TRANSIENCE

TRANSITIONING TOWARDS AN EFFICIENT, CARBON-NEUTRAL CIRCULAR EUROPEAN INDUSTRY

Dec 2025 Stakeholder engagement workshop
CEPS, December 10, 2025

TRANSIENCE: An analytical framework and its modules for assessing the European industry's path to circularity, decarbonisation, sustainability

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www.transience.eu

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Project objectives, consortium, case studies

O_1 Model enhancement & integration (producing the MIC3 model ecosystem)

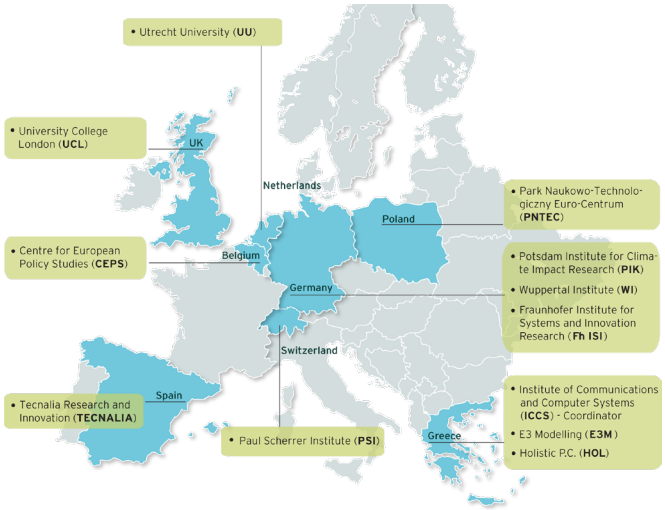
O_2 Investigation of EU industry circularity-decarbonisation-sustainability interplays

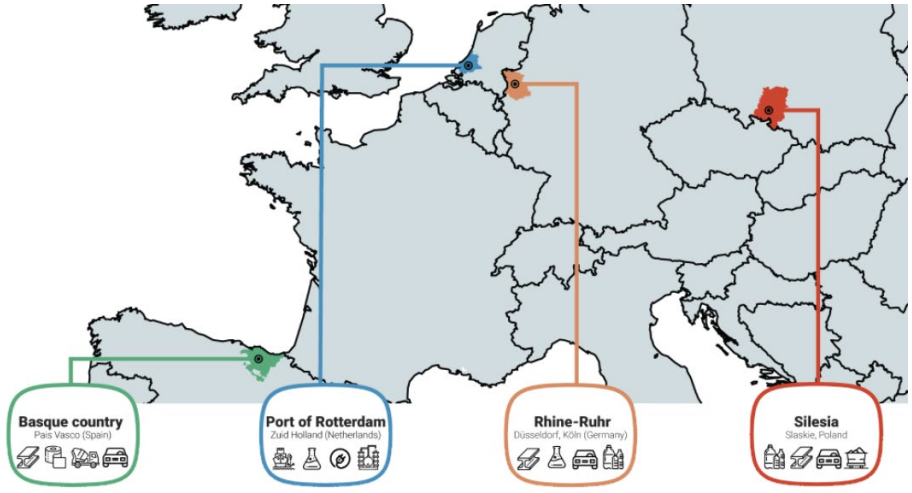
O_3 Provision of policy advice and promotion of best practice in industry

O_4 Transparency, openness, and legitimacy (open & FAIR science, IAM PARIS platform)

O_5 Reinforcing the role of all stakeholders (transdisciplinarity and validation)

O_6 Exploitation and capacity development (incl. a simplified modelling tool)





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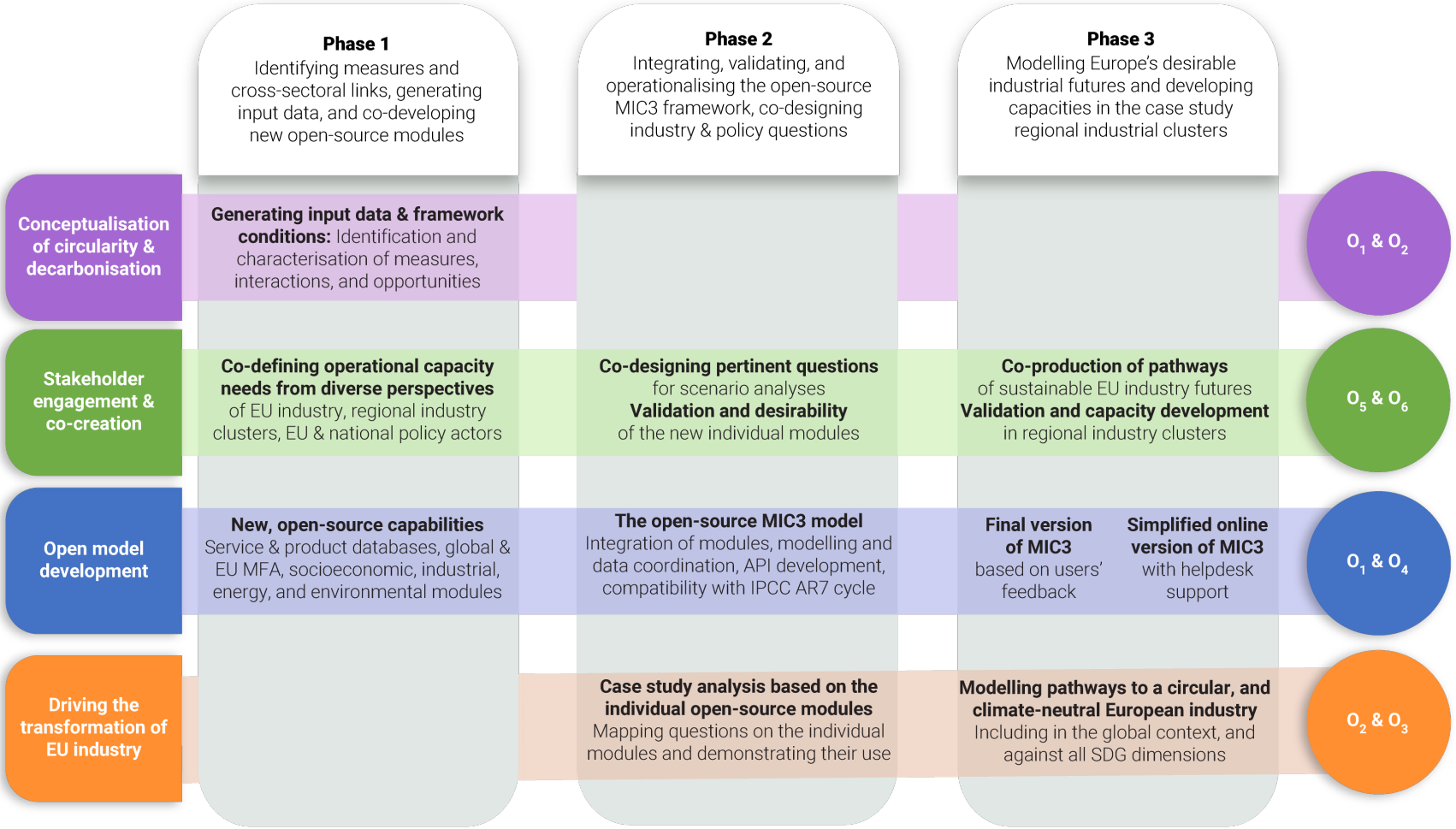
Breaking it down



