Interreg Baltic Sea Region

Co-funded by the European Union

ENERGY TRANSITION RenoWave

Guide on Data Availability and Setting Energy Efficiency Targets for the Building Stock

Housing Initiative for Eastern Europe (IWO)

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May 2025

About RenoWave

The project entitled “One-Stop-Shop extended model to increase the multi-apartment building stock renovation in the BSR” (RenoWave) is designed to bring homeowners, construction companies, energy agencies and public authorities together to initiate more energy-efficiency renovations in multi-apartment buildings. The main outcome of the RenoWave project will be a one-stop shop (OSS) model that includes both traditional and additional OSS services covering all the steps necessary to initiate and implement energy-efficiency renovation projects in multi-apartment buildings. The RenoWave project is being delivered as part of the Interreg Baltic Sea Region Programme 2021–2027 with the support of the European Regional Development Fund and is being implemented between January 2023 and December 2025.

Project partners

1. County Board of Dalarna (Sweden)
2. City of Lappeenranta (Finland)
3. Vidzeme Planning Region (Latvia)
4. Association of Communes and Cities of Małopolska Region (Poland)
5. Magistrat of the City Bremerhaven (Germany)
6. Baltic Environmental Forum Latvia (Latvia)
7. Housing Initiative for Eastern Europe (Germany)
8. Let’s renovate the city NGO (Lithuania)
9. Polish Foundation for Energy Efficiency (Poland)
10. North Sweden Energy Agency (Sweden)
11. Development Centre of Võru County (Estonia)

www.interreg-baltic.eu/project/RenoWave

The RenoWave project is designed to bring homeowners, construction companies, energy agencies and public authorities together to initiate more energy-efficiency renovations in multi-apartment buildings.

Brief summary

This guide analyses the data availability of building data in seven different European countries. It offers different approaches to sourcing and making use of building data. The guide proposes various ways for setting energy efficiency targets for the residential building stock and, taking this as a basis, creating roadmaps for determining the relevant data sources and their availability.

List of Abbreviations

Art.	Article
BPIE	Building Performance Institute Europe
BSR	Baltic Sea Region
DE	Germany
EE	Energy efficiency
EED	Energy Efficiency Directive
EFSI	European Fund for Strategic Investments
e.g.	for example
EIB	European Investment Bank
EP	Energy performance
EPBD	Energy Performance of Buildings Directive
EPC	Energy Performance Certificate
ESIF	European Structural and Investment Funds
ETS	Emission Trading System
EU	European Union
FI	Finland
GWP	Global warming potential
HVAC	Heating, ventilation and air conditioning
HOMAB	Home-owned multi-apartment building
IEA	International Energy Agency
IEQ	Indoor environmental quality
LT	Lithuania
LV	Latvia
NBRP	National Building Renovation Plan
NUTS	Nomenclature of territorial units for statistics
NZEB	Nearly zero-energy building
MEPSs	Minimum Energy Performance Standards
OSS	One-stop shop
PL	Poland
RED	Renewable Energy Directive
SE	Sweden

Contents

Preamble

Funded by the EU's Interreg Baltic Sea Region Programme, the RenoWave project aims to improve the energy efficiency of the residential building stock across seven countries in the Baltic Sea Region (Germany, Latvia, Lithuania, Poland, Estonia, Sweden and Finland).

The process of setting energy efficiency targets is emphasised as a crucial part of policy planning for meeting climate targets. This is particularly true of the building sector due to the significant potential for energy savings that it harbours. The revised Energy Performance of Buildings Directive (EPBD) reinforces this by encouraging Member States to draw up national roadmaps for reducing energy use, especially in the worst-performing buildings.

A central component of the project is the development and application of a data handling methodology that evaluates the availability and quality of energy efficiency data for buildings in each partner country. Each project partner collected relevant data using standardised templates tailored to their national context. Collecting the data enabled partners to analyse their building stock and set energy efficiency targets.

Setting targets for the building stock is very important for policy planning and strategic action relating to energy efficiency improvements. Within the RenoWave project, it was discovered that there is significant variation in availability and accessibility of building data across the individual BSR countries. As obtaining the same input data was not possible, some project partners came up with their own target-setting methods based on the data available to them.

Across three chapters, this guide not only maps the current data landscape but also introduces methodologies for setting energy efficiency targets at different levels developed and tested by project partners. These methods vary between countries due to differences in data availability. The project also proposes indicators for benchmarking building performance and supports the formulation of national roadmaps for improving energy efficiency, guided by both EPBD targets and the data handling insights gained during the project.

The proposed methodology and different methods can be replicated by actors such as municipalities or one-stop shops (OSSs) depending on the available data.

Availability of building stock data in BSR countries

Data availability in BSR countries

Introduction

This chapter presents the results of applying the OSS data handling methodology developed as part of the RenoWave project. The methodology evaluates the availability of data on building renovation in seven countries (DE, LV, LT, PL, EE, SE, FI). The analysis presented here only covers the data relating to the energy efficiency of the building stock. Data availability is analysed based on the weighted average of different data sources defined by the project partners.[1] Each project partner was provided with a template for the data sources to collect, and each template was adapted to the local context. The completed templates can be found in the annex.

Results and discussion

The project partners allocated weightings to the various types of data source. Table 1 shows the averages used to calculate data availability. The average weightings have been obtained based on those allocated by the project partners to the specific indicators. The weightings represent the importance of the indicator for the overview of the building stock according to the project partners.

Table 1 Data for the building stock – indicator weightings

Data for the building stock – indicator weightings	Average
Number of buildings	4.4%
Number of HOMABs	7.1%
Building area (m^2)	5.4%

[1] County board of Dalarna, City of Lappeenranta, Vidzeme planning region, Association of Communes and Cities of Małopolska Region, Magistrat of the City Bremerhaven, Baltic Environmental Forum Latvia, Housing Initiative for Eastern Europe, Let's renovate the city, Polish Foundation for Energy Efficiency, North Sweden Energy Agency, Development Centre of Võru County

Building living area (m^2)	6.9%
Year of construction	6.9%
Number of floors	2.9%
Type of HVAC systems used in buildings	4.8%
Housing ownership rate (%)	6.4%
Building ownership structure	7.4%
Primary energy source	7.4%
Energy source for electricity production	4.4%
Energy consumed to heat water (kWh/m^2)	9.4%
Energy consumed to heat rooms (kWh/m^2)*	10.9%
Current energy class of building [letter]*	9.4%
Carbon emissions of the building stock [tonnes]	4.2%
Solar gain (kWh/m^2)	2.5%
Total	100%

*Taken together, the energy consumed to heat rooms and that consumed to heat water constitute the **final energy consumption** of the building stock. Because some project partners allocated weightings that distinguished between the two indicators, while others weighted the final energy consumption as a single indicator, the weightings ultimately obtained are not equal.

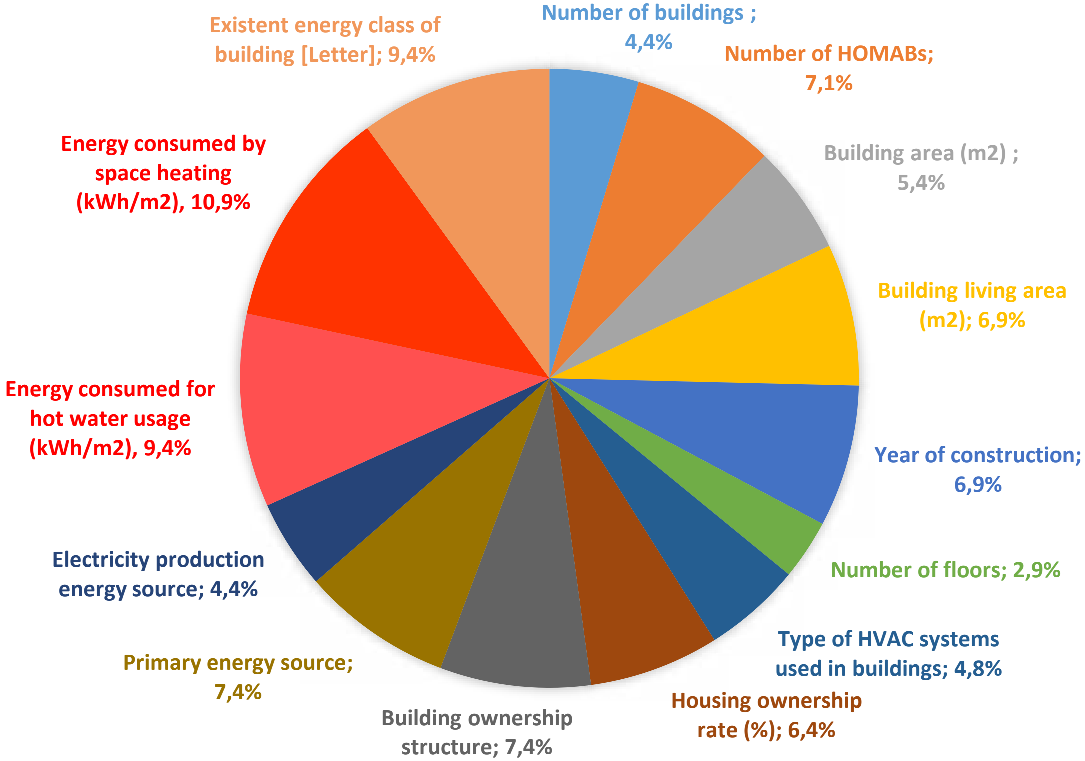


Figure 1 Indicator weightings allocated by project partners

It was important to find out what sources were available to all project partners. The results revealed that the data sources available to everyone were as follows:

- Final energy consumption [kWh/m²/year]
- Primary energy source
- Year of construction
- Building living area

However, not all of these available data sources provided by the project partners were open-access (see Figure 1). An additional indicator that could potentially be added in the future is the current energy class of buildings [letter], which was provided for all the countries except Germany. However, the main regulation governing energy performance data is expected to be revised, suggesting that such data sources might also become easier to access in the future.

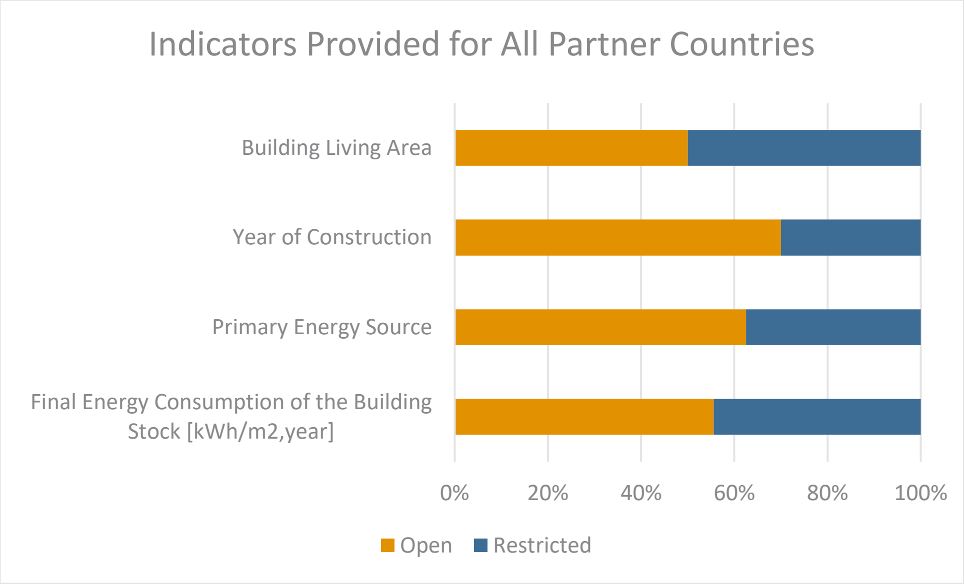


Figure 2 Availability of indicators provided by all partners

Data availability for the sources listed in Table 1 was evaluated based on the average weightings allocated by the project partners while completing the template. In addition, some project partners provided more data sources than were initially in the template, thus reflecting their local context in a more detailed way.

