

Assessment of environmental impacts of open spaces in relation to urban planning

Évaluation des impacts environnementaux des espaces extérieurs dans le cadre de l'aménagement urbain

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Context – The Quartier Energy Carbone method

WHAT IT IS

- A **tool to help design** and **evaluate** urban development or renovation projects via a **quantitative assessment of environmental performance** in LCA

WHEN TO USE IT

- Upstream **design** phases to **improve the project**
- Once the main development choices have been made, to **evaluate the project**

WHO IS IT FOR

- For all **development stakeholders** : **propose action levers to urban planners**

Spatial scope



Neighborhood (networks, waste collection, waste heat recovery, etc.)



Buildings ((housing, offices, public facilities, supermarkets, parking silos, etc.)



Open spaces (parks, roads, etc.)

Functional scope



Energy



Construction materials and equipment



Water management



Waste management



Mobility



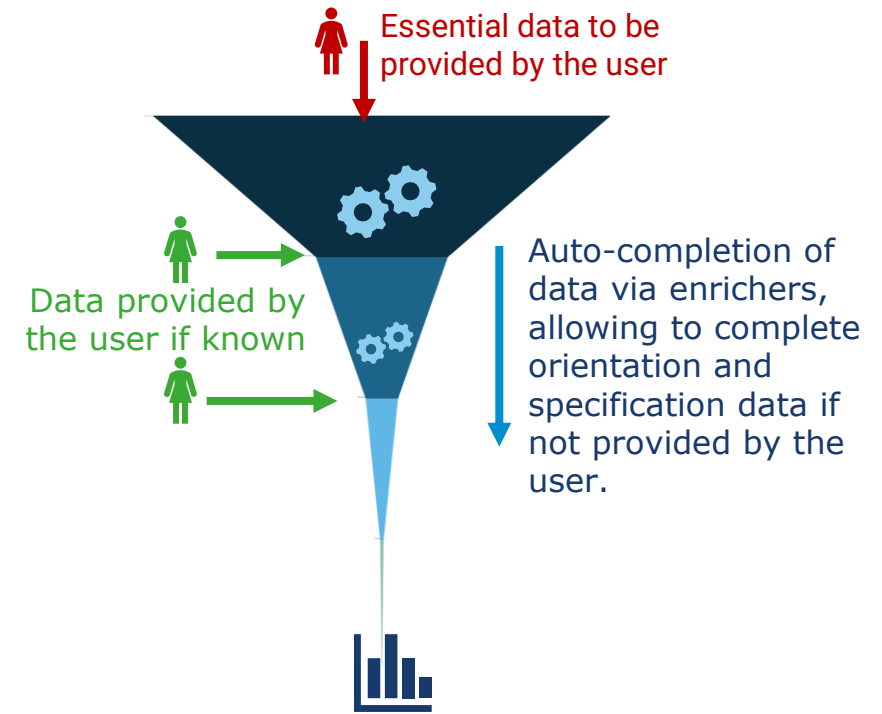
Earthworks, land use changes

Temporal scope

Reference Service Life : 50 years

Functional unit

Use of x m² of buildings and open spaces over a 50-year service life





Neighborhood LCA

- Development of LCA at neighborhood level
 - Key role of built environment
 - Stand-alone buildings assessment is not enough
- In LCA research, open spaces models are limited:
 - Often missing
 - Less transparency
 - Limited options
 - Missing life stages



Pavement LCA

- Most impact among open spaces
- Numerous LCA studies on roads:
 - Various scope
 - Various geography
 - Various design parameters
 - Lacking transparency in all LCA steps
- Results are not adapted to French neighborhoods context and are most often not reproducible



Goals of the study

Conduct - at pavement, open spaces and neighborhood scales - an LCA to:



Quantify environmental impacts of pavements and open spaces to improve the accuracy of LCA calculation at neighborhood level



Compare environmental performance of different pavement options to support urban planners in making informed design choices and to guide them toward reducing the overall environmental impact of their projects



Identify emission **hotspots** to determine the contributors most pressing to reduce

Scope

- France
- Cradle to grave
- Norm EN15804 + A2
 - Life stages
 - Impact categories, normalization and weighting
- Temporal boundaries: reference service life of 50 years
- Only construction materials



