Long-term renovation strategy 2020–2050

FINLAND

Report according to Article 2a of Directive (2010/31/EU) on the energy performance of buildings, as amended by Directive 2018/844/EU

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1. Overview of Mainland Finland’s building stock

Content of this chapter: Article 2a(1)(a) of the EPBD (2010/31/EU), as amended by Directive 2018/844/EU, an overview of the national building stock, based, as appropriate, on statistical sampling and estimated share of renovated buildings in 2020.
[Content of this chapter: an overview of the national building stock, based, as appropriate, on statistical sampling and expected share of renovated buildings in 2020]

The building stock overview of the Finnish report presents the residential and non-residential building stocks with the help of indicators:

- Number in 2020 (number of housing units, number of buildings, floor area)
- Age structure by decade of completion; the oldest age group consists of all buildings built by 1960
- Energy efficiency by age group with average heating energy consumption and energy classes as indicators
- Share of renovated buildings in 2020; all buildings that were built in or before the 2010s and fall in energy classes A, B and C are considered renovated buildings
- Share of the worst performing segment, i.e. buildings in energy classes F and G of the building stock in 2020
- Heating energy consumption, including delivered energy and energy generated with heat pumps
- CO_2 emissions in 2020

The source for the information on the number of buildings is the real estate, building and spatial information register of the Finnish Digital and Population Data Services Agency (DVV). The register data is based on building project notifications, and covers 100% of buildings. Statistics Finland annually compiles official statistics based on the register data (Buildings and free-time residences, Statistics Finland; Dwellings and housing conditions, Statistics Finland).

The energy class is calculated by first calculating the building’s energy consumption. When calculating the energy consumption, surface areas of building envelope structures, thermal bridges and U-values, the compass points in which windows face, annual heat recovery efficiency, efficiencies of the premises, ventilation/air-conditioning and water heating systems, as well as electricity consumption of technical systems, consumer devices and lighting systems are calculated. Energy consumption is allocated to the heated floor area, i.e. the floor area within the inner surfaces of the building’s exterior walls (the net heated area). Energy consumption is converted into an E-value by multiplying it by energy form coefficients. As of 2018, the energy form coefficients are (Government Decree on Energy Form Coefficients for Buildings; valtioneuvoston asetus rakennuksissa käytettävien energiamuotojen kertoimien lukuarvoista, 788/2017):

- Electricity 1.2
- Fossil fuels 1.0
- Renewable energy 0.5
- District heating 0.5
- District cooling 0.28

The E-value determines a building’s energy class, based on scales introduced in 2018 (Decree of the Ministry of the Environment on Building Energy performance certificates; ympäristöministeriön asetus rakennuksen energiatodistuksesta, 1048/2017). New and renovated buildings are in energy classes A, B and C. The worst performing segments of the building stock are in energy classes F and G.

Energy consumption is the most recently added piece of statistical data (Housing energy consumption, Statistics Finland; Energy supply and consumption, Statistics Finland). CO_2 emissions are calculated based on energy consumption using emission factors (Fuel classification, Statistics Finland). The emission factors for district heating and electricity take into account the energy production structure (Energy supply and consumption, Statistics Finland):

- Wood	0 g/kWh	
- Light fuel oil	263 g/kWh	(contains a bio share of 10.7%)
- Natural gas	198 g/kWh	
- Heat pump	0 g/kWh	
- District heating	160 g/kWh	
- Electricity	65 g/kWh	

Residential buildings: 011 Single-family and semi-detached houses, 012 Terraced houses, 013 Blocks of flats. Non-residential buildings: 03 Commercial buildings, 04 Office buildings, 05 Transport and communications buildings, 06 Buildings for institutional care, 07 Assembly buildings and 08 Educational buildings.

1.1 Single-family and semi-detached houses

Single-family and semi-detached houses include a total of 1.2 million housing units in a total of 1.1 million buildings, of which 91% are permanently occupied. According to a comparison of European countries (Living Conditions, Eurostat), Finnish housing units are in extremely good condition. According to the Finnish living conditions survey (Living conditions, Statistics Finland), only 0.2% of the Finnish population live in owner-occupied flats that are in poor condition. According to energy performance certificates, a total of 6% of single-family and semi-detached houses have low energy efficiency. These houses are responsible for one-quarter of the heating emissions of the entire housing stock.

1.1.1 Number and age

The combined floor area of single-family and semi-detached houses is 166 million square metres, and they include some 1.2 million housing units in 1.1 million buildings (Table 1; Figure 1). The single-family and semi-detached house stock includes a large number of buildings built prior to the 1960s, of which only 85% are permanently occupied.

Table 1. *Floor area and number of housing units in single-family and semi-detached houses at the end of 2019.*

Indicators	Unit	–1959	1960 –1969	1970 –1979	1980 –1989	1990 –1999	2000 –2009	2010 –2019	Unknown	Total
Floor area	**mill. m²**	43	14	22	29	19	23	15	0.4	166
	%	26	8	13	18	12	14	9	0%	100%
Number of buildings	**1,000 pcs**	374	112	151	183	115	128	86	3	1,149
Number of dwellings	**1,000 pcs**	347	111	153	194	122	138	93	3	1,161
Permanently occupied	**%**	85%	88%	93%	95%	96%	94%	92%	100%	91%
Sources	Buildings and free-time residences, Statistics Finland Dwellings and housing conditions, Statistics Finland Building and dwelling production, Statistics Finland									

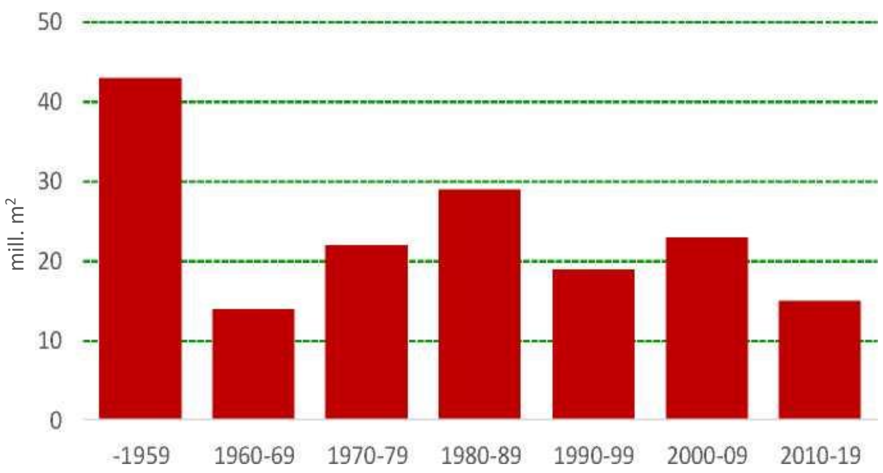


Figure 1. Floor areas of single-family and semi-detached houses according to year of completion, divided by decade. Total floor area at the end of 2019: 166 million square metres. Sources: Buildings and free-time residences, Statistics Finland; Building and dwelling production, Statistics Finland.

1.1.2 Energy efficiency

The energy efficiency of single-family and semi-detached houses is described using average heating energy consumption and energy classes. In Finland, the energy efficiency of new buildings has been persistently improved since the energy crises in the 1970s, particularly through building regulations for new construction. The average heating energy consumption has significantly decreased (Table 2). The average consumption level of buildings completed in the 1960s is 240 kWh/m^2, while for those completed in the 2010s it is one-third of this, or 85 kWh/m^2.

Table 2. *Average heating energy consumption in single-family and semi-detached houses of different ages (premises, ventilation/air-conditioning, water, electricity for heating systems).*

Indicator	Unit	–1959	1960–69	1970–79	1980–89	1990–99	2000–09	2010–19
Average heating energy consumption	kWh/m^2	225	240	220	190	175	145	85
Source	Long-term development of emissions, VTT Technical Research Centre of Finland and the Finnish Environment Institute (SYKE)							

The energy consumption of an old single-family house (built in the 1960s or 70s) is divided as follows, on average (Ekorem, 2005):

- Ventilation/air conditioning 25%
- Exterior walls 16%
- Windows 14%
- Roof structures 12%
- Water 8%
- Base floor 1%
- Lighting, electricity consumers 24%

The energy performance certificate register includes 63,454 certificates for single-family and semi-detached houses. There are 37,864 certificates compliant with the legislation from 2013 and 25,681 certificates compliant with the 2018 legislation (status in June 2019).
The energy efficiency requirements for new buildings in Finland became stricter in the 1980s, and therefore most more recently completed buildings are included in energy class D or above. The next major change took place in 2010. Almost all buildings completed after that time are included in energy class C or above (Table 3). When the distributions calculated based on the decade of completion are multiplied by the floor area shares by decade, the result is an energy class distribution for the entire single-family and semi-detached house stock (Figure 2).

New buildings built in the 2010s, and older renovated buildings are included in energy classes A, B and C. Such buildings amount to a total of 26% of the entire single-family and semi-detached house stock. Buildings with the lowest energy efficiency, in energy classes F and G, amount to 6% of the entire single-family and semi-detached house stock
(Table 4).

Table 3. *Energy class distribution of single-family and semi-detached houses based on the number of energy performance certificates, by decade. The figures for all buildings have been calculated by weighing the distributions, calculated by decade, by the floor area shares. Status in June 2019.*

Indicator energy classes	–1959	1960–69	1970–79	1980–89	1990–99	2000–09	2010–19	All buildings
A	0%	0%	0%	0%	0%	1%	14%	1%
B	3%	4%	5%	6%	4%	16%	80%	12%
C	8%	10%	16%	15%	15%	27%	4%	13%
D	32%	25%	27%	45%	53%	48%	1%	35%
E	45%	41%	43%	33%	28%	8%	0%	31%
F	8%	13%	6%	1%	0%	0%	0%	4%
G	4%	6%	3%	0%	0%	0%	0%	2%
Total	100%	100%	100%	100%	100%	100%	100%	100%
Floor area shares	26%	8%	13%	18%	12%	14%	9%	100%
Sources	Energy performance certificate register, 2018, statutory energy performance certificates, Housing Finance and Development Centre of Finland (ARA) Buildings and free-time residences, Statistics Finland							

Table 4. *Shares of new and renovated single-family and semi-detached houses (energy classes A, B and C) and single-family and semi-detached houses with the lowest energy efficiency (energy classes F and G) of the total number of single-family and semi-detached houses. The figures for all buildings have been calculated by weighing the shares of the different decades by the floor area shares. Status in June 2019.*

Indicators	–1959	1960–69	1970–79	1980–89	1990–99	2000–09	2010–19	All buildings
New and renovated buildings: energy classes A, B and C	11%	14%	21%	22%	19%	44%	98%	26%
Worst performing segments of the building stock	12%	19%	9%	1%	0%	0%	0%	6%
Source	Energy performance certificate register, 2018, statutory energy performance certificates, Housing Finance and Development Centre of Finland (ARA)							

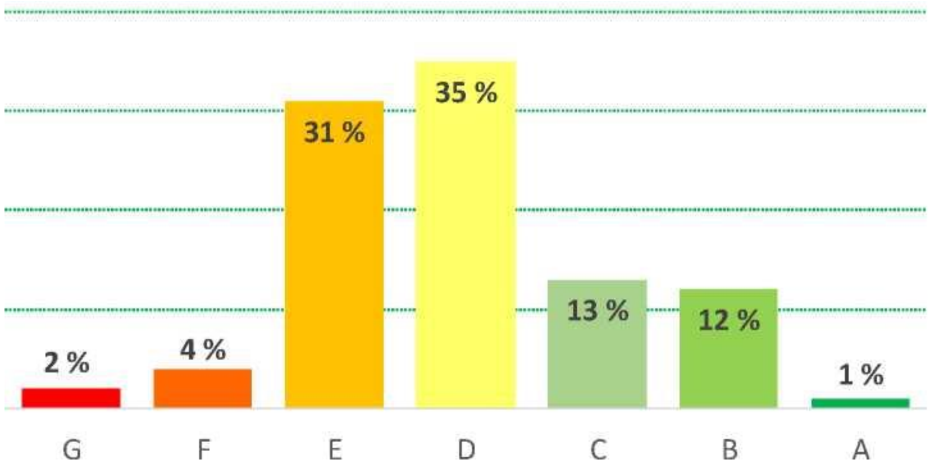


Figure 2. Energy class distribution of the detached and semi-detached house stock. The figures for all buildings have been calculated by weighing the distributions, calculated by decade, by the floor area shares. Status in June 2019. Source: Energy performance certificate register, 2018, statutory energy performance certificates, Housing Finance and Development Centre of Finland (ARA).

1.1.3 Energy consumption and emissions

A total of approximately 32 TWh of delivered energy (renewable fuels, fossil fuels, district heating, electricity) and energy generated with heat pumps is used in the heating of single-family and semi-detached houses. Of this energy, 35% is generated with wood and 30% with electricity. In addition to electric heating, the electricity includes that required to operate heat pumps and other heating systems. Most of the emissions in the heating of single-family and semi-detached houses comes from fossil fuels used in property-specific heating. The second largest source of emissions is electricity. The CO_2 emissions of single-family and semi-detached houses amount to a total of approximately 1.9 million metric tonnes (Table 5; Figure 3).

Table 5. *Heating energy consumption and CO_2 emissions of single-family and semi-detached houses by heating type.*

Indicators	Unit	Wood	Oil, other fossil fuels	Generated with heat pump	District heating	Electricity	Total
Energy consumption	% GWh	35%	10%	15%	10%	30%	100%
	GWh/year	11,380	3,150	4,960	2,630	9,610	31,730
CO_2 emissions	1,000 t CO_2	0	830	0	420	620	1,870
Sources	Housing energy consumption, Statistics Finland. Energy supply and consumption, Statistics Finland. Fuel classification, Statistics Finland District heating and electricity emission factors on the basis of the production structure and fuel classification						

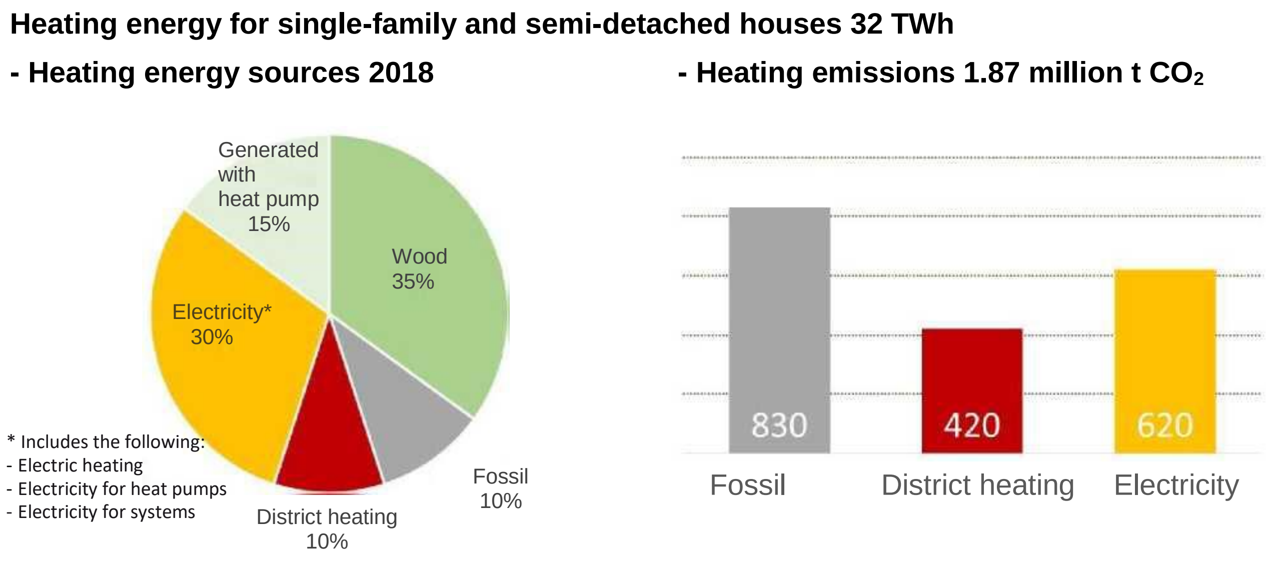


Figure 3. Heating method distribution of single-family and semi-detached houses, and CO_2 emissions from heating. Sources: Housing energy consumption, Statistics Finland; Energy supply and consumption, Statistics Finland; Fuel classification, Statistics Finland.

1.2 Terraced houses

Terraced houses include a total of 0.4 million housing units in a total of 82,000 buildings, of which 89% are permanently occupied. According to a comparison of European countries (Living Conditions, Eurostat), Finnish housing units are in extremely good condition. According to these statistics, less than 5% of Finns live in housing units that are in poor condition. According to energy performance certificates, 4% of all terraced houses have low energy efficiency. The share of terraced houses of the emissions from the entire building stock is less than ten per cent.

1.2.1 Number and age

The combined floor area of terraced houses is 35 million square metres, and they include some 0.4 million housing units in 82,000 buildings (Table 6; Figure 4). A large number of terraced houses were built in the 1970s and 80s. A considerable number of the housing units in the oldest terraced houses (built prior to the 1970s) are not permanently occupied.

Table 6. *Floor area, as well as number of buildings and number of housing units in terraced houses at the end of 2019.*

Indicator	Unit	–1959	1960 –69	1970 –79	1980 –89	1990 –99	2000 –09	2010 –19	Unknown	Total
Floor area	**mill. m^2**	1	2	8	11	6	4	3	0	35
	%	3	6	23	31	17	11	9	0	100
Number of buildings	**1,000 pcs**	2	3	14	29	16	10	7	0	82
Number of dwellings	**1,000 pcs**	12	18	88	140	72	48	36	0	414
Permanently occupied	**%**	76%	82%	87%	90%	91%	94%	90%	-	89%
Sources	Buildings and free-time residences, Statistics Finland Dwellings and housing conditions, Statistics Finland Building and dwelling production, Statistics Finland									

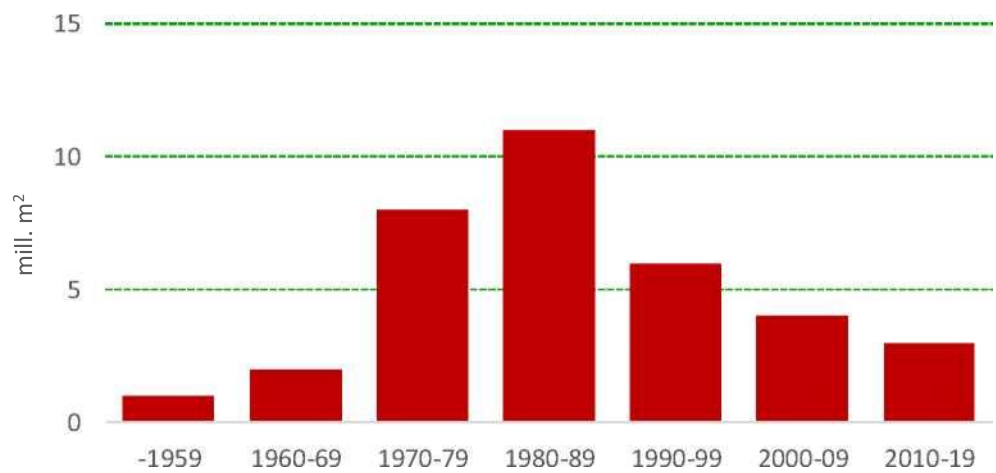


Figure 4. Floor area of terraced houses according to year of completion, by decade. Total floor area at the end of 2019: 35 million square metres. Sources: Buildings and free-time residences, Statistics Finland; Building and dwelling production, Statistics Finland

1.2.2 Energy efficiency

The energy efficiency of terraced houses is described using average heating energy consumption and energy classes. In Finland, the energy efficiency of new buildings has been continuously improved since the energy crises in the 1970s, particularly through building regulations for new construction. The heating energy consumption of terraced houses has decreased by half (Table 7). The average consumption level of buildings completed in the 1960s is 195 kWh/m^2, while the figure for those completed in the 2010s is half of this, or 100 kWh/m^2.

Table 7. *Average heating energy consumption of terraced houses of different ages.*

Indicator	Unit	–1959	1960–69	1970–79	1980–89	1990–99	2000–09	2010–19
Average heating energy consumption	**kWh/m²**	195	195	175	165	165	130	100
Source	Long-term development of emissions, VTT Technical Research Centre of Finland and the Finnish Environment Institute (SYKE)							

In an old terraced house, energy consumption (heat losses) is distributed as follows (Taloyhtiön energiakirja, 2011):

- Ventilation/air-conditioning 27–31%
- Exterior walls 12–13%
- Windows 15–18%
- Roof structures 12–18%
- Base floor 10–15%
- Water 14–18%

The energy performance certificate register includes 15,406 certificates for terraced houses. There are 10,988 certificates compliant with the legislation from 2013 and 4,418 certificates compliant with the 2018 legislation (status in June 2019). Most terraced houses are included in energy classes C, D and E. Almost all of the buildings completed after 2010 are included in energy class C or above (Table 8). When the distributions calculated based on the decade of completion are multiplied by the floor area shares for each decade, the result is an energy class distribution for the entire terraced house stock (Figure 5). New buildings built in the 2010s and older renovated buildings are included in energy classes A, B and C.
Such buildings amount to 22% of all terraced houses. Buildings with the lowest energy efficiency, in energy classes F and G, amount to a total of 4% of the terraced house stock (Table 9).

Indicator energy classes	–1959	1960–69	1970–79	1980–89	1990–99	2000–09	2010–19	All buildings
A	0%	0%	0%	0%	0%	0%	7%	0%
B	3%	2%	2%	1%	1%	2%	82%	1%
C	9%	22%	24%	14%	16%	42%	7%	21%
D	39%	48%	41%	38%	43%	30%	2%	39%
E	40%	25%	27%	44%	38%	27%	0%	35%
F	6%	3%	5%	3%	3%	0%	0%	3%
G	4%	0%	2%	0%	0%	0%	0%	1%
Total	100%	100%	100%	100%	100%	100%	100%	100%
Floor area shares	3%	6%	23%	31%	17%	11%	9%	100%
Source	Energy performance certificate register, 2018, statutory energy performance certificates, Housing Finance and Development Centre of Finland (ARA) Buildings and free-time residences, Statistics Finland							

Table 8. *Energy class distribution of terraced houses completed during different decades as shares of the total numbers. The figures for all buildings have been calculated by weighing the distributions, calculated by decade, by the floor area shares. Status in June 2019.*

Table 9. *Shares of new and renovated terraced houses (energy classes A, B and C), and terraced houses with the lowest energy efficiency (energy classes F and G) of the total number of energy performance certificates (%). The figures for all buildings have been calculated by weighing the shares of the different decades by their floor area shares. Status in June 2019.*

Indicators	–1959	1960–69	1970–79	1980–89	1990–99	2000–09	2010–19	All buildings
New and renovated buildings: energy classes A, B and C	12%	24%	26%	15%	17%	44%	96%	22%
Worst performing segments of the building stock: classes F and G	10%	3%	7%	3%	3%	0%	0%	4%
Source	Energy performance certificate register, 2018, statutory energy performance certificates, Housing Finance and Development Centre of Finland (ARA)							

Energy class distribution of terraced houses. The figures for all buildings have been calculated by weighing the distributions, calculated by decade, by the floor area shares. Status in June 2019. Source: Energy performance certificate register, 2018; statutory energy performance certificates, Housing Finance and Development Centre of Finland (ARA).

Figure 5. Energy class distribution of terraced houses. The figures for all buildings have been calculated by weighing the distributions, calculated by decade, by the floor area shares. Status in June 2019. Source: Energy performance certificate register, 2018; statutory energy performance certificates, Housing Finance and Development Centre of Finland (ARA).

1.2.3 Energy consumption and emissions

A total of 5.4 TWh of delivered energy (wood, fossil fuels, district heating, electricity) and energy generated with heat pumps is used in the heating of terraced houses. By far the most terraced houses, a total of 60%, are heated with district heating, but electric heating also has a major role in the terraced house stock (25%). Most of the emissions of terraced houses come from district heating. The total CO_2 emissions from the heating of terraced houses amount to 0.6 million metric tonnes (Table 10; Figure 6).

