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# ECONOMIC EVALUATION OF NEW AIRCRAFT TECHNOLOGIES FOR SHORT RANGE AIRCRAFT: INSIGHTS FROM PROJECT EXACT

**Jennifer Ramm**

German Aerospace Center (DLR e.V.)

Institute of Maintenance, Repair and Overhaul



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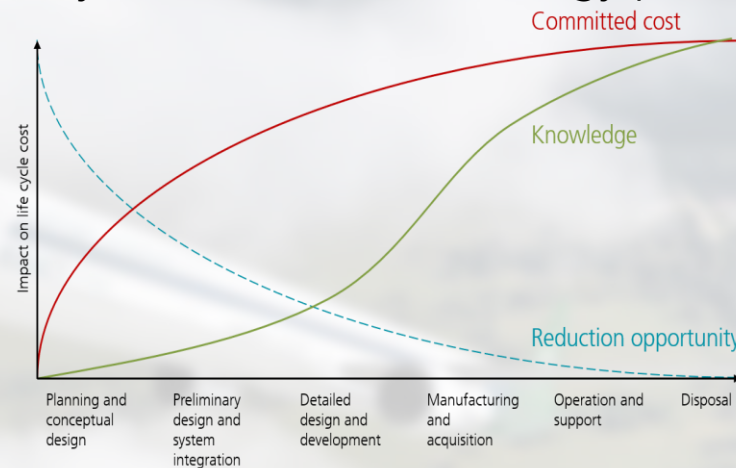


Rising global **climate impact** from **aviation** sector:



Innovative solutions for **low-emission aircraft** concepts

Early estimation of technology potential



**Method**



**Results**



**Outlook**



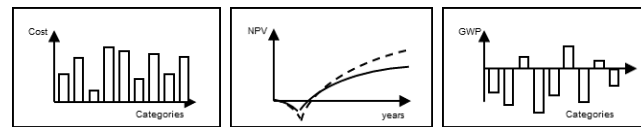
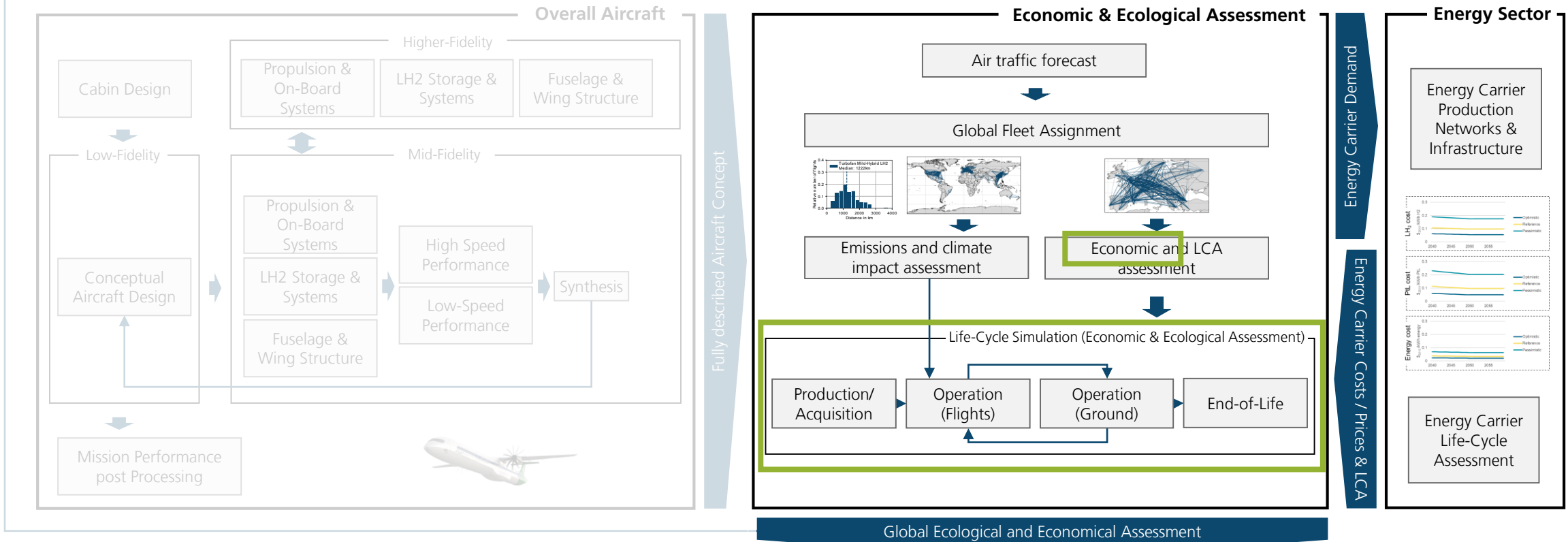