Energy



Construction
Materials



Water



Waste



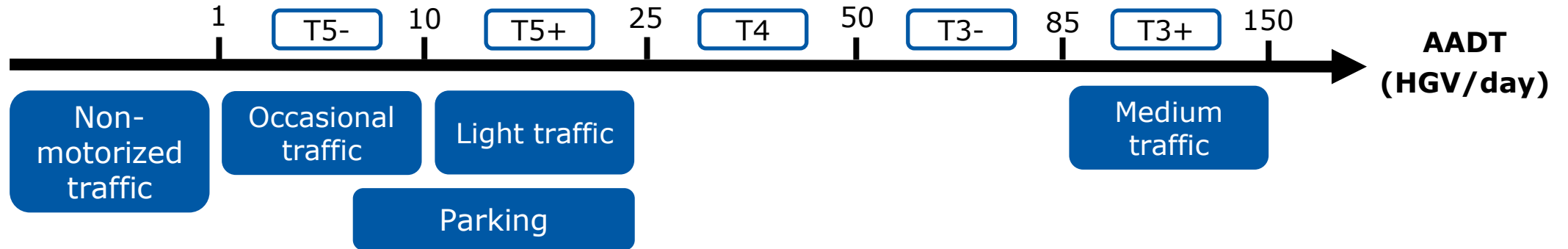
Mobility



Construction
Site



Definition of pavement functions



Medium traffic: "Allow the circulation of **medium traffic** on 1 m² of a French urban **roadway** for 50 years".

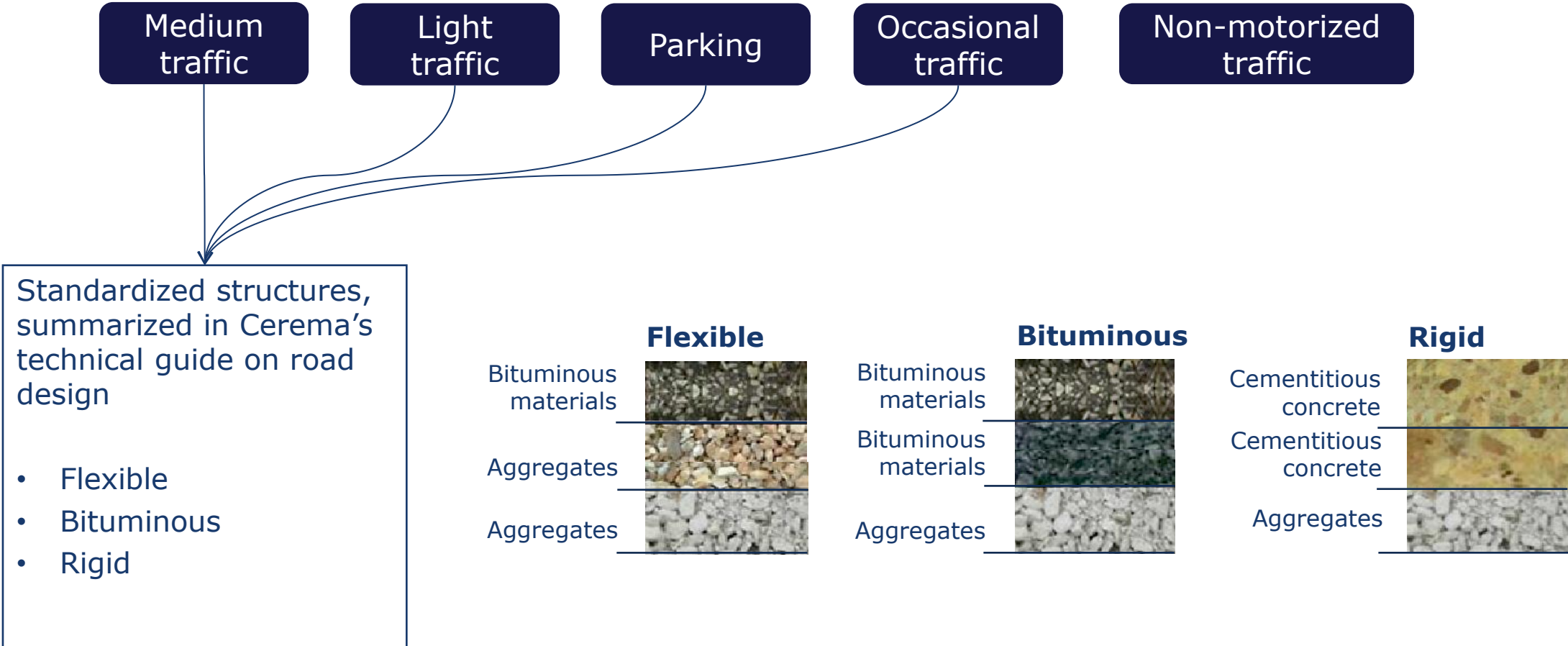
Light traffic: "Allow the circulation of **light traffic** on 1 m² of a French urban **roadway** for 50 years".

