Every Molecule (of CO2) Counts: General Aviation Pilots' Acceptance of a New Automatic Digital Pilot Logbook-Based Carbon Emissions Calculator with Carbon Offsetting Functionality

Michael Stiebe[1,2], Matthias Niederhäuser[3], Andreas Ryser[4], Widar von Arx[1]

[1] Lucerne University of Applied Science and Arts, Institute of Tourism and Mobility ITM, Competence Center for Mobility CCM
[2] University of Basel, Graduate School of Business and Economics (GSBE)
[3] volunt.aero (CEO), Niederhäuser Solutions GmbH
[4] Aero-Club Switzerland AeCS

Introduction and Research Aim

While the industry, researchers, and political stakeholders are investing substantial efforts into the sustainability transformation and decarbonization of commercial aviation, General Aviation (GA) keeps mostly flying under the sustainability radar. GA has a high-aged fleet (avg. 50 years [1]) dominated by small piston-engine-powered aircraft whose engines are primarily fueled by leaded aviation gasoline (AVGAS 100LL). Even if GA accounts for only less than 1% of civil aviation's CO_2 emissions [2, 3, 4] and the external political and societal pressure on GA are still relatively low, the internal pressure within the GA community to facilitate a transition towards sustainability is remarkably high, especially to send "positive signals". Recent research in Switzerland showed that 79% of the GA community consider sustainability be highly important in GA [5]. Considering the high average fleet age, the still limited possibilities of available electric planes (e.g., Pipistrel Velis Electro), the current lack of sustainable aviation fuel (SAF) solutions for airplane piston engines, and the low fleet renewal and innovation rate, one of the most feasible decarbonization solutions for the next few decades and the sustainability transition is carbon offsetting via various methods (e.g., tree planting projects, SAF book & claim, direct air capture etc.). To date, only 6% of GA pilots compensate their flight emissions [5]. But even if pilots want to offset their carbon emissions, this still necessitates substantial manual data input to calculate the CO2 calculations for a GA flight. In a 2022 survey, more than 50% of GA pilots expressed their support for a potential digital logbook-integrated CO2 calculator [5] Studies have shown that the willingness of people to adopt sustainable technologies and behaviors (e.g., voluntary carbon offsetting (VCO)) increases with heightened emissions awareness and perceived ease of use [6-9]. While VCO is a relatively common practice and highly available in commercial aviation contexts (e.g., via compensaid, myclimate etc.), such easy-to-use solutions, or even logbook/aircraft registry coupled solutions, are not present in the GA market.

This paper presents first results from an ongoing (02/23-12/23) Swiss Innovation Agency (*Innosuisse*)-funded research cooperation between Lucerne University of Applied Sciences and Arts HSLU and the start-up company *volunt.aero* providing GA pilots with a solution to quantify and offset their GA-related carbon emissions via various methods. Hence, SAF is a Jet-A1 (kerosene) fuel substitute, most private pilots cannot profit from SAF. However, volunt.aero will offer a "book & claim" solution, where private pilots can compensate their emissions via buying SAF for commercial flights which will be then filled into airliners. The research, focusing on the DACH market, addresses several questions, among others:

1) How high are the a) user acceptance of volunt.aero as a standalone and logbook-integrated solution, and b) willingness to voluntarily offset GA-related carbon emissions?
2) Which compensation methods are preferred by the GA-community?

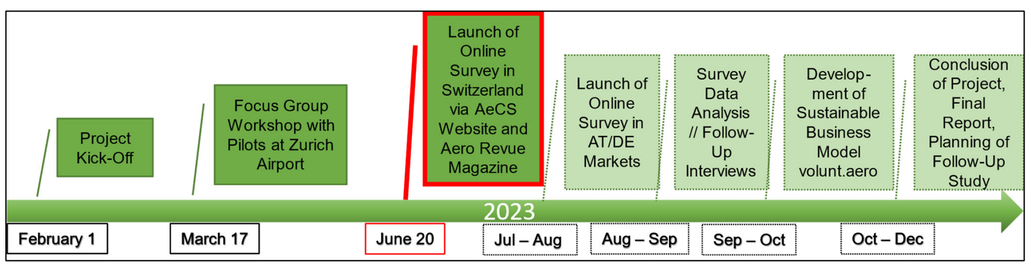

Figure 1. Simplified Research Project Timeline

Theoretical Perspective

The research is based on a pragmatism-rooted mixed-method approach combining both qualitative and quantitative research methods. The employed methods are secondary research/market analysis, focus group interview, quantitative survey, and follow-up qualitative interviews.

The theoretical frame of this research draws on two pertinent concepts, namely the Geelsean Multi-Level Perspective (MLP) on Sustainability Transitions [10], and Green Technology Acceptance Model (GTAM) proposed by Chen and Lu [11]. The GTAM is based on Davis' Technology Acceptance Model, however, alters the original "perceived usefulness" to "green perceived usefulness" referring to the extent to which individuals believe that the technology in question will improve the environmental performance of some part of their life within a specific context, in this case volunt.aero emissions calculation and VCO offers.

