DURING DISCUSSION THE FOLLOWING POINTS WERE RAISED:

Electrification of motor transport is uneconomic; it would be better in the short term to improve the efficiency of combustion engines. The displacement of oil for use in transport by electric vehicles would require a massive investment. In order to be able to rely on the introduction of more electric vehicles in the future we should have decided to renew our nuclear power stations very much earlier. We no longer have this option available to us in the short term. The availability of oil is not the issue, the availability of energy is. Two approaches have been presented, the macro approach discussing estimates of the likely total amount of oil available and the micro approach concerned with an explanation of the contradictions between differing company estimates for peak oil. These estimates drive the science agenda since if oil is going to run out in the short term this will impact on geopolitical issues such as the need for sequestration which will be less important in the absence of oil. However, there is a massive disconnect between the current rate of oil depletion and the need to minimise climate change. Oil should be reserved exclusively for transport where it is responsible for 14% of greenhouse gas emissions and stationary supplies of energy should come from other sources.

Energy comes in many forms but there is an essential requirement for fuel in a liquid form. For example, in the USA corn ethanol is a very popular fuel. Price control should be used to help to reserve the use of oil for transportation and thus help to extend its availability further into the future. Peak oil is only the peak of what has been discovered, however the peak of the ultimately recoverable resources of oil is ultimately of more importance. OPEC do not insist on the production of relevant data and it is not possible to interpret the data they produce reliably. Peak oil is therefore currently based on what is actually produced. The Middle East is currently producing less than the rest of the world. Two decades hence most oil will be coming from that region. If we wait for oil to run out before reacting this will be a disaster.

In addition to actions driven by Climate Change many other initiatives are currently required such as investment in biofuels, battery technology for electric vehicles, renewable energy (wind, wave, solar), nuclear power and unconventional resources (tar sands). However better data are required to a common reporting standard.

DO WE NEED MORE MULTI-SKILLED SCIENTISTS AND ENGINEERS TO MANAGE ECONOMIC RECOVERY AND CHANGE?

National Science and Engineering Week Seminar on Thursday 12th March

The Parliamentary and Scientific Committee joined with the Department for Innovation, Universities and Skills to host the Seminar, which was jointly chaired by Dr Douglas Naysmith MP and Lord Drayson.

Every year in March a week is set aside to enable scientists and engineers, and the scientific, commercial and industrial organisations they are associated with, to celebrate their national achievements in Science and Engineering. The objective is to inform the public about the important and innovative work being done at present and to encourage the young to follow a career which will enable them to join in and become part of these achievements in the future. The Committee's contribution to this week was an afternoon of presentations by scientists, industrialists and entrepreneurs who are leading the way, followed by informed discussion.

The Rt Hon Lord Drayson
Minister of State for Science and Innovation

The first speaker was Lord Drayson, Minister of State for Science and Innovation in the Department of Innovation, Universities and Skills (DIUS), who is himself an engineer, the only one in the present Government.

Introducing Lord Drayson, Dr Douglas Naysmith MP, Chairman of the Parliamentary and Scientific Committee, thanked him for coming and reminded him that the wings of the Airbus are made in Bristol, his own constituency, and as an engineer Lord Drayson would appreciate and understand the value of the aircraft industry and of the work being done there.

In his introduction to the seminar and in response to questions from the floor, Lord Drayson made three main points:

Science and technology are at the heart of the national response to global recession and our strategy for long-term competitiveness. The country has never had a greater need for innovative scientists and engineers. The Government will not allow science to become a victim of the recession; instead, it will develop science – which includes engineering, social and physical sciences– as a means to economic recovery.

Government and the science community must identify priority sectors and where the best prospects for economic growth exist. They then need to decide where scientists and engineers will be

most needed and how best to invest in a UK research base with sufficient skills, breadth and scale. The minister stressed the importance of both pure and applied research.

Scientist and engineers need complementary skills that will help them to engage with policy makers, communicate with the general public, and pursue commercial possibilities arising from their research. Scientists with managerial skills, for example, are crucial at major sites like Diamond synchrotron and in conducting large-scale clinical trials. They also need an appreciation of the social context in which they operate. Lord Drayson recalled how wide-ranging, integrated training during his own PhD in robotics has benefited him in his subsequent career.

