

Engineers Australia - Energy for the Future

Energy Return on Investment (EROI)

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CLIMATE & ENERGY COLLEGE

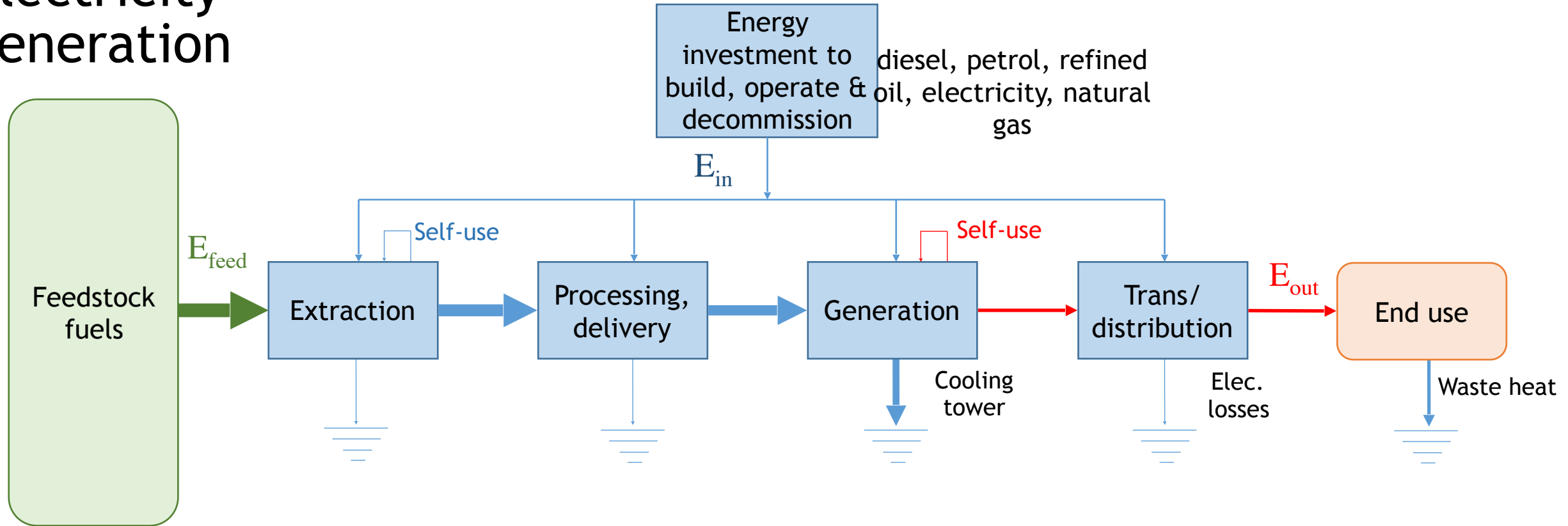
Overview

- Introduction
- Define EROI
- How to measure EROI
- Purpose
- How does EROI relate to the economy
- EROI and oil supply
- EROI of Australian electricity supply

EROI defined :

EROI (energy return on investment) is the ratio of how much energy is gained from an energy production process compared to how much of that energy (or its equivalent from some other source) is required to extract, grow, etc., a new unit of the energy in question.

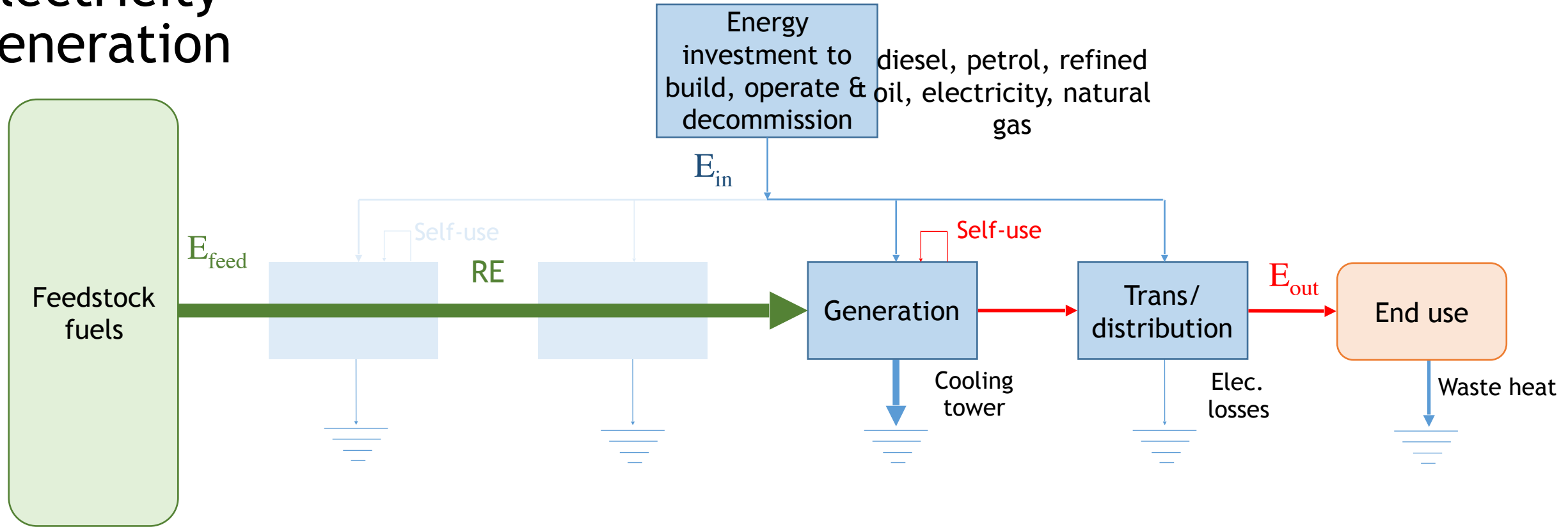
Electricity generation



coal , crude, methane
wind, solar
hydro

$$EROI = E_{out} / E_{in}$$

Electricity generation



coal , crude, methane
wind, solar
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$$EROI = E_{out} / E_{in}$$



