



THE UNIVERSITY
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forestry
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"Future stocks and wood flow in the Canadian housing sector: A bottom-up analysis based on shared socioeconomic pathways. "

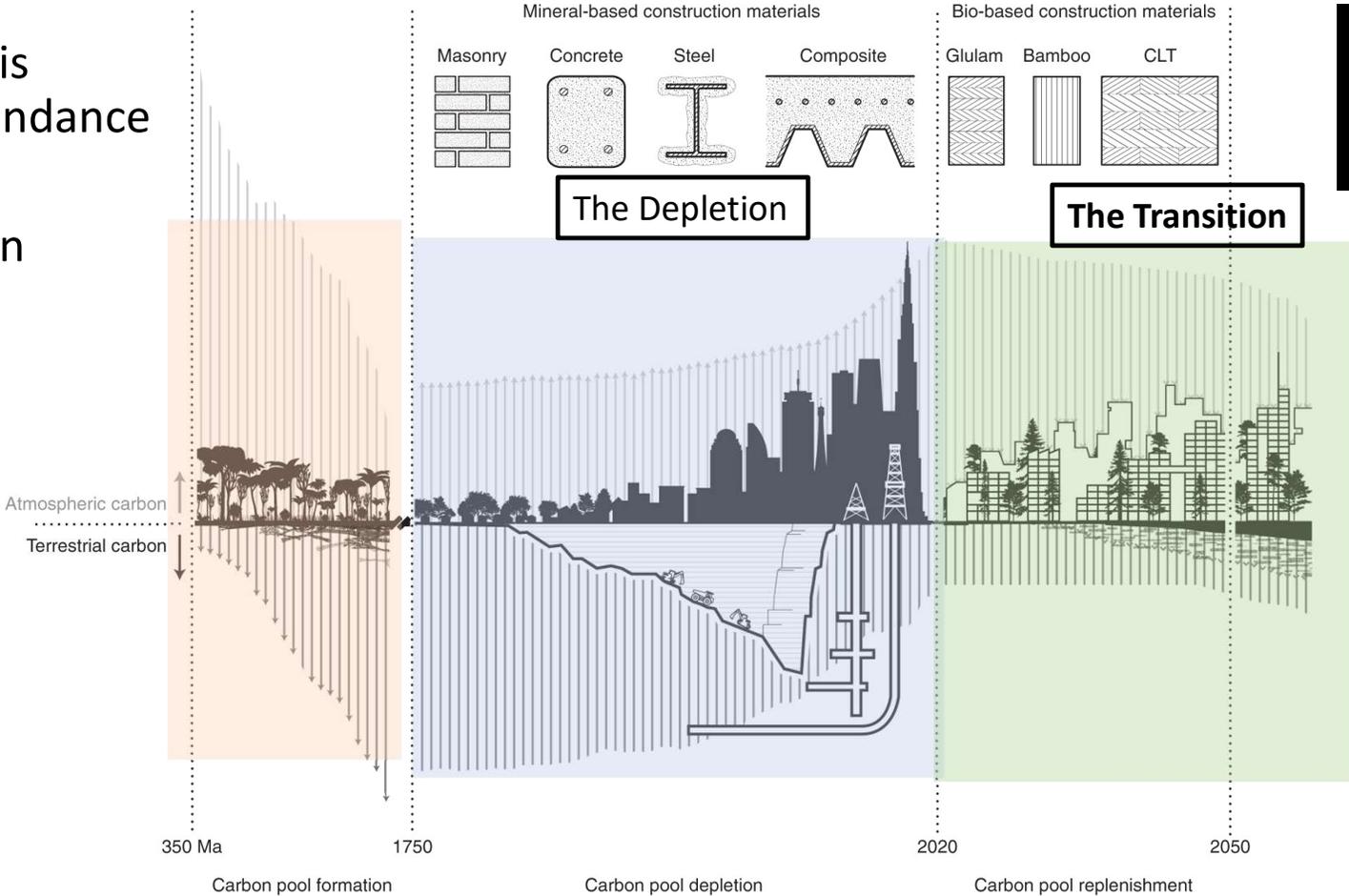


Sustainable
Bioeconomy
Research Group

Chronicle of natural resources

Until Now: Energy is scarce, but the abundance of material

Future: Transition in material choices.



[Churkina et al., 2020](#)



Global impact of current economy: example from construction sector



1.

Buildings
consume 50%
of the world's
natural
resources.



2.

Responsible for
30% CO2
emissions.



3.

40% of the
world's energy
consumption



4.

