



**PETROFED**

Ref. No.: PF/9  
October 19, 2011

Shri G. C. Chaturvedi  
Secretary  
Ministry of Petroleum & Natural Gas  
Shastri Bhavan  
New Delhi

**Sub.: India's Roadmap for Sustainable Aviation Fuel**

Dear Sir,

This is further to our letter of even reference dated June 1, 2011 (copy enclosed) seeking support of the Ministry of Petroleum & Natural Gas to spur development of a roadmap for sustainable bio-fuels for India so that implementation can begin within the remaining almost five months of the Eleventh Plan period and stepped up in the Twelfth Plan.

Some recent news reports in this area are enclosed. While KLM and Lufthansa have already powered flights using cooking oil and fuel made from bio-mass respectively, Virgin Atlantic is planning a demo flight in 12 to 18 months, followed by commercial use on Shanghai and Delhi to London routes, with a waste gas-based fuel that is said to have half the carbon footprint of standard aviation fuel.

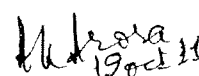
The Head of International Air Transport Association (IATA) and former Chief Executive of Cathay Pacific believes that the most significant leap forward in the industry's environmental performance in the coming years will be the commercial use of sustainable bio-fuels. It may be recalled that IATA estimates that 15% of all jetfuel is expected to be bio-derived by 2020 and 50% by 2040.

In the absence of timely adequate facilities for supplying aviation bio-fuels within the country, India may lose the re-fueling business of international airlines in the country and be a late starter.

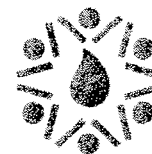
It may, therefore be necessary to develop a strategic plan and policy for focussed attention on the subject and also include it in the Twelfth Plan action plan.

Thanking you in anticipation.

Yours faithfully,

  
A. K. Arora  
Director General

Encl.: as above



**PETROFED**

Ref. No.: PF/9

June 1, 2011

Shri G. C. Chaturvedi  
Secretary  
Ministry of Petroleum & Natural Gas  
Shastri Bhavan  
New Delhi

**Sub.: India's Roadmap for Sustainable Aviation Fuel**

Dear Sir,

During the National Seminar on 'Bio-energy Solutions' organised by PetroFed in association with member companies UOP India and Indian Oil Corporation Limited on March 28, 2011 the need for setting-up a National Taskforce to comprehensively plan and monitor supply chain management regarding bio-derived jetfuel had been brought out. The International Air Transport Association, with 230 member airlines in 140 countries, estimates that 15% of all jetfuel is expected to be bio-derived by 2020 and 50% by 2040. The United States Air Force has mandated that all its aircraft be powered by a 50% bio-blend by 2020, beginning 2016. Several commercial airlines overseas have also prepared their path forward to use bio-derived aviation fuel to reduce CO<sub>2</sub> emissions.


In this context, you will be happy to find with this letter two recent reports:

1. Flight Path to Sustainable Aviation by the Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia - providing a roadmap for establishing a local commercially viable supply chain for sustainable aviation fuel. The report lists 14 recommendations for interventions in market structure, bio-mass supply, refining and certification. It has an attachment in the form of a summary of sustainable alternative aviation fuel activity.
2. A Sustainable Aviation Fuels Northwest (SAFN) report analysing opportunities and challenges with a flight path to develop complete supply chains for bio-mass based aviation fuel in the northwest states of Washington, Oregon, Montana and Idaho in USA.

You may find these reports comprehensive enough to spur development of a roadmap for sustainable aviation bio-fuels for India so that implementation can begin within the XI Plan period and stepped up in XII Plan (a CD containing these and other articles on the subject is also enclosed).

Thanking you.

Yours faithfully,

  
A. K. Arora  
Director General

Encl.: as above

For the Director General, Ministry of Petroleum & Natural Gas

## Virgin to Fly Planes on Waste Gas by 2014



Virgin Atlantic Airways plans to fly commercial routes, by 2014, with a waste gas-based fuel that the company says has half the carbon footprint of standard aviation fuel.

