Can Aviation get-off Kerosene?

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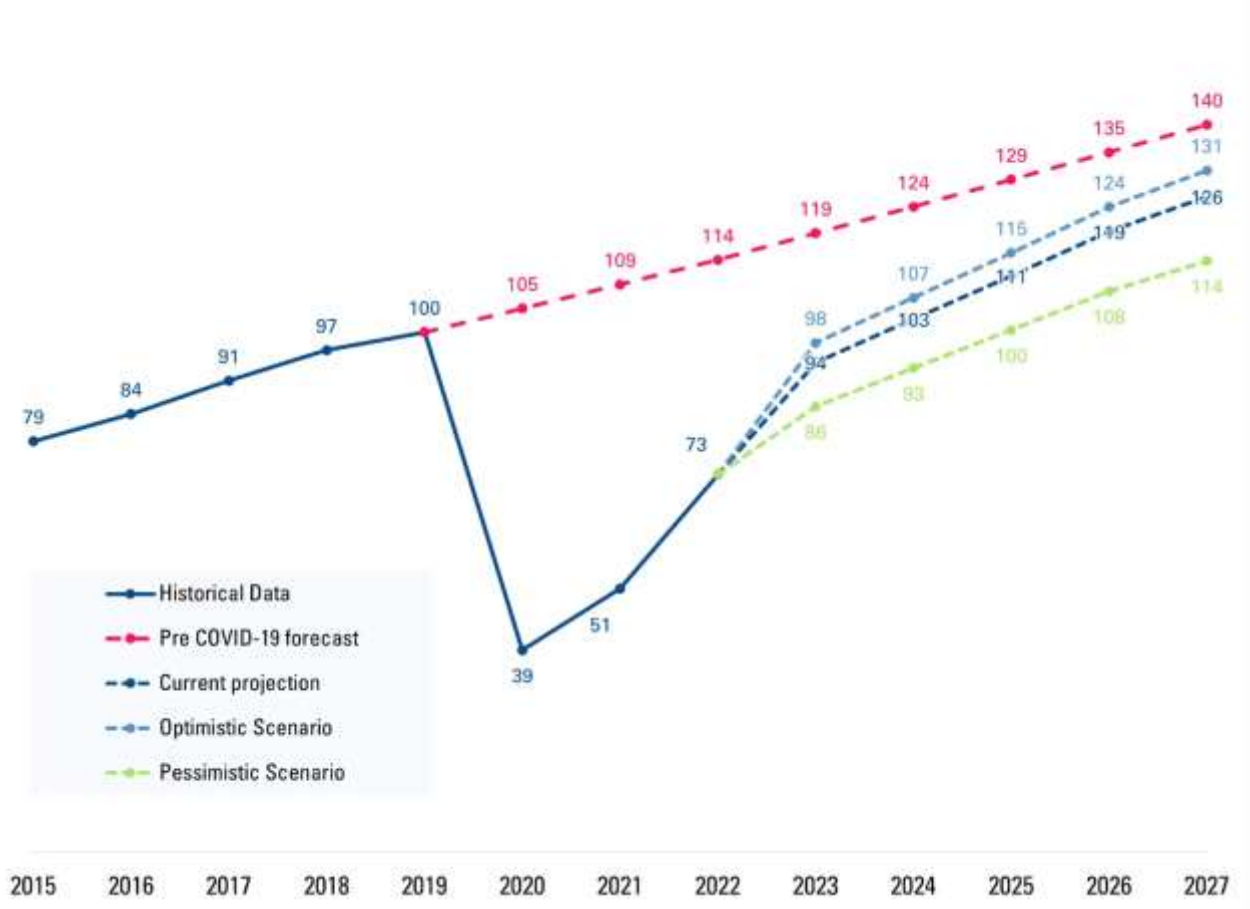
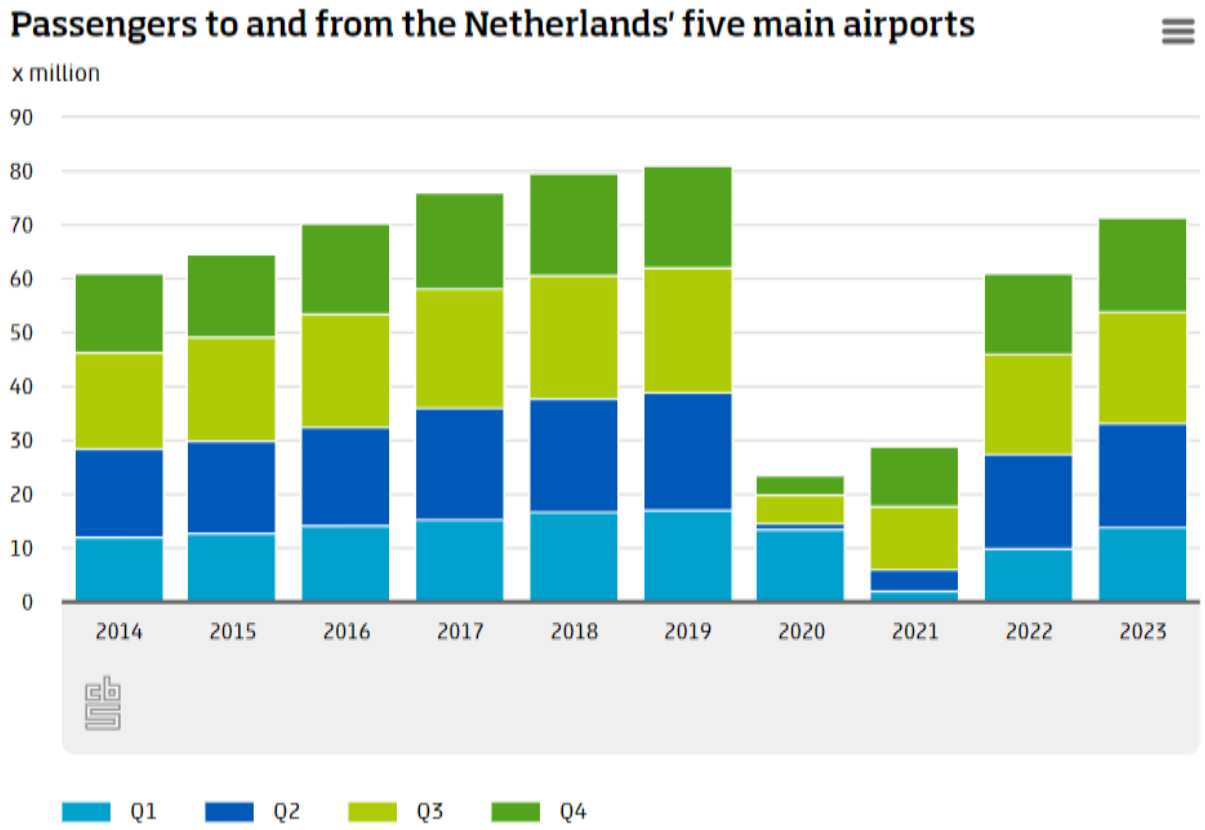
Rebound of Aviation

