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Impact Assessment Methodology
MünchenerHyp Green Portfolio

Rationale, Framework, Data

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on behalf of

MünchenerHyp

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List of Abbreviations

Abbreviation	Meaning
BE	Belgium
COM	commercial (non-residential) buildings
DE	Germany
ES	Spain
FED	final energy demand
FR	France
GHG	greenhouse gas emissions
GWP	global warming potential
NL	Netherlands
PED	primary energy demand
PEF	primary energy factor
RES	residential buildings
UK	United Kingdom
US	United States

The paper at hand presents the principles and methods applied for the impact assessment of the green building portfolio by the mortgage bank (residential and commercial property financing) MünchenerHyp. For further information and the full impact report see https://wupperinst.org/en/p/wi/p/s/pd/1975.

1 Rationale for Methodology

MünchenerHyp aims to quantify the potential positive climate effects from green buildings in their portfolio. Green buildings in this context are expected to have a lower energy demand for heating compared to similar buildings of the same type and in the same countries. The selection of eligible buildings is not part of the impact assessment and entirely in the hands of the mortgage bank (in line with their Green Bond Framework 2021 in MünchenerHyp (2022)). However, a second party opinion is available that corroborates the claim that these buildings fulfil the minimum energy standards and exceed them in most cases (ISS ESG, 2022).

The rationale of the impact assessment is that the financing and/or ownership of commercial and residential buildings with low energy demands avoid greenhouse gas emissions, that would otherwise have been emitted from conventional buildings used for the same purpose. Since other stakeholders are involved in this process (other shareholders, owners, rentals), we define this process as "financing potential greenhouse gas reductions". The functional unit is tons CO_2-equivalents (or CO2e) per building and share of financing (1% to 100%). As a normalized unit of comparison, tons CO_2-equivalents (or CO2e) per million € (EUR m) financed are calculated as well. The global warming potential refers to 100 years (GWP 100a) and is calculated with the help of characterization factors for Kyoto-Gases by the IPCC (AR5).

This rationale is in line with current market practices as suggested by the ICMA *Green Bond Principles* as well as *Harmonized Framework for Impact Reporting* (ICMA, 2021b, 2021a).

2 Framework

The original input data contains information on the type of buildings and in some cases also the purpose of buildings. Previous impact assessments classified the results according to these building types (e.g., office and storage buildings, or single-family and multi-family homes).

However, the focus of the assessment is to provide the most reliable results which is why a different classification is chosen for the current report (and from 2022 onward). Each building is assigned to 1 out of 4 classes for the quality of data and the resulting calculation:

- Type A: high data quality
- Type B: medium data quality
- Type C: low data quality
- Type D: no data (estimates)

The following sections describe how these data cluster are assigned to the two main asset classes (1) commercial buildings (COM) and (2) residential buildings (RES).

2.1 Calculation for Commercial buildings (COM)

There are 46 contracts in the commercial portfolio that refer to 33 assessable buildings. These buildings are large and mainly used as offices for rentals. Some of the buildings are also either fully used as storage facilities or consist of large areas that are not heated.

The calculation method for potentially avoided GHG emissions draws on the difference for the energy demand of the building in the portfolio compared to similar buildings in the European and US building stock of office buildings.

If all the relevant data is available, the following equation (A1) is used for Type A buildings:

$$GHG_{avoid,COM-A} = \left(\frac{FED_{heat}}{area_{net-cond}} - fed_{stock}\right) x\ ghg_{carrier}\ x\ area_{net-cond}\ [kg\ CO_2 - equ./\ building\ p.a.]\ (A_{COM})$$

with

$GHG_{avoid,\ COM-A}$:	potentially avoided GHG emissions for type A data in [kg CO2e]
FED_{heat}:	final energy demand for heating of the building in [kWh]
$area_{net-cond}$:	net-conditioned area of the building in [m^2]
fed_{stock}:	specific final energy demand for heating in building stock in [kWh/m^2]
$ghg_{carrier}$:	GHG intensity of the energy carrier for heating in [kg CO2e/kWh]

It is also assumed that data on the primary energy demand of the buildings lead to similarly robust results, although additional data is necessary to convert primary energy demand in a country into the final energy demand for the building user. We use results from the ENTRANZE project to derive the ratio of final energy demand for heating compared to the overall primary energy demand of office buildings in Berlin, Paris, Madrid.

