University of BRISTOL DTU

“Facts are uncertain, values in dispute, stakes high and decisions urgent”

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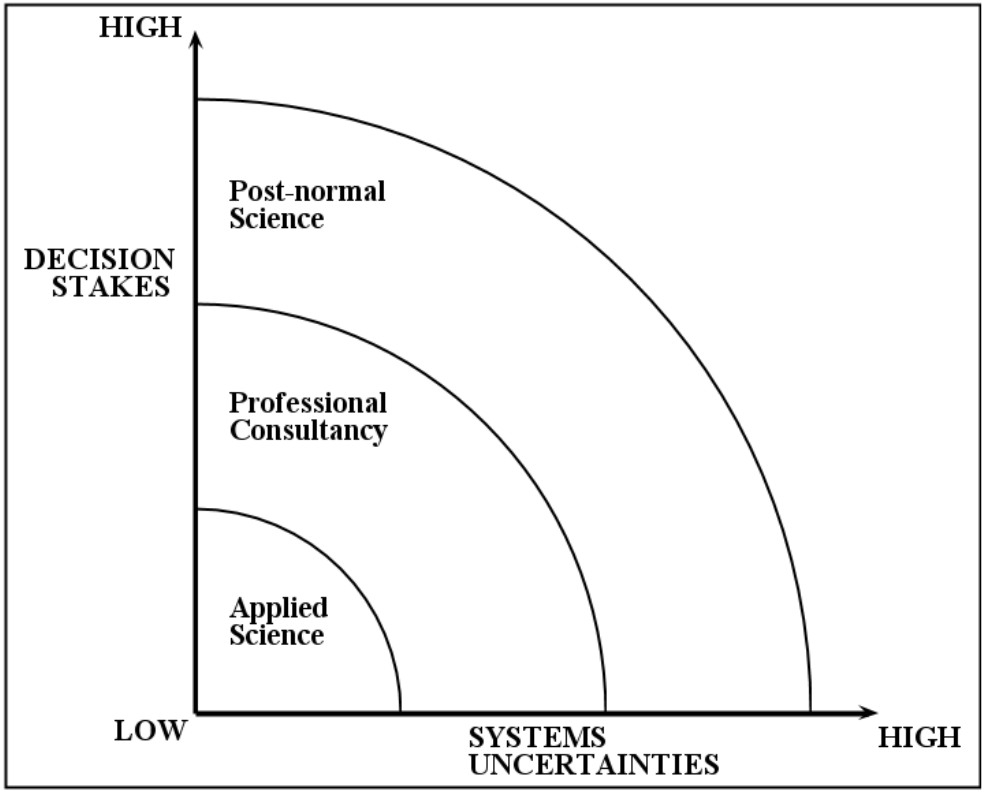
Post-normal science

The quote in the title is from Funtowicz and Ravetz, who describe where the procedures of science break down and fail to provide an answer owing to other, confounding variables. They, and others, argue that we find ourselves in that position today.