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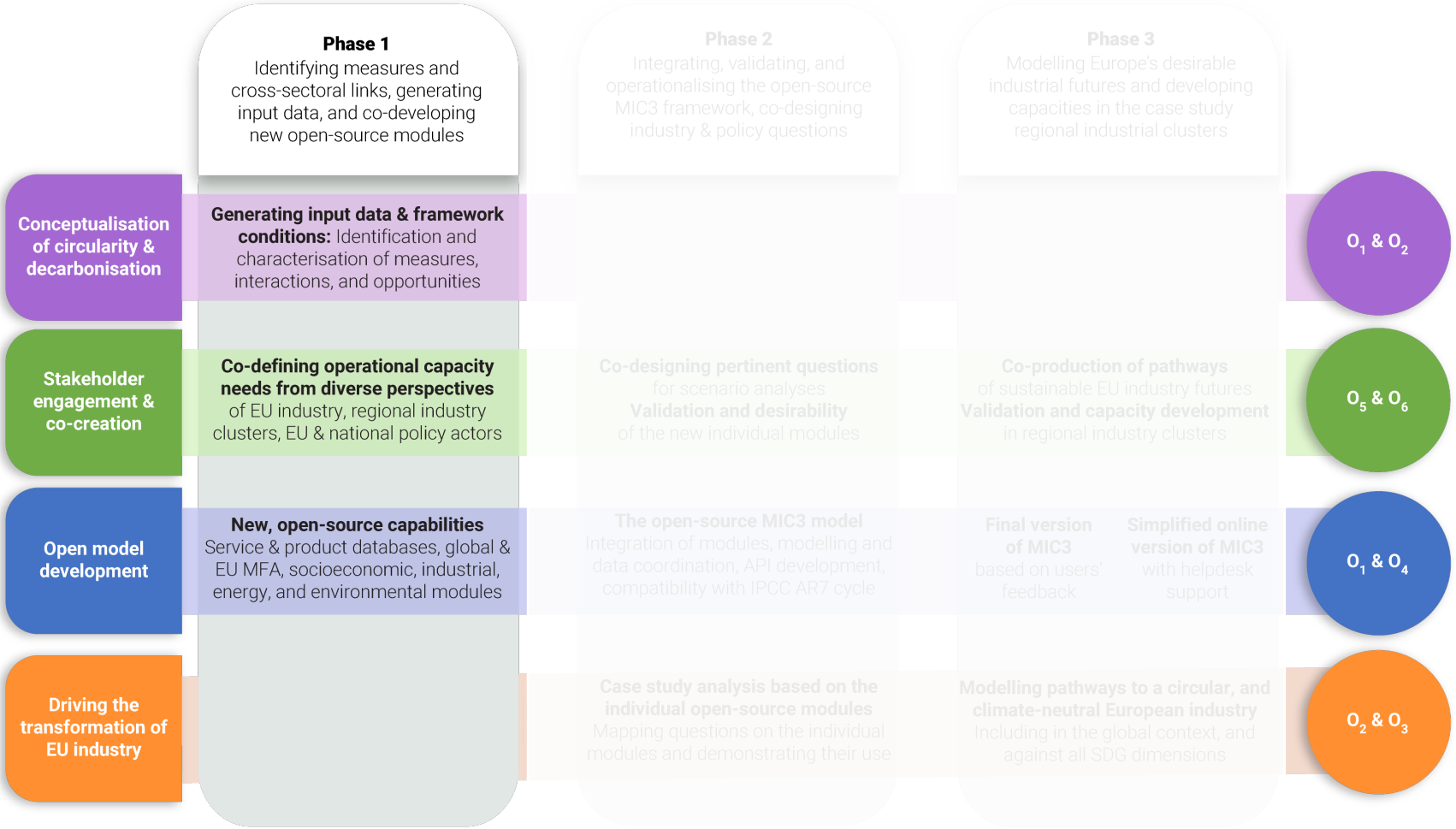
Progress in project's first phase



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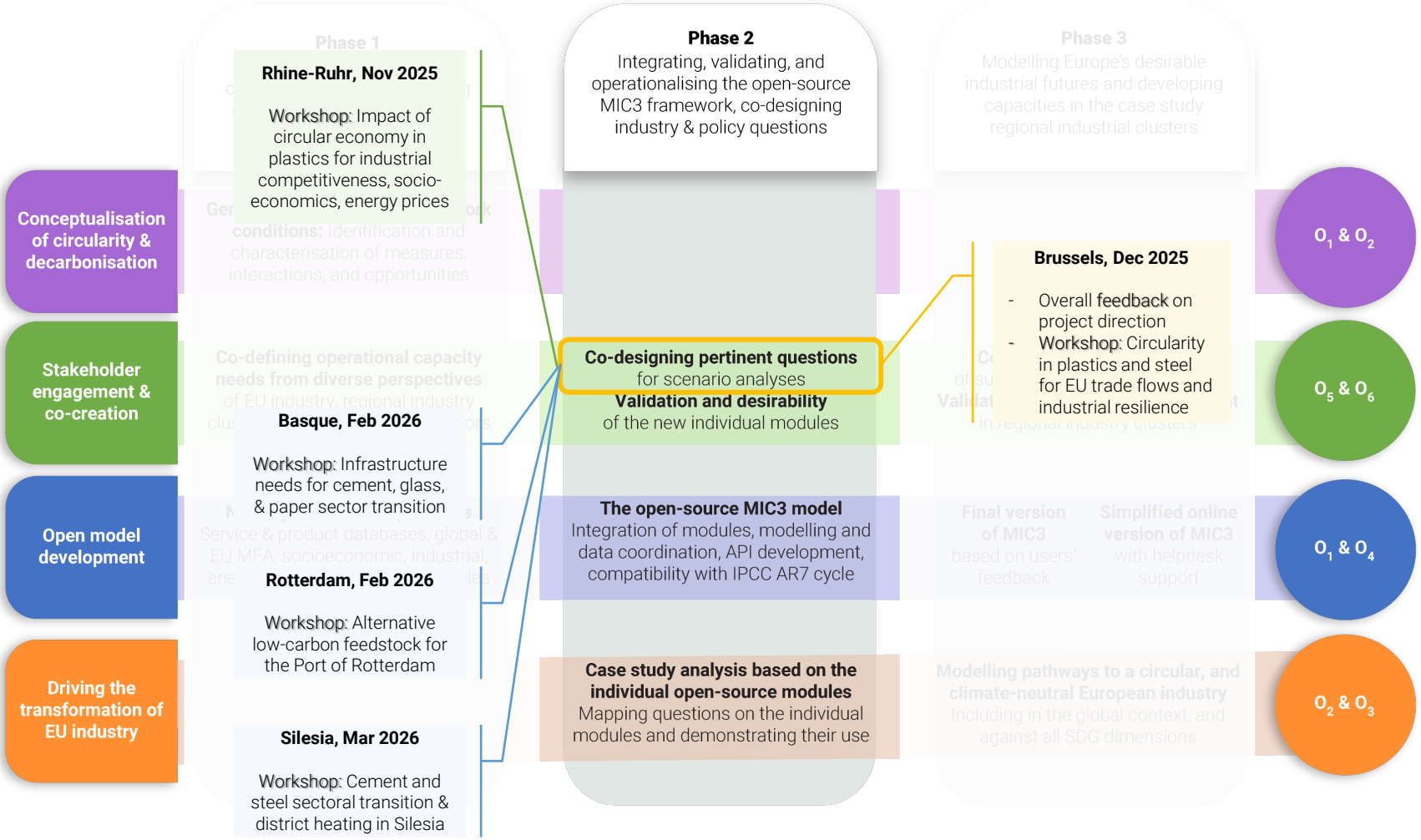
Current phase – workshop scope



