

Máster Universitario en Administración y Dirección de Empresas Full Time MBA

Crunching numbers for sustainability

Professor Andrea Saltelli

Crunching numbers for sustainability

Where to find this talk

August 25 2023: The politics of modelling is out!



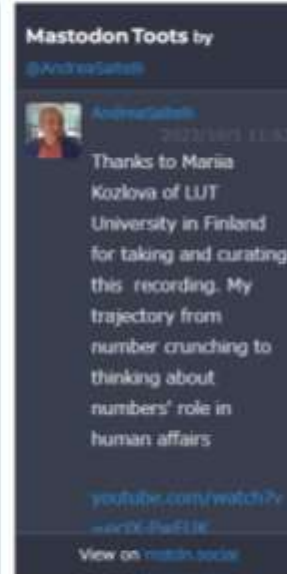
Praise for the volume

"A long awaited examination of the role —and obligation —of modeling."

Nassim Nicholas Taleb, Distinguished Professor of Risk Engineering, NYU Tandon School of Engineering. Author, of the 5-volume series *Incerto*.

"A breath of fresh air and a much needed cautionary view of the ever-widening dependence on mathematical modeling."

Orrin H. Pilkey, Professor at Duke University's Nicholas School of the Environment, co-author with Linda Pilkey-Jarvis of *Useless Arithmetic: Why Environmental Scientists Can't Predict the Future*, Columbia University Press 2009.



The talk is also at

<https://ecampus.bsm.upf.edu/>,

where you find additional reading material

In this set of slides:

3 Energy Ethics

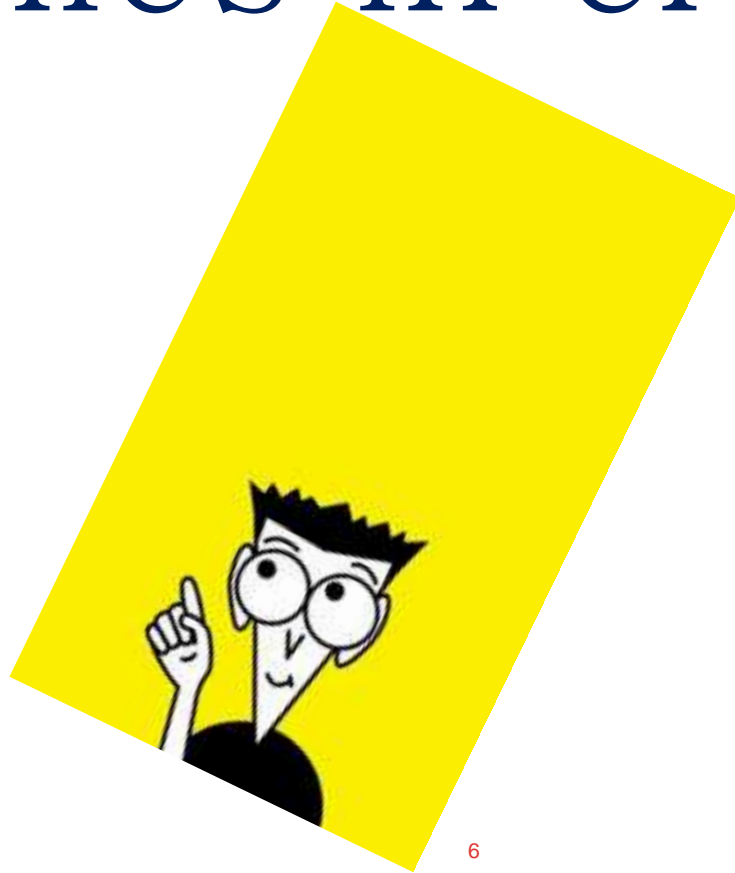
2.

From Daniela's slides: Trilemma and quadrilemma; Langdon Winner do artifacts have politics

Energy Ethics

Ethics in crumbs; Golden Rule, Nicomachean ethics; Biophysical economy; Charles A. S. Hall; Odum; Georgescu Roegen; The dialogue on climate; Transitions; Truth or justice? Roger Pielke; Mary Douglas cultural theory of risk; Myths of Nature; Wynne's and Winner's dissent; Vaclav Smil's Energy transitions; The economy of promises; Digital Twins for the transition? Jasanoff; Merton and the CUDOS. If time allows something from the following: How are we taught our science? Why Science and Ethics? The Vienna Circle, Popper, Kuhn, Lakatos, Feyerabend (based on Ravetz's "Ideological commitments in the philosophy of science"); Michal Polanyi;

Ethics in crumbs



Philosophical quests:

Ontology: what is

Epistemology: how to know

Ethics: what to do

Question:
which
comes
first?



Golden rule

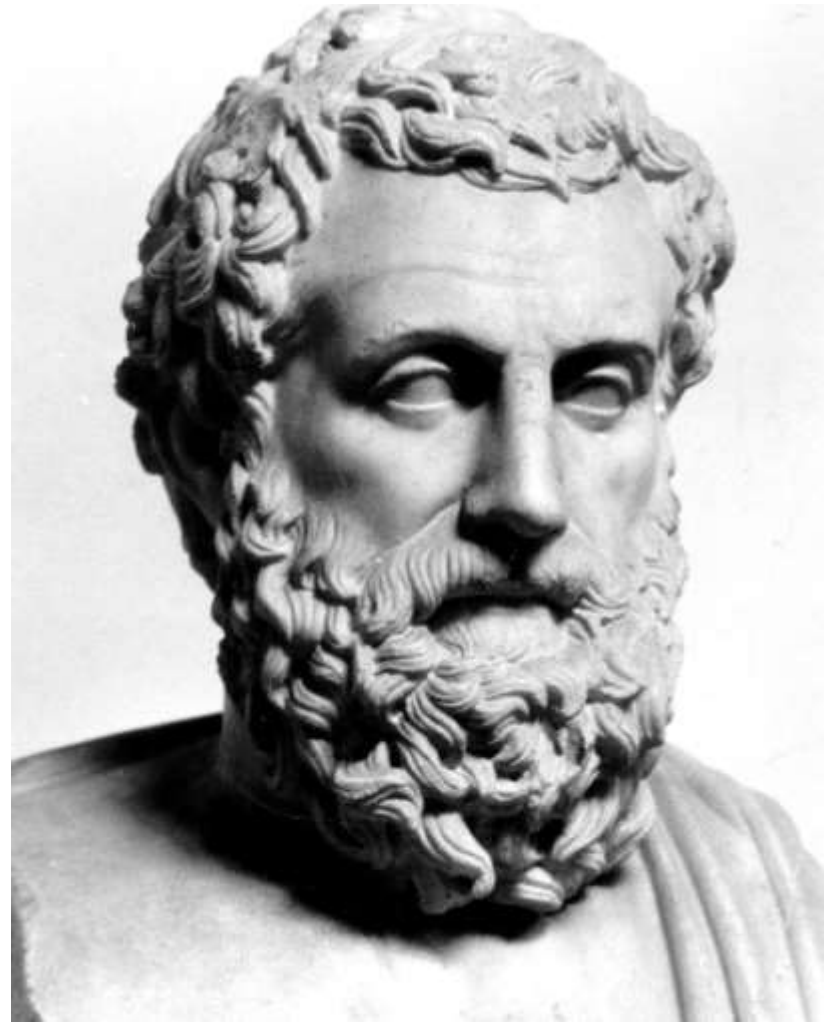
“treat others as you treat yourself” (Mahābhārata, ~IX–V century BCE)

“Avoid doing what you would blame others for doing” (Thales ~624 BC, ~546 BC)

“Treat your inferior as you would wish your superior to treat you” (Seneca, ~4 BC, 65 AD)

“Thou shalt love thy neighbour as thyself”, (Paul the apostle, ~5, ~64 AD)

Aristotle's Nicomachean Ethics



For Aristotle (384, 322 BC) strict relation between ethics and politics

Ethics: How to live a good life (myself)

Politics: How to promote a good life (in the polis)

“...though it is worth while to attain the end merely for one man, it is finer and more godlike to attain it for a nation or for city-states. These, then, are the ends at which our inquiry aims, since it is political science, in one sense of that term”, Book 1, Chapter 2

Ethics for educated citizens [Athenians], no children, no barbaroi, no slaves or craftsmen, no idiots, no women, [but their happiness important]

Unlike in Plato, there is no universal good (no summum bonum)

As the function of man is intellectual activity, his 'good' must be plural and coincide with the exercise of virtues (aretas), among which justice is key

Question: which are the other three virtues?



As the function of man is intellectual activity, his 'good' must be plural and coincide with the exercise of virtues (aretas), among which justice is key



Question: which are the other three virtues?

Biophysical economics

Flow-Fund Theory of Nicholas Georgescu-Roegen

**Southern
Economic
Journal**

January 1975 Volume 41
Number 3

ENERGY AND ECONOMIC MYTHS*

NICHOLAS GEORGESCU-ROEGEN

Vanderbilt University

So you can now all go home and sleep peacefully in your beds tonight secure in the knowledge that in the sober and considered opinion of the latest occupant of the second oldest Chair in Political Economy in this country, although life on this Earth is very far from perfect there is no reason to think that continued economic growth will make it any worse.

Wilfred Beckerman



Nicholas
Georgescu-
Roegen
(1906-1994)

Nicholas Georgescu-Roegen

- Father of ecological economics
- Ante-litteram advocate of degrowth?
Inspired the Club of Rome
- The first to note that the laws of thermodynamics, particularly the second law, which emphasizes the irreversibility of natural processes, are ignored in economics

- Defines "flows" (current resources) and "funds" (accumulated resources) to be used in economics → sustainability
- Reintroduces Entropy in economics

“... the viewing of the economic process as a mechanical analogue consisting – as all mechanical analogues do – of a principle of conservation (transformation) and a maximization rule.

...

The economic science itself is thus reduced to a timeless kinematics”

**Southern
Economic
Journal**

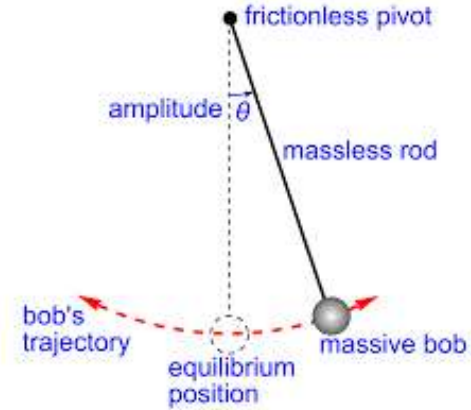
January 1975 Volume 41
Number 3

ENERGY AND ECONOMIC MYTHS*

NIKOLAS GEORGESCU-ROGEN

Yale University

“Everything now turns out to be just a pendulum movement. One business "cycle" follows another. The pillar of equilibrium theory is that, if events alter the demand and supply propensities, the economic world always returns to its previous conditions as soon as these events fade out”



Source: Wikipedia Commons

**Southern
Economic
Journal**

January 1975 Volume 41
Number 3

ENERGY AND ECONOMIC MYTHS*

NICHOLAS GEORGESCU-ROEGEN

Yale University

“An inflation, a catastrophic drought, or a stock-exchange crash leaves absolutely no mark on the economy. Complete reversibility is the general rule, just as in mechanics”



Plastic waste dumping site at Thilafushi, an example of no mark.
Source: <https://www.dreamstime.com>

**Southern
Economic
Journal**

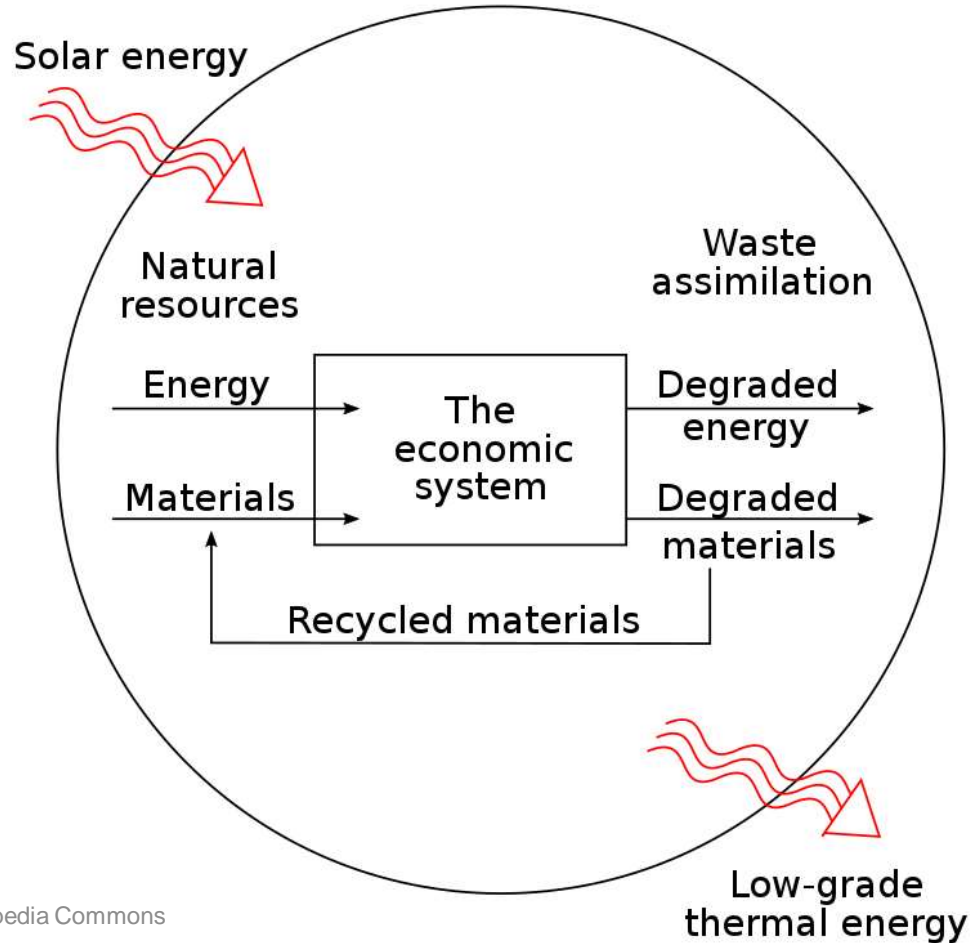
January 1975 Volume 41
Number 3

ENERGY AND ECONOMIC MYTHS*

NICHOLAS GEORGESCU-ROGHIEN

Yale University

The Earth's biosphere



MECHANICS VERSUS THERMODYNAMICS

To equate the economic process with a mechanical analogue implies, therefore, the myth that the economic process is a circular merry-go-round which cannot possibly affect the environment of matter and energy in any way

Entropy = “entropy as an index of the amount of unavailable energy in a given thermodynamic system at a given moment of its evolution”

**Southern
Economic
Journal**

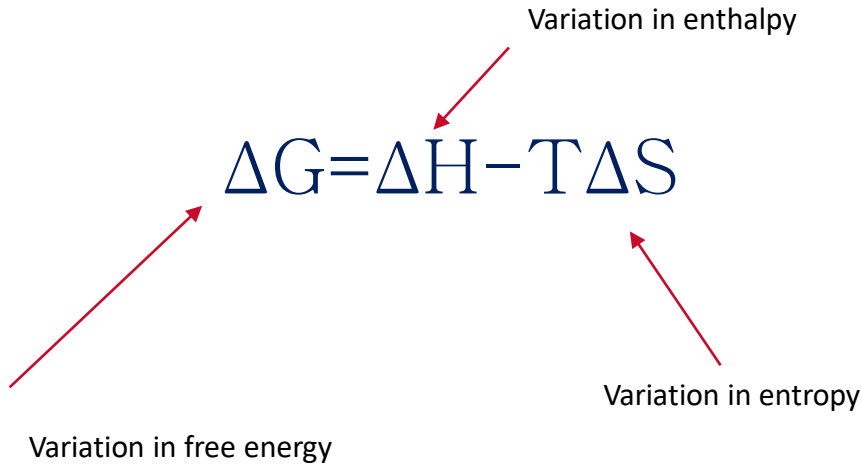
January 1972 Volume 41
Number 3

ENERGY AND ECONOMIC MYTHS*

NICHOLAS GEORGESCU-ROEGEN

Yale University

Entropy = “entropy as an index of the amount of unavailable energy in a given thermodynamic system at a given moment of its evolution”

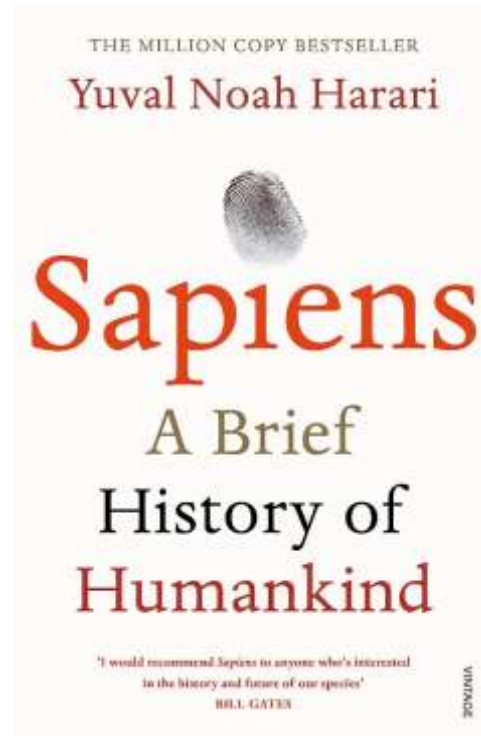


Remember this from college's thermodynamics?

