ENERGIAKLUB
CLIMATE POLICY INSTITUTE
APPLIED COMMUNICATIONS

NEGAJOULE2020
Energy efficiency potential of Hungarian residential buildings

Report

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ENERGY EFFICIENCY POTENTIAL OF HUNGARIAN RESIDENTIAL BUILDINGS

Report

www.negajoule.hu

ENERGIAKLUB Climate Policy Institute and Applied Communications

May 2011

This analysis is the summary report of ENERGIAKLUB's **NegaJoule2020** research project.
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Special thanks to Imre Dobossy and Gábor Valkó (Central Statistical Office), Judit Barta (GKI Energy Research and Consulting Ltd.), József Hegedűs (Metropolitan Research Institute) and András Murányi for their help during the project.

The research project was supported by :
National Innovation Office

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SUMMARY

The research project called NegaJoule2020 had two obejctives: on the one hand, by means of a wide-range national sampling of households those basic data supplemented that enable a deeper insight in the correlations as regards the energy consumption of residential buildings. The publishing of survey data furnishes not only for us but also other researchers, decisions makers and the profession with indispensable data. On the other hand, by combining technical knowledge usually missing from economic analyses with economics, hundreds of basic calculations were carried out that provided detailed information on the energy consumption of various residential buildings and on the scale of energy saving attainable at a national level through energy effciency.

Energiaklub considers it as evident that energy efficiency is the first step towards decreasing energy consumption and making it more sustainable. Therefore, our research deals with only the energy savable by means of energy-efficient technologies and investments, and renewables are not touched upon herein. Energy efficiency investments are the external insulation of the buildings, the replacement of doors and windows and the modernization of the heating and hot water generation systems of the buildings. An important aim was to gain a picture not only of the energy saving potential available by theory but also of the energy efficiency potential that can be profitably gained therefrom. In addition, another objective was to make predictions on the volume of investments and energy savings expectable on the basis of the investment plans and opportunities of the households.

According to the results, 33% of the total Hungarian primary energy consumption (360 PJ) is consumed by the heating and hot water demand of residential buildings. The energy consumption of family houses account for a predominant part, that is 81%. Out of the primary energy consumption related to the heating and hot water demand of residential buildings, 68% is provided by natural gas and 28% by firewood-consumption. Should the households implement all the available energy efficiency refurbishments, more than 42%, a major part of the consumed energy (152 PJ) could be saved. Enormous energy saving opportunities reside primarily in family houses – a reason for this is that family houses tend to have a far bigger floorspace than flats in apartment houses and that they lose heat on a relatively bigger surface.

According to the calculations, 117 PJ, which is 77% of the theoretical-technical potential, could be profitably gained even beside the strict profitability cirteria set by Energiaklub, that is, the cost of energy saved by means of the investments would exceed the total costs in the case of most investments. A result worth considering is that for the majority of family houses the joint insulation and replacement of doors and windows would be a more profitable investment than a long-term bank deposit.

The exploitation of the total technical-theoretical potential calculated at current prices would generate investments worth of almost HUF 7,400 billion (ca. EUR 27 billion). This would require that within the period until 2020 about 330 thousand households should perform one or another kind of renovation of the building on an annual basis. If the state wished to contribute to the financing of this, that would mean an annual cost of HUF 220 billion (EUR 0,8 billion) for the state beside the current state subsidy level of 30%, which can be considered as minimal.

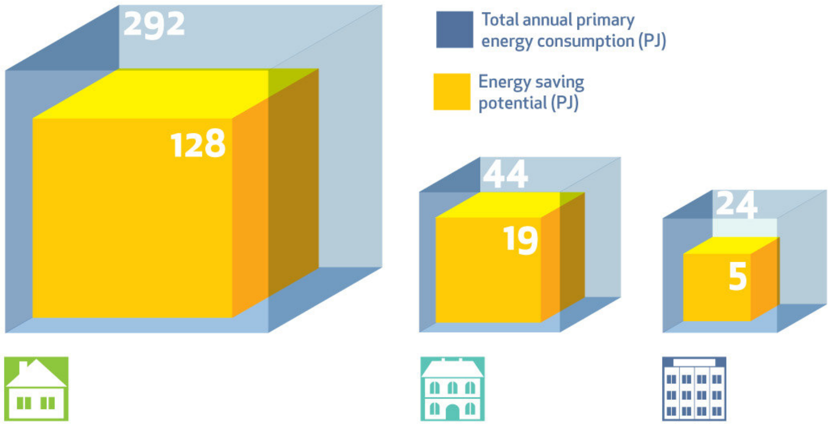
If only the econimic potential is considered, that would mean a total national investment of about HUF 2,400 billion (ca. EUR 9 billion), and would require that investments primarily focusing on insulation and the replacement of doors and windows should be annually implemented in an average of 160 thousand households until 2020. This, with a subsidy level of 30% would cost and annual HUF 85 billion (EUR 0,3 billion) for the state.

At the end of this analysis it has been laid down that the majority of the households is unable to finance bigger investments, even if the investment later proved to be profitable. Evidently, this limits the number of potential investments significantly, and indicates the necessity of state contribution to motivate the refurbishment of residential buildings with predominantly weak energy performance.

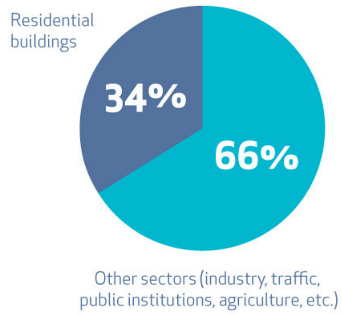
Energiaklub believes that these calculations and their analysis may help decision makers in the elaboration of residential subsidy programs and in the amendment of the National Energy Efficiency Action Plan, which has to be performed until the 30th of June, 2011, similarly to the other EU member countries.

ENERGY SAVING POTENTIAL IN HUNGARIAN RESIDENTIAL BUILDINGS

ENERGY SAVING POTENTIAL AT THE DIFFERENT TYPES OF BUILDINGS

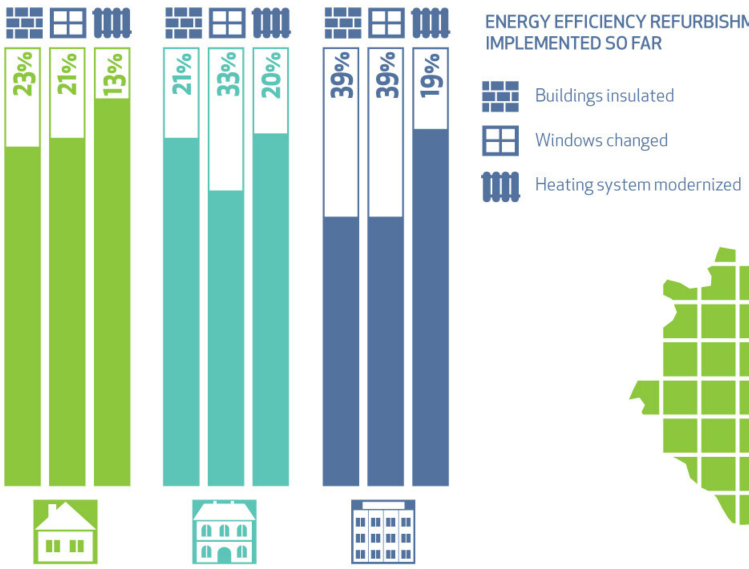


THE DISTRIBUTION OF THE HUNGARIAN PRIMARY ENERGY CONSUMPTION AMONG THE SECTORS

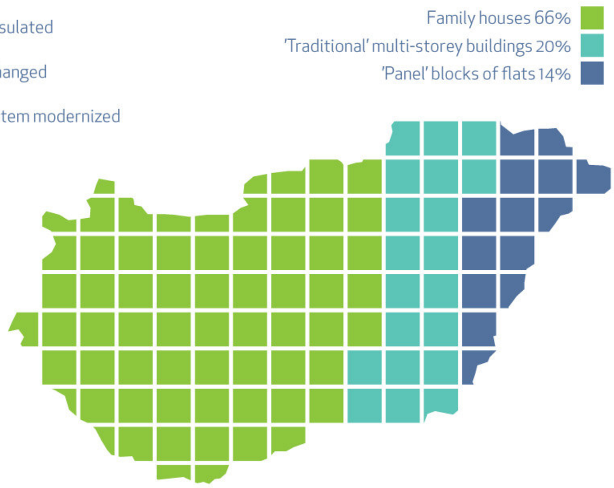


One-third of Hungary's primary energy consumption is effected in residential buildings, during heating and hot water generation. Stunning but true: the total annual energy consumption of family houses, 'traditional' multi-storey buildings and 'panel' blocks of flats is equal to the quantity of fuels burnt in all the Hungarian large-scale power plants in a year. However, more than 40% (152 PJ) of the energy consumed by Hungarian households could be saved by making the buildings more energy-efficient. As it is also shown in the chart, the biggest energy saving is attainable by the refurbishment of family houses.

ENERGY EFFICIENCY REFURBISHMENTS IMPLEMENTED SO FAR



THE BREAKDOWN OF RESIDENTIAL BUILDING TYPES



Out of the Hungarian households 66% live in family houses, 14% in 'panel' blocks of flats and 20% in 'traditional' multi-storey buildings. So far only in a minor ratio of residential buildings have been energy efficiency refurbishment effected: only 24% of all the households are equipped with modern windows, 25% of them have performed an external insulation on the building and only 16% of them have renovated the heating system. Ratios vary at the different types of buildings.

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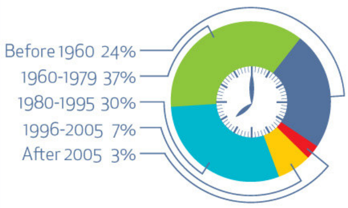
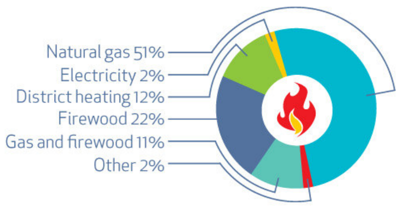
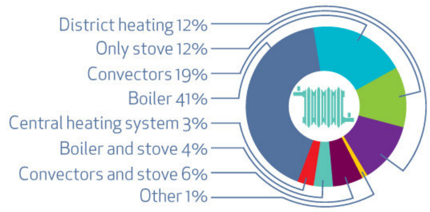
WHEN WERE HUNGARIAN RESIDENTIAL BUILDINGS BUILT?



WHAT ENERGY SOURCES ARE USED FOR HEATING IN THE HOUSEHOLDS?



WHAT ARE THE HEATING SYSTEMS LIKE IN RESIDENTIAL BUILDINGS?



Source of data: www.negajoule.hu, ENERGIAKLUB 2011.

INTRODUCTION

„There are no two identical buildings" is an objection often raised by special experts when discourse is going on about national calculations, models and the lack thereof. And this is true. Still, in our NegaJoule2020 research project, we endeavour to set up a model of buildings that may give a good approximate of the composition and energy consumption of Hungarian residential buildings and on the scale of energy saving attainable at a national level by means of energy-efficiency investments. Energiaklub believes that this effort has brought a result– the respective research report is contained hereunder.

