A smart approach to biofuel can help in facing up to energy and climate concerns. **Professor Patricia Harvey** of the University of Greenwich explains

Developing biofuels

Global CO_2 levels have risen relentlessly since 1950 and will continue to do so well beyond 2035, in spite of well-meaning global interventions to place limits on CO_2 emissions embodied in the 1997 Kyoto Protocol, to which 191 states have signed up. In the UK for example there is a legally-binding target to ensure that the net UK carbon account for 2050 is at least 80% lower than the 1990 baseline.

This is because economic performance and energy emissions are inextricably linked. And global energy demand is expected to rise by over one-third in the period to 2035, underpinned by rising living standards in China, India and the Middle East. The reason for the stark correlation with energy and emissions is clear: fossil energy is much cheaper than renewable energy and likely to remain so until new breakthroughs in green energy research come to fruition. Thus, according to IEA figures, in 2010, 81% of all energy provision came from fossil fuels and by 2035 this is predicted to continue to be dominated by fossil fuel sources (79%) as increasing supplies of unconventional gas come on to the market.

Estimates of costs and emissions from the combustion of waste glycerol from biodiesel manufacture to provide decentralised heat and power provides a good example of the nature of the problem. As a result of new patented technology by a UK company, Aquafuel Research, it is now possible to combust glycerol in an internal combustion engine. Glycerol has a volumetric energy equivalent to 20.16MJ/l, more than methanol and similar to that of ethanol. It is also renewable, biodegradable and on emissions targets, produces no combustion particulate, no SO_x, reduced primary NO_x, extremely low VOC and aldehyde emissions and no catalyst poisons. Replacing heat and electricity provided by an existing fossil fuel boiler and grid electricity with glycerol combustion in an engine of capacity 367kWe for Combined Heat and Power (CHP) has been estimated to save nearly 2,000 tonnes of CO_2 per annum but cost an additional 1.65 times more per annum to operate than the present arrangement. By contrast, a gas engine CHP would save around 500 tonnes CO_2 per annum but produce an annual saving of over £60,000.

Professor Patricia Harvey

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A salt-pan operation in Namibia with a stream of algae-enriched water in the foreground, representing an abundant supply of future biofuel

The solution for green energy adoption has to lie in making green energy more affordable and for this, support for innovation and research is crucial. In this regard, efforts of the European Commission are to be commended. In January 2013, the Commission published a strategy document which advocated support for sustainable advanced biofuels from lignocellulose feedstocks and wastes as well as algae and micro-organisms but recommended no further public support for first generation biofuels produced from food crops after 2020.

The EC also proposed that market incentives should be provided for biofuels with no or low indirect land-use emissions, in particular the second and third generation biofuels including those from algae, straw and wastes. And in this regard research into algae that produce glycerol *de novo* could lead the way forward for glycerol-CHP. In salt ponds across the globe, algae that produce glycerol have been discovered. These algae also produce an abundance of nutraceuticals such as carotenes. By exploring opportunities for establishing a biorefinery based on such algae it may be possible in the future to have glycerol-CHP systems to provide heat and power for communities around the globe. Distributed power generation from such a renewable source will also contribute to electrically-driven forms of transportation, further reducing carbon and other unwanted emissions.

Professor Patricia Harvey
Professor of Biochemistry
Head of Bioenergy Research
University of Greenwich

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