DGNB
Deutsche Gesellschaft für Nachhaltiges Bauen
German Sustainable Building Council

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GUIDE TO CLIMATE POSITIVE BUILDING STOCK

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You can find further information and downloads relating to the Guide online at: **www.dgnb.de/wegweiser**

For better readability, CO_2 is used as a simplified indication of the measure of CO_2 equivalents in the context of this publication.

The DGNB Guide to Climate Positive Building Stock - an invitation to all people involved with buildings to get started.

If we are serious about our actions to curb the climate crisis, each and every one of us should leave no stone unturned in the crucial next few years and lead by example. Our successes will inspire others to follow suit and quickly spark a major movement. Any failures we may experience can be avoided by others if we talk about them. That's why we should use platforms for serious exchange, get involved, get smart and immediately scale what works - in terms of CO_2-reduction - as far as possible in our areas of impact.

This Guide is an opportunity for many stakeholder groups to gain inspiration and guidance for climate-crisis-appropriate action. However, not only the stakeholder groups named in the list of measures "Our path to climate positive building stock - part 2" are called upon to take immediate and continuous action, and thus all members of the DGNB, but also the DGNB organisation itself, because the objective of climate positive building stock can only be achieved together.

Demonstrate your serious commitment by embracing our objectives and implementing effective measures.

The effects of climate change are already reality for many people today and they will affect everyone in the future. Stabilising the climate is the major task of this decade. On the one hand, this requires rapid, far-reaching measures in all sectors that lead to an immediate reduction in greenhouse gas emissions. It is also essential that we adapt our societies to the changes in climate. In addition, we must maintain and build effective carbon sinks. All this is necessary and there is no alternative. And because we, as stakeholders in the construction and property industry can do it, the common objective is one that we must achieve as quickly as possible: climate positive building stock.

The "Guide to Climate Positive Building Stock" consists of three parts.

OUR PATH Part 1

In the basic document **"Our common path - part 1"**, the common starting point (see Chapter 4) is shown based on the political framework and an analysis of the building sector. Also highlighted are specific measures for various stakeholders that have an immediate and large effect on the climate goal (see Chapter 5). The necessary assistance for climate positive construction, operation and renovation is also outlined (see Chapter 6).

OUR PATH Part 2

"Our common path - part 2" includes a comprehensive list of measures to achieve climate positive building stock for all stakeholders concerned.

MY CONTRI-BUTION

In the stakeholder-specific programmes of measures shown under **"My contribution"**, the measures for individual stakeholders are listed as well as set out with specific envisioned targets.

www.dgnb.de/wegweiser

1 Our common objective: climate positive as soon as possible!

> Global warming of 1.5°C and 2°C will be exceeded during the 21st century unless deep reductions in carbon dioxide and other greenhouse gas emissions occur in the coming decades.
>
> *IPCC (2022b)*

The sixth and most recent Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) makes it clear once again that our actions in the coming decades will be critical to preventing an increase in global warming. The consequences affect all of humanity: Increases in heat extremes, heavy rainfall, droughts, and tropical cyclones, as well as declines in permafrost, Arctic sea ice, and snow cover are just a few examples.[1]

In order to limit global warming to 1.5°C, global greenhouse gas emissions must start falling by 2025 at the latest and be reduced by 43 percent by 2030.[2] The pathway that limits warming to 2°C also foresees greenhouse gas emissions peaking in 2025.[3] The decisions and actions taken now and in this decade are critical to maintain stable livelihoods for humanity and the basis for a secure, peaceful and worthwhile future for younger generations and those that follow.

> We are at a crossroads. The decisions we make now can secure a liveable future. We have the tools and know-how required to limit warming.
>
> *IPCC Chair Hoesung Lee, IPCC (2022), press release Apr 4*

To limit warming to 1.5°C or at least to 2°C, rapid and deep GHG emission reductions are needed in all sectors.[4] As a major contributor to GHG emissions, stakeholders in the construction and property industry (see Chapter 4.2) also have an obligation to take measures that are compatible with climate goals. According to the IPCC, all existing buildings, if retrofitted, and buildings yet to be built, can approach net zero GHG emissions in 2050 if appropriate measures are taken.[5] These include sufficiency, efficiency, and renewable energy measures and the removal of decarbonisation barriers. **Because it is necessary and there is no alternative, and because we can, the objective we must achieve as soon as possible is: climate positive building stock.** "Virtually climate neutral" would be nowhere near ambitious enough to have a relevant, positive impact on climate action. The technologies and knowledge are there, the potential is enormous, the cost of waiting would be greater than the cost of implementing, so now the stakeholders in the construction and property industry have to want it and do it.

There is still time to achieve the climate goals. But following must now apply to all: Act now, remove barriers now, collaborate now.

[1] Cf. IPCC (2022a), p. 1. | [2] Cf. IPCC (2022a), p. 22. | [3] Cf. IPCC (2022a), p. 22. | [4] Cf. IPCC (2022a), p. 4. | [5] Cf. IPCC (2022a), p. 5.

Act now

Anyone who considers the individual costs and individual risks and contrasts the options of "wait and see" vs. "act now" already comes to the conclusion that "act now" is the more favourable and less risky option - regardless of whether they are a municipality, construction company, manufacturer of construction products, planner, builder, owner or waste disposal provider.

The costs and risks arising from the "wait and see" option are manifold. On the one hand**, climate-related damage and damage costs**, e.g. due to floods, storms and heavy rainfall, must be factored in.[6] Also, **damage to the health of** the residents can become a problem due to poor thermal insulation and, as a result, overheating of the interiors.[7] Heat stress also worsens indoor air quality by releasing hazardous substances or causing mould spores to multiply.[8]

Construction companies and designers run the risk of being held **liable for damage** that occurred due to foreseeable climatic changes.[9] Extreme weather events can also lead to delays in construction, with corresponding increases in costs.[10] This is also accompanied by health hazards on construction sites due to strong winds, heavy rain as well as heat and the associated drop in performance, which can lead to interruptions in construction.[11]

Furthermore, rising CO_2 prices and levies required according to legislation must be expected. Loss of reputation due to a lack of climate action measures can also lead to lower revenues, less cooperation or, in the case of a municipality, a lack of attractiveness. The last point to mention is a lack of ability to service the market, as there is an increasing market demand for low-carbon and climate-friendly products and solutions.[12] It is essential that each and every individual implements effective measures today and now on a "small" scale, i.e. in every project, every design and purchasing decision. At the same time, it is important to prioritise preparatory measures that will result in large-scale changes as quickly as possible.

Remove barriers now

If barriers stand in the way of implementing measures, or if barriers are perceived, these must now be clearly identified and dealt with. Barriers can exist, for example, in processes, in one's own company, in one's own attitude or in the attitude of other stakeholders, in the procurement of information or in terms of qualifications. Existing barriers need to be worked on and removed.

Potential barriers can also be due to missing, insufficient or wrong framework conditions. Therefore, this document also sets clear requirements for national and municipal policy makers. The regional level can likewise set an example for the national level and implement ambitious measures in advance. The Baden-Württemberg Climate Protection Act (Klimaschutzgesetz) can be taken as an example here, which, for example, sets out an obligation to install photovoltaic systems for power generation on roof surfaces when constructing new buildings or in case of substantial roof replacements.[13] But an enormous amount can also be achieved at the city level if objectives and measures are tailored to the appropriate situations. For example, much can be learned from the decision-makers in the City of Freiburg.

[6] UBA (2011), p. 21. | UBA (2011), p. 21. | [8] UBA (2011), p. 72. | [9] UBA (2011), p. 21. | [10] UBA (2011), p. 21. | [11] UBA (2011), p. 72. | [12] Agora Industrie, p. 5. | [13] UM BW (2022).

Collaborate now

Buildings and districts connect a wide variety of stakeholders and many sectors. Therefore, it is essential to work together to achieve the individual and the common objectives. The aim is to break the "circle of blame" (see Fig. 1), remove obstacles, join forces and jointly develop new business models or adapt existing ones to make them climate-friendly.

In 2020, according to the 'Deutscher Startup Monitor' report, over 43 percent of products and also services can be assigned to the "green economy".[14] The year before, the figure was 36 percent.[15] New start-ups in 2020 also show the same trend. 21 percent of start-ups in Germany are considered green because they make a specific contribution to climate and environmental protection.[16] The number of green start-ups in Germany is around 6,000.[17]

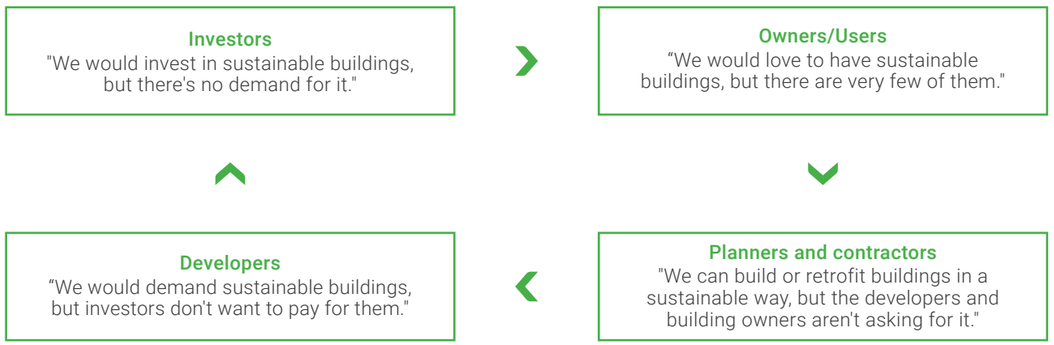


Fig. 1 | The Vicious Circle of Blame, Source: own illustration, based on: Cadman, D. (2007)

In a nutshell:

Without further hesitation and waiting, **take immediate climate action**.

Remove existing **barriers to** climate-related action **as quickly as possible**.

Strengthen collaboration among stakeholders for rapid implementation of climate-friendly solutions.

[14] Cf. BDS, PwC (2022), p. 41. | [15] Cf. BDS, PwC (2022), p. 41. | [16] Cf. Olteanu, Fichter (2020), p. 2. | [17] Cf. Olteanu, Fichter (2020), p. 13.

This DGNB Guide to Climate Positive Building Stock was developed by the German Sustainable Building Council, DGNB e.V., as part of the European #BuildingLife joint project in 2021 and 2022 with the broad participation of active members of the association and external experts. The #BuildingLife campaign was launched by the World Green Building Council in the run-up to the UN Climate Change Conference (COP26) with financial support from the IKEA Foundation, the Laudes Foundation and the European Climate Foundation.

The core of the campaign is the creation of national decarbonisation roadmaps, i.e. roadmaps or guides with the aim of driving forward climate action in the building sector in order to achieve climate neutrality for the construction, renovation, and operation of buildings. These roadmaps have been prepared by ten Green Building Councils within Europe for their countries in 2021 and 2022. In addition to this, the World Green Building Council published an "EU Policy Roadmap" in May 2022[18]. Accordingly, at the heart of the #BuildingLife campaign there is a call for national governments and the European Commission to support bold and ambitious policies that take into account GHG emissions over the entire lifecycle of a building and bring them to net zero.[19]

The DGNB's contribution to the #BuildingLife campaign consists of several elements, summarised in the **DGNB Guide to Climate Positive Building Stock**.

"OUR PATH to climate positive building stock

OUR PATH
Part 1 and 2

Part 1: Basic knowledge of the status quo of the policy level and building stock. Derive strategic objectives and action areas and identify key measures to achieve climate positive building stock that will not tolerate further delay.

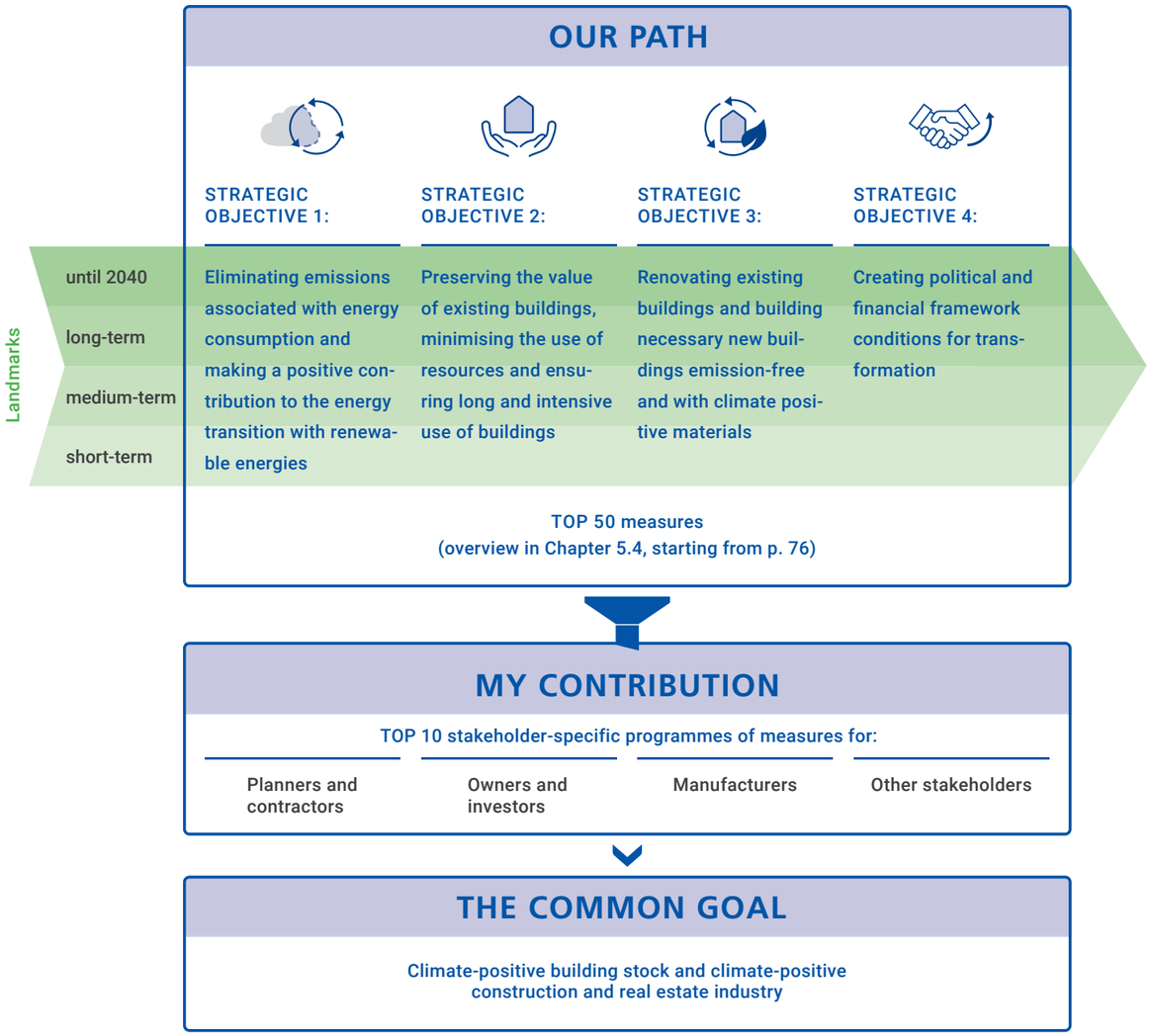
Part 2: Comprehensive collection of measures for the path to climate positive building stock. In addition to the most important measures, other, less urgent, preparatory and information-providing measures are listed here, which will only take effect later. These measures should also be implemented to achieve full alignment of the building sector towards climate neutrality or climate positivity.

"MY CONTRIBUTION to climate positive building stock."

MY CONTRIBUTION

Stakeholder-specific programmes of measures with specific envisioned targets.

[18] See World Green Building Council (2022): EU Policy Whole Life Carbon Roadmap. | [19] For more information on the project #BuildingLife and the work of DGNB, please refer to www.dgnb.de/buildinglife.



A common language definitions and glossary 3

To ensure that all stakeholders have the correct understanding of key terms used in the DGNB Guide, basic definitions are given in this chapter. A common language is important so that all stakeholders have the same understanding of the objective of climate positive building stock. Only together, with all parties pulling in the same direction, will this objective be achievable.

Term	Definition
Carbon neutrality and climate neutrality	According to the Federal Climate Change Act (Bundes-Klimaschutzgesetz) in the version of 2019, the term 'carbon neutrality' refers to a situation where anthropogenic CO_2 emissions from sources are balanced by removals of such gases by sinks. The term 'climate neutrality', on the other hand, "is a state in which human activities have no net effect on the climate system. These activities include climate-changing emissions, actions aimed at removing greenhouse gases from the atmospheric cycle, and human-induced activities that have regional or local biogeophysical effects [...]."[20] "[...] the objective of climate neutrality requires a different and more ambitious policy than the objective of carbon neutrality, since all other effects of human action on the climate must be taken into account in addition to greenhouse gas emissions [...]." [21] The term "carbon neutral" therefore refers to an offset of emissions, whereas "climate neutral" includes the further effects on the climate. In linguistic usage, in politics, and in the construction and property industry, the term "climate neutral" is predominantly used for conditions that should actually be called "carbon neutral."
Carbon neutral in operation and use / climate neutral operated buildings	If a balanced state between greenhouse gas emissions and carbon sinks from the operation and use of buildings is achieved over a defined period of time, we can speak of "carbon neutral operation and use" of buildings. The DGNB uses the term "climate neutral operated buildings" to refer to a condition of building-related and user- and occupancy-related greenhouse gas emissions of energy expenditure that is mathematically balanced over a period of one year. The offset can be achieved between actual greenhouse gas emissions and avoided greenhouse gas emissions according to the definition of the DGNB. The avoidance of greenhouse gas emissions can be calculated mathematically via energy generated at the building or close to the building and exported in surplus for external use via an average or a specific quantity of correspondingly "displaced", non-climate neutral generated energy. According to the DGNB, the difference between the amount of greenhouse gas emissions emitted by the operation and use of a building and the amount of greenhouse gas emissions avoided by "CO_2-free" energy generated at the building and supplied externally over a one-year period is zero or less than zero.[22]

[20] UBA (2021), p. 1. | [21] UBA (2021), p. 1 et seq. | [22] Cf. DGNB (2020a), p. 8.

Term	Definition
Building-related / embodied / grey emissions	Construction materials, products and systems for the construction or modernisation of buildings as well as defined scenarios for the further life cycle, i.e. the building-related maintenance and modernisation processes, and scenarios for the "end of life" (post-use phase) can be determined with the help of life cycle greenhouse gas balances or life cycle assessments with the use of the "global warming potential" (GWP) indicator. The sum of these greenhouse gas emissions related to the building is often also referred to as the "grey," "embodied," or "material-bound emissions," or (misleadingly) as the "grey energy." The technical basis for the determination is DIN EN 15978, which has been interpreted and elaborated in detail by the DGNB certification system for buildings (see criterion "Building life cycle assessment - ENV1.1" of the DGNB) and which allows a modular statement of emissions. It makes sense to differentiate the emissions according to the point in time of the emissions in order to be able to build or renovate as quickly as possible in a carbon-reduced or carbon-neutral manner with regard to the urgency of the task. For this reason, the term "upfront emissions" is increasingly used to describe the emissions of life cycle modules A1 to A5 (manufacture and installation).
Life cycle greenhouse gas emissions from buildings	When analysing greenhouse gas emissions from buildings, the entire life cycle should be considered. Lifecycle greenhouse gas emissions are the collection and summation of all emissions that occur from raw material extraction, production and construction, through operation and use with maintenance, to the post-use phase and the potential positive and negative impacts outside the system's own boundary.
Climate positive buildings	When it comes to the climate action contribution of buildings, one can argue whether neutral is already good enough. In the balancing approach described, the concept of neutrality is synonymous with the mathematical target value of zero as a minimum requirement. If we move away from the purely balance sheet-based view, "neutral" only inadequately expresses what the buildings that are already operated in a climate neutral manner today actually do: make a positive contribution to climate action. Climate positive buildings actively contribute to the climate and energy transition by avoiding more CO_2 emissions than they cause. The DGNB gives an award for "climate positive buildings" which, in addition to proven carbon neutral operation, places further requirements on energy use.[23]

[23] Cf. DGNB (2020a), p. 8.

Term	Definition
Climate neutral building life cycle / carbon neutral over life cycle	If the sum of the life cycle greenhouse gas emissions of buildings is zero or less than zero, we could consequently speak of a carbon neutral life cycle. Currently, this condition is only possible if credits "occurring outside the direct system boundaries of the building", e.g. via the overproduction of energy, are calculated to have a positive effect in the surrounding energy system and displacement occurs. The faster the surrounding energy system moves to a low to net-zero CO_2 emission state, the smaller the effect of displacement. In the longer term, it will be increasingly possible to achieve a "climate neutral building life cycle" via the provision and consistent accounting of carbon sinks and stores. See also “Carbon sinks and stores” below. (see Fig. 2).[24]

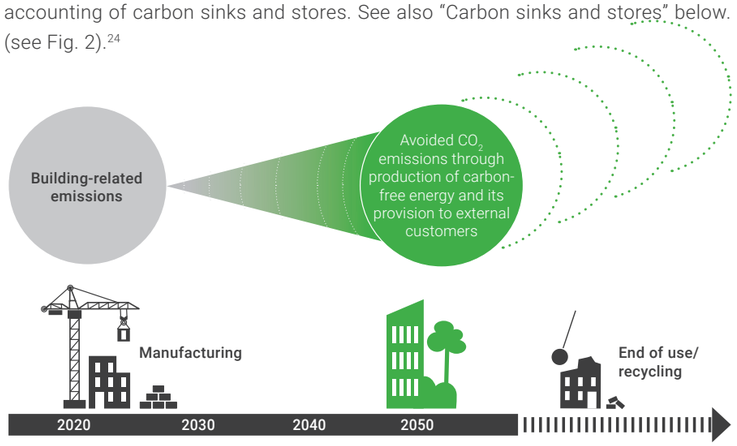


Fig. 2 | Compensation of building-related greenhouse gas emissions during building operation
Source: DGNB (2020a), p. 9.

