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Fossil fuels: reserves and resources
An Economist's Perspective

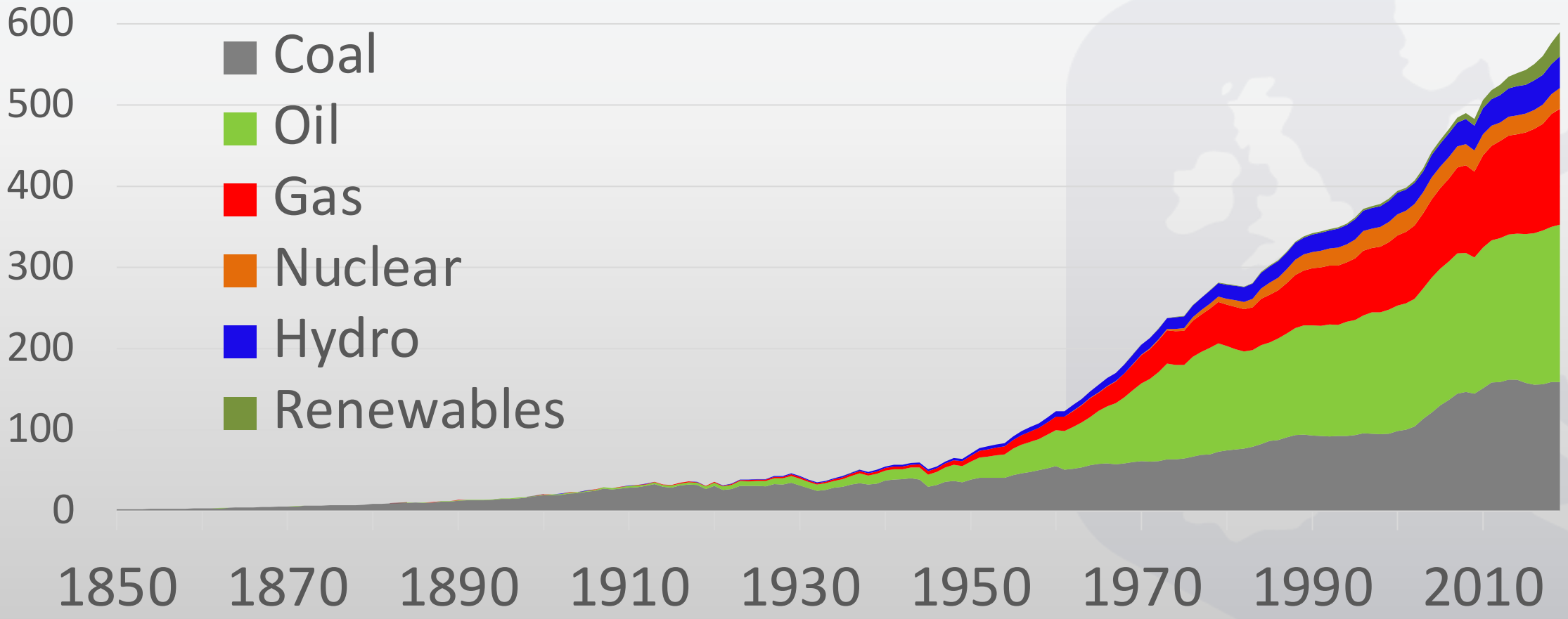
Erkal Ersoy
Julian Fennema
Mark Schaffer

Centre for Social and Economic Data Analytics (CSEDA)
Edinburgh Business School
Heriot-Watt University
https://www.hw.ac.uk/ebs/research/social-economic-data-analytics.htm

