



# WASTE TO CHEMICALS A NEW CONCEPT OF BIOREFINERY

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*14th Concawe Symposium*





# AGENDA

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1. The pathway to fuel decarbonization
2. Waste as a resource
3. The waste to chemical pathway
4. Products valorization
5. Conclusion

# MAIRE TECNIMONT GROUP

## OPERATING COMPANIES



HYDROCARBONS

GREEN ENERGY

## PRESENCE IN THE WORLD

~9,300

EMPLOYEES &  
PROFESSIONALS

50

OPERATING  
COMPANIES

45

COUNTRIES

## FY 2019 & 2020 RESULTS



REVENUES

2019 €3.4 BLN

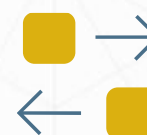
2020 €2.6 BLN



EBITDA

€236 MLN

€172 MLN



BACKLOG

€6.4 BLN

€6.0 BLN





## WHY A NEW CONCEPT OF BIOREFINERY?

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In 2009 **Renewable Energy Directive** was released

Main target was to include a share of renewable source for energy production equal to **20%**  
With energy production it was embedded the **TRANSPORT** sector, which specific target was **10%**

In the same year **Fuel Quality Directive** was released

Main target was to reduce the GHG emissions of **6%** in respect to the reference average emission value of fuel in 2010, 94.1 kg CO<sub>2</sub>/MJ



The automotive industry requires a new kind of product

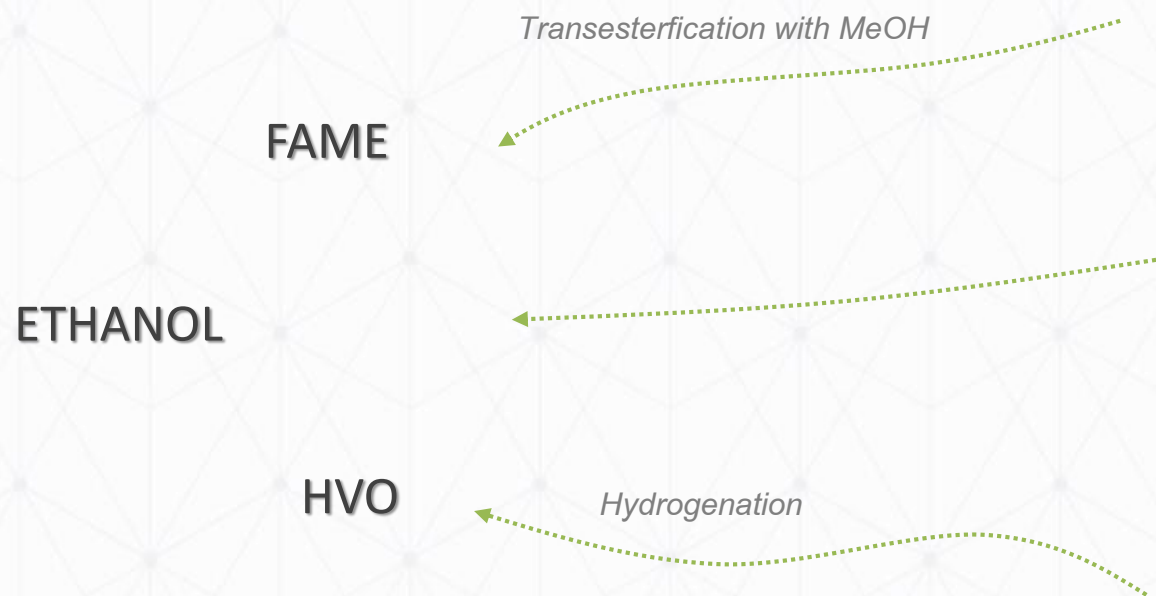
**LOW CARBON FOOTPRINT FUEL**



# FIRST BIOFUEL GENERATION

Biorefinery is born to reach the new legislative targets

The new feedstocks of biorefinery were vegetable oils



*Rapeseed oil*



*Palm oil*



*Sunflower oil*



*Soya oil*



## TO MORE RESTRICTIVE FRAMEWORK

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In order to reduce impact with the food area and increase the use of biocomponents, in 2018, a new release of **Renewable Energy Directive (II)** was launched. It has set a limit of **7%** to the share of fuel produced from vegetables which comes from crops countable as biofuel, and it has been introduced the concept of advanced

