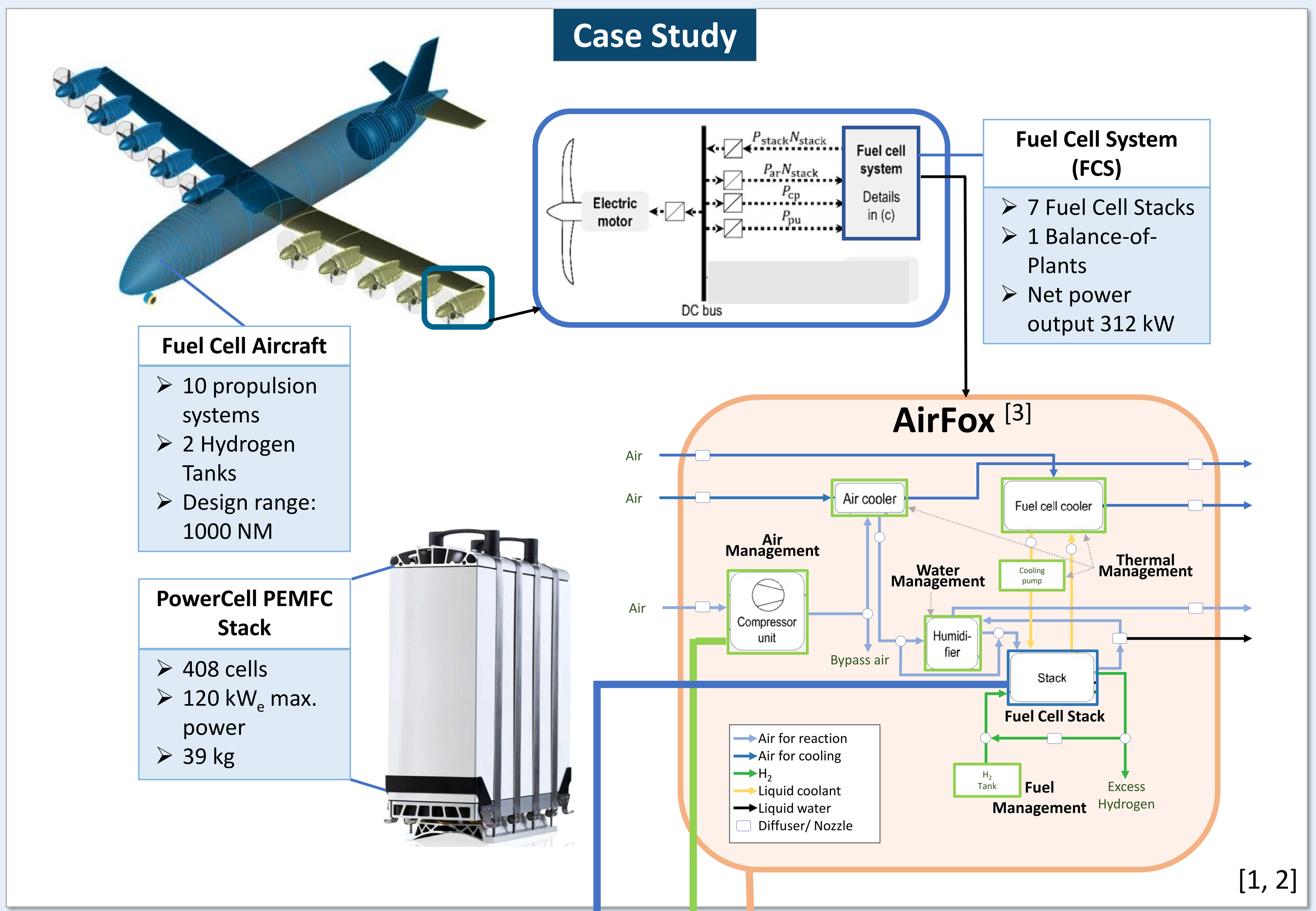
#ArchitectingAviation

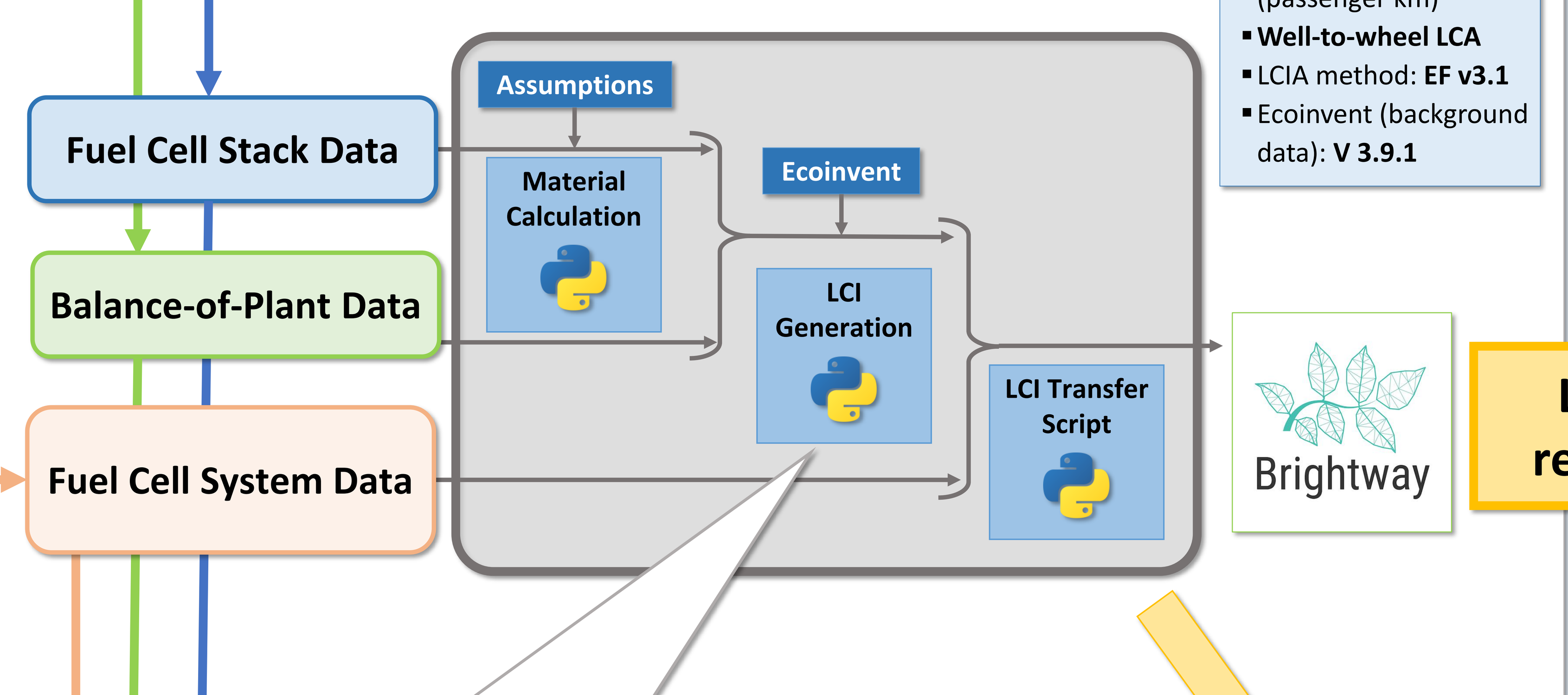
Life cycle assessment of an aircraft fuel cell system

Automated LCI Framework for Fuel Cell Systems in Regional Aircraft using AirFox Data: Enabling Flexible Data Input and Environmental Impact Analysis for Various Aircraft Sizes and Flight Missions.

