The challenges, dynamics and activities in the building sector and its energy demand in Finland

D2.1 of WP2 from Entranze Project

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EEG	Energy Economics Group, Institute of Energy Systems and Electrical Drives at Vienna University of Technology
NCRC	National Consumer Research Centre
Fraunhofer	Fraunhofer Society for the advancement of applied research
CENER	National Renewable Energy Centre
eERG	end use Efficiency Research Group, Politecnico di Milano
Oeko	Öko-Institut
SOFENA	Sofia Energy Agency
BPIE	Buildings Performance Institute Europe
Enerdata	Enerdata
SEVEn	SEVEn, The Energy Efficiency Center

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The ENTRANZE project

The objective of the ENTRANZE project is to actively support policy making by providing the required data, analysis and guidelines to achieve a fast and strong penetration of nZEB and RES-H/C within the existing national building stocks. The project intends to connect building experts from European research and academia to national decision makers and key stakeholders with a view to build ambitious, but reality proof, policies and roadmaps.

The core part of the project is the dialogue with policy makers and experts and will focus on nine countries, covering >60% of the EU-27 building stock. Data, scenarios and recommendations will also be provided for EU-27 (+ Croatia and Serbia).

This report provides an overview of the building stock of Finland and its related energy demand. It includes main buildings characteristics, space heating and cooling systems and energy consumption and is based on data collection that was carried out during WP2.

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Some definitions/scope of country report

The common **database year** of these country reports is 2008. This year has been chosen because it is one of the most recent years with enough available data. And year 2009 has been avoided because of structural effects caused by the global crisis.

The building sector, as it is subject of this report, refers to two main categories of buildings: residential buildings and non-residential buildings. Whereas residential buildings are relatively homogenous and can further be divided into single/two-family houses and apartments blocks, non residential buildings are more heterogeneous. They refer to buildings in the service or tertiary sector and include several building categories (esp. office buildings, hospitals, schools and universities, hotels and restaurants, buildings in wholesale and retail trade). Within the residential stock, we consider only permanently occupied dwellings.

Floor area: The floor area as it is reported in the following sections is the net floor area; it does not include the common areas in multifamily buildings (e.g. corridors, etc.).

Specific consumption for space heating is calculated at normal climate: it corresponds to the energy consumption required to heat one dwelling on average, it is calculated in final energy.

Climate correction (normal climate): Making climatic corrections enable to monitor energy indicator trends that are independent on the year-to-year variations in the winter climate. The climatic corrections are made only for the part of the final consumption corresponding to space heating.

Central heating systems: it includes district heating, block heating, individual boiler heating and electric heating; a central heating system implies that all rooms are well heated, as opposed to room heating, where generally a stove provides heat to the main room only.

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1. Building characteristics

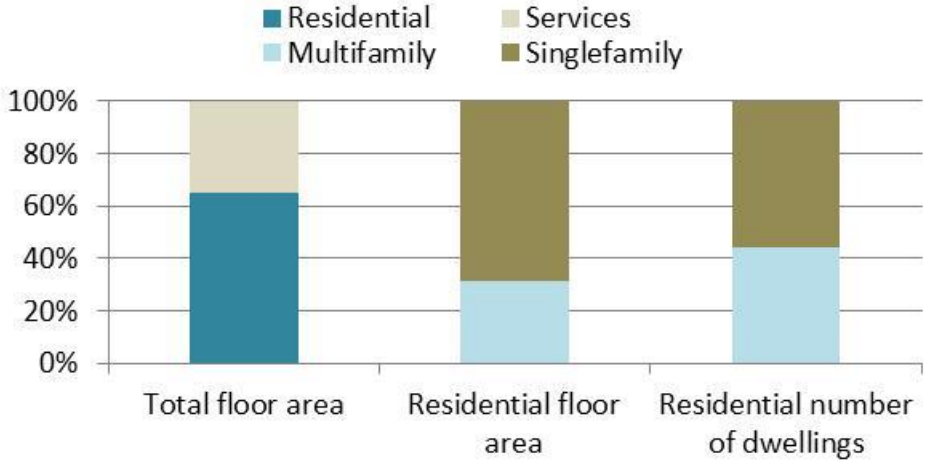
1.1 Building sector

The total area of residential and tertiary buildings in Finland is some 307 Mm². Two thirds (200 Mm²) of it is residential and the rest of it (107 Mm²) is services (Figure 1and Tabe 1). There are almost two and a half million residential dwellings in total, of which almost a half are multifamily dwellings and a little bit over a half single-family.