Carbon sinks / Carbon stores	Carbon sinks are natural reservoirs of carbon that can absorb CO_2 released by mankind from the atmosphere and store it for a certain period of time. Such natural carbon storage mediums are soils, peatlands, forests or even oceans, for example. However, the amount of CO_2 emitted by mankind corresponds to many times the storage capacity of natural carbon sinks. There are also technical processes for carbon capture and storage (CCS) and carbon capture and utilisation (CCU). In the former, CO_2 is stored in underground reservoirs. The latter allows subsequent use of the carbon compounds. This requires various processes and process steps, which are associated with energy and resource consumption. Neither method is currently established and there are technical risks. In the future, technical processes for carbon sinks and stores will play a greater role, especially in the construction sector, since long technical utilisation periods are a good prerequisite for storage in incorporated construction products.

[24] Cf. DGNB (2020a), p. 10, buildings that are demonstrably operated in a climate neutral manner based on their real consumption data can receive the DGNB "Climate Positive" award.

Term	Definition
Climate action roadmap	The building-specific climate action roadmap is a tool that helps to systematically pave the way for buildings to become climate neutral or climate positive. It is the basis for effective, low-risk climate action management of real estate. In this context, the climate action roadmap is the result of analyses of various scenarios for achieving climate action goals in the specific context of a building. It describes in detail, over a specifically defined time horizon, the measures that are sensible and necessary to continuously reduce a building's greenhouse gas emissions in a targeted manner without exceeding a defined decarbonisation path. The individual decarbonisation path results from linking the baseline situation and an externally specified target year (currently 2045). The property-specific defined target year, on the other hand, should be set as ambitiously as possible. A good basis for creating a climate action roadmap is an individual renovation roadmap.[25]

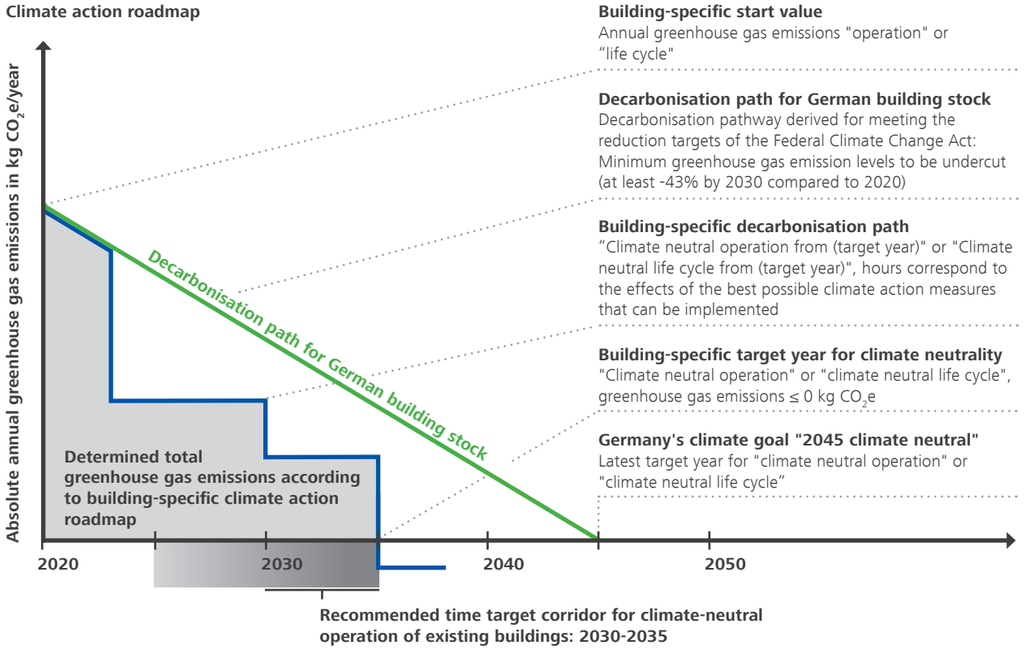


Fig. 3 | DGNB Climate Action Roadmap, source: DGNB (2022)

[25] Cf. DGNB (2020a), p. 20.

This chapter provides an overview of the key regulatory framework at national level in Germany and at EU level that are of interest to the building sector. In addition, an insight into the main sources of greenhouse gas emissions in the German building sector is provided and the status quo of the building stock is shown. The last section in this chapter presents a compilation of developments in the building sector.

4.1 OBJECTIVES AND POLICY FRAMEWORK

Climate positive building stock and a climate positive construction sector are critical to achieving national as well as international climate goals and commitments. Since annual figures for target values change constantly with new findings, it is important not to remain fixated on a target year once it has been set, but to adjust target years and target values in an agile manner according to current findings. However, there should be consensus that all measures that can be taken to put Germany, the EU and the world on the path to climate neutrality more quickly must be implemented as soon as possible.

Below, the most important strategies, legal regulations and programmes of the German sustainability policy (4.1.1) and the sustainability policy of the European Union (4.1.2) are shown.

4.1.1 GERMANY

The **German Sustainable Development Strategy (GSDS)** reflects the Sustainable Development Goals of the United Nations (Agenda 2030[26]) and translates them into a national strategy. The 2030 Agenda consists of 17 Sustainable Development Goals (SDGs) with 169 associated targets for sustainable development in the economic, social and environmental spheres. The Federal Government has determined six Principles for Sustainable Development in its Sustainable Development Strategy. These include assuming global responsibility, strengthening the natural resource base on which life depends, preserving and enhancing social cohesion and strengthening sustainable economic activity. Germany has had a national sustainability strategy since 2002; it has been further developed and adapted since then. The 2021 update introduces new indicators and includes areas of transformation to a greater extent, among other things. Areas of transformation include, for example, the circular economy, sustainable building, as well as the transformation of transportation.

The requirements of sustainable building include energy efficiency, climate neutrality, reduction in land area used, preservation of biodiversity, resource conservation and respect for human rights in supply chains.[27]

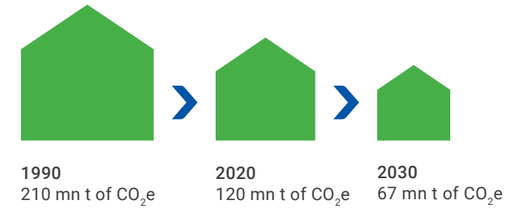


Fig. 4 | Targets buildings Federal Climate Change Act
Source: based on: Federal Government (2021b)

Germany has committed to achieving carbon neutrality across all sectors by 2045 under the **2021 Federal Climate Change Act.**

[26] You can find out more about Agenda 2030, the Sustainable Development Goals and the work of the DGNB in our report "Building for a better world". | [27] Cf. Federal Government (2021c), p. 14 et seqq.

Other milestones include reducing greenhouse gas emissions by 65 percent from 1990 levels by 2030 and by 88 percent by 2040 (see Fig. 4).[28] Negative emissions are targeted from the year 2050.[29] In the buildings sector, the Climate Change Act stipulates a reduction of two-thirds in emissions compared with 1990 levels by 2030.[30] These savings are to be achieved through the replacement of heating systems, tax incentives for energy-efficient building renovations, and energy consulting.[31]

In order to achieve the climate goals of the Federal Climate Change Act, specific measures are necessary and must be financed. Over 80,000 million euros have already been earmarked for climate action investments across sectors in the past two years. The Immediate Climate Action Programme for 2022, which was adopted in 2021, provides over 8,000 million euros to finance additional measures. At 5,500 million, the building sector receives the largest share of the funding (see Fig. 5). The aim is to promote the energy-efficient renovation of residential buildings, the renovation of social housing and climate-friendly new construction by 2025. Accordingly, the Federal Funding

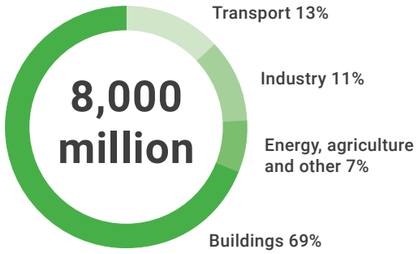


Fig. 5 | Distribution Immediate Climate Action Programme
Source: BMU (2021)

for Efficient Buildings programme (Bundesförderung für effiziente Gebäude, BEG) will be topped up with funding. In the industrial sector, the steel industry, among others, will be supported in switching over to hydrogen. 95 million will be provided to support the energy sector in the expansion of heating networks and expand the national hydrogen strategy.[32] The national carbon footprint for 2021 once more exceeded the building sector's targets by about 2 million metric tonnes of CO_2 equivalent (million t CO_2e) and thus failed to meet them. Therefore, a new immediate programme is to be expected.[33]

CLIMATE ACTION PROGRAMME 2030

Measures in the building sector:

- Tax relief for energy-efficient renovation
- Replacement premium for oil heating systems
- Funding for serial renovation
- Urban energy renovation
- Energy consulting and public relations
- Further development of the energy standard
- Climate action through urban redensification
- Further development of the innovation programme ‘Zukunft Bau’
- Energy Efficiency Strategy 2050 (EffSTRA)
- Federal Funding for Efficient Buildings (BEG)

Fig. 6 | Climate Action Programme 2030, building sector
Source: BMF (2019)

Under the **Climate Action Programme 2030**, measures are set to achieve the 2030 climate goals. General objectives represent the reduction of CO_2 emissions, higher mandatory and environmental standards, CO_2 pricing and monitoring of climate goals.[34] The measures in the building sector are listed in Fig. 4.

The Federal Government considers the **Federal Funding for Efficient Buildings (BEG)** to be a key component in achieving climate goals for the building sector. This was launched on 1 January 2021. As of 1 July 2021, sustainable construction is now also eligible for funding to a much greater extent under the "Energy-efficient Construction and Renovation" programme. Residential buildings (BEG WG), non-residential buildings (BEG NWG) and individual measures (BEG EM) can be funded.[35]

In this context, the BEG scheme includes funding programmes promoting energy efficiency, the use of renewable energy sources in buildings, the use of new or the optimisation of existing HVAC systems, and the optimisation of the building envelope.[36] In addition, parts of the technical planning and construction supervision of the measures can be subsidised.[37] Measures implemented as part of an individual renovation roadmap also receive a 5 percent grant subsidy[38]. The individual renovation roadmap itself is also subsidised by up to 80 percent[39]. Within the framework of an individual renovation roadmap, the actual and target state is listed according to the implementation of the measures or work packages. In addition, energy costs, final energy, primary energy, and greenhouse gas emissions are reported in both states.[40] As part of the new construction subsidy, since 21 April 2022, applications can only be submitted for projects that meet the KfW Efficiency House 40 standard with sustainability class or the KfW Efficiency Building 40 standard with sustainability class (status: 21 April 2022).[41] The prerequisite is the Sustainable Building quality seal. Buildings with a DGNB certification receive an additional funding bonus (sustainability bonus).[42]

In addition to public funding, the Federal Government defines the German **Buildings Energy Act (GEG)** as a key regulatory instrument. The Buildings Energy Act replaces the Energy Saving Ordinance (Energieeinsparverordnung, EnEV), the Energy Conservation Act (Energieeinsparungsgesetz, EnEG) and the Act on the Promotion of Renewable Energies in the Heat Sector (Erneuerbare-Energien-Wärmegesetz, EEWärmeG) as of 1 November 2020. The law specifies HVAC technology and thermal standards for both new and existing buildings. One requirement for new buildings is that certain values of annual primary energy demand and heat loss through the building envelope are not exceeded. In addition, new construction projects must be covered by a certain percentage of renewable energy sources or compensatory measures must be taken. In the case of existing buildings, the GEG places particular requirements on the degree of thermal permeability of building components. There are also individual retrofit and replacement obligations relating to insulation and heating systems, as well as the decommissioning of old boilers. In addition, from 2026, new installation of oil and coal boilers will be prohibited. Furthermore, stricter due diligence requirements apply to energy performance certificates in order to improve their quality. For example, the CO_2 emissions of a building must be stated. The GEG will be reviewed for the first time in 2023; thus, there may be further increased requirements, such as taking grey energy into account (meaning the limitation of life cycle greenhouse gas emissions).[43]

Energy performance certificates have been mandatory for new buildings or extensively renovated buildings since the Energy Saving Ordinance came into force in 2002.[44] In 2009, the scope was expanded to include new leases, as well as sales and leases of existing buildings. A distinction can be made between energy requirement certificates (Bedarfsausweis) and energy consumption certificates (Verbrauchsausweis). New buildings usually require an energy requirement certificate. For existing buildings, the owner may choose between energy requirement and energy consumption certificate.[45]

The Federal Ministry for Economic Affairs and Climate Action (BMWK) envisages a GEG amendment as part of the so-called "summer pact" in 2022. A draft bill is already available, which envisages raising the standard for new buildings to the Efficiency House 55 (EH-55) standard and, from 2025, a new building standard of EH-40. Other aspects of the Federal Government's coalition agreement are also to be set out in the GEG. In particular, a solar roof obligation and the requirement of 65 percent renewable heat in new heating systems, which will apply from 2024, should be mentioned here. In connection with the increase in energy standards, the requirements system is also to be adjusted and will include CO_2 emission savings in the future. In addition, a more comprehensive efficiency parameter is to be integrated into the insulation requirement.[46]

In the **coalition agreement** of the Federal Government elected in 2021, consisting of the Social Democratic Party (SPD), Alliance 90/The Greens (Bündnis 90/Die Grünen)

[28] Cf. BMUV (2021). | [29] Cf. BMUV (2021). | [30] Cf. Federal Government (2021b). | [31] Cf. Federal Government (2021b). | [32] Cf. BMF (2022). | [33] Cf. UBA (2022g). | [34] Cf. BMWK (2022a). | [35] Cf. BAFA (n.d.).

[36] Cf. BAFA (n.d.). | [37] Cf. BAFA (n.d.). | [38] Cf. KfW (2022). | [39] Cf. BMJV (2020). | [40] Cf. BAFA (2020). | [41] Cf. KfW (2022). | [42] For more information on BEG funding in the context of a DGNB certification, please visit: www.dgnb.de/beg. | [43] Cf. BMUV (2022); cf. UM BW (2020). | [44] Cf. EPREU (2002). | [45] Cf. dena (2018). | [46] Cf. Bundestag (2022), p. 1 et seqq.

and the Free Democratic Party (FDP), the expansion of renewable energies and grid expansion is seen as a central project. 80 percent of the gross electricity demand in 2030 of 680-750 terawatt-hours is expected to be supplied by renewables. To cope with the grid expansion, the subsidy under the Renewable Energies Act and, for example, long-term power purchase agreements (PPAs) and trading in guarantees of origin are envisaged. [47]

4.1.2 EUROPEAN UNION (EU)

The fundamental climate goal of the European Union and its Member States is to achieve the target agreed in the **Paris Agreement** adopted at the Paris Climate Change Conference (COP21) to limit global warming to 2°C as well as undertaking to make efforts to limit the increase to 1.5°C (see Fig. 7).[48]

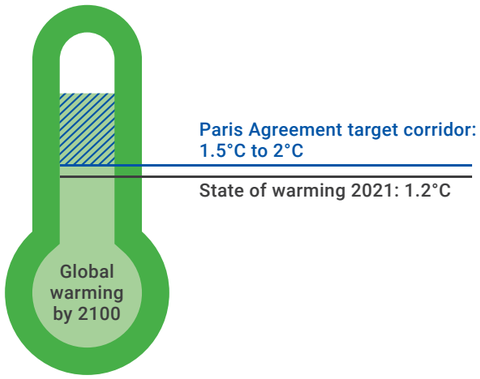


Fig. 7 | Global warming
Source: UBA (2022)

The aim of the European Green Deal, which is the overarching EU strategy and focus of EU policy on sustainability, is an economy where there are no net emissions of greenhouse gases in 2050. The European Green Deal is enshrined in law in the European Climate Law. The milestone target is to reduce greenhouse gas emissions by 2030 to 55 percent compared with 1990 levels (see Fig. 8).[49] A total of 1,800,000 million euros will be invested in the Green Deal.[50] The European Green Deal aims to achieve a sustainable as well as competitive Europe.[51] This is to be achieved through the decarbonisation of the energy sector, energy- and resource-efficient renovation and construction, and a circular economy and industry.[52] It also aims to help industry innovate and build a green economy, and to shift to sustainable and smart mobility.[53]

In order to achieve the European Green Deal milestone target of 55 percent greenhouse gas savings by 2030, the EU Commission released the 'Fit for 55' package in July 2021. It consists of proposals to revise existing Council regulations, directives or draft decisions or to make them more ambitious and also presents new initiatives.[54] Among other things, the **Fit for 55 package** includes*

- tightening of the EU Emissions Trading Scheme and introduction to road transport and buildings, as well as
- stricter CO_2 emission standards in the transport sector, which should pave the way for a transition to zero-emission mobility.
- In addition, revised versions of the
  - Energy Efficiency Directive (EED)
  - Renewable Energy Directive (RED) and the
  - Energy Performance of Buildings Directive (EPBD) come into force.[55]

With the updated **Energy Efficiency Directive (EED)**, obligations to provide tenants/users with consumption and billing information during the year and to enable remote reading of meters and heat cost allocators take effect.[56] In addition, the renovation rate for public buildings should be increased to 3 percent per year.[57]

[47] Cf. Federal Government (2021d), p. 54 et seqq. | [48] Cf. EU Commission (2022c). | [49] Cf. EU Commission (2019). | [50] Cf. EU Commission (2022d). | [51] Cf. EU Commission (2019). | [52] Cf. EU Commission (2019). | [53] Cf. EU Commission (2019). | [54] Cf. EU Commission (2021a). | *Update (9 November 2022): Regulation (EU) 2018/842 of the European Parliament and of the Council (Effort Sharing Regulation: Germany's CO_2 reduction target by 2030 has been raised from around 38 to 50 percent in the buildings, transport, agriculture and waste sectors.

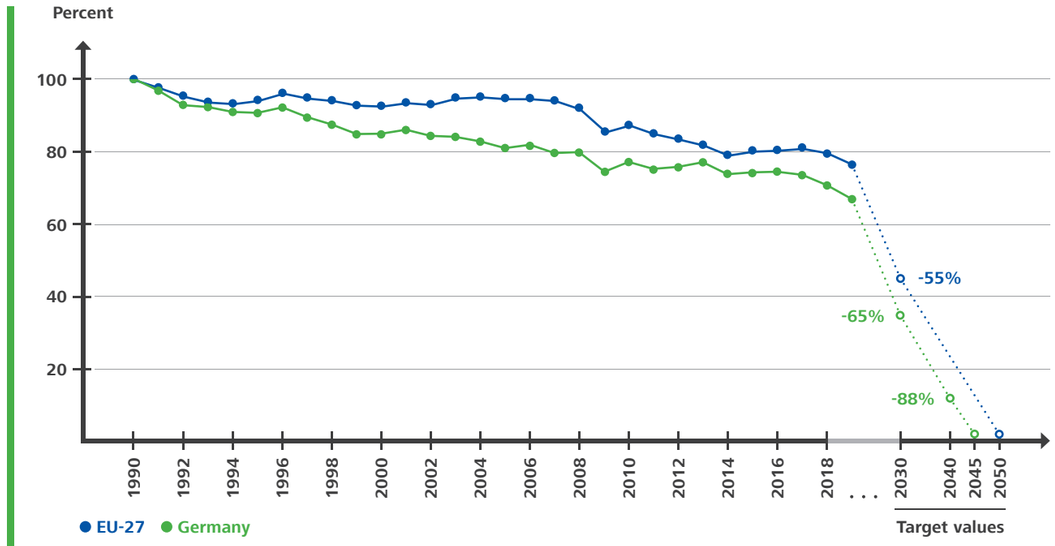


Fig. 8 | Target paths for EU and German emissions (base year 1990 - 100%), source: BMWK (2022c); Federal Government (2021a)

The amendment to the **Renewable Energy Directive (RED III)** proposes to increase the overall binding target to 40 % of renewables in the EU energy mix by 2030 (previously 30 %) and the promotion of greater integration into the energy system.[58]

The 2021 draft of the **Energy Performance of Buildings Directive (EPBD)** includes, in particular, an obligation to be carbon neutral ("zero-emission buildings") from 2030 for all new buildings and from 2027 for new public buildings. In addition, for new buildings, the global warming potential must be reported based on life cycle emissions. Another component is the introduction of minimum energy performance standards (MEPS) for existing buildings and the renovation of 15 percent of the EU building stock. The most energy inefficient buildings will be considered first. Non-residential buildings must achieve at least an energy efficiency class F by 2027 and class E by 2030. For residential buildings, there is a three-year delay. In addition, the energy performance certificate requirement is to be extended to buildings undergoing major renovations, to public buildings, and to buildings with a lease renewal.

Furthermore, energy performance certificates are to be standardised across all Member States by 2025, with a new scale and shorter terms. The draft EPBD also provides for the introduction of a national database for energy performance certificates. In addition to the energy performance certificate, a building renovation passport for existing buildings, to facilitate planning with the objective of climate neutrality, should also be introduced.[59]

Other key approaches of the European Green Deal also include a **renovation wave** for the construction sector, the Circular Economy Action Plan and the Commission Action Plan on Financing Sustainable Growth (see Chapter 4.1.3).