1901, Texas
Lucas gusher
(Spindletop),
about 18 million barrels/
yr



2016, Russia far east
Berkut platform
about 30 million barrels/
yr

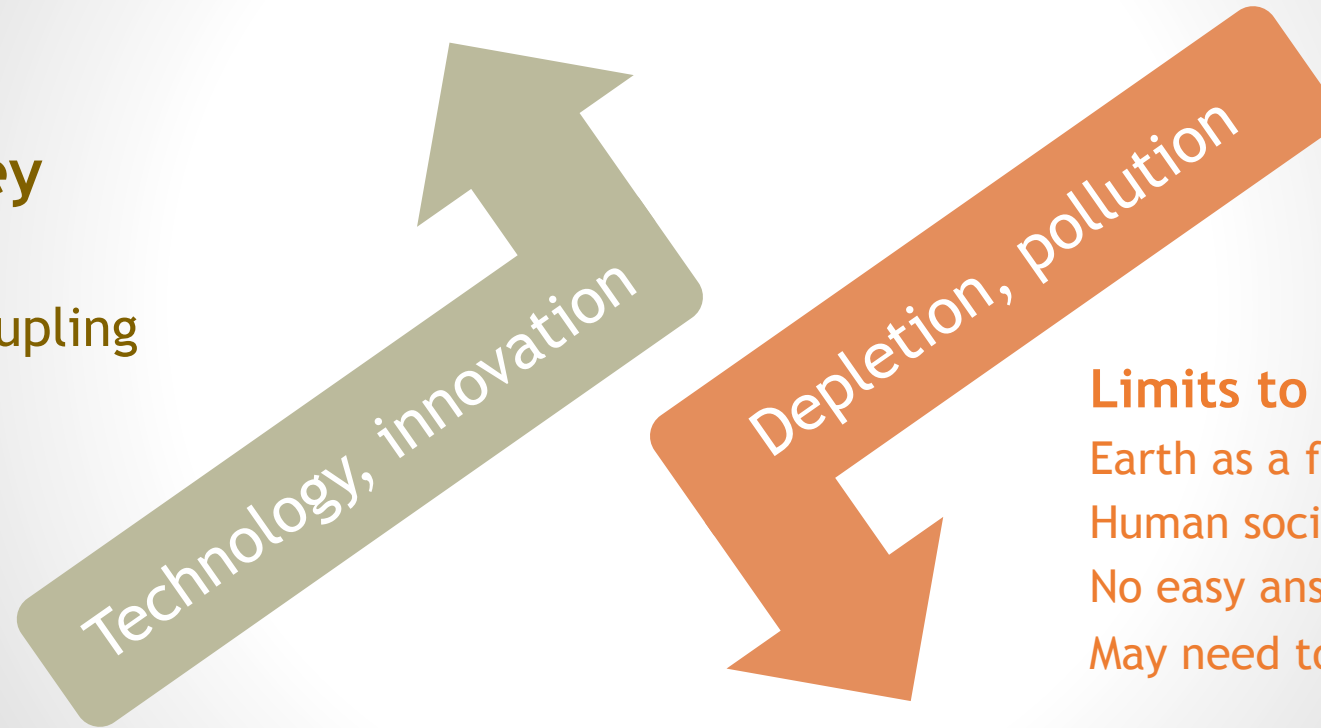
EROI is focused on the competitive struggle between resource depletion and technology

