Nurturing UK cleantech enterprise

four steps to improve low carbon innovation

green alliance...

by Matthew Spencer and Paul Arwas

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Green Alliance
Green Alliance is a charity and independent think tank focused on ambitious leadership for the environment. We have a track record of over 30 years, working with the most influential leaders from the NGO and business communities. Our work generates new thinking and dialogue, and has increased political action and support for environmental solutions in the UK.

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Cover image: Aquamarine Power

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Matthew Spencer is director of Green Alliance. He has 25 years' experience of UK and international environmental issues. Prior to Green Alliance, Matthew was head of government affairs at the Carbon Trust, campaign director at Greenpeace UK and founder and chief executive of the renewable energy agency Regen SW, where he developed Wave Hub, the world's first proving ground for wave energy farms. Matthew was a member of the Renewables Advisory Board 2005-10 and currently sits on the Department of Energy and Climate Change's Carbon Capture and Storage Development Forum.

Paul Arwas has over 20 years' experience as a professional consultant in Europe and North America. He has a passion for innovation and issues related to climate change. As vice president of Arthur D Little, he was active in the company's energy and technology management practices as well as a member of its executive team for the UK business. Paul has run strategic reviews of low carbon technology innovation for the Committee on Climate Change, the former Department of Trade and Industry, the Department of Energy and Climate Change and the Department for Environment, Food and Rural Affairs. He was a leader of the programme of work that has revolutionised the way the UK manages low carbon technology innovation, as embodied by the new Technology Innovation Needs Assessment (TINA) process.

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Foreword

Mariana Mazzucato
Professor in science and technology policy at the University of Sussex

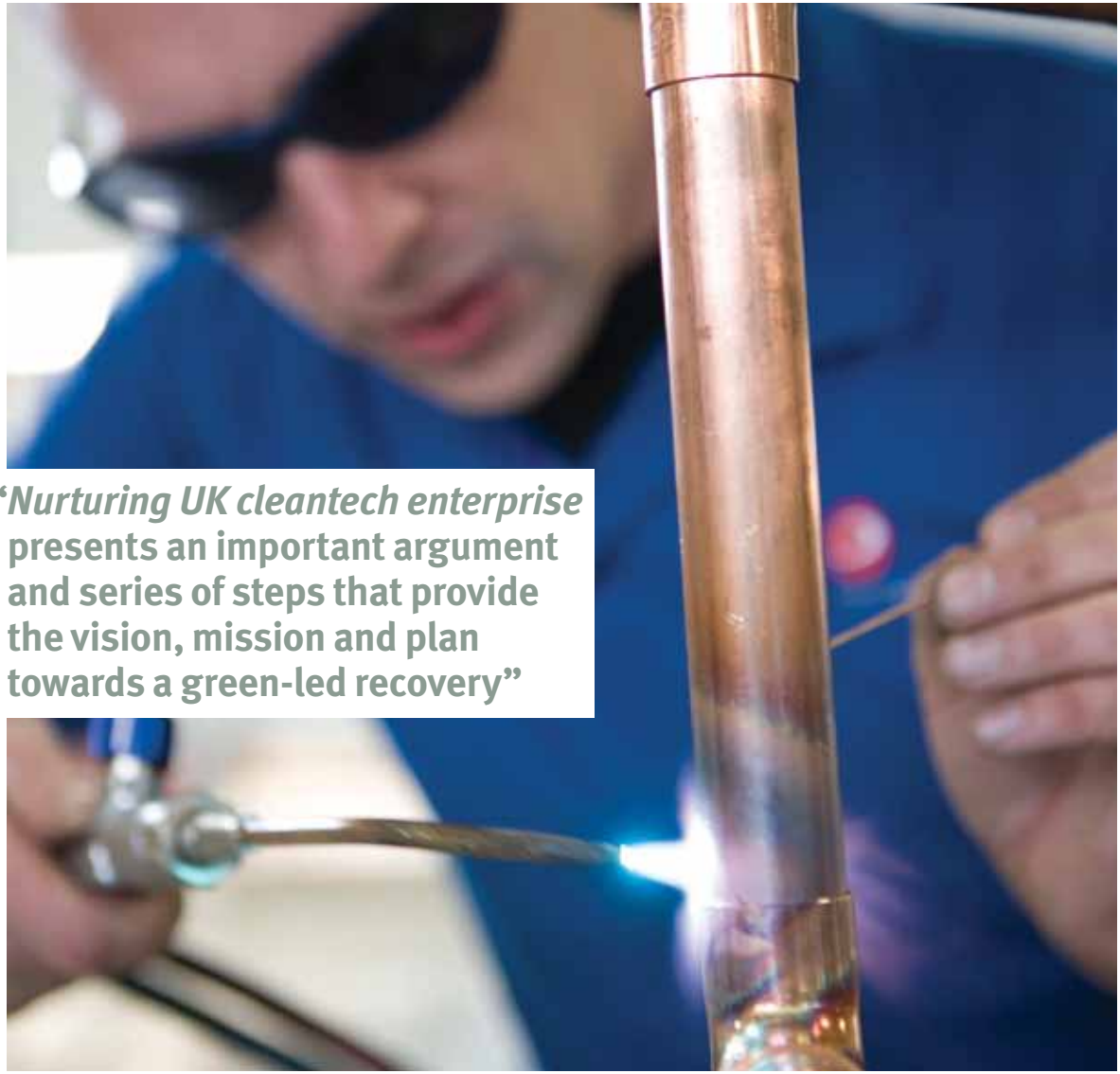
During a period in which economic growth is an urgent objective – by any means necessary – it is too easy to forget that there are concrete choices to be made on the types of investments and growth that can be achieved. Green investments can help to get the economy moving again, and do so in a way that makes it more sustainable. The fact that the spending multiplier is proven to be higher when investments are given a direction means that green is also an opportunity to bring together new industrial policy with macroeconomic growth objectives.

