Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

54th LCA Discussion Forum
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Environmental impacts of buildings assessed with the Ecological Scarcity method

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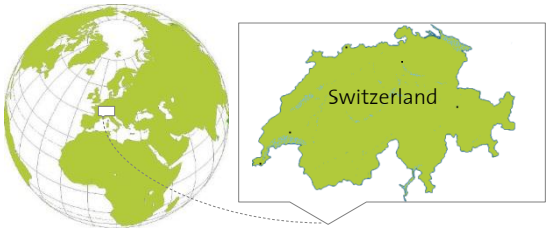
Introduction



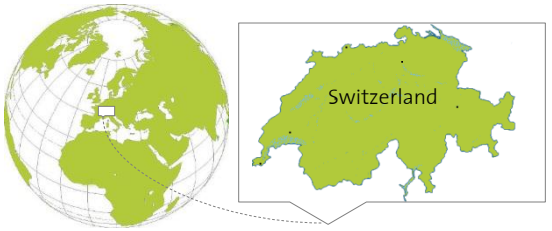
Initial position:

The **building sector** consumes about 40% of all global primary energy and contributes to around one third of the entire man-made CO_2-Emissions for heating, cooling and lighting of buildings.*

Optimisation of **residential buildings**, which in Switzerland for example contribute about 88%** to the overall Swiss building stock, will be especially important in the future in order to minimise environmental impacts.

* Source: UNEP (2007). Building and Climate Change: Status, Challenges and Opportunities. Paris, United Nations Environment Programme: 87.
** Source: Wallbaum, H., Heeren, N. et al. (2010). Gebäudeparkmodell, Vorstudie zur Erreichbarkeit der Ziele der 2000-Watt-Gesellschaft für den Gebäudepark der Stadt Zürich Schlussbericht.

Introduction



Initial position:

Life Cycle Assessment (**LCA**, regulated by EN ISO 14040 and 14044) offers a method to evaluate the environmental impact of a building over its entire life cycle (construction-, operation- and disposal-phase).

LCAs of buildings still need to be well-established so that in the future, architects and planners will already be able to conduct them at early design stages.

Introduction

Aim:

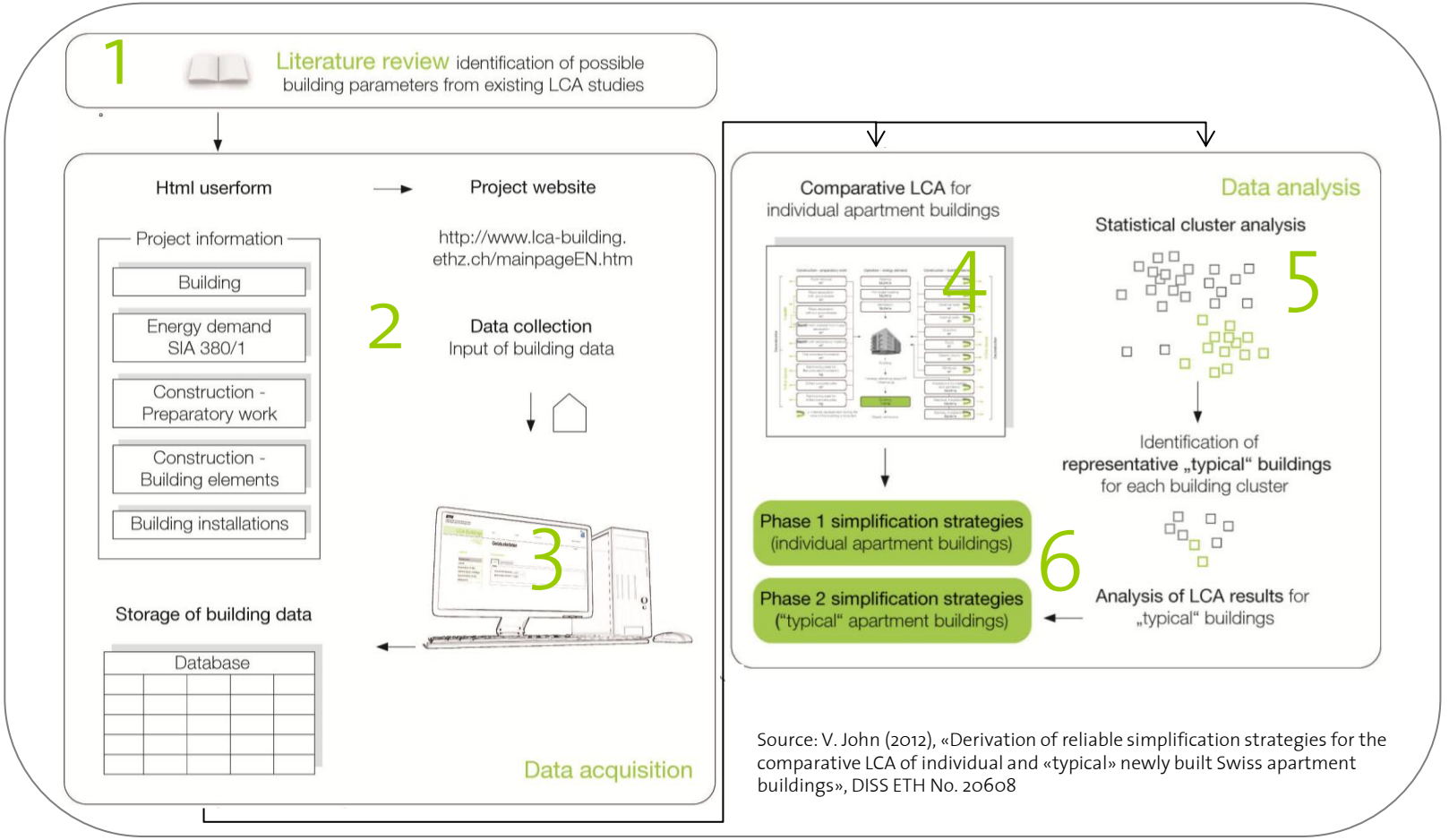
Identifying most environmentally relevant building parameters (e.g. construction components, materials, heating energy etc.) using LCA.