35% of the
waste
produced
globally

A potential sector to make a positive impact: Wood-based construction



1.
Substitution of
carbon-
intensive
material

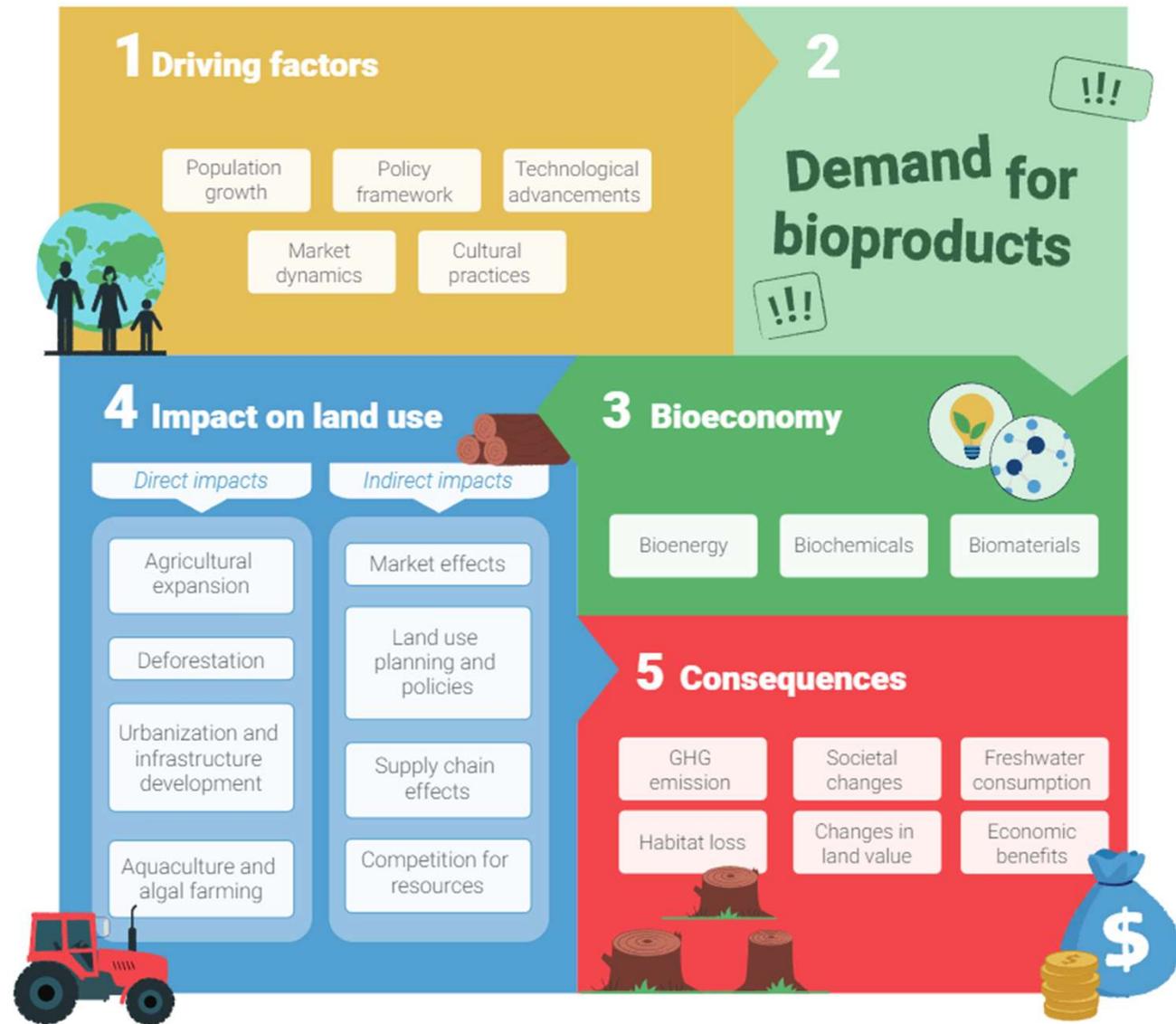


2.
Global carbon
sink

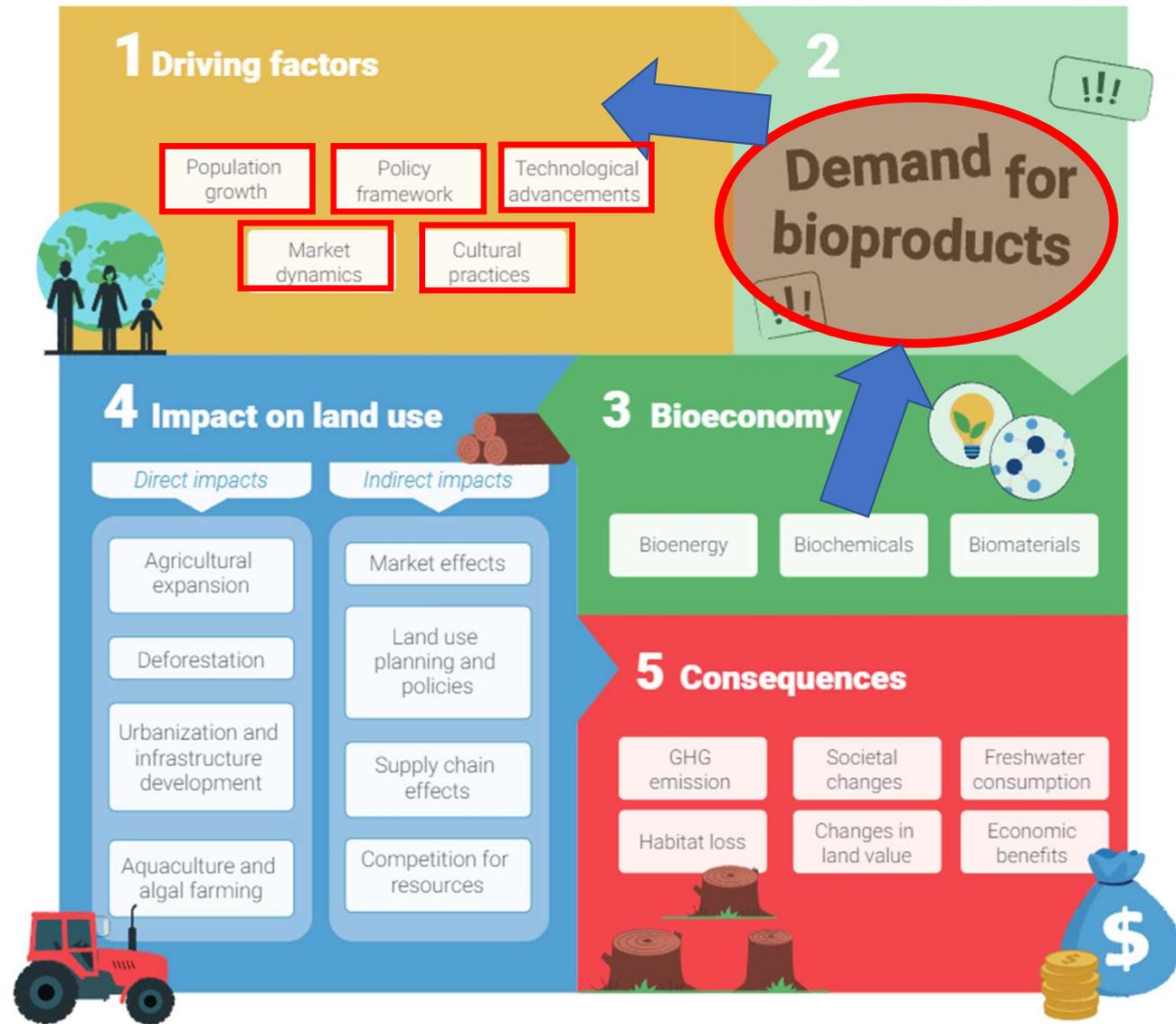


3.
Energy
generation and
product
innovation

Driving factors for end-use demand?



Driving factors for end-use demand?



RQ: How does wood demand evolve in the housing sector, when estimated based on demand for end-use services?



*Gap:
There is a
modelling gap in
projecting the
demand for wood
based on socio-
economic factors
and resource
efficiency
strategies.*



1.
Wood
skyscraper



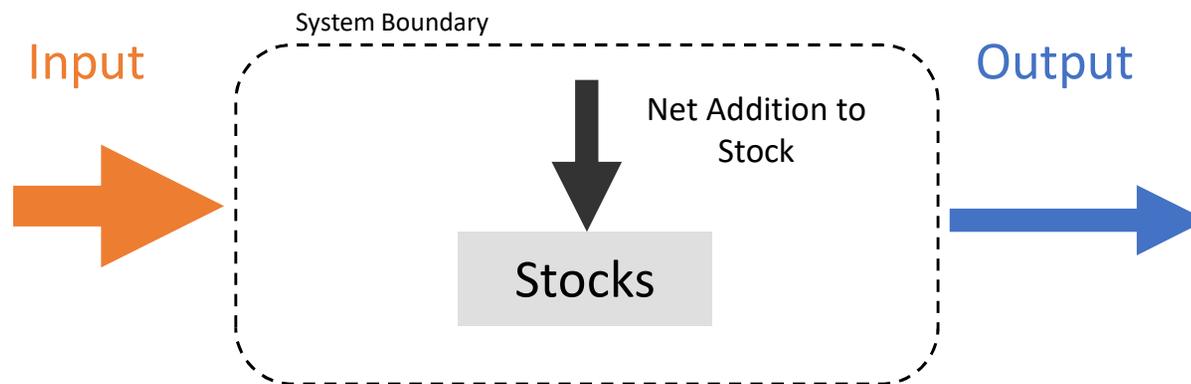
2.
Source of
power



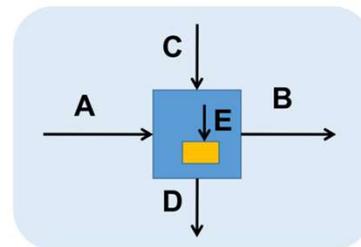
3.
Biomaterials

Method: Material Flow Analysis (calculating the wood dynamics)

- “Material flow analysis (MFA) is a systematic assessment of the flows and stocks of materials within a system defined in space and time.” (Brunner and Rechberger, 2005)



Mass
conservation



$$A + C = B + D + E$$

(E may be + or -)

Why do an MFA?

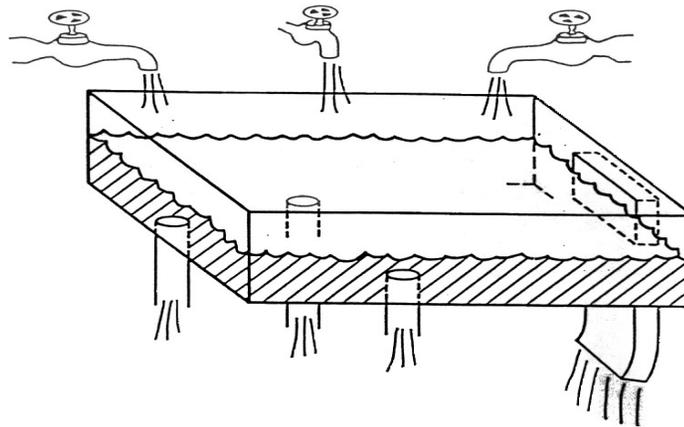
- Find inefficiencies and optimize conversion processes
- Anticipate future depletion and accumulation
- Project and anticipate future emissions and impacts
- Design efficient and compatible material flow systems

Static MFA

- A snapshot of material stock and flows of a given time period

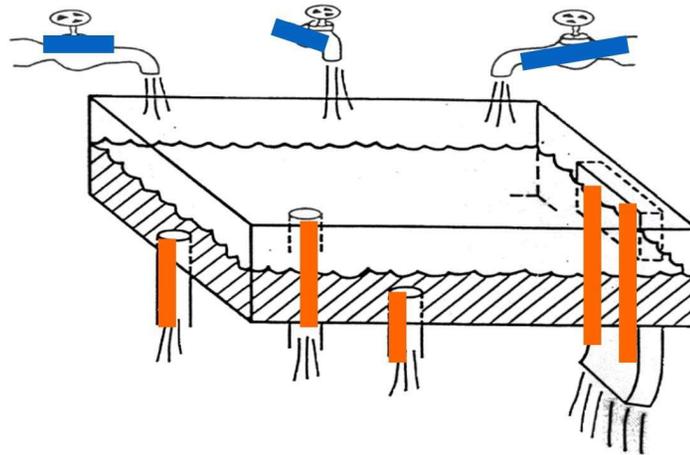


Static MFA (Calculation principle)



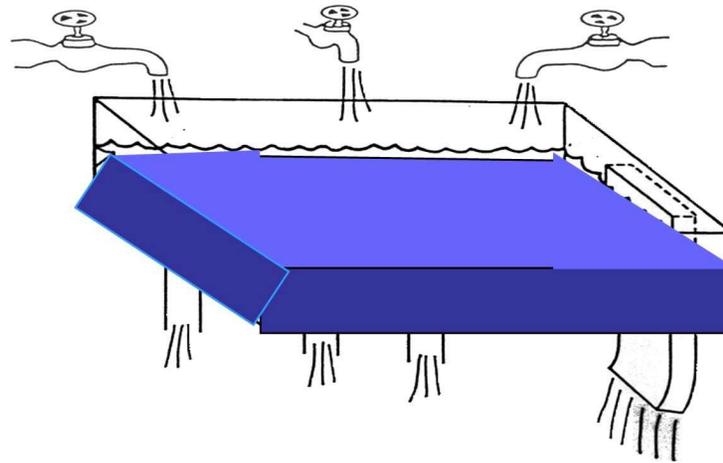
Courtesy of Barbara Reck (Yale Center for Industrial Ecology)

Static MFA (Calculation principle)



Courtesy of Barbara Reck (Yale Center for Industrial Ecology)

