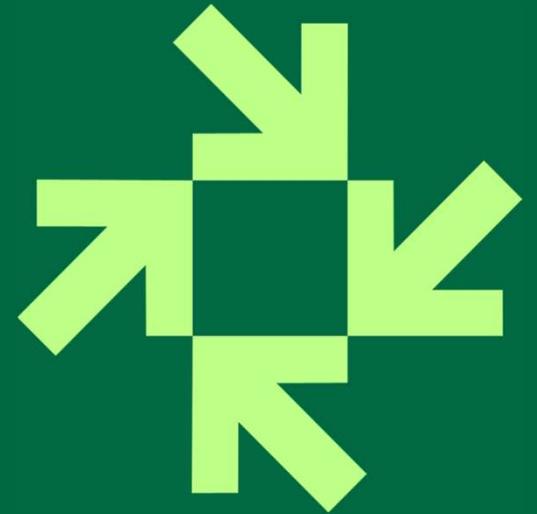


WP7: Society and business impact assessment



Sjoerd Herlaar (TNO)



The project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement 101059909.

WP7: Society and business impact assessment

Objectives:

- To **evaluate the societal and business performance** (economic, environmental, and circular) of collection, sorting, transport and mechanical and (thermo)chemical recycling of plastic waste and biobased streams
- **to support technological and policy development** as well as upscaling and implementation of optimal organised circular plastic business cases and value chains in the ARRRA region and Europe.

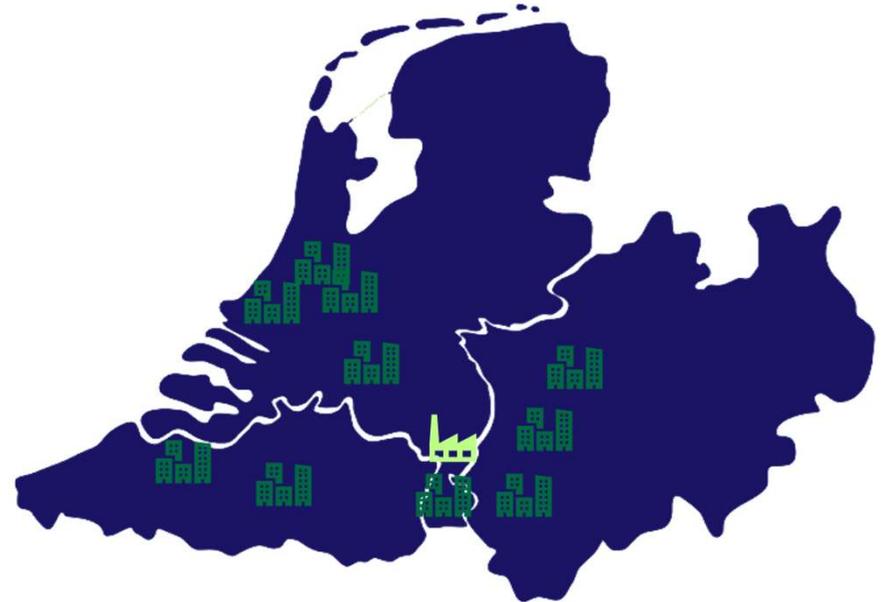
Over Time

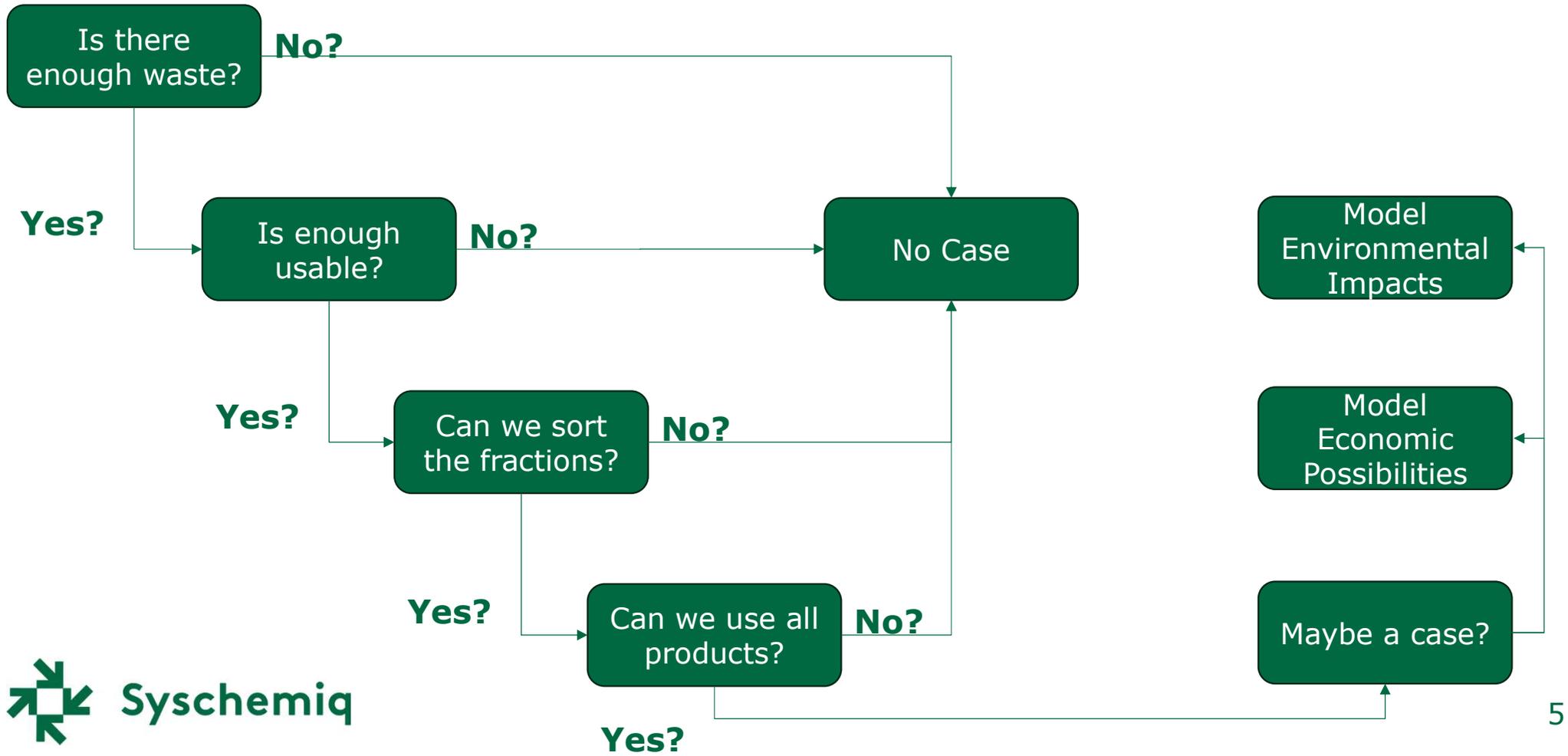
Mechanical versus Chemical Recycling

	Mechanical Recycling	Chemical Recycling
	Grind & Melt	Chemically "reset"
Resource Intensity	Lower	Higher
Energy Intensity	Lower	Higher
Product Quality	Lower	Higher
Blending factor	Lower	Higher
Product value	Lower	Higher