Parking: "Allow the circulation of **light traffic** on 1 m² of a French urban **parking** for 50 years".

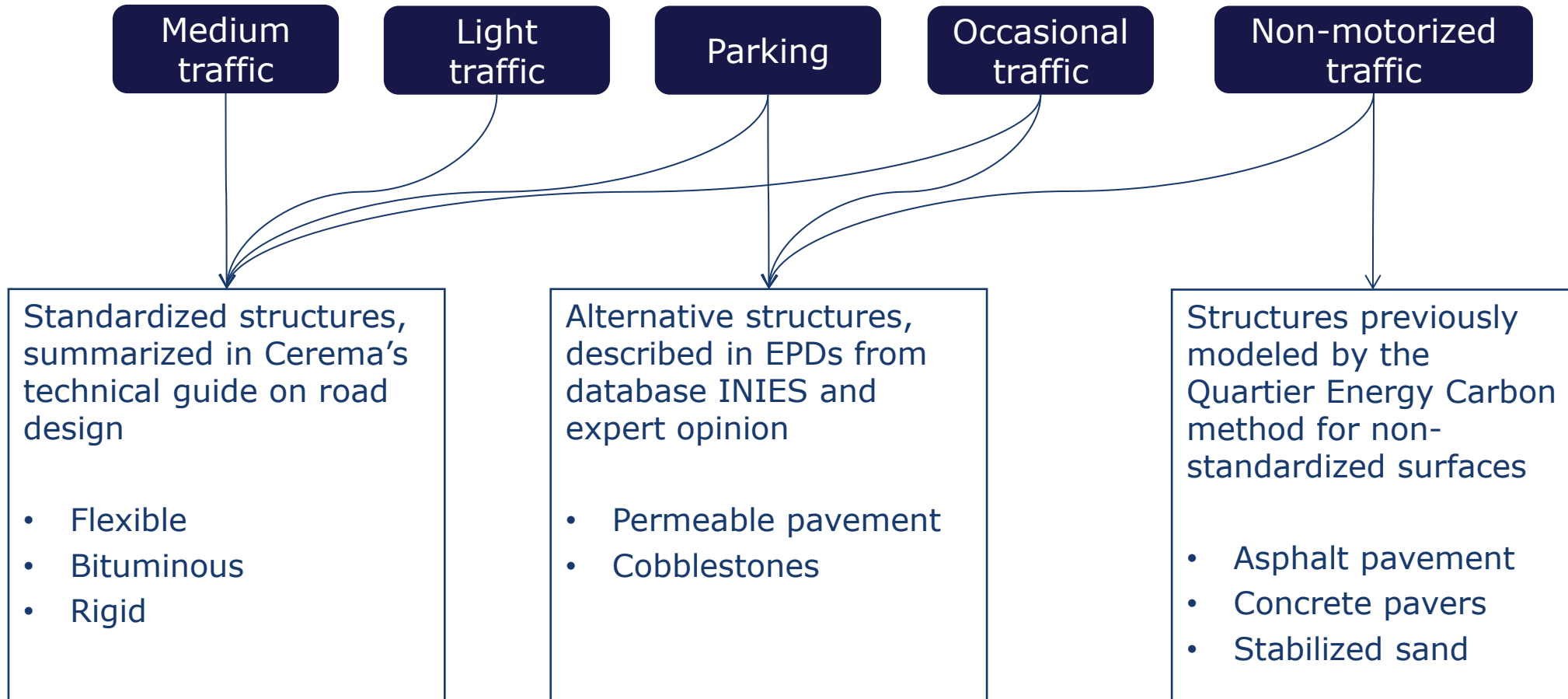
Occasional traffic: "Allow the circulation of **occasional traffic** on 1 m² of a French urban **pavement** for 50 years".

