Decarbonizing aviation: comparing nine policies

Delft, 7 August 2020
Arie Bleijenberg, Koios strategy

Assessing policy options

Aviation needs to bring its CO_2 emissions down to zero not far beyond 2050. To achieve this, a wide range of technologies and policies is considered. Among these are taxes, ban on short flights, faster trains, electric planes, zero-carbon fuel and enhanced energy efficiency of aircraft and operations. For policy development and for investment decisions, it is useful to have insight into the impact of alternative approaches. The table below assesses the three most important consequences of different policies: CO_2 emissions, ticket price and travel volume. This gives a first comparative overview. The data are estimates, based on uncertain assumptions (see below). This assessment is not intended as final answer, instead as a kick-off for discussion and improvements. Despite its limitations, the overview shows that sustainable fuels will have a large role in decarbonizing aviation.

Policy options	Illustration of impact on:	CO_2 emissions	Ticket price	Travel volume
Reference = 100	Fossil kerosene 0.50 €/l, No taxes	100	100	100
Modal shift Air2Rail	HSR between all major cities Europe, Airport capacity restricted	87	100	92
Expected pricing policy aviation	Ticket taxes 5%, ETS price 50 €/tonne CO_2	87	109	93
No CO_2 flights < 500 km	Half flights avoided, half zero CO_2, Airport capacity restricted	87	104	97
10% blending of green kerosene	Green kerosene 3.00 €/l, 10% CO_2 compared to fossil	67	108	94
Taxing aviation	0.33 €/l kerosene, VAT 25%	66	138	77
25% blending of bio or blue kerosene	Bio or blue kerosene 1.50 €/l 10% CO_2 compared to fossil	64	108	94
50% blending of green kerosene	Green kerosene 2.50 €/l 5% CO_2 compared to fossil	31	129	82
50% green kerosene and taxing aviation	Green 2.50 €/l, 5% CO_2 VAT 25%, ETS 100 €/tonne CO_2	25	165	67
80% green kerosene	Green kerosene 2.00 €/l 0% CO_2 compared to fossil	10	143	75

Modal shift Air2Rail

The estimates are from my study Air2Rail. It is assumed that all rail links in Europe have the same quality as the contemporary best High-Speed Rail links. This reduces air travel by 48 billion passenger-kilometres, corresponding with 8% of total intra-European aviation. CO_2 is reduced by 7.4 Mt or 13%. Furthermore, it is assumed that the freed-up airport capacity will not be used for new flights. If short flights are replaced by long-haul, total aviation emissions might even go up.

Pricing

International aviation is currently hardly taxed. It is exempt from VAT and fuel taxes. The European Commission published an overview of existing aviation taxes. The 'expected pricing' policy assumes an average ticket tax of 5% and a price of 50 euro per tonne CO_2 for ETS-allowances purchased by airlines. The 'taxing' policy, as advocated by environmental NGO's, includes 25% VAT on tickets and 0.33 euro per litre fuel tax on fossil kerosene (corresponding with the minimum diesel tax in the EU). Fuel tax has a larger impact on CO_2 than VAT, because a fuel tax of 0.33 €/l improves the energy efficiency of aviation by an estimated 5%. VAT only increases the ticket price, and therefore has a stronger impact on travel volume.

No CO_2 flights <500 km

This policy ends all flights shorter than 500 km, except for carbon-free flights. This can be electric aircraft or using green kerosene in a conventional plane. In both cases the energy used needs to be entirely without emissions of CO_2. This policy gives a strong incentive to develop and deploy carbon-free aviation. The estimates in the table assume that half of the current flights below 500 km will be skipped, and the other half will be replaced by carbon-free flights. Next, it is assumed that the ticket price for carbon-free flying will initially double. The price increase in the table is the average of all intra-European flights. Finally, it is assumed that the freed-up airport capacity will not be used for new flights. If short flights are replaced by long-haul, total aviation emissions might even go up.

Blending sustainable fuels

It is technical feasible to blend sustainable fuels with fossil kerosene and to use this mix in a conventional aircraft. Big advantage is that no new planes and engines have to be developed and introduced in the fleet. This would last several decades. Sustainable aviation fuels can be bio or synthetic kerosene. Bio kerosene is produced from agricultural or other wastes. Because its limited supply, synthetic kerosene is needed as well. Synthetic kerosene can be 'blue' or 'green' and is produced from hydrogen. Blue kerosene is made from natural gas in combination with carbon capture and storage. Green kerosene is made from solar and wind power.

Sustainable aviation fuels are more expensive than fossil kerosene. Their future price levels are still uncertain. Bio and blue kerosene will probably cost the same, while green kerosene will be more expensive. Therefore, bio and blue are considered transition fuels, while green kerosene is the ultimate technology. The estimates in the table use a variety of price levels for sustainable fuels, reflecting the uncertainties. Different values for the remaining CO_2 emissions from sustainable fuels are also used.

The increased fuel price is an incentive for further improvements in the energy efficiency of aircraft and operations. This generates an additional reduction in emissions. To illustrate this with the policy '50% blending of green kerosene': the 69% reduction in CO_2 is partly caused by a 10% improvement in energy efficiency and a 18% reduction in travel volume. Blending mandates for sustainable aviation fuels are an effective lever to decarbonize aviation.

Non-CO_2 impact

The contribution from aviation to climate change is not limited to its CO_2 emissions. Climate relevant emissions include nitrogen oxides (NO_x), sulphur oxide (SO_2), water vapor (H_2O), aerosols, contrails and contrail cirrus. The total climate impact of aviation is estimated to be two to four times higher than the effect of CO_2 emissions alone. Contrails formed by high flying aircraft have roughly an equal impact on global warming as the emitted CO_2. Recent research indicates that the contribution of contrails can be reduced by 90% through a shift to cleaner engines and changes in the flying altitude of only 2% of the flights.

Technical assumptions

- Fuel costs as percentage of total operating costs: 25%
- Fuel price elasticity on energy consumption: - 0.3
- Fuel price elasticity on energy efficiency: - 0.1
- Ticket price elasticity on travel volume: - 0.8

These are estimates for average values. These parameters show a wide variety for specific routes, aircraft types and carriers.