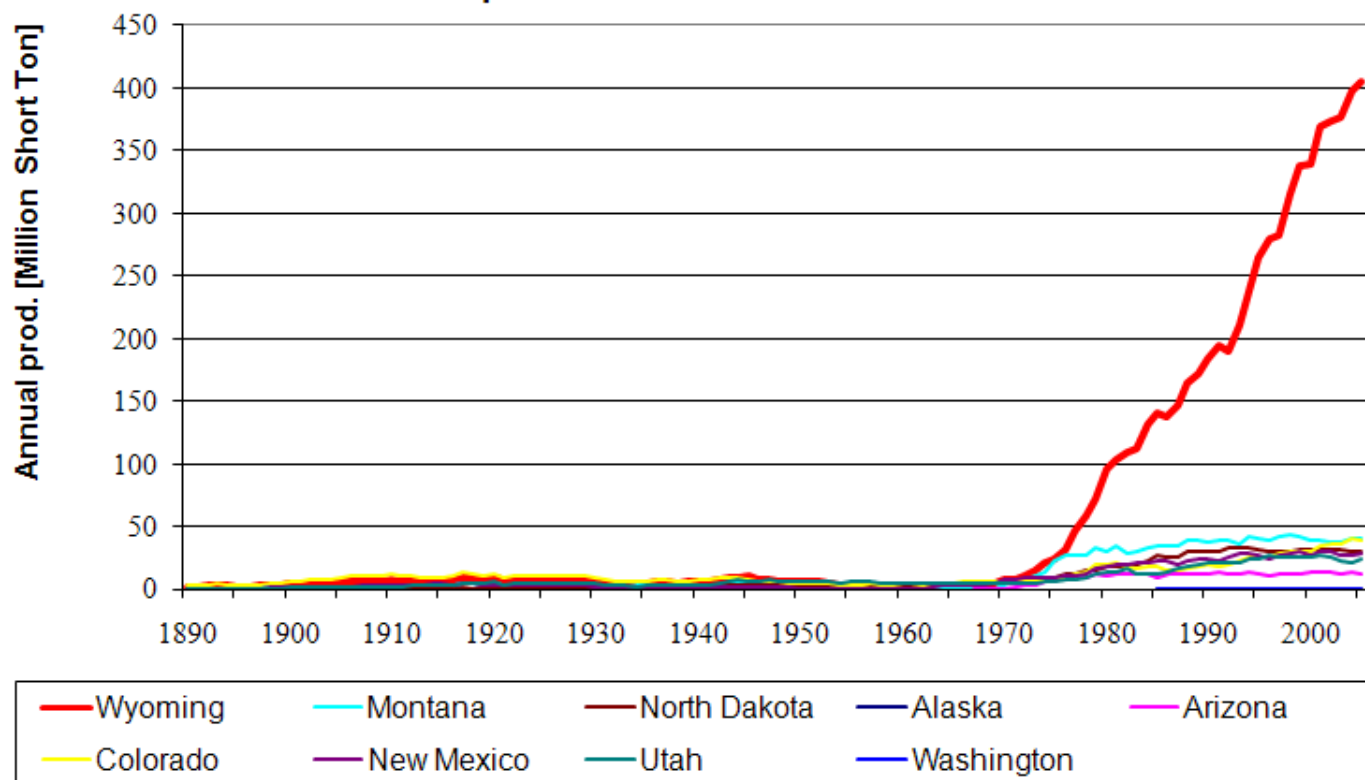
# Interior basin





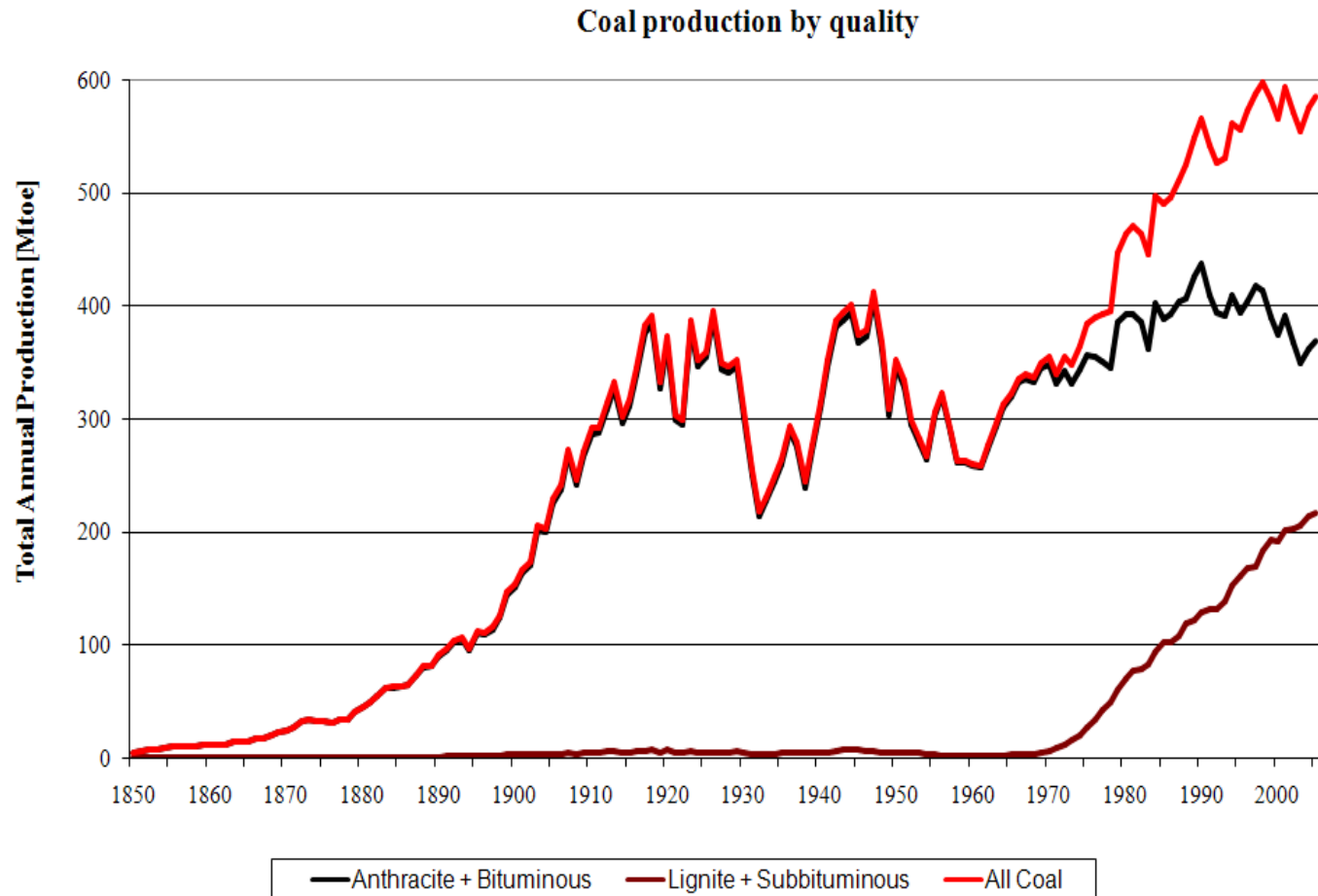
# Western basin

Coal production from the Western Basin



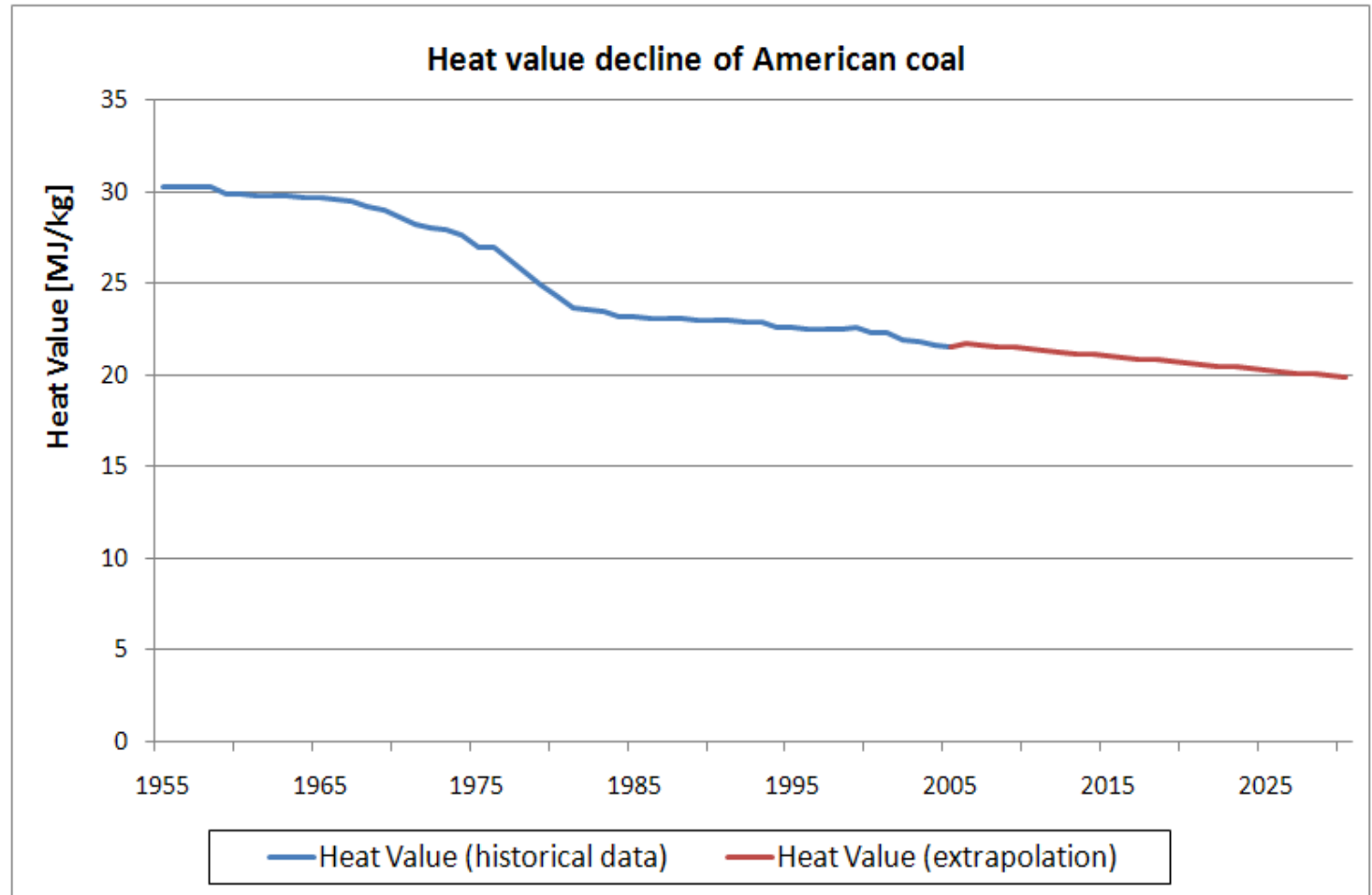


# Decline in hard coal production



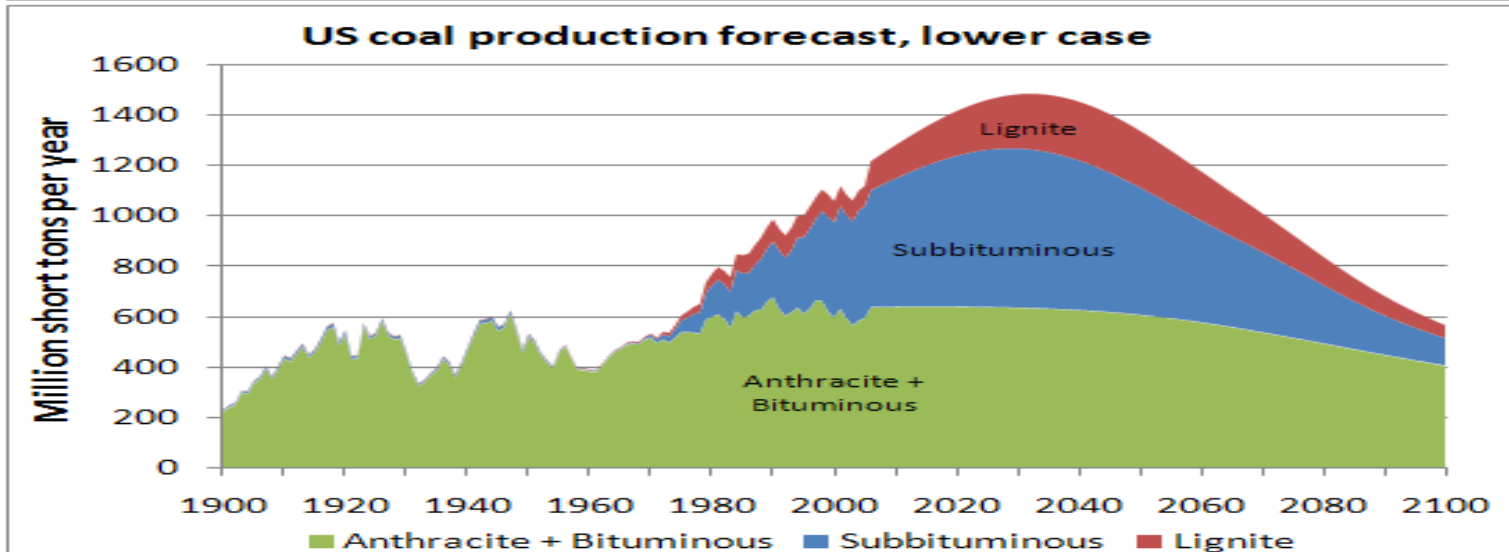
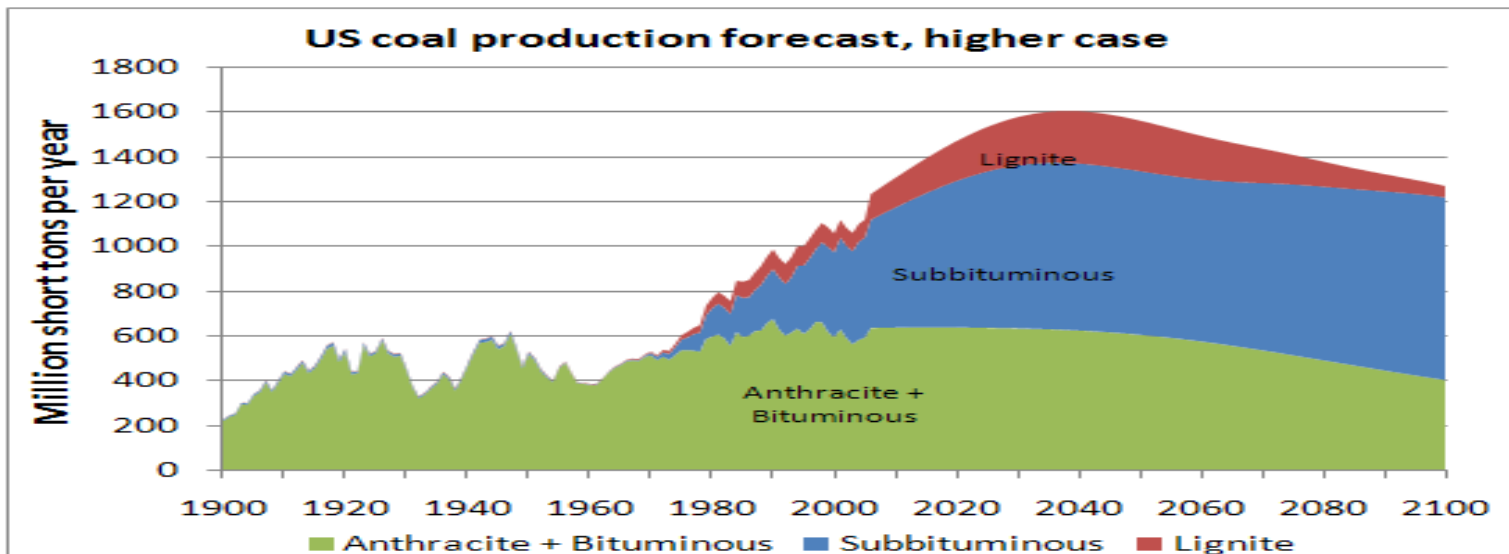


# Declining energy content





# USA forecast





# World forecast

- Similar arguments and analysis can be applied to the entire world
- Coal reserves have been continuously downgraded for a very long time, despite increasing coal prices and introduction of new technology
- Coal resources have never been converted to reserves on a significant scale



# The Big Six

- The six largest coal nations are USA, Russia, China, India, Australia and South Africa.
- Together they control about 85% of the worlds coal reserves
- They also account for about 80% of the worlds coal production
- Can be used to predict the future world production of coal





# Future of coal

- The world do not have coal for “hundreds of years”
- China are about to reach peak coal very soon, in the near future
- Coal is no solution to peak oil
- Higher coal prices and new technology have not been able to increase coal reserve throughout history

