Hubbert's Peak, The Coal Question, and Climate Change

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slides with sources (.ppt) and spreadsheets (.xls) at
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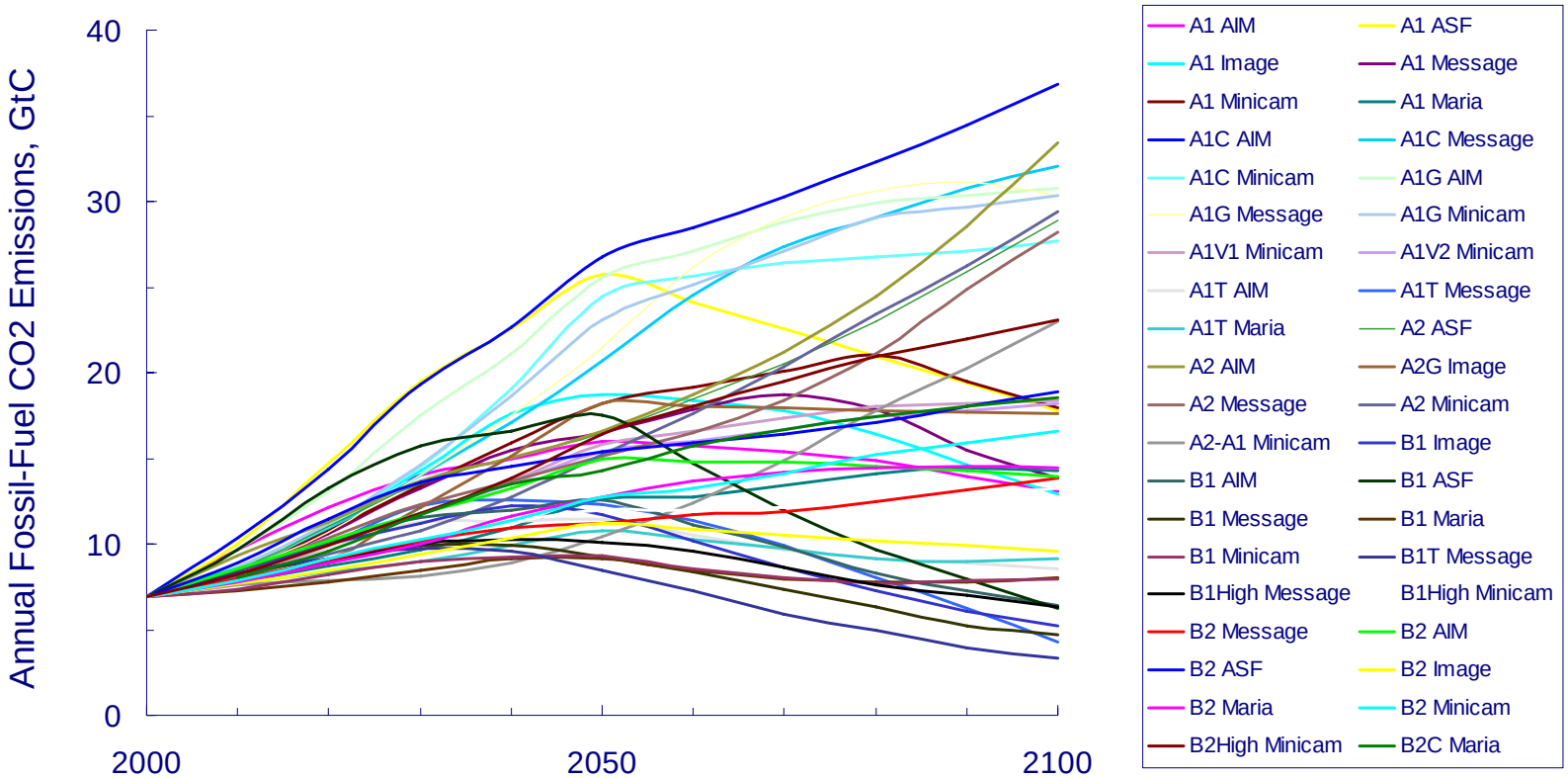
The UN Panel on Climate Change

- This year the UN Intergovernmental Panel on Climate Change (IPCC) shared the Nobel Peace Prize with Al Gore
- The IPCC released its 4th assessment report
  - Updated measurements show that the temperature is rising 0.13°C per decade
  - Report discusses climate simulations for 40 scenarios

The 40 UN IPCC Scenarios

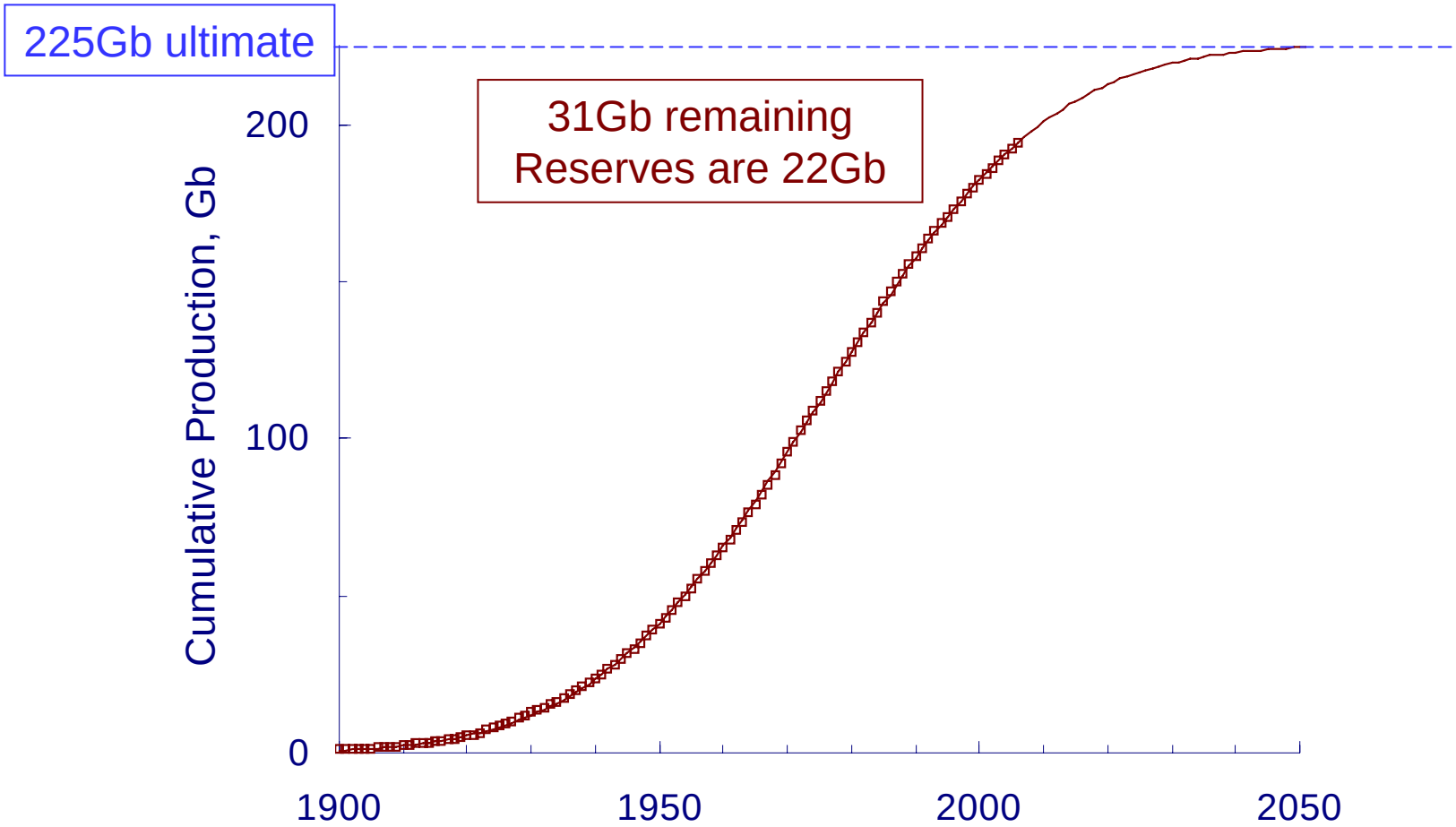


- Ratio of total carbon-dioxide emissions is 4:1 from top to bottom
- The ratio is closer to 10:1 if the years beyond 2100 are considered
- Oil production in 13 scenarios has not peaked by 2100