Average size of dwellings in Finland is 80 m². Multifamily dwellings are on average of 56 m² and single family dwellings 97 m². The smallest (<70 m²) dwellings have been built between 1920s and 1960s and the largest (97 m²) dwellings in the 1980s. Post-millennium dwellings are on an average 94 m².

The type of single-family dwellings has an impact on the space heating energy performances because of different insulation characteristics implying different specific space heating consumption (due to different wall area in contact with the outdoor): a semi-detached house consumes on average 15% less per m² than an isolated dwelling[1]. In Finland, three quarters of single family dwellings are detached houses and one quarter are semi-detached or row houses.

Figure 1: Decomposition of buildings by type (2008[2])



Source: Odyssee

[1] Source ECN for The Netherlands and simulation with EQTOR model for France (http://www.anah.fr/fileadmin/anahmedias/eqtor).

[2] The reference year chosen for this report is 2008, in order to get as much as possible available data among European countries.

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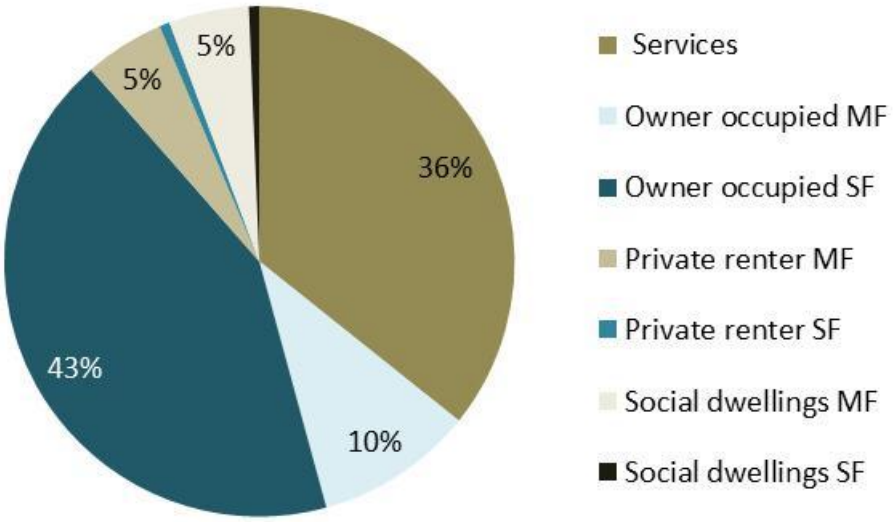
Table 1: Decomposition of buildings by type (stock and floor area, 2008)

	Stock (k)	Floor area (Mm2)
Total Residential	**2 449**	**199 920**
Multi-family	1 086	60 816
Single-family	1 363	132 211
Service		**107 121**

Source: Odyssee

Figure 2 represents the distribution of the residential and tertiary sector building floor area according to the status of occupation. The most typical kind of occupation is owner occupied single family, with a 43% of the total floor area. 36% of the floor area is occupied by services, 10% by owner occupied multi-family buildings, 5% by private renter multi-family buildings and another 5% by social multifamily buildings[3].

Figure 2: Breakdown of floor area by ownership structure (2008)[4]



Source: Housing Statistics, Odyssee and national sources

Between 2000 and 2010, altogether 326 000 residential dwellings were constructed in Finland, which means 30 000 dwellings per year on average (Figure 3). The most

[3] Right-of-occupancy housing is not considered separately here. The 40 000 right-of-occupancy dwellings are considered here as part of the rental sector.

