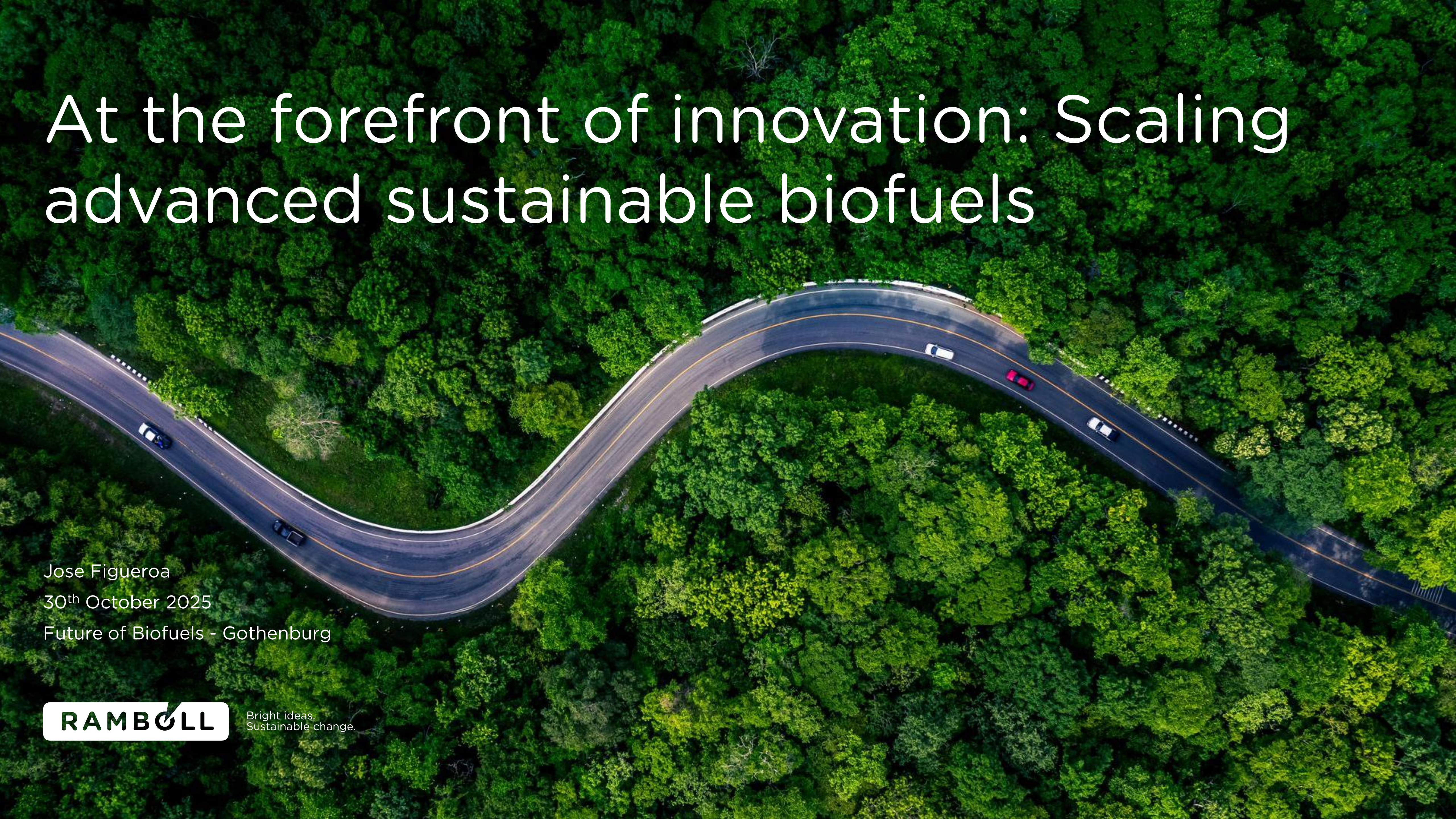

At the forefront of innovation: Scaling advanced sustainable biofuels

Jose Figueroa

30th October 2025

Future of Biofuels - Gothenburg

Bright ideas.
Sustainable change.

