EXCELLENCE IN SCIENCE

THE ROYAL SOCIETY

THEO MURPHY INTERNATIONAL SCIENTIFIC MEETING ON

The sustainable planet: opportunities and challenges for science, technology and society

Monday 12 – Wednesday 14 July 2010
The Kavli Royal Society International Centre

Organised by Professor Judith Howard CBE FRS, Professor Ash Amin FBA, Professor Martyn Chamberlain and Professor Matthew Davidson

- **Programme and abstracts**
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- **Poster abstracts**

The abstracts that follow are provided by the presenters and the Royal Society takes no responsibility for their content.

Monday 12 July 2010		Tuesday 13 July 2010				Wednesday 14 July 2010	
SESSION 1		**SESSION 2**		**SESSION 3**		**SESSION 4**	
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12.00	REGISTRATION AND LUNCH						
13.00	Welcome by Stephen Cox and Judith Howard	**09.30**	**Ian Wilmut** Biomedical and social contributions to sustainability	**14.00**	**Laurie Peter** Towards sustainable photovoltaics: the search for new materials	**09.00**	**Robert Edwards** Plants: biofactories for a sustainable future?
13.15	**Vicky Pope** The reality of climate change: evidence and myths						
13.45	Discussion	**10.00**	Discussion	**14.30**	Discussion	**09.30**	Discussion
14.00	**Stuart Lane** Water, risk and the future: the challenges of modelling and prediction	**10.15**	**David Newbery** The economics of strategic resource shortages and climate change	**14.45**	**Daniel Nocera** Personalised energy for 1 (x6 billion)	**09.45**	**Jackie Hunter** Challenges for pharmaceutical industry - how to inspire and incentivise innovation
14.30	Discussion	**10.45**	Discussion	**15.15**	Discussion	**10.15**	Discussion
14.45	Tea	**11.00**	Coffee	**15.30**	Tea	**10.30**	Coffee
15.15	**Lynda Armstrong** Towards a sustainable energy future: realities and opportunities	**11.30**	**David Satterthwaite** How urban societies can adapt to resource shortage and climate change	**16.00**	**Matthew Davidson** Challenges and opportunities for sustainable chemical technologies	**11.00**	**Magdi Yacoub** Disease appearance and evolution against a background of climate change and reduced resources
15.45	Discussion	**12.00**	Discussion	**16.30**	Discussion	**11.30**	Discussion
16.00	**Allan Jones** Low carbon options for the future provision of power	**12.15**	**Anthony Costello** Global health and climate change: moving from denial and catastrophic fatalism to positive action	**16.45**	**Jonathan Jones** Why GM crops	**11.45**	**Alan Bilsborough** **&** **Tom McLeish** Panel discussion: overview and future directions
16.30	Discussion	**12.45**	Discussion	**17.15**	Discussion	**12.15**	CLOSE
16.45	CLOSE			**17.30**	CLOSE		
18.30	DINNER	**13.00**	LUNCH	**18.30**	DINNER		

The sustainable planet: opportunities and challenges for science, technology and society

Organised by Professor Judith Howard CBE FRS, Professor Ash Amin FBA, Professor Martyn Chamberlain and Professor Matthew Davidson

Monday 12 – Wednesday 14 July 2010

Synopsis

This meeting will review global sustainability in the context of: climate change; supply of essential materials, food and energy; and new disease patterns. The challenges to global societies will be discussed and the potential of advances in biology, chemistry, physics, medicine, energy technology and materials science to ameliorate these problems will be considered, together with the intrinsic limits of wholly scientific solutions.

Monday 12 July 2010

12.00 Registration and lunch

13.00 Welcome by Mr Stephen Cox CVO, Executive Secretary, Royal Society
Welcome by Professor Judith Howard CBE FRS, Organiser

Session 1
Chair – Professor Martyn Chamberlain, Durham University, UK

13.15 The reality of climate change: evidence and myths
Dr Vicky Pope, Met Office Hadley Centre, UK

13.45 Discussion

14.00 Water, risk and the future: the challenges of modelling and prediction
Professor Stuart Lane, Durham University, UK

Jean Baudrillard argued in 1981 that our representations of the world, such as those created by mathematical models, commonly preceed it. Rather than reflecting the reality of the world as it is, or as it will become, in some kind of passive sense, our representations of future worlds are actively involved in transforming it. This is of particular importance to risk assessment, a major element of which is translating our understanding of the past into an assessment of the future, such that we can settle on interventions which reduce those risks assessed as meriting our attention. Such interventions have long been recognised as ones that can effect future risk. For instance, Gilbert White in 1942 described how the apparent elimination of the risk of floodplain inundation that follows construction of a levee effects a whole series of responses, ranging from individual misperception of eliminated risk through to community level decisions over where it is safe to build. In this paper, I want to go one step

further by showing how futures are effected by more than just the material interventions (e.g. the decision to construct levee) that follow from particular representations of the future (e.g. a mathematical model). I will show that the kinds of futures that we effect come about from a series of practices that cause the future to be represented in particular ways. These practices give hegemony to particular kinds of knowledges, institutions and interventions and go on to have material expression through the kinds of methods deployed to reduce flood risk. In turn, this creates 'sanitised landscapes', void of risk, and the experience of risk associated with living with flood events, and necessitating the development of 'virtual exposure' as a replacement for real exposure in an attempt to help us to learn how to live with flood risk. I conclude by arguing that it is through rethinking practice rather than representation that more sustainable water futures might come about.

14.30 Discussion

14.45 Tea

15.15 Towards a sustainable energy future: realities and opportunities

Lynda Armstrong OBE, Shell International Exploration and Production BV, The Netherlands

Billions of people today are still deprived of aspects of daily life that Europe and the US consider normal – clean water, electricity, sanitation. To lift people out of poverty, economic growth is a necessary – though not sufficient – condition. Increased energy demand is therefore not simply a reality, but a necessity in the coming decades. The challenge for industry, government and society is meeting this increased demand when existing energy sources are already under pressure and managing CO_2 and other emissions is an urgent imperative.