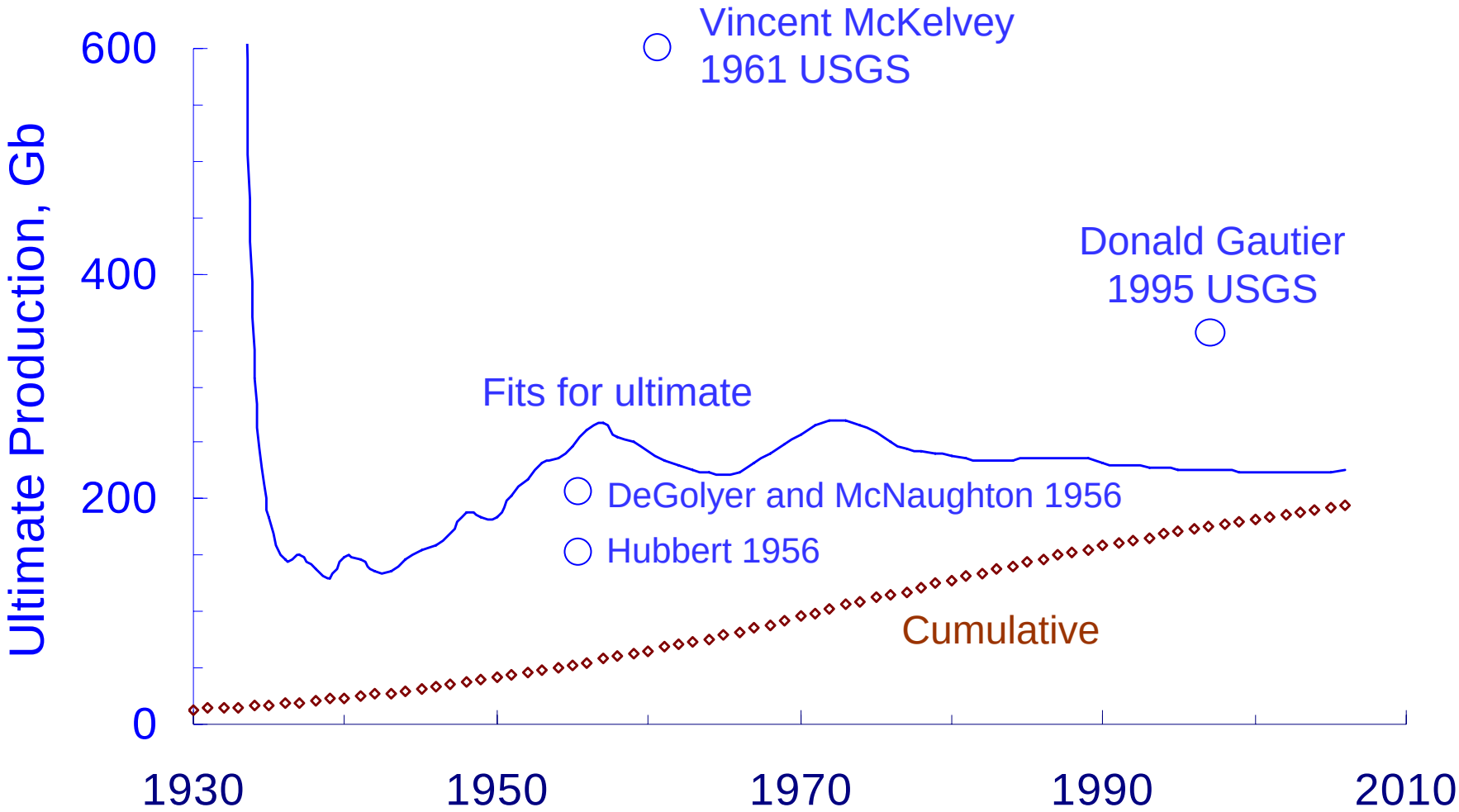
Outline

- The 4th UN IPCC Assessment Report
- Hubbert's peak
  - The history of US oil production
  - Reserves
  - How much oil and gas will the world produce?
- The Coal Question
  - The history of British coal production
  - American coal
  - How much coal will the world produce?
- Discussion
  - Alternatives to fossil fuels
  - Simulation of future CO2 levels and temperatures
  - Summary
  - Proposal — Fossil-Fuel Preserves
  - Conclusions

Cumulative Plot for US Oil



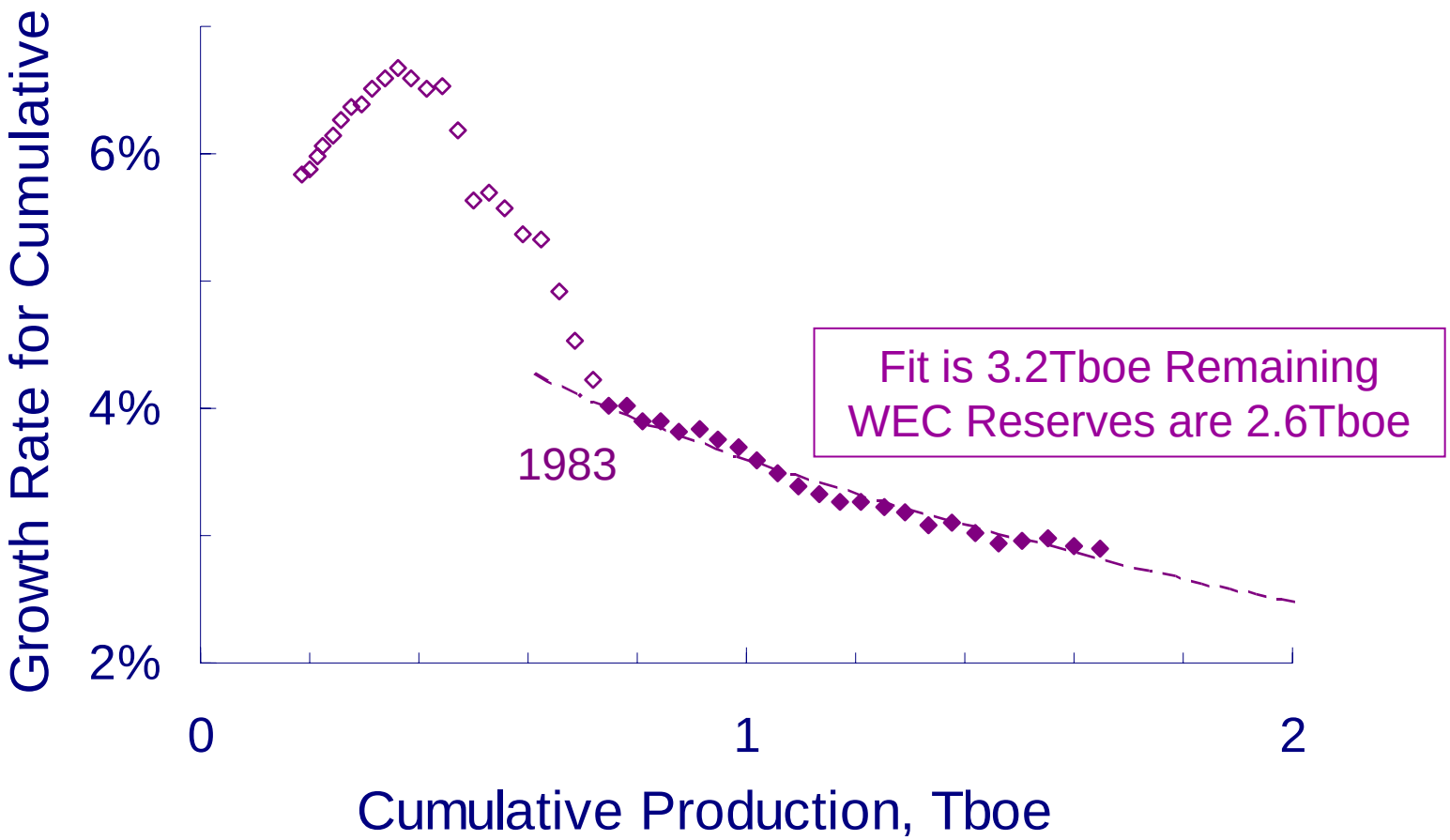
Historical Fits for the Ultimate



Reserves and Resources

- *Reserves* are resources that can be extracted at current prices and with current technology
- For oil and natural gas, remaining production should be larger than the reserves, because of future discoveries
- Coal reserves are calculated in three steps
  1. Measure the coal seams
  2. Apply restrictions, like minimum seam thickness, maximum depth, and forbidden areas
  3. Multiply by a recovery factor to account for coal left behind
- Wolfgang Zittel and Joerg Schindler of the German Energy Watch Group have noticed that for many countries, coal reserves have been dropping at a rate that is much larger than production, and they propose that the remaining production will be less than the reserves