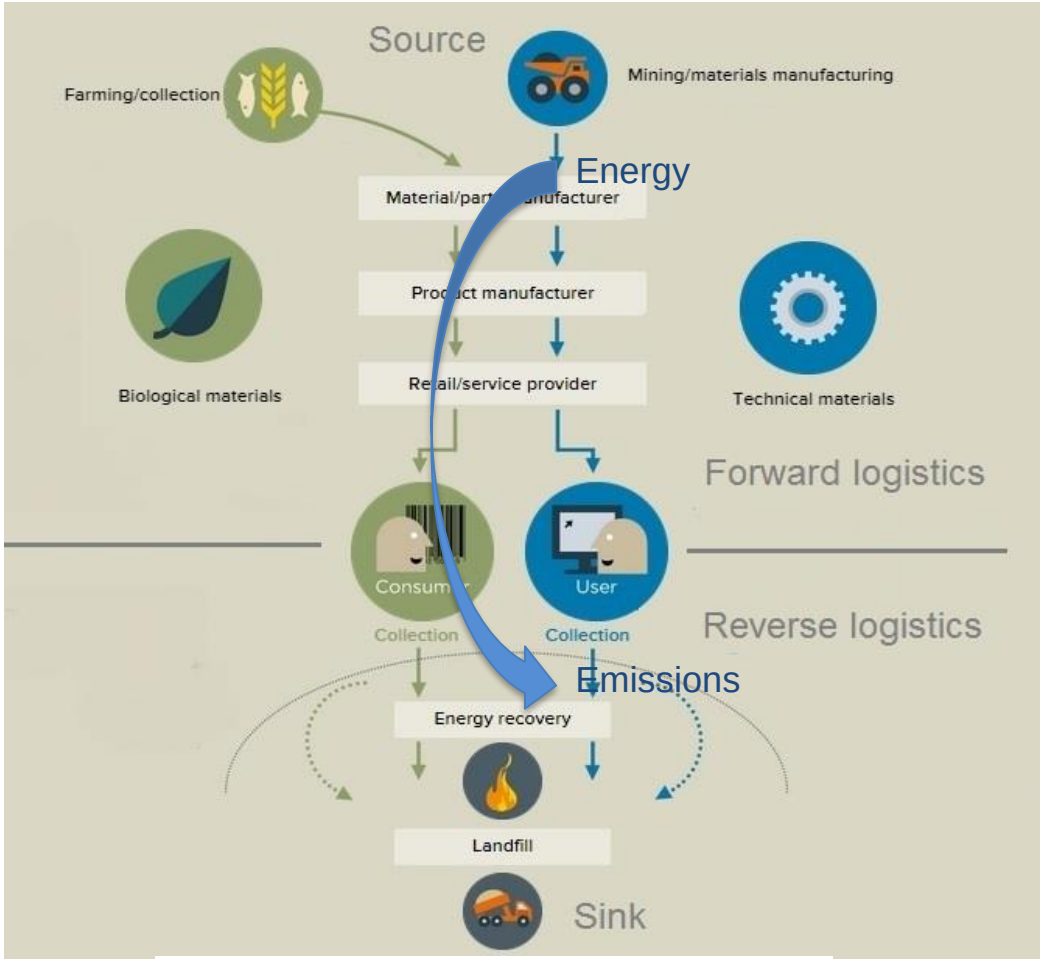


Funtowicz, S. O., & Ravetz, J. R. (1991). A new scientific methodology for global environmental issues. Ecological economics: The science and management of sustainability, 10, 137.

Our engineered world

Our economic activities involve material flows from sources to sinks:

- Energy is the lifeblood of these flows
- Many materials stay in use for years, but
- We have constraints at each end of the flows



Source: Ellen MacArthur Foundation, SUN, and McKinsey Center for Business and Environment; Drawing from Braungart & McDonough, Cradle to Cradle (C2C).

We have an urgent need for action

Live Science > Planet Earth

Last Month Was the Hottest June on Earth Ever Recorded

By Kimberly Hickok, Reference Editor | July 18, 2019 04:47pm ET

We have an urgent need for action

But we have incommensurate world views:

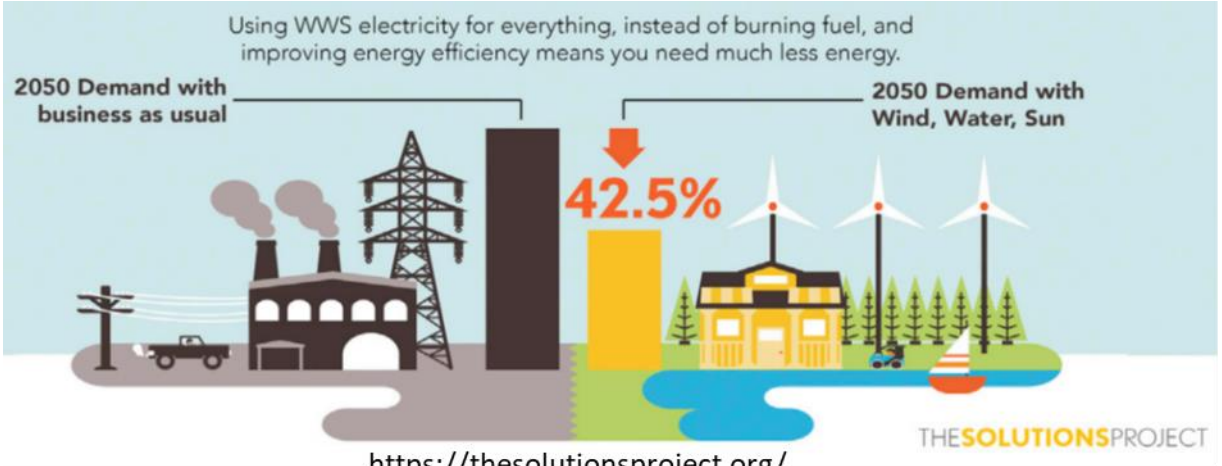
	Ecocentrism		Technocentrism	
	Deep ecology	**Communalism**	**Accommodation**	**Cornucopian**
Green labels	Extreme **preservationist**	Resource **preservationist**	Resource **conservationist** and managerial	Resource **exploitative** and growth oriented
Type of economy	**Very deep green economy**. Highly regulated	**Deep green economy**. Steady state economy	**Green economy**, green markets, economic incentives	**Anti-green** economy. Unfettered free markets
Management	**Reduced** scale of economy and population.	**Zero** economic and population growth.	**Modified** economic growth.	**Primary** policy to maximise growth.

Adapted from Dusch, Crilly and Moultrie, 2010, and Pearce, 1993

People will change when we can offer something better!

"Wind, solar and biomass have the potential to supply all the world's energy needs. Jointly, we can make that happen if we want. So, why not?" Henrik Stiesdal

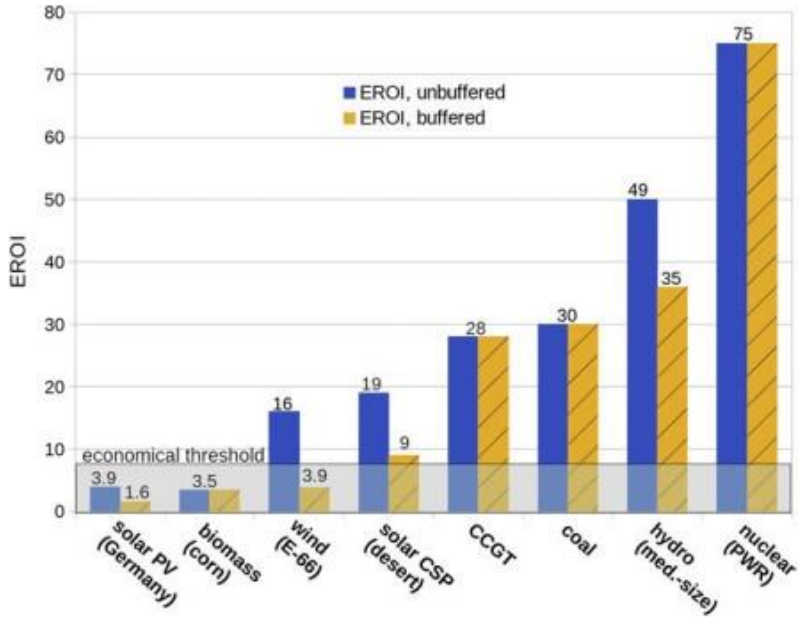
"Developing nations have a choice today to 'leapfrog' over heavy investment in dirty forms of energy" Emil Noordeh



https://thesolutionsproject.org/

However . . .