With the renovation wave strategy, the European Commission aims to at least double the renovation rate to 2 percent by 2030 and promote far-reaching energy reno-

[55] Cf. BfEE (2021). | [56] Cf. BMWK (2021). | [57] Cf. EPCEU (2021). | [58] Cf. EU Commission (2021b). | [59] Cf. EU Commission (2021c).

vations, especially for energy-inefficient buildings. The aim is to ensure that 35 million building units are energy renovated by 2030 and also that the renovation wave creates 160,000 additional green jobs in the EU construction sector. Furthermore, the renovation wave provides for a strengthening of information, incentives, legal certainty and targeted funding for owners. In addition, capacity needs to be built in the construction sector and the market for sustainable construction products and services needs to be expanded.[60] It also aims to reduce buildings' greenhouse gas emissions by 60 percent, their final energy consumption by 14 percent, and energy consumption for heating and cooling by 18 percent by 2030.[61]

The new Circular Economy Action Plan in particular contains strategies, measures, initiatives as well as a necessary legal framework to further develop and promote the life cycle approach of products. Furthermore, a functioning EU market for high-quality secondary raw materials and an improved waste policy are to be established. In addition to value chains, the Circular Economy Action Plan also sees the construction industry and the built environment as key. The EU construction sector is responsible for 35 percent of waste generation and demands enormous resources. Measures must be taken that consider the entire life cycle of buildings. For example, the Construction Products Regulation is to be revised or the renovation wave is to be in line with the circular economy. In addition, the European reporting framework for sustainable buildings "Level(s)" is to be applied in public procurement.[62]

Level(s) is a voluntary reporting framework of common EU indicators to capture the sustainability performance of buildings over their entire life cycle. The aspects of resource use and environmental performance, healthy and comfortable interiors, as well as costs, values and risks over the life cycle of a building are addressed. Level(s) focusses on planning, financing and execution, promoting a common understanding across all trades as well as across all countries.[63,64]

The European Green Deal is culturally complemented by the **New European Bauhaus**, which is a creative and interdisciplinary initiative. The New European Bauhaus serves as an experimentation and networking platform with the aim of guiding thinking and patterns of behaviour towards new ways of living and building. The focus is on the three values of sustainability, aesthetics and inclusion.[65]

EU renovation rate related to energy and resource efficiency

(according to EU Renovation Wave)

ACTUAL: 1%

TARGET: 2–3%

[60] Cf. EU Commission (2020), p. 2 et seqq. | [61] Cf. EPCEU (2020). | [62] Cf. EU Commission (2020). | [63] Cf. EU Commission (n.d.), p. 1 et seqq.; cf. EU Commission (2022a). | [64] For further information, see EU Commission (2022a). | [65] Cf. EU Commission (2022b).

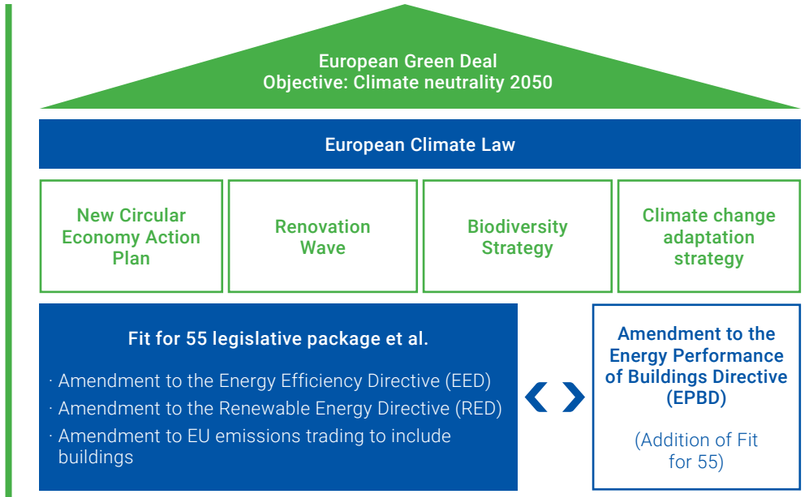


Fig. 9 | Overview of Green Deal initiatives, source: adapted from: BAK-Verbindungsbüro Brüssel, Beate Aikens

4.1.3 SUSTAINABLE FINANCE[66]

In order to comply with the Paris Agreement, the European economy must be a pioneer of a sustainable and climate neutral society. According to estimates, this transformation will require annual investments of 175,000 to 290,000 million Euros as well as new structures, which will be bundled within the European Green Deal. As a key focus area, "Sustainable Finance" is also an essential component here. At its core, it is about channelling capital flows to promote sustainable investment.

In parallel to this political development, it can be observed that sustainability aspects have gained in importance as factors for economic (investment) decisions by private investors. In line with and as a result of increased demand, the range of financial services that appeal to customers under the heading of "sustainability" is growing. These include green bonds, green mortgages, and (national) subsidy programmes, to name just a few.

For the construction and real estate sector, the topic of sustainable finance is a key factor in the transformation toward greater sustainability.

According to the European Commission, private investors play a crucial role in covering the necessary investments for the planned transformation. So far, however, the corresponding investments have been too low*. One reason for this is a lack of signals or clear definitions regarding which investments specifically support European climate action goals. In order to direct capital flows towards sustainable investments, manage financial risks arising from climate change, resource use, environmental degradation, and social issues, and to promote transparency and long-term economic activity, the EU Commission already developed a plan in 2018 to strengthen sustainable finance - the Commission **Action Plan on Financing Sustainable Growth**. This includes, but is not limited to:

[66] For more information on Sustainable Finance, visit www.dgnb.de/sustainablefinance
*(as of 2021)

- The establishment of a clear and detailed EU classification system for sustainable activities (taxonomy) to create a common language for all stakeholders in the financial system. Which means that this relates to criteria and standards which, on the one hand, enable investors to assess the actual sustainability of the products advertised and, on the other hand, are used by the real economy as a basis for reporting to the financial sector.
- The introduction of measures to clarify the obligations of asset managers and institutional investors with regard to sustainability.
- Strengthening the transparency of companies through disclosure regarding their environmental, social and governance policies (ESG) and their sustainability-related data.
- Promoting sustainable corporate governance and focussing on the long-term nature of activities on the capital markets, as well as encouraging investment in sustainable projects

The **EU taxonomy** should be highlighted as a key building block. With the EU Taxonomy, the EU has developed a classification system for sustainable activities that can be broken down into three dimensions. The dimensions take into account **environmental (E), social (S) and governance (G) (ESG) considerations** when making investment decisions in the financial sector, leading to longer-term investments in sustainable economic activities and projects.[67] The EU taxonomy system formulates technical requirements to classify economic activities - mainly in the "E" area. So far, only minimum requirements have been defined for "S" and "G".

To be considered environmentally sustainable under the taxonomy system, economic activities must make a substantial contribution to one of the following six environmental objectives. At the same time, they must not significantly affect the other five environmental objectives. In the system, this is called the "do no significant harm" (DNSH) principle. Technical evaluation criteria are developed for all six environmental objectives, which can be used to assess the specific activities in terms of their environmental sustainability.

ENVIRONMENTAL OBJECTIVES OF EU TAXONOMY

- Climate change mitigation
- Climate change adaptation
- Sustainable use and protection of water and marine resources
- Transition to a circular economy
- Pollution prevention and control
- Protection and restoration of biodiversity and ecosystems

Fig. 10 | Environmental objectives of the EU taxonomy
Source: BMWK (2020)

With the economic activities covered by the taxonomy, priority was given to sectors responsible for 93.5 percent of all direct greenhouse gas emissions in the EU. Evaluation criteria have already been defined for these activities in order to make a significant contribution to the environmental objectives of "climate change mitigation" and "climate change adaptation". The respective DNSH evaluation criteria for the other environmental objectives were also established. The rule is that the entire set of requirements must be met in order for the economic activity to be classified as taxonomy-compliant. The technical requirements for the remaining four environmental objectives are currently in draft form or not yet published (as of June 2022).

Fig. 11 | Requirements for an economic activity
Source: BMWK (2020)

[67] Cf. EU Commission (2021d).

The Regulation (EU) 2020/852 of the European Parliament and of the Council of 18 June 2020 on the establishment of a framework to facilitate sustainable investment (referred to as the EU Taxonomy Regulation) is linked to Regulation (EU) 2019/2088 of the European Parliament and of the Council of 27 November 2019 on sustainability-related disclosures in the financial services sector, referred to as Sustainable Finance Disclosure Regulation, or SFDR in short. The legal framework of the EU obliges financial market participants, including providers of investment funds, asset managers and providers of occupational pension plans, as well as companies to publish non-financial statements.

In the construction and property industry, the activities that fall within the scope of the EU taxonomy include

- new construction;
- the renovation of buildings;
- individual measures and professional services; as well as
- the acquisition and ownership of real estate.

In order to make a significant contribution to climate action as defined by the taxonomy, the design and construction of **new buildings** must enable a net primary energy demand that is at least 10 percent below the lowest energy level prescribed in national regulations.[68]

Renovations must meet local, national, or regional requirements for "major renovations" under Directive (EU) 2018/844 of the European Parliament and of the Council of 30 May 2018 amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency, referred to as Energy Performance of Buildings Directive II (EPBD), or require at least a 30 percent improvement in primary energy use. Investments in individual measures and services count as sustainable if they contribute to reducing the energy consumption and/or CO_2-emissions of a building.[69]

For **acquisition and ownership**, buildings (built after December 2020) must meet new construction criteria. Buildings constructed before 2021 must either be able to demonstrate a Class A energy certificate or, alternatively, be comparable to the top 15 percent of the national building stock in terms of calculated primary energy use during the use phase. In addition to the climate action criteria, the DNSH criteria formulated in each case must also be complied with.[70]

4.2 EMITTERS OF GREENHOUSE GASES IN THE BUILDINGS SECTOR IN GERMANY

With regard to our buildings, we know that the use of fossil energy sources for heating, cooling, lighting, etc. is associated with massive emissions of greenhouse gases - so massive, in fact, that in Germany **more than one-third of all emissions emitted in the country are attributable to buildings** and are assigned to the "buildings sector" under the Climate Change Act. In 2021, as in the previous year, the building sector exceeded the annual emission level of 113 million metric tonnes of CO_2e specified in the Federal Climate Change Act.[71] in 2021, emissions were 115 million metric tonnes of CO_2, a reduction of approximately 3 million metric tonnes of CO_2 compared to the previous year.[72] However, there is no single "buildings sector", but instead more than **20 million individual properties** that are built, used, converted, further used, demolished and rebuilt. The life cycle assessment is incomplete if only the use, or more precisely only the conditioning, of buildings is considered. It becomes complete when material and energy inputs, building investments, and material and energy output flows for manufacturing, construction, conversion, renovation, and recycling/disposal are also considered. Therefore, the energy sector, which is considered the main source of greenhouse gas emissions in Germany, is closely linked to the building sector. The industrial sector should not be ignored either; due to the production of raw materials and construction materials, it is particularly energy- and CO_2-intensive. Greenhouse gas emissions caused by the production of construction materials are attributed to the industrial sector according to the source principle.

[68] Cf. DGNB System (2022a). | [69] Cf. DGNB System (2022b). | [70] Cf. DGNB System (2022c). | [71] Cf. BMWK (2022b). | [72] Cf. BMWK (2022b).

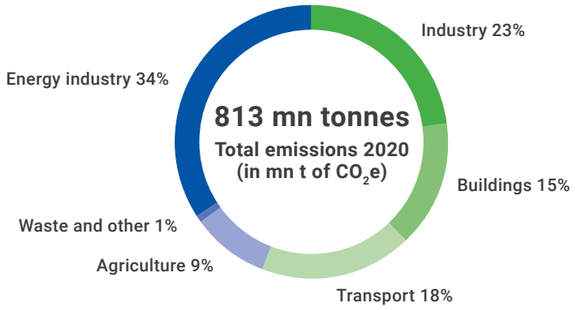


Fig. 12 | Total emissions by sector
Source: UBA (2021a)

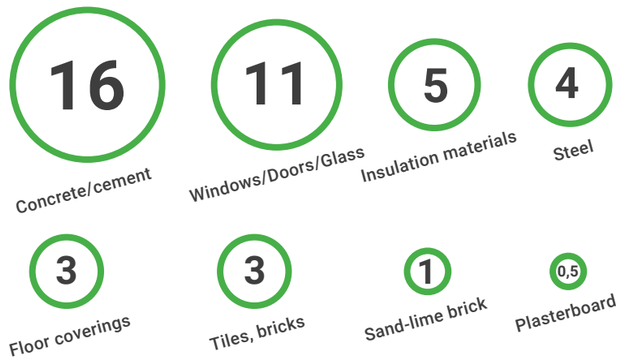


Fig. 13 | Greenhouse gas emissions from building materials in house construction in mn t of CO_2e, source: dena (2022)

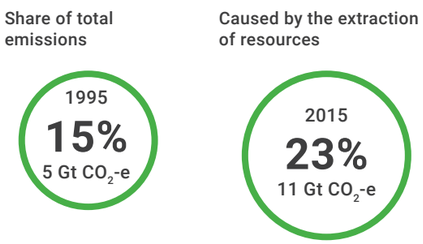


Fig. 14 | Greenhouse gas emissions caused by the extraction of resources
Source: dena (2021a)

For example, the concrete/cement industry alone represents CO_2e emissions of 16 million metric tonnes (see Fig. 13). In total, **construction materials in building construction** generate 44.6 million t CO_2e.[73] In the period from 1995 until 2015 global emissions caused by resource extraction increased from 5 to **11 gigatonnes CO_2e** (see Fig. 14). The extraction, processing and use of resources is also a cause of biodiversity loss and is associated with environmental impacts throughout the value chain.[74]

According to a study by the BBSR (2020), 362 million t CO_2e were caused by the **production, construction or modernisation** as well as the **use and operation of buildings**. A further 35 million t CO_2e emissions associated with the import of construction materials and products were caused by suppliers abroad. The largest share, **297 million t CO_2e, is in the area of use and operation** (see Fig. 15).[75]

Grey energy and the resulting grey or material-based CO_2 emissions[76] must not be neglected either. Grey energy refers to the non-renewable energy required for the manufacture, transport, storage, sale and disposal of products over their entire life cycle.[77] According to a study by BBSR (2019), a typical new building generates 10 to 16 kg CO_2e per square metre in terms of grey or built emissions.[78] The study sees resource-saving construction methods as essential to save 7 million metric tonnes CO_2 in grey emissions annually.[79] However, it is important that the assessments and comparisons are made over the entire life cycle.

For example, the recycling potential and thus the thermal use, if any, may vary.[80]

[73] Cf. dena (2022). | [74] Cf. UBA (2022e). | [75] Cf. BBSR (2020), p. 1 et seq. | [76] T The built-in emissions can be determined with the aid of life cycle assessment calculations in accordance with DIN EN 15978. The evaluation parameter is the global warming potential (GWP). The most widespread, used and reliable database in Germany is "Ökobaudat". Externally verified environmental data on construction materials or products over their entire life cycle are provided in the form of environmental product declarations (EPDs) in accordance with DIN EN 15804 by various organisations, such as the Institut für Bauen und Umwelt (IBU). More information on tools and data can be found in the DGNB Life Cycle Assessment Guide. | [77] How grey emissions in individual action areas can be reduced can be found in the DGNB publication "Framework for carbon neutral buildings and sites", see DGNB (2022b). | [78] Cf. BBSR (2019a), p. 3. | [79] Cf. BBSR (2019a), p. 3. | [80] Cf. dena (2022), p. 65 et seq. | [81] Cf. DGNB (2021). | [82] Multi-family home, plus-energy standard

Evaluations by the DGNB, presented e.g. in the study "Benchmarks for greenhouse gas emissions from building construction", show that the CO_2 emissions of the construction of conventional new buildings generate about half a tonne of CO_2e per m² of floor space (calculated over a reference useful life of 50 years). The operation of such conventional buildings, which are usually climate-controlled using fossil energy sources, is estimated at **30 to 50 kg CO_2e per m² per year**. For energy-efficient buildings, 10 to 20 kg CO_2e/m² per year can be expected.[81]

If **greenhouse gas emissions** are considered by **use** (see Fig. 16), the largest consumption of energy and also the largest emission of greenhouse gases (86 percent) is in the generation of space heating. Overall, the generation of space heating is responsible for 108 million t CO_2e, trailed significantly by the generation of hot water (12 million t CO_2e). Process heat (4 million t CO_2e) and mechanical energy (1 million t CO_2e) account for the remainder of the total 125 million t CO_2e.

A comparison of the **global warming potential of various building elements** (see Fig. 17)[82] shows a distribution of approx. 22 percent each for exterior walls, technical systems and ceilings, closely followed by interior walls.

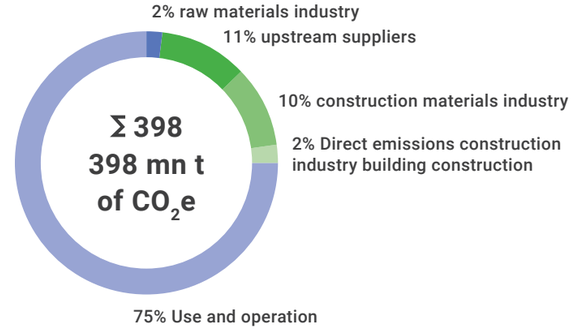


Abb. 15 | Construction and use of buildings (residential/non-residential)
Source: BBSR (2020)

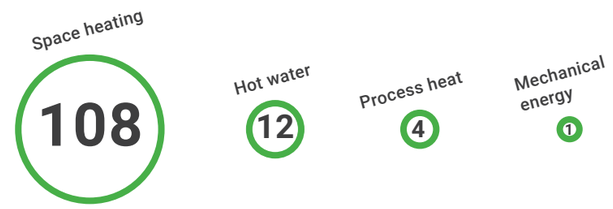


Fig. 16 | Greenhouse gas emissions in million t CO_2e by use (2016)
Source: Prognos, Öko-Institut, Wuppertal Institute (2020)

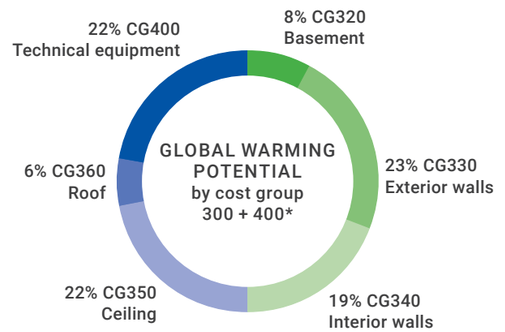


Fig. 17 | Global warming potential of building elements
Source: dena (2021a)
*Multi-family home, plus-energy standard

4.3 STATUS QUO IN THE BUILDING SECTOR

The building stock in Germany amounts to approximately **19 million residential buildings**. Of these, about 3.2 million are multi-family homes and almost five times as many are single- and two-family homes (about 15.8 million)[83] (see Fig. 18). In total, there are **21.7 million residential and non-residential buildings** in Germany.[84] In the last official census survey in 2011, the vacancy rate was 1.83 million dwellings in residential and non-residential buildings.[85] 68 percent of the buildings are pre- or post-war (see Fig. 19).[86] This means about 13 million residential buildings were built before the Thermal Insulation Ordinance (Wärmeschutzverordnung, WärmeschutzV) and the Energy Saving Ordinance (EnEV) entered into force. At the same time, **about a quarter of the worst residential buildings have 200 kWh/m²a** or more.[87] This means energy efficiency class F and worse and a consumption of **44 percent of the final energy of all residential buildings**.[88] Out of around 340,000 buildings analysed, it also shows that the level of renovation can be improved. Thus, only 50 percent of the buildings are partially renovated and 36 percent are not renovated at all (see Fig. 20).[89] The renovation rate - currently only one percent - urgently needs to be raised to at least 4 percent in order to achieve the climate goals (see Fig. 21).[90] In addition to the renovation rate, the depth of renovation is also crucial.

