

# US feedstock trends: algae

*Shortages of soyabeans, rapeseed and palm are driving interest and investment in algae*

According to a new study, the US and the EU will reach impressive biodiesel production capacity numbers in 2008, each at nearly 3 billion gallons or about 11 million tonnes.

Actual production numbers are far less impressive, demonstrating biodiesel demand and capacities are expanding faster than feedstock supplies. The study – Biodiesel 2020: A Global Market Survey, 2nd edition – finds demand for biodiesel in the US, EU and Malaysia in 2008 will exceed each region's domestic agricultural capacity to produce feedstocks. These include soyabean oil for biodiesel in the US, rapeseed in the EU, and palm oil in Malaysia in the same year.

In each region the study finds the amount of available,

arable land that can be dedicated to fuel crops is approaching its limits to produce sufficient quantities to feed local populations, supply export markets, and still meet B2/B5 targets at home.

As the US, Europe and Malaysian markets approach and surpass their limits to grow soya, rape and palm for food, export and fuel consumption, an urgent need for alternative, non-food and next-generation feedstocks is growing. Among alternative feedstocks, algae holds enormous potential to provide a high-yield, non-arable land use, non-food, non-rainforest source of biodiesel, ethanol and hydrogen fuels.

## Future feedstocks

The Biodiesel 2020 study finds algae may hold the key to meeting large-scale, sustained feedstock shortages in the US,

Feedstock	Yield per acre
Soya	40-50 US gallons/acre
Rapeseed 110-145	US gallons/acre
Mustard	140 US gallons/acre
Palm	650 US gallons/acre
Algae	10,000 US gal/acre

Source: Biodiesel 2020: A global market survey, 2nd edition

Europe and Asia. According to the US National Renewable Energy Laboratory (NREL), biodiesel manufactured from domestically grown soyabeans, rapeseed and canola only has the potential to meet approximately 10% of the US' fuel needs.

Between 1978 and 1996 the NREL performed a study on harvesting oil from algae. They estimate that algae can produce up to 10,000 gallons of biodiesel per surface acre per year, versus soyabeans at 48 gallons per acre and canola/rapeseed at 120 gallons per acre. Due to these factors, algae is attracting a great deal of interest and investment in the US, Europe and worldwide.

Algae are the fastest-growing plants in the world. Like other plants, they use photosynthesis to harness sunlight and carbon dioxide. Energy is stored inside the cell as lipids (the source for oil) and carbohydrates, and can be converted into fuels such as biodiesel and ethanol.

Among biofuels related projects, algae is commonly grown in two scenarios. The first is in ponds or lakes (both open and closed), and the second is grown in closed, translucent tubes or containers also called photo bioreactors. In both cases the growth of algae requires a source of carbon, light, nutrients, and warm water. When these

elements are selected in appropriate quantities and cultivated under specific conditions, oil-rich strains of algae have the potential to produce a significant amount of vegetable oil for biodiesel production, as well as meal that can be processed into ethanol, fertiliser or other products.

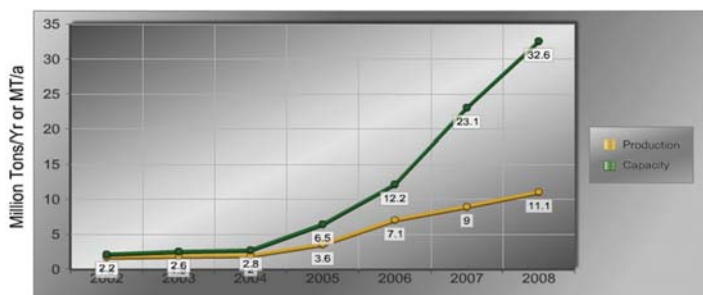
## Algae applications

The Biodiesel 2020 study also examines multiple applications for algae in the transport (biodiesel, ethanol, hydrogen) and power generation sectors. One system of interest aims to capture carbon dioxide from the smokestacks of a power plant and use the carbon to produce algae for low-emissions biofuels for transport – a double benefit for environmental pollution. Another system aims to process algae biomass via a biomass to liquid (BTL) thermochemical process to use the entire algae plant mass to create bio-oil (also called bio-crude, or syncrude) that can then be re-processed into diesel and ethanol fuels.

One system seeks to grow carbohydrate-rich algae strains for the purpose of creating ethanol feedstock. Another is in BTL processes that can be converted into methane gas, and another commonly cited system aims to use waste streams from municipal water authorities to grow algae.

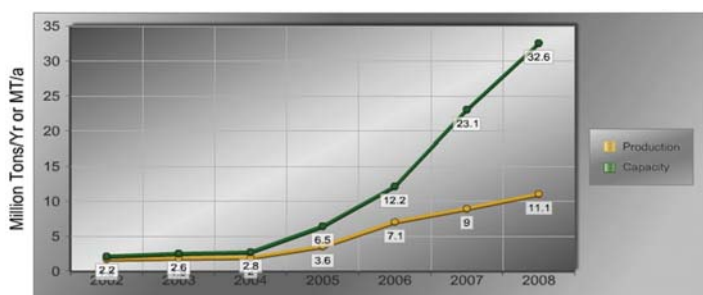
Some of the leaders in the US algae to biofuels arena include large national laboratories, small private companies, and joint ventures. One in particular is GreenFuels, an organisation

## World biodiesel production and capacity



Source: Biodiesel 2020: A global market survey

## US biodiesel production and capacity



Source: Biodiesel 2020: A global market survey, 2nd edition



One view of the future – large scale, multiple raceway algae pond system

Source: Solix Biofuels

that uses algae to capture and convert carbon from coal-fired power generation sources into biodiesel, ethanol or hydrogen for transport fuel.

Valcent GlobalGreen Solutions has created a vertical photobioreactor system capable of increasing yields in smaller enclosed spaces. PetroAlgae is another private venture with an open pond technology that has plans for large scale commercialisation with an aim to produce 2.5

billion gallons of algae oil by 2010. Solazymes has been active in promoting its early-stage algae progress via its algae-biodiesel Mercedes promotion car.

There are several public-private collaborative ventures between large US based energy laboratories and large energy companies. LiveFuels is a public-private venture with Sandia Labs and other labs to turn algae into biocrude. Another public-private venture

is between UOP (a division of Honeywell) and the US Defense Advanced Research Projects Agency to process algae into military grade jet fuel. The US National Renewable Energy Laboratory is working with Chevron and other companies to explore methods of turning algae into biodiesel and ethanol fuel. Shell and HR Biopetroleum have formed Cellana in cooperation with the University of Hawaii to create algae in open ponds to produce biofuels for transport.

### Commercialisation outlook

More than two dozen projects have been identified worldwide, which are working to mass produce algae into biodiesel, although none have yet achieved large scale commercial viability. Many company reports, analysts and scientific experts agree some

initial form of algae-based systems will start to arrive in late 2008 and 2009, with small scale commercial offerings and capabilities.

The Biodiesel 2020 study concludes some time around the end of 2009 is when the larger algae-based systems for biodiesel production are likely to start entering the mainstream with larger production capabilities and greater efficiency. If existing algae projects can achieve biodiesel production price targets of less than \$1 (€0.7) a gallon (or about \$4/litre), the US and EU may realise their visions to replace up to 20% of transport fuels by 2020 by using environmentally and economically sustainable biofuels from algae. ●

#### For more information

This article is an excerpt from the February 2008 study Biodiesel 2020: A Global Market Survey, 2nd edition, written by William Thurmond at Emerging Markets Online ([www.emerging-markets.com](http://www.emerging-markets.com))