"To replace all UK-based [cars] today with electric vehicles . . . assuming they use the most resource-frugal next-generation NMC 811 batteries, would take . . . just under two times the total annual world cobalt production, nearly the entire world production of neodymium, three quarters the world's lithium production and . . half of the world's copper production during 2018."



Weißbach *et al.*, *Energy* **52** (2013) 210

https://www.nhm.ac.uk/press-office/press-releases/leading-scientists-set-out-resource-challenge-of-meeting-net-zer.html

THE PROBLEM

Huge quantities of waste electronic and electrical equipment (WEEE) are disposed of each year in the European Union. Although certain valuable materials are recovered in the recycling of waste electronic equipment (e.g. aluminium, copper), many "critical raw materials" (CRM) are not, and are lost from the system **forever**...

WEEE CATEGORIES

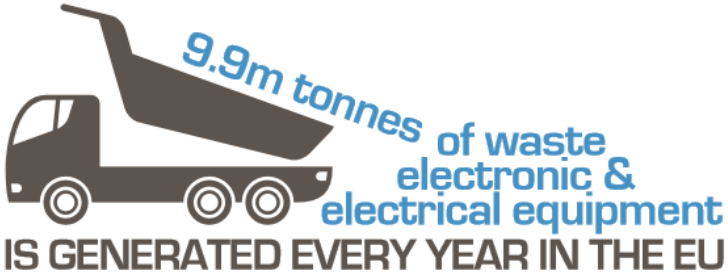
Displays (typically LCD screens)

ICT

Consumer Electronics

Small mixed WEEE (including batteries)

ESTIMATED CRM RECOVERY FROM WEEE



IS GENERATED EVERY YEAR IN THE EU

BUT ONLY IS PROPERLY COLLECTED & RECYCLED

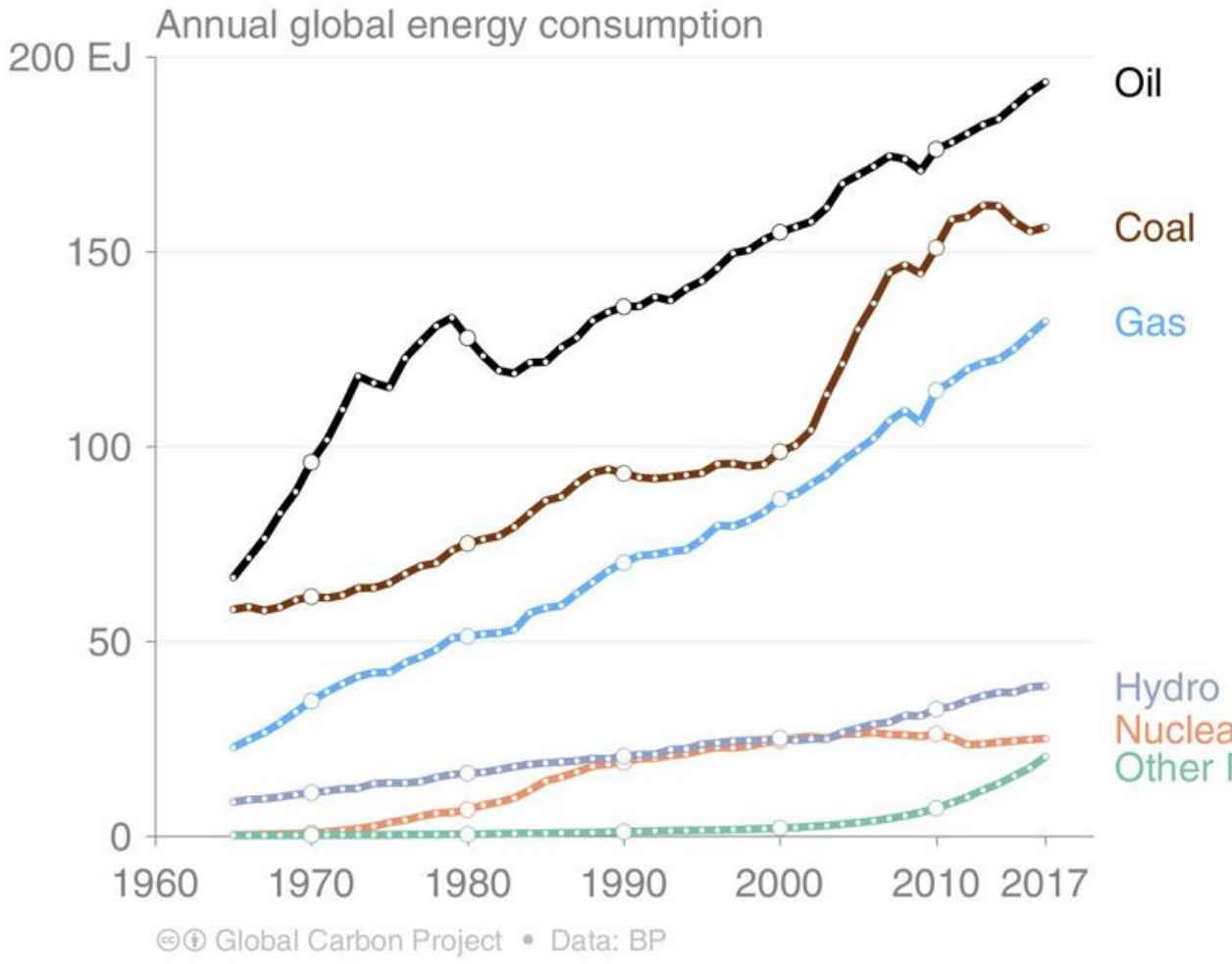
POTENTIAL PRECIOUS METALS IN EU WEEE per annum

