Tackling climate change: will technology save us?

Dr Stuart Parkinson

Scientists for Global Responsibility
Scientists · Architects · Engineers · Technologists

SGR
Promoting ethical science, design and technology

http://www.sgr.org.uk/

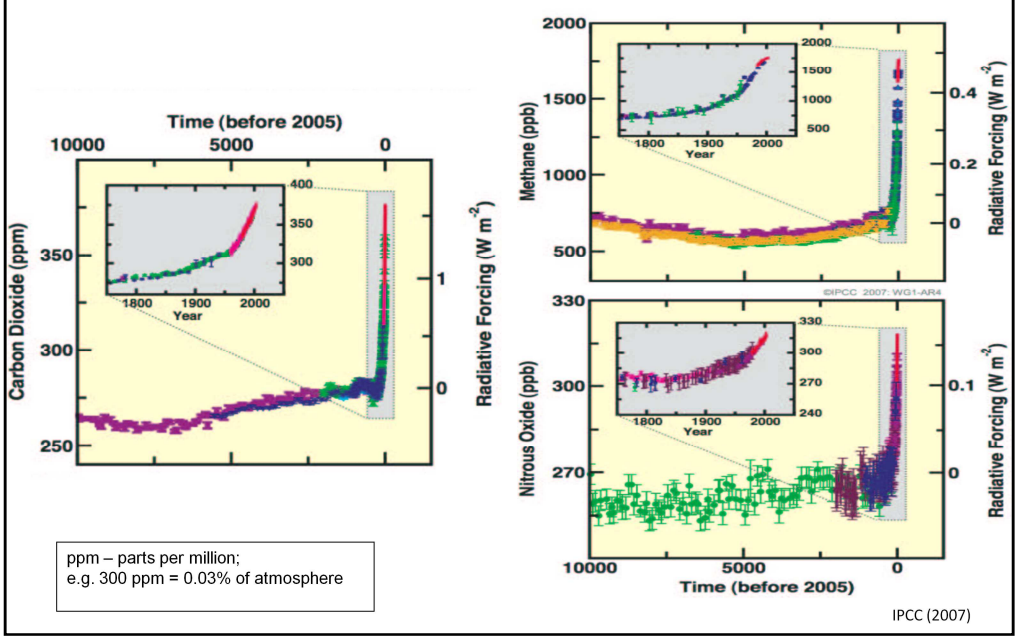
Presentation at the Warwick Climate Forum, Warwick University, 24 November 2012.

Main greenhouse gases emitted by human activity

Greenhouse gas (GHG)	*Main anthropogenic (human) sources*
Carbon dioxide (CO_2)	• **burning fossil fuels (coal, oil, gas)** • **deforestation**
Methane (CH_4)	• cattle • gas pipeline leaks • paddy fields
Nitrous oxide (N_2O)	• artificial fertilisers • nylon production
'F' gases/ Halocarbons (HFCs, PFCs, SF_6)	• refrigerators • air-conditioning • electronics industry

- Table based on Houghton (2004)
- CO2 is responsible for more than ¾ of warming (IPCC, 2007a)

