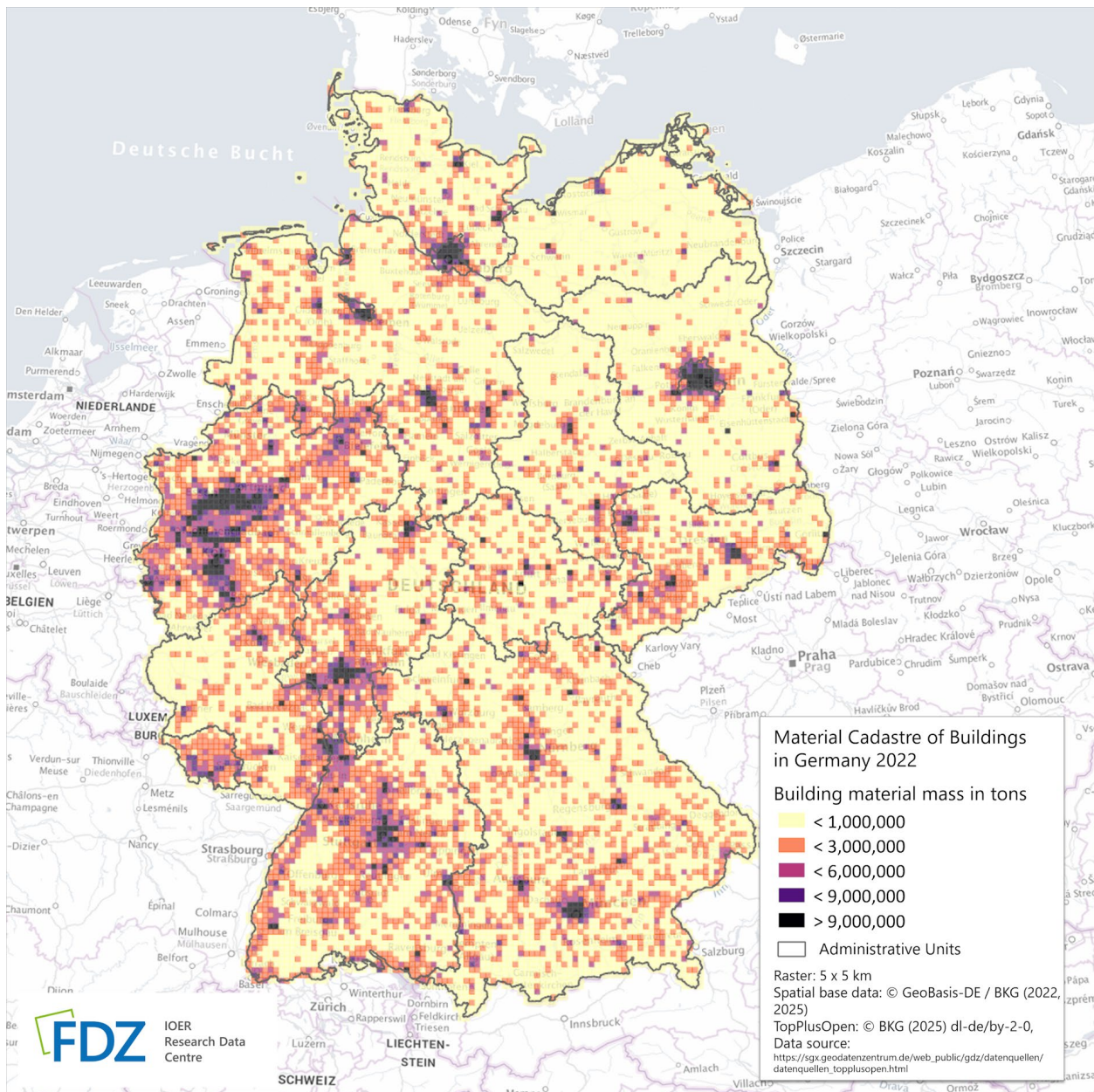


–Documentation of the dataset– Material Cadastre of Buildings in Germany 2022



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–Documentation of the dataset– Material Cadastre of Buildings in Germany 2022

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Keywords

building, building typology, circularity, circular construction, building material, material stock, global warming potential

Summary

The dataset provides building material indicators for the German building stock in 2022. This includes the quantities of building materials and their global warming potential for 44 and 11 material groups, respectively. The results are provided as geodata (GeoPackage) on the level of buildings, administrative units (status: 2022), and geogrid.

The data were calculated at building polygon level using the "3D Building Metrics Germany 2022" (3DBM-DE). This data set is derived from the official "3D building models for Germany in Level of Detail 2 (LoD2-DE)" and provides building footprint geometries with geometric attributes.

