Green residential buildings – top 15% Methodology

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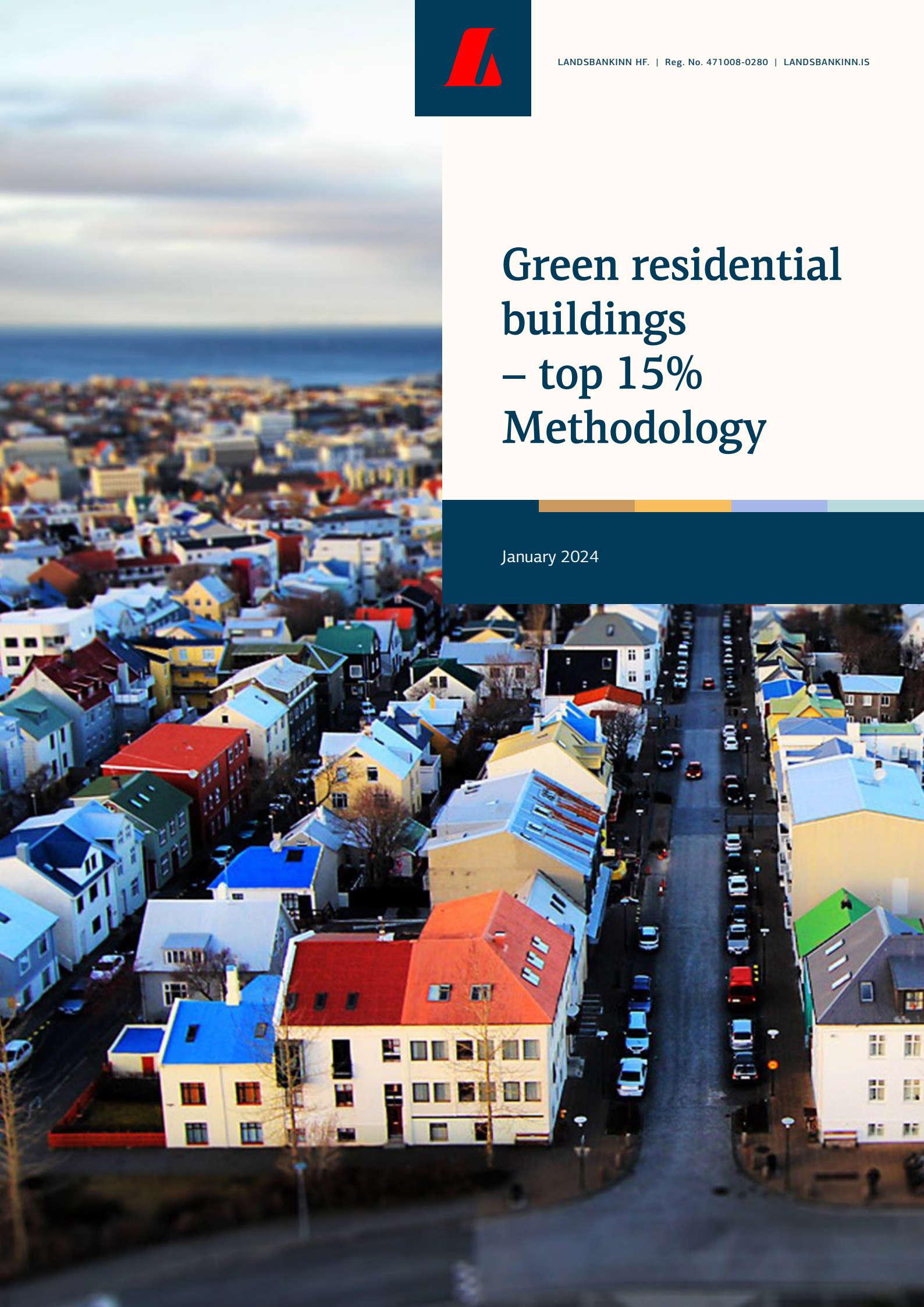

Introduction

The building sector indisputably has a significant impact on the environment yet information on emissions from the domestic sector is limited. We do know that the share of operational emissions in the life cycle assessment (LCA) of buildings is much lower for Iceland than other countries. That is because electricity production and space heating in Iceland is over 99% from renewable sources with very low emissions. As a result, embodied carbon has the greatest climate impact over the lifetime of built structures in Iceland.

