

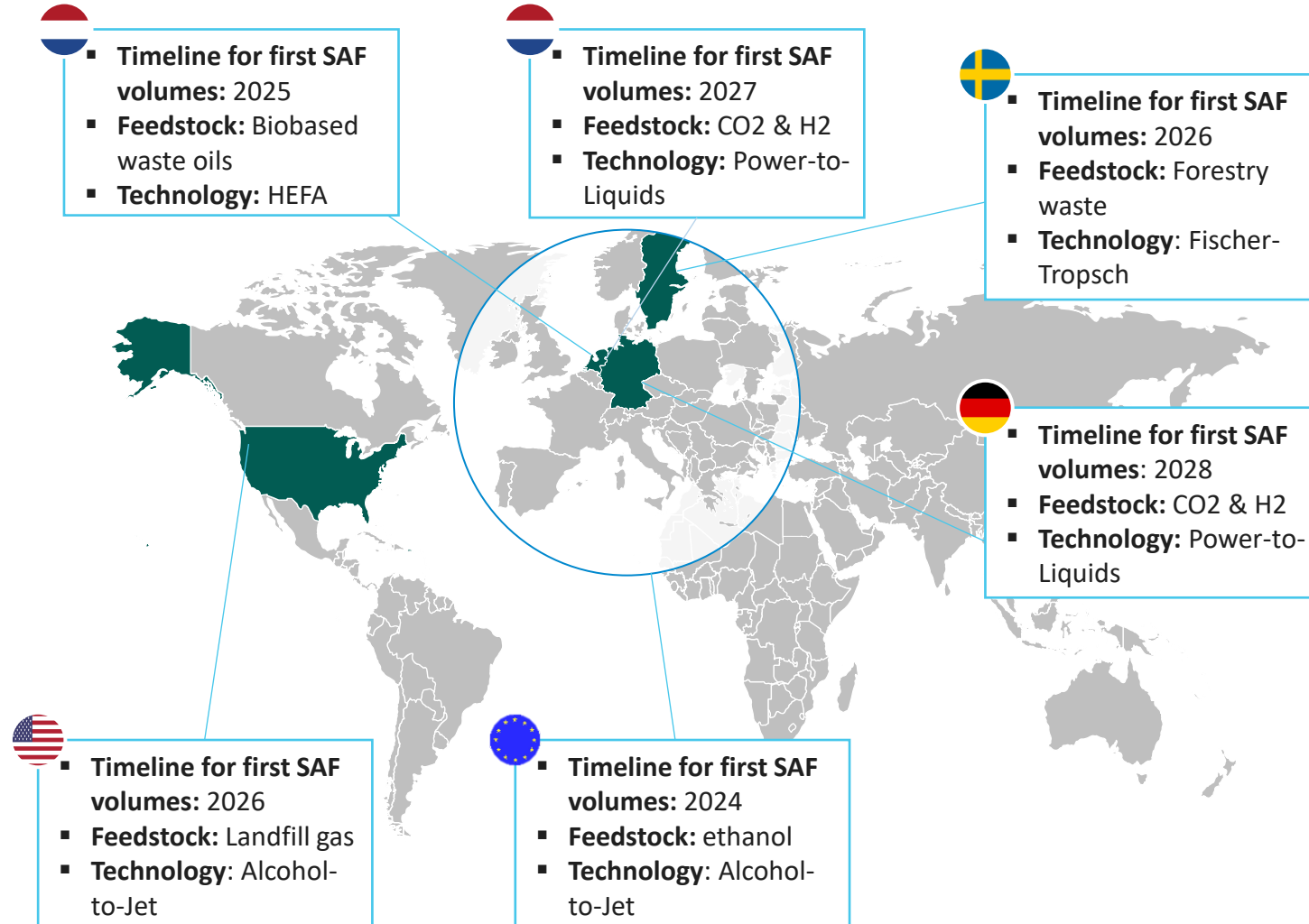
# **THE ROLE OF CO2 BASED FUELS IN MAKING AVIATION MORE SUSTAINABLE**

**CO2 CAPTURE, STORAGE AND REUSE CONFERENCE  
18-05-2022**




# AT SKYNRG WE ARE COMMITTED TO DO OUR PART TO MAKE SAF THE NEW GLOBAL STANDARD

## SAF plant development tracks







## Corporate SAF programs



**KLM Corporate SAF Programme**




- ▶ Corporate clients of KLM can buy SAF to reduce the carbon footprint of their business-related travel. Initiated in 2011 by SkyNRG.
- ▶ Members include:
 



