Commercializing Conventional and Advanced Liquid Biofuels from Biomass

Task 39
IEA Bioenergy

Inside This Issue

From the Task

By Susan van Dyk, Jack Saddler and Jim McMillan

This issue of the Task 39 newsletter highlights biofuels developments of likely interest to Task 39 stakeholders, including some of Task 39's recent work. As this is the start of the new 2016-2018 triennium there have been some changes in Task membership. We are VERY pleased that the European Commission has re-joined Task 39 and we look forward to their valuable contributions to the Task`s work.

The Task held a business meeting in Delft, the Netherlands in March 2016. We are grateful to and thank our colleagues at DSM for providing the facilities for this meeting. The main agenda items included country report presentations and discussions on the Task's current ongoing deliverables including: Advanced Fuels in Advanced Engines; Updated Algal report; and LCA model comparisons. Several other prospective new projects were also discussed, including an update to the drop-in report, with an increased focus on aviation and marine biofuels as well as the need for good policy. The updated Algal report is now in its final draft stage and under review; we intend for this report to be finalized and become publicly available by or before the end of this year.

The Advanced Fuels in Advanced Engines project is approaching completion of its first phase which involves a biofuels-focused survey including the advanced biofuels categories of HVO, FT, DME, OME, Methanol, cellulosic ethanol, Bio-LNG and LBG.

The March Task 39 business meeting was held in conjunction with the ECO-BIO 2016 conference in Rotterdam and 8 Task 39 members spoke in two sessions within this conference, highlighting technology and industry developments in their respective countries.

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In other news, a number of biofuels related reports were published during the past four months. Download links are provided in the News section. A report commissioned by a coalition of companies, including Volkswagen and Shell called for the promotion of biofuel-powered cars over electric vehicles (EV) as the report authors claim that this will provide the lowest cost route to reducing carbon emissions. The report, entitled "Integrated Fuels and Vehicles Roadmap 2030 and Beyond," concludes that additional reduction potential through 2030 could be achieved through an adaptive policy approach. This involves promoting within society those technologies with the lowest greenhouse gas emission abatement costs and highest customer acceptance. Both VW and Shell see alternative fuels such as E85 offering an easier, less costly path than EVs. Shell's Colin Crooks posits that liquid fuels will remain essential during the EU's transition since internal combustion engines are expected to be required for quite some years to come. (Read more)

Other recently issued reports of interest include:

- "Towards advanced biofuels – options for integrating conventional and advanced biofuel production sites (RES-T-BIOPLANT)", looked at integration of advanced (2nd generation / 2G) biofuel plants with conventional (1st generation / 1G) biofuel plants and how this could lead to significant synergies and cost savings.
- The USDA published a report on the Energy balance of corn ethanol 2015.
- The National Renewable Energy Laboratory (NREL) updated its annual survey of U.S. non-starch ethanol and renewable hydrocarbon biofuels producers. The survey report is titled *2015 Survey of Non-Starch Ethanol and Renewable Hydrocarbon Biofuels Producers*.

A few of the recently published reports are controversial, such as the United Nations Conference on Trade and Development (UNCTAD) report entitled, "Second generation biofuel markets." The report gives an optimistic view of the current status of second generation biofuels and markets but data on production and capacity is inaccurate.

The European Commission finally published the Globiom Study on indirect land use change [ILUC] (the release of the report had been delayed during prolonged consultation on the RED program). The study indicated that increased demand for European produced ethanol would likely have a low impact on land use change.

We welcome your feedback. Please direct your comments to Susan van Dyk

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From a policy perspective, the last four months have seen regulatory developments in several countries. India doubled its ethanol blend to 10%, Argentina increased its ethanol blend from 10% to 12%, Belgium increased its ethanol blend from 4.5% to 8% from Jan 2017, and Brazil increased their biodiesel mandate to 8%. More details can be found in the News section.

Although the ongoing low oil prices have slowed the pace of development, around the world several new facilities were announced, some nearing completion while others are progressing to detailed planning stage. The first generation or conventional biofuel facilities that have been announced include a wheat-based ethanol plant in Punjab, India, a molasses-based ethanol plant in Uganda, a biodiesel plant in New Zealand and a cassava-based ethanol facility in Ghana. (Details in the News section)

Advanced biofuel facilities have also been in the news. Ensyn announced it will start producing renewable biofuel in Georgia in 2017 (based on pyrolysis of woody biomass). The construction of Red Rock Biofuels' facility (based on gasification and Fischer-Tropsch synthesis of biofuels) was slightly delayed, after they were bought by Joule. Two advanced biofuel facilities in India were announced, a cellulosic ethanol plant based on bamboo feedstock and a demonstration facility based on IH2 technology (by Shell India Markets). Another advanced ethanol facility was announced in Jamaica, while RenFuel and Nordic paper signed an agreement to build a test facility to produce advanced biofuels from lignin. The cellulosic ethanol facility operated by POET-DSM Advanced Biofuels in Emmetsburg, Iowa, announced that they were ramping up production and hoped to reach full capacity soon. In addition, Diamond Green Diesel announced expansion of its renewable diesel facility in Louisiana from 160 MMgy to 275 MMgy.

Developments also took place on the aviation biofuels front. Oslo Airport (Gardermoen) became the first airport to offer renewable aviation fuel as part of their fuel hydrant system. The biojet fuel will be provided by Neste as part of their ITAKA project. In the US, AltAir Paramount in California started commercial production and delivery of biojet fuel to United Airlines. The biojet fuel will be blended with regular jet fuel and used by United for flights between San Francisco and Los Angeles. This biojet fuel is produced from upgrading of oils and fats. Air New Zealand and Virgin Australia also announced a partnership to investigate options for locally produced (and used) aviation biofuel. The big news in the last few weeks was ASTM's approval of Gevo's alcohol-to-jet (ATJ) pathway based on upgrading of isobutanol obtained from renewable feedstocks (alcohol to jet synthetic paraffinic kerosene or ATJ-SPK). This form of biojet can be used in blends of up to 30% and Alaska Air will purchase the fuel and fly commercial flights using ATJ-SPK-blended fuels.

Task 39 has been fortunate to have Sweden as a member of the Task since its inception within IEA bioenergy. Sweden is a recognized leader in sustainable silvaculture and has always been at the forefront of innovating biofuels for transport, such as importing cars from Brazil as one way of more quickly establishing a flexifuel infrastructure, by encouraging their forest sector to expand production of bioenergy, and by having many internationally recognized academics working on advanced biofuels and biorefining, incuding Guido Zacchi, Leif Jönsson, Lisbeth Olsson, Barbel Hahn-Hagerdahl, Gunnar Linden and many others.

The lead article in this issue is authored by Tomas Ekbom, Sweden's new representative to Task 39, and does an excellent job of showing how Sweden continues to be at the forefront of developing and using advance biofuels.

As always, we appreciate your feedback. Please send us any ideas on how we might increase the value of these Task 39 newsletters. We hope to hear from you via email to get your feedback and suggestions.

Jim, Jack and Susan

Sweden takes the lead in biofuel-use in Europe

Tomas Ekbom

1. General introduction - A fossil free energy supply by 2050

The production and use of biofuels in Sweden have increased substantially since the mid-2000s. According to preliminary statistics from SPBI, the share of renewable energy in the road sector was 14.7% in 2015 based on energy content (Figure 1). If the calculation is made according to the Renewable Energy Directive's (RED) calculation methodology the share is estimated at about 23%.

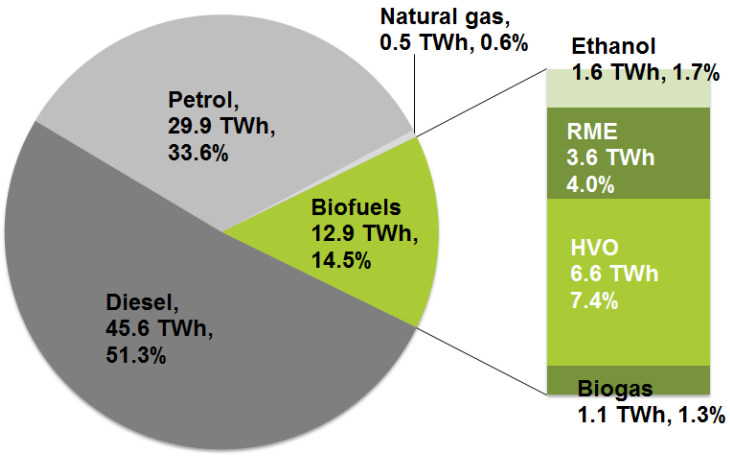

Figure 1. Energy usage in the road transport sector 2015, preliminary statistics. Reference: Swedish Energy Agency, 2015.