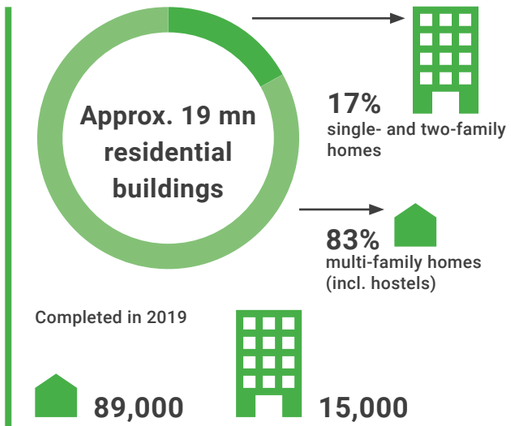


Fig. 18 | Building stock and new buildings 2019
Source: based on dena (2022)

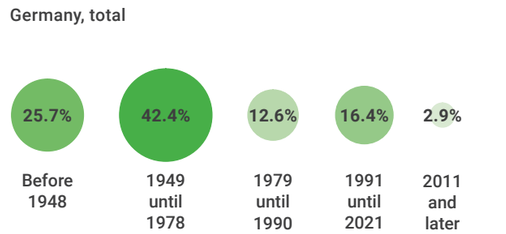


Fig. 19 | Building age classes of residential buildings (as of: 2018)
Source: according to Statista (2022d)

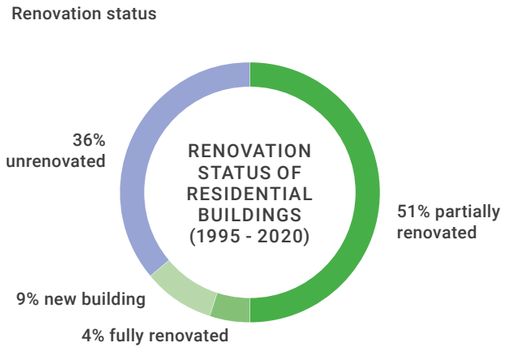


Fig. 20 | Renovation status of residential buildings
Source: according to UBA (2019)

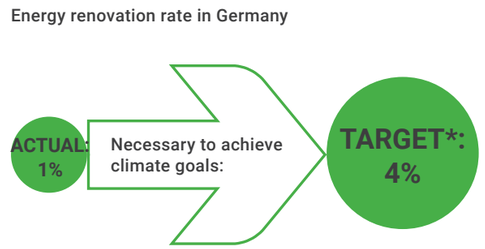


Fig. 21 | Renovation rate
Source: Wuppertal Institute (2020)
* According to Kopernikus (2021), an energy renovation level of at least KfW55 standard is necessary

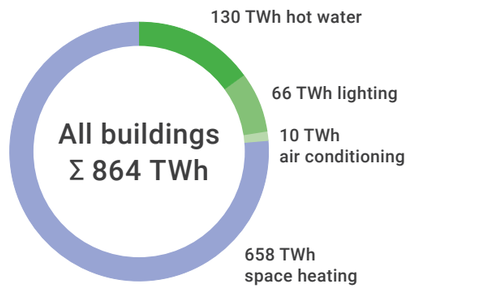


Fig. 22 | Final energy-related building energy consumption (2019)
Source: dena (2021a)

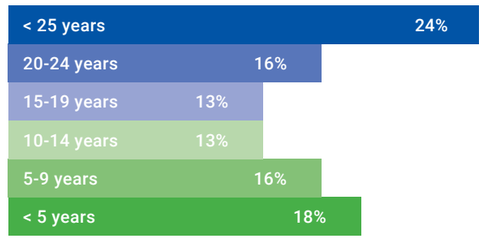


Fig. 23 | Age of heating systems
Source: BDEW (2019)

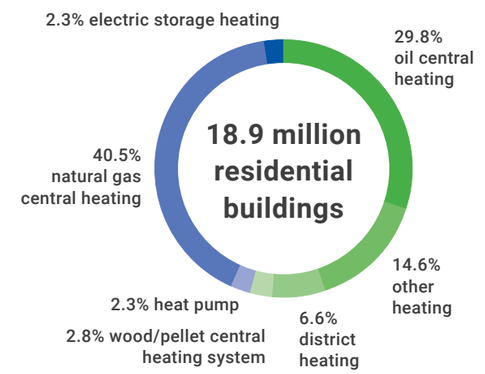


Fig. 24 | Heating systems in residential buildings (as of 2019)
Source: BDEW (2019)

Energy

Coupled with the largest share of CO_2 emissions in the generation of space heating, as shown in Chapter 4.2, the largest share of **final energy-related building energy consumption** is also attributed to the generation of space heating, at 76 percent (658 TWh) (see Fig. 22). Hot water generation follows with 15 percent. Both values refer to residential and non-residential buildings. For non-residential buildings, the second most important issue is lighting. Air-conditioning plays a smaller role in energy-related building energy consumption for residential and non-residential buildings.[91]

At 17 years, the average age of **heating systems of** single- and multi-family houses demonstrates the link to building energy consumption and space heating, (see Fig. 23). The largest share, 24 percent, is accounted for by heating systems in Germany that are 25 years or older. Of nearly 19 million residential buildings analysed, 70 percent use natural gas or oil-fired central heating. Only 14 percent of residential buildings have electric storage heating, a heat pump, wood or pellet central heating or district heating (see Fig. 24).[92]

As part of an energy renovation, 15 percent of energy can be saved by replacing or modernising heating systems. 50 percent energy savings can be achieved by insulating the façades, windows, basement and roof. Overall, the savings potential through energy renovation is 80 percent (see Fig. 25).[93]

The share of gross electricity consumption powered by renewables fell from about 45 percent to 41 percent in 2021. For the first time since 1997, there was no increase in the share of renewables. Reasons for this include less favourable weather and increasing electricity demand. In final energy consumption for heat, on the other hand, the share of renewable energies rose from around 15 to 16.5 percent. Renewable energy sources are critical to reducing fossil energy sources and thus avoiding greenhouse gas

[83] Cf. dena (2022). | [84] Cf. dena (2019a). | [85] Cf. BBSR (2019b). | [86] Cf. UBA (2019), p. 8. | [87] Cf. Kuhnhenne (2022), p. 16. | [88] Cf. Kuhnhenne (2022), p. 16. | [89] Cf. UBA (2019), p. 17. | [90] Cf. dena (2019a), dena (2019b).

[91] Cf. dena (2021a). | [92] Cf. BDEW (2019). | [93] Cf. KfW (2022c).

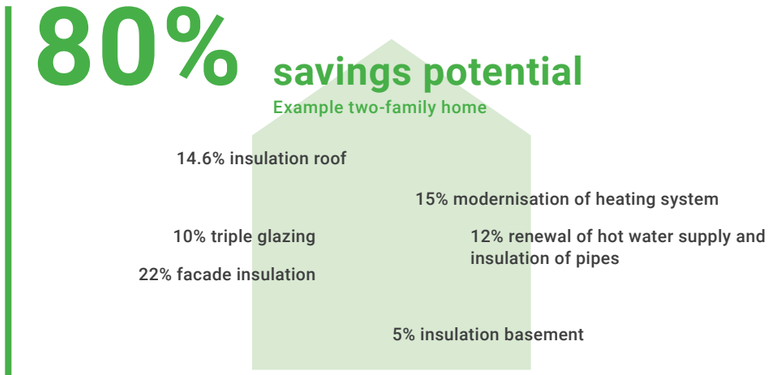


Fig. 25 | - Savings potential through energy renovation, source: KfW (2022c), Dämmen-lohnt-sich.de (n.d.)

emissions. In 2021, the use of renewable energies thus resulted in the avoidance of 221 million metric tonnes of greenhouse gas emissions.

The importance of using renewable energies in all sectors is also shown by the increased investment in power generating systems , which amounted to around 13,000 million euros in 2021. Economic effects from the operation of existing systems of around 20,000 million euros were also evident in 2021.[94]

With the introduction of the Energy Saving Ordinance (EnEV), energy performance certificates became mandatory for new buildings and for existing buildings after extensive renovation, sale, lease or new rental. In contrast to other European countries, Germany does not have a central data collection point.

Resources

Global demand for renewable resources exceeds the Earth's capacity to reproduce them. Earth Overshoot Day indicates when resources that can be sustainably used each year are depleted. This day intends to clearly signal the limits of the planet. In Germany, Earth Overshoot Day in 2022 fell on May 4.[95] About 35 kg of raw materials are removed per day and per capita in Germany.[96] If **resource consumption** everywhere in the world were as high as in Germany, three earths would be needed to meet the needs of the whole population.[97]

Not only can the construction industry be blamed for a large consumption of energy and resources, but the disposal of construction materials also plays a role. Waste generated totalled 417 million tonnes in 2019.[98] **Construction and demolition waste** accounted for around **230 million metric tonnes**, or 55 percent of the total waste.[99]

However, the built environment represents an immense **anthropogenic stock of raw materials. 52,000 million tonnes of material are embedded in the German building stock**.[100] The material value amounts to around 1,300,000 million euros.[101] This installed material could be reused after appropriate processing and deconstruction. Therefore, buildings should be designed and constructed in a circular manner to ensure the reuse and recycling of construction materials. Circular economy measures can reduce the amount of primary raw materials needed by 68 percent.[102] In total, 358 million t CO_2e could be saved from 2018 to 2030 in the areas of energy supply, mobility, industrial production, waste, agriculture and land use, as well as in construction and housing.[103] The share of the construction and residential sector corresponds to 13 percent of this.[104]

[94] Cf. UBA (2022g), p. 17. | [95] Cf. Overshootday.org (2022). | [96] Cf. dena (2021c). | [97] Cf. Statista (2022a). | [98] Cf. Destatis (2022). | [99] Cf. Destatis (2022). | [100] Cf. UBA (2015). | [101] Cf. UBA (2017). | [102] Cf. CEID (2021), p. 7. | [103] Cf. CEID (2021), p. 39. | [104] Cf. CEID (2021), p. 39.

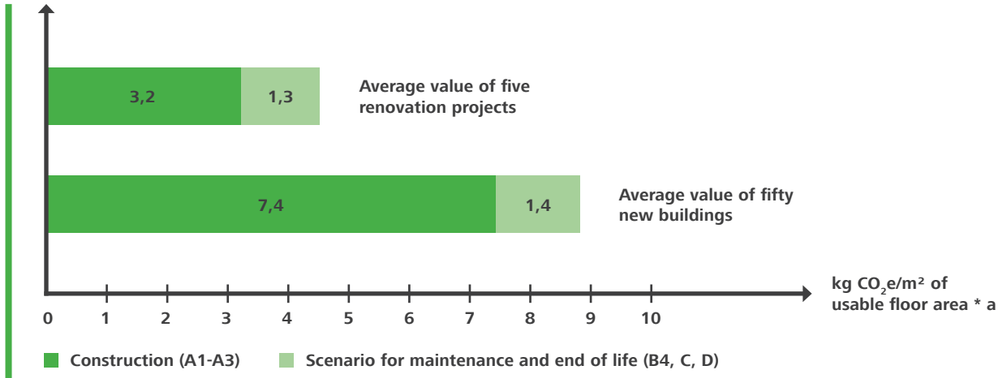


Fig. 26 | Typical life cycle CO_2 emissions of new buildings and renovations, source: DGNB (2021)

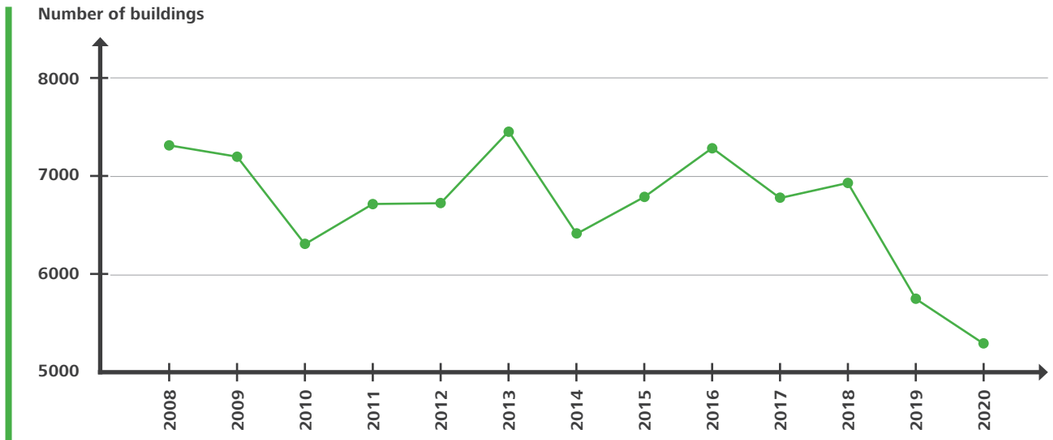


Fig. 27 | Demolition of residential buildings in Germany, source: Statista (2022b)

Both from a climate action perspective and for the purpose of saving raw materials, the approach of **"renovation before construction"** also applies. About two-thirds of the material can be saved through renovations compared to new construction.[105] In terms of CO_2 emissions, renovations are also better than new buildings. If CO_2 emissions associated with the production of new buildings are compared with those of renovation, it becomes clear how advantageous renovation is. From Figure 26, it can be deduced that with the same level of CO_2 emissions, either 23 buildings could be renovated for energy efficiency or ten new buildings could be constructed. When considered for a single building, the new construction of each square metre of usable space causes about half a tonne of CO_2e. Depending on the scope of the renovation, only 50 to 350 kg CO_2e per m² of usable floor area can be expected for a renovation in the production of materials and construction products, i.e. up to one order of magnitude less than for a new building. However, a total of about 5,300 residential buildings were completely demolished in 2020.[106] The number of new residential buildings is about ten times higher than the **demolition rate** (see Fig. 27). The demolition of non-residential buildings has declined in Germany since 1999. In 2008, around 9,000 non-residential buildings were demolished.

[105] Cf. UBA (2010), p. 8. | [106] Cf. Statista (2022b).

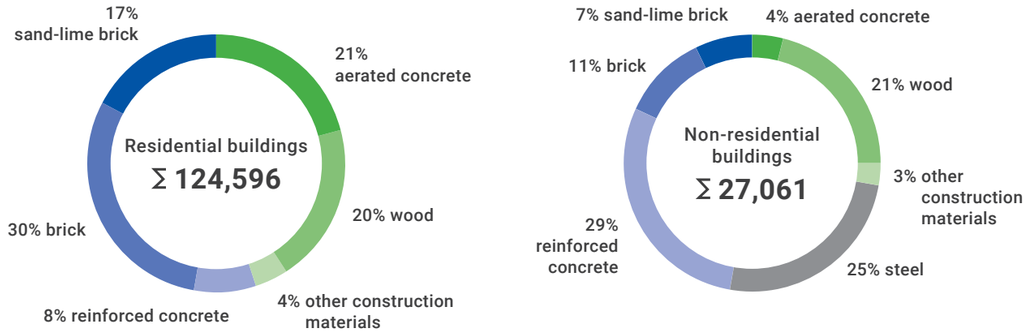


Fig. 28 | Building permits (new construction) by predominantly used construction material, source: Destatis (2021a)

Since conventional construction materials are very energy- and CO_2-intensive in the manufacturing phase and partly in the disposal phase, it is important to use alternative raw materials in circular structures. For example, alternative insulation materials made from renewable raw materials such as flax, jute, hemp, straw, or cellulose can be used. However, at 7%, natural insulating materials still only account for a small share of the insulating materials market.[107] Building with wood also brings CO_2 savings - on the one hand through the less energy-intensive production or extraction, processing and transport, and on the other hand through the binding and permanent storage of CO_2 in the wood. This means that prefabricated timber construction can achieve a saving of 80 t CO_2 compared to conventional solid buildings.[108] Building permits for new buildings in 2020 show that wood is used as a building material in 20 percent of cases (see Fig. 28).[109]

Energy and resources*

2/3
2/3 resource savings through renovation instead of new building

221 million tonnes
million tonnes of greenhouse gas emissions are saved through the use of renewable

55%
of the waste generated in Germany is caused by construction and demolition waste

1/3
of global resources are consumed by the built environment

*see source reference in text above

[107] Cf. DUH (2016). | [108] Cf. Forum Holzbau, p. 9. | [109] Cf. Destatis (2021a).

4.4 DEVELOPMENT OF THE BUILDING SECTOR

Chapter 4.2 has already clearly presented the building sector as a massive source of emissions, while Chapter 4.3 has shown the status quo, needs for action, and potentials. This chapter is intended to show the development of the building sector and to illustrate the need for action. Germany's share of the EU's total building area is 24 percent, while its population share is 18 percent.[110] In addition to this above-average land use, the amount of living space required per inhabitant has also risen steadily from 1995 to 47 square metres (see Fig. 29).[111]

The amount of construction and demolition waste also increased significantly between 2006 and 2019. Within 13 years, there has been an increase of approximately 17 percent (see Fig.30).[112]

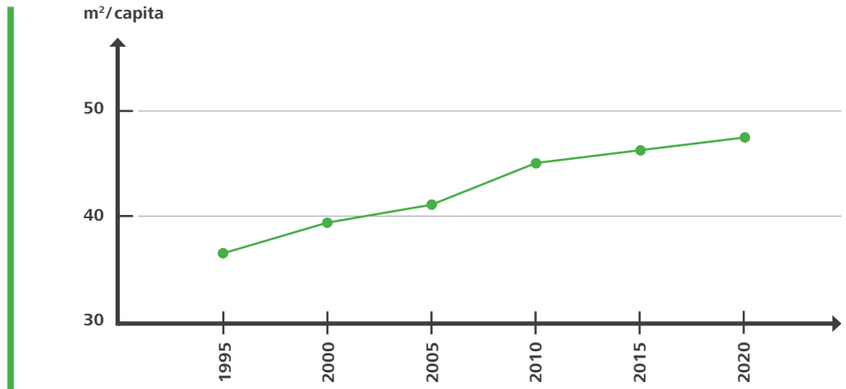


Fig. 29 | Development of residential space per inhabitant in Germany, source: Statista (2022c)

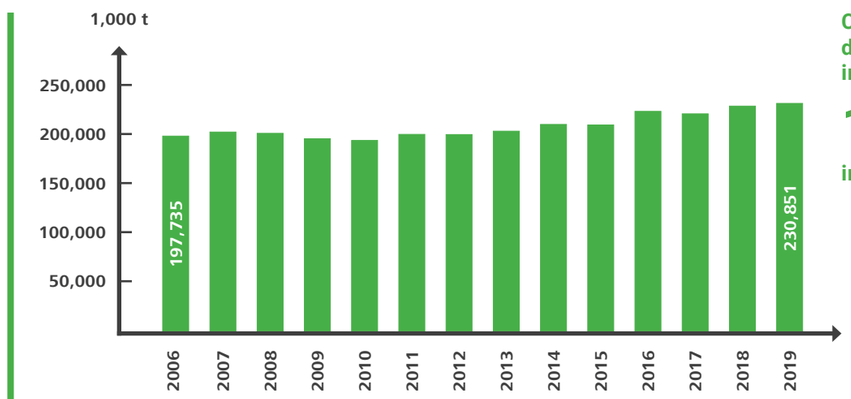


Fig. 30 | Construction and demolition waste in Germany, source: Destatis (2021b)

[110] Cf. McKinsey & Company (2021), p. 76. | [111] Cf. Statista (2022c). | [112] Cf. Destatis (2021b).

4 Our common starting point status quo

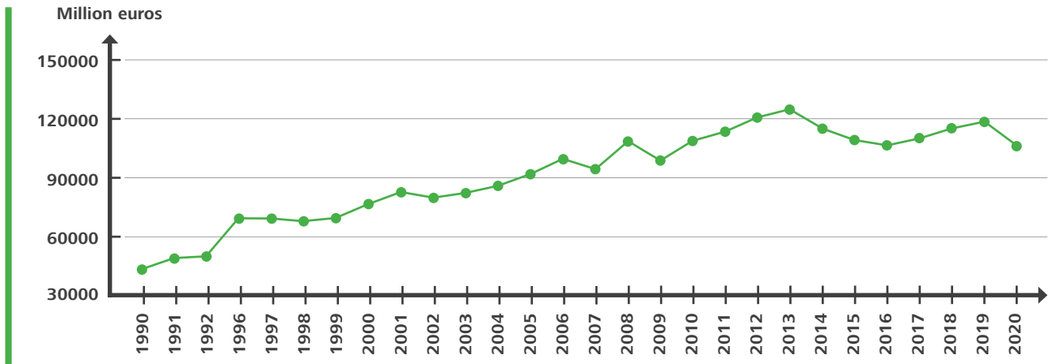


Fig. 31 | Energy costs of all private households, source: BMWK (2022d)

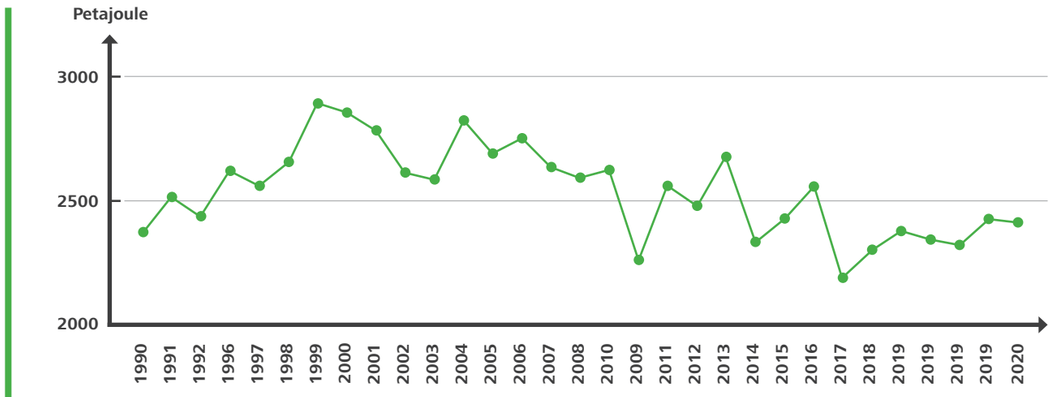


Fig. 32 | Final energy consumption of households: source: BMWK (2022d)

Energy costs increased to approximately 125,000 million euros from 1990 to 2013 (see Fig. 31). Final **energy consumption** by **households** underwent numerous fluctuations over the years 1990 to 2020. The peak of 2,890 petajoules was in 1999. in 2020, the value was 2,411 petajoules (see Fig. 32), which is only slightly lower than the 1990 value of 2,367 petajoules.[113]

Final energy consumption in the commercial, trade, and services sector was just under 1,300 petajoules in 2020, only a small reduction from 1990 consumption (1,800 petajoules).[114] If the energy sources of the final energy consumption of private households and of trade, commerce and services are considered (see Fig. 33), a shift away from hard coal and lignite is evident. In the case of district heating, there has been a significant increase in residential heating over the years, but not in commercial, trade and services. Here, the district heating share is declining.[115]

Other positive developments include sales figures for heat generators between 2019 and 2020.

[113] Cf. BMWK (2022d). | [114] Cf. BMWK (2022d). | [115] Cf. BMWK (2022d).

