RSA Projects

// INTELLIGENT PUBLIC SERVICES // AND AN INTERCONNECTED // INNOVATIVE AND SUSTAINABLE SOCIETY // TECHNOLOGY IN A COLD CLIMATE //

BY JAMIE YOUNG

RSA Projects

TECHNOLOGY IN A COLD CLIMATE //

BY JAMIE YOUNG

About the RSA//
The RSA's central belief is its faith in the power of civic action. At the heart of the RSA's mission is the desire to bridge the social aspiration gap: the gap between the society people say they want and the way they behave. Our principal challenge is to develop a dynamic, credible and persuasive account of what the future citizen needs to be if we are to deliver the world we want.

The RSA engages practitioners and thinkers in concrete, practical action and the development of ideas aimed at creating the kind of state, civic and commercial institutions we need to enable active citizenship.

The Royal Society for the encouragement of Arts, Manufactures and Commerce
8 John Adam Street
London WC2N 6EZ
T +44 (0)20 7930 5115
www.theRSA.org

Registered as a charity in England and Wales no. 212424

The RSA is an Enlightenment organisation devoted to finding innovative practical solutions to today's pressing social problems. Through its 27,000-strong Fellowship it pursues its mission: to help people be the people they need to be to see the change they want in the world.

The citizens of the future will need to be self-reliant, engaged and other-regarding if they are to create a principled and prosperous society.

More information can be found at the RSA website:
www.theRSA.org.uk

With many thanks //
To those involved in steering the project: Julian David, Sam Gaudois, Carrie Hartnell, Ben Hammersley, John Higgins, William Higham, Tom Hockaday, Ian Hosking, Aled Jones, Patrik Karrberg, Jonathan Liebenau, Garry Miller, Andy Naish and Tristan Wilkinson.

To the authors that contributed academic research papers: Peter Edwards, John Farrington, Jeremy Howells, Helen Margetts, Dennis Pamlin and Sarah Skerratt.

To those who spoke at the symposium: Stephen Timms for delivering the keynote speech, and Ben Hammersley, William Heath, Luke Johnson and Kevin Smith for joining the panel discussion.

To those who facilitated seminars during the symposium or responded to the authors: Katherine Corrick, Julian David, Emma Fryer, Nick Leon, Jonathan Liebenau, Jeff Masters, Garry Miller, Richard Miller, Jeremy Oates, Jonty Oliff-Cooper and Graham Walker.

To all who attended the symposium and contributed their time and expertise.

To Intellect and their members who kindly funded this project.

FOREWORD //

It is time for a new kind of innovation. The shock-waves caused by the credit crunch are gradually receding from the private sector, but in their place they are leaving a massive public deficit, high unemployment, and a generation of young people that are disconnected from the economy. This could be more than a "cold snap" – many believe it to be the start of a long chilly climate. We are not simply facing the short term costs of an economic downturn, but the consequences of an ageing, unsustainably consuming and carbon-dependent society.

It is an absolute imperative that we innovate our way out of the recession. However the right question is not simply whether we should be innovating, rather, to what purpose are we innovating?

The present cold snap should indeed make governments, businesses and charities furiously innovative; generating creative new ideas by the bucket-load, then testing them and refining the ones that don't work out. At the beginning of 2010 we are in a good place to innovate - knowing more than we ever have about how new ideas are successfully introduced.

We know for example that innovation be led by an entrepreneur, someone with a vision like James Dyson, or by an existing business, such as ARM who leverage intellectual property to great effect. Sometimes it is led by individuals who customise the things they buy, like the first mountain bikes or extreme surf-boards. Or innovation can be described by the effect it has on the market; sometimes it leads to a sustaining, incremental improvement and sometimes to disruptive and radical change. Over the last few years we have also realised the value of innovation clusters; silicon valley in California, silicon fen in East Anglia and now silicon round-about in Clerkenwell.

How do we put this knowledge to use? What sort of society are we innovating towards? Wealth creation is usually the incentive behind much innovation in the private sector. While there is nothing wrong with this, it has become abundantly clear that wealth creation and economic measures of success alone are insufficient to create the world to which we aspire. When innovation becomes detached from its wider purpose it can cause problems. The financial services became a hot-bed of service-economy innovation in recent years, but the creativity behind collateralised debt obligations and credit-default swaps failed to satisfy the longer term purposes of society. As we enter double figures in the new millennium it is time for a new level of purposive innovation.

Nicolas Sarkozy recently commissioned Joseph Stiglitz and Amartya Sen to explore a new measure of a nation's performance that would take into account not just GDP but other factors such as environmental protection and work/life balance. Speaking before a G20 summit last year the President said "The crisis doesn't only make us free to imagine other models, another future, another world. It obliges us to do so". Such concerns are not only exhibited by world leaders, but mirrored in today's graduates, who are no longer content to work for organisations simply motivated by financial gain. One poll shows that 35% of graduates polled by Fujitsu Siemens would reject a job offer from a company whose ethics did not live up to their own stringent standards.

During this short project, the RSA has explored some of the innovations and inventions that satisfy more than simply economic criteria. The UK's information and communication technology sector is the ideal lens through which to look at the future of innovation; they contribute a large segment of the UK's economy and employ one million people, many of whom are incredibly innovative individuals. Among the innovations contained in this report are technologies that could give us one of the best chances we might have in mitigating anthropogenic climate change, help us care for the booming number of citizens that are approaching old age, and enable everyone from individual home-owners to world leaders and international negotiators to make more informed and longer term decisions about our communities, health and impact on the environment.

The recession is the best chance we will have to turn society on its head, to ask difficult questions, and to work together to create the world we want. We know that we need to innovate, but we need to be innovating in the right direction – it's time for purposive innovation.

Matthew Taylor

CONTENTS//

1. EXECUTIVE SUMMARY //

The UK faces severe challenges that manifest themselves in the short term in a cold economic climate, in which unemployment is high and a large government deficit threatens to reduce public sector spending. Furthermore, in the medium term other trends such as a rising, ageing and unsustainably developing population are likely to lead to global problems: food, water and energy shortages. The effects of anthropogenic climate change will almost certainly compound these threats. Together such challenges point towards an uncertain period in which resources are scarce and the threat of hardship looms large.

We suggest that in difficult times, the most valuable technological innovations are those that are versatile, purposive and enable society to become parsimonious and decentralised.

Versatile

The diversity of the challenges we face, encompassing issues from making savings in the cost of law enforcement to dramatically cutting carbon emissions, indicates that we need generic technologies that allow a range of outcomes to be accomplished using the same tools. Rather than specific inventions, ICT is one such "general purpose" technology which is sufficiently versatile to contribute to solving social, economic and environmental problems.

ICT can be used to raise levels of social capital, by joining people and communities through collaborative community websites that deal with issues from parenting[1] to healthcare[2]. ICT could also transform supply chains of energy and other resources by connecting sensors and intelligent devices together, creating "smart grids".

Although ICT promises great things, it appears that the full benefits are not yet being felt across the UK due to a combination of skills, culture and technical infrastructure. While broadband is widely available, take up by individuals is not yet universal and small businesses have been slow to capitalise on the potential. In addition, the copper cables that form broadband's current

[1] See http://www.mumsnet.com/
[2] See http://www.patientopinion.org.uk/

infrastructure would need upgrading in order to carry sufficient data for the most effective applications – such as high definition video conferencing – to be used to their full social and environmental effect.

Purposive
The cold climate requires a greater level of purposive technological innovation in the public and private sectors. Purposive innovation would take into account the full range of challenges that we face; creating new solutions that do not simply mitigate short term economic problems, but the enormous social and environmental problems that we all face.

Technological innovation could help mitigate climate change, but recent measures have favoured short term economic gains with seeming less thought to possible environmental gains. A clearer understanding between government and private sector over the technologies and markets required in the future is critical.

The UK has had many good innovation policies in the past, including a number of ground-breaking initiatives, though they have not always been effectively enforced. However there are notable gaps in innovation policy. The public and private sector, for example, invest much lower amounts in research and development than comparative economies. In addition, the UK is particularly weak at growing small or medium businesses into large ones.

