13th EASN International Conference – Salerno (Italy), September 5-8, 2023

Sizing of Airport Infrastructures in Support to Hydrogen-Powered Fleets

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As the interest in hydrogen as an energy source for future aircraft is boosting worldwide, numerous studies are being pursued to envisage airframes designed to accommodate innovative propulsion systems, based on fuel-cells or turboengines. The impact of such a radical transformation on the whole civil aviation system cannot be understated, starting with the radical transformation of infrastructural requirements. As a contribution to solving this problem, the present paper presents the AHRES (Airport Hydrogen Refuelling Equipment Sizing) methodology focused on the sizing of airport infrastructures in support of H_2-powered commercial fleets.

AHRES application provides an estimate of the required infrastructural needs based on the knowledge of the airport's flight schedule and the characteristics of the operating aircraft. The latter are retrieved by applying the HYPERION airplane preliminary sizing tool, which outputs candidate design solutions for H_2-powered aircraft, thus delivering the corresponding hydrogen quantities to be loaded on board for any mission of interest. With these data, AHRES defines an optimal solution to the sizing of the complex airport equipment, including the hydrogen generator (for on-site production), the liquefier, the storage tank, and the dispensing units. Optimality is based on minimizing the total cost, comprised of the procurement of all equipment items and the energy purchased from the grid. The output is the sizing of each item, supplemented by the optimal time scheduling of production, storage, and delivery operations. This eventually provides the cost of H_2 per unit mass "at the pump", a decisive piece of information for the overall feasibility of the hydrogen revolution.

Application studies are illustrated, including the reconfiguration of two existing aerodromes, a large regional airport and a major international hub. For the Athens International Airport (ICAO code: LGAV), we restricted to the needs to support a regional fleet composed of fuel-cell-powered aircraft. For a possible realistic scenario, Figure 1 shows the time histories of the hydrogen mass stored in the cryogenic tank (H2 in ST) and the delivered to the airplanes (H2 to DU), supplemented by the airport's flight schedule (Departures). The case of the Malpensa International Airport (LIMC) is also discussed, with results related to H_2-burning airliners.

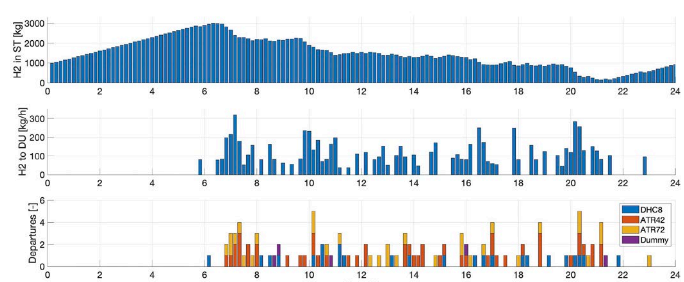

Figure 1: AHRES optimal time operations of hydrogen on-site generation (top) and delivery (middle) related to the departure scheduling (bottom) for the LGAV case study