Conversion of Plastic Waste via Slurry Hydrogenation Technology

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Agenda

Plastic Waste Scenario

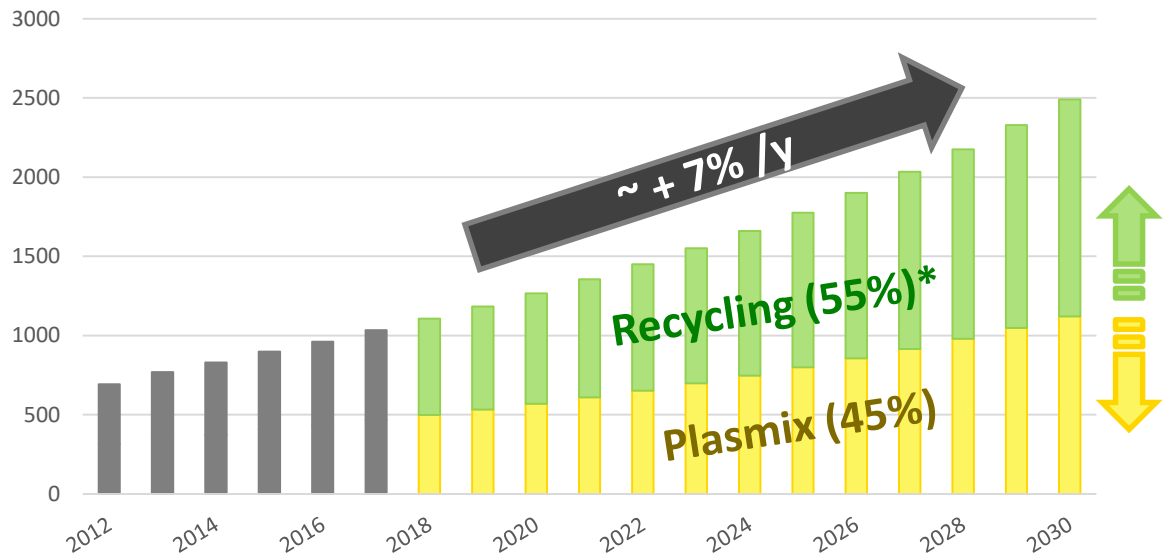
Chemical recycling of Plastic Waste

Eni Slurry Technology to Convert Plastic Waste

Moving on…..

The numbers of Plastic Waste Challenge

Recovery of Plastic WASTE in Italy kt/y



* Mechanical Recycling: these processes often downgrades the quality of the recycled plastic which became unusable after few cycles and are generally not suitable for valuable application such as food packaging

Mixed PLASTC WASTE Availability in ITALY (Corepla National Consortium for the Collection and Recycling of Plastic packages)			
Year	2018	2025	2030
Kt/y	~450	~700	~1000

Plastic WASTE– circular economy

The Concept of Circular Economy is already applied on Plastics Materials, and Mixed Plastic Waste (Plasmix) is the Residual Waste from a virtuous Recycling System.

The numbers of Plastic Waste Challenge

Mixed Plastic Waste plastic composition:

- Polyethylene
- Polypropylene
- Polystyrene
- Polyethylene terephthalate
- Polyvinyl chloride
- Other packaging plastics

Characterization of PLASMIX (Source: COREPLA)	
C	60.8 %wt
H	5.6 %wt
N	0.3 %wt
O	19.9 %wt
Cl	0.8 %wt
Ashes	7.6 %wt
Moisture	5.0 %wt
Lower Heating Value	**24.4 MJ/kg**

MECHANICAL RECYCLING

ENERGY RECOVERY

Thermal valorization

CHEMICAL RECYCLING

Recycled Building Blocks

*Source: COREPLA

Circular Economy Approach: The Chemical Recycling

CHEMICAL RECYCLING		
Gasification	Pyrolysis	Refinery Processes
$CO + H_2$	Pyrolysis Oil	Naphtha

Chemical – Petrochemical Industry
Methanol
Ammonia
Dimethyl Ether

Refinery
Diesel by Fischer-Tropsch process

Refinery:
Upgrading of Pyrolysis Oil

Petrochemical Industry :
Steam cracking naphtha, Plastic production

Refinery processes evaluation

CHEMICAL RECYCLING

Refinery Processes

Recycled Building Blocks
Naphtha

Petrochemical Industry:
Steam cracking naphtha, Plastic production

Refinery Processes Technical Evaluation

Thermal conversion processes:

- **Visbreaking** and Thermal Cracking
  - Good Conversion of Plastic Waste
  - Poor Products Quality
  - Risk of coalescence of plastic particles

Catalytic conversion processes:

- Fixed bed, Fluidized Bed, Ebullated Bed
  - Catalyst deactivation

Hydro Conversion processes:

- Good Feedstock Conversion
- Good Distillate Qualities (low Sulphur, nitrogen and olefins)

EST: The Eni solution for the BOTTOM of the BARRELL Conversion

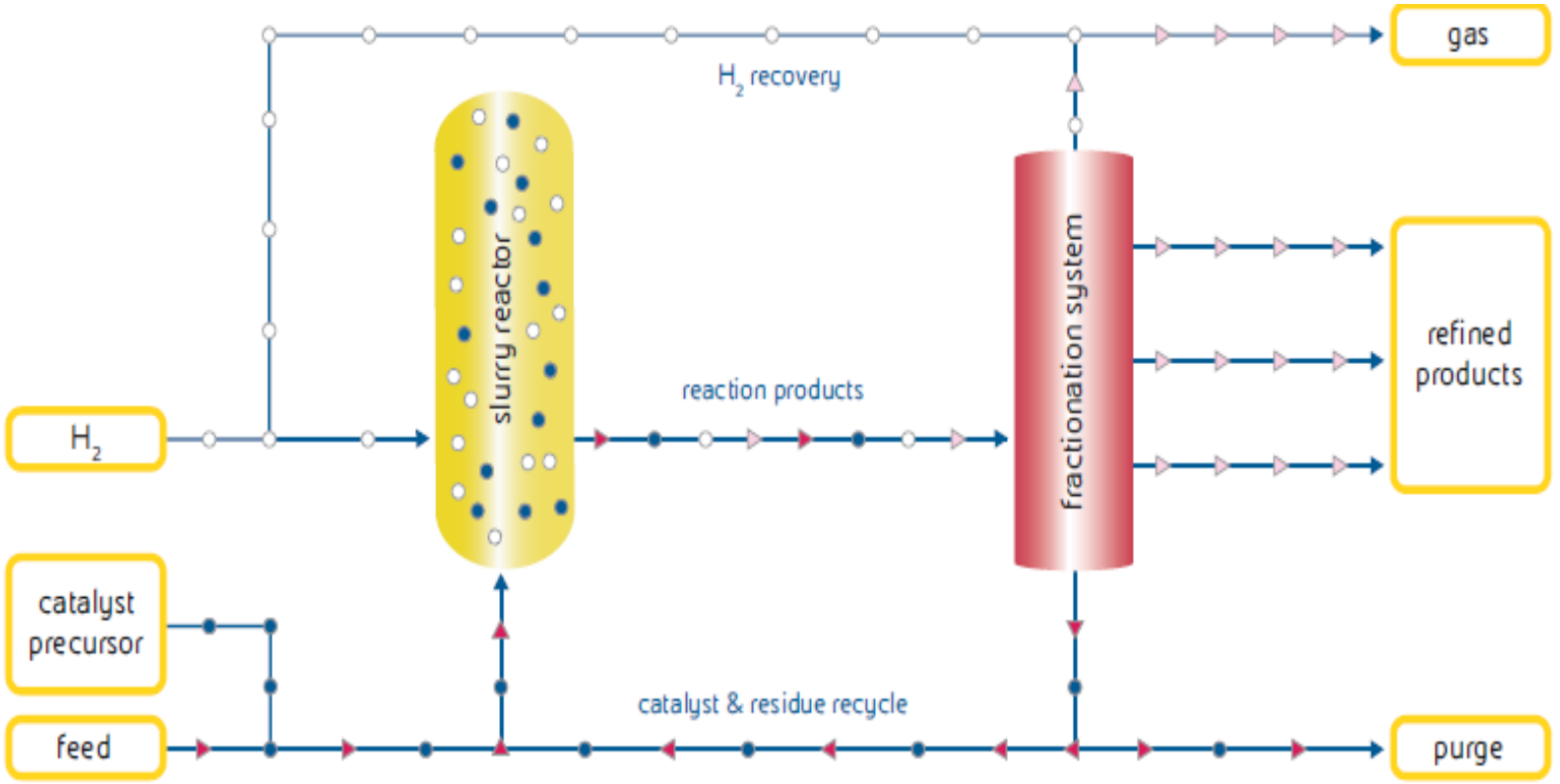
Catalyst: very active, well dispersed, no-ageing, slurry

