

RENOVATE IN ONE STEP, STEPWISE, OR RECONSTRUCT?

Three pathways towards carbon neutrality of existing single-family dwellings: what are the tipping points?

Yanaika Decorte, Prof. dr. ir.-arch. Marijke Steeman, Prof. dr. ir.-arch. Nathan Van Den Bossche

Background

The existing building stock is outdated, consumes a lot of energy, and highly contributes to the global greenhouse gas emissions. Consequently, there is a urgent need for a transition of the existing building stock towards energy and carbon neutral buildings. In order to reach this goal, a 97% conversion of the existing building stock is required.

There are three main pathways that could facilitate this transition:

- One-step deep energy renovation,
- Step-by-step deep energy renovation,
- Demolition followed by new build.

The importance of a sustainable transition of the existing building stock raises the question of how the environmental impact and financial cost of these three main pathways relate for different types of single-family dwellings. When is reconstruction recommended over a deep energy renovation? And how does a theoretical one-step deep energy renovation relate to a more common step-by-step renovation?

No previous research is found that systematically compares the three main pathways from a financial and environmental point of view and defines tipping points in the decision-making.

The existing standards on how to perform an LCA (i.e. ISO 14040, ISO 14044, EN 15804, and EN 15978) are very conceptual and too vague to allow for a fair and consistent comparison of the three main pathways.

- A renovated building will have a shorter remaining service life than the estimated service life of a reconstructed building. How to compare buildings with different service lives in a fair way?
- When comparing one-step renovation with step-by-step renovation, how to differentiate between renovation measures applied at different moments in time?
- Both in case of renovation and reconstruction, an existing building is the starting point of an LCA which causes an overlap between different life cycles. How to allocate the impact of existing materials?
- When a building is horizontally extended, how to define the functional unit to consider different useful areas?

In addition, the standards leave freedom to LCA practitioners to make assumptions, implement simplifications and set own boundary conditions. This can contribute to variations and contradictions in the trade-off between the pathways.

There is a need for a well-defined and robust methodological LCA framework that allows for a fair and consistent comparison of the three main pathways.