Table 10. *Heating energy consumption and CO_2 emissions of terraced houses by heating type.*

Indicators	Unit	Wood	Oil, other fossil fuels	Generated with heat pump	District heating	Electricity	Total
Energy consumption	**% GWh**	1%	4%	10%	60%	25%	100%
	GWh/year	130	190	590	3,110	1,380	5,400
CO_2 emissions	**1,000 t CO_2**	0	40	0	500	90	630
Sources	Housing energy consumption, Statistics Finland. Energy supply and consumption, Statistics Finland. Fuel classification, Statistics Finland District heating and electricity emission factors have been calculated on the basis of the production structure and fuel classification						

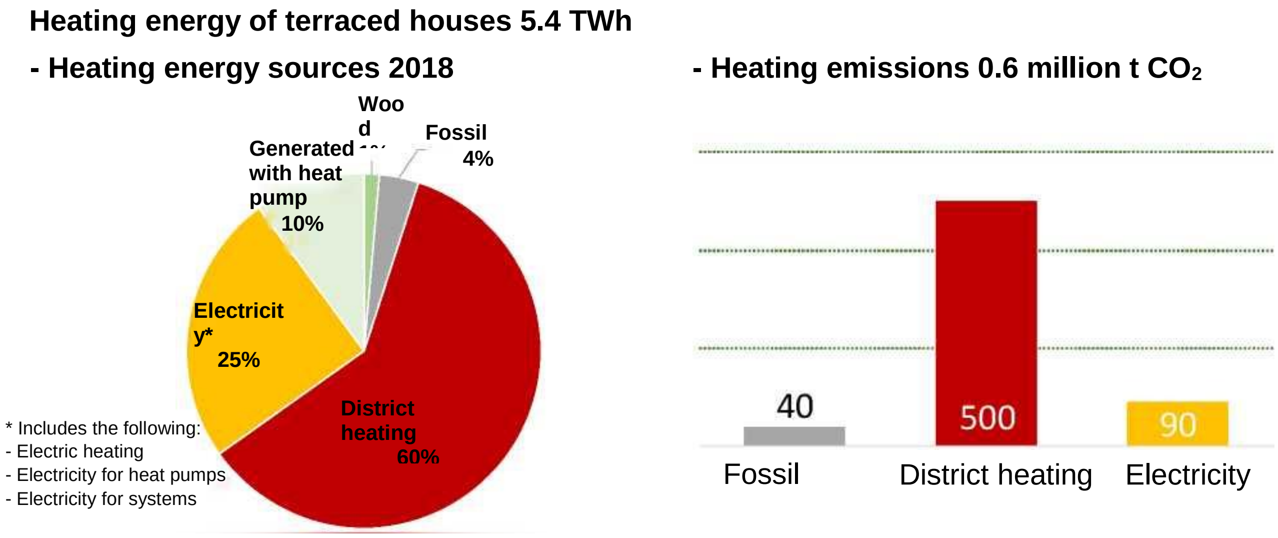


Figure 6. Terraced houses' heating energy and CO_2 emissions from heating. Sources: Housing energy consumption, Statistics Finland; Energy supply and consumption, Statistics Finland; Fuel classification, Statistics Finland.

1.3 Blocks of flats

Blocks of flats include a total of 1.4 million housing units in a total of 62,000 buildings, of which 88% are permanently occupied. According to a comparison of European countries (Living Conditions, Eurostat), Finnish housing units are in extremely good condition. According to the living condition statistics, less than 5% of the population live in housing units that are in poor condition. According to energy performance certificates, 10% of all blocks of flats have low energy efficiency. Blocks of flats are responsible for 30% of the heating emissions of the entire housing stock.

1.3.1 Number and age

The combined floor area of blocks of flats is 104 million square metres, comprising 1.4 million housing units in 62,000 buildings (Table 11; Figure 7). A large number of blocks of flats were built in the 1970s when a large share of the population moved to cities and other urban areas. The older the block of flats, the more unoccupied housing units there are. For example, only 84% of the housing units in blocks of flats completed prior to 1960 have permanent residents. There are unoccupied housing units in areas suffering from depopulation, but also in Helsinki, where they are being used as a second home or by a student, or rented out for short periods of time.

Table 11. *Floor area and number of housing units in block of flats at the end of 2019.*

Indicator	Unit	–1959	1960–69	1970–79	1980–89	1990–99	2000–09	2010–19	Total
Floor area	**mill. m²**	17	16	24	12	11	10	14	104
	%	16	15	23	12	11	10	13	100
Number of buildings	**1,000 pcs**	11	9	12	9	8	6	7	62
Number of dwellings	**1,000 pcs**	222	230	335	167	151	130	205	1,442
Permanently occupied	**%**	84%	87%	87%	89%	92%	92%	87%	88%
Sources	Buildings and free-time residences, Statistics Finland Dwellings and housing conditions, Statistics Finland Building and dwelling production, Statistics Finland								

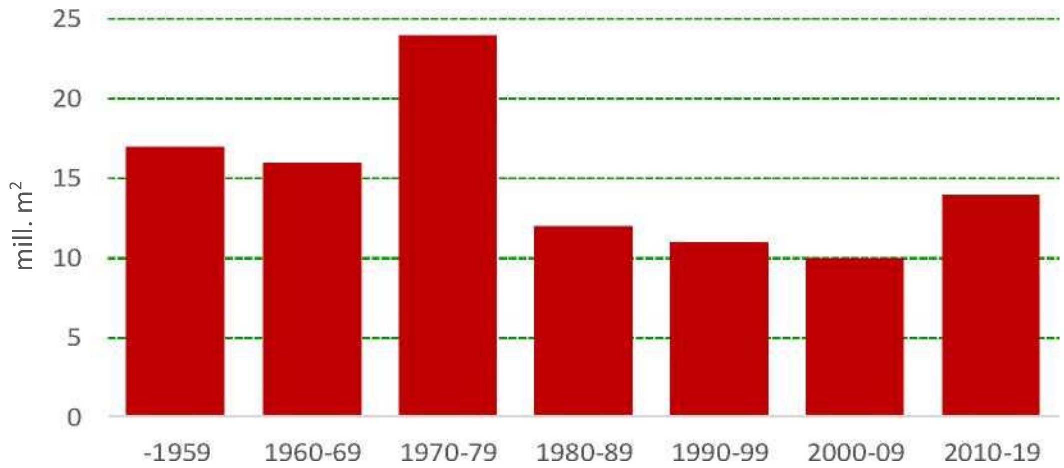


Figure 7. Combined floor area of blocks of flats completed during different decades: 104 million square metres at the end of 2019. Sources: Buildings and free-time residences, Statistics Finland; Building and dwelling production, Statistics Finland

1.3.2 Energy efficiency

Average heating energy consumption levels of blocks of flats are lower in newer buildings. In Finland, the energy efficiency of new buildings has been continuously improved since the energy crises in the 1970s, particularly through building regulations for new construction. The average heating energy consumption (heating of premises, ventilation/air-conditioning, water, electricity for heating systems) level of buildings completed prior to 1960 is 190 kWh/m^2, while the average consumption level of buildings completed after 2010 is only 85 kWh/m^2 (Table 12).

Table 12. *Average heating energy consumption of blocks of flats of different ages.*

Indicator	Unit	–1959	1960–69	1970–79	1980–89	1990–99	2000–09	2010–19
Average heating energy consumption	**kWh/m²**	190	185	175	165	175	130	85
Source	Long-term development of emissions, VTT Technical Research Centre of Finland and the Finnish Environment Institute (SYKE)							

In an old block of flats, energy consumption (heat losses) is distributed as follows (Taloyhtiön energiakirja, 2011):

- Ventilation/air-conditioning 36–37%
- Exterior walls 13–17%
- Windows 19–21%
- Roof structures 4–6%
- Base floor 5–6%
- Water 17–19%

A total of 12,854 energy performance certificates for blocks of flats are available (status in June 2019), of which 9,690 certificates comply with the 2013 legislation and 3,164 certificates comply with the 2018 legislation. Approximately 75% of block of flats completed before 2010 are included in energy classes D and E. The most common energy class since 2010 is B (Table 13).

New (completed in the 2010s) and renovated old buildings fall in energy classes A, B and C. A total of 23% of all blocks of flats are included in this group. A total of 10% of all blocks of flats are included in the lowest energy classes F and G (Table 14; Figure 8).

Table 13. *Energy class distribution of blocks of flats of different ages. The figures for all buildings have been calculated by weighing the distributions, calculated by decade, by the floor area shares. Status in June 2019.*

Indicators (energy classes)	–1959	1960–69	1970–79	1980–89	1990–99	2000–09	2010–19	All buildings
A	0%	0%	0%	0%	0%	0%	6%	1%
B	1%	1%	1%	1%	0%	5%	81%	11%
C	8%	5%	13%	9%	9%	31%	11%	11%
D	25%	38%	49%	59%	55%	40%	2%	39%
E	42%	35%	28%	29%	33%	23%	0%	28%
F	20%	18%	7%	2%	1%	1%	0%	8%
G	4%	4%	2%	0%	1%	0%	0%	2%
Total	100%	100%	100%	100%	100%	100%	100%	100%
Floor area shares	16%	15%	23%	12%	11%	10%	13%	100%
Source	Energy performance certificate register, 2018, statutory energy performance certificates, Housing Finance and Development Centre of Finland (ARA) Buildings and free-time residences, Statistics Finland							

Table 14. *Shares of new and renovated blocks of flats (energy classes A, B and C), and blocks of flats with lowest energy efficiency (energy classes F and G) of the total numbers. The figures for all buildings have been calculated by weighing the shares of the different decades by their floor area shares. Status in June 2019.*

Indicators	–1959	1960–69	1970–79	1980–89	1990–99	2000–09	2010–19	All buildings
New and renovated old blocks of flats: energy classes A, B and C	9%	6%	14%	10%	9%	36%	98%	23%
Worst performing segments of the blocks of flats: energy classes F and	24%	22%	9%	2%	2%	1%	0%	10%
Source	Energy performance certificate register, 2018, statutory energy performance certificates, Housing Finance and Development Centre of Finland (ARA)							

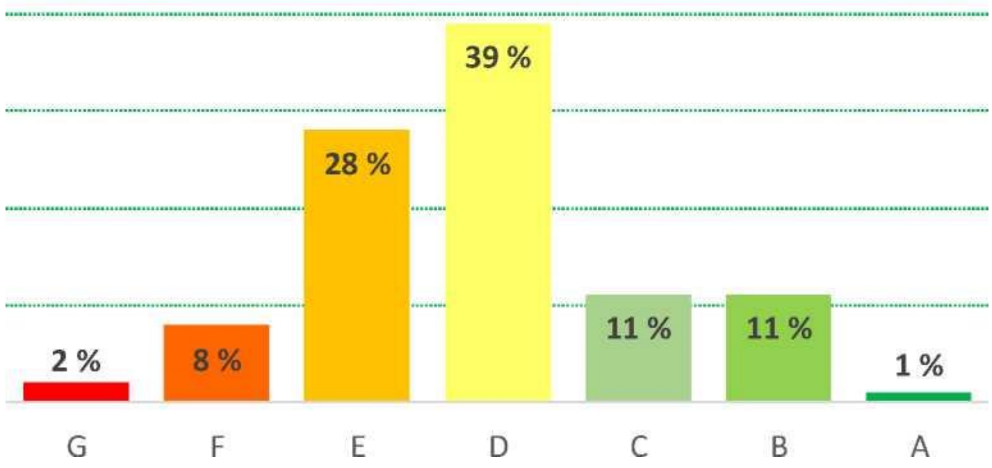


Figure 8. Energy class distribution of blocks of flats. The figures for all buildings have been calculated by weighing the distributions, calculated by decade, by the floor area shares. Status in June 2019. Source: Energy performance certificate register, 2018, statutory energy performance certificates, Housing Finance and Development Centre of Finland (ARA).

1.3.3 Energy consumption and emissions

A total of 15.4 TWh of delivered energy (fossil fuels, district heating, electricity) and energy generated with heat pumps is used in the heating of blocks of flats. District heating amounts to a total of 89% of the heating for blocks of flats, and almost all of the CO_2 emissions from blocks of flats are the result of district heating. The total CO_2 emissions from the heating of blocks of flats amount to 2.4 million metric tonnes (Table 15; Figure 9).

Table 15. *Heating energy consumption and CO_2 emissions of blocks of flats by heating type.*

Indicators	Unit	Wood	Oil, other fossil fuels	Generated with heat pump	District heating	Electricity	Total
Energy consumption	% GWh	<1%	3%	1%	89%	7%	100%
	GWh/year	50	540	80	13,630	1140	15,440
CO_2 emissions	1,000 t CO_2	0	135	0	2,180	75	2,390
Sources	Housing energy consumption, Statistics Finland Energy supply and consumption, Statistics Finland Fuel classification, Statistics Finland District heating and electricity emission factors have been calculated on the basis of the production structure and fuel classification						

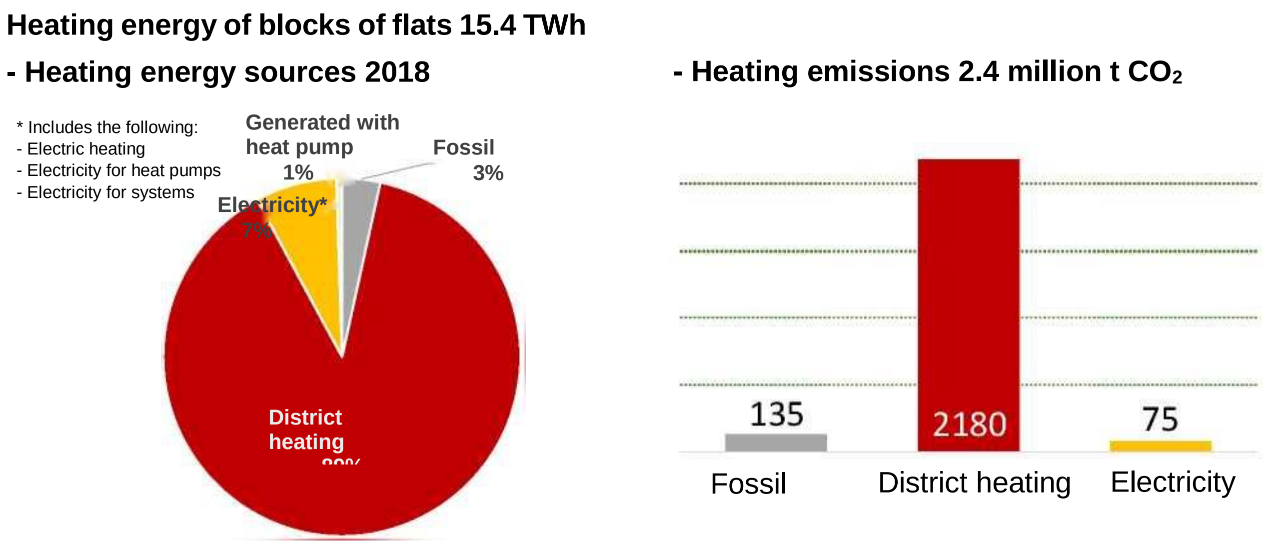


Figure 9. Heating energy and heating emissions of blocks of flats. Sources: Housing energy consumption, Statistics Finland; Energy supply and consumption, Statistics Finland; Fuel classification, Statistics Finland.

1.4 Non-residential buildings

There are a total of 144,700 non-residential buildings with a combined floor area of 110 million square metres. They are divided into commercial buildings and transport and communications buildings (40%), office buildings (20%), buildings for institutional care and educational buildings (30%) and assembly buildings (10%). According to energy performance certificates, 12% of the non-residential buildings have low energy efficiency. Non-residential buildings are responsible for almost 40% of the heating emissions of the entire housing stock.

1.4.1 Number and age structure of non-residential buildings

There are a total of 144,700 non-residential buildings with a combined floor area of 110 million square metres. Non-residential buildings include commercial buildings and transport and communications buildings (100,800 pcs; 46.7 million m^2), office buildings (10,800 pcs; 19.7 million m^2), buildings for institutional care and educational buildings (18,500 pcs; 32,9 million m^2) and assembly buildings (14,600 pcs; 10,6 million m^2). The non-residential building stock includes a large number of old buildings for institutional care and educational buildings built prior to 1960. Commercial buildings and transport and communications buildings are clearly more recent than the other public buildings (Table 16; Figure 10).

Table 16. *Floor areas of non-residential buildings divided by intended use and decade of completion.*

Number of non-residential buildings divided by building class and age group										
Indicator	**Unit**	**–1959**	**1960–69**	**1970–79**	**1980–89**	**1990-99**	**2000-09**	**2010-19**	**Unknown**	**Total**
Commercial buildings and transport and	**mill. m^2**	4.8	4.0	6.3	9.0	6.4	8.6	7.2	0.4	46.7
Office buildings	**mill. m^2**	4.6	2.0	2.9	3.9	2.1	2.6	1.5	0.1	19.7
Buildings for institutional care and educational buildings	**mill. m^2**	9.1	4.9	4.7	4.8	2.8	2.6	3.6	0.3	32.9
Assembly buildings	**mill. m^2**	2.5	0.9	1.5	2.0	1.3	1.1	1.1	0.1	10.6
Non-residential buildings total	**mill. m^2**	21.0	11.8	15.5	19.8	12.6	15.0	13.4	0.9	110.0
	%	19	11	14	18	11	14	12	1	100
Sources	Buildings and free-time residences, Statistics Finland Building and dwelling production, Statistics Finland									

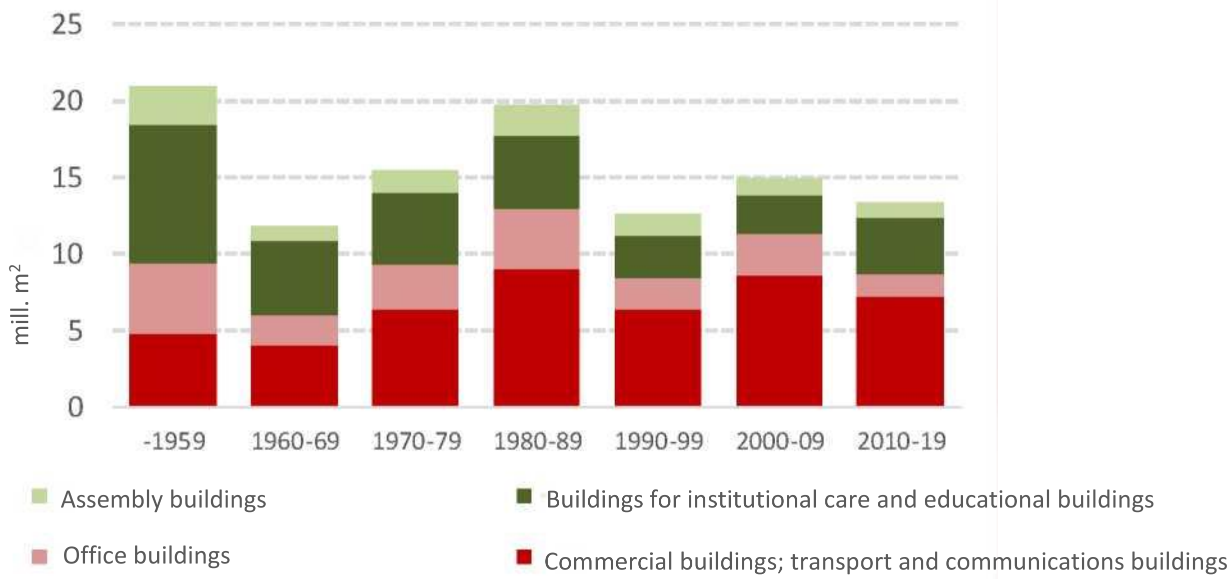


Figure 10. Combined floor area of blocks of flats completed during different decades: 110 million square metres at the end of 2019. Sources: Buildings and free-time residences, Statistics Finland; Building and dwelling production, Statistics Finland

1.4.2 Energy efficiency

The energy efficiency of non-residential buildings is described using average heating energy consumption and energy classes. In Finland, the energy efficiency of new buildings has been persistently improved since the energy crises in the 1970s, particularly through building regulations for new construction. The average heating energy consumption has significantly decreased (Table 17). The average consumption level of buildings completed in the 1970s is 195 kWh/m^2, while the average consumption level of buildings completed in the 2010s is less than half of that, or 95 kWh/m^2.

Table 17. *Average heating energy consumption of non-residential buildings of different ages.*

Indicator	Unit	–1959	1960–69	1970–79	1980–89	1990–99	2000–09	2010–19
Average heating energy consumption	**kWh/m^2**	190	165	195	175	170	105	95
Source	Long-term development of emissions, VTT Technical Research Centre of Finland and the Finnish Environment Institute (SYKE)							

The energy consumption of non-residential buildings is divided as follows, on average (Ekorem, 2005):

- Ventilation/air-conditioning 45%
- Exterior walls 10%
- Windows 9%
- Roof structures 7%
- Water 2%
- Base floor 1%
- Lighting, electricity consumers 27%

There are a total of 7,984 energy performance certificates for non-residential buildings (status in June 2019), of which 5,980 certificates comply with the 2013 legislation and 2,004 certificates comply with the 2018 legislation. Approximately 60% of the buildings completed prior to 2010 are included in energy classes C and D. The most common energy class of buildings completed after 2010 is B (Table 18). When the energy class distributions of the different age classes are divided by the floor area shares, the result is the energy class distribution of the entire non-residential building stock (Figure 11).

New (completed in the 2010s) and old renovated buildings fall in energy classes A, B and C. Their share of all non-residential buildings is 54%. A total of 14% of all non-residential buildings are included in the lowest energy classes F and G (Table 19).

Table 18. *Energy class distribution of non-residential buildings of different ages based on number of buildings. The figures for all buildings have been calculated by weighing the distributions, calculated by decade, by the floor area shares. Status in June 2019.*

Indicator (energy classes)	–1959	1960–69	1970–79	1980–89	1990–99	2000–09	2010–19	All buildings
A	0%	1%	0%	1%	0%	0%	15%	2%
B	7%	8%	15%	7%	9%	10%	77%	16%
C	28%	40%	44%	51%	34%	40%	5%	36%
D	25%	31%	16%	19%	24%	20%	2%	20%
E	18%	8%	14%	10%	15%	18%	0%	13%
F	6%	6%	4%	6%	9%	9%	0%	6%
G	15%	5%	8%	6%	10%	3%	0%	8%
Total	100%	100%	100%	100%	100%	100%	100%	100%
Floor area shares	19%	11%	14%	18%	11%	14%	12%	100%
Source	Energy performance certificate register, 2018, statutory energy performance certificates, Housing Finance and Development Centre of Finland (ARA)							

Table 19. *Shares of new and renovated non-residential buildings (energy classes A, B and C), and non-residential buildings with the lowest energy efficiency (energy classes F and G). The figures for all buildings have been calculated by weighing the shares of the different decades by the floor area shares. Status in June 2019.*

Indicators	–1959	1960–69	1970–79	1980–89	1990–99	2000–09	2010–19	All buildings
New and renovated buildings: energy classes A, B and C	35%	47%	59%	59%	43%	50%	97%	54%
Worst performing segments of the buildings: classes F and G	21%	11%	12%	12%	19%	12%	0%	14%
Source	Energy performance certificate register, 2018, statutory energy performance certificates, Housing Finance and Development Centre of Finland (ARA)							

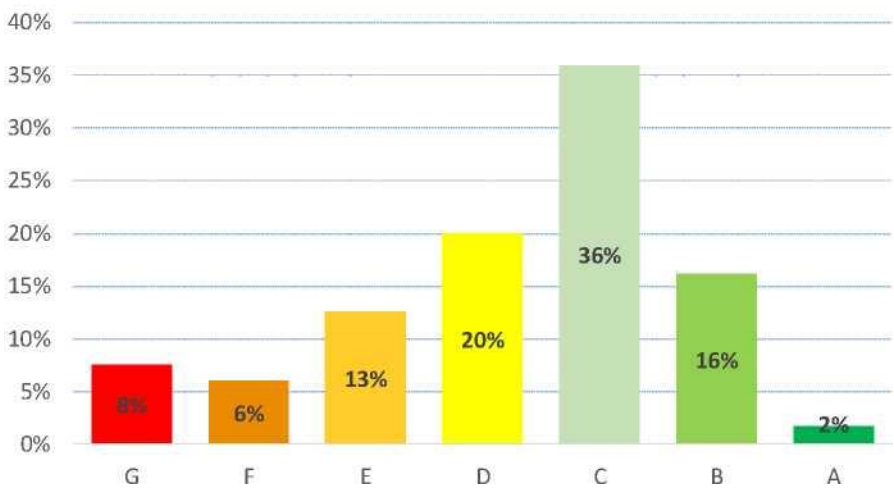


Figure 11. Energy class distribution of non-residential buildings. The figures for all buildings have been calculated by weighing the distributions, calculated by decade, by the floor area shares. Status in June 2019. Source: Energy performance certificate register, 2018, statutory energy performance certificates, Housing Finance and Development Centre of Finland (ARA).

1.4.3 Energy consumption and emissions

A total of 18 TWh of delivered energy (wood, fossil fuels, district heating, electricity) and energy generated with heat pumps is used in the heating of non-residential buildings. Most of the heating energy (65%) is generated by means of district heating, but the share of oil and other fossil fuels is significant (20%) in the case of non-residential buildings. District heating amounts to the majority of the CO_2 emissions from non-residential buildings. The total CO_2 emissions from the heating of non-residential buildings amount to 2.9 million metric tonnes (Table 20; Table 12).