Some commentators suggest that there is a simple answer: change immediately to renewable sources of energy. However, any notion of a single 'silver bullet' to solve the global energy challenge is unfounded and unhelpful. Fundamental forces, including costs, availability, the time and resources needed to convert existing extensive infrastructure, and the ongoing progress in delivering cleaner fossil fuel energy, mean that oil, gas and coal will be key ingredients in a sustainable energy future. Fossil fuels will provide an economically, socially and environmentally viable future – and will continue to account for the dominant share of the energy mix until mid-century and beyond.

The real key to solving the energy challenge lies in diversity of energy sources. It is essential to have informed debate about what constitutes the right balance of energy sources. However, such debate is currently clouded at times by lack of definition and clarity (especially around the term 'peak oil'), and by the ongoing propagation of certain myths. Three myths in particular will be examined: that global gas supply is declining; that oil sands will never be cost effective; and about the real cost and contribution of renewables. The impact of technology on the changing energy landscape will be considered, and key areas of focus for business and public policy decision makers will be highlighted.

15.45 Discussion

16.00 Low carbon options for the future provision of power

Professor Allan Jones FREng, E.ON New Build & Technology Limited, UK

The impact of an energy 'trilemma' is now fully understood as governments, industry and academia globally try to develop technologies and resulting roadmaps for a low carbon future in order to

combat climate change. There is a clear requirement for a concerted RD&D effort to address the often conflicting issues of cost, security of supply and environmental impact when considering the extensive range of possible technology solutions for the generation and supply of electricity that could contribute to first stabilisation and then possible reversal of the increasing levels of carbon dioxide in the atmosphere. Add to these three primary concerns the unpredictable rate of introduction of suitable technologies, which could be adversely affected by the procrastination of governments, the absence of suitable market mechanisms, public scepticism, environmental campaigners and slow progress through necessary pre-commercial demonstration, and the quandary facing the energy companies in respect of planning future investments becomes clearly evident.

In this presentation, the options for carbon abatement in electricity generation and end-use are reviewed and residual issues and impediments discussed: specific attention is focussed on the research and demonstration needs of some of the new candidate technologies.

16.30 Discussion

16.45 Close

Tuesday 13 July 2010

Session 2
Chair – Professor Ash Amin FBA, Durham University, UK

09.30 Biomedical and social contributions to sustainability
Professor Sir Ian Wilmut FRS, University of Edinburgh, UK

New developments in regenerative medicine have the potential to make a great contribution to sustainability of human society. Stem cells may be used to provide new therapies by their use to identify drugs that prevent the development of symptoms or to replace cells that have either died or lost their physiological function. While most conditions that might be treated in these ways are common to all communities, some are more prevalent in specific races. One such example is thalassaemia, a genetic disease of red blood cells. Strategies are being developed to provide a means of correcting the genetic cause of more severe cases through production and genetic modification of stem cells that would be returned to the patient.

Provision of these and other benefits depends not only on attainment of the research objectives, but also upon our ability to make the new opportunities available throughout both the developed and developing communities.

10.00 Discussion

10.15 The economics of strategic resource shortages and climate change
Professor David Newbery FBA, University of Cambridge, UK

Concerns are growing over the ability of the planet to sustain predicted resource demands as population and standards of living are forecast to rise – global GDP has been growing at over 3% for the past 25 years and is doubling every 23 years. Resurgent China and India seem likely to if anything

accelerate that trend, which is already putting pressure on such resources as oil, key minerals like phosphorous, fresh water, fertile land, forests, and, critically, the assimilative capacity of the atmosphere, the acidity of the oceans and biodiversity. This paper looks at one illustrative example, oil, of the role of economics in the analysis of resource 'shortages' and contrasts it with the problem of the global commons posed by climate change. Oil is an exhaustible resource, and under ideal conditions and with well-functioning markets, both unfortunately absent, its price would tend to rise as it became more scarce, and hence efficiently used until its price rose to the level at which replacements would become relatively cheaper. The paper will discuss market failures and the potential disruptions these may cause. The problem with climate change is that GHG emissions now arise from highly valued activities but produce persistent global pollutants with uncertain future impacts, mostly damaging to human welfare and natural capacities, and thus giving rise to the most important market failure or tragedy of the global commons facing mankind. Market solutions can be imagined but require political agreement to create the coalitions needed to support these or other solutions. The paper asks what economists can bring to that political discussion.

10.45 Discussion

11.00 Coffee

11.30 How urban societies can adapt to resource shortage and climate change
Dr David Satterthwaite, International Institute for Environment and Development, UK

With more than half the world's population now living in urban areas and with much of the world still urbanising, there are concerns that urbanisation is a key driver of unsustainable resource demands. Urbanisation also appears to contribute to ever-growing levels of greenhouse gas emissions while large sections of the world's urban population are or will soon be at high risk from the impacts of climate change. In much of Africa and Asia, urbanisation has long outstripped local governments' capacities as can be seen in the high proportion of the urban population living in poor quality, overcrowded, illegal housing lacking provision for water, sanitation, drainage, health care and schools. But there is good evidence that urban areas can combine a high quality of life with relatively low greenhouse gas emissions and resource demands. This presentation will use some of these examples and consider what these imply for urban policies in a resource-constrained world that also needs to reduce greenhouse gas emissions.

12.00 Discussion

12.15 Global health and climate change: moving from denial and catastrophic fatalism to positive action
Professor Antony Costello, University College London, UK

The health effects of climate change have had relatively little attention from climate scientists and governments. Climate change will be a major threat to population health in the current century through its effects on communicable disease, heat stress, food and water security, extreme weather events, vulnerable shelter and population migration.

