

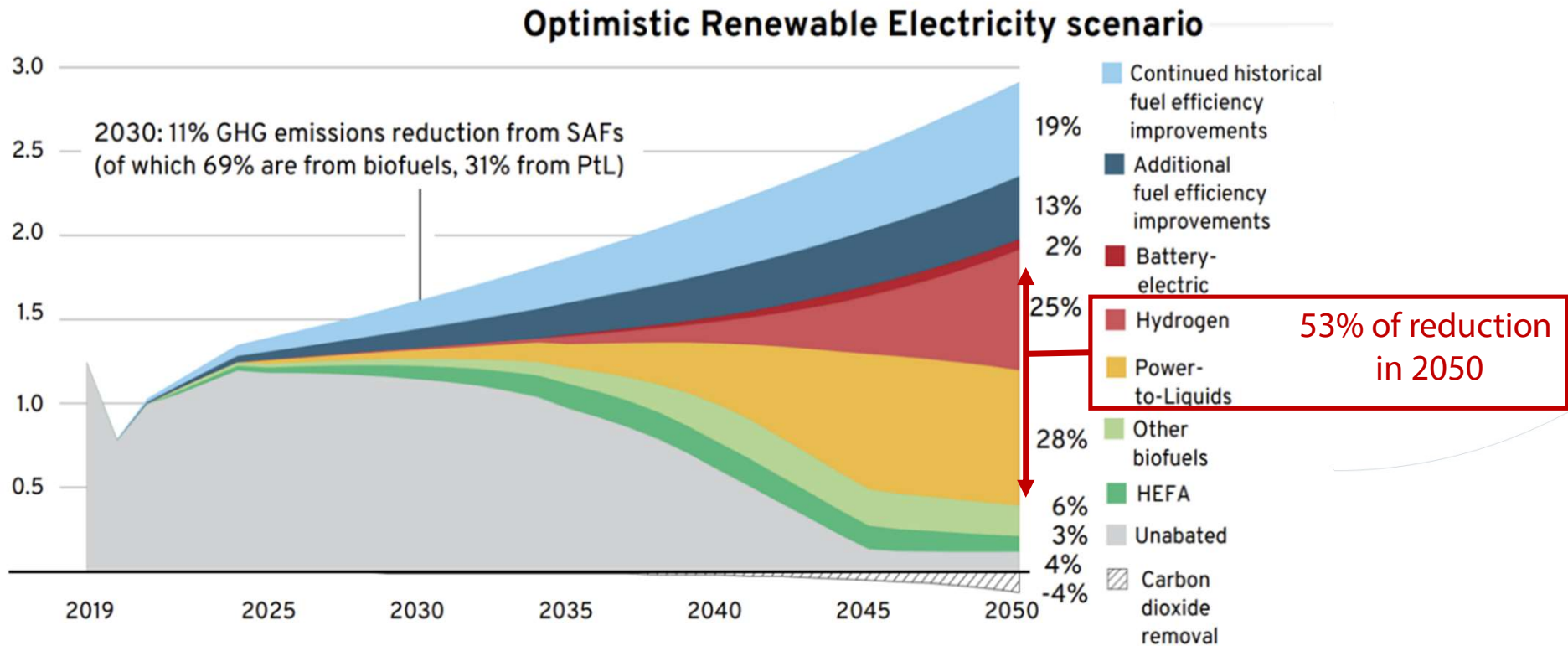


Hydrogen for SAF

IHAC 2023

No silver bullet, but a silver bucket

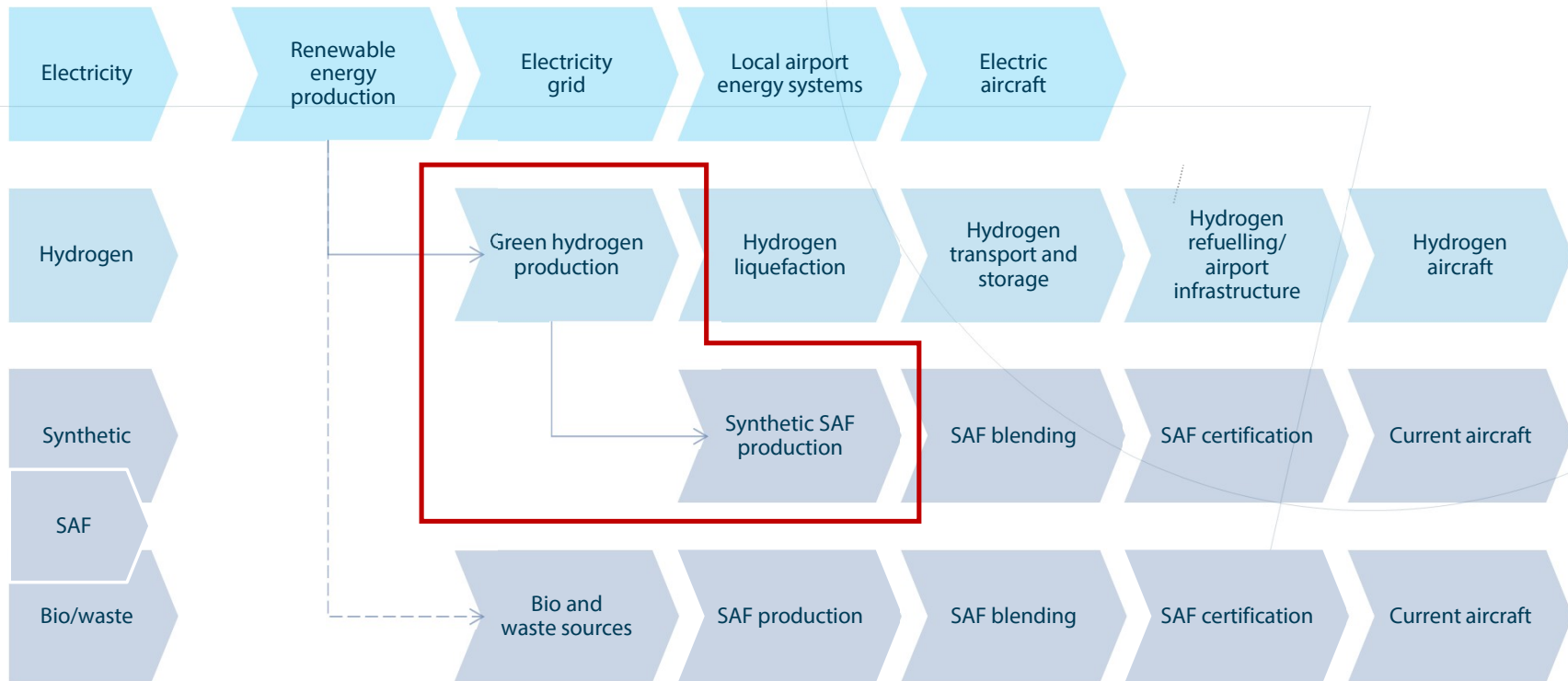
➤ Green hydrogen and Synthetic SAFs represent a majority of the technology needed to decarbonize aviation by 2050.