“... to act in accord with a myth is the distinctive characteristic of man among all living beings”



Harari's recipe for humans' success: believing shared stories in large collectives



“Thermodynamics a, peculiar branch of physics, so peculiar that purists prefer not to consider it a part of physics because of its anthropomorphic texture”

“Energy thus came to be divided into available or free energy, which can be transformed into work, and unavailable or bound energy, which cannot be so transformed. Clearly, the division of energy according to this criterion is an anthropomorphic distinction like no other in science”

**Southern
Economic
Journal**

January 1975 Volume 41
Number 1

ENERGY AND ECONOMIC MYTHS*

NIKOLAS GEORGESCU-ROEGIN

Yale University

“The myth of perpetual motion of the second kind, which is that we may use the same energy over and over again, still lingers on in various veiled forms”

“Another economic myth is that man will forever succeed in finding new sources of energy and new ways of harnessing them to his benefit”

**Southern
Economic
Journal**

January Volume 41
1975 Number 3

ENERGY AND ECONOMIC MYTHS*

NIKOLAS GEORGESCU-ROEGH

Yale University

Bootlegging entropy

The danger of linear thinking

The myth that the price mechanism can offset any shortages, whether of land, energy or materials

The fallacy of endless substitution

**Southern
Economic
Journal**

January 1975
Volume 41
Number 3

ENERGY AND ECONOMIC MYTHS*

NIKOLAUS GEORGESCU-ROEGEN

Yale University

Substitution within a finite stock of accessible low entropy cannot possibly go on forever – the similitude of the perfect empty kitchen



**Southern
Economic
Journal**

January 1975 Volume 41
Number 3

ENERGY AND ECONOMIC MYTHS*

NICHOLAS GEORGESCU-ROEGEN

Yale University

NGR on waste:

“Robert A Solo [an economist] also asserts that because of growth and technology, the present society could eliminate all pollution ... at a bearable cost. It is only because of some perversity of our values that we are not doing it. That we could devote more effort to pollution disposal is beyond doubt. But to believe that with nonperverse values we could defeat the natural laws reflects an indeed perverse view of reality”

**Southern
Economic
Journal**

January Volume 41
1975 Number 3

ENERGY AND ECONOMIC MYTHS*

NICHOLAS GEORGESCU-ROEGEN

Yale University

“But to believe that with nonperverse values we could defeat the natural laws reflects an indeed perverse view of reality”

Could the same be said of our delayed energy transitions? Paul-Marie Boulanger disagree on this, see <https://judithcurry.com/2021/02/12/a-climate-of-dialogue> or in full here: <http://www.andreasaltelli.eu/file/repository/SerafimovaBook.pdf>



Chapter 3, A Climate of dialogue, with Paul-Marie Boulanger





Chapter 3, A
Climate of
dialogue, with
Paul-Marie
Boulanger



In a
nutshell

Me: science's epistemic authority is today staked on a sense of urgency of impending climatic catastrophe which is irresponsible

P-MB: climatic action is urgent in view of our responsibility to future generations

Me: An accelerated exit from a fossil fuel dominated energy mix is both unfeasible and undesirable

PMB: This is instead an objective to pursue with renewed political determination

See http://www.andreasaltelli.eu/file/repository/Saltelli_Climate_2.pdf



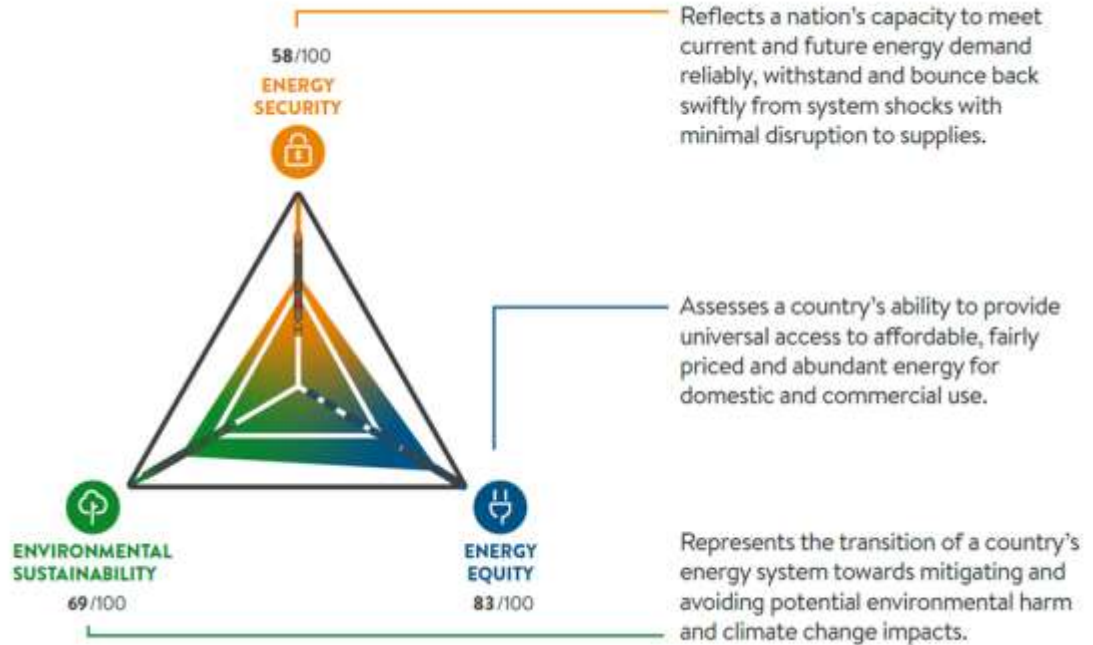
Images from the World Energy Council's *Harmonising Energy* Series featuring *InfraGreen* (Germany) produced by BBC StoryWorks.

WORLD ENERGY

TRILEMMA INDEX 2022

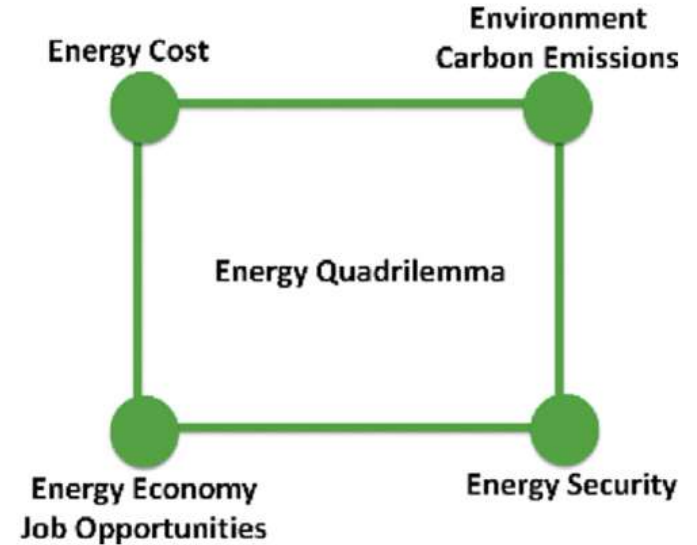
In partnership with Oliver Wyman

Courtesy of Daniela Tafani, University of Pisa



The Quadrilemma

The energy quadrilemma adds the fourth element (of social dimensions of energy) that focuses on people, their involvement, and the acceptance of decisions in the energy industry. This fourth issue concerns itself with providing energy in a just and sustainable way. Generally referred to as 'energy justice', it is concerned with identifying when and where injustices occur in energy systems and how best law and policy can respond (16). Conceptualized as having three principal tenets (distributional justice, procedural justice, and recognition justice) (17), it deals with both macro-justice (on societal impacts of energy and how fair and just their institutional decisions are) as well as micro-justice (how individuals are impacted by systemic outcomes) (18). However, as demonstrated above, we still do not have an energy source that fully satisfies the energy trilemma or is clearly socially accepted as 'justice-neutral'. (19)




<https://icpac.medium.com/energy-and-climate-the-dilemma-trilemma-and-quadrilemma-839a8d657369>

<https://www.sciencedirect.com/science/article/abs/pii/S0360544216310696>

LANGDON WINNER

Do Artifacts Have Politics?

 The MIT Press



Do Artifacts Have Politics?
Author(s): Langdon Winner
Source: *Daedalus*, Vol. 109, No. 1, Modern Technology: Problem or Opportunity? (Winter, 1980), pp. 121-136
Published by: The MIT Press on behalf of American Academy of Arts & Sciences
Stable URL: <http://www.jstor.org/stable/20024652>
Accessed: 06/10/2009 20:50

Do Energy Systems Have Politics?



Contents lists available at ScienceDirect

Energy Research & Social Science

journal homepage: www.elsevier.com/locate/erss

Original research article

Embodied energy injustices: Unveiling and politicizing the transboundary harms of fossil fuel extractivism and fossil fuel supply chains

Noel Healy^{a,*}, Jennie C. Stephens^b, Stephanie A. Malin^c^a Department of Geography, Salem State University, 352 Lafayette St., Salem, MA 01970, USA^b School of Public Policy & Urban Affairs, Global Resilience Institute, Northeastern University, 650 Huntington Ave., RP 310J, Boston, MA 02115, USA^c Department of Sociology, Colorado State University, B234 Clark Building, Fort Collins, CO 80523, USA

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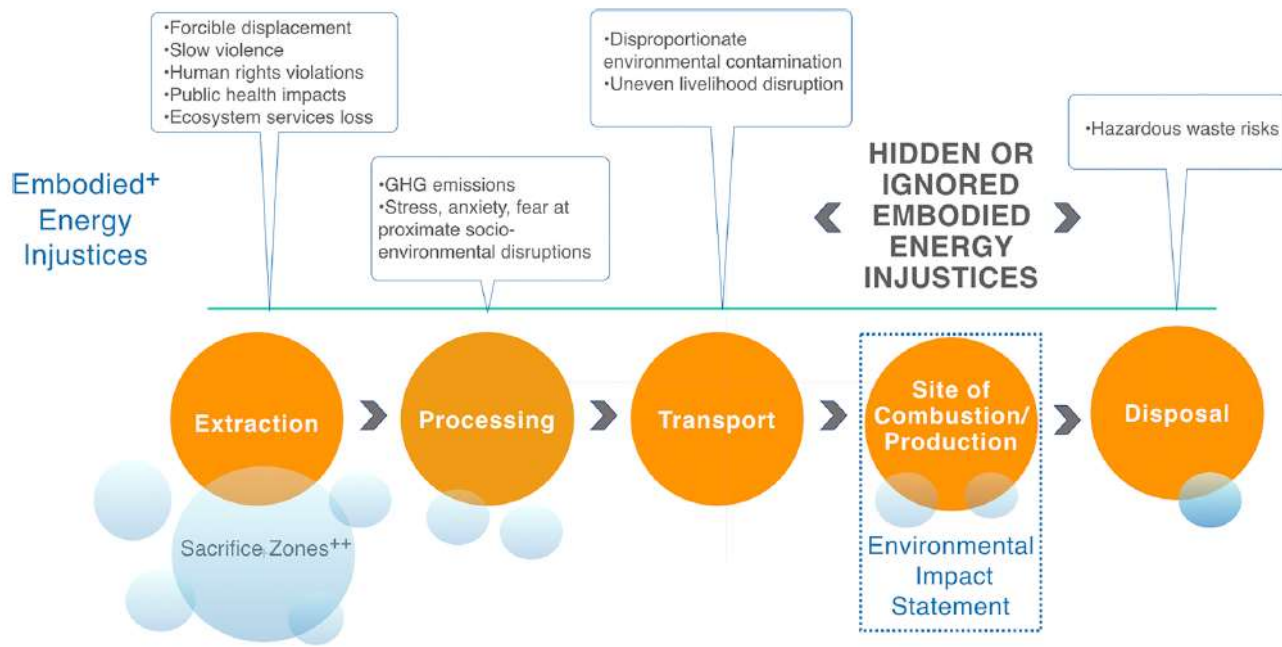
Coal

Fracking

Energy transitions

ABSTRACT

We introduce the new concept of *embodied energy injustices* in order to encourage integrative, systemic, transboundary assessment of the global implications and responsibility of energy-policy decisions. Embodied energy injustices reframe considerations of energy justice to explicitly consider hidden and distant injustices (upstream or downstream) arising from the extraction, processing, transportation and disposal of energy resources. We assess the embodied energy injustices connected to the decision to decommission a coal-fired power plant in Salem, Massachusetts, US, and its replacement with a natural-gas-fired power station. *Cerrejón* open-pit coalmine in La Guajira, Colombia, powered the Salem plant for over a decade. Fracked gas from Pennsylvania now supplies fuel for the new power station. Comparing the extraction of these two very different fuels reveals multiple parallel injustices. But the regulatory environment fails to account for the different constituencies, jurisdictions and effects that fall outside the formal remit of existing impact assessments. We therefore call for mandatory transboundary impact assessments of large-scale energy-related projects, which explicitly integrate previously unrecognized social-environmental harms and injustices. Expanding energy law and policy discussions to incorporate embodied energy injustices can enhance sustainable energy governance and enable corporate accountability for the transboundary harms of fossil fuel extraction and use. Linking *chains of energy injustice*—by revealing their interconnected positions along fossil-fuel supply chains—may help generate and unite powerful trans-local solidarity movements, which politicize local struggles within wider national, regional and global energy politics.



+ The injustices listed can occur anywhere along the supply-chain but typically are most prevalent around sites of extraction.
 ++ Sacrifice zones are areas poisoned or destroyed for the supposed greater good of economic progress.

Fig. 1. Embodied energy injustices explicitly consider hidden and distant injustices (upstream or downstream) arising from the extraction, processing, transportation and disposal of energy resources.

“There always was a tension on this subject, as proved by the now famous exchange in the 70’s involving [Daly \(1997a\)](#) [\(1997b\)](#), [Stiglitz \(1997\)](#) and [Solow \(1997\)](#)” – see a summary of the discussion here

Environmental Science and Policy 142 (2023) 99–111



Contents lists available at [ScienceDirect](#)

Environmental Science and Policy

journal homepage: www.elsevier.com/locate/envsci



Impact assessment culture in the European Union. Time for something new?



Andrea Saltelli ^{a,b,*}, Marta Kuc-Czarnecka ^c, Samuele Lo Piano ^d, Máté János Lőrincz ^d,
Magdalena Olczyk ^c, Arnald Puy ^e, Erik Reinert ^{f,g}, Stefán Thor Smith ^d,
Jeroen P. van der Sluijs ^{b,h}

“The debate - started in 1975–1979 by Georgescu-Roegen in opposition to Solow and Stiglitz - was about to what extent one can substitute capital for natural resources in a growth equation, and what role technology could play to make this substitution more effective.

Herman E. Daly... restarted the debate in 1997 in open opposition to neoclassic economists, iterating Georgescu-Roegen’s unanswered critique that one cannot "assume that agents of transformation (funds) can substitute for the resources undergoing transformation (flows)" (Daly, 1997a)”



Herman E. Daly
(1938–2022)

Peter Victor
Fri 11 Nov 2022 19:20 CET
f t e 1

The Guardian

Obituary
Herman Daly obituary

Pioneering ecological economist who foresaw the catastrophic effects of unlimited economic growth

Environmental Science and Policy 142 (2023) 99–111

Contents lists available at ScienceDirect

Environmental Science and Policy

journal homepage: www.elsevier.com/locate/envsci

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Environmental Science & Policy

Check for updates

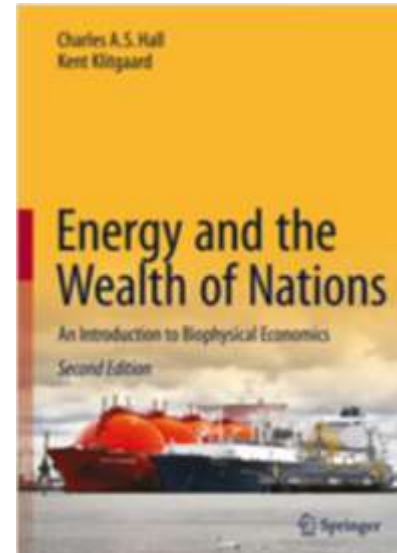
Impact assessment culture in the European Union. Time for something new?

Andrea Saltelli^{a,b,c}, Marta Kuc-Czarnecka^a, Samuele Lo Piano^d, Máté János Lőrincz^d, Magdalena Olezyk^e, Arnald Puy^f, Erik Reinert^{g,h}, Stefán Thor Smith^d, Jeroen P. van der Sluijs^{b,i}

Some slides courtesy of Professor Charles A. S. Hall



chall@esf.edu

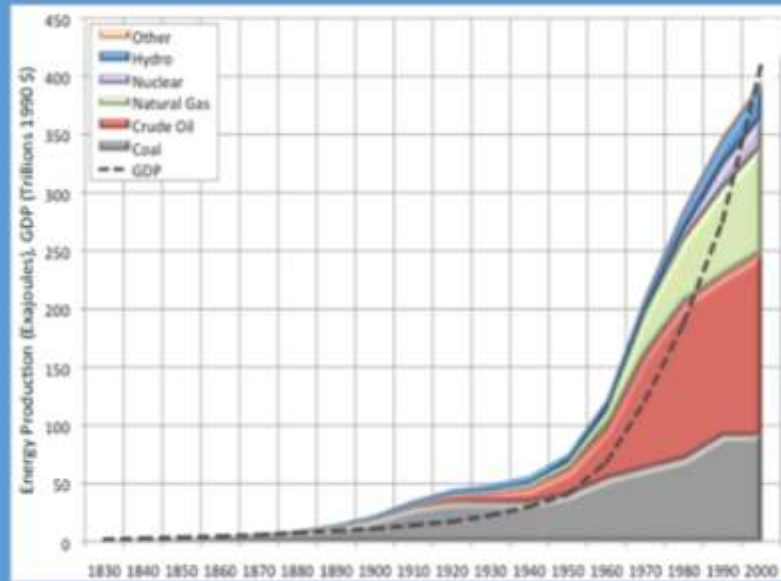




Conventional economics is based on "sets of plausible but entirely arbitrary assumptions" leading to "precisely stated but irrelevant theoretical conclusions".
(W. Leontief, Nobel Laureate in Economics)

chall@esf.edu

The dirty secret to wealth production: Use more energy



Global GDP and
global energy use

chall@esf.edu

u

Replacing our present reliance on fossil fuels with renewables, if possible, will be extremely fossil fuel intensive

chall@esf.edu

il existe une solution simple et fausse.



More resources from Charles A. S. Hall



YouTube playlist with all videos: <https://www.youtube.com/playlist?list=PLpPcX-rwKS6JucZpentitMCH-2FYvCfgy>

Medium versions with transcript: <https://medium.com/@alysion42/list/biophysical-economics-df1b957adb88>

Together with ecologist Howard T. Odum, Charles A.S. Hall has developed the concept of Energy Return on Investment

EROI assesses the efficiency and sustainability of energy sources



Howard T. Odum
(1924–2002)

$$\text{EROI} = \frac{\text{amount of energy produced (or extracted) by an energy source}}{\text{the energy input required to obtain, process, and distribute that energy}}$$

- $EROI > 1$: An energy source produces more energy than it consumes in its life cycle, making it a net energy gain.
- $EROI = 1$: Energy input equals energy output
- $EROI < 1$: An energy consumes more energy than it produces, resulting in a net energy loss.

Example: a mean EROI of 20:1 for wind power means that you get ~20 units of electricity in return for every unit of energy invested in manufacturing, installing, maintaining and decommissioning a wind energy system (Hall et al., 2014)

Melgar, Rigo, and Charles Hall. 2023. 'Energy Return on Investment: A Unifying Principle for Socio-Ecological Sustainability'. in *Elgar Encyclopedia of Ecological Economics*. Rochester, NY.

C A Hall , J G Lambert , S B Balogh, EROI of different fuels and the implications for society, *Energy policy* , volume 64 , p. 141 – 152, 2014.

