UK Science & Innovation Network

Report

UK-India-Brazil-Africa Workshop
on
Green Chemistry for Sustainable Production of Biofuels

22 August 2014
Durban, South Africa

Organised by

UK Science & Innovation Network

in partnership with

Royal Society of Chemistry

For more information on this workshop, please contact:
Dr Vijay Iyer
UK Science & Innovation Network India

Dr Helen Driver
Royal Society of Chemistry

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Green Chemistry for Sustainable Production of Biofuels

21-22 August 2014
Durban, South Africa

AGENDA

August 21

1830 - 2200 **Networking Reception and Dinner**

August 22

0845 **Welcome**
Vijay Iyer, UK Science & Innovation Network (India)

0855 **Delegate introductions**

0910 **Panel Discussion 1 – What are the key research and commercialisation challenges for achieving 'clean' production of biofuels?**

- James Clark, Green Chemistry Centre of Excellence, University of York, UK
- Darbha Srinivas, CSIR-National Chemical Laboratory, India
- Telma Teixeira Franco, Nucleus for Energy Research of the State University of Campinas (UNICAMP), Brazil
- Daniel Visser, Council for Scientific and Industrial Research, South Africa

0945 **Session 1: Group Discussions**

- What are the barriers to achieving 'clean' production of biofuels?
- Best practices in the sustainable production of biofuels

1015 **Summary of discussion points by each group**

1030 **Break**

1100 **Opportunities for international collaboration**

- Helen Driver, Royal Society of Chemistry
- Colin Miles, Biotechnology and Biological Sciences Research Council, UK

1130 **Panel Discussion 2 – How can the global community work together to progress research in 'clean' biofuels? Where are the opportunities for collaboration?**

- Patricia Harvey, University of Greenwich, UK
- Arvind Lali, Institute of Chemical Technology, India
- Johannes Awudza, Kwame Nkrumah University of Science and Technology, Ghana
- Jason Hallett, Imperial College London, UK

1205 **Session 2: Group Discussions**

- Opportunities for collaboration in biofuels research
- Are we missing key skills/disciplines?
- Suggestions and ideas for international engagements

1235 **Summary of discussion points by each group**

1250 **Lunch**

1400 **Country Discussions**

- Strengths and research needs
- What can your country offer to the global research community? Expertise and Capabilities
- Statement of Opportunity – Who, What, Where, Why, How?

1500 **Summary of discussion points by each group**

1515 **Next steps**
James Clark

1530 **Closing remarks and farewell**
Fikiswa Majola, UK Science and Innovation Network (South Africa)

1540 **Close**

DELEGATE LIST

No.	Name	Affiliation	Country
1	James Clark	University of York	UK
2	Jason Hallett	Imperial College London	UK
3	Patricia Harvey	University of Greenwich	UK
4	Karen Wilson	Aston University	UK
5	Magdalena Titirici	Queen Mary University of London	UK
6	Janet Scott	University of Bath	UK
7	Colin Miles	Biotechnology and Biological Sciences Research Council	UK
8	Helen Driver	Royal Society of Chemistry	UK
9	Hannah Spry	Royal Society of Chemistry	UK
10	Vijay Iyer	UK Science & Innovation Network	UK
11	Darbha Srinivas	CSIR-National Chemical Laboratory	India
12	Arvind Lali	Institute for Chemical Technology	India
13	Parasuraman Selvam	Indian Institute of Technology Madras	India
14	Thallada Bhaskar	CSIR-Indian Institute of Petroleum	India
15	Asim Bhaumik	Indian Association for the Cultivation of Science	India
16	Rakesh Kumar Sharma	University of Delhi	India
17	Yogesh Chandra Sharma	Indian Institute of Technology – BHU	India
18	Vivek Polshettiwar	Tata Institute of Fundamental Research	India
19	Fikiswa Majola	UK Science & Innovation Network	South Africa
20	Anwar Jardine	University of Cape Town	South Africa
21	Daniel Visser	Council for Scientific and Industrial Research	South Africa
22	Kate Haigh	Stellenbosch University	South Africa
23	Steve Davis	Sugar Milling Research Institute NPC	South Africa
24	Vânia Gomes Zuin	Federal University of São Carlos (UFSCar)	Brazil
25	Telma Teixeira Franco	Nucleus for Energy Research of the State University of Campinas (UNICAMP)	Brazil
26	Yonas Chebude	Adis Ababa University	Ethiopia
27	Johannes Awudza	Kwame Nkrumah University Of Science And Technology	Ghana
28	Egid B. Mubofu	University of Dar es Salaam	Tanzania

Outputs from Session 1: Group Discussions

Key research and commercialisation challenges for achieving 'clean' production of biofuels

- Efficient fractionation processes in place akin to petroleum refinery industry for maximising utilisation of side products from biofuels production
- Clean, green, and sustainable methods
- Solid fuels and life cycle assessment thereof
- Feedstock valorisation and advanced processing methods for complex feedstocks
- Updated biomass database and its properties
- Key policies and drivers to create market opportunity for biofuels
- Lack of knowledge transfer from one industry to another
- Use of enzymes for biofuels production and economics thereof
- Performance, cost-effectiveness, and sustainability
- Identification of suitable resources and appropriate processes - thermal/chemical/enzymatic
- Development of feedstock agnostic technologies
- Identification of outlets for high value hydrocarbons from diverse biomass feedstocks
- Processing complex substrates
- Recycling of phosphorous and nitrogen
- Life cycle assessment including water table
- Understanding of lignin from various feedstocks and processes (ethanol and pulp & paper industries)
- Development of catalysts and their behaviour in biomass conversion
- Lack of standards/protocols

Opportunities for research collaboration in 'clean' biofuels production

- Implementation of an interdisciplinary approach – engineers and scientists need to team up with researchers from other disciplines such as anthropology, history, sociology, economics, agriculture, soil sciences
- EU microalgae biorefinery project
- Macroalgae biorefinery in major countries
- Setting up of innovation platforms to draw in all stakeholders
- Attractive multi-country technology framework e.g. BRICS, India-Brazil-South Africa (IBSA)
- Designing projects of common interest
- Focus on capacity building
- Building frameworks for international funding programmes