Explain why Chemelot & ARRRA

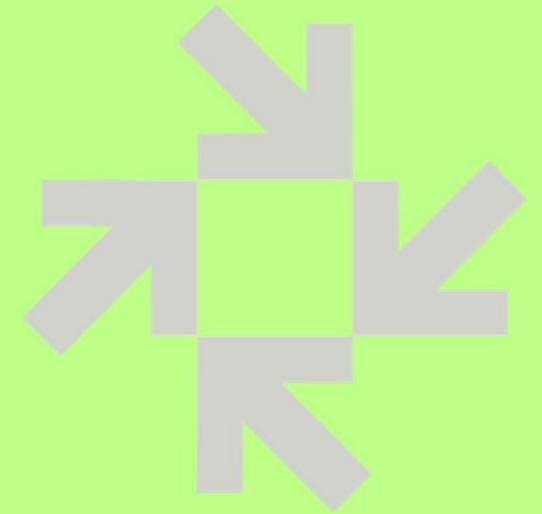
- Heavily Urbanised
 - Developed Industry
 - Formal Waste management
-
- Everything for a case study





Modelling Framework

How to answer these questions



Syschemiq Project confidential

WP 7 model framework in place



WP 7 model framework in place

MEASURES: Governance & policy measures (WP1)
Social preferences & acceptance, Policy measures (regulation, financial, information, etc.)

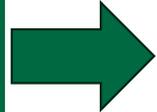
DRIVERS: Scenarios

- GDP
- Population
- Plastic demand & waste
- Prices (energy & polymers)

GEO
Geographical Information System



Localised waste forecasting & logistics optimisation costs
BUSINESS PERSPECTIVE



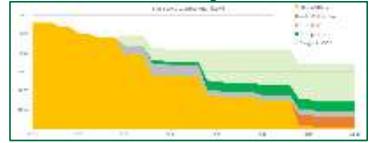
PRISM Plastic Recycling Impact Scenario Model



System optimization costs / environmental impacts / circularity;
SOCIETY PERSPECTIVE



CIMS
Chemelot Integrated Model System



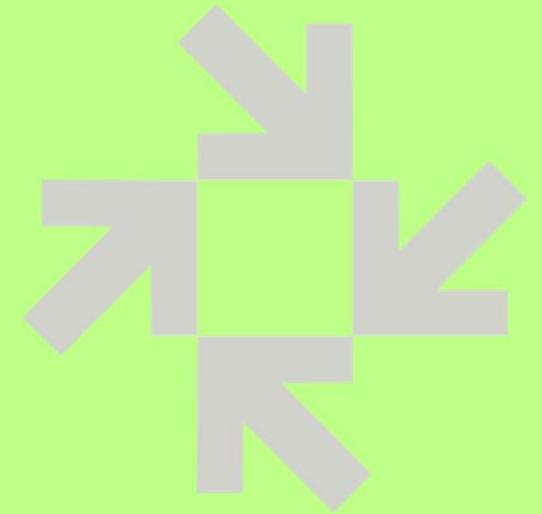
Site optimization costs / CO2
BUSINESS PERSPECTIVE

Visualised Results

- LCA Impacts
- Shadow Costs
 - Site Optimisation

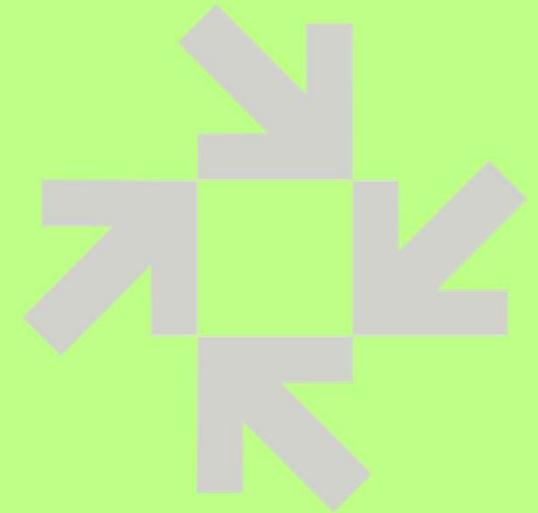
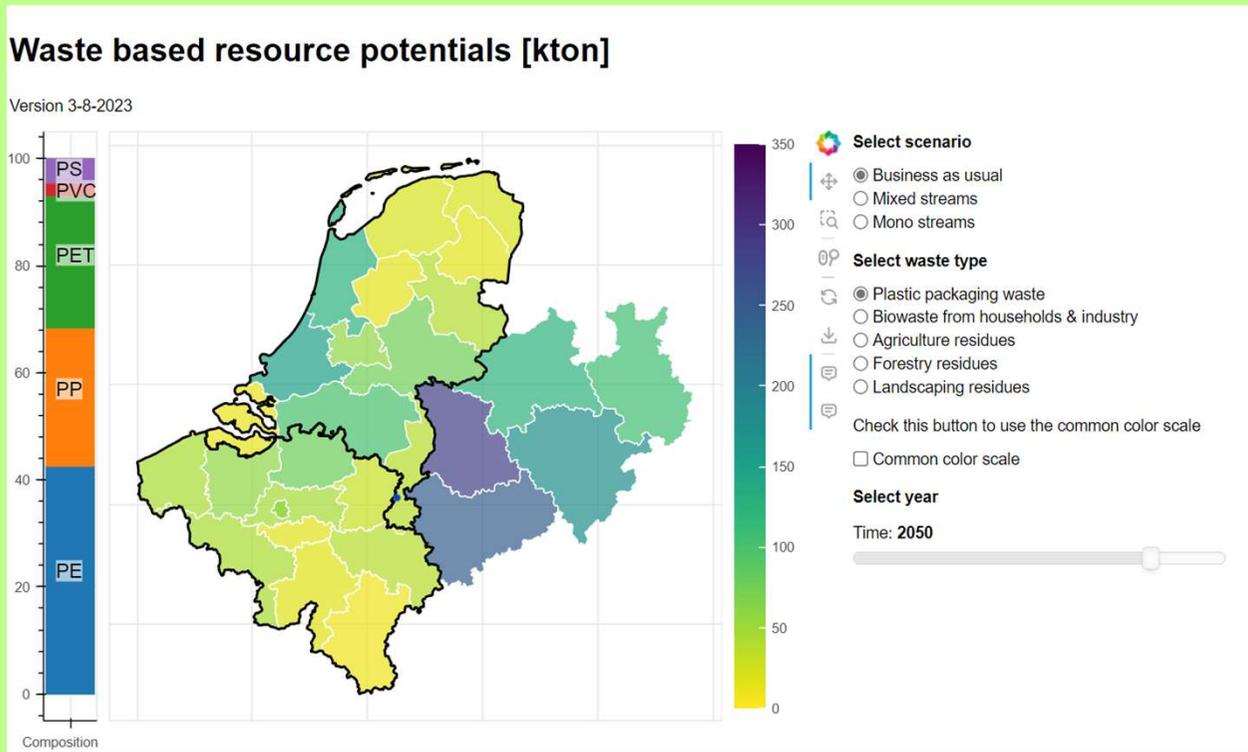
GEO Tool