The analyses and calculations were carried out with the objective of showing to those concerned by energy efficiency, to the profession and decision-makers and to other experts and non-professionals interested in this subject what an energy efficiency potential is lying in Hungarian residential builings. In the course of its existence of 20 years, ENERGIAKLUB had to face again and again the lack of data concerning the energy consumption of households and the energy performance of Hungarian buildings. This made serious calculations impossible, and not only for us, but also for other researchers and even the decision-makers. With our NegaJoule2020 research project we wish to render such basic data and calculations.

The research contained herein is unique in Hungary in two aspects: on the one hand, calculations were preceded by a representative, large-scale statistical sampling that served with detailed basic data necessary for the study. On the other hand, we did not use in our calculations technical data of unspsecified origin and cited from international literature, but hundreds of energy calculations – basically sample energy performance certificates - were prepared on various types of buildings with the assistance of a practising energy engineer. According to our information calculations of a similar scale have not yet been conducted in Hungary.

It has to be underlined that model calculations do not substitute for energy performance certificates prepared on the specific, individual buildings, which, by definition, can touch upon the individual attributes of buildings and the specific expectations of the owners regarding the individual investments. This model, similarly as in the case of most statistical data, refer to everyone and to noone. However, outcomes of this study show that by this means a fairly good approximation could be given on Hungarian residential buildings.

Finally, why do we consider energy efficiency so important? Because this is the most economic and effective way of answering the main energy-and climate policy challenges of these days. Energy efficiency serves the sustainability of the environment, a safer energy supply and the competitivenes of the economy at the same time. A reduced energy consumption arising from efficiency leads to, on the one hand, less greenhouse gas emission, that is, a better environmental sustainability and a more environment-friendly energy consumption (and production). On the other hand, demand for fossil, that is depleting and mainly imported fuels, decreases, thus the Hungarian import dependency reduces. This way the Hungarian foreign trade balance improves, and Hungary will be less exposed to the international fluctuations of energy prices. Moreover, the demand for energy-efficient industries, products and services will grow, which (may) significantly improve economic performance.

The exploitation of the opportunities lying in energy efficiency also depends of the Hungarian Government. We wish to contribute to the elaboration of residential energy effciciency programs and the revision of the National Energy Efficiency Action Plan with our analysis and calculations

METHODS APPLIED

1 The frameworks of the research

Our research focused on the existing Hungarian building stock. The primary reason for this is that the cessation ratio of flats in the country as compared to the building stock and the ratio of flat construction is rather low: while lately 30-35 thousand new flats were built annually on the average, only 4-5 thousand flats were left off in the meantime and this even shows a decreasing trend (the 2010 data of the National Statistical Office show that the number of both the newly constructed and of the ceased flats touched bottom). This means that the majority of the existing residential buildings will be in use in the forthcoming decades, too, therefore their modernization and renovation remain to be on the agenda.

1. The number of newly constructed and ceased flats in Hungary

Another reason why we focused on the existing residential buildings instead of the newly built ones is that, on the one hand, according to current information, no significant aggravation as regards newly consturcted buildings is expectable in Hungary in the near future. On the other hand, the currently effective requirements concerning newly constructed flats, are, if not revolutionarily ambitious, but on principle, they guarantee a residential building with acceptable energetics parameters (at least category C, with an annual energy consumption of 110-230 kWh/m^2). The expression „on principle" is used because due to the indiscipline at Hungarian building designs and constructions or due to the lack of competence the effective performance of the buildings may lag behind values in principle. It is also mentioned here that with the year 2010 acceptance of the amended directive[1] the European Union set as an objective and task for the member states that by 2020 they aggravate the requirements concerning the newly constructed buildings to a value that corresponds to the energy consumption of low energy consumption residential buildings[2].

Renewables were not touched upon in the study, only the energy savable by energy efficient technologies and investments. We consider as evident that energy efficiency is the first step towards a decreased energy consumption. It is easy to admit that it is no use applying renewables if that is done in a wasteful way – renewable (and also non-renewable) energy is simply too expensive to be wasted. Hungary is seriously lagging behind in energy efficiency, this is why this was the focus of this study. However, our calculations might be later extended on the field of renewables, as the issue of systems fuelled by renewables is inevitably raised in connection with the more efficient heating and hot water generation systems. Furthermore, if the state is seriously intends to achieve the national target value of renewables, it has to be clarified in which fields this can be the best implemented the most effectively.

In our calculations we dealt with the energy used for the heating of rooms and hot water generation, as these are the two fields that demand the most energy in households. At the same time, these were the two fields to which the least attention had been paid so far, while there are significantly more data and information available as regards electric household appliances. Therefore the energy performance of buildings enjoyed priority, though the efficiency of household appliances is also in the focus – a separate analysis will be dedicated to this subject.

Our calculations were based on the calculation methods and values specified by the 7/2006[3] State Minister decree and the 176/2008[4] Government decree. It is to be underlined that in certain aspects contradiction between theoretical values and real performance may arise. Take for example the structures built from concrete panels, which have undergone significant but mostly unrevealed structural changes since their construction. The results of the measurements[5] ordered by the

[1] Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings

[2] No standard European definition does exist as regards this, however, the profession usually considers buildings with an energy consumption of a 40-50 kWh/m^2 low energy consumption buidings.

[3] TNM Decree 7/2006 (V. 24.) on the specification of the energergy performance attributes of buildings

[4] Government Decree 176/2008. (VI. 30.) on the energy performance certificate of buildings

[5] Compliance reports on the measurements of panel wall structures, Épületfenntartási K+F Alapítvány, 2009.

Ministry for National Development and Economy in 2009 also show that attributes specified by the state decree for panel walls are more favourable than in reality. However, we took the rates of the state decree as the basis of our calculations, mostly due to the fact that the performance of other construction materials, which we did not have any information about, may also lag behind theoretical values. Nevertheless, in the case of panel buildings we used the results of the measurements as well – it will be in each case detailed at the corresponding subject.

2 Statistical sampling

With the aim of getting hold of basic data necessary for our model and the calculations – in lack of sufficiently detiled, official statistics – a nation-wide, large sample, representative sampling was carried out in 2010. Data survey was planned and managed with the participation of expert organizations.

The volume of the sample

Data survey took place in 2000 households. From the aspect of the reliability of data survey, in the case of a larger and relatively homogenous mass of people a sample volume of 1,000 is usually enough, be it either about a town of one hundred thousand inhabitants or about a country with 10 million citizens (in the case of 1,000 people questioned, the sampling error is not more than 3%). A larger sample volume is necessary if the mass of people is planned to be broken up into a number of smaller sample parts, though according special literature a sample that is wider than 2,000 people is necessary to be taken only in specific cases because, above a certain level, this does not perceivably increase the accuracy of the sample – but rather the cost of the study.

It is later introduced in the study that though the basic mass of people was broken up into a number of sample parts in order to frame the building-model, this was used exclusively in the estimation of the mass ratios, and no information was drawn this way on correlations within the categories – always categories of a larger number of items were set up for such purposes. This way, the volume of the sample was set at 2,000 households.

The sampling method

The sampling method included a two-step, layered, quota-based sampling, where in the first step the sample settlement was shaped. The sample was representative on the types of settlements and on the regions set by the Central Statistical Office (KSH), bearing in mind the number of households there. During the calculation of the quota KSH data were used. According to the specific aims of data survey the quota of the households to be questioned at the selected settlements was specified in two dimensions:

- According to the ratio of occupied flats in the residential zones characteristic for the given type of settlement.
  Residential zones were as follows:
  - City-type area (terraced houses),
  - Blocks of flats,
  - Family house areas
  - Suburbs with villas,
  - Village-type areas (this differs from the family house area in that a regular agricultural activity, animal breeding and farming may take place at houses here).
- According to the ratio of the groups set up as per the number of household members.
  The household quota calculated on the basis of KSH data was as follows:
  - 1 member (20%),
  - 2 members (30%),
  - 3 members (20%),
  - 4- or more (30 %).

The interviewers had to select the households for the completion of the questionnaire by random walking. This means that it was the interviewer who could decide on the addresses and households visited within the specified area – by observing the quotas specified. The household member who was asked to answer the questions was the one who contributes to the household income with the highest amount (main earner) or the one who is mostly familiar with household issues (main consumer).

Data were analysed with the SPSS statistical program. Both the questionnaire and the data processed are available at www.negajoule.hu.

3 Technical calculations

The calculations concerning the energy consumption of various types of buildings for heating and hot water generation were made by an energy engineer, with WinWatt, an energy engineering program also used for the preparation of energy performance certificates. The program is based on calculation methods and data specified in the decrees mentioned before.

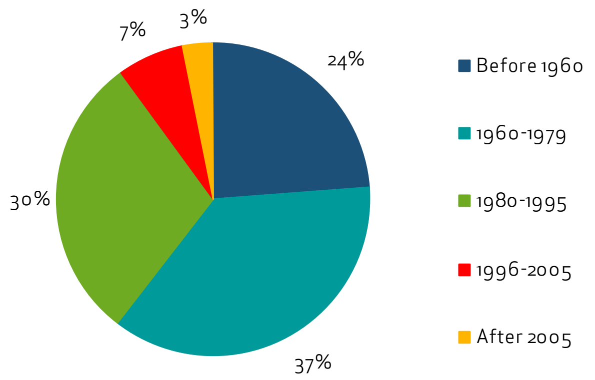
The calculation methods, the model building and the preliminary presumptions and data are introduced in chapters 3., 4. and 5.

THE BREAKDOWN OF HUNGARIAN RESIDENTIAL BUILDING STOCK

The data survey provides a large number of interesting and valuable data as regards the energy consumption of residential buildings. Only the most important ones are introduced hereunder, while detailed data are available at the website[6] of the research project.

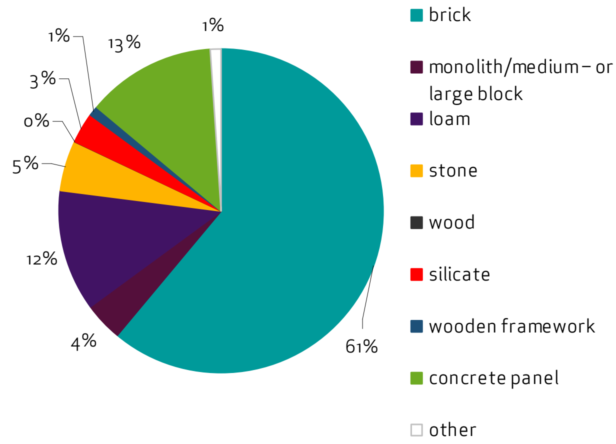
Data show that most Hungarian residential buildings are rather old: more than 60% of them were built before 1980 and only 10% of them were built in the last 15 years.