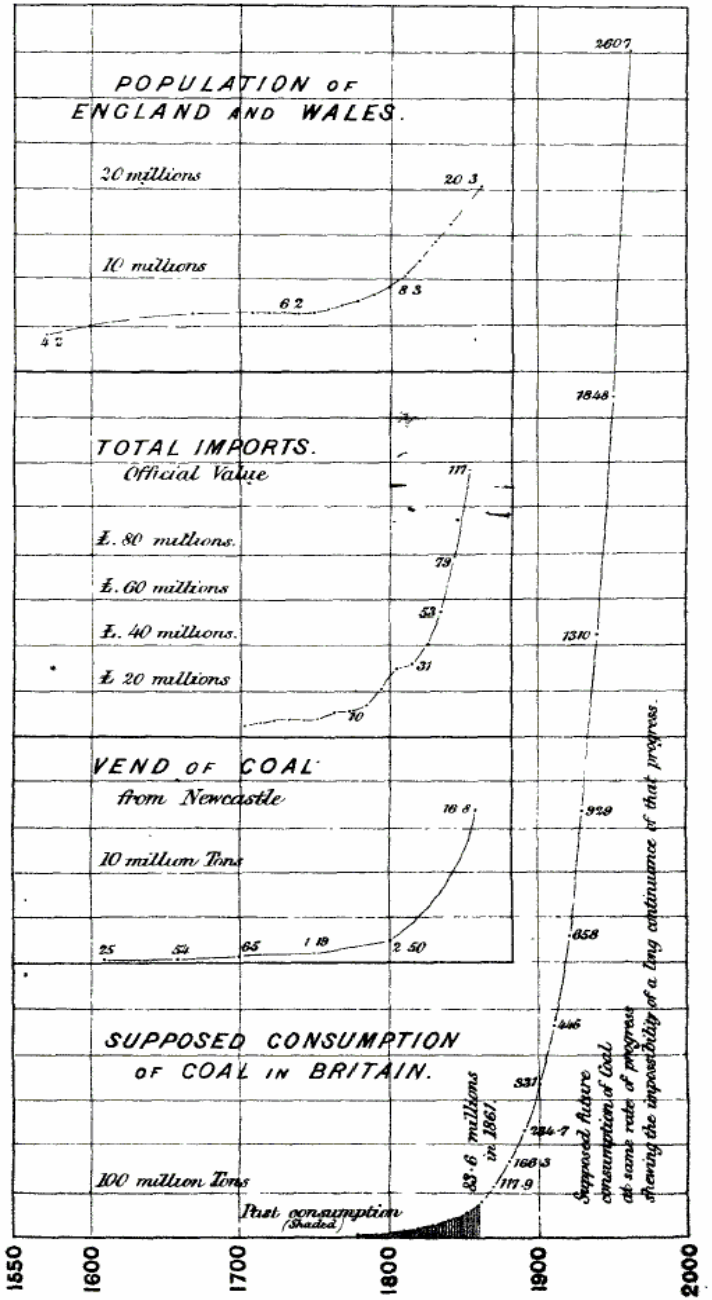
Rate Plot for World Oil and Gas



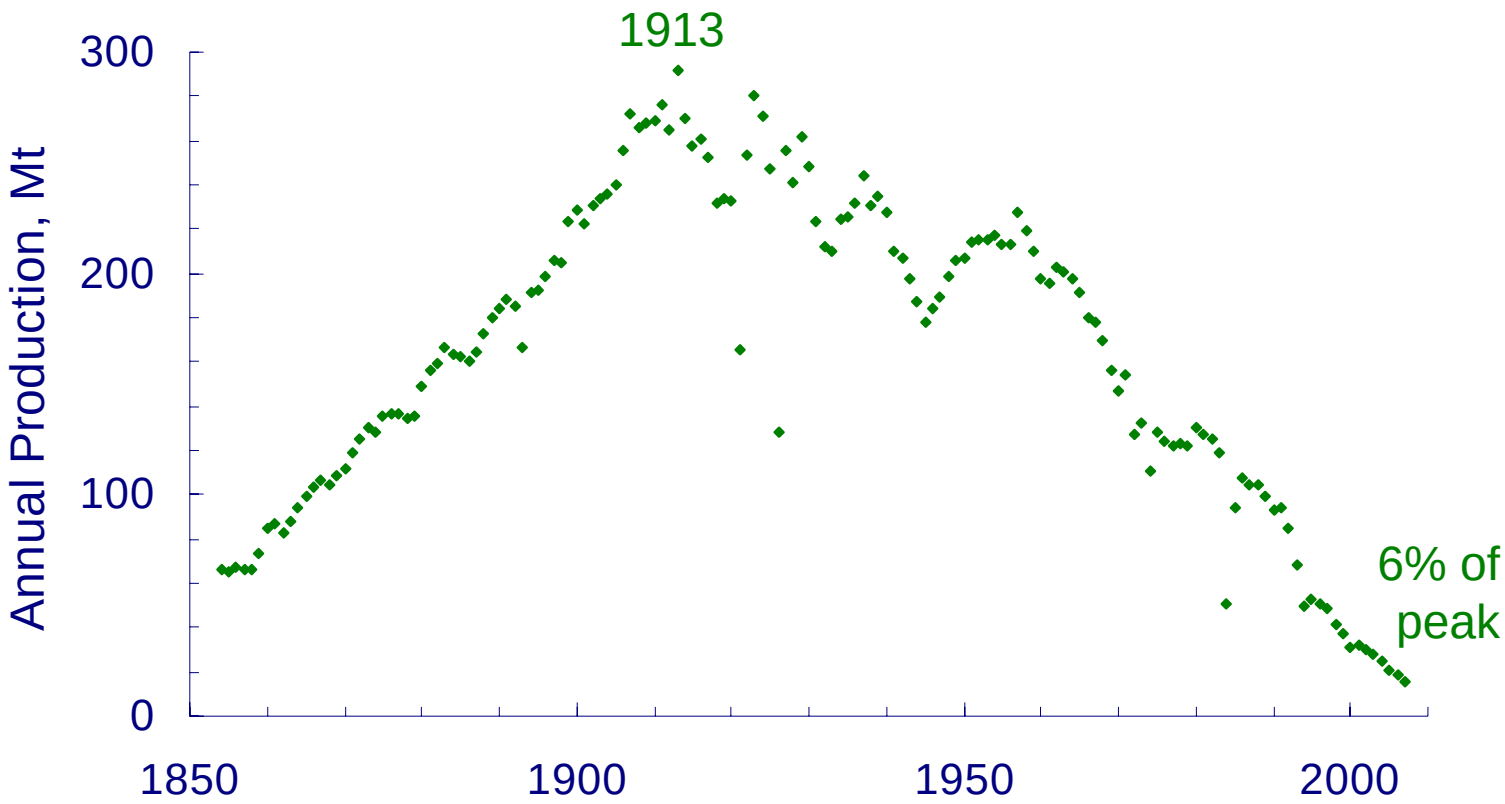
- Tboe = trillion barrels of oil equivalent
- UN IPCC scenarios assume 11-15Tboe is available


British Coal
Photo by
John Cornwell

The Coal Question
Stanley Jevons (1865)

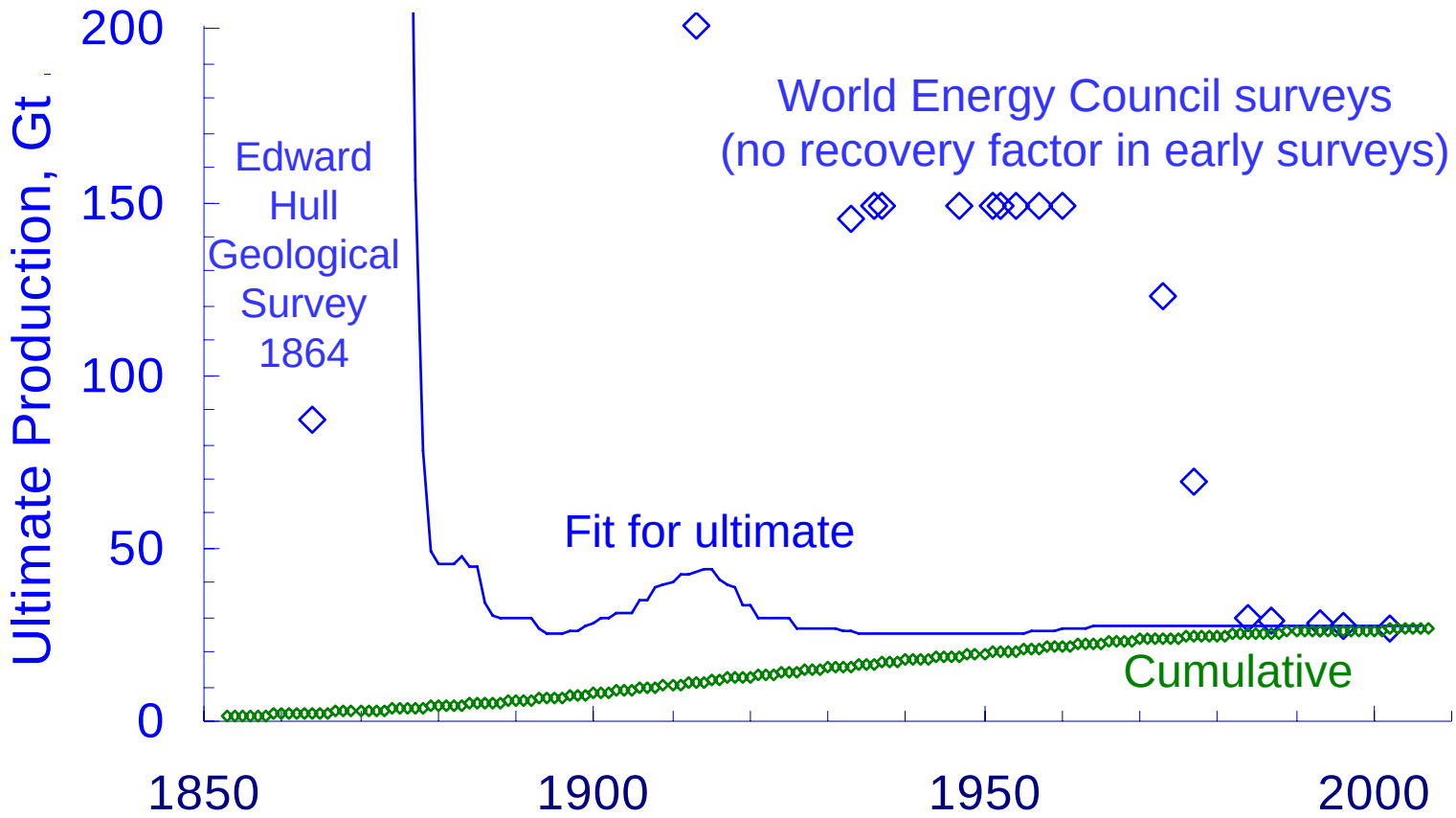


British Coal Production



- Mt = millions of metric tons

Historical Fits for the British Ultimate

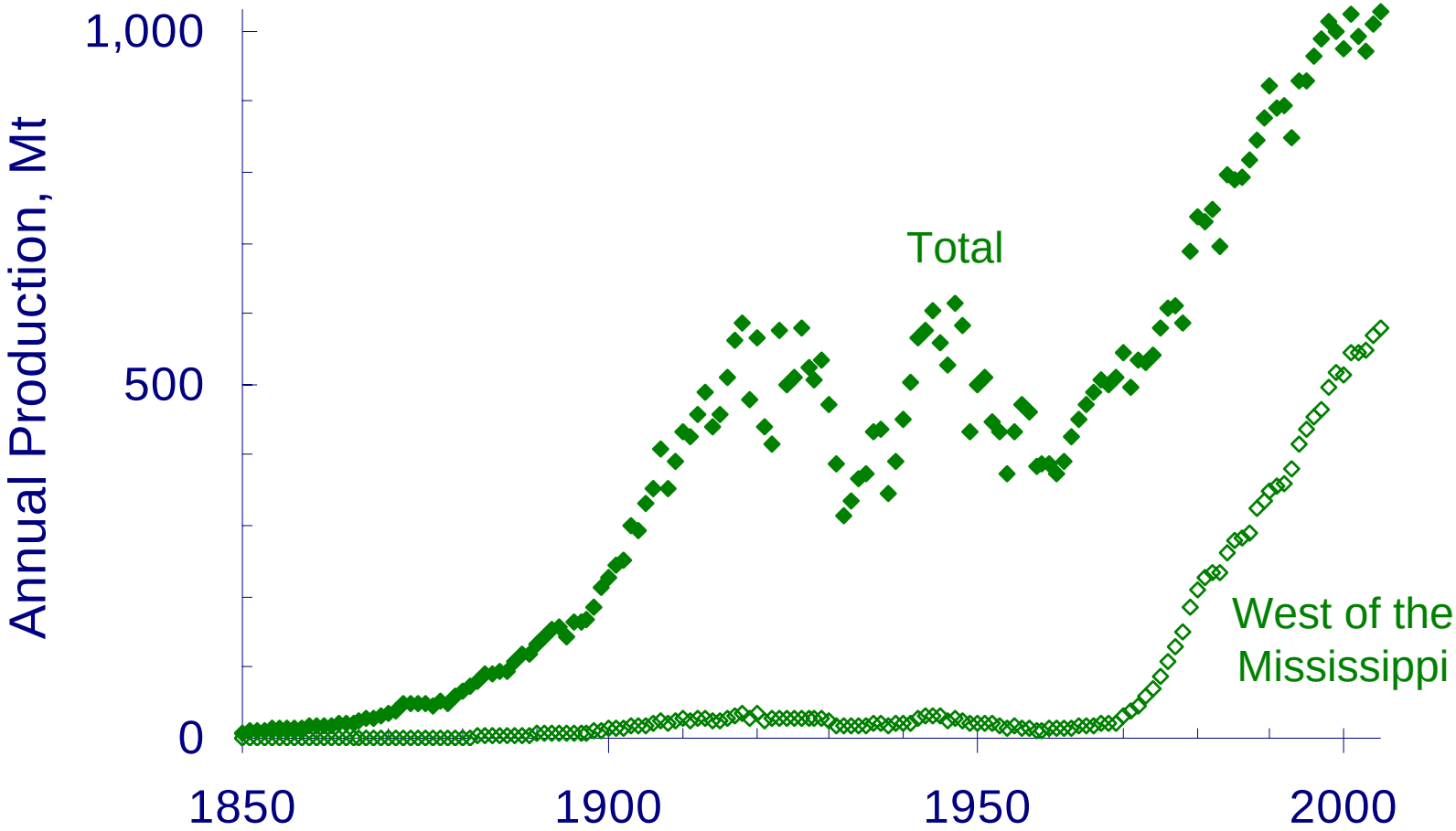


- Edward Hull used a recovery factor of 2/3
- Only 29% of Hull's reserves have been produced