# METHOD

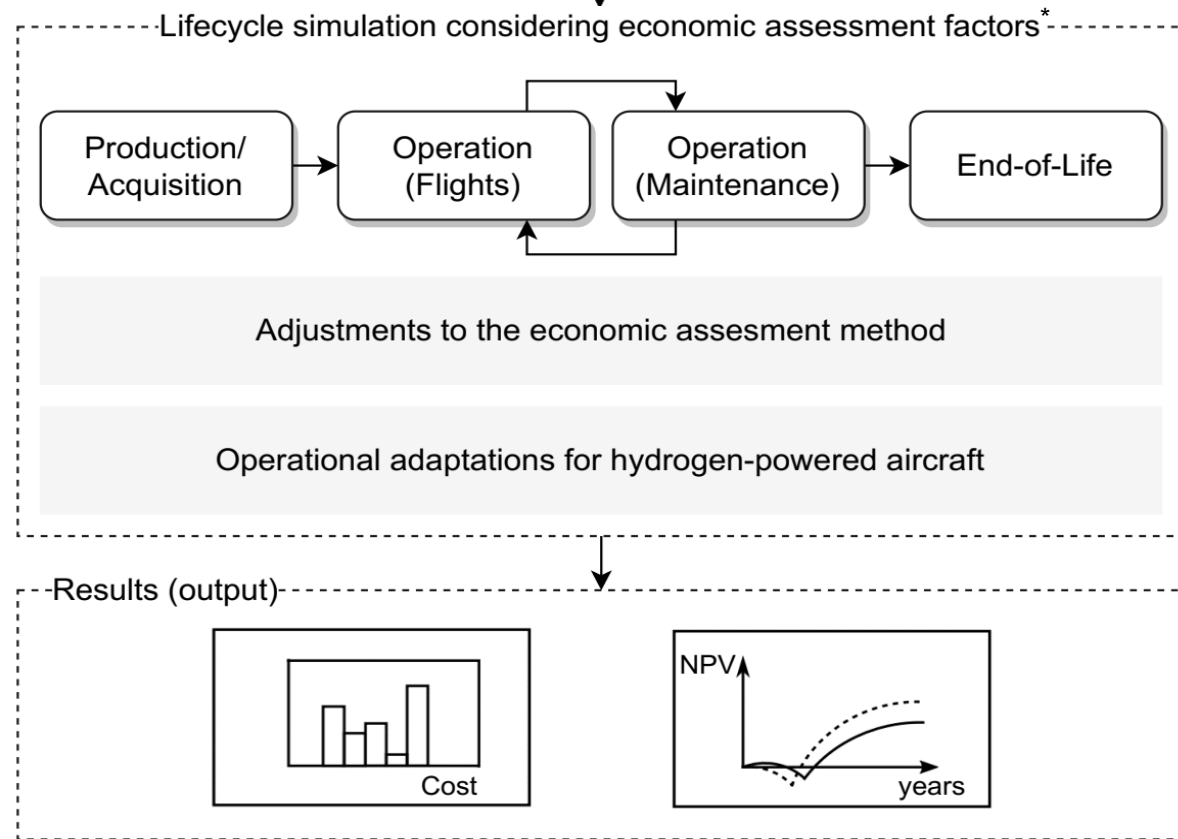
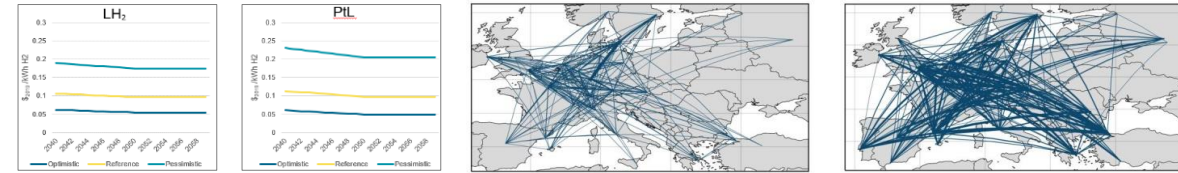
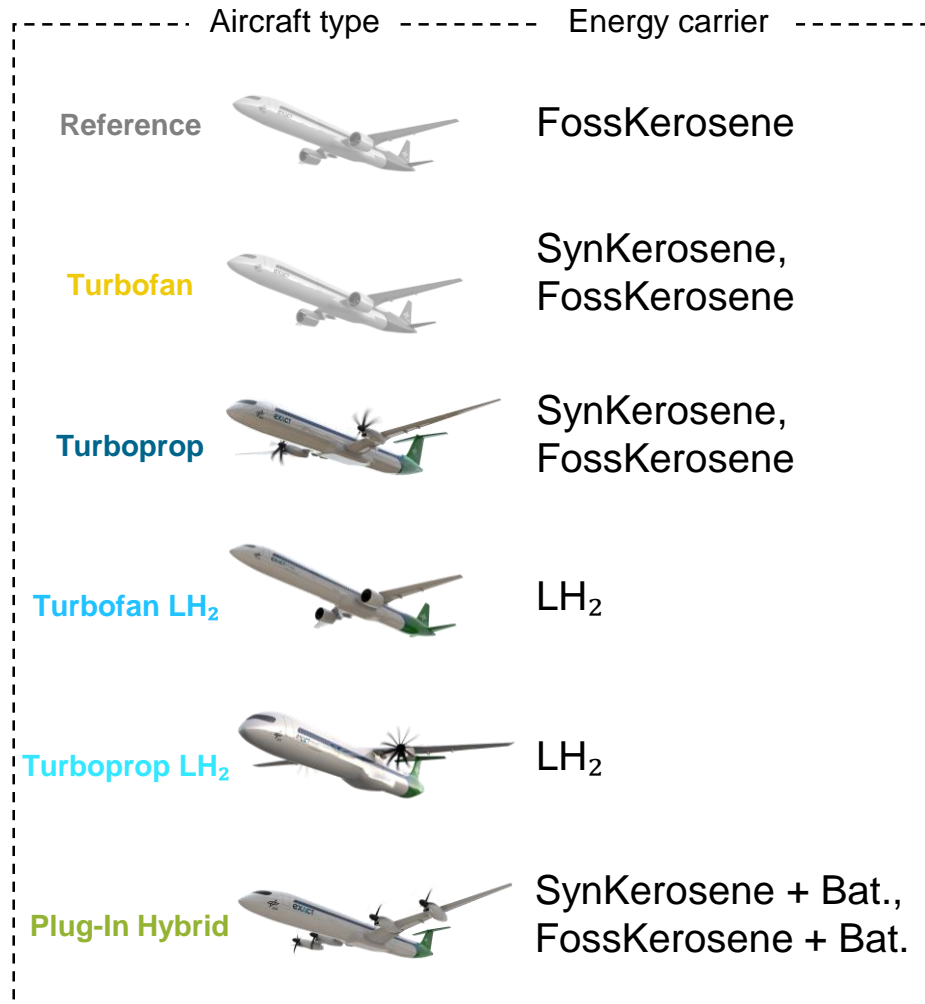
# Overall EXACT Process



**Overall System Requirements and Scenarios**  
 Top-Level-Aircraft-Requirements, Technology, Economic, Ecological boundary conditions



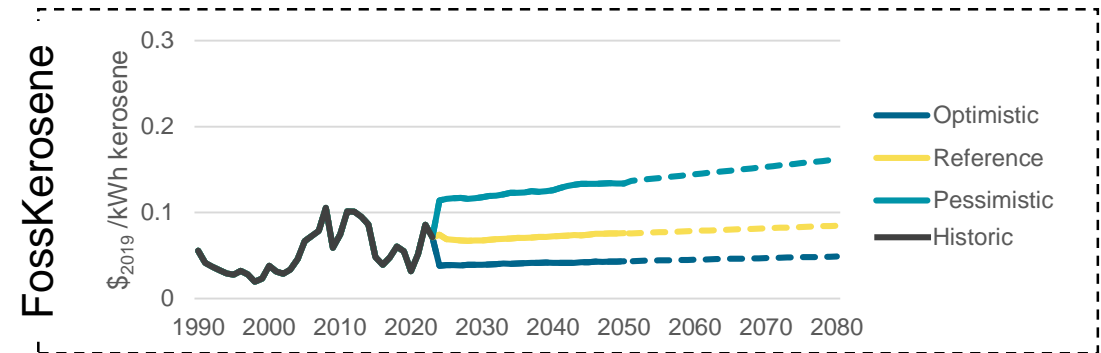
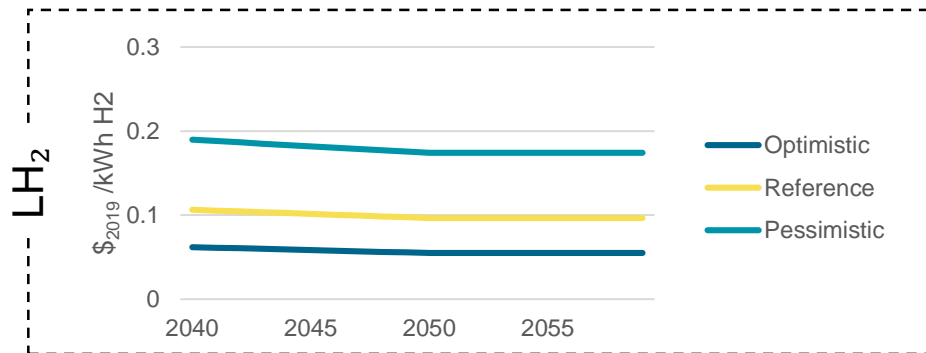
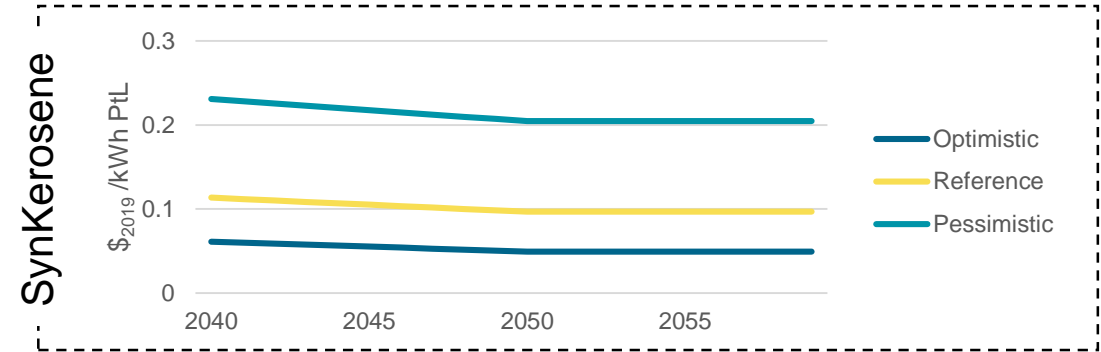
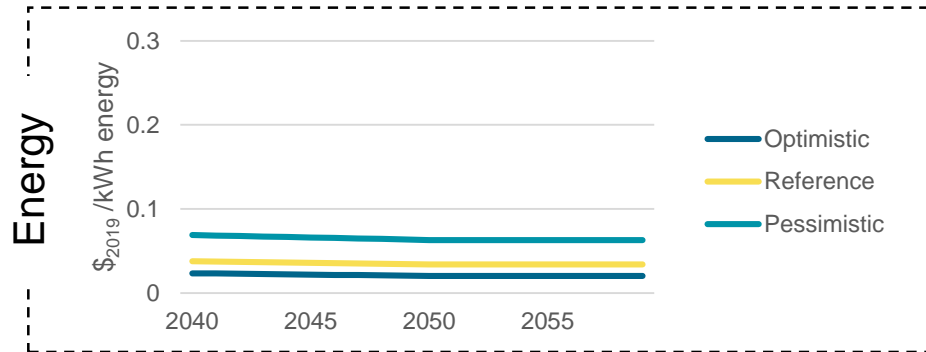
# Use Cases and Methodology