Figure 3 shows data availability. However, these results need to be placed in context. Despite the lowest level of data availability being shown for Sweden, this only relates to indicators chosen for the analysis presented in Table 1. The template for Sweden was complemented by other indicators, and weightings were assigned to them. Furthermore, even if data is available, this does not mean that everyone can access it. The case of Germany is worth mentioning here as, despite the high degree of data availability, it is not the case that this data can be easily accessed. This is why it is worth considering the percentage of open-access data sources in order to obtain a more complete picture of data availability (see Figure 4).

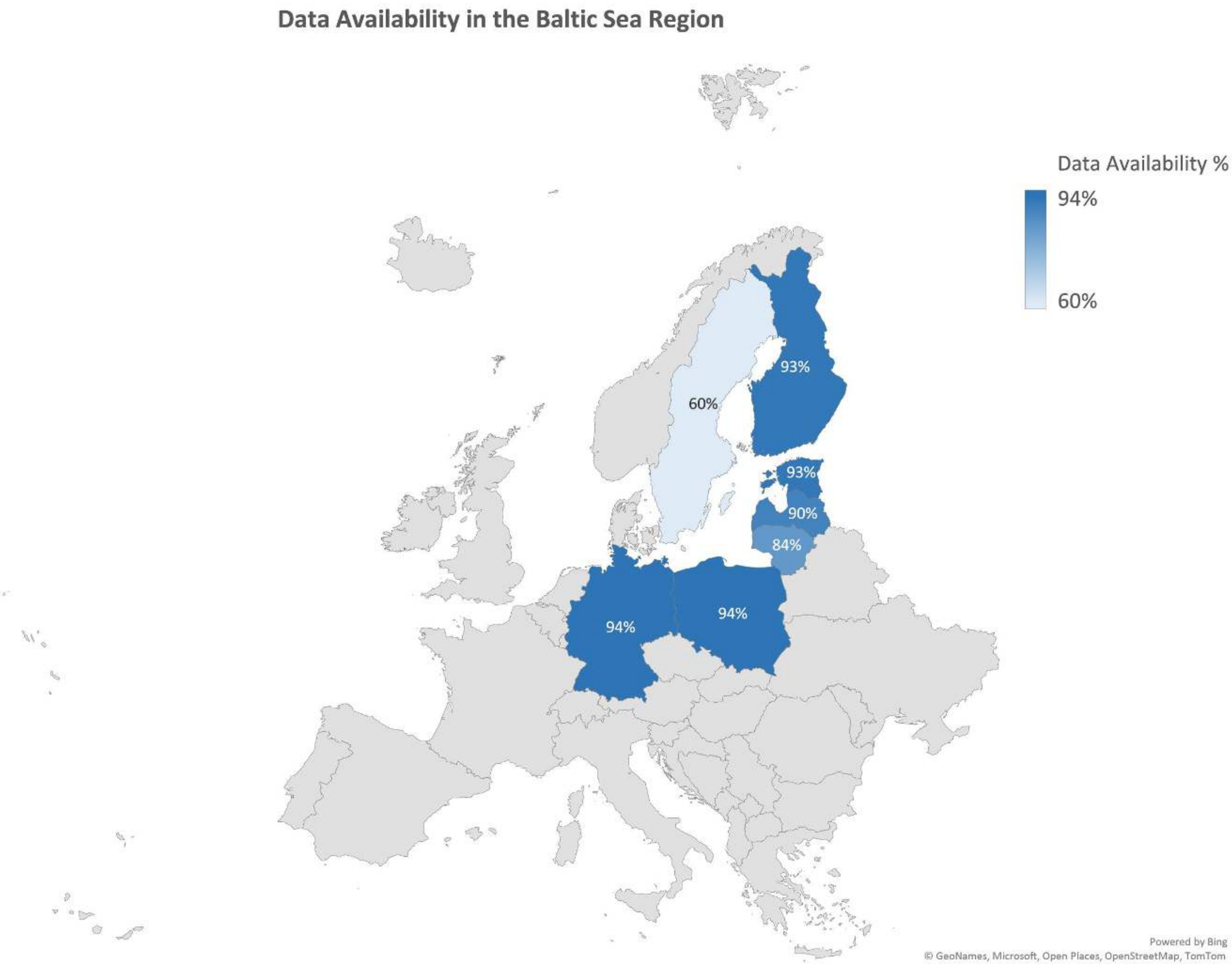


Figure 3 Data availability in the Baltic Sea Region

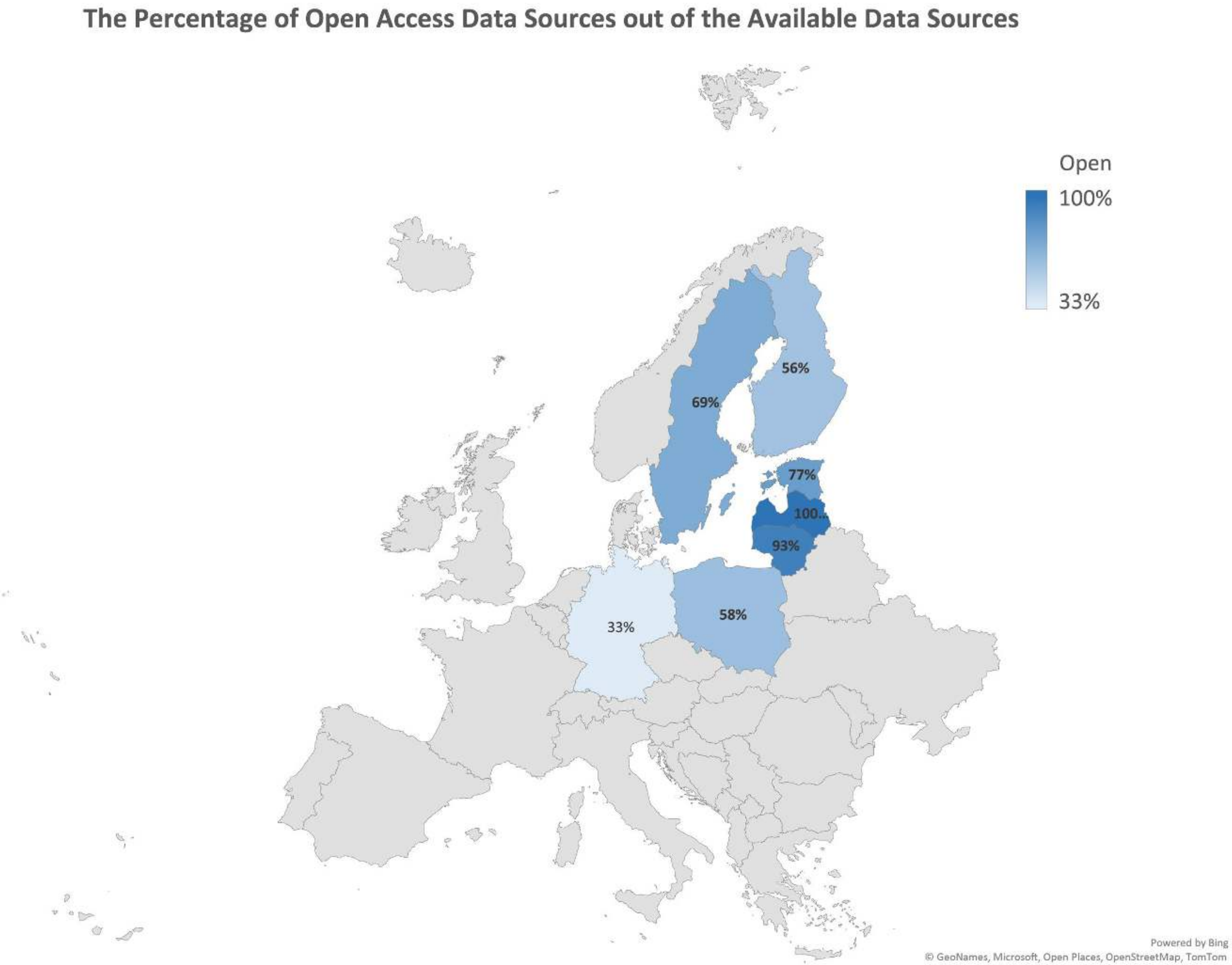


Figure 4 Open-access data sources as a percentage of available data sources

Figure 4 shows that, in Latvia, all the sources provided in the template were publicly available, while in Germany only 27% of the sources provided could be accessed without any restrictions. Restricted access implies that the data cannot be easily accessed by private individuals and requires either a special request to be made, permission to be sought or a fee to be paid. In the case of Poland, for example, the restricted nature of the data means that local governments have to submit a request before they can access it.

To obtain a more comprehensive idea of source accessibility, Figure 5 shows open sources as a percentage of all those provided for the BSR countries. We can see that most of the sources provided were open access, while more than a third had restricted access. As the project partners who provided these sources represent different actors, such as municipalities and municipal and regional agencies, NGOs, OSSs and energy agencies, some of them could access the sources labelled as "restricted", while private individuals might not be able to do so without paying a fee, making a request or seeking special permission.

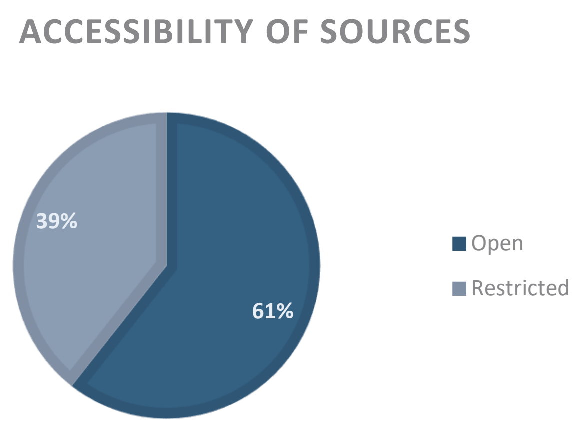


Figure 5 Accessibility of sources

If we consider the levels at which the data is available, we can see that most data is available at NUTS level 3. Figure 6 shows the distribution of the sources provided by the NUTS levels. The fewest sources were available at NUTS level 2. In the case of Sweden, the data sources were provided for the level lower than NUTS3. The second highest percentage was provided for NUTS level 0 (national level). Overall, the data availability at the lower statistical levels sends out a positive signal for more local and tailored action by actors such as OSSs and municipalities.

