
The Future of Coal in a Low Carbon World

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Outline of Presentation

- The recent coal boom
- Types of coal (coking, thermal, brown/lignite)
- The case for coal
- CCS
- World Coal Association proposals
- CHP and co-firing with biomass
- Coal prices (and oil & gas prices)
- Have we reached peak coal?
- Share prices & bankruptcies
- Divestment and responses by fossil fuel companies

Coal was the fastest growing fuel

Growth 2003-2013

● Coal	51%
● Natural Gas	29%
● Oil	12%
● Nuclear	-6%
● Hydro	43%
● Other Renewables	317%
● Biofuels	345%

Source: BP Statistical Review

Coal cannot be dismissed easily

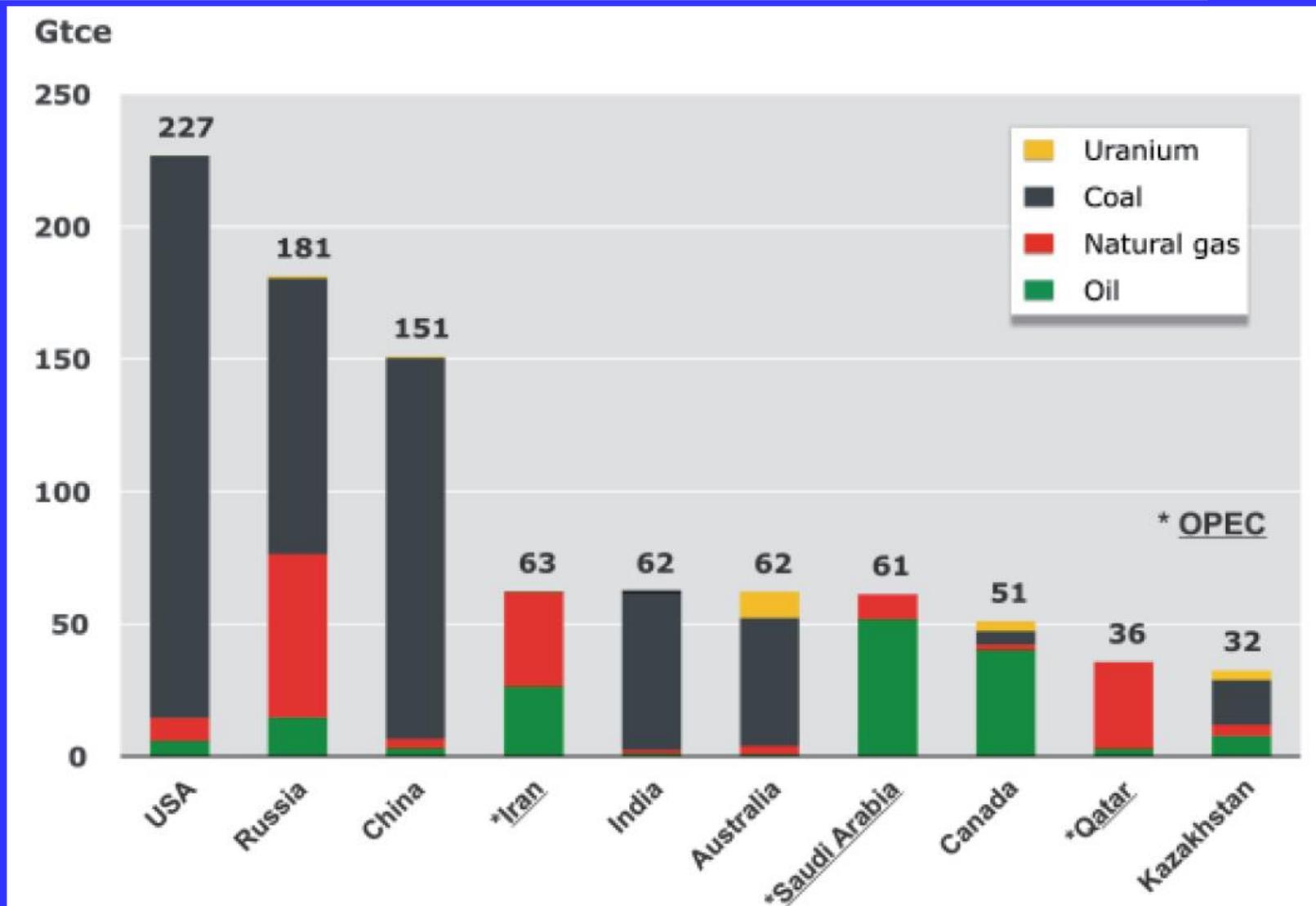
- Coal's share of world primary energy production/consumption remained static at around 24% since 1980, but increased to 30% in 2013, its largest share since 1970
- Coal has provided ~40% of the world's **electricity** for the last 40 years; gas has only recently exceeded 20% and all of the other sources (oil, nuclear & renewables) are smaller
- Coal is an essential raw material in the production of 70% of the world's **steel** and 90% of the world's **cement**.