While Iceland is not an EU member state, it is a member of the EEA and EU regulations are implemented in a limited way, some with exemptions while others have not been and will not be implemented. To date, no official definition for primary energy demand (PED), energy performance certificates (EPC) or nearly zero-energy buildings (NZEB) exists for Icelandic buildings like in other neighbouring or EU countries.

The Icelandic building regulation includes certain requirements for energy calculation. They will be used in addition to the following criteria described in this document.

This criteria is used to identify the threshold representing the most energy-efficient residential units in Iceland and define green buildings for the purpose of Landsbankinn's portfolio and to estimate average carbon emissions from it.

Embodied emissions

Embodied emissions are part of the production stage in LCA. The embodied emissions used in these calculations are based on results from table 3 in the report Green Residential Buildings. It provides information on embodied carbon based on an LCA for residential buildings in Iceland and fits well with the housing that is in Landsbankinn's portfolio.

Table 1: Embodied carbon based on building material.

Building material	Embodied carbon
	[$kgCO_2/m^2$/year]
Wood	1.2
Steel	3.4
Concrete - wood	3.6
Concrete - metal	4.8
Concrete*	6.1

*Including concrete – brick, hollow stone and pre-concrete

Energy emission factor

An emission factor was calculated for each postal code in the country based on the proportional division between energy sources for each postal code. Information about the division was a source from the Property Register and the National Energy Authority.

The number of residential buildings in Iceland that only use fossil fuel for heating and/or fossil fuel produced electricity is extremely low. The majority of residential buildings in the country utilise renewable energy for general use, such as electricity, geothermal energy and district heating.[1] While a limited number of buildings base heating on wooden pellets, this is an unknown quantity and not included here.

Carbon emissions from thermal water from geothermal power plants are assumed to be zero based on the Environment Agency of Iceland's factor for electricity, which was used in the analysis. Emissions from hot water in low-temperature fields was considered negligible, cf. this report. The emission factor for district heating was calculated according to annual reports and data from the companies in question.

According to data from the National Energy Authority, 91.2% of Icelandic residential housing was heated with geothermal energy, 6.1% with electricity, 2.4% with district heating and 0.2% with fossil fuel in 2020.

1 District heating is generated by a central source where electricity and, as the case may be, fossil fuel is used to heat water that is then distributed for domestic heating.

EU and Icelandic legislation and definitions

As stated in Annex I to the Commission Delegated Regulation 2021/2139/EU, the definition of PED is:

> "The calculated amount of energy needed to meet the energy demand associated with the typical uses of a building expressed by a numeric indicator of total primary energy use in kWh/m2 per year and based on the relevant national calculation methodology and as displayed on the Energy Performance Certificate (EPC)."

In Annex I to Directive 2010/31/EU, the EPC is defined as:

> "The energy performance of a building shall be determined on the basis of the calculated or actual annual energy that is consumed in order to meet the different needs associated with its typical use and shall reflect the heating energy needs and cooling energy needs (energy needed to avoid overheating) to maintain the envisaged temperature conditions of the building, and domestic hot water needs."

It further states that the energy performance of a building shall take into account:

> "...primary energy factors per energy carrier, which may be based on national or regional annual weighted averages or a specific value for onsite production."

It also states that the following aspects shall be taken into consideration in the calculation methodology:

a) the following actual thermal characteristics of the building including its internal partitions:
   i. thermal capacity;
   ii. insulation;
   iii. passive heating;
   iv. cooling elements; and
   v. thermal bridges;
b) heating installation and hot water supply, including their insulation characteristics;
c) air-conditioning installations;
d) natural and mechanical ventilation which may include air-tightness;
e) built-in lighting installation (mainly in the non-residential sector);
f) the design, positioning and orientation of the building, including outdoor climate;
g) passive solar systems and solar protection;
h) indoor climatic conditions, including the designed indoor climate;
i) internal loads; and
j) positive influence from e.g. energy from onsite renewable sources and natural lighting.

The Icelandic building regulation states:

> "The total energy demand of a building must be determined taking into consideration total conduction loss, building air exchange and outside and inside air temperature."

and

> "The total conduction loss of a structure, taking into consideration thermal bridges and the U-values of all its relevant building components, must not be higher than what is obtained when only the net area of the building components and the maximum U-values are taken into account."

