Process for monitoring the decarbonization of the building stock

Contents

PREFACE

This report is a part of the Nordic Sustainable Construction programme initiated by the Nordic Ministers of Construction and Housing and funded by Nordic Innovation. The programme contributes to the Nordic Vision 2030 by supporting the Nordics in becoming the leading region in sustainable and competitive construction and housing with minimised environmental and climate impact.

The programme supports the green transition of the Nordic construction sector by creating and sharing new knowledge, initiating debates in the sector, creating networks, workshops and best practice cases, and facilitating Nordic harmonisation of regulation for buildings' climate impact.

The programme runs from 2021-2024 and consists of the following focus areas:

Work package 1 – Nordic Harmonisation of Life Cycle Assessment

Work package 2 – Circular Business Models and Procurement

Work package 3 – Sustainable Construction Materials and Architecture

Work package 4 – Emission-free Construction Sites

Work package 5 – Programme Secretariat and Capacity-Building Activities for Increased Reuse of Construction Materials

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Nordic Sustainable Construction

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Summarized reflections/recommendations

To be added

1 Introduction

The purpose of this report is to conduct a comprehensive analysis of appropriate methods and approaches for monitoring decarbonization in the Nordic countries. In this part of the report, two sets of recommendations for monitoring the decarbonization of the building stock in the Nordic countries will be developed. One will be based on existing and available data. Next, recommendations including new data or alternative environmental modeling approaches will be developed.

We will investigate the databases and information sources from each nation, and assess the quality of information they provide. This analysis will provide essential information on which databases can be utilized for different monitoring approaches.

Additionally, we will examine various environmental building stock modeling approaches that can be employed with the existing databases. This will enable us to identify the most suitable method for carbon monitoring in the building stock of the Nordic countries, using the existing database landscape.

Finally, we will develop recommendations for carbon monitoring methods with new data. The recommendations will serve as valuable guidance for policymakers, organizations, and stakeholders in their collective efforts to promote a more sustainable and environmentally responsible buildings sector.

2 Methodology

2.1 Identify the current database landscape and key attributes to monitor the decarbonization of the building stock

To develop recommendations for monitoring based on existing data, the existing data needs to be uncovered and mapped out. To identify the existing data landscape, we will conduct a thorough investigation of databases and other relevant information sources containing data on building characteristics, operations, materials, and GHG emissions related to these, available in each nation.

Although they may not be structured in a typical database format, all data sources (structured databases, statistic banks, websites, schemes, etc.) that contain useful information for the objective, will be referred to as a database in this report.

We will create a database inventory that summarizes the databases and information sources available in each Nordic country. This inventory will be a valuable resource for identifying which data can be used for monitoring decarbonization in the building stock and will inform the development of our recommended monitoring approach.

Identifying the attributes useful for monitoring the decarbonization of the building stock in the Nordic countries is a critical step in developing the recommendations for a monitoring approach. To identify these attributes, we will first review the current literature on decarbonization monitoring in the building stock. Once we have identified the key attributes, we will evaluate and categorize the existing databases and information sources to determine which of these attributes are available in the existing data sources.

2.2 Recommendation for environmental monitoring of the building stock with existing data

Based on the database and attribute mapping analysis, we will recommend an approach for monitoring the decarbonization of the building stock. We will distinguish between existing building stock and added building mass to the building stock. Recommendations for measuring the embodied carbon intensity level of the existing building stock are not included in this report. The added building mass will also be referred to as material flow in the building stock and includes newly constructed buildings and renovations.

Limitations or challenges that may arise from our proposed approach will be documented. Based on our findings, we will provide recommendations for addressing these challenges to develop a good and effective approach that can be applied across all Nordic countries.

2.3 Recommendations for new data for environmental buildings stock monitoring

To propose recommendations for new data collection for monitoring the decarbonization of building stock in the Nordic countries, we will first assess any limitations and challenges associated with the existing databases and related approaches. In addition, we will also investigate whether constructing new data or implementing alternative environmental modeling approaches could be more effective in addressing these limitations. Based on our analysis, we will recommend specific data collection methods or databases that can be utilized to address any gaps in the current data sources.

3 Overview of the existing database landscape

This section aims to offer a detailed overview of the databases and other relevant information sources, that have been gathered. The objective here is to ensure that readers gain a deep understanding of the data sources at our disposal.

In Table 3.1, a summary that lists the names of the databases used in our research is presented. Together with the country abbreviation, the numbers 1-8 create a unique identifier (e.g. DK1) for each database which will be used to refer to the databases going forward in the report. For a more comprehensive and detailed overview, including the attributes and characteristics of each database, please refer to Appendix A.

Table 3.1. *Databases and other relevant information sources containing data on building characteristics, operations, building materials, and GHG emissions related to these, are available in each nation.*

	DENMARK (DK)	ESTONIA (EST)	ICELAND (ICE)	FINLAND (FIN)	NORWAY (NOR)	SWEDEN (SWE)
1	**DK1** BBR - Building and Housing Register	**EST1** Estonian Building Register (EBR)	**ICE1** Mannvirkjaskrá (Building register)	**FIN1** Climate Database	**NOR1** The land register	**SWE1** Property register
2	**DK2** FBB - Protected and listed buildings	**EST2** Land Register /Immovables Register	**ICE2** Fasteignaskrá (Property register)	**FIN2** Energy certificate database	**NOR2** Statistics Norway (Statistisk Sentralbyrå)	**SWE2** Building register
3	**DK3** Waste data system (ADS)	**EST3** Statistic Estonia	**ICE3** Statistics Iceland	**FIN3** Registry of Finnish Heritage buildings	**NOR3** Cultural heritage search (Kulturminnesøk)	**SWE3** Climate Database
4	**DK4** Energy label	**EST4** JATS	**ICE4** Data library of The National Energy Authority (Orkustofnun)	**FIN4** Land, property, and ownership registry	**NOR4** Energy rating (energimerke)	**SWE4** Energy declaration register
5	**DK5** Building archive (Byggesagsarkiv)	**EST5** PLANK - Planning database	**ICE5** Veitur Utilities	**FIN5** Statistical information on buildings, land, and everything	**NOR5** GeoNorway - Listed buildings (freda bygninger)	**SWE5** SCB - Statistics Sweden
6	**DK6** LCAbyg component library	**EST6** Emission factors for building materials	**ICE6** Úrgangstölfræði	**FIN6** Built environment information data	**NOR6** Case inspection (Saksinnsyn)	**SWE6** Energiläget
7	**DK7** Building regulation 2018 (BR18) Appendix 2 table 7	**EST7** Geoportal	**ICE7** GreenBookLive		**NOR7** OneClickLCA	**SWE7** Boverkets Klimatdeklaration sregister
8	**DK8** Danish statistics				**NOR8** DiBK limit values tool	**SWE8** BM Tool

3.1 Denmark

The Building and Housing Register (BBR) contains information about all buildings and residences in Denmark, including their location, usage, size, and age. This information can be used to create building stock models that consider the spatial distribution of buildings, their usage, and age. However, the responsibility for data input lies with the building owner, which can result in limited validity of data, particularly for existing buildings. This is because owners lack the incentives and competencies needed to update the data. Additionally, the register of Protected and listed buildings (FBB) includes detailed information about the material composition of protected and listed buildings, which could be used to define building techniques from different periods. Nevertheless, this database only applies to listed and protected buildings, which comprise a small portion of all buildings in Denmark. Furthermore, the FBB data relies on the BBR data, which implies that it faces the same challenges as the BBR data.

The Waste Data System (ADS) provides information about waste streams in Denmark, which could be used to estimate the quantity and type of waste (materials) generated from building construction and demolition activities.

The Energy Labeling database contains information on the energy consumption of buildings in Denmark. It is maintained by the Ministry of Climate, Energy, and Utilities and is publicly accessible for free. Energy labeling of buildings can only be carried out by certified companies. The database is updated only when the building is sold or rented out, which means that any renovations made to the building in the meantime will not affect the energy label. This results in outdated data.

The Building archive (Byggesagsarkiv) contains all documents related to building permissions from the time of erection and throughout the building life, including drawings with build-up details and material descriptions, calculations, and simulations. It is managed by the Municipalities, represented by the umbrella organization Kommunernes Landsforening. The database is publicly accessible for individual cases, with no access to the entire database, and is free of charge.

The Danish Statistics/Statbank database provides statistical data on the population, economy, and society of Denmark. It is managed by Statistics Denmark and is publicly accessible for free. It includes generic Danish data related to building stock, building type, area, electricity mix, heating measured, and waste from households, which could be used to estimate the future demand for buildings and their usage.

The LCAbyg component library provides typical component build-ups for Danish buildings, which could be used to estimate the material composition and environmental impact of the building stock. Building Regulation 2018 (BR18) Appendix 2 Table 7 presents conservative emissions data for construction products used in Denmark, which could be used to estimate the environmental impact of building materials.

3.2 Iceland

Mannvirkjaskrá (Building Register) and Fasteignaskrá (Property Register) are a compilation containing a wide range of information on buildings including size, properties, permits, audits, and more. The Building Register is currently in the process of implementing an entry for LCA results, which will be useful once implemented in 2025 for creating aggregated building stock models that consider the

carbon footprint of buildings. The two databases complement each other well, though combining them could potentially streamline the process of creating such models.

Statistics Iceland collects and disseminates data on the economy and society, including the construction of residential buildings in Iceland and the capital region. This information could be used to identify trends in building construction and energy use over time, which could be useful for creating aggregated building stock models. The data is typically updated once a year.

The Veitur Utilities database contains information on energy use in buildings in the capital area and southwest Iceland, including hot water, electricity, and water use. This information could be useful for creating aggregated building stock models that consider the energy and water use of buildings in these regions. Currently, the data has not been made available to the public. The process of updating these devices into newer smart-meter models is ongoing.

3.3 Estonia

The Estonian Building Register (EBR) is a national database that allows construction-related documents to be submitted and processed. It contains data on both existing and planned buildings, such as building permits, construction notices, use permits, energy labels, heating types, material descriptions, areas, and years. The building owner is responsible for data input, but any changes are overseen by the Building Register. The database is updated once per working day and is available through an API. As the responsibility for data input lies with the building owner, the quality of the data may be compromised, resulting in information that is not always accurate or up to date.

The Land Register, also known as the Immovables Register, includes cadastral data, owners, and restrictions, and allows for checking mortgages over property data. It is maintained by the Tartu County Court, Land Registry, and Registration Department. The database is updated once per working day and is available through an API.

Statistics Estonia tracks changes in society and offers information important for the demographic, social, economic, and environmental development of Estonia. The data collected by Statistics Estonia are necessary for making development plans and projections, for policy planning, scientific and applied research, and for making informed decisions. The database contains multidomain statistics, including population and housing census, and is updated annually, depending on the dataset. Although the dataset is national and therefore dependable, the fact that it is only updated annually means that it may be outdated for the majority of the year.

The Emission factors for building materials database is a draft method of Estonian building CO2 calculations that was published along with a calculator that includes an initial database for generic building materials emission factors. The database is created by Tallinn University of Technology and is being updated within the LIFE IP BuildEST project[1].

3.4 Finland

The Finnish Climate database provides conservative emissions data for construction products used in Finland as well as for energy and fuel. If you are making a climate declaration, you must use data from

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[1] https://kliimaministeerium.ee/en/buildest

this database. The database is free and available to the public. The content is also available via an API.

The energy certificate database provides energy declarations for all buildings in Finland. The energy declaration is a document that shows how much energy a building uses when it is in use. The energy declaration is carried out by a certified energy expert who collects information about the building, carries out an energy inspection, and submits the completed energy declaration to the system. The database is free and available to the public in CSV format on the website.

The Registry of Finnish Heritage Buildings provides a database of all heritage information from archaeology to buildings. The Finnish Heritage Agency is responsible for protecting environments with cultural history value, archaeological culture heritage, and architectural heritage, collects and presents a culture-historical national collection, studies material cultural heritage, and supports and develops the museum field nationally. The database is for the most part free and available to the public, in various file types and webpage formats on the Finnish Heritage Agency's website, some information requires an official inquiry. The content is also available via an API that includes drawings, and material, which could be useful in the monitoring of decarbonization in the building stock.

Land, property, and ownership registry provides information about all buildings, apartments, and residences in Finland. The property register is Finland's official register of how the land in the country is divided and who owns what. The database is free and available to the public in various formats, including maps, topographics, aerial photos, etc., on the National Land Survey of Finland's website. Some information requires an official inquiry. The content is also available via an API that includes building and ownership information, addresses, buildings, properties, land rights, soil, natural risk zones, and enrollment information.