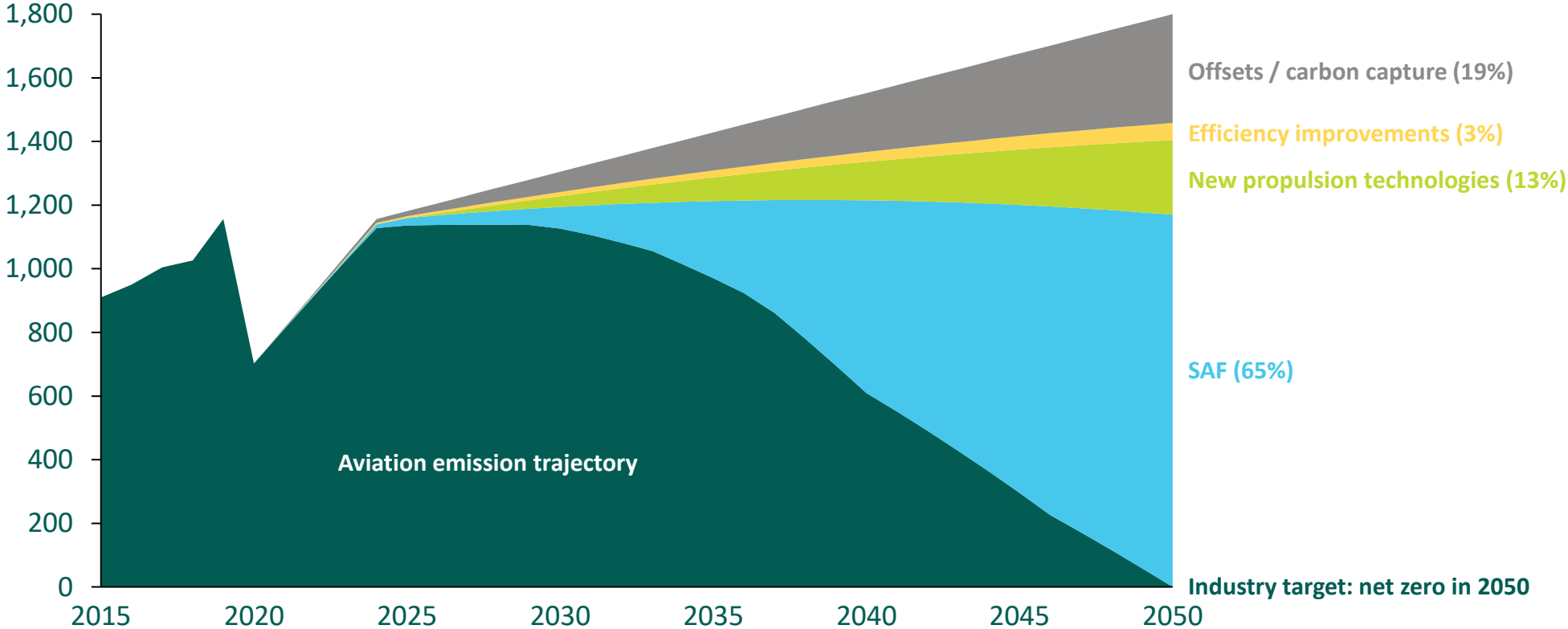
**Board Now Programme**

- ▶ Partnering companies purchase SAF in advance to finance and enable a specific production facility
- ▶ Additionally, the program is unique since it is not bound to an airline
- ▶ Members include:
 

# THE AVIATION INDUSTRY HAS COMMITTED TO NET ZERO IN 2050; SAF IS KEY TO ACHIEVE THIS GOAL

Global aviation emissions (Mt CO2)  
Based on business-as-usual trajectory of IATA\*

