Axens
Powering integrated solutions

AXENS PTQ WEBINAR

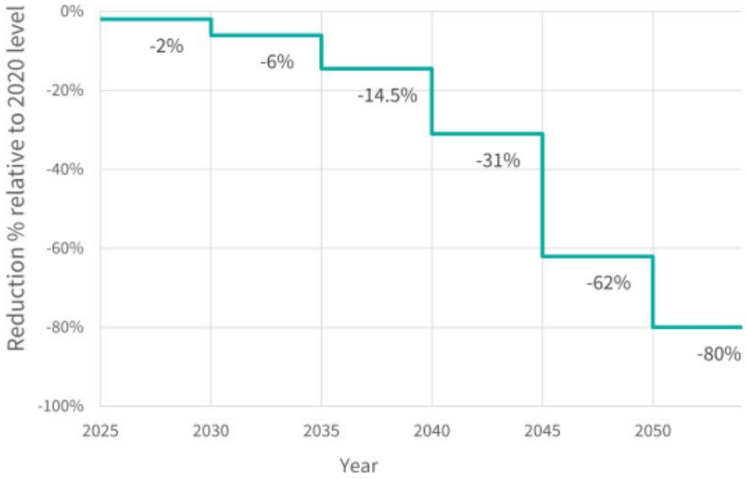
5 December 2023

Overcoming Roadblocks to Decarbonization

Leandro Labanca,
Jordi Pinent-Armengol,
Cécile Plain

EU Regulations

Decarbonize Maritime Sector



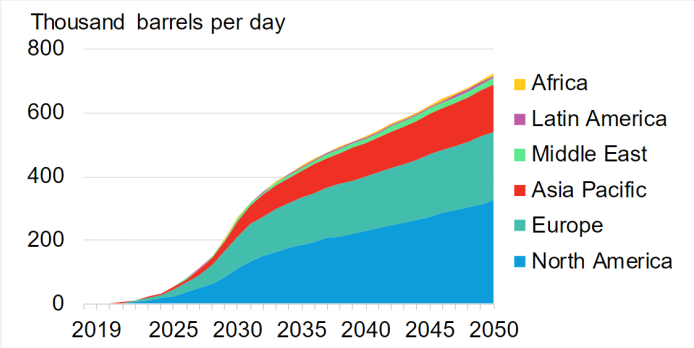
Source: FuelEU Maritime

Reduce Pollution

*"As part of the **Green Deal, 55%** of plastic packaging waste should be recycled by **2030"***

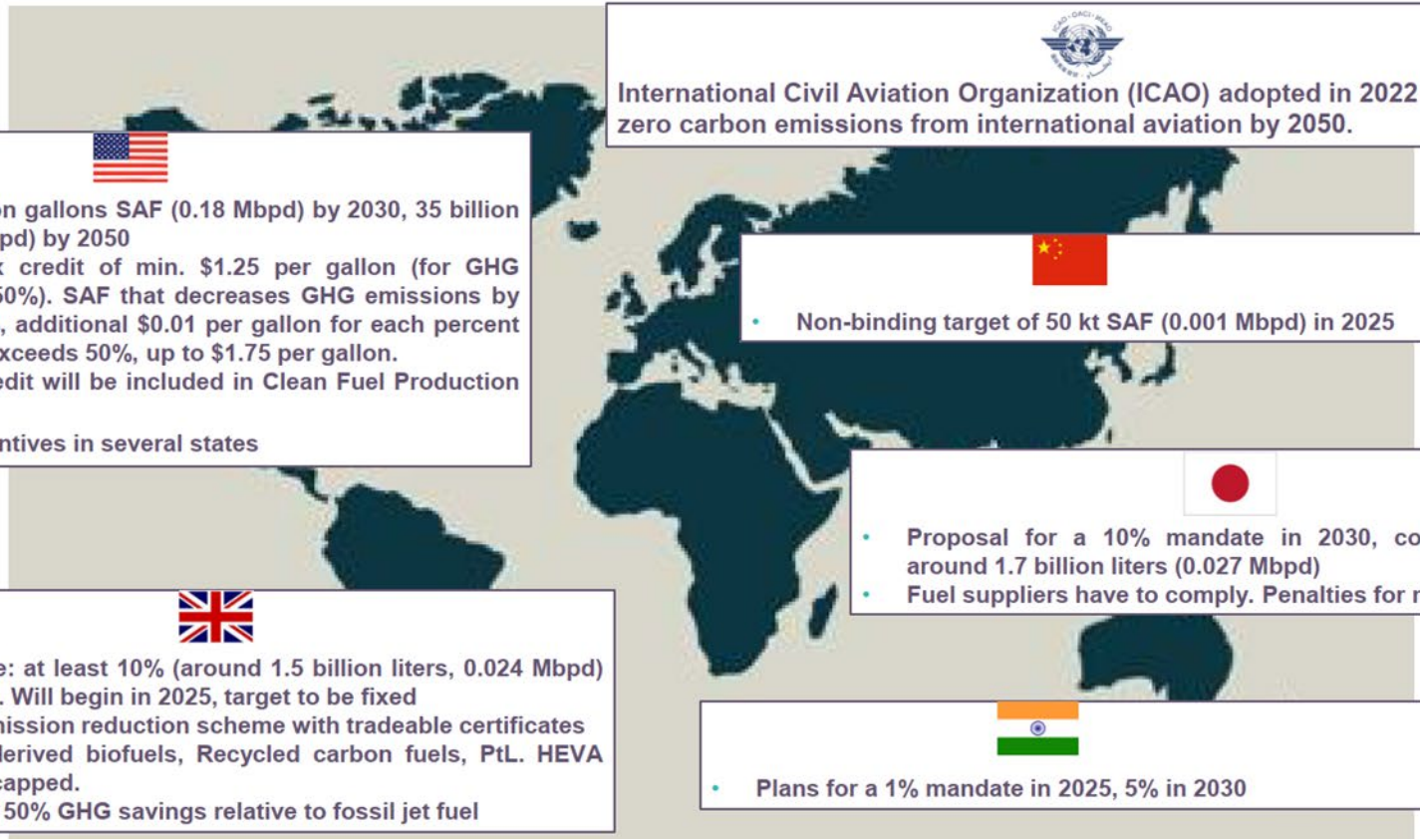
Decarbonize Aviation Sector

ReFuel EU SAF Targets	2025	2030	2035	2040	2045	2050
% of SAF used in air transport	2%	6%	20%	34%	42%	70%
of which synthetic fuels	-	1.2%	5%	10%	15%	35%



Policies Evolving Globally

Source: Transport Energy Strategies and various sources, compilation by Axens



International Civil Aviation Organization (ICAO) adopted in 2022 a goal of net zero carbon emissions from international aviation by 2050.

- Targets: 3 billion gallons SAF (0.18 Mbpd) by 2030, 35 billion gallons (2.1 Mbpd) by 2050
- 2023-2024: Tax credit of min. $1.25 per gallon (for GHG emissions by 50%). SAF that decreases GHG emissions by more than 50%, additional $0.01 per gallon for each percent the reduction exceeds 50%, up to $1.75 per gallon.
- 2025+ : Tax credit will be included in Clean Fuel Production tax credit
- Additional incentives in several states

- Non-binding target of 50 kt SAF (0.001 Mbpd) in 2025

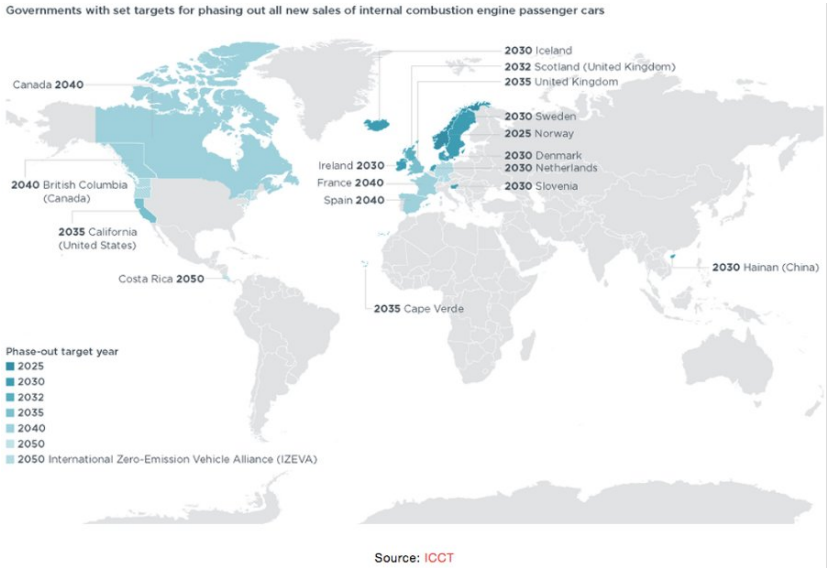
- Proposal for a 10% mandate in 2030, corresponding to around 1.7 billion liters (0.027 Mbpd)
- Fuel suppliers have to comply. Penalties for non-compliance

- Mandate: at least 10% (around 1.5 billion liters, 0.024 Mbpd) by 2030. Will begin in 2025, target to be fixed
- GHG emission reduction scheme with tradeable certificates
- Waste-derived biofuels, Recycled carbon fuels, PtL. HEVA will be capped.
- At least 50% GHG savings relative to fossil jet fuel

- Plans for a 1% mandate in 2025, 5% in 2030

In February, the European Parliament voted to approve a new law banning the sale of petrol and **diesel cars** from 2035.

