IEA Bioenergy Task 39

Commercializing 1st- and 2nd- Generation Liquid Biofuels from Biomass

Task 39 Newsletter • Issue # 20 • April 2008

SUMMARY

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FROM THE TASK

Welcome to the latest issue of the Task 39 newsletter. As the number of meetings focused on biofuels has grown, and the cost of travel continues to rise, there seems to be an emerging trend towards 'localized' spheres of interest among our membership. It is getting harder to justify travelling around the world when so much is happening at home, or next door! This increases the importance of Task 39's role in bridging the gap between our members, and acting as a conduit linking the European Union and other nations active in the liquid biofuels area, with particular emphasis on the USA. In our Task, we have greatly benefited by the technical expertise of Mike Himmel, and look forward to working with Jim Macmillan, who is our current US Country Representative.

We hope to see many of you at our upcoming meeting in Cork, Ireland, being organized by Jerry Murphy, to be held on September 15-17. On the first day, this meeting will offer each of our Task members an opportunity to get together and discuss the latest developments in their member nations. Jerry has done a terrific job of lining up a range of technical and industrial presenters for the second day, and a technical tour is scheduled for Day 3. If you are interested in attending this meeting, please contact Emmanuel Ackom; space is limited, so we encourage you to hurry!

This newsletter marks a change in the support staff of Task 39. Warren Mabee, who has served as webmaster and editor for several years, will be taking up a new faculty appointment at Queen's University (Canada); while Warren will continue to serve as an Associate Task Leader, he will no longer be able to maintain the website and newsletter. Emmanuel Ackom, a postdoctoral fellow at the University of British Columbia, will be taking on this role for the Task. Emmanuel will also be involved in organizing future Task 39 meetings and workshops.

As always, we invite you to continue to use the Task 39 website. Task members can access presentations from past Task 39 meetings as well as up-to-date reports such as the Biofuel Implementation Agendas; all visitors to the site will find older reports and a wealth of information on liquid biofuels. We hope to continue to expand the website into a one-stop resource for those looking for information on Task 39 personnel and biofuels research. - *Jack Saddler*, *Emmanuel Ackom*

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IN THE NEWS

Australia - Biofuel projects cut but LPG scheme gets boost

Cuts to ethanol projects will deliver more than $15 million in savings to the Government next financial year, but the LPG conversion scheme established by the Coalition will receive additional funding.
More information

Canada - Biofuel Backlash

The world is on the verge of experiencing one more round of global food inadequacies with the prospect of catastrophic

effects -- thanks to the clamour for oil profits. More information

EU - RPT-Law, not grain price, hits biofuel output

Legislation and low wholesale prices for ethanol are squeezing biofuel production margins rather than high grain prices. More information

Germany - Merkel Calls on Brazil to Make Biofuel Production Sustainable

Merkel held a press conference in Brazil's capital of Brasilia and emphasized the need to ensure rain forests are protected during the production of biofuel. More information

UK - Biofuel targets attacked by group of MPs

The Government must impose an immediate moratorium on biofuel targets in the face of rising food prices, an influential group of MPs have urged. More information

USA - Gross Negligence

As the international food crisis makes its way onto America's front pages, climate realists have watched in amazement the groundswell of finger-pointing at ethanol. In the last 30 days alone, over 3,000 news reports have discussed the biofuel connection to rising prices and grain shortages across the globe. More information

USA - US disputes IMF on food prices

The Bush administration on Wednesday disputed the International Monetary Fund's claim that their push to increase biofuel production has been the biggest factor in rising food prices. More information

USA - Latest potent biofuel made from Sweet sorghum sap

Sweet sorghum is grown in the U.S. for cooking and livestock feed. But the tall plant also might help at the gas pump. More information

USA - How new US biofuel legislation will subsidize oil consumption

Why new US biofuel legislation is on track to waste billions of tax dollars, while subsidizing oil consumption. More information

USA - DuPont, Danisco join forces for non-food ethanol

A new joint venture by DuPont and Danisco aims to develop what could be the first large-scale non-food ethanol production, which could lighten the pressure of biofuels on the food industry. More information

Asia - Myanmar biofuel drive deepens food shortage

"It was the national duty," said Sai Khur Hseng, a Myanmar exile who has extensively studied the government's biofuel programme. "Everybody had to plant it." More information