A fraction of biofuel must be **ADVANCED**, i.e. generated from some category defined in Annex IX of RED in which are included organic fraction of waste and residues

The incoming release of **Renewable Energy Directive (III)** requests **24%** of biofuel



## THE BIRTH OF A NEW CONCEPT OF BIOREFINERY

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**NEW GENERATION LOW CARBON FOOTPRINT FUEL**

based on

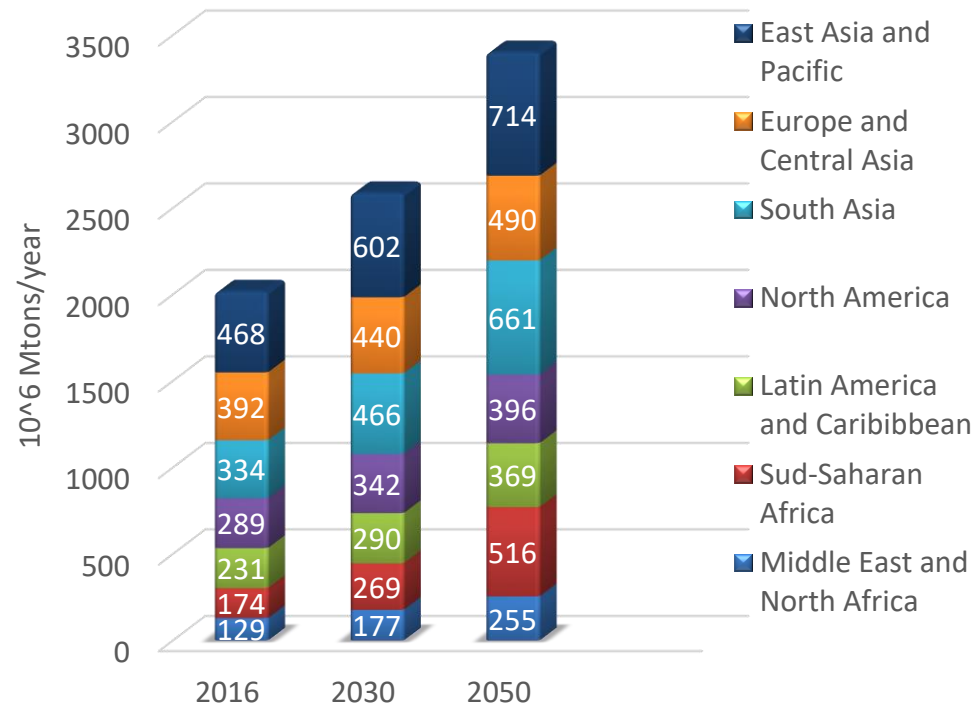
**MUNICIPAL SOLID WASTE and NON RECYCLABLE PLASTIC**

can be considered as another option to reduce CO<sub>2</sub> emissions in the automotive industry



# WORLD MUNICIPAL SOLID WASTE PRODUCTION 2016-2050

WORLD PRODUCTION OF WASTE IS CLOSED TO 2 BILLION MTONS PER YEAR.  
DUE TO GROWTH OF POPULATION AND GDP, IT IS EXPECTED TO REACH 3,4 BILLION MTON PER YEAR IN 2050 (WORLDBANK).