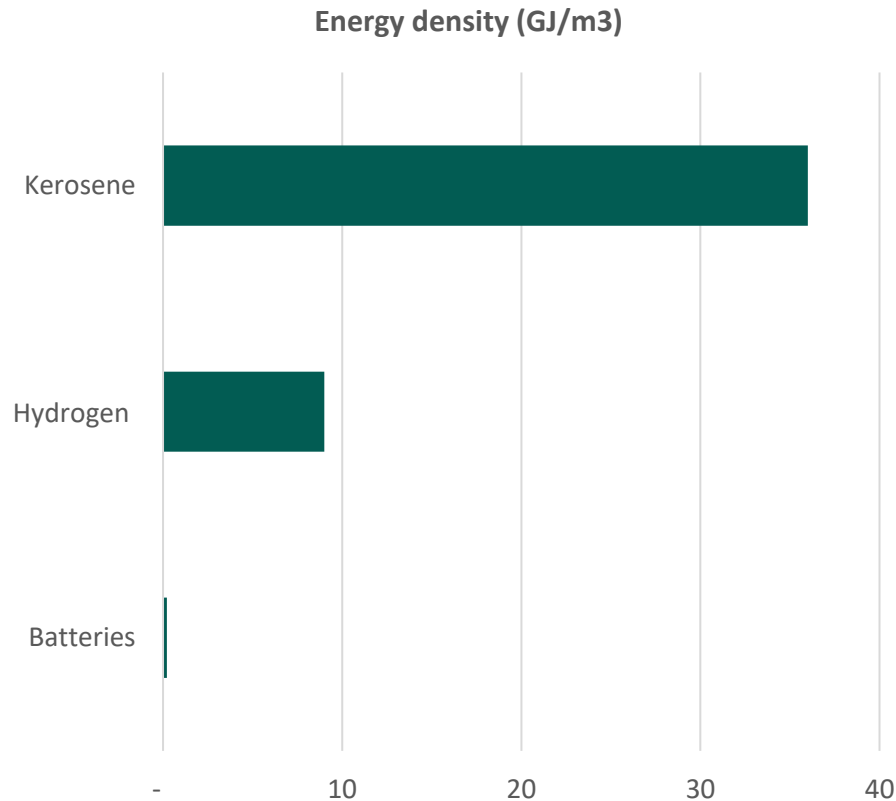


Source: IATA 2021, SkyNRG analysis

\*this trajectory includes an annual efficiency improvement of 1.5-2% per year



# SAF IS THE MOST EFFECTIVE MEASURE TO REDUCE CO2 EMISSIONS IN THE NEAR TERM GIVEN ITS OPTIMAL ENERGY TO VOLUME RATIO



- ▶ Jet fuel is a very efficient energy carrier
- ▶ This is key since every kilogram or cubic meter counts in the air
- ▶ 1 liter of jet fuel contains approx. 8,000 kilocalories

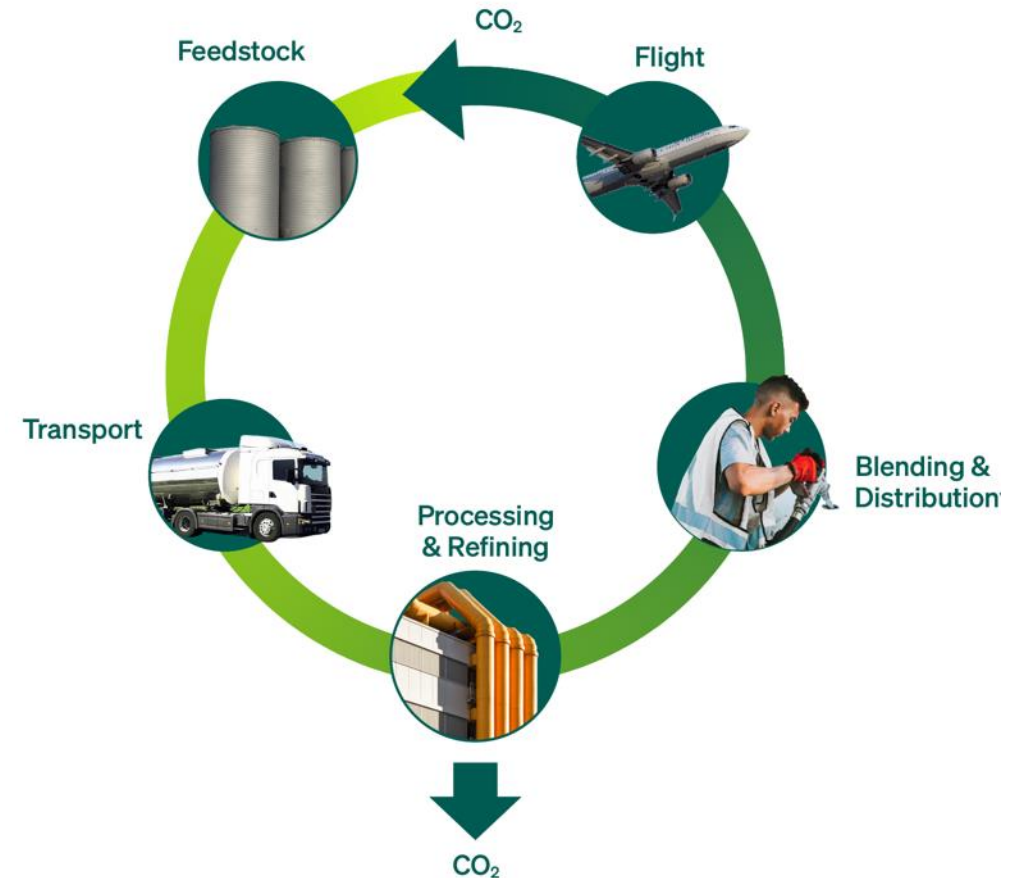
- ▶ H<sub>2</sub> could work from a weight perspective since it's more efficient than fuel but space is the challenge it needs to be pressurized
- ▶ High pressure is challenging in terms of engineering and safety

