

## ENERGY CONSUMPTION IN HOUSEHOLDS

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*The article offers an overview of the energy consumption of Estonian households in 2010, based on the data of the 2011 Household Energy Consumption Survey. Energy use in Estonia and other European countries is compared, whereas the main focus is on household energy consumption in 2010.*

### Introduction

Energy is one of the most important resources in modern society. Its availability is the prerequisite for many activities in business and at home. Estonia is a country with relatively high energy consumption. This is primarily indicated by the energy intensity of the economy (i.e. total energy consumption in relation to the gross domestic product), which is more than three times higher than the European Union average. Countries (incl. Estonia) that extract and export natural energy sources generally have higher energy intensity than countries that import energy sources. Nevertheless, Estonia does have great potential for energy savings.

Household energy consumption accounts for a large share of total energy consumption. The value of this indicator for Estonia is also one of the highest among European countries. Many of the energy consumption habits of the Estonian residents were formed during a period when no one considered resource depletion and sustainable energy consumption. A large part of the dwelling stock is also from the same period and thus has clearly not been built with energy efficiency in mind. Technological development has increased the demand for contemporary products and services, and the growing use of products and services has increased the demand for energy and resources.

### Household final energy consumption in Estonia and other European countries

Despite the high energy intensity of the economy, final energy consumption<sup>a</sup> in Estonia has decreased by more than a half since the 1990s (Figure 1, p. 7). At the same time, energy consumption has grown in the European Union (EU) as a whole (Figure 2, p. 7). The significant reduction in final energy consumption in Estonia compared to the early 1990s is related to the fact that energy-intensive industries disappeared after the restoration of independence.

Over the years, household energy consumption has remained more or less the same both in Estonia and in the European Union as a whole. The vigorously promoted energy saving measures have not really lowered this level. In the EU as a whole, household energy consumption is showing an upward trend instead: since 1990, energy consumption in households has increased by 0.6% in Estonia, while the EU average has grown by as much as 12%.

In Estonia, the share of household energy consumption in total energy consumption is one of the largest in the EU. According to the data for 2010, the share of household energy consumption in total energy consumption was 27% in Europe and 35% in Estonia (Figure 3, p. 8). Household energy consumption depends on the geographical location of the country, the income level and size of households, but also on the cultural background and traditions. In addition to Estonia, household energy consumption accounts for more than 30% of total energy consumption also in Latvia, Lithuania, Poland, Hungary, Denmark and the United Kingdom. The share of household

<sup>a</sup> Final energy consumption – energy which is received and consumed after conversions into other forms of energy (electricity, heat, fuel). Final consumption excludes the use of energy for non-energy purposes, self-consumption by power plants, and losses. Hereinafter also referred to as 'consumption'.

energy consumption is the biggest in Romania and the lowest in Luxembourg (a little over 10%). Households account for a relatively small part of total energy consumption also in the small countries of Malta and Cyprus (within 15%). In the remaining European countries, this share usually ranges between 20 and 30 percent.

A look at household energy consumption by type of energy or fuel highlights the economic-geographical differences even more clearly. In the EU as a whole, gas holds the biggest share in energy consumed by households, whereas in Estonia the share of gas is relatively small (Figure 4, p. 9). Residential gas consumption is very different in different countries. Gas accounts for 75% of total domestic consumption in the Netherlands, and for nearly 70% in the United Kingdom; its share is larger than 50% also in Hungary, Slovakia and Italy. At the same time, the share of gas in residential energy consumption in Finland, Sweden, Norway and Bulgaria is only 1–2%. The share of gas in household energy consumption is 5% in Estonia and slightly higher in Latvia and Lithuania.

The share of electricity in household energy consumption is more similar across Europe. It remains within 20–30% in most countries, although in Norway electricity constitutes as much as 77% of final household energy consumption. The share of electricity is more than 50% also in Cyprus and Malta. In Estonia, electricity consumption accounts for slightly under 20% of total household energy consumption – the EU average is a little over 20%.

