The Future of Jet Fuel and Sustainable Aviation Fuel

Post-COVID recovery, long-term outlook to 2050, decarbonization impacts, sustainable aviation fuels, and new technology and players

Multi-Client Study Prospectus

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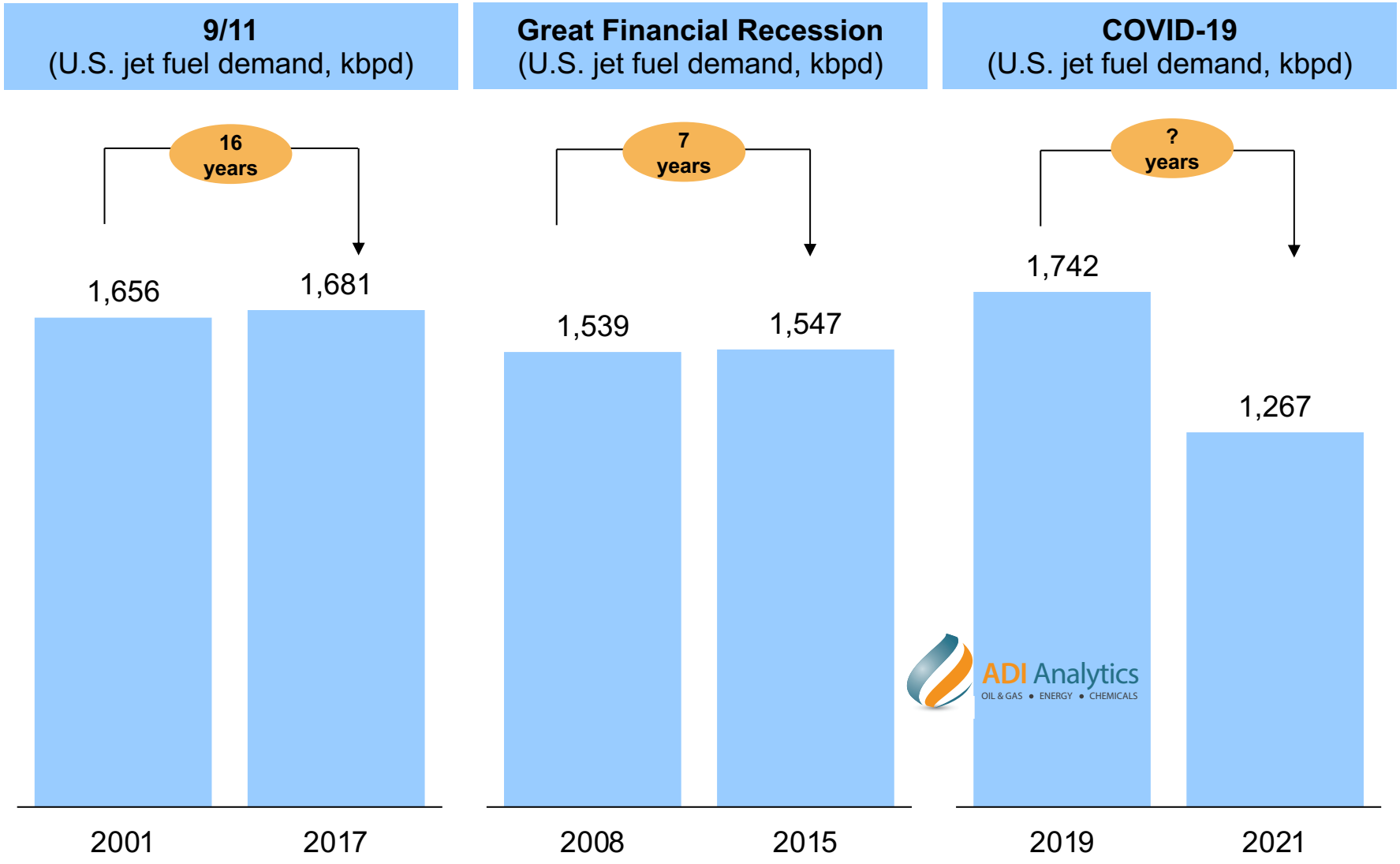
Outline

