

# Integration of material and energy performance of buildings:

$$I = M + E$$

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## Background

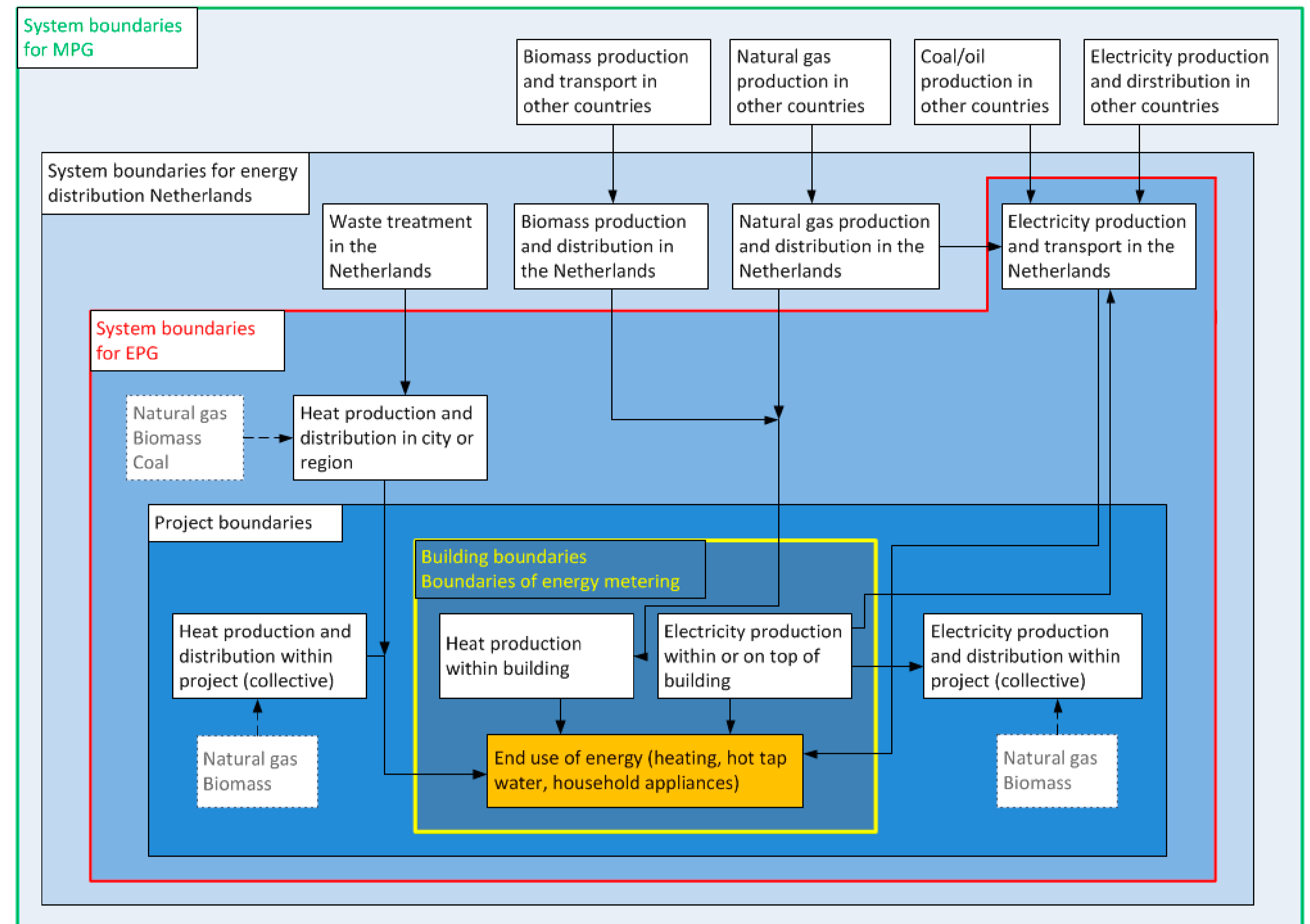
With the successful efforts in the Netherlands and other European countries to improve the energy performance of buildings, the role of building materials and embodied energy or CO<sub>2</sub> in the environmental performance has become more and more important. Since 2014, it is in the Netherlands obligatory to make also a so-called "material performance" calculation for new building projects (dwellings and offices). This raises the problem that designers, project developers and property managers have to work with two separate indicators, one for energy performance and one for material performance.

## Goal of research

To develop a new framework to integrate the materials and energy performance calculations of buildings into a single indicator, based on LCA, taking into account not only the embodied and operational energy, but also other environmental impacts that are usually addressed in LCA.

## Issues addressed

- Environmental profile of energy carriers
- Materials for energy installations and infrastructure
- Differences in system boundaries
- Allocation for district heating and cogeneration plants



## Materials: M

Materials performance indicator

- Environmental performance of materials used in the building
- **Dutch building legislation** (new buildings): calculation obligatory using Dutch harmonized calculation method
- **LCA**: CML-2 method, weighting as shadow prices
- **System boundaries**: global economy
- **Functional unit**: gross floor area

## Energy: E

Energy performance indicator

- Environmental performance of operational energy consumption in building (heating, cooling, hot tap water, building installations)
- **Dutch building legislation** (new buildings): Energy performance calculation, based on EPBD; EPG value below maximum value
- **System boundaries**: building (behind energy meters)
- **Functional unit**: m<sup>2</sup> heated floor area

## Energy: E\*

- **LCA**: CML-2 method, weighting as shadow prices
- **System boundaries**: plot boundaries (energy meters) plus production of energy carriers
- **Functional unit**: m<sup>2</sup> gross floor area

M + E\*

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Sustainability performance indicator: I

## Example: single family row house (1979)

	Current	Renovation
Façade / roof	Rc = 1.25-1.55	Rc = 7.5
Glazing	50% single, 50% double	Triple glazing
Heating	HE natural gas	Heat pump (air)
Solar energy	None	Solar PV and solar boiler
EPG	1.53 (label C)	-0.18 (label A++)
MPG	1.12	1.42