- ▶ Batteries will improve in the coming years
- ▶ Electric flying has potential on short-haul flights

# **SUSTAINABLE AVIATION FUEL (SAF) IS MADE FROM RENEWABLE RESOURCES AND HAS THE POTENTIAL TO REDUCE GREENHOUSE GAS EMISSIONS BY UP TO 100%**

SAF has the potential to reduce life-cycle emissions up to 100%

- ▶ SAF can be produced from a wide range of renewable feedstocks including biomass, industrial flue gases and pure CO<sub>2</sub>
- ▶ SAF can reduce greenhouse gas emissions by up to 100%<sup>1</sup>, depending on the feedstock and technology used and production context
- ▶ SAF also reduces emissions of particulate matter (by up to 90%) and sulphur (by up to 100%)
- ▶ The production context matters: SAF producers should ensure they avoid (in)direct land use change, do not compete with food supply, or do not cause adverse social or economic impacts



Sustainable aviation fuels (SAF) use renewable feedstocks, thereby closing the carbon loop

1. By combining SAF production with carbon capture and storage it is technically possible to move beyond 100% greenhouse gas reduction

# AFTER A DECADE OF VOLUNTARY MARKET BUILDING, GOVERNMENTS ARE STEPPING UP TO CREATE A LONG-TERM, STABLE SAF MARKET

SAF demand will be driven by policies...



The EU just announced a SAF blending mandate starting with 2% in 2025 and growing to 63% in 2050



In addition, various European countries announced more ambitious SAF targets



The United States already incentivize the use of SAF; The Biden administration targets 100% SAF use in 2050



The global CO<sub>2</sub> framework CORSIA framework is expected to cost airlines 3-12 B\$ by 2030<sup>1</sup>

