Transsolar
KlimaEngineering

Living Places – Germany

Standard German Single family house

NA, IT, KH, PV, SdV, FG, LO

Stuttgart

07.04.2026

Introduction

Objective

In order to compare the business case within the^Living Places product develpment, Transsolar and DGJ have been investigating a benchmark, the so called „standard house“. The airm is to represent a typical german single famly home, in terms of

- Size and typology
- Construction materials
- Energy concept

Upon defiing the standard house the resulting performance of the building has been analyzed with respect to

- Energy
- Indoor-Air-Quality
- Daylight
- Thermal Comfort
- Embodied Carbon

The results have been summarized within 2 LCA performance protocolls, DGNB and QNG.

The active house framework will partially summarize the results.

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Standard House

Definition of an average single-family house in Germany

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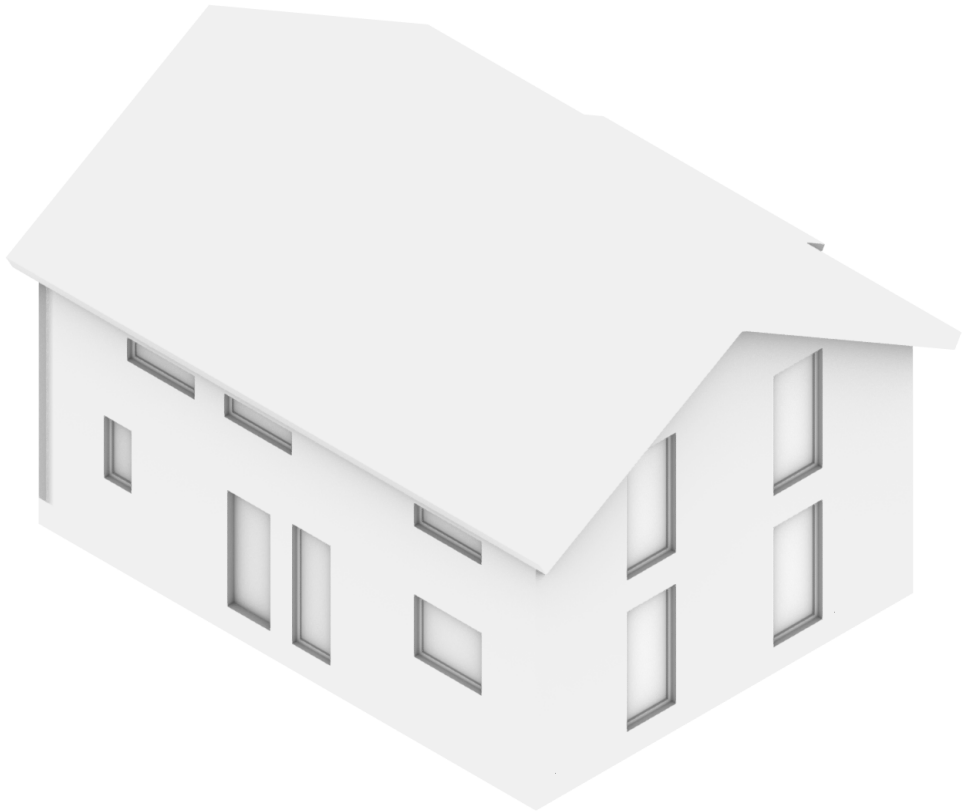
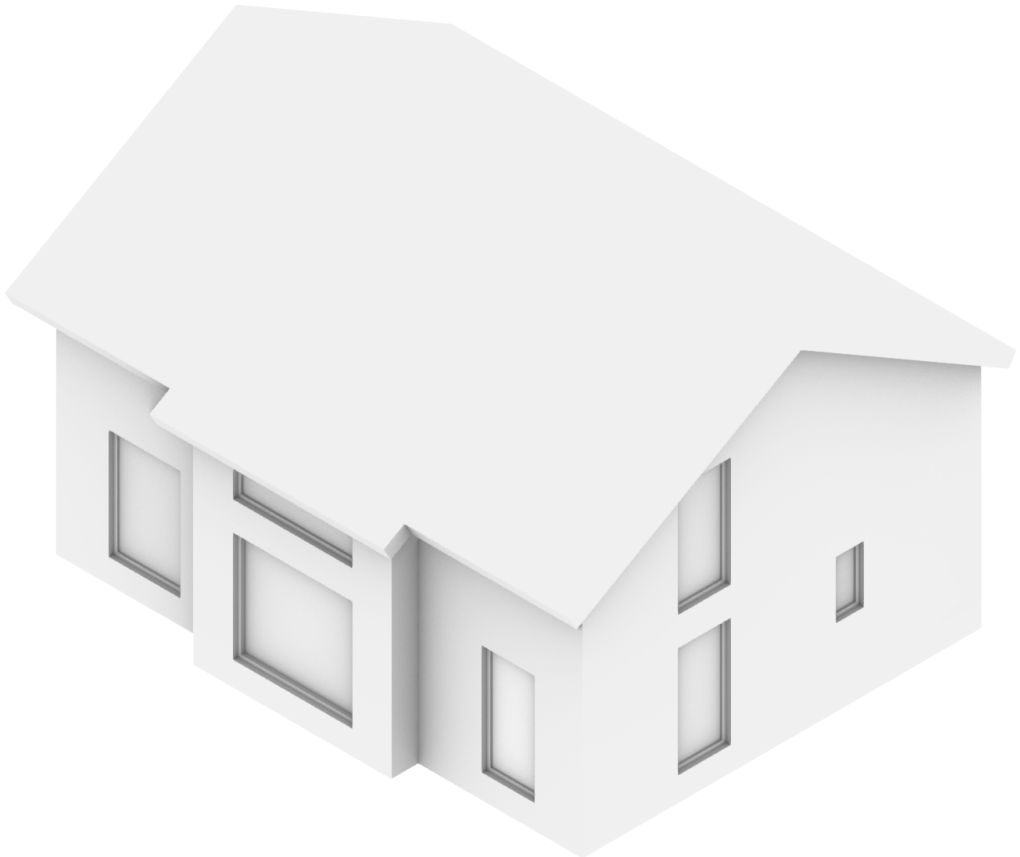
Standard House

Description

Axonometry



NW View



SE View

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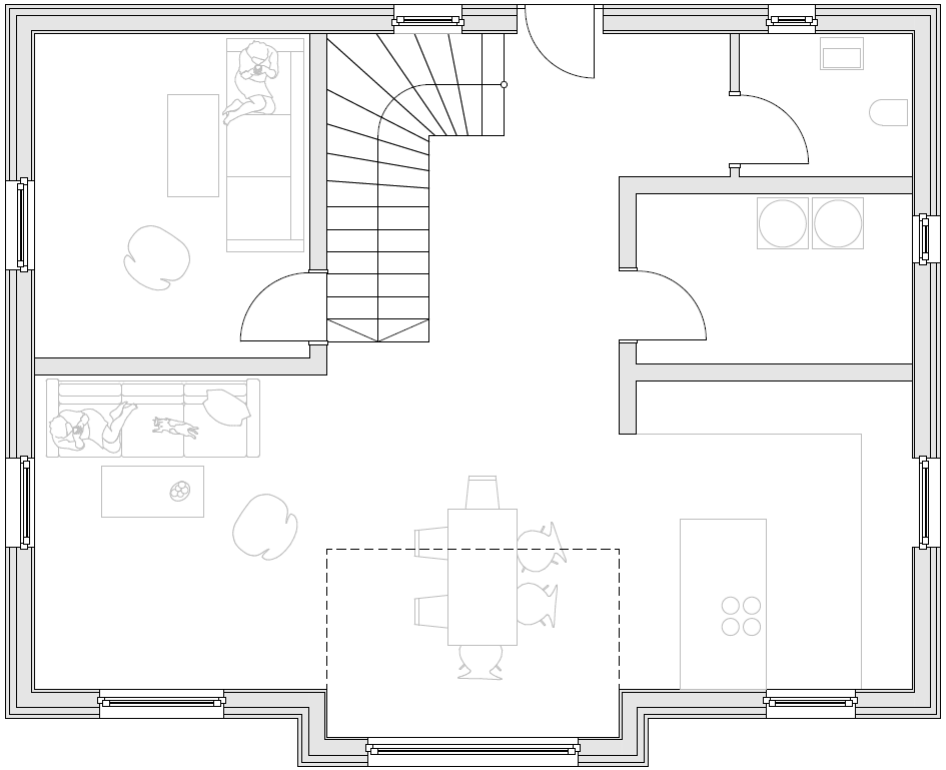
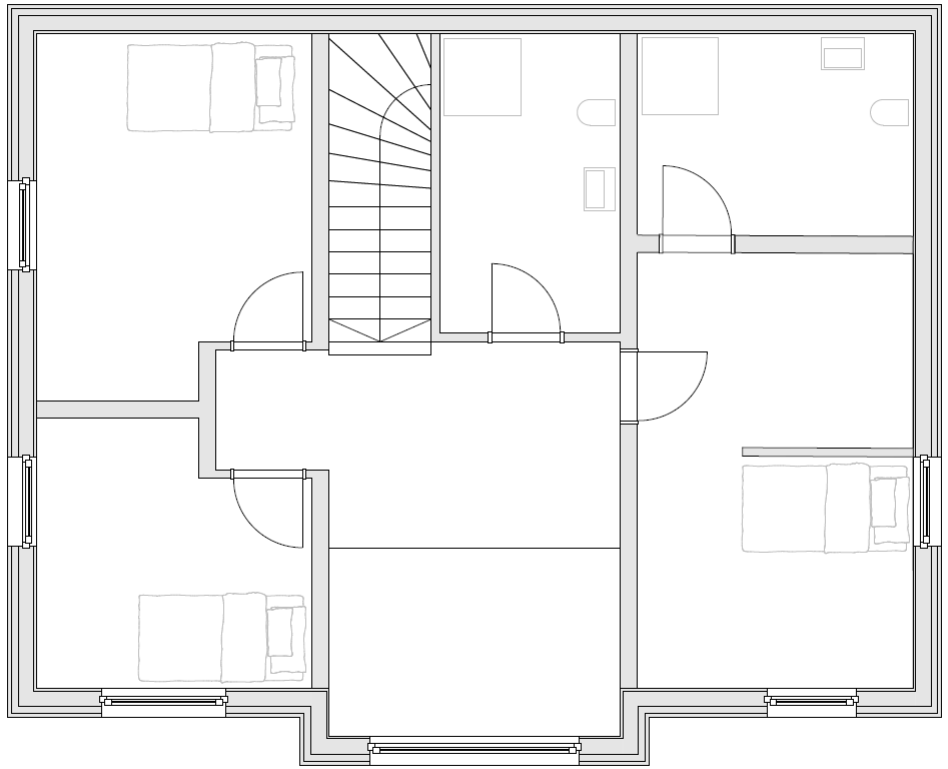
Standard House

Description

House floor plans



GROUND FLOOR



FIRST FLOOR

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Standard German House | LCA

Boundary conditions: Construction Layers – Elements from KG 300

In collaboration with DGJ, it was decided that the Standard Haus would feature a structural exterior shell made of aerated concrete blocks, with slabs serving as structural components constructed from reinforced concrete. For vertical support, load-bearing interior walls composed of calcium-silicate were recommended.The insulation systems were also chosen in consultation with the architects, aligning with the typical market requirements for this type of project.

Roof: Wooden structure with concrete roof tile, mineral wool and wood fibre insulation board

Roof Windows: PVC with triple glazing

Internal walls:
Structural walls with calcium silicate masonry
Partition walls with steel frame and mineral wall

Windows: PVC with triple glazing

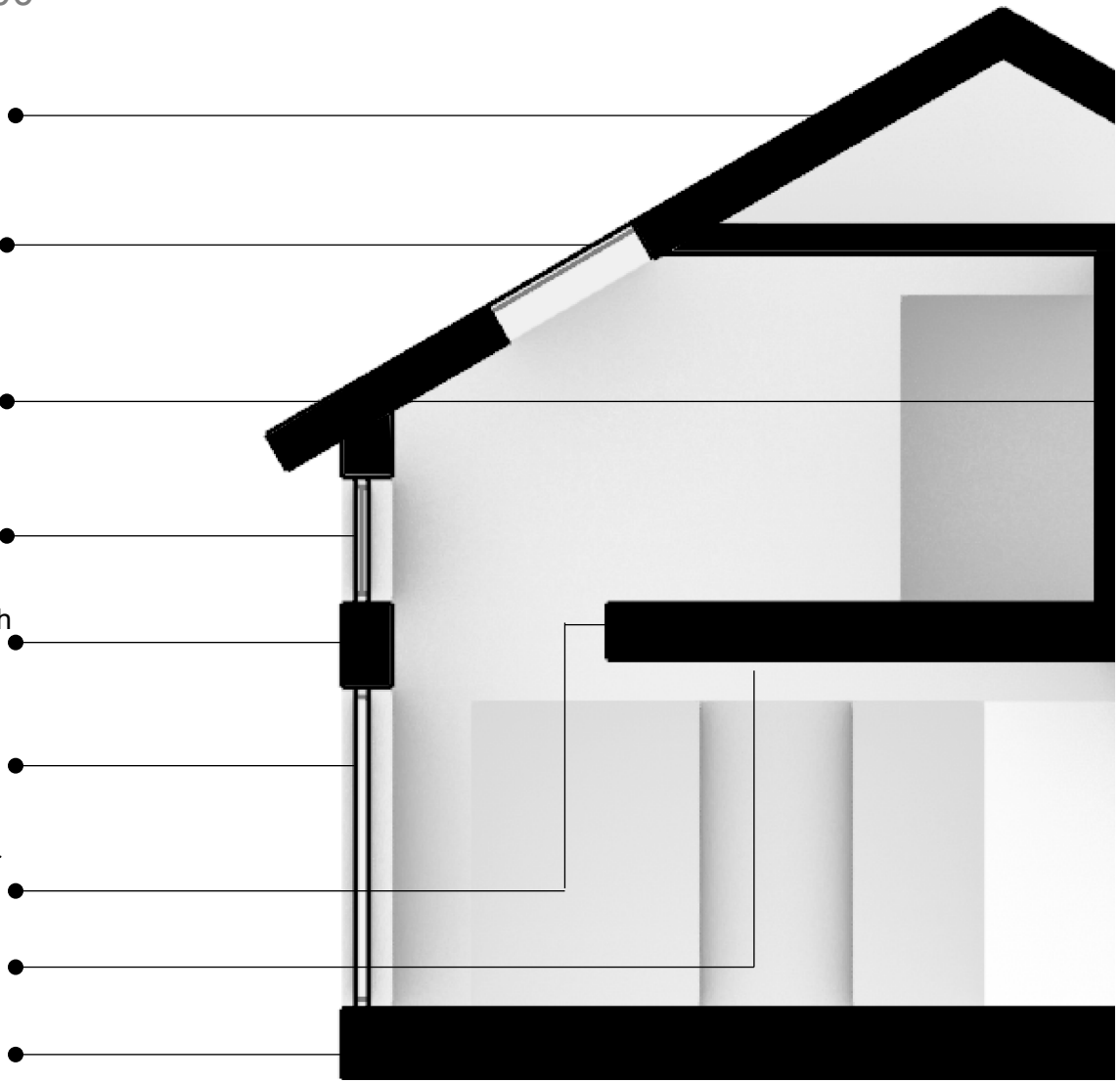
External walls: Aereted concrete block with lime-cement plaster

Doors: Insulated triple glazing, PVC frame

Slabs: Reinforced concrete, with Parkett or Ceramic tiles

Ceiling: Gypsum Plasterboard

Ground slab: Reinforced concrete, with Parkett or Ceramic tiles



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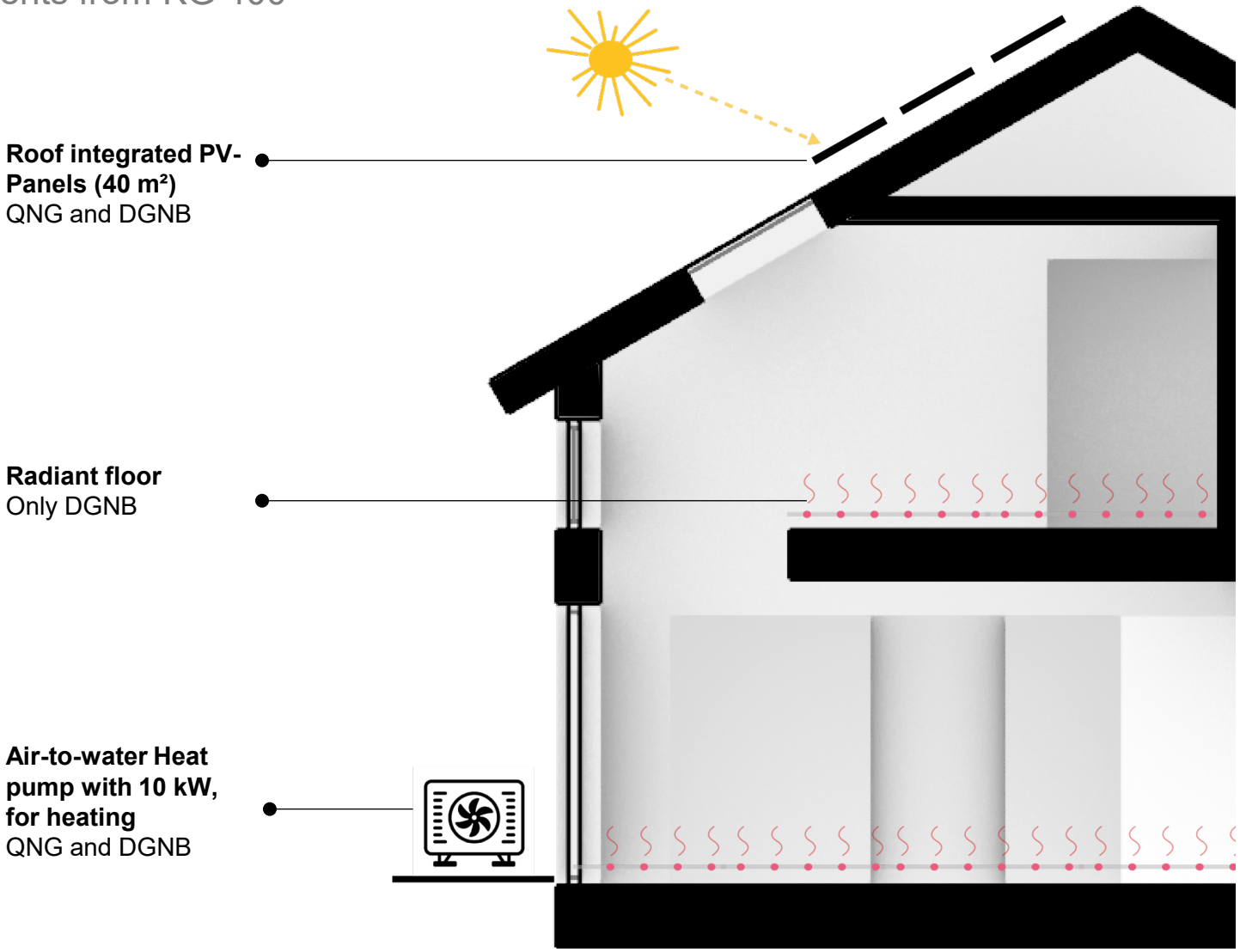
Standard German House | LCA

Boundary conditions: Construction Layers – Elements from KG 400

To account for the technical systems, both evaluation frameworks account only for the major components, such as PV-Panels, heat pumps, heat and energy storage systems and so on.

Smaller elements, like the radiant floor, radiators, pipes, and cables, are represented by a fixed value as specified by the standard.

In the case of the Standard Haus, this fixed value is 1.3 kgCO2/m².a.



