



Coal: A Double-Edged Sword

Mark Thurber

EWI, University of Cologne

8th April 2019



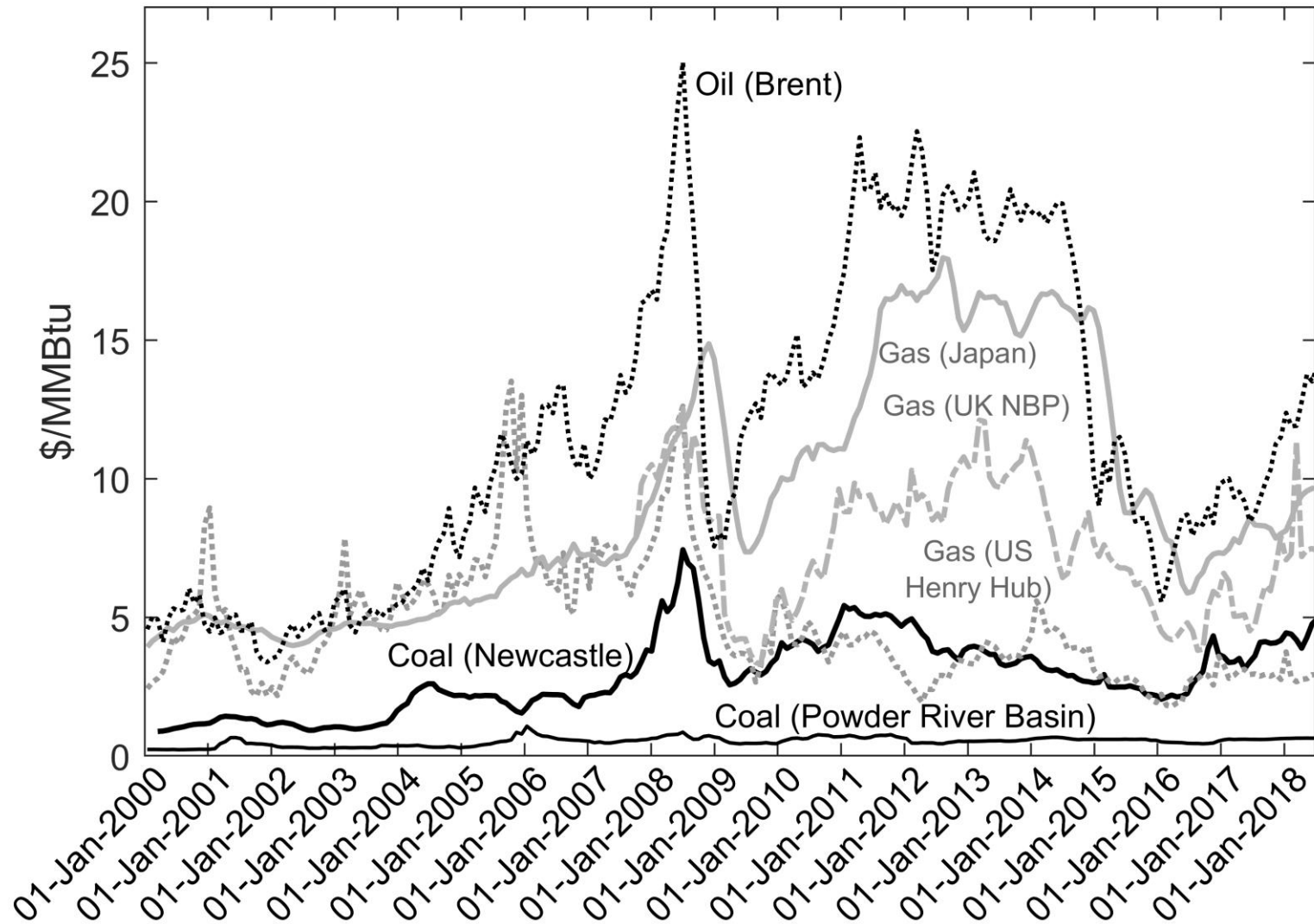
Coal

MARK C. THURBER