- **Study Prospectus**
- Sample pages
- About ADI

Jet fuel markets have taken a very long time to recover from past demand disruptions



Jet fuel markets face a very slow recovery post-COVID in the short term and critical disruptive challenges in the long term

Background and strategic questions

- Jet fuel markets are in a deep slump today due to COVID-19 and expectations for a quick recovery from pent-up economic and consumer demand have been stunted by new infection waves
- Historical analysis shows that prior demand disruptions, e.g., following 9/11 and the Great Financial Recession, took much longer to recover from
- Simultaneously, Energy Transition and decarbonization momentum is gaining pace very quickly posing a number of long-term challenges to the outlook for jet and aviation fuel markets

A **Demand / supply**

- What will post-COVID jet fuel demand look like? Will it recover to 2019 levels?
- What do post-COVID demand drivers for jet fuel looks by region and why?
- What is jet fuel supply outlook including sustainability aviation fuels?

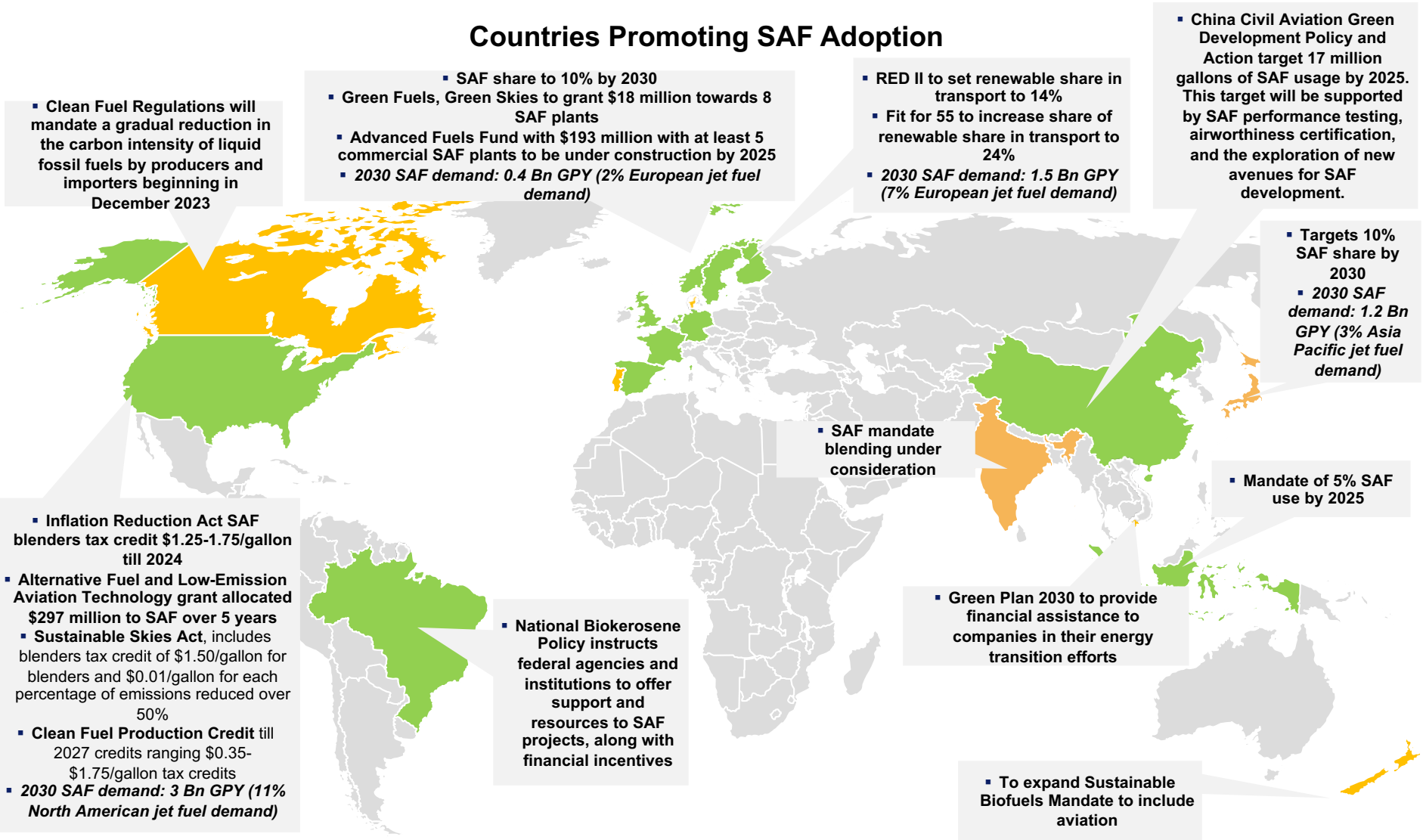
B **Regulations and innovation**

- How are policies and regulations shaping aviation and jet fuel markets? Why?
- What innovation and technologies will allow decarbonization in aviation fuels?
- Which technologies are likely to achieve commercial status and scale?

C **Value chain participants and strategic implications**

- How are jet fuel customers and suppliers adjusting strategies? Why?
- Who is likely and succeed and where? Implications for supply and demand?
- What should jet fuel value chain participants do and prepare for the future?

A handful of countries in Europe along with the U.S. are driving SAF adoption policies



These factors will be addressed by ADI's multi-client study as reflected by its comprehensive table of contents

1	**Executive Summary** *Key conclusions, findings, and strategic implications with a review workshop and data spreadsheet*	7	**Low-Carbon / Sustainability Aviation and Jet Fuels** *Inventory and profiles of sustainable aviation and jet fuel supply processes, pathways, and technologies*