[4] MF: Multi-family dwellings; SF: single family dwellings.

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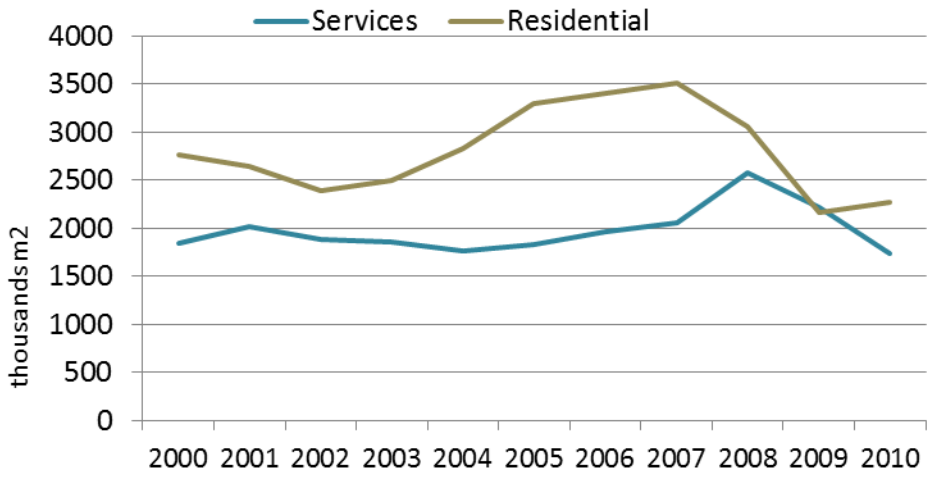
successful year was 2007 with almost 35 000 constructed dwellings. In the beginning of the 2000s construction rate was decreasing, but since 2003 it started increasing until 2007. After that the effect of the global economic crisis can be seen in the dramatically decreased amount of constructed residential buildings. A slight rebound happened in 2010. In 2008, dwellings built in 2000s represented 11 % of total stock.

Throughout the last decade single family dwelling construction has been dominant compared to multifamily dwelling construction. In year 2000 the share of single family construction was 67 % of total floor area of dwellings and 72 % in 2010.

Apart from year 2009, services have been built lesser than dwellings in 2000s. Also the service construction has been affected by the global economic crisis after the peak year 2008. In total almost 23 000 m2 of services were constructed in comparison to slightly over 30 000 m2 of dwellings constructed.

Figure 3: Dynamics of building construction



Source: ODYSSEE

1.2 Residential sector

The average age of buildings and the share of new buildings in the total stock represent a good indicator of the quality and standards of construction. The higher the share of recent dwelling, i.e. built with more efficient standards, the higher the energy performance of the stock: in Finland, 60 % of the stock is built after 1970, since when the energy efficiency has improved remarkably (Figure 4).

