CONCERTED ACTION
ENERGY PERFORMANCE OF BUILDINGS

Implementation of the EPBD Sweden

Status in 2021

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Important information: *This country report was written during December 2021/January 2022 and comprises a summary of all measures of the EPBD implemented in Sweden as of December 2021. The report summarises the national regulatory framework ranging from Acts and Ordinances to mandatory provisions and general recommendations of governmental agencies, particularly from the Swedish National Board of Housing, Building and Planning (henceforth Boverket).*

1. Introduction

Sweden had most elements of the EPBD already in place in 2014. Since then, Sweden has been working hard on evolving the Nearly Zero Energy regulations, i.e., establishing the NZEB levels and a numerical indicator for energy performance. The 2018 revision of the EPBD has resulted in the following revised acts and regulations.

Sweden introduced NZEB regulations in the Planning and Building Ordinance, PBF (2011:338) (henceforth PBF) in December 2016, and in Boverket's[1] Building regulations BBR (BFS 2011:6) (henceforth BBR) in 2017, with the new concept, the primary energy number, as a measure of the building's energy performance. In 2018, NZEB and the primary energy number were introduced in Boverket's Regulations on energy performance certificates for buildings, BED (BFS 2007:4) (henceforth BED).

In July and September 2020, the PBF and the BBR were revised when weighting factors, instead of primary energy factors, were introduced. This revision also meant that the requirements for energy performance for buildings were tightened. In March 2021, the Act (2006:985) on energy performance certificates for buildings as well as Boverket's BED was updated regarding inspections.

In 2017, the building stock (referred to as the housing and service sector in the national statistics), accounted for 39% of the final energy consumption in Sweden[2]. Temperature-corrected statistics divided by building surface in the period of 1995-2017 show a trend where energy use decreased by 33% for single-family houses, 22% for residential apartment buildings and 21% for non-residential buildings.

2. Current Status of Implementation of the EPBD

2.I. Energy performance requirements: NEW BUILDINGS

2.I.i. Progress and current status of new buildings (regulation overall performance)

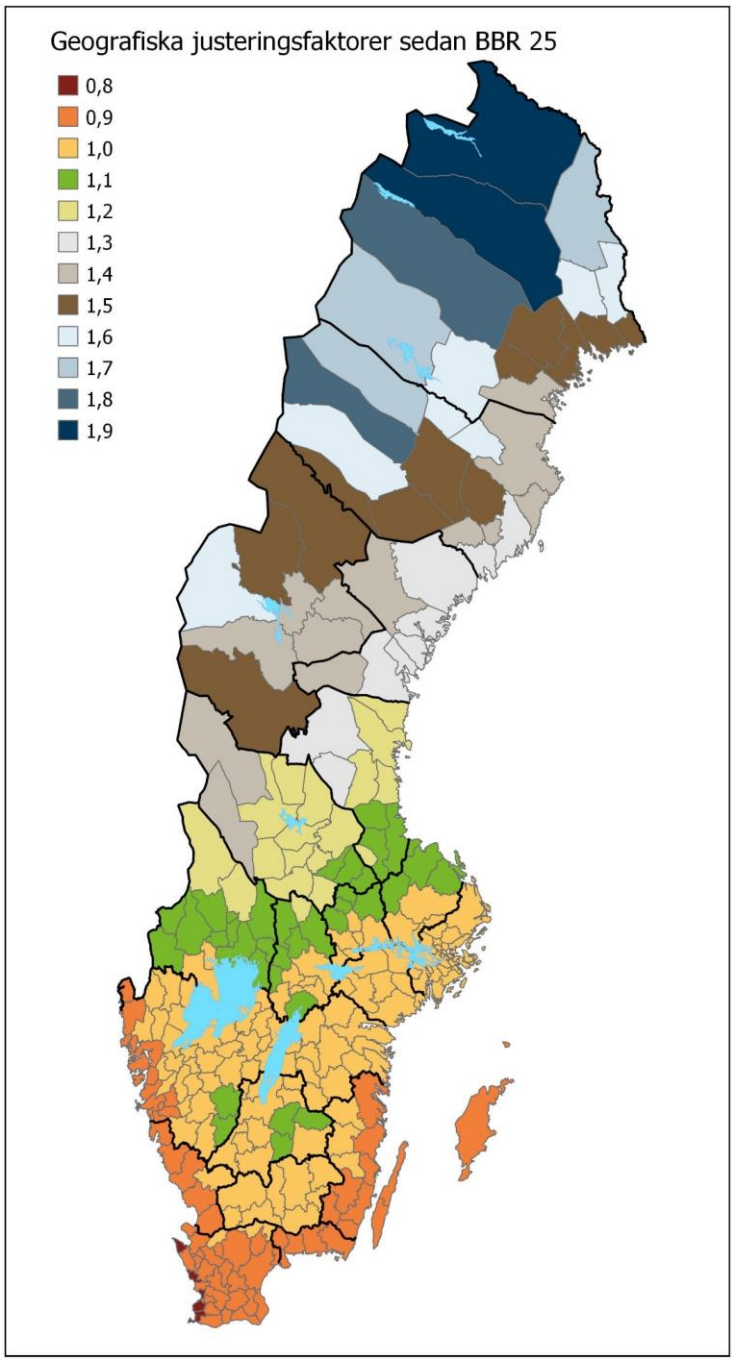

Figure 1. Climatic zones

From 2006 to 2017, Sweden had energy requirements set in the BBR that were continuously tightened to gradually improve the energy performance of new constructions.

In 2015 (BFS 2015:3 BBR 22), the requirements were tightened, and the geographic climatic zones for climate correction (Figure 1) of energy requirements were changed. As an example, see in Table 1 how the energy performance requirement for an apartment building in Växjö has developed over time.

	2006	2009	2012	2015	2017	2020
Not electrically heated (specific, delivered, energy)	110	110	90	80	-	-
Electrically heated (specific, delivered, energy)	75	55	55	50	-	-
All apartment buildings (primary energy number)	-	-	-	-	85 New system boundary	75 New system boundary

Table 1. Development of energy performance (kWh/m^2 A_{temp} and year) requirement, for apartments buildings over time.

A new method for adjusting to normal use was developed and came into force in December 2016, in Boverket's Regulations on the determination of the building's energy use during normal use and a normal year, BEN[3] (2016:12) (henceforth BEN).

In 2017 (BFS 2017:5 BBR 25), a major change in the requirements was implemented with the introduction of the NZEB definition in Swedish regulations. The system boundaries for energy performance requirements in BBR were changed from measured delivered energy to a primary energy number. The numerical requirements levels were changed, but the change was not intended as a 'tightening' of existing requirements levels, but rather comprised a recalculation according to the new system boundaries.

In 2020 (2020:4 BBR 29), changes were made concerning how the primary energy number is calculated, when weighting factors, instead of primary energy factors, were introduced. This revision of the BBR also meant that the requirements for energy performance of buildings were tightened, for most types of buildings. The revised requirement levels were based on the calculation of cost-optimal levels.

2.I.ii. Format of national transposition and implementation of existing regulations

Since September 2020, new requirements for energy performance apply in the BBR which now also includes regulations on accessibility, fire safety, hygiene, health and the environment (including ventilation and thermal comfort), acoustics and safety in use, as well as energy performance.