2	**Jet Fuel Demand Outlook to 2050** *Forecasts for jet fuel demand by type through 2050 with key drivers and corresponding scenarios by region*	8	**Sustainable Aviation Fuel Market Drivers** *Population / economic growth, business / consumer travel, infrastructure investments, regulations / policies*
3	**Jet Fuel Demand Recovery Post-COVID** *Analysis of jet fuel demand recovery pathways and drivers including historical recovery analyses*	9	**Cost and Economic Analysis** *Regional and technology analyses around costs and economics of various jet fuel supply options*
4	**Jet Fuel Supply Outlook to 2050** *Jet fuel supply outlook by region through 2050 in key scenarios including new, sustainable supply options*	10	**Corporate Landscape Analysis** *Lists of key jet fuel users and their initiatives around long-term decarbonization and sustainability improvements*
5	**Aviation and Jet Fuel Regulatory and Policy Review** *Review of policies and regulations on decarbonization and sustainability of aviation and jet fuels*	11	**Suppliers' Competitive Analysis** *Lists of key jet fuel suppliers including new technology and process developers and competitive landscaping*
6	**Decarbonization Challenges in Jet Fuel Value Chain** *Aviation and jet fuel value chain's carbon footprint and challenges with decarbonization*	12	**Strategic Implications and Opportunity Analysis** *Findings and conclusions, strategic implications, risks and mitigation strategies, and opportunity analyses for jet fuel suppliers*

Key deliverables of ADI's "Future of Jet Fuel and Sustainable Aviation Fuel" study

Outcomes	Deliverables
1 In-depth coverage of jet fuel markets globally and across key regions	~100-page report
2 Jet fuel supply-demand through 2050 and near-term demand recovery analysis	~20-page executive summary deck
3 Decarbonization and sustainability in jet and aviation fuel markets globally	Spreadsheet data package
4 Economics and competitive landscape of jet and aviation fuels	Review workshop and analyst access
5 Global feedstock supply availability and analysis	Quarterly subscription option to stay updated

Contact Uday Turaga, +1.281.506.8234 or info@adi-analytics.com to purchase this study.