Silicon Valley mindset

Resource decoupling

RE + batteries

Fracking



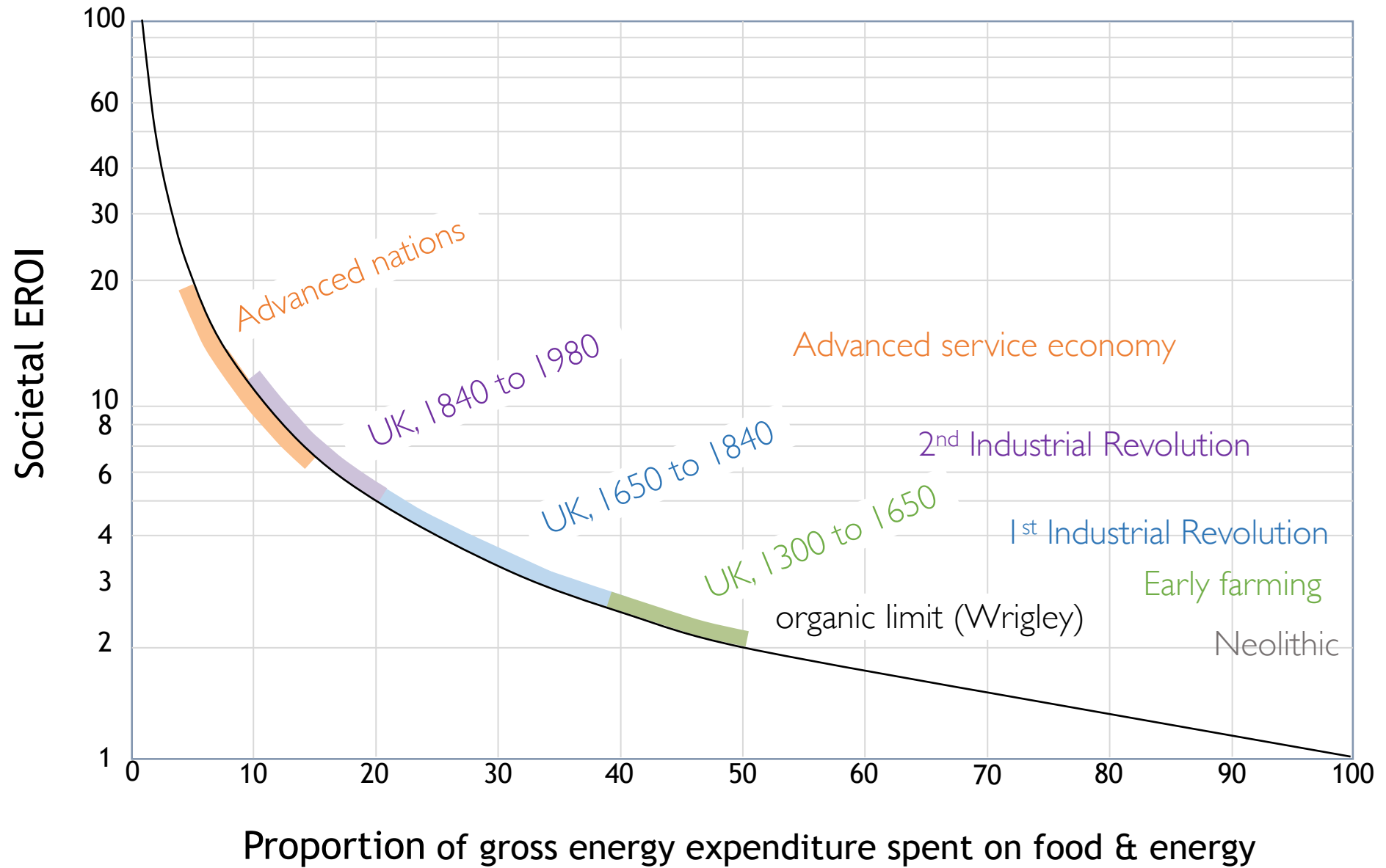
Limits to growth

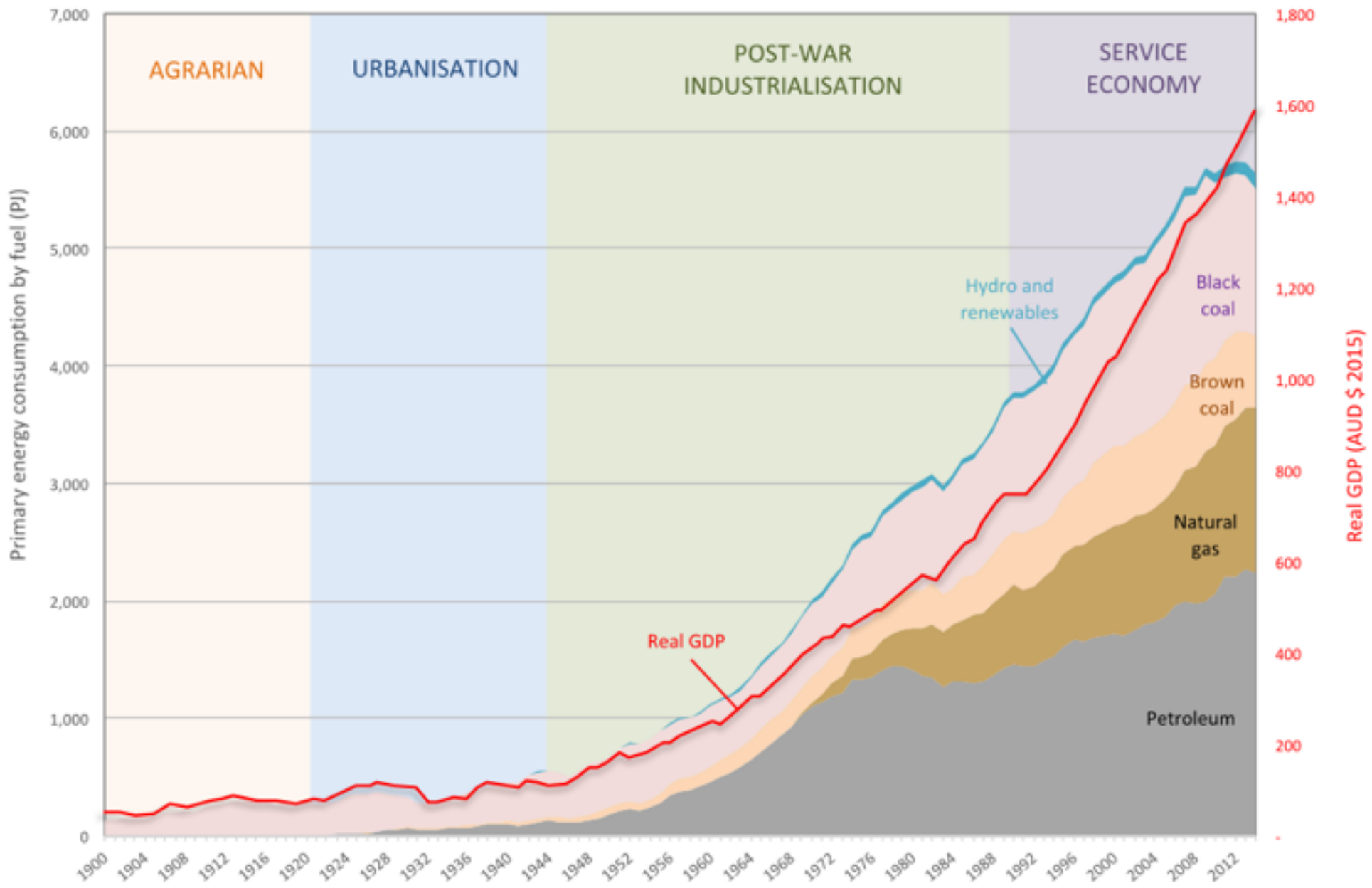