Reactor: the slurry bubble column is perfectly **homogeneous** and **isothermal**

Process with Recycling: the **unconverted oil** and **the catalyst** are recycled back to the reactor.

EST in the world:

1 Industrial Scale Plant in Italy
2 Industrial Plants in China ready for start-up



\+ High Feedstock Conversion
\+ High Feedstock Flexibility (no metals limitation)
\+ High Distillate Qualities (low sulphur)

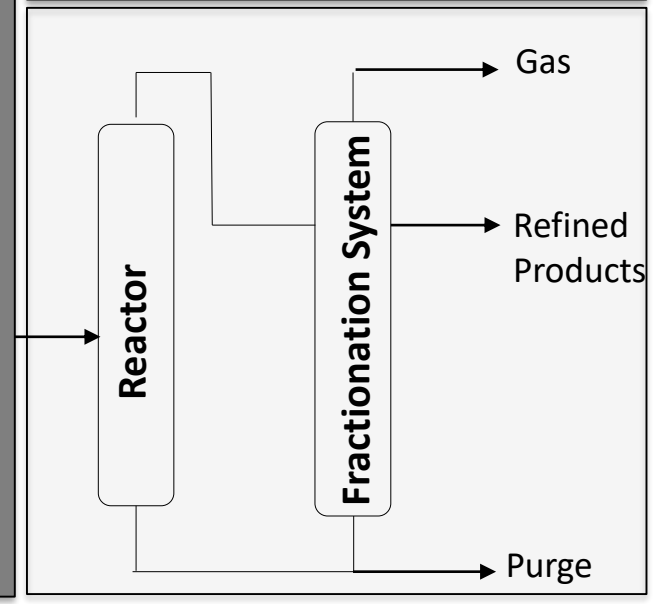
Idea: Eni Slurry Technology to Convert Plastic Compounds directly into Naphtha

Co-processing of Vacuum Residue & Plastic Compounds in Eni Slurry Technology (EST)

Mixed Plastic Waste Selection, Purification and Densification

Selected Secondary Raw Material Pretreatment and Mixture Preparation with Vacuum Residue

Eni Slurry Technology



Eni Experience and Technical results @ bench scale: Pretreatment and Mixture Preparation

- *Raw Material: Purified and Densified Plasmix*
  - *From Mixed Plastic Waste it is necessary to oversort, to purify , to treat it in order to obtain a suitable feedstock*
  - *It has be defined as a secondary raw material → Selected Secondary Raw Material*
  - *It has to be easy to transport it*

- *Secondary Raw Material Pretreatment and Mixture preparation:*
  - *Modular system*
  - *Plastic Components Homogenization*
  - *Mixing with Vacuum residue*

Eni Experience and Technical Results: from Pilot Plant Data to Detailed Industrial Simulation

TRL-6

Pilot Plant Test:

54 days feeding **Synthetic Plasmix**-Vacuum Residue Mixture @ different concentration