ENGINEERING THE FUTURE!

Dr John Wood CBE FREng
Chair of European Research Area Board, Chair of International Steering Committee European XFEL

Dr Wood said we need to revise our university structure to educate engineers for the 21st Century; the motivation is that in a changing world we need to change engineering and recognise that engineering is a verb as well as an adjective.

As the Prime Minister had already said:
"Engineers built our history and they will build our future"
Gordon Brown – Romaines Lecture, Oxford University, March 2009

The nature of engineering jobs is changing, they are becoming more complex as management becomes more complex with increasing globalisation. The number of engineers in the UK is static at about 24,000 but as a percentage of the UK undergraduate population it is low and falling.

A recent industry study concluded that, although our best engineers are competitive with the best elsewhere, we need more high calibre people and that the shortages are costing us money.

The conclusions of an academic survey agreed with industry that there is a need for more industry involvement, for instance, more opportunities to get your hands dirty, and this should have a higher priority.

Of greater concern, and perhaps more frightening, is the declining motivation of engineering students. To counter this and provide the vision we need to promote our flagship projects such as Racing Green, new medical developments and the new holistic approach to engineering.

The opportunity for the young to meet people who have made a difference is also important. We also hope the increasing number of female students will make a difference. The training of research engineers and PhDs needs to develop in a holistic way; the new teaching models start with practice. This new approach is a whole body problem to develop students with the calibre to deal with information around the world.

Open innovation is important as the scope of innovation continues to change; we are now progressing from closed to open innovation. Philips research at Eindhoven is now an open campus.

Research in the laboratory now starts with the needs of the end user. Open innovation and clustering is successful but under-funded. Today's engineers work in multi-disciplinary teams and the concept of clustering in major projects has been important in making something happen, transforming innovative ideas into reality, by identifying strategic priorities and in solving major engineering problems.

Massive projects with major design problems such as Airbus, ITER and CERN were undertaken in this way. And in these projects the UK are world experts in data management. The relationship between engineers, data and science is changing. The world of engineering is changing and university education must change also to continue to contribute to the innovative process. We are looking for quality, not quantity.

. . . The nature of engineering jobs is changing, they are becoming more complex . . .

THE SCIENCE AND TECHNOLOGY FACILITIES COUNCIL

Dr Andrew Taylor OBE FRSE
Director, Facility Development and Operations; Head ISIS, Science and Technology Facilities Council, Rutherford Appleton Laboratory

Science and engineering can provide a strong foundation for economic growth in the UK as we begin to move out of recession. As the Business Secretary Lord Mandelson has pointed out, the investment we maintain now in skills, transport and science is not only the ladder by which we will climb out of the downturn – it is also critical to our success in the upturn.

But to keep the UK at the forefront of the knowledge economy we will need to have the appropriate breadth and depth of technical skills in our workforce.

STFC is one of Europe's largest multidisciplinary research organisations. It operates a diverse set of world-class large-scale research facilities for universities, industry and other research councils. STFC also runs multidisciplinary centres of excellence and provides grant funding to universities in disciplines including particle and nuclear physics, space science and astronomy.

We are the UK partner in CERN, developing the Large Hadron Collider to probe the fundamental forces of nature. Through our telescopes around the world, we explore the heavens across a multitude of wavelengths. Our satellites look down on the earth and monitor its environment, and in the UK we have developed world-leading facilities to explore the molecular world.

HOW DOES STFC CONTRIBUTE TO THE UK SKILLS BASE?

To deliver these capabilities, we require world-leading technologies – making us a significant provider of advanced technology and engineering skills. So investment in this science base automatically delivers investment in skills.

Our training of PhD and post-doctoral researchers is one of the best forms of knowledge transfer. Attracting the best young minds into research creates new innovative applications for exploitation, some of which deliver the breakthrough technologies needed to keep this country at the forefront of the knowledge economy in the longer term. Training and retaining more UK-based researchers, and attracting researchers from overseas, is crucial for a science-led economic recovery.

But a truly unique factor which STFC can offer is the outstanding training environment provided by its UK facilities and the science and innovation campuses on which they sit.