Sample: Newly built Swiss apartment buildings (as of 2006).

Hypothesis:

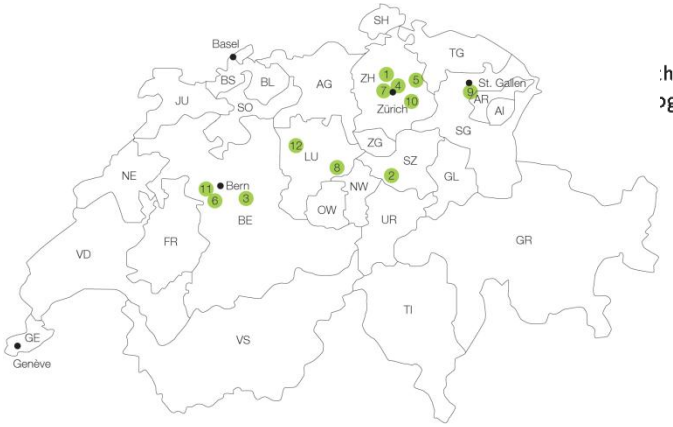
Applicable and reliable simplification strategies for comparative LCAs of buildings can be derived from a larger building sample by the identification of those building parameters and environmental impact indicators which are most relevant for the depiction of the environmental impact of a building throughout its entire lifetime.

Methodology Course of action



Source: V. John (2012), «Derivation of reliable simplification strategies for the comparative LCA of individual and «typical» newly built Swiss apartment buildings», DISS ETH No. 20608

Building characteristics

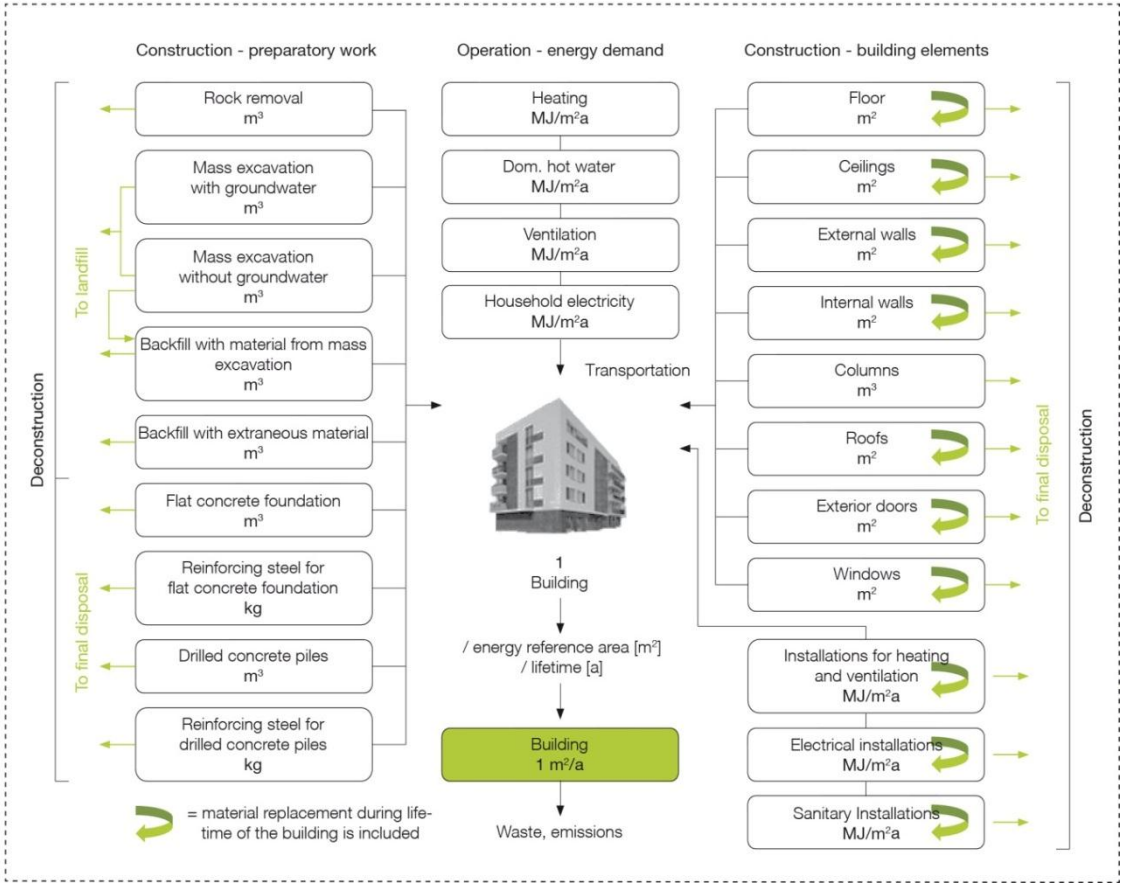


12 individual apartment buildings:

	Number of accommod. units (type of construction)		Energy reference area [m²]:
mfh05:	132	(medium weight)	20400.00
mfh01:	111	(massive)	12430.00
mfh07:	89	(massive)	13441.00
mfh11:	22	(massive)	2966.00
mfh10:	10	(massive)	1120.00
mfh12:	10	(medium weight)	1170.00
mfh08:	6	(medium weight)	1121.90
mfh04:	4	(massive)	622.20
mfh09:	4	(medium weight)	510.10
mfh06:	3	(lightweight)	408.00
mfh03:	3	(lightweight)	374.00
mfh02:	2	(medium weight)	350.40

LCA of 12 individual apartment buildings

System boundary LCA



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Life Cycle model:
"from cradle to grave"