Methodical background is a building typology approach that is used for a characterization of the building stock in order to summarize buildings with comparable geometric patterns, building constructions, and structural characteristics in order to provide the interlinkage to the type-related building material indicators. For this purpose, we use the building function, derived by the 3D building dataset (LoD2-DE), to differentiate the non-residential building stock and a complex geometric approach to differentiate residential buildings in single-/two-family and multi-family houses.

When using the data, it should be noted that –due to the type-based approach– the information provided on the individual buildings will differ significantly from the materials actually used in the building. Targeted data aggregation of the building-related dataset is essential for a meaningful and appropriate interpretation of the data.

1 Dataset overview

1.1 Content

File Inventory

The root folder provides the README/LIESMICH files in English and German as well as the folder "data" and "other". The folder "data" contains the data, organized according to the spatial/geometric basis (three subfolders).

The folder "data" contains:

→ The subfolder "adm" includes aggregated results related to administrative units

→ The subfolder "bfp" includes the results on building footprint level

→ The subfolder "grd" includes aggregated results related to grid cells

The folder "others" provides the cover image and the documentation of the dataset.

```

├─ data
│   ├─ adm
│   │   ├─ matcad2022_de_adm2022_mps1.gpkg
│   │   │   Layer: → mun_Mat1, mun_Gwp1
│   │   │   → dst_Mat1, dst_Gwp1
│   │   │   → fst_Mat1, fst_Gwp1
│   │   │   → fed_Mat1, fed_Gwp1
│   │   └─ matcad2022_de_adm2022_mps2.gpkg
│   │       Layer: → mun_Mat2, mun_Gwp2
│   │       → dst_Mat2, dst_Gwp2
│   │       → fst_Mat2, fst_Gwp2
│   │       → fed_Mat2, fed_Gwp2
│   └─ bfp
│       ├─ matcad2022_de-xx_bfp_mps1.gpkg (16 files)
│       │   Layer: → Mat1, Gwp1
│       └─ matcad2022_de-xx_bfp_mps2.gpkg (16 files)
│           Layer: → Mat2, Gwp2
│   └─ grd
│       ├─ matcad2022_de_grd_mps1.gpkg
│       │   Layer: → grd0500_Mat1, grd0500_Gwp1
│       │   → grd1000_Mat1, grd1000_Gwp1
│       └─ matcad2022_de_grd_mps2.gpkg
│           Layer: → grd0500_Mat2, grd0500_Gwp2
│           → grd1000_Mat2, grd1000_Gwp2
└─ other
    ├─ matcad2022_de_documentationDE.pdf (documentation German)
    ├─ matcad2022_de_documentationEN.pdf (documentation English)
    └─ matcad2022_de_cov-img.png
    
```

Attributes and Abbreviations

All attributes used are listed in the "Appendix" of this document, except for the building typology abbreviations. These are explained in the chapter 2.2.

1.2 Technical specifications

Time status of the dataset

Building stock: 2022

Administrative units: 2022

Spatial extent

Germany, terrestrial territory without maritime areas, without Lake Constance and without the German-Luxembourg condominium.

Spatial structures

Buildings: Building footprints (2D)

Administrative units: Municipalities, Districts and district-free cities, Federal states, Federation

Geogrid: (500 x 500 Meter, 1000 x 1000 Meter)

Language

German/English. All names and nominations within the data files are given in English, except geographical names (data column: GEN). However, the "README"/ "LIESMICH" file and the documentation are provided in English and German.

Data formats and data volume

All data files are provided as GeoPackage database (.gpkg). The files are zipped separately (.zip) in order to optimize storage space requirements and to ensure a selective download. It should be noted that the materiality of the buildings is provided as a set of 44 material groups ('mps1') and in a summarized variant based on 11 material groups ('mps2'). The data sets otherwise have the same content. Depending on the level of detail required, it is recommended to select and to use one of the two variants - 'mps1' or 'mps2'.

Table 1 Data volume

Filenames	Uncompressed volume	Compressed volume (.zip)
matcad2022_de_adm_mps1	0.47 GB	0.24 GB
matcad2022_de_adm_mps2	0.47 GB	0.23 GB
matcad2022_de_grd_mps1	1.7 GB	0.45 GB
matcad2022_de_grd_mps2	1.3 GB	0.3 GB
matcad2022_de-xx_bfp_mps1	Σ of 16 files: 59.5 GB	Σ of 16 files: 19.7 GB
matcad2022_de-xx_bfp_mps2	Σ of 16 files: 43.8 GB	Σ of 16 files: 15.9 GB

Georeferencing

Based on the spatial extension and the context, the data are provided in different geo projections, listed in the table.

