1st Bioenergy and Biorefinery International Forum

Monday 13st March 2017

www.theibest.org

BA Building for day time session
Oak Suite 1 &2 for evening session
University of Surrey

IBEST *Advancing cross-disciplinary knowledge and education in Biorefinery Engineering*

The University of Surrey and IBEST warmly welcome you to participate in the 1st International Bioenergy and Biorefinery Forum at the University of Surrey on 13 March.

Since its creation in 2015 supported by the Newton funding scheme and UK Research Councils, the Institution of Biorefinery Engineers, Scientists and Technologists (IBEST), has grown internationally to include over 50+ organisations as members. Many of these are looking to seriously invest in bioenergy and biorefinery businesses. Our organisation bases include South-East Asia, South America and African countries.

The UK are actively supporting research and development for poverty alleviation in developing countries. Bioenergy and alternative systems such as biorefineries have an important role to play in poverty alleviation, job creations and security of resources in these countries. This event supported by the HEFCE Newton Fund is aimed at understanding the role of and scopes for alternative systems being researched and developed in the UK, in poverty alleviation in developing countries.

Chair:
Professor Sai Gu, Head of Chemical and Process Engineering

PI of the HEFCE Newton Fund supporting the Forum:
Dr Jhuma Sadhukhan, j.sadhukhan@surrey.ac.uk

Cover page designer:
Dr Elias Martinez-Hernandez, University of Bath

International Bioenergy and Biorefinery Forum, University of Surrey

Chaired by Professor Sai Gu, Head of Chemical and Process Engineering

Organising Committee Members: Dr Jhuma Sadhukhan, Dr Bolaji Shemfe, Dr Elias Martinez-Hernandez and Ms Hilary Mitchell

Postgraduate Student Volunteers: Kelly Cheng (Photography of the Forum), Aliyu Saidu and Giselle Crowder

TIME	ORGANISATION	SPEAKER
9:00 – 9:30	Registration and Tea / Coffee and Refreshment	
9:30 – 9:40	Welcome, House-keeping, Format for day	Bolaji Shemfe
9:40 – 10:00	Centre for Environment and Sustainability, University of Surrey (presentation)	Richard Murphy
10:00 – 10:20	CESPOR and University of Nottingham Malaysia (presentation)	Denny K S Ng
10:20 – 10:40	Novozyme Malaysia (presentation)	Hong Wai Onn
10:40 – 11:00	**Discussions with the speakers**	Chair: Sai Gu
11:00 – 11:30	Recycling Technologies (presentation + 10 mins Q&A)	Matt Gear
11:30 – 12:00	University of Surrey and University of Bath	Jhuma / Elias
12:00 – 13:00	**Industrial exhibition and poster sessions at 22 BA02**	Chair: Sai Gu
13:00 – 14:00	Group photo and Lunch	
14:00 – 14:30	Biorenewables Development Centre (presentation + 10 mins Q&A)	Peter Hurst
14:30 – 15:00	Fiberight Ltd (presentation + 10 mins Q&A)	Nick Thompson
15:00 – 15:30	Coffee arrives – take coffee into the meeting room	Future of IBEST
15:30 – 16:00	Indian Institute of Technology Roorkee (presentation + 10 mins Q&A)	Raja Chowdhury
16:00 – 16:30	University of Groningen, The Netherlands (presentation + 10 mins Q&A)	Peter Deuss
16:30 – 17:00	The Center for Research and Advanced Studies (Cinvestav), Mexico (presentation + 10 mins Q&A)	Arturo Sanchez
17:00 – 18:00	**Industrial exhibition and poster sessions at 22 BA02**	Chair: Sai Gu
18:00 – 19:00	Drinks and reception at Oak Suite 1 & 2	
19:00 – 19:30	Aeropuertos y Servicios Auxiliares (ASA) - Gob, Mexico (Aviation Biofuel Manager at ASA, Mexico Government) at Oak Suite 1 & 2 (presentation)	Tania Buenrostro Domínguez
19:30 –	Dinner at Oak Suite 1 & 2	

Profile of the Chair

Professor Sai Gu, Chairing the event, is the Head of The Department of Chemical and Process Engineering at the University of Surrey (UoS). He is leading a large research team covering a wide range of bioenergy research including biomass thermochemical conversions, catalysis and material synthesis, biorefinery, biomass resources and management. He has published over 120 journal papers. His team has won numerous awards for their energy research including the 2011 UK Scopus Young Researcher Award in Engineering for their publications in biomass fast pyrolysis and the Felix Weinberg Prize in the Institute of Physics Combustion conference in 2011 for modelling of fluidised bed gasification. He obtained a Ph.D in materials from the University of Nottingham and further developed his research career at University of Cambridge as an EPSRC researcher. He currently is the PI for EPSRC SUPERGEN Bioenergy Challenge project 'Development of fast pyrolysis based advanced biofuel technologies for biofuels' (EP/K036548/1), Gas CCS Challenge project 'Computational Modelling and Optimisation of Carbon Capture Reactors' (EP/J020184/1), EPSRC/TSB Energy Catalyst project 'Combined Energy Recovery & CO_2 Removal' (EP/N508615/1) for biomass CHP systems. He is also a CoI of EPSRC project: Novel low energy plasma/catalytic gas cleaning process to deliver high quality syngas from the gasification of waste biomass (EP/M013162/1). He has coordinated numerous EU projects including ECOFUEL (EU-China Cooperation for Liquid Fuels from Biomass Pyrolysis) and iComFluid (International Collaboration on Computational Modelling of Fluidised Bed Systems for Clean Energy Technologies). His research has a strong element of industrial collaboration, successfully completed 20+ Industrial CASE awards, KTP and TSB projects as the lead academic. His KTP project with Metallisation Ltd won the Lord Stafford 'Impact through Innovation' Award. His TSB project with Monitor Coatings led to a patented miniSpray technology (EP2411554B1). His collaboration with Indian Institute of Petroleum (IIP) on biomass fast pyrolysis has been published as a Case Study for Royal Academy of Engineering.

