Deutsche Bank

Residential Real Estate – Leading to Net Zero

#PositiveImpact

Contents

Executive Summary

Real estate is one of the most important areas in the fight against climate change. In the European Union, buildings account for around 40% of energy usage and 36% of all greenhouse gas emissions. Residential real estate accounts for a significant proportion of this total, with 119 million residential buildings in Europe, of which nearly 20 million in Germany alone. For nations to fulfil their commitment to net zero emissions by 2050, defining a clear pathway toward greater energy efficiency in real estate is vital.

Residential real estate: a core part of Deutsche Bank's sustainability agenda

The real estate sector plays a central role in Deutsche Bank's sustainability agenda. As at year-end 2022, loans of € 182 billion globally, of which € 175 billion in Europe, were residential real estate, primarily mortgage loans to German private clients. This represents some 40% of Deutsche Bank's total loan portfolio. The bank's residential loan portfolio is considerably larger than its € 107 billion corporate loan book; however, financed emissions related to residential real estate are far lower, at 3.9 million tonnes of CO_2 emissions equivalent per year, compared to 30.5 million tonnes for the corporate loan book.

The pathway towards greater energy efficiency in residential real estate is driven by several factors which differentiate it from energy-intensive industries:

- The energy efficiency of most existing real estate is low: around two thirds of residential properties were built before 1979 with no energy efficiency requirements, and majority of today's residential real estate is therefore of relatively low energy efficiency
- The cost of transition falls primarily on private citizens, not corporations. The financial and social impact of this transition is therefore substantial, particularly at a time of rising inflation and interest rates. The cost of retrofitting Deutsche Bank's existing real estate portfolio to Energy Performance Certificate (EPC) class A, to reduce emissions, would be some € 80 billion, or close to 50% of the residential loan book
- The impact of 'upstream' industries is considerable: the energy efficiency of residential real estate is influenced substantially by industries further up the value chain which supply power and building materials, such as utility companies and steel producers; this has also a major impact on Scope 3 emissions of the sector
- Public policy in this area is still in development, both in respect of regulation and government financial assistance to homeowners, both for new build and renovations. This is particularly important given the EU Parliament's decision in March 2023 that all new buildings must be zero emission from 2028

The pathway to more sustainable real estate: Deutsche Bank's integrated strategy

Deutsche Bank's real estate strategy reflects the unique characteristics of the sector and takes account both of the factors which determine progress toward greater energy efficiency and the challenges in achieving this progress. Our strategic objectives are:

- To provide private individuals and households with a comprehensive package of financial assistance on their pathways to greater energy efficiency. In order to reduce operational (Scope 1 and 2) emissions this includes mainly accessing financial support for energy efficiency retrofitting and renovation
- To work closely on decarbonization pathways with corporate clients in 'upstream' industries which provide energy and materials to the residential real estate sector. Reductions in carbon emissions in these industries will positively impact energy efficiency in residential real estate by reducing embodied or Scope 3 emissions. In some of these industries, Deutsche Bank already has quantitative targets and net zero pathways in place, as set out in our white paper of March 2022
- To engage with policy makers, governments, financial industry peers and other public and private bodies to determine methodologies and priorities for reducing emissions from residential real estate; and
- To contribute Deutsche Bank's experience and know-how to harmonize approaches to increasing energy efficiency in this sector and address industry-wide challenges of data quality and reporting

The path to more sustainable residential real estate: an integrated service for private clients

As at the end of the first quarter of 2023, Deutsche Bank's cumulative ESG financing and investments since January 1, 2020, had reached € 238 billion (ex-DWS). The bank remains committed to its target of € 500 billion cumulatively by end-2025. Of the total to date, the Private Bank has contributed € 53 billion, including € 11 billion in financing, mostly related to real estate.

Going forward, the Private Bank aims to build on this progress through its partnership with the World Wildlife Fund Germany, launched in early 2023, to expand its support for clients, in Germany and beyond, on improving energy efficiency in this sector.

Addressing financial and social challenges: a partnership approach with clients

Deutsche Bank's strategy is based on in-depth analysis of the challenges facing private clients on the path to more energy-efficient residential real estate which indicates that:

- Two thirds of Deutsche Bank's private real estate clients have the financial ability to retrofit in the short term. However, clear and transparent information on the practicalities of retrofitting is essential to support clients in this process
- The remainder need both information and financial assistance. They do not have the financial capacity to retrofit their buildings to an EPC 'A' rated building or zero carbon ready building. Even current publicly available support schemes will not overcome this gap
- All stakeholders therefore need to jointly develop attainable goals for homeowners in this category. Support could consist of government assistance, less demanding ratings, and sequencing of tasks during renovation
- Energy performance classes will likely impact real estate prices, driving up loan amounts for the more energy-efficient buildings and increasing pressure in cases where less energy-efficient buildings already have high loan-to-value ratios. Banks' collateral evaluation practices will need to be adapted in order to take this into account
- It is important not merely to increase, but simplify, the financing of renovation. While banks tend to fund new constructions, the integration of emissions into business strategies and risk appetite will lead to increased focus on renovation, and current regulatory requirements only allow this at a higher cost (i.e., interest rates, costs for energy advisory, EPCs, increasing building material requirements, etc.) to homeowners
- Given the significant financing requirement of the transition to more energy-efficient housing, and the financial challenge facing private homeowners, it is vital to avoid unintended consequences when establishing targets. A 'net zero' target, comparable to those Deutsche Bank has established for carbon-intensive industries, risks restricting the flow of financing into energy-efficient housing and penalizing private citizens at a time of inflationary pressures and rising interest rates

First-time disclosures and new commitments

This white paper represents a landmark for Deutsche Bank's sustainability strategy in a number of ways, including:

- Publication, for the first time, of the financed emissions (Scope 1 and 2) of Deutsche Bank's residential real estate loan portfolio, broken down by country, totalling 3.9 million tonnes of CO_2 emissions equivalent per year as at year-end 2022. With this disclosure, Deutsche Bank has now published financed emissions relating to approximately 60% of its total loan portfolio
- Pathways to net zero in residential real estate under three scenarios – Stated Policies (STEPS), Announced Policies (APS) and Net Zero Emissions by 2050 (NZE), together with an outlook for the impact of Scope 3 emissions
- The commitment to incorporate the reporting of financed emissions in European real estate into the bank's non-financial disclosures from the fourth quarter of 2023
- Integration of energy requirements into the bank's valuation and credit processes and into contract conditions

Chapter outline and content summary

Chapter	Chapter Content
2. Residential real estate in Deutsche Bank's sustainability strategy	Deutsche Bank's Group Sustainability Strategy and Governance, which is the fundamental to our residential real estate approach
3. Partnering with our clients to become net zero	Accompanying households and supporting clients by providing much-needed advice and products to finance transition in the real estate sector.
4. Energy efficiency in the European residential real estate market	Current view on European housing market for CO_2 emissions and energy efficiency
5. Developing methodological approaches to net zero alignment	Deutsche Bank's approach to calculation of the CO_2 footprint and its pathway for real estate (technical details in Chapter 8)
6. Finances emissions: focus on European residential real estate	Deutsche Bank's CO_2 footprint and pathway for its European residential real estate portfolio
7. Further analysis of the European real estate sector	Creating awareness of the unique challenges for homeowners and financial industry in residential real estate sector
8. Methodological approaches to net zero alignment in detail	Methodological supplement on applied methodology and implementation challenges (especially on parameters and data quality)

Table 1

1 Introduction

1.1 Net zero by 2050

Net zero by 2050: a historic challenge

The world faces a historic challenge. Without urgent and coordinated action, climate change will have devastating effects on the world's population and its biodiversity. To avoid these effects, it is critical that policy makers, companies and individuals act to achieve net zero emissions by 2050 in order to limit global temperature increases to 1.5°C above pre-industrial levels by 2100.

An important role for the banking industry

Meeting this target will require unprecedented investment to transform the global economy. For example, worldwide capital investment in the energy sector will need to rise to approximately $ 5 trillion per year in 2030, 4.5% of global GDP and more than double today's levels according to the International Energy Agency (IEA[1]).

The banking industry will play an important role in financing this transformation.

A core part of Deutsche Bank's sustainability strategy is therefore our commitment to act as a reliable partner to our clients to achieve these ambitious targets. We aim to ensure a just and orderly transition to a lower carbon economy without causing unnecessary negative social effects or widening inequality.

As a first step Deutsche Bank will deploy three principal levers to decarbonize:

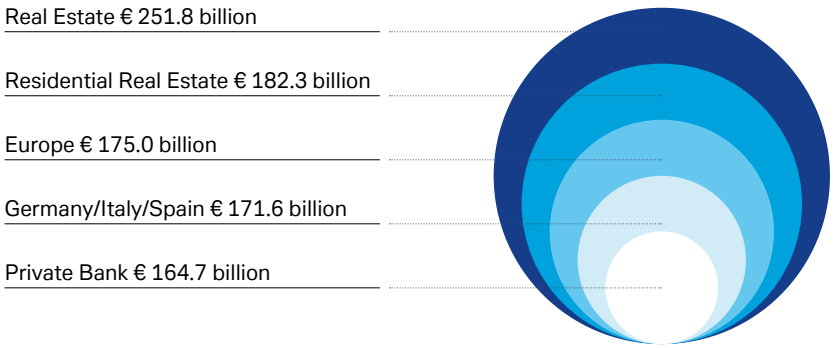
- First, we will provide financing to corporate clients to facilitate their transition
- Second, we will rebalance our loan portfolio towards an emphasis on corporate clients who have greater focus on developing decarbonization plans and net zero commitments, as well as on less carbon intensive technologies such as renewables
- Third, we will reduce our exposure to corporate clients with limited willingness to decarbonize

1 IEA Net Zero by 2050 – A Roadmap for the Global Energy Sector, page 81

Already in March 2022, Deutsche Bank published its white paper 'Towards net zero emissions', highlighting the net zero aligned pathways for four of the most carbon intensive sectors (Oil & Gas, Power Generation, Automotive and Steel) in Deutsche Bank's corporate loan portfolio and subsequently published net zero aligned targets for these sectors in October 2022.

This paper focusses on Deutsche Bank's largest portfolio: European residential real estate. Buildings are responsible for around 40% of the EU's energy consumption and 36% of its greenhouse gas emissions. Since real estate is an important asset class for investors and private clients, Deutsche Bank will concentrate on the CO_2 footprint, net zero pathway as well as on major observations and conclusions.

Figure 1 — Real estate as part of Deutsche Bank's loan portfolio



Reducing carbon intensity in our loan portfolio: key disclosures

At our Sustainability Deep Dive in March 2023, we pledged to publish details of the carbon footprint of our loan portfolio and our pathways to net zero for the building sector. This paper represents a milestone on that path, focusing on Deutsche Bank's European loan portfolio secured by residential real estate. We disclose the financed emissions in our loan book based on the Partnership for Carbon Accounting Financials (PCAF) standard, combining the level of energy efficiency measured in terms of kWh/m² energy consumption assessed according to respective Energy Performance Certificate (EPC) labels for the collaterals and the gross carrying amount of the respective loan. Our PCAF data quality scores, which provide additional transparency for investors, include collected EPC data. We also describe emission reduction pathways for the building sector, focusing on European residential real estate.

1.2 Defining the pathway to net zero: selecting the scenarios and key metrics

Deutsche Bank uses the IEA Net Zero Emissions by 2050 scenario (NZE) to define pathways towards net zero and within this white paper focusing on the building sector. However, for an illustration of our portfolio development, we will also apply the Stated Policies Scenario (STEPS) and the Announced Pledges Scenario (APS). Deutsche Bank uses metrics which are aligned with the decarbonization pathways of the building sector: TCO_2e/y financed emissions or emission intensity $kgCO_2e/m^2/y$.

Overview

Scenario	IEA Net Zero Emissions
Sector	Building sector
Metrics	kWh/m² CO_2e/y (CO_2 emissions per year) CO_2e per m^2 per year CO_2e per unit per year

Table 2: Overview of used scenario, sector and metrics

Even though the projections of the selected scenarios demonstrate pathways by 2050, Germany has committed to net zero by 2045. The selected scenarios should not be seen as contradictory to these commitments.

Overview of IEA scenarios[2]:

Stated Policies Scenario (STEPS), which does not look at what governments state they will achieve, but rather at what they are doing to achieve the targets and objectives they have set out and assesses where this leads the energy sector.

Announced Pledges Scenario (APS), which examines where all current announced energy and climate commitments – including net zero emissions pledges as well as commitments in areas such as energy access – would take the energy sector if implemented in full and on time.

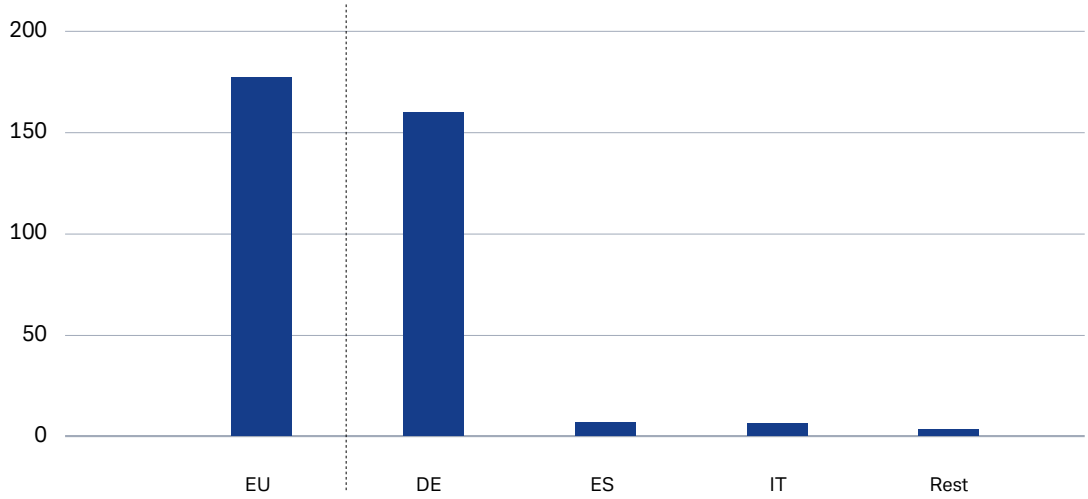
Net Zero Emissions by 2050 Scenario (NZE), which maps out a way to achieve a 1.5°C stabilization in global average temperature and meet key energy-related UN Sustainable Development Goals.

2 Source: IEA World Energy Outlook 2022, page 84

Measuring our financed emissions

As of December 31, 2022, Deutsche Bank's total assets amounted to € 1,337 billion, of which € 489 billion are in Deutsche Bank's loan portfolio. Of this, € 251.8 billion, or 51.5%, consist of loans secured by real estate based on FINREP[3]. In this white paper, we focus on our European residential real estate business with a volume of € 175 billion.

Figure 2 — Residential real estates volumes (in € billion)



EU = Europe, DE = Germany, ES = Spain, IT = Italy

3 FINREP: European Central Bank Financial Reporting


2

2 Residential real estate in Deutsche Bank's sustainability strategy

Sustainability is an integral part of our 'Global Hausbank' strategy and is embedded into our products, policies and procedures with a focus on four pillars: sustainable finance, policies and commitments, people and own operations as well as thought leadership and stakeholder engagement.

Making progress along these four pillars will enable us to maximize our contribution to the achievement of the Paris Climate Agreement's targets and the UN Sustainable Development Goals (SDG).

Governance

Our sustainability strategy is governed by the Group Sustainability Committee. Chaired by our Chief Executive Officer, the committee consists of Management Board members, the heads of our business divisions and representatives from infrastructure functions. Detailed information regarding the sustainability governance can be found in Deutsche Bank's Non-Financial-Report 2022 in section GRI 2-9/12/13/17.

Our Group Risk Committee, chaired by the Chief Risk Officer, serves as the central forum for review and decision making on matters related to risk, capital and liquidity. It is responsible for the development of our holistic climate risk management framework including the definition of key metrics and risk appetite.

Financing the transition

The transition to net zero will require a redirection of existing capital flows towards clean energy technologies alongside a substantial increase in the overall level of investment in energy. Most of this increase will need to come from private sources, mobilized by public policies that create incentives, set appropriate regulatory frameworks and reform energy taxes.

Clearly, the banking sector has a critical role to play in financing this transition, including via on-balance sheet lending, capital market financing and an increase in sustainable assets under management.

In May 2020, we announced that we intend to achieve at least € 200 billion in sustainable financing and investments by year-end 2025, as defined in our Sustainable Finance Framework and related documents, which are published on our website. This target was

accelerated twice to year-end 2022 and outperformed by € 15 billion. At our Sustainability Deep Dive in March 2023, we reconfirmed the target to facilitate € 500 billion in sustainable financing and investments and associated modelled revenues of ~€ 1.4 billion by the end of 2025 (initially announced at our Investor Deep Dive in 2022). By the end of the first quarter 2023, the amount had increased to € 238 billion. Within this total, the Private Bank accounted for € 53 billion, of which € 11 billion in financing, primarily real estate lending.

Decarbonizing our loan book, which stood at € 489 billion as at year-end 2022, is a crucial element of our sustainability strategy. Deutsche Bank has committed to net zero targets in four of the most carbon-intensive industries and plans to build on this with targets in at least four further sectors by the end of 2023.

Residential real estate accounts for some 40% of our total loan portfolio, but a far smaller proportion of financed emissions. Our strategy in tackling the carbon footprint of residential real estate, which is set out in more detail in Chapter 3 below, is focused on supporting and financing homeowners on the path to more energy-efficient residences, thus reducing Scope 1 and 2 emissions and forging partnerships with corporate clients in carbon-intensive 'upstream' industries to reduce the carbon footprint of construction, renovation and energy provision for the real estate sector, thus reducing Scope 3 emissions, as set out in Chapter 5.

Industry engagement

Deutsche Bank is involved in a range of industry initiatives to support the development of data and methodologies to enable banks to measure and monitor emissions and set robust, science-based emission reduction targets.

Deutsche Bank joined the Net Zero Banking Alliance (NZBA) as a founding member in April 2021. The NZBA, convened by the United Nations Environment Programme Finance Initiative (UNEP FI), is a coalition among many of the world's largest financial institutions to support the alignment of their business activities with net zero emissions by 2050. Our NZBA commitment pledges us to set and disclose net zero aligned targets for key carbon intensive portfolios, publish a board-level reviewed transition strategy and report on progress accordingly.

Via our membership of the NZBA we are also a member of Glasgow Financial Alliance for Net Zero (GFANZ), a global cross-industry coalition which is committed to accelerating the decarbonization of the economy.

The bank is active in several projects of the UNEP FI including a working group which is assessing the quantitative relationships between energy efficiency improvements and loan probability of default.

We are members of the Partnership for Carbon Accounting Financials (PCAF) and participate in its sovereign and capital markets instruments working groups as well as its climate data working group. We are also a member of the Science Based Targets Initiative's (SBTI) Expert Advisory Group which is focused on the development of the framework for financial institutions.

Risk management

Throughout the COVID-19 pandemic and macro-economic headwinds resulting from Russia's invasion of Ukraine, Deutsche Bank's risk profile remained very sound, reflecting tight risk discipline and a high-quality loan book. Deutsche Bank is thus well positioned to manage the risks associated with financing the transition to more energy-efficient residential real estate.

Furthermore, reducing the emissions intensities of our portfolios and supporting our private clients in retrofitting their properties towards higher energy efficiency will have significant risk management benefits by reducing our exposures to climate transition risks – in particular, those arising from higher carbon taxes and reduced global demand for fossil fuels and related products. These actions will also support a reduction in acute and chronic physical risk events over the medium-to-long term.

We have developed and embedded, the tools and frameworks needed to manage climate transition and physical risks to our portfolios in line with the ECB's guidance on climate related and environmental risks. Our net zero commitment is embedded in our Group Risk Appetite Statement and our activities are governed by a dedicated Climate and Environmental Risk policy which outlines roles, responsibilities as well as qualitative risk appetite principles and quantitative risk appetite principles and quantitative risk appetite metrics. For European real estate this is also reflected in the Risk Appetite Statement of the Private Bank.

Metrics and ambitions

The key metrics that we use to assess transition risks to our portfolios are energy intensity, carbon intensity and financed emissions. As outlined in more detail below, we estimate and monitor these metrics using the standard of PCAF and further external databases such as Hotmaps.

We are currently setting targets for new business in residential real estate by providing green mortgages and special purpose loans.

Target setting for the transition to more energy-efficient residential real estate needs to reflect the distinct characteristics of the sector, which differ from the decarbonization pathways announced for Deutsche Bank's corporate loan book, in order to avoid unintended consequences. Any reduction in residential financing for private clients runs the risk of (i) slowing the pace of energy-efficient renovations and improvements to existing residences and (ii) increasing the financial pressures on homeowners and their families at a time of rising inflation and interest rates. Accordingly, a 'one size fits all' approach is neither in the interests of society nor of the drive for more energy-efficient real estate.

At this time we face several challenges, which Deutsche Bank will work towards addressing in order to set further targets. For existing business these include:

- Data availability: i.e., energy efficiency information from Energy Performance Certificates
- Social Aspects: we need to further investigate the impact on private clients regarding financial capacities to better understand unintended financial implications for our private clients
- Dependencies: i.e., all applied scenarios rely on new constructions, renovation rates, product-supply and craftsmen, as well as the client's financial capacity and willingness to retrofit. Meaning all measures must be executed in order to realize the future CO_2 emissions-pathway

Furthermore, the applied scenarios have additional dependencies on policy makers' discussions, i.e., like ongoing national/European discourses.

Tracking and managing our progress towards net zero

We will report the development of our portfolio financed emissions and emission intensities against our selected net zero aligned pathways annually. Internally, we will produce detailed, quarterly climate risk information for senior committees.

While we are a 'Global Hausbank', we also have a strong local offering to private clients in Germany, Italy and Spain. For most of our clients the acquisition of their own property is the largest investment in their lifetime. An additional improvement of energy efficiency at acquisition is a major challenge for many private clients, due to their financial capacity and/or willingness (see analysis in Chapter 7). Therefore, we will not set any targets for our private residential real estate clients. This will not impact our commitments towards other sector targets. However, we will set targets on new loans to improve energy efficiency (see Chapter 3) and embed measurements into our Deutsche Bank Group strategic planning, governance and risk management processes.

By the end of 2023, we aim to incorporate the reporting of financed emissions for European real estate in our non-financial disclosure.


3

3 Partnering with our clients to become net zero

The range of services within the mortgage business includes different variants of annuity loans as well as home loan savings products processed via the subsidiary 'BHW'. Deutsche Bank's Private Bank division combines the private banking expertise of Deutsche Bank and Postbank brands in Germany, along with the global network of the International Private Bank (IPB), which includes its global business with wealthy clients as well as with private clients. With new business of more than 150k private mortgage transactions per annum, we are the largest lender for private clients in Germany.