Statistical information provides data on buildings, energy consumption, building type, living types, and classifications. The data is available in the form of data sheets and maps on the Statistics Finland website. The database is free and available to the public in various formats.

3.5 Norway

The land register is Norway's official property register and contains information about property limits, areas, buildings, housing, and addresses. The Norwegian Mapping Authority manages this database, which is continuously updated and available for free on its website. However, the information is limited and cannot be downloaded for several properties.

Statistics Norway is the national statistical institute of Norway and provides official statistics related to the economy, population, and society at national, regional, and local levels. They maintain a building statistics database that includes information about building stock, construction year, number of buildings, construction cost for residential buildings, waste from buildings and construction, and energy mix. This database is available for free and allows users to filter information and show different parameters. It is also possible to download stats in .xlsx and. CSV formats.

Kulturminnesøk is a website managed by The National Antiquary that provides information about cultural environments, cultural monuments, and landscapes. It contains information on over 220,000 objects, including listed buildings, listed cultural environments, world heritage sites, churches, archaeological cultural monuments, and underwater cultural monuments. The information is presented

in a map that is easy to understand and search for different parameters. Data includes building type, material description, owner, and year. This information is available for free. However, this database is limited to cultural buildings and monuments, which constitute a minor fraction of all buildings in Norway.

Energimerke from Enova manages the energy rating database, which contains data on all issued energy certificates and is updated in real time. The database includes information about energy rating, the number of energy certificates by year, building category, heating rating, registration type, building technical regulations (TEK), and national carbon emissions from all sectors. The database is available for free on Enova's website and is updated in real time.

The Planning and Building Agency of Oslo municipality manages the case inspection (Saksinnsyn) database, which contains documentation from construction matters, planning matters, property matters, and lift matters in Oslo municipality. The database includes information about permits, building drawings, technical information about the buildings, and owner information. This information is available for free on the municipality's website, but users are required to log in with their number to access the information.

OneClickLCA is an automated life cycle assessment software for the construction industry that includes a tool called carbon designer that generates reference buildings that reflect typical building element compositions and typical environmental factors for materials. This software is available for a fee and includes a tool with an attached climate database for building materials. It should be noted that one-click LCA is not specifically tied to Norway's building industry.

Finally, the Directorate for Public Procurement assistance manages the DiBK limit values tool that shows limit values per different types of buildings (A1-A3, A4, and B4 in kg CO2e/m2). This tool is based on typical buildings, and the information is available for free on DiBK's website. However, it is not a database as such but rather built on a large amount of literature studies, that supports the discussion of a starting point for limit values.

3.6 Sweden

The Swedish Property Register is an official register that provides information about the land division and ownership of buildings and residences in Sweden. It includes details about buildings, such as their location, usage, size, and age, and is managed by the Land Survey, which is responsible for the Property Register. The register is structured and can be accessed by the public for free, with a fee added for larger extracts.

The Building Register is a national information system that contains information about the built cultural heritage, including protected monuments and churches. The register is managed by the National Antiquities Office and is accessible to the public for free. It includes details such as facade and roof materials, the number of floors, and a material description, which could be useful in the monitoring of carbonization in the building stock. However, this only applies to cultural buildings and not the entirety of buildings in Sweden.

The Climate Database, managed by the Swedish National Board of Housing, Building, and Planning, presents conservative emissions data for construction products used in Sweden, templates for use in calculating A4-A5 in the regulated climate declarations. It is accessible to the public for free and

includes climate impact for transports for the generic construction products included in the database, waste of construction products, and different types of energy and fuel use.

The Energy Declaration Register is a structured database managed by the Swedish National Board of Housing, Building, and Planning that provides energy declarations for rental properties, and residential or commercial premises. The energy declaration gives information about the building's energy use, promoting efficient energy use and a good indoor environment in buildings. It includes all commercial buildings since they have to update their energy declaration every 10th year, but only residential buildings that have been sold after 2009. The database is continuously updated and accessible to the public for free.

Statistics Sweden is responsible for official statistics and develops, produces, and disseminates statistics on a variety of subjects including housing, construction, and building. It provides general statistics, housing and rent data, real estate prices and registrations of title, and statistics on building permits for housing and non-residential buildings. The database is updated Monday to Friday at 8 am.

The Swedish Energy Agency publishes Energiläget once a year, which gives an overall picture of the energy area in Sweden and its development, including energy usage in buildings. The statistic is presented in historic time series from the 1970s and is accessible to the public for free in PDF, Excel, and PPT formats.

The Swedish National Board of Housing, Building, and Planning maintains Boverkets Klimatdeklarationsregister, a register that contains all climate declarations. The register is closed to the public, but it is possible to request a separate climate declaration from Boverket as a public document.

BM (Byggsektorns miljöberäkningsverktyg) is a tool used to calculate the climate impact of a building (A1-B7), managed by the Swedish environmental research institute, IVL. The tool gives access to a database with climate data from different sources, including Boverkets database, BM's own database for building materials and their associated carbon intensity. The tool is accessible to the public for free with a simple license.

4 Identifying key attributes to monitor the decarbonization of the building stock

A diverse array of attributes was identified in the reported databases and other sources of information. They were classified and condensed to the following key attributes that were found relevant for aggregated building stock modeling:

- **Owner**
  Knowing the ownership of buildings is essential for assessing the incentives and decision-making processes behind energy efficiency and sustainability. Different owners may have varying priorities, budgets, and motivations, which can affect the environmental performance of buildings. Owners can be categorized as privately owned, government-owned, or organizationally owned.

- **Year**
  The year of construction provides insights into the age of buildings and their compliance with historical and contemporary building codes and environmental standards. Older buildings may have different energy efficiency characteristics compared to more recently constructed ones.

- **Materials**
  The materials used in construction have a substantial impact on a building's environmental footprint. Materials can vary in terms of embodied energy, carbon emissions, and durability.

- **Building type**
  Different building types (e.g., residential, commercial, industrial) have distinct energy consumption and emissions profiles. Modeling building stock requires categorizing buildings into types to estimate environmental impacts accurately.

- **Area**
  The size or area of a building is a fundamental parameter that influences its energy use and embodied emissions. Larger buildings tend to consume more energy and have a more substantial environmental impact, so area data is critical for modeling.

- **Embodied emissions**
  Embodied emissions refer to the carbon emissions associated with construction materials frequently used in the country. These emissions are vital for assessing the total environmental impact of a building.

- **Operational emissions**
  Operational emissions represent the ongoing carbon emissions resulting from the day-to-day use of a building, including heating, cooling, ventilation, water, and electricity. These emissions are a significant contributor to a building's environmental impact.

Figure 4.2 illustrates the identified key attributes through a hierarchical tree model, showcasing their interrelation with the overarching objective of monitoring the decarbonization progress of the building stock. These attributes have been categorized into either "building stock"-descriptors or "emission"-descriptors.
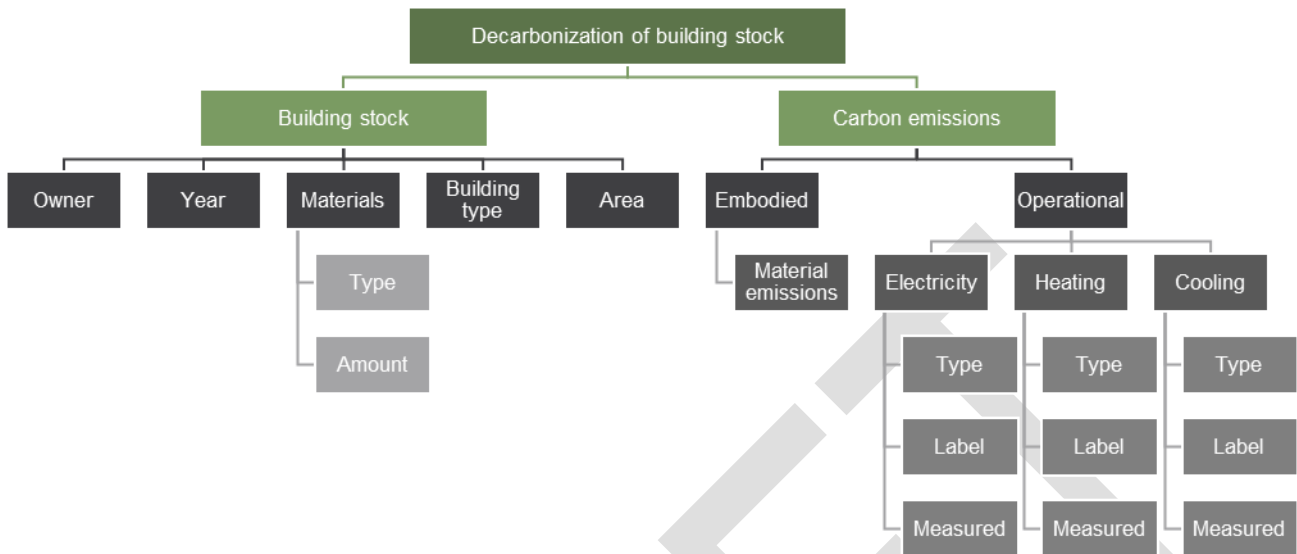
Figure 4.1: *Key attributes derived from the databases presented in a relational tree model*

6 Mapping and assessing the databases concerning key attributes

Each of the databases was carefully mapped following the key attributes presented in Figure 4.2. A summary of this mapping is presented in Table 4.3.

For a more detailed representation of the database mapping, showcasing each country, reference can be made to the individual tree diagrams featured in Appendix B. These diagrams offer insight into how each country's database mapping aligns with the overarching framework.

Table 6.1.: *Databases mapping concerning key attributes*

		DENMARK (DK)	ICELAND (ICE)	ESTONIA (EST)	FINLAND (FIN)	NORWAY (NOR)	SWEDEN (SWE)
Building stock	**Owner**	DK1	ICE1	EST1	FIN4	NOR1	SWE1
			ICE2	EST2			
	Year	DK1	ICE1	EST1	FIN2	NOR2	SWE1
		DK8	ICE2	EST3	FIN3	NOR3	SWE2
			ICE3		FIN4	NOR5	
					FIN5		
	Materials	DK1	ICE1	EST1	FIN4	NOR6	SWE2
		DK2	ICE2	EST4	FIN5		
		DK3			FIN1		
		DK5					
	Building type	DK1	ICE2	EST1	FIN4	NOR1	SWE1
		DK8	ICE3	EST3	FIN5	NOR2	SWE5
				EST5	FIN2	NOR3	
	Area	DK1	ICE1	EST1	FIN4	NOR1	SWE1
		DK2	ICE3	EST3	FIN6	NOR2	
		DK8			FIN5	NOR3	
Carbon Emissions	**Embodied**	DK6		EST6	FIN1	NOR7	SWE3
		DK7				NOR2	
	Operational	DK1	ICE3	EST1	FIN2	NOR2	SWE4
		DK2	ICE4	EST3	FIN5	NOR4	SWE5
		DK4	ICE5		FIN1		SWE6
		DK8	ICE7				

The following section of this report is dedicated to an analysis of each of the key attributes, as well as the corresponding databases resulting from the mapping exercise. In this detailed examination, we will delve into the specifics of data quality and database type to assess their potential in describing aggregated levels for use in building stock modeling within Nordic countries.

The objective of this analysis is to define whether the selected attributes and databases possess the potential to provide a foundation for robust and reliable environmental building stock modeling in Nordic countries. This evaluation will be instrumental in shaping our conclusions and recommendations.

6.1 Building stock – Owner

Data regarding ownership is not essential for carbon monitoring, however, it can be a useful filter to see which types of owners are responsible. Each country has at least one database, and in some cases, like Iceland and Estonia, there are two separate databases. The most typical way of categorizing the ownership is into either public ownership, company ownership, or private ownership. However, some countries like Denmark go into further detail and include additional categories such as organizational-owned, state-owned, municipal ownership, and others. This results in it being harder to combine the different databases from the Nordic countries when the owner categories do not match.

6.2 Building stock - Year

There are several reasons why the construction year of a building is important. For instance, it can help us determine the age of the building and identify construction methods and materials used. This information can be used to estimate the building's carbon footprint and plan for future renovations or demolitions. For future monitoring of material flows, a building's construction year will be an important parameter to record to capture the temporal aspect of the decarbonization of the building stock.