0.74 kg per day per capita  
(but ranges widely,  
from 0.11 to 4.54)



C	32-55% w
H	5-8% w
O	20-28% w
Cl	0.5-3% w
N	0.5-1.5% w
S	0.1-1% w
Moisture	10-20% w
Ashes	5-20% w



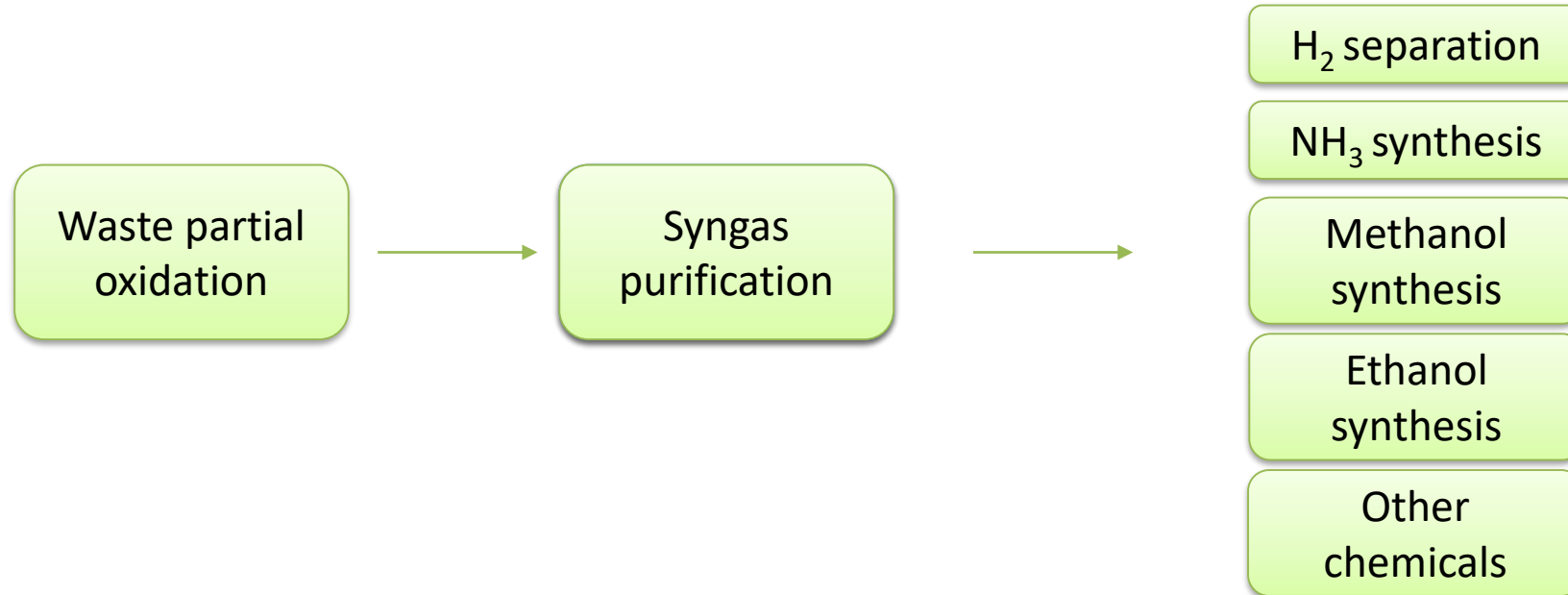
C	47-61%
H	5-7%
O	14-20%
Cl	0.8-1.5%
N	0.2-0.5%
S	0.02-0.3%
Moisture	5-9%
Ashes	7-20%