Sweden currently has the largest share of biofuels in the transport sector in Europe (tied with Finland) according to the RED calculation rules and in terms of actual energy content. Sweden stands out compared to the rest of the EU because increased biofuels consumption consists of both the low- and high-blends (neat fuels). The use of biogas in the automotive sector is also larger in Sweden than in other EU countries. Figure 2 below illustrates the growth of biofuels use in Sweden since 2006.

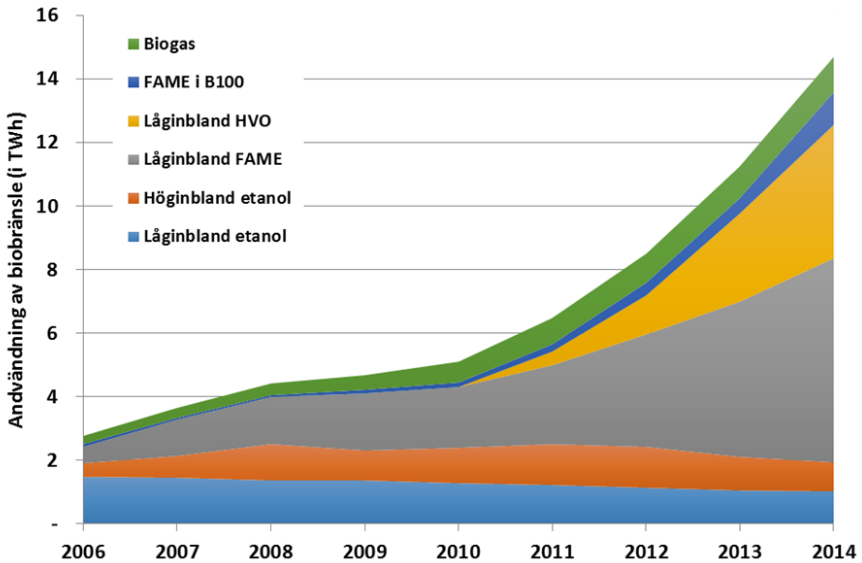

Figure 2. Development of biofuels usage in the road transport sector 2006-2014. Reference: Swedish Energy Agency, 2015.

2. The HVO market development

There are two types of biodiesel in the Swedish market today, FAME and HVO. HVO is short for hydrogenated vegetable oil and can be made of various types of oilseeds such as rapeseed, sunflower, soybean and palm. HVO can also be produced from tall oil, which is a waste product from the forest products industry. As technology has progressed, several different types of raw materials have been used successfully to produce HVO. It is also possible to manufacture HVO from rendered animal fats.

HVO is a drop-in fuel and thus functionally similar to fossil diesel. It can be used in the current distribution and refuelling infrastructure without needing to make any additional investments. HVO can be produced in oil refineries because there are most likely already hydrogenation processes there. However, it may require some additional investments to develop new HVO production capacity.

2.1 Actors in the Swedish market

There are mainly two major HVO producers on the Swedish market today, Preem and Neste. Preem HVO has been on the Swedish market since 2011 and Neste HVO has been available since 2012 (although they only have storage capacity in Sweden, no production plants). A third company, ColabitOil, develops HVO and claims to have hydrogenation technology and is building a small pilot plant.

Preem produces HVO from crude tall oil (CTO) supplied by SunPine, with the CTO obtained as a residual product from the chemical pulp industry. Crude tall oil is processed in two steps. First, raw tall oil is processed to crude tall diesel in the SunPine plant in Piteå. Then, the crude tall diesel is transported to Gothenburg, where it is further processed in the Preem oil refinery. SunPine is jointly owned by Preem, Södra forest owners, Sveaskog, Lawter and Kiram and has a production capacity of about 100 000 m^3 of crude tall diesel per year.

Figure 3. SunPine production plant in Piteå. Reference: SunPine.

In February 2014, Preem announced an investment of SEK 300 million to expand capacity at its refinery in Gothenburg. With the HVO retrofit the capacity is estimated to increase to 200 000 tonnes per year. The construction began in the winter of 2014 and work was finished in the autumn of 2015. To ensure that there is sufficient raw material for the increased production, Preem will use additional vegetable oils and animal fats feedstocks (like fish oil residues from Norway).

Preem launched a new product in June 2015 called Evolution Petrol which contains 5% biofuel made from tall oil, as well as the required 5% ethanol. Evolution Petrol will initially be sold at 40 stations in southern Sweden. Their target

is to launch a product with a larger percentage of renewable content, similar to Evolution Diesel but blended at levels of more than 30% by volume. Preem states that a long-term policy framework is a prerequisite for making required investments.

Neste has three HVO production facilities, one each in Finland, Singapore and the Netherlands. Neste's raw material base consists mainly of waste from palm oil and animal fats. The company's goal is that their HVO feedstock shall consist of 100% residues and wastes by 2017. Neste invested in two of its three refineries in 2014-2015 in order to expand HVO production. Overall, in 2015, Neste expects to produce 2.3 million tonnes of HVO. In 2017, they expect to increase HVO production to 2.6 million tonnes.

2.2 Distribution

The distribution of HVO to private consumers takes place mainly by fuel companies Preem, Statoil, OKQ8 and St1. Preem provides a product called Preem Evolution Diesel which contain 25% HVO and 7% RME (FAME, see Section 3) in fossil diesel, as well as a pure HVO product: the HVO Diesel 100. Statoil sells its product through HVO Miles diesel with about 35% HVO in fossil diesel. They also sell pure HVO in two test stations to certain "test customers". The product is called HVO100. OKQ8 sells pure HVO at four filling stations under the name Bio Diesel HVO. They also provide HVO through its product Diesel Bio+, which has about 20% HVO blended in fossil diesel. St1 sells HVO in their product Citydiesel, which contains about 25% HVO. In 2014, the average level of blending of HVO in fossil diesel in total was about 9%. HVO is also sold to business customers through distributors TRB and Energifabriken.

2.3 Consumption

The use of HVO has grown steadily since it was introduced to the Swedish market in 2011. Table 1 shows the increasing use of low-blend HVO between 2012 and 2015.

Table 1. **Consumption of HVO in Sweden, low-blend, 2012-2015 [1000 m^3].** Ref: Swedish Energy Agency, 2016.

Year	2012	2013	2014	2015
Low-blend HVO	131	289	439	650

In 2014, the share of HVO of total consumption of biofuels reached 39%, and this share continues to rise, and the total share of all biodiesel, by energy, reached 71%, including high- and low-blends of FAME and HVO.

3. The development of markets for FAME

FAME stands for fatty acid methyl esters and FAME biodiesel can be made from various types of oilseeds such as rapeseed, sunflower, soybean and palm. It is also possible to produce FAME biofuels from animal fats and vegetable and animal waste oils. In Sweden, it is common to use rapeseed oil in production. Rapeseed oil has thermal properties that make it suitable for the Swedish climate. This particular kind of FAME biodiesel is rape methyl ester or RME produced through a chemical process in which rapeseed oil is reacted with methanol to form RME, producing glycerol as a by-product. Methanol can be from fossil origin or produced from biomass. In cases where the methanol input chemical to the RME process is renewable-based, the end product RME is regarded as 100% renewable.

3.1 Actors in the Swedish market

There are two companies in Sweden that produce FAME at a larger scale, Perstorp BioProducts AB in Stenungsund and Ecobränsle AB in Karlshamn. There are also a number of smaller companies in the agricultural industry which produce relatively small amounts of FAME fuel.

