Summary stakeholder statements of Expert and Science organizations, Industry, Governments and NGO's

Introduction

After compiling an extensive overview document on the sustainability developments in the aviation industry (the technical underlayer), we shared it with representatives of the main societal stakeholders ranging from industry, expert and science organizations, various NGO 's and EU government. We asked their perspective on:

Do we fly in 2040 and if yes under what premises and conditions?

Below we provide the outcome of the interviews and email communications. It provides a good insight in the technical, societal and political hurdles regarding the prospects foreseen and the solutions to realize a sustainable aviation industry.

Summary of CMG conclusions from technical underlaying 2022 report and interviews

- We will fly in 2040, but less in EU on the short and medium distances but the global south will fly more. Depending on local developments of population, wealth, SAF production and climate policy flying will become 2 to 3 times as expensive merely due to SAF fuel costs. Unless a progressive tax for frequent flyers is imposed in the transitional years, aviation will only be affordable for the richer part of society.
- The aviation industry has still the possibility to meet its net-zero CO_2 targets in 2050 provided flying/fuel cost will increase, effective SAF technology and infrastructure developments will be introduced and the phase out of fossil fuels is actively being pursued. For the global south, in particular the CO_2 crediting approach is seen as a means to contribute to the zero-emission policy.
- Although the global aviation industry has preset targets to meet the CO_2 net-zero targets in 2050, they appear to take insufficient measures and are not equipped to combat the accompanying other emissions such as NOx, naphthalene's, soot and particulates and water vapors related contrails.
- For travel journeys up to 1000 kilometers, trains are able to replace flying. To allow this option to flourish the limitations related to current railway transport systems (China, India) and the high costs related to the investment in new railway transport systems in EU and other populated area's need to be overcome.
- New aviation technologies will not grow as fast as foreseen, because of the scarcity/ huge demand for sustainable electricity. This green electricity required for green hydrogen but is competing with other hydrogen users in the chemical industry and mobility. Also, the high capital costs of H_2 fuel-cell technology needs to be overcome.
- Biobased SAF fuels are developed rapidly, but with limited sustainable production capacity. In certain biomass rich continents, it will remain/become an important fuel during the transitional years.
- Although H_2 as propellant in fuels cells is the least developed and confronted with high technical and economical hurdles, it is seen to be ultimately the most all-encompassing environmental aviation solution for climate and environment.
- The UN and global based IATA/CORSIA type of agreements are conditional for the global implementation of a real sustainable aviation industry.
- The value of air-travelling towards mankind's wellbeing, enriching it with new experiences, building trust in human relations , businesses, science and politics seems insufficiently qualified and quantified.

Concluding: cost and access to sustainable energy and access to proven (H2) conversion technologies will be mayor factors, limiting the short-term viability of a sustainable aviation industry. Non-CO_2 effects need to be included in the overall approach to come to a real sustainable approach for aviation as they comprise about 2/3 of the net radiative forcing. To overcome the transition in coming years we need to aim for a reduction in aviation possibly by taxing kerosine, more rigorously enforcing CO_2 reduction schemes, ensuring well certified CO_2 crediting schemes and progressively taxing the frequent flyer, until we have overcome the major hurdles.

Summaries of interviews

Karen Faber, Milieu defensie NGO
We hope that there will be less flying in the future. We don't think that using new aviation fuels will help, because they are too expensive and use a lot of scarce energy needed for more essential applications. We want to reduce not only CO_2 emissions, but also other problems like noise and bad air quality. Milieu Defensie would like the government to stop giving subsidies to airlines and airports, so they have to pay a fair price for being sustainable. The government should only invest in options that have no primary emissions, like trains that go really fast and connect all of Europe. We also think there should be an progressive frequent flyer tax on airplane tickets.

DEFIS-AZEA team, The EC European Directorate-General for Defense Industry and Space
We clearly see a role for aviation in 2040 and beyond. We believe that flying has its place in the future, as it brings multiple personal, societal and economic benefits.
Flying needs to become climate neutral and that can be realized with zero-emission flight technologies. Industry and national and European research programs are working hard on that. SAF's form part of the solution and have many advantages as drop-in fuels, they require no or little change to airport infrastructures and to the aircraft themselves. The big challenges for SAF's is to have it produced in the necessary volumes. (ref cost and access to sustainable energy sources)

Paul Peeters, lector Sustainable Tourism & Transport Breda University of Applied Sciences.
If we are careful about how much we fly, we can still go on long trips by airplane, but it will cost more and we won't fly as often. A lot airflight and CO_2 reducing scenarios were modeled to see if we can stop making CO_2 when we fly, but none of them worked well enough to reach our goal by 2050. The government can help by making rules about the fuel use and by charging a CO_2 tax. The government can also encourage people to go on vacations closer to home. But even with these rules, we might still emit too much CO_2 because more people are flying in countries that are starting to get richer.

