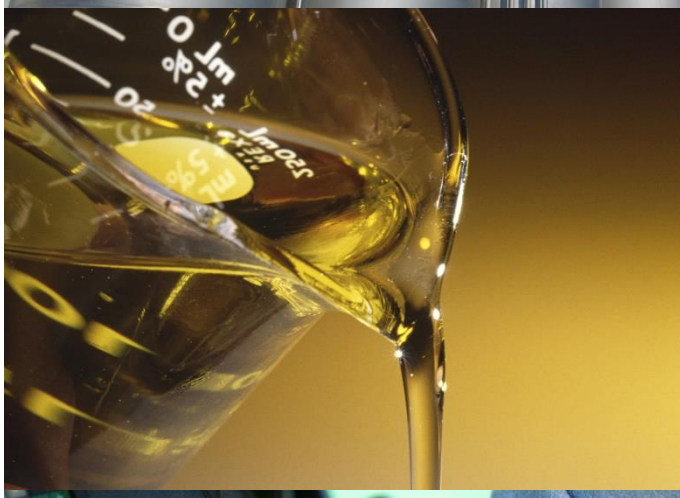
The Bioeconomy Consultants

NNFCC

News Review

August 2017

Each month we review the latest news and select key announcements and commentary from across the biofuels sector.



Contents

Foreword

Hello and welcome to August's Biofuels News Review.

We begin with the small (indeed, microscopic) matter of algae. The potential has always been there for algae to be a key source of biofuels, but the development that brings them out of the lab and into the realm of commercial production has thus far proved elusive. The US' Sandia National Laboratories is seeking to change that. Traditionally, algae for biofuels are grown in raceways; these systems are shown to produce high quality algae, usually in monoculture, which is ideal for biofuels production, but these systems are high maintenance, requiring fertilisers, clean water, and CO2 input, and are highly susceptible to infection by pests, causing huge crashes and loss of yield. Sandia's proposed "Algal Turf Scrubber" system looks to account for these problems by growing the algae in water from polluted lakes, and not in monoculture. This removes the need for expensive water treatment and fertiliser provision, as the algae have been shown to grow happily in the polluted waters, and the lack of a monoculture greatly increases their resistance to pests. It is also theorised that this system could have the added benefit of cleaning the polluted lakes, preventing future dangerous algal blooms by using algae to remove the conditions which are so favourable for such blooms. It remains to be seen how productive this system is, which will be the key factor behind its adoption by the industry – cutting costs is all well and good, but only if productivity doesn't decrease by a comparable amount.

But the focus may well shift away from algae if HelioBioSys' developments bear fruit. The company has eschewed algae in favour of working with cyanobacteria. The theory behind this is that cyanobacteria produce sugars and secrete them directly into the water they are grown in, which can then be fermented to produce ethanol for biofuels. It's easy to see why this is lucrative, as filtering sugar from water is an easier and less expensive process than extracting lipids from algae, and the yield from cyanobacteria in lab-testing has been over 4 times that of algae for the same volume. If this technology takes off, it could cause a great reduction in the price of ethanol-based biofuels, making them competitive with petroleum-based fuels for the first time.

Read on for the latest news.

Policy

Report assesses EU's prospects of meeting 2020 biofuel targets

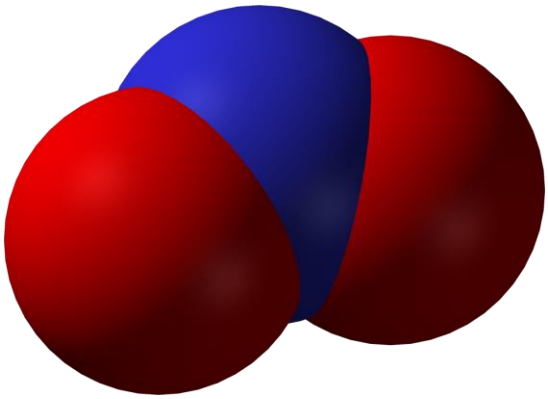
A recently released USDA Foreign Agricultural Service report provides data on EU biofuels and progress being made towards the EU's 2020 mandates. In reviewing policy developments affecting markets, the proposed sustainability requirements in the new legislative proposals for the revised Renewable Energy Directive (RED II) are viewed as a potential trade barrier for the import of wood pellets.