In Perstorp's plant in Stenungsund, the production capacity is about 148 000 m^3 per year. In 2015, Perstorp bought an existing production plant in Fredrikstad, Norway to produce Perstorp RME, and the goal was to start production by

the end of 2015. When this new plant reaches in full production Perstorp will almost have doubled its production capacity. Perstorp produces a 100% renewable FAME product called Verdi Polaris Aura by means of a bio-based methanol. The methanol is purchased from BioMCN in The Netherlands and is in reality based on natural gas, however, BioMCN purchases equivalent amounts of biogas and thereby substitutes the energy used which makes it renewable based. BioMCN produced during 2010-2014 methanol from glycerol actually a by-product from FAME production, but stopped due to alkali-salt problems.

Figure 4. Perstorp's production plant in Stenungsund. Reference: Perstorp.

The production plant of Ecobränsle has a capacity of about 55 000 m^3 per year. They had planned to expand production capacity by 15 000 m^3 in 2015, but because of increased taxes on FAME and lower fossil fuel prices, the company instead cut back on production. As an alternative, Ecobränsle will start selling HVO at its filling stations.

3.2 Distribution

FAME is sold as neat fuel as B100 and as a low-blend in fossil diesel. B100 is primarily used by heavy-duty vehicles such as trucks and buses. FAME is basically blended in all fossil diesel sold at public filling stations. In 2014, the average blend level was about 5.5%. B100 is mainly sold directly by the producer to the customer, but the product is also available at a smaller number of fuel stations. B100 has become an important fuel for the bus industry. In 2014 nearly 17% of the Swedish bus fleet was fuelled with RME.

In Sweden, it is allowed to blend 7% by volume FAME in fossil diesel under the Swedish Environmental Class 1 standard. The EU Fuel Quality Directive restricts higher blends of FAME in diesel. It is possible to run vehicles on 100% FAME, but this requires some material adjustments to a normal diesel engine. It also requires approval from the vehicle engine manufacturers.

3.3 Consumption

The use of FAME increased between 2006 and 2012 and then levelled off. This is because fossil diesel use has stabilized in recent years. Use of high-blend FAME has increased throughout the period 2006-2015, but it still represents a small portion of the total FAME use.

Table 2. **Consumption of FAME, 2008-2015, [1000 m^3].** Reference: Swedish Energy Agency, 2016.

Year	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*
Low-blend	160	194	207	224	252	240	256	245
High-blend	5	12	18	26	42	53	112	170
Total	165	205	225	250	294	293	368	415

3.4 Import and export

The FAME which is imported into Sweden comes mainly from Lithuania and Germany. Imports from Germany has decreased significantly in 2013 but increased again in 2014. Exports in comparison are very small, and mainly are to Italy and the U.K.

4. The development of markets for ethanol

Ethanol is blended in principle in all 95 octane petrol and in some volumes of 98 octane petrol and also sold in high-blend as E85 (85% ethanol in petrol) and ED95 (95% ethanol with 5% ignition improvers).

4.1 Actors in the Swedish market

There are three producers of fuel ethanol in Sweden today, Lantmännen Agroetanol, Domsjö Fabriker and St1. The former has its plant in Norrköping and has a current production capacity of 180 000 m^3 per year. Domsjö Fabriker is in Örnsköldsvik and has a capacity of about 19 500 m^3.

There is also a small ethanol from wood pilot plant based on with SEKAB's E-Technology located in Örnsköldsvik. This process technology called CelluTech™ fractionates biomass into bioethanol, biogas and solid fuel. Since 2013 the plant operation is managed by SP Sveriges Tekniska Forskningsinstitut. They have started to develop this facility into a Biorefinery Demo Plant.

Lantmännen Agroetanol produce ethanol by fermenting grain which largely comes from Swedish farmers. In 2014, one of the two production lines was closed, lowering the production capacity from 230 000 m^3 per year. In the second half of 2014, investments were made in a new plant to process residues from food and food waste. During 2015-2016, an estimated 17 000 tonnes of food residues will replace an equal amount of grain raw material. The company is also working to expand the raw material base further to include straw and sawdust.

To improve the climate performance of ethanol, cooperation was initiated with AGA Gas, where carbon dioxide from ethanol production is converted into carbonic acid in AGA's facility that is adjacent to Agroetanol. Most of Lantmännen's ethanol is exported to Germany for low-blends in petrol. Some is also sold as E85 or ED95 in Sweden.

Figure 5. Lantmännen Agroetanol's production plant in Norrköping. Reference: Lantmännen.

The ethanol from Domsjö Fabriker is sold to SEKAB which distributes it as technical ethanol and fuel ethanol. The raw material used is sugar-rich black liquor from a sulphite pulp mill. This ethanol is mostly sold to Finland, where it can be double-counted in the country's obligation schemes. Some is also sold in Sweden as ED95.

In 2014, St1 Biofuels Oy delivered Etanolix, a plant for the production of bioethanol, to North European Oil Trade Oy in Gothenburg. Residual products from bakeries and the like are used as feedstock, e.g., bread from grocery stores that has passed its expiration date. The plant is located at the St1 refinery in Gothenburg. In Finland, St1 already has four such ethanol plants in operation. The ethanol from the plant is used for both low and high-blends. The plant has a capacity of 5000 m^3 of ethanol per year and production started in early 2015.

Table 3 below details domestically produced quantities of ethanol between the years 2010-2014. As the table shows production went down significantly in 2014, which was due to Lantmännen Agroetanol shutting down one of its production lines as mentioned above. This can be compared with the deliveries of fuel ethanol to the market during 2014 which totalled 326 560 m^3.

Table 3. **Production of fuel ethanol in Sweden, 2010-2014, [1000 m^3].** Reference: Agra-net, 2015.

Year	2010	2011	2012	2013	2014
Ethanol	205	200	224	219	160

In September, the government sent out a memorandum on notification of biofuels, which was a requirement of the EU to continue to receive tax exemptions for biofuels. There are certain criteria a producer and distributor and importer must obey in order to receive this "licence document". How the proposal will affect the Swedish market is difficult to say at this point. However, it is likely that no new facilities for food-based biofuels will be established and that the existing food-based biofuels will be negatively affected. The Swedish Energy Agency estimates that the regulations may pose a direct threat to trade of ethanol from sugar cane and palm oil from Brazil and Southeast Asia. The same applies to some ethanol from corn and wheat from the EU.

4.2 Distribution

Distribution of ethanol occurs in three forms, namely ED95, E85 and low-blends in petrol. ED95 is sold today by two actors, SEKAB and Lantmännen Agroetanol, who both sell directly to customers. Lantmännen Agroetanol began

supplying ED95 to the market in early 2015, whereas SEKAB has developed and sold ED95 since the 1980s. SEKAB sells to about ten countries, including Brazil where Sao Paolo has developed buses that run on ED95.

In principle, all the petrol sold at fuel stations in Sweden contains about 5% by volume ethanol. According to both the fuel quality directive and the standard used in Sweden (EN228), 10% ethanol in petrol is allowed. E10 is however not available on the Swedish market today because it is only given a tax reduction on maximum 5% by volume. Low-blends above this level are fully taxed.

According to the so-called Pump Act, filling stations that sell over a certain volume of fossil fuels, must also provide a renewable fuel option. Of the country's 2723 filling stations, 2060 stations sold at least one renewable fuel in 2014, which was a few more than in 2013. In 2014, 1846 of these filling stations offered E85. The trend is towards fewer filling stations and most definitely less stations selling E85.

4.3 Consumption

In 2012, the sale of E85 stalled and has since decreased significantly. Previously, the E85 sales price at the pump, adjusted for energy content, has been lower than petrol. This was, however, not true during 2012-2014, when sales fell even though the ethanol price was lower than the price of petrol. In 2015, the price was slightly above the price of petrol due to maintenance work in several European production plants reducing supply.

The amount of ethanol used for low-level blends in gasoline depends on the total gasoline use, which has gradually decreased since 2005. The decrease is due to more efficient engines in new cars and diesel cars taking an increasing market share. Until 2011, the use of high-blend ethanol increased more than the use of low-blends decreased, which explains the relatively high levels of consumption even after 2005; see Table 4 below. In recent years, however, the overall level decreased, because the use of high-blend ethanol also started to decline. As the table shows, fuel ethanol consumption continued to decline in 2015.

Table 4. Consumption of ethanol, low- and high-blend, 2008-2015, [1000 m^3]. Reference: Swedish Energy Agency, 2016.