The **Centre for Environment & Sustainability (CES)** http://www.surrey.ac.uk/centre-environment-sustainability at the University of Surrey is an internationally-recognised centre of excellence in research and teaching in Sustainability. This position has been established over the ~25 years since CES was founded by Professor Roland Clift. The Centre is truly multi-disciplinary in outlook with approx. 50% of our staff having Engineering backgrounds, 25% natural science backgrounds and 25% social science and economics backgrounds and this combination of disciplinary interests is supported by extensive interactions with colleagues in Sociology, Psychology, School of Hospitality & Tourism, Surrey Business School etc. at Surrey. We also have an extensive multi-disciplinary network of national and international collaborations for research and teaching with colleagues from academia, business & industry and policy making. The importance of Sustainability has been emphasised in the University's Research Strategy by it, together with Urban Living, being the first two of six named University Research Themes from 2017. Prof Richard Murphy and Prof Matt Leach, both from CES, were appointed as the University's Research Theme Champions for these Research Themes.

Profile of the Speaker

Prof Richard Murphy Richard is a Fellow of the Institute of Materials (FIMMM) and the Royal Society of the Arts (FRSA), a past President of the Institute of Wood Science (IWSc) and a past section Chairman of the International Research Group on Wood Preservation. He has worked in fungal biology, bio-based materials and bio-energy research in the UK, New Zealand and The Netherlands. His research interests include lab-based experimentation on the fungal decay of wood and other ligno-cellulosic materials, anti-fungal treatments, plant-based bio-materials and bio-energy (biofuels and power) and LCA and techno-economic assessment to evaluate their sustainability profiles. His research has been funded by BBSRC, EPSRC, NERC, UK government, the EC and industry and he enjoys extensive international collaborations. He has used LCA since 1992 in materials-focused projects ranging from preservative treated wood products, coppice forestry systems, coating systems for wood, sustainable bamboo construction, agro-fibre products and bio-based packaging. In the last six years he has worked extensively on biofuels and bioenergy. His LCA research has explored prospective future contributions of the bio-based economy to energy and materials provision encompassing a focus on uncertainty and sensitivity analyses and their communication. He has authored/co-authored over 140 publications and conference papers and, together with colleagues, has founded two spin-out companies (Mycologix Ltd and LCAworks Ltd) in the 2000s. He has undertaken consultancy work with The Coca-Cola Company, Braskem SA, Deloitte, and BT amongst others and advised the UK Climate Change Committee on LCA, is an appointed member of DEFRA's Hazardous Substances Advisory Committee (2013-) and has given evidence to the House of Lords Science & Technology Select Committee's enquiry into Waste Opportunities.

Summary of the Speech

Materials, energy carriers, chemicals and many needs of human societies can be met from bio-based, renewable resources. Bio-based products (such as biofuels) can, with careful development, offer ***relative*** carbon benefits by substituting fossil resource uses. A few have an extremely useful further ability: they can act as carbon-neutral technologies (CNTs) and as ***absolute*** 'carbon sinks' [whereby CO2 is removed from the atmosphere, is retained in products in use and is also not returned to atmosphere at end-of-life disposal]. In this presentation examples are given of bio-based products and provisional life-cycles that can offer such absolute 'carbon negative' properties within the context of the Planetary Boundaries concept and the UN's Sustainable Development Goals (SDGs).

Centre of Sustainable Palm Oil Research

The University of Nottingham
UNITED KINGDOM · CHINA · MALAYSIA

Centre of Sustainable Palm Oil Research (CESPOR), The University of Nottingham, Malaysia is founded in November 2014. CESPOR a renowned industrial relevant multi-disciplinary research centre for sustainable palm oil research for the entire value chain of palm oil industry. Mission of CESPOR is to develop best practice example of what can be achieved in the drive for sustainability in palm oil industry. CESPOR currently operates a commercial Palm Oil Mill a state-of-the-art multi-process/multi-product facility to help managing the (60 tph) crude palm oil mill waste by its conversion into an annual production of bioelectricity 21.6 MWh (via biogas 1200 m3/h), bio-fertiliser (24 kt), water (103 kt), pellet (24 kt) and fibre (4.8 kt). This integrated system located adjacent to Havys Oil Mill Sdn Bhd in Palong. Various research works have been conducted at this onsite research facility. CESPOR has managed secure more than RM 8 millions of research funds from government agencies and industries to conduct applied research related to palm oil industry.

Profile of the Speaker

Denny K. S. Ng, PhD, MIChemE CEng is the Head of Business Engagement and Innovation Services (BEIS), The University of Nottingham, Malaysia Campus. He is also Professor at the Department of Chemical and Environmental Engineering and Founding Director of Centre of Sustainable Palm Oil Research. His areas of specialisation include energy management, resource conservation via process integration techniques (pinch analysis and mathematical optimisation), synthesis and analysis of biomass processing and integrated bio refineries, as well as energy planning for greenhouse gas emission reduction. Dr Ng is well-published and well-cited (over 120 papers with an h-index of 27) and presented more than 150 papers in various conferences. He was the recipient of various international and national awards on his great achievements and contributions to the society. Apart from focusing on research and development (R&D), Prof Ng also applied his R&D output in industrial consultation projects. Prof Ng is also currently executive director for a spin-off company of university, Nottingham Green Technologies Sdn. Bhd., which mainly commercialise the development technologies to the industry.

Summary of the Speech

Sustainable Value Chain Strategy for Palm Oil Industry in Malaysia

Palm oil (PO) was the most consumed vegetable oil in 2015/16, accounting for 60.96 million tonnes out of 178.31 million tonne total vegetable oil produced globally. In addition, projected consumption of PO is increasing and it is critical to have sustainable production to support world demand. Malaysia is the second largest oil palm producer in the world with more than 5 million hectares of land planted. The PO industry in Malaysia accounts for ~6 % of total Malaysian gross domestic product. The PO industry in Malaysia has faced many challenges that cause the reduction of overall productivity, which include climate change, pests and diseases. Mono-culture of oil palm, high usage of chemical fertiliser, under-utilising biomass generated, and high concentrations of pollutants in wastewater are the sustainability issues that face by PO industry. There is approximately 1 million hectares of space between young and under old palms available for intercropping under-utilised crops (e.g., Bambara

groundnut, Okra, etc.) enhancing the economic, social and environmental sustainability of the plantations.