California's 2035 petrol and diesel new-car ban one step closer to reality



France announces plan to outlaw diesel and petrol cars by 2040

South Korea to phase out ICE vehicles by 2035

Source: Reuters

L'ORÉAL PARIS

- *"By **2025**, **100%** of our plastic packaging will be refillable, recyclable, reusable, or compostable.*
- *By **2030**, **100%** of the plastic used in our packaging will be either from recycled or biobased sources…".*

*"**L'OCCITANE** is following its three R's, Reduce, Recycle, React and has pledged that, by **2025**, **100%** of its bottles will be made out of **100% recycled plastic**"*

L'OCCITANE EN PROVENCE

AIRFRANCE

*"By **2030**, we aim to incorporate at least **10%** of this fuel on all our flights, to achieve **63% in 2050** (…) support the **SAF** incorporation objectives of French and European roadmaps, whilst at the same time aiming to exceed them"*

*"…expanded progress to decarbonize its global supply chain, with more than 300 manufacturers now committed to using **100% clean energy** for their Apple production by **2030**…".*

How is the Market Adapting?

Focus on O&G companies' commitment…

From Axens, S&P IHS Markit (2022)

The Evolving World brings NEW PLAYERS into the field:

SKYNRG · EDF · gevo · Elyse · AIR PRODUCTS · MICHELIN · Microsoft · PORSCHE · PLASTIC ENERGY · uniper · JEPLAN Japan Environment PLANning · AIRFRANCE · norwegian · ***Others?***

Axens

Decarbonization: A Complex Matter

Solutions
- Mutiple paths
- Technologies
- Maturity

Legislation
- Carbon taxes
- ETS

Assets
- Existing configuration
- Core business

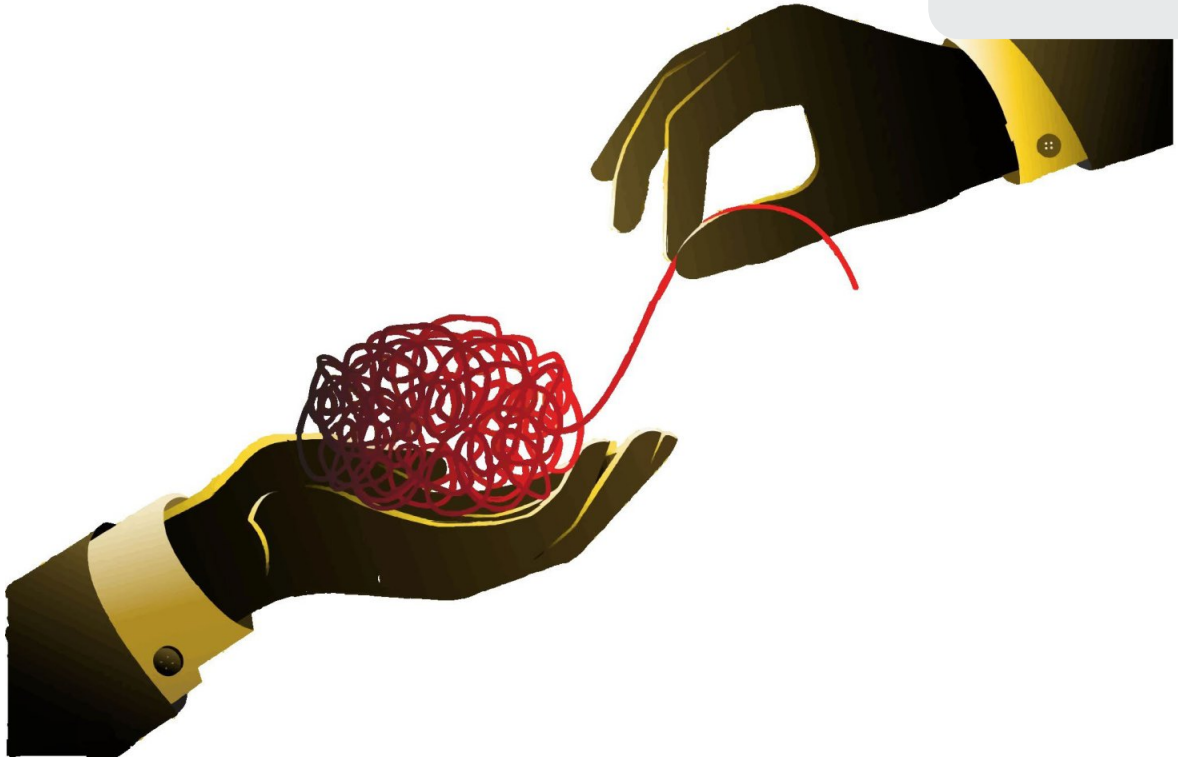
Financing
- Banks
- Subsidies

Level of Change
- Quick Wins
- Deep transformation

Markets
- Changing
- Incentives/Taxes
- Expansion

Decarbonization: Made Simpler

DeCARBON'us™



Axens Horizon's Strengths

Partnering for Success and De-Risking

DeCARBON'us™

01 Technology Expert
Largest portfolio of technologies
Evaluate different decarbonization pathways with access to expert knowledge

02 Collaborative
Developing decarbonization studies tailored to customer's needs

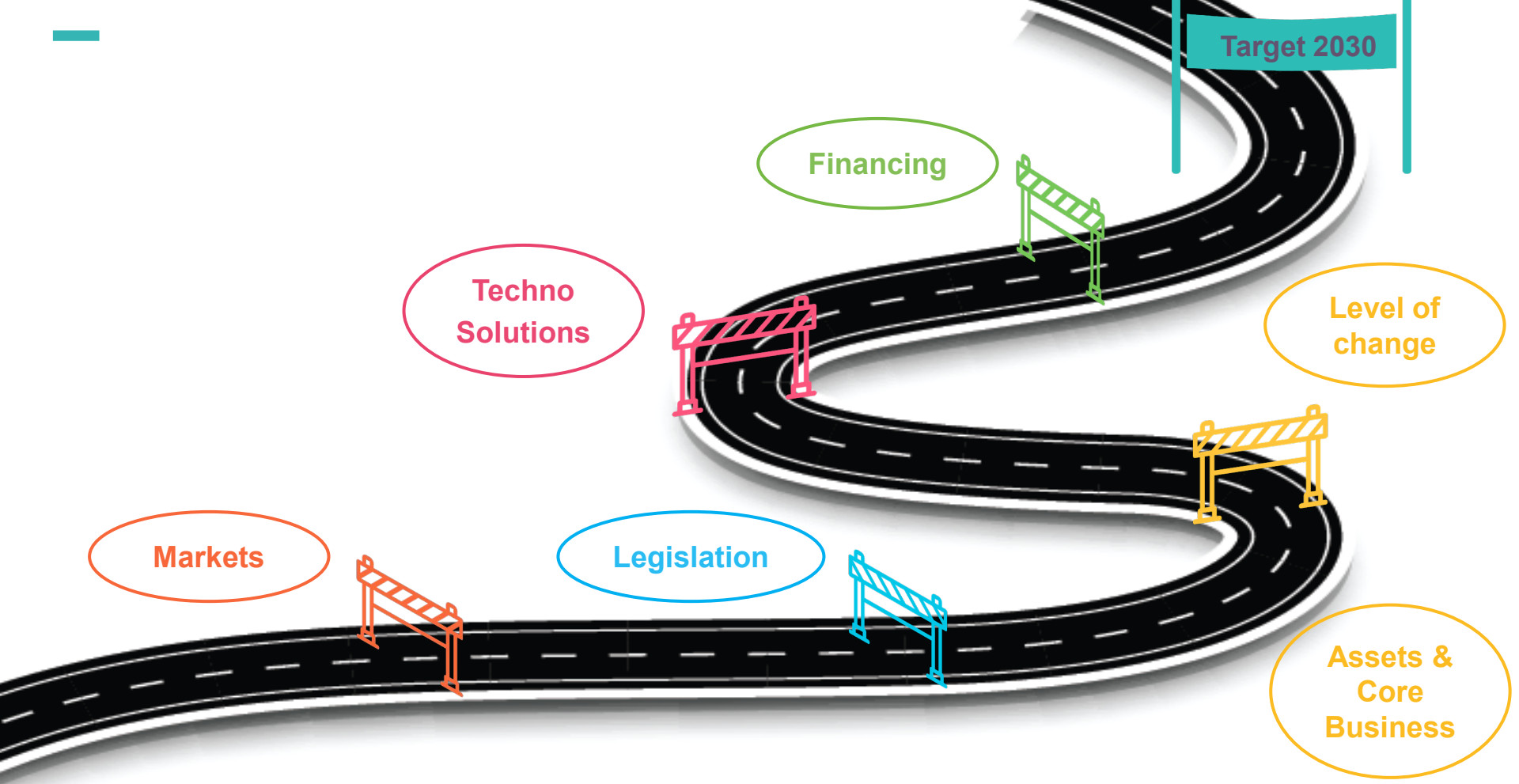
03 Agile
Quick definition of "typical" feedstock
Multi-criteria analyzes requiring various skills