Mission Possible report, WEF, 2022

Syn-SAF and hydrogen

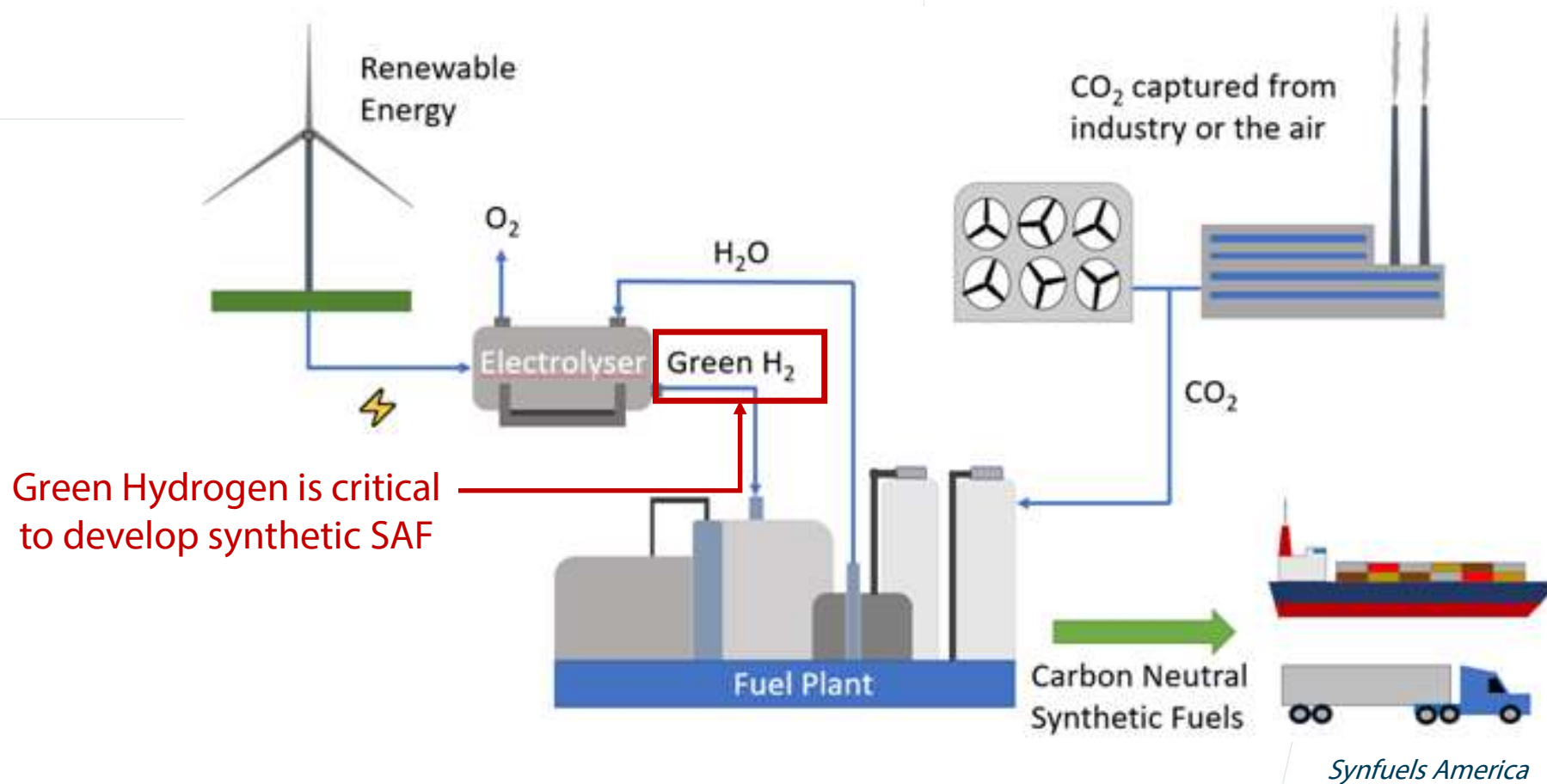
➤ Green hydrogen and renewable electricity to capture carbon are critical components for Synthetic SAFs