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Active House | Comfort

Daylight

STANDARD HOUSE

Boundary conditions

Vertical windows

Glass
Transmission 70%

Frame
Reflectance 80%

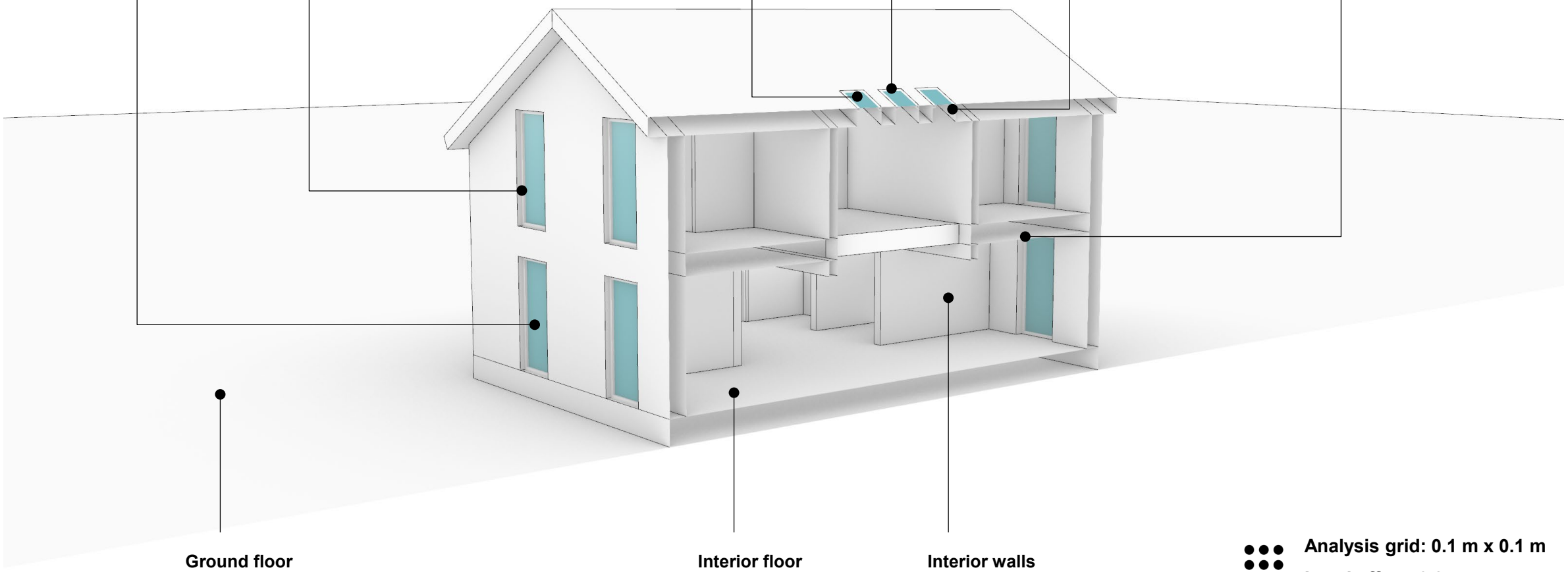
Roof windows

Glass
Transmission 62%

Frame
Reflectance 80%

Window lining
Reflectance 80%

Ceiling
Reflectance 80%



Ground floor
Reflectance 20%

Interior floor
Reflectance 30%

Interior walls
Reflectance 50%

Analysis grid: 0.1 m x 0.1 m

Level offset: 0.85 m

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Standard German House

Description

Qualities

Typical Characteristics of a New Single-Family House (EFH) in Germany, 2021–2025 *(Statistically representative)*	
Attribute	**Typical Value (Median / Mode)**
Construction year	Peak between 2021–2023; strong decline in 2024–2025
Client / Builder	Private households (81.4% of all EFH building permits in 2024)
Construction type	Mineral construction (brick or aerated concrete) and timber frame construction, roughly equal shares
Living area	150–160 m² living space (WFL), approx. 200 m² gross floor area (GFA)
Number of rooms	5 rooms (modal value)
Number of storeys	1.5 storeys dominant (~50%); bungalow increasing (23% in 2025)
Building volume	Average gross cubic capacity (GCV) ≈ 575 m³; average GFA ≈ 200 m²
A/V ratio	0.72–0.82 (typical); up to 0.95 for bungalows
Energy standard	Minimum standard according to GEG 2021 or Efficiency House 55 (EH55)
Heating system (2024)	Heat pump (air-to-water), used in 57% of new buildings
Share of timber construction	20% in 2021; 28.5% in 2024 (record high)
Main mineral construction material	Mineral

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Comfort

Daylight

Active House | Comfort

Daylight

Summary of the results according EN 17037

STANDARD HOUSE

	Occupied space reaching the target daylight factor $D_T \geq 2.2\%$
Ground floor	76%
First floor	37%

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Active House | Comfort

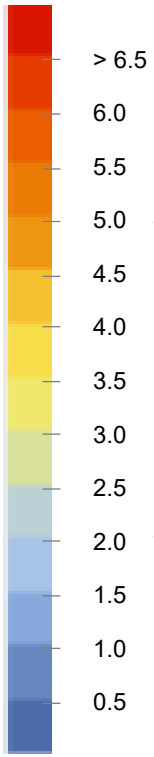
Daylight

Daylight factor (DF [%])

Daylight access can be assessed by daylight factor calculation. The daylight factor is the **ratio** of the **internal horizontal illuminance** (Ep in lux) compared to the **external horizontal illuminance** (Ea in lux) under an **overcast sky** (CIE Overcast) expressed in percent. The calculation is used as a measure of the daylighting of rooms in buildings under overcast conditions. The effect of direct sunlight is not shown. The daylight factor is **independent of the direction of the sky**, **as well as of the date and time**. Influences of glazing and pollution are included.

Daylight

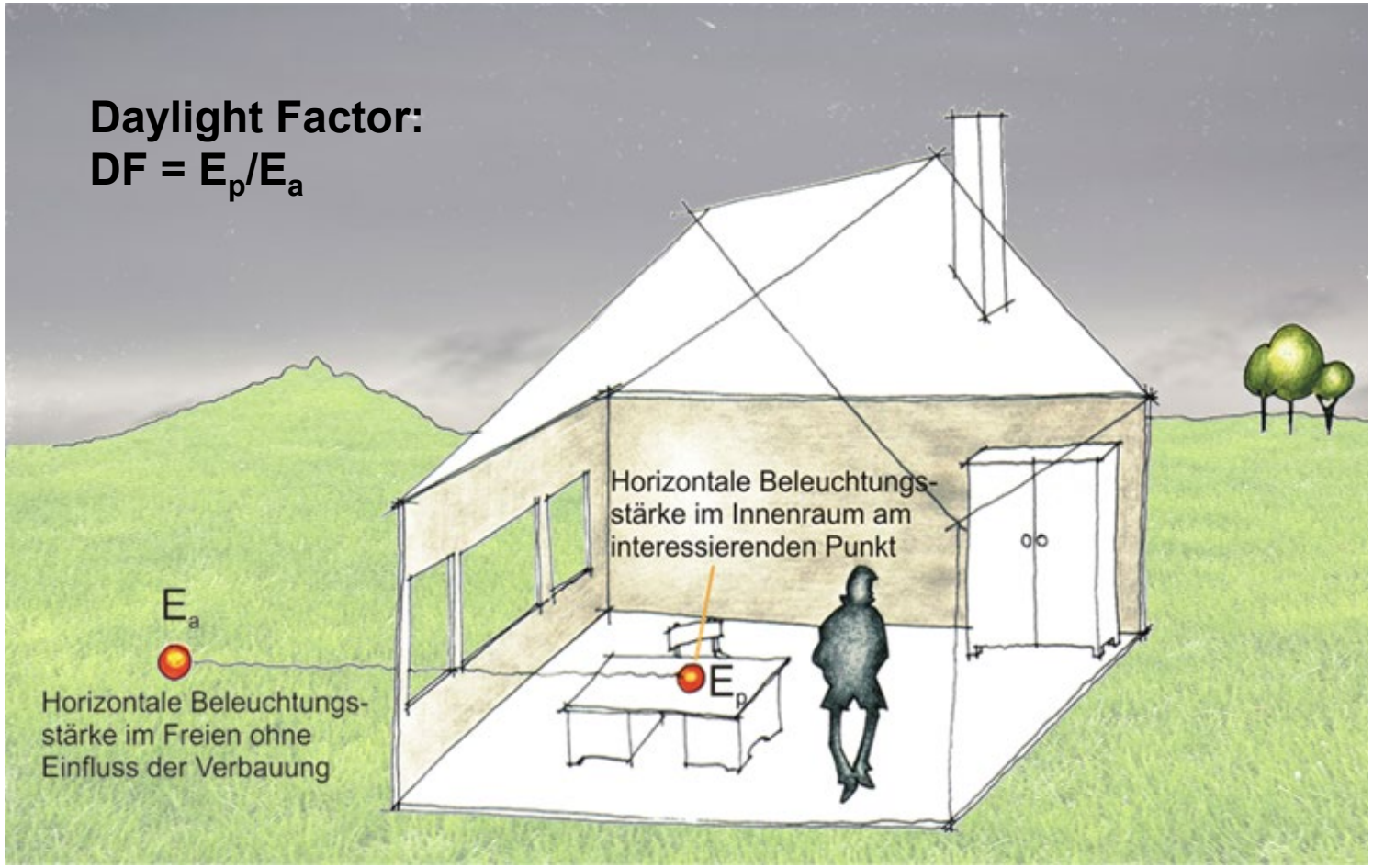
Factor DF [%]



Higher than 6%
Electric lighting is rarely needed during the day, but there is a risk of overheating

Between 2% and 5%
Good daylight illumination, little to no artificial lighting needed during the day. Good balance between daylight and thermal comfort.

Smaller than 2%
Low daylight illumination, high demand for artificial light



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Active House | Comfort

Daylight

Active House – Daylight criteria, option 1: Daylight factor method according EN 17037

The EN 17037 (European Standard) considers measured median external illuminance levels for the capital cities of European countries in function of their latitude. For Berlin in Germany, the median external diffuse illuminance value is 13 900 lx – being 3 900 lx more than the standardized 10 000 lx that are usually assumed for the calculation of the daylight factor.

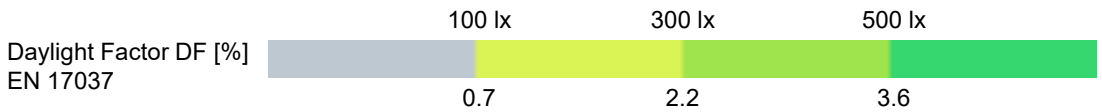
This means lower DF values are required to achieve the same illuminance levels (i.e. the illuminance target of 300 lx is already achieved with a daylight factor of 2.2%).

Table A.3 — Values of *D* for daylight openings to exceed an illuminance level of 100, 300, 500 or 750 lx for a fraction of daylight hours $F_{time,\%}$ = 50 % for 33 capitals of CEN national members

Nation	Capital [a]	Geographical latitude φ [°]	Median External Diffuse Illuminance $E_{v,d,med}$	*D* to exceed 100 lx	*D* to exceed 300 lx	*D* to exceed 500 lx	*D* to exceed 750 lx
Poland	Warsaw	52,17	14 700	0,7 %	2,0 %	3,4 %	5,1 %
The Netherlands	Amsterdam	52,30	14 400	0,7 %	2,1 %	3,5 %	5,2 %
Germany	Berlin	52,47	13 900	0,7 %	2,2 %	3,6 %	5,4 %
Ireland	Dublin	53,43	14 900	0,7 %	2,0 %	3,4 %	5,0 %

➔ Target: daylight factor ≥ 2.2%

Accordingly, the results were filtered in order to display equivalent illuminance levels (in lx) using a user-defined legend.



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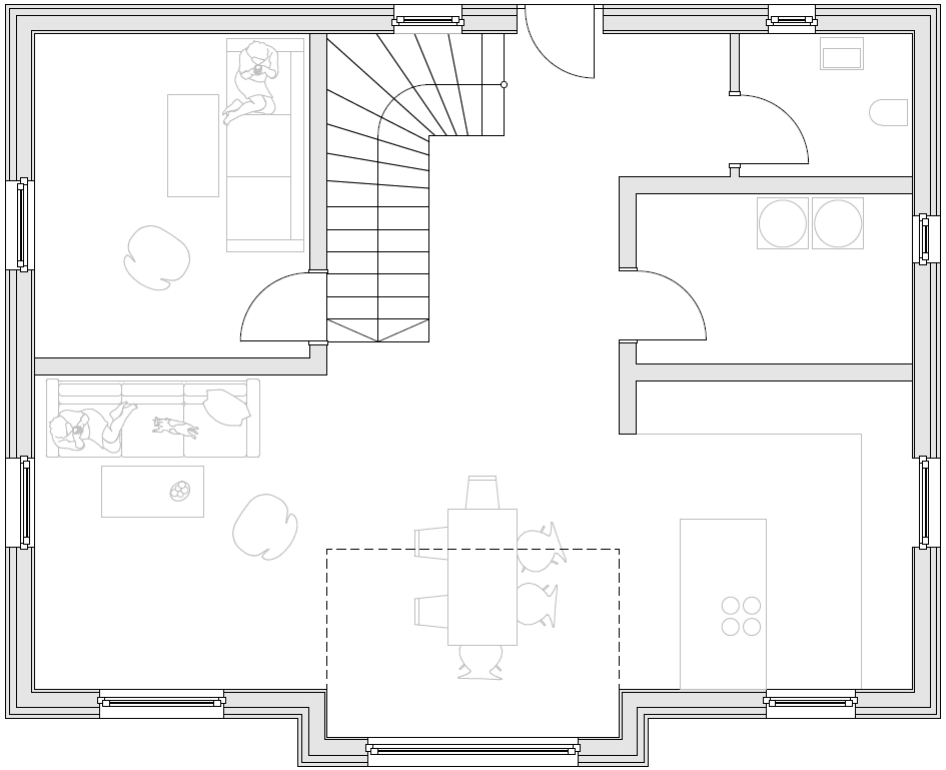
Active House | Comfort