Individual Country Discussions

UK
Strengths • Technology development • Strong academic base • Well connected – nationally and internationally • Efficient coordination between engineering and basic sciences • Access to EU funds • Strong base of small and medium sized enterprises (SMEs) **Research Needs** • Greater interdisciplinary engagement • Engagement of young researchers • Techno-economic assessment of early stage technologies **Expertise/Capabilities** • Catalytic processes • Biotechnology • Algae production • Synthetic organics • Demonstration facility (e.g. Centre for Process Innovation) • Chemicals/materials from bio based feedstocks • Innovation biobutanol production technology developed by Butamax Advanced Biofuels LLC (a joint venture between BP & DuPont) • High end functional materials • Academic research/demonstration capabilities **Opportunities** • Toolkits for processing different feedstocks • Sourcing rice straw/citrus waste – Asia, Brazil, China, Thailand • Valorisation of bagasse • Identifying resources for feedstocks • Engaging partners for pilots and beyond (e.g. industry) • Public sector investment

INDIA

Strengths

- Research capabilities in chemistry and bioengineering/dedicated scientific institutions
- Availability of feedstocks
- Biodiesel manufacturing
- Small scale pilot plants
- Potential for utilising aquatic biomass(e.g. macro algae, water hyacinth)

Research needs

- Translation capacity (i.e. availability of funds)
- Organisational capabilities
- Holistic approach towards problem solving
- Life cycle assessment

Expertise

- Catalysis research groups
- Training capabilities (for students, researchers)

Opportunities

- Employing food and agricultural waste for biofuels production
- Presence of petroleum refinery companies such as Indian Petrochemicals Corporation Limited, Reliance Industries Limited

BRAZIL

Strengths

- Long history of sugarcane processing and biodiesel production
- Availability of flexible processes for various feedstocks (e.g. sugar, bioethanol)

Research Needs

- Pilot plants
- Infrastructure (pipes)
- Knowledge base
- Extensive research work on socio-economic implications of biofuels

Expertise

- Biofuel production by Petrobras
- Presence of centres of excellence such as Bioethanol Science and Technology Centre (CTBE), Embrapa
- Technology roadmap for biofuels production

Opportunities

- Deployment of food waste in biofuels production
- Exchange programmes for scientists and students

AFRICA

Strengths

- Availability of varied biomass sources including waste but excluding edible food sources
- Opportunities available to bypass older generation technologies
- Strong research infrastructure (basic → applied)
- Strong collaboration between South Africa and other African countries
- Possibility of sharing infrastructure/facilities within Africa
- Opportunity to export bio-based products
- Presence of emerging markets in Africa
- Well established intellectual property laws in South Africa

Research Needs

- Capacity building
- Availability of advanced technologies
- Markets for value-added products
- Identification and validation of technologies
- Stronger collaboration between research community and industry
- Laboratory equipment and skills development
- Coordination of activities (national/international)
- Increased awareness regarding intellectual property rights
- Greater access to patent information and publications

Expertise

- Technology translation (within African context)
- Physical bioconversion (milling) technologies in sugar and pulp industries
- Training capabilities (academic and vocational)

Opportunities

- Strong drive for implementation of a 2nd generation biofuel/biorefinery in South Africa
- Africa can play a major role in biorefinery products owing to large biomass availability
- Shale gas

Barriers to achieving 'clean' production of biofuels

- Lack of interest in mainstream chemistry communities
- Unavailability of technologies for processing complex feedstocks
- Chemistry still based on single molecules
- Political and economic considerations
- Availability of feedstocks and 'green' catalysts
- Lack of resources for small and medium enterprises
- Upscaling
- Investment in new technologies
    - country dependent
    - risk-laden

- Inadequacy of non-food sources and appropriate technologies
- Water management
- Diversified feed stock need diverse processing technologies
- Shale gas
- Regional variations in resources and processes
- Country specific implementation challenges
- Balancing technology and scale
- Hazards vs. costs
- Assessment of lifecycle and supply chain including energy & by-products
- Producing high value chemicals from biofuel production
- Multi-disciplinary approaches required –inputs from social and political experts
- Variance in international approaches
- Cost implications/availability of feedstock
- Inputs
    - availability of high quality raw materials
    - technologies to produce 'clean' raw materials
    - inaccessibility of upstream fractions
- Process
    - technology development is important
    - based on feedstock - must target maximum efficiency
- Outputs
    - More focus on value addition to side streams/diversification for maximum value
        - Clean glycerol in biodiesel products (valorisation of glycerol)
- Environment
    - Understanding and integration of
        - economic considerations
        - social impacts
    - SWOT analysis of cutting edge technologies

Desirable practices in sustainable biofuels production

- Need more inter-disciplinary research (e.g. engineers, chemists, biotechnologists)
- Improved water management
- Improved technologies for deriving biofuels from waste (e.g. Greenergy)
- Fractionation of feedstock
- Combining fuels and advanced materials
- Adapting to product needs in different regions
- Considering food and fodder production *against* needs
- Evaluating cost vs. output/location vs. scale
- Recycling methodologies

- Standardisation of analytical practices considering country needs
- Making use of by-products
- Limiting hazardous materials
- Consideration of environmental effects and socio-cultural perceptions
- Life cycle assessment
- Policy makers and governments must learn from international best practices
- Technologies for processing vinasse (by product of sugar industry)
- Zero waste production
- Recover valuable elements e.g. phosphorous
- Appropriate selection of feedstock
- Tax breaks for general public/consumers to encourage biofuels consumption
- Pump tax revenues into biofuels research
- Develop biorefineries locally - close to feedstock source
- Government subsidies are essential for boosting biofuels production
- Use of environmentally friendly catalysts in biofuels production
- Life cycle assessment must be carried out early on in process development
- Deployment of metabolic engineering technologies involving fit-for-purpose organisms
- Evaluation of carbon footprint
- Biofuels refinery must replicate the fractionation processes that exist in petroleum industry. This will enable the extraction of a wide range of products.
- Inclusion of phosphorous and nitrogen cycles
- Minimising discharge of harmful metals to natural resources
- Study of supply chain management
- Incentivising biofuels producers

