REPORT

Residential building portfolio - carbon and energy footprint 2022

CLIENT

Sparebanken Møre

SUBJECT

Norwegian Residential Buildings Portfolio Footprint

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REPORT

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1 Introduction

On assignment from Sparebanken Møre, Multiconsult has studied the Sparebanken Møre residential loan portfolio and estimated its energy efficiency and CO_2-emissions related to energy demand in use. In this report, the methodology is presented and substantiated based on energy requirements in the national building code.

2 The Norwegian building stock

The Norwegian building stock consists of approximately 2.6 million dwellings in apartment buildings and small residential buildings. Figure 1 illustrates the building stock according to the latest available statistics.

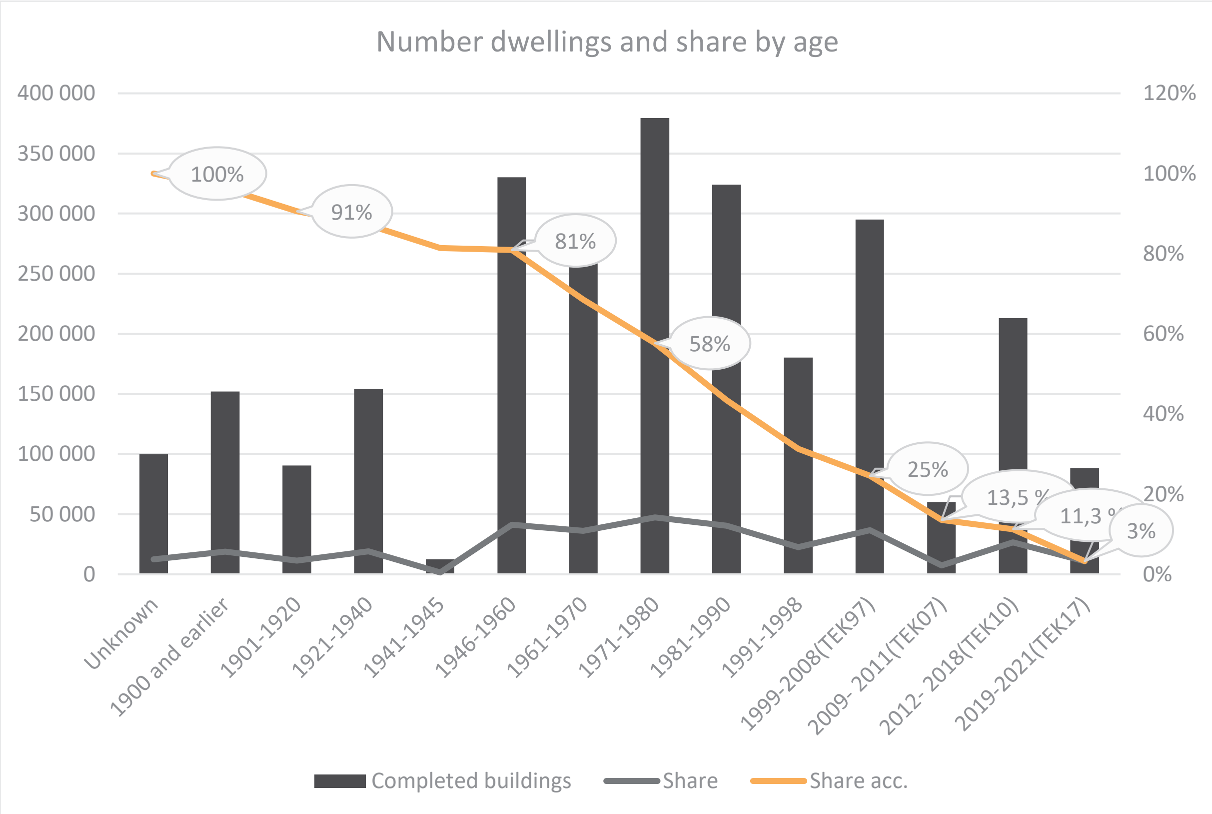


Figure 1 Age and building code distribution of dwellings (Statistics Norway and Multiconsult, January 2022)

Of the total stock, apartments constitute 30%, and small residential buildings the remaining 70%. However, the share of apartments is increasing and has been over the last couple of decades.

Energy

The energy consumption of Norwegian buildings is predominantly electricity, with some district heating and bioenergy. The share of fossil fuel is very low and declining.

In 2013, Statistics Norway assessed energy use in Norwegian households. They found demand was covered by electricity (79%), fossil oil and gas (4%) and bioenergy etc. (16%). Already in 2007, the building code was in clear disfavour of fossil energy, and the use of fossil energy in buildings has declined since. From 2020, fossil oil is banned from use in buildings. The fuel mix in Norwegian district heating production in 2021 included only 4% from fossil fuels (oil and gas) (Fjernkontrollen[1]). In 2021, the Norwegian power production was 99 % renewable (NVE[2]).

As shown in figure 2, the Norwegian production mix in 2021 gives resulting emissions of 4 gCO_2/kWh. This value varies from year to year. Using a life-cycle analysis, the Norwegian Standard NS 3720:2018 "Method for greenhouse gas calculations for buildings" takes into account international trade of electricity and the fact that consumption and grid factor does not necessarily mirror domestic production. The mentioned standard calculates the average CO_2- factor for the lifetime of a building to 136 gCO_2/kWh for EU27+UK + Norway and 18 gCO_2/kWh for Norwegian production mix only. Applying the factor based on EU27+UK + Norway energy production mix and the influx of other energy sources for heating purposes, the resulting CO_2- factor for Norwegian residential buildings[3] is on average 111 gCO_2/kWh.