In 2016, the blending of bioethanol and biodiesel in transport fuels was respectively 3.3 and 5.8 percent (energy basis), and thus well below the 10 percent target for 2020. This can partly be explained by the double counting of advanced biofuels. The blending of conventional biofuels in transport fuels is estimated at 4.0 percent, still well below the seven percent cap. With the potential outlook of capping the use of conventional biofuels after 2020, the market conditions appear to be dim for these types of food based biofuels.

The blending of advanced biofuels in transport fuels is about 1.2 percent, and thus already surpassing the non-binding 2020 target of 0.5 percent. Since 2011, hydrogenated vegetable oil (HVO) production has taken off in the EU. HVO is produced from predominantly non-food feedstocks. In 2016, production is estimated at 2.4 billion litres, and is expected to increase to about 2.6 billion litres in 2017. The current capacity of cellulosic ethanol is about 60 million litres, and could possibly increase to about 200 million litres in 2021. Based on the proposed maximum blending rates for conventional and minimum blending rates for advanced biofuels in the RED II, the consumption of advanced biofuels must increase significantly from 2020.

Click here for more information.

UK government's Nitrogen Dioxide plan



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The UK government has published a statutory air quality plan for nitrogen dioxide (NO_2), setting out how the UK will be reducing roadside nitrogen dioxide concentrations.

These documents and zone plans set out the government's comprehensive approach to meeting the statutory limits for nitrogen dioxide, and the policy background.

The technical report details the modelling techniques and assumptions used when developing the plan.

The Direction requires specified local authorities to carry out studies to identify how to meet legal limits for nitrogen dioxide in the shortest possible time, and sets deadlines.

Click here for more information.

Markets

Macquarie completes Green Investment Bank acquisition

New owner Macquarie has committed to the GIB's target of leading £3 billion of investment in green energy projects over next 3 years.

The Climate Change and Industry Minister, Claire Perry, confirmed on 18th August 2017 that the sale of the Green Investment Bank (GIB) to Macquarie Group Limited had been completed.

The £2.3 billion deal ensures that all the taxpayer funding invested in GIB since its creation, including set-up costs, has been returned with a gain of approximately £186 million.

As well as fully meeting the government's objectives, the deal secures the future of the GIB with an ambitious new owner committed to growing the business. The Edinburgh office will be home to a new revenue-generating business as well as providing services to the green energy portfolios of both Macquarie and GIB in the UK.

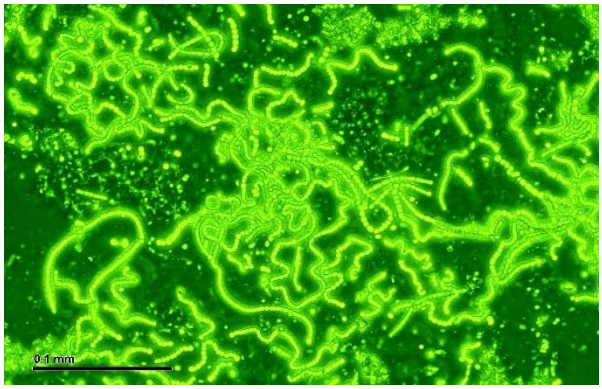
The government decided that moving it into the private sector now would free it from the constraints of public sector ownership allowing it to increase investment in our green infrastructure as we transition to a green economy. GIB's independent Board supported the government's decision to sell the business to Macquarie.

In order to build on the company's success within the private sector, Macquarie and GIB have announced today that the company will now be known as the Green Investment Group (GIG) so that it will be able to make overseas investments.

Click here for more information.

Research & Development

Cyanobacteria as more efficient biofuels option than algae?