South America - Sugarcane biofuel becomes Brazil's second energy source

Biofuel and other derivatives from sugarcane have for the first time overtaken hydroelectric power as an energy source in Brazil, according to an annual official study released Thursday. More information

South America - Peruvian minister: Biofuel production not sole cause of food crisis

Biofuel production is not the only cause of the world food crisis, said Peruvian Agriculture Minister Ismael Benavides on Tuesday. More information

United Nations - UN urges biofuel investment halt

The UN's new top adviser on food has urged a freeze on biofuel investment, saying the blind pursuit of the policy is "irresponsible". More information

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ADDRESSING CONCERNS OVER LARGE SCALE BIOFUEL PRODUCTION

Warren Mabee & Emmanuel Ackom, IEA Bioenergy Task 39

As you are all aware, the rapid development of liquid biofuels - principally from agricultural crops - has been in the news lately. Media bulletins and scientific articles alike have increasingly reported on perceived negative impacts associated with biofuel production, most focusing on the correlation between biofuel production and rising food prices. On April 14, the United Nations Special Rapporteur for the Right to Food made the dramatic statement that 'Producing biofuels today is a crime against humanity'. Right or wrong, this bad press is having an impact; an advisory panel to the European Environment Agency has asked the EU to suspend its goal of 10% renewable fuels by 2020, and the New York Times recently published an editorial calling for Congress to 'rethink ethanol' - specifically, to cut subsidies and remove the renewable fuel mandate which targets 136 billion litres of ethanol production by 2022. Even cellulosic ethanol - which Task 39, and many other groups, has identified as a highly promising fuel from both an energy- and carbon-balance perspective - has come under fire, with the publication of two articles in the prestigious *Science* journal that raise the spectre of 'carbon debt' associated with land use change which will likely be needed to increase bioenergy crop production [Searchinger et al. 2008, Fargione et al. 2008]. How do we respond to these arguments?

Food versus fuel

Certainly there has been a recent rise in demand for feedstocks for biofuel production; the most dramatic increases have been in corn production for biofuels, primarily in the USA, which in turn has impacts on other cereal crops. This has had a downstream impact on food prices. One of the first widely-reported examples was the "Mexican tortilla crisis" in January 2007, which saw prices for this staple rising 300% over those seen in the summer of 2006, to a high of approximately US$1.81/kg from only US$0.63/kg the previous year [Roig-Franzia 2007]. The cause of this crisis was reputedly high corn prices and a shortage of Mexican corn, resulting in increased imports from the US, where corn is in high demand for bioethanol production. At the time, some commentators questioned this analysis, citing the fact that most biofuel production is based on "yellow" or livestock-grade corn, while tortilla production uses "white" or human-grade corn, which had not (at that time) seen dramatic price changes in the US [Philpott 2007]. However, there is now increasing evidence that surpluses of white corn are diminishing as farmers move towards biofuel feedstock production [Baker et al. 2008]. Because cereal crops are essential for livestock production, the cost of meats and grains for the table must be impacted when large quantities of cereals are diverted to non-food production. As Task 39 has previously reported, the Food and Agriculture Organization of the United Nations predicted in 2007 that biofuel production under existing mandates would increase food costs by 10-15% towards 2010. In reality, food commodity prices have risen by as much as 43% in the year that has passed since that report was released [McMillin et al. 2008].

The US government has stated that the use of corn for ethanol can account for only up to 3% of the reported increase in food prices, but the International Food Policy Research Institute in Washington suggests that biofuel production might account for 25-33% of the increased cost [Rosegrant 2008, Rosegrant et al. 2006, Rosegrant et al. 2005]. Under every scenario, however, other factors must be taken into account. Perhaps the most important factor to recall is the increase in population worldwide, which has led to major increases in demand. We know that global cereal production has essentially doubled over the last 40 years, increasing at an average rate of about 26 million tonnes/year since 1965 (see figure below). However, the availability of grain per capita has remained at approximately 320 kg/capita since the mid-1970's. Population growth, which has approximately doubled over this period, has been supported by this increase in global grain production. However, as more of the world's population advances through the stages of economic development, consumption of commodities is also rising; more people are demanding more goods like meat for the table, and fuel for the tank.