Non-motorized traffic: "Allow the circulation of **non-motorized traffic** on 1 m² of a French urban **pavement** for 50 years".

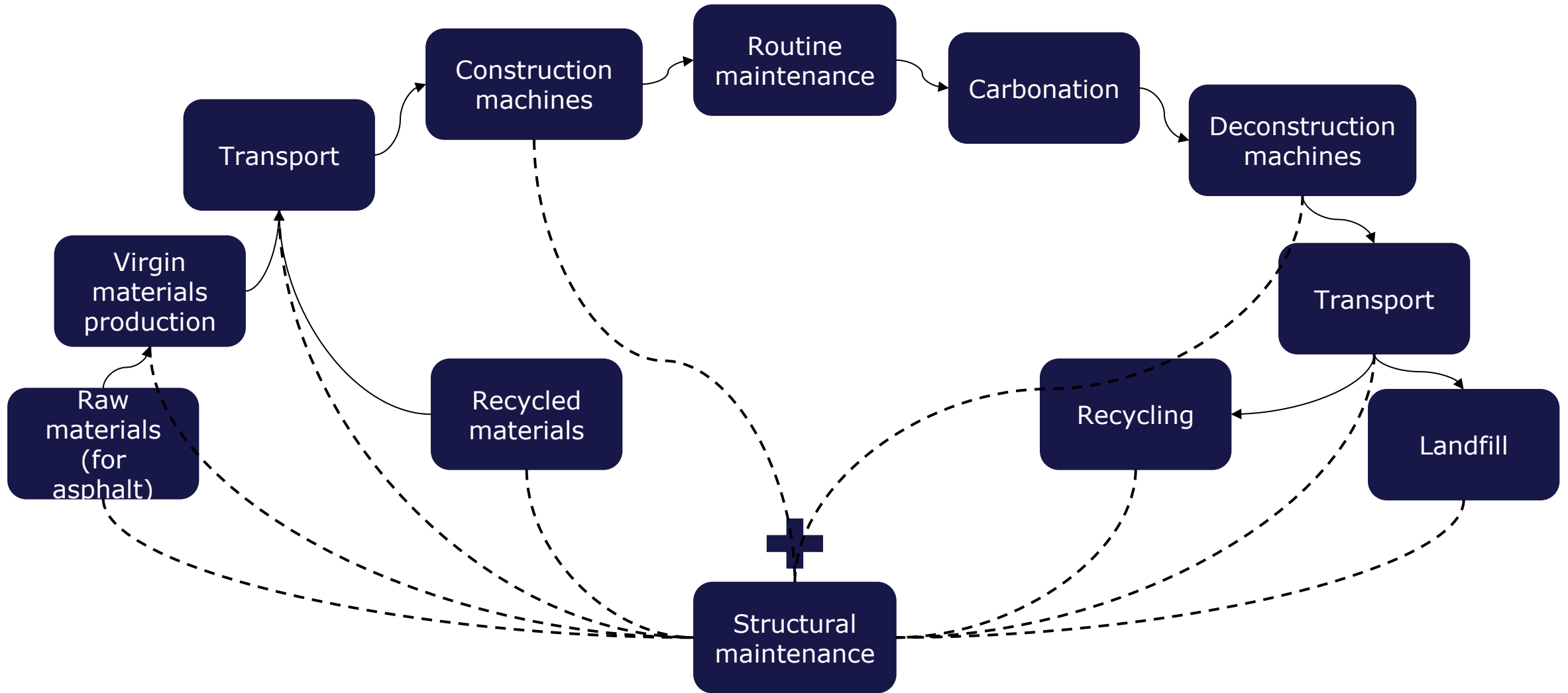