Table 2 Georeferencing of the geodata files

Basis	Spatial extension of the files	Georeferencing Projection
adm	Germany	ETRS 1989 UTM Zone 32N (EPSG:25832)
bfp	Federal states of Germany, Prj-West	ETRS 1989 UTM Zone 32N (EPSG:25832)
bfp	Federal states of Germany, Prj-East	ETRS 1989 UTM Zone 33N (EPSG:25833)
grd	Germany	ETRS 1989 LAEA (EPSG:3035)

→ Federal states, Prj-West¹: SH, HH, NI, HB, NW, HE, RP, BW, BY, SL, ST, TH

→ Federal states, Prj-East¹: BE, BB, MV, SN

¹ Abbreviations are based on ISO-3166-2-Codes for the federal states of Germany (here: without federation code (DE_))

2 Methods

2.1 Data source

Geodata: Building footprints

The 3DBM-DE data set provides the main data basis for the description of the building stock. This dataset uses the 3D building model of LoD2-DE for the year 2022 and provides 2D building footprints and a set of geometric parameters supporting the further geodata processing.

The dataset comprises a total of 56,377,167 objects. 4,781,009 objects are assigned to constructions. Further 829 objects have no defined building function. These belongs to –as already mentioned in the 3DBM-DE dataset description– to silos (51003_1201) and tanks (51003_1205). In addition, 114 objects were identified that exist twice or refer to the same real object. These objects were removed from the dataset. As a result of mapping the objects, 51,595,215 objects are identified as buildings, that are considered and processed within the material cadastre.

Table 3 Overview about the objects within the dataset 3DBM-DE

Sum of objects	constructions	removed objects	Objects without attribution of the building function	buildings
56.377.167	4.781.009	114	829	51.595.215

Geodata: Administrative Units VG25 (adm2022)

To evaluate the material cadastre information at the level of administrative boundaries, the official municipality key from the VG25 dataset (as at 31.12.2022) was first added via a spatial join. It shows that the building datasets divided by federal states contain some polygons that belong to the neighboring federal states. When aggregating the building material information to the administrative units, the common AGS key ensures correct allocation of the buildings to the corresponding administrative units.

Geodata: Coordinates of buildings (in German: Hauskoordinaten HK-DE)

Some row standing buildings in the LoD2-DE/3DBM-DE geodata set, are mapped as one building complex without specifying a boundary between the individual buildings. This means that the geometric characteristics of the individual buildings get lost. However, the characteristic is required to differentiate the residential building stock in single/two-family and multi-family houses. Therefore, the coordinates from the data set HK-DE were used as an auxiliary variable to determine the number of buildings within a building complex and thus to obtain average geometric characteristics for the individual building.

Grid cells: GeoGrids INSPIRE (GeoGitter INSPIRE)

The dataset provides aggregated results based on grid cells with resolution: 500 x 500 m and 1000 x 1000 m. The chosen INSPIRE-compliant grid serves as a linkage to the European spatial data infrastructure and supports the interoperability of the geodatabase.

2.2 Building typology

For modeling the material cadastre, a typological approach was used that combines buildings into groups which are comparable in terms of building construction and spatial patterns and thus provide the linkage to type-related data and information. The “building function” attribute (bldg_function) –provided by the LoD2-DE / 3DBM-DE dataset– was used as basis to typified the national wide building stock.

The building function attribute offers a wide range of features. However, the degree to which these are used varies from country to country. For this reason, we have created specific, hierarchically structured sets of building types and assigned them to the corresponding federal states in order to make the best possible use of the available differentiations (see Table 5 and the signatures of the building types in Table 4).

In addition, we have developed a complex geometric filter to differentiate building function, with a focus on the residential buildings. Based on the parameters of building volume, building floor area and building height, we allocate one/two-family and multi-family houses.

The building typology derived for the material cadastre is aimed at a nationwide modeling of materiality with a uniform overall methodological approach. However, the building typology achieved in this way is not yet able to depict regional building stock characteristics. For regional material flow analyses, it should be checked whether further detailed data, field surveys, and hot spot analysis can be used to refine the provided information.

Table 4 Building types and related signatures

Sig	Description
SFH	Single family houses
MFH	Multi family houses
PUB	Public buildings
IHO	Industry/handcraft/others
OFC	Offices, administrative buildings
HSN	Hospitals and sanatoriums
ONR	Other non-residential buildings
TRD	Trade buildings
HOT	Hotels and restaurants
PRO	Factories/workshop buildings
STG	Storage buildings
NAS	Other non-agricultural service buildings
ASB	Agricultural service buildings

Table 5 Set of building types and their allocation to the federal states according to the scope of the "Building functions" attribute used.