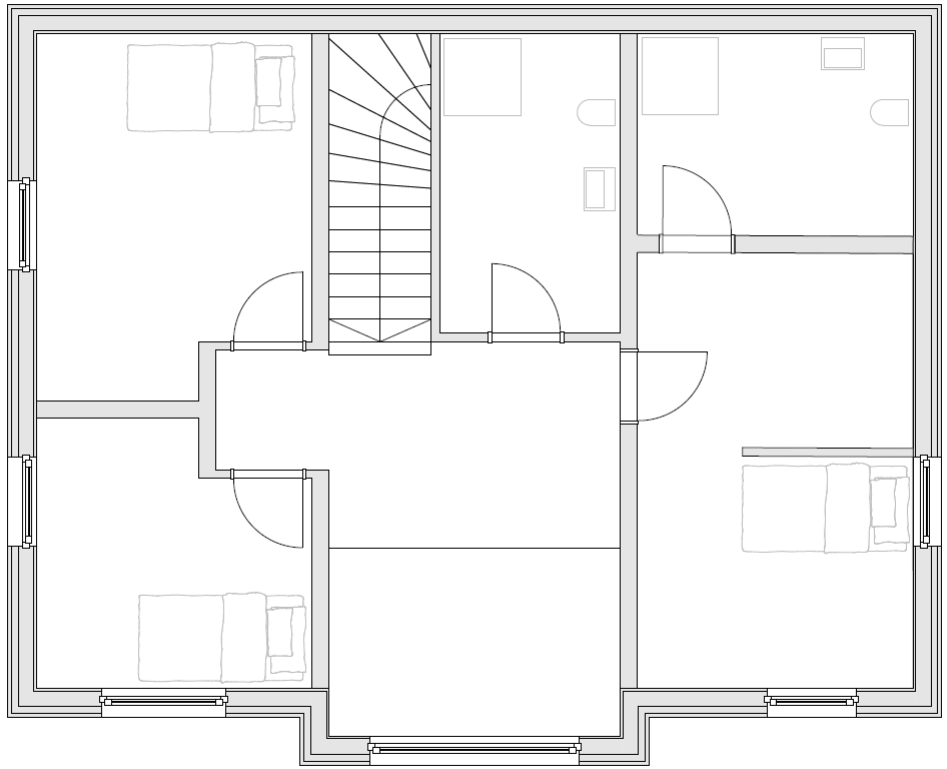
Daylight

STANDARD HOUSE

Boundary conditions: house plans



GROUND FLOOR



FIRST FLOOR

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Active House | Comfort

Daylight

STANDARD HOUSE

Boundary conditions

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Glass
Transmission 70%

Frame
Reflectance 80%

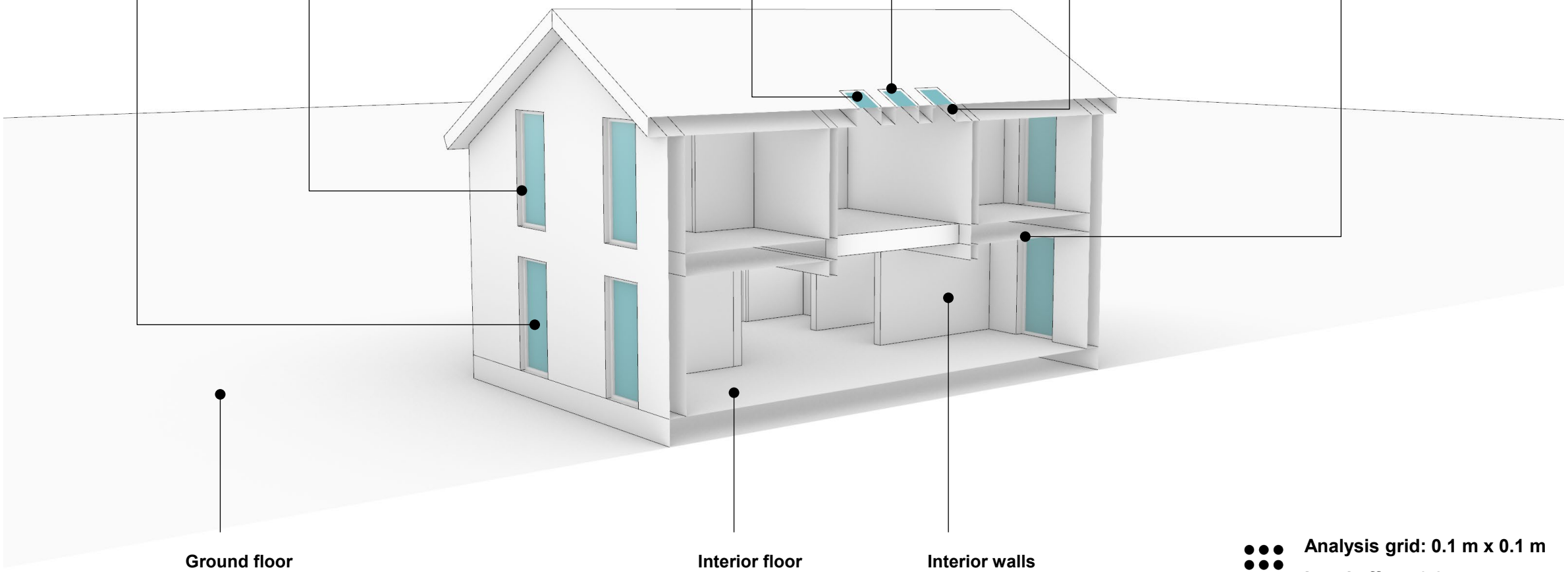
Roof windows

Glass
Transmission 62%

Frame
Reflectance 80%

Window lining
Reflectance 80%

Ceiling
Reflectance 80%



Ground floor
Reflectance 20%

Interior floor
Reflectance 30%

Interior walls
Reflectance 50%

Analysis grid: 0.1 m x 0.1 m

Level offset: 0.85 m

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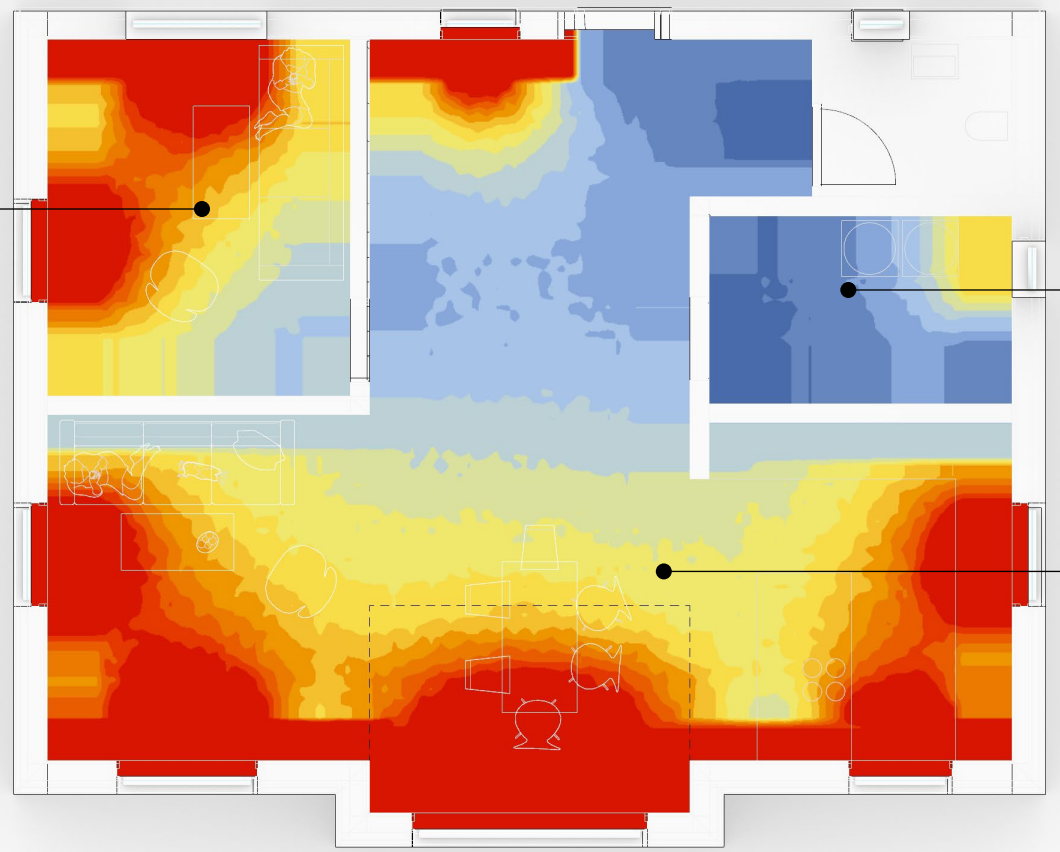
Active House | Comfort

Daylight

STANDARD HOUSE

Results – Daylight factor

Ground floor



Room ①

Room surface	12.5 m²
Average DF	4.73%
Median DF	4.51%

Room ②

Room surface	6.5 m²
Average DF	1.17%
Median DF	0.92%

Room ③

Room surface	56.7 m²
Average DF	4.25%
Median DF	3.54%

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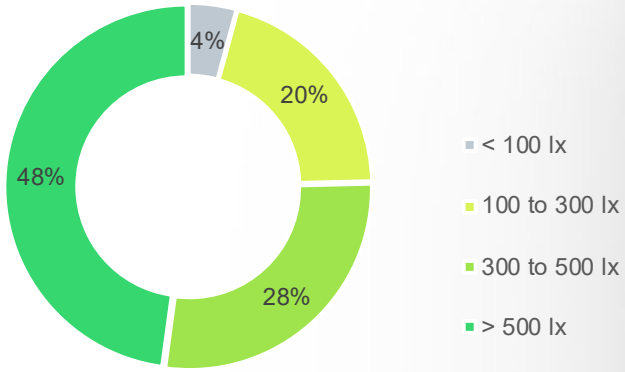
Active House | Comfort

Daylight

STANDARD HOUSE

Results according EN 17037

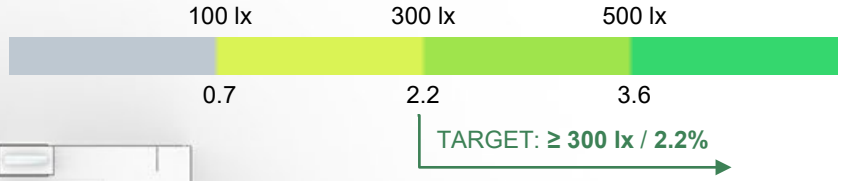
Overall area percentage



➔ Target daylight factor D_T ≥ 2.2% is reached for **76% of the occupied space** analyzed.

Ground floor

Daylight Factor DF [%]
EN 17037



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Active House | Comfort

Daylight

STANDARD HOUSE

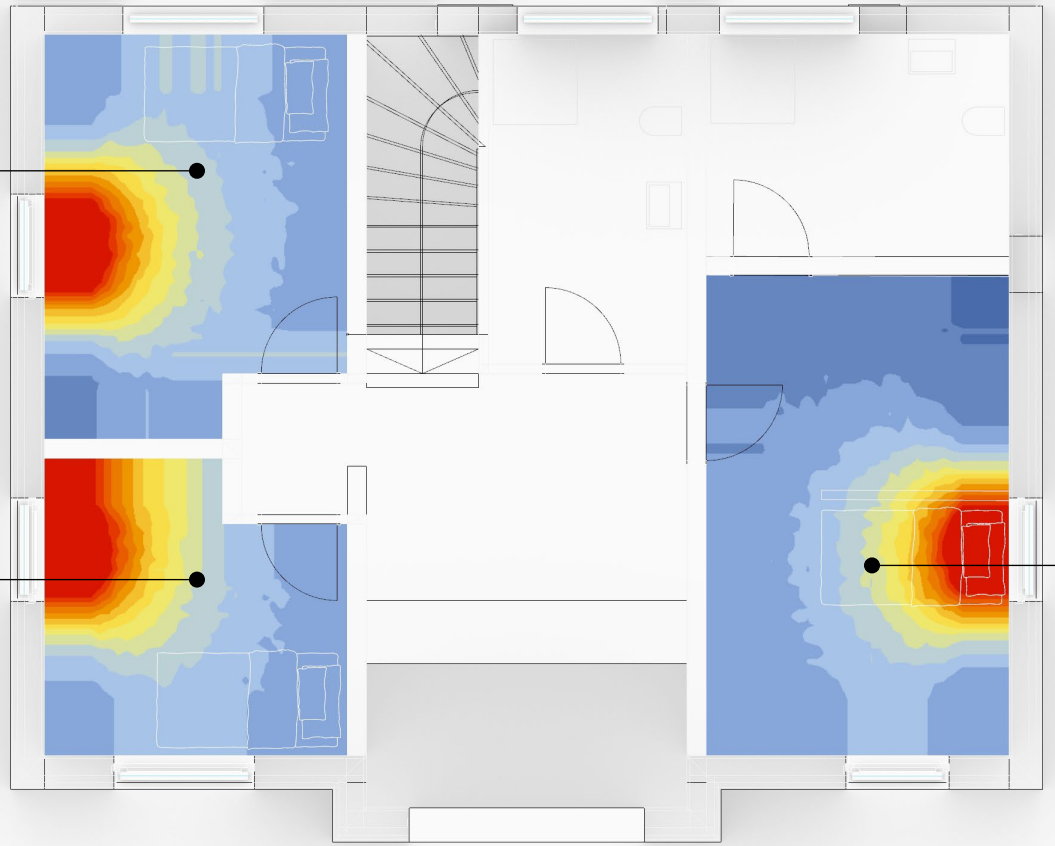
Results – Daylight factor

First floor

Daylight Factor DF [%]

0 | 1.0 | 2.0 | 3.0 | 4.0 | 5.0 | > 6.0

TARGET: **≥ 2.2%**



Room ④

Room surface	13.0 m²
Average DF	2.49%
Median DF	1.98%

Room ⑤

Room surface	9.3 m²
Average DF	2.88%
Median DF	2.16%

Room ⑥

Room surface	16.5 m²
Average DF	1.94%
Median DF	1.51%

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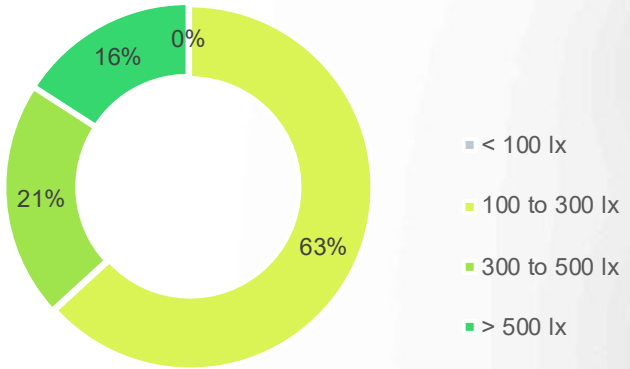
Active House | Comfort

Daylight

STANDARD HOUSE

Results according EN 17037

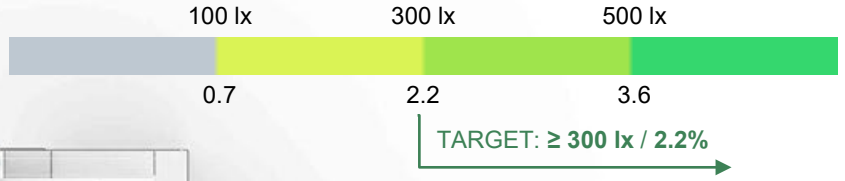
Overall area percentage

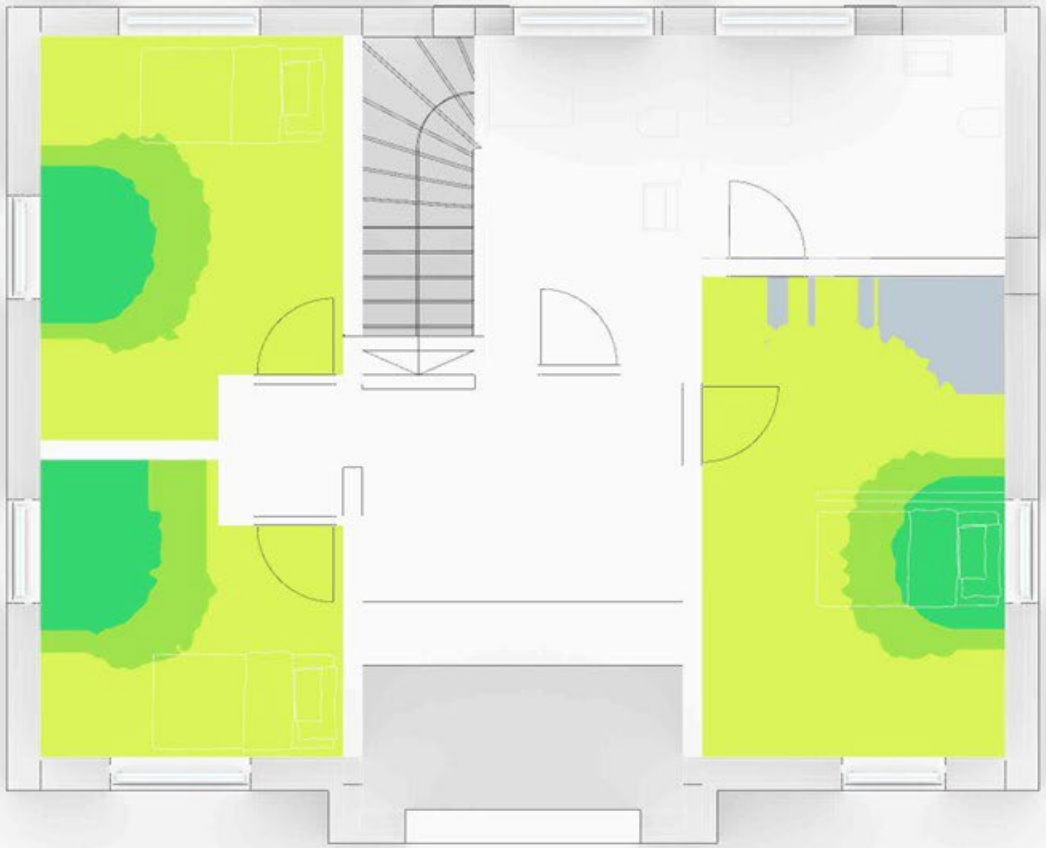


➔ Target daylight factor D_T ≥ 2.2% is reached for **37% of the occupied space** analyzed.

First floor

Daylight Factor DF [%]
EN 17037





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Comfort

Thermal environment & Indoor air quality

Active House | Comfort

Thermal simulations: thermal environment and IAQ assessment

Thermal comfort summary of the results as per Active House

STANDARD HOUSE

Summer comfort: Maximum operative temperature (without air conditioning)

	Percentage of occupied time (target: minimum 95%)
$T_{i,o} < 0.33 \times T_{rm} + 20.8°C$	92%
$T_{i,o} < 0.33 \times T_{rm} + 21.8°C$	96%
$T_{i,o} < 0.33 \times T_{rm} + 22.8°C$	98%
$T_{i,o} < 0.33 \times T_{rm} + 23.8°C$	100%

Winter comfort: Minimum operative temperature

	Percentage of occupied time (target: minimum 95%)
$T_{i,o} > 21°C$	59%
$T_{i,o} > 20°C$	96%
$T_{i,o} > 19°C$	100%
$T_{i,o} > 18°C$	100%

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Active House | Comfort

Thermal simulations: thermal environment and IAQ assessment

Indoor air quality summary of the results as per Active House

STANDARD HOUSE

Standard fresh air supply per room

	Percentage of occupied time (target: minimum 95%)
< 400 ppm above outdoor CO2 concentration	100%
< 550 ppm above outdoor CO2 concentration	100%
< 800 ppm above outdoor CO2 concentration	100%
< 1100 ppm above outdoor CO2 concentration	100%

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Active House | Comfort

Thermal simulations: thermal environment and IAQ assessment

STANDARD HOUSE

Geometry & envelope

Geometry and construction

Area (modelled NGF)	154 m²
Volume	458 m³
Orientation	Sloped roof oriented North-South
Location	Frankfurt, Germany

Opaque constructions

Floor to ground	Massive construction	U = 0.16 W/m²K
External walls	Massive construction	U = 0.15 W/m²K
Roof	Massive construction	U = 0.13 W/m²K

Windows

Sloped roof windows	Glazing	Ug = 0.80 W/m²K Tvis = 55% g-value = 41%
	Frame	26% frame factor Uf = 1.2 W/m²K
Vertical windows	Glazing	Ug = 0.72 W/m²K Tvis = 71% g-value = 50%
	Frame	10% frame factor Uf = 1.2 W/m²K
Solar protection	External shutters on roof windows, controlled according to solar radiation received on window Sloped roof windows shutters: fc = 80%	

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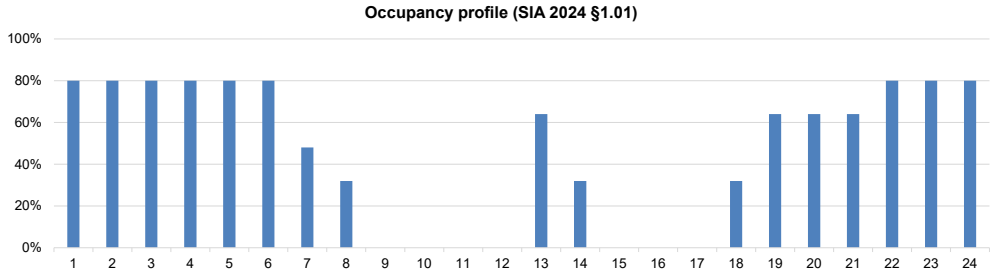
Active House | Comfort

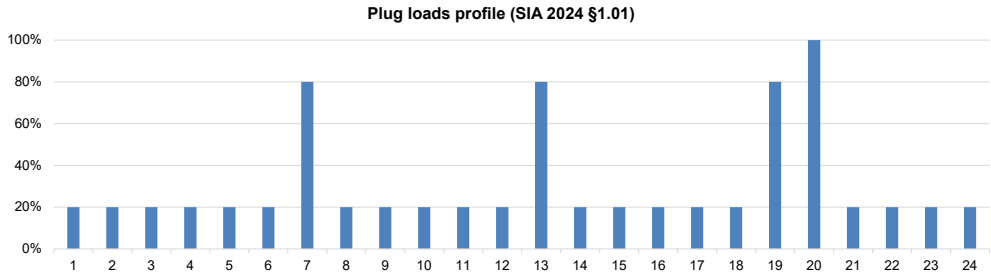
Thermal simulations: thermal environment and IAQ assessment

STANDARD HOUSE

Internal Gains

People	Sensible loads 70 W/pers Latent loads 50 W/pers (80 g/h) 3 people Profile occupancy
Artificial lighting	5 W/m² Control based on occupancy and daylight
Plug loads	5 W/m² Profile plug loads





Room conditions

Room conditions	Heating setpoint 20°C min. operative temperature No active cooling
Ventilation strategy	Hybrid ventilation 50 m³/h Supply air temperature 20°C or Tamb depending on outdoor temperature in hybrid mode no humidification / no dehumidification HR sensible = 80% HR latent = 0%
Infiltration	0.15 ACR

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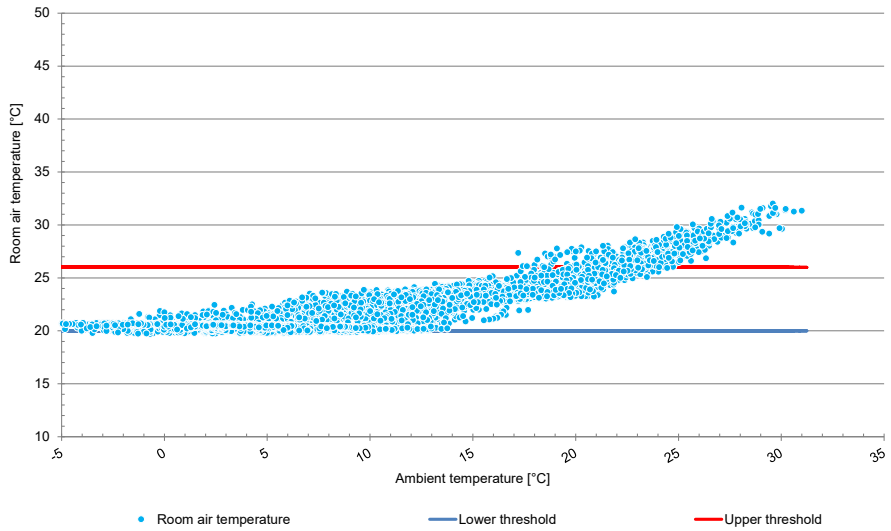
Active House | Comfort

