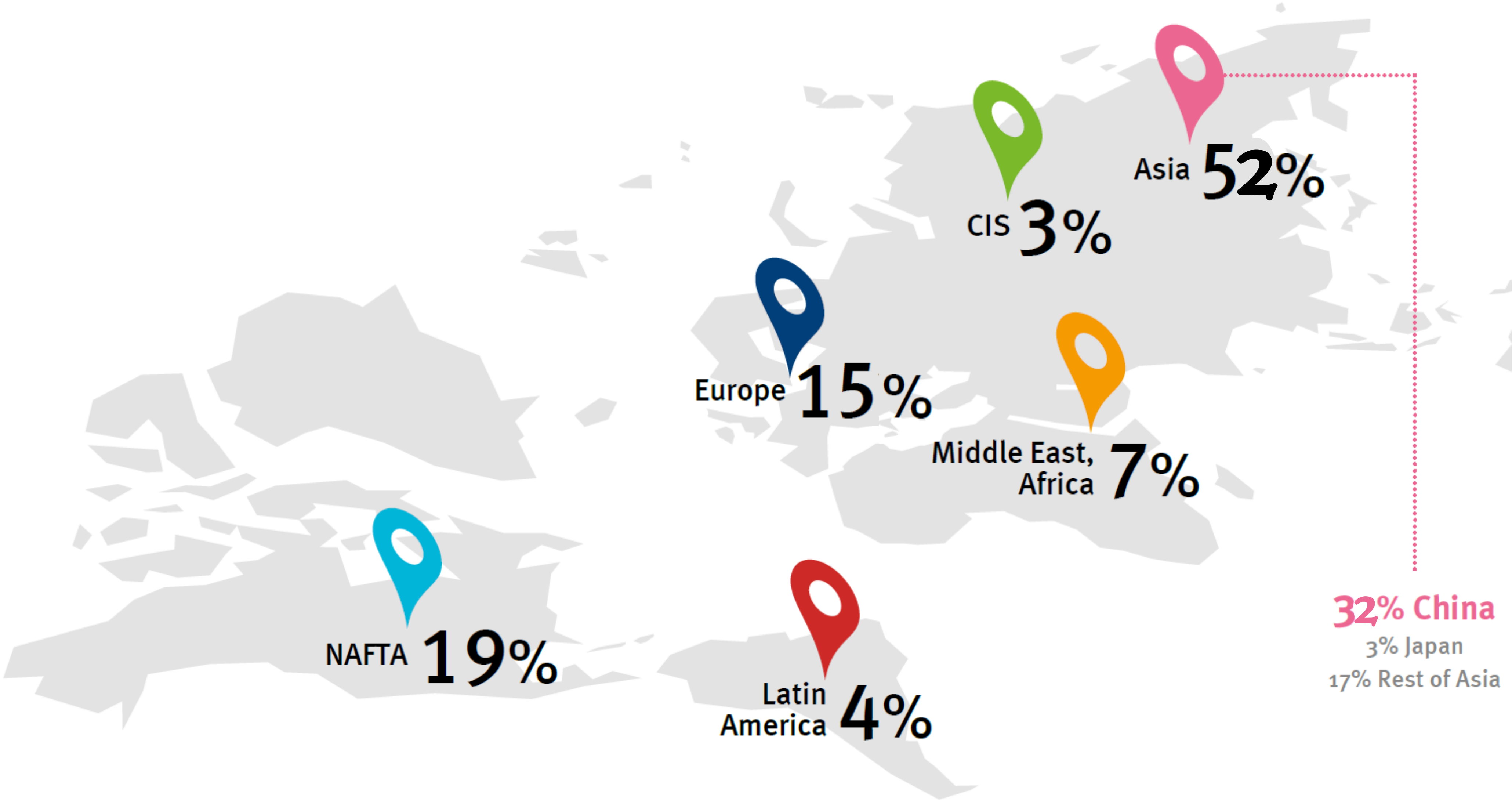
DEPARTMENT OF MATERIALS, TEXTILES AND CHEMICAL ENGINEERING (MaTCh)
LABORATORY FOR CHEMICAL TECHNOLOGY (LCT)