\* Ramm et al. - *Assessing the Feasibility of Hydrogen-Powered Aircraft: A Comparative Economic and Environmental Analysis*, Journal of Aircraft 2024, DOI: 10.2514/1.C037463

# Fuel prices for different energy carrier\*

## Cost progression over the years



- **Average values** calculated, **weighted** with the energy demand per airport
- Values **interpolated** between 2040 and 2050
- Values **held constant after 2050**, as it is uncertain how the trend will look that far into the future.

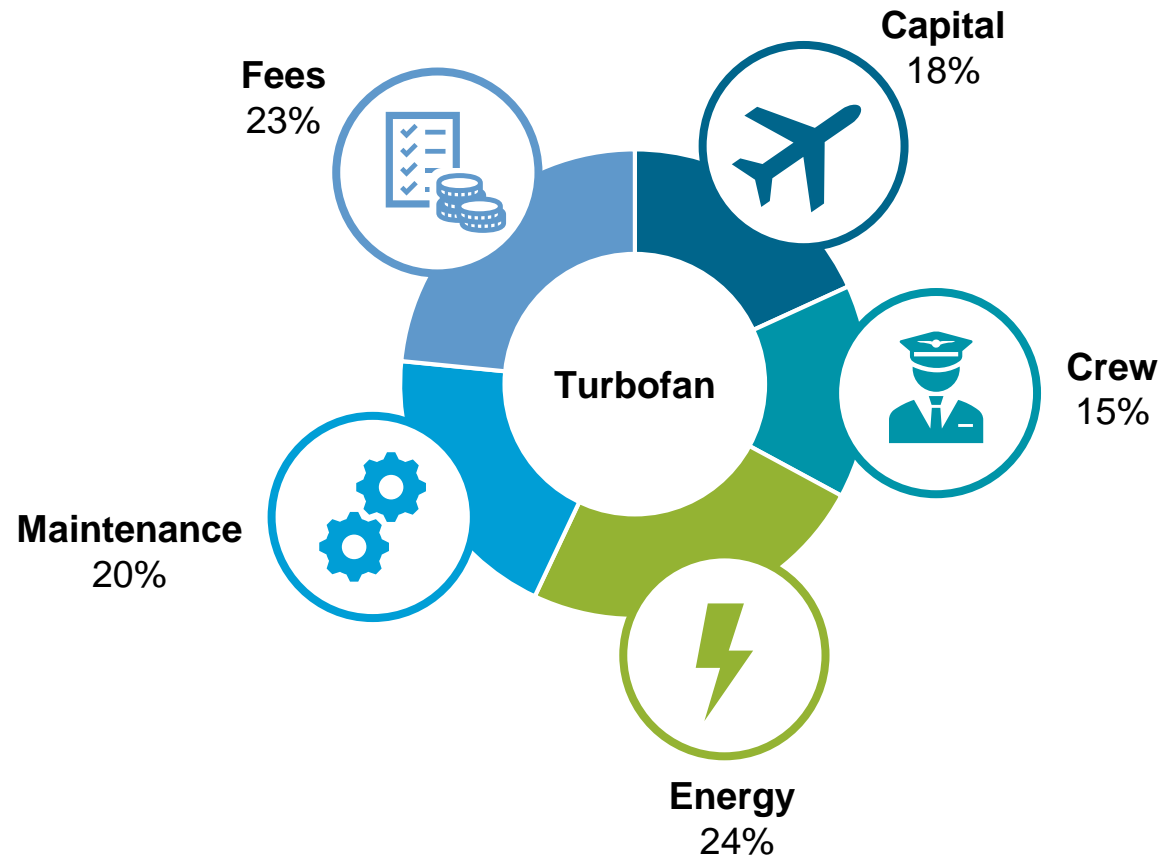
- 1990 to 2023: Historic fuel prices
- 2024 to 2050: Fuel price predictions from the Annual Energy Outlook
- 2051 to 2080: Extrapolation based on a regression from the years 2040 to 2050