Interactive Result Mapping

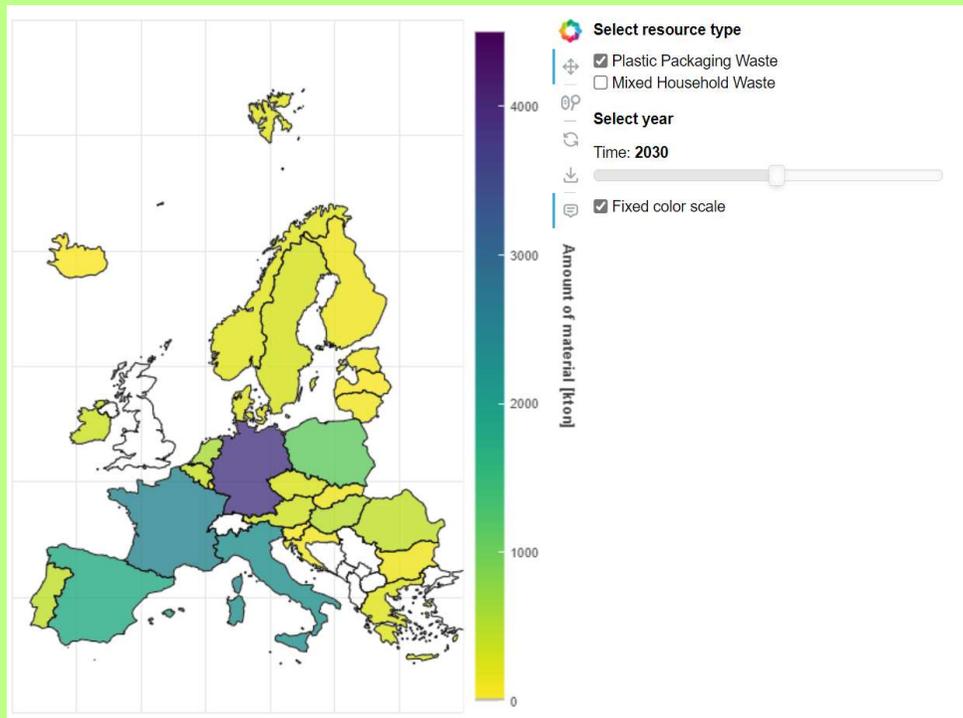
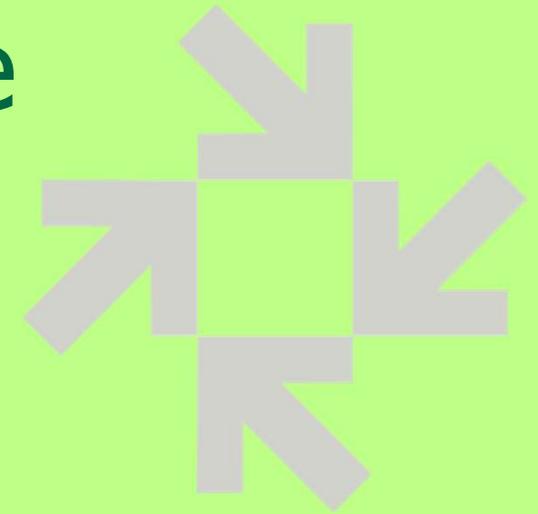


Syschemiq Project confidential

GIS tool for waste projections

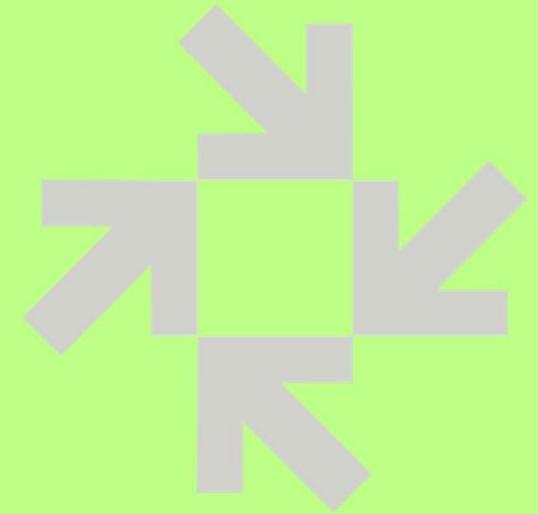


Geo waste tool for Europe



PRISM

Connecting Recycling Technologies



Syschemiq Project confidential

PRISM

Plastic Recycling Impact Scenario Model

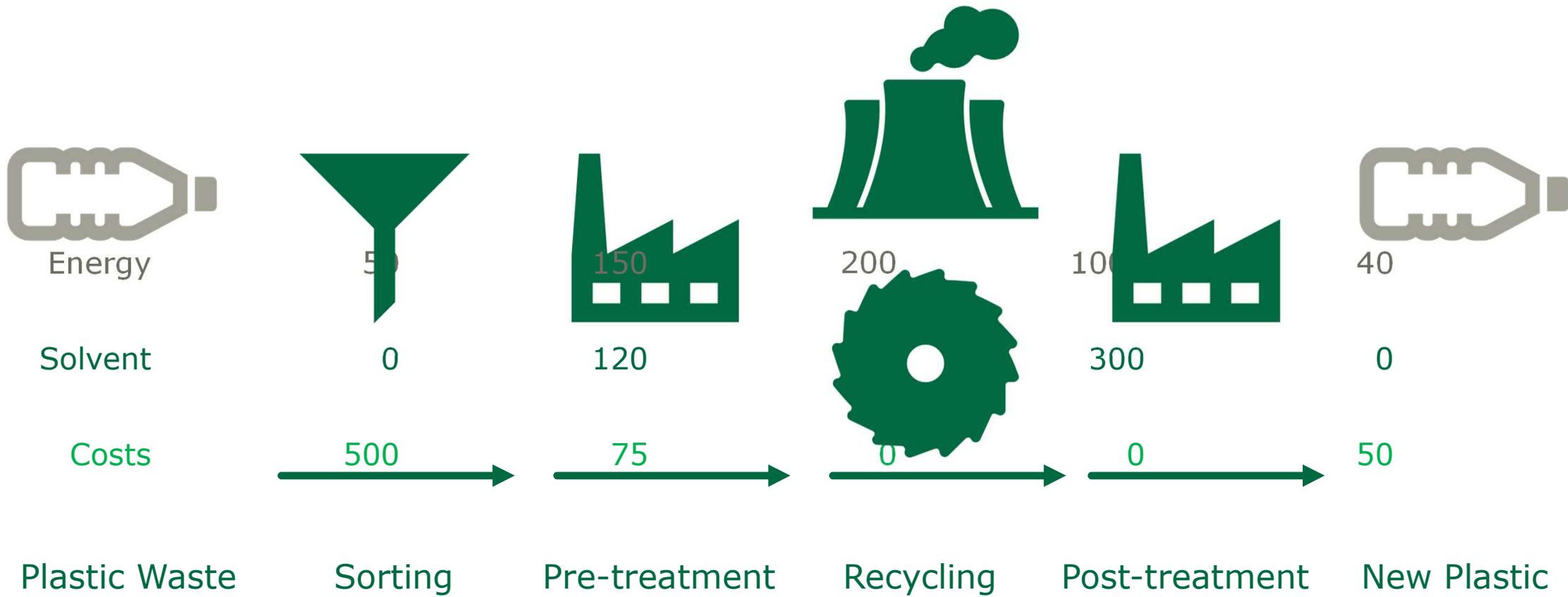
Model to find the best* recycling technology system, for a given supply and composition of plastic waste streams varying over time