Case Study



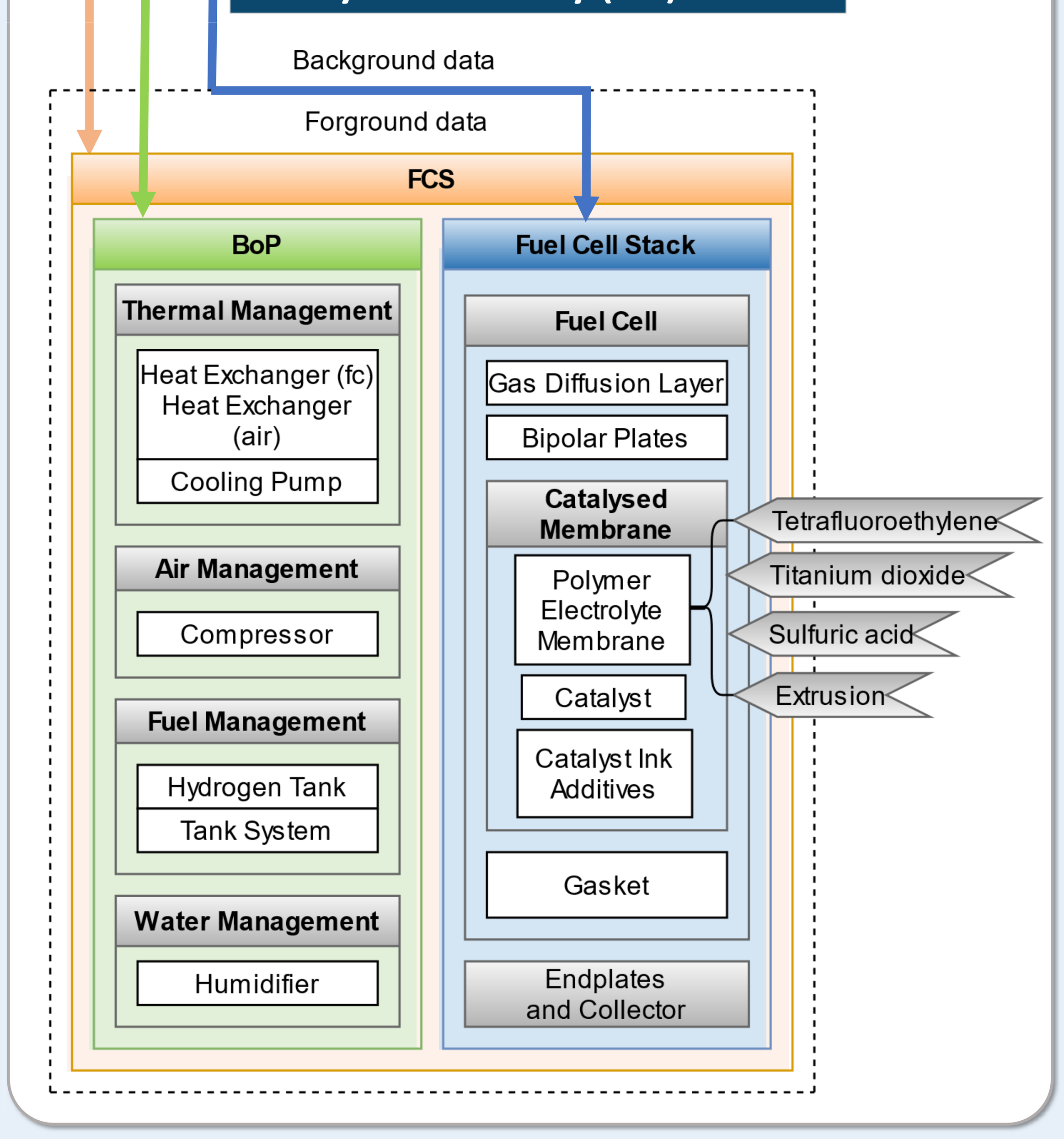
Methodology



- Functional unit: **1 pkm** (passenger km)
- **Well-to-wheel LCA**
- LCIA method: **EF v3.1**
- Ecoinvent (background data): **V 3.9.1**