Thermal simulations: thermal environment and IAQ assessment

STANDARD HOUSE

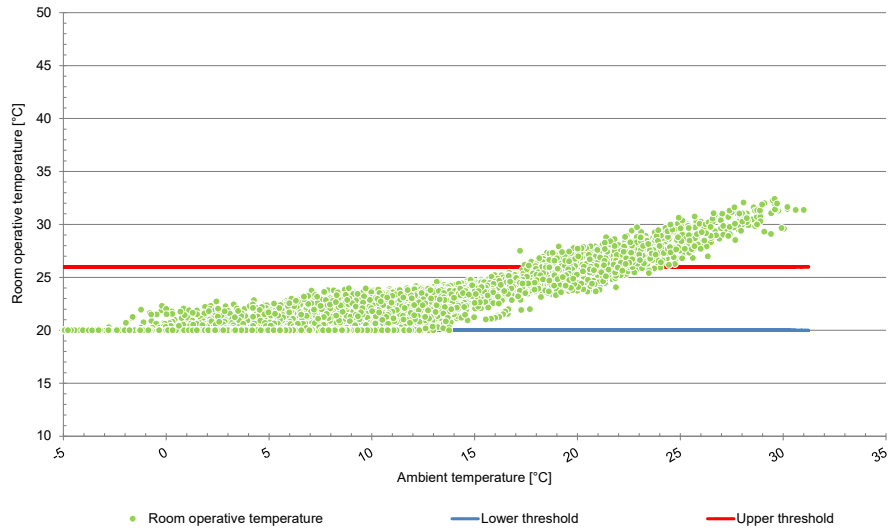
Standard house

Room air temperature during occupancy



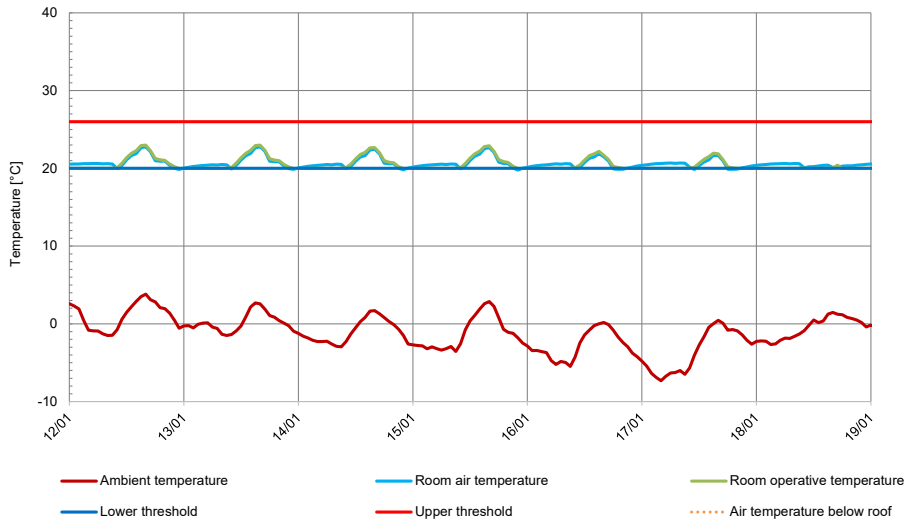
Standard house

Room operative temperature during occupancy



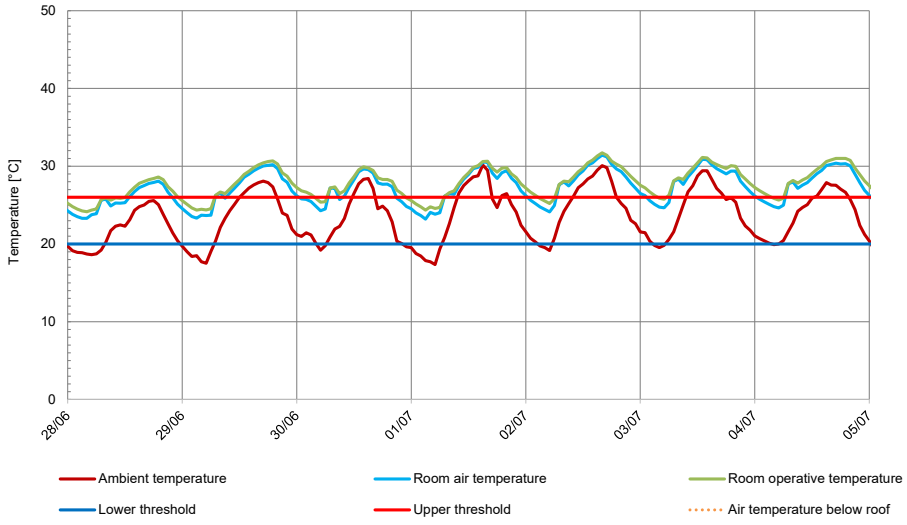
Standard house

Temperatures evolution during a cold winter period



Standard house

Temperatures evolution during a hot summer period



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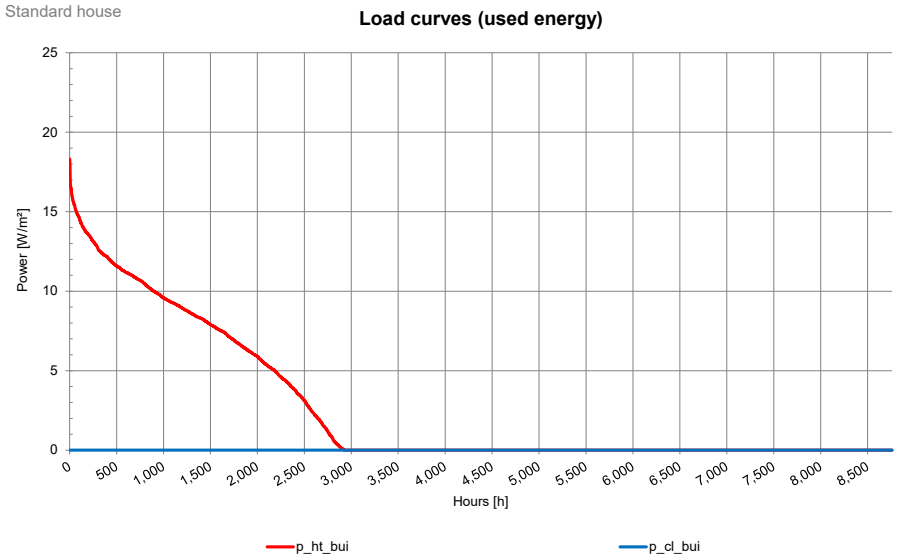
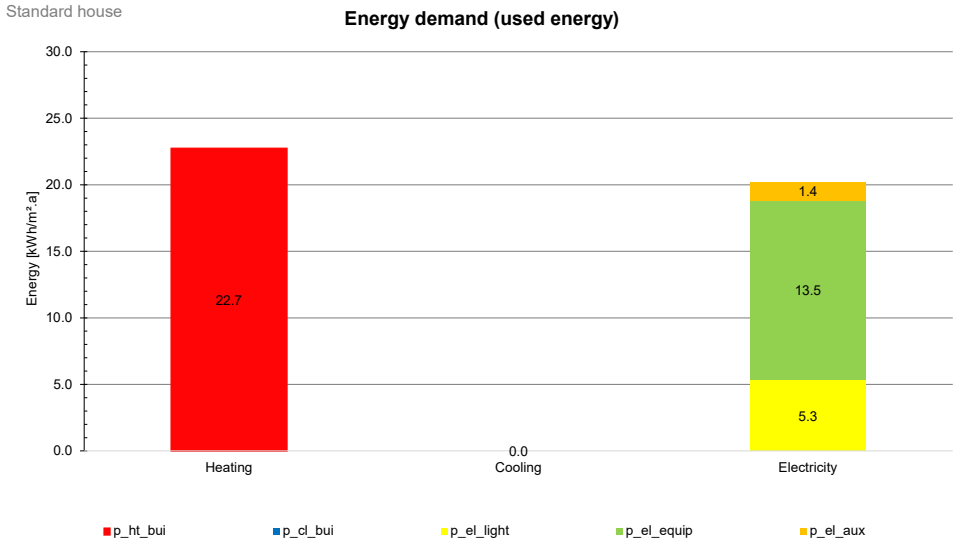
Thermal simulations: thermal environment and IAQ assessment

STANDARD HOUSE





p_ht_bui: heating
p_cl_bui: cooling
p_el_light: electricity for artificial lighting
p_el_equip: electricity for electrical equipments
p_el_aux: auxiliary electricity

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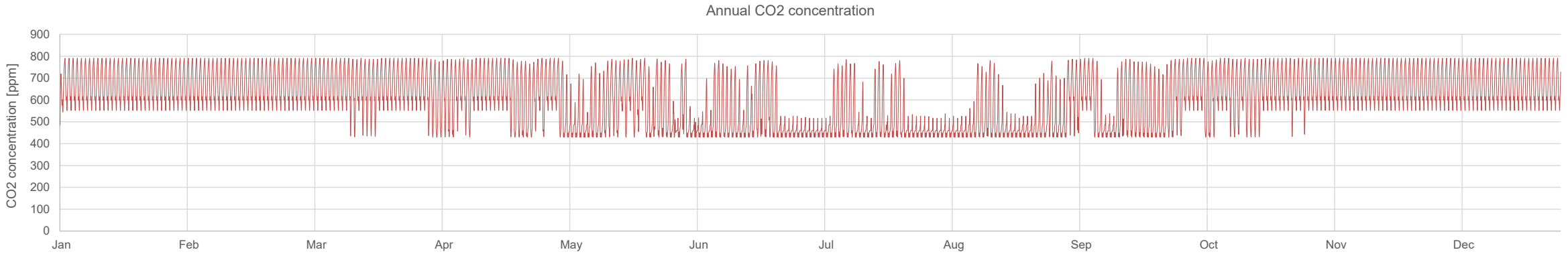
Active House | Comfort

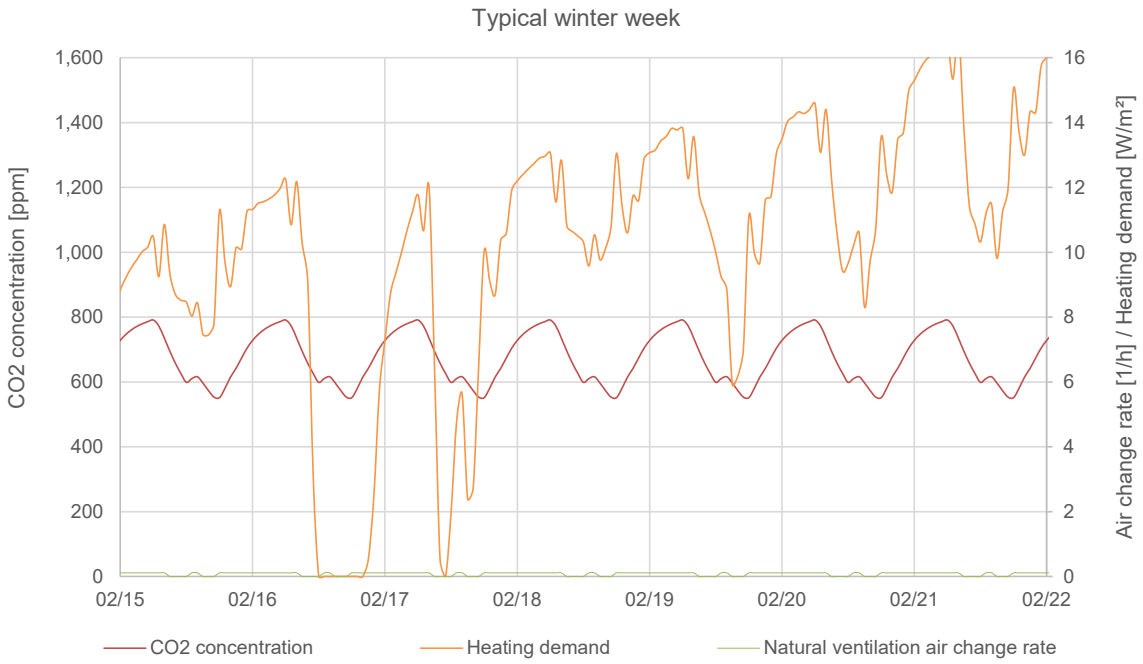
Thermal simulations: thermal environment and IAQ assessment

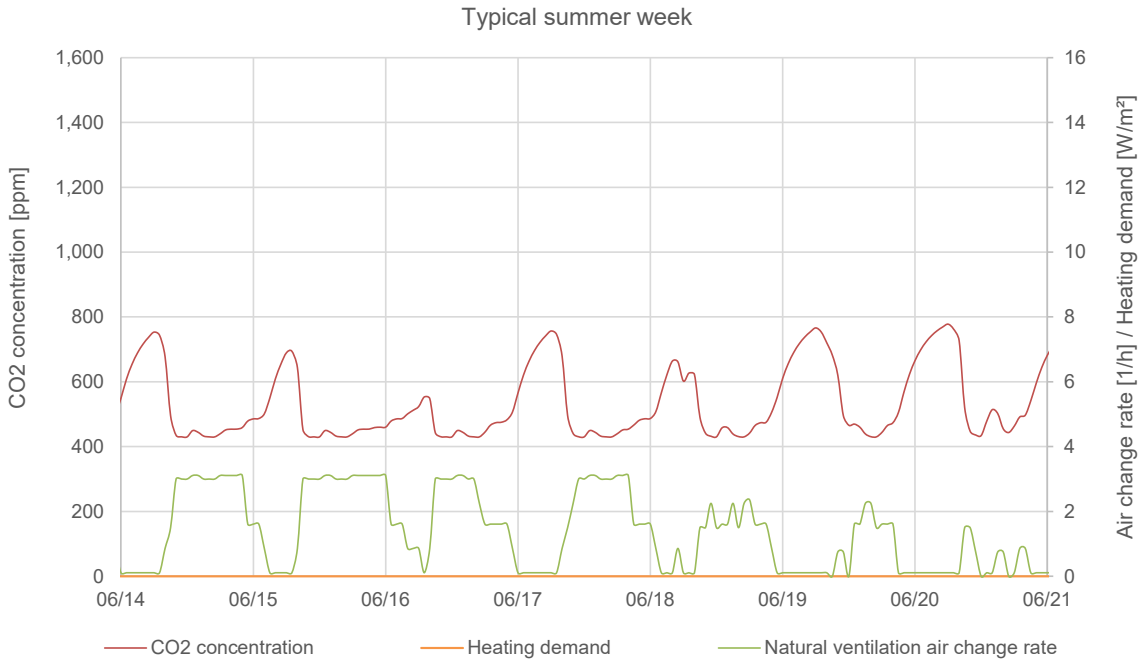
STANDARD HOUSE



➔ Maximum indoor CO_2 level: 791 ppm, being 361 ppm above outdoor level

➔ Average indoor CO_2 level: 608 ppm





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Energy

Energy demand, Energy supply, Primary energy

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Energy Demand & Supply

STANDARD HOUSE

Thermal Energy demand

		Energy demand
Heat pump	Heating demand	60.7 kWh/m²
	Auxiliary energy	3.6 kWh/m²
Direct electric heating	Domestic hot water	9.3 kWh/m²

Electricity demand

	Energy demand
Lighting	5.3 kWh/m²
Plug loads	13.5 kWh/m²

On-site renewable electricity supply

	Energy supply
Photovoltaic installation	42.3 kWh/m²

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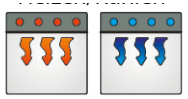
Energy Demand & Supply

GEG Studies - Boundary conditions – Standard house

STANDARD HOUSE 

- External wall: area = 172 m² U-value = 0,15 W/m²K A_{NGF} = 127 m²
- Ground slab: area = 92 m² U-value = 0,16 W/m²K A/V = 77%
- Roof: area = 126 m² U-value = 0,13 W/m²K
- Window area = 41 m² U-value = 0,95 W/m²K g-values = 53 %

ventilation: natural ventilation through windows



Heating: air-water-heat pump
floor heating

Cooling: no cooling

Domestic hot water: electric direct heater

Photovoltaik: 40 m² on the south roof

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Energy Demand & Supply

GEG Studies - Results – Standard house

STANDARD HOUSE

- Standard house results:
  - Spez. Endenergie 23,8 kWh/(m²a)
  - Spez. Primärenergiebedarf: 42,9 kWh/(m²a)
  - Spez. CO2-Equivalent: 13,3 kg/(m²a)

- The building has a high quality envelope, natural ventilation and use a air-water heat pump for heating.
- The standard house has floor heating

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Environment

Sustainable construction

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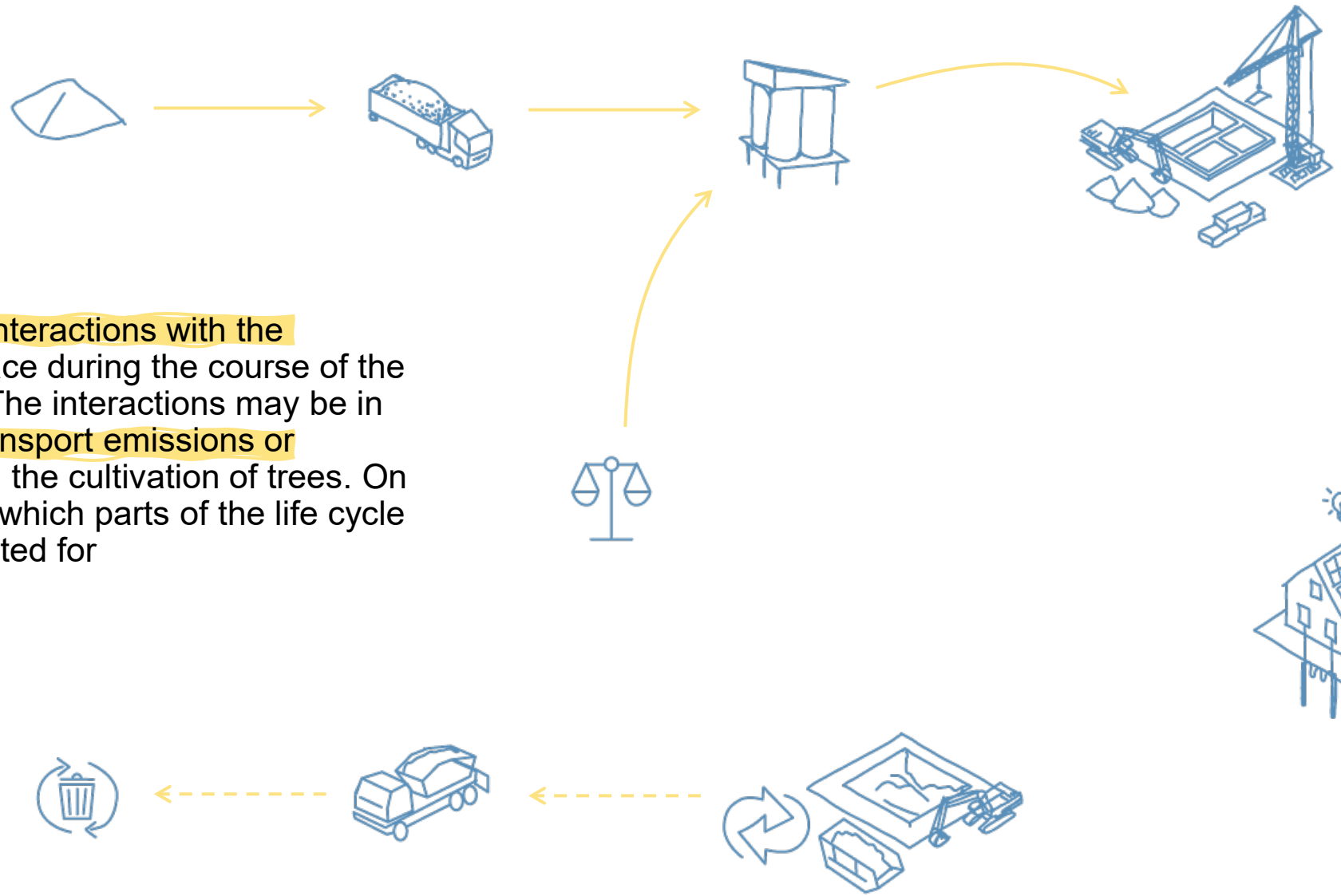
Life Cycle Analysis

Why do we perform a LCA?