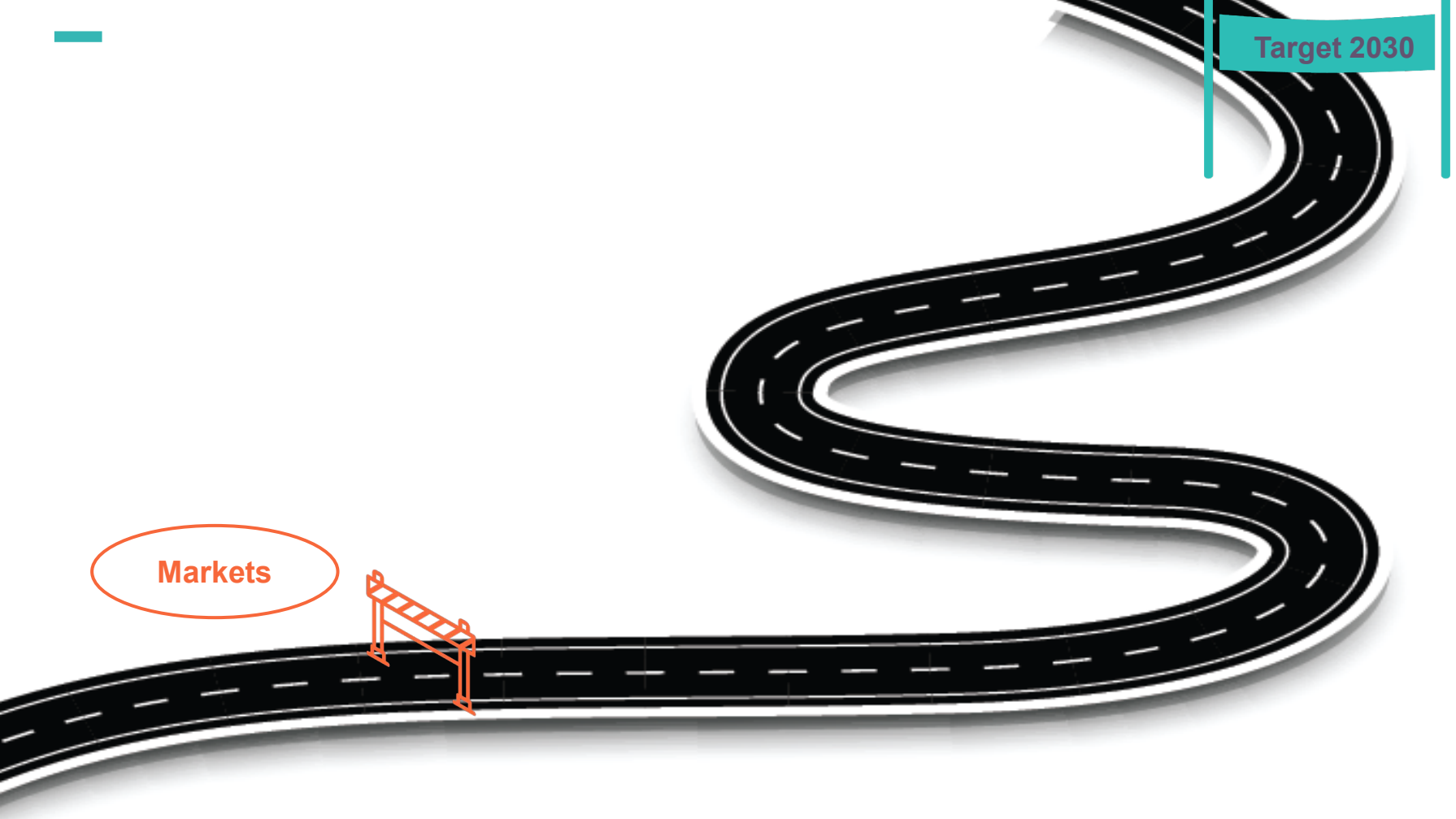
04 Holistic
Covering the complete value chain*
Full understanding of regulations & markets

*Technical, Economical and Life Cycle Analysis

05 Flexible
Quick mobilization & completion
Adapt to changes in demands & scopes

06 Walking Together
Consult on new opportunities
Support in partnership meetings


Target 2030
Financing
Techno Solutions
Level of change
Markets
Legislation
Assets & Core Business

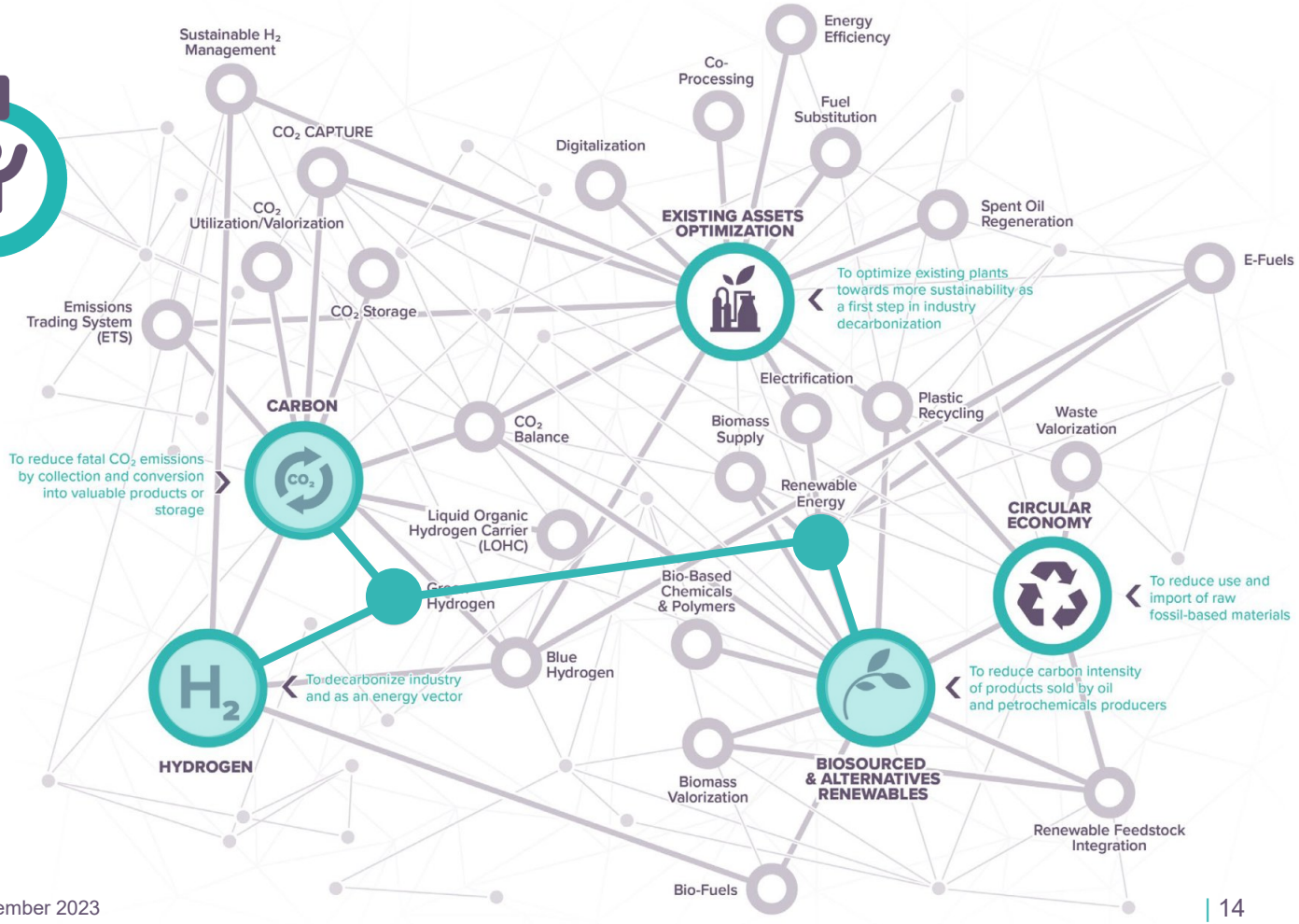

Target 2030
Markets

Market Evolution

Many domains…

New products & feedstock…

Which one(s) to invest in?