Static MFA (Calculation principle)



Courtesy of Barbara Reck (Yale Center for Industrial Ecology)

An example of static MFA study



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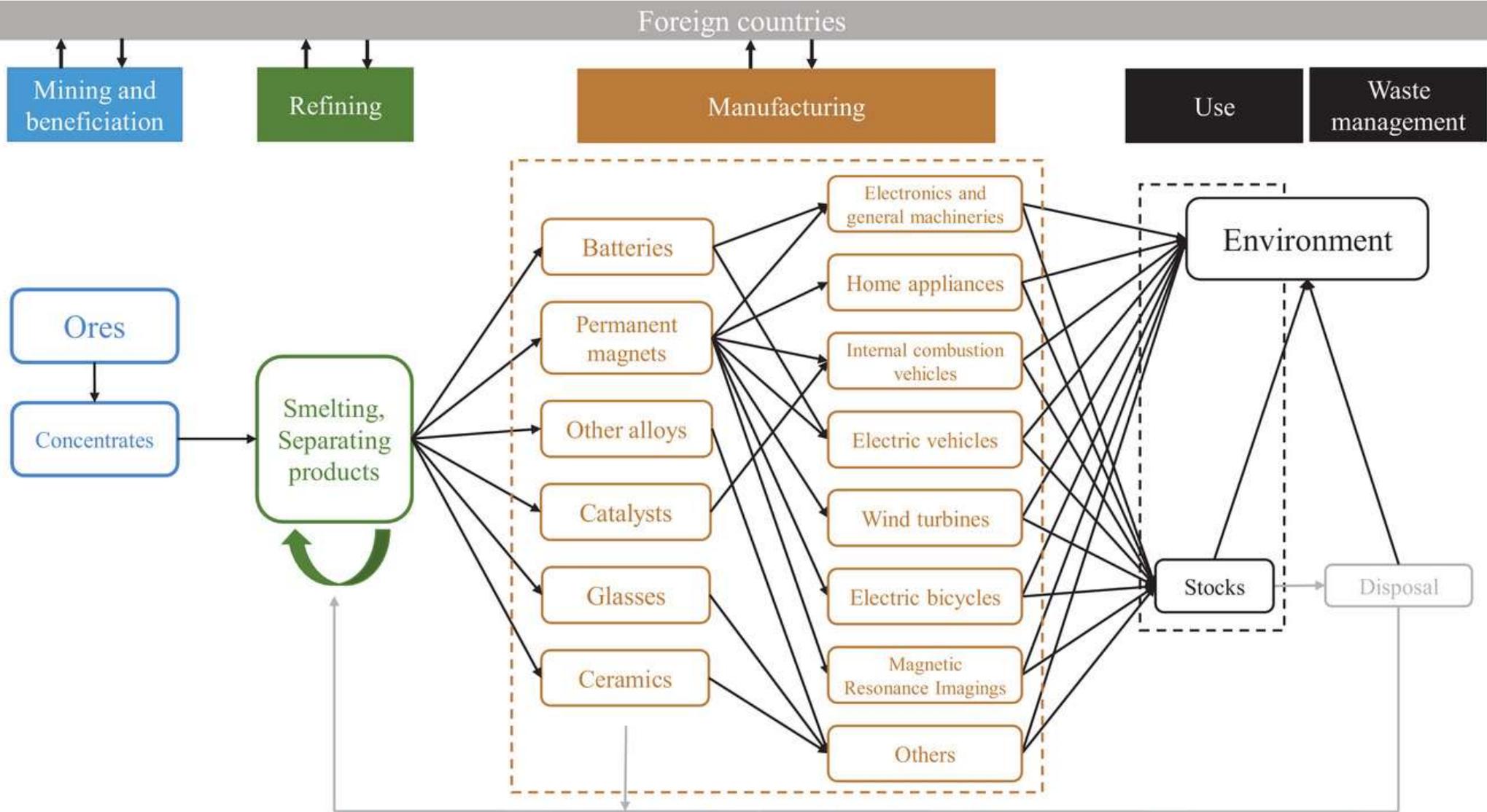
International Society
for Industrial Ecology