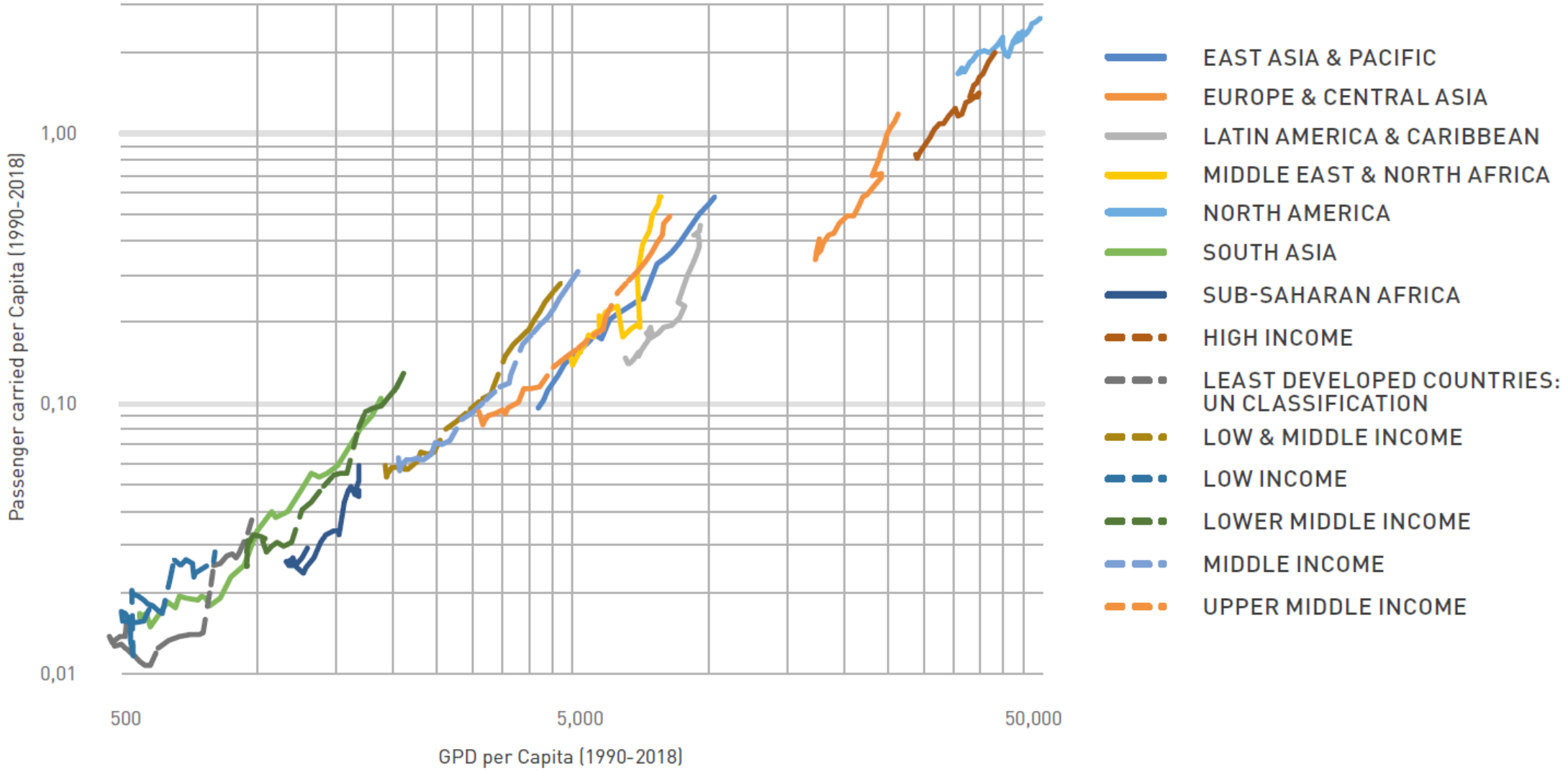


Medium-term global passenger traffic projection (indexed, 2019 = 100) Source: Airports Council International (ACI)



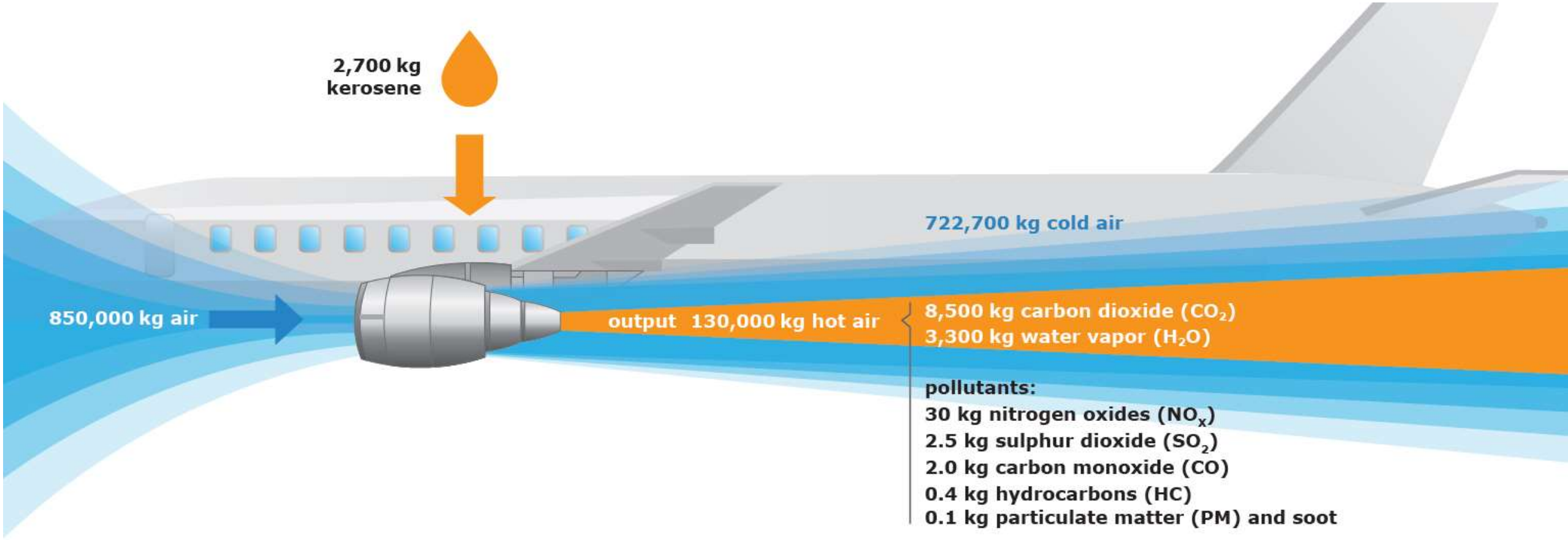
Source: CBS, The Netherlands

Aviation will continue to increase



ATAG, Waypoint 2050, 2021

Typical Aircraft Emissions



Emissions from a typical two-engine jet aircraft during 1-hour flight with 150 passengers (Source: FOCA)

Climate Impact of Aviation

Global Aviation Effective Radiative Forcing (ERF) Terms 1940 – 2018	ERF (mW m^{-2})	RF (mW m^{-2})	ERF / RF	Conf. levels
Contrail cirrus in high-humidity regions	57.4 (17, 98)	111.4 (33, 189)	0.42	Low
Carbon dioxide (CO_2) emissions	34.3 (28, 40)	34.3 (31, 38)	1.0	High
Nitrogen oxide (NO_x) emissions				
Short-term ozone increase	49.3 (32, 76)	36.0 (23, 56)	1.37	Med
Long-term ozone decrease	-10.6 (-20, -7.4)	-9.0 (-17, -6.3)	1.18	Low
Methane decrease	-21.2 (-40, -15)	-17.9 (-34, -13)	1.18	Med
Stratospheric water vapor decrease	-3.2 (-6.0, -2.2)	-2.7 (-5.0, -1.9)	1.18	Low
Net for NO_x emissions	17.5 (0.6, 29)	8.2 (-4.8, 16)	–	Low
Water vapor emissions in the stratosphere	2.0 (0.8, 3.2)	2.0 (0.8, 3.2)	[1]	Med
Aerosol-radiation interactions				
– from soot emissions	0.94 (0.1, 4.0)	0.94 (0.1, 4.0)	[1]	Low
– from sulphur emissions	-7.4 (-19, -2.6)	-7.4 (-19, -2.6)	[1]	Low
Aerosol-cloud interactions				
– from sulphur emissions	No best estimates	No best estimates	–	Very low
– from soot emissions			–	
Net aviation (Non-CO_2 terms)	66.6 (21, 111)	114.8 (35, 194)	–	–
Net aviation (All terms)	100.9 (55, 145)	149.1 (70, 229)	–	–