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The demand for clean, domestically produced, renewable energy has resulted in a lot of research on algae. Algae is a desirable biofuel source because it doesn't compete with food crops for land, water or other resources. The water used to grow algae is not usually suitable for agriculture. Typically, algae farms aim to produce large quantities of biomass, so they can then be harvested and converted into fuels, chemicals or other bio-based products.

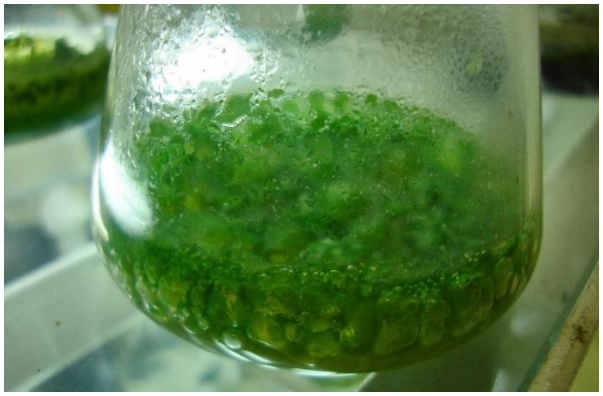
By contrast, HelioBioSys is working with organisms called cyanobacteria. Until the early 1900s, they were mistaken for algae. Like algae, colonies of cyanobacteria grow in water and have incorrectly been referred to as "blue-green algae." But unlike algae, these marine cyanobacteria excrete sugars directly into the water where they grow. A lot of it.

A typical algae operation might grow 1 gram of biomass per litre (0.04 ounces per quarter gallon). Small-scale testing on these cyanobacteria shows they can produce 4 to 7 grams of sugar per litre of biomass (up to 0.25 ounces per quarter gallon) — an improvement in concentration of up to 700 percent. Therefore, growing cyanobacteria for sugars is more efficient than growing biomass.

Filtering sugar from water is a much simpler and therefore less expensive process than extracting lipids from large quantities of algae mass. Sugar is easy, compared to biomass, to convert into a wide variety of chemicals and fuels. Furthermore, cyanobacteria do not require additional fertilizer to make their sugars. These cost savings could make biofuels competitive with petroleum.

Click here for more information.

Sandia develops less expensive growth system for biofuel algae



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Sandia National Laboratories is testing whether one of California's largest and most polluted lakes can transform into one of its most productive and profitable. Southern California's 350-square-mile Salton Sea has well-documented problems related to elevated levels of nitrogen and phosphorus from agricultural runoff. Algae thrives on these elements — a fact that causes environmental problems but could also be a solution to those problems.

Sandia intends to harness algae's penchant for prolific growth to clean up these pollutants and stop harmful algae blooms while creating a renewable, domestic source of fuel. Algae can be easily converted to fuels and chemicals using a Sandia Labs-patented fermentation process.

The Department of Energy's Bioenergy Technology Office (BETO) estimates the U.S. can produce at least 1 billion tons of feedstocks for biofuels every year, and doing so would have positive social, economic and environmental impacts. That amount equates to about 30 percent of our nation's need for fuels that would not have to be imported. Among these feedstocks, algae are unique in that they grow exponentially: in other words, under the right conditions, doubling every day.

Traditionally, companies grow single species of algae in raceways — structures vaguely resembling small race tracks or giant bathtubs. The raceways produce algae well suited for making high-value nutritional products like spirulina or beta carotene, as well as other nutraceuticals. Raceways also offer growers a lot of control. But there are a few drawbacks. They are generally high maintenance, requiring trained technicians, expensive fertilizers, carbon dioxide and high-quality water.

Additionally, an estimated 30 percent of production on algae farms can be lost each year due to pest-related pond crashes. Sandia is currently doing research to minimize crashes, including testing strains of algae for resistance to various predators and diseases, and learning to detect the signs of an imminent pond crash.

The newer farming method is called an "Algal Turf Scrubber" floway system, used for growing a collection of native algae species. To the untrained eye, the system looks like a free-standing rain gutter. It gurgles quietly as water is pulsed in waves across a sloped floway. The algae consume the nutrients, and clean water emerges from the lower end.