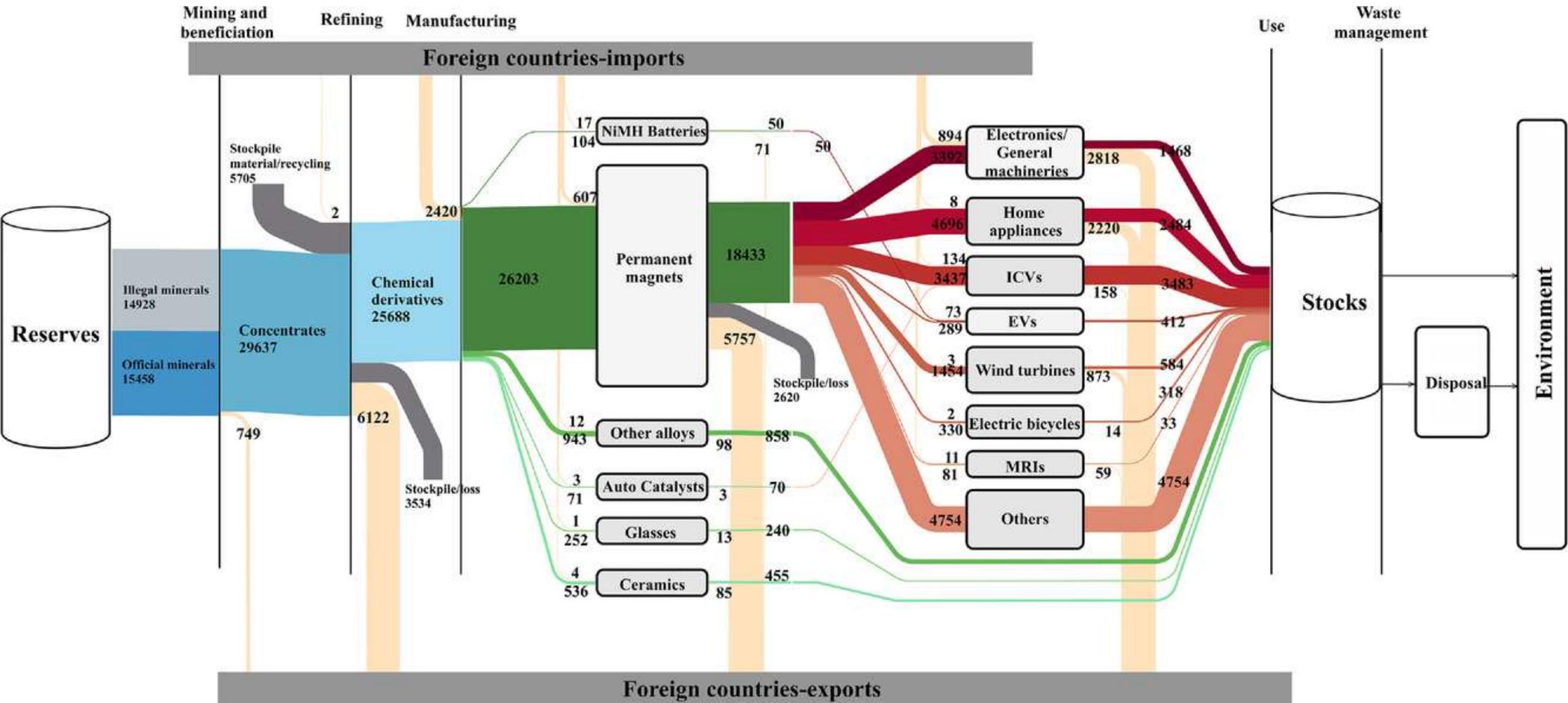
RESEARCH AND ANALYSIS |  Full Access

Static material flow analysis of neodymium in China

Jingxuan Geng, Han Hao , Xin Sun, Dengye Xun, Zongwei Liu, Fuquan Zhao

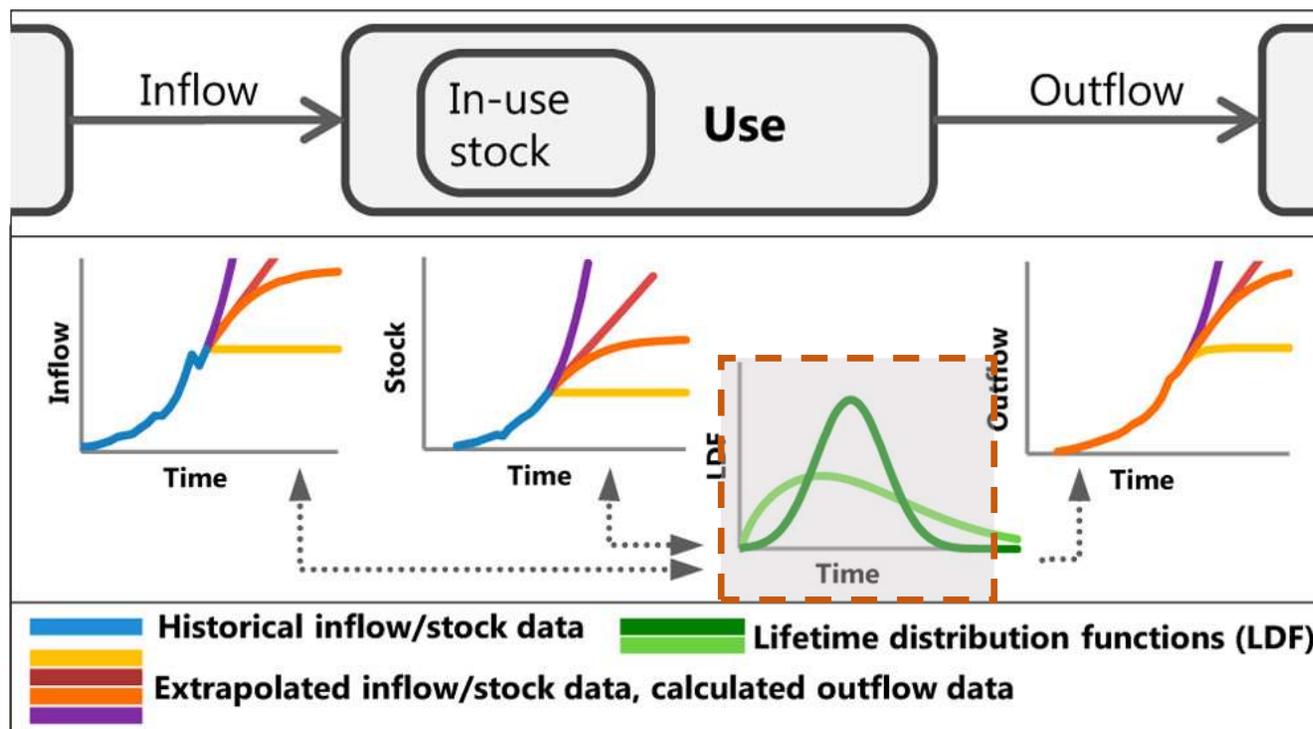
First published: 28 August 2020 | <https://doi.org/10.1111/jiec.13058> | Citations: 10





Dynamic material flow analysis (dMFA)

- dMFA describes the behavior of a system over a time interval.



Dynamic MFA (Calculation principle)



The top-down stock calculation

$$S_t = \sum_{T_o}^T (Inflow_t - Outflow_t) + S_o$$

T_o is the time of the initial time step

T is the current time step

S_o is the existant stock at the initial time step

Dynamic MFA (Calculation principle)

The bottom-up stock calculation

$$S[n] = \sum_{i=1}^I P_i[n] \cdot c_i[n]$$

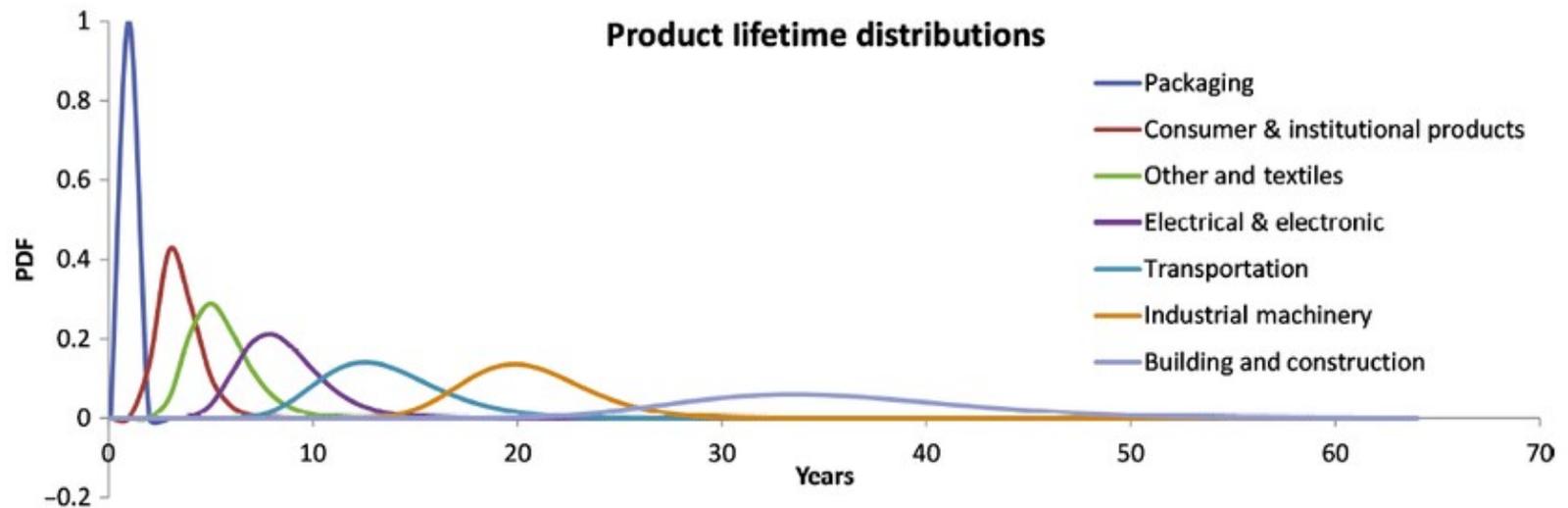
I : total number of products or end-use sectors

P : products or end-use sectors (e.g., automobile sector)

c : content of material in a product or end-use sector
(e.g., copper)

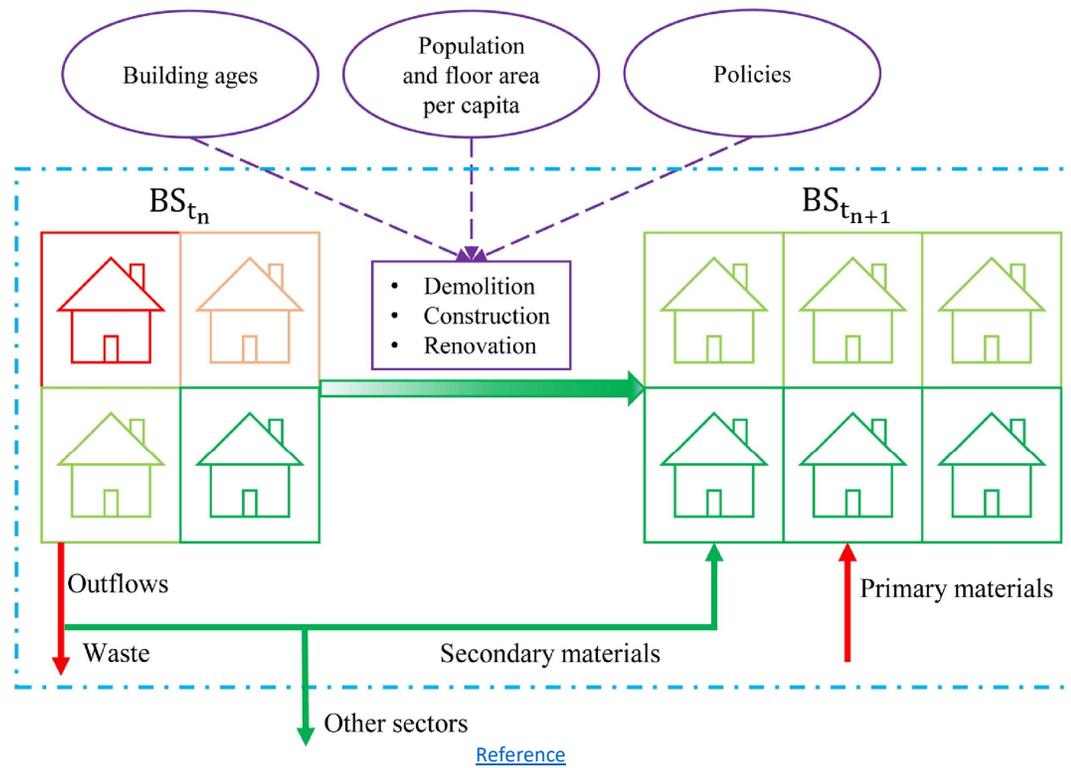


Dynamic MFA (Cause of change in stock: Lifetime distribution)