Earth as a finite system

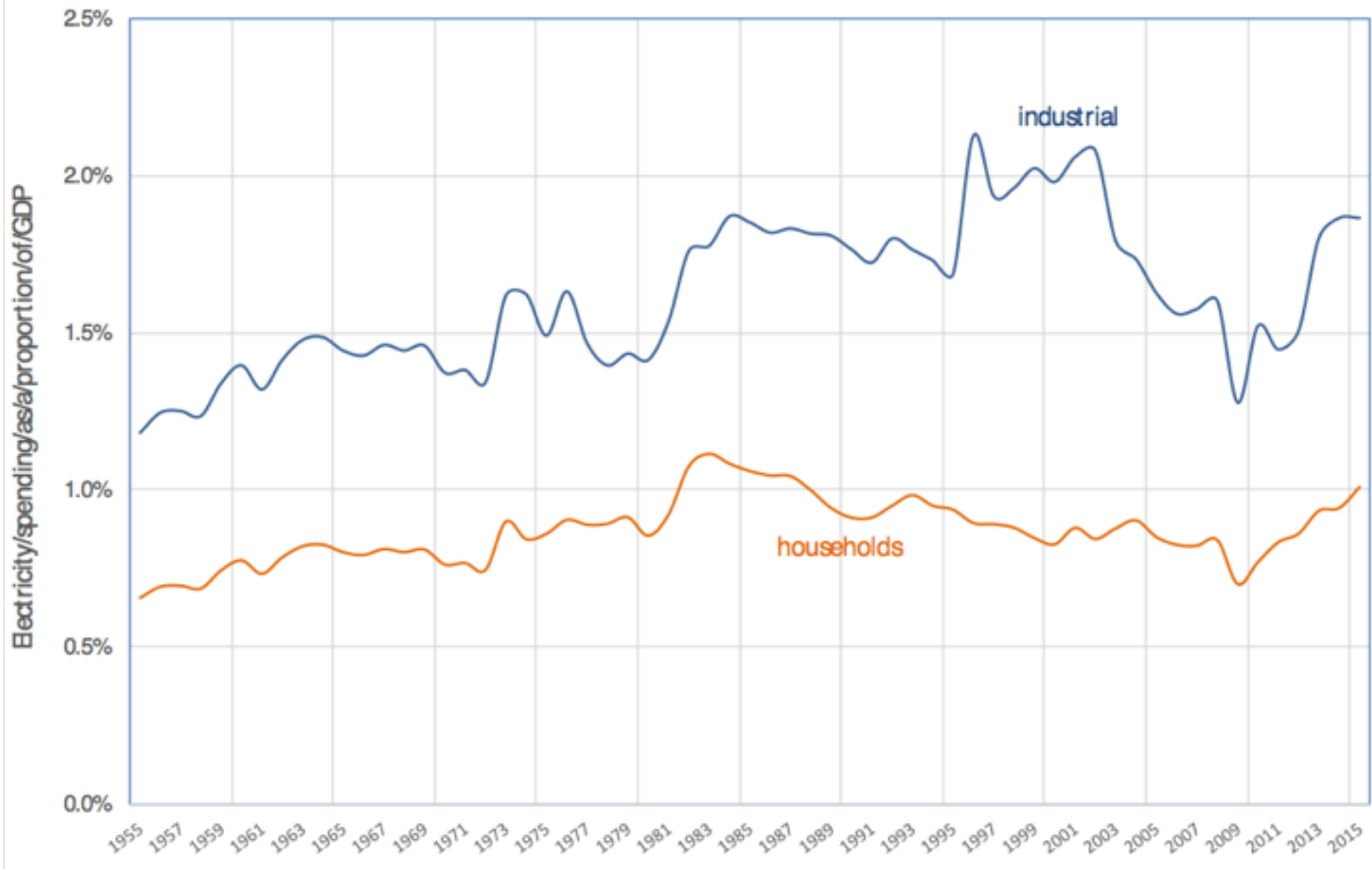
Human society as a dissipative system

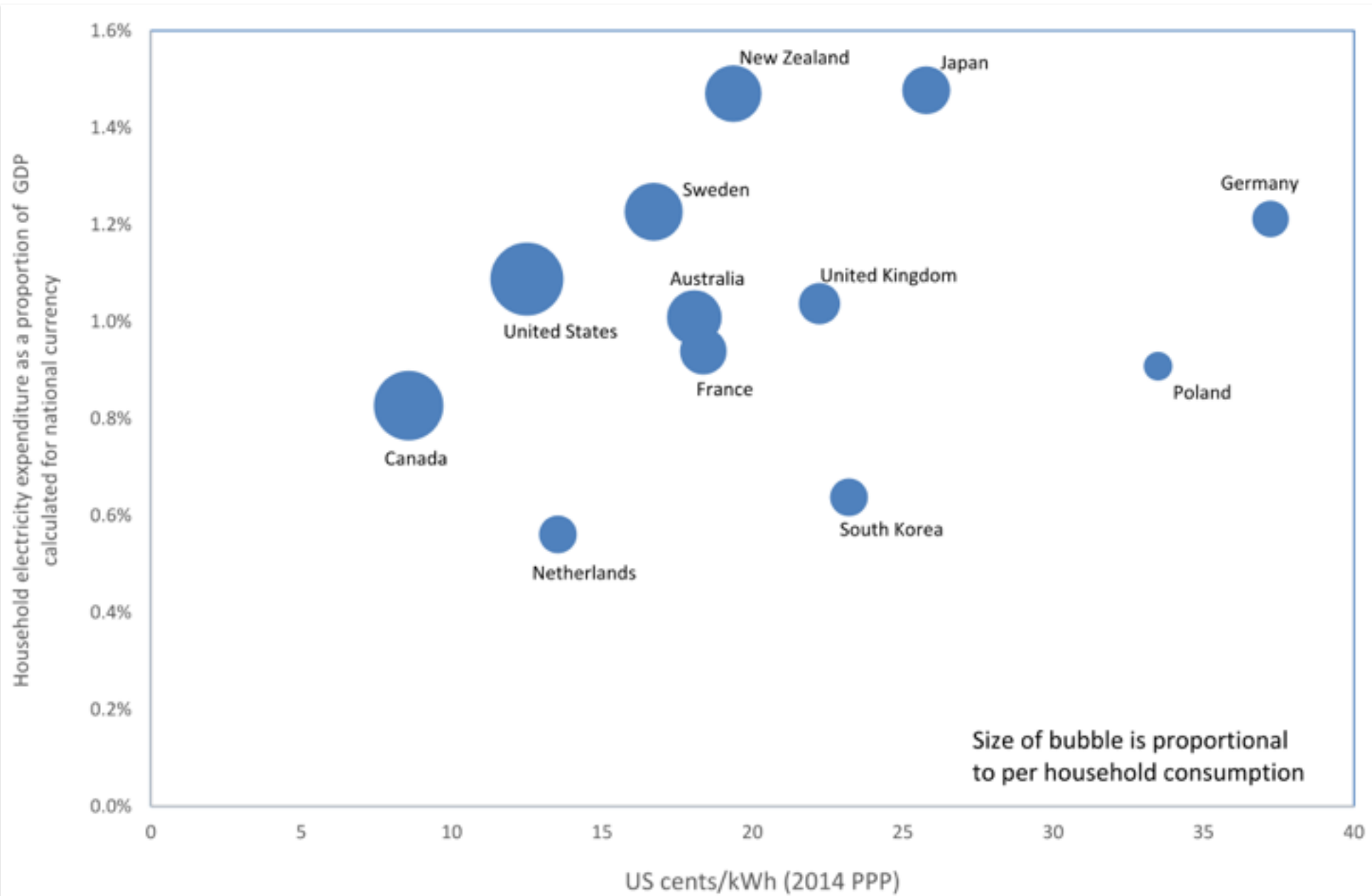
No easy answers to energy