One of the criticisms lobbed at algae as a biofuel source is that it uses too much water. Sandia have shown that they can grow algae in turf scrubber systems using water full of nasty components. In other words, there otherwise isn't much that can be done with this water until the pollutants are removed.

Click here for more information.

Gevo's isobutanol technology now available for licensing

At the BIO World Congress on Industrial Biotechnology taking place in Montreal, Canada, Praj Industries Ltd (Praj) and Gevo, Inc. (Gevo) unveiled a new commercial opportunity in renewable bioproducts, jointly announcing that Gevo's proprietary isobutanol technology will now be available for licensing to processors of sugar cane juice and molasses. This follows on the back of Praj's development work, adapting Gevo's technology to sugar cane and molasses feedstocks.

Isobutanol has several direct applications as a gasoline blendstock or as a specialty chemical solvent, or it can be used as an intermediate which can be further converted into other chemical products or hydrocarbons such as Gevo's alcohol-to-jet fuel (ATJ) and isooctane.

In comparison to other renewable jet fuels, Gevo's ATJ has the potential to offer the optimal solution in terms of operating cost, capital cost, feedstock availability and scalability. In addition to being a lower carbon alternative, ATJ also offers performance advantages such as lower particulates, low sulphur content and a lower freezing point. Alaska Airlines, the U.S. Air Force, the U.S. Army and the U.S. Navy have all flown flights using Gevo's ATJ, derived from isobutanol using corn and cellulosic materials as feedstocks.

Isooctane and renewable gasoline made from cane juice- and molasses-based isobutanol are expected to be very low in carbon content, offering new approaches to markets where low carbon fuels are valued, such as California and other geographies.

Gevo is expected to be the primary off-taker, marketer and initial distributor for isobutanol produced from the plants built by Praj that use Gevo's isobutanol technology.

Click here for more information.

Vertimass ethanol conversion technology approaching demonstration scale

Vertimass
Transformative fungible biofuels.

Vertimass

California based Vertimass has announced completion of the intermediate technology validation from the US Department of Energy's Bioenergy Technology Office (BETO). The BETO validation verified performance against negotiated milestones, provided progress on scale-up, and reviewed Vertimass' estimated cost for their transformative catalytic technology.

Developing a catalyst technology to convert ethanol into jet fuel, diesel fuel and gasoline blend stocks compatible with the existing fuel infrastructure, Vertimass believes the BETO verification paves the way to move to the demonstration scale.

The technology allows ethanol producers the ability to virtually eliminate the ethanol blend wall that now impedes market growth for sustainable fuels, and to produce renewable hydrocarbons. The result can be significant expansion in production of renewable fuels and chemicals while maintaining a low greenhouse gas footprint in the process.

These systems can be added to existing ethanol producers' facilities at fractions of the cost of a new facility while providing product flexibility that can adapt to changing market conditions. Producers can capitalize on the value this novel technology brings to the market.

Click here for more information.

Identifying barriers to SMEs entering the bioeconomy

There is increasing interest in the development of a bio-based economy in Europe with decreased profitability and sustainability of materials as driving forces. This research is a study of SMEs in South-East Finland. The objective of this paper is to analyse the main factors challenging new SME companies to find or develop new business opportunities in the bio-based economy. As Finland has a well-established forest industry in the midst of structural change, the results of this study are likely to be implemented in other countries and innovation environments as well. The study consisted of a Webpropol-based enquiry sent to South-East Finland SMEs active in the bio-economy and of the analysis of their answers obtained from 66 companies. The important role of SMEs as creating new sustainable businesses and jobs has been identified. The results show that key factors influencing the successfulness of SME companies are: Customer value-added, collaboration in R&D and supply chain. Knowledge of markets, products and processes are very important for SMEs entering into the new bio-based market, either as actors within the value chain, or as suppliers of raw materials or intermediary products to larger companies.

Click here for more information.

