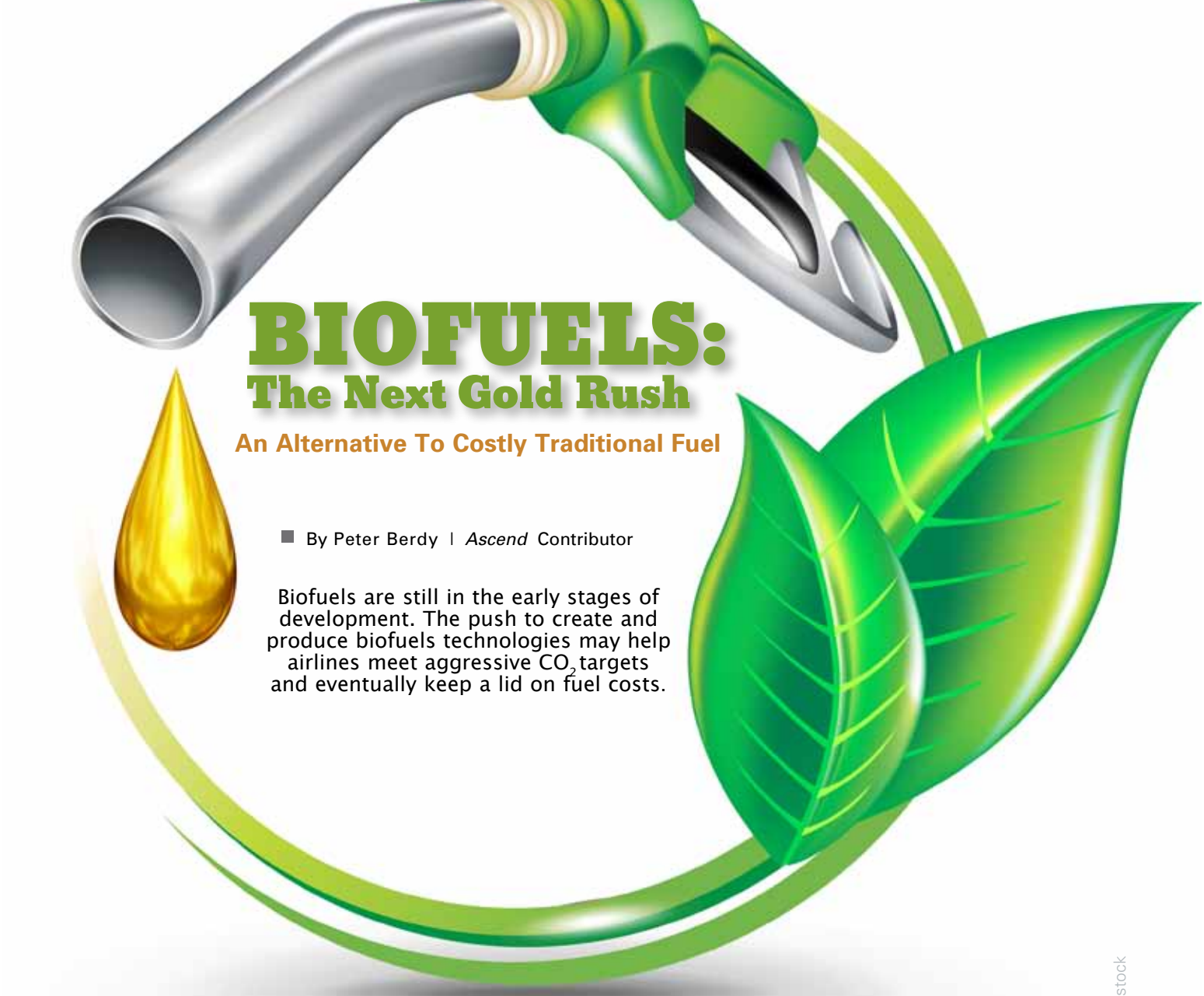

BIOFUELS: The Next Gold Rush

An Alternative To Costly Traditional Fuel

By Peter Berdy | *Ascend* Contributor

Biofuels are still in the early stages of development. The push to create and produce biofuels technologies may help airlines meet aggressive CO_2 targets and eventually keep a lid on fuel costs.