Research methodology

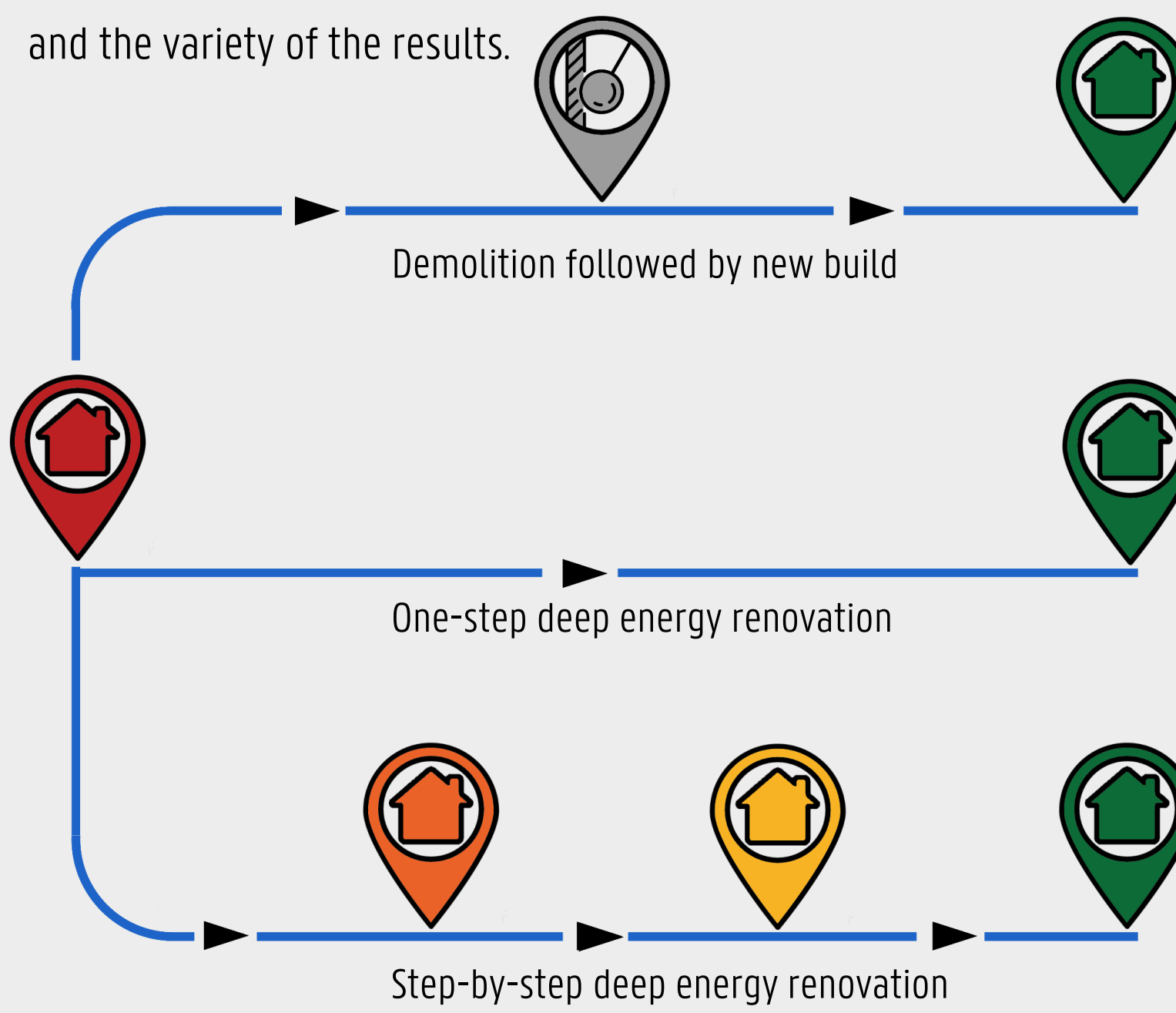
Single-family dwellings

A variety of single-family dwellings are considered to define building characteristic related tipping points. The existing building characteristics are derived from TABULA and varied.

- Construction period
 - 1940
 - 1960
 - 1980
- Dwelling typology
- Dimensions and component ratio
- Existing measures