Set	Building typology					Federal States	
	Residential		Non-residential buildings				
BtySet2	SFH	MFH	PUB			IHO	SN
BtySet3	SFH	MFH	OFC	HSN	ONR	IHO	BY, RP, ST
BtySet4	SFH	MFH	OFC	HSN	ONR	TRD, HOT, PRO, STG, NAS, ASB	BB, BE, BW, HB, HE, HH, MV, NI, NW, SH, SL, TH

2.3 Material indicators

The material indicators used here are based on a life cycle-related and consistent consideration of material flows, which integrates the extraction of raw materials, their use as building materials up to waste management and recycling (source material for secondary materials) and considers the resulting emissions. The raw materials are derived from recipes (the classification of raw material categories is based on common classifications in national and regional raw material planning). The waste categories resulting from demolition are determined related to the Waste Classification List (AVV). The material-induced emissions (grey emissions) are determined by linking them with environmental impact data from "Ökobaudat".

Building material groups

Building-type-specific material indicators are used, based on a detailed, technical analysis of characteristic buildings, in order to derive building type-specific material indicators through appropriate weighting. The underlying building material classification distinguishes 44 building material groups that subsume individual building materials. The dataset also offers a summarized version with 11 building material groups to provide a more concise overview of the information.

Global Warming Potential (GWP)

According to the building material, material-induced emissions (grey emissions) were determined, which are primarily based on life cycle assessment data from the Ökobaudat database (time status: August 6, 2024, compliant with DIN EN 15804+A2). The Global Warming Potential (GWP) is used that indicates the amount of CO₂ equivalent generated during the production process (Modules A1-A3) considering the given energy mix. Overall, the greenhouse gas potential was thus mapped for over 96% of the material quantities.

Analyse

The material cadastre was calculated at building polygon level. Depending on the building type, the building volume provided by the 3DBM-DE data set is multiplied with the type-specific material indicators that refers to the gross volume of the buildings. Beside the fact that the building volume of the 3DBM-DE data set neglect the underground parts of the building, it is assumed that the "above ground" building volume corresponds approximately to the gross volume of the building types. The results are given in tons and rounded to three decimal figures at the building polygon (rounding to kg). This does not correspond to the accuracy to be interpreted. However, it ensures comparability between the results at building level and the aggregated results at grid and administrative level.

3 Further Information

Website of the BKG (Federal Agency for Cartography and Geodesy) <https://gdz.bkg.bund.de/index.php/default/3d-gebaudemodelle-lod2-deutschland-lod2-de.html>

Documentation of the official 3D building models for Germany (only in German) https://sg.geodatenzentrum.de/web_public/gdz/dokumentation/deu/LoD2-DE.pdf

External Code List from the ALKIS-OK enumerating the values for building and structure functions <http://repository.gdi-de.org/schemas/adv/citygml/Codelisten/BuildingFunctionTypeAdV.xml>

4 Access and Terms of Use

Recommended Citation

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Source References

Münzinger, Markus, 2025, "3D Building Metrics Germany 2022 (<https://doi.org/10.71830/GVN-GUA>), ioerDATA, V1.

Gruhler, Karin; Griebßbach, Ulrike, 2025, "Material indicators for building types in Germany", ISBE - IOER Information System Built Environment, (<https://ioer-isbe.de/en/>), topicality: 2018.

Bundesamt für Kartographie und Geodäsie, Amtliche Hauskoordinaten Deutschland (HK-DE), (<https://gdz.bkg.bund.de/index.php/default/amtliche-hauskoordinaten-deutschland-hk-de.html>), topicality: 2022-04, Spatial base data: © GeoBasis-DE / BKG (2022)².

Bundesamt für Kartographie und Geodäsie, Verwaltungsgebiete VG 25 (administrative units), (<https://gdz.bkg.bund.de/index.php/default/digitale-geodaten/verwaltungsgebiete/verwaltungsgebiete-1-25-000-stand-31-12-vg25.html>), topicality: 31.12.2022, Spatial base data: © GeoBasis-DE / BKG (2022)².

Bundesamt für Kartographie und Geodäsie, GeoGitter Inspire, (<https://gdz.bkg.bund.de/index.php/default/digitale-geodaten/nicht-administrative-gebietseinheiten/geographische-gitter-fur-deutschland-in-lambert-projektion-geogitter-inspire.html>), Spatial base data: © GeoBasis-DE / BKG (2025)².