This paper addresses three health sector strategies to manage the health effects of climate change – promotion of mitigation strategies, tackling the pathways that lead to ill-health, and strengthening health systems. Mitigation of greenhouse gas emissions is affordable, and renewable technologies are

available now or will be in the near future. Pathways to ill-health can be managed through better information, poverty reduction, technological innovation, social and cultural change, and greater co-ordination of national and international institutions. Health systems strengthening requires increased investment in order to provide effective public health responses to climate-induced threats to health, equitable treatment of illness, promotion of low carbon life-styles and renewable energy solutions within health facilities. Mitigation through strategies for household energy, transport, food and agriculture, and electricity generation will produce substantial benefits for health such as reductions in obesity and heart disease, diabetes, stress and depression, and deaths from pneumonia and asthma, as well as major cost-savings within the health sector.

The case for climate change is overwhelming and the global health threat real and urgent. Action must not be delayed by contrarians, nor by catastrophic fatalists who say it is all too late.

12.45 Discussion

13.00 Lunch

Session 3
Chair – Professor Judith Howard CBE FRS, Durham University, UK

14.00 Towards sustainable photovoltaics: the search for new materials
Professor Laurie Peter, University of Bath, UK

The EU has set a target for photovoltaic (PV) generated electricity to become competitive with conventional generation by 2020-2030. If PV is to make a major contribution to a low-carbon energy economy, cost and sustainability issues need to be addressed. Current non-silicon PV technologies are based on cadmium telluride (CdTe) and the chalcopyrite $Cu(In,Ga)Se_2$ (CIGS). The availability and cost of indium are geopolitical issues, since indium is used in electronic displays. Similarly, the rarity of tellurium has implications for the sustainability of CdTe solar cell technology. These issues provide the rationale for expansion of the range of materials available for PV applications. A promising sustainable replacement for CIGS is Cu_2ZnSnS_4. (CZTS). This material can be prepared using electrochemical methods that have the potential for large scale low cost fabrication. In addition, electrochemical methods are powerful tools for characterization of PV materials and components. These two topics will be explored.

14.30 Discussion

14.45 Personalized energy for 1 (× 6 billion)
Professor Daniel G Nocera, Massachusetts Institute of Technology, USA

The capture and storage of solar energy at the individual level – personalized solar energy – drives inextricably towards the heart of this energy challenge by addressing the triumvirate of secure, carbon neutral and plentiful energy. Because energy use scales with wealth, point-of-use solar energy will put individuals, in the smallest village in the non-legacy world and in the largest city of the legacy world, on a more level playing field. Moreover, personalized energy (PE) is secure because it is highly distributed and the individual controls the energy on which she/he lives. Finally, the doubling of global energy need by mid-century and tripling by 2100 is driven by 3 billion low-energy users in the non-legacy world and by 3 billion people yet to inhabit the planet over the next half century. The possibility

of generating terawatts of carbon-free energy, and thus providing society with its most direct path to realizing a low GHG future, may be realized by making solar PE available to the 6 billion new energy users by high throughput manufacturing. Notwithstanding, current options to harness and store solar energy at the individual level are too expensive to be implemented, especially in a non-legacy world. The imperative to science is to develop new materials, reactions and processes that enable personalized solar energy to be sufficiently inexpensive to penetrate global energy markets and especially the non-legacy world.

Personalized energy at low cost presents new basic research targets. Because personalized energy will be possible only if solar energy is a 24/7 available supply, the key enabler for personalized energy is inexpensive storage. Studies in the Nocera group have led to the creation of a new catalyst that captures many of the functional elements of photosynthesis and in doing so provides a highly manufacturable and inexpensive method to effect a carbon-neutral and sustainable method for solar storage – solar fuels from water-splitting. By developing an inexpensive 24/7 solar energy system for the individual, a carbon-neutral energy supply for 1 × 6 billion becomes available.

15.15 Discussion

15.30 Tea

16.00 Challenges and opportunities for sustainable chemical technologies
Professor Matthew Davidson, University of Bath, UK

16.30 Discussion

16.45 Why GM crops
Professor Jonathan Jones FRS, The Sainsbury Laboratory, Norwich Research Park, UK

GM (genetically modified) crops have had additional genes, that confer defined useful traits, added to their gene complement. It has been rapidly adopted; 14 million farmers grow GM crops on 135 million hectares, and these numbers have increased by about 10% per year over the last decade. Insecticide applications have been reduced thanks to built-in insect resistance in Bt crops. Bt maize is safer to eat because of lower levels of mycotoxins. Protection from rootworm means maize crops capture more water and fertilizer, so less is wasted. Farmers must always control weeds; herbicide tolerance facilitates this control, and has enabled replacement of water-polluting persistent herbicides with the more benign and rapidly inactivated glyphosate (Roundup). New genomics tools facilitate the isolation and deployment of disease resistance genes from crop relatives, without the linkage to deleterious traits that constrains conventional introgression breeding.

And yet in Europe, we seem stuck in a timewarp; hostility to GM food and crops appears widespread. I will discuss the benefits of the technology, and consider why European consumers have not been convinced, and what might be required to persuade them.

17.15 Discussion

17.30 Close

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Session 4
Chair – Professor Matthew Davidson, University of Bath, UK

09.00 Plants: biofactories for a sustainable future?
Professor Robert Edwards, Durham University, UK

In addition to feeding a growing population, we are increasingly turning to plants as renewable feed-stocks to replace fossil fuels. By analogy to the oil industry, efficiently refining plants is a massive interdisciplinary challenge to plant scientists, chemists and engineers, with the technology of biorefining now rapidly developing, initially driven by the needs of biofuel production but in the longer term to derive platform and fine chemicals. One obvious drawback of using higher plants as feed-stocks is their biochemical heterogeneity and difficulties in extraction and processing. Current approaches have concentrated on improving down-stream chemical and biological processing. In an alternative strategy, with our increasing knowledge of biochemistry and physiology it should be possible to design plants to be better feedstocks for biorefining. As such, the new science of synthetic biology whereby organisms can be selectively re-engineered with new and complex traits offers a means of fast-tracking plants to be better starting materials for biorefining. In response to this opportunity an interdisciplinary community of biologists and physical scientists has been supported by the UK research councils to form a network in synthetic biology termed Synthetic Plant Products for Industry to develop this concept.

