Can hydrogen or natural gas be alternatives for aviation? – A life cycle assessment

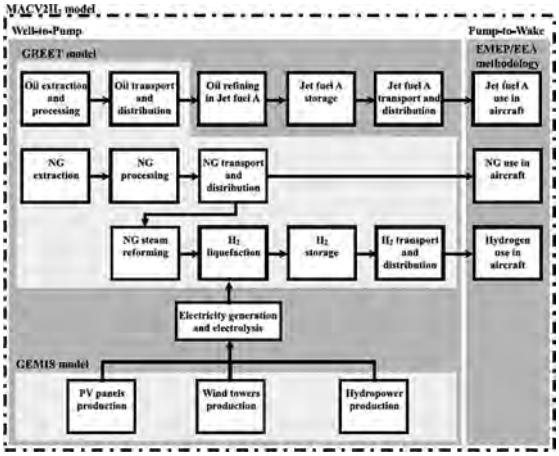
Sérgio R. Pereira[1], Tânia Fontes[1], Margarida C. Coelho[1]

1 — Department of Mechanical Engineering & TEMA, University of Aveiro

The main objective of this research was to evaluate promising alternative fuels in the aviation sector using Life Cycle Assessment (LCA) approach. Liquid natural gas (LNG) and liquid hydrogen ($L.H_2$) produced by different sources were compared with jet fuel A. Steam reforming (SMR) and the electrolysis with electricity from renewable sources (wind, photovoltaic and hydro energy) were considered in the $L.H_2$ production.

Energy consumption and pollutant emissions from the production of the renewable and non-renewable technologies were evaluated, which means that all stages of LCA were considered. Figure 1 presents the main steps of this methodology. In Well-to-Pump (WTP) and Pump-to-Wake (PTW) analysis the Model for Life Cycle Assessment for Hydrogen ($MACV2H_2$_v2.0) was used. This model is the second version of a numerical platform developed by Pereira and Coelho.

Figure 2 presents the energy consumption for the WTW approach for all considered aircrafts in the two flights type (short-range and long-range), also considering the aircraft capacity. Hydrogen is presented as a very competitive solution with respect to energy consumption and environmental costs. Even $L.H_2$ produced by fossil energy sources (SMR) and applied to aircrafts has 8% lower energy consumption than the same aircraft with jet fuel A. The best solution comes from renewable energy sources for hydrogen production. $L.H_2$ obtained by electrolysis with electricity from hydro energy and applied to the aircrafts allows a reduction in environmental costs between 51% and 60% (depending on the type of aircraft and flight) in relation to the same aircraft with jet fuel A. For energy consumption the reduction is 19%. Furthermore, $L.H_2$ from hydro energy presents 80% and 84% less fossil fuel consumption than jet fuel A and LNG, respectively.



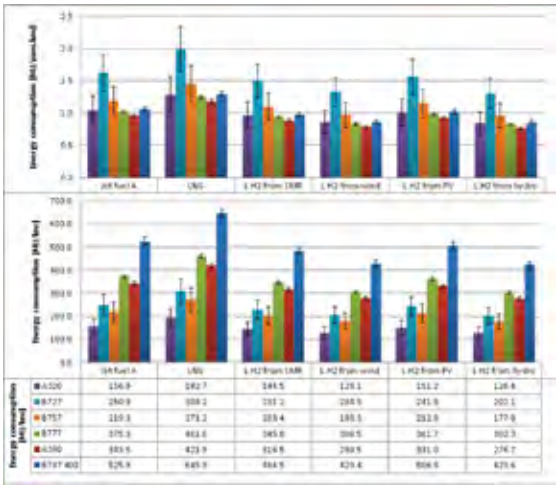


FIGURE 1
Methodological framework in the well-to-wake approach for aviation.

FIGURE 2
Energy consumption (MJ/km and MJ/pass.km), for short and long-range aircrafts, using WTW approach.