Potential international collaborations

- Engagement among nations in:
    - BRICS (Brazil, Russia, India, China, South Africa), South East Asia, and African countries
- International meetings designed and driven by research organisations
- Exchange of research scholars and teachers
- Engagement with the United Nations on all aspects of biofuels production
- Identifying appropriate and focused funding streams to enable international collaborations
- Joint PhD programmes involving international organisations
- International partnerships could facilitate:
    - creation of knowledge database to identify reasons for project failures and troubleshooting
    - risk analysis

  - multinational, multidisciplinary committees to assess collaborative potential
  - web portals to host online forums and communities
- Countries involved in biofuels production
  - *Technology*: India, UK, Brazil, USA, China, the Netherlands
  - *Producers*: Malaysia, India, South Africa
- Which countries to collaborate with?
  - That have capacity (knowledge, people, funds)
  - That need capacity building
  - Current examples: bilateral - many; multilateral - G8/EU e.g.: European Cooperation in Science and Technology (COST)
  - More partners → need frameworks in place to address potential complications
  - Develop locally and export internationally
  - Countries with large scale natural resources

Opportunities

- Building a team composed of:
  - a range of disciplines/organisations
  - communities and cultures
- High level framework
  - what needs to be addressed and by who?
- Working with energy based companies
  - what do they need in order to scale up biofuels production?
  - how to contribute to their long term strategies?
- Increased engagement among members of worldwide biofuels research community
- International input - key to developing a sustainable bioenergy strategy
- Development of sustainable technologies
- Low volume and high value chemicals from biomass
- Pooling of financial and technological resources
- SWOT analysis for different types of biomass (e.g. algae, lignocellulose)
- Biomass producing countries could become technology producing countries
- Creation of a research & innovation platform (e.g. Bio-Value SPIR, Denmark)
- Toolkit for processing different types of feedstocks
- Deployment of rice straw/citrus waste produced in Asian countries, Brazil, China, Thailand
- Valorisation of bagasse
- Valorisation of lignin from ethanol and pulp & paper industries
- Identifying sustainable resources for feedstocks
- Engaging with partners (e.g. companies) for pilots and beyond
- Public sector investment

Missing skills/disciplines

- Mapping of:
  - biorefineries in BRICS and Africa
  - end users of by-products
- Bioenergy power engagement (e.g. smart grids)
- Engaging with senior industrialists
- Transcending interdisciplinary competence (chemistry, engineering, biology)
- Upstream competencies – production, water, soil, toxins
- Downstream competencies – producers, end users
- Databases
  - sources and locations of biomass
  - physicochemical properties of different types of biomass
  - differences between same type of biomass
- Tapping capabilities of agricultural scientists
- Establishing a balanced stakeholder engagement from different disciplines - Engineering/Chemistry/Biology/Economics
- Cohesion of communication at national and international levels
- Robust public-private partnerships
- Scaling up of process development
- Macroeconomics of biofuels (as opposed to process economics)
- Industrial biotechnology
- Synthetic biology
- Life cycle assessment of biofuels
- Integration of agronomy with feedstock
- Requirement + Value (biochemistry)
- Sociology/social life cycle assessment
- EIR (environment + impact + risk assessment)
- Non-technical experts
- Social sciences, economists, political scientists, lawyers, environmentalists, historians (industrial history)
- Chemistry - biology - engineering (technical core)

Summary of challenges and opportunities

Feedstock	Process	Products
• Availability of land not used for food production • Maximise use of waste • Deploy advanced characterisation methodologies • Sourcing from	• Developing a technology tool kit • Exploring feedstock agnostic technologies • Consideration of scale, flexibility, technology vs. cost • Examine and optimise	Desirable to have: • more than one product • more than just fuel in product portfolio • a combination of products: chemicals, materials, and fuels

industries with by-products • Using finite plant resources (non-native) • Evaluating sustainability – of starting materials • Deploying waste products from other industries (e.g. paper)	all inputs/outputs • Establish and examine pilot scale studies	
Stakeholder engagement		
Farmers/Growers	Chemical industry	Companies interested in more than one product

Outputs and Next Steps: Path Forwards

The delegates discussed several aspects of this important research area. The discussion presented many opportunities for researchers from Brazil, India, Africa and the UK to learn from each other, and work together to advance research in this area.

Each delegate took away new learning and input towards their research areas, as well as avenues to collaborate across international boundaries.

The main next steps and recommendations from the delegates of this workshop are outlined below:

- Aim to form an interdisciplinary, global action group tasked with:
    - identifying funding opportunities (e.g. UK Newton Fund, European Cooperation in Science and Technology (COST), UK Research Councils, EU funding, South Africa's Department of Science and Technology or National Research Foundation)
    - setting criteria and priorities for collaboration
    - identifying avenues for potential international projects
    - seeking corporate and industrial collaborations

  This group should include at least three countries, and more than one scientific discipline.
- Aim to engage with the Network of Experts in Social Sciences of Education and Training (NESSE)
- International thought project (e.g. Delft Skyline Debates)
- Highlight the interest from the delegates to study the use of biofuels pilot plants in countries such as the Netherlands and Australia, e.g. QUT Mackay Renewable Biocommodities Pilot Plant, hosted by the Mackay Sugar Racecourse Mill, Australia.

- Map the availability of different feed stocks in different countries to compare the type and volume of availability
- Working towards establishing the science and business models to enable biofuels production and use to replicate the petroleum refinery model, where the process includes the provision for the manufacture of high-value chemicals as well as energy production

In summary, this was a highly successful meeting of the best researchers from across the world in the field of biofuels production. The Royal Society of Chemistry and UK Science and Innovation Network jointly organised this meeting to enable a thoughtful discussion and progression in the area of biofuels production.

If you wish to find out more, or be involved, then please contact –

- Dr Vijay Iyer, UK Science & Innovation Network
- Dr Helen Driver, Royal Society of Chemistry

BIOGRAPHIES

Vijay Iyer
UK Science & Innovation Network
India

Vijay Iyer is a Senior Adviser with the UK Science and Innovation (S&IN) network, and based in the British Deputy High Commission, Mumbai, India. He focuses on energy (nuclear and renewables), and advanced manufacturing sectors.