2. The breakdown of residential buildings according to the year of construction



The majority of Hungarian households, that is 66% (ca. 2,5 million households) live in family houses, 14% (ca. 530 thousand households) live in blocks of flats made of 'panels' and 20% (760 thousand) in other apartment blocks mainly built of brick. The most frequent construction material of family houses is brick or loam, family houses built of silicate and stone exist in a smaller ratio, and the least frequent are wooden framework houses. (It has to be noted that silicate was not represented among the possible answers, but it occurred among „other" answers to such an extent that silicate was rated in a separate category in data processing.) At the compilation of the questionnaire concerning construction materials by and large the categorization of the KSH applied also at the census was used, as most households cannot answer questions about more specific types of construction material.

3. The breakdown of residential buildings according to construction material



Family houses usually have a larger floorspace than apartment blocks built of 'panel' or brick, and they generally have more rooms, too. The headroom is the highest in the case of brick houses.

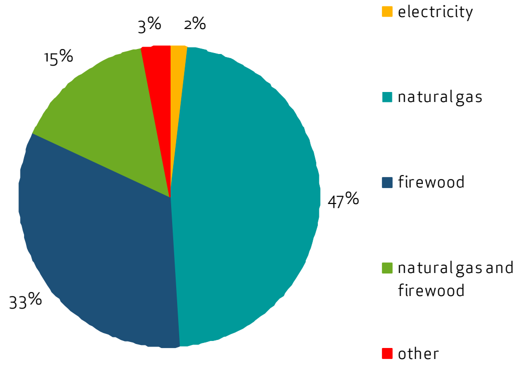
I. The average lifetime and size of flats at the various types of buildings

	Age of building	Flat size	Number of rooms	Head-room
	year	m²	pcs	cm
family houses	41	99	3	267
'non-panel' apartment blocks	52	67	2,4	296
'panel' blocks of flats	30	55	2,4	261
Total	42	86	2,8	272

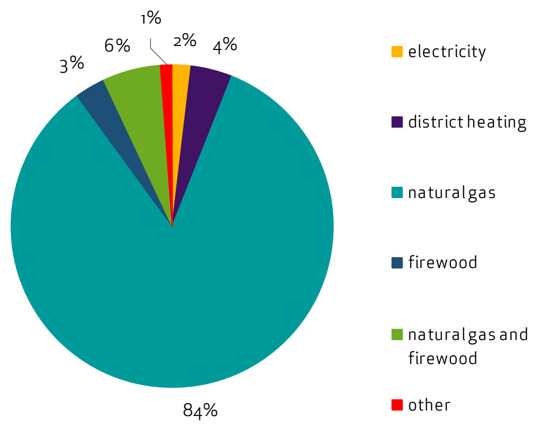
Though 80% of the households are connected to the natural gas pipeline, only about half of the households use gas for heating, 10% of them use both firewood and gas, and a high ratio of 20% use only firewood. A significant difference can be found among the various types of houses as regards the energy source used for heating: while in family houses firewood is highly frequent, the heating at most traditionally -built apartment blocks is based on natural gas. In most blocks of flats built by industrialized technology (mainly concrete panel) more than 80% are district heated.

6 www.negajoule.hu

4. The breakdown of family houses according to energy sources used for heating

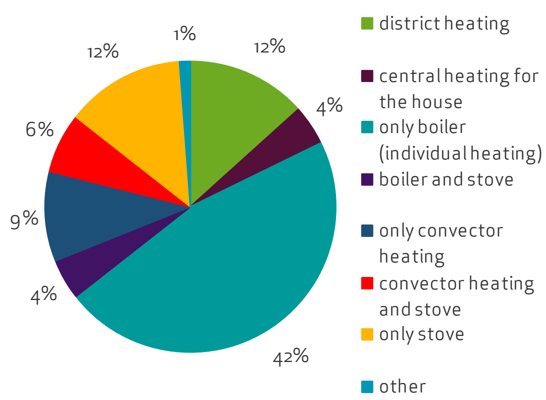


5. The breakdown of 'non-panel' apartment blocks according to energy sources used for heating



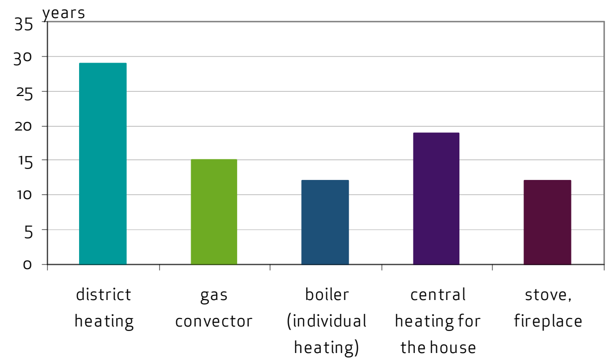
As reagards heating systems, households heated by a boiler or a central heating for the apartment account for the majority of households, while the ratio of households heated by convector heating, district heating or a stove is also significant.

6. The breakdown of households according to heating systems



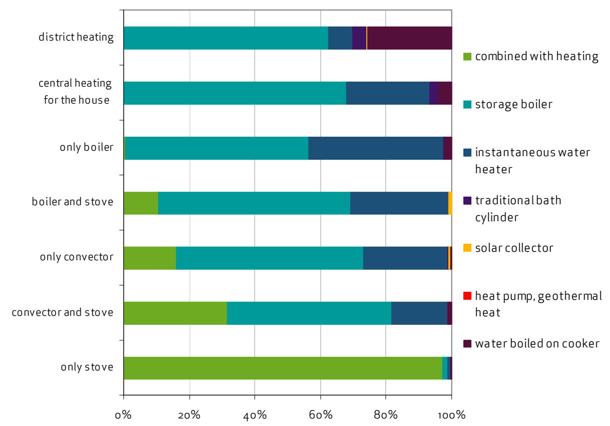
Heating systems are rather obsolete: heating with a convector or a stove are automatically concerned less effective, while boilers and central heatings for the flat are also relatively old, their average age is more than 12 years. Out of of the heating systems district heating systems are the oldest – they are almost 30 years old.

7. The average age of heating systems



Only in one-fifth of the households is hot water provided by the heating system, in other households some kind of a hot-water generation device is operating. Out of these the most frequent is the storage boiler, three-quarters of which operate with electricity. Instantaneous water heaters, at the same time, operate with gas in 90% of the cases. The ratio of hot water generators using renewables is under 1%, they are almost untraceable statistically. Relatively high, about 4% is the ratio of those households that can generate the necessary hot water only by heating on the cooker.

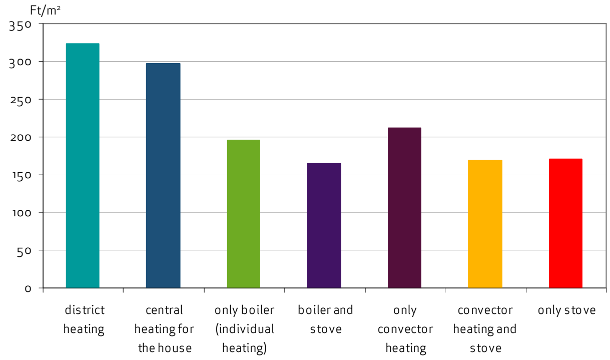
8. Hot water generation in the bathroom by heating systems



In a small part of the households (10%) there is a hot water system separate from the one in the bathroom: in 40% of the households these are storage boilers, in 30% instantaneous water heaters and in a further 30% water is boiled on the cooker.

Survey data show that if heating costs are studied according to the type of the heating system, district heating proves to be the most expensive one (even if the reduced VAT in the case of district heating significantly decreases the gross price of district heating as compared to other means of heating). The lowest prices are paid by those who have a stove.

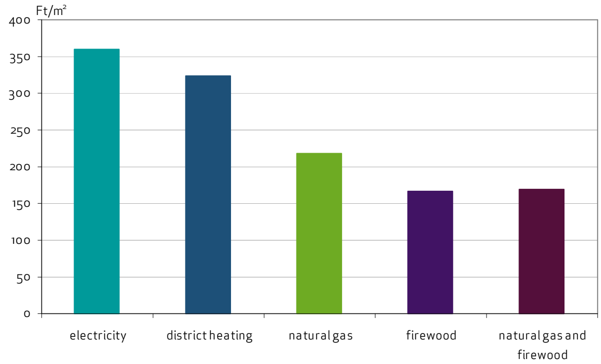
9. The average heating cost per square metre by heating systems



If this issue is investigated according to the energy sources used for heating, the most expensive is heating with electricity, while firewood or the combination of natural gas and firewood result in the lowest monthly heating costs.

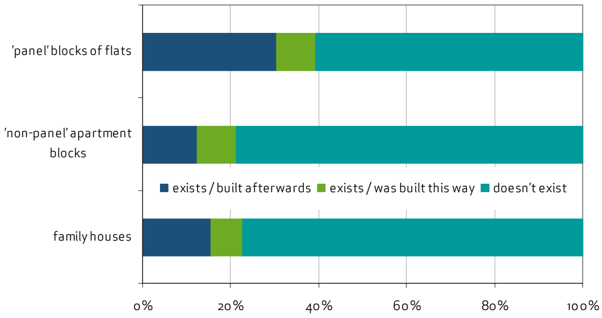
Obviously, heating costs depend on the individual comfort feeling of the households, but survey data did not show significant differences as regards the typical temperature in the households (this, however, probably proves that households do no know what the temperature is in the flat.)

10. The average heating cost per square metre by energy sources

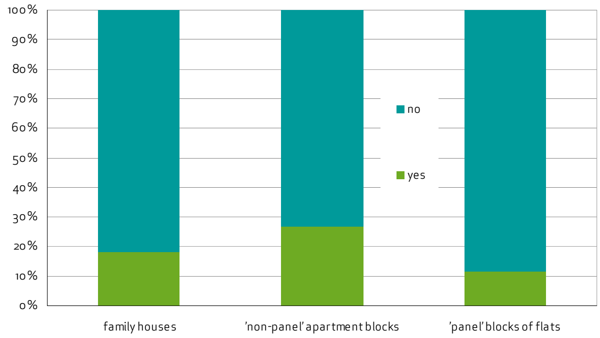


So far, energy efficiency refurbishments have taken place in a very small ratio in residential buildings: only a quarter, 25% of the households have effected insulation outside the building and the replacement of the doors and windows, and only 16% have upgraded the heating system.

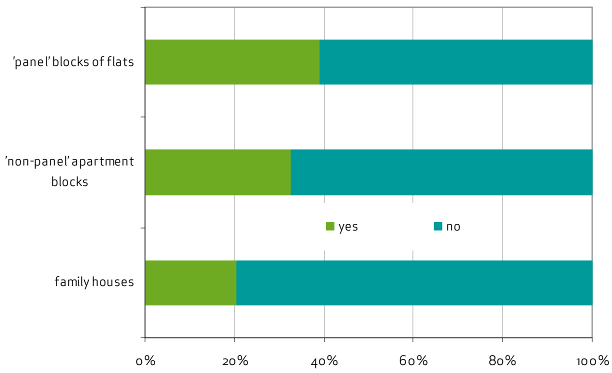
11. External insulation of the various types of buildings



12. The modernization of heating devices at various types of buildings



13. Replacement of windows at various types of buildings



THE ENERGY CONSUMPTION OF RESIDENTIAL BUILDINGS

On the basis of household data from our survey, and the applied technical proficiency and data a model of the Hungarian residential building stock could be made.

