Integrated Catalytic Recycling of Plastic Residues Into Added-Value Chemicals

Plastic Circularity Multiplier Virtual Conference

José M. Serra

14th October 2020

This project has received European Union's Horizon 2020 research and innovation funding under grant agreement N° 820770.

Sustainable Process Industry through Resource and Energy Efficiency

Outline

1. *iCAREPLAST mission*
2. *Project objectives*
3. *Project implementation*
4. *Where are we at M23*
5. *Expected Impact*
6. *Susplast*

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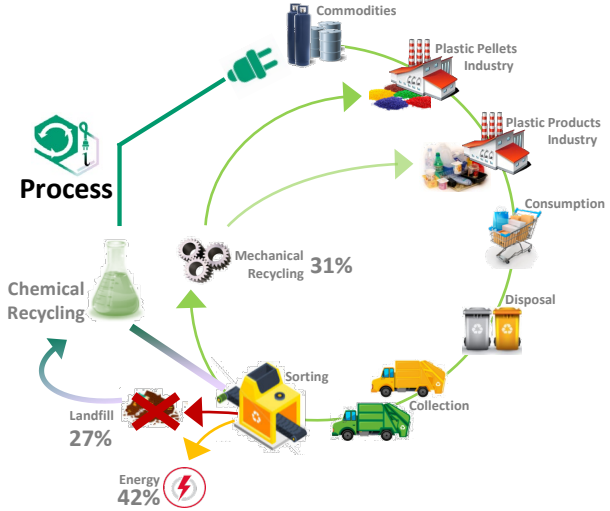
1. iCAREPLAST mission

iCAREPLAST addresses the **cost and energy-efficient recycling** of a large fraction of today's non-recyclable plastics and composites. The process combines **chemical routes** (pyrolysis, catalytic and separation steps) to produce **valuable chemicals**.



27.1 Mt/year Plastic waste recovered in EU

70 % ≅ **18.5 Mt/year NOT RECYCLED**

- ⇢ 42% Incineration
- ⇢ 37% Landfill

Advisory Board

Air Liquide

Shell

P&G Procter & Gamble

Fundación Comunidad Valenciana Región Europea

Imperial College London

ITQ

CSIC Consejo Superior de Investigaciones Científicas

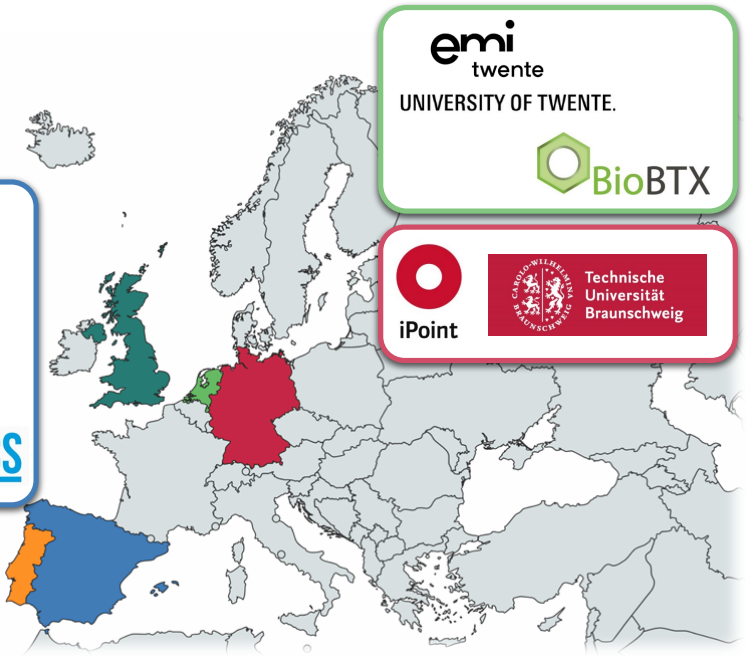
ai2 Instituto de Automática e Informática Industrial

urbaser

Universitat Politècnica de València

KERIONICS

LNEG



emi twente

University of Twente.

BioBTX

iPoint

Technische Universität Braunschweig

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SPIRE Sustainable Process Industry through Resource and Energy Efficiency

EFFICIENT & SUSTAINABLE
in terms of products, energy-cost and environmental impact

FLEXIBLE
suitable for treating heterogeneous plastic materials
Operation flexible

INTEGRATED
with current value chains

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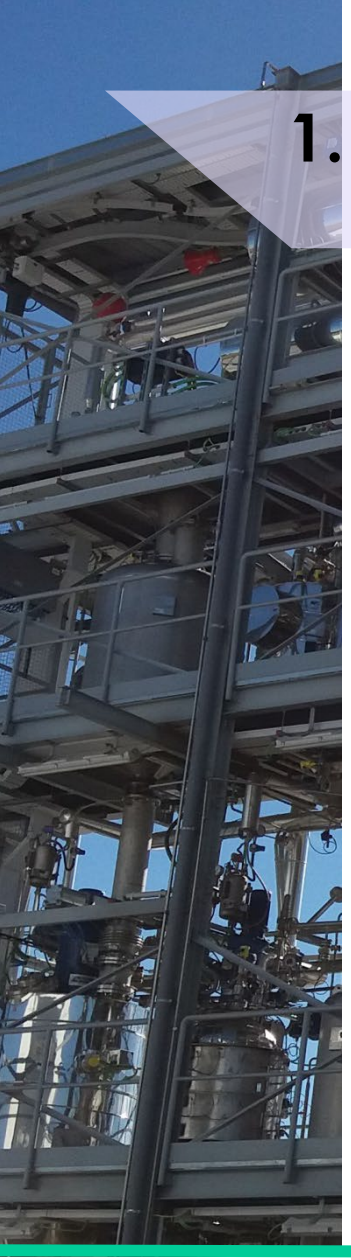
Sustainable Process Industry through Resource and Energy Efficiency