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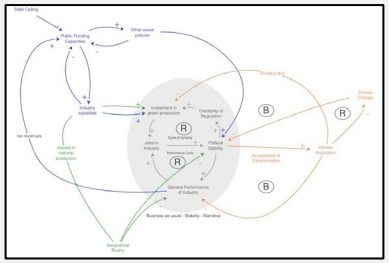
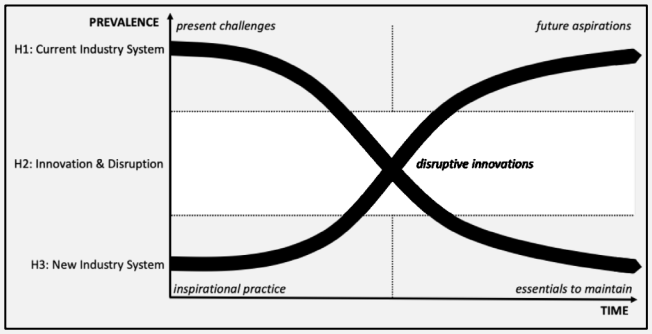
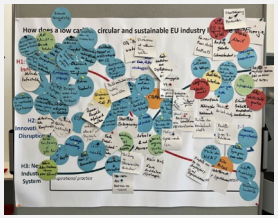
High-level research questions

- Brussels/ EU-wide
- Basque Country
- Port of Rotterdam
- Rhine-Ruhr
- Silesia







- RQ1: Modelling extreme scenarios
- RQ2: Cost of resilience measures
- RQ3: Effects of circular economy on resilience and competitiveness
- RQ4: Modelling minimal public investments
- RQ5: Socio-economic effects of industrial policy
- RQ6: Effects of green lead markets
- RQ7: Modelling the symbiosis of industrial clusters
- RQ8: Infra-structure demands of transformation
- RQ9: Modelling space constraints in industry
- RQ10: Modelling the feedstock transformation

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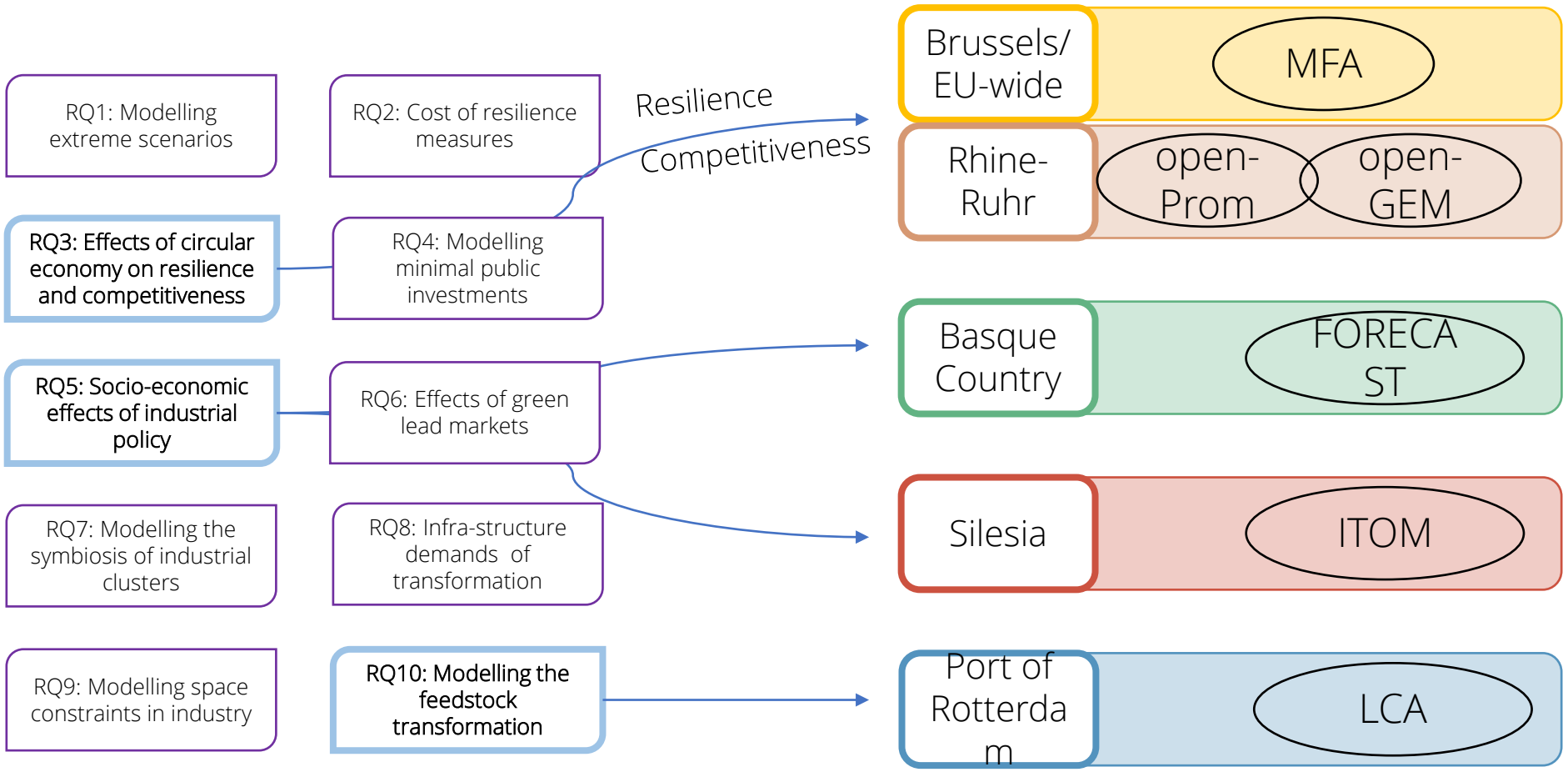
Pairing RQs with case studies



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The MIC3 ecosystem jigsaw

OPEN-GEM — Socioeconomic perspective

to study European industry in terms of global competitiveness, trade, employment, and interdependencies of industrial transformation by sector (GitHub)

P&S DB — Product/end-use perspective

to characterise, among others, key service and product specifications and characteristics, covering energy storage, associated devices, and transport service (Zenodo)

EU- & REMIND-MFA — Material perspective

to translate the demand for selected end-uses into demand for critical materials provided by industries, enhancing material stock and flow representation for all EIIs in Europe (GitHub) and globally (GitHub)