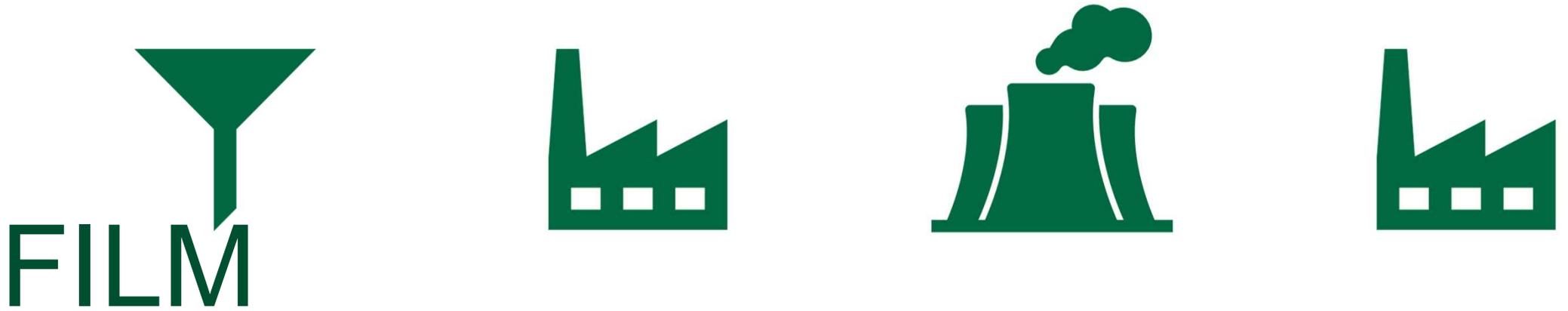
*Considering impacts and costs

Technology database

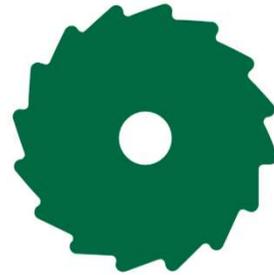
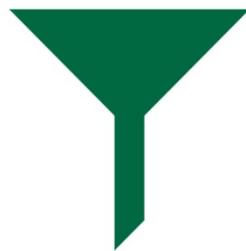
Technology database