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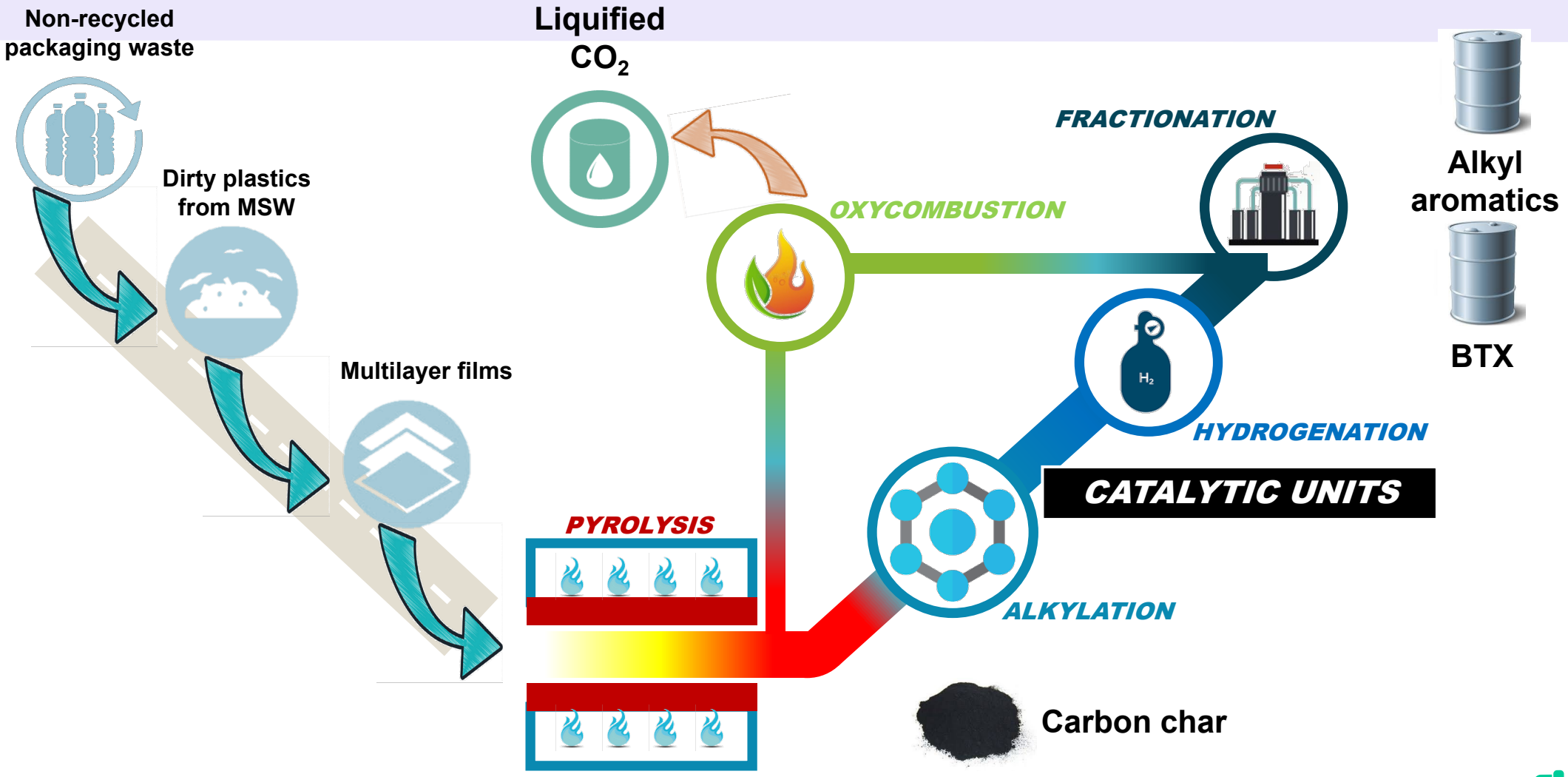

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pressurization

CO_2

H_2O

OXYCOMBUSTION

Paraffin fraction

Gas fraction

Electricity

AIR

CATALYTIC UPGRADING

LLDPE Short-Branched

Linear HDPE

PP

Long-Branched LDPE

Cracking, Aromatization

Polystyrene

Paraffin

Olefin

Aromatic

Alkylation

Alkyl aromatic

Hydrogenation

HYDROGEN

Char fraction

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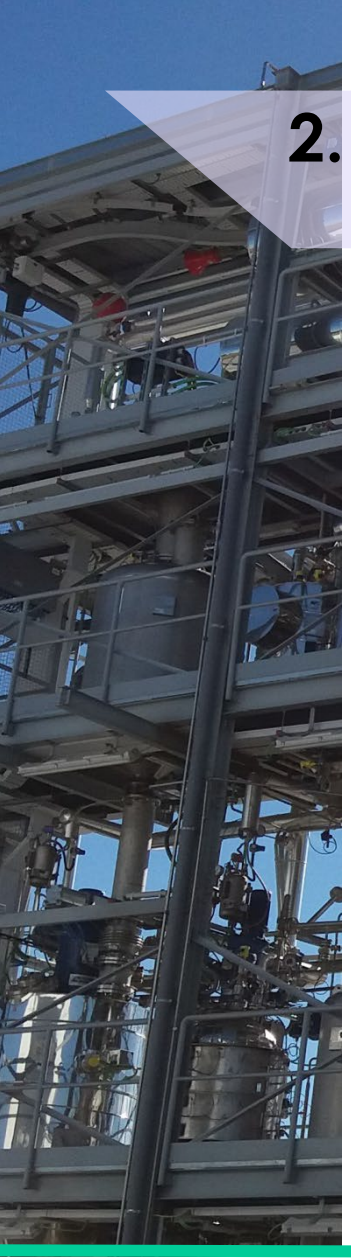
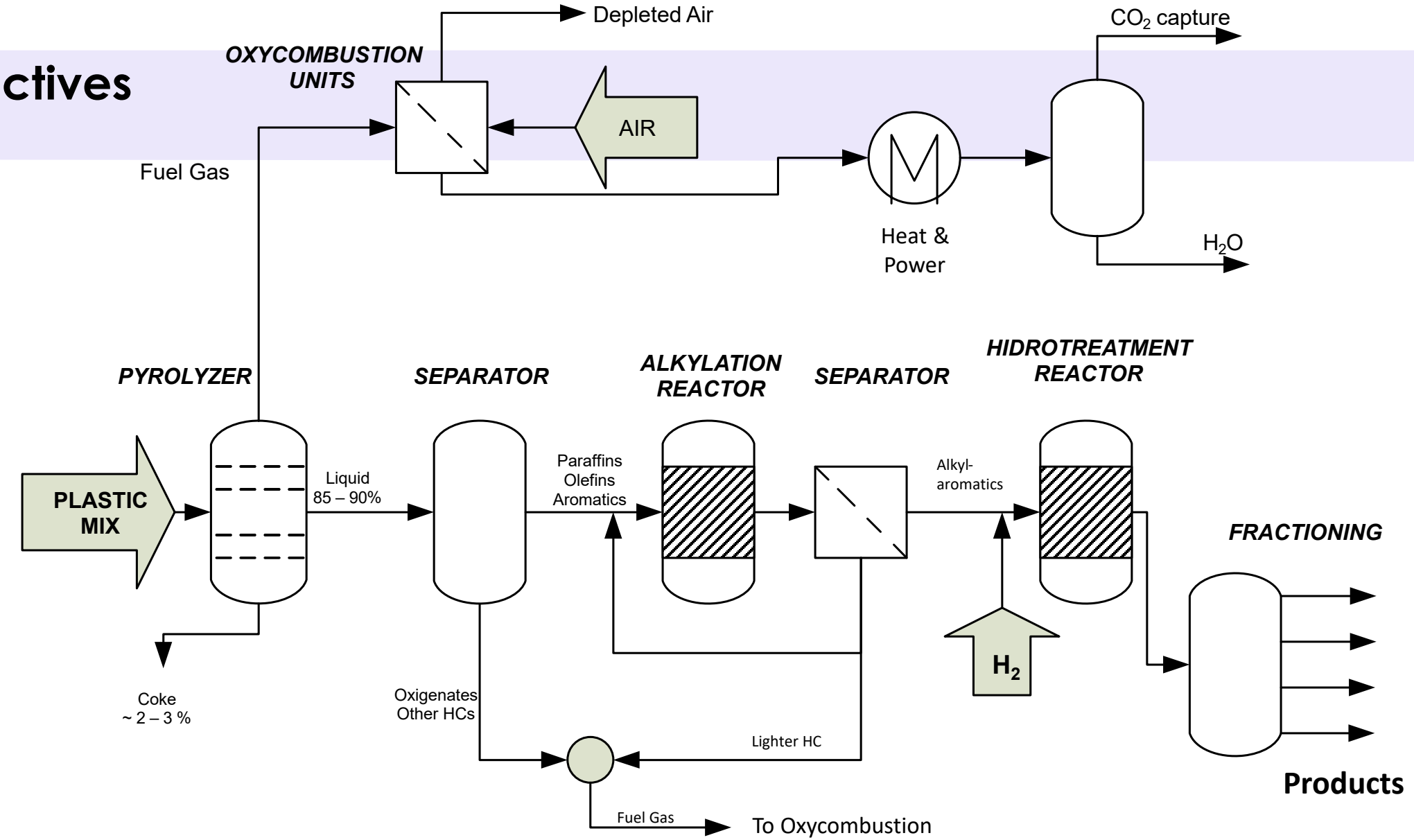