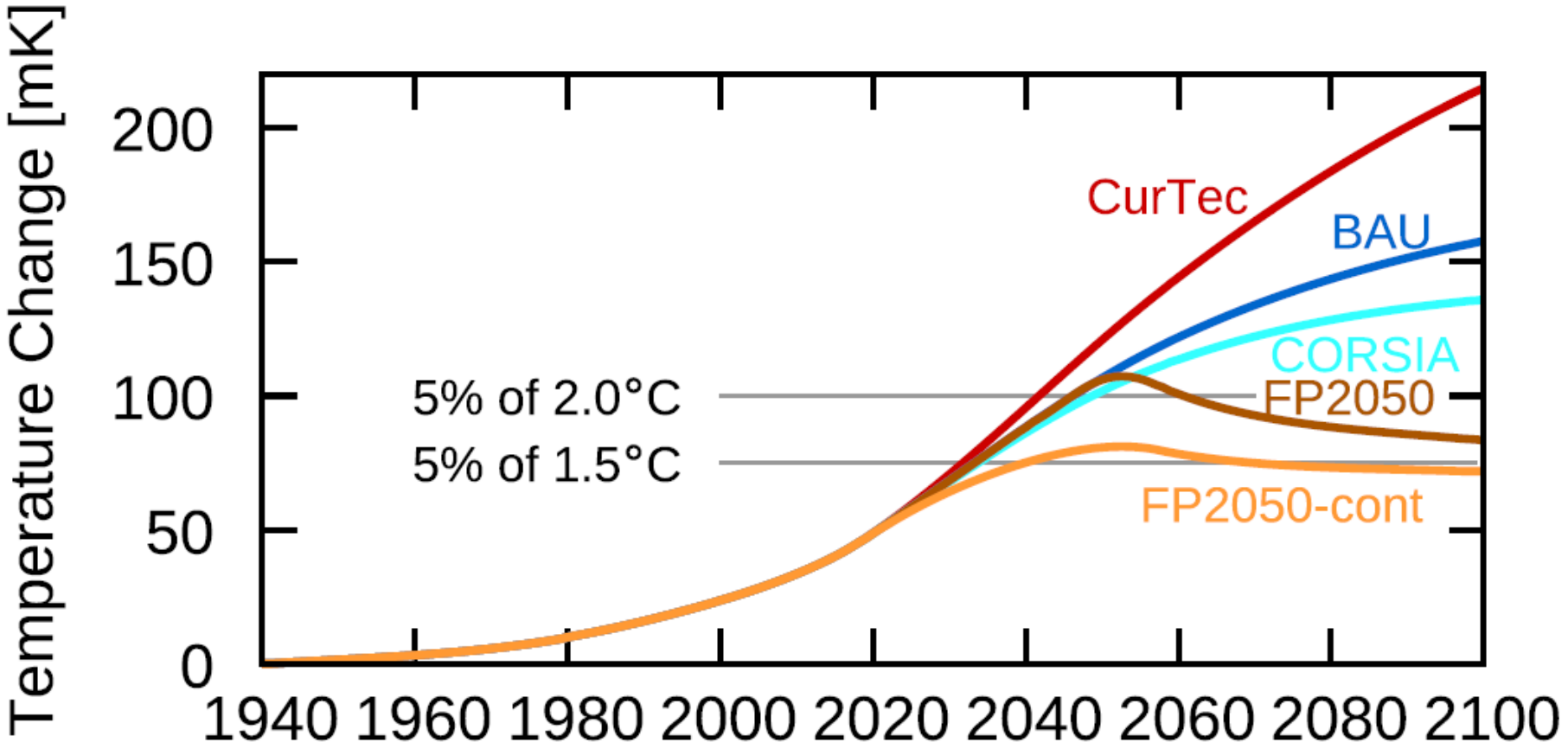
Lee *et. al.* (2020), The contribution of global aviation to anthropogenic climate forcing for 2000 to 2018.

Contrails from Aviation

In 2018, aviation was responsible for more than 1 billion tonnes of CO_2, 2.5% of global CO_2 emission and around 3-5 % of global warming

Picture: Prof. Henri Werij

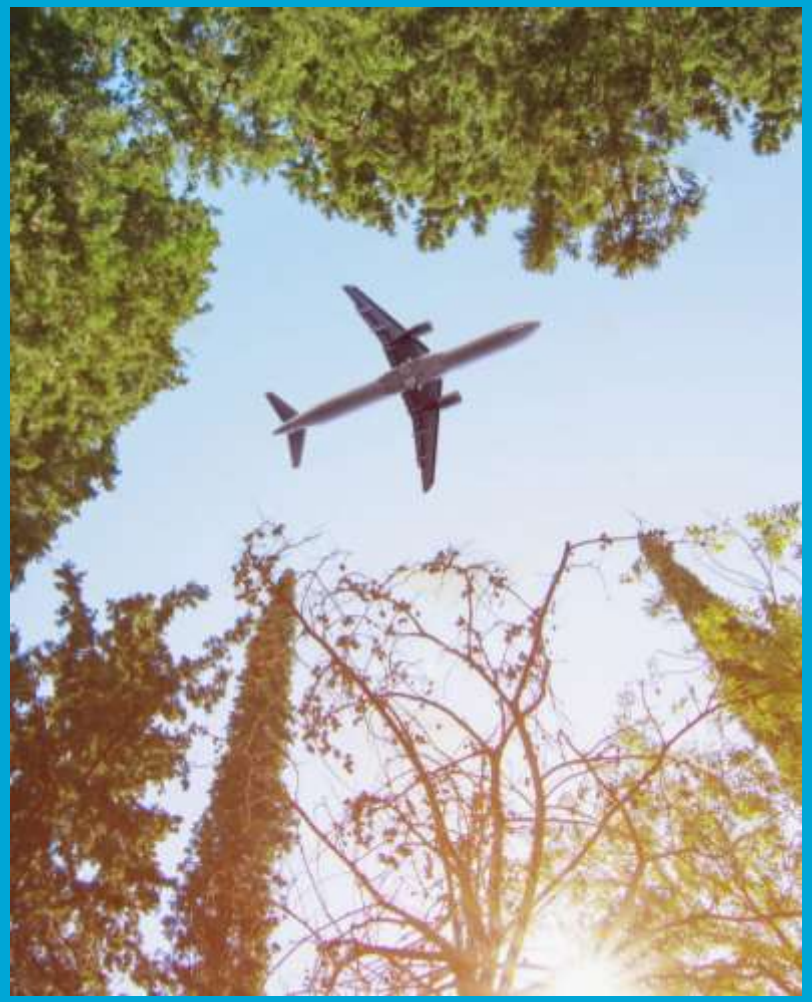
Effect of Aircraft Emissions

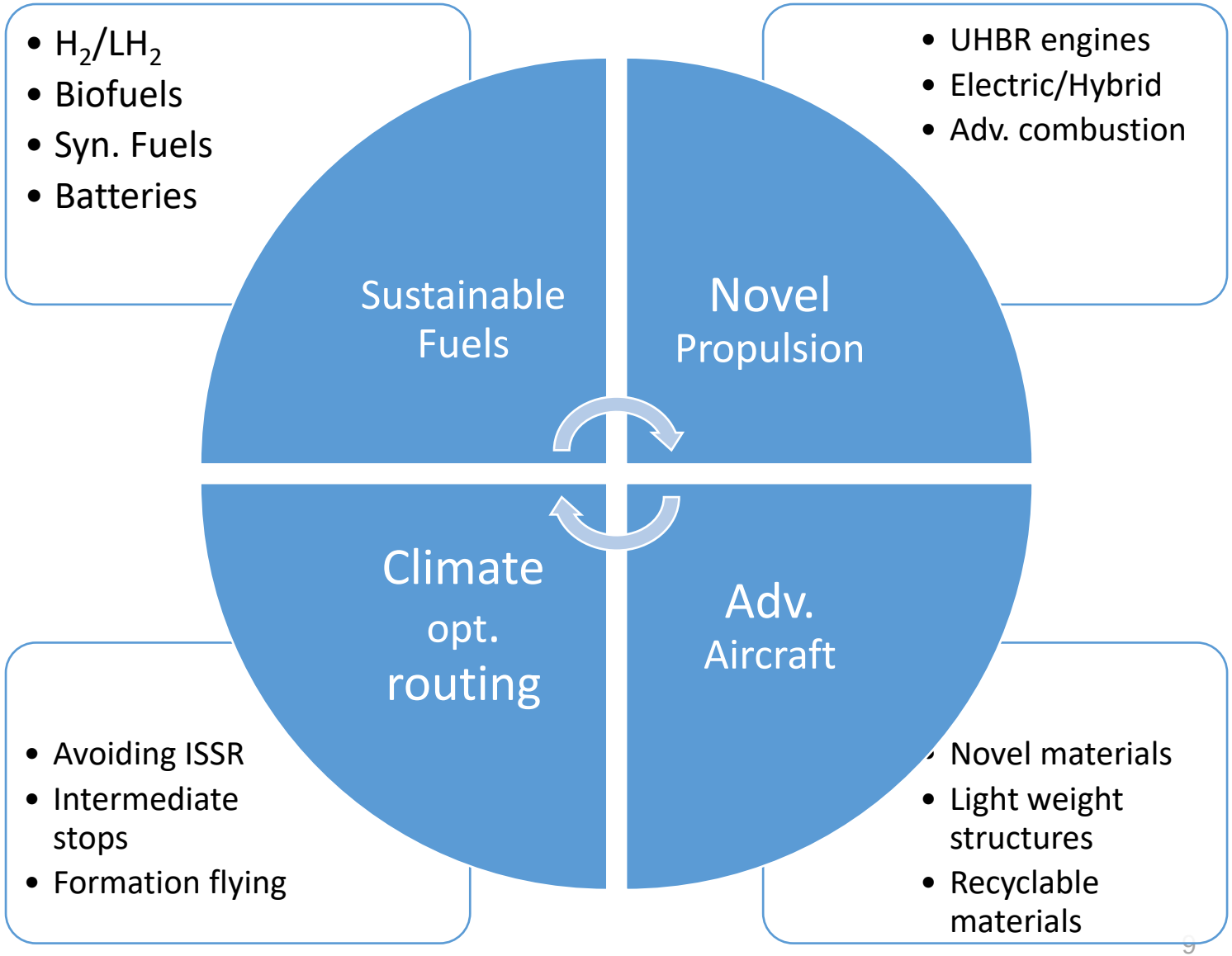


Prof. Dr. Volker Grewe

Grewe, Gangoli Rao, et al. “Evaluating the climate impact of aviation emission scenarios towards the Paris agreement including COVID-19 effects”, Nature Communications, June 2021

How can we make aviation sustainable?

