CAALA
UNLOCKING SUSTAINABILITY

LCM 2021

Tu.3.A

Parametric LCA as a Decision-Making Support Tool in Pre-Design Phases

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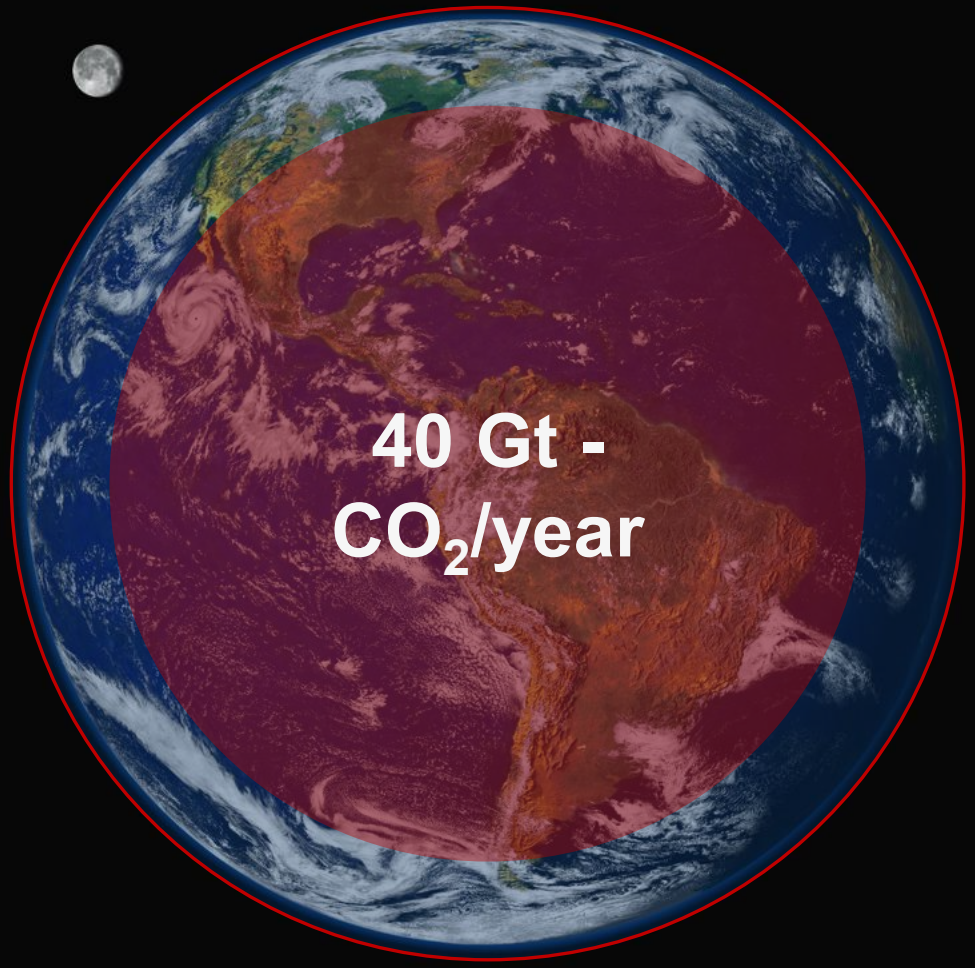
Motivation

Budget (2019):
~669 Gt -CO_2

1.5 °C Scenario



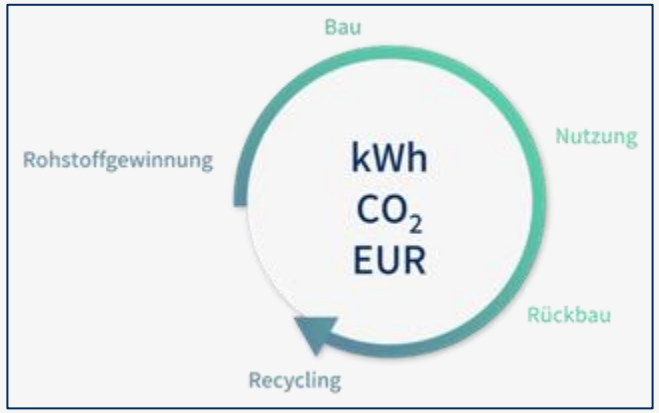
Budget left (2021):
~589 Gt -CO_2

Time left:
14-15 years

1,5°C Scenario based on: Rockström, J., Gaffney, O., Rogelj, J., Meinshausen, M., Nakicenovic, N., Schellnhuber, H. J. (2017): A Roadmap for Rapid Decarbonization. In: Science, Vol. 355, No. 6331, p. 1269-1271.

Parametric Life-Cycle Assessment

LIFE-CYCLE APPROACH



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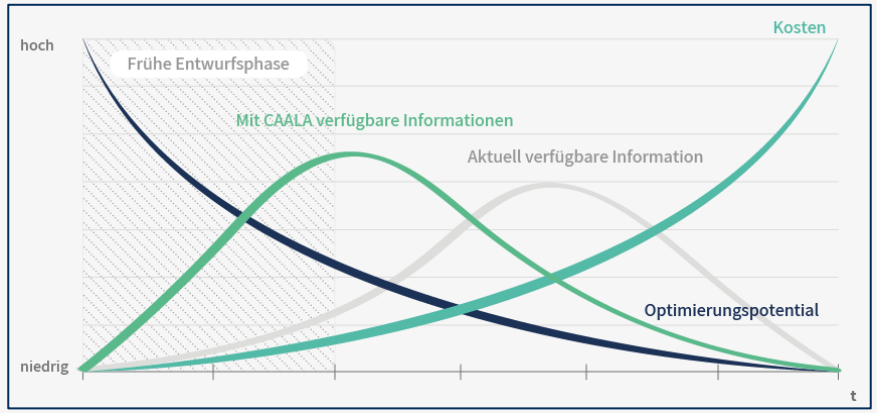
EARLY STAGE DESIGN