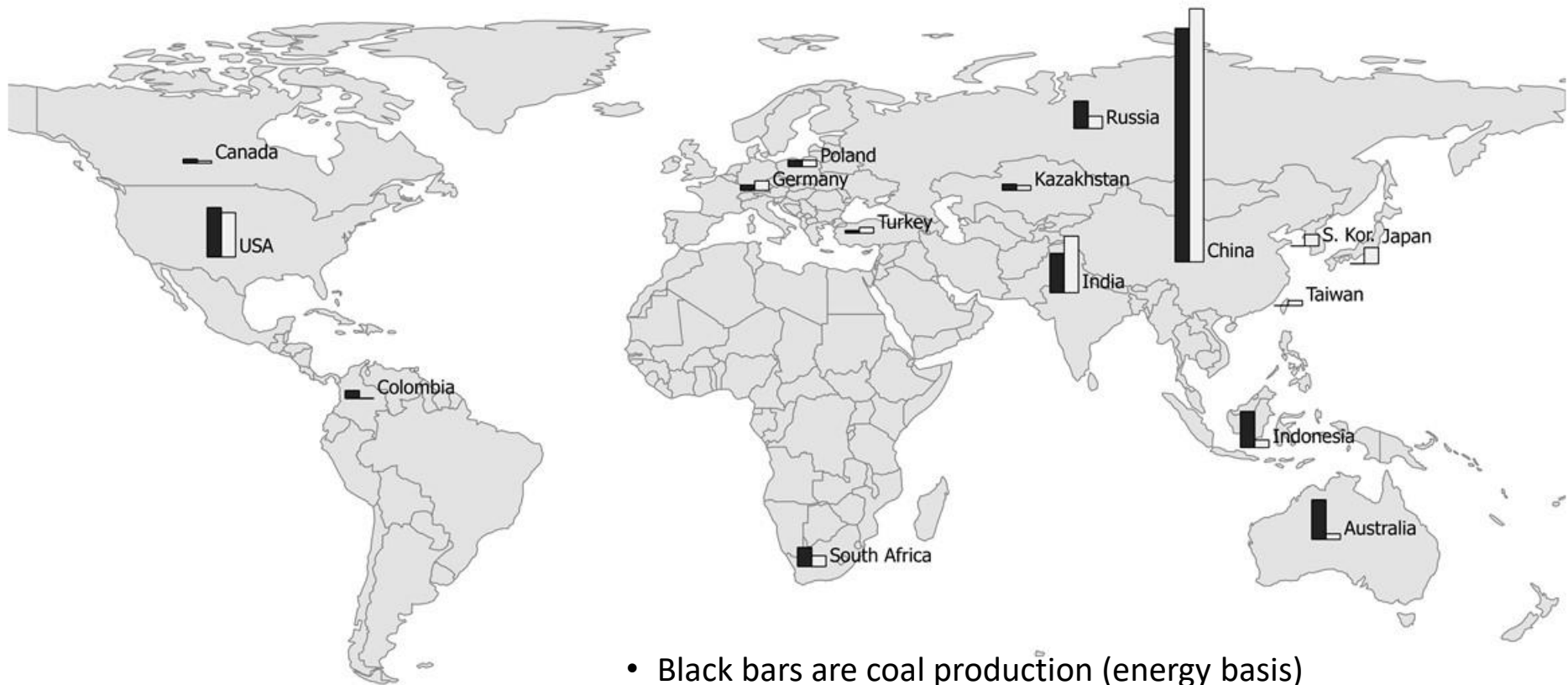
Now available

Coal in the global context

Coal is cheap



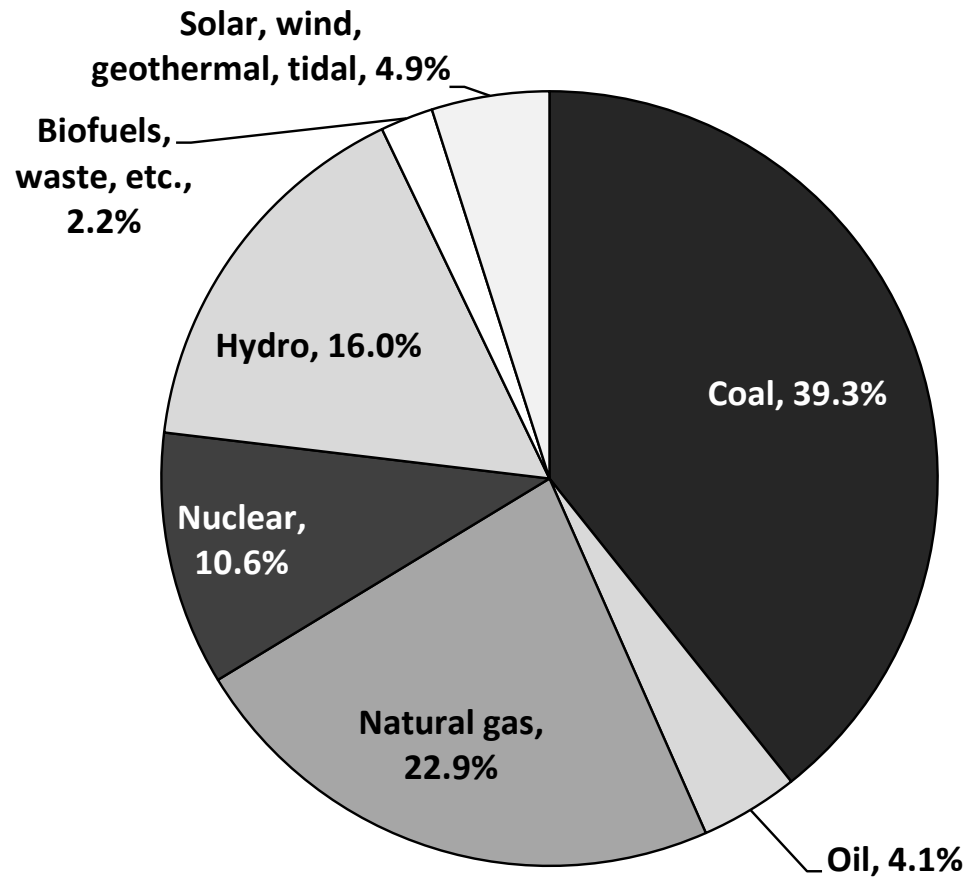