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The rapid progress of biofuels is part of a global shift toward alternative energies to reduce dependence on fossil fuels, for both economic and ecological reasons.

The airline industry sees biofuels as a principal way to achieve zero carbon growth. This means keeping carbon emissions at the current level while the airline industry continues to grow.

Commercial use of biofuels in aviation is imminent. There are strong interests behind it to scale up quickly. Global use of biofuels requires local development of feedstocks as well as local conversion to biofuels to reduce transportation costs. However, this may not be economically practical due to other considerations.

Food Or Fuel For Thought

Like agriculture crops, biofuel feedstocks suffer from:

- Uncertain crop yields,
- Changing weather patterns,
- Requirements for fertilizers and water.

A recent example is the drop in Brazil's sugar cane production in 2011. The 17 percent decline was largely due to weather.

The aviation industry and policy makers speak about novel sources for biofuels. They claim these new crops will not compete with food or forests. The list of new-generation (Gen2) raw material, or feedstock, includes algae, camelina, jatropha and the salt-resistant herb salicornia.

Despite large-scale plantation developments, so far there are no commercial supplies of oil from these crops. Palm oil is rarely mentioned; however, jet fuel from palm oil appears to be a real choice for commercial aviation biofuels in the next few years.

According to a recent report by Biofuelwatch entitled "Aviation Biofuels in 2011," reaching the airline industry's goal of zero carbon growth will require 225 refineries the same size of Neste Oil's 800,000-metric-ton biofuel refinery, Europe's largest. Feedstock for a single refinery at full production requires about 800 square miles of oil palm plantations and even more land for other feedstocks, based on average palm oil yields. This means that a minimum of about 174,000 square miles of land, slightly larger than the state of California, would be needed to meet IATA's goal to be carbon neutral by 2020.

If camelina was used instead of palm, even with an optimistic yield assumption, 533,000 square miles of land worldwide would need to be planted to meet the industry's stated goals. Compared to the total biofuel feedstocks currently in production in the world, oil palm plantations cover 46,000 square miles of land, and the total land area used to grow biofuels is between 77,000 to 96,000 square miles.

Millions of hectares of jatropha have been planted across tropical and subtropical countries. Large-scale plantings began around 2006, yet, commercial output is still very low. Despite claims about jatropha "thriving" with little water on poor soils, the opposite appears to be the case. Jatropha requires fertile soils and more water than virtually any other biofuel feedstock.

Biofuel Feedstock Jatropha seeds and the plants they produce require fertile soils and more water than nearly any other biofuel feedstock. Tests performed by several airlines use a mix of biofuels from a variety of sources including jatropha.

"The results of this survey, taken from interviews with hundreds of jatropha farmers throughout Kenya, show extremely low yields and generally uneconomical costs of production," according to a report by the World Agroforestry Centre. "Jatropha currently does not appear to be economically viable for smallholder farming when grown either within a monoculture or intercrop plantation model."

Biofuel production is still in the early research and development stages. Converting solid biomass into liquid fuel isn't new. However, more energy is required than is gained, and basic problems must be overcome before this technology is economically viable.

Green Light For Biojet Fuels

Biofuel manufacturers are creating "drop-in" replacements for petroleum-based fuel. This means they require no modification to either the engines or the aircraft. Requirements include high purity and low freezing point.

Before putting a single drop of biofuel in airplane tanks, biofuels must meet the same safety standards as regular aviation fuels. The U.S. technical standards body ASTM International, formerly known as the U.S. American Society for Testing and Materials, sets these requirements. In June 2009, the Aviation Fuel Subcommittee of ASTM passed a new fuel specification for the use and testing of synthetic fuels, including biofuels, in air transport. This approval took place following successful demonstration flights of commercial aircraft powered by different biofuel blends.