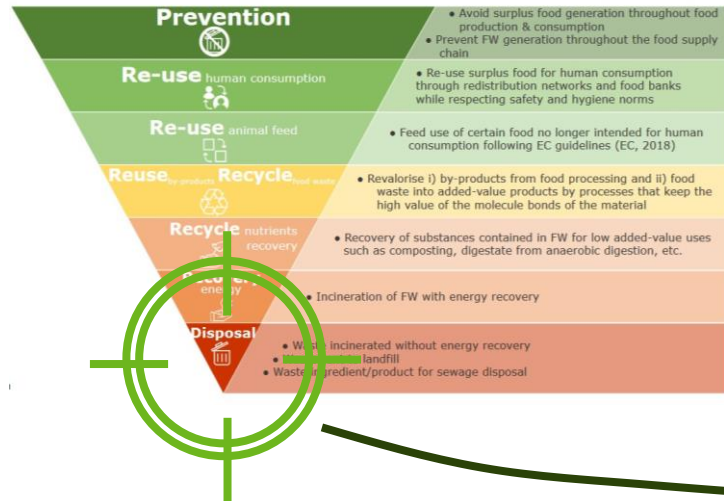
## WASTE TO CHEMICAL PROCESS

The waste to chemical process is **innovative** in the concept of lining up technologies belonging to different industrial sectors



Each process block is  
**industrially-proven**

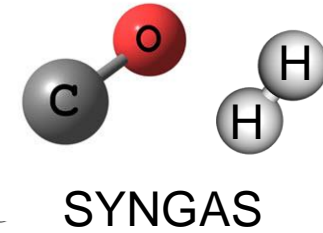
# CHEMICAL CONVERSION OF WASTE, HIGHLIGHTS



RDF, PLASMIX

Stabilization  
Zone

1000-1200°C



600-800°C

Reaction Zone

1600-2000°C

Melting Zone

Slag

Vetrified inert fraction (granulate)

**INERTS**

≈ 10% in mass  
≈ 1% in volume

Granulate is composed by oxides  
The most prevalent are  
 $\text{SiO}_2$ ,  $\text{CaO}$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{Fe}_2\text{O}_3$