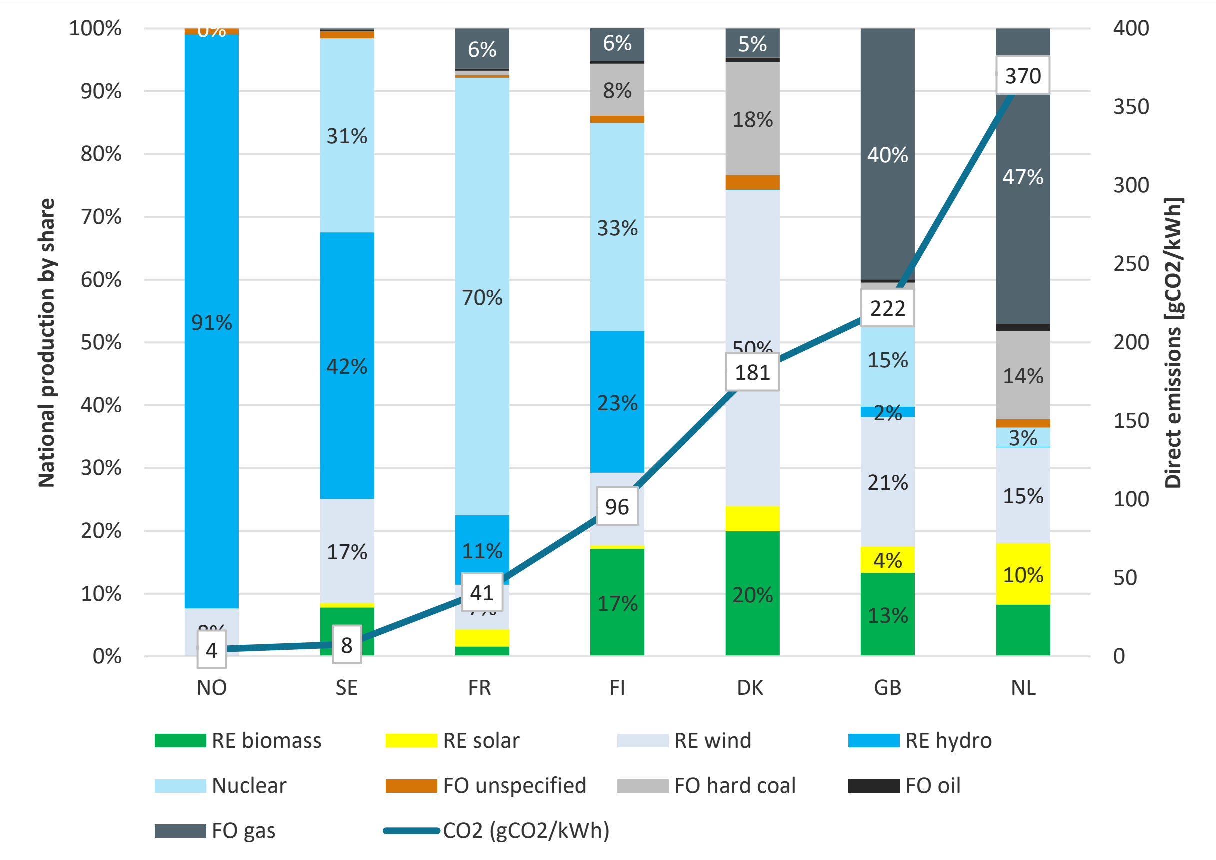


Figure 2 National electricity production mix in some selected countries (European Residual Mixes 2021, Association of Issuing Bodies[4])

[1] http://fjernkontrollen.no/
[2] https://www.nve.no/energy-supply/electricity-disclosure/?ref=mainmenu
[3] Multiconsult. Based on building code assignments for DiBK
[4] https://www.aib-net.org/facts/european-residual-mix

3 Energy efficiency in the building stock

The actual energy performance of individual buildings is not publicly available, and the bank cannot request energy data from their clients and expect sufficient data of reliable quality. Two options for describing buildings' energy performance are presented in the following chapters. The two are historic energy requirements in the national building code and the Energy Performance Certificate system (EPC). The two have different qualities and for the purpose of describing a full portfolio, the building code approach stands out as the most reliable.

3.1 National building code

Changes in the Norwegian building code have consistently, over several decades, resulted in more energy efficient buildings. The calculated specific energy demand (kWh/m^2) dependent on building code, presented in Figure 3, illustrates how the energy demand declines with decreasing age of the buildings.