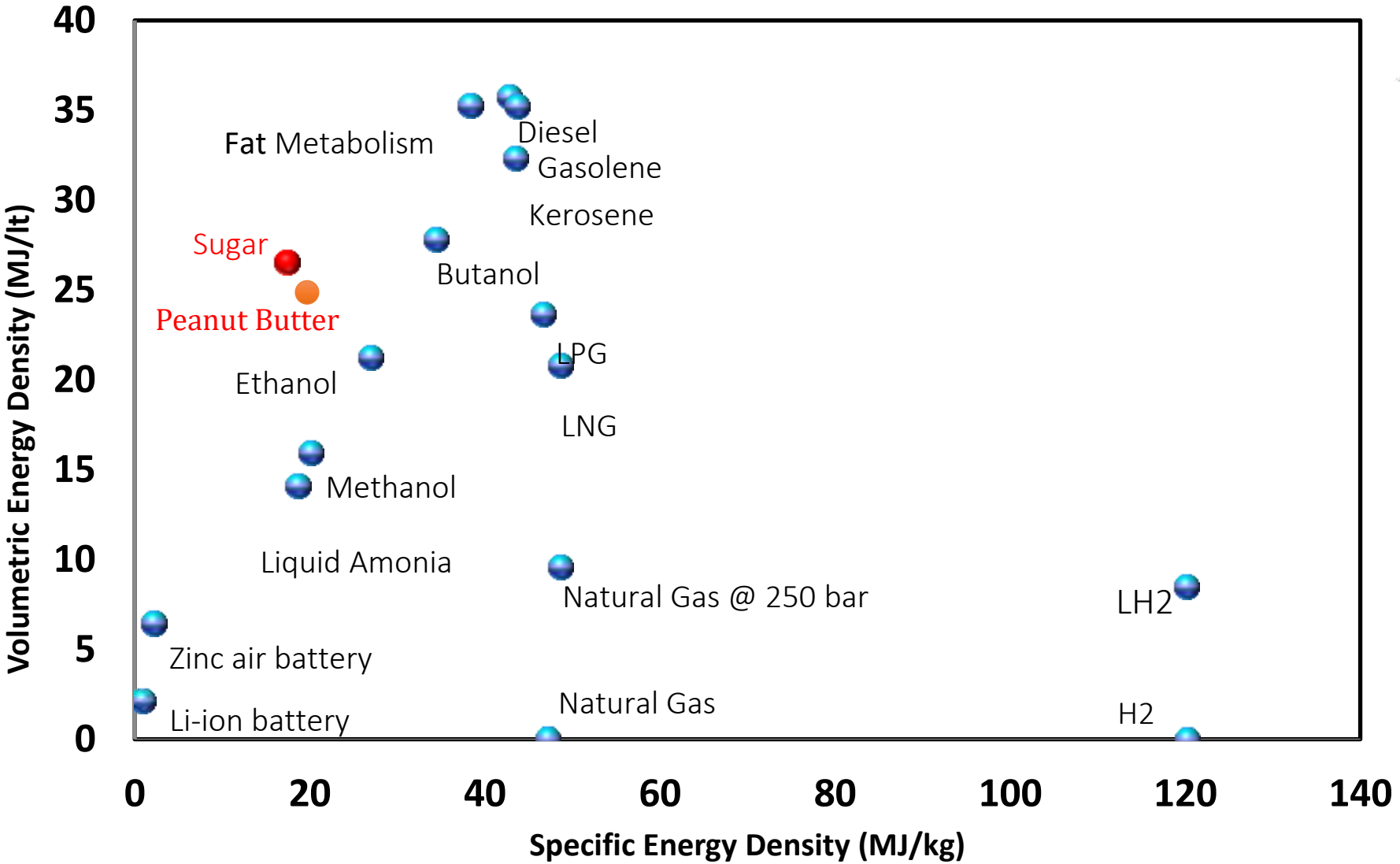




* This list is not extensive

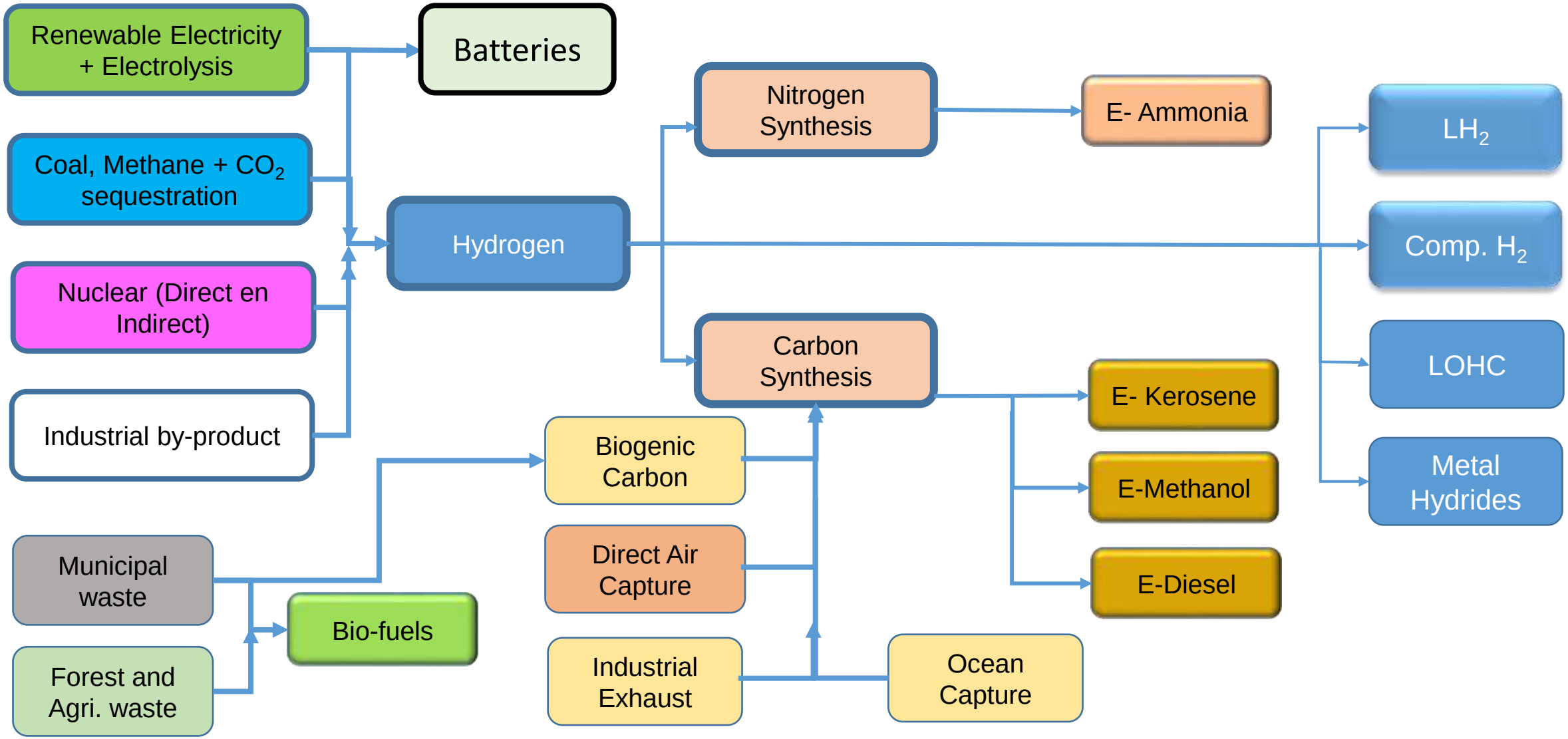
Factors affecting choice of energy source/carrier

