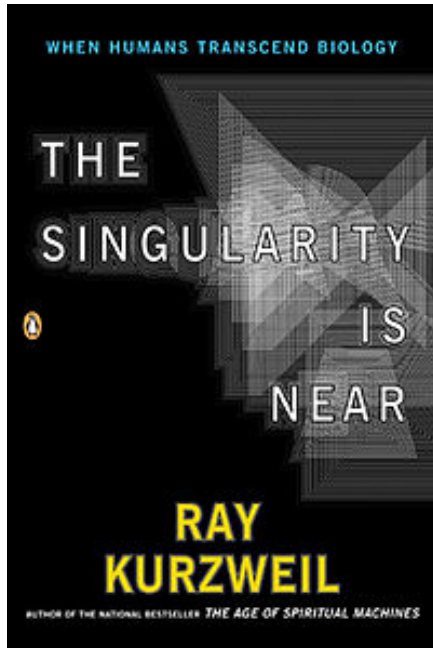


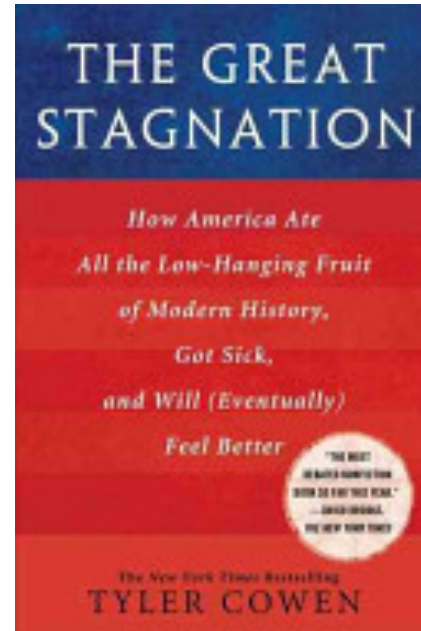
"Can innovation ever be responsible? Is it ever irresponsible not to innovate?"

Richard Jones

Two current narratives about innovation

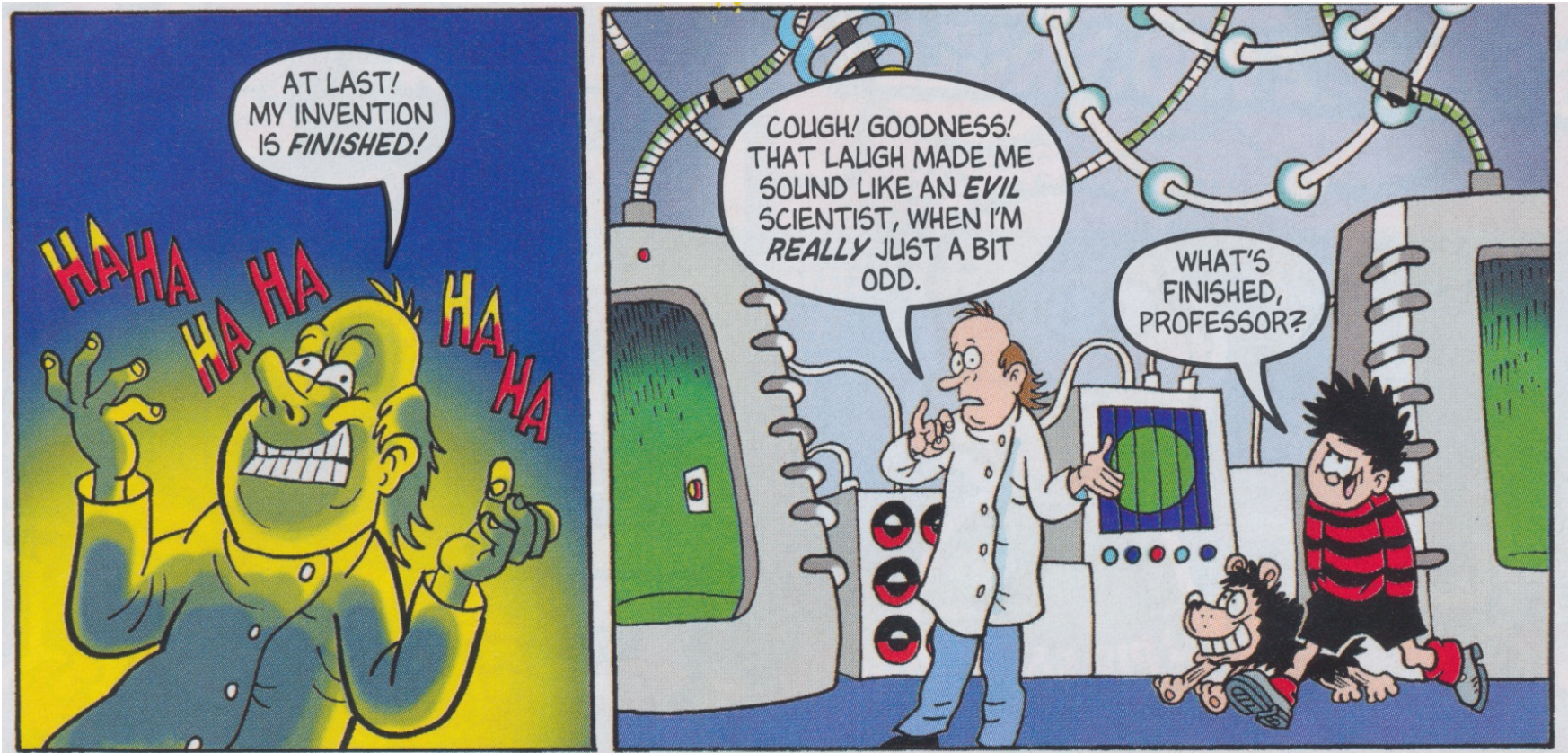


- Technological innovation is accelerating
- The pace of innovation is beyond society's ability to control it



- Technological innovation is slowing down
- The pace of innovation is insufficient to save us from secular stagnation

Everyone knows what irresponsible innovation looks like...



Irresponsible innovation

The Telegraph



[HOME](#) » [SCIENCE](#) » [SCIENCE NEWS](#)

Prince asks scientists to look into 'grey goo'



An artist's impression of a nanobot gripping a red blood cell

By Roger Highfield, Science Editor

12:01AM BST 05 Jun 2003

 [Comment](#)

Fears by the Prince of Wales that armies of microscopic robots could turn the face of the planet into an uninhabitable wasteland have prompted the nation's top scientists and engineers to launch an inquiry.

- Exponential self-replicating nanobots consume the entire biosphere
- Probably not entirely desirable as an outcome
- How likely is it?
- What purposes are served by this kind of “existential risk discourse”?

Irresponsible innovation?

NATURE | NEWS



US suspends risky disease research

Government to cease funding gain-of-function studies that make viruses more dangerous, pending a safety assessment.

Sara Reardon

22 October 2014



PDF



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ChinaFotoPress/Getty

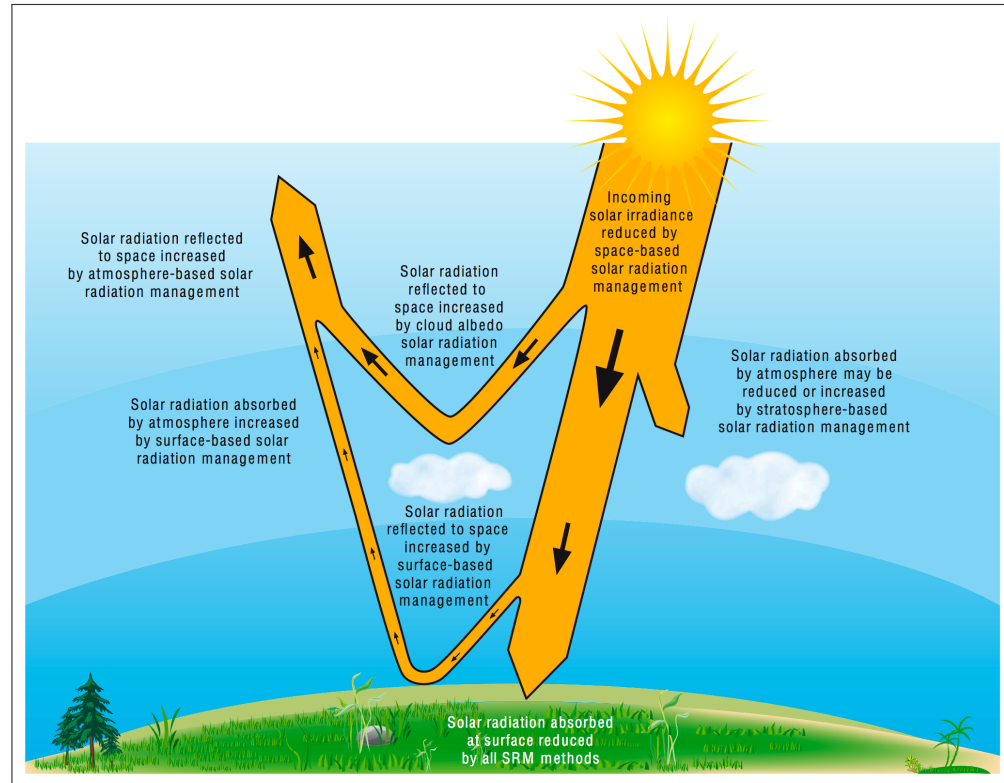
Outbreaks of influenza have prompted research into strains with pandemic potential.