To improve the productivity and sustainability of the PO industry, the economic, environment and social aspects have to be considered. The value chain of the PO industry can be divided into plantation (agronomy and estate management), processing (milling and refinery) and supply chain management (consumer and transportation). Fresh fruit bunches (FFBs) are harvested from plantations and processed in PO mills to extract the crude PO. The oils are sent to refineries to convert into other PO products (shortening, soap, cosmetics, etc.). Huge amount of biomass and wastewater are generated. Part of the biomass could be converted to biofertilisers for plantations to reduce chemical fertiliser usage. The wastewater can generate biogas and power for downstream activities. Supply chain management can be improved to ameliorate the cost and environmental impact of transportation and processing. An integrated solution an integrated solution for a sustainable PO industry with objectives (a) maximising the productivity of PO (b) utilising wastes, (c) mitigating climate change on oil palm growth and yield and (d) minimising impacts on environment. Furthermore, increasing the productivity of existing plantations will reduce pressure to convert pristine ecosystems into new plantations, thus reducing greenhouse gas (GHG) emissions from land use change. It is predicted to increase PO contribution to Malaysia GPD to 8 – 9%. GHG will be reduced by 4 MM tons CO2– equivalent per year and waste recovery rate of 80 – 90%.

Novozymes is a global biotechnology company headquartered in Bagsværd outside of Copenhagen, Denmark employing approximately 6,400 people by the end of 2016. The company has operations in a number of countries around the world, including Malaysia, China, India, Brazil, Argentina, United Kingdom, the United States, and Canada.

The company's focus is the research, development and production of industrial enzymes, microorganisms, and biopharmaceutical ingredients. As of 2016, the company holds an estimated 48% of the global enzyme market, making it the world's largest producer of industrial enzymes.

Profile of the Speaker

Hong Wai Onn is a Chartered Chemical Engineer and Chartered Member of the Institution of Chemical Engineers (IChemE). He is also a Corporate Member of the Institution of Engineers, Malaysia (IEM). In addition, he has been an active Project Management Institute (PMI) member and Project Management Professional (PMP) ® credential holder since 2013.

Hong Wai Onn is currently a Technical Service Manager of Novozymes Malaysia Sdn Bhd. Prior to that, he held positions as Project Manager for Sibelco Malaysia Sdn Bhd and Senior Engineer for Genting Plantations Berhad. His work experience covering a very wide spectrum of responsibilities and working not only in Malaysia, but also overseas countries such as Indonesia, Lao PDR, Papua New Guinea, and Philippines. He is the Chair of IChemE Palm Oil Processing Special Interest Group. He sits on the Industry Advisory Panel for Chemical Engineering at Monash University Malaysia. He received his degree in Bachelor of Engineering with Honours from the University Malaysia Sabah in 2006.

Summary of the Speech

Advanced Biorefining in Asia Pacific – Opportunities and Challenges

Today our world is dependent on oil, which is a finite, expensive resource contributing to climate change. This dependency is particularly clear in transportation, which is predominantly fuelled by oil-derived products such as gasoline and diesel. Alternatives are few, and demand is projected to rise going forward. The International Energy Agency (IEA) projects that demand for transport fuel globally will grow rapidly and it is rising particularly quickly in the Asia Pacific region, where demand for energy in the transport sector is projected to grow 88% by 2035. In addition to transportation, oil is also a key ingredient in a wide range of everyday products such as plastics, furniture, clothes and materials. Simply put, we depend on oil to sustain our everyday lives as we know it.

Many renewable alternatives to the use of coal and gas for electricity production are emerging, including solar power, wind power and biogas. However, fewer renewable alternatives exist for transportation (with biofuels as a notable exception), which makes it more challenging to replace this type of fossil fuel with sustainable alternatives. Fortunately, biorefining offers an attractive opportunity to convert locally produced, renewable resources into biobased products that replace oil-based products, thus putting abundant and often under-utilized biomass resource to good use. This paper gives a brief introduction to the opportunity offered by conversion of biomass into biobased products as well as its challenges facing particularly in Asia Pacific region.

Recycling Technologies Ltd are developing modular chemical recycling plants which take plastic waste that recyclers currently cannot process and through a thermal cracking process produce a series of valuable hydrocarbons named Plaxx®. The system is transportable mounted within ISO freight modules, allowing convenient installation at existing waste processing sites or as part of integrated plastic recycling facilities.

Profile of the Speaker

Matthew Gear is an EngD researcher from the University of Surrey Centre for Environment and Sustainability placed with Recycling Technologies Ltd in Swindon. Matthew's work centres on the development of methodologies and tools for integrating LCA into the design process in order to maximise sustainability.

Summary of the Speech

A Life Cycle Assessment toolkit for Early Stage Design

The development of a novel process is a challenging task, especially to develop a process that is environmentally benign. Often, the environmental aspects of a process are given less attention than technical ones resulting in late stage design changes that detrimentally affect both cost and performance. For design tools to be useful in the design process, they need to be easy to use, and they need to be capable of being applied on a live basis.

To address these issues a toolkit was developed using Life Cycle Assessment (LCA) to provide information needed by the design engineer without significantly increasing the workload or requiring expertise beyond that of an LCA practitioner.

The toolkit developed brings together approaches including comparisons of design changes, hotspot analysis, identification of key impact categories, environmental break-even analysis, and decision analysis using ternary diagrams that give detailed guidance for design while not requiring high quality data. A case study based on the Recycling Technologies process for producing hydrocarbon products from mixed plastic waste using thermal cracking is used to demonstrate the application and success of this toolkit.