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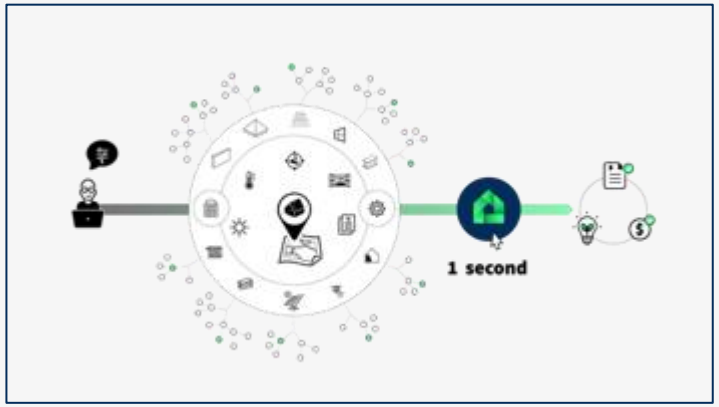
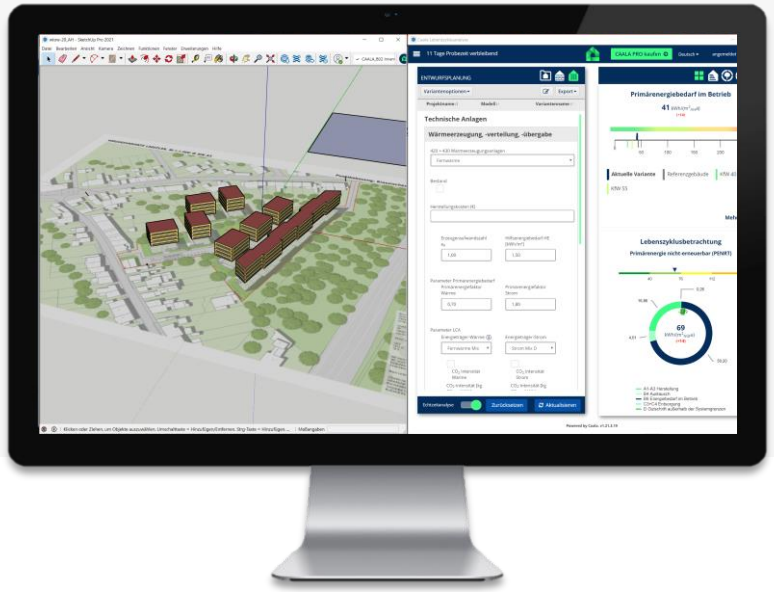
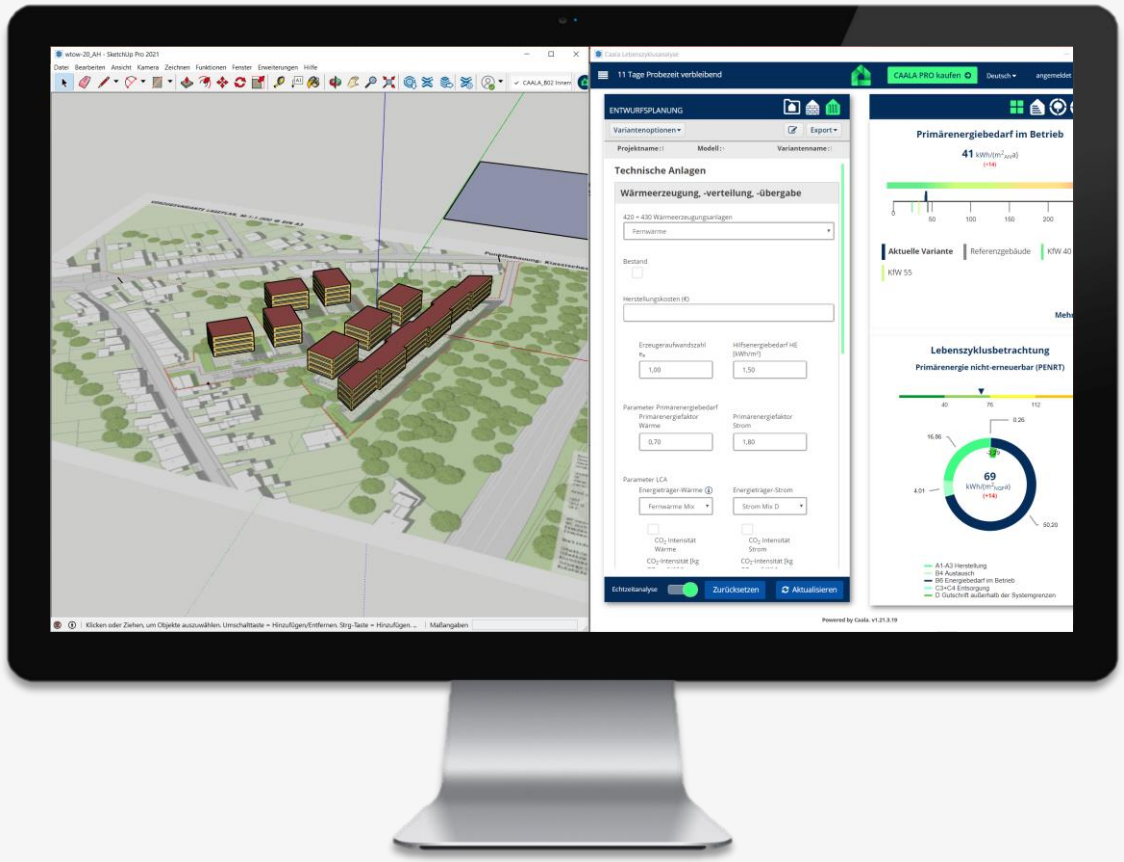
PARAMETER VARIATION





Goal & Scope



The goal of early stage design (ESD) decision-making in the “Lerchenweg“ project is to identify and quantify greenhouse gas emission savings.

To determine the greenhouse gas emissions, a life cycle assessment was carried out for a variety of different variants in accordance with EN 15978, EN 15804 and based on the ÖKOBAUDAT database. Following the simplified approach according to the German Sustainable Building Council (DGNB), the following life cycle modules were calculated:

A1 – A3	Production
B4	Replacement
B6	Operational Energy Use
C3 + C4	End of Life
D	Potential Benefits and Loads

RSP: 50 years

Functional Unit: per m^2 of NFA

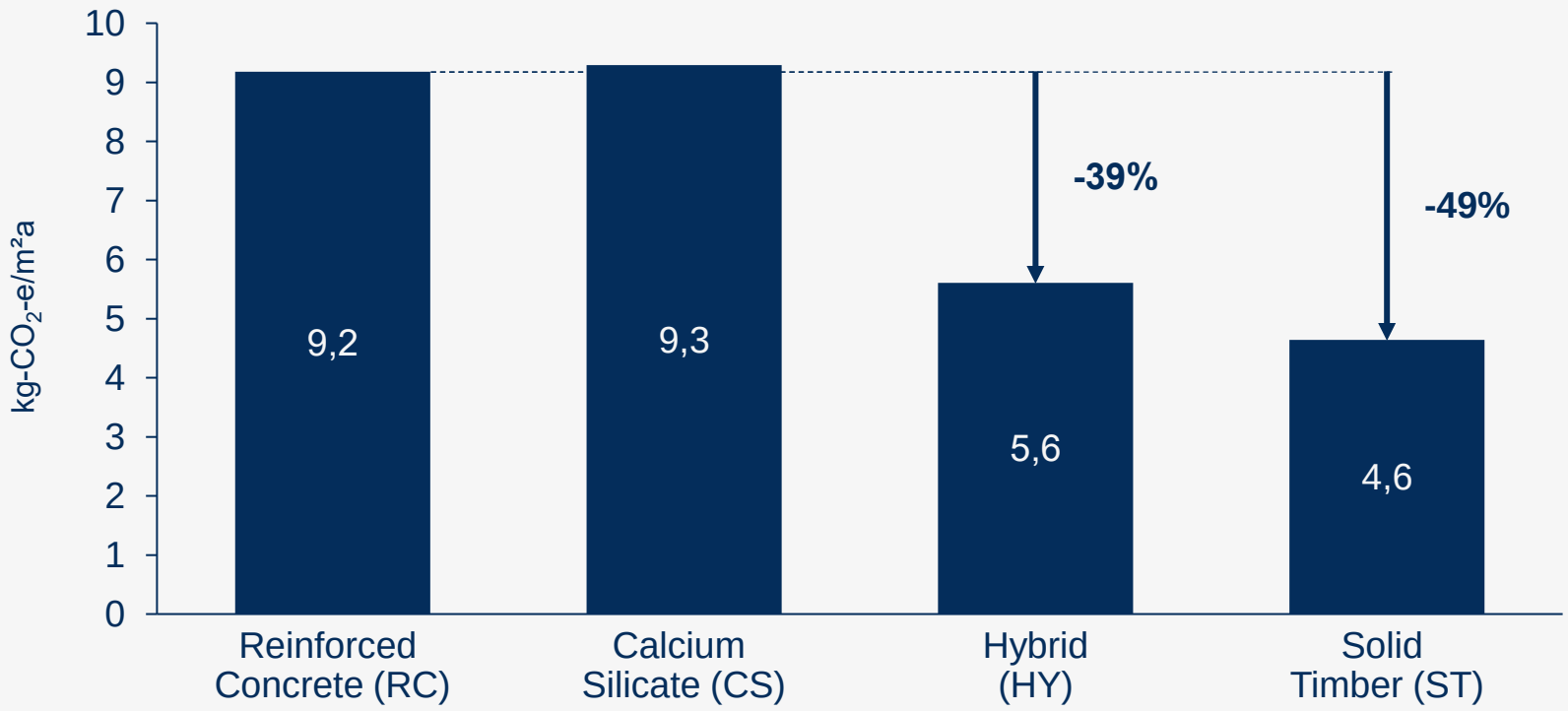
Sources: ISO 14040, ISO 14044, EN 15804, EN 15978

Goal & Scope | **Parameter Variation**

CONSTRUCTION METHOD	UNDERGROUND PARKING	TECHNICAL EQUIPMENT	INSULATION STANDARD	WINDOW TO WALL RATIO	PHOTOVOLTAIC SYSTEMS
V1 Reeinforces Concrete (RC)	Complete Underground Parking (UP full)	District Heating (DH)	GEG (MIN)	20%	100%
V2 Calcium Silicate / Limestone (CS)	Reduced Underground Parking (UP half)	Gas Condensing Boiler (GB)	Standard (MID)	20/40%-S	50%
V3 Timber-Concrete Hybrid (HY)	Underground Basement (UG)	Heat Pump (HP)	Ambitious (AMB)	40%	0%
V4 Solid Timber (ST)					

