İzmir University of Economics, Balçova, İzmir

Geopolitics of Coal and Global Environment

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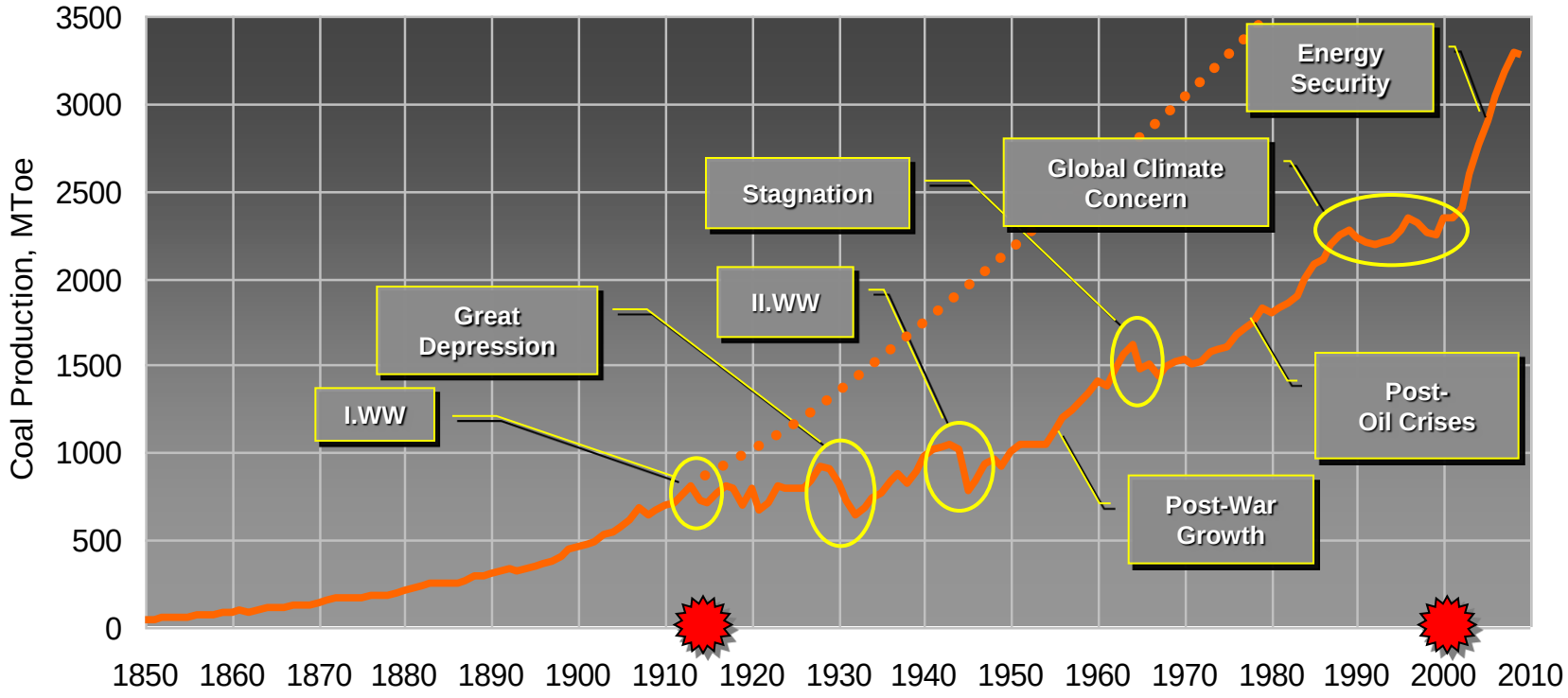
INTERNATIONAL PITTSBURGH COAL CONFERENCE
UNIVERSITY OF PITTSBURGH SWANSON SCHOOL OF ENGINEERING

27th Annual International Pittsburgh Coal Conference
Plenary Session-3; Hilton Hotel, İstanbul, 14 Oct. 2010

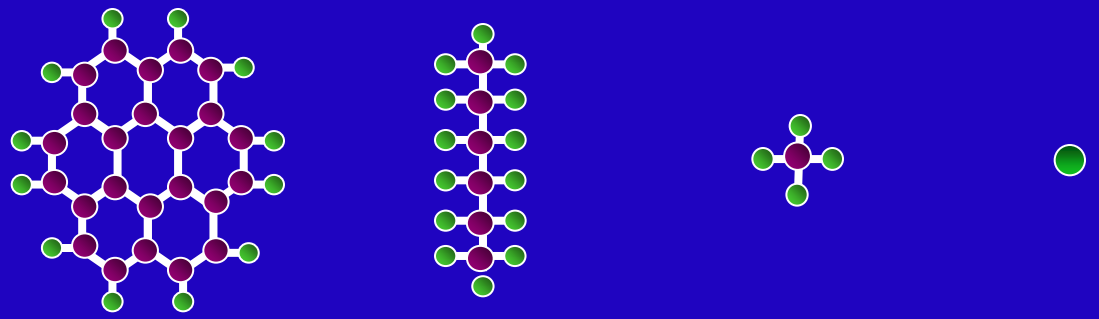
GROWING COAL USE IN THE WORLD

Secure, Abundant Domestic Reserves and Relatively Low Prices

Ming Dynasty, 1637



DECARBONIZATION
EVOLUTION OF H/C RATIO



WOOD	COAL	OIL	GAS	H
1/10=0.1	*1/1=1.0*	*2/1=2.0*	*4/1=4.0*	*100.0*

C ⇨ HC ⇨ H

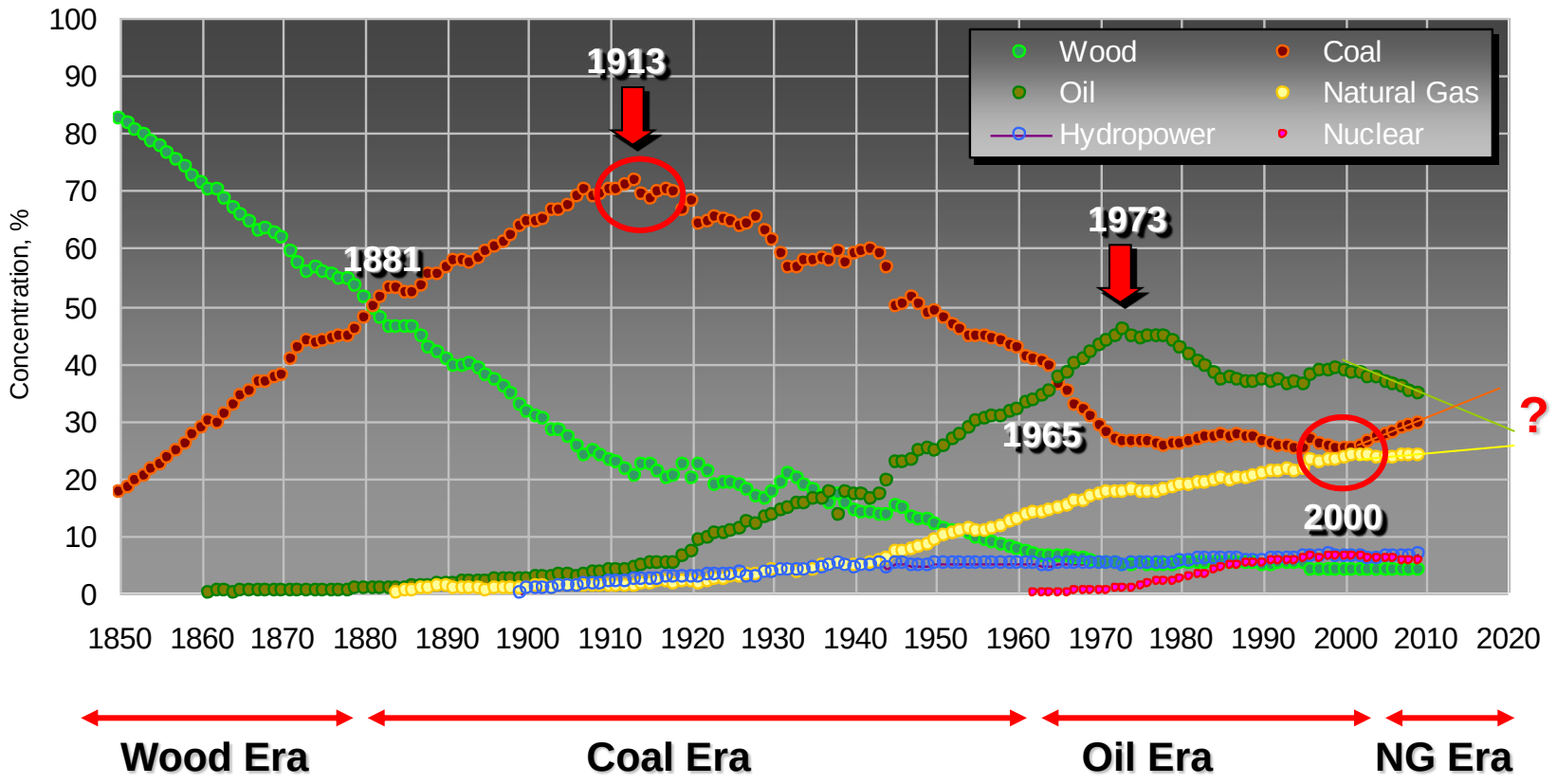
Sheikh Ahmed Zaki Yamani,
Oil Minister of Saudi Arabia in the 1970s

