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

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 ISI	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 France 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

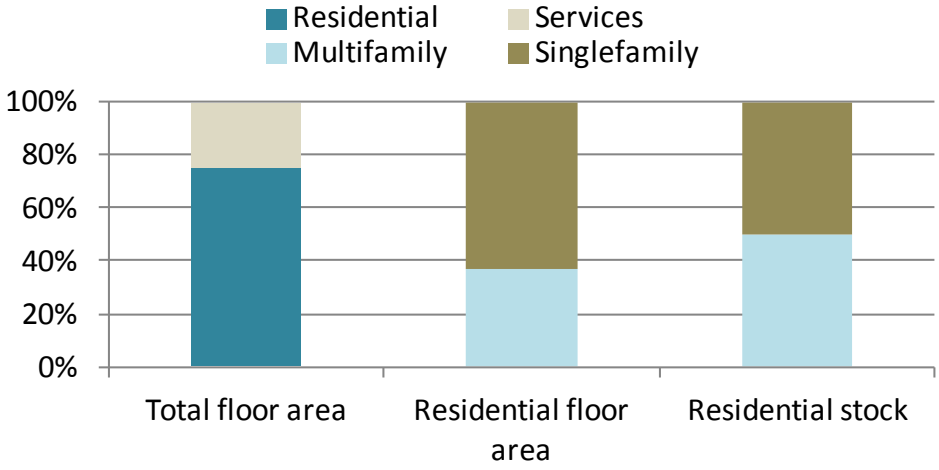
The total useful floor area of buildings (residential and service) in Austria in 2008 amounted to 455 million m^2. Residential dwellings dominate and represent approx. 75% of total floor area of residential and service sector (Müller et al 2012). Industrial buildings and storage buildings are not included.

Figure 1 shows the dwelling types, single and multifamily, specified by floor area and stock. Single family dwellings with 63% make up the largest distribution of total floor area. The share of multifamily houses is 37%. According to Statistic Austria, single family buildings normally have 1 or 2 dwellings, while multifamily buildings have 3 to 10 dwellings (small multifamily buildings) or more than 10 dwellings (large multifamily buildings).

The total number of residential dwellings was 3.5 M in Austria in 2008 (seeTable 1). The number of multi-family dwellings was 1.77 M with the share of 49.7% of total residential building stock, while single-family dwellings were 1.79 (50.3%). There are two types of typical single-family house: single-family detached house and single-family semi-detached house, which represent 1.31 and 0.48 M respectively.

The number of service buildings was 0.147 M. The considered service dwellings include offices (public and private), wholesale and retail trade, hotel and restaurants, health service buildings and educational buildings

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



Source Müller et al 2012 based on Statistics Austria 2010b, Statistics Austria 2009, Zoll 2010

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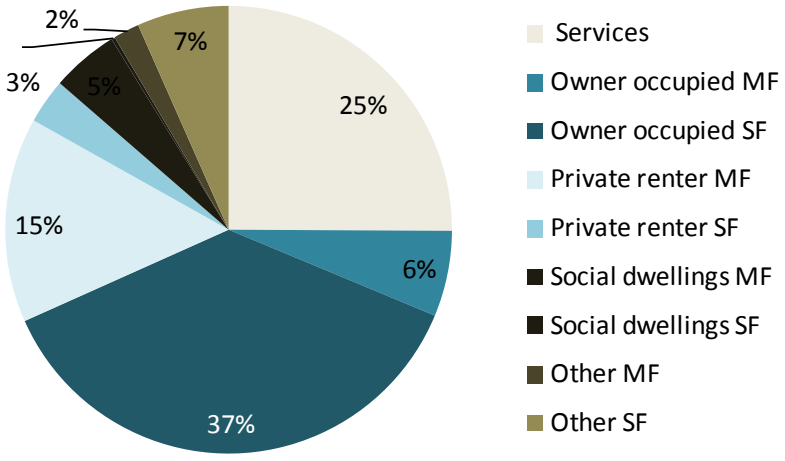
Table 1: Decomposition of buildings by type (stock and floor area, 2008)

	Stock (k)	Floor area (Mm2)
Total Residential	**3562**	**341436**
Multi-family	1771	126745
Single-family	1792	214740
Service	**147**	**114320**

