Developing the offering of Sustainable Aviation Fuel

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Abstract

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This study assesses the customer interest of SAF delivered to the correct airplane claiming the emission reductions. The study is conducted both from customer and supplier points of view. Customer point of view consists of a study to the private customers and semi structured interviews to airlines and some chosen business customers.

Aviation as an industry is responsible for about 1.9% of global carbon dioxide emissions due to the fossil fuels burned in airplanes. Tackling climate change and limiting global warming needs new solutions and new technologies. Sustainably Aviation Fuel (SAF) is a drop in -solution that will cut the CO2 emissions of flying in the future. On a single flight compared to conventional fossil JET fuel it can generate up to 80% less greenhouse gas emissions. After the Covid-19 short term drastic impacts, the airline industry is estimated to grow significantly during the next decades. Estimates vary, but 3 - 5% growth a year is a common figure. From emissions point of view this creates challenge where demand for flying is growing, but at the same time the emissions should be cut.

Currently only a few different operating models are used in producing and distributing aviation fuel. Basic JET -fuel is produced at a refinery, followed by the addition of required additives and the product batch is officially manufactured and certified. From the certification and blending facility - typically a terminal - the fuel is deliver to the airport storage tanks, from which it is then delivered to the airplanes by using in to plane trucks or fuel hydrant.

The survey results were encouraging. Respondents acknowledge the need to cut the emissions and they are hoping airlines will use more SAF. Respondents also accept the resulting increased price of flying and are willing to pay– however, a very small number of respondents have yet compensated the emissions of their flying, despite the options given to do so. Conclusion of the study is that the problem is generally recognized but there are still barriers preventing actions. Cost of SAF is the biggest barrier, as well as the non-transparent process and fear of greenwashing. Business organizations have developed different kinds of emission gapping services but naturally there is a need for the customers and consumers to be willing to pay for those. The services are still somewhat hard to understand, and when customer has the opportunity to choose, as long as no mandatory policies in place, the money is quite a strong driver, specially with older age groups.

Keywords
Aviation, SAF, emissions, businessmodels

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1 Introduction

The global emissions gap is growing. The 1.5-degree goal is gasping for breath. National climate plans are falling woefully short. And yet, we are not retreating. We are fighting back.

United Nations, Secretary General António Guterres 19.12.2022 (UN, 2022)

Climate change refers to long-term shifts in temperatures and weather patterns. These shifts may be natural, such as through variations in the solar cycle. But since the 1800s, human activities have been the main driver of climate change primarily due to burning fossil fuels like coal, oil and gas. (UN, 2022)

Burned oil generates carbon dioxide and other greenhouse gasses that accelerate global warming. Aviation as an industry is responsible for about 1.9% of global carbon dioxide emissions due to the fossil fuels burned in airplanes. Yearly more than 20 million international or domestic flights take place. People fly for several important reasons, business, holiday or to visit family. Airplanes are the fastest and many times the most convenient way to travel long distances.

Tackling climate change and limiting global warming needs new solutions and new technologies. Sustainably Aviation Fuel (SAF) is a drop in -solution that will cut the CO2 emissions of flying in the future. On a single flight compared to conventional fossil JET fuel it can generate up to 80% less greenhouse gas emissions. Together with the ramp up of the SAF production the business models are evolving with high speed, and they require development to reach the emission reduction target set by the industry.

1.1 Aims and research questions

Aim of this thesis is to develop SAF offerings at Helsinki-Vantaa airport and develop business models related to it. As is, the whole market follows the book and claim system, where molecules of sold SAF cannot be distributed to the actual plane that claims the emission reductions. In book and claim distribution the physical flow of the product is separated from the claimed emission reductions.

This study assesses the customer interest of SAF delivered to the correct airplane claiming the emission reductions. The study is conducted both from customer and supplier points of view. Customer point of view consists of a study to the private customers and semi structured interviews to airlines and some chosen business customers. This thesis can be used as a pre-study material when assessing a possible business case of delivering SAF to the airplanes linked to the claimed emission reductions.

To reach the aims of this thesis, two main research questions were formed, with a few supporting questions to lead into the topic and gain understanding from the customer perspective. Similar questions were used in quantitative research for private customers as well as in qualitative semi structured interviews with the chosen business customers.

Q1 “How important for SAF usage is to have the actual SAF molecule in the plane that the emission reduction is applied?”

Q2 “What is the value of being able to deliver the SAF molecule to the actual plane instead of mass balance?”

1.2 Limitations

This thesis is researching the difference between two business models related to SAF: The mass balance / book and claim (how the market works now) and the physical delivery of SAF into the wing tip of the actual plane that is claiming the emission reductions. All thought the customer survey is done in Finland and the interviewed companies mainly operate at Helsinki-Vantaa airport, the same concepts are applicable in other airports as well. Thesis is not covering the challenges of the production, feedstock, supply chain, logistics or segregated airport fuel infrastructure of SAF. Which all are important and crucial parts of the end-to-end delivery model. Also, the business case opportunities, calculations, investments and estimations are not in the scope of this thesis.

1.3 Definitions

ASTM - American Society for Testing and Materials

ASTM International is standardization organization with over 12.000 international standards. ASTM D7566-21 (Standard Specification for Aviation Turbine Fuel Containing Synthesized Hydrocarbons) is the main standard for SAF conversion process approvals (ASTM 2023).

SAF – Sustainable Aviation Fuel

SAF is a commonly used acronym for Sustainable Aviation fuel. Air BP defines it as being “produced from sustainable feedstocks and is very similar in its chemistry to traditional fossil jet fuel”. (Air BP, What is SAF, 2022). IATA (International Air Transport Association) defines it similarly stating: “Sustainable aviation fuel (SAF) is the main term used by the aviation industry to describe a nonconventional (fossil derived) aviation fuel” (IATA, What is SAF, 2022).

SBTI-Targets

The SBTi defines and promotes best practice in science-based target setting. Offering a range of target-setting resources and guidance, the SBTi independently assesses and approves companies' targets in line with its strict criteria (SBTI 2023).

JIG – Joint inspection group

JIG is the world-leading organization for the development of aviation fuel supply standards covering the entire supply chain for Aviation Fuels from refinery to wingtip. Its Standards are followed by over 100-member organizations globally, operating at more than 2.750 airports and supply & distribution locations in over 100 countries (JIG 2023)

CO_2 – Carbon dioxide

Carbon dioxide (CO_2) is a greenhouse gas emitted from burning fossil fuels (such as coal, oil, and natural gas), wildfires, and natural processes like volcanic eruptions. CO_2 accelerates the global warming.

IATA – International Air Transport Association

The International Air Transport Association is the trade association for the world's airlines, representing about 300 airlines in 120 countries, thus covering about 83% of total air traffic (IATA 2023)

IEA – International Energy Association

IEA is an association formed by OECD countries to shape energy policies for a secure and sustainable future. The IEA has 31 member countries, 11 association countries, and 4 accession countries (IEA 2023)

ICAO – International Civil Aviation Organization

ICAO is a special organization under the United Nations. Its purpose is to develop aviation principles and techniques as well as promote international aviation traffic planning and development. ICAO has 193 member countries (ICAO 2023)

ACI - Airports Council International

ACI represents the collective interests of airports around the world to promote excellence in the aviation industry. ACI has 717 members in 185 countries and 1950 airports (ACI 2023)

Book and claim

Book and claim is a system according to which the SAF distribution works today. This means that the physical flow of product is separated from the sustainability claims. Thus, a plane claiming emission reductions may not actually be fuelled by SAF.

2 Decarbonizing aviation

As said in the introduction, the global warming is a causing pressure to gap the emissions in all sectors of life. Our World in Date presents the global emissions sector by sector from 2020:

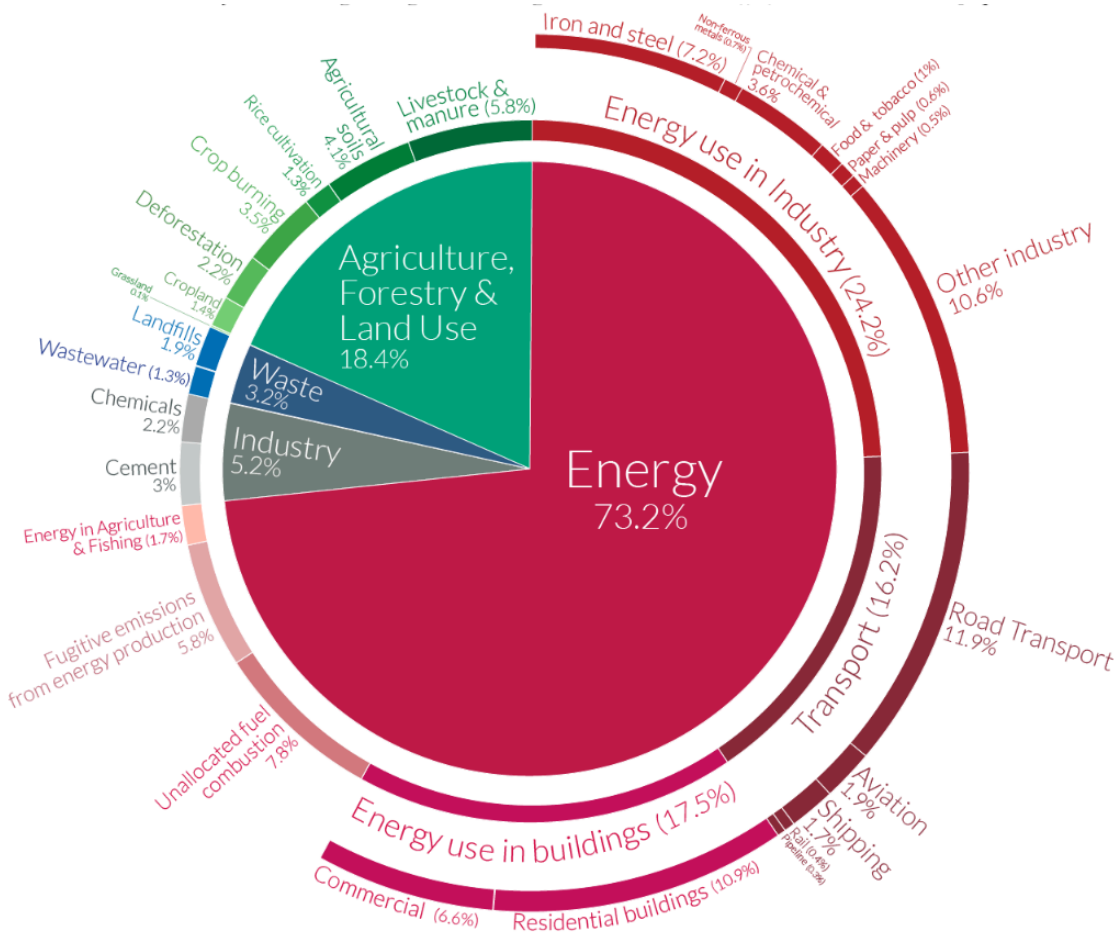


Figure 1, Global emissions (Our World in Data 2020)

From this breakdown can be seen that a many of sectors and processes contribute to global emissions. This means there is no single or simple solution to tackle climate change.

Even within the energy sector, which dominates the graph and accounts for almost three-quarters of emissions – there is no silver bullet to fix it all. For example, if we could fully decarbonize our electricity supply, we would also need to electrify our heating and road transport fully. And we'd still have emissions from shipping and aviation. For us to reach net-zero emissions we need innovations across many sectors. Single solutions will not get us there.

Transport in total is responsible of 16.2% of global greenhouse gas emissions and that is dominated by the road transport (11.9%) and followed by aviation (1,9%), ship (1,7%), rail (0,4%) and pipeline (0.3%). 81% of aviation emissions come from passenger travel and 19% from freight.

In passenger travel 60% of emissions come from international travel, and 40% from domestic. (OurWorldInData, 2022)

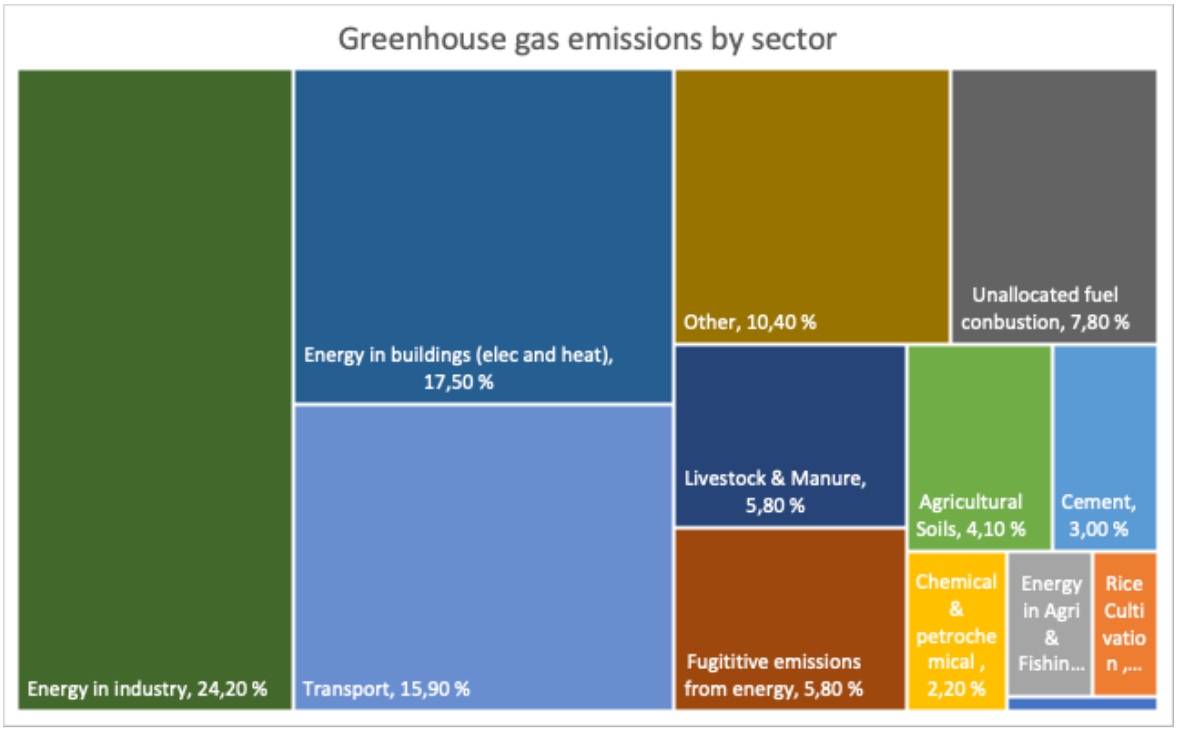


Figure 1, Greenhouse gas emissions by sector Transport in total is responsible of 15.9% of global greenhouse gas emissions and that is dominated by the road transport (11.9%) and followed by aviation (1,9%), ship (1,7%) and rail (0,4%)

At the 77th IATA (International Air Transport Association) Annual General Meeting in Boston 2021, a resolution was passed by IATA member airlines committing them to achieving net zero carbon emissions from their operations by 2050. (IATA, 2021). After a drastic drop in the emissions due to Covid-19, IEA estimates the emissions to keep increasing in coming years.