At Daresbury we have unique capabilities in both accelerator and computational science and in detector technologies. At the Rutherford Appleton Laboratory we have world-leading facilities such as the ISIS neutron spallation source, the Diamond Light Source and VULCAN, the petawatt high power laser facility.

More than 4,000 university researchers use these facilities each year – at least half of them under thirty. As well as developing and maintaining the skills required for our own research programmes, we help the academic community to build its own research skills. And we help develop talented and experienced people for industry.

We therefore provide people who come to work at STFC – both staff and university researchers – with a unique training environment and outstanding learning and development programmes which enhance the national skills base.

Research centres like those operated by STFC are a melting pot of different disciplines that make them a creative hub of innovation. At ISIS, for example, we have technicians and engineers working alongside neutron scientists, biologists, chemists and physicists. This leads to the regular and efficient flow of ideas and knowledge and the sharing of different experiences, which enables new collaborations and projects to be developed – an outstanding example of knowledge transfer in practice.

Our engineers and scientists work at the very frontiers of technical knowledge and human ingenuity. We give our user communities access to equipment and capabilities that are often not available anywhere else in the world. Our people confront and solve extreme engineering and physics challenges every day, and many

of them then take this experience into other parts of the UK economy such as high-value engineering, aerospace, computing and the telecommunications industry.

APPRENTICESHIPS AND GRADUATE TRAINING

Our facilities on the science and innovation campuses at Daresbury and Harwell have a highly-regarded apprenticeship scheme and popular graduate training programmes. These graduate training schemes are accredited by the Institution of Mechanical Engineers, the Institution of Engineering and Technology and the Institute of Physics and are an accelerated route to achieving Chartered status.

The best evidence of a successful skills and training scheme is, of course, what people do afterwards. One former member of my team joined us as a technician. He showed real potential and we sent him to study in Germany. When we needed a very technically demanding development, he had the skills and knowledge to make it work, and today he is head of our linear accelerator programme. There are many stories like this.

At the ISIS second target station (TS2) we have a project manager who first joined STFC as a craftsman, and a project scientist who joined our organisation from school and is now a visiting professor at Oxford University.

The whole TS2 project would not have happened without the recruitment and training of talented young engineers and scientists through STFC's graduate programme.

While some of those we train stay to help maintain STFC's cutting-edge research capabilities, many of them go on to have impact elsewhere. Of the 11 graduate engineers we employed to work on TS2, for example, one now works on UK's fusion energy programme, one works in France on the ITER research facility and three have taken their skills into UK industry. The rest remain with STFC, helping to keep ISIS at the forefront of its field.

ECONOMIC RECOVERY

UK scientists, and the skilled engineers and technologists who develop and maintain their facilities and research tools, have a significant part to play in delivering economic recovery and continued prosperity to the UK.

During a recent consultation on STFC's strategy, we asked leading academics what they would do in the short-term with an increased UK science budget. They told us to spend it on training, skills and people.

This supports the prime minister's recently-stated view that the winners in globalisation will be the countries which train people with the skills to create value-added products and services.

It is only by increasing the number of skilled people that the UK will be able to address challenges such as energy, climate change and healthcare. These economic, societal and environmental challenges cannot be tackled without bright and committed people who are equipped with the right skills and knowledge, and provided with suitable resources.

In conclusion I would like to stress the link between scientific research and the UK's skills base. Investment in science is an investment in skills. Whether these skills stay in science or go and make an impact elsewhere in the economy, we need more of both.

THE ROLE OF A NATIONAL LABORATORY IN HELPING ECONOMIC RECOVERY

Professor John Pethica FRS
Chief Science Advisor,
National Physical Laboratory

The National Physical Laboratory (NPL) works at the interface of research, industry innovation and regulation. This position grants us a unique insight into how science and engineering can pave the road to economic recovery.

NPL was founded in 1900 to promote links between science and industry. At this time the UK Government was concerned about the economic impact of its competitors in rising new economies such as the US and Germany setting up national laboratories.

So there is nothing new about our concerns, and the issues we have to deal with today are effectively the same. There are now only a few national laboratories in the UK, but the Government needs to invest more in them if we are to stay ahead of the game.