Outline

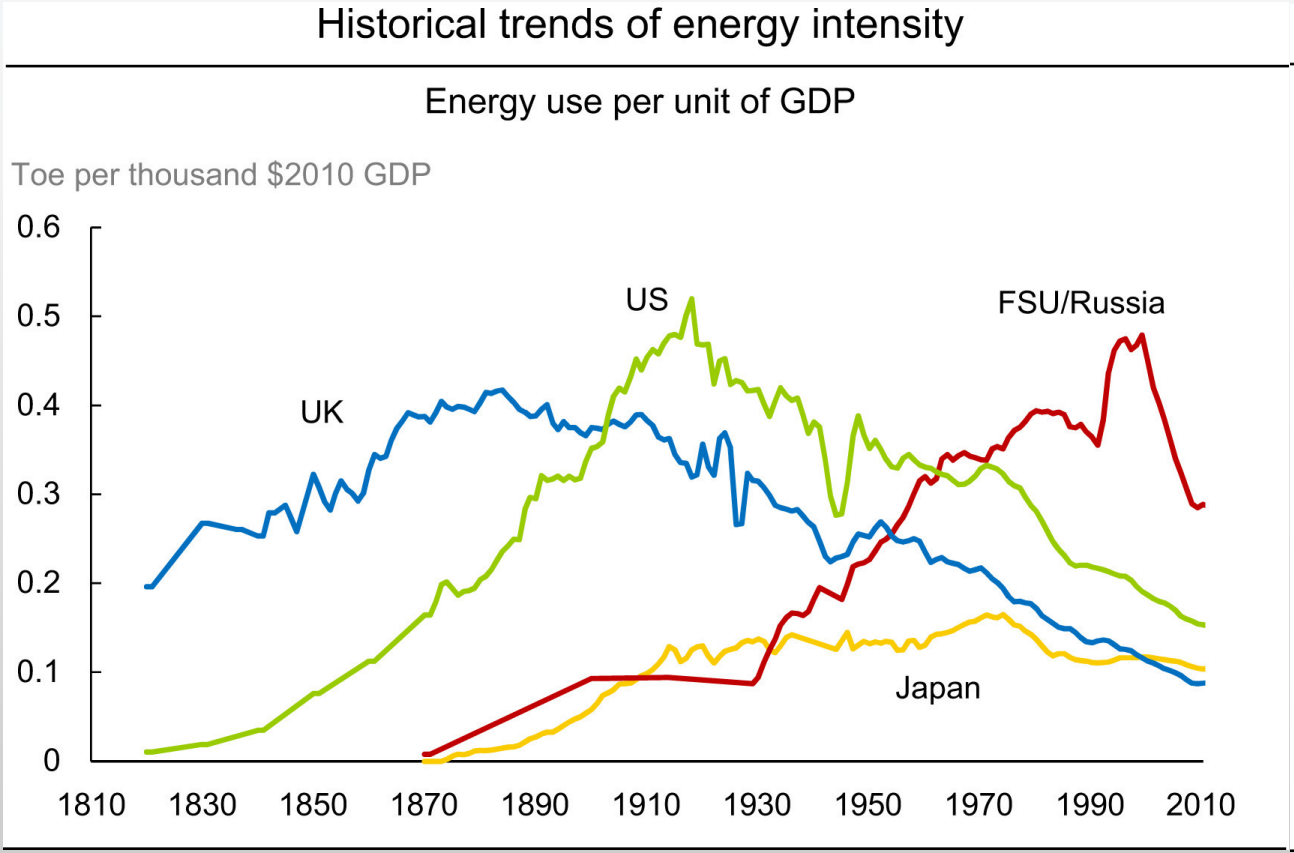
- The long-run perspective.
- “Resources” vs “Reserves” (Humpty Dumpty Economics).
- Focus on example of oil, but principles apply to all fossil fuels.
- Whatever happened to “Peak Oil”?
- Stranded Assets.
- Scarce resources.