2. Objectives



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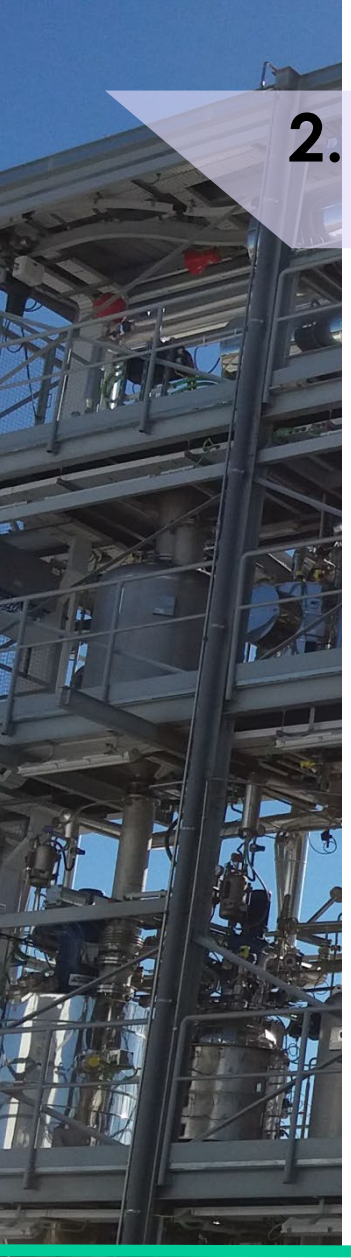

2. Objectives

1. Characterisation of plastic waste streams
2. Identification of pre-treatment operations
3. Optimisation of feeding mixtures
4. Optimisation of operational parameters of pyrolysis reactor
5. Design of separation processes to selectively remove impurities and bulky hydrocarbons from pyrolysis products
6. Optimisation of operational parameters of alkylation reactor

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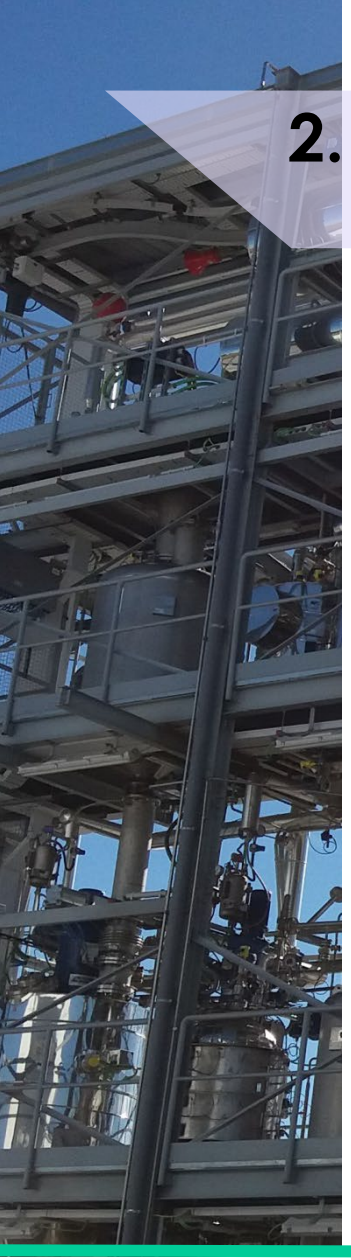

2. Objectives

7. Design of membranes to separate alkyl-aromatics from mixtures obtained after the alkylation reaction
8. Optimisation of operational parameters in hydrotreatment
9. Optimisation of operational parameters of the distillation column
10. Design of oxyfuel combustion units with CO_2 capture
11. Identification of efficiency and sustainability indicators, and real-time optimisation and control of integrated operation

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2. Objectives

12 **Pilot plant demonstration and integration of individual processes**

13 **Characterisation of products and valorisation of by-products**

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3. Project Implementation

Validation of Key Enabling Technologies → Lab/bench scale studies → Process units design and fabrication → Pilot Plant Engineering, Integration, Installation and Commissioning → **Pilot Plant Testing** → **INDUSTRIAL EXPLOITATION**

Ex-situ piloting of selected units

	Pyrolysis		Catalysis	Separation	
Plastic Mix PE+PP+PS	→	T, P, t	→	→	Target products BTX vs. Alkylaromatics Data for OPEX (CAPEX?)
		Liquid Yield MW distribution P-O-A ratio Energy needs		Alkylation HT Aromatization	Membranes