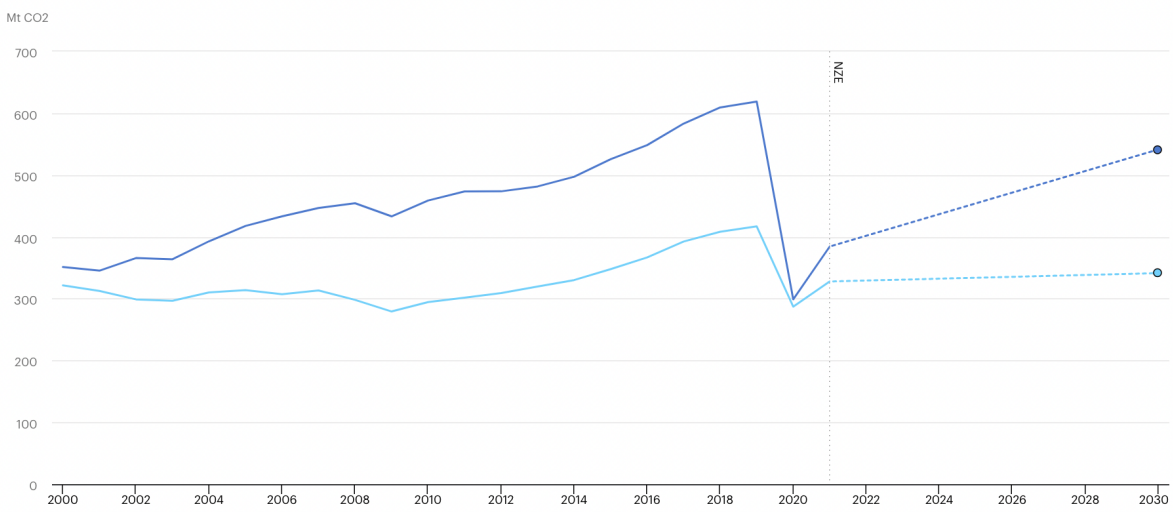


Figure 2, estimation of direct CO2 emissions from aviation in the Net Zero Scenario 2000-2030. (IEA, 2022)

Sustainable Aviation Fuel is considered as one major tool for decarbonizing aviation. Assessments vary, but to reach the IATA target of net zero emissions by 2050, a big increase of SAF usage is needed. IATA estimates it to cover 60% of emission reductions to reach the net zero target by 2050.

2.1 Jet fuel demand and outlooks

After the Covid-19 short term drastic impacts, the airline industry is estimated to grow significantly during the next decades. Estimates vary, but 3 - 5% growth a year is a common figure. Global growth is driven mainly by economic growth and growing middle class particularly in Asia. IATA estimates that pre-Covid-19 levels will be reached during 2024 and with yearly growth rate of 3.3%,

the passenger journeys will rise to 7.8 billion per year by 2040.

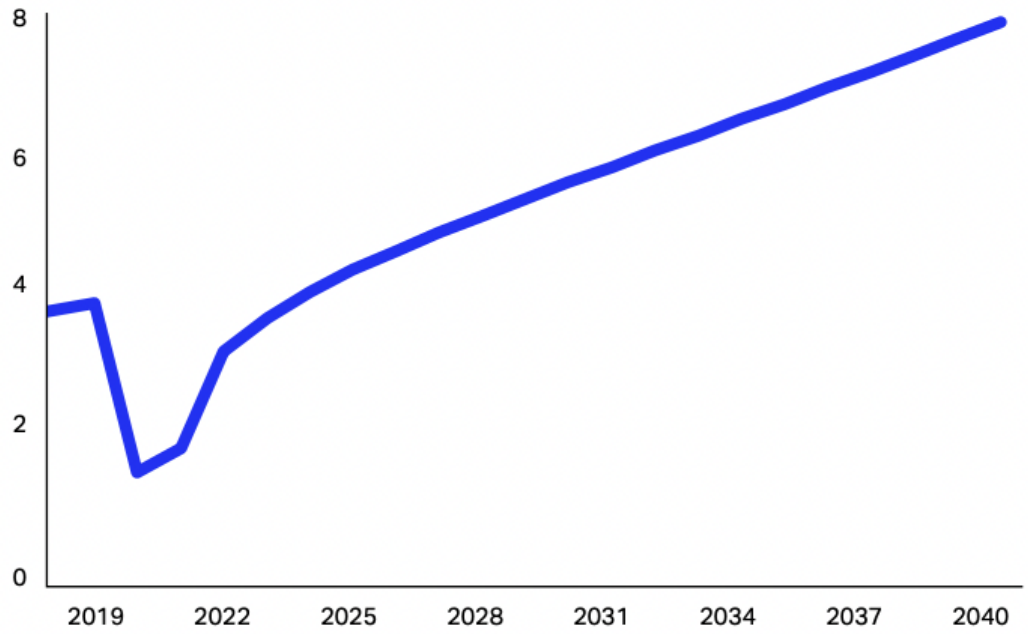


Figure 3, Global passenger journeys estimation. IATA, Global Outlook for Air Transport 2022 (IATA 2022)

IATA (2022) also estimates that the revenues will catch up pre-covid forecast in 2030-2035, so the covid impact remains only short and midterm. ICAO updated the yearly growth rates in their traffic forecasts after covid from yearly 4,2% downwards as low as 1,2% in the lowest scenario.

Table 1, ICAO estimation of traffic forecasts in different scenarios. (ICAO 2022)

	10 Year (2018-2028)	20 Year (2018-2038)	30 Year (2018-2048	32 Year (2018-2050)
Post-Covid LOW	1,2 %	2,4 %	2,8 %	2,9 %
Post-Covid MID	2,6 %	3,3 %	3,5 %	3,6 %
Post-Covid HIGH	3,6 %	4,2 %	4,2 %	4,2 %
Pre-Covid MID	4,2 %	4,2 %	4,2 %	4,2 %

From emissions point of view this creates challenge where demand for flying is growing, but at the same time the emissions should be cut. Sustainable aviation fuel is the single most important way of reducing emissions of flying. IATA (2022) estimates SAF being the single most impactful tool to cut the emissions in order to reach the net zero target by 2050. Achieving net zero by 2050 will require a combination of maximum elimination of emissions at the source, offsetting and carbon capture technologies. IATA estimates the SAF covering 65% of the emission reductions. Rest of the 35% is to be done by offsets and carbon capture (19%), new technology, electric and hydrogen (13%) and by developing infrastructure and operational efficiencies (3%)

2.2 SAF production

Even though for the most parts SAF is a drop in solution which means it is ready for use and not requiring any updates to be done for aircrafts, enabling emission cuts via SAF is somewhat time-consuming. SAF production is not yet on a sufficient level required for significant emission reductions, nor are there rules or regulations in place to ensure fair competition. New logistics chains will require building and - not insignificantly - customers need to be persuaded to become willing to pay for the unavoidable price increases. Also, aviation is a heavily regulated area of business due to its safety critical nature, thus in order to fly with new fuels, the producers must ensure that those fuels are approved by industry standards.

2.3 International jet fuel standardizations

The JIG (Joint Inspection Group) Standards have been developed by JIG Members and endorsed by IATA. They define internationally accepted minimum standards for aviation fuel product quality control, for the safe and reliable handling of aviation fuel throughout the supply chain and for aircraft refueling operations. (JIG, Aviation Fuel quality controls and operating standards for airport depots and hydrants, 2021)

The JIG Standards comprise the following documents:

- JIG 1 - Aviation Fuel Quality Control and Operating Standards for Into-plane Fueling Services.

- JIG 2 - Aviation Fuel Quality Control and Operating Standards for Airport Depots and Hydrants.

- JIG 4 - Aviation Fuel Quality Control and Operating Standards for Smaller Airports.

- EI/JIG Standard 1530 — Quality assurance requirements for the manufacture, storage and distribution of aviation fuel to airports.

- JIG Health, Safety, Security and Environmental Management System Standard (HSSE MS) - for Aviation Fuel Facilities.

ASTM International (American Society for Testing and Materials) is another well-known and appreciated body for aerospace standardizations. Their ASTM D7566-21 (Standard Specification for Aviation Turbine Fuel Containing Synthesized Hydrocarbons) has approved different conversion process to produce sustainable aviation fuels from 2009 onwards.

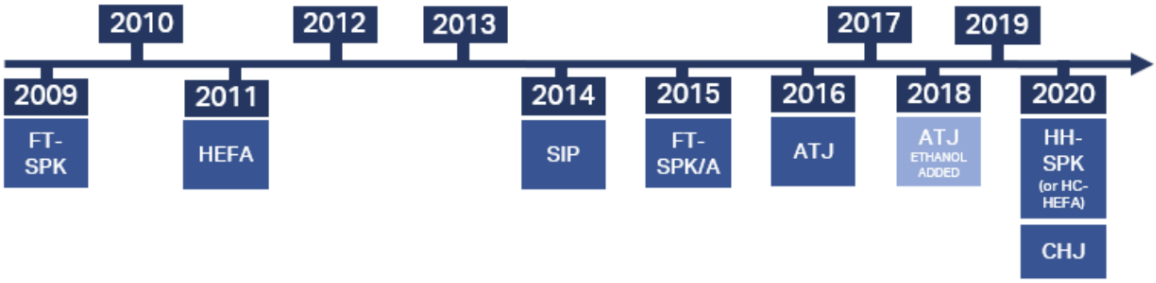


Figure 4, ASTM D7566-21 approvals for different SAF conversion processes. (IATA 2022)

2.4 Production of Sustainable Aviation Fuel

Sustainable Aviation Fuel (SAF) is a general term for aviation fuel produced from sustainable feedstocks with different technology processes. All have different emission cut rates and conversion processes as well as feedstock sources. Today there are nine different standardized processes to produce certified SAF (ICAO, 2022)

Table 2, Conversion processes for SAF (ICAO, 2022)

Conversion process (abbreviation)	Possible Feedstocks	Blending ratio by volume	Commercialization proposals / Projects
Fischer-Tropsch hydroprocessed synthesized paraffinic kerosene (FT)	Coal, natural gas, biomass	50%	Fulcrum Bioenergy, Red Rock Biofuels, SG Preston, Kaidi, Sasol, Shell, Syntroleum
Synthesized paraffinic kerosene from hydroprocessed esters and fatty acids (HEFA)	Bio-oils, animal fat, recycled oils	50 %	World Energy, Honeywell UOP, Neste, Dynamic Fuels, EERC
Synthesized iso-paraffins from hydroprocessed fermented sugars (SIP)	Biomass used for sugar production	10%	Amyris, Total
Synthesized kerosene with aromatics derived by alkylation of light aromatics from non-petroleum sources (FT-SKA)	Coal, natural gas, biomass	50%	Sasol
Alcohol to jet synthetic paraffinic kerosene (ATJ-SPK)	Biomass from ethanol or isobutanol production	50%	Gevo, Cobalt, Honeywell UOP, Lanzatech, Swedish Biofuels, Byogy
Catalytic hydrothermolysis jet fuel (CHJ)	Triglycerides such as soybean oil, jatropha oil, camelina oil, carinata oil, and tung oil	50 %	Applied Research Associates (ARA)
Synthesized paraffinic kerosene from hydrocarbon-hydroprocessed esters and fatty acids (HC-HEFA-SPK)	Algae	10%	IHI Corporation
co-hydroprocessing of esters and fatty acids in a conventional petroleum refinery (co-processed HEFA)	Fats, oils, and greases (FOG) co-processed with petroleum	5%	
co-hydroprocessing of Fischer-Tropsch hydrocarbons in a conventional petroleum refinert (co-processed FT)	Fischer-Tropsch hydrocarbons co-processed with petroleum	5%	Fulcrum

ICAO (International Civil Aviation Organizations) follows up the development of SAF globally. In October 2022 ICAO (ICAO, 2022) recognizes there to be:

- 57 airports distributing SAF.
- 24 policies adopted or under development.
- 34,9 billion liters of SAF under offtake agreements.
- 9 conversion processes certified for aviation.
- >440k commercial flights flown by utilizing SAF.

International Energy Association holds a list of SAF related activities. List is growing rapidly and almost every day we can see some press releases about either airline starting to use SAF or production to be scaled up.

Table 3, Chosen SAF related initiatives (IEA 2022).

Role	Company or initiative	SAF usage/ production target	Target year
Aviation general	Clean Skies for Tomorrow	10%	2030
Logistics			
	FedEx Corp	30%	2030
	Deutsche Post DHL Group	30%	2030
	Amazon Air	5%	2030
Airlines			
	Alaska Air Group, Delta Air Lines, Finnair, International Airlines Group, JetBlue Airways, Malaysia Airlines, Qantas Airways, Royal Air Maroc, Sri Lankan Airlines	10%	2030
	Norwegian Air Shuttle	16-28%	2030
	Scandinavian Airlines System	17%	2030
	Ryanair	12.5%	2030
	Lufthansa Group	5-10%	2030
Fuel providers			
	Neste	1.5 Mt	2023
	Shell	2 Mt	2025
	OMV	0.7 Mt	2030
	Eni	0.5 Mt	2030

SAF is already produced around the world. ICAO holds a map of different facilities and conversion processes that are up and running or in planning or construction phase. Not all the plans will materialize and there is still a big gap between the production, plans and the expected demand. From this map can be easily visualized hot the production is focused to Europe, North America and South-east Asia.

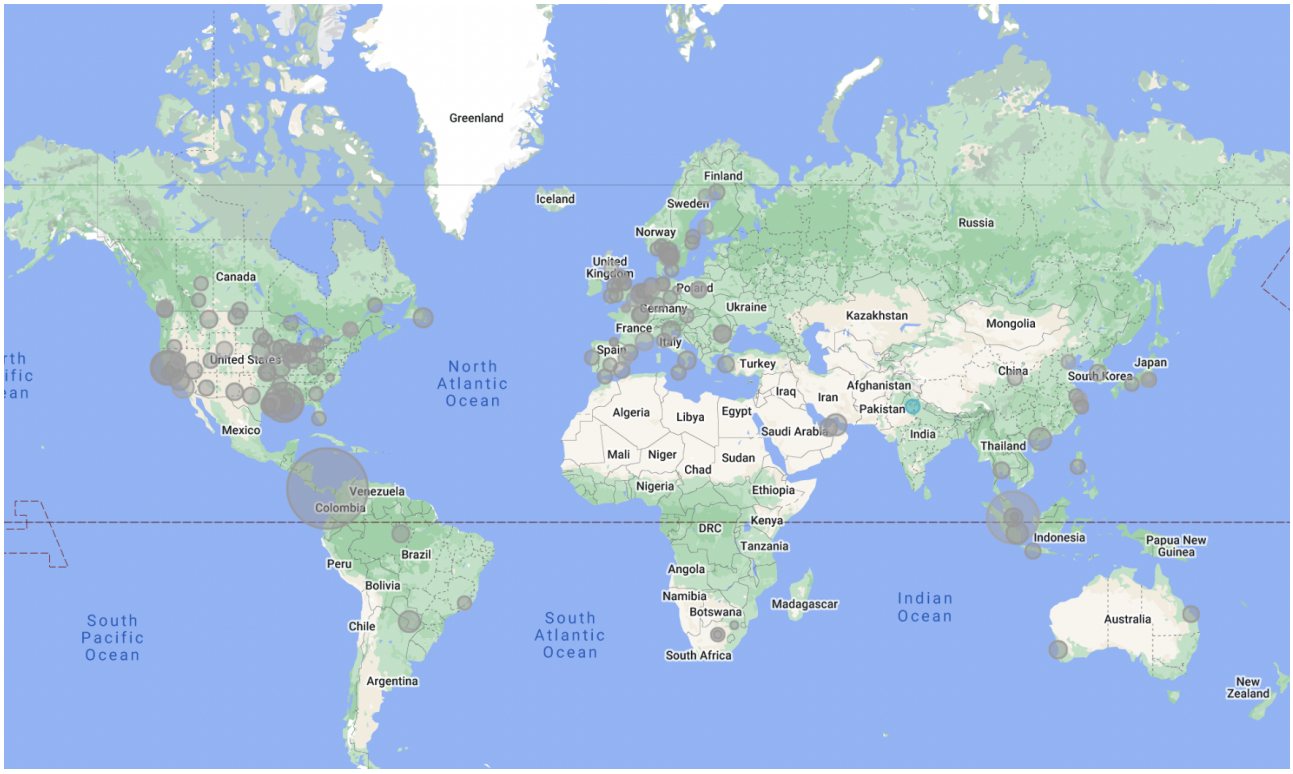
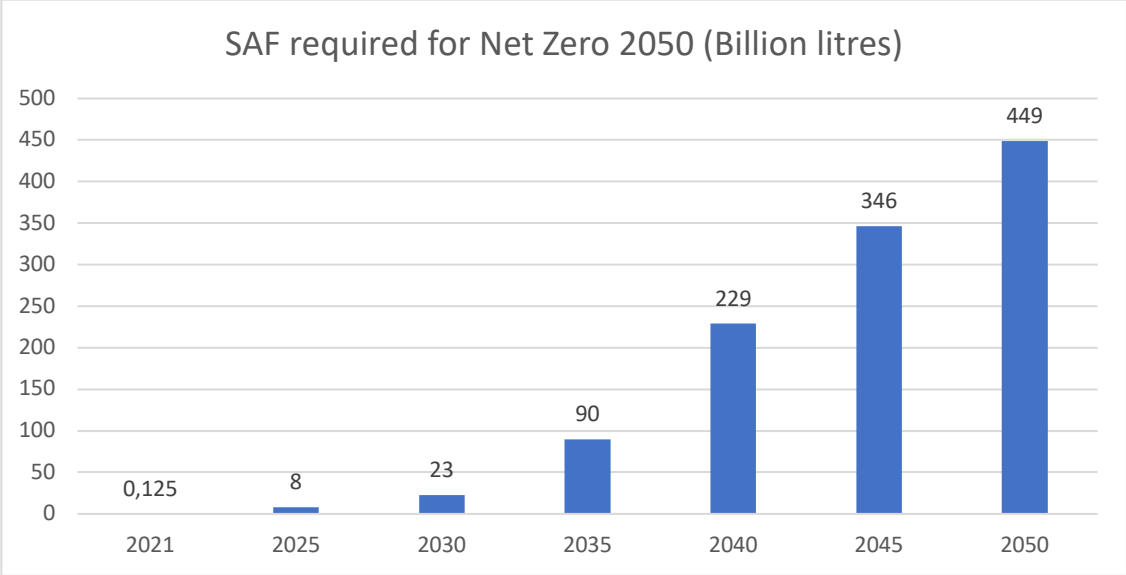


Figure 5, SAF panned and in operation production sites globally (ICAO 2022).

