THE FOUNDATION FOR SCIENCE AND TECHNOLOGY

ROUND-TABLE DISCUSSION SUMMARY

Driving down the cost of solar generation and associated storage

Held at The British Academy on 27th November, 2013.

Chair: **The Earl of Selborne GBE FRS**
Chairman, The Foundation for Science and Technology

Speakers: **Professor Sir David King FRS**
Foreign Secretary's Special Representative for Climate Change
Foreign and Commonwealth Office
Ian Simm
Chief Executive, Impax Asset Management

Recorder: **Dr Bernie Bulkin**
Director, Ludgate Investments Limited

SIR DAVID KING summarised his proposal with Lord Layard that there should be an international programme to drive down the cost of solar and associated storage to make it more attractive than fossil fuel alternatives.

IAN SIMM set out the perspective from the investor community of investment in power generation.

DR BERNIE BULKIN has summarised the opening statements and discussion by posing a number of questions:

1. What is the background and context of the problem today?

The picture on climate change does not offer much in the way of encouraging news. The issue has been pushed to the back burner in many countries, especially following the 2008 economic crises, combined with disappointments over some technological wonders that didn't materialize. If we look at the last five years, CO_2 has declined, but only at the rate of 0.7% per annum, and if we are to reach our targets by mid-century for keeping temperature increases at the 2°C level, this would need to accelerate to 1.8% now, and 3.2% by 2017. From a carbon budget point of view, if we continue with business as usual all fossil fuels would have to be switched off in 2042. A tough challenge in almost every respect.

There is also very little to encourage us, yet, from the international negotiations. It is possible that something will happen, and that some countries will still show the required leadership, but at the moment it is not at all clear where that will come from.

So the need, as set out in the two articles (FT and Guardian online) by Sir David King and Lord Layard is clear: We must find renewable sources of energy that are cheaper than fossil, which can be deployed at scale, and soon. Because only if we can get the cost down below that of coal, gas, and oil will the growth of renewables be inexorable, and independent of government subsidies. In this, the only good news is that in most of the world the prices for fossil fuels has been trending up, and are at the very least uncertain. However, offsetting this price instability is the undeniable fact that over the past decade the amount of oil and gas reserves has increased dramatically. The problem is not going to be solved because we are running out of fossil fuels – it will only be solved when the world accepts that at least half of the fossil fuel reserves we now know about must be left in the ground.

While this leads some to focus on solar, as the technology that has come down in price most quickly, and to some prognosticators has the best chance of being the technology that is cheaper than fossil fuels and widely applicable, not everyone agrees with this approach. There is a strong feeling that the Princeton 'wedges'[1] approach, where we do 5-10 big things, is still the right way forward, and which wedges are chosen depends very much on the country, its geographical position, its resources, and to some extent just national choice. Among the wedges, there is strong feeling from some quarters that, though immature in terms of deployment, Carbon Capture and Storage must be a part of the solution if we are to achieve our goals at reasonable cost.

Around the world, government policies with regard to decarbonisation, energy efficiency, CCS,

[1] http://cmi.princeton.edu/wedges/

nuclear, and support for renewables has been inconsistent at best. What is clear is that this creates uncertainty, retards the introduction of new technologies and raises the cost of capital even for those technologies like onshore wind that are already deployed at scale.

And finally, as background, for those countries like the UK that strongly favour a market-based approach to energy, especially to electricity, there needs to be a broader consensus on priorities – and a way to resolve the tensions between decarbonisation, security of supply, and affordability. Markets need to become more transparent and more liquid. It seems unlikely that this will happen for renewables unless and until large subsidy programmes can be eliminated, validating the initial premise of King and Layard.

2. What is the overall strategic need? And where will the leadership come from?

If we are to look at the problem from a high level strategic point of view, it seems as if we need development of strategy in four broad areas:

- Technology – which technologies to support, and how, what combination of government and industrial support is going to be most effective, and what is the timescale of expectation for success?
- Industry – how does this country, or any country, define and justify its investment not just in new technologies but in the associated infrastructure, things like grid (including much greater interconnection), ports, supply chain SMEs, etc?
- Regulatory – what combination of regulations in specific areas of commercial and residential buildings, heavy and light duty transport, and energy intensive industries will help us to meet our goals?
- Finance and Trade – raising and resolving issues of competition and cooperation, and the role of Government

There is a consensus that much more needs to be done across all these strategic dimensions, and in many countries, for us to make progress.

