THE IMPORTANCE OF GREEN HYDROGEN INFRASTRUCTURE FOR H2-POWERED AIRCRAFT – REVIEW AND RESEARCH GAPS

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Abstract

In the light of global directives pushing society towards climate neutrality, the hard-to-abate sector of aviation is increasingly under pressure to reduce its climate footprint. One potential lever to address this challenge is the introduction of aircraft powered by green hydrogen (H2) which would enable zero-carbon flights. However, the aviation industry is highly cost driven and the economy of flying with green H2 as a fuel is not fully determined yet. While previous research already focused on comprehensive technology evaluations for H2-powered aircraft technology and its cost, analyses on infrastructure-related cost factors are rarely undertaken.

Therefore, this paper aims to provide a holistic overview of previous efforts and introduces a new approach to assess the importance of a H2 infrastructure enabling H2-powered aviation. Moreover, two reference designs (Table 1), a short- and a medium-range aircraft, are modeled and modified with a H2 propulsion system. Based on these, a detailed cost analysis is carried out, comparing both aircraft related and infrastructure related direct operating cost (DOC).

It is found that the integration of H2 combustion engines and LH2 tanks on-board the aircraft causes a cost increase of aircraft capital expenditures (CAPEX) and maintenance. This might lead to a total DOC increase of 5% and 6% for the short- and medium-range design, respectively. In contrast to that, the price for liquid H2 (LH2) supply might increase DOC fuel cost compared to kerosene by a factor 2.4 to 6.7 depending on the scale up of a global H2 economy driven by H2 demands (FIG 1). Overall, this underlines that the economy of H2-powered aviation highly depends on the availability of low-cost, green LH2 supply infrastructure, since total DOC might increase between 8-58% (short-range) and 13-86% (medium-range) due to LH2 cost alone (FIG 2).

In a final step, a detailed research agenda is derived for future work based on the identified gaps in the literature survey and the cost assessment for LH2 supply cost. It highlights the importance of investigating local and global H2 supply and demand setups for aviation, their interconnections to other H2 and Power-to-X applications, their integration into air traffic transport networks and the need for multi-criteria evaluation of such infrastructure setups.

Keywords: Hydrogen Aviation, Hydrogen Fuel Supply, Liquid Hydrogen, DOC model

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Table 1: Fossil aircraft reference data for short-range and medium-range segment

Parameter	Unit	Short-Range	Medium-Range
Design Range	nm	1500	4000
Design PAX	-	180 (single class)	290 (Two class layout)
Cruise Mach-Number	-	0.78	0.83
Design Block-Fuel	t	6.1	33.7
MTOM	t	65	171
OEM	t	40	105
Entry Into Service	-	2035	2035
Flight Cycles p.a.	-	1591 (for 800nm)	932 (for 2000nm)

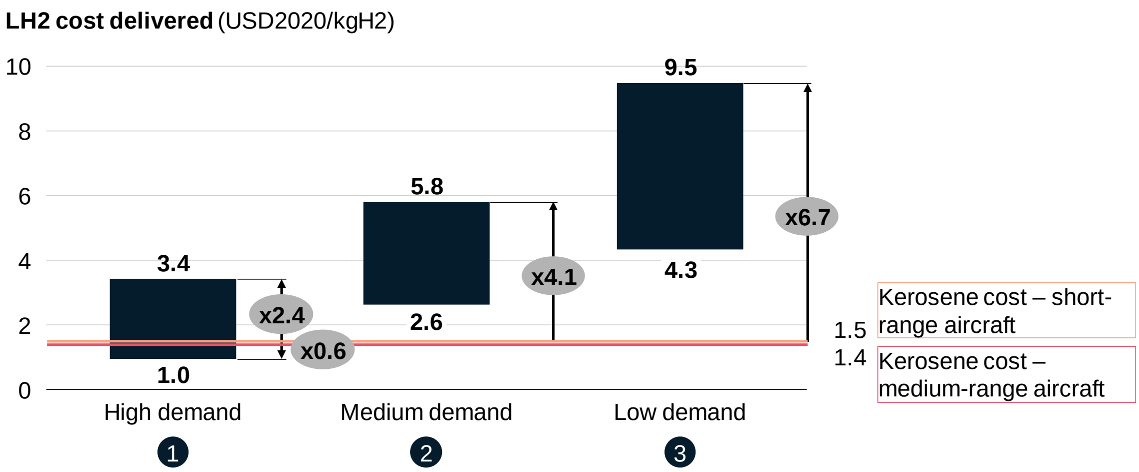

FIG 1: Cost ranges for liquid hydrogen at the dispenser derived from literature review and cost model depending on the hydrogen demand scenario (from low to high demand); comparison to kerosene cost for short- and medium-range aircraft translated into LH2-equivalent cost

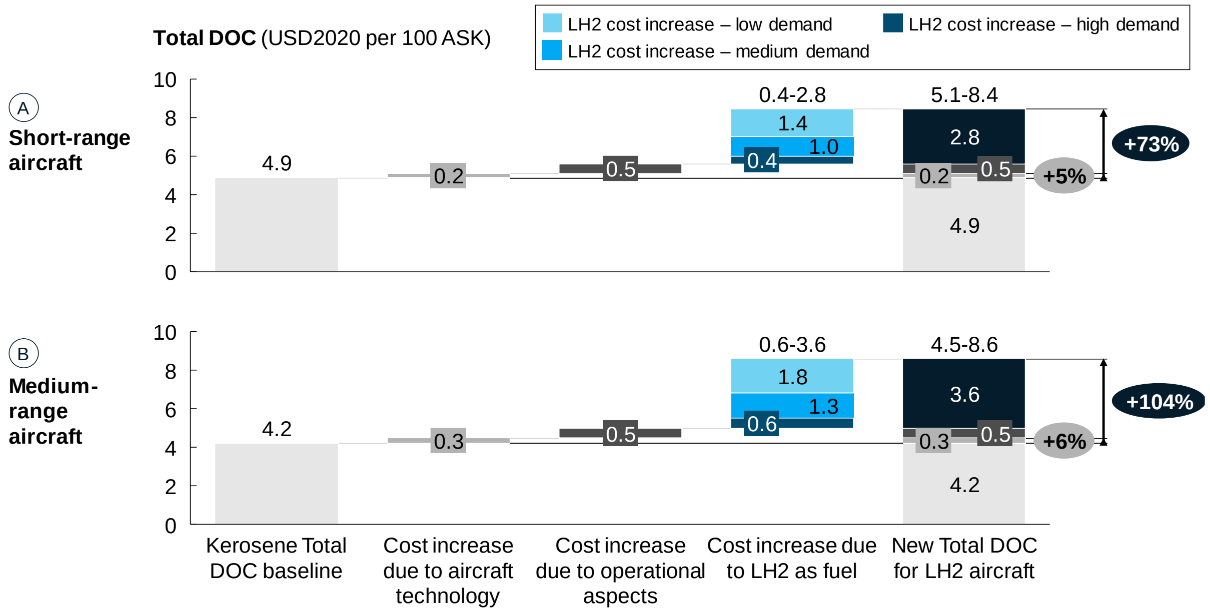

FIG 2: Total direct operating cost (DOC) for A) short-range and B) medium-range H2-powered aircraft compared to a kerosene-powered reference aircraft