IATA estimates that in order to meet the NetZero 2050 targets, the global SAF-production should ramp up from current 125 million liters up to 449 billion liters by 2050. This ramp up is substantial, henceforth requiring significant investments of time and resources from a number of stakeholders such as policymakers, airlines, fuel providers and customers.

Table 4, SAF production required for Net Zero 2050 (IATA 2022).



To put this in perspective Neste produces c. 100,000 tons of SAF and production will increase to 1.5 million tons (around 1.875 billion liters) annually by the end of 2023 (Neste, 2022)

Population of the world is growing and getting wealthier – more and more people in the developing countries are able and willing to fly in the future for several purposes. This is driving the growth of the aviation in the future. Same time we are in the situation where the emission are accelerating the global warming and those must be cut, in order to meet or even get close to the set targets. This mismatch generates a challenge for the aviation industry, where the demand is growing but the emissions must be decreasing. Solutions are available, but of course they are not easy to implement in world scale, they are expensive and no silver bullet is available. Green transition is a term that refers to lowering and getting rid of the dependence of the fossil fuels generating CO2-emissions. Effective green transition requires effective business models, political ambition and at the end of the day support from the private customers. As aviation industry is heavily regulated there it generates a positive opportunity to regulate also the fuels for example via blending mandates. Challenge is that the regulation must be equal to all operators globally to ensure fair competition between the airlines, fuel companies and other stakeholders in the whole value chain.

3 Theoretical framework

Business model can be defined as the way in which a company creates, delivers, and captures value. It outlines the key components of a company's operations, including its target customers, revenue streams, and cost structure (Johnson, Christensen and Kagermann, 2008). Munna (2021) presents other different definitions to economic business models such as one from Allan Afuah: “Business model can also be seen as a framework for making money. It is the set of activities which a firm performs, how it performs them and when it performs them so to offer its customers benefits, they want and to earn a profit”. And one from Thomas Wheelen and David Hunger; “Business model is a method for making money in the concrete business environment. It is consisted of key structural and operational characteristics of company – how company earn and create profit”

Hokkanen (Hokkanen, Walker and Donelly, 2020) refers to Bertolini when assessing the drivers to modify business models. When evaluating business model relevancy, one should consider competitors’ models, sources of appropriation, external threats, and sustainability of the business. Hokkanen also refers to Sorescu et al. how they defined six drivers related to capturing and creating value that motivate, incentivize, or force retailers to consider business model reconfiguration. First, they highlight opportunities to gain operational efficiency, this includes efforts to streamline back-end operations (e.g. sourcing, inventory levels), enhance the store environment (e.g. seeking cost reductions and increased profits in-store), and make cost savings (e.g. automation, process digitization). Second, opportunities to gain operational effectiveness, such as finding ways to maximize probabilities in meeting organizational objectives (e.g. investments enabling longer-term profit, or market expansion). Third, opportunities to design lock-in themes, which involve the development of mechanisms that minimize customer costs and increase switching costs (e.g. memberships, subscriptions, or guarantees).

3.1 Business model of aviation fuel

Currently only a few different operating models are used in producing and distributing aviation fuel. Basic JET -fuel is produced at a refinery, followed by the addition of required additives and the product batch is officially manufactured and certified. From the certification and blending facility - typically a terminal - the fuel is delivered to the airport storage tanks, from which it is then delivered to the airplanes by using in to plane trucks or fuel hydrant.

SAF business model typically follows the book and claim pattern / operating model, where the physical flow of products is separated from the sustainability claims / emission reductions done by the company. This operating model is in common use in the electricity markets - while a customer

has the option of switching to green energy today, this is merely a theoretical switch, and the electricity provided from their plugs is still sourced the same way as yesterday. Customer can switch to green electricity today, but in fact the electricity coming out of the plug is same electricity as yesterday.

As an example, Airports Council International presents the process from Zurich airport that as follows:

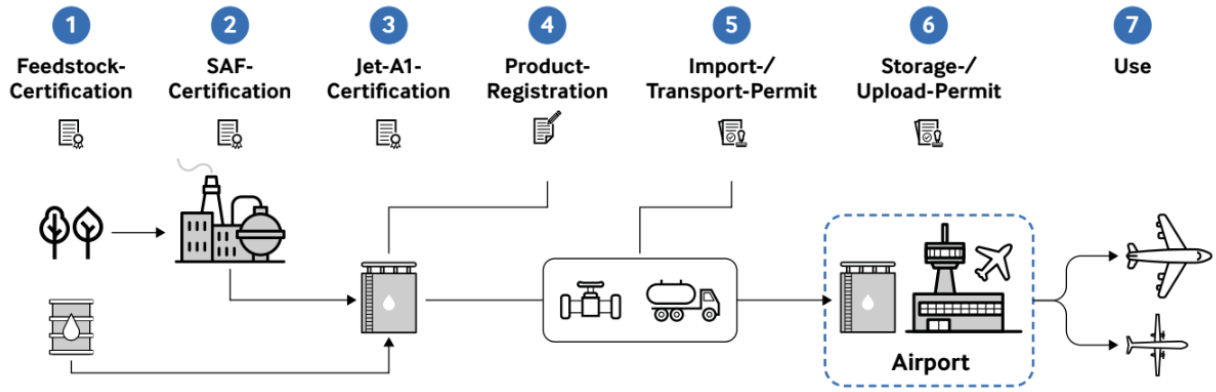


Figure 6, Supply chain of sustainable aviation fuel (ACI 2022).

As can be seen from the picture in phase 3 the fossil and sustainable raw materials are combined, and thus in practice, the SAF molecules are delivered evenly to all customers. To be able to distribute different products to the end customers, segregated supply chains would be required from the certification throughout to the into plane fueling.

3.2 Aviation fuel market segments

The Aviation fuel market works mainly in business to business (B2B) mode, as no individual consumer buys the fuel directly from the distributor. However, the business to consumer (B2C) segment is valid in this study, as the consumers are important stakeholder in the whole chain and setting the expectations for airlines and also carrying the cost escalation of more expensive fuel.

B2B refers to transactions or interactions between two or more businesses, as opposed to transactions between businesses and individual consumers. In a B2B setting, the focus is on meeting the needs of other businesses by providing products or services that support their operations or help them achieve their goals. (Kotler and Armstrong, 2005)

B2B transactions often involve larger quantities of goods or services than B2C transactions, and the customers are typically other businesses, government agencies or institutions, rather than individual consumers. B2B companies can be manufacturers, suppliers, distributors, or service

providers that work together to create a product or service that is then sold to other businesses. B2B transactions can be complex and involve multiple stakeholders and decision-makers within each company. As a result, B2B sales often require longer sales cycles, larger sales teams, and more complex pricing structures. B2B relationships tend to be longer-term and more strategic than B2C relationships, with an emphasis on building partnerships and mutually beneficial arrangements. (Chen 2022)

Business-to-consumer (B2C) refers to the exchange of goods, services, or information between a business and individual consumers who are the end-users of the products or services offered. In B2C transactions, businesses typically target consumers through advertising and marketing efforts, and consumers make their purchases based on their personal needs, preferences, and purchasing power. In B2C transactions, businesses are typically focused on creating and maintaining strong relationships with their customers through effective branding, marketing, and customer service strategies. This involves understanding the needs and preferences of individual consumers, tailoring products and services to meet those needs, and providing exceptional customer experiences that encourage loyalty and repeat business. B2C models can take on different forms depending on the nature of the product or service being offered and the target consumer demographic. For example, some B2C models are focused on offering low-cost, high-volume products to a mass consumer audience, while others are focused on providing high-end, personalized products or services to a smaller, more niche audience. (Kenton, 2023)

3.3 Service design and offering development

When developing the fuel offering in the context of current business models, it must be done together with the customer. Instead of thinking the fuel to be the bad necessity of flying but looking the whole fuel supply as an emission reduction service, it gives the possibility to develop it by using the service design and offering development tools. The role of service design and process has developed during the years. Services has moved from being uncelebrated necessity of the manufacturing economy to boost the growth and currently being the modern way of value creation and innovation (Miettinen & Valtonen 2013, 96). In 2020, services were the largest economic activity in the EU measured in terms of gross value added (GVA) generated. Services accounted for 73% of the EU's total GVA, followed by industry and construction (25%) and agriculture (2%) (Eurostat 2020). "This increasing role has been fully recognized of late with a flourishing of innovation studies and policy programs aimed at deepening the understanding and at supporting the development of the service sector"). As of late, the classical opposition between products and services has also been criticized (Miettinen & Valtonen 2013, 96).

The Copenhagen institute of interaction design defines service design to be an emerging field focused on the creation of well thought trough experiences using a combination of intangible and tangible mediums. It provides numerous benefits to the end user experience when applied to sectors such as retail, banking, transportation and healthcare (Stickdonrn & Schneider 2011, 30). Stefan Moritz has simplified the service design to help innovate (create new) or improve (existing) services to make them more useful, usable, desirable for clients and efficient as well as effective for organizations. It is a new holistic, multi-disciplinary, integrative field (Stickdorn & Schneider 2011, 31). Mager is highlights the client point of view by noting that service design aims to ensure service interfaces are useful, usable and desirable from clients point of views and on the other hand effective, efficient and distinctive from the suppliers point of view (Stickdorn & Schneider 2011, 31).

Service design is a systematic way to approach development of services both analytically and intuitively (Tuulaniemi 2011, 10). Service design can help companies to solve and develop complex challenges and it can help companies to reach direct or indirect benefits to business (Koivisto, Säynäjäkangas & Forsberg, 2019, 151). For this thesis the direct benefits are new business models and increased revenues, indirect again customer knowledge and trust built with the customer when developing services together, for example. Other indirect and internal benefits of the service design for the organization can be (Tuulaniemi 2011, 98):

- It defines and develops innovation process.
- Gives tools for development and combines customer and business aspects.
- Defines the organization's resources that bring the biggest value to customer.
- Ensures that the service offering is tested to match customer needs before making investments to the production.
- Finds aspects to lower production costs of the service.

Service design is an interdisciplinary approach that combines different methods and tools from various disciplines. It is a new way of thinking as opposed to a new stand-alone academic discipline (Stickdorn & Schneider 2011, 28)

Stickdorn & Schneider (2011, 34) argues that as there is no common definition for service design. Instead of defining the process, they approach the topic by way of thinking needed. They have defined five core principles to cover the service design process. First of their lenses is about being customer or user-centered. It highlights the need to genuinely understand the customer beyond the statistical and empirical analysis. Gaining authentic customer insights includes the application of methods and tools that enable the service designer to slip into the customers shoes and understand their individual service experience and its wider context. In this thesis this was done in interviews for chose b2b customers.

Second lens is about service design being co-creative. This means to develop the services together with different identified stakeholders. There are variety of methods and tools for gaining genuine insights from different user perspectives in the creation of services and for the development, prototyping and testing of these service concepts. On added benefit to co-creation during the design process is that it facilitates a smooth interaction between the stakeholders during the actual service launch which is essential for sustainable customer and employee satisfaction.

Third lens Stickdorn and Schneider present is sequencing. Service design process should deconstruct the service process into single touchpoints and interactions. Service moments are then created by combining these. This lens is more important when putting together a service in field of b2c, but also relevant for business-to-business customers. Target of this is to keep a sense of expectation without exacting strain upon the customer. Stikcdorn and Schneider compare top class services to stage plays. Audience only sees what is happening on the stage, but in that case the service moment also includes multiple backstage processes to support the actors on the stage. With good sequencing the interest of customer (or audience) can be held trough out the play or service process.

Fourth lens is about evidencing. It means that intangible services should be visualized in terms of physical artefacts. Evidencing is super important in the case of SAF deliveries, where the value (less greenhouse gases) the customer buys is very intangible. Evidencing can occur in a variety of forms: bills, mail, emails, brochures, signs, souvenirs, or other products. These add a tangible component to what would otherwise have been an intangible experience.

Last lens is about being holistic. It means that it is very important to keep the big picture. Genuinely working in the holistic way is an illusion, it is simply impossible to consider evert single aspect of the service. However, the intention should always be to see the wider context in which a service process takes place. Stickdorn and Schneider summarizes that service design thinking supports the co-operation of different discipline towards the goal of corporate success trough enhanced customer experiences, employee satisfaction and integration of sophisticated technological processes in pursuing corporate objectives.

Design Council’s “double diamond” -process (Koivisto et al. 2019, 43), which consists of four main phases and Tuulaniemi (2011) have defined the service design process quite similarly. In Double-Diamond process there are four phases and in Tuulaniemi´s model five phases, last phase being the loop back to the beginning by assessing the process.

Double Diamond model:

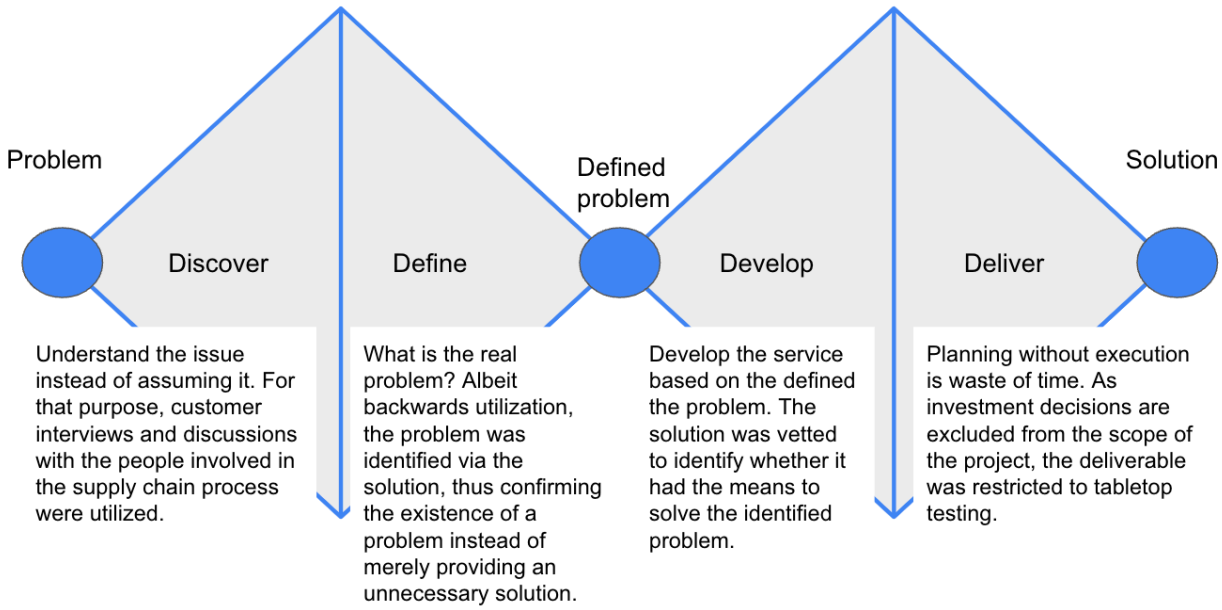


Figure 7. Double diamond model (Koivisto et al. 2019)

Tuulaniemis quite similar 5 step process in his book (Tuulaniemi 2011, 127-128). Tuulaniemi adds the fifth element of assessing the success, which is important part. This is also in link with commonly known continual improvement tool, the PDCA-circle. There the development loop goes on and on trough four steps; Plan – Do – Check – Act.