Structure options



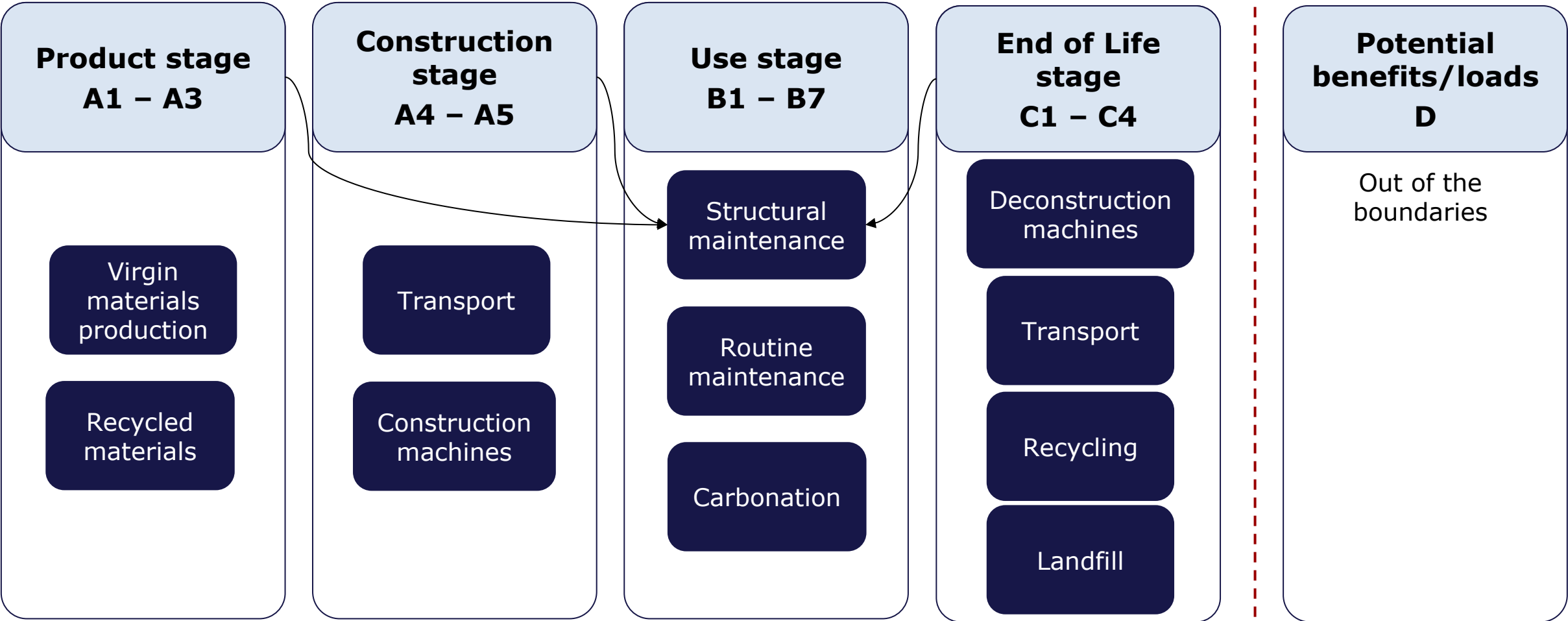
Structure options



Construction of processes



Aggregation of process groups



What can be parametrized?