Under the scenario of rapid population growth that we have experienced, world food production has moved to an increasingly industrial model which relies heavily upon trade. However, the ability of major cereal-exporting nations to supply food to countries in need, whether through trade or via food aid programmes, has been limited recently by a variety of factors, including drought in Australia (linked to climate change), increased production and transportation costs (linked to the high cost of oil), and increasing demand for livestock feed (linked to economic development and increases in meat consumption, as already mentioned). Unfortunately, the rise in food commodity prices has a much larger impact in countries with lower GDP, where purchasing power is limited. Indeed, food riots have been observed in several countries that fit this bill - including Haiti, Bangladesh, Egypt, Mozambique, and elsewhere.

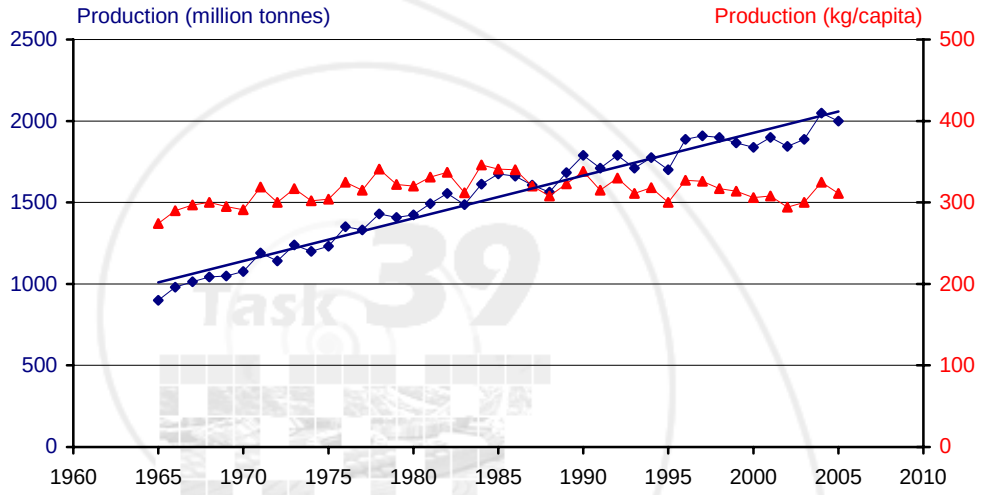

Figure 1: Comparison of total cereal production (worldwide) and per capita grain production, 1965-2005 [FAO 2005, UN 1999]

Virtually all parties agree that biofuels are influencing food prices - although there are diverging views on how much of an impact these fuels are having. However, the true impact that biofuels are having on food commodity costs might not matter too much. Of all the root causes of the current food crisis - including climate change, the high cost of oil, economic development, and increased use of crops for non-food purposes - only biofuels can be linked directly to policy decisions that in turn could be reversed. Thus, from a political perspective, reducing subsidies and rolling back mandates for biofuels might be considered a viable option to respond to public outcry over increased food costs. This reality must be considered in the advancement of a strategy to develop better, more effective renewable fuels from biomass.

Non-food feedstocks

In many countries, the development of 2nd-generation biofuels (like cellulosic ethanol or biomass-to-liquid technologies) forms a major component of biofuel strategies in the mid- to long-term. For example, the US hopes that 83 billion litres of cellulosic ethanol production will be available by 2022 to help meet the current renewable fuel mandate, in addition to about 53 billion litres of corn-based ethanol. Most studies agree that cellulosic ethanol is characterized by a much better energy balance and lower greenhouse gas emissions, in comparison to corn-based ethanol or petroleum fuels.

Figure 2 below provides a review of pertinent studies carried out by the National Resources Defence Council [NRDC, 2006] indicates that under current production methods, corn (starch-based) bioethanol represents only a slight improvement in energy efficiency over petroleum, providing on average 1.3 x as much energy in the final product as is required to produce the liquid fuel. Cellulosic (wood-based) bioethanol has a better ratio, providing on average 4 x as much energy out as is required to produce the fuel. These data indicate that development of cellulosic liquid biofuels utilizing forest feedstocks has the potential to improve energy efficiency and the overall energy balance. There are dissenting studies. One very well known document, by Pimentel and Patzek, has been widely quoted by anti-ethanol groups; however, this study used significantly higher energy inputs than are usually considered standard, thus generating far lower energy returns than were obtained by the majority of researchers in this field.