Most Nordic countries have multiple databases that contain information on the age of the building. However, the information provided in these databases can vary. Some databases include the year of construction and not the year of renovation, resulting in slight discrepancies in the data that can complicate the process of combining information from different databases.

In most of the databases, it's only possible to extract information on the year of construction for one building at a time. Although some national statistics databases provide information on the number of buildings constructed in a specific year, this data doesn't include information on individual buildings.

6.3 Building stock – Materials

In most of the Nordic countries' databases, the material description is primarily focused on the roof and facade, while some countries like Estonia provide more detailed information on additional building

elements like foundations and surface materials. One challenge with this attribute is that none of the databases mention specific built-ups of different building elements.

Currently, it's not possible to extract information on building materials on a larger scale for multiple buildings, which makes the process of extracting material information tedious and time-consuming. Additionally, the quality of data isn't good enough to make final decisions or estimates to use an inventory for LCA calculation.

Due to the lack of information on material composition in the data that is being recorded today, a building-by-building approach for modeling the environmental building stock and quantifying the environmental impact of individual buildings in the stock can be challenging.

6.4 Building stock – Building type

There are multiple databases recording building typology available in each country. There are databases available for both individual buildings and building stock on a larger scale. This makes it easy to extract the required information and determine the total number of buildings in each typology.

The information can be especially useful when using an archetype-based aggregation approach. Archetype-based aggregation approach is a method used in building stock modeling to represent a large number of buildings with a smaller number of representative building types or archetypes. This approach involves clustering buildings based on common characteristics such as building type, construction year, size, and climate conditions, and then defining a limited number of archetypes that represent the diversity of the building stock.

The archetypes can be used to model the environmental impacts of the entire building stock by calculating the environmental impact from each typology and then aggregating the values with the built area of each type. This approach is commonly used in building stock modeling due to the large number of buildings involved and the limited availability of detailed building data.

In the Nordic countries, the building typologies are quite similar, with single-family homes, terraced homes, and apartment buildings being the most reported buildings in the databases. This makes it easier to compare and combine the different countries and their correlated typologies.

6.5 Building stock – Area

Information about the built area can be an important parameter to monitor the building stock. Each country has at least one, and often two or three databases that provide this information. The databases vary from individual building level to national statistics databases, which often have the average floor area for different types of buildings recorded. This makes the information easily extractable.

In Nordic countries, the building and property databases contain data on the gross floor area (GFA) of all buildings, while a subset of other buildings in the databases have additional information on other types of areas. The building and property registers define GFA in varying ways and incorporate different elements in the calculation of the floor area (As seen in Table 6.2.).

Table 6.2. Elements incorporated in GFA.

Country/Region	Regulation (in place or proposed)	External wall thickness	Primary functions	Secondary functions (e.g. circulation areas, storage)	Internal wall and columns	Basement/ cellar	Stairs	Common facilities (in multi-units, incl. Staircase, lift, vertical voids)	Enclosed car park connected to building	Attic	Loft	Rooftop terrace	Plantrooms on roof	Balcony	External area including car park
Denmark	Bygningsreglementet 2018 (Br18)	✓	✓	✓	✓	if ceiling height > 1.25 m over terrain	✓	✓	✓	✓	If area > 4.5 m²	If enclosed	✓	100% accounting if enclosed, 25% if external areas are connected.	100% accounting if enclosed, 25% if external areas are connected.
Estonia	Ehitusseadustik	✓	✓	✓	✓	✓	✓	✓	✓	If height > 1.6m	If height > 1.6m	-	-	-	-
Iceland	Byggingarreglugerð	✓	✓	✓	✓										
Finland	Rakentamismääräy-skokoelma	✓	✓	✓	✓	If intended as a primary function	✓	If heated	Is included in a few municipals	If intended as a primary function	-	-	-	Only for greenrooms	-
Norway	Technical Regulations for Construction Works 2017 (TEK 17)	✓	✓	✓	✓	if ceiling height > 1.5 m over terrain	-	-	✓	If area is more than 1/3 of the usable floor	If area is more than 1/5 of the usable floor	If enclosed	✓	-	-
Sweden	Boverkets Byggregler (BBR)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	If enclosed	✓	If enclosed	-

Additionally, the definition of the area used for calculating climate declarations in the Nordic countries varies (As mentioned in task 4.1a). For the climate declaration in Estonia and Finland, the heated net floor area is used. In Denmark, the area used in the climate declaration is divided into two. To find the environmental impact per square meter, environmental impacts from the building operation (module B6 in LCA) are divided by the heated GFA, and environmental impacts from materials (modules A, rest of B, and C) are divided by the total GFA. In Sweden and Norway, the total GFA is used.

6.6 Carbon emission – Embodied

Most Nordic countries have been provided with a database or list, by their respected authority, which is often required to be followed when using generic environmental impact data for building materials in the national climate declarations. However, Norway and Iceland do not have access to such databases or lists. Instead, the Norwegian government property agency has signed an agreement to use OneClickLCA as their LCA calculator tool, utilizing their adapted Norwegian attached database in the software. Meanwhile, Iceland does not have a specified database for emissions on generic construction materials, leading to the current use of different databases. This makes it harder to compare carbon footprint calculations.

The data in each database differs based on external factors such as the energy mix, transportation distance, and original location of the products. The databases are tailored to each country and as a result, the embodied carbon emissions for the same type of materials vary for each country. Sweden's database only includes the product stage (A1-A3) and construction stage (A4 – A5), which is commonly known as the upfront embodied carbon.

6.7 Carbon emission – Operational

Carbon emissions related to the operation of a building, such as water usage, heating, and energy consumption in buildings are not reported in any databases. Several databases are reporting on both labels (energy), actual usage (energy/heating/water), and supply type (energy/heating). National emission factors can be used to calculate the carbon emissions related to the operations.

There are databases available at both the individual building level and on a larger scale for building stock. However, for water usage in buildings, there is only a national larger-scale database for building stock, not at the individual building level. The larger-scale databases originate from national statistic banks, but they may not be updated frequently, with updates often occurring every one or two years.

Table 6.3.: Building energy labels in the Nordic countries

Denmark*	Estonia**		Finland	Sweden	Norway**		Classification
Limit value [kWh/m^2]	Apartment Limit value [kWh/m^2]	Office Limit value [kWh/m^2]	Limit value [kWh/m^2]	Limit value [Energy performance of a new building]	Apartment Limit value [kWh/m2]	Office Limit value [kWh/m2]	Energy label
27							A++
< 30 + 1000/Areal							A+
< 52,5 + 1650/Areal	< 170	< 100	< 90	EP is ≤ 50%	90	85 + 600/Areal	A
< 70,0 + 2.200/Areal	< 171 - 200	< 101 - 130	< 91 - 155	EP is > 50 - ≤ 75%	115	95 + 1000/Areal	B
< 110 + 3.200/Areal	< 201 - 250	< 131 - 160	< 156 - 192	EP is > 75 - ≤ 100%	145	110 + 1500/Areal	C
< 150 + 4.200/Areal	< 251 - 300	< 161 - 210	< 193 - 272	EP is > 100 - ≤ 135%	180	135 + 2200/Areal	D
< 190 + 5200/Areal	< 301 - 350	< 211 - 260	< 273 - 402	EP is > 135 - ≤ 180%	220	160 + 3000/Areal	E
< 240 + 6.500/Areal	< 351 - 410	< 261 - 320	< 403 - 472	EP is > 180 - ≤ 235%	275	200 + 4000/Areal	F
> 240 + 6.500/Areal	< 411 - 470	< 321 - 400	< 473	EP is > 235%	> F	> F	G
	> 471	> 401					H

*A2020, A2015 and A2010 instead of A++, A+ and A
** Varies for different building typology

For all the Nordic countries except Iceland, there are energy label databases for every newly established building, making it easy to compare energy and heating demand within the nation. However, the energy label grades do not align across countries, making comparisons between countries difficult with the label alone (see Table 6.3). Additionally, the energy label in Estonia and Norway varies with the typology of the building. The energy labels are primarily updated when there is a transfer of ownership or tenant for the buildings.

Besides the national databases, it is worth mentioning the EU Building Stock Observatory (BSO) that was established in 2016 as part of the Clean Energy for All Europeans package. It aims to provide an understanding of the energy performance of the building sector through reliable, consistent, and comparable data. The background data for the operational energy use in BSO originates from Eurostat's energy statistics on household energy use.

7 Recommendations for environmental building stock monitoring with existing data

To monitor the decarbonization of the building stock of Nordic countries using existing data from the databases presented in the previous section, there are various approaches, scopes, and environmental modeling types available. In this segment, the methods will be discussed, and a recommendation will be presented. It is important to note that the recommendations in this section will be based only on the currently available data. In the next chapter, future aspects including new data will be considered.

7.1 Life Cycle Scope

Monitoring carbon emissions from the building stock requires a common scope that aligns with all the Nordic countries. In task 4.1a an analysis was undertaken, of the life cycle assessment methods and scopes in the Nordic countries. In this analysis, a conclusion was reached that the most probable first action toward Nordic harmonization of forthcoming limit values is for the Nordic countries to reach a consensus regarding reporting upfront emissions (A1-A3 in LCA).

With regards to scope, our recommendation is to monitoring the decarbonization is to focus on the up-front carbon emissions (module A1-A3 in LCA). The recommendation is based on two main principles. The upfront emissions happen in the year of construction while modules B and C are in the future for a specific building but there is also a certain carbon emission on the building stock level every year related to renovation materials and operation of buildings. Our recommendation is to monitor waste treatment and renovation separately from the building stock model as there are large uncertainties about the lifetime of buildings and elements.

Secondly, Sweden and Norway are currently only including up-front emissions in their methodology for climate declarations in the building regulation and are thus the "lowest common denominator" when it comes to LCA modules included in the climate declaration scope. The official list of material data, to be used as generic data (Boverket), in Sweden, is only enriched with up-front emissions (A1-A3). If other modules were to be included in the monitoring, the Swedish generic dataset would have to be supplemented with data for these modules.

Monitoring the decarbonization of the building operations (module B6 in LCA), could potentially also be included. The building stock observatory (BSO) platform and goal of providing comparable data, serve as an inspiration for reporting carbon monitoring from building operations on the building stock level. The BSO can't be used directly for the Nordic countries because it is EU-specific and doesn't cover Norway and Iceland. National emission factors would have to be added to the energy data to show the environmental impact of operations.

7.2 Environmental Modeling Types

Röck et. Al's studies on environmental modeling of building stock are categorized into four types of modeling approaches: type A, product life cycle approach; type B, materials and flows focus; type C, building energy simulation; and type D, cost-benefit analysis:
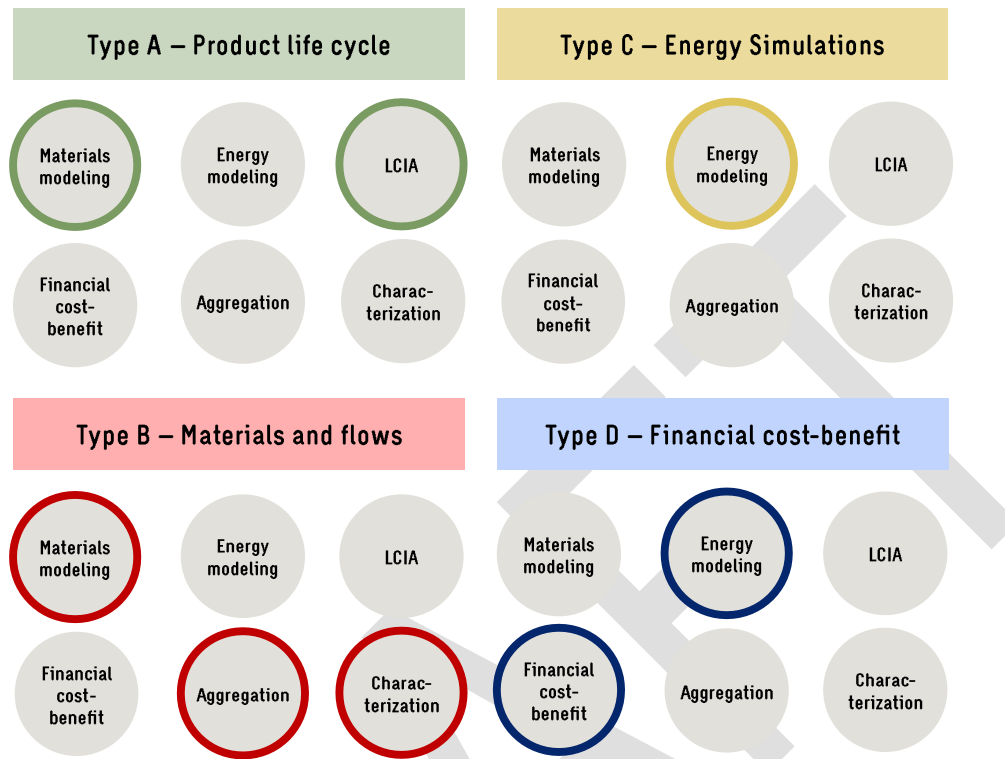
Figure 7.1.: Overview of the identified environmental modeling types and included modules from Röck et. Al.