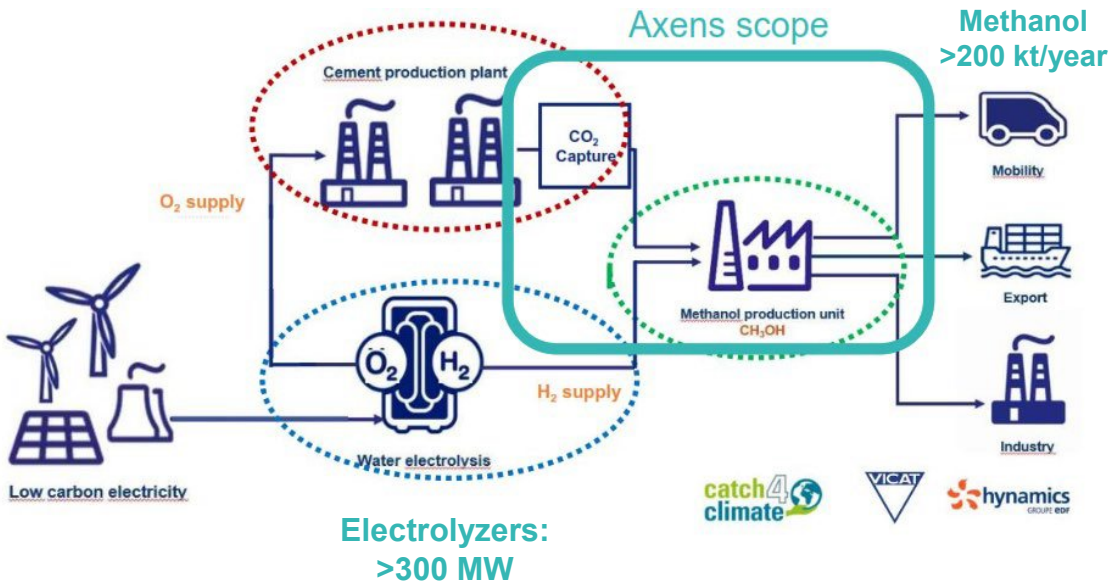
Case Study 1: Carbon Capture & Methanol PFS

Context

- **Cement:** 2% of CO_2 emissions in France
- **Ambition**: Carbon neutral **in 2050 throughout the entire value chain of its operations**

Project Goals

- 40% reduction of CO_2 emissions at Montallieu site
- Use decarbonized electricity
- Evaluate production of Methanol from captured CO_2 and H2



Application to l'IPCEI financing

500 000 t CO_2 / year avoided

Case Study 1: Carbon Capture & Methanol PFS

- **Market study on methanol**
- Review of existing **distribution logistics** in Rhône-Alpes (France)
- Review of flue gas and selection of **flue gas collection** point
- **Identify technological blocks** needed for carbon capture and methanol production
- **Comparative assessment** of production technologies
- **Multi-criteria analysis**

Key Facts

Market Study

- ↑ **5,5% methanol world consumption**: wide range of applications + renewable origin
- Decarbonized methanol locally produced vs today (mainly composed of imported fossil-based one).
- Methanol increasingly seen as a clean & sustainable fuel in addition to a basic chemical block.

Technology Screening

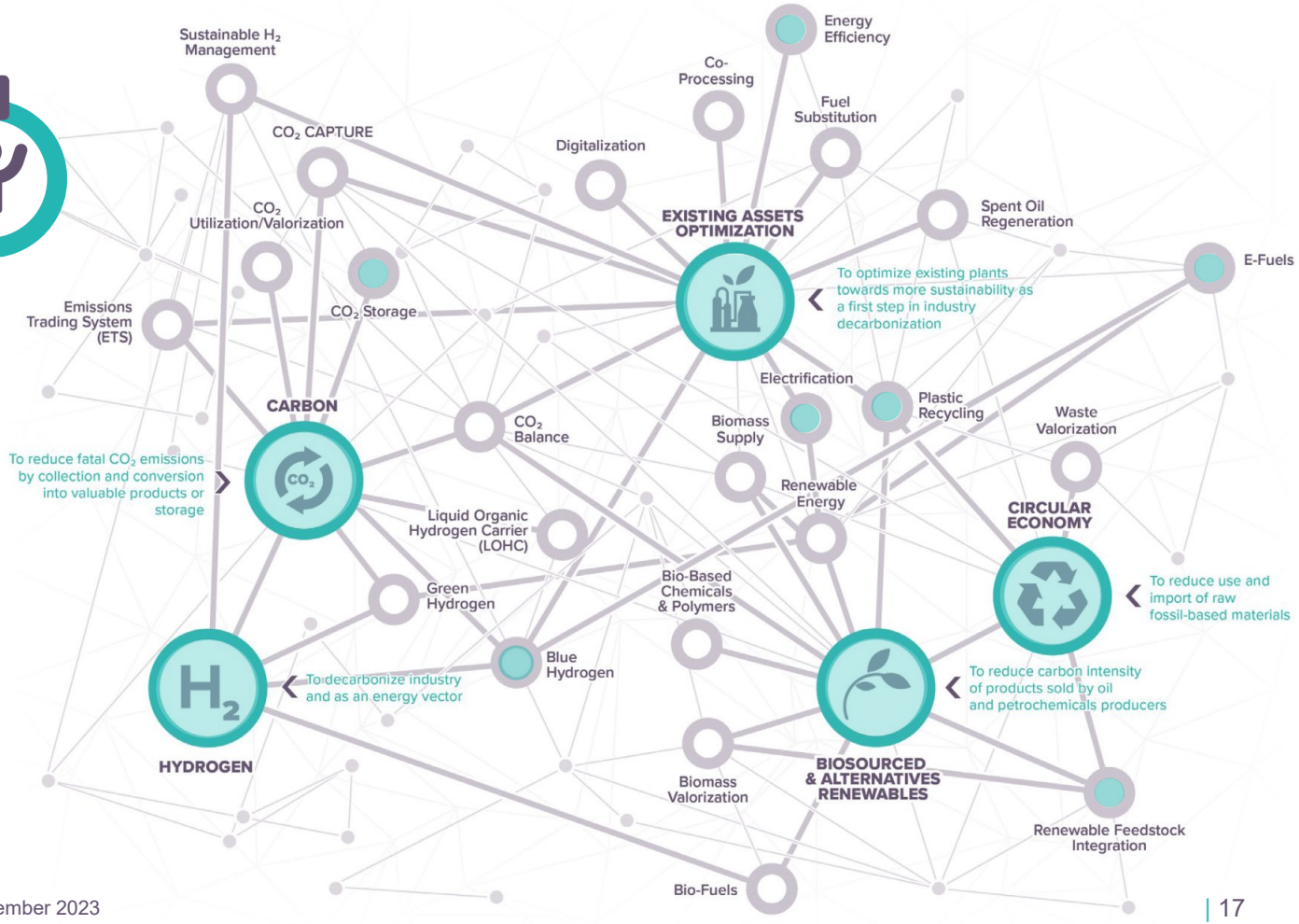
- **Carbon Capture:** Chemical solvents most appropriate. DMX™ technology complies with IPCEI acceptance criteria
- **Methanol Production:** preselection of heterogeneous catalysis technology

Market Evolution

Many domains…

New products & feedstock…

Which one(s) to invest in?



Case Study 2: Find the Right Decarbonization Opportunities

Context

Decarbonization Screening

- Define Priorities, identify quick wins and more long-term **solutions for Decarbonization** (Scope 1 to 3)

- Mid-size **European refiner**
- Large industrial location
- Leading Port

2-days Brainstorming Workshop

Coached by 10 Axens experts (technology and process experts)