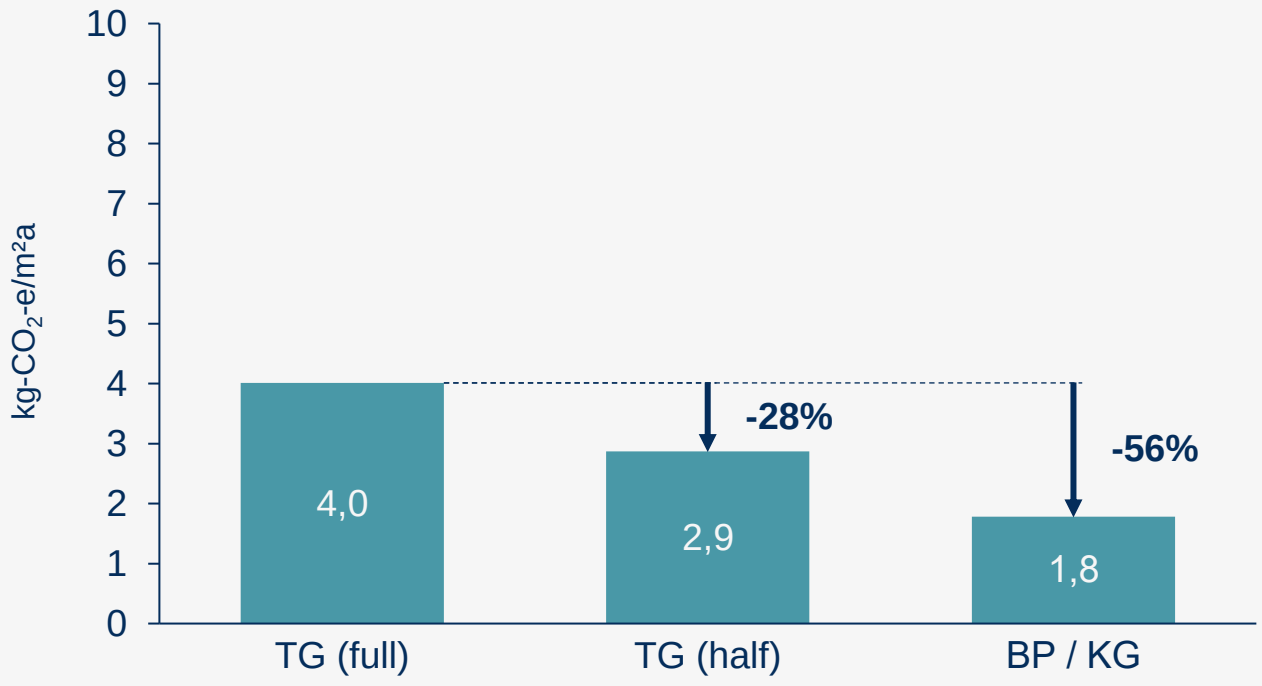
324 combinations

Embodied Carbon| **Construction Method**



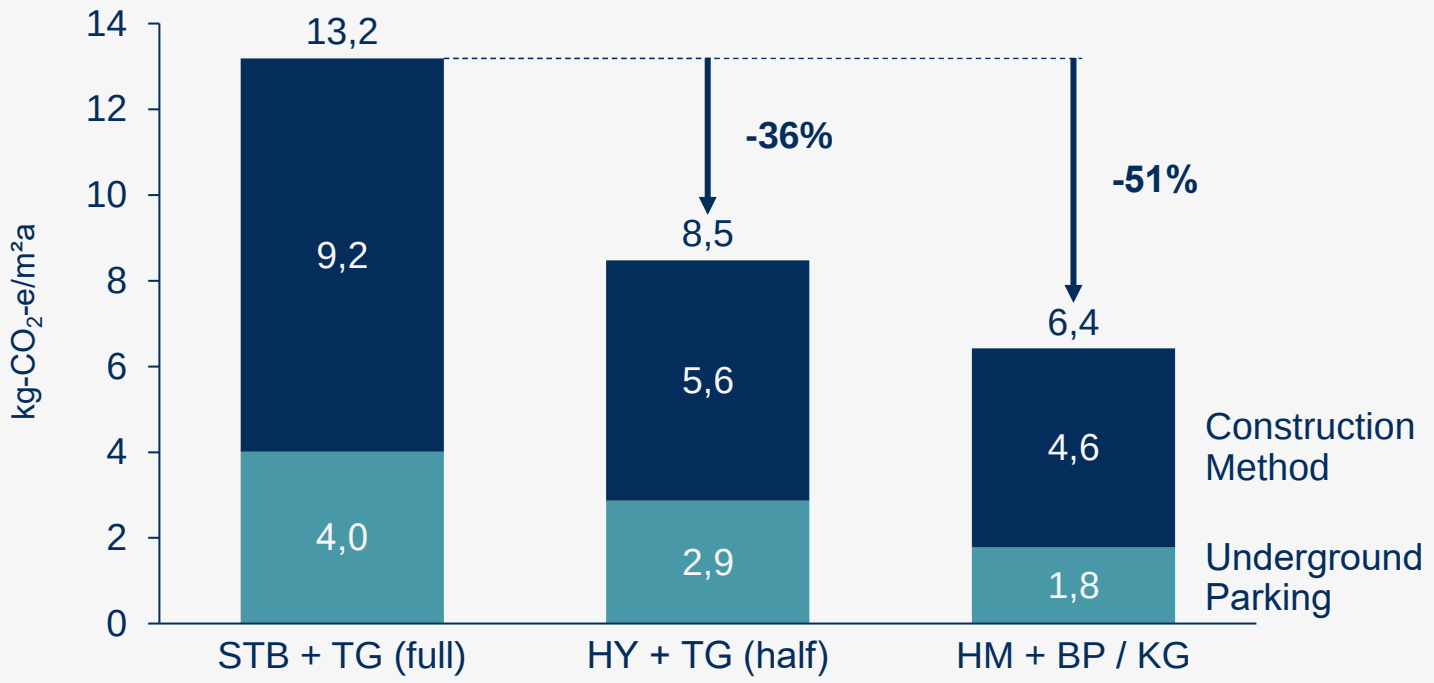
Scope: Results include the LC stages A1-A3, B4 and C3-C4 for the Cost Group 300

Embodied Carbon | **Underground Parking**



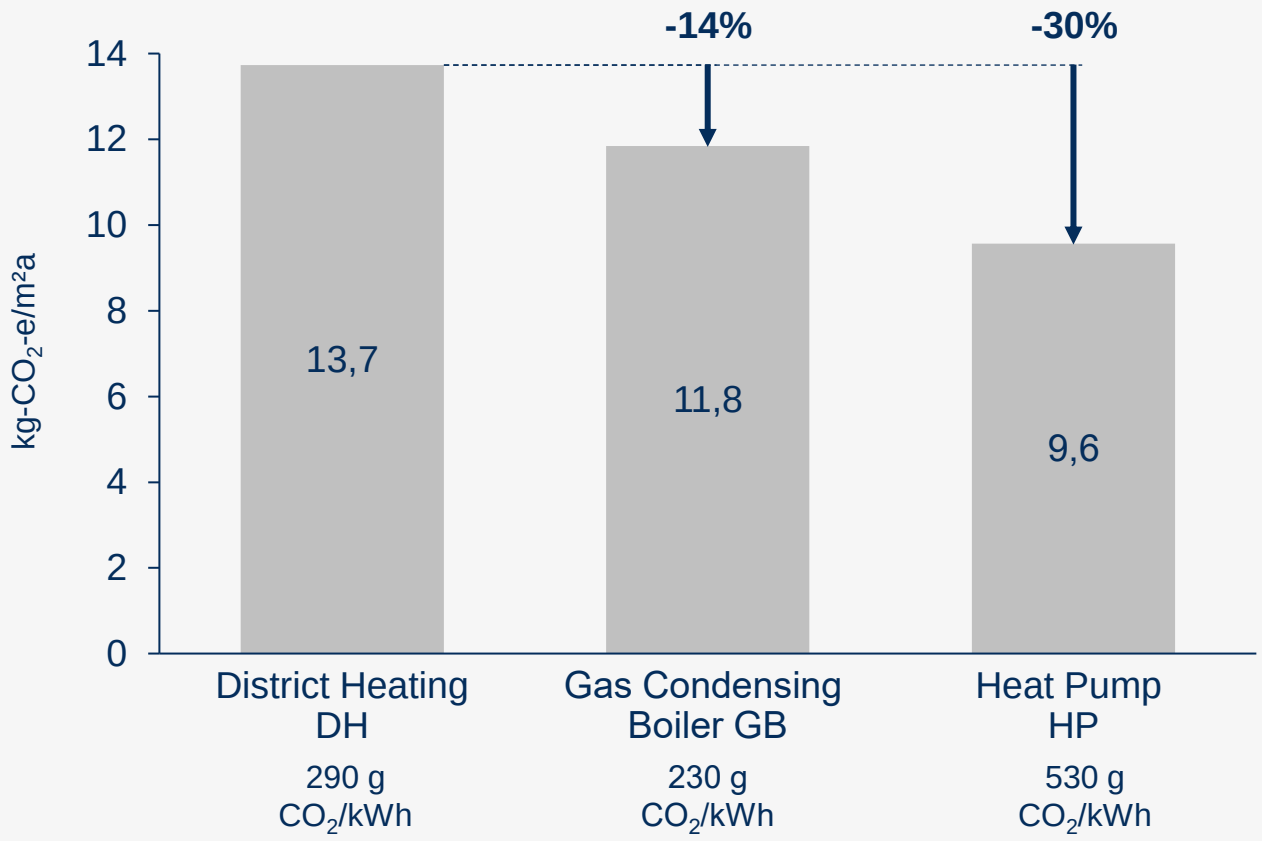
Scope: Results include the LC stages A1-A3, B4 and C3-C4 for the Cost Group 300

