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1. The problem

At the 2013 Beesley Lecture on climate change policy[2], David Kennedy, Chief Executive of the Climate Change Commission (CCC), discussed the role of the Commission in providing support for promising but not-yet-economic technologies. The last CCC budget report identified these technologies as: wind power (especially off-shore wind), tidal range, geothermal, solar and potentially CCS (carbon capture and storage).
As described by David Kennedy, current CCC and government policy is to provide support for these technologies until they can float off into commercial operation without government support. But, what happens if they don't successfully graduate? *Who will pull the plug? When, how and on what basis?* David Kennedy was very clear that the policy was for the support plug to be pulled on unsuccessful technologies, but when, how and on what criteria was left very unclear. Based on previous experience, I – along with several others at the Lecture - was very sceptical that the public support plug would actually be pulled before a large volume of resources had been wasted on failed demonstration projects that should have been killed off a lot earlier.

This is far from a new problem. Back in 1985, David Henderson's Reith Lectures famously discussed Concorde and the AGR nuclear programme as probably the two most costly failed projects ever funded by government. Both were essentially demonstration projects on the basis of which the UK could develop new high-tech, export industries and which, like other similar projects, successfully saw off opposition and received continued support. It is worth noting that the same mantras about 'green jobs' and UK export potential are strongly associated with renewables policy, particularly offshore wind where some people have suggested that Britain has the potential to build a world-leading industry.

2. Climate change and demonstration projects

As explained by David Kennedy, current UK climate change policy is based to a considerable extent on promoting nominated technologies that are supported by a minimum price underpinned by contracts for differences (CfDs). The minimum price is a specified strike price and this strike price varies considerably by technology, depending on how close each technology is judged to be to commercial operation. For renewables, the support is intended to provide a protected test-bed for technologies that have reached the 'demonstration-project' stage – development rather than research.

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[1] CCRP, City University, London.

[2] George Yarrow, *Alternatives to wooden headedness: (much) less costly ways of regulating carbon emissions*, www.rpieurope.org

The degree of selectivity involved in the process is shown in the range of strike prices. These were announced by DECC on 6 December 2013 and range from £55/MWh for sewage gas to £305/MWh for wave power and tidal stream. Onshore wind has a strike price of £95/MWh up to 2017/18, falling to £90/MWh thereafter, while offshore wind has a strike price of £140/MWh. How have these prices been determined? There is reference to "… underpinning assumptions informed by the consultation responses ….", but the reality is that they were determined by informed guesswork on potential energy scenarios. Note that these underpinning assumptions include projections of future fossil-fuel prices. Future levels of these prices 25 or more years ahead are not only unknowable but are highly uncertain in direction as well as in magnitude.

So, if (say) offshore wind were still to require a significant level of strike-price subsidy after 2020, would the plug be pulled and the support be terminated for a failed technology? Or, would reasons be found to continue the support? David Kennedy said very clearly at the November 2013 Beesley Lecture that current policy was based on the plug being pulled and that this is definitely what was intended to happen. That may be the intention but historical evidence and standard political economy reasoning suggest that this was unlikely to happen.

The Government and the CCC can point to the Levy Control Framework as imposing a budget constraint on the level of renewables support. However, the £7.6bn cap for the support costs (at 2011-12 prices) is only settled for the period up to 2021. In addition, there is no legal or other reason why the cap couldn't be increased before 2020, let alone after. In practical terms, even without any change in government, this does not imply a genuinely hard budget constraint.

There are, of course, other problems with technology specific development programmes. One of the most obvious is that they skew support towards identified and currently known technologies and against the development of excluded and, in particular, currently unknown technologies. This is very important both in theory and in practice, but is not the main topic of this note.

3. Political economy and demonstration project funding

For R&D, there is a widespread view that research, particularly basic research, should – and has to be – very largely funded by governments (or specialist charities) rather than commercially. Conversely, there is general consensus that the development of near-market technologies and activities can and should be carried out by companies, including demonstration projects.

It should be noticed that much of the success of major high-tech research based companies (e.g. pharmaceutical and large IT and software companies) comes from their effective management of R&D *including the knowledge and experience of how to pull the plug on failed schemes.* Of course, there are programmes that were arguably stopped too soon – Xerox Labs and the development of the GUI interface are a classically quoted example. However, against that are

the many projects that, if development expenditure had continued, would have seriously weakened or bankrupted the company involved had they not been terminated sooner rather than later.

