

## RECC – Resource Efficiency – Climate Change mitigation framework

**An open scenario development tool for material cycles and the circular  
economy**

**Overview:** The resource efficiency–climate change (RECC) mitigation model framework is a step towards the interdisciplinary scientific assessment of material efficiency and its links to service provision, material cycle management, and climate policy. RECC is based on dynamic material flow analysis and links the services provided (individual motorized transport and shelter) to the operation of in-use stocks of products (passenger vehicles and residential buildings), to their expansion and maintenance, and to their material cycles to model mitigation strategies and analyze trade-offs for environmental impacts along the products' life cycle.

A key innovation of RECC is the upscaling of product archetypes with different degrees of material and energy efficiency, which are simulated with engineering tools. RECC scenarios are driven by parameters that augment the storylines of the shared socioeconomic pathways (SSP) to describe future service demand and associated material requirements. In its current implementation (model versions 2.5 (2023) and 2.6 (scheduled for 2024)), ten material efficiency strategies at different stages of the material cycle can be assessed individually or combined into bundles of strategies, by ramping up their implementation rates to the identified technical potentials.

RECC provides scenario results for the life cycle impacts of ambitious service–material decoupling concurrent with energy system decarbonization, giving detailed insights on the RECC mitigation nexus to policy-makers worldwide.

**RECC developers:** Stefan Pauliuk and the research group for industrial ecology and socio-metabolic research in Freiburg, Niko Heeren, Zurich municipal administration, Edgar Hertwich and the industrial ecology program in Trondheim, multiple users, software, and data contributors across the world

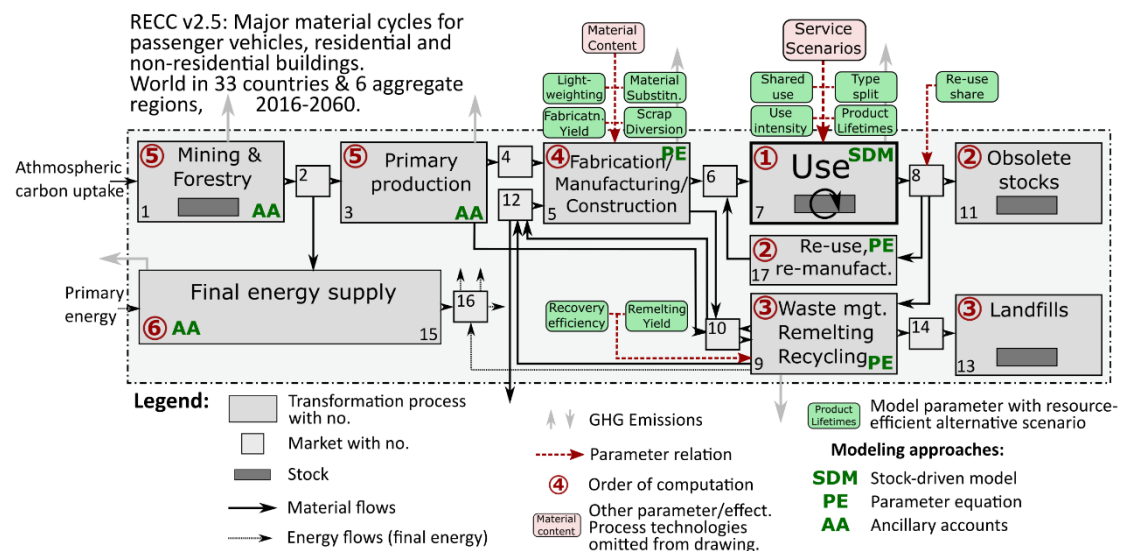
**Central RECC resource (landing page):**

<https://www.industrialecology.uni-freiburg.de/odym-recc>

## Core RECC features:

- Start with a service scenario (m<sup>2</sup> buildings, vehicle-km), calculate the in-use stocks needed for service provision, the stock turnover, the material cycle, the energy and material supply for all processes, and env. impacts.
- Global coverage: single EU country resolution, large world economies, aggregated world regions, from 2020 to 2026
- High product detail: 13 residential and 24 non-residential building types, 6 drive technologies, 150 future building & 24 future vehicle archetypes
- 3 socio-economic (low demand, SSP1, SSP2) and two climate policy (no new policy and RCP2.6 compatible energy supply) scenarios available
- Up to 10 circular economy strategies on top of each scenario
- Implemented in Python, data input and output via excel files

## RECC system definition:



## Central references:

Haberl, H., Wiedenhofer, D., Erb, K.-H., Görg, C., Krausmann, F., 2017. The Material Stock–Flow–Service Nexus: A New Approach for Tackling the Decoupling Conundrum. *Sustainability* 9, 1049. <https://doi.org/10.3390/su9071049>

Kalt, G., Wiedenhofer, D., Görg, C., Haberl, H., 2019. Conceptualizing energy services: A review of energy and well-being along the Energy Service Cascade. *Energy Res. Soc. Sci.* 53, 47–58. <https://doi.org/10.1016/j.erss.2019.02.026>

Pauliuk, S., Fishman, T., Heeren, N., Berrill, P., Tu, Q., Wolfram, P., Hertwich, E., 2021a. Linking service provision to material cycles: A new framework for studying the resource efficiency–climate change (RECC) nexus. *J. Ind. Ecol.* 25, 260–273. <https://doi.org/10.1111/jiec.13023>

Pauliuk, S., Heeren, N., Berrill, P., Fishman, T., Nistad, A., Tu, Q., Wolfram, P., Hertwich, E., 2021b. Global scenarios of resource and emission savings from material efficiency in residential buildings and cars. *Nat. Commun.* 12, 5097. <https://doi.org/10.1038/s41467-021-25300-4>

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