FORECAST & ITOM — Industrial perspective

to study the European industry in a bottom-up approach reaching site-level detail, considering a wide range of strategies, across industries (GitHub), and with sectoral deep dives (GitHub)

OPEN-PROM — Energy system perspective

to capture the complex links between industrial transformation and the energy transition in the EU and neighbouring countries (GitHub)

LCA-TRANSIENCE — Environmental perspective

to quantify environmental implications for climate change, human health, ecosystem quality and biodiversity, resource scarcity, and other lifecycle impacts (GitHub)

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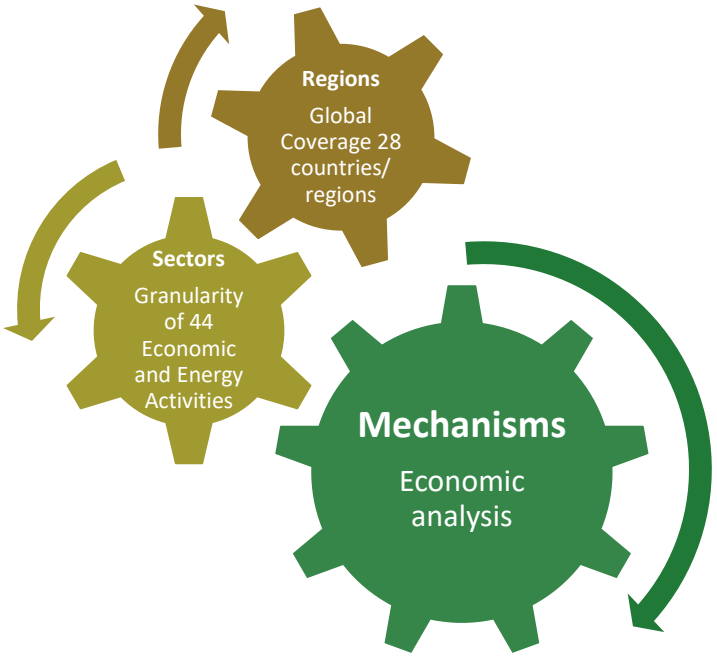
Background: Europe's transition toward circularity and decarbonisation is transforming its economic system, increasing the need for detailed disaggregation of the economic sectors to assess their impact.

OPEN-GEM simulates economic system transformations with detailed sector dynamics (both trade and intercompany)



Role in MIC3

Provides the boundary conditions of the macroeconomic system (GDP, sectoral production, trade) and assess the impacts of the twin transition on economic system dynamics and development

Accessibility

https://github.com/e3modelling/OPEN-GEM

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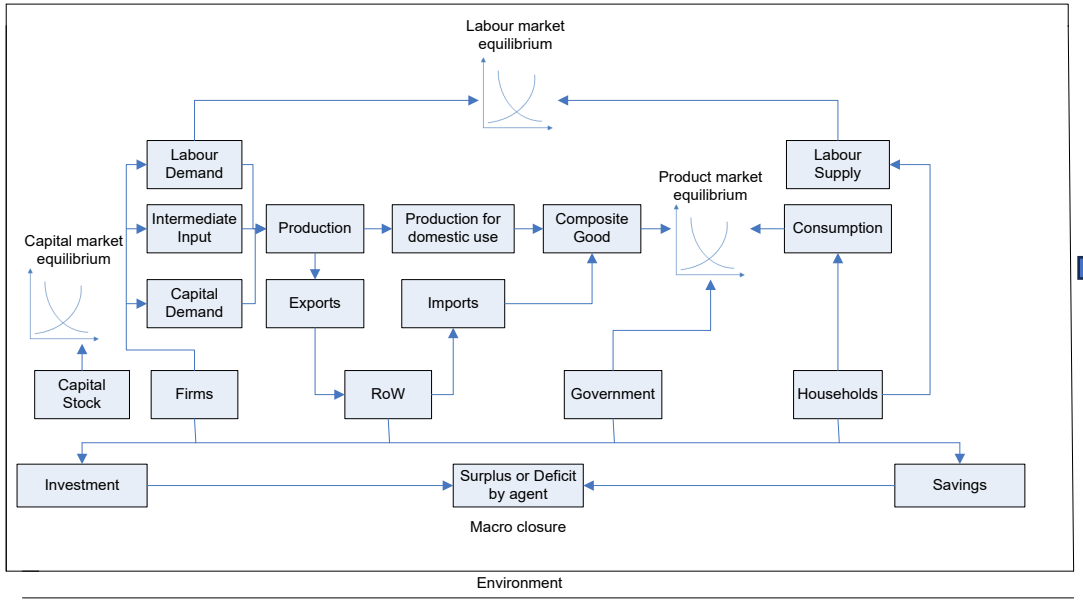
OPEN - GEM

INPUT

- Population
- Productivities
  - Total factor productivity
  - Labour productivity
- Investment
- Government expenditures
- Production scheme
- Consumption scheme
- Environmental policies and constraint



OUTPUT

- GDP
- Employment
- Consumption
- Exports
- Imports
- Sectoral Production
- Exports by sector
- Imports by sector

Core novelty

Endogenous macroeconomic projections, enhanced industrial sector modelling and integration of circular economy effects.

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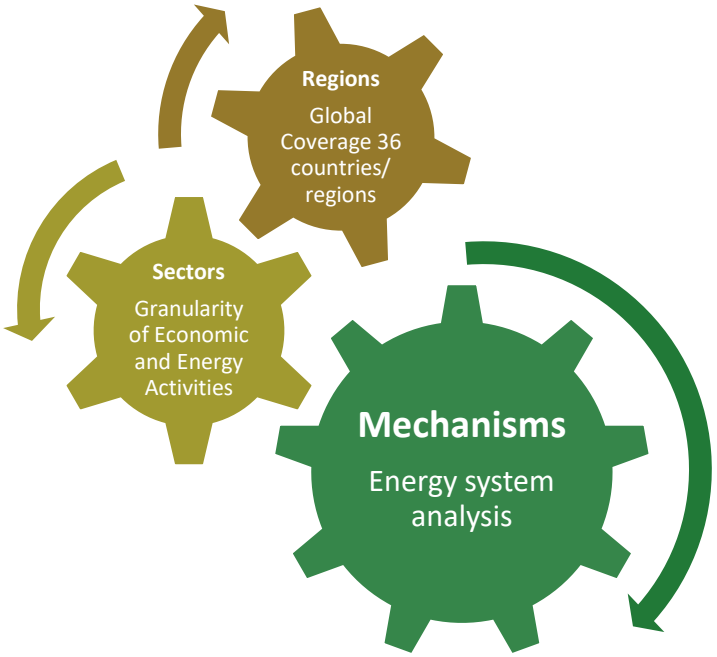
Background: Europe's transition toward circularity and decarbonisation is transforming its energy system, increasing the need for energy models to assess their impact.

OPEN-PROM simulates energy system transformations with detailed technology and sector dynamics.