Building a Supply Chain

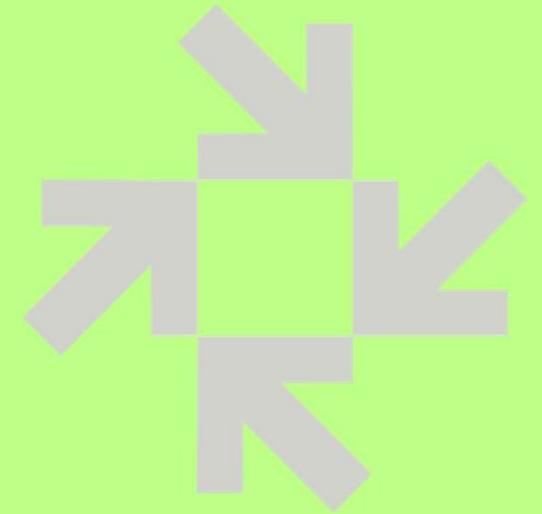


PE



CIMS

Simulating Industrial Symbiosis



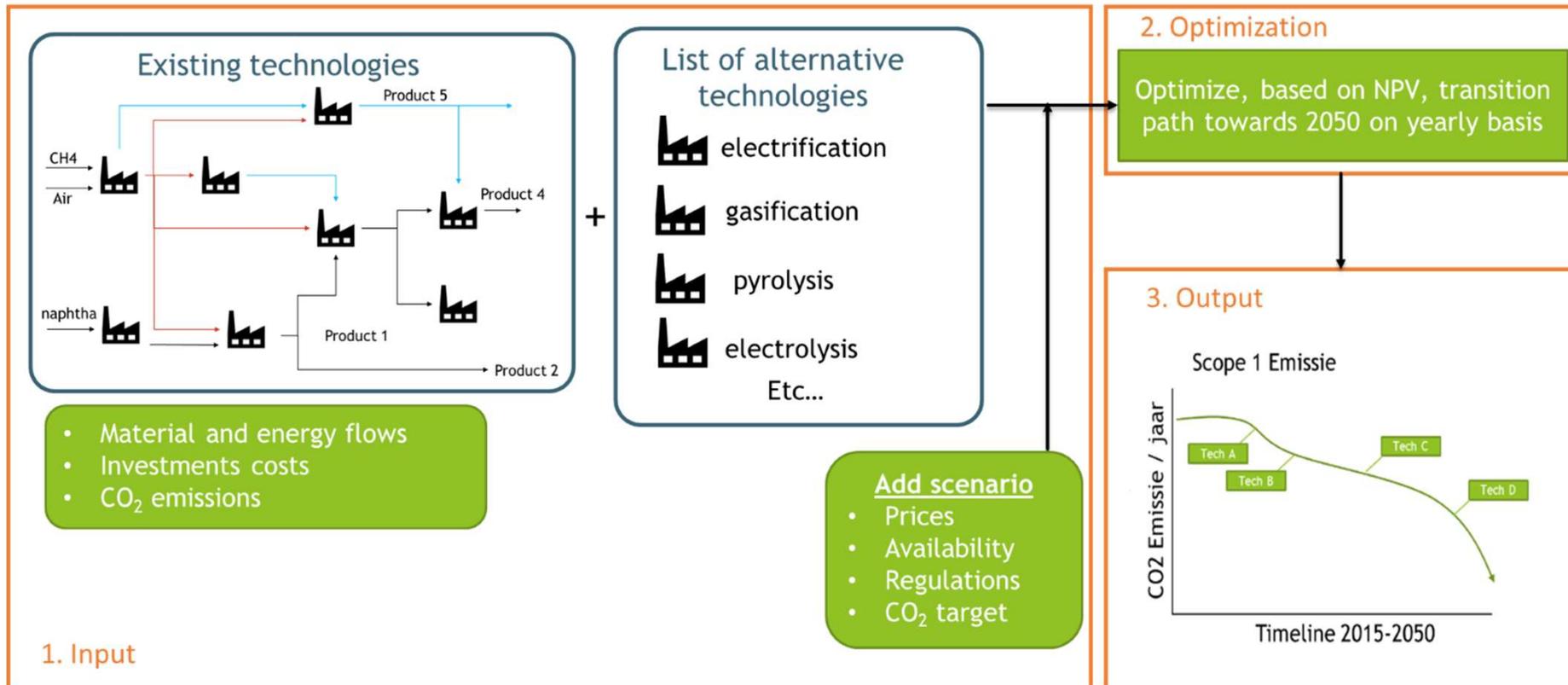
CIMS

Chemelot Integrated Model System

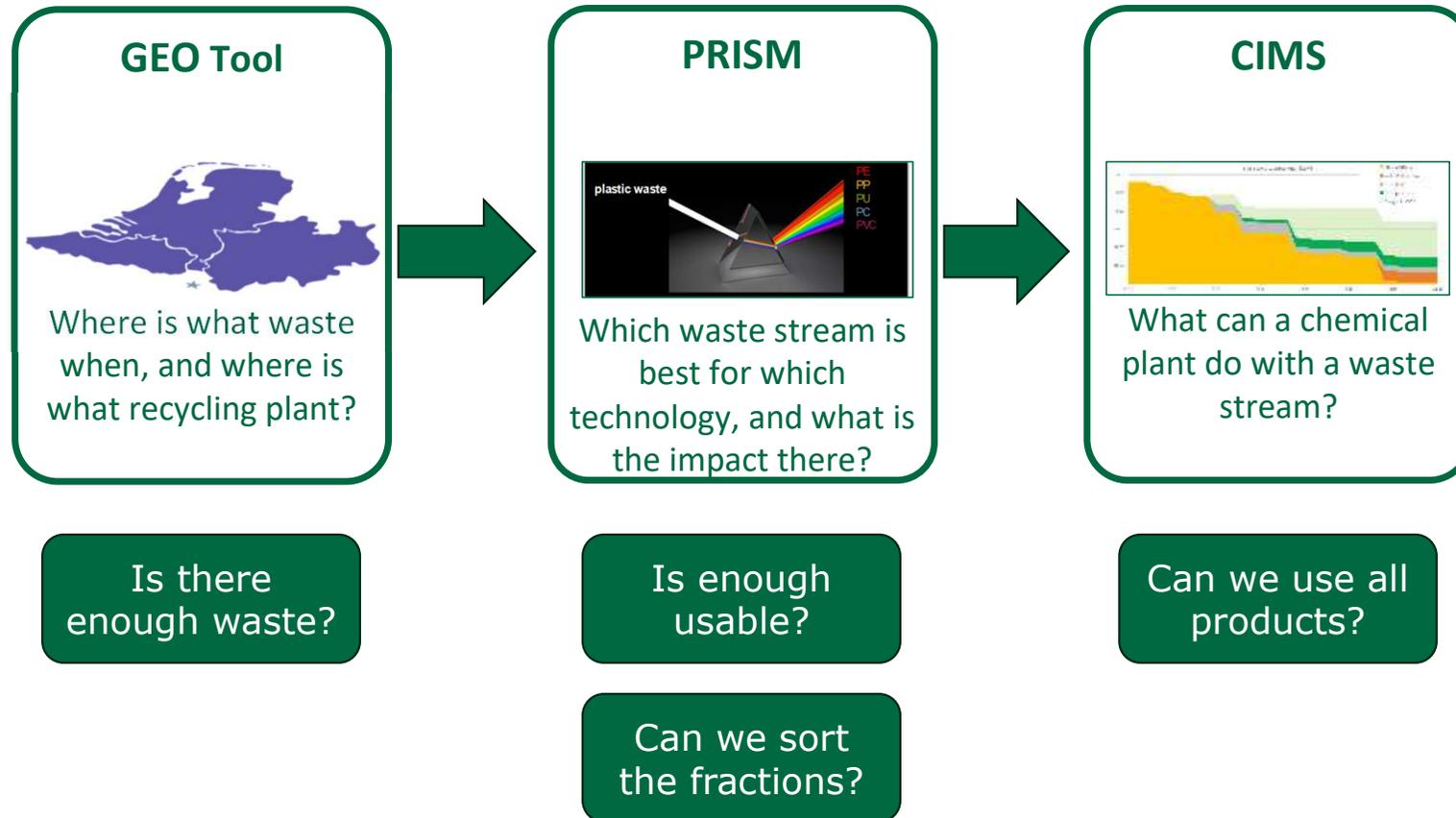
A cost-optimization model that calculates technological pathways to reach CO₂-equivalent targets over time at least system costs



CIMS Framework

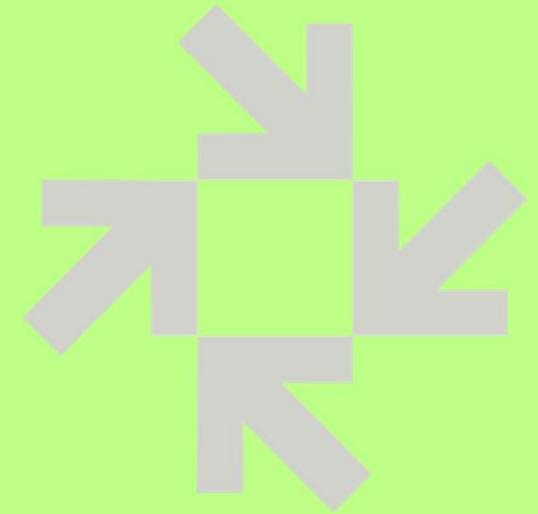


WP 7 model framework in place



WP1 – Policy Packages

Testing policy effects



WP 7 model framework in place

MEASURES: Governance & policy measures (WP1)
Social preferences & acceptance, Policy measures (regulation, financial, information, etc.)

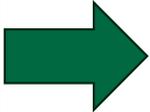
DRIVERS: Scenarios

- GDP
- Population
- Plastic demand & waste
- Prices (energy & polymers)

GEO
Geographical Information System



Localised waste forecasting & logistics optimisation costs
BUSINESS PERSPECTIVE



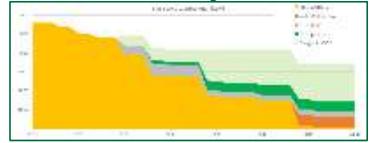
PRISM Plastic Recycling Impact Scenario Model



System optimization costs / environmental impacts / circularity;
SOCIETY PERSPECTIVE