“... There certainly are oil shales from which we could extract one ton of oil only by using more than one ton of oil”

**Southern
Economic
Journal**

January 1973 Volume 41
Number 1

ENERGY AND ECONOMIC MYTHS*

NICHOLAS GEORGESCU-ROEGH

Yale University



Ecological Economics 22 (1997) 261–264

ECOLOGICAL
ECONOMICS



Ecological Economics 22 (1997) 267–268

ECOLOGICAL
ECONOMICS

FORUM
Georgescu-Roegen versus Solow/Stiglitz

Herman E. Daly

School of Public Affairs, University of Maryland, College Park, MD 20742-1021, USA

Received 23 September 1998; accepted 25 February 1997

REPLY
Georgescu-Roegen versus Solow/Stiglitz

Robert M. Solow

Stern School of Business, New York University, New York, NY 10012-1118, USA



Ecological Economics 22 (1997) 269–270

ECOLOGICAL
ECONOMICS



Ecological Economics 22 (1997) 271–273

ECOLOGICAL
ECONOMICS

REPLY
Georgescu-Roegen versus Solow/Stiglitz

Joseph E. Stiglitz

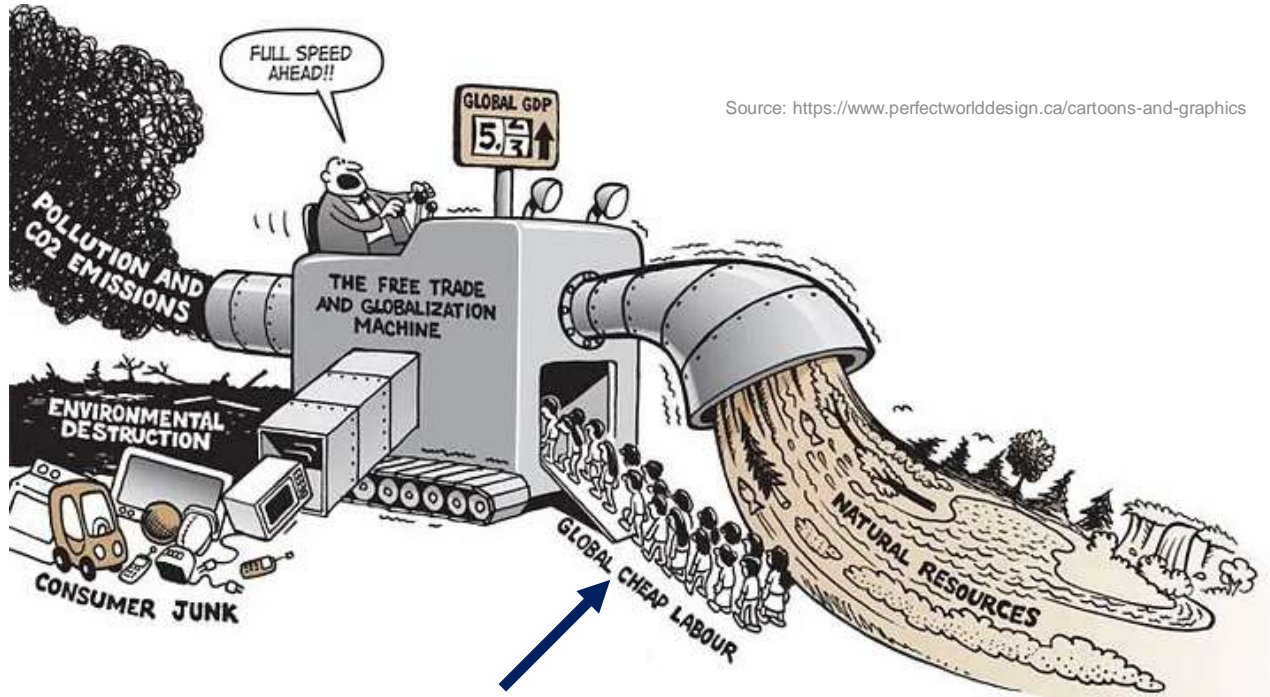
The World Bank, Washington, DC 20473, USA

FORUM
Reply to Solow/Stiglitz

Herman E. Daly

School of Public Affairs, University of Maryland, College Park, MD 20742-1021, USA

Old (1997) or new debate?



Part of the equation

Gunnar Skirbekk

Epistemic Challenges in a Modern World

From “fake news” and “post truth”
to underlying epistemic challenges
in science-based risk-societies

Das Zentrum für Wissenschaftstheorie an der Universität
hat einen Druckkostenzuschuss bereitgestellt.

This book is printed on acid-free paper.

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The Deutsche Nationalbibliothek lists this publication in the Deutsche
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Interlude
George Carlin and the
environment

Interlude: George Carlin and the environment –
<https://www.youtube.com/watch?v=EjmtSkI53h4>



ay (k)

Test in the classroom: engage
with Carlin's narrative and
develop pro- and counter-
narratives (15m+ 10m
discussion)



The Ethics of Transitions

Pursuit of truth or pursuit of justice?

Can a scientist be an activist?

Can a scientist not-be an activist?

The case of the transition to a carbon-free future

The Latin motto

Fiat justitia ruat caelum

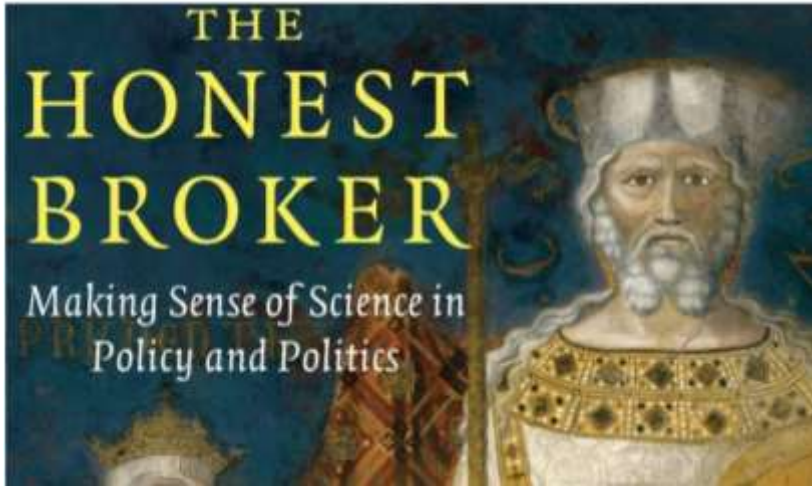
Could easily be morphed into

Fiat veritas ruat caelum



Source: René Goscinny's Asterix comix

Both formulations clash with ... *prudencia*?



Cambridge
University
Press, 2007



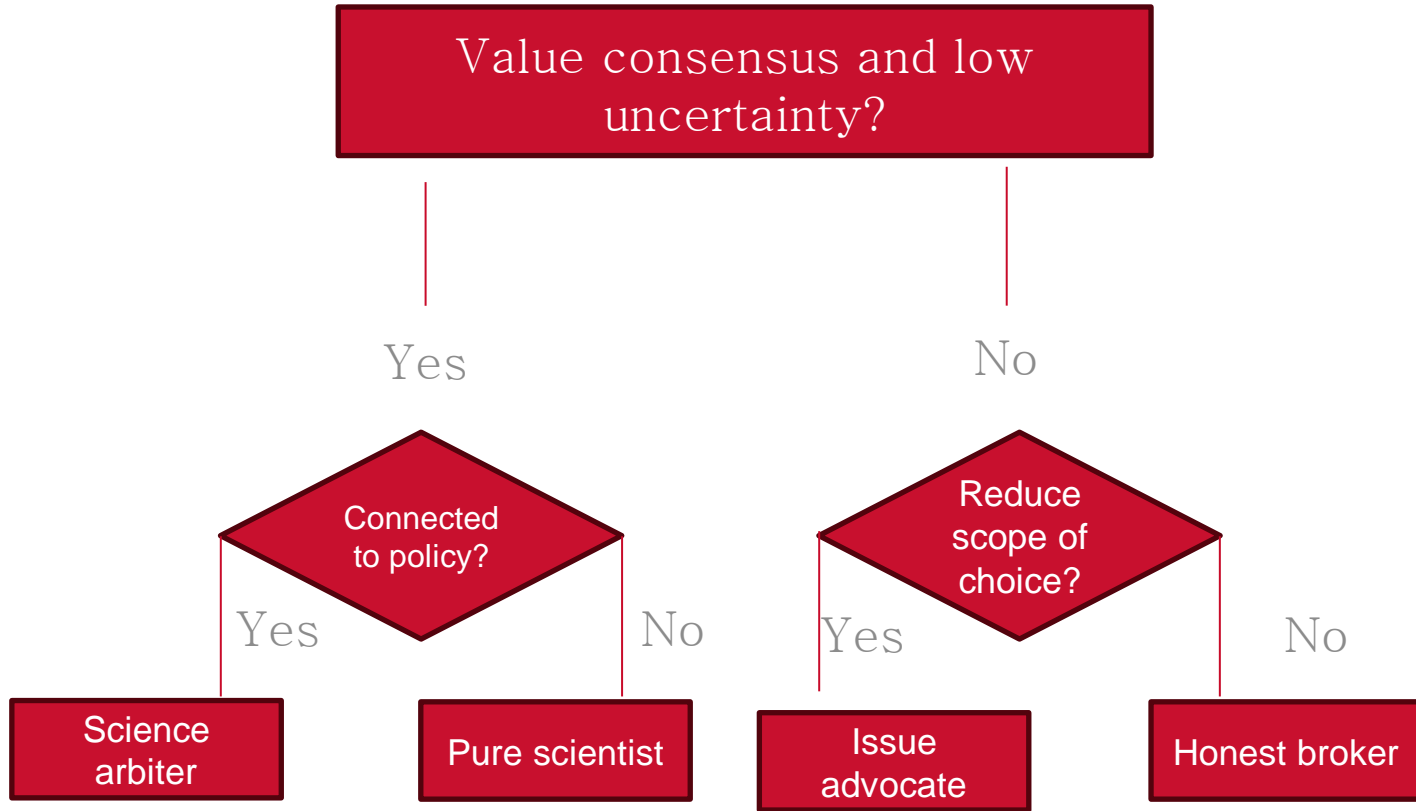
Roger Pielke
<https://rogerpielkejr.com/>



The Honest Broker

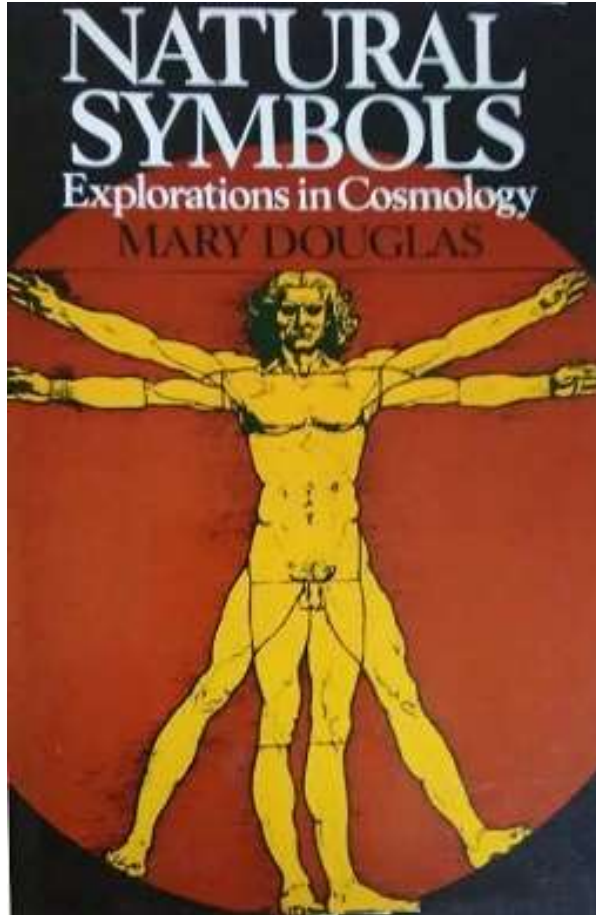
Making sense of science, policy and politics

By Roger Pielke, Jr.  Over 15,000 subscribers



Mary Douglas' cultural model of risk

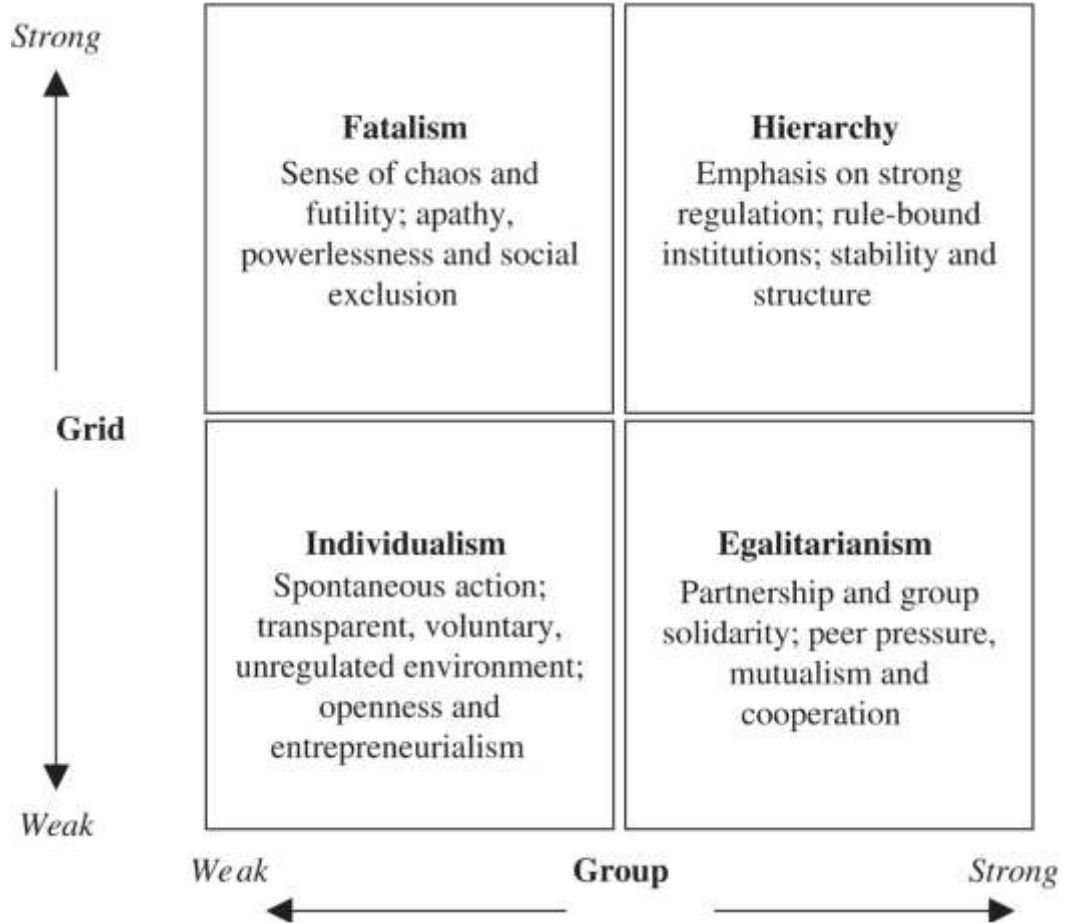
Douglas, M. (1970).
Natural symbols: Explorations in cosmology, London: Cresset Press.



Mary Douglas
(1921-2007)

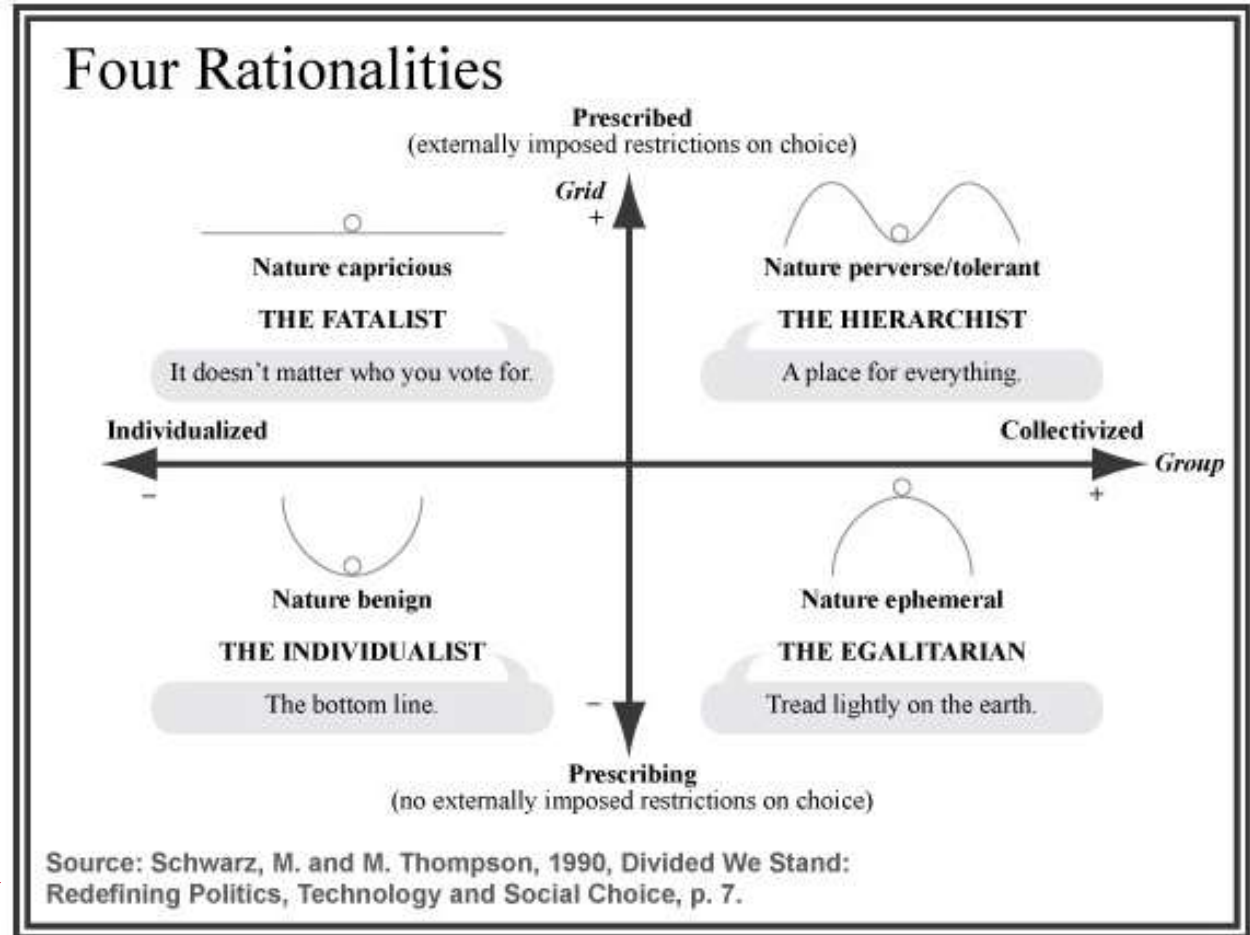
Group
degree of
incorporation
within a bounded
social unit