When cellulosic liquid biofuel production is compared with food-based liquid biofuel production and conventional petroleum use, a significant reduction in GHG emissions can be seen, as shown in Figure 3. Two recent integrative reports brought together the major LCAs conducted in a number of OECD countries in Europe and North America. One, the VIEWLS project, first reported in November of 2005 [VIEWLS, 2005] and corroborates data released in the other, earlier report by the Institute for Energy and Environmental Research in Heidelberg, which provides some additional LCA reviews [Quirin et al., 2004]. It is estimated that cellulosic ethanol would produce net emissions of about 38-42 g CO_2-e per km driven; compare this to gasoline (~170 g), bioethanol from corn (~140 g), or even bioethanol from sugarcane (~80 g). This is because of the 'green' CO_2 emissions associated with the production of cellulosic ethanol, which are discounted in a net emission scenario. In general, both reports show that biofuels made from both agrofuels and woodfuels are characterized by reduced CO_2 emissions compared with similar food-based and petroleum products (shown by striped and white bars, respectively), and thus become important components of GHG reduction strategies (including Low Carbon Fuel Standards).

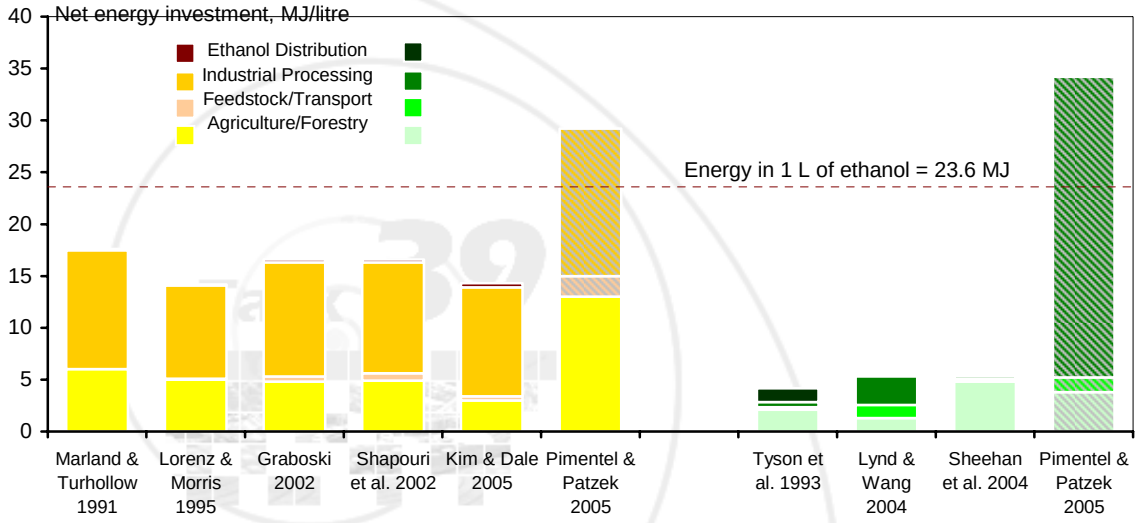

Figure 2: Comparison of energy efficiency of bioethanol production, various studies [NRDC, 2006]