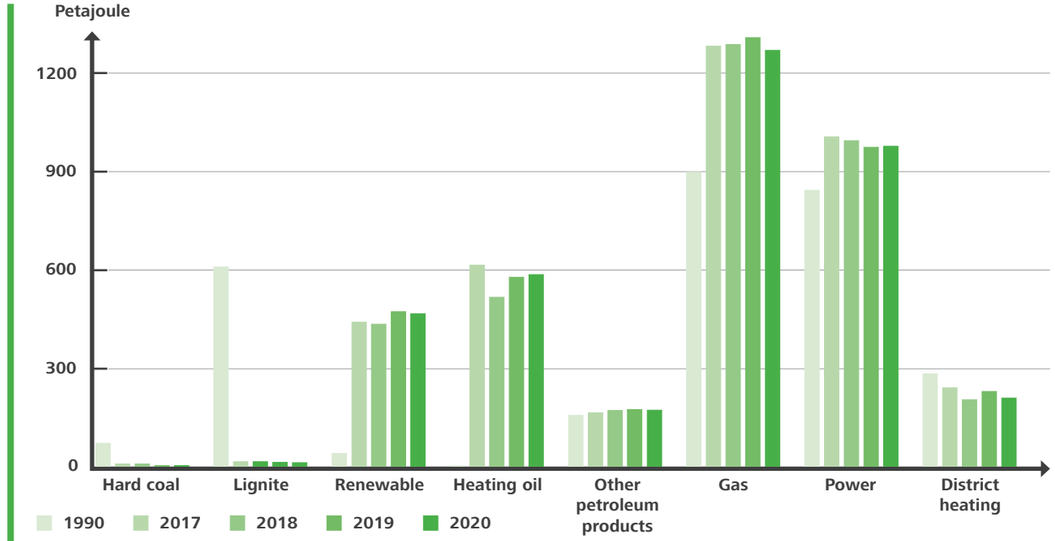


Fig. 33 | Final energy consumption by energy source - private households and trade, commerce, and services
Source: BMWK (2022d)

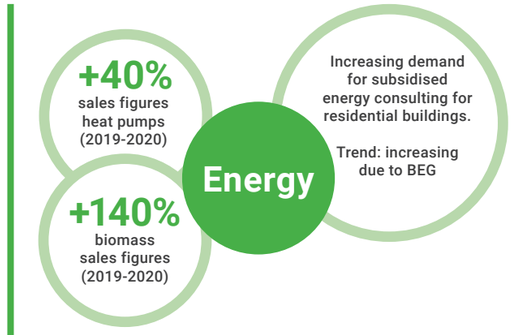


Fig. 34 | Growth rates heat generators
Source: dena (2021a)

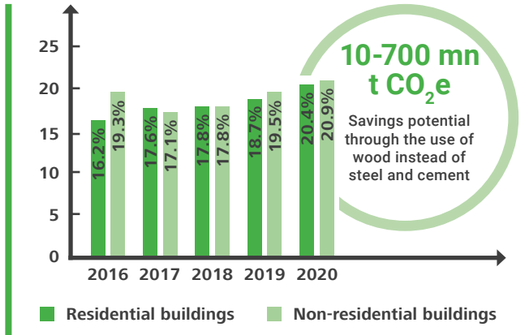


Fig. 35 | Wood construction rates
Source: Holzbau Deutschland (2021), PIK (2020)

Heat pumps experienced a 40 percent increase and biomass a 140 percent increase; they thus recorded the highest growth rates among heat generators (see Fig. 34). Also, in 2020, subsidised energy consulting for residential buildings experienced increased demand due to the increase in federal subsidies for energy consulting.[116]

At the same time, the rates for residential and non-residential buildings built with wood have increased slightly in recent years to about 21 percent (see Fig. 35).[117] Buildings can become carbon stores by using more wood instead of cement and steel. In addition, the greenhouse gas emissions generated by energy-intensive cement and steel production are reduced. The choice of wood as a building material, for example, has the potential to save between 10 and 700 million tonnes of CO_2.[118]

[116] Cf. dena (2021a). | [117] Cf. Holzbau Deutschland (2021). | [118] Cf. PIK (2020), cf. Churkina, Organschi, Reyer (2020).

5 Act effectively now
Specific objectives, specific measures

This chapter shows the approach of the DGNB, which is behind the list of measures "Our path to climate positive building stock - part 2" (see Chapter 5.1). In addition, the strategic objectives and the presentation of the strategic targets (see Chapter 5.2) as well as the action areas (see Chapter 5.4) are derived in terms of content.

Finally, Chapter 5.4 presents an excerpt of the top 50 most effective measures that can no longer be postponed and for which there are no barriers. In the view of the authors, the measures in this document must be implemented immediately without further excuses in order to achieve decarbonisation of the building stock as quickly as possible. The measures listed in Part 1 should therefore be implemented with priority, and the other measures, presented in Part 2, should be addressed immediately thereafter.

A more detailed overview with envisioned target, indicators, target values and time frame for the four strategic objectives can be found in Part 2 of the DGNB "Guide to Climate Positive Building Stock".

1. Eliminating emissions associated with energy consumption and making a positive contribution to the energy transition with renewable energies

Action area 1
Capturing the current situation with climate action roadmaps and planning climate neutrality in specific terms

Action area 2
Reducing energy demand and consumption of buildings

Action area 3
Using 100% renewable energies and acting as an active element in the energy transition

Action area 4
Establishing climate-neutral and efficient energy supply systems

2. Preserving the value of existing buildings, minimising the use of resources and ensuring long and intensive use of buildings

Action area 5
Reducing land requirements and using land intensively

Action area 6
Preserving existing buildings or using them as a source of raw materials

Action area 7
Strengthening longevity with adaptable and circular structures and components

Action area 8
Building simply, adding on, redensifying - creating qualities using less resources

3. Renovating existing buildings and building necessary new buildings emission-free and with climate positive materials

Action area 9
Manufacturing climate action-oriented, carbon-free materials and products

Action area 10
Planning and implementing climate action-oriented renovations and new buildings

Action area 11
Using buildings as carbon sinks and stores

4. Creating political and financial framework conditions for transformation

Action area 12
Setting the course for immediate climate action in the building sector at regional and national level

Action area 13
Putting municipalities on a climate positive course

Action area 14
Promoting and financing sustainable solutions

Action area 15
Reducing subsidies harmful to the climate and aligning tax policies with climate action

Measures for the building stock

5.1 LIST OF MEASURES - OUR PATH TO CLIMATE POSITIVE BUILDING STOCK - PART 2

OUR PATH
Part 2

The collection of measures listed in **"Our path to climate positive building stock - part 2"** is the result of evaluations of over 70 studies, publications, topic-specific roadmaps and interviews, as well as our own additions and assessments.

At the end of 2021, these measures were discussed, adapted and supplemented with members active in DGNB committees. In a second series of workshops in 2022, these revised proposed measures were once more evaluated with individual stakeholder groups, envisioned targets and corresponding interim targets were highlighted with measurable key performance indicators (KPIs), and **stakeholder-specific programmes of measures** were drawn up.

The climate goals and the objective of climate positive building stock can only be achieved with a combination of measures in a wide range of areas.[119] The collection of measures is therefore divided into **STRATEGIC OBJECTIVES 1 TO 4**, with a total of **15 action areas, packages of measures** within the action areas, and finally the individual measures (see Fig. 36).

The strategic objectives cover the core topics of the construction and property industry, which are the key factors in decarbonisation.

These are:

- energy and heat:
  STRATEGIC OBJECTIVE 1
- circularity, land requirements, and resource use:
  STRATEGIC OBJECTIVE 2
- materials and construction:
  STRATEGIC OBJECTIVE 3

as well as

- political and financial framework:
  STRATEGIC OBJECTIVE 4

STRATEGIC OBJECTIVE 1

Eliminating emissions associated with energy consumption and making a positive contribution to the energy transition with renewable energies

Action area 1 Capturing the current situation with climate action roadmaps and planning climate neutrality in specific terms
Recording building stock in terms of climate action, determine requirements and analysing potential
Planning and implementing path to climate neutrality with climate action roadmaps for all buildings
Action area 2 Reducing energy demand and consumption of buildings
Planning and implementing renovations
Implementing increased requirements for new construction
Reducing and avoiding climate-damaging refrigerants
Using and (further) developing technologies to reduce emissions and to increase efficiency in existing and new buildings
Action area 3 Using 100% renewable energies and acting as an active element in the energy transition
Using heating technologies that utilise renewable heat sources or are based on renewable energy sources
Actively producing energy at the buildings or on-site
Action area 4 Establishing climate-neutral and efficient energy supply systems
Driving forward decarbonisation of local and district heating
Optimising network operation and heat transfer
Promoting technical developments for climate neutral and efficient energy supply

Fig. 36 | General overview DGNB Guide

[119] Cf. Kuhnhenne (2022), p. 22.

STRATEGIC OBJECTIVE 2

Preserving the value of existing buildings, minimising the use of resources and ensuring long and intensive use of buildings

Action area 5 Reducing land requirements and using land intensively
Promoting land sufficiency
Promoting land efficiency
Action area 6 Preserving existing buildings or using them as a source of raw materials
Questioning deconstruction and promoting long-term asset value of the existing building stock
Promoting reuse
Promoting the use of secondary raw materials
Action area 7 Strengthening longevity with adaptable and circular structures and components
Establishing circular construction as a premise for planning and execution
Providing for deconstructability and enabling future reuse and recycling
Promoting convertability, repurposing, and adaptability
Action area 8 Building simply, adding on, redensifying - creating qualities using less resources
Achieving simplicity in building
Adding on, extending, redensifying

Fig. 36 | General overview DGNB Guide

STRATEGIC OBJECTIVE 3

Renovating existing buildings and building necessary new buildings emission-free and with climate positive materials

Action area 9 Manufacturing climate action-oriented, carbon-free materials and products
Manufacturing climate action-oriented, carbon-free and cycle-oriented materials and products
Implementing climate action-oriented, carbon-free production processes
Creating transparency on greenhouse gas intensity of products
Action area 10 Planning and implementing climate action-oriented renovations and new buildings
Implementing and promoting climate action-oriented construction methods
Informing, qualifying and creating a basis for decision-making
Exploiting economies of scale through pre-production and serial construction and building up capacities in a targeted manner
Implementing climate-friendly construction site processes, efficient logistics and climate-friendly transport
Contributing climate action expertise through cooperative and digitally supported (implementation) planning
Using climate-friendly construction materials and products and promoting reuse and recycling in construction processes
Action area 11 Using buildings as carbon sinks and stores
Identifying and implementing effective carbon sinks and stores in construction projects
Expanding research into carbon sinks and stores in the construction sector and bringing it into use as quickly as possible

Fig. 36 | General overview DGNB Guide

STRATEGIC OBJECTIVE 4

Creating political and financial framework conditions for transformation

Action area 12 Setting the course for immediate climate action in the building sector at regional and national level
Increasing renovation rate
Creating framework conditions for the use of climate-friendly energy
Amending the Building Energy Act (GEG)
Climate action-oriented, sustainable settlement development, land and real estate policy
Enabling existing buildings to be preserved and viewing buildings as a source of raw materials and building in a circular way
Promoting and demanding climate positive materials, products and production processes
Strengthening knowledge transfer, cooperation and information sharing
Strengthening climate-friendly infrastructure
Questioning existing legislation and adapting it in line with climate action requirements
Action area 13 Putting municipalities on a climate positive course
Achieving climate neutral municipality - focus on buildings
Creating information baseline
Enabling preservation of existing buildings, viewing buildings as a source of raw materials, building in a circular way and use land intensively
Adapting to climate and protecting against extreme weather events
Achieving climate-compatible infrastructures in the areas of mobility, waste, and heat
Action area 14 Promoting and financing sustainable solutions
Creating sustainable financial markets
Aligning funding policy with climate action
Aligning investments and loans with climate action
Action area 15 Reducing subsidies harmful to the climate and aligning tax policies with climate action
Introducing climate action-oriented tax relief and subsidies
Reducing land consumption through climate action-oriented land and property policy

Fig. 36 | General overview DGNB Guide

5.2 DERIVATION OF THE STRATEGIC OBJECTIVES AND PRESENTATION OF THE ENVISIONED TARGETS

In this chapter, the strategic objectives, which represent core topic areas of the construction and property industry and the key factors in decarbonisation, are derived:

› STRATEGIC OBJECTIVE 1:
Eliminating emissions associated with energy consumption and making a positive contribution to the energy transition with renewable energies

› STRATEGIC OBJECTIVE 2:
Preserving the value of existing buildings, minimising the use of resources and ensuring long and intensive use of buildings

› STRATEGIC OBJECTIVE 3:
Renovating existing buildings and building necessary new buildings emission-free and with climate positive materials

› STRATEGIC OBJECTIVE 4:
Creating political and financial framework conditions for transformation

It also identifies landmarks for achieving each strategic objective.

5.2.1 STRATEGIC OBJECTIVE 1: ELIMINATING EMISSIONS ASSOCIATED WITH ENERGY CONSUMPTION AND MAKING A POSITIVE CONTRIBUTION TO THE ENERGY TRANSITION WITH RENEWABLE ENERGIES

With the current energy consumption of the building stock, a hundred percent renewable energy supply could only be achieved with enormously high costs, very large land requirements, and huge infrastructure projects. The share of renewable energies for operating existing buildings is currently around 12 percent.[120] Today, a very high proportion of the building stock still consists of buildings that are not very efficient in terms of energy and are often not operated optimally. However, envelope surfaces and exterior areas of buildings offer enormous potential for energy activation, even beyond the building's own energy demand, but this potential is currently still very little used.

For these reasons, it is essential,

- to create full transparency on energy performance and planned measures
- and to create all the capacity necessary for the energy transition of the building stock.

The energy transition for buildings means,

- massively reducing the real energy and heat consumption of the building stock as quickly as possible
- switching the supply completely to renewable energy sources
- and, where possible, activating the building stock for the production of energy beyond its own needs and acting in a grid-serving way, e.g. via load management or energy storage.

For the building stock as a whole, and therefore for each individual building, all activity must be geared toward the following five objectives:[121]

STRATEGIC OBJECTIVE 1

Eliminating emissions associated with energy consumption and making a positive contribution to the energy transition with renewable energies

short-term (by 2025)	medium-term (by 2030)	long-term (by 2035)	by 2040
Transparency Establishment of a central building database: real energy consumption, demand, and GHG emissions. Description of energetic status of the building stock. Knowledge of planned measures from renovation/climate action roadmaps.	**Objective:** Information from the central building database is used to define control instruments and subsidies, as well as necessary capacities and investments.		
Efficiency All energy renovations and all new buildings will be highly energy efficient or "low temperature (LT)-ready".			**Objective**: Nearly all of the building stock is highly energy efficient or LT-ready.
Renewable energies Nearly all energy renovated buildings and new buildings use the building envelope and/or adequate outdoor areas for on-site energy production.		**Objective**: The share of renewable energy sources in the energy supply of the building stock is almost 100%.	
Renewable energies Nearly all energy renovated buildings and new buildings use the building envelope and/or adequate outdoor areas for on-site energy production.			**Objective**: The building stock contributes significantly to energy production in Germany in a way that serves the grid.
Energy production and storage Massive build-up of utility, industrial, and human resource capacity to achieve energy and climate goals/the "construction transition." Establish digital planning tools that support full CO_2 accounting.	**Objective**: All the supply, industrial and human capacities are available, which are necessary to secure an efficient building stock that is operated using renewable energies and is energetically activated in the long term.		

[120] Cf. BMWK (2015), p. 41. | [121] A more detailed overview with envisioned target, indicators, target values and time frame for the four strategic objectives can be found in Part 2 of the DGNB "Guide to Climate Positive Building Stock".

5.2.2 STRATEGIC OBJECTIVE 2: PRESERVING THE VALUE OF EXISTING BUILDINGS, MINIMISING THE USE OF RESOURCES AND ENSURING LONG AND INTENSIVE USE OF BUILDINGS

The amount of land required per person has grown considerably in recent decades. At the same time, we have an average vacancy rate in Germany of around 3 percent.[122] Also, in 2020, about 5,300 residential buildings were completely demolished.[123] At the same time, the number or area of additions to buildings over the years has been extremely small.

Another aspect that needs to be changed is that construction activities today are almost exclusively carried out with a high demand for primary raw materials. The use of secondary raw materials and reuse is currently very low. At the same time, the mass of material used in German residential buildings per inhabitant is over 100 metric tonnes. Another 80 metric tonnes are needed for all other buildings per inhabitant.[124]

For these reasons, there is an urgent need
- to preserve and enhance the building stock,
- to use it efficiently,
- and to activate or repurpose vacant buildings.

In addition, the entire potential of redensification and the addition of new storeys must be used, and existing buildings worth preserving should not be demolished as obsolete, in order to erect "replacement buildings" in their place.

[122] Cf. BBSR (2019b). | [123] Cf. Statista (2022b). | [124] Cf. BSBK (2018).

We must work toward the following objectives for the entire building stock:[125]

STRATEGIC OBJECTIVE 2

Preserving the value of existing buildings, minimising the use of resources and ensuring long and intensive use of buildings

short-term (by 2025)	medium-term (by 2030)	long-term (by 2035)	by 2040
Moderate and high-quality building space requirement Reducing the vacancy rate in urban areas.	**Objective:** Growth in commercial/residential space requirements stagnates.		
Reduce demolition to what is really necessary and only with high-quality recirculation	**Objective:** There is no "unjustified" demolition of buildings without considering quality requirements. Construction and demolition waste is almost entirely managed in high-quality cycles.		
Productive circular economy The use of materials over the life cycle of buildings is recorded for all construction projects in the form of building resource passports and significantly reduced compared to current levels.			**Objective:** Almost all materials used come from high-quality material/ product cycles or from sustainably-sourced renewable resources.
Long-lasting and valued building stock Conversion concepts or deconstruction and recycling instructions are available for all renovated buildings and new buildings. The actual potential of expansions and additions is known to all decision makers.			**Objective**: Buildings are used for much longer and planned for longer useful lives than is currently the case. The potential for expansions and additions is almost fully utilised in locations with high demand for usable floor area.

[125] A more detailed overview with envisioned target, indicators, target values and time frame for the four strategic objectives can be found in Part 2 of the DGNB "Guide to Climate Positive Building Stock".

5.2.3 STRATEGIC OBJECTIVE 3: RENOVATING EXISTING BUILDINGS AND BUILDING NECESSARY NEW BUILDINGS EMISSION-FREE AND WITH CLIMATE POSITIVE MATERIALS

Building construction activities, particularly the construction materials and energy industries, are a significant contributor to national greenhouse gas emissions.[126] In addition, there are foreign supply chains of raw material extraction and value creation that are not included in the national balance. In addition, there are emissions from the construction of infrastructure projects (civil engineering) such as roads, bridges, and supply and disposal facilities.

Greenhouse gas intensities are now widely known for most construction materials, materials and products, at least at the generic level. Manufacturer-specific EPDs (Environmental Product Declarations) are currently available for around 1,750[127] construction materials and products. Climate positive construction materials and products, i.e. carbon sinks and stores, have so far only been available on the market on a very small scale.[128] The greenhouse gas intensity varies greatly depending on the building material, product and manufacturer and should be evaluated in context and not in a generalised way. For an evaluation, the standardised method of life cycle assessment or life cycle greenhouse gas calculation is used.[129]

It is estimated that, based on the total number of sustainability certifications, a few hundred greenhouse gas calculations are carried out each year, either during the planning phase or as verification in the execution phase, almost never with a consideration of the construction site processes or project-specific transport. In addition, planners can develop many very good climate-friendly solutions if they take advantage of the entire range of optimisation options: from demand reduction through circular and long-lasting strategies to material-saving solutions and the use of materials and products with low greenhouse gas intensity.

For these reasons

- materials must be manufactured in a way that produces little to no CO_2 and has a clear focus on the renovations to come;
- planners need to develop the skills to conduct life cycle CO_2 assessments and establish them as new normal planning parameters in their processes. Another field that is still far outside the current discourse on solutions to the climate crisis for most manufacturers, planners and builders is the development of the carbon sink and storage capacity of buildings:
- materials and processes that absorb and store CO_2 must be identified for the construction sector;
- and new "climate positive" or "CO_2-negative" products must be developed accordingly and used in building renovations and necessary new buildings.

[126] Cf. BBSR (2020), p. 16 et seq. | [127] Cf. IBU (2022), version: 12 May 2022. | [128] Cf. IBU (2022). | [129] See also DGNB System and BNB system.

For the production of construction materials and construction products, as well as their use in all renovation and necessary new construction activities, the following objectives must be pursued:[130]

STRATEGIC OBJECTIVE 3

Renovating existing buildings and building necessary new buildings emission-free and with climate positive materials

short-term (by 2025)	medium-term (by 2030)	long-term (by 2035)	by 2040
Establish "carbon-free" construction materials and construction products in the market (Specific/generic) EPDs are available for almost all products available on the market.		The energy productivity of production processes has increased massively. The share of renewable energies in production processes is very high. The CO_2 intensity (incl. supply chains) of all products on the market is greatly reduced. There is a wide range of products and innovations for renovation and construction with carbon sinks and stores.	**Objective:** All construction materials, products and components available on the market are produced in a carbon-neutral manner.
Life cycle CO_2 targets in design and construction processes Requirements for adherence to thresholds are set for all new construction and renovation projects. In every design office there is know-how for the determination and consultation.	**Objective:** Nearly all renovation and new construction projects are implemented with CO_2 balancing that can be used cooperatively and threshold values are adhered to.		
Renewable energies Nearly all energy renovated buildings and new buildings use the building envelope and/or adequate outdoor areas for on-site energy production.		**Objective**: With pre-produced and serial solutions, the speed of renovation is significantly increased.	
Energy production and storage Massive build-up of utility, industrial, and human resource capacity to achieve energy and climate goals/the "construction transition." Establish digital planning tools that support full CO_2 accounting.	Carbon sinks and thus long-term CO_2 storage can be built into all renovation and new construction projects, and this is actually being done.		**Objective**: A clear effect of the removal of CO_2 from the atmosphere by construction activities is demonstrable.

[130] A more detailed overview with envisioned target, indicators, target values and time frame for the four strategic objectives can be found in Part 2 of the DGNB "Guide to Climate Positive Building Stock".

5.2.4 STRATEGIC OBJECTIVE 4: CREATING POLITICAL AND FINANCIAL FRAMEWORK FOR TRANSFORMATION

Climate action for the building sector has not been the focus of national policy-makers in recent decades; rather, it was only about the rational use of energy for heating. Since 2016, the requirements have not been tightened, and the standard introduced at that time has been declared the "nearly zero energy building standard" under the Energy Performance of Buildings Directive (EPBD). Only since 2020 has the reporting of GHG emissions for the operation of buildings become a legislative requirement via the German Buildings Energy Act (BEG). The Federal Funding for Efficient Buildings (BEG), introduced in 2021, continued the previous energy-focused funding. Integrated into this is a new "sustainability class", which as one element requires a limitation of lifecycle CO_2 emissions and which can be verified, for example, with a DGNB Certificate. A more climate action-oriented subsidy has been announced for 2023. The application of the BNB system (Sustainable Building Assessment System), which is also being introduced and applied in some German regions and includes climate action aspects such as a life cycle CO_2 balance, has applied to construction activities of the Federal Government since 2009.

At regional level (federal states), there is a complex patchwork of building codes and other regulations, as well as subsidy programmes of the individual federal states. Some very good approaches are being taken at municipal level, with ambitious statutes, guidelines, subsidies, or requirements for municipal building companies. From the European side, the introduction of binding criteria for the environmentally-responsible procurement of building construction measures is planned. Climate action, climate adaptation and the circular economy are the main focus here.

With few exceptions, the financial sector has paid little attention to the issue of sustainable real estate finance and sustainable portfolios in recent decades. Only recently has a great deal of activity been reported, largely triggered by the "EU Action Plan on Financing Sustainable Growth" and its accompanying requirements and projects.