Metsä commissions new bioproduct plant

Metsä

Metsä Group's next-generation bioproduct mill in Äänekoski came into operation as planned on Tuesday, 15 August 2017 at 6:00 in the morning. Pulp deliveries from the new mill to customers will begin in early September 2017. The construction project was carried out as planned, in accordance with its schedule and its EUR 1.2 billion budget.

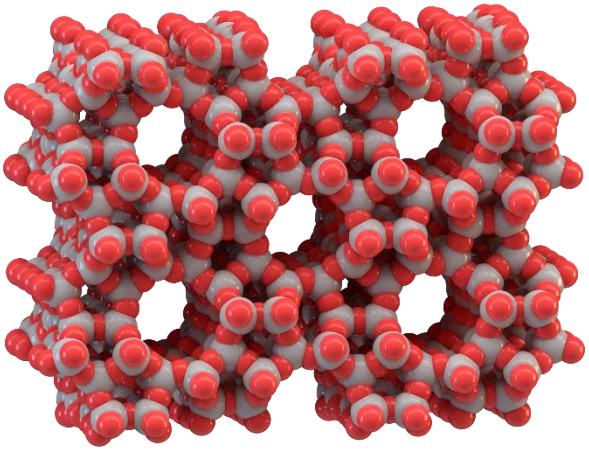
Before the bioproduct mill started up, the old pulp mill in Äänekoski was shut down and its dismantling is currently in progress.

The bioproduct mill will achieve its nominal capacity approximately a year after start-up. The mill will produce 1.3 million tonnes of pulp per year, along with other bioproducts such as tall oil and turpentine. New bioproducts that already complement the product concept include product gas from bark, sulphuric acid from the mill's odorous gases, and biogas and biofuel pellets from sludge.

With this new bioproduct mill Äänekoski's industrial ecosystem is developing and growing, and the mill will be a platform for production of new bioproducts. Several processes and product paths are being actively studied. The most important new bioproduct development projects are lignin products, textile fibres, and biocomposites.

Click here for more information.

New catalyst could reduce Nitrogen Oxides in exhaust fumes



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Researchers have discovered a new reaction mechanism that could be used to improve catalyst designs for pollution-control systems to further reduce emissions of smog-causing nitrogen oxides in diesel exhaust.

The research focuses on a type of catalyst called zeolites, workhorses in petroleum and chemical refineries and in emission-control systems for diesel engines.

New catalyst designs are needed to reduce the emission of nitrogen oxides, or NOx, because current technologies only work well at relatively high temperatures. Perhaps the biggest challenge is related to reducing NOx at low exhaust temperatures, for example during cold start or in congested urban driving.

However, in addition to these "transient" conditions, future vehicles will naturally operate at lower temperatures all the time because they will be more efficient.

Zeolites have a crystalline structure containing tiny pores about 1 nanometre in diameter that are filled with copper-atom "active sites" where the chemistry takes place. In the new findings, the researchers discovered that ammonia introduced into the exhaust "solvates" these copper ions so that they can migrate within the pores, find one another, and perform a catalytic step not otherwise possible.

These copper-ammonia complexes speed up a critical bond-breaking reaction of oxygen molecules, which currently requires an exhaust temperature of about 200 degrees Celsius to occur effectively. Researchers are trying to reduce this temperature to about 150 degrees Celsius.

Click here for more information.

Bioethanol

Rises in EU ethanol production expected despite declining consumption

EU ethanol production is expected to grow in 2017 and 2018, according to the USDA Foreign Agricultural Service's EU Biofuels Annual 2017. This growth will come despite bioethanol consumption being in decline since 2011.

The slight increase anticipated in 2017 and 2018 is based on increased use of existing capacity and a growing demand from member states as they attempt to reach their 2020 targets under the Renewable Energy Directive. The report highlights Germany, the UK, the Netherlands, Hungary and Poland as the main countries that are currently increasing production.

Production in France, Belgium and Austria has stabilised and is expected to remain flat through 2018. A slight decrease in production is forecast in Spain and Romania.

The report points out that while the proposed changes to the Renewable Energy Directive, dubbed RED II, progressively cap the use of food based biofuels, the blending rates for advanced biofuels are progressively increased. This is likely to see a significant increase in production of hydrogenated vegetable oils (HVO), which can be produced from waste oils and fats.