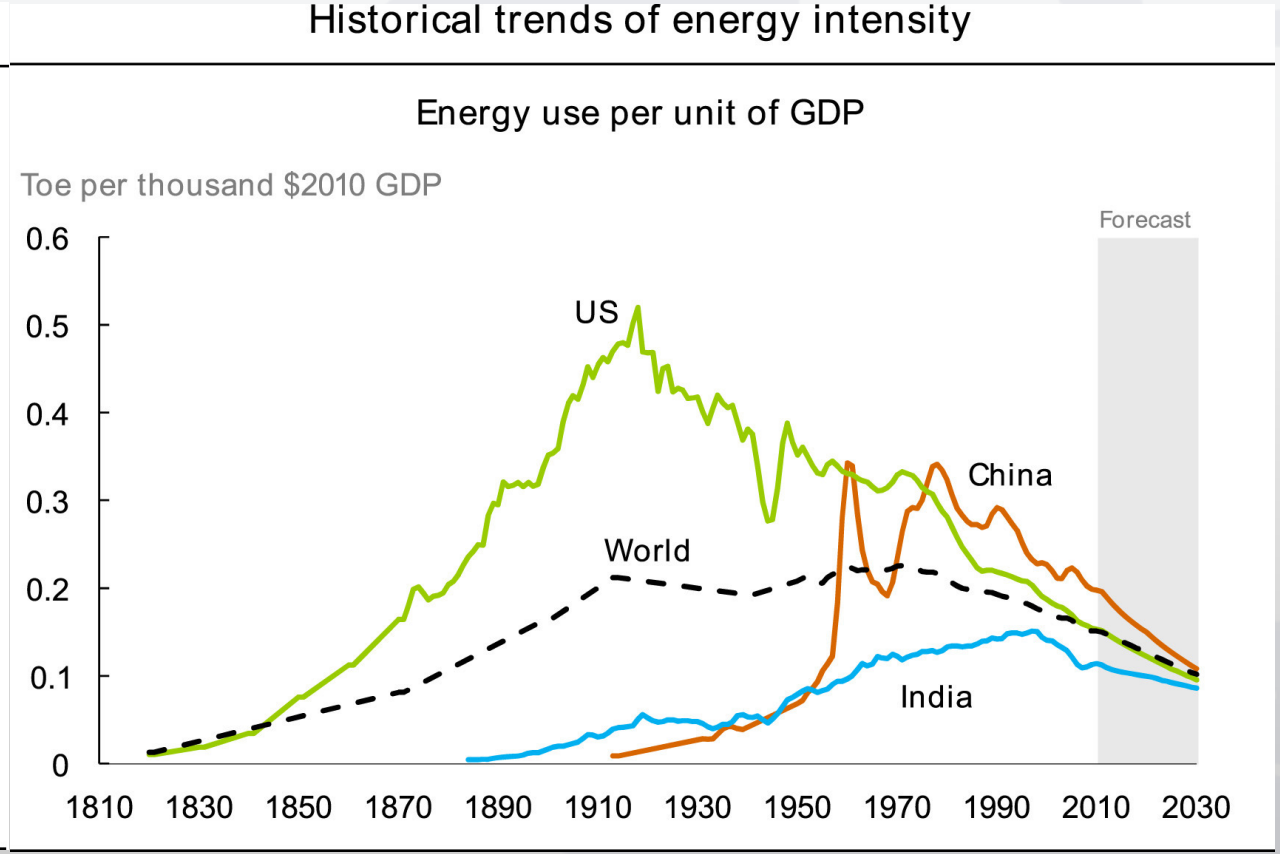
The Long Run: World energy consumption 1850-2019 (EJ)



Data from BP Statistical Review of World Energy 2020 & authors' calculations

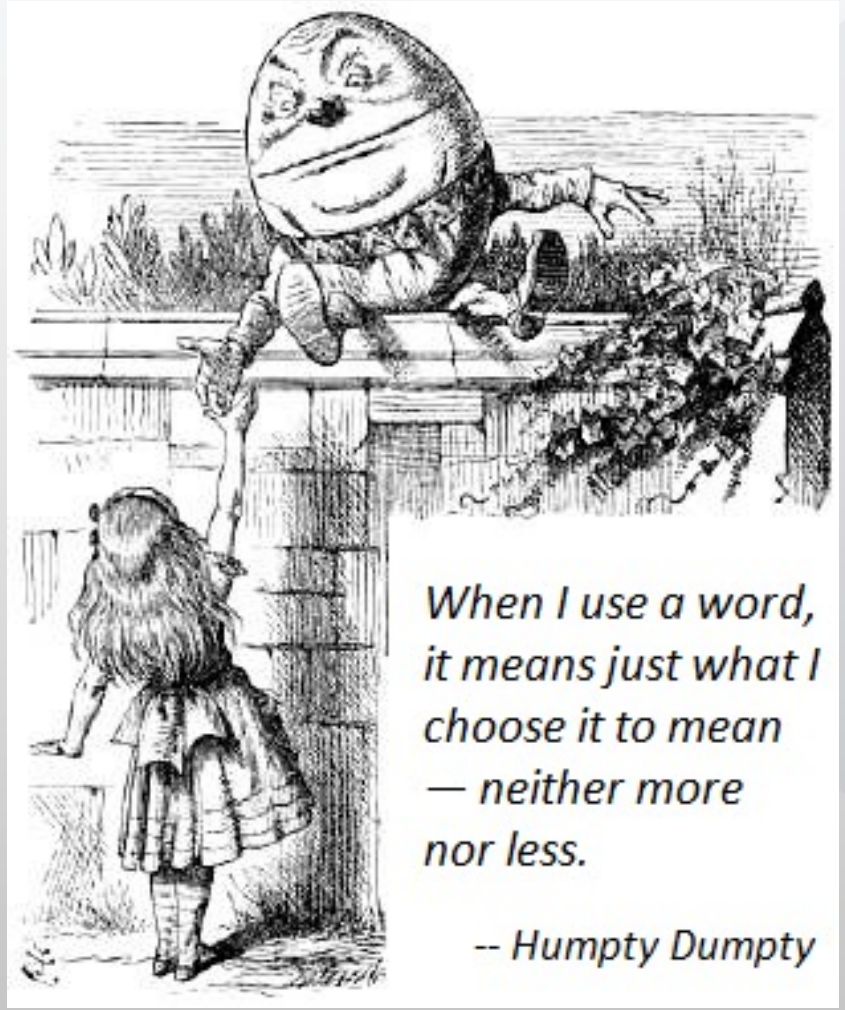
The Long Run: Energy intensity over 2 centuries