The Case for Coal

- Coal reserves are plentiful
- Coal is low cost:
electricity from coal is cheaper than gas in India
and everywhere further East
- No substitute for coal for making new steel
- Coal prices are independent of oil & gas prices
- Coal can be clean and efficient
- Carbon capture & storage (CCS)
is technically proven
- IEA and CCC include coal with CCS in projections
of the best way of limiting global CO₂ emissions

Top 10 energy reserves countries

Source: Paul Baruya, IEA Clean Coal Centre, from BGR, 2009



Reserves at the end of 2014 (2007)

		<u>Reserves</u>	<u>R/P ratio (years)</u>
Hard coal	Gt	403	56
Other coal	Gt	488	603
All coal	Gtoe	432	110
Oil	Gt	240	52
Gas	Gtoe	165	54

The R/P ratio in China for coal is 30 years

(Source: BP Statistical Review of World Energy)

Coal deposits are widespread

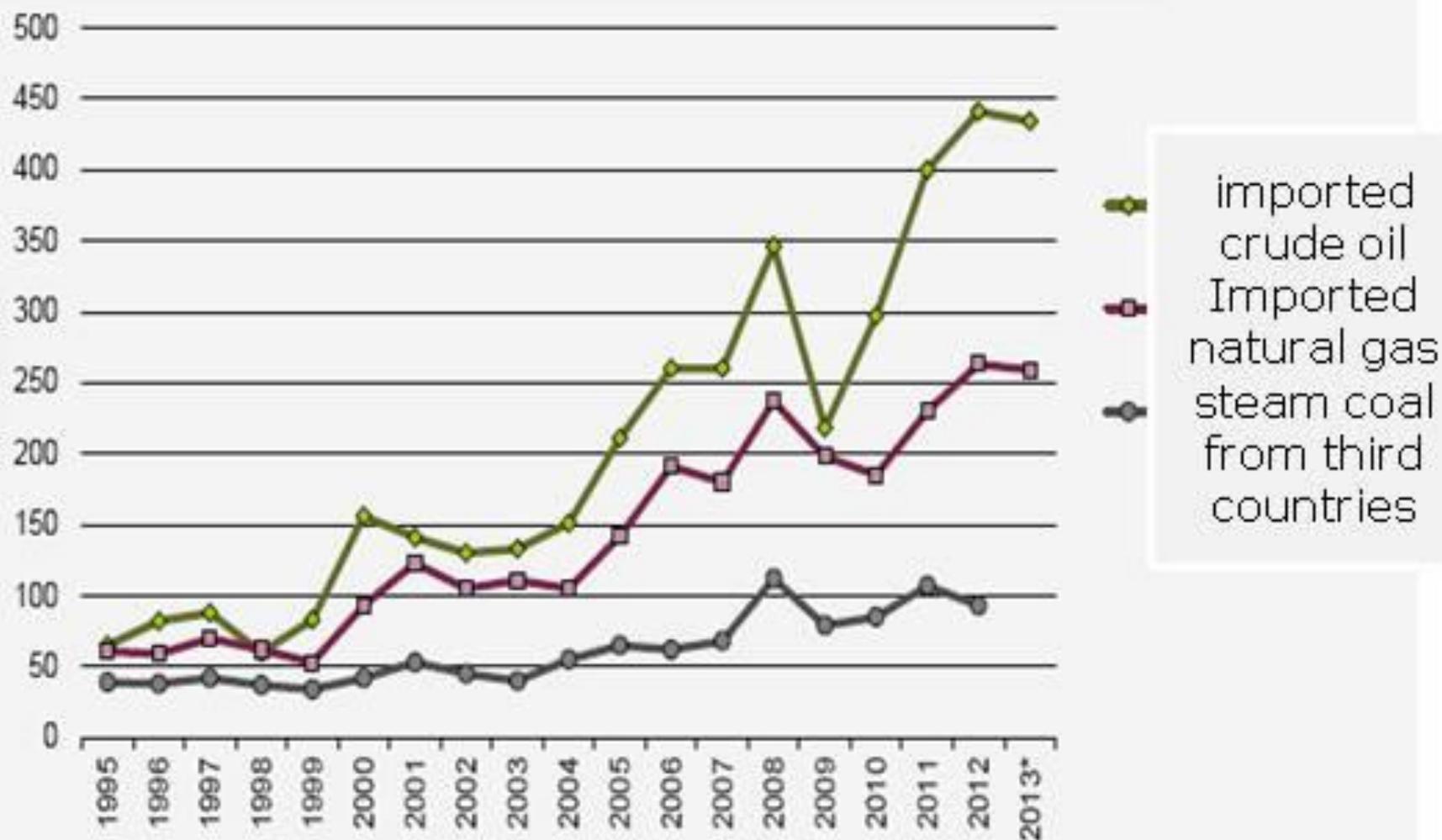


Free competition

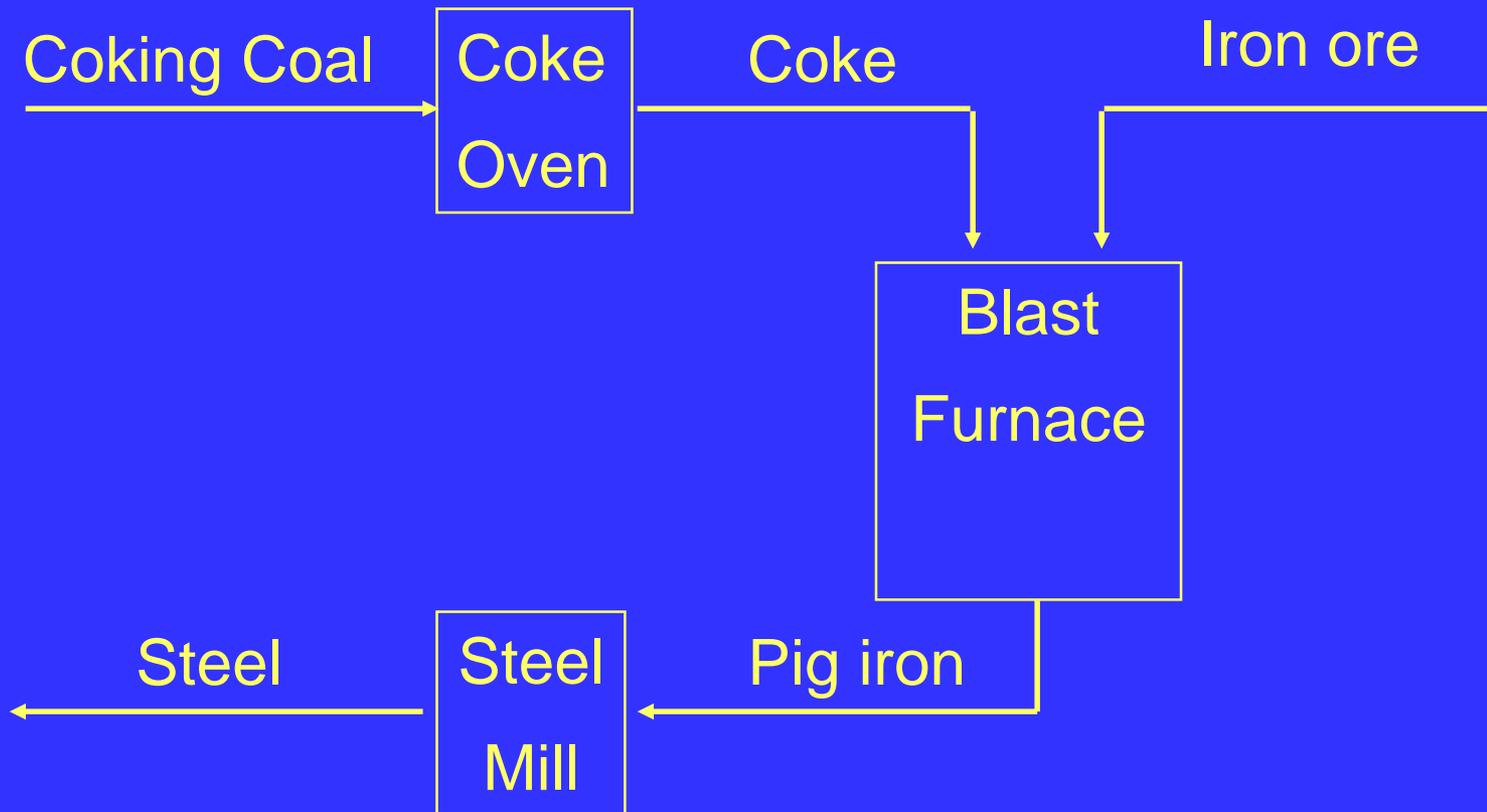
- There is a sufficient number of countries or companies to prevent anyone from being able to dominate the international market
- The major coal exporting countries have 'anti-trust' laws that prevent collusion on prices

Development of selected energy prices

Annual averages in €/TCE



Steel making



Types of Hard Coal

- **Coking coal** (often called met coal), used to make coke which is an essential input for blast furnaces for steel making. There is no effective substitute for coking coal.
- **Steam coal** (also called thermal coal), mainly used in power stations, some goes to cement plants and other large industrial plants. Substitutes for steam coal are oil, gas, nuclear and renewables.

Some mines produce both coking coal and steam coal