The University of Surrey offers the skills and capabilities necessary to fully support the Newton funded programmes. The University profoundly contributes to the governance and management of such existing project consortia. The University has developed an effective Research Strategy which involved a process of external horizon scanning to identify current and future societal challenge areas as well as an internal review to identify the University's key capabilities and research assets. One of those themes is "Sustainability". With UK and international, academic and industrial partners, the University seeks to develop a series of high quality research programmes under the Sustainability theme. The selection of Sustainability as a theme reflects, in part, the critical mass the University has already developed in this area, in the Centre of Environment and Sustainability (formerly Centre for Environmental Strategy) with a key focus on Sustainability and Engineering Systems. This initiative with its focus on bioenergy and biorefinery is fully aligned with the University's Research Strategy and can therefore expect to benefit from additional capital resourcing and preferential treatment in for example, exchange visits and scholarly . There is also a budget bearded to the Theme Champion for community building, sandpits and pilot studies. With its focus on Sustainable Energy Systems, it goes without saying that this project is aligned with a number of national priorities and Research Council challenges.

Profile of the Principal Investigator (PI) / Speaker

Dr Jhuma Sadhukhan, PI of the HEFCE Newton Fund supporting this Forum, is a Chartered Engineer (CEng), a Chartered Scientist (CSci) and a FIChemE (Fellow of the Institution of Chemical Engineers), and Senior Academic of Sustainable Resources in the Centre for Environment and Sustainability and a Full Member of Academic staff in the Department of Chemical and Process Engineering at the University of Surrey, a Visiting Academic in Imperial College, London and was previously Lecturer in The University of Manchester in the UK. She has industrial experience as a Senior Engineer with MW Kellogg Ltd. and as a Process Systems Engineer with Technip. She is the founder of IBEST: Institution of Biorefinery Engineers Scientists and Technologists www.theibest.org.

She has principally coordinated two highly successful Surrey led British Council Researcher Links Workshops, UK & Mexico ("*Biorefinery Research – Promoting International Collaboration for Innovative and Sustainable Solutions*"), at the Instituto Mexicano del Petróleo, Mexico City, Mexico in May 2015 and UK & Malaysia ("*Bioenergy, Biorefinery, Bioeconomy: Promoting Innovation, Multidisciplinary Collaboration and Sustainability*"), held at Kuala Lumpur, in May-June, 2016. Full reports and actions from these are available at www.theibest.org. One outcome of the UK-Mexico workshop being a ground-breaking collaborative research project between Mexico and UK on "*Economic Value Generation and Social Welfare by Waste Biorefining*" supported by a current grant from the Royal Academy of Engineering Newton Research Collaboration fund.

She is an investigator of (i) an EPSRC grant "Liquid Fuel and bioEnergy Supply from CO_2 Reduction" (LifesCO2R) (EP/N009746/1), (ii) a NERC grant "Resource Recovery from Wastewater with

Bioelectrochemical Systems" (METEORR) (NE/L014246/1) and other grants such as EP/D04829/X, EP/F063563/1, RD-2005-3186 and IAA and several industrially sponsored projects.

She is the first author of **Biorefineries and Chemical Processes: Design, Integration and Sustainability Analysis** by **Sadhukhan, Ng and Martinez**, Wiley, 2014, being adopted as textbook or main reference book in many universities, worldwide. This with **1150 pages** including paperback and Web materials is the first authored textbook in the field.

She has altogether 130 contributions including peer-reviewed journal publications, conference proceedings, editorials and book chapters. She has obtained various esteem awards, top three Finalists in the WBM Bio Business Award 2015 Feedstock of the Year, IChemE Junior Moulton Medal 2011, IChemE Hanson Medal 2006, First Prize Awarded in IChemE International Conference on 'Gasification for the Future', The Netherlands, Apr 10-14, 2000.

Summary of the Speech

Ultimate MSW valorisation

Dr Jhuma Sadhukhan and Dr Elias Martinez-Hernandez will show a video on "Ultimate MSW valorisation" based on the outcomes of their fundamental R&D applying process systems engineering principles. The video illustrates valorisation of streams of municipal solid waste (MSW) into high value platform molecules, from synthesis to systems.

Bio-based products, such as food and pharmaceutical ingredients, fine, specialty and platform chemicals, polymers and fibres, biofuel and bioenergy in chronological order have the highest sustainability potential encompassing triple bottom line social-environmental-economic criteria, compared to equivalent functional products from fossil resources. These products have to be produced in an integrated system, biorefinery, to achieve highest resource efficiency and sustainability. Some chemicals are referred as 'sleeping giants' owing to their vast potentials in the emerging bioeconomy due to their key positions in the production of biomass-derived intermediates and transition from fossil based to bio-based economy. For newer biorefinery businesses, targeting such chemicals as bio-based products alongside bioenergy and biofuel product, which has a higher demand and lower market price, is more profitable option, compared to a stand-alone biofuel or bioenergy production facility.

Here, they focus on synthesis across the scales, of five 'sleeping giant' priority building block molecules, levulinic acid, 5-hydroxymethylfurfural, 2,5-furandicarboxylic acid, succinic acid and lactic acid. Diverse applications (e.g. healthcare sector, cosmetic products, specialty chemicals, food industry, agrochemicals, fuel, pigments and plastics) of product derivatives from these building block molecules and replacement potentials of petroleum derived products are the rationale of selection of these molecules. Not a drop should be wasted or go to landfill; every bit is a resource and has a value to the society, who is responsible in generating it at the first place – same as the "utilisation of bottom of barrel" strategy that has founded the petroleum industry. Process development and integration into existing biofuel plants (retrofitting) is also a perspective to consider as some residual streams could be sources of high value compounds that could enhance the economic and environmental viability of biorefineries. This is also needed for enabling biomass as a basis for green chemistry and for developing a sustainable bioeconomy. The authors have made a serious attempt to convey that research efforts should be in "process integration" imperative to accelerate shift from a fossil based economy to a bio based circular economy.

University of Bath, Bioprocessing Research Unit's innovative research, prestigious degree programmes and strong relationship with the commercial sector make the University of Bath's Chemical Engineering department one of the most successful in the UK. Our Department's research has been ranked top ten in the 2014 Research Excellence Framework (REF). The Department has also been ranked Top 3 in the UK for Chemical Engineering (2017 Complete University Guide and The Times Good University Guide 2016).

The bioeconomy is now estimated to make a £36.1bn contribution to the UK economy, with UK Industrial Biotechnology generating up to £3bn in sales revenue. However, to deliver a sustainable bioeconomy then the concept of the circular economy, where all by-products and wastes from a process are used as the feedstocks in another, must also be embraced. We aim to bring these two concepts together to create the Bioprocessing Research Unit. BRU carries out interdisciplinary research at the interface between biology, chemistry and chemical engineering.