Parsimonious
The cold climate requires us to be parsimonious, with public money and with natural resources. Efforts to reduce the government's deficit will make the public sector subject to a squeeze on spending. This could be achieved in some cases by using the internet more effectively, for example increasing the amount of public services delivered online. Research estimates that developing a facility to allow people to apply for Job Seekers Allowance online could save £100 million annually. However the UK's public sector has a poor record of using ICT, resulting in unusually large contracts and missed targets, which is likely to come under increased scrutiny in a cold economic climate.

Other applications of ICT could help society adopt much more sustainable patterns. For example, high speed connectivity could allow energy-intensive activities such as commuting to be replaced with high definition video conferencing. More transformative changes could be brought about as more devices become capable of connecting to the internet, and as electronic sensors miniaturise. This combination of sensors and ICT could allow many more companies to switch from selling their products via an ownership model, to leasing them as a more environmentally sustainable service.

Decentralised
Encouraging and empowering individuals to play their own part in the face of the challenges ahead will be vital; individuals and communities will need to become

more engaged with the big challenges and more self-reliant in a period of uncertainty and possible hardship. As already noted, ICT can join people together, but it's great benefit is being able to dissolve distances and harness the power of many people.

An early example of this would include online public services that use web 2.0 features in the way that commercial sites like Amazon.com use them to harness people's collective knowledge and experience, sharing advice and pointing forward to how public services could be further developed. Such social media (and the ICT that carries it) could also be used to co-produce public services at a deeper level, in the way illustrated by volunteer and third sector organisations like MySociety and Rewired State who re-publish public sector data in innovative and useful ways.

As more public sector organisations release their data and people find new ways to tailor and publish it to individuals, new opportunities for communicating that data open up. Providing data in real-time through mobile devices could lead to much more effective ways to encourage and enable people to adopt new behaviours in response.
The development of augmented reality applications for smart phones could be the forerunners of this.

2. KEY FINDINGS & RECOMMENDATIONS //

// High speed digital connectivity offers significant social, environmental and economic benefits, but it is unlikely to be commercially viable to deliver them to everyone who wants them. We suggest that where the market fails to extend access to all, that the government create the conditions through which this can be corrected.

// Some of the cost savings necessary to reduce the government's deficit could be attained by delivering more public services via the internet. We suggest a combination of segmentation according to personal internet use, incentives and greater use of intermediaries to establish which services could be transferred online and encourage and enable people to use them.

// The UK's public sector has struggled to effectively procure and apply technology, leading to higher costs than other countries and a bias towards large projects which often fail to meet all their targets. We suggest that dividing projects into smaller, off-the-shelf rather than highly customised, packages of work and the retention of more internal expertise on technology could lead to more successful use of technology in the public sector. Publishing more data on government ICT procurement could also improve transparency and accountability.

// ICT has a significant environmental cost, but the benefits it brings through replacing resource-intensive current practices with alternatives could offset this footprint by as much as five times. We suggest that a greater emphasis is placed on ICT as an instrument to bring about a more sustainable society

// Encouraging greater communication and higher levels of engagement between people and the government will be important in difficult times. We suggest that online public services provide an excellent enabler of co-production between public servants and people. More online services should be designed to encourage and harness this collective knowledge using features like comments and ratings.

// The trend towards constant and mobile digital connectivity and the welcome launch of more public sector data could be used to significant effect by helping people to visualise the effect of their personal actions on their own health or the natural environment. We suggest that government become more aware of the new possibilities that mobile technology platforms enable.

// The UK considers itself an advanced-knowledge economy, but although it has some excellent innovation policies and mechanisms, it does not seem to have implemented these well, leading to lower levels of R&D investment and a poor record of exploiting knowledge to full advantage. We suggest that the UK's position is critically assessed, and that innovation policies are more proactively evaluated throughout their lifetime.

// There does not seem to be a sufficiently strong discourse between policy makers and business regarding the nature of the society we are aiming towards and the role that technology could play. There is a need for more collaborative foresight work to establish a clearer vision of the society we aspire to and the markets and technologies which will be required to support it.

// Demand-led innovation is critical for the future success of the UK's technology sector. Such demand could be stimulated through incentive schemes and demonstration programmes and also by changing how firms view innovation and growth. There is also a key role for public sector procurement to stimulate the right sort of demand.

3. **INTRODUCTION** //

The cold snap of the economic downturn has affected many people and organisations over the last year, but is only the start of a longer cold economic climate for many – particularly the public sector. It is clear that we face challenges on social, environmental and economic fronts, but it is not yet clear that we are responding by fully realising our potential for innovation and invention.

Technology in a Cold Climate aims to engender a greater understanding among the technology sector and policy makers about the role that technologies could play in meeting the UK's ambitions and challenges. To contribute towards this aim, through a short period of research and validation we have identified some measures that could help the UK make more of technology in an economic climate of relative scarcity, uncertainty and adversity.

As the set of tools that we use to adapt to our environment, technology is constantly evolving and the cold climate provides a reason to revisit the options that are open to us. This project takes a broad look at the role that technology, particularly information and communication technology (ICT), could play in meeting some of the big challenges posed by the cold climate.

The statistics are grim: at the time of writing, preliminary figures show that the UK has just emerged by a small figure from one of the longest periods of recession since in post war history. Unemployment, though not as severe as during other recessions is at its highest since 1992[I] , and government debt is expected to reach its highest level since the second world war. Additionally, the global population is growing, ageing and unsustainably developing. But as others have noted[II] , challenges such as these should not encourage us to "keep calm and carry on": rather we should be energetically experimenting and inventing.

The RSA is known to many as "a society for inventions that would make the world a better place"[III] . This confidence that technology has something to offer society as well as pure economic development is exemplified in a story from the society's records. Child labour was

rife in eighteenth century London, with children being used as near slaves to carry out dangerous tasks like sweeping the city's filthy chimneys. In 1796 the RSA responded with a competition for equipment for "obviating the necessity of children being employed within flues".
The submissions to this competition were prototypes of the first extendible chimney sweeping brushes, paving the way for legislation that eventually outlawed the practice of child labour in sweeping chimneys.

The challenges that we face and the technologies that are our tools have moved on, but the RSA retains its enthusiasm for innovation and inventions. Today the society is predominantly concerned with how individuals and communities can become more engaged, pro-social and self-reliant in response to the grand challenges we face.
Some commentators note that there is a risk in people becoming passive consumers rather than engaged citizens[IV] ; making impossible demands of the government but contributing little to society themselves.
Among other issues, Technology in a Cold Climate examines the potential of technology to enable and encourage people to become more engaged citizens.

Through a brisk four month process, we have worked with large and small technology companies, public servants, academics and other leading thinkers to explore emerging technologies that could help us meet such challenges.

We commissioned four research papers from accomplished authors to collate the knowledge on fields that seemed fertile to us:

// **Public sector use of technology**

// **The potential of a more digitally interconnected society**

// **The contribution that ICT could make towards a more sustainable society**

// **A review of UK innovation and the support available to it**

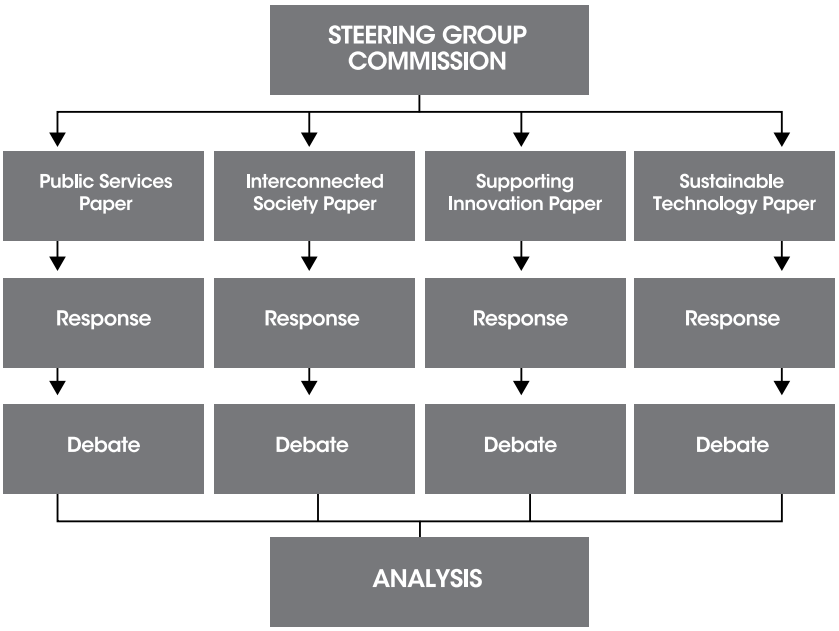
As well as mapping out the current landscape, each author was asked to suggest a few recommendations that could help the UK make the most of technology in a cold climate.

