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The Future of SAF Panel: feedstocks, conversion, and innovation beyond 2030

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bp's ambitions in the energy transition

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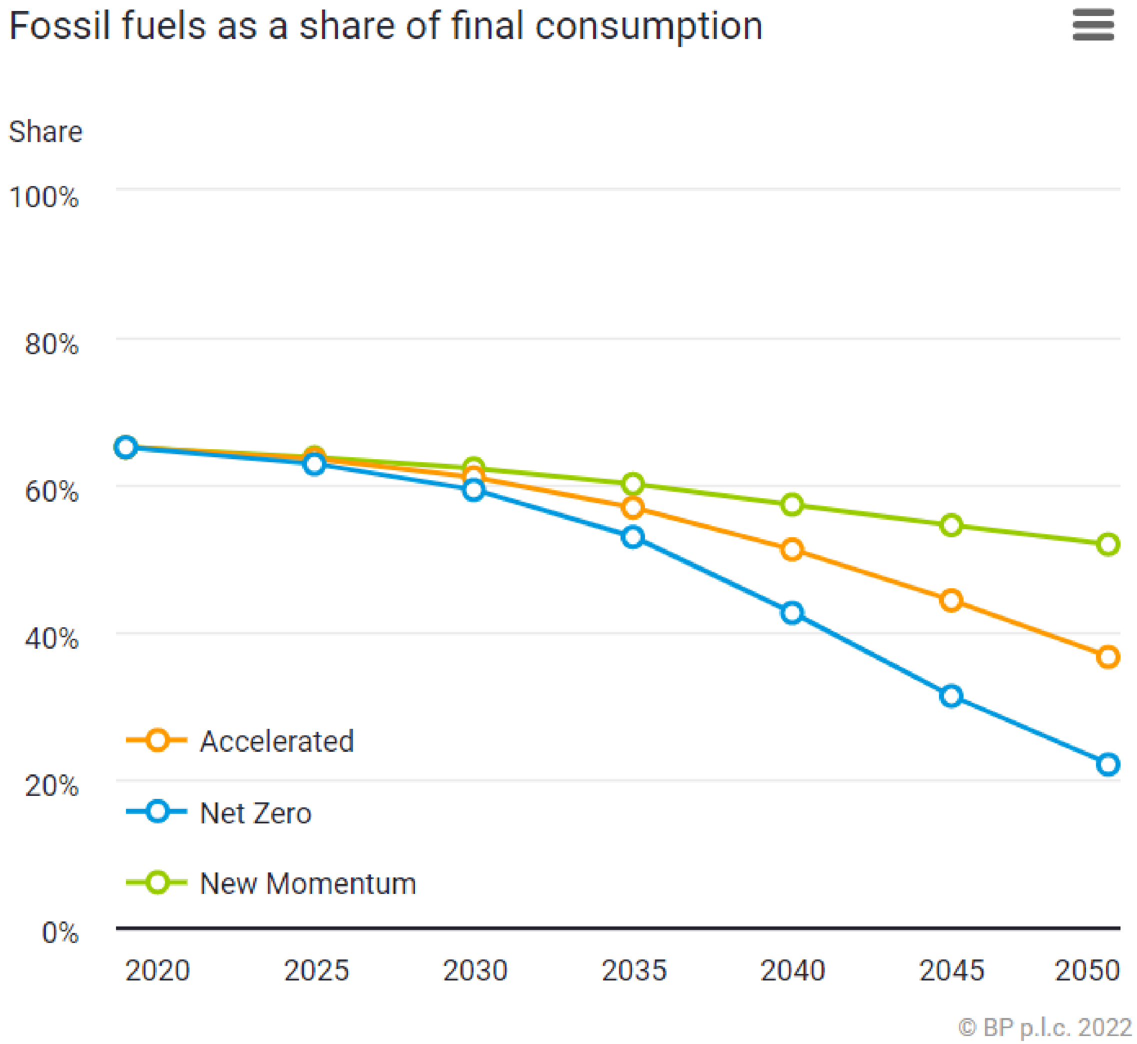
Strategic progress – **sustainability**