Energy performance regulations apply to all buildings, except for:

- greenhouses or similar buildings that could not be used for their intended purpose if these requirements had to be met;
- residential buildings used, or intended for use, for either less than four months per year or during a limited part of the year corresponding to an energy use estimated to be less than 25% of what would be the case in full-year use;
- buildings that do not require space heating or AC for most of the year;
- buildings where no space is intended to be heated to more than 10 ºC and where the need for energy for comfort cooling, hot water and building property energy use is low.

The requirements are differentiated per the following building types: single-family houses, residential apartment buildings and non-residential buildings. For single-family houses, requirements depend on the size of the building, where the smallest single-family houses are allowed a slightly higher primary energy number.

According to the building regulations (BFS 2011:6), new buildings must be designed in such a way that energy use is limited by low heat losses, low cooling demands, efficient use of heating and cooling, and efficient use of electricity.

Buildings must be designed so that the following information can be provided:

- the primary energy number (EPpet) (energy performance);
- the installed maximum electric power rating for heating devices (partial EPB requirement);
- the average air leakage of the building envelope (partial EPB requirement, only applicable for buildings of less than 50 m^2);
- the average thermal transmittance (Um) of the building envelope (Aom) (partial EPB requirement), amounts, as a maximum, to the values indicated in Table 2.

	Energy performance expressed as a primary energy number (EP_{pet}) [kWh/m^2 A_{temp} per year]	Installed electric input for heating (kW)	Average heat transfer coefficient (Um) [W/m^2 K]	Climate envelope's average air leakage rate at 50 Pa pressure difference (l/s m^2)
Residential buildings				
Single-family houses > 130 m^2 A_{temp}	90	4.5 + 1.7 x (F_{geo} – 1)[1)]	0.3	In accordance with the BBR 9:26
Single-family houses > 90 – 130 m^2 A_{temp}	95			
Single-family houses > 50 – 90 m^2 A_{temp}	100			
Single-family houses ≤ 50 m^2 A_{temp}	No requirement	No requirement	0,33	0,6
Residential apartment buildings	75[4)]	4.5 + 1.7 x (F_{geo} – 1)[1)] [5)]	0.4	In accordance with 9:26
Non-residential buildings				
Non-residential buildings	70[2)]	4.5 + 1.7 x (F_{geo} – 1)[1)] [3)]		In accordance with 9:26
Non-residential buildings ≤ 50 m^2 A_{temp}	No requirement	No requirement	0.33	0.6

1) An addition may be made by (0.025 + 0.02(F_{geo} -1)) x (A_{temp} – 130) when A_{temp} is greater than 130 m^2. If the geographical adjustment factor F_{geo} is less than 1.0, it is set at 1.0 when calculating the installed electric power.
2) An addition may be made by 40 x (q_{medel} – 0.35) when the outdoor air flow in temperature-regulated spaces, for reasons of increased hygiene, is greater, than 0.35 l/s per m^2, where qmedel is the average specific outdoor air flow during the heating season and may as a maximum be included up to 1.00 l/s per m^2.
3) An addition may be made by (0.022 + 0.02(F_{geo} -1)) x (q – 0.35)A_{temp} when the outdoor air flow, for reasons of continuous hygiene, is greater, than 0.35 l/s per m^2in temperature regulated spaces, where q is the maximum specific outdoor air flow at DVUT. If the geographical adjustment factor Fgeo is less than 1.0, it is set at 1.0 in the calculation of installed electric input.
4) An addition may be made by 40(qmedel – 0.35) in multi-dwelling blocks where A_{temp} is 50 m^2 or greater and that predominantly (>50% A_{temp}) contain apartments with a living area of no more than 35 m^2 each and qmedel the outdoor air flow in temperature-regulated spaces exceeds 0.35 l/s per m2 . The addition can only be used due to requirements for ventilation in special spaces, such as bathrooms, toilets and kitchens and may as maximum be included up to 0.6 l/s per m2.
5) An addition may be made by (0.022 + 0.02(Fgeo -1)) x (q – 0.35)A_{temp} in multi-dwelling blocks where A_{temp} if 50 m^2 or greater and that predominantly (>50% A_{temp}) contain apartments with a living area of no more than 35 m^2 each. The addition can only be used when the maximum outdoor air flow at DVUT in temperature regulated spaces q exceeds 0.35 l/s per m2 due to requirements for ventilation in special spaces, such as bathrooms, toilets and kitchens. If the geographical adjustment factor Fgeo is less than 1.0, it is set at 1.0 in the calculation of installed electric input.

Table 2: Maximum accepted primary energy number, installed electrical input for heating, average heat transfer coefficient and average air leakage, for single-family houses, apartment buildings and non-residential buildings (Table 9:2a, BBR 29).

The requirements in section 9:2 need not be met for buildings where the heating supply from industrial processes within the building covers most of the space heating needs. This shall be shown through a special investigation. For buildings above 50 m^2, the requirement concerning air leakage is that the building's climate envelope shall be so airtight that the requirements of the building's primary energy number and installed electric input for space heating are met (BBR 9:26).

The primary energy number (EPpet) is calculated according to the equation below:

$$EP_{pet} = \frac{\sum_{i=1}^{6}\left(\frac{E_{uppv,i}}{F_{geo}} + E_{kyl,i} + E_{tvv,i} + E_{f,i}\right) \times VF_i}{A_{temp}}$$

The energy demand for heating (Euppv) divided by a geographic adjustment factor at the municipal level is added to the energy demand for cooling (E_{kyl}), hot water (E_{tvv}) and auxillary energy (E_f), all of which are multiplied with a corresponding weighting factor (VF). The total weighted energy demand is finally divided by the area intended to be heated to more than 10 °C (A_{temp}).

The energy performance of the building is expressed as the primary energy number. The calculation of the primary energy number is based on the delivered energy and shall represent normal use. Values for normal use, for example indoor temperature and domestic hot water consumption are set in a regulation (BEN) as well as how to adjust measured values in case the use differs from the normal values. The geographical adjustment factor F_{geo} corrects the heating demand so that buildings in various parts of Sweden can be compared with respect to the difference in climate. The factor is derived as the fraction of heating demand in a type of building in the actual location to the heat demand for the same type of building in a reference location. The factor takes for example temperature, wind and insulation into consideration. The factor value is between 0.8 and 1.9. For Stockholm, the factor is 1.0. Replacing the previous climate zones with the geographical adjustment factor applied on the space heating energy made it possible to have a common national energy performance requirement as well as to use measured values for the determination of the energy performance.

Weighting factors are used for different energy carriers, see Table 3.

Energy carrier	Weighting factors (VFi)
El (VFel) – Electricity	1.8
Fjärrvärme (VFfjv) – District heating	0.7
Fjärrkyla (VFfjk) – District cooling	0.6
Fasta, flytande och gasformiga biobränslen (VFbio) – Biofuel (oil, gas, solid)	0.6
Fossil olja (VFolja) – Fossil oil	1.8
Fossil gas (VFgas) – Fossil gas	1.8

Table 3. Weighting factors (Table 9:2b, BBR 29)

BBR also requires that the building's primary energy number be verified, according to Boverket's regulations and general advice on determining the building's energy use in normal use and a normal year, BEN. See also 2.I.v.