Embodied Carbon | **Building + Parking**



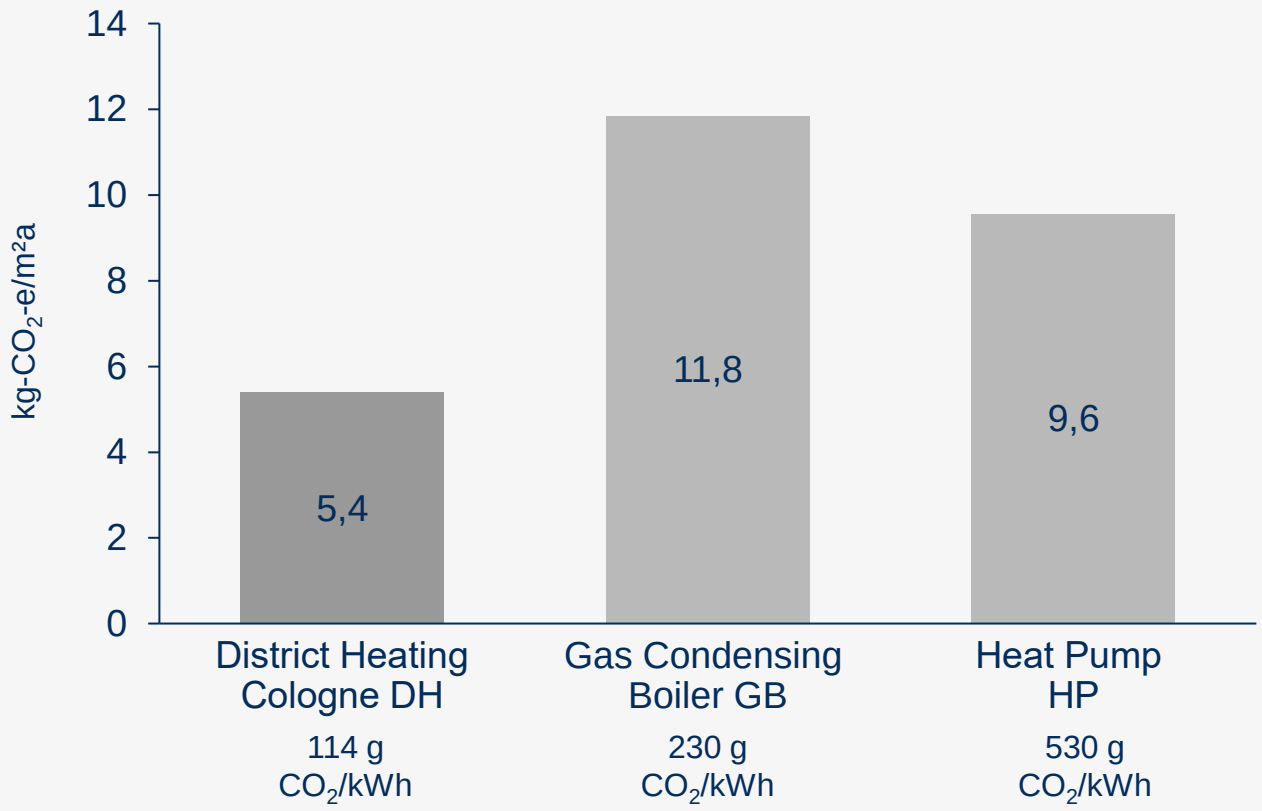
Scope: Results include the LC stages A1-A3, B4 and C3-C4 for the Cost Group 300

Operational Carbon | **Technical Equipment**



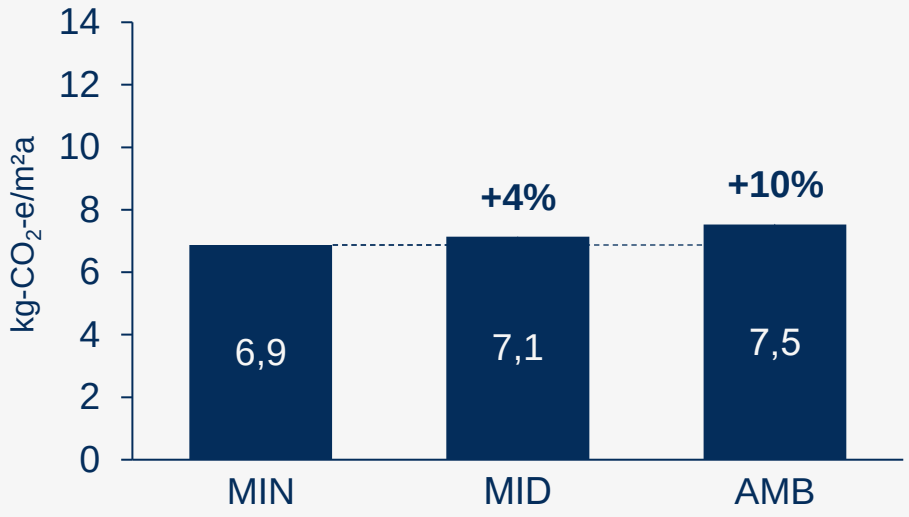
Scope: Results include the LC stages B6 with an average insulation standard

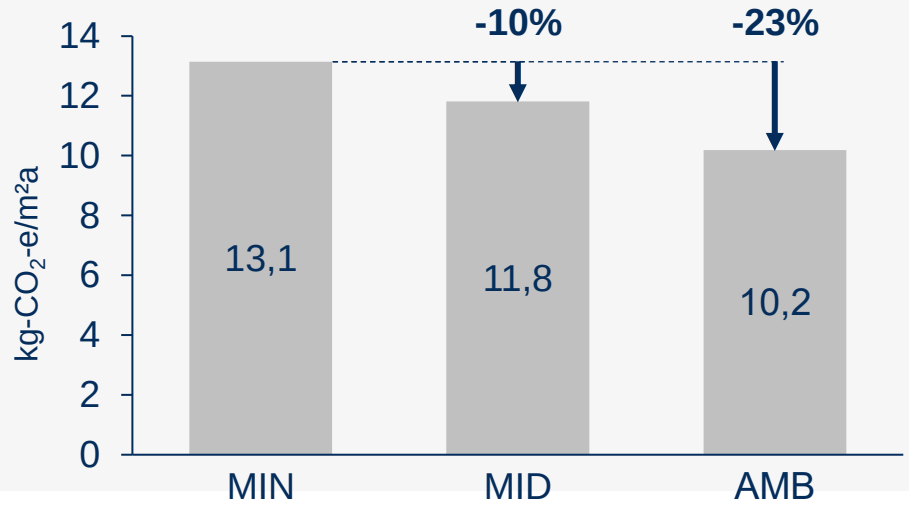
Operational Carbon | **Technical Equipment**