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About Ramboll

Ramboll in brief

Independent Engineering, Architecture and Consultancy company

- Established in 1945 in Copenhagen
- Top 10 leading energy consultancy in Europe
- "All in" on sustainability and decarbonisation
- Owned by an independent foundation: The Ramboll Foundation

Mission:

To create sustainable societies where people and nature flourish

35	>18,000	2.3 Bn
Countries covered by global office network	Experts	Global revenue, in 2024 across all markets

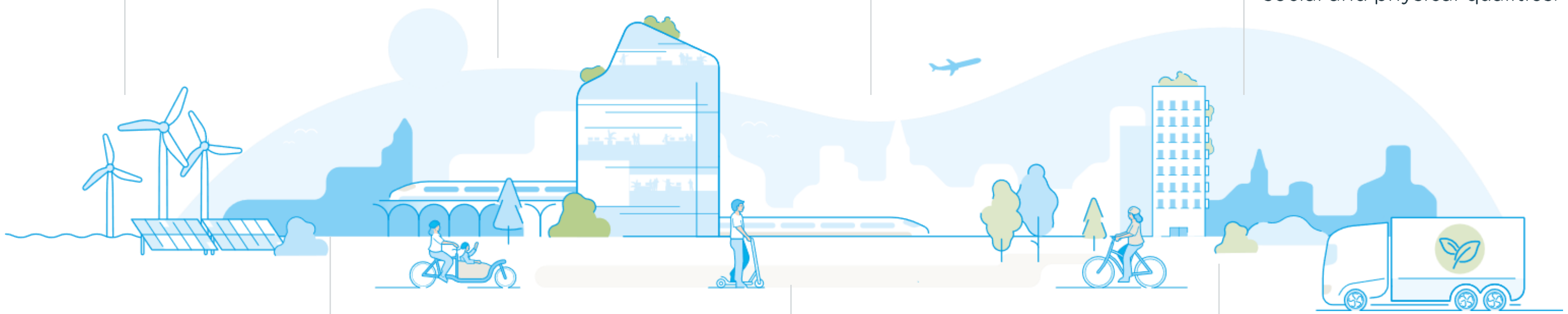
We embed sustainability into every project, and we walk the talk ourselves

Energy
We continue to develop our sustainable solutions to provide affordable and clean energy while combating climate change.

A multi-disciplinary approach
We pursue collaborative opportunities to create more sustainable cities and communities while combating climate changes.

Environment & health
Environment & Health helps clients minimise their environmental footprint with solutions that prevent and mitigate negative impacts on public health and ecosystems.

Buildings
Sustainable solutions in buildings will support the development of resource efficiency and holistic solutions in the built environment and promote our liveable buildings approach founded on synthesis between cultural, social and physical qualities.



Management Consulting
We quip our clients to address the transformation toward green growth in an increasingly global world within digitalisation, mobility, liveability, climate change and sustainability.

Transport
Transport supports the development of resilient projects for international, regional and local mobility with minimum impacts on the natural environment.