In July 2011, ASTM revised the standard (D7566) to approve blended fuel processed from algae, inedible plants and organic waste with traditional jet fuel. Under the new revised standard, up to 50 percent bio-derived elements can be added to conventional jet fuel. This revision paved the way to use biofuel in commercial flights.

"The real winners of this type of regulatory breakthrough will be technology companies involved in the production of aviation biofuels," said Harry Boyle, an analyst at Bloomberg New Energy Finance.

Biofuel Lifecycle Dilemma

Biofuel lifecycle analysis indicates that the climate impact of some biofuels may be worse than the fossil fuels they replace. There has not been a universally accepted agreement on how to estimate the total lifecycle emissions of biofuels, causing a dilemma.

According to the U.S. Environmental Protection Agency, the term "lifecycle greenhouse gas emissions" means the aggregate quantity of greenhouse gas emissions related to the complete fuel lifecycle. This includes all stages of fuel and feedstock production and distribution, where the mass values for all greenhouse gases are adjusted to account for their relative global-warming potential. The stages comprise feedstock generation or extraction through the distribution, delivery and use of the finished fuel to the ultimate consumer.

In the European Union, biofuels must meet certain sustainability criteria according to the European Commission Climate Action. The purpose is to reduce undesired impacts from biofuels production. Therefore, greenhouse gas emissions must be substantially lower than comparable fossil fuels, and raw materials used in the biofuels cannot come from land with high biodiversity or high carbon stock.

The European Commission also recommends that greenhouse gas emissions be calculated on a lifecycle basis. This includes the emissions from extracting, processing and distributing fuels. The increased demand of agricultural products for use in biofuel production may lead to more land elsewhere being converted for agriculture. This indirect land-use change leads to increased emissions overall. Therefore, emissions must be reported when land is directly converted to agricultural use to produce biofuels in order to determine the relative greenhouse gas impact compared to fossil fuels.

The European Union also believes that the carbon absorbed by biofuel plants will offset their CO_2 emissions when burned. Under the E.U. Emissions Trading System draft regulations, the biofuel component will be counted as zero emissions.

"The CO_2 emitted from burning biofuels is assumed to be carbon neutral, as the carbon was taken out of the atmosphere when the biomass grew," according to an E.U. official. "It therefore does not add carbon to the atmosphere, as this carbon is part of the existing carbon cycle."

Starting this year, each gallon of regular jet fuel will incur carbon costs of about 27 cents starting in 2012. The cost is based on the price of carbon and the average cost of jet fuel in 2011. However, this premium would not apply to biofuels.

Algae-based Biojet Fuel As of July 2011, blended fuel processed from algae (along with inedible plants and organic waste) can be mixed with traditional jet fuel. Up to 50 percent bio-derived elements can be added to traditional jet fuel. This has paved the way to use biofuel in commercial flights.

There's much controversy around the fact that biofuels will be counted as zero emissions. A panel of 19 European Environment Agency scientists decided that this neglected the fact that other carbon-absorbing plants would have grown in the biofuels place if the land was fertile. Any carbon absorption from the biofuels would then be "double counted."

"In recent years, there has been a growing interest for large-scale land acquisition for securing future supply of food, as well as for investment opportunities including biofuel production," according to the United Nation's Food and Agriculture Organization. "This development raised concerns about land tenure security, particularly since the poorest segment of the population depends on this resource for their livelihood and food security. Therefore, issues related to land-tenure security need to be carefully assessed, in particular for bioenergy production."

Campaigners from Friends of the Earth say camelina competes with food crops. It is specifically concerned about jatropha driving land-grabbing in Africa and India, especially given the amounts of fuel required by the aviation industry.

