FST meeting, Royal Society

Tuesday 16 October 2007

Adaptation and Mitigation in Climate Change

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One rule I make on such occasions is never to start with an apology, but in this case I do need to make an exception. As you have heard already, Lord Browne is unfortunately unable to join us this evening. In discussion with him, we agreed that I should present his thoughts on this subject, perhaps augmented with a few of my own.

Our title this evening is Adaptation and Mitigation in Climate Change. This autumn has seen a series of meetings in London addressing the engineering perspective of climate change.

Many of us will have attended the Royal Academy of Engineering's prestigious International Lecture held at the RIBA two weeks ago and given by Dr Pachauri, Chairman of the Intergovernmental Panel on Climate Change, the IPCC.

He stressed the critical role of both adaptation and mitigation in helping the world respond to climate change and he urged the Academy to provide intellectual direction to government and the corporate sector in developing innovative and practical technologies. This evening I would like to explore what this means for engineers and for engineering.

We need to start by setting the context – why do we need to challenge the engineering profession now? In recent years, we have seen how the world of science has gathered its thoughts, developed a process and delivered, through the IPCC's latest 4th Assessment Report, a comprehensive and convincing statement of where we stand and where we are heading on a global scale.

Our understanding of climate change has been transformed in the past decades by ever more detailed and comprehensive data of the oceans, the atmosphere and the land surface. If the fact of global warming is no longer in doubt, there remain considerable scientific challenges in understanding causation and how some mechanisms affect climate, particularly at regional scale.

The role that science and engineering, two inter-related disciplines, have played and continue to play in human progress is the key to defining the next steps for the engineering profession. The Royal Academy of Engineering is our national academy for engineers and is working ever more closely with the major engineering institutions in partnership to present a ‘single voice’ for government on strategic matters. Together, we count around 250,000 professional engineers as members of the engineering community. We need to set out what we as a profession can do to take forward the work of the IPCC and Sir Nicholas Stern.

In recent decades it has become fashionable amongst some in the UK to see technology as part of the problem, rather than part of the solution. Yet we know that much of the progress in recent decades that society seems to take for granted – in health, life expectancy, communications, travel and quality of life to name a few – has been powered by the twin engines of science and engineering. In all these fields, the frontier of human knowledge was first extended through scientific analysis. Unknowns and complexities were laid to rest as a result of patient, sustained scientific enquiry. And practical choices were then researched and developed.

This gets us to an understanding of the proper role of science and engineering with respect to government, as illustrated by the role of the Royal Academy and the Engineering Institutions. Scientists and engineers improve understanding and they provide practical choices. In other words, our job is to *inform*.

To do this we need to offer independent, expert, authoritative advice. But it is not our role to make public policy or to set goals and targets. That is the responsibility of our elected representatives and public servants.

Let me return now to the subject of climate change. Science has fulfilled, and continues to fulfil, key roles in the discovery and dissemination of knowledge.

First, it has advanced our understanding both of the phenomenon of climate change and its likely impact on the planet.

And secondly, thanks to the IPCC and many other scientific organizations, our levels of confidence in the links between anthropogenic emissions, the concentration of greenhouse gases in the atmosphere, and the increase in global temperatures is now much higher than it was ten years ago.

For example:

- we know with “virtual certainty” that past greenhouse gas emissions will increase the global mean temperature over the next few decades and that continued greenhouse gas emissions – at or above current rates – are very likely to produce further significant warming and induce other changes in the global climate system during the 21st century;
- and we know that it is “very likely” that extreme weather, such as heat waves and heavy rainfall events, will become continuously more frequent.

Overall, there is a broad scientific acceptance that the risks to our planet – and to human activity – are considerable.

Science is also pointing the way to what needs to be done in the face of the climate change threat. Scientists and engineers are presenting policymakers with real, practical options for reducing greenhouse gas emissions – all within the range of current technical capability.

Take, for example, the work by Bob Socolow at Princeton, who has 'materialised' the challenge by suggesting a series of fifteen practical options that would each reduce carbon emissions by one billion tons each (1 GtC/year).

Socolow's wedge concept shows what trajectory must be set for any option starting from now to achieve the target 1 GtC/year reduction in fifty years time. These trajectories provide a useful benchmark against which to measure the scale of investment required, whether engineering, policy or incentive.

Seven of these 1bn ton 'wedges' would lead to enough reductions in carbon emissions to stabilise atmospheric CO_2 at safe levels by 2050, compared with business-as-usual projections. But these are not easy targets.

