Global energy technology challenges and priorities

Prof Sir Mark Walport FRS and Prof David MacKay FRS

October 29, 2013

Guidance:

When writing, please can you try to emphasize what is new about your case, to distinguish it from the raft of other material that has been published on energy solutions for climate change. I've attached a few examples so that you can see our style. Please can you aim for a general audience – at the level of a New York Times article – and feel free to use a conversational and informal tone, with anecdotes and specific examples to illustrate, so that the piece is engaging and widely read. Note that the piece will be fully edited, and we recommend following the structure below for clarity. We can draw up 1-2 figures and/or graphics; please supply raw data/ideas when you send your text.

- a 250 word precis of your thesis: what the problem is, and what in a nutshell you propose we should do about it

- 3 x 500 words tackling each subsidiary issue including telling examples of what works and what doesn't and counter arguments to detractors

- 250 words of conclusion, emphasising two or 3 pressing, tangible and practical next steps.

Please try to include specifics: who must do what exactly to whom, when, how; and what will be the impact of heeding your call to action, and of not doing so? We can include a figure (max 2) to support your argument; up to 10 references are permitted. Our art department can redraw graphs and prepare bespoke graphics, so please feel free to suggest them.

Please convey only one main point in each paragraph; please introduce big new ideas at the beginning of sentences and paragraphs. Throughout, please provide enough detail that an expert in your field will feel enlightened by the work, but no jargon that will lose all the other scientists attempting to read it.

When you file, please also include:

- your full institutional postal address
- the phone number where you can be most easily reached
- notice of any days holiday or unavailability you may have upcoming
- an e-mail address you would be happy to have printed as a corresponding address on your opinion piece.

Many thanks

Joanne

Dr Joanne Baker
Senior Editor | Comment | Nature
The Macmillan Building | 4 Crinan St | London N1 9XW | UK
+44 (0)20 7843 4567 | j.baker@nature.com | www.nature.com/nature

From: Ankers Jeremy (GO-Science) On Behalf Of MPST Walport
Sent: 18 September 2013 16:37

Mark has spoken to Joanne Baker at Nature to follow up discussions with Philip Campbell on your joint OpEd on energy research challenges.

Mark explained his vision for the piece around the 2050 calculator scenarios and Joanne was positive. She asked for around 2000-2500 words in the first draft. The challenge would be that they would need a first draft in 4 weeks to publish in late October/November. Do you think this would be possible?

Global energy technology challenges and priorities

Prof Sir Mark Walport FRS and Prof David MacKay FRS

October 29, 2013

Avoiding dangerous climate change would be easy if the climate were insensitive to carbon emissions; if it were sufficient to reduce emissions rates just a little; or if low-carbon technologies could be deployed at a cost similar to or lower than that of today's fossil-fuel-dominated infrastructure. Sadly, it is likely that the climate is sensitive to carbon emissions; limiting climate change requires emissions rates to reduce to zero; and most low-carbon technologies are expensive. But on this third point, there is room for science and technology to make a difference. We advocate a determined programme of global innovation to drive down the costs of low-carbon technologies. [106 words]

The recent IPCC report provides a stark warning of the challenges facing the world if we continue carbon emissions at their present level. Thanks to the very slow clearance of carbon dioxide from the atmosphere, continuing emissions leave a legacy that lasts for thousands of years. Figure 1 shows the predicted global average surface-temperature rise for four different future emissions scenarios (with emissions rates shown in the inset), ranging from RCP8.5, a business-as-usual scenario in which emission rates continue to rise decade on decade and carbon dioxide concentrations pass 900 ppm before 2100, to RCP2.6, a radical emissions-reduction scenario, in which carbon dioxide concentrations peak at about 450 ppm mid-century and then fall, thanks to both a rapid reduction in fossil-fuel use and the deployment at a massive scale of technologies that suck out of the air. What figure 1 shows is that the predicted increase in average global temperature depends principally on the *cumulative total* of carbon emissions [cite Myles Allen Nature paper also]. This has a simple consequence: if the international community wishes to adhere to the goal of limiting the increase in average global temperature to *any* value (such as 2C, which has often been mentioned in the discussions of recent years), then carbon emissions *rates* must be reduced to *zero* (unless the international community wishes to compensate for some continued emissions by steadily increasing deployment of solar radiation management). [233 words]