- Genetic modification and synthetic biology to make pathogens more dangerous...
- recreate historical pathogenic strains...
- or create entirely new pathogens...
- Some legitimate grounds for research, perhaps
- But certainly cause for concern

Responsible or irresponsible?

Geoengineering

- Con
 - Opportunity cost
 - Moral hazard
- Pro
 - We might need it...
 - So why not do the research so we're prepared?



Scientists criticise handling of pilot project to 'geoengineer' climate

Advisers call into question decision to announce test date before sufficient public discussion of the project's implications

Camila Ruz

guardian.co.uk, Thursday 17 November 2011 12.44 GMT

[Article history](#)



The project will test the feasibility of injecting particles into the atmosphere to reflect some of the sun's energy. Photograph: Gallo Images/Getty Images

Governance of the UK's first [geoengineering](#) project, which aims to inject particles into the stratosphere to cool the planet, is in need of improvement and researchers should have done more to explain its aims to NGOs and the public, say scientists.

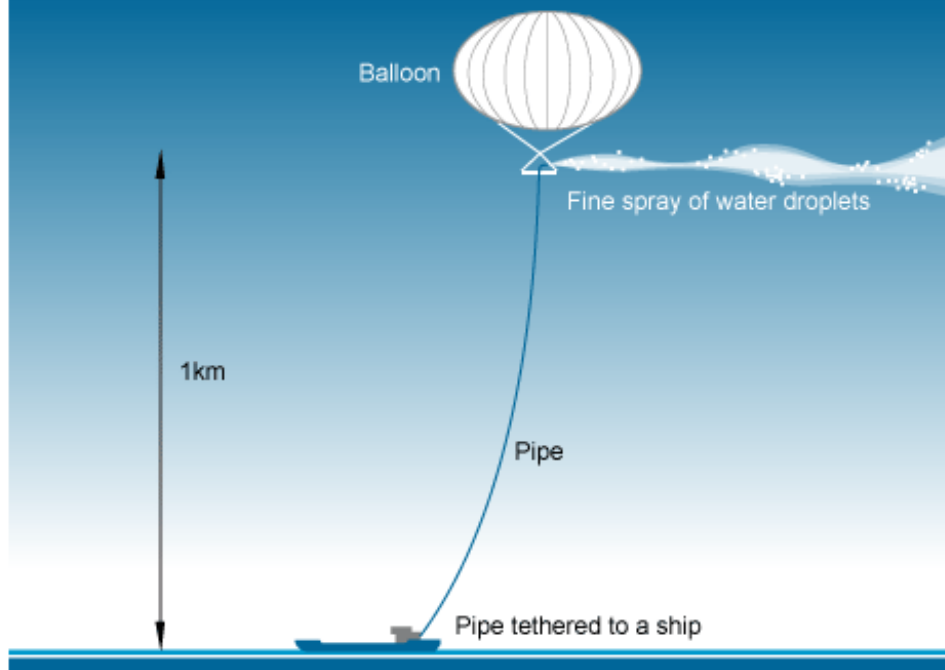


George Monbiot

guardian.co.uk, Friday 2 September 2011 13.01 BST

[Article history](#)

Tethered boom delivery system



A team of British academics will undertake the world's first major 'geo-engineering' field test in the next few months

It's atmospheric liposuction: a retrospective fix for planetary over-indulgence. Geo-engineering, which means either sucking carbon dioxide out of the atmosphere or trying to shield the planet from the sun's heat, is an admission of failure, a failure to get to grips with climate change. Is it time to admit defeat and check ourselves into the clinic?

Responsible or irresponsible?

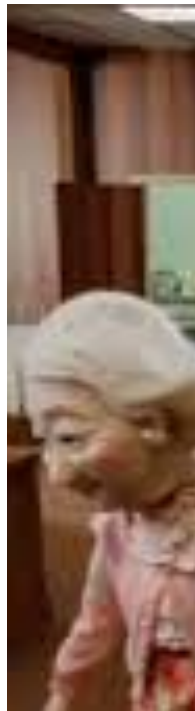
Fracking

- Pro
 - Gas replaces coal – transition fuel?
 - Economic growth
 - Energy security
- Con
 - Locks in fossil dependency
 - Methane leakage – greenhouse gas?
 - Environmental/water effects?



Gasland. 2010 film

Responsible or irresponsible?



Financial Services



May 24, 2009 4:50 pm

Wonga pushes v

By Maija Palmer, Technology Corre

Wonga.com, a UK internet loan downturn. With banks reluctant thousands of people are coming loans.

However, Wonga is pushing inn create a faster, slicker, more foo automated and available 24 hou system pulls in about 1,500 data accepted, the money can be in a 2am.

Financial Services



Last updated: October 2, 2014 5:09 pm

Wonga to write off £220m of loans owed by customers

By Emma Dunkley and George Parker

[Author alerts](#)

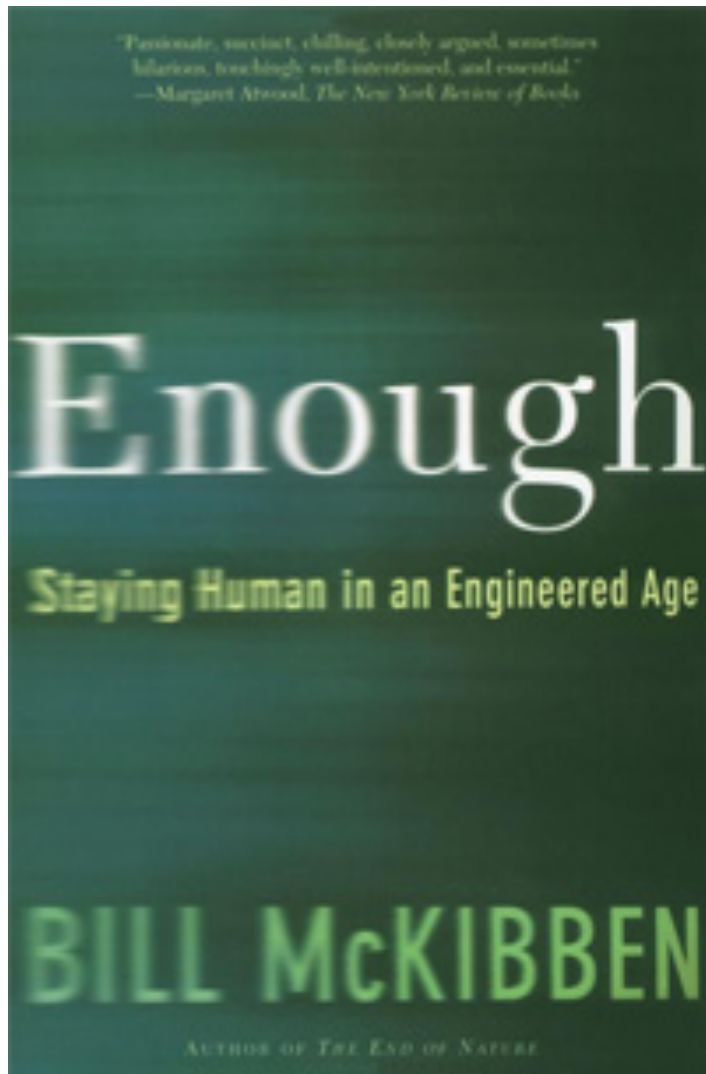


Wonga suffered its second big setback in three days as it agreed with the UK regulator to write off the debt of 330,000 struggling customers who would not have qualified for loans under tougher new affordability checks.