Energy sources for aviation



"No fuel is cheap when you have to make it yourself" -Prof. G. Eitelberg

Alternative Energy Carriers for Aviation & Maritime



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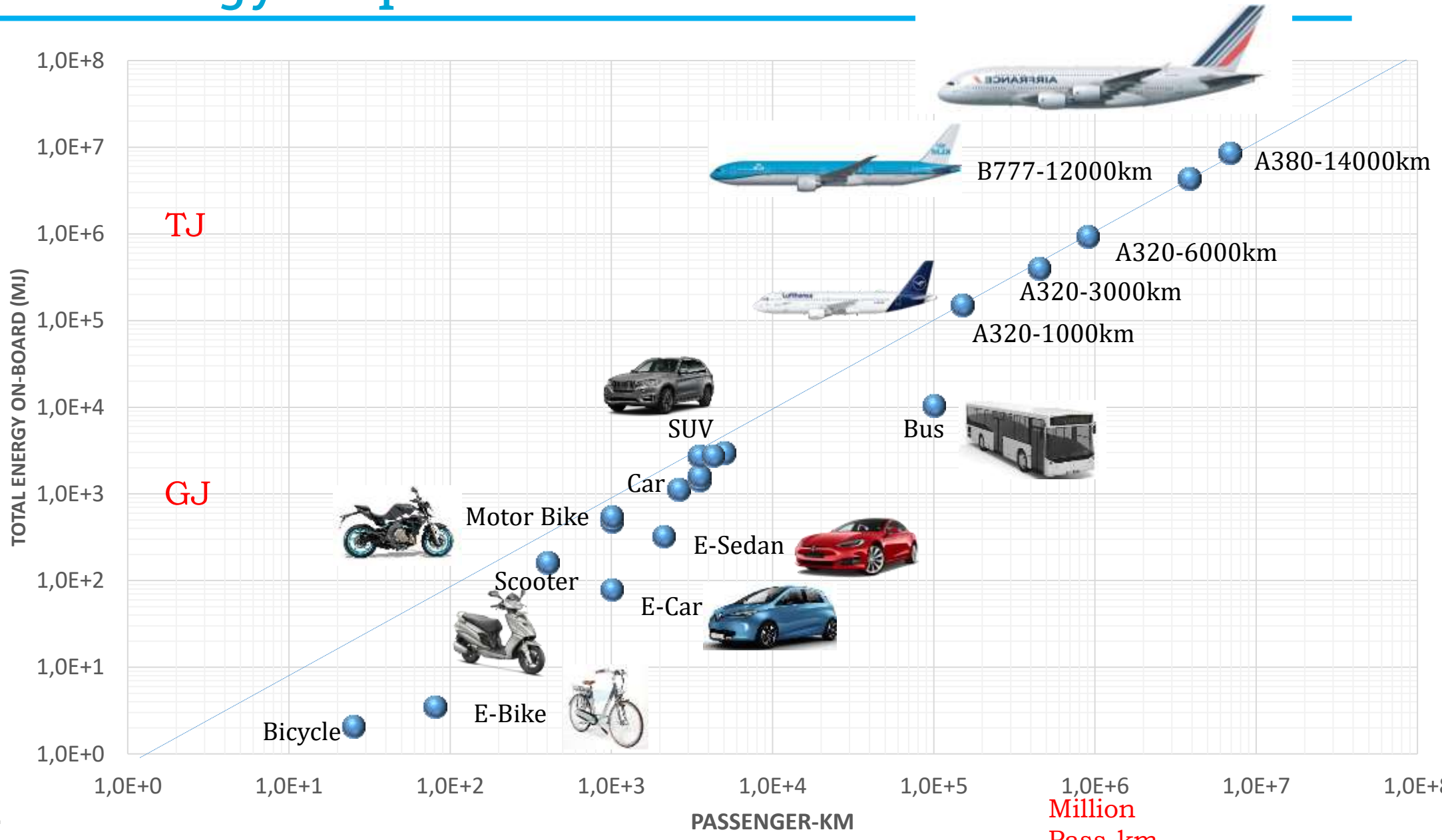
Vehicle Energy Requirement



02

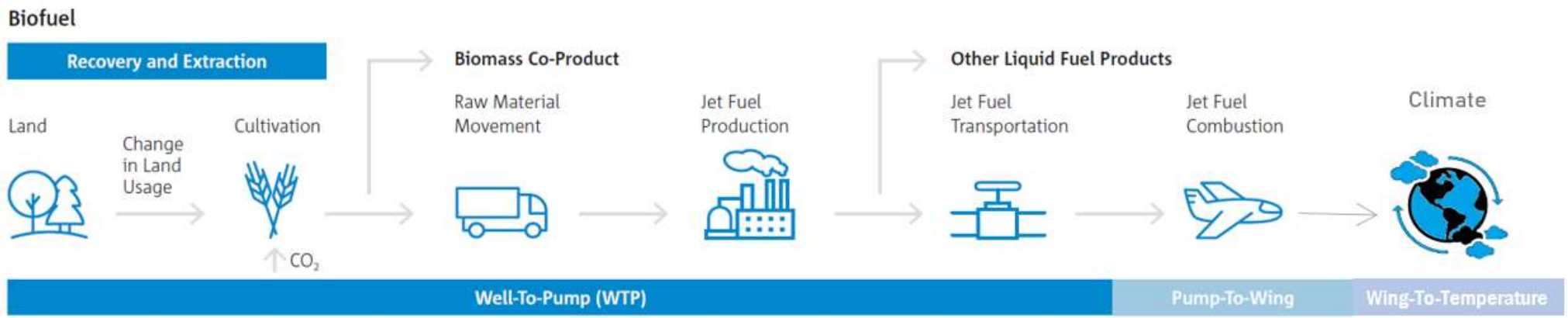
Need for Holistic Approach

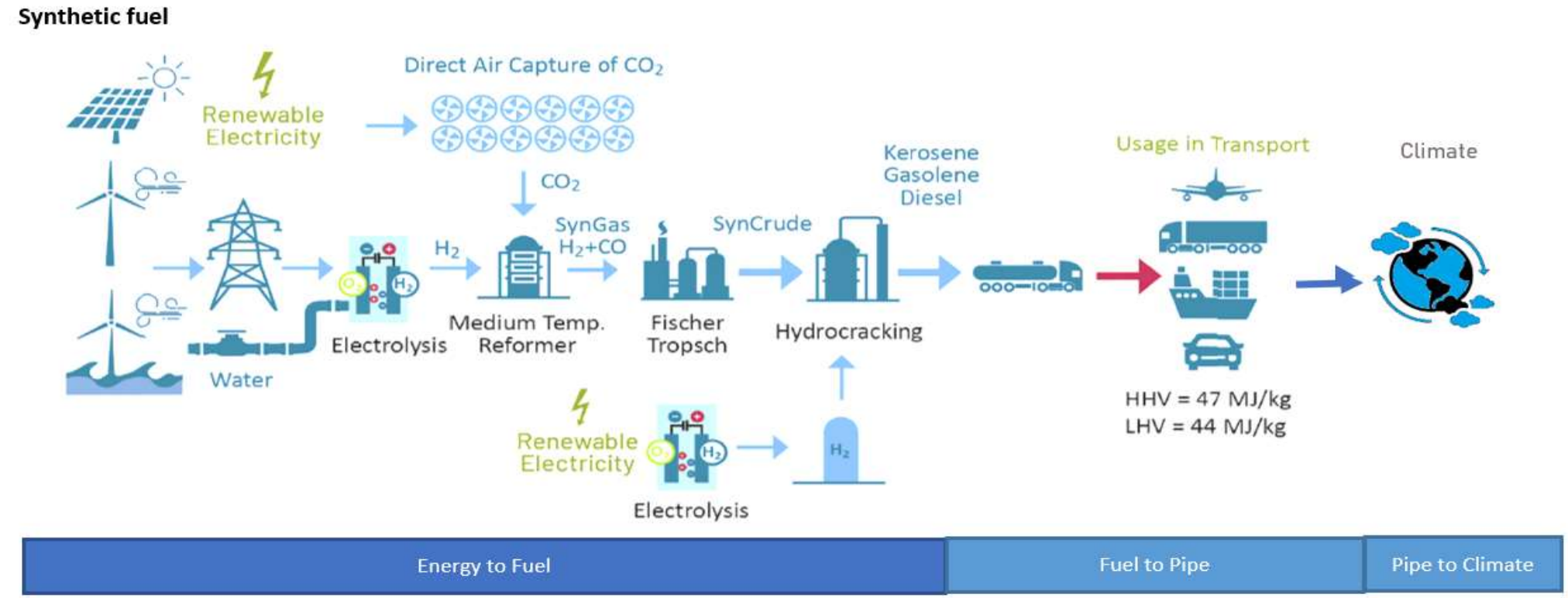
The complete cycle (Flagship Project)