Year	2008	2009	2010	2011	2012	2013	2014	2015
Low-blend	228	229	216	204	191	179	171	167
High-blend	194	160	184	216	215	176	156	97
Total	422	389	400	420	407	355	327	264

5. The development of markets for biogas

Biogas produced and sold for the transport sector is called “Fordonsgas” in Sweden. Biogas produced with anaerobic digestion contains a large share of carbon dioxide and small share of sulphur compounds. This raw biogas can be upgraded to nearly pure methane biogas (about 98% by volume) and then used as a gaseous vehicle fuel, Fordonsgas.

Fordonsgas was introduced on the Swedish market in the early 1990s and initially consisted mainly of natural gas (fossil methane). As biogas production plants started to be built in Sweden in the mid-1990s, the opportunity came to upgrade the biogas and use it as a fuel in the transport sector. In Sweden, about 1.8 TWh of biogas was produced during 2014 from a total of 277 production plants. 57% of the biogas was upgraded to Fordonsgas, whereas 24% was used for heating, 3% went to power production, 11% was flared and 4% was used for industrial purposes.

Since biogas production began to make a mark in the fuel statistics in 1996, its proportion has gradually increased, and in 2008 biogas production exceeded natural gas production on an energy basis and has since become the dominant share of vehicle gas. The average mix since 2009 has been around 60% biogas and 40% natural gas. The exact mixture is regionally determined and depends amongst other things on the nearby biogas production and access to infrastructure. A general commitment within the industry in Sweden is that vehicle gas must always contain at least 50% biogas.

Through contracts with Fordongas Sverige, Grön100 consisting of 100% biogas is also sold. E.ON has a clearing system in place since 2014 that will ensure that the purchase of the biogas complies with contracted volumes of biogas sold over time. E.ON offers two products for biogas, Biogas 50 and Biogas 100. At the end of 2014, there were 155 public filling stations around the country as well as 63 non-public stations, such as bus depots.

5.1 Distribution

Distribution of biogas can be done in three different ways; via networks, in liquid form or in compressed form in gas tanks and bottles on trucks. According to Energigas Sverige, 21% of the biogas in Sweden was distributed through the gas network in 2013, the remaining 79% was distributed via trucks. In order to transport liquefied biogas the gas must be cooled down to very low temperatures (almost cryogenic temperatures) where condensing to liquid form, LBG, occurs at about -162°C. The town of Lidköping has Sweden's first and only biogas liquefaction plant. The advantage of LBG is that it is a more energy-dense biofuel that can be transported over longer distances.

5.2 Consumption

The use of compressed natural gas (CNG) has increased every year since the mid-1990s when it was introduced on to the Swedish market. Since 2005, consumption has increased by about 300%, as shown in Figure 6 below.

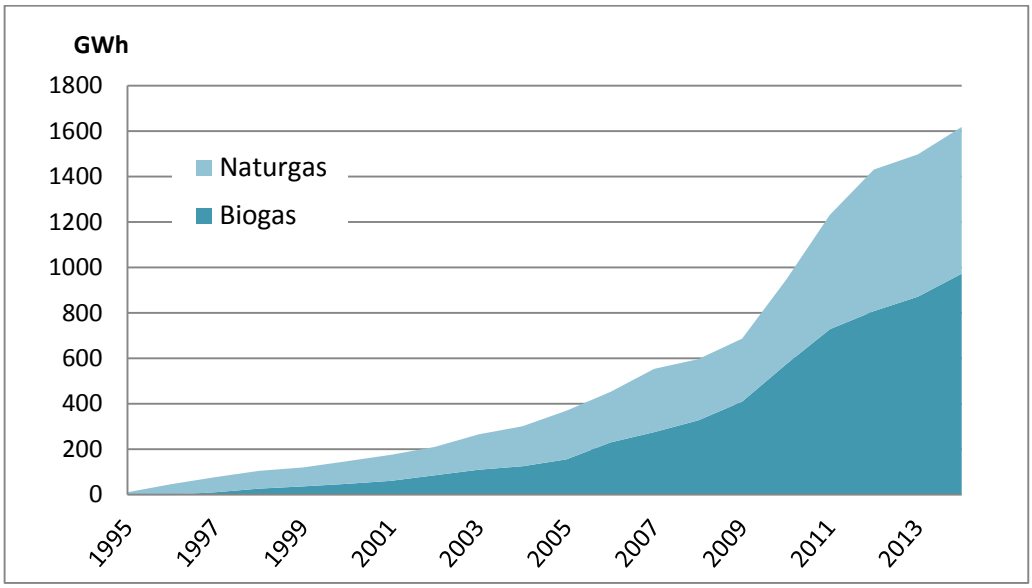

Figure 6. Consumption of Fordonsgas during 1995-2014. Reference: Swedish Energy Agency, 2015.

The upward trend is partly due to more and more municipalities choosing to invest in Fordonsgas as the fuel for local and regional buses and delivery vehicles and the increased availability of new filling stations. The increased use also correlates to an increase in the biogas vehicle fleet. At the end of 2014, there were 50,102 registered gas vehicles in Sweden, an increase of more than seven percent from 2013.

Fordonsgas can be used directly in converted engines and in passenger cars with petrol in spark ignition engines, so-called bi-fuel engines. For heavy-duty vehicles there are both spark ignition engines for gas alone and a combination of diesel and CNG, so-called dual-fuel engines. In Malmö there are since last summer also hybrid-drive buses with built to use both electricity and Fordonsgas – the first of their kind in the world.

For the past three years liquid biogas has started to be used both as bunker fuel for shipping and truck fuel by road. Although the volumes of liquid gas are very small, the percentage increase in consumption grows steadily every year.

5.3 Imports

Sweden is currently the world leader in making the greatest use of biogas as vehicle fuel. The current sustainability legislation, however, has been found to pose difficulties in cross-border transport of biogas via the natural gas network. Sustainability legislation, based on the Renewable Energy Directive, includes requirements for traceability according to the mass balance principle. This traceability requirement is impossible to meet when biogas is transported through the natural gas network to other countries because the physical quantity cannot be followed. Any import and export of biogas would then violate the traceability requirements of sustainability legislation.

6. Current research and development with demonstration in biofuels

6.1 Biobased petrol

SEKAB recently announced a cooperation project with Preem and Sveaskog (state-owned forest owner) to develop and evaluate conversion of wood residues like sawdust and grot (branches and tops), even straw, to biobased petrol components together with a French company. The process is based on the fractionation of wood-based raw materials to a cellulose based sugar solution using CelluAPP technology, followed by fermentation and thermochemical conversion to two platforms for biofuels, iso-butene and iso-butanol. Based on these platforms, the production of iso-octane, one of the naturally occurring chemicals in petrol, will be studied.

6.2 Fuel from lignin

In recent years, interest has increased in the use of lignin as a potential feedstock for production of biofuels in a refinery process similar to that used for crude oil. Lignin is a complex polymer of aromatic alcohols contained in plant cell walls and is one of the main components of wood, stem wood of pine consists of about 28% lignin.

In the manufacture of paper pulp, wood is chipped and lignin is dissolved by cooking with chemicals to release the fibres used to make paper. The liquid that remains after the pulp fibres have been separated is called black liquor, which is where the lignin is found. This black liquor is then concentrated by water evaporation, and fired in a recovery boiler to recover cooking chemicals and to utilize the energy content of lignin to produce electricity and steam.

In many pulp mills the bottleneck is the recovery boiler which is the single largest investment in a mill. A way to increase capacity without retrofitting the recovery boiler or to build a new one is to relieve the recovery boiler by separating a portion of the lignin from black liquor. To remove the lignin and convert it to biofuels creates a similar synergy that already exists between the pulp industry and refinery industry with tall oil, but the resource is significantly larger.

The separated lignin can then be converted to a lignin oil with different process technologies (including pyrolysis) and catalysts. The lignin oil represents an intermediate product, which can be further processed using various refinery processes into petrol and diesel components. The black liquor can also be gasified directly as shown with the Chemrec black liquor gasification process demonstrated in Piteå.

6.3 Lignin research projects

The Swedish Energy Agency has in recent years been supporting research for the conversion of lignin to lignin oil from different sources, which in turn can be converted into biofuels.