Equation (B) is therefore considered to deliver robust results for Type B data.

$$GHG_{avoid,COM-B} = \left(\frac{fed_r}{ped_r}\ x\ \frac{PED_{tot}}{area_{net-cond}} - fed_{stock}\right) x\ ghg_{carrier}\ x\ area_{net-cond}\ [kg\ CO_2 - equ./\ building\ p.a.]\ (B_{COM})$$

with

$GHG_{avoid,\ COM-B}$:	potentially avoided GHG emissions for type B data in [kg CO2e]
fed_r:	specific final energy demand in sampled buildings in specific region in [kWh/m^2a]
ped_r:	specific primary energy demand in sampled buildings in specific region in [kWh/m^2a]
PED_{total}:	primary energy demand of the building in [kWh]

For buildings of type C, only data on the conditioned area and the heating system is available. We assume that these buildings achieve at least a light renovation standard which corresponds to a primary energy demand saving of 16% compared to the building stock. Equation (C) shows how primary energy factors (PEFs) are used to estimate the saving in final heat demand when applying that assumption.

$$GHG_{avoid,COM-C} = \left(\frac{saving_{PED}}{PEF_{carrier}}\ x\ \frac{fed_r}{ped_r}\ x\ fed_{stock}\right) x\ ghg_{carrier}\ x\ area_{net-cond}\ [kg\ CO_2 - equ./\ building\ p.a.]\ (C_{COM})$$

with

$GHG_{avoid, COM-C}$: potentially avoided GHG emissions for type C data in [kg CO2e]

$saving_{PED}$: primary energy demand saving for light renovation in [%]

$PEF_{carrier}$: primary energy factor for heat carrier in [kWh/kWh]

For type D buildings, only the conditioned area is available. Although the estimation is in line with type B buildings, we assume the most conservative case with electricity being the main heat energy carrier (highest PEF with 2.3). The equation (D_{COM}) is therefore very similar.

$$GHG_{avoid,COM-D} = (\frac{saving_{PED}}{PEF_{electricity}} \ x \ \frac{fed_r}{ped_r} \ x \ fed_{stock}) \ x \ ghg_{carrier} \ x \ area_{net-cond} \ [kg \ CO_2 - equ./ \ building \ p.a.] \quad (D_{COM})$$

with

$GHG_{avoid, COM-D}$: potentially avoided GHG emissions for type D data in [kg CO2e]

$PEF_{electricity}$: primary energy factor electricity in [kWh/kWh]

2.2 Calculation for Residential Buildings (RES)

There are 7.523 buildings in the input data of which 7,461 buildings had sufficient data to be assessed. They are grouped into the categories single-family house (SFH), multi-family house (MFH) and terrace house (TH). The years of construction range from earlier than 1859 to 2016 and newer. No building has a higher primary energy demand than 70 kWh/a as defined by the issuer's framework or 55 kWh/a if the building was financed after the 1st of May 2020.

For buildings of type A, the financing data, primary energy demand, living space, building type and year of construction are known (no data on final heat demand and heating system). The equation (A_{RET}) is considered to deliver the most robust result for impact reporting:

$$GHG_{avoid,RES-A} = \frac{ped_{ref} - ped}{PEF_{gas}} * ghg_{gas} * A \ [kgCO_2 - equ./ \ building] \quad (A_{RES})$$

with

$GHG_{avoid,RES-A}$: potentially avoided GHG emissions for type A data in [kg CO2e]

ped: specific primary energy demand of building [kWh/m²a]

ped_{ref}: specific primary energy demand of buildings in stock at year of construction [kWh/m²a]

PEF_{gas}: primary energy factor for gas (representing all heating systems)

$ghg_{carrier}$: GHG intensity of gas for heating in [kg CO2e/kWh]

A: living space as conditioned area in [m²]

For buildings of type B, only the primary energy demand is not known. In accordance with the issuer's requirements, each building is assigned a maximum primary energy demand of either 70 kWh/a (until 30th of April 2020) or 55 kWh/a (from 1st of May 2020 onward).