- **Type A** focuses on the life cycle of building products and materials and the environmental impacts associated with their production, use, and disposal. This approach uses a product-based inventory and impact assessment and is often used for the assessment of individual building components or materials.

- **Type B** focuses on the material flows and composition of building stocks and the environmental impacts associated with their use and end-of-life. This approach uses an element-based inventory and impact assessment and is often used for the assessment of building stocks at the urban to national scale.

- **Type C** focuses on the energy performance of buildings and is limited to the environmental impacts associated with their operation or in-use phase. This approach uses a building energy simulation model to estimate energy demand and associated emissions and is often used for the assessment of building stocks at the building or portfolio scale. Based on the limitation in the phases of this approach, it is often combined with life cycle models (Type A).

- **Type D** focuses on the economic costs and benefits of building interventions and the environmental impacts associated with these interventions. This approach uses a cost-benefit analysis to evaluate the environmental and economic impacts of different building interventions and is often used for the assessment of building stocks at the urban to national scale.

The different modeling approaches have their unique strengths and limitations. The overall goal is to monitor carbon emissions from the building stock and the recommended scope, as mentioned previously, is to monitor for upfront carbon emissions, based on the current database landscape. It would be advisable to use a combination of material and flow-focused and product life cycle-focused environmental modeling methods.

If the recommended scope included an operational perspective, type A/B could be combined with an energy model (type C). An energy modeling approach could be heavily influenced by the method used in the EU BSO to account for energy use on the building stock scale. Alternatively, the reported energy labels on buildings in the national energy label databases could be used to create an aggregated building-by-building energy model.

Financial-cost benefits modeling is also proposed in several studies when researching environmental building stock modeling. All EU Member States and EFTA countries are legally required to provide data according to the European environmental accounts which are established in Regulation (EU) 691/2011. The Regulation provides a legal framework for a harmonized collection of comparable data from all EU Member States and EFTA countries. The European environmental accounts are consistent with the SEEA 2012 CF and are structured in modules.

7.2.1 Archetype modeling

Building-by-building based carbon monitoring would require detailed environmental impact information on each building in the building stock. This level of detailed information currently does not exist in a structured format. That leaves archetype-based building stock aggregation as the recommended option for carbon monitoring the building stock.

Archetype-based modeling is a method used in building stock modeling to represent many buildings with a smaller number of representative building types or archetypes. This approach involves clustering buildings based on common characteristics such as building type, construction year, size, and climate conditions, and then defining a limited number of archetypes that represent the diversity of the building stock. The archetypes are then used to model the environmental impacts of the entire building stock.
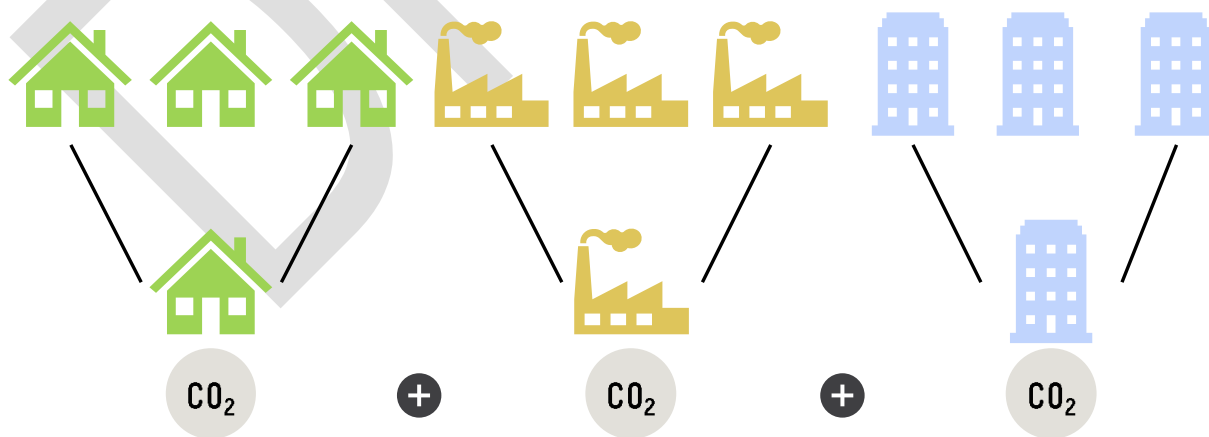

Figure 7.2. Archetype-based environmental building stock modeling.

For archetype-based modeling, archetypes would have to be defined. We recommend utilizing the database description of building typology, construction year, and gross floor area to define the archetypes. A life cycle assessment reporting the emissions, from the recommended scope (A1-A3), would have to be carried out for each archetype to be used for building stock carbon monitoring. The LCA should be updated regularly to follow the decarbonization.

For archetype-based modelling, in the Nordic countries, it is recommended to utilize the building typology attribute, to define the archetypes. This attribute is identical across the Nordic countries including the three dominant building types: terraced houses, detached houses, and apartment complexes. This approach can also be extended to the rest of the typologies of commercial, industrial, institutional, and religious buildings, which are also well-documented in the databases.
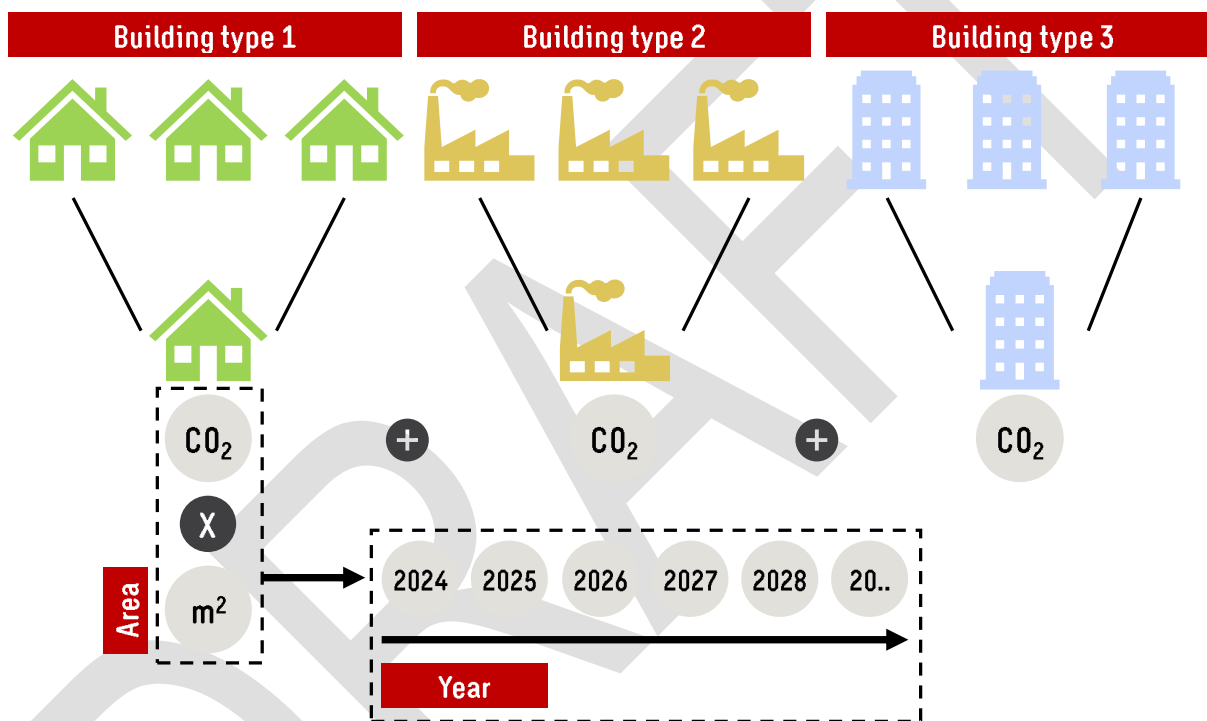

Figure 7.3.: The attributes: building type, area, and construction year utilized for environmental building stock modeling and monitored yearly.

The attribute "floor area" presents some compatibility issues since it is not standardized across the Nordic countries. This talks about aggregating the emissions on a national level.

7.2.2 Aggregation

To estimate the carbon emissions in the newly established building stock, the building stock aggregation would utilize environmental data from the archetype LCA modeling, paired with building stock characterization data (building typology).

Two approaches to combine and compare the carbon emissions in the building stock for the Nordic countries have been identified. One approach involves aggregating the building stock on a Nordic level. This would entail gathering the total number of buildings for each building typology in all Nordic

countries and then pairing them with an average or estimated carbon footprint from an archetype that is compatible with every Nordic country.

The other approach involves aggregating the building stock on a national level, with the archetype based on the national level as well. For this project, it is recommended to aggregate on a national level rather than a Nordic one. While this approach requires more archetypes, each country would require the same archetype. Moreover, a modeling archetype that is compatible with every Nordic country may be impossible or lead to numerous uncertainties and implications.
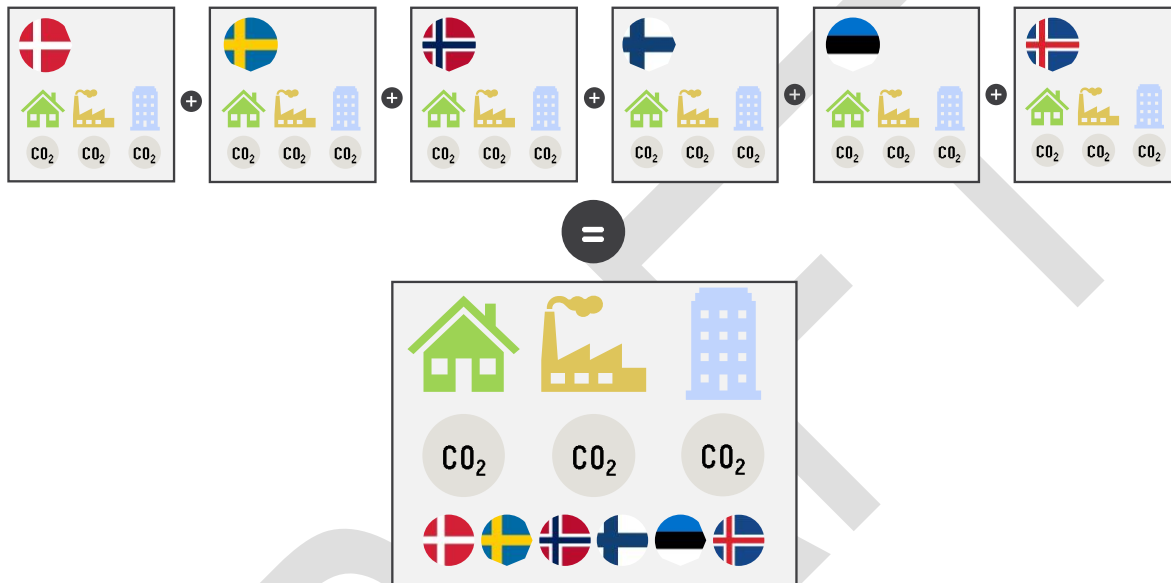

Figure 7.4: Aggregating the building stock on the National level and summed up to reach the Nordic level. National emission factors can be used for each building type.

7.2.3 Input-Output modeling

In the pursuit of overcoming challenges associated with existing databases for monitoring environmental impact, alternative modeling approaches, such as Environmental Input-Output Models, warrant consideration.

EIOM is a class of models that extend the traditional economic input-output analysis to account for the environmental consequences of economic activities. These models provide a systematic framework for assessing the direct and indirect environmental impacts associated with the production and consumption of goods and services across various sectors of an economy.

National environmental accounts are typically based on a variation of an Input-Output model. Aligning calculation methods between carbon monitoring of the building stock and the national environmental accounts facilitates a good understanding of the building sector's contribution to the total national environmental impact and decarbonization goals.

