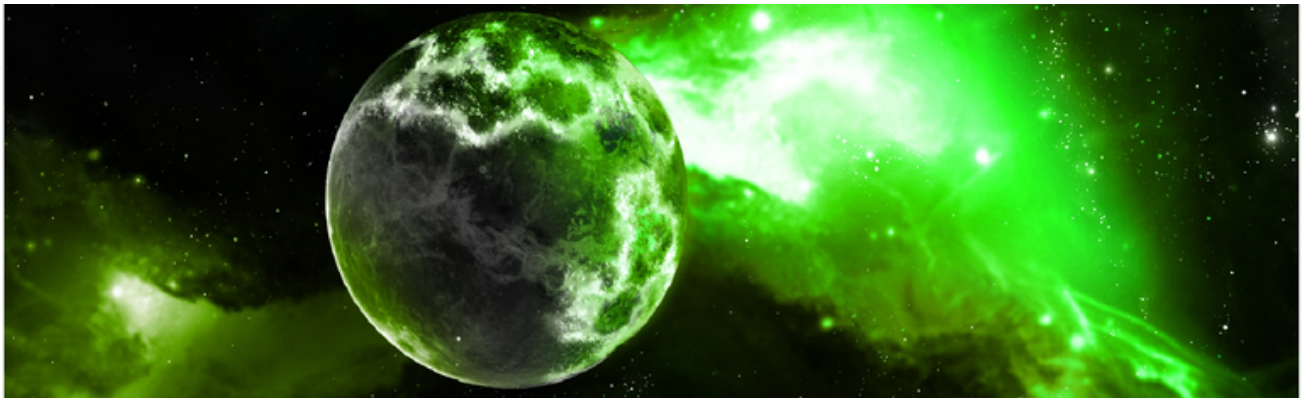
10th May 2016: Building up a Picture



Research gaps

This forum introduced some new photosynthetic technologies and examined the extent of the contribution new and existing technologies can make in helping to alleviate problems faced in off-grid energy areas.

Edgar Blanco described various photosynthetic opportunities to improve energy production, although such solutions must be used in conjunction with other energies (as, for example, covering the UK with energy crop would not meet our current energy needs). **Both direct and indirect energy savings must be considered.** Thus, photosynthetic fertilisers could save energy by decreasing the need for ammonia production. Land-based energy crops are available for rapid deployment, and crop yields and biomass production could be increased by modifying photosynthetic pathways. However, more focus is needed on water-based photosynthetic solutions, such as improving water treatment by using phototrophic, instead of heterotrophic, algae. There is also an opportunity to capture more energy from UK green waste disposal. **Despite such advances, rising energy demands mean political and societal improvements have to be made.**

Professor Chris Howe **introduced a new technology, biophotovoltaics, which could provide another option for producing off-grid energy.** As part of the photosynthetic process algae and plants also produce electrons, some of which escape through the cell and can be harnessed by an electrode. The current energy production is measured in milliwatts but with more research this may be scaled up to a useful power source that could, for example, charge mobile phones and power LEDs. There are potential advantages to this methodology over solar photovoltaics despite the disparity in power output: some energy is produced even when it is dark; they are simple to make and maintain; and their environmental impact is lower. **There is scope for combining this energy production with bioremediation or large-scale agriculture.** A key problem is generating funding and overcoming public scepticism for a technology with a smaller power output.

This talk was supplemented by a live demonstration of the technology from Paolo Bombelli. A photosynthetic organism is placed in an anodic compartment and they settle on the anode after a few hours forming a bio film. Electrons are collected and pass through an external circuit to a cathode. A byproduct of this process is the purification of water around the cathode.

Dr John Mullett focused on the energy requirements of a rapidly increasing Sub-Saharan population, particular those in slums. A primary energy need is fuel for cooking, and the favoured fuel is charcoal, which is cheap, light and energy dense. Charcoal is the second biggest expenditure, after food, for a family. **The current rate of consumption is unsustainable and causing tree degradation. This, combined with increasing population, is leading towards fuel starvation.** Other solutions, such as rapid growth biomass to make feedstock for biogas, are needed. Key challenges include changing traditional practices, the lack of adequate land rights for ethical investment and a lack of infrastructure to transport fuel. Decentralised technologies for energy production and more efficient stoves are crucial for off-grid areas.