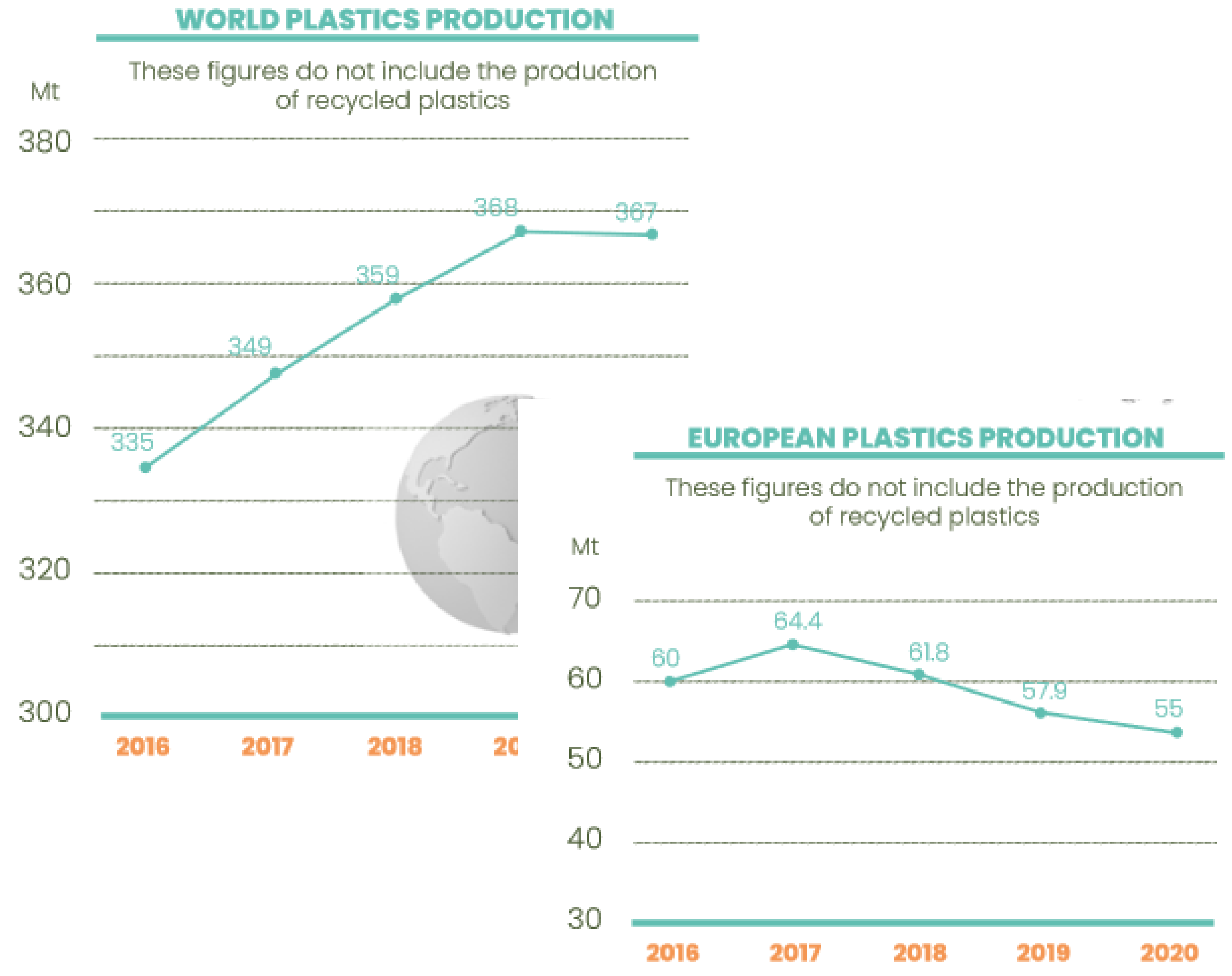
PSYCHE Project

Dr. Ir. Elisabeth Delbeke, 02/06/2022

Plastics production

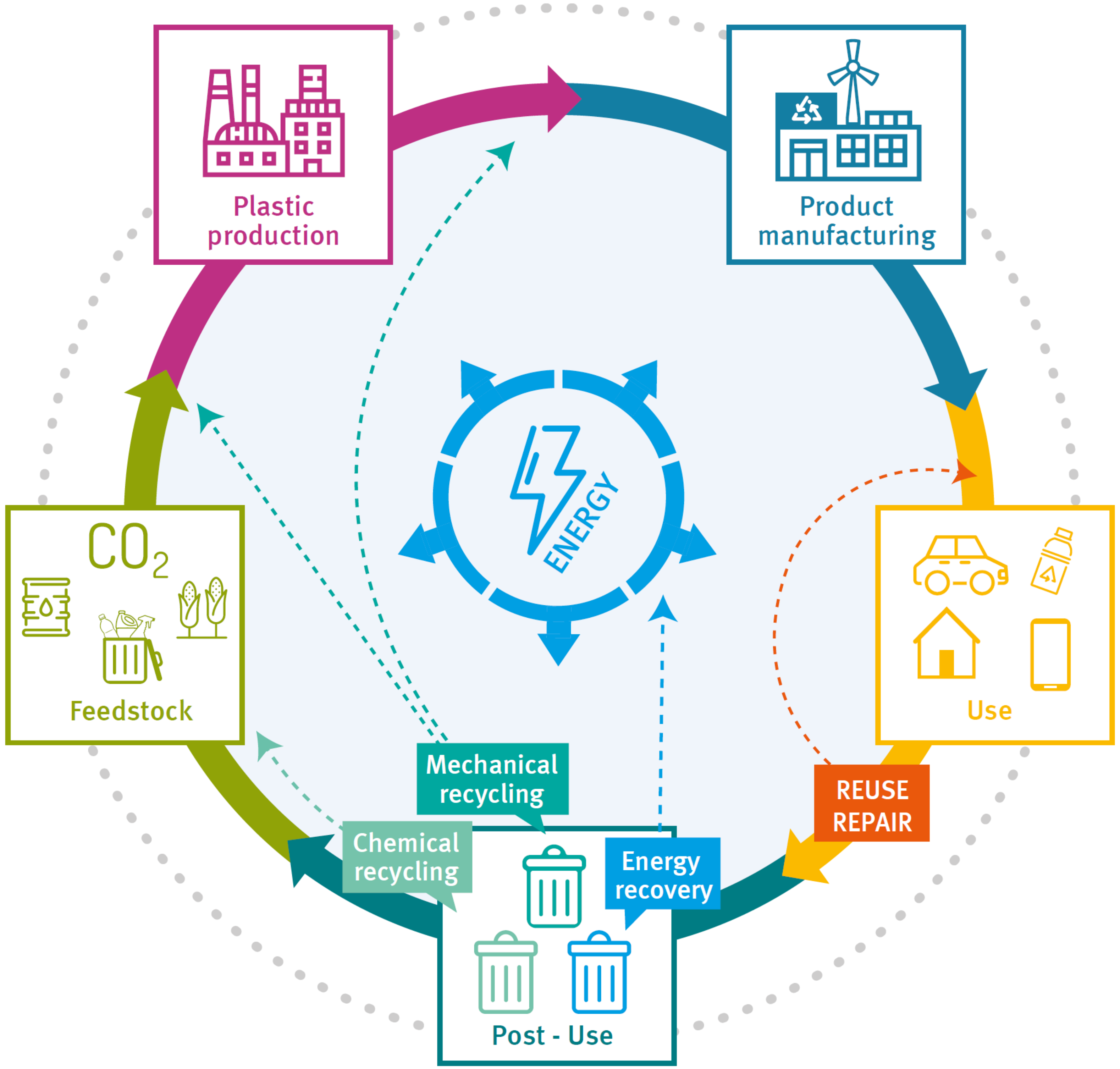
- World Plastics Production (MT) in 2019➔2020: 368➔367
- EU Plastics Production (MT) in 2019➔2020: 57.9➔55





PlasticsEurope, 2021. Plastics – the Facts 2021: An analysis of European plastics production, demand and waste data, PlasticsEurope Brussels, Belgium.

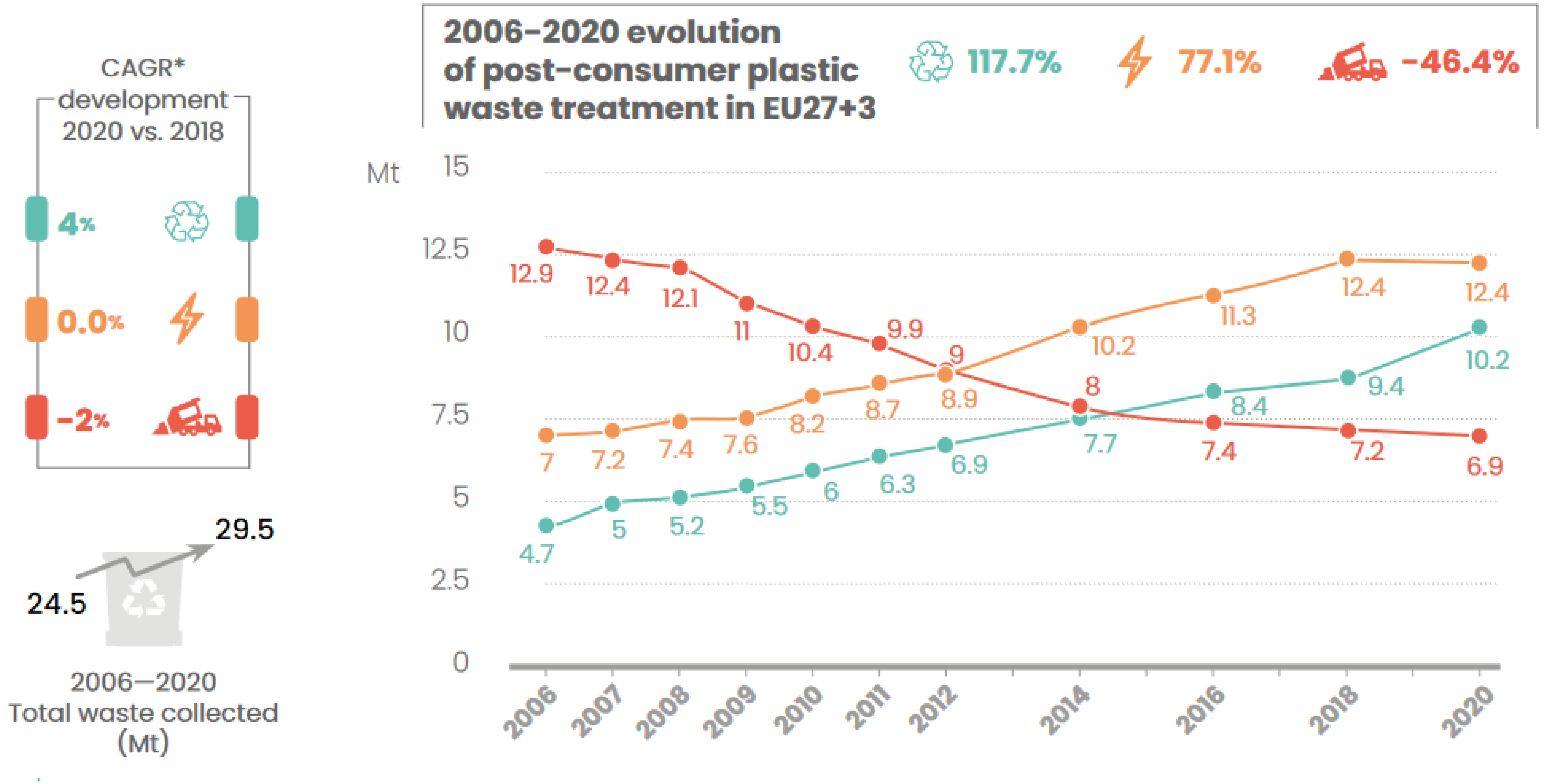
Circular Economy



PlasticsEurope, 2018. Plastics – the Facts 2018: An analysis of European plastics production, demand and waste data, PlasticsEurope Brussels, Belgium.

Increased plastic waste recycling

- EU plastic waste treatment from 2006 to 2018
- In 2016, landfill became lower than recycling



