Jean Christophe VIGUIE



Low Carbon Fuels Production Technology Development

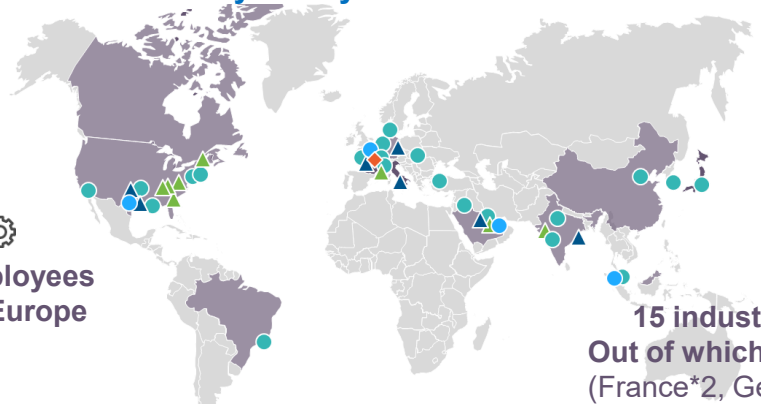
AXENS – Mid-size industrial company with innovation as DNA

French/European Technology Champion

1,2 Mds€ Turnover ***x7*** in 25 years

>15% Low Carbon chemistry

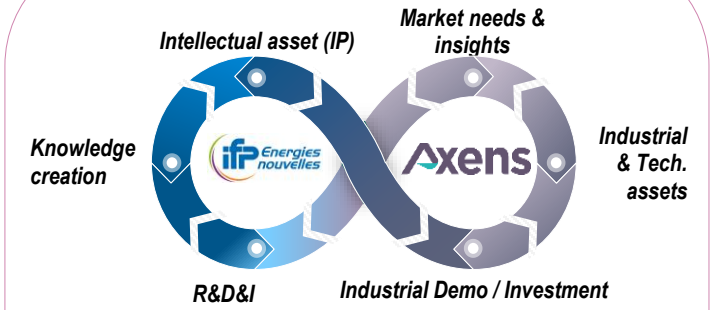
3 000 Licensed Units
500 Modules
115 000 t/y Catalyst Production and Services



>2 500 employees
>70% in Europe

15 industrial sites
Out of which 4 in Europe
(France*2, Germany, Italy)

AXENS-IFPEN
A unique & virtuous partnership



1 280
PhD & post-docs

>70%
Low Carbon R&D

>10 000
Active patents

Axens - Large Technology Portfolio for multiple Industries and Markets

Driving Innovation in Clean Fuels, Gas & Chemicals intermediates

- Chemicals Intermediates
- Clean Fuels
- Natural Gas Treatment
- Energy Efficiency

Pioneering Low Carbon Fuels and Chemicals

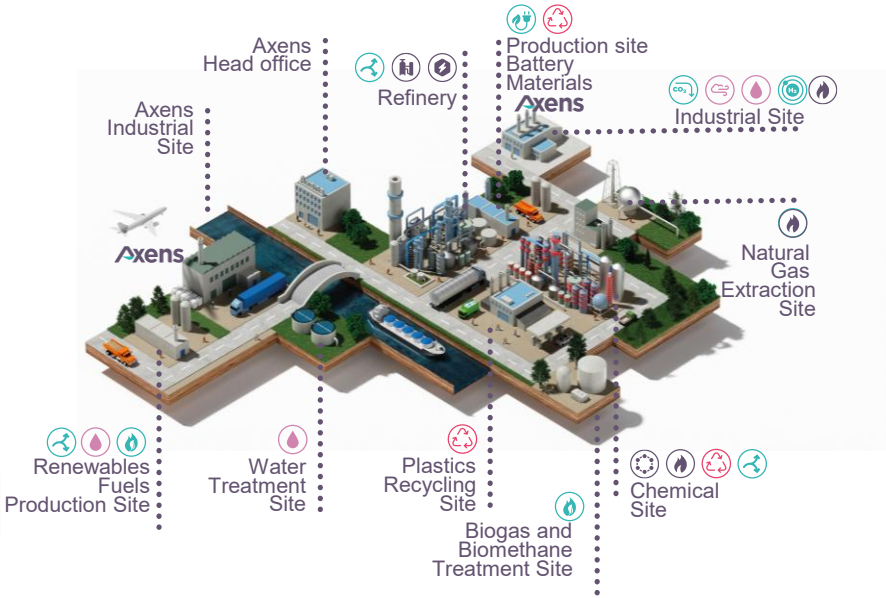
- Renewable Fuels & Bio-Based Chemicals
- Carbon Capture Utilization & Storage
- Low-Carbon Gases
- Electrification / Battery Materials