Source: Ruehl-Appleby-Fennema-Naumov-Schaffer, *Energy Policy*, 2012

“Resources” versus “reserves”



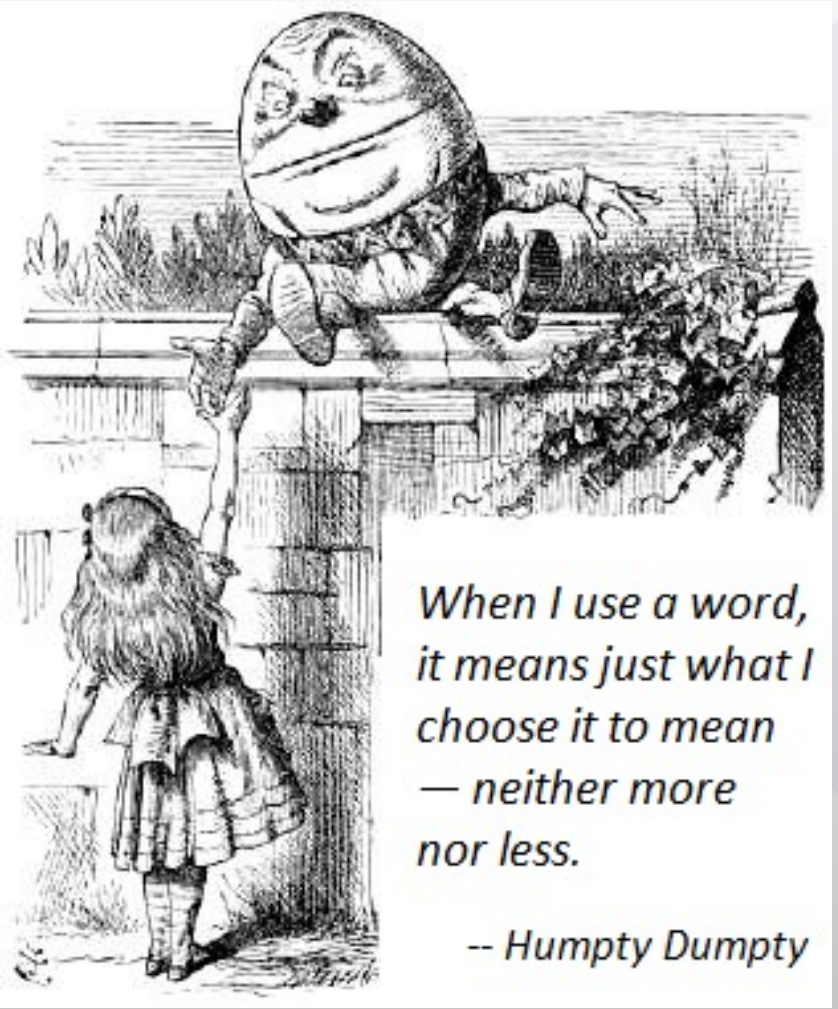
“Resources” versus “reserves”

Resources:

What we think might be there.