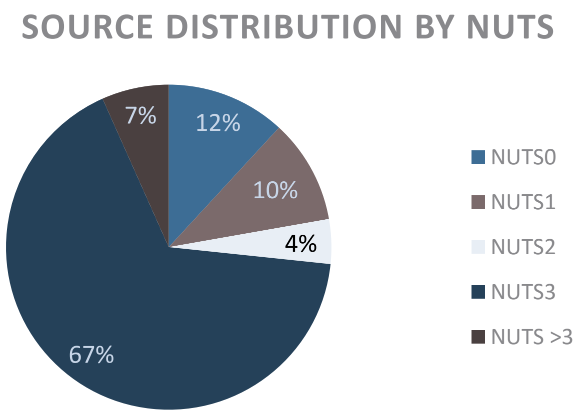


Figure 6 Distribution of sources by NUTS

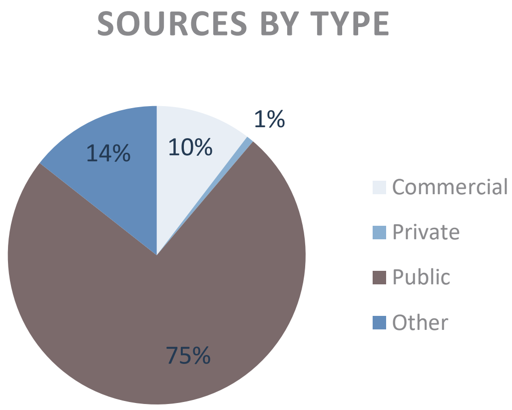


Figure 7 Distribution of sources by type

Figure 7 presents the source distribution based on type. Most of the sources provided are public in nature. The "Other" types of sources were provided by the partners from Poland, Finland and Germany. In Poland, this relates to Energy Performance Certificates (EPCs), where the data could be either public or private depending on who owns the building concerned. For Finland, this is Trimble Locus,[2] the building manager of HOMABs or the electricity provider. For Germany, this category included reports from the regional association of chimney sweepers (Landesinnung der Schornsteinfeger). If a source is commercial, this does not necessarily mean that access to it was always restricted; there were some instances of open-access data amongst commercial sources.

Conclusion

The findings in this chapter demonstrate the results of applying data handling methodology to the building renovation work forming part of the RenoWave project, itself funded under the Interreg BSR Programme. The findings are based on the inputs of the data sources provided by the project consortium partners, representing seven countries of the Baltic Sea Region (DE, LV, LT, PL, EE, SE, FI). The results show that the most important data sources according to the project consortium are: final energy consumption, comprising the energy consumed to heat rooms and heat water; the current energy class of buildings; the primary energy source; and the building ownership structure. The following data sources are available for all project partners: final energy consumption; primary energy source; year of construction; and building living area. Poland, Estonia, Germany and Finland show the highest degree of data availability for their chosen data sources, with Latvia and Lithuania boasting the largest share of open-source data. Overall, open sources represent more than 60% of all sources collected. Most of the sources provided represent NUTS level 3 and are public in nature. The application of the methodology demonstrates the importance of placing data in the correct context. For example, not all commercial sources have restricted access, while a high degree of data availability does not necessarily mean that the sources are open access (e.g. in Germany); conversely, if the degree of data availability is low for the sources used in the analysis presented here, it does not mean that the general availability of the sources useful for the analysis of the building stock is also low, as there might be alternative data sources that are useful for the given context (e.g. in Sweden).

[2] A solution that enables local governments to manage their built environment data in 3D and that provides all the tools required for 3D geospatial data management and map production.

Roadmaps for data availability and target-setting

Why set targets for the building stock? How can one find the relevant data?

Target-setting is an important part of every policy of coordinated action since it offers a way to measure and monitor the effectiveness of that action. When it comes to buildings, target-setting also enables more coherent policy planning because it offers significant potential for energy efficiency savings. The building sector is one of the main areas of focus for policymakers looking to meet European, national and local climate targets. The latest impact assessments for the EU's climate targets suggest that the residential sector is likely to contribute more than the services sector to overall energy savings in buildings, with 29% savings in 2030 compared with 2015 (as against 23% savings in services), 39–41% across scenarios in 2040 (27–32% savings in services) and 44% in 2050 (31% savings in services) (Commission Staff Working Document. Impact Assessment Report. Part 3., 2024).

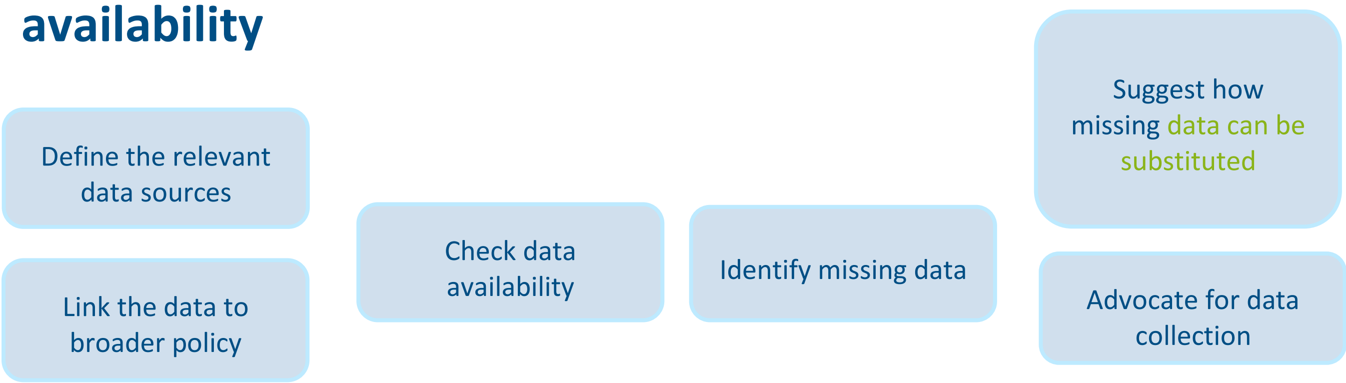
Buildings that are more energy efficient bring better indoor environmental quality (IEQ), lower energy bills and a positive environmental impact. The importance of setting targets for the building stock has also been highlighted by the recast of the Energy Performance of Buildings Directive (EPBD), which helps Member States to adopt a national trajectory for reducing the average primary energy use of residential and non-residential buildings, focusing on the lowest-performing buildings in their national stock.

The energy efficiency of the residential building stock in the BSR is being addressed with the RenoWave project. As things stand, the trend in EU policy will require targets to be set for the building stock. To permit benchmarking across the BSR, a method for setting energy efficiency (EE) targets for both the whole residential building stock and individual buildings should be formulated based on the tools and methodologies developed within RenoWave. In addition, a roadmap for every partner region country based on its data sources, its availability and how to collect the data from these sources will be developed for/by each partner for the specific circumstances and needs in their region.[3]

This chapter is intended as a guide for preparing the roadmaps for data sources relating to the energy efficiency of the building stock and its availability. It will also guide the setting of energy efficiency targets for the building stock as a whole and for individual buildings. This chapter also includes some of the energy efficiency targets set by the EPBD and proposes the indicators to use for benchmarking building energy performance in the BSR.

[3] RenoWave's partner countries are Sweden, Finland, Estonia, Latvia, Lithuania, Poland and Germany.

How to prepare a roadmap for the relevant sources and their availability



The first step is to come up with an initial definition of the kind of data that might be relevant to an assessment of the energy performance of the building stock. As part of the RenoWave project, the template for the data handling methodology was developed,[4] which identified the following data as important:

- Number of buildings
- Number of HOMABs
- Building area (m²)
- Building living area (m²)
- Year of construction
- Number of floors
- Type of HVAC systems used in buildings
- Home ownership rate (%)
- Building ownership structure
- Primary energy source
- Usable energy (kWh/m²)
- Energy source for electricity production
- Final energy consumption of the building stock [kWh/m²/year][5]
    - Energy consumed to heat water (kWh/m²)
    - Energy consumed to heat rooms (kWh/m²)
- Current energy class of building [letter]
- Carbon emissions of the building stock [tonnes]
- Solar gain (kWh/m²)

This list is not exhaustive, of course, but provides some useful insights and initial guidance on a potential starting point. **Access to data** is one of the key determinants of its effective use. When preparing a roadmap, it is important to indicate whether anyone can access the data. If access can be granted based on a request, or if it is only accessible by a specific type of actor (e.g. municipality), the availability of that data might be high but the accessibility low.

[4] The complete template can be found in Annex A1.
[5] Final energy consumption is the sum of the energy consumed to heat water and rooms; either one indicator or a combination of the two can be used depending on the context.

It is also important to address **the level at which data is available** (NUTS0, NUTS1, NUTS2, NUTS3), what sources it comes from and how reliable or up-to-date it is. The template also checks the data sources provided against the abovementioned criteria.

Since the roadmap should reflect the local context in a high level of detail, **the additional sources and indicators** reflecting the energy efficiency or overall characteristics of the building stock should be explored. Therefore:

- Consult the website of the relevant national statistical office website and check out sources such as the national building register, EPC database, Eurostat, EU Building Stock Observatory, etc. to identify what data is collected on buildings. It is useful to check what kind of data is offered by commercial sources and if the same data can be accessed through public institutions.
- Pay attention to the unique building data being collected for the context you are operating in. These data sources that are not common may give you some hints for setting future targets.
- Also **explore national, regional or local policies** and evaluate what indicators are used there for planning and if they are available.

To link your actions with the broader policy context, it is worth considering the obligatory and optional indicators that will be used in the EPBD for the overview of the building stock. These indicators mentioned in the EPBD are linked with the obligation to develop the **national building renovation plans (NBRPs)** (EPBD, Art. 3) and monitor their performance. These indicators include:[6]

Obligatory indicators:

- Number of buildings and total floor area (m^2)
  - for each building type (including public buildings and social housing)
  - for each energy performance class
  - NZEBs
  - worst-performing[7] (including a definition of the term)
- Number of EPCs
- Annual renovation rates: number and total floor area (m^2)
- Primary and final annual energy consumption (ktoe)
- Energy savings (ktoe)
- Share of renewable energy in the building sector (MWh installed or GWh generated)
- Annual operational greenhouse gas emissions ($kgCO_2eq/(m^2.y)$)
- Annual operational greenhouse gas emission reduction ($kgCO_2eq/(m^2.y)$)
- Market barriers and failures (description)
- Energy poverty (definition)
- Primary energy factors[8]

Optional indicators:

- Reduction in energy costs (EUR) per household (average)
- Annual life-cycle global warming potential ($kgCO_2eq/(m^2.y)$) in new buildings

[6] The extended list, including additional descriptions and sub-divisions of indicators, can be found in Annex II to the EPBD.
[7] The EPBD defines “worst-performing buildings” means that are within the 43% of buildings with the poorest energy performance in the national building stock.
[8] This describes the ratio between primary energy use and final energy supply and thus the efficiency of the final energy supply.

Once you have identified the relevant data sources and assessed their availability, you can **map what is missing.** It might be the case that the data is either present but access to it is restricted, or the data is not collected at all. You might also face a situation where the data is only available on a larger or smaller scale than you need. Try to explore using proxies to estimate the numbers for the scale that you need. If you have the average country-level data, for example, you could estimate the regional level based on e.g. m^2. This estimation is not very precise and could be misleading, of course, but it might offer you a starting point. If the data that you need is not collected at all, the roadmap can be used as an argument for lobbying and campaigning to bring about some changes in data collection for your country or region. It is important to mention why precisely this data source is vital to be collected in your opinion. The need to set targets for the energy performance of the building stock within the overall policy planning may come in handy for lines of argument like this.