3. What is the current state of solar technologies?

There is general agreement that PV is dominated today by crystalline silicon, as it has been for some time, but with one big exception, namely the copper indium gallium selenide (CIGS) modules supplied by First Solar. Costs for crystalline silicon have been driven down by the determination of the Chinese to scale up and improve manufacture, but credit must also be given to First Solar, not a Chinese company, for producing the best cells in terms of cost/watt, and taking a substantial market share. Crystalline silicon can certainly be considered mature, yet to most observers of a decade ago the dramatic cost reduction achieved was not expected. Certainly given the installed capacity for manufacturing, we can expect crystalline Si to dominate for some time. There is also a niche for Cadmium Telluride (CdTe).

The costs of CIGS can continue to be driven down, and there are still some improvements in costs of crystalline Si. It was pointed out that there are lots of locations with high insolation and very high electricity costs, particularly island economies, where PV using these existing commercial technologies makes good economic sense today. In a number of cases, the issues are around storage, and capacity of the grid to accommodate larger amounts of variable generation.

There has been some deployment of concentrated solar thermal at scale, especially in California. The technology is relatively straightforward, and it still seems likely that, with proper leadership, big installations can be built in North Africa, which would potentially impact southern Europe.

4. Could there be a technology breakthrough in PV?

In terms of new materials, there is a general consensus that the developments in various perovskite materials, from the Snaith group at Oxford, the University of Pennsylvania, and others, are the most promising for conventional PV. In four years, at least at laboratory level, these materials have already matched or exceeded crystalline Si in efficiency. The challenges of manufacturing and durability remain, but many believe that perovskites could achieve efficiencies at least double the best cells available today, and possibly at less than half the cost. Now that would be, without doubt, a breakthrough.

Other things are still very much at lab scale, or not advancing as fast as hoped. Examples are solar storage in chemical bonds, organic PV, and novel solar thermal designs.

Given the possibility of perovskites to be transformative, we must ask how to best support development at scale, and with pace.

5. What is the current state of play of energy storage technologies, what is the need, and what is the outlook?

There is very broad consensus that energy storage is critical to decarbonisation, if this is to be achieved through substantial deployment of renewables. Storage can be for short or long times (hours to months), at small scale (household, ie 1-3 kW) or large (utility, say >1 MW). Today we have battery storage being used for small systems, especially on some island economies and other remote locations; there is pumped storage at some sites, but with limited new development.

The one new technology that seems to be moving towards commercial scale is cryogenic storage. Where this can be advantageously sited, alongside sources of cold, costs could be as low as or lower

than pumped storage today, with good round trip efficiencies.

Other technologies that have attracted attention in the past include flow batteries (which have encountered many problems) and hydrogen as a storage medium. There appears to be renewed interest in hydrogen.

No matter what direction (or more likely what combination of directions), advances in energy storage technologies are 'no regrets'.

6. What about solar/renewables business models?

But it is not all about technology, as was made clear earlier. Solar deployment has been driven forward as well by innovative business models, and there is space for more. Some of the ideas mentioned could involve finding innovative and convenient ways for more middle class householders to earn returns from small scale solar investment, improving the attractiveness of offers to medium-size businesses to achieve quick returns, looking specifically at models that will work in Africa, and looking carefully at US models that have been effective (eg SolarCity), adapting them to fit other countries.

7. What is the mind-set we need now?

The discussion of PV, storage, and other renewables often swings between looking hard at the horizon of new technologies, with all the barriers to go from innovation to rolling out at scale, and the subsidies, policies and business models to deploying what we have now as quickly as possible. Sure, we have well known theory and examples of new technologies sweeping away the old, and in fields that are not so far from what we are discussing here. But at the same time, we have now something that is good, that works, and that could be deployed at many times greater scale than is currently the case. In some places PV is the best (lowest cost, most reliable) energy technology available today, and even in such places it is not even close to being used optimally.

The challenge for us is to merge these two mind-sets. We must hold on to the possibility that technology innovations (such as perovskites) will prove disruptive, while moving forward at pace with CIGS, CdTe, and crystalline Silicon. This is a challenge for business and for government.

In so doing, we must not lose sight of the cost of moving technologies forward. Some believe that the Chinese spent $70 billion to scale up crystalline Silicon PV and drive the costs down. New energy technologies do not displace incumbents without major resource – probably close to a billion dollars is what it takes to get to scale, and more to get to lowest cost. We do not always see the size of investment, spread out as it is over decades, many companies, false starts, etc. There has been 25 years of investment to drive down costs and increase reliability of onshore wind, and there is still more to come. This is not just about money, it is also about determination and skills.