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Various technologies based on type of aircraft will have to be adopted to improve fuel efficiency in aviation

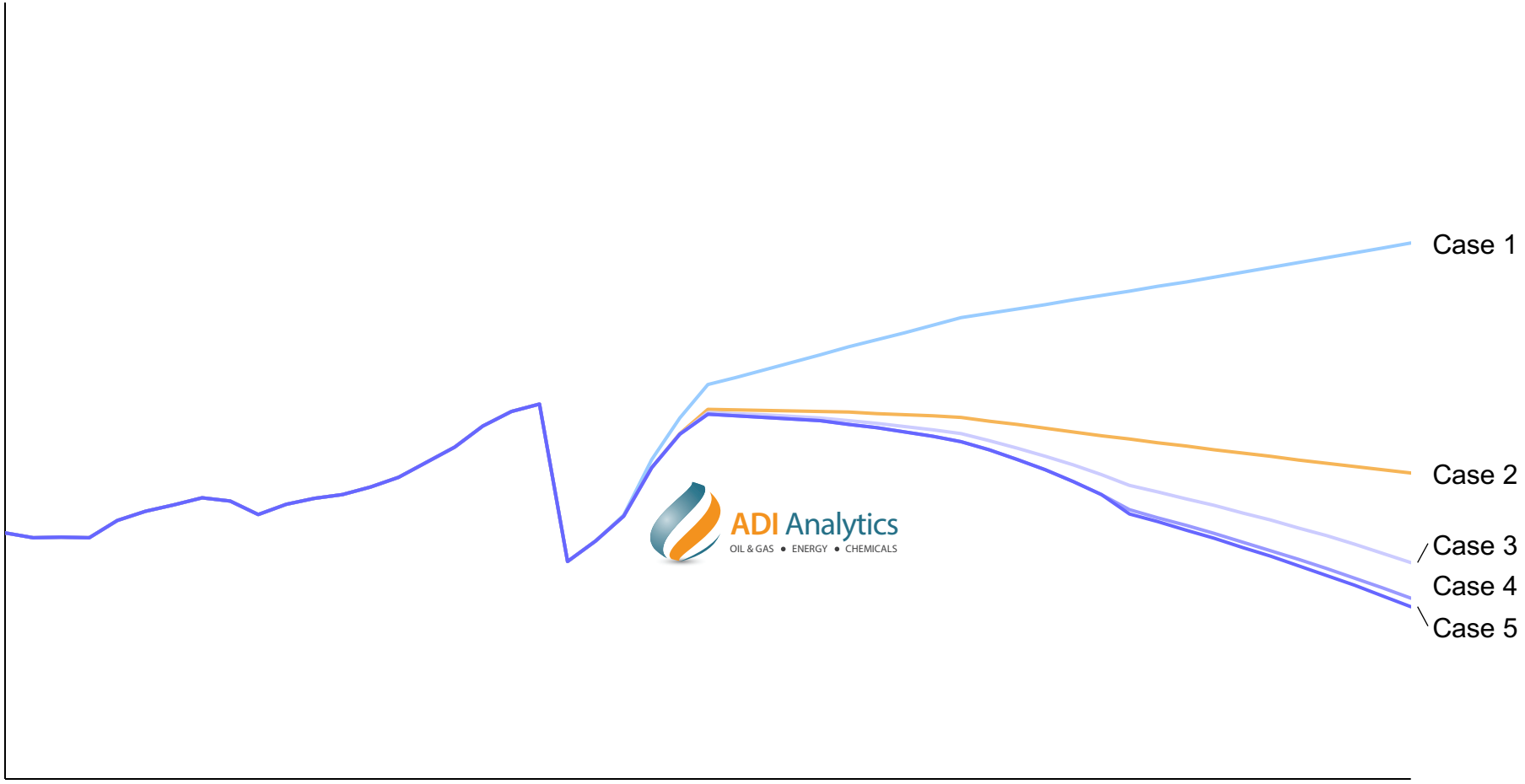
Roadmap to Decarbonization in Aviation

Options to decarbonize / Aircraft type	Long-haul	Medium-haul (250 seats)	Short-haul (160-170 seats) ~1,200 miles	Regional (80 seats)	Commuter (<19 seats)
SAF	■	■	■	■	
Retire old aircraft	■	■	■		
Carbon offset schemes	■	■	■		
Better navigation path	■				
Improved wing aerodynamics	■	■			
More electric systems	■	■	■		
Optimized flight path		■	■	■	
New wing technology		■			
H_2 fuel		■	■		