CIMS
Chemelot Integrated Model System



Site optimization costs / CO2
BUSINESS PERSPECTIVE

Visualised Results

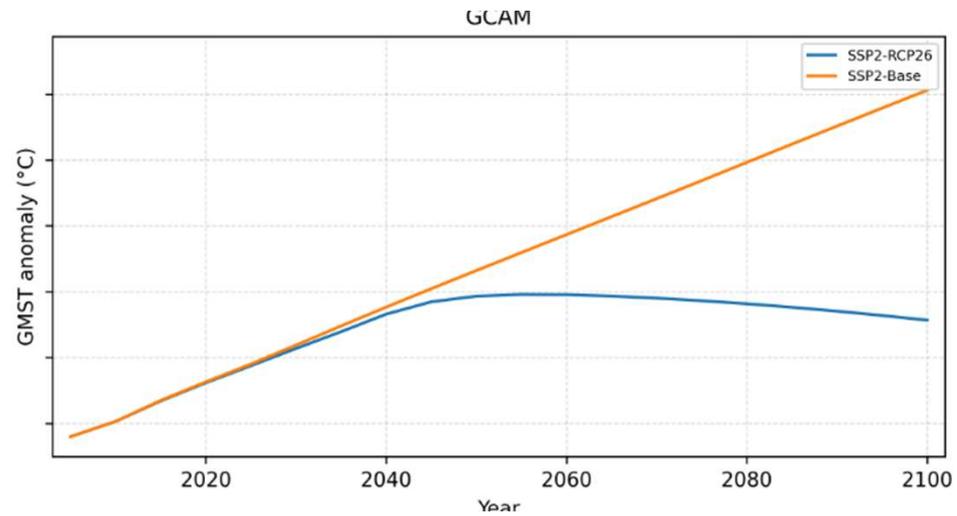
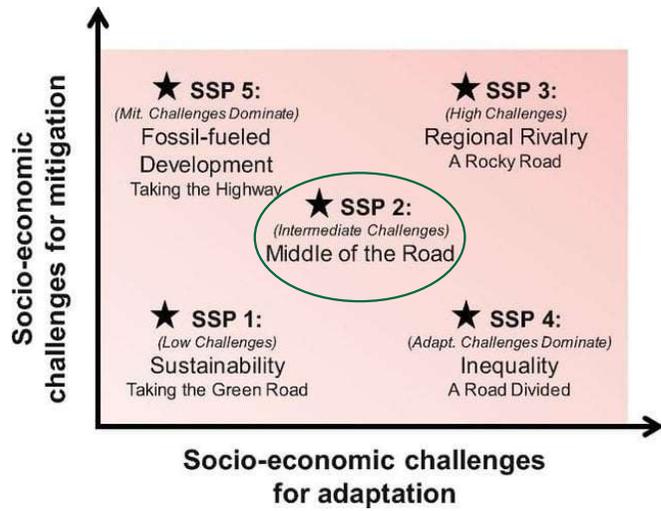
- LCA Impacts
- Shadow Costs
- Site Optimisation

System Boundaries

Dimensions	Scope	Function
Geographical	NL, BE, DE	Population, GPD
Material	(Bio-based) Plastics	Waste stream boundaries
Technical	Mechanical, Chemical recycling	Available Technologies
Temporal	2020-2060	Time over which changes happen

💡 SSPs used as foundation for temporal change within system boundaries

SSP Overview



WP 7 model framework in place

MEASURES: Governance & policy measures (WP1)
Social preferences & acceptance, Policy measures (regulation, financial, information, etc.)

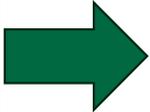
DRIVERS: Scenarios

- GDP
- Population
- Plastic demand & waste
- Prices (energy & polymers)

GEO
Geographical Information System



Localised waste forecasting & logistics optimisation costs
BUSINESS PERSPECTIVE



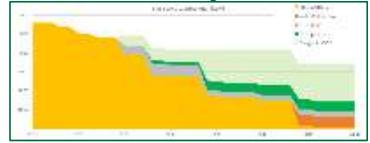
PRISM Plastic Recycling Impact Scenario Model



System optimization costs / environmental impacts / circularity;
SOCIETY PERSPECTIVE



CIMS
Chemelot Integrated Model System

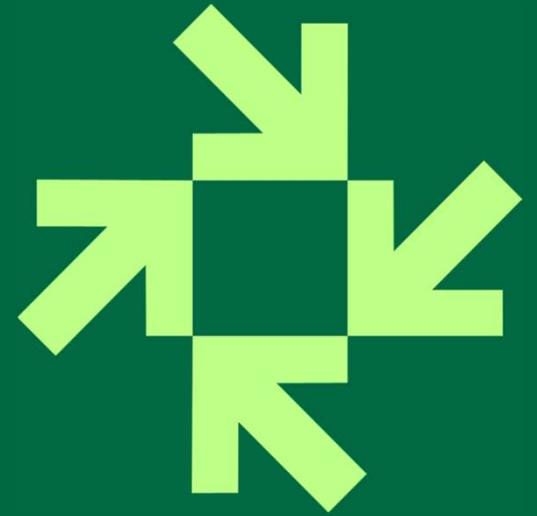


Site optimization costs / CO2
BUSINESS PERSPECTIVE

- ## Visualised Results
- LCA Impacts
 - Shadow Costs
 - Site Optimisation

	Name	Function	Effect
PP1	ERP Scheme	Carbon Credits but for plastics	Demand recycle up
PP2	Packaging Agreements	Producers set minimal production standards	More homogenous waste streams
PP3	Protectionism	EU-based industry protected with taxing	Industrial capacity remains
PP4	Eco Modulation	Recyclable products get recycling discount	Demand recycle up

Results



Background scenario & Foreground scenarios

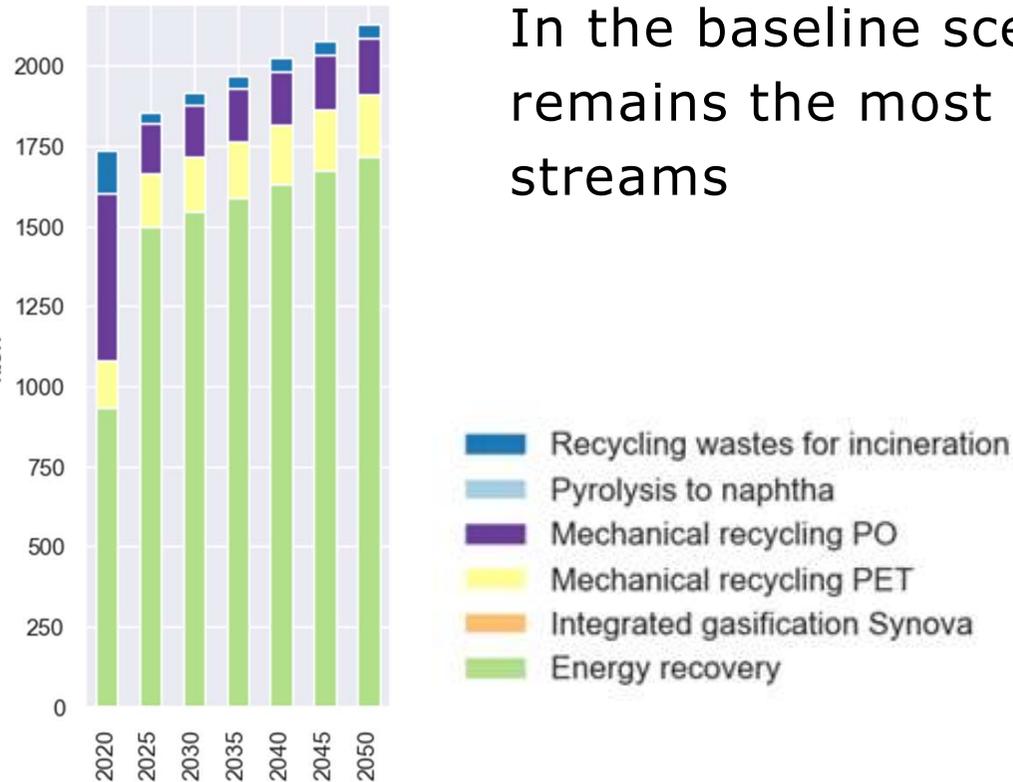
Background: Energy mix & price; CO₂-price