A share price discipline imposes hard budget constraints on companies that leads to a reasonably effective selection of which large projects to abort. The most successful pharmaceutical and IT companies are the ones that are most successful in avoiding major haemorrhaging of cash – and pull the plug sooner rather than later. The damage caused by not pulling the plug is illustrated by Nokia and the late abandonment of its delayed and uncompetitive smartphone software platform. Large projects can and do threaten companies with bankruptcy because of their scale relative to the company's asset base.

This pressure does not arise with publicly funded research. No country has had to appeal to the IMF or similar because of the costs of large demonstration projects. A few very large national defence projects and similar are increasingly funded on a multi-national basis so as to share the risks; but in general the scale of development expenditure does not seriously threaten the viability of national finances even for those projects. For the UK, even if all of the £7.6 billion assigned to renewables under the Levy Control had to be written off, this would not seriously jeopardise the UK's financial position or credit rating.

For publicly funded demonstration projects, not only are the financial incentives to terminate poorly performing projects much weaker than for companies, but there are additional incentives for continued funding beyond the point where any market test would suggest aborting. These incentives most often involve employment claims, frequently with references to jobs from potential export increases.

Demonstration projects are frequently based in relatively low wage and high unemployment areas. Hence the continuation of the project implies *both* the maintenance of existing high-quality jobs *and* the possibility (however remote) of future sustained employment once (should) the demonstration project prove successful – particularly if it were to increase net exports. As will be shown below, these arguments have typically been crucial for explaining why the funding of such projects has been maintained for far longer than any private company would have done.

Another set of reasons why publicly supported demonstration projects and similar are supported too long has to do with *reputation and optimism bias*. For publicly funded projects, bygones are often far from bygones. Where funding is stopped and project employees lose their jobs, there is a need for Governments and Ministers to admit that their choice was mistaken and that the failure of the project has wasted public funds that, in retrospect, could have been more usefully allocated elsewhere. Moreover, for novel projects, there is the issue that it is very difficult to find good comparator projects with which to control natural optimism biases.

The underlying mechanisms at work here are well demonstrated in Daniel Kahneman's discussion of a failed attempt at curriculum reform with which he was unhappily involved. He labels the failure to cut short a semi-doomed project as "irrational perseverance" where "…. Facing a choice, we gave up rationality rather than give up the enterprise". Hence, for publicly funded demonstration projects we frequently observe what Kahneman terms the "sunk cost fallacy[3]" and without any countervailing strong budget constraint. This combination is typically a major contributor to the inability to pull the plug on non-commercially funded demonstration projects.

4. Fluidised bed combustion: a classic energy demonstration project failure

Fluidised bed combustion (FBC) of coal is a technology that was pursued in various UK demonstration projects from 1960–1988, when public support for it was finally withdrawn. Development started under CEGB aegis in the 1960s with the increasingly active involvement of British Coal and the British Coal Research Establishment. Of course, both CEGB and British Coal operated as full-blown, nationalised industries throughout the period. Indeed, privatisation of the electricity industry and tougher budget constraints on British Coal were undoubtedly important in bringing the FBC demonstration programme to an end.

The main period over which the FBC development programme was pursued was 1974-84. It commenced in serious terms around 1960 but had languished in the pre-1973 period of low oil and gas prices; it was, however, strongly pursued after 1974 under the UK "Plan for Coal" programme. After 1974 there was additional support for it from the International Energy Agency plus US and German funding. The international contribution ended after the 1984 miners' strike. The post-1974 development work was focused on the Grimethorpe development facility which was closed in 1988.

I was very marginally involved in the discussions around the final closure of the project. During the period 1985-88 I was the economic adviser for employment related issues at the UK Treasury and so was asked to advise on whether further funding for this project should be given for employment-related reasons. The (recently established) British Coal Corporation (BCC) had applied for a £38 million grant to continue the development of the project. I was not enthusiastic.

I have a vivid memory of how the proponents of the scheme argued fervently that, in spite of 14 (if not 28) years of support, the project would become fully commercially successful and that it would create as well as maintain lots of jobs in high unemployment areas *if only* they could be given a further 4 years of funding. An appeal by the chairman of British Coal was made to the "… *potential* to develop an even higher efficiency of the PFBC … - *a uniquely British invention*" [my emphases].[4]

[3] See D. Kahneman "Thinking Fast and Slow", Chapter 23 and, in particular, p.247.