Partners LanzaTech and Swedish Biofuels are creating the new fuel by capturing, fermenting and chemically converting waste gases from industrial steel production. Virgin Atlantic says this process recycles gases that would otherwise be burnt into the atmosphere as carbon dioxide, and overcomes the land use issues associated with some earlier generation biofuels.

Virgin says this development will take the airline well beyond its pledge of a 30 percent carbon reduction per passenger km by 2020.

The partners are piloting the technology in New Zealand, with plans to commission a larger demonstration facility in Shanghai this year, and to start the first commercial operation in China by 2014.

Virgin Atlantic will be the first company to use this fuel, with plans for a demo flight in 12 to 18 months, followed by commercial use on routes from Shanghai and Delhi to London Heathrow. The company says it could then roll the fuel out to the rest of the world.

LanzaTech estimates that its process could apply to 65 percent of the world's steel mills. The process can also apply to metals processing and chemical industries, growing its potential considerably further, the company said.

Virgin, LanzaTech, Swedish Biofuels and Boeing are working towards achieving the technical approval required for using new fuel types in commercial aircraft. The Roundtable for Sustainable Biofuels will advise the team to ensure the fuel produced meets key environmental, social and economic criteria.

Virgin Atlantic was the first commercial airline to test a bio-fuel flight, according to its president, Sir Richard Branson. In 2008 the company flew one of its Boeing 747 jumbo jets from London to Amsterdam on a biofuel composed of babassu oil and coconut oil.

Tony Tyler, the head of the International Air Transport Association and former chief executive of Cathay Pacific, told the New York Times he is "amazed" at the progress made with aviation biofuels.

Tyler said that just a few years ago, the idea of powering planes with biofuel seemed "very pie-in-the-sky and futuristic." Now, he said, "I believe that the most significant leap forward in the industry's environmental performance in the coming years will be the commercial use of sustainable biofuels."

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## World-first low carbon aviation fuel to be developed for Virgin Atlantic

<http://www.virgin.com/travel/news/world-first-low-carbon-aviation-fuel-to-be-developed-for-virgin-atlantic>

Virgin Atlantic today announced the development of a world-first low carbon aviation fuel with just half the carbon footprint of the standard fossil fuel alternative.

Richard Branson joined Virgin Atlantic at Battersea Power Station in London to reveal the exciting news read his [blog on the groundbreaking new aviation fuel](#).

The ground breaking partnership with LanzaTech represents a breakthrough in aviation fuel technology that will see waste gases from industrial steel production being captured, fermented and chemically converted using Swedish Biofuels technology for use as a jet fuel. The revolutionary fuel production process recycles waste gases that would otherwise be burnt into the atmosphere as carbon dioxide.

Within three years Virgin Atlantic plans flights with the new fuel on its routes from Shanghai and Delhi to London Heathrow as LanzaTech and partners develop facilities in China and India. The technology is currently being piloted in New Zealand, a larger demonstration facility will be commissioned in Shanghai this year, and the first commercial operation will be in place in China by 2014. Following successful implementation, a wider roll-out could include operations in the UK and the rest of the world.

LanzaTech estimates that its process can apply to 65 % of the world's steel mills, allowing the fuel to be rolled out for worldwide commercial use. The energy company believes that this process can also apply to metals processing and chemical industries, growing its potential considerably further.

Virgin Atlantic will be the first airline to use this fuel and will work with LanzaTech, Boeing and Swedish Biofuels towards achieving the technical approval required for using new fuel types in commercial aircraft. A 'demo' flight with the new fuel is planned in 12-18 months.

Dr Jennifer Holmgren, Chief Executive of LanzaTech, said: "This technology will enable airlines to dramatically reduce their carbon footprint by reusing gases that would otherwise have been emitted directly into the atmosphere. It promotes sustainable industrial growth, as the process enables manufacturing plants to recycle their waste carbon emissions.

"While there is still work to be done and logistical hurdles to cross, we have excellent partners in Virgin Atlantic, Swedish Biofuels and Boeing and we are confident that we will have a facility with the capacity to produce fuel for commercial use by 2014."