# RESULTS

# Detailed DOC analysis USD<sub>2010</sub>/ASK

## Of the Turbofan aircraft using SynKerosene



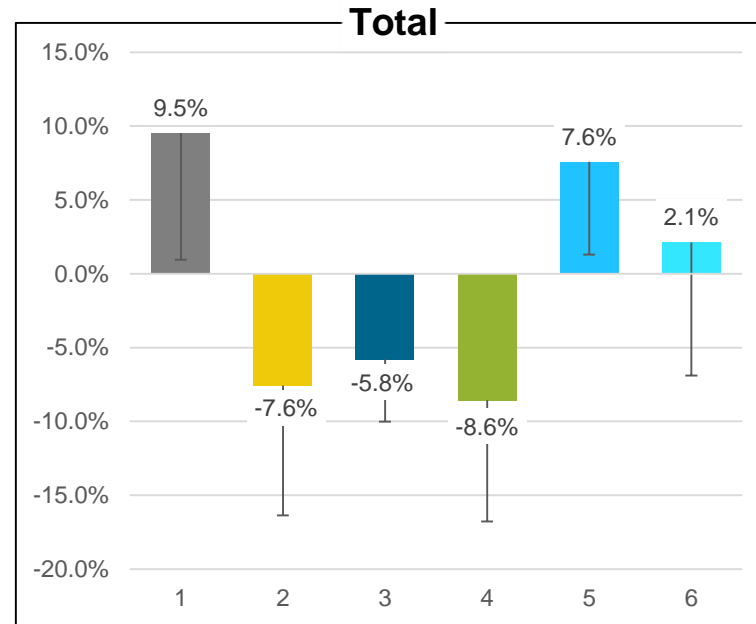
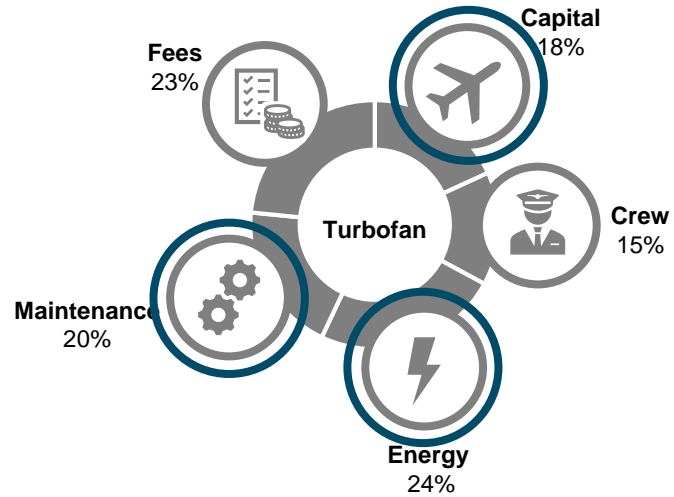
Results are subject to current assumptions, among others:

- Mid capital cost and maintenance cost assumptions
- Turbofan LH<sub>2</sub> optimized network
- Fees are the same for all aircraft types except for landing fees
- No consideration of CO<sub>2</sub> costs



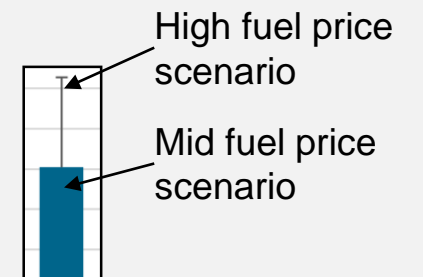
# Detailed DOC analysis USD<sub>2010</sub>/ASK