- **Brown Coal** (also called lignite) has a low calorific value (CV: energy per unit of mass) and is therefore uneconomic to transport long distances; it is mainly used in power stations near the mine. There is a very little international trade.

In practise there is no clear cut-off between steam coal and brown coal: there is a continuous range of CVs.

World Coal Production & Trade (2014)

(Mt)		<u>Production</u>	<u>Trade</u>	<u>%</u>
Coking Coal		1065	322	30%
Steam Coal		6147	1054	17%
Brown Coal		810	8	1%
All Coal	Mtoe	3943	853	22%
Oil	Mt	4221	2788*	66%
Gas	Mtoe	3127	897	29%
	(of which LNG (liquefied natural gas)		300	10%)
(*incl oil products)	(Source: IEA and BP Statistical Review of World Energy)			

World Coal Consumption

(2013)

Electricity & heat plants 64%

Steel industry 14%

Other industry etc (incl cement) 20%

Residential 2%
(93 Mt in China)

Carbon Capture & Storage (CCS)

- 15 large-scale projects operating capturing 27 Mt CO₂/a
- 7 more expected online by 2018
- 115MW Boundary Dam, Saskatchewan first on existing coal-fired power station, online Oct'14
- Operators think they could reduce costs of future plants by 30%
- 2 more coal CCS expected online in 2016 in USA

CCS costs

- CCS for gas-fired power stations is more expensive than for coal-fired power stations
- Comparing the cost of CCS with renewables must take account of the intermittency of renewables
- IEA estimates revenue streams from coal & gas plants with CCS will be \$1.3 trillion each to 2040, but investment in CCS needed now to secure these

CCS applicability

- CCS cannot be used for most emissions from oil as they are from vehicles
- CCS is the only technology that will allow new steel production
- Geologists are convinced safe storage sites are available worldwide
- Transport & storage could be a regulated monopoly, leaving capture to be done competitively by emitting plants