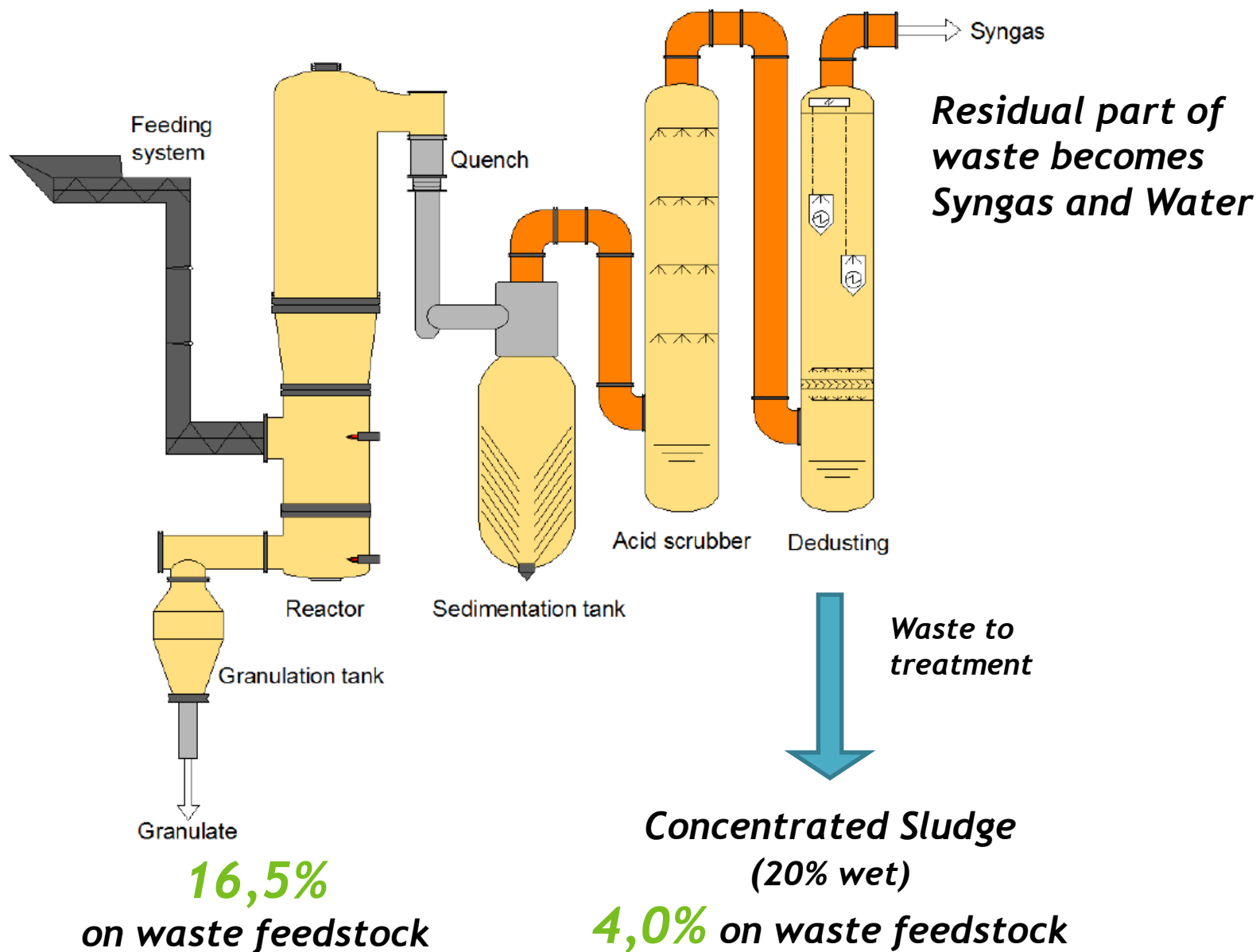
Ceramic Industry

Concrete industry

# WASTE TO CHEMICAL TECHNOLOGY - OVERALL BALANCE