Hybrid-electric				■	■
Fuel cell applications			■		
Full electric					■
Full hydrogen					■

- **June 2020: first full electric 2-seater is certified by EASA**
- **Sep 2020: first flight hydrogen-electric 6-seater is tested, fuel cell, 500nm range, EIS 2023**
- Around 2025: Airbus new mid-sized aircraft program is expected to launch
- **2026: Do228, fuel cells powered 19-seater are expected to launch**

ADI estimated CO_2 emissions and SAF demand over several cases of adoption of SAF and other disruptive technologies

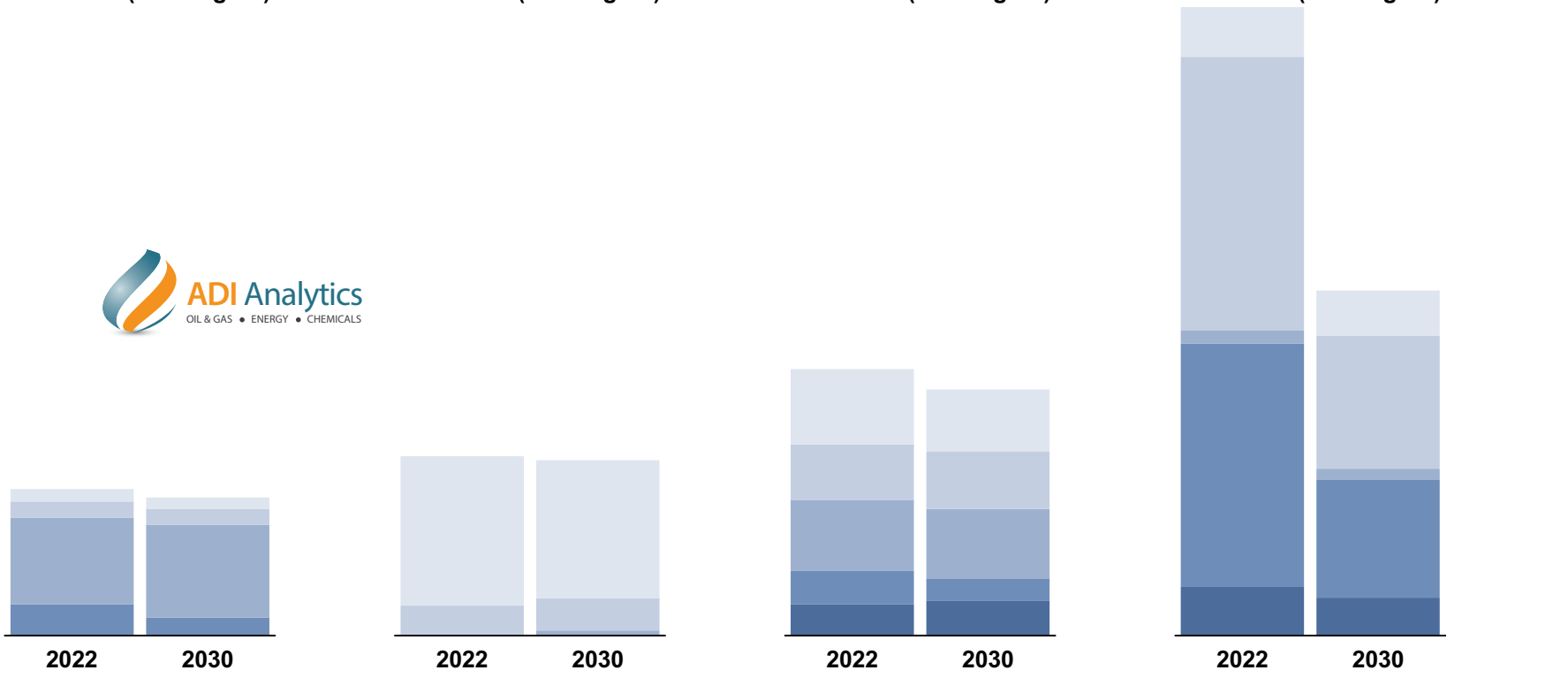
Lifecycle Jet Fuel CO_2 Emissions Outlook
(Billion Tons Per Year)