In September 2015, the Agency granted support of SEK 71 million to the company RenFuel. RenFuel has recently announced a SEK 140 million project to construct a pilot plant at the Nordic Paper pulp mill in Bäckhammar, Värmland county, with operations to commence in 2017. Lignin is removed from the black liquor in Bäckhammar and RenFuel will then process the lignin and transport the lignin oil to an existing refinery (owned by Preem), where it will be converted to petrol or diesel. The plant will have a capacity to process 1500 tonnes of lignin per year.

SCA Energy has also announced a similar scheme and received a grant from the Swedish Energy Agency for an investment of SEK 50 million for construction of a pilot plant at the Obbola pulp mill outside Umeå, in northern Sweden. This plant will be built during 2016, with operation commencing in 2017. There are thus several interesting projects for biofuels from lignin to be demonstrated in a couple of years. The table below shows some current, selected lignin to biofuel projects.

Table 5. Selected Swedish development projects for lignin to biofuels.

Affiliation	**Project title or process description**
SunCarbon	From lignin to third generation renewable fuels
Renfuel	Strategic choices in the upscaling of the Lignol process
SCA Energy	Biofuel from black liquor lignin integrated with a pulp mill
Cellulose Fuels Sweden	Validation of process concepts for biofuels from lignocellulose
OrganoFuels	Organic catalysis of lignin to biofuels
Renewable Energy Technology International	LignoSys – System study of small-scale thermo-chemical conversion of lignocellulose-rich feedstock to biomethane
Stockholm University	Green Bergius process for 100% wood based petrol and diesel (black liquor to renewable diesel and petrol)
SP Energy Technology Center AB	From wood to petrol via cyclone pyrolysis and zeolite catalysis
SP Energy Technology Center AB	Concept verification in pilot scale for upgrading of kraft lignin via catalytic slurry hydrocracking
SP Processum	Reboot: Hydrolyse lignin – Transformation to Renewable Bio oil
Luleå Technical University	Prestudy: Liquefaction and upgrading of industrial by-products and wastes
Chalmers Technical University	Base catalysis depolymerisation of lignin in near-critical water
Mid Sweden University	Eco-Lignofuel: Novel eco-technology for converting lignin to advanced biofuels
Lund University	Lignin process for hydrogenation in refinery environment
Royal Institute of Technology	Thermo-mechanical catalytic reconstruction of biomass to liquid biofuels

Reference: Svebio, 2016.

Moreover, other international initiatives that have made progress include CRI from USA with its “Integrated Hydropyrolysis and Hydroconversion - IH2” project, BTG-BTL from the Netherlands with its “Pyrolysis from forest fuels to transportation fuels” project, and Valmet Technologies from Finland with its “Advanced pyrolysis from forest fuels to transportation fuels” project.

6.4 Wood gasification to biofuels

Göteborg Energi, which is owned by the city, has the mission to actively contribute to the sustainable development of the city. The Gothenburg Biomass Gasification Project, GoBiGas, is Göteborg Energi's largest investment in biogas production (biomethane or Bio-SNG) through gasification of solid biofuels and forestry wastes. The project was split into two phases, a first demonstration phase to produce 20 MWth product gas (from 32 MW fuel input), to be followed by a second phase to produce 80-100 MWth output of product gas. Göteborg Energi’s technology and project development is illustrated in Figure 7 below.

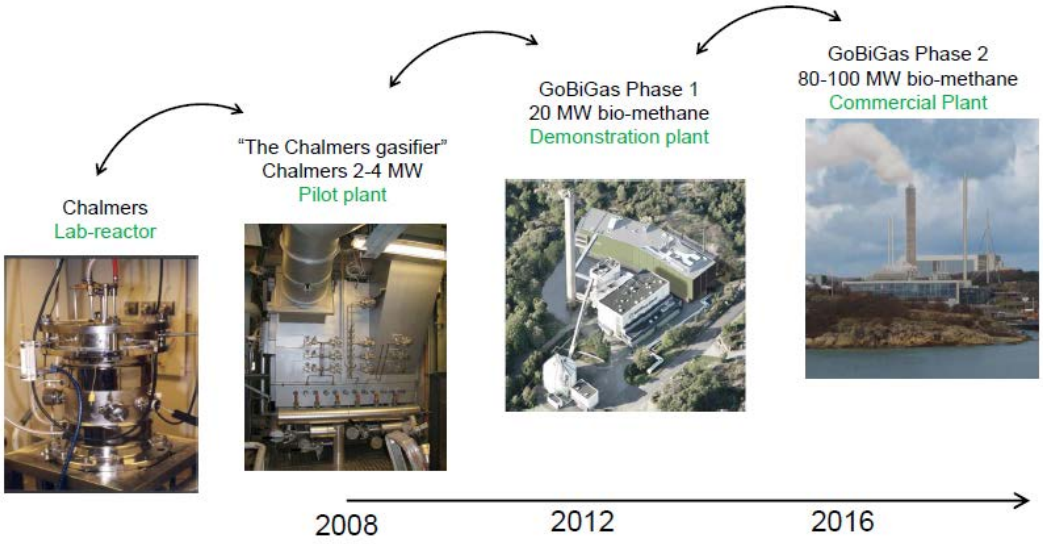

Figure 7. Illustration of the technology development for Gobigas. Reference: Göteborg Energi.

The approach chosen for the first phase was indirect gasification technology from the Austrian company Repotec. In 2008/2009, a basic design was carried out for the proposed technology for phase 1. For the methanation technology, the CTU technology piloted in Güssing was evaluated, but the final choice was for the technology of Haldor Topsøe. The investment decision was taken in December 2010 and plant commissioning was expected to begin in 2013. The estimated cost in 2008 was SEK 825 million with a grant of SEK 222 million in 2009 from the Swedish Energy Agency. In late 2011, it was announced that the costs had risen to SEK 1300 million, and the last reported investment cost was some SEK 1800 million.

The solid biomass fuel (wood pellets) is converted to a gaseous intermediate in the gasification plant. This so-called synthesis gas is purified and then upgraded in a methanation plant to biogas with a quality comparable to natural gas so that the two types of gases can be mixed in the gas network. Through the choice of technology and plant design, the project aims to achieve as high efficiency as possible. The goals are to obtain 60-65% of the biomass as biogas and an overall energy efficiency above 90%. This includes, however, the use of electric heat pumps, and the import of electricity is not accounted for in the efficiency calculations, or the fact that a dry pellet fuel is used.

The phase 1 plant was built in the western harbour area of Rya, adjacent to other energy installations of Göteborg Energi including a biomass pellet-fired district heating boiler and a 220 MWe combined-cycle CHP plant.

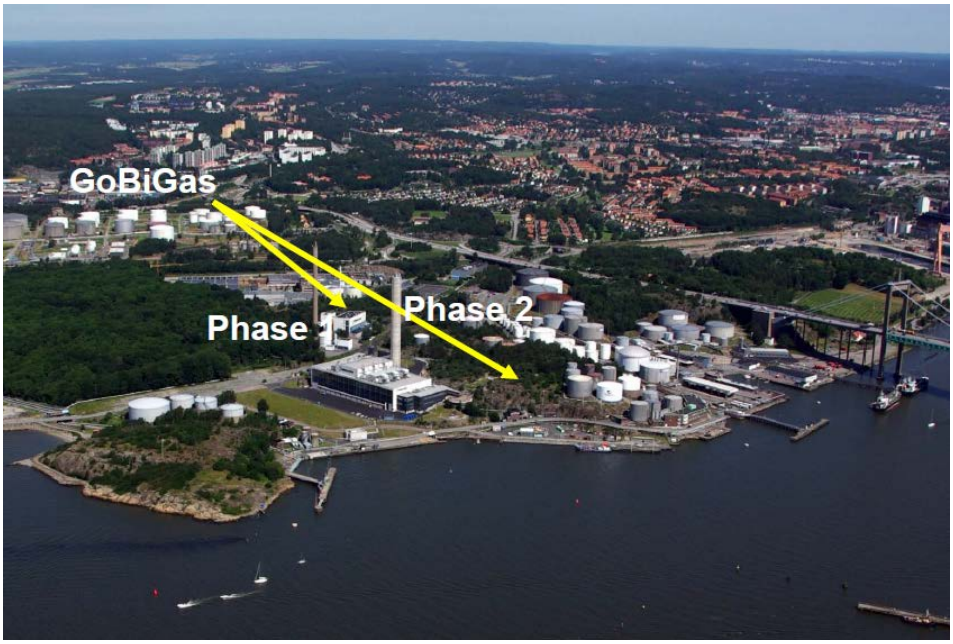

Figure 8. Photo of the Rya location showing the Gobigas plants. Reference: Göteborg Energi.