How to set energy efficiency targets for the building stock

Having ambitious targets is good, but they have to be realistic. Following the data availability analysis, the next step is to **define the indicators** that will be used to set your targets. This step should enable the baseline definition, based on the assessment of the existing building stock.

Indicators for comparison might include:

- Final energy consumption of the building stock
- EPC class of the building
- Usable energy
- Primary energy use
- Carbon emissions from the use of buildings

It also makes sense to evaluate some of the indicators per m^2 to have a better understanding of the energy efficiency and to be able to compare. EPC classes, for instance, may be compared in terms of what percentage of the building stock has a certain energy class. The new EPBD will require targets to be set for the worst-performing building stock, to be measured against primary energy use. This may also be an approach to consider when evaluating the status quo. Identifying what part of the building stock to focus on first is important for the action being targeted. Targets can also be set in the form of a renovation rate but, in this case, it will be important to be specific about what qualifies as "renovation" and to be sure that it has an impact on energy efficiency.

There is an obligation for the roadmap to set national targets for 2030, 2040 and 2050 for national building renovation plans specified by the EPBD. In these targets, the EPBD implies not only the energy-related indicators but also the wider benefits of renovation. These wider benefits can be defined in different ways. One of the possible definitions is the reduction in energy poverty expressed as a percentage. Some of the obligatory indicators that will be used in the roadmaps are as follows:[9]

- Targets for annual renovation rates: number and total floor area (m^2)
  - for each building type
  - worst-performing
- Targets for expected primary and final annual energy consumption (ktoe)
  - for each building type
  - for each end use
- Expected energy savings
  - for each building type

[9] The extended list with additional descriptions and sub-divisions of indicators can be found in Annex II to the EPBD.

- Targets for increasing the share of renewable energy in line with Art. 15a of Directive (EU) 2023/2413
- Numerical targets for the deployment of solar energy in the building
- Targets for expected operational greenhouse gas emissions (kgCO_2eq/(m².y)
- Targets for expected operational greenhouse gas emission reduction (%)
- Expected wider benefits
  - reduction (as a %) in the number of people affected by energy poverty

Energy efficiency targets set by the EPBD

The EPBD stresses that action should be concentrated on the worst-performing building stock, setting thresholds for this purpose.

For non-residential buildings, MEPSs ensure that they do not exceed the specified maximum energy performance threshold. These thresholds are to be established based on the non-residential building stock on 1 January 2020, on available information and, where appropriate, on statistical sampling.

A "16% threshold" is to be set in such a way that 16% of the national building stock is above that threshold, and a "26% threshold" is to be set in such a way that 26% of the national building stock is above that threshold. The maximum energy performance thresholds may differ between different building types and categories.

- The minimum energy performance standards are to ensure at the very least that all non-residential buildings are below:
  - the 16% threshold as of 2030; and
  - the 26% threshold as of 2033.

- Member States shall ensure that, compared with 2020 levels in each case, the average primary energy use in kWh/(m².y) of the whole residential building stock:
  - decreases to at least 16% by 2030; and
  - decreases to at least 20–22% by 2035.

  Member States shall ensure that at least 55% of the decrease of the average primary energy use is achieved by renovating the worst-performing residential buildings.

- Member States shall ensure the deployment of suitable solar energy installations, if technically suitable and economically and functionally feasible, as follows:
  - by 31 December 2026, on all new public and non-residential buildings with a useful floor area of over 250 m²;
  - by 31 December 2027, on all existing public buildings with a useful floor area larger than 2,000 m²;
  - by 31 December 2028, on all existing public buildings with a useful floor area larger than 750 m²;
  - by 31 December 2030, on all existing public buildings with a useful floor area larger than 250 m²;
  - by 31 December 2027, on all existing non-residential buildings with a useful floor area larger than 500 m² where the building undergoes major renovation or an action that requires an administrative permit for building renovation, roof work or the installation of a building services system;
  - by 31 December 2029, on all new residential buildings; and
  - by 31 December 2029, on all new covered car parks physically adjacent to buildings.

- Member States shall ensure that the total annual primary energy use of a new or renovated zero-emission building is covered by:

- energy from renewable sources generated on site or nearby, fulfilling the criteria of Article 7 of Directive (EU) 2018/2001 [amended RED];
- energy from renewable sources provided from a renewable energy community within the meaning of Article 22 of Directive (EU) 2018/2001 [amended RED];
- energy from an efficient district heating and cooling system in accordance with Article 24(1) of Directive (EU) [recast EED]; or
- energy from carbon-free sources.

  Where it is not technically or economically feasible to fulfil the requirements set out in this section, the total annual primary energy use may also be covered by other energy from the grid complying with criteria established at national level.

It is crucial to ensure that the proposed targets are consistent with the other policies. This will be relevant when **defining the relevant mid-term milestones.** The Building Performance Institute Europe (BPIE) recommends aligning MEPSs with decarbonisation objectives for the building stock. MEPSs and building codes[10] are seeing increasing use in an attempt to standardise and simplify the process of increasing EE in the building sector across countries to meet the targets for 2030 and achieve decarbonisation by 2050 (BPIE, 2023). The International Energy Agency (IEA) has voiced the need for countries to make their building stock **zero-carbon-ready** by 2030. "Zero-carbon-ready" buildings are defined as highly energy-efficient and resilient ones that either use renewable energy directly or rely on an energy source that can be fully decarbonised, such as electricity or district energy. The zero-carbon-ready concept includes both operational and embedded emissions. According to the IEA, setting targets for zero-carbon-ready buildings can stimulate long-term investment. These targets can include a penetration quota, a ban on fossil fuels and target renovation rates (IEA, 2024).

Benchmarking

Within the RenoWave project, project partners proposed the indicators for target-setting that were the most relevant in their national contexts. The indicators that were suggested by the majority of partners were:

- Primary energy source
- Energy class of the EPC
- Year of construction

When filling the templates for the data handling methodology,[11] all the project partners provided the following indicators:

- Building living area (m²)
- Year of construction
- Primary energy source
- Final energy consumption of the building stock (kWh/m²/year)

[10] A building code is a set of rules that specify the standards for constructed objects such as buildings and non-building structures. The Eurocodes are a series of 10 European technical standards that provide a common approach to the structural design of buildings and other civil engineering works.

[11] The template can be found in the "One-Stop-Shop Data Handling Methodology" deliverable for the RenoWave project.

Benchmarking in the Baltic Sea Region

Based on the policy research done and the cooperation within the RenoWave project consortium, the **following indicators are proposed for the BSR benchmarking**:

- Primary energy use (kWh/m²/year)
  - ✓ For the residential building stock, the progress made towards hitting the target for 2030 set in the EPBD of at least a 16% decrease in primary energy consumption can also be evaluated. At the same time, 55% of the decrease is achieved by renovating the worst-performing residential buildings.

- Annual renovation rates: number and total floor area (m²)
  - ✓ For each building type
  - ✓ Worst-performing

- Final energy consumption (kWh/m²/year)
  - ✓ Shows the total energy consumed in order to meet the demand from all final end uses
  - ✓ Additionally, if it is possible to calculate/simulate the usable energy required for heating and ventilation purposes and to prepare domestic hot water in buildings, this measure will enable you to estimate the amount of energy lost due to building inefficiencies.

- EPC classes of the building stock
  - ✓ The new EPBD will make the EPC classes more harmonised across Member States, and the establishment of data based on the energy performance of buildings will also be linked to this.

The purpose of these indicators is to enable a simplified comparison in order to obtain an overview of the energy performance of the building stock in the BSR, since its member states would be required to collect this data on their building stock to prepare their national building renovation plans (NBRPs).

Questions remain as to which NUTS level (except 0 (national)) the data will be available and what contextual factors will accompany it. When benchmarking the building energy performance and the progress made towards meeting the targets set in the EPBD, it is important to complement the numbers with contextual indicators such as available governmental support options, public opinion, the effectiveness of the operating OSS, etc. The RenoWave project consortium has stressed the importance of placing the raw data in context and taking into account soft factors that have an enormous impact on facilitating building renovation. The wider benefits of improved building energy performance can also be benchmarked. For example, improved IEQ and, with it, better health and productivity of the occupants can become a second, more advanced step in a comprehensive comparison of the building stock performance.

Financing and support options

After setting energy efficiency targets and preparing the overview of data availability, it is worth looking into how to achieve the targets set. One of the first questions will most probably be how to finance the energy efficiency improvements. It may come in handy to look to available subsidy schemes and support options in your municipality, region or country. When considering the support options, it is worth looking for support at different levels (local, municipal, regional, national and international). Analysing the conditions and requirements for accessing these support options will help you to include important elements in the roadmap. The support options are often tied to energy performance, which in turn links to the data on buildings. Commercial and development banks may also offer loans for energy efficiency improvements, and it is worth exploring the support options that these offer.

There are also financing options at EU level that are worth looking at. Although these might not be able to finance the refurbishment itself, they might come in handy for awareness-raising events, capacity-building and other activities. Several funding streams can be used for financing building renovations. Amongst the most important are the European Structural and Investment Funds (ESIFs), the European Fund for Strategic Investments (EFSI), Horizon 2020, and the ELENA facility offered by the European Investment Bank (EIB). More specific financial instruments to support building renovations are also being developed between 2021 and 2027 under InvestEU. In addition, there is a new LIFE programme which has four sub-programmes, including one on the clean energy transition.

Support for homeowners extends beyond telling them how and where they can obtain financing. Raising awareness and educating people to change their general behaviour towards energy is fundamental but, of course, less readily quantifiable. Raising awareness is crucial to achieve results in terms of reducing energy consumption. Educating people about using energy sensibly enables them to change their attitude towards energy; it can affect energy consumption even without improving the actual condition of buildings.

Here, it remains critical to consider how households respond to energy efficiency improvements, what energy behaviours they adopt and how energy consumption is shaped by social and cultural norms. The so-called **rebound effect** explains the situation where expected energy savings are lower because of the growth in energy consumption. Consumption grows because the energy itself or the cost of energy or utilities becomes cheaper, meaning that it is used less wisely. A big role is played by people´s perception. After the energy efficiency of a building has been improved, residents usually expect lower costs, so they do not pay as much attention to their energy use as they did before, pushing up both their consumption and the amount they thus have to pay for their energy. The existence of the rebound effect is widely acknowledged, but the true nature and size of the effect are debated. Research has been done that analyses the effect of wealth and income, home ownership and rental housing on the extent of the rebound effect. The key takeaway here is that energy savings require both energy-efficient dwellings and well-aware households. The rebound effect should be considered in policymaking (Erdal Aydin et al., 2017) (Erdal Aydin et al., 2017).

Conclusion

This chapter offered a number of hints for developing a roadmap for data availability for the sources related to the building stock as well as for selecting potential indicators for target-setting. The need to set targets for the buildings and position them within the broader policy context has been discussed. It is relevant to start preparing the ground and making an initial analysis of the state of the building data as soon as more data-driven policy elements, such as the NBRPs, need to be established. The document also provides recommendations for indicators proposed by the RenoWave project consortium that enable a comparison of building energy performance.