Although EIOM presents itself as a promising alternative for monitoring building environmental impact, the model also inherits a range of challenges such as:

Data Quality and Availability

EIOMs heavily rely on comprehensive and accurate input-output tables, as well as reliable environmental data. Limited or poor-quality data for certain sectors can undermine the accuracy of the model's results.

Temporal Dynamics

Environmental impacts can vary over time, and EIOMs may struggle to capture dynamic changes. Updating the model to reflect evolving economic and environmental conditions poses a challenge.

Intersectoral Spillover Effects

The model assumes that changes in one sector do not significantly affect the production processes or environmental impacts of other sectors. There may be spillover effects that are challenging to quantify accurately.

Affordability Bias

One of the significant challenges with Environmental Input-Output Models (EIOMs) is their potential bias towards affordability. The models may inadvertently prioritize economic growth and affordability over environmental sustainability. This bias arises because products with lower environmental impact may be more expensive due to sustainable production practices or the use of eco-friendly materials.

Neglect of Sustainable Innovation

The models may not sufficiently account for the potential innovations in technology and processes that could make sustainable practices more economically viable in the long run. This oversight could underestimate the positive impact that investments in sustainable innovation might have on both the economy and the environment.

8 Recommendation for new data and alternative approaches for environmental building stock monitoring

8.1.1 Building-by-building modeling with new data recording

The primary limitation of existing databases mapped out in previous chapters, is their inability to directly facilitate the monitoring of environmental impact from buildings. The archetype-based modeling approach, while promising, presents challenges in terms of defining archetypes, calculating impacts, and aggregating results to the building stock level. Sustaining accurate and up-to-date information for each archetype adds complexity to understanding the evolving carbon intensity scenario.

To address the limitations associated with existing databases and modeling approaches, a shift towards a building-by-building methodology is recommended. This approach aligns with the introduction of new climate declarations in the Nordic countries in the forthcoming years. Furthermore, the EU Energy Performance of Building Directive Article 7 states that Member States shall ensure that the life-cycle Global Warming Potential (GWP) is calculated per Annex III and disclosed through the energy performance certificate of the building:

A. as of 1 January 2027, for all new buildings with a useful floor area larger than 2000 square meters; and
B. as of 1 January 2030, for all new buildings.

Establishing a digital infrastructure to manage data derived from climate declarations and/or GWP disclosed in the energy performance certificates, can provide a more robust foundation for environmental modeling.

The proposed building-by-building approach allows for a comprehensive assessment of environmental impacts. Leveraging the data from climate declarations ensures that the information is readily available, facilitating the extraction of data for monitoring both new buildings and potential renovations. This approach not only enhances the accuracy of the environmental impact picture but also streamlines the process of creating and updating monitoring systems.

Benefits of the Building-by-Building Approach:

1. Accuracy: A building-by-building approach offers a more granular and accurate understanding of environmental impacts, avoiding the generalizations inherent in archetype-based models.
2. Efficiency: Digital infrastructure managing climate declaration data streamlines the extraction of information, reducing the workload required for creating and updating monitoring systems.
3. Adaptability: The approach allows for easy integration of data from new buildings and potential renovations, providing a comprehensive view of the entire building stock's environmental impact.

A more detailed picture of the building-related emissions (materials, building parts, building types). Understanding why and what instead of how much

In conclusion, transitioning to a building-by-building approach based on climate declarations emerges as a practical solution to the limitations associated with existing environmental modeling databases. The implementation of a digital infrastructure to manage this data not only addresses current challenges but also positions the system to adapt to future developments in climate declarations. This recommendation signifies a step towards a more accurate, efficient, and adaptable environmental modeling framework for the assessment of building impact.

About this Publication

Process for monitoring the decarbonization of the building stock

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9 Appendix

9.1 Appendix A – Building information database inventory

Appendix A.1 - Database inventory, Denmark

#	Database name	Brief description	Responsible organization	Link to organization	Link to database	Datatype	Relevant key data	Coverage area	Accessibility	Access cost	Format	Responsible for datainput	Update frequency	Integration	Legal consideration	Challenges	Opportunities
DK1	BBR - Building and Housing Register	In BBR (Building and Housing Register), you can find information about all buildings and residences in Denmark. There is a lot of information available for each individual building, such as its location, its usage, size, and age	Ministry of Taxation (Skatteministeriet (Vurderingsstyrelsen))	https://vurdst.dk/	https://bbr.dk/forside	Building register	Area Facade material Roof material Type of heating Number of floors Year Owner	Nationwide	Public	Free	Structured database	Building owner	Continuously (when changes are made)	No		The building owner is responsible for datainput. This results in a limited validity of data especially in existing buildings, because owners lack incentives and competences to update them	Comprehensive record of all buildings in DK with valuable information. Especially data on facade and roof cladding, which is not provided by the other available structured database on energy labels.
DK2	Protected and listed buildings	FBB is the register of Protected and listed buildings in Denmark maintained by the Danish Agency for Culture and Palaces. FBB contains information about approximately 7,100 protected buildings in the country and about 370,000 buildings whose preservation value has been assessed. Additionally, FBB includes basic information about over 4 million buildings in Denmark. This information is sourced from the Building and Housing Register (BBR) and is automatically updated.	Ministry of Culture (Kulturministeriet (Slots- og kulturstyrelsen))	https://slks.dk/	https://www.kulturarv.dk/fbb/index.htm	Register for preserved buildings	Area Facade material Roof material Type of heating Number of floors Material description	Nationwide	Public	Free	Structured database	Data comes from BBR and Ministry of Culture	Continuously	No		Data comes from BBR where the building owner is responsible for the datainput. This results in a limited validity of data especially in existing buildings, because owners lack incentives and competences to update them	Detailed description of listed buildings material composition. Could be used to define building techniques from different periods.
DK3	Waste data system (ADS)	The Waste Data System is a web-based database that collects information about waste streams in Denmark. According to the Waste Data System Order, companies responsible for waste treatment are required to report to the Waste Data System. During reporting, they need to specify the source of the waste, the type of waste, and how the waste should be treated. Companies reporting waste data have the ability to edit and retrieve their own waste data, while certain waste data is publicly accessible.	Ministry of Environment (Miljøministeriet (miljøstyrelsen))	https://mst.dk/	https://www.ads.mst.dk/Default.aspx	Waste register	Type of waste (sector) Type of waste (category) Amount of waste	Nationwide	Public	Free	Structured database	Companies responsible waste treatment	Minimum yearly. Also possible to update continuously	No			Could be used to define material composition based on demolished buildings
DK4	Energy label	Energy labeling makes the energy consumption of buildings visible and serves as a type of product declaration. The energy performance certificate also provides an overview of energy-related improvements that are financially viable. Residential properties, public buildings, and buildings for commerce and services are subject to energy labeling regulations. It is mandatory for a building to undergo energy labeling when it is being sold or rented out.	Ministry of Climate, Energy and Utilities (Klima-, Energi- og forsyningsministeriet (Energistyrelsen))	https://ens.dk/	BBr	Energy label register	Calculated energy demand	Nationwide	Public	Free	Structured database	Energy labeling of buildings can only be carried out by companies that are certified to perform energy labeling. Certification requires a quality management system in accordance with the rules of the international standard ISO 9001.	Continuously	No			
DK5	Building archive (Byggesagsarkiv)	All documents related to building permissions from the time of erection and throughout the building life. Includes drawings with build-up details and material descriptions, calculations and simulations	Municipalities, represented by the umbrella organization Kommunernes Landsforening	https://www.kl.dk/	Individual access to all 98 municipalities	Text documents and drawings	LCA input and output including material type and quantities. Further documentation of all legal requirements such as energy demand, U-values, structural system and so on	Nationwide	Public access to individual cases. No access to the entire database (requires change of law)	Free	LCA model data is potentially structured (machine-readable PDF, yet in testing stage). Other data is not structured (PDF, DOC, image)	Client represented by consultants and the municiipal authorities	When new permissions are applied	No	(what to write here?)	lacking legal basis for database access	Structured LCA model data
DK6	LCAbyg component library	Typical component build-ups for Danish buildings of differnt typologies and 1-5 storeys. Includes the quantity of generic building products for 1 unit functional component layer. Such as 1m2 external wall, 1m beam or 1 piece district heating unit. This is based on the national generic product database and default impact values for building services	BUILD (Aalborg University)	https://www.build.aau.dk/s	Tool: https://lcabyg.dk Library publication: https://vbn.aau.dk/da/publications/eksempelbibliotek-til-lcabyg	Building product types and quantities for functional component layers	The amount of generic building product in a given component layer.	Nationwide	Public access of individual items, not the entire database	Free (at the moment)	Proprietary LCAbyg file format	BUILD (Aalborg University)	1-2 years	No	(what to write here?)	Small challenges regarding a broad monitoring approach include: classification, terminology, detailing, variation in practice	Usefull for modelling building stock archetypes
DK7	Building regulation 2018 (BR18) Appendix 2 table 7	The database presents conservative emissions data for construction products used in Denmark and also for energy and fuel.	The Social and Housing Agency (Social og boligstyrelsen)	https://sbst.dk/	https://bygningsreglement	Database with generic climate data	Product stage A1-A3 C3, C4 and D	Nationwide	Public access	Free	Excel	The Social and Housing Agency	1-2 years	No			
DK8	Danish statistics/Statbank	Statistics Denmark is the national provider of statistical data on the nation. They collect, produce and presents statistics related to the population, economy and society,	Danish statistics	Contact Statistics Denmar	Statistics Denmark (dst.dk) https://www.statbank.dk/statbank5a/default.asp?w=1280	Database with generic danish data	Building stock Building type Area Electricity mix Heating meassured Waste from households	Nationwide	Public acces	Free	Excel	Danish statistics	Continuously	No			

Appendix A.2 - Database inventory, Estonia

#	Database name	Brief description	Responsible organization	Link to organization	Link to database	Datatype	Relevant key data	Coverage area	Accessibility	Access cost	Format	Responsible for datainput	Update freequenzy	Integration	Legal considetation	Challenges	Opportunities
EST 1	Estonian Building Register (EBR)	The Building Register is a national database through which construction-related documents can be submitted and processed.	Building Register Department of the Ministry of Economic Affairs and Communications; will be under newly created Climate Ministry	https://www.mkm.ee/en/construction-and-residential-sector/construction/building-register	https://livekluster.ehr.ee/ui/ehr/v1	Building Regsiter	building permit, construction notice, use permit, energy label, heating type, material description, area, year and view. The Building Register contains data on both existing and planned buildings.	Nationwide	public	Free	Structured database, JSON format, output in CSV	building owner is responsible for datainput, but any input changes are overseen by Building Register	1 time per working day	API		Same as for DK: The building owner is responsible for datainput. This results in a limited validity of data especially in existing buildings, because owners lack incentives and competences to update them	Up to date record of all buildings in Estonia.
EST 2	Land Register /Immovables Register	Land Register includes cadastral data, owners and restrictions, allows to check mortgages over properties data	Land Registry and Registration Department	https://www.kohus.ee/en/estonian-courts/estonian-court-system/county-courts/tartu-maakohus/land-registry-and-registration	https://kinnistusraamat.rik.ee/Avaleht.aspx?lang=Eng		cadastral data, owners and restrictions	Nationwide	public	Free, some info requires service fee (state fee)	Structured database	Tartu County Court, Land Registry and Registration Department	1 time per working day	API, integrated with local business register			
EST 3	Statistic Estonia	Statistic Estonia tracks changes in the society and offer information important for demographic, social, economic, and environmental development of Estonia. The data collected by Statistics Estonia are necessary for making development plans and projections, for policy planning, scientific and applied research, and for making informed decisions.	Statistics Estonia	https://www.stat.ee/en/	https://andmed.stat.ee/en/stat	Statistical data	Environment Economy Population Social life Multidomain statistics Population and Housing Census Discontinued datasets Year of construction, Building type, Area, Waste, Water and Electricity mix	Nationwide	public	Free	Structured database	Statistics Estonia	Depending on the dataset, usually once per year	-	Official Statistics Act https://www.riigiteataja.ee/en/eli/517122019002/consolide	Not all data is updated frequently enough.	Reliabla National data
EST 4	JATS Waste data		Environmental Agency	https://keskkonnaagentuur.ee/	https://jats.keskkonnainfo.ee/main.php?page=statquery2public	Environmental data	Waste production by category	Nationwide	public	free	Structured database	Environmental Agency and other organisations (depending on topic)	annually	-	Waste law: https://www.riigiteataja.ee/akt/109112011004?leiaKehtiv		
EST 5	PLANK Planning database	The national database of plans (PLANK) collects and stores all established building plans, regardless of the type of plan.	Ministry of Finance	https://www.fin.ee/	https://www.planeeringud.ee/plank-web/#/planning	Building plans	Any plans that are being processed by municipalities	Nationwide	public	free	Structured database	Local municipality		API availalbe			
EST 6	Emission factors for building materials	Draft method of Estonian building CO2 calculations was published along with a calculator that includes initial database for generic building materials emission factors	Ministry of Climate	https://kliimaministeerium.ee/en/climate-and-environment-protection/climate	https://eehitus.ee/timeline-post/uuring-ehituse-susiniku-jalajalg/	Emission factor data	building material emission factors, intial draft for national database	Nationwide	public	Free	Excel	Tallinn University of Technology created the first version, in the future it's likely not their responsibility	Not known for now		In work	Challenge to publish emission factors that are accepted by the industry	Opportunity to introduce and guide manufacturers to publish their own EPDs or otherwise communicate their impact
EST 7	Geoportal	Portal that functions as a platform for various space related data.	Estonian Land Board	https://geoportaal.maaamet.ee/eng/	https://geoportaal.maaamet.ee/eng/Spatial-Data-p58.html	Spacial data	address data, cadastral data, administrative and settlement division, 3D data, geodetic data, soil data, geological data, topographic data, satellite data	Nationwide	public	free	Structured database	Land Board	Depending on the dataset	APIs available			Gathers any spacial data in Estonia and links that to relevant other databases (such as building register)