Changes in atmospheric levels of GHGs over last 10,000y

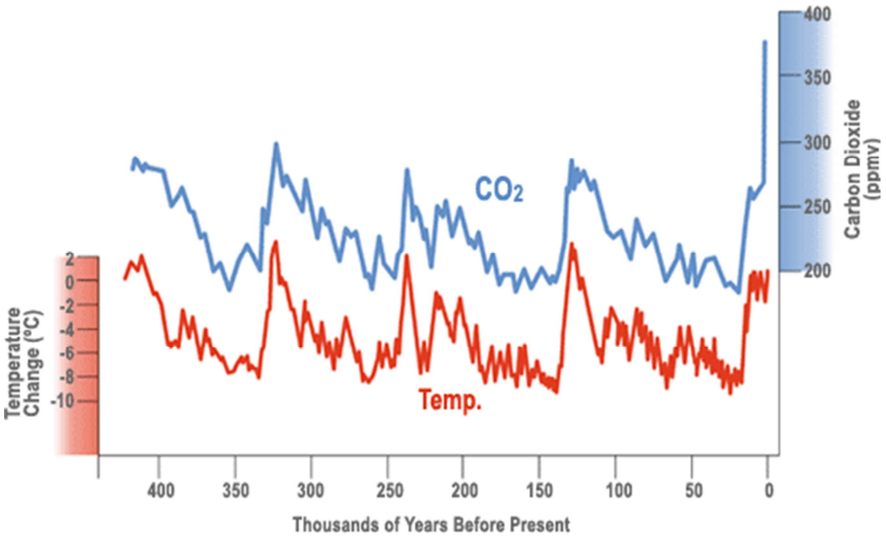


ppm – parts per million;
e.g. 300 ppm = 0.03% of atmosphere

IPCC (2007)

IPCC (2007b)

Climate change over last 430,000 y



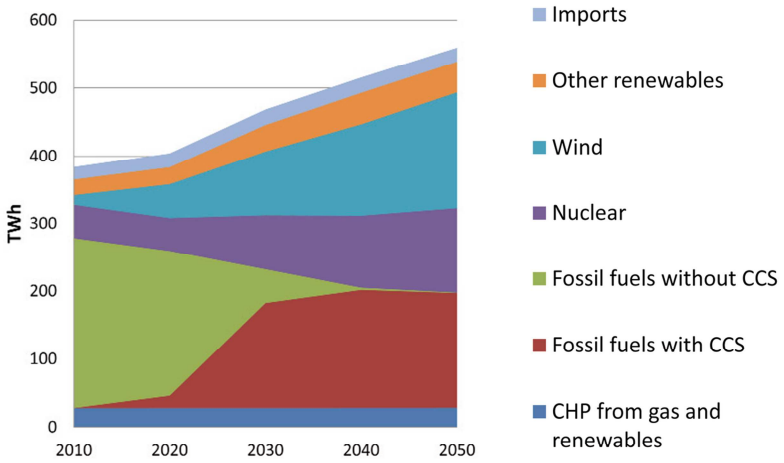
- CO2 level in atmosphere and global temperature move up and down together (historically due to 'wobbles' in Earth's orbit around the Sun)
- Temperature difference between the Ice Ages and the warm interglacial periods such as at present has been 4-7ºC (IPCC, 2007c)
- Through fossil fuel burning and other activities, we have raised the CO2 level fair beyond any level seen for at least 430,000y
- Graph data from Petit et al (1999)
- Current temp is 0.76ºC higher than in ~1875 (IPCC, 2007b)

Mainstream climate strategies: shortcomings

Mainstream climate strategies

- Key attributes:
  - Reliance on technological change
  - Driven by industry and large corporations
  - Large-scale use of complex/ non-renewable technologies
    - Nuclear power
    - Fossil fuels with Carbon Capture and Storage (CCS)
  - Minimal change to economic system and lifestyles
  - Increasing role for climate engineering

UK electricity: Industry-led low carbon scenario



Carbon emissions reduction target:
80% cut between 1990 and 2050

Source: Transition Pathways Project (2012)

Reasons to doubt mainstream strategies

- Economic flaws
  I. Export of high emission activities
  II. Efficiency gains undermined by economic growth
- Flaws in wider techno-economic system:
  1. Breaching many 'planetary boundaries'
  2. Operating under high uncertainty and 'ignorance'
  3. Undermining democracy
  4. Failing to tackle many wider problems

Points I & II mean that these strategies are unlikely to reduce carbon emissions markedly.

Points 1-4 mean that other problems will be exacerbated by these strategies.