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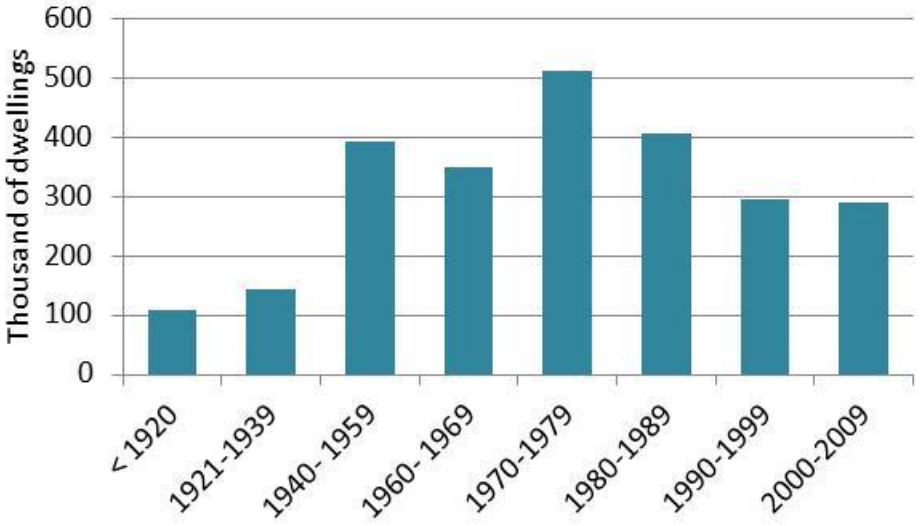
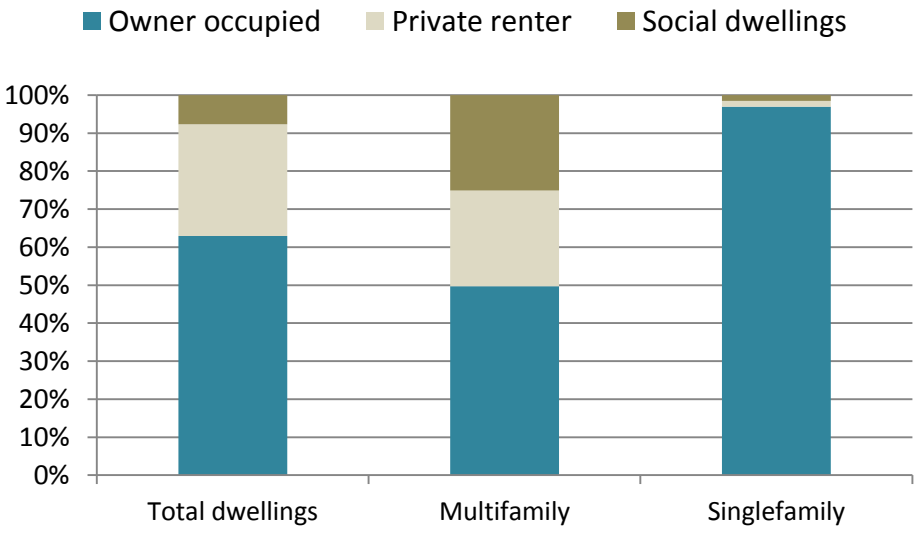
Figure 4: Residential dwellings according to construction date



Source: BPIE

Owner occupation is dominant in residential buildings with 66% of total stock and as much as 97% in single-family dwellings. Ownership structure is distributed more heterogeneously in multi-family dwellings with 50% of owner occupant, 25% of private renter and 25% of social dwellings (Figure 5).

Figure 5: Breakdown of ownership & tenure (2008)



Source: Housing Statistics

Figure 6 shows the U-values that measure heat loss in building elements, such as wall, floor or roof, i.e. how well the buildings components are insulated. In Finland, U-values have decreased significantly in every element. Values have dropped from 27% in windows to 60% in walls during the century.

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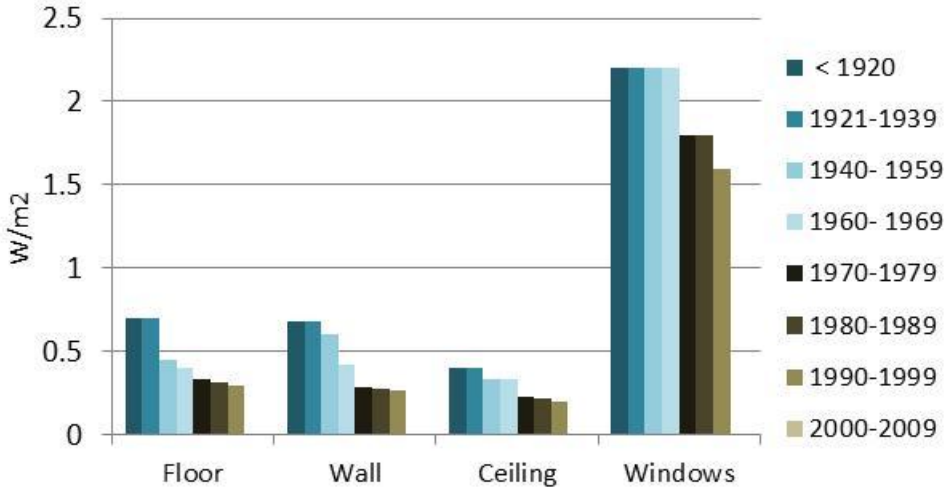
Figure 6: U-values by construction period (multifamily and single family)