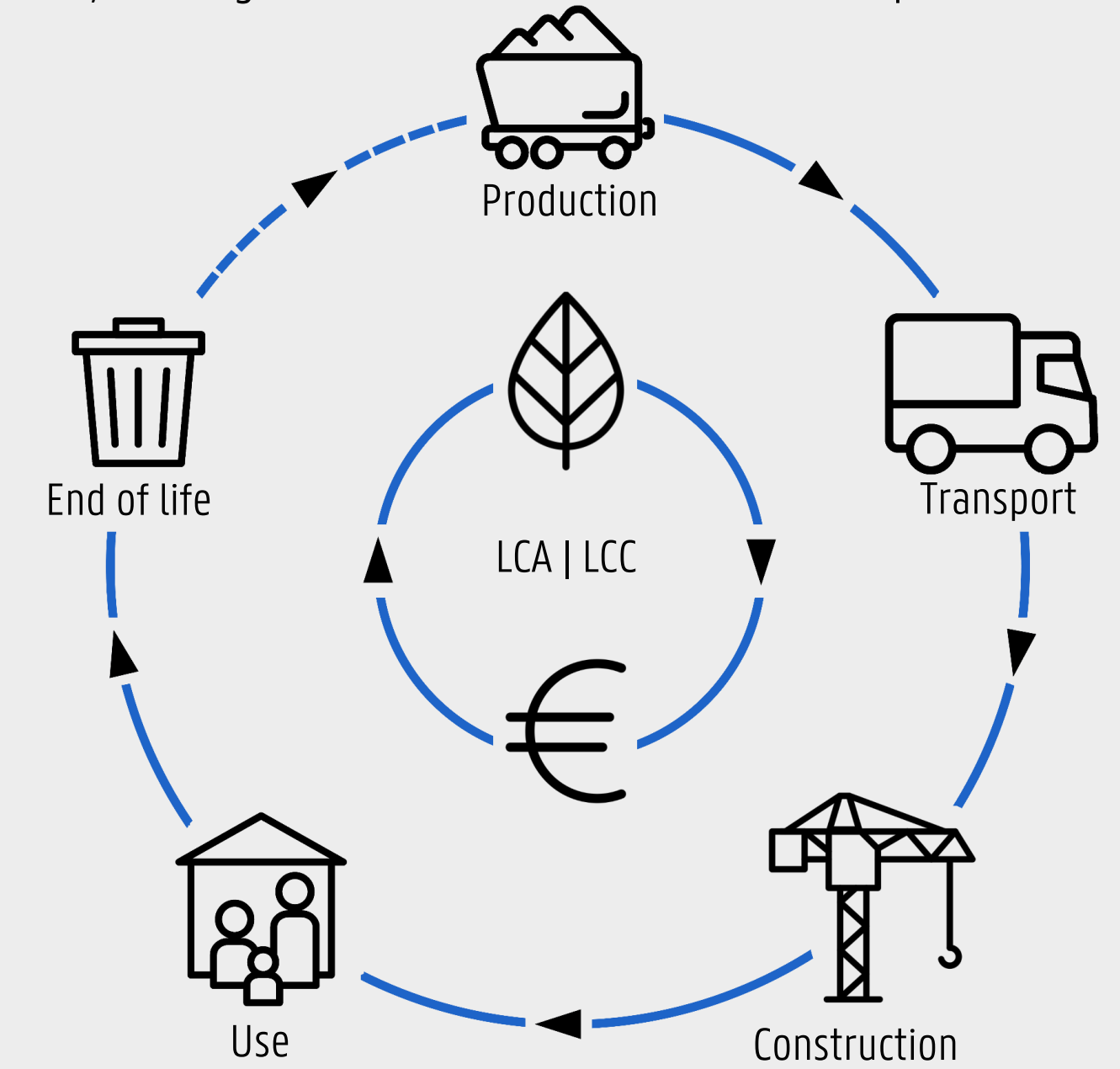
Possible pathways towards climate neutrality

Three main pathways are considered. In addition, different combinations of building envelope measures and technical installations are evaluated to give insight into most effective measures and the variety of the results.