Heat consumption refers to the consumption of district heat in European Union countries. The energy sources used to produce heat in local boiler stations are recorded as fuels. The biggest residential consumers of district heat in the EU are the Nordic countries, where heat consumption constitutes 30–40% of total household energy use. There are also a number of countries in Europe where district heat is not consumed at all or is consumed in very small amounts – these are mostly southern European countries, but also the United Kingdom and Ireland. In Estonia, district heating accounts for a relatively large part (over 30%) of household energy consumption.

In this comparison, solid fuels include coal, peat, peat briquettes, coal briquettes and some other similar solid fuels. Households mainly use peat briquettes and coal. The share of solid fuels in household energy consumption is relatively small, both in Estonia (under 1%) and in Europe as a whole (4% on average). Households in Poland and Turkey are the biggest consumers of solid fuels – there, solid fuels account for about 30% of household energy consumption.

The next big group of fuels used in households is renewable fuels. Renewable fuels include biomass (mostly wood fuels: firewood, wood waste, pellets, etc.), other biomass (straw, reeds, etc.), solar energy, biogas, charcoal and geothermal energy. Although all these types of renewable fuels are represented in household consumption in European countries, it is wood fuels that are used the most. Wood constitutes 95% of the total renewable fuel consumption of European households. Besides wood, the use of solar energy is quite considerable. In many countries, including Estonia, household consumption of solar energy is close to zero. In Europe as a whole, the share of solar energy in household consumption is also relatively small – 3% of renewable energy consumption. At the same time, solar energy has a major share in household renewable energy consumption in Cyprus (85%), Croatia (46%) and Greece (22%). In addition to these southern European countries, solar energy is used more widely by households in Ireland, Germany, the Netherlands, Austria, Spain and Portugal.

In Europe, the share of liquid fuels in household energy consumption is more than 10% on average. In Estonia, the value of this indicator is very small, as in the European comparison the use of motor fuels in cars is registered under road transport, not as household consumption. The main liquid fuel used in households is light fuel oil, which is used for heating. Liquefied gas is also a liquid fuel. The share of liquid fuels is the biggest in Switzerland and Greece – over 40% of the final energy consumption of households – followed by Malta, Luxembourg, Ireland and Belgium.

Household consumption has a significant share in final energy consumption. As mentioned above, the share of household consumption in Estonia is among the largest in Europe, at 35% of total final energy consumption. This share rises above 40% if we include the household consumption of motor fuels, which is not considered as household consumption in the European

comparison. In order to obtain data on household energy consumption, consumer surveys are carried out in Estonia and other European countries. The periodicity of these surveys varies across countries, and the assessment of data in the years between two surveys is based on the most recent survey data and other data sources. In Estonia, the latest energy consumption survey was conducted in 2011 and was called the Household Energy Consumption Survey. The population of the survey included all households whose primary dwelling was located in Estonia. The address list prepared by Statistics Estonia for the 2011 Population and Housing Census was used for the sampling frame. The following more detailed overview of household energy consumption in Estonia is based on the data of this survey.

## **Dwellings and households in Estonia**

Most of the energy consumed by Estonian households is used for building services. 72% of the dwellings in Estonia are located in urban areas (incl. cities without municipal status) and 28% in the countryside (small towns and villages). Based on the type of dwelling, more than 80% of urban dwellings are located in apartment buildings, while nearly 60% of rural dwellings are single-family houses.

The overwhelming majority – nearly 65% – of all dwellings are located in large apartment buildings with 10 or more flats (Table 1, p. 10). In Estonia, a relatively high share of dwellings (almost 85%) is in private ownership.

In terms of energy needs, the age of the building has great importance. The majority of dwellings in use today are located in buildings built in the Soviet era, between 1946 and 1990. These buildings make up 75% of the dwelling stock in urban areas and 54% in rural areas (Figure 5, p. 10). 14% of dwellings are situated in buildings built before 1946, with more than half of these located in rural areas. The share of residential buildings built before 1946 is as high as 30% in the rural dwelling stock, whereas in urban areas their share is below 10%. 12% of dwellings are located in buildings built in the last 20 years – most of these are in cities.