The transformation therefore needs governmental, clearly formulated objectives, as described in the Climate Change Act, but it also needs the accompanying framework conditions which will drive the change to take place as quickly as possible. The political and financial framework must be created by all levels and requires collaboration, foresight and ambition at national, regional and municipal level. Furthermore, in order to mobilise the necessary funds for the transformation, banks and insurers also have a duty to make climate goal-compatible offers or make the allocation of funds subject to specific conditions.

To achieve climate goal-compatible frameworks, it is essential to work toward the following objectives:[131]

STRATEGIC OBJECTIVE 4

Creating political and financial framework conditions for transformation

short-term (by 2025)	medium-term (by 2030)	long-term (by 2035)	by 2040
Renovation targets for the entire building stock Targets for energy efficiency of entire building stock: see indicators strategic objective 1	The energy renovation rate is > 4%. More than a quarter of the building stock is considered "climate neutral-ready."		**Objective:** The building stock has been almost completely renovated in a climate neutral manner.
Greenhouse gas emissions from building stock operations and all construction activities The actual greenhouse gas emissions of the entire building stock operations are recorded and known via energy performance certificates. All newly issued energy performance certificates include renovation/climate action roadmaps.	Emissions from all construction activities in the new construction/renovation sector are recorded and are limited by defined climate goal paths and threshold values. Share of renewables in heat/electricity supply to buildings: see strategic objective 1		**Objective**: The entire building stock is operated in a carbon neutral manner. All (building) construction and renovation activities are carried out in a carbon neutral manner.
Climate goal compatibility of public buildings Renovation/climate change roadmaps are available for all public sector buildings.		**Objective:** All public sector buildings are operated in a carbon neutral manner. All (building) construction and renovation activities are carried out in an almost carbon neutral manner.	
Climate goal-compatible municipal requirements Objective: Municipalities have set climate goals that are at least compatible with national targets and are adequately integrated into their own municipal plans and instruments.			

[131] A more detailed overview with envisioned target, indicators, target values and time frame for the four strategic objectives can be found in Part 2 of the DGNB "Guide to Climate Positive Building Stock".

5.3 DERIVING THE ACTION AREAS

In the following chapter, the content of the action areas is derived and an introduction to them is provided. In the process, co-benefits or positive side effects of implementation as well as disadvantages of delayed or non-implementation of measures in the respective action area are highlighted.

STRATEGIC OBJECTIVE 1

Eliminating emissions associated with energy consumption and making a positive contribution to the energy transition with renewable energies

Action area 1
Capturing the current situation with climate action roadmaps and planning climate neutrality in specific terms

Action area 2
Reducing energy demand and consumption of buildings

Action area 3
Using 100% renewable energies and acting as an active element in the energy transition

Action area 4
Establishing climate-neutral and efficient energy supply systems

STRATEGIC OBJECTIVE 2

Preserving the value of existing buildings, minimising the use of resources and ensuring long and intensive use of buildings

Action area 5
Reducing land requirements and using land intensively

Action area 6
Preserving existing buildings or using them as a source of raw materials

Action area 7
Strengthening longevity with adaptable and circular structures and components

Action area 8
Building simply, adding on, redensifying - creating qualities using less resources

STRATEGIC OBJECTIVE 3

Renovating existing buildings and building necessary new buildings emission-free and with climate positive materials

Action area 9
Manufacturing climate action-oriented, carbon-free materials and products

Action area 10
Planning and implementing climate action-oriented renovations and new buildings

Action area 11
Using buildings as carbon sinks and stores

STRATEGIC OBJECTIVE 4

Creating political and financial framework conditions for transformation

Action area 12
Setting the course for immediate climate action in the building sector at regional and national level

Action area 13
Putting municipalities on a climate positive course

Action area 14
Promoting and financing sustainable solutions

Action area 15
Reducing subsidies harmful to the climate and aligning tax policies with climate action

5.3.1

STRATEGIC OBJECTIVE 1

Eliminating emissions associated with energy consumption and making a positive contribution to the energy transition with renewable energies

Action area 1
Capturing the current situation with climate action roadmaps and planning climate neutrality in specific terms

Building-specific climate action roadmaps are already an existing and applicable tool for continuous optimisation towards a climate neutral/climate positive building. They help to systematically record and evaluate existing buildings, taking into account their use, and show the way to climate positive operation based on action plans. They can also be used for new buildings to map their path to climate positive operation. However, climate action roadmaps or the individual renovation roadmaps, which focus on reducing energy consumption, are not yet a mandatory requirement and are currently used to plan step-by-step renovations. However, measures based on an individual renovation roadmap receive special funding under the Federal Funding for Efficient Buildings (BEG) programme.

The scope and content of climate action roadmaps are essential to ensure the quality and necessary depth of the renovation measures. The description of the approach, adequate target definitions, sanction options in case of non-achievement of targets and agreed steps as well as funding possibilities must be fixed components of a climate action roadmap.

Since construction measures such as extensive renovations must be well planned, there is a relatively long lead time before implementation. Only if an early start is made and targeted planning is carried out can the reduction targets be achieved. The action plan within the framework of a climate action roadmap creates the necessary transparency for all parties involved and thus enables effective action. The targeted and planned approach achieved in this way provides structure and clarity and avoids expensive rescheduling and duplication. In addition, climate action roadmaps include a monitoring concept and so that it will be possible later to review target achievement during building operation. This enables rapid intervention and correction during the operating phase.

For entire building stocks, it makes sense to first make a general prioritisation based on indicators to decide for which specific buildings individual climate action roadmaps will be created. Alternatively, "type roadmaps" can and should be created for typical building clusters, allowing for faster implementation and bundling of measures.

CO-BENEFITS

- Consideration of all relevant parameters in a single tool: Energy, costs, climate action
- Evaluation of the full range of improvement opportunities based on defined action areas
- **Economic benefits** for consumers: **Information** about funding opportunities
- **Increased user satisfaction**: Objective and path are clearly defined (also important for investors and funding bodies)
- **Cost reduction for** users (no need to purchase fossil fuels in the foreseeable future)
- Knowledge leads to better planning and more cost-effective construction
- **Satisfaction of** building owners/users, district solutions become more important ➔ Acceptance is increased
- **Job** security

DISADVANTAGES OF DELAY OR NON-IMPLEMENTATION

- Continued **"mindless" planning and implementation** (e.g. purely according to economic criteria)
- **Time factor**: Planned approach and bundling of sensible measures without overburdening consumers financially takes time
- **Cost savings** thanks to tailor-made solutions
- **Reduced** material and thus **resource consumption**
- **Underutilisation of supply structures** possible, redundancies possible, no synergies
- **No targeted planning** possible without climate action roadmap ("deterioration" possible due to wrong sequence of measures)
- **No monitoring concept**: Climate neutral operation is not achieved and no one knows why, nor can countermeasures be taken; leads to increased CO_2 emissions

Therefore, in **"Action area 1:** Capturing the current situation with climate action roadmaps and planning climate neutrality in specific terms" it is necessary to implement **two packages of measures**. These are:

Recording building stock in terms of climate action, determining requirements and analysing potentials
Planning and implementing path to climate neutrality with climate action roadmaps for all buildings

Action area 2
Reducing energy demand and consumption of buildings

The energy demand has an important influence on the CO_2 balance of a building. In Germany, buildings are responsible for 30 percent of CO_2 emissions and around 35 percent of final energy consumption.[132] 13 million of a total of 19 million residential buildings in Germany were built before 1979, i.e. before the first Thermal Insulation Ordinance.[133]

In order to achieve climate positive building stock, it is necessary to significantly reduce energy consumption and meet the remaining demand with renewable energies, as well as to drastically increase the renovation rate from the current one percent. There is much potential for improvement. An important objective is the increased implementation of renovation measures for existing buildings. In particular, energy renovations such as thermal insulation of roofs, façades and basements as well as a change in the heating system offer great potential for energy savings. In the case of non-residential buildings, this potential lies especially in the optimisation of air-conditioning and ventilation systems. The architecture and choice of materials also play an essential role in both residential and non-residential buildings. Passive thermal protection can be achieved through appropriate architecture and material selection for the site. With the Buildings Energy Act (GEG) (see Chapter 4.1.1), the Federal Government prescribes minimum requirements for building standards and energy certificates.

Furthermore, renovation measures should be accompanied by an increase in the current level of renovation in order to achieve appropriate qualities of renovation. The renovation measures should be coordinated and planned within the framework of a climate action or individual renovation roadmap in order to avoid so-called "lock-in effects". Life cycle assessments identify environmental effects and help to evaluate measures.

In the case of existing buildings, it is important to promote the use and (further) development of energy-saving and efficiency technologies in addition to renovation measures. The occupancy phase and thus the building users and the building technology in terms of daily behaviour also represent a significant factor when it comes to energy demands and consumption. Use and operation cause 75 percent of all CO_2 emissions when it comes to the construction and use of building constructions (see Chapter 4.2). This corresponds to an amount of almost 300 million t CO_2e.[134] Saving energy can often be achieved relatively quickly and easily. However, this requires transparency regarding consumption, its evaluation as well as information and dissemination to the building users, operators and owners.

The objective of reducing and avoiding refrigerants should also not be neglected. Although these are only used in a limited number of buildings, they have a particularly harmful effect in relative terms. Fluorinated gases account for 2 percent of total GHG emissions in Germany.[135] Regulation (EU) No 517/2014 of the European Parliament and of the Council of 16 April 2014 on fluorinated greenhouse gases stipulates a gradual reduction of the quantity of hydrofluorocarbons (HFCs) by 79 percent by the year 2030.[136]

The objective is to achieve climate positive operation of new construction and renovation projects. This is the only way to implement climate policy objectives. The demand for energy must be further reduced. More efficiency and greater savings - both are necessary and possible.

> A form of lock-in effects arises if building renovations and individual measures are not already geared towards climate neutrality today. This can be avoided by comprehensive planning of measures within the framework of a climate action roadmap.

[132] Cf. UBA (2022b). | [133] Cf. Statista (2022d). | [134] Cf. BBSR (2020), p. 3. | [135] Cf. UBA (2020), p. 18. | [136] Cf. UBA (2020), p. 5.

CO-BENEFITS

- **Reduced environmental impacts**: Fewer emissions in the air, decrease in coal mining, fewer pollutants from refrigerants
- Greater **independence from price fluctuations** and **imports**
- **Satisfaction/Acceptance**: Decreasing costs for consumers ➔ Decreasing or preventing social tensions
- **Secures jobs** and offers prospects in future-relevant areas; renovations secure local jobs
- **Opportunities** through new business models
- Energy renovations go hand in hand with **greater comfort** and **strengthening of** health protection
- **Higher satisfaction** among users due to climate positive use

DISADVANTAGES OF DELAY OR NON-IMPLEMENTATION

- Continued high demand for fossil energy sources and therefore (presumably) **rising energy prices** for consumers
- Continued strong **dependence** on fossil fuel **imports**
- Continued **negative consequences of** the **use of refrigerants** as well as **scarcer** and **more expensive media** (global warming)
- **Reputational damage**: Europe/Germany as a role model in the fight against climate change

Therefore, in **"Action area 2:** Reducing energy demand and consumption in buildings", **four packages of measures** are to be implemented. These are:

Planning and implementing renovations
Implementing increased requirements for new construction
Reducing and avoiding the use of climate-damaging refrigerants
Using and (further) developing energy-saving techniques and, in the case of existing buildings, efficiency techniques and new buildings

Action area 3
Using 100% renewable energies and acting as an active element in the energy transition

The share of renewables in the electricity sector is about 41 percent (2021), while in the heat sector it is only about 17 percent (2021). Electricity from renewables is composed of wind (49 percent), photovoltaic (21 percent), biomass (22 percent), hydropower (8 percent), and geothermal (<1 percent), totalling 233.6 terawatt-hours in 2021. In the heat sector, various forms of biomass represent the largest share (86 percent). Other sources include solar thermal systems (4 percent) and geothermal systems (10 percent). In total, renewable energy sources in the heat sector contributed about 199 billion kilowatt-hours (2021).

Increased use of heating technologies that utilise renewable heat sources or are based on renewable energy sources will push back fossil energy sources. The use of renewable energy sources must also be promoted in the area of electricity generation. Here, buildings can act as an active element of the energy transition by generating energy directly at the building.

The implementation of measures in this area leads to an immediate reduction in CO_2 emissions and makes an immediate contribution to achieving climate goals. Local and regional conditions must be taken into account, as not all renewable energy sources are practical or possible at every location. Here, an approach tailored to the individual project is important. A neighbourly approach promotes the acceptance of the owners and users.

CO-BENEFITS

- **Reduced environmental impacts**: Fewer emissions in the air, decrease in coal mining
- Greater **independence from** price fluctuations and imports
- **Relief for** the **energy sector**
- **Satisfaction/Acceptance on site**: Local value creation, lower distribution effort and transportation losses, promotion of local jobs
- **Innovation potential** in growing market segment: new ideas as well as export opportunities for companies; securing local jobs
- Local power generation ensures **local value creation**

DISADVANTAGES OF DELAY OR NON-IMPLEMENTATION

- Continued high demand for fossil energy sources and therefore (presumably) **rising energy prices for** consumers
- Continued strong **dependence** on fossil fuel imports
- **Reputational damage**: Europe/Germany as a role model in the fight against climate change
- **Time factor**: Plant technology has a relatively long lifetime of 20 years. In order to achieve the targets, it is therefore essential to start implementation now, otherwise **climate goals and sector targets** cannot be met.

Therefore, in "**Action area 3**: Using 100% renewable energies and acting as an active element in the energy transition" it is necessary to implement **two packages of measures**. These are:

- Using heating technologies that utilise renewable heat sources or are based on renewable energy sources
- Actively producing energy at the buildings or on-site

Action area 4
Establishing climate-neutral and efficient energy supply systems

The share of renewable energy sources in the supply systems can be expanded, as already shown in action area 2. A climate neutral and efficient energy supply is an essential building block for achieving the climate goals. Consumers rely on energy supply systems. The potential for saving CO_2 emissions is large, since a change in supply systems achieves a large climate effect. Not only are individual consumers affected, but entire neighbourhoods and districts can benefit from the decarbonisation of energy supply systems. However, conversions need to be planned now, as a lead time is required before implementation.

The focus here is on the objective of decarbonising local and long-distance district heating networks. Associated with this is the task of operating the network efficiently and optimising heat transfer to avoid losses. In order to drive decarbonisation of local and long-distance district heating networks, technical developments and new business management approaches are foreseeable and should be promoted, e.g. in the field of green hydrogen or synthetic energy sources. In the case of new developments, it is important to bring together the various stakeholder groups and to develop regional as well as supra-regional and site-specific solutions.

Another important aspect is also the building owners' understanding of the relevance of local and long-distance district heating networks. In some cases, it is already compulsory to connect to available long-distance district heating networks in housing developments in Germany.

CO-BENEFITS

- **Independence** from fossil fuel trading
- **Role model:** Citizens, municipalities and energy suppliers act together
- **Increase quality of life and satisfaction/acceptance:** Local solutions are positive for the local economy
- **Innovation potential:** new business models and revenue opportunities
- **Planning security and use of synergies**

DISADVANTAGES OF DELAY OR NON-IMPLEMENTATION

- Continued **dependence** on fossil fuel imports (global market)
- Possible high (fine) **payments** e.g. due to exceeding CO_2 values
- **Reputational damage**: Europe/Germany as a role model in climate change
- Consumer **energy costs** remain subject to **world market fluctuations**

Therefore, in "**Action area 4:** Establishing climate-neutral and efficient energy supply systems" it is necessary to implement **three packages of measures**. These are:

Driving forward decarbonisation of local and district heating
Optimising network operation and heat transfer
Promoting technical developments for climate neutral and efficient energy supply

5.3.2

STRATEGIC OBJECTIVE 2

Preserving the value of existing buildings, minimising the use of resources and ensuring long and intensive use of buildings

Action area 5
Reducing land requirements and using land intensively

The demand for living space per inhabitant in Germany, as shown in Chapter 4.4, has risen steadily from around 37 square metres in 1995 to 47 square metres in 2020.[137] There are many reasons for this. For example, more and more households are recorded as having a smaller number of persons, or parents remain in large family apartments or houses after the children have moved out.[138] Space that is no longer needed often remains unused or vacant.

The aim is therefore to question previous space requirements for new buildings and renovation measures and to reduce them through appropriate and sufficient planning. At the same time, it is important to increase the intensity of use and the utilisation of new and existing space in new buildings, but above all also in existing buildings, by means of efficient building utilisation. This can be implemented, for example, through the concept of multiple use, because spatial design should not be limited to one particular use; the potential benefits of multiple use must be highlighted and leveraged. Examples of the concept of multiple use include sharing common areas, parallel use of spaces by a higher number of users, use at different times, and more. In this context, it is important to create a balance between the structural prerequisites for premises that can be used in a variety of ways and adapted to changing needs and the provision of space reserves that are flexible in terms of use.

Flexible and intensive land use and the redefinition of land requirements, but also the promotion of land sufficiency, offer great potential. There are new opportunities for cooperation and networking among building users, as well as the use of synergies that can lead to resource and cost savings. Measures to promote multiple use must counteract the occurrence of rebound effects as far as possible.

The specific contribution to climate action is that by reducing the amount of land required and making more intensive use of already built-up areas, not only is the use of new land avoided; an increase in energy and resource consumption and possibly pollutant emissions caused by the construction and operation of additional buildings is also prevented.

[137] Cf. Statista (2022c). | [138] Cf. UBA (2022d).

CO-BENEFITS

- Use of **synergies, cost savings** for users
- Stronger **social networking**
- Increase of **site quality**
- **Promoting participation**, opportunities for use by financially weak stakeholders
- Energy efficiency, **reduction of resource consumption**
- **Emergence of new markets**, facilitation of market entry for new stakeholders

DISADVANTAGES OF DELAY OR NON-IMPLEMENTATION

- Creation of non-essential **emissions** due to new buildings
- Increasing **area consumption**
- **Vacancy rate** of buildings/districts

Therefore, in "**Action area 5**: Reducing land requirements and using land intensively" it is necessary to implement **two packages of measures**. These are:

Promoting land sufficiency
Promoting land efficiency

Action area 6
Preserving existing buildings or using them as a source of raw materials

Buildings consume immense resources, causing 30 percent of greenhouse gas emissions in Germany, and produce 55 percent of Germany's total waste, as shown in Chapter 4.3. The consequences of this are negative impacts on people and their livelihoods. Emissions have already been created during the construction of buildings, so buildings should be maintained for as long as possible to avoid additional emissions. Reduced resource availability and rising raw material prices also highlight the need to rethink and conserve resources already in use. For this, the building stock must be viewed as a valuable resource and as an anthropogenic (man-made) repository.According to calculations by the German Federal Environment Agency, there were 51,700 million tonnes of material in the anthropogenic stockpile in 2010. These resources must be appreciated and used for as long as possible to maintain their value. This means that building owners are in fact important resource owners. The more that can be preserved, the lower the loss in value, which is why it is important to preserve entire buildings, if possible. If this cannot be done, at least the components or resources already brought in should be reused and recycled.

The aim in this action area is therefore to preserve existing buildings wherever it makes sense from an ecological point of view and, against this background, to largely avoid demolitions. If the existing building is demonstrably not worth preserving, the objective is to preserve the value of the resources already used within it. Thus, the first step is to promote the reuse of components, construction products and materials contained in the building, and the second step is to promote their recycling.

By preserving existing buildings and raw materials already in use, the need for new construction and the need for further manufacture of construction products is reduced, thus avoiding additional climate-damaging emissions. The use of existing buildings is an essential component in achieving a climate neutral building stock and thus makes an important contribution to climate action.

CO-BENEFITS

- **Contribution to resource conservation (reuse** and recycling, avoidance of waste)
- Promotion of the greatest possible **value retention**
- Development and strengthening of **the market for reused components and construction materials as well as for secondary raw materials**
- Development and establishment of a comprehensive and cross-stakeholder **logistics system for reuse and recycling**
- Reduced amount of waste reduces the **negative impact of** the construction sector on people and their livelihoods
- **Internalisation of external costs**
- **Scaling future-proof solutions**
- **Avoidance of rising disposal and landfill costs**
- **Promotion of local value creation**
- **Creating awareness, stronger identification with** built environment, preservation as part of building culture

DISADVANTAGES OF DELAY OR NON-IMPLEMENTATION

- **Creation of non-essential emissions** due to new buildings
- Distorted image ("climate action causes costs") is maintained instead of identifying true cost drivers
- **Functional resources** become **waste**, repeated **resource consumption**
- **Pollutants** are introduced into cycles and prevent future recycling
- Sustainability is perceived as an **additional expense**
- **Dependence on imports** and **price fluctuations**
- Climate goals and targets for **resource conservation** cannot be achieved
- **Opportunities** for maximum value retention remain untapped

Therefore, in "**Action area 6**: Preserving existing buildings or using them as a source of raw materials" it is necessary to implement t**hree packages of measures**. These are:

- Questioning deconstruction and promoting long-term asset value of the existing building stock
- Promoting reuse
- Promoting the use of secondary raw materials

Action area 7
Strengthening longevity with adaptable and circular structures and components

In the past, and to some extent still today, buildings were and are planned for a limited use and lifetime. Conversion and deconstruction or the end of life are not taken into account in the planning. As a result, these buildings cannot be easily adapted to current and ever-changing needs and requirements. Buildings are therefore deconstructed, although a large part is still functional. If repurposing, conversion and deconstruction capability are integrated into the planning, the lifetime can be extended further and further in the future and cycles can be closed.

The challenge lies in an increasingly rapid change in use and in the fact that future needs and requirements are not yet known today. However, buildings can be designed to be adapted to our needs not the other way around. In this way, the building stock can create a positive contribution for people and their livelihoods. Future circularity (including aspects of longevity, ease of conversion and deconstruction) should be established as a fundamental premise. The aim is to design buildings in such a way that they can be used for as long as possible in the future, while being flexible enough to adapt to constantly changing needs and requirements. Materials and construction materials should be installed in the building in such a way that they can be removed without being destroyed and can be separated according to type after any necessary conversion or dismantling measures and are available for further cycles of use. This requires the use of materials that retain their value, are low in pollutants and emissions, and can be used in the same way at the end of their life, i.e. reused, or at least recycled. The design should therefore be based on the principle of circularity and a concept for future conversions and deconstruction should be developed. This information should be documented and available throughout the life cycle.

