

Hard facts. Clear stories.



Copenhagen  
Economics  
Stockholm

CE

# Biofuels at Remote & Peripheral Airports

## English Summary

Trafikverket, 2018



Northern Periphery and  
Arctic Programme  
2014-2020



EUROPEAN UNION

Investing in your future  
European Regional Development Fund

## Summary in English

Aviation is an important part of the Swedish transport system. In a large and sparsely populated country like Sweden, air travel is necessary in order to connect different parts of the country. The importance of aviation is evident from the 36 airports with regular traffic located around Sweden. Nowhere is the importance greater than in the northern half of Sweden, traditionally called *Norrland*, which makes up 60 per cent of Sweden area, but houses a mere 12 per cent of the population. For many of the roughly 1.2 million people living in Norrland, reaching Sweden's capital Stockholm for a day-trip is only possible by flying. Aside from ensuring the connectivity to and from Norrland, air travel is important for both the local and national economy as many of Sweden's natural resources (e.g. iron ore and forests) and the associated businesses are located in the northern parts of the country.

However, flying affects the environment. The use of fossil fuels leads to emissions of greenhouse gases, e.g. carbon dioxide, which contributes to global warming. Balancing the need for ensuring reliable connectivity to all parts of the country, and the need to limit the environmental impacts of flying are the two goals underpinning Swedish transport policies.

The aviation sector, e.g. airlines and airports, has taken step to reduce its environmental impact, both on the ground and in the air. In order to achieve deep cuts in emissions, replacing the fossil-based jet fuel used to today with fossil-free alternatives is key. Biofuels for aviation are the only commercially viable option for fossil-free aviation today. The Swedish aviation sectors has therefore set targets that imply that domestic aviation in Sweden will be fossil free in 2030. In order to reach this, the use of biofuels for aviation will need to be scaled up in the coming years.<sup>11</sup>

Biofuel for aviation is currently 2-4 times as expensive as fossil-based jet kerosene, based on the prices paid for delivering fuel to the Swedish market. This increased cost is the main obstacle to transitioning to a sustainable aviation industry, not least because it would imply higher cost of maintaining the connectivity that flying offers today.

In light of these challenges, Copenhagen Economics have been asked by the Swedish Transport Administration to analyse if it is possible to achieve 100 per cent biofuel<sup>12</sup> at regional, non-governmentally owned airports in northern Sweden while limiting the cost of ensuring connectivity to the region. As a part of this task, we are to propose an action plan

---

<sup>11</sup> Svenska regionala flytplatser (SRF), an organisation representing non-state-owned airports, aim to offer 100 per cent fossil-free refuelling at their airports in 2030. Swedavia, which owns the ten state-owned airports, four of which in Norrland, aim to contribute to a fossil-free domestic aviation sectors by 2030. SRF's goal is to offer 5 percent blend-in 2018, 50 percent 2025 and 100 percent by 2030. If this goal is met, domestic aviation emissions of carbon dioxide could be a quarter of today's level.

<sup>12</sup> Current certification requirements limit the share of biofuel blend-in to 50 per cent. However, it is technically possible to fly using 100 per cent biofuels. For the purpose of this report, we have assumed that certification schemes will allow 100 per cent biofuels by 2030.

for how airports and the government can increase the deployment of biofuels at these airports.

Our analysis is based on a three-stage approach where we (i) analyse the barriers on the supply side to reach a target of 100 per cent biofuels, (ii) analyse the barriers on the demand side, and (iii) make recommendation what different actors can and should do in order to bridge the gap between demand and supply, thereby enabling the transition to a fossil-free aviation sector in Sweden.

Our analysis shows that it is possible to reach a goal of 100 per cent biofuels at regional, non-government owned airports in northern Sweden. This requires governmental support, and that the airports take necessary steps to complete this transition. More specifically, we find that the low share of biofuel uptake today is due to barriers both on the supply and demand side, and that there is a lack of economic instruments needed to overcome these barriers directed at the aviation sector.

**Supply side: Small-scale production, low level of competition, and high transport costs make biofuels for aviation expensive.**

The price premium for aviation biofuels compared to fossil-based jet fuel can be explained by three main factors:

*Firstly*, it is expensive to produce biofuels for aviation using today's production methods.<sup>13</sup> As demand and the produced volumes are still relatively low, the production cost per unit of fuel is high. Most deliveries of aviation biofuels are tailor-made, with small batches of fuel produced individually for each deal. The first continuous production of biofuels was not put in place until 2017. This may lead to a downward pressure on prices, but no such trend is yet visible.

*Secondly*, the low demand for aviation biofuels means that potential new entrants face a sizeable risk should they attempt to enter the market. There is only one producer that produces aviation biofuels continuously today, AltAir in California, which produced fuels from used cooking oil. All aviation biofuel for aviation used in Sweden today comes from this producer. Low competition can lead to higher prices as producers can charge higher margins without risking losing customers. The lack of a global market with benchmark prices for aviation biofuels means that comparing prices between suppliers is difficult.

*Thirdly*, transporting biofuels from the production facility in California to Sweden is costly. The transport cost may for some deliveries double the total cost for users of aviation biofuels in Sweden.