"The World Bank and OECD have recommended removing support for biofuels, yet the aviation industry continues obliviously," said Robbie Blake from Friends of the Earth Europe. "It would be irresponsible to grow enormous amounts of crops and grab land to fuel flights, rather than to feed the hungry."

Another report by the Organization for Economic Cooperation and Development states that, "Statistical results reveal that agricultural price volatility is found to be higher now than in the '90s for most products. In this context, experience in recent years may suggest that authorities and stakeholders now face additional challenges with volatile prices and agricultural trade and should coordinate their policy responses. The high correlation with crude oil price for some agricultural products during the 2000s may confirm that biofuel products have played a role in the recent price surges."

Airline Biofuel Use

Is airline biofuel use good public relations or a true environmental concern?

If airline capacity grows, so will the growth of CO_2 emissions. Per IATA, the aviation sector is expected to grow 4.5 percent annually through 2050. At this rate, fuel consumption should also grow about 3 percent a year.

To combat this increase:

- Some European governments (such as Germany, the United Kingdom and Austria) have created "green" taxes on aviation in the form of surcharges.
- IATA members have pledged to improve fuel efficiency, make the industry carbon-neutral by 2020, and reduce CO_2 emissions by 50 percent by 2050.
- The European Union has started including aviation in the E.U. Emissions Trading System this year.

But these regulations, taxes and extra costs are not the only reasons airlines will move to biofuels. They're doing it for true environmental concerns, good public relations and marketing advantages.

Who's Using It

Numerous airlines have performed or plan to perform limited tests using a mix of biofuels with regular jet fuel. Biofuels for these tests come from a variety of sources including used cooking oils, camelina, jatropha and algae. Biofuels that meet industry standards are essentially identical to conventional jet fuel, meaning there are no performance or operability differences.

Airlines involved in biofuel testing include:

- Virgin Atlantic was the first airline to use first-generation biofuel (made from babassu and

Biofuel Leaders Airlines from around the world, including Air France, Finnair, Lufthansa, Thai Airways, United Airlines and Virgin Atlantic, lead the crusade of finding alternative jet fuels. These carriers have been involved in varying degrees with testing of biofuels.

coconut oil mixed with kerosene). The carrier plans to use fuel made from waste gases from steel mills.

- Finnair operated the longest commercial biofuel flight anywhere in the world to date.
- Air France claimed the world's greenest flight combining biofuel and air-traffic-management technology.
- Air China and Boeing conducted a flight demonstration with biofuels.
- In April, Qantas operated a commercial flight powered by sustainable fuel, the first flight of its kind in Australia.
- Thai Airways was the first airline in Asia to fly a commercial passenger flight using biofuels.
- Lufthansa's experiment with biofuels included a six-month trial on daily Frankfurt-Hamburg scheduled service that began in mid-2011 and ended in December. Lufthansa operated 1,186 flights with an Airbus A321 using traditional jet fuel in one engine and blended biofuel using a combination of jatropha, camelina and animal fats in the other engine. After the trial, Lufthansa examined the engines and saw no differences. Joachim Buse, Lufthahnsa vice president in charge of the biofuel project said the trial produced "a positive result from which we want to continue to work." He indicated that Lufthansa would not make regular use of the biofuel until global production increased to a level that could support routine operations.
- United Airlines signed a letter of intent with Solazyme to provide 20 million gallons a year of biofuel starting in 2014.
- British Airways signed a letter of intent with the Solena Group, which will convert municipal waste to biofuels. The London-based plant will convert half a million metric tons of waste per year to supply all of British Airways' operations from the London City Airport.

Boeing has been working to bring biofuels into the marketplace for six years.

"We've got research projects literally around the world to figure out where the sources are and what is sustainable and what can be economically scaled up to meet what we envision as market demand," said Terrance Scott, a member of Boeing Commercial Airplanes' environment and aviation policy team.

Biofuel test flights are also intended to show producers there is demand for biofuel, although at present, it doesn't make economic sense for airlines to buy a product that costs several times the price of conventional fuel.