In comparison to the Turbofan aircraft using SynKerosene



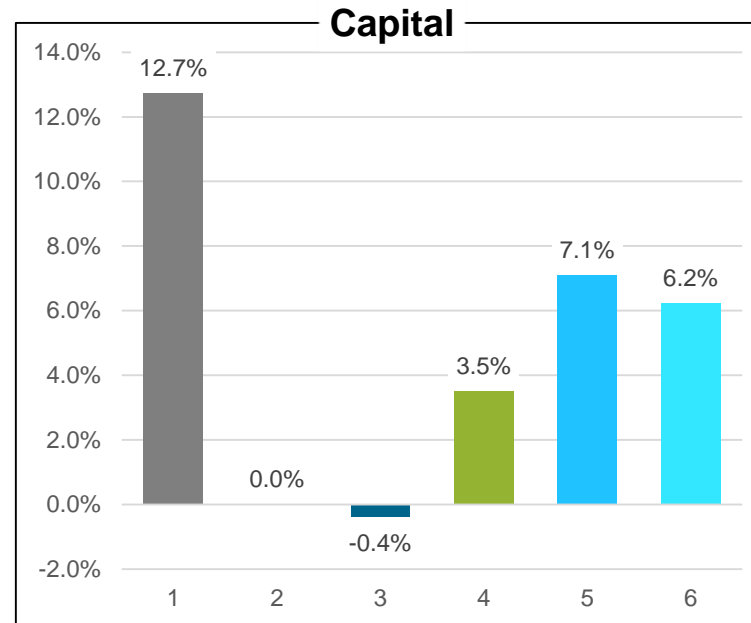
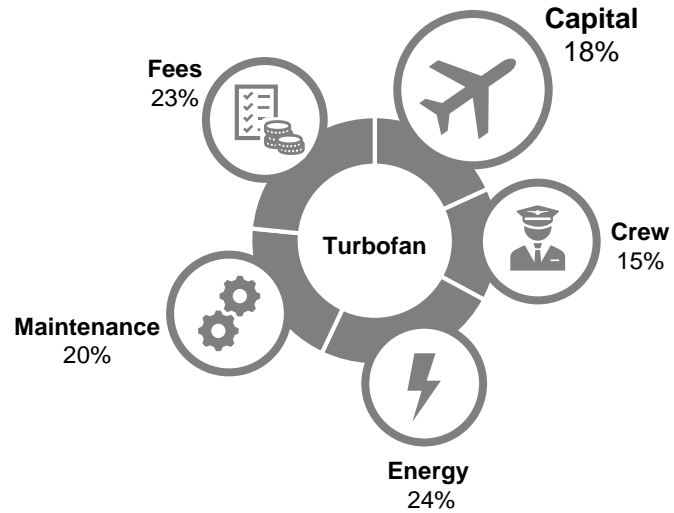
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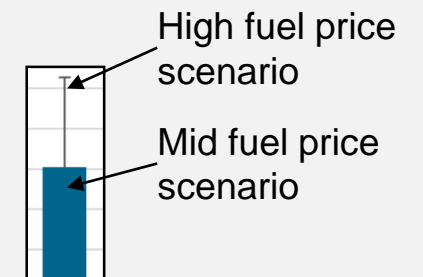
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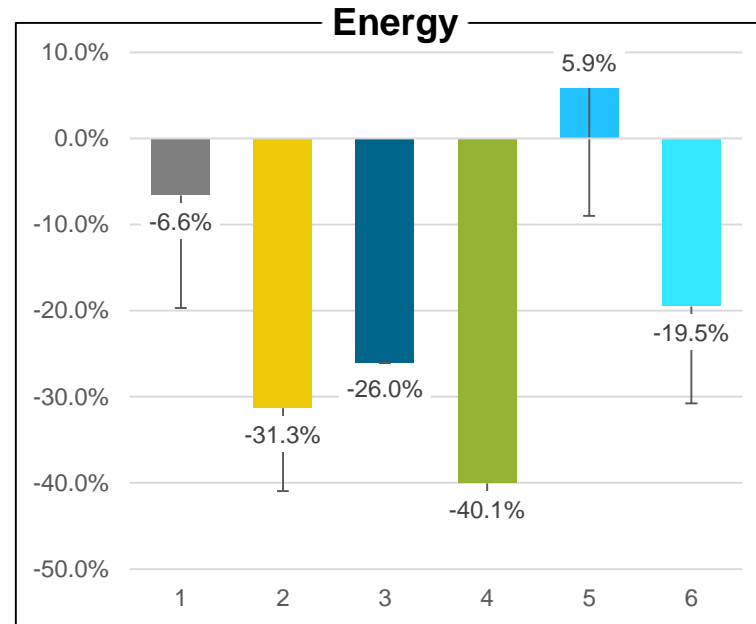
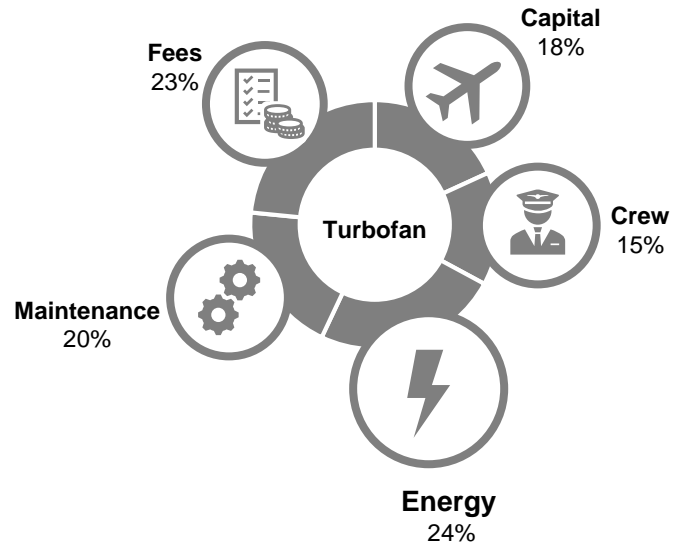
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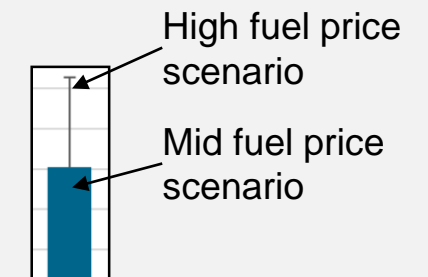
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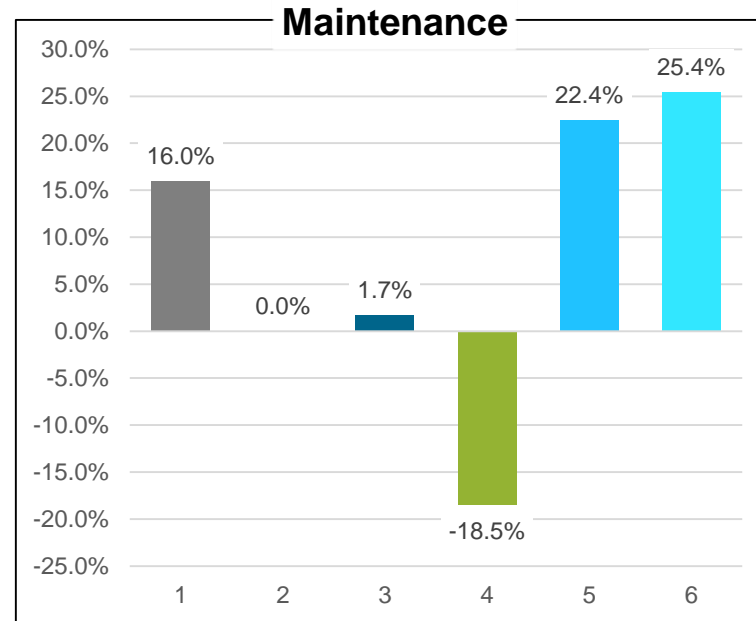
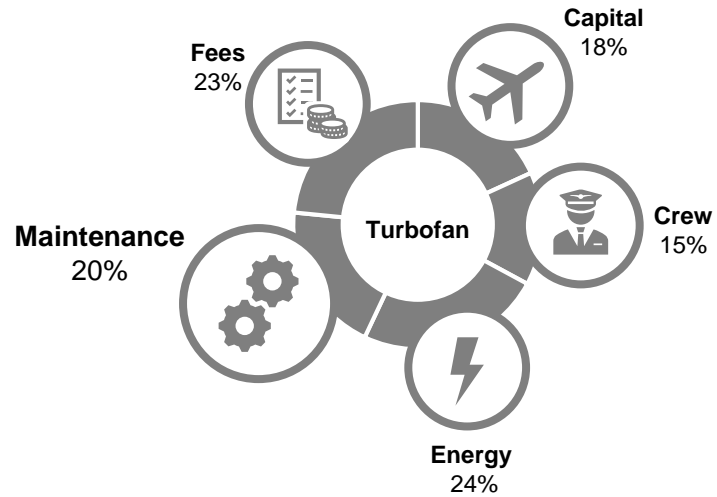
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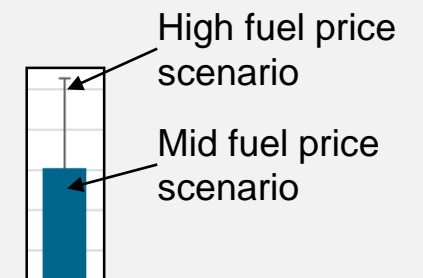
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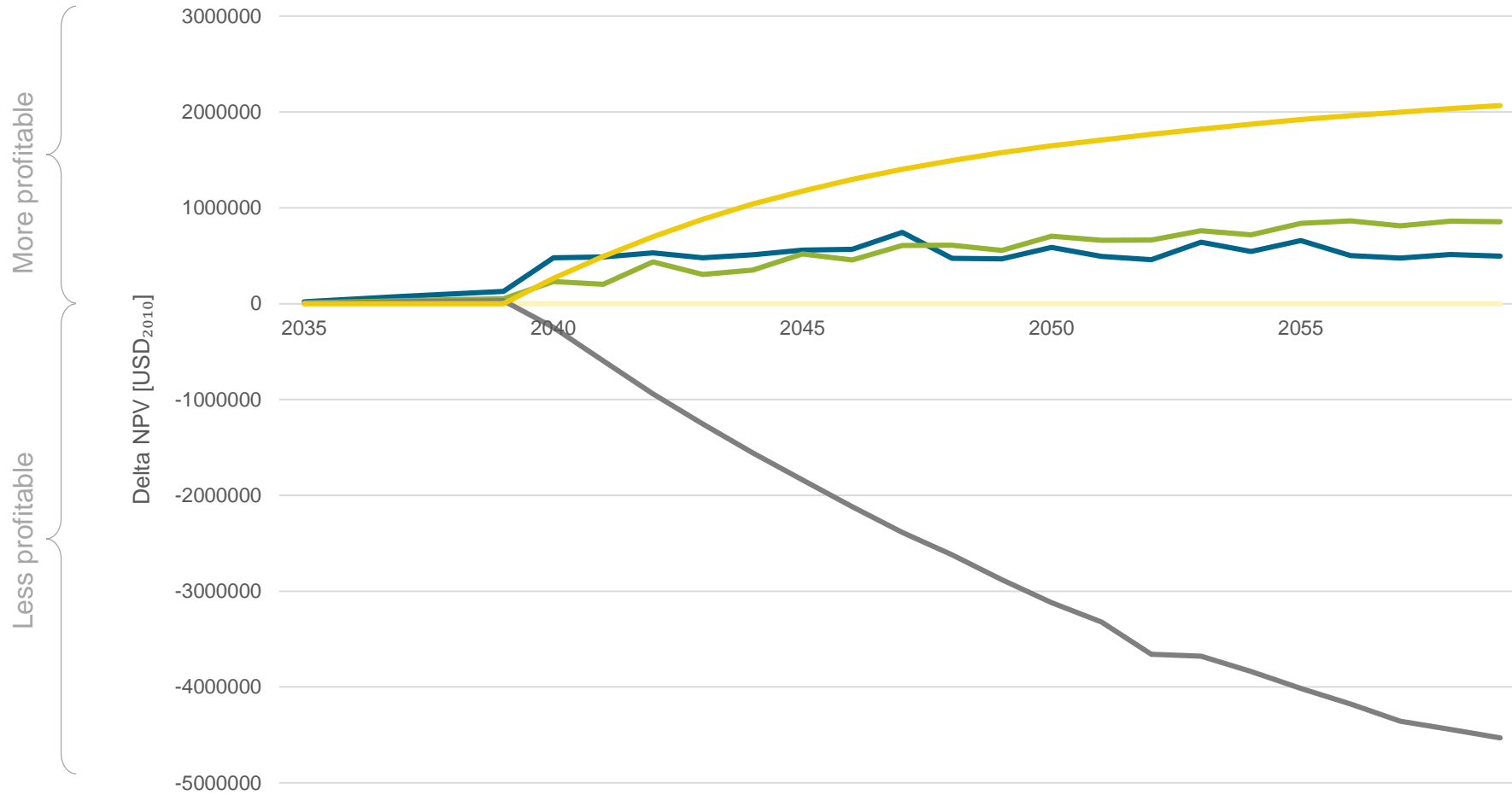
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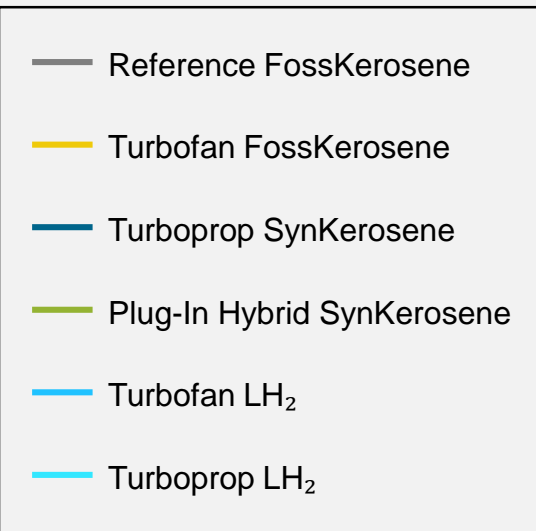
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- Mid fuel price scenario