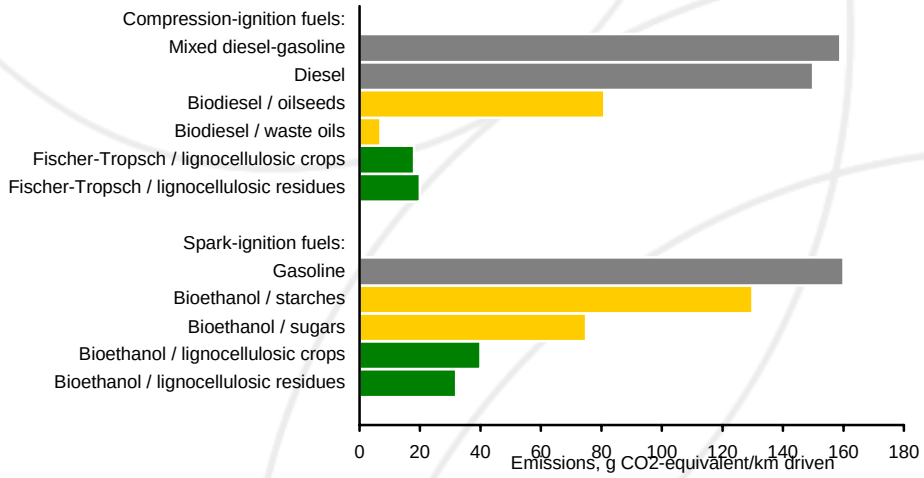

Figure 3: Comparing greenhouse gas emissions of biofuels and conventional fuels, using advanced (>2010) technologies for production and use [Spitzer et al. 2006, VIEWLS 2005]

The recent argument that has been made against cellulosic feedstocks is this: by converting land from its current use to the intensive production of cellulosic biomass, a 'carbon debt' is incurred which negates the positive performance of the resulting fuel. For example, Searchinger et al. [2008] agree that production and application of cellulosic ethanol can reduce total GHG emissions compared to petroleum use; they estimate that this reduction is on the order of 70%. However, with land use change factored in, they estimate that GHG emissions rise by 50% compared to petroleum use. In these calculations, the authors assume that there is loss of 'natural' or semi-natural ecosystems, including forests and grasslands, with an associated reduction in both aboveground and belowground carbon. Fargione et al. [2008] makes a similar argument. When the same calculations are applied to abandoned cropland, however, where land use change has already occurred, the carbon debt that is incurred is much smaller - approximately 5% by one calculation [Fargione et al. 2008]. It must be noted that an underlying assumption that these authors make is that productive cropland lost to energy crops will be replaced with new cropland.

The development of cellulosic ethanol may lead to the wholesale conversion of grasslands or forests to industrial plantations or energy crops. However, actual experience with energy crops, particularly in Europe and North America, does not necessarily suggest that such a change must occur. For example, in Sweden, the development of willow plantations for bioenergy production was initially expected to take place largely on abandoned cropland. In practice, the more successful willow plantations were located on productive farmland, while those situated on marginal land were not economically viable [Helby et al. 2006]. There is little suggestion that cropland lost to willow plantations has been replaced with new cropland created through land use change; in this case, the agricultural industry has merely made an economic decision to pursue energy rather than food crops.

The social, economic and ethical issues associated with diverting 'food to fuel' are major drivers to provide biofuels from sources

of biomass that are not directly used for food supply. Lignocellulosic feedstocks, such as forestry and agricultural residues, or purpose grown non-food crops are therefore receiving much attention at present [WWI 2007]. A good example of a residue-based industry is the wood pellet industry of British Columbia, which produces their solid biofuel product from sawmill residues. In this case, no land use change need occur to develop a new industry. Indeed, the development of a biomass-to-liquid or cellulosic ethanol industry based on wood fibre could be sourced entirely on residues and lower-value feedstocks, such as chips, which currently are utilized for traditional forest products. However, converting large areas of land to non-food (energy) crops exerts additional pressures on the environment [Righelato and Spracklen 2007]. In addition, while lignocellulosic feedstocks are much more abundant and cheaper than cereals, processing technologies to yield biofuels from biomass remain expensive and largely unproven. The current slate of demonstration projects, in the US, EU, and other countries around the world, should provide valuable data towards commercialization of biomass-to-biofuels.

Competition for biomass resources, whether these are food feedstocks or cellulosic fibre, will change the market for existing products. Predictions have been made for years suggesting that a vibrant bioenergy sector would increase competition for arable land [Monbiot 2004, Brown 2003, Klein and LeRoy 2007, WWI 2007]. As a corollary, however, the development of cellulose-based biofuels could lead to increased revenues for the sector providing the fibre input [Azar 2005]. Farmers would have greater economic incentives with higher energy prices to turn from cultivating crops for food to bioenergy, unless food prices rose to the point where profits matched those in the energy sector. Similarly, high energy prices will likely lead to increased competition for wood fibre, particularly between the pulp and paper industry and the emerging biofuel industry. One important issue for forestry biofuel developments will be fibre supply, especially for low grade fibre such as:

- small diameter/low quality trees that cannot be used economically for forest products manufacturing;
- residues that are presently left within the forest; and
- residues from forest products manufacturing.