I. Export of emissions

- High emissions sectors (e.g. mineral extraction, manufacturing) are shifting to developing countries
- Emissions of many wealthier countries are falling – but much is because of this export
  - For example, from 1992 to 2004:
    - UK emissions (officially reported) fell by 5%
    - UK emissions (including imports) rose by 18%

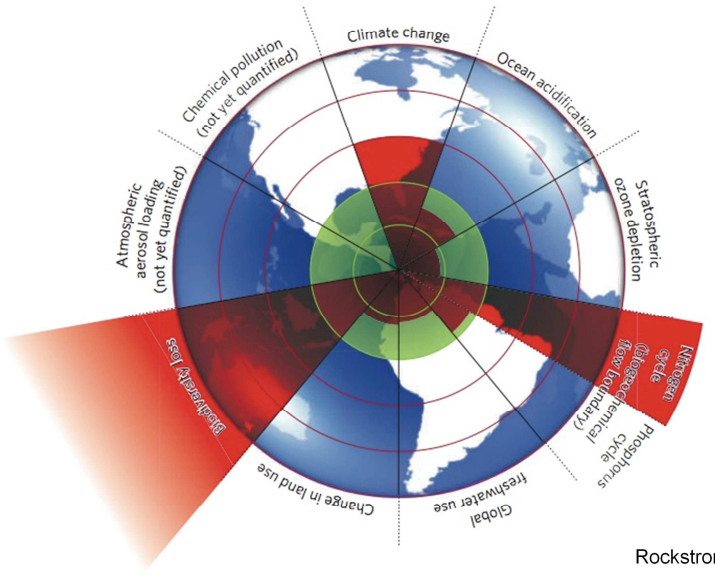
Wiedmann et al (2008): Government commissioned report (by DEFRA)

II. Efficiency undermined by growth

- Jevon's Paradox (1865):
  - Technological progress that increases the efficiency with which a resource is used tends to increase (rather than decrease) the rate of consumption of that resource
  - Modern energy-economic analysis has verified the effect
  - Only economic changes can tackle the problem
    - e.g. carbon taxes (at least!)

- Sometimes known as 'rebound' or 'backfire'
- More discussion in: Polimeni et al (2008); Huesemann and Huesemann (2011), chapter 5

1. Breaching 'planetary boundaries'



Rockstrom et al (2009)

• Our techno-economic system is causing numerous other global environmental problems – not just climate change

• Over the last 10,000y, several key biophysical variables have remained relatively stable, allowing human civilisation to flourish

• Human activities – especially fossil fuel combustion and industrial agriculture – are causing these variables to change markedly

• There is now serious concern that we may breach 'planetary boundaries' – when the potential for rapid, irreversible change becomes very significant

• Three of nine interlinked planetary boundaries are believed to have already been overstepped:

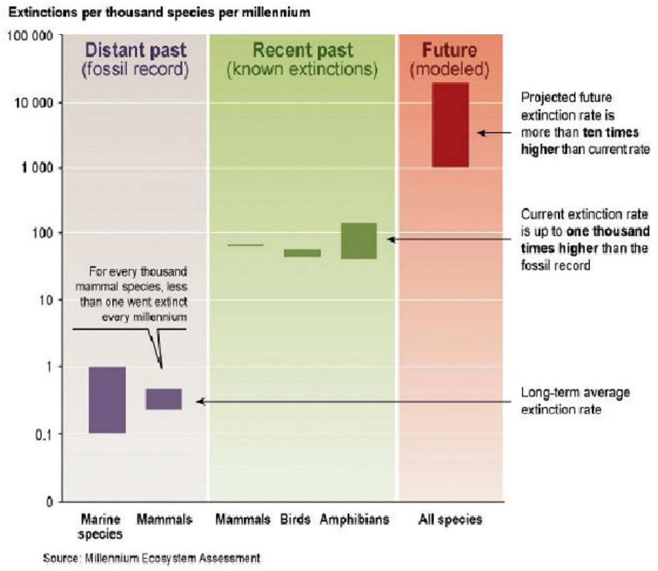
  • atmospheric greenhouse gas levels due mainly to fossil fuel combustion (climate change)

  • plant and animal extinction rates due to multiple factors (biodiversity loss)

  • removal rate of nitrogen from atmosphere due to fertiliser manufacture (and other agricultural processes)

Source: Rockstrom et al (2009)

E.g. Biodiversity loss (extinctions)



• Biodiversity is critical for human society due to 'ecosystem services' – e.g. water, food, fuel, climate regulation, soil formation, disease control

Millennium Ecosystem Assessment (2005), p.5

Unintended consequences?