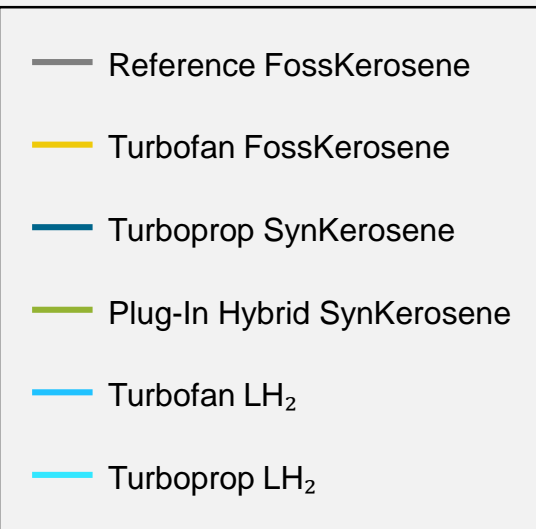
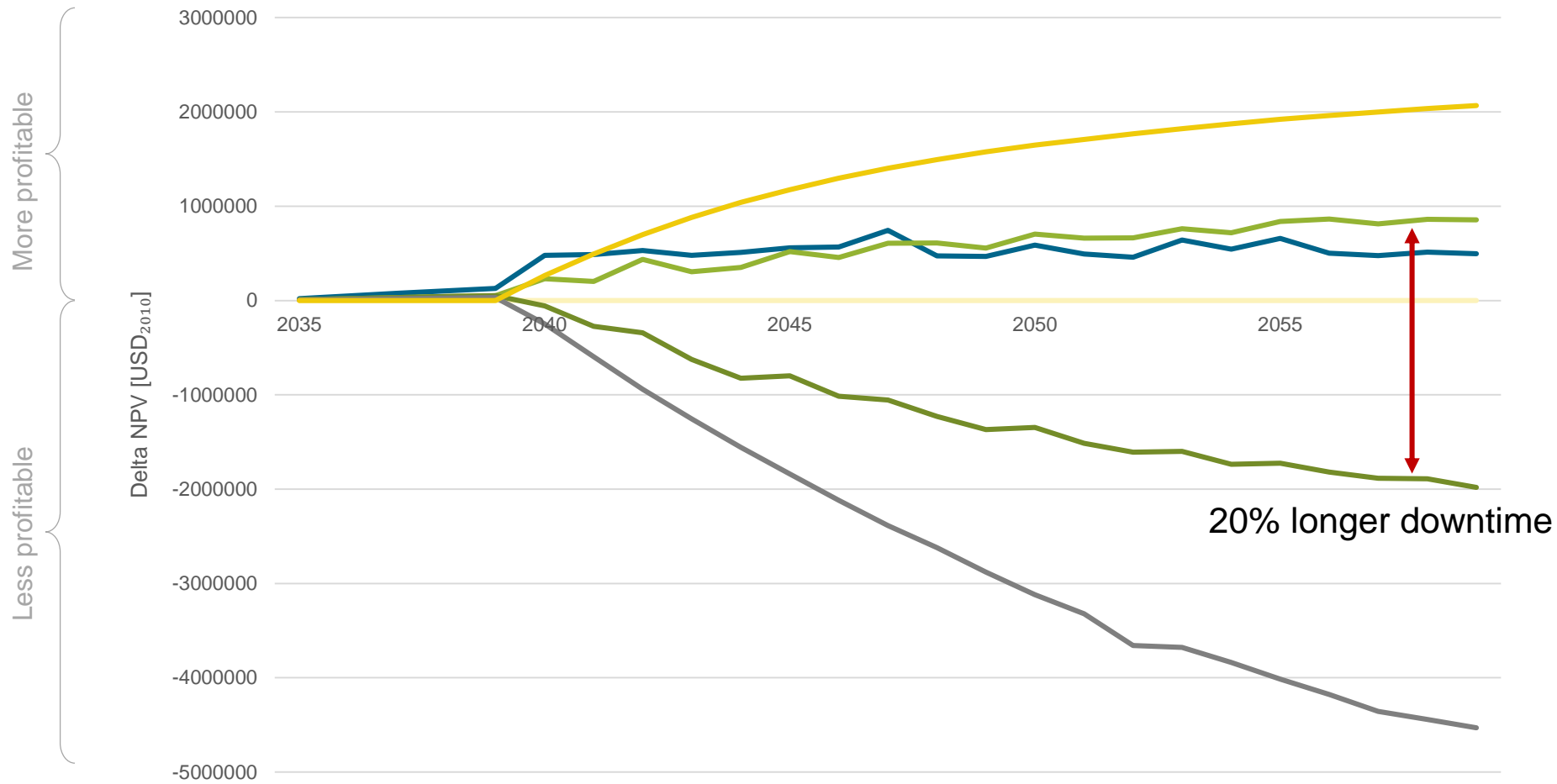
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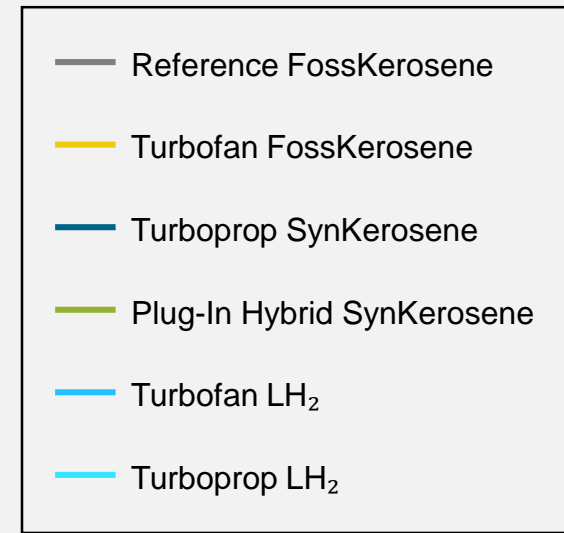
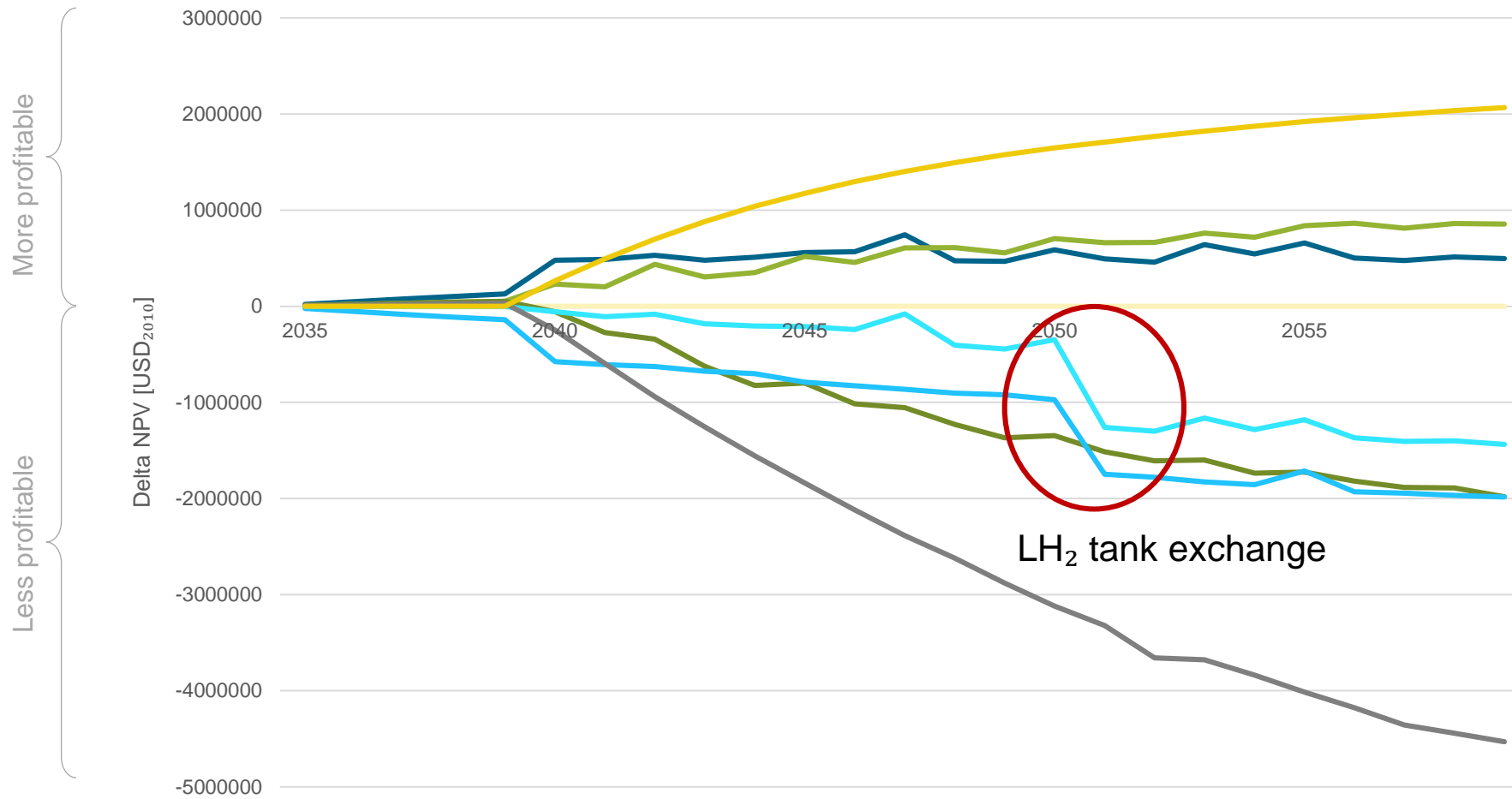