Private mortgages play an essential role in driving the transition towards climate neutrality. Financing renovations and remodeling in general can be considered as sustainable since buying or renovating existing properties leverages existing material. Our ambition is to achieve a sustainability target of € 12 billion New Business Volumes (gross volume) in mortgages by year end 2023.

3.1 Addressing the challenge of historical low-efficiency real estate

Market research shows that around 13 million properties, or 67% of Germany's total, were built prior to 1979[4] without any energy efficiency requirement, which results in around 58% of all properties having poor energy efficiency[5].

With the real estate sector accounting for more than 30% of Germany's total carbon emissions, Private Bank Germany aims to support the realization of Germany's 2045 climate goals, by enabling clients to align their properties with the low emission economy of the future. Therefore, Private Bank Germany will establish a systematic advisory approach on energy modernization.

With around 1.5 million financed properties and a mortgage lending portfolio of more than € 160 billion, the Private Bank has expanded its loan offering for green mortgages and financing remodeling. A local campaign has been launched to accelerate the growth of green mortgage volumes beginning of 2023. Given the international footprint, the decisive criteria are based on energy performance certificates – particularly in EU countries and the UK – or on similar, independent certificates for other markets that often include criteria beyond energy efficiency.

4 www.statistikportal.de/de/wohngebaeude-nach-baujahr
5 www.dena.de/en/topics-projects/energy-efficiency/buildings/

In Spain, IPB (International Private Bank) has also leveraged a partnership with manufacturers in its Avanza program to provide dedicated financing for renovations and remodeling.

We see this topic as a key issue for real estate owners and tenants at present. Partly as a result of the recent energy crisis, energy efficiency is becoming increasingly relevant for our customers also from a financial point of view. It is part of our mission to support as many homeowners as possible on their pathway to energy modernization and connecting them with experts.

The potential is huge. In Germany, we see a financial demand for energy modernization of around €600 billion. And hence the focus in our real estate business is changing. In the coming years, we will shift our efforts more towards the energy-efficient modernization of our client's properties.

3.2 Supporting new, energy-efficient residential constructions

Typically, in customer decision-making for a new residential construction the actual financing decision takes place at a comparably advanced stage of the project. Fundamental decisions regarding location, size, materials etc. have often already been made by the time clients contact financing partners. Consequently, a bank's ability to influence the parameters of construction is limited, especially since today's mandatory building regulations (at least in Germany) are already setting high standards in terms of energy efficiency measures. These are set to further increase with the upcoming amendment of EU commissions: the Energy Performance of Building Directive (EPBD) demands net zero buildings from 2028 onwards for the construction of residential properties.

> 'All new buildings should be zero-emission from 2028, with the deadline for new buildings occupied, operated or owned by public authorities in 2026. All new buildings should be equipped with solar technologies by 2028, where technically suitable and economically feasible (…)[6]'
>
> *(Decision by EU Parliament, press release March 14, 2023, cp. FN #)*

Taking this into account, we support our customers primarily in arranging a suitable financing solution for new constructions. In addition to in-house financing in the Deutsche Bank Group's brands and applying for state-aided loans by the KfW[7], we also assist customers by providing comprehensive information and the opportunity to identify subsidies and/or other aids from the numerous funding programs on federal, state and municipal level by means of our 'Förder-Service'[8] offering.

6 www.europarl.europa.eu/news/en/press-room/20230310IPR77228/meps-back-plans-for-a-climate-neutral-building-sector-by-2050

7 KfW loans: KfW supports builders who save energy, use renewable energies or remove barriers – with low-interest loans and attractive grants. Further information at https://www.kfw.de/inlandsfoerderung/Unternehmen/Wohnwirtschaft/

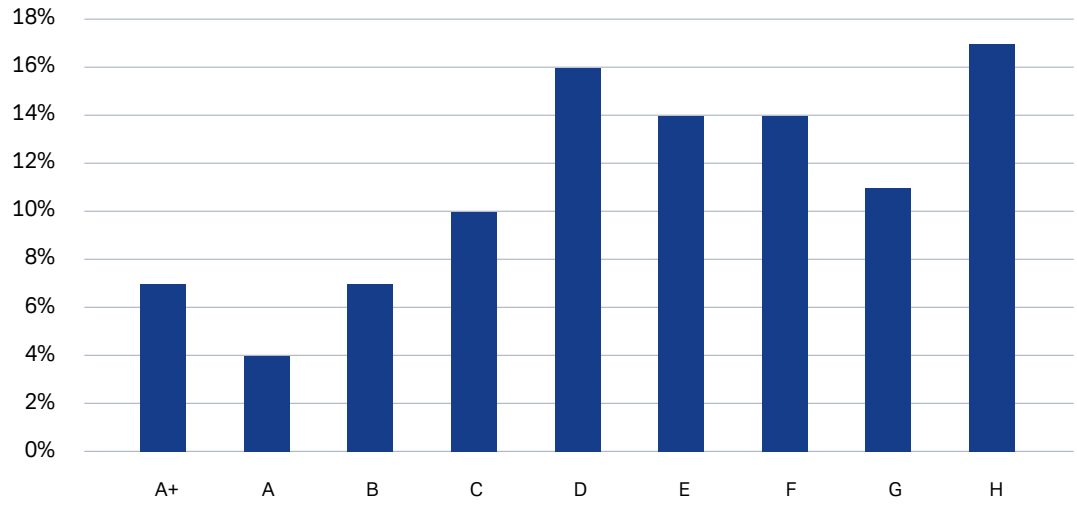
8 Keeping an overview of the funding landscape is a real challenge. That's why we have introduced the 'Förder-Service' by our co-operation partner Sunshine Energieberatung. Further information at https://www.bhw.de/startseite/ihr-plan/modernisieren/foerdermoeglichkeiten.html

With policy makers in the housing industry so far aiming primarily to reduce CO_2 emissions of day-to-day energy consumption, the one-time embedded emissions in the construction process are only covered indirectly currently. To close this perceived gap on a voluntary basis we are commencing in Q2 2023 to offer our customers in new building projects a simple CO_2-calculator[9] to estimate the emissions caused by building their respective new property in tons of CO_2 emissions. This creates on the one hand awareness of one-time CO_2 emissions and provides an impulse to think about reduction beyond the day-to-day energy consumption. On the other hand, it enables the client to consider making a voluntary construction project specific CO_2-compensation, for example via myclimate.de by a direct internet-linkage for an offsetting transaction.

3.3 Energy refurbishments are often budgeted as an extra loan

Financing existing residential properties represents the major share of private mortgages in new business volumes at Deutsche Bank. Although the proportion of comparably more energy-efficient buildings in new business is higher than in the total German stock, the majority of loans financing existing assets have an EPC class of E or worse. Given the challenge that not all transactions have EPCs, buying existing buildings also leads to a distribution of EPC labels which is prior to any renovation. See for example, our collected EPC data for new business in Germany where clients voluntarily delivered EPC ratings as part of their loan documents:

Figure 3 — EPC class distribution in new business Private Bank Germany



Based on EPC data Private Bank Germany

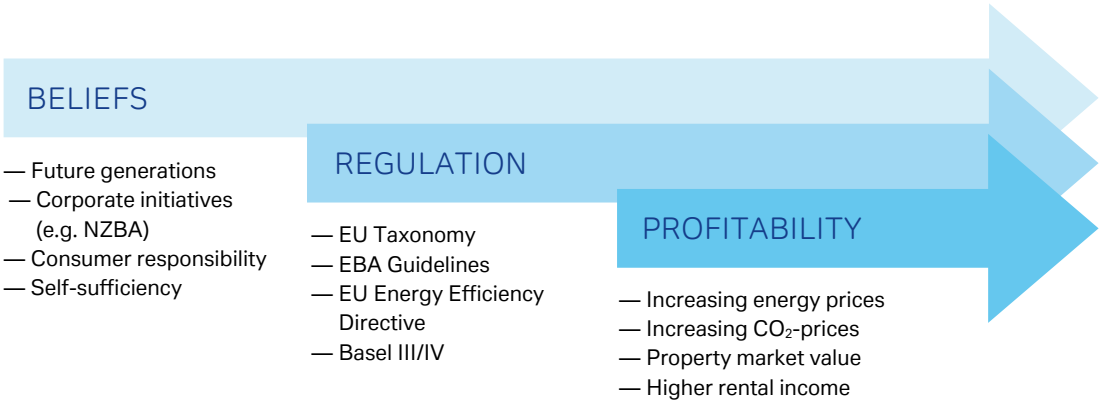
The aforementioned EPBD will most likely set EPC class minimum requirements for existing buildings in the medium term, requiring refurbishments for half of the stock in the next 7 to 10 years, demanding for residential buildings at least EPC class E (2030) respectively D (2033).

9 With just a few settings, an estimation of the individual CO_2 footprint of the new building can be performed.

'Residential buildings would have to achieve, at a minimum, energy performance class E by 2030, and D by 2033 – on a scale going from A to G, the latter corresponding to the 15% worst-performing buildings in the national stock of a member state.'

(Decision by EU Parliament, press release March 14, 2023, cp. FN # above)

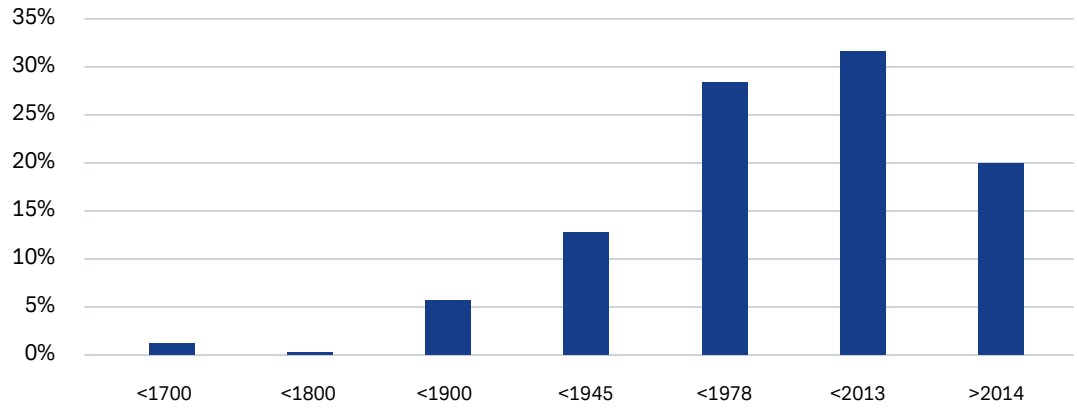
Clients exhibit also other motivations for modernization. To name a few:



In addition to regulation and beliefs, economic reasons provide more and more rationale to reduce energy consumption and CO_2 emissions, as energy prices and carbon taxes rise. Protection of the market value of the property has become much more important since our evidence indicates higher discounts in buildings with weaker energy efficiency levels.

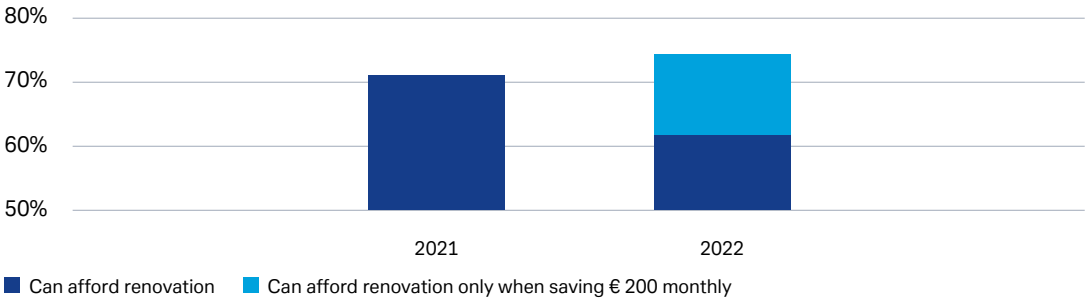
For the same reason, the collateral capacity of a refurbished dwelling is higher, which applies to approximately half our portfolio:

Figure 4 — Exposure by collateral per building year



As interest costs are rising and inflation is increasing, disposable household income is reduced, making comparably smaller investments more likely. Clients wishing to have their own homes might be more likely to look for older dwellings and refurbish these instead of looking for new, expensive EPC class-A buildings. By refurbishing, clients would potentially reduce CO_2 emissions compared to new construction and further stimulating the need for customer centric modernization approaches.

Figure 5 — Private clients' financial capacity



In response to a growing demand to even further increase refurbishment in the next years, we are creating a innovativ consulting approach to foster holistic energy-efficient refurbishment, offering tool-based advisory products to assist our customers in their modernization needs, which will be launched in the course of 2023. Based on a small number of non-technical input variables, different estimates are determined for status quo energy consumption/CO_2 emissions, potential refurbishment measures, energy savings, respective necessary investments, available subsidies and financing possibilities, to name a few.

The approach will incorporate other related services we are already offering via Deutsche Bank's German mortgage brand BHW. These include, among other things, the 'Heizungstausch-leicht-gemacht'[10] service, where we provide our customers with information regarding the benefit of upgrading their old heating system to a new one and making available tradespeople contacts from participating cooperation partners. A loan product designed especially for renovation measures of heat exchange or photovoltaic systems, the BHW 'KlimaDarlehen Express'[11], does not require collateral and is offered at a comparatively lower interest rate than the standard loan, helping less liquid clients who cannot secure additional mortgages but still benefit from reduced energy costs through modernization. Finally, the 'FörderService' to make use of possible subsidies is also an optional service in the modernization context. As energy modernization is key for Europe to achieve its climate targets, we are preparing to support our existing and future customers.

10 'Heizungstausch-leicht-gemacht' (www.bhw.de/startseite/ihr-plan/modernisieren/heizungstausch-leicht-gemacht.html)
11 BHW climate loan www.bhw.de/startseite/ihr-plan/modernisieren/produktuebersicht/klimadarlehen.html

Some facts make clear how big the challenge is: almost three quarters of Europe's buildings in scope of NZE by 2050 are already built. Hence, it is key for implementing the NZE strategy to retrofit buildings in Europe.

The continent faces two challenges when it comes to retrofit buildings: first, a large number of listed buildings (e.g., historical monuments) and second, listed buildings renovation ('Effizienzhaus Denkmal'/ the efficient listed house). Improving the energy consumption of existing buildings in Europe renovation is the key to fulfil assumption of scenarios. Without renovation measures the net zero target will not be achievable.

In cases where a client does not have sufficient financial means, the bank cannot be responsible for granting an additional loan to existing clients, as this would violate requirements of European banking law as well as requirements for banks with regards to customer protection schemes. This legal framework would also lead to many private clients not having sufficient financial capacity to buy a property in need of renovation. Hence, at origination, loans would not be granted by lenders and the respective private individuals will not have any access to financial resources to enter the housing market. Still, we recognize this combination of factors as of major importance for the successful achievement of net zero targets, and we understand the role of Deutsche Bank as to advocate this challenge with policy makers to find supportive solutions

3.4 Home loan saving products protect customers from long-term uncertainties

Depending on the age and condition of the property, energy-efficient refurbishments are often postponed, even if they are of benefit. Especially young families with children sometimes postpone the investment in order to be able to afford their own house.

In these cases, it is advisable to plan future renovations and make targeted savings. The advantage of a home savings contract is that it benefits on the one hand under certain conditions from state funding (e.g., in Germany 'Arbeitnehmersparzulage', 'Wohnungsbauprämie') and on the other hand there is a claim to a home savings loan with favorable interest rates. Especially now, in times of rising interest rates, home savings contracts are again very much in demand.

This way, the property owner can get an overview of their renovation plan and address key questions such as: When does the heating system need to be replaced? Does the house have to be insulated in the future to comply with designated standards for minimum EPC classes? Do windows and doors have to be renewed? Should a photovoltaic system be purchased to become more independent in the power supply?

Another state subsidy in Germany is the so-called 'Wohnriestern'. From 2024 onwards, this state-subsidized home annuity can also be used for the energy-efficient renovation of residential property.

This approach especially supports clients with reduced liquidity in their efforts to achieve higher levels of energy efficiency in the medium term by providing/facilitating financing options.

Excursus: Real estate transfer tax with impact on ESG

1) High initial costs with high barrier of entry for young and/ or weak clients (IDW[12] Study with impact on reduced transactions).
2) Barrier for downsizing from larger houses to small apartments for elderly people.
3) New German tax may have negative impact on ESG since energy-efficient houses (i.e., after modernization) lead to higher taxes – as this led to higher remaining building life cycle.

The challenges for real estate buyers, construction companies and owners are significant. Due to rising prices in the real estate sector in recent years and the higher interest rates for financing products, our customers have a greater need for expertise in tailor-made financing. This needs to be specifically customized to their project and other supporting services we provide in the context of facilitating the path to climate neutrality. Our consultants help to focus on the project and not getting lost in financial issues.

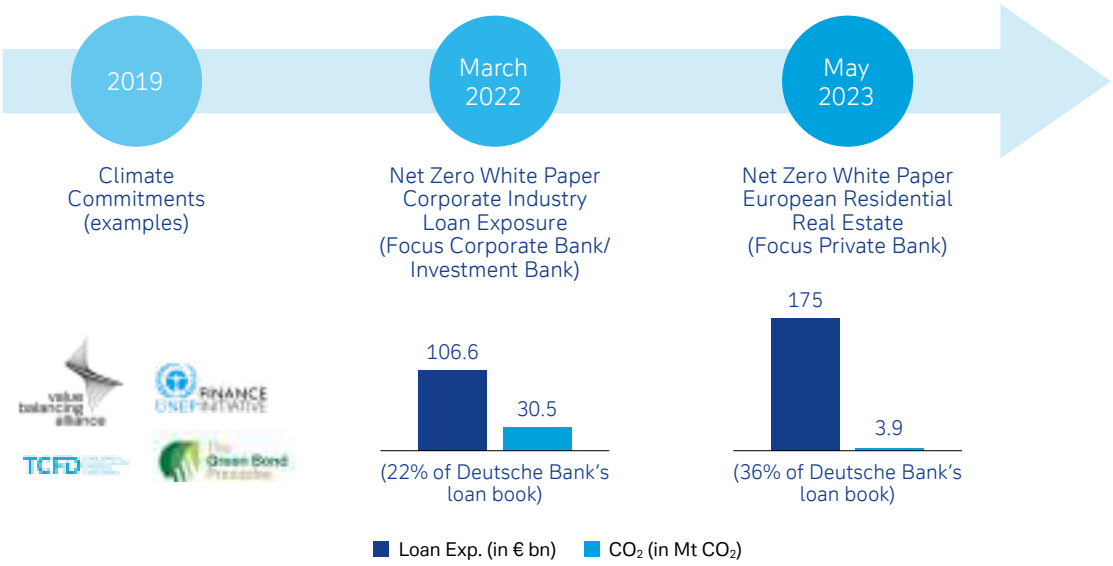
12 IDW: Institut der Wirtschaftsprüfer in Deutschland e. V. / Institute of Public Auditors in Germany, Incorporated Association

4

4 Energy efficiency in the European residential real estate market

Deutsche Bank's net zero goals

Sustainability covers a broad spectrum of environmental, social and governance issues, and climate change is one of the defining challenges of our time. Deutsche Bank recognized the risks of climate change and, as a global financial institution, we acknowledge the role we have to play in shaping the transition to a sustainable and climate-friendly economy. As outlined in Chapter 2 we have signed several climate commitments since 2019.



Financed emissions of Deutsche Bank Group

In March 2022, we calculated that our corporate loan book financed emissions amount to 30.5 Mt CO_2e/y on a loan exposure of € 106.6 billion with a PCAF data quality score of 4.3[13]. This reflects our heavy reliance on PCAF data proxies. As more clients disclose their GHG emissions over time, our data quality score will improve.

13 Non-Financial Report 2022: https://investor-relations.db.com/files/documents/annual-reports/2023/Non-Financial-Report-2022.pdf

For this white paper, we expand on the table in our March 2022 white paper by setting out financed emissions and data quality by adding loans secured on real estate. We updated table 3 within Deutsche Bank's 2022 Non-Financial Report. This enables us to increase the coverage of financed emissions in our loan book volume from 20% to 60%.

Year-end 2022	Loan Exposure (€ billion)	Financed Emissions (Scope 1 and 2 Mt CO_2 e/y)	PCAF data quality score
Total loans at amortized costs	489		
Total Corporate loan exposure	106.6	30.5	4.3
Total loans secured by Real Estate	251.8		
Total loans secured by non-RRE	69.5		
Total loans secured by RRE	182.3		
EU	175.0	3.9	4.2
DE	158.8	3.4	4.2
IT	5.9	0.1	3.9
ES	6.8	0.2	3.3
Rest-EU	3.4	0.2	5.0
Non-EU	7.3		

Table 3: Non-Financial Report (NFR) 2022 extended by residential real estate (RRE)

Buildings under construction are not in scope of this white paper since they only have embedded emissions (see Chapter 5 on 'CO_2 Emissions throughout a building life cycle' and Chapter 7.6). Deviating from this, we published in our NFR our commitments of our loan portfolio which includes also a split of the loan book beside corporates and real estate which is predominantly lending to Sovereigns, Financial Institution and individuals.

4.1 Focus on energy efficiency of buildings within Europe

Deutsche Bank is committed to the Paris Agreement, adopted in December 2015 under the United Nations Framework Convention on Climate Change (UNFCCC) and to 'The European Green Deal'[14] of the European Commission communicated in December 2019. The Energy Performance of Building Directive (EPBD) is strategically important to achieve a zero-emission building stock by 2050.

While there is a need to act prudently and swiftly to reach these goals, this needs to be balanced with the need to avoid unintended financial consequences on top of rising inflation and interest rates.

14 A European Green Deal (europa.eu)

There are 119 million residential buildings across the European Union: France[15] (21m) has the largest number followed by Germany (19m), with a further 11 million in the UK[15], and 10 million in Spain and Italy. The remaining 39 million are distributed between the other 23 EU Member States. The breakdown by building type is as follows: 42% flats/apartments; 34% detached dwellings; 24% semi-detached dwellings.

The required renovation wave for European real estate will require consideration of the following aspects:

- Energy efficiency to support lower CO_2 emissions. Net zero can only be reached in connection with significantly lower CO_2-energy supply
- EPCs are an indication of energy demand but energy consumption is highly dependent on client's lifestyle
- Sufficient expertise for homeowners, architects, craftsmen, real estate appraisers, local government, lenders, investors, etc.