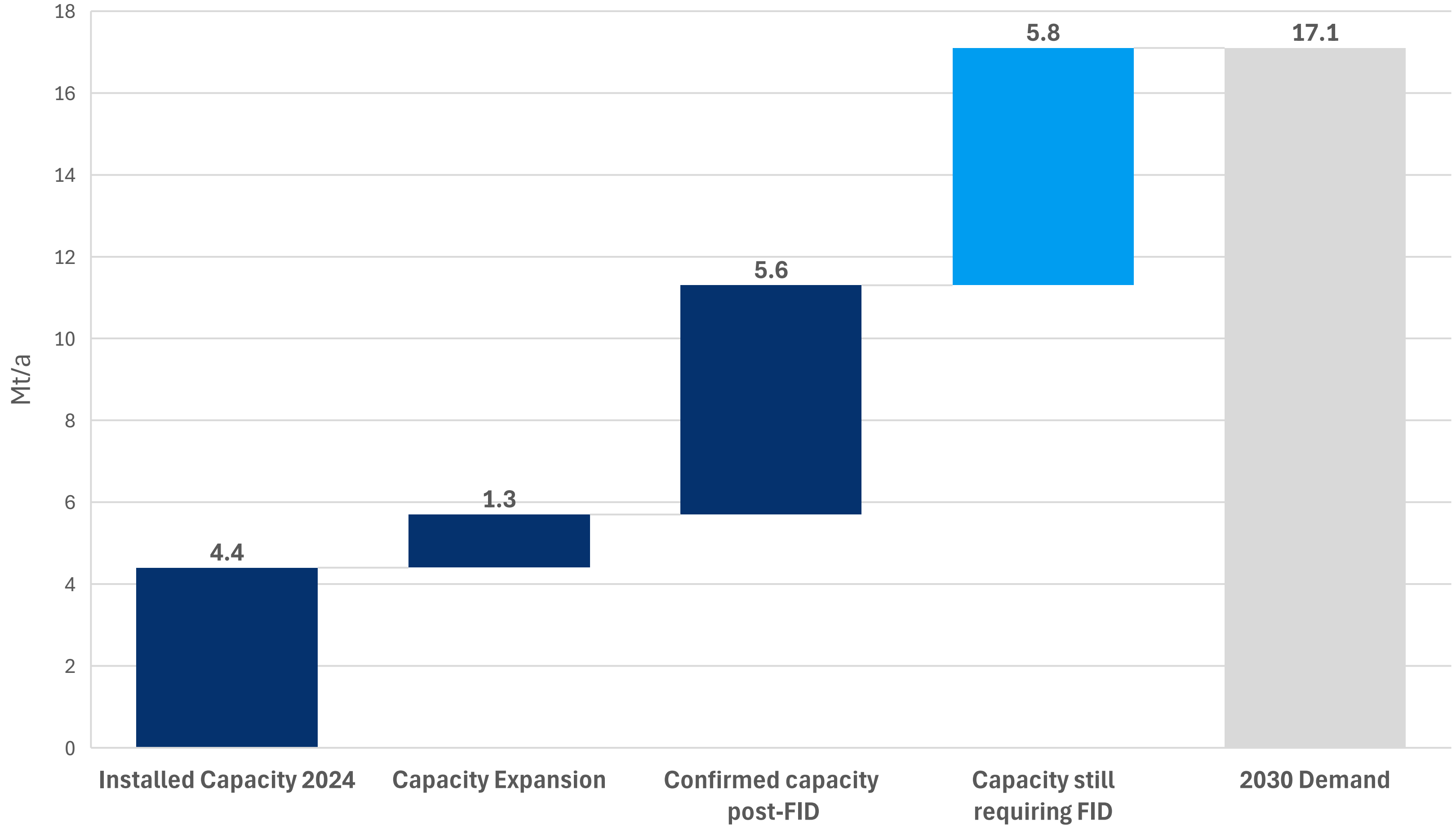
Water
Water addresses global water and climate challenges by working across the water cycle from water resources and supply, processing and treatment, to sewerage and discharge.

- We are passionate green transition consultants with a high focus on decarbonisation. Our expertise is based on the latest insights as we advise key players across the value chain.
- In addition to technical advisory on green transition, we are a trusted sustainability advisor for financial institutions, large corporations, energy agencies, international organisations and utilities and advise them on: GHG accounting, SBTi, sustainability reporting, decarbonization roadmaps, sustainable investments (SFDR etc.), EU Taxonomy and sustainable bonds.

- In 2021, Ramboll's Science-Based Carbon Reduction targets were approved by the SBTi. We commit to contribute our fair share in limiting the global temperature rise to 1.5-degrees.
- Ramboll commits that 80% of our suppliers by emissions covering purchased goods and services will have science-based targets by 2025.
- And we commit to reduce absolute scope 1 and 2 GHG emissions 46.2% and scope 3 emissions from business travel 27.5% by 2030 from a 2019 base year.

Context and Risk management

Current Biofuels Status
SAF Case



- HEFA is leading ~99% for SAF
- Expected to lead until 2030
- Yet limited – hard to source at scale
- AtJ, PtL and G-FT could take 40% market share by 2030
- 5.8 Mt/a Big Gap for expected 2030 Demand, still to reach FID.

Sources: WEF

Mitigating risk to prevent failure and delays

Today's picture

Shell scraps major biofuel project in the Netherlands

"We prioritize our capital towards projects that both meet our customers' needs and deliver value for our shareholders," says Machteld de Haan, Shell's head of renewable energy.

Fulcrum BioEnergy abandons trash-to-fuel plant in Nevada

The waste gasification start-up abruptly laid off most staff in mid-May

by Craig Bettenhausen

June 5, 2024

Clariant Closes Bioethanol Plant in Romania

6 December 2023

Industry analysts suggest that 20-30% of planned SAF projects faced FID delays in 2024 (Bloomberg NEF, IATA)

AUG 19, 2025

Vivergo begins laying off staff after UK plant closes

BIOENERGY | SUBSCRIPTION

Statkraft scraps biofuel venture

The company will completely withdraw from biofuels by the end of the financial year.

Never-opened $300 million-plus biofuels refinery facing foreclosure in southern Oregon

Published: Jan. 07, 2023, 6:00 a.m.