09.30 Discussion

09.45 Challenges for pharmaceutical industry - how to inspire and incentivise innovation
Dr Jackie Hunter CBE, Pharmivation Ltd, UK

Over the last decade the success of the pharmaceutical industry has declined in real terms whereas the costs of pharmaceutical R&D have increased significantly. It now costs over a billion dollars to bring a new product to market, including the costs of compounds that failed. There are other pressures on the industry including the need for new outcome measures, comparative effectiveness and other reimbursement requirements, constrained government healthcare budgets and the need for access to medicines by the developing world. Despite these and other pressures, new medicines are urgently needed and this requires both increased efficiency and innovation – some see these two as mutually exclusive but they are in fact highly connected. For innovation to be successful operational efficiency is required in its implementation. At the same time technological and organisational innovations are an essential component of efficiency.

There are four main areas where innovation will be critical for the industry:-
- Business models

These will include new collaborative models within and without the pharmaceutical industry, further reshaping of internal R&D and new commercialisation models
- Personalised medicine

Providing healthcare solutions for individuals will require significant innovation not only in terms of technology but also in the understanding and communication of risk-benefit
- Systems biology

Harnessing 'omics knowledge and physiology for better disease understanding and drug development will require innovation in both industry and academia

- Digital heathcare

The opportunities and challenges for innovation provided by the digital environment are potentially enormous but will require significant dialogue across all stakeholders.

10.15 Discussion

10.30 Coffee

11.00 Disease appearance and evolution against a background of climate change and reduced resources

Professor Sir Magdi Yacoub KBE FRS, Imperial College London, UK

Global health continues to face increasing challenges due to a variety of reasons which include the almost constant changes in disease appearance and evolution. Most, but not all of these changes, affect low income countries and are influenced by climate change. Tracking the recent and anticipated changes in the demographics and global distribution of these changes is essential for evolving effective new methods for dealing with the problems.

Up until recently, emphasis was put almost exclusively on infectious diseases which are responsible for a significant proportion of the problems facing global health. The recent recognition by the United Nations, of the importance of non-communicable diseases which include cancer and importantly cardiovascular disease is a major positive step in that regard. We here discuss changes in several diseases to illustrate the important issues concerned both with regard to emergent diseases and changes, sometimes unexpected, in the evolution of these diseases and discuss the possible relation of these changes to climate change and reduced resources.

11.30 Discussion

11.45 Panel discussion: overview and future directions

Professor Alan Bilsborough & Professor Tom McLeish, Durham University, UK

12.15 Close

Organiser, speaker and chair biographies

Professor Ash Amin FBA, Durham University, UK (Organiser and Chair)
Ash Amin is Professor of Geography at Durham University and Executive Director of the university's Institute of Advanced Study. He is a Fellow of the Academy of Social Sciences, Fellow of the World Academy of Arts and Sciences, and Fellow of the British Academy. He was awarded the Royal Geographical Society's Edward Heath Prize in 1998 for contributions to research on Europe.

One of the UK's most celebrated urbanists, Professor Amin is known for his work on the geographies of modern living, for example urban and regional society as relationally and materially constituted; and globalisation as an everyday process that thoroughly reconstitutes meanings of the local. He has also contributed to re-thinking the economy as a cultural entity, while his writings on multiculturalism have helped change policy on the management of ethnic diversity. He has (co) authored or (co) edited 17 books and (co) written over 100 journal articles and book chapters. His most recent books include: *Cities: Re-imagining the Urban* (with Nigel Thrift, , Polity,2002); *Architectures of Knowledge* (with Patrick Cohendet, Oxford University Press, 2004); *The Blackwell Cultural Economy Reader* (edited with Nigel Thrift, Blackwell, 2005); *Community, Economic Creativity and Organization* (edited with Joanne Roberts, Oxford University Press, 2008); *The Social Economy* (edited, Zed Books, 2009); and *Thinking About Almost Everything* (edited with Michael O'Neill, Profile Books, 2009).

Lynda Armstrong OBE, Shell International Exploration and Production BV, The Netherlands (Speaker)
Lynda is a Technical Vice President with Shell International. She leads Shell's Exploration & Production Global Petroleum Engineering field development planning and study organisation, which has centres in The Netherlands, Houston, Aberdeen, India and Qatar. She has worked for Shell for more than 30 years in a variety of assignments around the world. These have included positions in Hydrocarbon Exploration and Production, Commercial and HR when she worked in recruitment and international staff planning.

Previous assignments have included New Business Development Director in Shell UK and Exploration Director in Petroleum Development Oman. She is experienced in managing large technical organisations and has led several major business improvement programmes to enhance operating performance.

In 2003 she was awarded the Order of the British Empire by the British Government for services to the Oil and Gas industry. She is a Fellow of the Energy Institute, a member of the Industry Board for the UK Resource Centre for Women in Science, Engineering and Technology and on the Editorial panel of the *International Journal of Gender, Science and Technology.*

Professor Alan Bilsborough, Durham University, UK (Panel)
Alan Bilsborough is Emeritus Professor of Anthropology at Durham University. He was previously Demonstrator and Lecturer in Physical Anthropology, Cambridge University (1968-1984), and Professor of Anthropology at Durham (1985-2009), where he was also Dean of Social Sciences and Pro-Vice-Chancellor. His research interests are in the fossil record for human evolution, especially the cranio-dental evidence, and phyletic and adaptive interpretations based upon this. As well as several overview accounts, he has published

on facial structure and its adaptive basis in *Australopithecus* and early *Homo*, the nature, extent and significance of diversity within *Homo erectus*, Neanderthal and early modern cranial and dental morphology, and on contingency, patterning and species in hominid evolution. He is currently working on a survey of early hominid diversity, and is an Advisory Editor for the *Blackwell Encyclopaedia of Human Evolution.*

Professor Martyn Chamberlain, Durham University, UK (Organiser and Chair)
JM Chamberlain is Professor of Applied Physics and Master of Grey College at Durham University. Before taking up his present post, JMC worked at Nottingham and Leeds Universities. JMC is a semiconductor physicist by background, although for a number of years he has worked on the development of the technology and applicable science of the terahertz (THz) frequency range. This has involved the realisation of new types of components and systems, together with the exploitation of THz radiation in such areas as: medical imaging, biology, security and non-destructive testing. He has also led a number of EU programmes in this field. He is one of the founder members of the Durham Biophysical Sciences Institute. He has authored more than 250 papers, given many invited talks and is a Fellow of the Institute of Physics.