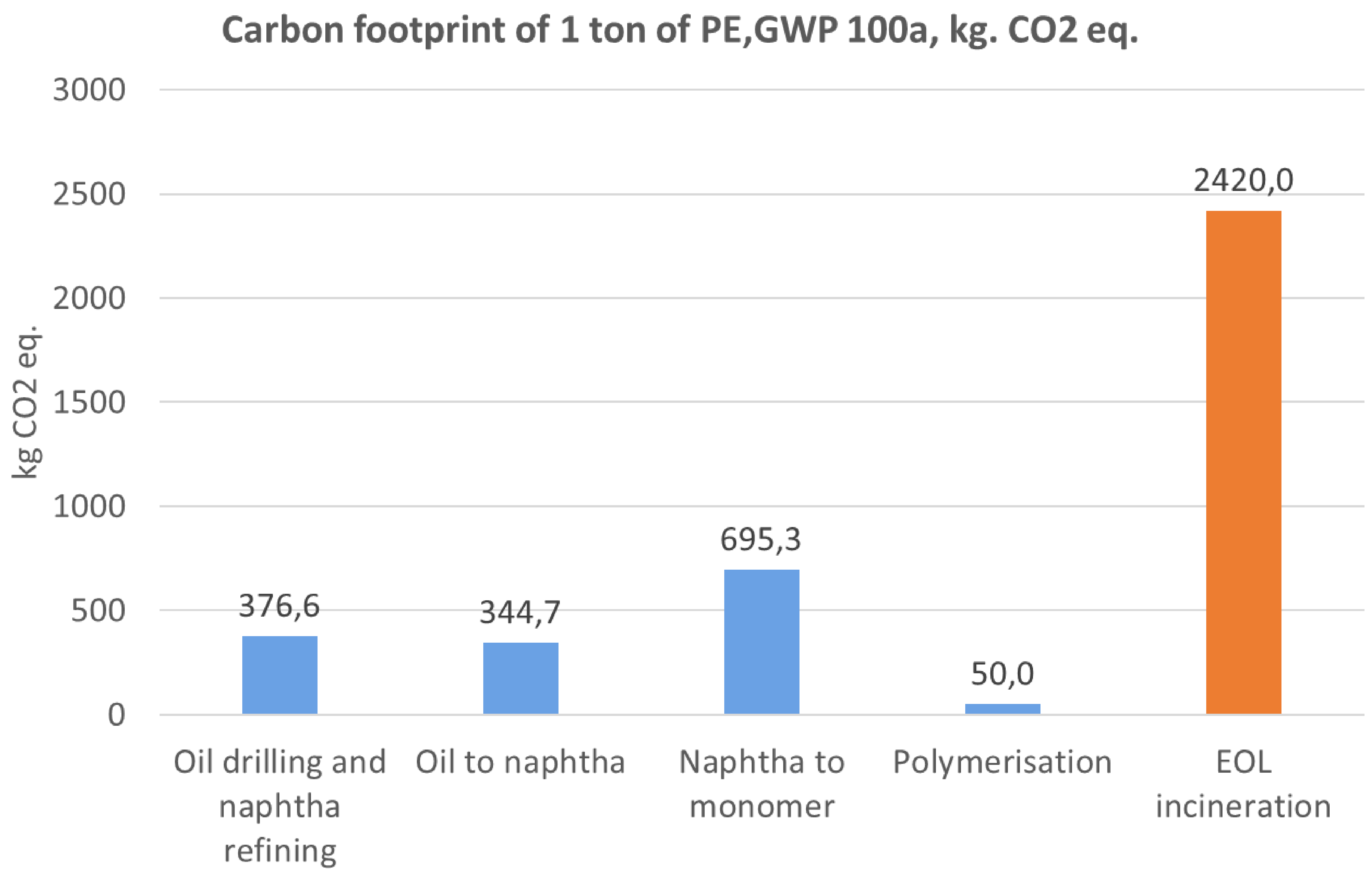
Recycling: 34.6%

Energy recovery: 42.0%

Landfill: 23.4%

PlasticsEurope, 2021. Plastics – the Facts 2021: An analysis of European plastics production, demand and waste data, PlasticsEurope Brussels, Belgium.

Polyethylene LCA: end of life emissions



- GWP 100a – global warming potential of emissions calculated over a time horizon of 100 years
- Significant fraction of emissions occur at ethylene plant itself.
- Most of the emissions come from combustion if we go for energy recovery

https://doi.org/10.1016/j.jclepro.2018.07.278

PSYCHE Project

– Conversion of plastic waste to base chemicals via gasification and subsequent Fischer-Tropsch synthesis

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€ 2.6 Million

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Work Packages

WP1 Project management

WP2 Communication

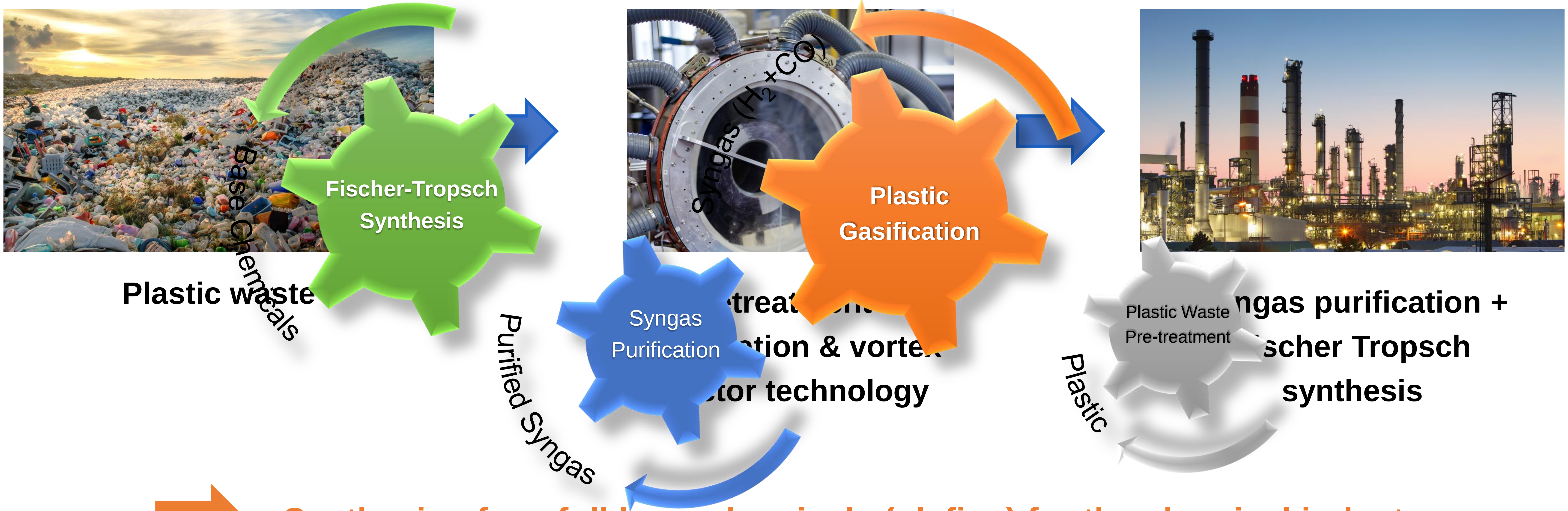
Experimental

WP3 Pretreatment and gasification of plastic waste

WP4 Syngas purification and Fischer Tropsch production of olefins

WP5 Education

PSYCHE Objective



Plastic waste

…treat… …ation & vortex …tor technology

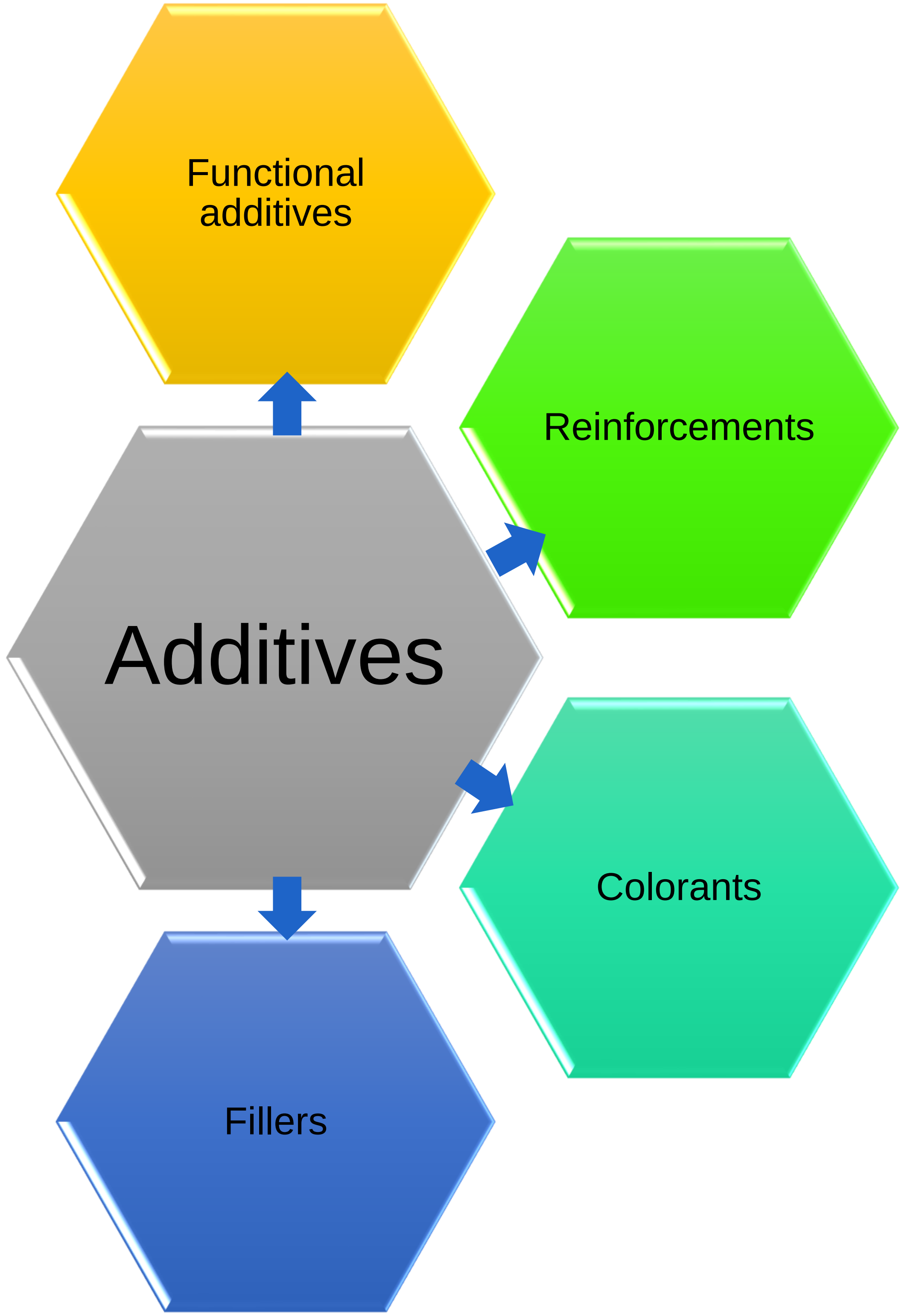
…ngas purification + …scher Tropsch synthesis

Synthesis of usefull base chemicals (olefins) for the chemical industry

Pre-treatment

Challenge in plastic processing: Additives

Additives improve physicochemical properties of plastics



HOWEVER

During processing they cause:

- Migration
- Emissions
- Leaching
- Degradation
- Release

Techniques for pre-treatment

Mechanical

Devolatilization

Solvent-based techniques

Conventional methods

- Soxhlet, Ultrasonic etc.