American Coal

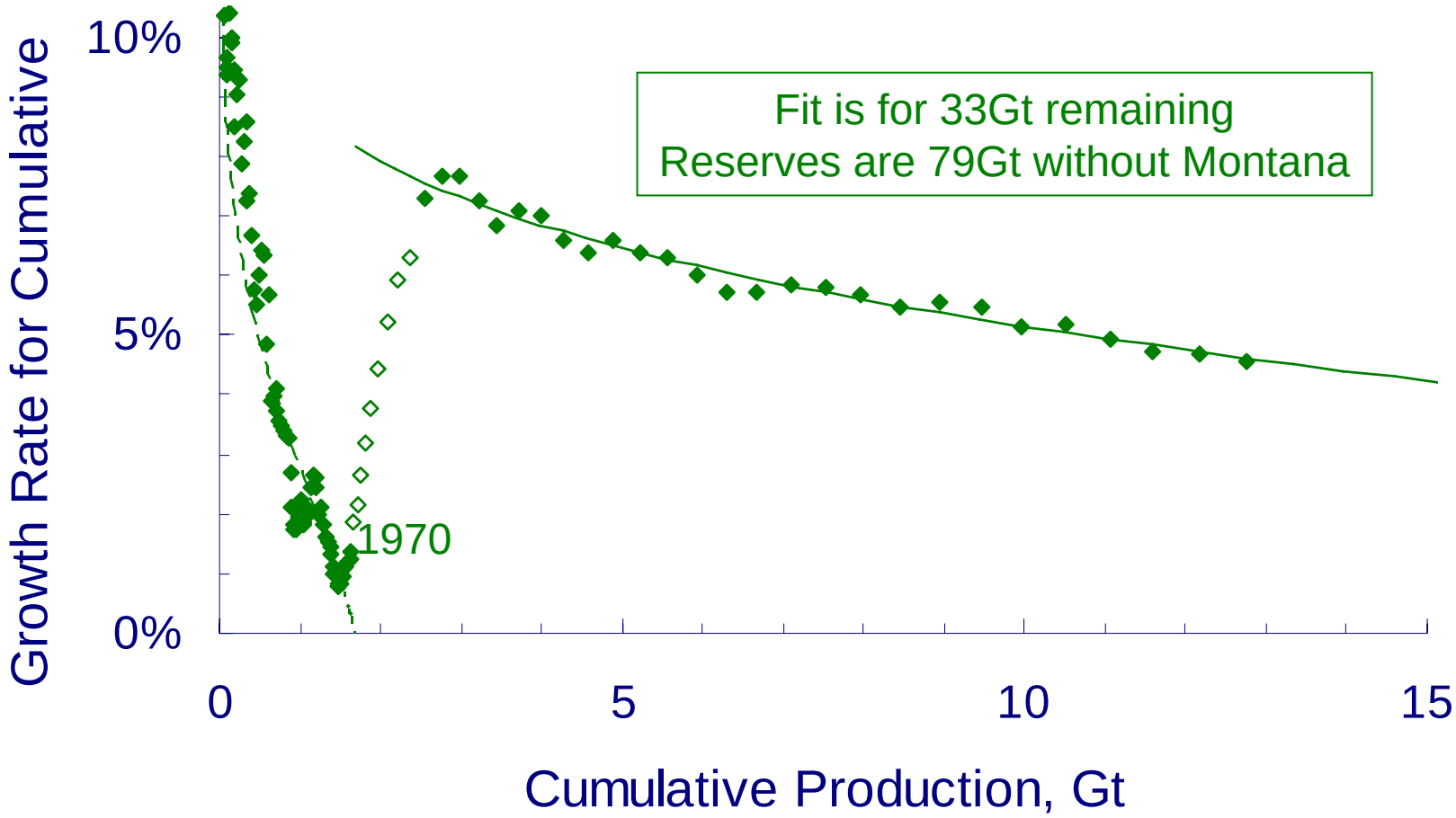
Photo by
Aaron Hockney

American Coal Production



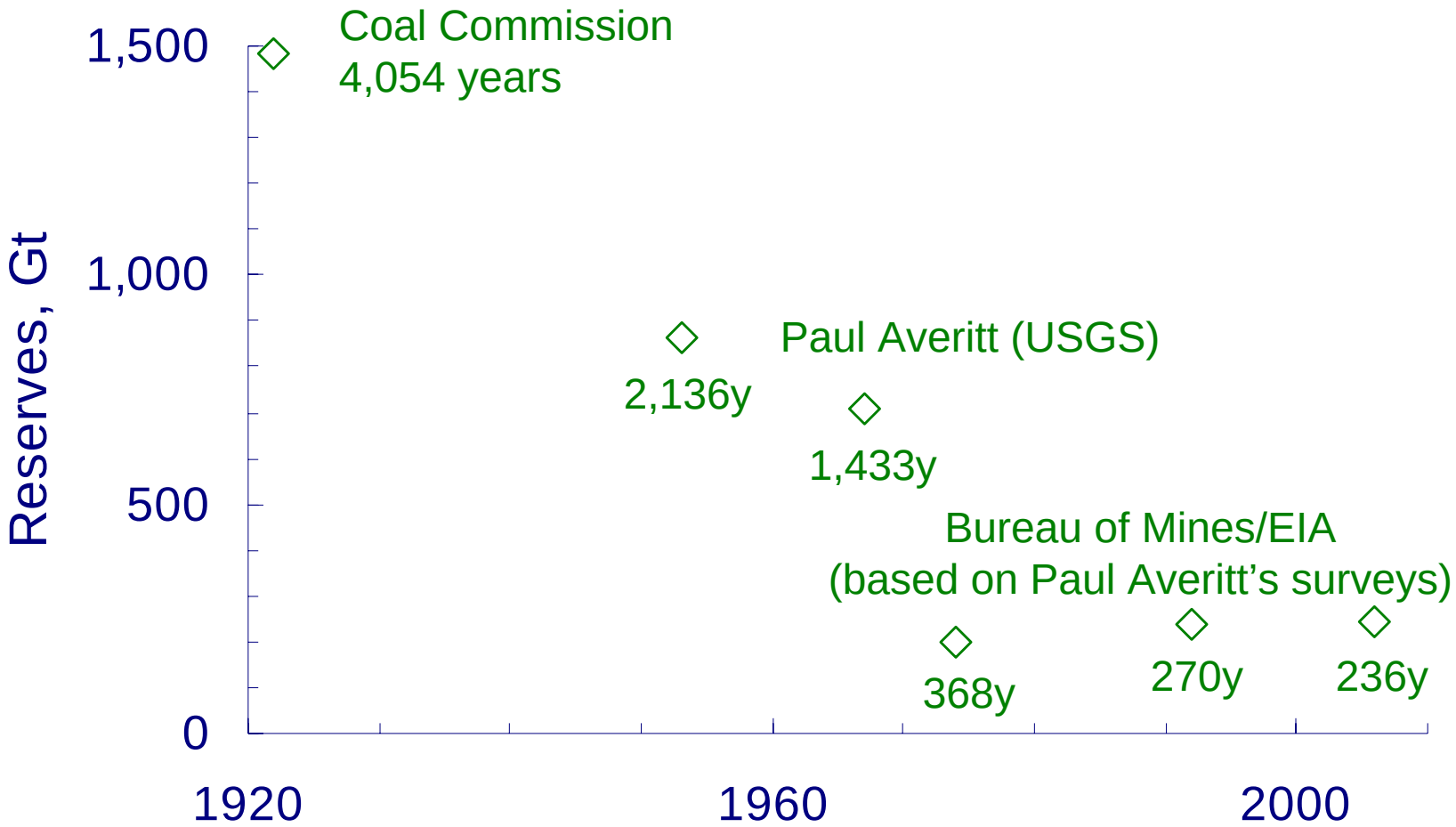
- Clean-Air Act during Nixon administration encouraged use of low-sulfur western coal

Coal West of the Mississippi



- Montana is the state with the largest reserves, 68Gt, but production is only 36Mt per year ($400 million dollars per year)