Yamani said in 2000:

> **"Stone Age did not come to an end because we had a lack of stones, and the oil age will not come to an end because we have a lack of oil."**

"Saudi Dove in the Oil Slick," ***The Observer,*** **January 14, 2001, 7.**

WORLD ENERGY SUBSTITUTION



THE COAL QUESTION

W. Stanley Jevons (1835-1882)

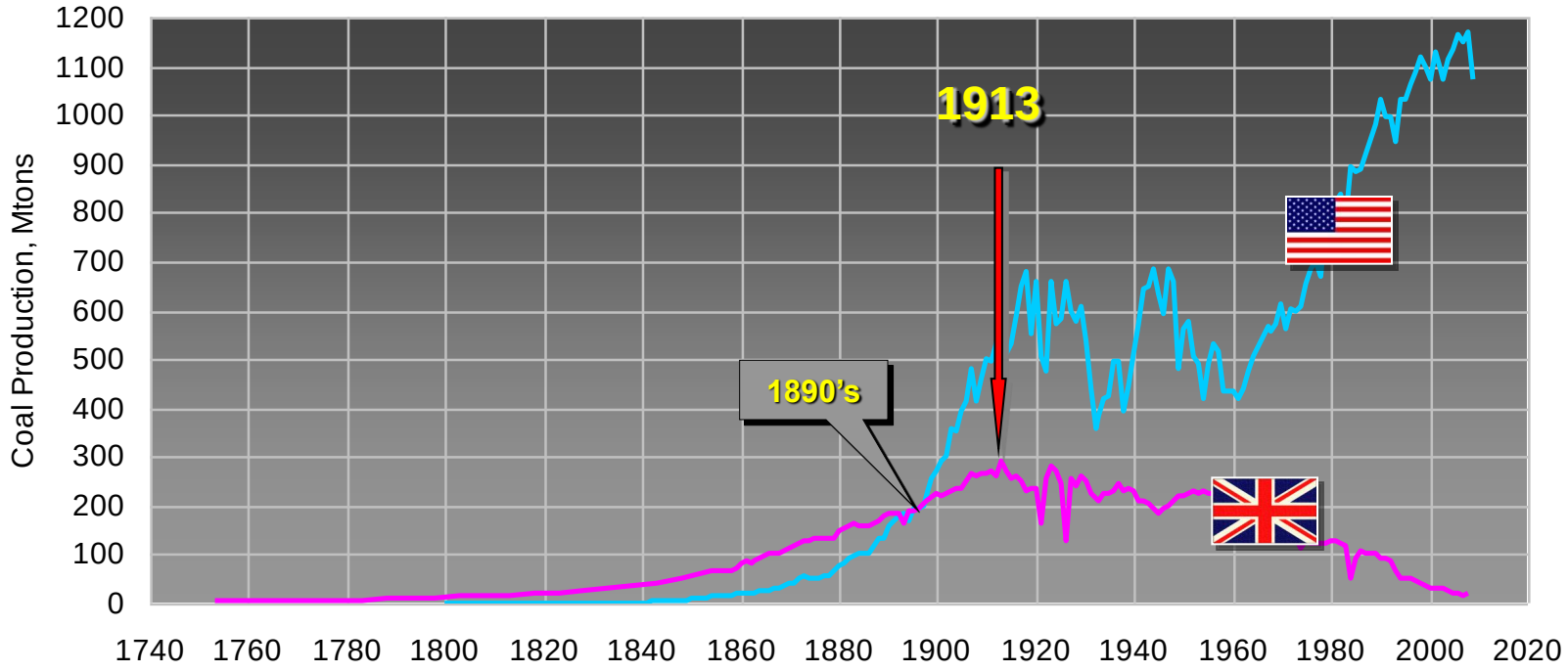
An Inquiry Concerning the Progress of the Nation, and the Probable Exhaustion of our Coal-mines

First Edition, 1865
Second Edition, Revised 1866
Third Edition, Revised 1906

W.S. Jevons

GEOPOLITICS OF COAL BETWEEN

PAX BRITANICA & PAX AMERICANA



GEOPOLITICS
German Geopolitik

Friedrich Ratzel (1844-1904); German Geographer-Ethographer

1897: *Politische Geographie;* "Lebensraum" (living space).

Johan Rudolf Kjellén (1864-1922); Swedish Political Scientist-Politician

1900: *Introduction to Swedish Geography*.
1916: *The State as a Living Form;* 5 key concepts of German geopolitik.

Sir Halford John Mackinder (1861-1947); English Geographer

1904: "The Geographical Pivot of History"; The term "Geopolitics"
1919: *Democratic Ideals and Reality;* The Heartland Theory.

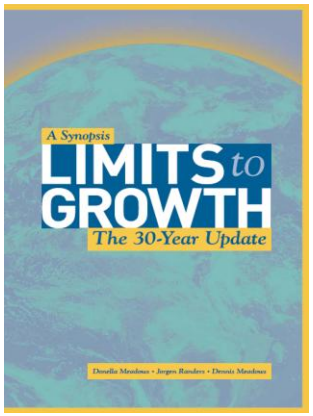
SIR WINSTON CHURCHILL'S DIVERSITY

1911-1916: First Lord of Admiralty

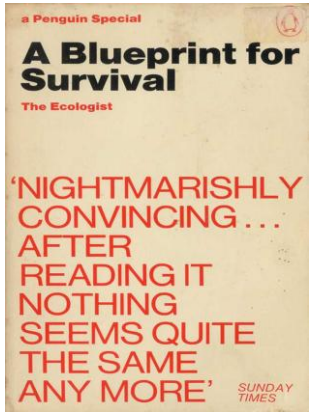
British Parliament; 17 July 1913:

"On no one quality, on no one process, on no one country, on no one route and on no one field must we be dependent. Safety and certainty in oil lie in variety and variety alone."

LIMITS TO GROWTH (1972)



It was among the first ones which pointed to the finite nature of fossil fuel: “If the rate of resource use is increasing, the amount of reserves cannot be calculated by simply taking the current known reserves and dividing by the current yearly usage, as is typically done to obtain a static index (exponential growth).”



The word “sustainability” was first used in this book: “If current trends are allowed to persist, the breakdown of society and the irreversible disruption of the life-support systems on this planet, possibly by the end of the century, certainly within the lifetimes of our children, are inevitable.”

SUSTAINABLE DEVELOPMENT

G. Bruntland, Ed., 1987, *Our Common Future*, WCED (The World Commission on Environment and Development)

Mrs Gro Harlem Bruntland
Prime Minister of Norway

Item 27:

Humanity has the ability to make development sustainable to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs.

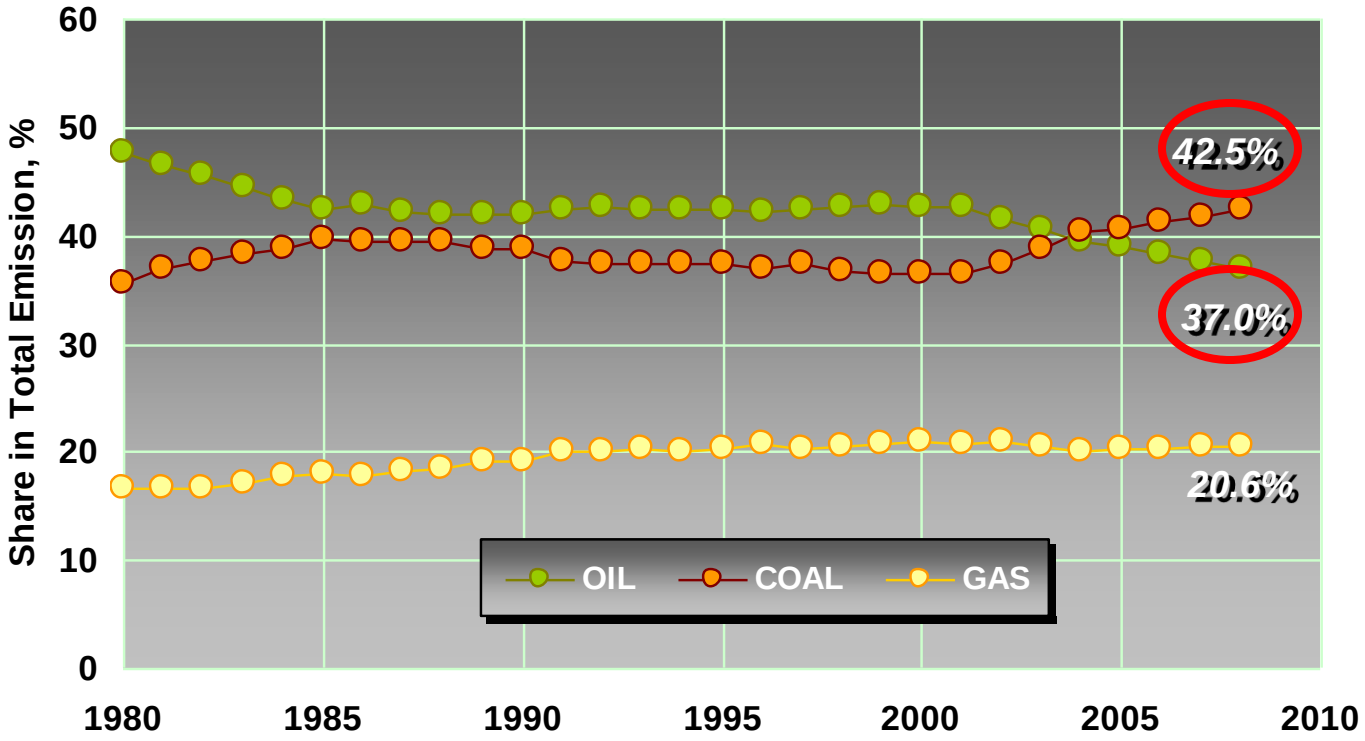
"We have not inherited the world from our fathers
-- we have borrowed it from our children"