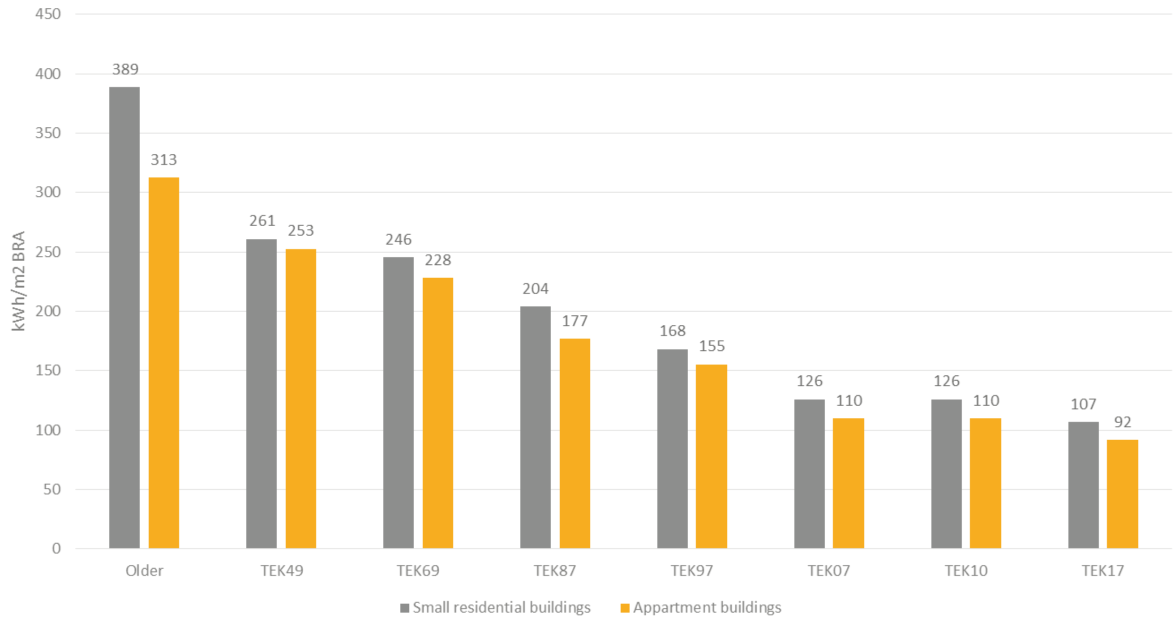


Figure 3 Development in calculated specific net energy demand based on building code and building tradition, (Multiconsult, simulated in SIMIEN)

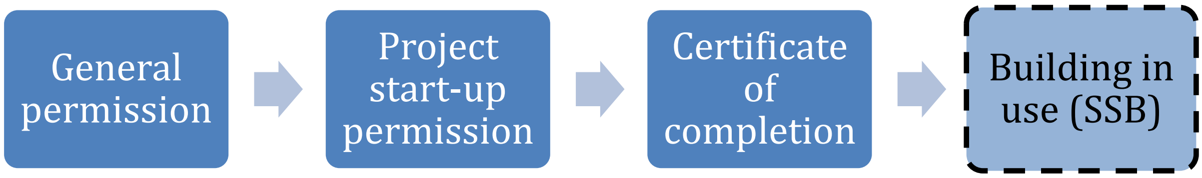
From TEK07 to TEK17 the reduction is about 15% and the former shift from TEK97 to TEK07 was no less than 25%. Note that, for residential buildings, there was no change between TEK07 and TEK10 with respect to energy efficiency requirements.

The figure gives theoretical values for representative models of an apartment and a small residential building, calculated in the computer programme SIMIEN and in accordance with Norwegian Standard NS 3031:2014 *Calculation of energy performance of buildings. Method and data*, and not based on measured energy use. In addition to the guiding assumption in Norwegian Standard NS3031:2014, experience with building tradition is included. Net energy demand is calculated for model buildings used for defining the building code. For older buildings, the calculated values tend to be higher than the actual measured demand, mostly because the calculated ventilation air flow volume in older buildings is assumed as high as in newer buildings, but without heat recovery. Indoor air quality is hence assumed not to be dependent on building year. This is the same methodology as used in the EPC-system (Energy Performance Certificate).

The building codes have a significant effect on energy efficiency. An investigation of the energy performance of buildings registered in the EPC database younger than 1997, shows a clear improvement in the calculated energy level for buildings finished after 2008/2009 when the building code of 2007 came into force. The same observation on improvement is evident when the building code of 1997 came into force. In the period between 1997 and 2007 - a period when there was no change in the building code - it is difficult to see any clear changes. However, a small reduction of energy use might have taken place in the latest years coming up to 2007. This might be due to an increased use of heat pumps in new buildings, and to a certain degree, better windows.

3.1.1 Time lag between building permit and building period

After the implementation of a new building code, there is some time lag before we see new buildings completed according to this new code. The lag between the date of general permission received (no; rammetillatelse), which decides which code is to be used, and the date at which the building is completed and taken into use, varies a lot depending on factors such as the complexity of the site and project, financing and the housing market.



The time from granted general permission to granted project start-up permission is often spent on design, sales and contracting. Based on Multiconsult's experience, six months to a year is a reasonable timespan for residential buildings in this phase. The figure below, based on statistics from Statistics Norway (SSB), indicates that approximately six months to a year construction period is standard for residential buildings.

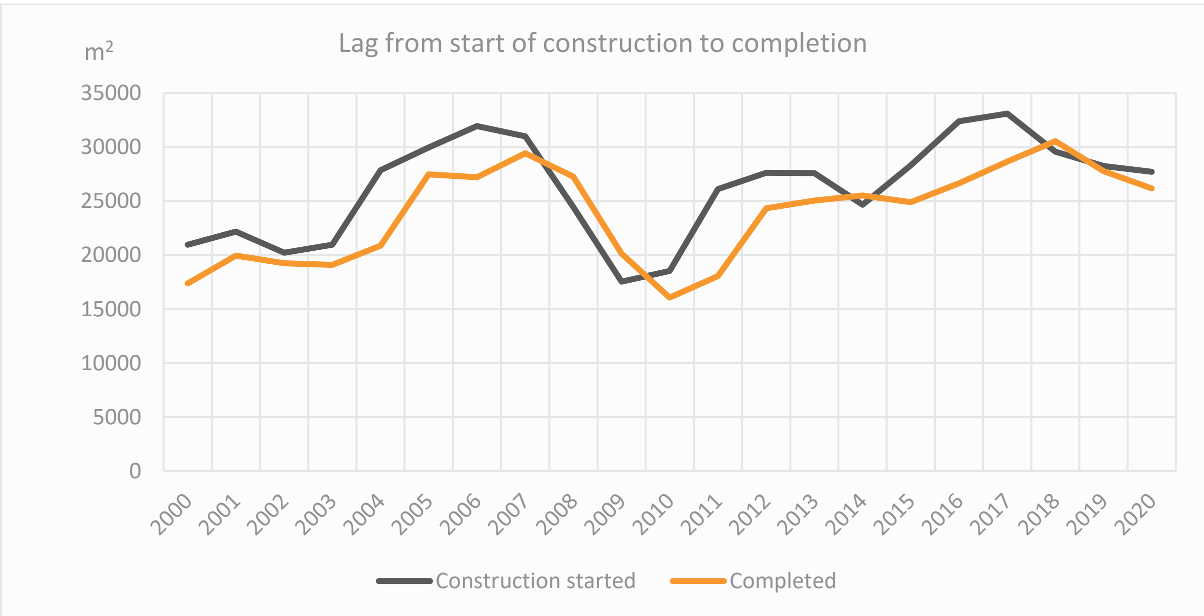


Figure 4 Project start-up and completion (Statistics Norway, bygningsarealstatistikken)