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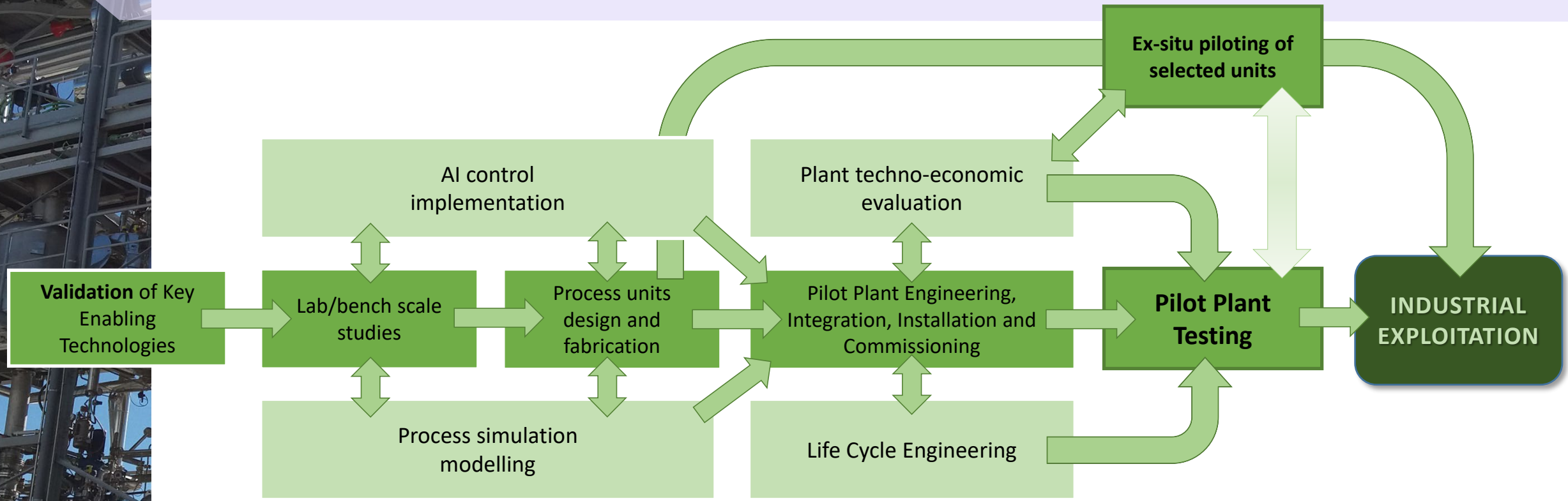
3. Project Implementation



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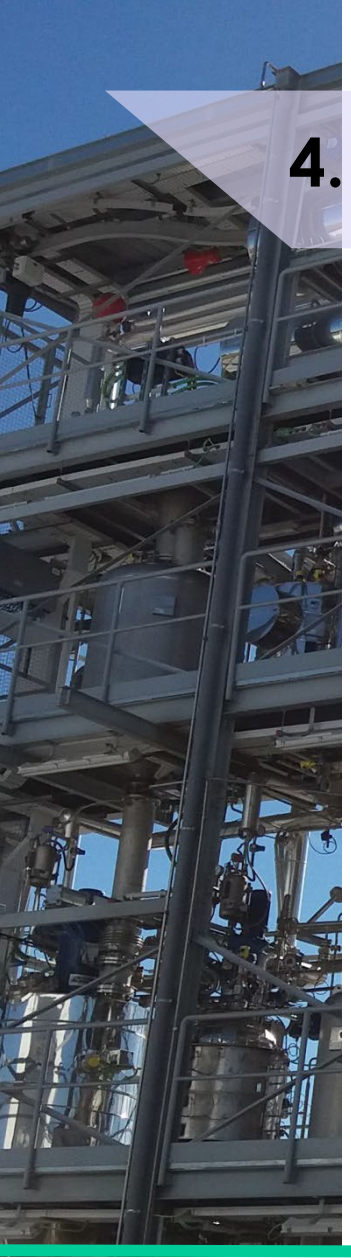

4. Where are we at M23?

Highlights

- Most Task/Activities are progressing as planned
- Pyrolysis and Catalytic approach consolidated
- Membrane separations are promising
- Quick progress in URB Pilot Plant activities
- Progress towards integrating sustainability information in the control and operation of iCAREPLAST process
- Strong interaction among WPs and partners
  - WP3-4 → WP5-6 → WP7
- Market analysis anticipated to improve decision-taking regarding the plant architecture
- Communication channels established
- Integrated in the future scenario of plastic circularity
- Bussines Plan preparation initiated

Plastics Circularity Multiplier

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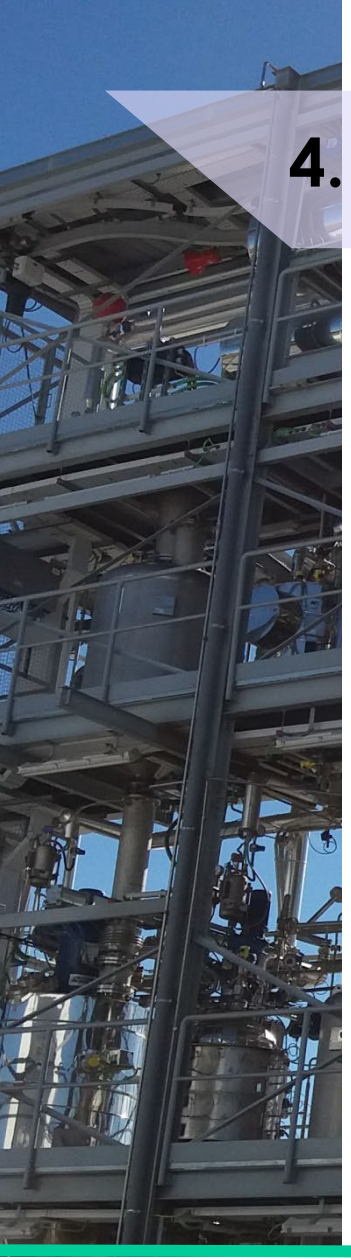