Bram Peerlings en Elisabeth van der Sman, NLR
The text outlines measures planned to make aviation more sustainable.

- Improvements in airplane operation can help in the short term, but won't have a big impact on the ultimate goal.
- Better engine and aircraft technology will help more, but hydrogen-powered planes won't be available for a while.
- Sustainable fuels like biofuel and synthetic kerosene will become more important after 2030, but they're more expensive than regular kerosene. Tickets will get more expensive and fewer people will fly, as airlines are not be able to internalize these costs in a global competitive market
- Economic measures like the EU ETS will help less over time, but we still need some "negative emissions" to reach zero CO_2 in 2050.

There will be a serious competition for:

a) green hydrogen by hydrogen-powered aircraft or as a raw material for synthetic SAF, especially now that a blending obligation with synthetic SAF has been proposed (Refuel EU Aviation)
b) renewable energy for the production of synthetic fuels.

The sustainability criteria are well defined within the EU regulations. Standards elsewhere are insufficiently developed to ensure a global sustainable approach.

Arvind Gangioli Rao Professor TU delft
In 2040, people will fly if they can afford it, as values and reasons remain existing across cultures. Those who earn over €100 per day are likely to continue flying. However, many people cannot afford to fly yet, and some don't have passports, particularly in China (10%) and India (6%) where passport ownership is low. But this is expected to change and lead to growth in the future.

Europe is in a good position to lead the aviation sustainability pathway; this is a moral responsibility and economic opportunity. USA will also invest in it with the inflation reduction act. Europe: Biobased, synthetic and hydrogen. Airbus and Boing are making new technology aviation planes also for other continents.

As far as propulsion options for the future will see further diversification. We will keep kerosene, some electric airplanes, sometimes hydrogen, biofuels or synthetic fuels. The diversity of technologies will not be uniform in

the world among India, Brazil (more biofuel), Middle East (more kerosene and synthetic kerosene). Trains are an alternative in Europe, but it is rather an exception in the world. Trains in India already run on maximum capacity. We tend to think in too binary and should look more for the spectrum of measures.

Sustainable fuels will never be available in sufficient quantities. As we transition to low-emission energy, we will have to make difficult choices. The future of aviation will be determined by cost and economics, as well as societal attitudes towards change. Programs that encourage flying, such as incentives to maintain frequent flyer status, should be discontinued.

Synthetic fuels made from CO_2 are energy intensive, but we are improving processes like Direct Air Capture and Fischer-Tropsch to create fuels in areas where energy is not a limiting factor. In Europe, only 25% of electricity is renewable, so there are limitations, but the Sahara has abundant solar energy, making capital costs more important than efficiency. Lastly, CO_2 is only part of the problem, water vapor, sooth, NOx, unburnt hydrocarbons also require attention.

Tom Berg. SKY Energy
The importance of flying is overlooked, as it connects people, promotes cross-cultural understanding, and facilitates aid and development. Climate activists do not fully consider the social dimension of flying in their approach. Flying plays a significant role in reducing polarization between people.

Taxes can help to reduce CO_2 emissions of flying. A flat tax will cause social unrest, but introducing a frequent flyer tax will create more support. This way you will keep it accessible to poor people. The revenue can be invested in sustainable aviation, but privacy issues need to be addressed.

New energy-intensive solutions such as Synfuels must go hand in hand with investments in sustainable energy and/or hydrogen supply. The gigantic demand (500 TW) lead to new imported sustainable energy dependencies from Africa and the Middle East, which we can steer. The biobased route to SAFs via gasification or Alcohol2Jet and others is inherently limited by availability of sustainable biobased feedstocks.

Regarding governance, the EU is ambitious. The UN is slow by lagging members such as India and China. IATA, the industry organization of airlines, has a net-zero target. During the World Economic Forum they pledged for 30% SAF in 2030, but there is no enforcement for non compliance.