Based on the discussions on time for design and construction, we regard a time-lag of two years, in most cases, between code implementation and completion of buildings based on this code, to be a robust and conservative assumption. Some deviations may however occur, but the methodology must account for the building year information (completed construction), which is only available to the bank on a yearly basis (for example, the 2010 building code (TEK10) was implemented July 1st, 2010). Since the energy requirements were unchanged from TEK07 to TEK10, it is a very robust assumption that all buildings finished in 2012 have used energy requirements according to TEK10. There are likely buildings finished in 2011 built under the 2010 code as well, but equally, the year 2012 may also contain projects built based on TEK07. All buildings finished in 2009 - 2011 are assumed to have used TEK07. There are likely buildings finished in 2008 built under that code as well, but equally, the year 2009 may also contain some delayed projects built later based on TEK97.

3.1.2 The suitability of building codes to demonstrate energy performance in large portfolios

The registered efficiency improvements substantiate that Norwegian buildings comply with the building code in force.

The bank may obtain sufficient information about the financed objects to estimate the energy performance of the buildings in a bank’s loan portfolio. For objects with available information on building year and building category, the energy performance may be calculated based on specific energy demand illustrated in Figure 3. Living area can be used when available, or an average for each building category may be utilized for large portfolios.

For buildings without recorded building year, the category *Older* in Figure 3 (buildings from 1951 and earlier) may be applied in a conservative approach.

3.2 Energy Performance Certificate

The Energy Performance Certificate system became operative in 2010. It was made obligatory for all new residences finished after the 1st of July 2010, and all older residences - sold or rented out - were to have an Energy Performance Certificate. Enova - entity owned by the Norwegian Ministry of Climate and Environment - is now responsible for operation and development of the Energy Performance Certificate system (EPC). The system is under revision and changes may include new limit values and calculation methods.

The energy label in the EPC system is based on <u>calculated delivered energy</u>, including the efficiencies of the building’s energy system (power, heat pump, district energy, solar energy etc.). The building codes are defined by <u>net calculated energy</u>, not including the building’s energy system.

The EPC consists currently of an energy label (A-G) and a heating label (defined as colour). The heating label is seldom used, and not considered relevant in the context of this work.

The whole database is available for statistical purposes and an investigation shows that, comparing the number of certificates with actual buildings in the building stock from Statistics Norway, coverage of individual dwellings is less than 50%. This is based on raw data, even before the database has been cleaned of double entries and test entries. Low coverage influences the basis for establishing a base line and eligibility criteria. Low coverage reduces the pool volume of which a bank may identify objects in their portfolio.

The registered properties in the EPC database are considered to be representative for the buildings built under the same building code, however not representative for the total stock, as younger buildings are highly overrepresented in the database.

Registration of certificates is performed in two ways. Professionals must be involved when certifying all new buildings and non-residential buildings. Non-professional building-owners that are selling their house or apartment can however, do the certification themselves in a simplified registration system. This latter system is based on simplified assumptions and conservative values, and the results are therefore less precise and might give a lower energy label than a registration for the same building performed by professionals.

The figure below shows how the complete stock of residences in Norway is distributed by building code, and their certificate label.

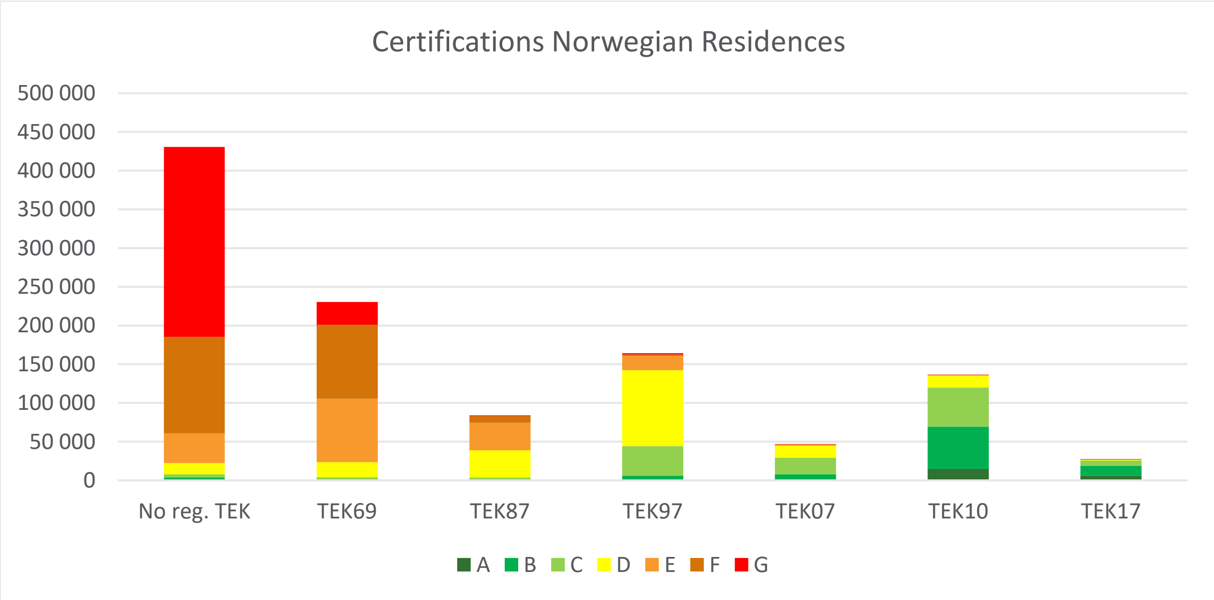


Figure 5 Registered EPC Certificates Norwegian residences distributed per building code and Energy Performance Certificate.(Source: EPC database, www.energimerking.no, January 2021).