Source: Müller et al 2012 based on Statistics Austria 2010b, Statistics Austria 2009, Zoll 2010

Figure 2 shows the building composition by ownership structure. It can be seen, that owner occupied single family dwellings represent the most typical ownership type with the share of 37%. Owner occupied multifamily dwellings make up 6% of the total building floor area. Rental multi-apartment makes up 15% of the total floor space. The share of rented single-family houses is less than 3%. Social dwellings or rented social houses in Austria are defined as houses, which are managed by municipalities and (Limited-Profit Housing Associations (LPHAs)). The share of this ownership type makes up 6% of the total floor area and is mainly in the capital of Austria – Vienna. 7% of the total building floor area is provided with other ownership type. According to Statistik Austria, other ownership type can be an official residence, service buildings or other. More about the ownership structure with precise descriptions of all types is available in deliverable D2.4.

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



MF – Multifamily dwellings, SF – single-family dwellings

Source: Statistik Austria 2001

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

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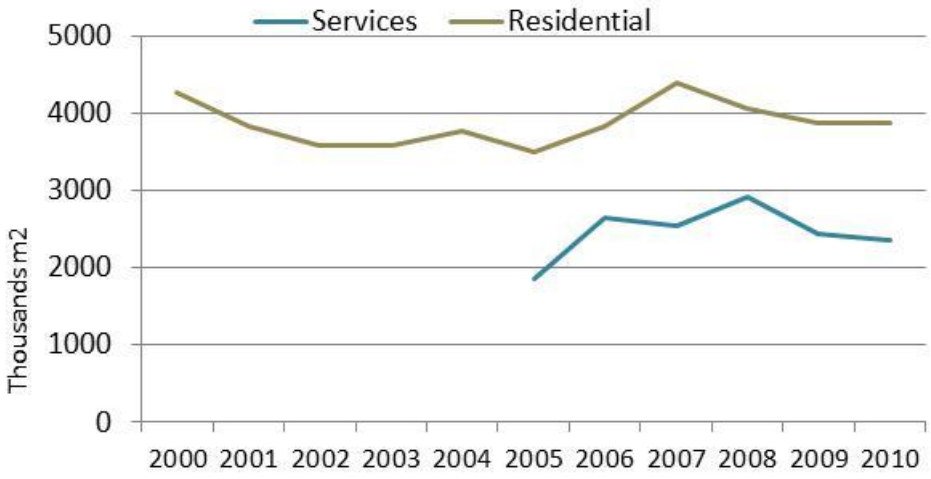
Figure 3 provides an overview of the dynamics of building construction in the period 2000 – 2010. According to ODYSSEE, residential building construction went down from 4 Mm^2 in 2000 to 3.5 Mm^2 in 2005. The construction of new residential buildings has increased from 2005 until 2007, with the highest point reached in 2007. In this year, residential construction floor area was more than 4.0 Mm^2. After 2007 residential building construction went down slowly and reached 3.9 Mm^2 in 2010.

According to Statistic Austria, which provides data on building permits in Austria, approximately 1.9 Mm^2 of service buildings were permitted to construct in 2005. In the period 2005 to 2008, the net floor area of service building permits increased each year and peaked over 2.9 Mm^2. Permitted floor area shows a slowdown after 2008, which continued until 2010.

Figure 3: Dynamics of building construction



Source: ODYSSEE, Statistics Austria 2010a

*Data of permitted service buildings for the period between 2000 and 2005 is not available

1.2 Residential sector

Almost 24% of Austrian residential dwellings were built prior to 1944. The share of dwellings, built from 1945 to 1970, represents 29% of all residential dwellings. Less than one third of all dwellings were built between 1971 and 1990. The number of dwellings built in the period 1991-2000 makes up 12% of the total. New dwellings built from 2001 to 2008 represent 6% of total residential dwellings (Figure 4).

