Can the world afford to wait for the next petroleum shock to arrive?

Future shock: new paradigm in algal biofuels

In 1973 the world experienced the first major supply shock from OPEC, leading to petrol shortages, and a sustained period of economic stagnation, and rampant inflation. As a response, the National Renewable Energy Laboratory (NREL) in an endeavor to explore pathways to energy independence via solar power and biofuels.

NREL established the Aquatic Species Programme (ASP), where algae was studied in depth as a source for biodiesel for nearly two decades. By the late 1990s, the ill effects of the OPEC supply shock were offset by the return of cheap oil, and the ASP programme was closed.

Fast forward to October 2007, in response to rising oil prices the US Congress passed the Energy Independence and Security Act in December of 2007, it also raised the Renewable Fuels Standard from a previous target of 7 billion gallons of transport fuels by 2012 five fold to 36 billion gallons of transport fuels by 2022.

Leap frog technologies

UOP, Neste Oil, Live Fuels, and Sapphire Energy, were among the first to introduce green crude or biocrude from algae as a petroleum substitute. The second half of 2008 witnessed an increasing number of companies using synthetic biology by employing microbes such as bacteria and algae to produce advanced biofuels.

One of the first companies in the field Amerys focused on using bacteria as a micro-refinery by feeding the bacteria sugarcane and then milking the microbe to secrete synthetic diesel. The microbe (algae, bacteria) had now become the mini-processor of biomass feedstock directly into fuels.

The emergence of synthetic biology in the biofuels arena represented a fundamental shift in thinking for producing and refining fuels from biomass. Instead of delivering biocrude to refineries, several companies and university research labs started focusing on using microbes (algae and bacteria) as micro refineries of biomass directly to biodiesel, ethanol, renewable diesel, renewable petroleum, and advanced aviation biofuels The advent of synthetic biology in the biofuels industry presented several new opportunities to leap frog the construction of capital-intensive biodiesel, ethanol, cellulosic, and petroleum refineries.

In late 2008, as these microbial-milking mini micro-refinery technologies evolved, several scientists presented a new challenge by asking the question: 'why grow terrestrial crops' to feed the microbes?

Terrestrial crops require the use of petroleum for tractors, fertiliser and increased land use. Instead, these companies proposed using waste streams as feedstocks such as carbon dioxide from power plants to bypass terrestrial crops (feedstocks) and petroleum refineries (processes) all together. It would also eliminate the costly need to transport thousands of tonnes of biomass to biorefineries, and then to transport the biocrude to petroleum refineries.

Within the domain of synthetic biofuels, these next generation of technologies arrived in a short span of time. This spawned a new era of investment into waste-to-energy projects. Aurora Biofuels received $20 million (€15.2 million) in funding due to this next-generation model by using carbon dioxide waste from power generation as the feedstock to milk the microbe (blue-green algae or cyanobacteria) to produce biodiesel. Sapphire Energy received $100 million in funding to produce renewable petrol from algae by employing synthetic biology.

Arizona State University (ASU) has engineered cyanobacteria to use carbon dioxide from smokestacks as the feedstock. ASU's blue-green algae serves as micro-processors to secrete a fuel with very similar properties to kerosene and aviation fuel. This was of particular interest to the defense aviation industries for energy independence initiatives, and to US commercial aviation industries facing imminent carbon reduction penalties in 2012.

Algenol, a company with 15 years of experience in algal biofuels, has modified blue-green algae to produce ethanol. Algenol also uses carbon dioxide from smokestacks as the feedstock for these microbial mini-refineries, and seawater (instead of fresh water).

The company uses a fermentation process within photobioreactors where the ethanol is secreted from the algae, evaporates from the water as a gas within the tubes, and is then condensed back into liquid ethanol. The organisation has chosen non-harmful strains of algae to accelerate acceptance and commercialisation of their technologies. Algenol, in a $850 million agreement with Biofields of Mexico, is also transforming sea water into drinking water, another commodity like petroleum, corn, and oilseeds that is already in short supply and in increasing demand over the long-term.

Back to the future

Most investors, inventors and futurists will say that real, long-term change comes from disruptive, transformative technologies that challenge existing systems with more efficient and productive models.

The recent memory of $148 per barrel oil, and the arrival of imminent biofuels sustainability and land use criteria in the US and the EU serves as a reminder that continuous change and innovation are the only things that are able to bring the biofuels industry to the next level. ●

For more information:
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