Appendix A.3 - Database inventory, Iceland

#	Database name	Brief description	Responsible organization	Link to organization	Link to database	Datatype	Relevant key data	Coverage area	Accessibility	Access cost	Format	Responsible for datainput	Update freequenzy	Integration	Legal considetation	Challenges	Opportunities
ICE1	Mannvirkjaskrá (Building register)	Building registry, information on size, properties, status of work, permits, audits etc. Now under review and will soon include building handbook (usage registry). It is being prepared that carbon footprint results (design stage, final audit) will be registered in Mannvirkjaskrá	Húsnæðis- og mannvirkjastofnun (HMS) - The Housing and Construction Authority - operating under Ministry of Infrastructure (Innviðaráðuneyti)	https://hms.is/	https://mannvirkjaskra.is/ords/r/mannvirkjaskra/crp/home?request=INIT		Municipality and postal code, building size, land size, valuation, construction no and land no, building type, status of work (building permit), building audits and changes (since 2021), link to blueprints	Nationwide	public	Free	HTML, LaTeX, ePub, Texinfo (Sphinx)	Building owner and municipality's building commissioner	Continuously	With municipalities' blueprints and master plans			The building register now provides a real-time compilation of residential property buing built or in the process of getting permits, by type, size and status https://hms.is/maelabord-ibuda-i-byggingu and work is underway to prepare a systematic and conformed entry of building permit data for all municipalities, including LCA calculations + use information and changes
ICE2	Fasteignaskrá (Property register)	The Property Register is a data and information system run by the Housing and Construction Authority. The register contains information on properties and their attendant rights. The Property Register is a single, comprehensive register for multiple authorities, replacing the municipal property registers and district commissioners' property registration files.	Húsnæðis- og mannvirkjastofnun (HMS) - The Housing and Construction Authority - operating under Ministry of Infrastructure (Innviðaráðuneyti)	https://fasteignaskra.is/english/properties/about-the-property-register/	https://fasteignaskra.is/		Building types, year (issued when building is watertight), sizes (m3 and m2) of lots and buildings, information on building material (main building material) and description of building, registered rights (owners, mortgages), property valuation and fire insurance value	Nationwide	Public	Free/cost for more access or special data analysis, some data free for download https://fasteignaskra.is/gogn/grunngogn-til-nidurhals/	html, shp, csv	Municipal building authorities, district commissioners, The Housing and Construction Authority	Continuously				The property register moved from the Registers Iceland to HMS (The Housing and Construction Authority) in 2022, which has proved well in conjunction with the Building Register
ICE3	Statistics Iceland	Statistics Iceland collects, processes and disseminates data on the economy and society. See https://statice.is/about-statistics-iceland/	Statistics Iceland	https://statice.is/	https://px.hagstofa.is/pxen/pxweb/en/		Import of materials, quantities and origin, also construction of residential buildings in Iceland and capital region	Nationwide	Public	Free	PX-Web, PSV, CSV, excel, html, txt, json	Statistics Iceland	Depending on dataset, ca 1x per year				
ICE4	Data library of The National Energy Authority (Orkustofnun)		Orkustofnun		https://orkustofnun.is/en/information/numerical_data/fuel		Development of fuel sales, district heating, energy and electricity by sector in Iceland										
ICE5	Veitur Utilities	Energy use of buildings in areas serviced by Veitur (capital area, S & W Iceland) , by type and age. Hot water, electricity and water.	Veitur	www.veitur.is	First attempt of data analysis (preliminary) https://byggjumgraennif ramtid.is/wp-content/uploads/2023/04/100449-SKY-001-V03-Orkunotkun-honnud-og-maeld-Gogn-um-orkunotkun-bygginga-		Hot water, cold water and electricity use of buildings	Capital area, S&W Iceland	Private	via communication				Property register		Data that has not been made available yet, ongoing work to work through them. Smart-meters are currently replacing older devices and will soon provide better data (simplifying input and facilitating data analysis)	First attempt at working through data https://byggjumgraenniframtid.is/wp-content/uploads/2023/04/10044 9-SKY-001-V03-Orkunotkun-honnud-og-maeld-Gogn-um-orkunotkun-bygginga-loka17202023_r2.pdf
ICE6	Úrgangstölfræði	Waste statistics nationwide, based on data from the Environment Agency Iceland	Environment Agency Iceland		https://urgangur.is/maelabord/		Waste by type and by municipality, e.g. "Blandaður byggingar- og niðurrifsúrgangur" (mixed construction and demolition waste) by year and municipality	Nationwide	Public	Free		Waste treatment companies, and Environment Agency Iceland	Yearly				
GLO1	GreenBookLive	Database for all certified BREEAM assessments in Iceland (new construction) - many of which have carried out LCA assessments for either design stage or both design and final stage, and also have energy calculations			https://www.greenbooklive.com/search/buildingsearch.jsp?partid=10023&subschemeid=0&subsubschemeid=0&companyName=&developer=&productName=&buildingRating=&certNo=&certBody=&assessorAuditor=&countryId=352&addressPostcode=&standard=&notes=&projectType=&id=202												Global LCA results database works with the tool Breeam. Could potentially be interesting to use as a reference.

Appendix A.4 - Database inventory, Finland

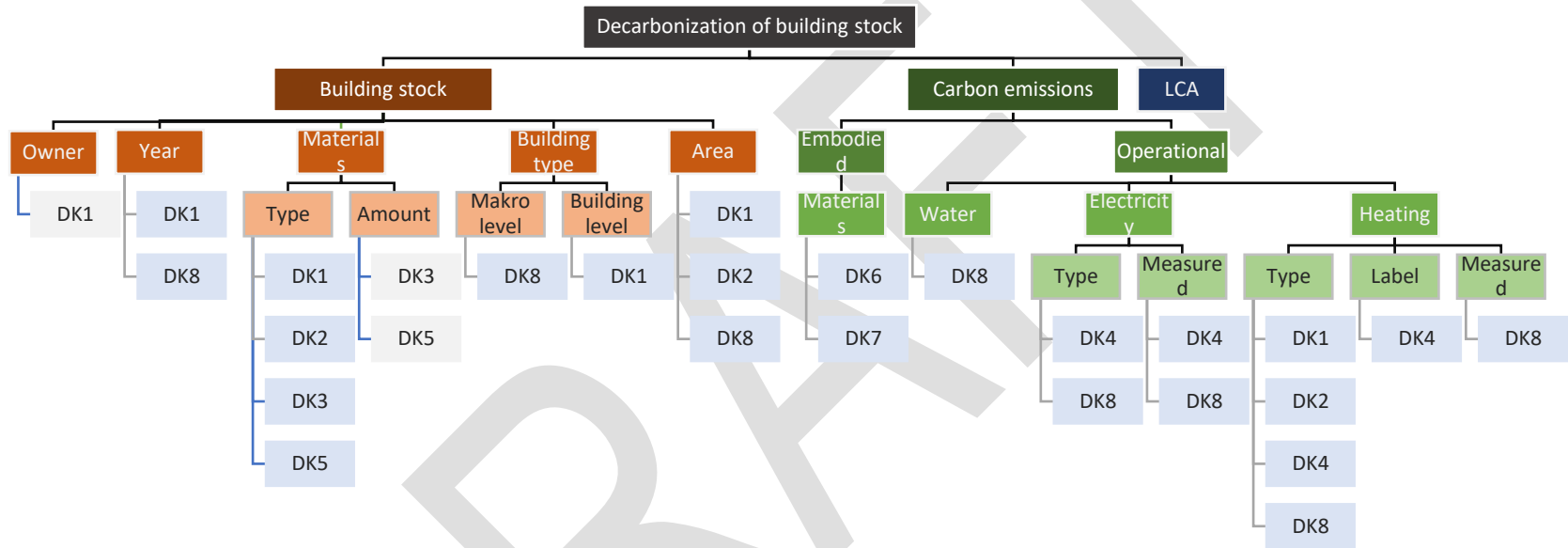| #	Database name	Brief description	Responsible organization	Link to organization	Link to database	Datatype	Relevant key data	Coverage area	Accessibility	Access cost	Format	Responsible for datainput	Update freequenzy	Integration	Legal considetation	Challenges	Opportunities
FIN 1	Climate database (Rakentamisen ja infrarakentamisen päästötietokannat, SYKE)	The database presents conservative emissions data for construction products used in Finland and also for energy and fuel. If you use generic climate data in your climate declaration, you must use data from the climate database from SYKE	Suomen ympäristökeskus/ Finnish Environment Istitute	https://www.syke.fi/fi-FI	https://co2data.fi/	Database for building materials emissions	Product stage A1-A3 Construction and infrastructure Services and prosesses Systems like building services	Nationwide	Public	Free	The file formats are offered in JSON and plain XML file, webpage	Finnish Environmental Institute (SYKE)	Many times in a year	The content is made available as open data via an API partly in JSON format and partly in XML format	(WCAG) 2.1 level AA		
FIN 2	Energycertificate datebase (Energiatodistusrekisteri)	The energy declaration is a document that, among other things, shows how much energy is used in a building when it is in use. All buildings must be energy certified. The energy declaration gives you information about the building's energy use.	ARA- The Housing Finance and Development Centre of Finland	https://www.ara.fi/en-US	https://www.energiatodistusrekisteri.fi/	Energy declaration register	Heatin type and estimated energy use, where all buildings are given a classification.	Nationwide	Public	Free	CSV, webpage	Energy declarations are carried out by a certified energy expert. This person will collect information about your building, carry out an energy inspection and submit the completed energy declaration to the system.	Continuously	The content is made available as open data via an API in CSV format	(WCAG) 2.1 level AA		Makes it possible to compare buildings that have same building type or use, building year and heated net-area.
FIN 3	Registry of finnish Heritage buildings (Museovirasto)	Database for all heritage information from argeology to buildings with a lot of reports and guidance. The Finnish Heritage Agency is responsible, together with other authorities and the museum field, for protecting environments with cultural history value, archaeological culture heritage and architectural heritage, and other cultural property. It also collects and presents a culture historical national collection, studies material cultural heritage and both supports and develops the museum field nationally. The Finnish Heritage Agency provides varied and constantly developing services for all citizens. It operates under the Ministry of Education and Culture.	Finnish Heritage Agency/ Museovirasto	https://www.museovirasto.fi/en/	https://www.kyppi.fi/palveluikkuna/portti/read/asp/default.aspx	Register for preserved buildings and drawings for them, includes also information from whole villages	Maps of locations Drawings Guidance for renovation Material	Nationwide	Public	Free	pdf, doc, docx, webpage	Finnish Heritage Agency/Museovirasto	Continuously	no			
FIN 4	Land, property and ownership registry (Maanmittauslaitos)	The property register is Finland's official register of how the land in our country is divided and of who owns what. In the register you can find information about all buildings, apartments and residences. Information about buildings, everything from residential buildings to public buildings: information available for each individual building, such as its location, its usage, size, ownership and age.	NLS National Land Survey of Finland /Maanmittauslaitos	https://www.maanmittauslaitos.fi/en	https://www.maanmittauslaitos.fi/kiinteistot/ammattilaiskayttajille/kiinteistotiedot-ja-niiden-hankinta/kiinteistorekisteri	Building and ownership register	Maps- topographic, aerial photos, etc Addresses Buildings Properties Ownership Land rights Soil, natural risk zomes Save height information for building Other enrollment information	Nationwide	Public, some information require an offical inquiry	Free	Depending on the information	NLS National Land Survey of Finland /Maanmittauslaitos Some information is based on service interfaces published by the data providers, which means that they are as up-to-date as in the services of the data providers.	Continuously	Some open data is possible to download with CC4.0 license, some data is not possible to integrate			
FIN 5	Statistical information on building, land and everything (Tilastokeskus)	Statistical data on building costs, selling prices, rents, energy consumpion, building type, living types and classifications	Statistics Finland/Tilastokeskus	www.stat.fi	https://www.stat.fi/en/topic/housing-and-construction	Statistical information	Statistical data on living and building type in a form of data sheet and maps. This includes: electricity mix, measured heating amount for previous years and waste from households.	Nationwide	Public	Free	Depending on the information	Statistics Finland/Tilastokeskus	Continuously	Open source API with CC BY4.0-license, for example XLSX, XML, JSON, CSV	CC BY4.0-license		
FIN 6	Built environment information data (Suomen Ympäristökeskus, paikkatietoaineistot)	Built environment information systems are developed and maintained to support land use planning, monitoring and research, and participatory planning processes	Suomen ympäristökeskus/ Finnish Environment Istitute	https://www.syke.fi/fi-FI	https://www.syke.fi/fi-FI/Avoin_tieto/Paikkatietoaineistot/Ladattavat_paikkatietoaineistot	Maps and statistics	Land use data, building code and different enviromental data on areas	Nationwide	Public/ some data requires registration	Free/some data with a fee		Finnish Environment Istitute Some information is based on service interfaces published by the data providers, which means that they are as up-to-date as in the services of the data providers.	Continuously	Depending on data, maps are open for registered users for adding their own data			

