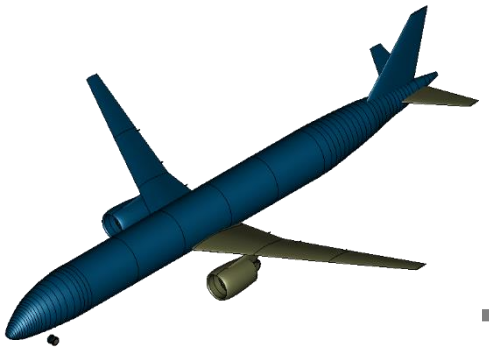
POTENTIALS AND CHALLENGES OF HYDROGEN POWERED AIRCRAFT CONCEPTS

Daniel Silberhorn

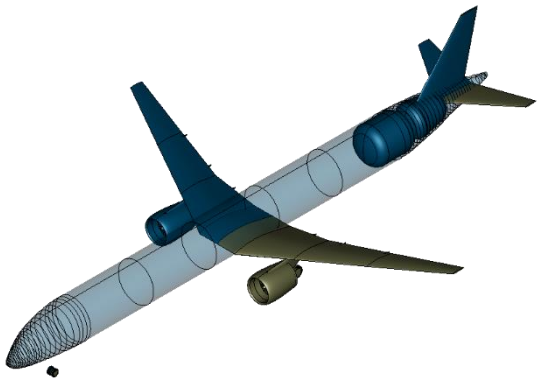
DLR

GENERAL LH2 AIRCRAFT CHARACTERISTICS

Block Energy Breakdown (LH2 vs Kerosene)



D250-321TF-2040



D250-TFLH2-2040

-5% BE
Hydrogen Combustion

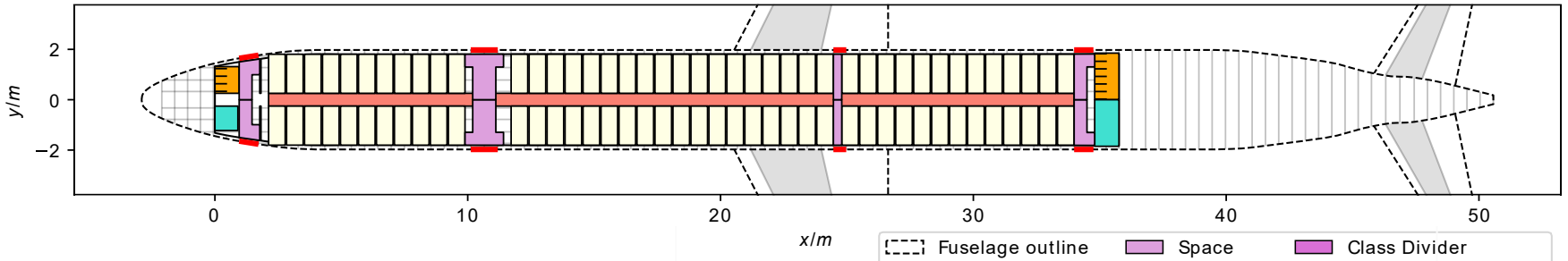
+3.5% BE
Total Mass Increase, incl. Snowball Effects
+Tank System Mass
+Fuselage Mass
-Engine Mass

+2.8% BE
Reduction in L/D
+Longer Fuselage
+Larger Wing
-Smaller Engines

+1.2% Total Block Energy (BE) increase with regard to Turbofan Baseline (D250-321TF-2040)

This chart breaks down the Block Energy (BE) per passenger difference into single technology/design improvements and penalties