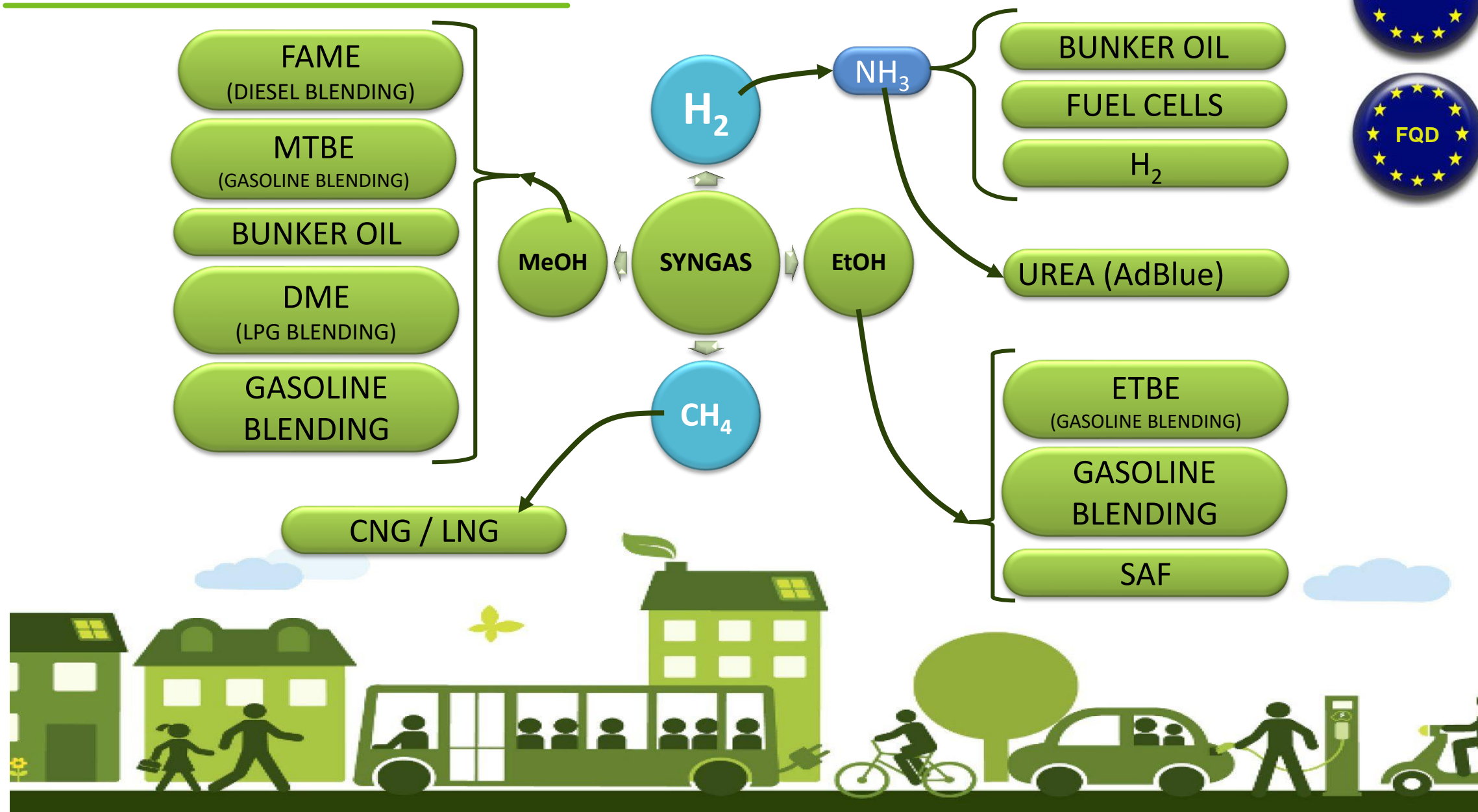
## Waste composition

C	38,88 %
H	5,38 %
O	21,54 %
N	0,85 %
S	0,20 %
Cl	0,93%
Umidità	15,70 %
Ceneri	16,52 %