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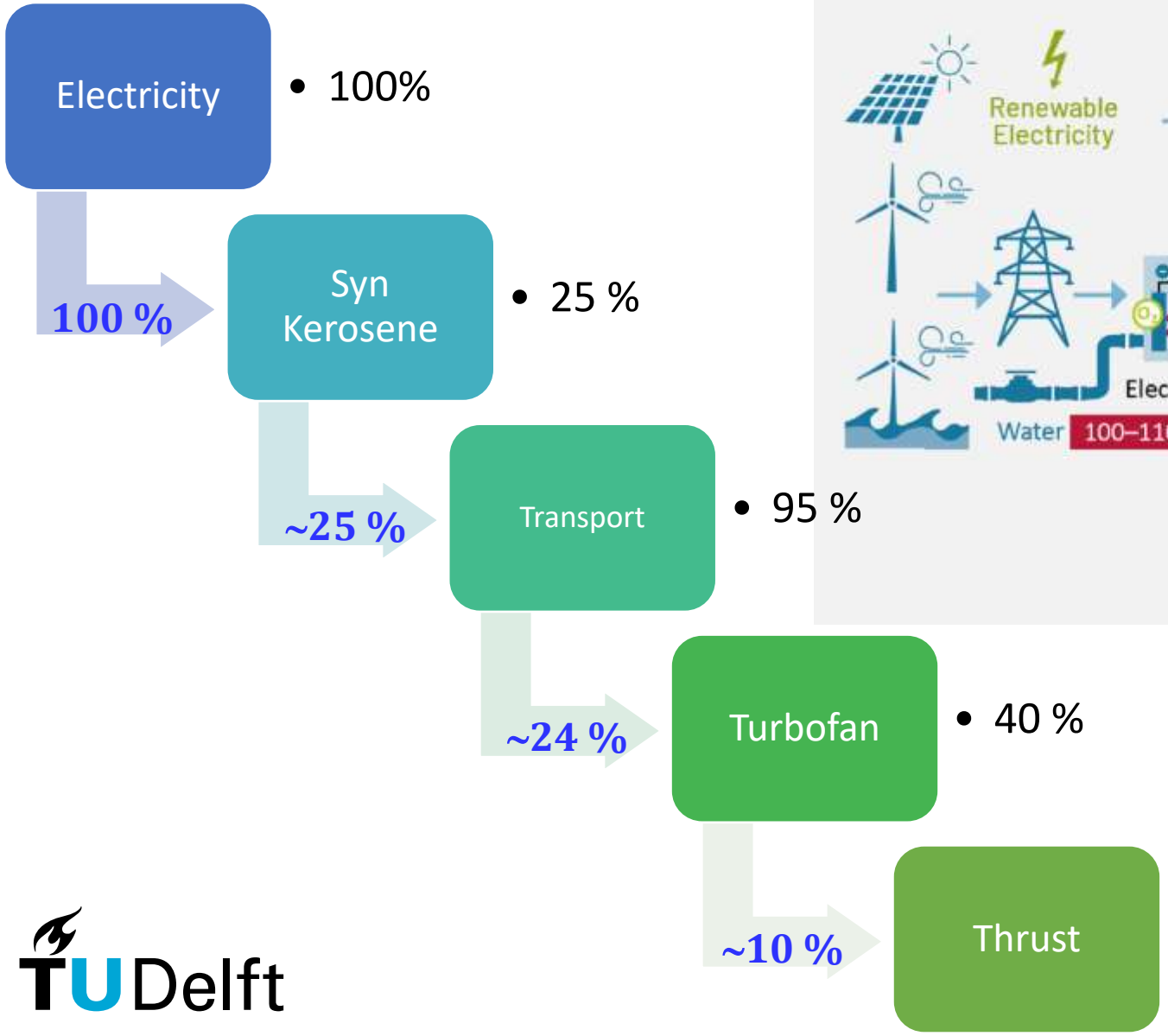
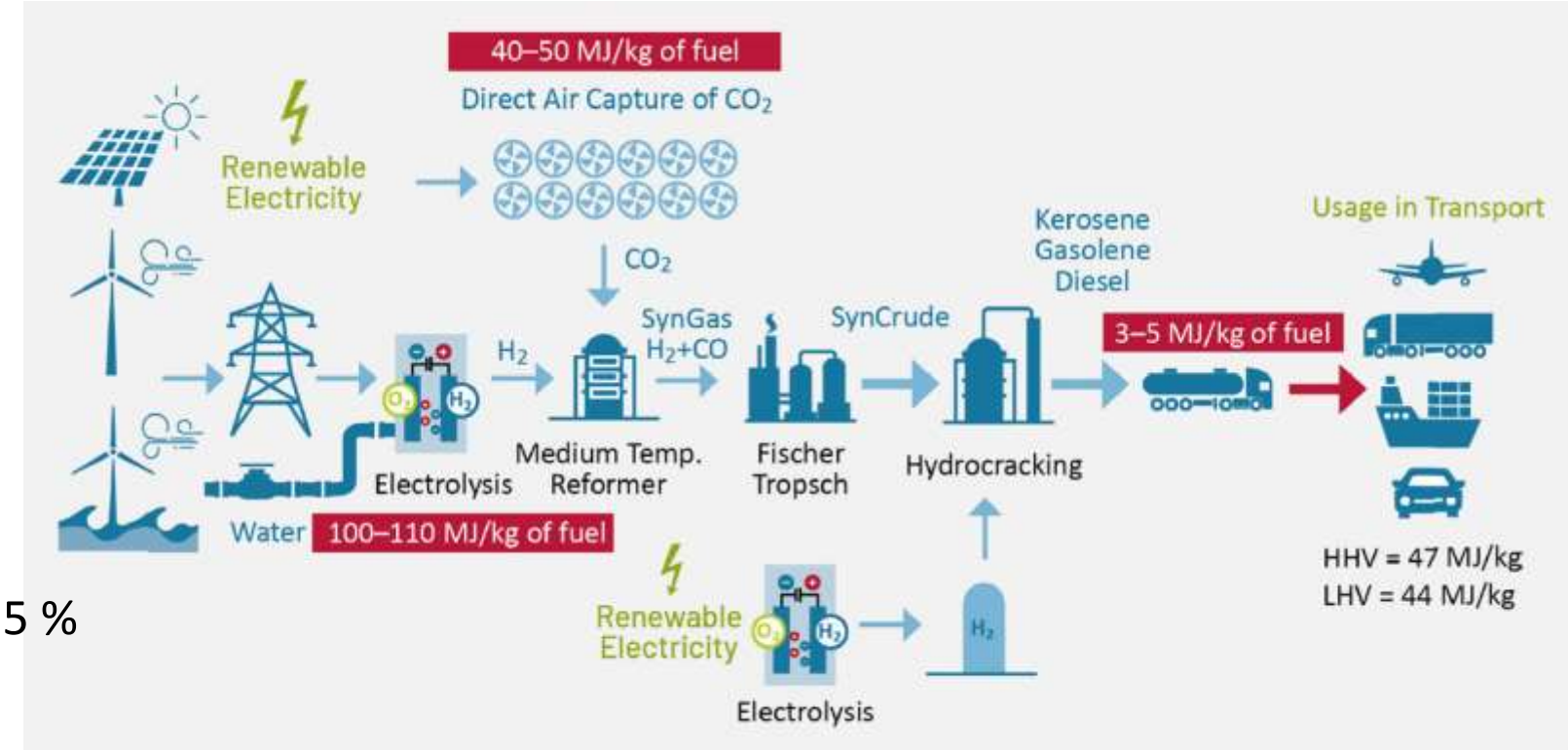
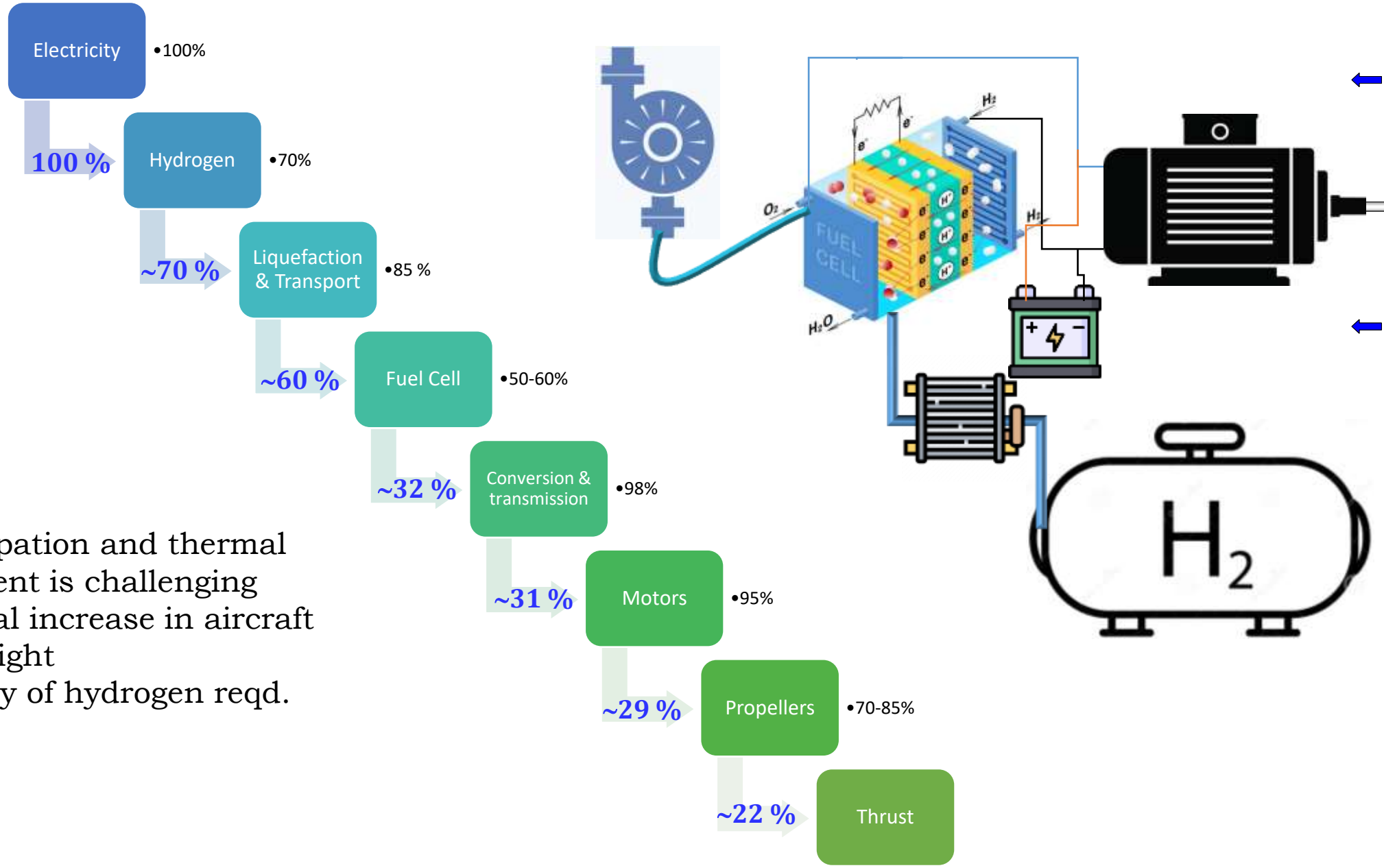
Synthetic Kerosene with DAC