Integrated LCA and LCC methodology

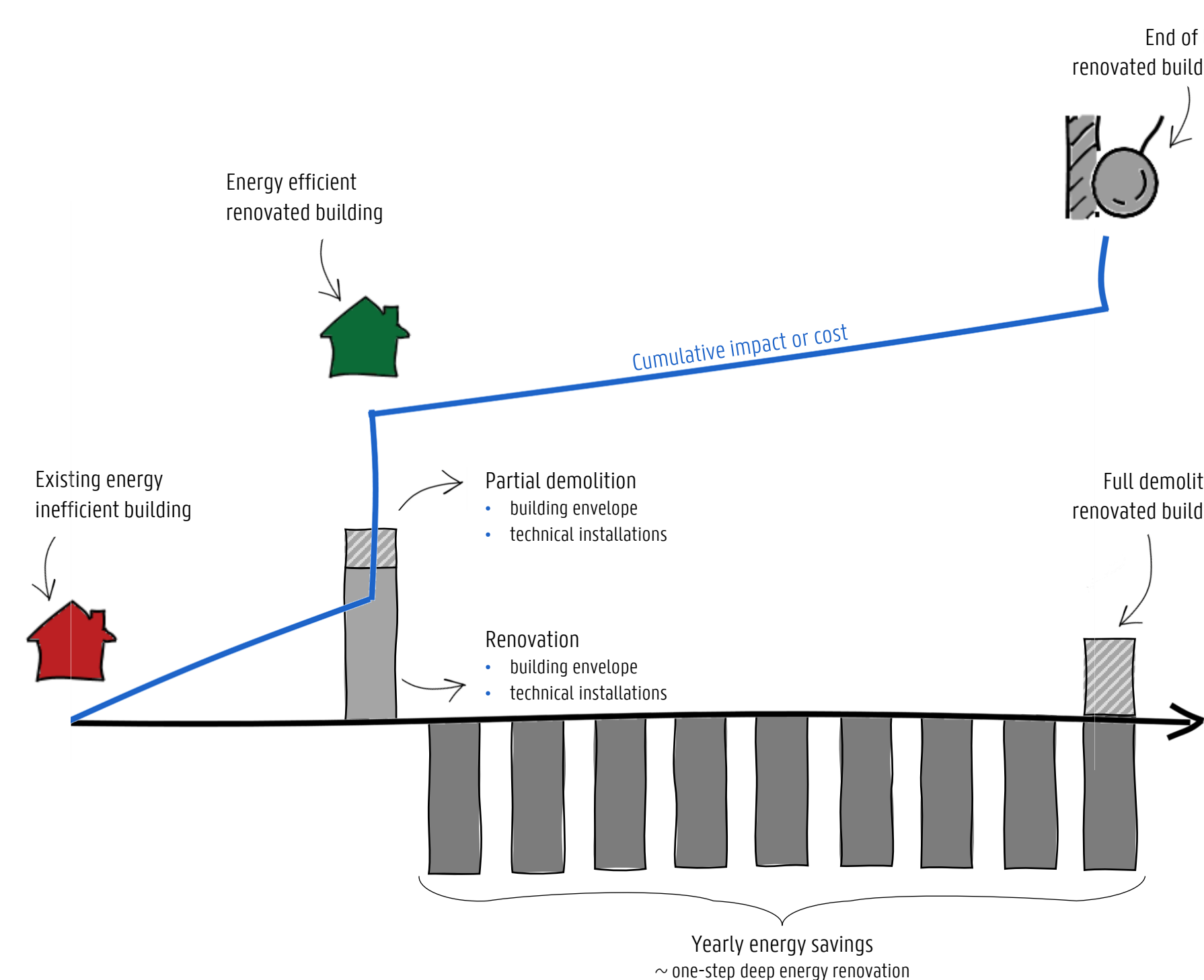
The rising focus on sustainability requires a trade-off between financial and environmental criteria. To avoid burden shifting, the full life cycle should be considered. Therefore, an integrated LCA and LCC method is developed.