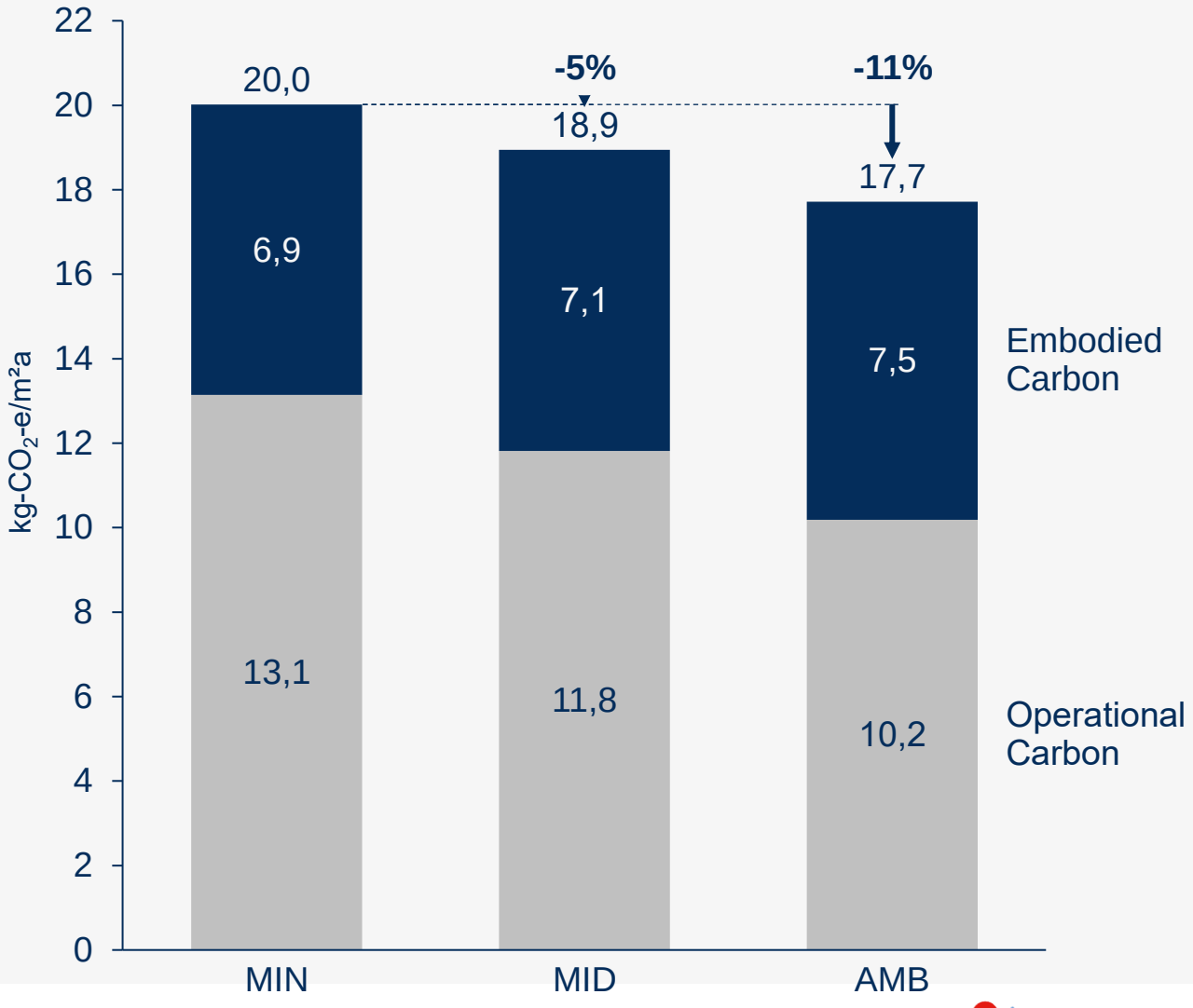


Scope: Results include the LC stages B6 with an averaged insulation standard

GWP Emissions over the Life-Cycle | **Insulation Standard**

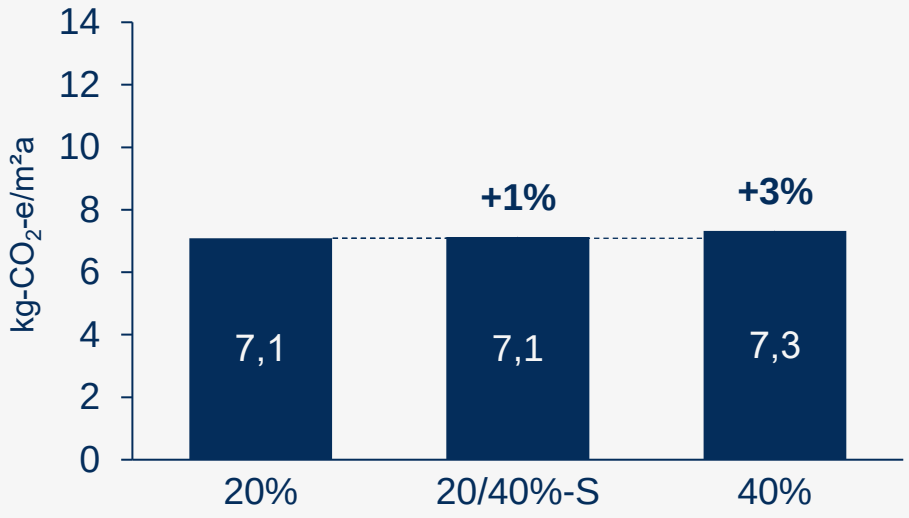


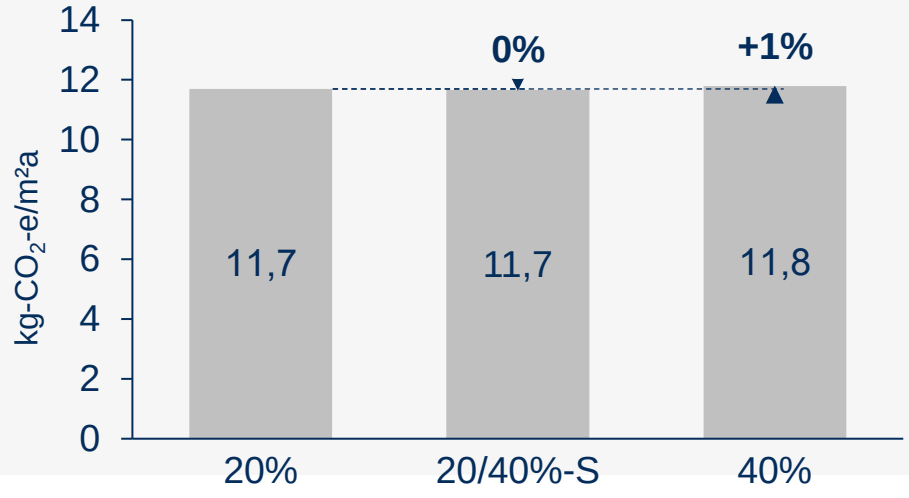


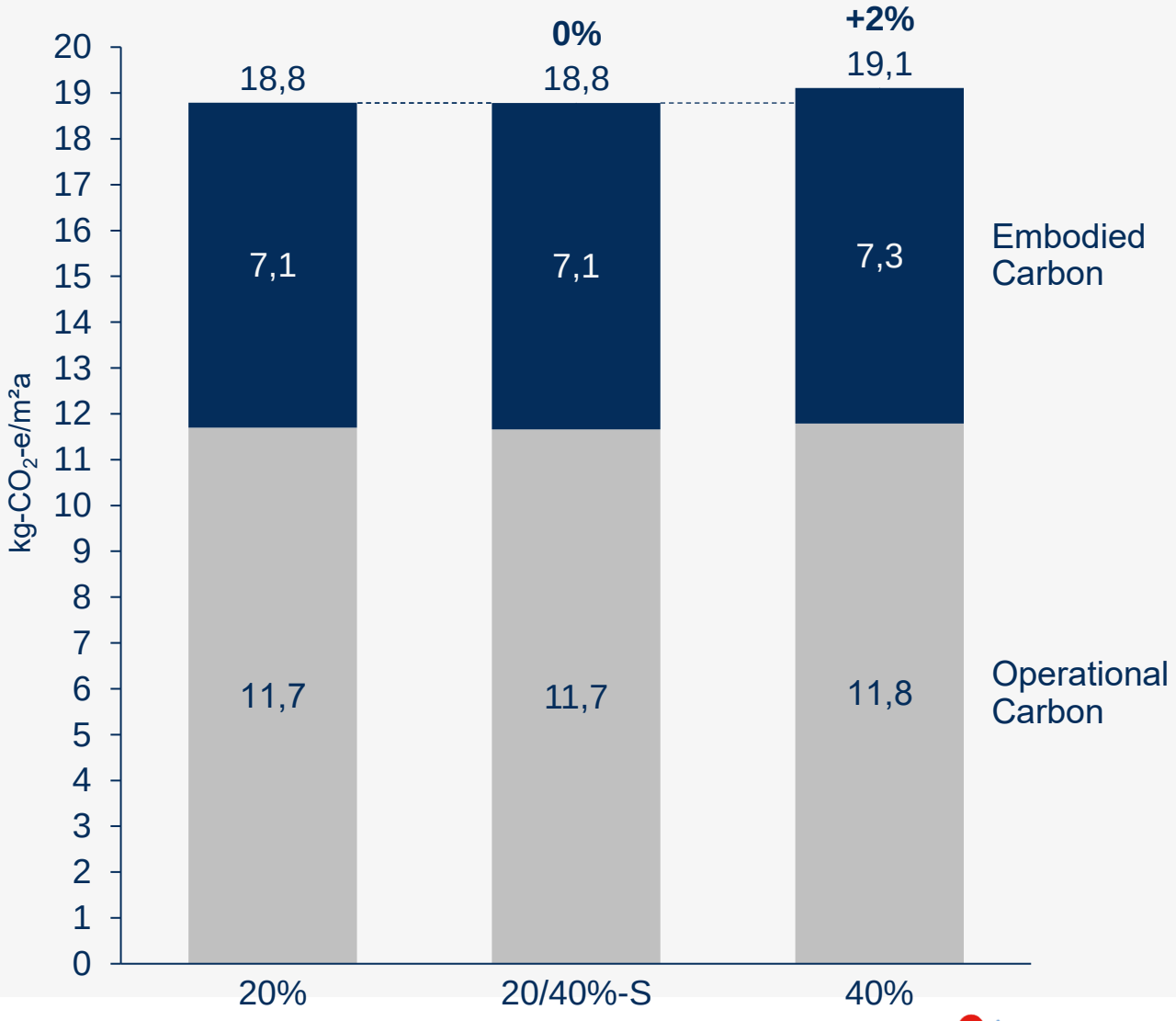