Table 20. *Heating energy consumption and CO_2 emissions of non-residential buildings by heating type.*

Heating energy consumption and emissions of non-residential buildings by heating type							
Indicators	**Unit**	**Wood**	**Oil, other fossil fuels**	**Geothermal**	**District heating**	**Electricity**	**Total**
Energy consumption	**% GWh**	1%	20%	2%	67%	10%	100%
	GWh/year	875	3,275	185	11,900	2,105	18,340
CO_2 emissions	**1,000 t CO_2**	0	840	0	1,905	135	2,880
Sources	Energy supply and consumption, Statistics Finland; Energy 2018 table service, Statistics Finland. Fuel classification, Statistics Finland District heating and electricity emission factors have been calculated on the basis of the production structure and fuel classification						

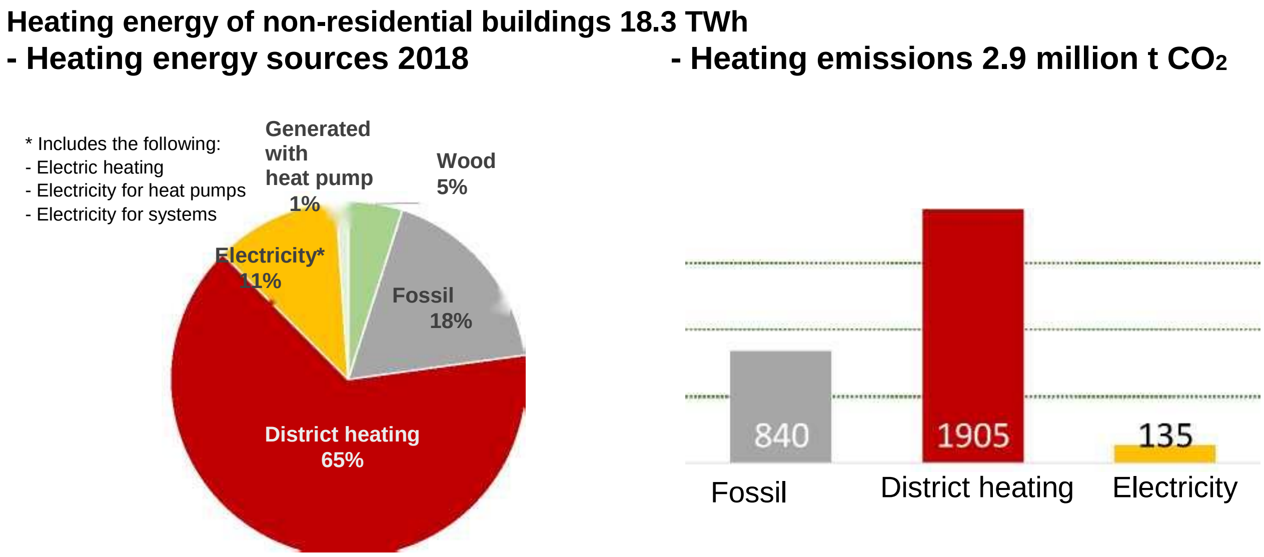


Figure 12. Heating energy and heating emissions of non-residential buildings. Sources: Energy supply and consumption, Statistics Finland; Fuel classification, Statistics Finland.

2. Cost-effective means of transforming the 2020 building stock to being highly energy-efficient and decarbonised

Contents of this chapter: Article 2a(1)(b) of the EPBD (2010/31/EU), as amended by Directive 2018/844/EU, the identification of cost-effective approaches to renovation relevant to the building type and climatic zone, considering potential relevant trigger points, where applicable, in the life cycle of the building.
[Content of this chapter: the identification of cost-effective approaches to renovation relevant to the building type and climatic zone, considering potential relevant trigger points, where applicable, in the life-cycle of the building].

Building loss and space utilisation efficiency, improvement of energy efficiency in connection with renovations and maintenance, as well as abandoning fossil energy sources in heat generation, have been identified as cost-effective approaches to promote energy efficiency and decarbonisation in Finland.

The estimated life cycles of the different building types have been analysed on the basis of the real estate, building and spatial information register of the Finnish Digital and Population Data Services Agency. Based on the regional population projections, underutilisation of the building stock will become more common in Finland. Removing all vacant buildings from the building stock would be profitable. It has been estimated that 70% of the 2020 building stock will remain in 2050.

To conserve natural resources and ensure cost-effectiveness, investments in energy efficiency improvements should be combined with renovations carried out based on other compelling reasons. The energy efficiency of all buildings in active use can be improved by means of careful maintenance and building automation.

CO_2 emissions from heating can be reduced in both property-specific heating in the burden sharing sector and centralised energy production in the EU ETS sector by abandoning fossil fuels.

2.1 Finnish climate

The climate of Finland is considered an intermediate climate, combining the characteristics of both maritime and continental climates. The weather in Finland depends to a large extent on the direction of the prevailing winds and the movements of low pressure areas. Finland's mean temperature is largely determined by the country's location in the middle latitudes, mainly between 60° and 70° north. The annual mean temperature varies from a little over +5°C in south-western Finland to a couple of degrees below zero in northern Lapland. The warmest time of the year is at the end of July (Figure 13).

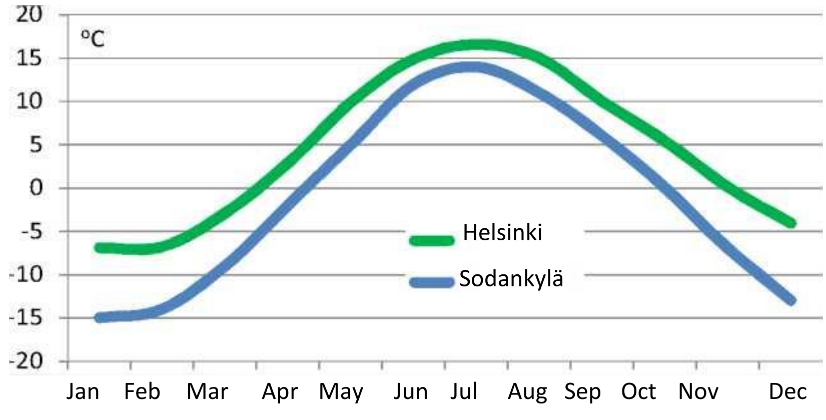


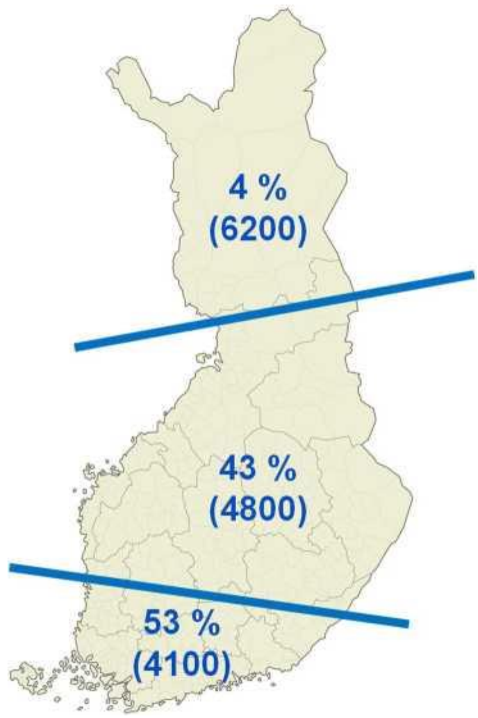
Figure 13. Long-term mean temperatures (1981–2010) in Helsinki (southern Finland) and in Sodankylä (northern Finland). Source: Monthly statistics of the Finnish Meteorological Institute.

In Mainland Finland, the highest summer temperatures outside the long-term averages are between 32 and 35°C. The highest temperature ever recorded in Finland dates back to July 2010: 37.2°C at Joensuu airport in Liperi. The coldest time of the year is at the turn of January and February. The lowest winter temperatures in Lapland and Eastern Finland are between -45°C and -50°C, and in other parts of the country usually between -35°C and -45°C. The lowest temperature recorded at a weather station in Finland in the 20th century was -51.5°C in January 1999 (Pokka, Kittilä, 28 January 1999).

The map below shows the geographical distribution of Finland's building stock and the regional heating degree days (Figure 14). By 2050, the increase in average temperature will shorten the heating season and reduce the demand for heating energy by 15–25%. The heating demand of buildings is expected to decrease in the coastal areas in particular. As the climate will still remain variable, peak demand during especially cold periods will still occur. Cooling and air-conditioning systems will consume 10–30% more energy than in 2020, but the consumption level will still remain low when compared to the heating demand.

The Ministry of the Environment commissioned the Finnish Meteorological Institute to conduct a study assessing what kind of future weather conditions Finland should be prepared for in terms of the constructed environment, buildings in particular, as the climate changes. The study focuses on the annual heating and cooling energy demand of buildings and weather changes influencing the systems' rated power demand. Another focus area is the impact of climate change on weather conditions that may cause extra load on the indoor heat and humidity conditions and the moisture performance of buildings. The impact of climate change on the environmental conditions of the constructed environment is assessed by comparing the simulated climate of 2030, 2050 and 2080 to the current situation. In addition to the average weather conditions, extreme weather phenomena that are significant in terms of the constructed environment, as well as their duration and magnitudes, are studied. The changes are compared to the climate in 1989–2018.

Figure 14. Geographical distribution of residential and non-residential buildings (percentages) and regional heating degree days (°C day). Source: Buildings and free-time residences, Statistics Finland and Heating degree days, Finnish Meteorological Institute.



2.2 Strategic policies

Three primary means of making the building stock completed by 2020 highly energy efficient and decarbonised have been identified: (1) building loss and improvement of energy efficiency, (2) improvement of energy efficiency in connection with renovations and maintenance, and (3) abandoning fossil energy sources in energy production. Natural changes to these directions can be observed due to structural changes, the development of technology and the change of valuation principles. The development will be promoted by means of binding and enabling legislation, government support, and investments in competencies and the dissemination of information (Figure 15).

Essential means of the Finnish renovation strategy

Natural development		
Regional demographic development Urban development Service network strategies Property and facility strategies ↓	Ageing of the building stock Smart automation and development of technology in general ↓	Citizens' values National objective Will and cooperation between cities Development of technology ↓
Building loss, Space utilisation efficiency	**Maintenance and renovations to improve energy efficiency**	**Decarbonised heating**
↑ Demolition subsidy from the Housing Finance and Development Centre of Finland (ARA), amendment of the Limited Liability Housing Companies	↑ Binding legislation Energy efficiency agreements Energy and renovation subsidies Undergraduate education and further education Dissemination of information and	↑ Binding legislation Taxation Subsidies
Policies and actions promoting the development		

Figure 15. Essential means of the Finnish renovation strategy.

2.3 Building loss and space utilisation efficiency

Long-term domestic migration has continued to concentrate the Finnish population in the large urban areas in southern Finland. Some residential and non-residential buildings have become vacant or underutilised in the areas that have lost part of their population. According to the most recent regional projection by Statistics Finland, this trend will continue, as natural population growth and migration will centralise in the large cities (Figure 16). The population will become older and smaller in many areas. The population of Finland will start to decrease after 2030.

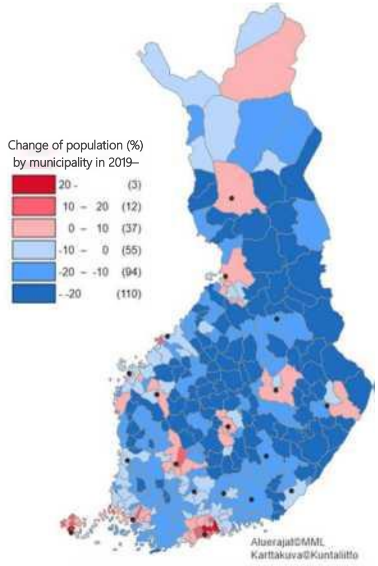
In addition to vacant buildings, building loss will occur due to technical, functional and financial reasons. Strategies to make the regional urban structure denser, service network strategies and organisations' space utilisation efficiency strategies are often implemented by giving up old buildings. On the basis of the anticipated life cycle of the old building stock and space utilisation trends, only some 70% of all the buildings completed by 2020 will remain in 2050.

The location of a building is an important factor when planning measures influencing the building. In all areas – and in the areas experiencing net emigration in particular – owners should consider the future use of the building/building stock. Is there a risk of a building becoming vacant or the building stock being underutilised? If a short future occupancy period is foreseen for the building, a major renovation is unlikely to be a profitable investment. If demand is expected in the long term, repair actions should be prioritised on the basis of the condition of the structures or systems.

If a building requires other expensive renovations in addition to measures taken to improve energy efficiency, demolishing the building may be an option worth considering. In areas with low demand, several buildings are often experiencing the same situation. Buildings in poor condition have low potential to succeed in the mutual competition for tenants or owner-occupants. In growing urban areas, it is possible to apply for rezoning of plots of land to construct a new, larger, more energy-efficient building.

In addition, rental housing companies, companies leasing commercial facilities and municipalities should organise the use of their building stock in a manner that involves abandoning underused buildings and buildings in poor condition. If a building requires plenty of other renovations in addition to those aiming at an improvement of the energy efficiency, or if there are health risks, demolishing the building and replacing it with a new one is a viable option, regardless of the location of the building.

Figure 16. Regional population projection of Finland. The population will decrease in the areas highlighted in blue and increase in the areas highlighted in red in the map (Regional population projection



2.4 Systematic maintenance

Regardless of their location, all buildings (in all energy classes and age groups) require sustained and systematic management. As part of property management, the owner should prepare a property-specific strategy or a strategy for the entire building stock on repair actions over the next 15–20 years. The strategy can involve gradual improvement of the building(s) towards the nearly zero-energy level, or preparation for the demolition of the building(s).

The correct use of facilities and technical systems involves verifying correct adjustments and settings (heating, ventilation, water pressure) and healthy indoor conditions, as well as real-time monitoring of water consumption and addressing any deviations.

Any structural damage and non-functional building technology systems should be repaired in connection with annual repairs at the latest. Annual repair actions include replacing the seals in taps and valves as necessary (influences water consumption) and resealing windows and entrance doors (influences heat losses).

2.5 Repair actions

The Ministry of the Environment has prepared guidelines for property owners and designers on achieving the energy efficiency requirements for old buildings (the National Building Code of Finland):

- Structural energy efficiency in renovation projects
- Improving energy efficiency during the renovation of culturally and historically valuable buildings
- Functional renovation solutions in terms of humidity
- Adding thermal insulation to buildings
- Repairing windows and doors, and guidelines for modification projects
- Exhaust air heat pumps in district heating systems

2.5.1 Single-family and semi-detached houses

Cost-effective measures in reducing the heat losses of old single-family and semi-detached houses that require renovation (Table 21) include adding thermal insulation in roof structures and replacing windows dating back to the time of construction. If the exterior wall structures require major renovation, adding more insulation in the wall structures is wise. The sealing capacity of the improved building envelope structures must be verified.

New single-family houses heated with electricity do not require any structural repairs. The energy efficiency of such buildings and older buildings heated with electricity should be improved with air source heat pumps and solar panels.

Table 21. *Improving energy efficiency and using decarbonised heating in single-family and semi-detached houses.*

Building component/s	Measures
Electricity	After the end of their technical service lives, replacing household appliances with new ones that are as energy efficient as possible. Replacing regular light bulbs with LEDs. Acquiring solar panels.
Ventilation	Replacing old heat recovery units with more energy-efficient ones after the end of their technical service lives.
Domestic hot water	Replacing taps and water fixtures with water-saving ones.
Windows	Repairing and resealing old windows. Replacing windows in poor condition with new, more energy-efficient ones.
Exterior walls	Sealing penetrations. Adding more thermal insulation in connection with a more major renovation of the exterior cladding.
Roof	Adding more thermal insulation if there is room. In the case of a building with a flat roof, adding thermal insulation when changing the roof type.
Exterior of the building	Adding new frost insulation to the exterior of the building.
Heating system	Direct electric heating: adding an air source heat pump. Electric storage heating: adding an air-water heat pump.
Decarbonisation	Oil heating: replacing the heating system with geothermal heating, an air source heat pump or wood heating. Fireplaces: replacing them with energy-efficient ones, such as replacing an open fireplace with a heat-storing fireplace.
Sources	Cost-optimal levels of minimum energy efficiency requirements in renovation projects, Ministry of the Environment Workshops in connection with the preparation of the strategy and a survey on Otakantaa.fi in September and November 2019. Replies to questions on effective means of improving energy efficiency.

Trigger points

The identified trigger point is the change of ownership of a single-family house. Around 14,500 single-family houses are sold every year (Property transactions, National Land Survey of Finland). Potential new owners are given information on the condition of the building and any renovation needs during a condition inspection performed in connection with the transaction. Condition inspections are not mandatory, but are usually performed, particularly in the case of old buildings. The inspection aims to ensure that the owner has accurate information on the condition and future repair needs of the building.

An energy performance certificate must be presented when selling or renting out a building. The energy performance certificate must be prepared by a qualified person. A person who prepares energy performance certificates must also have a suitable technical degree or corresponding work experience, and pass a test to demonstrate their familiarity with the preparation of energy performance certificates and the related legislation. The person who prepares the energy performance certificate must present cost-effective measures for improving energy efficiency as part of the certificate. Guidance on identifying such measures and assessing their impact is provided in training materials produced by the Ministry of the Environment (Energiatodistusopas, 2018).

Barriers
The assessment of a building's energy efficiency depends on the initiative and activity of the owner. If the owner does not show initiative, the impulse to perform repairs may come from product or service providers, in which case there is a risk that the repairs are random measures rather than ones based on assessing the improvements required by the building as a whole, taking into account the entire potential for saving energy. Furthermore, owners may refrain from implementing some repairs in fear of the repairs leading to other necessary repair actions. According to the population projection, some residential buildings will not be permanently occupied. Renovations to improve energy efficiency will not be made in the case of such buildings, because their estimated service lives are short.

2.5.2 Terraced houses

A cost-effective measure to reduce the heat losses of old terraced houses that require renovation (Table 22) is replacing windows that have reached the end of their service life with new ones, the U-value of which complies with the requirements for new buildings. Adding more insulation to the building envelope is only financially viable if the surfaces of the envelope need to be renovated for other reasons.

If the housing units in the terraced house have been equipped with mechanical ventilation including heat recovery from the very beginning, replacing the system with a more effective one is wise. The opportunity to add heat recovery or an exhaust air heat pump should also be studied.

The water consumption level can be decreased by reducing the water pressure – this can be achieved by installing a constant pressure valve and remotely readable water meters for all the housing units in connection with a pipeline renovation to benefit from invoicing based on actual consumption. Heating energy consumption can be reduced by adding smart automation to the central heating system.

These repair actions can be implemented at the same time (a deep renovation), but this is rare due to the differing service lives of structures and systems. Usually, buildings are renovated one building part at a time (staged deep renovation). The combined impact from the renovation of several building elements must be taken into account in planning. For example, if windows are replaced and more insulation is added to the building envelope, less heating will be required, which means that actions involving the heating system will also be necessary. Achievement of the energy saving objectives must be verified by means of diligent site-specific planning.

Table 22. *Improving energy efficiency and using decarbonised heating in terraced houses.*

Building component/system	**Measures**
Ventilation	Heat recovery: replacing heat recovery units with more energy-efficient ones at the end of their technical service lives.
Electricity	After the end of their technical service lives, replacing household appliances with new ones that are as energy efficient as possible. Replacing regular light bulbs with LEDs. Installing solar panels on the building's roof or purchasing a share in a solar panel farm.
Domestic hot water	Adjusting the water pressure. Replacing taps and water fixtures with water-saving ones. Installing remotely read separate water meters for all housing units in connection with a pipeline renovation.
Windows	Replacing windows that are in poor condition.
Exterior walls	Adding more insulation when the external cladding needs to be replaced. Sealing penetrations.
Roof, base floor	Adding more roof insulation if this is technically possible. In the case of a building with a flat roof, adding more insulation when changing the roof type. Adding thermal insulation in unheated basements and base floor structures.
Adding frost insulation on the exterior of the building	Replacing the frost insulation panels on the exterior of the building.
Heating system	Direct electric heating: adding an air source heat pump. Electric storage heating: adding an air-water heat pump.

	Balancing the heating system. Installing a smart ventilation and heating control system.
Decarbonisation	Abandoning fossil fuels in property-specific heating.
Sources	Cost-optimal levels of minimum energy efficiency requirements in renovation projects, Ministry of the Environment Workshops in connection with the preparation of the strategy and a survey on Otakantaa.fi in September and November 2019. Replies to questions on effective means of improving energy efficiency.

Trigger points
In the case of terraced houses, improvements in energy efficiency should be realised in connection with other repair and renovation actions to ensure ecological efficiency and cost-effectiveness.

A potential trigger point is a renovation/joint renovation project implemented in the neighbourhood. Finnish housing companies are small. By combining projects, housing companies can create a larger renovation project that interests a larger number of contractors, thereby achieving a genuine tendering process. This approach can create benefits in the form of cost savings or a higher-quality outcome in terms of energy efficiency improvements.

Barriers
Responsibility for the activities of a housing company lies with the Board of Directors, which usually consists of lay members who may lack the knowledge, skills and time to actively participate in the preparation and commissioning of renovation projects. The shareholder bases of housing companies are highly diverse. Decisions on repairs can be overturned due to opposition from the shareholders. One underlying reason for such opposition may be a lack of funds. Some repairs are not implemented because of a fear of the repairs leading to other necessary repair actions.

Banks will grant a repair loan amounting to a maximum of 50% of the building’s fair market value. According to the loan terms, a maximum of 30–50% of the housing units in the property may be owned and rented out by investors. If a terraced house includes a small number of housing units, a building-specific loan will not be granted. To cover the repair costs in areas with a low cost level, other funding is required in addition to a bank loan. The lack of such funding may prevent the implementation of a renovation.

Due to persistent migration, some terraced houses are about to become completely vacant or underused in areas suffering from depopulation. In areas suffering from depopulation, some buildings will not be renovated, as their remaining service life is expected to be short.

2.5.3 Blocks of flats

The most cost-optimal repair action in the case of old blocks of flats manufactured from precast elements (Table 23) involve using heat from the exhaust air to preheat the premises or water (with exhaust air heat pumps). More recent buildings are equipped with mechanical supply and exhaust ventilation that includes heat recovery. Replacing the heat recovery unit with a more efficient one is wise in the case of such buildings. If heat pumps are installed in a building, it should be investigated whether energy could be recovered from wastewater.

Windows that have reached the end of their service life should be replaced with new ones, the U-value of which complies with the requirements for new buildings. Adding insulation to the building envelope is only financially viable if the surfaces of the envelope need to be renovated for other reasons.

The water consumption level can be lowered by reducing the water pressure. This can be achieved by installing a constant pressure valve and remotely readable water meters for all the housing units in connection with a pipeline renovation to benefit from invoicing based on actual consumption. Heating energy consumption can be lowered by adding smart automation to the central heating system and making use of district heating system demand response.

These repair actions can be implemented at the same time (a deep renovation), but this is rare due to the differing service lives of structures and systems. Usually, buildings are renovated one building part at a time (staged deep renovation). The combined impact from the renovation of several building elements must be taken into account in planning. For example, if windows are replaced and more insulation is added to the building envelope, less heating will be required, which means that actions involving the heating system will also be necessary. At the very least, the heating system will have to be readjusted. Functionality of the ventilation system must also be verified. Achievement of the energy saving objectives must be verified by means of diligent site-specific planning.

Table 23. *Improving energy efficiency and using decarbonised heating in blocks of flats.*

Building component/system	**Measures**
Ventilation	Heat recovery: replacing units with more energy-efficient ones after the end of their technical service lives. Mechanical exhaust air system: adding an exhaust air heat pump.
Electricity	After the end of their technical service lives, replacing household appliances with new ones that are as energy efficient as possible. Replacing regular light bulbs with LEDs. Installing LED light fixtures with occupancy sensors in public premises and outdoor areas. Installing solar panels on the building's roof or purchasing a share in a solar panel farm.
Domestic hot water	Adjusting the water pressure. Replacing taps and water fixtures with water-saving ones. Adding heat recovery from waste water. Installing separate remotely-read water meters for all housing units in connection with a pipeline renovation.
Windows	Replacing windows that are in poor condition with new ones, taking into account the penetration of radio signals.
Exterior walls	Adding more insulation when the external cladding needs to be replaced. Sealing penetrations.
Roof, base floor	Adding more roof insulation if this is technically possible. In the case of a building with a flat roof, adding more insulation when changing the roof type. Adding thermal insulation in unheated basements and base floor structures.
Adding frost insulation on the exterior of the building	Replacing the frost insulation panels on the exterior of the building.
Heating system	Balancing the heating system. Installing a smart ventilation and heating control system.
Decarbonisation	Abandoning fossil fuels.
Sources	Cost-optimal levels of minimum energy efficiency requirements in renovation projects, Ministry of the Environment. Workshops in connection with the preparation of the strategy and a survey on Otakantaa.fi in September and November 2019. Replies to questions on effective means of improving energy efficiency.