An LCA adds up all of the interactions with the environment which take place during the course of the included life cycle stages. The interactions may be in the form of for example, transport emissions or resource consumption from the cultivation of trees. On the next page you can see which parts of the life cycle of the materials are accounted for

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Life Cycle Analysis

What are the phases included in the LCA?

Product stage

A1

Raw material

A2

Raw material

A3

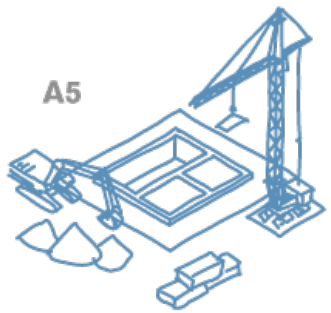
Manufacturing

Construction process stage

A4

Transport

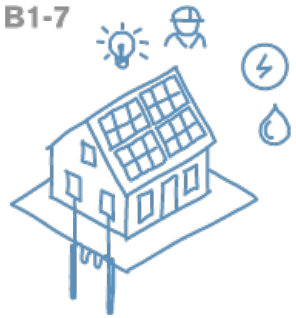
A5



Construction

Use stage

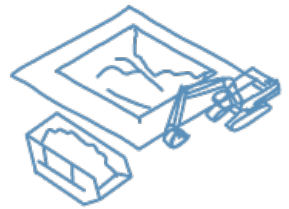
B1-7



B1 Use
B2 Maintenance
B3 Repair
B4 Replacement
B5 Refurbishment
B6 Energy use
B7 Water use

End of life stage

C1



Deconstruction

C2

Transport

C3

Waste processing

C4

Disposal

Benefits and loads beyond the system boundary

D

Reuse, recovery and recycling potetial

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Life Cycle Analysis

In the german market

A series of Life Cycle Assessment (LCA) studies were conducted to evaluate the performance of the Standard House in Germany. The research included a standard building model based on designs from the architectural firm DGJ Architektur.

- Standard House modeled according to QNG
- Standard House modeled according to DGNB

These two certification frameworks were chosen because of their relevance to the German market. DGNB is a Europe-wide sustainability certification commonly used for larger and mixed-use developments, while QNG is applied primarily when seeking public funding, with a particular emphasis on residential buildings.

Topic	DGNB	QNG
Evaluation logic	Relative (Reference House)	Absolute (thresholds)
Flexibility	High	Low, fixed structure for the evaluation
Database	EPD + project-specific until v.2018, from v.2023 only Ökobau.dat	Standardized only - Based on its own database, no EPD included
Goal	Optimization	Compliance
Result	Score (Silver–Platinum)	Pass/Fail
Phases of the LCA included	A1-A3, B4, B6, C3-C4	A1-A3, B4, B6, C3-C4
Utilisation of ecological materials	Advantage with extra points for circular and regenerative materials	No bonus
Role of LCA	One criterion among many, with associated points according to the complexity	Central requirement
Normalised emissions	NRF excluding garage	NRF

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Life Cycle Analysis

What are the phases included in the LCA?

Product stage

A1

Raw material

A2

Raw material

A3

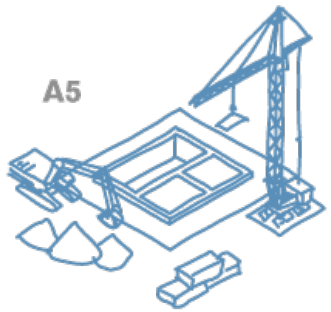
Manufacturing

Construction process stage

A4

Transport

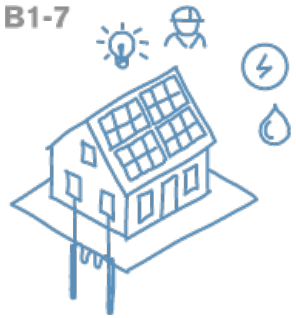
A5



Construction

Use stage

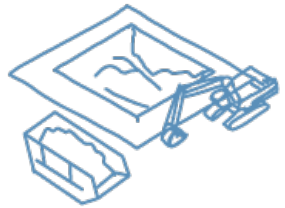
B1-7



B1 Use
B2 Maintenance
B3 Repair
B4 Replacement
B5 Refurbishment
B6 Energy use
B7 Water use

End of life stage

C1



Deconstruction

C2

Transport

C3

Waste processing

C4

Disposal

Benefits and loads beyond the system boundary

D

Reuse, recovery and recycling potetial

Phases included in the QNG and DGNB calculation

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Life Cycle Analysis

In the german market

Per the DIN276 standard, building costs in Germany are categorized into organized cost groups. The most significant and pertinent groups for this analysis include:

KG 300 – Building Construction (Baukonstruktionen)

This includes all structural and architectural building elements

- Excavation / earthworks (KG 310)
- Foundations (KG 320)
- Exterior walls (KG 330)
- Interior walls (KG 340)
- Floors / slabs (KG 350)
- Roofs (KG 360)

KG 400 – Technical Systems (Technische Anlagen)

All mechanical, electrical, and plumbing systems

- Wastewater, water, and gas systems (KG 410)
- Heating systems (KG 420)
- Ventilation / HVAC systems (KG 430)
- Electrical installations (KG 440)
- Conveying systems (elevators, etc.) (KG 460)
- Building automation (KG 480)

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Conclusions | LCA

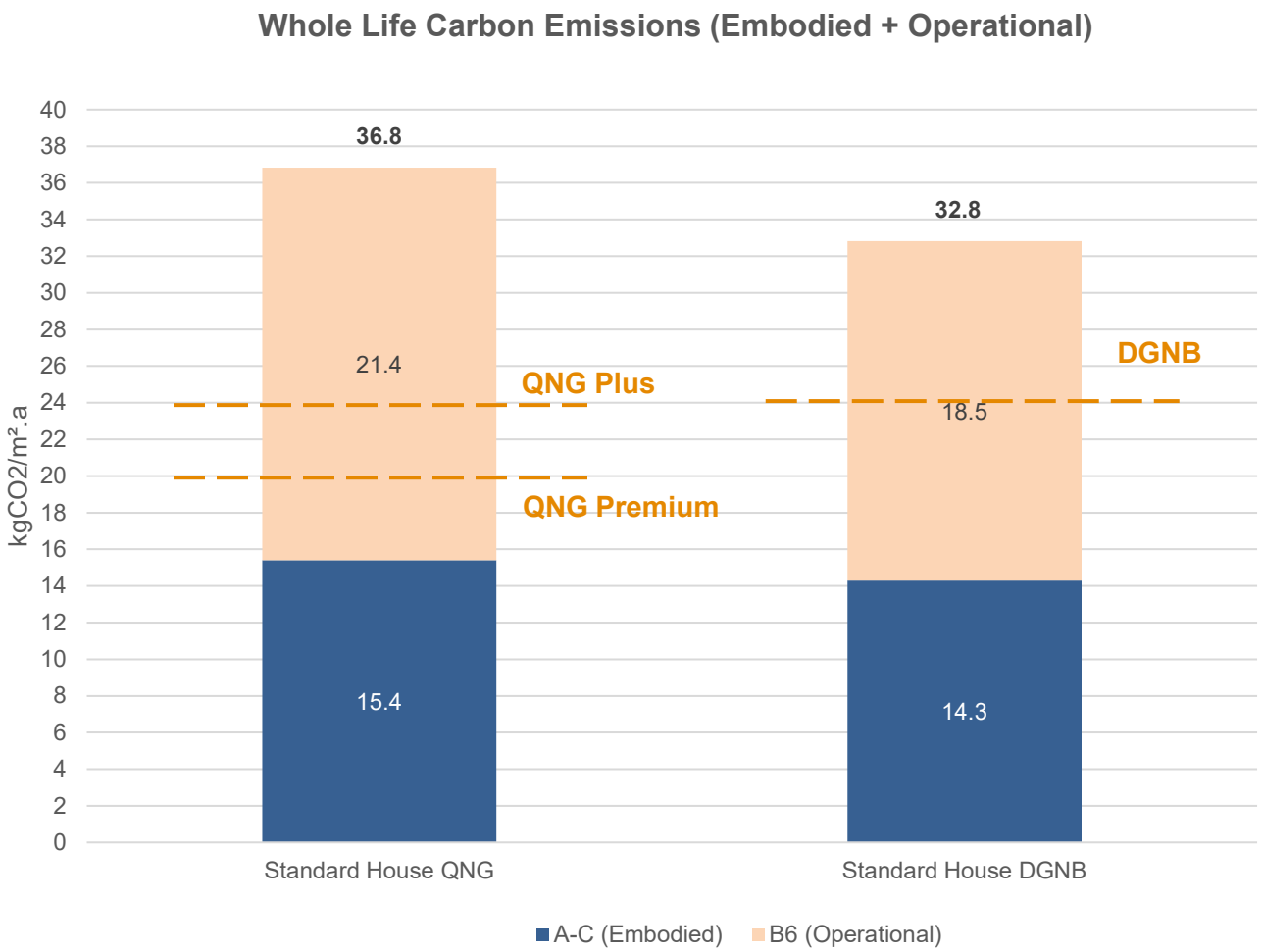
Whole life carbon emissions in comparison

The results show a consistent trend in both QNG and DGNB calculations. The Standard Haus performs moderately, staying above the reference values but relatively close to the limits.

Main differences between the two calculation methods are:

- The emission factor for the energy grid:
    - DGNB Electricity Factor: according to Ökobau.dat 2023, 0.465 kgCO2/kWh
    - QNG Electricity Factor: according to the QNG-Table 0.532 kgCO2/kWh

- PV Panels emission, not associated to a specific EPD rather to a generic source (Ökobau.dat/QNG-Table)



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STANDARD GERMAN HOUSE

Elements of Construction and results, embodied carbon

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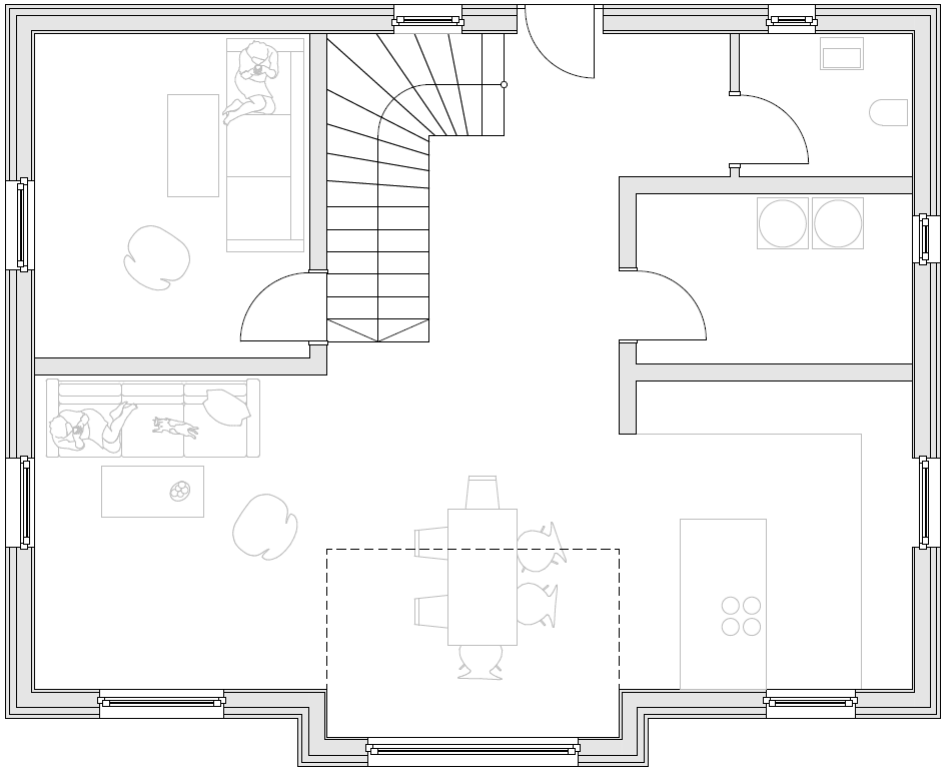
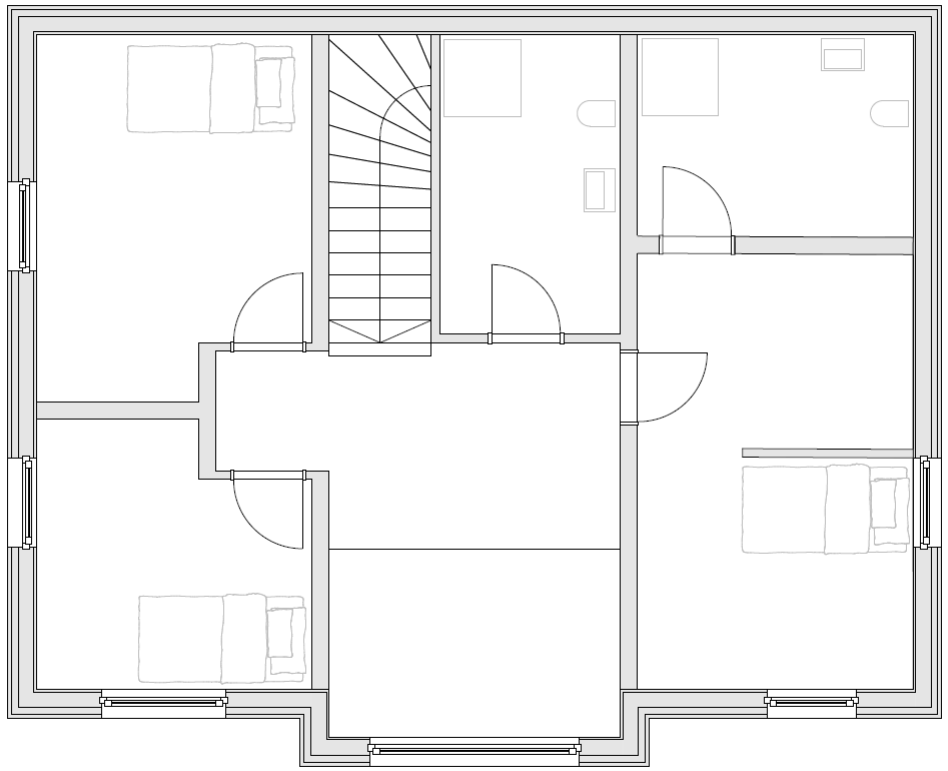
Standard German House | LCA

Boundary conditions: house plans



GROUND FLOOR



FIRST FLOOR

Brutto Area: 165.8 m²
Netto Area (for QNG/DGNB, including non-heated areas and circulation areas – NRF): 152.9 m²

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Standard German House | LCA

Boundary conditions: Construction Layers – Elements from KG 300

Roof: Wooden structure with concrete roof tile, mineral wool and wood fibre insulation board

Roof Windows: PVC with triple glazing

Internal walls:
Structural walls with calcium silicate masonry
Partition walls with steel frame and mineral wall

Windows: PVC with triple glazing

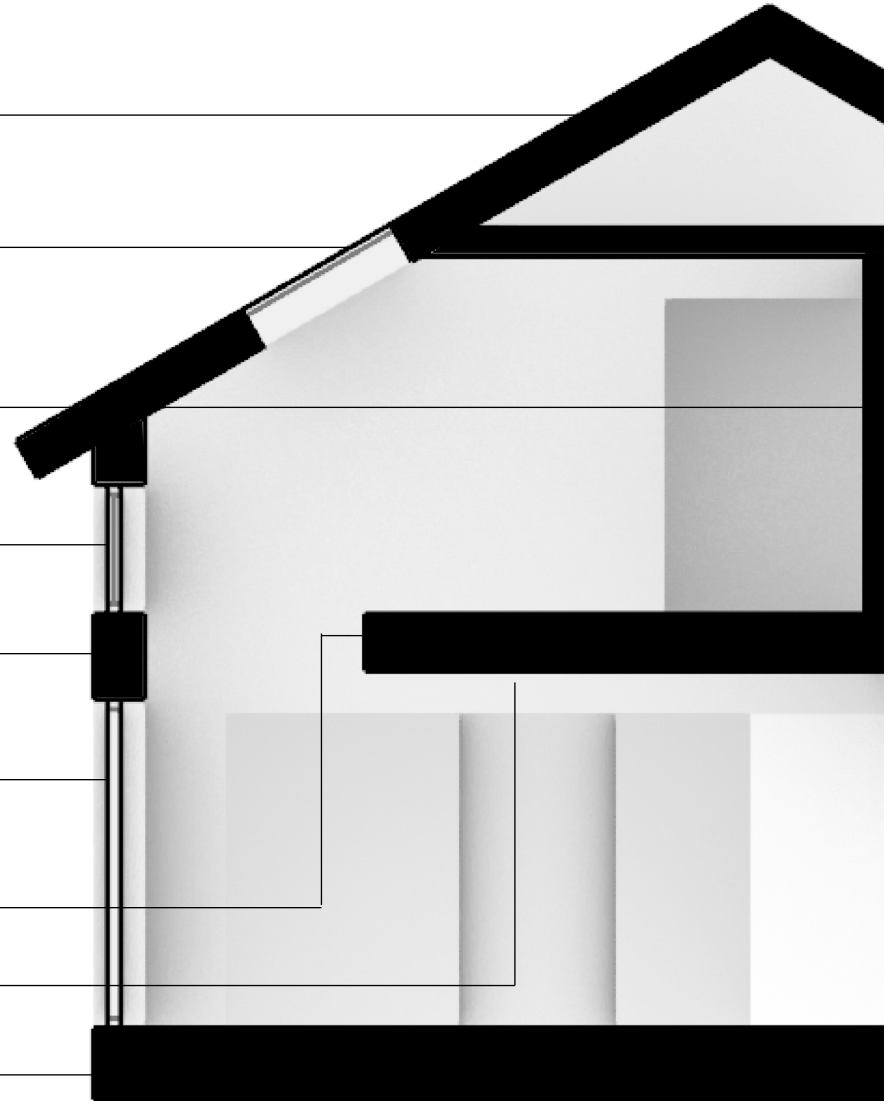
External walls: Aereted concrete block with lime-cement plaster

Doors: Insulated triple glazing, PVC frame

Slabs: Reinforced concrete, with Parkett or Ceramic tiles

Ceiling: Gypsum Plasterboard

Ground slab: Reinforced concrete, with Parkett or Ceramic tiles



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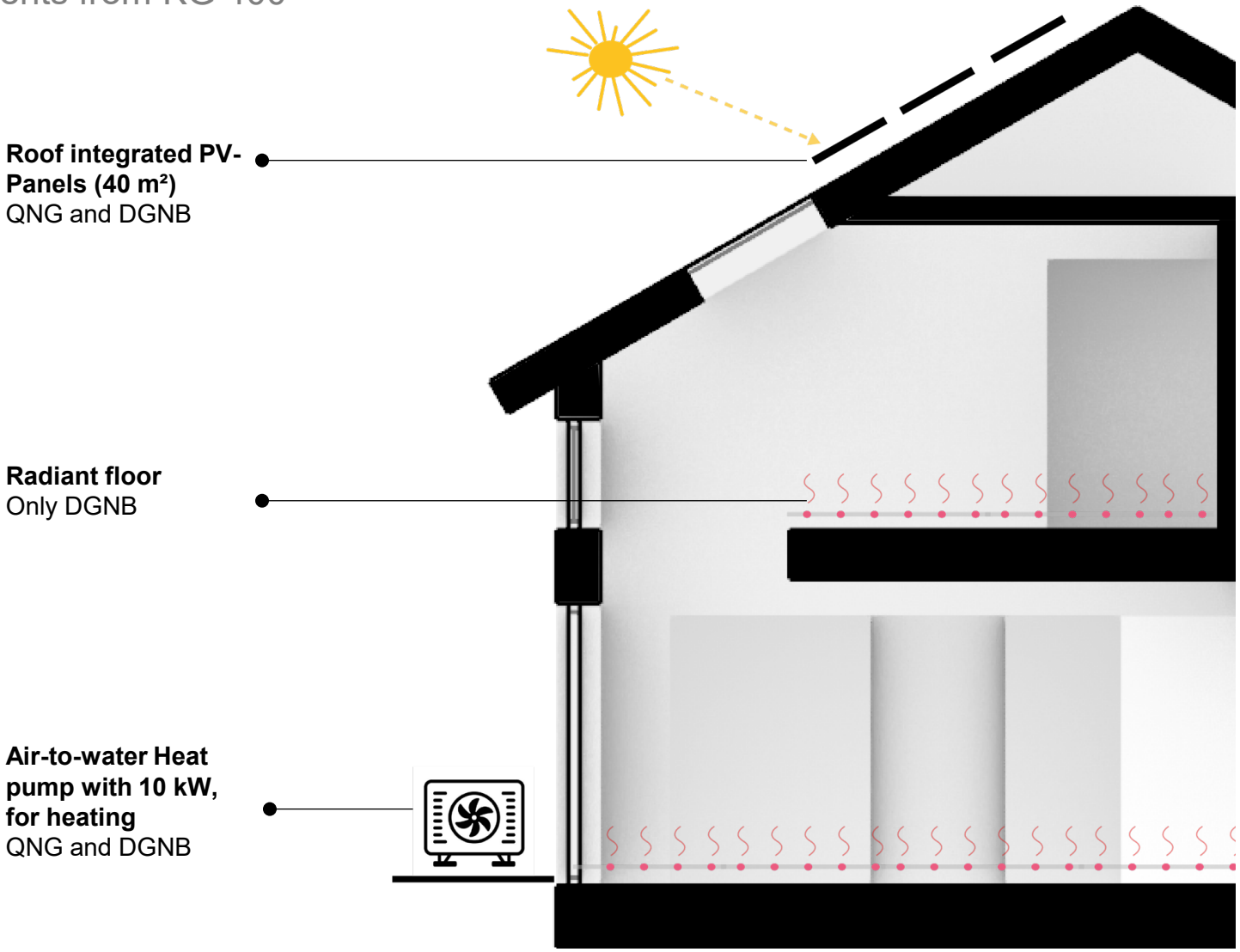
Standard German House | LCA

Boundary conditions: Construction Layers – Elements from KG 400

To account for the technical systems, both evaluation frameworks account only for the major components, such as PV-Panels, heat pumps, heat and energy storage systems and so on.