Pressure-assisted methods

- MAE, SFE, ASE etc

Dissolution-precipitation

✓ Start with a review of scientific literature based on extraction of various additives via solvent-based extraction techniques

Challenges and opportunities of solvent-based additive extraction methods for plastic recycling
By: Ugduler, Sibel; Van Geem, Kevin M.; Roosen, Martijn; et al.
WASTE MANAGEMENT Volume: 104 Pages: 148-182 Published: MAR 1 2020

Objectives

- Physicochemical pre-treatment of plastic waste via various **extraction methods**
- Assessment of various extraction methods on the removal of different **type of additives** from plastic waste
- **Optimization** of pre-treatment conditions for a broad range of plastics

Gasification in vortex reactor

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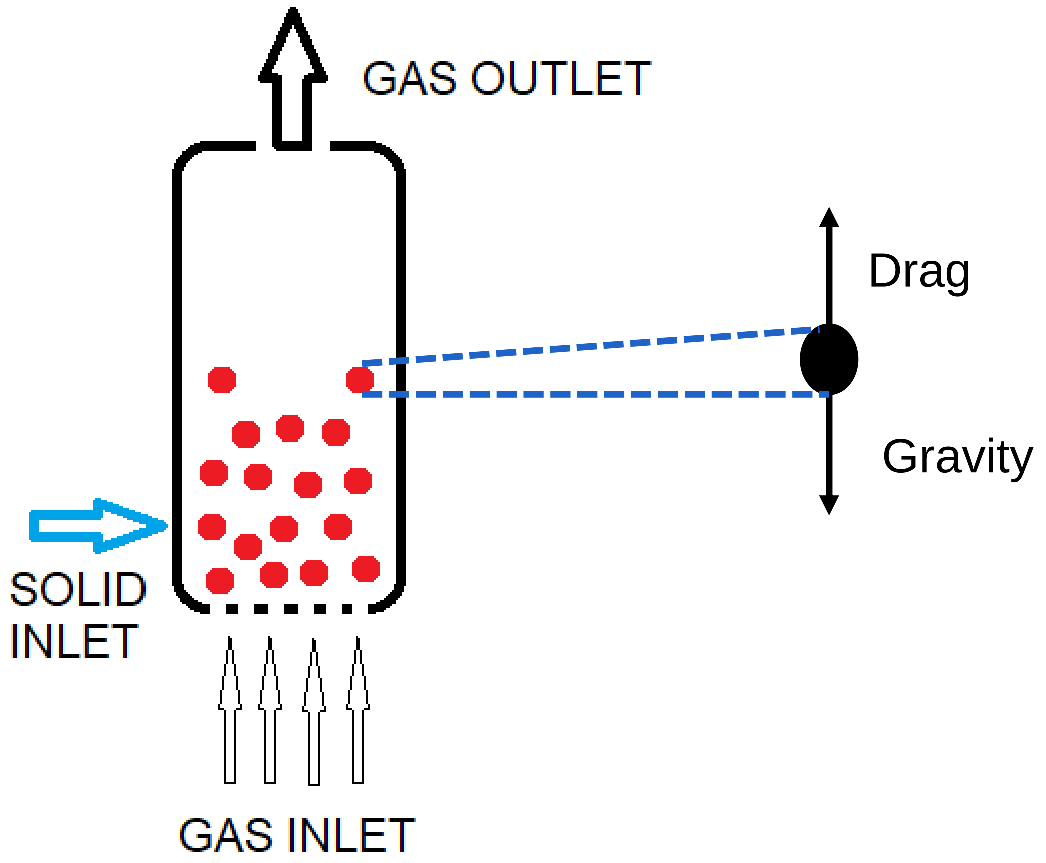
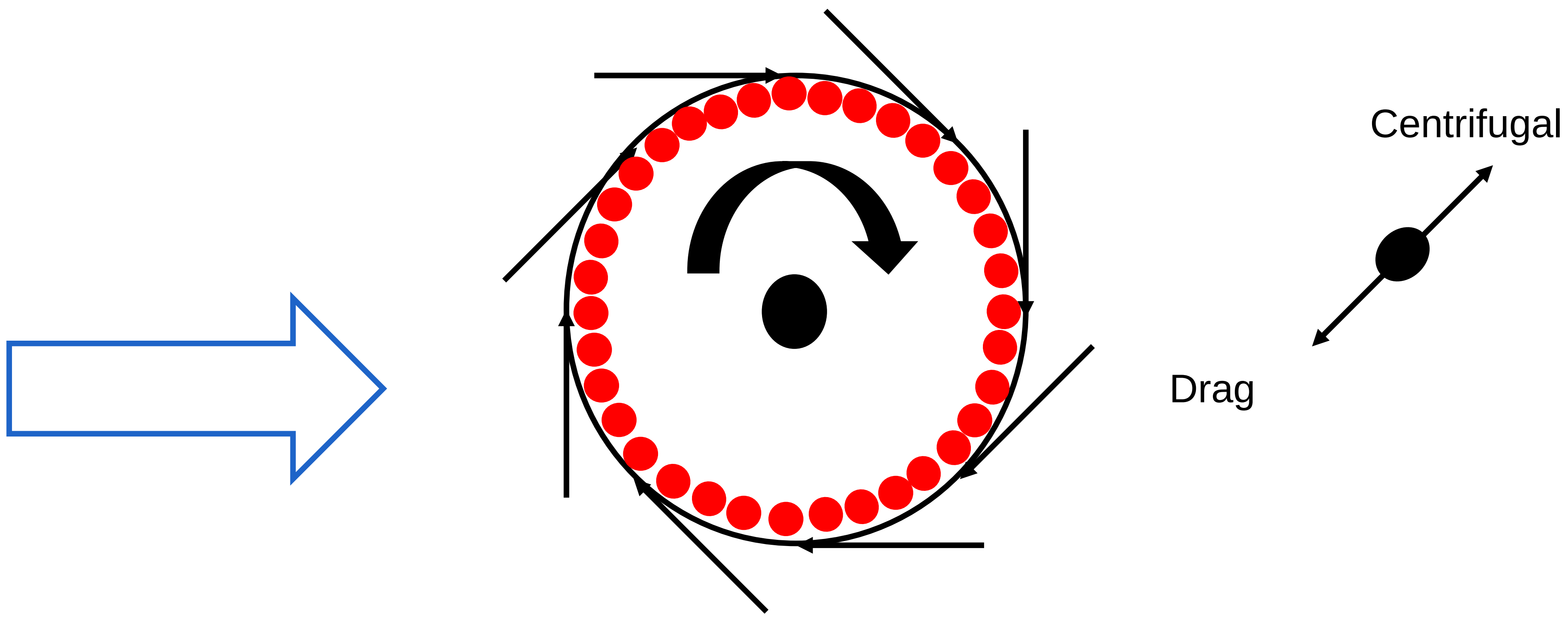
Gas-Solid reactors