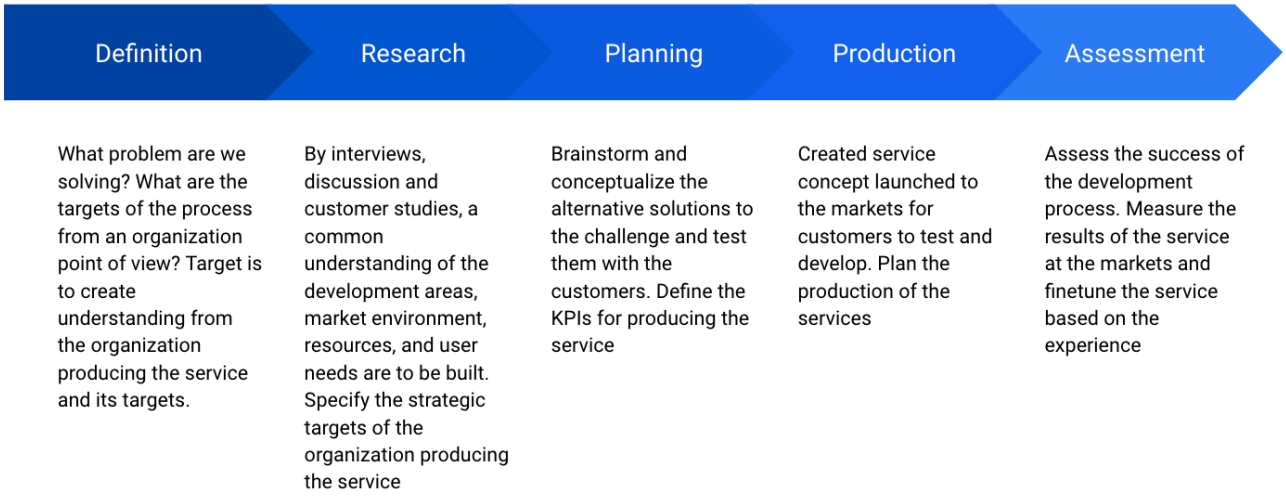


Figure 8. 5 step process of service design (Tuulaniemi 2011)

For the purpose of this thesis the combination of the above described approaches was used. As the first concept of the desired product was outlined in the very beginning, the focus was on research and gaining customer understanding.

This thesis focuses on exploring the ways of creating more and new value to the customer. Second research question is Q2 “What is the value of being able to deliver the SAF molecule to the actual plane instead of mass balance”. This value is complicated to define, as it is intangible from the customer point of view. Value can be defined according to the traditional industrial mindset as embedded in physical products. “Services as they do substantiate into a physical outcome, are not contributing to wealth accumulation, while consumers are perceived as ´destroying´ of any accumulated value” (Miettinen & Valtonen, 2013, 97). In contemporary view of value instead, consumers take part and co-create value by interacting with producers and other stakeholders. Tuulaniemi defines the value to be the link between benefit and price: Value is the benefit the stakeholder experiences (Tuulaniemi, 2011, 30). In this context the value investigated and captured is about having the SAF in the actual plane instead of just having the emission reduction claims.

The value that the customer experiences is coming from the interactions between the company and customer in different channels. The customer defines the value created based on the expectation and subjective experience of the service received. For the company, the value of a single customer is materialized by how many times the customer uses the service(s), how much money the customer is willing to spend and how profitable the customer is for the company (Tuulaniemi 2011, 33).

Tuulaniemi (2011) refers to the Business Model Generation by Alexander Osterwalder and Yves Pigneur to list the elements of value creation: Brand and status help us to make daily choices and to communicate our values by choosing sergeant brands. Significant value is created by making the service easy to use. This requires understanding of customer needs and behaviors to make services as simple to use as possible. Price does not equal to the value, but for example selling expensive product with lower price can create significant value to price sensitive customer. Design of the product is important, but it is hard to measure the impact of a design in a product, as it is very subjective. Features can be added or combined to products and services that can generate added value. Many services help and solve some customer needs (like laundry service) so they generate value for customer by simplifying life and save time and effort. Value can be also created by making it easier for the customer to reach the services or products. It can happen by bringing the service closer to the customer or making it some other way more accessible, like ice-cream vans driving around the neighborhoods. Many services help the customer to save time and money. Many industries have directed the customer to self-service to lower the costs and in some cases saving time as well. For added value the products can be finetuned to match the exact needs of the customer. Early adapters may find some added value when consuming products and services that are fresh on the market. This value is not very sustainable as there are always new and better

services coming to the market**.** For example, guarantee for the product adds value to the customer who wants to mitigate the risk of bad quality product or service.

3.4 Theoretical conclusion

Aviation fuel is of course a key component of all the business cases related to aviation as industry. According to IATA Fuel fact sheet (2022) the airlines fuel bills are around 30% of operating expenses. Customer of the airline doesn't pay for the fuel directly as it is part of the total price of the flight. Customer doesn't also notice the difference in experience when flying with a traditional fossil fuel or SAF blend. There for the value customer gets for paying more for better fuel, is intangible. That means that the service design has the challenge of making the value visible and clear to the customer, in order to make him or her pay more for the use of better fuel. Same challenge is with the business to business customers, such as freight companies. However, in todays business context hey are often reporting their total emissions to their customers, so the value of emitting less is more tangible. It requires tight co-operation and partnerships with the customers to develop business models related to SAF. There is always the customers customer present in the value chain and all parts of the chain must benefit of the developed business model. Presented double diamond model is good tool to develop model as it is highlighting the customer problem to be solved. Aim of the study is to get more clarity to the customer problem, and also to understand if the assumed problem (issues of book and claim) is really a problem from customer point of view to be solved or not. Presented current business models do not fully support all the values SAF has, but on the other hand they are easy to adapt.

4 Methods and data collection

In this business context of selling JET fuel there are customers and the customers customers present. In some cases fuel providers customers can be for example a freight customer who uses a certain airline to deliver their goods. The freight company might buy the SAF from a fuel company that is then burned in the engine of the airline, in this case the freight company would be eligible for emission reductions generated by the SAF. Airlines also have private and business customers. Due to this complexity of the market set up, the chosen approach utilizes two different methods: survey to private customers and semi-structured interviews of chosen airlines and a freight company.

Table 5, Interview and survey details

Method	**Sample / respondents**	**Date and duration**
Customer Survey	N=1000 Finnish respondents, By IROResearch Oy	12.-22.6.2022
Interview	Sales director, Private Airline company	17.8.2022 – 1h
Interview	Head of Cluster, Freight and Cargo	24.8.2022 – 1h
Interview	Head of fuel & Senior sustainability manager, Airline company	25.8.2022 – 1h

4.1 Research approach

Service design is a customer-centric approach to creating and improving services that focuses on the customer experience. This is a beneficial approach when developing a service for customers, as the goal is to create a good service experience. Target of service design is to create good service experience including all customers in the customer chain as well as the serving organization (Ojasalo et al. 3.5). Service design should always be proactive to identify visible and hidden needs of a potential customer (Tuulaniemi 2011, 73). As part of service design, I approach the topic via user research. That includes gathering data from customers about their needs and expectations of a service. This method helps to identify the needs and preferences of the customers and to determine how they want the service to be designed. Some of the sources of user research include surveys, interviews, observation, and feedback from customers.

Another topical trend has been to highlight customer dominant logic, in which the focus is on the need to pay attention to the interaction between customer and company (Koivisto et al 2019, 19). Service design approach was very co-creative, including interviews, surveys and workshops with internal stakeholders. When setting the customer at the center of the service design process, it was necessary to understand that there is more than just one customer group and each group possesses different needs and expectations (Stickdorn & Schneider, 2011, 38). In this thesis it was decided to study the opportunity for service development separately for business-to-business groups of cargo, private flights and airlines.

4.2 Quantitative research

Quantitative research is a research method where data is analyzed numerically. This means that topics and themes are generally assessed with numbers. Quantitative research again answers to questions such as “how many, how much and how often?” (Vilkka 2007, 14). In quantitative research the researchers get the research data in numbers and groups the qualitative data to numerical format. He or she presents the results in numbers and analyzes and explains the relevant information by words. He or she explains the correlations or de-correlations of different topics and results (Vilkka 2007,14). Increasing the customer understanding and surveying the expectations, needs and targets of the customer is the most critical phase of service design. Customer surveys in service design mean exactly the data collection from the material that can be utilized to direct the planning of the service and process (Tuulaniemi 2011, 142). Results of the survey were analyzed by comparing how respondents with different background data respond to different questions. The whole respondent group of 1000 is assessed together to get common insight of the group. Data is summarized and visualized to gain insights and findings.

4.3 Semi-structured interviews

Gaining understanding from limited number of stakeholders. Vilkka (2015, 124) states that semi-structured interview might be the most common way of research interviews. When conducting a semi-structured interview, the most relevant topics and themes are that area mandatory to assess to answer the research questions are chosen. It is irrelevant in which order the themes are covered during the interview. The target is that the responder is able to give views on all themes and that the themes are covered in a natural order. Semi-structured interviews are not only a data collection method for qualitative research but can also be used for quantitative research (Hirsjärvi et al, 2005, 197). Results of the interviews are analyzed thematically by grouping topics and themes from the interviews for conclusions. Thematic analysis is a qualitative research method used to identify, analyze, and interpret patterns or themes within qualitative data. Thematic analysis can be applied

to various types of qualitative data, including interviews, focus groups, surveys, observations, and written documents. (Braun & Clarke, 2006)

4.4 Customer survey

As part of the thesis, a survey to Finnish private customers was organized to understand viewpoints about the topic. #Tuhat suomalaista# by IROResearch Oy – study was done over the internet during 14.-22.6.2022. Survey was done in Finnish. Survey error marginal is approximately 3,2%

Gender, age, education, occupation, income and residence of the respondents were collected to understand the background of those surveyed.

Survey questions:

1. I believe SAF is one of the most important measures to cut the emissions of flying in future.
2. How much you would be willing to pay more to use fully renewable SAF in typical 200eur flight from Helsinki to London?
3. If you pay more for use of SAF, how important to you would it be that it would be used on the exact plane you fly with?
4. Estimate how much greenhouse gas emissions are generated from one economy-class flight from Helsinki to London?
5. Have you thought about compensate your own greenhouse gas emissions of flying?
6. Have you reduced flying due emissions?
7. Would you hope that the airlines would use more SAF, even though it would increase the price of tickets by 50%?

4.5 Airline and B2B interviews

I interviewed three airlines that operate from Helsinki-Vantaa. This included two major ones operating commercial passenger flights and one operating mainly private flights and some other special flights. The B2B interview was conducted with a major freight company offering a wide range of freight services, airfreight being one of them. Interviews were done during summer of 2022 as online meetings. All companies interviewed are customers of my employer Neste Markkinointi Oy.

In all interviews the goal was to find out

- “How important for SAF usage is to have the actual SAF-molecule in the plane that the emission reduction is applied?”

- “What is the value of being able to deliver the SAF-molecule to the actual plane instead of mass balance?”
- “How the voluntary market is working compared to the mandate-market from customer point of view?”
- “How much customers are willing to pay to decarbonize emissions of flying?”
- “How much customers know about emissions and how SAF is seen as a solution?”

5 Results and findings

In general, the survey results were encouraging. Respondents acknowledge the need to cut the emissions and they are hoping airlines will use more SAF. Respondents also accept the resulting increased price of flying and are willing to pay– however, a very small number of respondents have yet compensated the emissions of their flying, despite the options given to do so. One interesting general finding is that females tend to be more positive towards reduction of emissions with SAF.

5.1 Private customer study results

Respondents believe strongly that the SAF is one of the most important measures to cut emissions in the future. 79% of respondents agree or strongly agree with this statement.

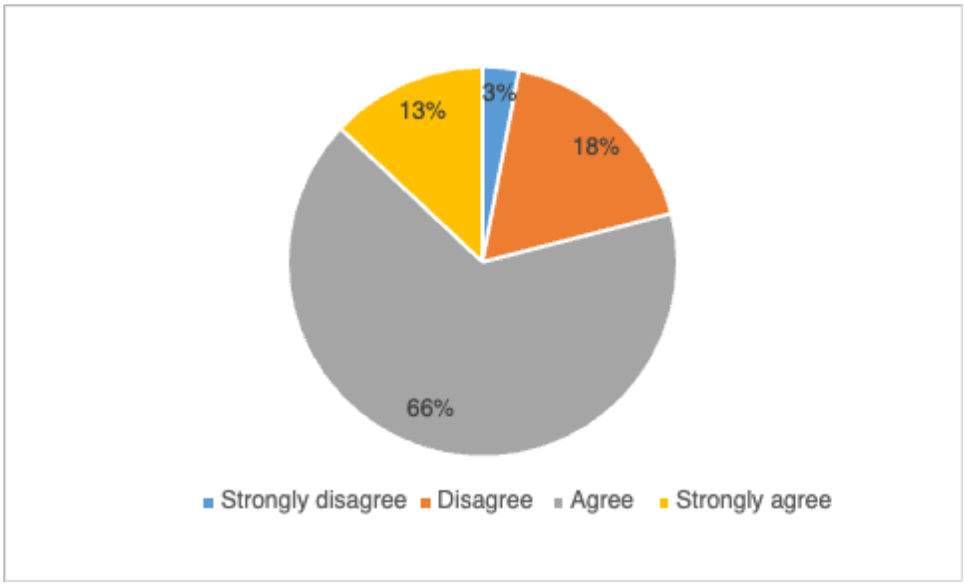


Figure 12. I believe SAF is one of the most important measures to cut the emissions of flying in future, N=1000

Females agree more (85%) than males (73%). These results are significantly higher than average results. Between different age groups there are no big differences – youngest respondents

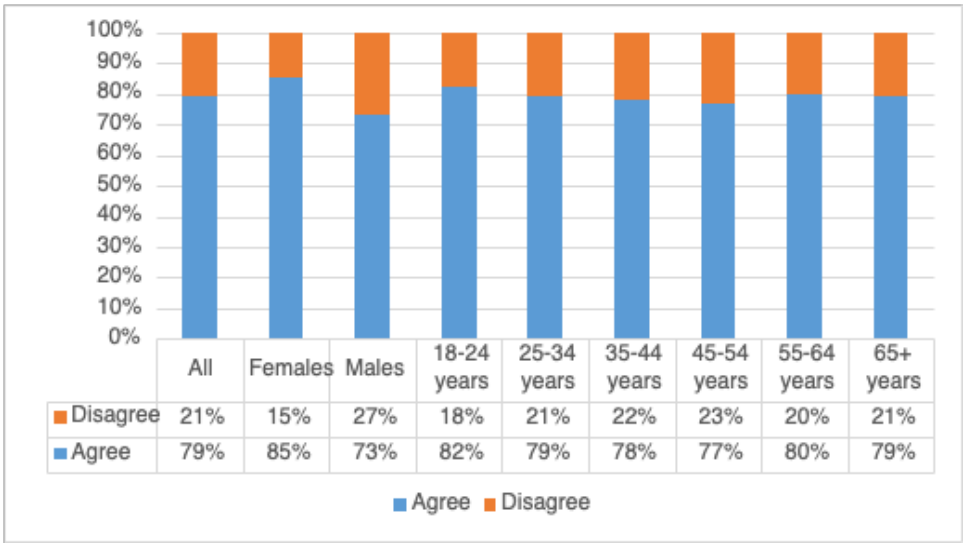


Figure 13. I believe SAF is one of the most important measures to cut the emissions of flying in future, N=1000

In open comments, there was lot of people acknowledging the problem. SAF was also recognized commonly as one important solution to it, also other aspects like smarter routing and simply reducing flying were identified as solutions to cut emissions in the future.

> "It is easy to use and put into use because it does not require major technical changes to the machines themselves and can be used together with current fuel."
>
> "Something must be done about the emissions of flying."
>
> "There are few other options, and the urban millennial wants to fly on vacation despite environmental issues and climate change."
>
> "Flying can also be reduced."
>
> "Renewable fuel will certainly improve the situation, however, I believe that smarter flight routing (= fewer half-empty flights) would help better."