In 2016, HVO production is estimated at 2.4 billion litres, and is expected to increase to about 2.6

billion litres in 2017. With new plants in Italy and France, production could further expand to about 4 billion litres in 2020.

The commercialisation of cellulosic ethanol is lagging behind compared to the development of HVO. The main factors that prevent operators from investing in cellulosic biofuels are high research and production costs and regulatory uncertainty.

According to the report, specific mandates will play an important role in the further commercialisation of advanced biofuels.

Italy was the first EU Member State to mandate the use of advanced biofuels. The Decree requires gasoline and diesel contain at least 1.2 percent of advanced biofuel made of waste and non-food feedstocks as of January 2018 and 2019, rising to 1.6 percent in 2020 and 2021, and 2 percent by 2022. Denmark also approved a specific target for advanced biofuels, namely a 0.9 percent blending mandate by 2020 for use in transportation.

Click here for more information.

Novozymes launches new enzyme to convert residual sugar to ethanol

Novozymes has announced the launch of Spirizyme® 2.0 T and Spirizyme Ultra T for the European ethanol market. The two products are part of the Spirizyme T Portfolio, an advanced suite of glucoamylase enzymes with trehalase that deliver yield enhancing activities documented to provide the highest total sugar conversion in the industry.

Trehalose, a type of sugar that is normally left unfermented in a standard ethanol plant, is targeted by the trehalase enzyme to produce glucose, which is then fermented to ethanol.

Trehalose makes up a significant part of the 'DP2 peak', which is a measure of disaccharides and contributes to the overall residual sugar in an ethanol plant. The more DP2 an ethanol plant can convert, the more ethanol it will produce.

HPLC spectra are used to determine the concentration of different components within a fermentation sample. After trehalase is added to the fermentations, via the Spirizyme T portfolio of products, the resulting DP2 peak, including trehalose, is significantly reduced. The other components in the sample, represented by the various other peaks, remain unchanged.

The Spirizyme T product portfolio is based on proven technology with low risk of process errors. The solution can be easily integrated in the production. The portfolio is built on industry known glucoamylase blends, now with the addition of trehalase to further enhance performance.

Click here for more information.

Innovative process improves efficiency of potato ethanol production

Torange

With more than two dozen companies in Pennsylvania manufacturing potato chips, it is no wonder that researchers in Penn State's College of Agricultural Sciences have developed a novel approach to more efficiently convert potato waste into ethanol. This process may lead to reduced production costs for biofuel in the future and add extra value for chip makers.

Using potato mash made from the peelings and potato residuals from a Pennsylvania food-processor, researchers triggered simultaneous

saccharification — the process of breaking down the complex carbohydrate starch into simple sugars — and fermentation — the process in which sugars are converted to ethanol by yeasts or other microorganisms in bioreactors.

The simultaneous nature of the process was innovative: the addition to the bioreactor of mold and yeast — *Aspergillus niger* and *Saccharomyces cerevisiae*, respectively — catalysed the conversion of potato waste to bioethanol.

The bioreactor had plastic composite supports to encourage and enhance biofilm formation and to increase the microbial population. Biofilms are a natural way of immobilizing microbial cells on a solid support material. In a biofilm environment, microbial cells are abundant and more resistant to environmental stress causing higher productivities. In this application, these benefits were especially important because mold enzyme activity required higher temperature and the yeast had to tolerate this.

Researchers evaluated the effects of temperature, pH and aeration rates in biofilm reactors, and the optimal conditions were found to be 95 degrees Fahrenheit and a pH of 5.8 with no aeration. After 72 hours, the researchers achieved the maximum ethanol concentration of 37.93 grams per litre. The yield was 0.41 grams or ethanol per gram of starch.

The research findings, which demonstrated that plastic composite supports can be used for simultaneous saccharification and fermentation processes in biofilm reactors with co-cultures when producing ethanol, were published in Fuel.