The EPC coverage is not equally distributed over the building stock. Assuming registered EPCs for each time period are representative for the building stock, we are able to indicate what the label distribution would be if all residential buildings were given a certificate. Figure 6 illustrates how EPCs would be distributed based on this assumption.

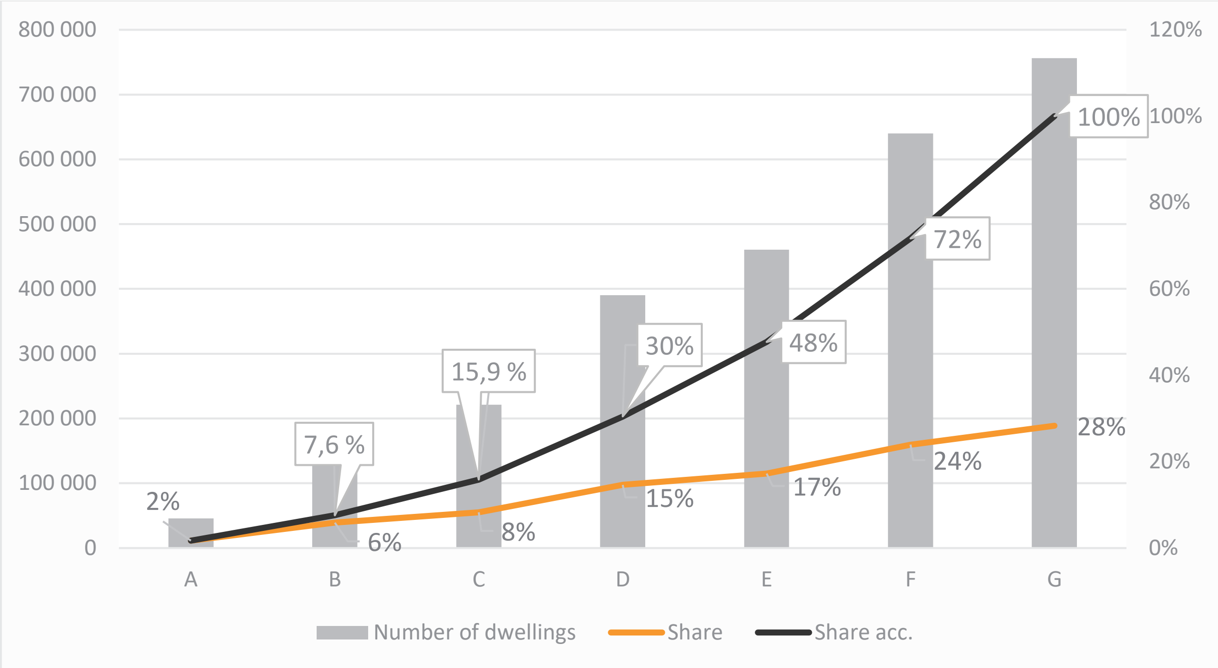


Figure 6 EPCs extrapolated to include the whole residential building stock (Source: energimerking.no and Statistics Norway, Multiconsult, January 2022)

Energy Performance Certificates have the potential to take into account building specific data and illustrate a buildings energy efficiency performance. The bank may obtain relevant information about the financed objects in the EPC database; however, this is today limited to the energy label and does not include specific energy demand.

3.2.1 The suitability of EPC to demonstrate energy performance in large portfolios

The EPC coverage, below 50%, is limiting for reporting purposes, as half of the dwellings are not to be found in the database. As well is the varied quality of the registrations. Coming changes in the EPC system, and more attention from the public regarding importance and quality of building documentation, may lead to an extensive use of the EPC system for portfolio footprint assessments in the future. Using the building code is considered a more conservative approach related to portfolio footprint calculations compared to using the EPC system, giving a larger footprint. In any later updates, consistency and transparency will be pursued when describing the portfolio's energy and climate performance, even with transition in methodology or enhanced data quality.

4 Sparebanken Møre Loan Portfolio - Energy Efficiency Analysis

4.1 Portfolio information

The analysis is based on the portfolio as of November 24th 2022. Of the Sparebanken Møre PM residential loan portfolio, 22,604 dwellings, 16,586 small residential buildings and 6,018 apartments, have been analysed. From the loan portfolio, holiday homes and buildings registered in the portfolio as second mortgages (no; tilleggssikkerhet) have been excluded from the analysis. These dwellings are excluded due to miscellaneous reasons; as there are no historical energy requirements in the building code (holiday homes), and to avoid double counting as same assets may be included in other portfolios (second mortgages). Figure 7 shows how the residential buildings in the portfolio are distributed by age, indicated by building code, and taking into consideration the time lag from time of implementation of a code to most finished buildings adhering to the new code. For objects without building year information, the building is conservatively assumed to fall into the "older" category. For dwellings without living area information, the category average in the national statistics is assumed.