Because SAF is more expensive than the traditional fossil JET fuel, it means more expensive flight tickets. Here the willingness to pay more was assessed by asking how much more would customer be willing to pay for 100% use of SAF on a regular 200eur flight from Helsinki to London. Notable that only 50-50 blend of SAF and traditional fuel is approved by standards at this point. Clear majority of the respondents is willing to pay more for use of SAF:

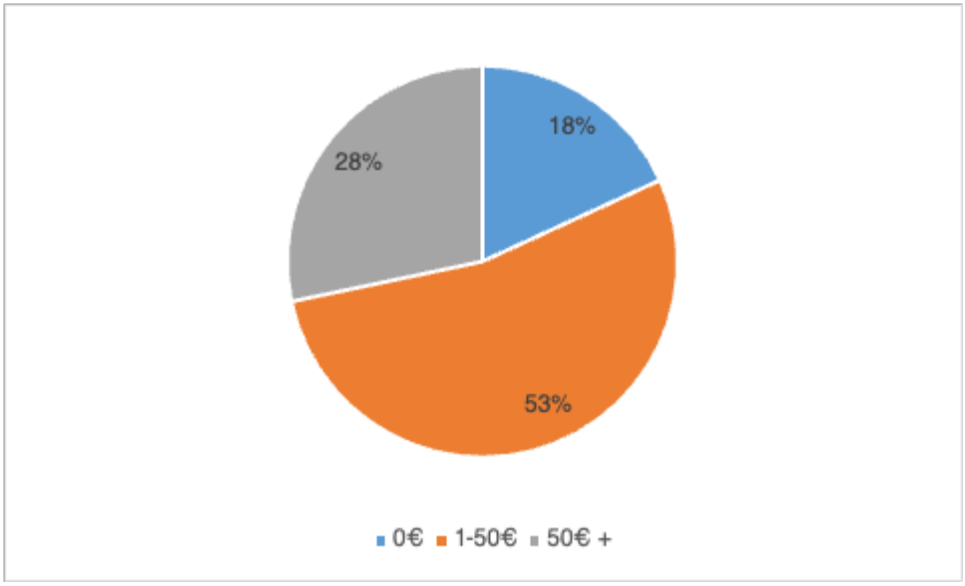


Figure 14. Average on how much more customer is willing to pay more on 200eur flight from Helsinki to London fo the 100% use of SAF N=1000.

On average, respondents claim the willingness to pay 44eur extra. 28% of the respondents claim to be willing to pay over 50eur more, increasing the price of the 200eur ticket by over 25%.

Age group 65+ were most the ones most willing to pay 49eur or average (significantly higher than average).

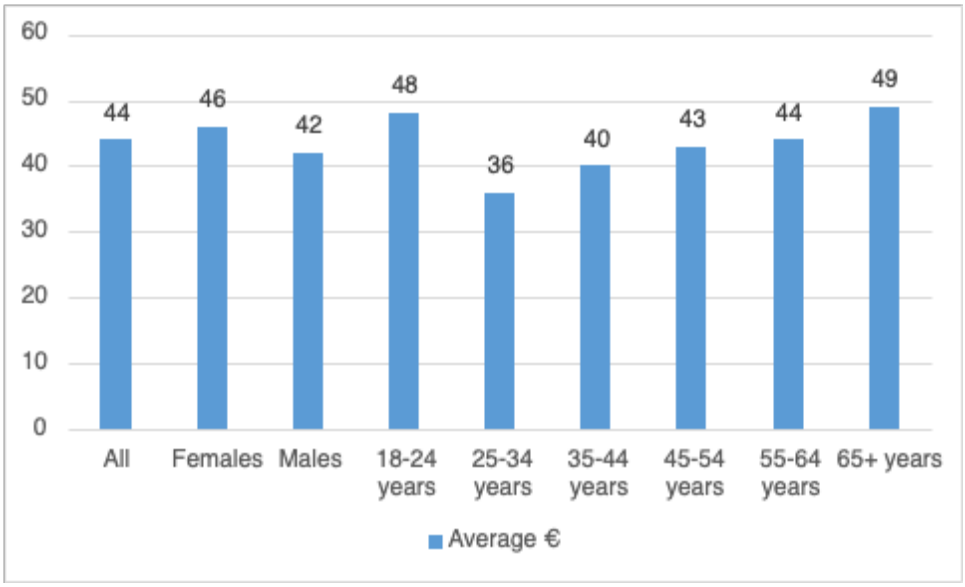
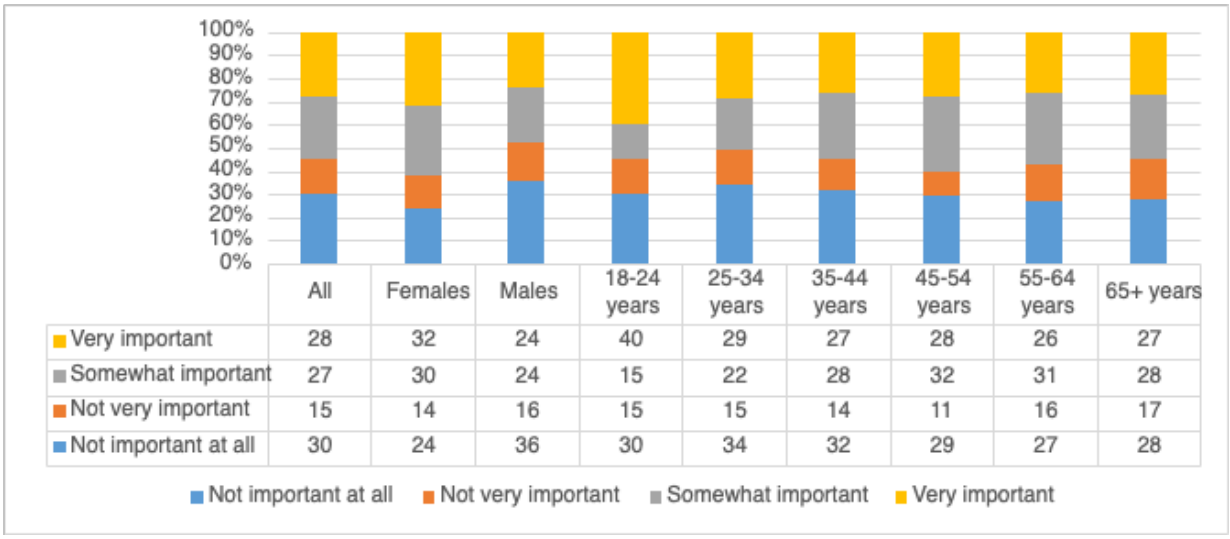


Figure 15. How much more customer is willing to pay more on 200eur flight from Helsinki to London fo the 100% use of SAF, N=1000.

From income perspective, it is notable that the respondents with the highest level of income are willing to pay the least. Respondents with the household total income over 70.000€ a year are willing to pay 40€ more and then on the other end the respondents with the household less than 30.000€ a year are willing to pay over 48€.

> “Reasonable compensation for higher manufacturing costs.”
>
> “I rarely fly, so I can compensate the fuel quite a bit."
>
> “Not to be paid by the customers.”
>
> “Flying is already expensive.”
>
> “Yes, you can pay a third more to save the earth for the next generations.”

As presented in the business models, the current market is working in “book and claim” where the physical flow of products is separated from the emission reductions. In the survey this dilemma and importance of having the SAF in the actual plane the customer flies with, was also assessed. 55% of the respondents find it somewhat or very important to have the SAF in the actual plane they are flying. Females (62%) find it more important than males (48%).



	All	Females	Males	18-24 years	25-34 years	35-44 years	45-54 years	55-64 years	65+ years
Very important	28	32	24	40	29	27	28	26	27
Somewhat important	27	30	24	15	22	28	32	31	28
Not very important	15	14	16	15	15	14	11	16	17
Not important at all	30	24	36	30	34	32	29	27	28

Figure 16. If you pay more for use of SAF, how important to you would it be that it would be used on the exact plane you fly with? N=1000.

In the youngest age group studied (18-24), the most common answer (40%) was that it is very important to have the SAF in the right plane. When comparing responses from different income levels, there were no big changes in answers.

> “If I fly, I want to get my money's worth.”

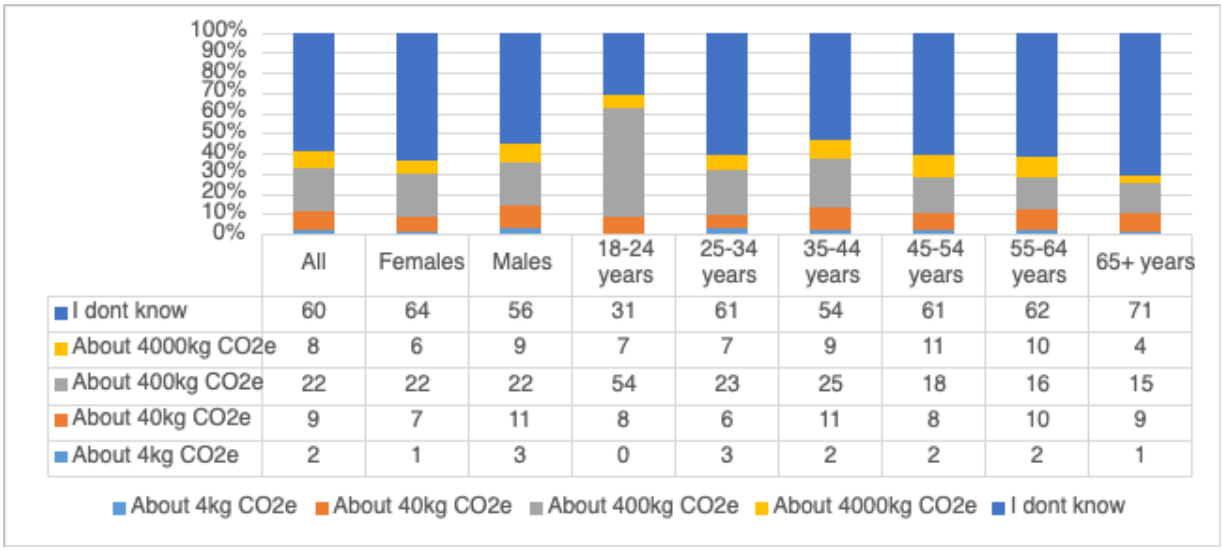
“The main thing is that the emissions decrease at least a little.”

“It seems unfair and someone doesn't pay for renewable fuel but still flies the same plane as those who do. Although atmospheric emissions are not affected in the end games.”

“Otherwise, we go to the fact that it looks good on paper, in reality no measures are taken.”

“In general, its effect should be felt on all flights. but maybe the willingness to pay would be better affected if you could be sure that this particular flight will damage the climate less.”

In the survey there was also a general question to asses emissions generated from a regular economy flight from Helsinki to London. Purpose of this question was to estimate how aware the respondents are about the emissions. The correct answer was c. 400kg, with 22% of respondents either guessing or knowing this. Most common answer (60%) was “ I Don’t know”.

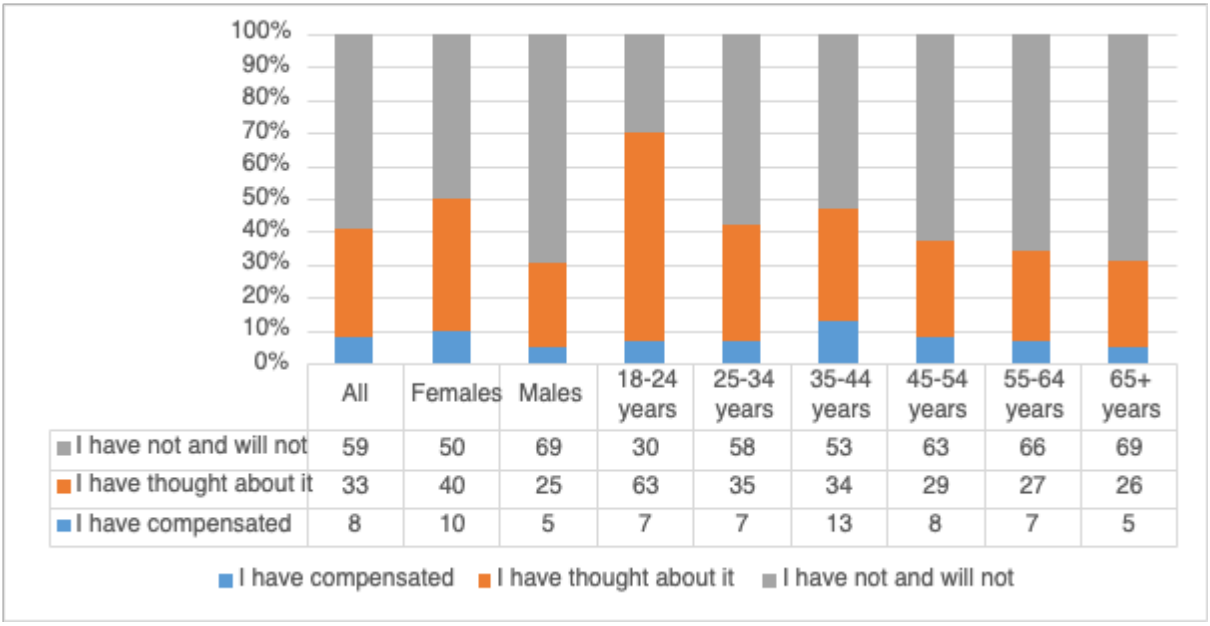


	All	Females	Males	18-24 years	25-34 years	35-44 years	45-54 years	55-64 years	65+ years
I dont know	60	64	56	31	61	54	61	62	71
About 4000kg CO2e	8	6	9	7	7	9	11	10	4
About 400kg CO2e	22	22	22	54	23	25	18	16	15
About 40kg CO2e	9	7	11	8	6	11	8	10	9
About 4kg CO2e	2	1	3	0	3	2	2	2	1

Figure 17. Estimate how much greenhouse gas emissions are generated from one economy-class flight from Helsinki to London? N=1000

54% of the youngest age group was correct in their answer, thus indicating that they are likely more aware of the emissions than others.

There are many commercial compensating options available for the customers, some airlines are also offering these as part of the flight ticket purchase process. As a total, 410 respondents out of 1000 have (80) or thought about (330) compensating the emissions of their flights.



	All	Females	Males	18-24 years	25-34 years	35-44 years	45-54 years	55-64 years	65+ years
I have not and will not	59	50	69	30	58	53	63	66	69
I have thought about it	33	40	25	63	35	34	29	27	26
I have compensated	8	10	5	7	7	13	8	7	5

Figure 18. Have you thought about compensate your own greenhouse gas emissions of flying? N=1000

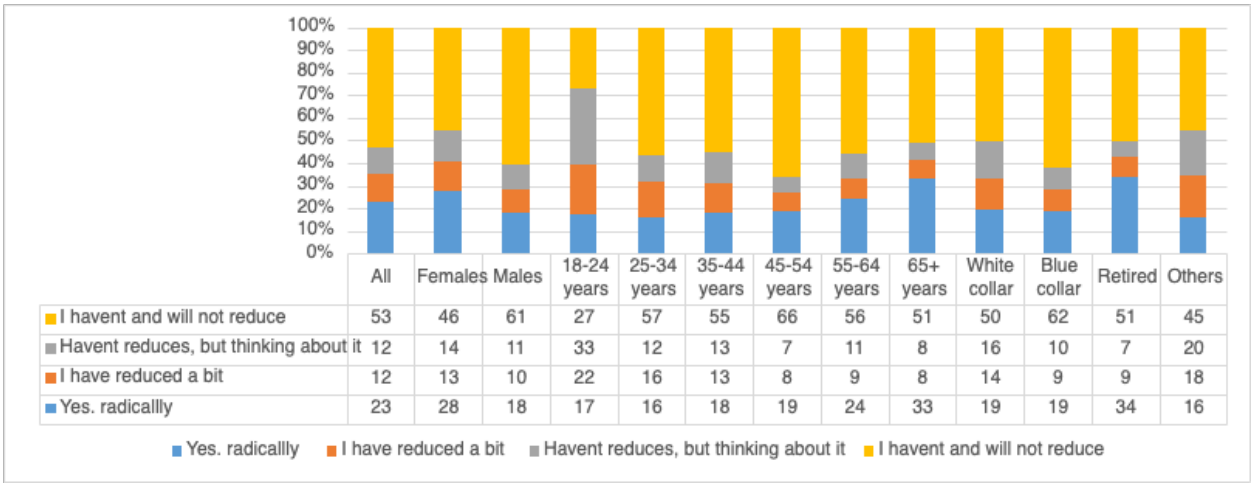
Again, females more (50%) than males (30%). Youngest people (18-24) have thought about it considerably more often than others, 63% in total – this is probably a combination of younger generation in general being more aware of the climate change and that they might not fully be paying for the flights. The age group 35-44 have compensated clearly more than average – which to me is positive sign. In the end I am comparing some questions together but clearly there is still a gap between “thinking about it” and actually “doing it”.