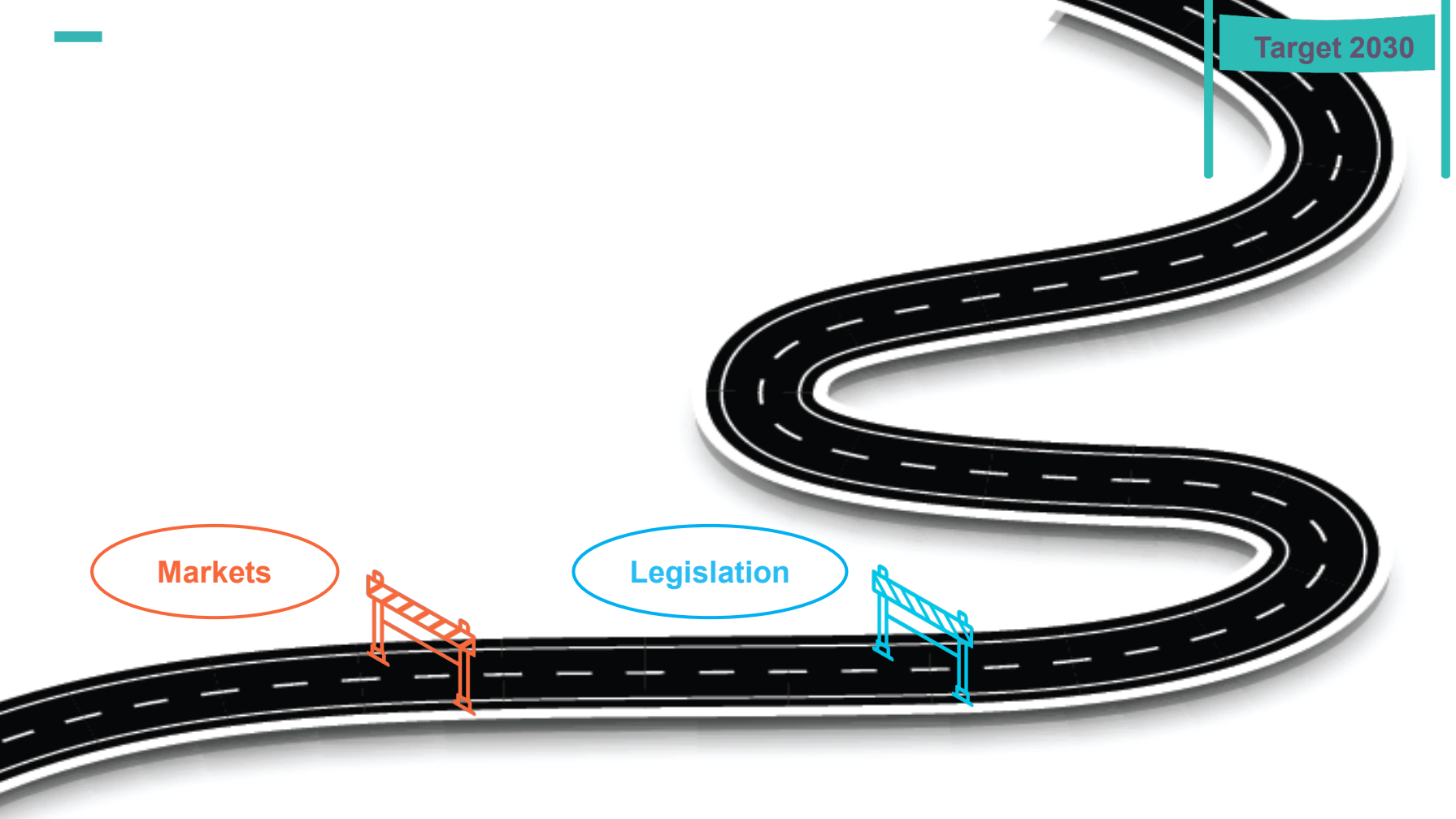
13 opportunities for decarbonization

7 opportunities for scheme improvement, for each:

› *Preliminary technical evaluation (yields, CO2 abatement…)*
› *Raw investment figures (CAPEX, OPEX)*
› *Comparison table*

Solution	Performance & Margin Improvement	CO_2 Abatement Potential	Estimated CAPEX & OPEX	Maturity of Technology	Execution Considerations
Energy Efficiency	++	+	++	+++	+++
Spent Lube Oil Regeneration	+++	+	++	+++	+
LOHC	+++		+	+++	+
Alcohol-To-Jet	+++	+++	++	++	-
Biomass to Ethanol	++	+++	++	+++	-
Extraction of Aromatics	++	--	+	+++	+
... 7 additional solutions					

✓ **Achieved in a 3 weeks study!**


Target 2030
Markets
Legislation

Advances in the Regulations

Good on Mechanical Recycling

Further advances needed for chemical recycling

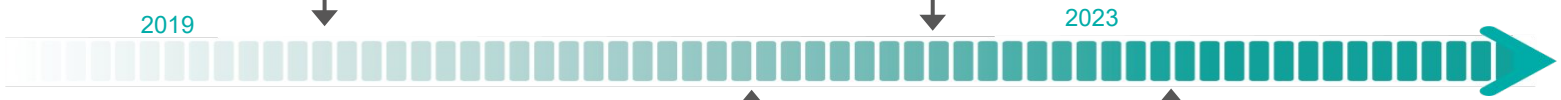
European Decrees in Emission Reduction

*RFNBO = Renewable Fuels of Non-Biological Origin

Green Deal

Package to reach EU Climate Neutrality by **2050** (12/2019)

Renewable Energy Directive (RED) Main changes	RED II 2030 Target (2018)	RED III 2030 Target (2023)
Overall renewable energy target	32%	> 42.5%
Transport sector	≥ 14% renewables (road & rail)	≥ 29% renewables (all transport modes) or 14.5% reduction of emission fuels
Advanced biofuels/RFNBO* in transport	≥ 3.5% advanced biofuels	≥ 5.5% (combined target advanced with at least 1% RFNBOs)



Fit for 55

Revise / update EU legislation to meet **2030** GHG emissions target: -55% versus 1990 levels (07/2021)

Carbon Border Adjustment Mechanism (CBAM)

Carbon tax for products made outside Europe. Prevent Carbon leakage, and contribute to decarbonization globally (10/2023)

Case Study 3: Exporting Products to Europe

Context

- **Middle East Petrochemical Producer**
- PP, PET, others export to **Europe**

Objectives

- Understand the **new regulations in Europe** (including CBAM)
- **Evaluate** impacts on the exported products
- **Benchmark** the products to competition
- Develop associated **roadmap of decarbonization**

Step 1: European Union Emissions Trading System (EU-ETS)

- Understand the EU-ETS
- Main points of revision 2023

Step 2: Industrial Producers covered by the EU-ETS

- Sectors & industries
- GHG emissions profiles & targets
- Free Allowances by sector

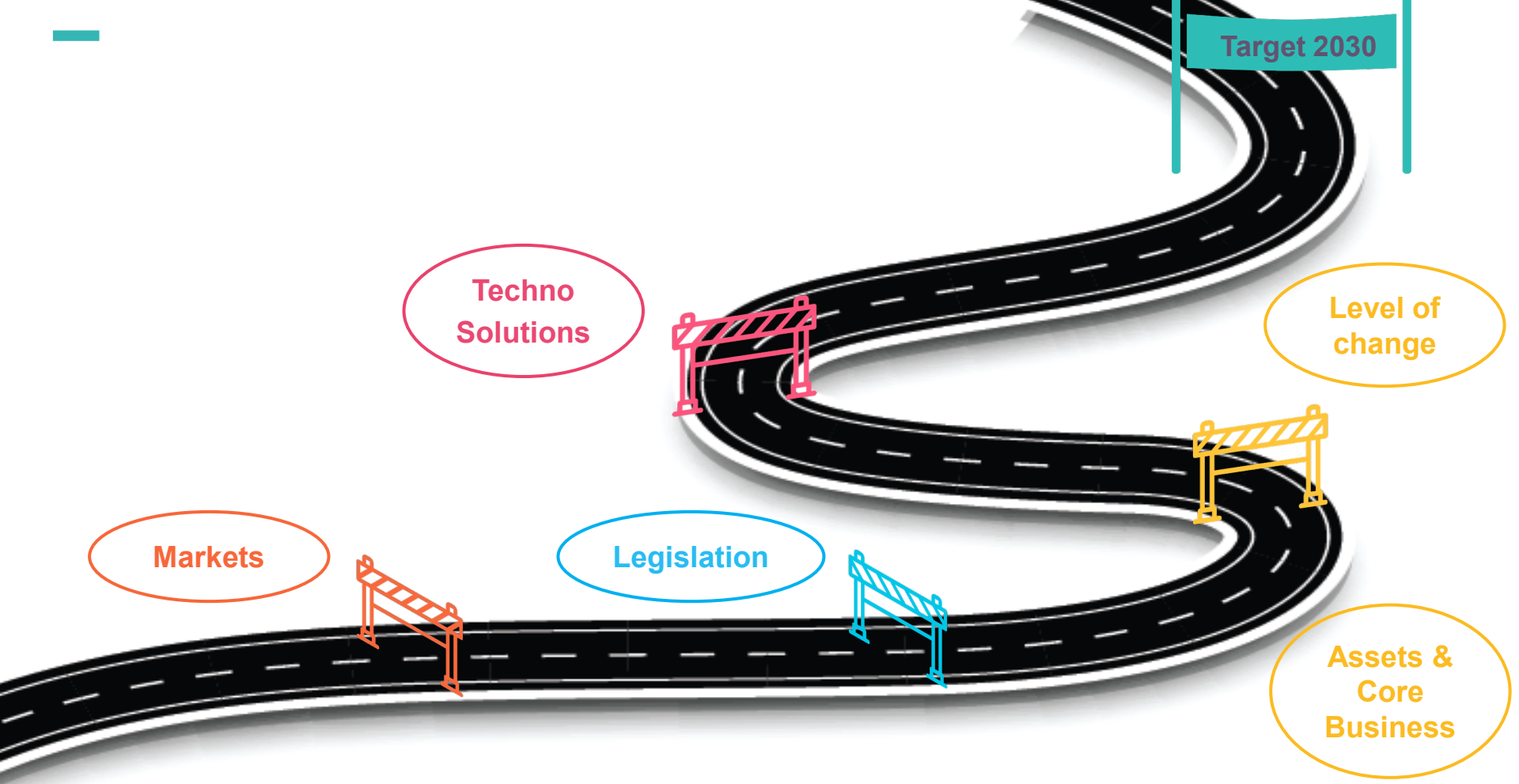
Step 3: Options to Reduce GHG Emissions in Product