Interesting things about Wonga

- Private sector
- Social as much as technical
- But technical underpinnings already in place (through mixture of state/open source/commercial innovation)
- Probably not foreseen
 - (or was it – when were pornography, gambling and loan sharking ever not the first sectors to take advantage of new technology?)
- Controlled after the event by regulation – FCA ruling
- In a sector in which “*disruption*” is regarded as a virtue

Is it more responsible not to innovate at all?



- We already have *enough* technology
- We should more fairly distribute the fruits of the technology we have
- New technologies – particularly nanotech and GM – have too much potential for damage and should be abjured

Not enough – when it's irresponsible not to innovate

We are existentially
dependent on technology



But the technologies we
depend on are not
sustainable

The two men who created our predicament

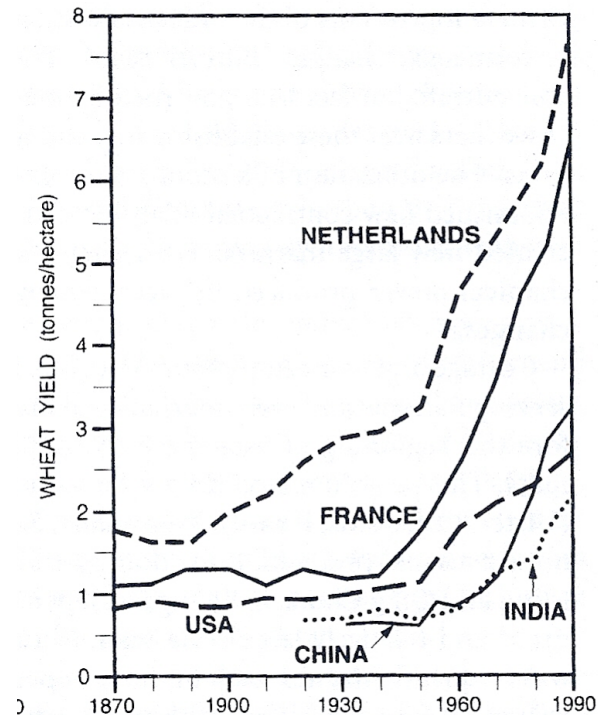
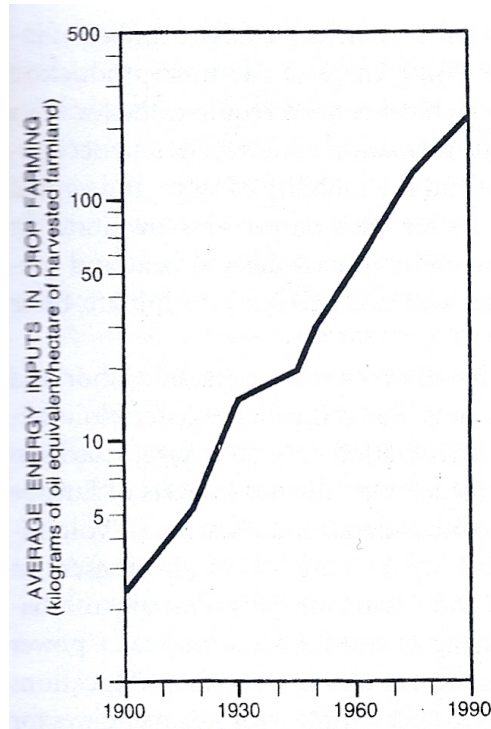


Fritz Haber 1868 - 1934



Karl Bosch 1874 - 1940

Energy and food



1900 to 1990 saw a 30% increase in cultivated land, but energy inputs per hectare – from artificial fertilizers and mechanical farming implements - increased more than *eightyfold*. The result was big increases in yield per hectare.

We eat oil...



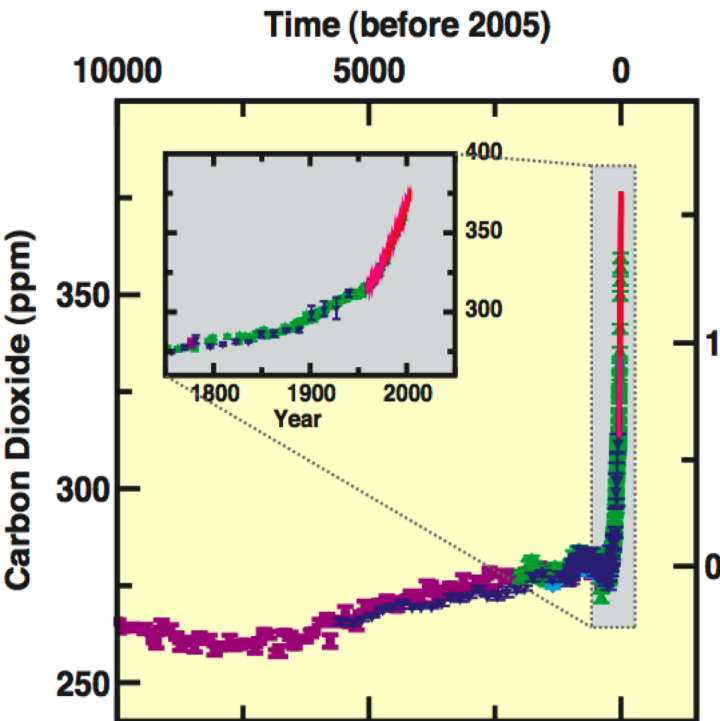
1 tonne of English winter wheat embodies about 20 kg of fixed nitrogen in fertilizer

10 tonnes of fixed nitrogen
in fertilizer embodies 6.7
tonnes of oil

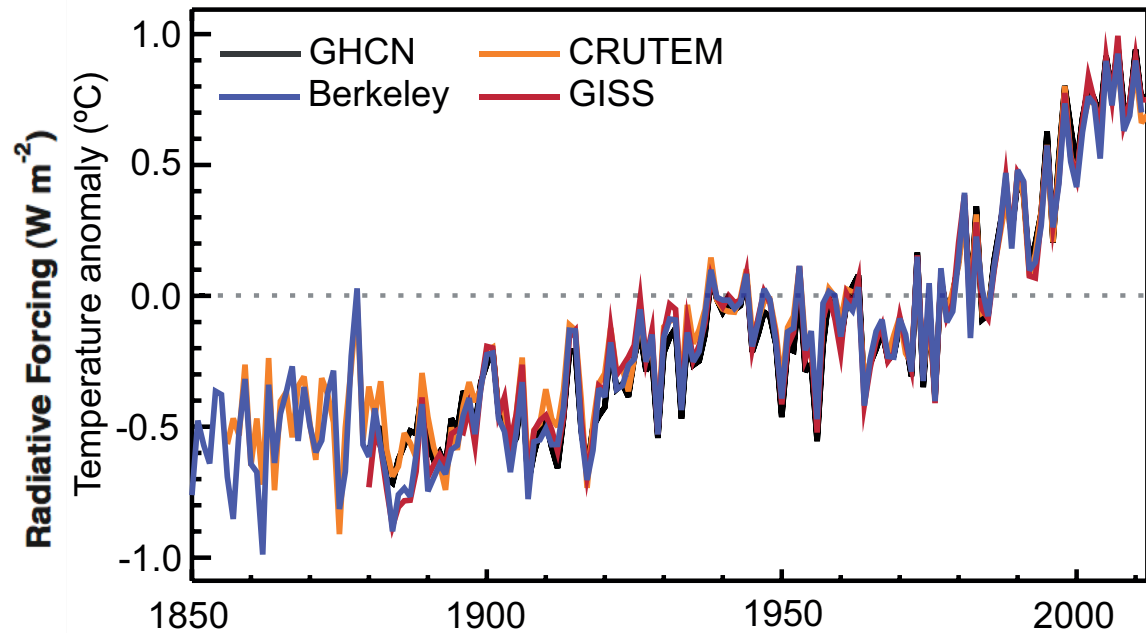
Without Haber-Bosch fixed
nitrogen more than half the
world's population would
starve