General Aircraft Characterisitcs

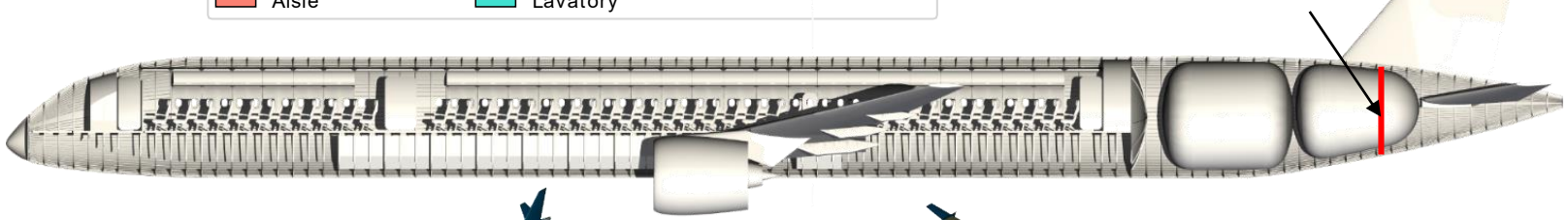


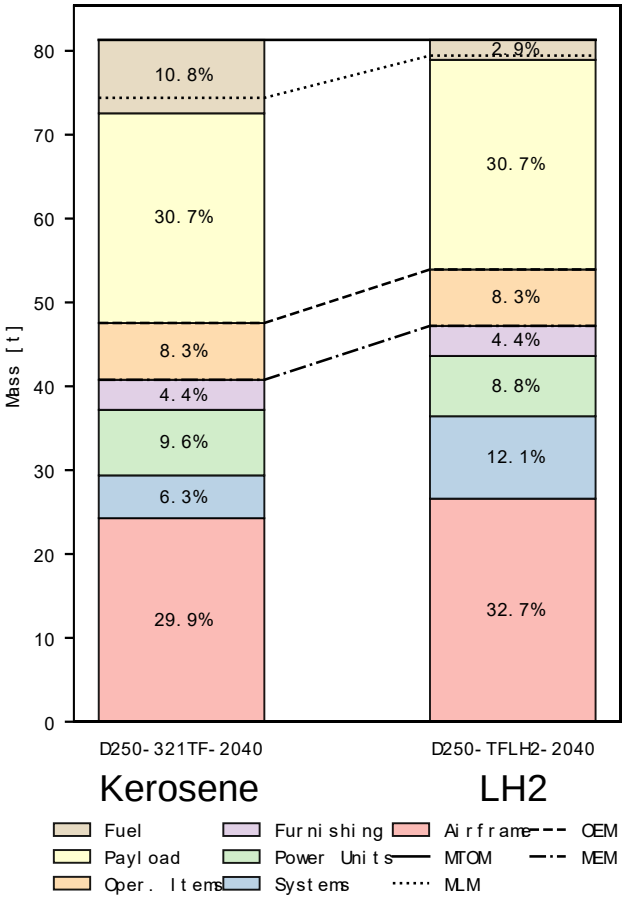
- 1.2 m shorter cabin
- 2 additional seats