Grid
degree of social
prescriptions and
externally imposed
rules, with
established
hierarchies



Source: <https://www.dustinstoltz.com/blog/2014/06/04/diagram-of-theory-douglas-and-wildavskys-gridgroup-typology-of-worldviews/>

Myths of Nature
(Schwarz and
Thompson, 1990)



Myths of Nature (Schwarz and Thompson, 1990)



Nature is capricious

Natural systems are unpredictable



Nature is tolerant, but within limits

Natural systems can cope with disturbances, if these stay within certain boundaries



Nature is benign

Natural systems are resilient and able to deal with large disturbances



Nature is ephemeral or fragile

In natural systems, a small disturbance may have enormous impacts

Source: Sander C. S. Clahsen et al., 2018, Why Do Countries Regulate Environmental Health Risks

Differently? A Theoretical Perspective, Risk Analysis, DOI: 10.1111/risa.13165

Several approaches to regulating risk reviewed here

Risk Analysis, Vol. 00, No. 0, 2018

DOI: 10.1111/risa.13165

Why Do Countries Regulate Environmental Health Risks Differently? A Theoretical Perspective

**Sander C. S. Clahsen,^{1,2,*} Irene van Kamp,¹ Betty C. Hakkert,³ Theo G. Vermeire,³
Aldert H. Piersma,^{2,4} and Erik Lebret^{2,5}**

... and yet this work (not necessarily the approaches it reviews) is paradigmatic of a vision of policy (or human affairs) where 'risk' is the substance of the matter

Risk Analysis, Vol. 00, No. 0, 2018

DOI: 10.1111/risa.13165

Why Do Countries Regulate Environmental Health Risks Differently? A Theoretical Perspective

Sander C. S. Clahsen,^{1,2,*} Irene van Kamp,¹ Betty C. Hakkert,³ Theo G. Vermeire,³ Aldert H. Piersma,^{2,4} and Erik Lebret^{2,5}

Risk is mostly perceived in relation to health, and is hence quantified by science. Additionally risk is also the result of a perception, and can thus be investigated, again by science

Why Do Countries Regulate Environmental Health Risks Differently? A Theoretical Perspective

Sander C. S. Clahsen,^{1,2,*} Irene van Kamp,¹ Betty C. Hakkert,³ Theo G. Vermeire,³ Aldert H. Piersma,^{2,4} and Erik Lebret^{2,5}

As a result, technology resistance is interpreted as misplaced or erroneous risk perception, which in turn can be attributed to incomplete or deficient scientific understanding of the lay-person

Why Do Countries Regulate Environmental Health Risks Differently? A Theoretical Perspective

Sander C. S. Clahsen,^{1,2,*} Irene van Kamp,¹ Betty C. Hakkert,³ Theo G. Vermeire,³ Aldert H. Piersma,^{2,4} and Erik Lebret^{2,5}

This is the so-called ‘deficit model’ – a sort of hydra



Source: <https://www.dndbeyond.com/monsters/16929-hydra>

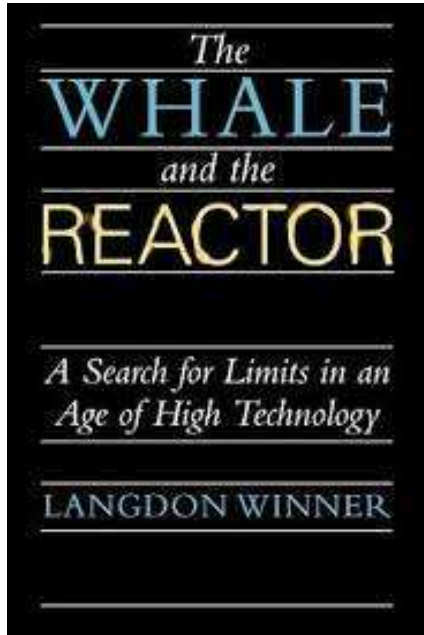
Different things can be at risk beside health, e.g. democracy, agency, justice, fairness, fundamental beliefs ...

Why should (health) risk dominate regulatory and policy narratives?

Winner (1986): ecologists should not fall into the trap of cost benefit analysis and risk analyses



Langdon Winner



(Chapter ON NOT HITTING THE TAR-BABY)

Winner, L., 1986. *The Whale and the Reactor: a Search for Limits in an Age of High Technology*. The University of Chicago Press, 1989 edition.

The deficit model
Who defines public meanings?
Science's hermeneutic imperialism



Special Issue: Public Engagement in Science

**Further disorientation in
the hall of mirrors**

Brian Wynne

Lancaster University, UK; University of Oslo, Norway

Public Understanding of Science

2014, Vol. 23(1) 60–70

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“After seamlessly extending from informing policy, to justifying resultant political commitments, science now plays a further role ... as de facto author of public meanings, thus also of proper public concerns”

This results in a confusion of the role of science

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**Further disorientation in
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Brian Wynne

Lancaster University, UK; University of Oslo, Norway

“.. a problematic presumption... that scientific meanings themselves, as given to public objects like ‘risk’, are also just facts, which therefore have natural proper authority over those of non-experts”



Special Issue: Public Engagement in Science

Further disorientation in the hall of mirrors

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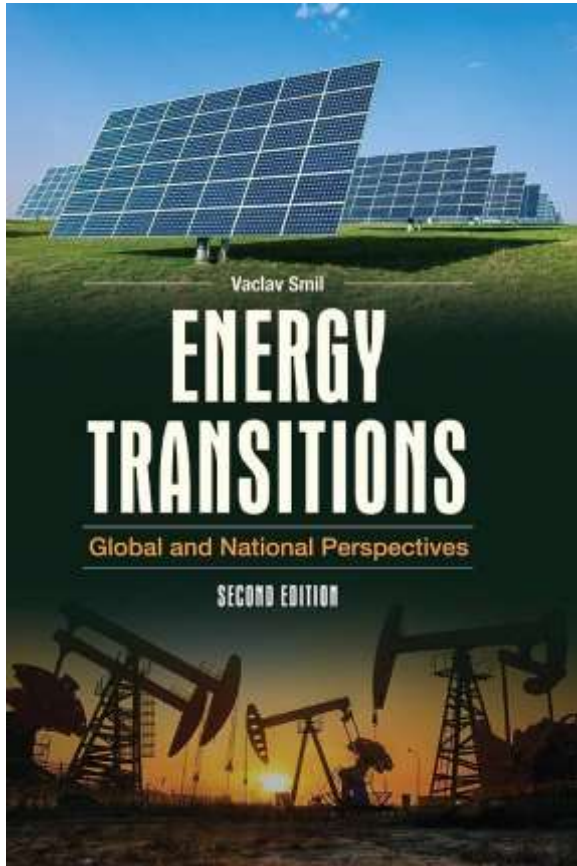
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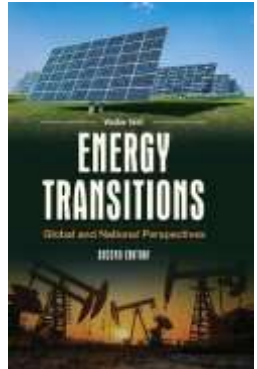




Vaclav Smil

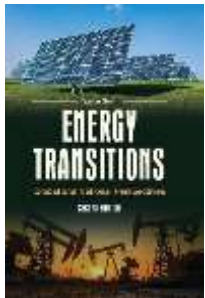
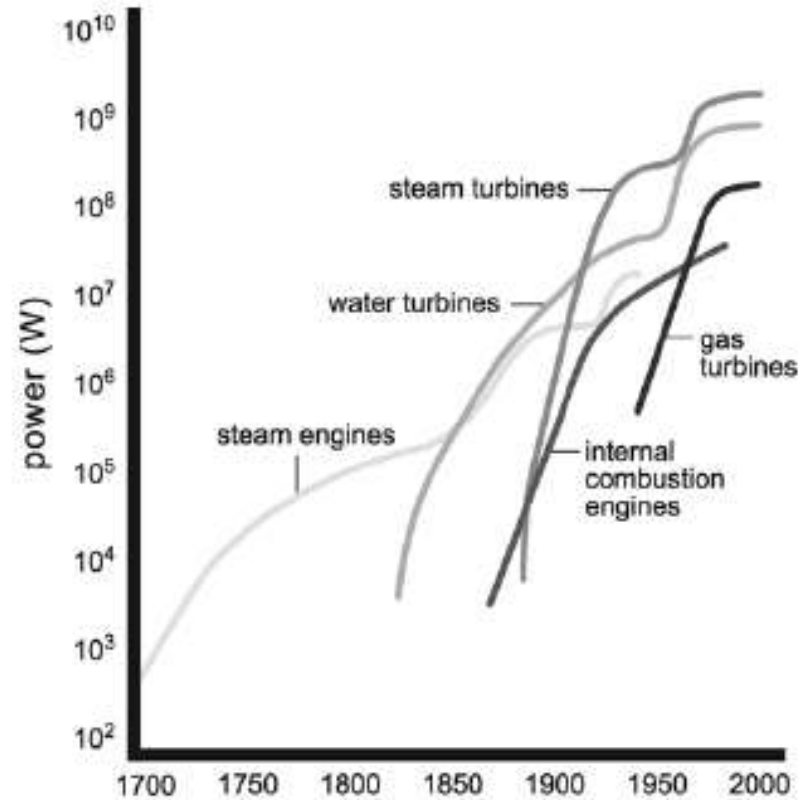
Promise of rapid transformation away from fossil fuels are often based on misconceptions

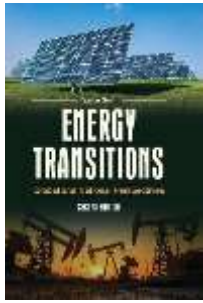
- Confusing installing capacity of renewables with actual energy output
- Confusing contribution to energy generation from renewables with fraction of total energy utilization



Energy transitions are more than a change in the fuel base (wood, charcoal, carbon, oil, renewables...) but involve primary energy movers

Figure 2.11 Maximum capacities of inanimate prime movers, 1700–2000. Based on Smil (1994).





History of past transition shows “gradual, prolonged affairs with new sources taking decades to become significant contributors”

Figure 2.12 Fisher-Pry plot of the global primary energy transition from biomass fuels to coals, hydrocarbons, and primary electricity, 1800–2010. Data points calculated from statistics in UNO (1956 and 1976) and BP (2009). The most remarkable phenomenon is the post-1970 stasis of all fossil fuel shares.

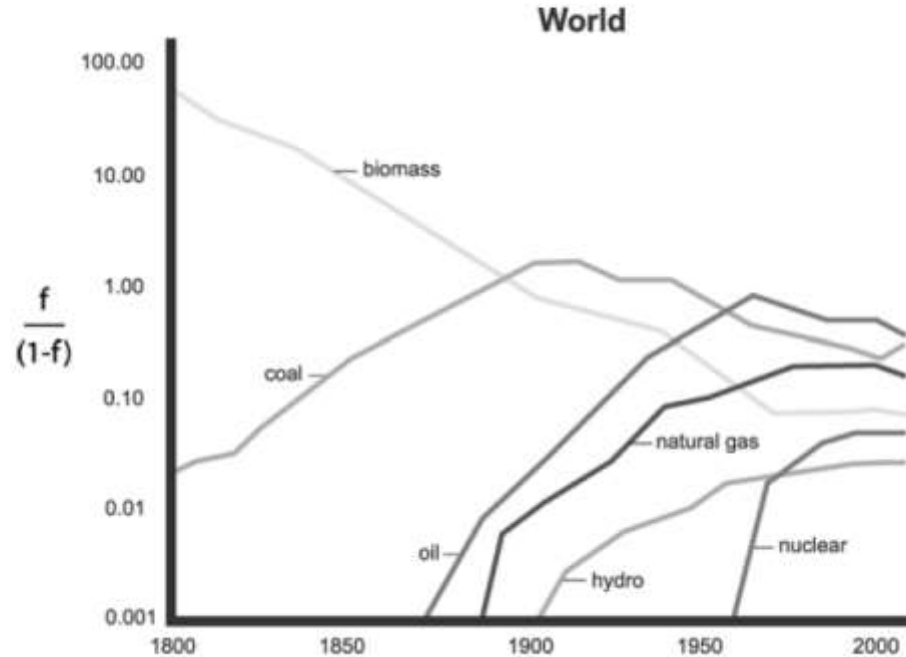
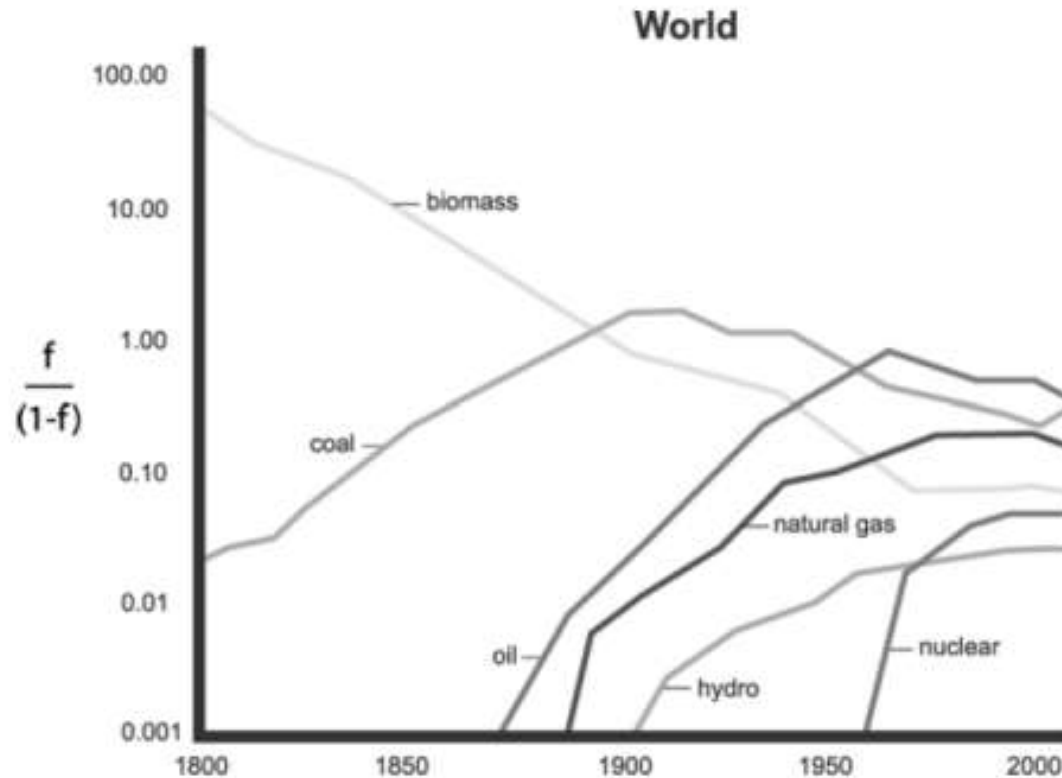


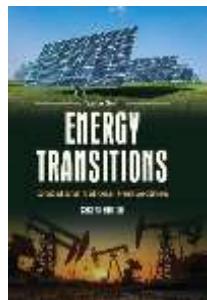
Figure 2.12 Fisher-Pry plot of the global primary energy transition from biomass fuels to coals, hydrocarbons, and primary electricity, 1800–2010. Data points calculated from statistics in UNO (1956 and 1976) and BP (2009). The most remarkable phenomenon is the post-1970 stasis of all fossil fuel shares.



$$\frac{1}{f} \frac{df}{dt} = r_0(1-f)$$

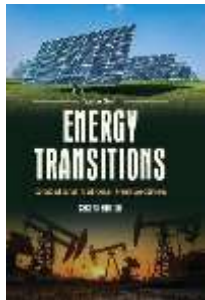
$$\frac{f}{(1-f)} = \exp(r_0 t)$$

Fisher-Pry model



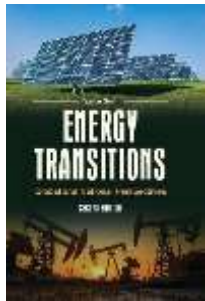
Five factors of the challenge

- Overall scale of the shift
- Magnitude and distribution of renewable
- Lower energy density of biofuels replacing liquid and solid fossil
- Intermittency of renewables
- Lower power densities of renewables



Unavoidable surprises

- Who would have predicted in the 70's (all dams are good) the present hesitancy (not even the World Bank now thinks the same)
- Who would have predicted in 1965 when nuclear were set to boom that nuclear would become a contested option in just two decades



Source: Wikipedia
Common

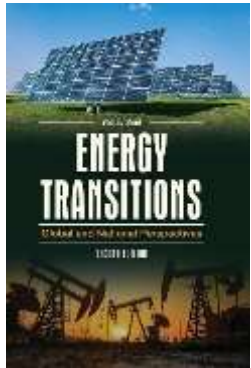
Lewis Strauss's 1945 prophesy of nuclear power 'too cheap to meter'

Trivia: The 'villain' in the latest Oppenheimer movie



Bold predictions

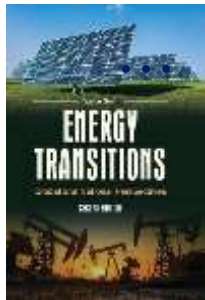
“The uselessness of the 2100 scenario, equivalent to envisaging the energy realities of 2015 from the perspectives of 1930 is all too obvious...”