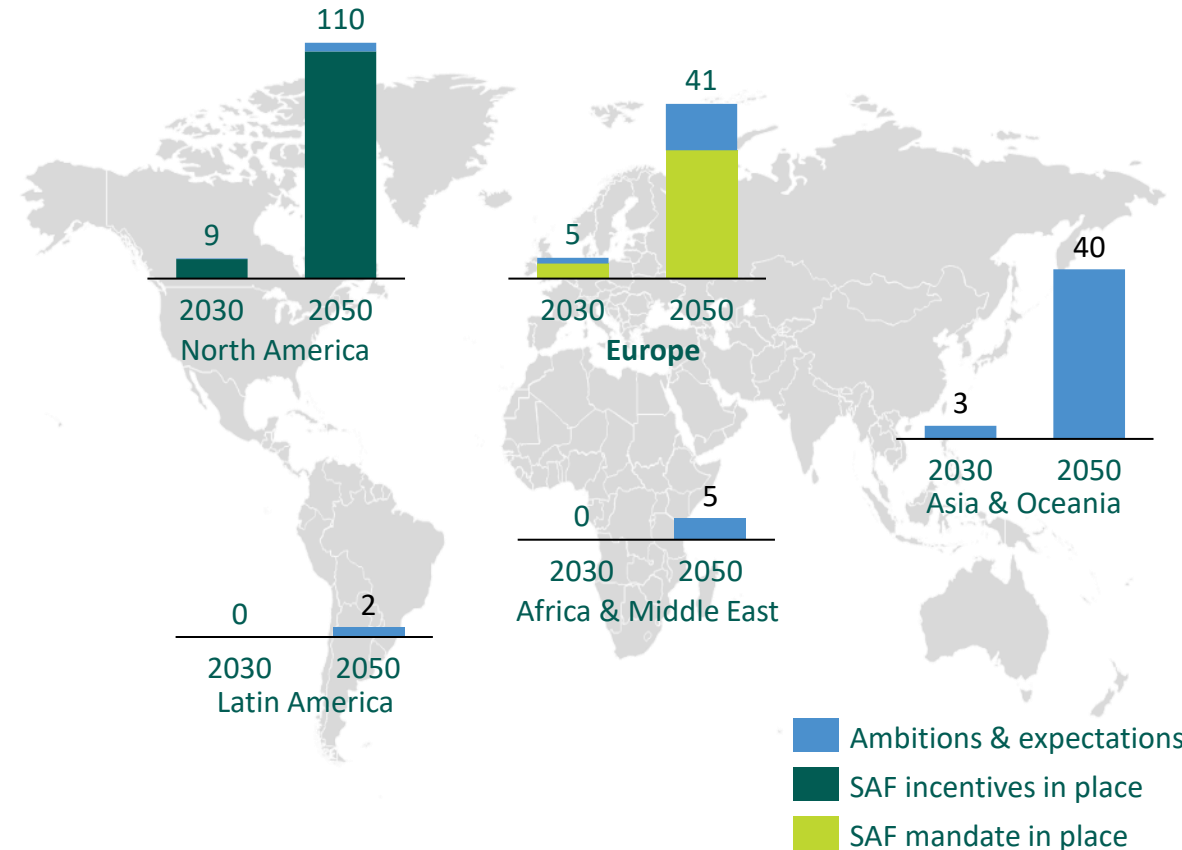
...and voluntary uptake



There are strong demand signals from corporates, airlines and cargo carriers which are starting to get backed by long-term offtakes, including, e.g.:

- DHL Express: 30% of fuel uptake by 2030 (~2 Mt)
- Delta Airlines: 10% of fuel uptake by 2030 (~1 Mt)
- IAG: 10% of fuel uptake by 2030 (~1 Mt)

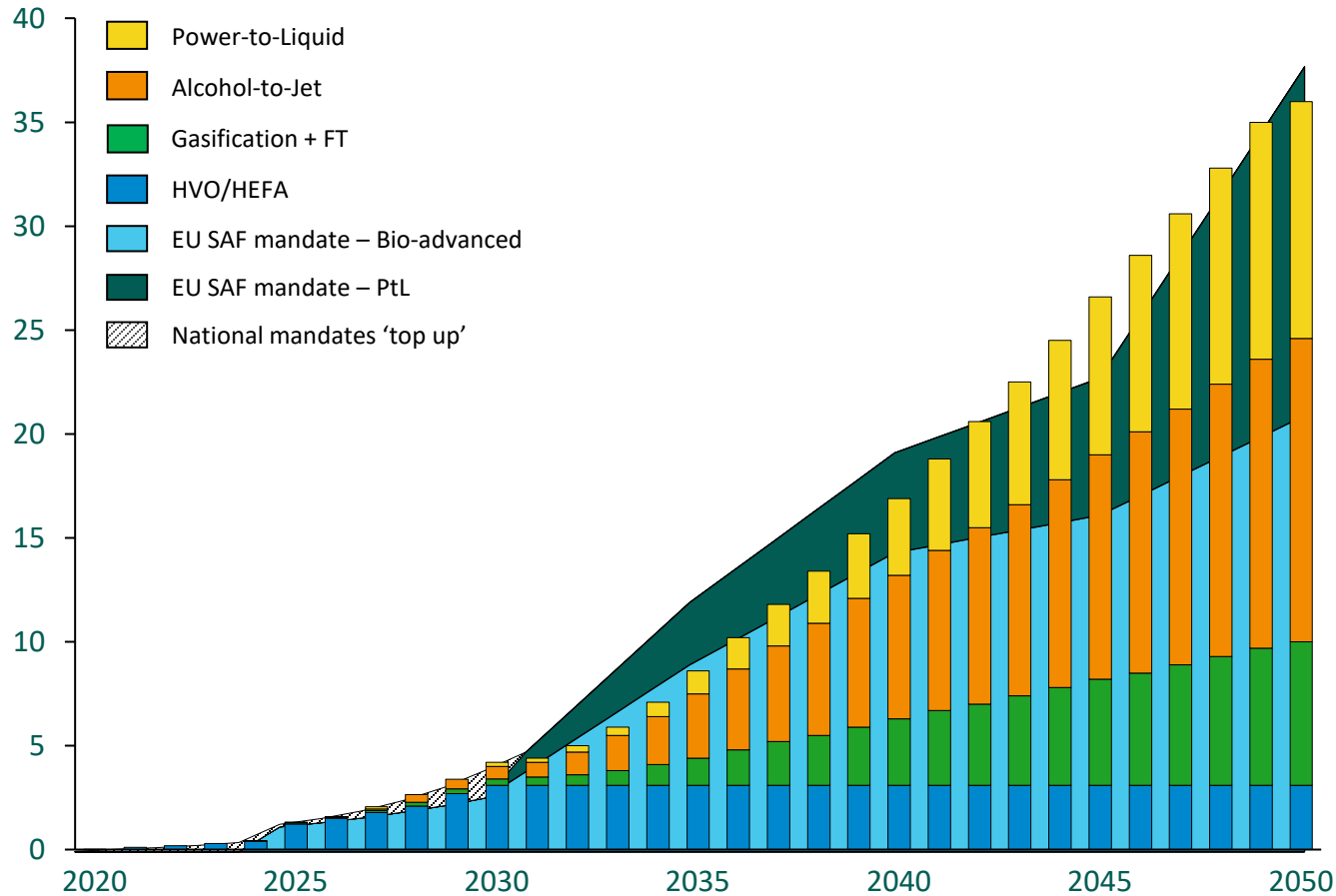
SAF demand projected to increase to 17 Mt in 2030 to ~200 Mt in 2050  
NB. Graphs denote SAF demand in million tonnes (Mt)