[4] Letter quoted in House of Commons debate on Grimethorpe FBC closure November 1988. See http://hansard.millbanksystems.com/commons/1988/nov/02/fluidised-bed-experiment-grimethorpe

The background was that the electricity industry was in the process of being privatised so that the grant application was put in by the BCC. In addition, by 1988, the BCC had rather tougher budgetary constraints – a requirement to break-even and to earn a 10% return on assets. Hence, the project could only continue with explicit tax support – which was refused. Given harder budget constraints, the (claimed) promise of 'jam tomorrow' was not sufficiently powerful to ensure continued funding as it had been before.

The main arguments presented in favour of grant support were to do with the long-term development of the coal industry and, in particular, the maintenance of current and long-term employment in coal mining areas. In November 1988, the MPs for the Barnsley mining areas called a House of Commons debate in which they argued for continued support. Their main arguments were that ending support would, firstly, allow the technology to go to other countries (from which we might have to buy it back); and, secondly, the need to maintain current and future employment in mining areas (particularly Barnsley and elsewhere in Yorkshire). There were some appeals to environmental benefits but these were not pushed hard.

In refusing the grant, the main argument of the responding Minister (Michael Spicer) was that the next stage of the work was near-commercial. The practicality of the technology was established and it was now up to the commercialised electricity and coal companies as to whether they wished to use it. If yes, fine; if not, so be it. As we now know it was not taken up; the Grimethorpe development facility was closed and the project died.

Interestingly, Michael Spicer referred in the debate to the cost and commercial superiority of large coal power stations fitted with FGD (flue gas desulphurisation) relative to the fluidised bed technologies. FGD had developed post-1945 outside the UK – in the USA and Japan. Maybe FGD would have been developed in the UK and possibly earlier if publicly funded research resources had not been focused so much on FBC. After all, the first coal power stations operating with FGD were built in the London area in the 1930s, although abandoned after 1940.

We cannot know what might otherwise have happened, but what does seem clear is that the FBC Grimethorpe research would probably have been terminated much earlier if it had been subject to real market tests and a genuinely hard budget constraint.

5. Concluding comments

Economic reasoning suggests that pulling the plug on demonstration projects commissioned and funded from outside the market process is extremely difficult. This is confirmed by historical experience as shown above.

The pressures not to cancel are even greater when demonstration project operators and advocates can cite major externalities as an additional reason for continued tax or equivalent support, as is the case with climate change. Given that – and the UK's legal obligations under

EU energy and climate change agreements, it is very difficult to expect that any of the recently approved renewables' demonstration projects would be ended within a reasonable period – at least not unless they were obviously total failures.

So, where does this leave the current UK policy on renewable electricity development, based on pre-identified tchnologies, of which offshore wind seems to be the leading candidate? The case for it is that it will help construct a commercially viable UK renewables manufacturing industry. One problem, however, is that this doesn't look very likely. (See, for instance, Jim Platts' trenchant and well-informed December 2013 article in The Conversation, setting out the case why offshore wind is unlikely to graduate to commercial viability.)

There is, of course, an alternative to the current policy. As several UK economists have suggested, it would be possible to put in place a carbon tax (or quantity equivalent) and let electricity generator companies decide on their chosen low-carbon development and investment expenditure against the tax–inclusive price. If government decided that additional support were needed for for renewables, it would be possible to create a technologically-neutral fund and invite bids for fixed period funding – or, similarly, to make more use of prizes.

These options (and variants) could create a market-based framework and provide incentives for companies to manage development possibilities and demonstration projects so that hard budget constraints were in place. In particular, this line of approach would provide genuine incentives to pull the plug on low efficiency/high cost options. The current Government and CCC approach based on non-market financed support of pre-approved technologies creates the opposite incentives for any company whose supported technology looks to be failing. For any DECC/CCC approved technology where the prospects are looking poor, we can expect repeated pleas on the lines of "Just three more years of support, please and there is a real possibility of major benefits to the UK and emissions – and don't forget the employment and export gains!"

Given those pleas, how likely is it that support for any failing technology would actually be terminated with less than 10-15 years support? Will governments be willing to impose genuinely hard budget constraints on these projects? I find it hard to believe that support for offshore wind would actually be terminated before 2025-30 if it fails to become cost efficient, particularly if some of its producers are in high unemployment areas.

I wouldn't put much money on that, but it's not up to me. Mesdames et messieurs, faites vos jeux – place your bets.