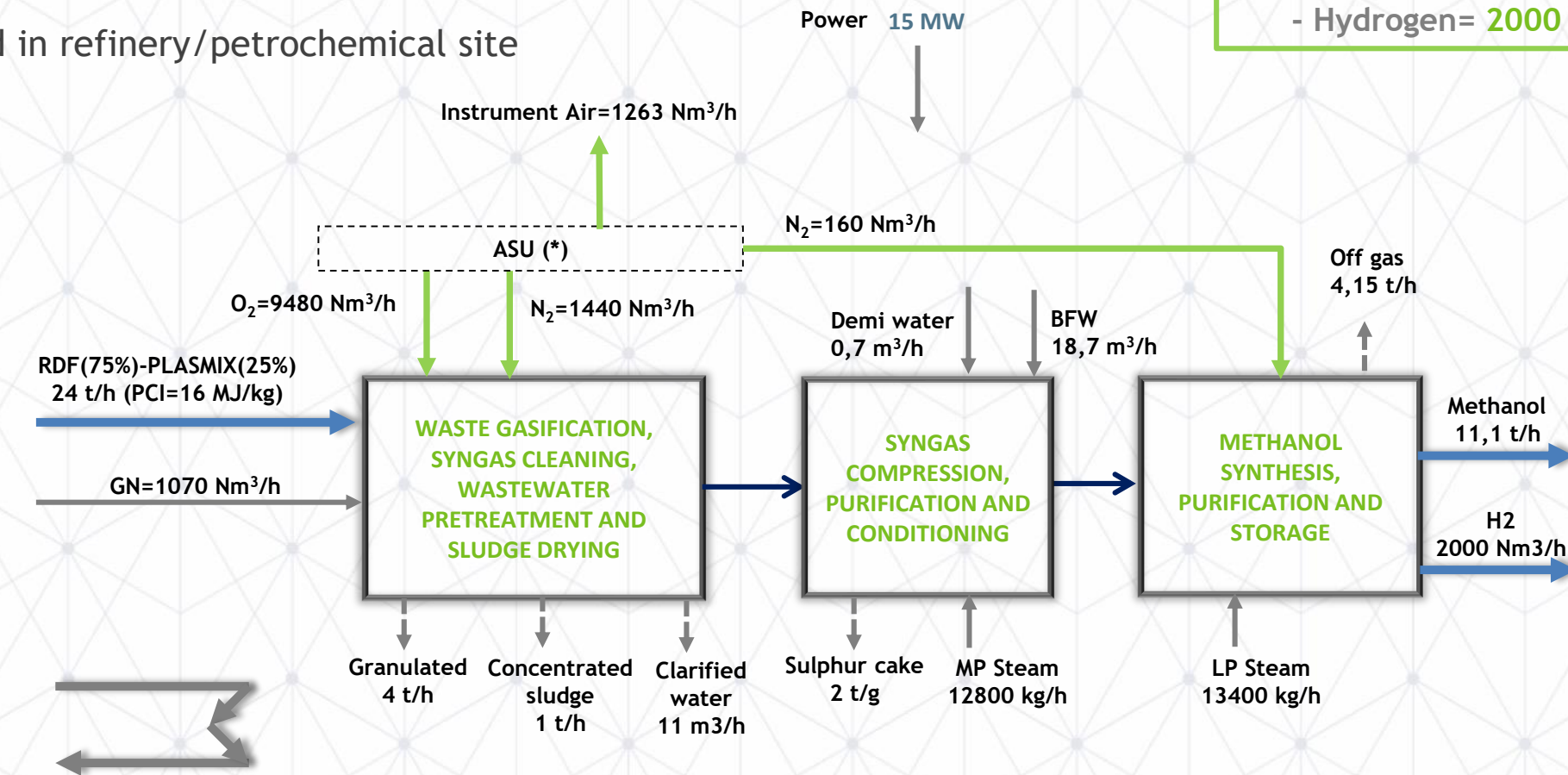
# WASTE GASIFICATION FOR SUSTAINABLE MOBILITY