The UK Department of Energy and Climate Change has published an interactive open-source tool, the 2050 Pathways Calculator, which allows the user to explore the effectiveness for the UK of different combinations of demand-side and supply-side actions. The UK government's *Carbon Plan*, published in December 2011, illustrates the magnitude of effort required to achieve the UK's 2050 goal of 80% decarbonization. The *Carbon Plan* sketches a corridor of pathways in which: per-capita demand in the UK falls by between 31% and 54%; nuclear power generation capacity increases from today's 10 GW to between 16 GW and 75 GW; renewable electricity-generation capacity increases from

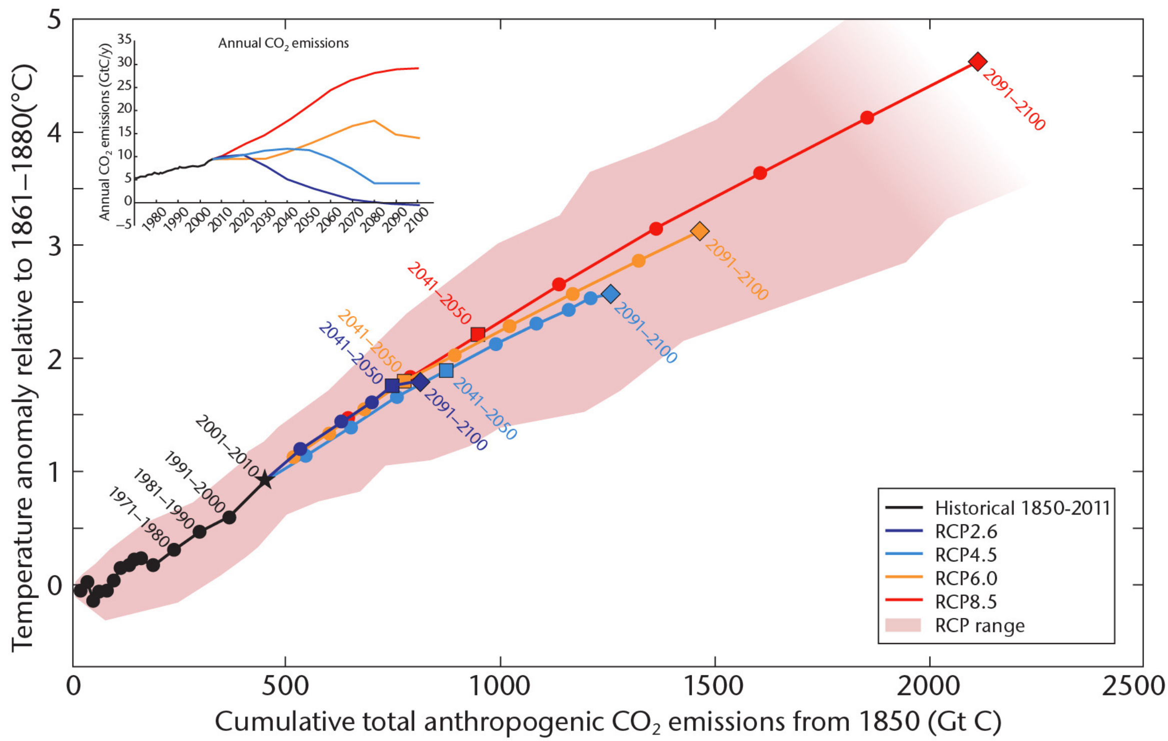

Figure 1: Global average surface-temperature rise for four different future emissions scenarios (with emissions rates shown in the inset).