---

<sup>13</sup> It costs about five kronor per liter to produce fossil-based aviation fuel, but two to three times as much to produce bio-fuel with today's production method. See e.g. Ramböll (2017), Bærekraftig drivstoff til luftfart. Status 2017; De Jong, S., Hoefnagels, R., Faaij, A., Slade, R., Mawhood, R., & Junginger, M. (2015). The feasibility of short-term production strategies for renewable jet fuels—a comprehensive techno-economic comparison. *Biofuels, Bioproducts and Biorefining*, 9(6), 778–800.

These cost drivers may partly fall as the global market for sustainable aviation fuels develops. Production costs may fall as global demand increases, thereby allowing more suppliers to join the market, with larger production volumes driving down unit costs. However, a larger global demand for biofuels will also drive up demand for raw materials from which the biofuels are made. Unless global supply of raw materials keeps pace, the cost of producing certain types of biofuels may instead rise in the future. This is partly driven by political processes, such as EU-regulation on which feedstocks are to be considered sustainable.

### **Demand side: Low willingness to pay and lack of knowledge among travellers are barriers to a bio-based domestic aviation sectors in Sweden**

The price premium of bio-based aviation fuels means that passengers who wish to travel with the equivalent of 100 per cent biofuels must pay SEK 400 (EUR 40) per hours of flying time. For a typical domestic trip in Sweden, e.g. Stockholm to Sundsvall, which takes 50 minutes, paying for biofuels would add one third to the ticket price, or SEK 300.

Air travellers who wish to do so can pay for flying with biofuels by transferring money to Fly Green Fund, an outfit set up by various actors in the aviation sector. Fly Green Fund procures biofuels using the money they have raised and delivers it to participating airports, thereby replacing fossil-based jet fuel. However, few people take advantage of this option, partly due to low awareness. A recent survey by Swedavia, which runs the state-owned airports in Sweden, found that only a quarter of respondents were aware of the possibility of flying with sustainable aviation fuels.

Several studies conducted in recent years find that many air travellers in fact are willing to pay more for flying with biofuels. For the journey between Stockholm and Sundsvall, corporate travellers are willing to pay around SEK 230 to fly with 100 per cent biofuels.<sup>14</sup> For private travellers, the corresponding willingness to pay is slightly lower, around SEK 130.<sup>15</sup>

With a price premium in excess of 300 SEK for the same trip, there is still a gap between the price of flying with biofuels, and the passengers' average willingness to pay for it. Demand for biofuels in aviation is also held back by public institutions travel and environmental policies, which often encourage public employees to refrain from flying altogether, without regard to the fuels used. In some policies set up by municipalities, air travel is even punished by adding an extra internal levy on airfares, the proceeds of which are put into climate funds for local investments, such as putting up charging points for electric cars.

---

<sup>14</sup> Goding (2016)

<sup>15</sup> Rains, T., Winter, S. R., Rice, S., Milner, M. N., Bledsaw, Z., & Anania, E. C. (2017). Biofuel and commercial aviation: will consumers pay more for it? *International Journal of Sustainable Aviation*, 3(3), 217. <https://doi.org/10.1504/IJSA.2017.086846>

### **The government should try to reduce the barriers which reduce the market conditions for biofuels for aviation**

Our analysis of the demand and supply side shows that the conditions for a well-functioning market for aviation biofuels in Sweden are largely missing. A high price keeps demand low. Low demand means that the production volumes are low, leading to higher prices. In order to scale up production, further investments are needed. These investments will not take place with the current uncertainty surrounding the demand for the biofuel produced, and the potential of recouping investments. While this production could take place anywhere globally, there is a large potential in turning Swedish biomass, primarily residues from the forest industry.

In order to develop a market for aviation biofuels, outside investments are required. These can be targeted specifically at the problems identified above – on the supply side as well as on the demand side. We have identified two measures that the Swedish government can take in order to increase the incentives for a large-scale production of biofuels in Sweden accelerate the establishment of a biofuel market in Sweden. These are *the introduction of a reduction obligation for aviation fuel* and *state aid for commercialisation of biofuel production processes in Sweden*. In addition to these measures, the government can also act to increase the demand for biofuel fuel in Sweden in the short term. These would not provide as strong signals to potential providers as they do not guarantee long-term demand for biofuels.

A reduction obligation for aviation fuel implies that fuel suppliers are required to blend in biofuels into the delivered fuel so that the environmental impact per litre of fuel falls at a certain pre-determined rate. This would increase and stabilise the demand for biofuels, thus creating stronger market signals for potential biofuel suppliers. Another benefit of a reduction obligation is that provides fuel suppliers with an incentive to choose the biofuels that have the lowest environmental impact, making it a cost effective tool for reducing emissions from air travel.

A reduction obligation for the aviation sectors would also mirror the reduction obligation for road traffic, in place in Sweden since the start of 2018. Since the production of biofuels is largely carried out in plants that can also produce biodiesel for road use, the absence of similar economic instrument directed at the aviation sectors would be likely to favour production of biofuels for road use.