In the analysis of energy consumption, it is also important to know the heated area of a dwelling. The heated area refers to the entire area which is heated at the expense of the residents living in the dwelling. It does not include the area of balconies, garages, auxiliary premises and other unheated rooms. More than half of dwellings have 50–100 m<sup>2</sup> of heated area, and 40% of dwellings have 20–49 m<sup>2</sup> of heated area. The number of dwellings larger than 100 m<sup>2</sup> or smaller than 20 m<sup>2</sup> is quite small. At the same time, most bigger dwellings are situated in rural areas, due to the greater proportion of single-family houses in rural areas. The number of dwellings is only 3% smaller than the number of households. This means that there are few dwellings that are shared by two or more households. A household is a group of people who live in a common main dwelling and share financial and/or food resources. Most households have up to three members. In rural areas, bigger households have a larger share than in cities.

## **Energy consumption of Estonian households**

The survey data on the final energy consumption of Estonian households are in general comparable with the household consumption data for other European countries, except for the fact that, in this survey, household consumption also includes the motor fuel consumption of the cars used by households. Most of the energy and fuels consumed by Estonian households is used for heating. This includes district heating, fuels used for heat production (wood, natural gas, peat briquettes, coal) and also a part of electricity. Based on the average calorific values of fuels, the total energy consumption of households in terajoules (TJ) was calculated. Energy from wood fuels holds the biggest share in the final energy consumption of Estonian households. According to the survey, the share of energy from wood fuels in total household consumption was more than 30%, and even over 50% in rural areas. If we exclude motor fuels, wood fuels accounted for more than 40% – and about 70% in rural areas – of household final energy consumption. Firewood made up most (94%) of the wood fuels used, followed by wood briquettes, wood pellets and

wood waste. A third of the consumed firewood and a half of the wood waste were stockpiled by the households. It is possible that some of the wood waste used by households was reported under firewood, because it is quite difficult for people to assess the use of wood waste they have stockpiled themselves.

Nearly 30% of household final energy consumption is purchased heat (which also includes the purchase of hot water from a district heating system), while the share of motor fuels is a little more than 20% and the share of electricity is 13%. Consumption of other fuels (natural gas, liquefied petroleum gas, peat briquettes, light fuel oil, hard coal) is 6% (Figure 6, p. 11).

The picture changes dramatically when we consider the structure of final energy consumption based on the cost of energy. Households spend almost half of their total energy expenditure on motor fuels, a quarter on district heating and slightly under 20% on electricity. The share of other types of energy in the total energy cost is much smaller. The cost of energy from wood fuels – the biggest energy source – constituted only 6% of the total energy cost of households. However, the total energy cost of a household depends on the specific household, i.e. the fuels and energy sources used the most in that household.

For example, in households using wood pellets or fuel oil, the cost of these fuels accounted for about 15% of the total energy cost. At the same time, these fuels are expensive and consumed by few households – the cost of both of these fuels constituted less than 1% of the total energy cost of households (Table 2, p. 12).

Next, the use of specific types of energy and fuels by households will be analysed. These data are outlined in Table 3 (p. 12). The data indicate that electricity was used by 99.7% of households and district heat by 58% of households. Firewood is the most widely used fuel – it was used by 37% of households, and in rural areas even by 73% of households.

Almost 20% of all households and 25% of urban households are connected to the natural gas grid. In rural areas, the use of natural gas is limited, mainly due to the lack of a natural gas network. At the same time, 17% of households in rural areas use liquid petroleum gas (LPG). The share of other fuels in household consumption is lower. Wood pellets produced in Estonia are also not used much (0.2%) because of the quite high price.

The annual average energy consumption per household in quantitative energy units is shown in Table 4 (p. 13). The data show the average for all households that used the particular type of energy.