May need to reconfigure society

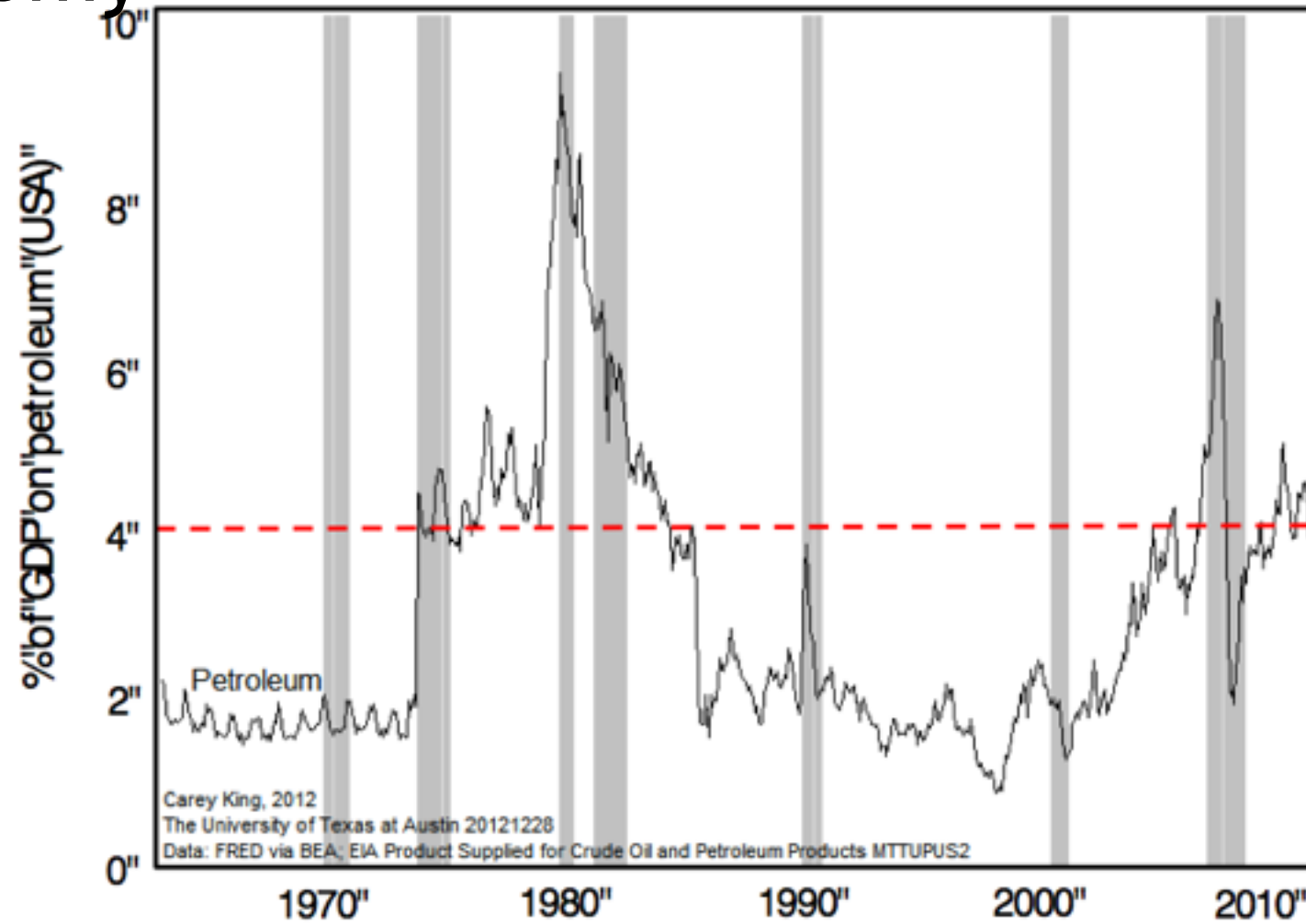








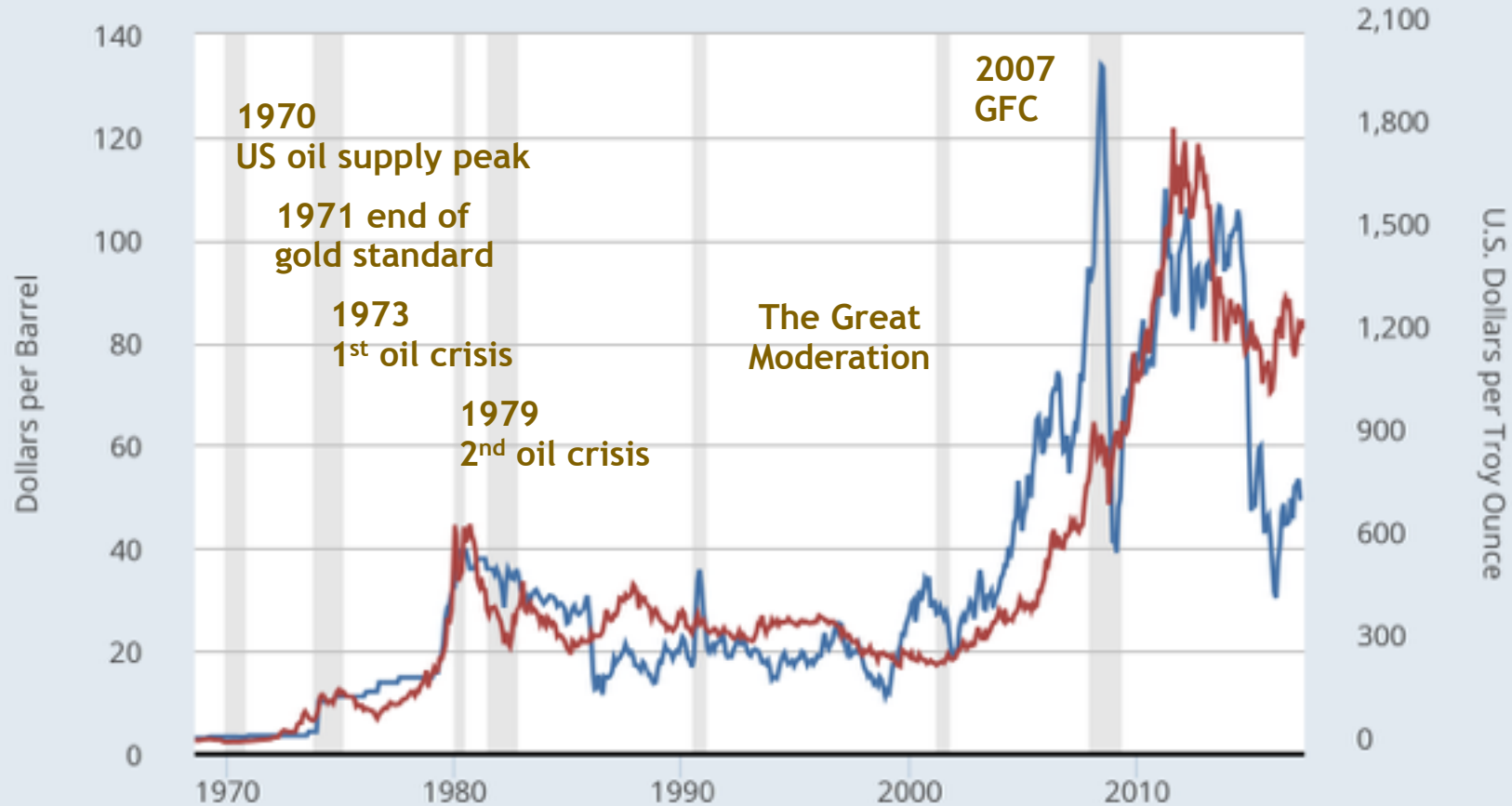
Energy and the macroeconomy



Energy and the macroeconomy



— Spot Crude Oil Price: West Texas Intermediate (WTI) (left)
— Gold Fixing Price 10:30 A.M. (London time) in London Bullion Market, based in U.S. Dollars© (right)