Boverket is regularly monitoring the results of the cost-optimal calculation requirements, in accordance with the EPBD. At these times the possible effects of further tightening of requirements are examined. In case of changed technical conditions, or favourable economic conditions, the regulations are tightened to correspond with what is calculated as cost-optimal.

2.I.iii. Action plan for progression to NZEB for new buildings

The NZEB definition has been fully implemented in Sweden as of 2017. The first NZEB-related requirement levels were set in 2015. The progression plan at the time indicated a planned tightening of the levels in 2020, when both primary energy number requirements would be tightened, and the primary energy factors would change.

The last step in the Swedish implementation of NZEB for new buildings was taken in September 2020 when the PBF and the BBR were revised and **weighting factors**, instead of primary energy factors, were introduced. The revision was implemented with the aim of creating a better balance between the different types of energy systems (electrical heat pumps, district heating, local boilers). The revision meant a tightening of the energy performance requirements for certain types of buildings and a relaxation of requirements for other types of buildings. The new requirements, however, include criteria that focus on building components: the average thermal transmittance (U_m) of the building envelope (A_{om}).

The amended regulation means that weighting factors replace primary energy factors when a building's energy performance (the primary energy number) is calculated. At the same time, a clarification that the small amount of energy supplied to NZEB should largely come from renewable sources was introduced in the PBF.

The next calculation of cost-optimal levels in accordance with the EPBD is expected to be called upon by the EC in 2023.

2.I.iv. Requirements for building components for new buildings

Sweden uses functional, rather than detailed, requirements. This means that the developers are free to choose which areas they will focus their efforts on. As a result, there are no qualitative figures on specific building components. The requirements, however, include criteria that focus on building components: the average thermal transmittance (U_m) of the building envelope (A_{om}).

As long as the verified primary energy number (EP_{pet}), as well as the Um-value (and the installed electrical power for heating), is lower than the requirements, see Table 2, the building is regarded as compliant.

Small stand-alone buildings < 50 m^2 are exempted from energy performance requirements. Thus, only requirements for average U-values and airtightness apply to small buildings.

2.I.v. Enforcement systems new buildings

The parties responsible for building compliance are the developer and its representatives, the (certified) inspection manager, and the local municipal building council.

Compliance includes verification of the building's compliance to energy performance requirements. Verification can be based on calculation or measurement of actual energy data, in either way adjusted to normal use (BEN). Measurement is recommended in the BBR. The verification can be done with the help of an EPC. An EPC is issued by a certified energy expert. The EPC can also be based on calculated or measured data.

The municipal control includes all building regulations. In case the mandatory requirements are not met, the municipality can prohibit the use of the building or fine the developer until compliance is reached.

2.II. Energy performance requirements: EXISTING BUILDINGS

In existing buildings, the requirements only come into force when the building is altered, no matter how small the alteration. When a building is renovated or refurbished, it is the altered part of the building that should comply with the regulations for new buildings. Requirements are set in relation to the extent of the alteration, e.g., a window should meet the requirements for a new window, if possible according to the technical possibilities for changes in the building.

Existing buildings can have cultural values (architecture, historical context, etc.) that should be preserved even in the case of alterations to the building. This can sometimes hinder energy efficiency measures. For such cases, the BBR regulates requirements for caution and prohibition of distortion, particularly for valuable buildings, building conditions and the scope of the alteration through paragraph 1:22, and these requirements are taken into consideration when deciding on energy performance requirements for the particular building.

2.II.i. Progress, current status and plans to improve the existing building stock (regulation overall performance)

In 2017, the building stock (referred to as the housing and service sector in the national statistics), accounted for 39% of the final energy consumption in Sweden. Temperature-corrected statistics divided by the building surface in the period 1995-2017 show a trend where energy use decreased by 33% for single-family houses, 22% for residential apartment buildings and 21% for non-residential buildings.

In Sweden, different definitions of area are used; BOA refers to the residential floor area in single- and multi-family houses, not including cellars and A_{temp} refers to the temperature-controlled areas intended to be heated to more than 10 ºC, including cellars, in all type of buildings.

In Sweden, 43% of the dwellings (or 93% of residential buildings) are single-family houses, and in 2017 this part of the building stock used 32 TWh energy for heating and hot water. In 2016, the heated area amounted to 302 million m^2 (BOA, residential area in accordance with Swedish Standard SS 02 10 53, not the same as the area definition A_{temp}) and the average energy consumption for heating and hot water was 106 kWh/m^2 (excluding auxiliary energy). As of July 2019, 22% of single-family houses had an EPC (existing single-family houses are only required to be declared on sale, which explains the low proportion – new single-family houses are required to have an EPC but the proportion of new buildings is low). The declared single-family houses have an average energy performance expressed in a primary energy number of 144 kWh/m^2_{Atemp}, year. Fifteen per cent (15%) of the declared single-family houses meet the requirement for NZEB, i.e., energy class A-C.

The residential apartment buildings in Sweden comprise 51% of the dwellings (but only 5% of the buildings), and in 2017 this part of the building stock used 27 TWh of energy for heating and hot water. In 2016, the heated area amounted to 196 million m^2 (BOA) and the average energy consumption for heating and hot water was 136 kWh/m^2 (excluding auxiliary energy). Sixty-three per cent (63%) of apartment buildings had an EPC as of July 2019 (sometimes property owners do not declare the EPC even though they are subject to EPC-regulation). The declared apartment buildings have an average energy performance expressed in a primary energy number of 149 kWh/m^2_{Atemp}, year. Five per cent (5%) of the buildings meet the requirement for NZEB, i.e., energy class A-C.

The non-residential buildings that are included in the sector for residential and service (i.e., not industrial buildings) used 23 TWh of energy for heating and hot water in 2017. In 2016, the average energy consumption for heating and hot water was 124 kWh/m^2 (excluding auxiliary energy). In July 2019, there

were 55,675 non-residential buildings with an EPC. The declared buildings have an average energy performance expressed in a primary energy number of 186 kWh/m^2_{Atemp}, year. Fourteen per cent (14%) of the buildings meet the requirement for NZEB, i.e., energy class A-C.

Energy requirements apply to existing buildings only in the event of a change. A modification of a building shall not impair energy efficiency, unless there are exceptional reasons, or if the building nevertheless meets the energy requirements applicable to new buildings.

The main principle is that requirements are the same for both existing buildings undergoing change and new buildings. Accordingly, NZEB requirements also include existing buildings. Each time the regulation for new buildings is tightened, a tightening of the regulation for existing buildings follows.

2.II.ii. Regulation on individual parts, distinct from whole building performance

Energy requirements apply to existing buildings only in the event of a change. A modification of a building shall not impair energy efficiency, unless there are exceptional reasons, or if the building nevertheless meets the energy requirements applicable to new buildings.

If the altered building, for special reasons, cannot meet the energy performance requirements for new buildings, the changes in the building's envelope shall strive to ensure U-values, see Table 4.