Scope: the LC stages A1-A3, B4, B6 and C3-C4 for the Cost Group 300, with the following characteristics:
MIN - H'T:0,39 | MID - H'T: 0,32 | AMB - H'T: 0,23

GWP Emissions over the Life-Cycle | **Window to Wall Ratio**

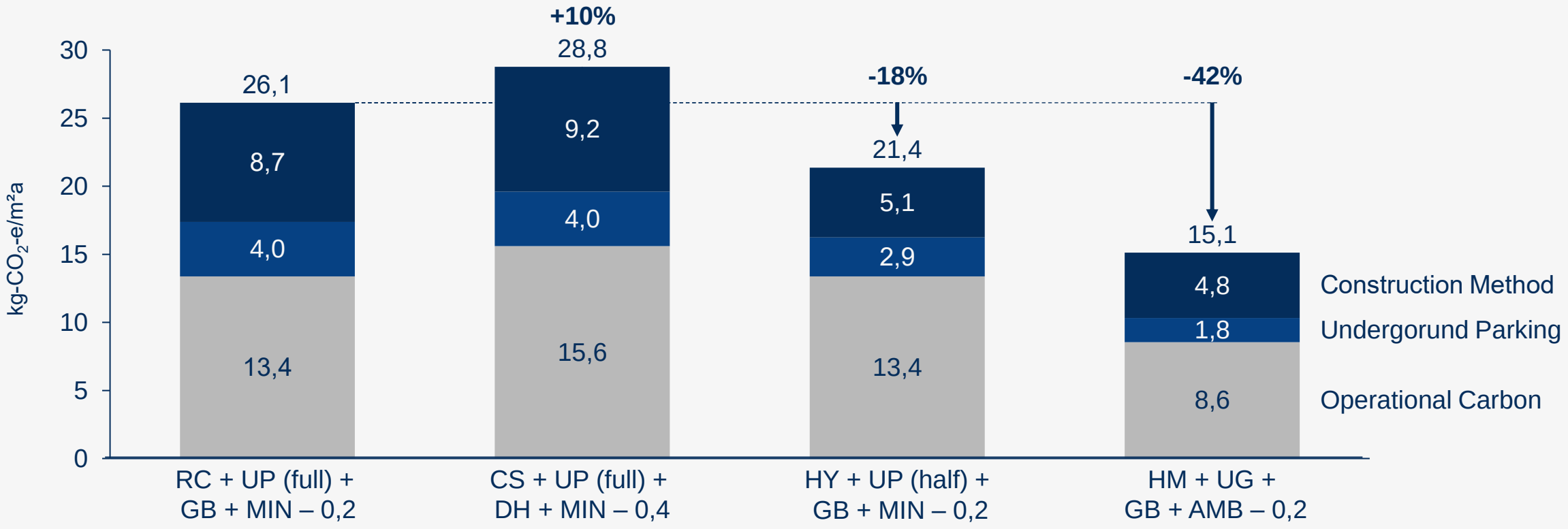






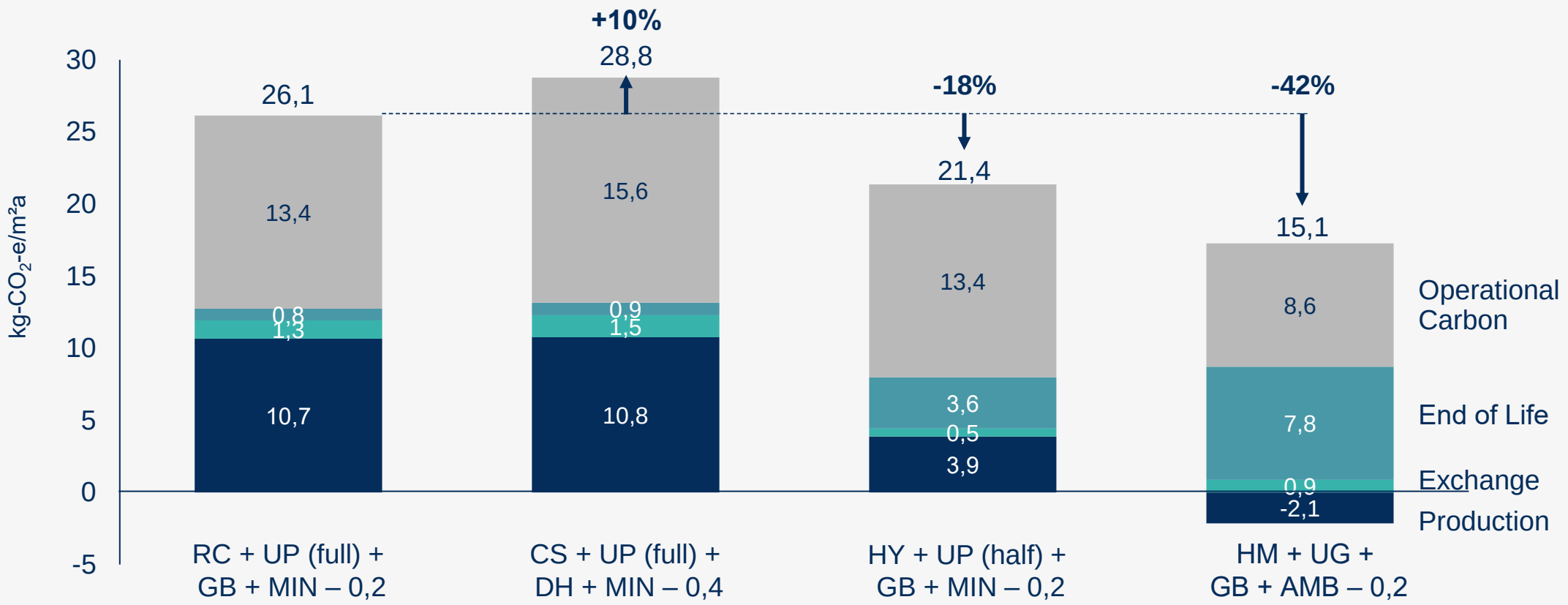
Scope: the LC stages A1-A3, B4, B6 and C3-C4 for the Cost Group 300, with an averaged insulation standard