Sources: IBA, St. Louis Fed
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myf.red/g/dCKT

FRED

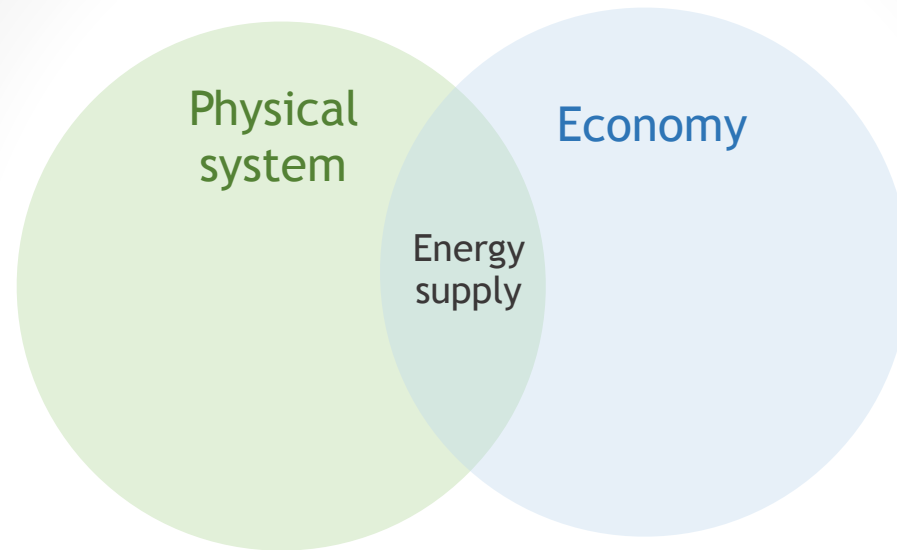
— Spot Crude Oil Price: West Texas Intermediate (WTI) (left)
— Gold Fixing Price 10:30 A.M. (London time) in London Bullion Market, based in U.S. Dollars (right)

- EROI provides a link between energy and the macroeconomy
- Energy resources are the reserve account behind currency
- The economy can grow as long as there is surplus affordable energy. The economy stops growing when the cost of energy production becomes unaffordable.

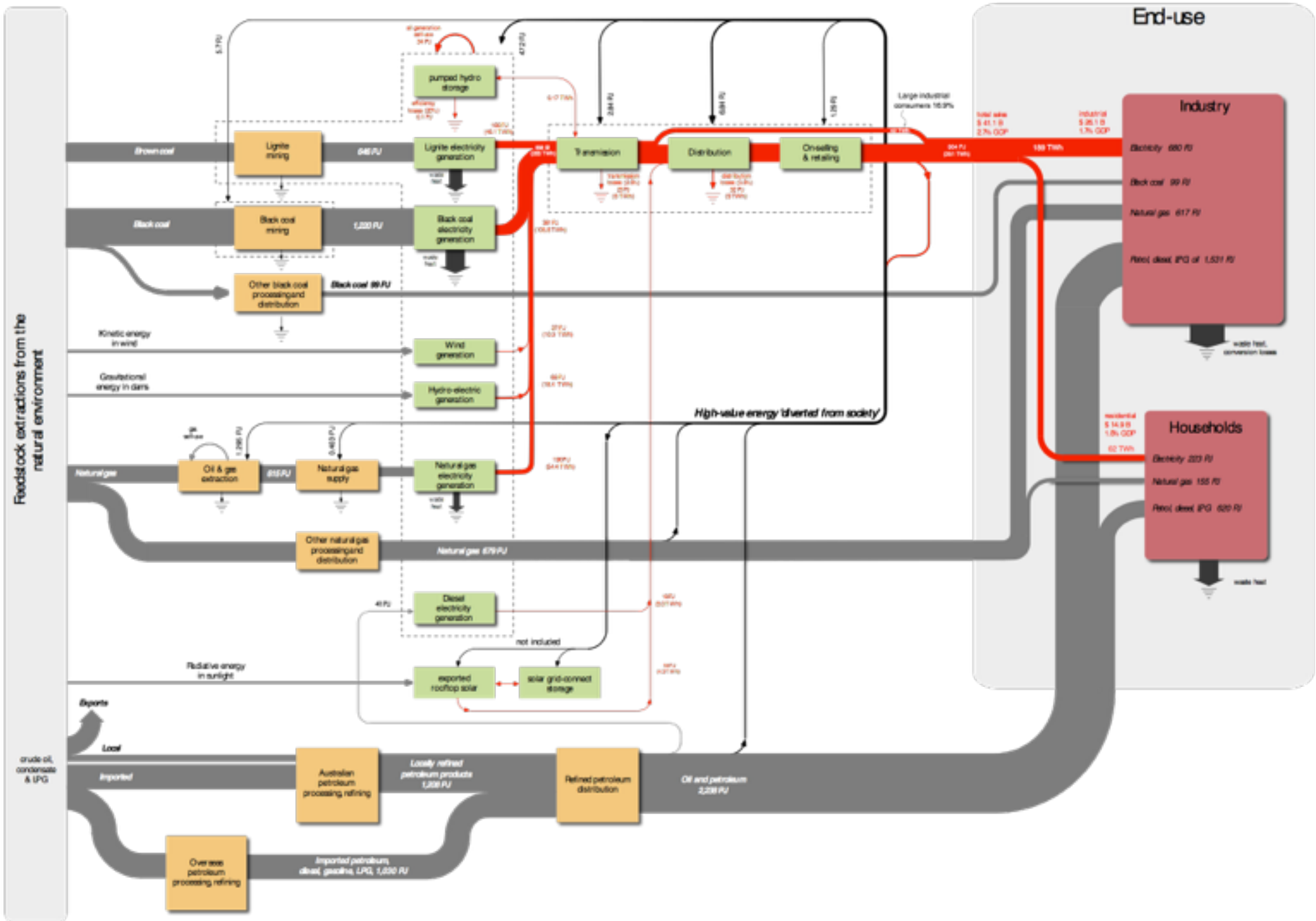
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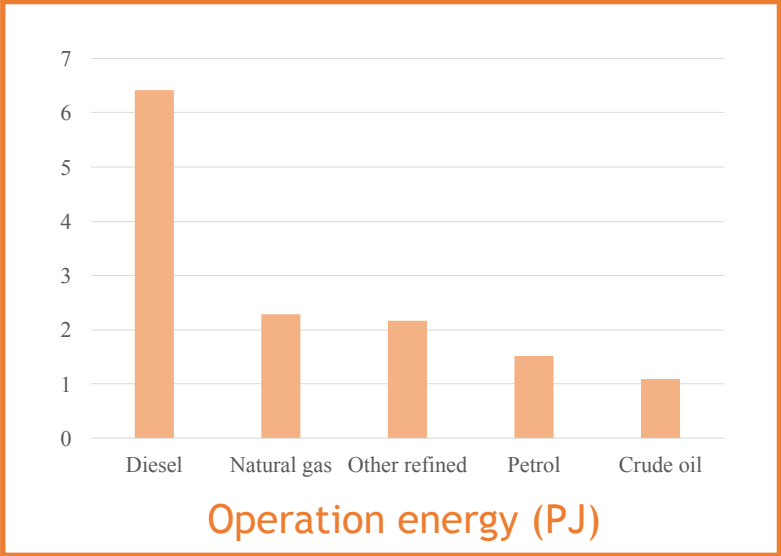
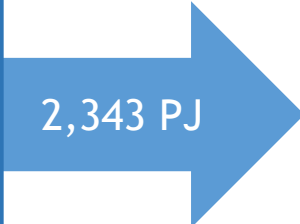
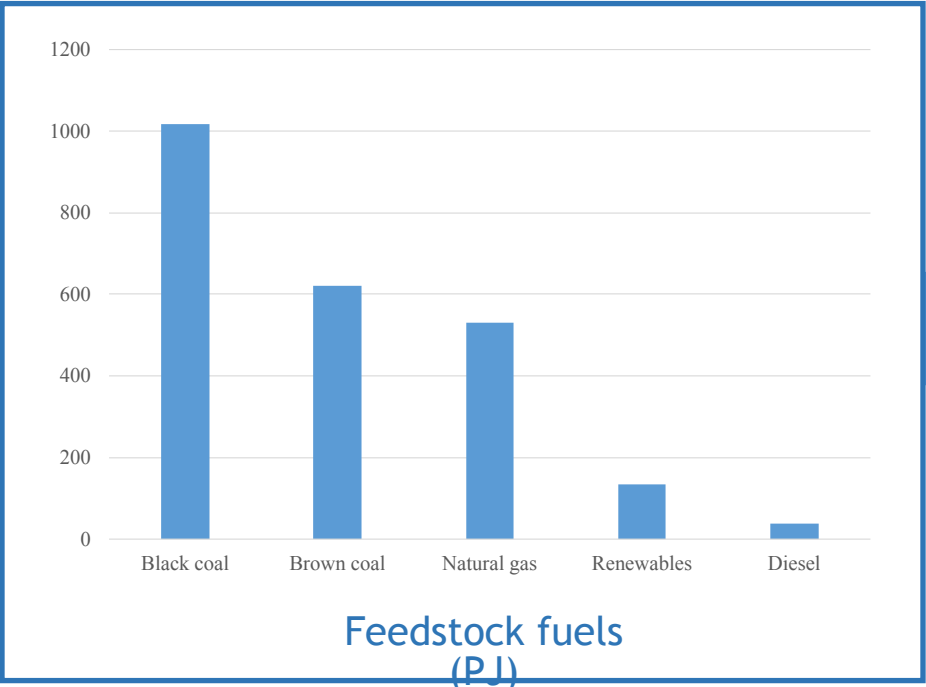
The energy supply industries operate at the intersection of the physical energy system and the economy