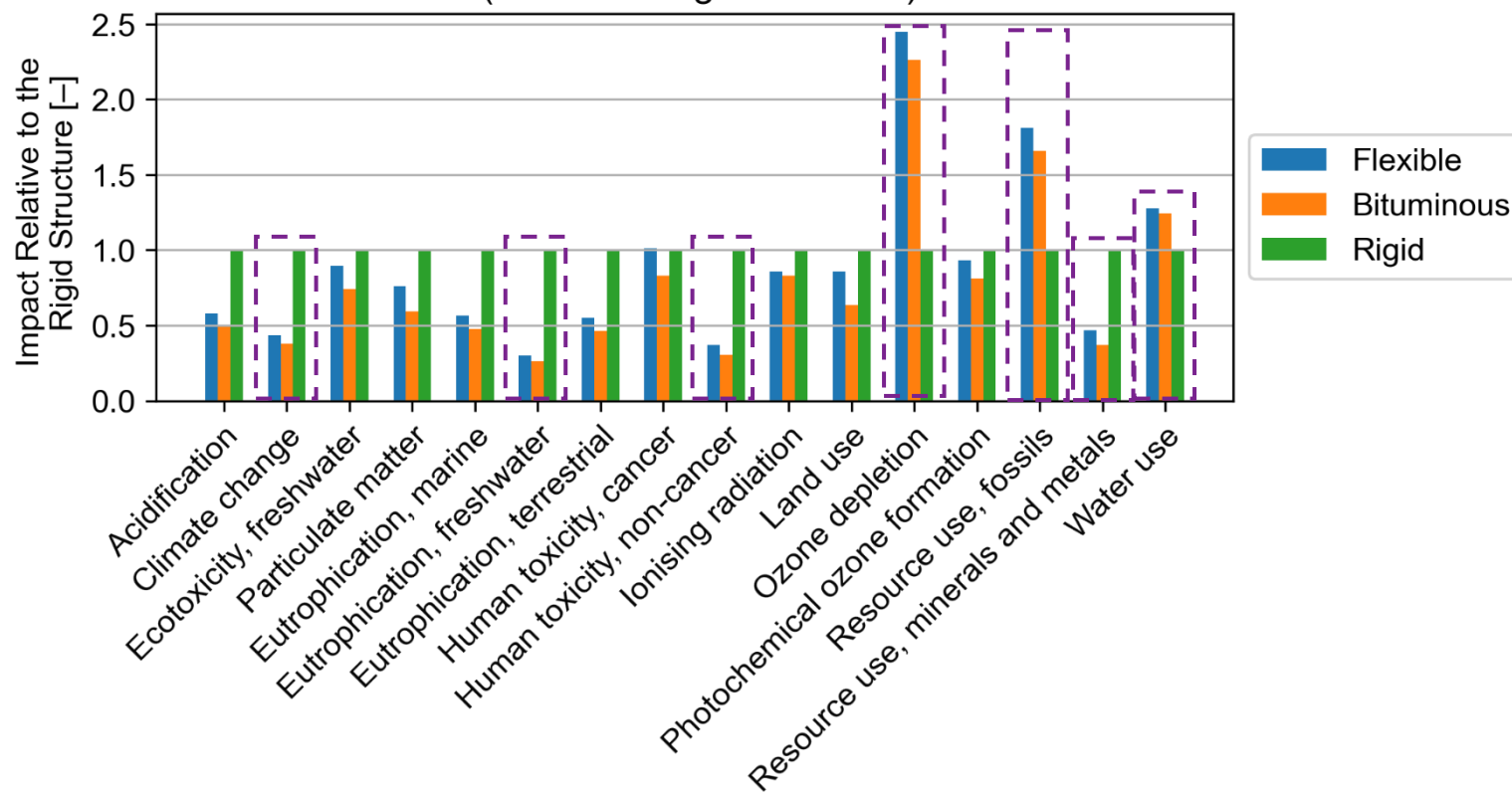
- For each course
 - Choice of material
 - Density
 - Thickness
 - Service Life
 - Losses during construction
- Transport: distances from and to recycling (aggregates)