Fortunately, access to the data is set to be simplified in the future as the EPBD will oblige Member States to set up a national database for the energy performance of their buildings that allows data to be gathered on both individual buildings and the overall national building stock.

Collection of methods for setting energy efficiency targets for the building stock

Energy efficiency targets are key to the EU's policy planning and the achievement of its climate objectives. This document focuses on the energy efficiency targets for the building stock, since buildings are responsible for 40% of final energy consumption and 36% of greenhouse gas emissions. The recent policy context encompasses the energy crisis, the extension of the EU-ETS system and the adoption of the new EPBD and EED. Implementing the new EPBD effectively will require greater attention to be paid to setting targets for the building stock. It focuses on the worst-performing buildings and establishes the trajectory for gradually renovating the stock of residential buildings, ensuring MEPSs and strengthening the role of the OSSs.

The RenoWave project mapped data availability/accessibility in the BSR countries. The following step was taken not only to obtain an understanding of the status quo but also to use this knowledge to propose a method for setting energy efficiency targets. The data mapping revealed that the situation regarding data availability is too varied across the partner countries (LV, LT, EE, SW, FI, PL, DE). Hence some project partners developed a method to set targets for their building stock depending on the input data available to them. The following chapter lists the methods used by the project partners based on the available data and the targets that the partners set for their individual contexts. Each method is described using the data used, providing the source and a description of the method in each case.

Method 1: Analysis of buildings

Association of Communes & Cities of Małopolska

Data used

Data from energy audits and building EPCs was used and was collected in the following categories:

- Building name/address
- Building area [m²]
- Heated usable area [m²]
- Cubic capacity [m³]
- Year of construction
- Number of floors
- Ventilation type
- HVAC system used in the building
- Apartment ownership index
- Ownership structure
- Thermal energy sources for domestic hot water

- Source of electricity
- Useful energy demand [kWh/m²/year]
- Final energy demand [kWh/m²/year]
- Final energy demand for domestic hot water [kWh/m²/year]
- Final energy demand for central heating [kWh/m²/year]
- Primary energy demand [kWh/m²/year]
- Energy class of the building's carbon emissions [Mg]

Data source

The data sources are documents collected by the municipalities.

Description of the method

Data that had already been generated based on the methodology for determining EPCs for buildings was incorporated, and the following indicators were also used:

- Final energy to useful energy ratio EK/EU (i.e. final energy/useful energy)
- EP difference of the building analysed in relation to the collective housing building WT2021 [kWh/m²/year]
- EP difference of the building analysed in relation to the collective housing building WT2021 [%]
- EP difference of the building analysed in relation to the public utility building WT2021 [kWh/m²/year]
- EP difference of the building analysed in relation to the public utility building WT2021 [%]

Different data analyses of the building structure and of the energy demand and carbon emissions resulted in the creation of a tool for analysing buildings against the background of technical conditions, thus enabling the worst-performing buildings to be identified.

Method 2: Primary energy under 100 kWh/m²

County Board of Dalarna

Data used

- Total number of buildings for main categories of building
- A list of all buildings
- Energy use per m^2 [kWh/m^2] (both primary energy and real energy use)

Data sources

- Data from the national building register https://www.sverigesfastighetsregister.se/
- Data from the national EPC register, collected by our own data code https://energideklarationsregistret.se/renowave

Description of the method

The starting point is to calculate how much energy is possible to use to meet certain primary energy criteria.

Discussions with real estate companies and energy experts suggested a reasonable level to reach without major investment and climate impact and what primary energy use this would equate to. (The conclusion reached was 100 in primary energy use.) Then, to calculate the effect, calculations were done of how much this would mean in terms of energy savings for the whole building stock, if the target for all buildings of under 100 kWh/m^2 were to be met.

Results of the target-setting

A target of under 100 kWh/m^2 in primary energy can be met without very significant investment, and meeting the target would bring more in energy savings than required under the EPBD.

Method 3: Determine energy use for the building stock of a designated area (neighbourhood) and potential for improving energy efficiency

Magistrat of the City Bremerhaven

Data used

- Basic data: building locations (ALKIS and LoD2), building class, usage (residential vs. industrial/ commercial)
- Energy data: sources of heating (oil, gas, district heating, solar, etc.), sources of electricity (conventional electricity mix, renewables, solar, etc.), energy demand (kWh/year), final energy consumption (kWh/year);
- Building data: insulation of roof, walls, windows, floors (U-value: w/(m^2K)

Data sources

This data was either already held by the municipality or was collected by the municipality from energy providers and grid operators, building associations and chimney sweeps. Knowing that building data is not publicly available in Germany and on account of GDPR, the data collected in the RenoWave project is highly confidential, and no Internet links can be given here.

Description of the method

Primary energy use was calculated first of all, which involved recording all renewable and non-renewable energy flows involved in extraction, conversion, transport and storage. These were combined into a specific primary energy factor that relates to the final energy consumption.
Then the carbon emissions of energy consumption were calculated. The impact indicator for the effects on climate change is referred to as the global warming potential (GWP). The GWP brings together the trace gases previously identified as causing the greenhouse effect as a meaningful indicator. For periods of 20, 100 and 500 years, the greenhouse warming effect of one kg of trace gas compared to one kg of CO_2 was determined and the conversion factor calculated. If the mass is known, therefore, the greenhouse effect can also be expressed in kg CO_2eq.
Taken together, both of these determine the final energy demand of the neighbourhood as well as the climate effect. Based on this, different scenarios for renovation and improving energy efficiency at individual building

level are calculated and then scaled up to neighbourhood level. This analysis of potential considers final energy, primary energy and greenhouse gas emissions.

Calculation example Bremerhaven „Alte Bürger“

	End energy	CO2-emissions	Primary energy
Buildings	17.837 MWh/a	5.031 t CO2/a	21.543 MWh/a
Electricity	1.021 MWh/a	421 t CO2/a	2.379 MWh/a
PV-Panels		490 t CO2/a	1.560 MWh/a
Solar thermal energy		83 t CO2/a	22 MWh/a
Total	18.859 MWh/a	6.025 t CO2/a	25.504 MWh/a
Total annually until 2030	2.357 MWh/a	753 t CO2/a	3.188 MWh/a

The total reduction in final energy by 2030 is 18,859 MWh, the reduction per year is 2,357 MWh. Using the building typological methodology

- a moderate refurbishment of all buildings can reduce the demand for thermal energy by 40% and the demand for electricity by 14%,
- effective refurbishment of existing buildings would reduce demand for heat by 75% and for electricity by 24%.

The potential reduction in emissions of greenhouse gases results from the building typological potential for energy savings in heat and electricity and the expansion of renewable energies. This potential amounts to 6,025 tonnes per year by 2030 (based on 2021). The annual reduction rate is 753 t/a.

Method 4: Access to reliable energy data

Vidzeme Planning Region

Data used

Data from energy audits and building EPCs was used.

Data was collected in the following categories:

- Building name/address
- Building area [m²]
- Heated usable area [m²]
- Year of construction
- Number of floors
- HVAC system used in the building
- Thermal energy sources for domestic hot water
- Source of electricity
- Final energy demand [kWh/m²/year]
- Final energy demand for domestic hot water [kWh/m²/year]
- Final energy demand for central heating [kWh/m²/year]
- Primary energy demand [kWh/m²/year]
- Energy class of the building carbon emissions [Mg]
- Energy losses

Data sources

The data mainly came from municipalities, building maintenance companies and energy providers. Limited general information can be found on the national building register (https://bis.gov.lv/en/). Specific data was collected through manual research and by reaching out directly to more than 100 HOMABs that applied for the thermographic method. This data includes the important indicator of heat losses. The thermographic method involved taking photographs of the buildings using a thermographic camera. This made the weak points of the buildings in terms of energy efficiency (i.e. the areas of heat loss) visible to their owners, who are now more aware of how energy efficient their buildings are and who can make more informed decisions about improving them.

Description of the method

A lack of data makes it hard to get an overview of the building stock and its current state. To be able to set concrete targets and define a strategy, therefore, the primary objective in Vidzeme was to access reliable building energy data. Data from energy audits, EPCs and the national building register facilitated the systematic collection of the necessary data. This data was gathered as part of a broader Strategic Plan for Energy and Climate Resilience for the Vidzeme region in 2024.

Method 5: Regional energy performance live map

Development Centre of Võru County

Data used

- Percentage of buildings with EPCs
- Percentage of buildings with an energy performance class of C or better
- Average final energy consumption of a building with a valid EPC
- Number of buildings in the “HOMABs” target group

Data sources

Estonian Building Registry and its open API: https://swaggerui.ehr.ee/

Description of the method

Existing data is collected for the region, and spatial attributes are already recorded in the Building Registry (i.e. a municipality code for each building). This is used to display data at municipality level. An online application synchronises the information with the Building Registry at regular intervals.

Buildings are sorted into groups according to their size (net area in m²) as per the Building Registry. No specific calculations are made.

The progress and status of the energy performance of buildings in different municipalities can be seen. This serves to provide transparency for the general public and inspiration for HOMABs.

Method 6: Identification of the worst-performing HOMABs

City of Lappeenranta

Data used

- Database of EPCs
- Percentage of buildings with an energy performance class of F or G
- Addresses and contacts of HOMABs in the energy performance class F or G
- Database of customers in Finland

Data sources

Database of EPCs in Finland: https://www.energiatodistusrekisteri.fi/

Database of customers in Finland: https://www.asiakastieto.fi/web/fi/

Description of the method

Energy advisor services operate as OSSs in Lappeenranta and in the South Karelia region. One of their main tasks is to promote the implementation by all stakeholders of energy efficiency measures. This method is geared towards identifying potential for energy savings, especially in the multi-apartment buildings owned by private households (HOMABs). The potential was identified by mapping and collecting existing data sources, which could facilitate an evaluation of the renovation requirements both in Lappeenranta municipality and in the whole province. The mapped data sources are publicly available, commercial or provided by authorities. Some are free of charge, while others require a fee to be paid or special access/a permit to be obtained before they can be studied. Furthermore, the data sources include both technical and socio-economic information on buildings and their occupants.

The mapping process identified a total of 41 data sources (18 public data sources, 4 commercial ones and 19 ones provided by authorities; 24 technical and 17 socio-economic data sources).

The worst-performing HOMABs (class F or G) were identified with the help of two databases. The EPC database helped to identify these HOMABs (17 in total for the region) and also enabled addresses to be found out. The named contacts for these HOMABs could be identified in the database of customers. The responsible entity (e.g. the municipality) could then initiate the whole long journey of the renovation process by first making contact with the decision-makers (board chairmen and members of the HOMAB).

Conclusion

The six methods presented for setting targets show various ways of arriving at targets for the building stock. Although all the methods use different indicators, the main ones common across the board are:

- Basic building data (e.g. location of the building)
- Energy demand and/or consumption.

As you can see, the project partners used additional types of data to arrive at a target-setting method that works in their contexts with different scopes. The approaches work on different scales – at regional level, at neighbourhood level – and the basis for all of this is analyses at building level.
The methods presented can be replicated depending on the available data.