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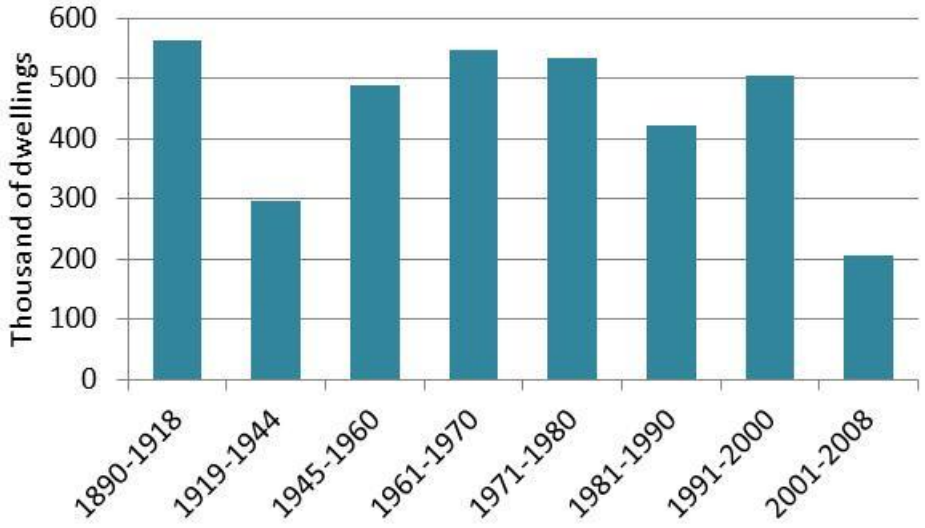
Figure 4: Residential dwellings according to construction date (2008)3



Source: Müller et al 2012 based on Statistics Austria 2010b, Statistics Austria 2009

Less than half of the residential dwelling stock in Austria is owner occupied dwellings. 31% of all dwellings are privately rented while the remainder includes social dwellings and different ownership types. Social dwellings in Austria are rental social houses, which are owned and managed by municipalities and mostly by municipality of Vienna and Limited-Profit Housing Associations (LPHAs). The share of this ownership type makes up 9% of the total dwellings.

There is a huge difference between multifamily and single family dwellings in their ownership status. 79% of single family houses are owner occupied, while the number of owner occupied multifamily dwellings is only 22% of the total number of multifamily dwellings. Social dwellings are typically multifamily houses with a share of 17% in total multifamily dwellings.

[3] The age categories correspond the revision of building standards (i.e. 1975, 1982, 1989, 2001 and 2005).

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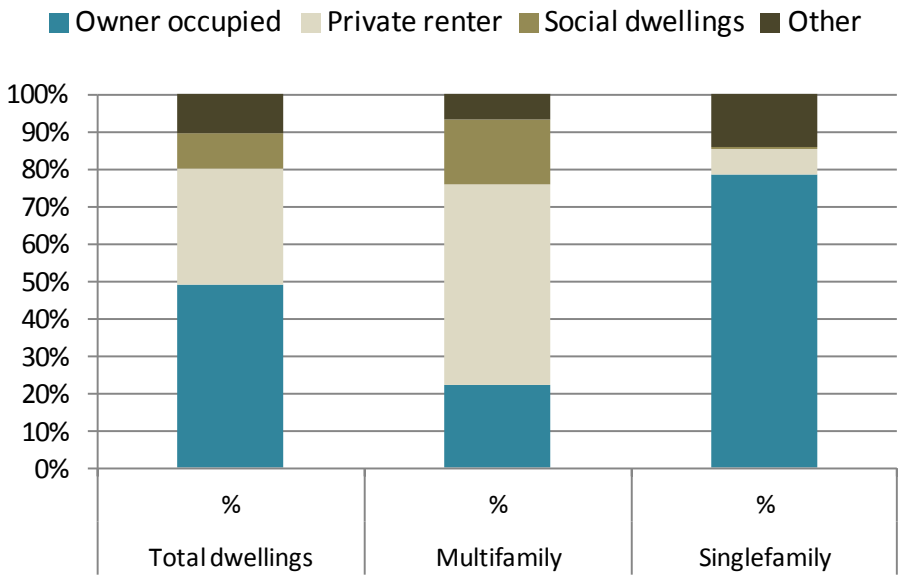
Figure 5: Breakdown of ownership & tenure (2008)



Source: Statistik Austria 2001

Figure 6 shows the U-values of building elements by different construction periods. The highest U-values represent buildings which were built in the period until 1980. The values of new buildings built after 2000, represent U-values, which are almost three times lower compared to buildings completed between 1890 and 1970.