Vijay has over five years' experience in technology commercialization, innovation management, and intellectual property strategy through professional stints at organisations based in India and the USA including the National Chemical Laboratory, Temple University, and the Boston Consulting Group. Vijay earned his PhD (Chemistry) from the University of Fribourg, Switzerland and an MBA from the Fox School of Business, Philadelphia, USA.

Fikiswa Majola
UK Science & Innovation Network
South Africa

Fikiswa Majola is a Science & Innovation Officer with the UK Science and Innovation (S&IN) network, and based in the British Consulate-General, Cape Town, South Africa. Fikiswa studied Chemical Engineering at the Cape Peninsula University of Technology, and previously worked for the National Research Foundation's Hartebeesthoek Radio Astronomy Observatory and the Cape Town Science Centre doing Science Communication in South Africa and across the African continent.

Helen Driver
Royal Society of Chemistry
UK

Helen obtained a BSc in Medicinal and Pharmaceutical Chemistry from Loughborough University, before moving to the University of Bath to undertake a PhD titled 'Drug Design and Novel Anti-Cancer Therapeutics: Inhibitors of 17β Hydroxysteroid Dehydrogenase Type 3', under the supervision of Prof Barry Potter FMedSci. She then took up a role with the UK's Engineering and Physical Sciences Research Council (EPSRC), where she worked with the Research Councils' Digital Economy Programme. In 2011, Helen moved to India as the Deputy Director of Research Councils UK (RCUK) India, based at the British High Commission, New Delhi. During this time she worked to

initiate opportunities for UK and Indian researchers to collaborate, across a wide remit of research. Helen moved back to the UK in 2014 and started her current the role with the Royal Society of Chemistry in Cambridge.

Johannes A. M. Awudza
Kwame Nkrumah University of Science and Technology
Ghana

Johannes A. M. Awudza obtained the B.Sc. (Hons) and M.Phil. in Chemistry from the Kwame Nkrumah University of Science and Technology (KNUST), Kumasi, Ghana. After completing his M.Phil. degree, he was employed as a lecturer in the Department of Chemistry, KNUST. He later went to the then University of Manchester Institute of Science and Technology (UMIST), UK (which is now part of the new University of Manchester) for his Ph.D. degree in polymerization catalysis. After obtaining his Ph.D. degree, he returned to KNUST to continue with his teaching and research and has remained there since then. Johannes is still associated with the University of Manchester as a visiting scientist.
Johannes's current research focuses on the development of next generation biofuels using catalysis, development of polymer-based nano-materials for solar cells, catalysis in polymer synthesis and plastic waste management. He has been a chartered chemist and a member of the Royal Society of Chemistry since 2000. He is currently the representative of the Royal Society of Chemistry in Ghana. He is also an affiliate member of IUPAC, a member of the Ghana Science Association and the Ghana Chemical Society.

Egid B. Mubofu
University of Dar es Salaam
Tanzania

Dr. Egid B. Mubofu graduated from the University of Dar es Salaam (UDSM) with BSc.(Ed.) in 1992. He then spent a year working for Unilever in Tanzania in the tea production section. He later secured a grant from NORAD and joined a colloidal and surface science group in the Chemistry Department, UDSM where he completed his thesis in 1997 under the supervision of Dr. L.L. Mkayula. He immediately secured a NORAD Scholarship under the University of Dar es Salaam capacity building to join for a PhD programme at the University of York under the supervision of Prof. dr. James Clark and Dr. Duncan Macquarrie where he graduated in June 2002. He went on to become The National Research School Combination Catalysis (NRSCC, Netherlands) postdoctoral research fellow at the University of Groningen, Stratingh Institute where he worked on the use of water as an alternative cleaner solvent for performing organic reactions, especially Lewis acid catalysed Diels-Alder reactions in aqueous media under Prof. dr. Jan

Engberts. In December 2003, he returned to Tanzania and took the position of a lecturer in the Chemistry Department at the University of Dar es Salaam where he is now a senior lecturer and Head of the Department. His research interest is on green chemistry, nanomaterials and catalysis.

Yonas Chebude
Addis Ababa University
Ethiopia

Yonas Chebude received his MSc in Chemical Engineering from the Technische Hochschule Leuna Merseburg, Germany. He worked for some years as a project consultant in Addis Ababa, Ethiopia before pursuing his academic career to receive his PhD in Inorganic Chemistry from the University of Wuppertal, Germany. His PhD research focussed on basic research in fluorine and boron chemistry. He joined the Department of Chemistry, Addis Ababa University in 2000 as an Assistant Professor. He has been teaching Inorganic Chemistry, both at the undergraduate and postgraduate level and has supervised more than 30 MSc theses and research projects.

He served as the Associate Dean for Research and Graduate Programs for the Faculty of Science (December 2005- September 2007). Dr.Yonas Chebude is currently Associate Professor at the Department of Chemistry, Addis Ababa University and is actively involved in both teaching and research. He is the project coordinator of the Green/Sustainable Chemistry Unit at the Department, which tries to promote Green/Sustainable Chemistry in Higher Education in Ethiopia. He is also an executive member of the Federation of African Societies of Chemistry (FASC).

Anwar Jardine
University of Cape Town
South Africa

- PhD (1995), University of Cape Town, RSA
- Andrew Mellon Foundation Fellowship (1996-97), University of Cape Town Medical School, RSA
- Harvard Medical School/South African Medical Research Council Fellowship (1998—1999)

Research Interests: Medicinal Chemistry, Chemical Biology, Enzymology, Natural product a, Organic synthesis, Drug Design and Development

Research Summary: The inseparable nature of Chemistry and Biology has encouraged many productive collaborations leading to the establishment of this relatively new

research and teaching environment. The chemistry and biology of poly-, oligo- and monosaccharides and their enzymatic processing is particularly interesting in health and disease. Our focus is on the applied chemistry and value addition of abundant natural marine polymers, such as chitin and alginates. Our interest also includes targeting small molecule carbohydrate biomarkers that has been proven critical for the survival of pathogenic bacteria.

