Pressure on the aviation industry to balance increasing demand with environmental protection is at an all-time high, according to the International Civil Aviation Organisation.

The sustainability of the aviation sector is increasingly in the spotlight, thanks to its impressive growth rate and the fact that it uses so much fuel. This is reflected in the EU’s move to include it in its Emissions Trading System and ICAO’s tortuous progress towards a global scheme.

The industry collectively agreed in 2008 to the world’s first sector-specific climate change targets, including a commitment to continue improving fleet fuel efficiency by 1.5% per year until 2020.

From 2020, aviation will cap its net carbon emissions and by 2050, the industry has committed to reducing its net carbon footprint to 50% below what it was in 2005. In addition, the European Commission wants to see 4% of aviation fuel coming from bio-based sources by 2020.

There are plenty of ways to make aircraft more fuel efficient, from winglets to lightweight composite materials to more efficient engines. But when it comes to fuel, aviation is different from other forms of transport in that it has little alternative to liquid fuels – electrification is not an option because batteries are too heavy and do not provide enough power to get an aircraft off the ground.

SUSTAINABLE QUANTITIES

As a result, according to Tom Enders, former chief executive of Airbus and now chief executive of EADS, “the production and use of sustainable quantities of aviation biofuels is key to meeting our industry’s ambitious CO₂ reduction targets”. And given the relatively small size of the aviation fuel market compared with other forms of transport, it is hoped that in time, biofuels will play a major role in improving the sustainability of air travel. Analysis suggests that biofuels will reduce overall life-cycle CO₂ emissions by 80% compared with traditional jet fuel.

Already, significant progress has been made – from a standing start in 2007, more than 1,500 passenger flights have been made using biofuels produced from feedstocks ranging from household waste to excess gas, industrial processes and algae.

The major challenge now is to work out how to produce large quantities of sustainable biofuel at a cost that is commercially competitive to airlines. At the moment, biofuel costs around three times as much as conventional jet fuel, although this is expected to fall as production capacity is increased beyond the current small-scale projects. At the same time, Jet...
A-1 prices are expected to head in the opposite direction as conventional oil becomes scarcer and harder to obtain. However, in the short term, the scaling-up process has been held back by the sector’s caution about using biofuels that are not sustainable, including first-generation fuels made from feedstocks such as corn that compete with food for resources or those made from palm oil grown on land cleared from rainforest, which have a huge impact on emissions. “Sustainability is a must for us,” stresses Frederic Eychenne, new energies programme manager at Airbus.

ENERGY DENSITY
The aviation industry took careful note of the negative effects when the first generation of biofuels were deployed in road transport and is determined not to repeat those mistakes, says the industry pressure group Aviation Benefits Beyond Borders. In addition, many of these fuels were unsuited to aviation — ethanol does not have the required energy density, while biodiesel has a tendency to freeze at high altitudes.

The other factor that has to be taken into account is the need for any sustainable alternative fuel to be of “drop-in” standard, so that it has the same chemical properties as conventional jet fuel. With drop-in fuel, “no new engines, no new aircraft and no separate fuel delivery systems are needed at airports,” says the Air Transport Action Group (ATAG). “It is the most practical solution. More biofuel can be added to the system as it comes on stream.”

This leaves companies dependent on new feedstocks that do not cause deforestation or other environmental impacts and that do not compete with food crops for land or water. But before a particular type of biofuel production can be scaled up, it must first win certification from one of two certification bodies — ASTM, a US-based body that deals with standards for civil aviation, UK-based Def-Stan, which focuses on fuel for use in military applications, which have slightly different requirements, or the US Department of Defense.

PARAFFINIC KEROSENE
It is not just the feedstocks that are under scrutiny but the production process. There are currently two approved processes for producing alternative aviation fuels, explains Richard Mills, UK director of strategy at Boeing. The first to be approved, as far back as 2009, was synthetic paraffinic kerosene (SPK) produced using the well-understood Fischer-Tropsch process that allows the use of a range of feedstocks, including municipal solid waste and various types of biomass.

The other approved process, which was certified in 2011, is known as hydro-processed esters and fatty acids (HEFA), which produces fuel derived from biomass feedstocks such as camelina, jatropha or algae. Certification of aviation fuels is an arduous process, says Mark Rumizen, who worked on the HEFA standard as lead of the certification-qualification group for the US-based Commercial Aviation Alternative Fuels Initiative (CAAFI). “Because of the great emphasis on safety when you’re dealing with aviation fuel, the [certification process] required a collaborative and co-operative effort between the members of the aviation fuels community.”

“There will be a number of different winners because different feedstocks are appropriate in different parts of the world”

RICHARD MILLS
UK director of strategy, Boeing

“Certification is a long process where everyone is involved, from the airframers to the engine manufacturers, to the component makers, to the regulators,” says Eychenne. The whole process can take three to four years, he adds, and we are likely to be at least a decade away from having a large amount of alternative fuels on the market.

According to Mills, the next fuel pathway likely to be approved is the direct conversion of alcohol to jet (ATJ) fuel, which would enable airlines to use more fuel derived from bioethanol. Given that there are already large amounts of bio-ethanol on the market – principally from Brazil, where it is made from sugarcane and the US, where corn is the main feedstock – this would enable rapid scaling up to commercially viable quantities.

There is the added advantage that ATJ does not need to be blended with kerosene because it already contains aromatics. Critics, however, argue that the environmental benefits of burning ATJ fuels are minimal when the whole life cycle is taken into account, particularly with corn as the feedstock. Nonetheless, ATJ is likely to play a major part in the market – Brazilian airline Azul recently ran a test flight using ATJ supplied by Amyris during the Rio+20 sustainability conference.

Mills warns that no one fuel will be a silver bullet: “There will be a number of different winners because different feedstocks are appropriate in different parts of the world – we will see a portfolio of different fuels.”

Boeing is working on algae in China, for example, as well as looking into using halophytes, a plant that grows in salt water, in the United Arab Emirates.

Meanwhile, Airbus is researching the use of camelina in Romania and Spain and jatropha in Brazil, as well as the Mallee bush in Australia and algae in Qatar.

The aviation biofuels industry is still in its very early days, says Mills, and a lot of investment will be needed to allow the sector to cross the classic valley of death that afflicts new industries, “where the technology has been demonstrated at pilot scale and shown to work but it needs to scale up. However, banks are reluctant to invest until the first full-scale plant is up and running.”

But as the industry matures, “further investment will allow us to look at new types of feedstock/pathway combinations that might offer better economics”, he adds.