Trigger points

In the case of blocks of flats, the improvement of energy efficiency should be realised in connection with other repair and renovation actions to ensure ecological efficiency and cost-effectiveness.

A potential trigger point is a renovation/joint renovation project implemented in the neighbourhood. Finnish housing companies are small. By combining projects, housing companies can create a larger renovation project that interests a larger number of contractors, thereby achieving a genuine tendering process. This approach can create benefits in the form of cost savings or a higher-quality outcome in terms of energy efficiency improvements.

Barriers

Responsibility for the activities of a housing company lies with the Board of Directors, which usually consists of shareholders who may lack the knowledge, skills and time to actively participate in the preparation and commissioning of renovation projects. The shareholder bases of housing companies are highly diverse. Decisions on repairs can be overturned due to opposition from the shareholders. One underlying reason for such opposition may be a lack of funds. Some repairs are not implemented because of a fear of the repairs leading to other necessary repair actions.

Typically, banks will grant a repair loan amounting to a maximum of 50% of the building's fair market value. According to the loan terms, a maximum of 30–50% of the housing units in the property may be owned and rented out by investors. To cover the repair costs in areas with a low cost level, other funding is required in addition to a bank loan. The lack of such funding may prevent the implementation of a renovation.

Due to persistent migration, some blocks of flats are about to become completely vacant or underused in areas suffering from depopulation. In areas suffering from depopulation, some buildings will not be renovated, as their remaining service life is expected to be short.

2.5.4 Non-residential buildings

The most cost-effective measures for non-residential buildings (Table 24) involve ventilation (efficient ventilation units, efficient heat recovery, ventilation system that suits the needs) and lighting systems (LED lighting, occupancy sensors).

A renovation project involves identification of the building elements to be repaired and replaced, and the building technology elements to be replaced. Instead of old procurement practices, it is recommended that building technology be purchased on the basis of requirements set for their energy efficiency properties and technical performance, so as to ensure the interoperability of system components.

These repair actions can be implemented at the same time (a deep renovation), but this is rare due to the differing service lives of structures and systems. Usually, buildings are renovated one building part at a time (staged deep renovation). The combined impact from the renovation of several building elements must be taken into account in planning. For example, if windows are replaced and more insulation is added to the building envelope, less heating will be required, which means that actions involving the heating system will also be necessary. Achievement of the energy-saving objectives must be verified by means of diligent site-specific planning.

Table 24. *Improving energy efficiency and using decarbonised heating in non-residential buildings.*

Building component/system	Repair actions
Ventilation	Replacing the ventilation control system with a smart system (ventilation as necessary). Replacing the heat recovery system with a more efficient one or installing a heat recovery system if there is
Electricity	Replacing fluorescent lighting with LED lighting. Installing a lighting system with occupancy sensors. Installing solar panels if the building is in use all year round.
Heating system	Installing a smart heating control system in connection with an automation system renovation. Balancing the heating system.
Exterior walls	Adding more insulation when the external cladding needs to be replaced. Sealing penetrations.
Roof	Adding more insulation if this is technically possible. If the building has a flat roof, adding additional insulation in connection with a roof renovation.
Windows	Replacing windows in poor condition.
Base floor	Renovating or adding frost insulation. Isolating the ceiling of the ground floor in storage spaces.
Domestic hot water	Adjusting the water pressure. Replacing taps and water fixtures with water-saving ones. Adding heat recovery from wastewater, if high volumes of water are used.
Decarbonised heating and cooling	Abandoning fossil fuels in property-specific heating systems. Replacing the fossil fuels with geothermal heating or another emission-free energy source. Whenever possible, replacing electrical cooling with district cooling or geothermal cooling.
Sources	Cost-optimal levels of minimum energy efficiency requirements in renovation projects, Ministry of the Environment Workshops in connection with the preparation of the strategy and a survey on Otakantaa.fi in September and November 2019. Replies to questions on effective means of improving energy efficiency.

Trigger points

In the case of non-residential buildings, the improvement of energy efficiency should be realised in connection with other repair and renovation actions to ensure ecological efficiency and cost-effectiveness. Many commercial buildings are rented properties, where renovations can be performed when the tenants change.

Whole new accessories can also be separately acquired. For example, solar panels have been acquired through a joint procurement process (such as KL-Kuntahankinnat Oy’s national joint procurement of solar panel systems in 2016–2020). Joint procurement is an easy and affordable way for the property owner to invest in the improvement of energy efficiency.

Barriers
Cultural and historical values are not a barrier to the improvement of energy efficiency (Improving energy efficiency during renovation of culturally and historically valuable buildings, Ministry of the Environment).

In the case of commercial non-residential buildings, the focus lies in the activities carried out at the premises. Property management costs, including energy costs, are a minor cost item compared to other costs arising from operations. However, saving energy and using renewable energy are more and more attractive options to companies due to the image boost they offer.

Many commercial buildings are rented properties, where renovations can be performed when the tenants change. Such timing is not always optimal for carrying out energy efficiency improvements. Some commercial buildings are underused, even though there is demand for commercial premises in the area. This is because potential tenants choose more recent buildings.

Due to the energy crises in the 1970s, some measures were implemented in public buildings that were not compatible with old structures. For this reason, energy efficiency improvements still have a bad reputation as a cause of indoor air quality problems. If ventilation rates and operating times are increased to a level meeting the current requirements or the indoor air quality is improved, energy consumption will increase and savings will not be achieved.

Finland's dependency ratio, low employment rate, industrial restructuring and trade deficit have led to budgetary problems. This is directly reflected in opportunities to invest in the renovation of public buildings.

There is a large number of vacant commercial facilities in growing urban areas in Finland compared to other countries. Changing the intended use of commercial premises to residential premises is difficult because of zoning requirements and requirements imposed on residential buildings. Due to the Finnish climate, such vacant buildings have to be heated.

2.6 Decarbonised heating

2.6.1 Property-specific heating

After the expiration of the technical service life of a property-specific oil heating system, the system should be replaced with a district heating system, a heat pump (a geothermal heat pump or an air-water heat pump; an additional heat source may be required during very cold periods) or a biofuel system. Electric heating is also a good option for oil heating if the building's remaining service life is expected to be short.

Switching from oil heating to geothermal heating is the most cost-optimal way of meeting the requirements set for renovations of detached and semi-detached houses. The idea of replacing oil heating with a less expensive heating system is also supported by a report on energy poverty in Finland, which identified households with limited means living in oil-heated buildings as a risk group.

The 2019 Government Programme includes an entry on abandoning fossil fuel oil by the beginning of the 2030s. The plan is to abandon fossil oil in state-owned buildings by 2024. A subsidy for detached and semi-detached houses abandoning oil heating is being planned for 2021.

2.6.2 Centralised heat generation

Most of the heating energy for terraced houses, blocks of flats and non-residential buildings is generated in the EU ETS sector by the energy industry. Goals on reducing carbon-intensive fuels have been set, such as abandoning the use of coal in heat generation by 2029 (Act on Prohibiting the Use of Coal in Energy Generation; laki hiilen energiakäytön kieltämisestä, 416/2019).

3. Policies and actions promoting the measures

Contents of this chapter: Article 2a(1)(c) of the EPBD (2010/31/EU), as amended by Directive 2018/844/EU, policies and actions to stimulate cost-effective deep renovation of buildings, including staged deep renovation, and to support targeted cost-effective measures and renovation, such as by introducing an optional scheme for building renovation passports.
[Content of this chapter: policies and actions to stimulate cost-effective deep renovation of buildings, including staged deep renovation, and to support targeted cost-effective measures and renovation for example by introducing an optional scheme for building renovation passports.]

Making the Finnish building stock highly energy efficient and decarbonised will be promoted by means of binding legislation, enabling legislation, voluntary agreements and the dissemination of information.

3.1 Binding energy efficiency legislation

3.1.1 Renovation energy efficiency requirements

The building regulations on all buildings are based on the Land Use and Building Act and its supplementary decrees. Renovation projects are governed by Decree 4/2013 of the Ministry of the Environment on Improving the Energy Efficiency of Buildings during Renovation and Modification Projects (ympäristöministeriön asetus 4/2013 rakennuksen energiatehokkuuden parantamisesta korjaus- ja muutostöissä). The decree was supplemented in 2017 with a definition of nearly zero energy construction (Decree 2/2017). The regulatory level set for renovation projects has been deemed technically and financially sound. In the case of renovations, the nearly zero energy level is the same as for new buildings, and it is laid down in Decree 1010/2017 of the Ministry of the Environment.

- *Implemented: When renovations are implemented, the set requirements must be followed.*

Building envelope

1. Exterior walls: Original U-value x 0.5, but not exceeding 0.17 W/(m^2 K). When changing the intended use of a building, the original U-value x 0.5, but a minimum of 0.60 W/(m^2 K).
2. Roof: Original U-value x 0.5, but not exceeding 0.09 W/(m^2 K). When changing the intended use of a building, the original U-value x 0.5, but a minimum of 0.60 W/(m^2 K).
3. Base floor: Improving the energy efficiency as much as possible.
4. Windows: The U-value of new windows and entrance doors must be a minimum of 1.0 W/(m^2 K). When repairing old windows and entrance doors, the thermal resistance must be improved where possible.

Technical systems

1. The amount of heat to be recovered from exhaust air originating from a building's ventilation system must equal at least 45% of the amount of heat required to heat the ventilation system; in other words, the annual heat recovery efficiency must be at least 45%.
2. The specific electric power of a mechanical supply and exhaust ventilation system may be a maximum of 2.0 kW/(m^3/s).
3. The specific electric power of a mechanical exhaust ventilation system may be a maximum of 1.0 kW/(m^3/s).
4. The specific electric power of a ventilation system may be a maximum of 2.5 kW/(m^3/s).
5. The efficiency of heating systems must be improved when the related equipment and systems are replaced with respect to the refurbished components. After replacement.
6. The provisions applicable to new buildings also apply to the modernisation of water and/or plumbing systems.

The efficiency of heating systems must be improved when the related equipment and systems are replaced with respect to the refurbished components. After replacement, the ratio between the efficiency of the building's main heat production system and the efficiency of the spaces' main heat distribution system must be at least 0.8. This ratio must be calculated as the quotient of the annual efficiencies achieved by the main heat production system and the main heat distribution system.

The annual efficiency of the main heat production system or the spaces' main heat distribution system must be at least 0.73. If the new main heat generation system of the building is a heat pump, the ratio between the SPF of the heat pump and annual efficiency of the spaces' main heat distribution system must be at least 2.4. The ratio must be calculated as the quotient of the SPF of the heat pump and the annual efficiency of the spaces' main heat distribution system.

After the renovation, the specific electrical energy consumption of the accessories of the spaces' main heat distribution system must not exceed 2.5 kWh/net m^2 (per net heated area).

Ensuring functionality

1. Building envelope and technical systems: Anyone undertaking measures to improve the energy performance of a building envelope must ensure that the building envelope and the joints between all windows or entrance doors and the surrounding structures are sealed in such a manner that the thermal insulation layers are protected from the detrimental effects of air flow on the thermal insulation properties.

   When planning or implementing a renovation or replacement project concerning the building envelope or technical systems, the measures must be selected so as to ensure correct functioning of the thermal and acoustic insulation, moisture barriers and fire insulation of the structures.

2. Ventilation: If necessary, plans detailing measures to improve the energy performance of a building must demonstrate how the correct operation of the ventilation system and a sufficient supply of supply air are ensured if the building is equipped with a mechanical exhaust ventilation system or a natural ventilation system.

   If the energy performance of a building is improved by adopting unit-specific mechanical supply and exhaust air systems equipped with heat recovery, these must be designed and installed so that the air intake or exhaust from an external wall does not cause any adverse health effects in other units.

3. Functionality of technical systems: In connection with improving the thermal insulation or airtightness of the building envelope of a building or a considerable part thereof, in connection with the replacement of windows or measures aimed at improving the energy efficiency of windows, or after measures aimed at improving ventilation, correct and energy-efficient functioning of the heating and ventilation systems must be verified and it must be ensured that any necessary building systems have been balanced and adjusted as needed.

3.1.2 Building automation

The Directive on the energy performance of buildings requires that the energy efficiency of large non-residential buildings be improved with smart automation and control systems. In addition to monitoring consumption levels, the systems can be used to analyse the use of energy and find opportunities to improve the building's energy efficiency. The amended Directive also includes requirements on technical building systems.

- *In preparation: An automation and control system must be installed in heating and ventilation systems with a capacity of more than 290 kW by 2025 and in renovated buildings as of 2021 (a Government bill will be issued in 2020).*
- *In preparation: Requirements on technical building systems will be specified. These requirements will cover overall energy efficiency, correct installation methods, as well as appropriate dimensioning, adjustment and control. The requirements will apply to new and improved technical systems that replace old building systems, and they must be applied insofar as it is technically, financially and functionally feasible (a Government bill will be issued in 2020).*

3.1.3 Energy performance certificates

The energy performance certificate system has been developed since 1996. Binding legislation entered into force in 2008. An amendment on nearly zero energy buildings entered into force at the beginning of 2018. In the case of existing buildings, an energy performance certificate must be presented when selling or renting out the building or a part thereof. The Housing Finance and Development Centre of Finland (ARA) maintains the energy performance certificate system and the related information system. ARA also monitors compliance with the obligation. In Finland, announcements on housing units for sale or rent are given on commercial platforms. For the time being, energy class is a non-mandatory piece of information on such platforms.

- *In preparation: Attempts will be made to make energy class a mandatory piece of information in the announcements on housing units for sale or rent on commercial platforms.*

3.1.4 Maintenance and modification of housing companies

The Limited Liability Housing Companies Act (2009/1599) obligates all housing companies to prepare a five-year plan on future repair needs. The procedure is that the Board of Directors presents a written plan on the repairs to be performed in the next five years at the annual general meeting.

- *Recommendation: Easy-to-use tools will be made available to improve the quality of the plans and the consideration of energy efficiency (such as Raku, developed by the Finnish Real Estate Federation and the Building Information Foundation RTS).*

3.1.5 Energy efficiency agreements

Since 1997, municipalities and companies have been encouraged to improve their energy efficiency through voluntary energy efficiency agreements. Finland has used the energy efficiency agreements to implement the Energy Service Directive (ESD, 2006/32/EC) and the Energy Efficiency Directive (EED, 2012/27/EU). Negotiations on the energy efficiency agreements have been conducted by several ministries (the Ministry of Economic Affairs and Employment and the Ministry of the Environment) and federations in the industry.

The negotiating party from the property industry was RAKLI. A total of 32 rental housing companies have joined the programme of measures for residential lettings associations (vuokra-asuntoyhteisöjen toimenpideohjelma, VAETS). They consist of a total of 5,300 sites with approximately 254,000 housing units (as of February 2020). A total of 80 companies have joined the programme of measures for business premises (toimitilojen toimenpideohjelma, TETS). They have of a total of 1,856 sites (status in February 2020). Companies that have joined the energy efficiency agreement for business premises have the opportunity to receive an investment subsidy amounting to a maximum of 20% of the investment value for regular energy efficiency investments.

The negotiating party from the municipal sector is the Association of Finnish Local and Regional Authorities. A total of 90 municipalities and six joint municipal authorities have joined the energy efficiency agreement for municipalities (kunta-alan energiatehokkuussopimus, KETS; status in January 2020). Municipalities, joint municipal authorities and small enterprises can receive an auditing subsidy from Business Finland. In addition, the municipalities that have joined the energy efficiency agreement for municipalities have the opportunity to receive an investment subsidy amounting to a maximum of 20% of the investment value for regular energy efficiency investments.

- *Implemented: Rental housing companies, property companies and municipalities (for their offices) that have joined the energy efficiency agreements must implement the energy saving objectives for the 2025 agreement period.*

3.2 Promotion of carbon neutrality

One of the objectives of the Finnish national energy and climate policy is to become carbon neutral by 2035 (Government Programme 2019). Some cities and municipalities aim to become carbon neutral by 2030. To achieve this objective,
the use of fossil fuels in heat generation will be limited:

- *Implemented: Coal will no longer be used in energy production as of 2029 (Act on Prohibiting the Use of Coal as an Energy Source, laki hiilen energiakäytön kieltämisestä, 416/2019). Energy producers that abandon coal by 2025 will be supported with funds amounting to EUR 90 million.*
- *Implemented: Part of fossil fuel oil must be replaced with bio oil (Act on the Promotion of the Use of Bio Oil, laki biopolttoöljyn käytön edistämisestä, 418/2019).*
- *In preparation: Central government and municipalities will cease using oil heating by 2024 (Government Programme 2019).*
- *In preparation: During the 2020s, properties heated with oil will be encouraged to start using other energy sources with a separate programme of measures (Government Programme 2019).*
- *In preparation: In the case of residential buildings, property-specific oil heating will be abandoned by 2050 (energy and climate strategy).*

In a survey extending until 2030, an energy efficiency working group established by the Ministry of Economic Affairs and Employment has identified 53 actions to improve energy efficiency and promote decarbonisation at the level of the national economy (report of the energy efficiency working group, 2019). Furthermore, the Ministry of Economic Affairs and Employment launched the preparation of industry-specific carbon neutrality roadmaps in 2020:

- *In preparation: Managed by the Confederation of Finnish Construction Industries RT, companies in the construction industry will prepare a roadmap for decarbonisation of the industry and take action to achieve the strategic objectives.*
- *In preparation: Managed by RAKLI, companies in the construction industry will prepare a roadmap for decarbonisation of the industry.*
- *Implemented: The report by the energy efficiency working group of the Ministry of Economic Affairs and Employment has been completed and implementation of the actions is currently being planned.*

In 2017, the Ministry of the Environment published a decarbonised construction roadmap (Hiilijalanjälki rakentamisen ohjauksessa). The control of decarbonisation in the life cycle of buildings will be introduced in the 2020s.
Testing of the first version of the assessment method in construction projects started in the autumn of 2019. As part of the development of the system,
applicability of the EU Levels method was tested (Level(s) - test report from Finland, Ministry of the Environment).

- *In preparation: Creating databases and calculation systems for the LCA assessment of renovation projects.*
- *In preparation: Legislation on the LCA assessment of renovation projects.*

3.3 Energy efficiency in maintenance and renovation projects

Good maintenance ensures that a property functions as planned, promotes the property's energy efficiency and decarbonisation, and influences the longevity and indoor air conditions of the property. A comprehensive set of tools and materials is available to support maintenance (Figure 17). Some of the tools, such as a variety of building user and maintenance manuals and tools for long-term planning (building maintenance plan) are freely available. Other tools are commercial products, services subject to a charge, or member benefits offered by associations or federations. The figure below shows some of these models and tools. There are other models and tools in addition to the ones listed in the image, such as proprietary products.

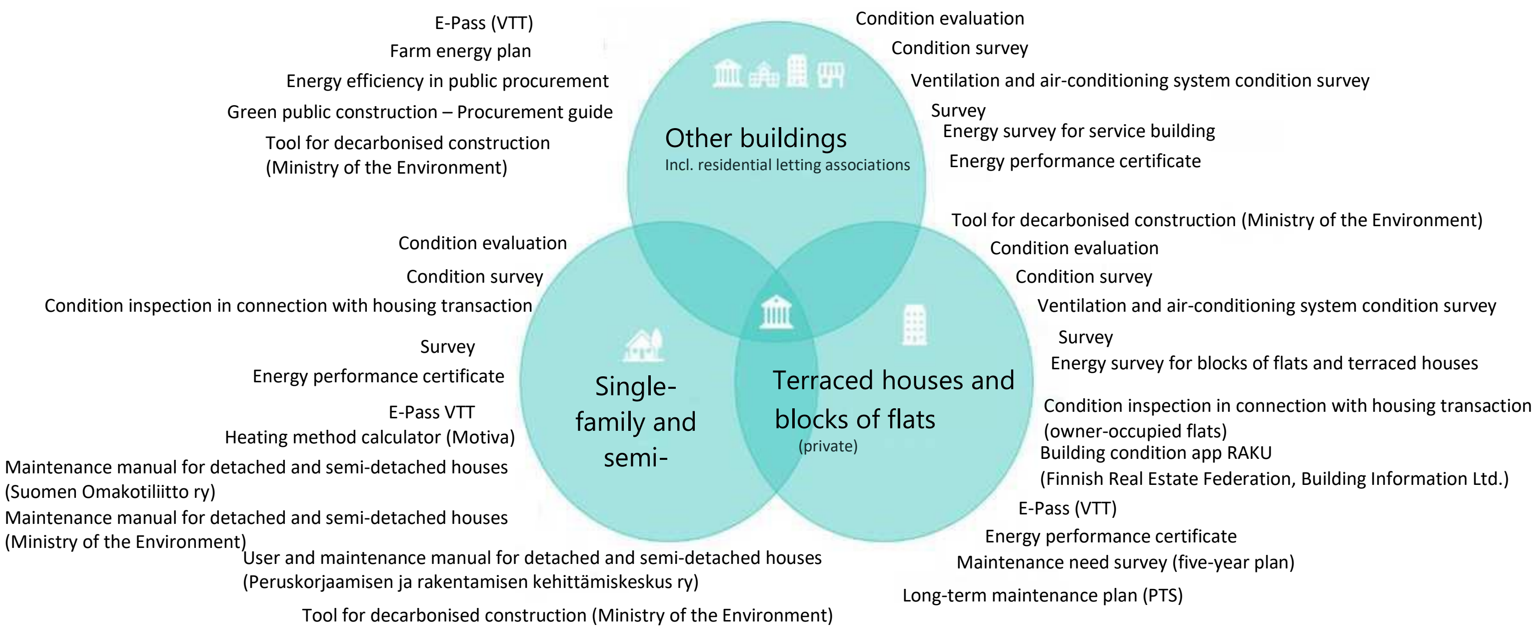


Figure 17. Tools for systematic property management.

An energy survey model was developed and introduced in Finland in 1992. Surveys have been performed in energy production and properties. Large-scale enterprises are no longer eligible for a government subsidy for an energy survey, but small- and medium-sized enterprises and municipalities can still receive an energy survey subsidy. A municipal renewable energy survey model to support the energy survey has been developed. A government subsidy for this model is also available. Municipalities have actively performed both survey types.

Energy efficiency can only be improved if the renovation project is carried out professionally and in compliance with the required quality from start to finish, and if the functionality of the building is considered as a whole. The client needs to specify what they want to achieve from the renovation in terms of energy efficiency, the engineers need to find means of meeting the objectives, and builders need to execute the measures and ensure that the energy efficiency objectives are achieved. After this, responsibility usually returns to the owner of the building who must, either alone or together with service providers, ensure that the condition achieved due to the improvements is maintained.

In many cases, residential renovation projects are implemented without any separate planning by the contractors and device manufacturers as part of the sales of the devices and systems. In the case of residential buildings in particular, it is important for the renovation project to always consider decarbonisation and energy efficiency in the future. This will also assist the owners of the buildings in acting more systematically and taking the building into account as a whole. In practice, this means that projects must be investigated and planned with care. The availability of designing engineers should be improved, especially in the case of housing companies, detached houses and semi-detached houses.

Suggestions for promoting far-sighted property management:

- *Recommendation: Establishing the tools developed to support property maintenance (building user and maintenance manuals, condition evaluation, building maintenance plan, etc.).*
- *Recommendation: Promoting farsightedness of property maintenance with a property strategy of 10–15 years.*
- *Recommendation: Including a plan on improving energy efficiency and reducing CO_2 emissions in the property strategy.*
- *Recommendation: Staged deep renovation would require changes in the current building permit procedure (validity of the permit, energy efficiency improvement plan).*
- *Recommendation: Improving availability and use of designing engineers, particularly in the case of residential renovation projects.*

4. Targeted policies and measures

Content of this chapter: Article 2a(1)(d) of the EPBD (2010/31/EU), as amended by Directive 2018/844/EU, an overview of policies and actions to target the worst performing segments of the national building stock, split incentive dilemmas and market failures, and an outline of relevant national actions that contribute to the alleviation of energy poverty.
[Content of this chapter: an overview of policies and actions to target the worst performing segments of the national building stock, split-incentive dilemmas and market failures, and an outline of relevant national actions that contribute to the alleviation of energy poverty.]

4.1 Worst performing segments of the building stock

Buildings falling under the scope of the energy classes F and G in compliance with the 2018 legislation are considered the worst performing segments of the building stock in terms of energy efficiency. Of the total floor area of single-family and semi-detached houses, there are 6% of such buildings, of terraced houses 4%, of residential buildings 10% and of non-residential buildings 14%.

The requirements laid down for renovation project energy efficiency in Decree 4/2013 of the Ministry of the Environment must be followed when renovating the building envelope or technical systems. An energy subsidy for such renovations can be applied for between 2020 and 2022. The energy subsidy may also be used to cover project planning costs. Buildings included in the worst performing segments of the building stock will have an easier time to meet the subsidy requirements than buildings that are in better condition. A renovation subsidy can also be applied for in the case of a housing unit/residential building with humidity/microbial damage or indoor air problems, as well as for the planning costs of renovations in such housing units/buildings.