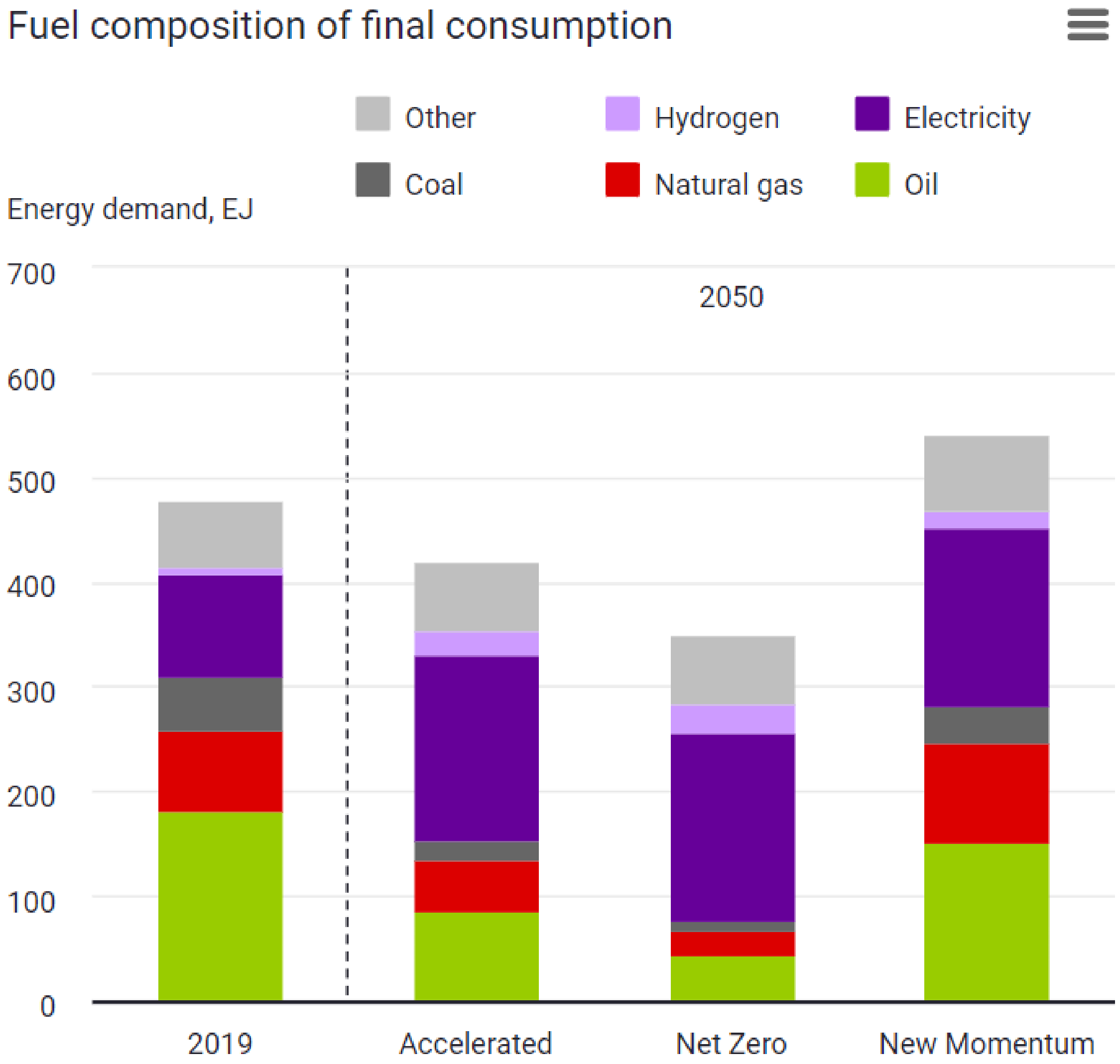
Sustainability – we are accelerating our net zero ambition in line with the progression of our strategy

	Scope	2025	2030 aims	2050 or sooner aims
Aim 1 Net zero operations*[1]	Scope 1+2	20%	50%	100%
Aim 2 Net zero production*[1]	Scope 3	20%	35-40%	100%
Aim 3 Net zero sales*[1]	Lifecycle intensity (including end-use emissions)	5%	15-20%	100%
Aim 4 Reducing methane	Methane intensity	0.20% (measurement approach)		