Heat transfer coefficient to be sought for individual building parts Ui [W/m^2 K]	
Ui	**[W/m^2 K]**
U_{tak} (roof)	0.13
$U_{vägg}$ (outer wall)	0.18
U_{golv} (floor)	0.15
$U_{fönster}$ (window)	1.2
$U_{ytterdörr}$ (door)	1.2

Table 4. U-values to aim for (Table 9:92, BBR 29).

2.II.iii. Initiatives / plans to improve the existing building stock

In the analysis of the first national plan for renovation, Sweden identified the lack of knowledge in the area of energy efficiency renovations as an important obstacle. The government therefore proposed in 2017 the establishment of a national information centre for sustainable buildings. For further information see section 2.II.vi.

In the analysis of the second renovation strategy, Sweden identified further areas that need to be developed in order to achieve a higher rate of energy efficient renovations. These areas comprise further development of the EPCs, developing guidance documents for all actors taking part in the renovation process, with specific emphasis on the relation between landlord and tenants, and a broadened scope for the existing governmental insurance for banks.

On 1 December 2019, an amendment was made to the Ordinance (2014:348) on energy metering in buildings, which imposes certain requirements on the installation of individual metering and charging systems (IMD) of heating and hot water. The IMD requirement is a consequence of the EU energy efficiency directive. The objective is to give residents incentives to actively save energy by lowering the indoor temperature or using less domestic hot water.

The requirement for IMD applies to those apartment buildings with the worst EPC classification. Exceptions to the IMD requirement are granted if the building owner implements energy efficiency measures that sufficiently improve the classification. Exceptions can also be granted in relation to technical and

economical feasibility, or sometimes in relation to the requirements for caution and prohibition of distortion of particularly valuable buildings.

Sweden has several policy instruments in place that provide incentives for energy efficiency in connection to renovations. Many policy instruments complement each other and aim to correct for various market failures linked to energy efficiency and renovation, such as shared incentives or a lack of access to information. Policy instruments can also aim to speed up development in order to reach decided goals at the lowest cost possible for society. Policy instruments aimed for houses and service are:

- the Energy and carbon tax
- the Ecodesign directive
- the Energy labelling regulation
- building regulations
- energy and climate guidance
- Energy Performance Certificates
- training programmes for buildings with low energy use

In addition to this, there are policy instruments directed towards the industrial sector, which can be used for energy efficiency of industrial buildings:

- the 'industrial step'
- the 'energy step'
- requirements and support for energy audits
- energy and climate coaches
- energy efficiency networks

In addition to these policy instruments, there are a number of supportive measures in place for mobilising energy efficiency investments:

- support for market introduction, technology development and innovation clusters, administered in the form of networks with funding from the Swedish Energy Agency : residential apartment buildings (BeBo), commercial and public non-residential buildings (BeLok), single-family house manufacturers (BeSmå), public sector renting non-residential buildings (HyLok) and food distribution (BeLivs). For energy-efficient new constructions, there is a network of co-financing from the Swedish Energy Agency and the industry (Lågan);
- risk minimisation measures for investors in the form of credit guarantees (Boverket);
- use of public funds to stimulate the private sector (see point 2.II.v);
- management of investments towards energy-efficient public buildings (see point 2.II.v);
- accessible and transparent advice tools (see paragraph 2.II.vi).

2.II.iv. Long Term Renovation Strategies, status

In accordance with the governing EU directives, each Member State shall submit a Long-Term Renovation Strategy to the European Commission. The strategies must provide support for the building stock to have a high degree of energy efficiency and make it easier for existing buildings to be converted into NZEB in a cost-effective way. The strategies will also contribute to the EU's long-term goals of energy efficiency and reduction of greenhouse gas emissions and become part of Member States' national energy and climate plans.

Boverket and the Swedish Energy Agency (Energimyndigheten) were commissioned to produce a basis for the renovation strategy, which was reported to the Government Offices in December 2019. Sweden's third Long-Term Renovation Strategy was published in March 2020.

The strategy describes Sweden's building stock and provides an estimate of the pace as well as the need for renovation. The strategy also describes relevant instruments and measures and contains a roadmap with indicative milestones for 2030, 2040 and 2050.

2.II.v. Financial instruments and incentives for existing buildings

Sweden provides different types of incentives, e.g., administrative, economic and informational, including research and market introduction of efficient technologies to support energy efficiency measures in the existing building stock.

Tax deduction schemes

For single-family houses there is a tax deduction system[7] in place to stimulate renovation. Since 2009, the average total amount of deductions amount to about 11 billion SEK[8,9] (~ 1 billion €). Since 2021, there is also a tax deduction system in place for owners of single-family houses or apartments to stimulate the instalment of 'green technology' (instalment of grid-connected PVs, systems for storage of self-produced electricity and installation of charging points for electric vehicles). For apartment owners, the instalment must be made to explicitly serve the apartment owners. As of November 2021, with the system having been in place for less than a year, deductions amount to about 800 million SEK (80 million €).

Past and present financial support for the private sector

- Support aimed for stimulating the renovation and energy efficiency of rental housing in areas with socio-economic challenges, 2016-2019;
- Green bonds.

Past and present financial support for the public sector

- Municipal investments, green loans for energy-efficient apartment buildings and credits for renovation with greater energy efficiency;
- Governmental grants for the renovation of school premises with the aim of improving the learning and working environment and reducing the environmental impact, 2015-2018;
- The Public Real Estate Cooperation Fund – exchange of experience and driving development.

Financial support for energy efficiency measures in residential apartment buildings 2021

In June 2021, the government issued an ordinance for supporting energy efficiency in apartment buildings (SFS 2021:664), in force since 1 October 2021. Summarised:

- Financial support may be provided for additional costs that improve energy performance by at least 20% in apartment buildings with a primary energy number above 100 kWh/m^2 per year;
- The eligible additional costs of investments shall be determined in accordance with Article 38 of Commission Regulation (EU) No 651/2014;
- Support can be granted to buildings that predominantly contain residential apartments that are leased with a tenancy, cooperative tenancy or condominium;
- The support can be granted with a maximum of 50% of the eligible dossier. However, for medium-sized enterprises, the support may not exceed 40% and for large enterprises, not more than 30% of the eligible base;
- The requirements for caution and prohibition of distortion of particularly valuable buildings must be taken into account by having the issue of building permits investigated before the support is applied for;
- In order to receive support, the person implementing the actions must contribute to the training of new professionals in the construction sector through active collaboration with relevant upper secondary schools and the Swedish Public Employment Service (Arbetsförmedlingen), as well as by receiving apprentices;
- An independent expert shall approve the energy efficiency actions and the additional costs of investments to which the application relates, and certify after completion that the measures have been implemented, what the additional costs are and what energy efficiency is estimated to have been achieved.

In September 2021, Boverket's regulations and general advice on support for energy efficiency in apartment buildings were published, to enter into force on 1 October 2021 (BFS 2021:6). In connection with the ordinance, Boverket was also given a specific assignment from the government to inform owners of apartment buildings (the target group) about the financial support available. In connection with the entry into force of the regulation, Boverket also produced guidance on the application procedure.

2.II.vi. Information campaigns / complementary policies

In 2017, Boverket was commissioned by the government to perform a procurement to establish and run the ‘national information centre for sustainable buildings’. Focus for the information centre was to be on improving energy efficiency while performing renovation works, and on energy-efficient construction with the use of sustainable materials with low environmental impact from a life-cycle perspective.