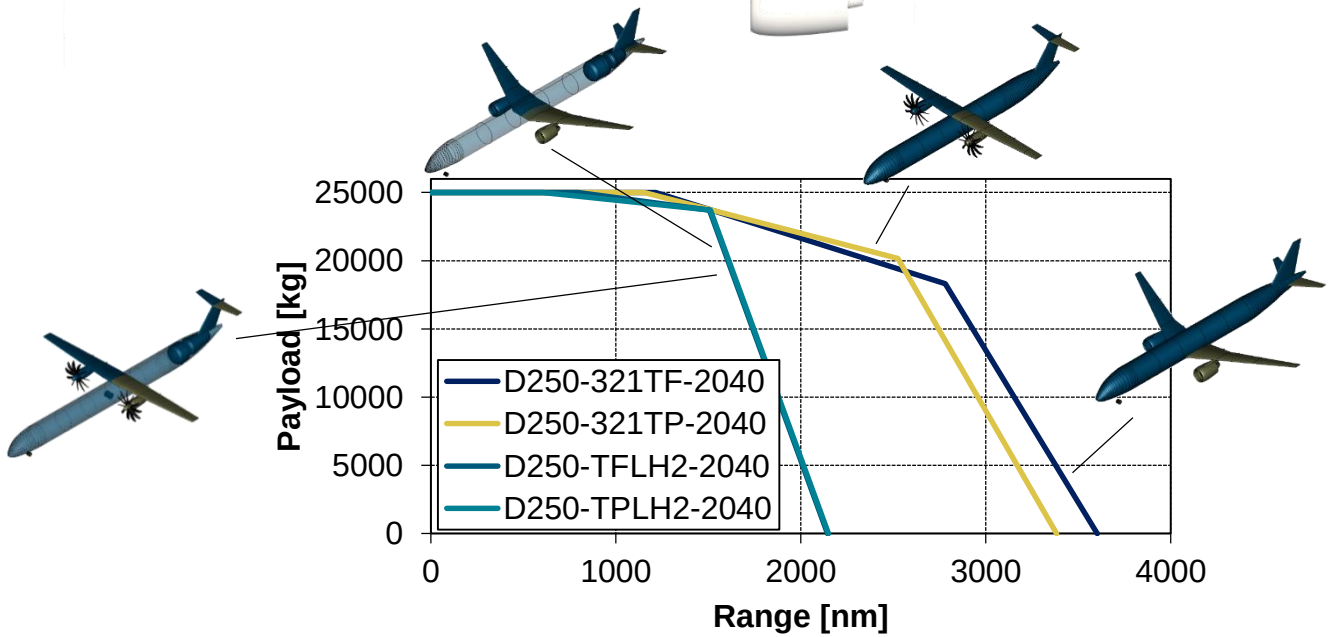
FUGA
Fuselage Geometry Assembler

Fuselage outline
Cabin boundary
Structure
Aisle
Space
Doors
Galley
Lavatory
Class Divider
Generic Module
Economy (252 Seats)