To70 research, Netherlands innovation baseline 2022

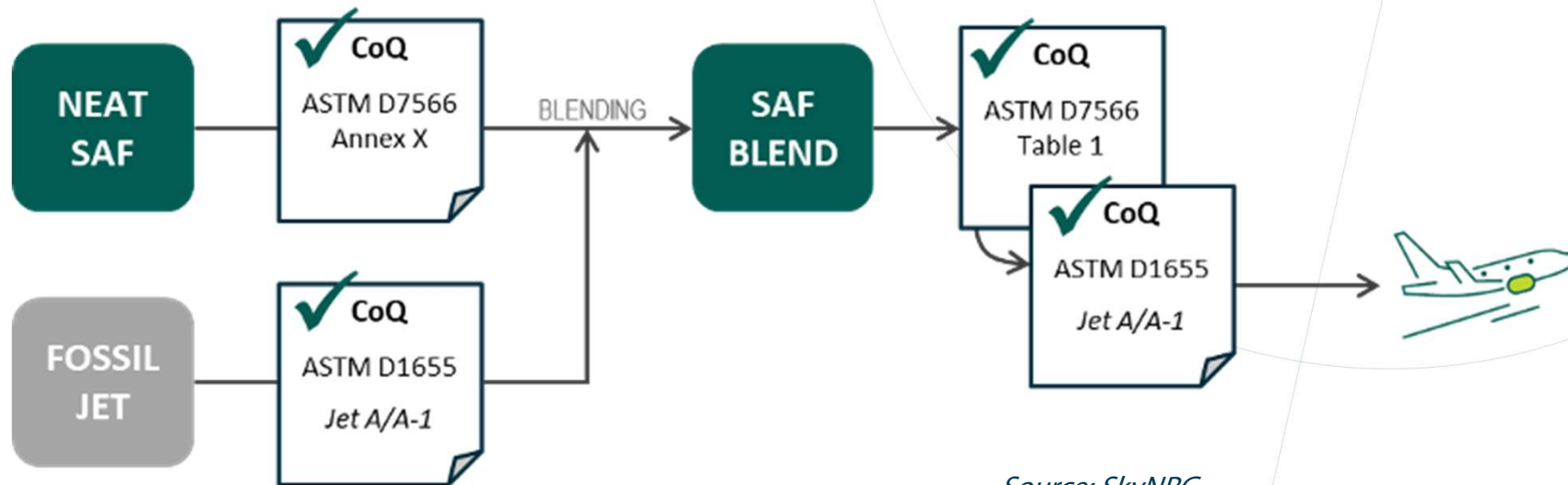
Syn-SAF and hydrogen

- Green hydrogen and renewable electricity to capture carbon are critical components for Synthetic SAFs



Syn – SAF ASTM approval

- Syn-SAF routes currently ASTM approved are Alcohol-To-Jet Synthetic Paraffinic Kerosene (ATJ-SPK) & Fischer-Tropsch Hydroprocessed Synthesized Paraffinic Kerosine (FT-SPK)¹. The production is at pilot scale with TRL levels of 5-6.



Source: SkyNRG

1. [Conversion processes \(icao.int\)](https://www.icao.int)

Syn – SAF Production

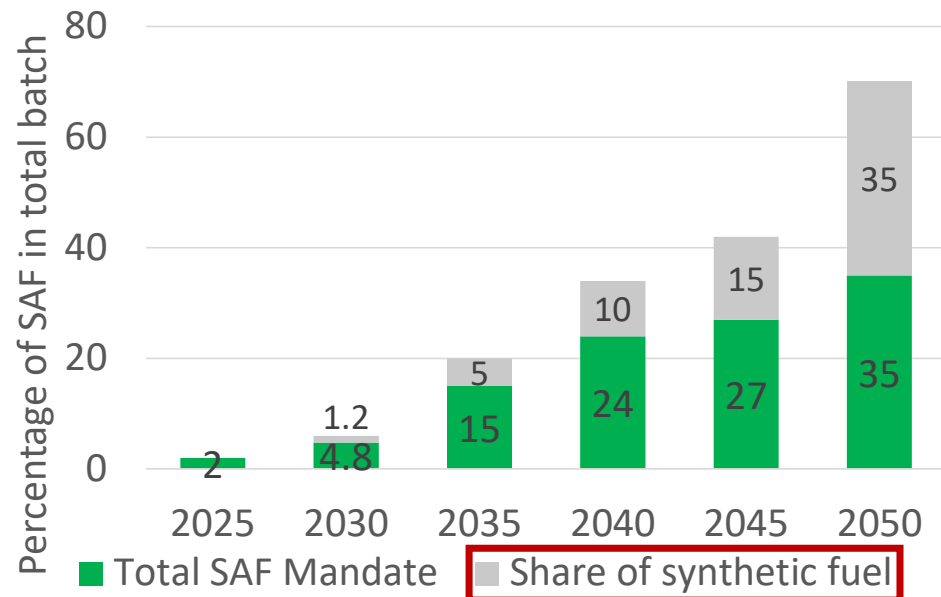
➤ Several startups are developing Synthetic fuel production, but output is limited as TRL remains low.