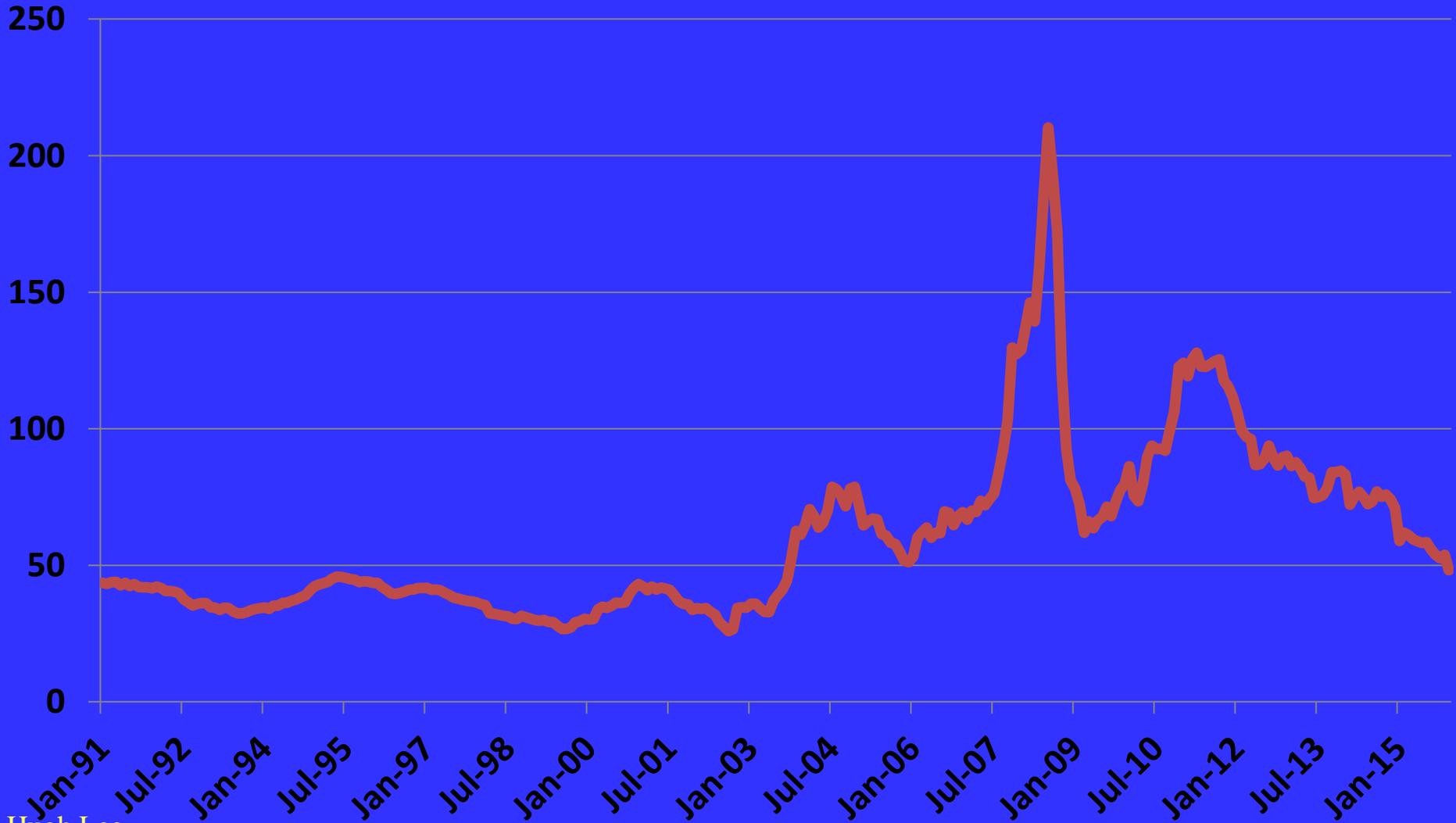
World Coal Association stance

- Deployment of current technology high efficiency, low emissions (HELE) power stations is an immediate low cost way of reducing CO₂ and other emissions
- Need Platform to Accelerate Coal Efficiency (PACE), an international mechanism providing support to accelerate HELE
- World governments' support for CCS is only 1% of their support for renewables