Allocation: Cut-off at end-of-life

Functional unit:
1m² of energy reference area/ 1 year of building lifetime

Building lifetime:
60 years

Life Cycle Inventory Data for energy- and material processes:
Ecoinvent database

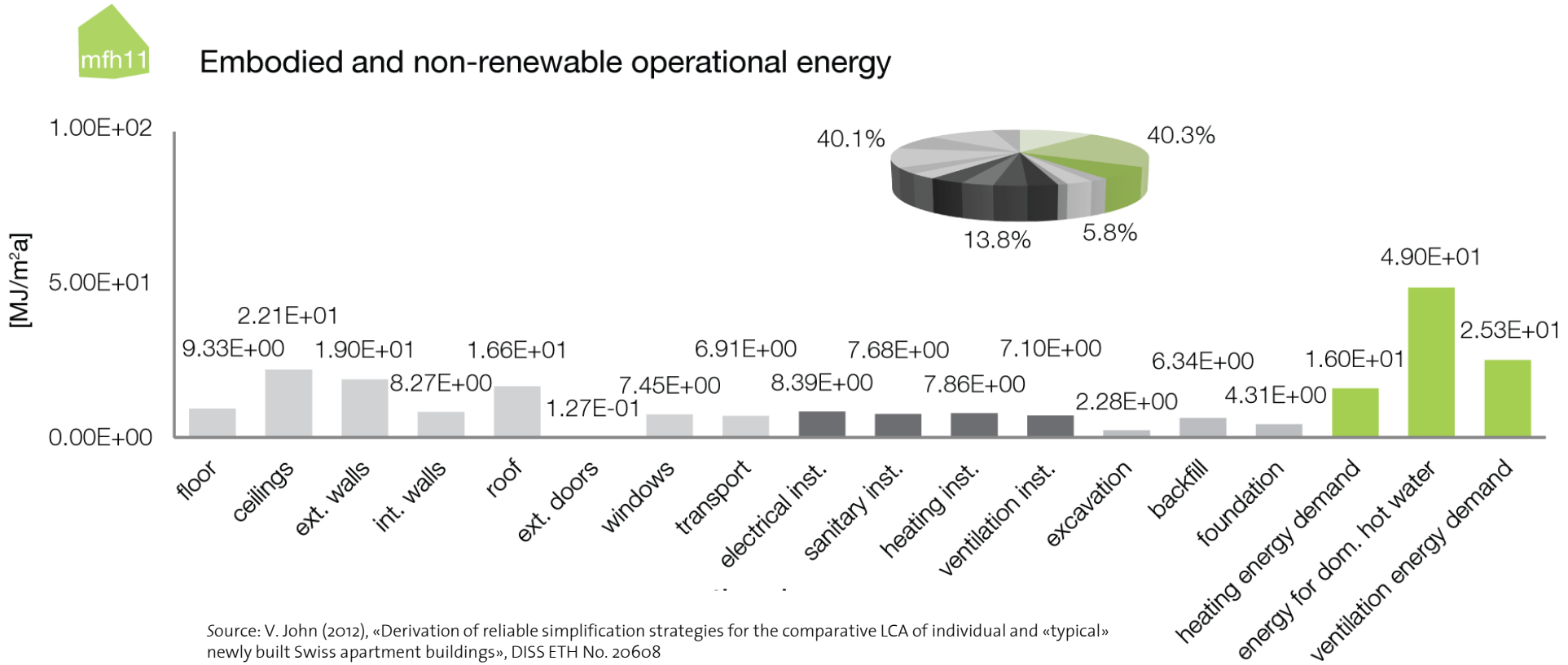
Modelling of building lifecycle /
Life cycle assessment
-> SimaPro Software

LCA of 12 individual apartment buildings

Applied environmental impact categories and indicators:

- Cumulative energy demand (CED)
- Non-renewable embodied and operational energy
- Embodied and operational emissions (GWP 100a)
- ReCiPe Midpoint (H) Europe
- Ecological Scarcity (UBP 06)

LCA of 12 individual apartment buildings



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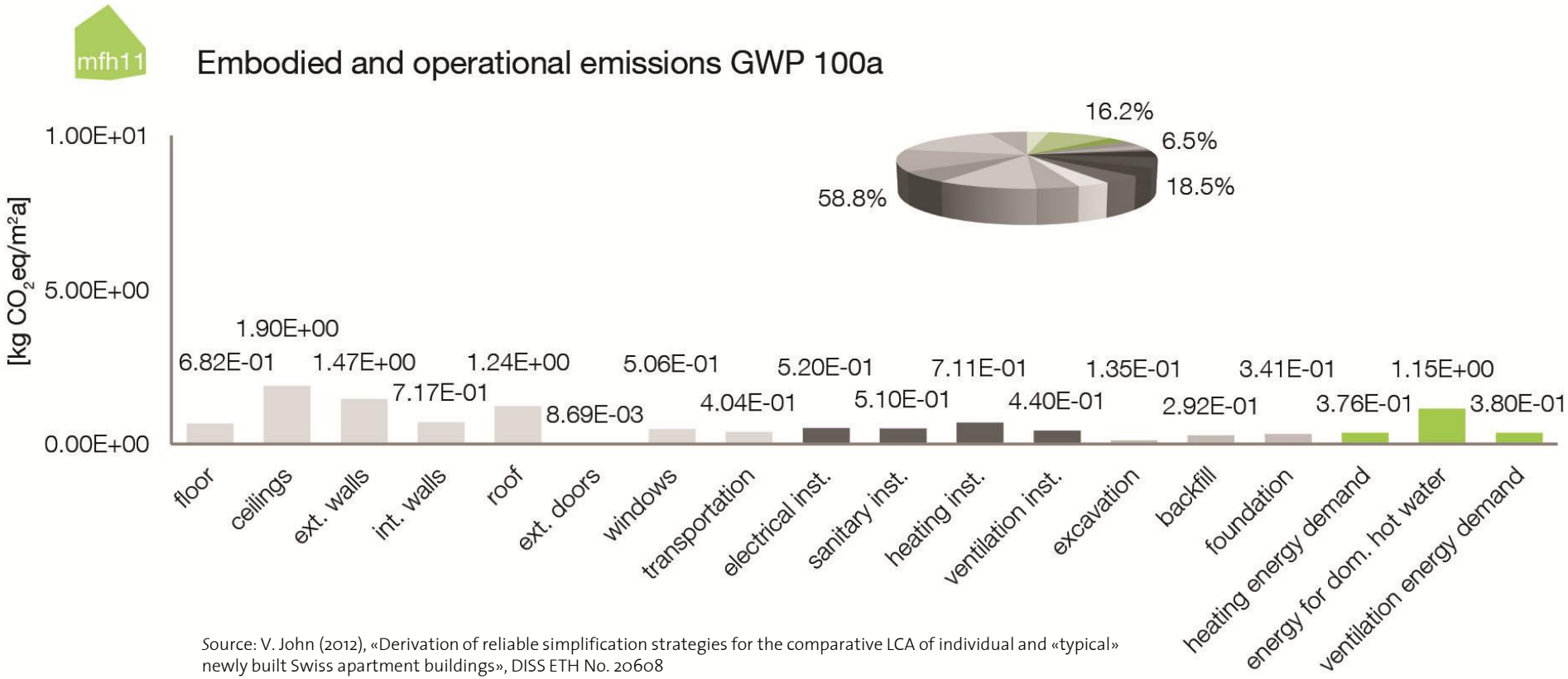