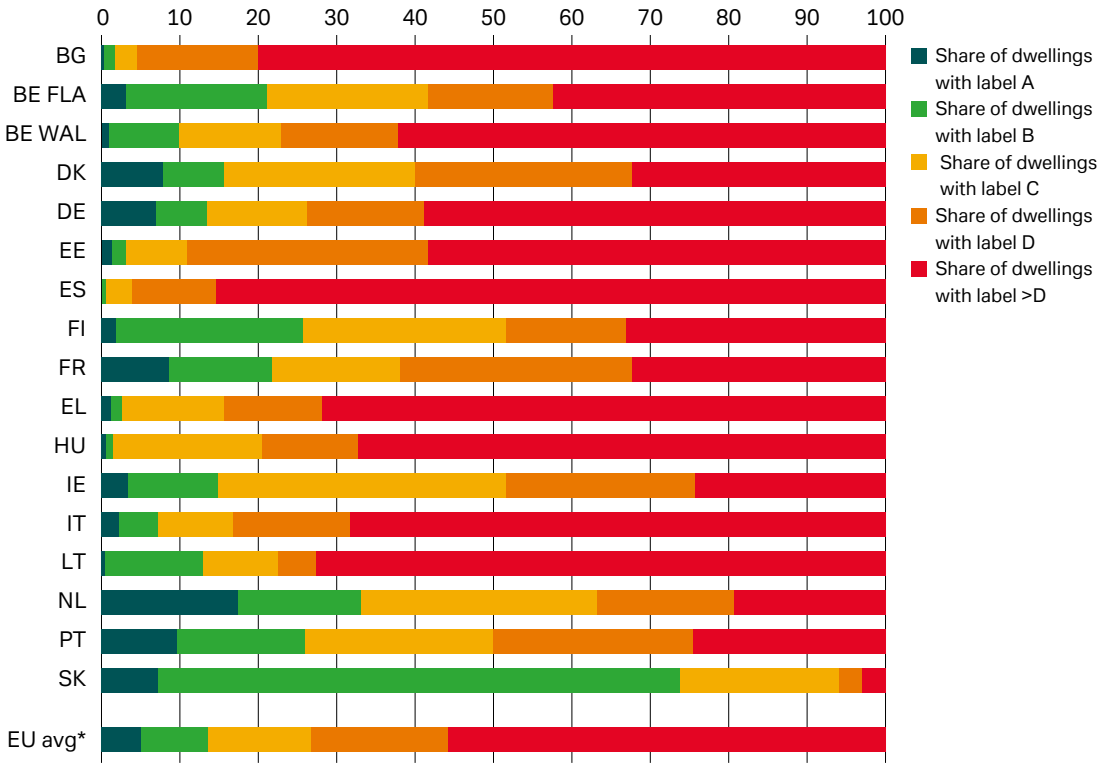
Within Europe, EPCs were introduced on national level mainly in 2013. For private households these EPCs are only required under certain conditions (i.e., when owners rent or sell the asset or for new residential buildings). For our portfolio this means that only 45% of our private clients (accounting for 67% of outstanding loans) have the legal obligation to hold an energy certificate. This group includes all contracts originated before national implementation of the Directive 2010/31/EU. Our experience is also that only banks in countries with a national register for energy performance certificates have a meaningful coverage of EPC data (up to 40% of their exposures). In countries with no or decentralized EPC registers, approximately 5–10% have reliable information on their energy efficiency status. We support efforts to achieve a sufficient database for buildings throughout Europe in order to obtain a level playing field.

4.2 EPCs: the lack of harmonization across the EU

Currently EPC labels are not fully harmonized throughout Europe due to the national differences in the underlying climate strategy as well as the methodologies applied to obtain EPCs, the local housing market and the climate zone where the respective building is located. There is no level playing field when comparing northern European countries with longer heating periods and higher building requirements with other European countries. Based on the SWD (2021) 453 final, only ~5% of residential properties in Europe have an EPC class A.

15 FR/UK: due to our business profile these markets are only included in EU rest

Figure 6 — Distribution of EPC label ratings in residential sector (% dwellings)



Brussels, 15.12.2021; SWD (2021) 453 final; IMPACT ASSESSMENT REPORT Accompanying the Proposal for a Directive of the European Parliament and of the Council on the energy performance of buildings, N.2: Distribution of EPC label ratings in selected residential buildings in the EU 18 (https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX-:52021SC0453#footnote19)

Energy efficiency will have impacts on the EU residential real estate markets in the medium-term. Insights into current European housing markets are incorporated in our annex Chapter 9.1.


5

5 Developing methodological approaches to net zero alignment

Focus sector deep dive: the building sector

In 2021, the global building sector was responsible for 30% of the global final energy consumption (IEA, World Energy Outlook 2022, page 150). Narrowing the focus to the EU – 40% of the energy consumption and 36% of its CO_2 emissions are caused by buildings (EPBD[16]). The building sector therefore has a significant leverage effect in supporting the NZE by 2050 scenario. Promoting NZE and increasing the energy efficiency of the building sector would bring advantages for affordability plus consumer welfare and most of the necessary/required technology is already available (i.e., for heat pumps, energy-efficient appliances, energy and materials efficient building designs).

CO_2 emissions throughout a building life cycle

Looking at the overall life cycle of a building CO_2 emissions in more detail shows the importance of 'upstream' industries in determining the energy usage of residential real estate. This underlines the importance of Deutsche Bank's focus on setting net zero pathways for 'upstream' industries in its corporate loan book as outlined in our March 2022 paper and on working with corporate clients on decarbonization plans.

Emissions in the building lifecycle can be segmented as follows:

1. Operational emissions: Direct emissions caused by on-site fuel combustion (i.e., for space heating, water heating, cooking, etc.) – GHG[17] Protocol Scope 1 emissions. Indirect emissions from purchased energy (electricity, steam, heat, and cooling) for space heating, water heating, space cooling, lighting, cooking, appliances, and miscellaneous equipment – GHG Protocol Scope 2 emissions
2. Embodied emissions relate to emissions caused by the construction of the building and the material used as well as in-situ initiated or electricity purchased by the user of the building – GHG Protocol Scope 3 emissions (spanning from material extraction and processing to building construction, maintenance and renovation, to the end-of-life stage in which the building is deconstructed or demolished and disposed of). CO_2 consumption linked to embodied emissions are to be defined as 'grey energy'

16 EPBD: Energy Performance of Building Directive
17 GHG: Greenhouse gas

Figure 7 — Distribution of life cycle costs

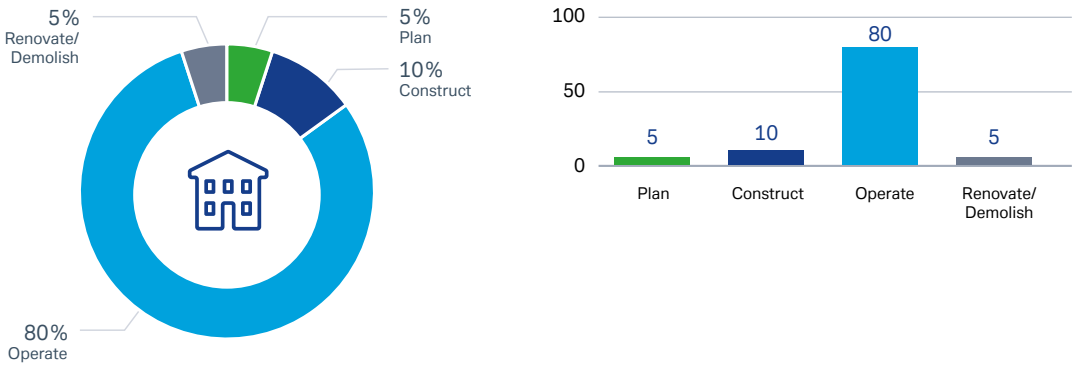


Figure 7: Building Life Cycle based on in-house analysis

IEA roadmap to net zero emission by 2050

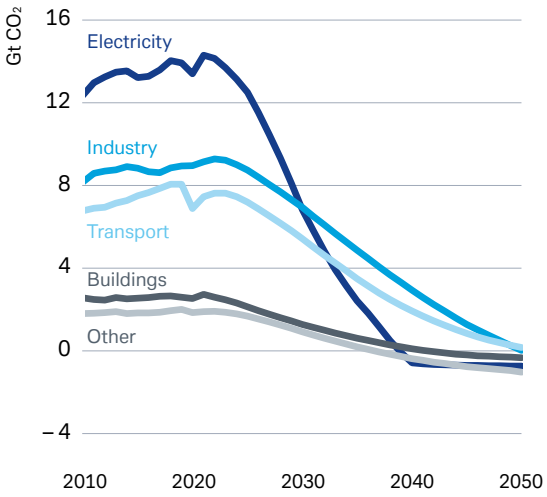
The energy consumption of residential real estate is based on operational emissions for heating and electricity (Scope 1 and 2) and on embodied carbon emissions for construction and renovation (Scope 3). As outlined in Chapter 5.1 Deutsche Bank will restrict its focus to operational emissions (Scope 1 and 2) and provide only an example in Chapter 7.6 on Scope 3 emissions in this white paper; however, the bank's net zero targets in carbon-intensive industries in its corporate loan book, as set out in our previous white paper, are expected to positively impact Scope 3 emissions in residential real estate.

Upon closer examination of operational emissions for real estate, it becomes clear that both the property itself and its power supply play an important role when it comes to emission factors. The degree of dependency is locally defined by the available (energy) infrastructure (e.g., district heating, gas lines, oil tanks…) and connected to transport (e.g., electronic cars powered via the property).

The power sector leads emissions reductions to 2030, but all sectors contribute to the net zero emissions goal, with residual emissions in 2050 balanced by atmospheric removals.

In respect of embodied (Scope 3) emissions, we note that the CO_2 footprint is dependent on industry sectors (such as cement, construction) which are needed for construction and retrofitting. Any technical improvements towards lower CO_2 emissions-intensive solutions will also reduce the Scope 3 footprint of real estate. Furthermore, new trends for cities and urban areas must be developed to best use existing infrastructure and/or to supplement individual solutions by systemic approaches (e.g., city design and digitization allowing easy access to services). For some industry sectors, there is a moral hazard between optimizing energy costs for the company versus a local energy supply for the local society (i.e., usage of energy for data center for district heating).

Figure 8 — Emissions by sector



Gross and net emissions

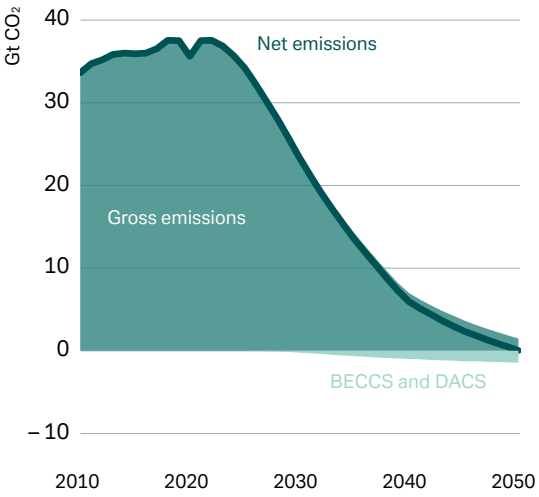


Figure 8: Energy-related CO_2 emissions by sector and gross and net emissions in the NZE Scenario, 2010–2050
Notes: BECCS = bioenergy equipped with CCUS; DACS = direct air capture and storage. Other includes agriculture and other energy transformation sectors.
Source: Figure 3.1, IEA World Energy Outlook 2022, page 126

Calculating operational emissions of Deutsche Bank's European real estate portfolio

Deutsche Bank is calculating the forward evolution of the CO_2 footprint for European residential real estate based on three scenarios from the IEA:

- STEPS: which does not look at what governments say they will achieve, but at what they are doing to achieve the targets and objectives they have set out and assesses where this leads the energy sector
- APS: which examines where all current announced energy and climate commitments – includes NZE pledges as well as commitments in areas such as energy access – would take the energy sector if implemented in full and on time
- NZE: which maps out a way to achieve a 1.5°C stabilization in global average temperature and meet key energy-related UN Sustainable Development Goals

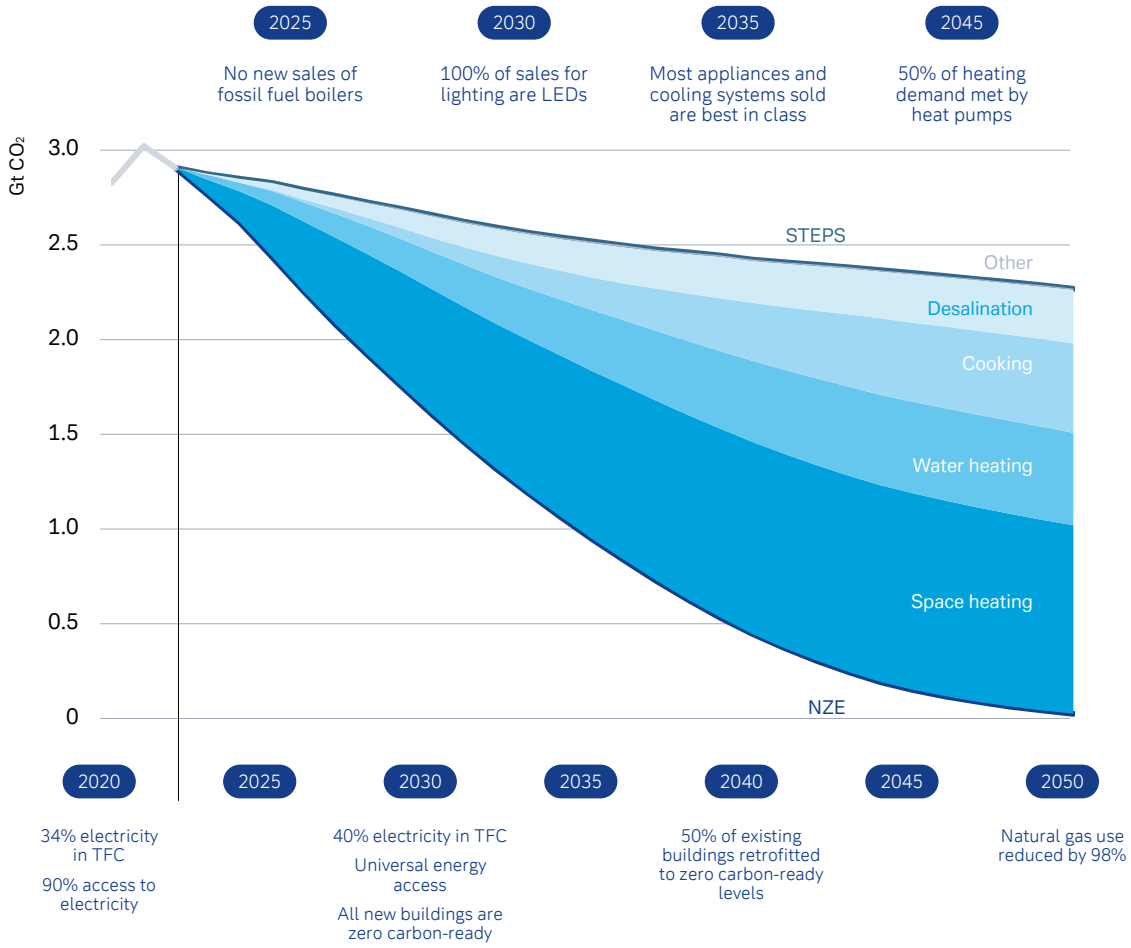
While we believe that the STEPS scenario is highly unlikely within Europe, we interpret the STEPS scenario as a 'do-nothing' scenario in order to see how our portfolio evolves over time, based on already-contracted and new business. In our view, this scenario provides a basis to relate to the necessary measures from policy makers, clients, investors and lenders. This also provides an understanding of the portfolio development respective target setting without any additional measures by lenders.

The APS scenario is most likely already outdated for Europe since the current measures regarding Fit-for-55[18] on a European level as well as additional national initiatives from Governments (e.g., to be CO_2 neutral in 2045 within Germany) may not be fully reflected in the current scenario assumptions.

The NZE scenario contains additional assumptions which will have to be introduced by policy makers, industry and clients in order to reach a carbon neutral equilibrium. Some parts may be already covered by renewing electronic equipment, heating systems and other measures.

The following graph illustrates the additional challenges the building sector is facing between STEPS ('do-nothing') and NZE ('being carbon neutral'):

Figure 9 — Space heating delivers 50% of emissions reductions in buildings, driven by electrification and demand reductions from efficiency and behavioral changes



Notes: TFC = total final consumption; LEDs = light-emitting diodes. A zero carbon-ready building is highly energy-efficient and uses either renewable energy directly or an energy supply that will be fully decarbonised by 2050 in the NZE Scenario (such as electricity or district heat). By 2025 in the NZE Scenario, any gas boilers that are sold are compatible with 100% low-emissions gases and in areas where fuel supply will be completely decarbonised before 2050.
Figure 9: Emissions reductions and key milestones in the buildings sector in the NZE Scenario relative to the STEPS, 2020–2050
Source: Figure 3.15, IEA World Energy Outlook 2022, page 151

18 Fit-for-55: Fit for 55 – The EU's plan for a green transition – Consilium (europa.eu)

Although these scenarios may fit for Europe quite well, it must be noted that the NZE and APS are global scenarios which currently fall short in implementation and execution globally. At present, we assume that the building sector will develop globally with overshootings towards the APS scenario. However, on a mid and long-term perspective, a higher European standard will lead to cheaper and easier to implement techniques to achieve higher energy efficiency and therefore lower energy costs. Already today, we observe tenants asking for higher energy efficiency in order to reduce additional costs for living as well as reducing the effect of elevated energy prices.

5.1 Harnessing the methodology

For Deutsche Bank's European residential real estate portfolio, EPC data is collected from our private clients (mainly at the time of origination of a loan). Furthermore, we retrieve data from local national databases, if these are publicly accessible. In all other cases we have chosen approaches to estimate EPC ratings depending on available collateral data. We include a detailed description to the applied methodology in Chapter 8. In general, this includes the following two steps:

1. Assign a value for energy demand per m^2, depending on the object information available
2. Map this value on a scale from energy demand to EPC rating

Based on the energy consumption per property, we estimated the CO_2 footprint based on national contribution factors.

We reviewed the different IEA scenario assumptions for real estate with the following main underlying assumptions to outline a first pathway towards net zero:

1. Deutsche Bank's market share in new transactions (i.e., buildings/financed object per year) remains unchanged to our new businesses in 2022
2. Increase of purchase price development for new buildings based on energy classes between decades; based on the respective NGFS[19] scenario (mapped by orderly or disorderly action of policy makers, for STEPS we applied the hot house scenario)
3. We applied no change in credit lending standards (i.e., credit risk parameters such as % of own equity within the transaction, Loan to Value (LTV) at origination, interest, repayment rates)

Since private mortgages are long-term loans (e.g., with a duration of more than 24 years in Germany) we additionally applied a certain improvement on the energy efficiency of the stock depending on the underlying scenario assumption:

- New built properties: zero carbon ready properties only in NZE, EPC class A for APS and STEPS (due to current building standards)
- Renovation: 2.5% p.a. of buildings will be retrofitted to zero carbon ready properties (only NZE), improvement by 1 EPC class every 40 years (for APS) and no improvement in energy labels (for STEPS)

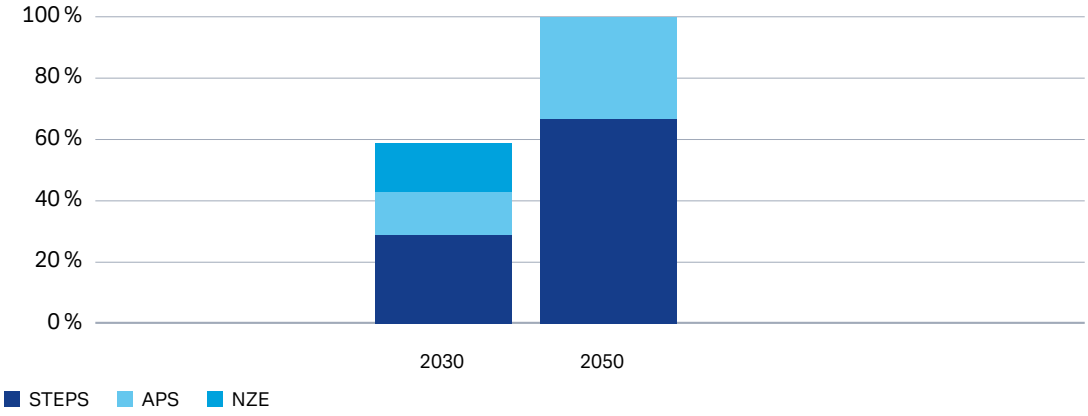
19 NGFS: the Network of Central Banks and Supervisors for Greening the Financial System

This leads to an estimation of the net zero pathway for Scope 1 and 2 emissions for residential real estate buildings. We excluded Scope 3 emissions for our main analysis and conclusions as they are a minor factor for residential real estate. PCAF and CRREM[20] have recently extended their approaches towards a 'whole-building approach'[21] which also takes Scope 3 emissions into account. Due to unavailable data for most properties in focus, this requirement is currently not mandatory. Hence, for this white paper, Deutsche Bank will restrict to operational emissions (Scope 1 and 2) and provide only an example in Chapter 7.6 on Scope 3 emissions.

5.2 Scenario selection

We selected the IEA NZE to assess the pathways required to align to net zero by 2050. The IEA NZE is our preferred benchmark, as it is in unison with limiting global warming to no more than 1.5°C above pre-industrial levels by 2100 and is compliant with the NZBA guidelines. We also chose the IEA NZE decarbonization pathways in order to be consistent with our publications on our corporate loan book. More details regarding this selection can be found in the white paper 'Towards net zero emissions: Corporate loan portfolio financed emissions and net zero aligned pathways for focus sectors' (March 2022). Based on the NZE scenario, global CO_2 emissions for real estate will have to fall by 59% by 2030 referring to 2020 as the baseline and by 100% by 2050.[22]

Figure 10 — Financed Emissions Reduction (layered)



20 CRREM: Carbon Risk Real Estate Monitor provides the real estate industry with transparent, science-based decarbonization pathways aligned with the Paris Climate Goals of limiting global temperature rise to 2°C, with ambition towards 1.5°C – CRREM – Make decarbonisation measurable & Manage Carbon Risk

21 Source: Accounting and Reporting of GHG Emissions from Real Estate Operations, 'Whole-building approach', page 32; Accounting and Reporting of GHG Emissions from Real Estate Operations Technical Guidance for the Financial Industry (carbonaccountingfinancials.com)

22 Source: Net Zero by 2050: A Roadmap for the Global Energy Sector, page 53

For transparency reasons, we additionally calculated the APS and STEPS scenarios for our European residential real estate portfolio. Currently, supplementary measures on energy performance of buildings are discussed by national and EU parliaments as well as the EU commission. Based on these efforts, this may lead to a shift in the APS scenario for Europe, moving closer to the NZE scenario. However, this will have social tension since it sets higher entry barriers for acquiring homes. We will include some further analysis on this in Chapter 7.