Note: CO_2 emissions from burning SAF are same as jet fuel but lifecycle emissions are reduced by 80%

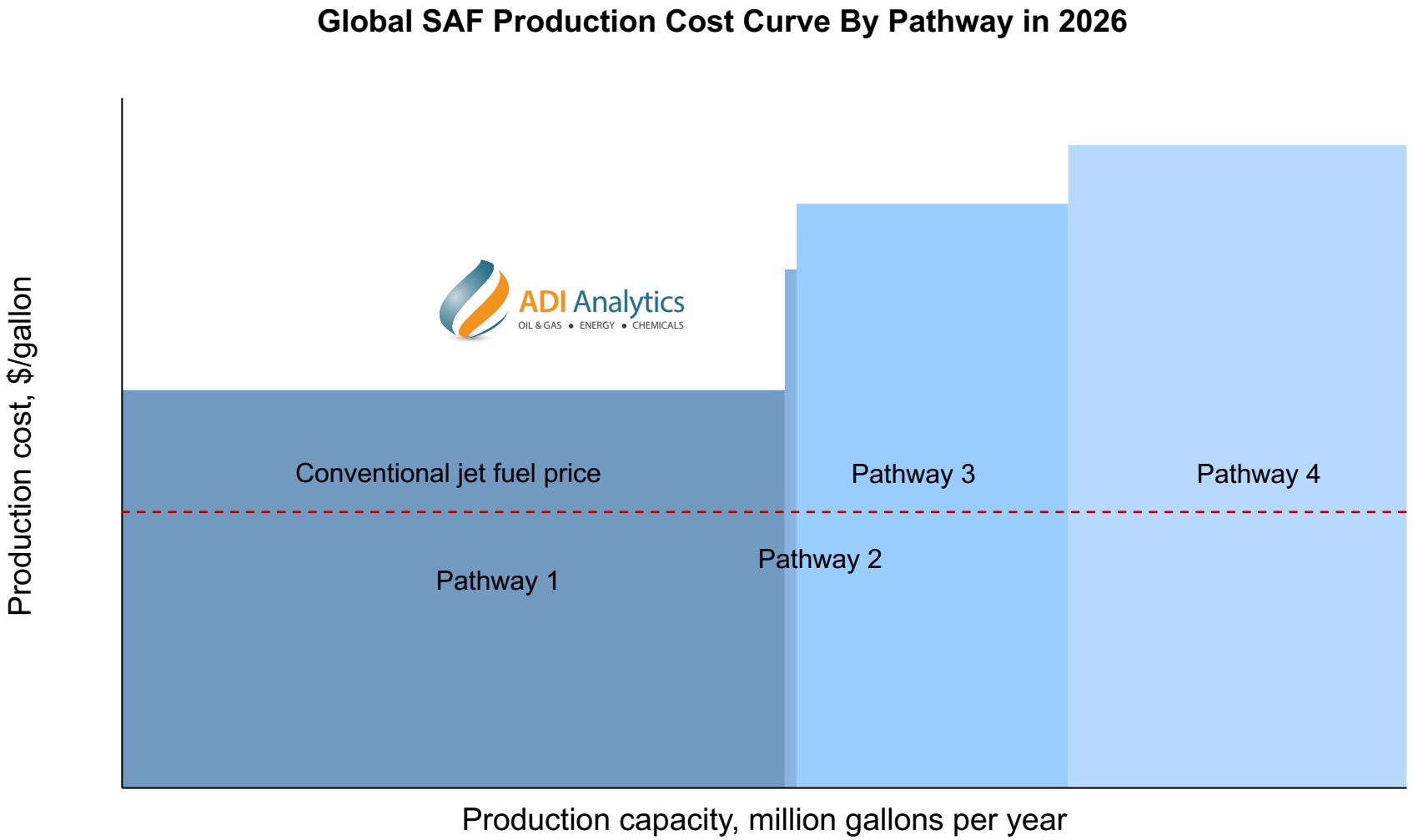
ATJ and gasification/FT SAF costs are driven by high capex costs