The plant is conveniently located adjacent to the exisiting Rya CHP plant for easy access to the natural gas grid and the district heating network. However, the location is limited for a large-scale plant because of the fuel logistics. Still, the waterways can be used and fuel transported by boat to a harbour. See figure above.

Figure 9. Photo of Gobigas plant before first gasifier startup (Oct. 2013). Reference: Göteborg Energi.

The plant is designed for several fuels including wood chips but operated initially with wood pellets. The switch will be made when stable operation has commenced. However, there is a small area for fuel receiving and storage while the fuel logistics are troublesome.

The plant was mechanically complete in Dec 2013 with first gasification in Nov 13, 2013. The plant was reported to supply gas to the grid in Q4 2013 but further progress has been delayed due to a number of problems. The operations can be divided into phase 1 and phase 2.

Phase 1
The operation between Nov 2013 and April 2014 only totalled to about 200 hours of operation, during which the following problems were encountered:

- Gas leakages,
- Cleaning of product gas coolers,
- Refractory repair (in Dec. 2013 and another in Feb. 2014) because of faulty installation,
- Malfunction of the RME scrubber due to faulty installation,
- Pressure fluctuations,
- Reprogramming of sequences (fuel, ash, etc),
- and more...

Phase 2
It is established that there was a mechanical problem with the brick-lining refractory, and not a chemical compatibility issue. The work onwards included how to reduce tar amounts as the tar molecular weight was heavier than expected which caused clogging of filters and heat exchangers. This problem was solved by introducing potassium which lowered the gasification temperature and consequently the formation of tars. The process operation has since been very successful.

Other plant operating activities have been recirculating coarse ash and adding some alkali in the gasifier which has increased the proportion of hydrogen in the gas composition as well as lowered carbon monoxide and methane levels. There has since not been a problem with the gas coolers; they only had to be cleaned once or twice during 2014. Sometimes the feeding screws have stuck. The lock-hopper system has also been found to have valves which loosen over time to allow backflow of product gas. Changes have been made but a final solution has not been reached.

The gas compressor is the single most costly item, the largest electricity consumer, and has been the most difficult item according to Göteborg Energi. Initially the gas torch showed a yellow flame indicating lots of tars in the gas. This has however changed and while torch flame shows a small tint of blue it is almost clear, which indicates good gas quality.

A major milestone was reached in December 2014 when the plant reached continuous operation with gas deliveries to the grid. The product gas contains 97-98% methane with very low amounts of nitrogen. The plant continued deliveries during 2015, with several planned and unplanned outages. In 2016, the plant started to switch the feedstock from pellets to wood chips. The accumulated hours of gasification are more than 3000 as of April 2015, with 900 hours being so far the longest period of continuous operation of the gasifier. The methanation part has reached at most about 84% of its capacity.

The evaluation of GoBiGas Phase 1 will be held over 7 years – until 2020. The purpose is to learn from the demonstration plant to enable upscaling. The evaluation will include the following parameters: product quality, plant performance – efficiency, availability, maintenance needs and operating costs. However, with the current decision not to go forward with phase 2 the outcome of the plant is most uncertain.

Similarly E.ON, which developed a 200 MWth product biomethane plant project Bio2G for southern Sweden with EU funding of EUR 203 million, has cancelled the project because of a lack of long-term biofuel policy from the Swedish government. Many other similar projects throughout Europe in the EU NER300 program have met the same fate.

6.5 Black liquor gasification

In Piteå, Chemrec have demonstrated black liquor gasification with bio-methanol and bio-DME production. Until today about 1000 tonnes of bio-DME has been produced in the development plant. The plant is located at the SmurfitKappa mill in Piteå and comprises an entrained-flow oxygen-blown black liquor gasification system operated

at 30 bar(g) with a capacity of 20 metric tonnes per day of black liquor solids, 3 MW(th). The plant was started up in 2005 and has accumulated more than 28 000 operating hours , with very high availabilities in the last years after initial year of operation. Moreover, the bio-DME plant has been in operation more than 10 000 hours since its start in 2011.

Figure 10. Photo of bio-DME plant in Piteå. Reference: Luleå Technical University.

The potential for DME biofuel is significant. In Sweden, up to one half of all heavy road transportation could be run on bio-DME from black liquor, and globally well over 30 million m^3 diesel equivalents per year could be produced from available black liquor feedstock, enough to fuel one million heavy duty trucks. Bio-DME from forest residues through the Chemrec process reduces net greenhouse gas emissions by about 95% compared to use of petroleum-based diesel oil, the traditional fuel for heavy road transport.

The produced bio-DME has been tested with a Volvo Truck test fleet of ten Volvo bio-DME trucks. They were used in regular operation and in 2012 the first of the ten trucks broke through the 100,000 kilometre barrier. All together, the trucks covered 400,000 kilometres at that point of time and continued through 2012, with a total 1,600,000 km when the project was finished. This was the first time bio-DME was being used as a vehicle fuel on a large scale.

In the beginning of 2013, Chemrec entered into a partnership with Luleå Technical University in order to continue the plant operation and research and development as the company faced economic difficulties when the large Domsjö Fabriker project of 200 000 tonnes of bio-DME was put on hold, despite a grant of SEK 500 million from the Swedish Energy Agency. The plant ownership was transferred to LTU Green Fuels which continued production in parallel with other developments such as, co-gasification of black liquor with pyrolysis liquids.

However, as of April 2016, Luleå Technical University announced that the only large-scale development plant producing liquid biofuels from wood has to be closed because of lack of further financing. In conclusion, Sweden has lost two gasification demonstration plants and the future for large-scale plants is uncertain. The problem is the lack of a stable policy framework for biofuels and at the same time the high cost to run smaller plants which are needed for technology demonstration.

However, with a change of policy the potential of wood can be unlocked, and a possible way is to implement an emissions reduction quota obligation system based on GHG emissions criteria with neat biofuels exempted from taxes for a period of time. The Swedish government is currently investigating a proposal for a mandate quota system based on GHG reduction or volumetric share and made predictions that a decision on this proposal will be made during 2017 at the latest.

In the News

Reports and Research

February 8. A recent report commissioned by the IEA Implementing Agreement for Renewable Energy Technology Deployment (IEA-RETD): "Towards advanced biofuels – options for integrating conventional and advanced biofuel production sites (RES-T-BIOPLANT)", looked at integration of advanced (2nd generation / 2G) biofuel plants with conventional (1st generation / 1G) biofuel plants and how this could lead to significant synergies and cost savings. The report can be downloaded here.

February 16. The USDA published a report on the energy balance of corn ethanol as of 2015. Ethanol made the transition from an energy sink, to a moderate net energy gain in the 1990s, and to a substantial net energy gain by 2008. This study investigates whether the ethanol energy balance is still improving and reviews some potential sources of future improvement. (Read more and download the report here)

February 24. The United Nations Conference on Trade and Development (UNCTAD) published a report entitled "Second generation biofuel markets" (download report here). The report gives an optimistic view of the current status of second generation biofuels and markets but data on production and capacity is inaccurate. The report has been slammed for being misleading and inaccurate, representing an overly optimistic assessment of second generation biofuels. (Read more)

March 15. The European Commission has finally published the Globiom Study on indirect land use change [ILUC] which it had withheld during consultation on the RED. (Read more and download report here). The GLOBIOM study finds that increased demand for European produced ethanol would have low impacts on land use change. (Read more)

March 17. The National Renewable Energy Laboratory (NREL) updated its annual survey of U.S. non-starch ethanol and renewable hydrocarbon biofuels producers. The survey report, titled *2015 Survey of Non-Starch Ethanol and Renewable Hydrocarbon Biofuels Producers*, documents important changes (e.g., biorefinery development, production capacity, feedstock use, and technology pathways) that have occurred since the publication of the original 2013 survey. (Read more and download report here)

April 28. Roland Berger was commissioned by a coalition of automotive companies and fuel suppliers to define and produce an Integrated Roadmap for EU Road Transport Decarbonization to 2030 and beyond. This study aims to provide an integrated roadmap taking into account the feasibility of all fuel and vehicle technologies along with infrastructure needs and the recommended policy framework beyond 2020. A key consideration was to identify a roadmap with the lowest, achievable GHG abatement costs to society. (Download report here)

May 11. The US Energy Information Administration (EIA) published the *International Energy Outlook 2016 (IEO2016)*, which assesses and projects the outlook for international energy markets through 2040. Chapter 8 discusses transport sector energy consumption and posits that petroleum and other liquid fuels will remain the dominant source of transportation energy, although their share of total transportation energy declines over the IEO2016 projection period, from 96% in 2012 to 88% in 2040. (Read more, and here)

Policy and Regulatory Developments

January 6. India has doubled its ethanol blending target to 10% (Read more), although reports indicate that the country will only achieve a 5% ethanol blend by September 2016.