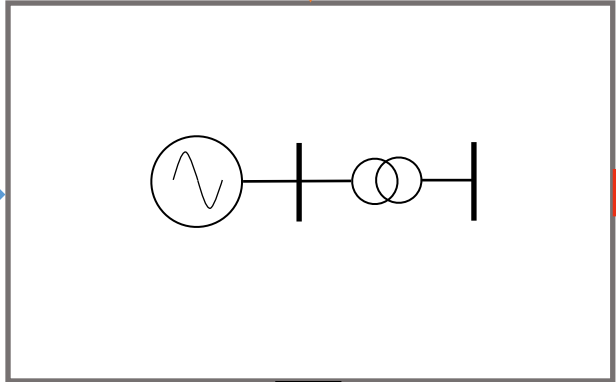
Metric	megajoules	MJ/\$	dollars
Constraint	1/EROI		% of GDP



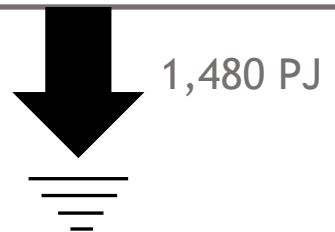
The Australian electricity system as a black box



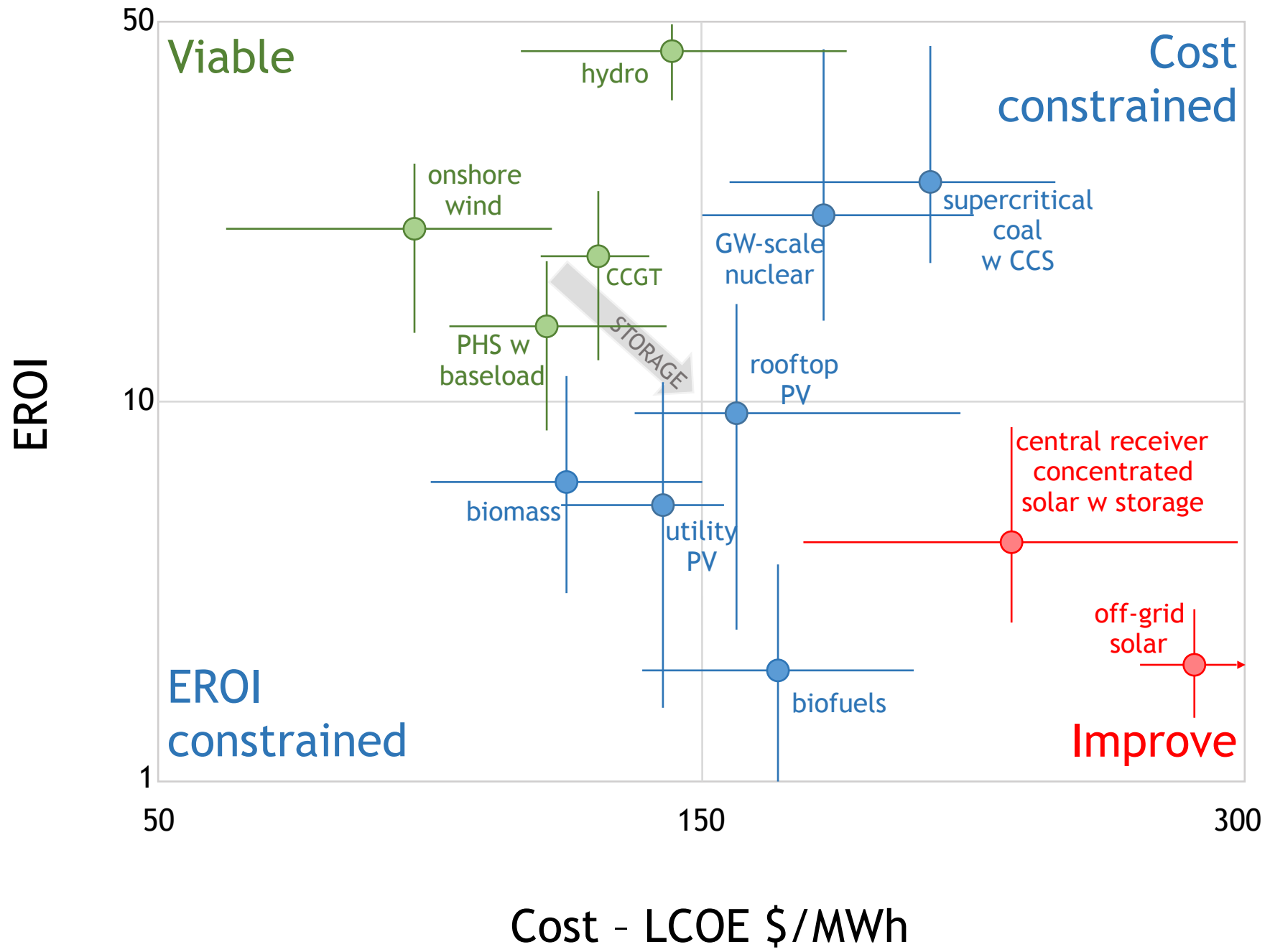
13.8 PJ



16.9 PJ



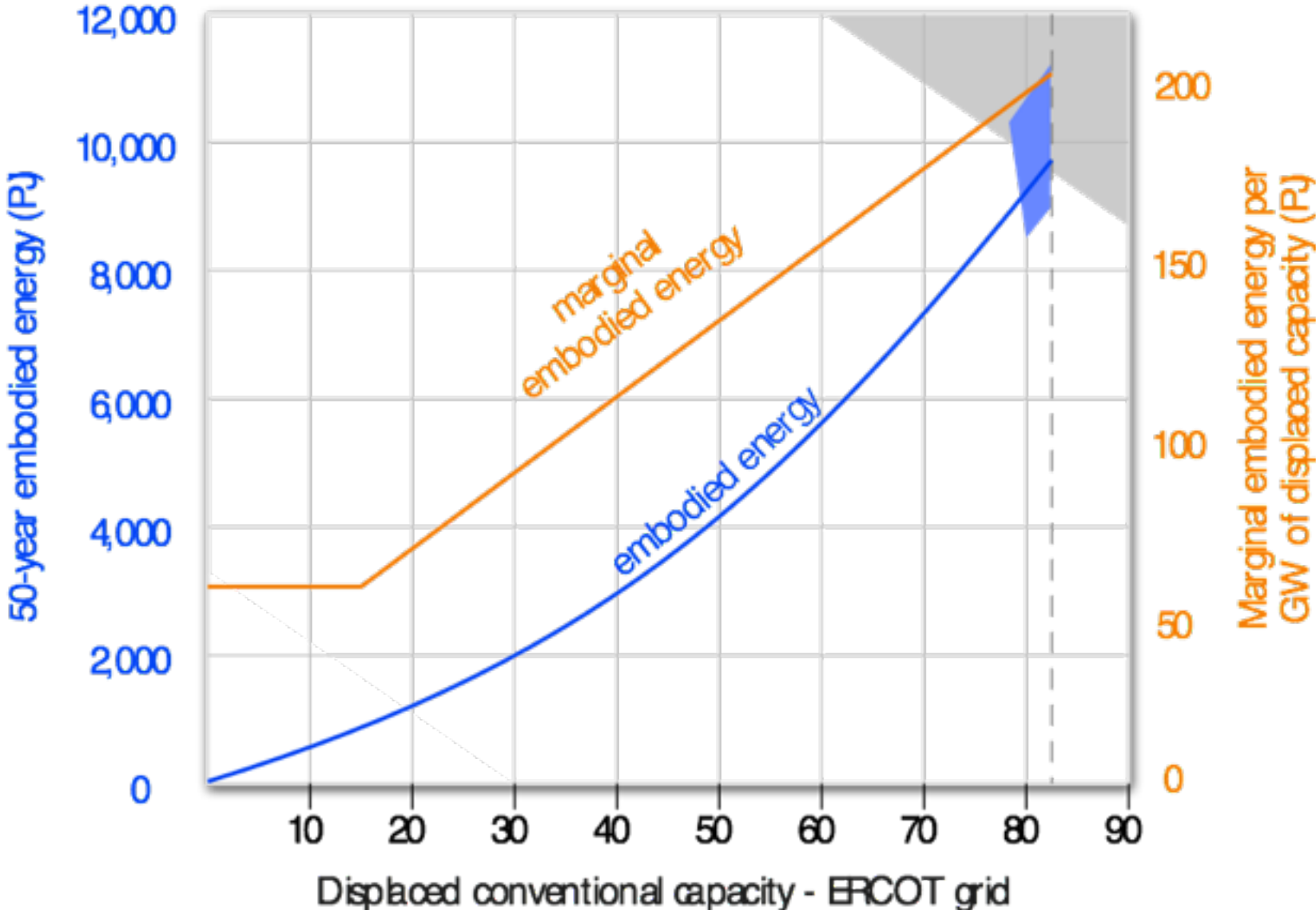
Electricity
894 PJ



EROI constraints versus cost constraints

Factors	Comments
Modularity	Factory built, easier to finance, higher energy intensity of production
Political support	Lowers admin/approval costs
Capacity factor	Higher utilisation, increased output
Energy density	Improved energy output for energy investment
Financing, insurance cost	Low energy intensity costs
Non-dispatchable	Energy costs of integration & storage

Variable renewable energy and storage



- Societies become more complex to solve problems and require more productive energy systems
- It is usually not possible for a society to reduce its consumption of resources voluntarily over the long run
- Society will contract or reconfigure to stay above some minimum EROI
- There is a competitive struggle between technology and depletion
- A shift from fossil fuels is more than a technology/cost problem

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