Source: BPIE

1.3 Service sector

Wholesale and retail trade represent the highest share of total service sector floor area in 2008 (33%). Education and offices take 13% shares each, health 8% share and hotels and restaurants 6% share. Other service buildings include e.g. transport buildings, assembly buildings and sports facilities.

Figure 7: Decomposition of service building areas by type (2008[5])

[5] Official data provide only total offices, i.e. without distinction between private and public sector. Public offices stock has been estimated by CEREN and French government data. Private sector has been calculated by difference.

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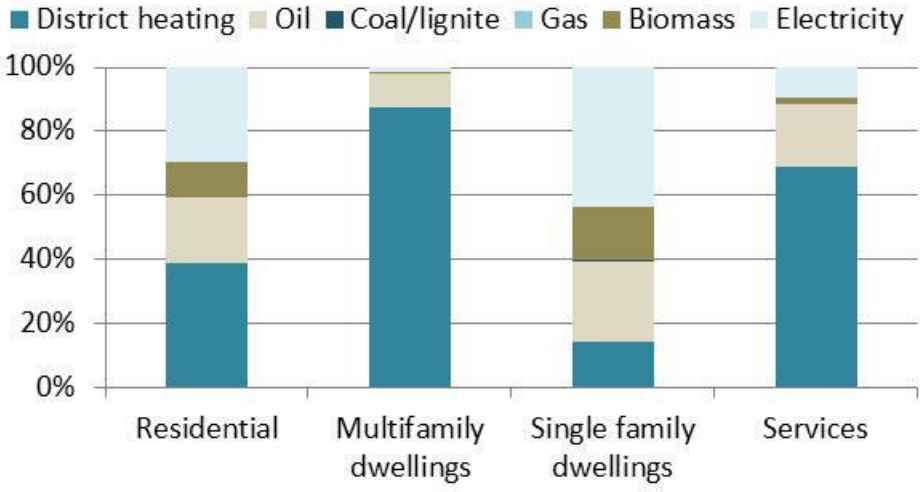
Source: BPIE

2. Space heating and cooling systems

District heating and electricity are the main space heating systems for Finnish households (Figure 8). The former is most typical in multifamily dwellings with 88% share and the latter one in single family dwellings with 43% share. Altogether district heating has 39% share, electricity 29% share, oil 20% and biomass 11% shares. Gas heating is non-existing.

The service sector is widely connected to the district heating system. Oil and electricity are less commonly used heating systems.

Figure 8: Dwelling area according to space heating systems by energy (2008)



Source: Odyssee

Figure 9 shows the penetration of heating systems. In Finland, almost entire multifamily dwelling stock is heated by district heating (88%) or collective central heating (11%). In single-family dwellings, however, the cost common types of central heating systems are direct electrical heating oil and biomass, whereas district heating is less common.