More attention should be paid to the non-CO_2 environmental effects that make up 2/3 of the total. The solution is multi-fold, starting with flying less, flying more efficiently, flying lower taking into account supersaturation and flying more sustainably. It is important to make binding agreements and introduce a CO_2 tax and a CO_2 budget to reduce fossil fuel demand.

On the global front, EU/US are front-runners Brazil, Japan, Canada are now also participating, but China and India are lagging behind and potentially account for a 2/3-fold of air traffic emissions. It is conditional that these countries commit themselves explicitly to the new goals.

The “Duurzame Luchtvaart Tafel” is potentially an important Dutch consultation body in which NGOs, governments, knowledge organizations and youth organizations share their vision, the objective is clear and **will lead to other ways of flying, including electric, less flying and other fuels, in the hope that this will eventually lead to will lead to aviation transition that is fair and just to all.**

Maurice van Uden, Schiphol watch/ Stay grounded organization
Whether it is environmentally and economical feasible and acceptable to fly in 2040 is debatable as the current proposed measures and alternative fuels are not adequate.

Efficiency improvements and cost reduction has lead to more flying and not a decrease in CO_2 emissions. To reduce the CO2 burden of flying, flight activities should be reduced. Electrical flying is only suitable for short distances, and the environmental impact of its batteries is significant. Certification remains an issue, and electrification only contributes to CO_2 reduction when the electric energy supply is 100% sustainable.

Hydrogen is currently only viable for short haul flights and is not a solution for long haul flights due to the need for huge amounts of sustainable energy and negative effects of H_2O vapor and contrails. E-fuels and biofuels

also require significant sustainable energy investments and have their own limitations. Therefore, reduction in flying is the most realistic and effective way to reduce CO_2 emissions. Net zero claims and initiatives are unproven to contribute significantly, as they are a too slow means to reduce CO_2 emissions and non-CO_2 emission effects are being ignored.

Louis Aartman, Lucht en Ruimtevaart.nl

Aviation has become an essential means of transportation over the last 100 years, but it is becoming increasingly clear that current methods are unsustainable. However, sustainable aviation is still a long-term goal, and L&R.NL is committed to developing innovations with industry, knowledge institutions, and governments to ensure long-term earning capacity with flying. The energy carrier options for aviation currently include battery electric propulsion for small airplanes and short distances, sustainable aviation fuels (SAF), and hydrogen. Battery electric propulsion is suitable for small airplanes for short distances. It is not a serious contender for large commercial aviation due to weight problems with on-board batteries.

SAF, which includes biofuels and synthetic e-fuels, faces challenges with feedstock and cost. The E-fuels require hydrogen, making the fuel more expensive than the hydrogen itself. Hydrogen is a carbon-free energy carrier that produces no CO_2 when burned or processed into electricity in a fuel cell. The advantage is that the current fleet can be maintained and the adjustments to the ground infrastructure can be overseen. This trajectory is planned for the medium term for all aircraft, and for the long term for very large long-haul aircraft. Boeing seems to be focusing primarily on SAF for the time being.

Regarding utilizing hydrogen directly, Airbus and Embraer are working on developing the propulsion technology required for these aircraft, but adjustments to devices and ground infrastructure are needed. A Dutch National Growth Fund (NGF) project called “Aviation in Transition” (Luchtvaart in Transitie) is examining the use of hydrogen through technology development and the creation of a number of demonstrators, looking at both direct combustion and fuel cell conversion to electric propulsion.

However, the processing of hydrogen leads to water vapor, a greenhouse gas, and the non-CO_2 effects of the combustion of kerosene on the climate are at least as great as those of CO_2 itself. It is still uncertain whether hydrogen can significantly reduce the climate impact of aviation, and guaranteeing the safety of cryogenic hydrogen storage and use on board remains complex. McKinsey recently prepared a report on this issue for Clean Aviation, providing a basis for the choices made so far with regard to climate impact.

Average values	CO_2	NO_x	Water vapor	Contrails	Total
Kerosene	100%	100%	10%	100%	**310%**
Synfuel	0%	100%	10%	75%	**185%**
H_2 turbine	0%	35%	25%	60%	**120%**
H_2 fuel cell	0%	0%	25%	30%	**55%**

Hydrogen-powered aviation | A fact-based study of hydrogen technology, economics, and climate impact by 2050