Coal is available



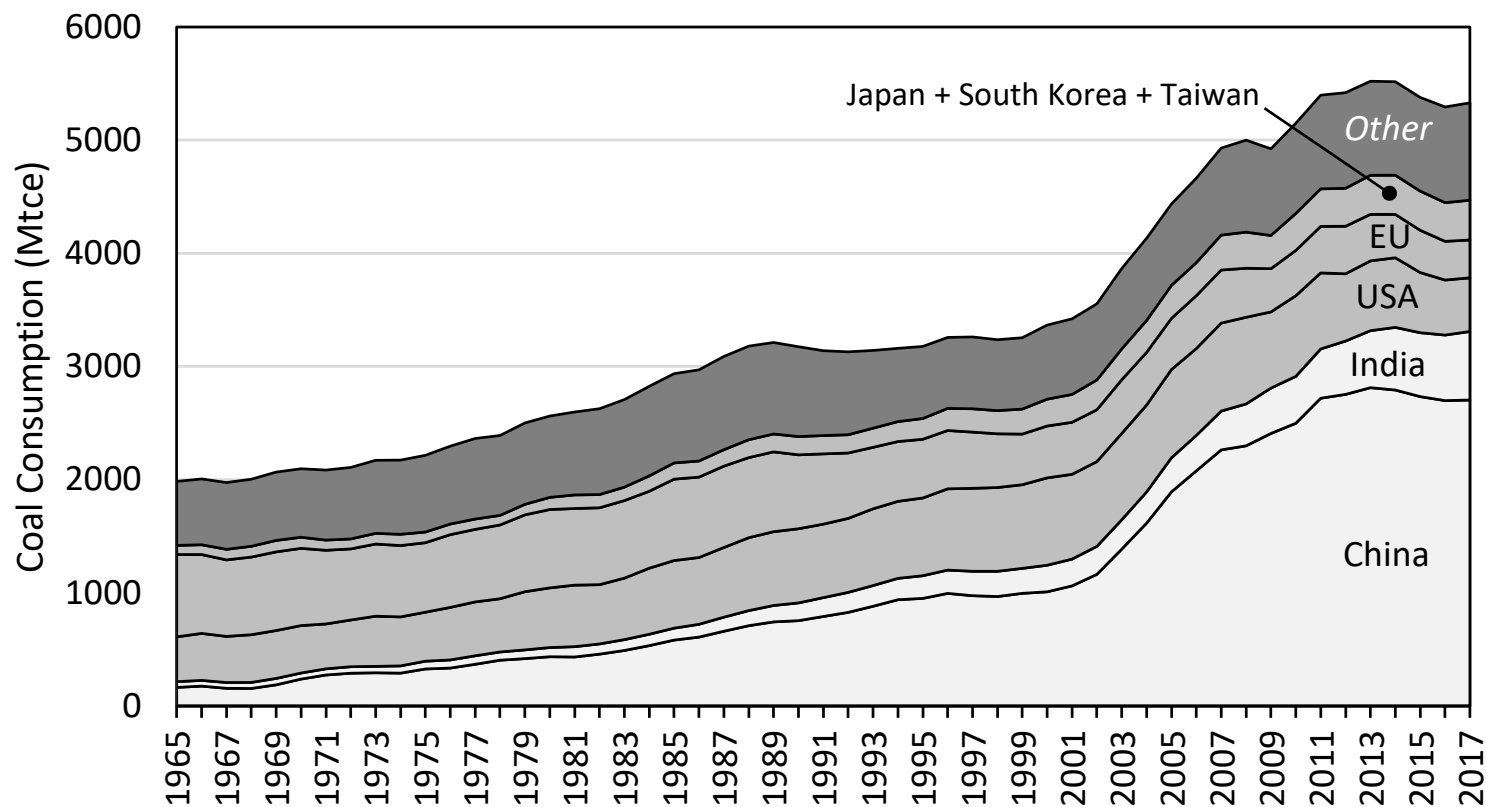
- Black bars are coal production (energy basis)
- Grey bars are coal consumption (energy basis)