The specific contribution to climate action is that by extending the lifetime of buildings in the future, new construction, and thus the generation of additional climate-damaging emissions, can be avoided. By making components and construction materials available again after the end of life, the consumption of additional resources and energy is also prevented.

CO-BENEFITS

- **Waste prevention**
- **Resource conservation**
- The greatest possible **long-term asset value** is promoted
- **Availability of information** and/or transparency is ensured
- **Awareness** is raised and strengthened
- **Costly analyses are avoided** in the future
- **Scaling future-proof solutions**
- **Cost savings**

DISADVANTAGES OF DELAY OR NON-IMPLEMENTATION

- Opportunities for maximum long-term asset value remain untapped → Functional resources become waste
- Renewed **resource consumption**
- **Pollutants** are introduced into cycles and prevent future recycling
- **Information loss**: Complex future re-identification (time, costs)
- **Creation of non-essential emissions** due to new buildings

Therefore, in "**Action area 7:** Strengthening longevity with adaptable and circular structures and components" it is necessary to implement **three packages of measures**. These are:

- Establishing circular construction as a premise for planning and implementation
- Providing for deconstructability and allowing for future reuse and recycling
- Promoting convertability, repurposing, and adaptability

Action area 8
Building simply, adding on, redensifying - creating qualities using less resources

The complexity of construction is constantly increasing. Complex control and building technology leads to excessive demands on planners and building users. Composite construction also makes it more difficult to reuse individual materials or construction products or to convert the building. It is necessary to focus on the essential aspects and implement simple construction methods. The contribution to climate action consists in lower material requirements and the reuse of materials at the end of life or in potential conversion. In the event that conversion is required, in the case of a building with a simple construction, it can also be implemented more durably, flexibly and also cheaper. In addition, energy costs and CO_2 emissions are reduced through, for example, the reduced use of materials and greater reuse. In addition, the objective is to avoid soil sealing as well as urban sprawl by means of compatible

urban development additions, extensions, and redensification. The objective is to utilise vacant land in existing developments. When adding another floor to an existing building or converting the attic into living space no additional space is needed. The advantage in all the aspects mentioned is also that infrastructure is already in place and does not have to be developed again.

CO-BENEFITS

- **Lower environmental impacts** such as land and resource consumption, development effort, traffic volume
- **Less (grey) CO_2 emissions**
- **Cost savings** due to the reduced use of materials and technology
- **Maintenance, energy requirements of the technology and land requirements are eliminated**
- **More durable, more flexible, less expensive to convert**
- **Circularity** is strengthened

DISADVANTAGES OF DELAY OR NON-IMPLEMENTATION

- **Excessive demands on building occupants** (e.g. due to complex control and building technology)
- **Additional CO_2 emissions** due to new construction instead of conversions and reuse
- Additional expenditure for insulation, façades
- Poor energy balance, (retrospective) installation of sun protection necessary
- High technical effort and costs
- High conversion and renovation costs, little flexibility if use changes

Therefore, in "**Action area 8**: Building simply, adding on, redensifying - creating qualities using less resources" it is necessary to implement **two packages of measures**. These are:

Achieving simplicity in building
Adding on, extending, redensifying

5.3.3

STRATEGIC OBJECTIVE 3

Renovating existing buildings and building necessary new buildings emission-free and with climate positive materials

Action area 9
Manufacturing climate action-oriented, carbon-free materials and products

In addition to the construction, modernisation and renovation, as well as the operation and use of buildings, there are other areas that should be considered in order to achieve climate positive building stock. The entire life cycle of a building must be brought into focus, from the production of the construction materials to the conversion, deconstruction or end of life of a building. It is crucial to consider the grey energy and the resulting GHG emissions. According to a study by BBSR (2019), a typical new building generates 10 to 16 kg CO_2e per square metre in terms of grey or built emissions. In total, construction materials in building construction generate approx. 45 million t CO_2e per year. In addition to operational emissions, it is therefore important to avoid new material-bound CO_2 emissions, to adequately appreciate CO_2 emissions that have already been "used" in existing buildings and to preserve them in existing buildings or the materials and to install materials and solutions in the future that act as carbon stores and sinks.

If, in the future, not only climate neutral materials and products were used for conversion, renovation and new construction, but materials that also remove CO_2 from the atmosphere during production or use, we could transform our building stock from the largest CO_2 emitter to a powerful carbon sink. Existing production processes must be questioned, rethought and operated with renewable energy sources. Likewise, research and promotion in the field of alternative processes and the use of green hydrogen in the construction materials industry must be pursued.

CO-BENEFITS

- **Reduced use of resources**
- **Lower demand for energy and electricity**: among other things, lower costs, fewer dependencies
- **Transparency** and thus **information** for all stakeholders
- **Innovation in the economy is strengthened**, low-CO_2 products are produced

DISADVANTAGES OF DELAY OR NON-IMPLEMENTATION

- **Climate goals are not** met, especially in the (construction materials) industry
- Measures **with high CO_2 emissions** are promoted
- **Business area is occupied by other** experts
- Continued **dependence** on imports
- **No understanding of** climate effectiveness of

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- **Reputation and image of German research are strengthened** (e.g. in the field of green hydrogen or CCU and CCS)
- Being eligible for **new grants** (sustainability class)
- **New business areas**, competitiveness is increased

own projects and measures
- **Lack of acceptance of** the method and no roll-out in political decisions

Therefore, in "**Action area 9**: Manufacturing climate action-oriented, carbon-free materials and products" it is necessary to implement **three packages of measures**. These are:

Manufacturing climate action-oriented, carbon-free and cycle-oriented materials and products
Implementing climate action-oriented, carbon-free production processes
Creating transparency regarding the greenhouse gas intensity of products

Action area 10
Planning and implementing climate action-oriented renovations and new buildings

In order to plan and implement renovations and necessary new buildings in a climate action-oriented manner, all those involved need to be appropriately qualified. Among other things, it must be ensured that planners and consultants are capable of calculating and correctly interpreting life cycle greenhouse gas balances. Owners and builders also need to be aware of the importance of such calculations. In addition to the competence for life cycle greenhouse gas balances, it is also necessary to build up competencies for climate action-oriented, cooperative as well as digitally supported design and implementation in order to exploit economies of scale through pre-production and serial construction. Sequential renovation can put buildings on a climate positive path much more quickly.

Another important point is to promote and achieve climate-friendly construction site processes, since construction site processes cause large amounts of CO_2 emissions and particulate matter. This can lead to damage to the health of those working on construction sites and those living nearby. This includes transport to construction sites, use of equipment and construction machinery, the entire construction site logistics, but also processing steps and waste. Optimisation of the construction process and the use of emission-free machines and vehicles are just one step towards avoiding CO_2 emissions. In addition to emissions, there is also a dependence on imports if renewable energy sources are not used. The specific contribution to climate action lies in the fact that all those involved are sensitised and qualified to implement planning and execution in a climate action-oriented manner through the appropriate development of capacities, qualifications and knowledge, and that serial renovation is carried across the board.

CO-BENEFITS

- Serial renovation and pre-production will achieve **climate positive building stock/climate goals** more quickly
- **Transparency, information** and **qualification of** all stakeholders
- **Material efficiency** on construction sites and thus **lower costs**
- **Data transparency and availability** through digitisation
- **Independence** from imports, rising disposal costs and price increases
- **Circular construction is increased**
- **Contribution to the energy transition**: public signal, reputation
- **Attractiveness of the occupational field is increased**, the range of services offered can be extended
- **New business areas** can be opened up, economies of scale, capacities can be planned, faster implementation
- **Higher scaling** and **increased productivity**
- **Design possibilities** in projects can be achieved

DISADVANTAGES OF DELAY OR NON-IMPLEMENTATION

- Massive **capacity and supply bottlenecks**
- **Wrong decisions** due to uninformed action
- Loss of recognised competencies as a technical solution provider and migration of skilled personnel and companies
- -> **Insufficient speed** to realise the potential
- **Health damage** due to particulate matter and emissions
- **Rising waste disposal costs** make construction and renovation more expensive; lack of preparation for upcoming regulation from EU Waste Directive
- **Price increases**, risk of future **bans**
- Dependence on voluntary measures, failure to meet targets
- **Reduced ability** to **plan the energy transition**
- **Ignorance regarding climate potentials**
- Implementation of specifications from external parties, **no own solution competence, not** very attractive professional field
- Myth "climate neutral buildings only exist for the wealthy", no own solution competence
- Failure to consider "low-hanging fruits", risk of imported standard solutions from other countries with **lower quality**
- Further **small-scale work**, time-consuming individual documentation and accompanying processes (legal, administrative)
- Business area is staffed externally

Therefore, in "**Action area 10**: Planning and implementing climate action-oriented renovations and new buildings" to implement **four packages of measures**. These are:

Informing and qualifying stakeholders and creating a basis for decision-making
Exploiting economies of scale through pre-production and serial construction and building up capacities in a targeted manner
Implementing climate-friendly construction site processes, efficient logistics and climate-friendly transport
Contributing climate action expertise through cooperative and digitally supported (implementation) planning

Action area 11
Using buildings as carbon sinks and stores

Conventional buildings are very energy and resource intensive in the manufacturing and disposal phases. It is necessary to focus on alternative raw materials in circular structures, which are currently given little consideration. Natural insulating materials, for example, only account for up to 7 percent of the insulating materials market.[139] The field of alternative construction materials and processes should be researched and promoted more.

Renewable raw materials such as wood can be used as façades, doors and windows or as a whole structure. But alternative insulating materials such as flax, jute, hemp, straw, cork, and cellulose, natural paints or natural construction materials such as clay and lime can also be used. Such construction materials made from alternative, renewable raw materials have the potential to store CO_2 for a significant period of time. Even in their extraction and production phases, little energy is usually required. In addition, renewable raw materials contribute to good indoor air quality, as they do not emit any substances of concern. Buildings made of renewable alternative construction materials have great potential to become carbon sinks. This storage capacity should be used and additionally strengthened by suitable roof and façade greening.

The protection of soils should also be taken into account in construction projects, as peat soils in particular have immense CO_2 storage capacities. Sealing of natural soils always leads to a reduction in climate change mitigation, even if it seems small compared to the emissions from construction activities. Therefore, consideration should be given to soils and biodiversity on construction sites, new construction should be questioned, and new sealing should be avoided. Natural soils must be preserved and strengthened, but carbon capture and usage (CCU) as well as carbon capture and storage (CCS) technologies, which can extract CO_2 from the atmosphere and deposit it, must also be taken into account and their potential must be used more in the future.

[144] Cf. DUH (2016).

CO-BENEFITS

- Good **indoor air quality** (less adverse health effects)
- **Resource availability** through the use of alternative materials
- **Reputation and image of German research are strengthened** (e.g. in the area of CCU and CCS), innovation driver
- **Climate change adaptation**: Formation of heat islands is prevented by building greening
- **Biodiversity is promoted** through building greening
- **Habitats and biodiversity are protected**
- Carbon sinks are created and thus **CO_2 is stored**

DISADVANTAGES OF DELAY OR NON-IMPLEMENTATION

- **Loss of biodiversity** and climate action performance due to sealing of areas/soils
- Due to lack of soil and peatland protection: **Release of large amounts of CO_2**
- **Loss** of **technology leadership**
- Reputation loss

Therefore, in "**Action area 11**: Use buildings as carbon sinks and stores", **two packages of measures** are to be implemented. These are:

Identifying and implementing effective carbon sinks and stores in construction projects
Expanding research into carbon sinks and stores in the construction sector and bringing it into use as quickly as possible

5.3.6

STRATEGIC OBJECTIVE 4

Creating political and financial framework conditions for transformation

Action area 12
Setting the course for immediate climate action in the building sector at regional and national level

Strong national, regional and local policies focused on climate action are essential. Political stakeholders have a responsibility to create the framework conditions for this, as well as to question existing legal foundations and adapt them in a climate action-oriented manner. In many areas, the course for prioritising climate action has not yet been properly set, leaving individual stakeholders unable to act.

The building stock is in poor condition in terms of energy: sixty-eight percent of the buildings were pre- or post-war, and the renovation rate is too low, at one percent.[140] Framework conditions must be created and adapted that contribute to an increase in the renovation rate and strengthen the use of climate-friendly energy. Land use must also be reduced through climate action-oriented, sustainable settlement development, land and property policies. In this context, public planning and procurement must also be considered, as there are no generally applicable minimum requirements in the area of climate action.

It is also necessary to adapt infrastructures and develop climate action-oriented infrastructure concepts. The tools available are knowledge transfer, cooperation, consulting, communication, education, and subsidies, in addition to necessary legal requirements. Positive incentives must be set through such soft levers for better and longer-term social acceptance.

CO-BENEFITS

- **Role model function** is adopted and strengthened
- Public, strong signal for stronger climate action (national and international)
- **Pioneering role** is adopted and maintained
- I**ncrease in quality of life** and **satisfaction/ acceptance**
- **Job** creation
- Contribution to **resource conservation**
- **Independence** from imported products
- Contribution to the **energy and heat transition**
- **Reduction of area consumption and development effort**, thereby protecting/promoting biodiversity and habitats
- Transport: Cross-sectoral evaluation also has positive effects in the transport sector; new acquisition/need for own car is questioned; less motorised individual transport = fewer **mobility emissions**

DISADVANTAGES OF DELAY OR NON-IMPLEMENTATION

- **Climate goals will not be achieved!**
- **Economic damage**, e.g. due to extreme weather events
- Possibly high (fine) **payments** e.g. due to exceeding CO_2 values, non-achievement of climate goals
- **Reputational damage**
- **Species extinction and biodiversity loss** (accompanied by low production rates in the agricultural sector)

Therefore, in "**Action area 12**: Set the course for immediate climate action in the building sector at regional and national level" **nine packages of measures** are to be implemented. These are:

Increasing renovation rate
Creating framework conditions for the use of climate-friendly energy
Amending the Building Energy Act (GEG)
Climate action-oriented, sustainable settlement development, land and real estate policy
Enabling conservation and seeing buildings as a source of raw materials and building in a circular way
Promoting and demanding climate positive materials, products and production processes
Strengthening knowledge transfer, cooperation and information sharing
Strengthening climate-friendly infrastructure
Questioning existing legislation and adapting it in line with climate action requirements

[145] Cf. UBA (2019), p. 8.

Action area 13
Putting municipalities on a climate positive course

As mentioned in the previous action area 12, strong national, regional and local policies focused on climate action are indispensable. At the municipal level, too, framework conditions must be adapted and created to enable all stakeholders to act. To reliably put municipalities on a climate positive course, it is necessary to anchor climate action more firmly in public planning and procurement. In this context, it is important to optimise or introduce new public sector instruments to achieve climate neutral use of public sector properties as well as for citizens' (residential) buildings. In addition, a climate action-oriented, sustainable settlement development, land and real estate policy must also be established at the municipal level. Public procurement in particular should be geared towards this. The aspect of climate adaptation and protection against extreme weather events must also be taken into account. This includes the prevention of heat islands, the preservation or protection of natural sinks and planting on buildings. In addition, infrastructures must be adapted to the objective of climate action. This applies to both the transport infrastructure and the waste disposal infrastructure.

CO-BENEFITS

- **Role model** function is adopted and strengthened
- **Increase in quality of life** and **satisfaction/ acceptance**
- **Job creation**
- Contribution to **resource conservation**
- **Independence** from imported products
- Contribution to the **energy and heat transition**
- **Carbon sinks are preserved/protected**

DISADVANTAGES OF DELAY OR NON-IMPLEMENTATION

- **Economic damage**, e.g. due to extreme weather events
- Possible high (fine) **payments** e.g. due to exceeding CO_2 values
- **Heating up of the city climate, photochemical smog**
- **Reputational damage**
- **Species extinction** and **biodiversity loss**

Therefore, in "**Action area 13**: Putting municipalities on a climate positive course" it is necessary to implement **five packages of measures**. These are:

- Achieving climate neutral municipality/city - focus on buildings
- Climate action-oriented, sustainable settlement development, land and real estate policy
- Enabling preservation of existing buildings, seeing buildings as a source of raw materials, building circularly and use land intensively
- Adapting to climate change and protecting against extreme weather events
- Achieving climate-compatible infrastructures (mobility, waste, and heat)

Action area 14
Promoting and financing sustainable solutions

In order to implement the climate goals of decarbonising all sectors by 2045 and to achieve the climate goals of the building sector, a rethink in the area of financing and funding is required in addition to the action areas mentioned above. For the construction and real estate sector, the topic of sustainable finance is a key factor in the transformation toward greater sustainability.

With the ESG criteria and the EU taxonomy, the first steps have already been taken in the area of sustainable financial markets, as also presented in Chapter 4.1.3. However, financial market participants, investors, building owners, policy-makers at national and regional level, as well as investors and funding bodies must go far beyond this in order to achieve sustainability and transformation in the building sector. In addition, national and regional policy-makers, as well as investors and funding bodies, are called on to align their subsidy policy in a climate-friendly manner and, in particular, to further develop the content of the BEG programme, as well as to make subsidies available for heating networks, land-saving housing and qualification of stakeholders. Furthermore, investments and loans must be geared to climate action.

CO-BENEFITS

- Germany's financial market are made future-proof
- **Investors** focused on long-term success are attracted
- **Climate transformation is secured** through private funding and new financing models
- Marketing, identification of potential for improvement

DISADVANTAGES OF DELAY OR NON-IMPLEMENTATION

- **Climate action goals not met,** potential **penalties**
- **Measures (e.g. renovation) are not taken, massive loss of value of existing buildings**
- **Migration of relevant investors** to sustainably designed financial markets
- **No visibility of good solutions**

Therefore, in "**Action area 14**: Promoting and financing sustainable solutions" it is necessary to implement **three packages of measures**. These are:

- Creating sustainable financial markets
- Aligning funding policy with climate action
- Aligning investments and loans with climate action

Action area 15
Reducing subsidies harmful to the climate and aligning tax policies with climate action

If Germany is serious about pursuing the objective of climate neutrality, all subsidies that are harmful to the climate and the environment must be ended immediately. Funds no longer tied-up should go toward incentives for energy-efficient, climate action-oriented renovations, such as tax relief and subsidies. Further climate action-oriented subsidies and taxation, such as taxation of fossil fuels, should also be ramped up. In addition, CO_2 pricing must be further developed and CO_2 shadow prices must be taken into account when calculating the profitability of a project. CO_2 shadow prices can also be seen as a form of future pricing, since any higher (fuel) prices or damage caused are taken into account in planning as an internalisation of external costs. This is the only way to ensure, for example, that investors have a fully comprehensive picture of project life cycle costs. Furthermore, it is necessary to revise the current urban development policy and to take measures for a climate-friendly handling of soils as CO_2 storage.

CO-BENEFITS

- **Financial relief for** socially disadvantaged **population groups**
- **Non-profit use of taxpayers' money** for hazard mitigation through climate change reduction
- **Reliable cost calculations** for investors
- Biodiversity is promoted through soil conservation
- **Resource savings** through taxation or subsidies
- **Cross-sector trade** becomes possible
- **Waste prevention** and **resource conservation**

DISADVANTAGES OF DELAY OR NON-IMPLEMENTATION

- **Reputational damage and distorted awareness of** the population by setting false incentives through **climate-damaging subsidies**
- **Massive bad investments**
- **Risk of compensation claims**
- **Less revenue** for public sector: other sources of income must be found

Therefore, in "**Action area 15**: Reducing subsidies harmful to the climate and aligning tax policies with climate action" it is necessary to implement **two packages of measures**. These are:

- Introducing climate action-oriented tax relief and subsidies
- Reducing land consumption through climate action-oriented land and property policy

5.4 OVERVIEW OF THE TOP 50 MEASURES

The measures presented in this section represent an excerpt - the "Top 50 measures" - from the entire list of measures presented in Part 2 . In the authors' opinion, these top 50 are the most effective measures that can no longer be postponed and where there are no barriers. The measures identified should be immediately implemented widely by the relevant stakeholder groups so that decarbonisation of the building stock can be achieved as quickly as possible. The top 50 must therefore be implemented with priority, and the other measures, presented in Part 2, should be addressed immediately thereafter.

A more detailed description of the measures with the respective reference as well as an assessment of the climate impact, temporal effectiveness and feasibility is presented in the DGNB guide **"Our path to climate positive building stock - part 2"**. The measures can be found via the action area and measure number.