1. Under the CORSIA framework, airlines need to offset emissions to achieve carbon-neutral growth. Source: ATAG Waypoint 2050 (2020), EU ReFuel package (2021), US SAF Grand Challenge (2021), Argus (2020), McKinsey & Company (n.d.), CORSIA (2018), SkyNRG market outlook on SAF (2021), SkyNRG analysis

# CO<sub>2</sub> BASED E-FUELS PLAY A PIVOTAL ROLE TO MAKE AVIATION MORE SUSTAINABLE

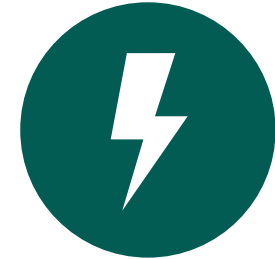
EU SAF supply (Mt SAF)<sup>1</sup>



## Key takeaways

- ▶ About 350 SAF plants will be needed in the EU by 2050 (vs. ~25 currently announced)
- ▶ Pathways depending on cellulosic feedstock will become essential to achieving mandated volumes
- ▶ Given the limited feedstock pockets of sustainable biomass, CO<sub>2</sub> based e-fuels will make an important contribution to make aviation more sustainable

# WE SEE A VARIETY OF FEEDSTOCK AND TECHNOLOGY PATHWAYS NECESSARY TO FULFIL THE SAF DEMAND - CURRENTLY, THERE IS A MISMATCH BETWEEN TRL AND SCALABILITY