A one billion ton per year 'wedge' is achieved by:

- increasing the fuel economy of 2 billion cars from an average of 30 miles per gallon to 60 mpg;
- replacing 1,400 coal fired power stations with natural gas fuelled ones;
- replacing 700 GW coal power with nuclear fission (this is twice the current capacity);
- adding 2 million 1MW peak wind turbines (50 times the present capacity);
- installing 700 times the current global capacity of solar panels; or
- creating 3,500 'Sleipners' for geological disposal of CO_2. (Sleipner is the Statoil gas field in the North Sea where about 2,800 tonnes of carbon dioxide are separated daily from the gas production and injected into the saline sandstone aquifer formation, rather than released to the air.)

Carbon capture and storage is one of the more exciting technologies emerging today for emission reduction. The technical concept, as you know, is that we can capture 90% of a coal or gas-fired power plant's emissions, transport them, and store them safely and permanently underground. We need both pre and post-combustion technologies to be developed. A particular challenge is where to store the CO_2 – whether in saline aquifers, or in depleted oil and gas reservoirs – both tend to be a long way away from centres of population and power generation. And if CO_2 is stored close to people, how will they react? CCS is expensive, but maybe we simply have to do it.

Biofuels is another technology that we urgently need to improve global energy security. We are familiar with first generation biofuels – made from food crops. Henry Ford's first car, built in 1896, was designed to run on ethanol. Today new ethanol plants are under construction around the world. Sugars and starches are converted to ethanol relatively easily. But the switch from food to fuel has led to price rises of staple crops globally and public concern over food security. Research is now focused on extracting fuel from 'biomass', discarded plant waste matter like corn husks, straw, prairie or 'switch' grass, by developing technologies for breaking down lignocellulose, the 'woody' component of the plant cell wall. Bringing the cost of conversion down is the principal barrier. Breeding plants to increase their biomass is one approach. Genetically engineering plants to make it easier to break down the lignin and cellulose is another. Demonstrator projects are now being subsidized in the US to build large scale facilities that will convert biomass to fuel on an industrial basis.

The third area I would highlight is demand reduction.

By any statistic, the opportunities within the built environment to reduce emissions are staggering. BRE estimate that about 40% of all emissions of greenhouse gases are associated with energy use in buildings. Typically, about 80% of emissions arise from the use of a building and 20% from its construction and demolition. About 60% of emissions are from housing – largely for heating. Important though it is to develop standards for new build, it is obvious that improving the insulation of our existing building stock must be a top priority. Indeed many of the opportunities in demand reduction are cost-positive. The challenge is to change a culture that does not encourage people to adopt an integrated approach to energy management. Our experience in the UK is poor – research shows that the time to achieve market penetration has in the past been measured in decades, even if the technologies are already available. Real time pricing would give feedback to people on their energy use. Allowing people to generate electricity and put it back into the grid would be a paradigm shift.

Of course, there is much more to do: more engineering development and innovation of low carbon technology is needed and large scale demonstration is vital.

And more science is needed on the detailed pattern of causation and on the impact of climate change. Through the work of the Hadley Centre and others we are beginning to be able to anticipate the detailed impact of warming on particular areas. This will give us the primary tool for a sensible managed programme of adaptation which will go hand in hand with a programme of emissions reduction.

Overall then, scientists and engineers are playing their proper roles in society in relation to climate change: helping to advance the frontier of climate change understanding and offering society practical choices for reducing emissions.

Business is also playing its part.

Thanks to the increasingly compelling scientific evidence, the overwhelming majority of business opinion has accepted that the climate change threat is real, that immediate action is necessary and that the costs of taking it are manageable. Ten years ago only a handful of companies – including BP – belonged in that camp.

If you look through any newspaper or business magazine you will find innumerable companies describing what they are doing on environmental issues in general and climate change in particular.

This is not just an issue of branding or public relations, though it is fascinating and indeed very encouraging that so many companies feel they should be advertising in this way.

It's about good business. Successful companies aren't measured by single transactions but by long-term performance. And effective long-term performance depends on conducting business in a sustainable way. It also depends on recognizing emerging constraints – as well as exploiting new business opportunities by taking risks – as governments and consumers start demanding goods and services delivered in a different way.

Of course the most important actor in the current climate change picture is government. The truth is only government can create and police the framework within which genuine progress can be made.

History seems to show that at moments of a fundamental shift of values, the leadership role, which has enabled society to keep making progress, has been the responsibility of government.

There are almost as many climate change policy recommendations as there are policymakers. But one of the biggest steps forward would be to put in place a robust international climate policy framework.

Of course this could develop from the bottom up - country by country, continent by continent - and that's the way we have started. But this is a global problem and the world's atmosphere cannot be divided up. It is clear that the most effective solution is to work on the largest possible scale – that way targeting reductions, and the resources required to achieve them, to the places where the cost of abatement is lowest and the impact is highest.