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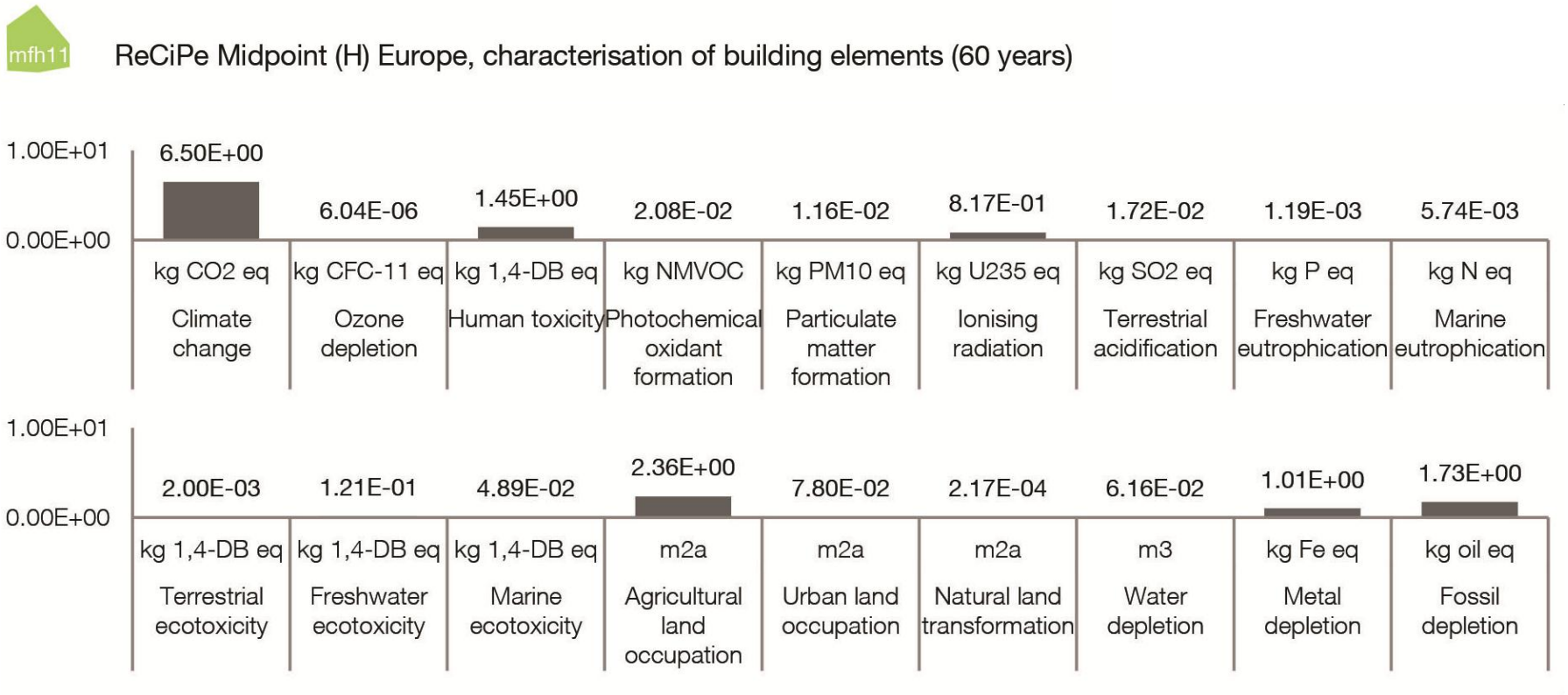
LCA of 12 individual apartment buildings