What burning all that carbon did



Source: IPCC AR4



Global annual average land surface temperature anomaly relative to 1961-1990, four different data sets

P187, Climate Change 2013 The Physical Science Basis (WG1, AR5), IPCC

Our fossil fuel dependence grows

By region

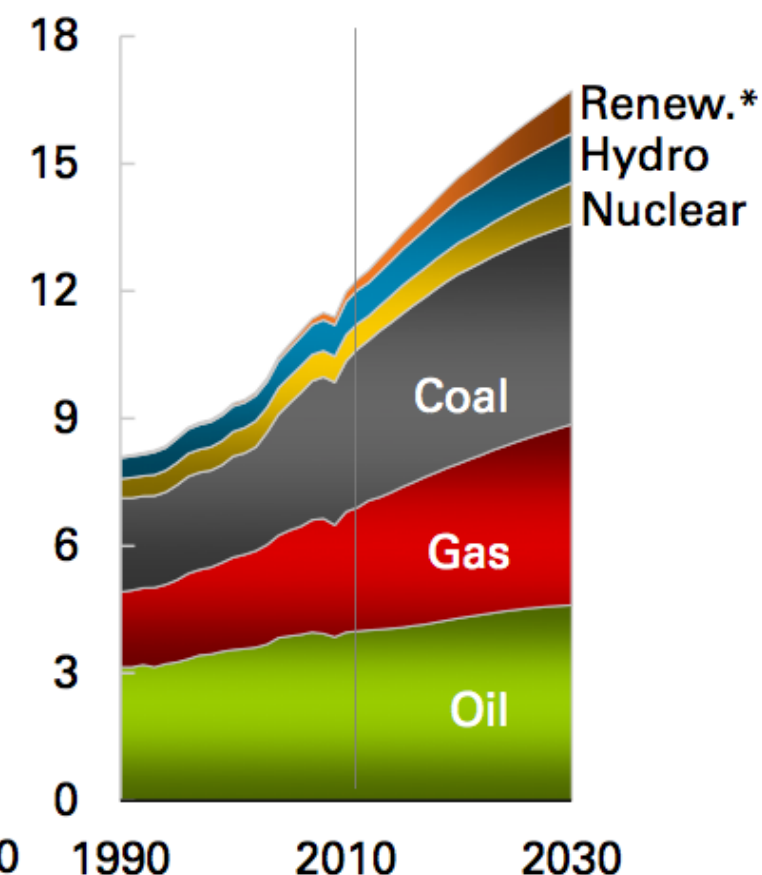
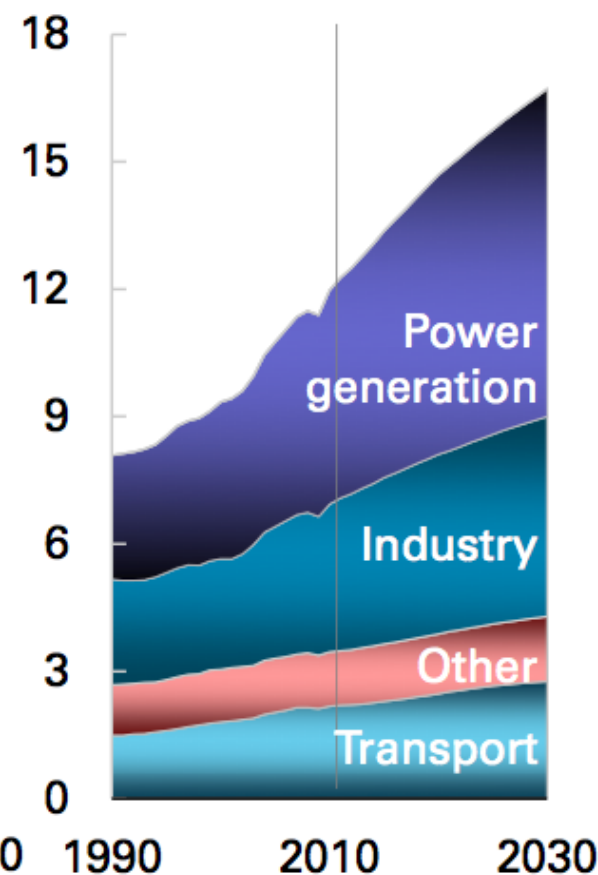
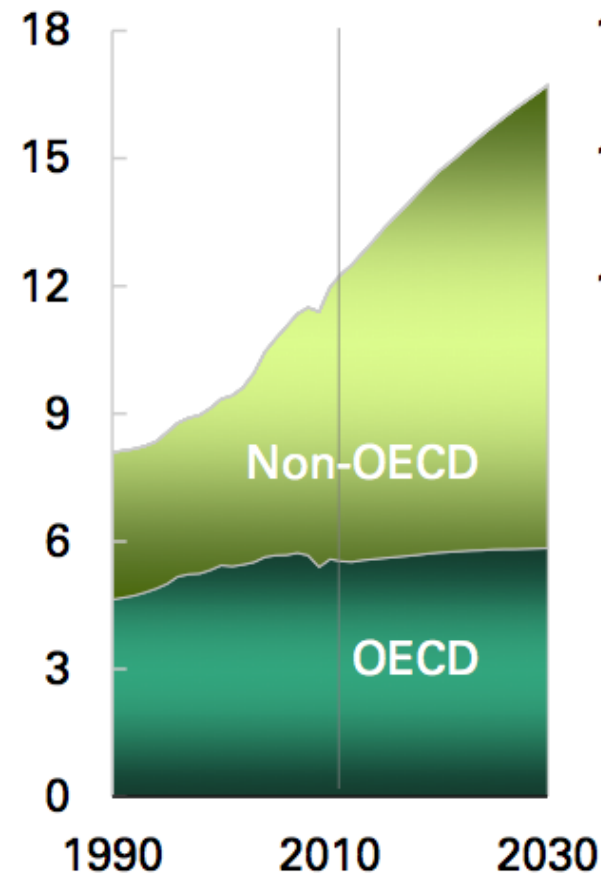
By primary use