- State-of-the-art options for reductions in European producers
- Additional decarbonated production cost per technology

Step 4: Competitivity Producer outside of Europe

- Estimation of carbon content
- Production costs with CBAM certificates
- Sensitivity analysis

Step 5: Develop Decarbonization Road-Map on Targeted Product


Target 2030
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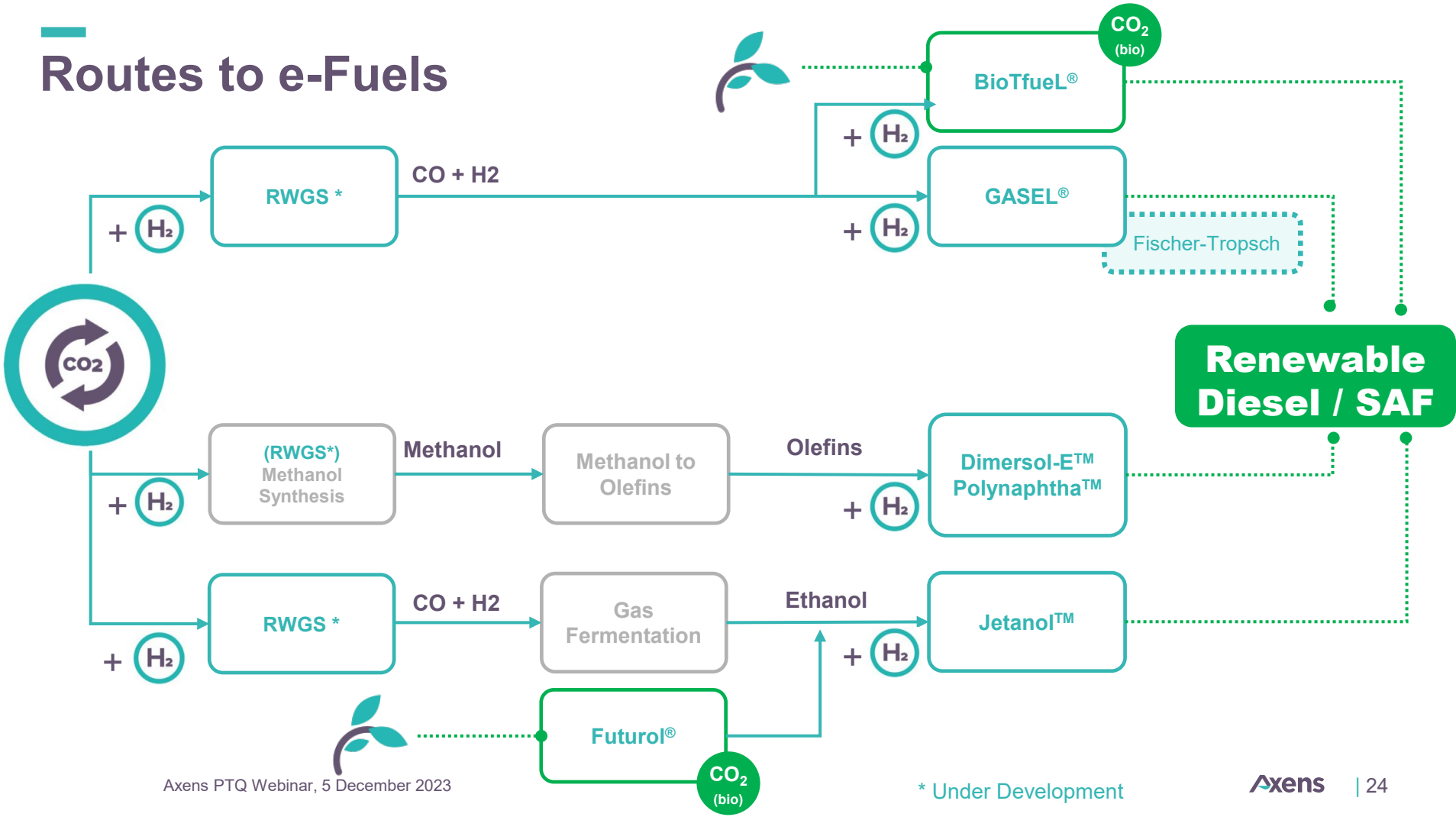
Routes to e-Fuels



* Under Development

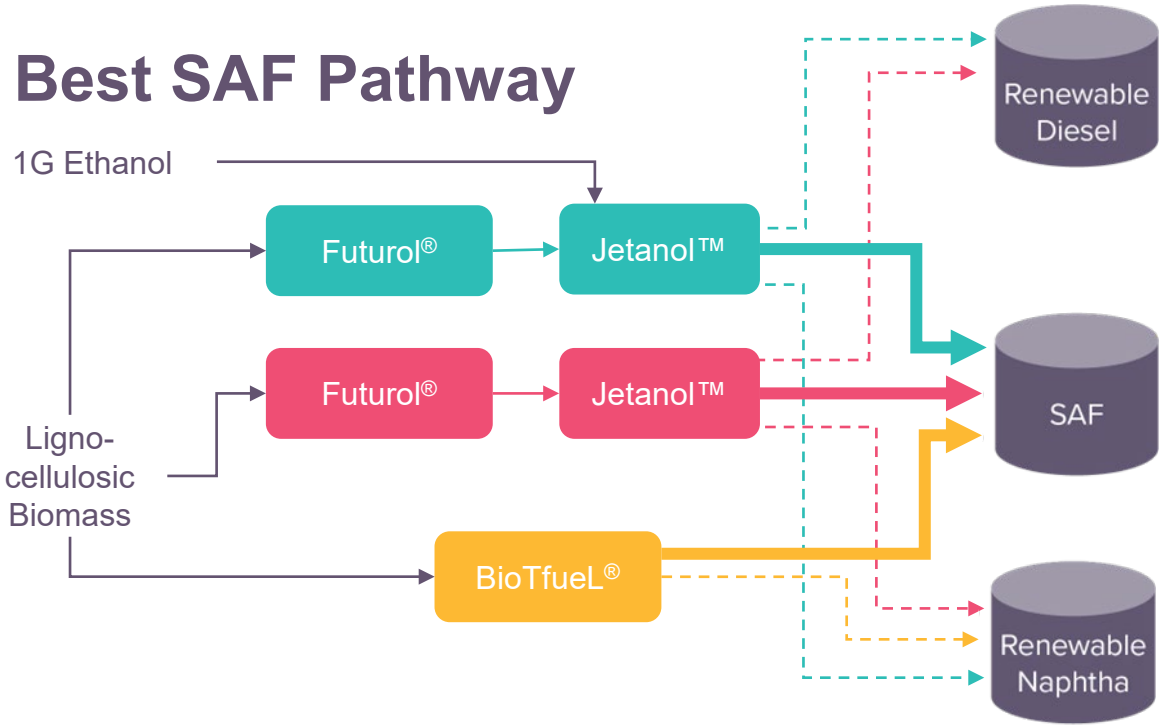
Case Study 4: Identify Best SAF Pathway

Context

- **American Refiner**
- Availability of pine trees residues closeby
- SAF production to reduce fossil origin of sold products

Objective

- Identification of best SAF pathway before investing
- SAF production: **2000 BPSD**



Phase 1: Preliminary Studies to Compare options

Product Carbon Index

Plot Plan

Flexibility

Feedstock consumption

Product distribution

Production costs (CAPEX, OPEX, etc)

Phase 2: Development of selected pathway(s)

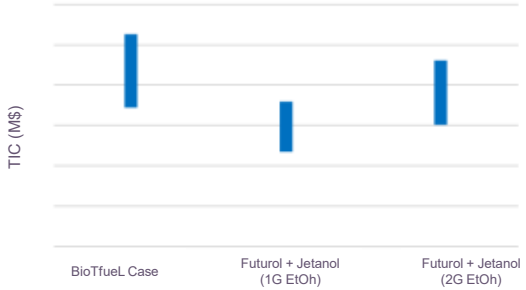
Technical Information

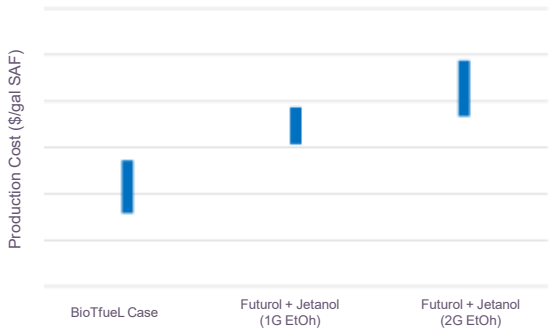
Economical Information

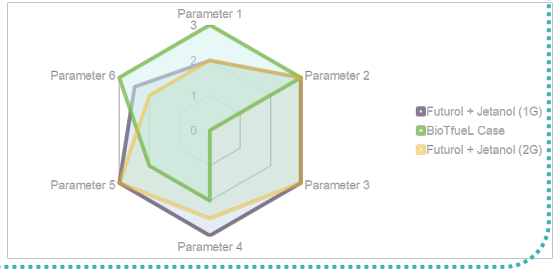
Economical Analysis + Sensitivity Analysis