Professor Antony Costello, University College London, UK (Speaker)
Anthony Costello is Professor of International Child Health, Director of the Centre for International Health and Development at the UCL Institute of Child Health, and Director of the UCL Institute for Global Health. His areas of scientific expertise include the evaluation of community interventions on maternal and newborn mortality, women's groups, the cost-effectiveness of interventions, community and social life saving treatments for maternal and newborn mortality in the poorest populations, nutritional supplementation and international overseas aid flows for maternal and child health. He has published over 100 papers in international journals, including the Lancet, BMJ, Pediatrics, American Journal of Clinical Nutrition, PLOS Medicine and Biomed Central journals, and has received award grants of over £20m including programme and project grants from the UK Department for International Development, the Wellcome Trust, Saving Newborn Lives Initiative, the Big Lottery Fund and the Health Foundation. He is the founder and Executive Director of Women and Children First, a UK based NGO which has developed an international programme of support for programmes to improve maternal and child health in poor populations. He is an Honorary Consultant Paediatrician at Great Ormond Street Hospital for Children NHS Trust and at the Hospital for Tropical Diseases, UCLH Trust.

Mr Stephen Cox, Executive Secretary, Royal Society, UK (Welcome)
Stephen Cox is the Executive Secretary (Chief Executive) of the Royal Society, a post he has held since 1997. He is a geographer by background and has worked overseas in South America, Eastern Europe and West Africa. Previously he was the Chief Executive of the Westminster Foundation for Democracy working closely with both Houses of Parliament to support institutions in the emerging democracies of Central Europe, former Soviet Union and Anglophone Africa. Before that he was appointed by the Secretary of State for Foreign and Commonwealth Affairs to be Director General of the Commonwealth Institute in London. He joined the Overseas Career Service of the British Council in 1969, was posted to Warsaw, Poland and then spent time in West Africa, notably Ghana and Toga, with the British Council. He did voluntary Service Overseas in Bolivia.

He was born and educated in Blackburn and at Atlantic College and graduated in geography from Birmingham University in 1969, has a postgraduate diploma from Leeds University and an MA from The University of Sussex.

He is a Fellow of the Royal Geographical Society, Vice-President of the Parliamentary and Scientific Committee, member of the governing body of Kingston University, the Commonwealth Round Table and

Council for Assisting Refugee Academics. He was awarded a CVO in 1997 Queen's Birthday Honours and an honorary Doctorate of Science from Lancaster University in 2003.

Professor Matthew Davidson, University of Bath, UK (Organiser, Speaker and Chair)
Matthew Davidson is currently Whorrod Professor of Sustainable Chemical Technologies at the University of Bath. He graduated in Chemistry from the University of Wales, Swansea, in 1990 and received a PhD from the University of Cambridge in 1993. He was elected to a Research Fellowship at St John's College Cambridge in 1992 and held Lectureships in the Department of Chemistry at Cambridge (1995) and at Durham University (1995-1999) before being appointed to a Chair of Inorganic Chemistry at the University of Bath in 1999. He established the Centre for Sustainable Chemical Technologies (CSCT) at Bath in 2008 and is currently Director of its EPSRC Doctoral Training Centre (DTC). Professor Davidson is a Fellow of the Royal Society of Chemistry and is a previous recipient of the Harrison Memorial Prize of the Royal Society of Chemistry and a Royal Society Industry Fellowship.

Professor Robert Edwards, Durham University, UK (Speaker)
Robert Edwards trained as a biochemist at the Universities of Bath (B.Sc 1981) and London (Ph.D 1984), specializing in the biotransformation of synthetic compounds. He has subsequently worked in the private sector in the UK and US (Schering Agrochemicals; Noble Foundation), before moving to Durham University as a lecturer in 1991. As an independent investigator, he has developed interests in herbicide selectivity, plant secondary metabolism and most recently in biorefining and has published over 200 related papers, book articles and patents. In 2004, in recognition of his contributions to plant biochemistry, he was awarded a 5 year research development fellowship by the Biotechnology and Biological Sciences Research Council. Currently Head of the Biology Department at Durham, he will be taking on the role of Chief Scientist at the Food and Environment Research Agency as of August 2010.

Professor Judith Howard CBE FRS, Durham University, UK (Organiser and Chair)
Professor Judith Howard CBE FRS began her career as a DPhil student at Oxford carrying out neutron studies of biological molecules with Nobel laureate Professor Dorothy Hodgkin OM. Research in Bristol (1969-91) preceded appointment to the foundation chair of Structural Chemistry and first female Professor of Chemistry at Durham (1991). She became the first woman president of the British Crystallographic Association in 1992 and the first woman to head a five-star chemistry department at a UK university in 2006, a post from which she just retired. She is now the Director of the newly founded Biophysical Sciences Institute at Durham which spans 6 departments in the Science Faculty.

She was a Royal Society Vice-President 2004-5, and has also served on many national and international scientific and educational committees and working groups.