Synthetic SAF demand

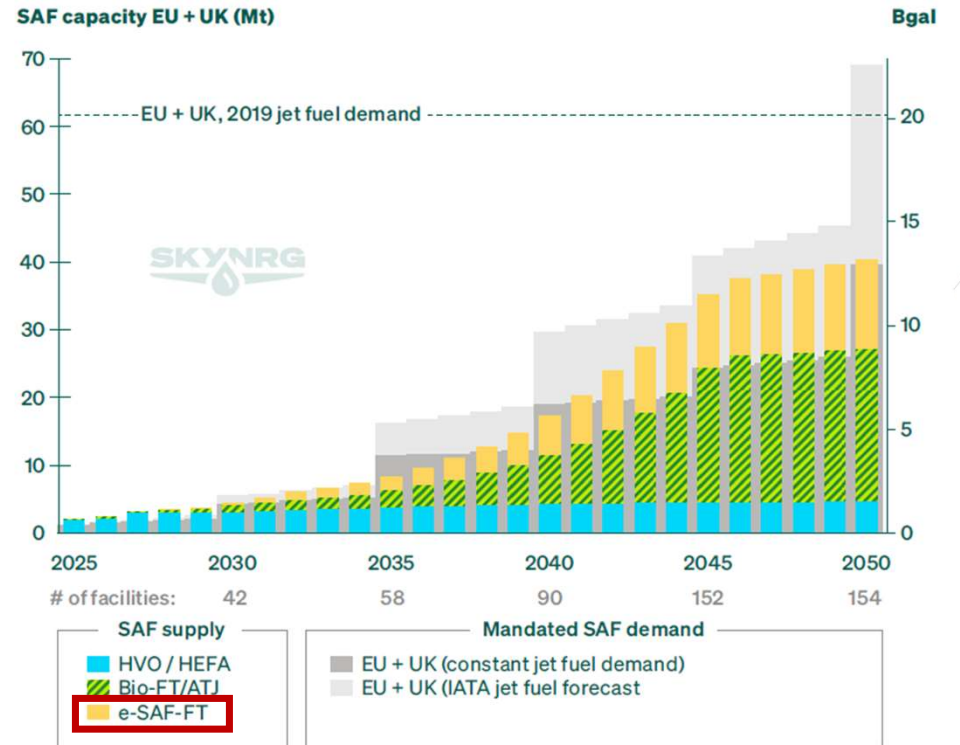
➤ With limited bio-feedstocks Syn-SAF is expected to fill the gap. In Europe, demand is set through mandates.

European SAF targets – under review



To70 research based on internal sources

European SAF capacity vs. mandated SAF demand until 2050

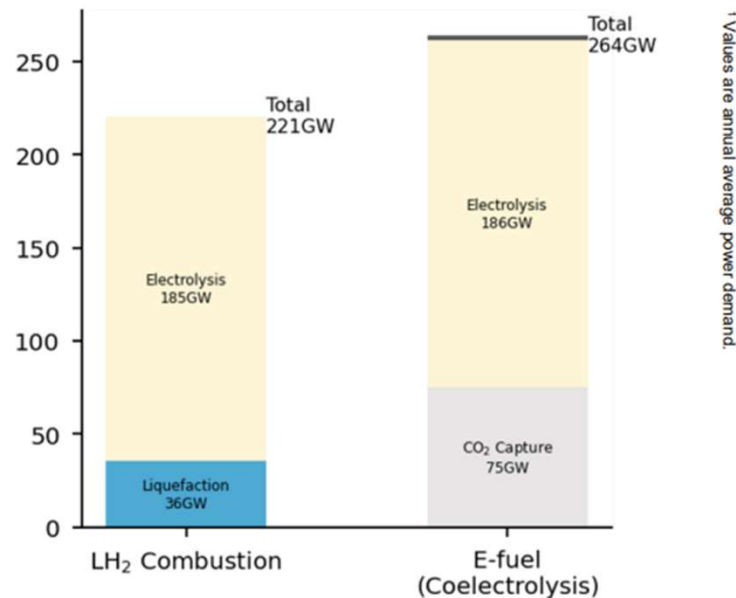


SkyNRG SAF market outlook 2023

Syn – SAF ~~v.s.~~ **AND** Hydrogen trade-off

- Synthetic SAF requires more energy than hydrogen. Both require large amounts of renewable energy

Electric power consumption of fuel production¹
broken down by process step, in GW



For comparison:

U.S. power generation capacity (2019): 1.2 TW
 Cumulative global PV capacity (2019): 627 GW