Coal is the most significant source of electricity

Global Gross Electricity Production in 2015

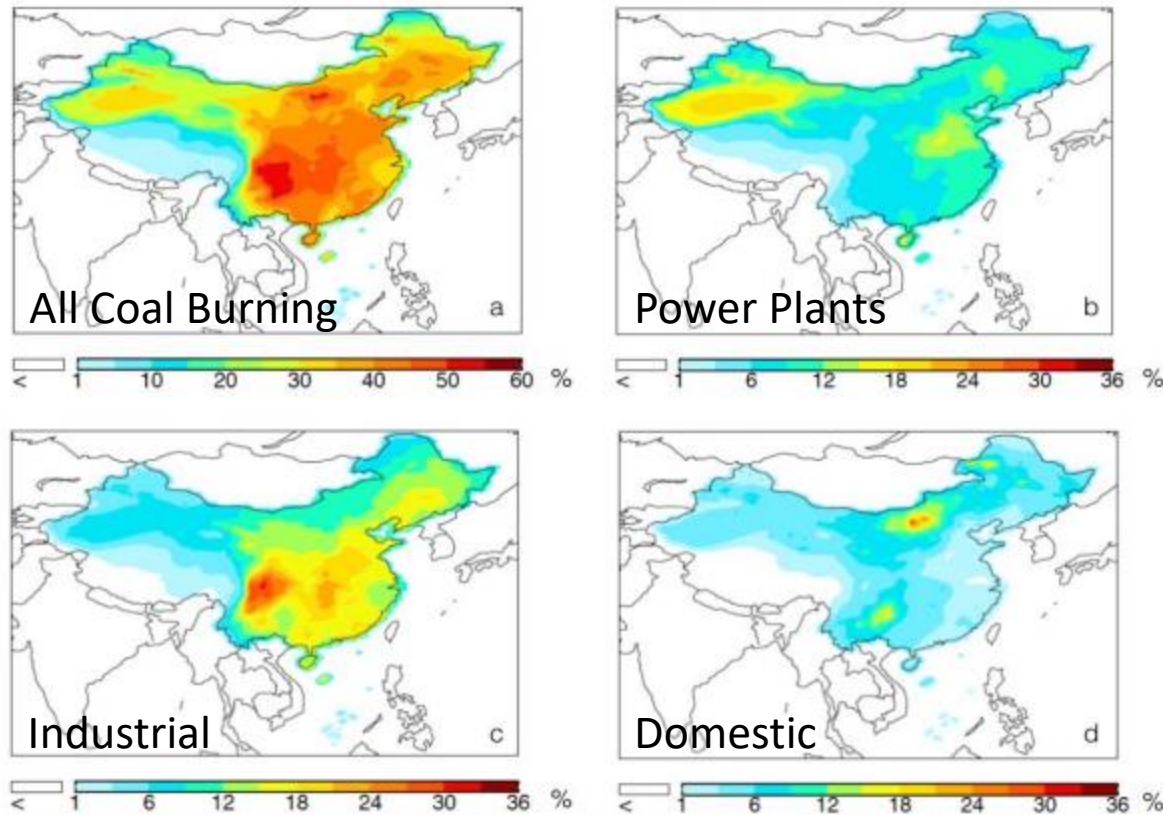


It's been the “default fuel” for emerging economies



Coal is polluting

Simulated Contributions of Coal Burning to PM_{2.5} in China



Data source:
Health Effects
Institute 2016

Figure 14. Simulated percentage contributions to ambient PM_{2.5} in the (2013) base year from total coal-burning (a) and coal-burning in specific sectors (b-d for power plant, industrial, and domestic, respectively).

- Premature deaths from PM_{2.5}: Estimated 366,000 in China (2013) and 80,000-115,000 in India (2011-2012)
- 2016 top 20 most polluted cities (PM_{2.5}): 4 in China, 10 in India

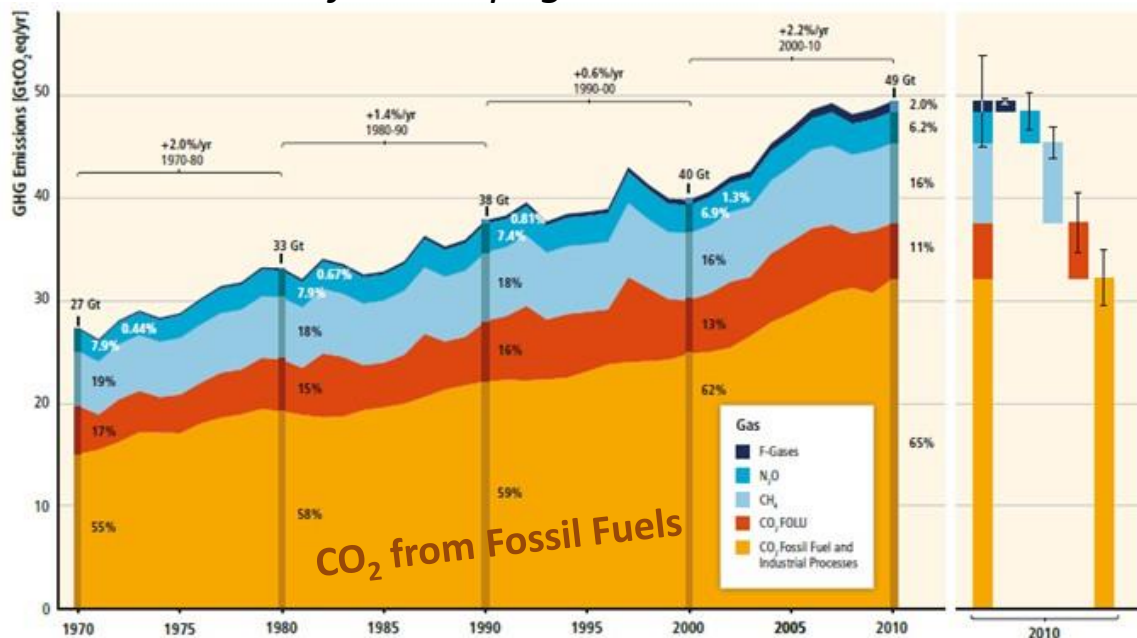
Coal is most important source of anthropogenic greenhouse gases