Dr Jackie Hunter CBE, Pharmivation Ltd, UK (Speaker)
Dr Jackie Hunter has worked in the pharmaceutical industry for over 20 years and in 2002 she was appointed SVP and Head of the Neurology and Gastrointestinal Centre of Excellence (CEDD) for GlaxoSmithkline. The CEDD was focussed on the development of new therapeutics for neurodegenerative disorders, pain and gastrointestinal diseases such as inflammatory bowel disease.

In 2008 she became Head of Science Environment Development where she was responsible for developing an R&D strategy for precompetitive research and working with external scientific partners. She established GSK as a leader in open innovation and led the creation of the world's first 'open innovation' campus for the pharmaceutical industry in Stevenage UK. She also played a leading role in the establishment of the Innovative Medicines Initiative in Europe and chaired the EFPIA research Directors Group.

In 2010 she left GSK forming Pharmivation Ltd, to concentrate on open innovation in bioscience. Jackie is also non-executive director of Proximagen Neuroscience. She was recently named as one of 2010's Women of Outstanding Achievement in Science, Engineering and Technology for her contribution to innovation and entrepreneurship.

Professor Allan Jones FREng, E.ON New Build & Technology Limited, UK (Speaker)
Allan Jones is the UK Country Director for New Build and Technology, E.ON's centre of excellence for Science, Engineering and Technology with offices in Gelsenkirchen and Hannover in Germany and Nottingham in the UK Nottingham.

Allan is a fuels, combustion and emissions expert with almost 35 years experience in the field. Previously to his current role, Allan held the role of Head of Research and Development for E.ON UK.

Following his work on technologies to reduce dust emissions from oil fired utility boilers; Allan was the recipient of a prestigious Royal Society Esso Energy Award. He gained a second award, the Institute of Energy Caleb Brett award, for his work on demonstrating the viability of Orimulsion as a reburn fuel to reduce NOx emissions.

Allan graduated from Southampton University with both a BSc and PhD in Physics. In 2004 he was elected as a Fellow of the Royal Academy of Engineering in recognition of his efforts to produce cleaner power from fossil fuels and he gave the 2005 BCURA Coal Science Lecture for which he was awarded the Robens Medal. In August 2006 he was awarded a Special Professorship in Low Carbon Technologies for Power Generation by the University of Nottingham. He was awarded a second Special Professorship in the School of Building Physics and Civil Engineering at Loughborough University in 2008.

His expertise is recognised through his holding of many key posts including Chairman of the Combustion Physics Group of the UK Institute of Physics, Director and now President of British Flame, Director and Vice President of the British Coal Utilisation Research Association, Chairman and founder member of the UK Coal Research Forum, a member of the UK Government Advisory Committee on Carbon Abatement Technology and a member of the UK Advanced Power Generation Technology Forum. He is also a Board Member for the UK Energy Technologies Institute; and sits on the Research Advisory Committee of the Electric Power Research Institute (EPRI) of the USA.

Professor Jonathan Jones FRS, The Sainsbury Laboratory, Norwich Research Park, UK (Speaker)
After PhD studies in cereal cytogenetics with Dick Flavell at the Plant Breeding Institute in Cambridge, Jonathan Jones (JJ) was a postdoc with Fred Ausubel at Harvard, working on symbiotic nitrogen fixation.

He then (1983-1988) worked in the private sector at a startup agbiotech company (Advanced Genetic Sciences, Oakland, California) founded to exploit new developments in molecular biology for crop improvement. This company was the first to field test a GM organism ("Frostban" the "ice minus" Pseudomonas strain for frost protection).

In 1988, he became one of the first recruits at The Sainsbury Laboratory in Norwich, and is a leading researcher in plant disease and disease resistance. His publications include: "The plant immune system", Jones JD, Dangl JL. Nature [2006] 444; 323-9 and "Plant pathogens and integrated defence responses to infection", Dangl JL, Jones JD. Nature. [2001] 411: 826-33. He currently uses new genomics methods to investigate how pathogens suppress host defences.

He has co-founded 2 companies; Mendal Biotechnology, founded in 1997 to discover key regulators of crop productivity, and Norfolk Plant Sciences Ltd, to combine health-promoting and disease resistance traits in potato and tomato.

JJ was elected a Professor at the University of East Anglia in 1997, a member of EMBO in 1998, and was elected FRS in 2003. He is a board member of the European Plant Science Organization (EPSO). He was part of the Royal Society working group that produced the "Reaping the Benefits" report.

He has posted comments on GM crops at the Independent (independent.co.uk/arts-entertainment/why-im-happy-to-play-god-with-your-food-1163739) and the Guardian "Comment is free" website (commentisfree.guardian.co.uk/jonathan_dg_jones/profile) His lab page is tsl.ac.uk/profile/jonathan-jones.asp.

Professor Stuart Lane, Durham University, UK (Speaker)
MA, PhD, Cambridge (1994). PhD research coupled civil engineering and geomorphology to understand how rivers work. Lectured in Cambridge until 2000 when he took up a Chair in Leeds, moving to a Chair in Durham in 2004, becoming Director of Durham's Institute of Hazard, Risk and Resilience in 2008. Research concerned with innovative modelling of rivers and catchments and their impacts upon people and organisms, including floods, droughts, fish and bugs. Has received a number of awards - from the International Association of Geomorphologists, International Association of Hydraulic Research, Remote Sensing and Photogrammetry Society and a Phillip Leverhulme Prize in Earth and Environmental Science.

Professor Tom McLeish, Durham University, UK (Panel)
Tom McLeish did a first degree in physics and PhD (1987) in polymer physics at the University of Cambridge. He became a lecturer in physics at the University of Sheffield, building a group working on the theory of dynamics of complex fluids. In 1993 he took the chair in polymer physics at the University of Leeds. He has since won several awards both in Europe and the USA for his work on molecular rheology of polymers, and ran a large collaborative and multidisciplinary research programme in this field from 1999-2009 co-funded between EPSRC and industry.

From 2000-2005 he was a Senior Research Fellow of the EPSRC (UK), and from 2003-2009 the Director of the UK Polymer IRC, a multidisciplinary consortium of over 100 polymer scientists from university and industry. From 2004-2008 he was also Director of the White Rose Doctoral Training Centre in Biomolecules and Cells. He has consulted for a number of chemical industries.