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Annex 1

Template used for the Data Handling Methodology

Data for Building Stock	Source	Source Type	Access Type	NUTS Level	Indicator Weight	Data Availability	Data Reliability	Availability of Data for Individual Building	Availability of data per building type
Number of buildings									
Number of HOMABs									
Building area (m²)									
Building living area (m²)									
Year of construction									
Number of floors									
Type of HVAC systems used in buildings									
Housing ownership rate (%)									
Building ownership structure									
Primary energy source									
Usable energy (kWh/m²)									
Electricity production energy source									
Final energy consumption of the building stock [kWh/m²/year]									
Energy consumed for hot water usage (kWh/m²)									
Energy consumed by space heating (kWh/m²)									
Existent energy class of building [Letter]									
CO_2 emissions of the building stock [tonnes]									
Solar gain (kWh/m²)									
						%			

Annex 2

Data Sources and Availability Country by Country

Poland

Data for Building Stock	Source	Source Type	Access Type	NUTS Level	Indicator Weight	Data Availability	Data Reliability	Availability of Data for Individual Building	Availability of data per building type
Number of buildings	Baza Danych Obiektów Topograficznych (Topographic Objects Database) – BDOT10k, https://www.geoportal.gov.pl/	Public	Open	3	1%	1%	somewhat reliable	Yes	Yes
Number of buildings	CEEB Centralna Ewidencja Emisyjności Budynków (Central register of emissions of buildings) – https://zone.gunb.gov.pl/	Public	Restricted	3	2%	2%	very reliable	Yes	Yes
Number of buildings	Low-Emission Economy Plans in Municipalities	Public	Open	2	1%	1%	somewhat reliable	No	No
Number of HOMABs	Baza Danych Obiektów Topograficznych (Topographic Objects Database) – BDOT10k, https://www.geoportal.gov.pl/	Public	Open	3	1%	1%	somewhat reliable	Yes	Yes
Number of HOMABs	CEEB Centralna Ewidencja Emisyjności Budynków (Central register of emissions of buildings) – https://zone.gunb.gov.pl/	Public	Restricted	3	2%	2%	very reliable	Yes	Yes
Number of HOMABs	Low-Emission Economy Plans in Municipalities;	Public	Open	2	1%	1%	somewhat reliable	No	No
Building area (m^2)	Bank Danych Lokalnych (Local Data Bank) – https://bdl.stat.gov.pl	Public	Restricted	3	1%	1%	somewhat reliable	No	No

Building area (m^2)	Urząd Statystyczny w Krakowie (Statistical Office in Kraków) – https://krakow.stat.gov.pl	Public	Open	1	1%	1%	somewhat reliable	No	No
Building area (m^2)	Energy Performance Certificates	Other	Restricted	3	1%	1%	very reliable	Yes	Yes
Building area (m^2)	Low-Emission Economy Plans in Municipalities;	Public	Open	2	1%	1%	somewhat reliable	No	No
Building living area (m^2)	Energy Performance Certificates	Other	Restricted	3	2%	2%	very reliable	Yes	Yes
Building living area (m^2)	Low-Emission Economy Plans in Municipalities;	Public	Open	3	1%	1%	somewhat reliable	No	No
Year of construction	Low-Emission Economy Plans in Municipalities;	Public	Open	2	1%	1%	somewhat reliable	No	No
Year of construction	Energy Performance Certificates	Other	Restricted	3	3%	3%	very reliable	Yes	Yes
Year of construction	Low-Emission Economy Plans in Municipalities;	Public	Open	2	1%	1%	somewhat reliable	No	No
Number of floors	Energy Performance Certificates,	Public	Restricted	3	2%	2%	very reliable	Yes	Yes
Number of floors	Baza Danych Obiektów Topograficznych (Topographic Objects Database) – BDOT10k, https://www.geoportal.gov.pl	Public	Open	3	1%	1%	unreliable	Yes	Yes

Type of HVAC systems used in buildings	CEEB Centralna Ewidencja Emisyjności Budynków (Central register of emissions of buildings) – https://zone.gunb.gov.pl/	Public	Restricted	3	3%	3%	very reliable	Yes	Yes
Type of HVAC systems used in buildings	Energy Performance Certificates,	Other	Restricted	3	5%	5%	very reliable	Yes	Yes
Housing ownership rate (%)	Główny Urząd Statystyczny (Central Statistical Office) – https://stat.gov.pl/	Public	Open	1	1%	1%	unreliable	No	No
Building ownership structure	Główny Urząd Statystyczny (Central Statistical Office) – https://stat.gov.pl/	Public	Open	1	1%	1%	unreliable	No	No
Primary energy source	CEEB Centralna Ewidencja Emisyjności Budynków (Central register of emissions of buildings) – https://zone.gunb.gov.pl/	Public	Restricted	3	5%	5%	very reliable	Yes	Yes
Primary energy source	Energy Performance Certificates,	Other	Restricted	3	5%	5%	very reliable	Yes	Yes
Electricity production energy source	Distribution System Operator (in Małopolska TAURON Dystrybucja S.A.)	Commercial	Restricted	3	5%	5%	very reliable	Yes	Yes
Electricity production energy source	Energy Performance Certificates,	Other	Restricted	3	5%	5%	very reliable	Yes	Yes
Final energy consumption of the building stock [kWh/m²,year]	Energy Performance Certificates	Other	Restricted	3	0%	0%	very reliable	Yes	Yes
Final energy consumption of the building stock [kWh/m²,year]	District heating system operator	Commercial	Restricted	3	0%	0%	very reliable	Yes	Yes

Energy consumed for hot water usage (kWh/m²)	Energy Performance Certificates	Other	Restricted	3	10%	10%	very reliable	Yes	Yes
Energy consumed for hot water usage (kWh/m²)	District heating system operator	Commerci al	Restricted	3	7%	7%	very reliable	Yes	Yes
Energy consumed by space heating (kWh/m²)	Energy Performance Certificates	Other	Restricted	3	10%	10%	very reliable	Yes	Yes
Energy consumed for hot water usage (kWh/m²)	District heating system operator	Commerci al	Restricted	3	7%	7%	very reliable	Yes	Yes
Existent energy class of building [Letter]	Energy Performance Certificates	Other	Restricted	3	7%	7%	very reliable	Yes	Yes
CO_2 emissions of the building stock [tonnes]	Low-Emission Economy Plans in Municipalities;	Public	Open	2	1%	1%	somewhat reliable	No	No
CO_2 emissions of the building stock [tonnes]	Energy Performance Certificates	Other	Restricted	3	3%	3%	very reliable	Yes	Yes
Solar gain (kWh/m²)	Global Solar Atlas – www.globalsolaratlas.info;	Public	Open	1	1%	1%	somewhat reliable	No	No
Solar gain (kWh/m²)	Photovoltaic Geographical Information System – https://re.jrc.ec.europa.eu/pvg_tools/en/	Public	Open	1	1%	1%	somewhat reliable	No	No
					100%	100%			

Sweden

Data for Building Stock	Source	Source Type	Access Type	NUTS Level	Indicator Weight	Data Availability	Data Reliability	Availability of Data for Individual Building	Availability of data per building type	Data for Building Stock
Number of buildings						0%				
Number of HOMABs 1)	Alla bolag	Commercial	Open, Restricted	3	8%	8%	very reliable	No	Yes	Yes
Building area (m²)					8%	0%				
Building living area (m²)	SCB	Public	Open	3	2%	2%	very reliable	No	Yes	Yes
Year of construction	SCB	Public	Open	3	3%	3%	very reliable	No	Yes	Yes
Number of floors						0%				
Type of HVAC systems used in buildings						0%				
Housing ownership rate (%) 5)	SCB	Public	Open	3	7%	7%	very reliable	No	No, Yes	Yes
Building ownership structure						0%				
Primary energy source	Energimyndighet en	Public	Open	3	10%	10%	very reliable	No	Yes	Yes
Electricity production energy source						0%				
Final energy consumption of the building stock [kWh/m²,year]	Energimyndighet en	Public	Restricted, Open	3	10%	10%	somewhat reliable,	Yes, No	No, Yes	Yes

Energy consumed for hot water usage (kWh/m^2)						0%				
Energy consumed by space heating (kWh/m^2)						0%				
Existent energy class of building [Letter]	Boverket API-register	Public	Restricted		5%	5%	somewhat reliable	Yes	No	No
CO_2 emissions of the building stock [tonnes]						0%				
Solar gain (kWh/m^2)						0%				
Number of households in different kind of residential buildings (Single family detached house, Rental multi apartment building and Homeowned multiappartment buildings)	SCB	Public	Open		9%	9%	very reliable	No	Yes	Yes
Permanent or holliday house	SCB	Public	Open		7%	7%	very reliable, somewhat reliable	No	Yes	Yes
Number of households in homeowned multi appartments					3%	0%				
Real estate registration number	Fastighetsregistret i Gävle	Commerci	Open, Restricted			0%	very reliable	Yes	No	No
Year of construction	Boverket API-register	Public	Restricted		3%	3%	very reliable	Yes	No	No
Adress and contact information for individual HOMAB association	Alla bolag	Commerci	Open, Restricted		7%	7%	somewhat reliable	Yes	No	No
Number of apartments for individual HOMAB associations	Boverket API-register	Public	Restricted		3%	3%	very reliable	Yes	No	No

Final energy consumption for individual buildings [kWh/m²,year] (including heating, hot water, electricity)	Boverket API-register	Public	Restricted			0%	somewhat reliable	Yes	No	No
Total Energy consumption (including heating, hot water, electricity)	Energimyndigheten	Public	Open		10%	10%	somewhat reliable	No	Yes	Yes
Primar energy use 6)	Boverket API-register	Public	Open, Restricted		5%	5%	somewhat reliable	No , Yes	Yes, No	No
					100 %	**89%**				

Link to Building Register
SCB; https://www.statistikdatabasen.scb.se/pxweb/sv/ssd/START__EN/
Energimyndigheten https://www.energimyndigheten.se/statistik/den-officiella-statistiken/
Boverket https://www.boverket.se/sv/om-boverket/publicerat-av-boverket/oppna-data/publikt-api-for-energideklarationer/om-apiet/
Fastighetsregistret https://www.sverigesfastighetsregister.se/

1) HOMAB associations
2) Even if open, it can come with a cost. So, in that sense, it is a bit limited.
3) We have a municipal level, is lower than NUTS level 3.
4) For the different ownership types, not the technical type of buildings
5) Square meters of living area and number of households divided in ownership of multi-apartment buildings (Private company, publicly owned, owned by homeowner association)
6) Energy consumption per m² x primary energy data = primary energy use (taking in consideration how the energy source was produced). In all EPC defining what energy class it will be.