Reserves History for American Coal



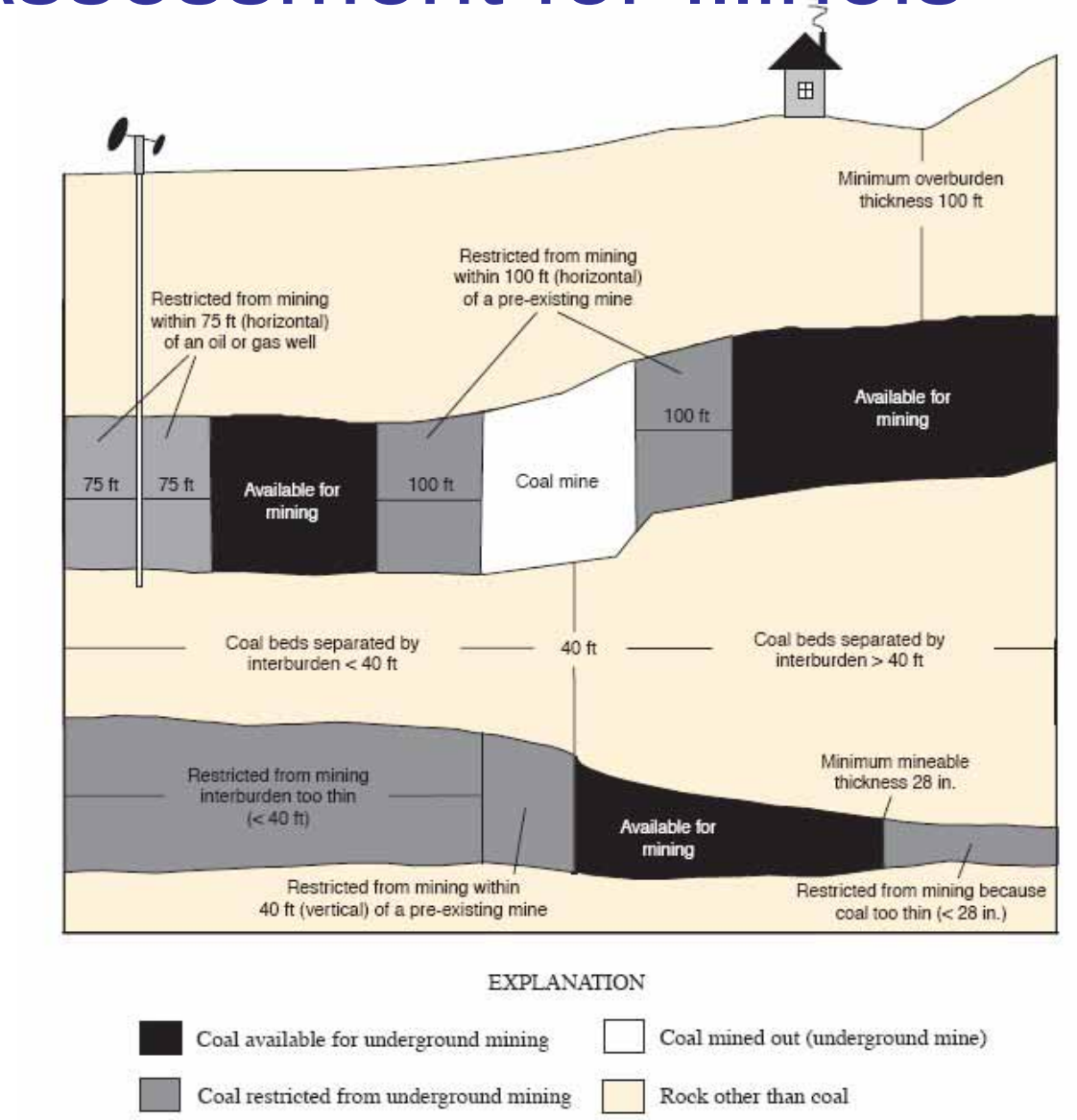
Are US Coal Reserves Too High?

"Present estimates of coal reserves are based upon methods that have not been reviewed or revised since their inception in 1974, and much of the input data were compiled in the early 1970s. Recent programs to assess reserves in limited areas using updated methods indicate that only a small fraction of previously estimated reserves are actually minable reserves."

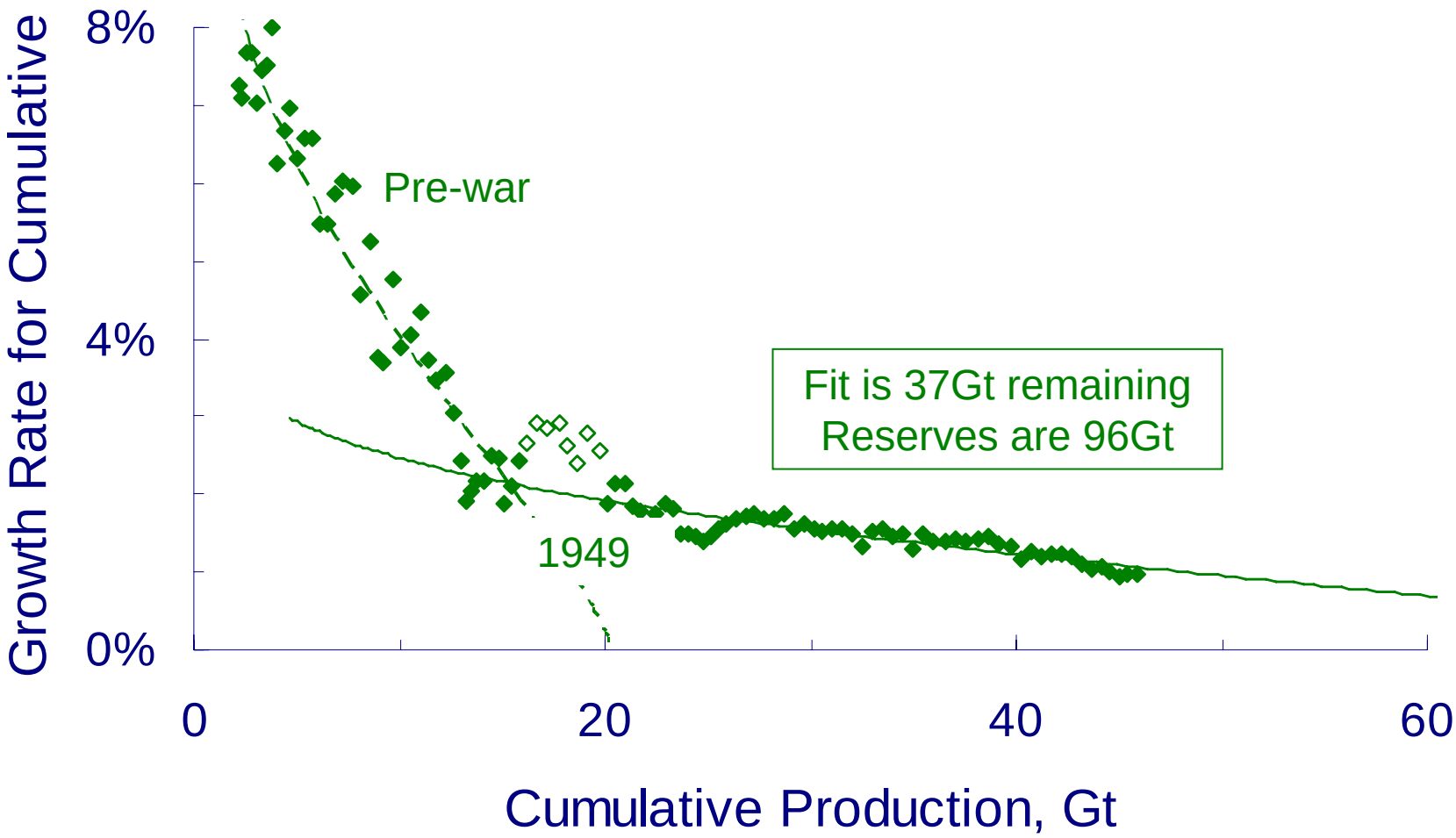
from the National Academy of Sciences
Report on Coal, June, 2007

USGS Assessment for Illinois

- From the USGS National Coal Assessment for the Illinois basin
- As more restrictions are taken into account, the reserves drop
- We will take the reserves to be an upper limit for remaining production