Fluidized bed reactor



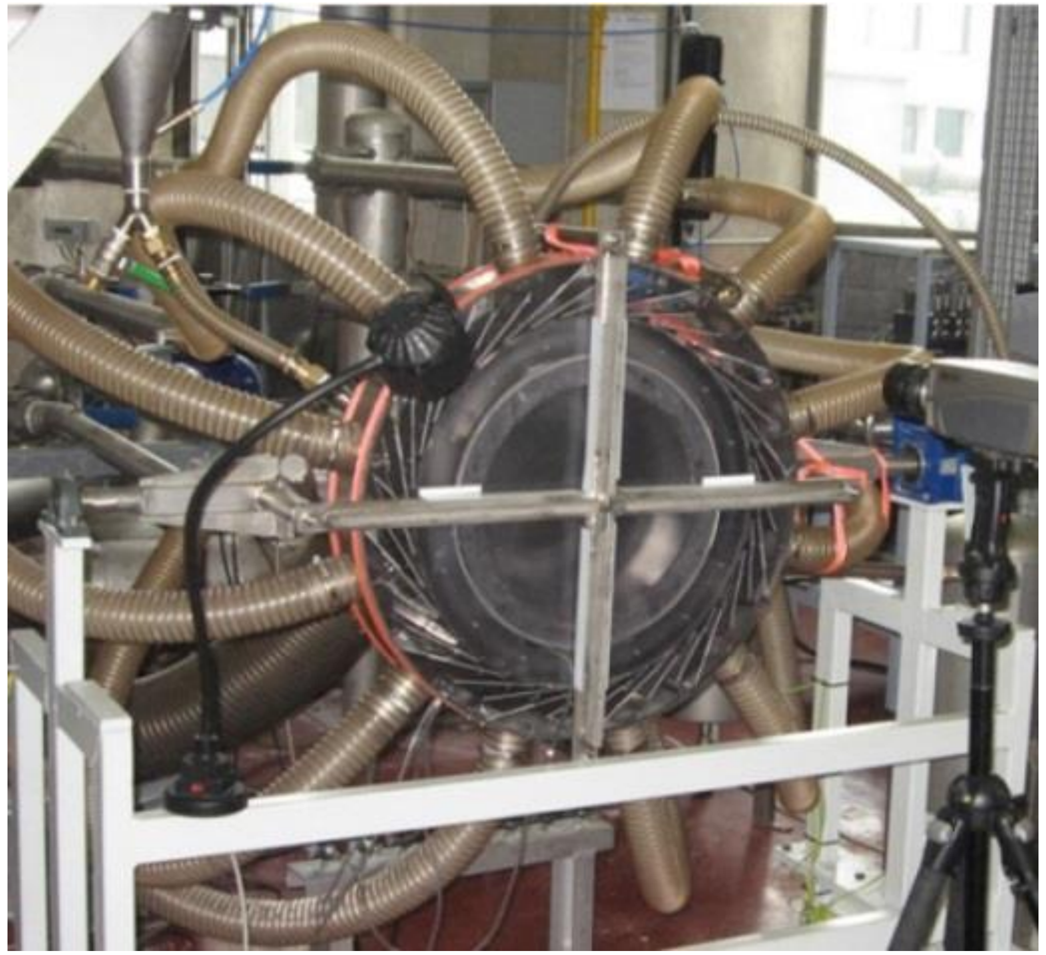
Gas Solid Vortex Reactor (GSVR)



- Gas velocity limitation.
- Diluted bed.

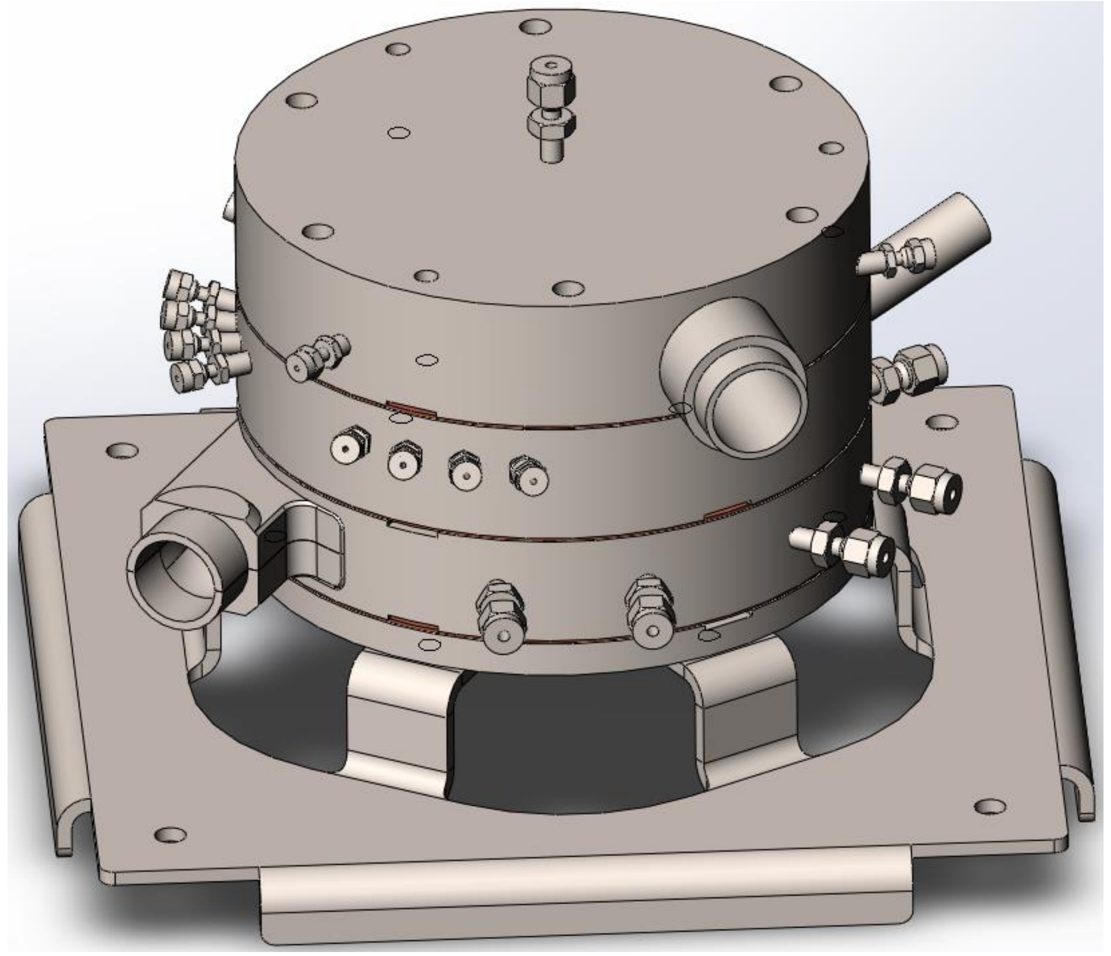
- Higher gas velocity
- High gas-solid slip velocity.
- Packed bed.
- Short gas space time.
- More compact reactor
- = intensification