Indeed, green is starting to define the next technological revolution, which includes both the technologies and the direction through which all sectors are transformed, as they were with electricity and the internet. Those countries that make the early lead investments are not only the ones that will set the stage for others to follow, but that also create the excitement that attracts national and foreign firms to step up to the challenge. Because innovation is a cumulative process characterised by path-dependency and dynamic returns to scale, attracting investment today means potentially retaining competitive advantage in this new technological race for decades to come.

This pamphlet presents this challenge in a dynamic way, avoiding the usual static trade-offs: focusing on growth vs sustainability or spending on science vs commercialisation. The authors start off by acknowledging that, while there are major problems with the signals that UK businesses are receiving about the green direction, getting the signals right won't be enough. Both technology push and pull measures are needed. And it is the former that will have the most effect in allowing the UK to become a green leader in the long term, rather than just a follower.

Bringing technology push and pull strategies together into a dynamic strategy and plan requires a vision. Indeed, all missions that have driven technological races, from putting a man on the moon to the envisioning and funding of the internet, were ones that cannot be explained by market failure theory, ie through the 'wedge' between private and social returns which justifies policy intervention. The stakes – and the dreams that define them – are much broader, and there are private returns to be made, although not visible to all. Indeed, jobs (hence profits) in the UK are being lost today due to the lack of a green vision, as both GE and Vestas expressed eloquently recently.

Nurturing UK cleantech enterprise presents an important argument and series of steps that provide the vision, mission and plan towards a green-led recovery, as well as a basis for the UK's future competitive leadership. The four steps it proposes will help policy makers to catalyse and support the entire innovation cycle. Most importantly, it does so with a sense of excitement, which in the end is what makes the difference between good policy making which has an effect and run of the mill policies that don't.



"*Nurturing UK cleantech enterprise* presents an important argument and series of steps that provide the vision, mission and plan towards a green-led recovery"

source: Kensa Engineering

Executive summary

- Innovation is the only reliable route to economic prosperity in a crowded and resource constrained world. It is also the greatest ally in tackling climate and energy security because it produces the applied learning that drives down costs, and makes new technology attractive to use. Successful innovation could save the UK up to £160 billion in energy supply costs to 2050 and generate UK-based business activity contributing up to £89 billion to GDP over the same period.

- Critical to the UK's low carbon innovation performance is strengthening investor certainty in market 'pull' instruments which drive learning through deployment. But this will not be enough. There has been too little attention paid to technology 'push' support earlier in the innovation chain which is essential to bringing the benefits of new business activity, technology learning and cost reduction to the modernisation of the UK's energy, transport and buildings infrastructure.

- Successive governments have chopped and changed the institutions charged with technology development, spreading funding too thinly and lacking the focus and patience needed to get promising low carbon innovations through to the deployment phase.

- Financial markets are failing to provide funding for early stage cleantech companies with great innovation potential. Less than 30 early stage cleantech deals were made in the whole of the UK in 2011 from a pool of over a thousand start up or seed businesses seeking such finance from UK venture capital funds. As a result, start-up businesses are failing or growing slowly because of the lack of risk capital, and supply chains lack the competitive stimulus provided by new entrants. Without decisive action we risk losing a generation of new UK enterprises, importing more technology and paying too much to decarbonise our economy.

- Better technology push can be achieved at current levels of public spending. But it will require choices to be made about the focus of spending to avoid the tendency to 'spray and pray'. These will have to be made at arm's length from the political process to foster policy learning and ensure dispassionate decision making. Critically it requires the nurturing of institutions which can focus relentlessly on the obstacles to technology commercialisation over many years. It is hard and unglamorous work, but is the key to getting UK benefit from UK investment in the modernisation of our infrastructure.

This report identifies four practical steps to address to raise the UK's low carbon innovation performance:

1 Invest in existing public innovation institutions but focus on fewer technologies

The UK's three main political parties should undertake not to create any new energy innovation institutions in the next ten years, and government should commit to a minimum level of funding for existing institutions including the Technology Strategy Board, the Energy Technology Institute and the Carbon Trust for the same period. In return for

greater stability, the government should expect existing institutions to focus on the commercialisation of a smaller number of technology families. These should be those where the UK has significant competitive advantage and where the technology is likely to be critical to meet carbon budgets in the period to 2030.

2
Help small business to innovate

Approximately 70 per cent of the £1 billion R&D tax credit goes to large companies, and the suspicion is that much of it is paying for research by multinational companies which would happen anyway. At this point in the economic cycle, where many big companies are cash rich, switching a proportion of the funding from R&D tax credits to early stage cleantech funding for smaller business would be a better use of public money. **Ten per cent of the R&D tax credit cost should be redirected to a £100 million early stage UK green venture capital fund.** This could be disbursed by an existing innovation organisation, or an existing specialist private fund manager, who would be given a strict remit to invest in early stage UK cleantech businesses.