These papers and recommendations were subsequently developed during a small conference of experts drawn from large and small technology businesses, the civil service, political parties, think-tanks and academia. These experts met at a symposium at the RSA in late 2009 to use their collective experience to discuss the most important recommendations.

The first chapter of this report documents the challenges that were uppermost in our mind when thinking about the cold climate and summarise some of the new developments in technology. Secondly, a summary of the research that we commissioned and the responses made by those from industry or policy given

during the Technology in a Cold Climate symposium. Thirdly, from the challenges, the research, the responses and debate of the symposium, a number of themes are extracted, which include recommendations of how the potential of technology in a cold climate could be maximised.

We present this report's key findings and suggestions as avenues that could help the UK maximise the social and environmental potential of technology in the current cold climate and the difficult times ahead.



4. **CHALLENGES** //

"You never want a serious crisis to go to waste"

It was the cold economic climate that sparked this project into life, but the UK and global society face challenges on social and environmental sides as well as the current economic.

As Rahm Emanuel, President Obama's chief of staff, said of the economic downturn: "You never want a serious crisis to go to waste"[V]. The challenges we face are opportunities to re-think our aims and the way we go about achieving them. What sort of society do we want, how do we measure our progress towards this goal, and what challenges stand in our way?

The big questions about the society we want are social and political questions beyond the scope of this report, but we can assume that many of the grand challenges that we face stand in the way. What do we know about these grand challenges that could help us identify the nature of the tools and technologies we need to help us meet them?

The Cold Snap:
Public Sector Spending

Following the credit crunch that sent shockwaves through the private sector, the economic downturn has moved on to the public sector. Through bailing out the banks, quantitative easing and rising spending, in September 2009 UK public sector net debt stood at 59% of the Gross Domestic Product[VI] , the highest for over ten years. The debt is expected to rise to 79% of GDP by 2013 – its highest level since the Second World War[VII] .

The cost-saving implications for the government are severe. The Institute for Fiscal Studies notes that recent pre-budget reports and budget indicate that the government will need to make increasingly tightening cuts until they are saving £90 billion each year from 2017-18 onwards[VIII]. Such cuts would reverse the rise in spending on public services seen under the Labour government unless taxes rise or welfare payments are cut. How can we achieve such tightening while preventing them from adversely affecting our aims for society?

ICT is often suggested as a way in which public services could be delivered more efficiently, but too often the opposite occurs. The UK invests more than any other country in contracts much larger than any other country, but one government CIO reportedly said that only 30% of public sector ICT projects meet all of their targets. How can public sector ICT move from being a source of waste to a way of contributing real cost savings?

Cutting public service spending is not simply a matter of making efficiencies. As policy makers wonder exactly how such large savings can be made, eyes are turning to Canada, who were running a similarly large (to the UK) national debt of 70% in the 90s and underwent dramatic fiscal reforms in response. Jocelyne Bourgon, head of the Canadian civil service said of the reforms that she led that the real key is not incremental efficiency improvements, but "a process of modernisation of public institutions including the role of the centre of government, the role of departments and rethinking of the relationship with citizens"[IX].

However this crucial relationship is at a low ebb, with one recent study indicating that 71% of people distrust the government[X]. This is unusually apparent in the issues around government use of technology, which too often seems a source of distrust rather than a means of empowerment and engagement. A number of large databases and high profile losses of personal information mean that many people do not trust the government to look after their personal data.

It is clear that spending on public services must be cut, but how could such cuts actually be delivered? How can the fractured relationship between citizens and the state be repaired and made productive?

Other Challenges Ahead: Sustainability and Climate Change

If the squeeze on public sector spending is the cold snap, what are the mid to long term challenges that we face? The economic challenge is likely to be compounded by even more serious demographic and environmental trends. Forecasted by the government's chief scientific advisor to coincide in a "perfect storm" around 2030[XI] , the intervening years are our last chance to either mitigate or adapt to these challenges.

One such trend is the rising global population. In July 2009, the population of the world was estimated at 6.8 billion[XII] , projected to rise to 8.3 billion by 2030, and surpass 9 billion by 2050. A business-as-usual projection puts the UK on course for a population of 71.6 million in 2033 (currently 61 million), with a significant contribution made by migration[XIII] .

Another trend linked to development is that society's population is living longer. Both in developed and developing countries, the population aged over 60 is growing at the fastest rates ever – currently 2% annually in the developed world[XII.] The UK is no exception; over the

last 25 years, the percentage of the population aged under 16 has decreased and that over 65 has increased[XIV]. By 2033, it is projected that 23% of the population will be 65 or over and 18% will be 16 or under.

A growing population is not inherently a problem, but the manner in which society has developed to use natural resources is unsustainable, and rising populations will exacerbate the problem. Humanity's global footprint now exceeds the Earth's capacity to regenerate by about 30%[XV,] and if trends remain the same, by the mid 2030s we will require two Earths to provide the resources we currently consume. The UK's ecological footprint stands at 5.3 global hectares (a unit of land with the average capacity to produce resources and absorb waste) per person, but the sustainable threshold is 2.1. The average UK citizen has the 15th highest ecological footprint in the world.

Anthropogenic climate change, although an example of unsustainable resource use, stands apart from other sustainability issues for its global impact and urgency. The average global temperature has risen by 0.74°C[XVI] during the last century and is expected to rise further by up to 6.4°C during the current century. The cause of the warming is accepted as the release of Green House Gasses (GHGs), including Carbon Dioxide (CO^2), through some of the industrialised world's activities.

The expected global impacts of climate change are well known and far reaching; extreme weather, glacier retreat, sea level rise, changes to the oceans' content, economic and social impacts, ecosystem change, health impacts, water scarcity and security implications to name some of the headline impacts. The UK has set a target of reducing its GHG emissions by 80% (on their 1990 levels) by 2050[XVII]. This target is to be achieved in a series of five-year carbon budgets. The first three five-year budgets require a 34% reduction by 2022[XVIII] .

Such challenges, when collected together, form a broad set of drivers of innovation; where could technology most effectively play a role in helping us address them?

Technology Trends

Many exciting developments are occurring in various fields of technology including biotech, cognitive science, energy technology, material science, nanotechnology, robotics and transport. Some startling advances are being made that could have significant social and environmental gains.

Advances in genome sequencing, for example, has led one biotech company to develop miniature chips that should allow an individual's entire genome to be sequenced at very low cost, opening the door to inexpensive personalised medical treatment such as selecting the most effective type of chemotherapy based on the results of a tumour biopsy.

Likewise, recent advances in cognitive science are expected to result in a wiring diagram for the neural circuits of the brain which could bring new insights to psychiatric illness. Even those prosaic fields such as battery technology which have only seen incremental improvements for decades are now areas of rapid advance, resulting in innovations like the entirely "liquid" batteries that will be cheaper, longer-lasting and operate at far higher currents than any battery currently on the market, enabling entirely solar-powered street lighting and more effective electric cars.

Enthusiasts & Sceptics

Technology often divides opinions; some seeing unlimited potential for economic growth or social gain, others seeing only undesirable side-effects. Undoubtedly technology can cause harm as well as good. Nowhere is this more obvious than in the application of nuclear science to weapons technology. The dreadful potential of such technology once led Albert Einstein to say: "It has become appallingly obvious that our technology has exceeded our humanity". It is the purpose of weapons technologies to cause great damage, but all technologies can have unintended side-effects on society and the environment. The main technologies that we rely on for energy also emit greenhouse gasses in such quantity as to unbalance the natural carbon cycle or leave us with waste that remains hazardous for many years to come. or leave us with waste that remains hazardous for many years to come.