## Heating supply

Most dwellings in Estonia are connected to the central heating system, which provides heat to almost 70% of all dwellings. A district heating system is the dominant solution, but local central heating systems are also used. In the Household Energy Consumption Survey, district heating means a heating method whereby residents pay for the heat consumed; and local central heating means that the dwelling is heated by a local boiler station and residents buy fuel for the central heating system of their house or group of houses. The remaining 30% of households used stoves, cookers or fireplaces to heat the dwelling. 8% of dwellings use electrical heating, but only slightly more than 4% of these have stationary electrical heating equipment.

Underfloor heating is an important type of electrical heating. In case of electrical underfloor heating, the heat is transferred by heating elements installed under the floor surface. Hydronic systems are low-temperature pipe systems where the heat for heating the fluid (usually water) is generated by heat pumps, boilers or solar energy. The water in the underfloor pipes is the heat transfer medium. Electric systems were used in 15% and hydronic systems in 3% of dwellings. Underfloor heating is mainly used in bathrooms and wet rooms; there were relatively few households where underfloor heating was only used in the main rooms.

In recent years, there has been a rapid increase in the number of households using heat pumps. A heat pump is an electrically powered compressor pump which accumulates heat from the earth,

water, waste water or air. Depending on the outdoor temperature, heat pumps can be used for heating (in winter) or cooling (in summer) the indoor premises. Almost 75% of the heat pumps in use were installed in the period 2008–2010. The survey results show that only slightly more than 3% of dwellings have had a heat pump installed. In many cases heat pumps are used in combination with other heat sources. In Estonia, the use of air source heat pumps is significantly limited by the fact that these pumps are not effective in winter when the outside temperature falls below  $-15^{\circ}\text{C}$ . Households primarily use air source heat pumps (mostly air-to-air system) and to a lesser extent also ground source heat pumps. About 30% of the households using heat pumps used them both for space heating and hot water supply; the remaining households used heat pumps only for space heating. Although Estonia is located in a relatively cool climate zone, more than half of the heat pump owners said that they use the pump for cooling as well

10% of households have no hot water supply. In rural areas, there are four times more households with no hot water supply than in urban areas – the shares of such households are 23% and 5% respectively. Almost half of the households get hot water from the district heating system, but there is a great difference between urban and rural areas: the district heating system provides hot water for more than 60% of urban households, but only for 7% of rural households. 35% of households have a water heater (Figure 7, p. 14). The share of rural households using a water heater is the same (nearly 60%) as the share of urban households supplied with hot water by the district heating system. Heat pumps have a quite insignificant share in hot water supply, and this share is relatively similar in both urban and rural areas.

## Electricity supply and electrical appliances

Electricity accounts for a significant part of household energy consumption. The survey results show that the level of electricity supply in Estonia is close to 100%: only 0.3% of households in Estonia did not have electricity supply. Most households get electricity through the distribution network. Only 0.1% of households use a local hydro-, wind- or solar-powered or other electric generator.

The electricity consumption of Estonian households has started to grow with each year. The main reason is the increasing number of appliances owned by households. Sales of electronic equipment (e.g. TVs, desktop and laptop computers, mobile phones and kitchen appliances) are increasing, and the rapid technological progress means that appliances are being replaced more frequently than in the past.

The average annual use of electricity was 3,465 kWh per household. The annual consumption was higher in rural areas – 4,553 kWh. In cities, the average annual consumption of electricity was 3,060 kWh per household.

Almost all households have a refrigerator – only 1% of households did not have one. Additionally, 16% of households have a standalone freezer. 93% of households have a vacuum cleaner and 89% of households have a washing machine (Table 5, p. 15).

Another common group of electrical appliances is TV equipment. 97% of households have at least one TV, and 17% of households have two or more TVs. 62% of households own the older type TV (cathode ray tube or CRT). 41% of households have an LCD or LED TV, and 9% have a plasma TV. The share of households with a 3D TV was under 1%.