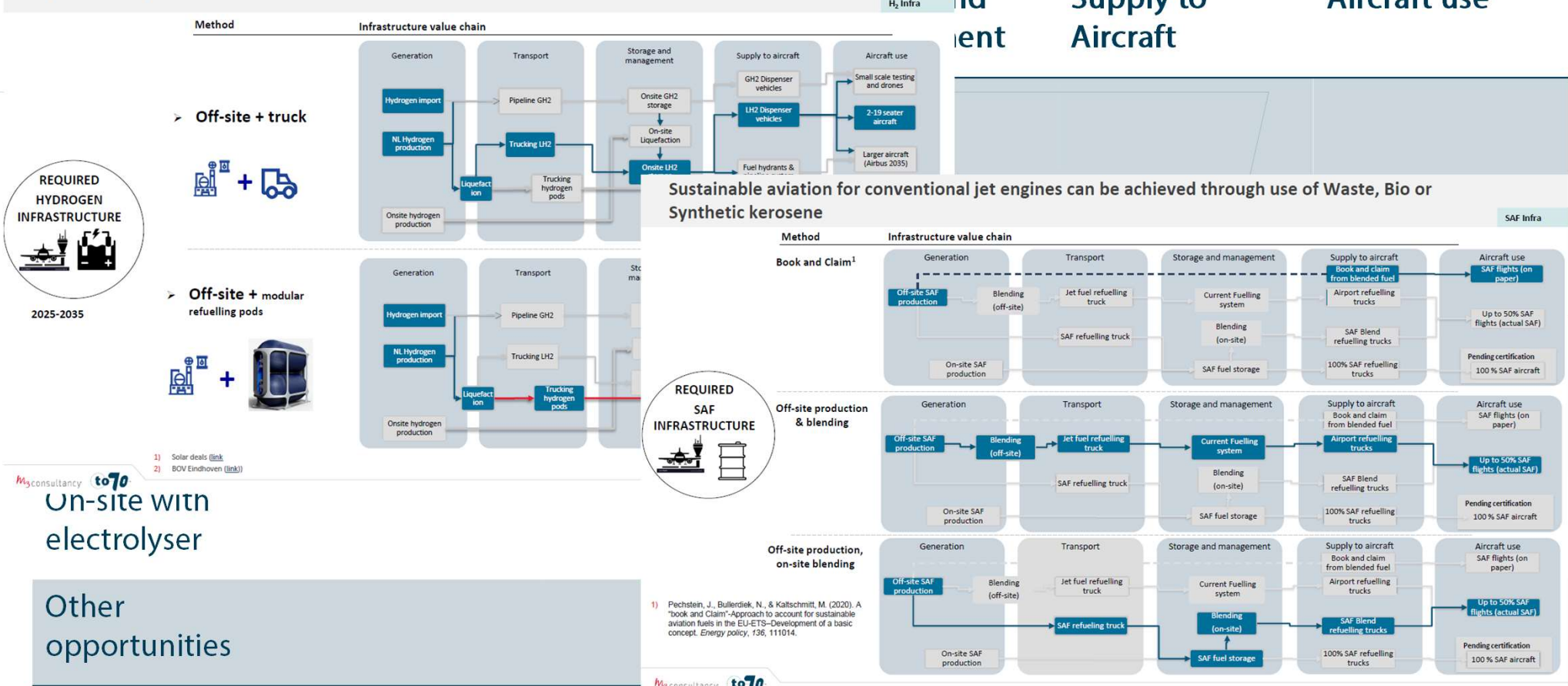
Graphic and data courtesy of MIT from ASCENT Project 52

[CAAFL ASCENT SAF update 2023](#)

Syn – SAF v.s. **AND** Hydrogen trade-off

➤ Synthetic SAF has different impacts at the airport than hydrogen. Both require planning ahead