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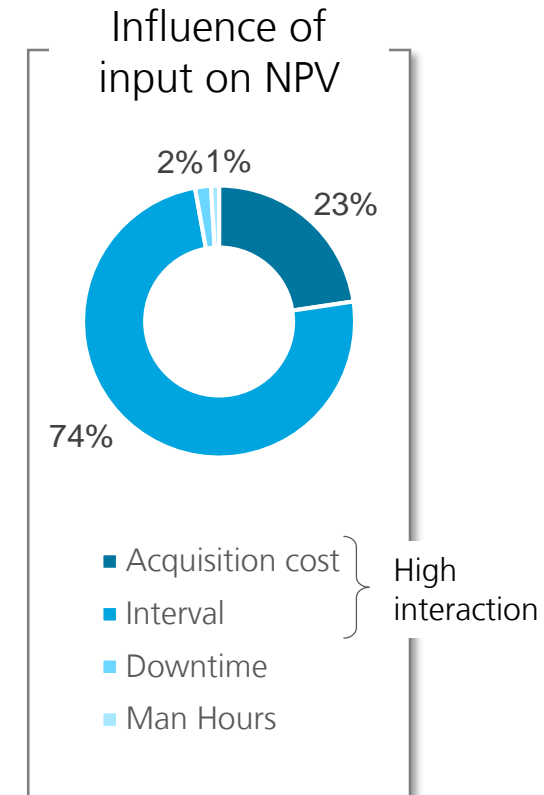
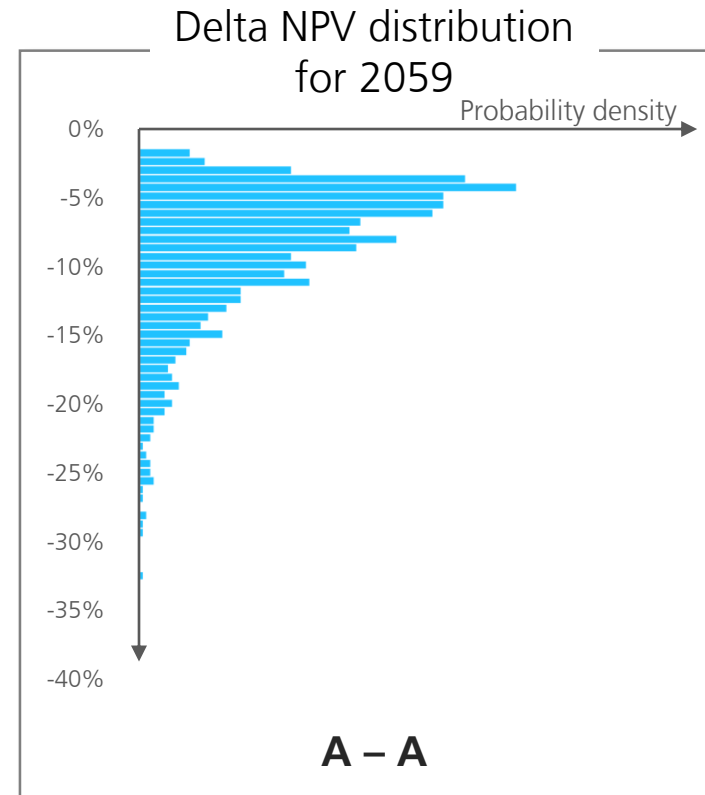
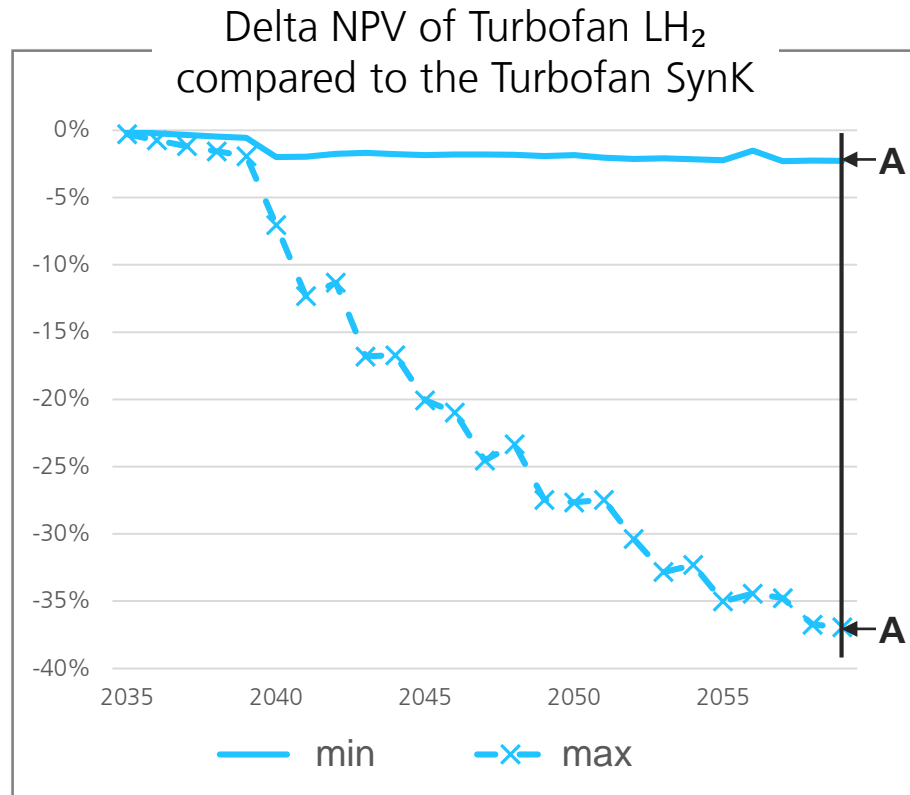
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- Mid fuel price scenario