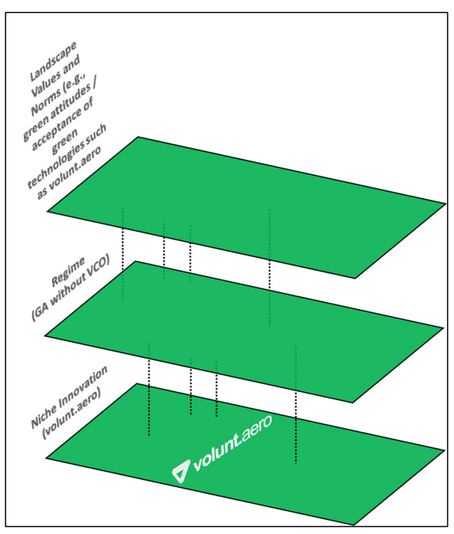

Figure 2. Adapted MLP for volunt.aero

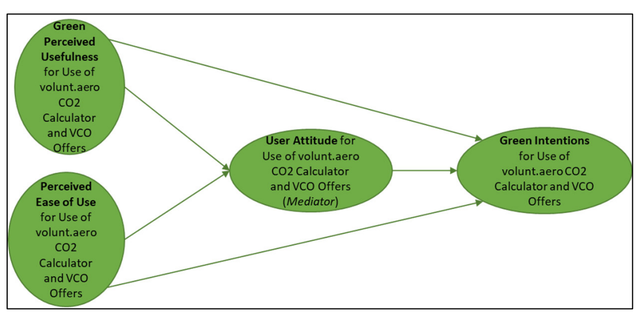

Figure 3. Adapted GTAM for volunt.aero

Methods

Since the survey was just launched recently and the sample is still too low for quantitative analyses, this section will present results from the market analysis, as well as the approximately 4-hour long focus group discussion at Zurich Airport on the 17th of March, 2023 that aimed at finding out what the critical views private pilots have on various compensation options and how compensation costs, geographic context of the compensation (e.g., tree planting in Nicaragua vs. Swiss forest conservation projects), and U.S. SAF subsidization policies for influence the pilots' views on compensation methods.

The focus group contained a simulation game in which the participants had a certain monetary budget (poker chips) to allocate to a selection of four offsetting methods (favorite compensation mix), i.e., 1) SAF Book & Claim, 2) Traditional Climate Protection Initiatives (e.g., tree planting), 3) Support of Academic Sustainable Aviation Research or Start-Up Companies (e.g., ETHZ e-Sling), and 4) Technological Climate Protection Initiatives (e.g., Direct Air Capture via climeworks). Before the simulation started, the pilots received brief introductions of each method and its way of functioning.

Round 1:
- Pilots had to express their compensation preferences without further information on the methods' costs or any SAF subsidization schemes

Round 2:
- Pilots were provided with information on the actual costs of the offsetting methods as well as the American SAF subsidization policies

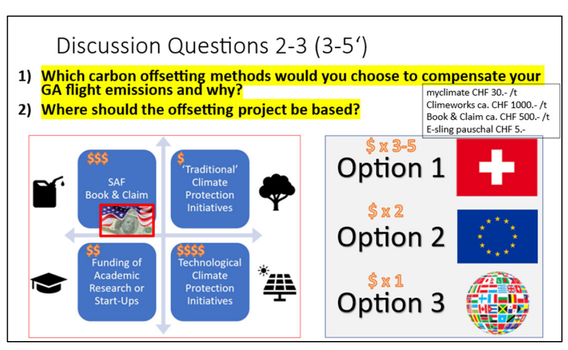

Figure 4. Round-2 Slide from Focus Group Game

Figure 5. Pilots Expressing Offsetting Method Preferences

Results

Market Analysis
- There currently is no equivalent product or directly comparable service in the DACH economic region comparable to volunt.aero
- Some slightly similar services include: 4AIR (USA), CLEAN SKY AVIATORS (Germany), aerops (Germany), myclimate (Switzerland)
- Potential market size for volunt.aero relatively small in DACH, but attractive due to first mover advantage

Table 1. Market Size Estimation for DACH (License Data from 2021)

		Estimated Market Sizes		
Country	**PPL(A) Licenses (2021)**	**20%**	**15%**	**10%**
Germany	21000	4200	3150	2100
Austria	3908	782	586	391
Switzerland	4363	873	654	436
Total	**29271**	**5854**	**4391**	**2927**

Focus Group Discussion
- Preferences for ideal compensation **mixes changed substantially after information on cost differences**, and geographically-related cost differences
- **SAF book & claim clearly preferred option by most pilots**
- **DAC is a liked option, but too expensive for most pilots**
- Logbook-integration appreciated, but many do not have digital logbook yet

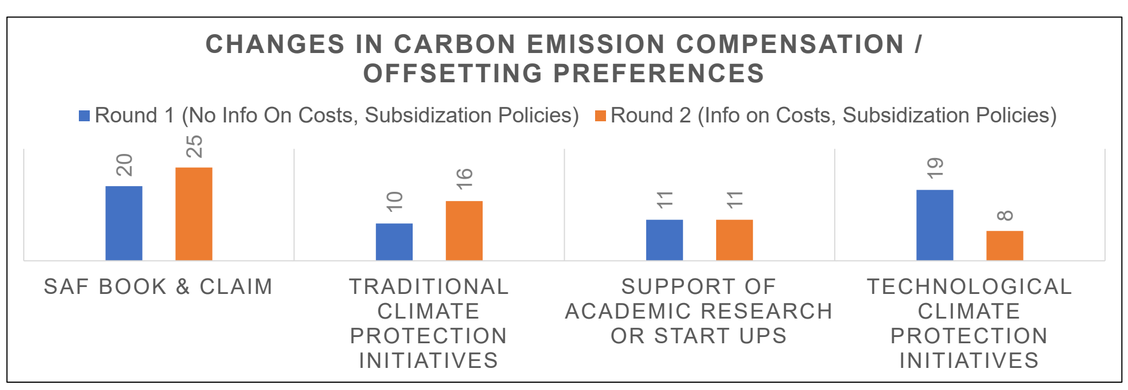

Figure 6. Changes in Offsetting Preferences (Before/After Price and Subsidization Info was Provided)

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