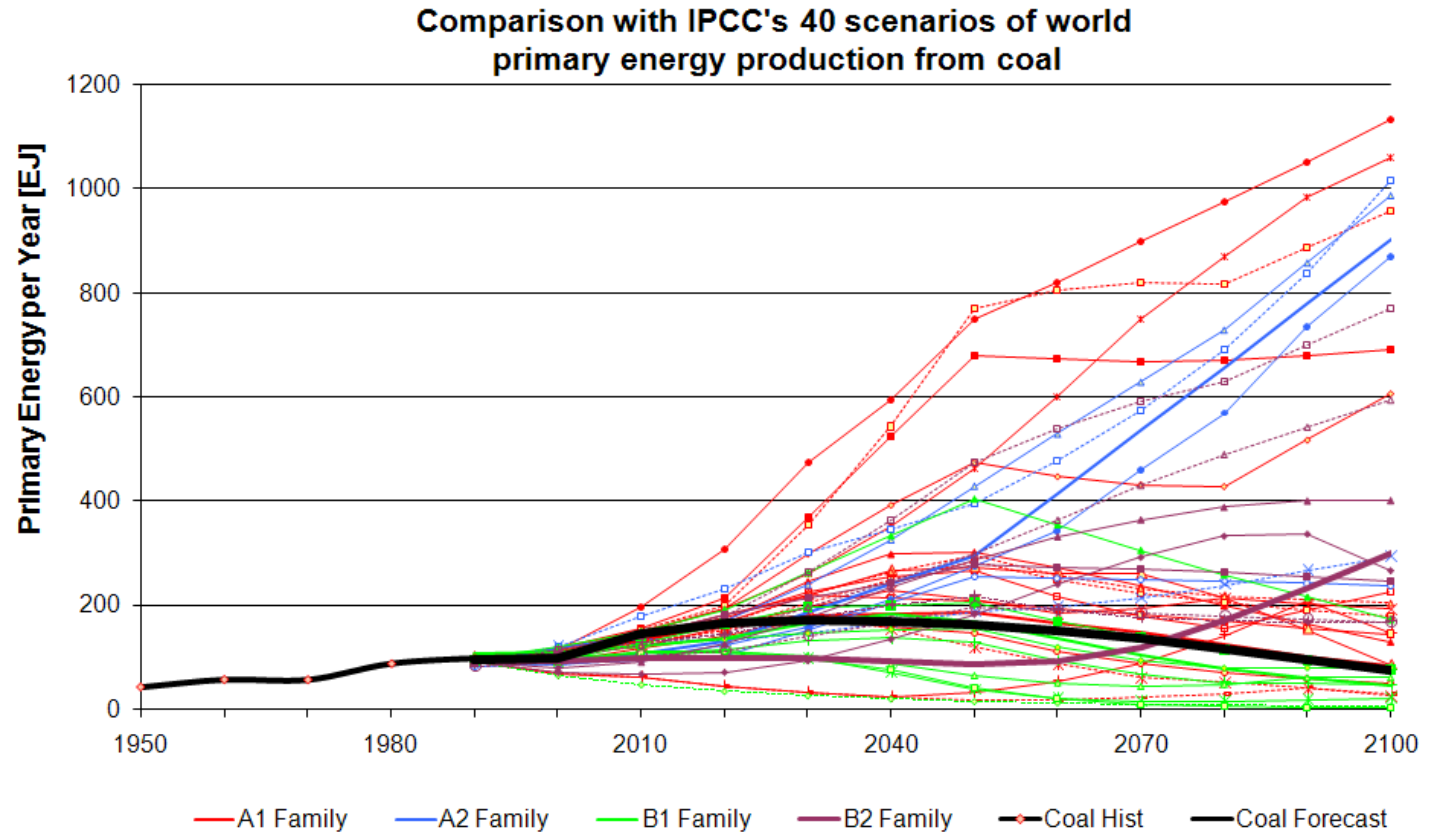


# Some will be losers

- Continued dependence on coal in a post peak situation will likely result in dire economic consequences
- Many investments can turn out to be bad if they do not get their future coal supplies



# But climate will be a winner!





# Securing the future



China must secure the energy needed to power the future

Continued reliance on coal is not a sustainable alternative, since it is subject to depletion

Coal production will get problems much sooner than most think



# Summary

- Coal is a fossil fuel and subject to depletion
- The world reserves have been decreasing steadily despite increasing prices, thus disapproving the neoclassic economical myth
- Much of the worlds coal are located in a small number of countries which affect the world situation significantly