Sources: [Shell], [C&E News], [Clariant], [Oregon Live]

Risk landscape within biofuel's project development

Biorefinery project risks spread across the whole value chain and throughout a wide timespan of the project development cycle

Regulation and Policy Risk

- Uncertainty
- Short termed
- Complexity
- Permitting
- Only local focus
- Certification

Market risk

- Price
- Offtake and commitments
- Geopolitics
- Scaling
- Industry competition

Feedstock risk

- Supply/availability
- Eligibility and sustainability
- Industry competition
- Feedstock characterization

Technology risk

- Technical and commercial readiness level
- Scale-up challenges
- Cumbersome/long-time certification (e.g. ASTM)

Project schedule risk

- Delays in general
- Excessive CAPEX/OPEX
- Technology integration
- EH&S challenges

Risk mitigation within biofuel's project development

Market risk

- Price
- Offtake and commitments
- Geopolitics
- Scaling
- Industry competition

Competent and Integrated DD (Technical, Commercial, ESG)

Market studies/assessments

Efficient Tech integration

FID facilitation schemes

Scale up ecosystem in place

Funding diversification

Guarantees and Insurance Instruments

Strong Project Development

Technology risk

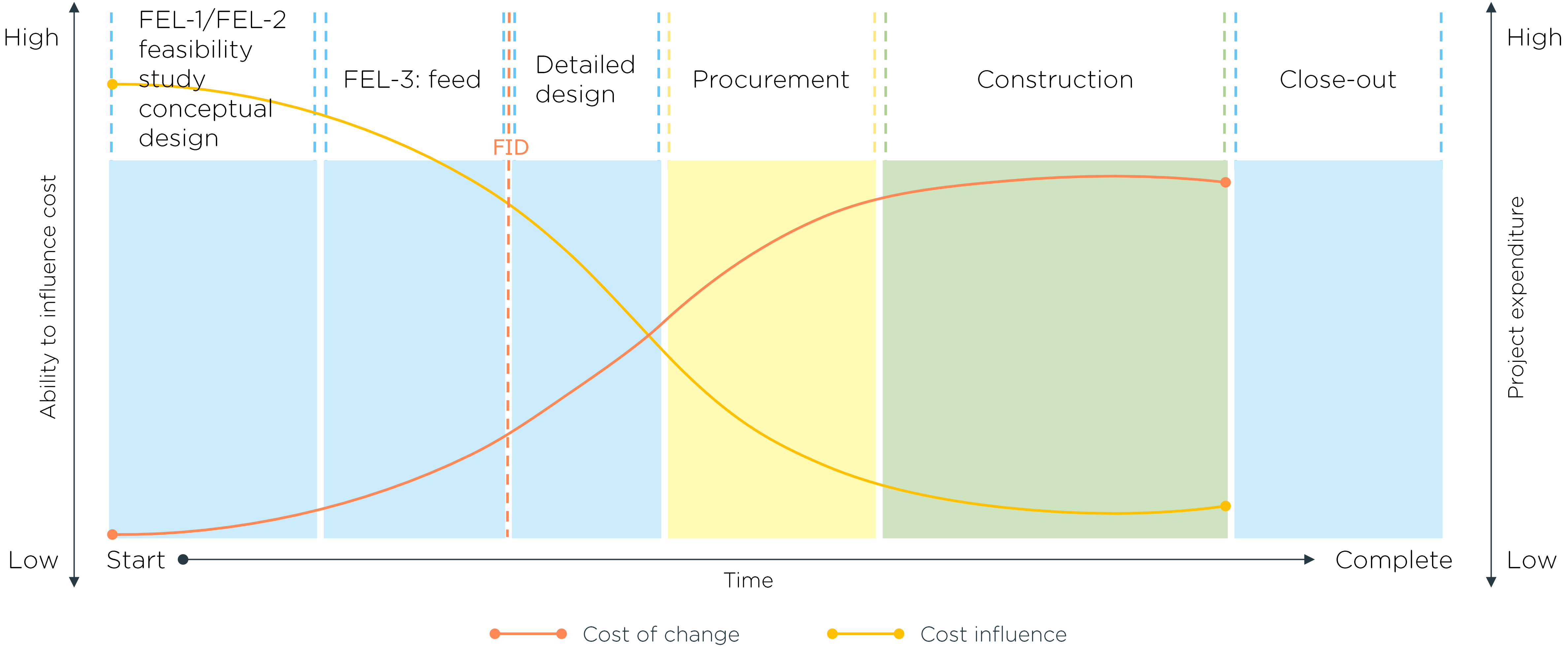
- Technical and commercial readiness level
- Scale-up challenges
- Competitiveness
- Cumbersome/long-time certification (e.g. ASTM)