Recoverable resources:

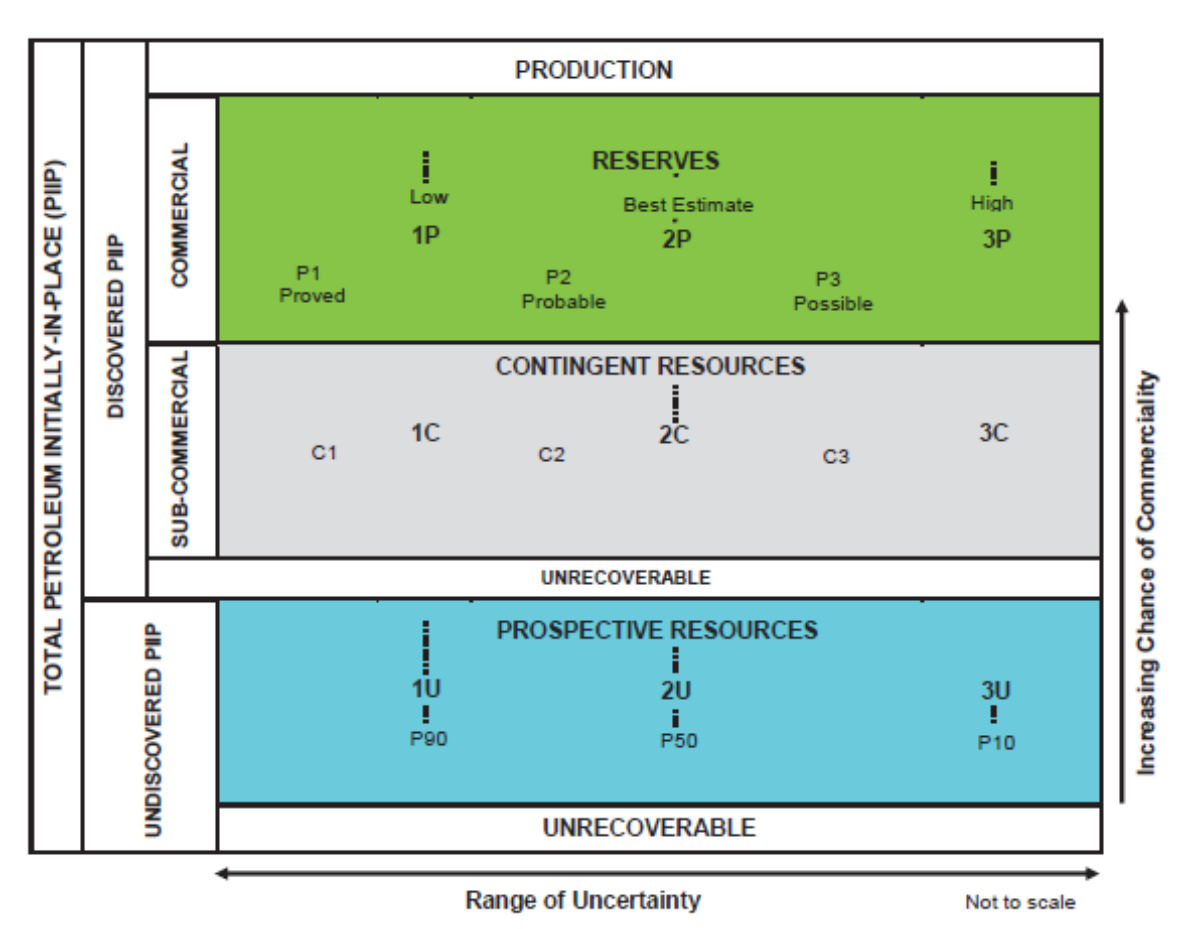
What we think might be there and technically extractable.



Reserves:

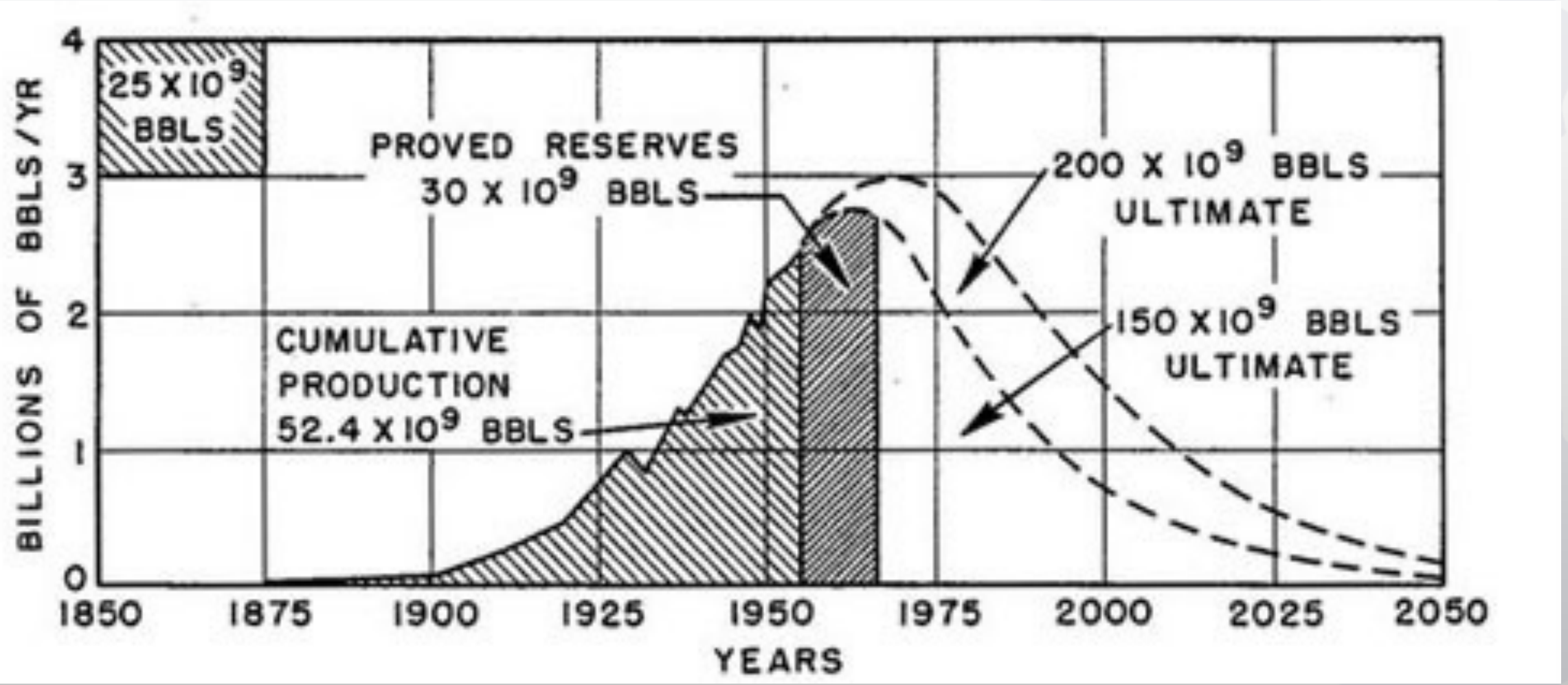
What we think might be there and technically **and economically** extractable.

Resources versus reserves – PRMS classification



- For oil and/or gas to be classified as reserves, it must be:
  - discovered (*information*),
  - recoverable (*technology*),
  - remaining (*not yet extracted), and*
  - **commercial** (*economics*).
- Technical progress generally adds to reserves.
- Production generally subtracts from reserves.
- New information can move reserves up or down.
- **Price, regulation, policy can move reserves up or down.**

Peak oil? The origins (Hubbert 1956)



Peak Oil: The view from 2007

Headline in the *Independent* newspaper, 14 June 2007:
"World oil supplies are set to run out faster than expected, warn scientists"