# BUSINESS CASE - WASTE TO METHANOL + H<sub>2</sub>

Located in refinery/petrochemical site

- WASTE: 192,000 t/y
- Methanol= 89,000 t/y
- Hydrogen= 2000 Nm<sup>3</sup>/h



(\*) Over the fence configuration

Cooling water = 5530 m<sup>3</sup>/h

On stream factor 8000 h/y

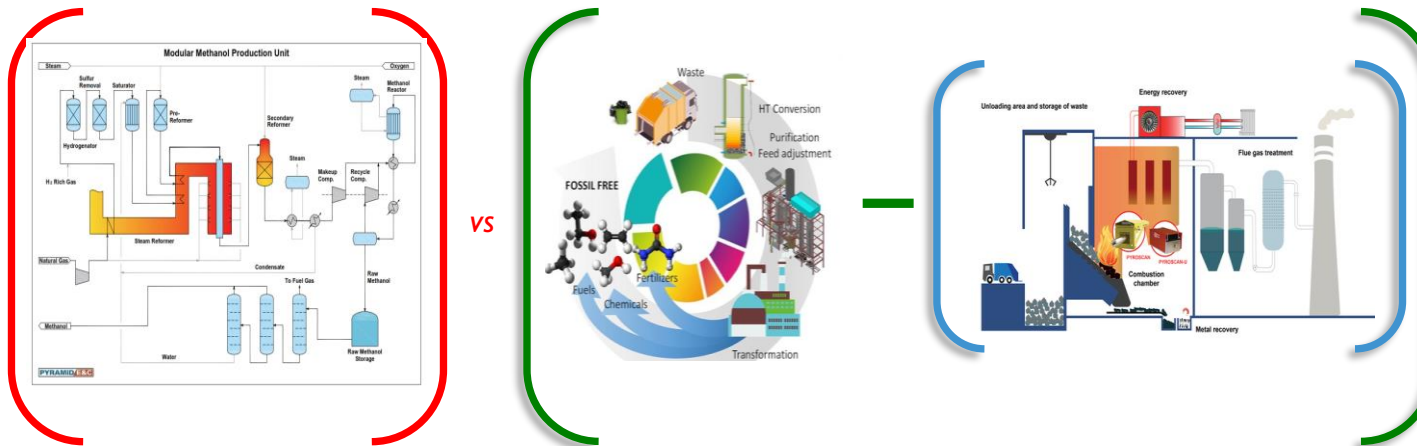
CAPEX 220 MI €

IRR 13%

# WASTE TO CHEMICALS - ENVIRONMENTAL BENEFIT

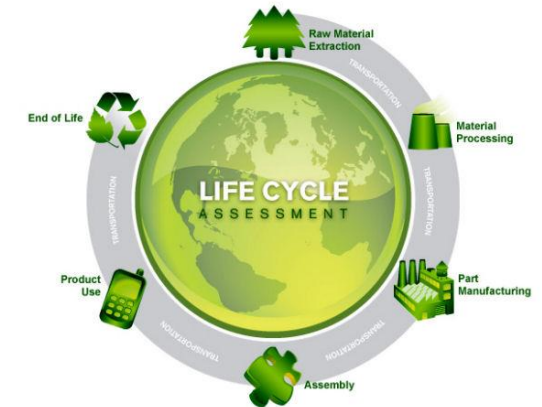
The proposed waste to chemicals technology would ensure significant reduction of carbon dioxide emissions from a **Life Cycle Analysis** perspective, with positive consequences in terms of environmental impact, in accordance with circular economy principles

$$\text{SAVING CO}_2 = \frac{[\text{CO}_2 \text{ conventional process}] - [\text{CO}_2 \text{ Waste to Chemicals} - \text{CO}_2 \text{ incineration}]}{[\text{CO}_2 \text{ conventional process}]}$$



CO<sub>2</sub> saving

>80%







## REFINERIES/PETROCHEMICAL AS BEST LOCATION

Refineries are the best location for the new biorefinery:

- Brown field available
- Existing facilities which can be integrated with the process
- Huge knowledge available collected during years of operations
- Being on the site of the off-taker of the product
- Contribution to CO<sub>2</sub> footprint reduction of the site

## FUELS FROM WASTE BY NEXTCHEM GASIFICATION

- ❑ According to European RED II **fuels produced from liquid or solid waste of non-renewable origin** are recognized as **RECYCLED CARBON FUELS**
- ❑ Further waste contains near to 50% of organic matter. This fraction is recognized by Annex of RED II as feedstock from which **ADVANCED** biofuels can be produced
- ❑ At the time being a defined market for **RECYCLED CARBON FUELS** or **ADVANCED methanol** does not exist. Nevertheless the market values can be retrieved proportionally – on energy content basis - from the value of products which methanol would substitute
- ❑ How to detect the organic fraction from which methanol has been produced?  
By C-14 analysis on methanol

### **RECYCLED CARBON METHANOL** WOULD REPLACE **FAME**

LHV: 20 MJ/kg

Equivalent price: **450-470** €/ton

Fossil price: 400 €/ton

LHV: 38 MJ/kg

Price: 850-900 €/ton



For feedstock composed of  
50% of biogenic carbon

**725-785** €/ton

### **ADVANCED METHANOL** WOULD REPLACE **ADVANCED ETHANOL**

LHV: 20 MJ/kg

Equivalent price: **1000-1100** €/ton

Fossil price: 400 €/ton

LHV: 28 MJ/kg

Price: 1500-1600 €/ton





## COMMERCIAL AGREEMENTS IN PLACE WITH

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Gazification section



Methanol & Hydrogen



Ethanol





# CONCLUSIONS



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