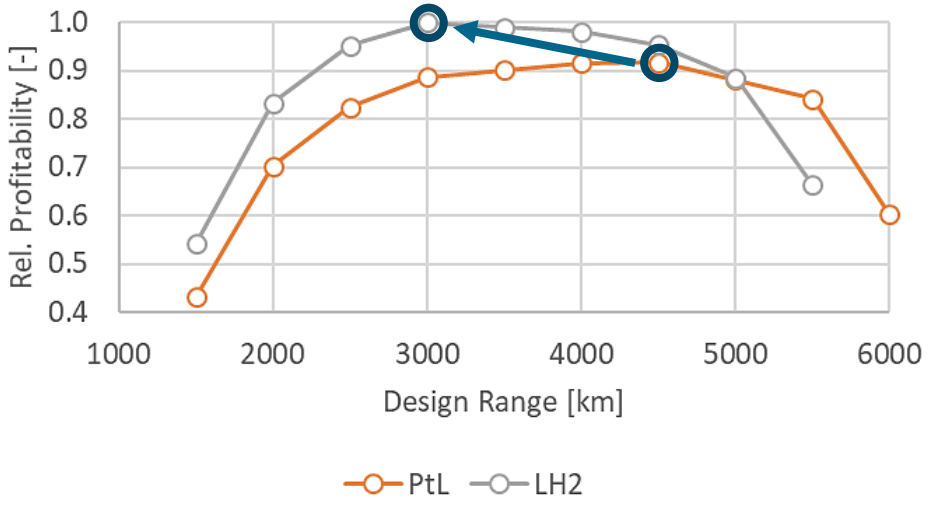
Reinforced frame for VTP loads

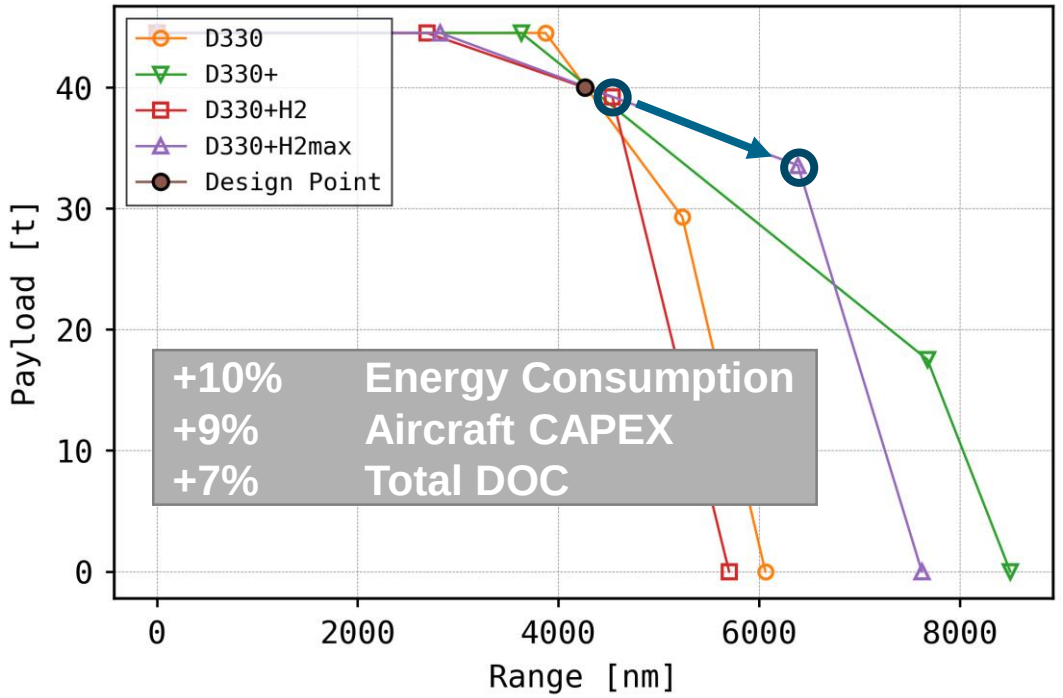


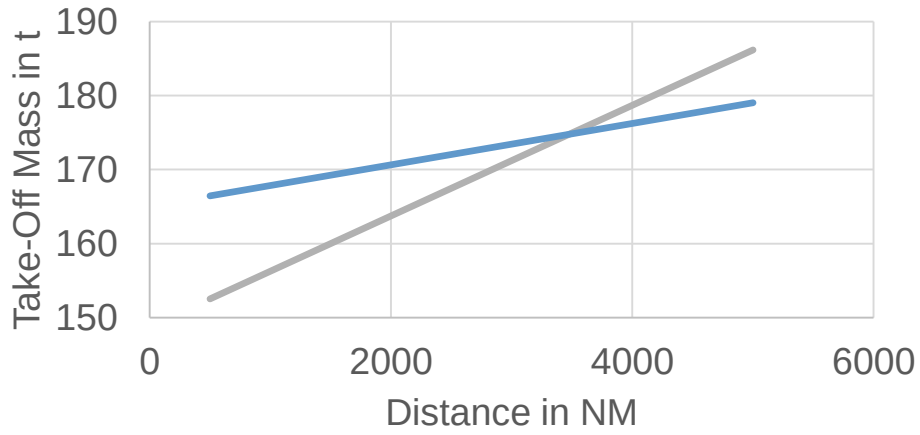


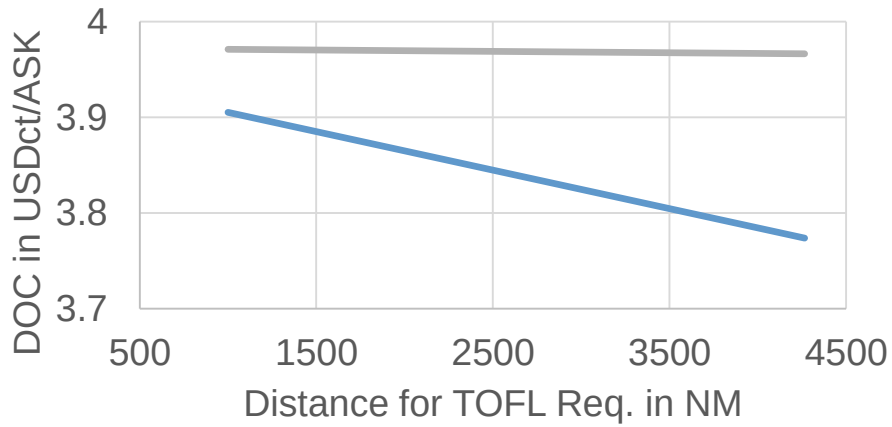


Impact of Aircraft Requirements on Performance and Operating Costs



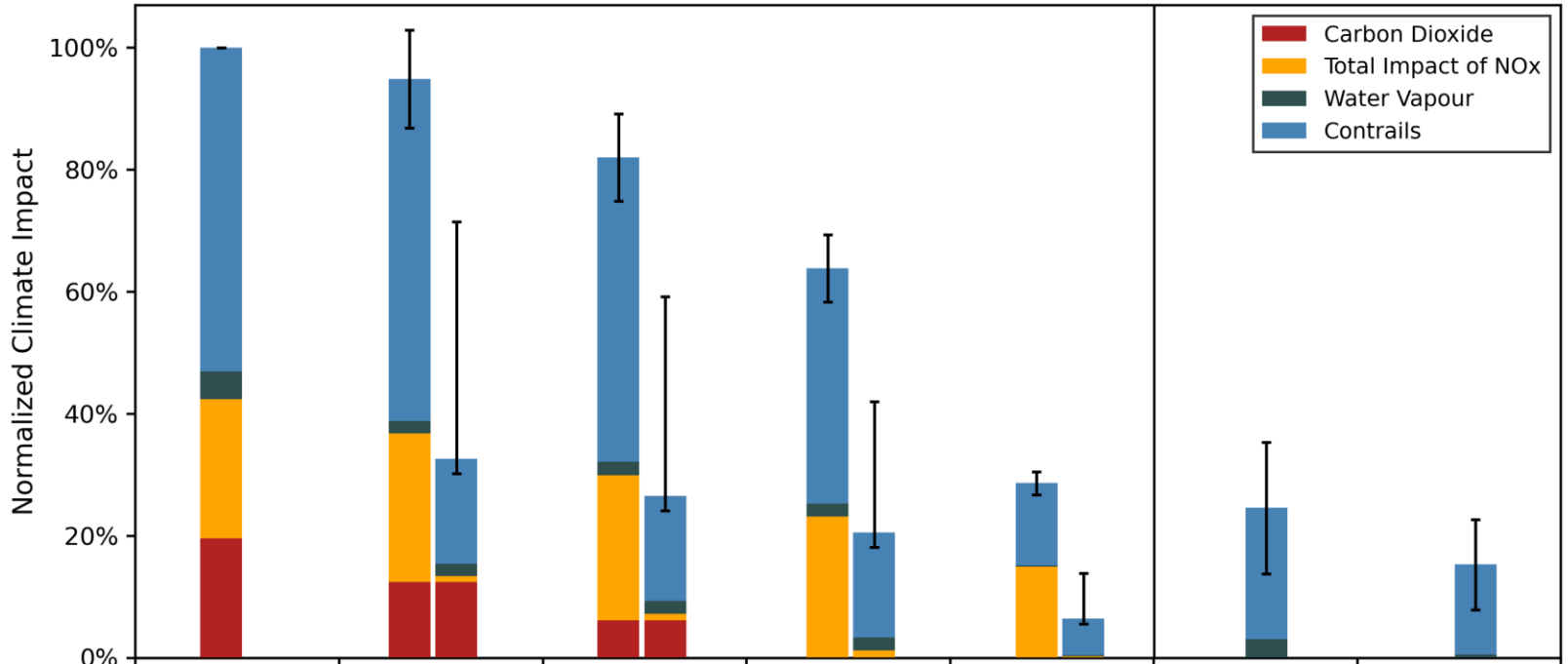






CLIMATE IMPACT REDUCTION POTENTIAL

What is the climate impact reduction potential of green LH2 and synthetic kerosene?



	D261	D261+		D261+DropIn		D261+SAF		D261+SAF +5% DOC		D261+H2	D261+H2 +5% DOC
Energy Carrier	Fossil Kerosene	Fossil Kerosene		Drop-In Fuel		SynFuel		SynFuel		Green LH2	Green LH2
Entry Into Service	1986	2040		2040		2040		2040		2040	2040
Combustion Chamber	Conventional	Conv-entional	Low NOx Low Soot	Conv-entional	Low NOx Low Soot	Conv-entional	Low NOx Low Soot	Conv-entional	Low NOx Low Soot	Low NOx	Low NOx
Max. Flight-Level	FL 410	FL 410		FL 410		FL 410		FL 290		FL 410	FL 290
Cruise Mach-Number	0.8	0.8		0.8		0.8		0.75		0.8	0.75