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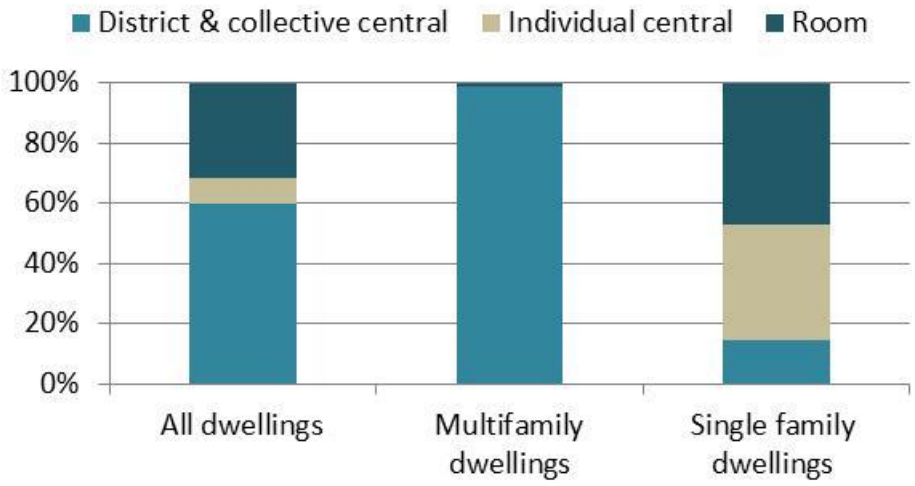
Figure 9: Dwellings according to centralisation of heat supply (2008)



Source: Odyssee

The diffusion of efficient and renewable heating systems, such as heat pumps, promoted by subsidies or tax credits, significantly improve the average heating energy efficiency. In Finland, the most common type of renewable heating systems are heat pumps, which have been sold at best 60 000 pieces per annum (Figure 10).[6] Air/air heat pumps are the most typical kind of pumps. Some 9% of the pumps are geothermal.[7] Air/water pumps are still only marginal.

Biomass heating systems are not being sold at the same rate as heat pumps. In 2006, a total of 3 660 wood log boilers and 3 440 pellet boilers were sold, which make up to 7 100 biomass heating systems.

[6] Statistics Finland gives some 10% to 60% greater amounts than ODYSSEE, for example for top year 2008 66k compared to 60k.

[7] Geothermal heat pumps include water/water, ground/ground and ground/water heat pumps.

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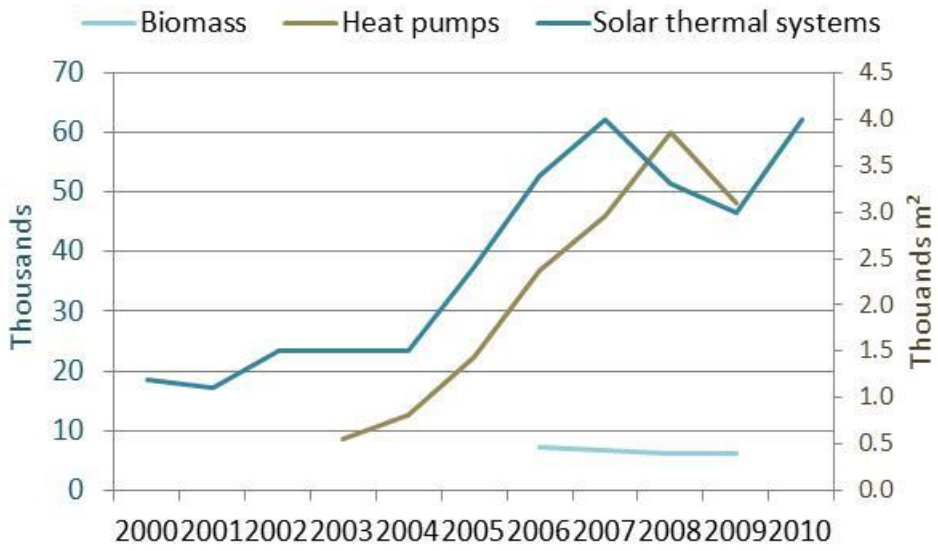
Figure 10: Sales of energy efficient and renewable systems in recent years



Source: Odyssee

Data about the diffusion of air conditioning is unfortunately unavailable. Air conditioning is typically used in service facilities.

3. Energy consumption

In Finland, electricity and district heating are the dominant source of energy in both residential and service sector (Figure 11). Electricity takes a 42% share of total consumption and district heating takes a 31% share. Biomass is the third greatest source of energy (14%) and is used especially in residential buildings. Oil is the fourthly used energy source and the others are only marginal.