40% of the total dwellings built before 1970 have a low insulation level respectively the high U-value. According to Müller et al 2012, almost 44% of these buildings have already carried out at least some minor renovation activities. Though, these dwellings still provide the largest energy saving potential.

Since 1970, the buildings were constructed with higher insulation level. According to Amtmann 2011 as a result of the energy crisis since the 1970, methods to increase the energy efficiency became important. Industrially prefabricated thermally insulated construction systems and thermal insulation were used. It can be seen (Figure 6), that the U-values are approx. 20 % lower compared to the U-values in the period before.

14% of the total Austrian dwellings, constructed from 1991 to 2008, have a relatively high insulation level. As a result of new building codes and an increasing importance of energy efficiency, the U-values of these buildings are almost three times lower compared to old buildings. U-values of 0.5 and 0.25 W/m2/K for floor, wall and ceiling as well as approx. 1.5 W/m2/K for windows are common.

U-Values derived in the project TABULA (Amtmann 2011) lead to similar ranges compared to Müller et al 2012.

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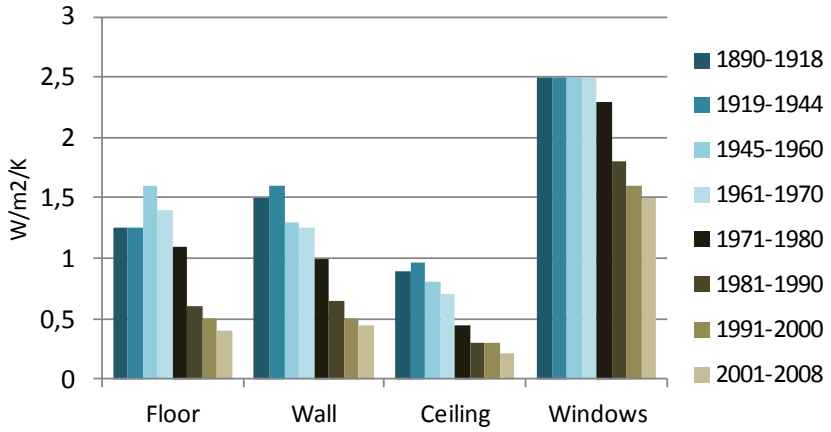
Figure 6: U-values by construction period (multifamily and single family, 2008)



Source Müller et al 2012 based on Austrian Institute of Construction Engineering 2011 TABULA 2011, Statistics Austria 2010d

1.3 Service sector

The total floor area of service buildings in Austria in 2008 was 114.3 Mm^2 (Müller et al 2012). Figure 7shows the composition of building types by floor area of service buildings. The share of office buildings is 32%. 12% of the total floor area is in buildings for wholesale & retail trade. Education buildings represent 12% of the total floor area followed by health service buildings (4%). The share of hotels & restaurants is 32%. Other buildings make up 8% of total service buildings and represent the buildings for entertainment, sport etc.

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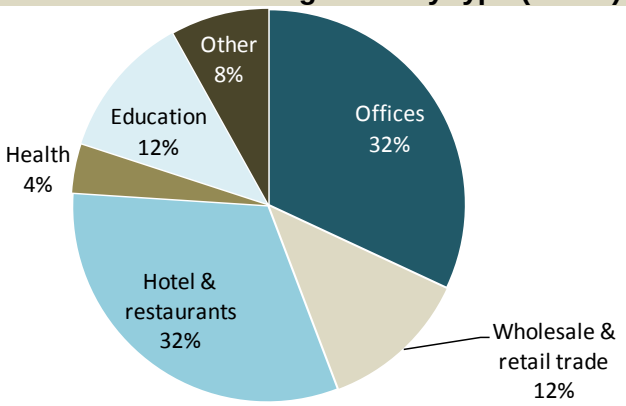
Figure 7: Decomposition of service building areas by type (20084)



Source: Müller et al 2012 based on Zoll 2010, Statistics Austria 2001, Statistics Austria 2009

2. Space heating and cooling systems

Figure 8 shows the share of different energy carriers for space heating in Austria. Most common fuels for space heating are natural gas and heating oil used in 31% and 27% of the total residential dwellings, respectively. 18% of the total residential building stock use district heating, followed by biomass (17%). Electricity is used in 6% of dwellings. The use of coal/lignite amounted to 1% of the dwellings.