Lithuania

Data for Building Stock	Source	Source Type	Access Type	NUTS Level	Indicator Weight	Data Availability	Data Reliability	Availability of Data for Individual Building	Availability of data per building type
Number of buildings	https://www.registrucentras.lt/p/1075	Public	Open	1	10%	10%	very reliable	Yes	Yes
Number of HOMABs	https://www.registrucentras.lt/p/1075	Public	Restricted	1	10%	10%	very reliable	Yes	Yes
Building area (m²)	https://www.registrucentras.lt/p/1075	Public	Open	1, 3	9%	9%	very reliable	Yes	Yes
Building living area (m²)	https://www.registrucentras.lt/p/1075	Public	Open	1, 3	9%	9%	very reliable	Yes	Yes
Year of construction	https://www.registrucentras.lt/p/1091	Public	Open	3	9%	9%	very reliable	Yes	Yes
Number of floors	https://www.registrucentras.lt/p/1091	Public	Open	3	5%	5%	very reliable	Yes	Yes
Type of HVAC systems used in buildings	https://www.registrucentras.lt/p/1091	Public	Open	3	7%	7%	very reliable	Yes	Yes
Housing ownership rate (%)	Information is not available			1	0%	0%			
Building ownership structure	Not applicable, as all the apartments are privately owned				0%	0%			
Final energy consumption of the building stock [kWh/m²,year]	https://www.ssva.lt/registrai/pensreg/pensert_list.php	Public	Open	1	5%	5%	somewhat reliable	Yes	No

Energy consumed for hot water usage (kWh/m²)	https://www.ssva.lt/registrai/pensreg/pensert_list.php	Public	Open	1	5%	5%	somewhat reliable	Yes	No
Energy consumed by space heating (kWh/m²)	https://www.ssva.lt/registrai/pensreg/pensert_list.php	Public	Open	1	5%	5%	somewhat reliable	Yes	No
Existent energy class of building [Letter]	https://www.registrucentras.lt/p/1091	Public	Open	3, 1	6%	6%	somewhat reliable	Yes	Yes
CO_2 emissions of the building stock [tonnes]	https://www.ssva.lt/registrai/pensreg/pensert_list.php	Public	Open	1	5%	5%	somewhat reliable	Yes	No
Solar gain (kWh/m²)	Not available in general, and only for individual buildings, most likely in IP or EPC				0%	0%			
					85%	**85%**			

Link to Building Register
https://www.registrucentras.lt/
https://www.registrucentras.lt/en/

Estonia

Data for Building Stock	Source	Source Type	Access Type	NUTS Level	Indicator Weight	Data Availability	Data Reliability	Availability of Data for Individual Building	Availability of data per building type
Number of buildings	https://livekluster.ehr.ee/ui/ehr/v1/infoportal/buildingdata	Public	Open	3	10 %	10 %	very reliable	Yes	Yes

Number of HOMABs	https://kinnistusraamat.rik.ee/Avaleht.aspx	Public	Restricted	3	20 %	20 %	very reliable	Yes	Yes
Building area (m²)	https://livekluster.ehr.ee/ui/ehr/v1/infoportal/buildingdata	Public	Open	3	0%	0%	very reliable	Yes	Yes
Building living area (m²)	https://livekluster.ehr.ee/ui/ehr/v1/infoportal/buildingdata	Public	Open	3	5%	5%	somewhat reliable	Yes	Yes
Year of construction	https://livekluster.ehr.ee/ui/ehr/v1/infoportal/buildingdata	Public	Open	3	5%	5%	very reliable	Yes	Yes
Number of floors	https://livekluster.ehr.ee/ui/ehr/v1/infoportal/buildingdata	Public	Open	3	3%	3%	very reliable	Yes	Yes
Type of HVAC systems used in buildings	https://livekluster.ehr.ee/ui/ehr/v1/infoportal/buildingdata	Public	Open	3	3%	3%	unreliable	Yes	Yes
Housing ownership rate (%)	https://kinnistusraamat.rik.ee/Avaleht.aspx	Public	Restricted	3	10 %	10 %	somewhat reliable	Yes	Yes
Building ownership structure	https://kinnistusraamat.rik.ee/Avaleht.aspx	Public	Restricted	3	10 %	10 %	very reliable	Yes	Yes
Primary energy source	https://livekluster.ehr.ee/ui/ehr/v1/infoportal/buildingdata	Public	Open	3	0%	0%	somewhat reliable	Yes	Yes
Electricity production energy source	https://livekluster.ehr.ee/ui/ehr/v1/infoportal/buildingdata	Public	Open	3	0%	0%	somewhat reliable	Yes	Yes

Final energy consumption of the building stock [kWh/m²,year]	https://livekluster.ehr.ee/ui/ehr/v1/infoportal/buildingdata	Public	Open		10 %	10 %	somewhat reliable	Yes	Yes
Energy consumed for hot water usage (kWh/m²)					0%	0%			
Energy consumed by space heating (kWh/m²)					0%	0%			
CO_2 emissions of the building stock [tonnes]					5%	0%			
Solar gain (kWh/m²)					0%	0%			
					80 %	**75 %**			

Link to Building Register
https://livekluster.ehr.ee/ui/ehr/v1/infoportal/buildingdata

Latvia

Data for Building Stock	**Source**	**Source Type**	**Access Type**	**NUTS Level**	**Data Reliability**	**Availability of Data for Individual Building**	**Availability of data per building type**
Number of buildings	https://www.vzd.gov.lv/lv/registreto-buvju-skaits-sadalijuma-pa-galvenajiem-lietosanas-veidiem	Public	Open	0	very reliable	No	No
Number of HOMABs	https://www.vzd.gov.lv/lv/registreto-buvju-skaits-sadalijuma-pa-galvenajiem-lietosanas-veidiem	Public	Open	0	very reliable	No	No

Building area (m²)	• https://stat.gov.lv/lv/statistikas-temas/noz/buvnieciba/tabulas/buf010-dzivojamais-fonds-regionos-gada-beigas; • https://stat.gov.lv/en/statistics-themes/business-sectors/construction/tables/bue031c-commissioned-buildings-building-type https://data.stat.gov.lv/pxweb/en/OSP_PUB/START__NOZ__BU__BUE/BUE031c/table/tableViewLayout1/ https://stat.gov.lv/en/statistics-themes/business-sectors/construction/tables/bue031c-commissioned-buildings-building-type	Public	Open	0, 3	1	Yes	
Building living area (m²)	https://data.stat.gov.lv/pxweb/lv/OSP_PUB/START__POP__MA__MAS/MAS020/	Public	Open	0, 3	very reliable	No	
Year of construction	https://data.stat.gov.lv/pxweb/lv/OSP_PUB/START__POP__MA__MAS/MAS070/	Public	Open	0, 3	1	Yes	
Number of floors							
Type of HVAC systems used in buildings	• Boiler houses by type of fuel consumed (number) - https://data.stat.gov.lv:443/sq/17253 • Households using heat pumps and heat pump energy equipment, (%) https://data.stat.gov.lv:443/sq/17254	Public	Open	0	very reliable	No	
Housing ownership rate (%)	https://tradingeconomics.com/latvia/home-ownership-rate	Commercial	Open	0	somewhat reliable	No	
Building ownership structure	https://data.stat.gov.lv/pxweb/en/OSP_OD/OSP_OD__apsekojumi__energ_pat/EPM120.px/	Public	Open	0	very reliable	Yes	
Primary energy source	https://data.stat.gov.lv:443/sq/17326	Public	Open	0			
Electricity production energy source	https://data.stat.gov.lv/pxweb/lv/OSP_PUB/START__NOZ__EN__ENB/ENB140/table/tableViewLayout1/	Public	Open	0, 3	very reliable	No	
Final energy consumption of the building stock [kWh/m²,year]	https://building-stock-observatory.energy.ec.europa.eu/database/	Public	Open	0, 3	very reliable	Yes	
Energy consumed for hot water usage (kWh/m²)	https://data.gov.lv/dati/eng/dataset/bis_ygdi8jmgg-bneuijz7wiwq	Public	Open	0, 3	very reliabl	Yes	

Energy consumed by space heating (kWh/m²)	https://data.gov.lv/dati/eng/dataset/bis_ygdi8jmgg-bneuijz7wiwq	Public	Open	0, 3	very reliable	Yes	
Existent energy class of building [Letter]	https://data.gov.lv/dati/eng/dataset/bis_ygdi8jmgg-bneuijz7wiwq	Public	Open	0, 3	very reliable	Yes	
CO_2 emissions of the building stock	https://energy.ec.europa.eu/system/files/2021-01/lv_2020_ltrs_official_translation_en_0.pdf	Public	Open	0	somewhat reliable	Yes	
Solar gain (kWh/m²)	https://www.varam.gov.lv/sites/varam/files/content/files/19-10-2013-saules-energijas-izmant-tehnologijas-un-attistiba-latvija_andrejs_-snegirjovs.pdf	Private	Open	0.3	somewhat reliable	Yes	

Additional Available Data	**Source**	**NUTS-level**	**Indicator Weight**	**Data Reliability**	**Availability of Data per Building Type**
The number of registered buildings by main types of use (%)	https://www.vzd.gov.lv/lv/registreto-buvju-skaits-sadalijuma-pa-galvenajiem-lietosanas-veidiem	0		1	No
Final energy Consumption in household sector [ktoe]	https://ec.europa.eu/eurostat/databrowser/view/TEN00124/default/line?lang=en	0		1	No
Energy certificates register	https://bis.gov.lv/bisp/lv/epc_documents			1	Yes
Average energy resource consumption (kwh/m²)	https://data.stat.gov.lv/pxweb/lv/OSP_OD/OSP_OD__apsekojumi__energ_pat/EPM396.px/table/tableViewLayout1/	0		1	No
Distribution of households by average annual electricity consumption and dwelling type (%)	https://data.stat.gov.lv/pxweb/lv/OSP_OD/OSP_OD__apsekojumi__energ_pat/EPM395.px/table/tableViewLayout1/	0, 3		1	No
Boiler houses by type of fuel consumed (number)	https://data.stat.gov.lv:443/sq/17253	0		1	No
Households using heat pumps and heat pump energy equipment, %	https://data.stat.gov.lv:443/sq/17254	0		1	No
Energy Performance Aspects of Residential Buildings in Latvia	:10.2478/lpts-2023-0004			1	Yes
Energy sources consumed in households	https://data.stat.gov.lv:443/api/v1/lv/OSP_PUB/START/NOZ/EN/ENB/ENB050	0		1	No
Link to Building Register					
https://www.kadastrs.lv/					

Finland

Data for Building Stock	Source	Source Type	Access Type	NUTS Level	Indicator Weight	Data Availability	Data Reliability	Availability of Data for Individual Building	Availability of data per building type
Number of buildings	Energiatodistusrekisteri	Public	Open	3		0%	very reliable	Yes	Yes
	SIR	Commerci	Restricted	3		0%	very reliable	Yes	Yes
	Kiinteistotietopalvelut	Commerci	Restricted	3		0%	very reliable	Yes	Yes
	StatFin	Public	Open	3		0%	very reliable	No	Yes
	Paavo	Public	Open	3		0%	very reliable	No	Yes
	Rakennettu ymparisto	Commerci	Restricted	3		0%	very reliable	No	Yes
	Kaupunki - ja seutuindikaattorit	Commerci	Restricted	1		0%	very reliable	No	Yes
Building area (m^2)	Locus Trimble	Other	Restricted	3		0%	very reliable	Yes	Yes

	Kiinteisto-rakennus-ja-paikkatiedot	Other	Restricted	3		0%	very reliable	Yes	Yes
Building living area (m²)	Energiatodistusrekisteri	Public	Open	3	20%	20%	very reliable	Yes	Yes
	Kiinteistotietopalvelut	Commercial	Restricted	3		0%	very reliable	Yes	Yes
	Asuntojen hintatiedot	Public	Open	3		0%	very reliable	Yes	Yes
	Paavo	Public	Open	3		0%	very reliable	No	No
	Kiinteisto-rakennus-ja-paikkatiedot	Commercial	Restricted	3		0%	very reliable	Yes	Yes
	Rakennettu ymparisto	Commercial	Restricted	3		0%	very reliable	No	Yes
	Kaupunki - ja seutuindikaattorit	Commercial	Restricted	1		0%	very reliable	No	Yes
Year of construction	Energiatodistusrekisteri	Public	Open	3	10%	10%	very reliable	Yes	Yes
	SIR	Commercial	Restricted	3		0%	very reliable	Yes	Yes
	Kiinteistotietopalvelu	Commercial	Restricted	3		0%	very reliable	Yes	Yes