GWP Emissions over the Life-Cycle | **Embodied + Operational Carbon**



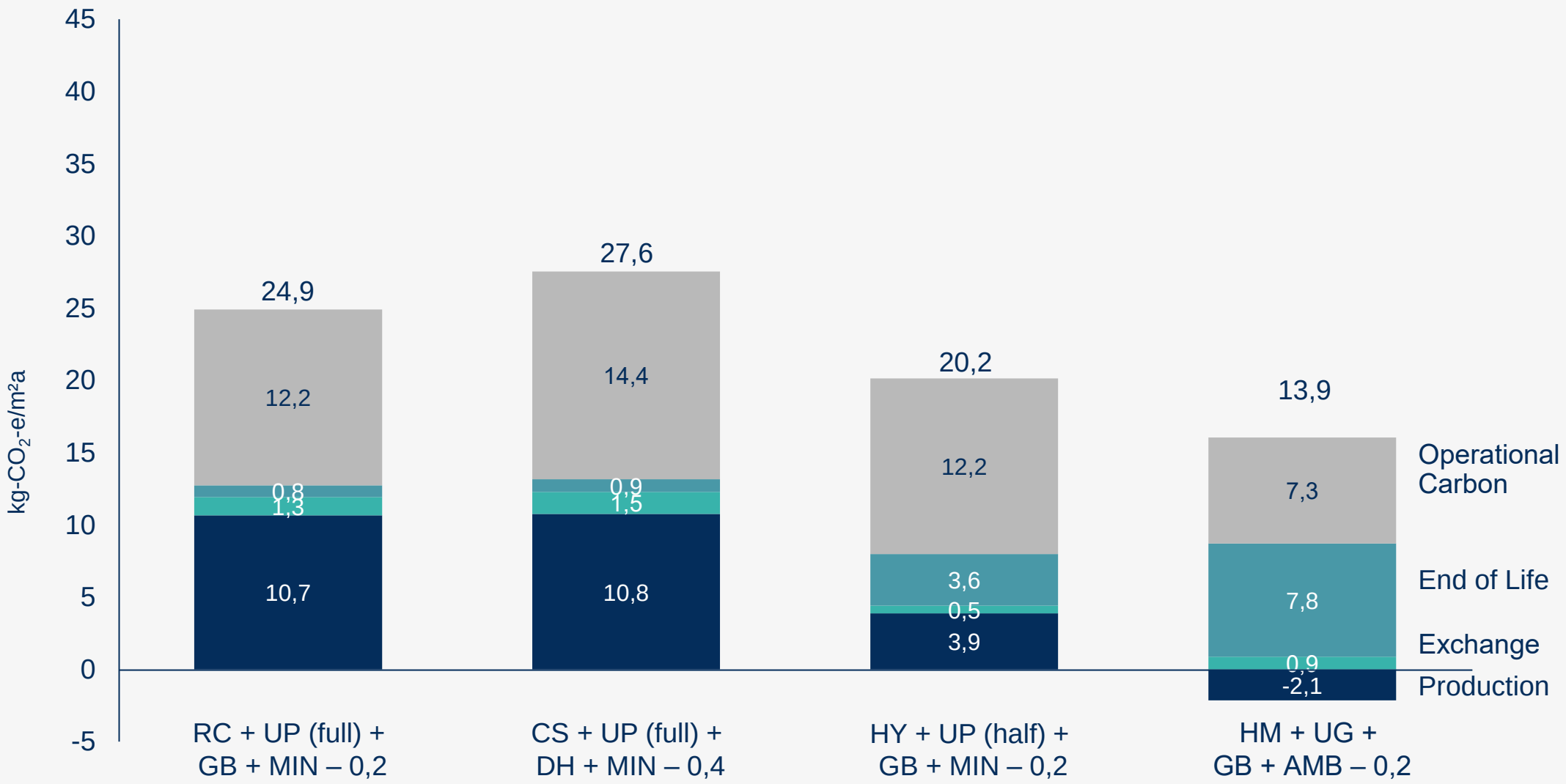
Scope: the LC stages A1-A3, B4, B6 and C3-C4 for the Cost Group 300, with an averaged insulation standard

GWP Emissions over the Life-Cycle | **Embodied + Operational Carbon**



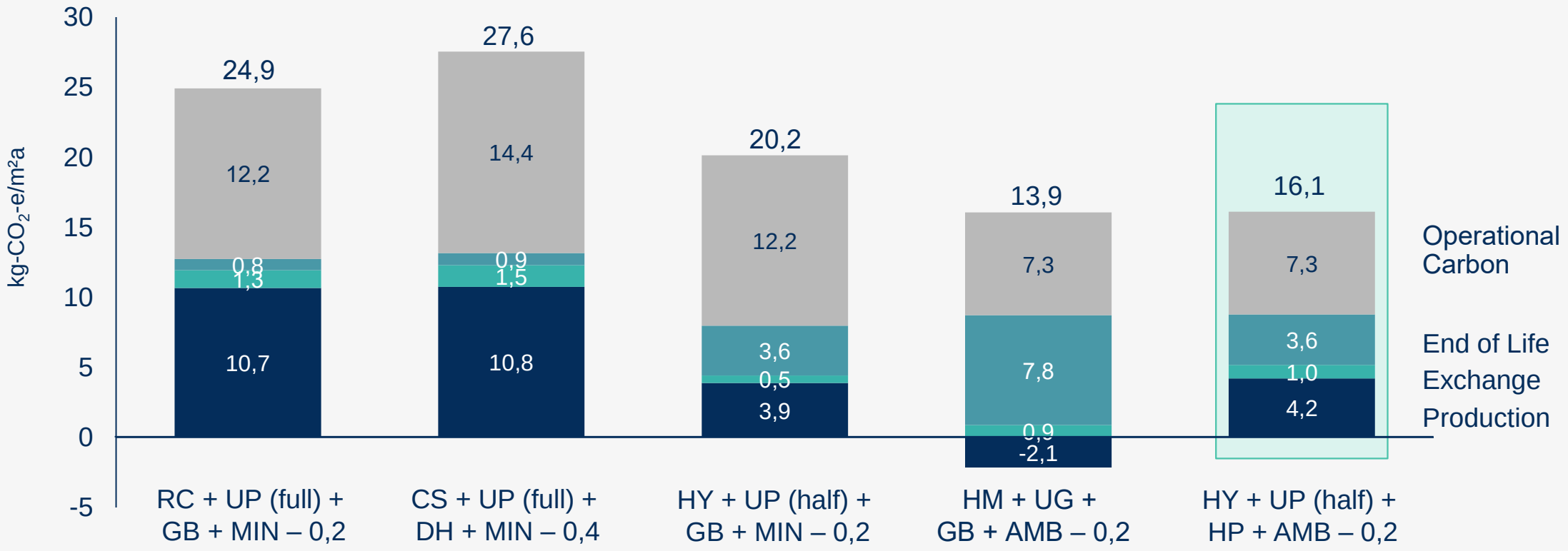
Scope: the LC stages A1-A3, B4, B6 and C3-C4 for the Cost Group 300, with an averaged insulation standard

Life-Cycle | **Embodied + Operational Carbon + User Electricity + PV**



Scope: the LC stages A1-A3, B4, B6 and C3-C4 for the Cost Group 300, with an averaged insulation standard and 10,9 kg CO_2/m^2 NGF
For user's electricity and 100% PV on the roofs