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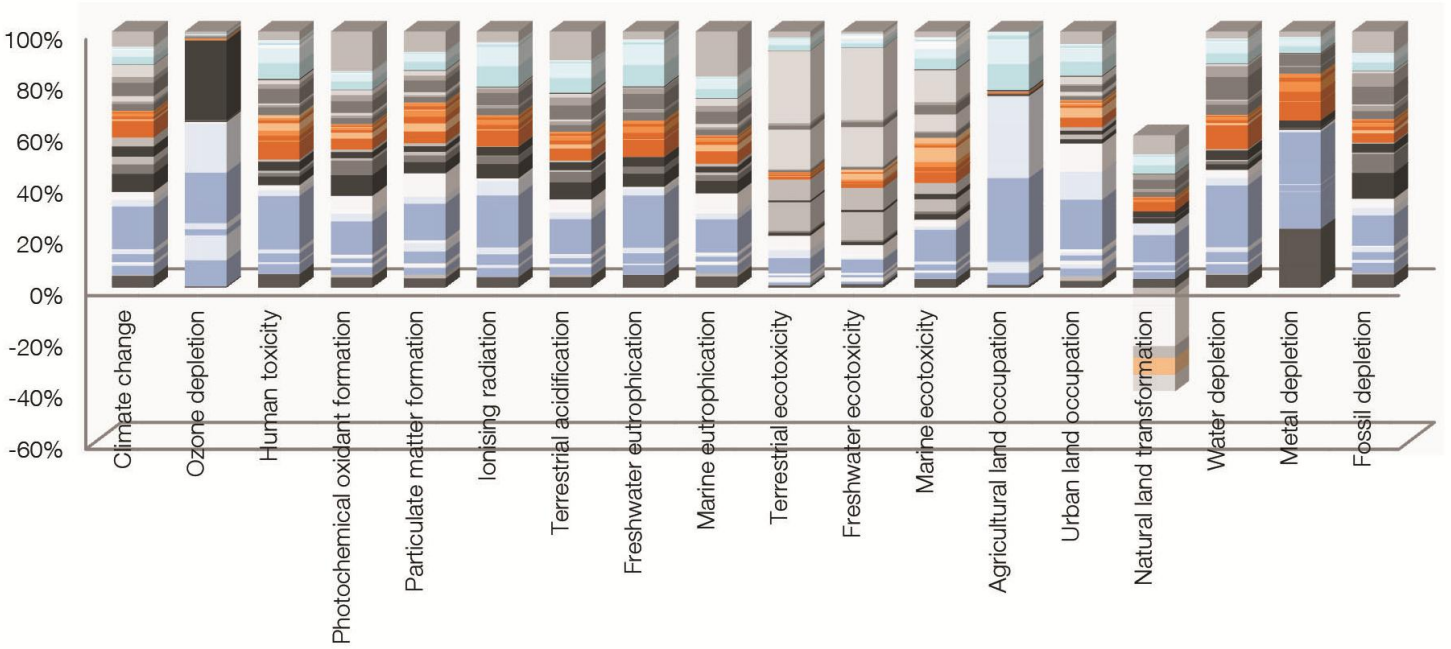
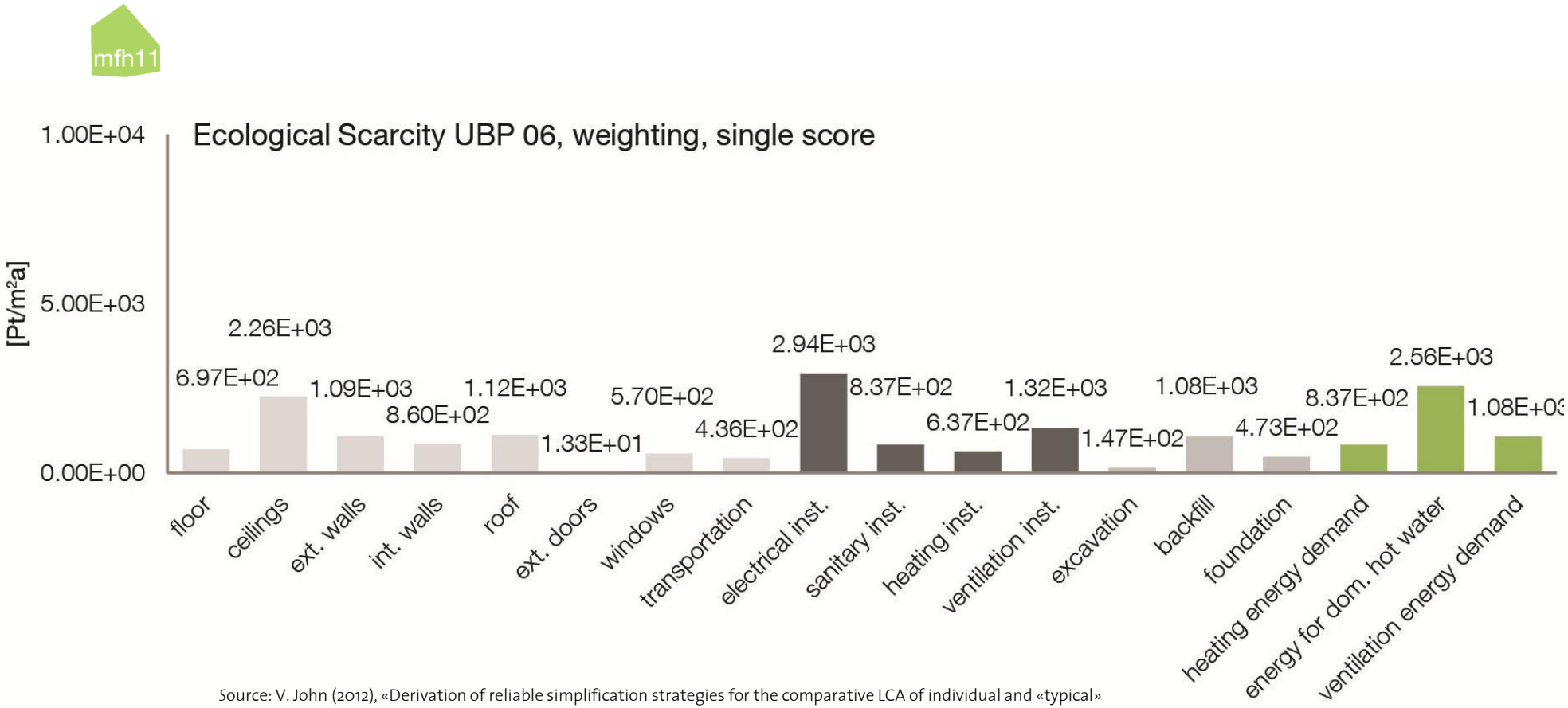
LCA of 12 individual apartment buildings

mfh11

ReCiPe Midpoint (H) Europe, characterisation of building elements (60 years)