Role in MIC3

Provide the boundary conditions of the energy system and assess the impacts of the twin transition on energy system dynamics and development

Accessibility

https://github.com/e3modelling/OPEN-PROM

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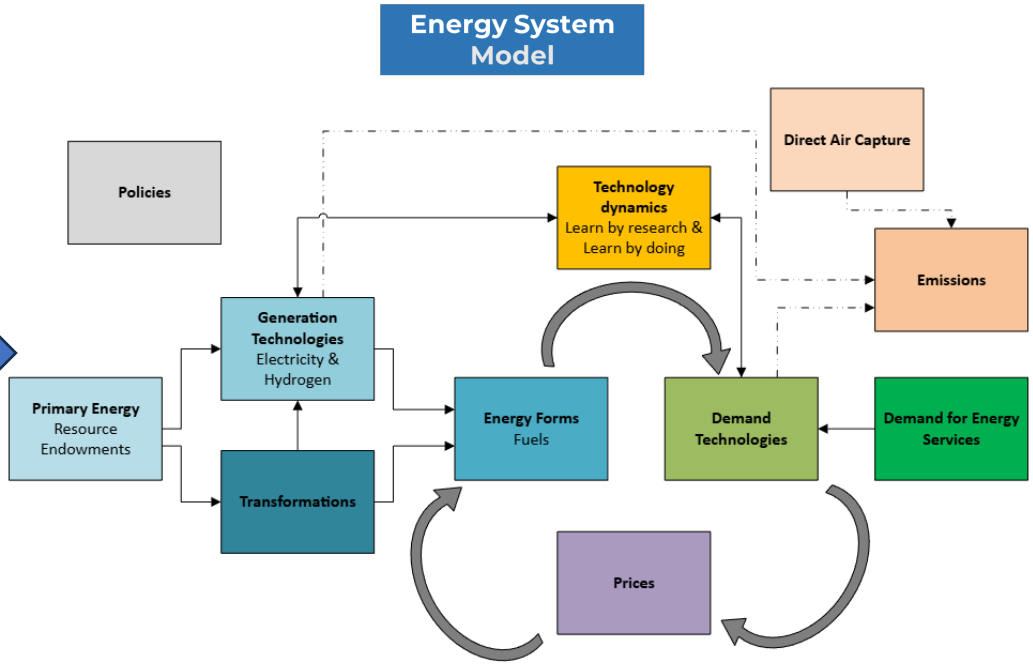
OPEN-PROM | Energy system perspective

INPUT

- Population, GDP and activity growth per sector
- Taxes and subsidies for energy products
- Interest rates, risk premiums, etc.
- Environmental policies and constraints
- Technical-economic characteristics of energy technologies (both for energy supply and demand)
- Energy consumption habits



OUTPUT

- Detailed energy balances
- Detailed demand projections by sector
- Electricity production and capacity by major technology
- Production of fuels
- Investment in all sectors, demand and supply, technology developments
- Transport activity, modes and vehicles
- Energy system costs and investment
- CO2 Emissions from energy
- Policy Assessment Indicators (e.g. imports, RES shares, costs etc.)

Core novelty

Endogenous pricing of carriers, enhanced industrial sector modelling and integration of circular economy effects.

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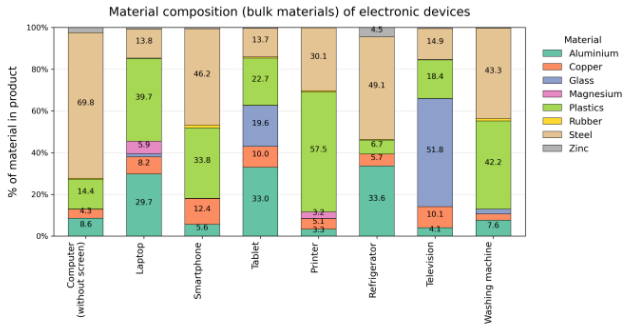
Context | Product/end-use perspective

Background: Provide detailed product information, material compositions, and supply chain-related aspects to consistently align MIC3 modules.

The product and service database provides product-specific information for MIC3.



Role in MIC3

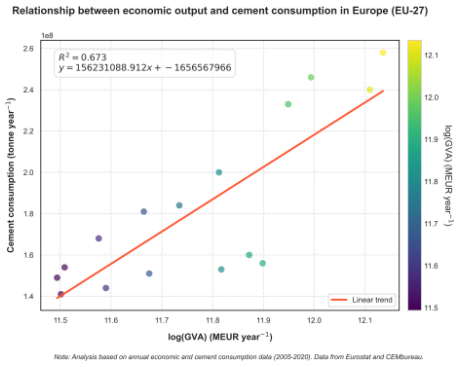
The P&S database is the “glue” that links modules throughout MIC3.

Accessibility

https://zenodo.org/records/15517592

1. Material compositions of various products, focusing on bulk and critical raw materials.

2. Translation method and data from service into product demand.



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Background: Current models fail to capture material flows and the full potential of a circular economy in combination with other decarbonisation strategies and depend on exogenous assumptions.

EU-MFA assesses potential of circularity measures for steel, plastics, and cement

Role in MIC3

Linking socioeconomic developments to industry relying on the product/ end-use perspective

Accessibility

https://github.com/wupperinst/transience-eu-mfa

REMIND-MFA assesses trade patterns in the context of the circular economy

Role in MIC3

Providing global trade flows for steel, plastics, and cement

Accessibility

https://github.com/pik-piam/remind-mfa

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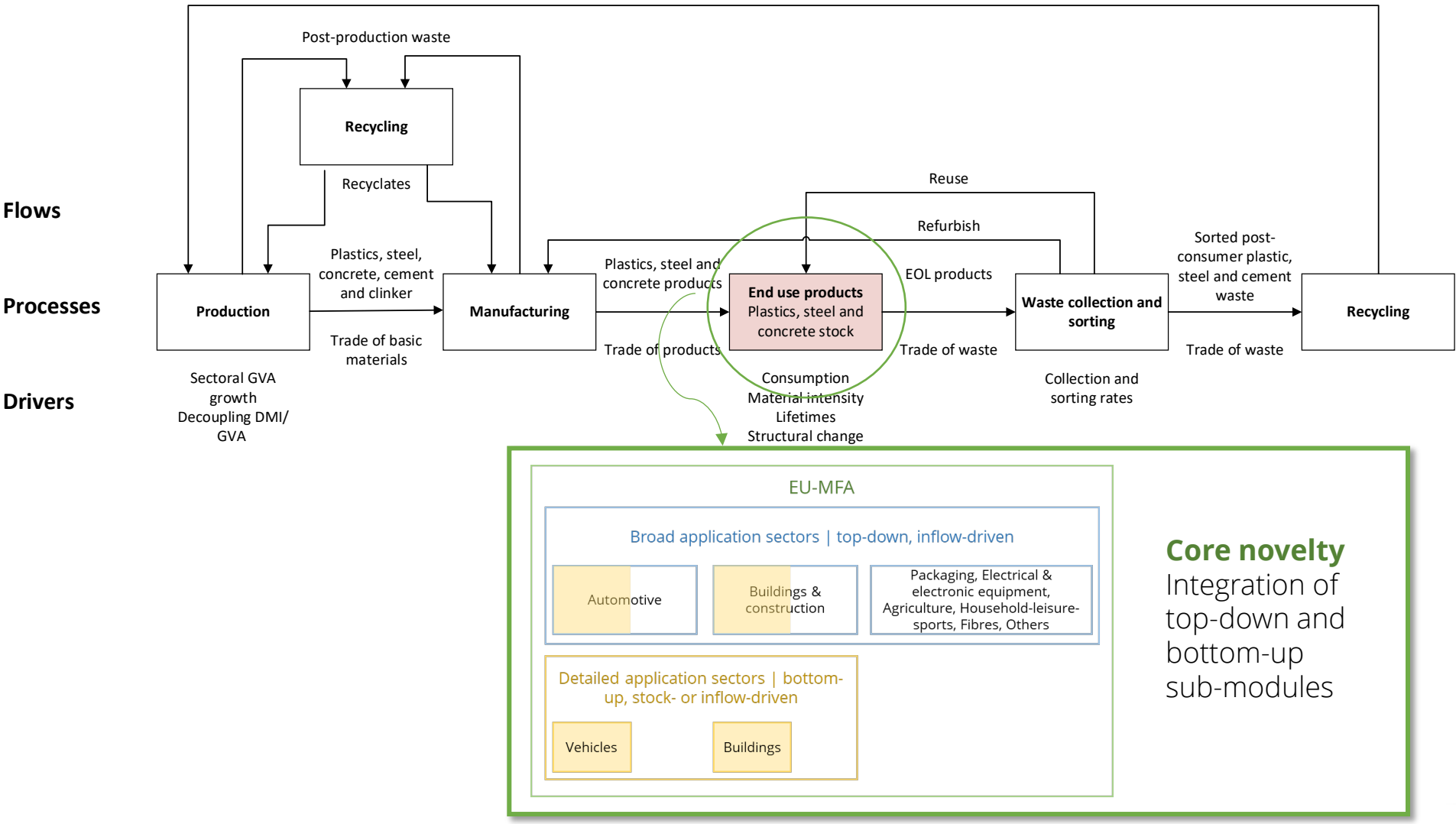
EU-MFA | Material perspective