To fulfil these purposes, the information centre shall collect and review data, ensure quality and disseminate information to target groups within the building industry. The information is distributed free of charge. The information centre is expected to improve the conditions for more renovation measures, leading to more efficient energy use, reduced climate impact, increased robustness for climate change and contribute to the fulfilment of EU directives on the energy performance and energy efficiency of buildings.

The private information service company Svensk Byggtjänst with partners was commissioned to run the website Information Centre for Sustainable Construction (ICHB) for two years (2018-2020). In 2020, the government assessed that the assignment should be conducted with a longer-term focus requiring a different form of organisation. Boverket was then assigned the main responsible for the information centre[10].

Boverket has not yet presented the future plans for the information centre.

2.III. Energy performance certificate requirements

2.III.i. Progress and current status on EPCs at sale or rental of buildings

Since 2009, all new buildings, as well as all existing buildings sold or rented, shall have an EPC. Boverket administers and supervises the EPC scheme and the national register of EPCs. This is regulated in Law 2006:985, Ordinance 2006:1592 and Regulation BFS 2007:4 on EPCs for buildings (henceforth BED).

In 2018, BED (BFS 2018:11 BED 10) was revised with the definition of the building's energy performance expressed as the primary energy number, to harmonise with the BBR. The change meant that the actual classification requirements were adjusted, but the rating levels remained unchanged.

- A = energy performance ≤ 50% of the requirement for a new building
- B = energy performance > 50 - ≤ 75% of the requirement for a new building
- C = energy performance > 75 - ≤ 100% the requirement for a new building
- D = energy performance > 100 - ≤ 135% of the requirement for a new building
- E = energy performance > 135 - ≤ 180% of the requirement for a new building
- F = energy performance > 180 - ≤ 235% of the requirement for a new building
- G = energy performance > 235% of the requirement for a new building

As of October 2021, over 680,000 buildings have been certified and registered in the national register of EPCs. Since May 2017, over 390,000 individual EPCs have been issued, a large proportion of these being related to renewal in case of sale or rental of buildings.

Boverket can enforce conditional fines in case a building owner has not obtained and registered an EPC. The first fine is at the level of the cost of an EPC, followed by further fines if the EPC is still not obtained[11]. More information is available in the relevant country report of the 'Book: 2016 – Implementing the Energy Performance of Buildings Directive (EPBD) – Featuring Country Reports'[11].

2.III.ii. Quality Assessment of EPCs

Quality Assurance

Quality assurance is made through automatic controls in the electronic certification system for all EPCs. These controls include, e.g., the level of energy performance, the heated area, the real estate information and the climate data. Controls are complemented with analyses of the EPCs database. If a certified energy expert does not meet the requirements concerning competence, access to the register and the EPC's issuing permit can be withdrawn.

The role of the independent energy expert

The EPC is issued by an independent certified energy expert on behalf of the building owner. First, an inspection is carried out, where an energy expert, preferably together with the building owner, walks through the building. The energy expert then prepares the EPC in Boverket's EPC register. Once the EPC is registered, the energy expert submits it to the building owner. The energy expert is responsible for ensuring that the EPC is prepared correctly.

In order to issue EPCs, the energy expert must be approved and certified by an accredited certification body. The certification body assesses the expertise of the energy expert. This means that the energy expert must meet the requirements and qualifications regarding training, experience and suitability for assignment, which are regulated in Boverket's regulations and general advice (2007:5) for the certification of energy experts (henceforth CEX).

To issue an EPC or inspection protocol, the energy expert must be independent in relation to the building owner. The expert shall make recommendations on cost-effective measures to improve the energy performance of the building. The recommendations shall be objective and adapted to the needs of the building. A building owner who has an independent expert employee may use him or her to issue an EPC or inspection protocol. This must then be stated in the EPC or inspection protocol.

Certification and accreditation bodies

A certification body tests and approves the person who wants to become a certified energy expert. The certification body ensures that the energy expert meets the requirements regulated in CEX. If the energy expert exhibits unsuitability for the task, the certification body may choose to revoke their certificate.

Swedac, (Swedish Board for Accreditation and Conformity Assessment) is a government authority for quality and safety. Their task is, among other things, to audit and approve certification bodies that issue certificates to energy experts. This is done on the basis of European and international standards.

Validity audit

In the Ordinance (2006:1592) on energy performance certificates, Boverket is required to conduct a yearly validity audit covering both input data and EPC results. The 2020 validity audit report concludes that the recently developed automatic user input validation function is effective in reducing unreasonable input values. The developed normalisation procedure in BEN, of the energy performance values in case with abnormal use, has also worked out with good results.

2.III.iii. Progress and current status of EPCs on public and large buildings visited by the public

Public buildings have been included in the certification system since 2008. The regulation follows the area limits provided in the EPBD Directive 2010/31/EU.

2.III.iv. Implementation of mandatory advertising requirement – status

Requirements for advertising have been implemented since 2012 and Boverket regularly carries out advertisement controls. The most recent control is mainly focusing on the information given by real estate agents during sales. If the requirements are not met, the supervisory authority can order a correction, which can be combined with a conditional fine.

Boverket has produced a manual with information about graphic elements and colour codes especially aimed at brokers and actors involved in advertising building sales[12].

2.IV Smart buildings and building systems

As a result of the amending Directive (EU) 2018/844, Sweden has implemented a number of changes related to the building's installation system, although it is not described in Swedish legislation as explicitly 'smart'. The amendments implemented in Swedish legislation concern:

- requirements related to the charging of electric vehicles (Articles 8(2) to 7), see 2.IV.i.;
- requirements for regular inspection of heating and AC systems (Article 14, 15), see 2.IV.v.;
- requirements for building automation and control systems (Article 14(4) and (4)), see 2.IV.iii.

No decision has yet been made on Sweden's implementation of the smart readiness indicator.

2.IV.i. Status and plans on smart buildings

In 2020, the PBL and PBF were revised with the addition that the technical characteristics of a building and requirements for construction works should include charging electric vehicles[13].

As of 2025, each parking space in car parks with more than ten parking spaces belonging to residential buildings has to be equipped with wiring infrastructure for charging electric vehicles. For non-residential buildings, at least 20% of parking spaces have to be equipped with wiring infrastructure, and car parks with ten (10) parking spaces or more shall have at least one parking space with a charging point installed. For buildings already constructed, which are not residential buildings, the requirement to have a charging point installed is eligible for car parks with 20 parking spaces or more.

2.IV.ii. Regulation of system performance

Sweden uses functional, rather than detailed, requirements. This means that the developers are free to choose which areas they will focus their efforts on (see also 2.I.iv and 2.II.ii).

BBR contains minimum requirements for hygienic ventilation flow (0.35 l/s per m^2 (floor area) BBR 6:25) as well as requirements for a satisfactory thermal climate (BBR 6:4). These requirements must always be achieved simultaneously with the energy requirements. The energy requirements in BBR include requirements for maximum installed electrical power for heating and domestic hot water. The requirements exist to steer away from direct electric heating as a heating method, and instead steer towards heat pumps.