This next generation technology overcomes the complex land use issues associated with some earlier generation biofuels - and detailed analysis suggests the fuel will produce around a 50% saving in lifecycle carbon emissions. The Roundtable for Sustainable Biofuels (RSB), the leading international body to ensure the sustainability of biofuels production, will advise the team to ensure the fuel produced meets key environmental, social and economic criteria.

Virgin Atlantic believes that this development will take the airline well beyond its pledge of a 30% carbon reduction per passenger km by 2020. The investment in renewable fuels is part of our wider programme to reduce carbon through measures such as using new, more fuel-efficient aircraft and supporting a global carbon cap and trade scheme, through our involvement in Aviation Global Deal group.

Bill Glover, Boeing Vice President of Environmental Strategy and Aviation Policy, said: "Boeing is proud to support this important partnership between Virgin Atlantic, LanzaTech and Swedish Biofuels. Sustainable aviation biofuel based upon conversion of alcohol to jet fuel is the next type of biofuel which will be under consideration for approval for use in commercial aviation. Boeing will be playing a key role in supporting the approval process drawing upon our extensive experience in sustainable biofuel development."

Peter Ryus, Manager of Certification and Implementation at the Roundtable for Sustainable Biofuels, said: "We are happy to be selected as the credible bar for this new fuel to meet. The team has demonstrated their commitment to ensuring sustainability criteria are met as the technology is developed, and we are happy to guide this process."

Dr Ausilio Bauen, Head of Bioenergy at Imperial College London, added: "The recycling of waste gases that would otherwise be emitted to the atmosphere to produce transport fuels, in a process such as the Lanzatech one, provides an excellent opportunity to reduce emissions associated with the use of petroleum fuels in transport."

Go to Virgin Atlantic's [Change Is In The Air](#) website to find out more.

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October 11, 2011 10:43 pm, Financial Times

## **Virgin to use 'recycled' fuel on flights**

By Rose Jacobs

Virgin Atlantic is aiming to run scheduled flights on a blend of ordinary and "recycled" fuel by 2015, giving a fillip to a technology that creates ethanol out of the emissions of carbon-intensive manufacturing operations such as steel plants.

The airline says it will use the fuel, which is being developed by New Zealand-based LanzaTech and Swedish Biofuels, on flights running between London and Shanghai and London and Delhi "within two or three years".

This summer, KLM flew a scheduled commercial flight powered in part by used cooking oil, and Lufthansa followed suit using fuel made from biomass. But Virgin's alternative fuel could prove cheaper, better for the environment and easier to produce in large quantities because it does not derive from elements of the food chain.

It is created by capturing the carbon released in the production of steel or other energy-intensive products, and converting that into ethanol using microbes found in rabbit gut. From there, the ethanol is transformed into a synthetic, aircraft-ready "drop-in fuel" that would be blended with conventional jet fuel in a 50:50 mix.

"In a nutshell, what we've gone into is the recycling business," said Sir Richard Branson, the airline's founder.

Virgin was an early innovator, flying the first commercial jet using a biofuel blend in 2008 - though no paying passengers were on board. The fuel was made from a mix of coconuts and Brazilian babassu nuts.

“It just isn’t acceptable to use that kind of feedstock now,” said Christopher Surgenor, editor of GreenAir, an online magazine about aviation and the environment. “Now sustainability is the name of the game.”

He said the challenge for Virgin and its partners, as with other alternative fuel makers, was scale. “As yet the only thing that exists is the pilot plant in New Zealand. They haven’t really been put into large-scale operation yet.”

Virgin has agreed to buy the fuel but is not an investor in either company. The fuel also needs to win approval for use in commercial aircraft, a process expected to take at least two years.

Should the partners jump those hurdles, the rewards could be great. Sir Richard said he believed the green fuel in development could come in at about the same price as conventional aircraft fuel.

Jennifer Holmgren, chief executive of LanzaTech, estimated the process could be adapted at two-thirds of the world’s steel mills. The first “demonstration facility” will be built this year at one of Baosteel’s plants in Shanghai.

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### **Quick Win: aviation biofuels offers breakout for clean energy**

Jim Lane | October 13, 2011



Aviation biofuels may represent the breakout success opportunity that biofuels, clean energy needs. The Digest looks at the case.