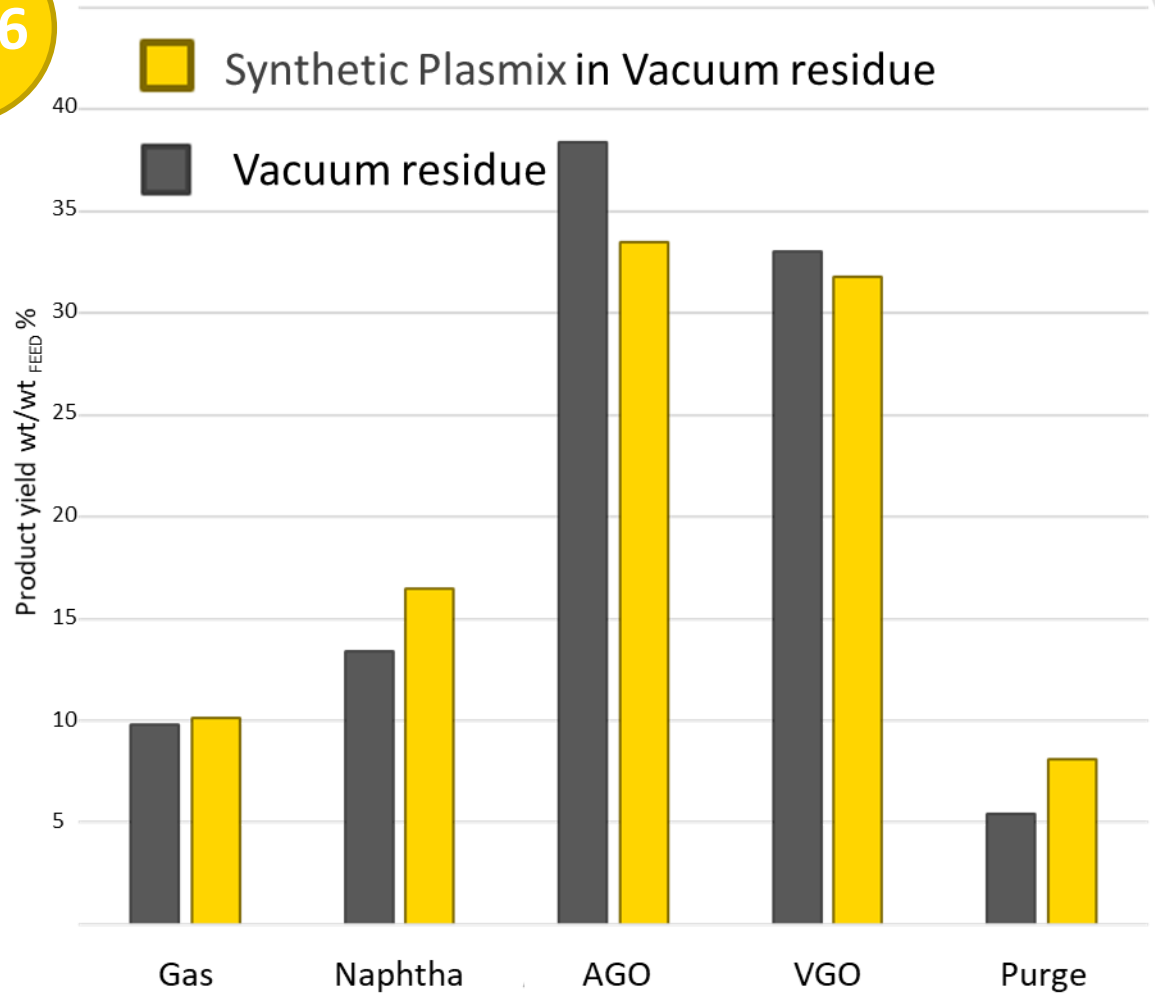
30 days @ 10% **Synthetic Plasmix** in Vacuum residue

From Pilot Plant Data the

Simplified Yield Model for Mixed Plastic Waste

was recovered

Detailed Process Simulation on EST Unit



Eni Experience and Technical: from Pilot Plant Data Results to Detailed Industrial Simulation