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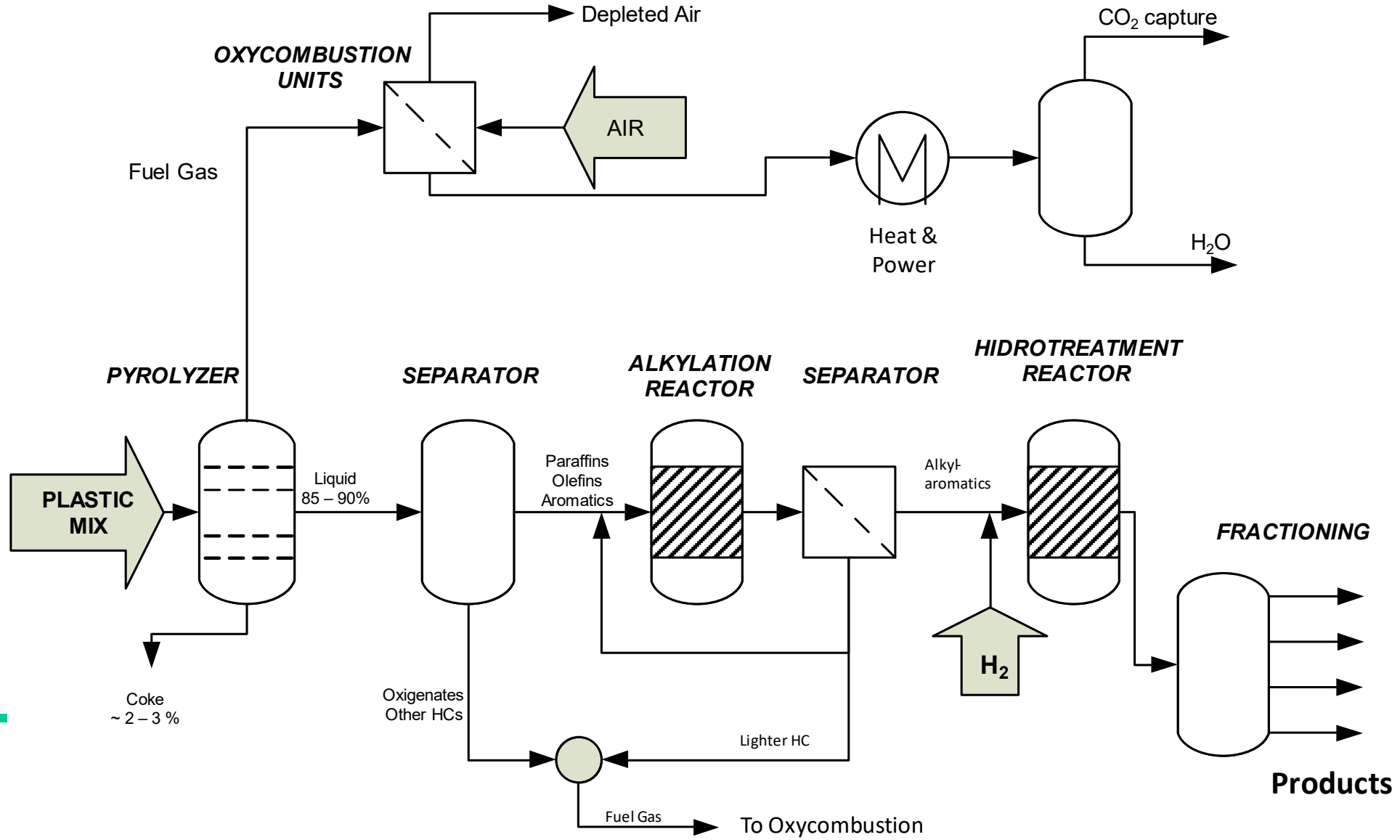
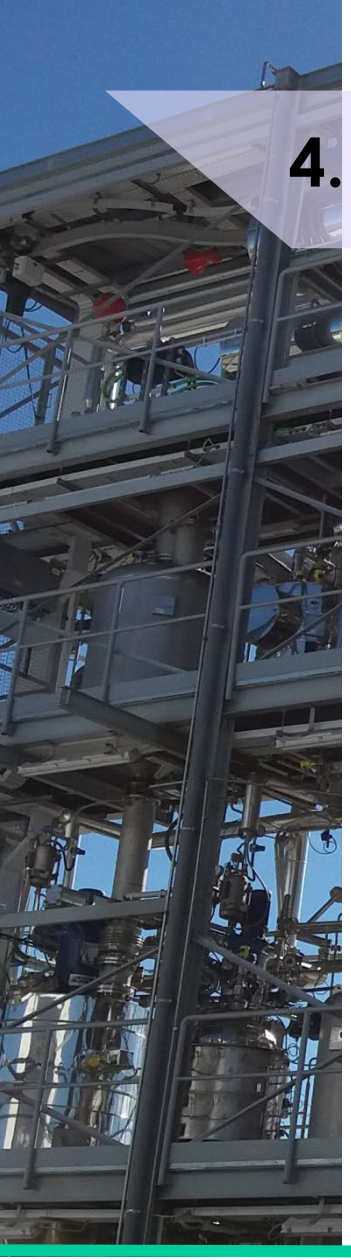
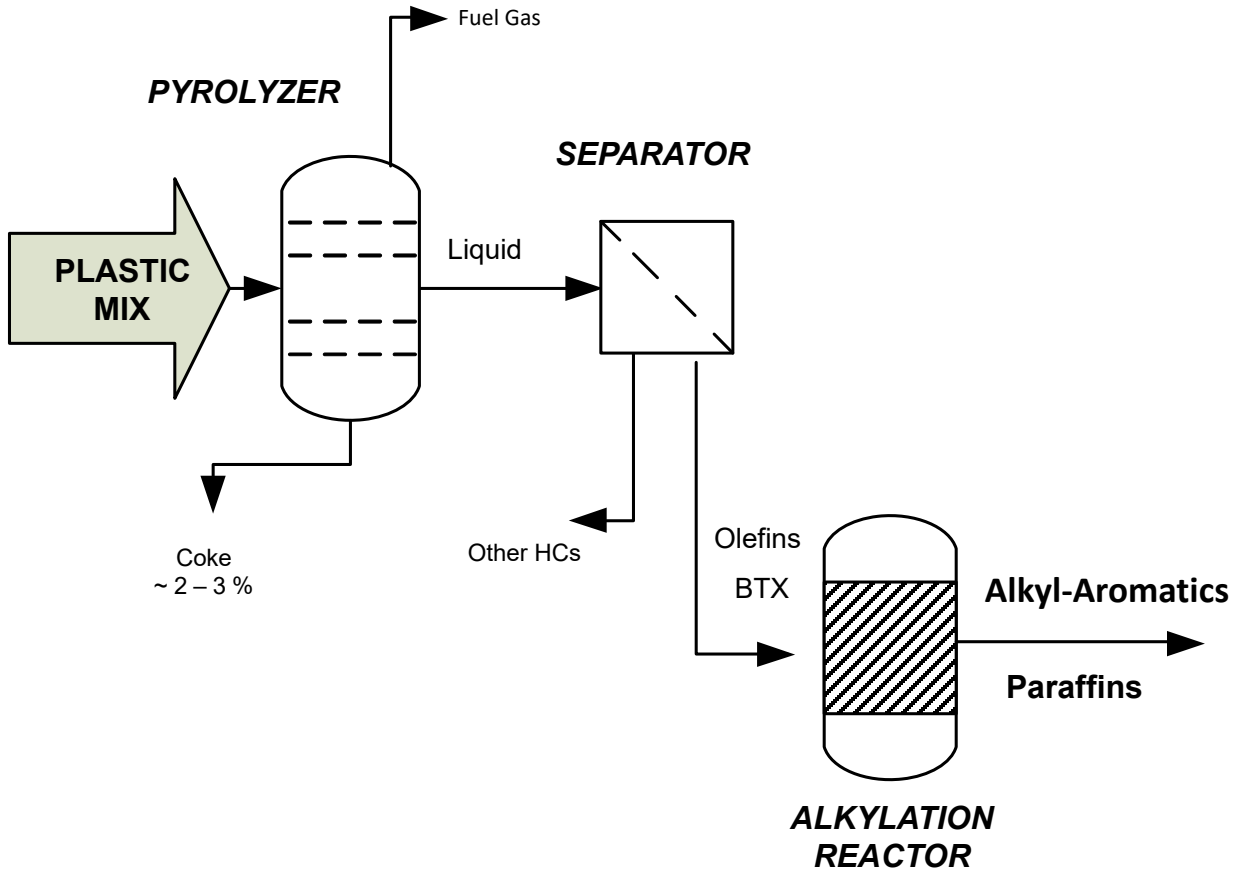