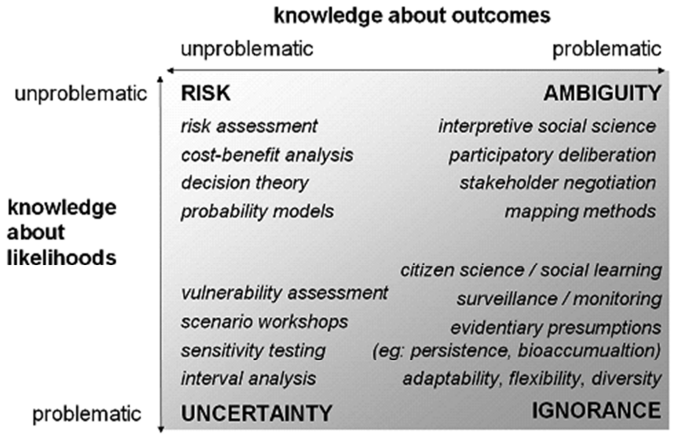
- Will technological solution to one environmental problem simply contribute to another?
  - e.g. replacing CFCs with HFCs – reduces *ozone depletion* but contributes to *climate change*
  - e.g. replacing petrol with biofuels – reduces *climate change* but has negative effect on *land use* (undermining food security)
  - e.g. replacing fossil fuels with nuclear power – reduces *climate change* but has a negative effect on *chemical pollution*

2. Operating under high uncertainty & ignorance

- Natural world
  - Current ecosystems and species are the result of millions of years of evolution
    - resilient to many ***natural*** impacts
- Current techno-economic system
  - ~150 years of development
  - Many technologies create materials & conditions which are outside natural evolutionary experience
- Modern science has only limited understanding of the impacts

Huesemann and Huesemann (2011)

How much do we know?



Stirling (2009)

Stirling (2009)