UNFCCC
United Nations Framework Convention on Climate Change
21 March 1994

KYOTO PROTOCOL
Int. Agreement Linked to the UNFCCC
16 February 2005

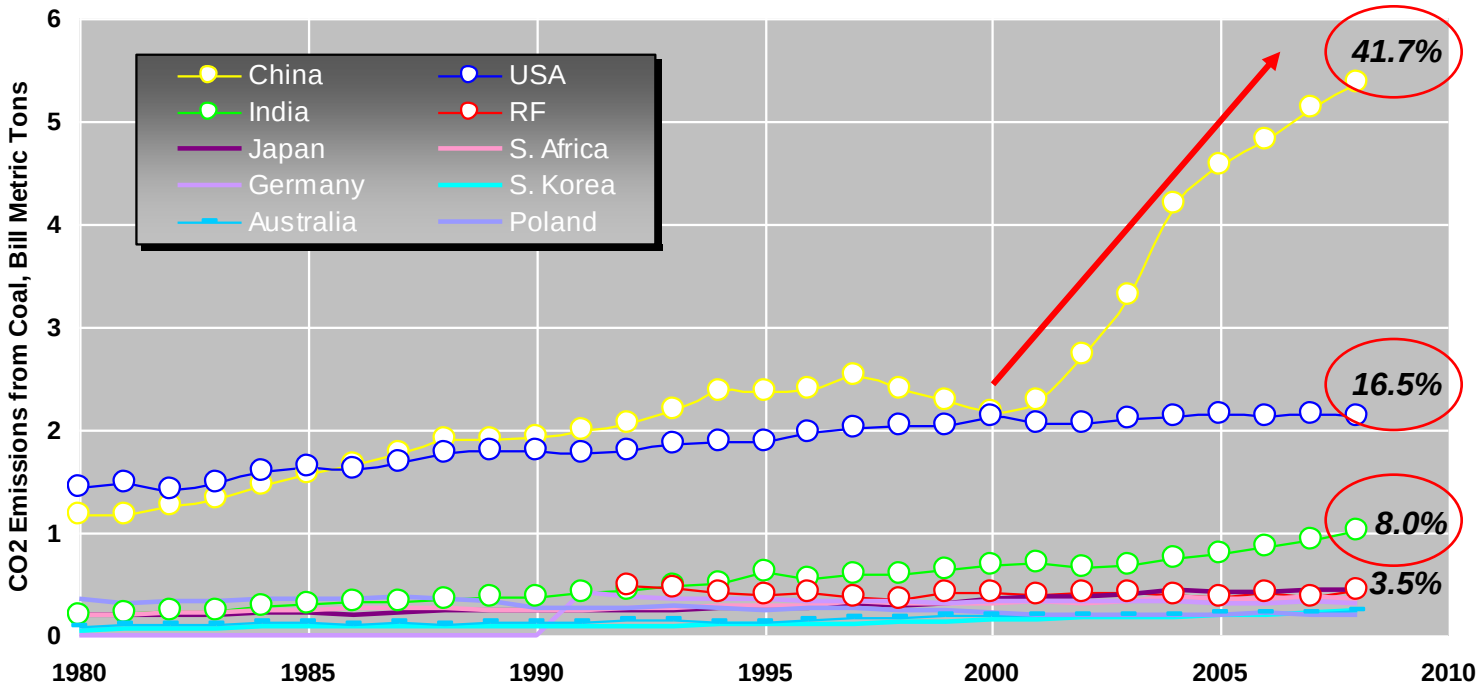
While the Convention encouraged industrialized countries to stabilize GHG emissions, the Protocol commits them to do so.
(GHG Emissions Reduction of -5%)