Kate Haigh
Stellenbosch University
South Africa

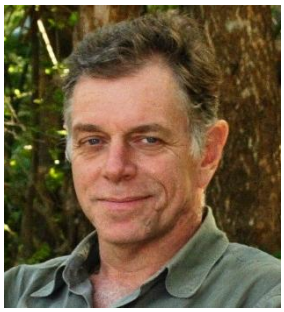
I attained my PhD from Loughborough University in field of environmentally benign biodiesel production and I'm currently working as a postdoctoral research fellow at Stellenbosch University. My work is focused on investigating options for converting biomass to fuel and other useful chemicals, particularly with regards to technical, social and economic aspects.

I was born in South Africa and gained a bachelor's degree in Chemical Engineering from the University of Cape Town. I then moved to the UK where I carried out water quality research work for a drinking water company. After four years with the company I decided that it was time for something different and I then attained a Masters degree from the University of Warwick in Business Technology and Process Engineering and as part of the study I investigated the options for using renewable energy to heat the university campus. Following this I worked at a defence company in various parts of the company including manufacturing and sales.

Daniel Visser
Council for Scientific and Industrial Research (CSIR)
South Africa

Daniel Visser, a senior biotechnologist at CSIR Biosciences was born in Kimberley, South Africa, the capital of the Northern Cape, also known as the Diamond City. He moved to Johannesburg in 1980 to pursue his secondary education at Krugersdorp High School. He then went to Rhodes University where he graduated with a BSc (Hons) in Biotechnology. He later secured a job back in Johannesburg and was unfortunately retrenched. This did not discourage him from moving on with his life at that very tender age. He decided to further his studies and registered at Wits University for an MSc (Biotechnology). While studying at Wits, he joined the CSIR and has been here for the past eight years. He earned his PhD in Biochemistry with Rhodes University.

His area of expertise is high throughput screening, enzymology, and biocatalysis technology development. He has contributed in developing technology for cheap ARV production, enabled the field of metagenomics within the Biosciences unit and driven high throughput screening. This passion and hard work secured him the Biosciences' most promising young researcher award in 2009, which he undoubtedly deserves. His principals describe him as someone who knows what the concept 'service delivery' means to clients, and is a valuable resource in the enzymes group.



Steve Davis
Sugar Milling Research Institute NPC
c/o University of KwaZulu-Natal
South Africa

Steve Davis is the Research and Development Manager at the Sugar Milling Research Institute NPC (SMRI) in Durban. A Professional Chemical Engineer, he studied for his BSc and MSc in Engineering at the University of Natal in Durban, and is a member of SAIChE and IChemE.

His research interests include clarification processes, colour removal from sugar juices and syrups (raw house and refinery), separation technologies and tracer testing. He is managing the Research and Development group at the SMRI in providing research outcomes to assist the processing industry to move towards and integrated biorefinery model to enhance sustainability. This includes the development of a general sugarcane biorefinery techno-economic model to advise research strategy and to provide intelligence to the industry on potential products and processes that the local industry could consider. He is responsible for development and effective implementation of the SMRI's research strategy (currently based on transformation of the South African sugarcane processing industry towards a biorefinery-based approach), development of the SMRI's annual Research Programme and delivery of approved targets against agreed milestones and timelines. He has written and presented numerous papers at local and international sugarcane and chemical engineering congresses and workshops.

James Clark
University of York
UK

James Clark is Professor of Chemistry and Director of the Green Chemistry Centre of Excellence (www.greenchemistry.net) at the University of York (UK). He is also Director of the new Biorenewables Development Centre (www.biorenewables.org) and Chief Technology Officer of Starbon Technologies Ltd (www.starbontechnologies.com), as well as being

President of the Green Chemistry Network (www.greenchemistrynetwork.org). James has led the Green Chemistry movement in Europe for the last 15 years: he was the first scientific editor of the world's leading scientific journal on Green Chemistry, he established the world's largest private membership network and he is now editor-in-chief of the RSC Green Chemistry Book Series (http://www.rsc.org/shop/books/series/81.asp). James has published over 400 research articles and some 20 books. He has won numerous awards and distinctions including the 2011 Royal Society of Chemistry Environment Prize, the John Jeyes medal, the Society of Chemical Industry Environment medal and Science for Industry award, the Royal Society of Arts, Manufacture and Commerce and EU Better Environment Awards, and the Prince of Wales Award for Innovation as well as honors from Universities worldwide including an honorary doctorate from Gent University in 2013. James will be President of the first meeting of international green chemistry centres (http://www.greenchemistrynetwork.org/workshop.html).

Patricia Harvey
University of Greenwich
UK

Patricia Harvey is a plant biochemist with BSc and PhD degrees from the University of Durham. A post-doctoral fellowship at the University of Durham to purify restriction endonucleases was followed by two years at Genzyme Biochemicals in R&D, then in Business Development. She returned to academia to conduct research into the biochemistry of lignin breakdown for 10 years at Imperial College, where fundamental BBSRC- and EU-funded research on lignocellulosic plant biomass degradation and mechanistic studies of the enzyme lignin peroxidase with redox mediators led to a major breakthrough in understanding the mechanism of polymeric lignin breakdown by wood-degrading fungi. This research served as a spring board for research programmes centred on renewable bioenergy at the University of Greenwich (1993-date).

Current research themes embrace the use of algal and non-food plant systems for the capture of CO2; biorefinery production of green chemicals and biofuels; plant and fungal enzyme applications in treating lignocellulosic waste streams; plant oils for biodiesel manufacture; biomass crops from contaminated land; anaerobic digestion and thermochemical treatment of food and agricultural by-products for biomethane production; and Bioenergy Supply Chains. Several of these themes were developed during her at time at the Institute of Advanced Study at Durham University as Biofuels, Science and Society Fellow.