His research interests include: (i) molecular rheology of polymeric fluids); (ii) macromolecular biological physics; (iii) issues of theology, ethics and science. He has published over 150 scientific papers and reviews, and is in addition regularly involved in science-communication with the public.
In 2008 he was appointed Pro-Vice-Chancellor for Research at Durham University.

Professor David Newbery FBA, University of Cambridge, UK (Speaker)
David Newbery, PhD, ScD, FBA, is Professor of Applied Economics at the University of Cambridge and Research Director of its Electricity Policy Research Group. Educated at Cambridge with degrees in Mathematics and Economics, he is a Fellow of the Econometric Society, the British Academy and the Centre for Economic Policy Research. He was President of the European Economic Association in 1996, awarded the Frisch Medal of the Econometric Society, 1990; and the IAEE 2002 *Outstanding Contributions to the Profession of Energy Economics* Award. Has advised Ofgem, Ofwat, and ORR, was a member of the Competition Commission, chairman of the Dutch Electricity Market Surveillance Committee. Currently on DEFRA's academic panel of environmental economists and chair of the Lead Expert Group, Foresight Land

Use Futures. Current research on electricity market design (including security of supply), transmission pricing, regulation, market power, environmental and energy policy design. Recent books *A European Market for Electricity?* (with others), and *Privatization, Restructuring and Regulation of Network Utilities*. Guest editor of *The Energy Journal* (2005) issue on European electricity liberalisation, and recently the recipient of *Papers in Honor of David Newbery: The future of electricity*¸ in *The Energy Journal* (2008).

Professor Daniel G Nocera, Massachusetts Institute of Technology, USA (Speaker)
Daniel G Nocera is the Henry Dreyfus Professor of Energy at the Massachusetts Institute of Technology, Director of the Solar Revolutions Project and Director of the Eni Solar Frontiers Center at MIT. His group pioneered studies of the basic mechanisms of energy conversion in biology and chemistry. He has recently accomplished a solar fuels process that captures many of the elements of photosynthesis outside of the leaf. This discovery sets the stage for a storage mechanism for the large scale, distributed, deployment of solar energy. He has been awarded the Eni Prize (2005), IAPS Award (2006), Burghausen Prize (2007), Harrison Howe Award (2008), ACS Inorganic Chemistry Award (2009) and the U.N. Intergovernmental Renewable Energy Organization's Science and Technology Award (2009) for his contributions to the development of renewable energy. He is a member of the American Academy of Arts and Sciences and the National Academy of Sciences. He was named as Times Magazine 100 Most Influential People in the World.

Nocera is a frequent guest on TV (*CNN, ABC Nightline*, *PBS, ABS Nature's Edge, Jim Lehrer News Hour, NOVA*, *CBS*, *CNBC, Discovery Channel, The Science Channel* and *Plum* in the U.S. and *Explora* and *RAI* in Europe), radio (*NPR, Bloomberg News, CBS, BBC, All Things Considered, Here and Now, Climate Connections, Voice of America*) and is regularly featured in print (*New York Times, National Geographic, Forbes, Discover, Wall Street Journal, Time Magazine, The New Republic, US News and World Report, Outside Magazine, Wired, Technology Review*). His 2006 PBS show was nominated for an Emmy Award. He worked with Robert Krulwich of ABC News to develop the pilot that was used to launch the PBS NOVA show, ScienceNow. He also worked with Mr. Krulwich and the web designer OddTodd to develop a five part series on *The Lifestyle of Carbon*, which was sponsored by the *National Geographic*. He opened the Mountain Film Festival 2007 in Telluride CO, the Aspen Forum in Aspen CO in 2008 and 2009, and the World Science Festival in NYC in 2008. He sits on several advisory boards and is currently working with several artists in the U.S and abroad, actors and producers in Los Angeles and major business leaders in the U.S. to help them develop a position that contributes positively to the energy and sustainability challenge confronting this planet. In 2008, he founded Sun Catalytix, a company committed to bringing personalized energy to the non-legacy world.

Professor Laurie Peter, University of Bath, UK (Speaker)
Laurie Peter studied in Southampton for his PhD before moving to Germany as a CIBA Research Fellow to work with Professor Heinz Gerischer in 1969. He stayed in Germany to become a researcher at the Fritz Haber Institute in Berlin, returning to the UK in 1975 to take up a lectureship in Southampton. He has been Professor of Physical Chemistry in Bath since 1991. He has been Chairman of the Electrochemistry Group of the RSC and a Vice President of the International Society of Electrochemistry. He was an Editor of the *Journal of Electroanalytical Chemistry*. He is currently working part time at the University of Bath and at the Helmholtz Zentrum Berlin.

Dr Vicky Pope, **Met Office Hadley Centre, UK (Speaker)**
Vicky has worked at the Met Office since graduating from Cambridge in the early 1980's and worked initially on stratospheric research and later on climate modelling. She was a founding member of the Met Office Hadley Centre set up in 1990 to provide climate predictions and climate science to underpin government policy on climate change. She led one of the teams who developed the climate models use in IPCC 3rd and 4th assessment reports and the UK Climate Projections published in 2009 (UKCP09).

From 2002, she took on various senior management roles including responsibility for delivering the Met Office Hadley Centre Integrated Climate Programme to the main government customers, DECC and Defra. She has also initiated new programmes of work, in particular a new partnership with DFID to improve climate advice and science capacity in Africa and a multidisciplinary collaborative programme for DECC to provide policy relevant advice.

Vicky is on a number of national committees and advisory bodies: for example UKCIP, the British Council and the advisory board for the new climate change gallery at the science museum.