LCA of 12 individual apartment buildings

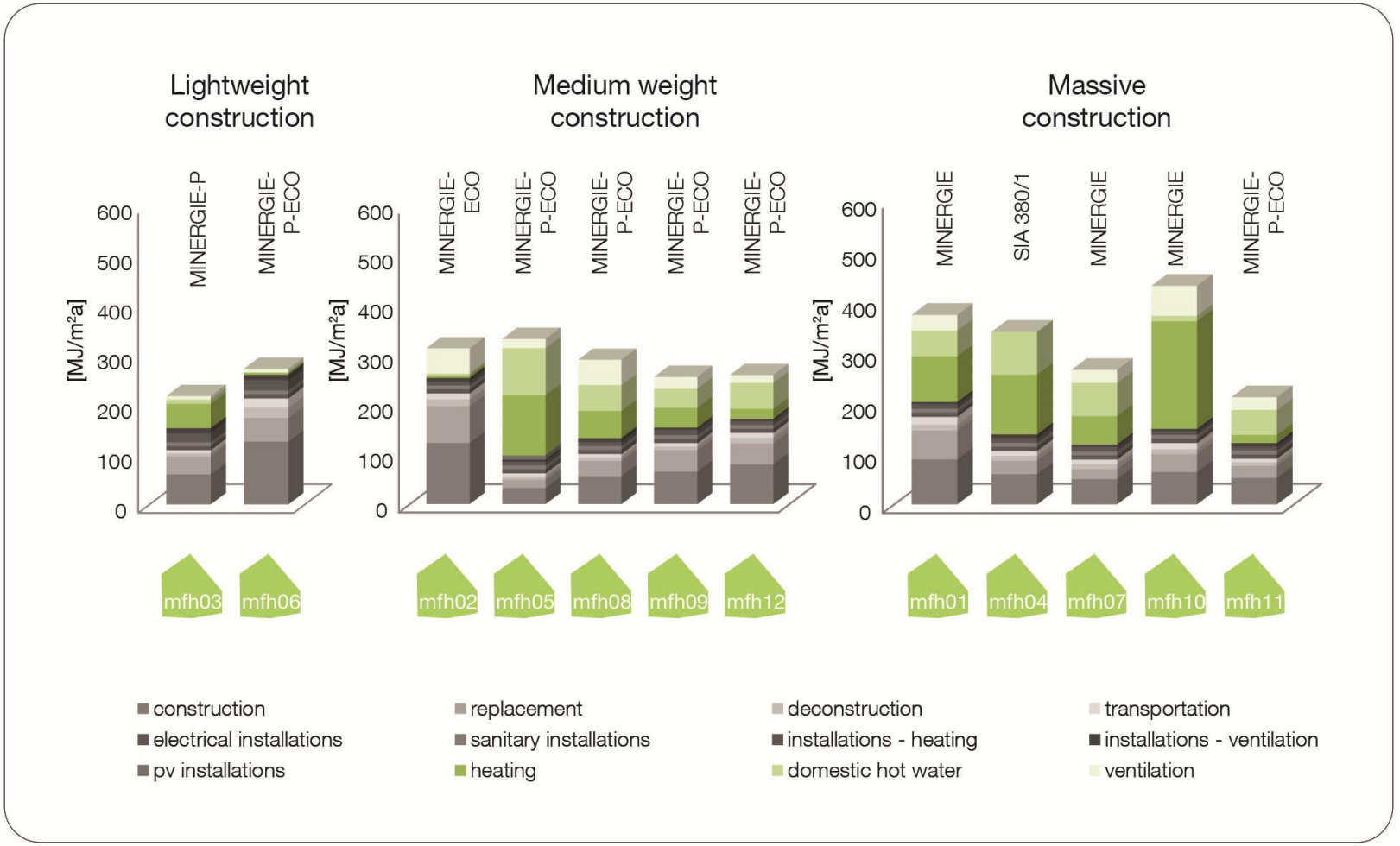


Source: V. John (2012), «Derivation of reliable simplification strategies for the comparative LCA of individual and «typical» newly built Swiss apartment buildings», DISS ETH No. 20608

LCA of 12 individual apartment buildings

Embodied and non-renewable operational energy

Source: V. John (2012), «Derivation of reliable simplification strategies for the comparative LCA of individual and «typical» newly built Swiss apartment buildings», DISS ETH No. 20608



LCA of 12 individual apartment buildings

Embodied and operational emissions (GWP 100a)