The main energy fuel in multifamily-dwellings is gas with a share of 48% of the total multifamily-dwellings stock. In the energy mix portfolio used in multifamily-dwellings the share of district heating is 30%. 15% of multifamily-dwellings use heating oil. Electricity and biomass have a share of 1% and 6%, respectively.

Heating oil and biomass are the two most common fuels used in single family dwellings, representing 33% and 39% of total single family dwellings stock, respectively. Natural gas is used in 14% of single family dwellings. The share of district heating is 7% and of electricity 6% single family dwellings. Less when 1% of single family dwellings use coal/lignite.

Gas is the most common fuel used in 37% of the total service buildings. The share of district heating is 23%, followed by oil (21%). The share of electricity space heating systems is almost 15% and of biomass space heating systems is just 4%.

[4] 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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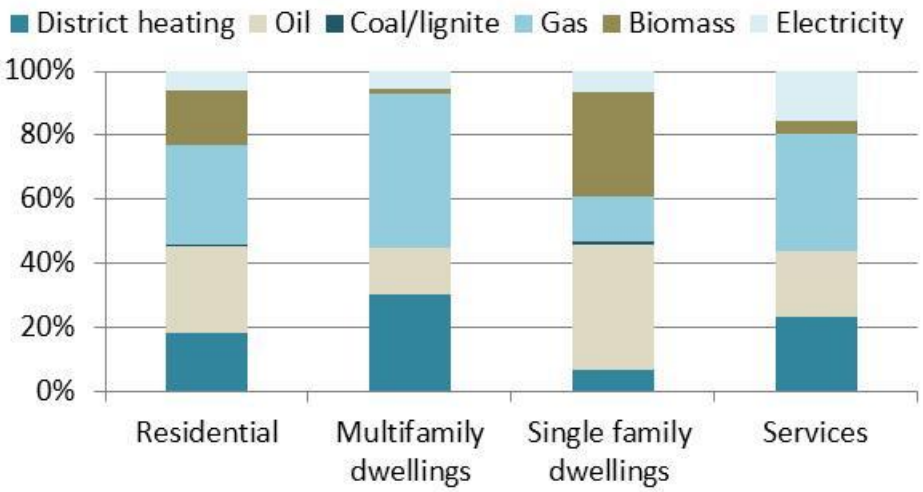
Figure 8: Dwelling stock according to space heating systems by energy



Source: Müller et al 2012 based on Statistics Austria 2001, Statistics Austria 2010c, and Statistics Austria 2010 d

Figure 9 shows the percentage of dwellings with district & collective central heating systems, individual central heating systems and individual room heating appliances. Individual central heating system is dominant and was installed in 62% of all dwellings in 2008 in Austria. The share of district & collective central heating is 30% of total dwellings. 8% of all dwellings in Austria have room heating appliances.

54% of total Austrian multifamily dwellings are connected to district & collective central heating system. Individual central heating is installed in 41% of multifamily dwellings. Room heating appliances are used only in 5% of multifamily dwellings.

83% of total single family dwellings have individual central heating.10% is connected to district & collective central heating and 7% is heated with room heating appliances.

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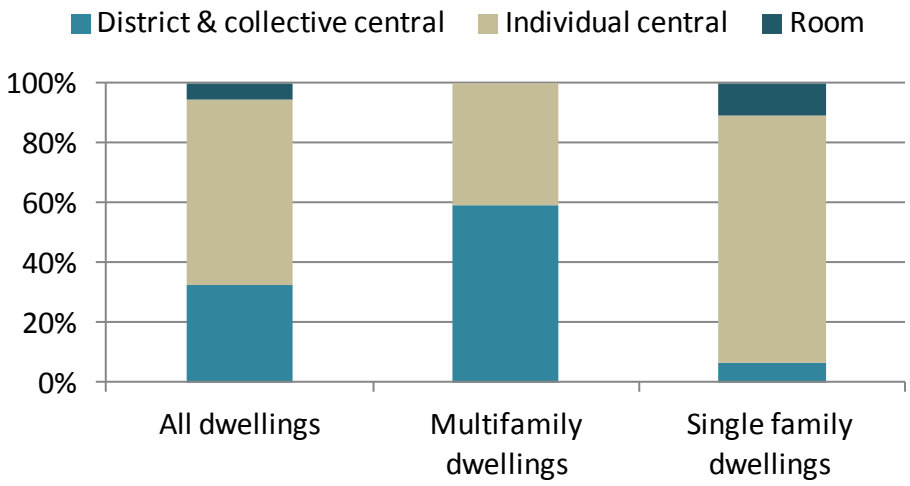
Figure 9: Distribution of dwellings according to centralisation of heat supply