The equation (B_{RES}) is therefore only slightly altered:

$$GHG_{avoid,RES-B} = \frac{ped_{ref} - ped_{max}}{PEF_{gas}} * ghg_{gas} * A \ [kgCO_2 - equ./ \ building] \quad (B_{RES})$$

with

$GHG_{avoid,RES-B}$: potentially avoided GHG emissions for type B data in [kg CO2e]
ped_{max}: maximum specific primary energy demand of buildings in portfolio in [kWh/m²]

For buildings of type C, the financing data, the living space and the building type are known. To account for the fact that no suitable reference building can be selected, the lowest primary energy demands for buildings in stock (conservative estimate) are used.

The results from type C buildings are therefore considered to be robust as a conservative estimate (it is unlikely that the actual buildings have higher energy savings) but less accurate:

$$GHG_{avoid,RES-C} = \frac{ped_{min}-ped_{max}}{PEF_{gas}} * ghg_{gas} * A \; [kgCO_2 - equ./\,building] \quad (C_{RES})$$

with

$GHG_{avoid,RES-C}$: potentially avoided GHG emissions for type C data in [kg CO2e]

ped_{min}: lowest specific primary energy demand for building types in stock in [kWh/m²a]

Data for buildings of type D, in addition to the restrictions of type C buildings, also lacks information on the living space of the buildings. As this data is available for all other buildings, a cost factor is calculated the allows to estimate the living space. It is drawn from the 3rd quartile of the total costs per square-metre of all other buildings in the sample in order to ensure a conservative estimate for the resulting avoided GHG emissions in equation D_{RES}.

$$GHG_{avoid,RES-D} = \frac{ped_{min}-ped_{max}}{PEF_{gas}} * ghg_{gas} * F * liv_{sample} \; [kgCO_2 - equ./\,building] \quad (D_{RES})$$

with

$GHG_{avoid,RES-D}$: potentially avoided GHG emissions for type D data in [kg CO2e]

F: total costs of building in [EUR]
liv_{sample}: financed living space per total costs, 3rd quartile of sample in [m²/EUR]

2.3 Matrix for Data Quality

The following table summarizes the input data availability for the four data classes for both commercial (COM) and residential (RES) buildings in the portfolio.

Type	**A:** **high data quality**	**B:** **medium data quality**	**C:** **low data quality**	**D:** **no data**
COM	financing data net conditioned area energy carrier heat final heat demand	financing data net conditioned area energy carrier heat primary energy demand	financing data net conditioned area energy carrier heat	financing data net conditioned area
RES	financing data primary energy demand year of construction building type living space	financing data year of construction building type living space	financing data building type living space	financing data building type

3 Data and Assumptions

3.1 Data and assumptions for commercial building portfolio

The following table summarizes the data sources and assumptions for the calculation of commercial (COM) buildings in the portfolio.