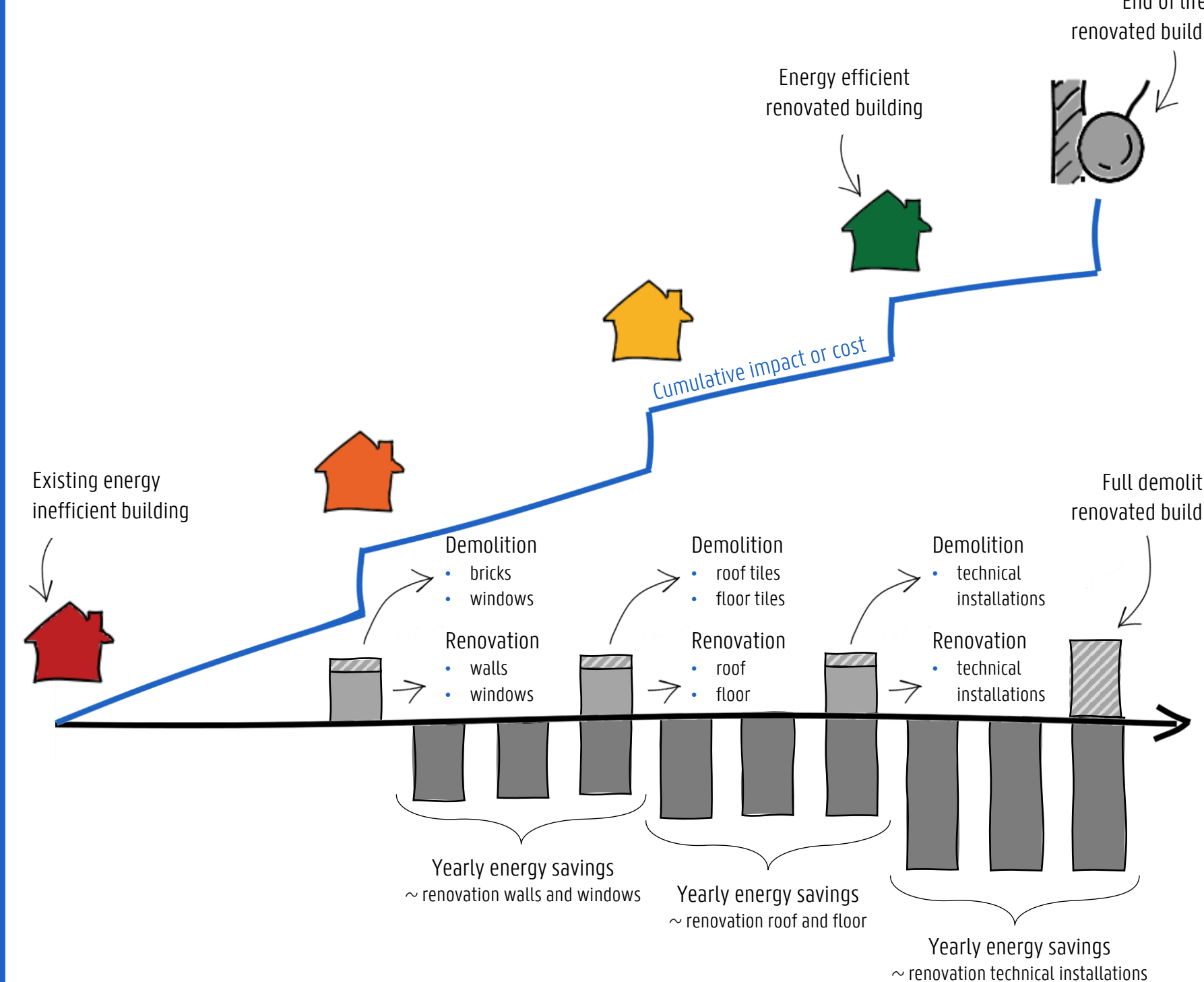
Systematically compare the three pathways based on an integrated LCA and LCC methodology.