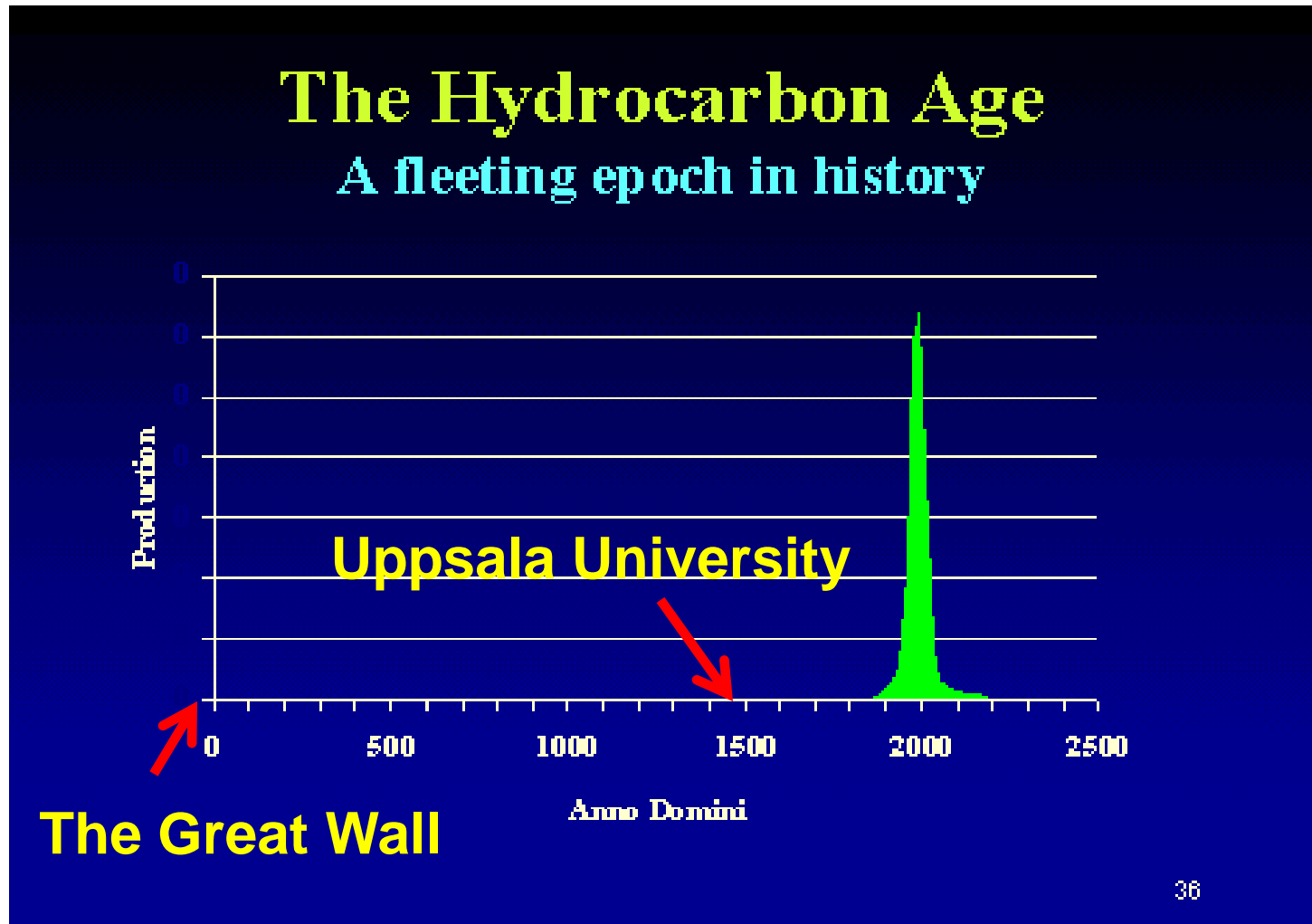


# Summary

- China is by far the worlds most important coal producer
- China will experience problems with coal supply in the near future
- USA also shows many signs of coming troubles
- The world production of coal will peak in the near/medium term future
- We do not have coal for hundreds of years!



# The Hydrocarbon Age





# Longevity

- If we want a long life we must recognize the problem in time and solve it before it grows big
- A small problem will quickly grow into a big problem if it is fed with indifference
- A society based and totally dependent on fossil fuels will not last long





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# Thanks for your attention!