Production Challenges

Major challenges that delay efforts to scale production of biofuels include unknown technical problems and the high cost of investment.

On the technical side, it is hard to apply processes created in a controlled laboratory setting to the real world. The biggest challenge may be the investment required to produce enough fuel to impact the industry.

Synthetic fuel components are significantly more expensive than conventional aviation jet fuel. The hope is that the price will decline as more feedstock becomes available, and that quality control will be critical to fuel quality and safety during production and use.

It is also capital intensive. Venture capital can get companies to the proof-of-concept stage. However, funding is rarely enough to pay for major scale up, so more capital is required.

Partnerships Are Key

A logical way to scale up involves partnerships with large companies. These "big sister" partnerships can include direct equity stakes, and provide support for research and development as well as financing for scale up and distribution. Logical partners for biofuel development include oil producers, refiners and chemical companies.

Close relationships with feedstock suppliers are also important since low-cost feedstock is a basic requirement for biofuel production. This is beneficial for feedstock suppliers since it is difficult to make money with conventional ethanol, and Gen2 companies offer a platform to sell premium-priced products using the exact same feedstock. Some examples include building biofuel plants next to sugarcane mills (Amyris and Solazyme in Brazil), and revamping corn-based ethanol plants (Gevo in the United States).

Feedstock partnerships can also involve non-food feedstocks. Waste Management, the world's largest solid waste services provider, is working with Enerkem on waste-to-ethanol projects. LanzaTech has partnered with multiple steel companies, including Chinese giant Baosteel Group, to produce ethanol and other biofuels from steel mill off-gases.

Some larger airlines are also forming partnerships with biofuel producers. Qantas Airways and Solazyme are targeting commercial production of an algae-based biojet fuel. Solayyme signed a letter of intent with United Airlines to supply up to 20 million gallons per year of biojet fuel starting in 2014. In addition, Gevo has a non-binding letter of intent to supply biojet to United's hub in Chicago starting in 2013. Virgin Atlantic has partnered with LanzaTech. Brazil's Azul has partnered with both Embraer and Amyris.

European airlines are moving ahead with biofuel plans to cut use of regular jet fuel. The European Commission, Airbus, several European airlines and biofuel producers launched an initiative to speed up commercialization of aviation biofuels in Europe.

The initiative, "European Advanced Biofuels Flight path," is a roadmap with milestones to create 2 million metric tons of biofuel a year by 2020 (about 3 percent of their current fuel use). It is a shared and voluntary commitment by its members to support and promote biofuels in aviation. It also targets getting the financial means to build biofuel production plants.

Prospective Biofuels Customers The U.S. military, along with commercial airlines, are the two largest prospective customers for biofuels. By 2016, the U.S. Air Force will acquire 50 percent of its jet fuel for domestic operations from alternative blends. By 2020, the U.S. Navy expects to reduce its total fossil fuel use by half.

Trends in the biofuels industry can help determine how much time it will take to produce significant quantities of Gen2 biofuels.

In the United States, less than 100 million gallons of biofuels are expected to be produced in 2012. Production jump to 800 million gallons of capacity online is expected by 2013, and then it should triple by the end of 2015. By comparison, current corn ethanol production is around 15 billion gallons a year, and it will continue to exceed Gen2 until at least 2020.

These numbers include all biofuels from ethanol and biodiesel for ground transportation as well as drop-in fuel for airplanes. To put this into perspective, approximately 64 billion gallons of jet fuel were used in 2010.

Assuming biofuels become commercially available, the aviation industry is assessing how to handle biofuels within the existing jet-fuel supply chain. One idea mentioned by Billy Glover, Boeing's managing director of environmental strategy, is through a "book-and-claim" method where an airline could book the purchase of biofuel that would then go into the general jet-fuel distribution system. Later, the airline could claim use of that biofuel because it had reduced the overall carbon footprint of fuel in the distribution system.