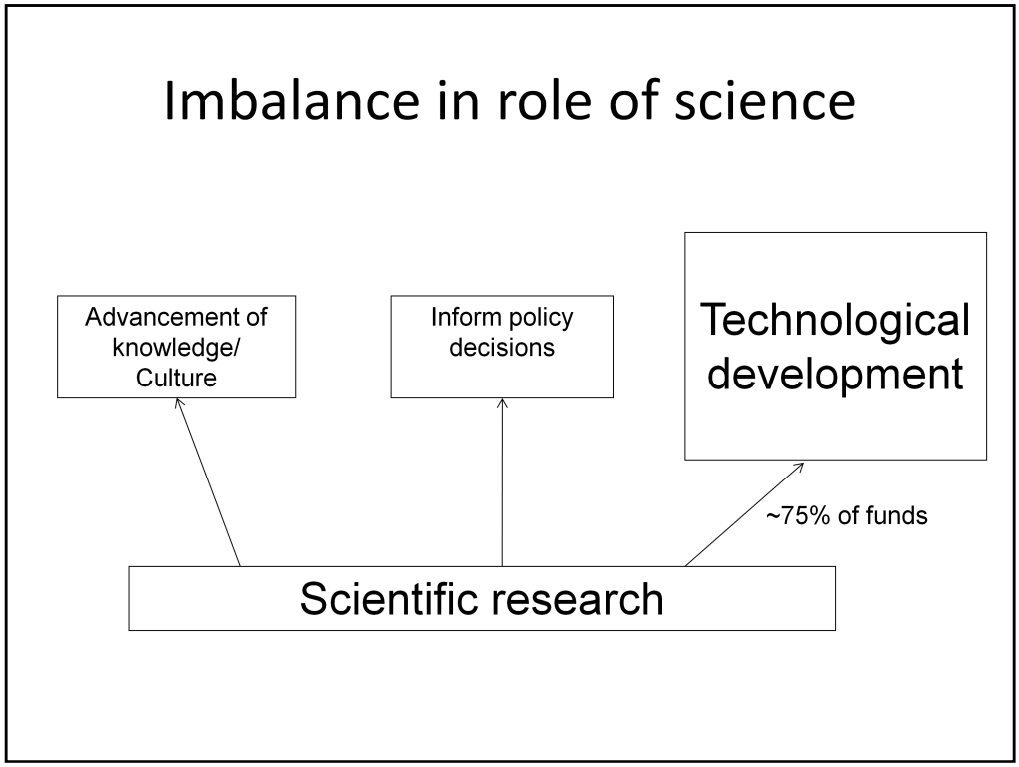
3. Undermining democracy

- In democracies, most major social decisions made by elected representatives (new policies, laws etc)
- Decisions on introduction of powerful new technologies generally made by industry
- Some control exerted through health and environmental impact assessments
  - Limited by available knowledge
    - often only from industry-funded scientists

4. Failing to tackle wider problems

- 1 billion malnourished
- Income gap between rich and poor growing
- 'Diseases of affluence' at epidemic levels
  - Obesity; cancer; heart disease; depression
- Military spending at record levels
  - Global stockpile: about 20,000 nuclear weapons
- Economic system is not stable
  - 2008 global financial crisis and continuing problems

More details about wider issues: Parkinson (2012)



- ~75% of the funding for research and development is spent on technological development
- estimate based on official UK science and technology statistics

Case study: nuclear power

- 60 years as commercial technology but still major problems
  - Weapons proliferation a very serious problem
  - Radioactive waste problem unresolved
  - Safety and security of power stations need improvement
  - Costs and build-times are still growing
  - Limited benefits

For more discussion, see: Parkinson (2007)

Nuclear power: weapons proliferation

- Technology overlaps between civil and military nuclear programmes
  - Uranium enrichment
  - Waste reprocessing: plutonium
- Iran's nuclear programme
  - War with Israel?
  - Saudi Arabian nuclear weapons?
- Previous civil to military examples:
  - France, Israel, India, Pakistan, South Africa, North Korea

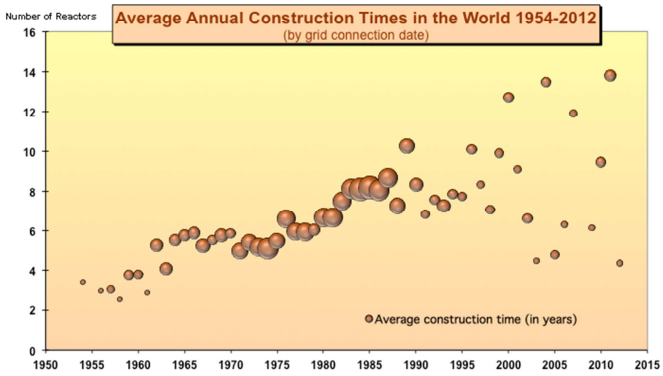
- Same basic technical processes used to enrich uranium for fuel (3-5% grade) and weapons (>90% grade)
- Reprocessing of radioactive waste yields separated plutonium
  - civilian grade can be used to make crude nuclear bomb (Royal Society, 2007)
  - UK has over 100 tonnes of civilian grade plutonium in storage (Royal Society, 2007)
- Industry needs very stringent international policing – very hard to do
- Also see: Schneider (2012)

Nuclear power: environmental and safety problems

- Radioactive waste problems
  - Large amounts needs to be isolated from biosphere for 10,000y +
  - 'Secure' deep disposal still in early development
- Safety and security of nuclear facilities
  - Fukushima disaster demonstrated scale of threat
    - 100,000 long-term evacuees
    - Costs $70-$250 billion
  - Terrorist threat is still significant

- Fukushima disaster costs
  - full cost, including compensation & decommissioning all 6 Dai-ichi reactors: 5.7-20trn yen ($70-$250bn): Japan Center for Economic Research (2011)