BBR requires that heating, cooling and air handling installations must be designed so that they have good efficiency during normal operation. The need for cooling (AC) should be minimised. Control and monitoring systems shall ensure good energy efficiency and thermal comfort, regulated by outdoor and indoor climate and the intended use of the building. Building technology installations requiring electrical energy shall be designed to limit the power demand and use energy efficiently.

In existing buildings, the requirements only come into force when the building is altered. When a building is renovated or refurbished, it is the altered part of the building that should comply with the regulations for new buildings. Requirements are set in relation to the extent of the alteration. When altering the

ventilation system, it is required to strive to ensure that the ventilation system does not exceed the recommended maximum values for specific fan power.

2.IV.iii. Building Automation and Controls (BACs)

The PBF was revised in 2020 with a new wording in Chapter 3 Requirements for construction works § 15, as well as a definition for the system for building automation and property management.

The PBF states that, as of 2025, buildings which are not residential shall be equipped with a building automation and control system if the effective rated output of the building's heating system, AC system or combined room heating or AC and ventilation systems exceeds 290 kW.

BBR (9:52) already states that the building must have a control and monitoring system in order to maintain good energy efficiency and thermal comfort. Heating, cooling and air treatment installations shall be equipped with automatic control equipment so that the supply of heating and cooling is regulated according to power requirements in relation to the outdoor and indoor climate and the intended use of the building.

2.IV.iv. Status and encouragement of intelligent metering

Regulation regarding power and/or heat distribution grids

Since 2018, the Ordinance of Electricity (1999:716) contains requirements regarding the following: the measurement, calculation and reporting of transferred electricity; provisions stating that measuring equipment should have an open customer interface, with the possibility for the electricity user to obtain detailed information; and the provision for remotely read electricity meters. The requirements will be mandatory in 2025. Previously, monthly reading requirements applied. Many electricity meters have been changed in the 2010s to ones that can be read remotely.

There is no existing corresponding requirement for remote reading of district heating meters, but monthly reading, either manually or automatically, applies in that case as well.

The Swedish Energy Markets Inspectorate (Energimarknadsinspektionen) has a supervisory responsibility for legal requirements related to the measurement of the electricity network and district heating companies.

Regulation regarding buildings

BBR requires that the building's energy use can be continuously monitored through a measurement system. The measurement shall be readable in such way that the building's energy consumption for the desired period can be determined (BFS 2016:13).

As general advice, the reading of energy measurements should be made readily available to the subscriber, in or adjacent to the building (BFS 2020:4).

2.IV.v. Progress and current status on heating systems (Inspection / Equivalence)

This section covers the progress and current status on both heating systems and AC systems (2.IV.vi), and Sweden’s change of approach in response to Articles 14 and 15 of the EPBD.

In 2018, Boverket and Energimyndigheten were given a government assignment to investigate new requirements for inspection of heating systems and AC systems, where Sweden previously applied advice,

as well as requirements for systems for building automation and property management. The investigation report suggested that Sweden should change its approach on the issue of inspection, and that requirements should be introduced as part of the energy performance certificate system, with amendments in the EPC Act for buildings, the Regulation on EPCs (BED), the Planning and Construction Act (2010:900) (henceforth PBL), and PBF. In 2020, parliamentary and government decisions were taken on the issue and new wording of the law and regulation entered into force in May 2020.

The Act (2006:985) on the Energy Performance Certificates of buildings was revised with:

- new definitions;
- requirements that for buildings subject to energy performance certificate requirements, heating systems and AC systems with an effective rated output of 70 kW or higher are to be inspected, before the energy performance certificate is produced;
- requirements that the EPC shall include recommendations for the cost-effective improvements of the inspected systems;
- requirements for inspection of heating and AC systems also in buildings that are not subject to energy performance certificate requirements.

The personal requirements for the independent expert conducting inspections are the same as for the energy performance certificate, governed in Boverket's regulations for the certification of energy experts (BFS 2007:5 through BFS 2016:15), CEX.

In March 2021, Boverket revised regulations and general advice on EPCs for buildings (BFS 2021:3 (BED 11)[14], which contained paragraphs on exemption from the obligation to inspect certain heating and AC systems (3 a §), requirements for inspection of heating and AC systems (4 b §, section 4 c §), requirements on other information to be specified in the EPC and inspection protocol (8 §), as well as requirements on the digital transfer of EPCs or inspection protocols (16 §).

Boverket also issued a revised manual for the certified independent expert with detailed descriptions on:

- which buildings are subject to inspection and when;
- content and objectives of the inspection;
- how to determine effective rated output;
- exceptions to inspection requirements.

2.IV.ii. Progress and current status on AC systems (Inspection / Equivalence)

See 2.IV.v.

2.IV.vii. Enforcement and impact assessment of inspections

Boverket is responsible for supervision and validity control (see also 2.III.ii) of EPCs and inspections.

As stated in Article 18 of the EPBD, EU Member States shall ensure that independent control systems for energy performance certificates and reports on the inspections of heating and AC systems are established. In Sweden, this is the responsibility of Boverket, that a validity check on data used for the preparation of

energy performance certificates as well as on the results stated in the energy performance certificates is carried out yearly. As of 2021, this validity check also includes inspections of heating and AC systems.

The impact assessment BFS 2021:3 (BED 11)[15] estimates there are approximately 75,000 apartment buildings and 65,000 non-residential buildings that have a heating system with an effective rated power above 70 kW (see Figure 2 and Figure 3 below). In addition, approximately 50,000 buildings are potentially subject to a requirement for the inspection of AC systems (see Figure 4). Many buildings may fall under both categories and thus be included in both Figure 2 and Figure 4, as well as in both Figure 3 and Figure 4.

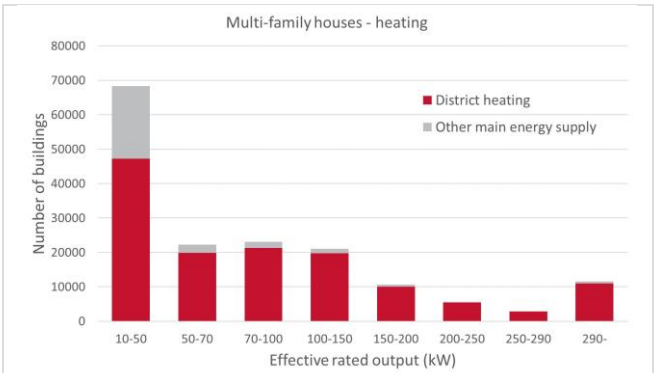

Figure 2. Distribution of estimated effective rated output for heating, residential apartment buildings (Boverket BFS 2021:3 (BED 11)).

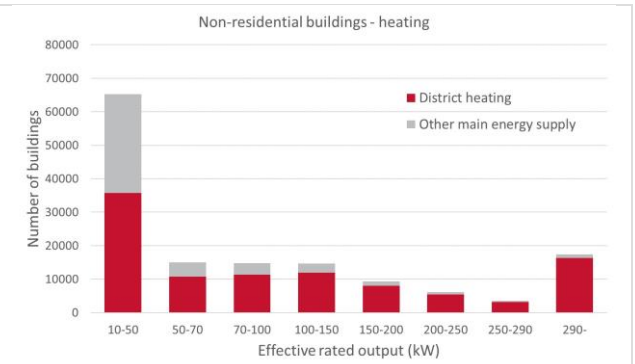

Figure 3. Distribution of estimated effective rated output for heating, non-residential buildings (Boverket BFS 2021:3 (BED 11)).