More efficient bioethanol production is needed to meet the demand for renewable energy and reduce the negative environmental impacts of petroleum fuel. To make ethanol production cost-competitive, inexpensive, and easily available, feedstocks such as potato mash are needed, as well as improved processing technologies with higher productivities.

Click here for more information.

Orchard waste into cellulosic ethanol

Pixabay

Aemetis, Inc. has announced that after successfully completing the construction and commencement of an Integrated Demonstration Unit, the company is now producing cellulosic ethanol from orchard waste, utilizing technologies from Aemetis, LanzaTech and InEnTec. The plant is a continuously operating demonstration facility located at InEnTec's Technology Centre in Richland, Washington that is processing various feedstocks and demonstrating the integration of technologies to be used in the full-scale operating biorefinery.

Yields and other data from operation of the integrated demonstration unit will be provided to the US Department of Agriculture (USDA) as part of completing the Phase II loan guarantee process under the USDA 9003 Biorefinery Assistance Program. Aemetis is building a 10 million gallon per year cellulosic ethanol production facility near the existing Aemetis 60 million gallon per year ethanol plant in Keyes, California.

Under the 2007 Federal Renewable Fuel Standard, the cellulosic ethanol production mandate limit increases each year to up to 16 billion gallons per year by 2022. The current market price of cellulosic ethanol sold in California is estimated to be $4.50 per gallon, which is approximately $3.00 more per gallon than conventional ethanol.

Click here for more information.

Other Fuels

84% drop in CO2 emissions from biogas-fuelled trucks

Lorries using the UK's first gas filling station emitted 84% less carbon dioxide (CO2) than equivalent diesel vehicles, a newly released study claims.

The UK's biggest gas network, Cadent, commissioned independent analysis of the first 14 months of operation of the fuelling station, operated by CNG Fuels at Leyland, Lancashire. The first station on the high-pressure gas network, it dispenses compressed natural gas (CNG) that is 100% renewable. Its customers include HGVs from supermarket chain Waitrose.

In a statement, Cadent says the newly published report provides evidence that CNG, ideally taken from high-pressure pipes, should be the fuel of choice for HGVs in the future.

Click here for more information.

Events

Chemistry and Industrial Biotechnology Showcase 2017

York, 20th-21st September 2017

Showcasing how UK chemistry and industrial biotechnology sectors are helping to enable growth in key UK supply chains through innovation.

This two-day conference and exhibition hosted by the Knowledge Transfer Network is a major event to bring together industry, researchers, investors and government agencies to showcase how the UK chemistry and industrial biotechnology sectors are helping to enable growth in key UK supply chains through innovation.

Click here for more information.

EFIB 2017

Brussels, 9th-11th October 2017

The 10th European Forum for Industrial Biotechnology and the Bioeconomy (EFIB) returns to Brussels October 2017 and will attract industry executives committed to a shift towards renewable, biologically-based manufacturing. EFIB is organised by EuropaBio, Europe's largest and most influential biotechnology industry group and Smithers Rapra, global leader in rubber, plastics, polymer and composites information products.

Click here for more information.

Bioeconomy Investment Summit

Helsinki, 14th-15th December 2017

Join us on 14-15 December 2017 in Helsinki, Finland for the 2017 Bioeconomy Investment Summit.

Over 30 speakers from across the globe will share their views on how we can bring together the economy and the environment.

New advances in technology mean that everything that can be made out of oil can be made from renewable, biological resources. There are huge environmental and business opportunities for a wide range of industries: construction, chemicals, textiles, energy, plastics.

The bioeconomy gives us a unique opportunity for building a sustainable future. Our speakers will focus on what investment steps we need to take to make it happen.

Click here for more information.

RRB 14

Ghent, 30th May - 1st June 2018

The 14th edition of the International Conference on Renewable Resources & Biorefineries will take place in Ghent, Belgium from Wednesday 30 May until Friday 1 June 2018. Based on the previous RRB conferences, this conference is expected to welcome about 350 international participants from over 30 countries.