Global SAF Production Costs by Production Pathway
(U.S. Dollars Per Gallon, Average)



Pathway 1	Pathway 2	Pathway 3	Pathway 4
▪ Feedstock: ▪ Hydrogen is produced via solar PV-based electrolysis	▪ Feedstock:	▪ Feedstock:	▪ Feedstock: ▪ Hydrogen used is produced via solar PV-based electrolysis

ADI assessed production cost and capacity outlook of key SAF production pathways



Note: Capacity based solely on announcements, assuming underlying oil price of $70 per barrel

ADI understands that SAF feedstocks must be sustainable and not threaten food security or increase indirect land usage

Feedstock Sustainability Criteria

Feedstock type	Feedstock category	Feedstock	GHG saving potential	Sustainability concerns
1st gen / crop-based	Edible oil crops	Palm	Not sustainable	Not sustainable
		Soybean	Not sustainable	Not sustainable
		Others (sunflower, canola)	Not sustainable	Not sustainable
	Edible sugars	Sugarcane	Not sustainable	Not sustainable
		Maize	Not sustainable	Not sustainable
		Other	Not sustainable	Not sustainable
Advanced and waste	Waste and residue lipids	Used cooking oil	Fully sustainable	Fully sustainable
		Animal tallow	Fully sustainable	Not sustainable
		Other (fish oil, POME)	Fully sustainable	Not sustainable
	Oil trees on degraded land	Jatropha, pongamia	Fully sustainable	Not sustainable
	Oil cover crops	Camelina, pennycress	Fully sustainable	Not sustainable
	Cellulosic cover crops	Miscanthus, switchgrass	Fully sustainable	Not sustainable
	Agricultural residue	Rice straw	Fully sustainable	Fully sustainable
		Sugarcane bagasse	Fully sustainable	Fully sustainable
		Other (cereal residue)	Fully sustainable	Fully sustainable
	Forestry residue		Fully sustainable	Fully sustainable
	Wood-processing waste		Fully sustainable	Fully sustainable
	Municipal solid waste		Fully sustainable	Fully sustainable
Recycled carbon	Reusable plastic waste		Not sustainable	Fully sustainable
	Industrial waste gas		Fully sustainable	Fully sustainable
Non-biomass based	CO_2 from direct air capture		Fully sustainable	Fully sustainable

Source: WEF

Not sustainable — Fully sustainable — Partially sustainable — Not sustainable

ADI actively tracks airlines that have committed towards SAF production and commercialization in addition to off-take deals