Case Study 4: Identify Best SAF Pathway

1st Phase Outcomes







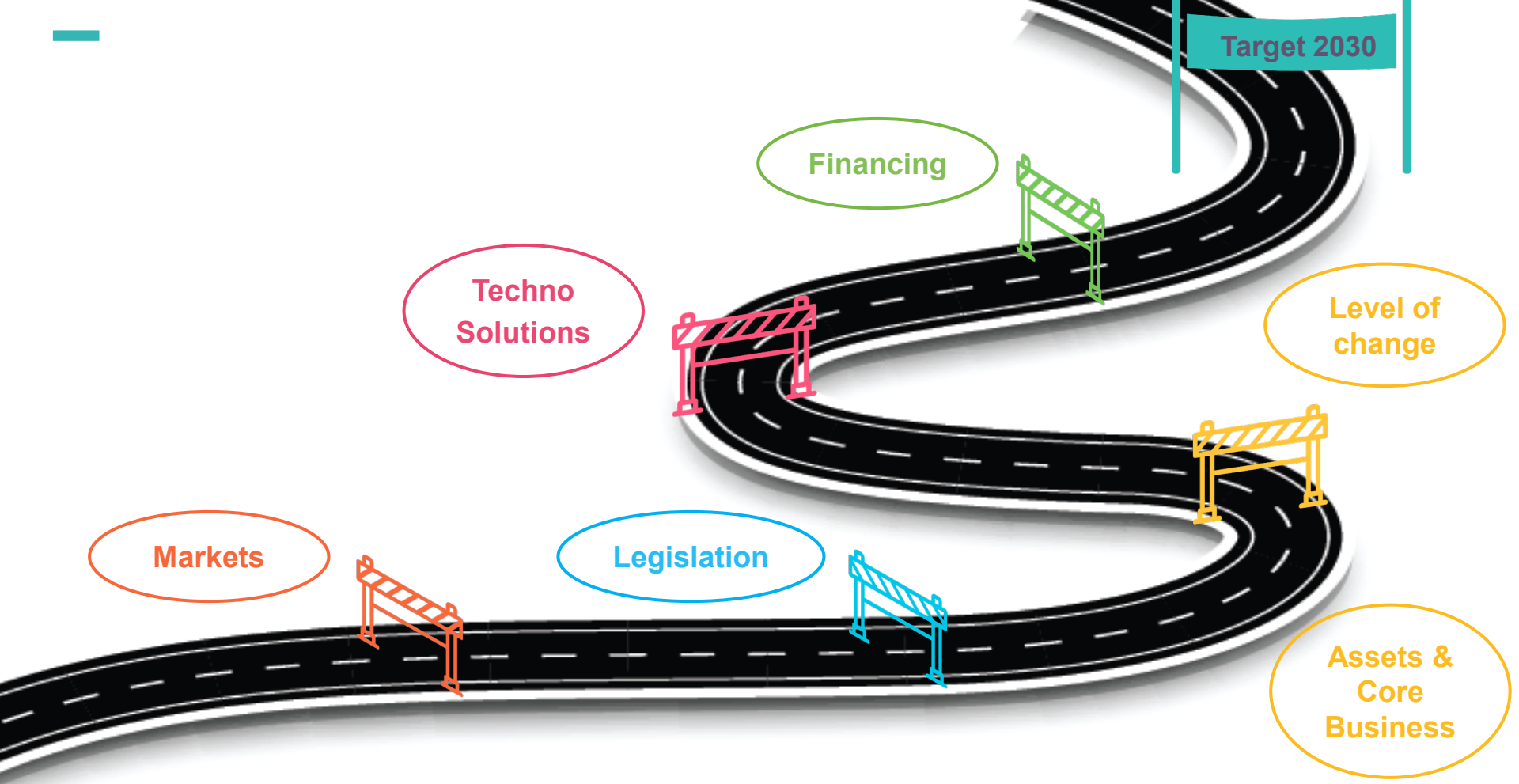
- Ethanol 1G option discarded due to market issue
- Other SAF pathways met client strategy:
  - BioTfueL®: higher CAPEX
  - Futurol®/Jetanol™: higher production cost, possibility for staged investment

… **Both pathways moved to 2nd Phase**

Project Status

✓Second Phase finalized with technical & economic analysis

✓Financing is on-going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Case Study 5: Example of Latin America Financing

European Commission

Latin America Investment Facility (LAIF)

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- Key information
- Objectives
- Impact
- Related documents

Key information

Total Budget
Approximately €12 Billion

EU contribution
€449 Million

Duration
From 2010 onwards

Geographical Coverage
17 Latin American countries: Argentina, Cuba, Nicaragua, Bolivia, Ecuador, Panama, Brazil, El Salvador, Paraguay, Chile, Guatemala, Peru, Colombia, Honduras, Uruguay, Costa Rica, and Mexico.

Implementing Organisations
European Investment Bank (EIB), the French Agency for Development (AFD), th… Development Bank, COFIDES, Central American Bank for Economic I… IDB

RÉPUBLIQUE FRANÇAISE
Liberté
Égalité
Fraternité

AFD
AGENCE FRANÇAISE DE DÉVELOPPEMENT

1,7
billion euros committed … AFD Group in …

70%
…ects have a positive …on the climate

…inequalities. It has committed 11 billion euros in the region since

Several Financial Opportunities for Decarbonization

Global Gateway

lacif

Latin American Green Bond Fund (LAG…

Sustainable Energy

LAGREEN is the first green bonds fund … investments and to mobilise local and in… …bonds in Latin America.

The specific objectives of this fund are:

- to mobilise additional funding for Natio… …ntributions (NDC) implementation;
- to push local capital market developme… …owards a transition to sustainable finance – thereby fostering transparency and long-term commitments in financial and economic activity;
- to reach a substantial greenhouse gas emissions mitigation and / or climate change adaption impact.

…

SECTOR: Sustainable energy | TOTAL ESTIMATED BUDGET: € 450 450 000 | LAIF CONTRIBUTION: € 16 050 000
DATES: Dec/2020 - Dec/2035 | STATUS: ONGOING | COUNTRIES: -Regional Central America-, -Regional Latin America-, Brazil, Colombia, Costa Rica, Ecuador, El Salvador, Mexico, Panama, Peru

LATIN AMERICA & THE CARIBBEAN

The 33 countries of Latin America and the Caribbean account for 8.5 percent of the global population — approaching 665 million people. A significant majority live in urban areas; in fact, this region is the most urbanized in the developing world.

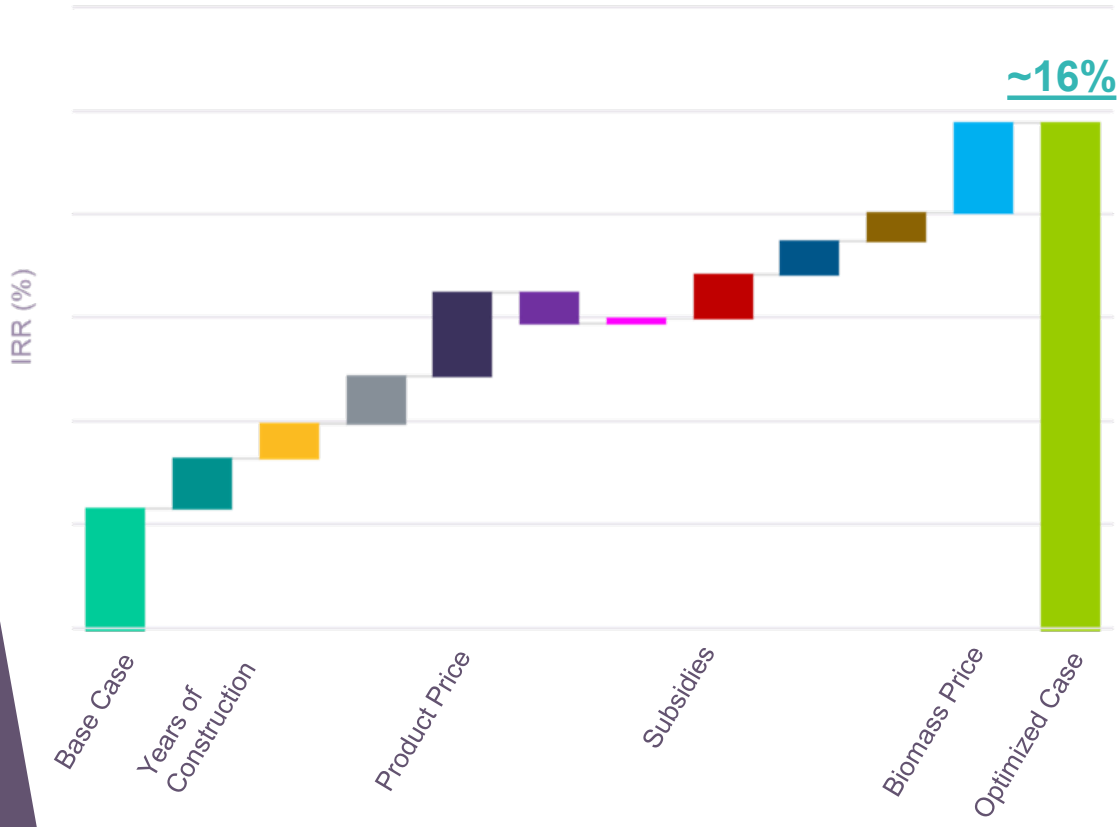
The region's natural wealth is vast. Nearly 50 percent of the total land area is covered by forest. Containing some of the most species-rich biomes on Earth, it is also home to 50 percent of the world's biodiversity.