Promoting Circularity

- Plastics Recycling
- Metals & Catalysts Recycling

Protecting Environment

- Air Treatment
- Water Treatment



Axens - A long history with Low Carbon Fuels technologies



1992 — First Biodiesel plant start-up **Esterfip-H** Technology

1998 — Beginning of **Gasel®** development



2001 — **Gasel®** demonstration plant start-up

2006 — 1st **Esterfip-H** start-up

2008 — Beginning of **Atol®** and **Jetanol®** Development

Beginning of **Futurol®** development

2010 — Beginning Of **BioTfueL®** Development

Gasel® ready for commercialization



2011 — **Futurol®** pre-commercial plant start-up

2015 — **Futurol®** industrial demo plant start-up



1st industrial reference of **Vegan®** TotalEnergies La Mède Biorefinery project

2018 — **Futurol®** ready for commercialization

BioTfueL® demonstration plant start-up

2020 — 1st industrial reference of **Futurol®** INA Sisak Biorefinery project



2021 — **BioTfueL®** ready for commercialization

1st **Atol®** plant start-up

2022 — **Jetanol®** 1st industrial reference, in collaboration with Gevo

BioTfueL® testing program completed

Vegan® 10 units under construction/design

2023 — **Carboverseo® RWGS** ready for commercialization

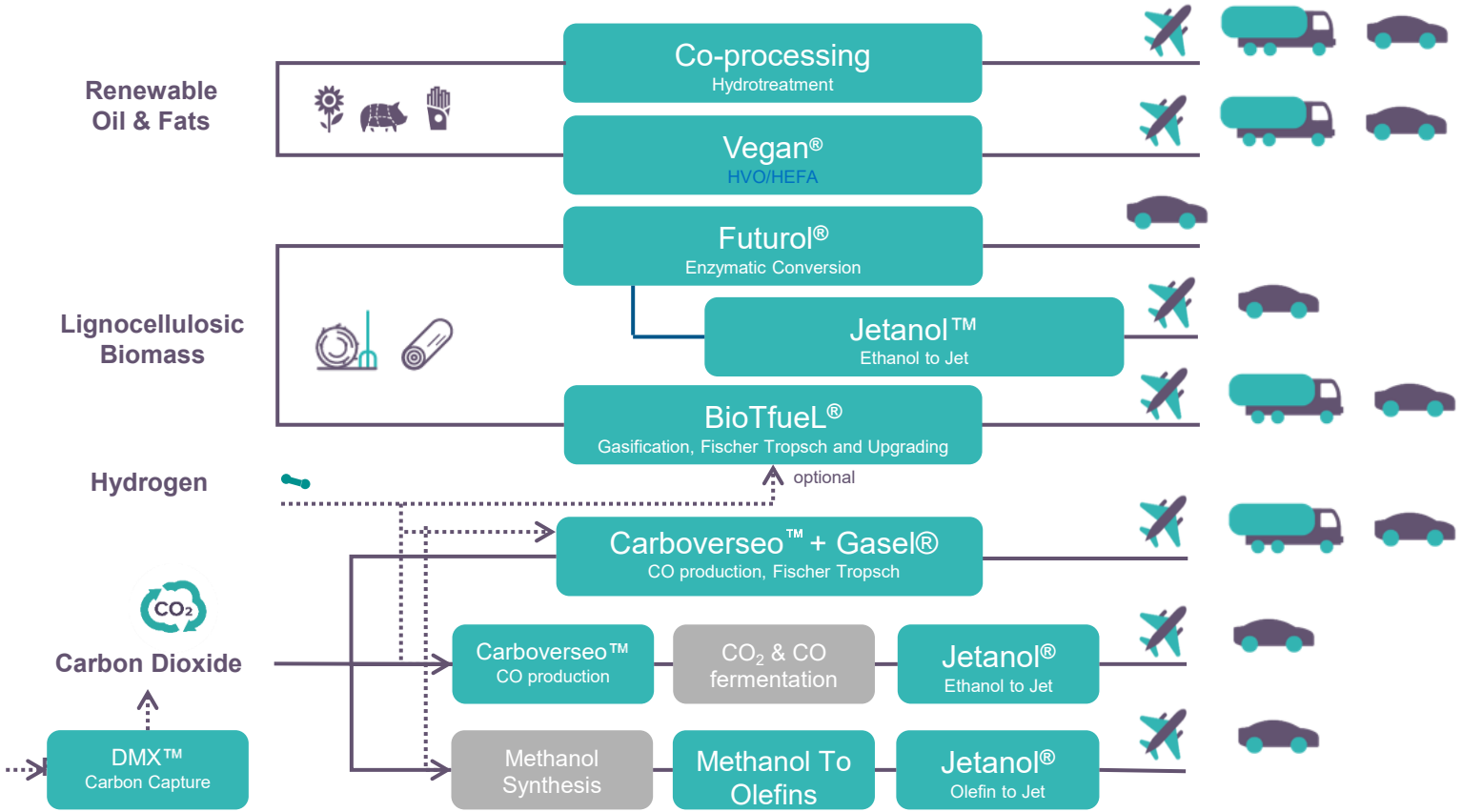
2025 — **BioTfueL®** 1st industrial Reference (BioTjet)

Take-Kair project e-SAF industrial pilot plant

rWGS project e-SAF technology development

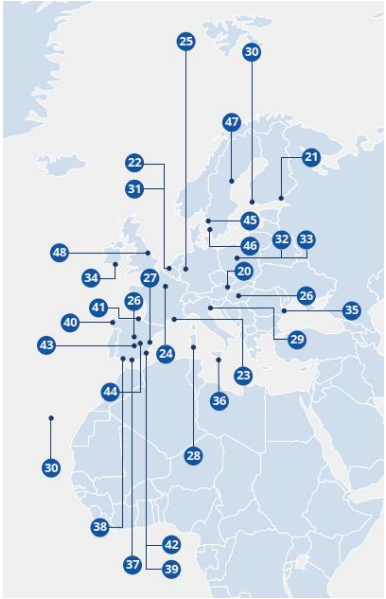
2026 — **MTPlus®** Acquisition for integrated MTJ offer

Axens unique position – All Pathways to Low Carbon Fuels and SAF



Low Carbon Fuels – some facts

1. HVO/HEFA & co-processing adopted by refiners



2. e-fuels, many projects (>1b€) by project developers, no FID…



3. The intermediate route
   - Ethanol as platform molecule
   - Ready for road transport
   - Compatible with maritime
   - Intermediate for SAF
   - Ecosystem to be demonstrated

Source : Argus 2025

Axens – 1st of kind to support Low Carbon Fuels industrial deployment

Development of BOO projects (Build-Own-Operate)

