

Energy Security and Net Zero Committee: Keeping the power on – our future energy technology mix

Submission by Applied Microbiology International

- **Does the Government sufficiently support development of innovative energy infrastructure?**

Innovation through the academic route is facilitated by the Innovate UK iCURE program¹. This program gives researchers funding to explore commercialisation avenues for technologies developed in their academic work, however there are no specific focusses with respect to discipline or industrial sectors. If the UK Government is interested in novel energy technologies and applications, this would be an appropriate way to grow in this space. A natural combination here would be funding similar to the UK Research and Innovation's (UKRI's) Industrial Cooperative Awards in Science & Technology (iCASE) funding, which is made available through the successful C1net NIBB funded by the Biotechnology and Biological Sciences Research Council (BBSRC) and similar national research communities. iCASE provide funding for doctoral studentships, where businesses arrange projects with an academic partner of their choice with the aim to provide students with research training experience within the context of a research collaboration between academic and partner organisations². C1net was one of several Networks in Industrial Biotechnology and Bioenergy (NIBBs) funded by the BBSRC to help grow the UK's Industrial Biotechnology sector, and was focussed on the development of gas fermentation^{3,4}.

Biotechnology and engineering biology holds a lot of potential in energy generation and carbon capture, however many projects in this area compete with lucrative projects in medical areas. Direct focusses on engineering biology and biotechnologies for energy applications from all levels by relevant research councils could be of excellent use. These can be combined with industrial partnerships to produce and incentivise clear pathways to impact. As mentioned, there are some effective pathways available through UKRI-led organisations. The

¹ https://www.icureprogramme.com/?utm_source=googleads&utm_medium=cpc&utm_campaign=icuresearch

² <https://www.ukri.org/what-we-do/developing-people-and-skills/epsrc/studentships/industrial-case/>

³ <https://sbrc-nottingham.ac.uk/associated-projects/c1net.aspx#:~:text=Overview%3A,for%20the%20whole%20IB%20community.>

⁴ <https://www.ukri.org/what-we-do/supporting-collaboration/supporting-collaboration-bbsrc/research-networks/networks-in-industrial-biotechnology-and-bioenergy-bbsrc-nibb/>

new Advanced Research & Invention Agency (ARIA) program should also be leveraged to accelerate research in these areas too⁵.

The UK's 'Energy Security Plan' (Powering Up Britain)⁶ emphasises the development of carbon capture, use and storage (CCUS) technologies. Plants and microbes' natural propensity for carbon dioxide conversion to biomass should be more directly considered; biomass is dead plant and animal material which can be used as fuel⁷. Projects currently funded at the national level (projects selected for Phase 2 of direct air capture and greenhouse gas removal program⁸) mainly focus on approaches which generate biochar. Biochar is created when biomass is heated to very high temperatures in the absence of oxygen, which creates energy-rich gases and liquids and charcoal (a carbon store)⁹. While this is an effective locking up of carbon dioxide (CO₂), there are other valuable products that could be made using CO₂ fixed by microbial and plant photosynthesis. CCUS can be criticised as it continues the utilisation of oil and gas-based methods for energy generation which maintains oil and gas companies' domination of the sector. There is scope industrially to uncouple energy production from other high value chemicals (e.g. fuels, pharmaceuticals, solvents etc) derived from crude oil by direct incentivisation and investment in bioproduction. Without this uncoupling it will be harder to economically justify the cessation of gas use.

- **Is the Governments plan for energy security sufficiently long term?**

While emphasis on carbon capture, use and storage (CCUS) technologies is excellent for both slowing and remediation of human-influenced climate change, gas-led energy generation continues to produce CO₂. A timeline should be made for the cessation of natural gas use for energy, and CCUS deployment should be considered in ways that are connected to this.

The UK's 'Energy Security Plan' (Powering Up Britain)⁶ also emphasises the use of mini fission reactors. This is great as an energy generating approach that is CO₂-free, but the persistence of nuclear waste produced here should be given serious consideration. Technologies for the accelerated deactivation of nuclear waste

⁵ <https://www.aria.org.uk/>

⁶ <https://www.gov.uk/government/publications/powering-up-britain/powering-up-britain-energy-security-plan>

⁷ <https://dictionary.cambridge.org/dictionary/english/biomass>

⁸ <https://www.gov.uk/government/publications/direct-air-capture-and-other-greenhouse-gas-removal-technologies-competition/projects-selected-for-phase-2-of-the-direct-air-capture-and-greenhouse-gas-removal-programme>

⁹ https://www.biochar.ac.uk/what_is_biochar.php

should be considered. Microbial processes have shown some promise in this area¹⁰.

The UK has generated some infrastructure for biomass use for energy generation. If the UK wishes to retain and develop this, a release of the moratorium on genetically modified crop use would be advantageous.

- **What current technologies could usefully be deployed at scale to deliver better energy security in the UK?**

Biogas production

Renewable energy sources – such as energy derived from biomass – emit low or no carbon emissions and are therefore considered vital in combating climate change. Biomass is organic (comes from living organisms e.g., plants and animals) and can be turned into energy through various means, such as through burning¹¹. Natural decay of biomass generates gases, therefore capturing and using these gases for energy causes less environmental harm than not capturing it¹².