“Robust optimism or naïve expectations”, p. 164

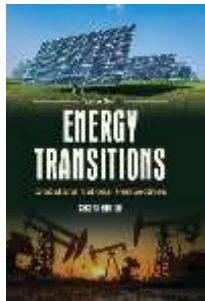
Al Gore in 2008: 100% electricity by renewable in ten years

CEC (now EC) in 2008: energy consumption from renewable in 2020 will reach 20%



The mixed record of Energiewende (p. 169–173)

2014: wind and solar contribute 22% to all primary energy derived from renewables while biomasses are at 60%; “in order to met its post 2020 targets Germany will have to import biomass, outsourcing impacts to the US South”





OPINION ENERGY

Germany's Energiewende, 20 Years Later >

Germany's far-reaching program to reduce the share of fossil fuels in energy has achieved almost exactly what the United States achieved, but at greater expense

BY VACLAV SMIL | 25 NOV 2020 | 3 MIN READ |



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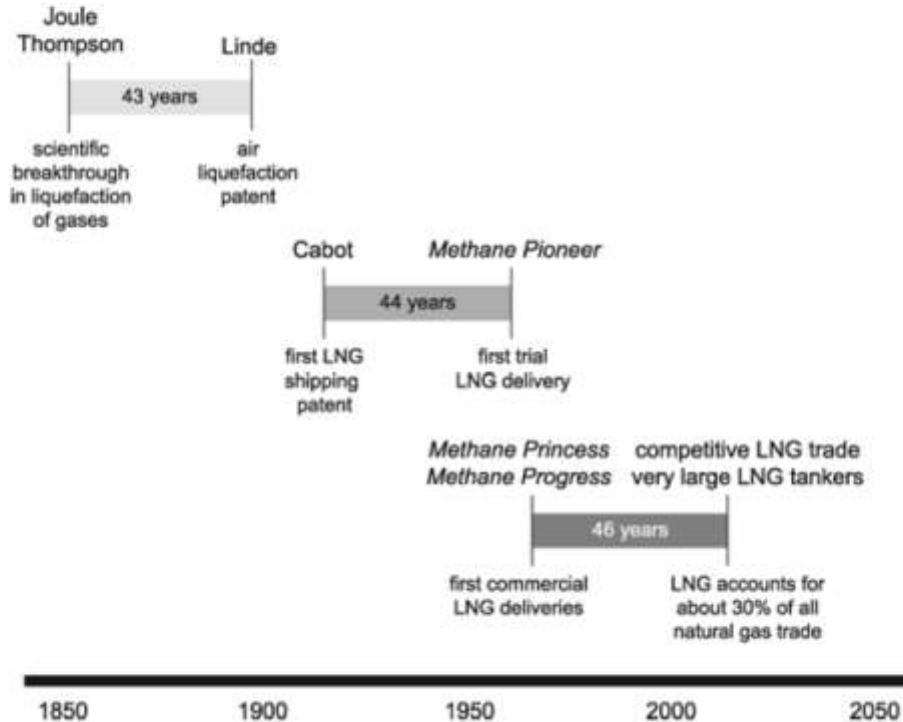
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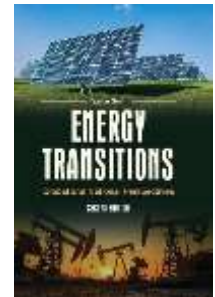
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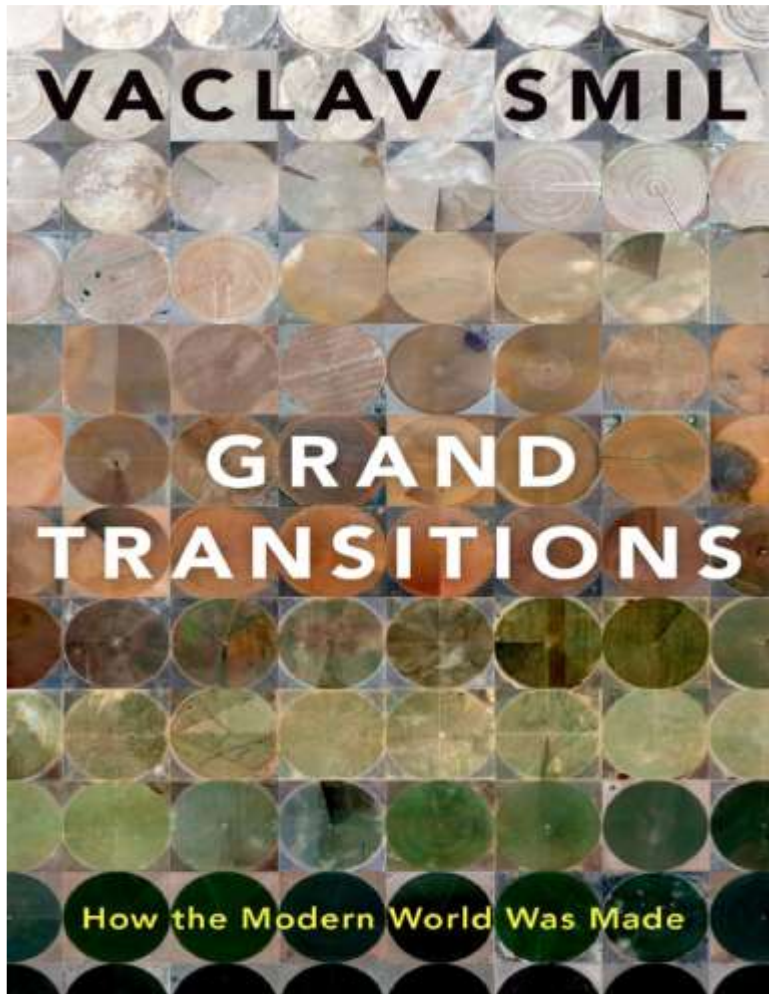


Figure 1.4 History of LNG shipments illustrates often very long time spans required for the maturation and diffusion of innovations in energy extraction, transport, and conversion.



Even a transition apparently uneventful as LNG has had its stop and go ... and the 2022–2023 war has put the issue back on the agenda





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(2021)

More recent work (2021)

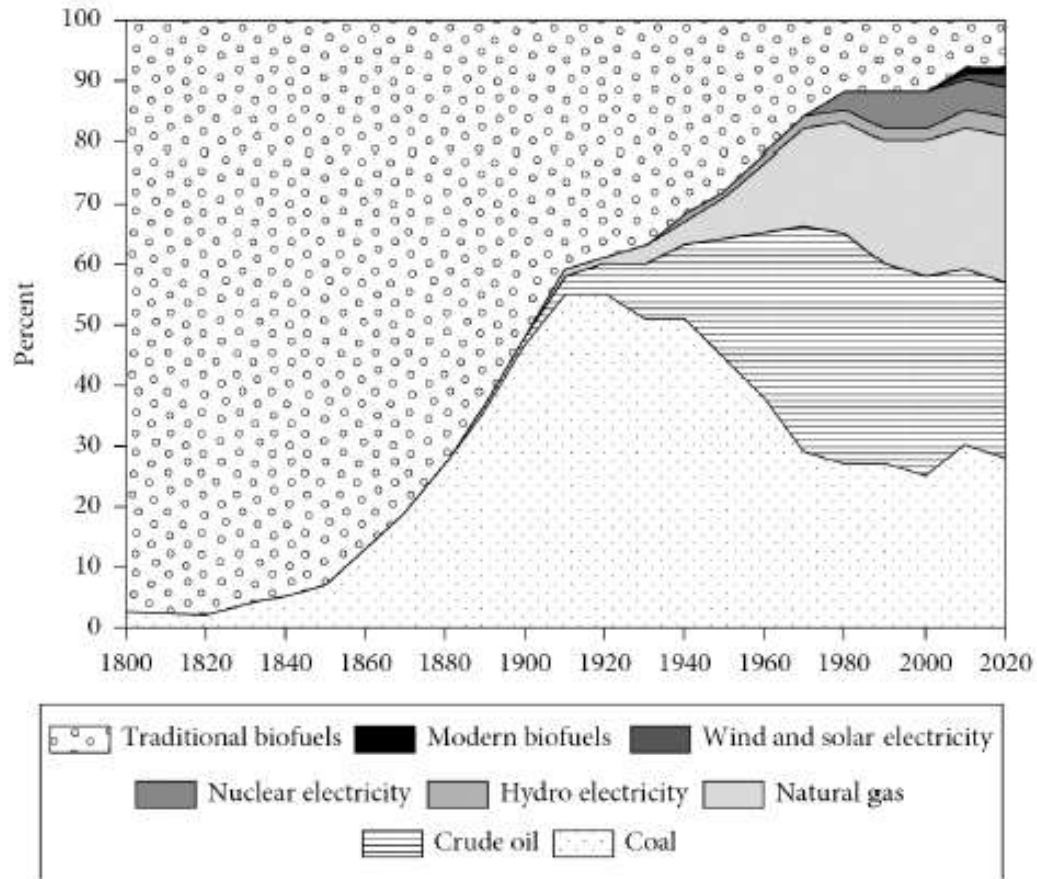
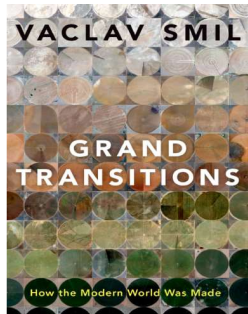


Figure 4.3 Global energy transitions, 1800–2015. Based on Smil (2017b).

Evaluating the Potential for Green Growth in a context of Technology Optimism and Technology Pessimism

A different way to look at transitions; adopting renewables and cleantech, not just for emission reduction, but because these embody technological change, manufacturing, learning curve effects, and are thus capable of capturing increasing returns. In contrast, fossil fuels are a typical diminishing returns activity.



Erik S. Reinert
(image Wikipedia Commons)

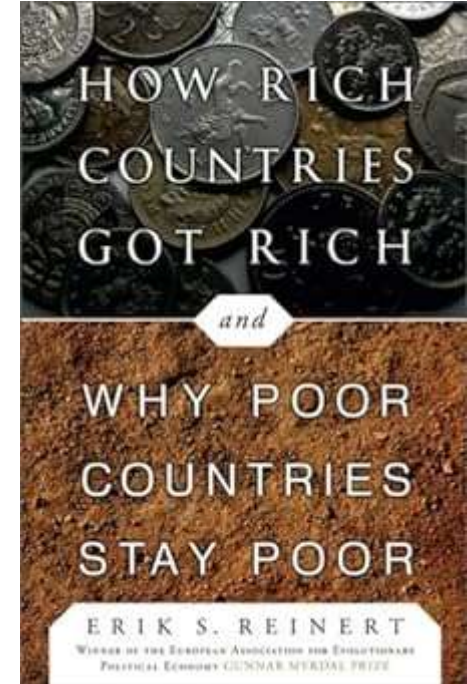
Based on: Andrea Saltelli, Lorenzo Benini, Silvio Funtowicz, Mario Giampietro, Matthias Kaiser, Erik Reinert, Jeroen P. van der Sluijs, 2020, The technique is never neutral. How methodological choices condition the generation of narratives for sustainability, Environmental Science and Policy, Volume 106, Pages 87–98, <https://www.sciencedirect.com/science/article/pii/S1462901119304721>. **OPEN ACCESS**

Evaluating the Potential for Green Growth in a context of Technology Optimism and Technology Pessimism

Putting renewable energies at the core of a country's industrial policy will drive down costs as the country moves along the learning curve...

With renewable power energy can be harvested, which at present is only practiced in hydropower, while with fossil fuels it needs to be extracted under diminishing returns...

As for the past, a period of protection will be needed to let these “infant industries” gain speed. At present, the case for renewables is opposed by vested interest of the fossil fuel sector as well as by the so called “neutral” economists who insist that markets should be allowed to function “free of interference”.



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The more things change, the more they stay the same: promises of bioeconomy and the economy of promises

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Optimistic promises can be looked at from a different angle

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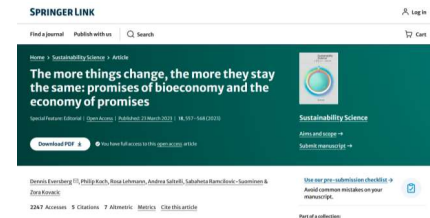


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“... promises of far-reaching change made by recent bioeconomy policies are in fact strategically directed at avoiding transformative change to existing societal arrangements”

→ “We live in a world of limited resources. Global challenges like climate change, land and ecosystem degradation, coupled with a growing population force us to seek new ways of producing and consuming that respect the ecological boundaries of our planet” (European Commission 2018, p. 4)

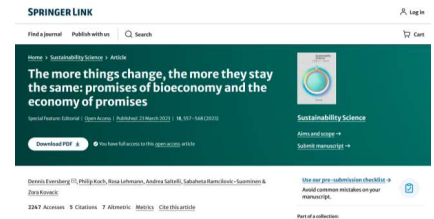
→ “... rapid, concerted and sustained changes in lifestyle and resource use that cut across all levels of society and the economy” (European Commission 2012, p. 3)



Benefits such as combating climate change, helping restore ecosystems, halting land degradation and reducing food waste while delivering new jobs in a sustainable ‘circular economy’ (European Commission 2018, pp. 5–7) are not to result from changes in lifestyles

The screenshot shows the Springer Link interface for an article. At the top, there is a navigation bar with 'SPRINGER LINK', 'Find a Journal', 'Publish with us', and a search bar. Below this, the article title 'The more things change, the more they stay the same: promises of bioeconomy and the economy of promises' is displayed in large white text on a dark green background. To the right of the title is a circular graphic with a blue and green color scheme. Below the title, the authors' names are listed: 'Dennis Eversberg, Philip Koch, Rosa Lehmann, Andrea Saltelli, Sabaheta Ramčević-Suominen & Zora Kovacic'. A 'Download PDF' button is visible. On the right side, there are links for 'Sustainability Science', 'Aims and scope', and 'Submit manuscript'. At the bottom, there are statistics: '2247 Accesses', '5 Citations', and '7 Altmetric Metrics'. A 'Part of a collection' link is also present.

Rather, [these achievements] are presented as resulting from ‘unprecedented advances in life sciences and biotechnologies, as well as innovations merging the physical, digital and biological worlds’ (European Commission 2018 p. 6)

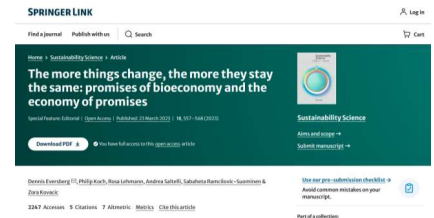


A model where “more of the same in technological advance and economic expansion will transform societies toward sustainability without actually transforming anything substantial about them”

Innovation here becomes a magic wand that help defuse the political nature of the problem, and to reframe it as a technical one




Source: Amazon.com



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The more things change, the more they stay the same: promises of bioeconomy and the economy of promises

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We talk of “economics of techno–scientific promises’ (ETP)” … The promise of ‘transformation without transformation’

ETP mobilizes the authority of science and its supposed impending breakthroughs as the mode of achieving change

This amounts to a ‘production of irreversibility’ and ‘lock-ins’ that renders society dependent and can progressively lock out any other solutions (P.-B. Joly)

DÉBORDEMENTS | Madeleine Akrich, Yannick Barthe, Fabian Muniesa, et al.



On the economics of techno-scientific promises

Pierre-Benoît Joly

p. 203-221

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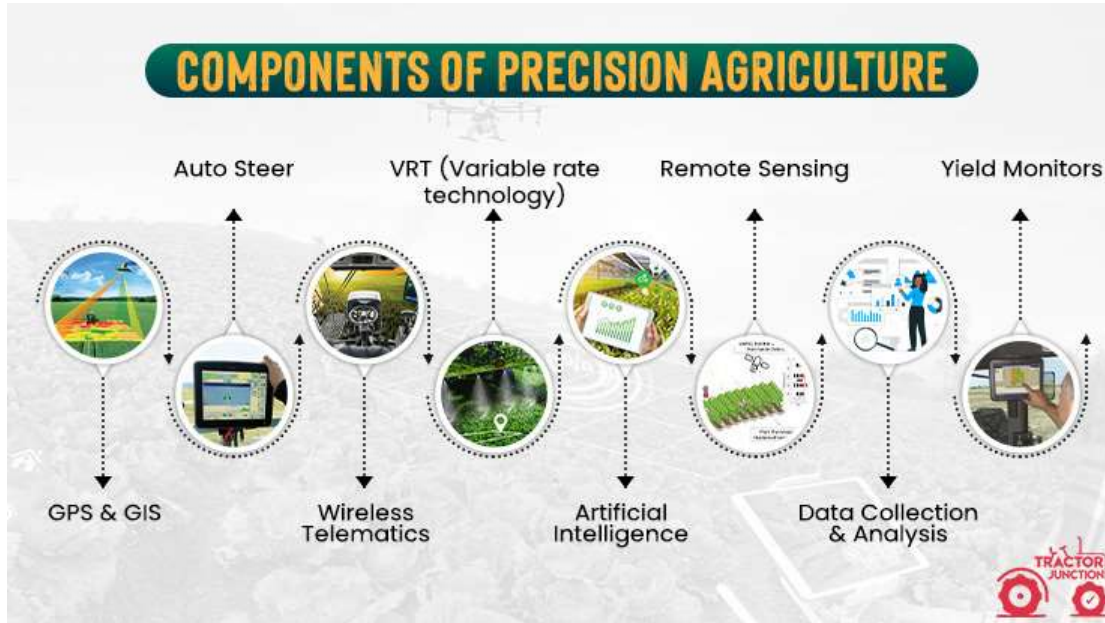


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... technologies promising to boost biomass production by improved control over genetic and environmental factors (GMOs, precision agriculture), ...