Both the existing pulp and paper industry and the emerging biofuel industry utilize lower-value feedstocks, and the potential economic return from biofuels is rapidly approaching a point where these products could compete with existing forest products. At the same time, the potential increase in the demand for these low grade fibres arising from the above competition will lead to additional pressures on our forest resources. It is therefore important to re-examine the limits of sustainable forest management in the exploitation of such low grade forest fibre resources.

The food-vs.-fuel argument has focused much attention upon biofuels and questions the wisdom of further developing the biofuel sector. However, the root causes of the current food crisis are myriad; biofuels cannot carry all of the blame. Having said that, the existing commercial biofuel sector is vulnerable to changes in policy which could see subsidies reduced or removed, and mandates slowed or abandoned. Many countries are already following an effective strategy to reduce the impact that biofuels have on food prices, by supporting research and development to diversify the biofuel sector towards 2nd-generation biofuels. The benefits that 2nd-generation or cellulosic biofuels have over currently commercial biofuels are clear and represent a positive step towards sustainability in terms of both energy consumption and greenhouse gas emissions. The questionable issue of 'carbon debt' is a powerful argument that calls for careful planning at the regional and national level; unrestricted development of 2nd-generation biofuels could lead to the unanticipated release of CO_2. However, this type of land use planning should actually be considered as part of an integrated strategy for ecosystem and climate management.

Success in the commercial development and deployment of 2nd-generation biofuel technologies could be supported by the following points:

- Support for research, development, demonstration and deployment around second generation biofuels, with particular emphasis on developing links between industry, academia, and governments, should be continued;
- A better understanding of the lignocellulosic biomass resources that could be utilized for second generation biofuel production or biorefinery applications is required;
- Support for second generation biofuels should complement existing support for first generation developments - the two classes of biofuels should be considered in a complementary but distinct fashion, possibly requiring different policies;
- Policies to support first and/or second generation biofuels should be part of a comprehensive strategy for land use as a whole, due to competition for the limited resource. A number of synergistic policy programmes should be included, such as transport, health, climate change, environment, renewable energy, rural employment, agricultural assistance, sustainable development, water use, local air pollution etc.

In a carbon-constrained world, the price of land is likely to increase along with the cost of biomass derived from the landbase, influencing prices for food, forest products, and other goods. Social, economic and ethical issues associated with diverting 'foods to fuel' might possibly result in an increased shift in the demand for cellulosic biomass from the forest and field.

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STUDENT EXCHANGE OPPORTUNITIES

One of the mandates of IEA Task 39 is to facilitate the movement of students and scholars between member countries. UBC recently hosted two students from Lund University in Sweden, Johanna Johansson (left in picture) and Hanna Landbring. In the course of completing their Master of Science in chemical engineering degrees at Lund University, they undertook a research project at UBC enabling them to write a thesis and complete their degrees. Hanna compared and contrasted bioenergy policies in Sweden and Canada, while Johanna worked in the lab on the bioconversion of hemlock and Douglas-fir to ethanol.

Typically, Task 39 can assist in facilitating exchanges by providing funds for travel or accommodation costs, with matching funds from the visitor's parent institution and from the host organization. In the past, we have found that the presence of some outside funding has made it easier for host universities to find matching funds. Any member countries interested in initiating an exchange should contact Jack Saddler or any of the associate task leaders.

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UPCOMING TASK 39 MEETINGS

The next Task 39 meeting will be held in Cork, Ireland from September 15-17, 2008. We would like to thank Jerry Murphy and

his colleagues at University College in Cork for their hard work in organizing this meeting! We would encourage you to contact Emmanuel Ackom for more details about this meeting; a detailed brochure is attached to this newsletter.

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UPCOMING/RECENTLY RELEASED REPORTS

1. Biofuel Implementation Agendas: A Review of Task 39 Member Countries

The implementation report is online at the Task 39 website, and available to all Task 39 members. Non-members wishing to view the report should contact their appropriate country representative.

2. Biodiesel Production: Technologies and European Providers

A comprehensive review of European technology providers for biodiesel producers has been completed and posted to the Task 39 website under the 'Task Outputs/Publications' page. Non-members may contact their appropriate country representative to obtain a copy.

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