3
Provide open access to data from all publicly funded projects

When public money is spent on research, the knowledge created is usually published in scientific journals and, therefore, a public good is created because others can use its insights. The same is not true, generally, of public spending on low carbon development. Only a sixth of projects supported by the Department of Energy and Climate Change's largest technology development programme have published full technical data. **It should be a requirement of funding that all performance data of technology development created with public investment should be placed in the public domain.**

4
Support technology experimentation in deployment

Our final proposal is to **redirect a small proportion of the huge low carbon energy deployment funding invested in offshore wind into new technology development via a 'requirement to experiment'.** The deployment of offshore wind will involve capital expenditure of around £50 billion up to 2020. New and improved turbines, foundations and installation methods, as well as a more developed and competitive supply chain, are all crucial to reducing costs. Encouraging developers to work with new equipment and new suppliers at the testing stage will accelerate learning and cost reduction. The requirement to experiment could be enacted rapidly either through programme agreements where the government is the landlord or through the consent system.

Chapter 1
The need to improve UK low carbon innovation

Innovation is the only reliable route to economic prosperity in a crowded and resource constrained world. It is also the greatest ally in tackling climate and energy security because it produces the applied learning that drives down costs, and makes new technology attractive to use. It will fuel the new business growth and economic dynamism that the UK needs to strengthen and rebalance its economy.

Much of the current debate about decarbonisation in the UK is about how to improve the confidence that business and investors have in low carbon deployment programmes. We share the view that strengthening certainty in market 'pull' instruments will be critical to the UK's innovation performance. But it will not be enough. There has been too little attention paid to technology 'push' support earlier in the innovation chain which is essential to bringing the benefits of new business activity, technology learning and cost reduction into deployment programmes.

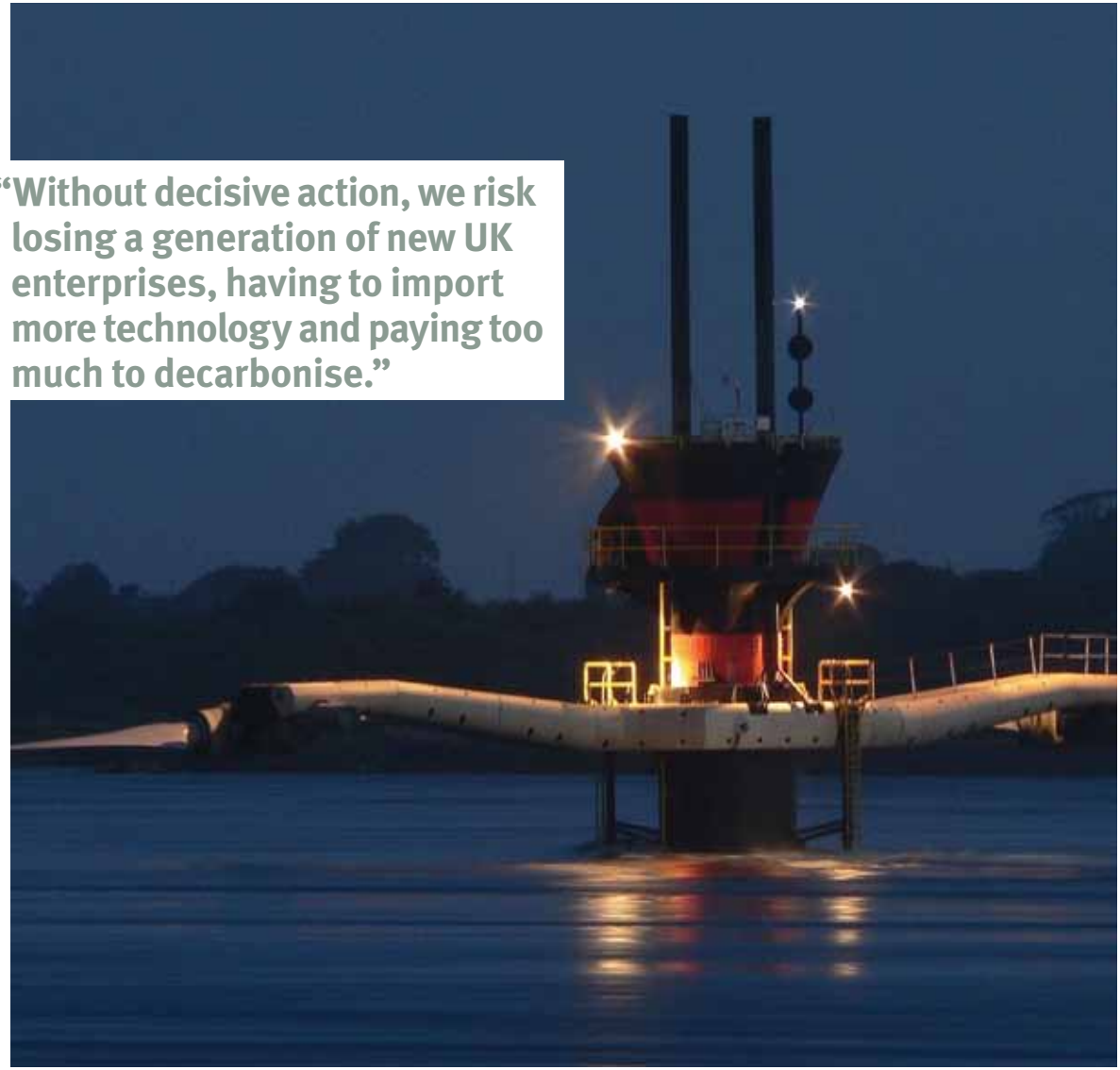
The cleantech business sector is a UK success story, now employing more people than the telecoms sector and exporting strongly. However, its steady growth is largely driven by market demand policies here and abroad. This disguises weak research and development activity, a financing crisis for promising new businesses and missed opportunities for stronger growth.