5.3 Outlook

At present, data on energy efficiency (including measures of energy consumption at the single building level or EPC) is not publicly available or easy to collect. In addition, not all clients are legally required to have an EPC. Even if required, not all mortgage loan documentations contain EPCs, e.g., in cases where the loan was contracted before the law was in place. These barriers have been discussed intensively in Chapter 8, resulting for example in the proposal to assess the feasibility of a proxy. In future, we believe that climate awareness and energy efficiency data quality will improve.

Since modern techniques for retrofitting properties to a higher level of energy efficiency are already developed and available in the market, we expect that there will be a constant improvement by replacing technical equipment (e.g., for cooking, heating) and continuous renovation of the buildings (e.g., exchange of heating systems, roof, windows).

Policy makers will improve national standards, while the cost of energy will additionally lead to a business need of energy efficiency. Deutsche Bank will support this approach by further integration of energy requirements into the valuation and credit process as well as in contract conditions.

In future updates, we believe that there will be a significant improvement in data collection, modelling, scenario pathways – and hence, in results. In light of this, we will also analyze how CRREM would be beneficial for our private client portfolio since CRREM provides a more sophisticated break-down for IAE NZE. Furthermore, we will review the 'Buildings Sector Science Based Target Setting Guidance' published by SBTI on May 14th, 2023, and as outlined in Chapter 5.1 assess the 'Accounting and Reporting of GHG Emissions from Real Estate Operations' released by PCAF and CRREM in March 2023.

6

6 Financed emissions: focus on European residential real estate

Deutsche Bank applies a model-based approach to calculate the CO_2 emissions of the European mortgage portfolio in these scenarios by using the IEA for the scenario projection and NGFS for the projection of market developments (i.e., house prices in the European market). Hence, the calculation of the CO_2 footprint depends on national emission factors. These factors may deviate locally due to dependencies on regional energy sources (gas, oil, district heating) and low percentage of energy-efficient buildings within the entire market.

To take the respective measures described for the STEPS, APS and NZE into account, we assumed certain renovation measures for the existing loan book:

- STEPS: No improvement in energy efficiency due to missing additional need for action
- APS: 2.5% p.a. of buildings will be improved by 1 EPC class since the financial capacity and willingness of private clients is assumed to be restricted
- NZE: 2.5% p.a. of buildings will be retrofitted to zero carbon ready properties in order to avoid stranded assets

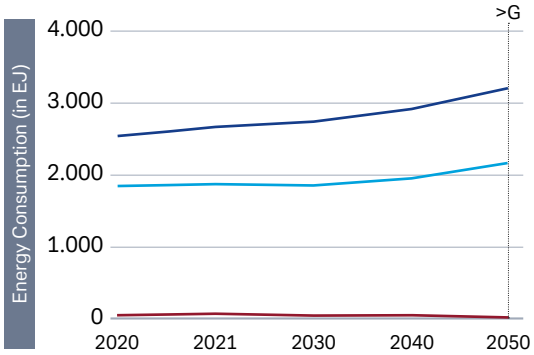
In addition, we applied in line with the underlying assumptions also an adjustment of our new business:

- STEPS: no adjustments of lending criteria based on energy efficiency labels prior to 2050. In 2050, requirement on new business with EPC class G to be improved by at least 1 EPC class
- APS: no adjustments of lending criteria based on energy efficiency labels prior to 2040. In 2040, no new business with EPC class G and in 2050 no new business with EPC classes G and F without improvements above these EPC levels
- NZE: no adjustments of lending criteria based on energy efficiency labels prior to 2030. In 2030, no new business with EPC class G, in 2040 no new business with EPC classes G and F and in 2050 no new business below EPC class E without any improvements above these EPC levels

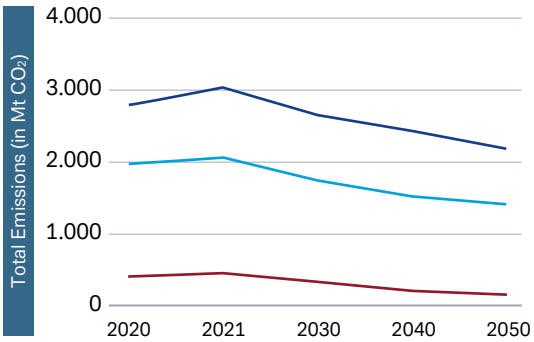
In all three scenarios we expect new business with the restricted EPC classes to already decrease (linearly) before the respective restrictions by policy makers come into effect. We also observed that building material and technical equipment currently fulfill these higher standards and that clients are demanding these to retrofit their properties.

Based on the underlying IEA scenario the new business assumption could be illustrated by the following Figure 11. This led to first comparisons in the different scenarios regarding energy consumption in EJ (Exajoule) and total emissions in MT[23] CO_2:

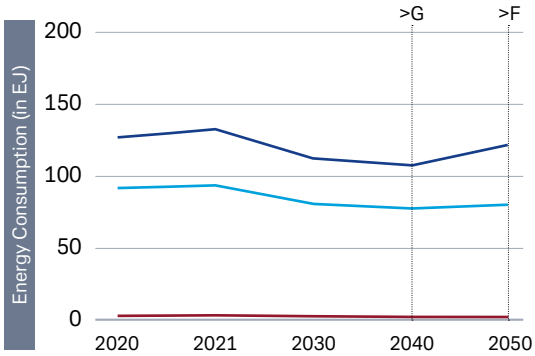
Figure 11 — Real Estate – STEPS



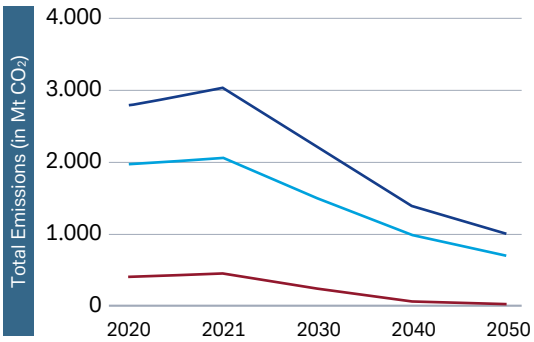
Real Estate – STEPS



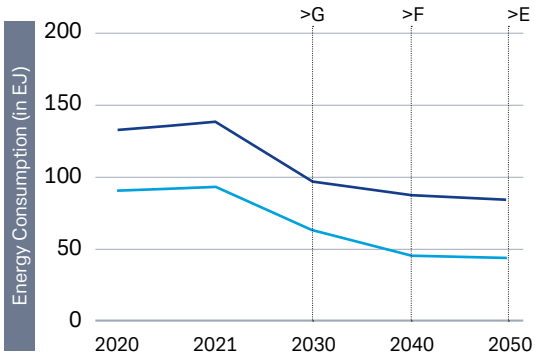
Real Estate – APS



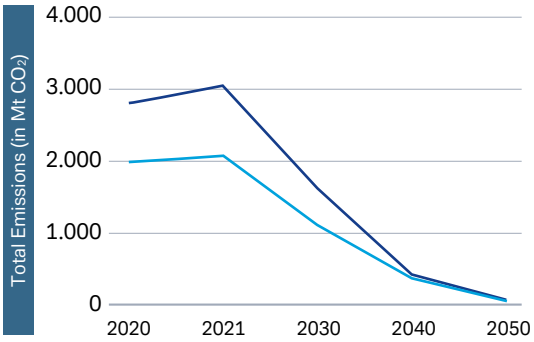
Real Estate – APS



Real Estate – NZE by 2050



Real Estate – NZE by 2050



Real Estate Worldwide Residential Real Estate Worldwide Residential Real Estate Europe

Figure 11: Real Estate Scenario Comparison (STEPS, APS, NZE)

23 Mt – Megaton

The EPBD supports the overall ambition of reducing energy poverty, decreasing the EU's dependence on fossil fuels, and helping meet the EU's climate targets and zero-emission building stock by 2050. The underlying assumption of the current version as decided by the European Parliament requires additional standards for newly built houses and for renovation.

— New built properties after 2030 will be zero carbon ready properties (only in NZE, no adjustments in APS/STEPS)
— Renovation: minimum EPC class for residential real estate is F (after Jan 1st, 2030) and E (after Jan 1st, 2033)

Within our scenario analysis, we have assumed

— New built properties: zero carbon ready properties only in NZE, EPC class A for APS and STEPS (due to current building standards)
— Renovation: 2.5% p.a. of buildings will be retrofitted to zero carbon ready properties (only NZE), improvement by 1 EPC class every 40 years (for APS) and no improvement in energy labels (for STEPS)

Based on the final implementation of the EPBD in national standards, we assume that IEA will update its APS scenario accordingly. In case there will be no further changes on EPBD, we assume that there will only be a minor difference between NZE and APS scenarios for European residential real estate going forward.

→ Energy performance of buildings directive (europa.eu)

European residential real estate based on FINREP

This white paper focusses on European residential real estate based on FINREP 'loans secured by real estate'. Residential real estate is defined as residential buildings being either single-family or multi-family housing units (i.e., buildings with two or more housing units), condominiums for sale, and rental apartments used primarily for human dwelling. This category is not limited to owner-occupied properties and small rental property portfolios and multi-family dwellings. This definition implies that the property is used primarily for residential purposes.

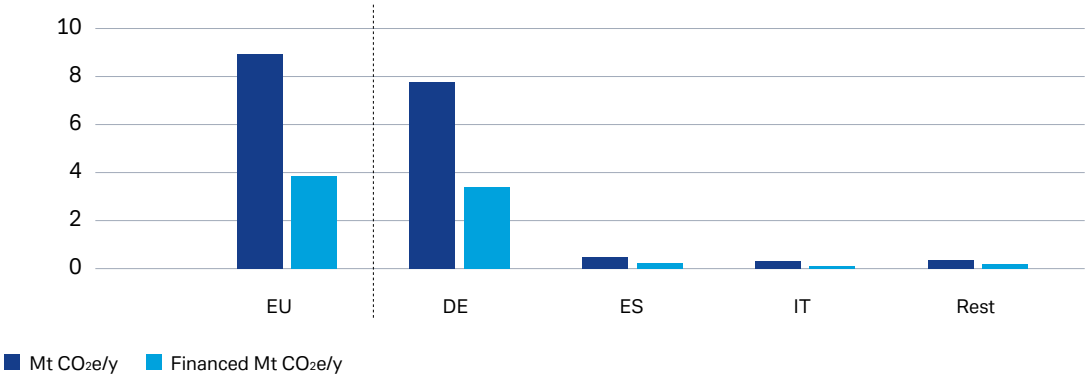
Mortgages are the key drivers of the Deutsche Bank loan book and cover 36.5% of the loan volume. For CO_2 consumption, a major part of our residential real estate portfolio is allocated to private mortgages in Germany, Italy and Spain.

Loans secured by real estate € 251.8 billion	
Residential Real Estate (globally)	o/w € 182.3 billion
European Residential Real Estate (scope)	o/w € 175.0 billion
Private Mortgage in Germany, Italy and Spain	o/w € 171.6 billion

Table 4: Loans secured by real estate

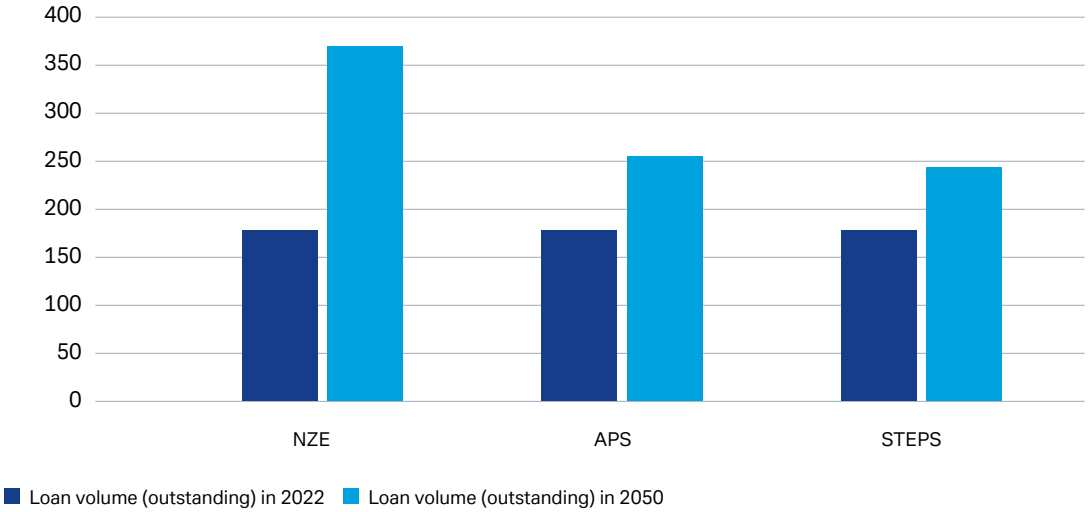
We calculated the CO_2 footprint for the European real estate portfolio as of December 31st, 2022. The calculation is based on the real estate collaterals and shows the Mt CO_2e/y for the respective collateral. Based on PCAF methodology, we restricted the carbon footprint to financed emissions which are defined by the proportion of the collateral linked to the outstanding loan amount.

Figure 12 — CO_2e/y footprint by main regions



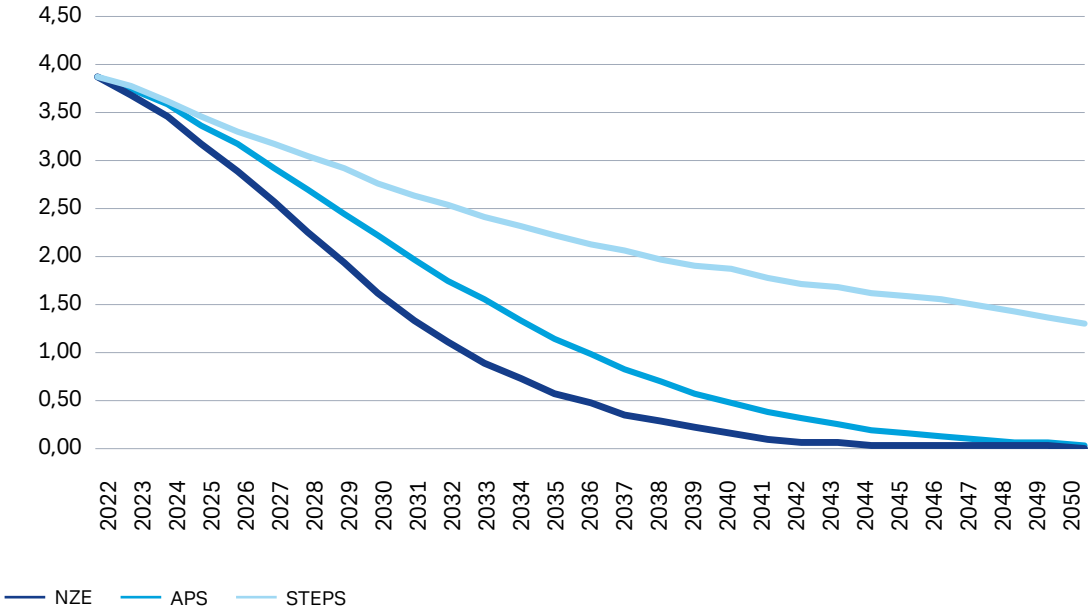
As of December 31, 2022, Deutsche Bank financed 3.9 Mt CO_2e/y via its European real estate portfolio of € 175.0 billion. Based on this background, the IEA scenarios and assumptions described in Chapter 5.1., we simulated first results on decarbonization of the European mortgage portfolio. The first step was projecting the outstanding amount of real estate exposure on Deutsche Bank's balance sheet. Due to different house price developments per EPC label the projected volume differs per scenario.

Figure 13 — Loan volume – € billion projection per scenario



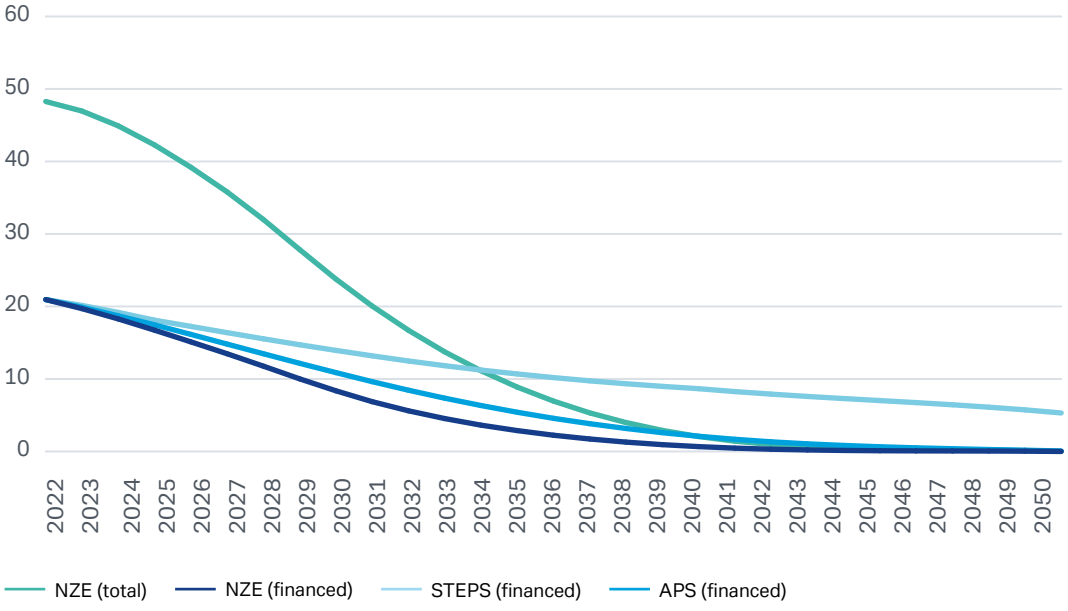
Based on IEA scenarios and these assumptions figure 14 shows Deutsche Bank's CO_2 pathway to net zero:

Figure 14 — Mt CO_2e/y (financed) projected by IEA scenario



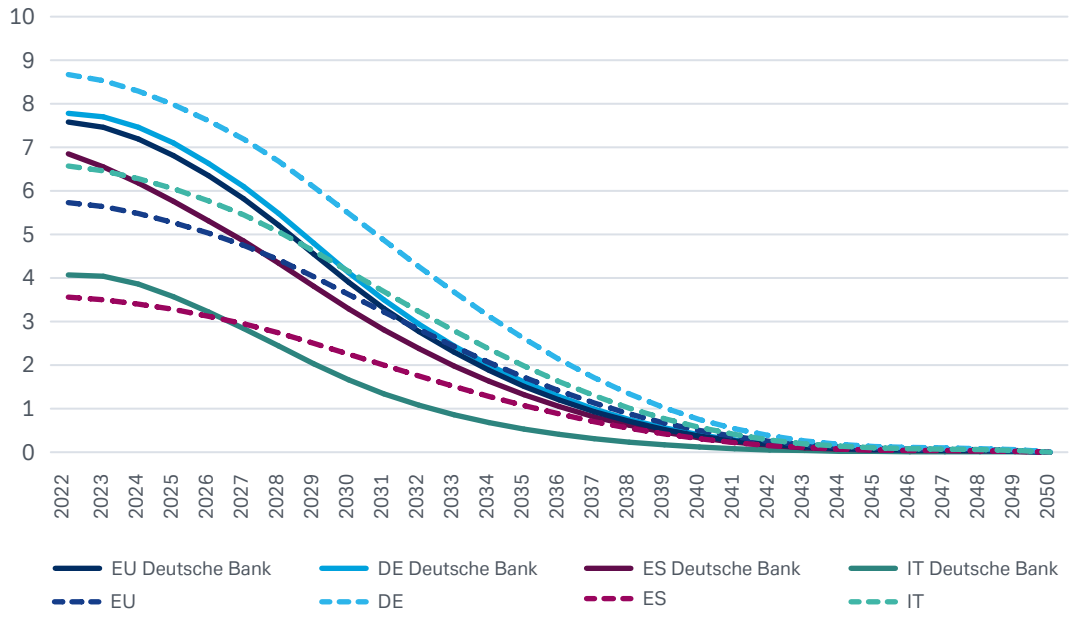
However, the volume projections do not have a material impact on the CO_2 emissions intensity per IEA scenario.

Figure 15 — CO_2 emissions intensity in kg CO_2/m^2



We would like to point out that the IEA scenarios rely on new constructions, renovation rates, product-supply and craftsmen, as well as the client's financial capacity and willingness to retrofit. The respective IEA scenario measures must be executed in order to realize the future CO_2 pathway. Therefore, our CO_2 footprint calculation is dependent on policy maker decisions for newly constructed buildings and renovation of existing buildings. Due to current discussions within the EU, we believe that European Union will develop a more ambitious scenario which is slightly below the APS scenario.

Figure 16 — Benchmarking of pathway t CO_2 emissions per year and property in NZE scenario



At this stage, our portfolio is dependent on our German home market which is significantly above the European average due to its CO_2 emissions-intensive operational emissions. Even with the current political ambition of the German government, Germany will only come close to the European average after 2040. Given that our portfolio emissions intensity is being already significantly below the German average, Deutsche Bank aims to beat the European average before 2035 which allows Deutsche Bank to be near net zero prior to 2050. Achieving net zero by 2050 is highly dependent on other factors, for example the treatment of historical monuments in the European building sector. Similar observations are also made for the housing markets in Italy and Spain.

7 Further analysis of the European real estate sector

For our loan book, Deutsche Bank performs a range of business and risk management analysis to review future business opportunities and/or downside risks. In the following section, we share some results obtained based on energy efficiency classes.

7.1 Renovation demand for our European real estate portfolio

Renovation is key to achieve higher energy efficiency levels and to fulfill the underlying scenario assumptions for the IEA scenarios. We have utilized two different approaches to estimate the loan demand for renovation within our European residential real estate portfolio:

- Estimate based on building year and property type
- Estimate based on energy efficiency class

Without impact on capacities of building materials and resources, we have assumed the renovation will be performed at once, thus excluding cost differences resulting from stepwise refurbishment. A projection towards future years would lead to higher renovation costs due to price increases for building material, energy and handicraftsmen. To illustrate that we have not overestimated renovation costs, we have applied the following table:

Renovation costs	
EPC Class A	–
EPC Class B	€ 15,000
EPC Class C	€ 35,000
EPC Class D	€ 50,000
EPC Class E	€ 65,000
EPC Class F	€ 80,000
EPC Class G	€ 110,000

Table 5: Estimated renovation costs

All renovation costs depicted in table 5 are assumed to improve the energy efficiency of the building to EPC class A. Starting from estimated total renovation costs of € 110,000 from EPC Class G to A, we linearly decreased the renovation costs for better EPC classes by the decrease of average energy consumption in the respective EPC class. In estimating the € 110,000 we assumed the following elements:

- Roofing € 20,000
- House exterior including insulation € 23,000
- Basement € 27,000
- Sanitary and electricity € 14,000
- Heating system € 13,000 and
- Windows, doors and interior insulation € 13,000

These costs refer to an illustrative building of specific building type and size. Renovation costs for other buildings can vary largely depending on building type, size and condition.