National laboratories provide trusted, impartial reference points based on leading, openly published research. This engenders trust in technologies for both industry and the public at large, and in the policy decisions and regulation arising from new technologies. National laboratories have the ability to sustain a capability over a long period of time. For example, if the planet is warming at 0.1 degrees every 50 years, we need to have thermometers and radiometers to measure accurately to that level of absolute temperature reference. Otherwise we have a potentially very large investment policy we

are uncertain about.

NPL's process of doing research is planned and influenced by industry. Panels that set work programmes have industrial representation.

We operate with tightly defined deliverables and schedules, on a spectrum of short and long-term projects that are based on our core research expertise. Leading research is vital, and NPL is known for a number of key innovations including the atomic clock (the basis of GPS), packet-switching, and the world's first Local Area Network, the basis of the internet.

A rising percentage of our income (around 30-40%) is from industry – indicating the exceptional value for money we provide to the UK, and our high return on investment.

NPL is extremely effective in boosting UK industry. In terms of value for money, we provide a greater than 10:1 return on investment. We work with more than 4,000 companies from SMEs to multinationals, and determine our science areas according to industry needs. A customer survey of 1,200 companies shows a profitability gain of £700m from National Measurement System investment of £60m. NPL has short-term, real impact on the economy.

It is essential that we look at this with an international perspective. If the UK invests more, but the competition abroad is investing twice as much again, then we should be concerned.

The US National Institute of Standards and Technology (NIST) has received US$610m in funds as part of the American Recovery and Reinvestment Act of 2009. The agency says it will use the funds for programmes that support US innovation and industrial competitiveness to spur economic growth.

This is the scale of what we are up against. The UK has very few national laboratories and less investment compared to our competition. We could have a much greater impact, and need to rise to the challenge.

NPL has demonstrated immediate economic impact and high return on investment. We can do even more by increasing activities and moving into new technical areas.

Specifically there are three projects where NPL can make a tangible and immediate difference to ensure that the UK is primed to recover and prepare for future growth.

We urge increased investment in Measurement for Innovators, a programme in which the first 200 participants had a total annual sales increase of £5.3m and a total annual profit increase of £5m. The programme provides rapid assistance for companies close to market, that need additional support to prove a concept or make the step change from idea to product.

Secondly, there is a high risk that talent will be lost during the recession, creating skill shortages for industry once economic stability returns and new business opportunities emerge. NPL could offer research opportunities that will nurture a 'hothouse of talent' in critically important areas for future growth, such as data security, climate change, energy generation and advanced materials. Scientists at NPL acquire key skills at the interface between research and business.

Finally, we propose a Centre for Carbon Metrology to establish the infrastructure required for the UK to remain at the forefront of the global carbon market. The centre would provide confidence in environmental data and regulation, underpin carbon trading and validate low carbon technology. By building skills in this area, the UK can lead in a key future marketplace.

National laboratories have a unique position on the boundary of research, industry innovation and regulation. The UK needs to compete and rise to the challenge of increased funding for national laboratories overseas. This will ensure the UK's national laboratories continue to make a real economic impact and pave the road to economic recovery.

THE BUSINESS OF SHAPING OUR WORLD

Dr David Bott
Director of Innovation Programmes,
Technology Strategy Board

The world faces serious challenges. The sheer number of people, quadrupled in the last century, only tells part of the story. In the same time our requirements for food have gone up nine-fold, our use of energy has risen 16-fold and our manufacturing output 40-fold. That increased number of people also has to live somewhere, and travel. Over the last 100 years the number of vehicles on UK roads has risen from a handful to over 33 million, and air transport, which didn't exist at the turn of the last century, has reached almost 1.5 trillion passenger miles globally. Better healthcare also means that we live longer; in the next 40 years there will be almost twice as many over 65s and almost three times as many over 85s as there are now.

All these changes challenge the way we live and must be addressed. The complication is that we have now realised that we are using up the resources of our planet and putting a strain on its climate system, so these problems must be solved within a finite resource. Our almost insatiable desire for energy means that we are consuming natural resources such as coal and oil many thousands of times faster than they can be replenished, and in the process generating the

greenhouse gases that are affecting the climate system.

These challenges can be addressed, but it takes co-ordinated action at a national level to have real impact. Government is already taking action, and the policies being implemented are starting to cause market shifts that innovative companies can take advantage of to develop new products and services.