Successive governments have exacerbated these weaknesses by chopping and changing the institutions charged with technology push, and by lacking the focus needed to support the commercialisation of low carbon technology. Without decisive action, we risk losing a generation of new UK enterprises, having to import more technology and paying too much to decarbonise our energy system.

Bridging the gap between the early development and the commercial deployment of new low carbon services and technology is the key to innovation success. The direct economic benefit of getting innovation right is large. Analysis of government data across just four low carbon areas (offshore wind, marine energy, carbon capture and storage and electricity networks) suggests that successful innovation could save the UK up to £160 billion in deployment costs to 2050 and generate UK-based business activity contributing up to £89 billion to GDP over the same period.[1]

Better technology development can be done at current levels of public spending. But it will require a longer term approach to nurture learning in small as well as large business, much greater public ambition, a focus on the UK's competitive strengths, and relentless attention to the barriers to better innovation performance. We believe that improving the UK's innovation performance is about fostering learning in policy making, creating and preserving an environment that allows good choices and excellent, steadfast execution of programmes. Here, we describe the current challenges for low carbon technology development and suggest practical steps for the UK to raise its game.

“Without decisive action, we risk losing a generation of new UK enterprises, having to import more technology and paying too much to decarbonise.”



source: Siemens

Chapter 2
Push and pull

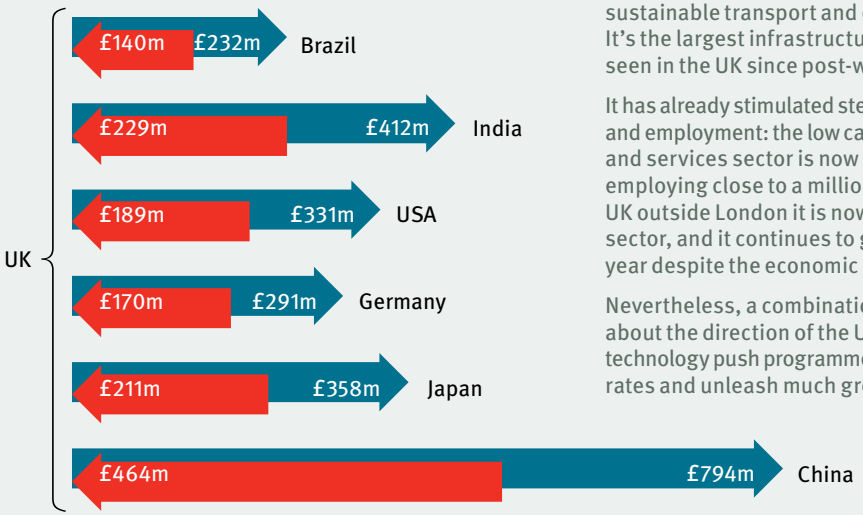
"There has been a high degree of consensus in UK politics that low carbon innovation is something that requires policy support."

source: ACAL Energy

What drives low carbon innovation?

There is vigorous debate between academics and business thinkers about whether the principal driver for innovation in business is the private sector's search for profits or the interaction between public policy and private endeavour.[2] This debate is less polarised for the low carbon sector because both the centre right and the centre left accept that the state has a critical role in facilitating the displacement of high carbon energy in existing markets, and that it can justify policy intervention on the grounds of market failure and public benefit. As a result there has been a high degree of consensus in UK politics that low carbon innovation is something that requires policy support. This has been delivered through a combination of powerful market pull mechanisms – including direct financial incentives for low carbon energy supply and energy saving, carbon pricing, and product and building standards – and through a variety of smaller technology push mechanisms such as R&D tax credits, business incubation services and public grant programmes.

UK green exports exceed imports from competitors[3]



The business opportunity

The Committee on Climate Change estimates that the UK currently spends approximately £5 billion per year on market pull mechanisms for low carbon energy generation, sustainable transport and energy efficiency in buildings.[4] It's the largest infrastructure modernisation programme seen in the UK since post-war reconstruction.

It has already stimulated steady growth in business activity and employment: the low carbon and environmental goods and services sector is now made up of over 50,000 firms employing close to a million people.[5] In all regions of the UK outside London it is now bigger than the telecoms sector, and it continues to grow at around four per cent a year despite the economic downturn.

Nevertheless, a combination of more policy certainty about the direction of the UK's energy policy and a strong technology push programme would stimulate higher growth rates and unleash much greater business innovation.

The need for technology push as well as market pull

The ICT revolution has given many people a distorted view of the time it takes to commercialise new technologies. It may take only a few years for a new smart phone to go from concept to widespread uptake, but for energy technology it takes over two decades to get from invention to significant levels of market deployment. A study by Chatham House indicated that, historically, the cleantech ideas patented by large multinational firms have taken an average of 24 years to reach the mass market.[6]

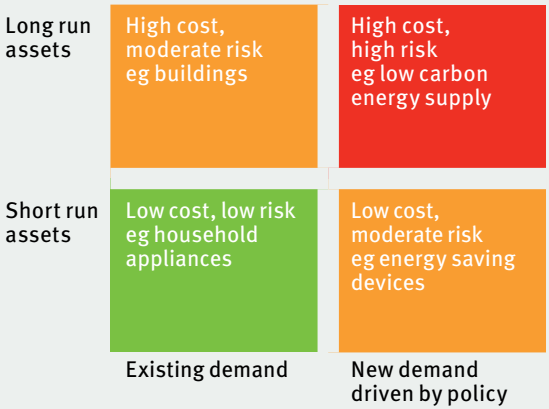
"The market risk for low carbon is that there will be no or low demand for clean energy in the future in the absence of effective public policy."