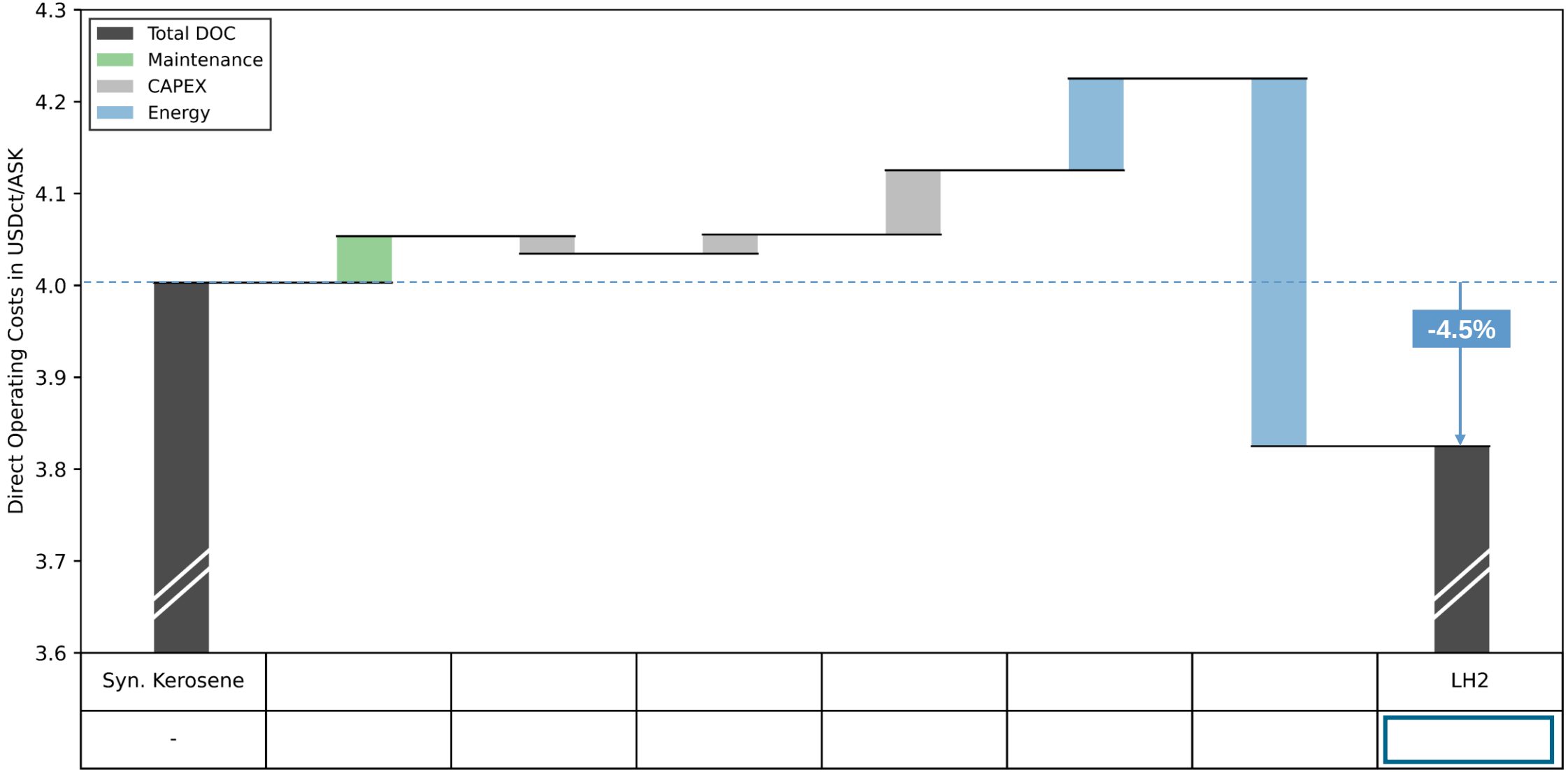
Silberhorn, D. and Dahlmann, K. and Görtz, A. and Linke, F. and Zanger, J. and Rauch, B. and Methling, T. and Janzer, C. and Hartmann, J., “Climate Impact Reduction Potentials of Synthetic Kerosene and Green Hydrogen powered Mid-Range Aircraft Concepts”, Applied Sciences 12.12 (2022): 5950.