An important aspect to consider is that the biofuel supply chain is not integrated. This would require selection of feedstock, refining contracts, distribution to airports, quality assurance, insurance, marketing and project funding with airports and airlines. One company — SkyNRG — has been doing this on a case-by-case basis.

Some airlines testing flights with biofuels want to demonstrate there is a market for biofuels.

"But there isn't yet current access to an adequate and affordable biofuel supply," said Bobbie Egan of Alaska Air Group. "So without an adequate supply, the costs are going to be extremely high."

To scale up quickly and integrate the supply chain, government initiatives are fundamental to reduce the high cost of biofuels.

Government Involvement

In the Biofuels Flight Path Technical Paper authorized by the European Commission, three hurdles prevent biofuels from being on the market. They include lack of:

- Government incentives,
- Financial means to build biofuel plants,
- Long-term agreements between biofuel producers and the aviation industry.

To overcome these hurdles, governments must support biofuels development by offering and funding policies that encourage such technological investments.

IATA's director general, Tony Tyler outlined six steps for governments to promote the successful commercialization of sustainable biofuels:

1. Foster research into new feedstock sources and refining processes,
2. Reduce the risk of public and private investments in aviation biofuels,
3. Provide incentives for airlines to use biofuels from an early stage,
4. Encourage stakeholders to commit to robust international sustainability criteria,
5. Make the most of local green growth opportunities,
6. Encourage coalitions encompassing all parts of the supply chain.

Several such practices are already in place.

"The United States is extending Department of Defense contracting authority, which is currently limited to five years for fuel purchases to 10 years and beyond," said Terrance Scott, a member of Boeing's environment and aviation policy team.

This can encourage start-up processing facilities, assuring a long-term viability for this market. Another example is the U.S. Department of Agriculture's encouragement to develop biofuel feed stocks, including guaranteed loans and viability on crops.

The United States Department of Agriculture (USDA) and U.S. Federal Aviation Administration (FAA) teamed up with the Farm to Fly program to help evaluate feedstock development needs. Under this program, the USDA and FAA teamed up to develop aviation biofuels in the United States.

In Europe, key regulations impact biofuels, including a 10 percent minimum target for

Plane Makers Keen On Biofuels Aircraft manufacturers have joined the biofuels movement. Airbus, along with the European Commission, several European airlines and biofuel producers introduced a program to speed up commercialization of aviation biofuels in Europe. Boeing, which has worked to bring biofuels into the market for six years, partnered with Air China to conduct a flight demonstration using biofuels.

renewable energy consumed in the transportation sector. Biofuels must meet certain criteria to count against the 10 percent goal and to meet specific sustainability requirements. These include minimum greenhouse gas emissions reductions as well as economic and social criteria such as the impact on food prices.

The diversity in member state approaches, combined with the approval by the European Commission of voluntary certification schemes, complicates the process of supplying biofuels to the E.U. market.

Military To The Rescue

The two largest potential customers for biofuels are the U.S. military and commercial airlines. The potential for airlines to use biofuels dwarfs what is needed for defense.

The U.S. Air Force plans to acquire 50 percent of its jet fuel for domestic operations from alternative blends by 2016, and the U.S. Navy plans to cut its total fossil fuel use in half by 2020. To meet these targets, the Navy and Air Force have begun implementation of test programs for alternative fuels with several start-up biofuel companies.

The U.S. Department of Defense, U.S. Department of Agriculture and U.S. Department of Energy jointly announced plans to spend US$510 million over a three-year period to support scale-up production of drop-in aviation and marine fuels.

"The focus is on working with [the biofuels] industry to figure out how best in 2012 to push the construction of biorefineries," said U.S. Agriculture Secretary Tom Vilsack. "The Defense Department is in a position to purchase the fuel, and the USDA is trying to ensure the cost is competitive."

According to Vilsack, there is ample feedstock available in the United States to meet demand from aviation and other forms of transportation without competing with food for land and water.