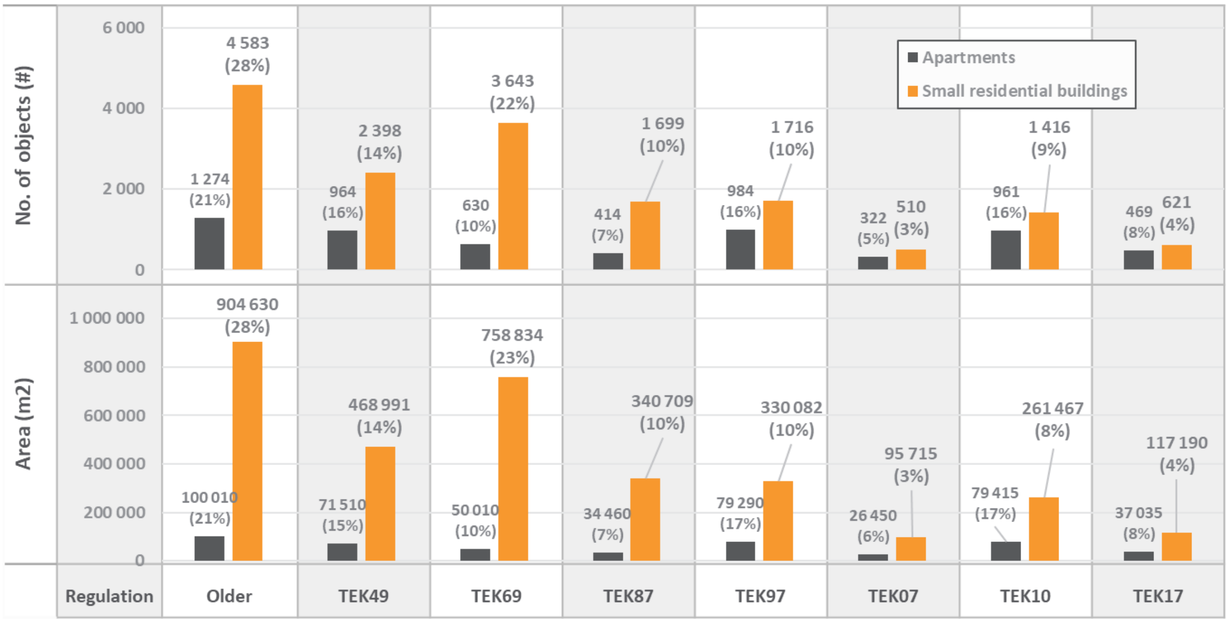


Figure 7 Sparebanken Møre residential loan portfolio as of November 24th 2022 (Source: Sparebanken Møre, Multiconsult)

4.2 Calculated energy demand

Combining the age distribution of the living area in the portfolio with calculated energy demand in the building stock dependent on building code, we can illustrate the energy demand in the whole portfolio. Over the years, the energy footprint of this dynamic portfolio will develop, and the bank will be able to monitor the energy efficiency of their portfolio.

Figure 8 illustrates energy demand in buildings in the current portfolio applying information in Figure 3 and Figure 7. The energy demand in the buildings is scaled down to reflect the bank's engagement. The scaling simply reflects the loan's share of the object value.

Buildings in the current portfolio, as of November 24th 2022, represents yearly energy demand of 938 GWh. Adjusted to only reflect the bank's engagement relative share of property value, the portfolio represents yearly energy demand of 505 GWh.

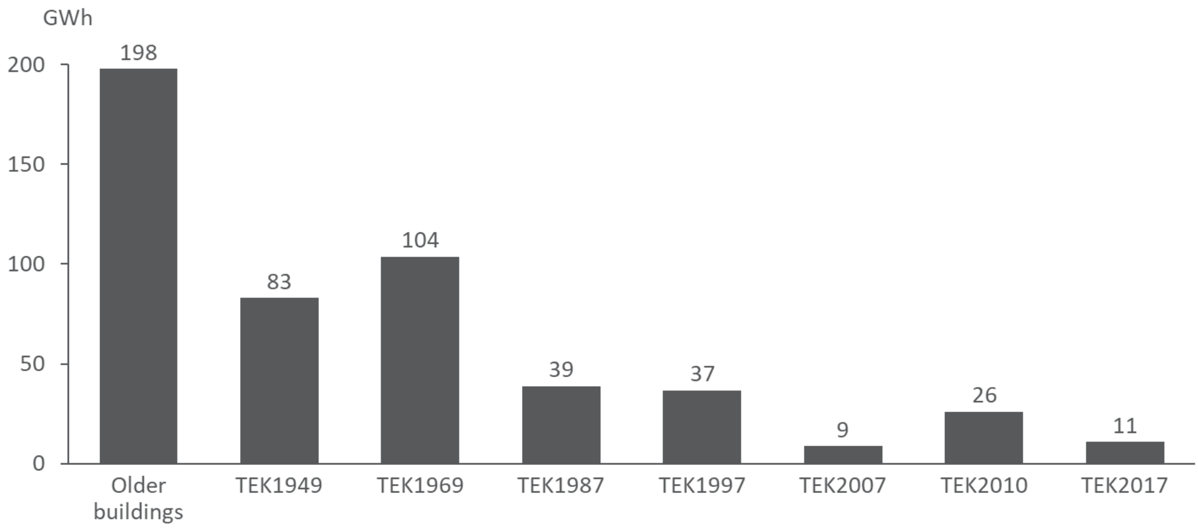


Figure 8 Portfolio in-use energy demand scaled by engagements share of property value distributed by age of buildings (Source: Sparebanken Møre , Multiconsult).