- Quantity of materials required for routine maintenance



Results for medium traffic – pavement scale

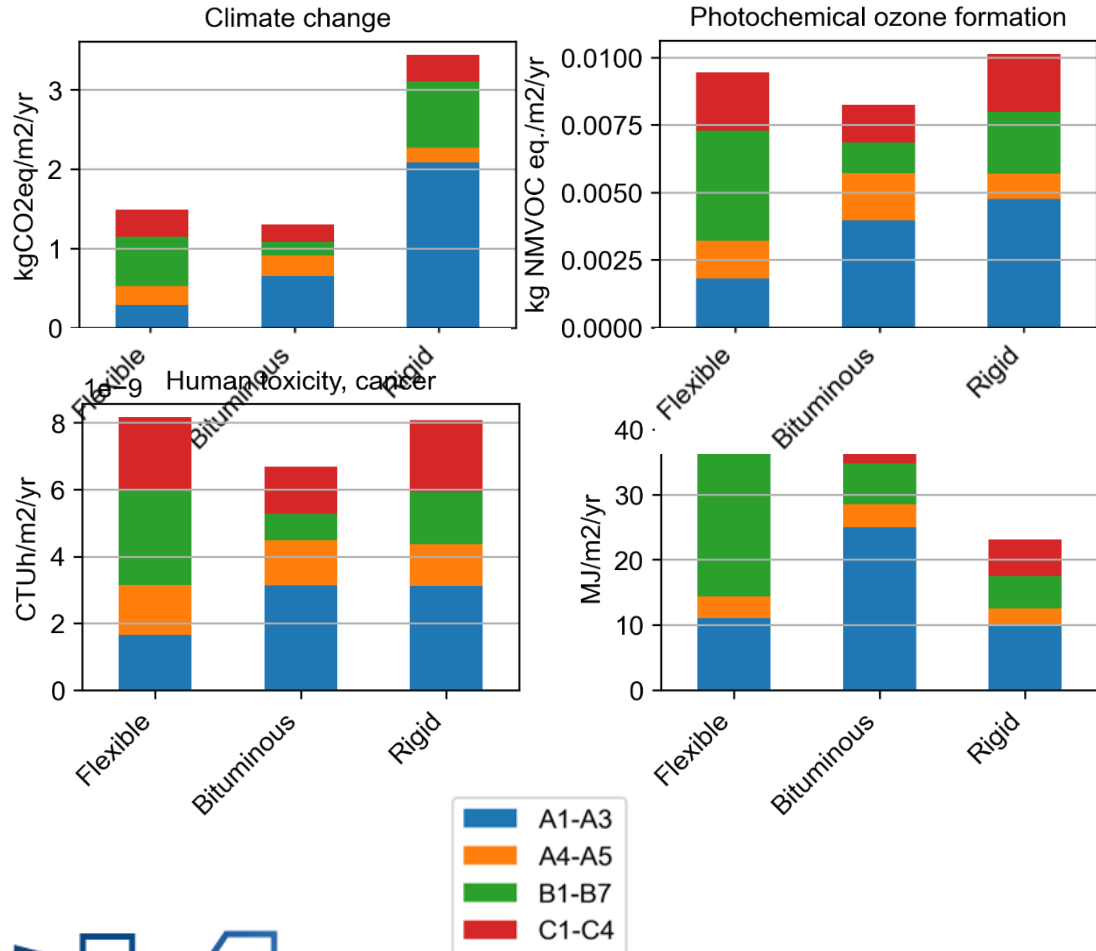
Results and discussion for FU = **medium traffic** and **initial state = new**