iCAREPLAST



4. Where are we at M23?

Aromatics products and Plant flexibility



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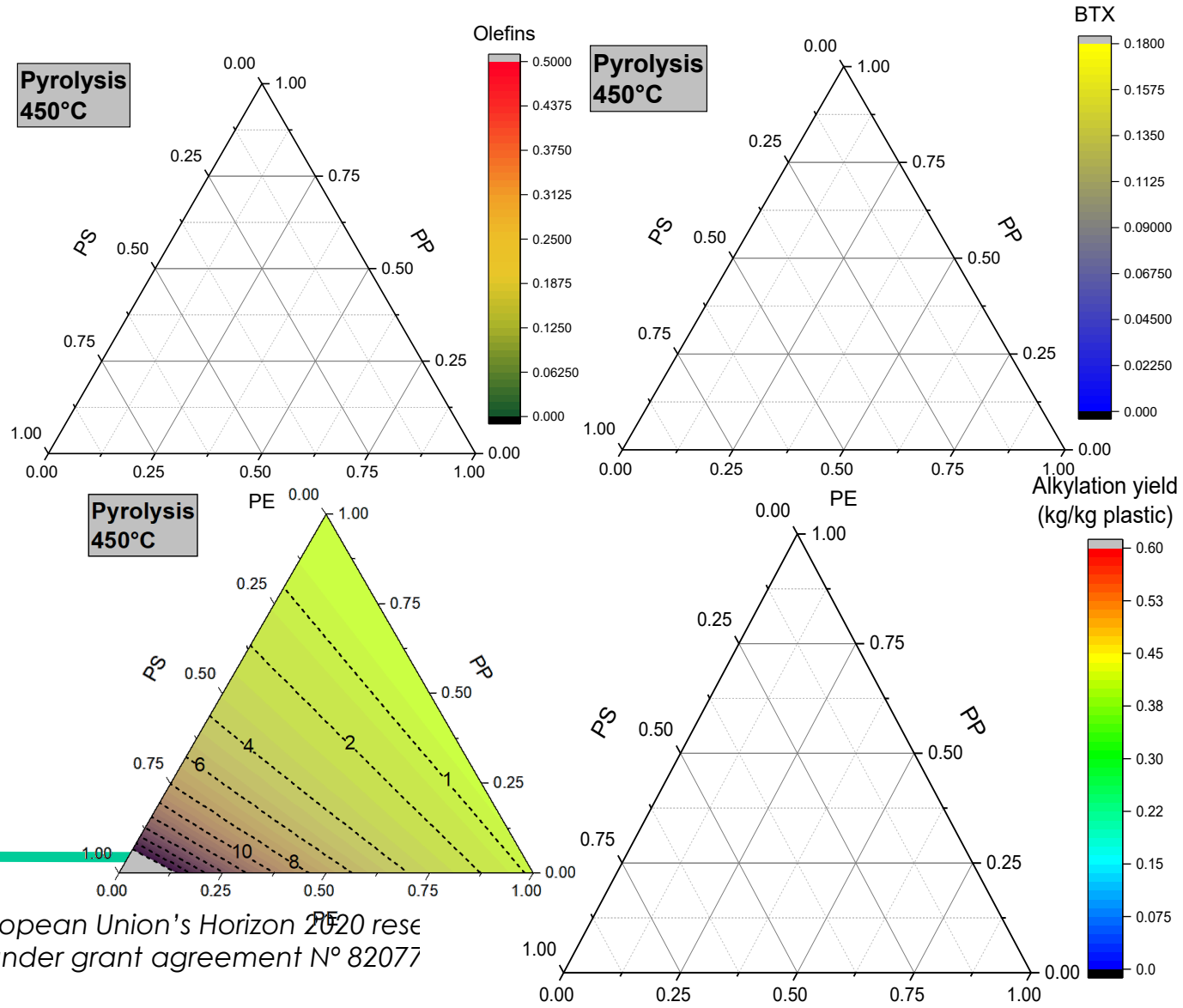
4. Where are we at M23?

Aromatics products and Plant flexibility

Key Data and Models for:
Process design. Units Design
Real-time plant control
→ Optimization of techno-economics
→ Environmental Impacts
→ Business plan