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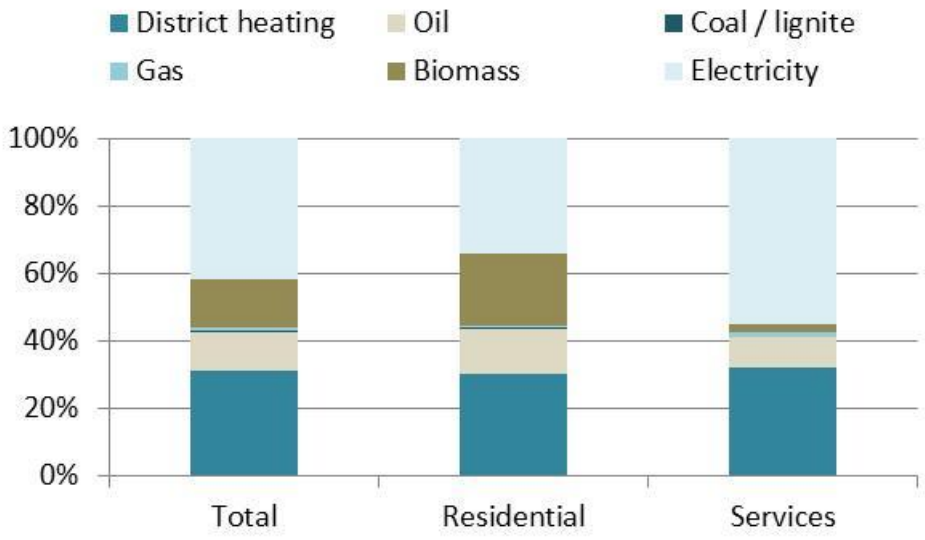
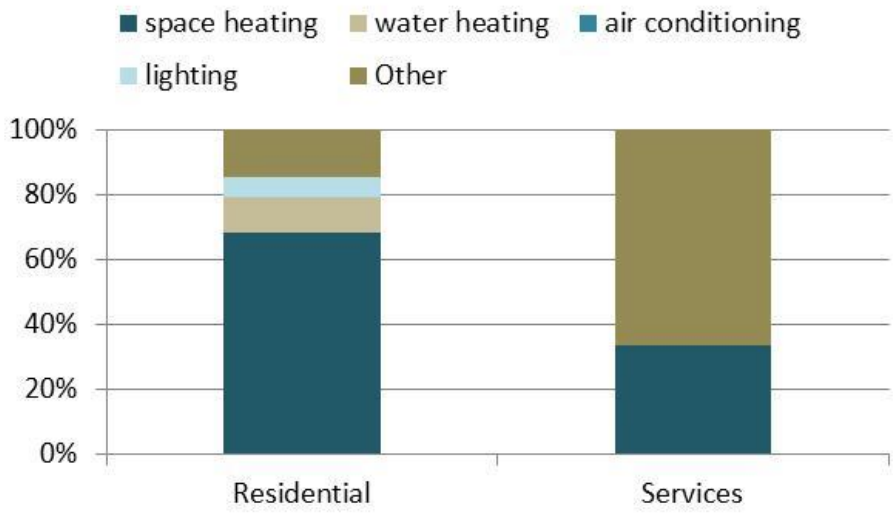
Figure 11: Total energy consumption of the building sector (2008)



Source: Odyssee

Space heating represents the largest share (68%) of household energy consumption (Figure 12), followed by water heating (11%), lighting (6%) and other[8] (15%). In services, other[9] functions than space heating (34%) consume notably more than in residential buildings. in category

Figure 12: Total energy consumption by end-use (2008, real climate)



Source: Odyssee

[8] Other includes air conditioning.

[9] Other includes water heating, air conditioning , electricity used for appliances and lighting.