5. **RESEARCH & RESPONSES**//

Our search for those technologies that could play a meaningful role in the challenges of the cold climate began with academic research. We commissioned four papers from experienced authors, each of whom carried out a survey of existing knowledge surrounding their topic, and suggested a few recommendations that could improve the current situation.

To draw in the perspectives of those with expertise in industry and policy, we organised a symposium for sixty professionals from business, government, the third sector and academia. During seminars in the symposium, each author presented their research and formal responses were delivered by two experts.

Interconnected Society
The academic research we commissioned[XXIII] on the interconnected society highlighted some of the benefits that ICT and digital connectivity are expected to bring, particularly in dissolving geographical boundaries. Digital connectivity is seen, and not just by technologists, as a necessity to improve social, economic and environmental standards. It was suggested however that the reality of these benefits did not currently match up to the rhetoric, due to a number of barriers and divides – including the physical infrastructure and gaps in levels of ICT skills.

The research summarised the ability of ICT to build relationships within and between people and communities (e.g. social networking websites such as Facebook or Twitter) but also highlighted the role of machine-to-machine connectivity in large scale grid computing applications such as SETI@home. The development of the semantic web, the re-organisation of data to make it understandable by computers as well as people, was outlined. It was suggested that many semantic web applications will occupy a space that involves both people-to-people and machine-to-machine connectivity.

The research also briefly explored the market and policy landscape surrounding the next generation of digital connectivity, noting that although the government's 50p landline levy could raise the funds to extend such fast broadband across the UK, this policy is subject to changes in the UK's

political landscape. The research suggested that since the benefits of connectivity are felt at various levels, the costs should similarly derive from multiple places. It was thought that the EU, UK and regional development agencies may each take a leadership role in extending next generation broadband to "the final third".

Responses to the paper agreed on the benefits of digital connectivity, but suggested that there were many issues surrounding digital connectivity that were not yet sufficiently publicly understood or debated; including privacy and security, digital inclusion and exclusion, technical standards and issues of governance.
The benefit of machine-to-machine communication, was highlighted as an application of ICT that could collect and employ huge amounts of data to maximum effect, having benefits from reducing food wastage to ensuring that energy is generated and distributed efficiently.

Public Services
The research we commissioned explored how digital technologies could equip public services to survive the recession. The paper included a brief history of central government's use of ICT, highlighting a number of failures in ICT procurement, and opportunities to use ICT to create more engaging and effective public services. Estimates were made of the cost savings made possible through transferring delivery of some key services to the internet.

The research recommended three measures to make more of ICT to deliver public services and improve government administration.
These included procurement issues; the adoption of smaller contracts and more effective use of existing databases instead of investing in larger databases. It was also noted that other country's governments have higher levels of expertise in ICT than is common in the UK.
In addition, the current problem of less than universal take up of broadband could be mitigated by targeting public services that are specific to segments of society that already have high levels of internet access. The use of web 2.0 features could also allow services to be more engaging, and allow a level of co-production of services through the world wide web.

Responses to the research included the perspective that while smaller ICT contracts could help, they could not expected to be a panacea for all the problems of public sector ICT procurement; small contracts may also fail. It was noted that the contract cost of smaller contracts must be correspondingly lower.
A role was seen for ICT to help government operate across departmental boundaries, with the example of the online DVLA licensing system noted as exemplar. The importance of free data as a lever to spark innovation was expounded. Responses also emphasised that the challenge of the "cold climate" would last for longer than the short term. The importance of ICT in untangling central government was again supported, as was the importance

of using ICT to co-produce public services. The potential of the web as a field for nudge-like behaviour change interventions was also noted.

Sustainable Technology

The research we commissioned[XIX] reported on some of the transformational changes that future technologies could make to help society adopt more sustainable patterns. The difficulties of predicting technological developments for long time frames were noted, and three key "technology service clusters" were chosen that were highly likely scenarios to transpire as well as having transformational potential; high speed digital connectivity, miniaturisation leading to ubiquitous computing, and the integration of the two; allowing data on the environmental impact of people's actions to be communicated to them in real-time.

Faster digital connectivity could allow energy intensive activities such as commuting to be replaced with video-conferencing, saving 50-150% of the emissions associated with traditional forms of travel. Miniaturisation of the devices currently able to connect to the internet will allow parts such as vehicle components to connect to the internet; allowing them to be tracked geographically. This could enable a shift towards a much more effectively-implemented service economy. Integration of digital connectivity and miniaturisation into people's lifestyles will encourage the emergence of ubiquitous augmented reality, allowing information to be presented to people in real-time. The importance of these technologies in three key areas of consumption; buildings, transport and food, was highlighted.

The research presented six measures that could support the acceleration of transformative technology that would enable a more sustainable society. The adoption of a one-planet framework that uses a benchmark of one million people to assess the sustainability of proposed solutions was highlighted, as was the need to promote reporting of company's positive impacts rather than their negative impacts.
A focus on transformative solutions that achieve savings of over 90% rather than those that achieve 10-20% was recommended.

Responses to the research reinforced the importance of the shift to a service rather than ownership economy and the cyclical lifespan of products that ICT could enable, citing the example of Integrated Vehicle Health Management or modular photocopying equipment.
The importance of differentiating between technology that allows incremental improvements and those that allow revolutionary improvements was also noted, as was the difficulty that policy can have in keeping up with latest developments.
Responses also highlighted the ability of ICT to monitor and control energy generation and distribution, and served as a reminder that digital infrastructure is just as important as roads and railways.

Supporting Innovation
We also commissioned a review of the state of innovation[xx] and innovation policies and measures in the UK. This research reported that while often dwelling too much on its failures, that in actual fact, the UK does relatively well across various areas. The UK's success in creativity, the importance of "grand challenges", sustainability as a driver of innovation, knowledge exchange, the higher education system, the value of demand-led innovation and the recognition of service innovation were all noted as exemplar.

However the review also noted two particular gaps in innovation, notably that the UK (both government and business) invests much lower amounts in research and development than comparative economies, and that the UK consistently fails to grow fledgling businesses into larger firms.

The paper concluded that while the UK's policies were ground-breaking, it has been less successful at implementing these policies. It was suggested that this could be due to insufficient resources assigned to implementing such policies. The importance of a greater emphasis on foresight, and a more proactive evaluation that appraises policies throughout their lifetime was noted. It was also suggested that a combination of incentive schemes and demonstration programmes could stimulate the necessary impetus to create demand-led innovation. The paper concluded that while the UK has always held a position as an innovative player, recent shifts in innovation, growth and productivity towards economies like Brazil, India and China makes this position fragile – undermining its position as an advanced knowledge economy.

Responses to this paper broadly agreed with its analysis, but drew a line between technological innovation and organisational innovation. The response suggested that our expectations of innovation in the UK should differ from those in areas such as Silicon Valley. It was urged that the significant amounts of venture capital money available to UK companies should be used to energise rather than scare, and banks should be more encouraging to those trying to grow businesses. The lack of mechanisms to grow little businesses to medium sized ones was noted, as was the role of organisations such as NESTA and government departments like BIS, but ultimately the importance of improving management within business was seen as critical, particularly in changing managers' attitudes towards innovation.

6. TECHNOLOGY IN A COLD CLIMATE //

The sweeping breadth of the challenges we face is noticeable; making significant cost efficiencies in public services involves finding new ways to deliver health, law enforcement, education and more. Climate change and demographic shifts bring their particular problems. It seems appropriate that the technologies required by the cold climate should be versatile, allowing a range of outcomes to be accomplished using the same technologies. Which technologies will be flexible enough to play a major role on social, economic and environmental fronts?

Perhaps most strikingly, the cold climate requires us to be parsimonious, both with the public purse and with our natural resources. The public sector deficit will require £90 billion to be saved and the UK Climate Change Act's target of 80% reduction in carbon emissions by 2050 mean that we must find radically more efficient ways of using public money and fossil fuel. How can technology help us make our money go further, and could it even help us do more for less?