The buildings included in the worst performing segments of the building stock were built prior to the 1980s, and some of them are located in areas experiencing net outward migration, where they are at risk of being underutilised or becoming completely vacant.

- *Implemented: Opportunity to apply for an energy subsidy for improving a building beyond the required level for residential buildings (subsidies, Housing Finance and Development Centre of Finland ARA).*
- *Implemented: Opportunity to apply for a renovation subsidy in the case of a housing unit/residential building with humidity/microbial damage or indoor air problems, as well as for the planning costs of renovations in such housing units/buildings (subsidies, Housing Finance and Development Centre of Finland ARA).*
- *Implemented: Opportunity to apply for a demolition subsidy for the demolition of a vacant building and/or a building in especially poor condition for which an ARA subsidy has been granted. The amount of subsidy was increased to 90% of the demolition costs as of 1 March 2020 (subsidies, Housing Finance and Development Centre of Finland ARA).*
- *Implemented: An amendment of the Limited Liability Companies Act (1330/2018) to offer housing companies the opportunity to demolish a building.*

4.2 Split-incentive dilemmas

A split-incentive dilemma refers to a situation where one party invests in the improvement of a building's energy efficiency but another party benefits from the savings achieved by the lowered energy costs. This is the case when a property, facility or housing unit is rented out when it is not heated, and the tenant only pays the rent to the landlord and acquires heating at their own expense. This is a highly exceptional procedure in Finland. In Finland, the heating costs of rented housing units and other facilities are, as a general rule, included in the rent. The owner should keep the building and its systems in good condition to ensure that as little energy as possible needs to be used to heat up the building.

The consumption of warm water depends on the efficiency of the system used to heat the water, the water distribution system, the water fixtures and water consumption habits. The water consumption habits of residents vary a great deal. Therefore, invoicing based on actual measured consumption is an opportunity to achieve savings in housing costs.

- *In preparation: Invoicing of warm water based on measured consumption (a Government bill will be issued in 2020).*

Usually, tenants pay for the electricity used by lighting systems themselves. This involves the possibility of a split-incentive dilemma, because old-fashioned lighting technology elements are often used in old buildings. More recent technology and control systems allow for a more high-quality lighting system that is more affordable.

- *Implemented: Green Lease and Light Green Lease templates developed by RAKLI, among others, are available to divide the investment costs and benefits between the landlord and the tenant.*

4.3 Market failures

In connection with this renovation strategy, the term 'market failures' refers to a range of problems that tend to delay the modification of the building stock and the tapping of the cost-effective energy savings potential, such as defective information about the building stock, energy consumption, energy saving measures or projects' funding opportunities, as well as limited use of smart technologies.

In Finland, the consumption of centrally produced and distributed energy is monitored with remotely readable meters. Smart measuring covers all electricity consumers and almost all customers who purchase district heating. Customers receive information on their own energy consumption at the very least through their own electricity bills, but they can also use digital monitoring services. The owners are responsible for monitoring the energy consumption of property-specific boilers (oil, biofuels). Information and consulting on the available opportunities to save energy is available from several authorities and other objective parties, as well as from commercial operators.

Typically, renovation projects are funded by means of own financing and market-based loans, and availability of funding is not considered a problem. However, market-based loans have become more difficult to obtain lately, particularly in areas where the housing or commercial premises market is non-functional and thus the collateral value of buildings is low.

The residential building stock, its repair needs and opportunities to improve energy efficiency are particularly well known. Studies on renovation projects have been carried out since the 1970s. During a normal year, the share of renovation projects is approximately half of the value of all the projects of a construction company, but during the 2018 economic boom the share was only 40% (Renovation building, Statistics Finland).

The biggest challenge in the case of renovation projects is finding design engineers who have familiarised themselves with energy efficiency. Such engineers are required to provide a preliminary report on the renovation, to plan the project and to perform construction design. Residential renovation projects, in particular, are often implemented without any separate planning by the contractors and device manufacturers as part of the sales of their products. The lack of competent workforce is a problem in many building construction specialities – building automation, in particular, where the development of technology and the entry of new products to the market have been rapid.

- *Implemented: The energy subsidy available for residential buildings in 2020–2022 can also be used to cover design costs.*
- *Recommendation: Investigating the possibilities to eliminate the identified expertise and workforce deficiencies by providing more training in universities of applied sciences, in particular, and by developing the content of automation training courses offered in vocational schools and universities of applied sciences, for instance.*
- *Recommendation: Investigating the possibility to support the development of the building stock and the improvement of energy efficiency in areas where there have been problems with the availability of market-based loans.*

4.4 Energy poverty

According to EU studies on energy poverty, 1.7% of Finns have had problems with keeping their homes warm enough, and 1% are in danger of being affected by energy poverty. According to EU indicators (Energy Poverty in the European Union, ENEA), however, there is hidden energy poverty in Finland. Energy poverty is not separated from general poor financial status, nor is it considered a problem (Energy poverty of low-income homeowners, Ministry of the Environment). Households with poor financial status can apply for a government subsidy for their housing costs through the Social Insurance Institution of Finland (Kela). Kela is a government agency that ensures the social security of people living in Finland and many Finns living abroad during different life situations. The offered subsidies are general housing allowance and social assistance (Housing allowances, the Social Insurance Institution of Finland, Kela).

- *Implemented: Households with poor financial status can apply for the general housing allowance for their housing costs, such as water and heating expenses.*
- *Implemented: Households with poor financial status can apply for social assistance for their basic expenses, such as the rent or maintenance charge of their home, the heating costs of their house, or water or household electricity expenses.*
- *Implemented: Subsidy for financial consulting services for tenants 2018–2021.*

A subsidy for improving the living conditions of elderly or disabled people can be applied for from the Housing Finance and Development Centre of Finland ARA. The subsidy is a maximum of 50% of acceptable renovation costs. A subsidy covering 70% of the costs can also be granted for a special reason. The subsidy can be used to cover the improvement of accessibility, the installation of additional insulation or changing of the heating type, for example. The subsidy can be granted for a private person or a community that owns a building which meets the prerequisites.

- *Implemented: Renovation subsidy for private persons to renovate the home of an elderly or disabled person.*
- *Implemented: A subsidy for private persons for a building condition survey and the planning of a major renovation.*
- *Implemented: A subsidy for housing companies for a building condition survey and the planning of a major renovation.*

5. Public buildings

Contents of this chapter: Article 2a(1)(e) of the EPBD (2010/31/EU), policies and actions to target all public buildings.
[Content of this chapter: policies and actions to target all public buildings]

In Finland, the obligations laid down in the Energy Efficiency Directive have been met by means of voluntary energy efficiency agreements. Approximately 70% of all Finnish municipalities (measured by the number of residents) are included in the scope of the energy efficiency agreement for municipalities. Some of the municipalities collaborate through the Towards Carbon Neutral Municipalities (Hinku) network, for example. Other major municipally-owned tenement buildings, rental housing companies and other significant owners of public buildings are included in the scope of the real estate sector energy efficiency agreement. These agreements obligate the parties to perform energy efficiency measures. The municipalities that have joined the energy efficiency agreement for municipalities have the opportunity to receive an investment subsidy amounting to a maximum of 20% of the investment value for regular energy efficiency investments (25% if the project is realised as an ESCO service).

- *Implemented: Municipalities and other owners of public properties that have joined an energy efficiency agreement will implement their energy saving measures for the 2025 agreement period.*
- *Implemented: An energy subsidy can be applied to realise the energy efficiency measures (Business Finland, energy subsidy).*
- *Implemented: An energy subsidy can be applied to realise energy efficiency measures implemented as an ESCO (Energy Service Company) service. Parties who have joined an energy efficiency agreement can receive a large energy subsidy (Business Finland, energy subsidy).*

Subsidies to realise energy surveys have been available in Finland since 1992. Municipalities have actively performed energy surveys. A municipal renewable energy survey model has been developed. Municipalities can apply for a government subsidy for this model. All subsidised surveys on energy and renewable energy are performed by trained surveyors in accordance with the survey models.

- *Implemented: Continuing with the performance of the voluntary municipalities' energy and renewable energy surveys.*

Central government will promote decarbonised heating with its own example.

- *In preparation: Central government will gradually abandon oil heating by 2025 and encourage other parties to do the same.*

Central government agencies are obligated to procure energy-efficient products, services and buildings if it is feasible from the viewpoint of cost-efficiency, finances, sustainability in a broader sense, technical characteristics and sufficient competition (Energy Efficiency Act, energiatehokkuuslaki, 429/2014). The Ministry of Economic Affairs and Employment has prepared instructions on how contracting authorities can ensure that energy efficiency is comprehensively taken into account in public procurement (Ministry of Economic Affairs and Employment, 2016).

A guide by the Ministry of the Environment on green public construction (Vihreä julkinen rakentaminen; Ministry of the Environment, 2017) includes recommendations on achieving an environmentally friendly public building stock. It also covers renovation projects. A guide on procurement criteria for decarbonised construction (Vähähiilisen rakentamisen hankintakriteerit; Ministry of the Environment, 2017) includes recommendations on reducing the carbon footprint of construction and renovation projects realised with public funds under the Act on Public Procurement and Concession Contracts.

Established in 2018, the Competence Centre for Sustainable and Innovative Public Procurement (KEINO) supports and assists contracting authorities in the development of sustainable, innovative public procurement. KEINO's Green Deal service assists municipalities, cities, joint municipal authorities and governmental contracting authorities in considering the carbon neutrality objectives, the wise use of resources and the circular economy in their procurement.

- *Recommendation: Establishing decarbonisation as an approach that covers not only the consumption of heating energy but the entire building life cycle (the LCA approach).*
- *Implemented: The Competence Centre for Sustainable and Innovative Public Procurement (KEINO) was established to provide procurement instructions that cover the carbon neutrality objectives, the wise use of resources and the circular economy.*

6. Smart technologies, know-how and education

Contents of this chapter: Article 2a(1)(f) of the EPBD (2010/31/EU), as amended by Directive 2018/844/EU, an overview of national initiatives to promote smart technologies and well-connected buildings and communities, as well as skills and education in the construction and energy efficiency sectors.
[Content of this chapter: an overview of national initiatives to promote smart technologies and well-connected buildings and communities, as well as skills and education in the construction and energy efficiency sectors.]

6.1 Smart energy system and smart buildings

In September 2016, the Ministry of Economic Affairs and Employment established a working group to investigate the concrete ways a smart electricity grid could serve the opportunity customers have to actively participate in the electricity markets and promote the security of electricity supply. According to the working group's recommendations, technical systems should be designed in a manner that ensures they serve the elasticity of demand (Flexible customer-centred electricity grid, the Smart Grid Working Group, 2018). According to the Smart Grid Working Group, the transfer to a smart energy system and networked buildings connected to the smart grid will require the following actions, among others (to be implemented in the early 2020s):

- *In preparation: Determining functional properties of smart electricity meters and installing second generation electricity meters.*
- *In preparation: Legislative amendments (such as legislation on energy communities).*
- *Recommendation: Installing smart automation systems in buildings in connection with renovations.*

Awareness of the elasticity of demand has already been promoted among owners of single-family houses and housing companies. The role of buildings in the electricity grid is already being studied in the project *Optimal transformation pathway towards the 2050 low-carbon target: integrated buildings, grids and national energy system for the case of Finland* by the Academy of Finland, for instance.

A common project of the public sector and private enterprises, KIRA-digi, and its follow-up project KIRAHub, have speeded up the commissioning of smart building technologies. More traditional development work takes place in the Smart Energy programme of Business Finland, for example. The programme studies and tests the utilisation of IoT, AI and BIM in the management of building energy production and consumption, as well as a classification system for smart building solutions (a Smart Readiness Indicator). Projects in progress:

- Smart Otaniemi, a smart energy innovation ecosystem for research projects and companies. The ecosystem focuses on platforms and networking, enabling technologies, smart buildings, elasticity of demand in the market and underground energy storage.
- Finest Twins, a shared top research unit of Aalto University and Talltech (Estonia) on smart city development and innovations.
- Solar energy research and education infrastructure at LUT University.
- Shared 6aika sustainable urban development projects of large Finnish cities, aiming to reach the climate targets by means of openness and smart technologies. The collaboration network will be expanded to medium-sized cities.
- H2020 SCC1 projects (mySmartLife/Helsinki, Stardust/Tampere, MakingCity/Oulu, Sparcs/Espoo, Iris/Vaasa, MatchUp/Kerava), which demonstrate new technologies and digitisation in energy production, the management of building energy consumption and the reduction of traffic emissions.
- Together with Motiva Oy, the Ministry of the Environment has launched a pilot project on a sustainable housing information service that utilises artificial intelligence in providing energy advice to consumers.
- Together with Motiva Oy and other companies in the industry, the Ministry of the Environment has launched a joint project on the sustainable use of water, which studies the water consumption of households and the impact water consumption has on energy consumption.
- In a pilot project on electricity consumption and dissemination of information to consumers, a randomised study is arranged to monitor the electricity consumption of consumers and the impact of the dissemination of information on the electricity consumption. The project utilises electronic consumption monitoring services. Funded by the Energy Authority, the project is implemented by Motiva, the BCDC Energy research project of the University of Oulu and energy company Porvoon Energia.

Information and data systems will be required for the entire society during the transfer to a smart energy grid. In Finland, there are ongoing projects in the fields of energy and the constructed environment that will produce useful tools for a smart energy grid and smart buildings for data transfer and joint development, for instance.

- *Implemented: Utilising Platform of Trust to support communication and the joint development of smart services for the constructed environment.*
- *In preparation: Introducing a centralised data hub for the retail electricity market in 2022.*
- *In preparation: In 2020–2022, an extensive collaboration group established by the Ministry of the Environment will verify the compatibility of information on the constructed environment, boost expertise in the field, and identify legislation and development needs through interaction with stakeholders (Compatibility of information on the constructed environment, Ministry of the Environment).*

6.2 Education and know-how

Due to the Finnish climate, energy efficiency of structures and building systems is an integral part of basic construction industry education at all levels. There are very few undergraduate-level degrees that focus exclusively on renovation or energy efficiency. One can supplement one's renovation or energy efficiency expertise by obtaining a further vocational qualification from a vocational school or a specialist vocational qualification at any level, or through further education (lifelong learning). Further education is offered in educational establishments owned by the central government, municipalities, foundations and private parties.

New requirements on buildings and new technologies require lifelong learning from both people in the industry and teachers and trainers in the field. Digital learning and teaching materials that are available to anybody are required to support and develop the learning and teaching. Proposed measures relating to know-how, education and training of the workforce:

- *Implemented: All undergraduate-level construction sector degrees cover structural physics, structural materials, production engineering, property maintenance and building technology, among other issues. These basics must also be taught to students upgrading their qualifications from other fields.*
- *Implemented: Digitisation of renovation processes, related expertise and development (KIRA-digi 2016–2018) will continue in the KIRAHub project.*
- *Recommendation: Increasing open, digital education in the fields of renovation and energy efficiency to support lifelong learning.*
- *Recommendation: Promoting the use of research data in education by boosting cooperation between universities, universities of applied sciences and institutes of basic vocational education.*
- *Recommendation: Promoting the acquisition of new competencies by all parties active in the field of renovation. New competence areas include the use of renewable energy sources in buildings (solar energy, heat pumps), related building technology, smart automation and energy storage, elasticity of demand, smart grid, overall performance (hybrid systems), life cycle costs (costs versus the properties of a building, such as health and safety aspects, functionality, lighting and accessibility).*
- *Recommendation: Promoting smooth implementation of renovation projects by adopting new contract models in addition to the traditional ones (such as cooperative contracting, life cycle contracting) and by recommending that local authorities responsible for construction supervision take a proactive role in renovation projects and improve the competence of lay clients.*
- *Recommendation: Producing freely available educational materials for teaching purposes in the fields of renovation and decarbonisation, for example (cf. BUILD UP Skills Finland training materials).*
- *Recommendation: Increasing the valuation of renovation and property maintenance expertise, improving the reliability of such activities and raising their prestige as a whole.*
- *Recommendation: Ensuring an uninterrupted study path for mathematical subjects from preschool through comprehensive school and upper secondary school to vocational and university studies.*

7. Direct and extensive impact

Contents of this chapter: Article 2a(1)(g) of the EPBD (2010/31/EU), as amended by Directive 2018/844/EU, an evidence-based estimate of expected energy savings and wider benefits, such as those related to health, safety and air quality.
[Content of this chapter: an evidence-based estimate of expected energy savings and wider benefits, such as those related to health, safety and air quality.]

The heating energy savings of buildings completed by 2020 consist of building loss and improved space utilisation efficiency, as well as improved energy efficiency of the buildings as part of maintenance and renovation projects. The realised development of the building stock, renovation projects and the introduced new means are expected to cut the energy consumption of residential and non-residential buildings by half by 2050 (Table 25).

CO_2 emissions from the heating of buildings will be further reduced by changing heating methods in both property-specific heating in the burden sharing sector and in centralised energy production in the EU ETS sector. The reduction in the use of fossil heating fuels will reduce the dependency on imported fuels. Thanks to the currently valid binding legislation and the plans to be realised, CO_2 emissions of the building stock completed by 2020 will be reduced by 90% by 2050 (Table 25).

Decarbonisation has been promoted by increasing fuel excise duties. The abandoning of fossil fuels will further reduce the excise duty revenue. Due to the electrification of heating, part of the reduction will be replaced with the energy tax on electricity and strategic stockpile fees. Except for peat, fossil fuels are imported. They cannot be fully replaced with domestic energy, however. For the time being, Finland is not self-sufficient in terms of electricity; instead, some 23% of the consumed electricity is imported (Energy supply and consumption, Statistics Finland).

According to the Finnish principles, improvements in energy efficiency are included in normal renovation activities so that the renovations can be performed cost-effectively and in compliance with the principle of material efficiency. Assessed on the basis of the cost-optimal level of the minimum energy efficiency requirements used in renovation projects (2018), implementation of the Finnish renovation strategy will cost EUR 24 billion over the course of 30 years,
or EUR 800 million per year. This amounts to 12,000 person-years in the construction products industry and service industries, as well as at construction sites (Social impact of construction, VTT Technical Research Centre of Finland). The costs will be 6% in relation to the annual building renovation volume of EUR 13 billion (Construction industry value 2018, Confederation of Finnish Construction Industries RT).

In the past few years, the development of smart technologies has led to changes in renovation projects. New products and new companies that allow for improving the energy efficiency of heating and ventilation systems in between renovation cycles have entered the market. The new technologies have increased interest among property owners to realise
energy efficiency improvements and heating method changes, such as using heat pumps to boost heat generation (Figure 23) and using exhaust air heat pumps to recycle heat.

All Finnish housing units are equipped with a heating system, and buildings are kept warm in their entirety to prevent pipes from freezing, for example. In terraced houses and blocks of flats consisting of several dwellings, the heat is generated in a centralised manner and the energy costs are divided between the housing units in relation to their surface areas. Households with limited means can apply for the general housing allowance or social assistance to cover their housing costs. Hence, people becoming ill or having a shorter lifespan due to cold living conditions is extremely rare in Finland.

Wrong renovation solutions have caused indoor air problems in the past. A programme on humidity and mildew (2009–2016)
provided information and instructions on how to resolve problems in residential buildings. The work will continue in a national indoor air and health programme (2018–2028). The underlying causes of indoor air problems are diverse. This has been understood and is being taken into account in renovation and energy consulting. In addition to successful renovation solutions, information on solutions that have caused problems is collected to be able to advise people to avoid these solutions (Construction Defect Bank, FISE).

8. Compliance with EU objectives and roadmap

Contents of this chapter: According to Article 2a(2) of the EPBD (2010/31/EU), in its long-term renovation strategy, each Member State shall set out a roadmap with measures and domestically established measurable progress indicators, with a view to the long-term 2050 goal of reducing greenhouse gas emissions in the Union by 80–95% compared to 1990, in order to ensure a highly energy efficient and decarbonised national building stock and in order to facilitate the cost-effective transformation of existing buildings into nearly zero-energy buildings. The roadmap shall include indicative milestones for 2030, 2040 and 2050, and specify how they contribute to achieving the Union's energy efficiency targets in accordance with Directive 2012/27/EU.

[The content of this chapter: measurable progress indicators, with a view to the long-term 2050 goal of reducing greenhouse gas emissions in the Union by 80-95 % compared to 1990, in order to ensure a highly energy efficient and decarbonised national building stock and in order to facilitate the cost-effective transformation of existing buildings into nearly zero-energy buildings. The roadmap shall include indicative milestones for 2030, 2040 and 2050, and specify how they contribute to achieving the Union's energy efficiency targets in accordance with Directive 2012/27/EU]

The European Union aims to decrease greenhouse gas emissions by 80–95% from the level of 1990 by 2050. Of Finland's current CO_2 emissions (46 MtCO_2; all greenhouse gas emissions 56 MtCO_{2ekv}), residential and non-residential buildings amount to 7.8 MtCO_2 (17%). The objective is to reduce the emissions from residential and non-residential buildings completed by 2020 by 90% to 0.7 MtCO_2 by 2050. The EU's climate roadmap (COM/2018/773) sets long-term targets for the heating energy consumption of buildings in 2050: the heating energy consumption should decrease by 53–69% in the case of residential buildings and 41–57% in the case of non-residential buildings when compared to the 2005 level. When the decrease in energy consumption (gross) is compared to the heating energy consumption of buildings in 2005, the energy consumption decrease for both residential and non-residential buildings in the Finnish roadmap is 55%. The Finnish targets are in line with the EU's energy efficiency and decarbonisation goals.

8.1 Energy efficiency and decarbonisation

8.1.1 Consumption of heating energy

Heating energy consumption describes the energy used for the heating, cooling, ventilation and water heating systems of the residential and non-residential buildings existing in 2020. The buildings' gross energy consumption covers both delivered energy and energy generated with heat pumps.

Between 2020 and 2050, the heating energy consumption will be influenced by climate change, building loss from the 2020 building stock, improved space utilisation efficiency, improved energy efficiency of the building envelope structures and technical systems, as well as maintenance actions (Figure 18; Table 25).

Heating energy consumption is monitored both as absolute energy consumption and as a percentage change from the heating energy consumption in 2020 according to the Housing energy consumption and Energy supply and consumption statistics of Statistics Finland.

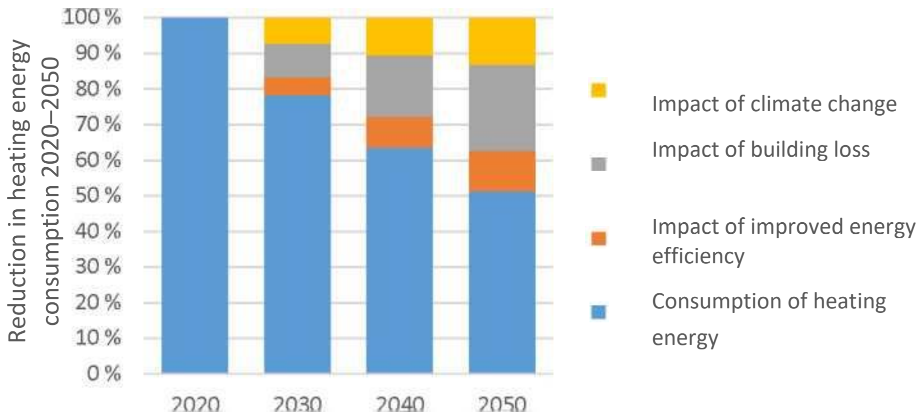


Figure 18. Heating energy consumption 2020 in the existing building stock 2020–2050. The blue bars indicate the reduction of heating energy consumption when compared to 2020 levels (%). The effects of climate change, building loss and improvement of energy efficiency are indicated with separate colours.

8.1.2 Heating method

The development of heating methods is described by the changes in the heat sources of the buildings completed by 2020. The heat sources include wood, fossil fuels (light fuel oil, incl. bio oil, natural gas, coal, peat), district heating, energy taken from the environment by heat pumps and electricity (incl. the electricity consumed by heat pumps and heating systems; Table 19). Statistics on the share of solar energy in heat generation are not maintained in Finland for the time being. The changes in property-specific heating methods influence the statistics with a delay. The statistical delay will most likely persist in the future, however, which means that the target and monitoring values are comparable.