4.3 Calculated CO_2-emissions related to operational energy demand

The CO_2-emissions resulting from in use energy demand in residential buildings depends to a large degree on the age of the building. This again is due to two factors; the differences in energy efficiency requirements in the building code, and development in the predominant solutions and energy sources for heating in new buildings. Examples of the latter are direct electric heating, various types of heat pumps, bio energy and district heating. Since the Norwegian buildings are predominantly heated by electricity, where the system boundary for power produced is placed heavily influences the emission factor. In these calculations a rounded average for the three years 2019, 2020 and 2021 indicate factors of 250 and 10 gCO_2/kWh for European and Norwegian mix respectively. This differs from the lifecycle average emission factor used in the green portfolio impact assessment, where that is more relevant. Figure 9 and Figure 10 illustrate the specific CO_2-emissions in the Norwegian residential building stock dependent on whether it is calculated based on a Norwegian power production mix or a European power production mix.

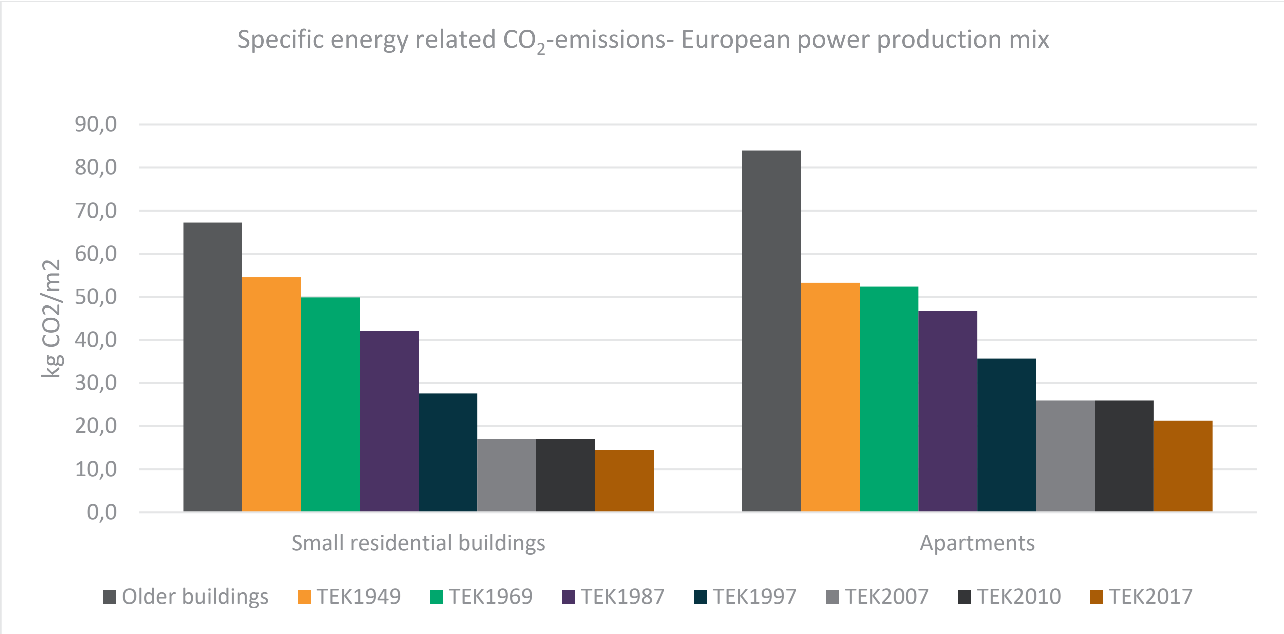


Figure 9 Total Norwegian residential building stock specific CO_2-emissions ($kgCO_2$-eq/m^2) dependent on building category and age of buildings, European power production mix (Source: Multiconsult)

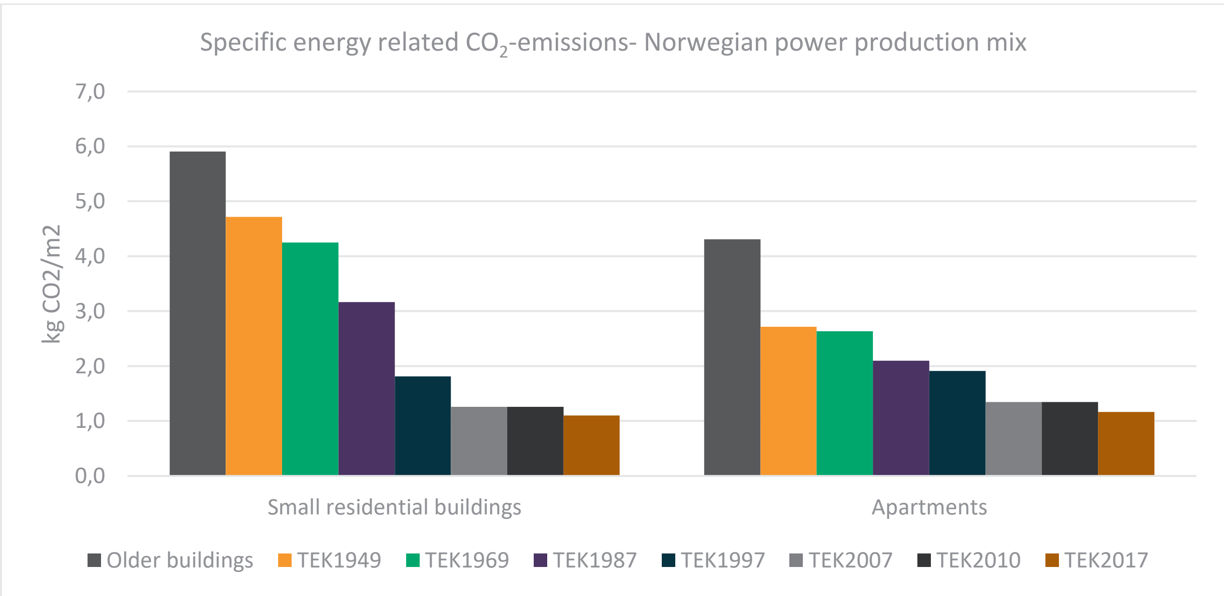


Figure 10 Total Norwegian residential building stock specific CO_2-emissions ($kgCO_2$-eq/m^2) dependent on building category and age of buildings, Norwegian power production mix (Source: Multiconsult)

The calculated energy demand distributed by age of the buildings in the portfolio and the estimated specific emissions in figures above, gives a basis to estimate the CO_2-emissions of the total Sparebanken Møre residential buildings portfolio. Figure 11 and Figure 12 illustrate the CO_2-emissions related to in-use energy demand in the buildings in the current portfolio scaled down to reflect the bank's engagement.