Source: bp financial results update for 2021

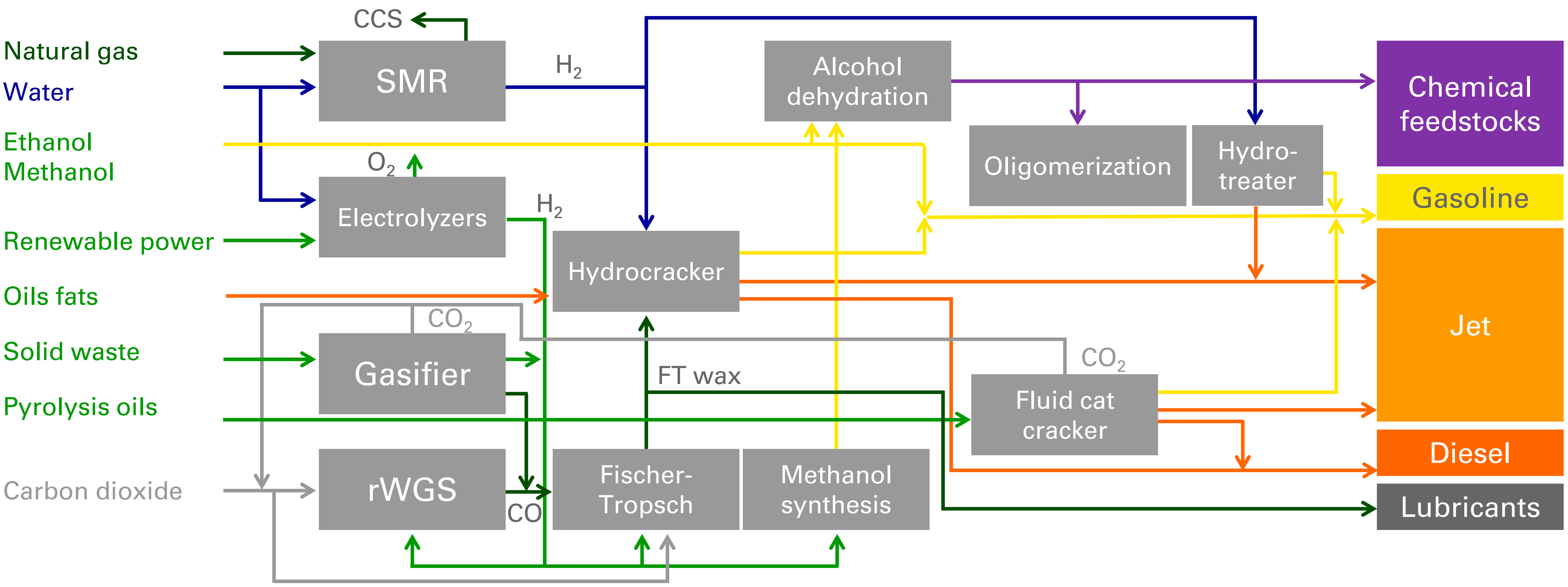
Total final energy consumption decarbonizes as fossil fuels are replaced by electricity and hydrogen