Nuclear power: construction delays and cost overruns



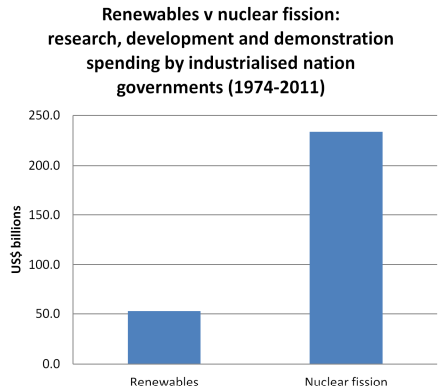
Schnieder et al (2012)

EPR reactor proposed for UK:

- 2 under construction (in Finland and France)
- Both 4+ years behind schedule; build costs have more than doubled

Schneider et al (2012)

Nuclear power: poor value for money



IEA (2012)

- Massive R&D spend but little to show for it
- Currently supplies less than 3% of world's energy consumption and falling
- Currently only used by 31 countries (16%)

- Research, development and demonstration spending data: IEA (2012)
- Share of world's (final) energy consumption: REN (2012)
    - breakdown for 2010: nuclear (2.7%); modern renewables (8.2%); traditional biomass (8.5%); fossil fuels (80.6%)
- Country usage data: Schneider et al (2012)

Other ‘techno-fixes’

- Climate engineering
  - e.g. ‘solar radiation management’ where reflective material is released into upper atmosphere to reduce heating from Sun
  - Concerns:
    - huge uncertainties
    - much potential to cause major negative effects
- Nuclear fusion
  - Concerns:
    - Many decades before potential deployment
    - R&D spending already very high

Climate/ Geo-engineering: e.g. Haigh (2011)

Nuclear fusion: R&D spending – IEA (2012)

Sustainable solutions

Sustainable climate change strategies

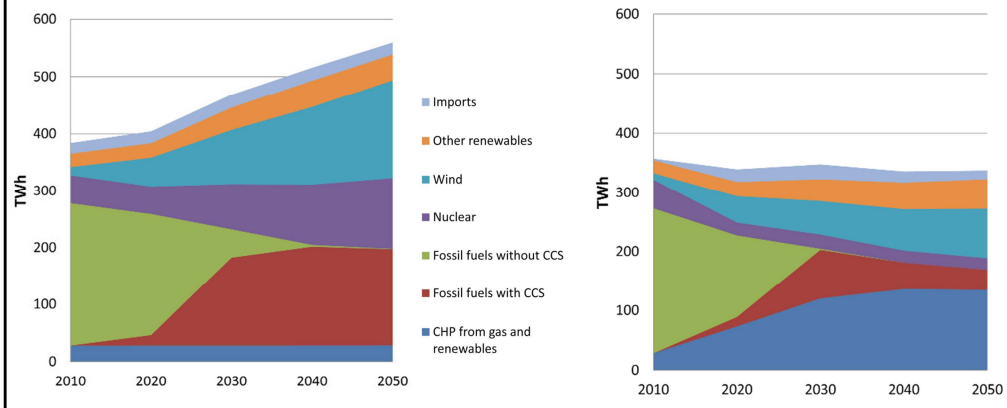
- Key attributes:
  - Balance between technological, economic and social change
  - Renewable energy and energy conservation are central
  - ‘Appropriate’ technologies in wide use
  - Community role very important
  - Major reform of economic system
  - Quality of life improvement

Economic reforms

- Ecological tax reform
- Circular economy
  - Produce durable products that can be easily repaired/ reused/ recycled
- Corporate governance
  - From neo-liberalism to regulated responsibility
- Move to a steady-state economy
- Quality of life not consumption

More discussion in (e.g.): Ellen MacArthur Foundation (2012); Jackson (2009)

Low carbon scenarios for UK electricity: From ‘industry-led’ to ‘community-led’