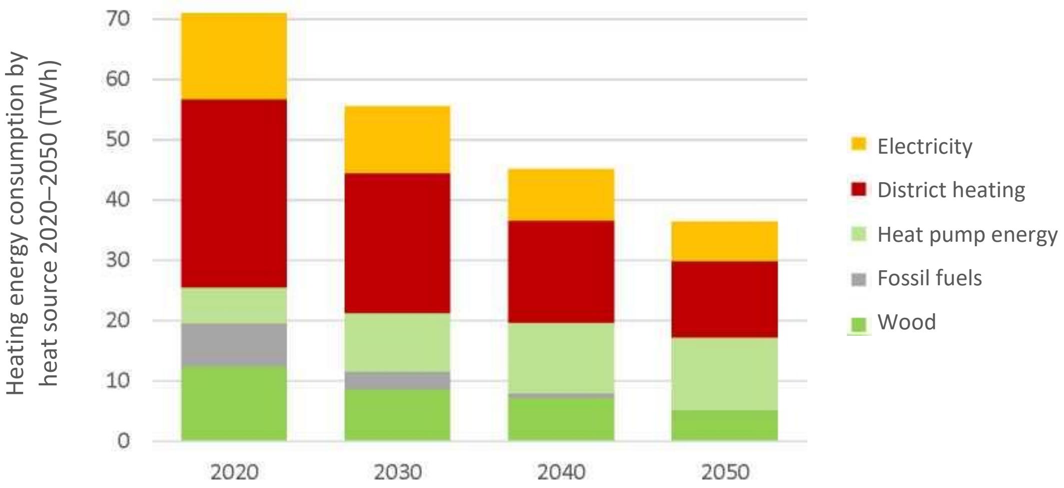


Figure 19. Heating energy consumption of residential and non-residential buildings built prior to 2020 (TWh) in 2020, 2030, 2040 and 2050. The figure shows both heating energy generated centrally in the EU ETS sector (electricity, district heating) and property-specific heating energy generated in the burden sharing sector (energy generated with heat pumps, fossil fuels and wood).

8.1.3 Carbon dioxide emissions

The development of CO_2 emissions of the building stock existing in 2020 is monitored for the building types presented in this report (absolute figures). Development of overall emissions of the said building stock is also monitored (absolute figures and relative change when compared to 2020). The initial data required for the monitoring indicators is obtained from the energy supply and emission classification statistics of Statistics Finland.

8.1.4 Heating emissions intensity

The heating emissions intensity describes the development of the decarbonisation of the heating heat sources. It is calculated as a ratio between the overall emissions (indicator 3) and the heating energy consumption (gross; indicator 1)
for the entire building stock being monitored.

8.1.5 Share of nearly zero-energy buildings

In connection with the Finnish renovation strategy, the term "nearly zero-energy building" refers to a building completed prior to 2020 that meets the requirements of Decree 1010/2017 of the Ministry of the Environment on the Energy Efficiency of New Buildings (ympäristöministeriön asetus uuden rakennuksen energiatehokkuudesta).

The number of nearly zero-energy buildings is monitored using an indicator describing the development of the 2020 building stock with the information available in the energy performance certificate register. The milestones are based on results of the calculation model used as the basis for the strategy. They are used to anticipate the development of the average E-value of the different building types during each decade.

Table 25. *Indicators describing the development of the building stock's energy efficiency and decarbonisation, as well as the estimated change 2020–2050.*

1. Consumption of heating energy	**Indicator**	**Unit**	**2020**	**2030**	**2040**	**2050**	**Sources**
Residential and service buildings total	Consumption of heating energy (gross)	GWh/a	70,900	55,500	45,100	36,400	Official Finnish statistics (SVT): Housing energy consumption. ISSN=2323-3273. Helsinki: Statistics Finland. Accessed at http://www.stat.fi/til/asen/index.html Energy/table service. Helsinki: Statistics Finland. http://tilastokeskus.fi/til/ene.html
Residential and service buildings total	Consumption of heating energy compared to 2020 (gross)	%	100	78	64	51	
Residential and service buildings total	Consumption of heating energy (delivered energy)	GWh/a	65,100	45,700	33,300	24,500	
Residential and service buildings total	Consumption of heating energy compared to 2020 (delivered energy)	%	100	70	51	38	
2. Type of heating	**Indicator**	**Unit**	**2020**	**2030**	**2040**	**2050**	**Sources**
Single-family and semi-detached houses	Wood	GWh/a	11385	7448	6257	4678	Official Finnish statistics (SVT): Housing energy consumption. ISSN=2323-3273. Helsinki: Statistics Finland. Accessed at http://www.stat.fi/til/asen/index.html Energy/table service. Helsinki: Statistics Finland. http://tilastokeskus.fi/til/ene.html
	Fossil	GWh/a	3148	1464	296	0	
	Heat pump	GWh/a	4958	7115	7881	7687	
	District heating	GWh/a	2629	1645	639	131	
	Electricity	GWh/a	9607	7253	5323	4200	
Terraced houses	Wood	GWh/a	126	80	73	54	
	Fossil	GWh/a	186	0	0	0	
	Heat pump	GWh/a	591	824	878	811	
	District heating	GWh/a	3105	2175	1594	1221	
	Electricity	GWh/a	1385	1132	861	650	
Blocks of flats	Wood	GWh/a	47	0	0	0	
	Fossil	GWh/a	543	0	0	0	
	Heat pump	GWh/a	81	836	1181	1180	
	District heating	GWh/a	13635	10356	7767	6083	
	Electricity	GWh/a	1136	810	687	436	
Non-residential buildings	Wood	GWh/a	874	1085	920	435	
	Fossil	GWh/a	3273	1460	435	4	
	Heat pump	GWh/a	183	953	1788	2249	
	District heating	GWh/a	11902	9028	6871	5328	
	Electricity	GWh/a	2106	1810	1613	1261	

3. Emissions	Indicator	Unit	2020	2030	2040	2050	Sources
Single-family and semi-detached houses	CO_2 emissions	1,000 t CO_2	1,873	735	247	56	Official Finnish statistics (SVT): Housing energy consumption. ISSN=2323-3273. Helsinki: Statistics Finland. Accessed at http://www.stat.fi/til/asen/index.html Energy/table service. Helsinki: Statistics Finland. http://tilastokeskus.fi/til/ene.html Official Finnish statistics (SVT): Fuel classification. Helsinki: Statistics Finland. http://www.stat.fi/tup/khkinv/khkaasut_polttoaineluokitus.html
Terraced houses	CO_2 emissions	1,000 t CO_2	636	200	123	63	
Blocks of flats	CO_2 emissions	1,000 t CO_2	2,398	812	514	279	
Non-residential buildings	CO_2 emissions	1,000 t CO_2	2,902	1,126	593	256	
Total	CO_2 emissions	1,000 t CO_2	7,809	2,874	1,476	654	
Total	CO_2 emission when compared to 2020	%	100	37	19	8	

4. Heating emissions intensity	Indicator	Unit	2020	2030	2040	2050	Sources
Residential and service buildings total	Emissions/consumption of heating energy (gross)	1,000 t CO_2/GWh	110	52	33	18	Official Finnish statistics (SVT): Housing energy consumption. ISSN=2323-3273. Helsinki: Statistics Finland. Accessed at http://www.stat.fi/til/asen/tau.html Official Finnish statistics (SVT): Fuel classification. Helsinki: Statistics Finland. http://www.stat.fi/tup/khkinv/khkaasut polttoaineluokitus.html

5. Share of nearly zero energy buildings	Indicator	Unit	2020	2030	2040	2050	Sources
Single-family and semi-detached houses E-value	Share of nearly zero energy buildings total	%	10	25	57	99	Energy performance certificate register. https://www.energiatodistusrekisteri.fi/
Terraced houses E-value < 105	Share of nearly zero energy buildings total	%	7	34	65	100	
Blocks of flats E-value < 90	Share of nearly zero energy buildings total	%	10	17	47	82	
Office buildings E-value < 100	Share of nearly zero energy buildings total	%	12	28	75	100	
Commercial buildings E-value < 135	Share of nearly zero energy buildings total	%	12	19	83	100	
Educational buildings and day-care centres E-value	Share of nearly zero energy buildings total	%	12	18	56	96	

6. Share of buildings completed in the 2010s and old renovated buildings	Indicator	Unit	2020	2030	2040	2050	Sources
Single-family and semi-detached houses	Share of A, B and C energy class buildings total	%	26	50	98	100	Energy performance certificate register. https://www.energiatodistusrekisteri.fi/
Terraced houses	Share of A, B and C energy class buildings total	%	22	54	99	100	
Blocks of flats	Share of A, B and C energy class buildings total	%	23	67	98	100	
Office buildings	Share of A, B and C energy class buildings total	%	48	77	100	100	
Commercial buildings	Share of A, B and C energy class buildings total	%	69	89	100	100	
Educational buildings and day-care centres	Share of A, B and C energy class buildings total	%	40	57	90	100	

7. Share of worst performing building	Indicator	Unit	2020	2030	2040	2050	Sources
Single-family and semi-detached houses	Share of F and G energy class buildings total	%	6	0	0	0	Energy performance certificate register. https://www.energiatodistusrekisteri.fi/
Terraced houses	Share of F and G energy class buildings total	%	4	0	0	0	
Blocks of flats	Share of F and G energy class buildings total	%	10	1	0	0	
Office buildings	Share of F and G energy class buildings total	%	7	2	0	0	
Commercial buildings	Share of F and G energy class buildings total	%	9	3	0	0	
Educational buildings and day-care centres	Share of F and G energy class buildings total	%	20	9	0	0	

8.1.6 Share of buildings completed in the 2010s and old renovated buildings

The share of buildings falling under energy classes A–C among all the buildings in the 2020 building stock is monitored with the information available in the energy performance certificate register, considering the share of buildings of different ages in the floor area.

8.1.7 Share of worst performing building stock segments

Buildings falling under energy classes F and G are included in the worst performing segments of the building stock. Their relative share of the entire 2020 building stock is monitored with the information available in the energy performance certificate register, considering the share of buildings of different ages in the floor area.

8.2 Development of the operating environment

8.2.1 Population of Mainland Finland

The official population projection for Mainland Finland, prepared by Statistics Finland, is a demographic trend calculation that is based on the demographic trends during the past few years. According to the projection, the population of Mainland Finland will start to decrease after 2030. The demographic trends involve a strong change in regional structure. According to the regional population projection that extends until 2040, the population will decrease in 85% of the 312 municipalities in Mainland Finland. The change of the regional structure is further emphasised by the fact that the population will experience strong growth in a small number of urban areas. Due to the changed regional structure, a significant part of the 2020 building stock will become underutilised or completely vacant in the areas suffering from depopulation. The demographic trends are monitored as one of the significant indicators of the heating energy consumption of the 2020 building stock (Table 28).

8.2.2 Housing and building stock

In 2020, there are a total of 3 million housing units in Mainland Finland. The combined floor area of all residential buildings is 305 million square metres. The floor area of non-residential buildings is 110 million square metres. Based on historical development, the population projection and development trends in the use of commercial premises, approximately 90% of the 2020 building stock will remain in 2030, approximately 80% in 2040 and approximately 70% in 2050 (Figure 20; Table 28). The impact on the heating energy consumption of the 2020 building stock will be higher, because the building loss will focus on buildings with lower energy efficiency than the average. Development of the 2020 building stock will be monitored as one of the significant indicators of heating energy consumption.

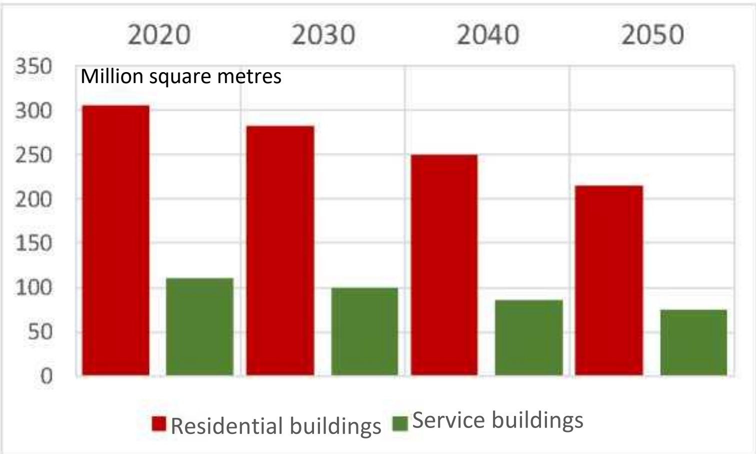


Figure 20. The 2020 building stock in Mainland Finland in 2030, 2040 and 2050.

8.2.3 Housing units in poor condition according to living condition statistics

The living condition statistics describe the living conditions of households. The data is collected by means of interviews included in an annual income and living condition survey that provides the information Finland contributes to the Eurostat statistics on income and living conditions (EU-SILC). Housing units in poor condition include all housing units with severe structural problems, such as a leaking roof, humidity problems in the walls or floor, or rotten window frames. A total of 1.2% of all households in Finland live in such housing units in poor condition. The development of living conditions is monitored as one of the indicators describing the level of housing.

Table 26. *Share of households living in housing units in poor condition.*

	2013	2014	2015	2016	2017	Source
Households living in housing units in poor condition	1.2%	1.2%	1.3%	1.0%	1.2%	Official Finnish statistics (SVT): Living condition statistics. ISSN=2669-8854. Helsinki: Statistics Finland

8.2.4 Emission factors

The electricity and district heating emission factors have been calculated on the basis of the average production level with the energy method. The energy sector policy measures are compatible with Finland's National Energy and Climate Plan (NECP). The electricity emission factor has been calculated based on the domestic production and consumption. The fossil fuels emission factor is based on the emission factor used for light fuel oil in the fuel classification of Statistics Finland. Development of the electricity and district heating emission factors, in particular, is monitored as an indicator of the reduction of the carbon intensiveness of the building stock's heating (decarbonisation; Table 28).

8.2.5 Targeted energy efficiency education

Due to the Finnish climate, structural energy efficiency and the functionality of technical building systems are an integral part of building construction, building technology and automation technology education in institutes of higher education (engineering, supervision) and vocational education (installation work). Qualifications for positions involving building energy efficiency are available. One can become a qualified energy system installer or a qualified energy efficiency assessor, for example (Table 27). Special qualifications are monitored as an indicator for the development of competence.

Table 27. *Special qualifications in the energy efficiency industry in 2020 (January 2020).*

Qualification	Number	Source
Energy performance certificate assessor (basic level)	813	Housing Finance and Development Centre of Finland, Assessors of Energy Performance Certificates https://www.energiatodistusrekisteri.fi/public_html?command=browse
Energy performance certificate assessor (higher level)	361	
Energy auditor	2300	Motiva, Certified energy auditors https://www.motiva.fi/ratkaisut/energiakatselmustoiminta/tem_n_tukemat_energiakatselmukset/patevoityneet energiakatselmoijat
Solar panel mechanic	65	Motiva, Certified mechanics https://www.motiva.fi/ratkaisut/uusiutuva_energia/palvelut/sertifioidut asentajat
Heat pump installer (mechanic with fixed cooling system installation qualification, e3a and y3a)	6911	TUKES, cooling system qualifications register http://rekisterit.tukes.fi/kylma-alan-patevyys
Property district heating supervisor	500	Information provided by Finnish Energy www.energia.fi

8.2.6 Heating demand

The annual fluctuation in the heating demand of buildings is described by the heating degree-day. The heating degree-day for the entire year can be identified by calculating the difference between all the outdoor temperatures measured during the year and the indoor temperature. The most commonly used heating degree-day is S17, where the indoor temperature expected in the calculation is +17°C. If the daily mean temperature is 0°C, for example, the annual heating degree-day for that day increases by 17°C per day. The annual heating degree-day is the sum of all the heating degree-days.

As an indicator describing the conditions, the heating degree-day indicates the annual fluctuation of buildings' energy demand and development in the long term, as the energy consumption of a building is proportional to the difference between the indoor and outdoor temperatures. The indoor temperature is usually higher than 17°C, but the calculation takes into account the fact that the presence of people and electrical equipment, as well as solar radiation, cause a heat load for buildings. The periods of time when the mean temperature is more than +10°C in the spring and more than +12°C in the autumn are not taken into account when calculating the annual heating degree-day. When calculating the heating degree-day, it is assumed that the heating systems of buildings are not switched on during this period.

In Finland, the Finnish Meteorological Institute provides the heating degree-day value, as the Meteorological Institute prepares heating degree-days for a total of 16 locations as both monthly and annual indicators. As the impact of climate change on the local conditions depends on the latitude, for example, the indicator consists of the annual heating degree-days for Helsinki (Kaisaniemi), Oulu and Ivalo.

Table 28. Indicators describing the operating environment and estimated change in 2020–2050.

1. Population projection for	**Indicator**	**Unit**	**2020**	**2030**	**2040**	**2050**	
Total	Population	Persons	5,501,000	5,534,000	5,491,000	5,391,000	Official Finnish statistics (SVT): Population projection ISSN=1798-5137. Helsinki: Statistics Finland http://www.stat.fi/til/vaenn/index.html
2. Housing and building stock	**Indicator**	**Unit**	**2020**	**2030**	**2040**	**2050**	**Sources**
Single-family and semi-detached houses	Housing units	1,000 pcs	1161	1060	939	807	Official Finnish statistics (SVT): Dwellings and housing conditions ISSN=1798-6745. Helsinki: Statistics Finland http://www.stat.fi/til/asas/index.html Official Finnish statistics (SVT): Buildings and free-time residences. ISSN=1798-677X. Helsinki: Statistics Finland http://www.stat.fi/til/rakke/index.html
	Floor area	1,000 m²	166	151	136	116	
Terraced houses	Housing units	1,000 pcs	414	390	348	301	
	Floor area	1,000 m²	35	34	28	27	
Blocks of flats	Housing units	1,000 pcs	1442	1320	1176	1020	
	Floor area	1,000 m²	104	97	85	72	
Non-residential	Floor area	1,000 m²	110	100	85	75	
Emission factors	**Indicator**	**Unit**	**2020**	**2030**	**2040**	**2050**	**Sources**
Type of heating	Fossil	t/GWh	263	263	263	263	Official Finnish statistics (SVT): Fuel classification. Helsinki: Statistics Finland. http://www.stat.fi/tup/khkinv/khkaasut
	District heating	t/GWh	160	76	64	45	
	Electricity	t/GWh	65	31	24	12	
Climate change	**Indicator**	**Unit**	**2020**	**2030**	**2040**	**2050**	**Source**

8.3 New indicators under development

8.3.1 Impact of repair actions on carbon footprint during building life cycle

The plan is to start regulating the carbon footprint during a building life cycle in the mid-2020s. The Ministry of the Environment is currently developing and testing a national method of calculating the building carbon footprint and preparing a national building material emission database. During the early stage, the carbon footprint regulation will probably only cover new buildings. The calculation method may also be applied to renovation.

Once the calculation method and the emission database are complete, emissions during major renovations may be included as one of the indicators describing the status of the 2020 building stock. However, this indicator cannot be used or any objectives be set for it before the carbon footprint calculation method and the building material database are both in use.

8.3.2 Profitability of repair actions

In 2020–2022, energy subsidies for residential properties will be available for the renovation of residential buildings. The subsidy recipients are obligated to submit information on the repair actions implemented with the subsidy. A database on the profitability of repair actions to improve energy efficiency will be prepared on the basis of this information. Profitability will be studied on the basis of energy costs (euros per saved kilowatt-hour during a selected review period) and emission reduction costs (euros per saved volume of CO_2 during a selected review period).

8.3.3 Effectiveness of dissemination of information to customers and consulting

In Finland, a significant part of all energy efficiency improvements are implemented voluntarily based on an incentive from the public sector or a joint agreement, such as an energy efficiency agreement or dissemination of information and consulting instead of mandatory heating and ventilation system inspections. The effectiveness and savings achieved by these measures have been reported. The opportunity to develop these and more extensive dissemination of information and consulting into a renovation strategy monitoring indicator is being studied.

8.3.4 Introduction of new technologies

The assumption is that the energy saving and emission reduction objectives specified in the Finnish renovation strategy will be achieved using technologies currently available on the market. The strategy also includes the monitoring of new technologies entering the market. Interesting potential energy technologies include geothermal heat wells drilled at a depth of two kilometres and emerging solar energy technologies. The storage of energy and the integration of energy systems can introduce whole new ways of utilising solar energy to the market.

9. Packaging supply and demand

Contents of this chapter: Article 2a(3)(a) of the EPBD (2010/31/EU), as amended by Directive 2018/844/EU, the aggregation of projects, including by investment platforms or groups, and by consortia of small and medium-sized enterprises, to enable investor access as well as packaged solutions for potential clients.
[The content of this chapter: the aggregation of projects, including by investment platforms or groups, and by consortia of small and medium-sized enterprises, to enable investor access as well as packaged solutions for potential clients.]

Joint building ventures have been tested and promoted by the Ministry of the Environment and local authorities. Guides on joint renovation projects have been prepared, for example. The legal status of the parties involved and the funding arrangements are secured by the Joint Building Ventures Act (ryhmärakennuttamislaki, 190/2015). The Act applies to both new buildings and renovation projects. In addition to traditional renovation projects, joint procurement of solar panels has been realised in Finland. Joint procurement encourages households and municipalities to acquire new technology and also calculate the unit costs of large procurement batches and repeatable measures.

- *Recommendation: Continuing with the regionally organised joint procurement and the encouragement of joint renovation projects.*

Owners take the initiative in the case of a joint building venture. Alternatively, the initiative could be taken by enterprises: companies could provide centralised renovation services that will clearly improve the energy efficiency of buildings and promote decarbonised heating.

- *Recommendation: Studying the opportunity to use an impact investment model where the renovation investment is funded by private investors and housing companies, and the investors receive a performance bonus when the set energy saving and emission reduction objectives are reached.*

10. Financial risk management

Contents of this chapter: Article 2a(3)(b) of the EPBD (2010/31/EU), as amended by Directive 2018/844/EU, the reduction of the perceived risk of energy efficiency operations for investors and the private sector.
[The content of this chapter: the reduction of the perceived risk of energy efficiency operations for investors and the private sector].

Banks will grant a repair loan amounting to a maximum of 50% of the building's fair market value. According to the loan terms, a maximum of 30% of the housing units in the property may be owned and rented out by investors. To cover the repair costs in areas with a low cost level, other funding is required in addition to a bank loan. The lack of such funding may prevent the implementation of a renovation. Applying for an interest subsidy loan for this purpose has been possible, but this opportunity has not been utilised.

- *Recommendation: Revising the terms of the interest subsidy loan provided by the Housing Finance and Development Centre of Finland ARA for residential buildings consisting of several housing units, to make the loan a more attractive option for sites that are unable to obtain market-based loan for their renovation projects.*

A prerequisite for market-based external funding is reliable information on the site being funded and the benefits obtained with the renovation project. Hence, the fact that financial institutions require information on buildings will be taken into account in the renewal of the energy performance certificate database. The energy subsidy programme for residential buildings in 2020–2022 requires the submission of a plan at the application stage to ensure that the project will be implemented according to the terms and conditions. Implementation of the plan is verified at the payment stage with an energy performance certificate.

- *Recommendation: Considering the information required by the financing sector when renewing the energy certificate database.*

Energy efficiency service providers and banks have developed leasing-based funding solutions for projects where a renovation to improve energy efficiency is paid in monthly instalments in accordance with the leasing model. The bank provides the funding for the renovation to improve energy efficiency and the service provider handles the planning, implementation and follow-up of the renovation. In such a case, the service provider provides the financial institution with a collateral security to verify financial feasibility of the renovation.

- *Recommendation: Companies providing energy renovation services providing financial institutions with verified information on the energy and cost savings that can be achieved with their products and services.*

Sustainable funding granted by a bank can mean supporting customers with the issue of green bonds, for example, so that enterprises and financial institutions can collect funding for projects that support their responsibility agenda. Sustainable funding may also mean providing green loans to customers, such as a loan for a project that aims to reduce CO_2 emissions. Public sector funding utilises green bonds and provides green funding, for example. Some private parties have also issued green bonds, which are used especially to improve the energy efficiency of their properties. Banks provide their customers with green mortgages, the criteria of which emphasise energy efficiency. In Finland, parties active in the real estate, construction and financial industries have participated in a project called EeMap (Energy Efficient Mortgages Action Plan, Horizon2020), for instance, the goal of which was to promote the development of green mortgages that promote energy efficiency.

- *Recommendation: Boosting consulting on green funding opportunities for renovation projects.*
- *Recommendation: Aiming to provide sustainable funding also in areas suffering from depopulation for buildings with long-term utilisation potential.*
- *Recommendation: Continuing with the close cooperation between the real estate, construction and financial industries.*

11. Public funding

Content of this chapter: Article 2a(3)(c) of the EPBD (2010/31/EU), as amended by Directive 2018/844/EU, use of public funding to leverage additional private-sector investment or address specific market failures.
The content of chapter: the use of public funding to leverage additional private-sector investment or address specific market failures].

As a general rule, funding for renovation projects is available. Funding will become a challenge if the building's value is low due to its poor condition or geographical location. In addition, public funding has to be allocated to projects that will introduce new solutions to the market.