STRATEGIC OBJECTIVE 1

Eliminating emissions associated with energy consumption and making a positive contribution to the energy transition with renewable energies

Action area 1
Capturing the current situation with climate action roadmaps and planning climate neutrality in specific terms

1–1	Determining **energy and climate action-relevant status quo** for each building.	• Planners and consultants • Building owners
1–3	**Identifying** all **potential** for climate action-optimised operation and **implementing low-investment optimisation measures immediately.**	• Planners and consultants • Building owners
1–6	Creating **climate goal-compatible, specific renovation or climate action roadmaps** with the objective of climate positive operation for each building and drafting specific action plans for each property. For large stocks of existing buildings: Prioritising by building type, only drafting detailed climate action plans in a second step.	• Planners and consultants • Building owners
1–7	Implementing **measures according to climate action roadmaps** (step by step). Setting interim targets and reviewing them regularly, ideally externally validated through sustainability certification of building operations.	• Planners and consultants • Building owners • Contractors

Action area 2
Reducing energy demand and consumption of buildings

2–1	**Clearly communicating ambitious energy and CO_2 objectives** at the start of each project and taking them into account at all design and planning stages. Determining the energy balance together with a CO_2 balance for all planned renovations and conversions	• Planners and consultants • Building owners
2–4	Implementing **all renovations** with high **energy efficiency** (in terms of final energy) and/or **LT-ready** (operation with low-temperature systems) and the objective of climate positive operation to avoid lock-in effects. Applying either individual solutions or - for acceleration - **serial solutions.**	• Planners and consultants • Building owners • Contractors
2–5	Promoting **training of professionals** for more and better **climate change competencies.** Intensifying and promoting **interdisciplinary collaboration** and exchange. Establishing a positive error culture to share lessons learned.	• Science and knowledge providers • Manufacturers • Municipalities • Building operators and facility managers
2–6	**Demand reduction:** Investigating as part of the demand planning process of all new construction projects whether new construction is actually necessary. In doing so, taking into account CO_2 emissions of the construction measure and the operation, give preference to activation of existing facilities or alternatives for meeting the demand without or only with minor construction measures.	• Planners and consultants • Building owners
2–9	Setting **high climate action requirements** for necessary **new construction.** Implementing projects at least meeting "EH 40" standard (according to innovation clause GEG) and climate neutral-ready, and preparing climate neutral supply by 2045 at the latest. To this end, drawing up and implementing ambitious climate action roadmaps and preparing appropriate measures.	• Planners and consultants • Building owners • Contractors
2–15	**Existing buildings: Optimally exploiting the efficiency and savings potential of existing building and supply technology and optimising energy use.**	• Planners and consultants • Building owners • Contractors
2–17	**Upgrading/improving heating and cooling systems,** replacing inefficient systems and preparing for or using LowEx systems (low energy systems, low temperature (LT) ready).	• Planners and consultants • Building owners • Science and knowledge providers • Contractors

[141] See DGNB guide "Our path to climate positive building stock - part 2", at www.dgnb.de/wegweiser.

Action area 3 Using 100% renewable energies and acting as an active element in the energy transition		
3–1	**No operation or installation of fossil-fuelled heating systems;** planning and implementing removal of existing systems.	• Planners and consultants • Building owners • Contractors
3–2	**Implementing heat supply completely using renewable energies or preparing for it.**	• Planners and consultants • Building owners • Contractors
3–4	**Activating all suitable roof areas and other suitable areas f**or the installation of **photovoltaic systems** or, where appropriate, solar thermal systems.	• Planners and consultants • Building owners • Contractors
Action area 4 Establishing climate-neutral and efficient energy supply systems		
4–1	Increasing **share of renewables in district heating production** and grids (target: 100 percent) taking regional conditions and infrastructures into account. In addition, increasing network efficiency and minimising line losses.	• Energy providers • Municipalities
4–9	**Long-term planning: Converting infrastructures** currently tailored to fossil energy sources for climate neutral energy sources.	• Municipalities • Building owners • Energy providers

STRATEGIC OBJECTIVE 2

Preserving the value of existing buildings, minimising the use of resources and ensuring long and intensive use of buildings

Action area 5 Reducing land requirements and using land intensively		
5–1	Reducing **space requirements** per person or alternative reference unit through appropriate and sufficient planning; raising awareness of renters/owners for spatial change.	• Planners and consultants • Building owners • Municipalities • Users
Action area 6 Preserving existing buildings or using them as a source of raw materials		
6–6	In the case where existing building fabric needs to be deconstructed, calling for tenders for **selective deconstruction** with the aim of recycling mineral demolition waste and removing components contaminated with pollutants. Checking implementation of selective dismantling.	• Building owners • Municipalities • Planners and consultants
6–18	Requiring and using **secondary/replacement/recycled (RC)** construction materials in all construction projects, aiming for a high overall percentage in buildings, and avoiding composite materials with low recycling potential.	• Manufacturers • Planners and consultants • Building owners
Action area 7 Strengthening longevity with adaptable and circular structures and components		
7–3	Consistently integrating **circularity** into the individual **service phases**, using it as the basis for determining variants in accordance with Official scale of fees for services by architects and engineers (HOAI), and integrating it into call for tenders and award of contract.	• Building owners • Planners and consultants
7–9	Creating deconstruction- and recycling-oriented **digital building documentation** in the form of **"building resource passports"**, storing them permanently and making them available at governmental level.	• Planners and consultants • Building owners • Manufacturers • National and regional policy-makers • Municipalities
Action area 8 Building simply, adding on, redensifying - creating qualities using less resources		
8–9	Leveraging **housing potential** through **interior development** of non-residential buildings: • Vertical, integrated redensification • Implementation of integration concepts • Conversion of the overhang • Addition/vertical redensification	• Planners and consultants • Building owners • Municipalities • Contractors

STRATEGIC OBJECTIVE 3

Renovating existing buildings and building necessary new buildings emission-free and with climate positive materials

Action area 9 Manufacturing climate action-oriented, carbon-free materials and products		
9–3	Selecting and handling materials in a climate action- and cycle-oriented manner in the manufacture of construction materials, products, and systems: • Using low-CO_2 materials or raw materials in products • Using alternative raw materials/materials • Using secondary raw materials • Developing and offering products with low material consumption • Avoiding internal production losses • Avoiding production offcuts and waste	• Manufacturers • Science and knowledge providers

9–5	Obtaining **quotations** for demonstrably **CO_2-reduced products/ construction materials** and always use them in renovations and necessary new buildings.	• Manufacturers • Planners and consultants • Contractors • Knowledge providers, Green Building Councils
9–6	**Closing cycles** for all construction materials and products: • Optimising logistics, recording and collection of recyclables and materials for recycling or reuse from demolition and construction site processes • Developing markets for secondary materials and digital networking of the supply and process chains • Recovering as many recyclable materials as possible from recycling • Creating reuse and recycling routes • Providing digital material passports or extended EPDs making them available as IoT (Internet of Things) solution with adequate information	• Manufacturers • Contractors • Planners and consultants
9–11	**Not offering climate action-oriented products/materials/systems in the overall portfolio at a higher price than the standard market variants** (e.g. via internal subsidisation). Not aligning pricing policy with higher willingness to pay.	• Manufacturers
9–15	Driving **fuel switching** in production: • converting to renewable energy sources • using waste-derived fuels with higher biogenic content • substituting fuel-fired furnaces with electric furnaces	• Manufacturers • Science and knowledge providers
9–21	**Voluntarily disclosing greenhouse gas intensity** of the entire product portfolio or obtaining **certification**. Obtaining certification of "low greenhouse gas" components, products, and construction materials with an accompanying communication campaign.	• Manufacturers • Science and knowledge providers
	Action area 10 Planning and implementing climate action-oriented renovations and new buildings	
10–1	Calculating and optimising **life cycle CO_2 balance** for each project, considering alternatives. Step 1: Achieve transparency. Step 2: Fall below defined maximum values for CO_2e in each project. Step 3: Reduce maximum values successively.	• Building owners • Planners and consultants
10–17	Proactively offering and implementing **serial renovation** on all (appropriate) projects. Checking feasibility as well as advantages and communicating them.	• Contractors

	Action area 11 Using buildings as carbon sinks and stores	
11–1	Strongly **supporting** the use of **materials** made from (rapidly) **renewable and other CO_2-absorbing solutions and raw materials** in new construction and renovations.	• National and regional policy-makers • Municipalities • Investors and funding bodies
11–10	**Advancing research** for fundamentals and potentials of carbon sinks in the construction industry and **identifying innovations.** Ensuring rapid transfer of knowledge into practice and increasing industry motivation for research.	• National policy-makers • Manufacturers

STRATEGIC OBJECTIVE 4

Creating political and financial framework conditions for transformation

	Action area 12 Setting the course for immediate climate action in the building sector at regional and national level	
12–2	**Gradually introducing minimum energy standards and minimum greenhouse gas standards for all building types under the Buildings Energy Act (BEG).** Announcing sanction options for non-achievement of energy targets with date and efficiency classes and introducing them as soon as possible.	• National and regional policy-makers • Municipalities
12–8	**Creating a framework and providing funding** to strongly encourage serial renovation and capacity building for it.	• National and regional policy-makers
12–9	**Preventing** climate-damaging **"replacement new buildings."** • Providing **no funding for new buildings** that have disadvantages from a climate action perspective compared to existing building activation/renovation. • Introducing mandatory use of a "conservation before replacement" **decision cascade** • Introducing and requiring **demolition permits** that use life cycle greenhouse gas balances and life cycle cost analysis as a basis and allocate demolition and disposal emissions to subsequent construction.	• National and regional policy-makers • Municipalities
12–13	Establishing a **central database for energy performance certificates**, where GHG emissions and renovation/climate action roadmaps are stored. Using findings from statistical evaluations for active control.	• Investors and funding bodies

12–14	**Expanding and developing Federal Funding for Efficient Buildings (BEG) programme:** introducing climate neutral/climate positive renovations and new construction. Demanding quality assurance via certifications. Promoting measures to achieve low-temperature (LT) ready standards and switch to renewable energy, heat pumps, climate-friendly/energy-producing façade elements more strongly.	• National and regional policy-makers
12–20	Issuing **new building permits** only for climate neutral operation (according to EPBD draft 2022 "net zero emission buildings"). Alternatively, issuing new building permits only for plans with climate action roadmap "2025/2030 climate neutral".	• National and regional policy-makers
12–21	Introducing **obligation** to install **photovoltaic systems** in new buildings and renovations, and reducing bureaucracy.	• National and regional policy-makers
12–51	Reference measure 10-2 for 12-51 **Making life cycle greenhouse gas balances for buildings the basis for approval of new construction/renovation projects.** Step 1: Demand transparency. Step 2: Require undercutting of maximum CO_2e values, both based on calculation models and measured in operation. Step 3: Reduce maximum levels successively to meet climate goals.	• National and regional policy-makers • Planners and consultants
12–64	Create obligation to expand **climate neutral heating networks**: Require municipal utilities/providers to expand and simultaneously transform to climate neutral generation.	• National and regional policy-makers • Municipalities

Action area 13
Putting municipalities on a climate positive course

13–1	Anchoring of **ambitious climate action** and sustainability aspects in municipal/city **sustainability plans/guidance documents/climate guidelines/service instructions** or similar.	• Municipalities • Science and knowledge providers
13–18	**Tendering/awarding of own design/build services:** Integrating environmental and social aspects in the subject matter of the contract and the specifications, considering qualitative evaluation criteria, requesting price optimisation over the life cycle, qualification of bidders, reuse.	• Municipalities • National and regional policy-makers
13–29	Reference measure 13-29 for 6-9 and 7-8 When issuing **building permits**, requiring proof of the **use of reused components/construction products** and submission of a **deconstruction plan/deconstruction concept** with the objectives of long-term asset value, reusability, and recyclability.	• Municipalities • National and regional policy-makers • Investors and funding bodies

Action area 14
Promoting and financing sustainable solutions

14–1	Self-commitment: Financial market participants voluntarily go **far beyond** the climate-relevant **EU taxonomy criteria for buildings and individual measures** for all contracts. Defined limits for life cycle GHG emissions are complied with. Using **transparency** on climate impact and risks for all existing building stocks as a basis for decision-making and pricing in impending loss of value due to climate risks.	• Investors and funding bodies • Investors, building owners
14–3	Developing and offering **financial products for climate transformation**: transformation loans, sustainability-linked loans, KPI-linked loans, etc. - based on individual climate action roadmaps.	• Finanz- und Fördermittelgebende • Investoren, Bauherr- und Eigentümerschaft
14–12	**Further developing the content of the BEG programme with a focus on existing buildings:** massively increasing subsidies for building stock transformation and promoting renovation measures within the framework of ambitious climate action roadmaps (e.g. climate neutral operation anticipated from 2030) with additional grants or concessionary loans. In addition, promoting the actual implementation of greenhouse gas-neutral operations or very low GHG emissions in operations, as verified by monitoring, with grants or bonuses. Additionally promoting low building-related CO_2 emissions.	• National and regional policy-makers
14–16	For **housing initiatives** (400,000 homes/year), making funding **authorisation requirement** that **at least 50%** be met from **revitalisations, vacancy reduction, additions, conversions, and extensions** to existing housing stock.	• National and regional policy-makers • Investors and funding bodies

Action area 15
Reducing subsidies harmful to the climate and aligning tax policies with climate action

15–1	**Promoting energy-efficient and climate action-oriented retrofits** by providing incentives to homeowners in the form of **tax relief and subsidies**, e.g., VAT waivers or reductions for energy renovations.	• National and regional policy-makers • Investors and funding bodies
15–4	In general: **Eliminating all subsidies that are harmful to the climate and the environment**. To do this, putting all subsidies to the test.	• National and regional policy-makers • Municipalities

6 Climate positive building, operation, renovation
The tools

In addition to the many measures included in this document and the accompanying tools, it is important to note that many implementation tools already exist and that there is no need to start from scratch. The following is a selection of tools that can make important contributions to climate positive building, operation and renovation.

TOOLS

1. Raising awareness with regard to sustainability

DGNB Wissensstiftung

The website of the DGNB Wissensstiftung norocketscience.earth provides compact knowledge modules on the topic of sustainability in an understandable form. The point is to find an easy entry point and get straight to work. The necessary knowledge and the right approaches already exist today to achieve the visions and objectives of a circular economy, biodiversity, climate neutrality and healthier living conditions. With the support of experts who make their expertise available on the platform, interested employees can deepen their knowledge here and gather new impetus. The website is currently available in German only.
www.norocketscience.earth

Training from the DGNB Academy

Here, specialist knowledge is imparted in a practical manner at a wide variety of requirement levels. In addition to specific topic-related training and education, the offering also includes information on new policy frameworks such as sustainable finance and taxonomy, as well as the Federal Funding for Efficient Buildings (BEG). You can find an overview of the various offerings in the Academy's calendar of events. In addition, the DGNB Academy also offers individual workshops customised for companies, in which their own objectives and content can be defined.
www.dgnb-akademie.de/academy-international

Framework for carbon neutral buildings and sites & "Climate neutral building" toolbox

The DGNB's Framework for carbon neutral buildings and sites makes a significant contribution to making the practical decarbonisation of the building stock feasible by 2045. In the framework, the DGNB has compiled its definition of climate neutrality and the associated explanations regarding procedures and strategies. The objective of the document is to create clarity in the market and to educate all stakeholders involved in the design, construction, operation and management of real estate regarding effective optimisation approaches to reduce GHG emissions.

To ensure that the transformation of the building stock can succeed, we have compiled a toolbox that provides relevant stakeholders in the construction and property industry with key information, recommendations for action and tools to help shape the process and design, construct and operate buildings and districts in a climate neutral way.
www.dgnb.de/en/council/publications/order/

Circular Economy

There are a wide variety of levers for implementing the concept of the circular economy in the construction and property industry. In its report “Circular Economy - Closing the loop means being fit for the future ", the DGNB has compiled a list of these issues and the stakeholders who need to be involved, and in what form. The report provides building owners and planners with a toolbox that shows how the concept of the circular economy can be implemented in a project.
www.dgnb.de/en/topics/circular-economy/

EU Level(s) reporting framework & DGNB System Renovation: Level(s) classification

Level(s) is a voluntary European framework for recording sustainability qualities over the entire life cycle. The EU Commission has prepared information on this reporting framework in a way that is suitable for the target group and has also explicitly emphasised the benefits for construction product manufacturers. The European Commission provides a detailed insight into the work with Level(s). The EU eLearning tool prepares step by step to use the framework. To understand the function of level(s), it is essential to relate this reporting framework to various existing certification systems. As part of the LIFE Level(s) project, the DGNB conducted a comparison and found a high level of compatibility, which will be further explored in the future. The results of this comparison are documented in the “Crosswalk System Sanierung & Level(s) EU-Rahmenwerk ”. The information is currently available in German only.
www.dgnb.de/life-levels

Sustainable finance

For the construction and real estate sector, the topic of sustainable finance is a key factor in the transformation toward greater sustainability. The DGNB has compiled a toolbox that includes an overview of the background, context and key terms. In addition, we present a number of DGNB activities and offerings on the topic, which you can use in your work and for your projects.
The joint study on the EU taxonomy by the DGNB and the Green Building Council España (GBCe), the Österreichischen Gesellschaft für Nachhaltige Immobilienwirtschaft (ÖGNI) and the Green Building Council Denmark (DK-GBC) shows that companies are only partially prepared for the requirements. Certified projects perform better in terms of their degree of fulfilment and assessment efforts. The information is currently available in German only.
www.dgnb.de/de/themen/sustainable-finance/

2. Integration of sustainability in construction projects

DGNB Handreichung für eine nachhaltigkeitsorientierte Planung und Beschaffung (Handbook on sustainability-oriented planning and procurement)
The DGNB “Handreichung für eine nachhaltigkeitsorientierte Planung und Beschaffung” is aimed at public and private developers.
To be found under "Publikationen zum Klimaschutz" at:
www.dgnb.de/de/themen/klimaschutz/toolbox/

“Klimapositive Städte und Gemeinden” (Climate positive municipalities) initiative
The "Klimapositive Städte und Gemeinden" initiative was founded in 2020 by the DGNB and eleven municipalities (co-initiators). The initiative now has 50 members. The aim is to initiate an exchange of knowledge around sustainability topics between municipalities, to jointly develop pragmatic solutions and to learn from each other. Participation is free of charge for all municipalities, regardless of their size or previous experience with sustainability issues. DGNB membership is also not a prerequisite. Target groups of the initiative are mayors, climate action managers and other persons who want to promote the topics of sustainability and climate action in their municipality. In the info video you can get a first impression.
www.klimapositivestadt.de

Phase Nachhaltigkeit
The Declaration of Sustainability in Architecture and the Declaration of Sustainability in Interior Design support the definition of individual project objectives and priorities. The structure of the declarations can serve as a discussion guide with planners and the developer; the collected suggestions can later be incorporated into the formulation of the planning contract. The early planning phases in construction projects in particular should be used to set ambitious yet realistic targets. This is where the greatest leverage exists on the subsequent environmental performance and sustainability qualities of the building.
www.phase-nachhaltigkeit.jetzt

Field-tested benchmarks of the DGNB
Developed as a planning and optimisation tool for assessing sustainable buildings and districts, the DGNB System helps to demonstrably increase real sustainability in construction projects, across all planning and construction phases. The DGNB Certificate is unique worldwide and is one of the most internationally recognised certification systems for sustainable building.
www.dgnb-system.de

Climate Positive award
One tool is the DGNB System for Buildings in Use. Whether for individual buildings or entire portfolios: As a transformation and management tool, it helps in a very practical, way to develop a sustainable, future-proof real estate strategy - for more climate action, and reduced risk of bad investments. Buildings that are already operated in a climate neutral manner can receive the "Climate Positive" award in addition to the DGNB Certificate. It recognises the positive contribution that these buildings are already making to achieving climate action goals. We present some case studies here.
www.dgnb.de/klimapositiv

Federal Funding for Efficient Buildings (BEG)
The DGNB Certificate can be used to gain access to the Federal Funding for Efficient Buildings (BEG). You can find all current information on the BEG programme here:
www.dgnb.de/beg-foerderung

3. Integration of sustainability at product level

Environmental Product Declarations & EPD programmes
EPDs provide life cycle assessment information of construction products in a standardised, traceable format. EPDs can thus be used to make the right planning decisions for ecological building quality. The association Institut für Bauen und Umwelt e.V. makes the product declarations available on its platform.
www.ibu-epd.com

DGNB Navigator
Make a strong statement in terms of sustainability as a manufacturer and present your products in the DGNB Navigator by providing the product characteristics which are relevant for planning and DGNB certification. Clearly documented product characteristics show your target audience all relevant information at a glance as well as support planners and architects in making product decisions.
www.dgnb-navigator.de

List of abbreviations

BBSR	Federal Institute for Research on Building, Urban Affairs and Spatial Development
BEG	Federal Funding for Efficient Buildings
BMWK	(Federal Ministry for Economic Affairs and Climate Action
CCS	carbon capture and storage
CCU	carbon capture and utilisation
CG	cost group
CO_2	carbon dioxide
COP21	Paris Climate Change Conference
COP26	UN Climate change Conference
DGNB	German Sustainable Building Council
DK-GBC	Green Building Council Denmark
DNSH	Do no significant harm
EED	Energy Efficiency Directive
EEWärmeG	Act on the Promotion of Renewable Energies in the Heat Sector (Erneuerbare-Energien-Wärmegesetz)
EH	Efficiency House
EnEG	Energy Conservation Act (Energieeinspargesetz)
EnEV	Energy Saving Ordinance (Energieeinsparverordnung)
EPBD	Energy Performance of Buildings Directive
EPDs	Environmental Product Declarations
ESG	environmental (E), social (S) and governance (G) considerations
ETS	Emissions trading system
EU	European Union
GBCe	Green Building Council España
GEG	Buildings Energy Act (Gebäudeenergiegesetz)
GHG	greenhouse gas
GSDS	German Sustainable Development Strategy
HFCs	hydrofluorocarbons
HOAI	Official scale of fees for services by architects and engineers (Honorarordnung für Architekten und Ingenieure)
IPCC	Intergovernmental Panel on Climate Change
KPI	key performance indicator
MEPS	minimum energy performance standards
LT	low-temperature
NWG	non-residential buildings
ÖGNI	Österreichische Gesellschaft für Nachhaltige Immobilienwirtschaft
PPA	long-term power purchase agreements
RC construction materials	secondary/replacement/recycled (RC) construction materials
RED	Renewable Energy Directive
SFDR	Sustainable Finance Disclosure Regulation
WG	residential buildings

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List of figures

Gefördert von:

IKEA Foundation

Laudes Foundation

Contributors (DGNB):
Dr. Anna Braune, Lea Hagenlocher, Dr.-Ing. Kathrin Quante,
Christine Ruiz Duran, Mieke Schleife

With the cooperation of active DGNB members and
DGNB committees in the period from 10/2021 to 11/2022.

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Please note: Equality for all people is a matter of course for us. Nevertheless, in the interest of better readability of the texts, we refrain from strict adherence to gender-equal language as long as there is no clearly stipulated requirement. All people should feel equally addressed.

Deutsche Gesellschaft für
Nachhaltiges Bauen – DGNB e.V.
Tübinger Straße 43
70178 Stuttgart

+49 711 722322-0

info@dgnb.de

www.dgnb.de

DGNB
Deutsche Gesellschaft für Nachhaltiges Bauen
German Sustainable Building Council