Delegates from university, industry, governmental and non-governmental organizations and venture capital providers will present their views on industrial biotechnology, sustainable (green) chemistry and agricultural policy related to the use of renewable raw materials for non-food applications and energy supply. The conference further aims at providing an overview of the scientific, technical, economic, environmental and social issues of renewable resources and biorefineries in order to give an impetus to the biobased economy and to present new developments in this area.

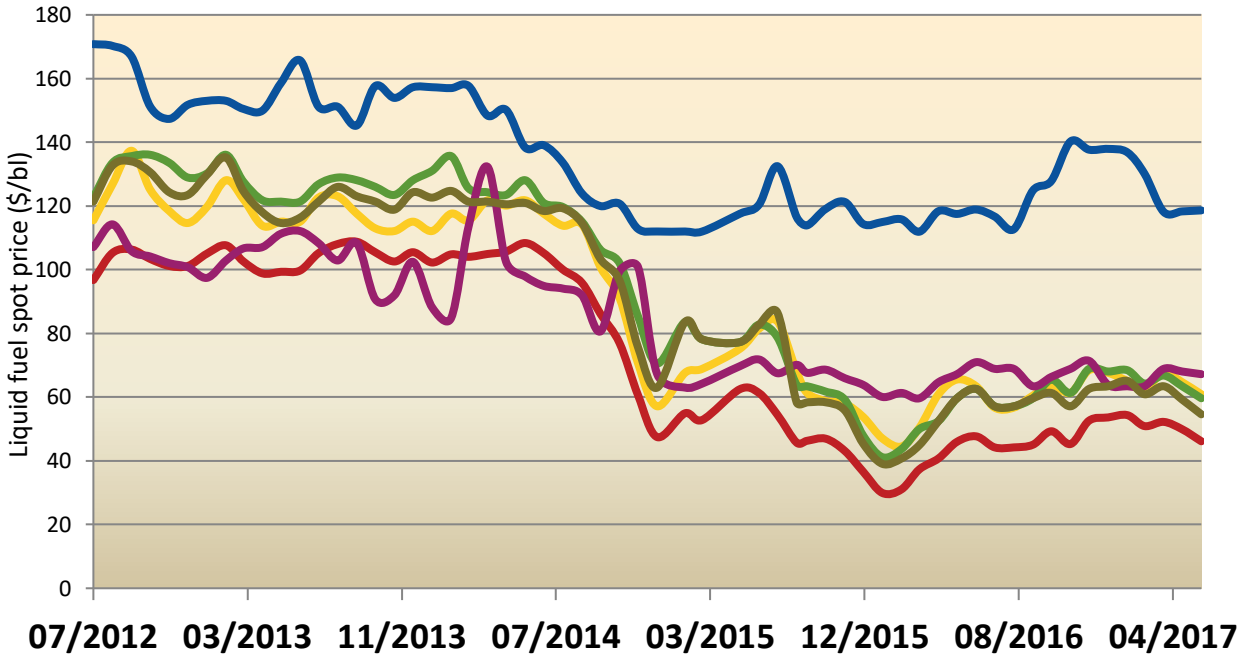
The conference will provide a forum for leading political, corporate, academic and financial people to discuss recent developments and set up collaborations.

The three-day international conference will consist of plenary lectures, oral presentations, poster sessions and an exhibition. Companies and research organizations are offered the opportunity to organize a satellite symposium.

Click here for more information.

Price Information

Historical spot prices of liquid fossil fuels and liquid biofuels. Five years prices and up to June 2017 are given in $ per barrel.



- Crude Oil (petroleum), simple average of three spot price
- Gulf Coast Gasoline
- Diesel - New York Harbor Ultra-Low Sulfur No 2 Diesel Spot Price
- Ethanol Average Rack Prices F.O.B. Omaha, Nebraska
- Jet Fuel Spot Price FOB - U.S. Gulf Coast Kerosene
- FAME 0° FOB ARA

Prices of Crude oil, diesel, gasoline, and jet fuel are recorded from www.indexmundi.com; Price of ethanol from www.neo.ne.gov; Biodiesel spot prices from http://www.kingsman.com

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