# Detailed NPV analysis variation - LH<sub>2</sub> tank exchange\*

In comparison to the Turbofan aircraft using SynKerosene



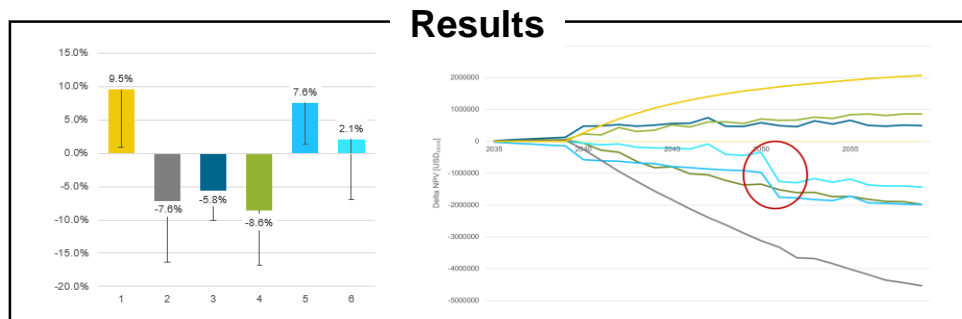
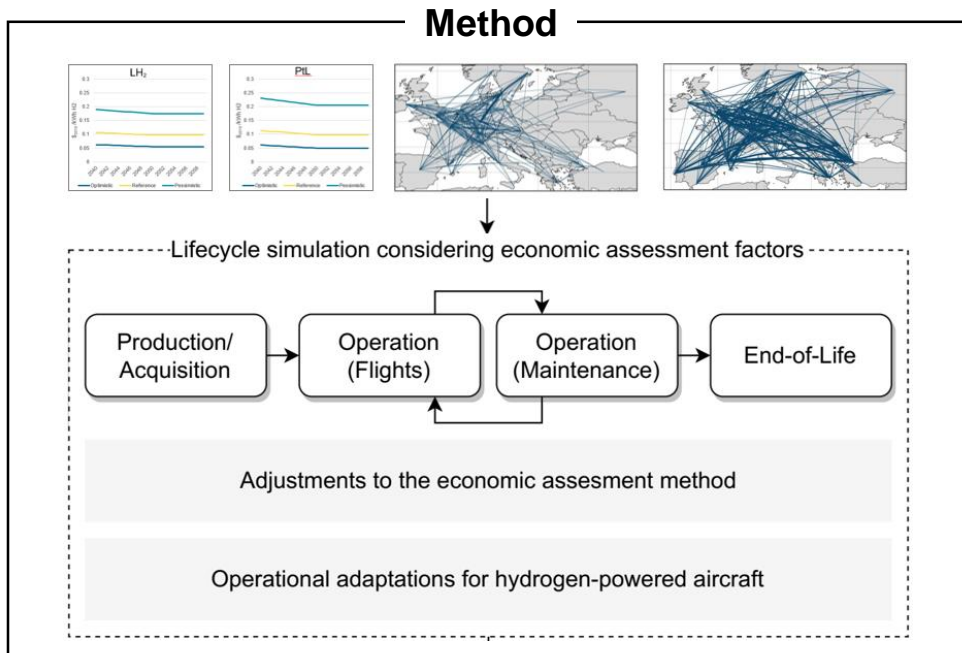
\* Ramm et al. - *Uncertainty quantification in hydrogen tank exchange: Estimating maintenance costs for new aircraft concepts*, International Journal of Hydrogen Energy 2024, DOI: 10.1016/j.ijhydene.2024.04.157





# RECAP AND OUTLOOK

# Recap and Outlook



- Maintenance plan and capital cost are based on multiple assumptions
- Only the medium and high fuel price scenarios were considered
- The assessment is subject to a lot of uncertainties
  - include in next assessment
- Dependence of ticket prices on fuel prices can make assessment more realistic
- Eco-efficiency metric could be used to combine the economic and ecological assessment



# Thank you for your attention!



Contact:

**Jennifer Ramm**

Institute of Maintenance, Repair and Overhaul

[jennifer.ramm@dlr.de](mailto:jennifer.ramm@dlr.de)



Topic:

**Economic Evaluation of New Aircraft Technologies for Short Range Aircraft: Insights from Project EXACT**

Date:

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Credits:

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