Low carbon fuels

nacre
Advanced Bio-Ethanol

FUTUROL

SAFIRIS™
Ethanol to Jet

Jetanol



Objectives

- Demonstrate at large scale the technology
- Build the complete ecosystem (sourcing, offtakes, financing, …)
- Set the path for Ethanol to SAF in 2035)

Axens - NACRE SPV

A biorefinery located in Induslacq : 30 kt/yr advanced bioéthanol



Local biomass

120-150 kt/yr$_{(dm)}$

- Agriculture ressources **≥ 70 kt/yr**
- Wood residues **≥ 55 kt/yr**

HR

- Biomass producers **2 x 200**
- Biomass logistics **x 60**
- Plant operation **x 50**
- Plant construction **x 400**

Futurol®



nacre

Biomethane

≈5 kt/yr

Advanced Bioethanol

30 kt/yr

CO_2

≈41 kt/yr

Lignin

≈55 kt/yr$_{(dm)}$

NG network

Fuel pool Chemistry

e-fuels, Food industry

Chemicals Plastics Energy...

DEMETER

BANQUE des TERRITOIRES

Axens

cargolux
you name it, We fly it!

euralis
NOURRIR VOTRE CONFIANCE

Alliance FORÊTS BOIS

ifp Energies nouvelles

ADEME

FRANCE 2030

Axens - FUTUROL® 10 years of R&D for a fully proven technology

1 kg/day biomass → x1000 → **1 t/day** biomass → x100 → **100 t/day(1)** Biomass → x4-5 → **TRL 8**

2007 — Launch of Project FUTUROL PROCETHOL 2G



- Technical and economic feasibility of the process chain

2008 Laboratory Studies

- Definition of transformation pathways
- Development of biocatalysts
- Industrial property

2011 Pilot Studies *at Pomacle-Bozancourt - Marne*



Small-scale version of an advanced ethanol plant: from biomass preparation to final distillation:

- Selection and validation of technologies
- Operability and process optimization
- Evaluation of +20 biomass types
- Development of physico-chemical models

2016-2018 Industrial demonstr. *at Bucy-le-Long (Tereos Site)*

Start of Axens Marketing phase



- Minimizing risks of errors when scaling up the project
- Validation of operability and performance
- Optimization of operations
- Built and operated for several thousand hours

- AXENS: the **exclusive licensor of Futurol®** technology
- High-performance guarantees with promising yields and product quality

11 PARTNERS

Industrials: Tereos, Office National des Forêts, TOTAL, VIVESCIA

Financing: UNIGRAINS, Crédit Agricole Nord Est, CGB Confédération Générale des Planteurs de Betteraves