Source: Müller et al 2012 based on Statistics Austria 2001, Statistics Austria 2010c

In the period from 2000 to 2009 (except 2006) the sales of solar thermal systems was growing significantly (see Figure 10). The sales in 2000 were 0.168 Mm^2 and 0.365 Mm^2 in 2009. Up to 2009 the market of solar thermal systems went down and reached sales of 0.292 Mm^2 in 2010. The market of heat pumps increased of over 72% in the period between 2000 and 2008. The number of heat pumps sold in 2008 was 18700 units. The most common type of heat pumps sold in 2008 was ground source heat pumps (water/water, ground/ground and ground/water). The market for all biomass boilers, including pellets, wood log and wood chips boilers, increased of 26.3% between 2000 and 2006 and reached sale numbers of 19700 units in 2006. According to Biermayr et al. 2011, the sales of pellet boilers were highest of all biomass boiler types in the periods between 2004 and 2006 as well as between 2007 and 2010 and peaked with 10500 units and 11100 units in 2008 and in 2006, respectively.

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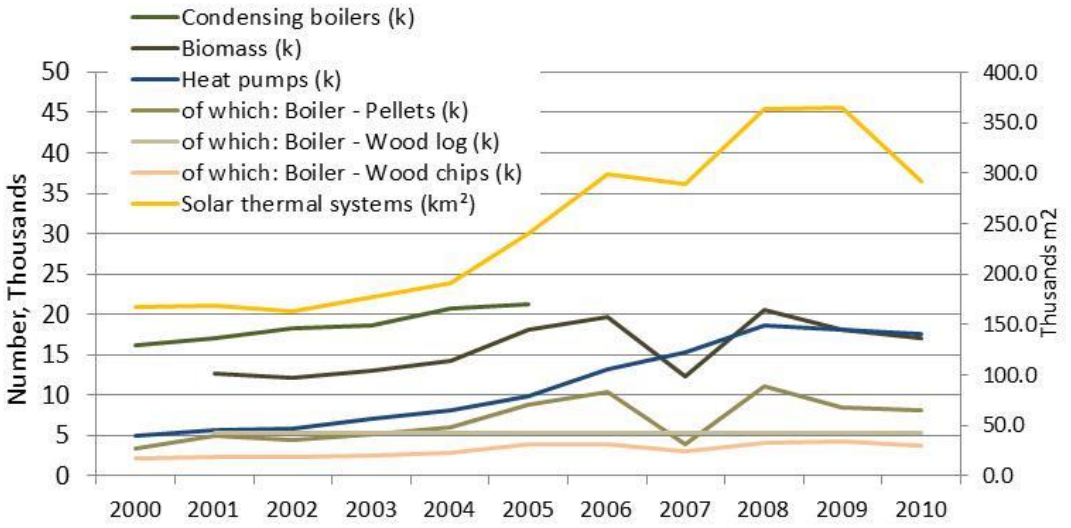
Figure 10: Sales of energy efficient and renewable systems in recent years



Source: ODYSSEE, Biermayr et al (2011)

2.1 Air conditioning

The share of residential buildings with AC equipment is approx. 0.3% of the total in 2000. From 2000 to 2010 the share of number with AC equipment increased and reached almost 0.7% of the total residential building stock.

There is no available statistical data on air conditioning used in service. According to an estimation made by Kranzl et al 2010, in the project “KlimAdapt” the conditioning floor area is approx. 35% in the wholesale & retail trade and offices buildings while in the education buildings is approx. 15% of total floor area.