Data	Sources	Assumptions
primary data on buildings	direct input data and additional building information (e.g., certificates) by client (MünchenerHyp, 2021)	COM 1) If specific energy demands or information on heating systems is only available for parts of a building complex, the entire complex is assumed to have this energy demand COM 2) If several heating systems are mentioned, a main heating system is selected
building stock data	for European buildings, data from Heat Roadmap Europe (Fraunhofer ISI et al., 2017, p. 31) for US buildings, data from the Commercial Buildings Energy Consumption Survey (U.S. Energy Information Administration, 2016)	COM 3) European data refers to all non-residential buildings COM 4) US data refers to office as well as warehouse and storage buildings
primary energy saving from renovation	average of renovation activities in European non-residential buildings (European Commission et al., 2019, p. 24)	COM 5) Class C and Class D buildings are assumed to have undergone a light-renovation (16% PED saving)
regional ratio of heat energy demand to primary energy demand	average of buildings in Madrid, Paris, Berlin from the ENTRANZE project (Boneta, 2014)	COM 6) Berlin attributed to NL, UK, DE Paris attributed to BE, FR Madrid attributed to ES US uses highest value from sample (81%)
primary energy factors	gas, heating oil, district heating, electricity default values according to the 2012 concerted action report (CEN) cited in Hitchin et al. (2018, p. 3) renewables defined to have a PEF of 1 in line with a review of the default primary energy factor (Esser et al., 2016)	COM 7) renewables have a PEF of 1
GHG intensity factors	GHG intensity of district heating refers to oekobau.dat data for Germany cited in the DGNB framework for climate-neutral buildings and locations (DGNB, 2020, p. 61) all other intensities are drawn from the Covenant of Mayors (CoM) default emission factor document provided by the European Commission (Koffi et al., 2017)	COM 8) German district heating value (120-400 kW) is used for other countries as well (3 cases)

3.2 Data and assumptions for residential building portfolio

The following table summarizes the data sources and assumptions for the calculation of retail buildings (RES) in the portfolio.

Data	Sources	Assumptions
primary data on buildings	direct input data and additional building information by client (MünchenerHyp, 2021)	RES 1) All buildings are heated with gas RES 2) Primary energy demand at least 70 kWh/a until April 2020 and at least 55 kWh/a from May 2020 onward (defined by issuer)

Data	Sources	Assumptions
building stock data	TABULA WebTool (IWU- Institut Wohnen und Umwelt, Darmstadt / Germany, 2012)	RES 3) Building stock are represented by "existing state" in TABULA building typology RES 4) Difference in primary energy demand of two buildings equals difference in final energy demand of two buildings
primary energy factors	GEG Regulation, Annex 4 (Gesetz zur Einsparung von Energie und zur Nutzung erneuerbarer Energien zur Wärme- und Kälteerzeugung in Gebäuden* (Gebäudeenergiegesetz - GEG), 2020)	RES 5) All systems have a primary energy factor of 1.1 (representing oil/gas)
GHG intensity factors	DGNB framework for climate-neutral buildings and locations (DGNB, 2020)	-

3.3 Limitations of the methodology

All data, assumptions and calculations shown here are suitable to estimate conservative estimates for the avoided GHG emission potentials. The energy savings in the actual buildings compared to buildings in stock are expected to be larger than shown here and in the impact assessment. It is also likely that many of the residential buildings achieve their low primary energy demands with the help of heating systems other than gas and oil. In these cases, an additional GHG saving effect would have to be considered that is caused by the difference in GHG intensities of the energy carriers (e.g., biomass versus gas).

In terms of overall accuracy, the lack of data for electricity use leads to less accurate results. This affects the primary energy demand of the buildings, as the share of heat and electricity use might differ strongly compared to the building stock. Commercial buildings in particular are also expected to be more electricity-efficient than their counterparts in the building stock, while many residential buildings are equipped with photovoltaic panels for their own electricity production (at less than 50 g CO_2-equivalents per kWh).

4 Reference data for comparison with literature

The quantification method results in a number of specific characteristics of both building samples. The specific final heat demand (fhd) for COM and the specific primary energy demand (ped) for RES buildings are documented here (see following table). These values can be compared to literature data (fhd of commercial, ped of residential buildings) to evaluate the energy efficiency of the buildings in the portfolio.

Data type	[fed, heat] specific final heat demand, COM	[ped] specific primary energy demand, RES
A	85 kWh/m²a	34 kWh/m²a
B	77 kWh/m²a	65 kWh/m²a
C	87 kWh/m²a	66 kWh/m²a
D	90 kWh/m²a	69 kWh/m²a a
weighted Average	85 kWh/m²a	40 kWh/m²a

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