"It's about the better utilization of resources," he said. "There are millions of acres of dead trees that have to be cleared out and replanted to preserve water. That creates millions of tons of biomass. Perennial grasses help retain water. We are also talking about better utilization of agricultural and landfill waste."

The main objective of this program is to construct or retrofit multiple advanced drop-in biofuel plants and refineries and avoid impacting the supply of agricultural commodities.

The U.S. government indicated it may purchase several hundred million gallons of drop-in advanced biofuels by 2016, based on an expected demand of 336 million gallons from the Navy and 587 million gallons from the Air Force. The Navy already placed the world's largest order of 425,000 gallons of renewable fuels for delivery in 2012, of which 100,000 gallons are jet fuel.

In addition to the military, the FAA is also involved in biofuels. Late last year, the FAA awarded US$7.7 million in contracts to develop or produce alternative jet fuel.

The FAA added that, "Alternative aviation fuels offer enormous potential environmental and economic benefits. This work, in combination with investments being made by other U.S. agencies and industries, will advance our pursuit of clean alternative jet fuels for a more sustainable NextGen aviation system in the United States and around the world."

Biofuels are seen as an alternative to help airlines achieve industry goals to reduce CO_2 emissions. However, biofuels are still in the early stages of development. Over time, biofuels are expected to be a game changer. For this to happen, it will require government support, continued technical breakthroughs and financing.

Scaling up production and integrating the supply chain is crucial to reducing prices and speeding up the use of biofuels in the airline industry. Airlines will receive benefits under the E.U. Emissions Trading System since biofuels are classified as carbon neutral.

Environmental challenges for biofuels need to be resolved. To quote Kermit the Frog from Sesame Street and The Muppets, "it's not easy being green."

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BIOFUELS PRODUCERS

New biofuel companies appear to be sprouting up on a daily basis, with new technology discoveries and the formation of new partnerships. Here's a look at some of them:

Amyris produces biofuels primarily with sugarcane. It works with sugar and ethanol mills in Brazil to reduce capital costs. Partners include French oil company Total; two large sugar and ethanol producers in Brazil, Cosan and Grupo São Martinho; and Procter & Gamble. Amyris plans to sell a renewable jet fuel in 2013, working with engine manufacturer GE, Embraer and Azul in Brazil.

Dynamic Fuels produces synthetic fuels from animal fats, greases and vegetable oils. The company is a joint venture of agribusiness giant Tyson Foods — one of the world's largest processors of chicken, beef and pork — and Syntroleum Corporation. Dynamic Fuels is producing 425,000 gallons of renewable fuels for the U.S. Navy this year — 100,000 gallons of which will be jet fuel. Their renewable fuels production plant will make the fuel from used cooking oil as well as algal oil supplied by Solazyme. Dynamic Fuels is conducting renewable jet fuel work with KLM Royal Dutch Airlines, Finnair, Thomson Airways and Alaska Airlines.

Gevo uses a fermentation platform to produce isobutanol. It is used as a building block for producing jet fuel, among other applications. Gevo's strategy is to retrofit U.S. corn ethanol facilities, and to form joint ventures with ethanol plant owners to avoid acquisition expenses. Gevo has some airline arrangements and has grants from the U.S. Government. Gevo began commercial-scale production of isobutanol in 2011, and it will expand to 400 million gallons of capacity by 2014.

Solazyme makes algal-based jet fuel using a fermentation process. By feeding plant sugars to its proprietary microalgae, Solazyme produces oils that can be processed into a wide range of products including biofuels. The company partners with Qantas, Chevron, Dow Chemical and Unilever among others. Solazyme signed a letter of intent with United Airlines to provide up to 20 million gallons a year of bio-jet fuel in 2014.

Corn Ethanol Gevo will retrofit U.S. corn ethanol plants and form joint ventures with their owners as part of its fermentation platform to produce isobutanol, which is used as a building block for producing jet fuel. The company began commercial-scale production of isobutanol last year. It plans to expand to 400 million gallons of capacity by 2014.