Criteria for PED calculations

Based on EU and Icelandic legislation and these definitions, the relevant factors mentioned in the last chapter will be taken into account in the methodology used to calculate the PED of residential buildings. Iceland's geographical location and low-temperature climate remove the need to include energy used for cooling purposes.

PED consists of total loss of conductivity through the building envelope, natural ventilation, use of domestic hot water and electricity for lighting and consumer equipment. Internal thermal loads from electrical equipment and humans are considered to be counteractive to heat demand in PED.

As buildings in Iceland use nearly 100% renewable energy sources, the primary energy factor (PEF[2]) is considered to be 1.0 for all energy carriers.

PED is only calculated for residential units as it is assumed that garages and other structures are built separately.

2 PEF is calculated as the inverse ratio between the amount of delivered energy and the primary energy required to provide it.

Residential units are split into five different types:

- Single-family house
- Terraced house
- Semi-detached house
- Flats
- Flats – 3+ storeys

The loss of conductivity through floor and roof are based on corresponding U-values in the Icelandic building regulation and previously on other building regulations. It does not specifically consider thermal bridges as it is considered that the total conduction loss of a structure does not exceed the maximum U-values in the regulations.

Conduction loss through walls is based on the weighted average U-value of walls in the regulation where loss through doors and windows is taken into account. The requirements are the same regardless of materials or structure and are the minimum criteria for energy efficiency.

Heat-loss requirements from the Icelandic building regulation that was in force in the construction year of a residential unit is used to calculate the heat demand.

Apartments and terraced and semi-detached residential units are connected and share at least one wall. The following assumptions are included in the calculations:

- Terraced: 2.5 outer walls (on average)
- Semi-detached: 3 outer walls
- Apartments:
  - <80m^2: 1 outer wall (on average)
  - 80-160m^2: 2 outer walls (on average)
  - >160m^2: 3 outer walls (on average)

Residential units are considered to have a roof with a 20° slope.

Heat loss through roof and floor in an apartment building is split evenly between all residential units. This is customary when splitting the heating costs in apartment buildings in Iceland.

The same indoor and outdoor temperature is applied to all residential units regardless of location to ensure a fair comparison. The average temperature in Reykjavík for the past 30 years is used.

The internal thermal loads per net heated area include heat from lighting and consumer equipment in addition to human occupancy. They are calculated in accordance with usage/occupancy rate and thermal load factors in table 2. This is considered to reduce the energy demand.

Energy demand for domestic hot water, lighting and consumer equipment is calculated according to table 2. The electricity energy demand of lighting and consumer equipment equals the thermal loads of these.

Heat loss through natural ventilation is applied to all residential units as no information exists on mechanical ventilation. The ventilation is considered to be 0.8 changes per hour for all spaces.

No regard is had for any renovations or action to improve the energy efficiency of residential units that may have taken place since initial construction. That information is currently unavailable. The same holds for on-site renewable energy sources.

Threshold for the top 15% energy efficient residential buildings

The carbon emissions produced and energy demand for each residential building in the Icelandic building stock was calculated based on the above criteria and methodologies.

The top 15% most energy-efficient residential units are expected to have PEDe[3] equal to or less than:

Type	PEDe kWh/m^2
Single-family house	319
Semi-detached	291
Terraced	279
Flats	239
Flats - 3+ storeys	196

Average carbon emissions of the top 15% residential units are calculated to be below 6.4 kgCO^{2}e/m^2.

As the building stock in Iceland continues to develop, it is necessary to reevaluate the threshold on a regular basis, at least annually.

3 Primary energy demand equivalent.

Table 2: Standardised use of buildings and domestic hot water[4]

	Usage/ occupancy rate		Internal thermal load per net heated area [W/m²/year]			Annual net heating energy demand for domestic hot water	
Housing type	*Lighting*	*Other*	*Lighting*	*Consumer equipment*	*Humans*	*Domestic hot water [kWh/m²/year]*	Max [kWh/unit/year]
Single family	0.1	0.6	6	3	2	35	4,200
Terraced / Semi-detached							
Flats							
Flats, 3+ storeys	0.1	0.6	9	4	3		

4 Decree of the Ministry of the Environment on the Energy Performance of New Buildings in Finland.