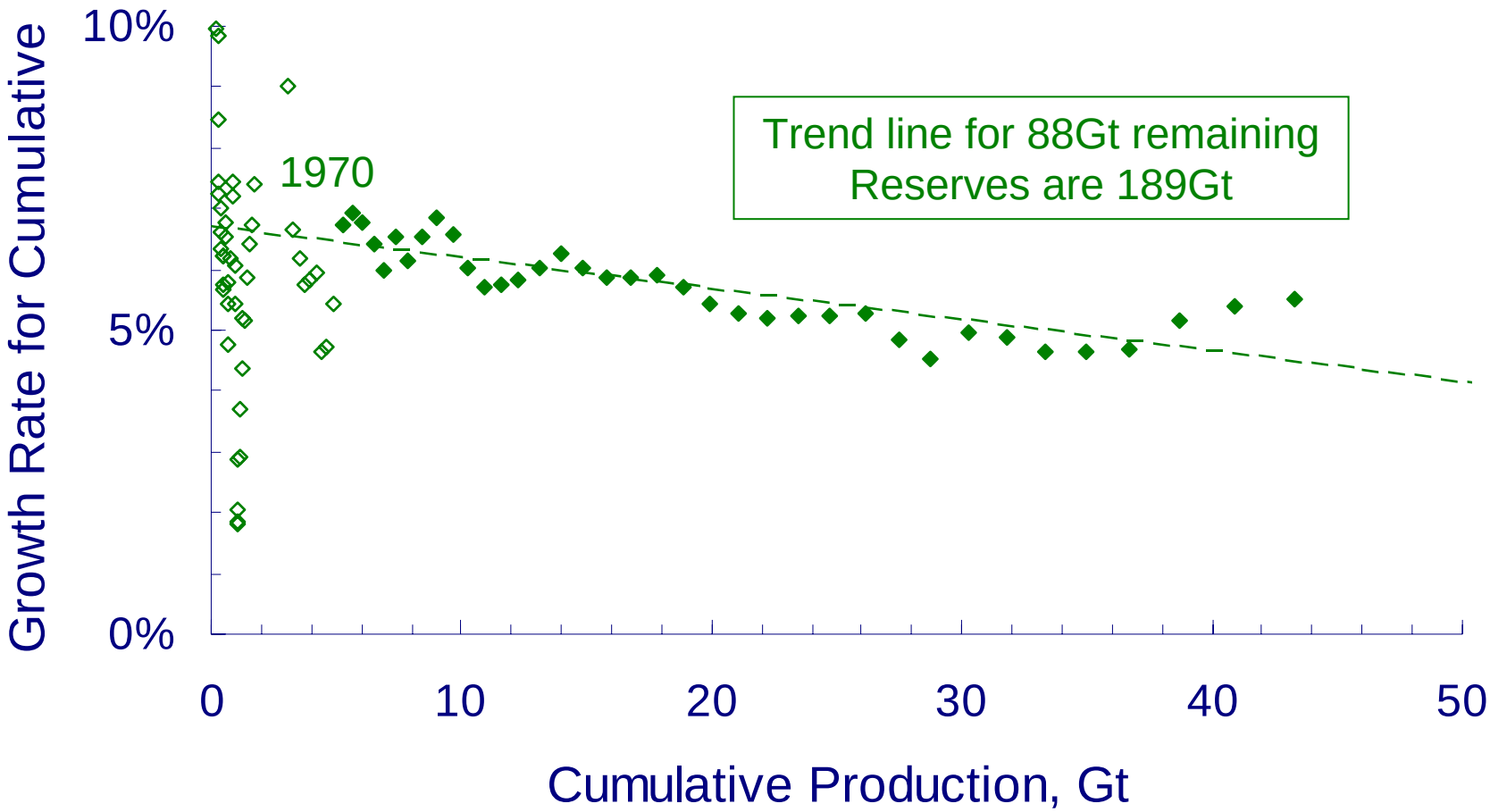
Coal East of the Mississippi



Chinese Coal

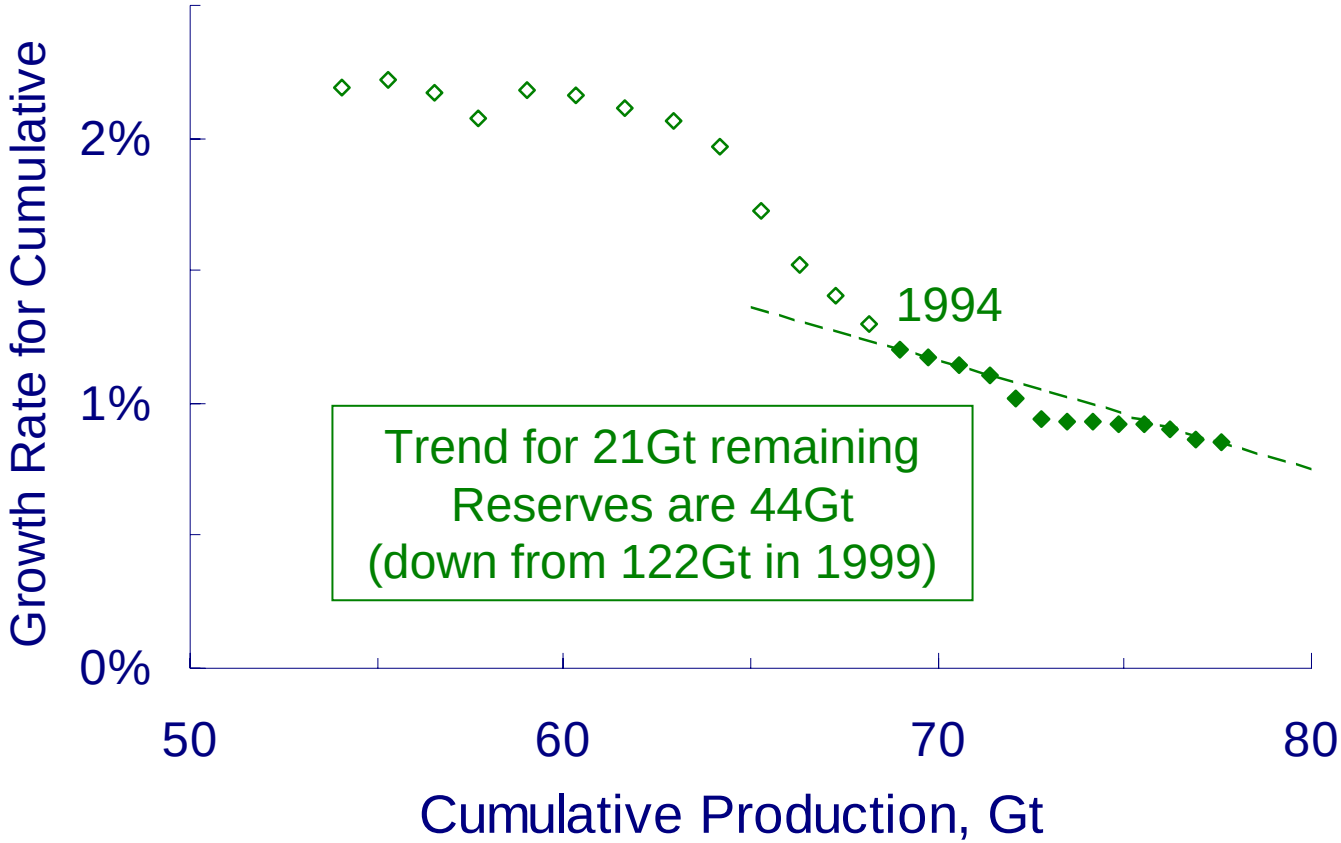
Photo by
Edwin Moise

Rate Plot for China



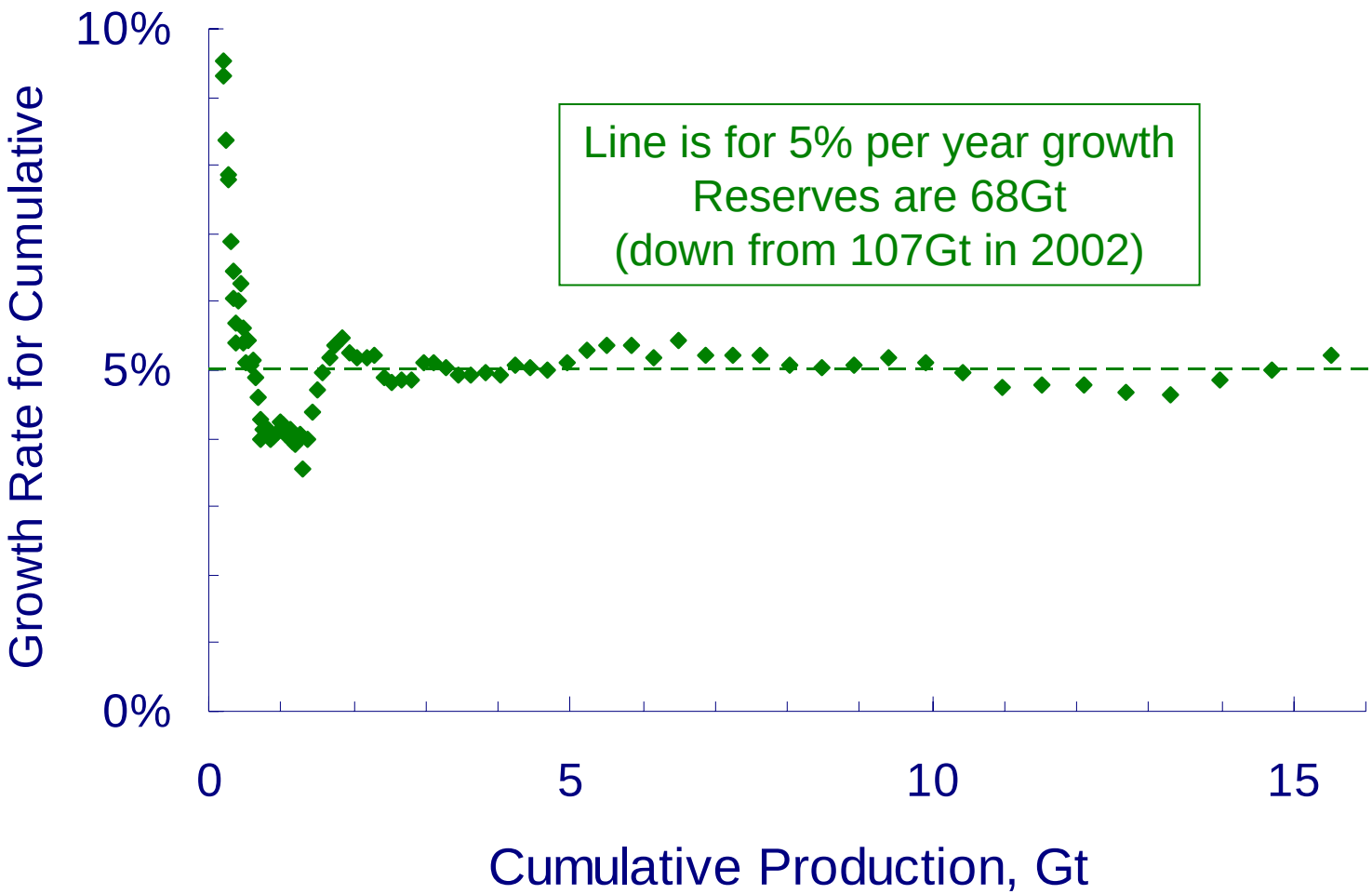
- Reserves from the Chinese Ministry of Land and Resources 2001 by way of Sandro Schmidt at the German resources agency BGR