Owners of single-family and semi-detached houses fund their renovations and energy efficiency improvements with their savings or a bank loan. The owners can use their tax credit for household expenses to cover part of the labour costs. Low income households can also use the general housing allowance or social assistance as necessary. Applying for a subsidy for renovations improving a building beyond the required energy efficiency level is possible in 2020–2022. The current energy subsidy scheme covers a period of three years. Subsidies should have a long life span. Short-term conjunctural subsidies will disturb the market and raise prices, and may lead to hasty renovation solutions. Foreseeable subsidies allow more time to diligently plan and prepare for the project. The outcome of such projects is more likely to be good. Financial incentives should be long-lasting and predictable. Subsidies with a long life span also allow development of the subsidies to better correspond to the needs and to correct any shortcomings. Being able to use subsidies to cover the planning costs of renovation projects is important as well, because it allows the use of a designing engineer when preparing the project. The fact that designing engineers are not used to plan the renovation projects of residential buildings is one of the observed challenges.

The owners of terraced houses and blocks of flats pay for the renovations with self-financing, cash flow financing, provisions, transfer to reserves or market-based external funding. Interest subsidy from the Housing Finance and Development Centre of Finland ARA is only available to non-profit corporations. Funding is also offered by international parties, such as the Nordic Investment Bank (NIB), the European Investment Bank (EIB) and the European Energy Efficiency Fund (EEEF). NIB finances property energy efficiency investments and projects related to the production of renewable energy, for example.

Available funding options for the energy efficiency renovations of non-residential buildings include self-financing, a bank loan or a loan from another financial institution, service provider's funding (a loan, a leasing arrangement, transfer of accounts receivable to a third party or financing tied to the balance sheet of the service provider) or the Business Finland investment subsidy, which is available to ESCO projects (requires guaranteed energy savings). Green bonds are also one way of obtaining funding. The party issuing the bond commits to investing the funding it has collected to projects promoting energy efficiency.

Another longstanding arrangement is cooperation with ESCO market operators to provide information for clients and service providers as well as to create client and service provider networks (annual meetings, procurement consulting services, etc.).

- *Recommendation: As short-term conjunctural subsidies will disturb the market and temporarily raise prices, financial incentives should be long-lasting and predictable.*
- *Recommendation: Continuing with the granting of the energy subsidy after 2022 and developing the terms and conditions of the subsidy as necessary.*
- *Recommendation: Allocating public funding and incentives especially to renovations improving a building beyond the required energy efficiency level and the testing of new technologies and concepts.*
- *Implemented: Energy subsidy for residential buildings (Government Decree 1341/2019) for renovations improving a residential building beyond the required energy efficiency level in 2020–2022. The subsidy can also be used to cover project planning costs.*
- *Implemented: The personal tax credit for household expenses (Tax Administration, 2019a) that can be used to cover part of the labour costs of energy renovations is valid until further notice.*
- *Implemented: Interest subsidy loans for major renovations of rental and right-of-occupancy buildings are available until further notice.*
- *Implemented: Loans against a personal guarantee for major renovations of housing companies are available until further notice.*

- *Implemented: Renovation subsidies for renovations of housing for the elderly and disabled persons are available until further notice.*
- *Implemented: Energy subsidies for companies and corporations (Business Finland, 2020) that have joined an energy efficiency agreement to cover investments in regular technology. Increased subsidies for ESCO projects. Validity period 2017–2025.*
- *Implemented: Energy subsidies for companies and corporations (Business Finland, 2020) for renewable energy investments. A decision is made annually.*
- *Implemented: Energy subsidies for demonstration projects (Business Finland, 2020) for innovative solutions that promote the transfer to a decarbonised energy system. A decision is made annually.*

12. Allocation of investments in improvement of the energy efficiency of the public building stock in accordance with Eurostat guidelines

Content of this chapter: Article 2a(3)(d) of the EPBD (2010/31/EU), as amended by Directive 2018/844/EU, guiding investments into an energy efficient public building stock, in line with Eurostat guidance.
[The content of this chapter: guiding investments into an energy efficient public building stock, in line with Eurostat guidance].

Improving energy efficiency as an ESCO service refers to a procedure where an Energy Service Company (ESCO) carries operational responsibility for an investment realised for an end customer in a manner which allows for full or partial financing of the investment with the savings generated by the investment. In Finland, projects realised by means of ESCO services are promoted with an ESCO subsidy, because they verify the achievement of the energy savings by means of measurements and follow-up, and because they lead to more significant and/or more permanent energy savings.

An ESCO subsidy can be granted to any company or corporation for an investment in regular technology. The subsidy is 25% for companies and corporations included in the scope of the energy agreement scheme and a maximum of 15% for other companies and corporations. If the ESCO project utilises new technology, obtaining an additional subsidy of a maximum of 40% is possible (Energy subsidy, Business Finland).

Prerequisites for the granting of subsidies for ESCO services include guaranteed savings of a minimum of 50% of the total savings (calculated in euros) and the estimated share of the verifiable savings from the total savings during the verification period being at least 80%, calculated in euros. There are no restrictions on the length of the ESCO project's service or agreement period.

- *Recommendation: Supporting and implementing ESCO projects in the public sector during the energy efficiency agreement period (2017–2025).*

13.Consulting

Content of this chapter: Article 2a(3)(e) of the EPBD (2010/31/EU), as amended by Directive 2018/844/EU, providing accessible and transparent advisory tools, such as one-stop-shops for consumers and energy advisory services, on relevant energy efficiency renovations and financing instruments.
[The content of this chapter: accessible and transparent advisory tools, such as one-stop-shops for consumers and energy advisory services, on relevant energy efficiency renovations and financing instruments.]

In Finland, the Ministry of the Environment is responsible for objective public renovation consulting. Consulting on energy efficiency is coordinated by the state-owned company Motiva Oy based on an assignment from the Energy Authority. Furthermore, associations and commercial actors provide renovation and energy efficiency consulting services. There are examples on the public consulting services and the consulting services provided by associations in Table 29 and a diagram on the overall consulting services (Figure 21). In addition to the parties listed in the image and the table, other associations, organisations and commercial parties (companies) provide consulting services.

Table 29. *Examples of consulting services.*

Consulting service provider	Subject matter	Examples of services
Ministry of the Environment; ARA	Comprehensive	Korjaustieto.fi Energiatodistusrekisteri.fi Guide on energy efficiency in renovation projects Improving the energy efficiency of culturally and historically valuable buildings
Energy Authority	Comprehensive	Regionally organised energy consulting
Motiva Oy	Comprehensive	Information, consulting, audit templates, calculators, campaigns, projects
Regional museums	Culturally and historically valuable sites	Renovation solutions
Finnish Heritage Agency	Culturally and historically valuable sites	Instructions and guides on the constructed cultural environment and a renovation card system
Finnish Association for the Welfare of Older People	The elderly and disabled war veterans	Surveying renovation needs, planning, organisation of projects and funding
Organisation for Respiratory Health in Finland	Comprehensive	Prevention of humidity and mildew damage
Suomen Omakotiliitto ry	Detached and semi-detached	Consulting, electronic maintenance records
Finnish Real Estate Federation	Residential associations	Consulting, training, property management tools, calculators
RAKLI ry	Property owners	Energy efficiency agreements, real estate industry roadmap for carbon neutral society, Green Lease contract templates
City of Oulu	Residential buildings	Energiakorjaus.info
Finnish Building Services Industries and Trade (Talteka)	Residential buildings	Energy efficiency improvement concepts Talotekniikkainfo.fi

In Finland, the consulting services aiming for energy efficiency improvements are well-established. Materials and tools have been created since the energy crises in the 1970s. Achievement of the energy and climate policy objectives requires improving the efficiency of the consulting by means of collaboration between the consulting organisations and other parties, by increasing recognition of the consulting services and by using means to communicate reliable information to the target groups on efficient means of improving the energy efficiency of buildings.

A new challenge in consulting is communicating reliable information on how old buildings can be converted into highly energy efficient and decarbonised buildings in a cost-effective manner, considering the different available funding options. It is proposed that the consulting and communications be further developed as follows:

- *Recommendation: Improving effectiveness of the consulting by providing better coordinated renovation and energy consulting.*
- *Recommendation: Ensuring that the consulting is backed up by freely available information on successful cost-effective measures in a format that can be easily utilised.*
- *Recommendation: Creating a renovation one-stop shop for consumers to provide them information on energy renovations, funding, subsidies and service providers, as well as assistance in combining projects (joint renovation projects).*
- *Recommendation: Providing the market and customers (the Tax Administration, insurance companies, tenants, owners) information on the impact of energy efficiency investments on the value of a property and its operating costs throughout its lifecycle.*

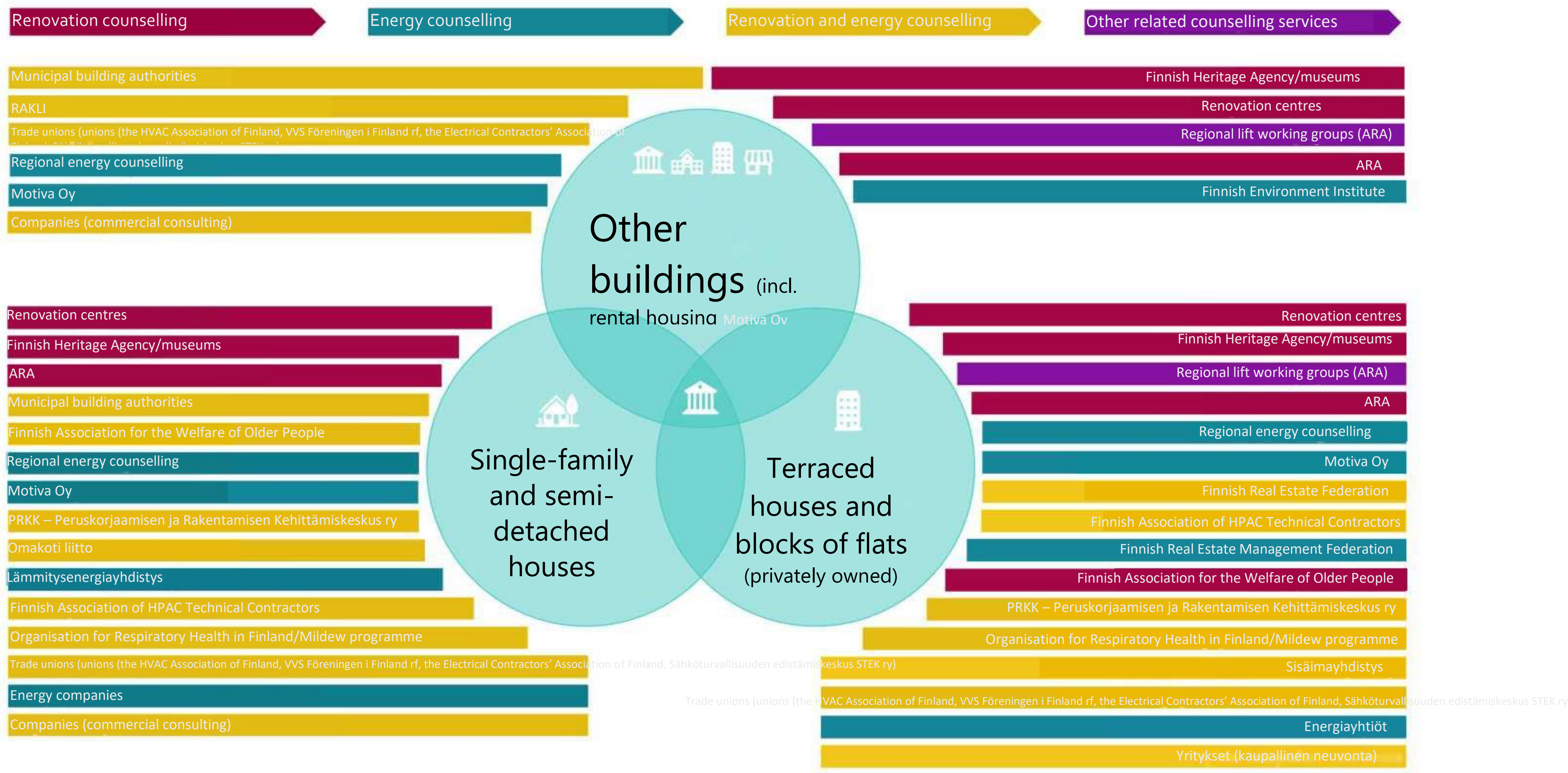


Figure 21. Summary of parties providing renovation and energy consulting in Finland in 2019.

14. Stakeholder cooperation

Content of this chapter: Article 2a(5) of the EPBD (2010/31/EU), as amended by Directive 2018/844/EU, to support the development of its long-term renovation strategy, each Member State shall carry out a public consultation on its long-term renovation strategy prior to submitting it to the Commission. Each Member State shall annex a summary of the results of its public consultation to its long-term renovation strategy.
[The content of this chapter: To support the development of its long-term renovation strategy, each Member State shall carry out a public consultation on its long-term renovation strategy prior to submitting it to the Commission. Each Member State shall annex a summary of the results of its public consultation to its long-term renovation strategy.]

The preparation of the renovation strategy was supported by a strategic advisory group consisting of representatives of real estate and construction industry associations and representatives of government agencies. The advisory group convened four times in 2019 and 2020.

The preparation of the strategy included two extensive public hearings (16 September 2019 and 11 February 2020), one expert consultation (28 August 2019) and six workshops (17 September 2018, 1 April 2019, 8 May 2019, 22 May 2019, 24 May 2019 and 10 December 2019). A total of 542 people attended the hearings and the workshops. The participants represented a total of 147 stakeholders and target groups (Figure 22), comprehensively covering the Finnish real estate and construction industries, public parties, target groups (consumers, residents of detached and semi-detached houses, housing companies, other buildings) and stakeholders (parties providing consulting services, professionals in the industry, educational organisations, financiers, etc.).

During the course of the work, the strategy was presented at 14 events attended by 1,287 people. Eight interviews were performed and one article on the project was written. The strategy was mentioned in many articles in the media. The combined circulation of the interviews, the article on the project and the articles in which the project was mentioned was 540,796.

The materials on the public hearings arranged in September 2019 and February 2020 were published for comments in the Otakantaa.fi service. A total of 43 parties provided comments in 2019 and eight parties in 2020. The stakeholders commented on the strategy during the hearing events.

A summary of the feedback on the renovation strategy (summaries of the hearing events, comments provided at the events and comments provided through Otakantaa.fi) is presented in Annex A to this report. The organisations that participated in the strategy process are listed in Annex B to this report.

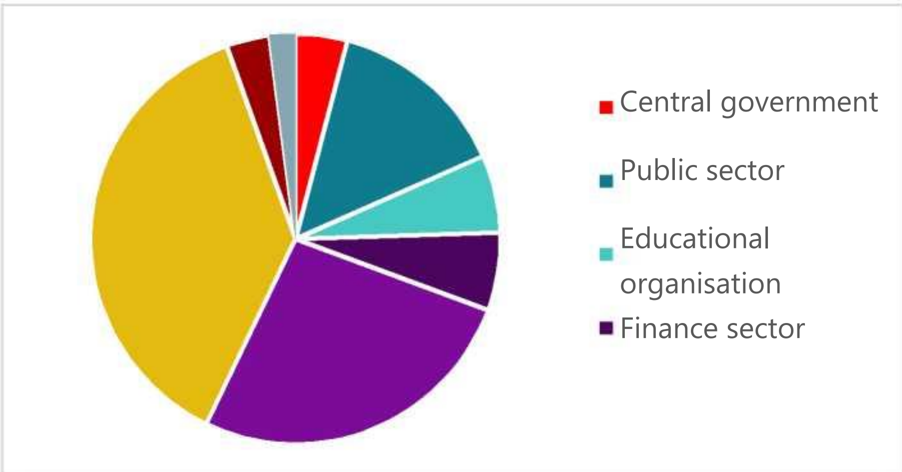


Figure 22. Organisations participating in the preparation of the renovation strategy divided by type.

15. Implementation and follow-up of the strategy

Content of this chapter: Article 2a(5) of the EPBD (2010/31/EU), as amended by Directive 2018/844/EU, each Member State shall establish the modalities for consultation in an inclusive way during the implementation of its long-term renovation strategy.
[Each Member State shall establish the modalities for consultation in an inclusive way during the implementation of its long-term renovation strategy.]

There are long traditions for collaboration between the public and private sector in Finland. Stakeholders have participated in the planning and implementation of Directives on energy production and consumption. A good example of this are the energy efficiency agreements, which have been used to set shared energy saving objectives since 1997.

Stakeholders participated in the development of all the three Finnish renovation strategies (2014, 2017 and 2020), and the collaboration will continue also during the follow-up of the strategy's implementation. The Finnish Environment Institute (SYKE) will develop a follow-up system for the strategy. The follow-up system will be published for all interested parties to peruse.

The advisory group for the preparation of the strategy consisted of a total of 16 parties representing central government and the real estate and construction industries. Those parties from the advisory group that committed to the promotion of the strategy's implementation and the follow-up of the objectives are listed below.

- Energy Authority
- Finance Finland
- Motiva Oy
- Finnish Association of Civil Engineers RIL
- RAKLI ry
- Finnish Association of Architects (SAFA)
- Finnish Real Estate Federation
- Suomen Omakotiliitto ry
- Finnish Environment Institute (SYKE)
- Tampere University of Applied Sciences (TAMK)
- VTT Technical Research Centre of Finland
- Ministry of Economic Affairs and Employment
- Ministry of the Environment

16. Implementation of the strategy pursuant to Article 4 of the EED

Content of this chapter: Article 2a(6) of the EPBD (2010/31/EU), as amended by Directive 2018/844/EU, each Member State shall annex the details of the implementation of its most recent long-term renovation strategy to its long-term renovation strategy, including on the planned policies and actions.
[Each Member State shall annex the details of the implementation of its most recent long-term renovation strategy to its long-term renovation strategy, including on the planned policies and actions]

Renovation strategies compliant with Article 4 of the Energy Efficiency Directive were also prepared in 2014 and 2017. In the progress reports, the consumption of heating energy was studied as a whole without dividing it into the old renovated building stock and new buildings. Furthermore, the progress reports focused on energy consumption and emissions.

Implementation of the previous strategy (submitted in 2017) is studied from different aspects:
- Implementation of the selected policies and measures
- Changes in heating energy consumption and heating methods

Improvements of the energy efficiency of buildings can be most cost- and resource efficiently implemented as part of normal maintenance and repairs. For this reason, the 2017 Finnish strategy emphasised far-sighted property management. The quantity and quality of renovation services have been improved by investing in the competencies and training of the workforce, technology, innovations and business operations. Improving the energy efficiency of their building is the most reliable method property owners can use to prepare for an increase of the energy costs.

16.1 Policies and measures

The tables below present the planned measures in italics in the left-hand column and the current status of the measures in the right-hand column. Most of the planned measures have been completed or prepared to a large extent.

Energy efficiency can only be improved if the entire renovation project is carried out professionally and in compliance with the required quality from start to finish, and if the functionality of the building is studied as a whole. The client must specify what they want to achieve with the renovation in terms of energy efficiency, and the designing engineers must find the means of meeting the energy performance objective and ensure that the energy efficiency objectives are met. Measures related to these objectives are presented in Tables 30 and 31.

Table 30. *Far-sighted property management.*

Measure in the 2017 strategy	Status 2019
*Increasing **the use of tools** developed to support property management (building user and maintenance manuals, condition evaluations, long-term maintenance plans).* *In addition to a short-term maintenance plan (5 years), property management should be considered on a longer term basis (e.g. 10–15 years) by preparing a **property strategy**.*	Single-family houses: In 2017, the energy performance certificate requirement was extended to cover single-family houses completed prior to 1980. The energy performance certificate must include recommendations on the improvement of the energy efficiency and instructions on where the building owner can obtain more information about the proposed actions. Terraced houses and blocks of flats: Together with the Building Information Foundation RTS, the Finnish Real Estate Federation has developed an online service that uses property data and RTS' databases to create a renovation programme for <5 years, 5–10 years and >10 years. https://www.kiinteistoliitto.fi/media/4368/raku esite paiv.pdf
*Staged deep renovation would require **a longer period of validity for the building permit** than the current five years.*	The building permit practice was not amended. The building permit application process and the management of related documentation has been digitised to make the process more fluent. An electronic building permit can be applied through https://www.lupapiste.fi/ or https://kunnat.trimble.fi/

Table 31. *Know-how, education and training of the labour force*

Measure in the 2017 strategy	**Status 2019**
*Promoting the **use of research data** in education by boosting cooperation between universities, universities of applied sciences and institutes of basic vocational education. At the moment, the possibility of merging universities and universities of applied sciences is being investigated.*	Finland's largest construction engineering training hubs have clearly increased the level of internal cooperation. The University of Oulu became the owner of the local university of applied sciences in 2018, and the university of applied sciences was moved to the university campus. In Tampere, the local university and university of applied sciences were merged as of the beginning of 2019. The university and university of applied sciences are part of the same group also in Lappeenranta. Shared teaching resources allow for more fluent transfer of research data into teaching. Another benefit of such cooperation are projects where the theoretical research results provided by the universities are tested in actual projects. https://www.tuni.fi/en https://www.oulu.fi/university/
*Awareness among renovation operators and access, based on digital services, to information on the industry's processes and operating methods are being promoted by one of the Finnish Government's key projects, called **Kiinteistö- ja rakennusalan digitalisaatio (Digitisation of the constructed environment and construction sector)**.*	The joint KIRA-digi project of the public and private sector has completed 139 experimental property management and construction process digitisation projects. The projects have combined information and telecommunications technology expertise with traditional construction engineering and building technology. http://www.kiradigi.fi/ The cooperation between the public sector and enterprises in the digitisation of property management and construction processes will continue in the KIRAHub forum, http://www.kirahub.fi/ VTT Technical Research Centre of Finland and Metropolia University of Applied Sciences have specified both parties' expertise requirements for projects based on data modelling, https://www.vtt.fi/sites/bimeet/Documents/Reports%20and%20publications/D3.2 Definition of learning outcomes short V1.2.pdf
*Promoting the **acquisition of new competencies** by all parties active in the field of renovation. New expertise areas include the use of renewable energy sources in buildings (solar energy, heat pumps), related building technology, overall performance (hybrid systems) and lifecycle costs (costs versus the properties of a building, such as health and safety aspects, functionality, lighting and accessibility).*	Certification training for the installation of renewable energy systems has been started, https://www.motiva.fi/ratkaisut/uusiutuva_energia/palvelut/sertifioidut asentajat/sertifiointikoulutus
*Promoting **smooth implementation of renovation projects** by means of agreement templates (falls within the responsibilities of Building Information), by adopting new contract models in addition to the traditional ones (such as cooperative contracting, life-cycle contracting) and by recommending that local authorities responsible for construction supervision take a proactive role in renovation projects and improve the competence of lay clients.*	The Finnish Real Estate Federation invested in the implementation of new contract forms in 2017 and 2018. The investments resulted in new document templates compliant with the shared contractual practices of the real estate and construction industries. They are available in digital format at www.sopimuslomake.net The Ministry of the Environment maintains a website on fluent renovation projects and building energy efficiency improvements, https://www.ymparisto.fi/fi-FI/Rakentaminen/Korjaustieto/Taloyhtiot/Korjaushankkeet Tahti production development by the Aalto University, https://www.aalto.fi/sites/g/files/flghsv161/files/2019-02/building_2030_tahti_suunnittelussa_ja_tuotannossa_loppuraportti_22.1.201.pdf

*Developing a voluntary certification scheme based on existing schemes for renovation and property **lifecycle management**. The objective is to increase expertise in renovation and property maintenance, improve the reliability of such activities and raise their prestige as a whole.*	Fise Oy organises the qualification system and maintains a register of currently valid qualifications. The register includes a total of 9,313 different qualifications with special focus on duties involving the completion of construction projects, such as condition surveys, planning, work supervision, construction site supervision and development. https://fise.fi/en/ Fise has prepared a separate guide on renovation qualifications https://www.esitteemme.fi/fise/WebView/

Digitisation is a common denominator in the renewal of business operations and the improvement of profitability in both the public and the private sector. By combining information and telecommunications technology with traditional building technologies, construction engineering in particular, it is possible to significantly improve the energy efficiency of buildings. Digitisation of properties and renovation projects has been the most important package of measures in the Finnish renovation strategy (Table 32).