→186t

→24t

→7.7t

http://www.criticalrawmaterialrecovery.eu/wp-content/uploads/2016/04/CRM-flyer-A4-trifold_mar



Renewable energy push barely dents fossil fuel dependence

Coal, oil and gas still expected to contribute 85% of primary power supply by 2040

Solar and wind capacity contributes to just a fraction of total energy consumption

Financial Times, 2 August 2019

The age of low-tech!

"Author of *The Low Tech Age, towards a technically sustainable civilization*, engineer Philippe Bihouix warns about the increasing depletion of metal resources . . because of their need for rare metals, the new energy technologies are not a panacea: unlimited and clean energy is a myth, you have to save, recycle, relocalise".

https://reporterre.net/La-croissance-verte-est-une-mystification-absolue

Principles of simple technologies

1	**Question the need**	→	**Ask yourself, why is this needed ?**
2	**Design and manufacture for true sustainability**	→	**To make simple and durable, remember to look for everything with an impact**
3	**Orient knowledge towards economy of resource use**	→	**On the upside, seek and transmit ageless knowledge, also to inspire yourself**
4	**Search for the balance between performance and conviviality**	→	**Design for lower performance Be satisfied with less beautiful or new**
5	**Re-localise without losing the good effects of scale**	→	**Re-localise with finesse, to a good standard**
6	**De-automate services**	→	**Replace people by machines with caution**
7	**Know how to remain modest**	→	**You will marvel at the complexity of nature**

Translated from L'Âge des low tech by Philippe Bihouix, Seuil, 2014.

So what to conclude from all this?

- This is not a conventional ‘problem to solve’, but a predicament that we have to face.
- Cornucopian and dystopian ideas are not helpful, we need to find middle ways, and be open to experiment.
- We should adopt a precautionary principle.
- We need to critically examine all of our conventional wisdom, and be prepared to countenance more radical departures from ‘business as usual’ than we have done to date.
- Design can contribute to any approach, but we should be more than simply technicians. Design thinking, together with systems, life-cycle and a new social/economic thinking, can provide the tools for ‘post-normal world’

Thank you for your attention!

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