Feb 5. Argentina increased the required blend of ethanol in gasoline to 12% from the current 10%. (here)

February 9. In Belgium, the government has approved the increase of ethanol blending to 8% from the current 4.5% with the mandate coming into force January 1, 2017. (Read more)

February 18. The Global Renewable Fuels Alliance called on national governments to end fossil fuel subsidies which annually amounts to about $490 bllion worldwide. (Read more)

March 17. In Iowa, the state's Senate voted to approve up to $10 million in tax credits to promote the renewable chemical industry. (Read more)

March 17. Solazyme, an algae-based bio-product producer in California, has abandoned its biofuels business and will be focusing its algae oil production on food and personal care industries. The company has been renamed TerraVia. (Read more)

March 24. Brazil increased its biodiesel mandate to 8%. (Read more)

March 30. The World Trade Organisation (WTO) ruled in favour of Argentina in its dispute concerning the anti-dumping duties imposed by the EU since 2013 on biodiesel imported from the country. (Read more)

April 13. ASTM International has approved alcohol to jet synthetic paraffinic kerosene (ATJ-SPK) derived from renewable isobutanol, paving the way for Gevo to sell their biojet commercially. (Read more). Five biojet fuels have now been approved by the FAA. (Read more)

Sustainability

January 22. Dutch company GoodFuels Marine, the first marine biofuel company focused on the global commercial fleet, received certification from the Roundtable of Sustainable Biomaterials (RSB). (Read more)

March 21. France approved an additional tax on palm oil imports in an attempt to stem demand that leads to environmental damage such as the draining of peat bogs, however imports for biodiesel production and those with sustainability labels will be exempt from the new policy. (Read more)

April 21. UPM Biofuels extended its sustainability certifications to cover all of its output streams from the Lappeenranta Biorefinery in Finland under the International Sustainability and Carbon Certification Scheme ISCC PLUS. (Read more)

Industry News

January 4. Oasis Group, an India-based technology, engineering and construction company, will build a wheat-based ethanol plant in Punjab. (Read more)

January 7. Shell India Markets, the Indian arm of Royal Dutch Shell, has announced plans to build a five tonne/day biofuel demonstration plant using IH2 technology on the site of its new technology centre in Bangalore, India. (Read more)

January 18. Kakira Sugar Works, a Uganda-based sugar giant, said it will start commercial output at its $37m ethanol plant by the end of July. The sugar firm hopes to produce 20m litres of ethanol annually using 74,000 tonnes of molasses. (Read more)

January 20. Canadian company Ensyn will start producing renewable fuel from its biofuel plant in Georgia starting in January 2017. The Dooly County facility will use 440 tonnes of wood tops and tree limbs to produce electricity and other fuels. It plans to annually produce 20m gallons of liquid biofuel. (Read more)

January 20. Eni S.p.A., the Italian oil major that converted its Venice oil refinery to a renewable diesel manufacturing plant, is rolling out its renewable blended product to 3,500 fuel stations across Italy. Named Eni Diesel +, the fuel contains 15 percent renewable diesel produced via the Ecofining process, jointly developed by Eni and Honeywell's UOP. (Read more)

January 21. Joule announced its acquisition of Red Rock Biofuels, a leading project development company of renewable jet and diesel fuel based on waste from biomass or other sources. (Read more)

January 21. Biodiesel producer Australian Renewable Fuels Ltd. announced that its board of directors has placed the company into a state of voluntary administration. (Read more)

January 22. Oslo Airport Gardermoen is the world's first airport to offer renewable aviation fuel refined by Neste for refueling airplanes. Neste's renewable aviation fuel is refined as part of the EU-funded ITAKA project at the Porvoo refinery from sustainably produced, 100 percent certified camelina oil. Its use reduces greenhouse gas emissions by 47 percent when compared to fossil fuel. (Read more)

January 25. The U.S. consumed a record of nearly 2.1 billion gallons of biodiesel in 2015, reducing America's carbon emissions by at least 18.2 million metric tons. According to this new U.S. EPA data, domestic production remained flat at about 1.42 billion gallons, compared with about 1.47 billion gallons in 2014 and 1.50 billion gallons in 2013. Meanwhile, imports rose from 510 million gallons in 2014 to an estimated 670 million gallons in 2015. EPA finalized new biomass-based diesel standards under the RFS requiring 1.9 billion gallons in 2016 and 2 billion gallons in 2017. (Read more)

February 1. Z Energy, a New Zealand-based energy producer, is on track to open the country's first commercial scale biodiesel plant in Wiri, south Auckland, in June. The plant will use tallow as a feedstock to produce 20 million litres of biodiesel a year, with the potential to scale up production to 40m litres a year. (Read more)

February 2. Gevo Inc. announced it has entered into a license agreement and a joint development agreement with Porta Hnos S.A. to construct multiple isobutanol plants in Argentina using corn grain feedstock. (Read more)

February 3. Caltech Ventures, a Ghana-based cassava cropping and processing company, will start producing ethanol from cassava beginning in March 2016. (Read more)

February 9. Ensyn has been granted key regulatory approvals by the California Air Resources Board (CARB) for its renewable fuel oil (RFO) to be used in coprocessing by California oil refineries. Ensyn is commercializing refinery coprocessing in partnership with Honeywell UOP. The regulatory approvals received from CARB cover the production of both gasoline and diesel by way of RFO coprocessing in specific California refineries using RFO produced from forest residues at Ensyn's facility in Ontario. The carbon intensity of the resulting renewable gasoline and diesel was determined to be in the range of approximately 20-25 g CO_2e/MJ, or approximately 70 percent less than traditional petroleum-based fuels. (Read more)

February 14. In Florida, ARA completed the delivery of over 150,000 gallons of 100% drop-in jet and diesel fuels to fulfill its DLA/US Navy certification fuel contract. The renewable jet and diesel fuels were produced with ARA's and Chevron Lummus Global's Biofuels ISOCONVERSION process which takes any kind of fat, oil, and grease, from yellow and brown grease to tallow to distiller corn oil to plant oil, and converts it into 100% drop in fuels. (Read more)

February 15. In India, an €110 million joint venture cellulosic ethanol project of Chempolis Ltd and Numaligarh Refinery Limited (NRL) is moving towards construction after getting approval from NRL's board. The project is expected to come online by 2019 and is based on using bamboo feedstock to produce ethanol, with furfural and acetic acid produced as co-products. (Read more)

February 19. Comet Biorefining announced the location of its commercial-scale biomass-derived sugar facility in the TransAlta Energy Park in Sarnia, Ontario. The 60 million pounds per year plant is scheduled to come online in 2018, producing dextrose sugar from locally-sourced corn stover and wheat straw. (Read more) Sustainable Development Technology Canada awarded Comet Biorefining a CA$10.9 million grant for the construction of its first-of-a-kind advanced bio-based chemicals plant. (Read more) On April 18, Comet announced an off-take agreement with BioAmber, a biosuccinic acid producer. (Read more)

February 22. Mercedes-Benz Trucks granted approval for the use of Hydrotreated Vegetable Oil (HVO) in their vehicles. (Read more)