Appendix A.5 - Database inventory, Norway

| # | Database name | Brief description | Responsible organization | Link to organization | Link to database | Datatype | Relevant key data | Coverage area | Accessibility | Access cost | Format | Responsible for datainput | Update frequency | Integration | Legal consideration | Challenges | Opportunities |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NOR1 | The land register | The land register is Norways official property register and it contains information about property limits, areas, buildings, housing and addresses | The Norwegian Mapping Authority (Kartverket) | https://kartverket.no/ | https://seeiendom.kartverket.no/ | Property register | Area Building type and number Building permit status Maps Owner Building stock | National | Public | Free (Some information require Minid) | Website | The Norwegian Mapping authority with input from the municipalities and other public and private actors | Continously | No | None | The information is limited and it is not connected to other databases. The searches are manual, and per property. Information cannot be downloaded for several properties, you have to search one by one | National database with information from the whole country. Simple to use, straightforward information, connected to "Norways map" website |
| NOR2 | Statistics Norway (Statistisk Sentralbyrå) | Statistics Norway is the national statistical institute of Norway and the main producer of official statistics. They collect, produce and communicate statistics related to the economy, population and society at national, regional and local levels. Statistics Norway also conducts extensive research and analysis activities. | Statistics Norway (SSB) | https://www.ssb.no/en | https://www.ssb.no/bygg-bolig-og-eiendom/bygge-og-anlegg | Building statistics | Building stock Building type Construction year Number of buildings Construction cost for residential buildings Waste from buildings and construction Areas Construction starts Energy mix and required amount from building sector National carbon emissions from all sectors including electricity heating and cooling production, industry emissions (incl material production) | National | Public | Free | Stats can be downloaded in .xlsx and .CSV | Statistics Norway | Monthly or yearly, depending on the subject | No | None | | Possible to filter the information and show different parameters. Official source for national statistics |
| NOR3 | Cultural heritage search (Kulturminnesøk) | Kulturminnesøk is a website where you can find information about cultural environments, cultural monuments and landscapes. In Cultural Heritage Search you will find over 220,000 objects. Listed buildings, listed cultural environments, world heritage sites, churches, archaeological cultural monuments and underwater cultural monuments. | The National Antiquary (Riksantikvaren) | https://www.riksantikvaren.no/organisasjonen/ | https://www.kulturminnesok.no/ | Listed or protected buildings | Location Year of construction Building type Building's description and history | National | Public | Free | Website | The National Antiquary | Continously | No | | | Information is presented in a map easy to understand, and search for different parameters. These maps can also be downloaded from Geonorge (see row 5) |
| NOR4 | Energy rating (energimerke) | The energy label statistics contain data on all issued energy certificates and are updated in real time. | enova | https://www.enova.no/ | https://portal.ems.enova.no/statistikk | Energy rating | number of energy certificates by year building category energy rating heating rating registration type building technical regulations (TEK). | National | Public | Free | Website | enova | Real time | No | Enova also offers third-party actors access to historical data from the energy label scheme for use that is in line with the scheme's purpose. Third-party actors must state the purpose for using and handling the data, and enter into a separate agreement with Enova to gain access. | To see historical data on a building, an agreement must be signed, and access to information has to be authorized by enova | Updated in real time, national statistics, |
| NOR5 | GeoNorway - Listed buildings (freda bygninger) | Buildings and churches that are automatically, by decision, regulation or temporarily protected by law and churches that have status as listed. | Askeladden | https://www.riksantikvaren.no/veiledere/askeladden/ | https://kartkatalog.geonorge.no/metadata/kulturminner-inner-freda-bygninger/a4bfd879-120f-490e-9907-68ba870664b1 | Listed or protected buildings | Location Building year | National | Public | Free | FGDB GML PostGIS SOSI XML | Askeladden, users | Continously | Yes | Information and data from Askeladden are exclusively protected under the Intellectual Property Act § 43 first paragraph. It is not permitted to resell data that has been exported from Askeladden. If data from Askeladden is included in commercial products, or passed on on a non-commercial basis, the warnings above must be included. In such cases, written permission from the National Archives must always be obtained first. Due to uneven quality, data should not be used as a basis for detailed planning without regional cultural heritage management being contacted in the process. | SOSI files have to be converted to another format for use in ArcGis | National database updated regularly |
| NOR6 | Case inspection (Saksinnsyn) | Documentation from construction matters, planning matters, property matters and lift matters in Oslo municipality. | The Planning and Building Agency (Plan- og bygningsetaten, PBE) | https://www.oslo.kommune.no/etater-foretak-og-ombud/plan-og-bygningsetaten/#toc-1 | https://innsyn.pbe.oslo.kommune.no/saksinnsyn/main.asp | Documentation | Permits (in process, authorized, denied) Buildings drawings Technical information about the buildings Owner | Oslo | Public (but you may be required to log in with your personal number to access the information) | Free | PDF | PBE | Continously | No | All processing and publication of personal data takes place in accordance with the Personal Data Act. | | Information is organized chronologically, |
| NOR7 | OneClickLCA | One Click LCA is an automated life cycle assessment software for the construction industry. In particular, OneClick has a tool called carbon designer that generate reference buildings that are assumed to reflect typical building element compositions and typical EFs for materials (generic) in accordance with TEK (building regulation) rules. | OneClickLCA | Life Cycle Assessment sol | Life Cycle Assessment soft | Sofware tool | LCA tool with attached database | Global Office in Finland United kingdoms United states France | For all paying users | Subscription plan or demo version | LCA tool with database | OneClickLCA | | | | | |
| NOR8 | DiBK limit values tool | Directorate for Public procurement assitance. They have a tool that show limit values per different types of buildings (A1-A3, A4 and B4 in kg CO2e/m2). These limit values are based on typical buildings (references that should reflect typical element compositions and material EFs), somewhat like the OCLCA references. | DiBK | | | Excel tool | Carbon emissions per building type | National | Public | Free | XML | DiBK (assisted by Asplan Viak) | Continously | | | Not a database as such but rather built on a large amount of literature studies. Need to look further into assumptions regarding material lifetimes, transport to building site (A4), typical material waste on building | Starting point for discussing limit values |

Appendix A.6 - Database inventory, Sweden

#	Database name	Brief description	Responsible organization	Link to organization	Link to database	Datatype	Relevant key data	Coverage area	Accessibility	Access cost	Format	Responsible for datainput	Update freequenzy	Integration	Legal considetation	Challenges	Opportunities
SWE1	Property register	The property register is Sweden's official register of how the land in our country is divided and of who owns what. In the register you can find information about all buildings and residences. In the buildings part of the land register, you will find information about buildings in Sweden, everything from residential buildings to public buildings for, for example, industry, culture or agriculture. There is a lot of information available for each individual building, such as its location, its usage, size, and age.	The land surveyor	https://www.lantmateriet.se/sv/	https://www.lantmateriet.se/sv/fastigheter/Fastighetsinformation/Fastighetsregistret/bestall-information-ur-fastighetsregistret/#anchor-1	Building register	Addresses Buildings Properties Community facilities Mortgages Legal speed Plans and regulations Rights Communities Community associations Assessment Land rights Other enrollment information	Nationwide	Public	Standard information is free. A fee is added for larger extracts	Structured database	The information comes from the Land Survey, which is the authority that manages and is responsible for the Property Register.	Continuously	No		The property classification in the map part of the property register is up-to-date, but the reporting of the property boundaries in the map has come about over a long period of time and is produced with widely different methods. The boundaries visible in the map therefore have large variations in positional accuracy, from centimeter level to an average error of tens of meters. This is a shortcoming but not an obvious inaccuracy.	
SWE2	Building register	The building register is a national information system with information about the built cultural heritage. All monuments and churches protected by the third and fourth chapters of the Cultural Environment Act and the Ordinance (1988:1229) on state monuments are registered in the register, with the exception of a few churches and chapels. In addition to these buildings, there are a large number of inventories published which contain different types of buildings.	National Antiquities Office	https://www.raa.se/	https://bebyggelseregistret.raa.se/bbr2/sok/search.raa	Register for preserved buildings	Facade material Roof material Number of floors Material description	Nationwide	Public	Free	Structured database	The information is produced and registered by regional museums, the Church of Sweden, county administrations, municipalities, universities and colleges in collaboration with the National Antiquities Office.	Continuously	No			
SWE3	Climate database	The database presents conservative emissions data for construction products used in Sweden and also for energy and fuel. If you use generic climate data in your climate declaration, you must use data from the climate database from the Housing Authority. factor.	The Swedish National Board of Housing, Building and Planning (Boverket)	https://www.boverket.se/	https://www.boverket.se/sv/klimatdeklaration/klimatdatabas/klimatdatabas/	Database with generic climate data	Product stage Climate impact for transports for the generic construction products included in the climate database Waste of construction products Different types of energy and fuel use	Nationwide	Public	Free	The file formats offered are Excel, JSON and XML.	Climate data for construction products is based on data from the IVL Swedish Environmental Institute	Yearly	The content is made available as open data via an API partly in JSON format and partly in XML format			
SWE4	Energy declaration register	The energy declaration is a document that, among other things, shows how much energy is used in a building when it is in use. All rental properties, residential or commercial premises, must be energy certified. The energy declaration gives you information about the building's energy use. The aim is to promote efficient energy use and a good indoor environment in buildings.	The Swedish National Board of Housing, Building and Planning (Boverket)	https://www.boverket.se/	https://www.boverket.se/sv/energideklaration/sok-energideklaration/	Energy declaration register	Estimated energy use	Nationwide	Public	Free	Structured database	Energy declarations are carried out by a certified energy expert. This person will collect information about your building, carry out an energy inspection and submit the completed energy declaration to the Housing Authority.	Continuously	No			
SWE5	SCB - Statistics Sweden	Statistics Sweden are responsible for official statistics and for other government statistics. This means that they develop, produce and disseminate the statistics. In addition, they coordinate the system for the official statistics in Sweden. Their main task is to supply users and customers with statistics for decision making, debate and research. They do this mainly through assignments from the government and other government agencies. They also have costumers from the private sector among researchers. They also conduct long-term cooperation projects with statistical offices in developing countries, which are financed by Sida. SCB have among other things statistics on housing, construction and building which is what is described in this scheme.	SCB - Statistics Sweden	https://www.scb.se/	https://www.statistikdatabasen.scb.se/pxweb/sv/ssd/	Statistics on housing, construction and building	Construction costs General statistics Housing and rent data Housing construction and conversion Income, costs and unlet dwellings in multi-dwelling buildings Real estate prices and registrations of title Real estate tax assessments Statistics on building permits for housing and non-residential buildings	Nationwide	Public	Standard information is free. If the public statistic not is enough SCB can offer statistic upon request for a fee	Structured database	SCB	The SCB database is updated Monday - Friday at 8 am. When statistics on specificly buildings are updated are not known	API	GDPR		
SWE6	Energiläget	The Swedish Energy Agency publish "Energiläget" which gives an overall picture of the energy area in Sweden at the moment and its developemt. The statistic is presented in historic time series from the 1970s. Every year "Energiläget i siffror" comes out which gather the information in Excel format. Every second year a publication comes out where figures and analysis are presented.	Swedish Energy Agency	https://www.energimyndigheten.se/	https://www.energimyndigheten.se/statistik/energiaget/?currentTab=1#mainheading	All type of energy statistic in Sweden. Among this energy usage in buildings.	This is the statistic presented in "Energiläget" in the context of buildings: - Final energy use in residential and services sector by energy carrier and subsector - Electricity use in the residential and services sector - Energy use for heating and hot water in dwellings and non-residential premises - Heated area in dwellings and non-residential premises - Energy prices for the residential and services sector	Nationwide	Public	Free	PDF, Excel, PPT	Swedish Energy Acency	Excel-file "Energiläget i siffror": first quarter every year, PDF report "Energiläget": every second year, PDF report "Energiläget - en översikt": every year	No			
SWE7	Boverkets Klimatdeklarationsregister	A register where all climate declarations are registered.	The Swedish National Board of Housing, Building and Planning (Boverket)	https://www.boverket.se/	https://www.boverket.se/sv/klimatdeklaration/registrera/	Climate declarations	Result of climate declarations	Nationwide	The register is closed. But it is possible to request a separate climate declaration from Boverket as a public document			The Swedish National Board of Housing, Building and Planning (Boverket)	Not known				
SWE8	BM Tool	BM (Byggsektorns miljöberäkningsverktyg) is a tool used to calculate the climate impact of a building.	IVL (Swedish environmental research institute)	https://www.ivl.se/english/ivl.html	https://www.ivl.se/projektwebbar/byggsektorns-miljoberakningsverktyg/om-bm-och-licenser.html	Climate data on building materials, transportation and site operations.	The tool gives access to a database with climate data from different sources: - Boverkets databas - BM:s own database for building materials - EPD:s - Parts of the Finnish database - Climate data on infrastructure from Trafikverkets own database (The Swedish Transport Administration)		Public if using the simpliest licens	There are differnet licenses. The simpliest one, "BM Free" is free	LCA tool with databases	IVL					