Based on this assumption, we estimated a renovation demand of at least € 80 billion for our portfolio. This would be approximately 15% of the current market values of our European residential real estate portfolio.

The renovation demand of € 80 billion is calculated as a total amount for renovation which in reality will be spread over several years. It does not include potential higher costs due to inflation or any discounted cashflows of future renovation investments. It has to be noted that part of these investments may be offset by replacing wearing parts (e.g., replacement of heating system).

We also analyzed that from an economic perspective it is more beneficial to perform improvements of energy efficiency at an earlier stage due to important factors:

- Cost of energy efficiency measures will increase due to inflation
- Cost of living will be less dependent on energy price volatilities, and
- Reduced energy costs will partly compensate interest on loans for funding measures

We believe that future technological developments may improve energy efficiency. However, for most real estate projects the major techniques have already been on in the markets for years. As outlined in 'Managing Transition Risk in Real Estate: Aligning to the Paris Climate Accord'[24], page 44, published by CRREM & UNEP FI, we emphasize the topic of 'getting the timing right' especially when taking the following into account:

- 'Will policy intervention become even more ambitious in the future?'
- 'Will retrofit measures become cheaper or more expensive?'
- 'How will commodity prices and other costs of decarbonization measures change?'
- 'Is security of energy supply important to us?'
- 'May carbon taxes increase in the future?'

24 Managing Transition Risk in Real Estate: Aligning to the Paris Climate Accord – United Nations Environment – Finance Initiative (unepfi.org)

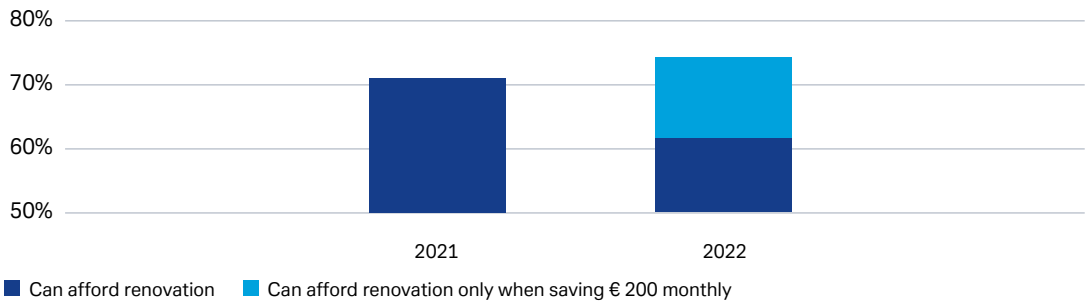
From our point of view, it is important to give more concerted guidance for measures to private clients to support them in their transformation. While we include this in our advisory approach, it would be helpful to describe these based on historical building standards (including cost overview re/retrofitting from G to E/F to D–A). Especially since the CO_2 emissions savings of the renovation measures are already well known.

7.2 Private clients' financial capacity for renovation

At origination, we perform a creditworthiness assessment of our clients based on their monthly income. Knowing the minimum renovation costs, we analyzed which proportion of our clients can cover such a renovation loan. This analysis is based on a full income statement per household, considering cost of living, energy, vacation and other goods (e.g., a car) or household members (e.g., children). The analysis was also performed based on the two mentioned approaches in Chapter 7.1, which do not lead to different results. Only 62% of our clients would have the possibility to cover their monthly expenses plus the additional renovation loan with their income.

Hence, we have also analyzed whether any benefit from governmental programs for improving energy efficiency and/or lower energy costs would be beneficial to these clients. For example, an improvement of current minimum building standards in Germany to KfW-50 resp. 40 could already lead to a reduction in energy costs of € 80 to € 110 per month (assuming apartment of average m^2 in Germany). Based on this, we estimated the proportion of clients who would have the possibility to cover their monthly expenses plus the additional renovation loan by their income if they save € 200 per month by reduced energy costs or governmental program:

Figure 17 — Private clients' financial capacity



It must be clearly stated that banks are not allowed to lend to a private client if the client does not have the necessary financial capacity to pay back the loan. Taking this into account, from our point of view there is a call for action towards national governments to support private clients to deliver the European Green Deal for residential real estate. Based on the results of Chapter 7.1 and 7.2 a bullet loan[25] with a long-term interest binding period could be an adequate financial instrument to fund the energy efficiency measures

25 Bullet Loan: a loan that does not require the borrower to pay principal and interest until the end of the loan term

for private clients. Such an instrument was developed by the think tank Climate Strategy: 'EU Renovation Loan: a new instrument to fund the EU Renovation Wave' (The EU Renovation Loan: a new instrument to fund the EU Renovation Wave | Climate Strategy & Partners). Private clients may have also other mitigation strategies (like reduction of expenses by additional own work or delayed implementation).

7.3 Behavioral changes of customers in NZE scenario

Despite all these efforts to improve energy efficiency, it has to be noted that abstaining from electricity consumption or heating is also an important component to reach these goals. Modesty and humility are important factors in the UN charter.

For private clients, energy efficiency also includes a moral hazard component. Investing in higher energy saving may be correlated also with investment in additional tools and components demanding energy, which may reduce the overall impact. During the winter 2022/23 many households reduced room temperature to save energy which in parallel also reduced the corresponding CO_2 emissions impact. Hence, it is also incumbent on private clients to decide whether they are changing their habits slightly or a deeper adjustment is needed.

'Buildings account for just over one-third of the total CO_2 emission reductions from behavioral changes in 2030. For example, adjusting thermostats to 19–20°C in winter and air conditioning to a maximum of 24°C in summer reduces CO_2 emissions by almost 300 Mt (when including the indirect CO_2 emissions associated with electricity generation and heat production).'[26]

Figure 18 — CO_2 emissions reductions due to behavioral changes in the NZE scenario

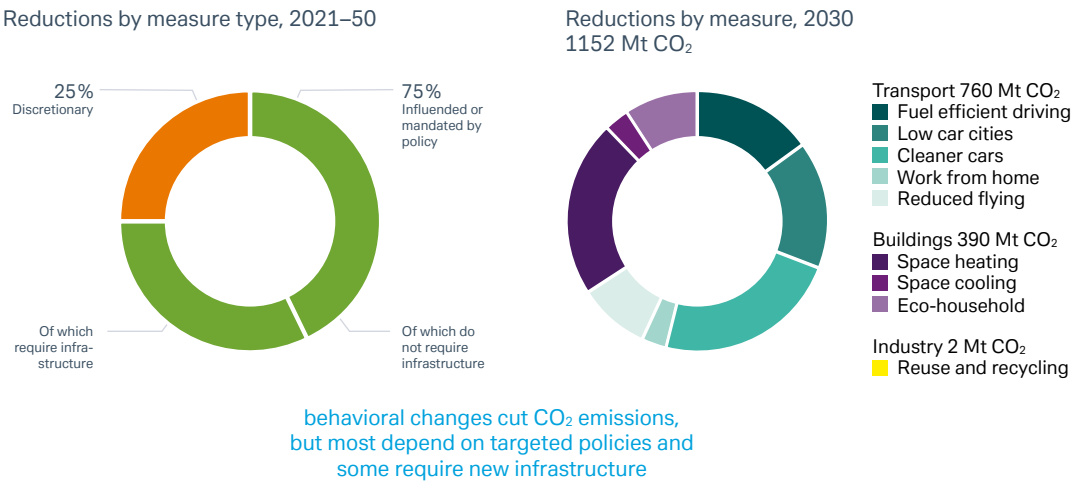
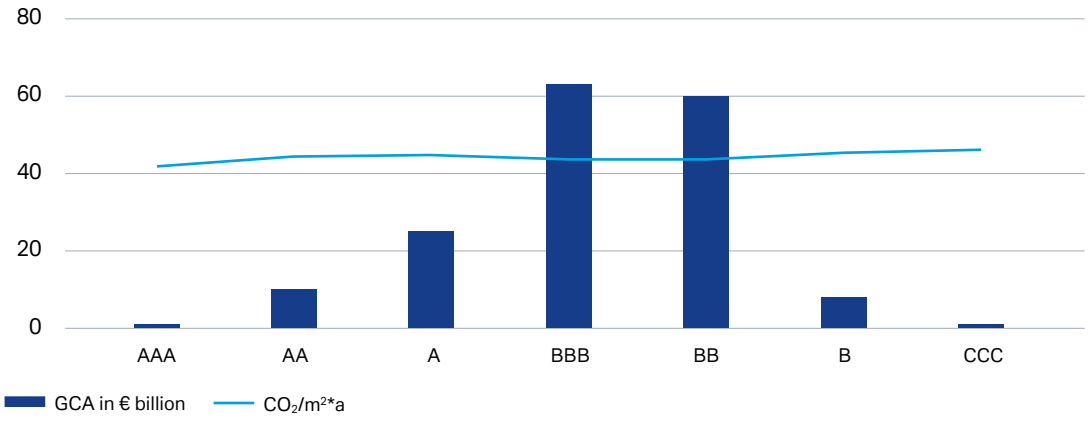


Figure 3.19 (IEA)
Source: IEA World Energy Outlook 2022, page 157

26 IEA World Energy Outlook 2022, page 158

From a credit risk point of view, we analyzed whether higher energy efficiency could lead to a lower default rate (e.g., the client is more forward looking). For our German portfolio, higher income trends to higher energy-efficient buildings where (of course) the higher income is the more dominant factor.

Figure 19 — Distribution rating/income/energy efficiency



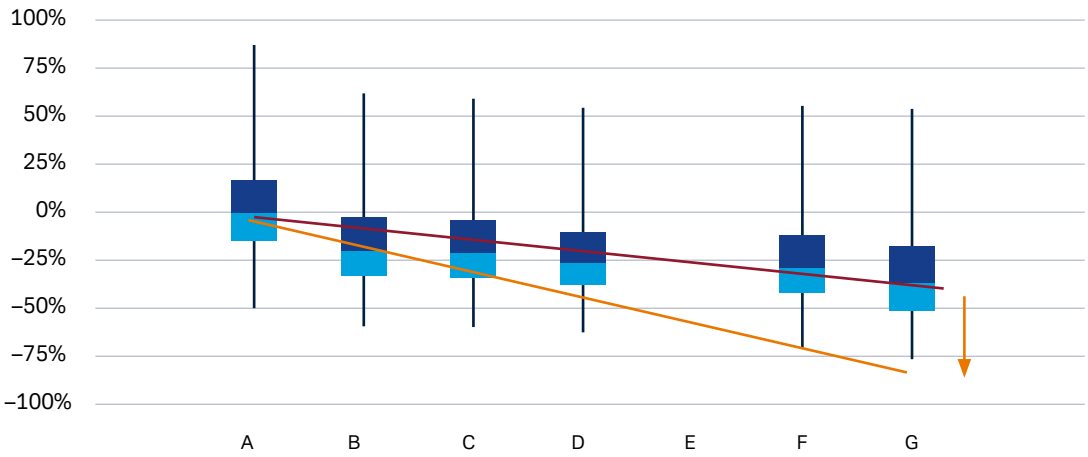
Based on our client experience, discussions with our clients to improve their ESG knowledge is also an important factor. In general, a higher education and a better work-life-balance lower growth of energy demand which should not predominantly depend on the income of a client.

7.4 Impact of EPC classes on house prices

Newly constructed houses are in general more expensive than existing properties due to additional renovation costs. In the last years, we observed for the German housing market that renovation costs did not have a significant price impact due to a high property demand. In attractive regions available houses or apartments were offered for only 24h. Hence, buyers were not able to factor in the additional renovation costs or additional energy efficiency measures which are harder to evaluate.

In general, it is assumed that higher energy efficiency leads to a higher market price. We believe this depends on the current market situation. Based on local districts within Germany, we compared (in case of a sufficient large sample) the market price per m^2 to measure deviation between EPC class A and other EPC classes. The largest difference is between EPC class A and B which is mainly linked to the fact that EPC class A contains a significant part of new built houses. The price differences between EPC class B and other is not significant. Hence, currently there is no statistically significant deviation as illustrated in the following graph.

Figure 20 — Price per square meter (observed)



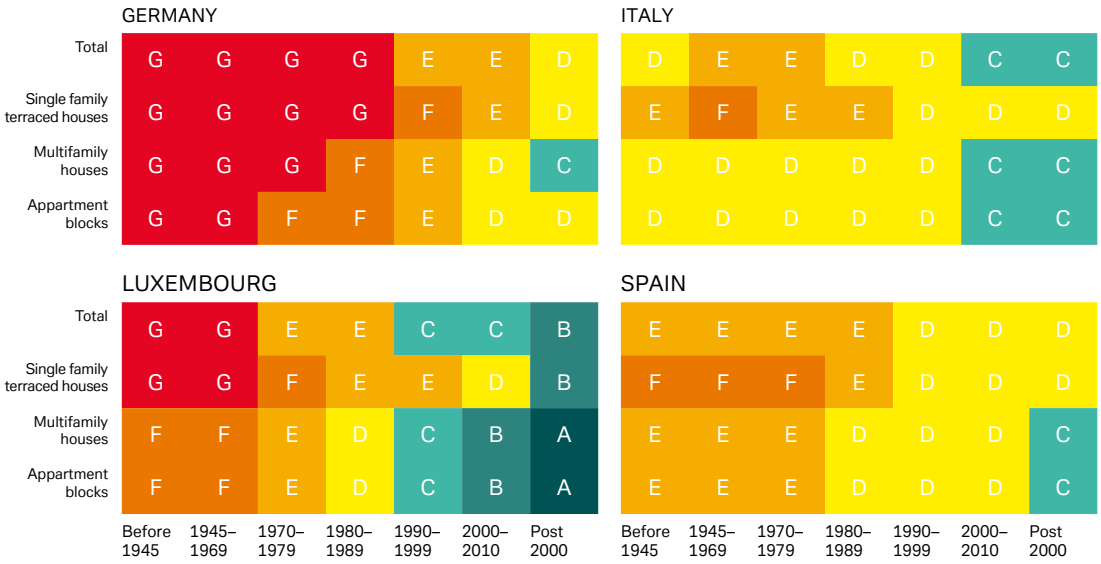
However, one has to point out that there are multiple input factors for house prices which currently are seen as more dominant factors. We assume that in the next ten years, regulations like the European Standard on Energy Performance of Building Directive may define so called 'stranded assets', meaning buildings which cannot be used prior to any renovation measures.

We also observed another statistically significant factor: the deviation of market prices between the top 5%-quantile and the bottom 5%-quantile is higher for higher energy-efficient buildings. Hence, selling an energy-efficient building could have an opportunity for higher market prices, but this is not normal market standard.

7.5 Dependency on regions and climate zones

As outlined in Chapter 5 'IEA roadmap to Net Zero Emission by 2050', energy consumption is dependent on operational emissions, i.e., heating. Hence, the duration of the heating period plays an important role for energy efficiency. Within Europe, we have different climate zones with different energy consumption levels (e.g., north/alpine vs. maritime zones). We have performed a national comparison of property types and building years based on our modelling of EPCs on Hotmaps and PCAF. While building techniques and requirements are in a similar range within Europe, a national comparison is conditional on the respective heating periods.

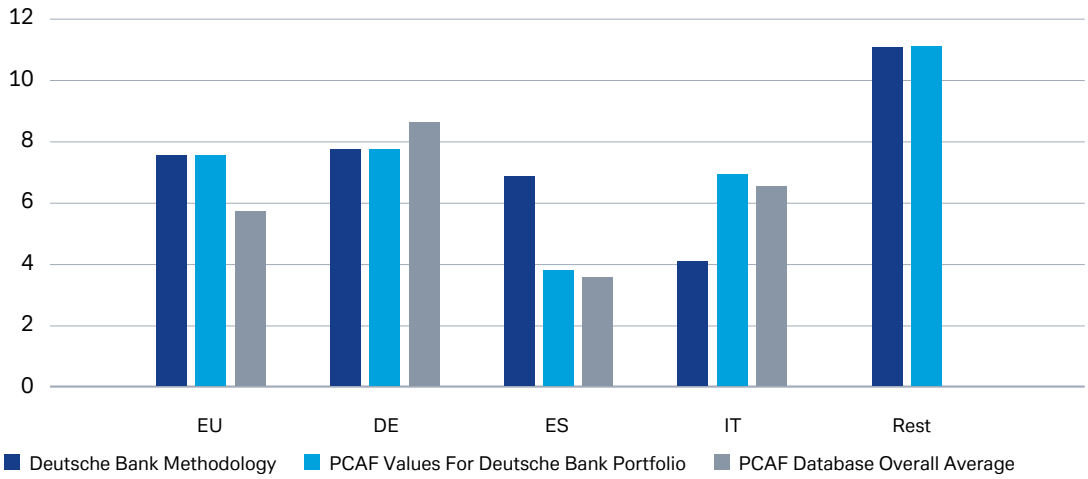
Figure 21 — Harmonization of EPC labels based on Hotmaps



In-house calculation

We did not analyze whether future climate developments may reduce or change requirements (e.g., heating vs. cooling) which may lead to a reduction of CO_2 emissions in the future. However, we are able to observe that our portfolio is impacted in the allocation within different regions.

Figure 22 — Benchmark of CO_2 footprint per region



Comparing data of the PCAF database (grey) demonstrates that there is a difference in CO_2-consumption per country. In general, this can depend on the different contribution factors depending on the national energy consumption as well as national standards for housing.

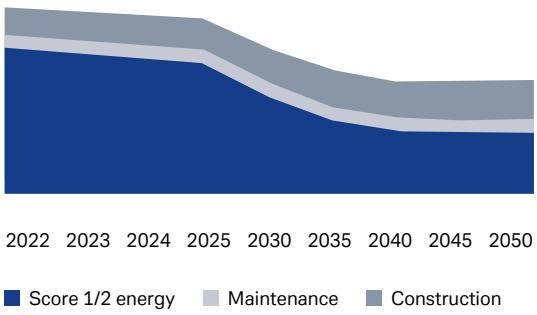
We have analyzed that for our Spanish portfolio, our methodology led to a major deviation from the Spanish PCAF data. We identified that national building characteristics are not important, but the location of the underlying buildings is dominating the CO_2 footprint. While PCAF assumes a fair distribution through all regions, Deutsche Bank's portfolio has a concentration on Catalonia. Catalonia is located in north-eastern Spain and has three different types of climate zones: alpine in the Pyrenees (cold mountain climate), oceanic in the small area north of the Pyrenees (cool and wet) and Mediterranean along the coast. Hence, our portfolio is dominated by a cold mountain climate which, of course, has a longer heating period and therefore a higher energy demand and respective CO_2 footprint compared to the average Spanish climate.

7.6 Grey energy of buildings

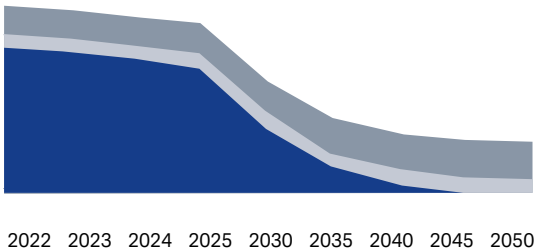
The current focus of carbon footprints and pathways is on operational emissions (Scope 1 and 2). The embodied emissions (Scope 3) are harder to identify and to measure. Hence, this needs a substantially higher knowledge of building material and methods, which is not the case for many clients, craftsmen but also for the bank. We believe that in the future, investments may consider the amount of embodied emissions for construction of a building ('grey energy' as defined in Chapter 5) and for the necessary infrastructure (e.g., streets, [waste] water lines, kindergarten, …).

Based on studies from Austria, which we assume to be comparable to Germany, we have estimated the additional energy consumption for renovation and building of our portfolio. Our new business assumption on newly built properties leads to an increased demand for grey energy. Hence, we have written off the grey energy over the lifetime of a building (100 years). We assume that new constructions are important to stabilize housing market prices and to ensure affordable housing.

Figure 23 — Energy Consumption (illustrative) – assuming zero carbon ready only for new buildings

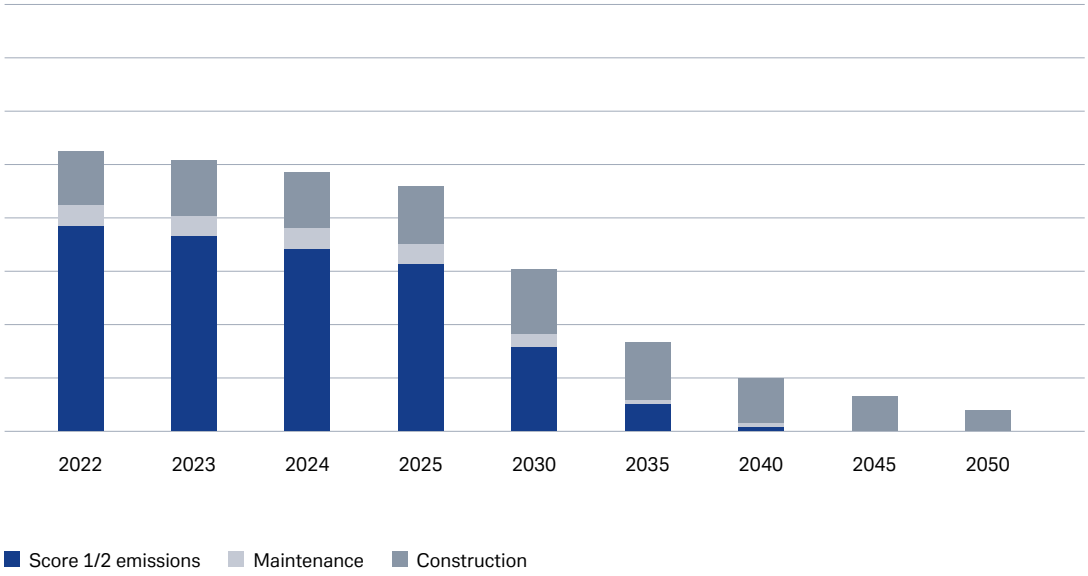


Energy Consumption (illustrative) – assuming zero carbon ready also for renovations



Taking also into account that under the IEA scenario NZE, the CO_2 emission efficiency of other sectors (e.g., steel, cement) improves, both scenarios would lead to the following CO_2 footprint for renovation (grey) and construction (dark grey).

