MatMat :
A energy-material-economy integrated model for prospective analysis at national level

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14 novembre 2024

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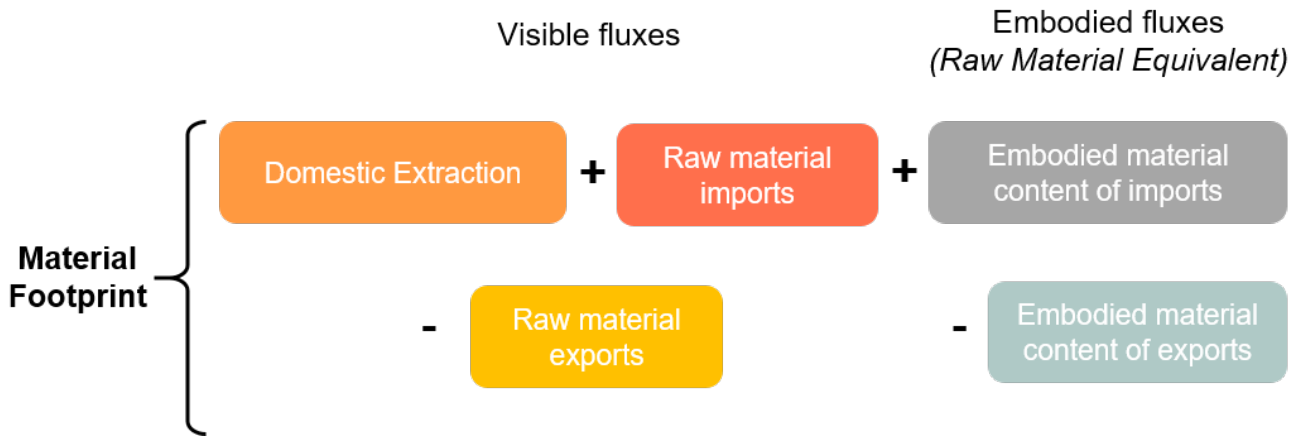
Why MatMat model ?

- **Material is a key lever of energy transition**
  - Domestic consumption levels ⇒ material production and imports ⇒ imported material and GHG footprints
  - (Green) investments require materials
  - Material efficiency can help reduce emissions (lighter cars, etc.)
- **Lack of integrated tools for prospective analysis on material-energy-economy issues**

Evaluating future material needs and GHG emissions

Scientific challenges of material description :

- Realistic description of material fluxes
- "Physical" projections of demand
- Life-cycle approach to encompass environnemental impacts across the whole value chain $\Rightarrow$ Material Footprint



Evaluating future material needs and GHG emissions

Development work on MatMat

- **A footprint-based methodology for evaluation of environmental impacts. Description across value chains, per products, location, final consumers.**
- **Prospective modeling functionalities. Able to combine sectoral expertises and macroeconomic trends.**
- **Input-Output database for France in hybrid units (material / energy / GHG)**

"MatMat" = *Material Matrices*.
Model developed since 2019 by CIRED-ADEME-SMASH to study environemental footprints of national energy transition scenarios.

✓ **Open-source publication is coming soon**

MatMat technical description

Main characteristics

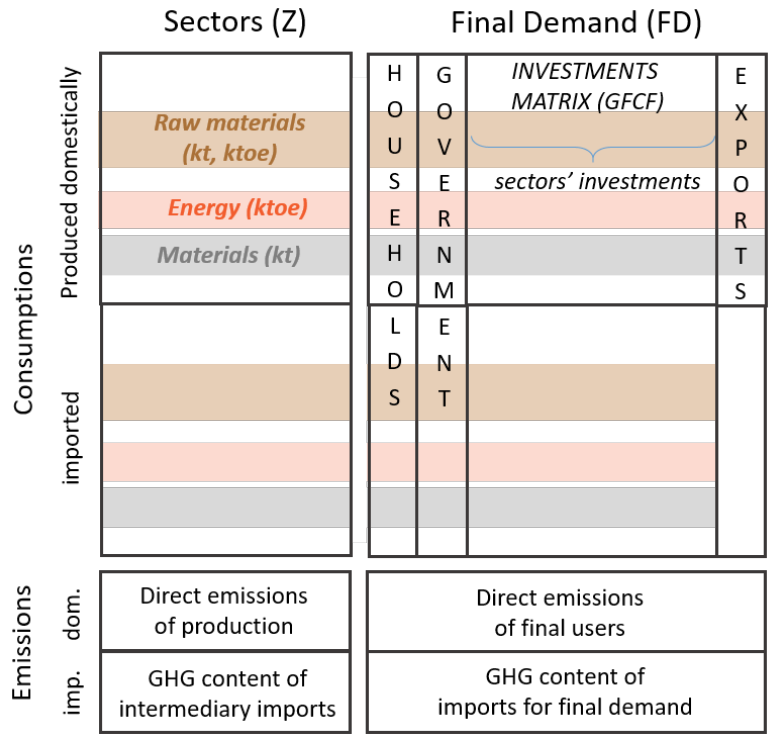
Calibration :