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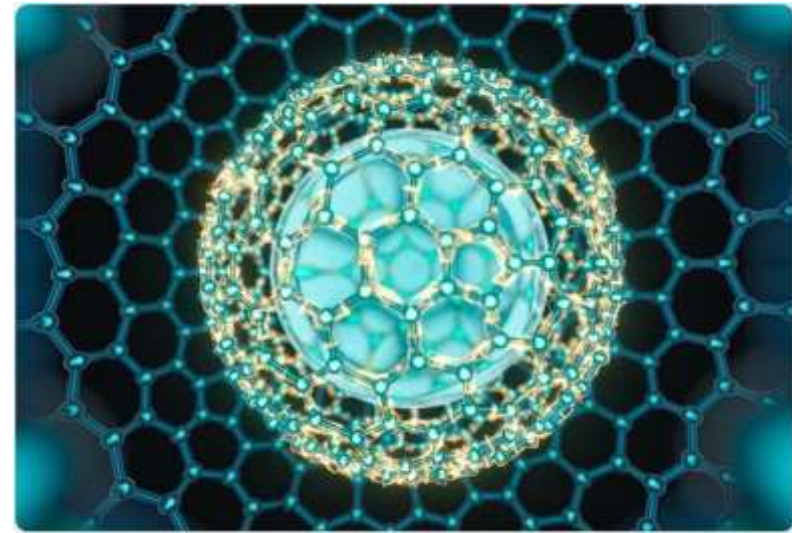
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… and/or substitute fossil-based materials and processes as bio-based drop-in replacements, such as tires made from dandelion or biopolymers produced by genetically modified bacteria



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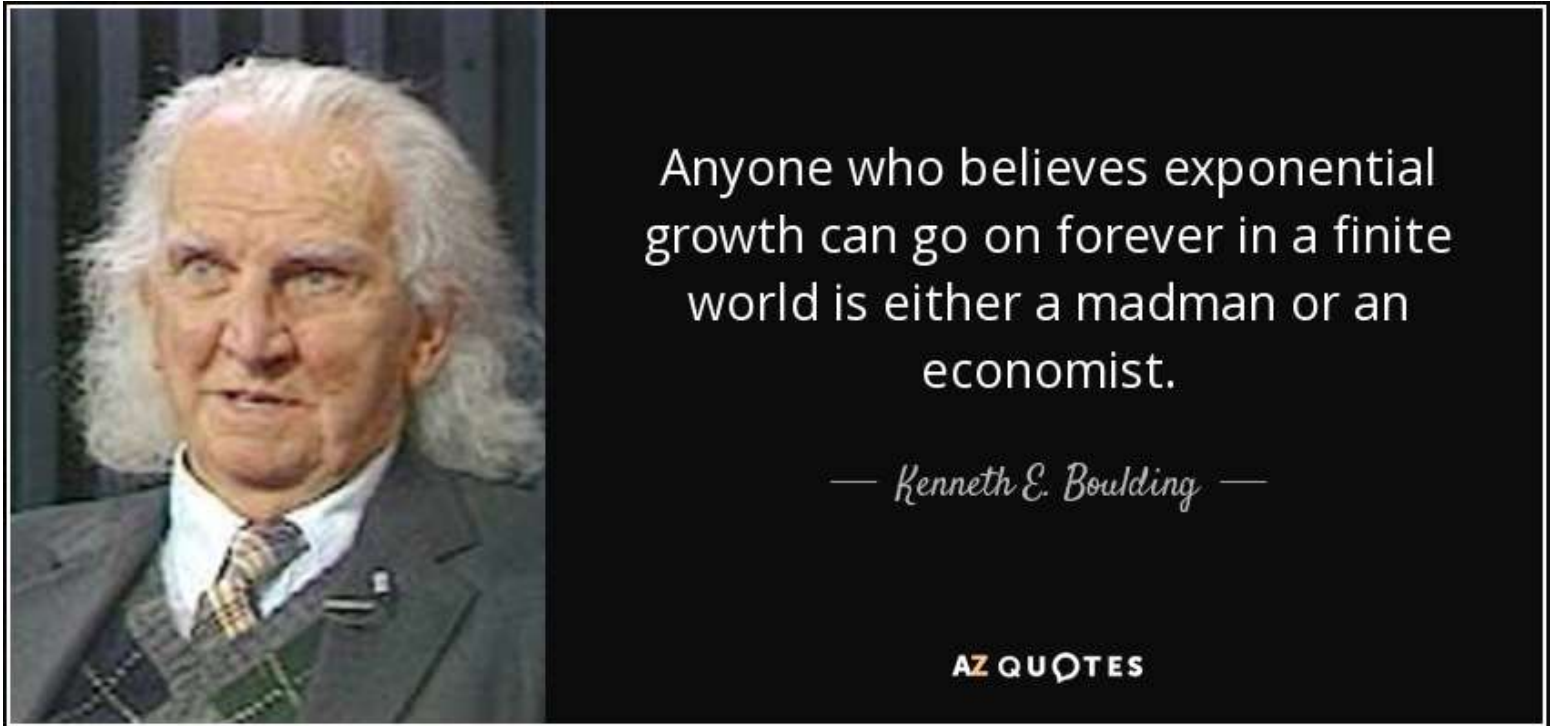
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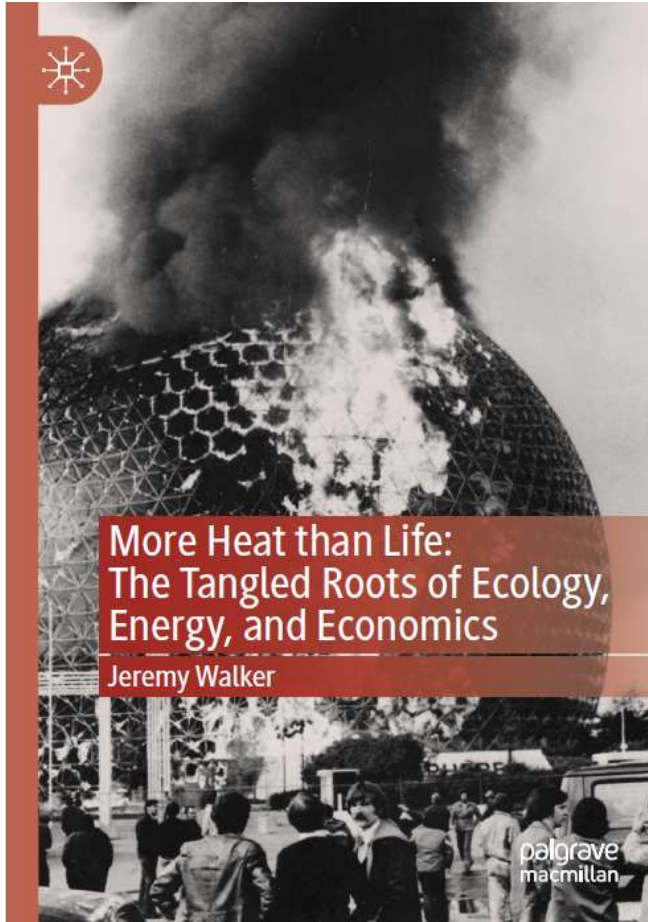
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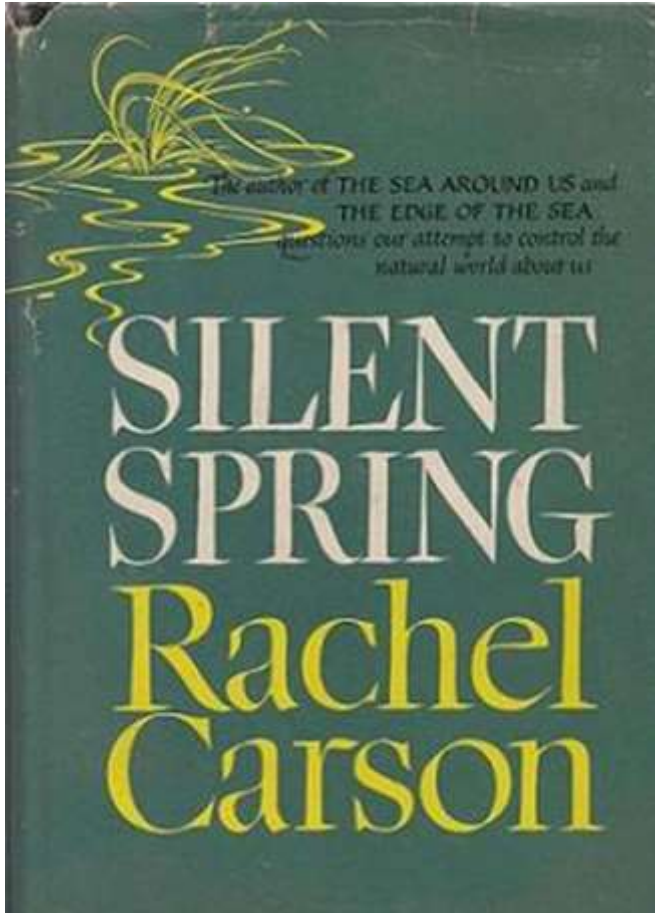
bioeconomy policies: contradictory efforts to deal with the destructive effects of economic expansion while at the same time attempting to keep it going at all costs





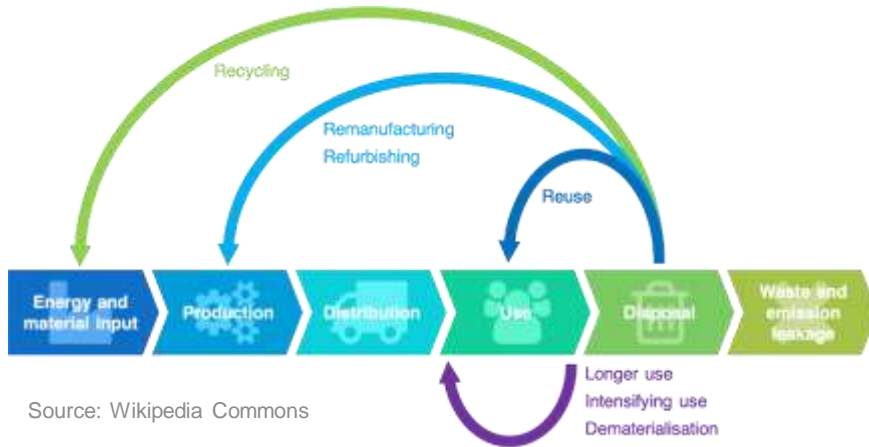
“How has the ecological world-view gone from a position of critical collision with economists’ denial of science and nature to subordinate collusion with neoliberal ‘solutions’, such as financial markets for carbon and ‘ecosystem services’, or techno-utopian geoengineering projects to make endangered ecosystems ‘resilient’ to planetary heating?”

How did we go from Rachel Carson 1962 critique ...



“The ‘control of nature’ is a phrase conceived in arrogance, born of the Neanderthal age of biology and philosophy, when it was supposed that nature exists for the convenience of man”

... to science enrolled in alimending the economy of promises



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The more things change, the more they stay the same: promises of bioeconomy and the economy of promises

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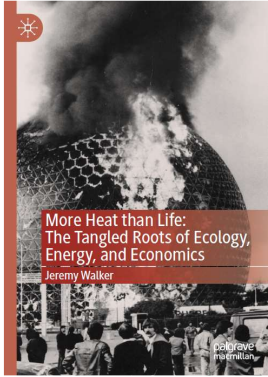
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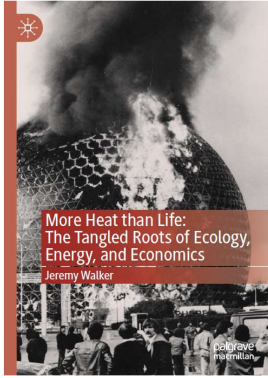


“The roots of our current condition might be traced to the crisis of American power of the early 1970s, a time when two bodies of knowledge—ecosystems ecology and the economics of the Chicago School—were transforming the institutions of the United States”

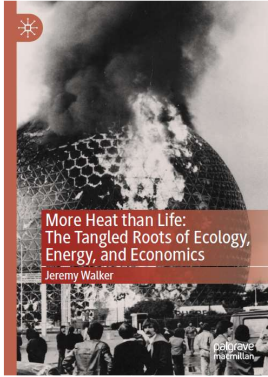
...

“both anchored their claims to the status of science in the energy physics developed by combustion engineers as the thermoindustrial revolution gathered momentum in the mid-nineteenth century”

ΟΪΚΟΣ



“It was not until the 1970s, however, that ecology and economics were brought into direct ontological and political conflict…”



“how do we account for the uncritical commitment to infinite economic growth pursued by almost all nation-states, given the extensive empirical evidence that this is undermining the very habitability of the Earth?”

...

“The 2nd law of thermodynamics, despite being the most directly relevant principle of physics to our economic existence on Earth, has never been integrated into the canon of economic theory”

Why don't we build in silico a digital twin of the earth to ease the transition?

A digital twin of Earth for the green transition

For its green transition, the EU plans to fund the development of digital twins of Earth. For these twins to be more than big data atlases, they must create a qualitatively new Earth system simulation and observation capability using a methodological framework responsible for exceptional advances in numerical weather prediction.

Peter Bauer, Bjorn Stevens and Wilco Hazeleger

The European Union (EU) intends to become climate neutral by 2050, and the set of policies designed to bring about this green transition — the European Green Deal — was announced in December 2019 (ref. 1). Accompanied by €1 trillion of planned investment, Green Deal policies aim to help the world's second-largest economy sustainably produce energy, develop carbon-neutral fuels and advance circular products in energy-intensive industrial sectors with zero waste and zero pollution.

A key element of the Green Deal is its dependence on the 'digital transformation' — an openly accessible and interoperable European dataspace as a central hub for informed decision making. The EU identified two landmark actions to support the necessary information systems: GreenData4All and Destination Earth'. Whereas GreenData4All will develop the European approach to discover, manage and exploit geospatial information, Destination Earth aims to construct highly accurate models, or 'digital twins', of the Earth to monitor and predict environmental change and human impact in support of sustainable development. Aligned with the new Digital Europe funding programme², Destination Earth is expected to start in 2021, and the first, high-priority digital twins serving extremes prediction and climate change adaptation will



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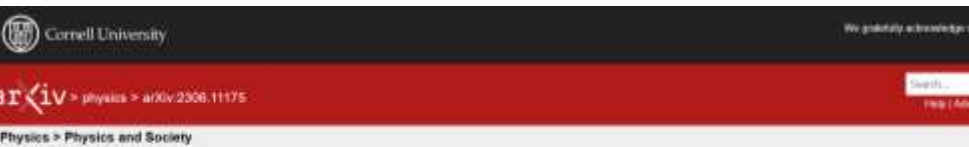
Review Article | Published: 02 May 2023

Big Data in Earth system science and progress towards a digital twin

Xin Li , Min Feng , Youhua Ran, Yang Su, Feng Liu, Chunlin Huang, Huanfeng Shen, Qing Xiao, Jianbin Su, Shiwei Yuan & Huadong Guo

Nature Reviews Earth & Environment 4, 319–332 (2023) | [Cite this article](#)

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Developing Digital Twins for Earth Systems: Purpose, Requisites, and Benefits

Yuhan Rao, Rob Redman, Kirstine Dale, Sus E. Haigt, Aaron Hopkinson, Ann Boettrom, Sid Boukabara, Thomas Geenen, David M. Hall, Benjamin D. Smith, Dev Nyogi, V. Ramaswamy, Eric A. Kille

The accelerated change in our planet due to human activities has led to grand societal challenges including health crises, intensified extreme weather events, food security, environmental injustice, etc. Digital twin systems combined with emerging technologies such as artificial intelligence and edge computing provide opportunities to support planning and decision-making to address these challenges. Digital twins for Earth systems (DT4ESs) are defined as the digital representation of the complex integrated Earth system including both natural processes and human activities. They have the potential to enable a diverse range of users to explore what-if scenarios across spatial and temporal scales to improve our understanding, prediction, mitigation, and adaptation to grand societal challenges. The 4th NOAA AI Workshop convened around 100 members who are developing or interested in participating in the development of DT4ES to discuss a shared community vision and path forward on fostering a future ecosystem of interoperable DT4ES. This paper summarizes the workshop discussions around DT4ES. We first defined the foundational features of a stable digital twins for Earth system that can be used to guide the development of various use cases of DT4ES. Finally, we made practical recommendations for the community on different aspects of collaboration in order to enable a future ecosystem of interoperable DT4ES, including equity-centered use case development, community-driven investigation of interoperability for DT4ES, trust-oriented co-development, and developing a community of practice.

Alternative voices; technologies of humility

- Winners and losers, voices to be heard from disciplines and societal actors

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Technologies of humility

[Sheila Jasanoff](#)

[Nature](#) **450**, 33 (2007) | [Cite this article](#)



Credits: D. Parkins

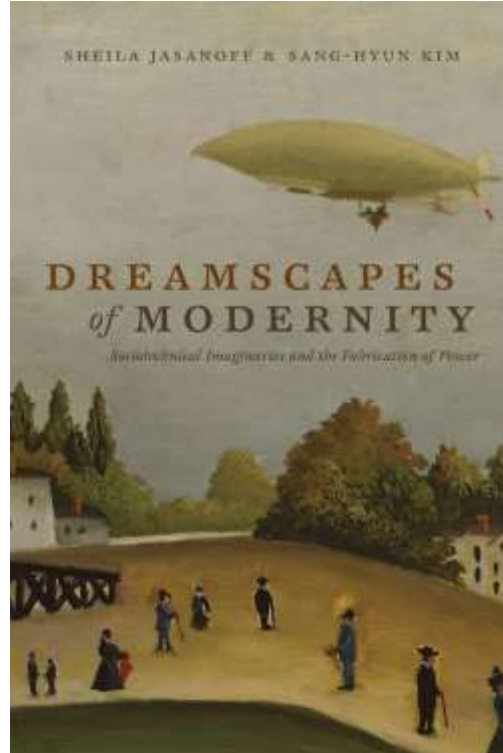


Sheila Jasanoff

Sociotechnical imaginaries: how visions of scientific and technological progress carry implicit ideas about public purposes, collective futures, and the common good



Sheila Jasanoff



The ethos of science



Robert K. Merton, sociologist of science,
considered the father of Science and Technology
Studies, 1910–2003

CUDOS

Communalism – the common ownership of scientific discoveries, according to which scientists give up intellectual property rights in exchange for recognition and esteem ...

Universalism – according to which claims to truth are evaluated in terms of universal or impersonal criteria, and not on the basis of race, class, gender, religion, or nationality;

CUDOS

Disinterestedness – according to which scientists are rewarded for acting in ways that outwardly appear to be selfless;

Organized Scepticism – all ideas must be tested and are subject to rigorous, structured community scrutiny

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Practicum here

- Split in groups
- Debate among yourselves the pros and cons of **one** norm & elect **two** advocated, one pro the norm and the other against (15m)
- The two advocates for each group report in class



The same R.K. Merton realized later in life that norms have corresponding counter norms

Mitroff, I. I. 1974, Norms and Counter-Norms in a Select Group of the Apollo Moon Scientists: A Case Study of the Ambivalence of Scientists, *American Sociological Review*, 39, 579–595.

NORMS AND COUNTER-NORMS IN A SELECT GROUP OF THE APOLLO MOON SCIENTISTS: A CASE STUDY OF THE AMBIVALENCE OF SCIENTISTS*

IAN I. MITROFF

American Sociological Review 1974, Vol. 39 (August): 579-595

This paper describes a three and a half year study conducted over the course of the Apollo lunar missions with forty-two of the most prestigious scientists who studied the lunar rocks. The paper supports the Merton-E. Barber concept of sociological ambivalence, that social institutions reflect potentially conflicting sets of norms. The paper offers a set of counter-norms for science, arguing that if the norm of universalism is rooted in the impersonal character of science, an opposing counter-norm is rooted in the personal character of science. The paper also argues that not only is sociological ambivalence a characteristic of science, but it seems necessary for the existence and ultimate rationality of science.

Three-and-a-half-year study conducted over the course of the Apollo lunar missions with forty-two of the most prestigious scientists who studied the lunar rocks

The paper supports the Merton-E. Barber concept of **sociological ambivalence**, that social institutions reflect potentially conflicting sets of norms

[We must] consider, first, how potentially contradictory norms develop in every social institution; next, how in the institution of science conflicting norms generate marked ambivalence in the lives of scientists; and finally, how this ambivalence affects the actual, as distinct from the supposed, relations between men of science (Merton, 1963a:80).