Profile of the Speaker

Dr Elias Martinez is a Chemical Engineer graduated from the National Autonomous University of Mexico and has obtained his PhD from University of Manchester, UK. Between 2013 and 2016, he worked as a Research Fellow at the University of Surrey and then at University of Oxford in the Department of Engineering Science. He then took up his post as Lecturer in Chemical Engineering at University of Bath. He was awarded a visiting scholar grant to visit University of Nottingham Malaysia Campus working with researchers at the Interdisciplinary Centre for Tropical Environmental Studies (MINDSET) in 2015. At Bath he is currently researching on integrated waste processing in biorefineries combining biochemical and thermochemical processes and also biomass value chains and interactions between technological and ecological processes and at the food-energy-water nexus to identify ways to meet human needs sustainably. He has published on process integration and sustainability of biorefineries, impact of bioenergy production on ecosystem services and urban biorefinery for waste processing. He co-authored the game-changer textbook "Biorefineries and Chemical Processes: Design, Integration and Sustainability Analysis" for training the next generation of biorefinery engineers. Dr Elias Martinez pioneered the promotion of biorefinery research and collaboration between UK and developing countries and he masterminded the workshop held in Mexico in 2015, and supported the organisation of the workshop in Malaysia in 2016. He is seeking collaborations on waste valorisation in waste biorefineries, renewable energy integration, life cycle assessment, food-energy-water nexus, and circular economy. He enjoys developing software and website applications to implement analysis tools and to communicate results to wider audiences. Dr Elias is part of the Bioprocessing Research Unit of the Department of Chemical Engineering at University of Bath.

The main areas of expertise at BRU include:

- Waste management and biomass conversion in integrated biorefineries
- Process development using life cycle thinking and holistic approaches
- Bioprocessing for tissue engineering
- Polymers and Biomaterials
- Bioenergy
- Aerobic and anaerobic fermentation of waste
- Process Systems integration and value chain optimisation
- Biosensors

Summary of the Speech

See: "Ultimate MSW valorisation" with Dr Jhuma Sadhukhan

Biorenewables Development Centre

1. Company Overview

The Biorenewables Development Centre (BDC) is a not-for-profit company based at the University of York that works with industry to implement new processes to convert plants, microbes and biowastes into high value biorenewable products. The main aim of the centre is to provide an open access facility allowing novel green technologies to be developed and demonstrated at a commercially-interesting scale. The BDC builds upon the R&D expertise of two research centres at the University of York: the Green Chemistry Centre of Excellence (GCCE) and the Centre for Novel Agricultural Products (CNAP). With this combined knowledge and expertise at the core of our approach it enables us to assist companies turn costly waste streams into a source of potential revenue, either through development of chemical and biochemical processes.

2. Presentation Topic

This presentation will include a number of case studies where we have assisted companies trying to turn a waste into a revenue stream. It will look at where we have tried to bridge the gap through demonstration between research carried out on a laboratory scale and bring it up to a pilot line. This will include our current work on a H2020 project which involves manufacturing a pilot line capable of producing up to 20kg/day of mesoporous carbon for catalysis and battery supports from renewable polysaccharides. In addition it would also provide an overview of projects where we have investigated co-locating a biorefinery into a current bioenergy operation.

Profile of the Speaker

Peter Hurst is currently a Senior Technologist at the Biorenewables Development Centre delivering commercial and grant funded projects of various sizes including H2020, BBSRC and Innovate UK. The majority of these projects are looking at bridging the gap between laboratory research work and bringing it to a pilot scale. This includes interpreting the results and critically evaluating the options available and communicating effectively to project partners. In addition to delivering projects he is responsible for the compliance of ATEX. He holds a PhD in Physical Organic Chemistry at the Green Chemistry Centre of Excellence at the University of York investigating the "The Effect of Fuel on Automotive Lubricant Degradation" sponsored by Shell Global Solutions.

Fiberight, a UK and US based waste-to-IB products company, has developed an innovative and novel process to recover value added products from residual waste. This is a true circular economy solution, enabling waste to be diverted from landfill for the generation of homogenous product outputs such as fibres, sugars, recyclables (plastics, metals, glass) and biogas. The municipal solid waste processing marketplace has failed to develop in the UK and other nations as entrants have been unable to add value to the key components of cellulose, food waste and plastic films. This results in this valuable carbon source being disposed of. By recovering more value from mixed residual waste, Fiberight's technology stands to overcome the challenges associated with a heterogeneous waste stream for the production of clean waste-derived building blocks for Industrial Biotechnology.

The Fiberight process has been developed and optimised since 2008, with a 16,000 tpa demonstration plant in operation in Virginia, USA. The company is now breaking ground on a commercial plant in Maine, USA.

Profile of the Speaker

Nick Thompson is the Managing Director for Fiberight Ltd (UK) and Chief Technical Officer for Fiberight LLC (USA). Nick has led Fiberight's R&D and process development since 2008, including process development activities (self-funded and publicly funded). Nick has overseen the design, scale up and operation of Fiberight's demonstration plant in Lawrenceville, USA. Prior to this Nick has held a number senior technical, operational and commercial positions, providing him with a unique skill set to both lead this project and commercialise the process output. This included the development of several cellulose fibre products while MD of Excel Industries allowing the company to secure over 50% of the UK market for these products. Prior to this Nick's experience included, Chemical Operations Manager at Kronospan where he ran the Technical Department and was responsible for 180,00 tpa thermoset resin production plant. He also worked for Knauf in the Plasterboard division as Operations Director with responsibility for the construction and start-up of the two new plasterboard plants.

Summary of the Speech

Fiberight are a company hoping to change the face of residual waste processing. With around 60% of global waste still going to landfill we need to employ smarter methods for dealing with waste to increase resource recovery, minimise pollution and reduce environmental problems caused by waste.

This presentation will look at the development of Fiberight and discuss how they are utilising waste as an alternative raw material for the production of energy, chemicals, fuels and plastics which are traditionally derived from fossil-fuels. Fiberight have a strong focus on collaborative Research and Development and they are dedicated to developing a sustainable and globally applicable process regardless of waste composition or subsidies.