The graph right illustrates the contrast between the cost reduction journey for onshore wind compared to the much shorter typical time span for commercialising a web-based business and the life of a typical closed-end venture capital (VC) fund. This partly reflects the slow turnover of energy assets, their high capital costs and the regulatory 'lock in' that can occur around incumbent technologies.

Asset risk profiles

The nature of the commercialisation challenge varies from one low carbon asset class to another, because of differences in asset time scale and market risk, as illustrated below. It is particularly pronounced in clean energy technology development. This is due to the long life of many energy assets and the difficulty of generating confidence in policy driven demand over long time scales. It has been exacerbated by the economic crisis which has led to a lower appetite for risk amongst investors; and by conflicting signals from the UK government about the direction of energy policy. Many of the arguments presented here apply across these asset classes but the majority of the recommendations apply to high capital and high market risk assets, such as low carbon energy supply technology, because it is the greatest innovation challenge.

Market risk profiles for distinct low carbon assets

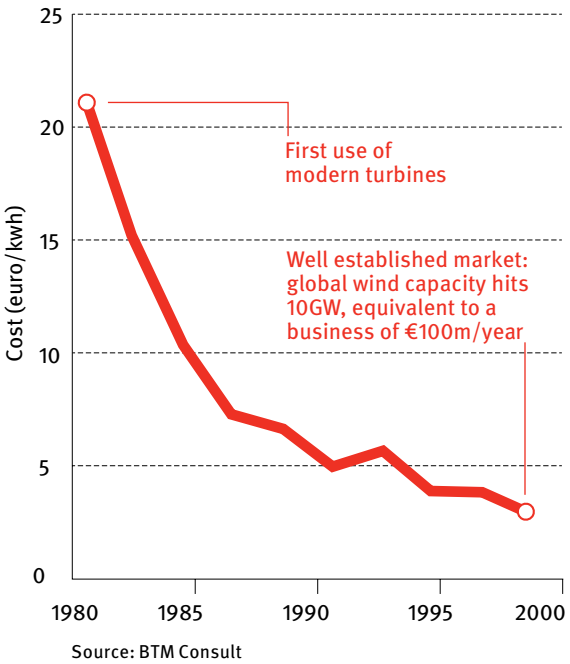


When an oil industry executive was asked why his company was prepared to invest billions of dollars in projects that would not come to fruition for ten or more years, he replied that he knew that 500 million people a day would get in their cars and use fuel. A clean energy investor cannot have the same confidence in future markets because they are largely driven by public policy. The market risk for low carbon is that there will be no or low demand for clean energy in the future because governments are sovereign and policy can change.

These risks can be partly mitigated in well designed deployment programmes if governments are willing to tie themselves and their citizens into long term incentive schemes, and make them bankable through legal contracts. This is the rationale for introducing contracts for low carbon power generation in the UK's reform of its electricity markets. The expectation is that reducing market risk will reduce the cost of delivering a fleet of new low carbon power stations.

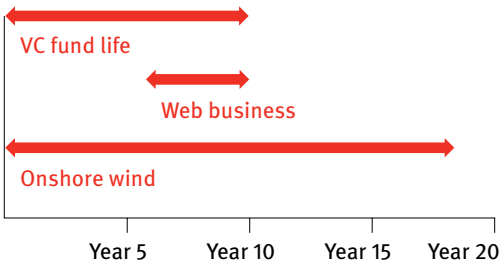
While well designed market pull policy can benefit those businesses with projects and technologies that are ready to deploy, the timescales involved in getting new technologies and businesses to maturity lead to low confidence further up the innovation chain. Early stage investors have little certainty that demand for clean energy will be growing in ten or twenty years, let alone that their business offer will be competitive in meeting such demand. The function of technology push programmes should be to overcome this inherent lack of certainty about the future for early stage clean energy enterprise, and so bridge the commercialisation gap to mass deployment.

Onshore wind cost evolution



Source: BTM Consult

Typical life of a VC fund compared with the commercialisation time of a web based business vs onshore wind



Chapter 3
The commercialisation gap

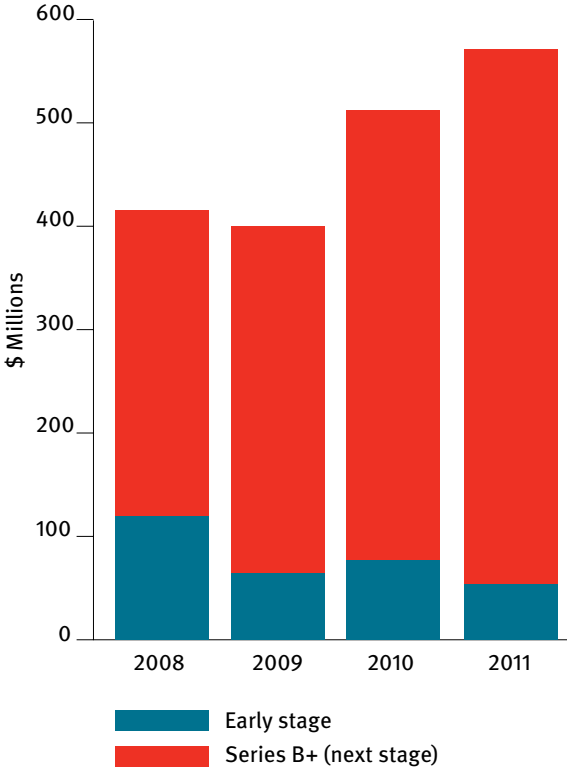
Financial markets are failing to provide finance to early stage cleantech companies with great innovation potential. Although economic theory suggests that, in a slump, new entrepreneurs should benefit from 'creative destruction' and find it easier to access financial and human capital.[7] The strongest empirical evidence for the impact of the financing gap comes from data on VC investment.