Smaller elements, like the radiant floor, radiators, pipes, and cables, are represented by a fixed value as specified by the standard.

In the case of the Standard Haus, this fixed value is 1.3 kgCO2/m².a.



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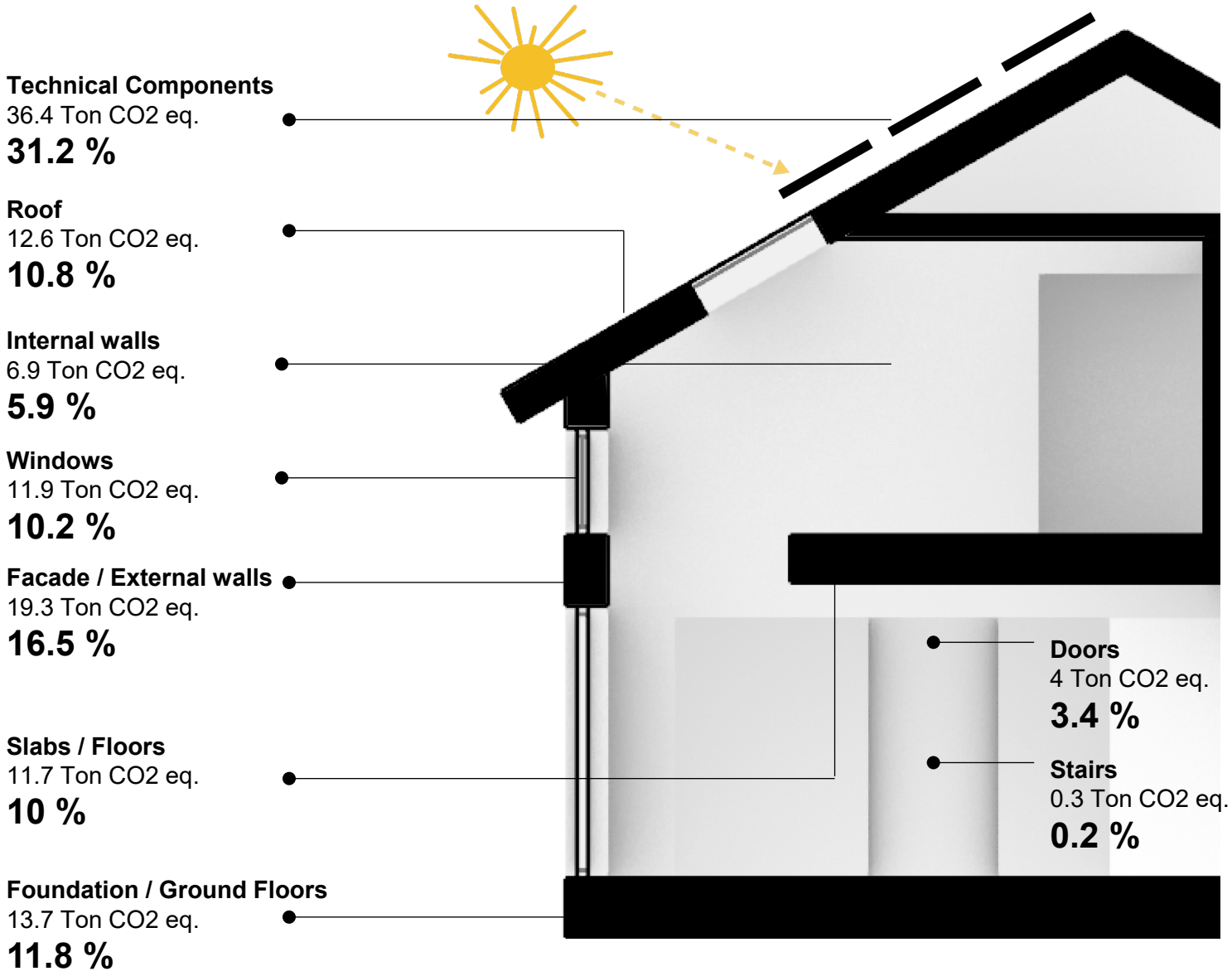
Results – Elements from KG 300

The components are grouped here according to the main categories from the construction process. Emissions are expressed in tons of CO2 equivalent and cover life cycle phases A1-A3, B4, and C3-C4.

The values presented align with the QNG standard. Given the dataset's characteristics, the two calculations show minimal differences.

The percentage distribution reflects what is typical for a small single-family house built with concrete and bricks.



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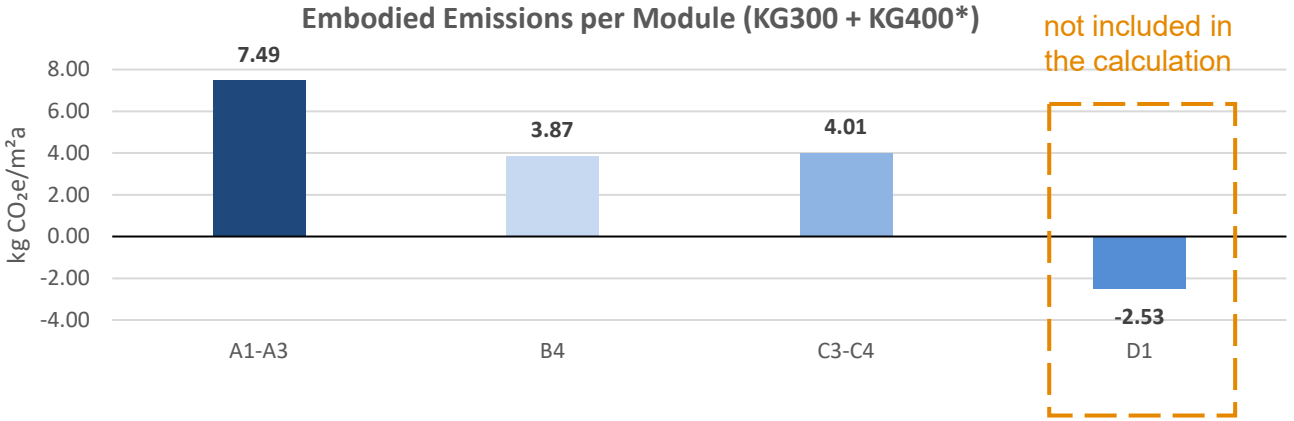
Embodied emissions according to the QNG Framework

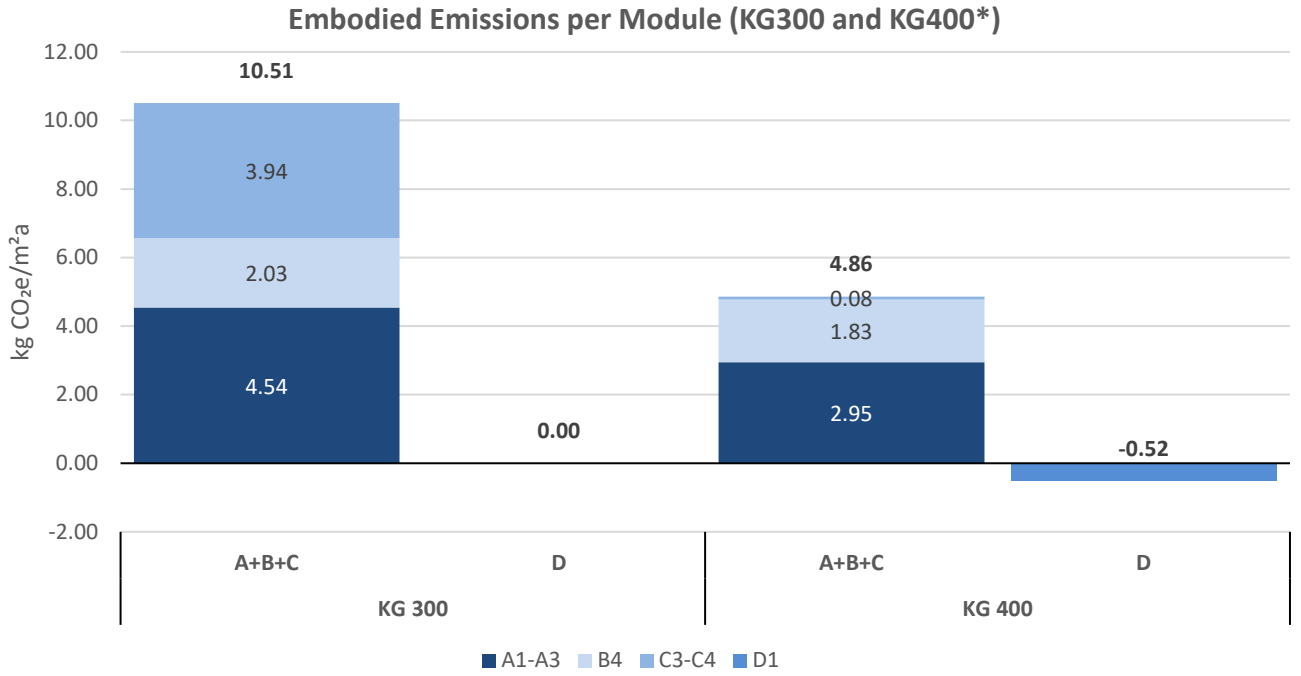
The table presents the emissions categorized by cost group and life cycle phase. In accordance with QNG methodology, module D is not included in the total calculation.

For the QNG calculation, a standard and fixed database from the certification is required to be used for material selection and the building's life cycle assessment. Consequently, certain simplifications are necessary to estimate the overall emissions throughout the building's lifespan

Based on this, the total emissions can be interpreted as follows:

A1-A3, B4, C2-C3: **15.4 kgCO2/m².a**





*KG300 – Construction materials
KG400 – Technical components

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Embodied emissions according to the DGNB Framework

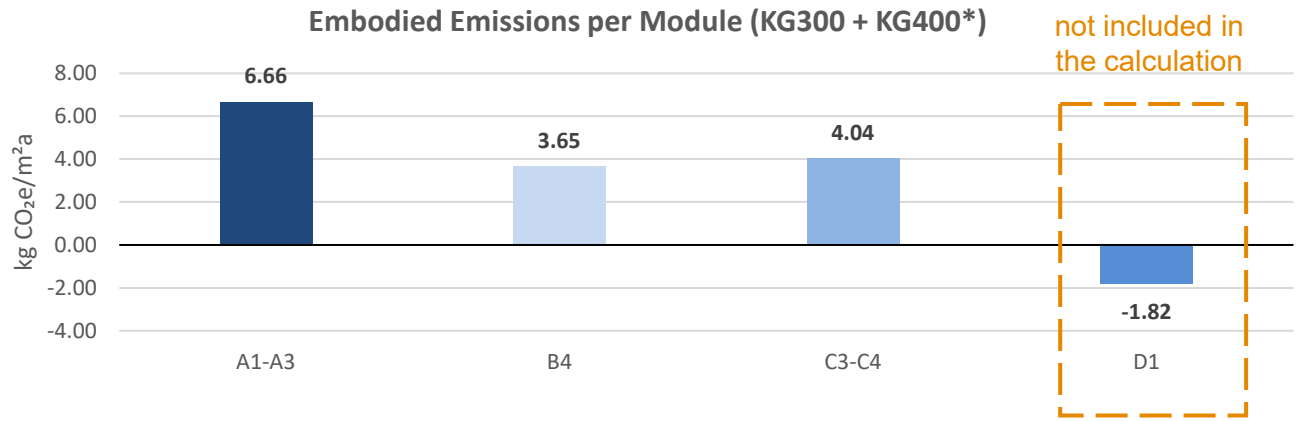
The table presents the emissions categorized by cost group and life cycle phase. In accordance with the DGNB methodology, module D is also not included in the total calculation.

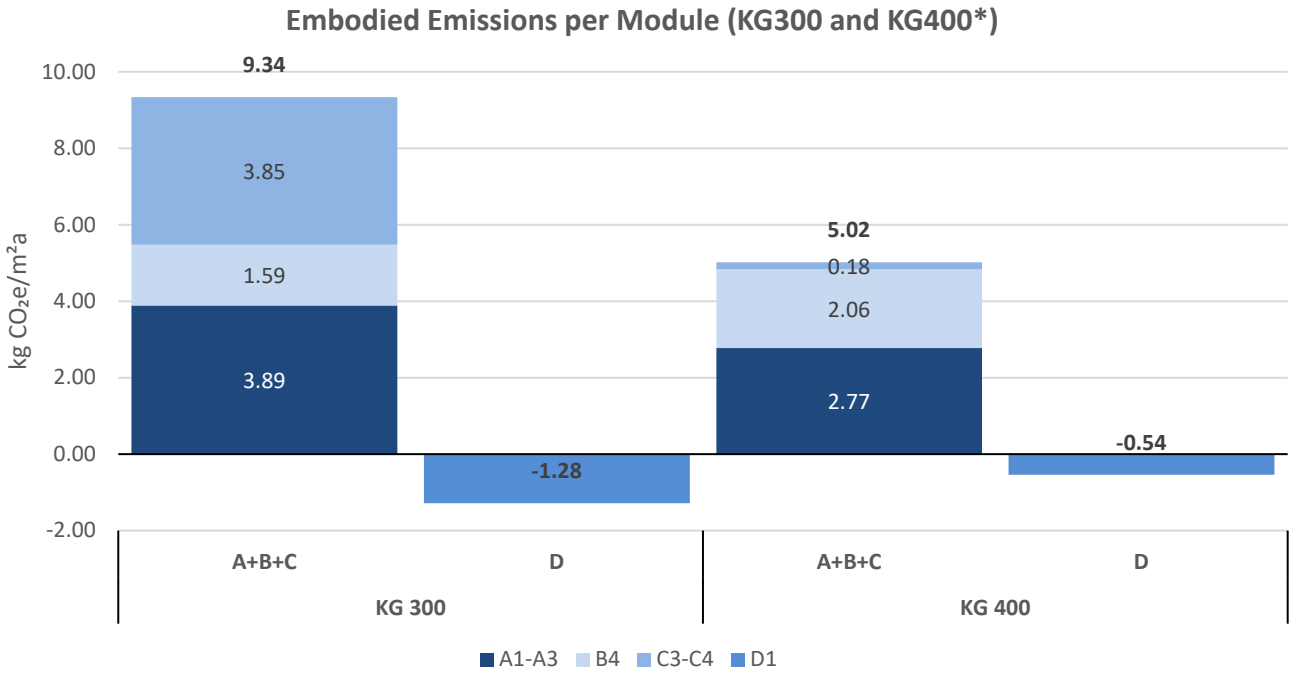
The framework allows the use of the Ökobau.dat as the database within its framework. Ökobau.dat has generic datasets and regional average datasets, as well as EPDs, enabling material choices that better reflect actual embodied emissions and provide a more accurate representation.

Note, however, that the values do not differ significantly in comparison with the QNG. This is because the selected materials are based into regional average, which corresponds as well to the normalized QNG-Database.

Based on this, the total emissions can be interpreted as follows:

A1-A3, B4, C2-C3: **14.3 kgCO2/m².a**





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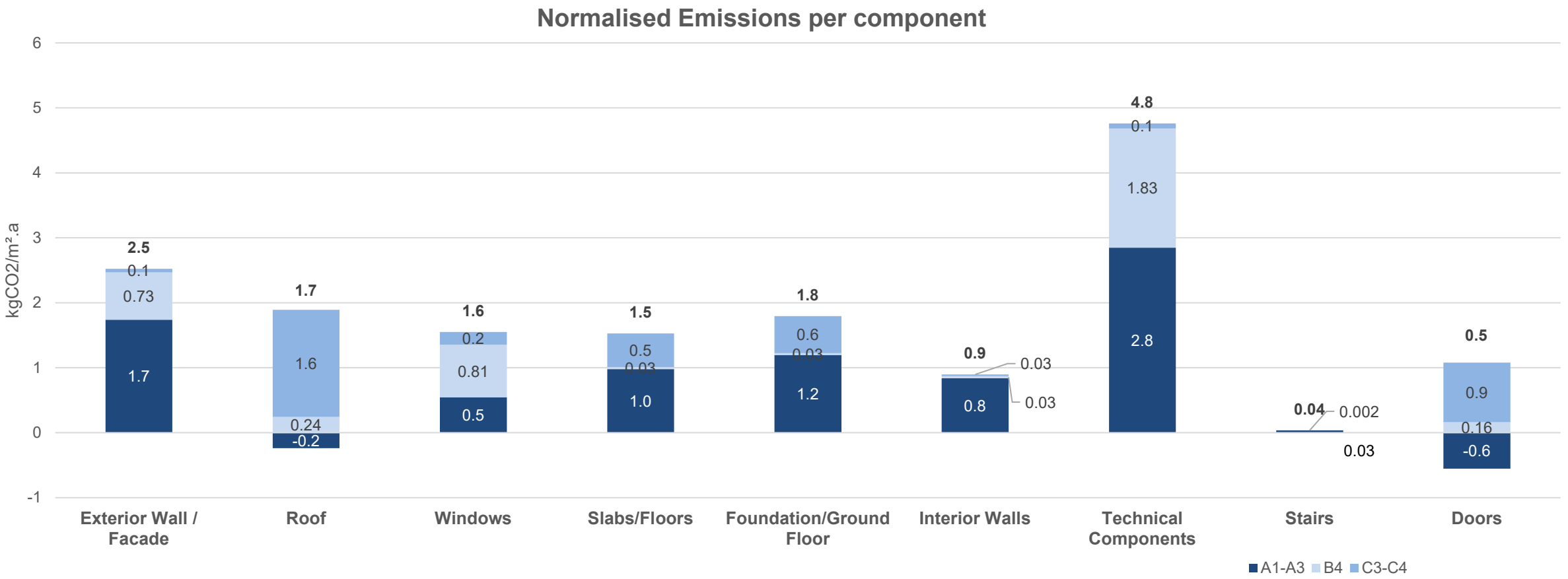
Embodied emissions per building component according to QNG

Here the largest components in the building are presented according to ist normalised emissions, subdivided into the phases of the life-cycle. Note that the obligatory value for the Technical Components (1.3kgCO2/m².a) is integrated into the phase A1-Ae3 of the element „Technical Components“.