Wicked problems and questions generated by the open discussion:

There is a danger that climate change, although it is a key challenge, is obscuring other significant problems that humanity faces. Escalating fuel starvation, global soil degradation and issues concerning competition for land and resources are being neglected. These issues need both research and action.

Can more be done to combine renewable energy solutions with other major development projects? It may be possible to combine biophotovoltaic technology and similar schemes with other large-scale projects, such as agriculture or water treatment, making them more attractive for business investment. **Combining different technologies provides the opportunity to reduce waste and use materials more efficiently.**

Is it possible or realistic to get energy to densely populated, off-grid conurbations? Understanding how to get energy into such areas is one of the most challenging issues faced by humanity. **Technological solutions (roof panels, urban agriculture, waste recycling, etc.) will only go so far, and behavioural practices, such as cooking methods, need to be changed.** Technological solutions, such as wired grids, can be materially valuable and thus are vulnerable to theft in economically deprived areas.

How important are technical solutions to solving global energy problems? Technological solutions can have unintended consequences or simply shift the problem to another area. Therefore the entire system needs to be examined through a multidisciplinary lens, with social sciences playing an important role. **Research Councils and other funding sources need to fund more interdisciplinary work.** Novel and potentially unconventional policy solutions should be explored, such as carbon passports/pricing or waste taxes to make people more aware of the impact of their energy decisions.

How can we better understand the local context? Talking to people who understand the populations and their needs is extremely valuable. Efficient ways of bridging the gap between scientist and consumer helps ensure you find the right place to intervene with appropriate technology in a way that is appreciated by the local population. **In many ways the biggest barriers to change or technology uptake are social issues.** Having young researchers from the relevant country could offer greater indigenous, sociological insights but this requires basic education. Community engagement and improving education in the area is fundamental to a successful technological intervention.

How can we encourage serendipity in technological progress? Often solutions appear in counter-intuitive ways and initially technologies may even be perceived as unnecessary**. Identifying what populations need – when they themselves may not know – requires deep sociological research.** As it stands, market research is largely focused on incremental change which can hinder innovation. Social attitudes and public perceptions of necessity and harm significantly affect the development of technology, policy and our understanding of what may be considered as progress.

Witness profiles

Edgar Blanco
Research and Development Manager, AnDigestion Ltd

For the last 19 years Edgar has worked as an industrial researcher targeting developments with measurable financial returns. Since 2006 he has worked for AnDigestion Ltd and provided the technical and scientific knowledge required to transition from landfill gas recovery to anaerobic digestion (AD). Edgar worked with regulators, industry and academia on the development of technical standards for the AD industry. Amongst other projects, Edgar has been working on new feedstocks for AD from “green biomass”, such as arable by-products, green waste and micro and macro algae.

Professor Chris Howe
Professor of Plant and Microbial Biochemistry, Department of Biochemistry, University of Cambridge

Chris has over 25 years of experience in plant molecular biology, with an emphasis on prokaryotic and eukaryotic algae and the biochemistry of photosynthesis. He is particularly interested in modifying the components of photosynthetic membranes that harvest and utilise light energy and harnessing the electron transfer reactions of photosynthesis for direct generation of energy or hydrogen (‘biophotovoltaics’). His lab was one of the first to identify the unusual chloroplast and mitochondrial genomes of dinoflagellate algae and discovered cytochrome c6A, an unusual form of cytochrome c6, formerly thought not to exist in plants.

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Dr John Mullett
Founder and Director, SOWTech (Sustainable OneWorld Technologies) CIC

John is currently working to achieve a significant increase in the treatment and reuse of organic waste materials, including human sewage in hot low income countries. SOWTech is a non-profit organisation that works with partners to bring new low cost options for sanitation, biogas and biofertiliser production. Currently he is involved in projects in Malawi, Uganda, Sierra Leone, Ethiopia and Tanzania. The latter of which is in association with the Cambridge Development Initiative, of which John is a trustee.