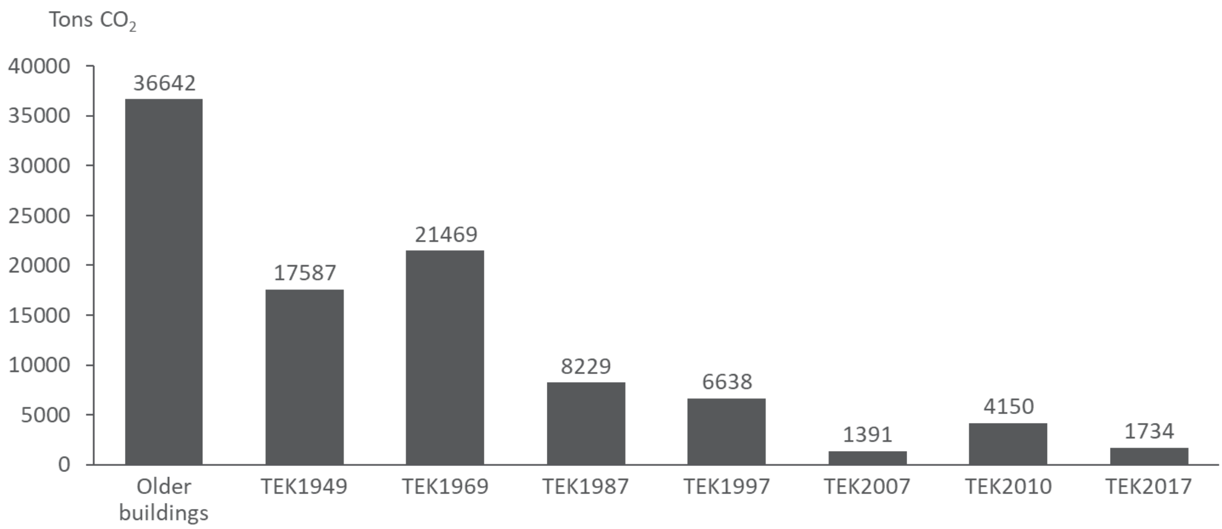


Figure 11 Portfolio CO_2-emissions related to yearly in-use energy demand, scaled by engagements share of property value. Current European power production mix as basis for calculation. (Source: Sparebanken Møre, Multiconsult)

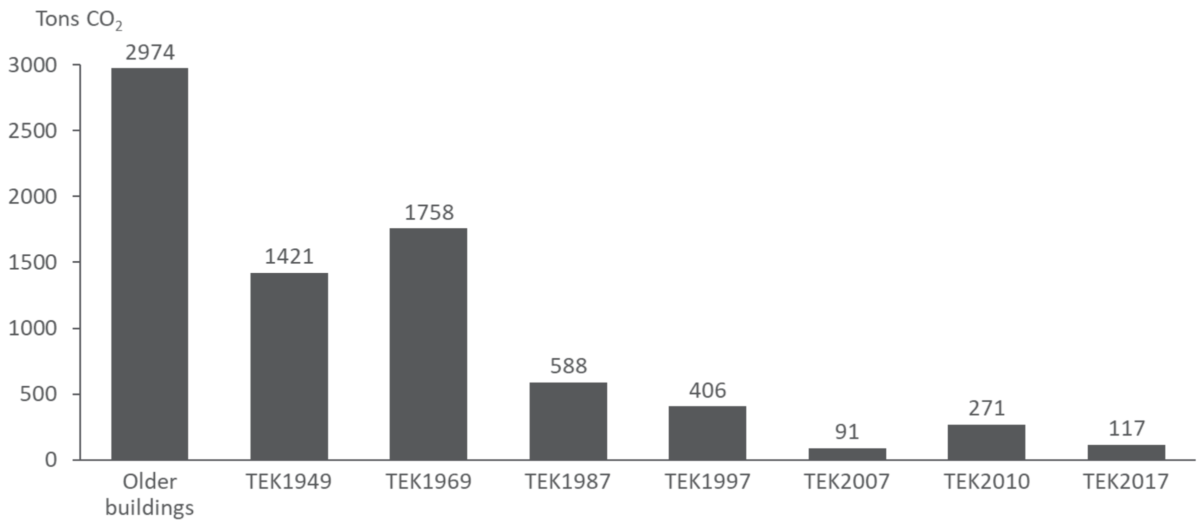


Figure 12 Portfolio CO_2-emissions related to yearly in-use energy demand, scaled by engagements share of property value. Current Norwegian power production mix as basis for calculation. (Source: Sparebanken Møre, Multiconsult)

Adjusted to only reflect the bank's engagement relative share of property value, the portfolio as of November 24th 2022 represents the following yearly emissions.

Scenario	CO_2- factor	Portfolio emissions per year
European 2019//20/21 production mix	~250 gCO_2/kWh	**97,840 tons CO_2eq**
Norwegian 2019//20/21 production mix	~10 gCO_2/kWh	**7,625 tons CO_2eq**

Table 1 Portfolio emissions of CO_2