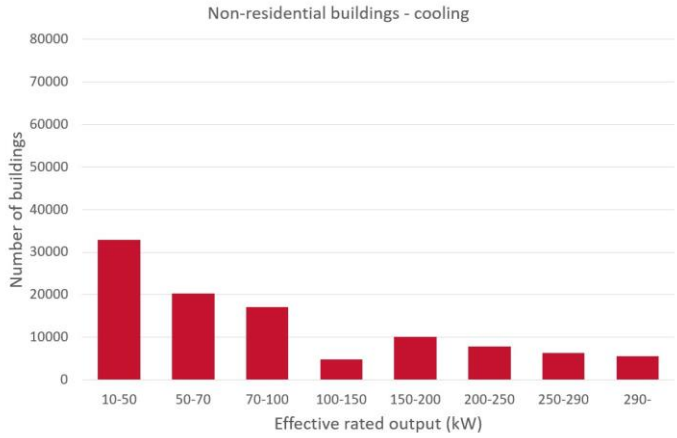

Figure 4. Distribution of estimated effective rated output nominal power for AC (Boverket BFS 2021:3 (BED 11)).

In the past, Sweden applied municipal or regional energy and climate advice instead of inspections. The impact of the advisory measures has been reported to the European Commission in equivalence reports for the alternative measures in 2014 (dnr N/2014/2681/E) and 2017 (dnr M2017/ 01474/Ee). However, there have been difficulties in sufficiently and properly demonstrating to the Commission that the advice has the same effect as inspections would have. In light of this, the government decided in 2020 that advice is no longer an option and inspections are therefore introduced into law, as of 2021.

4. Conclusions, future plans

Climate declaration requirements for new buildings

In addition to energy performance requirements, Sweden has as of 1 January 2022 a mandatory climate declaration requirement in place for new buildings.

The new Act (2021:787) on Climate Declarations for Buildings establishes the obligation to report the climate impact of the construction of a new building in a climate declaration. The purpose of the climate declaration is to reduce climate impacts from the construction of buildings by highlighting those impacts. The law on climate declarations for buildings limits reporting on emissions to the construction stage, i.e., until the building is completed, see Figure 5. The building elements included in the report are load-bearing structures, the building envelope and interior walls. The climate declaration is a partial Life Cycle Assessment (LCA), but it is still a major change for the construction sector to begin reporting on emissions.

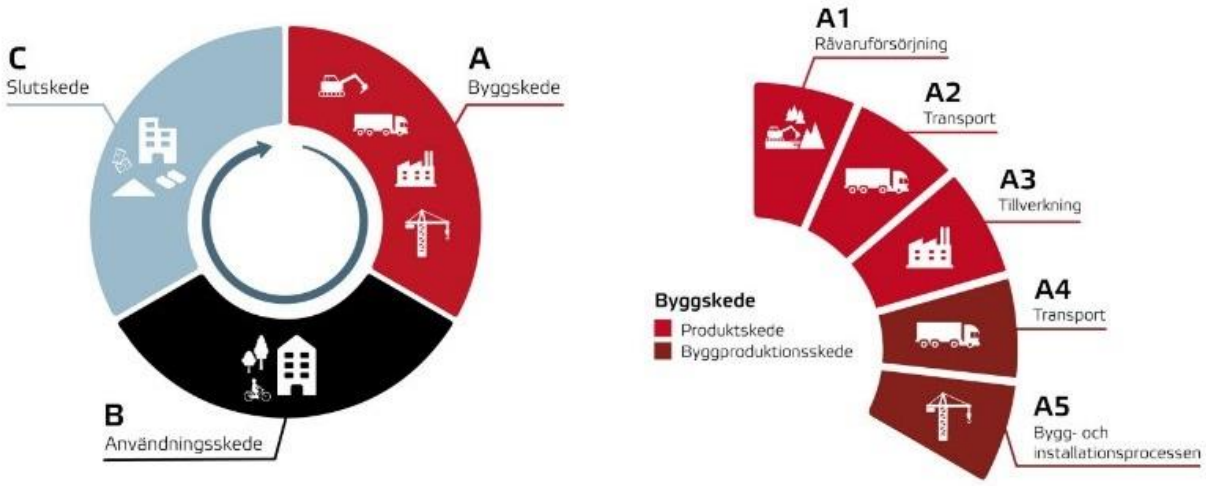

Figure 5: LCA and construction stage.

Endnotes

1. Boverket is the Swedish National Board of Housing, Building and Planning
2. http://www.energimyndigheten.se/statistik/energilaget/
3. Boverket´s regulation and general advice about the determination of the normal energy use of a building during a normal year
4. http://www.energimyndigheten.se/statistik/energilaget/
5. https://www.scb.se/hitta-statistik/statistik-efter-amne/boende-byggande-och-bebyggelse/bostadsbyggande-och-ombyggnad/bostadsbestand/pong/statistiknyhet/bostadsbestandet-2017-12-31/
6. Energimyndigheten, www.energimyndigheten.se
7. www.skatteverket.se/privat/fastigheterochbostad/rotochrutarbete/villkorforattfarotavdrag.4.5947400c11f47f7f9dd80004014.html
8. www.skatteverket.se/privat/fastigheterochbostad/rotochrutarbete/villkorforattfarotavdrag.4.5947400c11f47f7f9dd80004014.html
9. https://skatteverket.entryscape.net/store/9/resource/279
10. Uppdrag att inrätta ett informationscentrum för hållbart byggande - Boverket
11. www.epbd-ca.eu/ca-outcomes/2011-2015
12. https://www.boverket.se/contentassets/fc79f69c55564523a7e044912088aeaf/manual-for-annonsering.pdf
13. SFS2020-274.pdf (svenskforfattningssamling.se)
14. Boverkets föreskrifter om ändring i Boverkets föreskrifter och allmänna råd (2007:4) om energideklaration för byggnader, BFS 2021:3
15. Konsekvensutredning BFS 2021:3 - Boverkets föreskrifter om ändring i Boverkets föreskrifter och allmänna råd (2007:4) om energideklaration för byggnader