However, a reduction obligation would increase fuel costs for airlines, thereby making it more expensive to maintain connectivity to all parts of Sweden. Phasing in a reduction obligation should be done while keeping track of the overall market development to ensure that there is sufficient supply of aviation biofuels available at a reasonable price.

Another way to contribute to lower biofuel prices for airports and airlines in Sweden could be to offer support to commercialising production processes in Sweden. A large-scale production of biofuel fuel in Sweden would directly contribute to lowering biofuel

fuel prices, mainly due to the decrease in transport costs when the fuel is manufactured closer to where it is used.

However, the fuel produced in Sweden will be more expensive than other biofuels before it becomes cheaper. There are a number of pilot and demonstration facilities in Sweden that show that biofuel can be produced from biomass. While a production facility, producing at commercial scale, could be up and running within five years, the first plants are likely to produce relatively costly biofuel that would struggle to compete with current producers without some form of risk-sharing mechanism or other types of support. In the absence of private investments, the state could therefore provide financial support until the investment becomes profitable. Such temporary support schemes may be justified if the aim is to protect infant industries from competition, but must be compatible with EU state aid rules.

In addition to these two measures, we have also identified three other ways in which the government could increase the demand for biofuel in the short term:

*Firstly*, public organisations' internal climate funds can be used to finance the procurement of biofuel. Some public organisations impose their own fees on air travel. The proceeds from these fees are used to finance local climate initiatives. These could be used to pay for biofuels used for trips made by public officials.

*Secondly*, exemptions in the proposed aviation tax for domestic flights based on the degree of biofuel blended into the fuel. Airlines would instead be able to pay the money to a fund used to procure biofuel. A similar solution is currently being studied in Norway.

*Thirdly*, the government could place requirements that procured air routes fly using biofuels. The government procures a number of routes between northern Sweden and other parts of Sweden, mainly Stockholm, in order to ensure a minimum level of connectivity for residents. A requirement that these should use biofuels could be an option of increasing demand for biofuels, albeit marginally.

These three measures would increase the total demand for biofuel fuel, but would imply the use of public funds to support the production of biofuels in other countries considering the current supply situation. Furthermore, they would not provide long-term incentives to (potential) biofuel manufacturers to establish new production facilities or scale up existing ones, as opposed to a reduction obligation. In order for investments to take place in Sweden, potential producers would need clear signals that there is a long-term demand.

## **Regional airports play an important part in developing the market for biofuels for aviation**

Regional airports play an important role for the use of biofuel for aviation in Sweden. Airports can drive the development towards a functioning biofuel market by stimulating demand locally. Based on our analysis, we find that the regional, non-state airports in Norrland have the potential to drive the transition to biofuel through four main channels:

Decisions on major investments and other costs linked to a transition to biofuels for aviation these airports must be based on political decision made at the local and regional level. Since the airports are usually owned by municipalities and/or regions, they can play an important role in informing their owners about the importance of a transition to biofuels. Transitioning to biofuels could be part of a broader environmental strategy for the municipality.

A large-scale and Swedish production of biofuels would probably be based on raw material streams from forestry in Norrland. The airports in Norrland could thus play an important role in signalling that there is a long-term demand for biofuel, thereby making it more attractive for potential biofuel producers to invest in production capacity in northern Sweden.

Airports can also play a central role in raising awareness of the possibility - and hence the willingness to pay - to fly using biofuels.

Furthermore, regional airports can work together with fuel suppliers to offer biofuel refuelling to airlines. The exact role of the airports depends on where the biofuel is blended into the fuel mix that goes into the planes. Aviation biofuels are so-called drop-in fuels, i.e. they can be blended with the fossil jet fuel, and after the blend is certified, aircraft are fuelled with the mix. The blending can e.g. take place either at each individual airport or at one central blending facility, often close to a large regional airport. When a passenger pays for flying with biofuels, they are either paying for “actual” blending (the flight they are on is fuelled by biofuel in proportion to what they have paid) or “virtual” blending (the money they have paid is used to procure biofuels which at some point, somewhere replace fossil jet fuel, but not necessarily on the flight that passenger is on).

For the virtual blending solution, passengers to and from the regional airport pay for biofuel via Fly Green Fund, and the biofuel is blended into the overall fuel mix at a central location. Today, most biofuel gets blended into the system at Arlanda airport in Stockholm. This is a cheap solution for the regional airports with little to no start-up costs. Airports need only to market the opportunity to pay for biofuel through the Fly Green Fund. The disadvantage, however, is that it can be difficult to communicate the connection between passengers’ paying for biofuels, and the biofuels entering the system.

Blending could also occur at, or in close proximity to, the regional airport. This is a solution that several major airports in Europe have applied, but is not economically justifiable for smaller airports in Sweden due to the investments required. Adding further to the cost

of this solution is the fact that the final fuel mix must be approved in a certification process.

Between these two alternatives, there is a solution where the blending occurs at a central facility and then sent to regional airports for fuelling. An alternative to today's central blending at Arlanda could be a local facility for blending in Norrland, from which fuel can be distributed to regional airports. This solution would also be cost effective if there were production facilities for biofuel fuel in Norrland.