1 The model of the residential building stock

Aspects concerned when setting up the model

When setting up the model, the construction history facts and data briefly summarized hereunder were considered.

Wall structures

Until the end of the 40s' and 50s', mainly at urban regions, small-size, solid bricks were predominant, with a wooden or steel concrete slab, and without insulation. The typical wall width was a multiple of the small-size brick. In villages, clay bricks were typical instead, with a wooden slab.

Porous bricks appeared in the 60s and 70s, which are bigger than the small-size ones (e.g. B30 twin cell brick, Alfa block etc.). In industrial regions gas silicate appeared, and the industrialized (mainly panel) construction technology started to spread, which underwent several updatings during the decades, up to the early 90s.

Typical was the use of blocks in the 80s and 90s (HB 30, Thermoton, Poroton), and of the porous bricks from the 90s (Porotherm, Mátratherm, Ytong monoblocks). From the second half of the 90s complex structures also appeared, which were spreading even more intensely, the wooden framework construction technology (wooden- or metal frames+insulations+plaster or cladding brick) and the heavy, layered-structure buildings (brick+insulation, cladding brick, stone ornament, etc.). Energy efficient contruction means appeared as of the end of the 2000s.

Hungarian buildings were categorized in the study by bearing in mind all these technological developments. Certain simplifications, however, had to be made so that the model remain manageable (that is, there is a number of items in each category that can be interpreted). This way only the types of buildings with the largest ratio in the study were involved in the calculations. These were family houses built of bricks, loam and gas silicate and apartment blocks built of bricks and concrete panels (due to their similar energy efficiency parameters, buildings built of cast concrete, and blocks have also been categorized here).

Brick houses were divided into subcategories according to the type of the brick, as the various types of brick walls have different energy efficiency attributes. The type of the brick used could be concluded from the year of construction. Both in the case of family houses and of apartment blocks 4 different kinds of bricks were considered. These were as follows: in the case of family houses, buildings built of small-size 50, B30, PTH30 and PTH38 bricks while in the case of apartment blocks houses built of also small-size 50, HB30, PTH30 and PTH 38 bricks were distinguished. This way, residential buildings were divided into 11 basic categories. In the case of mud walls the slab was deemed wood while in the case of other construction materials, it was steel concrete.

The building categories specified according to the wall were all further divided into two basic categories: whether the household had effected an external insulation or not. There ratios were received from survey data.

Heating systems

The buildings above were further divided into subcategories according to heating systems, also on the basis of the survey.

Data show that in the case of family houses the most frequent heating device are boilers fuelled by firewood or gas, convectors and stoves fuelled by firewood. In the case of apartment blocks the convector heating, the individual boilers and the central boilers for the house are the most typical, while in the case of blocks of flats predominantly district heating, and to a smaller extent central heating and heating by convectors are present (the latter one is due to the fact that buildings with concrete/block walls have also been included in this category).

This way altogether 46 different types of building and household were differentiated.

Hot water systems

The categories and subcategories shaped as detailed hereabove have been further divided according to the hot water generation systems that are mostly characteristic for the categories.

Windows

In Hungary, until the 70s typically the wooden and so-called "Geréb"-framed windows were built in with single glazing. In the majority of Hungarian buildings this type of window is still predominant. Also typical was until the 70s that joint sash windows were built in, which was popular mainly in panel blocks of flats: they were made of wood and the frame was unscrewed only at cleaning.

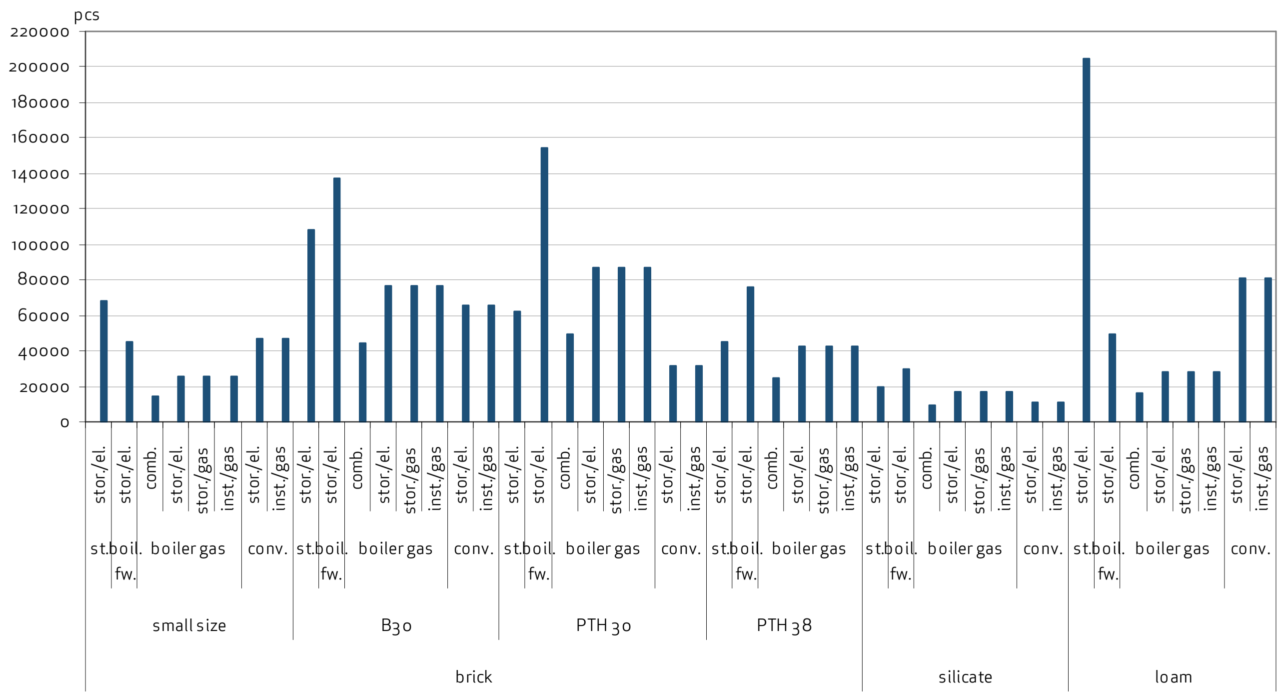
In the model the average heat transfer coefficient of buildings constructed before the 80s was estimated at U=2,8 W/m²K as regards the entire structure (it has to be noted that worse rates often occur in practice), while in the case of buildings constructed after the 80s, the coefficient estimated was U= 1,6 W/m²K.

As it is indicated by surveyed data, a certain percent of the households have changed the windows; in their case up-to-date windows with a heat transfer coefficient of about 1,2 W/m²K are presumed. In the case of these households no energy saving potential seemed necessary to be calculated as regards the windows.

The Hungarian residential building stock
When the categorization hereabove had been loaded with survey data, the ratios consequently formulated were projected on the entire Hungarian household stock. Its volume was set at 3.8 million, based on the Central Statistical Office (KSH) time series[7] between 2000 and 2008. This means that calculations were based on the number of households instead of that of the flats, so that unoccupied flats be selected from the model.

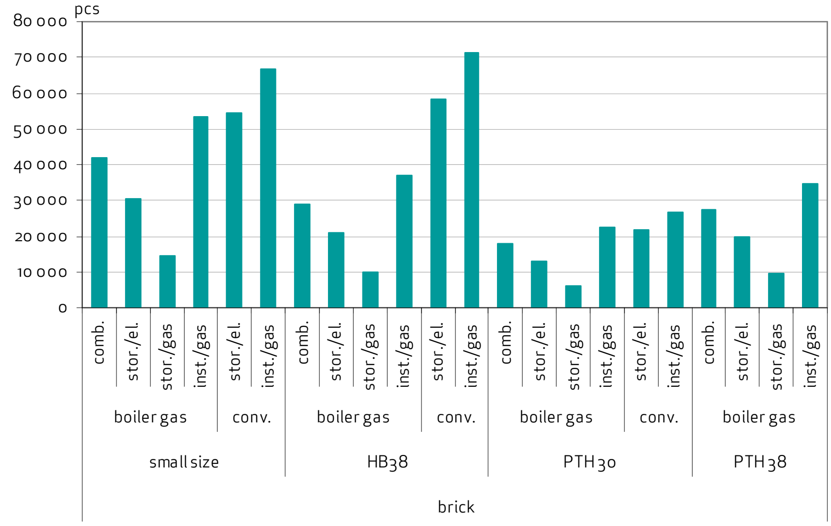
The diagrams hereunder show the breakdown of the household stock formulated this way according to the various types of residential buildings.

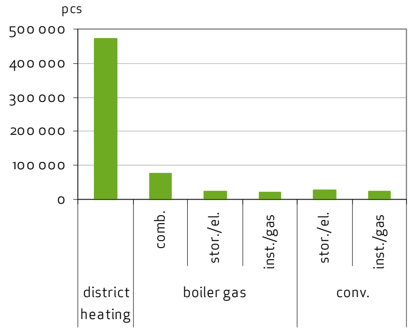
14. Residential building stock – family houses



[7] www.ksh.hu, Stadat system

15. Residential building stock – non-panel apartment blocks





16. Residential building stock – panel blocks of flat

Key:

st.:	stove (firewood)	**stor./gas:**	storage boiler/gas
boil. fw.:	boiler/firewood	**inst./gas:**	instantaneous water heater/gas
conv.:	convector	**comb.:**	combined heating and water heting system
stor./el.:	storage boiler/electricity		

As it can be seen in the diagrams, there are 74 different types of residential buildings or households specified. At all types two further subgroups were made according to whether exterior insulation and the replacement of windows have taken place or not: at the calculation of the energy consumption and of the energy saving potential those who have effected these investments were treated separately. (It is to be noted that this model is far more detailed and accurate than it is usual in studies of a similar subject in Hungary: they generally distinguish only 5-6 types of buildings.)

It is noted here, that the typology set up specified the frameworks of the calculations to be made. The low number of samples in the categories would not have allowed for finding correlations and draw conclusions within or among the categories (mean values, pivot tables, etc.), therefore this detailed system of categories was not used for such purposes. Mean values were always calculated from the items of a category of a higher number of samples: e.g. at the calculation of the average floorspace of a flat only the classification according to building materials was applied (brick, loam, gas silicate family houses and brick, panel blocks of flats), and calculations were made with these typical values when the energy consumption of the various flat types was investigated.

In the calculations no significant changes are expected in the existing household stock for the next two decades. (The low flat building and elimination rates are to be referred to here again.) However, unexpected changes may occur in flat sales and real estate trends, though the model would probably not be improved by making any presumptions as regards these issues. Due to these reasons, the current breakdown of the existing residential building stock is considered as constant for the forthcoming two decades.

2 Parameters influencing energy consumption

The typical energy consumption of the building types specified in the residential building model was calculated with the WinWatt software, and was based on the rates and calculation means specified in the 7/2006 decree of the State Minister.

As a first step, the typical size of the various building types had to be determined (floorspace and headroom), which could be concluded from survey data. Data, at the same time, do not provide other sizes of the building; when calculating the outside surface of the flat/house certain presumptions had to be made.