Airline	Producer	Discussion
UNITED	Alder Fuels	Made a multi-million-dollar investment along with Honeywell for commercial production of SAF
DELTA	NESTE, gevo	Committed to replace 10% of current jet fuel use with SAF with 2030
American Airlines	PROMETHEUS	Plans to procure 10 million gallons SAF by 2025
Alaska AIRLINES	SkyNRG, NESTE	Has SAF offtake agreements with
Southwest	NREL NATIONAL RENEWABLE ENERGY LABORATORY	Partnering to develop and commercialize SAF
Prime Air	world energy	Has purchased 6 million gallons of SAF
DHL EXPRESS	NESTE	Has pledged to use 30% SAF by 2030 and is planning a SAF demonstration project in northern Kentucky
jetBlue	SG Preston	Has partnered to boost SAF use to 8% by 2023
BRITISH AIRWAYS	PHILLIPS 66	Aims to achieve net-zero carbon emissions by 2050 and will source SAF from Philips66
Lufthansa	NESTE	Aims to halve net CO_2 emissions by 2030 compared to 2019 and achieve a net-zero CO_2 balance by 2050
QANTAS	air bp	To purchase 10 million liters of SAF in 2022 with an option to purchase another 10 million liters in 2023 and 2024

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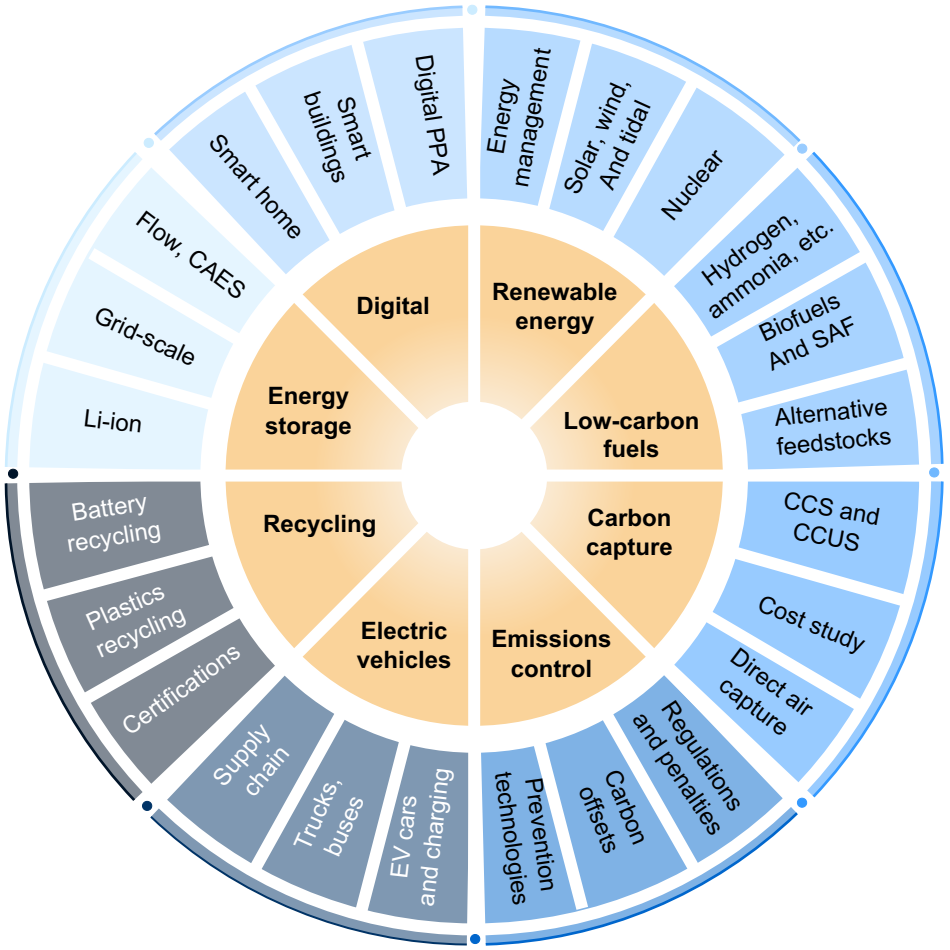
ADI is increasingly helping clients with their energy transition needs across the board driving sustainability in oil & gas



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