Ramboll has a profound understanding of the lifecycle of biofuels projects and the project risks

	Project development			Implementation			
Project Lifecycle	**Conceptualization**	**Pre-feasibility**	**Basic Design** (FEED & Procurement)	**Detailed Design** (Design review & coordination)	**Project financing and (FID)**	**Construction and implementation** (Inspections)	**Test, commissioning and operation**
Technical and commercial services	• Feedstock access and eligibility • Technology assessments • Performance estimates • Preliminary layout • Indicative budget & time scheduling • M&E balances and process calculations • PFDs/concept diagrams	• Further mature technical concept and scope • Assessment of utilities and interfaces • Final site selection • Feedstock selection and supply defined • Further layout development • Start and permitting • Risk assessment	• Selection of procurement strategy. • Contractor FEED studies • Develop procurement documentation • Conduct procurement • Finalized planning and permitting, obtain permits • Review risk assessment • Update budget & time scheduling	• Contractors detailed design of plant • Detailed design review • Review risk assessment • Update budget & time scheduling	• Assessment of budget, costs and returns • Economic returns demonstrated • Final commitment to providing funding (banks, equity) • FID by operator	• Contractors' manufacturing of equipment • Inspections, performance tests, safety procedure, trial operation period • Transportation of equipment to site • Site preparation • Mechanical and civil construction • Update budget & time scheduling	• Commissioning • Performance and guarantee tests • Safety procedures • Review risk assessment • Update budget & time scheduling • Review of guarantee tests • Performance monitoring • Final take over protocol • Inspection during revision stops • Contract management • Progress reports
Goal	Establish an understanding of viability of the project and alignment with strategic objectives & marked demand	Establish sound basis for launching the Basic Design	Establish sound basis for launching the project and ensure implementation contract	Ensure that plant is designed in accordance with contract	Securing project financing and Final Investment Decision (FID)	Ensure that plant is built in accordance with contract	Ensure that plant is in stable operation in accordance with contract. Closing of contract.
Dura-tion	Conventional Adv. Biofuels: 6-14 Months First-of-Kind: 12-24 Months		12-18 months	6-8 months	12-18 months	24-36 months	Conventional: 6-12 Months First-of-Kind: 12-24 Months

Note: The simplified project lifecycle presents a non-exhaustive list of services

Project phase influence on cost



Early project de-risking

Conceptualization

- Feedstock access and eligibility
- Technology assessments
- Performance estimates
- Preliminary layout
- Indicative budget & time scheduling
- M&E balances and process calculations
- PFDs/concept diagrams

Establish an understanding of viability of the project and alignment with strategic objectives and marked demand

Pre-Feasibility

- Further mature technical concept and scope
- Assessment of utilities and interfaces
- Final site selection
- Feedstock selection and supply defined
- Further layout development
- Start and permitting
- Risk assessment

Establish sound basis for launching the Basic Design

Conventional Adv. Biofuels: 6-14 Months
First-of-Kind: 12-24 Months

Basic Design

(FEED & Procurement)

- Selection of procurement strategy.
- Contractor FEED studies
- Develop procurement documentation
- Conduct procurement
- Finalized planning and permitting, obtain permits
- Review risk assessment
- Update budget & time scheduling

Establish sound basis for launching the project and ensure implementation contract