In Copenhagen this week, a coalition of companies and associations involved in aviation biofuels made a strong case for the sector not only as a quick win for biofuels, but as a quick win for clean energy as a whole.

Pitching Martin Lidegaard, the incoming Danish Minister for Climate, Energy and Building over a working lunch, Paul Steele, executive director of the Air Transport Action Group made the quick win case.

“Aviation is hard at work with a spectrum of activities to reduce environmental impact. But we see aviation biofuels as a quick win. First, we have just 1700 airports as fuel points, versus distributing to and possibly retrofitting hundreds of thousands of gas stations around the world. Second, aviation biofuels involve no infrastructure change -

they drop right into the existing engines. Third, you have a sector that has done everything it can to do the flight tests, the certifications, sustainability groups, and even participating with investment in biofuels, to stimulate production.”

The case is strong. To convert 20 percent of road transport around the world to biofuels - a threshold most would describe as a major clean energy “win” - would take a transformative infusion of capital, and require the aggregation of as much as 1.5 billion tons of biomass. The impact? Transformative. The logistics? Daunting. The timelines? Awfully long for a public which feeds on 24-hour news cycles and 1-2 year product life cycles.

Road transport is the big prize - there’s no doubt, but is it as well shaped up for a quick win?

By contrast, converting 20 percent of aviation to biofuels would transform modern aviation, be a major signal that clean energy can work at scale, and offers a model for developing R&D, certification and supply chain consortia. It would take around 12 billion gallons of biofuels, and perhaps 120 million tons of biomass, distributed to 1700 or so airports around the world.

### **Feedstock, regulatory and finance challenges**

The challenges, while simplified in terms of infrastructure, are complex enough when it comes to feedstock, capital and regulations.

For example, take sustainability rules. Naturally, there are different views around the world about how to define sustainability, and numerous groups like the Roundtable on Sustainable Biofuels are tackling the problem via slightly different methodologies. Which is fine in most cases, but taking off from Singapore, for example, where there are one set of rules, and landing in Frankfurt, where there might be another, can lead to problems.

A unified world standard for sustainability remains outside of the likely range of possibilities for some time, so groups like Boeing are calling for interoperability between standards, so that results under one set of rules can be swiftly translated into results in another, so that correct fuel sourcing approaches can be employed. With feedstock, the long term problems of finding enough acreage for energy crops, will likely come through global zoning rules for energy crop cultivation. After all, it is effective zoning that protects prime agricultural land from conversion to, say, office buildings. It may be time to do more than divide agriculture from, say, manufacturing, commercial and residential zones. It may well be time to separate out food land from energy land, though rules will need to take crop rotation into account.

It may well be fitting to do so. Calls for biofuels producers to avoid using food crops are, at best, facile and naive. Converting 15,000 acres of soybeans to camelina, for example, uses “non-food biomass,” but subtracts from the use of arable land for food production. By all accounts, these are complex issues, and will take time to build consensus. Another reason why aviation biofuels, which can scale without resort, on the whole, to large tracts of arable or marginal land.

### **Can aviation biofuels be scaled up without adding a single acre of biomass production?**

LanzaTech, in looking at just the inventory of waste gases from steel mills around the world, which form the feedstock for its alcohol-to-jet, estimated that there is enough carbon monoxide generated by steel mills to create 15 billion gallons of biofuels (though roughly half that, in aviation biofuels).

Solena Group, which is developing projects in Australia and the UK, in cooperation with British Airways and Qantas, just announced a new project with SAS, for Sweden. They could build a project in every major airport hub in the world, using municipal solid waste and other urban and agricultural residues.

That's not taking into account the substantial opportunities with algae grown in agricultural dead zones like Australia's northwest-shelf, or the renewable jet fuel that can be made today by Dynamic Fuels from animal rendering by-products. In short, there's more than enough waste to bring aviation biofuels to scale without troubling an acre of existing crop land, and that's another reason why aviation biofuels could be a quick win.

### **No electric plane on the horizon**

Not to mention that, unlike other areas of transportation fuels where there is controversy over competing platforms like electric hybrids, CNG vehicles, or biofuels - in the case of aviation, there really isn't much wiggling room, because an electric plane is only on the most distant horizon and belongs, at best, to planning for a post-2050 world.