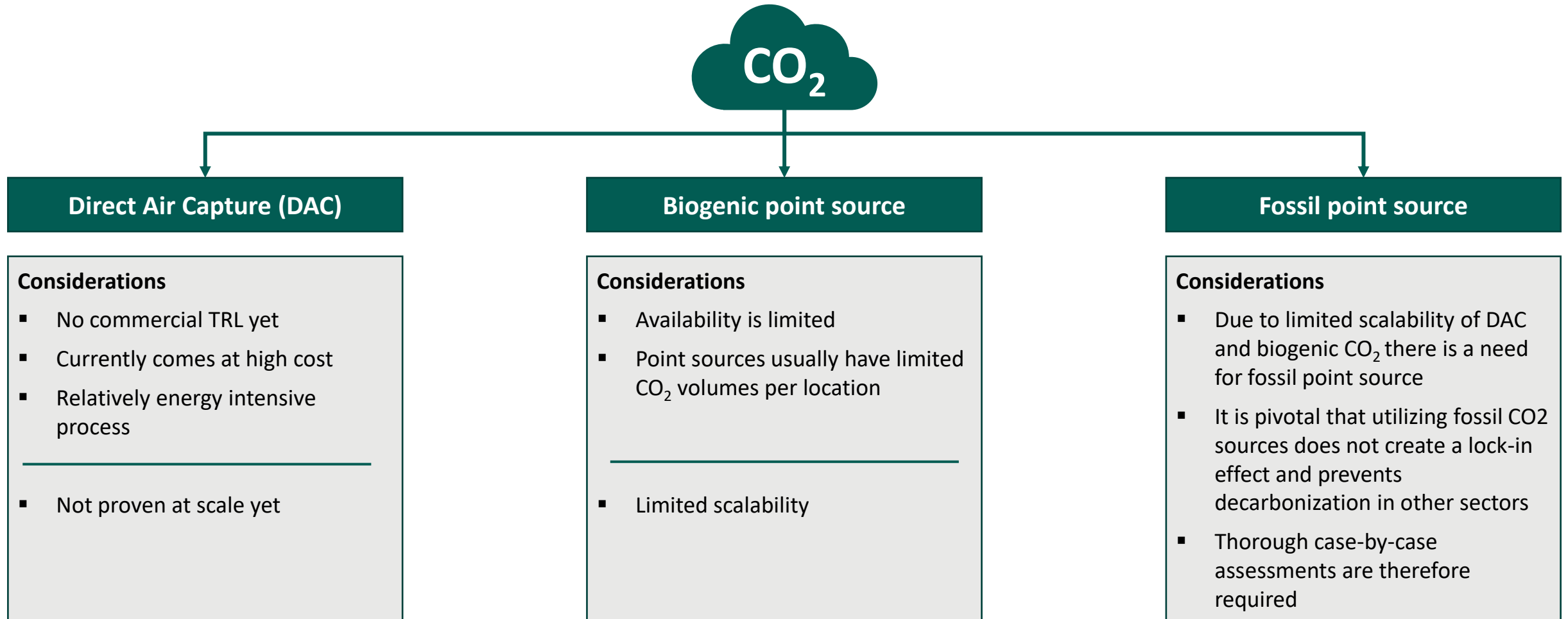


INDICATIVE & NOT EXHAUSTIVE

Feedstock bucket	Fats & Oils	Solid biomass	Power-to-Liquid
Sources	Used cooking oil (UCO), animal fat, vegetable oils	Forest residues, agricultural residues, Municipal Solid Waste (MSW)	Green Hydrogen + CO <sub>2</sub> (air captured or industrial flue gasses)
Scalability	Low	Medium	High
Technology Readiness Level	High	Medium	Low
Timeline	Short term	Medium term	Long term
Conversion technology	(HC-)HEFA Co-processing CHJ	Alcohol-to-Jet Fischer-Tropsch (FT)	Alcohol-to-Jet Fischer-Tropsch (FT)



# SUSTAINABLE CO<sub>2</sub> FROM THE INDUSTRY IS REQUIRED TO SCALE UP THE E-FUEL INDUSTRY IN THE NEXT DECADES



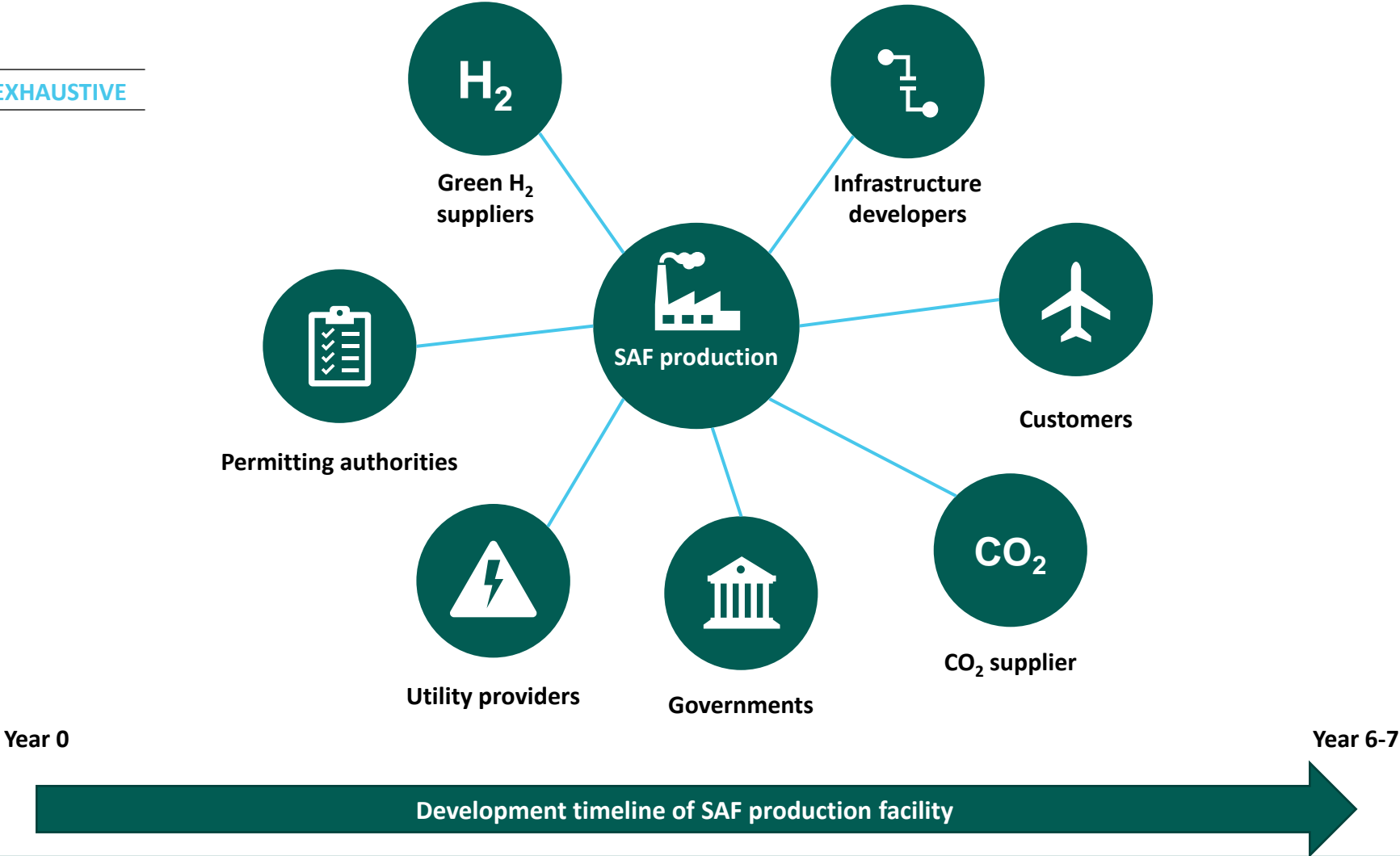
# FROM A CLIMATE PERSPECTIVE, UTILIZING CO2 FROM BIOGENIC SOURCES OR SUSTAINABLE POINT SOURCES IS EQUAL