Foreground: Polymer mix; Collection & sorting system

Foreground scenario Background scenario	Baseline / Current plastic mix	Mixed plastic policy (in design & post consumer separation)	Mono-plastic policy (in design & separate collection)
Baseline 3.5 °C world, no CO ₂ price	Baseline 3.5 °C - BAU		
1.5 °C world, green energy mix, <u>CO₂ price</u>	1.5 °C tax - BAU	1.5 °C tax - MIX	1.5 °C tax - MONO
1.5 °C world, green energy mix, <u>optimized for CO₂ emission reduction</u>	1.5 °C potential - BAU		

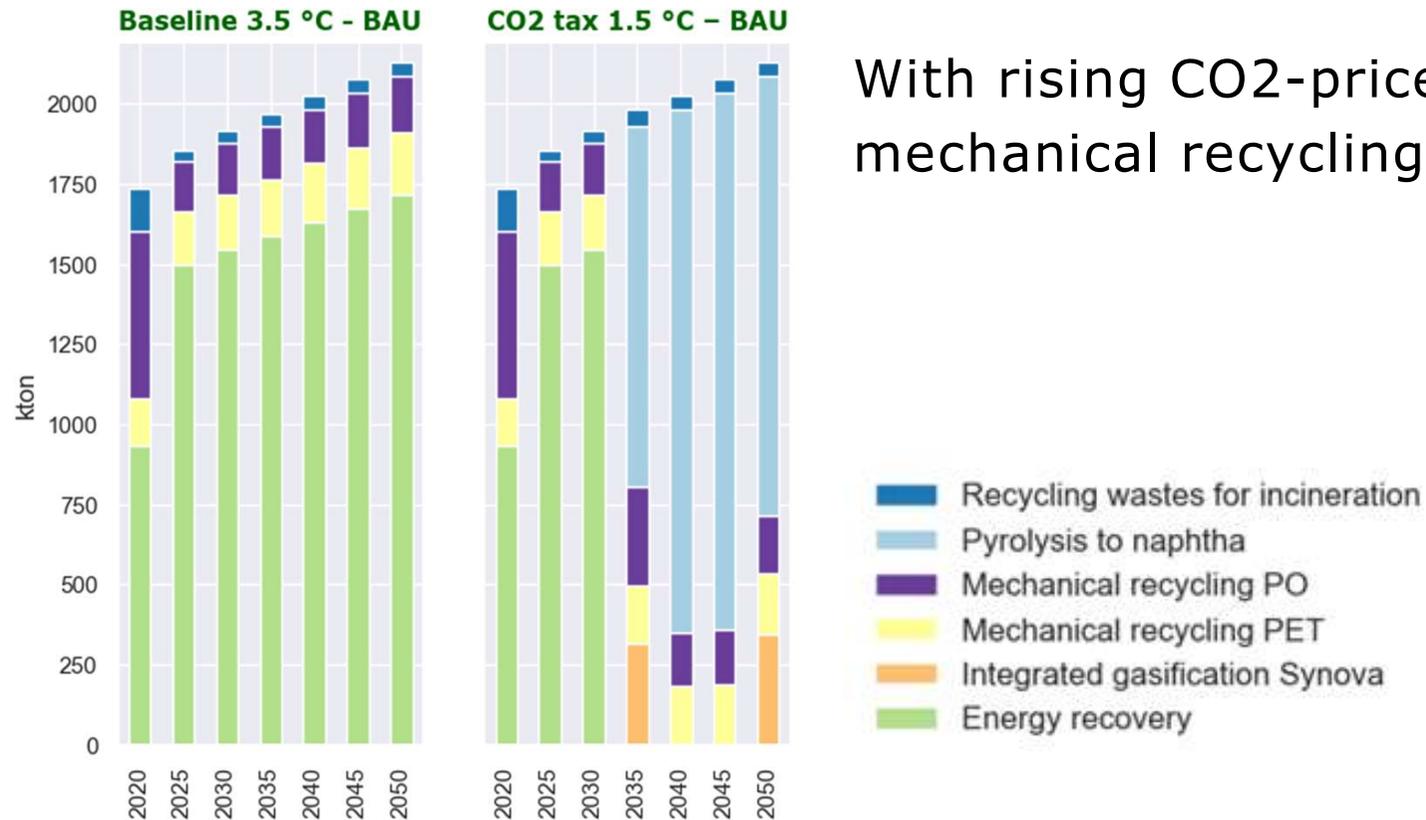
Plastic packaging waste allocation to waste treatment technologies