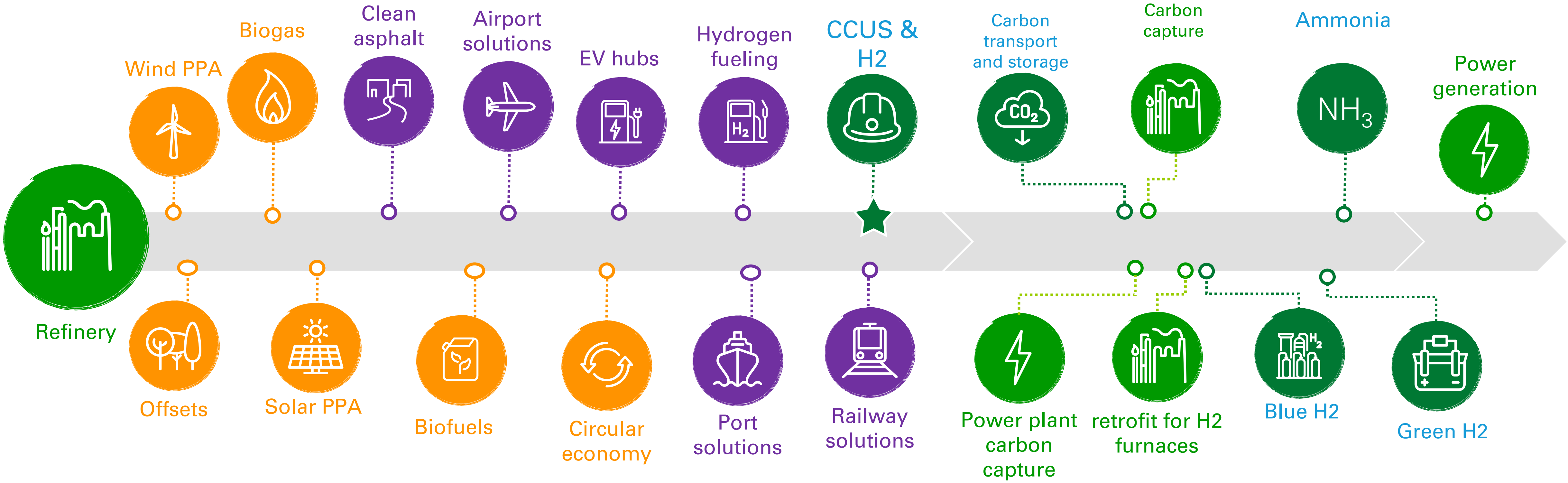
Source: bp Energy Outlook 2022

A net zero refinery*



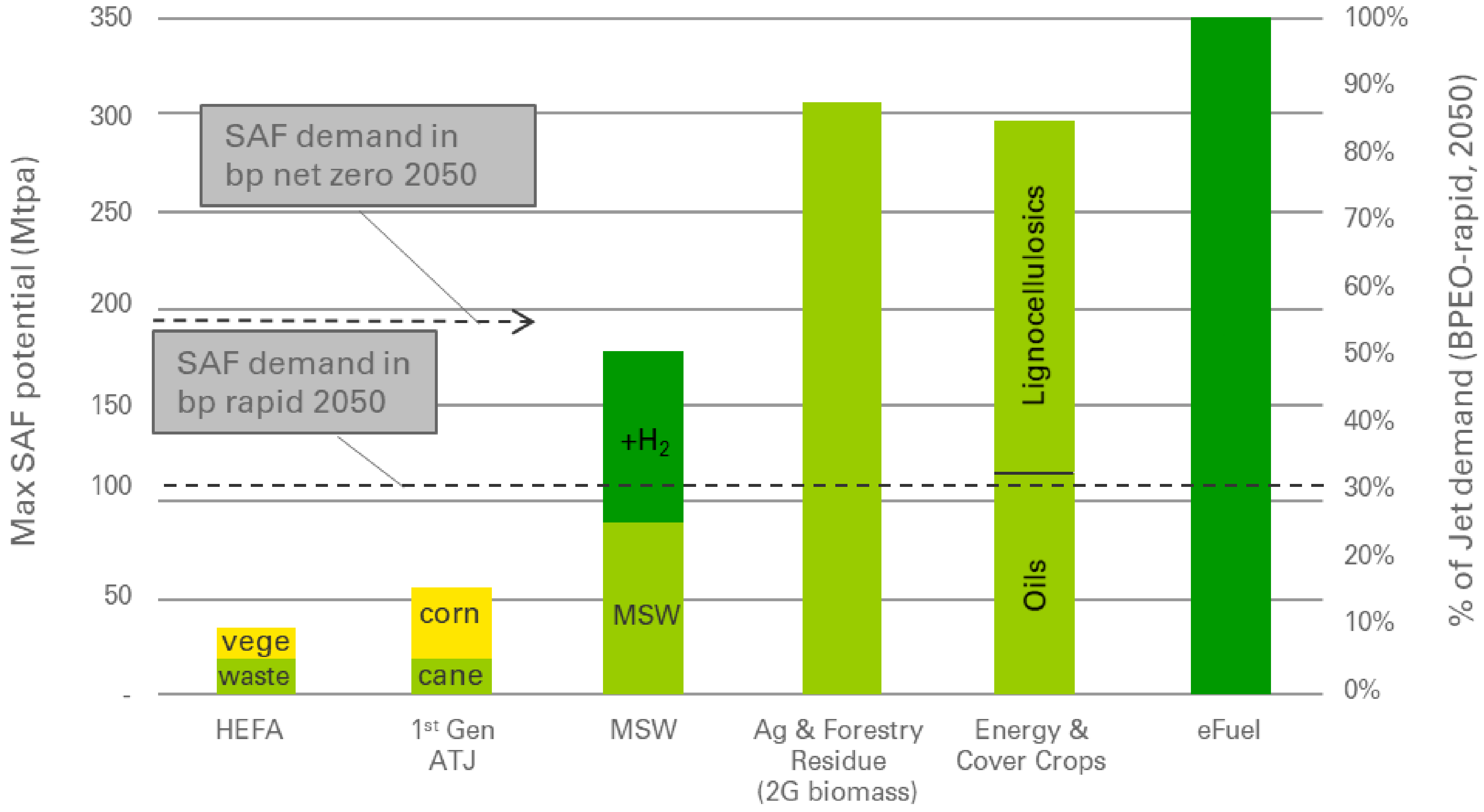
*Possible scenario

Integrated Energy Hub Example – many projects that require capital, multiple possible sources of value