LCIA results

Life Cycle Inventory (LCI) for FCS

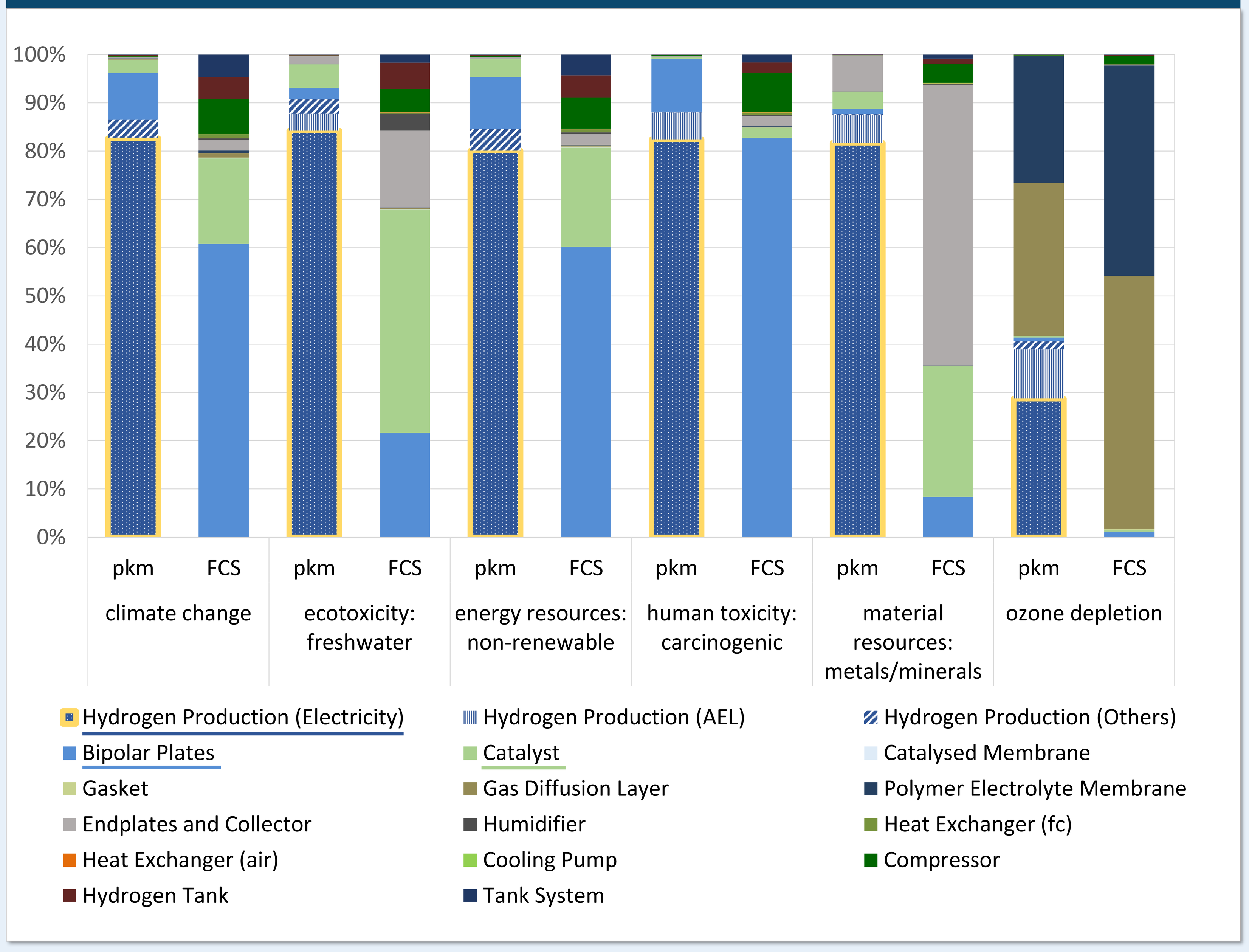


Python Tool Development

Flexible and adaptable python tool for AirFox-LCI coupling

- Flexible, parametrizable datasets
- Easy input modifications for component weight calculations
- Automates life cycle inventory generation
- Promotes data reuse across applications
- Accommodates various aircraft sizes and missions