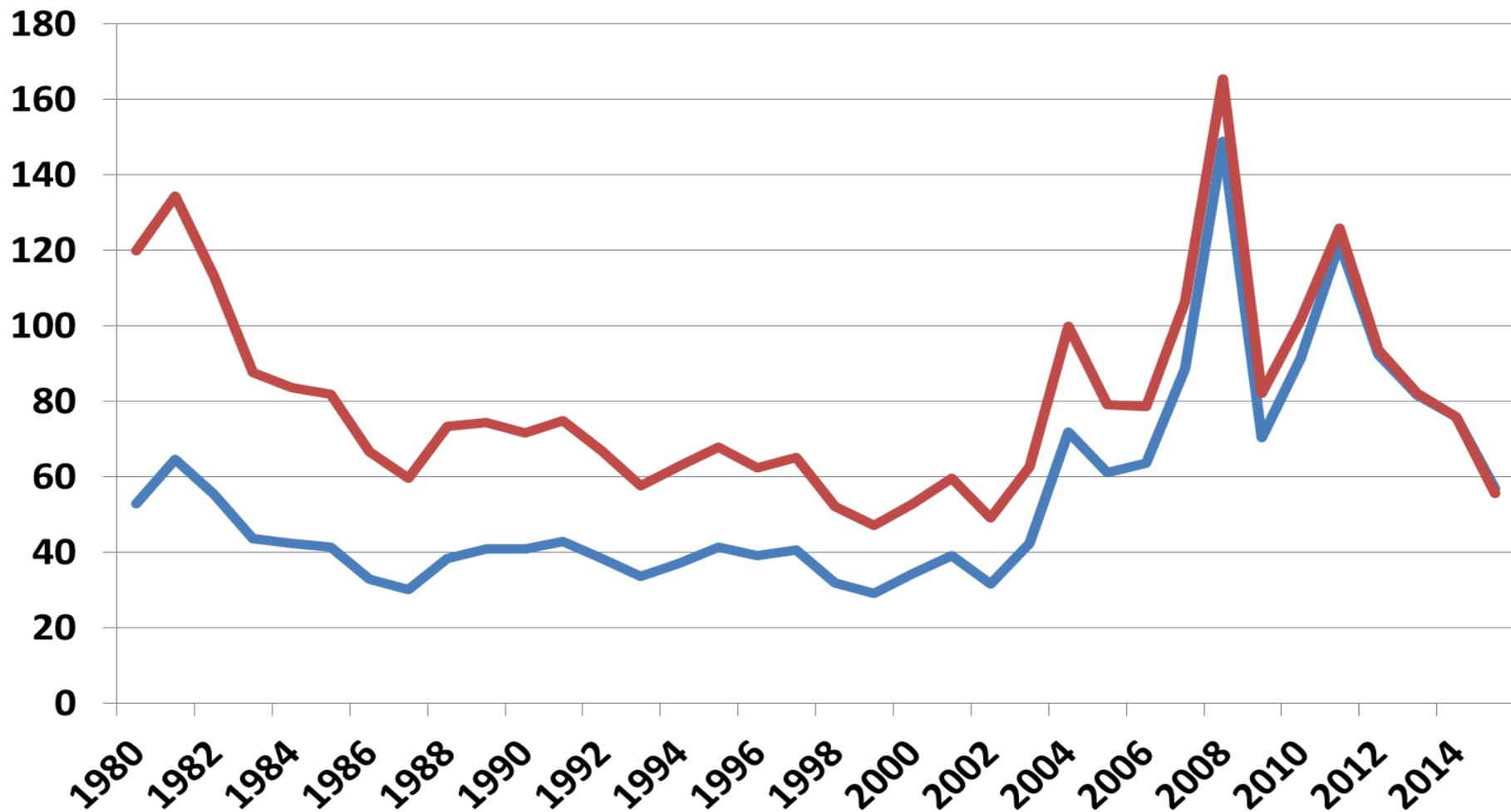
CHP and biomass

- The effective efficiency of a coal-fired power station can be increased to over 90% using combined heat & power (CHP)
e.g. Avedøre Power Station in Copenhagen
- Co-firing with biomass can reduce CO₂ emissions;
with CCS CO₂ emissions can be negative
- Any use of biomass must consider what would have happened to this biomass if it had not been burnt

Monthly ARA Prices US\$/t



Real (2014\$) & Nominal Annual Average ARA Prices US\$/t



Recent falls in mining costs

because:

- Fall in oil price reduced cost of fuel and many other supplies (e.g. tyres)
- Selective mining of lower cost parts of the concession (e.g. lower overburden ratios)
- Depreciation of currencies in exporting countries

US\$ appreciation

Since the beginning of 2012

- Australian dollar 40%
- Canadian dollar 25%
- Colombian peso 45%
- Indonesian rupiah 45%
- Russian ruble 80%
- South African Rand 50%

Coal prices versus Oil prices

- **When oil prices are “high”,**
coal prices are “de-coupled” from oil prices
(coal prices not directly affected by oil prices)
(coal prices move independently from oil prices
in the short term)
- **When oil prices are “low”,**
oil prices set a ceiling for coal prices
- When oil 30 \$/bbl, competitive price of coal
against LNG is ~55 \$/t CIF Japan

Have we reached peak coal?

- The peak for any commodity is unlikely to be a sharp peak, but rather a undulating plateau before a consistent downturn
- Many countries have passed peak production
- OECD has passed peak consumption
- China has reached the plateau
- India & ASEAN countries will continue to increase strongly
- CCS could result in a resurgence

China: coal-fired generation

TWh

3947 in 2013

+425 BAU growth

-225 reduced GDP elasticity of electricity demand

- 75 higher hydro capacity (+22GW)