	KVKL hintaseurantapalvelu	Commerci	Restricted	3		0%	very reliable	Yes	
	Kiinteistotietopalvelut	Commerci	Restricted	3		0%	very reliable	Yes	Yes
	Metroc	Commerci	Restricted	3		0%	very reliable	Yes	Yes
	Asuntojen hintatiedot	Public	Open	3		0%	very reliable	Yes	Yes
	StatFin	Public	Open	3		0%	very reliable	No	Yes
	Kiinteisto-rakennus-ja-paikkatiedot	Commerci	Restricted	3		0%	very reliable	Yes	Yes
	Rakennettu ymparisto	Commerci	Restricted			0%	very reliable	No	Yes
Number of floors	Locus Trimble	Other	Restricted	3		0%	very reliable	Yes	Yes
	SIR	Commerci	Restricted	3		0%	very reliable	Yes	Yes
	KVKL hintaseurantapalvelu	Commerci	Restricted	3		0%	very reliable	Yes	

	Kiinteistotietopalvelut	Commerci	Restricted	3		0%	very reliable	Yes	Yes
	Metroc	Commerci	Restricted	3		0%	very reliable	Yes	Yes
	Asuntojen hintatiedot	Public	Open	3		0%	very reliable	Yes	Yes
	Rakennettuymparisto	Commerci	Restricted	3		0%	very reliable	Yes	Yes
Type of HVAC systems used in buildings	Energiatodistusrekisteri	Public	Open	3		0%	very reliable	Yes	Yes
	SIR	Commerci	Restricted	3		0%	very reliable	Yes	Yes
	Kiinteisto-rakennus-ja-paikkatiedot	Commerci	Restricted			0%	very reliable	Yes	Yes
Housing ownership rate (%)	Building manager of HOMAB	Other	Restricted	3		0%	very reliable	Yes	Yes
Building ownership structure	Building manager of HOMAB	Other	Restricted	3		0%	very reliable	Yes	Yes
	Huoneistotietojärjestelmä	Commercial	Restricted	3		0%	very reliable	Yes	Yes

	Kiinteisto-rakennus-ja-paikkatiedot	Other	Restricted	3		0%	very reliable	Yes	Yes
	Kiinteistotietopalvelu	Other	Restricted	3		0%	very reliable	Yes	Yes
Primary energy source	Energiatodistusrekisteri	Public	Open	3	30%	30%	very reliable	Yes	Yes
	SIR	Commercial	Restricted	3		0%	very reliable	Yes	Yes
	KVKL hintaseurantapalvelu	Commerci	Restricted	3		0%	very reliable	Yes	
	Kiinteistotietopalvelut	Commerci	Restricted	3		0%	very reliable	Yes	Yes
Electricity production energy source	Each apartment owner has own agreement with some electricity provider company	Other	Restricted	3		0%	unreliable	No	No
Final energy consumption of the building stock [kWh/m²,year]	Energiatodistusrekisteri	Public	Open	3	20%	20%	very reliable	Yes	Yes
Energy consumed for hot water usage (kWh/m²)	Building manager of HOMAB	Other	Restricted	3		0%	very reliable	Yes	Yes
Energy consumed by space heating (kWh/m²)	Energiatodistusrekisteri	Public	Open	**3**		0%	very reliable	Yes	Yes

Existent energy class of building [Letter]	Energiatodistusrekisteri	Public	Open	3	20%	20%	very reliable	Yes	Yes
	SIR	Commerci	Restricted	3		0%	very reliable	Yes	Yes
	KVKL hintaseurantapalvelu	Commerci	Restricted	3		0%	very reliable	Yes	
	Asuntojen hintatiedot	Public	Open	3		0%	very reliable	Yes	Yes
CO_2 emissions of the building stock [tonnes]	N/A	Other	Restricted	0		0%	very reliable	No	No
Solar gain (kWh/m²)	Energiatodistusrekisteri	Public	Open	3		0%	somewhat reliable	Yes	Yes
Number of Households					0%				
Income level									

	https://yle.fi/a/74-20055665	Public	Open	3	25%	25%	very reliable	No	No
	Vipunen	Public	Open	2		0%	somewhat reliable	No	No

	[Kuntien avainluvut]()	Public	Open	3		0%	very reliable	No	No
	[StatFin]()	Public	Open	3		0%	very reliable	No	Yes
	[Paavo]()	Public	Open	3		0%	very reliable	No	No
	https://www.esaimaa.fi/paikalliset/6464816	Public	Open	3		0%	very reliable	No	No
Education level	https://liitto.ekarjala.fi/tietopankki/tilastot/maakuntakortti/	Public	Open	3	10%	10%	very reliable	No	No
	[Vipunen]()	Public	Open	2		0%	somewhat reliable	No	No
	[Työllisyyskatsaus]()	Public	Open	3		0%	very reliable	No	No
	[Kuntien avainluvut]()	Public	Open	3		0%	very reliable	No	No
	[Paavo]()	Public	Open	3		0%	very reliable	No	No
	[StatFin]()	Public	Open	3		0%	very reliable	No	Yes
	[Sijoittumispalvelu]()	Commercial	Restricted			0%	very reliable	No	No
Employment rates (%)	https://www.temtyollisyyskatsaus.fi/graph/tkat/tkat.aspx?ely=05&lang=fi	Public	Open	3	25%	25%	very reliable	No	No
	[Työllisyyskatsaus]()	Public	Open	3		0%	very reliable	No	No

	Kuntien avainluvut	Public	Open	3		0%	very reliable	No	No
	StatFin	Public	Open	3		0%	very reliable	No	Yes
Energy-poor population (%)	https://energy-poverty.ec.europa.eu/system/files/2023-01/EPAH_Energy%20Poverty%20National%20Indicators%20Report_0.pdf	Public	Open	1	20%	20%	very reliable	No	No
	https://kiinteistonvalitysala.fi/tilastot/	Public	Open	2		0%	very reliabl	No	No
Average property value in the district (pre-renovation)	Etuovi	Public	Open	3	10%	10%	very reliable	Yes	Yes
	https://op-koti.fi/myytavat/asunnot/lappeenranta?cityId=405	Public	Open	3		0%	very reliable	Yes	Yes
Housing prices (house price index)	Etuovi	Public	Open	3	10%	10%	very reliable	Yes	Yes
	Asuntojen hintatiedot	Public	Open	3		0%	very reliable	Yes	Yes
	StatFin	Public	Open	3		0%	very reliable	No	Yes

Germany

Data for Building Stock	Source	Source Type	Access Type	NUTS Level	Indicator Weight	Data Availability	Data Reliability	Availability of Data for Individual Building	Availability of data per building type	Comments

Number of buildings	Liegenschaftskataster (no link) and Strukturdatenatlas https://www.bremerhaven.de/sixcms/media.php/204/Bremerhavener+Strukturdatenatlas+komplett%2C+Stand+01.pdf	Public	Open, Restricted	3	1%	1%	very reliable	Yes	No	
Number of HOMABs	Statistisches Landesamt Bremen (old data from Zensus 2011) https://www.statistik-bremen.de/bremendat/statwizard_step1.cfm	Public	Open	3	1%	1%	very reliable	No	No	very old data, availabe on city level
Building area (m²)	Bauakten, Bauordnungsamt (no link)	Public	Restricted	3	4%	4%	very reliable	Yes	No	accessible for owners and muicipality
Building living area (m²)	Bauakten, Bauordnungsamt (no link)	Public	Restricted	3	4%	4%	very reliable	Yes	No	accessible for owners and muicipality
Year of construction	Bauakten, Bauordnungsamt (no link)	Public	Restricted	3	5%	5%	very reliable	Yes	Yes	
Number of floors	Bauakten, Bauordnungsamt (no link)	Public	Restricted	3	4%	4%	very reliable	Yes	No	
Type of HVAC systems used in buildings	Bericht der Landesinnung der Schornsteinfeger (availability expected in 2024)	Other	Restricted	3	10%	10 %	very reliable	Yes	No	first report expected in 2024, old data on heating sources available at StaLa
Housing ownership rate (%)	not available - own survey needed				3%	3%	somewhat reliable			own data collection necessary
Building ownership structure	Grundbucheinträge (no link)	Public	Open, Restricted	3	3%	3%	very reliable	Yes	No	

Primary energy source	Bericht der Landesinnung der Schornsteinfeger (availability expected in 2024)	Commercial	Restricted	3	10%	10 %	somewhat reliable	Yes	No	Access might be possible under new legislation 2024
Electricity production energy source	Energy grid operator wesernetz Bremerhaven GmbH contracted until 2032 (no link)	Commercial	Restricted	3	10%	10 %	somewhat reliable	Yes	Yes	Access might be possible under new legislation 2024
Final energy consumption of the building stock [kWh/m², year]	Energy grid operator wesernetz Bremerhaven GmbH contracted until 2032 (no link)	Commercial	Restricted	3	10%	10 %	very reliable	Yes	Yes	Access might be possible under new legislation 2024
Energy consumed for hot water usage (kWh/m²)	Energy grid operator wesernetz Bremerhaven GmbH contracted until 2032 (no link)	Commercial	Restricted	3	4%	4%	somewhat reliable	Yes	No	Access might be possible under new legislation 2024
Energy consumed by space heating (kWh/m²)	Energy grid operator wesernetz Bremerhaven GmbH contracted until 2032 (no link)	Commercial	Restricted	3	10%	10 %	very reliable	Yes	Yes	Access might be possible under new legislation 2024
CO_2 emissions of the building stock [tonnes]	CO_2 Bericht Land Bremen https://www.statistik.bremen.de/themen/energiestatistik-energiebilanzierung-und-co2-emissionen-1914	Public	Open	3	10%	10 %	very reliable	No	No	not differentiated
Existent energy class of building [Letter]	Argis - paid access only	Commercial	Restricted	3	1%	1%	very reliable	Yes	No	Access might be possible under new legislation 2024
					100 %	**100%**				
Solar gain (kWh/m²)	Energy grid operator wesernetz Bremerhaven GmbH contracted until 2032 (no link) and https://dashboard.wattbewerb.de/superset/dashboard/wattbewerb_kommunal/?preselect_filters=%7B%7D&standalone=true&native_filters_key=null or for potentials https://solardach.bremerhaven.de/de/	Public	Open	3	10%	10 %	very reliable	No	No	only shows Energy produced by solar panels for whole city

One-Stop-Shop extended model to increase the multi-apartment building stock renovation in the Baltic Sea Region

Project «One-Stop-Shop extended model to increase the multi-apartment building stock renovation in the BSR» (RenoWave) is implemented with the support from the EU funding Programme Interreg Baltic Sea Region 2021 -2027. The project develops One-Stop-Shop extended model specifically designed for the multi-apartment buildings in Baltic Sea Region countries. Partner countries - Sweden, Finland, Poland, Germany, Lithuania and Estonia.