Comparison of different structures in all characterized impact categories for medium traffic
(relative to rigid structure)

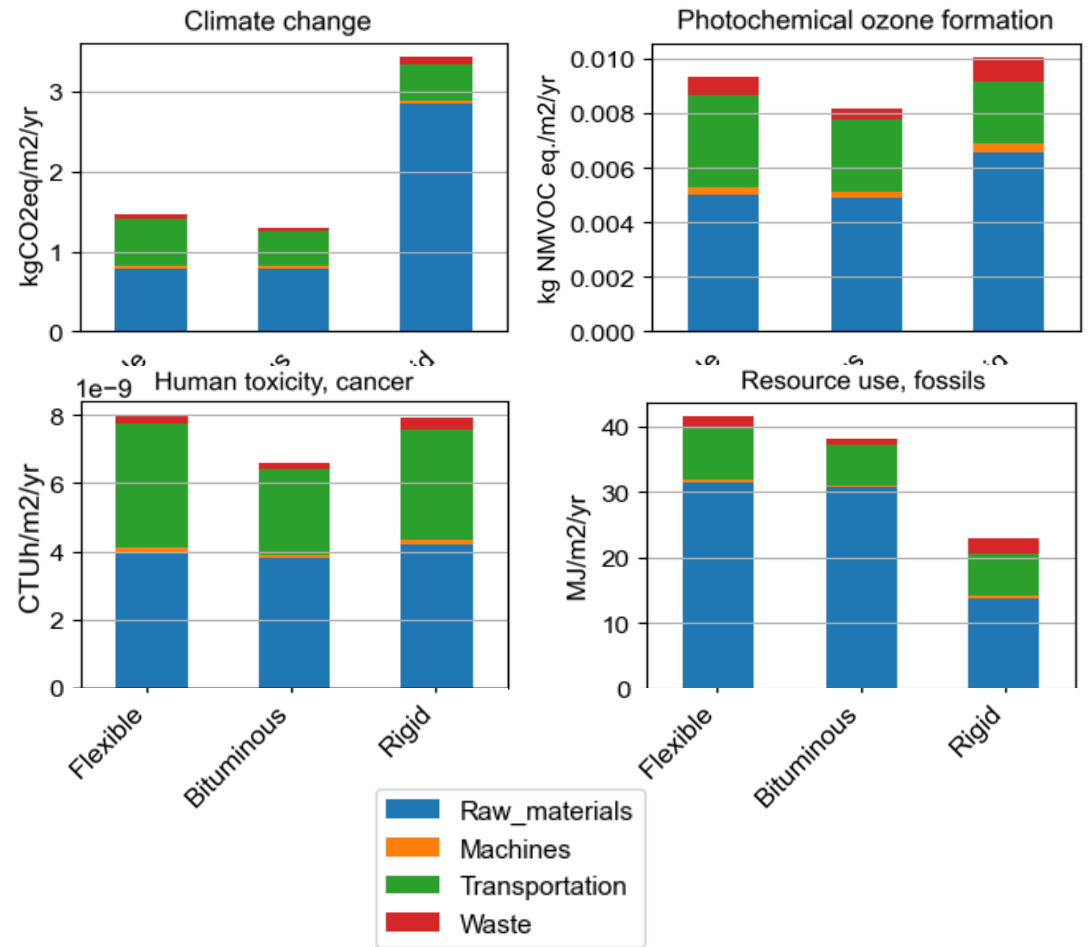


Results for medium traffic – pavement scale

Contribution analysis disaggregated by **life cycle modules**

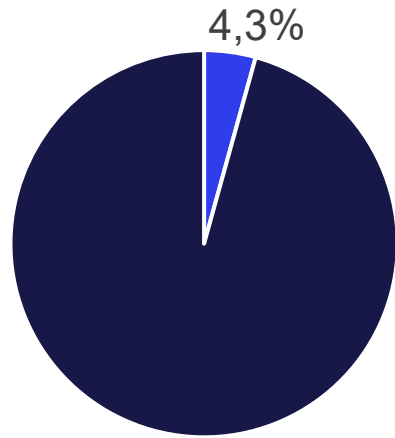


Contribution analysis disaggregated by **group of processes**



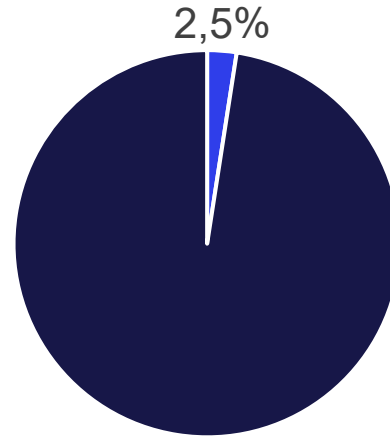
Results at neighborhood scale

Carbon footprint of the construction products of the neighborhood



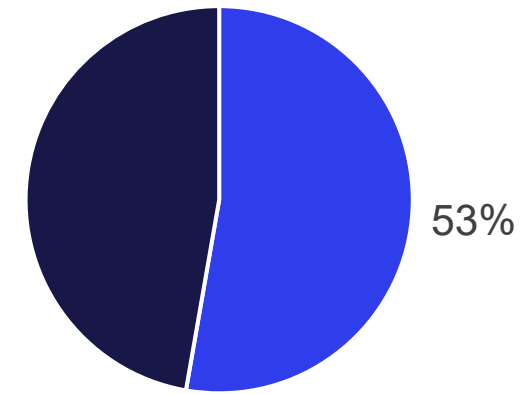
■ Open spaces ■ Buildings

Carbon footprint of all contributors of the neighborhood



■ Open spaces ■ Buildings

Carbon footprint of all contributors of the open spaces



■ Constructions products ■ Other impacts

→ Our object of study covers 1.3% of the total impacts of the neighborhood





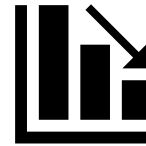
Environmental assessment:

- 5 different FUs
- 3 or 4 options for each FUs
- 3 initial states
- Parametric pavements
- Parametric open spaces

Contribution analysis:



- Raw material production and extraction
- Production and maintenance stages
- Transport not negligible



Comparison of options:

- Structures with hydraulically bound materials perform the worst.
- Flexible pavement is best for light and occasional traffic.
- Cobblestone is best for non-motorized traffic.
- Rankings are sometimes unclear.
- High impact difference at street level.





Pavement LCA

- Data representativeness
 - Temporal
 - Technological
- Uncomplete uncertainty analysis
- Parameters to be included in the scope
 - Albedo
 - Surface roughness



Neighborhood scale

- Missing open spaces
- Only construction materials
- LCA limitations
 - Local biodiversity
 - Stormwater runoff
- To complete LCA study:
 - Economical study with LCC
 - Social study on mobility choices
 - Size of cars
 - Mobility transition and modal shift



Thank you for your attention !