EMISSIONS FROM THE CONSUMPTION OF FOSSIL FUELS

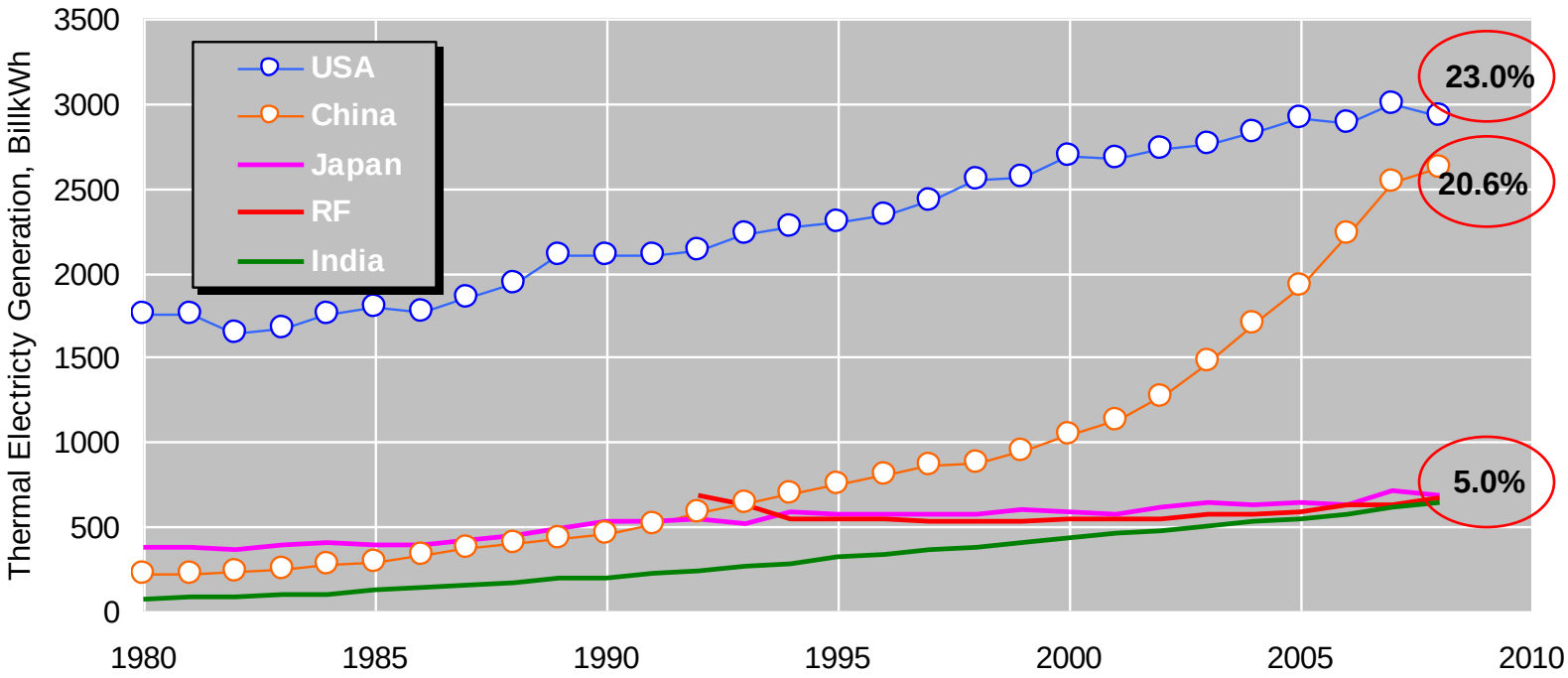


Data from US DOE IEA

EMISSIONS FROM THE COAL CONSUMPTION

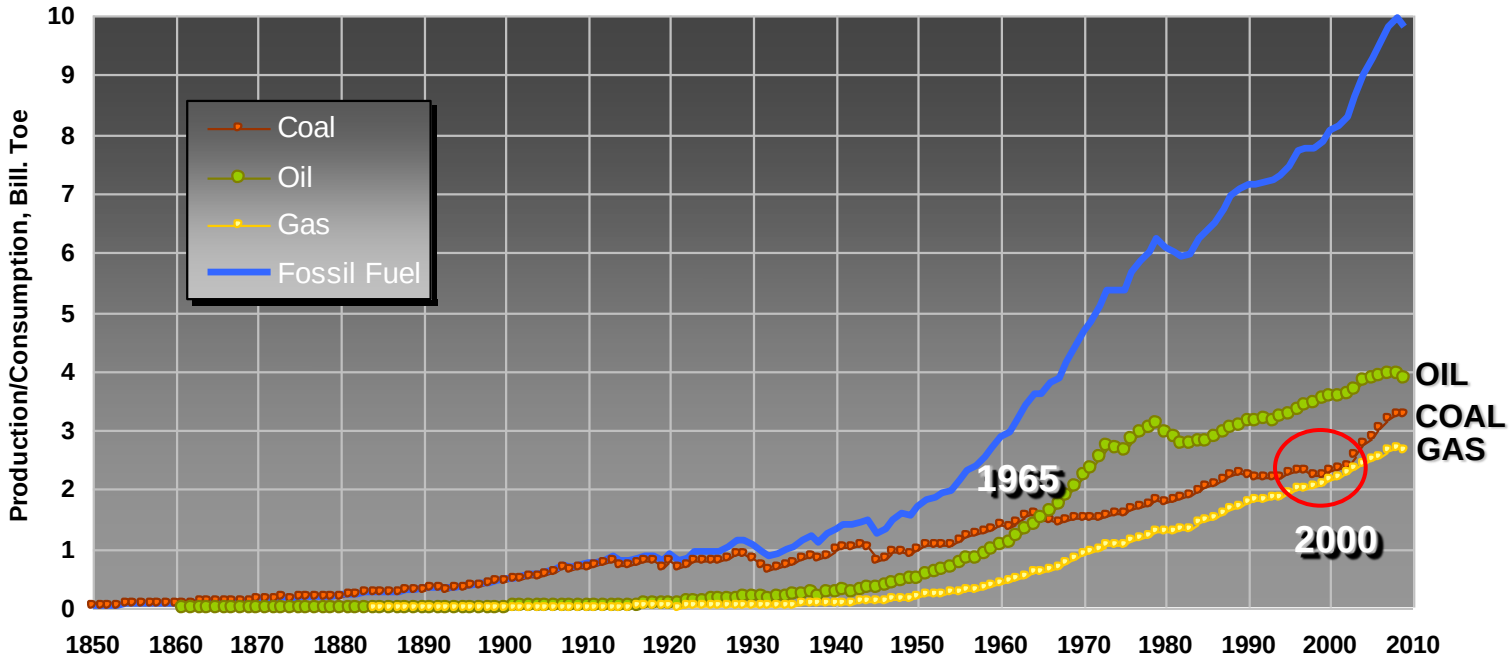


WORLD THERMAL ELECTRICITY NET GENERATION



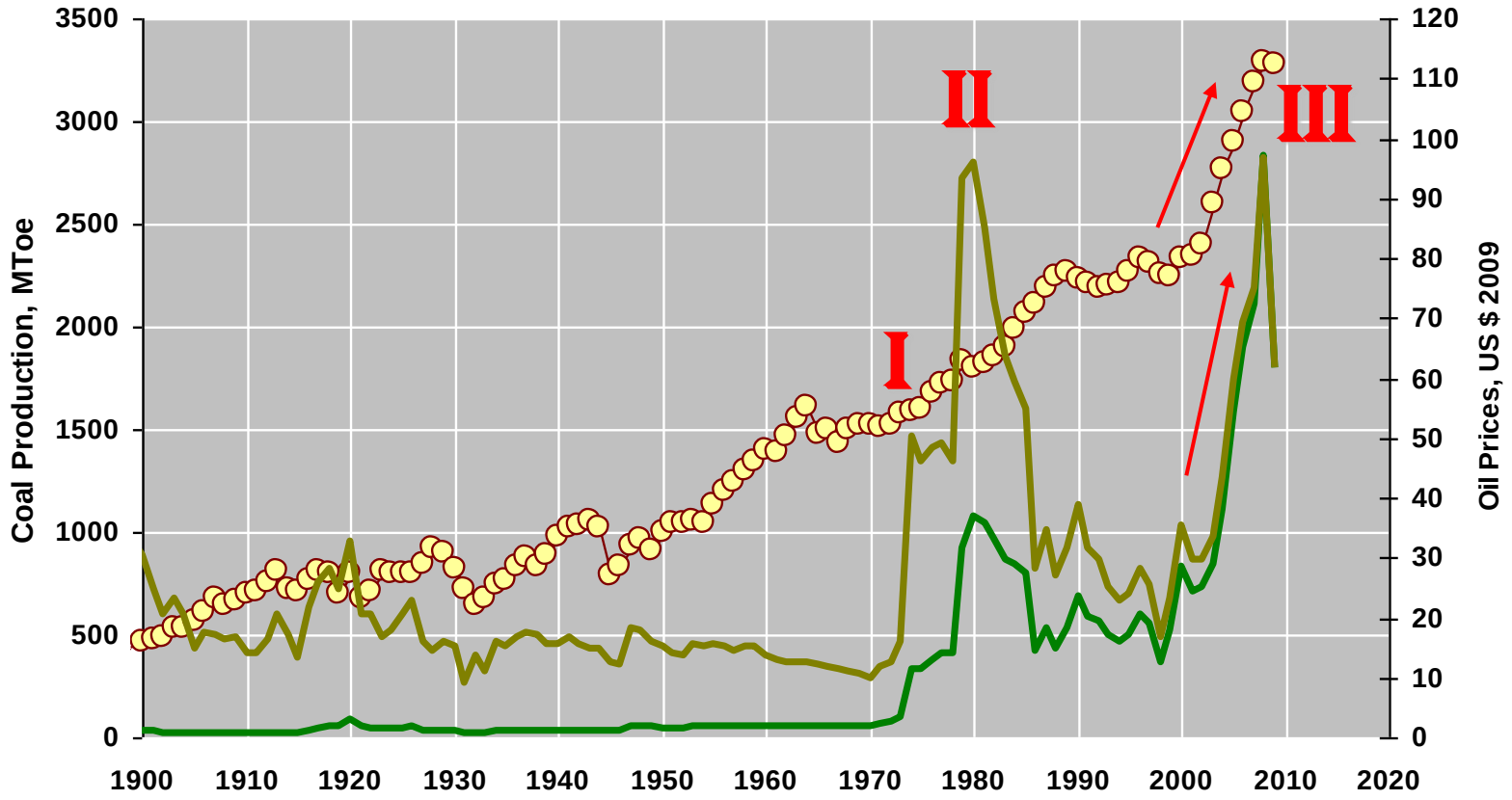
World Total Electricity Generation: 18,778.67 Bill. Kwh
World Thermal Electricity Generation: 12,739.98 Bill. kWh
World: 67.8%, USA: 71.1%, China: 81.2%

WORLD FOSSIL FUEL PRODUCTION

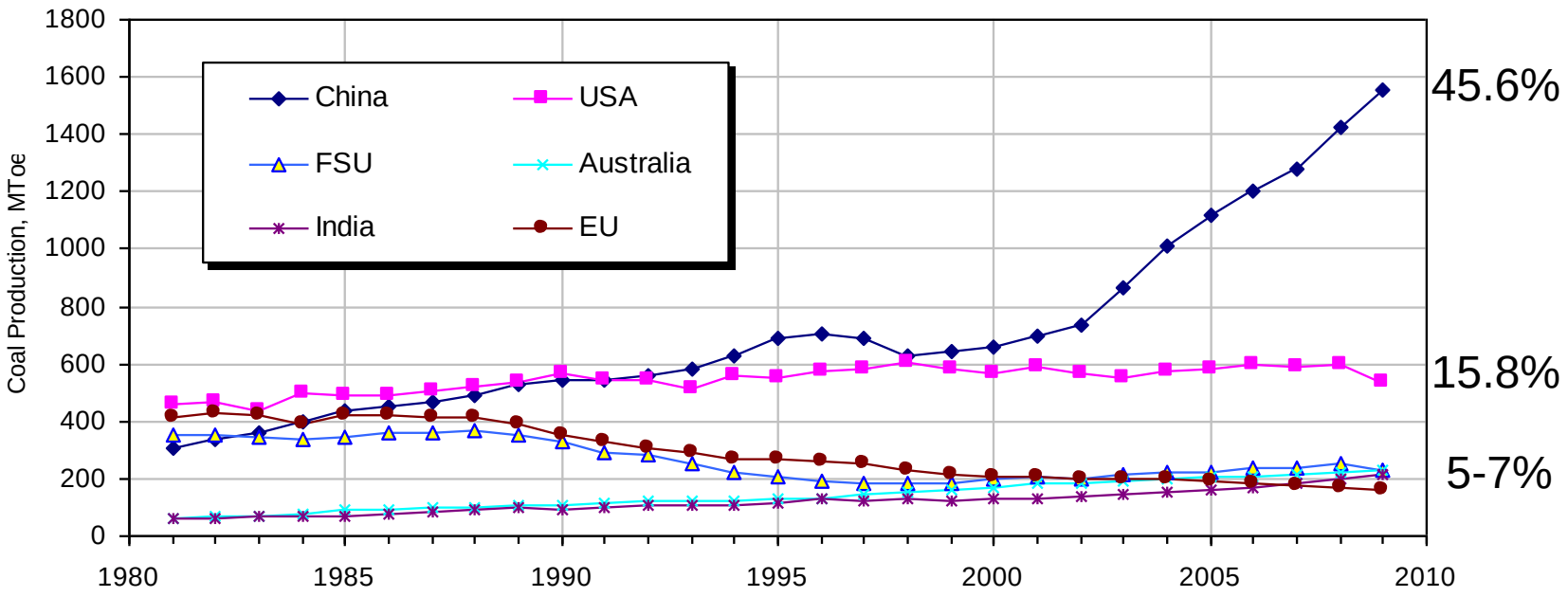


Data from Grübler (2003) and BP (2010)