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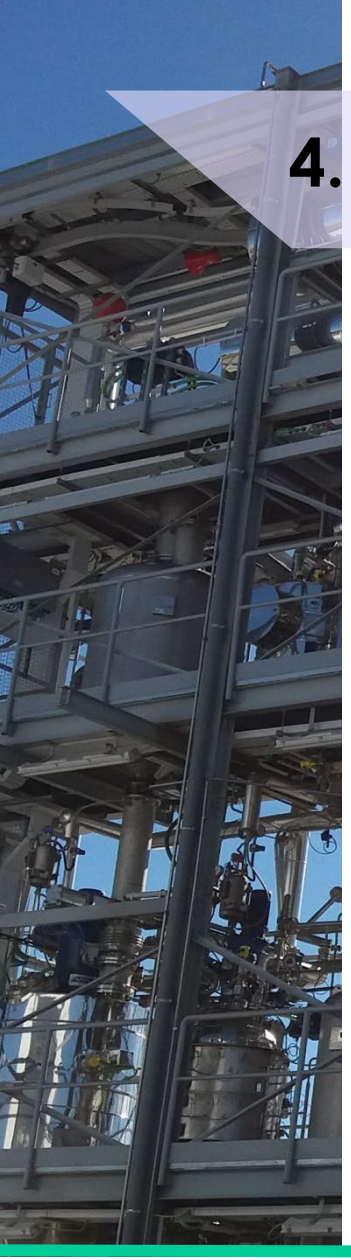
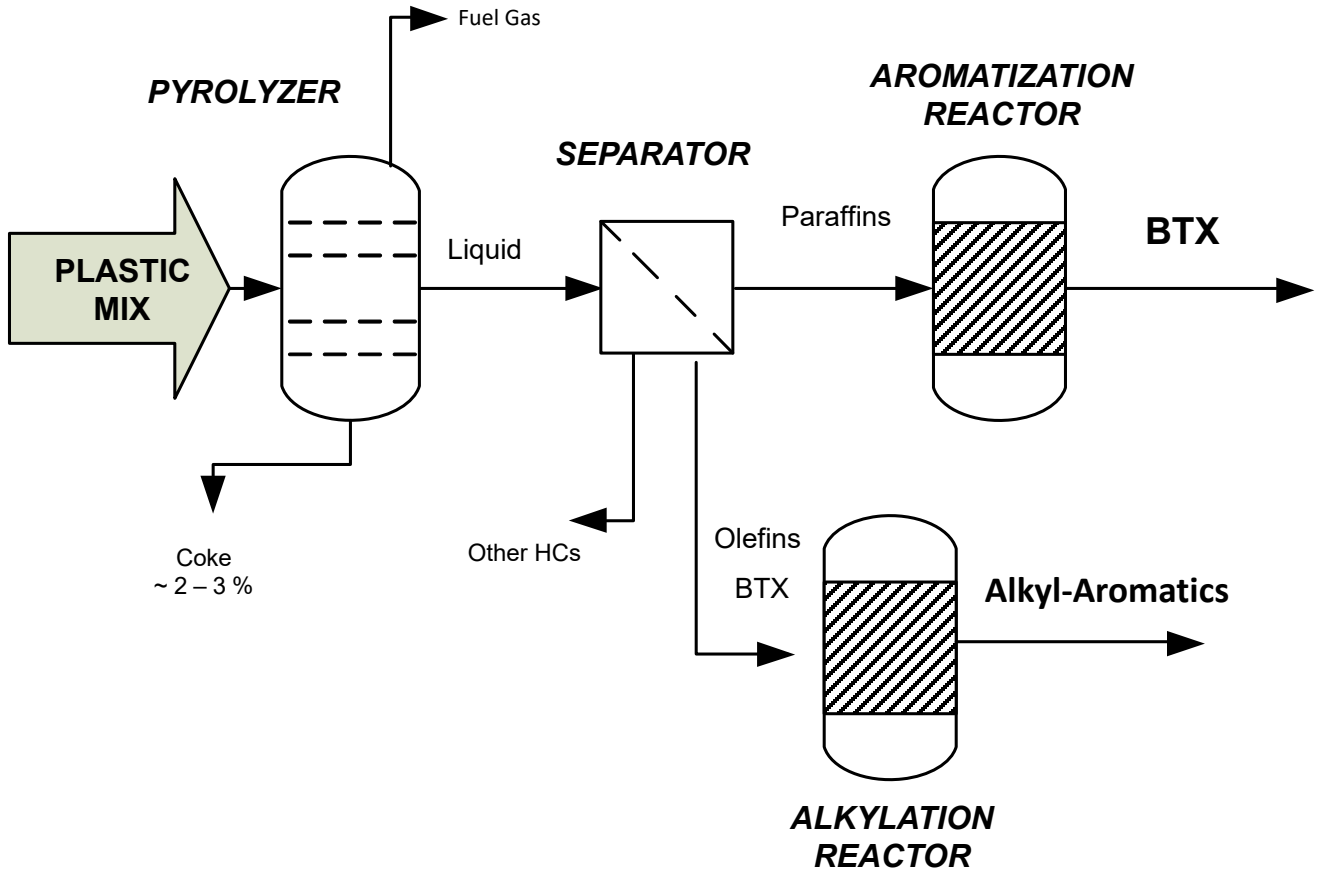


4. Where are we at M23?

Aromatics products and Plant flexibility



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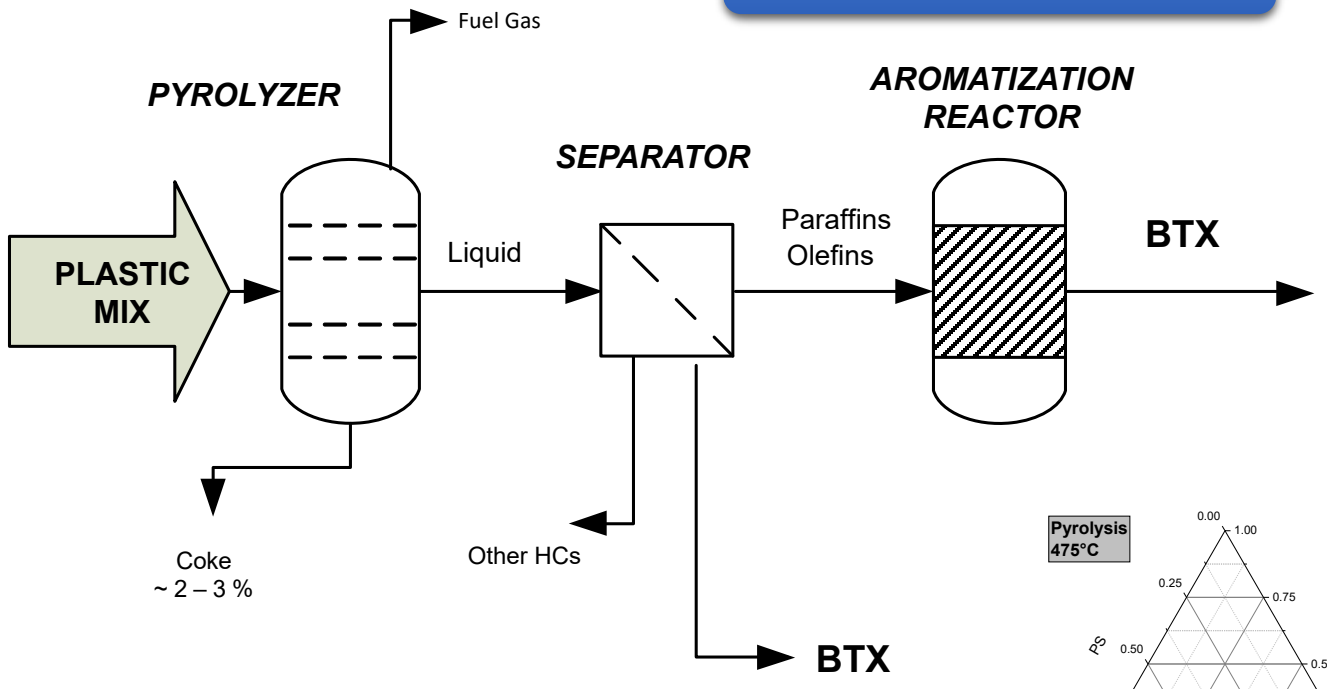
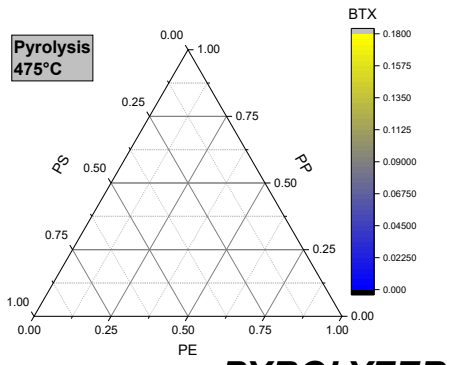
4. Where are we at M23?