Obviously (as also shown by survey data), most flats in the blocks of apartments are „middle" ones, namely, they are to a certain extent surrounded by neighbouring flats (they are not situated at the sides, top or bottom of a building). This is important because flats on the side have a typically higher energy consumption and they usually fall into a lower energy efficiency category. Calculations in this study were made on flats in the middle, assuming two external walls.

At family houses no floors built on top were considered. Though newly built houses typically have more than one storey, older buildings do not, and the latter ones are predominant in Hungary – that is why the calculations were made on family houses with one strorey.

Starting parameters are listed in the table hereunder:

II. Sizes of flats

	Floorspace	Walls lengths		Headroom
	m²	m*m		m
Family houses				
brick	104	14,4	7,2	2,7
loam	78	13	6	2,6
gas silicate	103	14,4	7,2	2,7
Apartment blocks				
brick	68	9	7,5	3*
panel	55	8,5	6	2,6

*3,4 in case of the oldest buildings constructed of small-size brick.

For heating systems , in the case of an individual heating system with boiler the assumed boiler capacity was 24 kW and 12 kW at family houses and apartment blocks, respectively, while in the case of a central boiler for apartment blocks the capactiy was set at 1.2 MW. At district heating a single pipeline, centrally controlled system was taken as basic version.

Though survey data do not provide information on the number of windows, it could be estimated on the basis of room numbers and external wall numbers. Also presumptions were made as regards windows sizes: the most typical windows were assigned to the various types of real estates.

III. Parameters of doors and windows

	Number of windows	Size of windows
	pcs	cm*cm
Family houses		
Window	4	90*120
Window	2	60*60
Window	4	150*120
Balcony door	1	100*240
Entrance door	1	100*210
Apartment blocks		
Window	3	150*120
Entrance door	1	100*210

The typical thickness and the order of layers of the walls are contained in the table hereunder:

IV. Walls

Construction material	Construction layers
Size 50 clay brick	Clay plaster+loam +clay plaster
Size 30 gas silicate	Lime plaster+gas silicate+lime plaster
Brick, small size 50	Lime plaster+solid clay brick wall +lime plaster
B30 brick	Lime plaster+B30 brick wall + lime plaster
PTH 30 brick	Lime plaster+Porotherm 30 N+F M100 mortar+lime plaster
PTH 38 brick	Lime plaster+Porotherm 38 N+F M100 mortar+lime plaster
HB 38 brick	Lime plaster+multiporous brick wall +lime plaster
Concrete panel	Steel concrete+polystyrene foam+steel concrete

At each type of building the indoor temperature was set at 20 °C.

3 Results

The energy efficiency calculations were made on all the 74 types of buildings specified in the residential building model. Results show that each type of building has rather unfavourable energy efficiency attributes in its original status, that is, without an exterior insulation, the replacement of the windows and with an old heating system.

In the case of family houses, depending on the construction material or the building engineering systems, mainly the F-G energy efficiency ratings were typical. This means that the primary energy consumption of the family houses is basically around 400-500 kWh/m² year. This is a fairly high value. (For comparison: at houses considered as low energy buildings this value is about 40-50 kWh/m² year). The least favourable is the energy efficiency of walls built of small size 50 and B30 bricks, and within this category the highest, in each case, is the energy consumption of flats with electric hot water generation devices.

The primary energy consumption of apartment blocks built of bricks is more favourable: again, depending on the type of the brick and the building engineering , the consumption data received were about 200-300 kWh/m² year. The energy efficiency rating cannot be exactly specified in this case because it largely depends on the surface-volume ratio, and no data was available on the entire building blocks. Pilot calculations, however indicated that in the case of detached buildings (A/V=0,58) typically F, while in the case of building blocks built as terraced houses (e.g. in old apartment houses areas) maily G rating was received by the flats. The least favourable energy efficiency was characteristic for apartment blocks built of small size bricks, that is, the oldest buildings.

Buildings constructed of prefabricated panels have a relatively favourable energy consumption in their original status; this is around 200 kWh/m² year. Panel buildings, as compared to the other building types, shows relatively good values, but it is to be noted again that theoretical values may differ from reality. In the case of apartment blocks built of bricks, the latest ones built of PTH38 bricks have similar rates.

The table below presents the parameters of the different types of buildings without any energy efficiency measures. Different types of brick have different U-rates, as it is indicated bythe range of the coefficient. In case of energy consumption the variance within one building type is caused by the different heating and hot water generation systems.

V. Energy consumption – initial state

	heat transfer coefficient W/m²K	primary energy consumption kWh/m²
family houses		
brick	0,46 - 1,18	397 - 546
gas silicate	0,83	394 - 458
loam	0,96	360 - 441
apartment houses		
brick	0,46 - 1,18	213 - 344
panel*	0,3	190 - 238

** According to the measurements already mentioned before, panel buildings often have a U –rate of around 0,9 W/m²K, increasing the primary energy consumption by ca. 15 % per m².*

The typical energy consumption of the various flat types was first multiplied by the floorspace of the flats, then projected to the entire Hungarian household stock, according to the following formula:

$PE_{residential}=\Sigma\ PE_{base,\,i} * N_i * T_i$

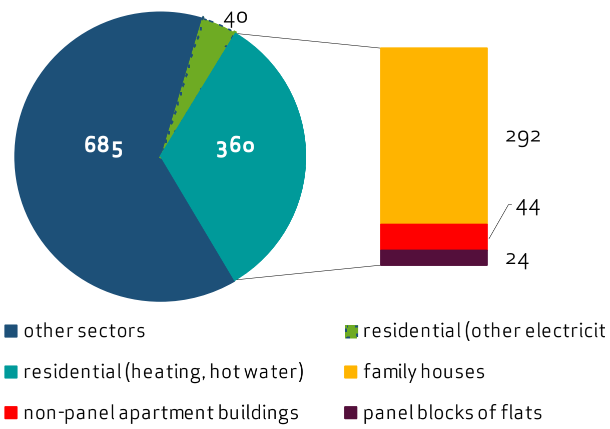
where:

$PE_{residential}$: primary energy consumption of all residential buildings at national level
$PE_{base,\,i}$: initial primary energy consumption per 1 square meter of the i reference building
T_i : floorspace of the i reference building
N_i : number of households living in the i reference building.

According to this calculation 360 PJ was received: this is the annual primary energy consumption of Hungarian buildings used for heating and hot water generation. This amount of energy accounts for 33% of the total annual Hungarian primary energy consumption[8].

[8] 1058 PJ, source: Energy Centre

17. The distribution of the Hungarian primary energy consumption among the sectors (PJ)



The heating and hot water generation in Hungarian residential buildings is calculated to account for a carbon-dioxide emission of more than 13 million tons. This amounts to about 24% of the total Hungarian CO_2-emission.

We wanted to compare the results received with the official statistics, but no exact data was available on the primary energy consumption of residential buildings. The respective data found are as follows:

VI. Statistics of residential energy consumption

	PJ	year	source
Final energy consumption / residential / without traffic	233	2008	Eurostat
Primary energy consumption / residential / with traffic (?)	383	2009	Energy Centre [9]
Final energy consumption / residential / without traffic	218	2007	Energy Centre [10]

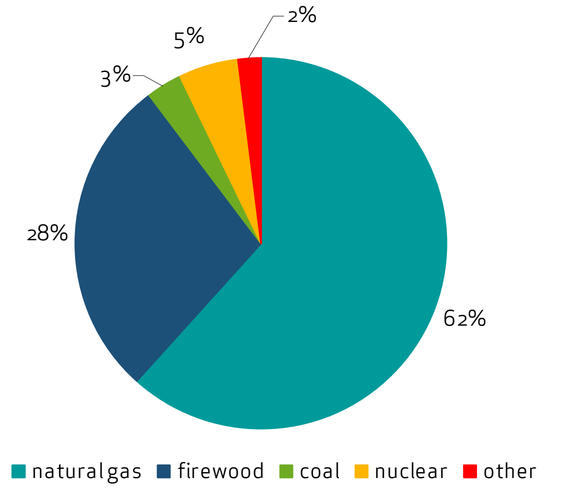
The final energy consumption – according to the 1990-2008 Eurostat time series – tends to be about 60-68% of the primary energy consumption. If the year 2008 Eurostat final consumption is divided by this ratio, a primary energy consumption between 340 and 390 PJ is received. It shows that our results correspond well to statistical data.

It is to be noted, however, that our results concern the primary energy consumption of heating and hot water generation, and does not include the energy consumption of other electric devices. According to statistics[11] the annual electricity consumption of households come to 38 PJ, and its primary energy consumption is about 90 PJ as calculated with the conversion factor specified in the State Minister decree. At the same time, the majority of this (about 50 PJ according to calculations) is already included in the 360 PJ calculated in the survey, due to hot water genearation.

Energiaklub believes that the results hereabove justify the bottom-up model, which means that the energy consumption of Hungarian residential buildings could be modelled by the building typology of the survey and the technical calculations made on the basis thereof, with close approximation.

The diagram hereunder shows the types and volumes of primary energy sources used for the heating and hot water generation of residential buildings.:

18. The primary energy consumption of residential buildings used for heating and hot water generation (360 PJ) by energy sources



It can be seen that the biggest part is represented by natural gas: this, on the one hand consists of the direct natural gas consumption of the households, on the other hand of the amount of natural gas burnt in power plants for the generation of electricity and heat used by the households. The firewood consumption of households is also significant.

[9] Energy consumption 2000-2009 (pdf)
[10] Energy map
[11] Electricity Statistics, Hungarian Energy Office, 2008

ENERGY SAVING POTENTIAL IN RESIDENTIAL BUILDINGS

1 Presumptions

In our calculations the external insulation of the building envelope (facade and slab), the replacement of windows, and the modernization of heating systems with more effective technologies were considered as investments improving energy efficiency.

As regards facade insulation the criteria was that the heat transfer coefficient of the wall reach a better rate than the currently set limit (0,45 W/m²K) because the standards in Western Europe are stricter and aggravation is expectable also in Hungary. For this reason, complex structures were specified in the research in a way that heat transfer coefficient be below 0,35 W/m²K.

This criterion was met by the structures as follows:

VII. Characteristics of insulated wall structures

Construction material	Thickness of insulation	Type of insulation
Small size brick	12 cm	Polystyrene foam
B30 brick	10 cm	Polystyrene foam
Gas silicate	10 cm	Polystyrene foam
HB38 brick	10 cm	Polystyrene foam
PTH30 brick	10 cm	Polystyrene foam
PTH 38 brick	5 cm*	Polystyrene foam
Concrete panel	5 cm	Polystyrene foam
Loam	10 cm	Polystyrene foam

* *Again, we refer to the contradiction between theoretical values and real performance of concrete panel buildings – if we take the data of the measurements mentioned before instead of those fixed by the state decree, an insulation thicker than 5 cm is necessary for achieving the criteria defined above.*

Basic calculations were conducted with not only polystyrene but also with rock wool, but due to its more common incidence and more favourable price, calculations were continued with polystyrene. Obviously, there are aspects that make the household (and also the energy expert) prefer other types of insulation material against polystyrene foam at certain buildings. Circumspection is necessary at for example, mud wall buildings, where vapour diffusion aspects are to be strictly observed so that the moisture may not exceed the officially set limits.