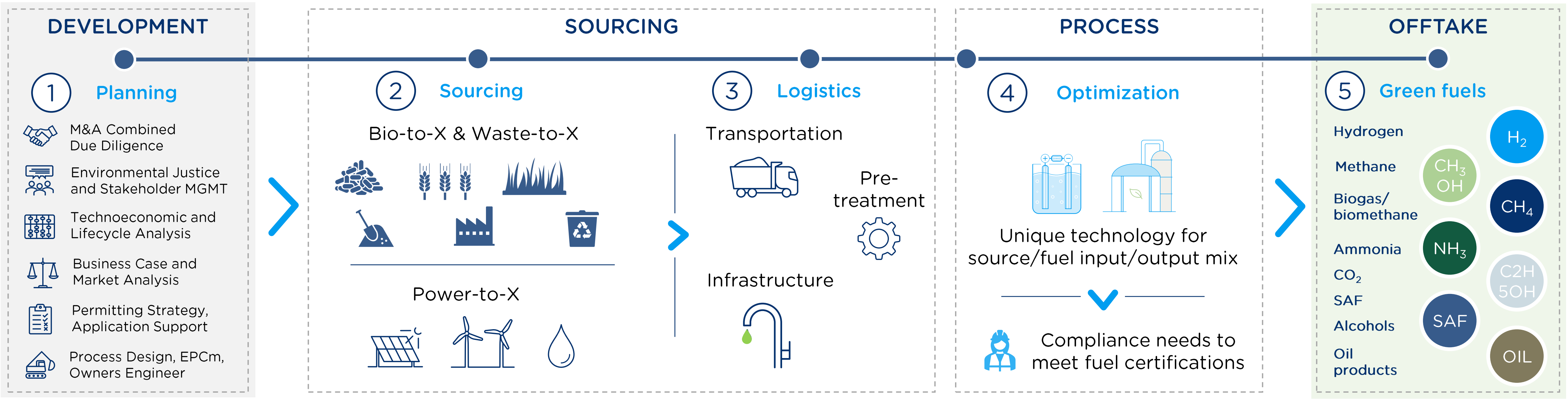
12-18 months

Early risk identification is paramount on a FOAK projects

Understanding TRL and the requirements for next levels towards commercialization to fill the gaps

Case Studies

Ramboll is an expert advisor on the technical, strategic and environmental aspects from sourcing inputs to offtake of green fuels



1 **Planning**
Ramboll supports the full range of technical and commercial advisory for new projects and acquisitions, including environmental, engineering, and commercial feasibility studies and access to public financial support.

2 **Sourcing**
Ramboll advises clients on various sourcing types leveraging on the deep technical knowledge in Power-to-X, Bio-to-X and Waste-to-X to choose the most relevant source dependent on the desired green fuel outcome.

3 **Logistics**
The choice of the most efficient logistics is unique for each source type. Ramboll has extensive knowledge and insights to optimise and choose the logistic set-up for clients.

4 **Optimization**
A large number of different combination options exist in choosing processes, technologies, operational and business models to arrive at the desired green fuel in the optimal way for the individual client's business case.

5 **Green fuels**
The desired green fuel type and the application defines the whole set-up of the other elements. Ramboll can advise on designing the unique client combination.

Feasibility study & LCA report to Kvasir's groundbreaking tech: Bio-oil production plant (100 kTa)

Lignocellulosic material → Solvothermal Liquefaction → Bio-oils → low carbon fuel applications (e.g. marine)

1

Feedstock agnostic

Whole non-edible biomass or pure lignin

(40% oxygen)

2

Simple process

Biomass break into smaller fragments expelling oxygen

(Heat to 400°C with recyclable alcohol solvent)

3

Sustainable bio-fuel

The result is stable and upgradable bio-fuel

(<10% oxygen)

Ramboll advised Kvasir to close development gaps in the fields of:

- Balance of plant (BoP), utilities, biomass handling, storage, and pre-treatment
- Grid connection study
- CAPEX/OPEX estimations
- Life Cycle Assessment (LCA)
- Permitting management

Integrated Due Diligence (DD) for Investment Decision on Biofuels Asset

Commercial DD (CDD)

- Target assessment
- Market/segment analysis incl. supply/demand, prices, regulatory landscape outlooks etc.
- Business plan evaluation
- Feedstock and offtake analysis
- Investment attractiveness

Technical DD (TDD)

- Asset condition
- Expansion and upgrade
- Asset planning
- Procurement
- Maintenance planning
- CAPEX/OPEX

ESG DD

- ESG Screening, incl. deviation from good practice, risks, improvement areas
- ESG value creation potential review, program development, and implementation
- Exposures to climate risks

Environmental DD

- EHS management systems implementation
- Permitting and EHS compliance assistance
- Contamination risks, costs and penalties
- Liability/cost estimation and reserve analysis

Trusted advisor

Ramboll has the capacity to offer several due diligence workstreams with subject matter experts for a TDD, ODD, EDD, and CDD. Through this integrated due diligence service and unmatched asset knowledge, Ramboll can support the client in the best possible way in their transactions or act as lender's independent advisor.