- Single-region input-output structure based on Exiobase (200 sectors) + national statistics
- Imported footprints considered (simplified SNAC approach)
- Fluxes in hybrid units (€/ kt / ktep) and multi-layer description

Prospective :

- Exogenous chocs on all input-output variables and coefficients of reference year (2015, 2019)

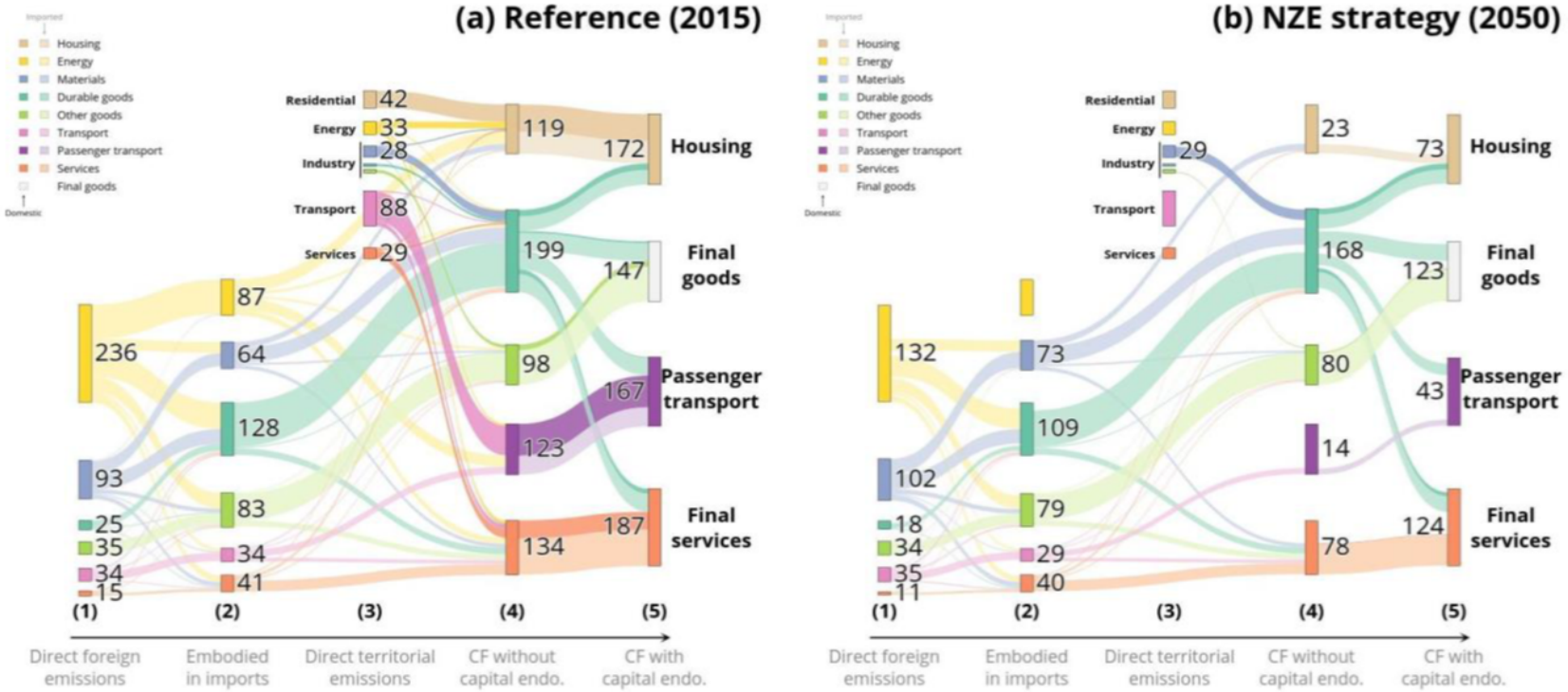
/!\ No endogenous economic dynamics



Input-output structure of MatMat.

Applications

Application 1 : Carbon footprint of materials



Decomposition of embodied emissions in end-use services in french NZE strategy.