IP Owners: ard, INRA Science & Impact, LESAFFRE, IFP Energies nouvelles

12 Involved R&D centers in France

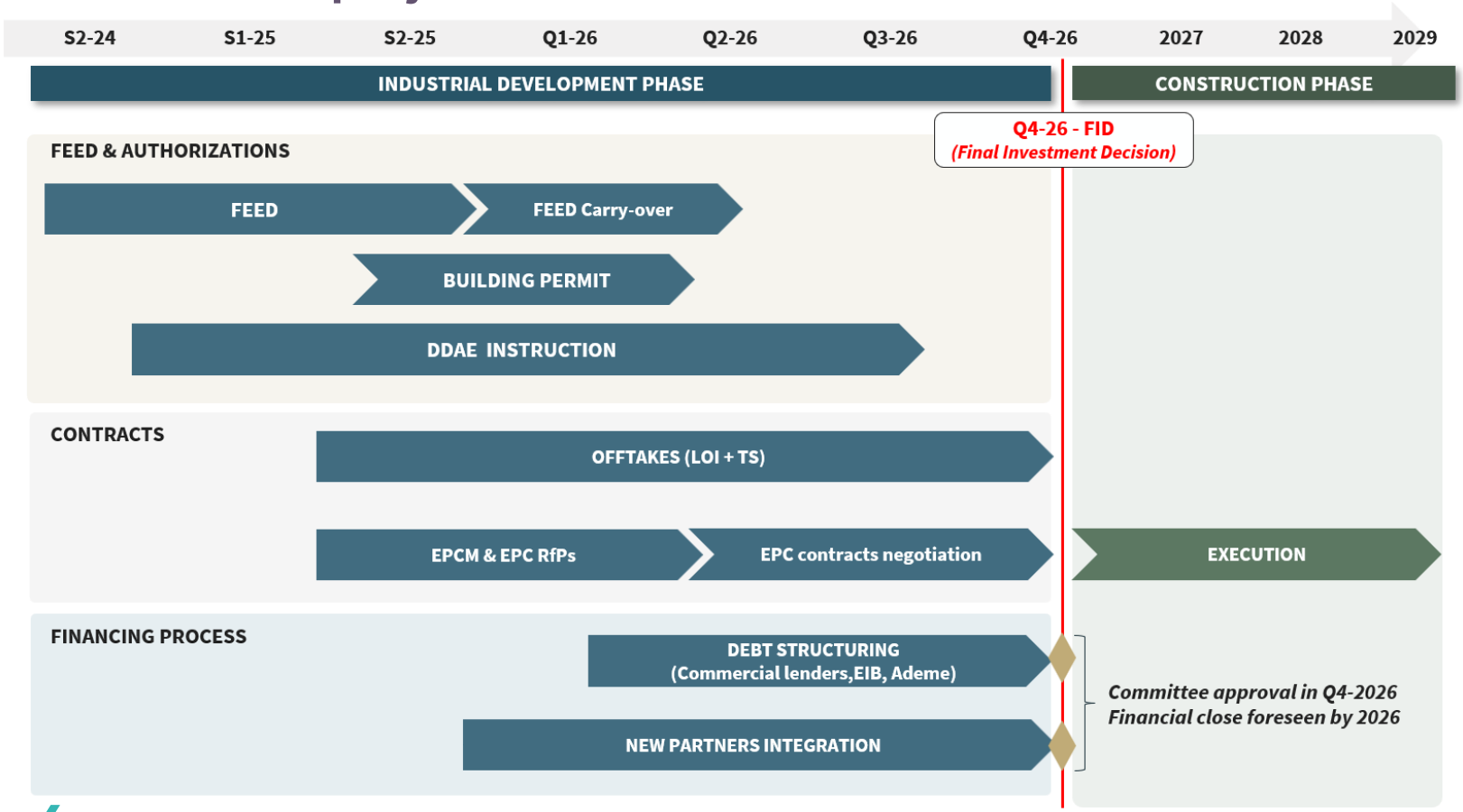
30+ Protected by patents

€90m Budget for R&D phase, including pilots

10+ years dedicated to the Futurol® technology development

(1) The 100t/day production corresponds to the pre-treatment phase, the most crucial part of the process

Axens - NACRE project schedule



Axens – SAFIRIS SPV

An advanced bioSAF plant : 50 kt/yr SAF

Advanced bioethanol

Renewable resources (not edible)

Local and traceable sourcing

1. Dehydration AtoL®

High-purity ethylene

~10 references

2. Oligomerization Dimersol™ & Polynaphtha™

Optimized C4-C18 olefins

>100 references

3. Hydrogenation + Fractionation

Kerosene-range cuts

>700 references

8 Jetanol licensees (Gevo, Idemitsu etc.)

SAF (Jet fuel)

ASTM D7566 Annex 5 (ATJ)