Time efficient
Communication and coordination are faster across the workstreams

Cost efficient
"One-stop-shop solution" presents a cost-efficient offer to the client

Increasing quality
Quick communication across the workstreams facilitates the DD quality

SAF production pathway economic and sustainability analysis

Feedstock analysis
SAF pathway review

CAPEX, OPEX, Carbon Intensity, SAF incentives

Offtake analysis tool delivered

The challenge

Creating a cost (LCoP) and carbon intensity (CI) models for SAF production pathways to support the airline's decision making on offtake agreements

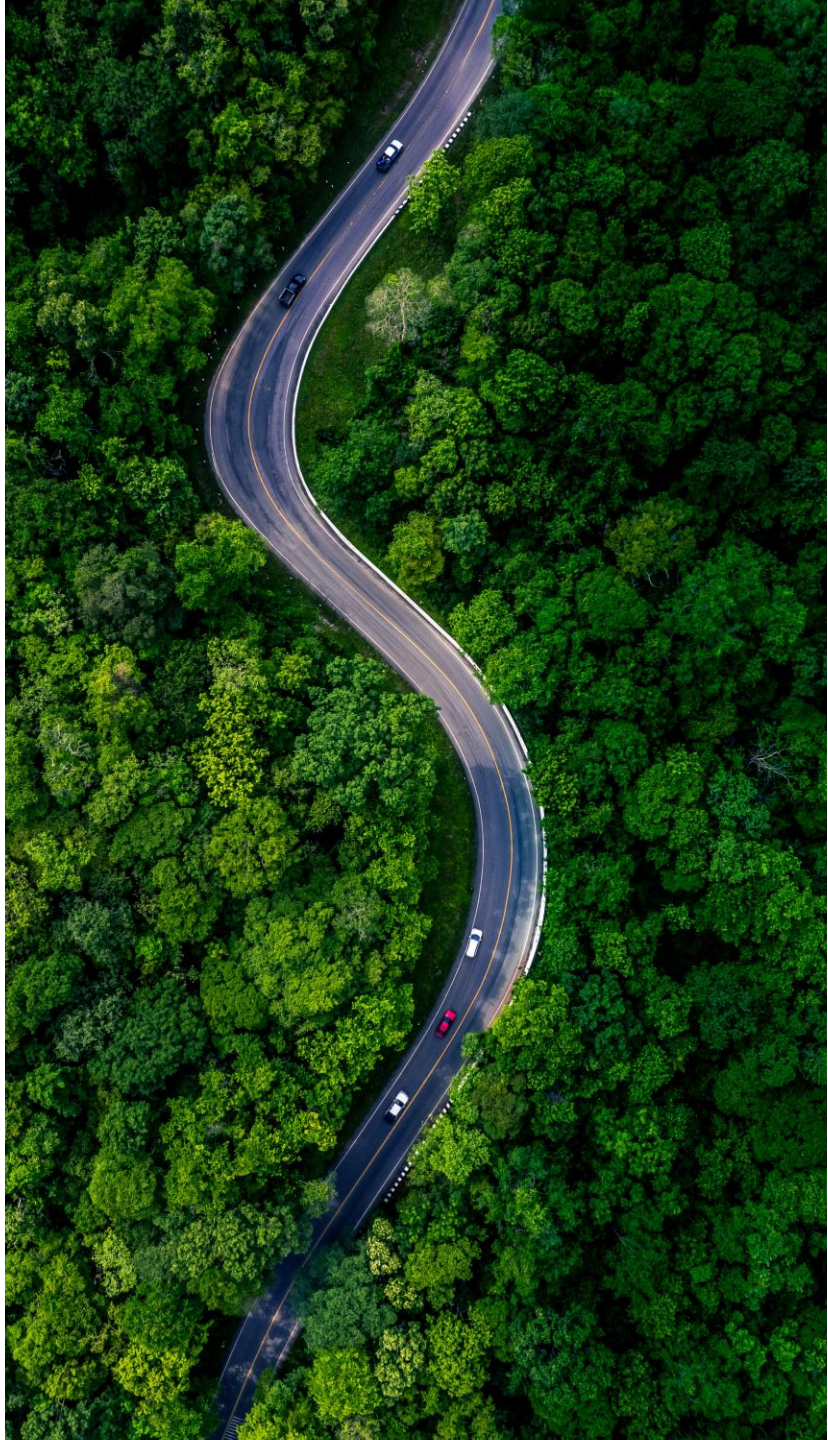
Our effort

Evaluation of 80+ SAF production pathways by using a set of tailored LCoP and CI models.

A user-defined analysis tool software was developed.