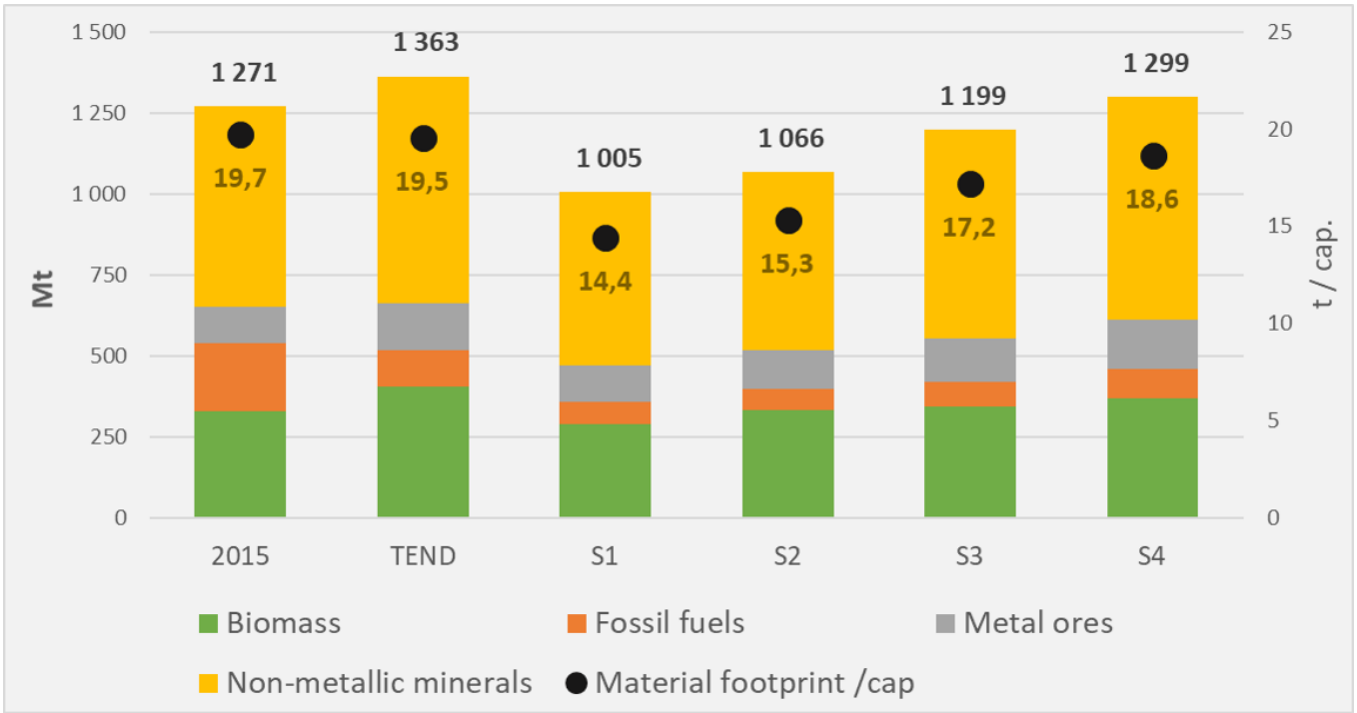
Antoine Teixeira, Julien Lefevre. Low carbon strategies need to tackle the carbon footprint of materials production. AFD Research Paper Series, 2023, 274, pp.1-21. https://hal.science/hal-04709787v1

Final goods and services are the main sources of remaining embodied emissions in 2050.

Application 2 : Material footprint

Evaluation of material and carbon footprints of 4 contrasted NZE scenarios for France ("Transition(s)2050" project by ADEME) :

- **Domestic NZE contributes to reduce material footprints (vs trend "TEND") and carbon footprints (vs 2015)**
- **Energy sufficiency is the most efficient strategy to reduce material and carbon footprint (scenarios S1 and S2)**



French carbon footprint per scenarios in 2050.

Antoine Teixeira, Fanny Vicard.

https://www.ademe.fr/les-futurs-en-transition/les-feuilletons/

Other applications

- **MatMat coupling with macroeconomic IAM model (IMACLIM-S France) to test the maximum reduction potential of recycling rates on material footprint.**
  ⇒ Main effects through material imports reduction, not through the decrease of domestic primary material production.
  Antoine Teixeira, PhD Thesis (2024) : `https://theses.fr/s229888`

- **MatMat coupling with multi-regional input-output (MRIO) module :**
  - to compare different mitigation strategies on imported footprints : worldwide decarbonization *versus* source shifting of imports
  - to correct regional aggregation bias

Next steps

Open-source publication of the model and technical paper (2025)

Model development :

- **Extending and consolidating calibration**
- **Improve MRIO/SRIO coupling for imported impacts measurements**
- **Breaking down environmental footprints by socio-economic characteristics of households**