Decentralisation of power and responsibility seems important; learning from the lesson of Canada in the 90s and from recent research on the lack of trust between individuals and central government. How can citizens become more engaged in the big challenges, and how can they become more self-reliant in an age of hardship and uncertainty? What role does technology have in enabling and empowering higher levels social productivity?

Finally there is the key question of innovation. The UK currently sees itself as an advanced knowledge economy, but the cold climate will require us to go beyond rhetoric to reality. Are we really innovating sufficiently, and do we support key innovations enough? As well as simply innovating, as the foreword to this report urges, we must be innovating with purpose, with sufficient foresight to look beyond the cold snap to the long cold climate ahead of us – is our innovation purposive?

The following sections take each of these themes in turn, identifying innovations and inventions that could be of use in the cold climate. If the cold climate require technologies that are versatile, and that enable society to be more parsimonious, decentralised and innovative, then which are the options?

6.1 **VERSATILE** //

The range of social and environmental challenges provoked by the cold climate includes matters as diverse as government administration, a diverse spectrum of public services and environmental sustainability. It follows that we will require technology that is versatile enough to be applied to a variety of problems.

Versatility is one of the reasons that Technology in a Cold Climate focuses on the potential of information and communication technology (ICT). Rather than any specific product, ICT is a general purpose technology[XXI], a technology that can be applied in diverse ways and which is capable of significant impact. Other such general purpose technologies include materials technologies, power, tools and transportation.

Predicting the Future

Our research[XXII] illustrated the difficulties of predicting technology futures with a example from the mobile phone market. In 1980, one consultancy predicted that there would be 900 thousand mobile subscribers by the end of the 20th century, when in fact there were over 100 million subscribers in the United States in the year 2000; over 100 times more than the prediction.

Instead, our research recommended that clusters of technologies be identified that could provide the same service. For example, the digital connectivity used by information and communication technologies provides a service that allows people and machines to communicate, but rather than dependent on one technology, it could be provided by a range of competitor technologies. For the digital connectivity example, such alternative specific technologies could include fibre, GSM, 3G or even satellite.

The advantage of identifying such clusters is that the foundational service is independent of any single technology. Such clusters should be selected on the basis of the foundational service being of use to many areas across different sectors so that multiple stakeholders are investing and a robust market exists, and the presence of a number of technologies capable of delivering the service.

Digital Connectivity

The development of large digital networks – particularly the internet – have given the field of ICT unparalleled versatility, allowing these technologies to play a role in areas as diverse as education, healthcare, the environment and transportation. Through the transformational changes that ICT has already brought, we live in the information age. Today's technology allows us to use that information to complete a wide range of tasks; from allowing people to learn online from the Open University or the Massachusetts Institute of Technology's OpenCourseWare[3] , to holding organisations with a public remit to account through websites such as TheyWorkForYou.com[4]. Our research also emphasised the benefits that digital connectivity and ICT bring to rural communities by enabling the economy and society to become less centralised through the ability of ICT and digital connectivity to dissolve the barrier of distance.

The advantages of digital connectivity are often thought of as synonymous with those of the world wide web; but in fact encompass a much broader set of channels including mobile phones, digital television, and machine-to-machine communications. The internet allows people to communicate with each other across spatial boundaries, and web 2.0 websites like Facebook and Twitter result in new communities. But other forms of connectivity allow machines to communicate with each other, resulting in applications such as SETI@home that harness the power of many home computers to analyse radio signals for signs of extra-terrestrial intelligence. This machine-to-machine digital connectivity is likely to become ever more prevalent, as more and more products are equipped with technology (RFID tags or similar) that makes them part of the internet. This so-called "internet of things" could have significant potential to help meet some of the challenges of the cold climate.

The infrastructure of digital connectivity would seem to be as important to the 21st century as the roads and railways were to the 19th century; bringing with it many of the benefits highlighted in this report and forming a platform that allows new businesses to spring up.

However varied and transformational the benefits, our research suggested that although the benefits are recognised by the government at European and national level, the advantages are being observed more slowly. Small to medium sized enterprises (SME) in particular, particularly those in rural areas, have been slower than their larger counterparts to take full advantage of digital connectivity.

A number of reasons were suggested for the lagging benefits, including digital infrastructure and levels of ICT skills. Such a view is reinforced by the Economist's annual E-readiness ranking, which in its 2009 report of different country's ability to apply ICT for social and economic impact, assessed the UK as having slipped from 8th to 13th place[XXIV].

[3] See http://ocw.mit.edu/
[4] See http://www.theyworkforyou.com/

Markets and Policies

The UK's current digital infrastructure for broadband is available to 99% of the population[XXV], with 63% of households having taken up the service by 2009[XXVI]. Actual speeds vary considerably due to the nature of the current copper based technologies, but average speeds of 4.1 mega bits per second (Mbps)[XXVII] in 2009 – sufficient for fairly simple tasks such as streaming video, e-mail, and downloading music and video files, but not enough to stream high definition television for example. "Next-generation" broadband, which offers speeds of up to 50Mbps could open the door to additional digital services like "telepresence" (high quality teleconferencing), some of which are examined in the following chapters. Next-generation broadband is expected to be rolled out by providers in the urban and semi-urban areas that are home to two thirds of the UK's population, but the lack of demand in rural areas means the full benefits of such connectivity may not r each everybody.

The government's Digital Britain strategy indicates their commitment to extend access of current levels of broadband service to all by 2012; as Gordon Brown recently wrote in the Times: "a fast internet connection is now seen by most of the public as an essential service, as indispensable as electricity, gas and water". In addition, through the 50p landline levy, the government plans to create leverage sufficient to fund the extension of next generation connectivity to the "final third" of the population – the most rural areas – allowing high broadband speeds to be available to 90% of the population. Our research indicated that the 50p landline levy is subject to changes in the political landscape, and if not implemented, the question of how to extend the benefits of next-generation broadband to the final third are unknown.

Rightly, there is reluctance among policy makers to pick specific technological "winners". Interfering in the market to support technologies that are likely to deliver benefit is undesirable, and an impossible task given the rapid pace of technological development. However the service provided by digital connectivity is largely independent of specific technologies, being an example of a general purpose technology, and we suggest that this service will be of significant value to society in the cold climate. In addition to providing some of the social and environmental benefits reported in the following chapters, one study shows that a (theoretical) investment of £5 billion could result in the creation or retention of 280,500 jobs, 94,000 of them in small businesses[XXVIII] .

// **High speed digital connectivity offers significant social, environmental and economic benefits, but it is unlikely to be commercially viable to deliver them to everyone who wants them. We suggest that where the market fails to extend access to all, that the government creates the conditions through which this failure can be corrected.**

6.2. **PARSIMONIOUS**//

Society faces the challenge of radically reducing public sector spending, as well as the manifestation, in climate change, of the effects of an unsustainable society. The cold climate will push us to become economical rather than extravagant with the resources we have.

Two of the research papers we commissioned explored how ICT could enable a more parsimonious society. One paper examined how ICT could be used by central government to save money on internal administration and public service delivery. The other looked at the role that ICT could play in helping society manage its consumption of natural resources more effectively. Our research highlighted the potential of ICT available today, such as the world wide web, but also pointed forwards to the role that digital connectivity could play in the near future.

Cost-effective Public Services

Our research showed that there were significant cost-saving opportunities for central government use of ICT; partly in delivering more public services digitally, and partly by improving use of ICT within and across government departments. The research also indicated ways in which central government's procurement of ICT itself could become more parsimonious.

Although central government has a long relationship with ICT, there are many public services provided by the government that make little or no use of the cost-saving potential of technology. The government set a target in 1999 that all transactions with the public sector should be available online by 2005. This has been fairly successful; a 2005 survey showed 39% of internet users reported e-government interaction in the last year. In 2007, this figure was 46% and in 2009, 59% had undertaken some e-government activity. However the same (2009) study showed that while 59% of people interacted with government online, 81% of people compared products and prices, 80% bought good and services online, and 76% made travel reservations online and 55% used online banking.
Our research showed that only 1% of interactions with Department for Work and Pensions (which has

by far the largest budgets) are carried out online. While growing online interaction is encouraging, there is still enormous potential and necessity to make this the norm.