The exterior walls comprise the structural parts and finishing.



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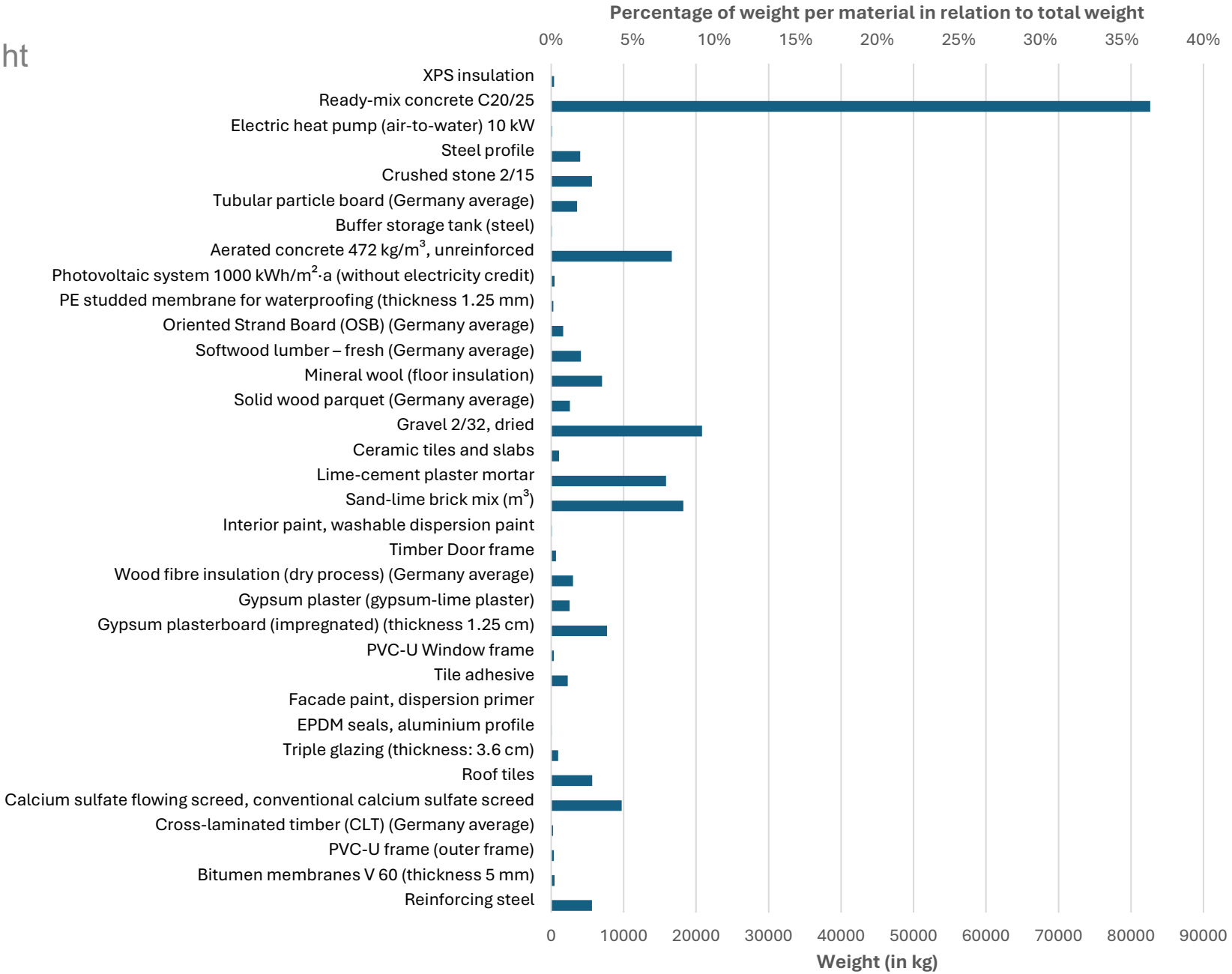
Contribution of each material in weight

This table arranges the construction elements considered in the calculation based on their weight and percentage representation.

It is evident from the table that concrete and its derivatives are the most prevalent materials used in the building.



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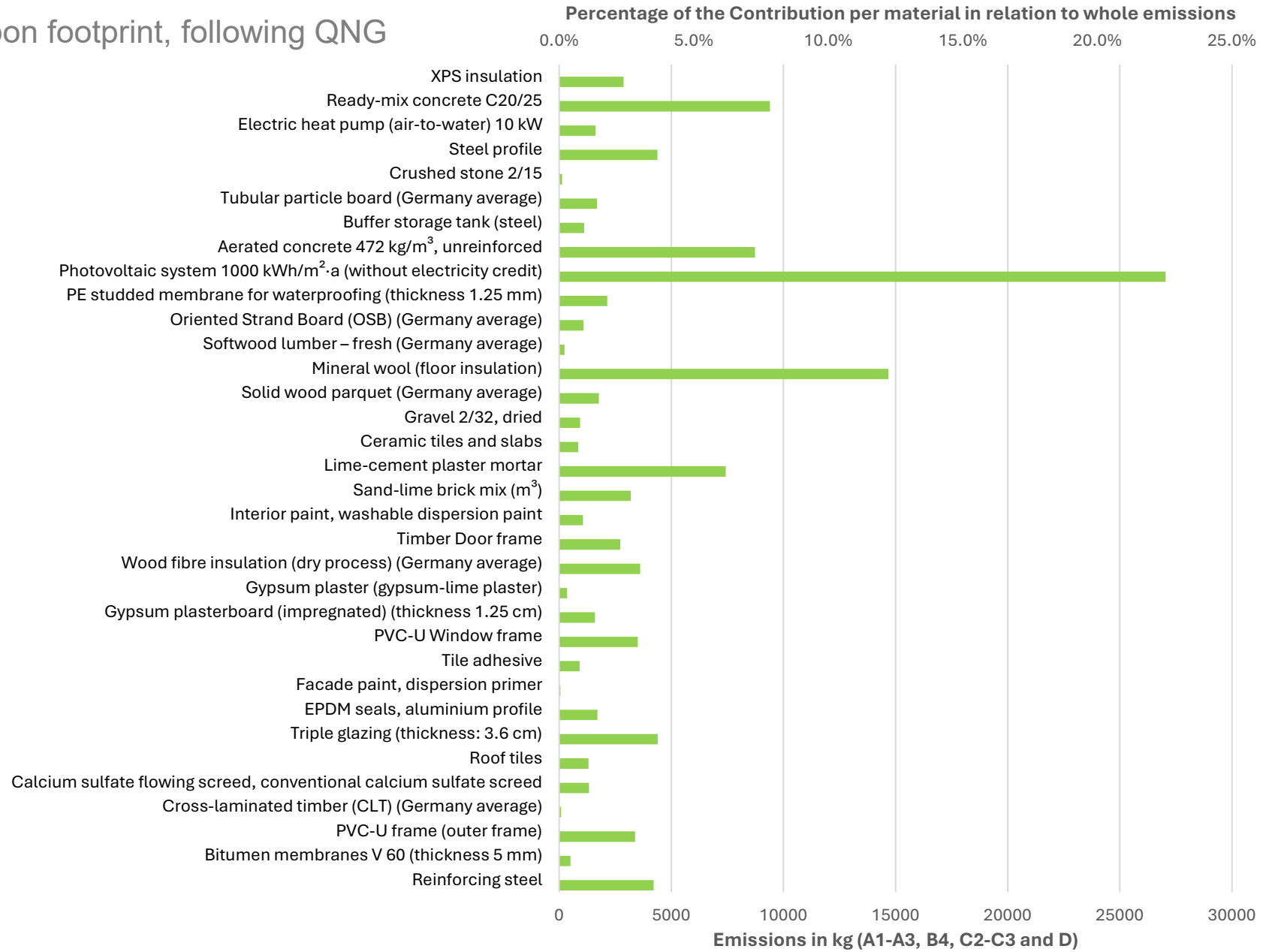
Contribution of each material in carbon footprint, following QNG

This table organizes the construction elements included in the calculation according to their embodied carbon emissions and their relative percentage contribution.

In contrast to the previous analysis, the results clearly show that the carbon footprint of materials varies significantly. Certain components, such as the photovoltaic system and mineral wool insulation, exhibit comparatively high total emissions despite their relatively low mass. In contrast, materials like concrete, although present in much larger quantities, contribute proportionally less to the overall carbon footprint.

This highlights that embodied emissions are not solely dependent on material quantity, but also strongly influenced by the emission intensity of each material.



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Energy Demand

This calculation was performed following the GEG Methodology, which is necessary for the fullfiment of the QNG requirements.

For both systems, a fixed value for User Energy (B6.3) is implemented according to the use. Here, for a unifamiliar house, the value of 20 kWh/m².a is integrated into the chart.

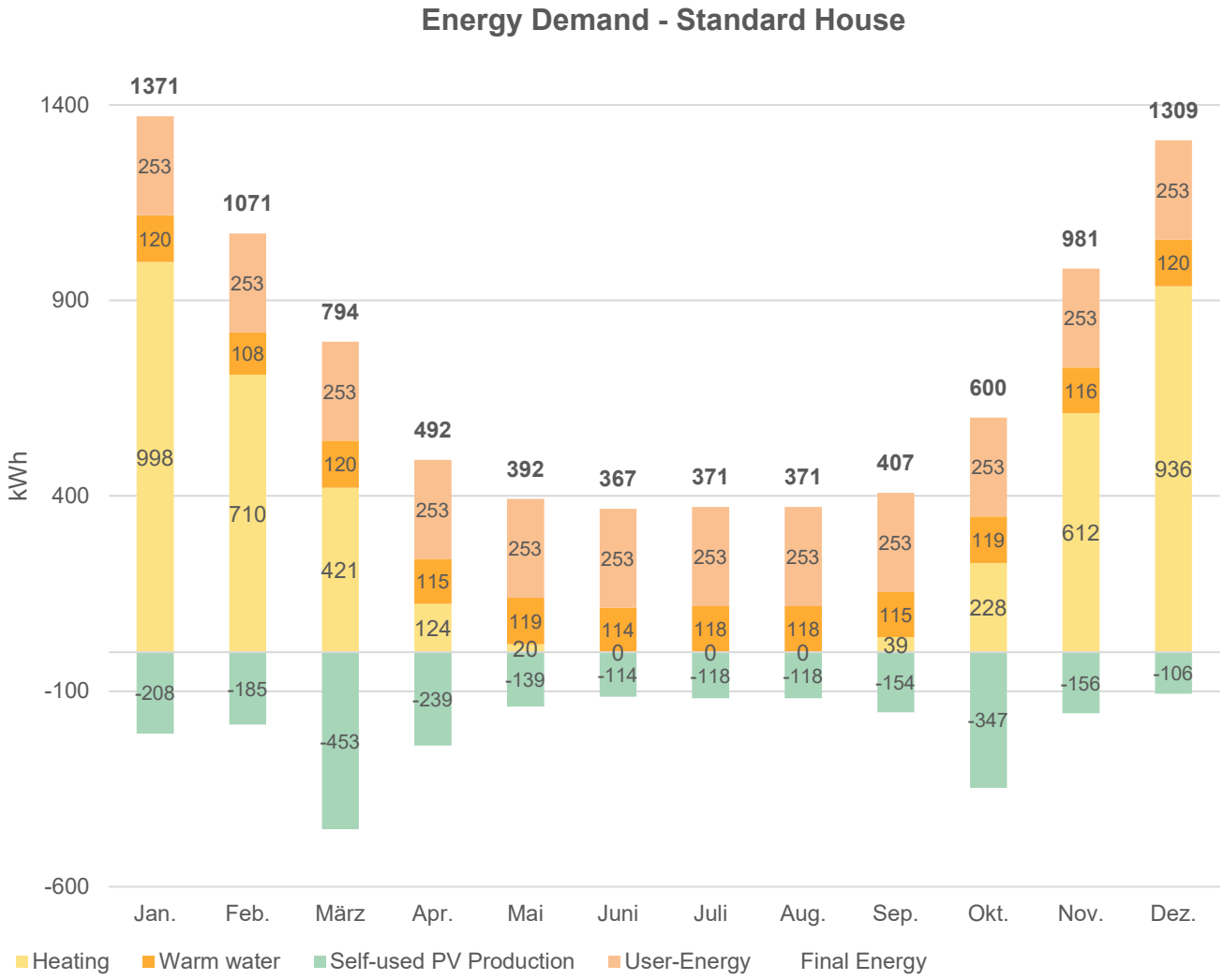
The demand for the Standard House is as expected higher in winter months. During the Summer, the PV produces enough energy

The high energy demand corresponds to the design directly:

- no heating recovery systems were implemented, increasing thus the general demand for heating,
- low energy production on site, through a small PV installed
- The warm water was generated solely through an electric descentralized system, thus increasing the grid-energy cosumption overall.

A summary of the renewable energy generated on site can be seen below:

Total generated energy: 2,337 kWh
Percentage of self-used generated energy: 39%



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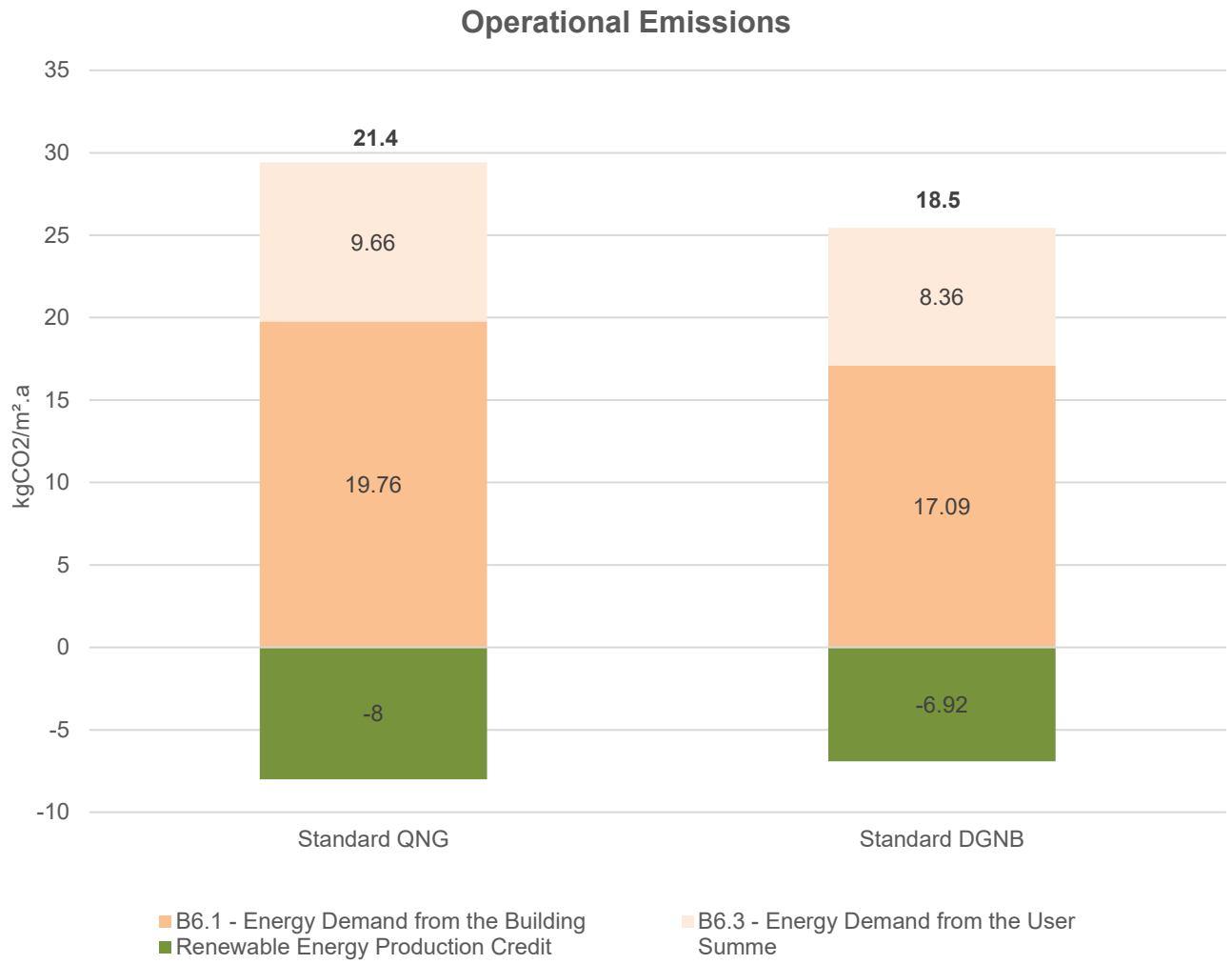
Energy Demand

Operational emissions differ according to the evaluation system, mainly because each system applies distinct carbon emission factors.

For the DGNB system, the electricity emission factor is derived from the German database Ökobau.dat version 2023, which assigns emissions of 0.465 kgCO2 per kWh.

On the other hand, the QNG system relies on the QNG database "Oekobilanzierung Rechenwerte 2023," attributing an emission value of 0.532 kgCO2 per kWh.

In both certification schemes, exported energy is excluded from the calculations, meaning, operational emissions cannot be lowered by accounting for energy fed back into the grid.



