Research Trends

Volume 1
Issue 13 *Research into environmental challenges*

Article 3

10-1-2009

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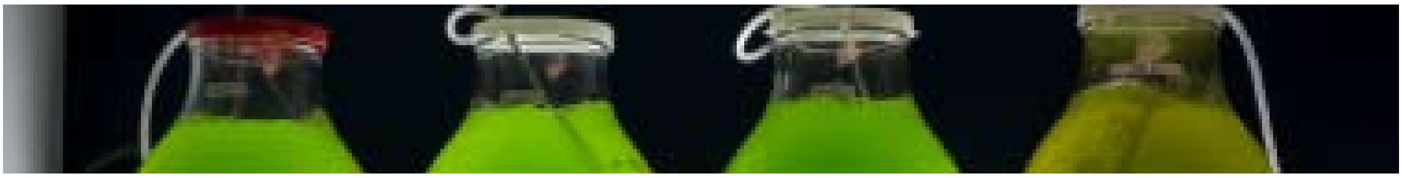
Elsevier

Bibliometrics



Biomass and biofuels – the promising potential of oilgae

SARAH HUGGETT

Biomass, commonly defined as a renewable energy source using energy from living or recently living organisms, is not a new initiative. As early as the beginning of the last century, pioneers such as Henry Ford and Rudolph Diesel designed cars and engines to run on biofuels and before World War II, the UK and Germany sold biofuels mixed with petrol or diesel.

However, as the case for climate change becomes more widely accepted, interest in renewable energies in general and biomass in particular is increasing. One outcome of the G8 summit in Italy in July was a document entitled *Responsible Leadership for a Sustainable Future (1)*, which introduced the idea of a "green recovery" through investment in ecological R&D, industry and infrastructure.

The G8 leaders also expressed a specific interest in biofuels: "We welcome the work of the Global Bioenergy Partnership (GBEP) in developing a common methodological framework to measure greenhouse gas emissions from biofuels and invite GBEP to accelerate its work in developing science-based benchmarks and indicators for sustainable biofuel production and to boost technological cooperation and innovation in bioenergy." *(1)* Interestingly, the list of most recently prolific institutes in the field (see Table 1) reflects this international awareness.

Food for thought

However, there is also an ethical issue associated with biofuels, as the agricultural land required to produce them takes scarce farmland away from food crops. "Biofuels could help mitigate emissions from the transportation sector," says Oliver Inderwildi, research fellow at the Smith School of Enterprise and the Environment, University of Oxford, "but not all biofuels are low-carbon fuels. Some emit even more carbon than conventional fossil fuels. Moreover, feedstock farming has serious effects on water resources, food prices and ecosystems. A considerable amount of research is focused on those environmentally unfriendly, high-carbon biofuels. This is because energy security concerns were the key drivers for the recent hype in biofuel research, rather than environmental concerns."

This is where algal fuel (also known as oilgae) comes in: not only is its productivity higher than that of other biofuel crops, but algae do not need arable land or potable water to thrive *(2)*, therefore reducing competition with food crops. Furthermore, algae sequester CO_2 as they grow, making them a carbon neutral energy source and the by-products of oilgae production

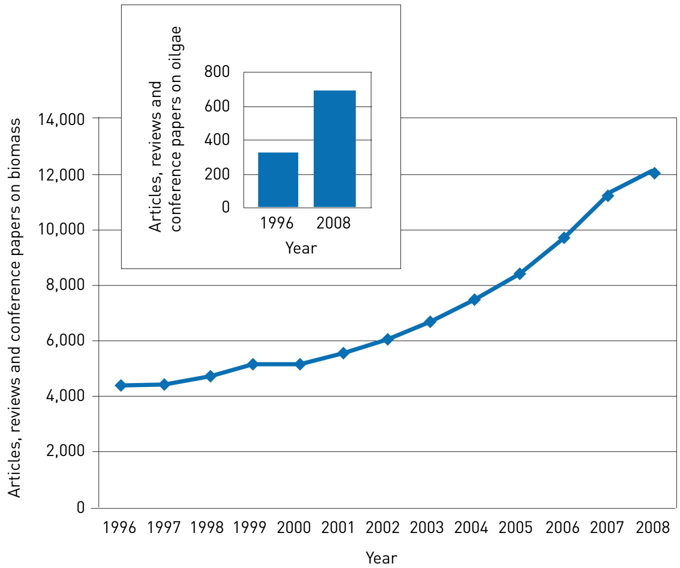


Figure 1 – Scientific literature on biomass has grown steadily over the past 12 years.
Source: Scopus