Our research highlighted two examples of cost savings that could save the Job Centre Plus service approximately £118 million a year. First, applications for Job Seekers' Allowance currently cost £89 to deliver, but the cost could be reduced by removing the cost of phone calls and information gathering costs that could comprise about half (or £45) of the total. With the rising rate of unemployment claims, a rate of 81% during the latter part of 2008 and early 2009, then the cost saving of allowing people to apply online for Job Seekers Allowance could be as large as £100 million. Secondly, Job Centre Plus currently spend £235 million annually on 9,300 personal advisors, 3,400 of which dedicated to new start or new deal programmes at a cost of £86 million. By making more use of the internet to deliver such advice, a saving of perhaps 20% or £18 million could be made on these resources.

Similar possibilities exist in the national health service. GP consultations with people aged 65 or over topped 6 million in 2007, at a cost of £20-25 each. If access to health advice on the internet for those aged 65 or over could be improved, then a modest reduction of 10% in such consultations could save the NHS £12 to 15 million a year.

One possible objection to the parsimonious potential of using ICT to deliver public services is that an online service could not displace traditionally-run services due to the current lack of universal access to digital connectivity. It is true that the savings would only be realised if an online service replaced a traditional service, but our research showed that the "digital divide" is not as significant a problem as previously thought.

Although 70% of households are connected to the internet; either through their telephone line, WiFi, PDAs, digital or cable television, 72% of non-internet-users responded that they definitely or probably could "use the internet to send an email or something now" [xxix]. These users have indirect access to broadband, through people that they know or library access to the internet. Such intermediaries play a valuable role, shrinking the digital divide to about 8% of people who are firmly excluded from internet access.

Intermediaries can be family members or friends, local libraries, or schemes such as UK Online Centres. They also offer the potential to combat another of the objections often raised at online services – that delivering services online can further isolate people from offline social contact. In addition, the internet has far higher penetration among particular segments of the population. For example, students have near universal take up of the internet which allows student loan administration to be delivered as a purely online service. It is likely that there will almost certainly be

other services primarily used by segments with very high levels of internet take up.

A combination of incentives for people to interact online, such as used by HMRC in their policy of mandating online interactions for late tax-filing (which achieved a rise from 44% to 58% online return) together with an understanding of the importance of intermediaries and the government's commitment to universal access to broadband by 2012 open the door to using ICT to much greater effect in public service delivery.

//**Some of the cost savings necessary to reduce the government's deficit could be attained by delivering more public services via the internet. We suggest a combination of segmentation according to personal internet use, incentives and greater use of intermediaries to establish which services could be transferred online and encourage and enable people to use them.**

Parsimonious Procurement
The UK government has been dependent on ICT for decades, but the pressures on the public sector are bringing a new focus on the way in which it is used. Large and centralised databases, massive contracts and high failure rates make ICT's reputation synonymous with making things bigger, centralised, complicated, expensive and intrusive. The pressure of the cold climate should provoke changes.

Our research showed that while ICT procurement has improved in the UK since its worse points of wastefulness, that there is still scope for improvement. A number of comparative models, from tight regulation to maintain a competitive supply market, to retaining in-house capability, to splitting contracts up into smaller pieces. The research concluded that smaller contracts were likely to lead to a more effective relationship between the government and ICT contractors. A reasonable level of support was shown for this suggestion from the delegates at our symposium, with the caveat that small contracts must mean small packages of work, and that the contract cost must be correspondingly low.

// **The UK's public sector has struggled to effectively procure and apply technology, leading to higher costs than other countries and a bias towards large projects which often fail to meet all their targets. We suggest that dividing projects into smaller, off-the-shelf rather than highly customised, packages of work and the retention of more internal expertise on technology could lead to more successful use of technology in the public sector. Publishing more data on government ICT procurement could also improve transparency and accountability.**

New Energy-efficient Services
ICT already has a significant carbon footprint – primarily due to the manufacture and use of PCs, data centres infrastructure and other devices – which in 2007 was estimated to contribute 2% of global carbon emissions, a figure comparable to the global contribution that aviation made in the same year[xxx] . In spite of efforts to reduce its impact, ICT's footprint is expected to rise at rate of 6% per year until 2020.

However our research shows that ICT is unusual, in that it enables new ways of living and working that could completely replace some practices that consume even more energy and have correspondingly enormous footprints. One study estimates that, even taking into account its growth, ICT could offset its own footprint by up to five times, enabling a society that is radically more parsimonious with its resource use.

ICT could achieve this partly through using the internet to replace activities such as commuting and business travel with teleworking and teleconferencing, by replacing paper mailing with online communications, by replacing high-street shopping with e-commerce and by replacing physical media such as CDs and DVDs with digital media.

// **ICT has a significant environmental cost, but the benefits it brings through replacing resource-intensive current practices with alternatives could offset this footprint by as much as five times. We suggest that a greater emphasis is placed on ICT as an instrument to bring about a more sustainable society.**

"Make Measurable What is Not So"
The world wide web is not the only way in which ICT could help society become more parsimonious. Digital connectivity, as well as enabling people to communicate across distances, also allows machines to communicate – which opens the door to new levels of control over our distribution and consumption of resources.

Galileo said "measure what is measurable, and make measurable what is not so" – or as modern day managers say: what gets measured gets managed. Measuring resource use more accurately and frequently and conveying that information to where it is most required is the first step in reducing waste, and an obvious and important application of ICT.

Currently we do not appear to be measuring our resource use nearly as much as we need to.
Taking energy as an example, consumers have no idea how much energy they are consuming, and suppliers have only a little more.

The next generation of electricity grids could change the way that energy is consumed in buildings by making energy consumption measurable and manageable.

ICT could be applied in the form of sensors, smart-meters and communication lines to the infrastructure that distributes resources. A smarter electricity grid, would allow electricity distribution to become less centralised, allowing individuals to contribute their own electricity to the grid more easily, and would be more energy-efficient resilient.

The benefits of the smart electricity grid have been estimated at; reduced transmission and distribution losses (8%), reduced congestion (2%), improved energy efficiency (6%), improved reliability and power quality (49%), and reduced operations and maintenance(19%). The US National Energy Technology Laboratory estimates that these benefits outweigh the investment cost by a factor of four to one. They estimate that the grid will require $165 billion over the following twenty years, but will benefit society by between $638 and $802 billion. The direct environmental benefits of such a grid are therefore about 14%, which could make a valuable contribution towards the UK's carbon budgets.

Smart grids are at a comparatively advanced state in some countries. Italy's smart grid was completed in 2005, where it saves €500 million (project cost €2.1 billion) each year. In the US, VCs have invested $1 billion dollars over the last few years in smart grid companies.

The smart grid also formed part of the government's American Recovery and Reinvestment Act – with over $11 billion earmarked to fund it. Six trial projects have been funded to date at a cost of over $47 million. In the UK, the Department for Energy and Climate Change have shown interest in smart grids, but no firm commitments have yet been made.

Energy use in buildings is only one area in which we waste resources. There are also enormous applications for ICT in the area of transportation, such as telecommuting, teleconferencing and smarter vehicles and traffic infrastructure. For example, existing studies show that greater take-up of telecommuting could reduce most people's commuting GHG emissions about 75%. If telecommuting was adopted by 10% of the population, a saving of 43 mega tonnes of CO2 could be achieved[xxxii] .

Transformations

A smart electricity grid is just one example of how machine to machine connectivity could enable parsimony in resource consumption. The "internet of things" describes the extension of internet connectivity to all devices: from fast-moving consumer goods to engine components. Often described as the addition of radio frequency identification tags to components, the internet of things essentially means that everything will be traceable throughout its lifetime. Although a controversial idea with a multitude of privacy issues, the internet of things could have transformational potential for environmental sustainability.