The Technology Strategy Board was "spun out" of Government in mid 2007 with the purpose of stimulating innovation in UK business. We have a wide range of tools and approaches to make this happen, from networks to research and development funding. To connect these Government programmes with business, we are currently running 'Innovation Platforms' in the areas of Intelligent Transport Systems and Services, Network Security, Low Carbon Vehicles, Assisted Living and Low Impact Buildings. We are constantly adding to this list by working with government departments to understand their policy goals and the actions they are taking to implement them.

The answers to these societal problems usually start with science and engineering – but that only goes so far towards providing the solutions that will be used in the real world. Psychologists and sociologists can help us understand the motivation of customers and others who will be needed to make these ideas work. Designers apply that understanding to make the solutions more attractive and more likely to be used. Economists bring understanding of potential impacts at the regional and national level. And most of all, entrepreneurs and business people can bring new ideas to life as real world products and services.

We have involved all these groups in our Innovation Platforms approach, and although a new organisation we are already seeing areas where we are making a real impact.

In a difficult economic climate it may sometimes seem difficult to justify investment in innovation. But that is exactly what is needed to help us find new market solutions which will help power the recovery and keep the UK competitive in the upturn.

Multi-skilled scientists and engineers will be vital to address the challenges we face, but it will take a holistic approach integrating science, innovation and business to bring solutions to bear which will really make a difference.

RENEWABLE ENERGY
A WEALTH OF OPPORTUNITY FOR SCIENTISTS, ENGINEERS AND THE UK ECONOMY

Philip Wolfe FEI, FRSA
Director General,
Renewable Energy Association

The renewable energy industry is undoubtedly a 'sunrise' sector of the economy with growth potential for many decades to come. Opportunities are particularly strong here in the UK as we have been slower than most countries to exploit our renewable energy potential even though openings are plentiful – indeed the UK has the best wind, wave and tidal regime in Europe.

A QUANTUM CHANGE IN RENEWABLE ENERGY DEPLOYMENT

The strong regulatory impetus provided by the new European Renewable Energy Directive should transform the situation. We have a binding obligation to increase the contribution of renewables from under 2% of the nation's energy today (held off the bottom of the European league table by Malta and Luxembourg) to 15% by 2020. At that level, renewables will have overtaken nuclear energy and coal, and be competing with oil for second place behind gas.

Apart from the scale of the change this will also present a wealth of opportunities by broadening the mix into a wide range of renewable technologies not commonly used in the UK today.

NEW OPPORTUNITY AREAS FOR SCIENTISTS AND ENGINEERS

The presentation highlighted some of the main engineering and technological opportunities in renewable energy production under three main headings:

New approaches in established technologies

Even proven and well-established technologies offer new technological opportunities

when deployed in novel ways or configured specifically to suit the UK market. Several elemental renewables technologies were identified, including:

- Offshore wind
- Tidal barrages and lagoons
- Building-integrated photovoltaics and solar thermal

Bioenergy technologies similarly offer opportunities of this type, including:

- Sustainable biofuels
- Bio-methane for injection into the gas grid

Higher volumes and efficiencies

Some renewable energy technologies are well established, but either not widely used in the UK or not yet optimised for application here. The following were specifically highlighted:

- Heat pumps
- Micro-hydro
- Biomass boilers and combined heat and power
- Anaerobic digestion

Emerging renewable technologies

Finally, and of self-evident interest to technologists are those approaches which are at an earlier stage of development. Of those listed in this category, several are areas where the UK already has an 'early mover' advantage:

- Wave energy conversion
- Tidal stream energy
- Second generation biofuels
- Microbial energy

A NEW ENERGY SYSTEM

It is also important to note that the whole infrastructure will change, for example, as we move to a higher proportion of decentralised energy. This will lead to new technological opportunities in areas such as:

- Heat networks
- Intelligent distribution systems
- Smart metering, incorporating improved user interfaces and real-time pricing
- Active load management and non-traditional storage options

A SUSTAINABLE 'NEW ENERGY DEAL'

To close, Philip Wolfe suggested that the pathway to recovery from the economic downturn must take us in a new direction, not return to the unsustainable model of the late 20th century. Extreme energy price volatility, climatic disasters and an unsustainable financial system have led to the present crisis and shown what we need to avoid in future.