Bringing us to finance. Airlines simply don't have the balance sheets, project finance is tough to unlock, project developers and their backers are near-to-tapped-out just bringing their technologies through to pilot and commercial demonstration. Meanwhile strategic investors are more attracted to the high-value markets in renewable chemicals

### **A new system for advanced biofuels finance**

In yesterday's Digest, we circulated some proposals made at Copenhagen that have been gaining early support amongst some aviation biofuels cognoscenti.

### **Answering the financial challenge**

In yesterday's Digest, we outlined a proposed three-part system for unlocking new investment channel in advanced biofuels. The source of the liquidity: direct investment from pension funds. How to protect Grandma's pension? Advanced biofuels risk insurance, offered and managed by private industry, funded by producer-paid premiums, sweetened regionally through government investment in insurance funds. How to reduce risk to insurers and premiums to producers? Streamlined yet detailed due diligence that rates projects according to the amount of core technology, feedstock and offtake risk in a given go-to-market package.

Yesterday, we wrote:

*"It has been proposed that a new asset class be established that will permit \$28 trillion in pension funds to include green growth and clean energy investments in their direct investment portfolios.*

*It has been proposed that - out of the ashes of failed sovereign loan guarantee systems - a new system be deployed to narrow the gap between the risk that the private sector can afford in deploying new technology, and the rates of deployment needed to meet the aforementioned global carbon and growth targets.*

*Specifically, there are discussions regarding technology risk insurance funds. Unlike green banks - which essentially are vehicles for directive state investment - these technology risk funds would, after appropriate due diligence, insure projects in order to reduce the*



*cost of financing. Since not all projects fail, insurance (like loan guarantees) foster more projects per dollar than direct investment.*

*Unlike loan guarantees, such a system would be based in public-private partnership - that is, governments could help to capitalize the privately-held, privately managed funds. The more that the government invests, the more projects built. It's a sweetener mechanism. How is this different from troubled institutions like Fannie Mae? First, by ensuring that government ownership does not mean government control. This isn't Private Money + Government Management, but rather Government Money + Private Money + Private Management. In other words, government sweetens the technology risk insurance pot to the extent that it wants to accelerate development. Sweeten very little, some projects get through. Sweeten more, more projects get through. Key to that system is reform in due diligence. It has to be both better and faster. Everyone understands that some projects will fail - just as, sadly, some houses burn down, that's the nature of insurance and why it exists. Striking the right balance between too much risk and too little risk, that's the key, and strong due diligence is a key to that."*

No new land required, a financing system identified, a committed end-user group, technologies ready to scale, and a small number of distribution points. All the forces have aligned.

What is missing is leadership. Leadership that is more than pointing the way toward the promised land, but taking the first steps and persuading others to join.

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### **Virgin-LanzaTech tie up to make low-carbon fuel**

Hindustan Times ; New Delhi, October 11, 2011

British carrier Virgin Atlantic on Tuesday announced a tie-up with energy firm LanzaTech for the development of low carbon aviation fuel with just half the carbon footprint of the standard fossil fuel alternative in India.

The partnership represents a breakthrough in aviation fuel technology that will see waste gases from industrial steel production being captured, fermented and chemically converted using Swedish Biofuels technology for use as a jet fuel.

The revolutionary fuel production process recycles waste gases that would otherwise be burnt into the atmosphere as carbon dioxide.

"India, which is amongst the world's largest steel producers, will be one of the first countries where the fuel will be produced as LanzaTech and partners develop facilities there. Within three years, Virgin Atlantic routes from Delhi to London Heathrow could see flights run on the new fuel," the airline said.

LanzaTech estimates that its process can apply to 65% of the world's steel mills, allowing the fuel to be rolled out for worldwide commercial use.

"We were the first commercial airline to test a bio-fuel flight and we continue to lead the airline industry as the pioneer of sustainable aviation. This partnership to produce a next generation, low-carbon aviation fuel is a major step towards radically reducing our carbon footprint, and we are excited about the savings that this technology could help us achieve," a release issued by the airline quoting its president, Richard Branson, said.