- Solitariness (secrecy, miserism) is often used to keep findings secret in order to be able to claim patent rights...

Instead of Communalism

- Particularism [...] a real issue, particularly when you consider the ratio of researchers in rich countries compared with those in poor countries

Instead of Universalism

- Interestedness arises because scientists have genuine interests at stake in the reception of their research...
Instead of Disinterestedness

- Dogmatism because careers are built upon a particular premise (theory) being true...

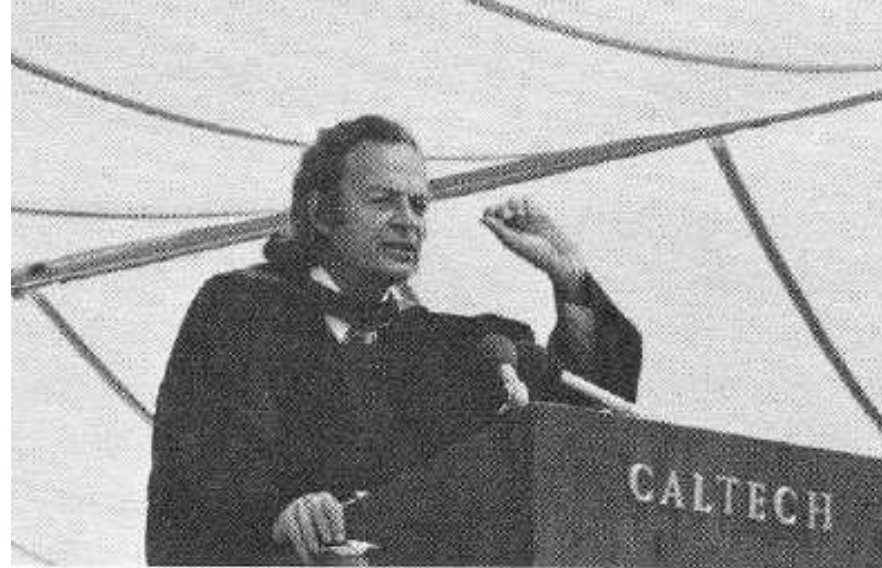
Instead of Organized
Skepticism

A lesson from a
recent past

Cargo Cult Science

by RICHARD P. FEYNMAN

Some remarks on science, pseudoscience, and learning how to not fool yourself. Caltech's 1974 commencement address.



<http://calteches.library.caltech.edu/3043/1/CargoCult.pdf>



“In the South Seas there is a cargo cult of people. During the war they saw airplanes land with lots of good materials, and they want the same thing to happen now.

So they've arranged to imitate things like runways, to put fires along the sides of the runways, to make a wooden hut for a man to sit in, with two wooden pieces on his head like headphones and bars of bamboo sticking out like antennas—he's the controller—and they wait for the airplanes to land”

“They're doing everything right. The form is perfect. It looks exactly the way it looked before. But it doesn't work. No airplanes land. So I call these things cargo cult science, because they follow all the apparent precepts and forms of scientific investigation, but they're missing something essential, because the planes don't land”



“[...] there is one feature I notice that is generally missing in cargo cult science. That is the idea that we all hope you have learned in studying science in school [...].”



It's a kind of scientific integrity, a principle of scientific thought that corresponds to a kind of utter honesty--a kind of leaning over backwards.



“Details that could throw doubt on your interpretation must be given, if you know them. [...] give all of the information to help others to judge the value of your contribution.”

Alternative voices

- Alternatives framings, styles and methods (lenses: system ecology, non-Ricardian economics, feminist economics, post-normal science...)













Environmental Science & Policy

Volume 142, April 2023, Pages 99-111



Impact assessment culture in the European Union. Time for something new?

[Andrea Saltelli](#)^{a b}  , [Marta Kuc-Czarnecka](#)^c , [Samuele Lo Piano](#)^d ,
[Máté János Lőrincz](#)^d , [Magdalena Olczyk](#)^c , [Arnald Puy](#)^e ,
[Erik Reinert](#)^{f g} , [Stefán Thor Smith](#)^d , [Jeroen P. van der Sluijs](#)^{b h} 

Some elements from history and philosophy of science

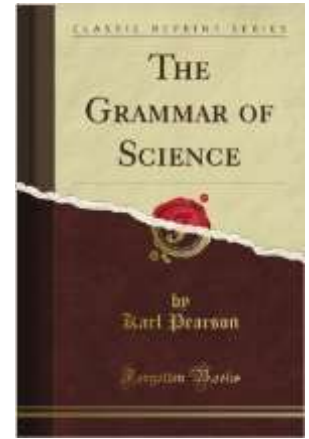
How are we taught our
science; the good and
the truth; from the
Vienna circle to ...

How are we taught
our science?

Karl Pearson (a social Darwinist) suggests not wasting resources on social programs as:

“No degenerate and feeble stock will ever be converted into healthy and sound stock by the accumulated effects of education, good laws, and sanitary surroundings”

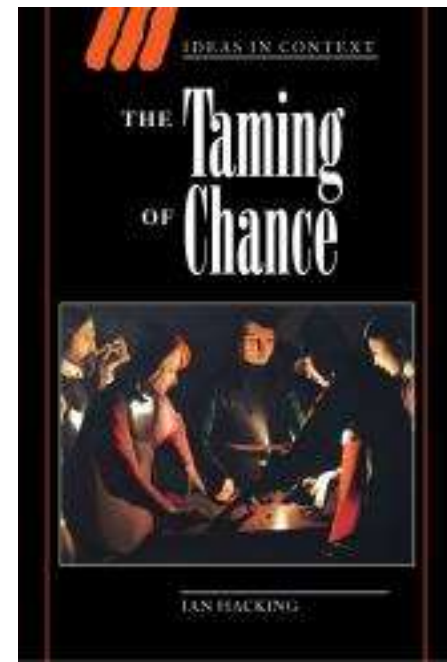
Karl Pearson



Pearson, K., 1892, The Grammar of Science, Walter Scott Publisher, London, p.32.

Francis Galton and Karl Pearson (the one of chi-squared); laboratory of biometrics; distinguishing army officers from private soldiers from criminals convicted of murder from non-violent felons from Jews ...

EUGENICS
"IS THE STUDY OF THE AGENCIES UNDER SOCIAL CONTROL, THAT IMPROVE OR IMPAIR THE RACIAL QUALITIES OF FUTURE GENERATIONS EITHER PHYSICALLY OR MENTALLY."
SIR FRANCIS GALTON.



Kuhn said that the “educational initiation that prepares and licenses the student for professional practice... is both rigorous and rigid”

and “It is a narrow and rigid education [in physics/science], probably more so than any other except perhaps in orthodox theology”



Thomas Kuhn, *The structure of scientific revolution*, 192, Chapters I and XIII

and “the member of a mature scientific community is, like the typical character of Orwell’s 1984, the victim of a history rewritten by the powers that be.”



Thomas Kuhn, The structure of scientific revolution, 192, Chapter XIII

Thus disciplinary advancements are presented in textbooks as the “perception of the obvious” made by one-eyed men in the kingdom of the blinds (Ravetz, 1971).

Can statisticians ignore their role in Eugenics, can chemists ignore what is phlogiston, or geologists how Alfred Lothar Wegener 1915 theory of Continental Drift was met with skepticism ...

Why ethics and science cannot be separated?



See a clean version here:

http://www.andreasaltelli.eu/file/repository/Ideological_committment.pdf

How science is conceived has important
political implications

The **Vienna Circle** and the fight against the ‘metaphysical and theologizing’ associated with fascism and national socialism (1929). Modern empiricism as a scientific world conception



RADICAL PHILOSOPHY

Archive + About + Support +

Issue 037 series 1 Summer 1984

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Ideological Commitments in the Philosophy of Science
With a Comment on Ravetz by Edgley

Jerry Ravetz and Roy Edgley
RP 037 (Summer 1984)

Verification or falsification?

Karl Popper

A radical departure from the principle of 'verification' that was at the heart of the Vienna Circle positivism (inductivism)



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Ideological Commitments in the Philosophy of Science
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RP 037 (Summer 1984)

ISSUE 037
SERIES 3
SUMMER 1984

Verification or falsification?

Karl Popper

Truth cannot be verified: it can only be falsified



A screenshot of the website for the journal 'Radical Philosophy'. The page features a navigation bar with links for 'Archive +', 'About +', and 'Support +'. Below the navigation bar, there is a search bar and a small disclaimer: 'The following text has been automatically reproduced by an Optical Character Recognition (OCR) algorithm. It may not have been checked over by human eyes. For matters of precision please consult the original pdf.' The main article title is 'Ideological Commitments in the Philosophy of Science' with a comment by Jerry Ravetz and Roy Edgley. The issue information is 'RP 037 (Summer 1984)'. On the right side, there is a red vertical banner with the text 'ISSUE 037 SUMMER 1984'.

Socratic ethos

Is Socrates saying that he knows the truth?



And what kind of man am I? One of those who would gladly be refuted if anything I say is not true, and would gladly refute another who says what is not true, but would be no less happy to be refuted myself than to refute, for I consider that a greater benefit ... I believe there is no worse evil for man than a false opinion about the subject of our present discussion

Courtesy of Kjetil Rommetveit

Verification or falsification?

Karl Popper

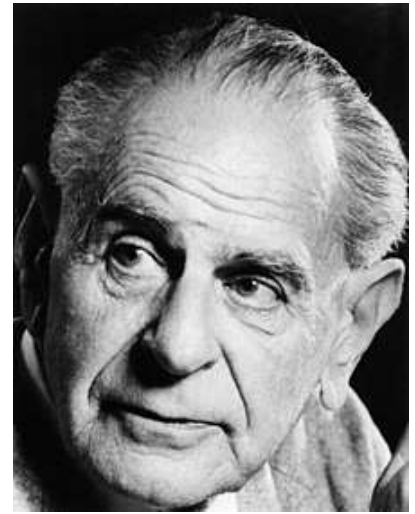
Demarcation science/non-science → Marxist historiography and psychoanalysis are not science

The screenshot shows the top portion of the Radical Philosophy journal website. At the top, the title "RADICAL PHILOSOPHY" is displayed in a large, bold, black font. Below the title is a navigation bar with links for "Archive +", "About +", and "Support +", followed by social media icons and a search bar. To the right of the navigation bar is a red vertical banner with the text "ISSUE 037" and "SUMMER 1984". Below the navigation bar, a small grey box contains a disclaimer: "The following text has been automatically reproduced by an Optical Character Recognition (OCR) algorithm. It may not have been checked over by human eyes. For matters of precision please consult the original pdf." Below this disclaimer, the article title "Ideological Commitments in the Philosophy of Science" is shown in bold, followed by the subtitle "With a Comment on Ravetz by Edgley" and the authors "Jerry Ravetz and Roy Edgley". At the bottom, the issue information "RP 037 (Summer 1984)" is displayed.

Verification or falsification?

A champion of liberal democracy at times of cold war; open society as an alternative to totalitarianism

A critical member of the Mont Pelerin society, with Friedrich Hayek, Milton Friedman, Ludwig von Mises and others,



Karl R. Popper
1902–1994



RADICAL PHILOSOPHY

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Ideological Commitments in the Philosophy of Science
With a Comment on Ravetz by Edgley
Jerry Ravetz and Roy Edgley
RP 037 (Summer 1984)

Paradigm shifts

Thomas Kuhn: a disenchanted vision of science as alternating between ‘normal’ and ‘revolutionary’

Puzzle solving, dogmatic science, then a paradigm shift ... then the same over again

Lost a direction a progress



Imre Lakatos: defending science from its enemies.
Remedying the weaknesses in Popper's program

“Proofs and Refutations” revealing the ambiguities of proof even in mathematics, on 'Euler Polyhedron Theorem'; If even mathematics can be ambiguous how can science be dogmatic?



Who remembers the theorem?

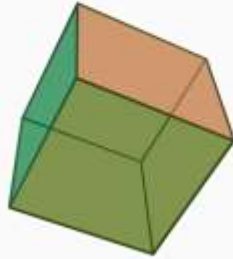
A screenshot of the Radical Philosophy journal website. The header features the title "RADICAL PHILOSOPHY" in large, bold, black letters. Below the title is a navigation bar with links for "Archive +", "About +", "Support +", and a search icon. On the right side of the header, there is a red box with the text "ISSUE 037 series 1 Summer 1984". Below the navigation bar, there is a small grey box with the text: "The following text has been automatically reproduced by an Optical Character Recognition (OCR) algorithm. It may not have been checked over by human eyes. For matters of precision please consult the original pdf." Below this, the main article title is "Ideological Commitments in the Philosophy of Science" in bold, followed by the subtitle "With a Comment on Ravetz by Edgley". At the bottom, the authors are listed as "Jerry Ravetz and Roy Edgley" and the issue information "RP 037 (Summer 1984)".

Euler's Polyhedron Formula

$$\text{Vertices} - \text{Edges} + \text{Faces} = 2$$



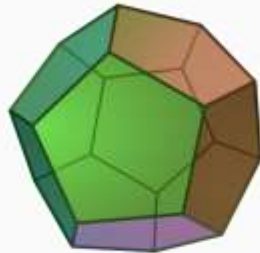
$$V = 4 \quad E = 6 \quad F = 4 \\ 4 - 6 + 4 = 2$$



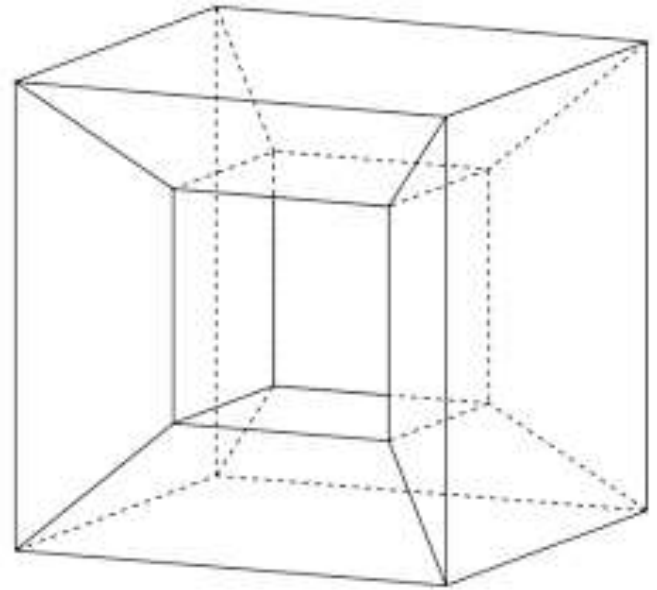
$$V = 8 \quad E = 12 \quad F = 6 \\ 8 - 12 + 6 = 2$$



$$V = 6 \quad E = 12 \quad F = 8 \\ 6 - 12 + 8 = 2$$



$$V = 20 \quad E = 30 \quad F = 12 \\ 20 - 30 + 12 = 2$$



A monster example?

Imre Lakatos: The idea of ‘decadal’ research programmes to save Popper’s falsificationism from Kuhn’s critique by combining the two visions, abandoning ‘naïve falsificationism’



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Paul Feyerabend

Perhaps the most erudite and most philosopher among the four; and the most destructive of any theory of scientific method

In “Against Method” he shows how the best among scientists (e.g. Galileo Galilei) violated any ‘rule’

A court jest, a fascist,
a Zen master? Asks Ravetz



Paul Feyerabend

Human imperfections of Galileo can 'blow the mind' of a student for whom the authority of science is as absolute

After such a shock the student may be ready to awaken to the truth that there is no truth to awaken to (Feyerabend as a Zen master?)



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Paul Feyerabend

For Ravetz, Feyerabend shows to the lay public science's sacred images being sprayed by a philosophical machine gun (Feyerabend as a fascist?)

Killing science as we know it or showing the hypocrisy of this image?



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Ravetz's conclusions

The edifice built by Popper and Lakatos was vulnerable to the critique of Kuhn and Feyerabend, perhaps because of its ideological aspirations

Yet the Enlightenment battle against the church cultural and political hegemony is over, so is a simplistic image of science upholding the Good and the True



RADICAL PHILOSOPHY

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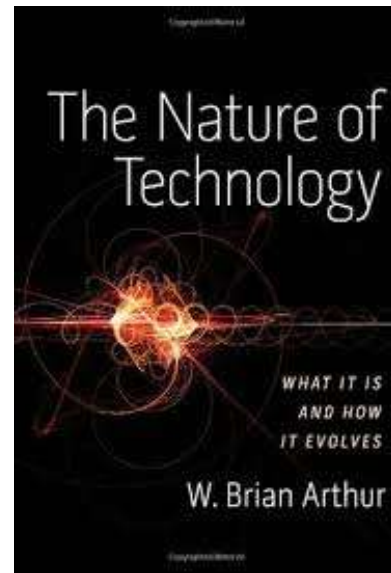
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Ideological Commitments in the Philosophy of Science
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RP 037 (Summer 1984)

Other critiques

What do Lyotard, Toulmin, Dewey, Bakunin, and (Fritz) Schumacher have in common?

From post-modern thinkers to pragmatists to anarchists to the fathers of the ecological movement, a common concern about mastering science and technology and its uses, about the dangers of modernity



Lewis Mumford explained in 1934 how well the 'machine' integrates with capitalism

CULTURAL PREPARATION

23

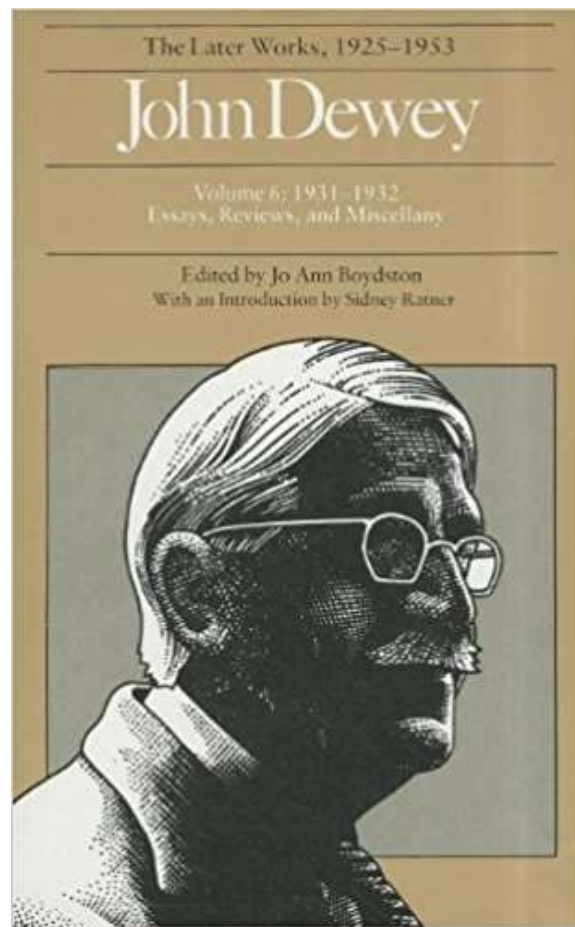
4: The Influence of Capitalism

The romanticism of numbers had still another aspect, important

Lewis Mumford, 1934, *Techniques and Civilization*, ROUTLEDGE & KEGAN PAUL LTD, p. 23-31 of the 1955 edition.