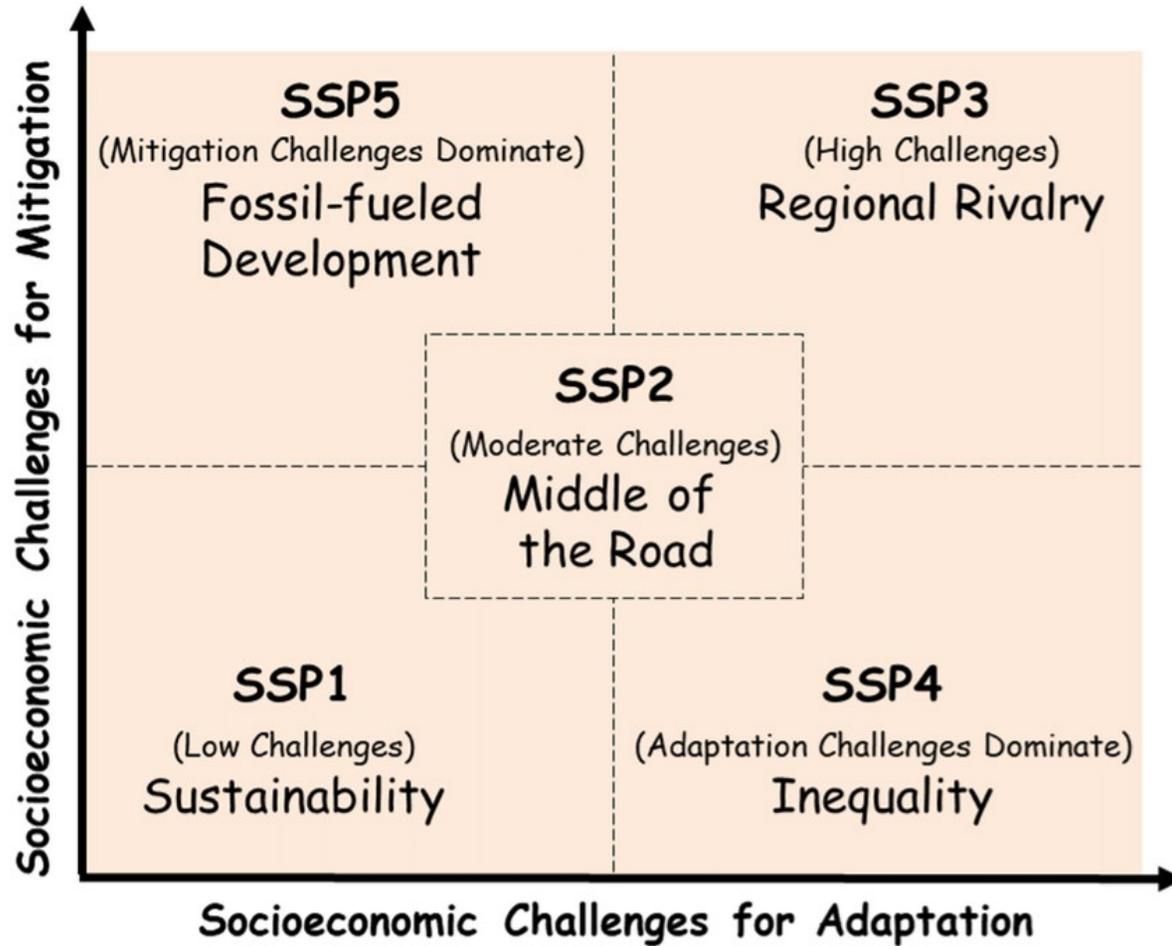


[Reference](#)

Dynamic MFA (Age cohort)



Method: Shared Socio-economic Pathways or SSPs (Socio-economic modelling in DMFA)