can have other applications, such as in animal feed or as a replacement for common petroleum products, such as plastics or cosmetics. There are even claims that genetic engineering has allowed scientists to modify algae to produce crude oil *(3)*, which can be used to generate different types of fuels and thus eliminates the need to retro-engineer existing engines.

Yusuf Chisti, Professor of Biochemical Engineering at Massey University in New Zealand, believes that using microalgae to produce renewable, carbon-neutral transport fuels is the only way forward. "The technology for transforming crude algal oils into diesel, gasoline and jet fuels exists already," he comments. "Only microalgae have the potential to provide crude oil in sufficient quantities to meaningfully displace petroleum-derived fuels. Microalgae can do this without affecting our food supply, animal feed or freshwater; producing fuels from algae will not cause deforestation. Algal fuels are currently expensive, however. But due to concerns about climate change, it's likely that we'll eventually have to switch to these environmentally friendly fuels."

However, genetic engineering comes with its own concerns: while the organisms created still require an artificial environment in which to live and multiply, there are concerns that they could escape and adapt to survive in a natural environment *(4)* where their potential impact is unknown.

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Challenges and champions

Despite the controversies, scientific literature on biomass has increased by 9% per annum over the past decade, representing a three-fold increase in articles, reviews, and conference papers between 1996 and 2008. At the same time, research into the subfield of oilgae grew 6% per annum, with the number of articles, reviews, and conference papers published each year on the subject more than doubling between 1996 and 2008 (see Figure 1). This is a strong indicator of the potential of this field.

While the high-yield capacity of algae has been experimentally proven, the production of algal biofuels in vast quantities remains a challenge. However, the G8 leaders expressed a multinational commitment to develop biofuels and invest in renewable energies as part of the "green recovery" plan. Significant R&D investment could help the industrial production of oilgae take off. Further developments on the subject are expected to be unveiled at the United Nations Climate Change conference in Copenhagen in December.

Useful links:

United Nations Climate Change Conference 2009
G8 Summit 2009

References:
(1) Documents of the G8 Summit 2009
(2) Jha, A (2008) "Oil from algae' promises climate friendly fuel", *The Guardian*
(3) Jha, A (2008) "Gene scientist to create algae biofuel with Exxon Mobil", *The Guardian*
(4) Rosenberg, J.N., Oyler, G.A., Wilkinson, L. and Betenbaugh, M.J. (2008) "A green light for engineered algae: redirecting metabolism to fuel a biotechnology revolution", Current Opinion in Biotechnology, 19 (5), pp. 430–436

Rank	Institute	Country	Articles, reviews, conference papers	Average citations by publication
1	Chinese Academy of Sciences	China	1135	1.79
2	USDA Agricultural Research Service	USA	462	3.24
3	University of Florida	USA	312	2.83
4	Universidade de Sao Paulo	Brazil	302	3.33
5	Zhejiang University	China	296	1.81
6	Wageningen University	Netherlands	286	3.81
7	UC Davis	USA	280	3.87
8	Russian Academy of Sciences	Russia	264	1.29
9	Sveriges lantbruksuniversitet	Sweden	261	4.26
10	Oregon State University	USA	248	6.38
11	University of British Columbia	Canada	229	4.73
12	Lunds Universitet	Sweden	223	5.04
13	Michigan State University	USA	221	5.44
14	Cornell University	USA	209	5.31
15	Tsinghua University	China	206	2.70
16	USDA Forest Service	USA	204	4.19
17	Iowa State University	USA	204	2.75
18	University of Tokyo	Japan	200	3.45
19	Universiteit Gent	Belgium	197	4.48
20	Consiglio Nazionale delle Ricerche	Italy	194	3.63

Table 1 – Most prolific institutes in biomass and biofuel research; publication and citation years: 2005–2008.
Source: Scopus