5 Contact

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² Spatial base data: © GeoBasis-DE / BKG (2022, 2025)

Terms of Use: https://sg.geodatenzentrum.de/web_public/nutzungsbedingungen.pdf

6 Appendix

Core attributes

Table 6 Core attributes and its mapping in relation to the geometric base

Name	Units	Description	bfp	adm	grd
bldg_gmlid	-	building key	x	-	-
OBJID	-	object key	-	x	x
AGS	-	official municipality key	x	x	-
GEN	-	geographical name (in German)	-	x	-
NUTS	-	europa statistics key (2016), NUTS 3	-	x	-
area_km2	km ²	area of the reference geometry	-	x	x
bldg_area	m ²	(Sum of) ground floor area	x	x	x
bldg_volume	m ³	(Sum of) building volume above ground	x	x	x
bldg_cnt	-	quantity of buildings	-	x	x
bldg_function	-	building function	x	-	-
BtySetID	-	key for the selected set of building types	x	-	-
BtyID	-	key of the building type	x	-	-
BtySig	-	signature of the building type	x	-	-
Mat_Sum	tons	total mass of building materials	x	x	x
Mat_	tons	prefix representing further 'Mat'-indicators	x	x	x
Gwp_Sum	tons	total mass of CO ₂ equivalents	x	x	x
Gwp_	tons	prefix representing further 'Gwp'-indicators	x	x	x

It should be mentioned here that the attributes "bldg_gmlid", "OBJID", "AGS" reflects the official and unique identifier of the used data sources.

Attributes of material indicators: Mat1/ Gwp1, Mat2/Gwp2

Please note that all signatures used as column header start with the prefix Mat_ or Gwp_ for clear differentiation of the table content. In addition to the prefix, the signatures of the parameter set "mps1" always comprise six letters and "mps2" 3 letters.

Table 7 List of 11 building material groups (Mat2/Gwp2)

Sig2	Description
Con	Concrete
Bri	Burnt clay bricks, clay roof tiles
Min	Other mineral building materials
Wod	Wood, wood-based materials
Rnw	Other renewable materials
Pla	Plastics
Btm	Bituminous minerals
Fem	Ferrous metals
Nfe	Non-ferrous metals
Slb	Sand lime bricks
Cal	Calcareous mortar and screeds

Table 8 List of the 44 Building material groups (Mat1/Gwp1)

Sig1	Sig2	Description (Sig 1)
ConNrm	Con	Normal concrete
ConLgt	Con	Lightweight concrete
BriBrt	Bri	Building bricks (burnt bricks)
Brilns	Bri	Building bricks with insulation
ClyRcv	Bri	Roof covering: clay roof tiles
CalMrt	Cal	Calcareous plaster mortar
AnhMrt	Min	Plaster and mortar containing gypsum and anhydrite
LoaMrt	Min	Clay and loamy plaster and mortar
SynMrt	Min	Plasters with synthetic components
CalScr	Cal	Calcareous screeds
AnhScr	Min	Screeds containing gypsum and anhydrite
AnhDsc	Min	Dry screed containing gypsum and anhydrite
SynScr	Min	Screeds with synthetic components
SlmBri	Slb	Sand-lime bricks
AcnBlc	Min	Aerated concrete blocks
ConBlc	Con	Concrete blocks
MudBri	Min	Mud bricks / Adobe bricks
GpsPlb	Min	(Gypsum) plasterboards
MinCnb	Min	Mineral construction boards
MinIns	Min	Mineral thermal insulation materials
ConRcv	Con	Concrete roof tile covering
FcmRcv	Min	Fiber cement roofing
SlrRcv	Min	Slate cover
OrgSbs	Min	Substrate layer (green roof)
MinFil	Min	Mineral fillings
MinGls	Min	Glass
NatStn	Min	Natural bricks
MinOth	Min	Other mineral building materials
TmbSwn	Wod	Sawn timber/Lumber
WodPrc	Wod	Processed wood
RnwIns	Rnw	Renewable thermal insulation materials
StrRcv	Rnw	Straw/Reed cover
RnwOth	Rnw	Other materials from renewable resources
HcbIns	Pla	Petroleum-based thermal insulation materials
PlaRcv	Pla	Plastic roofing
HcbRcv	Pla	Petroleum-based coverings, geomembranes
BtmRcv	Btm	Bitumen roofing
BtmMem	Btm	Bituminous coverings, waterproofing membranes
FemRcv	Fem	Metal roofing
FemOth	Fem	Ferrous metals
NfeAlm	Nfe	Coverings containing aluminum, sealing membranes
NfeAlu	Nfe	Aluminium
NfeCpr	Nfe	Copper
NfeOth	Nfe	Other non-ferrous metals