Carbon emissions reduction target:
80% cut between 1990 and 2050

Source: Transition Pathways Project (2012)

Case study: Scotland

- 2011
  - 31% of electricity demand from renewables
- 2020
  - Target: 100% of electricity demand from renewables
    - mainly from onshore/ offshore wind
  - Energy conservation to reduce demand by 12%
- Also
  - Large expansion of renewables for heat/ transport
  - Significant role for community schemes
  - Phase out of nuclear power

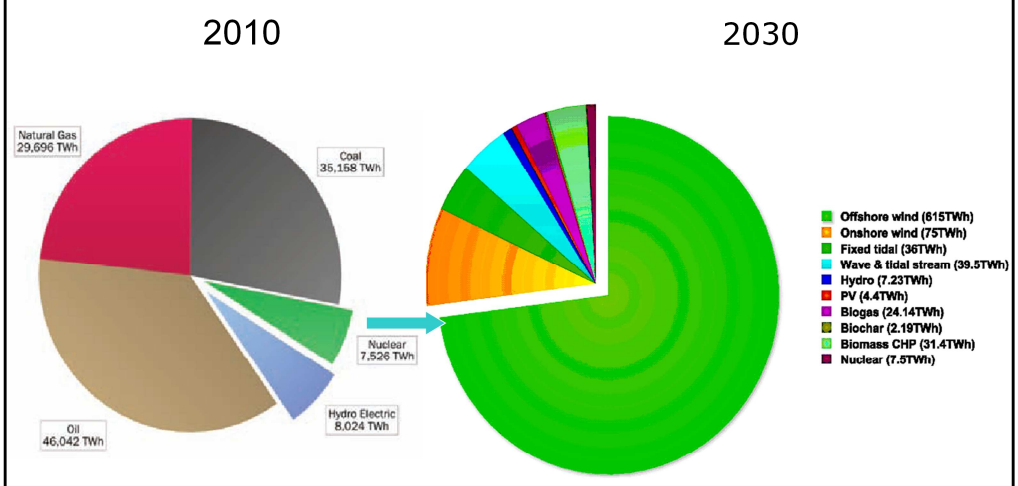
The Scottish Government (2011)

Case study: Zero Carbon Britain 2030

- Ambitious plan to reduce UK carbon emissions to zero in 20 years
- 'Power down'
  - 56% reduction in energy use
  - Energy-efficient buildings; better public transport; healthier diet; electric cars; efficient industry
- 'Power up'
  - Mainly offshore wind + onshore wind; marine; others + connection to EU supergrid
- High employment generation potential

Centre for Alternative Technology (2010)

A new electricity mix for 2030



Case Study: Lancaster Cohousing

Lancaster Cohousing: main elements

- 41 eco-homes
  - Super-insulated: heating demand 90% lower
  - Materials: sustainable timber; recycled concrete etc
  - Renewable energy: wood chips; solar; hydro
- Community facilities
  - Function room; guest rooms; laundry; bike store; pedestrian st.; car share scheme; food co-op; forest
- Office and workshop space
- Community owned and run

- Houses built to 'PassivHaus' standard and Code for Sustainable Homes Level 6
- Heating & hot water via wood chip fuelled district heating boiler
- Shared vegetarian meals several times a week in function room ('common house')
- Source: Lancaster cohousing (2012)

Lancaster Cohousing: benefits

- ‘One planet living’ both straightforward and comfortable
- Appropriate low carbon technology
- Community driven & accountable
- ***Better*** quality of life

References (p1)

Centre for Alternative Technology (2010). Zero Carbon Britain 2030. http://zerocarbonbritain.org/

Ellen MacArthur Foundation (2012). Towards the Circular Economy. http://www.thecircularеconomy.org/

Haigh J (2011). Geo-engineering the climate. Presentation at 'Emerging technology: are the risks being neglected?' conference, 21 May. http://www.sgr.org.uk/resources/geoengineering-climate-may-2011

Houghton J (2004). Global Warming: the complete briefing. 3rd edition. Cambridge University Press.