3. Energy consumption

In 2008, Austrian energy consumption in residential and service sectors for space and water heating, air conditioning and lighting was 9.33 Mtoe. The share of electricity in building energy consumption balance is 27%. Oil amounted to 19%, followed by biomass (18%). 19% of energy consumption was gas, 1% coal/lignite and 16% district heating.

Biomass, electricity and oil are the most common energy types, used in residential dwellings, representing 25%, 23% and 22% of total energy consumption, respectively. The share of natural gas is 22% and of coal/lignite less when 1%.

The most common energy type used in service sector is electricity, representing 36% of total energy consumption. The share of district heating, gas and oil is 26%, 20%, and 15%, respectively.

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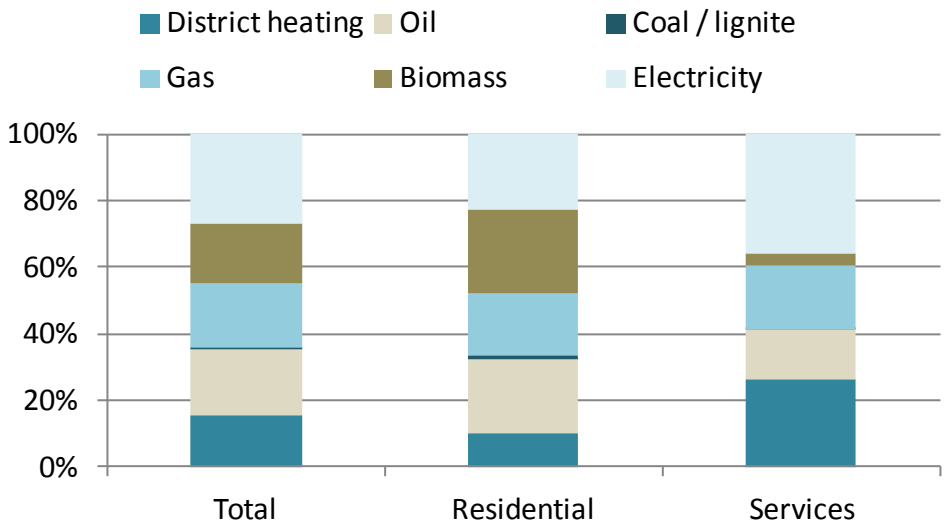
Figure 11: Total energy consumption of the building sector by type of energy



Source: ODYSSEE

Table 2 provides an overview of the energy consumption by energy carrier used for space and water heating, air conditioning and lighting in residential and service sectors in Austria in (2008). The most relevant fuel consumption in residential and service sectors is for thermal use, for space and water heating, which comes mostly from biomass.

Table 2: Total energy consumption by sector in Mtoe

	District heating	Oil	Coal / lignite	Gas	Bio-mass	Elec-tricity	Total
Residential	0,64	1,36	0,08	1,17	1,56	1.412	6.211
of which: space heating	0,46	1,23	0,07	0,98	1,48	0.159	4.376
of which: water heating	0,05	0,13	0,01	0,17	0,20	0.16	0.714
of which: air conditioning						0.004	0.004
of which: lighting						0.131	0.131
Services	0,81	0,47	0,01	0,61	0,10	1.13	3.13
of which: space heating	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
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.	n.a.	n.a.	n.a.	n.a.	n.a.

Source: ODYSSEE

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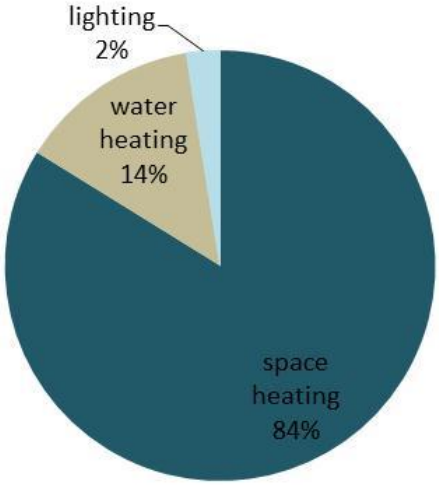
Figure 12: Total energy consumption by end-uses in residential sector