Core novelty
Integration of top-down and bottom-up sub-modules

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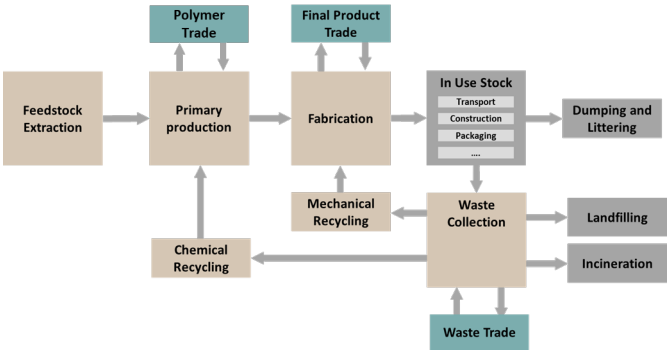
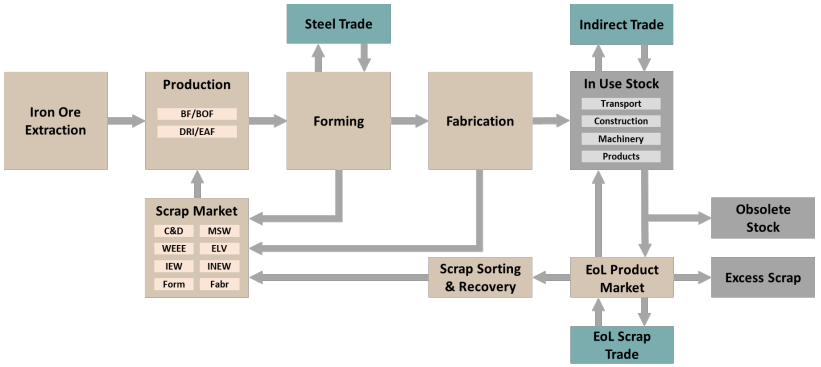
REMIND-MFA | Material perspective

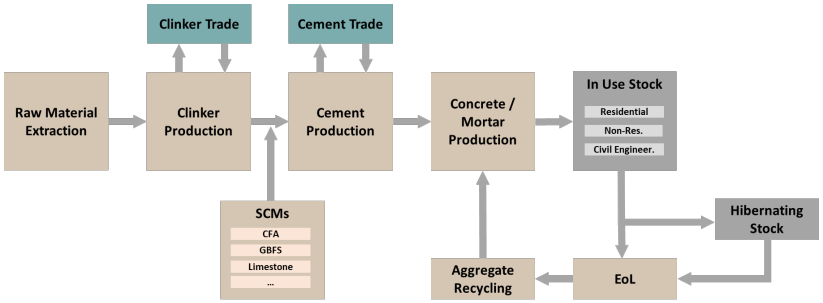
A) Plastics



B) Steel



C) Cement



Core novelty

First open-source prospective MFA of investigated materials to cover whole world and all use-sectors

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Background: The twin transition has a profound impact on energy-intensive industrial sectors. Models are needed to examine these complex systems.

ITOM analyses production systems of energy intensive industry sectors in detail.

Role in MIC3

Assessing the effects of the twin transition on industrial production networks

Accessibility

https://github.com/wupperinst/itom

FORECAST analyses industrial production across industry sectors.

Role in MIC3

Providing energy demands of industrial sector based on production and policy measures.

Accessibility

https://github.com/fraunhofer-isi/forecast-sites

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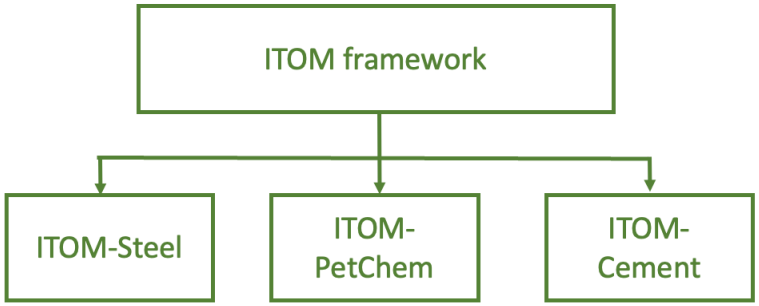
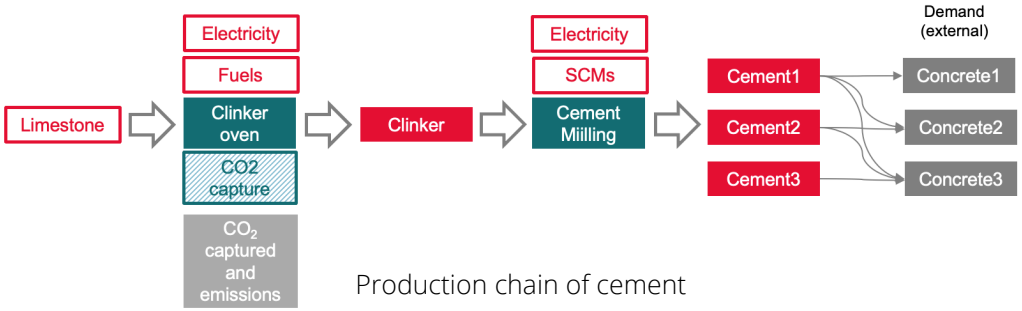
ITOM | Industrial perspective