- CO_2 from fossil fuels: ~65% of anthropogenic GHG emissions

- Coal's share: ~45%

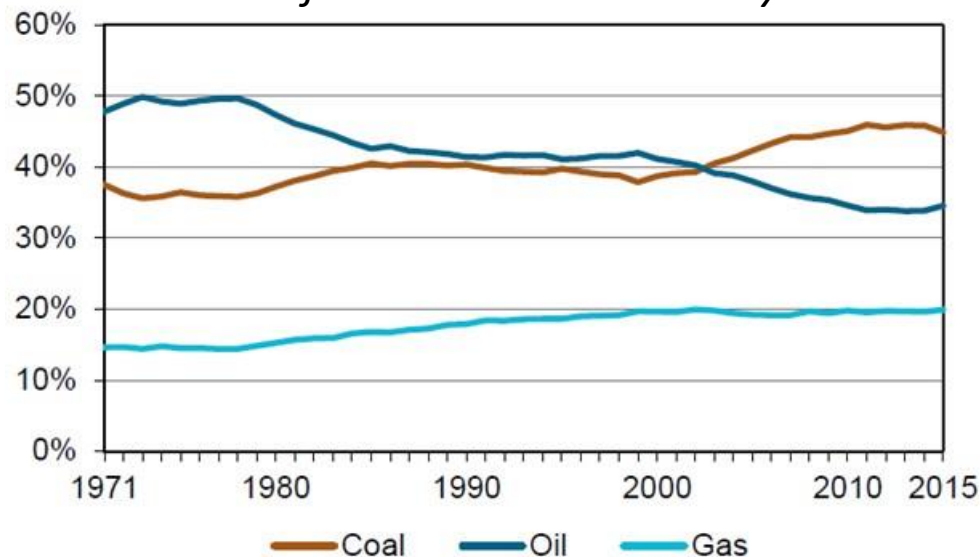
→ Coal responsible for ~30% of overall anthropogenic GHG emissions