Vicky has just taken on a new role to improve how we communicate climate science advice. She will look at how the Met Office can develop stronger links with users of climate information and refine the communication of climate change and related issues. She will focus on how the Met Office can provide the most appropriate information to decision makers and others and understand how they use that information so that it can be improved. She will also look more broadly at the role the Met Office should play in communicating climate science and climate change in the light of its increasing importance in the public arena.

Dr David Satterthwaite, International Institute for Environment and Development, UK (Speaker)
David Satterthwaite is a Senior Fellow at the International Institute for Environment and Development (IIED) and Editor of the international journal *Environment and Urbanization*. A development planner by training with a Doctorate in social policy, he also teaches at the Development Planning Unit, University College London. His recent books include: *The Earthscan Reader on Sustainable Cities* (editor), Earthscan, 1999; *Environmental Problems in an Urbanizing World* (with Jorge E. Hardoy and Diana Mitlin), Earthscan, 2001; *Reducing Poverty and Sustaining the Environment: the Politics of Local Engagement* (co-editor and co-author), Earthscan, 2005; and *Adapting Cities to Climate Change* (co-editor with Jane Bicknell and David Dodman), Earthscan, 2009. He was a member of the Intergovernmental Panel on Climate Change for the Third and Fourth Assessments (1998 to 2007) and has been contributing to preparations for the Fifth Assessment. In 2004, he was awarded the Volvo Environment Prize and made an Honorary Professor at the University of Hull.

Professor Sir Ian Wilmut FRS FRSE, University of Edinburgh, UK (Speaker)
Ian Wilmut is the Director of the MRC Centre for Regenerative Medicine at the University of Edinburgh. The Mission of the Centre is to develop new treatments for human disease through innovative research with stem cells. The new Centre covers the full spectrum of research - from basic mechanisms of stem cell regulation, via rigorous translational studies, to clinical trials with stem cells and their derivatives. Purpose designed facilities that will be completed in spring 2011 are being built alongside the new Royal Infirmary of Edinburgh. The research of Ian's own group is directed toward understanding the mechanisms that bring about reprogramming of nuclei and with exploiting new opportunities for reprogramming cells to study degenerative diseases, such as Motor Neuron Disease.

Poster numbers and titles

1	John Evans	Chameleon catalysts
2	Scott G. Mitchell	Fabrication of transition metal substituted polyoxometalate clusters capable of splitting water
3	Benjamin Smith	Mineral catalysed reactions of fatty acids

Poster abstracts

1. Chameleon catalysts

John Evans, Moniek Tromp, Bhrat Jyoti (University of Southampton, UK), Andrew J Dent, Anna Kroner-Niziolek (Diamond Light Source, UK) and Mark A Newton (ESRF, France)

Chameleon Catalysts Synchrotron radiation sources, such as Diamond (Oxfordshire) and the ESRF (Grenoble) provide bright X-ray sources that open up the possibility of investigating the structure of metal catalysts operating in real time. By using time resolved X-ray absorption fine structure spectroscopy (XAFS), the variability of the structure of models of the automotive exhaust catalysts was tracked on a sub-second time scale. One of the active metals, rhodium, changes its particle size depending upon the temperature and gas composition. These changes affect the retention of the catalyst on the bed and the catalyst's longevity and performance. "Stable" and effective catalysts are not necessarily of unchanging structure, but are able to respond to variation in operating condition with high reversibility. Managing the catalyst composition and the working conditions through energy management systems are keys to achieving low emission levels over a long period.

2. Fabrication of transition metal substituted polyoxometalate clusters capable of splitting water

Scott G. Mitchell, Pedro Molina-Sánchez, Sumit Khanra, De-Liang Long, Leroy Cronin (University of Glasgow, UK)

The fabrication of devices capable of converting solar energy into chemical bonds is one of the preferred strategies to achieve global energy security in a carbon-neutral economy. Splitting the water molecule and/or reducing atmospheric carbon dioxide would provide energy dense fuels from abundant raw materials.[1] Polyoxometalates (POMS for short) are anionic metal oxide compounds which are well posed to act as catalysts for the water splitting oxidation reaction, largely due to their oxidative stability and electrochemical tuneability.[2] Redox active transition metal motifs can be encapsulated within sandwich type transition metal-substituted POMs (TMSPs) and can be used to catalyse the oxidation of water in homogeneous systems.[3] Our research focuses on synthesising complexes capable of transforming solar energy into fuels *via* the splitting of the water molecule. Several model candidates of this class possess central manganese-oxo cubane motifs.[4] croninlab.com

[1] Lewis, N.S, Nocera, D.G. *PNAS*, **2006**, *103*, 15729.

[2] Long, D.-L., Tsunashima, R., Cronin, L. *Angew. Chem. Int. Ed.*, **2010** ,*49*, 1736.

[3] Yin, Q., Tan, J.M., Besson, C., Geletii, Y.V., Musaev, D.G., Kuznetsov, A.E., Luo, Z., Hardcastle, K.I., Hill, C.L., *Science*, **2010**, *328*, 342.

[4] Mitchell, S. G., Khanra, S., Molina-Sánchez, P., Miras, H. N., Long, D.-L., Cronin, L. *submitted*

3. Mineral catalysed reactions of fatty acids

Benjamin Smith, H.C. Greenwell and A. Whiting (Durham University, UK)

There is currently a global drive towards bio-derived energy and chemicals, with sustainable policy targets being set such as 20% renewable energy use in the EU by 2020. Crude oil is a finite chemical resource thus attempts are being made to extend the shelf life of infrastructure which relies on it. Hydrocarbons found in

the earth's sub-surface are believed to have been formed by the decarboxylation of fatty acids in the presence of natural clay catalysts present in formation rocks.

This study aims to investigate the use of layered double hydroxides (LDHs) for the production of bio-derived chemicals. LDH compounds are an interesting class of materials consisting of positively-charged metal hydroxide layers, charge-balanced by anions in the interlayer, where water is also found. When these materials are calcined they produce mixed metal oxides (MMOs) which are basic catalysts that can be used to upgrade biomass-derived fatty acids.