COAL CONSUMPTION AND OIL PRICES



COAL PRODUCTION



BIGGEST TEN IN COAL, 2009

	Reserve, %		Production, %		Consumption, %	
1	USA	28.9	China	45.6	China	46.9
2	RF	19.0	USA	15.8	USA	15.2
3	China	13.9	Australia (C: 1.6)	6.7	EU	8.0
4	Australia	9.2	India	6.2	India	7.5
5	India	7.1	EU	4.6	Japan (R: ?, C: ?)	3.3
6	Ukraine (P: 1.1, C: 1.1)	4.1	Indonesia (R:0.5, C: 0.9)	4.6	S. Africa	3.0
7	Kazakhstan (C:1.0)	3.8	S. Africa	4.1	RF	2.5
8	S. Africa	3.7	RF	4.1	Germany (R: 0.8, P: 1.3)	2.2
9	EU	3.6	Poland	1.7	S. Korea (R: ?, P: ?)	2.1
10	Poland	0.9	Kazakhstan (C: 1.0)	1.5	Poland	1.6
	%	94.2	%	94.9	%	92.1

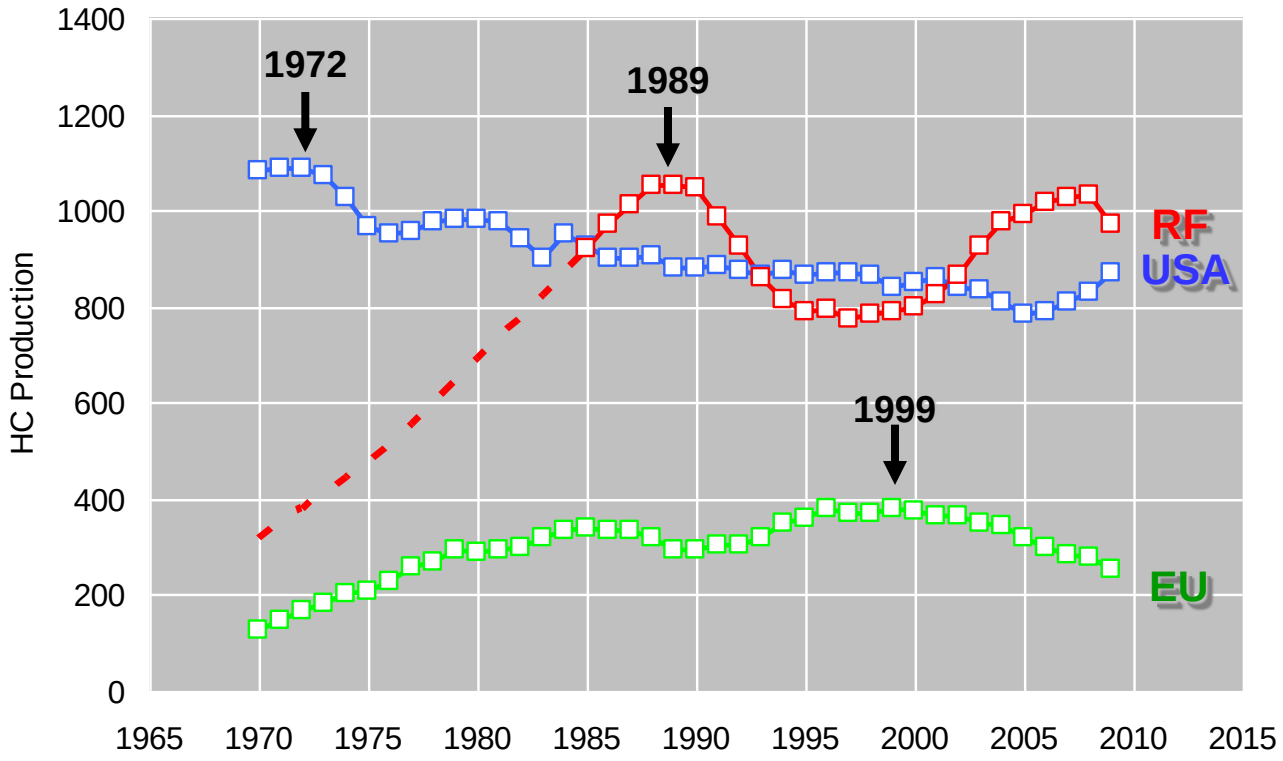
BIGGEST TEN IN OIL, 2009

	Reserve, %		Production, %		Consumption, %	
1	Saudi Arabia	19.8	RF	12.9	USA	21.7
2	Venezuela (C: 0.7)	12.9	Saudi Arabia	12.0	EU (R:0.5, P: 2.6)	17.3
3	Iran (C: 2.2)	10.3	USA (R:2.1)	8.5	China	10.4
4	Iraq (C: ?)	8.6	Iran	5.3	Japan (R: ?, P:?)	5.1
5	Kuwait (P: 3.2, C: 0.5)	7.6	China (R: 1.1)	4.9	India (R:0.4, P: 0.9)	3.8
6	United Arab Emirates (C:0.6)	7.3	Canada (R:2.5)	4.1	RF	3.2
7	RF	5.6	Mexico (R:0.9, C:2.2)	3.9	Saudi Arabia	3.1
8	Libya (P: 2.0, C: ?)	3.3	Venezuela (C: 0.7)	3.3	Germany (R: ?, P:?)	2.9
9	Kazakhstan (P: 2.0, C: 0.3)	3.0	United Arab Emirates	3.2	Brazil (R:1.0, P: 2.6)	2.7
10	Nigeria (P: 2.6, C: ?)	2.8	Iraq	3.2	South Korea (R:?, P:?)	2.7
	%	**75,6**	**%**	**61,3**	**%**	**73**