That is why experts like Professor Lord Stern have called[1] for at least 20% of the economic stimulus packages now being put forward to be deployed on 'green' initiatives. Analysis[2] shows that President Obama's recent package delivers about 12%, the Asia Pacific region led by China achieves 23% while France and Germany average 15%.

He called for an equivalent UK green stimulus package of which a major part should be deployed in the energy sector, led by energy efficiency. Four specific areas were identified for immediate investment in renewable energy:

Decentralised energy, and in particular a bridge to the introduction of the new renewable energy tariffs, through an extension of the Low Carbon Buildings Programme to 2011, creating some 10,000 jobs and establishing a trajectory to make DECC's 2020 target of 7m sustainable homes realistic. This should be combined with a similar extension to Bioenergy Capital Grants to stimulate new biomass heat projects and anaerobic digestion facilities.

Bulk energy supply and transport energy should be supported through an interim increase of the multiple for offshore wind in the Renewables Obligation, restoration of the Renewable Transport Fuel targets, demonstration of heat networks, biogas injection into the grid and bioenergy fuels and vehicles.

Energy infrastructure is a further area which would benefit from seed-funding through the recession for systematic smart metering roll-out trials, initial development of intelligent distribution networks and related services.

Skills, training and awareness was also a rich area for short-term investment in skills training and jobs for workers in the energy, building services and bio-energy sectors.

1 *An outline of the case for a 'green' stimulus;* Alex Bowen, Nicholas Stern et al.; February 2009

2 *A Climate of Recovery? The Green Dimension to Economic Stimulus Plans;* HSBC; February 2009

DURING DISCUSSION THE FOLLOWING POINTS WERE RAISED:

In brief sessions immediately after each presentation:

Time is now short; do we have sufficient time to increase the amount of effort required for change? Action is urgently needed to develop vitally important skills in conjunction with university training to help take us through the current economic downturn in conjunction with investment in innovative projects. However, it is difficult to unravel and understand the amorphous spaghetti-like mass of different organisations and agencies involved, and how to tap into them. There is a plethora of schemes available and it is important to raise the profile of one's own group and where necessary pool resources with other groups in order to make an impact. Part of the problem is due to the rigid structure of the UK university system. If it was more flexible this would enable some students to develop a wider range of essential skills for business management, in addition to academic studies. For example, Government support for one year Masters degrees, which take students to the point where they are employable immediately on graduation as engineering specialists and without additional training, has been withdrawn just when it is most needed, on the basis that this type of specialisation is too near market and the responsibility of industry to provide.

Careers advice in schools and universities is generally lacking in the sciences or very ill informed and of very poor quality. This discourages many young people from undertaking engineering where interdisciplinary training, involving the integration of SET subjects with management skills, is vitally important for industry. Engineering medicine for example is an area where radical new developments are offering scope for engineers with interdisciplinary skills.

We also have to deal with a throwaway society in which it could become economic to mine waste dumps for raw materials in the future. Broadband technology has the potential to transform working patterns, turning every home into a workplace, thus reducing the need for transportation.

We are dealing with global problems including the developing world, which is particularly affected by climate change and where the agricultural economy is very important. Part of the problem is that Government has already decided on priorities, however people will need to decide on priorities.

Capital funding sources in the High Tech sector are drying up. Although £1 billion may be available to invest, this is not sufficient as venture capital partners are needed, since SMEs can't operate directly with support from banks. It's all about survival.

In more general discussion following all presentations:

We need to use this economic recession as an opportunity to shout from the rooftops the need for more scientists. The opportunity should be taken by Imperial College, for example, to re-employ scientists coming back from the City with real life skills using an Intern scheme set up for this purpose. In China big projects greatly helped with the generation of more engineers. The funding for Masters Degrees should be reinstated. Scientists should be retrained in the management of people as well as ideas, by learning how to interact with other people. The UK equivalent to the US President's Stimulus Package for recovery would amount to about £20 billion. What chance is there for such a package in the UK? The experience gained from such a programme should be recycled back into university training. This would need hands to be taken off bureaucratic accreditation procedures and letting the scientists and engineers get on with managing the job themselves.