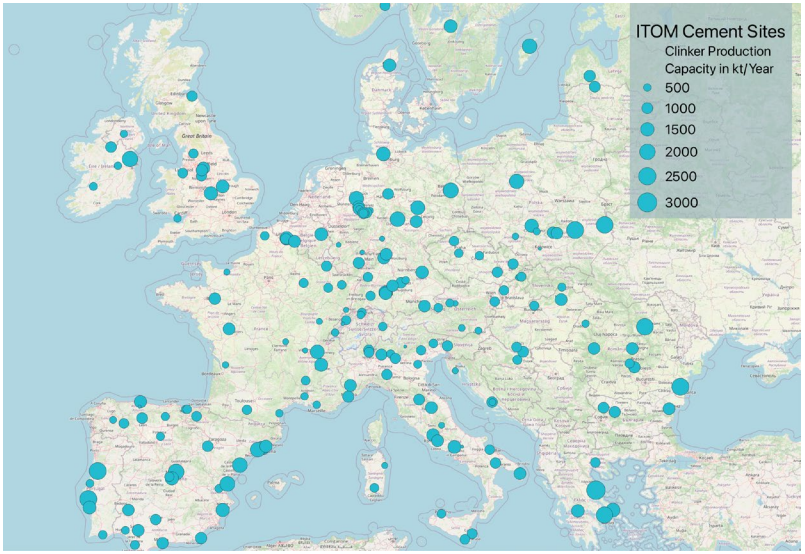


Core novelty
Model the transformation of production networks across sites and production steps endogenously

Sector module ITOM-Cement
Production chain and European site database



Production chain of cement



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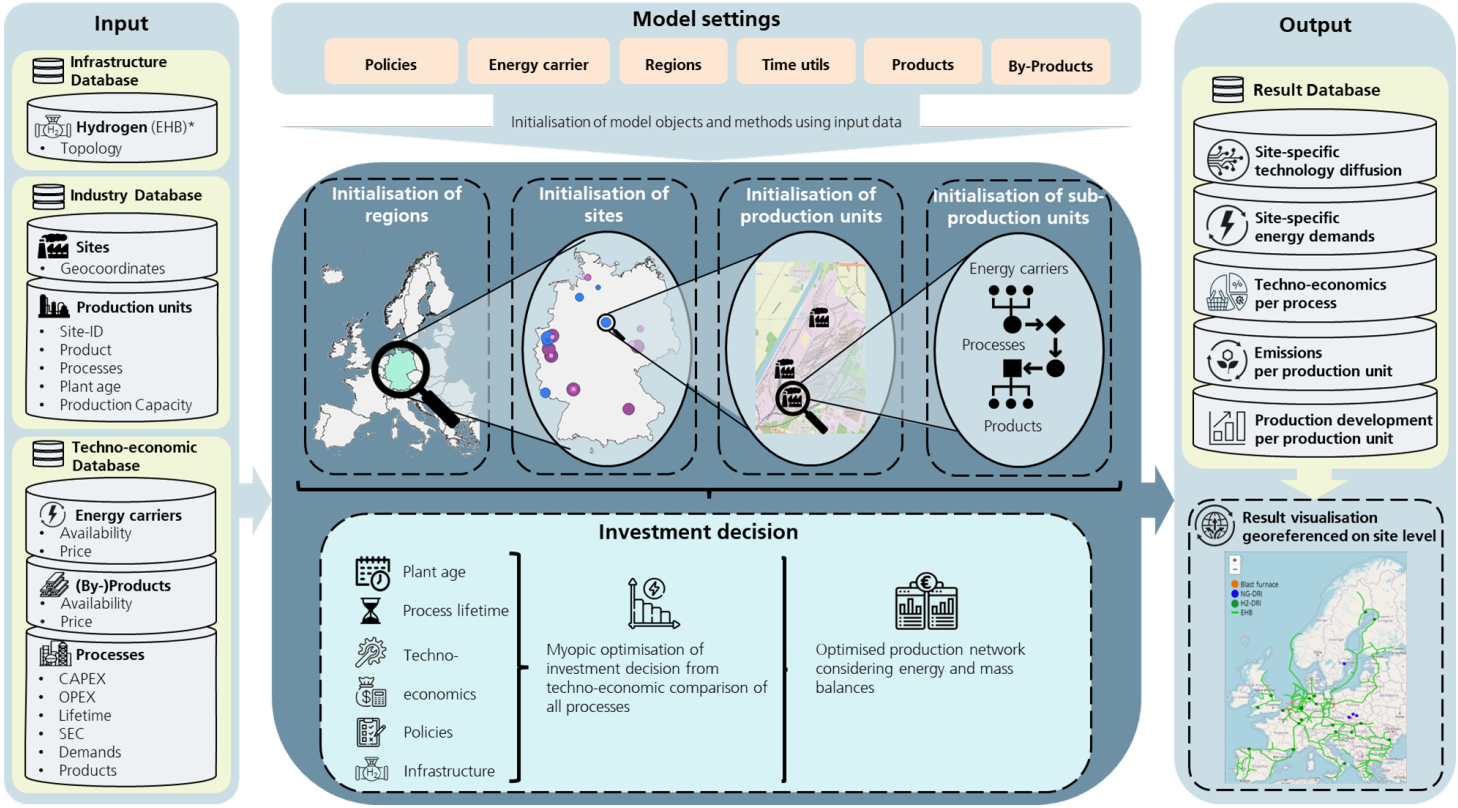
FORECAST-Sites
Production chain and European site database

Core novelty
Model the transformation of sites across Europe of several industry sectors considering production networks with side and intermediate products.



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Background: Current models fail to calculate the life cycle environmental impacts of products, industry transformations, and entire energy system modelling transitions based on consistent prospective changes of European decarbonization pathways.

LCA-TRANSIENCE assesses the environmental burdens of entire MIC3 pathways and/or industrial energy transformations.

Role in MIC3

Linking socio-economic pathways from MIC3 to life cycle environmental burdens.

Accessibility

https://github.com/tomterlouw/lca_transience

Beyond life cycle GHG emissions, we are able to quantify life cycle impacts on (critical raw) materials, human toxicity, and water (scarcity), and other environmental impacts.