"Start-up businesses are failing or growing slowly because of the lack of risk capital."

Bloomberg New Energy Finance (BNEF) data indicates that total investment in early stage business by VC funds continues to fall, with a 21 per cent decline in 2011.[8] Even specialist cleantech fund managers have stopped funding early stage businesses as their investors move upstream to lower risk, post-profit businesses. Less than 30 early stage cleantech deals were made in the whole of the UK in 2011 from a pool of over a thousand start up or seed businesses seeking such finance from UK VC funds.[9]

As a result, start-up businesses are failing or growing slowly because of the lack of risk capital, and supply chains lack the competitive stimulus provided by new entrants. The paradox is that we risk losing a generation of promising cleantech enterprises at time when money has never been cheaper and during a boom in the market for low carbon and environmental goods and services.

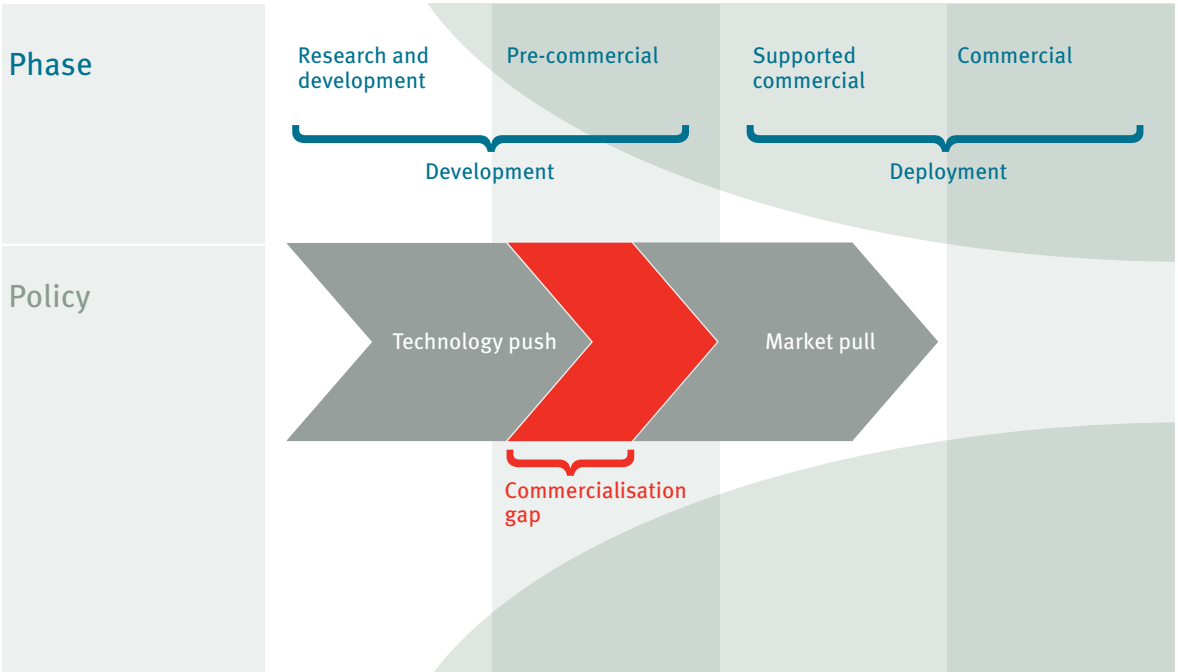
UK cleantech VC investment trends



Source: Cleantech Group

“We risk losing a generation of promising cleantech enterprises at time when money has never been cheaper and during a boom in the market for low carbon and environmental goods and services.”

The innovation funnel



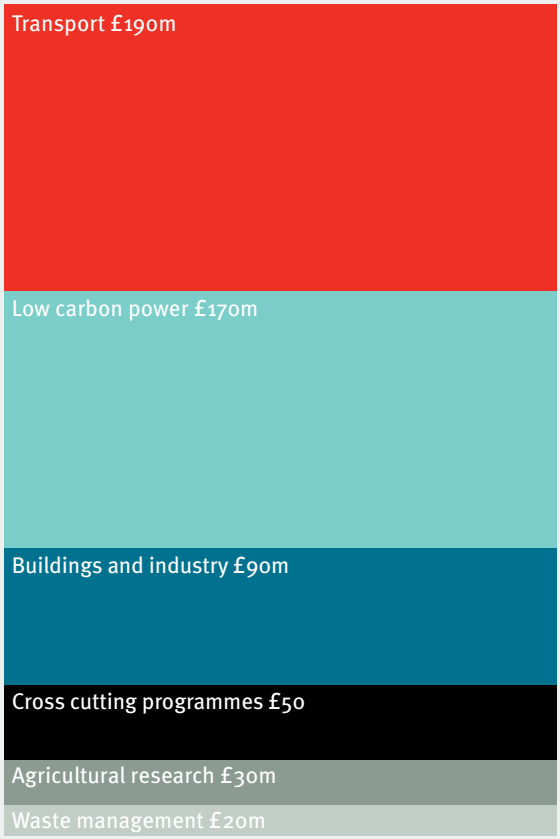
Public spending on low carbon technology innovation

The Committee on Climate Change estimates that public spending on low carbon technology RD&D (technology push) was approximately £550 million in 2009-10, compared to around £5 billion a year for deployment support (market pull).