By fuel

Billion toe

Billion toe

Billion toe



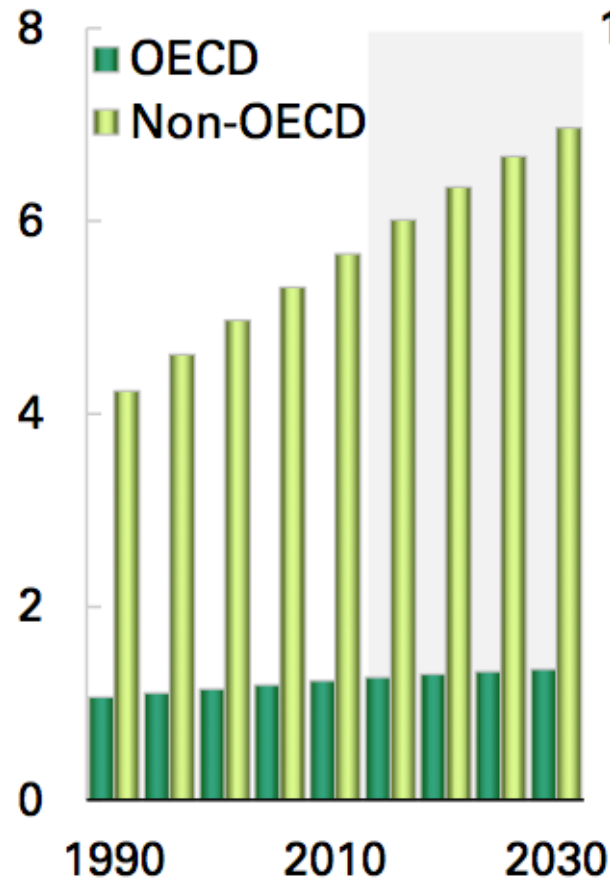
*Includes biofuels

Source: BP Energy Outlook 2030

Drivers of fossil fuel dependence

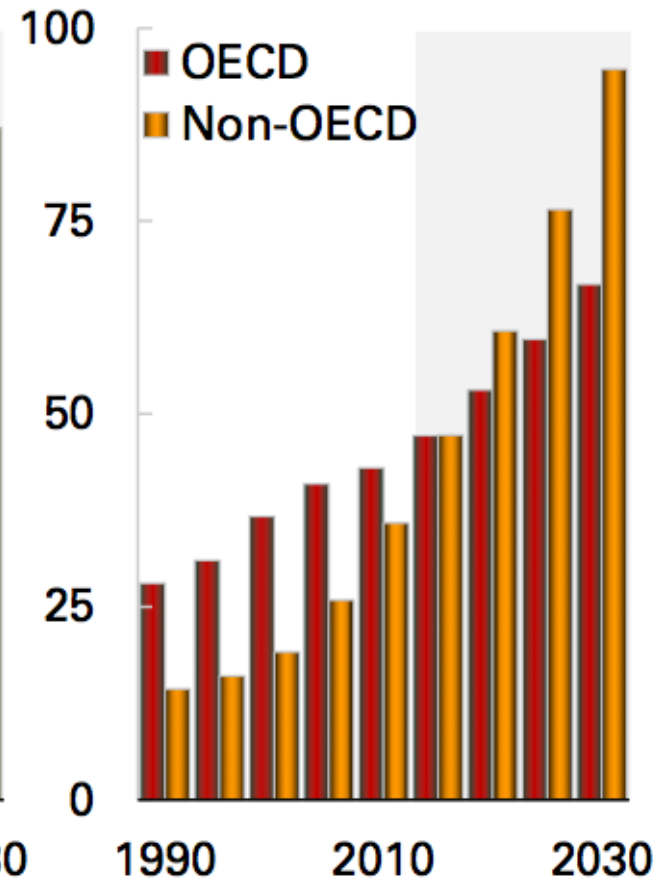
Population

Billion



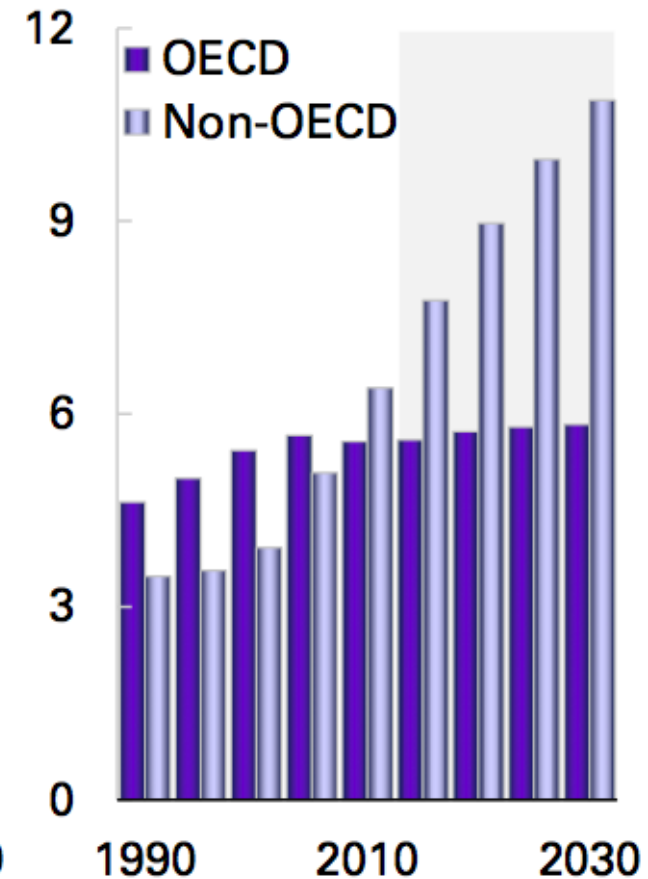
GDP

Trillion \$2011

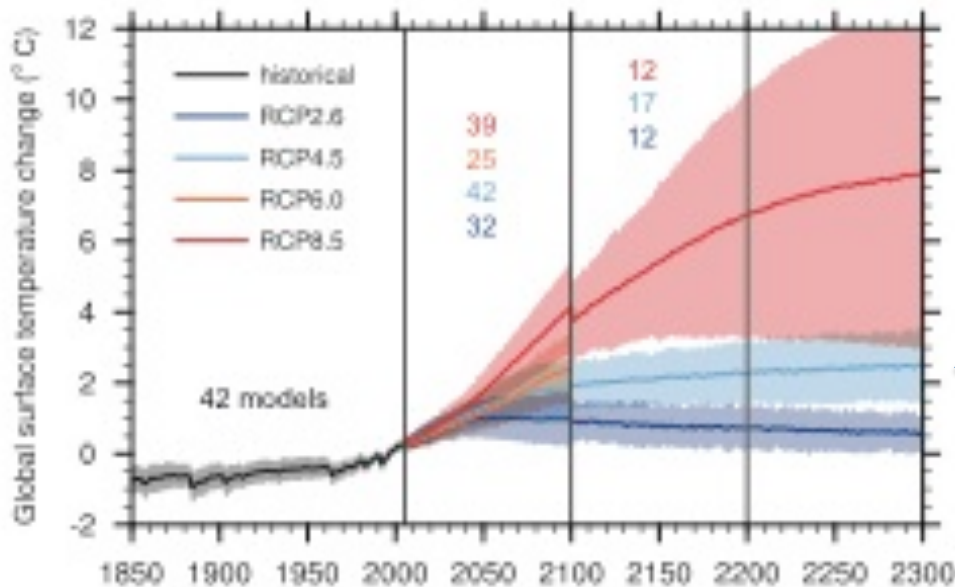


Primary energy

Billion toe

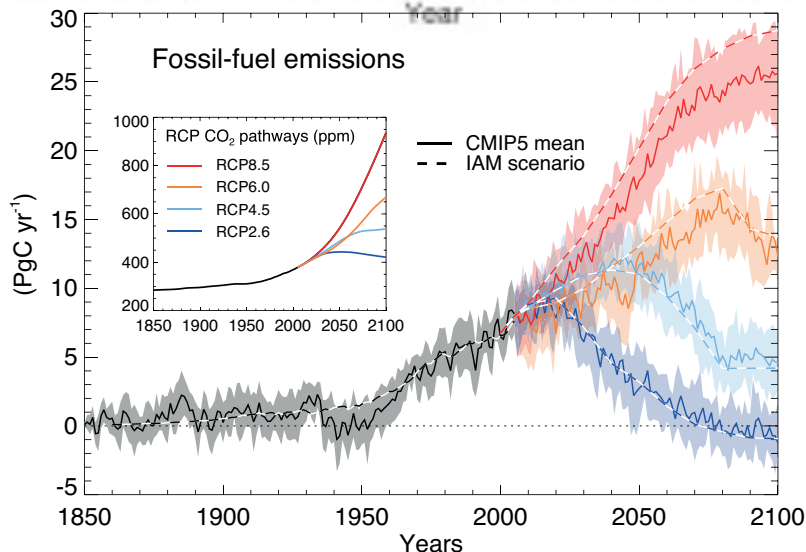


What can we expect for the future?



high population growth, slow economic development and slow technological change

rapid economic growth, a global population that peaks in mid-century and rapid introduction of new and more efficient technologies



rapid change in economic structures, with reductions in material intensity and the introduction of clean and resource-efficient technologies.

Source: pp 89&94, Climate Change 2013 The Physical Science Basis (WG1, AR5), IPCC

What do we mean by “responsible innovation”?

- (How) can we steer the development of science and technology so that it meets widely shared societal goals?
- An old idea – but every generation needs to re-examine it in a new science and innovation policy context

What the concerned physics student worried about in 1981

OH...HAVEN'T YOU HEARD
THE INDUSTRIAL REVOLUTION
IS OVER... WE WON.