Janet L. Scott
University of Bath
UK

Janet Scott is Group Leader in the Centre for Sustainable Chemical Technologies, University of Bath and also runs a consultancy company, JLS ChemConsult Ltd., focussed on open innovation projects and sustainable chemical solutions. Bornand educated in South Africa, she was a lecturer at the University of Cape Town (1992-1995) and R&D Manager, Fine Chemical Corporation, South Africa (1996-1998). Moving to Australia in 1999, she was an academic at Monash University,(2000-2006) and Deputy Director of the ARC funded Centre for Green Chemistry(2002-2006). In the UK, she held a Marie Curie Senior Transfer of Knowledge Fellowship at Unilever R&D, Port Sunlight (2006-2008), followed by a period as Director of a consulting company (continuing) before moving to the University of Bath. She is a Fellow of the Royal Society of Chemistry and a previous recipient of the Royal Australian Chemical Society's Green Chemistry prize. Research interests include chemical and materials from bio-based resources with a current focus on functional materials derived from cellulose and similar biopolymers for use in fast moving consumer goods, energy storage and electronic devices. Other interests include Green Synthetic Chemistry and Supramolecular Chemistry.

Colin Miles
Biotechnology and Biological Sciences Research Council
UK

Dr Colin Miles is Head of the Strategy for the Industrial Biotechnology and Bioenergy sector at BBSRC.
Colin joined the research councils in 1988 after a period as a postdoctoral research assistant. He has worked in a number of different areas in the research council system, including plant sciences, biomolecular sciences, structural biology, biochemistry, cell biology, drug delivery, bioinformatics, synchrotron, neutron and laser facilities, stem cells and regenerative medicine and systems biology.
His current role as head of strategy is to lead a team in BBSRC to help increase the capacity and capability of the UK academic base in research, training and knowledge exchange activities in UK industrial biotechnology and bioenergy research. This is being achieved through developing national partnerships with other UK sponsors and co-ordinators of research including industry, and internationally through partnerships with other European nations and countries such as India and China.

MagdalenaTitirici
Queen Mary University of London
UK

Magda Titirici completed her chemistry studies at the University of Bucharest with a diploma in Chemistry. Afterwards, she moved to Germany to earn a PhD in "Molecularly Imprinted Polymers".

Upon the successful completion of her PhD studies, she joined the Max-Planck Institute of Colloids and Interfaces (MPIKG) in 2005 within the department of Colloid Chemistry as a postdoctoral fellow. In 2006, she was promoted to the group leader position, which allowed her to develop an independent research group for a period of 5-7 years. At the MPIKG, she developed and brought new perspectives to the topic of "Hydrothermal Carbonization (HTC)" and in addition, worked on chromatographic applications using thermo-responsive polymers. She had her "Habilitation" examination in July 2013 and since January 2013, she has been with the School of Engineering and Materials Science at the Queen Mary University of London as a Reader in Materials Science. Magda has expertise in porous materials, energy storage, CO_2 capture, biofuels, fuel cells, hydrothermal carbonization.

Jason Hallett
Imperial College London
UK

Dr Jason Hallett received his PhD in Chemical Engineering from the Georgia Institute of Technology. He joined Imperial College, first with a Marshall-Sherfield Postdoctoral Fellowship in Sustainable Chemistry and in 2014 was appointed a Senior Lecturer in the Department of Chemical Engineering. He has authored over 60 articles and holds 4 patents. His current research interests involve the solvation behaviour of ionic liquids and the use of ionic liquids in the production of lignocellulosic biofuels and sustainable chemical feedstocks. This research is supported by both the EPSRC and industry. Dr Hallett currently serves as theme leader for Biorenewables and Biofuels research in the Manufacturing Futures Lab and for Underpinning basic sciences and engineering in the Industrial Biotechnology Hub.

Karen Wilson
Aston University
UK

Karen Wilson joined Aston in 2013 to take up a position of Chair of Catalysis and Research Director of the European Bioenergy Research Institute (EBRI).

Prior to this, Karen was a Reader in Physical Chemistry at Cardiff University (2009-2013) where she was also a member of the Cardiff Catalysis Institute and in 2011 was awarded a four year Royal Society Industry fellowship to work with Johnson Matthey on the development of catalysts for biofuel synthesis. From 2007 to 2009, she was a senior lecturer at the University of York, having first been appointed as a lecturer there in 1999. Prior to this, she undertook postdoctoral research in the Green Chemistry Centre of Excellence at York (1998-99) and at the University of Cambridge with Professor Richard M Lambert (1996-98).

D. Srinivas
CSIR-National Chemical Laboratory
India

Dr. D. Srinivas is a Chief Scientist working in the Catalysis Division of National Chemical Laboratory (NCL), Pune, India. He obtained his Masters Degree in Chemistry with Physical Chemistry as main subject from Andhra University, Waltair, India during 1980. He got his Ph.D. in Chemistry from Indian Institute of Technology (IIT), Chennai during 1986 - 87. Before joining NCL in 1998, Dr. Srinivas worked as a scientist in the Inorganic Chemistry and Homogeneous Catalysis Division of Central Salt & Marine Chemicals Research Institute, Bhavnagar, India during the period 1988-97. His research interests include design of novel materials for catalytic applications, green chemistry, utilization of renewable feedstocks for chemicals and fuels synthesis, material characterization by spectroscopic techniques, mechanistic investigations and structure-function correlations. Dr. Srinivas developed several sustainable catalytic processes. The catalysts and processes for biodiesel and biolubricants have been licensed to US companies. Dr. Srinivas guided 15 Ph.D., 9 M.Tech., 11 M.Sc. and 2 B.E students. He is a member of the Editorial Board of (1) Bulletin of Catalysis Society of India; (2) Catalysis Surveys from Asia – Springer; and (3) Applied Catalysis A: General - Elsevier. He is a peer reviewer for several catalysis and material chemistry journals. He has visited several countries and delivered invited talks in international conferences. He is a member/fellow of several professions bodies.