Possible differences between theoretical and real structure attributes are also to be noted in the case of concrete panel, where insulation material thicker than 5 centimetres may be necessary in practice. However, the methods specified in the State Minister decree, were not modified in the calculations.

The question arises in connection with panel technology whether it is worth at all to invest in buildings built this way or whether they should rather be pulled down. A common argument is that concrete panel buildings were designed for 30-40 years, which means that most of them are approaching the end of their lifetime. The opinion of the profession is split in this issue also at an international level, and this question cannot be answered within the framework of this study, as our research was not focusing on this issue. Nevertheless, the finally accepted presumption was that the lifetime of steel concrete applied in panel technology may reach even 100 years. What may primarily become obsolete and shrink is the polystyrene foam inserted between the layers. We considered this problem as improvable and remediable by means of a prudent insulation of the facades, therefore we included the renovation of the panel buildings in the potential calculations.

The criterion in the study for the insulation of slabs was that it may not be beyond the currently official limit of heat transfer coefficient (0,3 W/m²K). This requirement corresponds to the European practice, and no Hungarian aggravation is expectable in this issue, either. In the case of wooden slabs the 10 cm thick fibreglass while at steel concrete slabs the 15 cm fibreglass comply with this requirement, therefore calculations were based on these values.

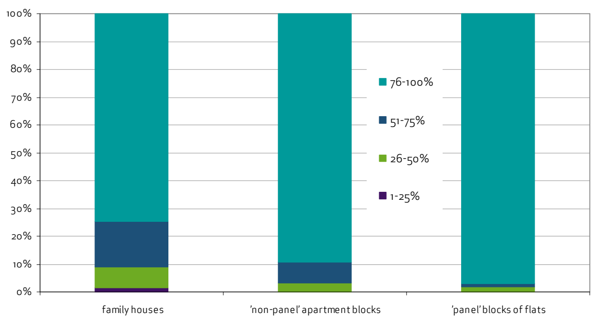
As regards doors and windows, we considered the ones with a heat transfer coefficient of U=1,2 W/m²K as energy efficient therefore the calculations concerning the replacement of doors and windows were done with this rate.

From an energy efficiency aspect, insulation together with the replacement of doors and windows may be considered as effective, though in those cases when one of the investments has already been performed, doing the other one separately is also reasonable – therefore calculations were also made on the energy saving potential of investments carried out at different times.

The modernization of heating systems may be considered as effective if the building envelope has been made more effective, this aspect was also considered in survey calculations. It is to be noted, however, that in the case of the oldest buildings having a facade that may not be altered due to the protection of historic buildings or cityscape aspects, modernization of the heating system is the only possibility for improving the building's efficiency.

No switch over to another energy source was considered at the heating systems because, as it has been previously indicated – this study strictly concentrates on energy efficiency. This way, at firewood-burning systems firewood-burning and at gas-burning systems gas-burning was considered, only the existing, inefficient systems were changed for more efficient technology: in the case of firewood-based stoves and boiler systems firewood gassing boilers (with electronic thermometer) and at gas heating condensing boilers (with electronic thermoregulator) were considered. It is to be noted here that such an investment may incur even an increased energy consumption because several households are heating only a part of the flat, in certain rooms and this may change if the entire heating system is built up.

19. The breakdown of households living in different types of buildings by the ratio of the heated area (as a percentage of the total floorspace)



Disconnection from the district heating was not considered in the study. Though, according to theory and the practice in a number of West European countries district heating is more effective than individual heating or the gas-based central heating for the house, there is yet not enough Hungarian data available on whether the district heating systems built 30 years ago on the average can produce in practice the results in theory. At the same time, no reliable calculations are available either on the opposite, therefore the idea of separation from district heating was not considered in the study. It is noted, however, that according to survey data, 5% of the households connected to district heating have left the system and a further 9% are also planning to do so.

In calculations within the study, in the case of households with district heating the modernization of the heating system means the conversion into a two-pipeline one and the mounting of thermostatic valves.

2 Technical / theoretical potential

At the calculation of the potential the new, reduced energy consumption rates were calculated after the various investments on each kind of building, and the main conclusions were as follows:

In the case of family houses, at buildings without insulation and built with old doors and windows the insulation and replacement of the doors and windows usually resulted in a primary energy saving of 50-60%. By means of such modernizations most family houses get in the B-C energy efficiency category, that is, they improve by even 3-4 categories.

In cases where doors and windows have already been replaced, insulation results in an energy saving of 30% on the average, and where insulation have been implemented, the replacement of doors and windows similarly generates an energy saving of 30%. It is to be noted that the more efficient windows (U=1.6 W^2/K) is not worth changing for windows with a U of about 1.2 because only some percentage of energy saving can be reached.

In the case of apartment blocks built of bricks an energy saving of a far lower ratio is reached, 15-25% on the average (depending on the wall and the building engineering systems), while at panel blocks of flats it is even less: about 10-15%. These buildings typically get into a 1-2 category higher rating as compared to their original rating. It is to be noted here again that the most difficult in the study was to model the sizes and floorspace of the apartment blocks therefore the improvement in practice may be bigger that as calculated, though calculations idicate well the scale of improvements.

The modernization of the heating systems after insulation has been performed and the windows are replaced does not result in an overly big primary energy saving at family houses, only 4-5% on the average. The rate of decrease may be higher if these are combined with renewables – calculations, however, did not cover this.

In the cases of apartment blocks the amount of primary energy savable is of higher ratio if heating is updated: it may reach even 25-30% in apartment blocks, except for blocks of flats with district heating, where only 5% can be reached at primary energy saving.

The reduced level of energy consumption after refurbishment of buildings is summarized in the table below:

VIII. Energy consumption – after energy efficiency measures

	primary energy consumption	
	after external insulation and replacement of windows	after external insulation, replacement of windows and modernization of the heating system
	kWh/m²	kWh/m²
family houses		
brick	170 - 270	160 - 210
gas silicate	180 - 210	170 - 200
loam	190 - 220	180 - 210
apartment blocks		
brick	190 - 250	130 - 150
panel	170 - 210	130 - 140

To summarize the amount of primary energy saving that can be realized by means of various investments in the types of buildings, and to extend them on the entire Hungarian household stock, we used the following formula:

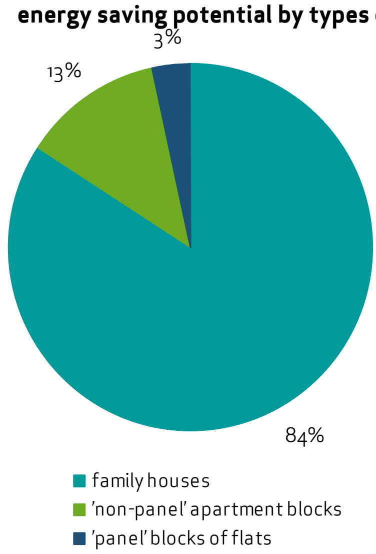
$$P=\Sigma\,(PE_{base,\,i} - PE_{new,\,i})\,*\,N_i\,*\,T_i$$

where:

P: energy efficiency potential
$PE_{base,\,i}$: initial primary energy consumption per 1 square meter of the i reference building
$PE_{new,\,i}$: primary energy consumption per 1 square meter of the i reference building after external insulation, replacement of windows and modernization of the heating system
T_i : floorspace of the i reference building
N_i : number of households living in the i reference building.

According to our calculations the total Hungarian primary energy consumption could be decreased by 152 PJ if the above mentioned energy saving measures in residential buildings were fully exploited. This is called technological or theoretical energy efficiency potential. The theoretical-technological potential is distributed between the types of buildings as follows:

20. The breakdown of the technological-theoretical energy saving potential by types of buildings



At this point we have to touch upon the issue of panel buildings again: as we already indicated, the calculations were carried out according to the relevant state decree, providing the result of 5 PJ savable by energy efficiency investments in panel buildings. Nevertheless, we also investigated the potential using the results of the mesurements mentioned before – this way, we got 7 PJ saving potential. It can be seen, that even if the real performance lags behind theoretical values in some buildings, it does not significantly affect the energy efficiency potential of panel buildings at national level.

By means of the exploitation of the technological-theoretical potential hereabove, a CO_2-emission of more than 6 million tons could be avoided in Hungary.

3 Economic potential

To study what ratio of the technologically available energy saving potential is economically exploitable, we had to choose between two approaches. The often applied simplified calculation of the rate of return simply compare the invested amount with the volume of the energy costs savable during the lifetime of the technology or the equipment. The other approach, mainly applied in business analyses accounts the opportunity cost on non-realized interest also as a cost, that – to put it briefly – estimates which solution is more profitable for the household: if it invests its money and thus saves energy cost or if it invests its money in another way (e.g. bank deposit, life insurance, shares, ets.).

It is to be noted, that we have reservations about both methods if it is about the refurbishment of residential buildings. The reason for this is that such retail investments cannot be considered as purely financial, investment transactions. A household may have several reasons why it does not contemplate either opportunity cost on profit or the savable energy costs before the investment. Such a typical reason may be e.g. that the obsolete system needs to be replaced due to safety reasons (e.g. a stove, boiler), or that it significantly improves the comfort of the tenants, and the financial offset or profit is hard to be expressed in money. Furthermore, most households have no idea or information about the future prospects of energy prices or money markets.

Having contemplated all these above we decided on the calculation with a financial approach, mainly because this sets stricter business conditions, and we would have preferred to give a more conservative estimation on the volume of profitable investments.

Presumptions

Investment costs

Investment costs were estimated from data surveyed in the study, where assistance was provided by the experiences of the energy expert in the research study. In the case of the apartment block investments, mainly at wall insulation and the modernization of heating systems the database of Non-profit limited liability company for Quality Control and Innovation in Building (containing the main values of the Panel Refurbishment Program) was also taken as basis. Based on those hereabove the volume of the average investment costs was specified as follows (gross values, wages included):

IX. Investment costs (HUF)

Family houses		Apartment blocks	
Replacement of windows	970.000	**Replacement of windows**	610.000
External insulation		**External insulation**	650.000
Brick:			
small size	590.000		
B30/HB38/PTH30	520.000		
PTH 38	410.000		
Gas silicate	510.000		
Loam	410.000		
Modernization of heating		**Modernization of heating**	
Only replacement of boiler :		*Only replacement of boiler:*	
Condensing boiler	350.000	Condensing boiler	350.000
Total heating system:		*Total heating system:*	
Condensing boiler	1.300.000	Condensing boiler	1.400.000
Wood gassing boiler	1.500.000		

In the case of the replacement of windows, replacement of both doors and windows was considered, and in the case of windows with an (insulated) shutter. Other means of shading, due to the lack of data on mounting and orientation were not calculated, but we believe that for a better summer heat protection of the buildings more attention should be paid to shading technologies.

Heat insulation data are varying at family houses due to the varying floor spaces and floor or insulation thickness.

At the modernization of heating systems stack lining was also considered becasuse in most cases this is necessary and incurs high costs.