Figure 24 — CO_2 emissions impact (illustrative)



In order to reduce CO_2 emissions in general, we assume that in a future stage policy makers will ask to incorporate the absolute CO_2 emission budget in investment decisions. This will lead to tradeoff decisions between renovation and demolish/rebuild in the future which may lead to an adjustment of any sustainable strategy (including grey energy).

Lessons learned published by CRREM & UNEP FI ('Managing Transition Risk in Real Estate: Aligning to the Paris Climate Accord'[27], page 42) enclose relevant key take-aways such as:

- 'Simply constructing efficient or even zero-energy buildings cannot deliver decarbonization'
- 'More focus should be placed on refurbish and reuse instead of demolish and rebuild'

27 Managing Transition Risk in Real Estate: Aligning to the Paris Climate Accord – United Nations Environment – Finance Initiative (unepfi.org)

7.7 Dependency on other sectors

The CO_2 footprint of buildings is highly dependent on heating/electricity (no oil, no gas, no coal/higher carbon taxes). The rapid drop in emissions from electricity generation helps to bring about continued reductions in emissions in the building sectors as they electrify[28]. And so, mortgage business has to support the energy sector to reach their emissions targets. Some countries, like Sweden, are using district heating and green energy in order to reduce the energy demand per building. Additional reductions can be promoted by increasing seed-funding for new techniques (incl. start-ups) with innovative ideas to combine the need for heating, for example, with need for cooling of data centers.

An important factor is an improvement of local infrastructure which allows to exchange heat by local district heating or energy between buildings. An improvement of the infrastructure could also include pipes for drinking water and water of a lower quality (e.g., for washing). Also, future development for more periods of heavy rains may require larger sewer pipes in order to mitigate physical risks. Infrastructure development is therefore an important area to improve, since it is also responsible for a large part of embedded emissions. The additional operational and embodied emissions could also be reduced, of course, by leveraging urban infrastructure. This would simultaneously also have a positive impact on transport (i.e., shorter distance, energy efficiency and higher electrification).

However, renovation and net-zero-carbon-ready houses will have a low carbon footprint in the future, but demand techniques and material (e.g., cement, steel) to build energy-efficient buildings or to improve existing ones. From a real estate perspective, these sectors contributing to constructions have to be supported in reducing their energy demand which will also have a positive impact on embedded emissions for real estate buildings.

28 Source IEA WEO-2022 page 124 & Fig. 3.1 Energy-related CO_2 emissions by sector and gross and net emissions in the NZE Scenario, 2010-2050

8

8 Methodological approaches to net zero alignment in detail

8.1 Methodology estimation of energy efficiency

In general, the chosen approach to estimate EPC ratings included two steps:

1. Assign a value for energy demand per m², depending on the object information available, and
2. Map this value on a scale of energy demand to EPC ratings

Given the divergent degrees of data availability, the first step included

- values being defined by own analysis of collected EPC samples or public EPC datasets, or
- values obtained from existing analyses such as the database of the Partnership of Carbon Accounting Financials (PCAF), publications from national authorities such as the German Energy Agency or the building stock dataset of the Hotmaps Project, a planning tool for public authorities, funded by an EU program grant, which provided somewhat more granular breakdowns by building type or construction period

The definition of rating scales was either adapted from law (in the case of Germany) or defined by the bank based on analysis of public datasets. For example, the German rating scale is defined by Gebäudeenergiegesetz (GEG):

EPC rating	Final energy demand (Energy performance score in kWh/m² of collateral)
A (and A+)	≤ 50
B	≤ 75
C	≤ 100
D	≤ 130
E	≤ 160
F	≤ 200
G (and H)	> 200

Table 6: EPC rating scale for residential buildings in Germany according to GEG

'Not relevant/out of scope': Mortgage exposure only secured by plots of land or parking lots was excluded from the portfolio of mortgages and considered out of scope, as these properties do not need to be heated and are thus unaffected by CO_2 emissions price shocks in transition risk scenarios. It is only integrated if the energy consumption of a building's car park cannot be disaggregated from the energy consumption of the building.

'Unknown' and therefore not included in the rating scales: Within the overall exposure related to real estate according to COREP[29], some parts were excluded and defined as not in scope of this exercise, unless the contract was indeed matched to property information with an actual or estimated EPC rating (i.e., contracts related to guarantees, overdrafts, overnight deposits, trade finance and consumer finance including credit cards). These products do not have any relation to green loans.

Allocating exposures to EPC ratings

Deutsche Bank uses a model-based approach to calculate financed emissions, using proxies as well as 'real' data such as EPCs. This needs to be done in line with national regulations depending on the location of the collateral. Regulations regarding EPCs differ across the different EU countries, with some having looser or stricter requirements for a given EPC rating.

For allocation of EPC ratings, Deutsche Bank uses different approaches to gather energy efficiency data. This can be illustrated in a type of waterfall model:

Approach	EPC data	PCAF data quality score for mortgages[30]
1	Usage of EPC data provided by client and m^2	Score 1/2[31]
2	Usage of EPC data provided by local register and m^2	Score 1/2
3	Usage of EPC data provided by external vendor and m^2	Score 1/2
4	Usage of EPC data provided by external appraiser and m^2	Score 1/2
5	Usage of EPC data modelled by external vendor and m^2	Score 4
6	Usage of EPC data modelled by Artificial Intelligence (incl. m^2)	Score 4
7	Usage of EPC data modelled by internal model based on location, property type, building year, m^2, …	Score 4
8	Usage of EPC data modelled by location, building year and m^2	Score 4
9	Usage of EPC data modelled by proxy and m^2	Score 4
10	Usage of EPC data modelled by proxy per property	Score 5
11	Flagging as unknown	Score 5

Table 7: Waterfall model – mapping EPC data to PCAF data quality score

29 COREP: Common Reporting framework
30 PCAF Global GHG Standard – Financed Emissions (2nd Edition), Table 10.1-5. Detailed description of the data quality score table for mortgages, page 146
31 Score ½: PCAF data quality data score 1 if 'supplier-specific emission factors to energy source' are provided, score 2 in case average emission factors are applied

Figure 25 — PCAF Quality Score EU in € billion

PCAF Quality Score ES in € billion

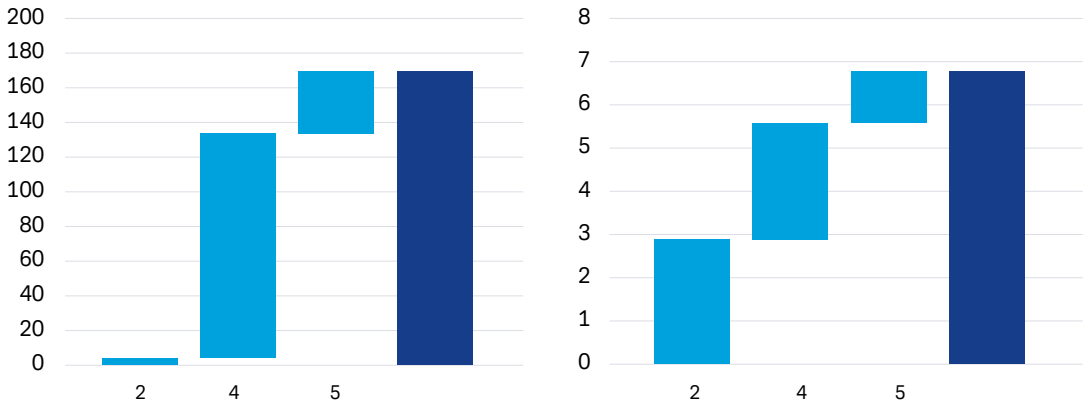


Figure 25: Mortgage Exposure by PCAF Quality Score (examples for EU and Spain due to available data)

Due to a missing EPC database for Germany, current tests using Artificial Intelligence did not provide sufficient results since the test group has to be sufficiently large to train data sets for machine learning algorithms.

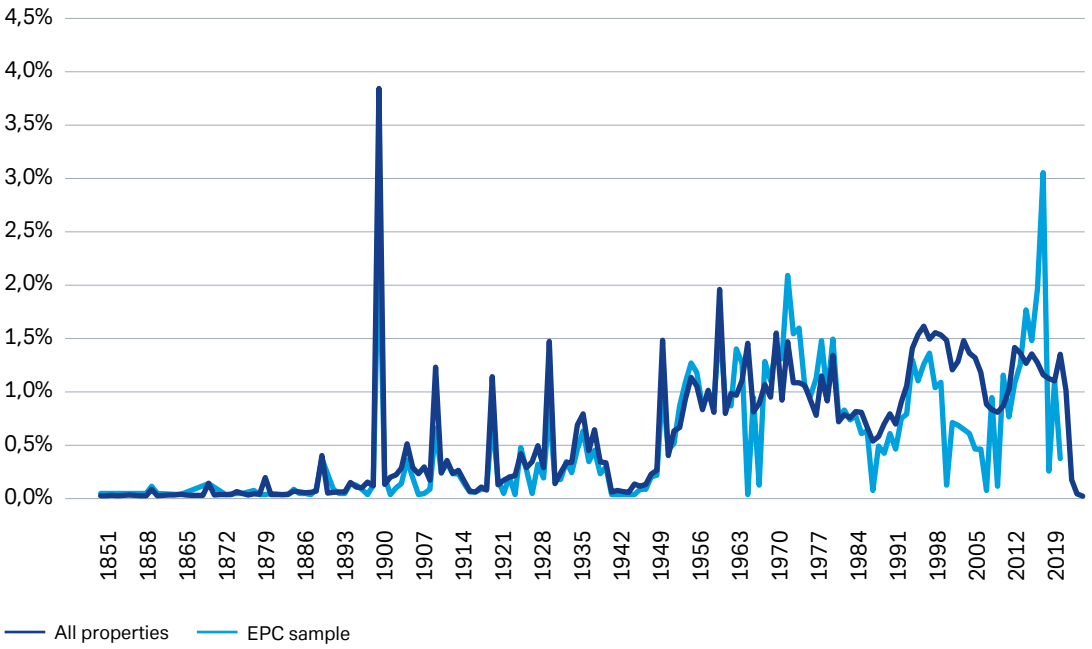
Example allocation in Germany (used approaches 1, 7–11)

For Germany, a publicly accessible EPC register does not exist but should be established in order to develop a level playing field with other jurisdictions in Europe, like France, UK, Spain and Italy. Hence, data on energy efficiency has to be collected or estimated.

For new business in Germany, EPC collection has been in place since August 2022. This included process implementation regarding OCR (Optical Character Recognition) technology by a third party extracting the relevant EPC data. Additionally, in a pilot a loan file review was performed for a sample portfolio to identify EPCs of residential buildings which have already been collected. The certificates were part of the mortgage documents on file but were not in a suitable format for analysis and had to be scanned and processed using OCR technologies.

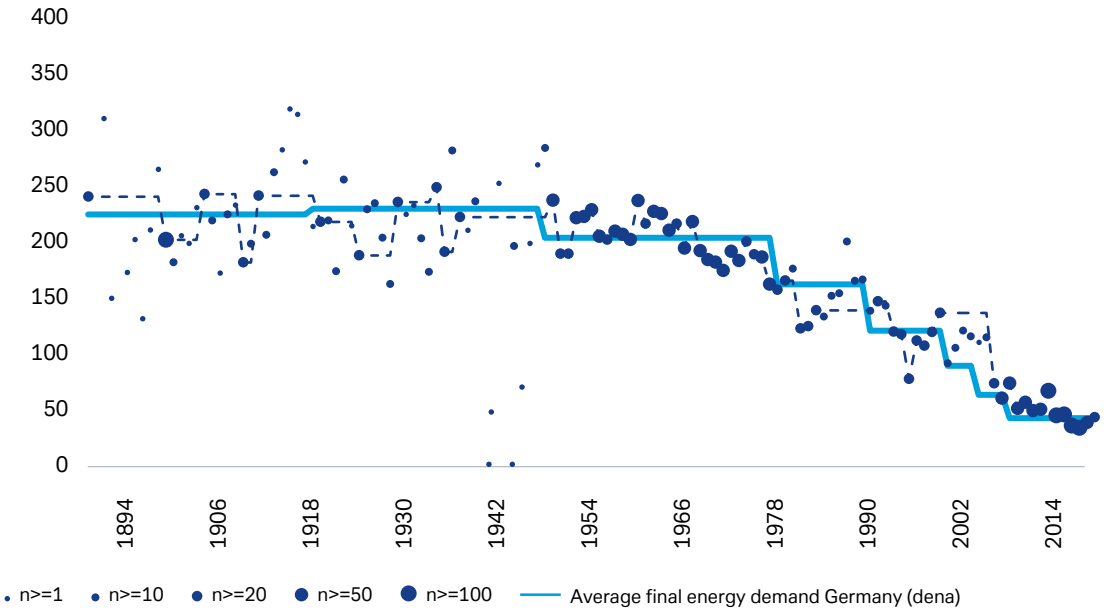
In terms of regulation, there are two types of EPCs for residential buildings in Germany: one based on an assessment of primary energy demand conducted by an energy consultant ('Bedarfsausweis'), and the other largely based on proof of final energy consumption, i.e., utilities bills ('Verbrauchsausweis'). These two certificates contain different types of information, demand and final consumption. These values are not necessarily comparable for older periods of construction, making the creation of a proxy method more difficult. The collected sample was broadly representative of the wider population of buildings in the portfolio in terms of age of the buildings (see below figure).

Figure 26 — Histograms by year of construction for overall German portfolio of residential real estate collateral and the collected EPC sub-sample



In-house analysis of the collected EPCs for residential buildings revealed a very close fit with an earlier analysis of the German Energy Agency (dena) [Gebäudereport 2016 p61] (see below figure) with the correlation coefficient between the final energy demand per m² per year and the average values by construction period calculated by dena very high at 0.93. Due to the distribution of our German portfolio dena is also adequate.

Figure 27 — Average energy demand of collected EPC sample by year of construction and average values per construction period (in kWh/m²)



Further, a lower average energy performance of single-family houses vis-à-vis apartment blocks in the sample could be established, with single-family homes having on average 3% higher energy demand than the overall sample average, and apartment blocks having 16% lower demand than the sample average.

Based on this analysis a simple rule-based estimation approach was defined: given the period of construction, the averages provided by dena were assigned, and in case of available information on the building type an adjustment was made for single-family homes and apartment blocks, except for buildings built after 2009, when single-family homes have become similarly efficient.

Applied to the sample, this rule-based method achieves an accuracy of 42.4% for the records containing information on year of construction and building type. This accuracy is clearly higher than guessing (14.3% at seven classes) or simply assigning the most frequent rating G by default (22.9%). For 70% of the records with year and type information the predicted rating is within +/–1 class around the actual EPC rating. For the largest share of contracts secured by residential real estate located in Germany information on building type and year of construction was available, thus this approach could be applied, contributing 98.8% to the estimation of mortgage exposure in scope.[32]

In the few cases where no real EPC data or information on the year of construction was available (0.5% of mortgage exposure), average energy demands of residential buildings, as used to construct the PCAF Emission Factors database[33], were used together with the ratings scale of the GEG, leading to an EPC rating of D for multi-family homes and E for all other residential buildings. While in most cases the year of construction is a useful predictor of energy efficiency, the variable is sometimes also problematic: in some cases, the year of the last significant renovation would be more meaningful. Further, missing documents, to a large extent also related to destruction during the first and second world wars, have increased uncertainty in terms of the year of construction, as could be seen earlier in the local peaks in the distribution for the years 1900, 1910, 1920, 1930, 1950 and 1960.

As an alternative, simple decision tree models using more variables were trained (e.g., floor surface area, macro-economic indicators such as regional GVA[34] or per capita household disposable income obtained via the postcode), which however could not beat the accuracy of the dena-method using only the year of construction and the adjustment for building type.

32 These percentage relate to the total exposure allocated to ratings A-G in the submission, thus excluding 'Unknown' or contracts considered out of scope of EPC
33 https://db.carbonaccountingfinancials.com/
34 GVA – Gross value added

Example allocation in Italy (used approaches 2,3,8–11) and Spain (used approaches 2,3,4,6,8–11)

In Italy and Spain, actual EPCs were matched with public regional EPC registers, using available information on address, land registry entries (in Spain) and building types. For Italy, additional matches with actual EPCs were achieved for records with missing object address information by using client addresses under certain conditions[35]. In both cases, only a fraction of properties in the portfolio can be matched to actual EPCs (around a quarter in Italy and half in Spain), since not every house is legally obliged to have one. In Spain, where certificates contain two ratings (for energy demand and CO_2 emissions), the most conservative rating was used. In addition, we used a vendor for Spain to provide EPC data and EPC estimates for the Spanish portfolio.

A review of the proportion of exposure that is based on real data or estimated at the level of location of the collateral reveals that some estimation methods do not include all seven EPC ratings (A-G).

Methodology and underlying data of external datasets

For the Hotmaps Project, the underlying Building Stock Dataset at Hectare level (heatmap) is derived from similar data at national level (energy consumption by energy carrier from Eurostat, building stock from EU Buildings Database) and is then enriched with further data, such as OpenStreetMap, to provide a more granular breakdown by building type and construction period. Furthermore, additional measures of energy demand are calculated as well as breakdowns for cooling, lighting and domestic hot water. For this exercise, the default values used for various building classes refer to calculated values of useful energy demand in kWh/m² per year for space heating, cooling and domestic hot water, as these are more comparable to data contained in EPC registers in Spain and Italy, where certificates are based on a professional assessment of energy demand.

To conclude, both external data sets rely on published data on energy demand by well-established statistical institutes and – at the national level for residential and non-residential buildings – relate to the total building stock and as such should be broadly representative also for the subset of buildings that are securities for the mortgage and corporate exposure secured by real estate in the portfolio of Deutsche Bank. In the country-specific sections for Spain and Italy, the consistency between the external datasets and data internally available or available in (regional) EPC registers are further demonstrated.

35 The NUTS3 region of the client has to be identical to that of the property

8.2 Methodology estimation of financed emissions

Application of emission factors

The purpose of the PCAF emission factor database is to more precisely report the carbon footprint of a real estate portfolio that a financial institution may have, in tons of CO_2 emissions equivalent for Scope 1 and Scope 2 emissions. This is done via the calculation of emission factors per unit of floor area (in m^2) or building unit that financial institutions can apply, based on several official sources and established research institutes. For European Union countries these sources are:

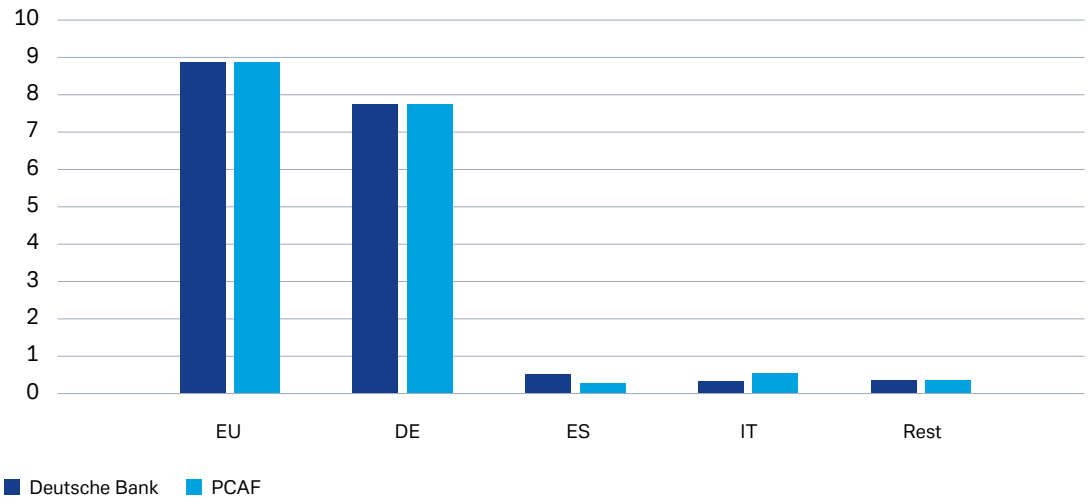
- Eurostat (total annual residential energy consumption of households by energy carrier)
- European Commission EU Buildings Database (total annual energy consumption by type of fuel and type of non-residential building)
- European Energy Agency (emission factors in g CO_2e/kWh for electricity)
- German Emissions Trading Agency (DEHSt) (emission factors for gas, solid fossil fuels, oil & petroleum products plus renewables & wastes)
- Ipsos & Navigant (emission factors for derived heat; total residential building stock in m^2 and number of units)

Since there is some difference in the variables contained in EPCs across EU countries, whereas some measure of energy demand is always available, we decided to re-engineer energy demand per m^2 by using the computed PCAF emission factors and the original source data from Eurostat/European Commission.

Backtesting of CO_2 footprint

To double-check our CO_2 footprint estimation, we performed a backtesting based on PCAF standardized values per property. In total, for our European residential real estate portfolio we achieve a nearly identical Mt CO_2e/y value compared to PCAF. Concerning the differences, we have analyzed these effects based on our collateral data. The deviation is mainly driven by the property type and square meters where our average property is deviating from the national average (i.e., more single houses with higher m^2 in ES, lower m^2 in IT). The Rest-EU is mainly depending on PCAF estimates; hence the deviation is small.

Figure 28 — Backtesting CO_2 footprint



8.3 Methodology for net zero aligned pathways

For the European residential real estate portfolio, the net zero pathways were calculated based on a projection of EPC data and CO_2 footprint. We reviewed the different IEA scenario assumptions for real estate with the following main underlying assumptions to outline a first pathway towards net zero:

1. Projection of balance sheet development for new business, house price development and implemented measures of improving energy efficiency
2. Application of Emission factors under the respective IEA scenarios

This leads to an estimation of the net zero pathway for Scope 1 and 2 emissions for residential real estate buildings. We excluded Scope 3 emissions for our main analysis and conclusions.