Baseline 3.5 °C - BAU

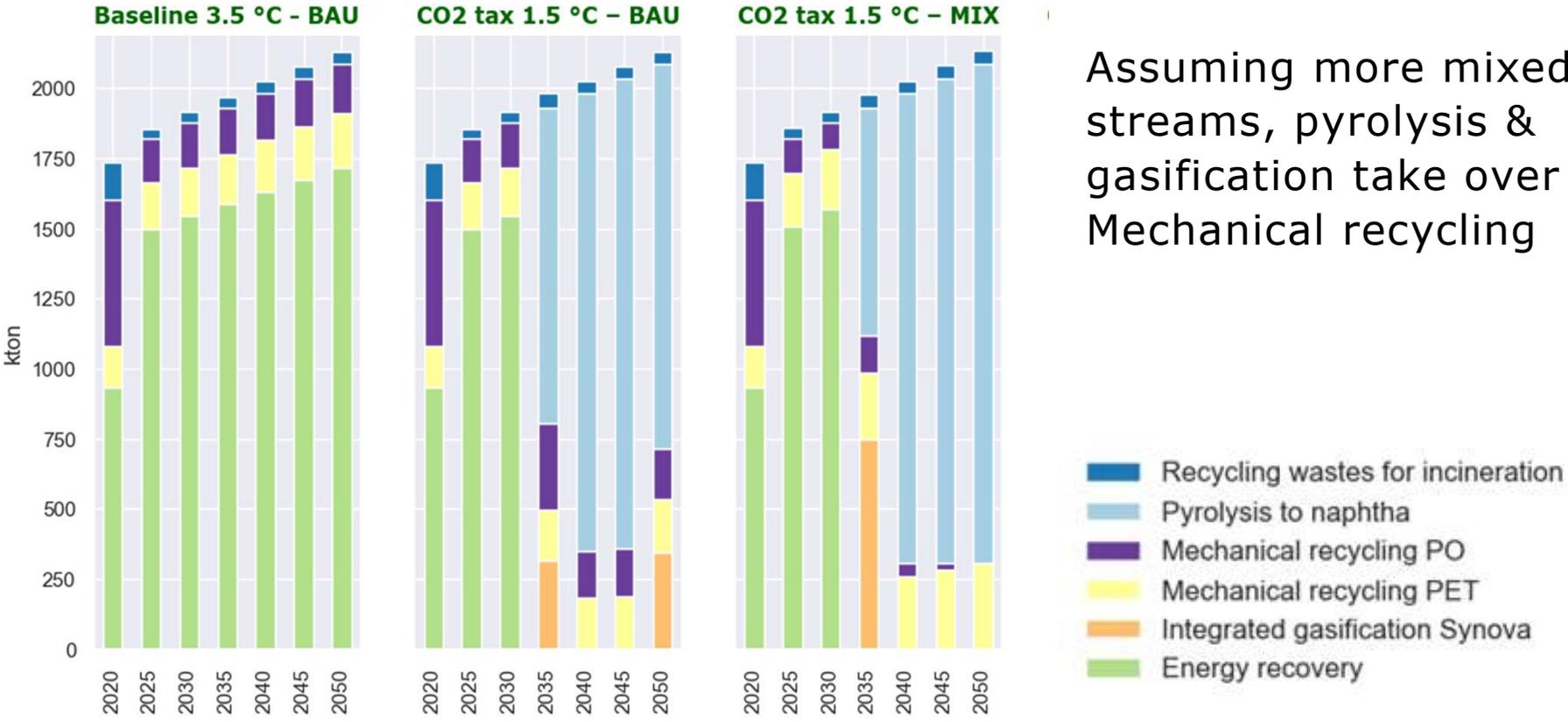


In the baseline scenario energy-recovery remains the most cost-effective for most waste streams

Plastic packaging waste allocation to waste treatment technologies

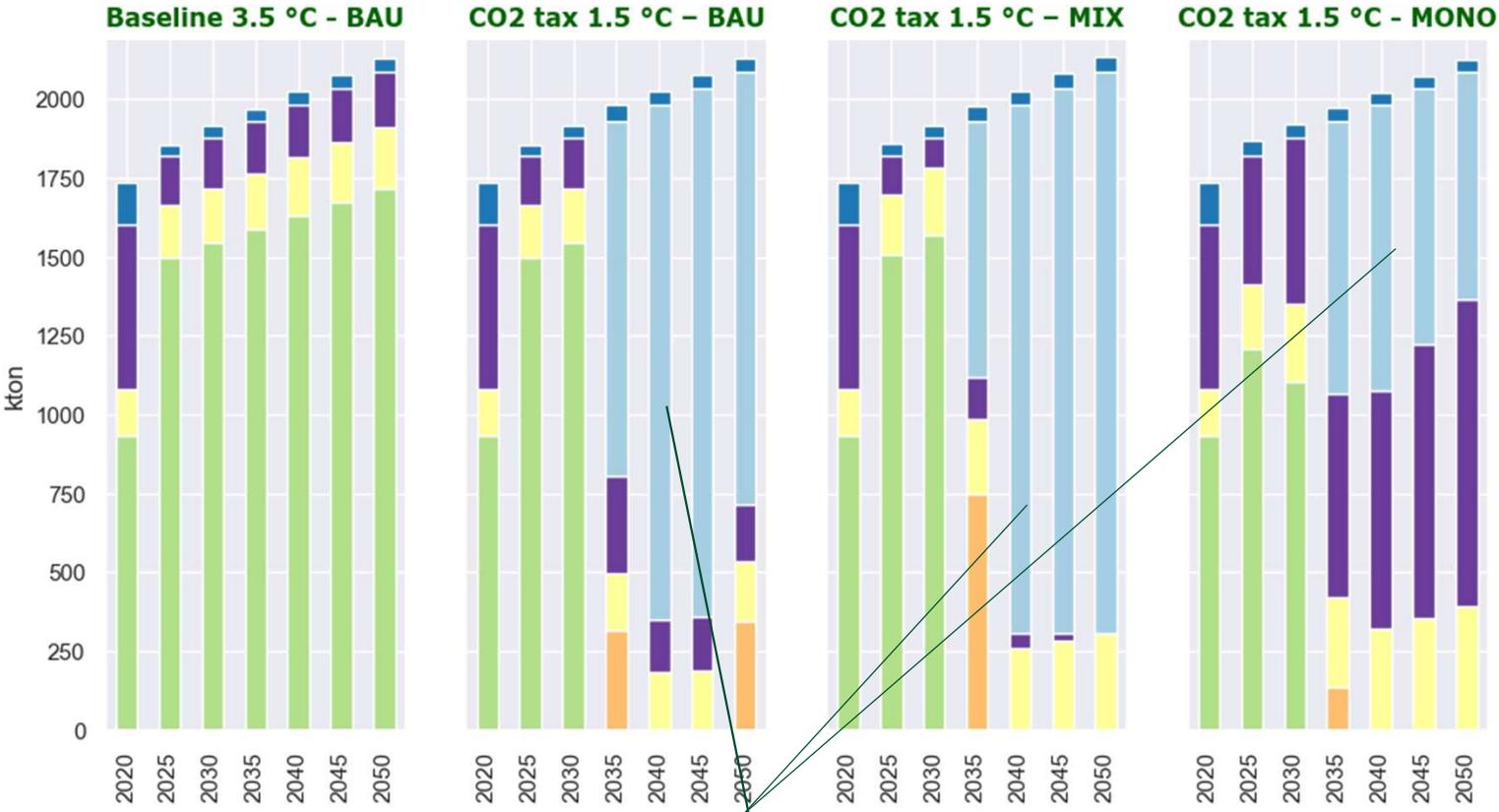


Plastic packaging waste allocation to waste treatment technologies



Assuming more mixed waste streams, pyrolysis & gasification take over from Mechanical recycling

Plastic packaging waste allocation to waste treatment technologies



With more mono-material product design & separate collection, mechanical recycling increases

- Recycling wastes for incineration
- Pyrolysis to naphtha
- Mechanical recycling PO
- Mechanical recycling PET
- Integrated gasification Synova
- Energy recovery

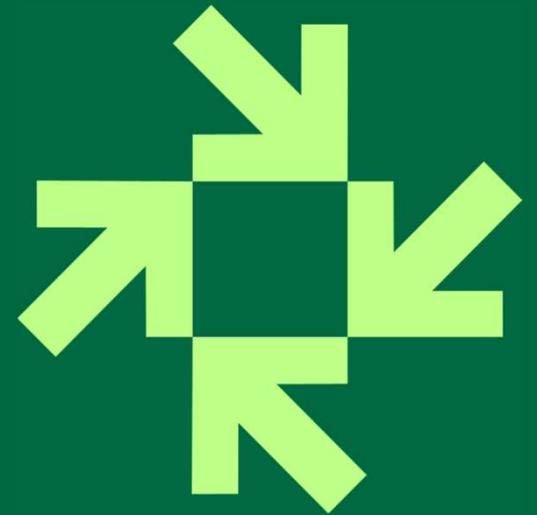


Pyrolysis waste potentials applied as input for CIMS

Applying the framework in other regions

- Data is key
 - How is waste collected
 - How is it sorted?
 - What facilities are available
 - Labour costs
 - Rules & Regulations
 - WP1 information for the “Policy Packages”
 - What is different about Lombardia?

TOK Workshop on WP2 & WP7 14-04



sjoerd.herlaar@tno.nl
for more information