Conceptual timeline of the three pathways

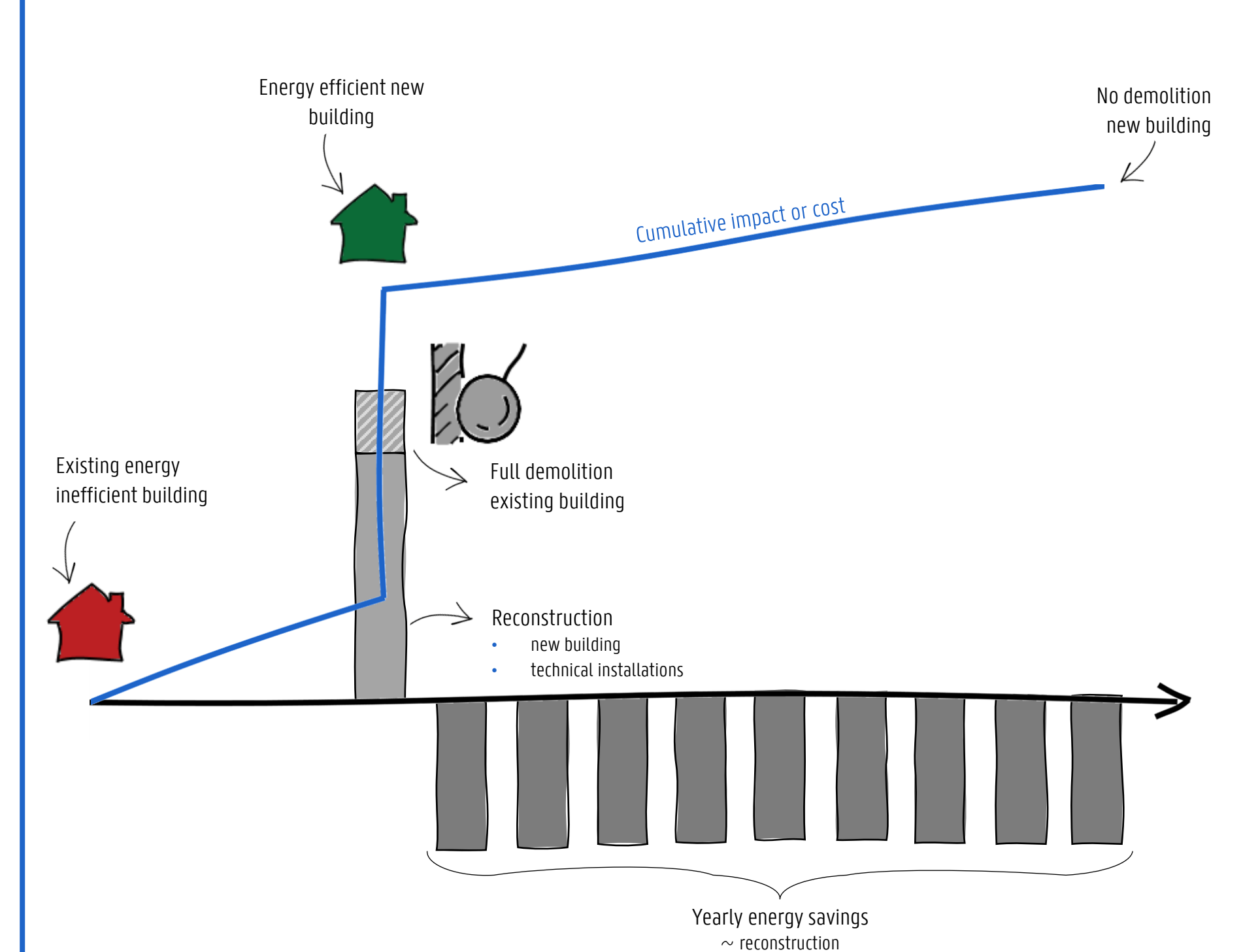
One-step deep energy renovation



Step-by-step deep energy renovation



Demolition followed by new build



Why?

Why not?

Involves less resources and waste as existing structure is being reused.

The existing building does not meet the minimum area requirements.

Why?

Why not?

Spread financial costs over time.

Duration and nuisances.

Why?

Why not?

The existing building has a deplorable quality.

Involves a lot of resources and waste.

WHAT WOULD YOU CHOOSE?

ADD YOUR OPINION AND THOUGHTS.

Research goals

- Develop a well-defined and robust methodological LCA framework to compare the three main pathways in a fair and consistent way.
- Provide insight into which pathways are most optimal to upgrade different types of single-family dwellings from an environmental and financial perspective.
- Determine tipping points in the trade-off between the pathways to define more tangible and general building renovation guidelines.

Contact

Architecture and Urban planning - Building Physics

✉ yanaika.decorte@ugent.be

🌐 Yanaika Decorte