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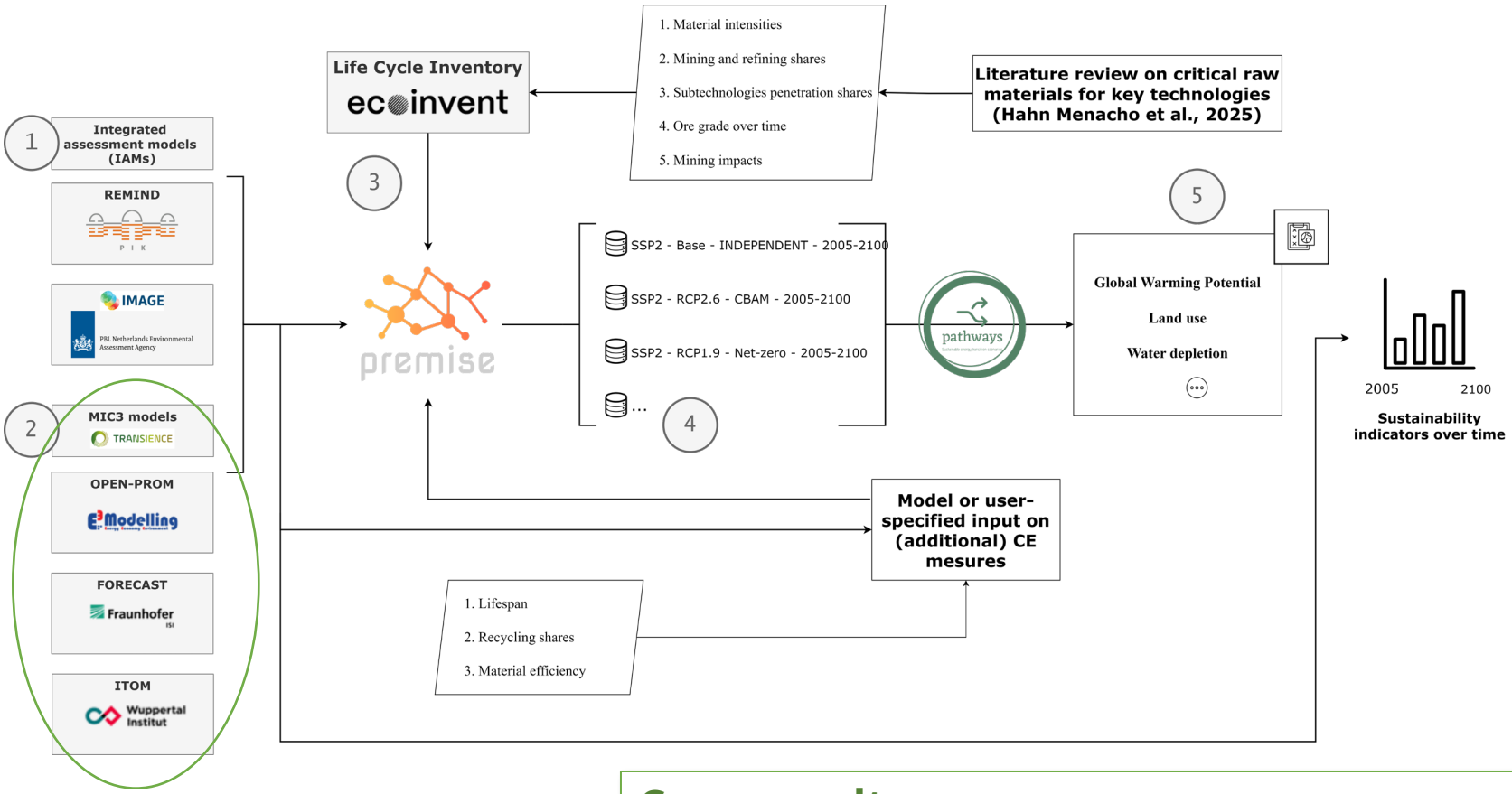
LCA-TRANSIENCE | Life cycle perspective



Core novelty

First LCA-based assessment framework to analyse the LCA impacts of entire (or industrial-specific) European transition pathways.

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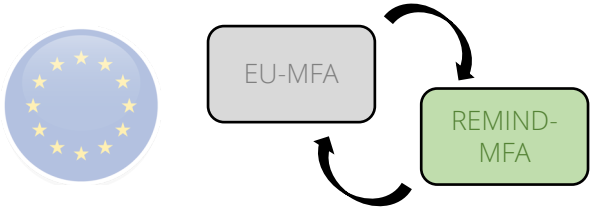
Which effect can circularity strategies have on EU trade flows and industrial resilience?



Modules and approach

Modelling the effect of circularity measures on material demand & secondary material availability in the EU using **EU-MFA**; harmonising changing global trade flows with **REMIND-MFA**

Scope and scenarios

Focusing on two circularity cases—i.e., **plastics packaging** and **passenger cars**—and analysing separate scenarios for individual circularity measures

Stakeholder engagement (see second part of today's workshop)

Gathering input to substantiate the scenario narrative and validating circularity indicators for each case/circularity measure

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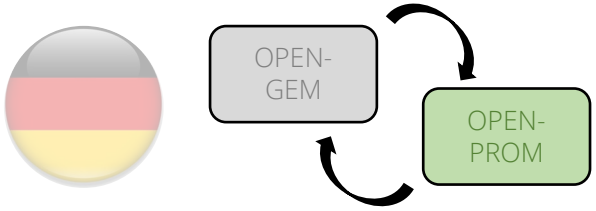
Which effect can circularity strategies have on resilience and competitiveness of EU industries?



Modules and approach

Modelling the impact of circularity measures – share of primary and secondary sectors using **OPEN-GEM**; harmonising activity of industrial sectors with OPEN-PROM

Scope and scenarios

Focusing on the chemical sector —i.e., **primary** and **secondary plastics**—and analysing separate scenarios to assess the impact on socioeconomic indicators and energy prices

Stakeholder engagement (Nov 2025)

Gathering input to substantiate the scenario narrative and validating circularity indicators for each case/circularity measure

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Which is the optimal technology configuration and what infrastructure is required?

FORECAST
-Sites

Modules and approach

Applying and validating Forecast-Sites.

Scope and scenarios

Evaluating transformation scenarios for the cement, glass and paper production in the Basque country, considering conventional and climate neutral technologies.

Stakeholder engagement (Feb 2026)

TRANSIENCE workshop in planing (February 2026) to align and improve the current research question, assumptions, and validate first results, ensuring that the model development is tailored to the interest of local stakeholders.

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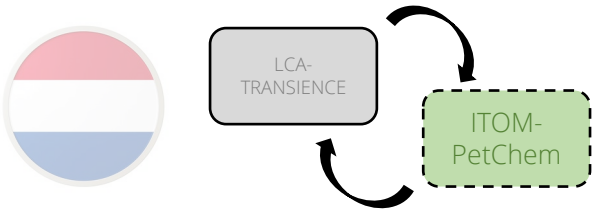
How does switching to low-carbon feedstocks affect costs and environmental burdens in the port?



Modules and approach

Applying and validating the Environmental LCA module (likely) complemented by external energy model outputs to capture feedstock trade-offs, system interdependencies, and cross-sector effects.

Scope and scenarios

Evaluating transformation scenarios for alternative carbon feedstock for the Port of Rotterdam, which may range from (simplified) LCA supported by integrated assessments using (external) energy system models.

Stakeholder engagement (Feb 2026)

TRANSIENCE workshop planned with the Port of Rotterdam (February 2026) to align and improve the current research question, assumptions, and potential data exchange, ensuring that model development is tailored to the interest of the Port of Rotterdam (and its stakeholders).

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What challenges/opportunities arise in a coal-heavy region from transition and energy demand shifts ?

Modules and approach

Modelling transformation pathways for the cement and steel sectors, validating the newly developed **ITOM-cement** module, building on existing knowledge from **ITOM-steel**.

Scope and scenarios

Transformation scenarios for the **cement and steel sectors** at the European level with zoom in on Poland; further analysis of these sectors and **district heating** in Silesia; implications for energy demand and impacts on the coal sector.

Stakeholder engagement (Mar 2026)

Validating scenario narratives and assumptions, discussing results with industrial companies and energy utilities, ensuring alignment with regional development strategies and national energy policies (e.g. PEP2040+, NECP).

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Thank you!

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