Sources of Anthropogenic Greenhouse Gases



Data source: IPCC

Share of Fossil Fuel Emissions by Fuel



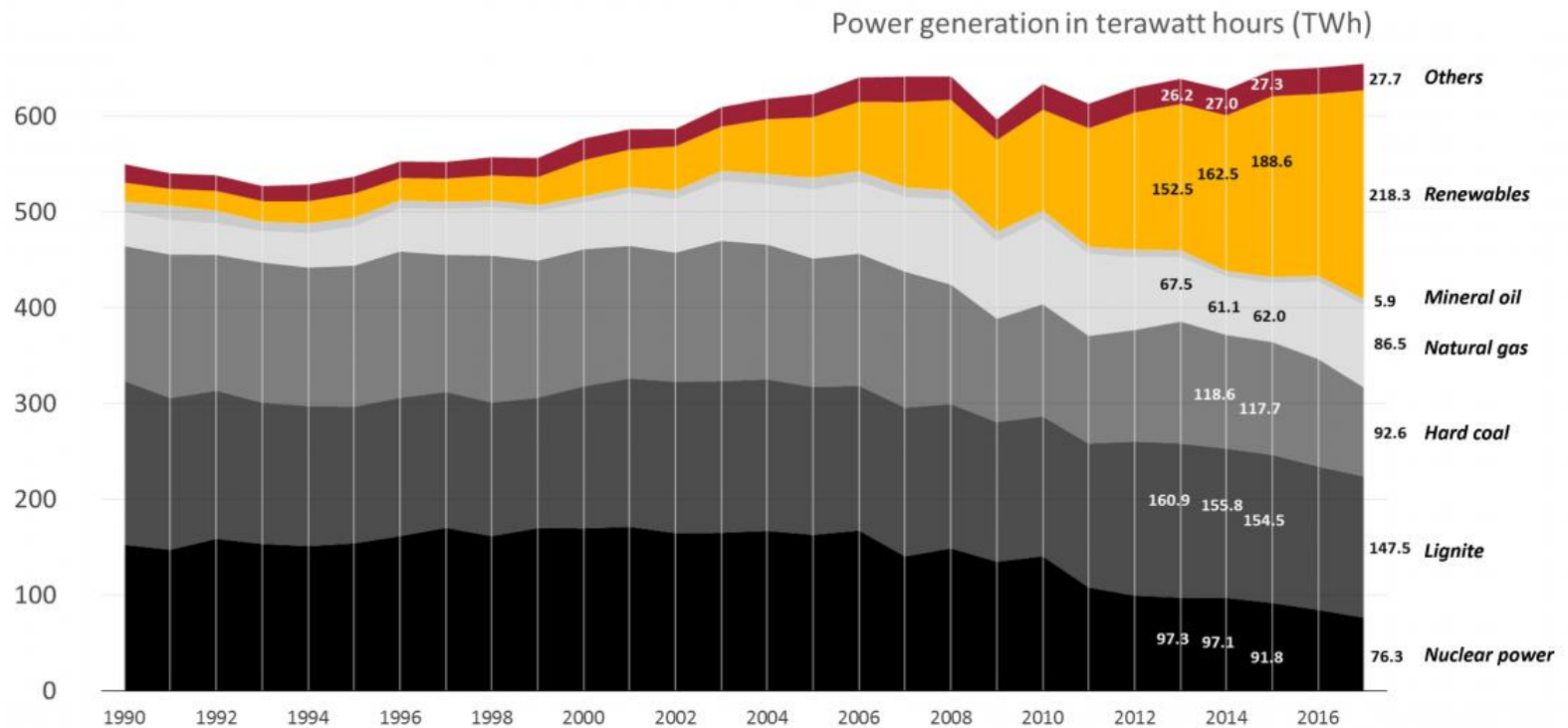
Data source: IEA

Coal and renewables

Role for coal in a high-renewables world?

Gross power production in Germany 1990 - 2017, by source.

Data: AG Energiebilanzen 2017, 2017 data preliminary.



Logic (and illogic) of the coal+renewables model

Want cheap power at scale? *Choose coal*

Want to be “green”? *Choose renewables*

Advantages of coal+renewables model

- Avoids confronting coal-producing and coal-using interests (traditionally powerful in US, Germany, Poland, India, China, others)
- Renewables can give political cover for coal use & expansion (e.g. India in run-up to Paris Climate Conference)

Disadvantages of coal+renewables model

- Inefficient greenhouse gas emissions reductions
- High fixed costs make coal-fired power plants uneconomic at high renewable energy shares

Is coal+renewables model the way of the future for South & SE Asia?

Can Germany help lead the world away from this model?

Lower-CO₂ options for backing up wind and solar (and the main challenges of each)

- Biomass: Land use concerns
- Hydro: Resource availability; drought
- Geothermal: Resource availability; capital cost
- Nuclear: Public acceptance; capital cost
- Natural gas: Transportation cost; no “green credit”
- “Clean coal”: High cost of CO₂ capture & storage
- Electricity storage: Need cheap long-term storage

Biggest challenge for coal w/CO₂ capture & storage: cost

Examples of carbon capture and storage (CCS) for gas separation:

- Sleipner (Norway): ~1 mtpa CO₂, operating since 1996
- Gorgon (Western Australia): 3-4 mtpa CO₂, start in 2019?

CCS for coal has had a rocky road:

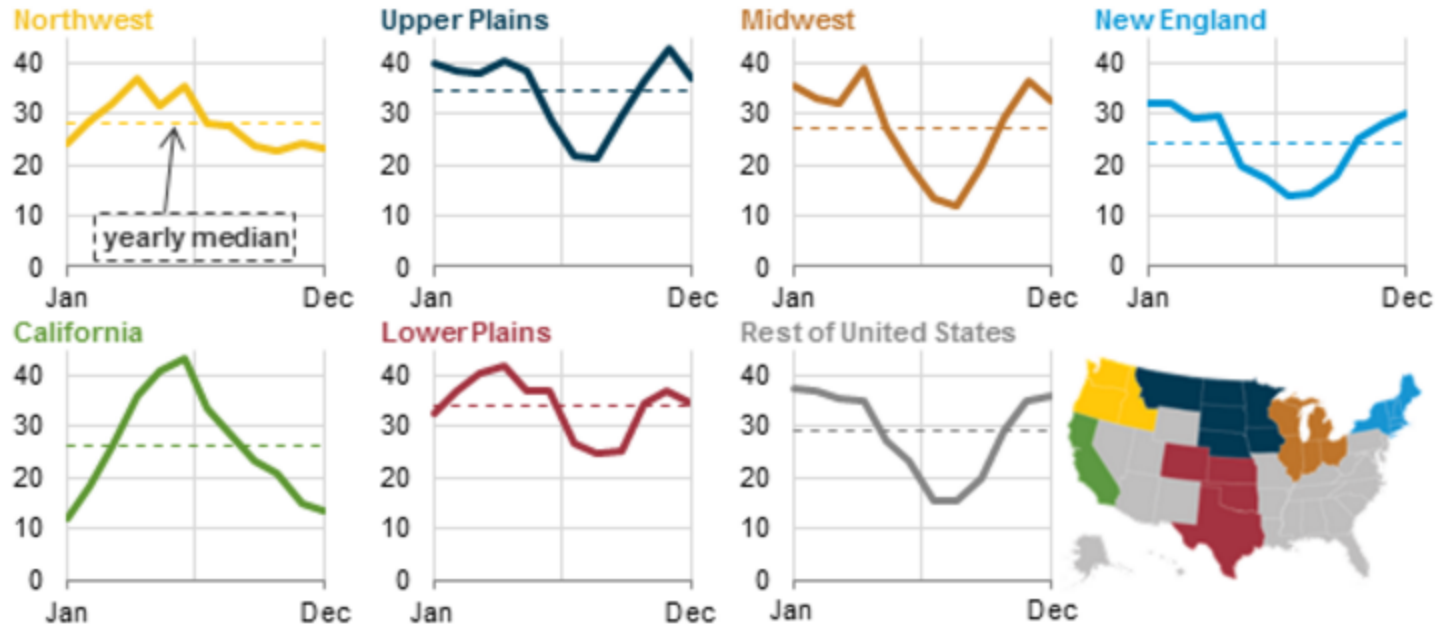
- National initiatives fizzled in US, Germany, Australia
- China has not been focused on CCS for coal-fired power plants
- Kemper CCS project in Mississippi was abandoned in 2017