Projection of balance sheet development

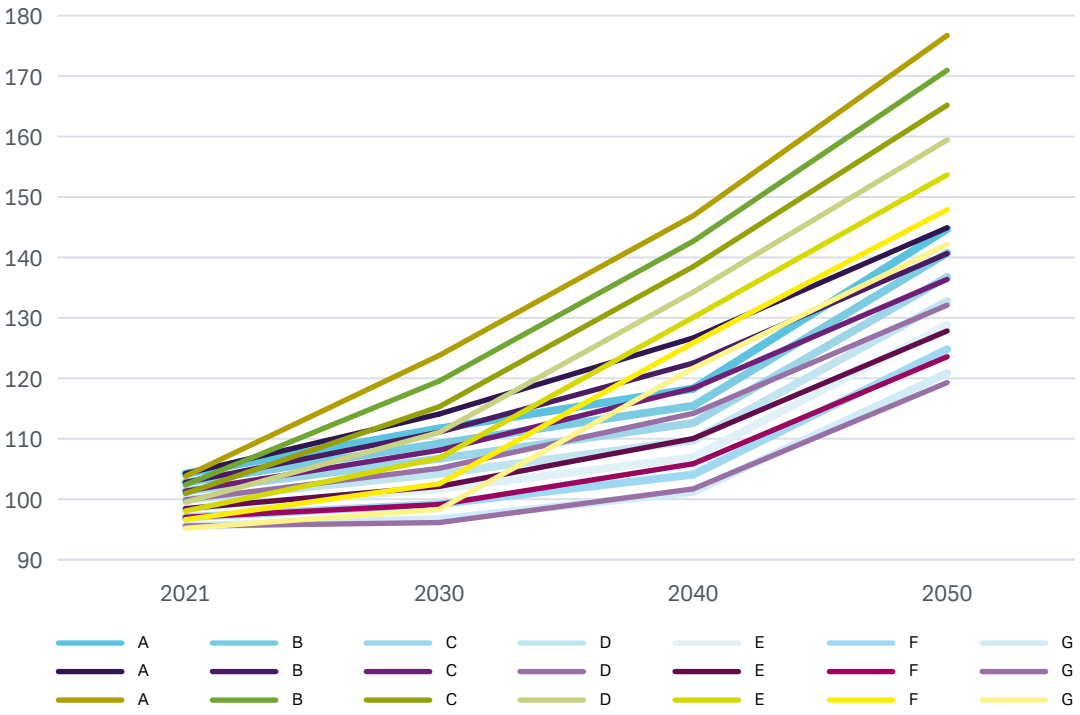
The balance sheet projection for our European residential real estate portfolio is based on national level and depending on the underlying scenario. To summarize, we apply the following assumptions based on the respective scenario:

Scenario Input	NZE	APS	STEPS
New built properties	Zero Carbon Ready/ EPC class A0	EPC class A	
Renovation	2,5% p.a. to be retrofitted towards net zero properties	retrofit/improvement by 1 EPC class every 40 years	no improvement in energy efficiency
New Business after 2030	no new business with G	no adjustments	no adjustments
New Business after 2040	no new business with G and F	no new business with G	no adjustments
New Business after 2050	no new business below E without any improvements above these EPC levels	no new business with G and F without improvements by at least 1 EPC class	requirement on new business with G to be improved by at least 1 EPC class

Table 8: Overview of Scenario Assumptions

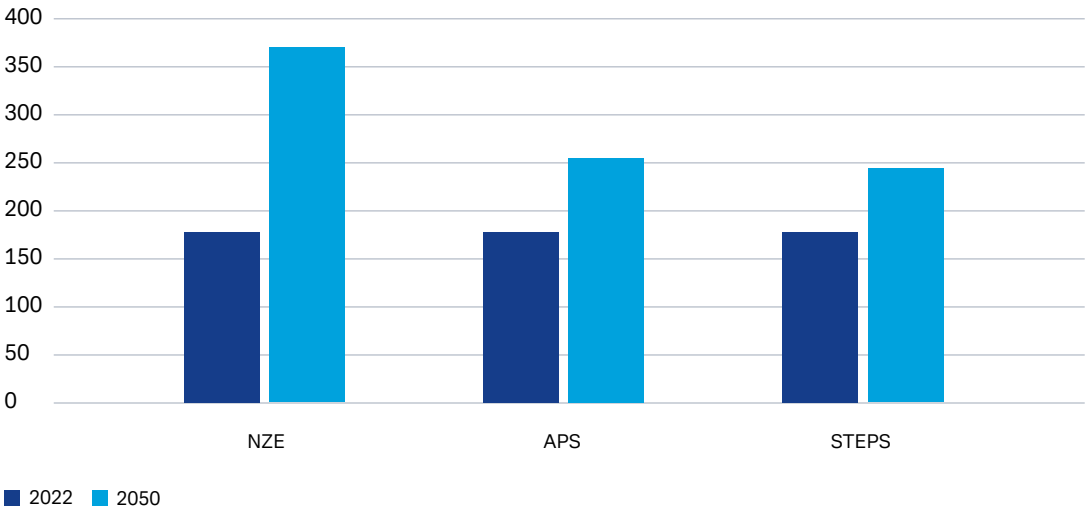
The new business volume is based on a constant number of transactions within the projection. The number is based on the new business volume in 2022 which is assumed to be maintained on average in the future. The respective new business volume per year is dependent on the EPC label and house price development. To estimate this, we applied the underlying assumptions of the NGFS scenarios (2021) for orderly, disorderly and hot house scenario.

Figure 29 — NGFS scenarios – orderly, disorderly and hot house



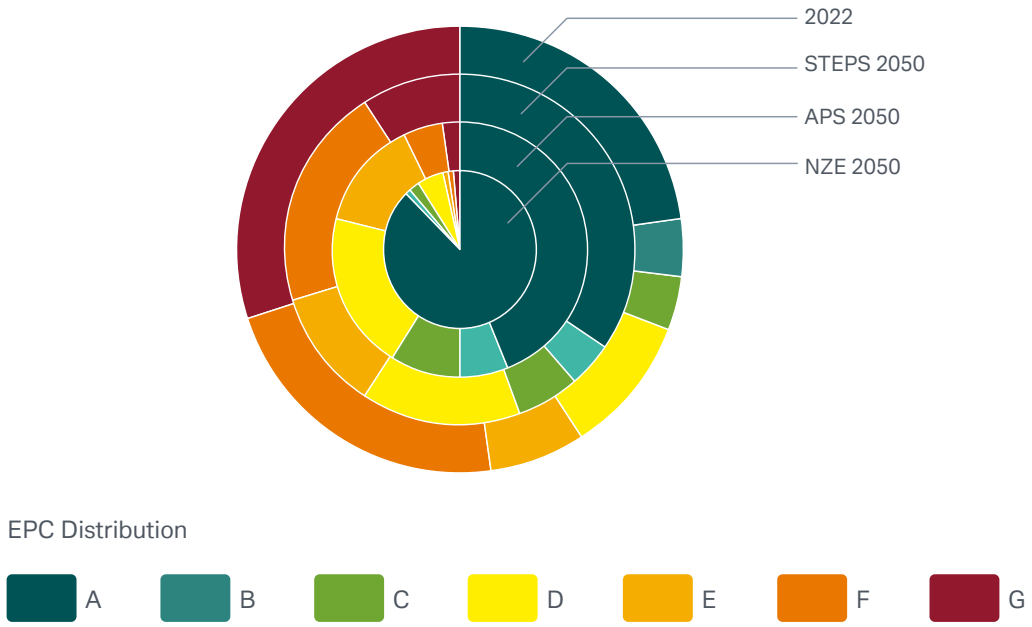
We applied no change in credit lending standards (i.e., credit risk parameters such as % of own equity within the transaction, Loan to Value (LTV) at origination, interest, repayment rates). However, based on the price development and EPC restrictions for new business, there is a significant difference in the respective balance sheet growth for mortgages.

Figure 30 — Estimation on EPC and scenario growth in billion €



Differences in volume growth will impact our financed CO_2 emissions as well as our CO_2 emissions intensity. The EPC classes for our German residential real estate portfolio in 2050 illustrates the dependency on national building standards. Looking on this improvement in EPC labels, one has to have in mind that only 25% of the German building stock is used as collateral in mortgages. Hence, the distribution is not reflecting the national German pathways for buildings in general. But it illustrates that in 2050 older/ historic buildings will have an impact on the stock of non-green buildings.

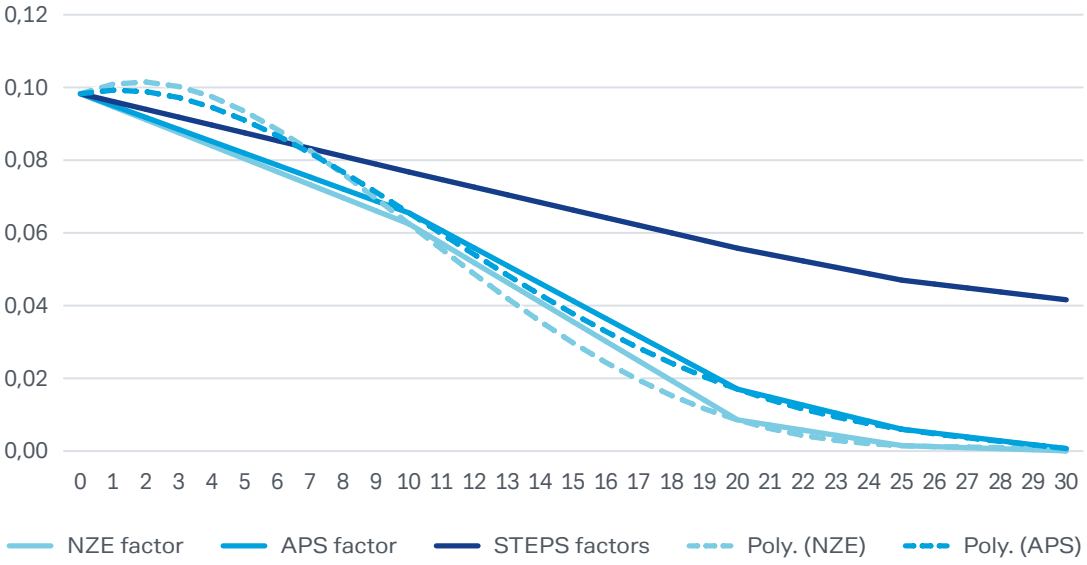
Figure 31 — Distribution of EPC rating in 2022 and for NZE, APS and STEPS in 2050



Application of emission factors und IEA scenarios

We selected the IEA scenarios NZE, APS and STEPS to assess the pathways required to align to net zero by 2050. For all scenarios, we used the IEA scenario assumptions on emissions factors for European residential real estate to estimate a relative change of the CO_2 emissions intensity per EPC class. Where necessary, i.e., in the NZE scenario, we extrapolated the European emission factors based on the global residential real estate emission factors per energy label. As an alternative, one could also use CRREM which provides a more sophisticated break-down for IAE NZE. The emission factors were applied as an index on our EPC distribution in the respective years. For illustration purposes, we smoothed the function of the underlying scenario parameters.

Figure 32 — NZE, APS & STEPS scenario parameters



8.4 Data and model related challenges

Climate related data is not comprehensively available today and is not subject to globally consistent and rigorous standards. This can be seen by the following factors:

1. Standardization of data definition
2. Measurement of actual data
3. Availability of data sources and providers
4. Standardization of scenarios
5. Standardization of models to estimate long-time projections

Standardization of data definition

Several policy makers and regulators around the globe are developing standardized requirements for climate and ESG related disclosures. Due to deviating goals throughout regions, we have narrowed the scope of the white paper towards Europe. However, even within Europe we identified deviations in energy efficiency certificates, EPC labels and corresponding standards which challenge a comparison between different jurisdictions. Most important for this white paper are energy consumption and energy demand of a residential real estate property with an EPC label. Metrics within an EPC label are not constantly available across regions.

Indicator	Germany	Spain	UK	Italy
Property Type	Yes	Yes	Yes	Yes
Part of building	Yes	Yes	No	Yes
Address	Yes	Yes	Yes	Yes
Year of construction	Yes	Yes	No	Yes
Year of heater	Yes	No	No	No
Number of apartments	Yes	No	No	No
Floor Space	Yes	No	Yes	Yes
Essential Energy Source	Yes	No	No	No
Renewable Energy	No	No	No	No
Cooling	No	No	No	No
CO_2 Emissions	Yes	Yes	No	No
Final Energy Demand	Yes	No	No	No
Primary Energy Demand	Yes	Yes	Yes	Yes
Final Energy Consumption	Yes	No	No	No
Primary Energy Consumption	Yes	No	No	No

Table 9: In-house analysis based on EPCs (YE 2021)

The amount of information displayed within an EPC label does not lead to any conclusion about the quality of EPC labels. In some countries, EPC contains additional information which are of a higher usage for private clients (e.g., climate zone in Italy and Spain, comparison with similar properties in Italy and Spain, potential future energy costs in UK). We anticipate that it will take several years before we see a meaningful improvement in quality and consistency.

Besides, at least for the example of German EPCs, not all the displayed metrics are mandatory. Additionally, there are two different EPC-formats, one demand-based, the other consumption-based, which may be used equivalently from a regulatory point of view although not necessarily displaying, identical EPC efficiency class levels for the same object. This problem can only (and needs to) be solved by a higher degree of regulatory standardization.

Commercial Real Estate (CRE):

We have assessed if currently available data is sufficient to include our CRE loan book in this white paper. Since our CRE portfolio is globally distributed with some concentrations within the US market, we are depending on energy efficiency information which are not linked to European EPC labels. Hence, other certificates like Energy Star, LEED, BREEAM, DGNB, CASBEE etc. would have to be included. These certificates are not standardized by policy makers (compared to EPCs). Therefore, different labels for different commercial buildings must be benchmarked. In case of missing energy efficiency certificates, we assessed if a model-based approach is feasible for CRE. This is currently not the case since the global CRE portfolio is very difficult to compare by property type or region.

Measurement of actual 'real' data

The challenge of measuring actual data begins by measuring the correct property. A loan agreement encloses a financed asset and a collateral linked to the transaction. Both may be real estate, but are not necessarily the identical property. Banks are now asked to publish:

1. CO_2 footprint for financed assets by EU Taxonomy, and
2. CO_2 footprint for collaterals by disclosure requirements (e.g., Pillar III)

Example Private Residential Real Estate: Shortly prior to retirement, a couple wants to move from the city to their hometown. In order to finance the construction of their new property, they take up a mortgage loan on their existing city apartment. The loan will be repaid by selling their apartment after moving into their new home. While the city apartment was built in the 1970's, their new home will be near zero carbon ready due to current market standards. Which subsequent actions must be taken by the bank?

Throughout this white paper all calculations are performed based on collaterals obtained by Deutsche Bank (in line with Pillar III disclosure). Although financed asset and collateral (in Germany residential mortgages) are >95% identical for the EU Taxonomy purpose, usually, EPCs are required for the financed assets.

Energy consumption and energy demand are currently the most critical data to estimate energy intensity metrics for buildings. However, these data require different processes to estimate. While energy demand is calculated based on standardized conditions by a certified professional (i.e., energy consultant, architect, construction engineers, interior designer), energy consumption is dependent on the energy spent in the last three years. This data can be diluted, e.g.

1. Building uses solar panels for heating and electricity
2. Building has a wall box for an electronic car
3. Building is large, but only used by an elderly owner, or is small, but used by a 4-person family
4. Building's m^2 are correctly measured for the purpose of energy efficiency (resp. CO_2 emissions intensity per square meter)

Within any future collateral valuation process, these differences must be considered in a standardized way, which will also increase the costs for the valuation process. Due to the size of our portfolio, especially in Germany, we assume for our calculations that these deviations will have no major impact at portfolio level at this stage.

At a future stage, additional data may be required (e.g., used building material for the estimation of grey energy as illustrated in Chapter 7.6 or water consumption for other environmental risks). Despite the need for additional data to perform proper decisioning, policy makers must consider that private clients are not all experts within this field. ESG policies should focus on simple requirements which can be complied with by every private client seamlessly.

Deutsche Bank will therefore use a model-based approach, applying different sources of energy efficiency data, to estimate energy efficiency and to validate collected data.

Data Quality: In 2020, Deutsche Bank established an OCR pilot for part of its portfolio in order to identify potential solutions for data gathering. Within this learning exercise, we identified several lessons learned which helped us to improve future processes:

1) Clients and client relationship managers were not trained to identify EPC

OCR pilot 2020

Energy Performance Certificate	91%
Energy Saving Certificate	1%
Airtightness Certificate	2%
Others	7%

Table 10: Types of Certificates

2) Not all pages of an EPC were scanned and/or could be extracted via the ORC software. We identified more than 13 different German EPC Standards (most prior to 2017)

OCR pilot 2020

0 pages scanned and extracted (primarily Airtightness Certificate and others)	9%
1 page scanned and extracted	13%
2 pages scanned and extracted	33%
3 pages scanned and extracted	44%

Table 11: Scanned pages

3) Quality of certificates and energy consultants improved significantly after 2017 (measured by completeness of fields)

Availability of data sources and providers

To comply with the EU taxonomy, disclosure regulation and requirements for ESG risk assessment banks need a sound, robust and efficient way to either acquire data regarding the energy efficiency of buildings and the impact of renovation measures, or at least apply measures to calculate the energy efficiency with an agreed methodology. Coordination is required to achieve a level playing field and provide agreed best practices for an efficient data supply. In general, energy efficiency data is not available for most of the collateral. While some local EPC databases are available for the UK, France, Spain and Italy, a major part of Deutsche Bank's portfolio is in countries without any public source (i.e., Germany).

Deutsche Bank is developing a group-wide strategy to improve the sourcing of emissions data from third party providers, as well as integrate data obtained directly from our clients (i.e., for residential real estate collateral attributes, EPCs) – subject to rigorous governance and controls. Client engagement will be key for us to build understanding of current emissions as well as transition strategies.

For portfolios within the EU, EPCs are collected for new residential real estate loans since mid-2022. This lack of availability is reflected in the high PCAF data quality scores for our financed emissions calculations.

General description of the data quality score table for mortgages

(score 1 = highest data quality, score 5 = lowest data quality)

Data quality	Options to estimate the financed emissions		When to use each option
Score 1	Option 1: Actual building emissions	1a	Primary data on actual building energy consumption (i.e., metered data) is available. Emissions are calculated using actual building energy consumption and supplier-specific emission factors specific to the respective energy source.
Score 2		1b	Primary data on actual building energy consumption (i.e., metered data) is available. Emissions are calculated using actual building energy consumption and average emission factors specific to the respective energy source.
Score 3	Option 2: Estimated building emissions based on floor area	2a	Estimated building energy consumption per floor area based on official building energy labels AND the floor area are available. Emissions are calculated using estimated building energy consumption and average emission factors specific to the respective energy source.
Score 4		2b	Estimated building energy consumption per floor area based on building type and location-specific statistical data AND the floor area are available. Emissions are calculated using estimated building energy consumption and average emission factors specific to the respective energy source.
Score 5	Option 3: Estimated building emissions based on number of buildings	3	Estimated building energy consumption per building based on building type and location-specific statistical data AND the number of buildings are available. Emissions are calculated using estimated building energy consumption and average emission factors specific to the respective energy source.

Table 12: PCAF data quality score for mortgages – Source: PCAF Global GHG Standard (2nd Edition), page 98

The 'Sustainable Finance Advisory Committee' of the German federal government proposed in 2021 to build up a European database, which shares standardized EPC data with owners, lenders, researcher and investors. This would reduce the costs for owners, lenders and investors and simplify processes for private clients.

Data availability for German Lenders: Due to legal requirements private clients in Germany are only required to have an EPC if the building is newly built since 2013, sold or leased. Since 2022, there is an additional requirement for major renovation. The legal requirement is based on the financed object, i.e., the purpose of the loan. Deutsche Bank holds more than 1.5m of real estate collaterals (incl. forest, building land and parking slots). However, based on our analysis of Deutsche Bank's German real estate portfolio only 45% of our lenders are legally obligated to have an EPC for their real estate collaterals. Historically, even if they own an EPC, there is no obligation to hand over the document to the bank. In our German residential mortgage business, the need for the EPC in the cases described above has been introduced as mandatory for the relevant new business loans since 2023.

Standardization of scenarios

Banks are required to use widely accepted science-based decarbonization scenarios to individually set both long-term and intermediate targets that are aligned with the temperature goals of the Paris Agreement. In addition, per guidelines, 'scenarios selected shall be 'no overshoot' or 'low-overshoot' scenarios,' and should have a >50% probability of limiting global warming to 1.5°C by the end of the century. Within the global community, there are potential scenario providers like the IEA, Intergovernmental Panel on Climate Change (IPCC), Network for Greening the Financial System (NGFS), Institute for Sustainable Futures at University of Technology Sydney (UTS) or UN PRI/Inevitable Policy Response. However, detailed information on data respective models used is often not provided and cannot be validated by the bank. Some scenario providers do not include local real estate pathways. Based on our own analysis, most of the scenario providers did not include impacts from macro-economic developments which are reflected in the bank's balance sheet projection. Furthermore, banks do not have the skills and/or technical equipment to rerun scenarios to model additional data points which may be needed for modelling their portfolio and regional specific requirements and estimation of impacts.

Hence, there are three areas of model uncertainty within the scenario selection:

1. Quality and accuracy of the underlying scenario
2. Scenario selection (e.g., specific input parameters for the respective portfolio)
3. Application of the scenario, i.e., the estimation of additional data points (e.g., matrix with renovation rates between EPC classes per year and region)

Data quality of the scenario providers and/or a misinterpretation of major scenario assumptions may lead to deviation in results. This could impact banks' strategies and may lead to reputational risks.

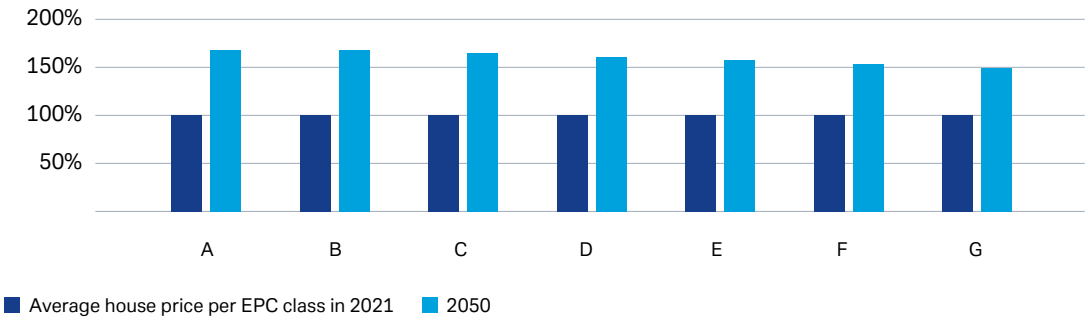
Standardization of models to estimate long-term projections

The long-term projection depends on

1. Projection of current contracts regarding client behavior (e.g., prolongation, early repayments, defaults)
2. Projection of new business volume
3. Projection of housing market and house price development

For the projection of current contracts and volume development, we used the 2022 new business volumes and did not perform any additional adjustments. Based on the missing scenario parameters described, we are not able to estimate how the market will develop in the future. Therefore, it would not be adequate to assume any adjustment in business strategy. We included house price developments of the NGFS scenario to better reflect house price developments for energy-efficient buildings. This seems to be plausible since outstanding renovation costs would be taken as a discount on the property value and may inflate over time. Current market experience for the German housing market demonstrates that a low amount of available property offers may partly offset assumed impacts on price deviations by energy classes. We did not consider whether loans for retrofitting would lead to a higher loan demand. Throughout the projection, it was assumed that Deutsche Bank has sufficient capital and liquidity ratios so that there are no constraints regarding loan volume growth.