This innovation investment is disbursed directly by five government departments: Communities and Local Government, the Department for Transport, the Department for Environment, Food and Rural Affairs, the Department for Business, Innovation and Skills and the Department of Energy and Climate Change; also through the devolved administrations, research councils, and specialist innovation organisations such as the Technology Strategy Board, the Zero Carbon Hub, the Energy Technology Institutes, the Carbon Trust and the Catapult centres.

Such diversity of sources could be a strength if funding levels were high but data from the International Energy Agency (IEA) suggests that the UK under-invests in energy RD&D and, combined with a lack of focus on particular technologies, this has led to funding being spread too thinly.[10] For example, offshore renewable energy Catapult funding of £50 million over five years will be spread across three organisations and three technologies (wind, wave and tidal energy), and looks underfunded compared to the German Fraunhofer institutes on which it is based. The Fraunhofer Institute for Wind Energy and Energy System Technology had an annual budget of £17.8 million (€22 million) in 2010.[11]

UK technology push public spending



Chapter 4
Four steps to better innovation

The UK has much to celebrate and build on. It has a diverse and growing cleantech sector, a strong academic research base, a new Green Investment Bank set up to de-risk low carbon infrastructure projects, and good innovations agencies with years of collective experience at commercialising new technologies. Crucially, it has ambitious commitments to deploy renewable energy, carbon capture and storage, electric vehicles and energy efficiency, which are driving business growth and providing incentives for innovation.

While these programmes have suffered recently from political uncertainty, the government could restore confidence and increase their innovation impact relatively quickly by locking in their commitments through legislation.

The chronic issue is lack of ambition to translate these strengths into world beating innovation, a reluctance to commit to technology development over the long term and the lack of focus on the technologies and businesses with the greatest potential to grow.

Four steps to address these weaknesses and raise the UK's innovation performance are set out on the following pages. They are informed by a common set of observations about innovation policy:

- it is extremely hard to get right; therefore, policy learning and innovation capability should be fostered actively;
- it requires choices to be made about the focus of spending to avoid the tendency to 'spray and pray';
- choices are best made at arm's length from the political process to ensure hard-headed decision making, and protection from political cycles;
- success requires the removal of specific obstacles to progress; it is hard and unglamorous work which requires steady efforts to improve performance over many years.

Step 1
Invest in existing public innovation institutions but focus on fewer technologies

As Mariana Mazzucato highlighted in her analysis of US pharmaceutical and ICT performance *The entrepreneurial state*, there was a long term public innovation programme behind many of the most successful businesses, such as Intel and Google. The US federal government funded the underlying innovation through a small number of specialist public institutions over many decades.

In contrast, the history of the UK's approach to low carbon innovation is one of constant change and reinvention. For instance, the previous Labour government created three new organisations: the Carbon Trust, the Technology Strategy Board and the Energy Technology Institute, and the Coalition government has added a fourth in the form of Catapult centres (see timeline below). There can be strength in such diversity, but these organisations have rarely had the funding stability to run long term commercialisation programmes to match the timescales needed for energy innovation. Too often institutions have spent three to five years building capability and knowledge to work effectively, only to see funding cut just as the fruits of that capability and knowledge begin to be borne. To make greater impact institutions need more stability and predictability in their funding.

Our first recommendation is, therefore, that the UK's three main political parties undertake not to create any new energy innovation institutions in the next ten years, that the government commits to a minimum level of funding for existing bodies over the same period, and that any further funding is allocated by competition between them. This will not require any increase in public funding. The role of government departments should be to bring greater clarity to the long term innovation outcomes sought. In return for greater stability, the

Timeline of UK low carbon development programmes and reviews

2001

Carbon Trust established

2007

July
Technology Strategy Board created

September
Energy Technology Institute set up

2010

June
National Audit Office publishes *Government funding for developing renewable energy technologies*

government should expect the institutions to focus on the commercialisation of a smaller number of technology families. These should be those where the UK has significant competitive advantage and where the technology is likely to be critical to meet carbon budgets in the period to 2030. The Carbon Trust laid out one way of making this assessment in its report *Focus for success* which has been taken forward by the Low Carbon Technology Needs Assessments.[12]

> **"To make greater impact institutions need more stability and predictability in their funding."**

An important benefit of having institutions outside government to nurture the development of specific low carbon technology families is to mitigate the risk of what Dieter Helm has called the 'climate change pork barrel'.[13] This is where companies lobby for support for technology from the taxpayer that they don't really need. Institutions accountable for low carbon outcomes, with strong analytical capability but no direct political interest, are much more capable of making hard-headed decisions about funding need than government departments subject to political pressure and manoeuvring.