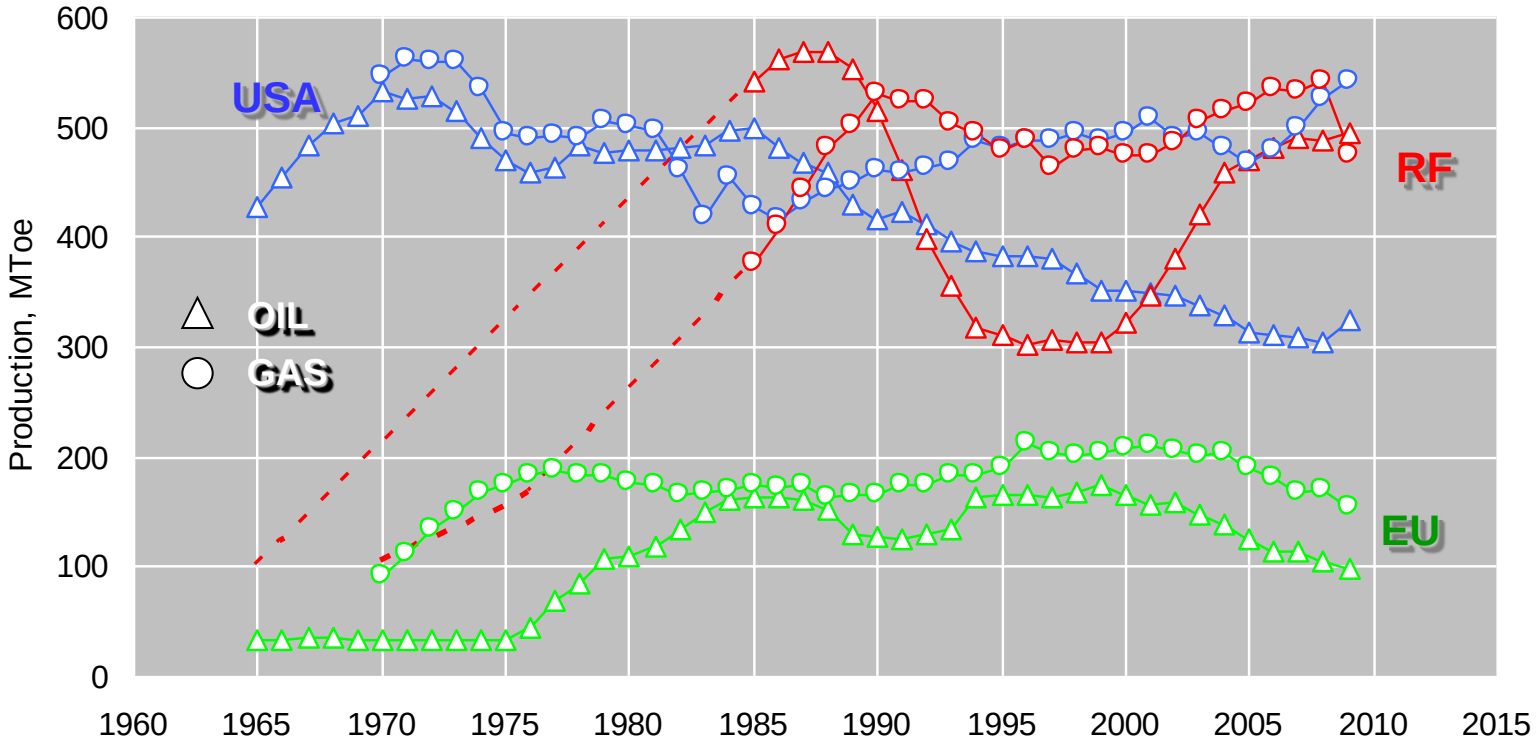
BIGGEST TEN IN GAS, 2009

	Reserve, %		Production, %		Consumption, %	
1	RF	23.7	USA	20.1	USA	22.2
2	Iran	15.8	RF	17.6	EU	15.6
3	Qatar (C:0.7)	13.5	EU (R:0.5)	5.7	RF	13.2
4	Turkmenistan (P:1.2, C: 0.7)	4.3	Canada (R:0.9)	5.4	Iran	4.5
5	Saudi Arabia	4.2	Iran	4.4	Canada	3.2
6	USA	3.7	Norway (R: 1.1, C:0.1)	3.5	China	3.0
7	UAE (P:1.6, C: 2.0)	3.4	Qatar	3.0	Japan (R: ?, P:?)	3.0
8	Venezuela (P: 0.9, C: 1.0)	3.0	China (R:1.3)	2.8	UK (R:0.2, P:2.0)	2.9
9	Nigeria (P:0.8, C:?)	2.8	Algeria	2.7	Germany (R:?, P:0.4)	2.6
10	Algeria (C: 0.9)	2.4	Saudi Arabia	2.6	Saudi arabia	2.6
	%	**76.8**	**%**	**67.8**	**%**	**72.8**

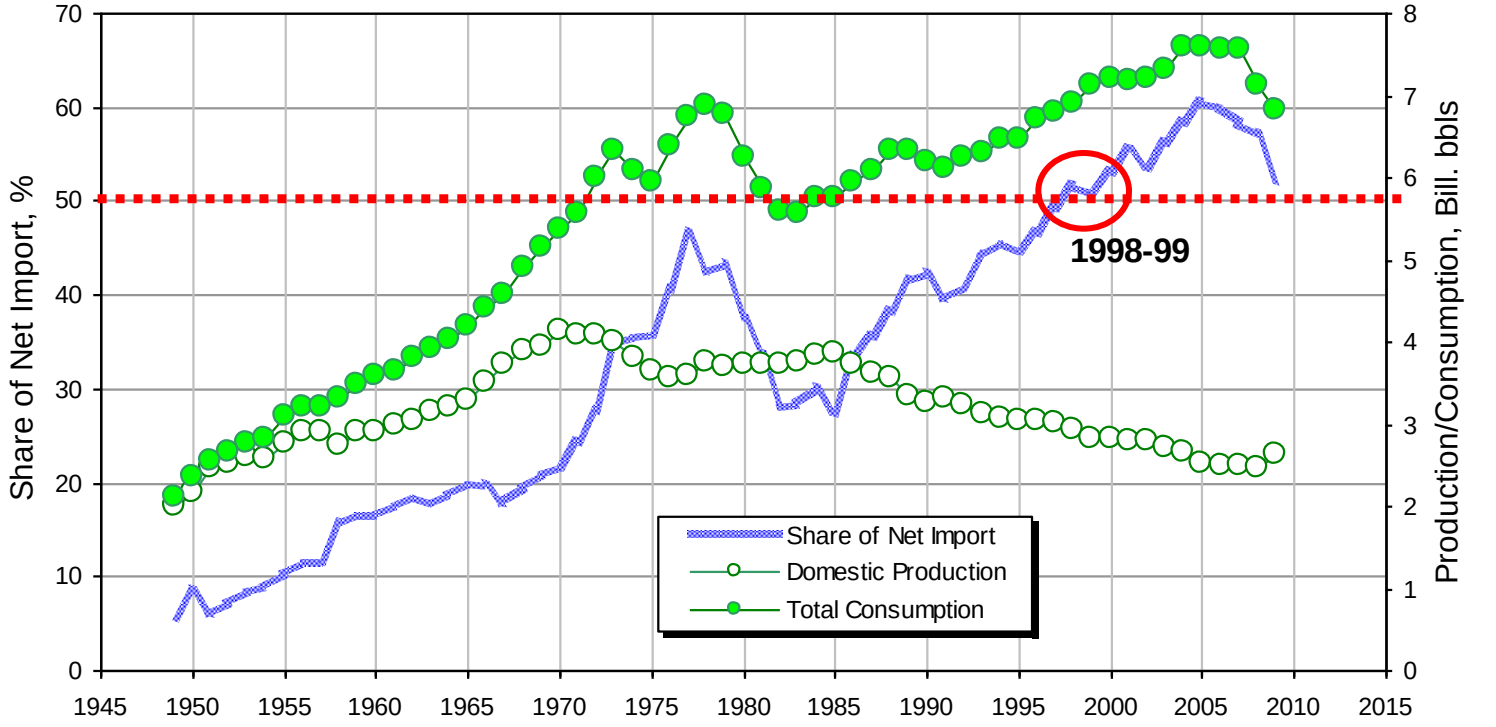
HYDROCARBON PRODUCTION



STRUGGLE OVER OIL AND GAS



USA'S OIL DEPENDENCY AND ENERGY SECURITY



European Union, 2009 (In 2030, 70% in Gas, 90% in Oil, 100% in Coal):

"to guarantee uninterrupted supplies of traditional energy sources while working to mitigate their environmental impact and investing in infrastructure that can help secure the supply of fossil fuels and exploit existing renewable technologies."

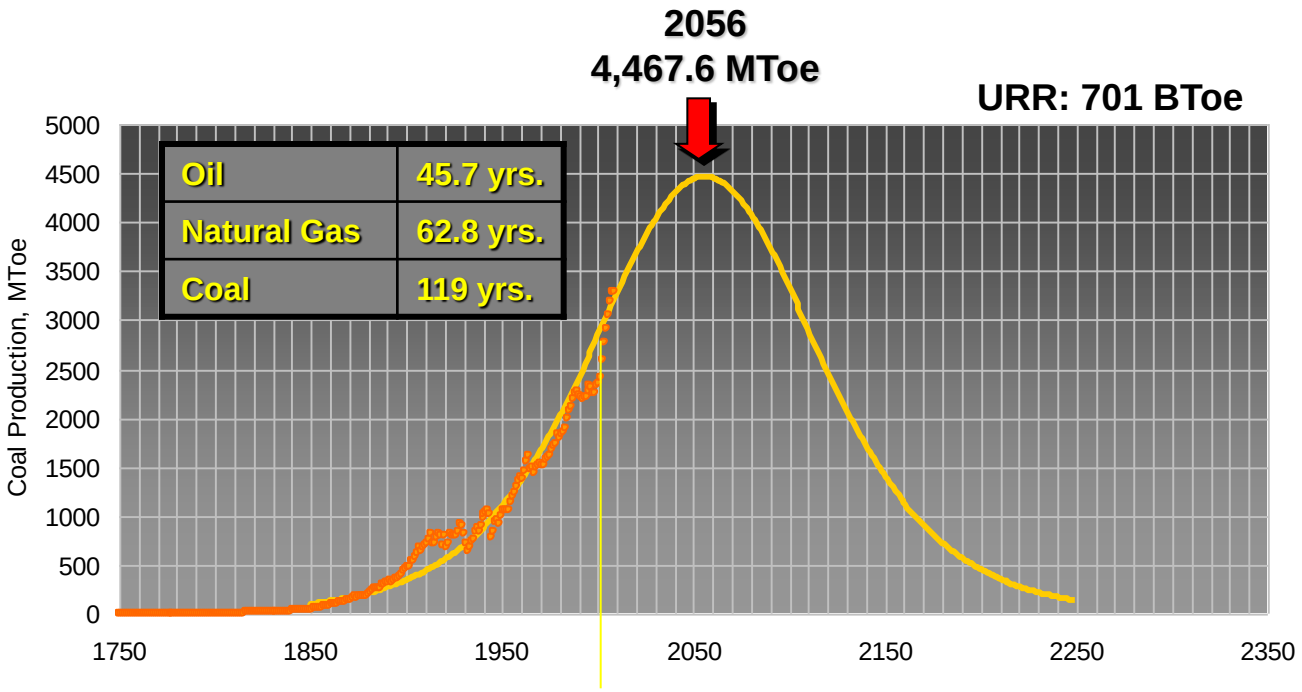
FOSSIL FUEL RESERVE BILLLIONAIRES

Btoe	Coal	Gas	Oil	FF	%	% Coal in FF
USA 	115.8	6.1	3.4	125.3	16.4	92.4
RF 	68.7	39.2	10.2	118.0	15.5	58.2
China 	58.9	2.2	2.0	63.1	8.3	93.4
Iran 	-	26.1	18.9	45.0	5.9	-
S. Arabia 	-	7.0	36.3	43.3	5.7	-
Venezuela 	0.3	5.0	24.8	30.2	4.0	1.1
Qatar 	-	22.4	2.8	25.2	3.3	-
UAE 	-	5.7	13.0	18.7	2.4	-
EU 	12.7	2.1	0.8	15.6	2.1	81.0
Total	256.3	115.8	112.3	484.5	63.5	52.9
World Total	412.4	168.7	181.7	762.8	100.0	54.1