Pick one:

To limit the peak warming to 2, 2.5, or 3 degrees above pre-industrial, the future *cumulative* carbon emissions budget from 2011 onwards would need to be set to something in the rough ballpark of 300 GtC, 500 GtC, or 700 GtC. [source: TFE.8 Figure 1, IPCC AR5 WG1 Technical Summary]

OR To limit the peak warming to 2, 2.5, or 3 degrees above pre-industrial, the *cumulative* carbon emissions budget (of which we have already spent just over 500 GtC) would need to be set to something in the rough ballpark of 800 GtC, 1050 GtC, or 1200 GtC.

Source: DECC/Met Office, adapted from IPCC WG1 SPM (2013).

today's 10 GW to between 22 GW and 106 GW; carbon capture and storage electrical capacity increases to between 2 GW and 40 GW; and bioenergy use increases from today's 73 TWh/y to between 180 and 470 TWh/y (21–54 GW). [147 words]

The 2050 Calculator is becoming globalised – China and South Korea are among the first countries to have published their own versions, and the UK is now leading the development of a 2050 Calculator for the world. These are powerful tools for public engagement. [44 words]

All would be simple if any of these approaches were cheaper than burning fossil fuel – but this is far from the case. What then are the grand challenges for research? Can we work in public / private partnership to crack some of these problems? Innovative business will be a key part of the solution as well as academia. And can we collaborate globally - as for example is being achieved for fusion? These are the grand challenges:

- Energy-saving / Efficiency / Demand reduction
  - Better building controls that enable users to save energy
  - Amazing insulation
  - Electric vehicles
    - batteries
    - capacitors
    - light-weighting
  - Heat pumps
  - ... and a social science challenge? – decouple growth from energy consumption and material consumption
- Energy supply
  - Cheaper wind, especially offshore (floating wind / kite power)
  - Proliferation-resistant, safe, low-waste nuclear power
  - Carbon capture and storage – at electrical power stations and heavy industry
  - Solar power
  - Deep geothermal
- Energy transmission, conversion, and storage
  - Smart grids
  - Interconnectors
  - Energy storage
  - Fuel cells (hydrogen or other fuels to electricity)

  - Fuel synthesis (eg hydrogen or other fuels from electricity) [electrolysis with less platinum or no platinum]
  - Biomass-to-good stuff
  - Waste-to-good stuff
- Geoengineering research – as recommended by the Royal Society
  - Negative emissions technologies / Greenhouse-gas reduction technologies
  - Solar radiation management

Now is the time for the global science, engineering and technology community to work together as never before. History has shown us that war is a powerful driver for innovation. We require a similar response to climate challenges. We have a choice: we can mitigate, we can adapt or we can suffer. In reality we will probably end up doing all three - but we must try to optimise the balance. [303 words]

[106+233+147+44+303 = 833 words]

1 Cut material

In their seminal paper of 2004, Pacala and Socolow[1] described how current technologies (energy efficiency, gas-to-coal switching, carbon-dioxide capture and storage, nuclear power, renewables, forest management, and soil management) could be used (and at what scale) to reduce emissions relative to business-as-usual.

To limit the peak warming to 2, 2.5, or 3 degrees above pre-industrial, the future *cumulative* carbon emissions budget from 2011 onwards would need to be set to something in the rough ballpark of 300 GtC, 500 GtC, or 700 GtC. [source: TFE.8 Figure 1, IPCC AR5 WG1 Technical Summary]

OR To limit the peak warming to 2, 2.5, or 3 degrees above pre-industrial, the *cumulative* carbon emissions budget (of which we have already spent just over 500 GtC) would need to be set to something in the rough ballpark of 800 GtC, 1050 GtC, or 1200 GtC.

[1] Pacala, S., and R. Socolow, 2004. 'Stabilization wedges: Solving the climate problem for the next 50 years with current technologies.' Science 305: 968972. The article and its detailed supporting online material are available at the website of Princeton University's Carbon Mitigation Initiative: http://www.princeton.edu/cmi/