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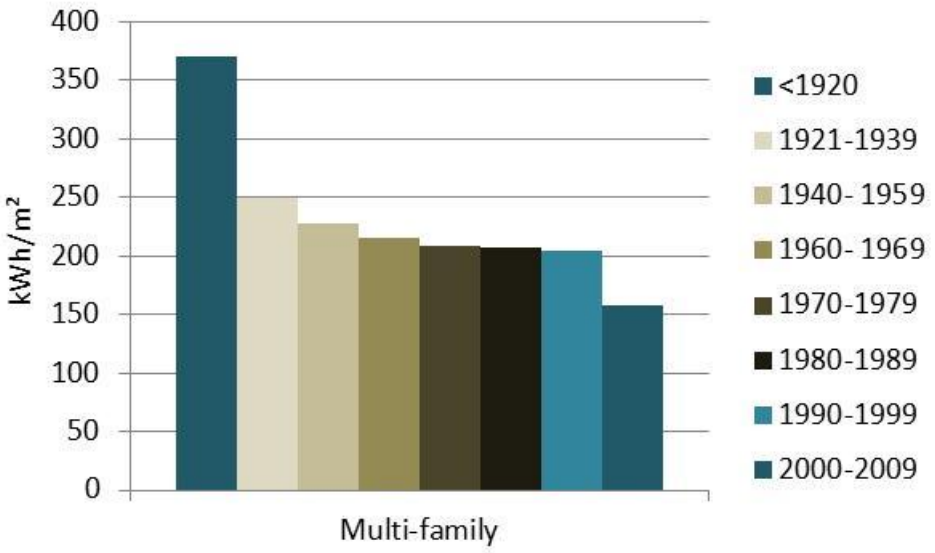
Figure 13 shows the development in energy efficiency, as the total energy consumed per dwelling decreases over the time from more than 350 kWh/m^2 in pre-1920 to about 150 kWh/m^2 in the 2000s. Especially the leap from the 1990s to the 2000s is quite outstanding. Unfortunately, the data on average energy use are only readily available for multi-family dwellings.

Figure 13: Specific consumption by age and by type of dwellings



Source: MECOREN

4. Conclusions

Residential buildings represent two thirds of total floor area in Finland, which here excludes industrial and farm buildings. The main stakeholders are owner occupant of single-family dwellings, with 43% of the total floor area.

In the 2000s, 326 000 residential dwellings have been constructed, i.e. 11% of 2008 total stock. Finland has renewed its residential dwelling stock quite fast compared to other European countries: 60% of the dwelling stock was built after 1970 since when the U-values, which measure heat loss in building elements, have decreased significantly.

Almost the entire multi-family dwelling housing stock (88%) in Finland is heated by district heating, whereas single family dwellings are heated mainly by electricity (43%), oil (25%) biomass (17%) and district heating (14%). Gas and coal are only marginal albeit in district heating, coal is a common source of energy. In single-family homes, direct electric heating is still the most common type of central heating system.

In Finland, the most common type of renewable heating systems are heat pumps, of which some 60 000 pieces were sold in 2008. Air/air pumps are the most typical type of pumps. Biomass heating systems are sold in around seven thousands per annum.

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Space heating represents the largest share (68%) of building-related household energy consumption, followed by water heating (11%), lighting (6%) and other (15%) such as air conditioning. In the service sector, others than space heating (34%) consume notably more.

5. References

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TABULA, Typology Approach for Building Stock Energy Assessment, http://www.building-typology.eu/country.html

6. Appendix

Table 2: Total energy consumption by sector (2008)

Mtoe	District heating	Oil	Coal / lignite	Gas	Biomass	Electricity	Total
Residential	1,43	0,62	0,01	0,04	0,99	1,59	4,67
of which: space heating	1,22	0,52	0,01	0,03	0,85	0,55	3,18
of which: water heating	0,20	0,09	0,00	0,01	0,14	0,09	0,52
of which: air conditioning	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
of which: lighting						n.a.	n.a.
Services	0,87	0,25	0,00	0,03	0,06	1,49	2,70
of which: space heating	0,61	0,17	0,00	0,02	0,00	0,11	0,92
of which: water heating	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
of which: air conditioning	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
of which: lighting						n.a.	n.a.

Source: Odyssee

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