Fuel Cell Electric Aviation



- Heat dissipation and thermal management is challenging
- Substantial increase in aircraft drag & weight
- High purity of hydrogen reqd.

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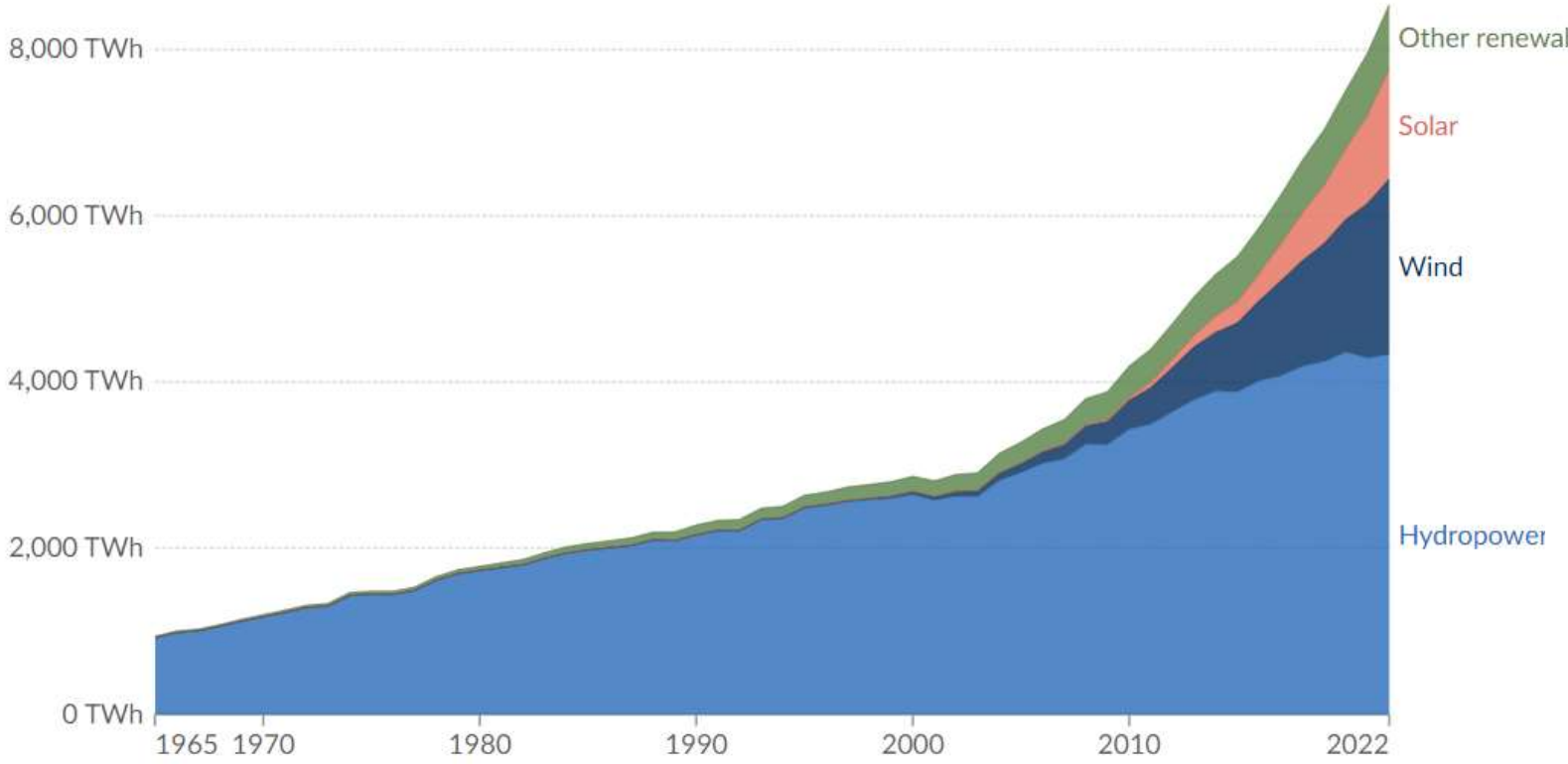
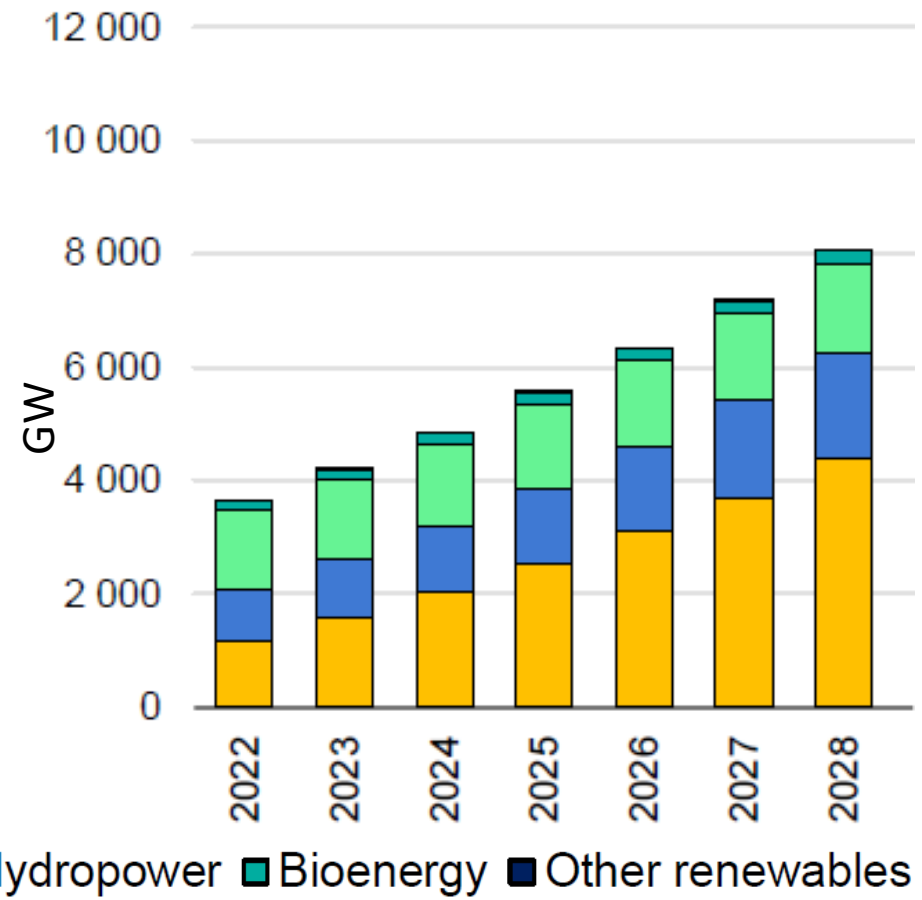
Growth in Renewable Energy



