Dr John Love, a 2013 BBSRC Innovator of the Year finalist from the University of Exeter, has developed a method of producing renewable artificial fuels which can be used in normal vehicle engines.

In 2011 Love obtained a BBSRC Industry Interchange Partnership Award, now the Flexible Interchange Programme, which allowed him to spend a year at Shell Biodomain in Chester. While at Shell, he proposed and successfully implemented a synthetic method of producing in bacteria molecules identical to fossil fuels.

Trials are now underway to increase yields of the biofuel, improve the energy- and cost-efficiency of the production process and enable industrial exploitation, as well as exploring ways of growing Love’s modified Escherichia coli on waste products.

“The bacteria we produced are the crucial first step towards a carbon-neutral and genuinely sustainable fuel that is compatible with existing infrastructure and lifestyles, and does not compete for agricultural land or food production,” says Love.

When successfully scaled up, Love’s method of obtaining artificial biofuels could help to meet the growing demand for sustainable fuels. The European Union directive on the promotion of the use of energy from renewable sources requires that by 2020 a minimum of 10% of all energy, including transport fuel, must come from renewable sources. With the biofuels market estimated to reach over 50 billion gallons per year by 2019, supply of high quality fuels, while reducing CO₂ emission, remains one of the top priorities of today’s economy.

Currently available biofuels are mostly produced by fermenting biomass or from cellulose – one of the components of plant cell walls. Because of their chemical composition, these biofuels can only be used when mixed with fossil fuels and cannot truly replace unsustainable energy sources. Presently, ‘green fuels’ contain only around 10% actual biofuel.

“Fossil fuels are composed solely of carbon and hydrogen. Currently produced biofuels also contain oxygen, which modifies fuel properties, affecting both the performance of the system and that of the engine,” explains Love. In contrast, the artificial fuels produced by Love contain only carbon and hydrogen and are chemically and structurally identical to fossil fuels.

Love and his team introduced a combination of genes from different bacteria strains into the bacterium E. coli. These genes enable the E. coli to convert free fatty acids, supplied in their food, into alkanes, which are the primary constituent in fossil fuels.

FLEXIBLE INTERCHANGE PROGRAMME (FLIP)

BBSRC’s FLIP awards provide opportunities for individuals moving between different organisations, disciplines and sectors at all stages in their career.

The aim of the program is to enable the exchange of knowledge, technology and people between the research base and user communities for economic and/or societal benefit and facilitate the development of partnerships to foster longer-term collaborations.

IMPACT SUMMARY

An artificial biofuel that can be used as a direct replacement for fossil fuels in existing combustion engines has been produced in bacteria. Its production is both carbon-neutral and sustainable. An innovative, two-way partnership based on shared staff, ideas and opportunities has been strengthened between the University of Exeter and Shell Biodomain.
INNOVATOR OF THE YEAR

BBSRC’s Innovator of the Year competition celebrates and rewards scientists who have sought and seized opportunities to ensure that their research contributes to wealth creation and wellbeing in the UK.

“These awards recognise the impact of bioscience both on the economy and society, through driving innovation, training highly-skilled people, improving businesses and public services and attracting foreign investment.”

David Willets, Minister for Universities and Science, March 2011.

Within a year of developing the idea, Love not only managed to produce the biofuels, but also customised them to ensure that they remain liquid and can be blended properly, so that they could be used in available engines. Furthermore, even though engines burning Love’s biofuels will still emit CO₂, the bacteria consume the same quantity of CO₂ as they grow and produce the biofuel, meaning that the overall net CO₂ production of the system would be zero.

Industrial perspective

The BBSRC award provided Love with everyday contact with the Shell team, which was invaluable in strengthening the relationship, leading to an effective two-way collaboration. “Obtaining the BBSRC Industry Interchange Partnership Award facilitated a more innovative academic-industry partnership that prioritised reciprocal interaction between industry and university-based researchers,” says Love. “That has encouraged our laboratory research to be responsive to real-world requirements and able to rapidly address critical knowledge-gaps that underpin industrial opportunities.” The interchange also proved to be highly beneficial from the industrial perspective.

“John’s expertise in the field of synthetic biology was not only instrumental in bringing the project forward, but also invaluable to us at a broader level, as John was actively involved in coaching new staff,” says Dr. Jeremy Shears, Global Manager for the Biodomain at Shell. “The collaboration was incredibly successful, a huge win-win for both sides and we are excited about similar joint projects in the future.”

Effects of the interchange have been long-lasting, with Shell remaining an active partner of the University of Exeter. The project has now expanded to a wider collaboration between the Universities of Exeter and Manchester, and Shell’s Biodomain laboratory in Houston, US.

REFERENCES

1. Dr John Love, University of Exeter: http://biosciences.exeter.ac.uk/staff/index.php?web_id=john_love&tab=research
2. BBSRC’s Industry Interchange Partnership Award has now been superseded by the Flexible Interchange Programme (FLIP) www.bbsrc.ac.uk/business/people-information/flexible-interchange-programme.aspx

Petrol pumps. The artificial biofuel could replace fossil fuels. Image: Edd Sowden/Flickr. CC BY-NC-ND 2.0