Half of all households have set-top-boxes or SAT-TV equipment. As for other entertainment systems, 73% of households have a stereo system, 42% have a DVD player and 12% have a home cinema system.

The rapid development of information technology means that more than two thirds of households have at least one personal computer. Roughly half of the households have a desktop computer and about the same number have a portable computer. 3% of households have two or more desktop computers and 9% have more than one portable computer. About one third of households have a printer.

*As for kitchen appliances, electric cookers are the most common with 72% of households having one. More than 60% of households have a microwave oven and nearly 20% have a standalone electric oven.*

*An electric sauna heater is one of the high-power household appliances. The sauna has a long tradition and is quite popular in Estonia. In rural areas, saunas are usually heated with wood, while electric sauna heaters are mostly used in cities. The survey showed that 4% of households have an electric sauna heater.*

*Households' ownership of the most common electrical appliances is outlined in Table 5 (p. 15).*

## **Consumption of motor fuels**

*Motor fuels constitute more than 20% of the final energy consumption of households. Based on cost, motor fuels hold the largest share in households' energy expenditure. In general, households spent nearly half of the total energy expenditure on motor fuels, whereas in rural areas the share of expenditure on motor fuels was nearly 60%.*

*In Estonia, 60% of households have a car – 45% of households have one car, 14% have two cars and 2% have three or more cars (Figure 8, p. 16). If we consider all car-owning households, the number of cars per household is bigger in rural areas.*

*Most cars (about 80%) run on petrol. The annual average fuel consumption per car was 745 litres for a petrol car and 863 litres for a diesel car. The annual average mileage per car was 11,394 kilometres. Consumption of gas as a transport fuel was minimal, but there were respondents who reported the use of gas for transport. In terms of the technical specification, more than half of the cars used by households had an engine with a capacity in the range of 1,501–2,000 cc. Nearly half of the cars were 10 to 20 years old. Slightly more than 40% were under 10 years old and nearly 10% were older than 20 years (Table 6, p. 16)*

*Over 60% of car owners buy fuel from a specific petrol station chain, 30% go where the lowest price is offered, and the remaining car owners do not care about where they fill up their car.*

*There is a strong correlation between a household's income and ownership of a car. The higher the household's income, the greater the probability that the household has one or several cars. More than 90% of households with a minimum income of 1,500 euros per month had a car (Figure 9, p. 17).*

## **Energy saving and consumption habits**

*Today's energy consumption is significantly different from the habits common a few decades ago. Consumption is influenced by several important factors, such as rising incomes, globalisation of the economy, technological developments (e.g. the Internet and mobile phones), decrease in the size of households, and population aging, among others.*

*Households have several ways to save energy by changing their consumption habits. Since people do not easily change their habits, the increasing energy costs have definitely the biggest impact on people's energy consumption. In order to save energy, people should first find out how much energy they consume and what this costs.*

*More than 60% of households monitor their energy consumption constantly. 25% monitor their energy consumption from time to time and the remaining households do not monitor it at all. If we look at energy-saving behaviour based on a household's income, it appears that the higher the income, the more likely it is that the household does not monitor energy expenditure very often. The lower the household's income, the more likely it is to monitor energy costs (Figure 10, p. 17).*

*As a rule, energy saving is based on measuring the volume of consumption. Consequently, households tend to monitor the consumption of those types of energy that they can measure themselves. Electricity consumption is definitely the easiest to monitor – more than 85% of households monitored their electricity use (Figure 11, p. 18).*

Natural gas consumption was monitored by only a little over 12% of households, even though all households using natural gas are connected to the gas grid and can easily measure their gas use. More than half of these households have a meter installed in their dwelling. In case of the remaining households, the gas consumption is metered for the entire building or group of buildings.