Lifetime

The average (minimum) lifetime of the materials built in at building modernizations was set as follows:

X. Average lifetime of products and technologies

Insulation materials	25 years
Doors and windows	25 years
Heating and hot water generation systems	20 years

It is noted that in the case of doors and windows and heating systems the rates do not mean the lifetimes in a strict sense because the case is not that the system breaks down and becomes useless, but that as a result of technological development they most probably become obsolete as compared to the new equipment.

Energy prices

The current average retail price of natural gas and electricity was taken from the price table issued by the Hungarian Energy Office. As regards the period until 2020 a forecast was prepared by GKI Energy Research and Consulting Ltd.[12]

As regards the average price of district heating Energiaklub conducted a survey in 2010: energy rates in 30 different towns were collected, and an averge was calculated therefrom. As regards the future, indices used in natural gas price forecasts were applied for calculation as at most settlements district heating prices are to a certain extent lagging behind in time natural gas prices.

The source of the average price of firewood and of the forecast until 2020 are those data in the model

[12] According to the agreement the index line may not be published.

calcuations done for the Hungarian Energy Office[13] that refer to the population. It is to be noted here that firewood consumption, both as regards quantities and costs, is more difficult to determine than that of the natural gas, electricity or district heating, mainly due to territorial differences, its quality and heat value and because it is not purchased on the market.

The lifetime of products and technologies applied at building modernizations, however, reaches beyond 2020: for the period afterwards the average rates of price changes before 2020 were taken as no better forecast was available.

It is to be underlined that energy prices have a significant effect on profitability and rate of return aspects: the lower are energy prices the less do they inspire households to modernize. This way, even for the even high energy consumption buildings it is worth rather being unthrifty and paying bills than investing in energy efficiency.

Interest rates
According to the investment barometer based on the survey of Gfk Hungária Group[14] three-fourth of the Hungarian households have no savings at all; and out of those who have, two-thirds have savings in the form of bank deposits. Therefore in the case of all banks where such an option is offered for retail clients, interest rates of bank deposits for a year or more were collected, and within these the constructions are exempt from tax on interest. In February 2011the mean value was about 6%, therefore calculations were based on this both for the present and for the future. This counts a fairly high value and obviously, nothing guarantees that interest rates remain this high. However, no reliable forecast is available for decades in advance, therefore 6% was kept, just for the very reason that the already relatively strict business criteria be rendered even more severe.

Results

Calculations were made by bearing in mind those hereabove and based on the model previously introduced, according to the following formulas:

$FE_{electricity}$= PE*0,75+(PE*0,25)/2,5
FE_{gas}= PE
FE_{DH}= PE/1,2

where
$FE_{electricity}$: final energy consumption at households using electricity for hot water generation
FE_{gas}: final energy consumption at households using gas for hot water generation
FE_{DH}: final energy consumption at households with district heating.

$S_a=(FE_{base,i}-FE_{new,i}) * p; S_{sum}= (FE_{base,i}-FE_{new,i}) * \Sigma_n p*i$

where:
S_a: energy costs saved per year
S_{sum}: energy costs saved during the lifetime of the technology
p: price of the given type of energy in 2010
n: lifetime of the technology, product
i: growth of energy prices per year.

$C=C_i + \Sigma_n C_i *k$

where:
C: whole costs of the invesment during the lifetime of the technology
C_i : investment costs
k: interest rate of bank deposit.

Results show that in the case of family houses both external insulation in itself and both together with the replacement of doors and windows count profitable investment at all building types. To put it in another way: it is worth for households rather to invest in insulation and the replacement of doors and windows than into bank deposits. At the same time, the modernization of heating proved to be profitable only at a few types of building and builing engineering.

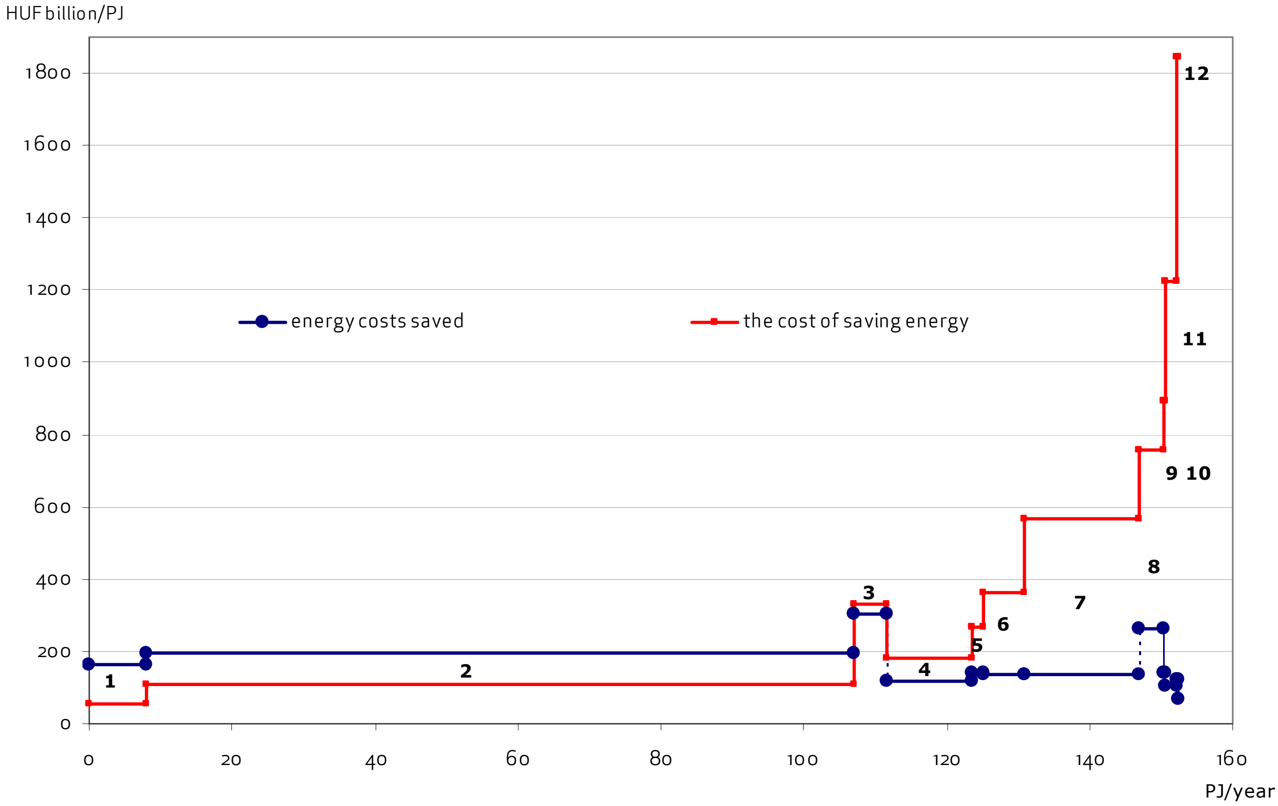
With apartment blocks this is just the contrary: heating reconstructions produced somewhat better results, though only a few types of building could comply with the profitability standards set by Energiaklub. It is to be noted that the distortion of the price of district heating (the 5% VAT) also has a (negative) distorting effect on profitability, the rate of return.

On the whole, the volume of primary energy savings attainable by means of investments rated as profitable can be still considered as remarkable: it is 117 PJ at national level, which is more than three-quarters of the theoretical/technical potential.

The profit and cost of the national economy related to energy efficiency investments as regards the total theoretical-technological potential is as shown in the diagram hereabove:

[13] The annual forecasts for years 2010-2020 of the demand, supply and price of biomass as power plant fuel. Report, essrg – KPMG, 2010
[14] Investment barometer study,Gfk Hungária Market Research Institute, July 2009

21. Energy saving costs of the Hungarian residential building stock



Key:

1. External insulation on family houses (where doors and windows have been replaced)
2. Joint external insulation and the replacement of doors and windows at family houses
3. Replacement of doors and windows at family houses (insulation have been implemented)
4. Modernization of heating in non-panel apartment blocks
5. External insulation on non-panel apartment blocks (where doors and windows have been replaced)
6. Joint external insulation and the replacement of doors and windows in non-panel apartment blocks
7. Modernization of heating in family houses
8. Modernization of heating in panel apartment blocks
9. Replacement of doors and windows in non-panel apartment blocks (where insulation is already implemented)
10. Replacement of doors and windows in panel apartment blocks (where insulation is already implemented)
11. Joint external insulation and the replacement of doors and windows in panel apartment blocks
12. External insulation on panel apartment blocks (where doors and windows have already been replaced)

In the diagram the blue curve indicates the energy costs savable by means of the investment, while the red one the total costs of investments necessary for energy savings. Where the red curve is below the blue one, the investment can be considered as profitable (according to the criteria of Energiaklub). It is clearly visible that the insulation and the insulation and replacement of doors and windows at family houses generate higher profit than costs as projected on their entire lifetime, that is, they may be considered as negative cost investments.

The exploitation of the total technological-theoretical potential would generate investments worth of almost HUF 7,400 billion (ca. EUR 27 billion) as calculated at current prices, and for this aim 330 thousand households would have to perform one or another building reconstruction annually until 2020. If the state intended to take part in its financing, that would annually cost HUF 220 billion (EUR 0,8 billion) with a minimal state subsidy ratio of 30%.

If only the economic potential is considered, that would mean a total investment of about HUF 2,400 billion (ca. EUR 9 billion) at national level, to which investments primarily focusing on heat insulation and the replacement of doors and windows should be performed in 160 thousand household on the average annually, until 2020. This, with a state subsidy level of 30% would cost HUF 85 billion (EUR 0,3 billion) annaually for the state.

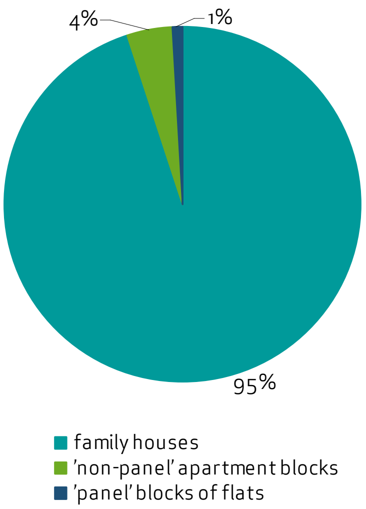
It is to be added here that the volume of the energy saving potential is further decreased by the fact that at a certain percentage of the existing buildings, due to the effective status of the buildings and/or the low value of the house, investment in the modernization of the building is not worth the effort.

This can be true primarily on the oldest brick and loam buildings, therefore, based on their number, the ratio of buildings where it is not worth modernizing is estimated around 15-20% of the residential building stock. It has to be added here that data and analysis on this particular issue were not available.

It is also noted that despite those explained hereabove a lot of such cases or individual situations may arise that a household finally decides to modernize its low value real estate because they wish to live there for the rest of their lives, and no new or significantly better house is available in the area, or they do not wish to build a house or cannot do so, etc.