Targeting resources to where they have the largest impact is what a business plan is all about. And that's what we need now: a global business plan for making the transition to a lower carbon future.

To deliver this, the international community should create an "International Climate Agency", with responsibility for:

- First, establishing a long term GHG stabilisation goal. There is much debate about what that level should be, and the view of what is acceptable seems to be falling rather than rising over time, but a level of 450 to 500 parts per million is the present consensus;
- Second, the agency would set fair and equitable emissions targets on a trajectory which leads to this goal;
- Third, it would issue emissions allowances in line with those targets;
- Fourth, it would design new mechanisms which encourage clean, low carbon development in the emerging market economies, where the largest increase in emissions will occur;
- Fifth, it would encourage global technology transfer;
- And finally, it would undertake monitoring and verification, which is necessary to build trust and credibility in any institution.

Of course this is an ambitious proposal. It would require stretching international legal norms to the limit of current understanding and practice. And it would require governments to re-find that sense of global collective endeavour that secured peace and prosperity after the Second World War.

But given the remarkable ramping up of public concern about climate change in recent years, real, concerted global action of this kind is becoming increasingly realistic.

The stark fact, and one recognised by publics around the world with increasing alarm, is that time is running out: emissions are growing and the pace of that growth is accelerating.

But that global public concern has not yet been matched by global public policy. A new climate change global 'business plan' – monitored and enforced by an international climate agency – would be the appropriate international response.

Such an institution would also provide a framework within which national policies could be made.

National governments already have several policy carrots and sticks – incentives and regulations – at their disposal. As a rule, incentives are preferable to regulations, but regulations will also play an important role, particularly in changing consumer behaviour.

Although national governments are bound to take into account existing political cultures and regulatory structures when making climate change and alternative energy policy, certain rules of thumb should apply:

- Policymakers should incentivise as broad a suite of low-carbon technologies as possible and should avoid picking winners.
- They should use, wherever possible, market mechanisms – to ensure resources are directed to areas where the biggest impact can be made at the lowest cost. That is one reason why cap-and-trade – assigning a cost to polluting – is emerging as the preferred carbon policy over carbon taxes in many parts of the world and why green certificate trading schemes, such as the Renewables Obligation in the UK, are proving increasingly popular.
- Policymakers should recognise that carbon pricing is not a 'silver bullet'. Transitional incentives, ranging from tax incentives to quotas to price support mechanisms, will also be needed in parallel, to accelerate the deployment and diffusion of less-mature low-carbon technologies – such as solar and wind power – and thereby drive cost reductions through economies of scale. Incentives will also be required to stimulate low-carbon technology R&D, such as second- and third-generation biofuels, wave power and solar nano.
- One particularly tough policy challenge is incentivizing technology demonstration projects. Some of the world's most promising clean technologies – like Integrated Gasification Combined Cycle or IGCC (technology to burn synthetic gas 'syngas' from waste or low value fuel) and Carbon Capture and Storage – are at demonstration phase. Demonstrating a new technology is costly and additional incentives are often needed to persuade business to go through with a first project. The problem is that a single carbon capture or IGCC project is huge and can swallow billions of dollars of investment capital in one go. This means required government support is also large and 'lumpy', perhaps hundreds of millions dollars at a time. Steering such sums through the political system quickly and fairly is not easy. This will require a new approach to policymaking as well as real political leadership.

- Finally, national governments must also act to remove policy barriers, some unseen, to low-carbon technology market entry. Current examples of policy barriers include
  - daily, as opposed to 'time-of-use', pricing of retail electricity, which effectively discriminates against solar power,
  - the current absence of a legal framework governing carbon capture and storage in most parts of the world, and
  - cumbersome planning rules that slow down onshore and offshore wind project development.

In conclusion then, action by governments remains the critical path in determining society's progress in response to climate change.

The role of the public is to communicate their concern to their political representatives and to hold those representatives accountable.

The role of business is to adapt their practices in anticipation of future constraints and to deliver on new opportunities by taking risks.

The critical role of scientists and engineers is to provide information – firstly on why, how and when climate change will occur and on what the effects will be – and secondly to develop real, practical options in the face of the numerous challenges and uncertainties.

And finally, the role of the Royal Academy and the Engineering Institutions is to offer independent, expert, authoritative advice on what solutions can be up-scaled effectively from existing demonstration technologies within the very short time window that we have left.

This is a substantial responsibility for us and for the engineering profession, but it is one that the science and engineering community is already rising to – and has risen to many times before.

Thank you very much.