$$Q_t = \frac{Q_{\max}}{1 + a \times e^{bt}}$$

HUBBERT CURVE OF COAL

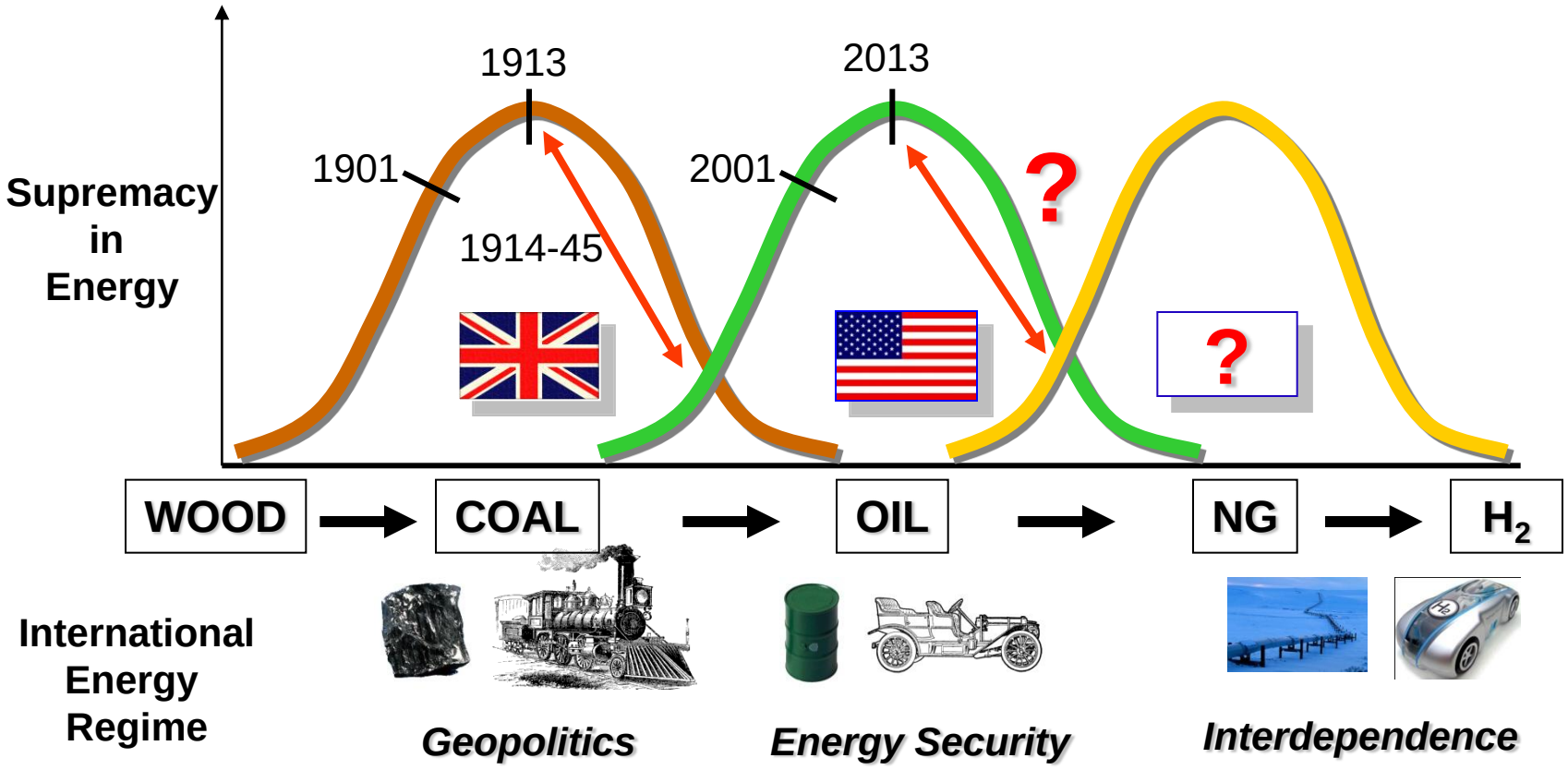
$$t_{\max} = \left(\frac{1}{b}\right) \times \ln\left(\frac{1}{a}\right)$$

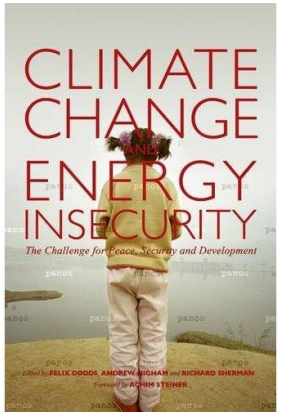


Liu Lin (2010)	China	~2025
Evans Mohr (2009)	World	2026/2034
Aleklett Höök (2009)	USA	2030
Total Shafiee (2010)	World	2042
Croft Patzek (2010)	World	2047

"UNPRECENTED UNCERTAINTY"

Our energy future has never been so uncertain





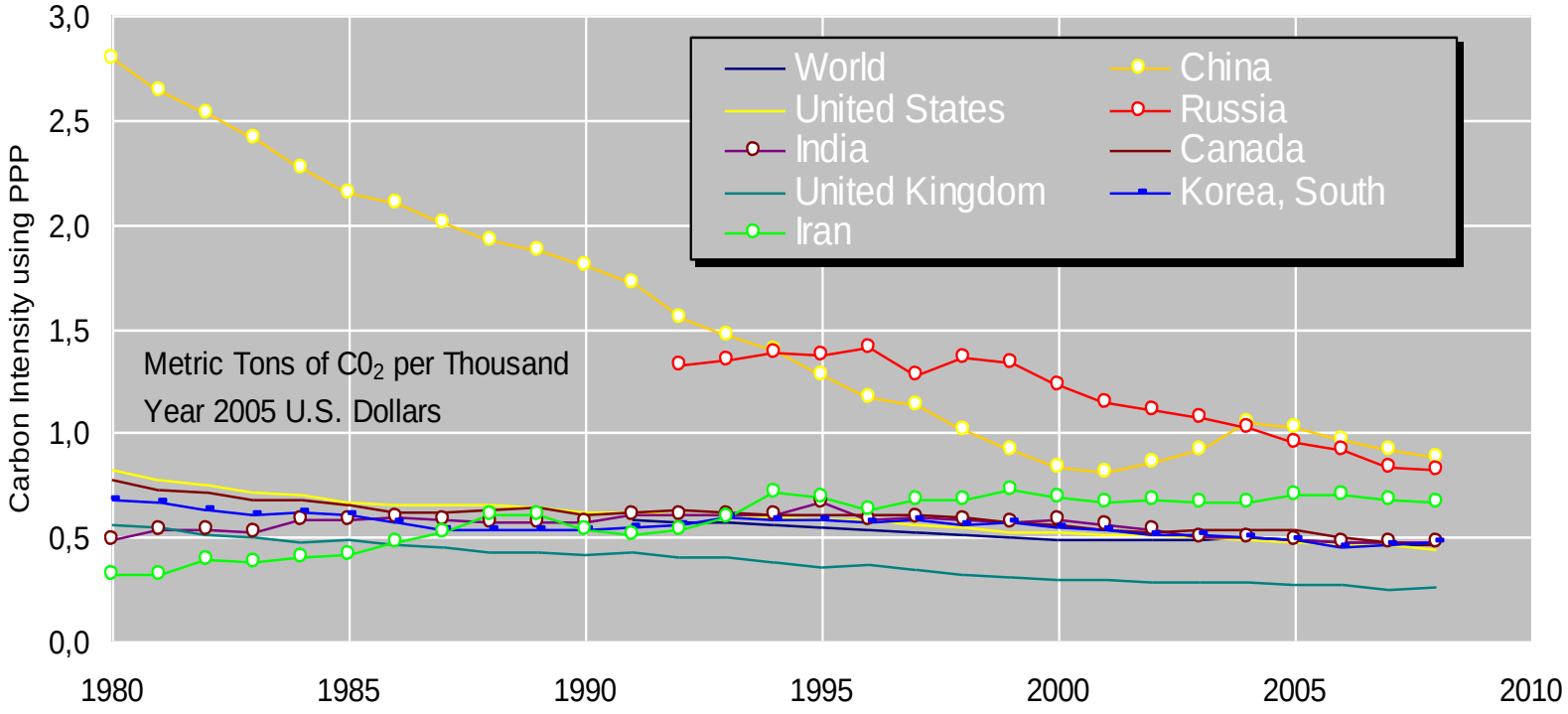
Climate Change and Energy Insecurity: The Challenge for Peace, Security and Development