- Publications –146, Book chapters – 3, Reviews – 5; Foreign Patents awarded – 82
- "Sistla Kameswari Young Scientist Award" of the Catalysis Society of India for the year 2000.
- VASVIK Technology award for the year 2011 in the category Chemical Sciences (2011)
- NCL Research Foundation's Scientist of the Year Award (2013)

Vivek Polshettiwar
Tata Institute of Fundamental Research (TIFR)
India

Dr. Vivek Polshettiwar is Reader in the Division of Chemical Sciences at TIFR Mumbai. Before joining TIFR, he obtained his Ph.D. (2005) under the supervision of Prof. M. P. Kaushik from Jiwaji University and DRDO, Gwalior. He then investigated nano-structured silica-catalysts, with Prof. J. J. E. Moreau in 2006 during his postdoctoral research at École Nationale Supérieure de Chimie de Montpellier (ENSCM), France. He then moved to United State Environmental Protection Agency (US EPA) (2007-2009) as ORISE research associate to research nano-catalysis for green chemistry with Prof. R. S. Varma. Then, he started his independent group of nanocatalysis at KAUST (2009-2013). During this period, he also worked as visiting scientist at CPE, Lyon, France with Dr. Jean Thivolle. Dr.Polshettiwar's research interests are in the area of of advanced nano-materials, nanocatalysis and green chemistry.

Yogesh Chandra Sharma
Indian Institute of Technology – Banaras Hindu University
India

Prof. Yogesh Chandra Sharma completed Ph.D. in Applied Chemistry (1991) and Doctor of Science (D.Sc.) in 2010 in Chemistry. He has made contributions in Adsorption, diffusion, monitoring of GANGES, and water pollution control and research and he was FIRST to 'coin' the term 'nano adsorbents' where his group made significant contributions. Professor Sharma has a large group of motivated young researchers. Latest research interests of Prof. Sharma are renewable energy, synthesis and characterization of biodiesel from different feed stocks including microalgae, bio butanol, and synthesis and characterization of heterogeneous catalysts for using in trans esterification for production of biodiesel. Professor Sharma has several important international collaborations. He has significant number of contributions in international professional journals. He has authored a dozen of reviews, which are highly cited. His work is highly cited and he has published many

articles which have been highly cited. His SCOPUS h index is 24. He is PI of an IBSA multilateral collaborative project on synthesis of biodiesel from algal feedstock.

Parasuraman Selvam
Indian Institute of Technology Madras
India

Parasuraman Selvam is currently Professor at Indian Institute of Technology-Madras, Chennai; Adjunct Professor at Tohoku University, Sendai, Japan; Honorary Visiting Professor, University of Western Sydney, Australia. Earlier, Professor Selvam was a Faculty at Indian Institute of Technology-Bombay, Mumbai (1992-2006) and at Tohoku University, Sendai (2002-2003). His research interests include nanostructured materials and heterogeneous catalysis for green chemical routes, environmental remediation processes, and energy conversion (biomass, solar hydrogen) and storage (methanol fuel cell, lithium ion battery) methods. Professor Selvam has published over 250 original research papers international peer reviewed journals and conference proceedings. He is one of the highly respected and well known scientists with several national and international honours: Fellowship of The Royal Society of Chemistry, London, U.K.; Royal Society of Chemistry Service Award, Cambridge, U.K.; Eminent International Visitor at the University of Western Sydney, Australia; Visiting Professorships at University of Geneva, Switzerland, Tohoku University, Sendai, Japan; The University of Queensland, Brisbane, Australia; Dublin City University, Dublin, Ireland; National Institute of Materials Science, Tsukuba, Japan; Institute of Chemical Technology, Mumbai; Awarded twice as Young Scientist for significant contributions in the areas of Solid State Chemistry and Catalysis; N. Venkatasubramanian/S. Lakshminarasimhan/Annamma Philip Endowment Awards; Honorary President and Treasurer, The Royal Society of Chemistry - South India; Treasurer, Catalysis Society of India; Member, Programme Advisory Committee (Physical Chemistry), Department of Science and Technology (DST), New Delhi; Member, German Excellence Initiative, Deutsche Forschungsgemeinschaft (DFG), Bonn, Germany; Member, Government of India Delegation to Novosibirsk, Russia, and Rostock, Germany; Member, Dublin City University's Research College & Advisory Panel, Dublin, Ireland.Professor Selvam also led recenly a delegation of scientists from India to St. Petersburg, Russia. *http://chem.iitm.ac.in/faculty/selvam*

Thallada Bhaskar
CSIR – Indian Institute of Petroleum
India

Dr Thallada Bhaskar, Senior Scientist, is currently heading the Thermo-catalytic Processes Area, Bio-Fuels Division (BFD) at CSIR-Indian Institute of Petroleum, Dehradun, India. He received Ph D for his work at CSIR-Indian Institute of Chemical Technology (IICT). He carried out Postdoctoral Research at Okayama University, Okayama, Japan after which he joined as Research Assistant Professor for ~7 years. He has about 90 publications in journals of international repute, contributed 14 book chapters to renowned publishers (ACS, Elsevier, Woodhead Publishing, CRC Press etc) and 12 patents to his in his field of expertise in addition to 250 national and international symposia presentations. His publications received 1780 citations (google scholar citations) with *h-index* 26. His 20 years of research experience cover various fields of science revolving around his expertise in heterogeneous catalysis thermo-chemical conversion of biomass, waste plastics and e-waste plastics into value added hydrocarbons. He has prepared several catalysts and thrown a light on the structure activity relationships of novel catalytic materials for hydrotreatment of fossil based crudes. In view of his expertise, he is on the editorial board of 3 international peer reviewed journals. He is a Guest Editor for Bioresource Technology (Elsevier) Special Issue on Thermochemical Conversion of Biomass. He received the Distinguished Researcher award from AIST (2013), Japan and Most Progressive Researcher award from FSRJ, Japan (2008). He is also the Fellow of Biotech Research Society of India and member of the Governing Council. He received the Raman Research Fellowship for the year 2013-14. He was also a JSPS Visiting Scientist to Tokyo Institute of Technology, Japan during 2009. He has organized several international symposia in India and abroad in this area and visited several countries to deliver invited/plenary lectures.