Chosen open comments:

> “The last time I flew, emission compensation was not available. Now, if I were to fly, I would definitely compensate.”
>
> “I pay attention to my own carbon footprint.”
>
> “Everything possible must be done for the future of our children.”
>
> “I don't think there is any evidence yet, whether we will do anything about it or just collect the money.”
>
> “I haven't flown or booked flights myself yet, so I'll be happy to do it when it becomes relevant. I want to help keep the earth as good a place as possible <3”
>
> “I don't fly. In the future, I will find out the possibilities to compensate.”

Probably the most efficient way of reducing the emissions of flying is to actually reduce the amount of flying, of course that is not always possible but in the survey already 35% of the respondents

say that they have reduced flying due to the emissions it generates. Mostly this is in the oldest age group (41%) and with pensioners (43%).



	All	Females	Males	18-24 years	25-34 years	35-44 years	45-54 years	55-64 years	65+ years	White collar	Blue collar	Retired	Others
I havent and will not reduce	53	46	61	27	57	55	66	56	51	50	62	51	45
Havent reduces, but thinking about it	12	14	11	33	12	13	7	11	8	16	10	7	20
I have reduced a bit	12	13	10	22	16	13	8	9	8	14	9	9	18
Yes. radicallly	23	28	18	17	16	18	19	24	33	19	19	34	16

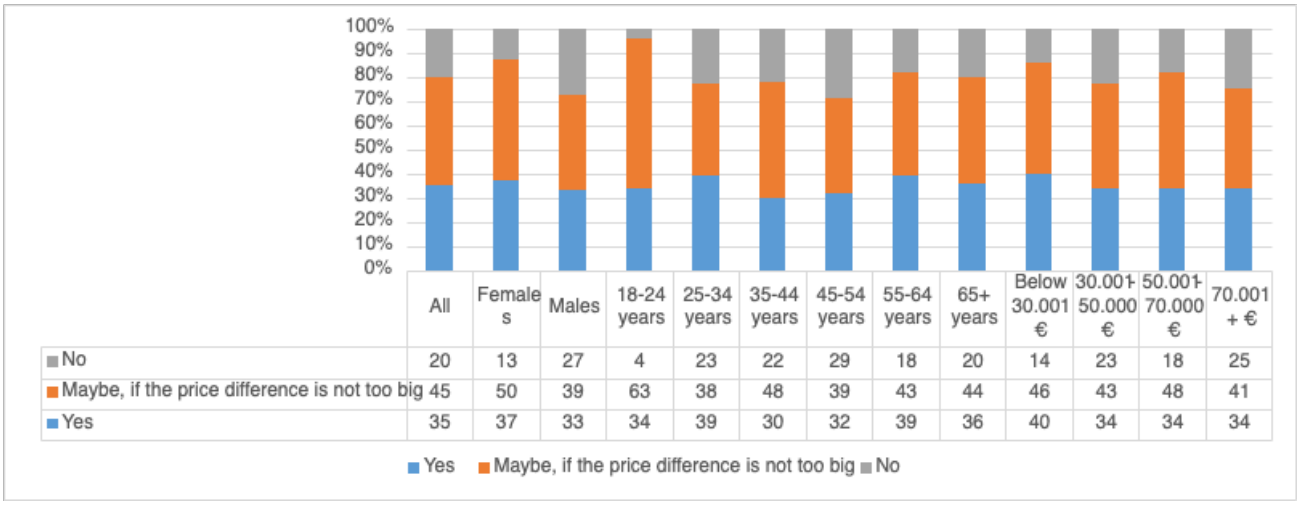
Figure 19. Have you reduced flying due emissions? N=1000

Another interesting point is with the youngest age group: 39% of them have reduced flying and 33% of them are thinking to reduce it. If compared for example with the age group of 45-54, the difference is significant; 66% of 45-55 years old have not and will not reduce flying, but with youngest group it is only 27% who will not reduce flying.

Chosen open comments:

> “Air travel is not necessary for me, so it's easy to reduce.”
>
> “I fly quite a bit anyway, but I try to avoid it.”
>
> “Some breaks are needed here and tourism is one of the few, I compensate by cycling to work and I don't own a car”
>
> “However, the reason is the pandemic rather than the emissions. But I have previously used the train instead of flying when it has been possible.”
>
> “I want to make a difference.”

In most of the cases, the customer cannot decide directly what fuel the airline or airplane is using. 35% of respondents would like airlines to use more SAF and 45% would like it to happen, if the price difference would not be that big.



	All	Females	Males	18-24 years	25-34 years	35-44 years	45-54 years	55-64 years	65+ years	Below 30.001 €	30.001-50.000 €	50.001-70.000 €	70.001 + €
No	20	13	27	4	23	22	29	18	20	14	23	18	25
Maybe, if the price difference is not too big	45	50	39	63	38	48	39	43	44	46	43	48	41
Yes	35	37	33	34	39	30	32	39	36	40	34	34	34

Figure 20. Would you hope that the airlines would use more SAF, even though it would increase the price of tickets by 50%?

Females are hoping for more SAF than the males. Also, in the youngest age group only 4% are not hoping the airlines to use more SAF.

> *"I might not be able to afford to fly anymore."*
>
> *"Ecology is important, but on the other hand, this would only emphasize people's inequality, i.e." "Travel would only be possible for the rich."*
>
> *"If you want to fly, you can afford to pay."*
>
> *"If you want to continue flying, you have to make it much, much more environmentally sustainable."*
>
> *"Of course, travelers have to pay. Rising costs cannot be left to be covered by the companies. So the driver pays himself, and not the oil company on behalf of the customer."*
>
> *"The prices are already high."*

5.2 Airline and B2V customer interviews

The purposes of the interviews were to investigate opportunities to develop SAF logistics in Helsinki-Vantaa and find out how potential customers of this service view the current situation. Two airlines and one B2B customer (a global freight company) were interviewed. All interviews began with a brief introduction on the previously conducted consumer survey:

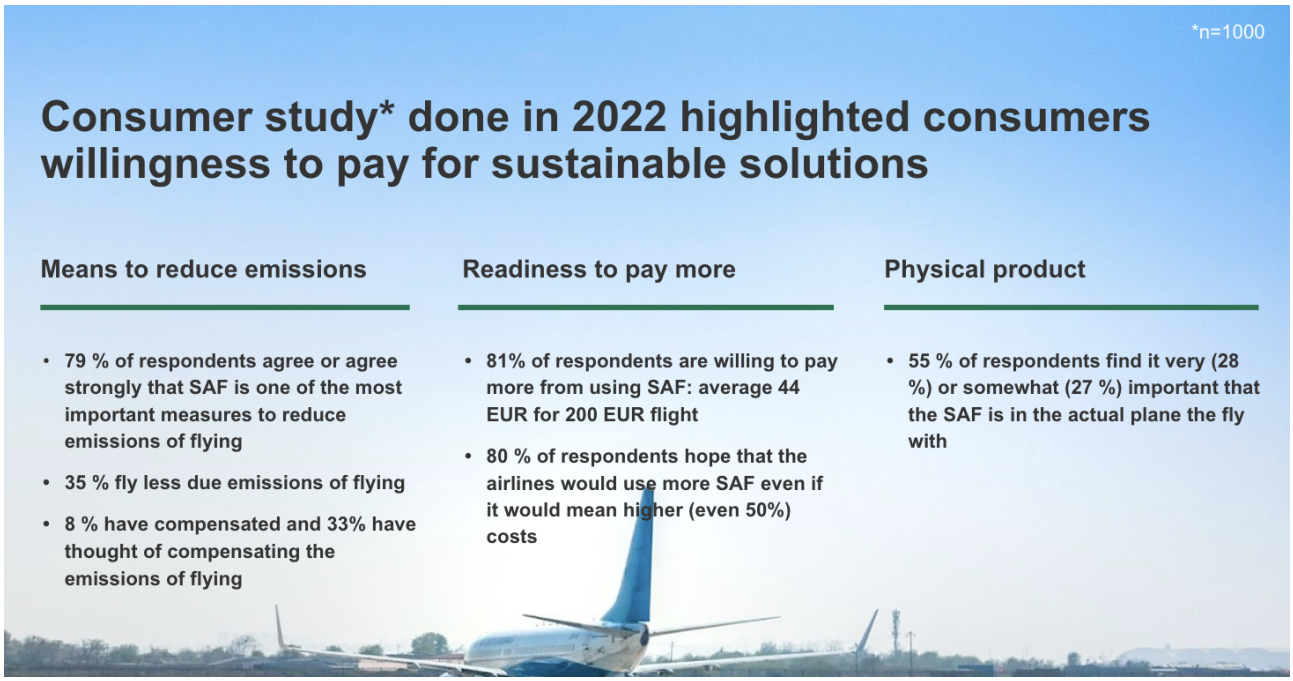


Figure 21, Customer survey results

Experience so far

The interviewed private airline is mainly conducting charter (business) flights to their customer. They have some experience of purchasing “book and claim” -style SAF during 2021. At the time they used as 35% blend in their operations. According to their previous experience of the interviewed private airline, especially when selling spot flights and offering the customer the opportunity to use SAF, the customer quite often either wanted to know whether the SAF will be in the actual plane, or then they assumed it to be.

> “Specially with “spot flights” customers question how the SAF is refueled and will it be in the actual plane they use”

Customers who buy a series of flights and choose to use SAF, do not that much concern themselves on whether the SAF is in the right plane or not, so long as they can claim the emission reductions.

> “Bigger customer who buys many flights doesn't care that much if the SAF is in the right plane or not”

Other interviewed bigger airline has also experience on the topic. Interest has not been too high mainly higher price.

> “Corporate customers not so active - price sensitive”

The company has purchased SAF and offer their customers the possibility to compensate for their flight emissions. So far, it is only about 1% of the customers who have chosen to compensate the emission via the service provided by the airline. In their service, the customer can choose the amount of compensation done by SAF and with offsets – usually the ones who choose to compensate choose somewhere around 5% of SAF and 95% offsets. Where the actual SAF is then used (if purchased) haven't raised question among their private customers

> “No questions about where the fueling is happening - as long as price is OK that’s enough.”

The intervied cargo airline have created their own “Carbon X”-services, where the customer can already today choose to compensate their freight emissions with different options. So far it has not been that easy to sell carbon products to customers customers.

> “Buy & sell model does not seem to work – carbon products are allocated to own use.”

Customers customers

Cargo airline said that when talking with their customers about SAF in airfreight, the general thought is that SAF is delivered to the actual plane, then when it is explained that it is not in this actual plane etc. it gets complicated and challenging to convince the customer of the value added by using more SAF.

> “Assumption from customers is that there is physical delivery.”

They also highlighted the importance of reporting and being able to allocate the volumes to the right customer, as in most of the cases there are always several freight customers using the services of a same flight. To ensure reaching companies’ climate goals, they must be able to track the use of SAF in the value chain. The private airline has major customers, who have an opportunity to require use of SAF, but they have for most cases chosen not to build in such requirements at this point.

> “Big customers have the opportunity to use SAF in contracts - but haven't done it - difference between the speak and actions is still big.”

On issue related to the topic for this airline is that when they fly all around the Europe it would not be enough for them to refuel it only at home base in Helsinki-Vantaa. Bigger airline see that the private customers are not that interested in where the actual fueling happens. On cargo and with B2B customers, they see that the Science based targets are pushing the companies further.

“Physical vs mass balance not raising from customer discussions, it would be nice additional.”

Future opportunities

One interesting opportunity the ability to deliver SAF-molecules to correct plane would generate is to have “SAF-routes” for example between Helsinki and Stockholm, that would then operate with high SAF-blend

> “Reoccurring flight makes more sense.”

In this market the private customers are also maybe more willing to pay for SAF, this kind of standardized flight would also make sense from emission reporting and communicative points of views. Also, the opportunity to create a “green HUB” at Helsinki-Vantaa would benefit not only via emission reductions but would also have a positive impact on the public image. Cargo airline sees also that their goal is also that the emission reductions that they offer to their customers occur as close as possible to the customer operations.

> “Our goal is that the emission reduction is happening as close to the customer as possible.“
>
> “SAF allocated to customers operations is demanded.”

The company sees it beneficial if it wer possible to deliver SAF to the actual plane, but they are a bit pessimistic if the customers would be willing to pay more for this service.

> “Not sure if they are willing to pay more for the physical delivery to the plane.”

In the interview of the private airline it came up also the challenge of communicating the use of SAF to some customers. It is known that some airlines publicly say that “we fly with SAF” and in reality, there might be one flight or some small 1% blend used somewhere and rest is still fossil based. This enhanced the need of clarity and visibility and some simplicity around the SAF. Very low SAF-blends are not supported.

> “Blend of 30-40% would be minimum to make it relevant.”
>
> “Less than 50 would be the right ratio for SAF vs fossil jet fuel.”

Consumer behaviour is together with the legislation at the end of the day driving the change. Based on the interviews of the consumers

> “Consumers want SAF either included as a mandatory option across all flights or purchased during the flight booking process.”

5.2 Key finding from the data

As said, the gap between considerations and action is still quite big. According to the study, 8% have already compensated the emissions, but 35% hope that airlines would use more SAF, even though it would be more expensive. So, you could argue that 35% rely on policies and decision makers to make it mandatory for all – hence they could compensate today as well, but are not doing it yet for some reason. It could be that respondents don't know how to compensate, or it is not too clear process now.

Females tend to be more positive towards SAF and favor cutting emissions. Also, from this study it is visible that the younger generation is more concerned about the emissions and maybe on the edge of transforming thought into actions.

When putting some questions together, it can be seen for example that from those people who have already compensated their flying emissions 62% find it somewhat or very important that the SAF is in the actual plane they fly with.

38% of those who find it somewhat or very important that the SAF is in the actual plane, have thought about compensating the emission, but only 8% have done it. This 38% is an interesting customer group, since they are thinking about it, but have not yet done it. Could we get them to invest in sustainable fuel and lower emissions if there would be option with SAF being delivered to the actual plane they fly with. Having the SAF delivered to the actual plane they fly with, may have the potential to action this thinking.

5.3 Validity and reliability

Heale and Twycross (2015) split the validity of a study into three segments; Content validity, construct validity and criterion validity. They define validity as the extent to which a concept is accurately measured in a quantitative study.

Table 6 types of validity (Heale & Twycross 2015).

Type of validity	Description
Content validity	The extent to which a research instrument accurately measures all aspects of a construct

Construct validity	The extent to which a research instrument (or tool) measures the intended construct
Criterion validity	The extent to which a research instrument is related to other instruments that measure the same variables

This study was scoped to cover respondents' views on sustainable aviation fuel and flying in general from emission point of view. It covers the chosen aspects.

Construction validity is hard to assess on this study, as it is about views of the respondents. Also as the responses were only analyzed in groups, it may not be possible to have high construction validity. One clear finding to decrease the construction validity is that way more of the respondents say to be willing to pay for compensating the emissions compared to the ones who say that they would like to pay for less emissions.

Criterion validity seems to be well in place, as similar results have come up from similar previous studies. For example, the resulted willingness to pay more is reflecting the results of a previous study in other countries done by Neste. Also, airline feedback to the result of people compensating was in line with their experience of paid compensations by their customers.

Reliability relates to consistency of a measure and can also be divided into three categories; Homogeneity (internal consistency), stability and equivalence. As an example of reliable survey, the participant should give approximately the same responses to the same questions (Heale and Twycroos 2015).

Table 7 Attributes of reliability (Heale & Twcross, 2015)

Attributes	**Description**
Homogeneity (or internal concistency)	The extent to which all the items on a scale measure one construct
Stability	The consistency of results using an instrument with repeated testing

Equivalence	Consistency among responses of multiple users of an instrument, or among alternate forms of an instrument

No internal consistency, stability or equivalence was calculated to this survey.