Felix Dodds, Andrew Higham and Richard Sherman, Eds., October 2009

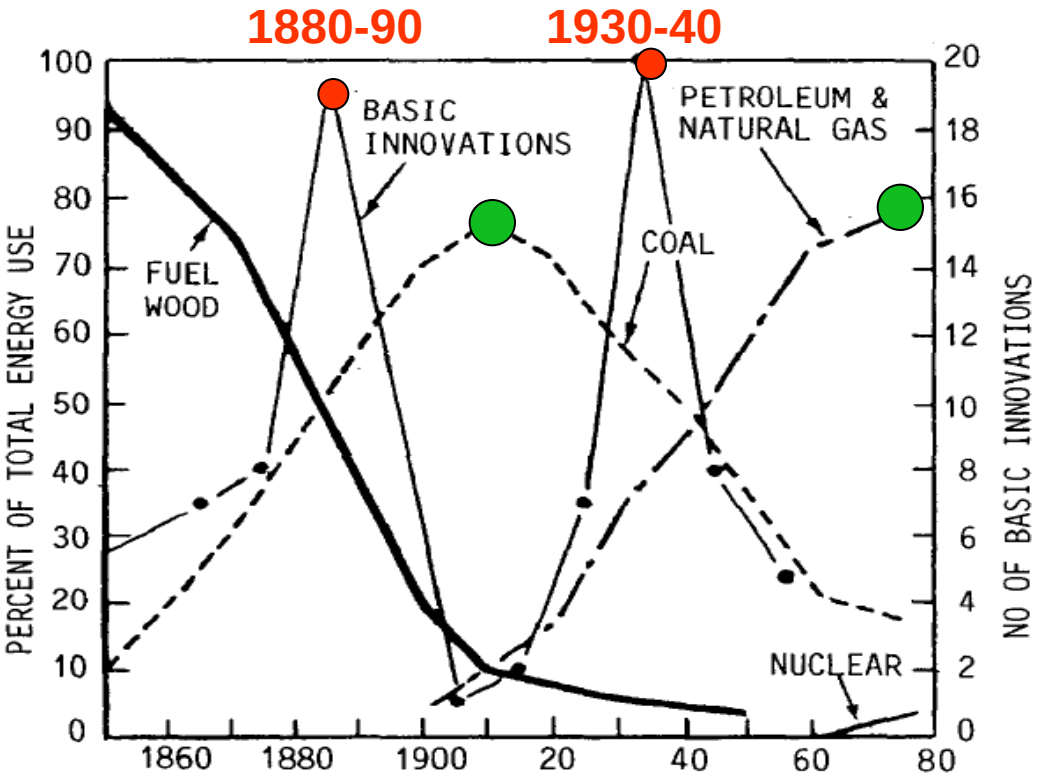
"We must treat climate as a security issue, the most important threat to global security we will ever face. Energy is at the heart of this transition. <u>Climate security and energy security are two sides of the same coin: one cannot be achieved without the other…</u>"

Maurice Strong
Secretary General of the Rio and Stockholm UN

CARBON INTENSITY

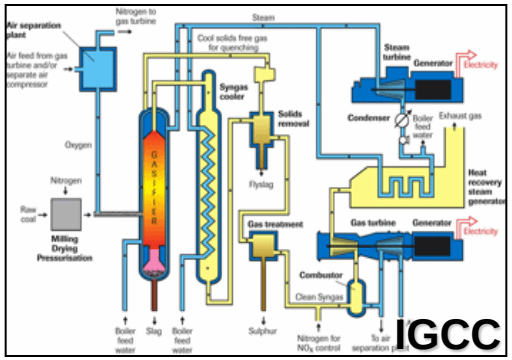


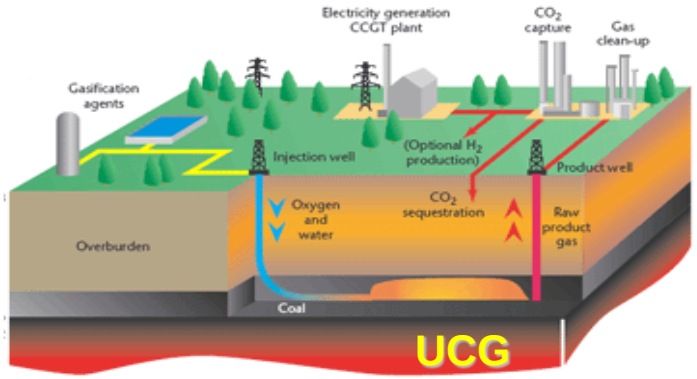
LONG WAVES IN DOMINANT ENERGY SOURCE AND BASIC INNOVATIONS

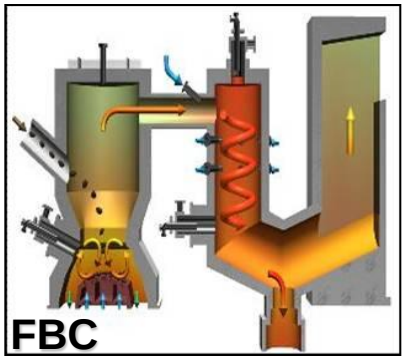


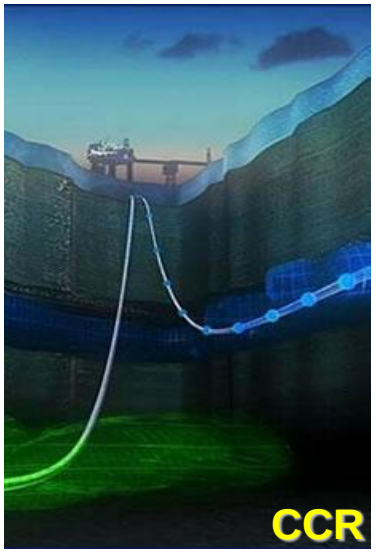
A.K. Graham and P.M. Senge, 1980

CLEAN COAL TECHNOLOGIES

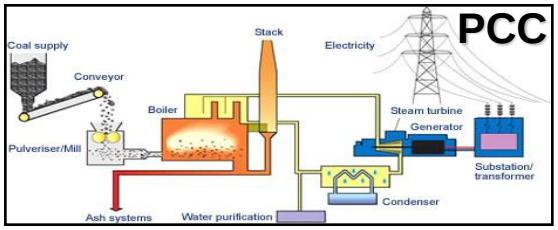


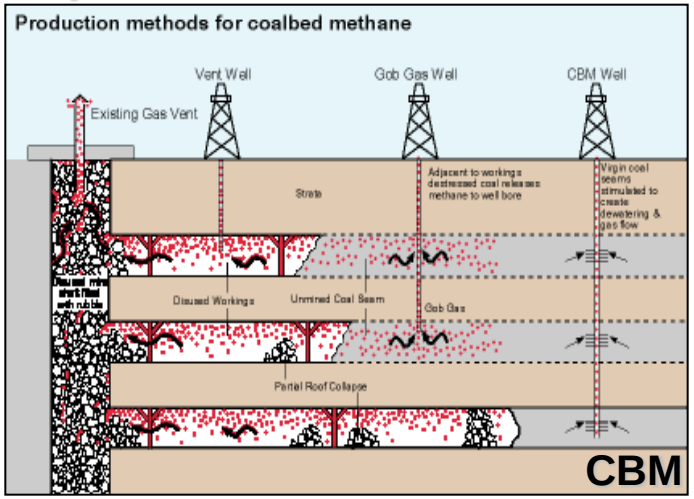


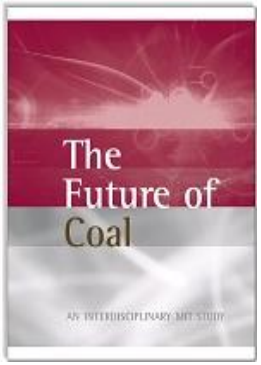




Integrated Gasification Combined Cycle
Underground Coal Gasification
Pulverized Coal Combustion
Fluidized Bed Combustion
Carbon Capture & Storage
Coal Bed Methane



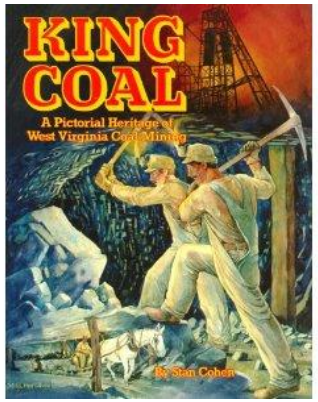




The Future of Coal
An Interdisciplinary MIT Study, 2007

- Options for a carbon constrained world
- This MIT study believes that coal use will increase under any foreseeable scenario because it is cheap and abundant.
- We conclude that CO_2 capture and sequestration (CCS) is the critical enabling technology that would reduce CO_2 emissions significantly while also allowing coal to meet the world's pressing energy needs.

KING COAL IS BACK?



INTERNATIONAL COOPERATION

ON NEW CLEAN COAL TECHNOLOGIES

FOR AN INTERDEPENDENT SUSTAINABLE FUTURE