About a quarter of households monitored their monthly heat consumption (i.e. purchased district heating). In most apartment buildings, it is technically not possible to measure the individual heat consumption of each dwelling – therefore, the total heat consumption is divided between dwellings according to their heated floor area. The survey showed that only 5% of households can meter the heat consumption of their dwelling. Most (95%) of district heating users pay on the basis of the heated floor area. Less than 1% of district heating users have special heating cost allocators (radiator-mounted devices) that measure the radiator surface area and room temperature. On the other hand, most households have meters to measure hot water consumption and usually pay for hot water on the basis of these meter readings. Only 4% of households use some other method (usually, the number of persons in the household) for the calculation of hot water cost.

Although motor fuel consumption accounts for a very large part of household energy consumption, it is continuously monitored by only 20% of households.

The main energy-saving measures used by Estonian households are related to heat and electricity consumption. The most common method is the thermal insulation of buildings. According to the survey, more than 60% of households have improved the thermal performance of their dwelling.

The most common improvements include the replacement of windows and the additional insulation of the building envelope (roof and outer walls), whereas getting new windows is the most popular method for improving the thermal insulation of one's dwelling (Figure 12, p. 18). At the same time, the indoor climate in a dwelling may deteriorate with the new, more airtight windows. Therefore, thermal insulation measures are increasingly combined with ventilation improvements. The survey revealed that nearly 13% of dwellings had forced (mechanical) ventilation systems, but only 8% of them had heat recovery equipment to reuse the energy in the exhaust air. Only one percent of all dwellings had heat recovery ventilation. The use of exhaust air means that the system uses the residual energy of the exhaust air to preheat the fresh air released into a room.

Nearly 40% of households have not taken any measures to improve the thermal insulation of their dwelling. Half of these households cited lack of money as the reason. More than half of the households who had not undertaken thermal insulation did also not plan to do it in the near future. Still, almost 20% of households had plans to improve the thermal insulation of their dwelling, and about the same share of households had postponed these improvements for at least three years (from the time of questioning).

Households are paying more and more attention to the indoor climate of dwellings. Rooms are expected to have fresh air and thermal comfort. Nearly 80% of households said that their indoor climate in the heating season is normal, while 15% considered their dwellings to be too cold and a few percent said that their dwelling is too warm or too damp.

If households want to save energy and reduce energy costs, they must – in addition to reducing the use of thermal energy – also reduce energy consumption elsewhere. The best way to do this is to use more efficient lighting and electrical equipment. More efficient electrical equipment is used by a relatively large proportion of households using a particular type of equipment. As for electrical appliances in everyday use, nearly 60% of households had refrigerators with class A efficiency and 52% of households had freezers with the same efficiency class. Yet, in case of each appliance, there is still a considerable share of households who do not pay attention to the energy efficiency class (Table 7, p. 19).

Slightly more than half of the households use low-energy light bulbs (halogen, fluorescent or LED lamps) in their dwellings. Low-energy light bulbs are mainly used indoors.

## Conclusion

*The energy costs of households increase from year to year. This is also the reason why in recent years there is more and more talk about the need to save energy.*

*Energy consumption habits are formed by many factors, with the general attitude, income and cost of energy being the most important. Energy prices have risen in the recent past and will rise in the future. In Estonia, the energy consumption of households is relatively high compared to other European countries. Consumption of heat, electricity and motor fuels constitutes a large part of the household budget. At the beginning of 2013, every single residential consumer could experience first-hand that the cost of electricity rose significantly, as the Estonian electricity market was opened. The dwelling stock is relatively old and requires a lot of energy for heating. Motor fuels hold the biggest part in the household energy budget – especially in rural areas where there is often no other option but to use one's own car due to the poor public transport options and long distances.*

*Estonian households usually monitor their energy costs, but this has probably more to do with the household income than any concern for the environment. As the income level increases, households pay much less attention to optimising the energy expenditure. In order to change or influence consumption habits, a person needs first of all to have a specific reason for changing the habits. On the individual level, the main reason is cost minimisation; on the wider scale, the motivation is environmental sustainability.*

*In the foreseeable future, energy will not get cheaper. Thus, the only solution is to use the energy resources more efficiently.*