February 24. A new report from Lux Research indicated that Abengoa's cellulosic ethanol is the most expensive to make ($4.55/gallon) while Raizen is the cheapest ($2.17/gallon). The big difference is in the cost of feedstock with Abengoa paying $90/dry tonne for corn stover and Raizen only $38/dry tonne for bagasse (Read more here and here)

February 25. In Mexico, Boeing, Aeromexico and Mexico's Airports and Auxiliary Services (ASA) will collaborate with a biojet program supported by Mexico's Sector Fund for Energy Sustainability (SENER-CONACYT) to advance research and development of sustainable aviation biofuel in Mexico. (Read more and here)

March 6. Benchmark Renewable Energy announced development of a 10 million gallon per year advanced ethanol project in Jamaica that will also produce 3 MW of renewable power. The company said that its project would also produce 500K gallons of drop-in aviation fuel and 60,000 gallons per day of fresh, desalinated water. The company, said it expects the project to be complete by the end of 2017, and could grow ultimately to a capacity of 20 million gallons, utilizing sweet sorghum as a feedstock. (Read more)

March 10. The International Energy Agency, commenting on Canada`s biofuel production, gave a pessimistic outlook that national ethanol production could fall to just over a billion liters by 2020 from 1.68 billion liters in 2015 while biodiesel production should hold steady at 348 million litres as a result of competition from US imports, low oil prices and the end of the ecoENERGY biofuels incentives program in 2017, among other factors. (Read more here and here)

March 10. SBI Bioenergy in south Edmonton is in the final stages of building a biorefinery to convert canola oil and animal fats into a renewable fuel that can replace or be blended with regular diesel. The Alberta government has earmarked $10 million from the existing carbon levy for the $20 million refinery. (Read more)

March 14. In 2015, U.S. exports of fuel ethanol exceeded 800 million gallons for the second time in four years, totaling 844 million gallons, nearly equal to the 846 million gallons exported in 2014. U.S. imports of ethanol, which totaled 73 million gallons in 2014, also increased in 2015, reaching a total of 92 million gallons. The United States remained a net exporter of fuel ethanol for the sixth consecutive year and exported the fuel to 35 different countries in 2015. (Read more)

March 14. Air New Zealand and Virgin Australia announced a partnership to investigate options for locally produced aviation biofuel. The trans-Tasman alliance partners are issuing a Request for Information (RFI) to the market to explore the opportunity to procure locally-produced aviation biofuel. (Read more)

March 14. In California, United Airlines made history by becoming the first U.S. airline to begin use of commercial-scale volumes of sustainable aviation biofuel for regularly scheduled flights with the departure of United Flight 708 from Los Angeles International Airport. (Read more)

March 23. In Canada the new government announced its Federal Budget for 2016 with a focus on climate change (Read budget here). The proposed budget provides C$50 million over four years to Sustainable Development Technology Canada (SDTC) to support the development of clean technologies; C$82.5 million over two years to NRC to bring clean technologies closer to commercialization; and C$2.9 billion over five years to address climate change

and air pollution issues, including taking action to reduce emissions from Canada's largest sources – transportation and energy.(Read more)

March 23. POET-DSM Advanced Biofuels, the U.S.'s first commercial-scale producer of cellulosic ethanol, is shipping the fuel from its plant in Emmetsburg, Iowa, and could hit full production by the end of 2016, according to POET founder and Chief Executive Jeff Broin. (Read more)

March 24. Aemetis has acquired 12 years of exclusive rights in California (based upon achieving certain milestones) to LanzaTech's technology for the conversion of agricultural waste, forest waste, dairy waste and construction and demolition waste to ethanol. (Read more) On May 5, Aemetis also announced that it was acquiring Edeniq with its proven cellulosic ethanol technology. (Read more)

March 24. In Australia, the Federal Government is establishing a $1 billion Clean Energy Innovation Fund to support emerging technologies making the leap from demonstration to commercial deployment. (Read more)

March 24. In South Korea, GS Caltex is set to start building a $44 million commercial-scale biobutanol facility during the first half of this year based on technology the company has been developing since 2007. It will use corn and cassava feedstocks for the facility. (Read more)

March 28. Gevo`s Alcohol to jet pathway based on isobutanol has been approved by ASTM and the FAA. (Read more)

March 29. In Queensland, the state premier Anna Palaszczuk, the Minister for State Development Anthony Lynham, and the Minister for Energy, Biofuels and Water Supply Mark Bailey jointly announced that a AUD $16 million advanced biofuels pilot plant will be built at Southern Oil Refining's Yarwun plant at Gladstone. (Read more)

March 31. KLM Royal Dutch Airlines is launching a series of around 80 biofuel flights from Oslo to Amsterdam operated with an EMBRAER 190. The remaining flights will be operated over the forthcoming period of five to six weeks, marking yet another step in the right direction towards making aviation more sustainable. What's more, Embraer will be conducting measurements during these flights to gauge the efficiency of biofuel in comparison with kerosene. (Read more)

April 6. Plans to implement a 5% blend of ethanol in Vietnam are not working. Compulsory E5 blending is being introduced on 1 June 2016, but plants have shut down as consumers are reluctant to use E5 as it costs the same as regular fuel. (Read more)

April 7. The US EPA approved Joule's *Sunflow®-E* ethanol process as an advanced biofuel to earn D5 RINs, with an estimated GHG reduction of 85% over conventional fossil fuels (Read more)

April 13. Colocation of biodiesel plants with ethanol plants – incorporating biodiesel production based on corn oil. (Read more)

April 18. RenFuel and Nordic Paper have signed an agreement to build a production test facility in Sweden to test manufacturing an advanced biofuel from lignin. RenFuel has developed and patented a method to refine the lignin from black liquor, a renewable byproduct from the production of paper pulp, into lignin oil. The oil, called Lignol, can replace fossil oil and be used as raw material in the production of renewable petrol and diesel. (Read more)

April 21. Diamond Green Diesel, a 160 MMgy renewable diesel facility in Norco, Louisiana, is expanding production to 275 MMgy. Completion is expected late 2017, with production to ramp-up in early 2018. (Read more)

April 22. Union Minister Harsh Vardhan inaugurated India`s first second-generation (2G) ethanol plant at Kashipur in Uttarakhand. The plant has a capacity to convert 10 tonnes of biomass per day. (Read more)

May 9. Algal biofuels are in trouble. This alternative fuel source could help reduce overall carbon emissions without taking land from food production, like many crop-based biofuels do. But several major companies including Shell and ExxonMobil are seemingly abandoning their investments in this environmentally friendly fuel. So why has this promising technology failed to deliver, and what could be done to save it? (read more)

Upcoming Meetings & Conferences

World Bioenergy 2016 and International Wood Biorefining Week
2016, May 24-26, Stockholm, Sweden

BIO International Convention
2016, June 6-9, San Francisco, California, USA

24th European Biomass Conference and Exhibition
2016, June 6-9, Amsterdam, the Netherlands

Oleofuels 2016
2016, June 21-22, Liverpool, UK

32nd Fuel Ethanol Workshop and Advanced Biofuels Conference and Expo
2016, June 20-23, 2016, Milwaukee, Wisconsin, USA

6th International Conference on Algal Biomass, Biofuels and Bioproducts
2016, June 26-29, Paradise Point, San Diego, USA

Bioenergy 2016: Mobilizing the Bioeconomy through Innovation
2016, July 12-14, Washington, D.C., USA

SIMB Annual Meeting and Exhibition
2016, July 24-30, New Orleans, LA, USA

252nd American Chemical Society National Meeting & Exposition
2016, August 21-25, Philadelphia, PA, USA

The European Forum for Industrial Biotechnology and the Bioeconomy
2016, October 18-20, Glasgow, Scotland

American Institute of Chemical Engineers – 2016 Annual Meeting
2016, November 13-18, San Francisco, California, USA.

ICBB 2016: 18th International Conference on Biofuels and Bioenergy
2016, December 29-30, Paris, France

For more events visit www.task39.org

IEA Bioenergy Task 39 Meetings

The following is an abbreviated tentative schedule of Task 39 events and meetings planned over the next 9 months. Please contact us for more detailed information:

- Task 39 meeting in Rotorua, New Zealand on 8-9 November 2016