Figure 33 — NGFS – development of house prices in orderly scenario



Conclusion

Despite these limitations, we believe that it is key to disclose our data and methodologies in their current state to provide transparency on our European residential real estate portfolio and the impacts of our transition strategies. Currently, Europe (incl. UK) is a motor for recent developments, while other regions lag behind. Due to the elevated cost of energy and higher energy demand these KPIs will be important globally anyhow to evaluate real estate projects irrespective of any political discussion about climate change.

We expect an impact on our financed emission estimates as data quality and comprehensiveness will improve in the upcoming two to five years. We will reflect changes and report the impact in our regular updates. Hence, conclusions drawn in this white paper may have to be revised or may be common knowledge in future discussions.

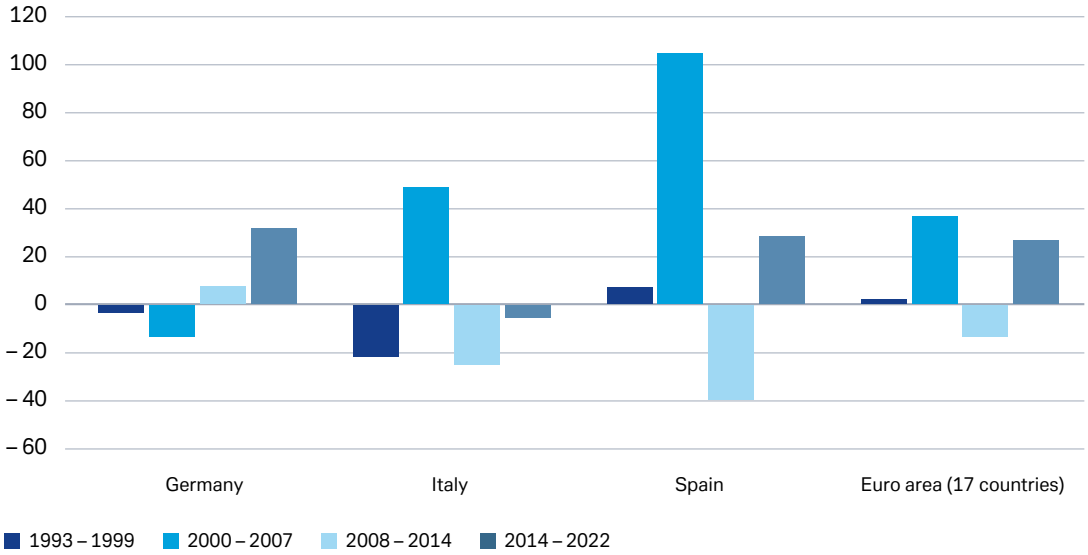
9

9 Annex

9.1 European housing markets

After the great financial crisis (GFC) and the related burst of several real estate bubbles in the Euro area, the market for private mortgages perceived an upward trend on demand and prices for more than a decade. The latter development was triggered by an ultra-low interest environment combined with monetary easing programs to support growth and financial stability within the monetary union. One of the side effects of this monetary policy was that of growing house prices due to rising demand and the search for yield. As can been seen in figure 34 those trends were not equally distributed across member states. High inflation and price levels are weighing on the disposable income and affordability for mortgage finance in short to mid-term. Against the backdrop of higher inflation, energy prices and interest rates, the outlook for the Euro area households has become gloomier, as reflected by a plunge in consumer confidence and expectations regarding their financial situation.

Figure 34 — Change in real house price (in %)



Spain became one of the worst affected countries by the GFC when the speculative bubble popped. In the period of 1997–2006, the price of housing in Spain had risen about 150% in nominal terms, equivalent to 100% growth in real terms. This massive price increase was fed by mortgage loans, so that on the verge of the GFC private households were heavily indebted with 115% of disposable income and even worse for the most part at variable interest rates.[36]

Since the burst of the real estate bubble, the Spanish mortgage market suffered as the country underwent another stress period, the European Sovereign Debt Crisis, which brought down demand (prices and transactions) further to a minimum in 2013, where house prices plunged 42% within six years while sales paralleled this movement (–68%) within the same time period.

From 2014 on, the market for housing recovered step by step. This development was accompanied by low interest rates, a stabilized government/banking sector and growing income as the unemployment rate came down from 26% in 2013 to 12.9% in 2022. Especially the latter component explains the recovery of transactions and prices as the Spanish housing market is driven much more by private, owner-occupied participants. The level of home ownership was 76% in 2021 and therefore slightly above the Euro Area average of 67%. But despite the stabilization, the multiple crises since 2007 had left scars. The home ownership quota dropped from 81% to 76% and it is reasonable to assume that this trend will go on as youth unemployment remained high during the last ten years. From 2008 to 2012 alone, workers younger than 35 had an average loss of purchasing power of 25.7%, more than a quarter of their income. (IMF, March 2012, Vol. 49, No. 1). As unemployment for this group remained relatively high, an own house financed by a mortgage is harder to afford as unemployment in youth hampers income levels over the whole work life. On the other hand, the Spanish mortgage/housing market is much more stable now. While the ratio of ownership with mortgages remained relatively stable since 2008 (30%) and house prices went up +28% from 2014 in real terms, debt to income ratio came down from 143% to 94% while house price to income ratio for the same period plunged from 150% to a through in 2014 of 98% and fluctuating around 120% since 2020.

Italy experienced the opposite regarding market volatility. While there was no mortgage or other asset price bubble at that time, the countries' GDP suffered since the start of the monetary union because of low competitiveness, high government debt and lack to compensate this through depreciation of its own currency. The GFC led to knock-on-effects which triggered non-performing loans in the banking sector and at end of this vicious cycle Italian government bonds came under speculative attack by the market participants. The ECBs 'whatever it takes' policy was needed to prevent broader financial stability risks.

Having said this, it becomes clear that the demand for mortgage financed housing was weak until 2014. This is reflected by a moderate growth in house prices with roughly 7% in real terms between 2000 and 2007 (Spain: 15%) and a slow but continuous fall in real terms since then. The latter accumulates to a loss of 30% until 2022. In line with this, the volume for mortgage finances grew on average between 2012 and 2020 by only 1% in nominal terms, while construction stagnated and gross disposable income of private households in real terms is lower today than back in 2007. To round up this summary, Italy (quite similarly to Spain) started with a huge over-supply of housing in this century. The vacancy rate was approximately 20% in 2000 (Spain: 15%). While for Spain this was a

36 Eurostat, 2023 (Database – Eurostat (europa.eu)

clear sign of an overheating market, with construction and mortgage lending jumping from year to year, for Italy this was more a symptom of the structural weakness. It took a long time to recover, and finally around 2014/2015 a turning point was reached, when demand was supported by the ultra-low interest rates, monetary easing by the European System of Central Banks and political support measures for the market[37]. The number of residential transactions reached approximately 748k in 2021, with a growth of +11.4% compared to 2019 and reached therefore levels last seen around 2006/2007. In line with this, vacancy rate dropped while household debt (debt to income at 90% in 2022) was never overly stretched and at the lower end of the Eurozone. Besides the economic effects, Italy shows a similar pattern relative to Spain regarding home ownership (74% in 2021) but was much more stable. The reason behind this is quite simple: The portion of households with home ownership having a mortgage was and is always quite low (16% out of the home ownership population vs. 30% in Spain). All in all, a much more robust market than 15 years ago.

Germany sees a mixed picture regarding market development in this century so far. Overcapacity in the market after the German unification and structural impediments labeled Germany as the 'sick man of Europe' (The Economist, 06/1999) from the late 90's to mid of the first decade of the century. This led to more or less lackluster development/ demand in the mortgage financed housing market and price development. Political reforms helped to improve German competitiveness and employment in the onset of the GFC while monetary easing paved the way for unprecedentedly low mortgage interest rates. Both effects fully kicked in, when demand supported by high migration inflows (EU internal migration and asylum seekers) pushed further. This development was exacerbated by the long-term consequences of overcapacities in production mentioned earlier. The latter was solved in a way that construction capacities bottomed-out in the early 2010s. High and increasing demand together with low and slow-moving supply culminated in a long-lasting upswing in house prices. Since 2010 prices doubled and the recent crisis marks only a pause on this trend as the fundamental drivers remain in place. This development is, regarding German regions, very broad. When it started, the urban areas were only the first focus point for private investors and households. As time goes by, more and more rural areas were affected, even more in times of COVID. The long and broad development in turn leads the press and banking supervisors to talk about an inflating mortgage bubble. While prices in some counties were overvalued up to 40% measured against its own fundamentals[38], a fully fledged real estate crisis was not on the way. Growth rates for mortgage loans were far away from dynamics seen in typical bubble episodes (i.e., Ireland, Spain, U.S.). Banks sharpened their lending standards over time and vacancy rates fell in almost all of 16 federal states until today. There is no room for speculative activities as prices are simply signaling shortage. Due to the Ukraine crisis, rising inflation and resulting change in monetary policy, construction has been going through a strong recession, adding even more pressure to supply while Ukraine refugees pushed demand.

From a financial perspective household debt serving capacity, at least for new business, became over stretched. While affordability was high as long as nominal interest rates were low, debt levels became hardly sustainable for median income households, however, ownership ratio was relative constant over the boom. With rising price levels, falling real disposable income and climbing interest rates mortgage business plunged since mid-2022.

37 For instance: Lower registration costs that came into effect on January 1,2014 for mortgages and cadastral documents, which are applicable to the transfer of real property (Article 10 of D.lgs 14 marzo 2011, n. 23)
38 Calculation by DB PRM (2021)

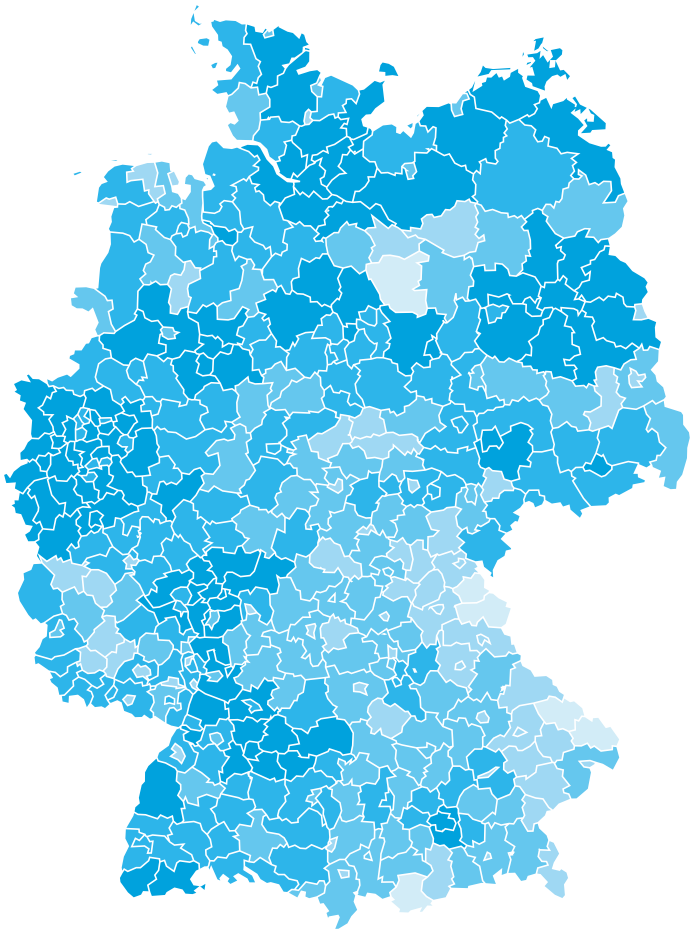
But this will be more a short-term break of one to two years. If inflation remains structurally high, interest rates will be high, too, and mortgage volume will remain subdued. We do not expect a strong correction in the house prices.

The high inflation and price levels are weighing on the disposable income and affordability of mortgage finance in the short to medium-term. Against the backdrop of higher inflation and energy prices, the outlook for the Euro area households has become weaker, as reflected by a plunge in consumer confidence and expectations regarding their financial situation.

9.2 Excursus on Deutsche Bank's German residential portfolio

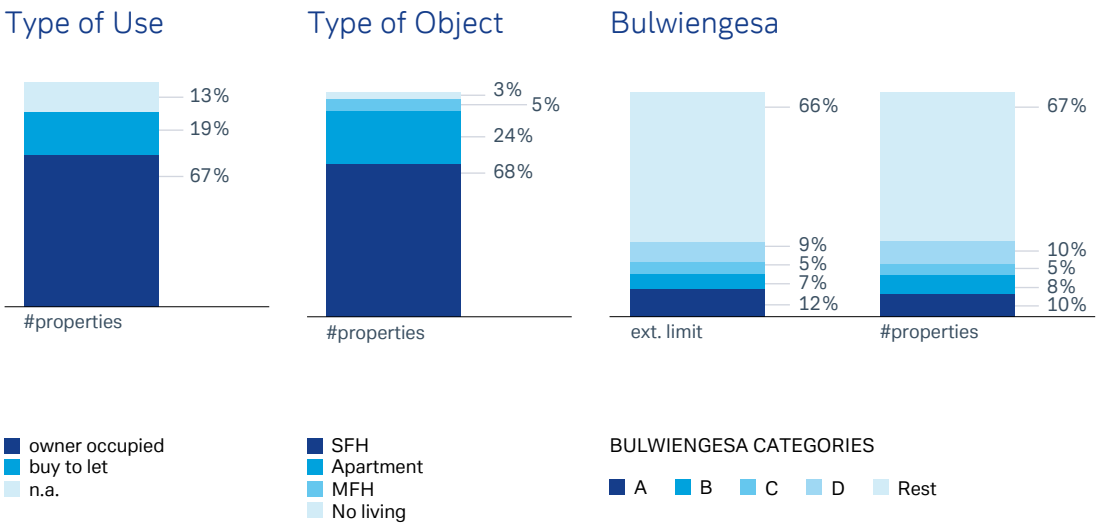
Our mortgage portfolio is well diversified through Germany with a larger concentration in crowded regions in North Rhine-Westphalia and Berlin.

Figure 35 — Diversification of the German residential portfolio



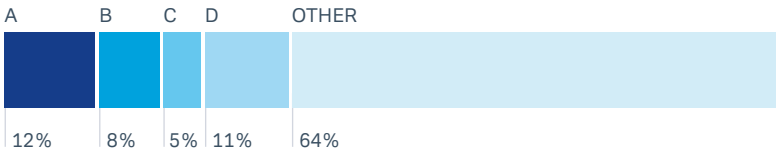
12% of the portfolio is located in the top 7 cities, almost along with market share. Distribution by regional classification bulwiengesa demonstrates that the regional distribution is highly correlated to the distribution of population in Germany. 2/3 of the portfolio are owner-occupied properties equaling the share of single-family houses.

Figure 36 — Characteristic of Deutsche Bank's real estate collaterals



Background bulwiengesa, an independent consultancy for the real estate industry in Germany, introduces an analysis-tool that divides locations with most commercial relevance into 4 regions of different functional importance:

Figure 37 — German population by bulwiengesa categories



Region A: Top 7 – most important German centers with national (and international) importance. Big, well working markets in all segments (e.g., Berlin, Cologne, Munich)
Region B: 14 large cities with national and regional importance (e.g., Bonn, Leipzig, Essen)
Region C: 22 important German cities with regional and restricted national importance (e.g., Kiel, Lübeck, Saarbrucken, Regensburg)
Region D: 84 small cities, focused on regional locations. Little market volume and sales
Remainder: other German cities and localities

Glossary

Announced Pledges Scenario (APS)
In the Announced Pledges Scenario (APS), governments get the benefit of the doubt. In this scenario, their targets are achieved on time and in full, whether they relate to climate change, energy systems or national pledges in other areas such as energy access. Trends in this scenario reveal the extent of the world's collective ambition, as it stands today, to tackle climate change and meet other Sustainable Development Goals.

CO_2-equivalent (CO_2e)
A metric measure used to compare the emissions from various greenhouse gases by converting amounts of other gases to the equivalent amount of carbon dioxide.

Energy performance of building directive (EPBD)
To boost energy performance of buildings, the EU has established a legislative framework that includes the Energy Performance of Buildings Directive 2010/31/EU and the Energy Efficiency Directive 2012/27/EU.

Together, the directives promote policies that will help

- Achieve a highly energy-efficient and decarbonized building stock by 2050
- Create a stable environment for investment decisions
- Enable consumers and businesses to make more informed choices to save energy and money

Following the introduction of energy performance rules in national building codes, buildings consume only half as much energy today, compared to typical buildings from the 1980s.

Economic emissions intensity
Absolute emissions divided by the loan and investment volume expressed as e.g., t CO_2e/€m invested — the PCAF standard, page 102.

Financed emissions
Greenhouse gas emissions that occur as a result of financing, including lending and investment activity. These activities fall within Scope 3, category 15 of the GHG protocol.

Greenhouse gases (GHG)

GHGs are atmospheric gases that absorb and emit radiation within the thermal infrared range and that contribute to global climate change. The seven gases include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF), and nitrogen trifluoride (NF_3).

Greenhouse Gas (GHG) Protocol

Comprehensive global standardized frameworks to measure and manage GHG emissions from private and public sector operations, value chains, and mitigation actions. The GHG Protocol supplies the world's most widely used GHG accounting standards.

Intergovernmental Panel on Climate Change (IPCC)

An organization of governments that are members of the United Nations or World Meteorological Organization (WMO). The objective of the IPCC is to provide governments at all levels with scientific information that they can use to develop climate policies.

International Energy Agency (IEA)

An intergovernmental organization that examines the full spectrum of issues related to energy and recommends policies to enhance the reliability, affordability and sustainability of energy.

Network of Central Banks and Supervisors for Greening the Financial System (NFGS)

A body formed to help strengthening the global response required to meet the goals of the Paris agreement and to enhance the role of the financial system to manage risks and to mobilize capital for green and low-carbon investments.

Net Zero Banking Alliance (NZBA)

The industry-led, UN-convened initiative of global banks committed to aligning their lending and investment portfolios with net-zero emissions by 2050.

Net zero emissions

A state achieved when carbon emissions are balanced by their removal, or when anthropogenic emissions are reduced to zero.

Net Zero Emissions by 2050 (NZE)

The IEA Net Zero Emissions by 2050 (NZE) Scenario works back from specific goals – the main one in this case being to cap global warming to 1.5°C – and shows how they can be achieved.

Paris Agreement

The 2015 Paris Agreement is a legally binding international treaty on climate change aimed to hold the increase in the global average temperature to 'well below' 2°C above pre-industrial levels.

Partnership for Carbon Accounting Financials (PCAF)

Global partnership of financial institutions that work together to develop and implement a harmonized approach to assess and disclose the greenhouse gas emissions associated with their loans and investments.

Science-Based Targets Initiative (SBTi)

A partnership between Carbon Disclosure Project (CDP), the United Nations Global Compact, World Resources Institute (WRI) and the World Wide Fund for Nature (WWF). The SBTi independently assesses and approves companies' Paris Alignment targets in line with its strict criteria, defines and promotes best practice in science-based target setting.

Scope 1, 2 and 3 emissions

Scope 1 covers direct GHG emissions from owned or controlled sources. Scope 2 covers indirect GHG emissions from the generation of purchased electricity, steam, heating and cooling consumed by the reporting company. Scope 3 are the remaining emissions that occur in the value chain of the reporting company which are not captured in Scope 1 nor 2.

Stated Policies Scenario (STEPS)

In the Stated Policies Scenario (STEPS), the IEA explores how the energy system evolves if we retain current policy settings. These include the latest policy measures adopted by governments around the world, such as the Inflation Reduction Act in the United States, but do not assume that aspirational or economy-wide targets are met unless they are backed up with detail on how they are to be achieved.

United Nations Environment Programme Finance Initiative (UNEP FI)

A partnership between the UN Environment Programme and the global financial sector aimed to identify, promote, and realize the adoption of best environmental and sustainability practice at all levels of financial institution operations.

Disclaimer

The transition to a sustainable economy is a long-term undertaking. In its current stage, we are confronted with the limited availability of climate related data. It is inevitable to use estimates and models until improved data will become available. Our expectations on the increase of data quality are based on reporting obligations as currently developed. New regulations on reporting will likely become effective in the coming years. This report is not based on the calculation methodology provided in the draft regulatory technical standards of the Sustainable Finance Disclosure Regulation (SFDR) as it is not applicable to this report. Harmonized standards and calculation methods are expected to be developed and will also improve data quality. This report includes metrics that are subject to measurement uncertainties resulting from limitations inherent in the underlying data and methods used for determining such metrics. The selection of different but acceptable measurement techniques can result in materially different measurements. The precision of different measurement techniques may also vary. The information set forth herein is expressed as of end of December 2022 and we reserve the right to update its measurement techniques and methodologies in the future.

We have measured the carbon footprint of our European Real Estate loan portfolio in accordance with the standards we discuss in this report. In doing so we used in part information from third-party sources that we believe to be reliable, but which has not been independently verified by us, and we do not represent that the information is accurate or complete. The inclusion of information contained in this report should not be construed as a characterization regarding the materiality or financial impact of that information. If emissions have not been publicly disclosed, these emissions may be estimated according to the Partnership for Carbon Accounting Financials (PCAF) standards. For borrowers whose emissions have not been publicly disclosed, we estimate their emissions according to the PCAF emission factor database. Since there is no unified source of carbon emission factors (including sustainability-related database, EPC data), the results of estimations may be inconsistent and uncertain. Past performance and simulations of past performance are not a reliable indicator and therefore do not predict future results. This report contains forward-looking statements. Forward-looking statements are statements that are not historical facts; they include statements about our beliefs and expectations and the assumptions underlying them. These statements are based on plans, estimates and projections as they are currently available to the management of Deutsche Bank Aktiengesellschaft. Forward-looking statements therefore speak only as of the date they are made, and we undertake no obligation to update publicly any of them in light of new information or future events. By their very nature, forward-looking statements involve risks and uncertainties. A number of important factors could therefore cause actual results to differ materially from those contained in any forward-looking statement. Such factors include the conditions in the financial markets in Germany, in Europe, in the United States and elsewhere from which we derive a substantial portion of our revenues and in which we hold a substantial portion of our assets, the development of asset prices and market volatility, potential defaults of borrowers or trading counterparties, the implementation of our strategic initiatives, the reliability of our risk management policies, procedures and methods, and other risks referenced in our filings with the U.S. Securities and Exchange Commission. Such factors are described in detail in our most recent SEC Form 20-F under the heading 'Risk Factors'. Copies of this document are readily available upon request or can be downloaded from our website (www.db.com/ir).