8. How do we bring urgency to the climate change discussion?

And the other part of the mind-set we need is urgency. We were reminded of the urgency that surrounded the possibility of a severe flu epidemic a few years ago, and the willingness to mobilize resources to prevent it. Many have invoked the moon landing program of five decades ago, or the Manhattan project, as examples of what is needed for climate change. But despite the presentation of an economic rationale for action, human civilisation seems to find it hard to act on threats that seem distant rather than imminent. Do people have a built in discount rate that operates in such situations?

Some of what we have done in the past in the UK is thought to have been effective, eg the advertising/public service campaigns of the Carbon Trust. We are no longer doing this, and it feels like action on climate change has slipped down the agenda. Perhaps this is intentional on the part of the Government, not just in the UK but in other countries as well, perhaps not. Clearly the economic situation of the past five years has meant that other issues are seen as more immediate. But if we are to have the dramatic step-up in decarbonisation rate that is required to meet mid-century goals, there must be much more general public awareness and commitment.

As ever, this is achieved through a combination of aspiration and fear. Aspiration that new technologies, and especially solar, are better for our health and for our society than the older fossil technologies; fear that unless we act now we are going to see increasing frequency and intensity of storms, flooding, drought, and other destructive weather events. It was suggested that the insurance industry, particularly the industrial insurers, could play a major role in quantifying the trends and the dangers ahead.

9. Is there potential for international cooperation or is it all about competition?

The EU has a track record of collective action, on climate change and on renewables. Yes, it has come apart to some extent under the heat of economic austerity, but there are many countries/governments where the commitment to collective EU action for the 2020s is still strong.

But international cooperation can and must be broader than this. The US position remains far from clear, but there are signs of behind the scenes negotiations with China and perhaps others. We may have some allies in China, Japan, Africa, and others who will work cooperatively. The UK, because of the Commonwealth and the British Overseas Territories, may have a very particular role to play in promoting such cooperation.

Of course there is competition – to develop the best technologies, scale them up to provide jobs and exports, leading to profitable growth. This is not a bad thing.

Perhaps the climate problem is best viewed as being solved by again bringing together two apparently contradictory mind-sets: cooperation on policy and goals, alongside competition on how to best reach those goals.

10. Summing Up

If renewables and associated storage/infrastructure can be cheaper than conventional fossil fuels, there is a consensus that they will displace, and on a timescale that is urgently required to solve the problem. Yes, PV is probably the best bet, because of current cost position and widespread applicability, but we must not ignore other technologies, other wedges. Government plays a vital role, international organisations and negotiations play a vital role, industry and finance are crucial.

So is behaviour change, and winning hearts and minds. But that is another discussion.

Dr Bernie Bulkin

TED Talk:

Professor David MacKay, Chief Scientific Adviser, Department of Energy and Climate Change
www.ted.com/talks/david_mackay_a_reality_check_on_renewables.html

Useful Links:

We must harness the power of the sun: David King and Richard Layard, The Observer, 29 September, 2013
www.theguardian.com/commentisfree/2013/sep/29/climate-change-energy-sources-solar-power

Carbon Trust
www.carbontrust.com

Department for Energy and Climate Change
www.gov.uk/government/organisations/department-of-energy-climate-change

The Energy Technologies Institute
www.eti.co.uk

Engineering and Physical Sciences Research Council
www.epsrc.ac.uk

European Climate Foundation: Roadmap 2050
www.roadmap2050.eu

Fraunhofer-Institute for Solar Energy Systems (ISE)
www.ise.fraunhofer.de/de/presse-und-medien/presseinformationen/presseinformationen-2013/was-kostet-die-umwandlung-von-erneuerbaren-energien-in-strom

The Foundation for Science and Technology
www.foundation.org.uk

Global Energy Assessment
www.iiasa.ac.at/web/home/research/Flagship-Projects/Global-Energy-Assessment/Home-GEA.en.html

Natural Environment Research Council
www.nerc.ac.uk

The Royal Society
www.royalsociety.org

Science and Technology Facilities Council
www.stfc.ac.uk

The Technology Strategy Board
www.innovateuk.org

The UK Energy Research Centre: Presenting the Future
www.ukerc.ac.uk/support/article3514-Are-we-getting-better-at-predicting-future-electricity-generation-costs

US Energy: the New Reality
www.chathamhouse.org/publications/papers/view/191405

World Energy Council: Cost of Energy Technologies
www.worldenergy.org/publications/2013/world-energy-perspective-cost-of-energy-technologies

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