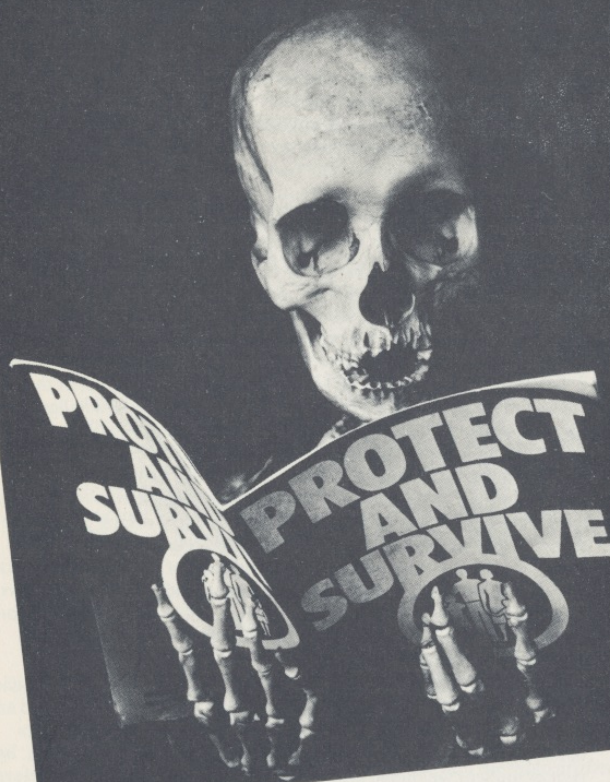
THE LUCAS EXAMPLE...

WHAT'S ALTERNATIVE
PRODUCTION?

IT USUALLY MEANS
MAKING THINGS
THAT ARE **SOCIALLY
USEFUL** AND NOT
WASTEFUL!

LIKE KIDNEY
MACHINES
INSTEAD OF
FIGHTER JETS

Have you ever wished
you were better informed?



“Responsible innovation” now

- A term of art in science policy discourse, e.g.
- Owen, Stilgoe, Macnaghten (for EPSRC)

“A commitment to care for the future through collective stewardship of science and innovation in the present”

- Von Schomberg (for EU Framework Program)

“Responsible Research and Innovation is a transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view to the (ethical) acceptability, sustainability and societal desirability of the innovation process and its marketable products(in order to allow a proper embedding of scientific and technological advances in our society).”

Von Schomberg's four signatures of irresponsible innovation

- Technology push
 - *GMOs in Europe*
- Neglect of fundamental ethical principles
 - *E-patient records in the Netherlands*
- Policy Pull
 - *Security theatre*
- Lack of precautionary measures and technology foresight
 - *Asbestos, hormones as growth promoters*

Public engagement in responsible innovation

- How do we know whether the goals of innovation are widely shared in society?
 - Through the mechanisms of representative democracy
 - Through the mechanisms of the market
 - Through the direct engagement of publics in deliberative processes

The rise of upstream engagement

- Public Understanding of Science – “Bodmer report”, 1985
- Lancaster critique of the “*deficit model*”, Brian Wynne

The task is to make **visible** the invisible, to expose to public scrutiny the assumptions, values and visions that drive science



See-through Science

Why public engagement needs to move upstream

James Wilsdon
Rebecca Willis

2004

“Nanoscale science: opportunities and uncertainties”

Royal Society/Royal Academy of Engineering
report, 2004

Working group included:

- › Scientists and engineers
- › Social scientists and philosophers
- › Representatives of NGOs

“a constructive and proactive debate about the future of nanotechnologies should be undertaken now – at a stage when it can inform key decisions about their development and before deeply entrenched or polarised positions appear.”

Royal Society report, 2004

What problem was public engagement trying to solve ?

I. Fear of an “anticipatory backlash”

- The shadow of GM
- Grey goo and “The future doesn’t need us”
- Nanoparticle toxicity and the shadow of asbestos

What problem was public engagement trying to solve?

2. Helping to make sounder decisions about highly interdisciplinary science in the context of societal needs
3. Keeping hold of the public value of science in the face of growing marketisation

Small victories in nanotechnology public engagement



- It did influence funding policy
- It did help us make better decisions
- Maybe it led to a richer public dialogue
- It certainly developed a cadre of reflective and socially engaged nanoscientists

2005-2008: a variety of public engagement processes around nano, run by NGOs, government and research councils



*People's inquiry into nanotech:
Nanodialogues - EA + Demos, Sciencewise*

Why is responsible innovation difficult?

- Because we don't know the future
- Can we be responsible in the way we think about the future?
 - No
 - Because the future is essentially pre-ordained (Technological determinists)
 - Because of the radical limits to our knowledge (Hayekians)
 - Yes
 - Because we can rationally plan the outcomes we desire (State planners)
 - Because we can reflexively adjust the process of innovation as it happens through a process of “*anticipation, reflection and inclusive deliberation*” (Responsible innovators)

Collingridge's control dilemma

- When a technology is young enough to influence its future trajectory, you can't know where it will lead
- When a technology is mature enough for you to have a good idea of its consequences, it's too late to change it – it's *locked-in*

The Hayekian critique

- Basic science provides a resource that innovators can apply in ways unpredicted and unpredictable by the science's originators
- Entrepreneurs make innovations and test them in the market
- The market – *our most reliable device for aggregating information distributed across society* – is the only way of assessing whether innovation is societally desirable

The “independent republic of science”

- Michael Polanyi (Minerva 1:54-74, 1962)

“the pursuit of science by independent self-co-ordinated initiatives assures the most efficient possible organization of scientific progress. And we may add, again, that any authority which would undertake to direct the work of the scientist centrally would bring the progress of science virtually to a standstill.”

“You can kill or mutilate the advance of science, you cannot shape it. For it can advance only by essentially unpredictable steps, pursuing problems of its own, and the practical benefits of these advances will be incidental and hence doubly unpredictable.”

- Division of moral labour between basic science, who can't/shouldn't consider the ethics of potential applications, and applied scientists, who should

*"Once the rockets are up, who cares where they come down
That's not my department," says Wernher von Braun.*

Tom Lehrer

- Against the direction of science – by politicians, or by the public
- Science as a Hayekian self-made order
- A widely held view in the scientific community

Objections to Hayekian views

- How the votes are weighted
- Naïve or disingenuous about power
- How easy is it to manipulate people's wants?
- *“(commercial) innovation is not following their needs; it is imagining their wants, fulfilling them and leading them somewhere.”*

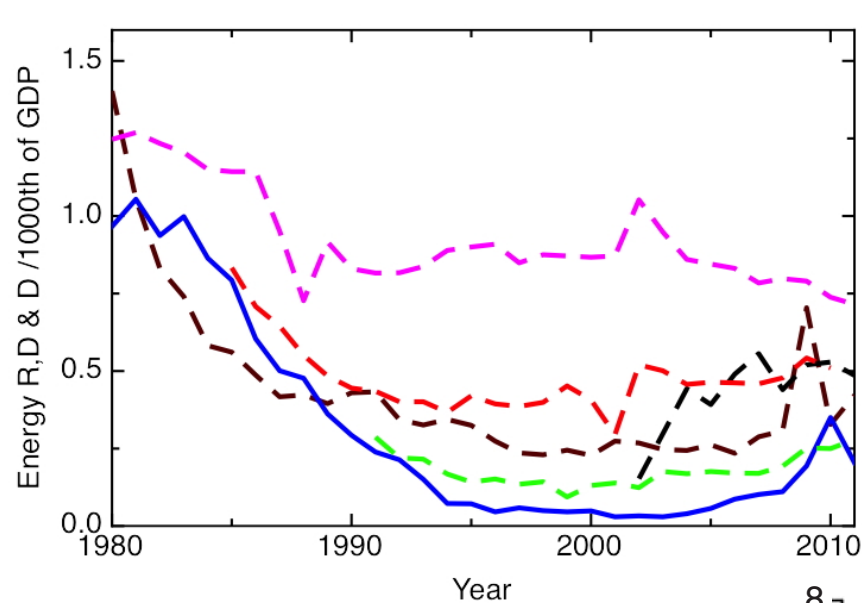
Demos Nanodialogues

- But people don't know what they want until its on offer
- *“If I had asked people what they wanted, they would have said faster horses.”* Henry Ford