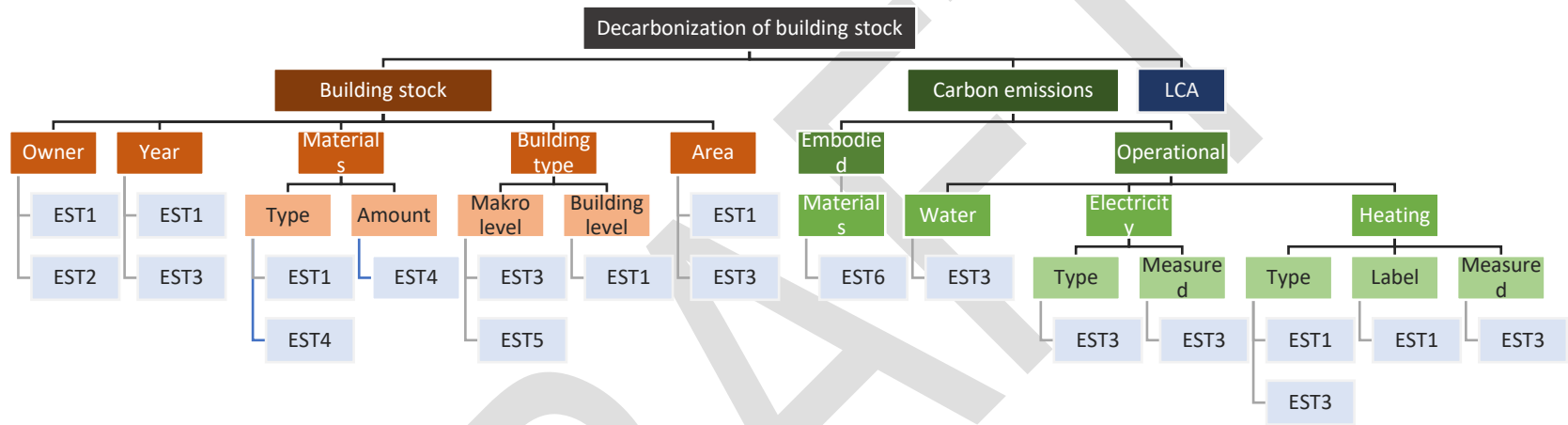## 9.2 Appendix B – Database mapping

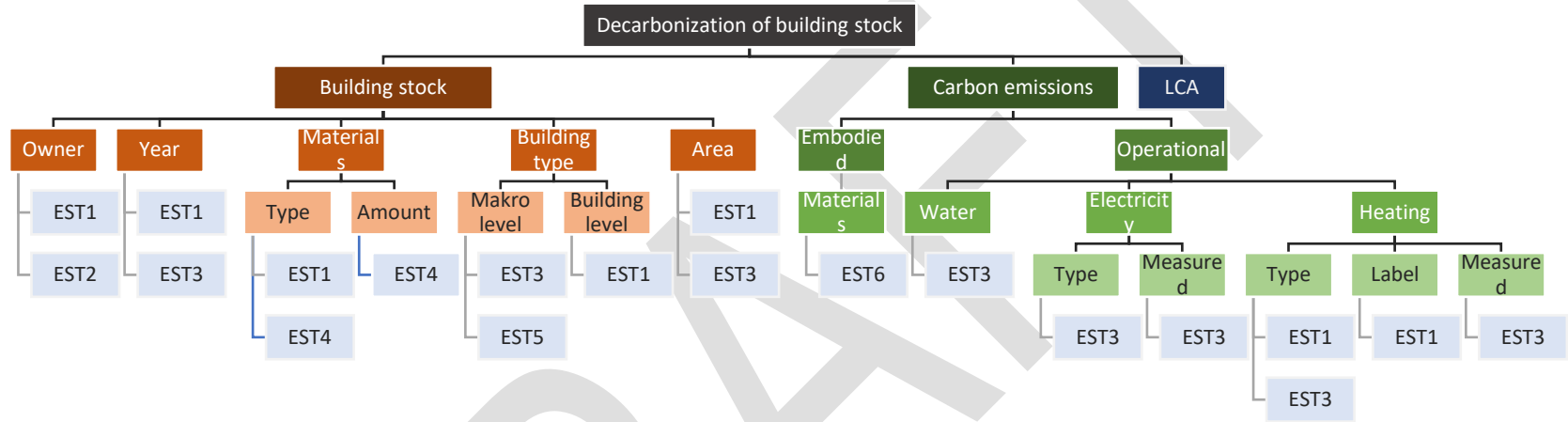### 9.2.1 Database mapping - Denmark

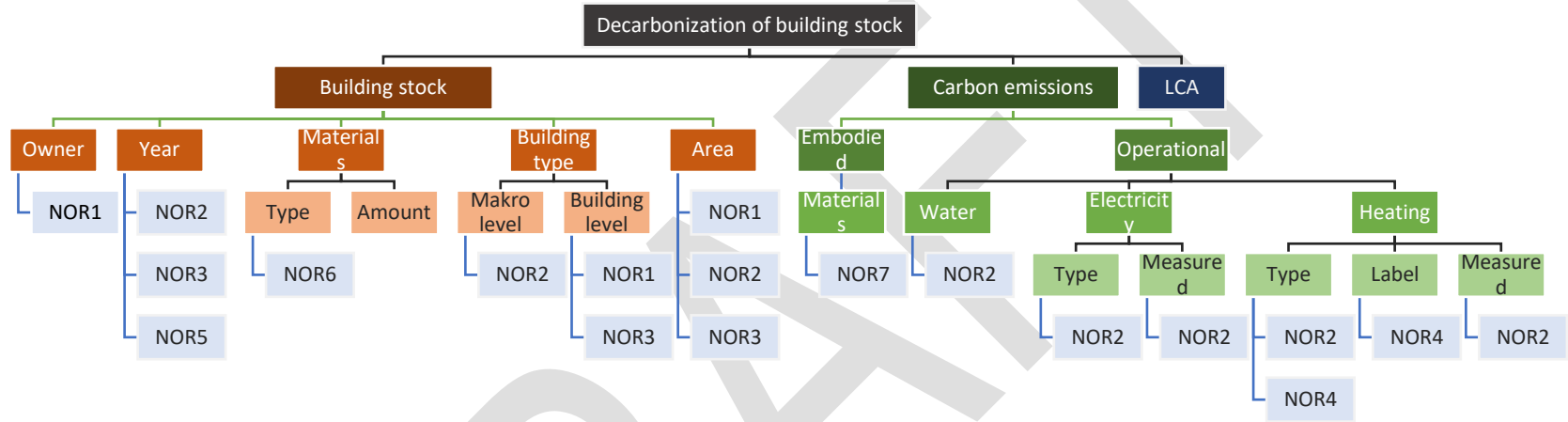## 9.2.2 Database mapping - Iceland
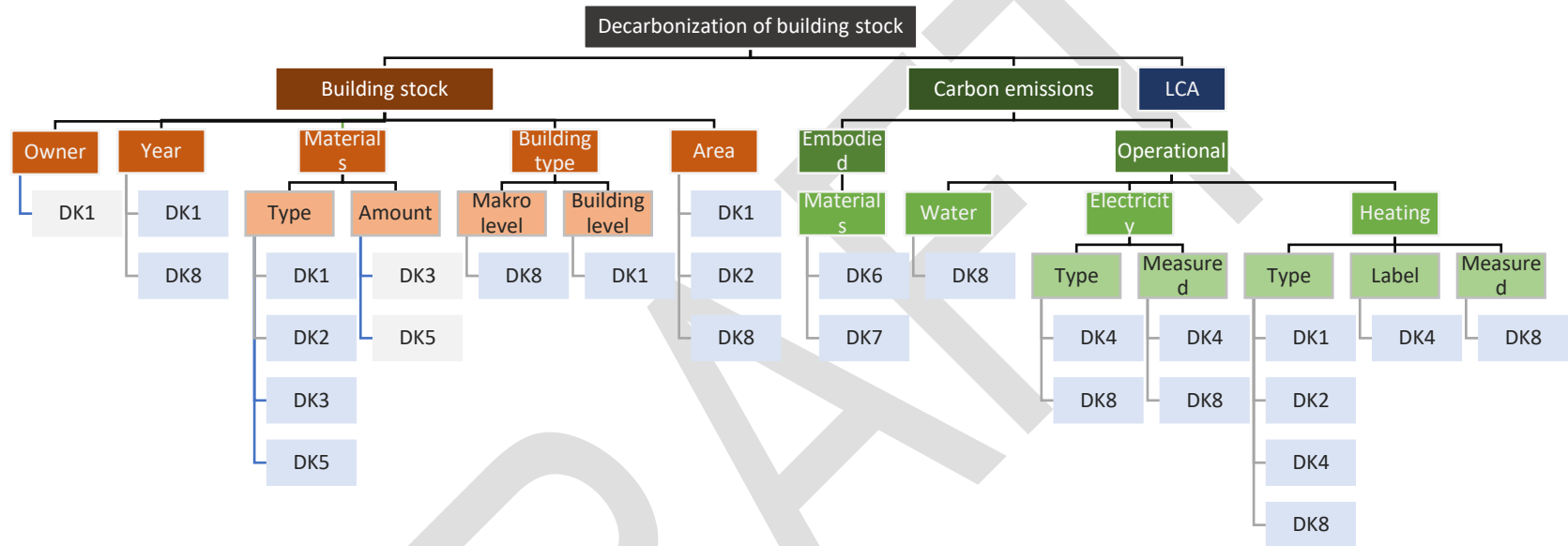
9.2.3 Database mapping - Estonia

9.2.4 Database mapping - Finland

9.2.5 Database mapping - Norway

9.2.6 Database mapping - Sweden