As sensors miniaturise and become less expensive, and ambient and wireless connectivity becomes the norm, the internet of things could open a door to a dramatically transformational shift from an ownership economy towards a service economy.

Companies such as Xerox and Rolls Royce are well known for their service business models, where clients buy a photocopying service or hours of flying time rather than photocopiers or airplanes. Adding ubiquitous ICT, through RFD tags or other wireless sensors could allow any component or product – from a can of coke to a car to take its place in a circular, closed-loop economy. Tags could hold information about the manufacturer of a finished product, enabling a truly cradle to cradle approach to the way that we use, re-use and recycle our natural resources.

Both large and small (one start-up have developed a platform to aggregate energy and other data from a variety of sources) technology companies are heavily innovating in this field.

//**ICT has a significant environmental cost, but the benefits it brings through replacing resource-intensive current practices with alternatives could offset this footprint by as much as five times. We suggest that a greater emphasis is placed on ICT as an instrument to bring about a more sustainable society.**

6.3. **DECENTRALISED**//

The low level of trust between citizens and government, and the observation that citizens seem more passive and less engaged than before are worrying signs in a cold climate. The experience of Canada, as well as the simple truth that people will need to become more self-reliant in an age of austerity indicate that decentralisation of power and responsibility is important.

Personal Data
Research into the rapid increase in personal data held by the government indicates that two thirds of the population do not trust the government with their personal data[XXXIII]. This has been accentuated by recent high profile cases of data loss, and reports that the amount of data held by the government has risen rapidly. Our research reported a "big database" mentality in central government, and noted that such large databases were unnecessary and linked to the problem of large contracts. Instead it was suggested that more effective use of existing databases be made.

Personal data, although a topic of significant debate and a factor in the distrust between citizens and government did not feature highly in our commissioned research, but was mentioned at several points.
One proposed alternative to government-held data was to decentralise it in the form of "volunteered personal data", which would allow individuals to own some parts of their data and release it to government to the extent they wish.

Public Service Co-production
In addition to highlighting ways in which ICT could deliver public services in a more cost-effective manner, our research also explored the possibilities of using technology to forge more innovative services. For example, the ability of web 2.0 applications allows people to leave feedback in the form of comments or star ratings on the public services they have experienced.
These actions create information that the government can use to improve services, and also allows other people to make more informed choices.
A variety of low-cost websites offer such services, and although some lessons from these sites have been adopted into official public sector websites, such as NHS choices, this new way of working is not an easy fit

for government's traditional modes of operation.

Taking such "co-production" of public services further, the release of public sector data allows civic-minded individuals with the right skills to "mash" data together from a variety of services to create innovative new public services. Websites such as WhatDoTheyKnow.com make it easy for individuals to submit freedom of information requests.

// **Encouraging greater communication and higher levels of engagement between people and the government will be important in difficult times. We suggest that online public services provide an excellent enabler of co-production between public servants and people. More online services should be designed to encourage and harness this collective knowledge using features like comments and ratings.**

Making Sense of Data: Augmented Reality & Nudging

We live in the information age, and there is little likelihood of the amount of information we come into contact with reducing in the near future. Our research indicates that, as digital connectivity speeds increase and the devices that we use to access digital networks decrease in size, information is likely to become more integrated in our lifestyles.

Integration is already happening through the emergence of augmented reality; the layering of data over the real world. Early applications for devices such as the iPhone use the device's internal GPS, electronic compass and screen to overlay information on tourist sites, travel networks and shared workspaces. This location-aware layer of data creates a simple but rich way to present relevant information to people. The potential of such information is significant; for example, the importance of encouraging "behaviour change" is recognised across both political parties. In a speech at the RSA in 2007, David Cameron cited various recent examples of physical assaults and said "My belief in social responsibility is not a laissez-faire manifesto. I believe that government has a vital role to play in changing social behaviour"[xxxiv]. Likewise the present government has carried out a growing amount of research over the last five years into more sophisticated ways in which people can be encouraged to eat more healthily, drink less alcohol, take fewer drugs, consume less energy and generate less waste.

Encouraging behaviour change is rightly regarded as a challenge, but here too, ICT has a valuable role to play. Presenting the right information at the right time has been shown to enable people to take more responsibility for their behaviour. The most common example being that of real-time energy displays, which trials indicate when installed in peoples' homes, result in 5-15% reduction in energy consumption.

ICT can help us visualise and project information into the future – could show us the effect that switching that light off could have, or eating that food, or doing our morning exercises. Could also help policy makers make better decisions; how would Copenhagen be different if negotiators could see the effect of their country's commitment projected into the future?

// **The trend towards constant and mobile digital connectivity and the welcome launch of more public sector data could be used to significant effect by helping people to visualise the effect of their personal actions on their own health or the natural environment. We suggest that government become more aware of the new possibilities that mobile technology platforms enable.**

6.4. **PURPOSIVE**//

Innovation is always key in an environment of global competition, but the challenges of the cold climate make it critical to achieving our goals for society. We suggest that the pressures of the cold climate first require innovation to be sufficiently occurring and to be effectively supported, and secondly, must be purposive.

The State of Innovation
Our research showed that while there are gaps and weaknesses in UK innovation, the UK has had several successes across different areas of innovation and innovation policy.

First, the UK is home to creative individuals, with a world-renowned design consultancy sector. The higher education system is extremely successful with two universities in the world top ten and five in the world top fifty, and a good record of licensing, spin-outs and knowledge transfer activity. Knowledge exchange is successfully achieved through the exchange of personnel between public and private sectors, and through the Knowledge Transfer Partnership schemes.

Second, the important role of demand-led measures to encourage and support innovation have become recognised across Europe, and recent publications have clearly identified the role of lead markets and particularly the government's role of public procurement as critical to supporting innovation.

However in addition to these reasons for optimism, the research also highlighted two weaknesses of innovation in the UK. First that business and government invest less in research and development than comparable economies, and second that while the UK has a fairly good record of entrepreneurship, we are less successful at growing and sustaining such small businesses.

Our research showed that the UK, although often representing itself as an advanced knowledge economy, falls behind many countries in the amount it invests in R&D. Although investment in innovation can take other forms than simply R&D, the proportion of GDP invested in R&D still gives a rough indication of how seriously a country takes innovation. In 2006, the UK invested 1.47% of GDP in R&D – below average for

the EU 27, and only just above China's 1.42%. Taking into account investment other than percentage spent on R&D; for example that spent on plant, equipment, training, design and software, the UK could still considered an 'innovation leader' within Europe but not on an international playing field.

Our research also highlighted that he UK tends to have a good record of creative entrepreneurship, but it routinely fails to develop these fledgling businesses into large firms. The transition period in developing into a large SME is particularly difficult. Various reasons are to blame for this. Cultural issues may be partly to blame, if the entrepreneur is not interested in growing the business, or conversely keen to quickly sell up and move on to their next venture. Another trend is that various foreign companies are keen to invest in UK innovations, which can have two negative (for the UK) side-effects; a reduction in R&D (often re-located to foreign sites) and the loss of headquarters; which are known to have an important 'multiplier' effect in their surrounding area.

// **The UK considers itself an advanced-knowledge economy, but although it has some excellent innovation policies and mechanisms, it does not seem to have implemented these well, leading to lower levels of R&D investment and a poor record of exploiting knowledge to full advantage. We suggest that the UK's position is critically assessed, and that innovation policies are more proactively evaluated throughout their lifetime.**

Purposive Innovation
As Matthew Taylor notes in the foreword, the challenges of the cold climate are such that it is not sufficient to simply innovate out of the recession, we must also be innovating in the direction of the society we want.

Our research showed that the UK is moving in the right direction, having taken on board the fact that many of the issues facing today's society are complex and inter-disciplinary. Such "grand challenges", like those brought on by the cold climate, are being tackled by innovation platforms from the Technology Strategy Board and Research Councils. Sustainability is one such challenge and represent opportunities for new markets in innovative products and services that exploit the need for a low-carbon and resource-light society.

Our research indicated however that although the UK has been strong at foresight in the past, that there is a need for a deeper conversation between government and business to establish which technologies and markets we must be supporting over the coming years.