The economics of innovation

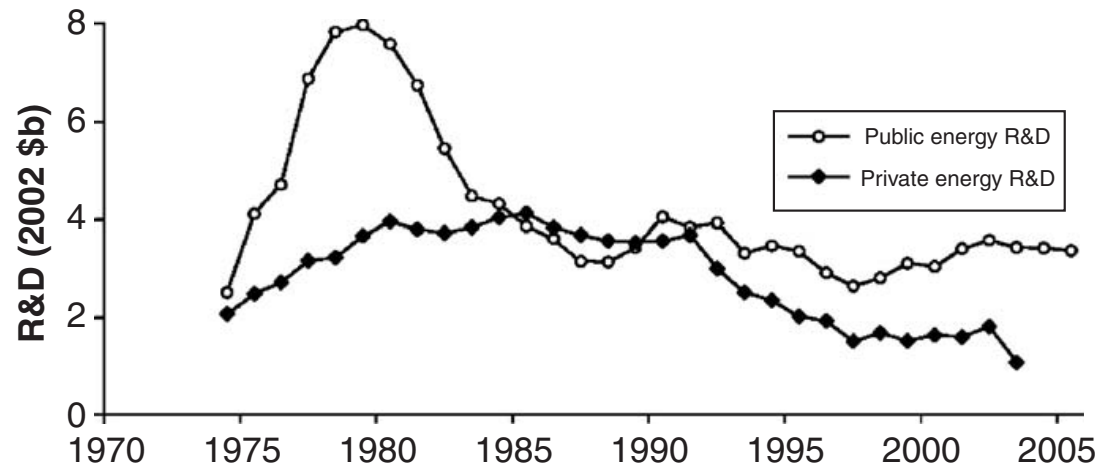
- Classical economics tells us that it is hard for an innovator to capture the full societal value of an innovation
- Neoliberal economic policy recognises this market failure, which it attempts to correct with supply-side measures
 - “Intellectual property” law
 - Support for basic science
 - R&D tax credits

The liberalisation of energy markets coincided with the shrinking of energy R&D



Govt energy RD&D as % of GDP

Public and private sector energy R&D in the USA, constant \$



What drives investment in innovation in neoliberal economies?

 **the ONION**
America's Finest News Source

HOME

VIDEO

RADIO

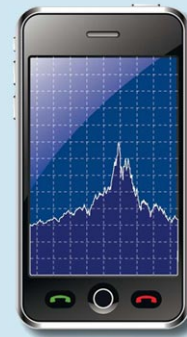
NEWS

Recession-Plagued Nation I Bubble To Invest In

JULY 14, 2008 | ISSUE 44•29

DOING CAPITALISM IN THE INNOVATION ECONOMY

"Wise, insightful, and rich with both economic history
and the personal stories of a brilliant investor."
Tim O'Reilly, Founder and CEO O'Reilly Media



WILLIAM H. JANEWAY

Technoscience bubbles

- Gisler/Sornette “social bubble” hypothesis
- *“strong social interactions between enthusiastic supporters of the Human Genome Project weaved a network of reinforcing feedbacks that led to a widespread endorsement and extraordinary commitment by those involved in the project, beyond what would be rationalized by a standard cost-benefit analysis in the presence of extraordinary uncertainties and risks.”*

Exuberant innovation: The Human Genome Project, Monika Gisler, Didier Sornette and Ryan Woodard
<http://arxiv.org/pdf/1003.2882v1.pdf>

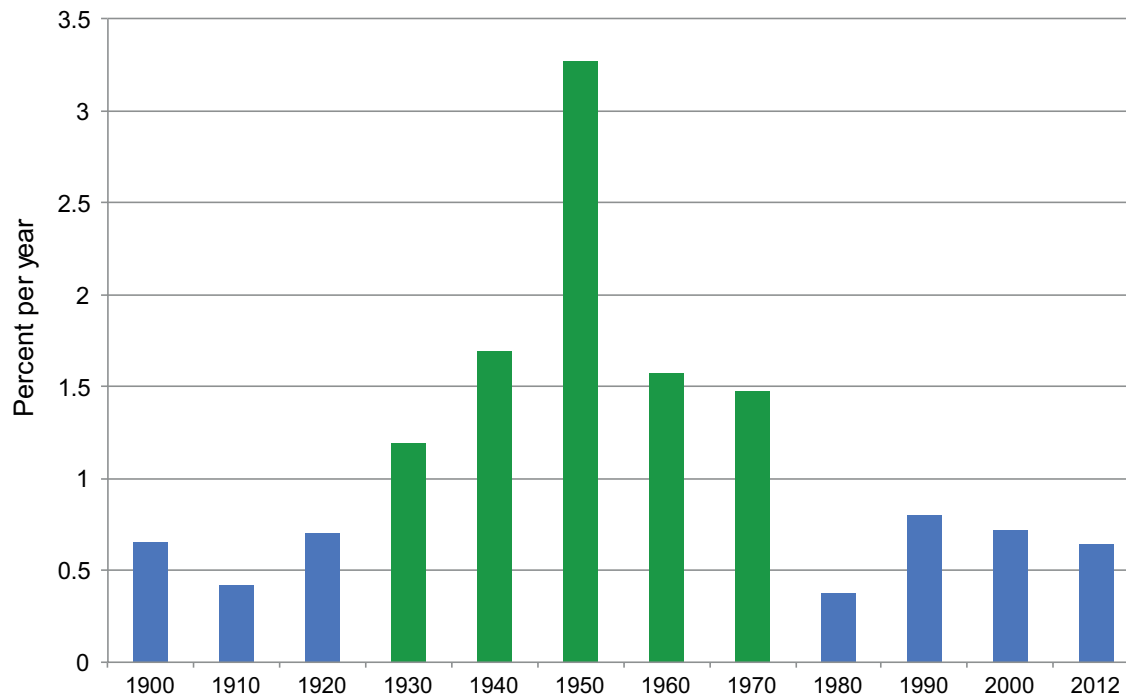
Spotting technoscience bubbles

- Some genuinely interesting science
- *“We mustn’t be left behind in this global race”*
 - Techno-nationalist appeals for special funding initiatives
- *“It’s the next industrial revolution”*
 - Foreshortened timelines to predicted transformational societal impacts
- *“It will be an n-billion dollar market”*
 - Attempts to inflate associated financial bubbles for technology start-ups
- *“It could lead to the end of the world as we know it”*
 - Speculative techno-ethics and existential risk discourse

1940-1980: the golden years of technological progress

growth rate of US total factor productivity (Solow residual) by decade

Figure 1 Annual growth rate of TFP for ten years preceding years shown, years ending in 1900 to 2012



From The Turtle's Progress: secular stagnation meets the headwinds, R.J. Gordon 2014
<http://www.voxeu.org/content/secular-stagnation-facts-causes-and-cures>

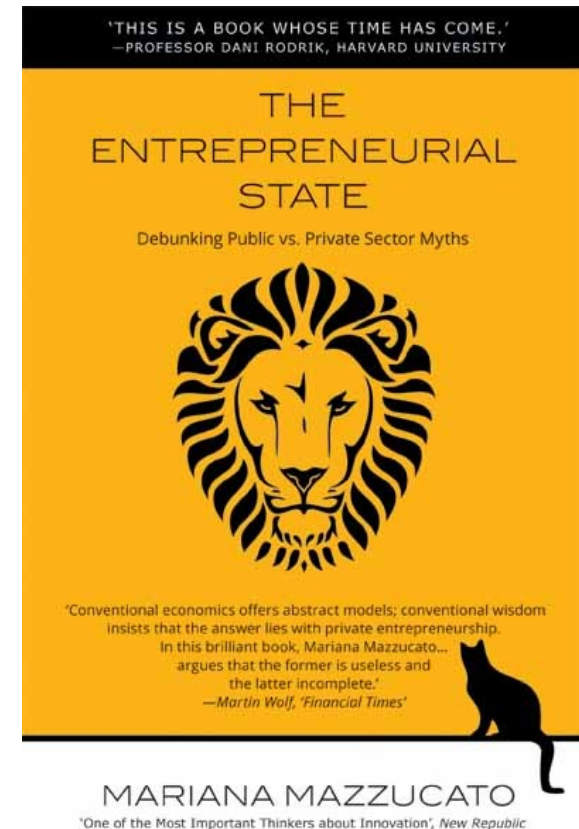
Are we in an age of technological stagnation?