The breakdown of the economic saving potential among building types is as follows:

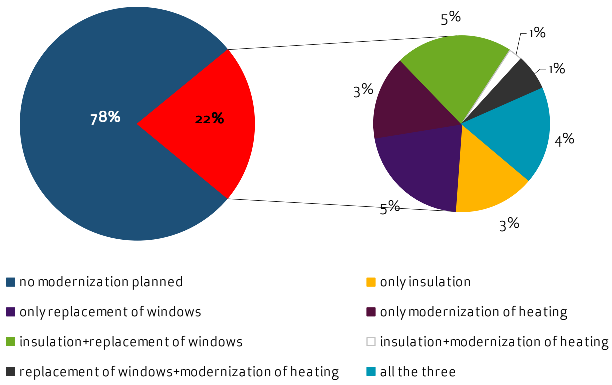
22. The breakdown of the economic potential among the types of houses



4 Practical potential

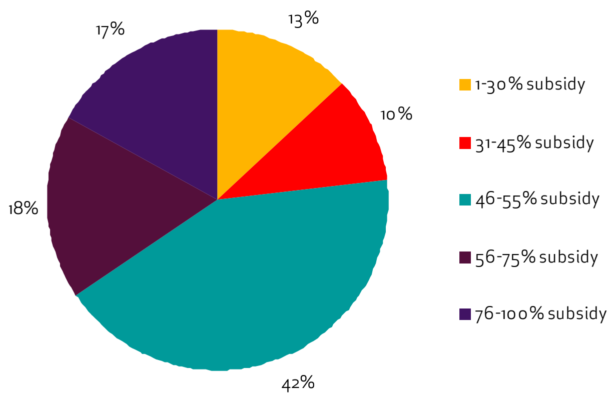
Survey data show that only 16% of the households are planning to insulate their flats or houses, 18% are planning to replace the doors and windows and only 10% are planning to modernize the heating system. Overlap amoung them, however, is significant: altogether 22% of all the households are thinking about some kind of a modernization. This means altogether 836,000 households as projected on the total Hungarian household stock.

23. The breakdown of households planning an energy efficiency modernization by the type of investment



According to the survey data out of the households that would like to or are planning to undertake an energy efficiency improving investment 60% would start doing so if they received a state subsidy. This means that out of the 836,000 households wishing to invest about 500 thousand would by all means need a state subsidy.

24. The expected ratio of sate subsidy



Households are expecting a 55% state subsidy intensity on the averege from the state. Out of the households wishing to invest in energy efficiency but only with a state subsidy, 13% would be willing to implement the investment with a subsidy intensity of 30% or even less. However, significant, that is almost 35% is the ratio of those who would expect a state subsidy intensity of 55% or more.

If a state subsidy ratio of more than 45% is considered as unrealistically high, the circle of potential investors further narrows, and together with those who invest by all means, their number dwindles to 450 thousand households. This would mean the modernization of annually 45 thousand households until 2020.

Almost 80% of the households that are planning an investment would not borrow a bank loan on investment. Those who would borrow, could undertake a monthly installment of HUF 18 thousand (ca. EUR 70), on the average. Data of the survey show that 32% of the households already have a loan on flat purchase or modernization or a loan on commodity or vehicle. The average monthly instalment of the earlier ones is about HUF 40 thousand (ca. EUR 150), while of the latter ones it was about HUF 30 thousand (EUR 110) in the 2010 data survey. The monthly fixed costs of the households with a debt service obligation (that is, amortization and energy costs together) reach 40% of the total monthly net income of the household.

Data show that there is no significant correlation between the income status of the households and their intention to modernize. However, respondents in the survey were not asked about the savings of the households therefore we refer here to the Gfk survey, which indicates that 75% of the Hungarian households have no savings whatsoever. (In West European countries this is around 30%.) According to the data of the Hungarian Financial Supervisory Authority, the total of household bank deposits is HUF 186 billion (EUR 0,7 billion), and if this is calculated with 25% of the households, it means savings of HUF 186,000 (EUR 690) on the average at bank deposits. This means that those who have savings do not have too much money saved (at least at banks). Gfk data show that out of those who have savings, only 1-2% have savings more than EUR 5,000 euros (about HUF 1.3 million).

This suggests that the majority of Hungarian households cannot finance major investments even if the investment later proved profitable. This implicitly minimizes the number of potential investments, which clearly indicates that state subsidies are necessary in urging the refurbishment of the residential building stock with typically bad energy performance.

THE EFFECT OF ENERGY SAVINGS ON THE HUNGARIAN PRIMARY ENERGY CONSUMPTION

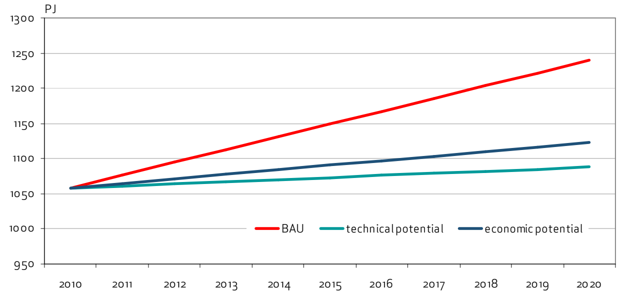
There are a number of calculations and concepts for the forecast of the Hungarian primary energy consumption in the future.:

An earlier estimation of GKI Energy Research Ltd. predicts an approximate primary energy consumption of 1240 PJ for 2020. The calculations of the Regional Centre for Energy Policy Research (REKK) for 2009[15] predict a far higher value of 1,400 PJ for 2020, with an annual 4% growth of the GDP. This would mean, based on the 2009 data, an average annual growth of 2%. Moreover, as REKK calculated that the Hungarian primary energy consumption was going to reach a long-time low with 901 PJ in 2010, according to REKK's estimation energy consumption would grow rapidly between 2010 and 2020, by an annual average growth rate of 5.5%. As the document does not give reassuring explanation for the unprecedented growth, the forecast is not considered realistic by Energiaklub. (It is to be added that the forecast for 2010 did not hold out, as according to data[16] the Hungarian primary energy consumption in 2010 was 1058 PJ.) In a position paper prepared by Energiaklub in 2007, based on the growth path in the past, a primary energy consumption of about 1240 PJ was estimated for 2020.[17] Bearing in mind the GKI's forecast as well, Energiaklub believes that 1240 PJ remains more likely as compared with 1400 PJ.

If this growth path is taken, and assuming a steady rate of energy efficiency investments until 2020, the Hungarian primary energy consumption in the next decade would change according to the diagram hereunder. Calculations only consider the decrease as attainable in residential buildings, and they do not include the volume of energy savable in other sectors (public buildings, traffic, industry, etc.).

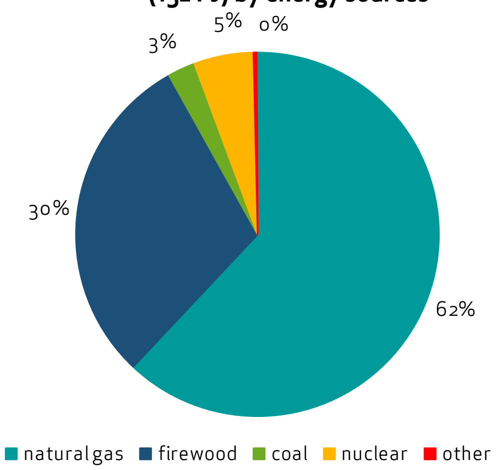
[15] The preparation of the Hungarian end-user energy consumption and electricity price forecasts until 2020, REKK, November 2009
[16] The processing of the January-July, 2010 energy supply and consumption based on preliminary data, Energy Centre, 2010
[17] Energia Klub's proposal to the elaboration of the National Energy Efficiency Action Plan, Energia Klub, August 2007

25. The trend of Hungarian primary energy consumption based on the regular business practices and the scenario of the energy saving potential



Out of the theoretically- technologically savable energy, about 30% would be accountable to firewood consumption, and 62% to natural gas – on the one hand due to the direct gas consumption of the households (85 PJ), and on the other hand as a result of the natural gas used in electricitiy production. This latter one is related to the hot water generation of households, as the use of electric boilers is significant in residential buildings. According to the model and the calculations, this incurs a natural gas consumption of about 8 PJ. The calculations were based on the breakdown of the energy sources currently used in Hungarian power generation[18], which may somewhat change with the spreading of renewables in the next decade, but the order of magnitude of energy sources is expected to remain the same.

26. The theoretical-technical energy saving potential (152 PJ) by energy sources



As Hungary gets hold of natural gas mainly form import, the 95 PJ saving of natural gas would release Hungary from a momentous import. (According to Eurostat data, the annual Hungarian import of natural gas is 390 PJ.)

[18] The source of data: Electric ityStatistics, Hungarian Energy Office, 2008

CLOSING THOUGHTS

The chapters hereabove explain what enormous opportunities are hiding in the energy efficiency refurbishment of the existing residential buildings. It was also introduced in the study in which domains can the largest and most economic energy savings be attained. Energiaklub believes that the data and calculations presented may give proper guidelines to the planning of state energy efficiency measures. However, as it was repeatedly referred to in the study, a number of dilemmas and questions to be decided arise as regards the energy saving opportunities of residential buildings, which need to be thoroughly contemplated by the state and a desirable direction has to be set.

Firstly, the state has to decide whether energy efficiency or profitability aspects are considered as primary, whether all investments resulting in energy saving be subsidized or the economic ones be preferred (or the contrary). If the latter one prevails, the state needs to specify its own profitability criteria – the approach applied in the study is only one from among the possible methods.

Social aspects also arise as probably mainly households with savings or assets can make use of investment subsidies. This obviously does not mean a problem as regards the energy saved, but may accelerate the trend that the poorest households lag more behind. It is to be noted here that the state can motivate people not only by investment subsidies – the exemplary role of the public sector and proper communication (e.g. prizes, launching competitions, etc.) can accelerate the refurbishment of the residential buildings as well.

Also an important issue is the effect of energy prices on the profitability of energy efficiency investments: it is important that the prices be a proper indication for the consumers and orientate them towards energy saving. Distorted prices, also including price subsidies also distort profitability aspects and do not motivate energy efficiency investments. Social aspects should not be managed by the energy prices but in social policy, while social policy have to bear in mind energy saving aspects, too.

It is to be noted that the issues of district heating pricing are becoming an ever more acute problem, which cannot be solved by building modernizations alone: it is about such a far-reaching problem, the roots of which need to be revealed and understood by the state before taking measures.

The issue of pulling down panel and other old (e.g. loam) buildings already mentioned in the study may also raise questions for the state, as about half a million households are concerned by this issue. In the case of such a mass of people possible demolitions may incur serious social consequences, difficulties and costs, which has to be considered before measures are taken. All these are closely related to housing policy.

The quality insurance of technological implementation cannot be postponed. The registered/qualified contractors and the list of products may be a good solution for that the granting system exclude bunglers and effectively ensure energy saving and the effective use of public funds.

It is noted here that the field of renewable energy potential of the residential buildings and the savings available by replacement of electric devices is also worth studied in detail. Studies similar to this one in public buildings and offices would be important to be made for that a complete picture be gained about the Hungarian building stock.

LIST OF CHARTS

LIST OF TABLES