Rate Plot for Europe

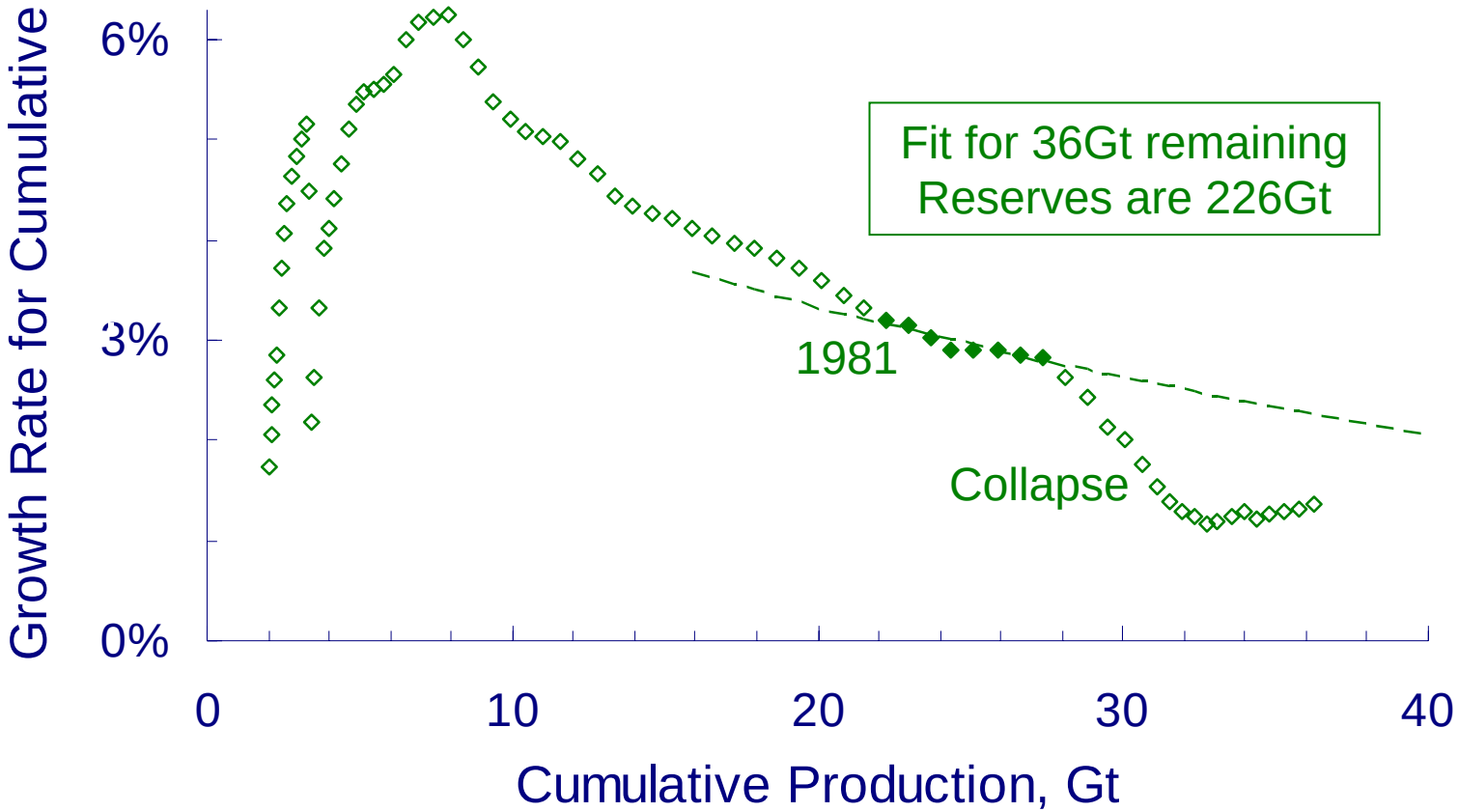


- France closed its last mine in 2004
- The last mines in the former West Germany will close by 2018

Rate Plot for South Asia



Former Soviet Union



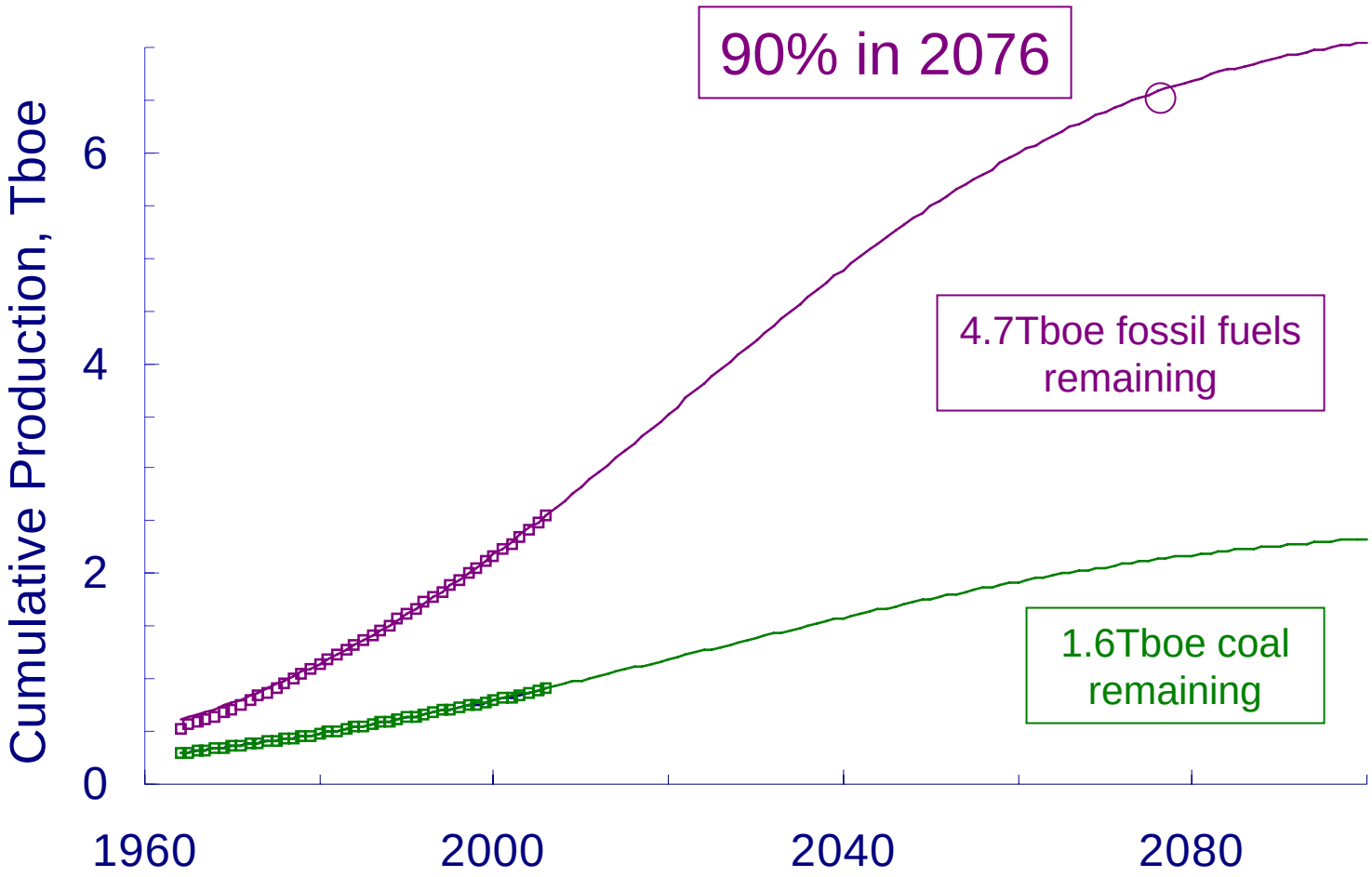
- It is probably time to cut the Ukrainian reserves for the Donets Basin to include only coal at working mines
- The Siberian economy is only about half the size it was in Soviet times

Projections vs Reserves for World Coal

Region	Projection Gt	Reserves Gt
Eastern US	37	96
Western US w/o Montana	33	79
Montana	68	
Central and South America	16 (down)	
China	88	189
South Asia	68 (down)	
Australia and New Zealand	50	77 (down)
Former Soviet Union	36	226
Europe	21	44 (down)
Africa	16	30 (down)
World (at 3.6boe/t)	435 (1.6Tboe)	903