- *“We wanted flying cars, instead we got 140 characters.”* Peter Thiel
- Three realms of innovation:
 - Digital realm: innovation is (relatively) easy
 - Material realm: innovation is harder
 - Biological realm: innovation is yet harder still

What you need for innovation in the digital realm

- *“At one point the entire early Twitter service was running on Glass' laptop. ‘An IBM Thinkpad,’ Glass says, ‘Using a Verizon wireless card.’”**
- Creativity, a handful of engineers and some low-cost hardware...
- ...and a huge pre-existing material base of hardware and software, developed in decades of public and private research and development

*From “The Real History of Twitter”, Nicholas Carson, Business Insider 2011

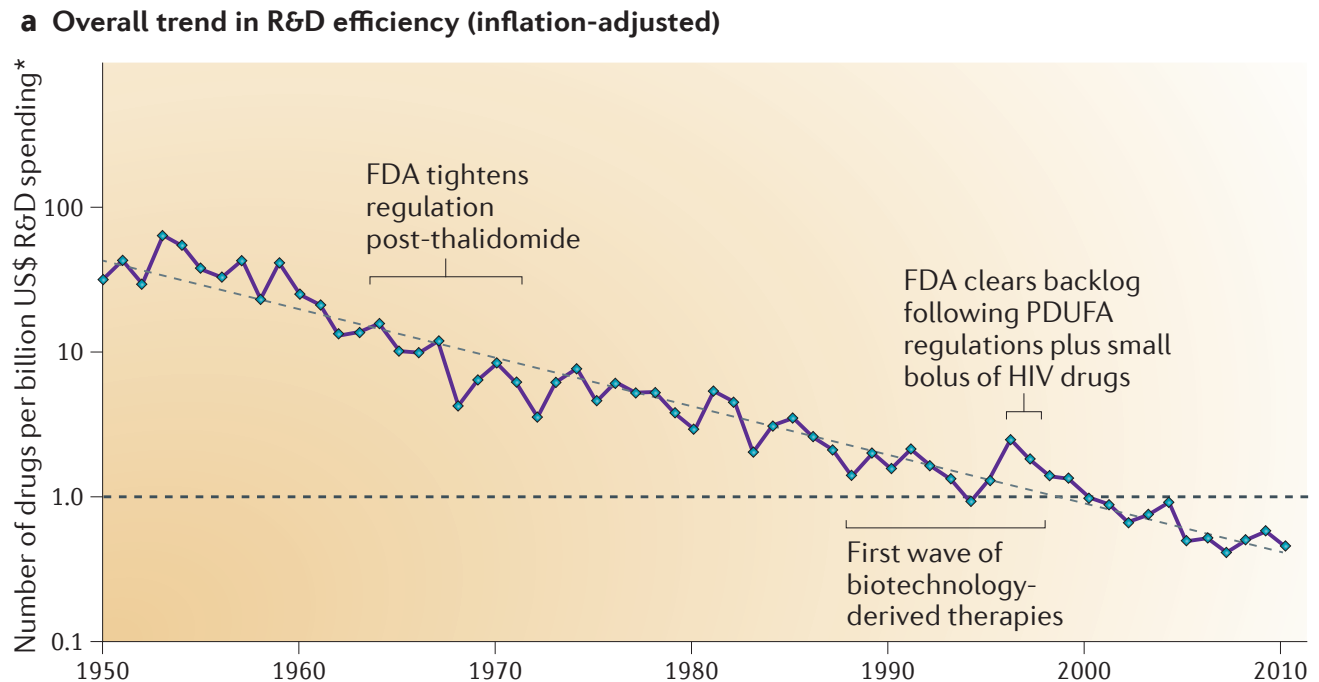


Material realm

- Big advances in chemicals, materials, energy, electronics need sustained, long-term investment of capital and people – R&D
- From 1871 – 1991, motivated as much by state power as economic growth
- e.g. Haber-Bosch process:
 - \$100m 1919 prices, \$1 billion current money, \$19 billion as share of economy,
 - half from German government

Innovation in the biological realm

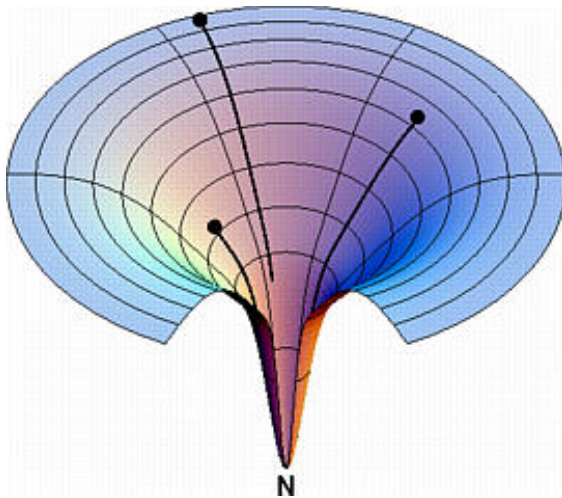
- Organisms have agency of their own
- In some important areas, innovation is slowing down and becoming unaffordable



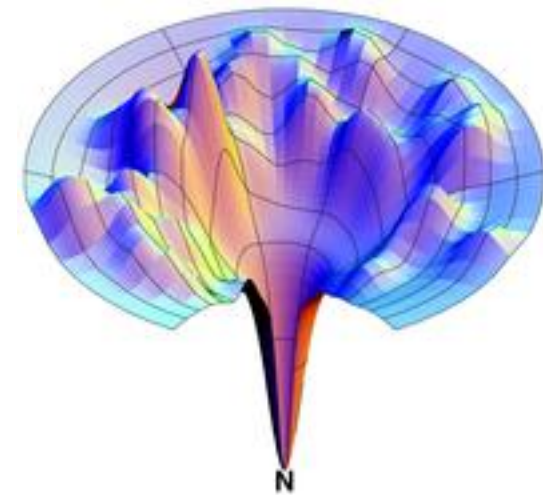
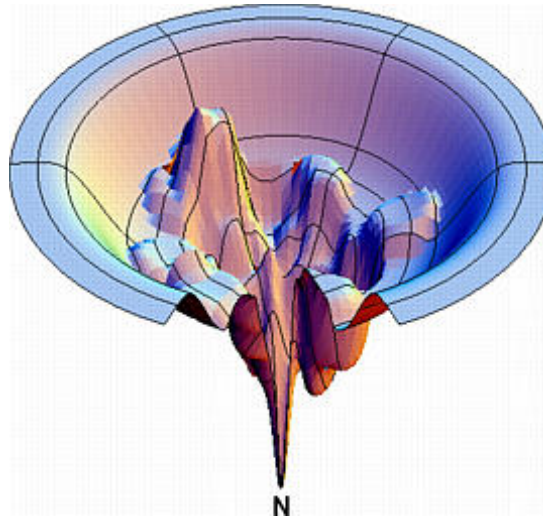
Diagnosing the decline in pharmaceutical R&D efficiency, J.W.Scannell, et al
Nature Reviews Drug Discovery, **11** 191 (2012)

Local optimisation vs technological saltations

Smooth funnel



Rugged landscape with hills and traps



Bumpy funnel with uphills

- To optimise in a complex landscape, you need to make big jumps – just rolling down hill won't do
- Technological change needs big investments of money and effort that the market's local optimisation won't deliver

Local optimisation doesn't optimise long-run growth

- Not a new insight:
 - *“A system – any system, economic or otherwise – that at every given point of time fully utilizes its possibilities to the best advantage may yet in the long run be inferior to a system that does so at no given point in time, because the latter's failure to do so may be a condition for the level or speed of long-run performance”*

Joseph Schumpeter, Capitalism, Socialism and Democracy

We need to get some Big Stuff Done

- Decarbonising world energy economy, adapting to the climate change we're already committed to, health and welfare of a growing and ageing world population
- Hayekian neo-liberalism can't do it
- Back to a cold war?
- Leave it to the whims of oligarchs?
- Responsibly directed, large scale, collective innovation needed!

Many dimensions of responsibility

- Responsible practise of science
- Responsibility about potential consequences – health, environmental etc
- Responsibility about visions of the future
- Responsibility about the real issues societies face and what appropriate responses might be
- Responsible salesmanship
 - To governments and funding agencies
 - To investors
 - To the public

Responsible innovation and irresponsible stagnation

- It's irresponsible to innovate without a reflexive process of alignment with widely held societal priorities
- But it's irresponsible not to innovate in the face of pressing societal challenges
- It's not obvious to me that our political economy is optimal on either front