*Both CO<sub>2</sub> systems have the same impact on the climate*

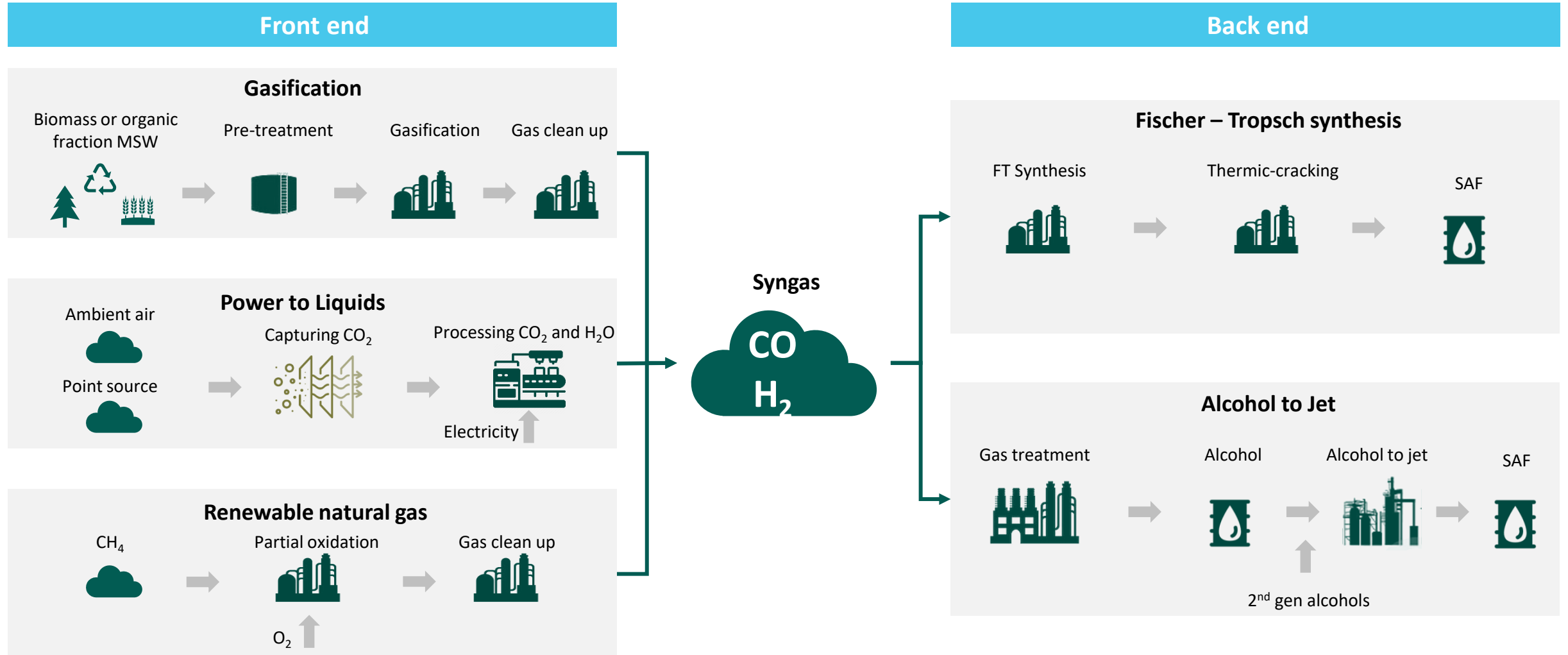


# COLLABORATION ACROSS THE VALUE CHAIN IS KEY TO DEVELOP THESE COMPLEX CO<sub>2</sub> BASED FUEL SUPPLY CHAINS

SIMPLIFIED & NOT EXHAUSTIVE



# THE COMBINATION OF VARIOUS TECHNOLOGY PLATFORMS FOR SAF PROVIDE INTERESTING OPPORTUNITIES WITH A KEY ROLE FOR SYNGAS



***FOR ANY FURTHER QUESTIONS, FEEL FREE TO REACH OUT:***

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