GSVR research at LCT

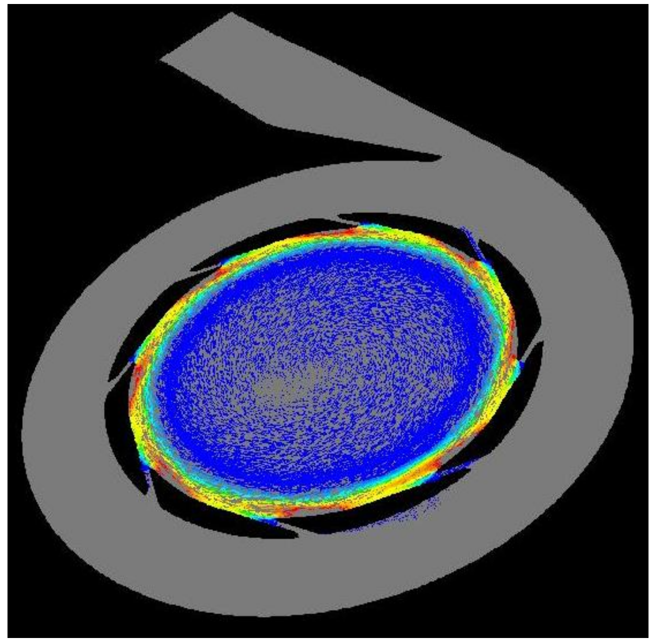


COLD FLOW GSVR

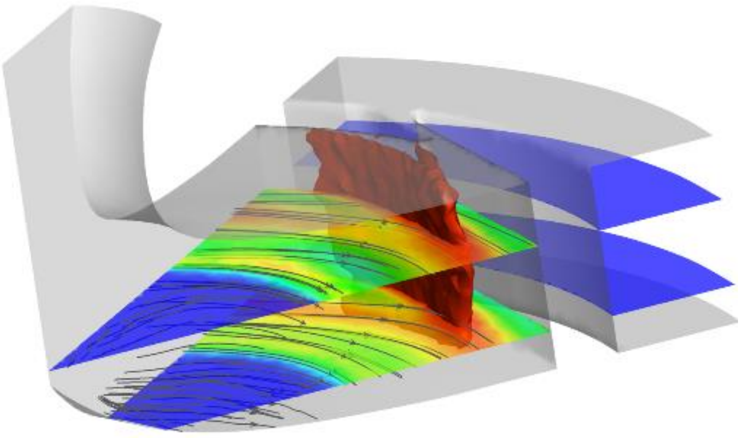
HOT FLOW GSVR



REACTIVE GSVR



CFD



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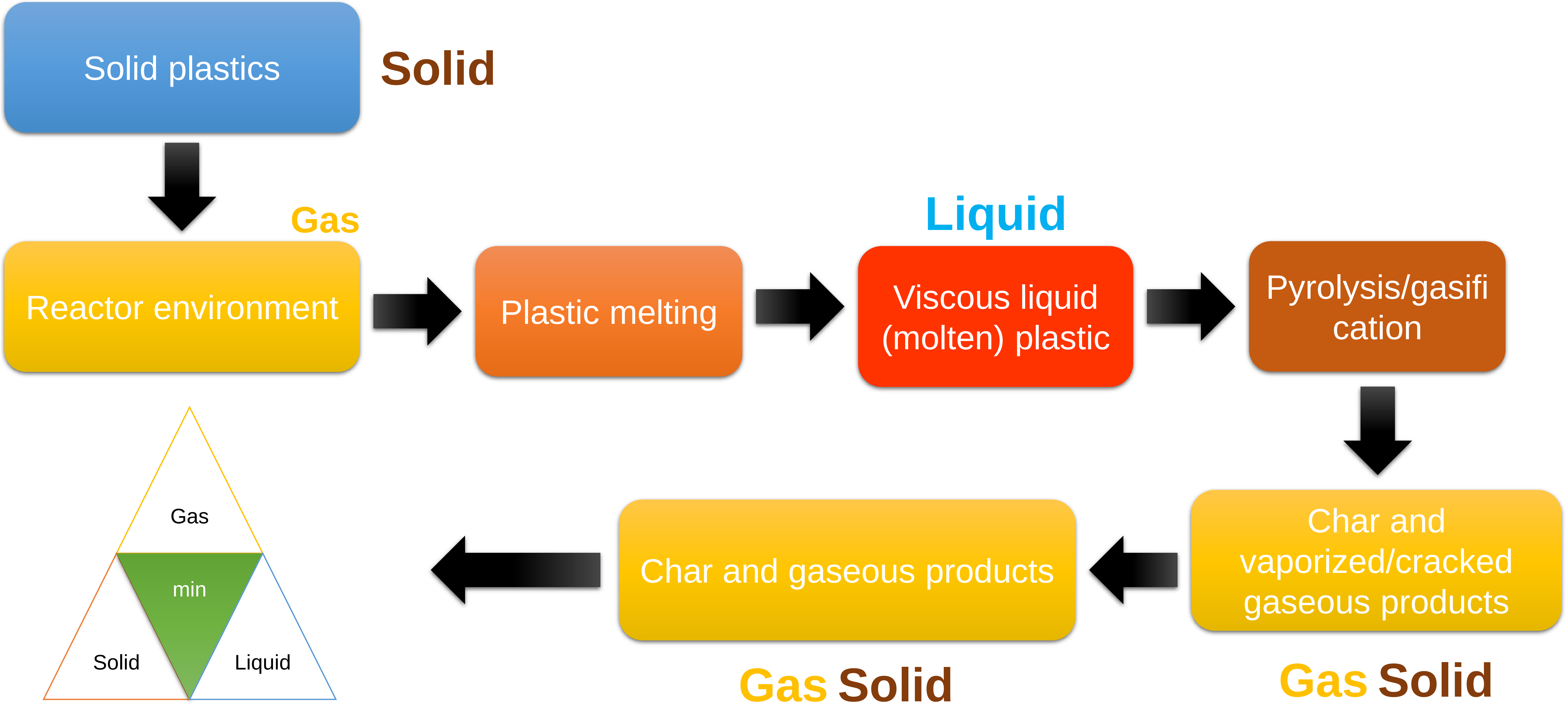
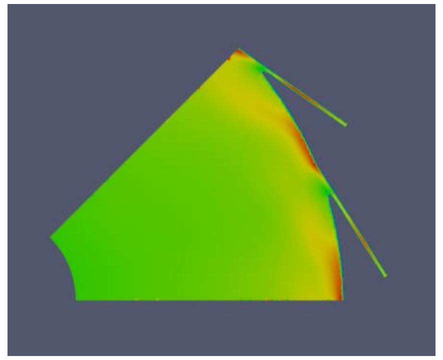
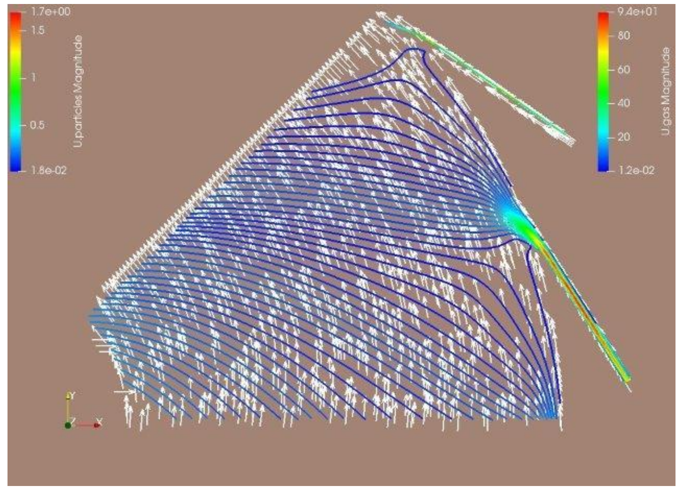
Plastic Gasification Process in GSVR