Hydrogen & hydrogen-electric aviation infrastructure – 2025 to 2035



On-site with electrolyser

Other opportunities

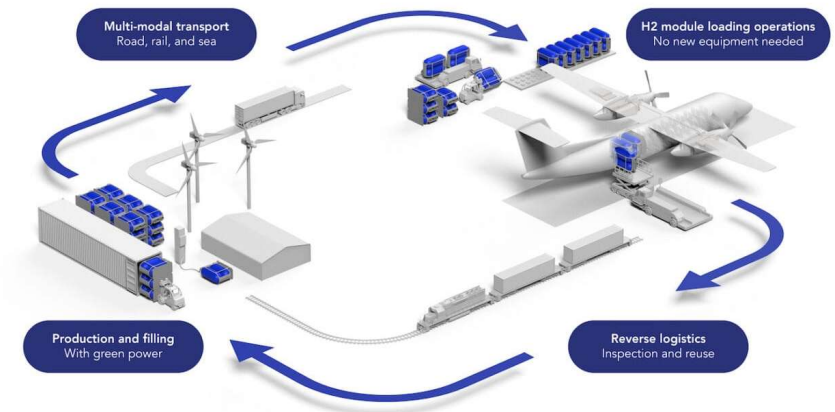
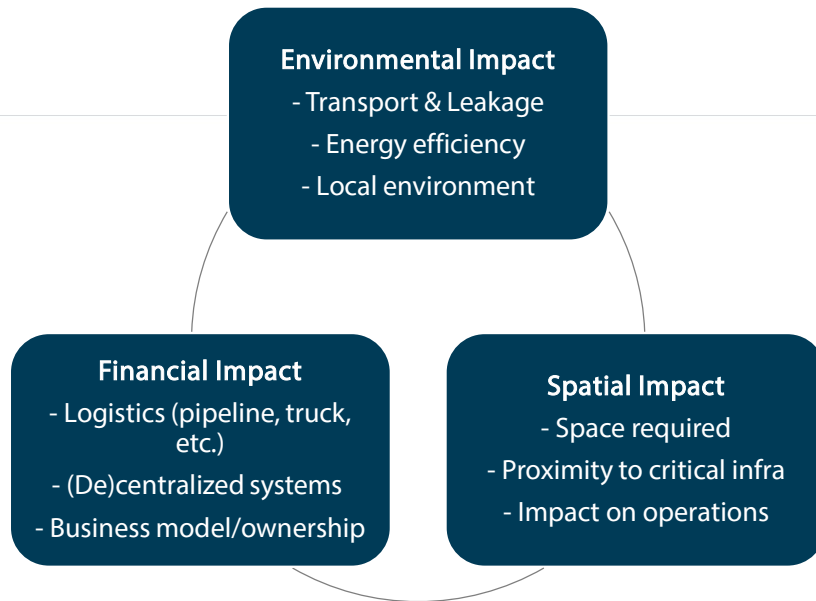
Syn – SAF **AND** Hydrogen **Compliment**

➤ Synthetic SAF requires more energy than hydrogen. Both require large amounts of renewable energy

Trade-off/ Compliment	Hydrogen	Synthetic SAF
<i>Use case</i>	Long term new aircraft required – regional and medium haul flights	Short term drop in – medium & long-haul flights
<i>Feedstock</i>	Renewable electricity	Green hydrogen, captured carbon
<i>Price</i>	High, expected to decrease	Higher, considering cost of capture carbon
<i>Efficiency (relative to renewable electricity)</i>	35-45% pending electrolysis dev.	20-30% pending electrolysis and CCU dev.
<i>Infrastructure at airport</i>	Complete redesign	Same systems can be adapted without great difficulty. Especially regarding the aromatics of Syn-fuels.
<i>Environmental impact</i>	No CO2 emissions, limited non-CO2	No CO2 emissions, non-CO2 emissions largely remain

Syn – SAF & Hydrogen role of airports

➤ Airports must consider both SAF and especially hydrogen infrastructure in their long-term master planning



Critical points:

- ✘ Impacts for infrastructure are yet unclear
- ✘ The balance between these points varies per airport

Conclusions

- ✦ Hydrogen is the key to unlocking the potential of Syn-SAF.
- ✦ Hydrogen and Syn-SAF use are **not competitors** but a shared target. Trade-offs must be understood but these forms of fuel can also **compliment**.
- ✦ Full understanding of green hydrogen & SAF is **critical** regardless of aircraft and airport development.



Based on research by To70 on Hydrogen for Maastricht airport



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Edinburgh, Geneva, Medellín, Melbourne,
Milan, Munich, São Paulo, Singapore,
Shanghai, The Hague, Toronto.



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