Huesemann and Huesemann (2011). Techno-fix: Why technology won't save us or the environment. New Society Publishers.

IEA (2012). RD&D statistics – database. http://www.iea.org/stats/rd.asp

IPCC (2007a). Climate Change 2007: Synthesis Report. (Summary for Policymakers.) Intergovernmental Panel on Climate Change. http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_spm.pdf

IPCC (2007b). Climate Change 2007: The physical science basis. (Summary for policy-markers.) Working Group I of the Intergovernmental Panel on Climate Change. http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-spm.pdf

IPCC (2007c). Frequently Asked Questions. Working Group I of the Intergovernmental Panel on Climate Change. http://ipcc-wg1.ucar.edu/wg1/Report/AR4WG1_Pub_FAQs.pdf

Jackson T (2009). Prosperity Without Growth: Economics for a finite planet. Earthscan.

Japan Center for Economic Research (2011). Redesigning of the Japanese Economy: Beyond the Earthquake Disaster. http://www.jcer.or.jp/eng/research/pdf/pe(iwata20110425)e.pdf

Lancaster Cohousing (2012). About the project. http://www.lancastercohousing.org.uk/Project

Millennium Ecosystem Assessment (2005). Ecosystems and Human Well-being: Synthesis. Island Press, Washington DC. http://www.maweb.org/

Parkinson S (2007). Nuclear power: yes or no? Presentation at Manchester University, 19 September. http://www.sgr.org.uk/resources/nuclear-power-yes-or-no

References (p2)

Parkinson S (2012). Science and technology: when does use become misuse? Presentation given at 'What is science for?' conference, 25 February. http://www.sgr.org.uk/resources/science-and-technology-when-does-use-become-misuse

Petit J.R., Jouzel J., Raynaud D., Barkov N.I., Barnola J.M., Basile I., Bender M., Chappellaz J., Davis J. Delaygue G., Delmotte M. Kotlyakov V.M., Legrand M., Lipenkov V.M., Lorius C., Pépin L., Ritz C., Saltzman E., Stievenard M. (1999). Climate and Atmospheric History of the past 420,000 years from the Vostok Ice Core, Antarctica. Nature, Vol 399, No 6735, pp429-436 (3 June).

Polimeni J, Mayumi K, Giampietro M, Alcott B (2008). The Myth of Resource Efficiency: The Jevons' Paradox. Earthscan.

REN21 (2011). Renewables 2012: Global Status Report. Renewable Energy Policy Network. http://www.ren21.net/default.aspx?tabid=5434

Rockstrom et al (2009). A safe operating space for humanity. Nature, 24 September, vol. 461, p.472-475.

Royal Society (2007). Strategy options for the UK's separated plutonium. Policy document 24/07. http://royalsociety.org/

The Scottish Government (2011). 2020 Routemap for Renewable Energy in Scotland. http://www.scotland.gov.uk/Publications/2011/08/04110353/0

Schneider M, Froggatt A, Hazemann J (2012). World Nuclear Industry Status Report 2012. Mycle Schneider Consulting. [website]

Stirling A (2009). Risk, uncertainty and power. Presentation at 'Knowledge in question: a symposium on interrogating knowledge and questioning science'. May. http://www.india-seminar.com/2009/597/597_andy_stirling.htm

References (p3)

Transition Pathways Project (2012). Layperson's guide to Transition Pathways. http://www.lowcarbonpathways.org.uk/lowcarbon/news/Pathways_A4_final.pdf

Wiedmann, T., Wood, R., Lenzen, M., Minx, J., Guan, D. and Barrett, J. (2008) Development of an Embedded Carbon Emissions Indicator – Producing a Time Series of Input-Output Tables and Embedded Carbon Dioxide Emissions for the UK by Using a MRIO Data Optimisation System, Report to the UK Department for Environment, Food and Rural Affairs by Stockholm Environment Institute at the University of York and Centre for Integrated Sustainability Analysis at the University of Sydney, June 2008. Defra, London, UK