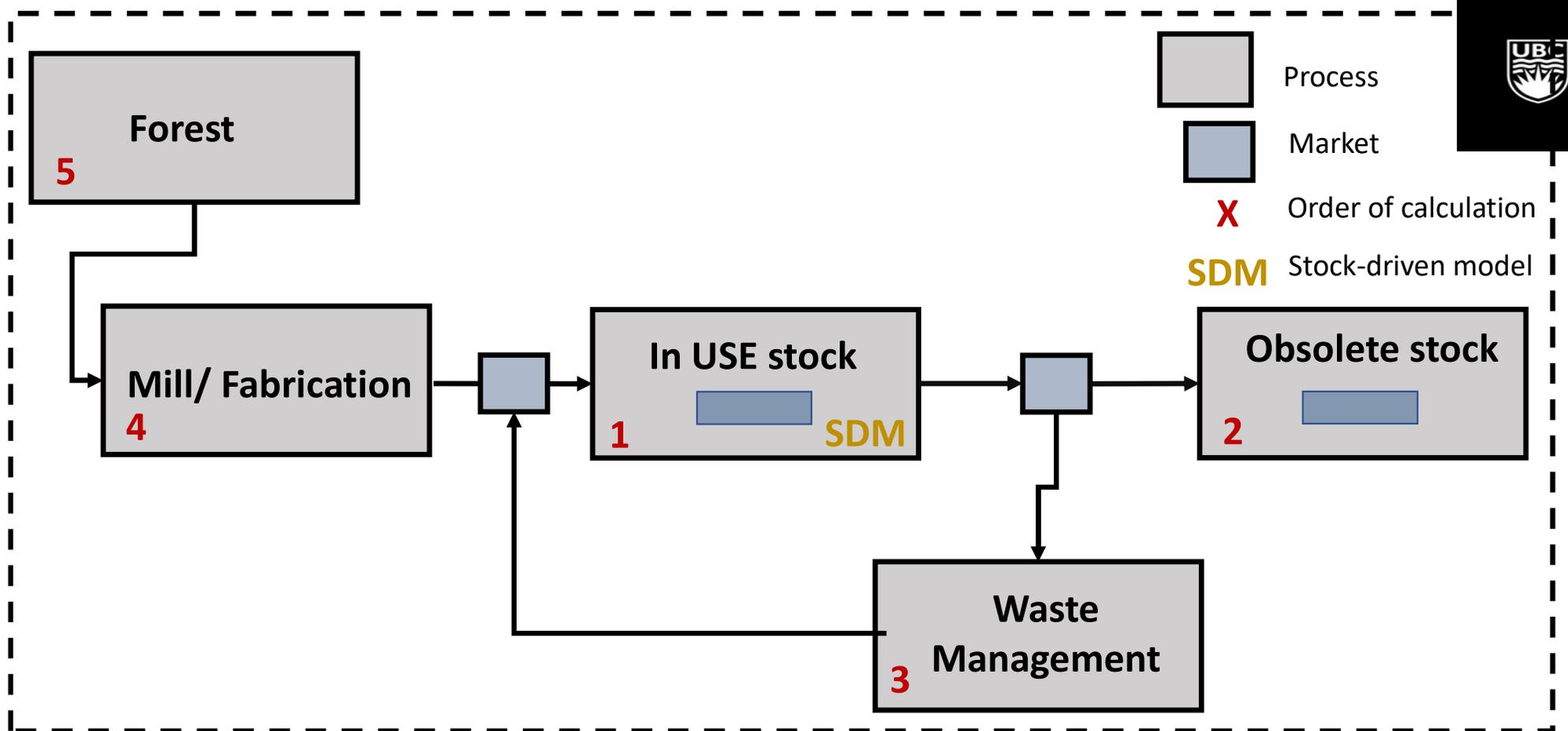


source: International Institute for Applied Systems Analysis

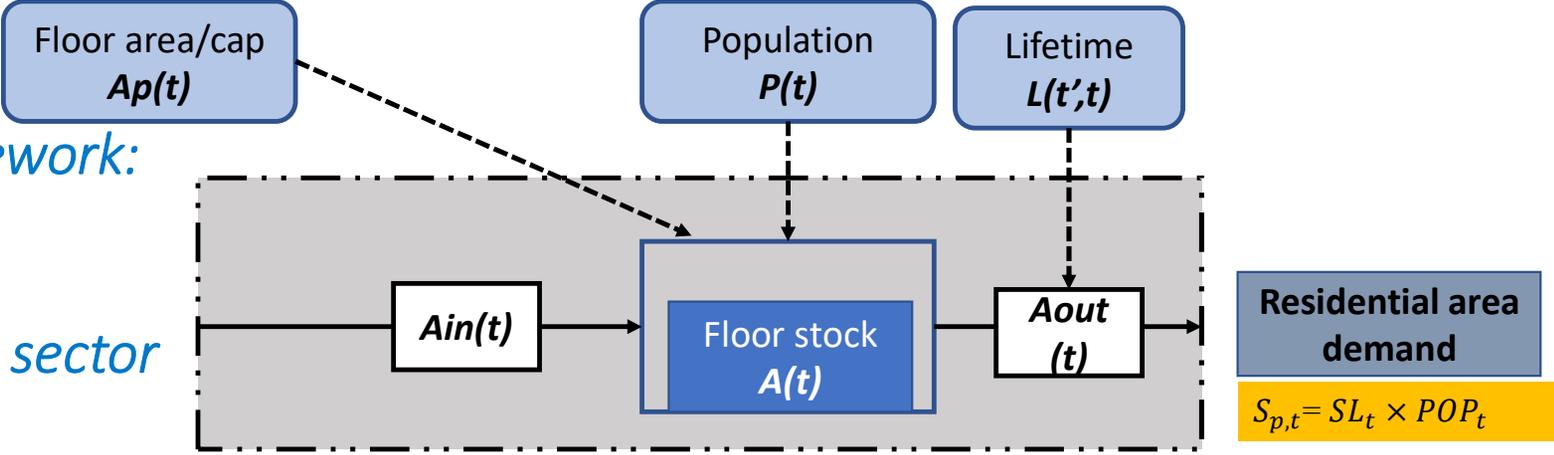


Simple system definition of Canadian wood dynamics in construction sector

Wood dynamics in the housing sector of Canada, 2000 to 2100

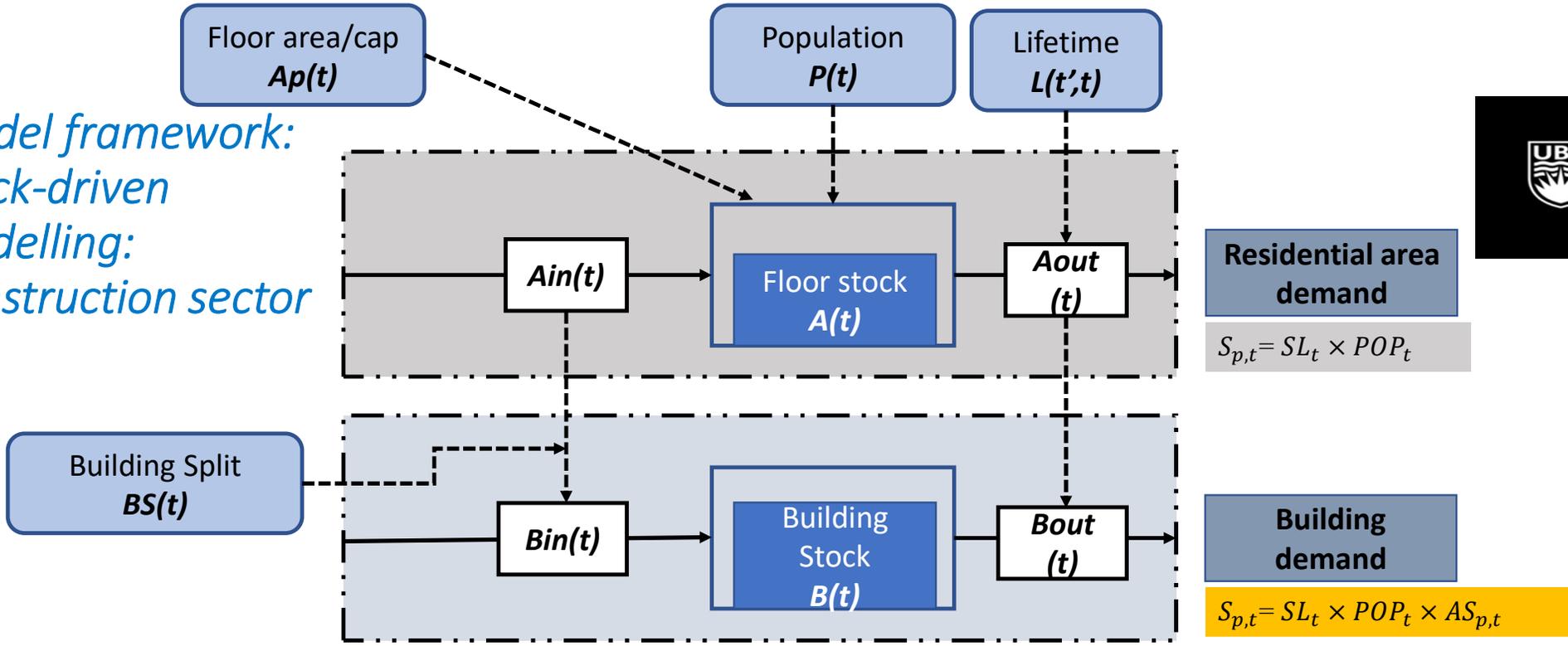


Model framework:
Stock-driven
modelling:
Construction sector



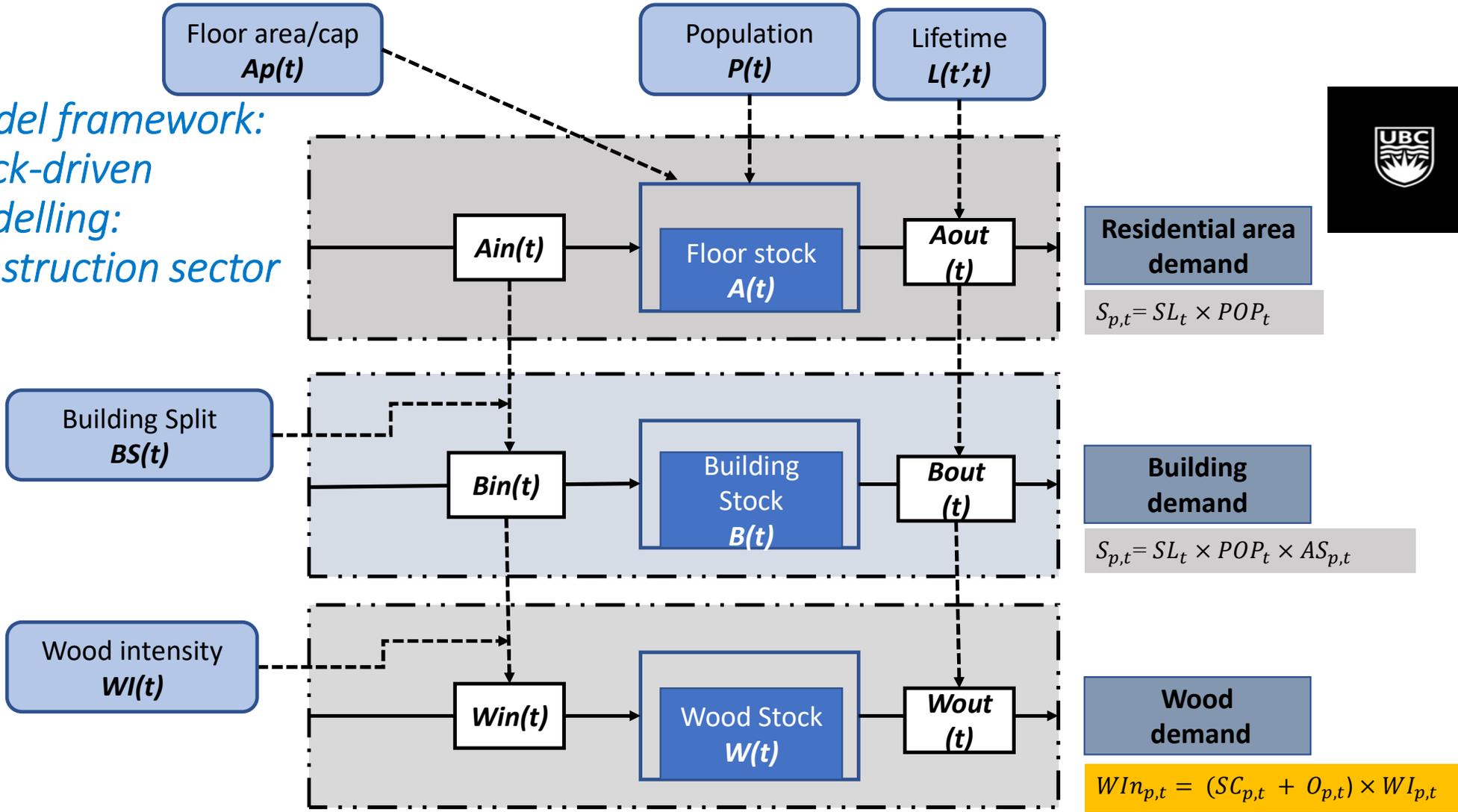


Model framework:
Stock-driven
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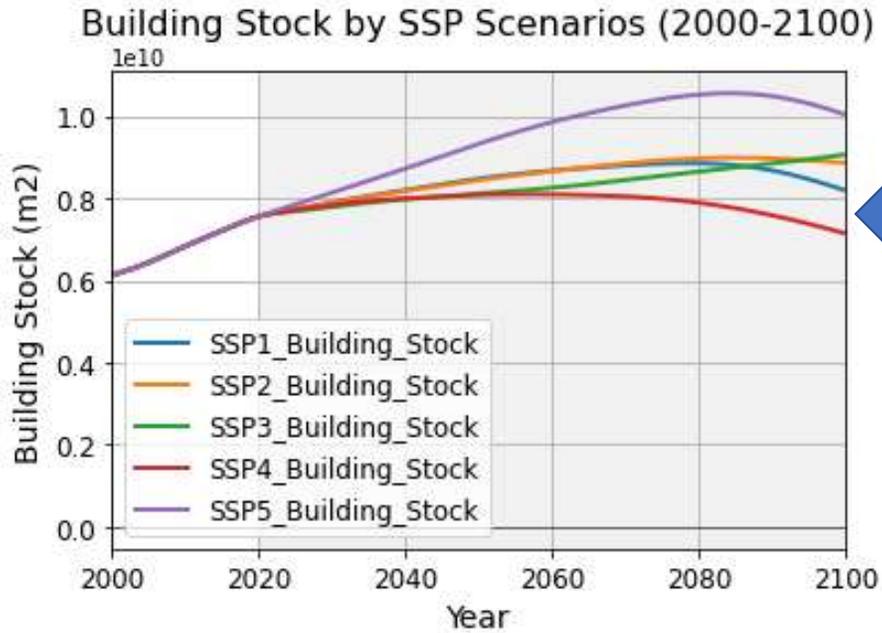




Model framework:
Stock-driven
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Construction sector