Low-carbon aviation fuel

>80% GHG emissions reduction

SAF capacity **50 kt/year**

Advanced ethanol **86 kt/year**

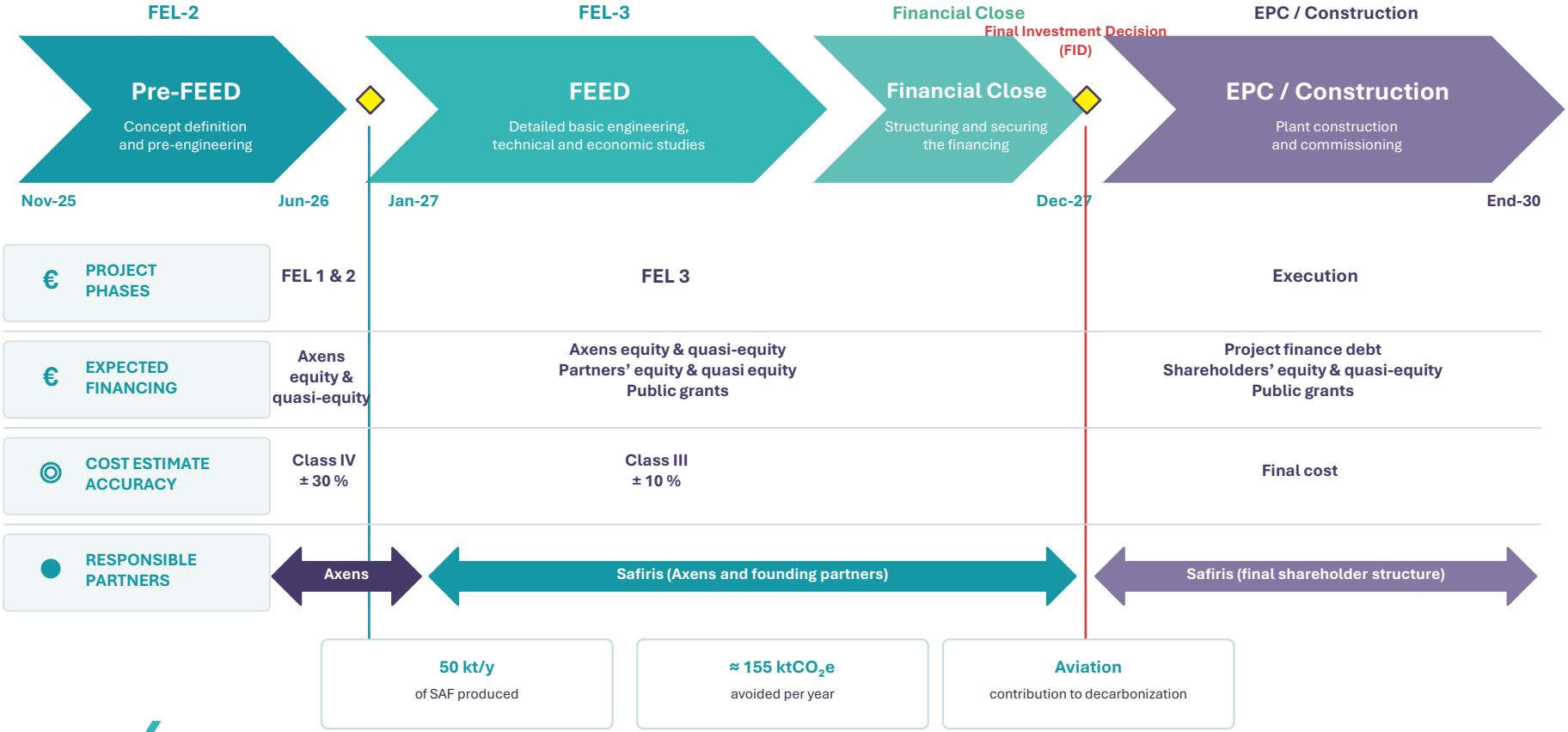
Plant location **France**

Targeted start-up **End-2030**

Significant GHG emissions reduction	**Sustainable feedstock, not competing with food**	**Industrially proven technologies (TRL 8)**	**Optimized, replicable industrial integration**

Axens – ERA project schedule

Roadmap to France's first industrial SAF plant based on advanced ethanol



Axens

Thank You!

Axens.net