2011

July
Committee on Climate Change publishes *Building a low carbon economy – the UK's innovation challenge*

October
Government announces £200 million for new Catapult centres

November
Public Accounts Committee publishes *Funding the development of renewable energy technologies*

November
DECC announces it will not provide more core funding to the Carbon Trust beyond 2011-12

December
Government publishes *Review of the low carbon innovation delivery landscape*

Step 2
Help small businesses to innovate

The R&D tax credit is the biggest government incentive to business innovation but it is a scattergun approach to dealing with market failure, and its cost effectiveness is questionable.[14] Approximately 70 per cent of the £1 billion R&D tax credit goes to large companies, and the suspicion is that much of it is paying for research in multinational companies that would happen without it.

The small proportion that goes to low carbon research appears to have very little leverage and high deadweight costs. The Committee on Climate Change has estimated that the R&D tax credit might generate an additional £7 million in low carbon R&D for a cost of £20 million in lost tax revenue.[15]

"We recommend that ten per cent of the UK's R&D tax credit cost is redirected to a £100 million early stage UK green VC fund."

At this point in the economic cycle, where many big companies are cash rich, switching a proportion of the funding from R&D tax credits to early stage cleantech funding would be a better use of public money. Venture capital appears to be particularly important for the UK's cleantech sector which is more reliant on smaller firms, and where larger companies do not appear to be as active at patenting technologies.[16] We recommend that ten per cent of the UK's R&D tax credit cost is redirected to a £100 million early stage UK green VC fund.

While public VC co-investment can't replace existing grants for the highest risk technology demonstration, such as wave and tidal, it can play a significant role, particularly for new energy efficiency products and services. Unlike grants, it provides a direct public benefit from public investment when the investment leads to a successful exit. A £100 million VC fund would double the size of the current UK early stage cleantech VC market and be big enough to follow on early stage deals, allowing the fund to be self-sustaining. This would not require a new institution to be set up as it could be disbursed by an existing innovation organisation, or an existing specialist private fund manager, who would be given a strict remit to invest in early stage UK cleantech businesses.

Step 3
Provide open access to data from all publicly funded projects

When public money is spent on research, the knowledge created is usually published in scientific journals and, therefore, a public good is created because others can use its insights. The same is not true, generally, of public spending on low carbon development. An examination of DECC's technology development programme shows both best practice in some areas, notably the publication of front end engineering studies from the CCS competition, and some very patchy or partial publication of data. A review of the recent Environmental Transformation Fund projects demonstrated that:

- results are not always published promptly, eg data from the 2004 Bio-energy Capital Grants Scheme has yet to be released;
- signposting of the information is poor with only a third of programmes giving clear information links and a full listing of all projects; eg only two of the four projects in the anaerobic digestion demonstration programme have published case studies;
- only a sixth of programmes published full technical data; this is a very low proportion even allowing for the fact that some projects are yet to be completed; eg the hydrogen fuel cell demonstration programme has published only one technical report from four projects supported.

Often, commercial sensitivity is claimed as a reason for not publishing data promptly and in full. Clearly, proprietary technical secrets cannot be published. However, it seems desirable and reasonable to expect that all performance data created with public investment should be in the public domain.

"It seems desirable and reasonable to expect that all performance data created with public investment should be in the public domain."

The benefits of this are likely to be significant. Almost all the literature points to the importance of learning by doing in the development and commercialisation phase. Promptly publishing good quality data on how a technology performs will speed up the learning process by widening knowledge and helping investors, developers and customers to make better, more informed choices.

Step 4
Support technology experimentation in deployment

Our final proposal is to redirect a small proportion of the huge low carbon energy deployment funding being invested in offshore wind into new technology development via a 'requirement to experiment'.

The deployment of offshore wind will involve capital expenditure of around £50 billion up to 2020.[17] It is critical that the cost of offshore wind is driven down to make sure it is affordable. New and improved turbines, foundations and installation methods, as well as a more developed and competitive supply chain, are all crucial to reducing costs. Encouraging developers to work with new equipment and new suppliers at the testing stage will accelerate learning and cost reduction.

This could be achieved by establishing a requirement for offshore wind developers to test equipment and methods still at the development or pre-commercial stage.

The scale of the obligation on project developers should be large enough to make a difference, but small enough not to impact project economies adversely. For example, if a new 100 turbine offshore wind farm tried out new technologies on two of its turbines that cost 50 per cent more than the standard turbine, the project cost would only increase by one per cent. This would materially increase the amount of testing and demonstration effort, which is a critical part of technology commercialisation and is often difficult to fund. The overall cost to consumers will still be capped by the Levy Control Framework so there will be no extra cost passed on, just a slight short term reduction in the amount of deployment delivered for each pound of subsidy. However, since a pound invested in the commercialisation of new technologies typically saves £5-£10 within three to five years as new innovation brings down total costs, this should speed up deployment over the medium term.

The decision about which innovations are supported should be made by the developers themselves acting in concert with an innovations institution holding the ring to ensure fair play. A good example of this is the Offshore Wind Accelerator where the Carbon Trust has convened all the key offshore wind developers to formulate and then co-fund a programme of technology commercialisation. Looping developers into the decision about which innovations to support will ensure hard-headed, practical decisions are taken with partners able to deploy at scale when the time is right.

This could be enacted either through programme agreements where the government is the landlord or through the consent system where it is not. It avoids the need for a new mechanism or instrument to be enacted, and allows experimentation to begin quickly and with limited bureaucracy.

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