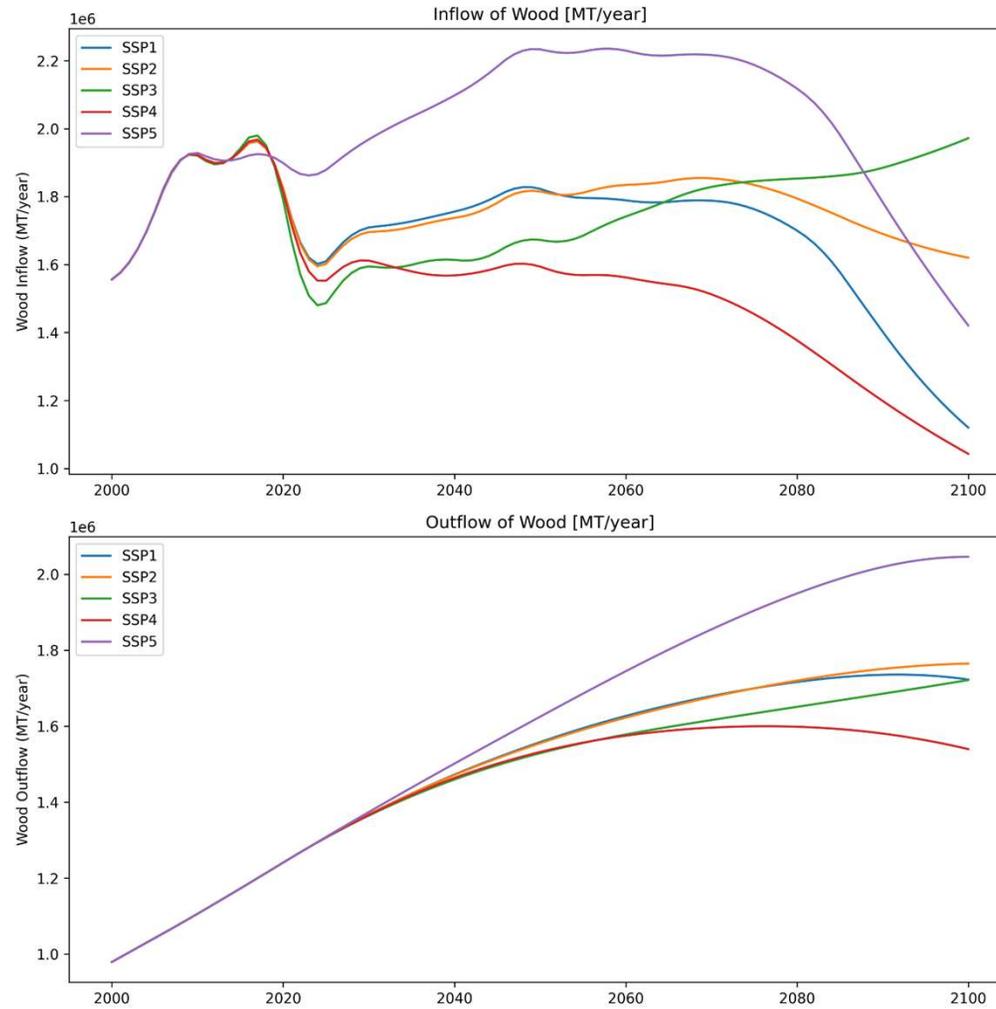
Results: Building area stock



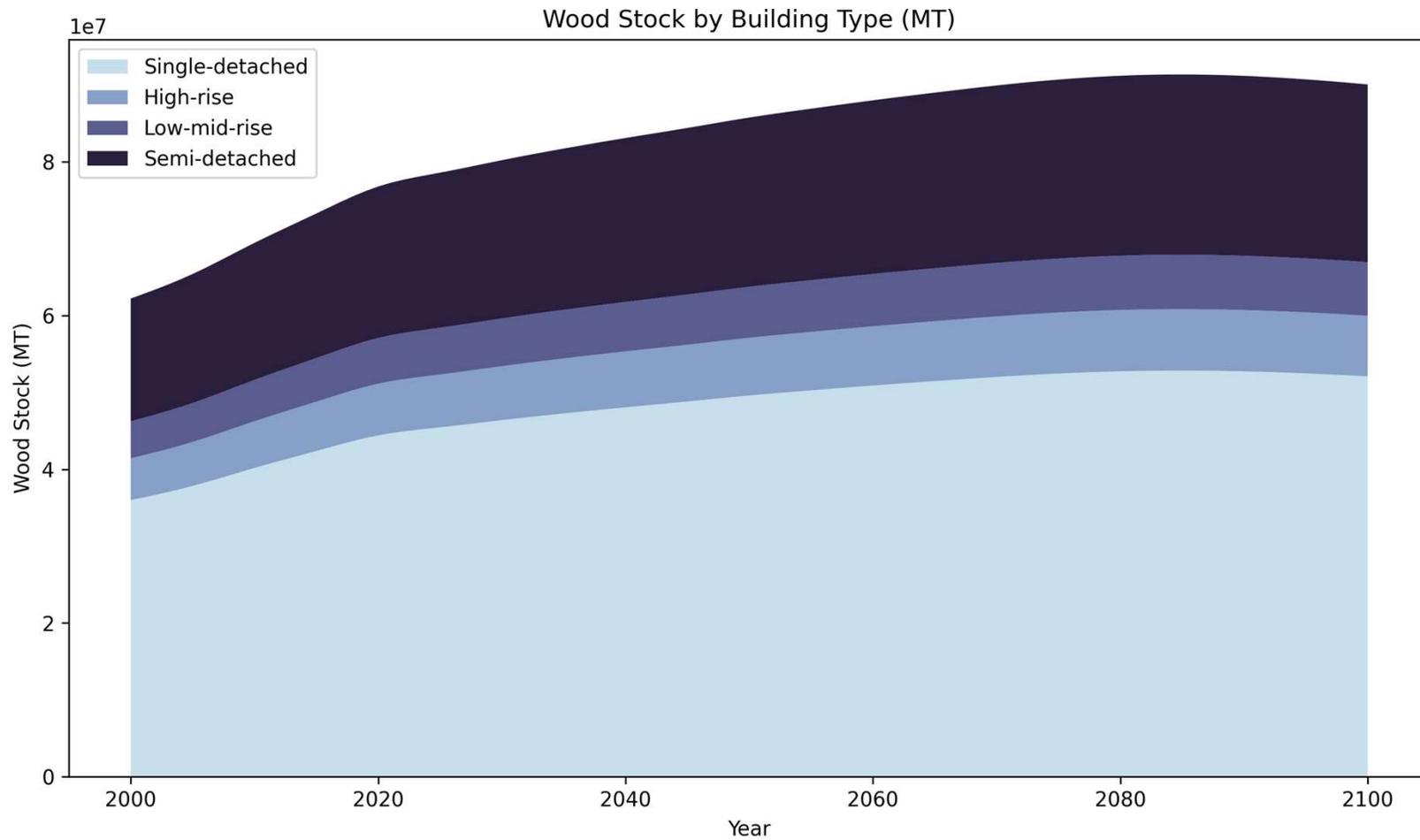
SSP1 & SSP2



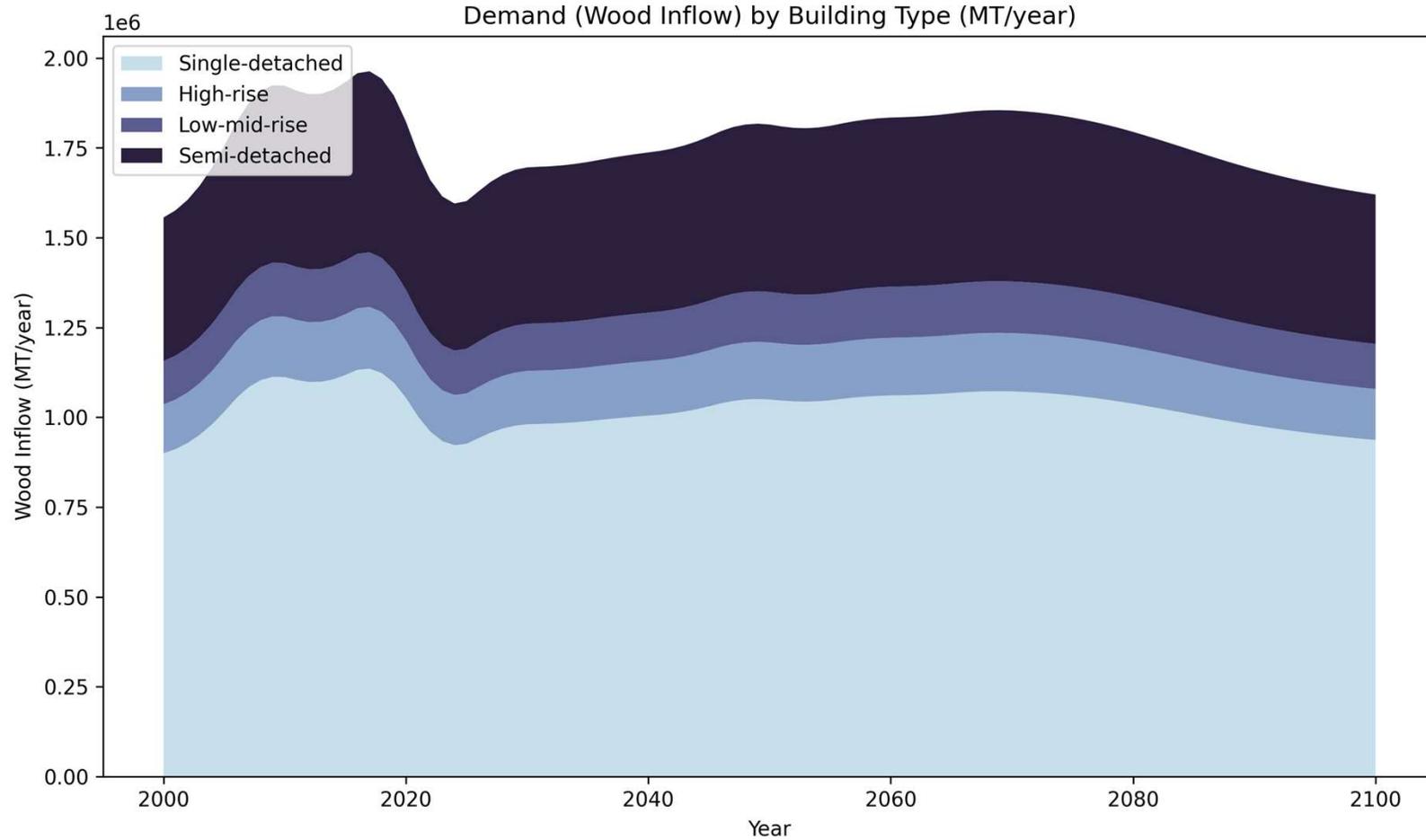
Result: Wood stock and flow in Canadian residential sector