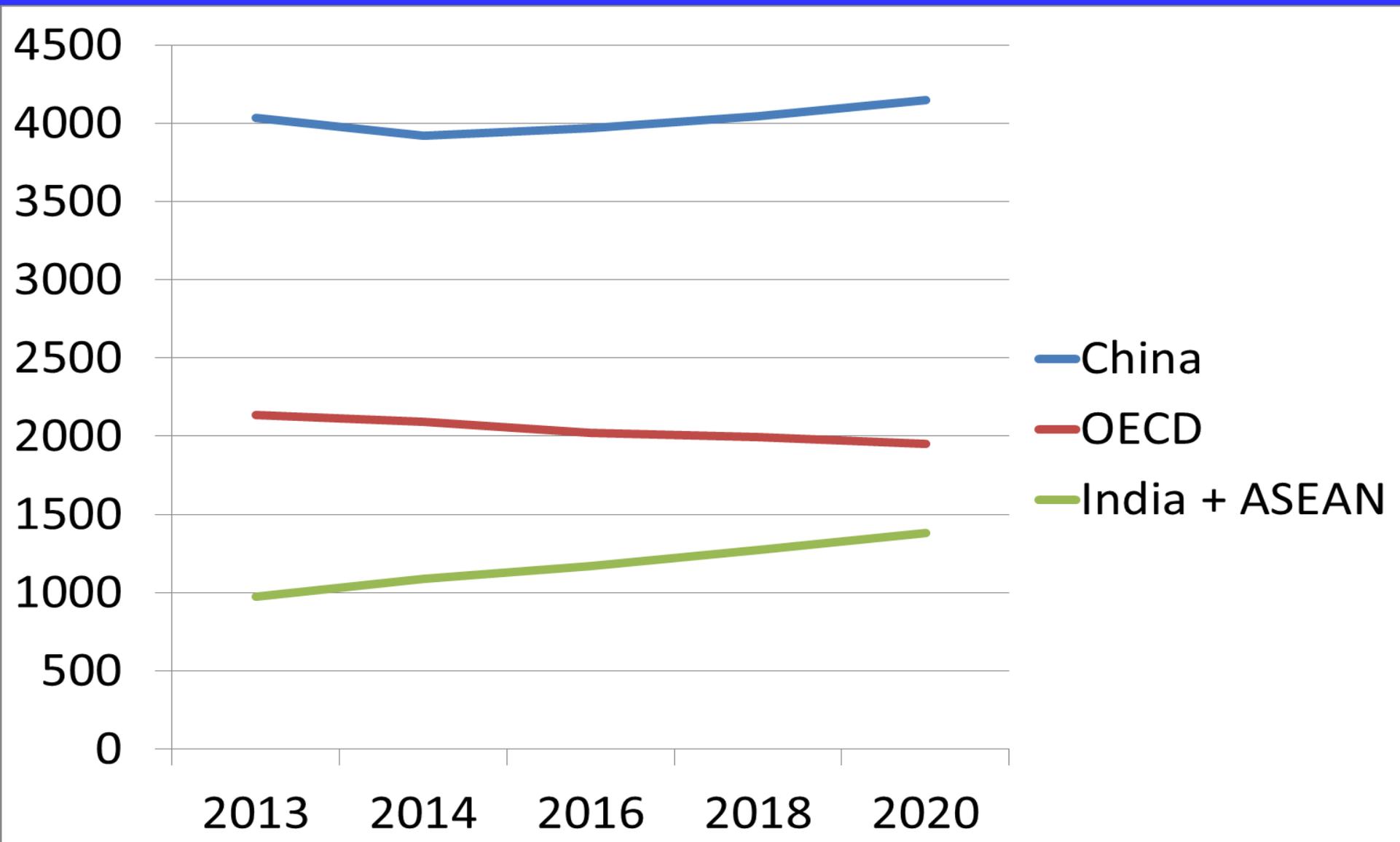
-100 higher rainfall

- 25 higher wind & solar generation

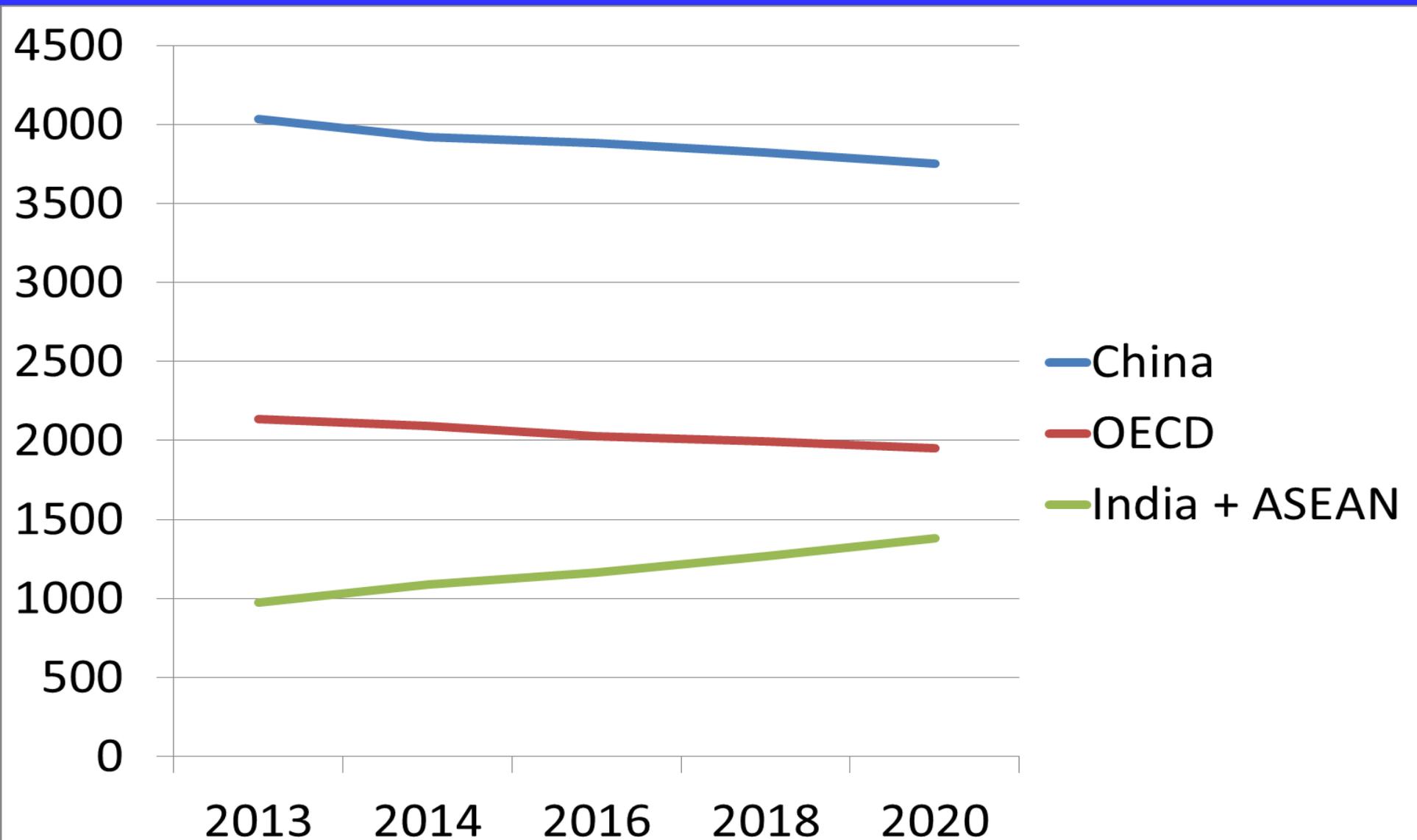
- 25 higher nuclear & other generation

3908 in 2014

IEA Coal Demand Forecast Dec'15



IEA Coal Demand CPCs



Fall in coal share price index

- The FT's Dow Jones Coal Index shows share prices of the 234 listed companies have dropped **85%** in the past year

Examples of falls share prices

Fall in share prices in last 36 months

Global Mining

Anglo American	87%
BHP Billiton	70%
Glencore	79%
Rio Tinto	54%

Others

Teck (Canada)	87%
Whitehaven (Aus)	87%

USA

Alpha	98%
Arch	89%
CONSOL	84%
Peabody	87%

China

Shenhua	67%
Yanzhou	78%

Bankruptcies in USA

- 5 coal companies in the USA filed for bankruptcy (Chapter 11) in 2015:
 - Alpha Natural Resources (ANR)
 - Edison Mission Energy
 - James River Coal
 - Patriot Coal
 - Walter Energy
- Arch Coal filed on 11/1/16
- CONSOL & Peabody
 - have also announced heavy losses

Fossil fuel companies & Climate Change

- To prevent run-away climate change, CO₂ emissions will have to be reduced by carbon taxes, emissions trading (cap & trade), or direct limits on emissions
- Fossil fuel companies are not yet protecting their long term interests by diversifying and sufficiently developing CCS, biofuels & renewables
- The proven reserves of fossil fuel companies have five times the carbon that the atmosphere can absorb to limit global warming to 2°C

Divesting from Coal

Financial institutions unwilling to lend to coal projects:

- World Bank
- European Investment Bank
- EBRD
- National export credit agencies

Institutions divesting from coal:

- Norwegian sovereign wealth fund
- Some universities
- Some churches
- Other NGOs

All this is making HELE more difficult,
so may be increasing CO₂ emissions!