ECONOMICAL POTENTIALS

Stepwise Comparison of Operating Costs

Refueling site Frankfurt

LH2 Tank Life equals Airframe Life

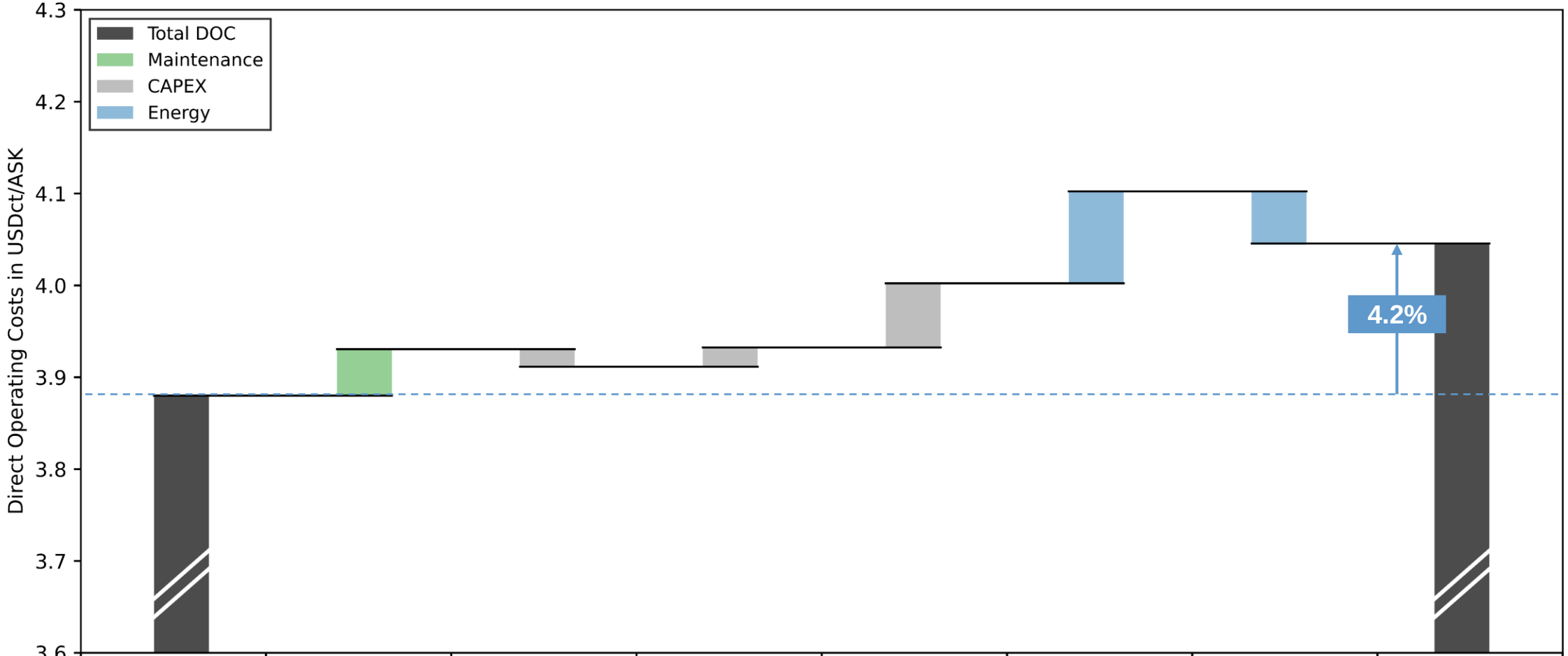


In cooperation with J. Hoelzen und F. Schenke, Leibniz University Hannover

Stepwise Comparison of Operating Costs

Refueling site Tokyo

LH2 Tank Life equals Airframe Life



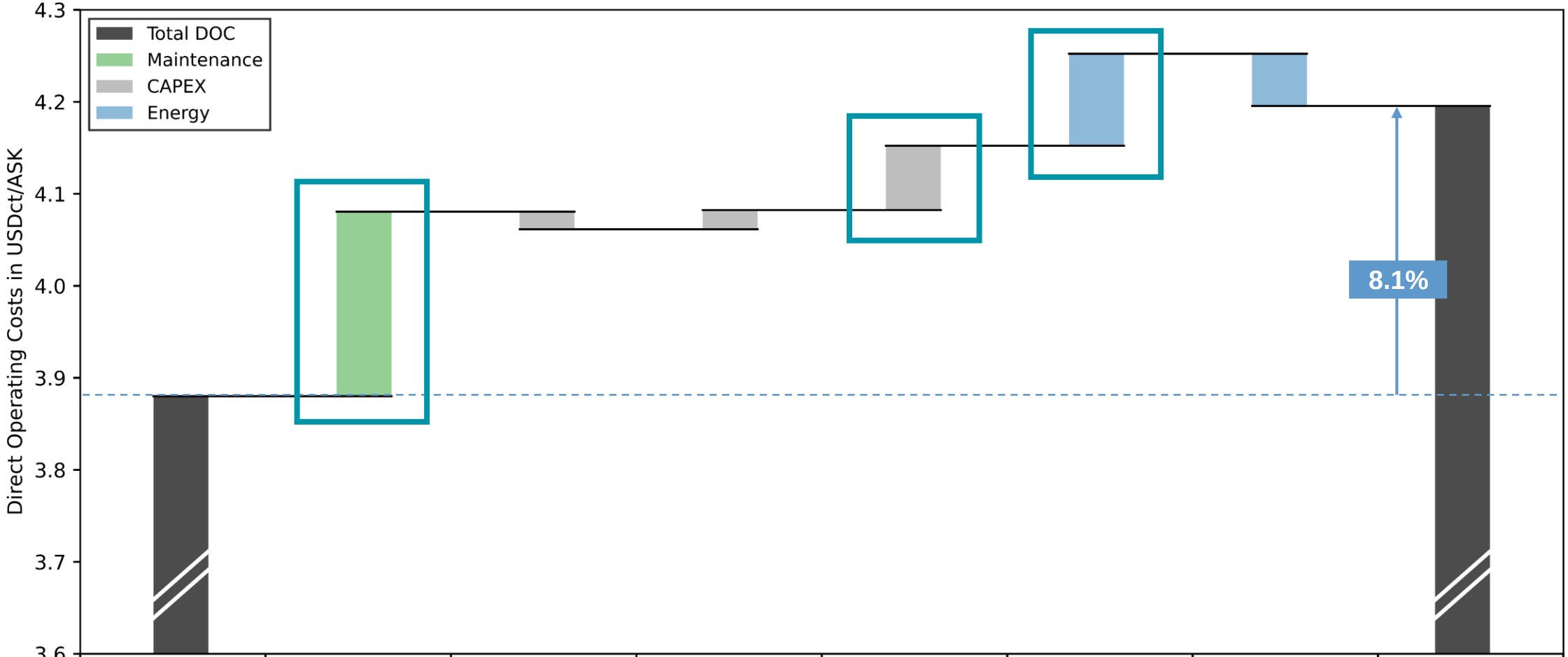
Syn. Kerosene	Maintenance	CAPEX Engine	CAPEX Airframe	CAPEX LH2 System	Aircraft Energy Efficiency	Energy Production	LH2
-	1.3%	-0.5%	0.5%	1.8%	2.6%	-1.5%	4.2%

In cooperation with J. Hoelzen und F. Schenke, Leibniz University Hannover

Stepwise Comparison of Operating Costs

Refueling site Tokyo

LH2 Tank Life 1/3 of Airframe Life



Syn. Kerosene	Maintenance	CAPEX Engine	CAPEX Airframe	CAPEX LH2 System	Aircraft Energy Efficiency	Energy Production	LH2
-	5.2%	-0.5%	0.5%	1.8%	2.6%	-1.5%	8.1%

In cooperation with J. Hoelzen und F. Schenke, Leibniz University Hannover

THANK YOU

Daniel Silberhorn

Daniel.Silberhorn@dlr.de

DLR