Life-Cycle | **Embodied + Operational Carbon + User Electricity + PV**



Scope: the LC stages A1-A3, B4, B6 and C3-C4 for the Cost Group 300, with an averaged insulation standard and 10,9 kg CO_2/m^2 NGF
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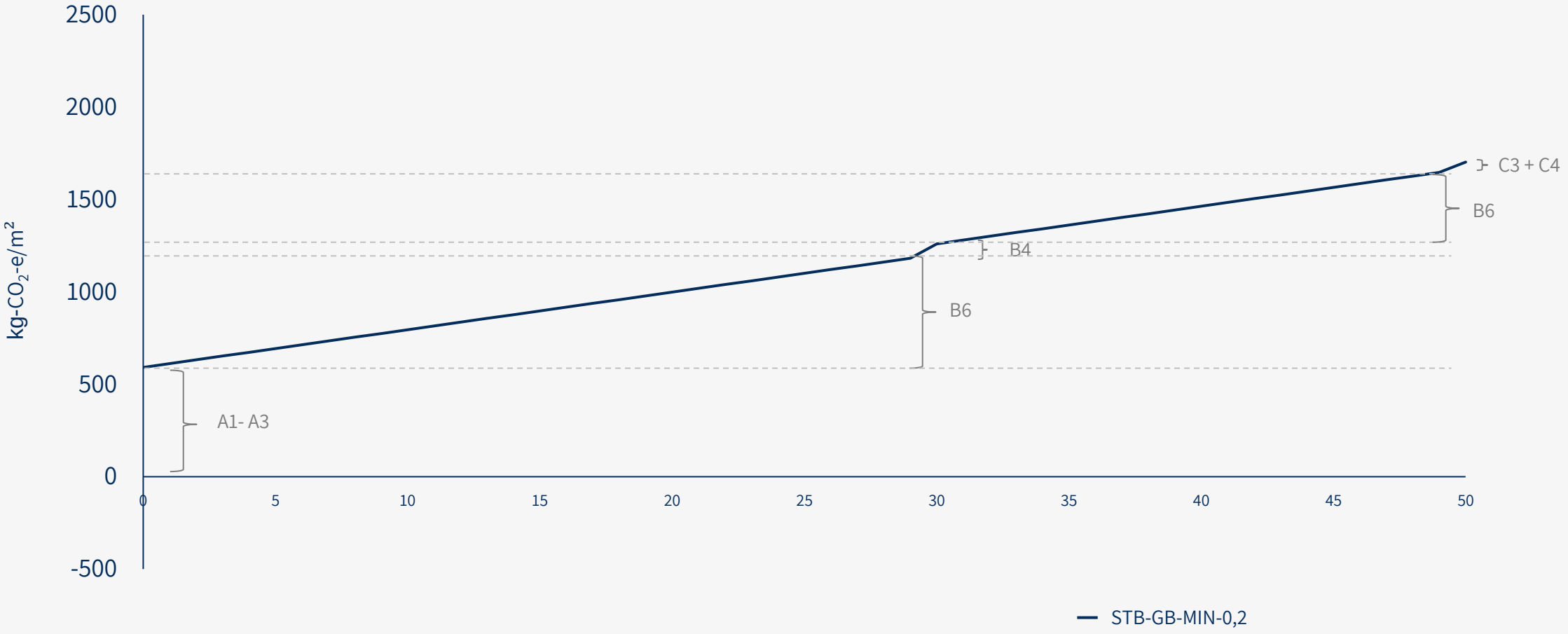
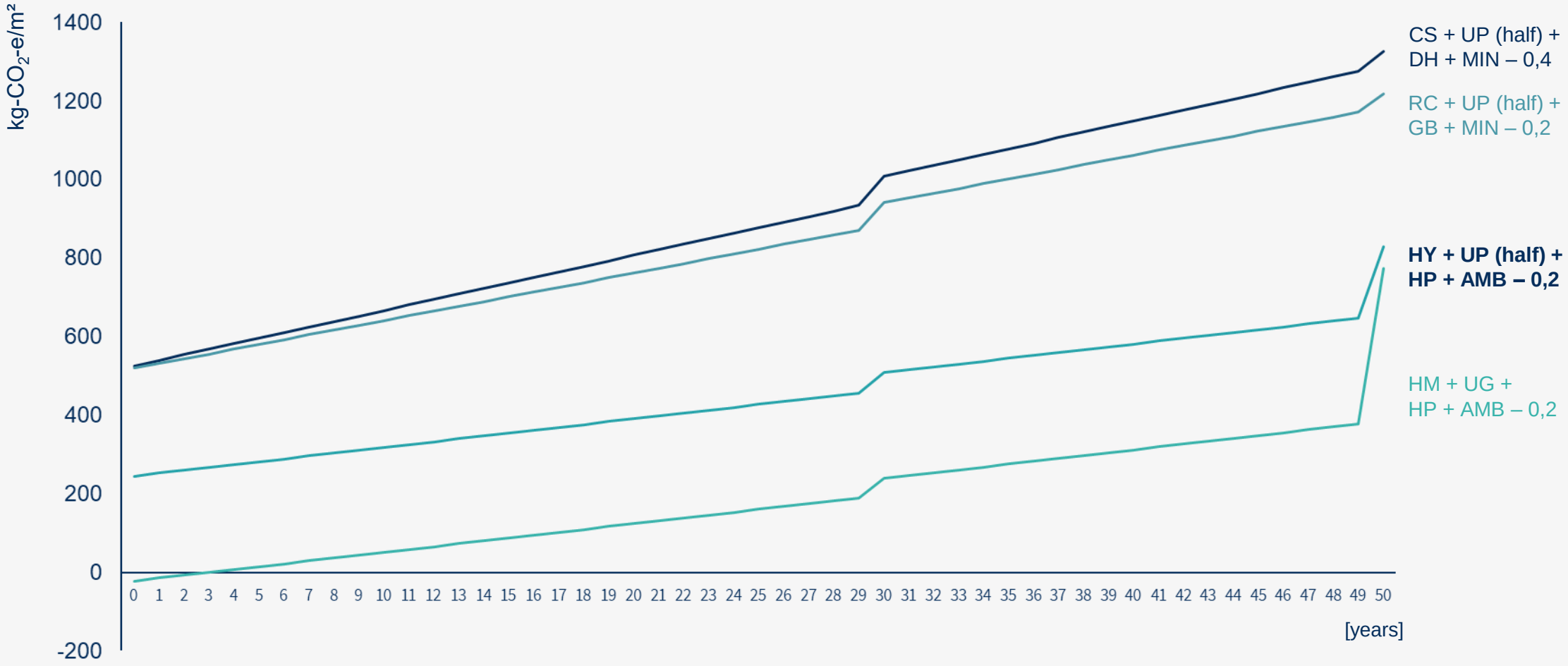
Life-Cycle | **Embodied + Operational Carbon + User Electricity + PV**



Life-Cycle | **Embodied + Operational Carbon + User Electricity + PV**



Summary | **Parametric Life-Cycle Assessment**

- The results provide a possible range of GWP indicator values
- The results show the effect of each parameter:
  - the Embodied Carbon offers a total **GHG Savings Potential** of **6,8 kg-CO_2/m²a**
    - **construction method**: massive timber vs reinforced concrete (up to 50% - 4,6 kg-CO_2/m²a)
    - **Underground** Basement vs Underground Parking (up to 55% - 2,2 kg-CO_2/m²a)
  - the **Technical Equipment** offers a total **GHG Savings Potential** of **4,1 kg-CO_2/m²a**
  - the **Insulation Standard** offers a total **GHG Savings Potential** of **2,3 kg-CO_2/m²a**
  - the window-to-wall ration offers little potential for reduction (0,3 kg-CO_2/m²a)
  - the **Photovoltaic Systems** offers a total **GHG Savings Potential** of **12,1 kg-CO_2/m²a**
  - the **User's Electricity** has a high contribution to Operational Carbon of **~10,9 kg-CO_2/m²a**

Conclusion | **Parametric Life-Cycle Assessment**

- The results depicted highlight the necessity to include aspects of timing and carbon storage.
- The methods used and the results gained make a strong case to combine LCA and BIM for decision-making in pre-design phases. The potential as a support tool and the challenges in the scope and application should be further discussed.
- In conclusion it can be stated, that this approach achieves the integration of environmental aspects in a pre-design stage in a way that is applicable not only for LCA experts, but for every planner.

Thank you for your attention!

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