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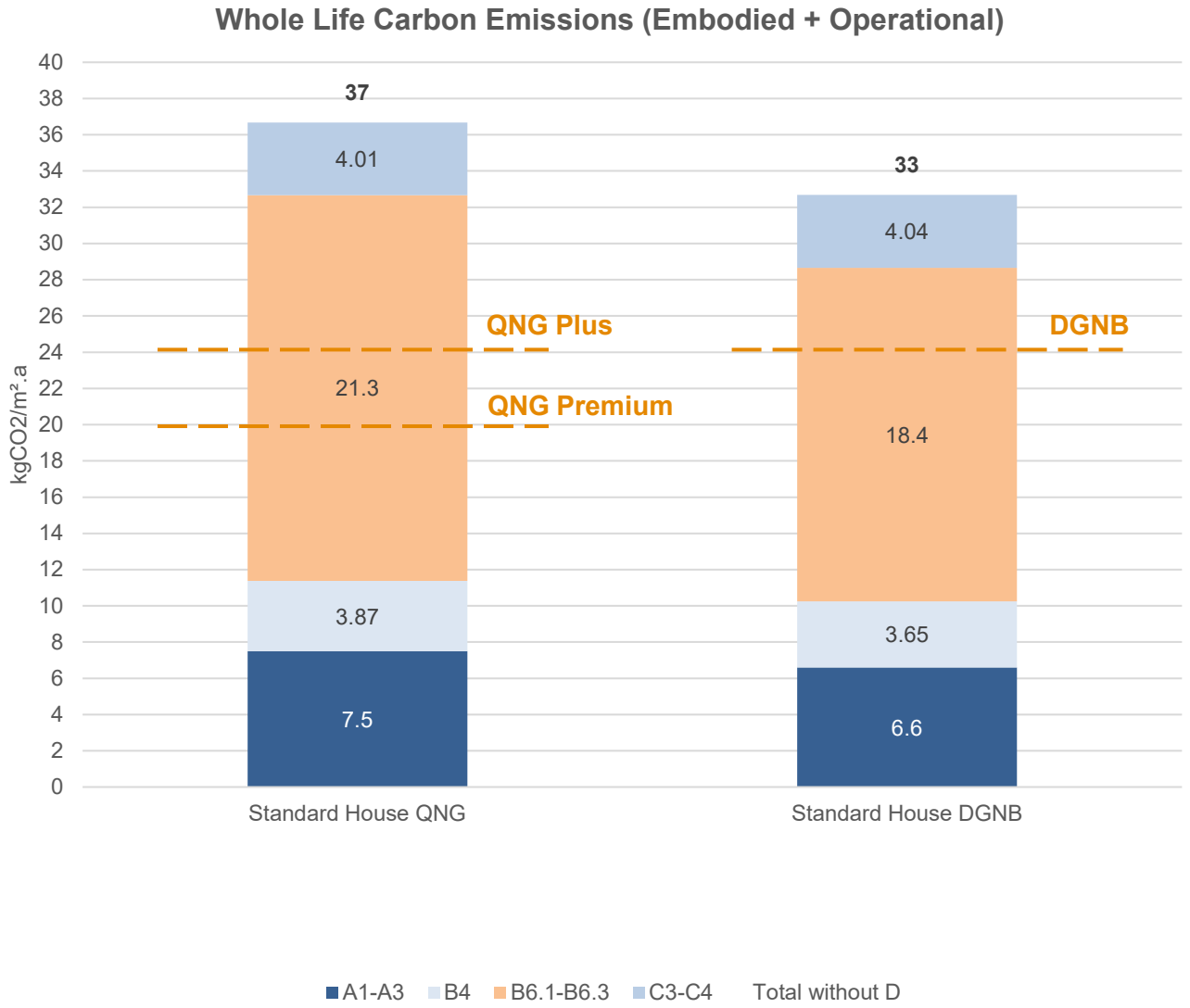
Whole Life Cycle Analysis

The findings indicate that, regrettably, the Standard House fails to meet the criteria of either evaluated system.
This outcome is unexpected, considering the selected construction materials and the absence of effective technical systems incorporated into the house.



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Inventory

Building parts	Area	Length	Thickness	Volume	Mass_	GWP_Total_	A1-A3	B4	C3	C4	D
Doors	**219.0**	**319.3**	**0.000**	**0.0**	**4247.8**	**4021.4**	**-4227.5**	**1241.9**	**7007.0**		**-1228.1**
Wooden door, exterior, frame	0.0	5.7	0.000	0.0	12.0	44.3	-0.8	22.2	23.0		-18.4
Wooden door, exterior, pane	4.6	0.0	0.000	0.0	75.1	32.3	-87.8	0.0	120.1		-4.2
Wooden door, interior, frame	0.0	313.6	0.000	0.0	661.7	2439.5	-46.2	1219.7	1266.0		-1010.6
Wooden door, interior, pane	214.4	0.0	0.000	0.0	3499.0	1505.3	-4092.6	0.0	5597.9		-194.9
External Walls	**1030.8**	**0.0**	**0.500**	**73.2**	**35285.5**	**19291.7**	**13301.6**	**5561.1**	**149.6**	**279.5**	**-34.9**
Exterior paint, scrub-resistant dispersion paint	147.3	0.0	0.000	0.3	14.7	53.9	13.3	40.4		0.2	-0.6
Lime-gypsum interior plaster	147.3	0.0	0.010	1.8	1325.3	217.5	197.6	0.0		19.9	
Aerated concrete block	147.3	0.0	0.240	35.3	16680.5	7979.0	7866.9	0.0	112.2		-34.3
Adhesive mortar	147.3	0.0	0.020	2.6	5301.0	2259.7	1050.3	1129.8		79.5	
Mineral wool	147.3	0.0	0.200	29.5	1362.1	4262.3	2073.0	2131.1	37.4	20.7	
Lime-cement plaster, base coat	147.3	0.0	0.020	2.2	5301.0	2259.7	1050.3	1129.8		79.5	
Lime-cement plaster, interior plaster	147.3	0.0	0.010	1.5	5301.0	2259.7	1050.3	1129.8		79.5	
First and second floor slab / 1OG und 2OG	**1522.3**	**0.0**	**0.350**	**43.2**	**44215.6**	**9854.4**	**5878.3**	**200.7**	**3705.7**	**69.8**	**-1615.4**
Gypsum plasterboard	253.7	0.0	0.020	1.6	2537.2	449.8	411.7	0.0		38.1	
Heated screed incl. underfloor heating	126.9	0.0	0.010	0.8	1141.7	142.3	126.7	0.0		15.6	
Impact sound insulation	126.9	0.0	0.040	5.1	431.3	697.9	679.5	0.0	11.8	6.6	
Interior paint, scrub-resistant dispersion paint	126.9	0.0	0.020	2.5	25.4	267.5	66.5	200.7		0.4	-1.1
Parquet flooring	126.9	0.0	0.020	2.5	1485.5	926.1	-1602.4	0.0	2528.6		-1133.3
PE foil	126.9	0.0	0.000	0.3	152.2	1044.6	518.7	0.0	525.9		-259.6
PU-based parquet adhesive	126.9	0.0	0.000	0.0							
Reinforced concrete ceiling slab	253.7	0.0	0.240	30.4	37598.3	5280.7	5043.9	0.0	236.8		-72.3
Service cavity (mineral wool, timber frame 40×60 mm, 625 mm spacing)	253.7	0.0	0.000	0.0	844.0	1045.3	633.5	0.0	402.6	9.2	-149.1
Floor Bathroom and Kitchen	**208.9**	**0.0**	**0.350**	**6.0**	**6450.0**	**1550.7**	**1342.5**	**27.5**	**161.5**	**19.1**	**-67.8**
Gypsum plasterboard	34.8	0.0	0.020	0.2	348.2	61.7	56.5	0.0		5.2	
Heated screed incl. underfloor heating	17.4	0.0	0.010	0.1	156.7	19.5	17.4	0.0		2.1	
Impact sound insulation	17.4	0.0	0.040	0.7	59.2	95.8	93.3	0.0	1.6	0.9	
Interior paint, scrub-resistant dispersion paint	17.4	0.0	0.020	0.4	3.5	36.7	9.1	27.5		0.1	-0.2
PE foil	17.4	0.0	0.000	0.0	20.9	143.4	71.2	0.0	72.2		-35.6
Reinforced concrete ceiling slab	34.8	0.0	0.240	4.2	5159.9	724.7	692.2	0.0	32.5		-9.9
Service cavity (mineral wool, timber frame 40×60 mm, 625 mm spacing)	34.8	0.0	0.000	0.0	115.8	143.5	86.9	0.0	55.3	1.3	-20.5
Tile adhesive	17.4	0.0	0.000	0.0	261.2	94.9	90.6	0.0		4.3	-0.7
Tiles	17.4	0.0	0.020	0.4	324.7	230.5	225.3	0.0		5.2	-0.9

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Inventory

Building parts	Area	Length	Thickness	Volume	Mass_	GWP_Total_	A1-A3	B4	C3	C4	D
Foundation / Fundamentplatte	**1034.0**	**0.0**	**0.790**	**74.6**	**80721.0**	**13719.9**	**9132.7**	**229.0**	**4175.2**	**183.1**	**-1776.0**
Bitumen waterproofing membranes	94.0	0.0	0.000	0.1	470.0	458.0	191.7	229.0		37.3	
Capillary break base layer	94.0	0.0	0.120	11.3	20868.0	847.2	694.1	0.0	153.1		-42.9
Gravel chippings	94.0	0.0	0.040	3.8	5640.0	120.8	82.9	0.0	37.9		-11.6
Heated screed + underfloor heating	94.0	0.0	0.060	5.6	8460.0	1054.5	939.1	0.0		115.4	
Impact sound insulation	94.0	0.0	0.060	5.6	479.4	775.7	755.3	0.0	13.1	7.3	
Parquet flooring	94.0	0.0	0.020	1.9	1100.7	686.2	-1187.4	0.0	1873.6		-839.8
PE foil	94.0	0.0	0.000	0.2	112.8	774.0	384.4	0.0	389.7		-192.4
PU-based parquet adhesive	94.0	0.0	0.000	0.1	1410.0	512.4	489.3	0.0		23.1	-4.0
Reinforced concrete floor slab	188.0	0.0	0.360	33.8	41789.0	5869.3	5606.1	0.0	263.2		-80.4
XPS insulation board	94.0	0.0	0.130	12.2	391.0	2621.8	1177.3	0.0	1444.5		-605.0
Internal Walls I	**150.0**	**0.0**	**0.200**	**7.3**	**13152.0**	**2228.4**	**2040.5**	**94.9**	**84.7**	**8.3**	**-26.4**
Interior paint, scrub-resistant dispersion paint	60.0	0.0	0.000	0.1	12.0	126.5	31.5	94.9		0.2	-0.5
Gypsum plaster	60.0	0.0	0.020	0.9	540.0	88.6	80.5	0.0		8.1	
Sand-lime Brick Mix	30.0	0.0	0.180	6.3	12600.0	2013.3	1928.5	0.0	84.7		-25.9
Internal Walls II	**160.0**	**0.0**	**0.220**	**8.8**	**2112.3**	**1551.4**	**1474.0**	**63.3**	**1.3**	**12.9**	**-280.4**
Gypsum plasterboard	80.0	0.0	0.040	2.0	800.0	141.8	129.8	0.0		12.0	
Interior paint, scrub-resistant dispersion paint	40.0	0.0	0.020	0.9	8.0	84.4	21.0	63.3		0.1	-0.3
Galvanized steel sheet as a U-shaped stud profile, 100 mm x 50 mm / Mineral wool insulation, 100 mm	40.0	0.0	0.160	5.9	1304.3	1325.2	1323.2	0.0	1.3	0.7	-280.1
Internal Walls III	**221.4**	**0.0**	**0.300**	**4.7**	**8247.5**	**1869.7**	**1733.0**	**58.4**	**38.1**	**40.2**	**-15.4**
Interior paint, scrub-resistant dispersion paint	36.9	0.0	0.000	0.0	7.4	77.8	19.3	58.4		0.1	-0.3
Tile adhesive	36.9	0.0	0.010	0.0	553.5	201.1	192.1	0.0		9.1	-1.6
Tiles	36.9	0.0	0.090	1.4	688.2	488.6	477.4	0.0		11.1	-1.8
Gypsum plaster	73.8	0.0	0.020	0.4	1328.4	196.2	176.2	0.0		19.9	
Sand-lime Brick Mix	36.9	0.0	0.180	2.8	5670.0	906.0	867.8	0.0	38.1		-11.6
Internal Walls IV	**128.7**	**0.0**	**0.230**	**5.4**	**1677.8**	**1201.0**	**1166.1**	**20.6**	**0.9**	**13.5**	**-183.4**
Gypsum plasterboard	39.0	0.0	0.030	0.9	390.0	69.1	63.3	0.0		5.9	
Interior paint, scrub-resistant dispersion paint	13.0	0.0	0.020	0.5	2.6	27.4	6.8	20.6		0.0	-0.1
Liquid waterproofing (polyurethane or SMP)	24.7	0.0	0.000	0.1							
Tile adhesive	13.0	0.0	0.010	0.0	195.0	70.9	67.7	0.0		3.2	-0.6
Tiles	13.0	0.0	0.010	0.2	242.5	172.1	168.2	0.0		3.9	-0.7
Galvanized steel sheet as a U-shaped stud profile, 100 mm x 50 mm / Mineral wool insulation, 100 mm	26.0	0.0	0.160	3.7	847.8	861.4	860.1	0.0	0.9	0.5	-182.1

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Transsolar Energietechnik GmbH | Balanstrasse 73, Haus 7 | 81541 Munich | Germany
Transsolar Inc. | 220 E. 23rd St. Suite 403 | New York, NY 10010

Standard German House | LCA

Inventory

Building parts	Area	Length	Thickness	Volume	Mass_	GWP_Total_	A1-A3	B4	C3	C4	D
KG400	**40**	**0**	**0**	**0**	**702.3**	**27201.**	**12606**	**14016.3**	**88.6**	**489.7**	**-3998.4**
Heat pump (air-water) 10 kW	0.0	0.0	0.000	0.0	134.0	1480.1	459.0	986.7	30.1	4.3	-724.6
Hot water tank	0.0	0.0	0.000	0.0	88.3	1015.1	279.8	676.8	58.6		-377.7
Sunpower Maxeon 3	40.0	0.0	0.000	0.0	480.0	24705.8	1187.4	12652.9		485.5	-2896.1
Roof	**1258.0**	**0.0**	**0.570**	**56.8**	**20858.3**	**12631.0**	**-1822.5**	**1847.4**	**12509.7**	**96.5**	**-7870.9**
Gypsum plasterboard	251.6	0.0	0.020	1.6	2516.0	446.1	408.3	0.0		37.8	
Interior paint, scrub-resistant dispersion paint	125.8	0.0	0.000	0.3	25.2	265.3	66.0	199.0		0.4	-1.1
OSB Boards	125.8	0.0	0.020	1.9	1660.6	989.2	-1714.2	0.0	2703.4		-692.3
Rafters (160 x 80 mm), center-to-center spacing 625 mm / Insulation 160 mm (e.g., mineral wool)	251.6	0.0	0.000	0.5	3230.3	2504.8	375.6	0.0	2106.6	22.7	-919.0
Wood fiber insulation board	125.8	0.0	0.160	20.1	3034.5	3296.7	-3145.7	1648.4	4794.0		-4991.5
Mineral wool (80%)	125.8	0.0	0.220	27.7	2352.5	3806.4	3706.1	0.0	64.5	35.7	
Counter-battens (30 x 50 mm, center-to-center spacing 625 mm / rear ventilation layer	0.0	0.0	0.110	0.0	1.6	0.1	-1.8	0.0	1.9		-0.9
Support battens (30 x 50 mm, center-to-center spacing 280 mm)	125.8	0.0	0.030	3.5	2376.7	124.2	-2699.9	0.0	2824.1		-1256.4
Concrete Roof Tile	125.8	0.0	0.010	1.3	5661.0	1198.2	1183.1	0.0	15.1		-9.8
Slab structural	**0.0**	**0.0**	**0.000**	**1.6**	**1975.8**	**277.5**	**265.1**	**0.0**	**12.4**		**-3.8**
Reinforced concrete beams	0.0	0.0	0.000	1.6	1975.8	277.5	265.1	0.0	12.4		-3.8
Windows	**32.7**	**368.2**	**0.000**	**0.0**	**1744.5**	**11860.7**	**4165.7**	**6189.8**	**1317.5**	**187.6**	**-2250.0**
Windows, PVC, fixed frame	0.0	127.2	0.000	0.0	356.2	3095.4	1049.5	1547.7	498.2		-821.4
Windows, PVC, movable frame	0.0	113.8	0.000	0.0	352.7	3199.6	1051.4	1599.8	548.4		-780.2
Windows, triple glazing	32.7	0.0	0.000	0.0	981.0	4008.9	1889.2	2004.5	99.2	16.1	-91.9
Windows, insulation EPDM membrane	0.0	127.2	0.000	0.0	54.7	1556.8	175.7	1037.9	171.7	171.6	-556.5
Stairs	**0.0**	**0.0**	**0.000**	**1.6**	**1975.8**	**277.5**	**265.1**	**0.0**	**12.4**		**-3.8**
Reinforced concrete	0.0	0.0	0.000	1.6	1975.8	277.5	265.1	0.0	12.4		-3.8

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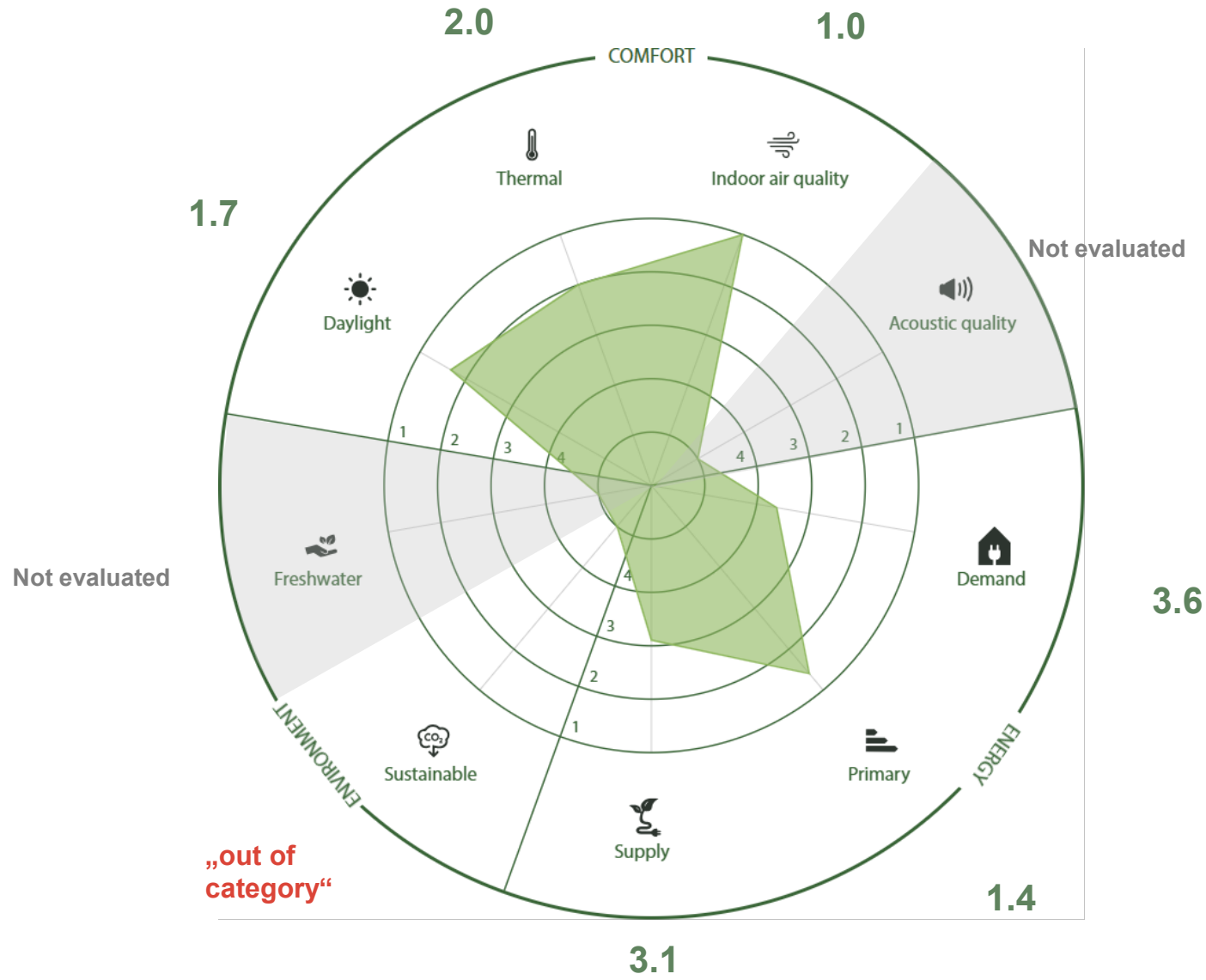
Active House Radar & conclusions

Active House Radar

Standard House results

STANDARD HOUSE



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