Environmental Impact Breakdown: 1 FCS and 1 pkm



Major Impact Contributors

1 FCS: Catalyst and bipolar plates

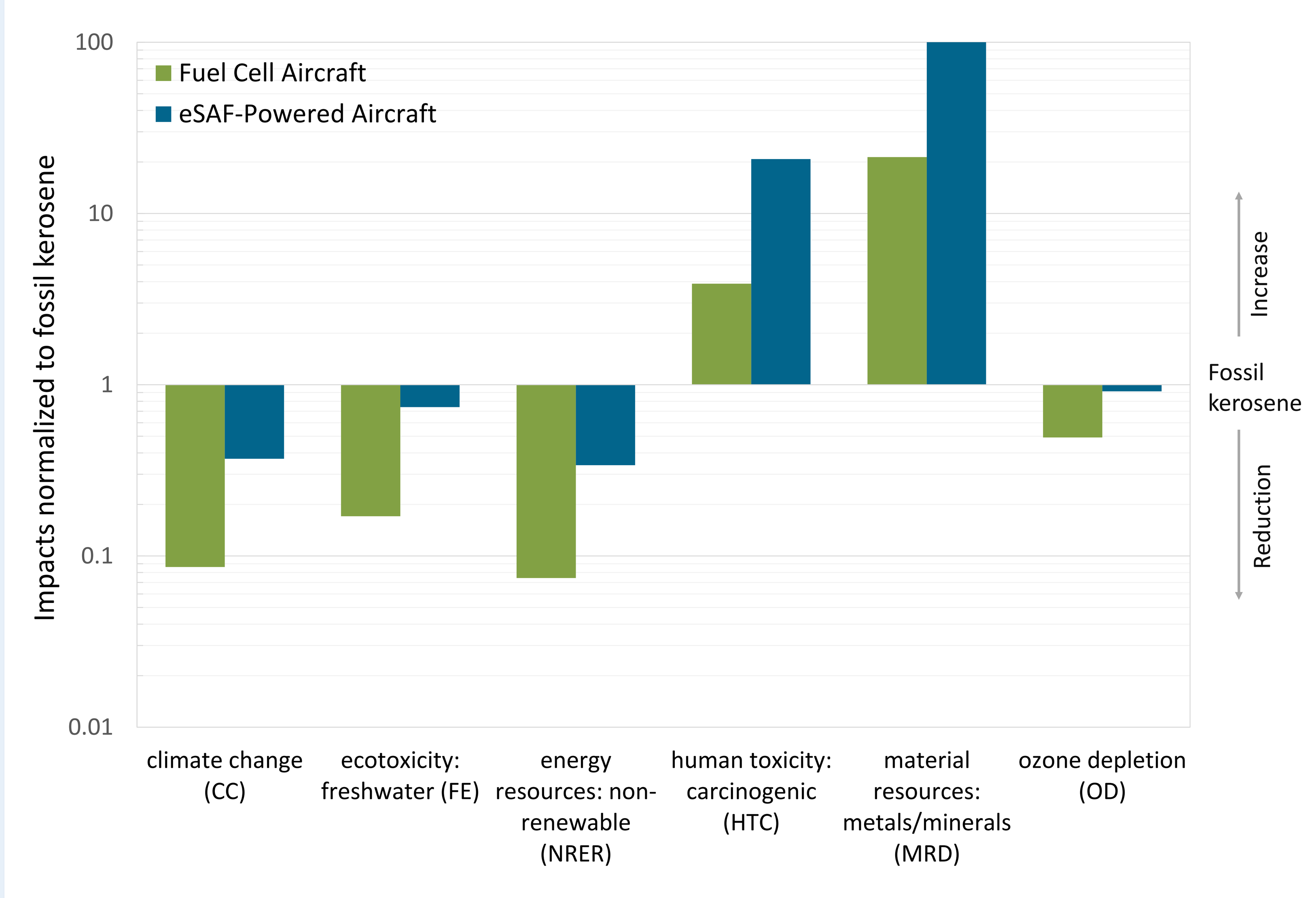
1 pkm: German wind electricity for hydrogen production

Simplified Impact Comparison

Lower impact of Fuel Cell Aircraft compared to eSAF Aircraft:
Mostly due to lower electricity consumption during fuel production

Higher impacts in comparison to Fossil Kerosene:
HTC: Chromium and mercury emission from wind turbine production
MRD: Longer supply chain

Simplified Impact Comparison (1 pkm)
Fuel Cell Aircraft vs. eSAF Aircraft[5] vs. Fossil Kerosene Aircraft



[1] Schröder *et al.* (2024), Optimal design of proton exchange membrane fuel cell systems for regional aircraft
[2] P Stack Datasheet, p-stack-v-221.pdf (powercellgroup.com)
[3] DLR Fuel Cell System Design Tool (AirFox) (https://www.dlr.de/de/tt/forschung-transfer/forschungsinfrastruktur/modellierungswerkzeuge/airfox/airfox)
[4] Mutel (2017), Brightway: An open source framework for Life Cycle Assessment
[5] Rojas-Michaga *et al.* (2023), Sustainable aviation fuel (SAF) production through power-to-liquid (PtL): A combined techno-economic and life cycle assessment

Contact
Rahnuma Bhuiyan Evon
Institute of Engineering Thermodynamics
rahnuma.evon@dlr.de

Contact
Julia Weyand
Institute of Engineering Thermodynamics
julia.weyand@dlr.de