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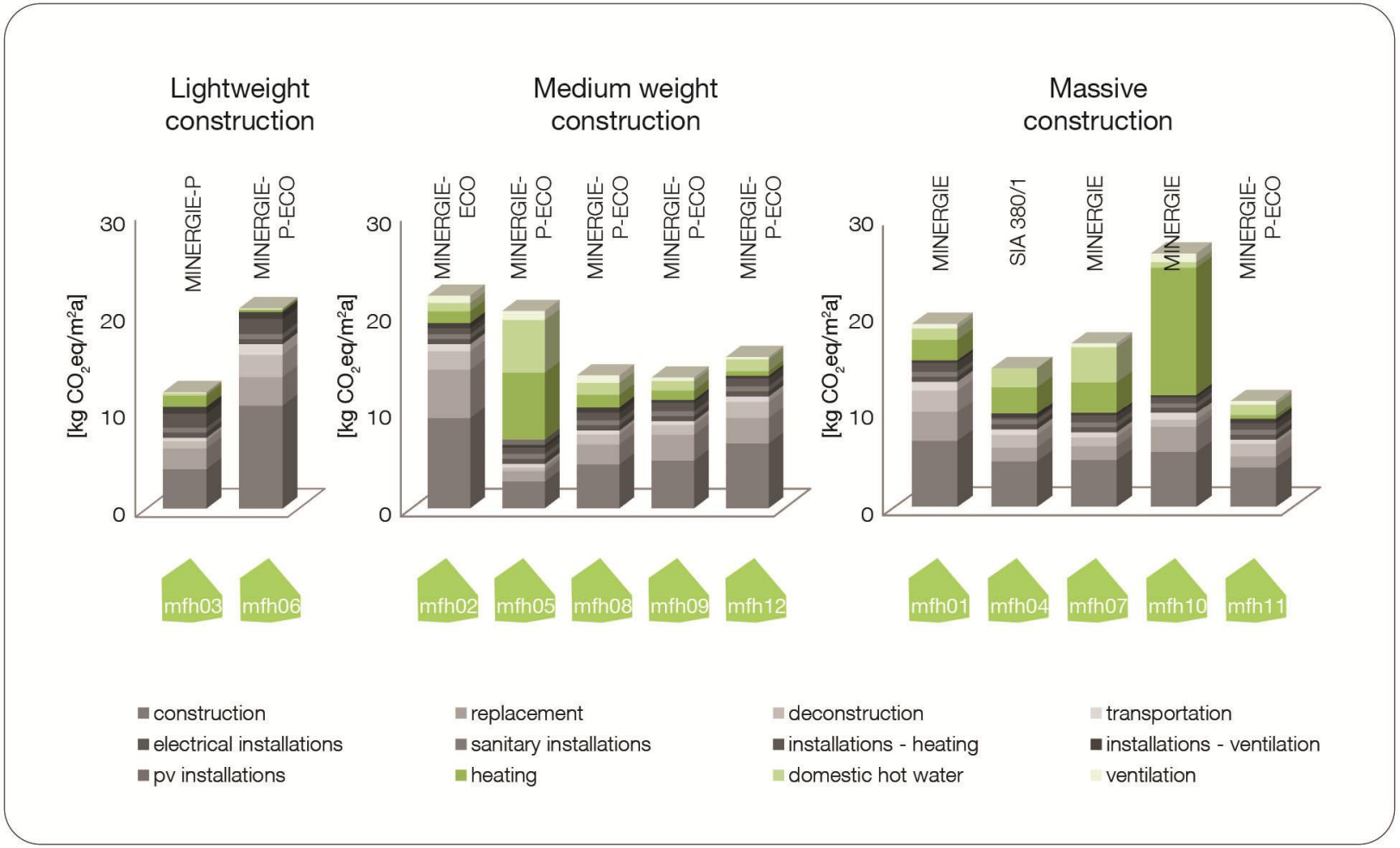
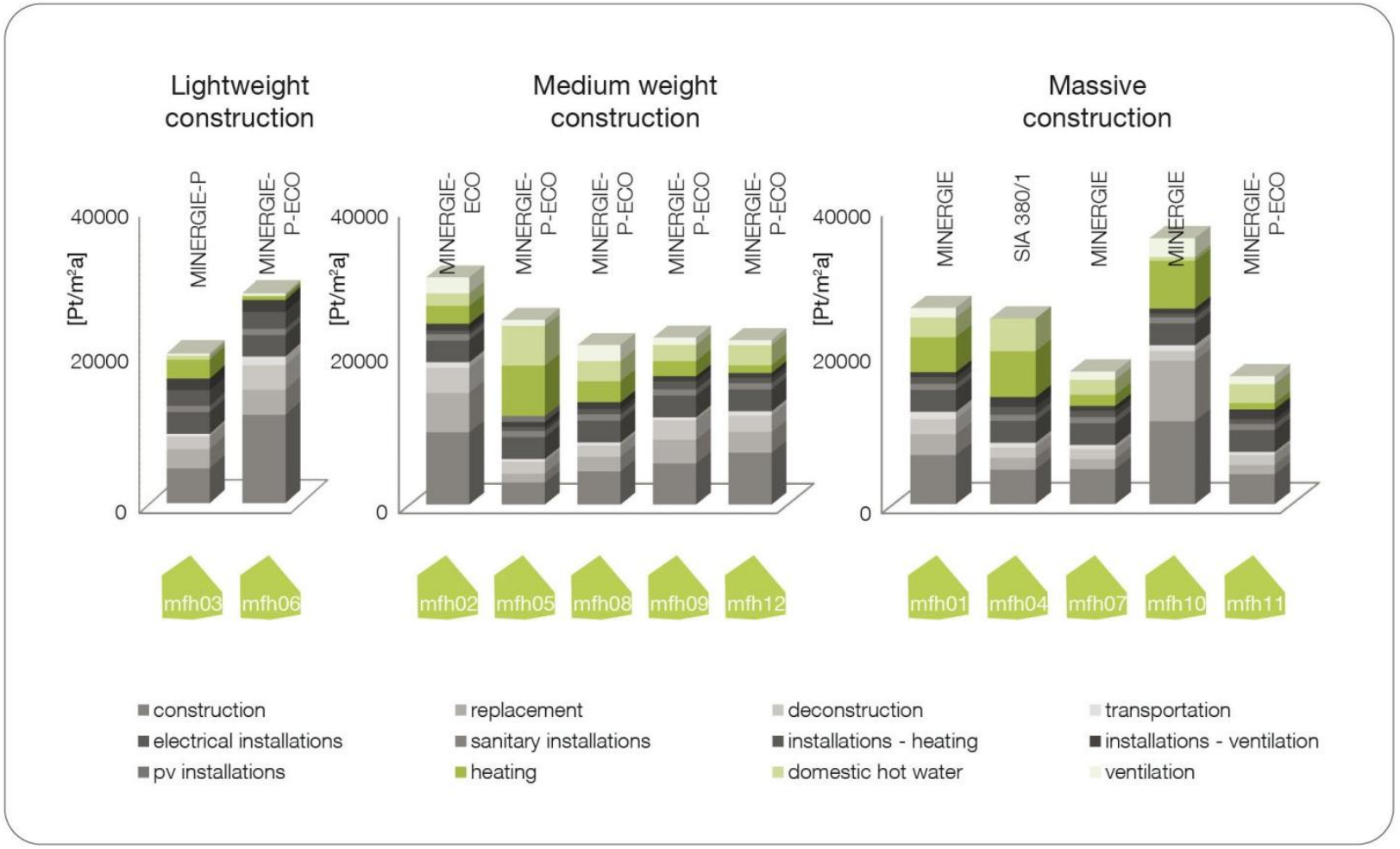