Source: bp project ideation

Sustainable and available feedstock in 2050 defines the maximum supply of SAF (global view)



Sources: ATK, S2Biome, FAO

2050 Rapid demand (conversion): 350Mtpa~8Mbd~15 Exojoules~115B gallons

There are several SAF technology pathways

HEFA and ATJ require lower CAPEX because they use/convert existing assets
All pathways produce SAF that is more expensive than conventional jet

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	HEFA (waste oil)*	1G Ethanol to jet	2nd Generation Biomass***	FT (MSW)	eFuel****
Time to market & current scale	**2020s** **Currently commercial.**	**2025-2035** 1G ethanol is mature. Dehydration to ethylene commercial. Ethylene to jet not yet commercial.	**2030-2035** Pyrolysis commercial demo. Pyrolysis oil to jet not yet commercial.	**2021-2030** **Commercial demo.**	**2030-2040** rWGS not yet commercial. FT demonstrated. Electrolysis is commercial.
Key opportunities	**Fungible feedstock, scaleable technology** Back-integration to refineries. Capital Lite.	Lower capital intensity **Attractive in areas with existing ethanol capacity (US/Brazil)**	**Significant feedstock availability** long-term **low-cost potential**	**Negative cost feedstock** FT technology integrates to eFuels	**Progress at pace of renewables societal preference** Highest sustainability credentials
Near term constraints	**Competition with renewable diesel** (HVO) for a highly limited feedstock	**Opportunity cost to sell ethanol** for road transport is high	**Costs and technology readiness** Investment risk	**Investment risk**	**Costs and technology readiness** Improvements required in multiple areas of technology
Long term constraints	**Feedstock supply is limited** to <1-5% jet demand unless oilseed energy crops emerge post 2035.	**Opportunity cost to** sell as chemicals may be high **sustainability concerns**	**Build rates** **biomass aggregation**	**High capital intensity** **MSW access** **GHG reduction is dependent on waste alternative use, and can be significantly improved through inclusion of CCS**	**Capital costs** **build rates for eFuel and power/H_2**
Estimated GHG reduction vs. fossil jet	65-79%	60-70% sugarcane; 20-30% corn	76-94%	70-100%**	100%
Key take away	HEFA is a near term option that uses fungible feedstock and back-integrates to refineries.	First generation ATJ is capital lite and produces SAF from existing ethanol markets.	Second generation biomass technologies have long term, low cost potential.	FT MSW provides near-mid term potential in urban areas with tipping fees for waste.	eFuels potential is increasing due to the pace of renewables and green H_2.

*1G food crop vegetable oils could also be used as a feedstock for HEFA
**assumes avoided landfill emissions are counted as part of analysis; landfill practice changes pose a risk to this accounting
***multiple other technology routes from 2nd generation biomass to SAF should also be considered including alternate catalytic/fermentative conversions, LC ethanol to jet, etc.
****alternate routes to eFuels also exist including a route through methanol and others at R&D stage

What do we need to scale SAF investment in US?

Federal (and state) programs are needed to create a wide and sustainable base for demand:

- Mandates provide regulatory certainty which is needed for significant investments
- Incentives – to close the gap to conventional (at least in transition)
- Recognize and address the gap with ground fuels economics

Multiple feedstocks and SAF technologies to achieve the industry goals

- All feedstocks and pathways are needed if they meet sustainability criteria
- Co- processing could help deliver SAF economically at refineries that can use this process and have access to feedstocks
- Mass balancing, book and claim, with robust assurance programs

Risk sharing with other industry stakeholders:

- Capex (especially for high capex pathways; ex: grants, co-investment, CFD)
- Feedstock
- Regulatory

Integrated projects can bring optionality, multiple sources of value and risk mitigation

Thank you!

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