Table 32. *Digitalisation, innovations and business operations*

Measure in the 2017 strategy	**Status 2019**
***Online permit services** relating to the constructed environment have been adopted in one-third of all municipalities.*	Almost all municipalities have digitised their permit services. https://www.lupapiste.fi/ ; https://kunnat.trimble.fi/
***Website on energy performance certificates**, which includes guidelines on drawing up energy performance certificates, calculation guidelines, a service for storing certificates and a database (open data).*	The Housing Finance and Development Centre of Finland ARA maintains an energy performance certificate website which provides a host of information for a variety of stakeholders on energy performance certificates, as well as a data bank and links to other organisations that provide additional information, https://www.energiatodistusrekisteri.fi/
***Property price information service** for old housing units (open data)*	The Housing Finance and Development Centre of Finland ARA maintains a housing unit price data service,
***Online form** service of the Housing Finance and Development Centre of Finland ARA.*	The Housing Finance and Development Centre of Finland ARA maintains an online form service, https://www.ara.fi/fi- FI/Lainat ja avustukset/Lomakkeet
*Testing **digital models** of buildings and applying standards in practice*	The joint KIRA-digi project of the public and private sector has completed 139 experimental property management and construction process digitisation projects. The projects have combined information and telecommunications technology expertise with traditional construction engineering and building technology. http://www.kiradigi.fi/ The cooperation between the public sector and enterprises in the digitisation of property management and construction processes will continue in the KIRAHub forum, http://www.kirahub.fi/ A common data platform, marketplace and community of leading actors, the Platform of Trust, has been established for promoting digitisation and safe communication in the real estate and construction industries, https://www.platformoftrust.net/
*Promoting practices that enable the use of harmonised/compatible **digital information** in various processes (such as remote control of consumption, real-time monitoring of consumption, power demand monitoring, facility-specific consumption monitoring and various consumption simulations and measurements) throughout the entire lifecycle of the constructed environment.*	
*Developing solutions to facilitate **communication of information** during design and construction and construction and operation, and thus speed up changes of key practices in the industry.*	
*Testing technologies tested that will assist in **cutting power demand** during peak periods by introducing flexibility in the energy consumption of buildings (automatic short-term disconnection of consumption).*	As early as in 2007, the Ministry of Trade and Industry established a working group to prepare measures to develop the elasticity of electricity demand and its adaptation to the electricity markets, https://tem.fi/hankesivu?tunnus=KTM009:00/2007 Final report of the Smart Grid Working Group of the Ministry of Economic Affairs and Employment, 2018. The transfer to a resource-efficient and climate neutral electrical energy system has been studied in the EL-TRAN project, for example (https://el-tran.fi/).

	The projects ProCem and ProCemPlus studied distributed electricity production and the role of consumers (http://www.senecc.fi/projects/procemplus) Elasticity of demand is a service that balances out the energy market in the large scale, https://www.fingrid.fi/kantaverkko/tehoreservi/ Fingrid and Motiva encourage the owners of detached and semi-detached houses to utilise the elasticity of demand, and have published a related guide, https://www.motiva.fi/files/15606/Kulutusjousto.pdf Smart automation is the key in cutting the heating power demand. Commercial energy companies provide elasticity of demand technologies for district heating systems – e.g. Tampereen Sähkölaitos, https://www.sahkolaitos.fi/alykkaita-energiapalveluita/alykas- kaukolampo--palvelu/, Fortum/Leanheat https://leanheat.fi/yritys) and IT service providers (such as Enermix https://www.talotohtori.fi/.
*Investments in the **commercial exploitation of the results of R&D&I projects** and new business should be increased (experimental building, promotion of agile development).*	KIRA-digi has arranged some quick experiments, http://www.kiradigi.fi/ The cooperation between the public sector and enterprises in the digitisation of property management and construction processes will continue in the KIRAHub forum, http://www.kirahub.fi/ Experiment searches have been arranged to investigate innovative means of improving energy efficiency, http://www.kokeilunpaikka.fi
*Business should be developed so that **services tailored** to match the range of energy efficiency improvements are available, as well as suitable production systems covering design, engineering, commissioning and contracting models (such as lifecycle and alliance contracting).*	The development of business focuses on the development of digital services. Development areas include both public and commercial services. Development work has been carried out through KIRA-digi, http://www.kiradigi.fi/ The cooperation between the public sector and enterprises in the digitisation of property management and construction processes will continue in the KIRAHub forum, http://www.kirahub.fi/

There is both research data on the improvement of energy efficiency and data obtained from tests performed at actual sites. Effectiveness can only be achieved by replicating good concepts as comprehensively as possible. Hence, communication is one of the development areas (Table 33).

Table 33. *Communications*

Measure in the 2017 strategy	Status 2019
***Communicating information about successful energy efficiency improvements** (the most cost-effective measures, technically and functionally feasible measures, indoor air quality improvements in connection with renovations) as well as risks relating to the optional solutions.*	The Ministry of the Environment commissioned a guide on structural energy efficiency in renovation projects in 2017, https://www.ym.fi/fi-FI/Ajankohtaista/Uutiset/Uusi_opas_auttaa_parantamaan_energiateho(42776), and a guide on improving energy efficiency during renovation of culturally and historically valuable buildings in 2018, http://julkaisut.valtioneuvosto.fi/handle/10024/161268 Motiva has arranged regular (biannual) training and communication events for parties preparing energy performance certificates, http://energiatodistus.motiva.fi/energiatodistustenlaatijat/tapahtumat/ Organisations of different cities arrange similar events for the owners of residential buildings, such as HSY in Helsinki, https://energianeuvonta.fi/koulutukset/ and Ekokumppanit in Tampere, www.ekokumppanit.fi. In addition to themed events, energy expert training is available. The training provides comprehensive information about the energy efficiency of housing companies.

	Some research projects (such as the SET project of the Academy of Finland) have generated information about demonstration sites.
A public database on ***cost-effective measures*** *for experts preparing energy performance certificates.*	Under investigation.
Indicators calculated per actual user *(kWh/resident or employee) or actual number of users (kWh/user or customer) for assessing energy efficiency if the efficiency of space utilisation will be improved during a renovation project.*	The energy efficiency assessment method was not changed during the revision of the energy performance certificate system. The energy efficiency requirements for renovation projects still comply with Decree 4/2013 of the Ministry of the Environment, as amended by Decree 2/2017.
A ***virtual model of implementing a renovation project*** *that requires planning permission (permits, design and engineering, supervision, surveys, inspections, implementation of the contract, commissioning and operation).*	There are ongoing EU projects on the utilisation of data modelling in renovation projects, such as BIM based fast toolkit for Efficient rEnovation of residential Buildings, https://www.bim4eeb-project.eu/
Providing the market and customers (the Tax Administration, insurance companies, tenants, owners) information ***on the impact of energy efficiency investments*** *on the value of a property and its operating costs throughout its lifecycle.*	When selling a housing unit, the seller must present a certificate issued by the property manager. In the case of a detached or semi-detached house, a condition evaluation report is usually presented. An energy performance certificate must be presented in connection with both transaction types. Combined with the housing unit price data, this information provides an idea of the overall condition of the site. The information required by the different stakeholders will be taken into account when reforming the technical energy performance certificate system.

Finland has selected a strategy of promoting energy performance improvements during renovation projects that would be realised in any case, which ensures that the improvements are implemented in a cost- and material efficient manner. Financial incentives for some special sites have been proposed (Table 34).

Table 34. *Financial incentives*

Measure in the 2017 strategy	**Status 2019**
Investigating the possibility of promoting deep renovation by ***supporting the planning of residential building renovation projects****. The amount of such aid should be significant, such as 50% of the planning costs if it can be demonstrated that the project will result in an energy efficiency improvement that is significantly higher than the required level and an impact assessment confirms that higher quality has been achieved. Project plans and information on savings achieved should be made publicly available to ensure that best practices can be used to improve the planning of similar projects.*	A renovation subsidy for condition surveys and renovation planning of housing units for special needs groups. Can be granted to a household or a housing company. For 2020–2022, EUR 100 million in energy subsidies has been budgeted to residential renovation projects that will result in an energy efficiency improvement that is significantly higher than the required level. The subsidy can be used for renovation measures or planning.
Promoting measures that allow ***the tenant of a housing unit or commercial premises to influence*** *the level of their rent by saving on heating energy or electricity costs, for example.*	The Finnish Government will propose to Parliament an obligation to base water bills on measured consumption (a Government bill will be issued in 2020). The Finnish Real Estate Federation has developed for its members ecologically efficient agreement practices where the property owner and tenant agree on mutually beneficial means of improving the site's ecological efficiency, https://www.rakli.fi/sopimusesimerkit/. Energy efficiency agreements for 2017–2025 have been signed. Their objective is to boost the efficiency of energy consumption in the real estate industry (tenement buildings, commercial premises). The agreements encourage companies and corporations to continuously improve their energy efficiency. Parties who have signed the agreements can obtain public funding for their projects.
Promoting measures that ***support the smooth functioning of*** *residential and commercial property markets. Far-sighted property management and good property maintenance should be reflected in the prices and rents of housing units and commercial premises. Similarly, the neglect of maintenance,*	

poor energy efficiency and merely aesthetic repairs should lead to lower prices and rents on the market.	

16.2 Heating energy consumption and heating methods

Carbon intensiveness of the heating of residential and non-residential buildings is quickly decreasing. In Finland, 35% of all the energy used to heat buildings is used for property-specific heating. When measured as useful energy, the share
decreases to 20%. Over the course of the past five years, the share of fossil fuels in property-specific heating has decreased by 3%. Fossil fuels have mainly been replaced with heat pumps (Figure 23). The share of energy generated with heat pumps has increased by 4%. Heat pumps have also claimed part of the market share previously held by wood. Heat pumps have been used to replace oil heating (geothermal heat pumps and air source heat pumps), boost the use of electricity in heating (air to water heat pumps) and the use of district heating (exhaust air heat pumps). Heat pumps have been identified as cost-effective. Hence, they were included among the recommended measures in the previous strategy.

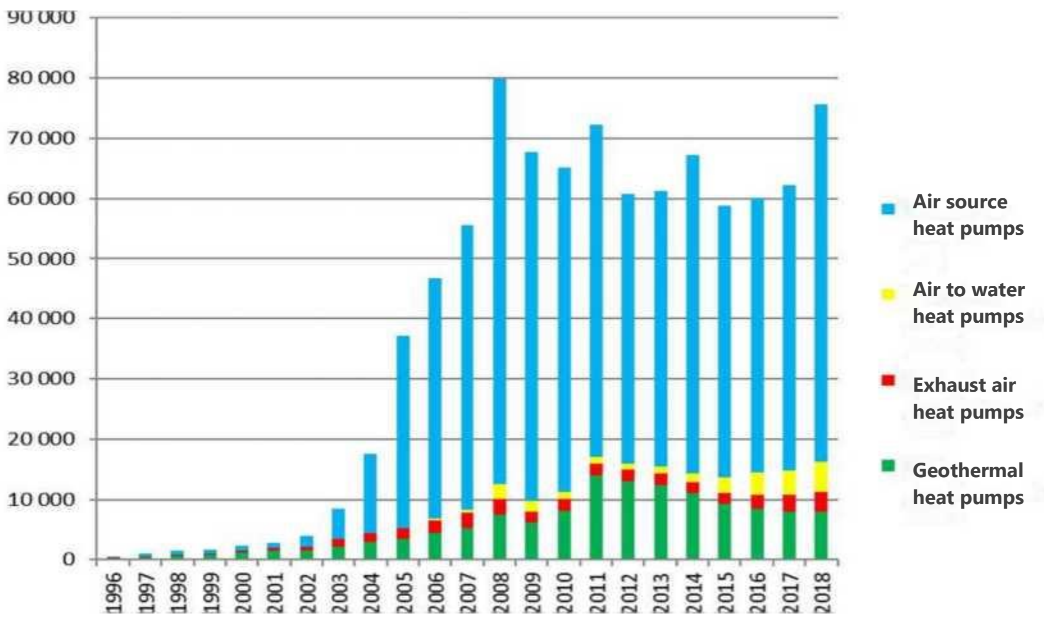


Figure 23. Annually commissioned heat pumps (Heat pump statistics, the Finnish Heat Pump Association).

The rest of the heating energy consumption, 65% (80% of the useful energy), is produced centrally in district heating plants, combined heat and power plants or electric power stations. The reduction of carbon intensiveness has been extremely fast in the centralised production of heat. In district heat production, the combined share of fossil fuels and peat has decreased from 63% to 53% in five years. Heat pumps have been introduced to centralised heat production as well. The share of fossil fuels has always been lower in electricity production than in district heat production. In five years, the share of fossil fuels and peat has decreased from 25% to 20%. Reducing the carbon intensiveness of centrally produced energy is part of the Finnish energy and climate strategy and the achievement of the carbon neutrality objective.

17. Fire safety and other significant requirements

Content of this chapter: Article 2a(7) of the EPBD (2010/31/EU), as amended by Directive 2018/844/EU, each Member State may use its long-term renovation strategy to address fire safety and risks related to intense seismic activity affecting energy efficiency renovations and the lifetime of buildings.

Article 7(5) of the EPBD (2010/31/EU), as amended by Directive 2018/844/EU, Member States shall encourage, in relation to buildings undergoing major renovation, high-efficiency alternative systems, in so far as this is technically, functionally and economically feasible, and shall address the issues of healthy indoor climate conditions, fire safety and risks related to intense seismic activity.

[Each Member State may use its long-term renovation strategy to address fire safety and risks related to intense seismic activity affecting energy efficiency renovations and the lifetime of buildings.

Member States shall encourage, in relation to buildings undergoing major renovation, high-efficiency alternative systems, in so far as this is technically, functionally and economically feasible, and shall address the issues of healthy indoor climate conditions, fire safety and risks related to intense seismic activity.]

The National Building Code of Finland is based on the Land Use and Building Act and its supplementary decrees. They apply to both new buildings and renovation projects.

17.1 Fire safety

Decree 4/2013 of the Ministry of the Environment includes requirements on the improvement of the energy efficiency of old buildings in connection with renovation projects. When planning or implementing a renovation or replacement project concerning the building envelope or technical systems, the measures must be selected so as to ensure correct functioning of the thermal and acoustic insulation, moisture barriers and fire insulation of the structures.

Decree 745/2017 of the Ministry of the Environment on Chimney Structures and Fire Safety (ympäristöministeriön asetus savupiippujen rakenteista ja paloturvallisuudesta, 745/2017) applies to retrofitted chimneys, chimney or flue repairs or recoating, replacement or modification of fireplaces and installation of new flues in existing chimneys or structural elements the intended use of which has been changed. The connecting flues of a chimney and the fireplace connected to the chimney, as well as their joints, must form a functional entity that is fire-safe and safe for people to use. The party completing a construction project must ensure that the chimney will be constructed and repaired according to the plans. Reports prepared during the preparation of the Decree have been published, https://www.ym.fi/fiFI/Maankaytto_ja_rakentaminen/Lainsaadanto_ja_ohjeet/Rakentamismaarayskokoelma/Paloturvallisuus. Furthermore, the Ministry of the Environment published in 2019 a guide on chimney structures and fire safety that includes examples of chimney and fireplace implementation methods.

Decree of the Ministry of the Environment on the Fire Safety of Buildings (ympäristöministeriön asetus rakennusten paloturvallisuudesta, 848/2017) must be followed in all construction projects. Buildings must be constructed in a manner which ensures that people inside the building can save themselves or be saved in case of a fire. The authorising body may require a safety report for sites that are especially demanding in terms of safe exit routes.

- *Implemented: A party implementing a construction project must ensure that the building will be designed and constructed in a manner which ensures that it is fire-safe when considering its intended use. The risk of a fire breaking out must be limited.*
- *Implemented: The load-bearing structures of a building must be such that in case of a fire, they will endure for the specified minimum period of time without the building collapsing and in a manner which allows for safe exit, rescue operations and containment of the fire.*
- *Implemented: Limiting the generation and spreading of fire and smoke in a building and the spreading of the fire to adjoining buildings must be possible.*
- *Implemented: Building products and technical systems applicable for the required level of fire safety must be used when constructing a building.*

17.2 Seismic activity

As Finland is located in the middle of a tectonic plate, earthquakes are weak, magnitude 0–4. Dozens of earthquakes are registered, but measuring instruments are required to detect them. Such weak earthquakes do not cause any damage requiring repairs in buildings.

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https://issuu.com/mediat/docs/taloyhtion_energiakirja

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https://julkaisut.valtioneuvosto.fi/handle/10024/80653

Vähähiilisen rakentamisen hankintakriteerit (Procurement criteria in decarbonised construction, 2017), Ministry of the Environment https://julkaisut.valtioneuvosto.fi/handle/10024/80654

Annex A Stakeholder comments on the strategy

This annex includes the results of its public consultation to the long-term renovation strategy pursuant to Article 2a(5) of the EPBD (2010/31/EU).
[Content of this chapter: Each Member State shall annex a summary of the results of its public consultation to its long-term renovation strategy.]

During the renovation strategy process, two extensive hearings were arranged, where various stakeholder organisations were able to comment on the strategy. A survey was implemented in connection with both hearings in Otakantaa.fi.

The actual public hearing events were arranged on 16 September 2019 and 11 February 2020. A total of six stakeholders provided comments at the events: the Finnish Association of Civil Engineers RIL, Suomen Omakotiliitto ry, RAKLI ry, Finnish Energy, the Finnish Association of Architects (SAFA) and the Finnish Real Estate Federation.

A total of 51 replies were received for the surveys realised in the public Otakantaa.fi service.

The cooperation with the stakeholders is described in more detail in Chapter 14. The organisations that participated in the process are listed in Annex B.

Summary of the stakeholder comments

General comments on the strategy and its content:

- The strategy is an excellent package of information on the Finnish building stock and a variety of measures, consulting and tools, for example.
- The fact that expertise and training are emphasised throughout the strategy is good. Expertise in new technologies is required by all parties active in properties and the real estate industry, especially those who are involved in the procurement, implementation and maintenance of the technologies.

Strategy sections	Summary of the comments

• Overview of Mainland Finland's building stock
• Cost-effective means of transforming the 2020 building stock to highly energy efficient and decarbonised by 2050
• Policies and actions promoting the measures
  o Binding energy efficiency legislation
  o Promotion of carbon neutrality
  o Energy efficiency in maintenance and renovation projects
• Targeted policies and measures
• Public buildings
	• Space utilisation efficiency and sensible use of premises should be emphasised.
	• The review of the building stock from the viewpoint of heating and energy efficiency – in addition to the decarbonisation viewpoint – was considered a good approach.
	• The role of residential buildings is important; there are plenty of them, and repairing them is a challenge.
	• As a general rule, the Finnish building stock requires a great deal of consideration on which renovations are wise and when they should be realised to secure absolutely necessary housing. Demolition is not a general solution.
	• The status of protected buildings and their energy requirements were separately mentioned.
	• The development of statistics was separately mentioned; how the statistics are developed is especially important – which are included in the existing building stock and which are new buildings. At which point will a new building become an existing one from the statistical viewpoint?
	• How will the building energy classes be developed in future, what will their significance be for reporting and follow-up? How well will the strategy control actions in future: what kind of impact will it have on the allocation of subsidies, for example?.

• • Smart technologies, know-how and education	• Ensuring continuous learning is important. • Training is also required for building maintenance personnel and designing engineers, in particular. • The link between the energy renovation strategy and the circular economy. • Training on the circular economy, decarbonisation, lifecycle costing (LCC) and procurement will be necessary. There is demand for such training especially in municipalities and housing companies. Designing engineers and building supervision authorities, developers and property owners also lack expertise. • Considering power demand in addition to energy efficiency is important, and smart technologies have an important role as enablers of elasticity of demand and development of the energy grid. • The collected information on the building stock and buildings should be better available to the different parties active in the construction industry.
• • Compliance with EU objectives and roadmap	• Considering climate change in the scenarios is important, because it affects both the heating and the cooling requirements. • Considering the fast reduction of the carbon intensiveness in district heating that is taking place in Finland is important. • The impact of energy efficiency could have been more ambitious; the current estimate is very conservative. • Energy efficiency still has an important role in the reduction of CO_2 emissions, but noting that it can also influence other matters, such as the indoor air conditions of properties, is important.
• Packaging supply and demand • Financial risk management • Public funding • Consulting	• Housing companies require support for their decision-making and the funding of their renovations. • Regional differences must be considered so that the funding and the consulting services can be correctly and appropriately allocated. • Financial support is required for planning, in particular. • The subsidies should be predictable and long-lasting. • Investigating the costs of renovation projects is absolutely necessary (both for the national economy and for private persons). • Consulting aimed at different groups and information on good renovation project examples and funding are important.
• Fire safety and other significant requirements	• Attention should also be paid to fire safety, safety and accessibility requirements in connection with the improvement of energy efficiency.

Annex B Organisations participating in the strategy process

This is a list of the organisations that participated in the strategy process by attending the workshops and hearing events, providing feedback and comments, replying to the surveys or participating in the work of the advisory group.

Organisations:

Aito Arkkitehtuuritoimisto – Minitalo Oy
Apollo Kaihdin ja Markiisi Oy
Housing Finance and Development Centre of Finland ARA
As Oy Keinutie 5
Kontulan Huolto Oy
Asunto Oy Petsamonkatu 14
Asunto Oy Riihitie 4
Attiva Oy/eTalkkari by Residentia
Aurinkosuojaus ry
Bionova Oy
Danske Mortgage Bank Plc
Ditekt Oy Ab
Ecopal Oy
Ekokumppanit oy
Finnish Energy
Energy Authority
eTalkkari™ by Residentia Oy
Ethica Oy
EVL
Fidelix Oy
Finance Finland
Finnfoam Oy
Finnwind Oy
FINVAC ry
FISE Oy
GBC Suomi ry
Granlund Consulting Oy
Helen Oy
HEKA Oy
City of Helsinki
University of Helsinki
Organisation for Respiratory Health in Finland
Helsinki Region Environmental Services Authority HSY
Häme University of Applied Sciences
Hämeen Remonttitiimi Oy
Town of Iisalmi
INFRA ry – Infra Contractors Association in Finland
Business Finland
Innovarch Oy
Insinööritoimisto Konstru Oy
Insinööritoimisto Leo Maaskola Oy
Finnish Real Estate Management Federation
City of Jyväskylä
Town of Kaarina
Karelia University of Applied Sciences
Karelia AMK
Kasvunoste
Finnish Real Estate Federation Eastern Finland
Finnish Real Estate Federation Pirkanmaa
Finnish Real Estate Federation Southwest Finland
Group management/Finances and financing
Kouvola Innovation Oy
Kuopion Opiskelija-asunnot Oy
Kuopion Tilakeskus
Municipality Finance Plc
Leanheat Oy
Liiketoimintajohtaminen PJH -kevytyrittäjä, SLP Group Oy/UKKO.fi
Finnish Association of HPAC Technical Contractors
Lujatalo Oy
MDI Oy
Ministry of Agriculture and Forestry of Finland
Motiva Oy
Finnish Plastics Industries Federation
Finnish Heritage Agency
MX6 Teknologiat Oy
NIBE Energy Systems Oy
nollaE Oy
Nordea Bank Abp
OP Corporate Bank plc
OP-Asuntoluottopankki
Oulu University of Applied Sciences
City of Oulu
Oulun Rakennusvalvonta
Oy Danfoss Ab
Pandia Oy
Paroc Oy Ab
Planera Oy
Peruskorjaamisen ja rakentamisen kehittämiskeskus
PRKK ry
PropertyLab Oy
Federation of the Finnish Woodworking Industries
Finnish Association of Civil Engineers RIL
Finnish Building Information Foundation RTS
Raimo Hakala Ky
Confederation of Finnish Construction Industries RT
Rakennustieto Oy
RAKLI ry
Ramboll Finland Oy
Ramirent Finland Oy
Construction design committee of the Finnish Association of Architects (SAFA)

Saint-Gobain Finland Oy
Savonia University of Applied Sciences ltd
Seneqo Oy
Signify Oy
Sisäilmayhdistys ry
Siun sote
Sitowise Oy
Smart Heating Oy
Sponda Plc
Finnish Association of Architects (SAFA)
Suomen Aurinkosuojaus ry
Suomen Energiainsinöörit Oy
Suomen Energiaturva Oy
Hypo
Finnish Real Estate Federation
Association of Finnish Local and Regional Authorities
HVAC Association of Finland, SuLVI
Suomen Lämmitystieto Oy/Lämmitysenergia Yhdistys ry
Finnish Heat Pump Association (SULPU)
Suomen Omakotiliitto ry, Uusimaa chapter
Suomen Omakotiliitto ry
Suomen Pelastusalan Keskusjärjestö SPEK ry
Finnish Environment Institute SYKE
SYKLI Environmental School of Finland
Suomen Yrittäjät
The Governing Body of Suomenlinna
Sweco Oy
Electrical Contractors' Association of Finland STUL
Sähkösuunnittelijat NSS rySähkösuunnittelijat NSS ry
Savings Banks' Union Coop
Confederation of Finnish Construction Industries RT
Talotekniikka magazine
Finnish Building Services Industries and Trade (Talteka) TaloTuki Oy
Tampere University of Applied Sciences (TAMK)
City of Tampere
University of Tampere/Department of Civil Engineering
Statistics Finland
Tampere Student Housing Foundation TOAS
City of Turku
T:mi Mutsal
Ministry of Economic Affairs and Employment
Työtehoseura TTS
Uponor Suomi Oy
VaasaETT Oy
Vahanen PRO Oy
Finnish Association for the Welfare of Older People
City of Vantaa
ViitaCon
VTT Technical Research Centre of Finland
Aalto University
WWF ry
VVS Föreningen i Finland rf
YIT Oyj
Ympäristömerkintä Suomi Oy
Ministry of the Environment
Zeneko Oy