Indian Institute of Technology, Roorkee. formerly University of Roorkee, is among the foremost of institutes of national importance in higher technological education and in engineering, basic and applied research. Since its establishment, the Institute has played a vital role in providing the technical manpower and know-how to the country and in pursuit of research. The Institute ranks amongst the best technological institutions in the world and has contributed to all sectors of technological development. It has also been considered a trend-setter in the area of education and research in the field of science, technology, and engineering. The Institute has completed 150th year of its existence in October 1996. The Institute offers Bachelor's Degree courses in 10 disciplines of Engineering and Architecture and Postgraduate's Degree in 55 disciplines of Engineering, Applied Science, Architecture and planning. The Institute has facility for doctoral work in all Departments and Research Centres.

Profile of the Speaker

Raja Chowdhury, Asst. Professor Dept. of Civil Engineering, IITR, is an assistant professor in the Dept. of Civil Engineering, Indian Institute of Technology, Roorkee, India. He holds the current position since 2014. Before joining IITR, Dr, Chowdhury held postdoctoral position in Portugal and in the US. He holds a PhD degree in Civil Engineering from University of Toledo, US. His current research interests are on bioenergy production from microalgae and life cycle assessment of bioenergy.

Summary of the Speech

Variability in energy demand and greenhouse gas emission in algal biofuel production resulted from nutrient recycling

This study was undertaken to understand the potential benefit of using dairy nutrients for algal biomass production instead of applying the raw manure to the agricultural field. To understand the benefit it was assumed that algal biomass was further processed for biodiesel and bioenergy production. Following processes were included to process the algal biomass (i) algal-biodiesel-production, (ii) anaerobic-digestion (AD), (iii) pyrolysis and (iv) enzymatic-hydrolysis. Four different scenarios were developed using above mentioned processes. In this study, it was observed that nitrogen was limited for algal biomass production. Therefore, produced algal biomass and sequestered carbon were expressed with respect to nitrogen. In both the scenarios one and two, if one ton nitrogen was added in the first cycle of operation would produce 7.63 tons of nitrogen where AD was incorporated for nutrient recovery. Nitrogen added in the later cycle of operation would produce less amount of nitrogen as compared to the first cycle. In 3rd and 4th scenario, in order to recover additional nutrients, enzymatic hydrolysis was utilized in addition of AD. Therefore, more nutrients were produced in scenario three and four as compared to scenario one and two. For

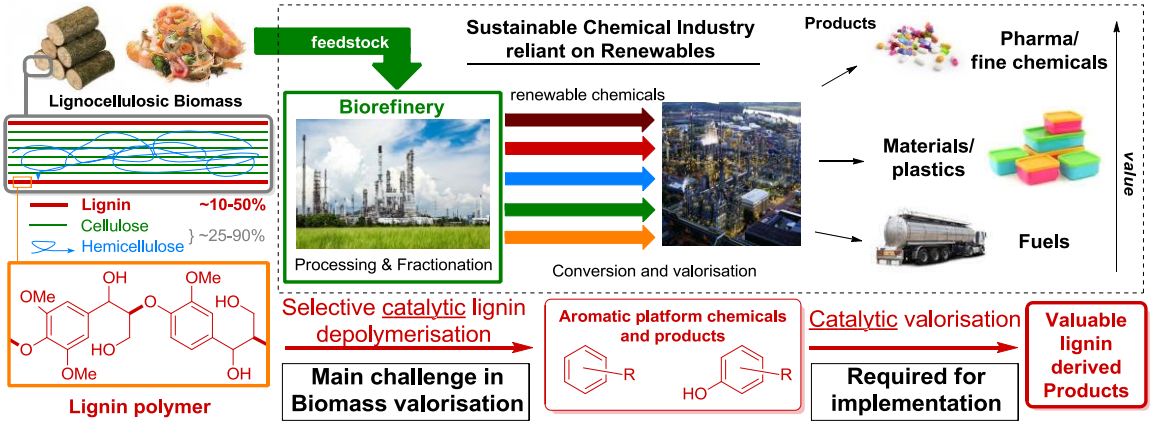
example, if one ton nitrogen were to be added during the first cycle of operation for scenario three and four, 9.64 tons of nitrogen would be produced. To understand the benefit of nutrient recycling, net energy demand, and GHG emission associated with nutrient recycling was compared with energy demand, and GHG emission from inorganic nutrient production. Unlike algal biomass production, production of sequestered carbon was different for each scenario. The highest amount of sequestered carbon was produced in the 2nd scenario followed by the 4th scenario. Increased amount of sequestered carbon production in the 2nd and 4th scenario was due to incorporation of the pyrolysis process in those scenarios. To understand the effect of dairy nutrient, residual algal biomass application on the agricultural land, DNDC model (biogeochemical model of carbon, nitrogen cycle developed by University of New Hampshire) was used to simulate nitrogen and carbon dynamics (CO2 emission, sequestration, nitrogen mass balance: nitrogen oxides emission, leaching and surface runoff). Currently, a fate transport model of nutrients was developed to understand the effect of nutrient recycling on GHG emission.

university of groningen / faculty of science and engineering / engineering and technology institute groningen ENTEG

The Chemical Engineering Department of ENTEG at the University of Groningen (The Netherlands) is specialised in the development of intensified catalytic technology for biomass conversion to biofuels and biobased chemicals and implementation of such chemicals via environmentally friendly routes into sustainable (polymeric) products.

Profile of the Speaker

Dr Peter J. Deuss's current research is centred on the catalytic valorisation of biomass by conversion of renewable (waste) resources to new platform chemicals as well as emerging chemical products. This should lead to renewable chemicals for a future sustainable chemical industry that is independent of fossil resources. The main focus is on the role of the aromatic biopolymer lignin in the future biorefinery and the development of solutions to create value from this inherently difficult to valorise polymer.