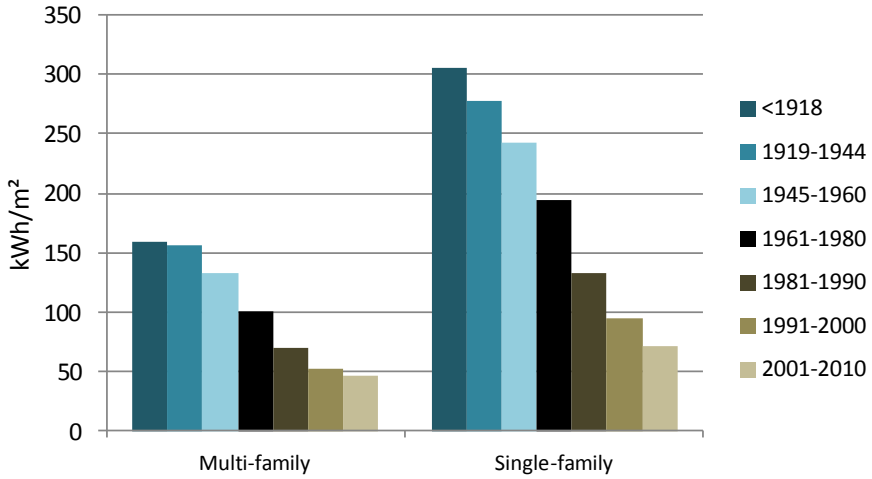


Source: ODYSSEE

According to Müller et al (2012), highest specific energy consumption is in the single-family dwellings, constructed prior to 1918 (see Figure 13). Specific energy consumption in those dwellings is 305 kWh/m^2. It can be seen a strong reduction of average consumption per dwelling in the single-family dwellings built after 1981. Specific energy consumption of the dwellings built after 1981 until 2010 is between 132 and 71 kWh/m^2.

The oldest part of the multi-family dwellings, built prior to 1918 until 1980, consume approximately 65% more compared to dwellings constructed between 1981and 2010. The “average” multi-family dwelling constructed between 2001 and 2010 consumed 46 kWh/m^2.

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



Source: Müller et al 2012 based on Statistics Austria 2010c, Statistics Austria 2010d, Austrian Institute of Construction Engineering 20011, TABULA 2010

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4. Conclusions

The building description shows the technical potential to increase energy efficiency and to reduce CO_2-Emission in Austria. High potential to improve thermal efficiency have buildings constructed before 1970. Their share of those residential and service buildings on the total building stock is about 40%. The insulation level is much lower compared to the subsequent construction periods. U-values of these buildings are approx. 50% higher than of buildings built after the year 2000. A part of these buildings have already carried out at least some minor renovation activities. Though, these dwellings still provide the largest energy saving potential.

Most common fuels for space heating are natural gas and heating oil used in 31% and 27% of the total dwellings, respectively. These fuels are mostly used in individual central heating system, which was installed in 62% of all dwellings in 2008 in Austria. That shows a potential to be replaced by renewable heating systems.

The market of solar systems, heat pumps and biomass boilers shows a significant increase in the recent years. The sales of solar thermal systems were growing by 54% in the period from 2000-2009 and reached sales of 0.365 Mm^2 in 2009. The market of heat pumps increased of over 72% in the period between 2000 and 2008. The sales of pellet boilers were highest of all biomass boiler types in the period between 2004 and 2010 and peaked with 11100 units in 2006. The market downturn of biomass boilers in the year 2007 was mainly caused by a strong increase in pellet prices during the year 2006 which reduced the consumer's confidence in the price stability. The economic crises and other factors led to reduced market growth of all renewable heating systems after 2008.

There is a lack of the statistical data on air conditioning used in residential and service buildings. According to estimations, the conditioned floor area in the residential buildings is still minor while in the wholesale & retail trade and offices buildings is approx. 35% and in the education buildings is approx. 15% of total floor area.

Because of the significant data gaps on service sector, the consideration of potential to increase energy efficiency is hardly available. The data gap exists for total energy consumption and thermal quality of buildings of service sector.

There are also significant data gaps of renovation activities in both residential and service sector.

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