Parts of the region are vitally important as a carbon sink. For example, the Amazon soaks up five percent of all greenhouse gas emissions. At the same time, Brazil and Mexico are amongst the top 20 contributors to global emissions.

The Caribbean is also home to Small Island Developing States (SIDS): they include Jamaica, St. Lucia, and St. Vincent and the Grenadines.

INVESTING IN LATIN AMERICA AND THE CARIBBEAN

Case Study 5: Improving Project Viability

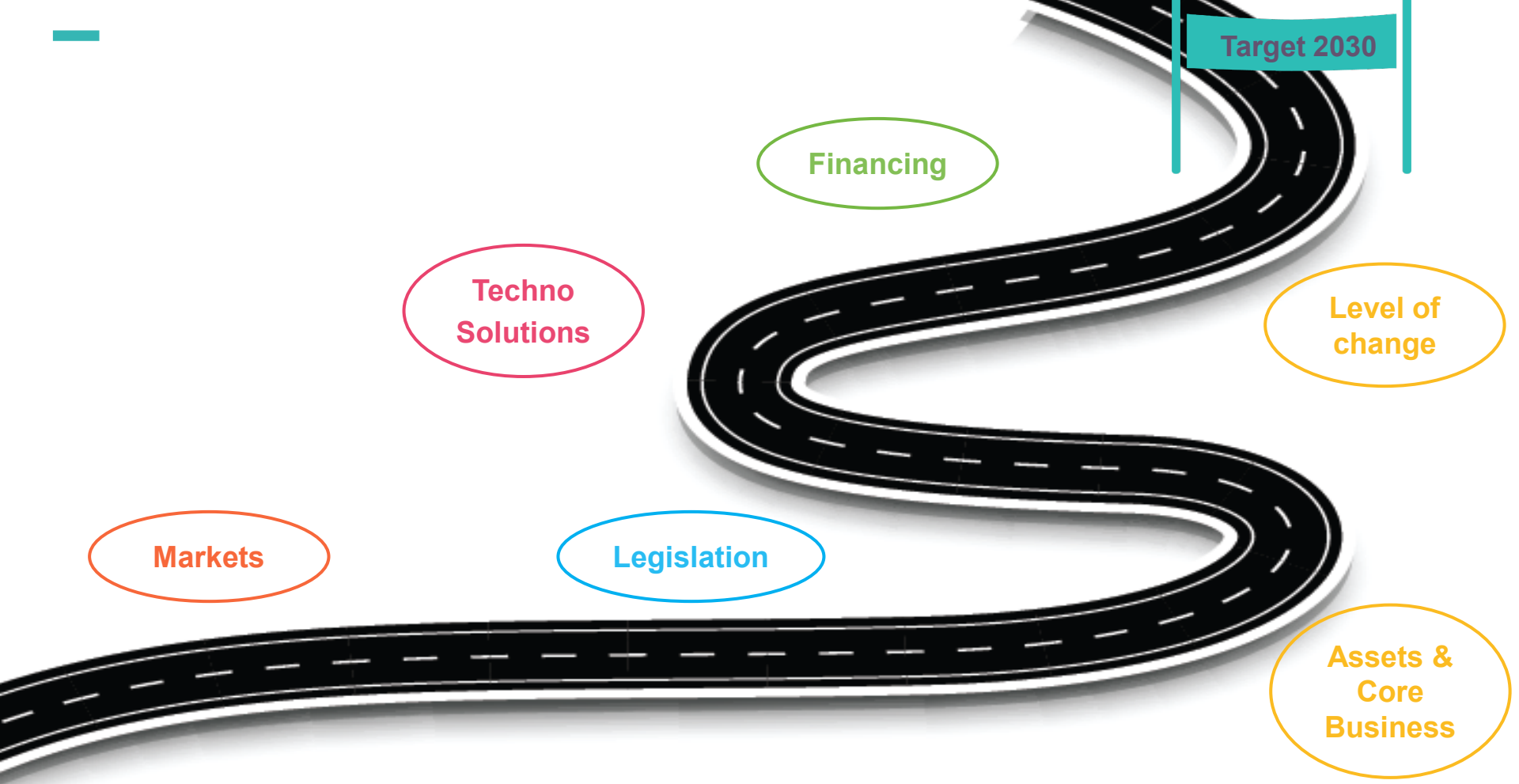


Context

- **South American biofuels producer.**
- Targeted **143 KTA of** SAF production based on two biomass.
- Pre-feasibility study done to **select best SAF pathway**

Objective

- **Optimize key parameters to improve the viability of project**
- Support customer in finding investment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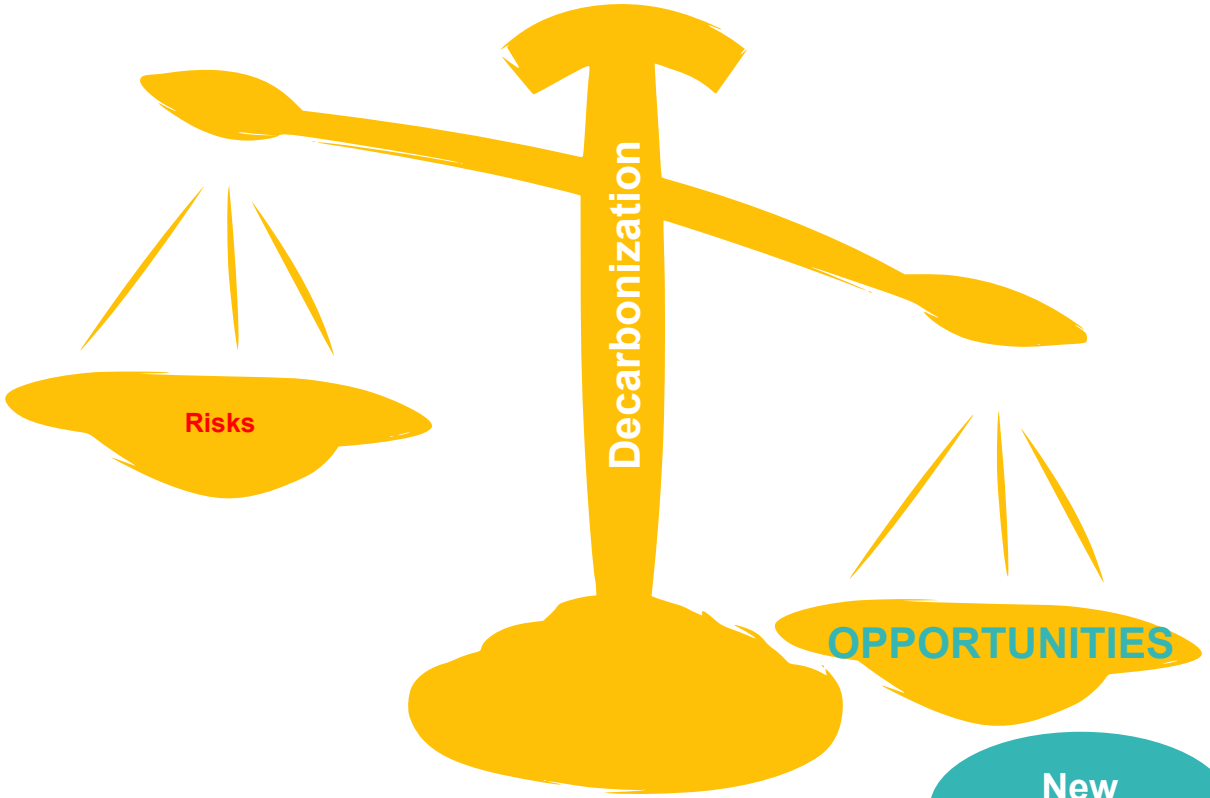
Decarbonization
Risks
OPPORTUNITIES
Improved Image
New high-value Products
New Markets
Green Financing
Secured off-takers

Axens PTQ Webinar, 5 December 2023

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Powering integrated solutions

axens.net

Thank you

Q&A

Contact us to

DeCARBON'us™ together…