Gases

5-15%

Refined Hydrogenated Products

65-85%

Purge

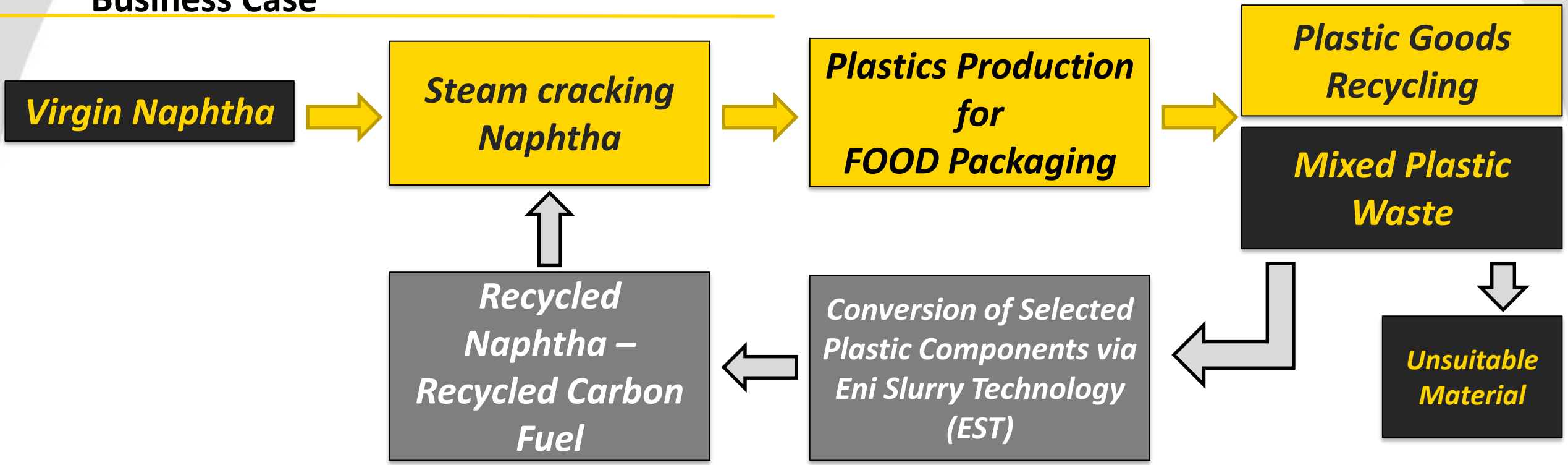
Uncorverted or
Partially converted
Polimeric compounds

Plastic Feedstock on EST Performance

The flexibility and robustness of EST allow to manage the Plastic Components co-feeding without issues

Production of 40% of Naphtha from Polymeric Components

Economics: Preliminary Simulation of Economics considering an hypothetic Business Case



CASE STUDY

50.000 t/y of Selected Plastic Components

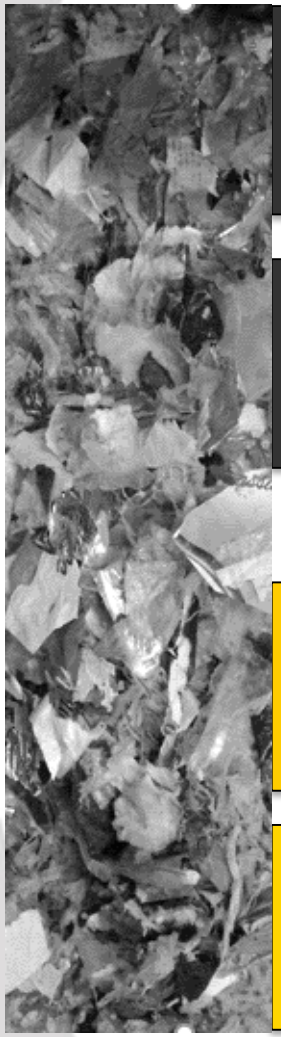
in mixture with Vacuum Residue

considering an Industrial EST Plant 1,0 MTPY

IRR

10,9%

Preliminary Life Cycle Assessment Analysis: CO_2 emission



Landfill			
Thermal valorization	***2.35 kg $CO_{2\ eq}$/kg Plasmix***	**Database: Ecoinvent 3.6**	
Gasification	***1.32 kg $CO_{2\ eq}$/kg Plasmix****	**Waste to Methanol**	
Eni Slurry Technology	***0.93 kg $CO_{2\ eq}$/kg Plasmix***	**Waste to Naphtha**	

(*) Plasmix + CSS

Data from Energy and Material balance
for 50.000 t/Y of Selected Plastic Components

Moving on…..

Preliminary Results, Evaluations & Conclusions

- **Technological feasibility,** on pilot scale, **of the possible conversion** of a synthetic mixture of **polymeric materials** via slurry hydrogenation proprietary process (EST).
- Evaluation of **Economic Profitability**
- Evaluation of **CO_2** emissions
- Identification of a **potential new route for the chemical recycling of Plastic materials**