Our impact

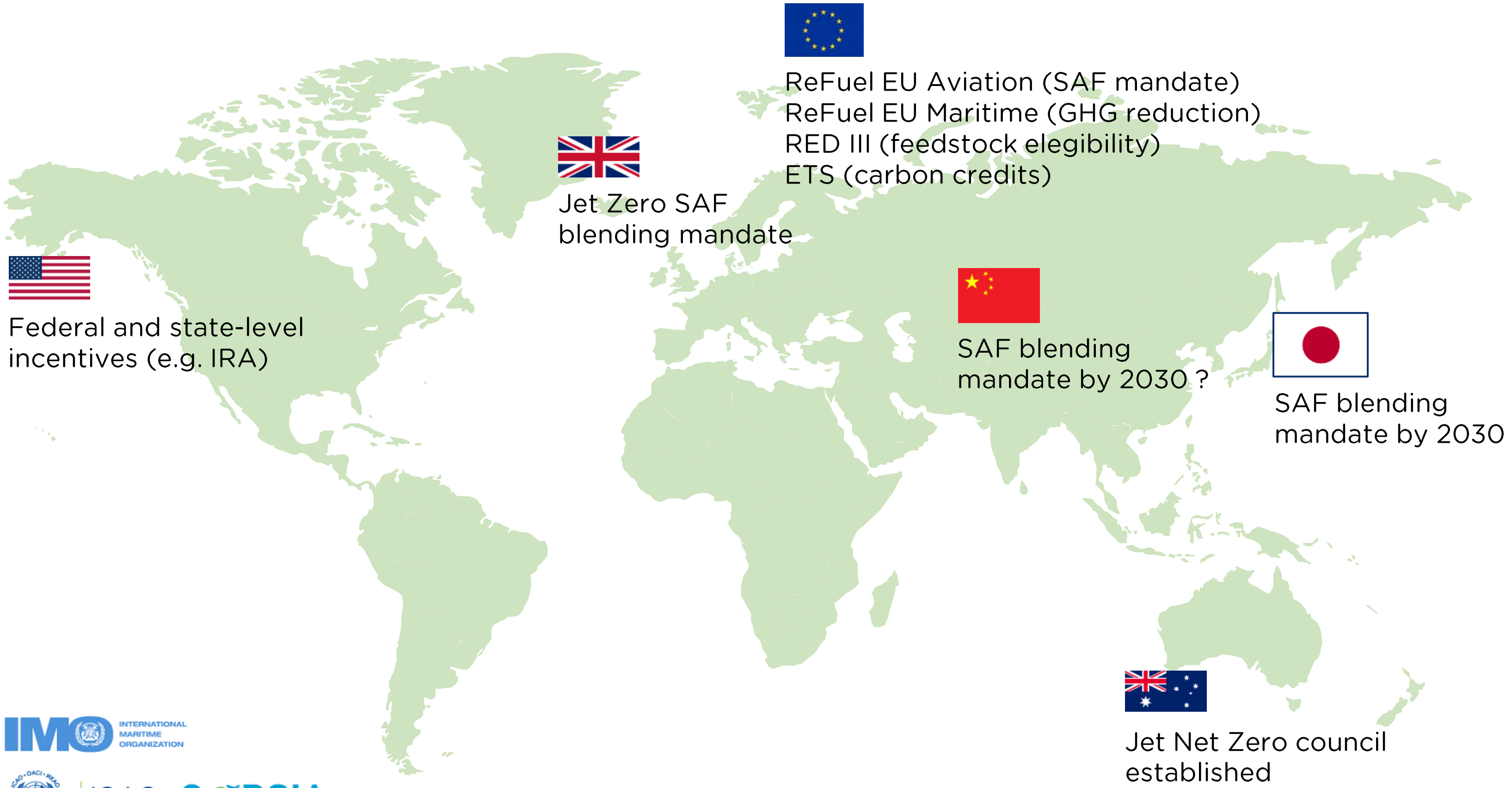
The airline could efficiently carry-over its decision-making process for SAF procurement (meeting decarbonization goals and cost-efficient fuel offtake)



Outlook and opportunities

Low carbon fuels regulation and policy is a complex landscape

Ramboll leverages years of experience across sectors and regions



Long and short term goals for emission reductions (CORSIA, CAAF/3)

Certification schemes: RSB & ISCC

Ramboll has a comprehensive knowledge an understanding of the EU, global and national level regulatory and policy landscape, and the implications of changing regulations and policies on complex market dynamics.

Our deep technical understanding helps us understand the impact of these changes and analyse how markets are developing in the short and long run.

Feedstock analysis:
- Availability
- Scalability
- Pricing

Regulation:
- Understanding mandates and penalties
- Feedstock eligibility
- EU, US, UK and global landscape

Policies:
- Understanding and leveraging incentives schemes

Certification:
- Feedstock certification (Annex IX, RED)
- Fuel certification (ASTM, CORSIA)

Contacts

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