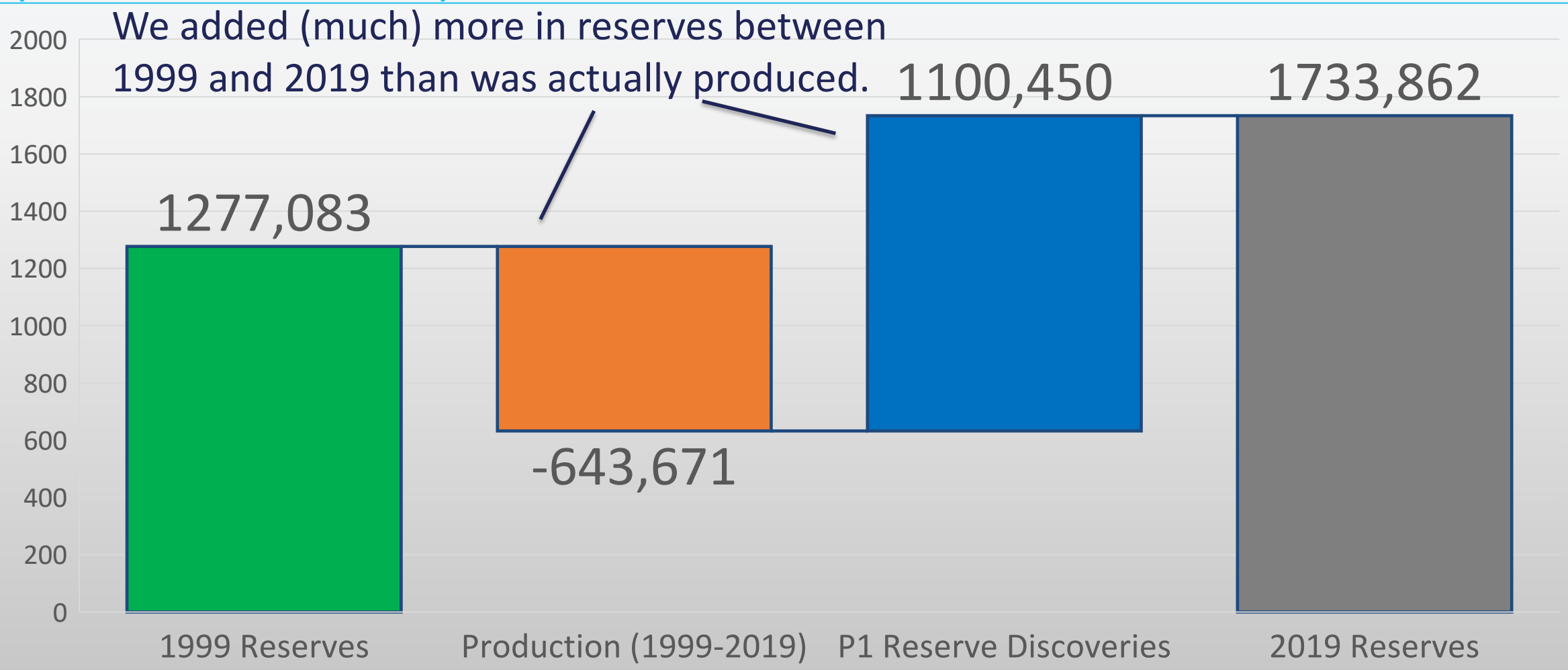
The head of the Oil Depletion Analysis Centre is quoted:
"It's quite a simple theory and one that any beer drinker understands. The glass starts full and ends empty and the faster you drink it the quicker it's gone."

This is *not* how reserves work (but ok for resources).

Extreme scenario: no new discoveries, no new technology. As oil is used up, it becomes scarcer. The price increases … and therefore more resources become commercially viable and added to reserves. The beer glass gets deeper.