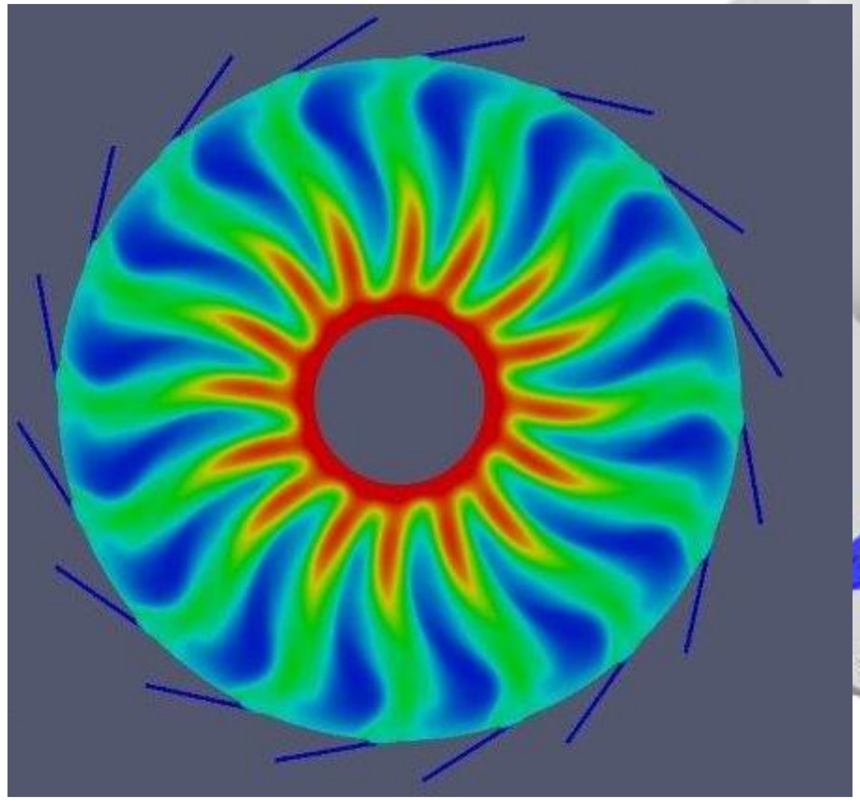


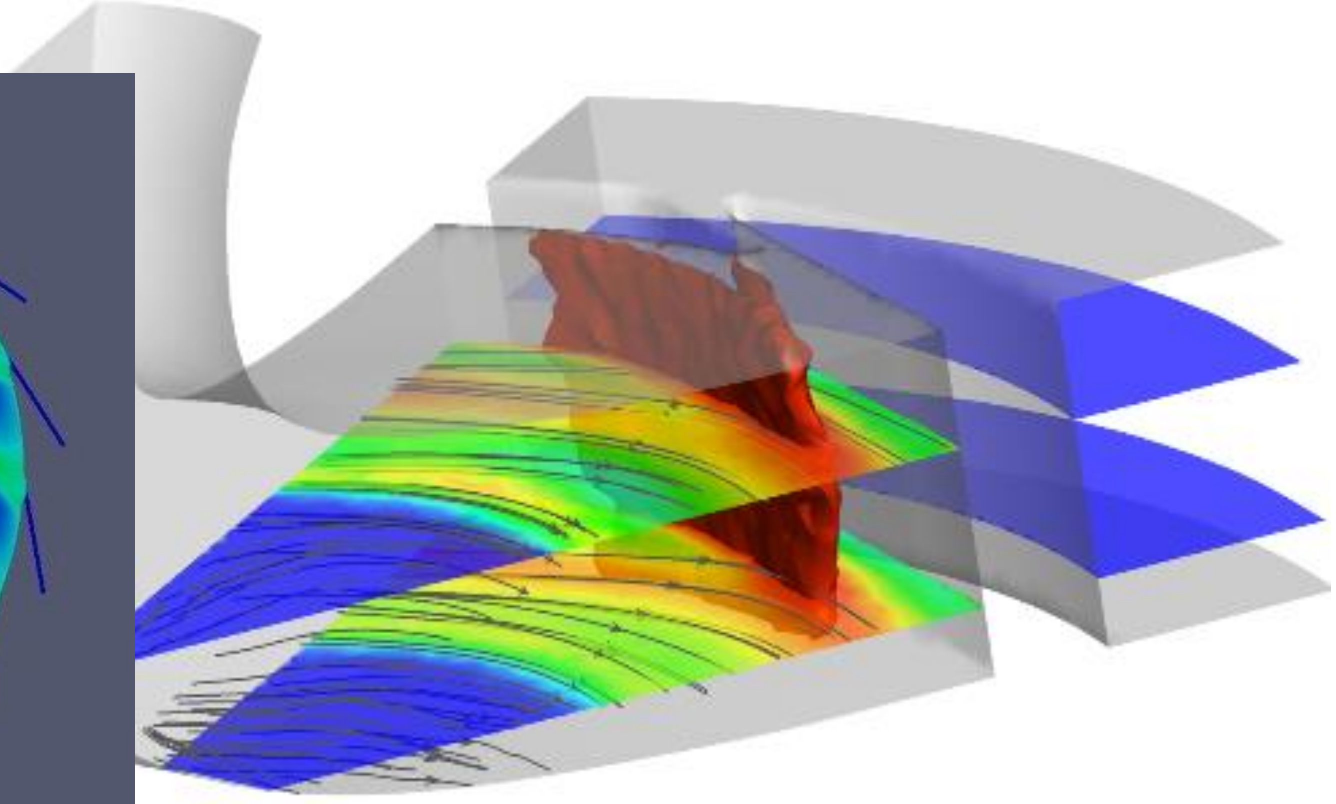
Objectives

– Numerical & experimental investigation of plastic waste gasification process in gas-solid vortex reactor
  - ➢Computational Fluid Dynamics (CFD)
  - ➢Coupling CFD and Kinetics from simplified to detailed level