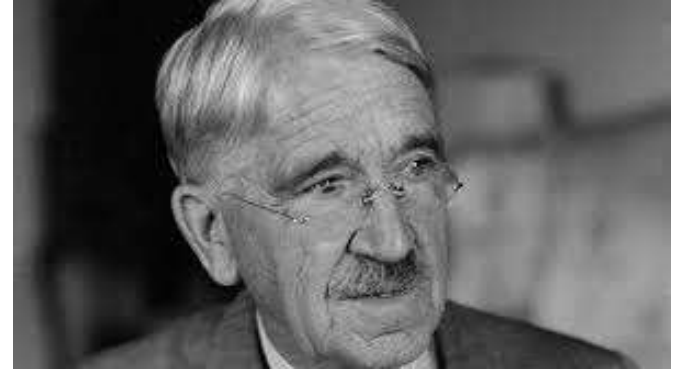
Here lies the heart of our present social problem. Science has hardly been used to modify men's fundamental acts and attitudes in social matters. It has been used to extend enormously the scope and power of interests and values which anteceded its rise. Here is the contradiction in our civilization. The potentiality of science as the most powerful instrument of control which has ever existed puts to mankind its one outstanding present challenge.

From J. Dewey 'Science and Society' in John Dewey: The Later Works, 1925-1953: 1931-1932, Vol. 6-ExLibrary



John Dewey 1859-1952

“Here lies the contradiction of our civilization. The potentiality of science as the most powerful instrument of control which has ever existed puts to mankind its one outstanding present challenge”



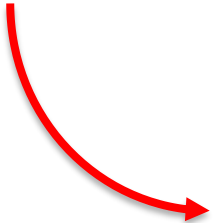
John Dewey

J. Dewey, Science and society, in ‘John Dewey: The Later work , 1931-1932 Vol. 6

“Science, which should have been the wind of truth to clear the air, has polluted the air, helped to brainwash, and provided weapons for war.”



Paul Goodman



Do we live after COVID a similar dissatisfaction with science?

Paul Goodman, 1970, *New Reformation, Notes of a Neolithic Conservative*, PM press (2010 Edition).

Doubts about the scientific quantification of the impact of new technologies



Fritz Schumacher

Langdon Winner

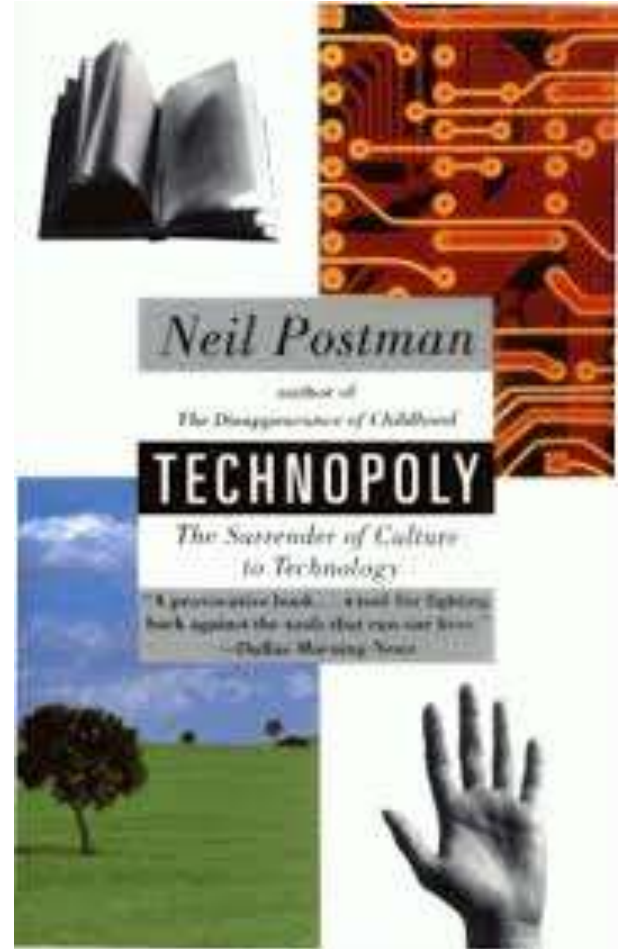


E. F. Schumacher, 1973, *Small Is Beautiful. Economics as if People Mattered*, Penguin Perennial.

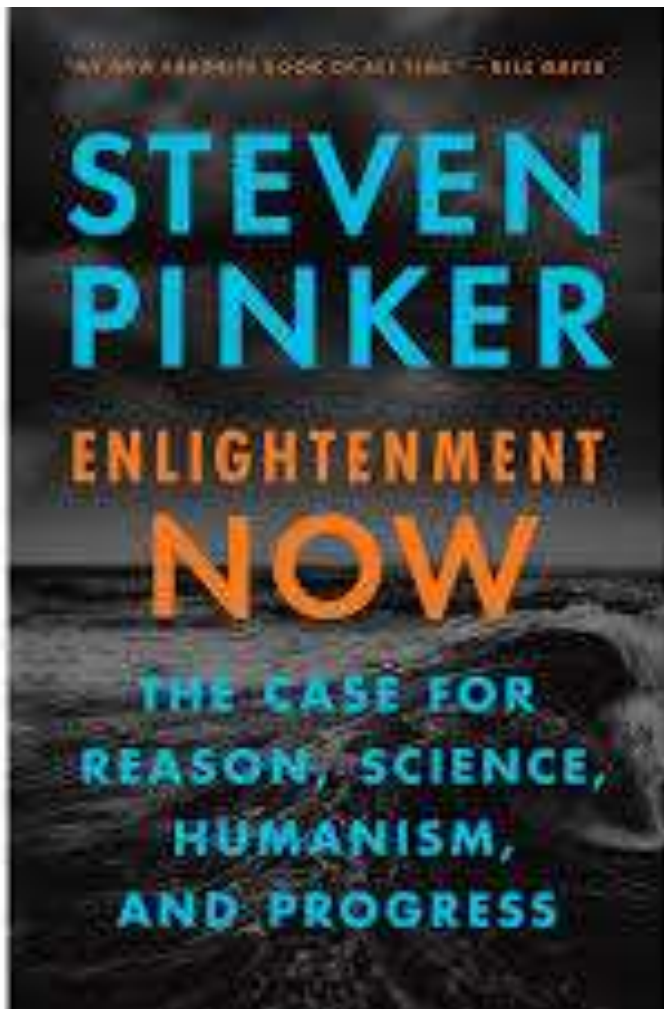
Winner, L., 1986. *The Whale and the Reactor: a Search for Limits in an Age of High Technology*. The University of Chicago Press, 1989 edition.

Funtowicz, S.O. and Ravetz, J.R. (1994). The worth of a songbird: Ecological economics as a post-normal science. *Ecological Economics* 10(3), 197–207.

“... it is inescapable that every culture must negotiate with technology, whether it does so intelligently or not”
(N. Postman, Technopoly)



The discussion on the
legacy of Enlightenment
goes on

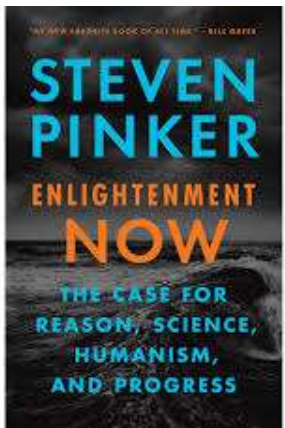


Steven Pinker



Jeremy Lent





“A future perfect. Steven Pinker’s case for optimism; “Enlightenment Now” explains why the doom-mongers are wrong”, The Economist

“Steven Pinker Wants You to Know Humanity Is Doing Fine. Just Don’t Ask About Individual Humans” (Jennifer Szalai, The New York Times)

“a monumental apologia for a currently fashionable version of Enlightenment thinking” ((John Gray, New Statesman)



The history of western history's two powerful metaphors: “man as master and possessor of nature” and “nature as a machine”

From the dualism of Greek and Christian philosophies to our days

Contrasted with alternative metaphors, such as nature as a system of systems

Thank you

Some cases III
Business Risk and Climate Analytics (next lesson)

Fiedler, Tanya, Andy J. Pitman, Kate Mackenzie, Nick Wood, Christian Jakob, and Sarah E. Perkins-Kirkpatrick. 2021. "Business Risk and the Emergence of Climate Analytics." *Nature Climate Change* 11 (2): 87–94. <https://doi.org/10.1038/s41558-020-00984-6>.

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Perspective | [Published: 08 February 2021](#)

Business risk and the emergence of climate analytics

[Tanya Fiedler](#), [Andy J. Pitman](#) , [Kate Mackenzie](#), [Nick Wood](#), [Christian Jakob](#) & [Sarah E. Perkins-Kirkpatrick](#)

Nature Climate Change **11**, 87–94 (2021) | [Cite this article](#)

12k Accesses | **83** Citations | **682** Altmetric | [Metrics](#)

Some cases II (to be expanded)

Climate, energy, and Sámi herders (next lesson)

Climate and water security (next lesson)

Lessons learned from COVID-19



Source: <https://www.nationalgeographic.com/>

Based on: Saltelli, Andrea, Marta Kuc-Czarnecka, Samuele Lo Piano, Máté János Lőrincz, Magdalena Olczyk, Arnald Puy, Erik Reinert, Stefán Thor Smith, and Jeroen P. van der Sluijs. 2023. Impact assessment culture in the European Union. Time for something new? *Environmental Science & Policy* 142: 99–111. <https://doi.org/10.1016/j.envsci.2023.02.005>, <https://www.sciencedirect.com/science/article/pii/S1462901123000382>. **OPEN ACCESS**

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<https://www.youtube.com/channel/UCz26ZK04xchekUy4GevA3DA>

Hints for more debates

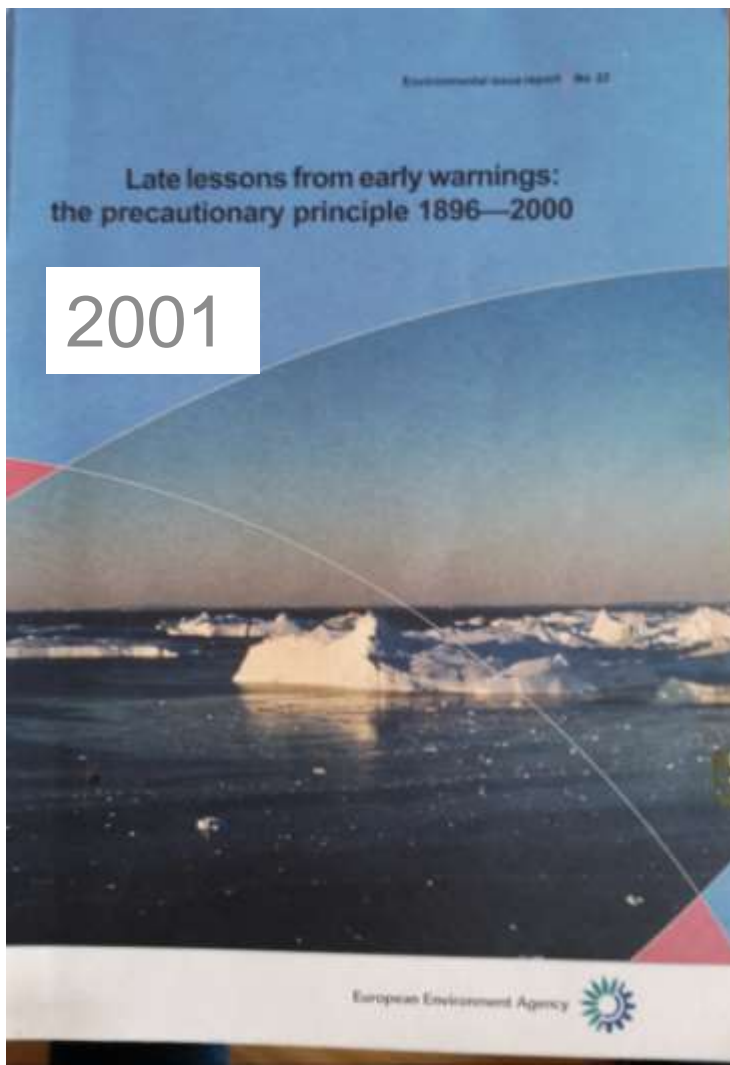
Academia as a pillar of evidence based policy?

http://www.andreasaltelli.eu/file/repository/ESOF2022_Saltelli.pdf

What is problem shifting ?

<https://www.problemshifting.directory/>

Lesson from the European Environment Agency



Late lessons from early warnings:
science, precaution, innovation

Summary

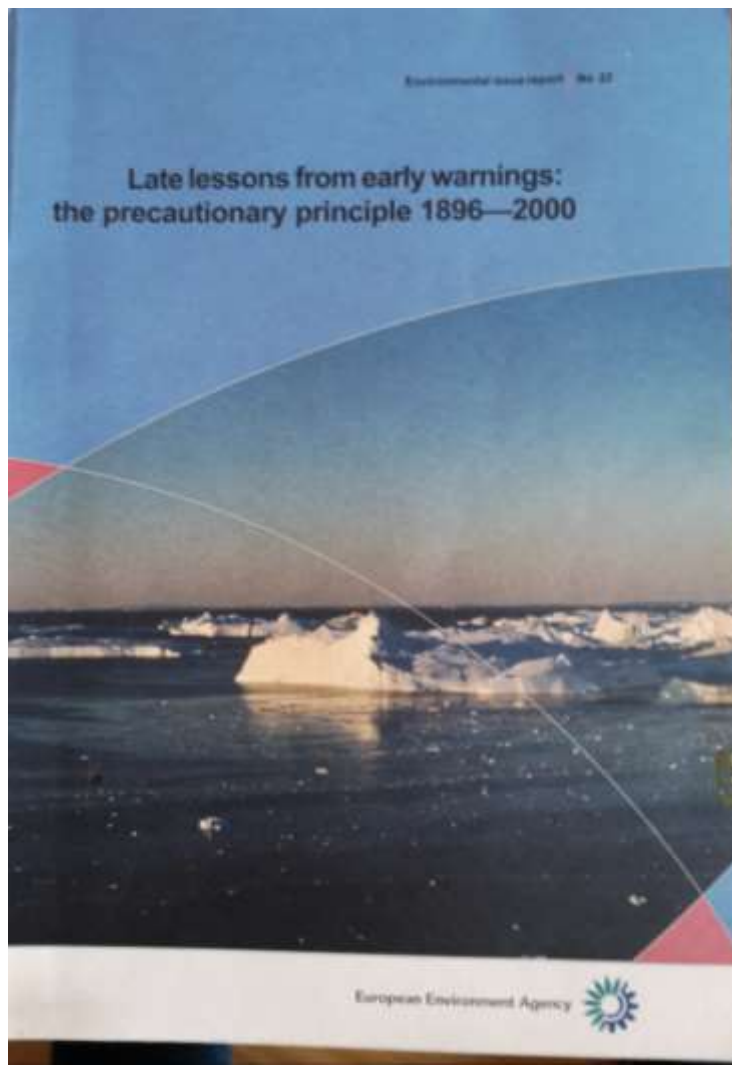
ISSN 1725-9177



2013



2001



https://www.eea.europa.eu/publications/environmental_issue_report_2001_22/Issue_Report_No_22.pdf/view

European Environment Agency (EEA, 2001):
Late Lessons from Early Warnings. The Precautionary Principle 1896–
2000

14 case studies of how not heeding early warnings led to catastrophe

Asbestos, chlorofluorocarbons, non-ionizing radiation, ‘mad cow disease’, sulphur dioxide, methyl tert-butyl ether (MTBE) in petrol, and others, leading to

➔ 12 “late lessons”

1. Acknowledge and respond to ignorance, uncertainty and risk in technology appraisal.



2. Provide long-term environmental and health monitoring and research into early warnings.

3. Identify and work to reduce scientific 'blind spots' and knowledge gaps.

4. Identify and reduce interdisciplinary obstacles to learning.



11. Identify and reduce institutional obstacles to learning and action.

5. Account for real-world conditions in regulatory appraisal.



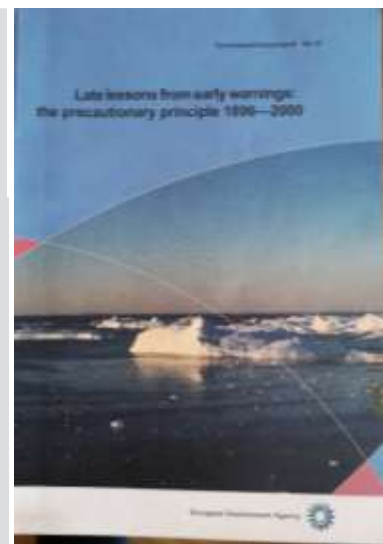
8. Ensure use of 'lay' knowledge, as well as specialist expertise.

6. Systematically scrutinize claimed benefits and risks.



9. Account fully for the assumptions and values of different social groups.

7. Evaluate alternative options for meeting needs, and promote robust, diverse and adaptable technologies.



→ Not because it can be done it should be done



**“Move fast and break things.
Unless you are breaking stuff,
you are not moving
fast enough.”**

–Mark Zuckerberg

10. Maintain regulatory independence of interested parties while retaining an inclusive approach to information and opinion gathering.



12. Avoid 'paralysis by analysis' by acting to reduce potential harm when there are reasonable grounds for concern.



2013

[https://www.eea.europa.eu/
publications/late-lessons-2](https://www.eea.europa.eu/publications/late-lessons-2)

Cases on lead in petrol, lead
in petrol

→ Be alert of regulatory capture;
exaggerating uncertainty can be used
to deflect regulation

(Mad cow disease: disgust of public
opinion to learn of cows fed on offal and
bodily waste)



EEA conclusions: doing enough?

The question seems not to be whether we have learnt the lessons, but whether we are applying them effectively enough to prevent nanotechnology being one more future case study on how not to introduce a new technology

Despite a good start, it seems that we have become distracted