Core problem with CCS for coal:

- 1) We use coal because it is cheap
- 2) Capturing and storing CO₂ would make it expensive

Biggest challenge for energy storage: seasonal storage

Monthly median wind plant capacity factors (2001-13)
capacity factor (%)

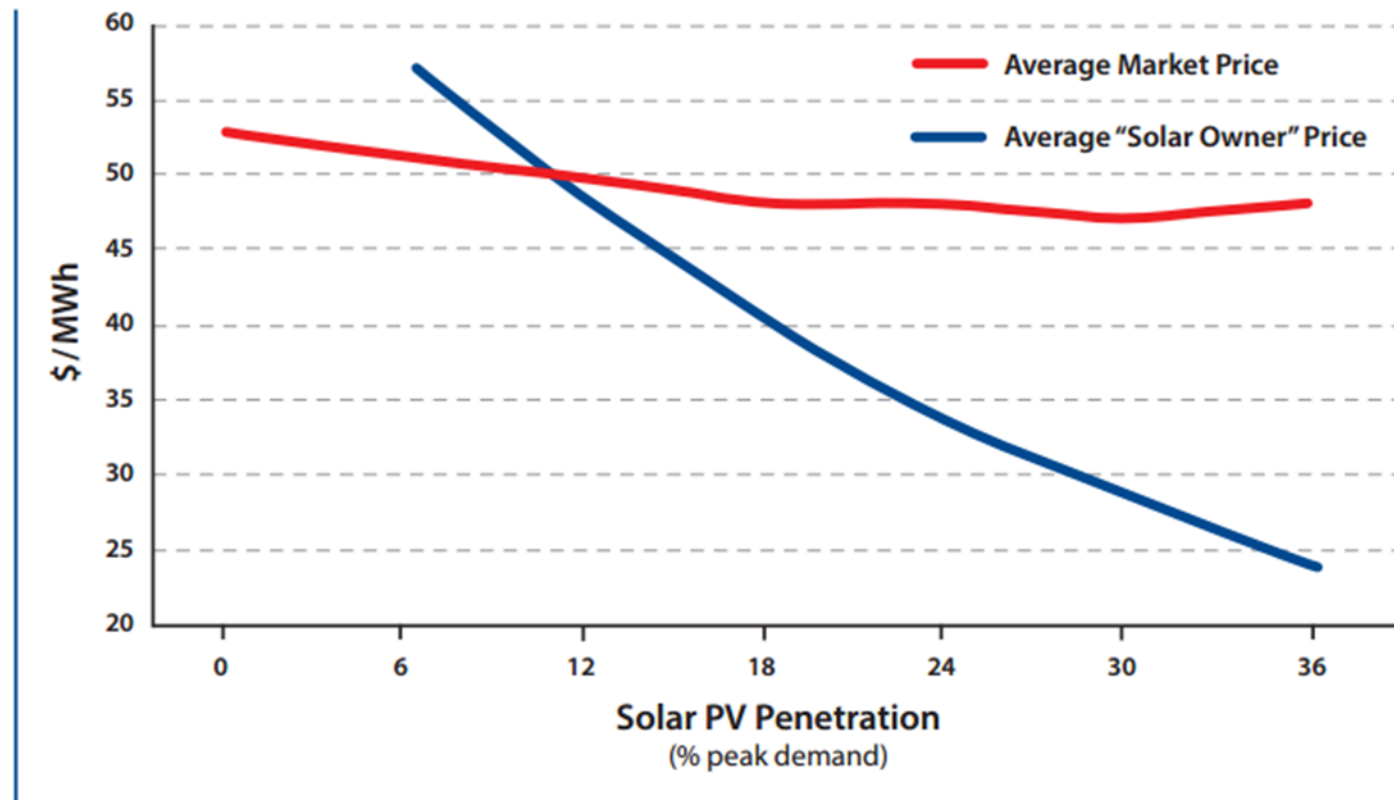


Source: U.S. Energy Information Administration, Forms EIA-860 and EIA-923
Note: Data include facilities with a net summer capacity of 1 MW and above only.