6 Discussion

Business organizations have developed different kinds of emission gapping services but naturally there is a need for the customers and consumers to be willing to pay for those. The services are still somewhat hard to understand, and when customer has the opportunity to choose, as long as no mandatory policies in place, the money is quite a strong driver, specially with older age groups.

As defined earlier by Miettinen & Valtonen (2013) in contemporary view of value consumers take part and co-create value by interacting with producers and other stakeholders. Development of sales of SAF is something where value is in cutting the emissions of flying which should be mutual interest of all stakeholders including the company itself. As also Tuulaniemi (2011) defined value to be the link between benefit and price. In this case the benefit of using SAF is the cut of the emissions, which is to some extent, complicated factor to make visible for the private customer. In business to business segment it is more easy, as all companies these days need to report emissions from their business. Current business models do not acknowledge or fully fulfill the need for transparency in some customer segments. Specially this was seen with private customers as well as private airlines. In the theory models of service design the important part is defining the problem. Based on the research the problem assumed (SAF not filled to the actual plane) is real problem for only some customer segments.

Main research questions of the thesis were:

Q1 “How important for SAF usage is to have the actual SAF molecule in the plane that the emission reduction is applied?”

Q2 “What is the value of being able to deliver the SAF molecule to the actual plane instead of mass balance?”

For question one the surveys and interviews show that it varies in different customer segments. For private customers and private airlines it is more important than to the bigger Airline, Cargo company was somewhere in the middle. All see it positive and at least “nice to have”. Second question related to the value was harder to capture and quantify. Of course in the customer survey came up a concrete number what customers are willing to pay more for reducing the emissions, but there is still the gap of willing and actually paying.

6.1 Conclusions

Conclusion of the study is that the problem is generally recognized but there are still barriers preventing actions. Cost of SAF is the biggest barrier, as well as the non-transparent process and fear of greenwashing. Conclusions also vary quite a bit with different customer groups.

Private customers

Consumers acknowledge the SAF as a solution to gap the emissions. They would like the airlines to use more SAF, and claim willingness to pay more, but still today only few percent are doing it, with the addition of a good 1/3 thinking about compensating in some way. For those who pay today, it would be important to have the SAF in the actual plane they fly with. Could we get more to pay for SAF if the clarity of the use would be enhanced?

Airlines

They would like there to be a certain flight powered with SAF from HEL, so there would need to be continuous supply. If it is physical, it's a nice additional value, but not necessary. Airlines are dependent of their customer behaviors and there the price of the flight is still big decision maker for may of the customer. Individuals do not need to report emissions of their life so there is no official pressure to cut the emissions.

Cargo

Cargo customers expect there to be a physical delivery. The most important thing is to be able to track the use and report the sustainability impact in the value chain as reduced Scope 3 emissions. Some cargo companies are more advanced and already offering SAF-powered deliveries and the visibility to delivery emissions to their customers. Trackability and reportability is the key, as it is rarely only one customer of the cargo plane.

Private airline

The high end customers, who purchase single flights, do not understand the current model with no physical SAF at Helsinki-Vantaa. They need a concrete way to communicate the impact. Physical delivery would allow them to scale the SAF use, which they currently cannot do. Most commonly it is only one individual customer who buys the flight service, so it is more simple to sell the idea of using SAF instead of fossil use – in this case it would me very beneficial to be then able to fuel that plane with actual SAF instead of just claiming the emission reductions and the SAF to be used somewhere at the airport.

Supply Chain

Supply chain was not in the original scope of this thesis but it came up quite a bit during the process. Challenge is that in order to offer separate products for airlines (traditional fossil fuel and SAF), the fuel operator needs to have fully segregated systems for the whole value chain. In most cases this means the production, shipping from the production site to coastal terminal, blending of

the product, distribution terminal, road logistics to the airport fuel facilities, airport fuel facilities and lastly the in to plane trucks from the airport fuel facility to wing of the airplane.

6.2 Managerial implications

As said, technically the solution is available. Customers understand that the emissions need to be lowered, but they are not fully approving the cost of it. For this kind of service to actualize, it would need some developments of the supply chain and investments in the infrastructure, but most importantly, customer willingness to pay for lower emissions. Planned policies on SAF-mandates will also challenge this kind of delivery model as then in every liter of JET fuel is agreed amount of sustainable aviation fuel.

In the background questions of the private customer survey it would have been good to find out the flying behaviors (e.g. frequency, leisure or business) of respondents. As this was not studied, no understanding of the correlation of spend on flights vs. willingness to pay more was gained.It might be relatively easy to say that flying should be more expensive and done more in sustainable way, if flying is not relevant for the responder.

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Figures

Tables

Appendices

Appendix 1. Customer Survey results – IROResearch Oy, 2022

Tutkimuksen tiedot

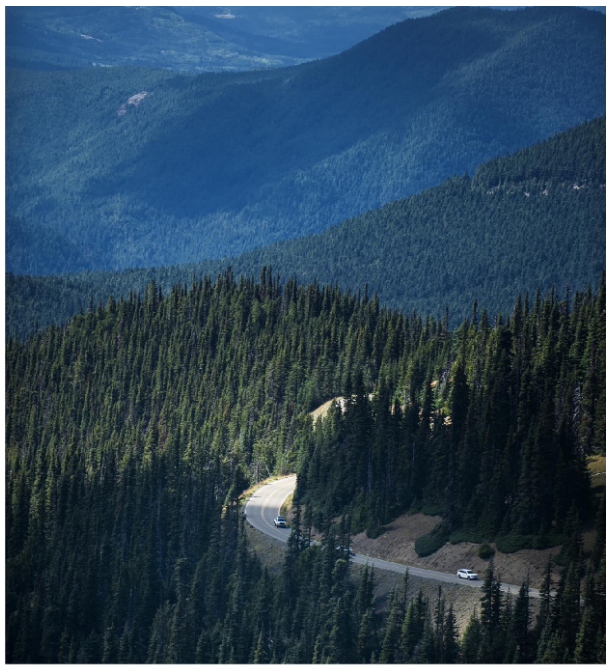
IROResearch Oy:n Tuhat suomalaista -tutkimuksen tiedonkeruu tehtiin internetissä IROResearch Oy:n valtakunnalliseen kuluttajapaneeliin.

Tutkimuksen otos painotettiin iän, sukupuolen, asuinpaikkakunnan tyypin sekä maakunnan mukaan vastaamaan suomalaista väestöä valtakunnallisesti.

Tutkimushaastatteluja tehtiin yhteensä 1000.

Tutkimuksen tiedonkeruuaika oli 14.-22.6.2022.

Tutkimuksen tilastollinen virhemarginaali on maksimissaan n. + 3,2 %-yksikköä.



Tutkimusaineisto validoidaan henkilön ja annettujen vastausten suhteen. Validointi tapahtuu vertaamalla paneelihallintajärjestelmän ja vastausten taustatietoja keskenään, analysoimalla annettuja vastauksia, lomakkeen täyttöastetta sekä erinäisin loogisuustarkistuksin.

SFS-ISO 20252:2019 sertifioitu

IRO Research & Consulting kiwa ISO 20252

Kasvihuonekaasupäästöt – Tuhat suomalaista / kesäkuu 2022

neste

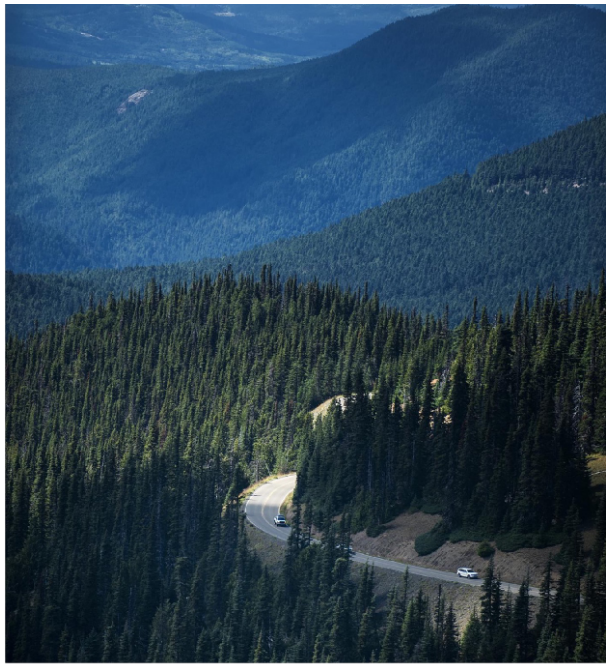
Aineiston rakenne

	Kaikki
	N=1000
	%
Sukupuoli	
Nainen	51
Mies	49
Ikä	
18-24 vuotta	10
25-34 vuotta	16
35-44 vuotta	16
45-54 vuotta	15
55-64 vuotta	16
65+ vuotta	27
Koulutus	
Peruskoulu	5
Kansakoulu	2
Keskikoulu	2
Ammattikoulu	17
Opisto	10
Ylioppilas/lukio	16
Ammattikorkeakoulu (alemman korkea-asteen koulutus)	22
Yliopisto/korkeakoulu (yl. korkea-asteen koulutus, tutkija-asteen koulutus)	25
Muu	1

	Kaikki
	N=1000
	%
Ammattiryhmä	
Työväestö	20
Alempi toimihenkilö	10
Ylempi toimihenkilö	12
Johtavassa asemassa oleva	3
Yksityisyrittäjä	5
Maanviljelijä	1
Opiskelija / koululainen	11
Eläkeläinen	30
Kotiäiti/-isä	1
Työtön	5
Muu	2
Asuinpaikkakunta	
Helsinki	11
Espoo, Vantaa, Kauniainen	9
Tampere	4
Turku	3
Muu yli 50.000 as. kaupunki	24
Alle 50.000 as. kaupunki	27
Maalaiskunta	22

	Kaikki
	N=1000
	%
Talouden bruttovuositulot	
Alle 10.000 €	6
10.001 - 20.000 €	9
20.001 - 30.000 €	9
30.001 - 40.000 €	11
40.001 - 50.000 €	11
50.001 - 60.000 €	8
60.001 - 70.000 €	8
70.001 - 80.000 €	6
80.001 - 100.000 €	7
100.001 € tai enemmän	10
Ei halua sanoa	16

Tulokset



Kasvihuonekaasupäästöt – Tuhat suomalaista / kesäkuu 2022

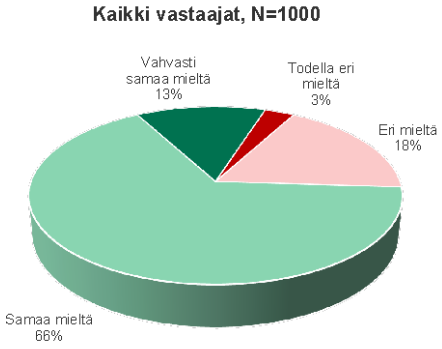
”Uusiutuva lentopolttoaine (Sustainable Aviation Fuel, SAF) vähentää kasvihuonekaasupäästöjä noin 80 prosenttia kun käytettynä 100 % tuotteena. Lähes 50 lentoyhtiötä maailmalla on kokeillut uusiutuvan lentopolttoaineen käyttöä. Nykyinen SAF-seossuhteen hyväksytty maksimi on 50 prosenttia. Uusiutuva lentopolttoaine on niin sanottu drop-in -polttoaine eli se toimii nykyisten lentokoneiden suihku- ja potkuriturbiinimoottoreissa. Uusiutuvalla lentopolttoaineelle ei tällä hetkellä ole erillisiä jakelukanavia, vaan tuote sekoittuu lentokentillä tankattavaan fossiiliseen lentopolttoaineeseen.”

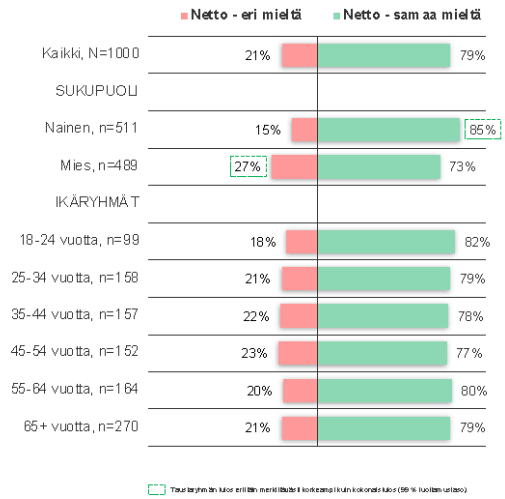
Intro: Lentoteollisuus vastaa n. 2 % globaaleista kasvihuonekaasupäästöistä ja on yleisesti sitoutunut nettonolla-päästöihin vuoteen 2050 mennessä.

Kasvihuonekaasupäästöt – Tuhat suomalaista / kesäkuu 2022

Uusiutuva lentopolttoaine lentämisen päästöjen vähentämisessä

"Uskon, että uusiutuva lentopolttoaine on yksi tärkeimmistä keinoista vähentää lentämisen päästöjä nyt ja tulevaisuudessa."





Esimerkkejä perusteluista

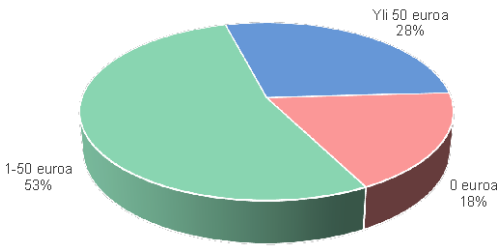
"Uskon, että uusiutuva lentopolttoaine on yksi tärkeimmistä keinoista vähentää lentämisen päästöjä nyt ja tulevaisuudessa - Perustelut"
On samaa mieltä väittämän kanssa

Intro: 100 % käytettynä uusiutuva lentopolttoaine pienentää lentämisen hiilijalanjälkeä jopa 80 % verrattuna fossiiliseen lentopolttoaineeseen 100 % käytettynä.

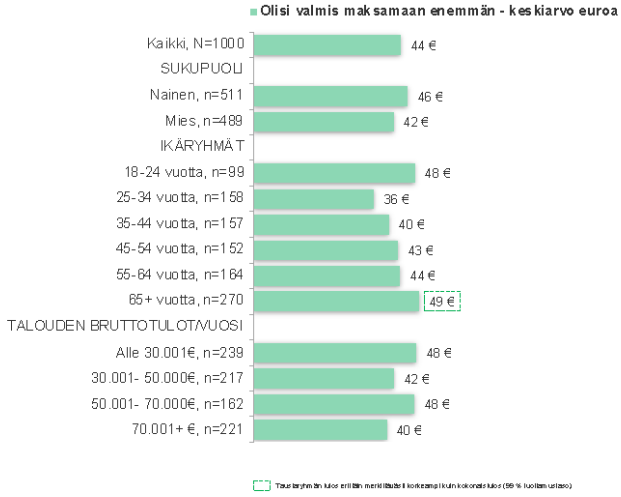
Valmius maksaa enemmän uusiutuvan lentopolttoaineen käytöstä

"Kuinka paljon olisit valmis maksamaan enemmän täysin uusiutuvan lentopolttoaineen käytöstä lisää tyypillisellä n. 200 euroa maksavalla Helsinki-Lontoo -lennolla?"