Aromatics products and Plant flexibility

TARGET → Only BTX





PYROLYZER

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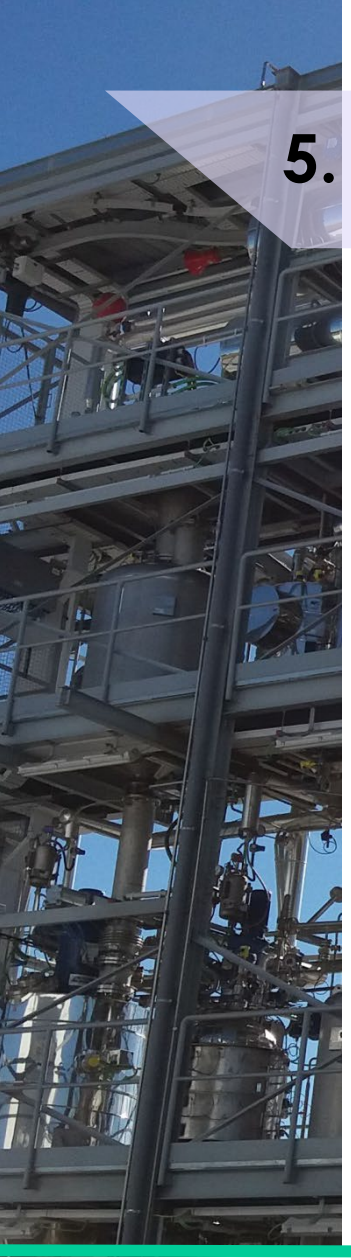

5. Expected impact

Indicator	Impact
Pyrolysis Liquid Yield	↑12%
Energy Required (MJ/kg plastic)	↓45%
Residues Production	↓95%
Economic Yield (€/kg plastic)	↑200%
Raw Material	Up-cycling of nowadays non-recycled plastics
Products	Virgin-like commodities
Plant Capacity	**Over 140,000 ton of plastic waste in 5 years**
Number of Installation	**29 plants around Europe in 5 years**
CO_2 emissions	↓40%

**Compared to benchmark recycling processes applying thermal conversions.*

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Interdisciplinary Thematic Platforms of CSIC

(*Plataformas Temáticas Interdisciplinares*, PTI)

- Joining the knowledge of CSIC expert groups with other groups from companies, universities, public research bodies, administration, and social agents
- Addressing well defined challenges, within specific deadlines, with clear milestones

Connecting with the **"Global Challenges"**

One of the novel CSIC PTIs is SusPlast:

"Interdisciplinary Platform for Sustainable Plastics towards a Circular Economy"

SusPlast

Interdisciplinary Platform for Sustainable Plastics towards a Circular Economy

Our "plastic" mission:

SusPlast
Interdisciplinary Platform for Sustainable Plastics towards a Circular Economy

SusPlast aims to develop research and innovation activities, including socio-educational strategies, aimed at plastic production processes and their recycling, ***through mechanical, chemical and biotechnological strategies*** *to meet the necessary requirements to implement plastics management based on a circular economy.*

14 SusPlast CSIC partner institutes in Spain

Private partners supporting SusPlast

RÖCHLING STIFTUNG
Konsequent in Verantwortung

aitiip centro tecnológico

REPSOL

Ercros

RECOAMBIENTE

ainia

EvoEnzyme
Customized Biocatalysts

Hispanagar
Oceans of Experience

ecenic resins

AIMPLAS
INSTITUTO TECNOLÓGICO DEL PLÁSTICO

DARWIN
Bioprospecting Excellence

<INNOVAMED>

PYRATES
smart fabrics

ecoembes

Ingénica
Soluciones Técnicas Sostenibles

Viscofan
The casing company

Biopolis
Tailor-made Biotechnology

ECONWARD

CENTRO TECNOLÓGICO
ITENE

solteco
madera plástica

PlasticsEurope
Productores de Materias Plásticas

Agromark
Fresh produce from Spain

tecnalia
Corporación Tecnológica

ZOITECH
lab

Current projects on polymers, plastic & bioplastic issues and their focus areas that are part of SusPlast platform:

SusPlast

Interdisciplinary Platform for Sustainable Plastics towards a Circular Economy

H2020 – NMBP

- mix-up 降塑再造 — mixed plastics biodegradation and upcycling using microbial communities
- SinFonia
- engicoin
- DAFIA

H2020 – BBI

- BIZENTE
- SUSBIND
- URBIOFIN — urban biorefinery
- WOODZYMES — WOOD TRANSFORMING ENZYMES
- AFTERLIFE
- REFUCOAT

H2020 – CE/CIRC

- BLACK CYCLE — Move to the green revolution
- CarE-Service

H2020 - SPIRE

- iCAREPLAST

H2020-INFRAIA

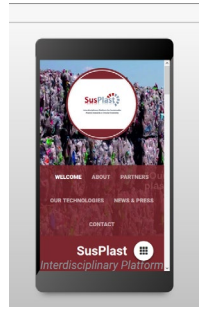
- IBISBA

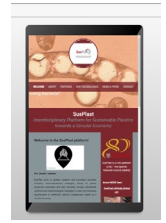
H2020 – ERA

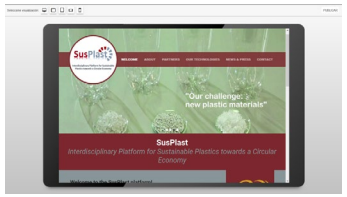
- MOPLACE
- MiLiMo — ERA LEARN
- BIOCARB -4-FOOD

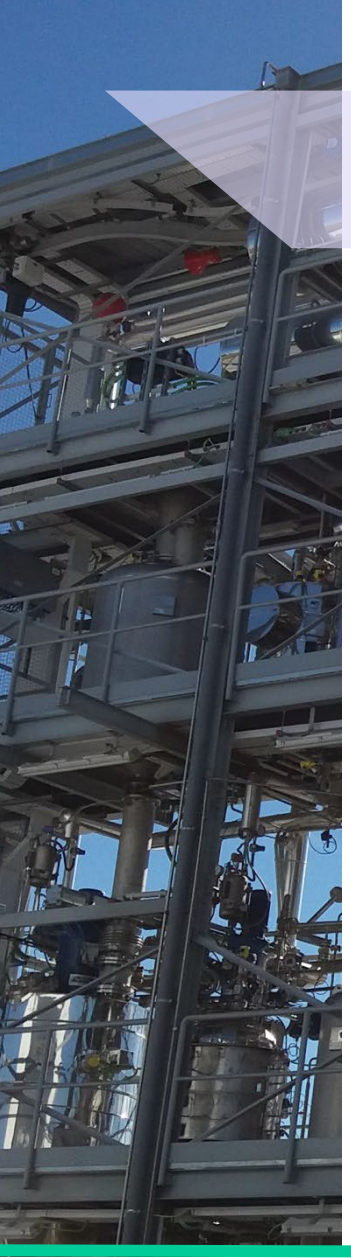
Find us at:

www.susplast-csic.org









Thank you for your attention

Watch the video made with collaboration from all partners!

https://youtu.be/1sSNRRSldTY

www.icareplast.eu/

https://twitter.com/iCAREPLAST/

https://linkedin.com/company/iCAREPLAST/

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