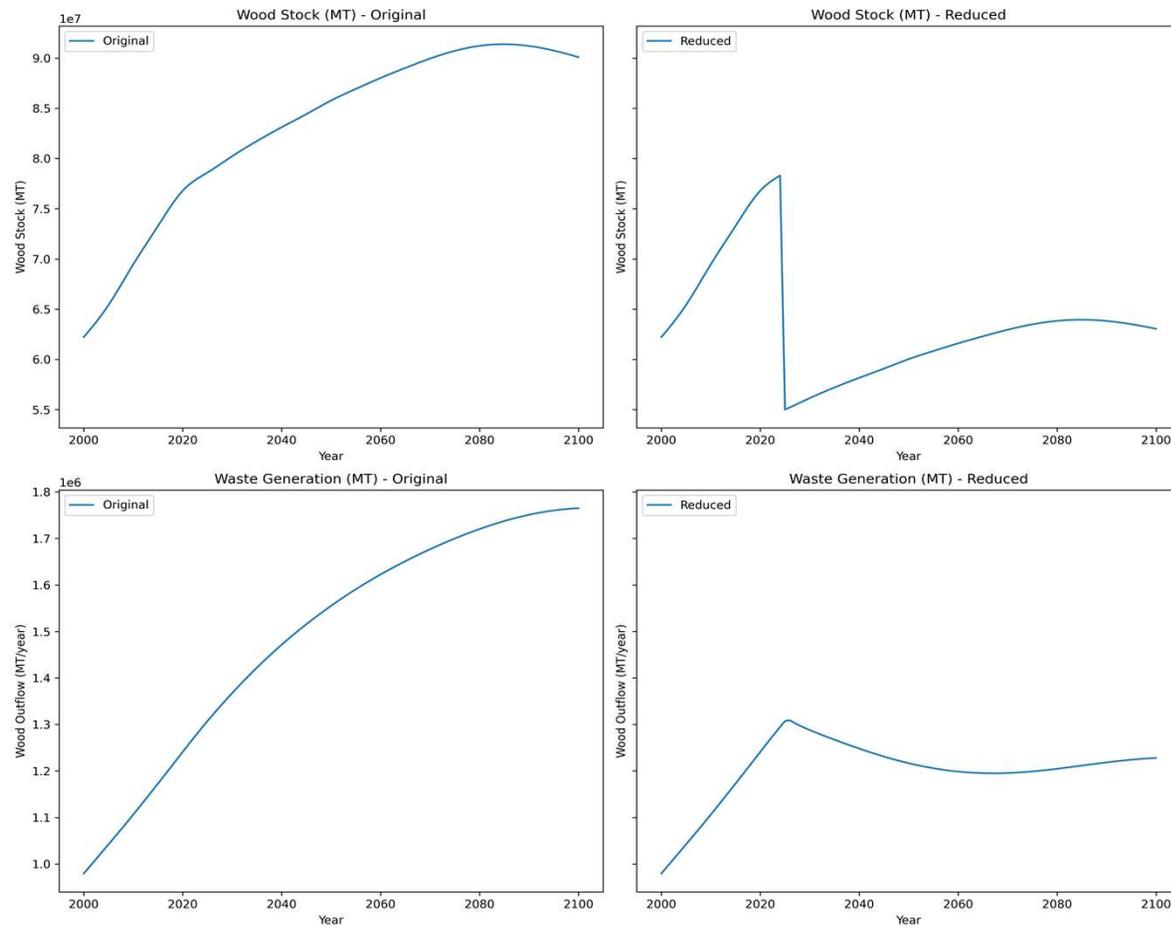
Result: Wood stock by building types (SSP2)



Result: Future demand of Wood by building types (SSP2)

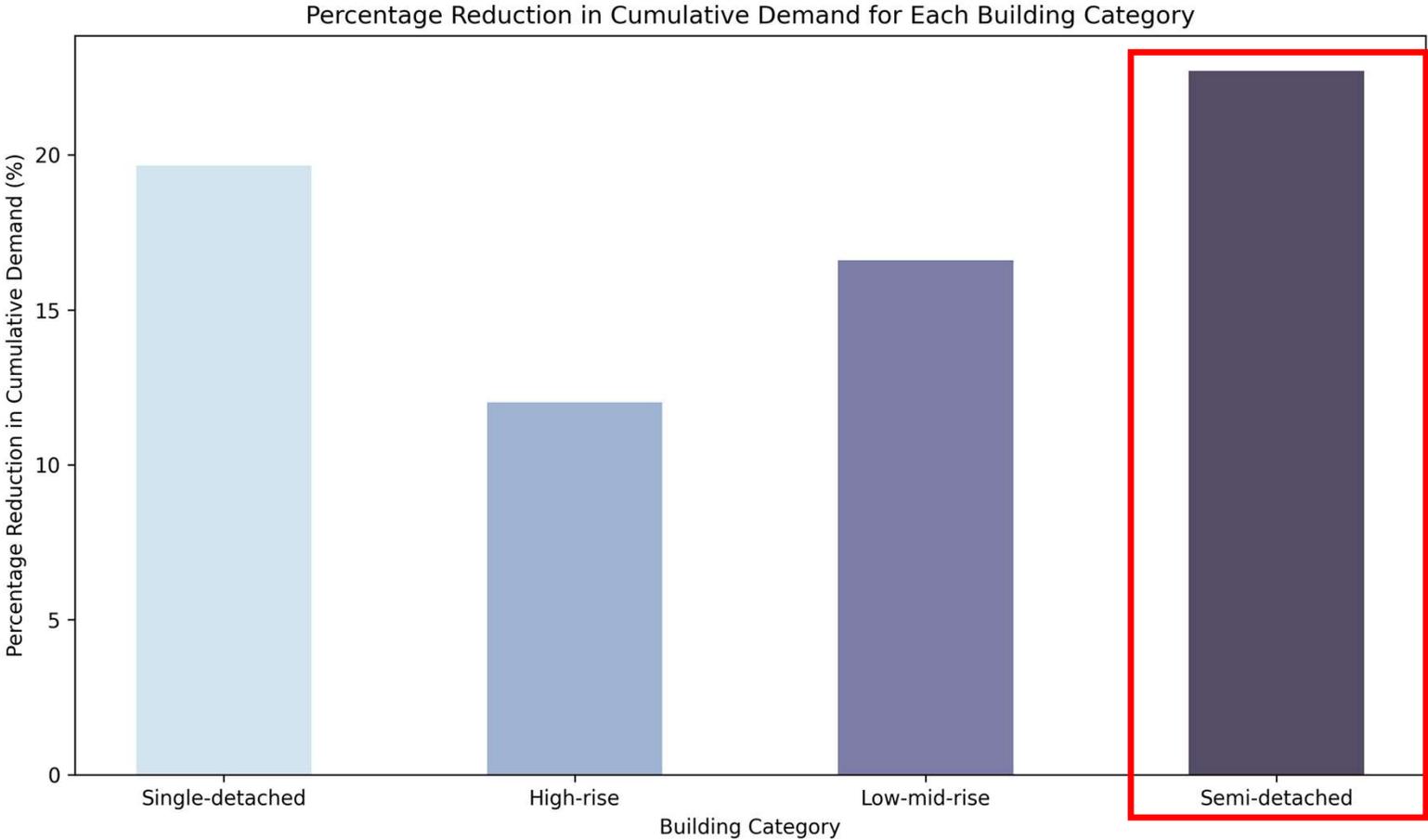


Scenario analysis: Cumulative demand reduction by Intense use



15% less per capita floor space after 2020

Scenario analysis: Cumulative demand reduction by Intense use



Key takeaways

- MFA is straightforward, yet the method is powerful in understanding the grand challenges such as resource efficiency and circularity
- Scenario analysis can be used to conceptualize future changes in material demand and inform sustainable policymaking.
- Opportunity to tweak socioeconomic, technological and material intensities could improve the accuracy of future projections of material, energy and carbon dynamics in the housing sector.



Thanks!