Kaikki vastaajat, N=1000



Keskimäärin 44 euroa enemmän



Kasvihuonekaasupäästöt – Tuhat suomalaista / kesäkuu 2022

Esimerkkejä perusteluista

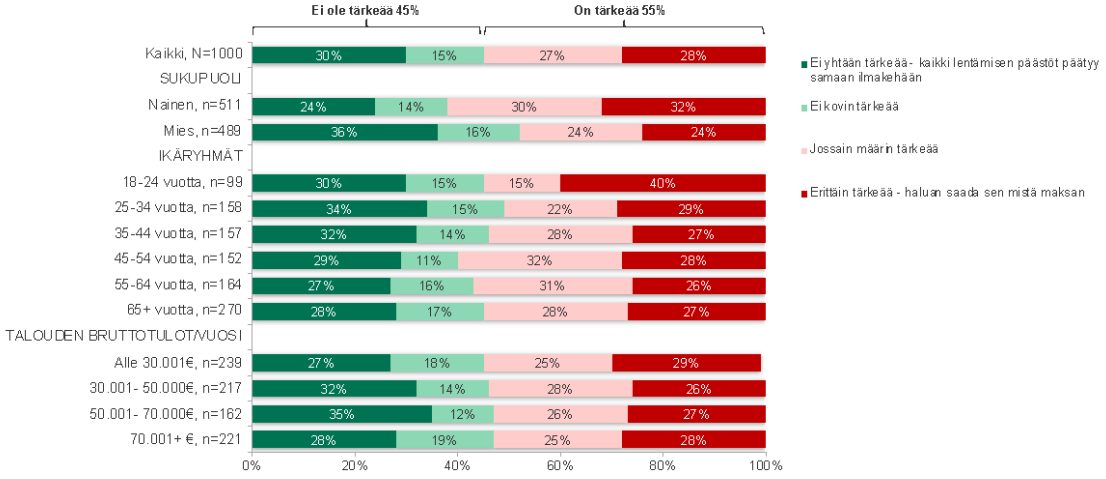
"Kuinka paljon olisit valmis maksamaan enemmän täysin uusiutuvan lentopolttoaineen käytöstä lisää tyypillisellä n. 200 euroa maksavalla Helsinki-Lontoo –lennolla? – Perustelut"

Intro: Tällä hetkellä uusiutuvaa lentopolttoaineita toimitetaan lentokoneisiin massabalanssilla (kuten uusiutuva sähkö), eli uusiutuva osuus sekoitetaan normaalin fossiiliseen lentopolttoaineen joukkoon. Käytännössä nykymallissa on mahdotonta lentokentillä kohdentaa uusiutuvat molekyylit koneeseen, joka varsinaisesti ostaa ko. tuotteen ja päästövähenemän.

Kasvihuonekaasupäästöt – Tuhat suomalaista / kesäkuu 2022

Lisämaksujen kohdentuminen juuri omiin lentoihin

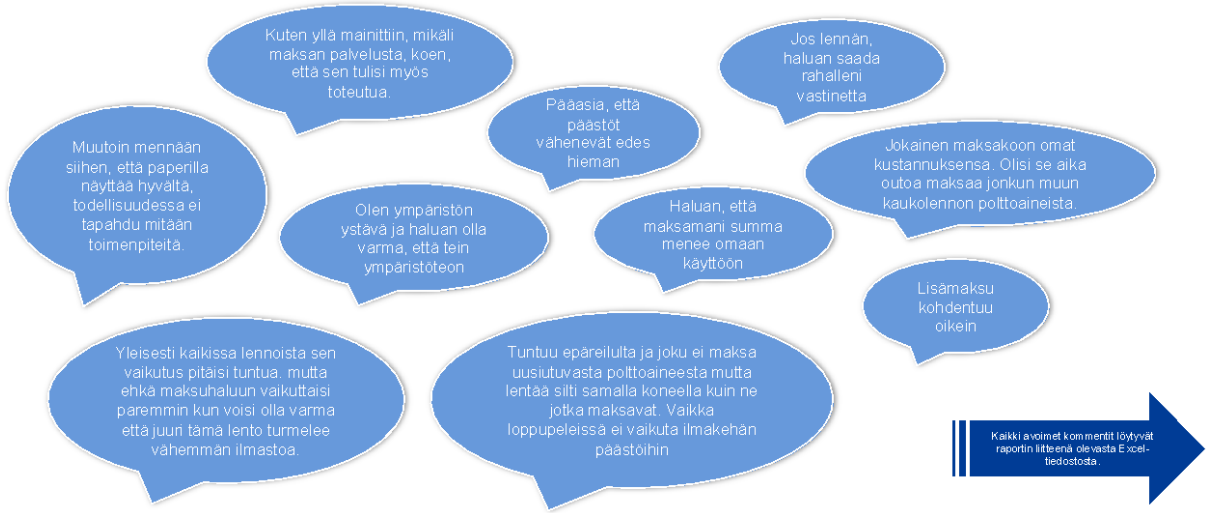
"Jos maksat lisää uusiutuvasta lentopolttoaineesta, kuinka tärkeää sinulle olisi, että se käytetään juuri siinä lentokoneessa, jolla lennät?"



Esimerkkejä perusteluista

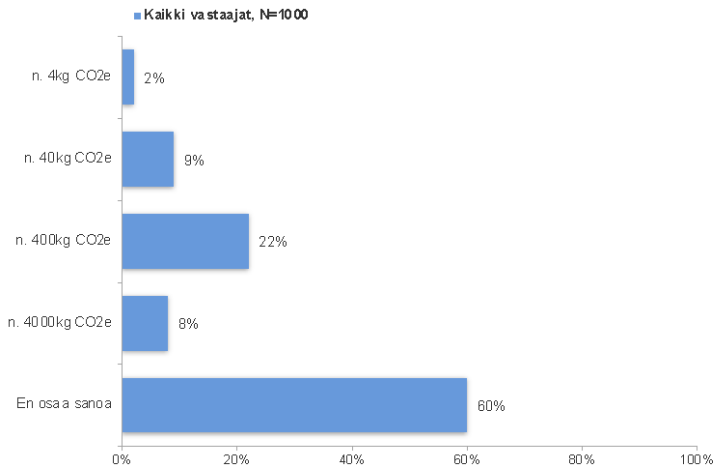
"Jos maksat lisää uusiutuvasta lentopolttoaineesta, kuinka tärkeää sinulle olisi, että se käytetään juuri siinä lentokoneessa, jolla lennät? – Perustelut"

Lisämaksujen kohdentuminen omiin lentoihin <u>on tärkeää</u>



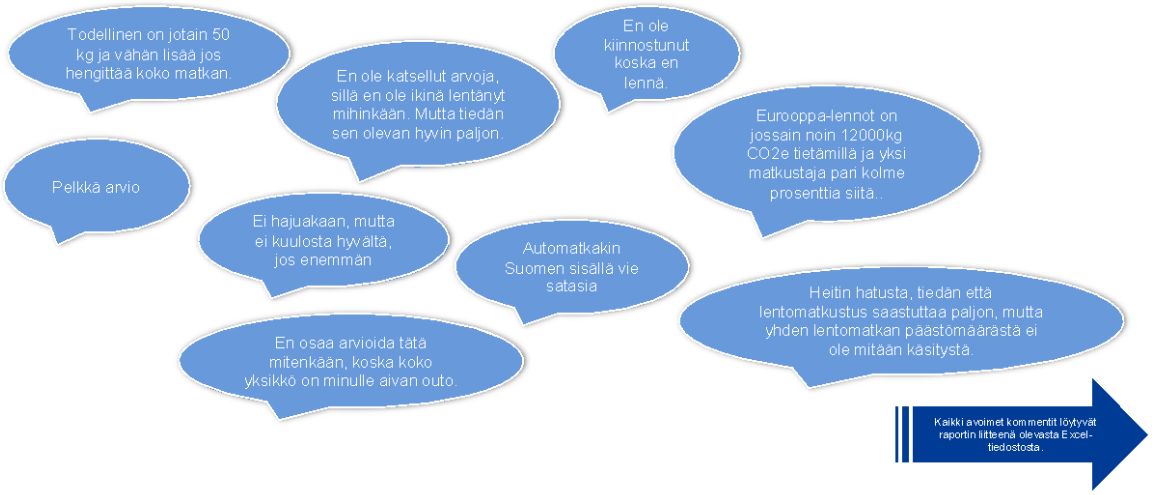
Arvio kasvihuonepäästöjen suuruudesta

"Arvioi kuinka paljon yksi economy-luokan matka Helsingistä Lontooseen tuottaa kasvihuonekaasupäästöjä."



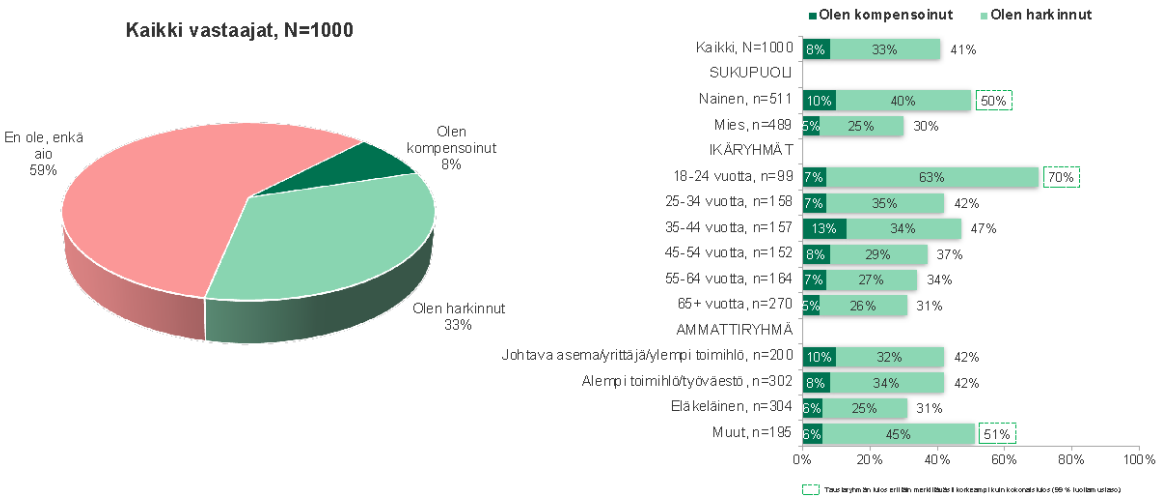
Esimerkkejä perusteluista

"Arvioi kuinka paljon yksi economy-luokan matka Helsingistä Lontooseen tuottaa kasvihuonekaasupäästöjä. – Perustelut"



Omien lentomatkojen päästökompensointi

"Oletko harkinnut päästökompensoida omien lentomatkojesi kasvihuonekaasupäästöjä?"



Esimerkkejä perusteluista

"Oletko harkinnut päästökompensoida omien lentomatkojesi kasvihuonekaasupäästöjä? – Perustelut"
On kompensoinut tai on harkinnut

Kun olen lentänyt edellisen kerran, päästökompensaatiota ei ole ollut saatavilla. Nyt jos lentäisin, kompensoisin ehdottomasti.

Kiinnitän huomiota omaan hiilijalanjälkeeni

Kaikki mahdollinen on tehtävä lastemme tulevaisuuden puolesta.

Se on kätevin tapa

En lennä. Tulevaisuudessa selvitän mahdollisuuksia kompensoida

Tähän saakka kompensointini on perustunut siihen, että lennämme vähän ja elämme muuten suomalaisen keskiarvon reilusti alittavaa, vähäpäästöistä elämää, mutta olen kyllä Antero Vartian yrityksen perustamisen tiimoilta pohtinut ihan suoraa kompensaatiotakin.

Vielä ei oikein ole näyttöä mielestäni tehdäänkö asialle mitään vai kerätäänkö vaan rahat.

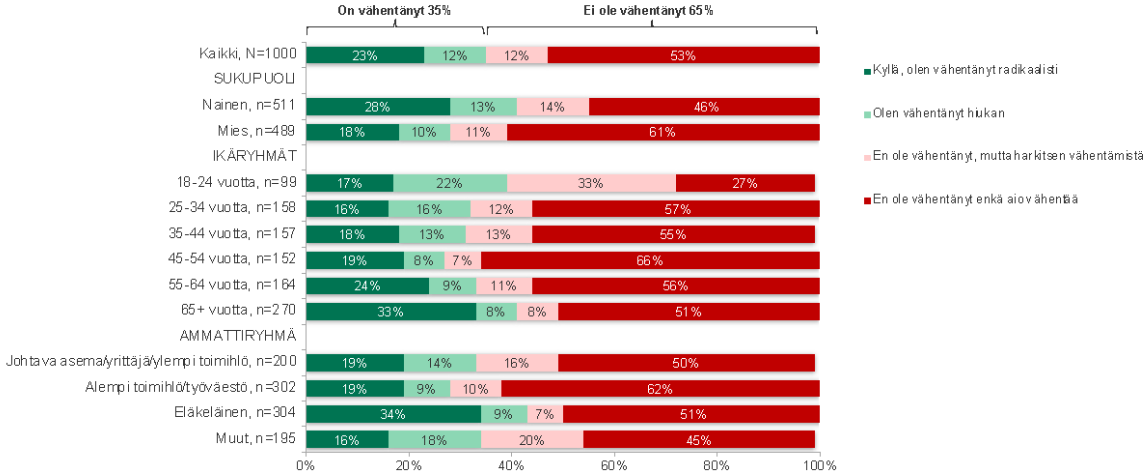
En vielä ole lennellyt tai varaillut lentoja itse, joten teen sitä ihan mielelläni, kun se tulee ajankohtaiseksi. Haluan auttaa pitämään maapallon mahdollisimman hyvänä paikkana <3

En ole lentänyt 8 vuoteen joten ei ole tarvinnut. Jos lennän tulevaisuudessa, kompensoin

Kaikki avoimet kommentit löytyvät raportin liitteenä olevasta Excel-tiedostosta.

Lentämisen vähentäminen päästöjen takia

"Oletko vähentänyt lentämistä sen aiheuttamien päästöjen takia?"



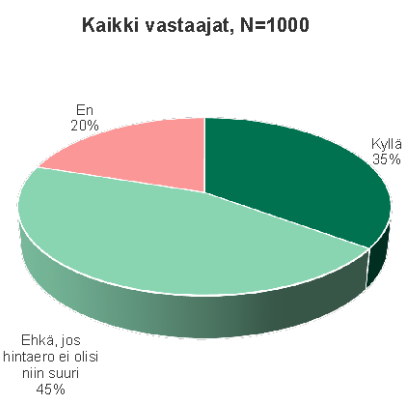
Esimerkkejä perusteluista

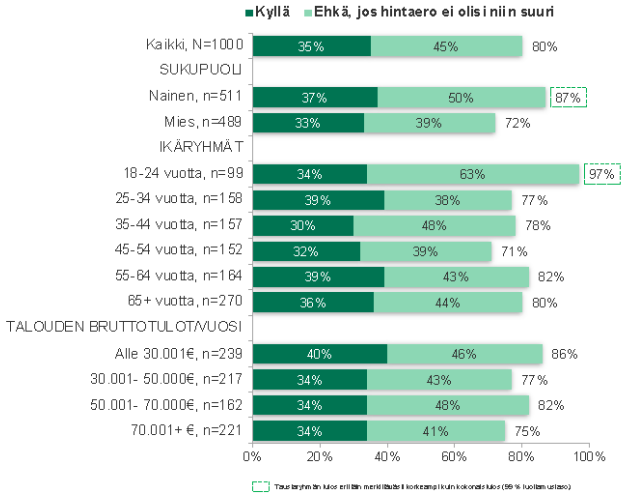
"Oletko vähentänyt lentämistä sen aiheuttamien päästöjen takia? – Perustelut"

***On vähentänyt** lentämistä radikaalisti tai hiukan*

Uusiutuvan lentopolttoaineen käyttö hinnan noususta huolimatta

"Toivoisitko, että lentoyhtiöt käyttäisivät enemmän uusiutuvaa lentopolttoainetta vaikka se nostaisi lentolippujen hintaa jopa puolella (50 %)?"





Esimerkkejä perusteluista

"Toivoisitko, että lentoyhtiöt käyttäisivät enemmän uusiutuvaa lentopolttoainetta vaikka se nostaisi lentolippujen hintaa jopa puolella (50 %) – Perustelut"
Kyllä toivoisi tai ehkä, jos hintaero ei olisi niin suuri

Taulukot ja avoimet kommentit


Taulukot


Avoimet

Taulukoiden lukuohje

- Taulukoissa sinisellä tekstillä on väritetty ne rivit, jotka kertovat vastaajien lukumäärän.
- Kun jokin prosenttiluku on taulukossa kirkkaan vihreällä tai pinkillä alustalla, tarkoittaa se sitä, että kyseinen tulos eroaa merkitsevästi vastaavasta kokonaistuloksesta 99 %:n luottamustasolla, eli se voisi olla sattumasta johtuva vain yhdessä tapauksessa sadasta. Vihreällä merkityt eroavat merkitsevästi ylöspäin ja pinkillä merkityt alaspäin.
- Kun luku on taulukossa vaalealla vihreällä tai pinkillä alustalla, on ero merkitsevä 95 %:n tasolla.

References

Appendices

Appendix 1. xxx