LCA of 12 individual apartment buildings

Ecological Scarcity UBP 06



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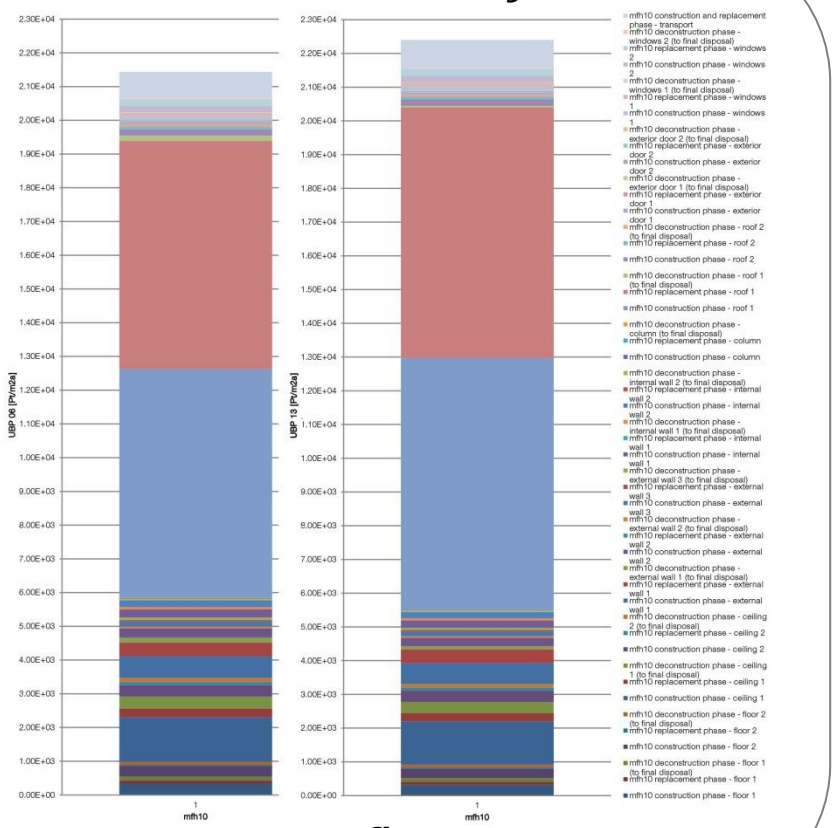
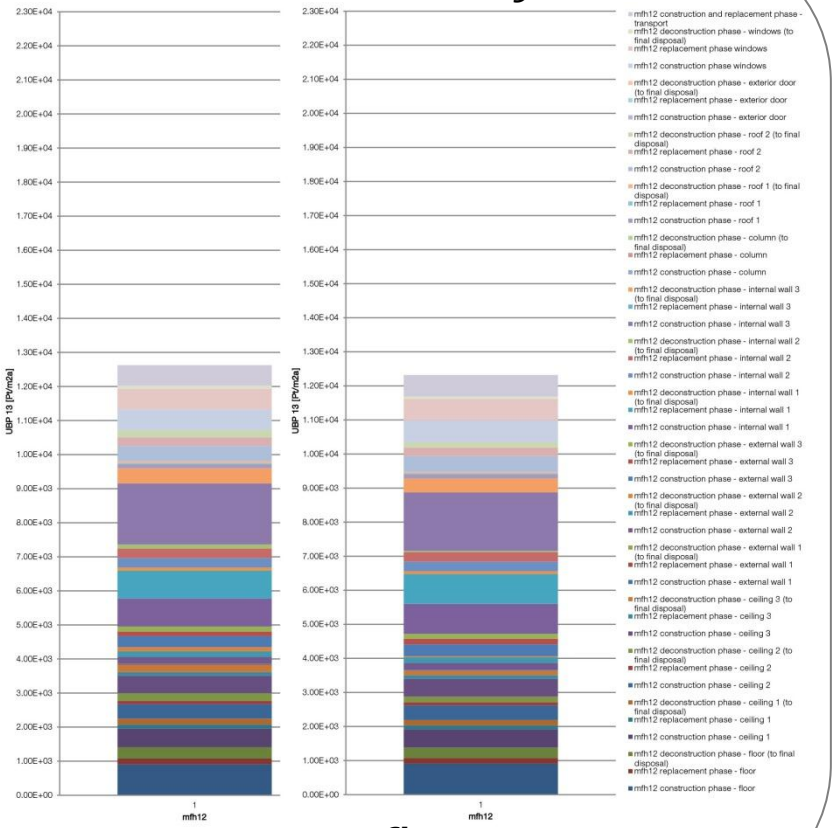
LCA of 12 individual apartment buildings

UBP06 UBP13



mfh10
massive construction

UBP06 UBP13



mfh12
medium weight construction

Findings

- Typically not all of the applied indicators come to the same conclusion.
- All indicators agree on the ranking of the most relevant building elements and differ to some extent in the assessment of the relative influences of the use phase and the building installations.
- The indicator Ecological Scarcity occasionally comes to different results than the other indicators. (For example, the electrical installations apparently induce a high impact with UBP06 which is only perceived by this particular indicator.)

Findings

- Lightweight, medium-weight and massive constructions all display a similar range of possible embodied energy and emissions and Ecological Scarcity points.
- The combination of construction and insulation materials contributes a major part to the environmental impact of the building elements.

Source: V. John (2012), «Derivation of reliable simplification strategies for the comparative LCA of individual and «typical» newly built Swiss apartment buildings», DISS ETH No. 20608

Findings

The following processes can be omitted as they contribute little to the LCA results of all buildings from the sample:

- **Preparatory works:** excavation, backfill and foundation
- **Building elements:** exterior doors, columns and transportation of materials to the building site
- **Building installations:** ventilation installations and sanitary installations

Source: V. John (2012), «Derivation of reliable simplification strategies for the comparative LCA of individual and «typical» newly built Swiss apartment buildings», DISS ETH No. 20608

Conclusions

- The choice of two of the considered environmental impact indicators (**"Non-renewable embodied and operational energy"** and **"Embodied and operational carbon emissions"**) suffices for roughly presenting the environmental performance of the buildings.

- Additionally, **"Ecological Scarcity"** can give a further perspective on the environmental impact of the buildings as compared to the other indicators. The single-score results are easy to communicate.

Thank you for your attention!