Current research topics :

- **Impacts on employment and GHG emissions of an extended sufficiency scenario for France**
- **Structural changes associated with a post-growth trajectory.**

Online resources

MatMat1 report (in french) : literature review of modeling options, footprint indicators, hybrid IO calibration issues.
https://librairie.ademe.fr
Construction de matrices de flux de matières pour une prospective intégrée énergie-matières-économie

MatMat2 report (in french) : model description, calibration updates and applications (Disentangling sufficiency/efficiency/substitution effects on carbon footprints ; MatMat-MRIO coupling)
https://librairie.ademe.fr
MatMat : Extension et développement du modèle de prospective intégrée énergie-matières-économie

Contacts

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Application 2 : Transition(s)2050 NZE scenarios

Evaluation of material and carbon footprints of 4 contrasted NZE scenarios for France (ADEME) :

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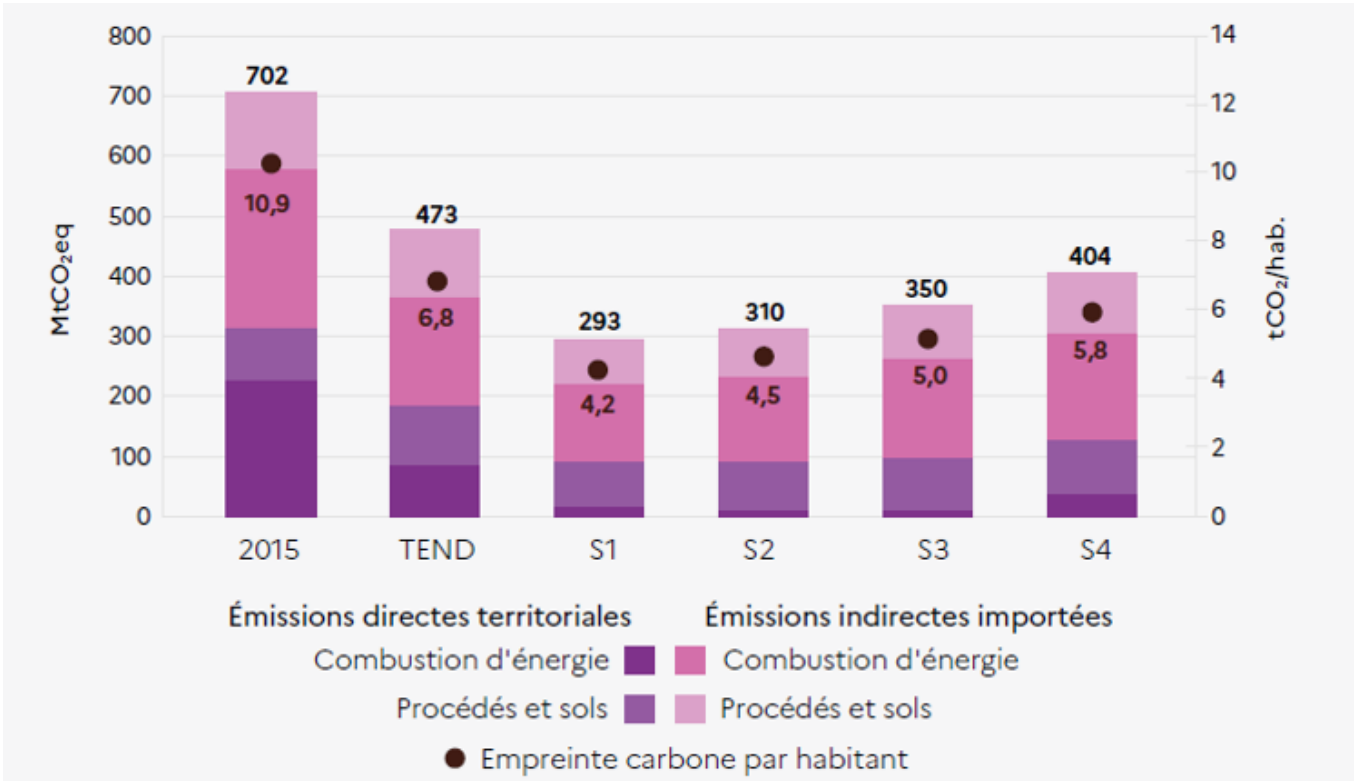

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Application 2 : Transition(s)2050 NZE scenarios

Complementary analyses :

- **Disentangling the role of energy sufficiency mitigation options in direct/territorial emissions reduction across these scenarios**
- **Assessing the amplified effect of energy sufficiency on reducing imported emissions and carbon footprint in regards compared to territorial emissions**