Pure Sugar Because of its abundance, low cost, price stability and sustainable production, Brazilian sugarcane is a primary source for biofuels producer Amyris. Working with GE, Embraer and Azul, the company will sell a renewable jet fuel next year.

Lanzatech converts waste gases into fuel and chemical products. It converts gas from steel manufacturing, oil refining and chemical production, as well as from forestry and agricultural residues, municipal waste, and coal into fuel and chemical products. Its partner, Swedish Biofuels, will convert the alcohols to jet fuel. Virgin Atlantic is working with LanzaTech to develop jet fuel made from these waste gases. LanzaTech received US$3 million in funding from the U.S. FAA to produce alternative jet fuels.

Neste Oil produces aviation fuel from a range of vegetable oil and waste products, such as palm oil and animal fat waste from the food industry. The Finnish company is the largest producer of aviation biofuels. It has supplied fuel for Lufthansa and Finnair biofuels tests, among others.

Sapphire processes algae to biofuel. It participated in a test flight using algae-based jet fuel in a Boeing 737-800 twin-engine aircraft in 2009.

Virent converts plant sugars to jet fuel. Virent received US$1.5 million in funding from the U.S. FAA to produce alternative jet fuels from corn production waste.

SkyNRG is a one-stop shop for biofuels tests. SkyNRG integrates the supply chain for airlines testing biofuels. By the end of 2011, SkyNRG conducted tests with 10 airlines including Finnair, KLM, Air France, Alaska Airlines and Thai Airways. SkyNRG launched after a KLM biofuel test flight in November 2009. Founding partners are Air France-KLM Group, North Sea Group and Spring Associates.

Rentech converts biomass and waste materials to synthetic fuels. Its technology is paired with Fischer-Tropsch process to make complex hydrocarbons. These hydrocarbons are upgraded to jet fuel by refining technology licensed from UOP. Rentech is working toward a definitive supply agreement with 13 airlines for certified jet fuel from Rentech's proposed synthetic fuels and power facility. The agreement may result in these carriers buying the entire synthetic jet fuel production (about 250 million gallons per year).

UOP has a green jet fuel process based on hydro-processing technology that is commonly used in refineries to make transportation fuels. In this process, hydrogen is added to remove oxygen from the biological feedstock. The result is a bio-derived jet fuel. UOP worked with Boeing and several airlines to produce biofuel for test flights. UOP also received US$1.1 million in funding from the U.S. FAA to produce renewable jet fuel from the alcohol found in natural feedstocks. UOP works with Gevo to convert sugars to a type of alcohol (isobutanol) and then to jet fuel. Fuels produced by Solazyme and Sapphire are upgraded to bio-jet fuel using UOP processes. UOP has worked with PetroChina to refine Chinese grown jatropha to bio-jet fuel.

Brazil's Experience With Ethanol: Potential Lessons For Biofuels Development

The development of Brazil's ethanol industry could provide lessons for government involvement and stimulation of biofuels development.

Brazil invested heavily in renewable fuels after the energy crisis in the 1970s. It's now the leading exporter and second-largest producer of ethanol thanks to incentive-based government policies that helped foster its initial growth. The Brazilian government set up a phased implementation of mandatory blending requirements to include a percentage of ethanol in gasoline. It offered discounted prices for ethanol fuels at the pump to create a guaranteed domestic market. In addition, ethanol producers were eligible for incentives including lines of credit, price guarantees and tax breaks.

Research and development by public institutions were critical to innovation, especially for agronomic and biotechnological improvements. The cost of production in the early stages of development exceeded the price of gasoline. Over time, this cost was reduced with technological advances and gains from economies of scale.

Ethanol Powerhouse Brazil is the leading exporter and second-largest producer of ethanol because of its significant investments in renewable fuels after the energy crisis in the 1970s.