Annexes -Key Indicators & Decisions

Key Indicators & Decisions - General Background

no	Key Implementation Decisions – General Background	Description / value / response	Comments
01.01	Definition of public buildings (according to article 9 b)	NZEB-regulation applies to all buildings independent of use or ownership. A definition of public buildings is therefore not necessary.	Fastighetstaxeringslag (1979:1152) http://www.notisum.se/rnp/sls/lag/19791152.htm Sec 2:2. Definitions of different types of buildings Ownership not defined in this paragraph
01.02	Definition of public buildings used by the public (according to article 13)		Lag (2006:985) om energideklaration för byggnader. http://www.notisum.se/rnp/sls/lag/20060985.htm Article 13 § 5 applies to premises often visited by the public with a heated surface of over 250 m^2
01.03	Number of residential buildings	Approx. 2,400,000.	Estimated total
01.04	Number of non-residential buildings	Approx. 110,000	Estimated total
01.05	If possible, share of public buildings included in the number given in 01.04		
01.06	If possible, share of commercial buildings included in the number given in 01.04		
01.07	Number of buildings constructed per year (estimate)	Approx. 5,000 buildings Building permit applications statistics: 2019: 10,600 2020: 10,550 2021: 14,500	Rough estimate relevant for 2016
01.08	If possible, share of residential buildings constructed per year (estimate, included in the number given in 01.07)	63,000 dwellings approx. 4,000 buildings Single-family houses approx. 7,000 dwellings/year Residential apartment buildings approx. 27,000 dwellings/year	
01.09	If possible, share of non-residential buildings constructed per year (estimate, included in the number given in 01.07)		
01.10	Useful floor area of buildings constructed per year in million square meters (estimate)	8.8 million m^2 on average. Building permit applications statistics: 2019: 8 million m^2 2020: 8 million m^2 2021: 10 million m^2	www.scb.se

Key Indicators & Decisions – New Buildings

no	Key Implementation Decision – New Buildings	Description / value / response	Comments
02.01	Are building codes set as an overall value, primary energy, environment (CO2), reference building or other?	Overall value primary energy number	
02.02	Requirements for energy performance of residential buildings in current building code	Building regulation (BFS 2011:6)	
02.03	Requirements for energy performance of non-residential commercial buildings in current building code	See above; same regulation applies	
02.04	Requirements for energy performance of non-residential public buildings in current building code	See above; same regulation applies	
02.05	Is the performance level of nearly zero energy (NZEB) for new buildings defined in national legislation?	Yes	
02.06	Nearly zero energy (NZEB) level for residential buildings (level for building code)	NZEB-level is set for all new buildings.	
02.07	Year/date for nearly zero energy (NZEB) as level for residential buildings (as indicated in 02.04)	2017	
02.08	Nearly zero energy (NZEB) level for all non-residential buildings (level for building code)	NZEB-level is set for all new buildings.	
02.09	Year/date for nearly zero energy (NZEB) as level for non-residential buildings (as indicated in 02.06)	2017	
02.10	Are nearly zero energy buildings (NZEB) defined using a carbon or environment indicator?	Environment indicator	
02.11	Is renewable energy a part of the overall or an additional requirement?	Taken into account	
02.12	If renewable energy is an additional requirement to NZEB, please indicate level		
02.13	Specific comfort criteria for new buildings, provide specific parameters for instance for airtightness, minimum ventilation rates	Building regulation (BFS 2011:6)	Sec. 6 BBR

Key Implementation Decision – Existing Buildings

no	Key Implementation Decision – Existing Buildings	Description / value / response	Comment
03.01	Is the level of nearly zero energy (NZEB) for existing buildings set in national legislation?	Yes	
03.02	Is the level of nearly zero energy (NZEB) for existing buildings similar to the level for new buildings?	Yes	
03.03	Definition of nearly zero energy (NZEB) for existing residential buildings (if different from new buildings)		
03.04	Definition of nearly zero energy (NZEB) for existing non-residential buildings (if different from new buildings)	No	
03.05	Overall minimum requirements in case of major-renovation	Same as the level of nearly zero buildings	
03.06	Minimum requirements for individual building parts in case of renovation	Tabell 9:92 U_i [W/m^{2}K] U_i [W/m^{2}K] U_{tak} 0.13 (roof) $U_{vägg}$ 0.18 (outer wall) U_{golv} 0.15 (floor) $U_{fönster}$ 1.2 (window) $U_{ytterdörr}$ 1.2 (door) (BFS 2011:26). Tabell 9:95 Maximum values for SFP (specific fan power for one ventilation system) respectively SFPv (Specific fan power for one unit) SFP, [kW/(m^3/s)] SFPv [kW/(m^3/s)] Exhaust and supply air ventilation with heat recovery 2.0 Exhaust and supply air ventilation without heat recovery 1.5 Exhaust air ventilation with heat recovery 1.0 Exhaust air ventilation 0.6 (BFS 2011:26).	
03.07	National targets for renovation in connection to Long Term Renovation Strategy (number or percentage of buildings)	Expected percentage of renovated buildings (apartment buildings, schools, offices) in 2020: • 15-25% for buildings built up to 1980 • About 2% for buildings built after 1980	
03.08	National targets for renovation in connection to Long Term Renovation Strategy (expected reductions and relevant years)	Expected energy efficiency 2020-2050 according to the reference scenario (purchased heat): • Apartment buildings: -17.7% • Schools: -13.6% • Offices: - 3.4%<	

Key Implementation Decision - Energy Performance Certificates

no	Key Implementation Decision – Energy Performance Certificates	Description / value / response	Comment
04.01	Number of energy performance certificates per year (for instance average or values for 3-5 years)	85,000 EPCs average	
04.02	Number of EPCs since start of scheme	680,000 (valid) + 280,000 (invalid, not yet renewed)	
04.03	Number of EPCs for different building types	680,000	
04.04	Number of assessors	870	
04.05	Basic education requirements for assessors	Engineers CEX regulation	
04.06	Additional training demands for assessors	Five (5) years of practical experience	
04.07	Quality assurance system	**Automatic controls** Input data is controlled by software in diverse (automated) ways, for example, by climate correction and validation of administrative information on the building through other national databases. There are also programmed warnings and error messages when input data is out of a certain range. Furthermore, the calculation of energy performance is controlled by software as well. **Independent energy expert** Validity checks are performed automatically on every EPC when the expert is issuing the EPC. The energy expert is responsible for ensuring that the EPC is prepared correctly. **Certification and accreditation bodies** A certification body tests and approves the person who wants to become a certified energy expert to ensure that the energy expert meets the requirements regulated in CEX. **Validity audit** Boverket is required to conduct a yearly validity audit covering both input data and EPC results.	
04.08	National database for EPCs	Yes	
04.09	Link to national information on EPCs / Database	Publicly available: https://www.boverket.se/sv/energideklaration/sok-energideklaration/	

Key Indicators & Decisions – Smart Buildings and Building Systems

no	Key Implementation Decision – Smart Buildings and Building Systems	Description / value / response	Comment
05.01	Is there a national definition of smart buildings?	No	
05.02	Are there current support systems for smart buildings?	No	
05.03	Are there currently specific requirements for technical building systems (for instance in building codes)?	No, general requirements	
05.04	Are there current requirements for automatics (for instance in building codes)?	No	
05.05	Chosen option A or B for heating systems (inspection or other measures)	A	
05.06	Number of heating inspections; reports per year (if option A)	Not yet available	
05.07	Chosen option A or B for cooling systems (inspection or other measures)	A	
05.08	Number of AC / cooling system inspections; reports per year (if option A)	Not yet available	
05.09	Is there a national database for heating inspections?	Yes, as a part of the EPC database	
05.10	Is there a national database for cooling / AC inspections?	Yes, as a part of the EPC database	
05.11	Are inspection databases combined with EPC databases for registration of EPCs and inspection reports?	Yes, included	
05.12	Link to national information on Inspection / Database	Energideklarationshandboken	

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