Summary of the Speech

The Biorefinery: Aromatic Monomers from Lignin

Lignin is the most abundant renewable aromatic polymer and available around the globe in large quantities as lignocellulosic biomass. Thus valorisation of this renewable resource via production of aromatic chemicals would be highly desirable and bears great potential in a biorefinery context. Recent progress on the development of one approach using integrated acid mediated lignocellulose fractionation combined with lignin depolymerisation to obtain specific aromatic products will be presented. Special interest lies with the effect of the structure of lignin on the product distribution as well as demonstration of the variety of products that can be obtained in good yields.

Relevant publications

1. P. J. Deuss, M. Scott, F. Tran, N. J. Westwood, J. G. de Vries and K. Barta, *Aromatic monomers by in situ conversion of reactive intermediates in the acid-catalyzed depolymerization of lignin,* J. Am. Chem. Soc, **2015**, 137 (23) 7456

2. C. W. Lahive*, P. J. Deuss*, C. S. Lancefield, Z. Sun, D. B. Cordes, C. Young, F. Tran, A. M. Z. Slawin, J. G. de Vries, P. C. J. Kamer, N. J Westwood and K. Barta (*shared 1st), *Advanced model compounds for understanding acid catalyzed lignin depolymerization: identification of renewable aromatics and a lignin-derived solvent,* J. Am. Chem. Soc. **2016**, 138 (28) 8900

3. P. J. Deuss, K. Barta and J. G. de Vries, *(Review) Homogeneous catalysis for the conversion of biomass and biomass-derived platform chemicals,* Catal. Sci. Technol. **2014**, 4 (5) 1174
4. P. J. Deuss and K. Barta, *(Review) From models to lignin: Transition metal catalysis for selective bond cleavage reaction,* Coord. Chem. Rev., **2016**, 306 (2) 510
5. P. J. Deuss, C. W. Lahive, C. S. Lancefield, N. J. Westwood, P. C. J. Kamer, K. Barta and J. G. de Vries, *Metal Triflates for the Production of Aromatics from Lignin,* ChemSusChem **2016**, 9 (20) 2974
6. C. S. Lancefield, I. Panovic, P. J. Deuss, K. Barta and N. J. Westwood, *Pre-treatment of lignocellulosic feedstocks using biorenewable alcohols: towards complete biomass valorization,* Green Chem. **2017**, 19 (1) 202
7. P. J. Deuss, C. S. Lancefield, A. Narani, J. G. de Vries, N. J. Westwood and K. Barta, *Phenolic acetals from lignins of varying compositions via iron(III) triflate catalysed depolymerisation,* Green Chem. Under revision

The Center for Research and Advanced Studies (Cinvestav) is a Mexican research institution ranked in the world top 120 research centers. The Bioenergy Futures Laboratory is located in Cinvestav Advance Engineering Unit at Guadalajara. The laboratory hosts applied research and technology development projects related to the use of vegetal biomass for the production of bioproducts and biofuels.

Profile of the Speaker

Arturo Sanchez, (B.Sc. Chem. Eng. ITESO, Mexico, 1985; M.I. Chem. Eng. UAM-I, Mexico, 1989; Ph.D. Imperial College, U.K., 1994). He is currently a Senior Scientist at Cinvestav-Gdl, Mexico. He has been a Visiting Research Scientist with the Dept. of Computing, Imperial College; the Group of Applied Mathematics, Mexican Petroleum Institute; and the Dept. of Eng. Sci., University of Oxford, U.K. He has published more than 140 papers and a book and has graduated more than 40 M.Sc. and Ph.D. students. His research interests are related to advanced biofuels process engineering.

Summary of the Speech

The Role of the Bioalcohols Consortium in the Introduction of Bioethanol as Transport Fuel in Mexico

Mexico has been aggressively modifying its energy policies in the past three years and is on the brink of introducing bioethanol as autotransport fuel. This seminar will present the current situation and opportunities being created in this country by the introduction of this biofuel.

The role of the Bioalcohols Consortium, a government –funded initiative created to promote the introduction in Mexico of state-of-the-art technologies for 2G bioethanol production, will also be introduced, discussing opportunities for collaboration in research and technology development.

Profile of the Speaker

Tania Buenrostro holds a bachelor´s of science degree in chemical engineering from the National Autonomous University of Mexico, conferred with honors, and has six years of experience in sustainable aviation alternative fuels supply chain.

She was the Executive Coordinator of the Flight Plan Towards Sustainable Aviation Biofuels in Mexico, carried out in 2010-2011. She has experience in development of supply chain diagnostic studies, management of governmental funds for R&D projects and technological surveillance. She also collaborated in the Mexican Association of Synthetic Biology in projects on third and fourth generation biofuels.

Tania has presented in conferences about sustainable aviation alternative fuels within multiple forums including IATA Alternative Fuel Symposium, Latin America and Caribbean Air Transport Association (Aviation Law Americas), Latin American Civil Aviation Commission, Ministry of Agriculture of Mexico, Mexican Petroleum Institute, International Civil Aviation Organisation, Inter-American Institute for Cooperation on Agriculture, National Laboratory of Genomics for Biodiversity and Ministry of Energy of Mexico.

Summary of the Speech

The presentation will be focused on the Mexican initiative to develop and deploy sustainable alternative aviation fuel in Mexico, exploring the opportunities Mexico has for biofuels and the main goals, opportunities and challenges of the initiative.

anaero technology

anaerobic digestion & fermentation equipment and research

Anaero Technology is a Cambridge-based developer of state of the art research digesters. Its products include patented automatic feeding systems for true semi-continuous anaerobic digestion (AD) research, BMP/RBP batch sets (from £9500/set), real-time gas flow meters, and Arduino-based loggers. Anaero have also made some of its logger designs open source. In stand-alone or bespoke format, state of the art Anaero Technology digesters could be what you need for advanced research. With several installations in the UK, Belgium and Colombia, our aim is to contribute to more representative and cost-efficient AD research. The new AD challenges require more capable research equipment!