- UN IPCC scenarios assume 18Tboe is available for production

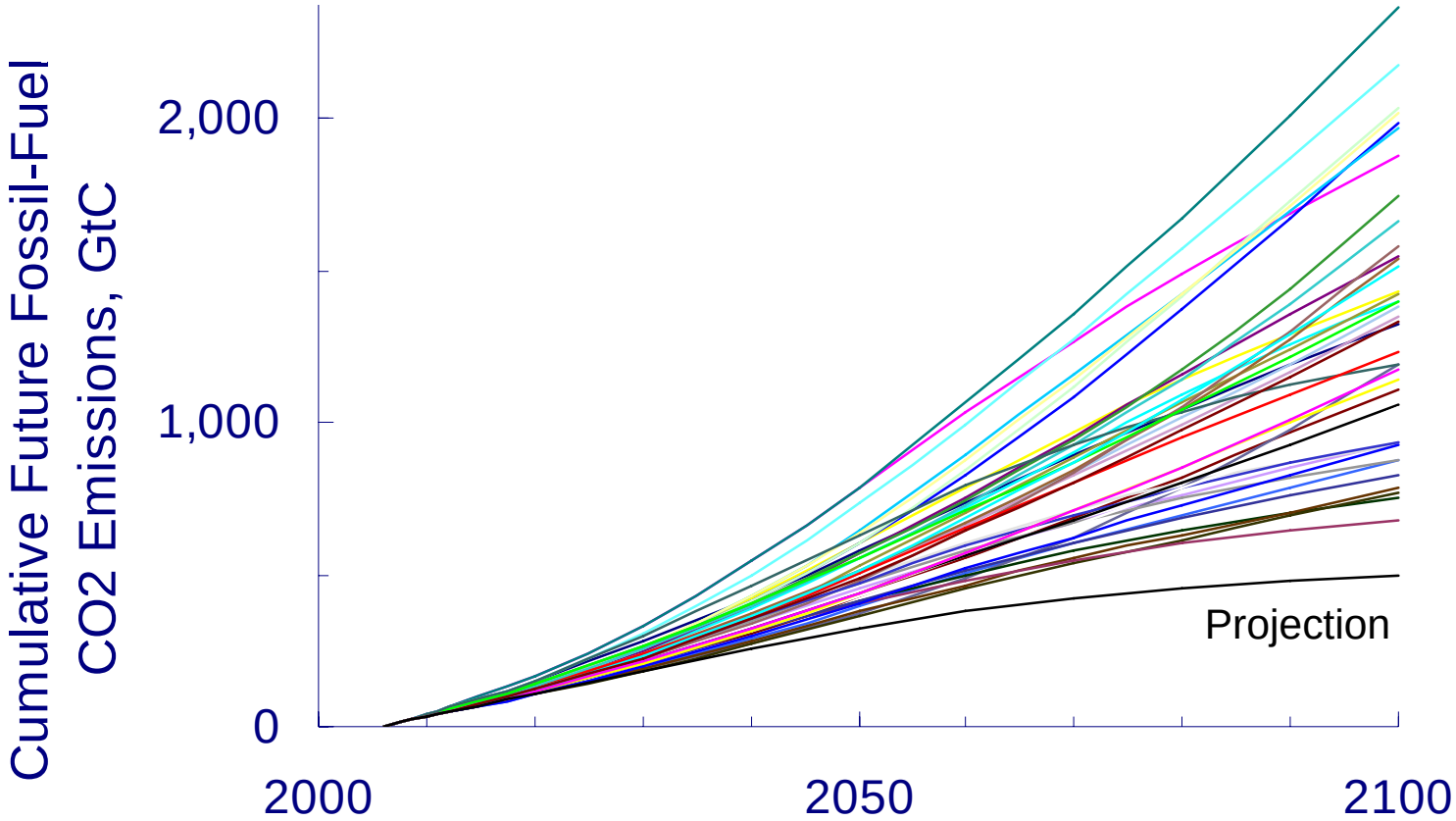
Future Fossil-Fuels Production



Alternatives to Fossil Fuels

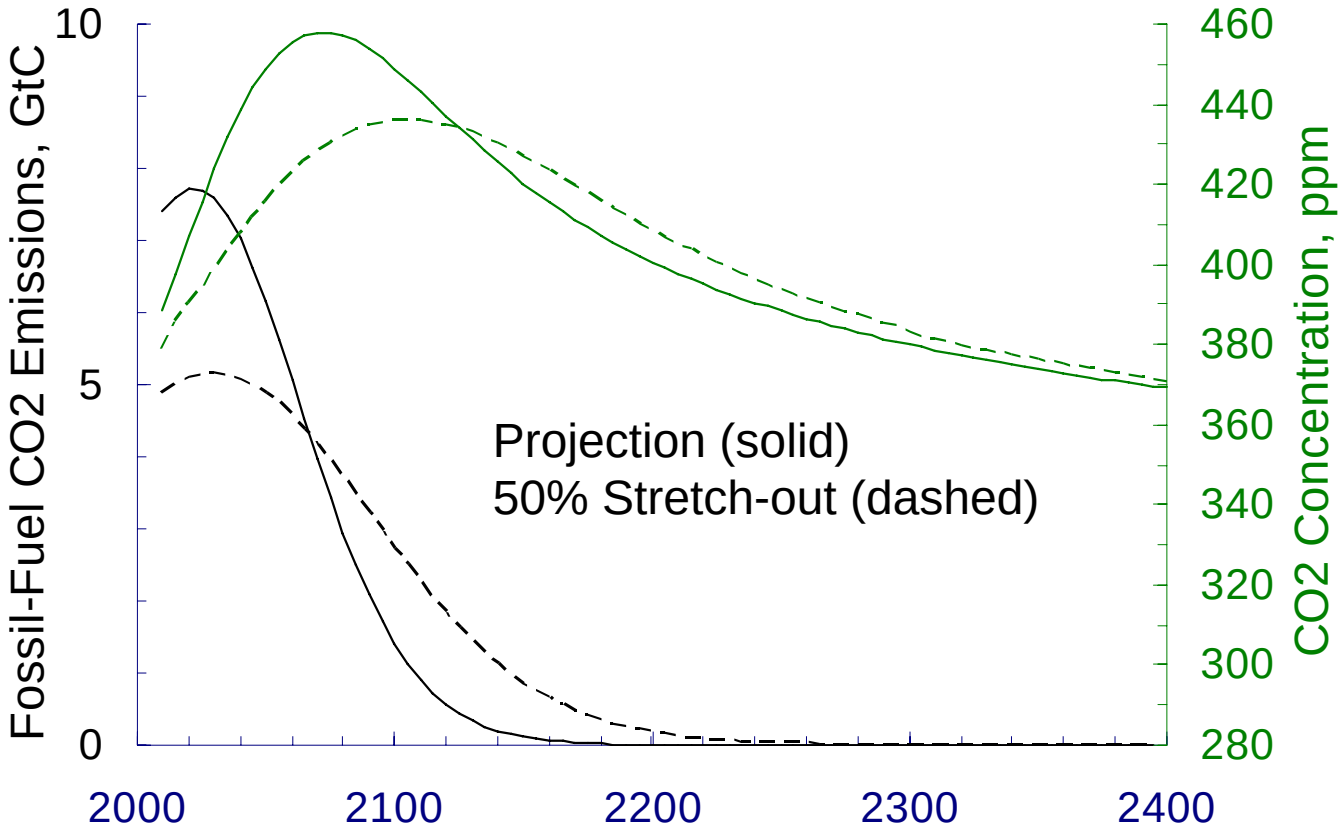
- Hydroelectric and nuclear are each about 15% of world electricity
- Wind
  - 74GW capacity (1.0% of world electricity)
  - Capacity has increased by a factor of 10 in 9 years
- Ethanol and biodiesel
  - 700kboe/d (0.8% of world oil)
  - Production has increased by a factor of 10 in 25 years
- Solar
  - Photovoltaics are 8GW capacity (0.1% of world electricity)
  - Capacity has increased by a factor of 100 in 22 years
  - Concentrating Solar Thermal is increasing rapidly in California, current bids are 11 cents to 12 cents per kWh

Comparing with the UN IPCC Scenarios



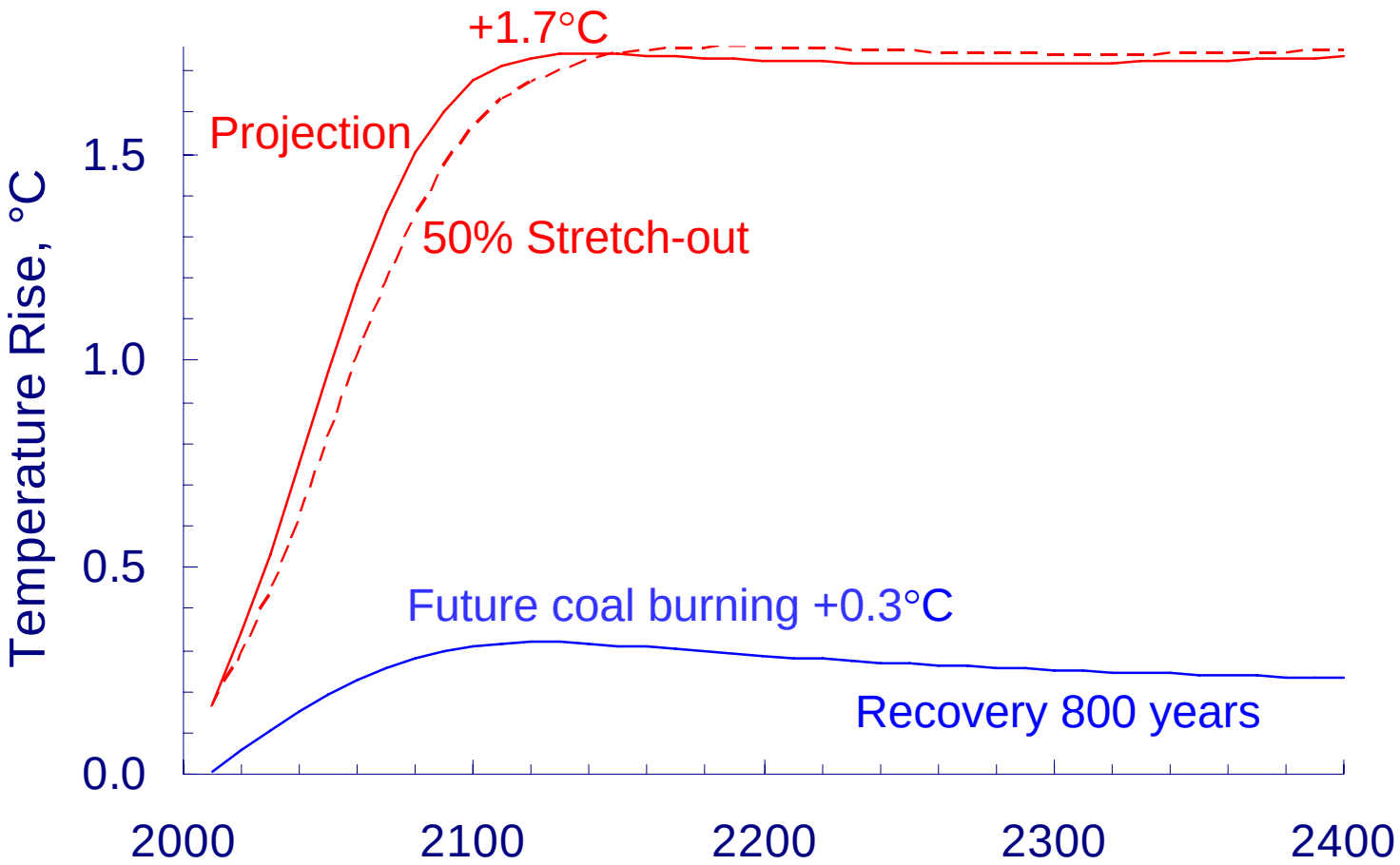
- Our projection has lower emissions than any of the 40 IPCC scenarios
- This is still true even with full coal reserves
- Jean Laherrere has been pointing out that something is wrong for years

Simulated Carbon-Dioxide Levels



- Our projection gives a peak CO2 concentration of 460ppm
- Simulations from the program MAGICC from Tom Wigley at the National Center for Atmospheric Research in Boulder. This program was used in the earlier UN IPCC Assessment Reports.

Simulated Temperature Rises



- 0.1°C of the rise is associated with future US coal burning, and this could be reduced by carbon-dioxide capture and burial

Summary

- The projection for remaining coal production is 435Gt, half of reserves
- The projection for the year of 90% exhaustion of world fossil fuels is 2076, giving a time frame for alternatives
- To reduce the temperature peak in the next century, it is critical to reduce ultimate production, not just slow down current consumption

Proposal — Fossil-Fuel Preserves

- Wouldn't our descendents appreciate having oil, natural gas, and coal left in the ground, rather than flattened mountains and more CO_2 in the air or buried?
- Federal lands account for 1/3 of fossil-fuel production
- We could make fossil-fuel preserves by not giving new leases for drilling and mining
- Future chemists could have feedstock for the petrochemical industry — oil, gas, and coal have special chemical properties that are lost if we just burn them

Conclusions

- For climate change, less minable coal is *good news*
- We need to keep up the present high growth rate for alternatives

2007 Houston World Oil Conference

Proceedings

- Conference Program
- Conference DVD
- Video Highlights
- Peak Oil Review
- ASPO-USA