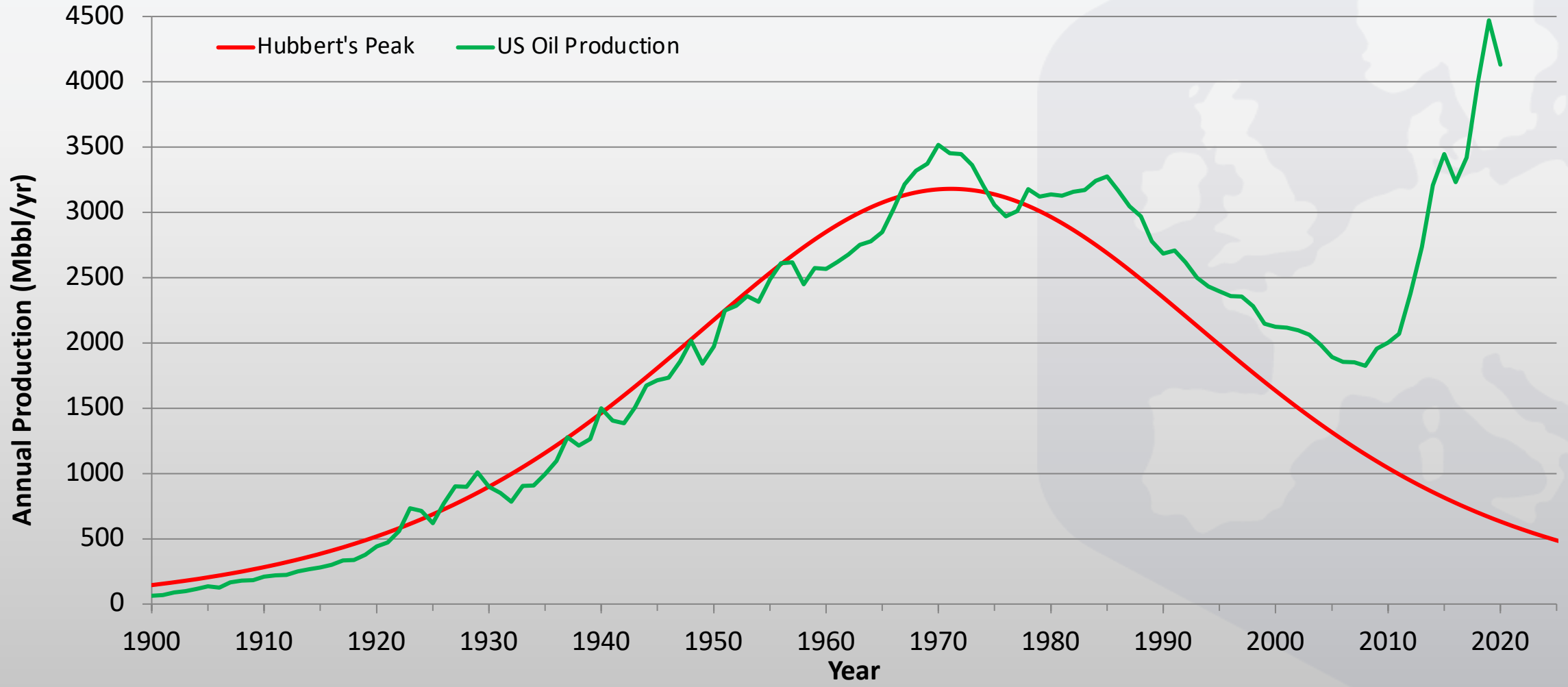
Oil Reserves Outflows and Inflows, 1999-2019

(thousand million barrels)



Data from BP Statistical Review of World Energy 2020

Was Hubbert right?



Reproduced and updated by authors from Dr. Huber's website (http://physics.gac.edu/~huber/hubbert/).

The missing pieces … are markets and technology

On the supply side…

» Sustained high prices of oil → incentives to develop new technologies, exploration and search for locations of resources.

» Sustained low prices of oil → expensive fields removed from (economic) reserves.

» “Shale oil revolution” in the US: Technology matures and is deployed on a large scale starting in the 2000s. Even at low prices, new and cheaper fields are added to reserves due to new technologies. Expensive fields, e.g. Canadian oil sands, now unlikely to be developed; subtract from reserves.

Supply side versus demand side

And on the demand side…

- Economic growth in the developing world vs. efficiency gains in the developed and developing world.
- Decarbonisation will remove reserves by shifting demand: lower demand for fossil fuels → lower prices (keeping supply constant) and, thus, lower reserves.
- “Stranded assets”: further, under climate commitments, we should not burn all proved reserves (e.g., McGlade and Ekins, 2015).
- How should we value these reserves if we have already identified more than we intend to use?

Resource scarcity?

» Stranded assets: under climate commitments, we should not burn all proved reserves (e.g., McGlade and Ekins, 2015).

Total reserves (as of 2010) unburnable before 2050 for the 2°C scenarios		
Fuel	**With CCS**	**Without CCS**
Oil	33%	35%
Natural Gas	49%	52%
Coal	82%	88%

» How should we value reserves that we do not intend to use?

Resource scarcity?

- Economic growth in the developing world is pushing demand up, while improvements in energy efficiency are having the opposite effect.
- OECD energy consumption 2019: 179 GJ per capita, population 1.3 billion.
- Non-OECD: 55 GJ per capita, population 6.4 billion.
- All resources are scarce (says the die-hard economist).
- But the global capacities to absorb CO2 emissions, to transition to new low-carbon technologies, and to mitigate the consequences of climate change, are the key scarce resources now.

ANY QUESTIONS