Data source: US EIA, 2015

Without affordable storage on all timescales, wind and solar face value erosion problem

Figure 8.11 Average Market Prices and Average Prices as Perceived by Owners of Solar Generation



Source: MIT, Future of Solar, 2015

Effect of policy on coal and climate

Effects of different policies on coal use

POLICY	TYPICAL EFFECT
Technology R&D for coal alternatives	Reduces coal use (e.g. US shale gas incentives)
Carbon pricing	Reduces coal use (e.g. UK carbon price floor)
Air quality regulation	Modestly reduces coal use (e.g. China SO ₂ regulation)
Renewables mandates	<u>Short-term</u> : No effect or supports coal use (e.g. initial case in Germany?) <u>Long-term</u> : Probably reduces coal use (e.g. US case? Germany now?)
Mandated coal phase-outs	We will see! (China's "coal cap" not effective so far)

- How different policies affect coal depends on the availability of affordable alternatives to coal

A possible approach to climate policy

- 1) Implement carbon pricing everywhere
- 2) Rich, enthusiastic jurisdictions go big on renewables, generating market & technology innovations
 - Long-term storage
 - Involvement of final demand
 - Low/zero-carbon technologies for backup
- 3) Use all available leverage points to avoid new coal development in emerging economies

Thank You



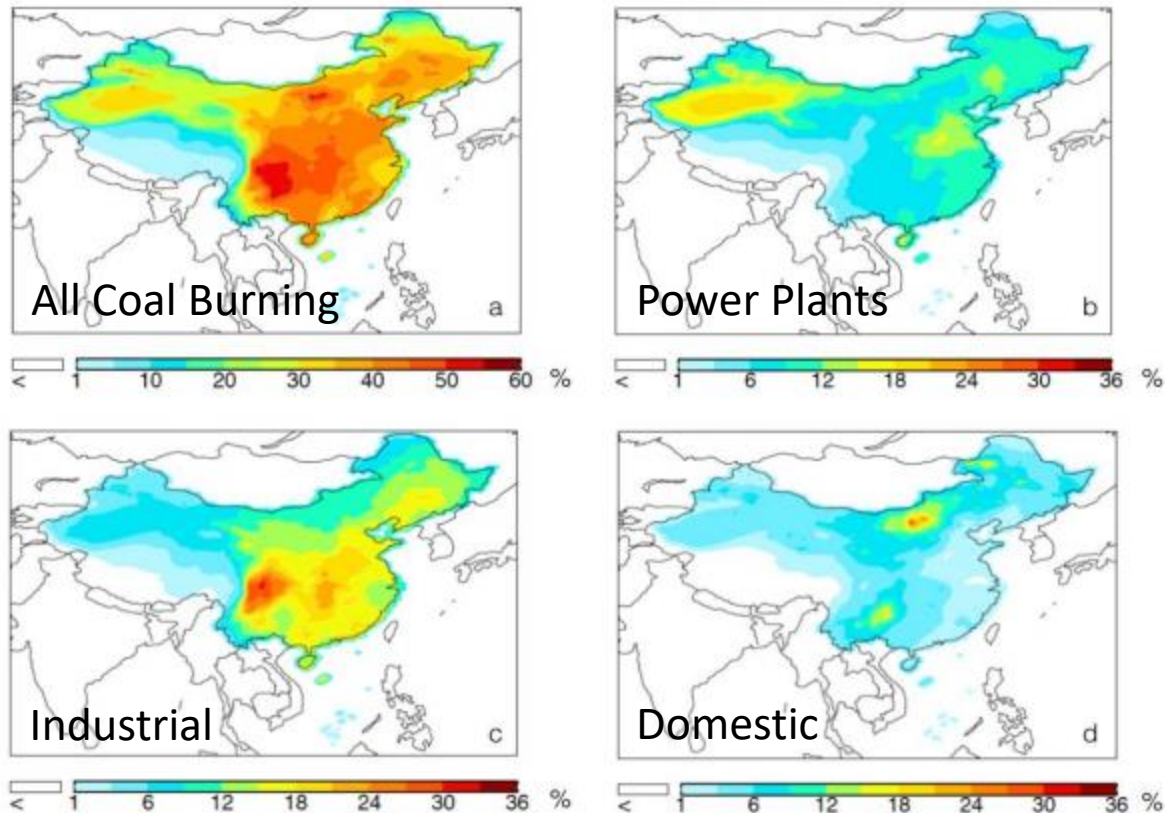
Coal

MARK C. THURBER

Now available

Significant air pollution reductions from coal-fired power are possible

Simulated Contributions of Coal Burning to PM_{2.5} in China



Data source:
Health Effects
Institute 2016

Figure 14. Simulated percentage contributions to ambient PM_{2.5} in the (2013) base year from total coal-burning (a) and coal-burning in specific sectors (b-d for power plant, industrial, and domestic, respectively).

- Requires political will + regulatory capability
- Industrial sources more difficult to control than power plants