Anaero offers two types of research equipment

1) BMP machine : This machine is used for batch tests, that allows effective evaluation of feedstock biogas and inhibition potential. The equipment has the novelty of mixing all reactors in the set at exactly the same intensity, a factor that causes difficulties in currently available equipment. Gas flow is recorded and converted to STP in real-time, providing useful insides into the kinetics of degradation of different feedstocks

2) Automatic fed CSTR system: Anaero Technology has developed and extensively evaluated a set of novel lab-scale anaerobic digestion research digesters capable of automatically feeding heterogeneous feedstock, as used in full-scale AD operation. This "CSTR" digestion system provides high quality replication of full-scale CSTR- AD processes, from feed storage, to digestate capture in a completely gas-tight set that allows efficient mass balances

We also do collaborative research with universities and industry. Currently, we are working with University College of London (UCL), UK and ICESI, Cali, Colombia on a Newton-Caldas project as a part of which ICESI are using two BMP machines and auto-fed CSTR for research on anaerobic digestion of vinasse. Some of our previous projects include 'Lab-scale evaluation of biogas potential from microalgae', 'Algal Biorefinery: routes for energy and nutrient recovery' in collaboration with Department of Plant Sciences, University of Cambridge.

Contact details

Edgar Blanco – Managing Director Email: edgar.blanco@anaero.co.uk Tel: +447397555544

Rashmi Patil – Research Scientist Email: rashmi.patil@anaero.co.uk Tel:+447459282111

Website: www.anaero.co.uk Twitter: @anaerotech

Profile of the Speaker

David Whittle is a Director of Creating Our Future (CoF) Ltd, a business transformation consulting firm formed in 2002. CoF helps client organisations significantly improve their operational and business performance, through a combination of technology, business processes and people. CoF has worked with global international energy companies such as BP, Shell and Total, state owned national oil companies such as Kuwait Petroleum, Bharat Petroleum and Benzina, and related companies in the retail, chemical and financial sectors.

David started his career with Texaco and Mobil, and for the last twenty-six years has worked in the management consulting sector, initially with PwC and Arthur D. Little. He has worked in Europe, US, South America, Middle East, India, Australia and Africa.

tel: +44 (0)7785 934448

skype: david.c.whittle

email: david.whittle@cofuture.org

LinkedIn: www.linkedin.com/in/davidwhittlecof

Mathew Paul has completed his Bachelor of Technology in Electrical and Electronics Engineering at Amrita Vishwa Vidyapeetham University, India. In 2016, Mathew secured an All India Rank of 257 among 150,000 candidates in the Graduate Aptitude Test in Engineering in the electrical stream.

tel: +44 (0) 7918 722070

email: mathewpk13@gmail.com

Summary of the Speech

In the developed and fast developing economies of the world we have a significant environmental problem with food waste. In the UK alone we send over 18 million tonnes of food waste to land fill every year, which equates to approximately 5 TW of power lost to the national grid if processed through anaerobic digestion. In India the scale of the problem is huge – over 40 million tonnes sent to landfill every year or left to rot, and growing by more than 10% per year. Yet the food waste to power process through anaerobic digestion has been with us for over 100 years, and small scale facilities are relatively inexpensive to setup and can be remotely monitored. So whilst food waste to power alone will not solve our climate change issues, it's an easy win, and has the added benefit of teaching our communities about municipal waste recycling.

Registered in England: 8227367
Registered Office: 263 Frimley Green Road, Frimley Green, Camberley, Surrey GU16 6LD, UK

E-mail: info@biotechconsultants.co.uk

The Company

BTCL is a technology development SME specialised in optimising the performance of the microorganisms for the scale up and enhancing microbial production of high value added chemicals and biofuels. BTCL's technical and scientific team members have a combined expertise of 50 years in running R&D programmes, using the company's own proprietary and established thermophilic microorganisms, tailor-made to valorise waste biomass and agro-industrial residues into bio-products, which can be used as platform chemicals, renewable raw materials and biofuels in chemical, food, cosmetic, pharmaceutical and motor industries. These raw materials include lactic acid and ethanol, which their production technologies have already been fully developed by the BTCL team and in recent times with the use of Synthetic Biology tools we have been able to produce advanced biofuels and platform chemicals.

Over years we have been developing in-house technologies in:

- Isolation of thermophilic microorganisms
- Improvement of thermophilic bacillus strains for conversion of lignocellulosic biomass into bioethanol and platform chemicals
- Fermentation process optimisation
- Optimisation of release of fermentable sugars from biomass

We at BTCL have proven track-record and long-standing experience of dealing with biomass conversion into bioethanol and platform chemicals. Our technical/scientific team members, as pioneers of studying thermophilic bacteria and their fermentation processes in the UK, have explored various areas of these biorefining processes from hydrolysis of lignocellulosic feedstocks to fermentation process itself and to the recovery and purification of the products.

Our company and our lead technologists have been involved in the past with both UK government-funded projects as well as EU funded collaborative RTD projects. Two more recent examples of these projects are as follows:

1. "Sustainable Liquid Biofuels from Biomass Biorefining" (SUNLIBB) – an FP7 EU funded project
2. "Validation of Thermophillic Fermentation at pre-production scale" – a TSB funded project in collaboration with Ensus Ltd.

The Management team

Dr. Namdar Baghaei-Yazdi is our Managing Director (MD) with over 30 years of experience in Microbiology and Biotechnology research and commecialisation, especially in the fields of biofuels, oil and gas microbiology and biodesalination. Namdar has his name on a number of publications and patents. He has a BSc degree in Microbiology from King's College London and a PhD in Biotechnology from Imperial College.

Dr. Muhammad Javed is our Chief Science Officer (CSO) with over 30 years of experience in Microbiology research and he has filed a number of patents. He has gained significant experience in engineering the metabolism of bacteria and archaea. Having an excellent understanding of primary metabolic flux analysis he has gained invaluable experience of the fermentation process development for metabolic products especially those of thermophilic ethanol production and has been involved in the designing of two demonstration plants for the ethanol process.

Malcolm Pearcey FCCA is our Finance Director with a significant amount of expertise of running the finances of small, medium and large companies including an R&D bio-ethanol group for the past 4 years and has been successful in EIS applications and obtaining R&D tax credits.

Hazel Hutchinson is the Business Development Adviser of the company. Hazel is the Managing Director of Aegis Corporate Strategies Ltd. with over 20 years of experience in venture capital, private equity, business strategy, management and new business development.