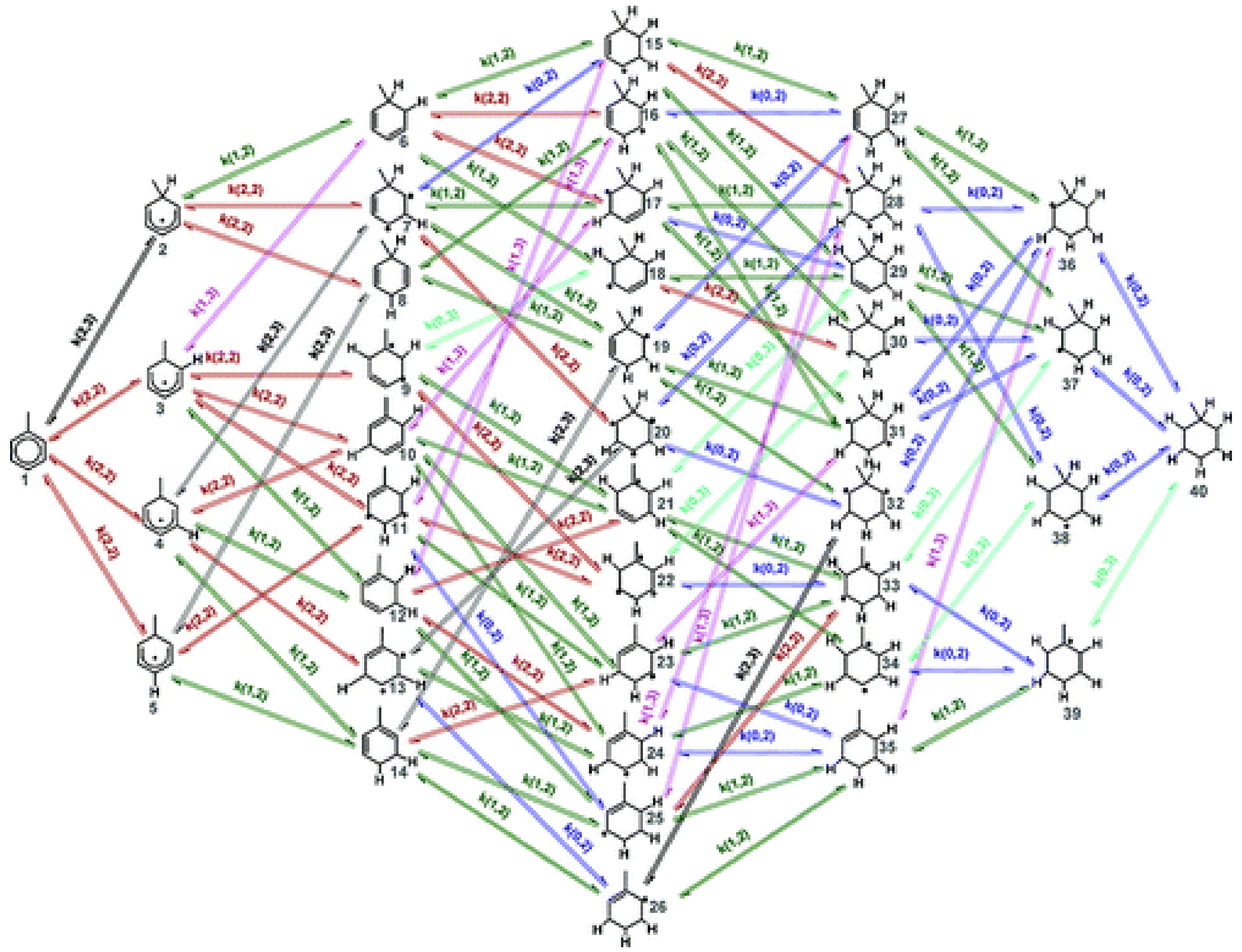




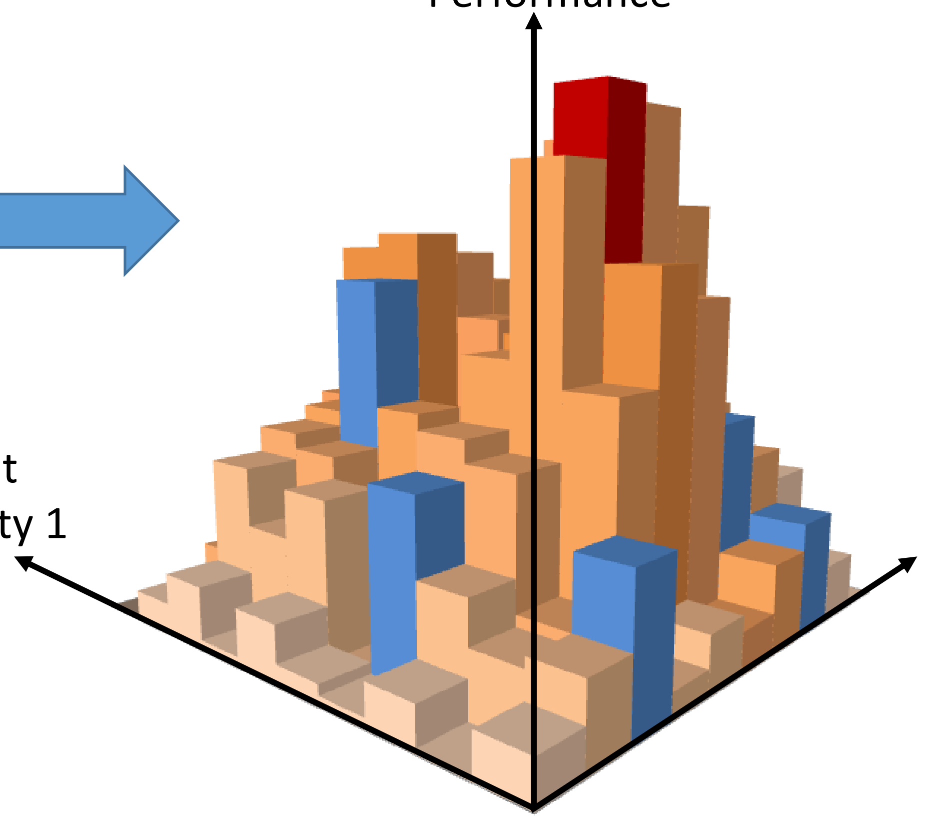
Olefin production from syngas

Model based catalyst design and optimization

Complex reaction phenomena



Catalyst optimization



Scale-up studies

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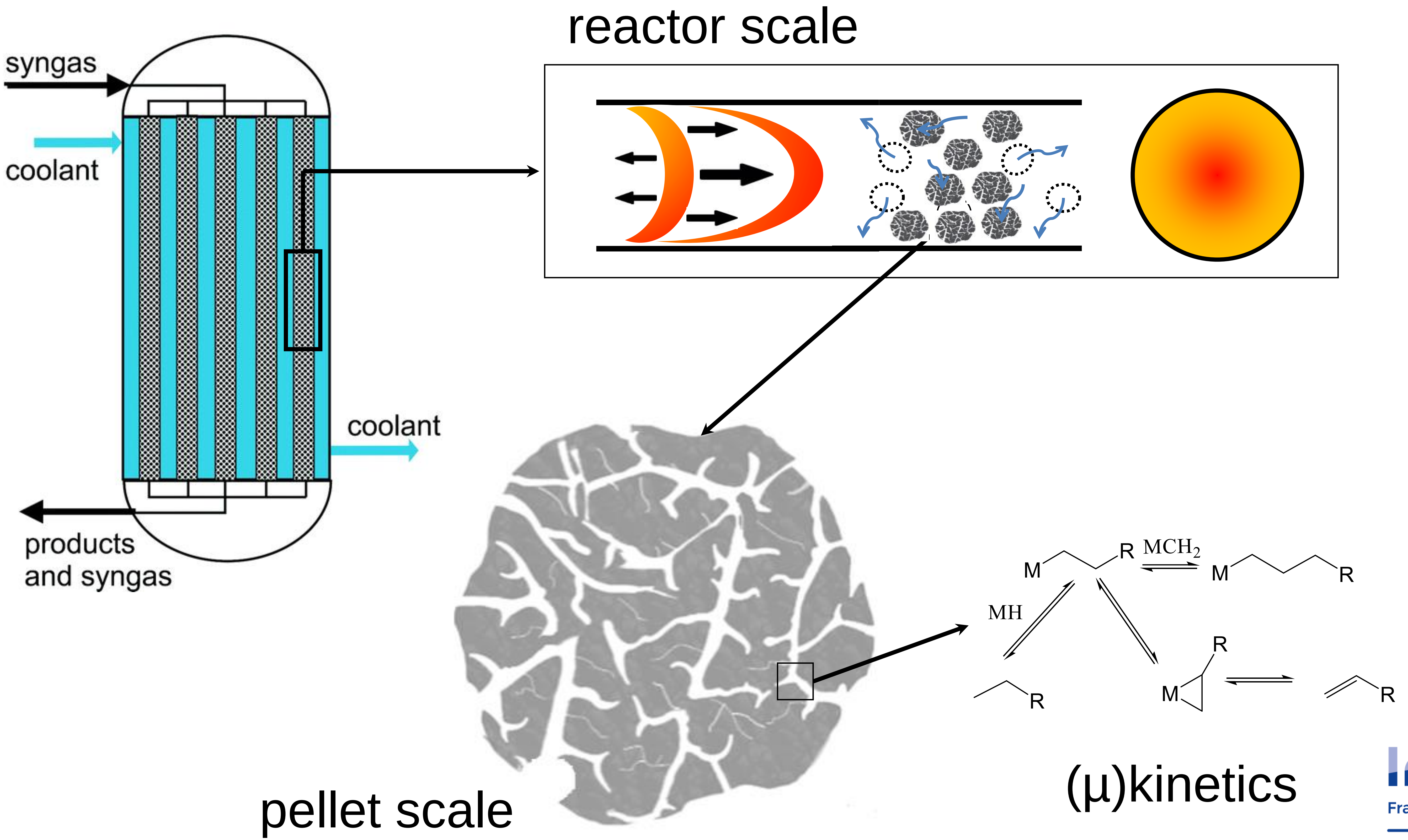
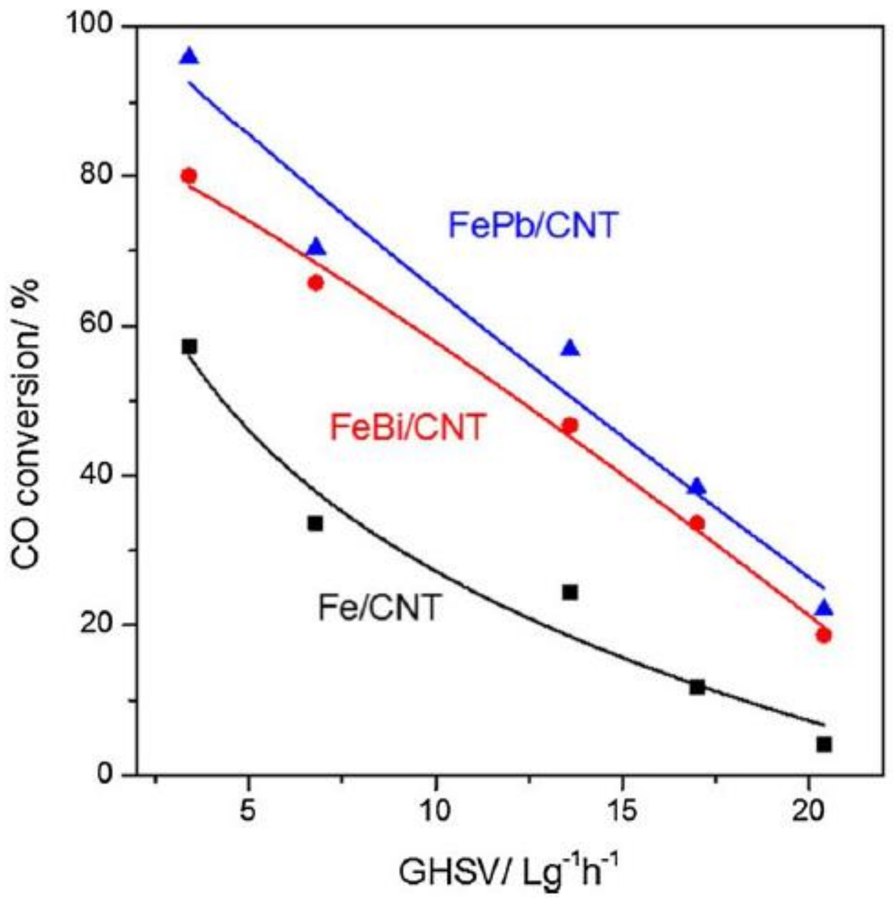
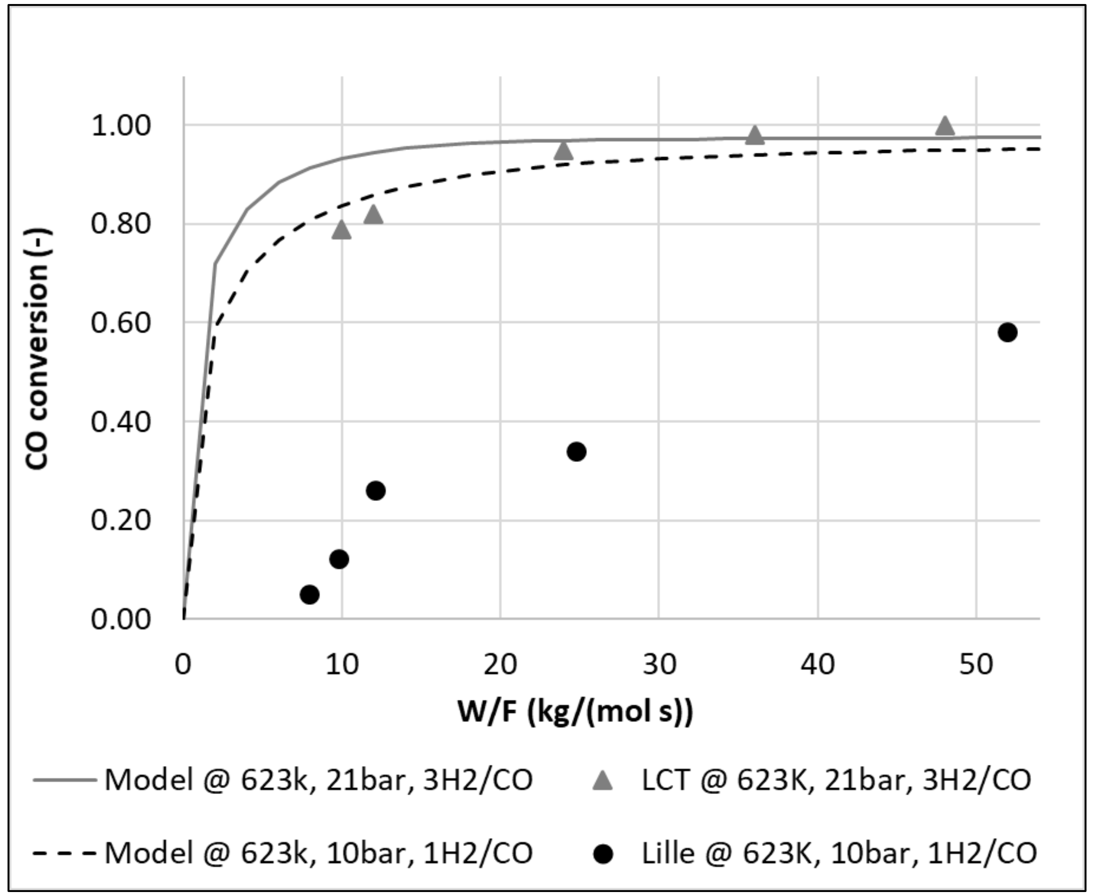
Multi-scale modeling for reactor design



Objectives

- To incorporate influence of catalyst descriptors, into the model.
- To allow extension of the model to other catalysts.
- To transforms the model into a useful tool for catalyst design and development.
- To validate this approach with experimental data





SEMK model for Fischer-Tropsch synthesis experimental data obtained on an iron-based catalyst with variation in promoters.

Acknowledgements

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Avec le soutien du Fonds européen de développement régional
Met steun van het Europees Fonds voor Regionale Ontwikkeling

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Questions

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