// **There does not seem to be a sufficiently strong discourse between policy makers and business regarding the nature of the society we are aiming towards and the role that technology could play. There is a need for more collaborative foresight work to establish a clearer vision of the society we aspire to and the markets and technologies which will be required to support it.**

Supporting Demand Led Purposive Innovation
Our research also highlighted the role of the public sector in encouraging demand-led innovation. In common with other governments, the UK responded (in the 2008 pre-budget report and 2009 budget) to the recession with a short term stimulus package designed to galvanise UK business. Many such packages were also intended to stimulate environmentally sustainable development as well as economic recovery – with countries such as China and the US leading the way allocating $221 billion and $112 billion respectively for measures like energy efficiency, improved water infrastructure, renewable energy, and other low carbon initiatives.

China's package devoted 38% of its total stimulus to developing more sustainable rail, grid and water infrastructure. This has included cutting sales tax on cars with smaller engines, subsidies for the development of electric vehicles, significant investment in building new rail track, and an improved electricity grid. It has also earmarked money to invest in broader environmental protection such as sewage treatment. The American

Recovery and Reinvestment Act aims to encourage renewable energy, building efficiency, low-carbon vehicles, mass transit, better grids and water through 12% of its total stimulus. This has included significant benefits to renewable energy suppliers; tax credits and subsidies to encourage plant construction, but also a commitment to Carbon Capture and Storage demonstration projects. Energy efficiency benefits in the shape of funding for energy saving programmes, tax credits for energy efficiency measures in the built environment, with significant amounts also invested in the electricity grid and transport (funding to develop advanced batteries, incentives for plug-in hybrid cars, mass transit). Money is also set aside for environmental protection measures like flood protection and the reliable supply of clean water.

The UK's package trails slightly in the sustainability stakes by devoting $2 billion, or 7% of its total stimulus package to green measures. This contained stimulus for low-carbon power, energy efficiency, modal shift and low-carbon vehicles and adaptation plans for flood defences. The UK's stimulus package seems to have been comparatively weak, both in terms of size and likely impact. It seems unlikely that future stimulus packages will be made available, but there is still a key role for government encouraging purposive innovation through public sector procurement.

// **Demand-led innovation is critical for the future success of the UK's technology sector. Such demand could be stimulated through incentive schemes and demonstration programmes and also by changing how firms view innovation and growth. There is also a key role for public sector procurement to stimulate the right sort of demand.**

7. **SUMMARY**//

Technology is a powerful tool in the face of challenges of difficult economic times and seemingly huge problems like unsustainability climate change. However it is a tool that we do not so far seem effective at using. Examples from other countries show that the benefits of general purpose technologies like ICT have been clearly seized by country's across the world, but the UK's experience to date suggests that there is still plenty of room for improvement.

Though Technology in a Cold Climate has been a brisk project, the combination of perspectives from academic, policy and business have been combined to give a relatively consensual snapshot of the current issues around the potential of technology in difficult times.

It seems clear that the principal value lies in those that are versatile, purposive and enable society to become parsimonious and decentralised, and we present our suggestions as avenues for further exploration in the process of learning to use technology more effectively. Although there is no doubt we face difficult times, the UK could seize on the difficult times and use tools like technology to convert the challenges into the foundation of the next phase of efficient and sustainable growth.

8. REFERENCES//

I http://www.statistics.gov.uk/cci/nugget.asp?ID=12

II **Matt Jones, Get Excited and Make Things, November 2009,**
http://magicalnihilism.com/2009/11/07/get-excited-and-make-things/

III **Luke Johnson,**

IV **Matthew Taylor, A new politics: Citizens not consumers, June 2009,**
http://www.guardian.co.uk/commentisfree/2009/jun/03/a-new-politics-constitutional-reform2

V See http://online.wsj.com/article/SB122721278056345271.html

VI **Office for National Statistics, UK Government Debt & Deficit, September 2009,**
http://www.statistics.gov.uk/cci/nugget.asp?ID=277

VII **BBC News, Deficit 'danger' worries Cameron, October 2009,**
http://news.bbc.co.uk/1/hi/business/8289350.stm

VIII **Institute for Fiscal Studies, Loosening public services squeeze requires tax rises or welfare cuts, September 2009,**
http://www.ifs.org.uk/publications/4618

IX **David Halpern and Jerrett Myers, Think tank: A model of brutality Britain can build on, May 2009,**
http://www.timesonline.co.uk/tol/comment/article6210977.ece

X See http://www.edelman.co.uk/mid-year-trust-2009/omnibus-poll-findings/

XI **BBC News, Global crisis 'to strike by 2030', March 2009,**
http://news.bbc.co.uk/1/hi/uk/7951838.stm

XII **United Nations, World Population Prospects: The 2008 Revision, 2009,**
http://www.un.org/esa/population/unpop.htm

XIII **Office for National Statistics, National Projections, November 2009,**
http://www.statistics.gov.uk/cci/nugget.asp?id=1352

XIV **Office for National Statistics, Ageing, November 2009,**
http://www.statistics.gov.uk/cci/nugget.asp?ID=949

XV **WWF, Living Planet Report 2008, 2008,**
http://www.panda.org/about_our_earth/all_publications/living_planet_report/lpr_2008/

XVI **Intergovernmental Panel on Climate Change, Climate Change 2007: The Physical Science Basis, 2007,**
http://www.ipcc.ch/publications_and_data/publications_ipcc_fourth_assessment_report_wg1_report_the_physical_science_basis.htm

XVII **HM Government, Climate Change Act 2008, 2008,**
http://www.opsi.gov.uk/acts/acts2008/ukpga_20080027_en_1

XVIII **Committee on Climate Change, Carbon Budgets,**
http://www.theccc.org.uk/carbon-budgets

XIX **Helen Margetts, Technology in a Cold Climate: Public Services, 2009**

XX **Jeremy Howells, Technology in a Cold Climate: Supporting Innovation, 2009**

XXI **Jonathan Liebenau, Innovation Trends: Prioritising Emerging Technologies Shaping the UK to 2017, 2007,**
http://www.berr.gov.uk/files/file39041.pdf

XXII **Dennis Pamlin, Technology in a Cold Climate: Sustainable Technology, 2009**

XXIII **John Farrington, Peter Edwards and Sarah Skerratt, Technology in a Cold Climate: Interconnected Society, 2009**

XXIV **Economist Intelligence Unit, E-readiness rankings 2009 The usage imperative, 2009,**
http://graphics.eiu.com/pdf/E-readiness%20rankings.pdf

XXV **OFCOM, Access and Inclusion, 2009,**
http://www.ofcom.org.uk/consult/condocs/access/ai_statement/ai_statement.pdf

XXVI **National Statistics, Internet Access, 2009,**
http://www.statistics.gov.uk/cci/nugget.asp?ID=8

XXVII **OFCOM, UK Broadband Speeds 2009, 2009,**
http://www.ofcom.org.uk/research/telecoms/reports/broadband_speeds/broadband_speeds/broadbandspeeds.pdf

XXVIII **Jonathan Liebenau, Robert Atkinson, Patrik Kärrberg, Daniel Castro and Stephen Ezell, The UK's Digital Road to Recovery, 2009,**
http://eprints.lse.ac.uk/23830/

XXIX **William Dutton, Ellen Helsper, Monica Gerber, The Internet in Britain 2009,**
http://www.oii.ox.ac.uk/research/oxis/OxIS2009_Report.pdf

XXX See http://www.gartner.com/it/page.jsp?id=503867

XXXII **WWF, The potential global CO2 reductions from ICT use, 2008,**
http://www.panda.org/about_our_earth/all_publications/ict/

XXXIII **Ross Anderson, Ian Brown, Terri Dowty, Philip Inglesant, William Heath, Angela Sasse, Database State, 2009**

XXXIV **D Cameron, Civility and Social Progress, 2007**

RSA

The Royal Society for the encouragement of Arts, Manufactures and Commerce
8 John Adam Street
London WC2N 6EZ
T +44 (0)20 7930 5115
www.theRSA.org

Registered as a charity in England and Wales no. 212424