OurWorldInData.org/renewable-energy | [CC BY](CC BY)

IEA, Renewables 2023



All the renewable energy can be used to make around 180 Million Tonnes of Synthetic kerosene ~ 60% of total kerosene used in 2019

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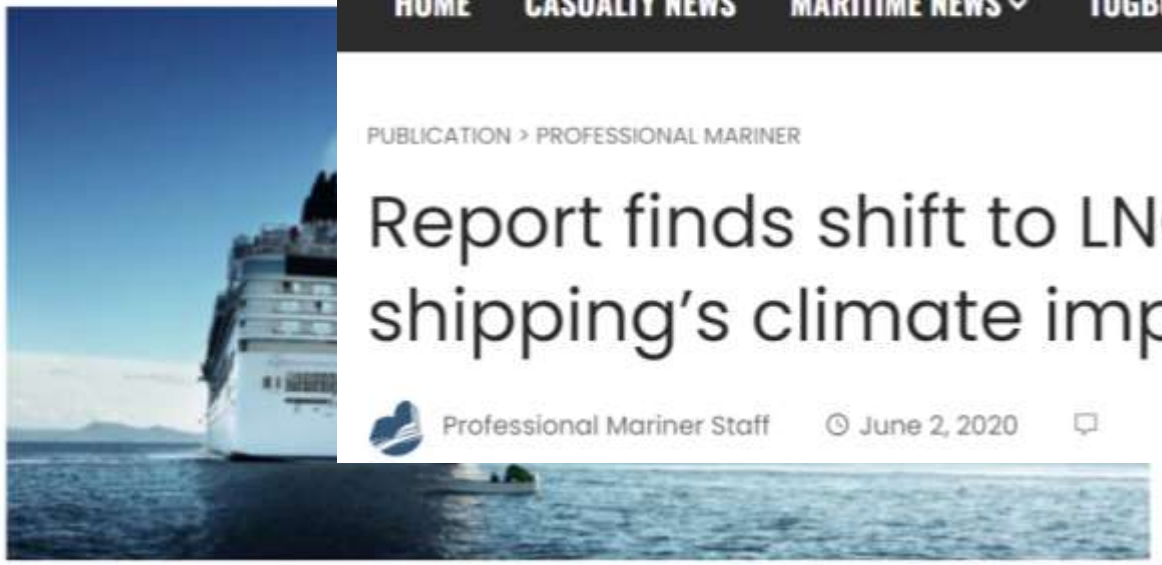
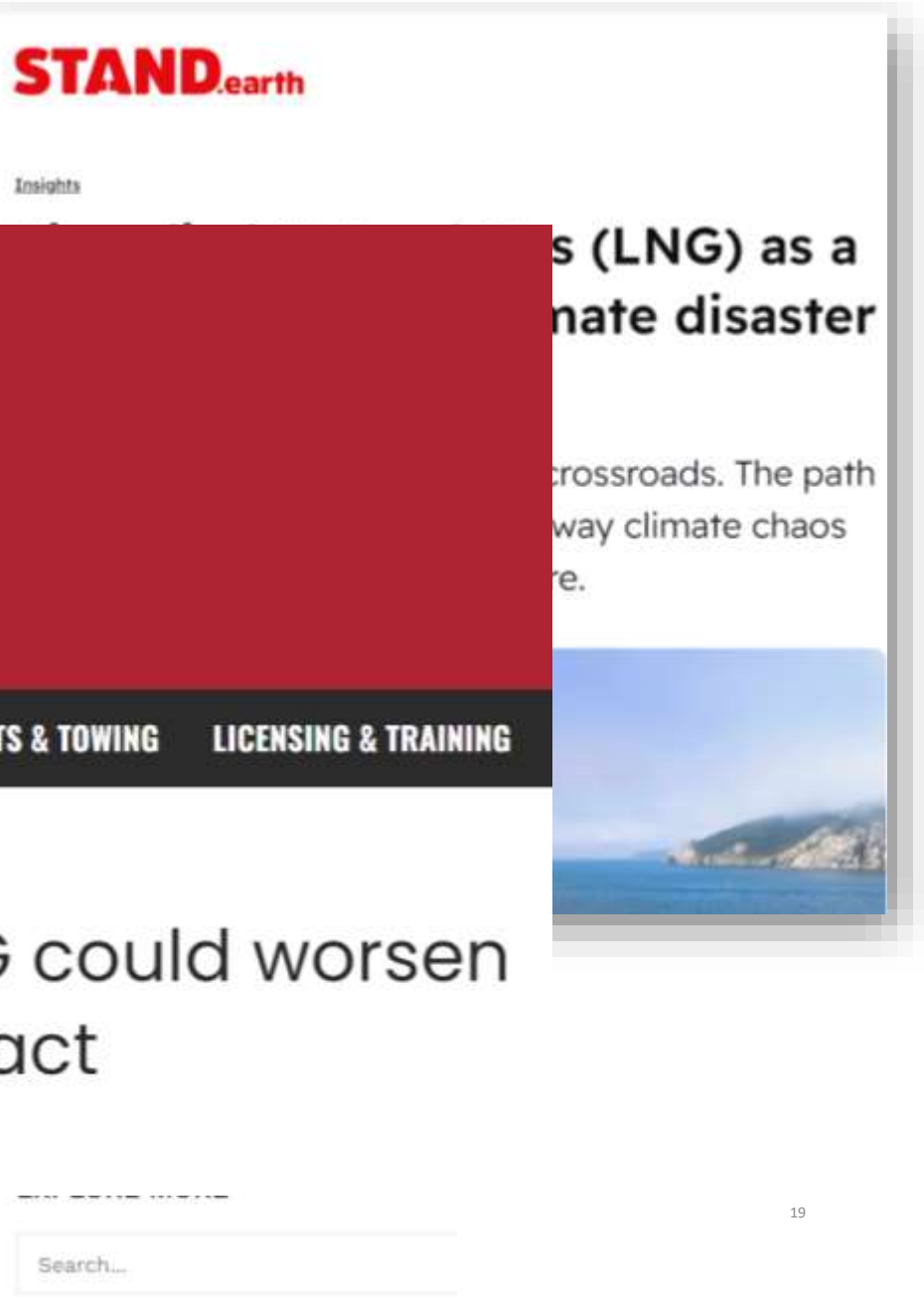
Wrong choices can be expensive





03

What are we doing?

The future belongs to those who anticipate it first

Arvind Gangoli Rao

Picture: DSE group 2015