Biomass energy (or 'bioenergy') constitutes 5.2% of the UK's current renewable mix¹³, however this could increase if more attention is given to biogas generation as a source of bioenergy. Biogas is a renewable energy source produced by microorganisms that breakdown food and animal waste in the absence of oxygen. It can be used as vehicle fuel or as a natural gas replacement (and therefore used for processes that historically use natural gas such as cooking/heating etc)¹⁴. These microorganisms – generally known as methanogens – therefore pose a potential solution to future energy problems¹⁵.

Biogas energy has many advantages and its deployment would help in working towards several of the UN Sustainable Development Goals (in particular UN SDGs 7, 11 and 13, which relate to affordable & clean energy, sustainable cities & communities, and climate action accordingly). For example:

¹⁰ Gilmour et al 2022, Sci Total Environ, Natarajan 2020, Environ Sci Pollut Res Int

¹¹ <https://education.nationalgeographic.org/resource/biomass-energy/>

¹² [What is biogas? | National Grid Group](#)

¹³ <https://www.lse.ac.uk/granthaminstitute/explainers/how-much-do-renewables-contribute-to-the-uks-energy-mix-and-what-policies-support-their-expansion/>

¹⁴ <https://www.nationalgrid.com/stories/energy-explained/what-is-biogas#:~:text=Biogas%20a%20renewable%20fuel%20that's,where%20there%20is%20no%20oxygen.>

¹⁵ Enzmann F, Mayer F, Rother M, Holtmann D. Methanogens: biochemical background and biotechnological applications. AMB Express. 2018 Jan 4;8(1):1. doi: 10.1186/s13568-017-0531-x. PMID: 29302756; PMCID: PMC5754280.

- The material used for producing biogas is called feedstock. Grasses are being considered as a potential feedstock for biogas production. Due to its low water consumption compared to other crops, and the ability to cultivate grasses in non-arable lands, this is a major benefit as it avoids biogas production being in direct competition with food crops. Although biogas production is limited by the characteristics of the feedstock, this could be taken care of via pretreatment procedures.
- Reducing waste – increasing waste is a growing problem as the world population increases. Using waste to produce biogas appears to be one of the most ecofriendly and promising solutions for waste management. Biodegradable waste types being considered as feedstock for biogas production include fruit peels and vegetables, tea leaves, tissue paper, egg shells, hair, leaves, dead flowers and municipal waste.
- Farm animals generate huge quantities of manure, which can be used in a similar way to produce biogas or other biofuels, such as bioethanol¹⁶. Research on using agricultural biomass to produce methane (the main component of biogas) is increasing due to the need to move away from the reliance on fossil fuels. An important next step would be investigating the methane productivity of different livestock waste types, both individually and when combined, in order to determine the most optimal mixing ratios of various slurries.

Increasing understanding of the microbiology of biogas production through further research will enhance its production. Understanding factors such as optimum environmental conditions (e.g., pH) and feedstocks for biogas production will be useful.

Algae-based biomass production

There are some USA-based companies which are capable of carbon capture, use and storage (CCUS) using algae (Algix, Algenol, Algae Systems). These are bioprocesses which utilise the algae's ability to convert CO₂ to biomass, which can be used for energy production. These processes are capable of making materials (Algix), fuels (Algenol) or biochar / other bio-oils (Algae Systems), and should be considered in addition to the biochar-focussed CCUS projects currently funded in the UK.

Microbial Fuel Cells

¹⁶ [Potential use of piggery excreta as a viable source of bioethanol production - ScienceDirect](#)

Microbial Fuel Cells (MFCs) can generate electricity from wastewater. Several UK projects spun out from universities (Bath University¹⁷, Bristol University¹⁸) have deployed technologies like this in developing nations. Their use should strongly be considered in UK wastewater treatment plants. Recent research has also shown that cyanobacterial photosynthesis can also power applications like small computers. Various technologies and manufacturing platforms appear near-mature for their deployment^{19,20,21}. Consideration of these photosynthetic routes to solar power also avoids supply chain issues experienced with contemporary solar cells in use.

About Applied Microbiology International

Applied Microbiology International is solving some of the world's greatest challenges by bringing the applied microbiology community together, across borders and disciplines, to enable meaningful collaboration that delivers scientific impact. With a strong focus on influencing international policy, we are organised around seven core UN Sustainable Development Goals and encourage partnership between academia and industry to increase our impact.

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¹⁷ <https://www.bath.ac.uk/announcements/soil-powered-fuel-cell-promises-cheap-sustainable-water-purification/>

¹⁸ <https://www.uwe.ac.uk/news/technology-turns-urine-into-electricity>

¹⁹ <https://www.ncl.ac.uk/apl/people/profile/marinsawa.html>

²⁰ Sawa M, Fantuzzi A, Bombelli P, Howe CJ, Hellgardt K, Nixon PJ, Electricity generation from digitally printed cyanobacteria, Nature Communications, 2017, Nov 07, <https://doi.org/10.1038/s41467-017-01084-4>

²¹ <https://www.sciencedirect.com/science/article/pii/S2589014X21001250>