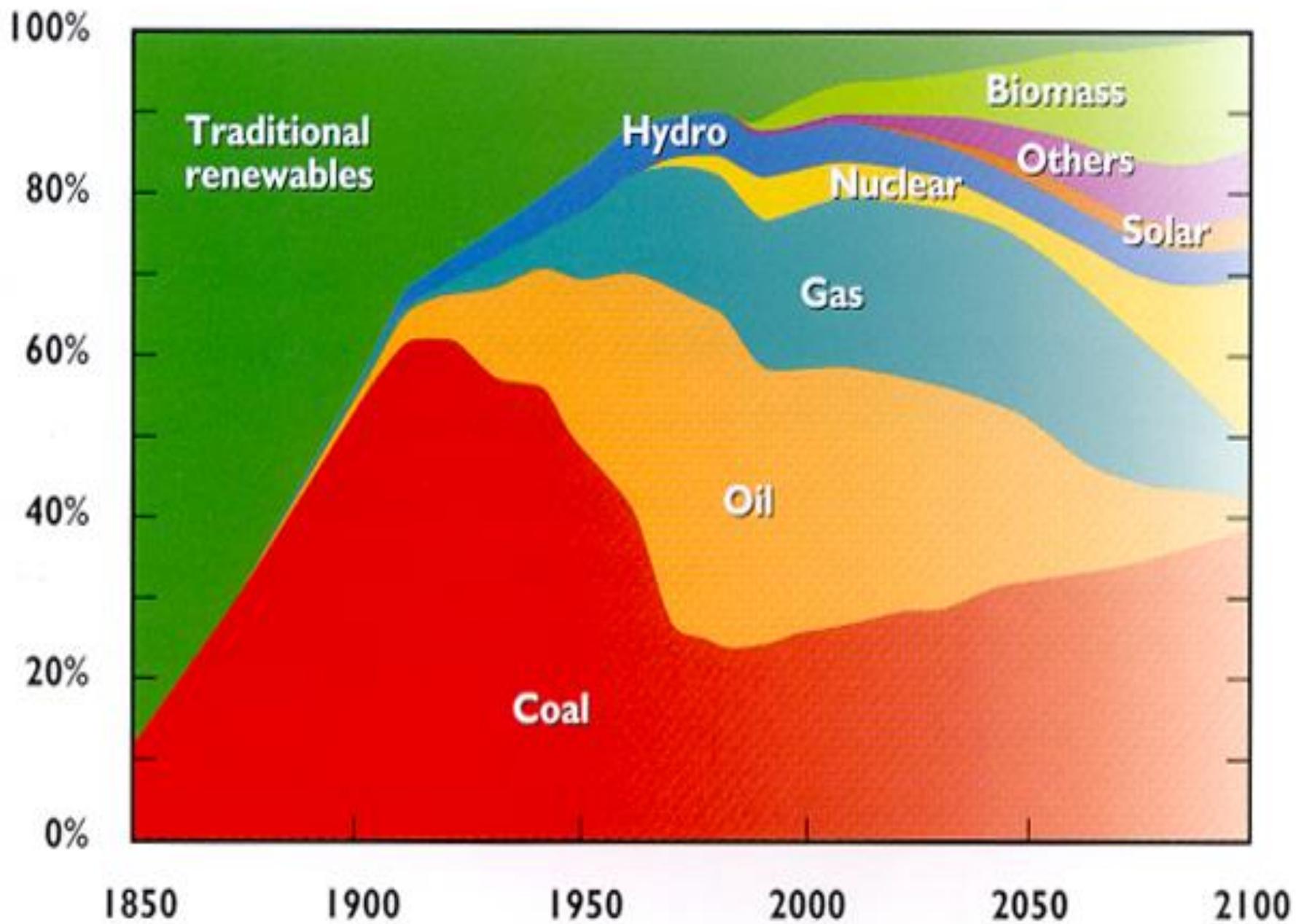
Some company responses

Comments by the CEOs of two coal companies:

- “It is arrogant to think that mankind can affect the climate”
- “CCS is a myth; it is pseudonym for no coal”
- Oil companies may be happy that all the disinvestment attention is on ‘dirty’ coal, as this diverts attention from their need to change

Will carbon policies halt the growth of world coal?

- **No:** India & ASEAN may use solar & batteries for rural electrification, but will use **coal for industrialisation**
- So carbon policies should give preference to HELE & CCS, including for steel works
- Uses of oil are not amenable to CCS, so we need to calculate the cumulative CO₂ acceptable in the atmosphere and limit cumulative oil production to this



Appendix

The following slides show
what was already being said
about unburnable fossil fuel reserves
two years ago

When will the carbon bubble burst?

- For only a 50% chance warming below 2°C, future cumulative emissions can be 1600 Gt of CO₂
- This is still only less than 60% of the proven fossil fuel reserves of 2795 Gt of CO₂
- This overvaluing of the reserves of fossil fuel companies is a serious risk to the world financial markets
- When will this carbon bubble burst?

OECD & Lord Stern aware of this

- “The looming choice may be either stranding those [Fossil Fuel] assets or stranding the planet.” –*OECD Secretary General Angela Gurría*
- “Smart investors can see that investing in companies that rely solely or heavily on constantly replenishing reserves of fossil fuels is becoming a very risky decision.” –*Professor Lord Stern*

Joan Walley MP

Chair of Commons Environmental Audit Committee:

“The UK Government and Bank of England must not be complacent about the risks of carbon exposure in the world economy. Financial stability could be threatened if shares in fossil fuel companies turn out to be over-valued because the bulk of their oil, coal and gas reserves cannot be burnt without further destabilising the climate.”

The stance of the fossil fuel companies

- The fossil fuel companies understandably say they will comply with any regulation, tax etc that is introduced to limit emissions – this is similar to the stance of the tobacco companies
- Perhaps a better parallel is the attitude of the banks before the 2008 crash
- \$674 billion was spent in 2013 to find and develop new potentially stranded assets (fossil fuel production, power stations etc)

Squeezing a balloon

- Improving energy efficiency does not often reduce energy consumption because it can lead to more energy appliances or us travelling further etc
- Developing low carbon technologies similarly does not necessarily cut emissions
- It is like squeezing a balloon – the more you squeeze in one place the more it expands in another place

“The Burning Question” Mike Burners-Lee & Duncan Clark, Profile Books 2013

CCS and the oil companies

- The oil and gas companies are uniquely placed to develop CCS
- They need to diversify from oil and gas production
- They have the technology and expertise for all parts of CCS:
 - ❖ Capture is a big chemical plant like an oil refinery etc
 - ❖ Transport is in pipelines
 - ❖ Storage requires exploration and drilling

China is limiting its coal consumption

- 12 of China's 34 provinces (44% of China's coal consumption) have pledged to implement coal control measures
- These imply a reduction in coal consumption of approximately 350 Mt/a by 2017 and 655 Mt/a by 2020, compared with business-as-usual growth

*“The End of China's Coal Boom”
Greenpeace report 11/4/14*

IPCC report 13 April 2014

- Investment in fossil fuel extraction and power plants needs to fall by \$30bn a year until 2030 and investment in low-carbon electricity supplies will have to rise by \$150bn a year to have a good chance of limiting global warming to below 2°C.