Rakesh Kumar Sharma
University of Delhi
India

Dr. Rakesh K. Sharma is presently Professor and Coordinator of Green Chemistry Network Centre (GCNC) at Delhi University. GCNC established in Delhi University under the recommendation of a panel of world leaders headed by Professor Paul T. Anastas with funding from IUPAC CHEMRAWN GCI-DEN Grant and Ministry of Textiles, Government of India. GCNC is working for promoting innovations in Green Chemistry by: (i) building a network between academia, industry and government; (ii) preparing and disseminating the educational materials; (iii) designing

and organizing training workshops; and (iv) taking up innovative Green Chemistry research projects. After obtaining his Ph.D. in 1986 from University of Delhi, Prof. Sharma worked on JSPS Postdoctoral Fellowship at Kumamoto University and University of Tokyo Japan. He has teaching experience of more than 25 years at Department of Chemistry. He has published more than 100 research papers in International journals. His major areas of research include Sustainable/Green Chemistry, Development of Green Analytical Methods. He has received several awards like 2010 INSA-JSPS award to visit Japan, 2010 UGC-TEC award to visit Mauritius, 2002 INSA-JSPS award, 1999 World Green Award, 1998 Research Grant Award by Royal Society of Chemistry London, 1998 Japan Society For The Promotion Of Science (JSPS) postdoctoral award, 1995 Indo-German Award, 1995UGC National Research Scientist award, He is a member of various committees constituted by Govt. of India, and universities.

Asim Bhaumik
Indian Association for the Cultivation of Science
India

Asim Bhaumik received his PhD in chemistry from the National Chemical Laboratory, Pune in 1997. After postdoctoral research as a JSPS fellow at the University of Tokyo during 1997–1999, followed by associate researcher at Toyota Central R&D Labs. Inc., Japan during 1999–2001, he had returned India and joined as a faculty member in Indian Association for the Cultivation of Science, Kolkata, where he is presently working as a professor. His research interest focuses on several aspects of energy, environment and biomedical sciences, including advanced materials for adsorption, gas storage, catalysis, sensing, photocatalysis, dye sensitized solar cells and drug delivery applications. He has designed several novel porous nanomaterials and explored their applications in energy and environmental research, like oxyanion-promoted synthesis of zeolites; mesoporous titanium phosphate with remarkable anion-exchange capacity; luminescent PMOs, which act as chemosensor and metal-ion scavengers. He has designed mesoporous Zn-sensor for selective sensing of Zn(II) in living cells and novel porous organic polymers having excellent CO2 storage capacities. He is coauthor of over 250 research publications and inventor of 13 patents. He is a board member of several journals and a Fellow of the Royal Society of Chemistry.

Arvind Lali
Institute of Chemical Technology
India

Arvind Lali is a well known expert in the area of bioseparations and biotransformations having provided technical support and solutions to most Pharma and Biopharma companies (Biocon, Dr. Reddys, Merck, Cadila, Strides-Acrolab, Unisankyo, Pepsico India/USA, General Mills Inc, USA etc.). He heads India's first Centre for Energy Biosciences funded by the Department of Biotechnology with objectives to create a sustainable R&D platform for biofuels. He has developed technologies that are being implemented at pilot scale level by Indian industries. Major research achievements include affinity adsorbent for antibody purification (PCT/IN2008/000254, Indian Patent: 248707), Fractionation of biomass and enzymatic hydrolysis (WIPO Publication Number WO/2010/137039), novel extraction for natural product extraction (PCT/IN2008/000218), Fluidised moving bed continuous chromatographic system for separation (PCT/IN2010/000133), and Oilseed biorefinery (Indian Patent Application No: 278/MUM/2012, Indian Application Number 3577/MUM/2010).
Prof. Lali has mentored several Ph.D. and M. Tech students at the Institute of Chemical Technology. He has 44 research publications, 2 book chapters and 70 patents to his credit. He is recipient of prestigious awards such as Vasvik Award in Biological Sciences & Technology and IIChE NOCIL award for excellence in design or development of process plant or equipment. He is an esteemed member of Core Group of Scientists in the area of Bioenergy with Ministry of New & Renewable Energy, Government of India and India Task Forces in Biofuels; Algal Biotechnology; and Bioproducts and Bioprocesses, Ministry of Science and Technology.

Telma Teixeira Franco
Faculdade de Engenharia Química - UNICAMP
Brazil

Telma T. Franco is a full professor of Bioengineering and also is the Coordinator of the Nucleus for Interdisciplinar Energy Planning (NIPE) of the State University of Campinas (UNICAMP), Campinas – SP, Brazil. She graduated from the University of Sao Paulo, USP (1987) and from the University of Reading (UK) (1992). Professor Franco is responsible for research projects related to bioprocesses and her principal interests are the use renewable/sustainable feedstocks for yeast, bacterial and microalgae bioconversion to chemicals, building blocks and biofuels, in integrated operations. She also investigates intelligent material for packaging. She published more than 80 peer reviewed publications, supervised more than 30 MSc and PhD students

fully (thesis already concluded) and several post docs projects. Currently supervises students under different research grants awarded. Since 1997, she coordinates the *Laboratory of biochemical engineering, biorefinery and products from renewable sources*(LEBBPOR), which already collaborated with large chemical and energy industries (Shell, Petrobras and Suzano Paper &Cellulose)in research projects on biorefinery and bioenergy.

Vânia Gomes Zuin
Federal University of São Carlos (UFSCar)
Brazil

Vania Zuin is a professor at the Federal University of São Carlos (UFSCar, Brazil). Her background is Analytical Green Chemistry and Green Chemistry Education, with major interests in developing green analytical methodologies that are incipient to determine bioactive high-value organic substances extracted from Brazilian agro-industrial residues, particularly in separation science. Prof. Zuin is an assessor in the Coordination for the Improvement of Higher Education Personnel (CAPES) and the State of São Paulo Research Foundation (FAPESP). She is author of several publications of high impact in the areas of her expertise (papers, chapters and books) and has been invited to give several lectures in the academic and industrial sectors relating to Green Chemistry. She was responsible for the project and acted as Secretary General of the 4th International IUPAC Conference on Green Chemistry, held in Brazil (2012). Since 2012, she has been a member of the IUPAC Subcommittee on Green Chemistry. Prof. Zuin is member of the Brazilian Chemistry Society (SBQ) and, since 2012, the coordinator the Green Chemistry Section of the SBQ. More details can be seen on:
http://lattes.cnpq.br/5265150425993880