Employment Impacts of a Large-Scale Deep Building Energy Retrofit Programme in Hungary

Executive Summary

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We apologise in advance if we forgot to include anyone in the list.

The 3CSEP Research Team

1 Executive summary

1.1 Background, aims and scope

In Hungary buildings are key to the climate challenge: they contribute approximately half of energy-related CO_2 emissions. This is partially caused by the inefficiency of the Hungarian building stock, which ranks among the top-ten EU27 countries in terms of specific dwelling energy consumption scaled to EU average climate (247 $kWh/m^2/year$ for the Hungarian average residential unit vs. 220 $kWh/m^2/year$ of the EU average in period 2000-2007). This sector has been also shown to have the highest cost-effective climate change mitigation potentials in Hungary.

If the energy efficiency of the Hungarian building stock is improved, not only can this reduce greenhouse gas emissions significantly, but it can also advance several other important social, political and economic policy agendas, including the improvement of energy security, social welfare, reduction of fuel poverty, new business opportunities, market values of real estate, as well as improved air and life quality and health. This has particular significance since, while Hungary is closer than most EU Member States to the fulfilment of its emission targets set under the European Union's burden sharing agreement, it faces important challenges in energy security (Hungary has one of the highest gas dependences of IEA member countries) and energy poverty (in Hungary, 80% of the population devote more than 10% of their net income to energy expenses – the often used definition for fuel poverty).

An especially important co-benefit of a programme aiming at a large-scale and deep renovation of the Hungarian building stock is the potential net employment growth, particularly as Hungary is the Member State with the second worst employment rate in the EU and the OECD. Little more than half of Hungary's working-age population has a declared job, and 4 out of 10 Hungarians aged 15-64 are out of the labour market (i.e. they do not have a job and are not looking for one). In such circumstances, the increase of the employment rate is a fundamental political priority, especially in the more disadvantaged population segments and regions.

The goal of the present research was to gauge the net employment impacts of a large-scale deep building energy-efficiency renovation programme in Hungary. The deep renovation of a massive amount of Hungarian buildings – beyond its other significant benefits such as reducing or eliminating fuel poverty and improving energy security – is expected to have a consistent impact on employment:

- Directly, by the creation of many new jobs in the construction industry;
- Indirectly, on all the sectors that supply materials and services to the construction industry itself;

- In addition, the savings caused by the reduction in energy consumption, plus the additional consumption fuelled by the wages of the additional jobs created, will increase the disposable income of the families; income that, when spent, will generate additional induced benefits to employment. These are referred to as *induced* effects.

These impacts are expected to be larger than the jobs lost in the energy supply sector as a result of reduced energy consumption. **Fig. 1-1** shows the chain of effects on employment of the proposed programme.

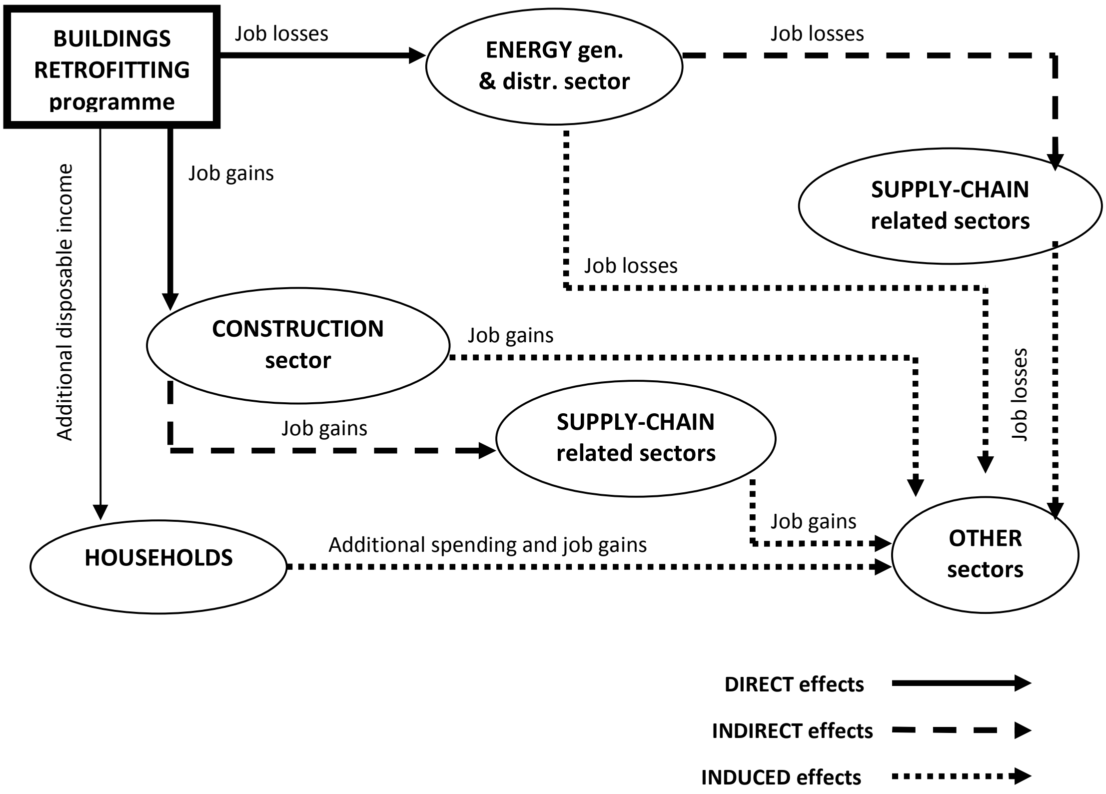

Fig. 1-1: Chain of effects on employment of the proposed intervention

This report has been produced in the framework of the European Climate Foundation (ECF) Energy Efficiency programme, in particular the "energy efficiency in buildings" strategic initiative pursued by the ECF.

1.2 Description of the renovation scenarios assessed in this study

Since the employment impacts (short- and long-term) are determined by the scale and schedule of the renovation programme, the study has investigated the impact of specific renovation scenarios. The scenarios depend mainly on the type or depth of retrofits included in the programme and the dynamic of renovation assumed. **Table 1-1** summarises the scenarios covered in this report.

Name	Scenario	Description
S-BASE	Baseline scenario	No intervention, business-as-usual renovation rate (1.3% of the total floor area), negligible improvement in energy efficiency
S-DEEP1	Deep retrofit with fast implementation rate	Deep retrofits, average renovation rate of around 20 million sqm (the equivalent of 250,000 dwellings, 5.7% of the total floor area) per year
S-DEEP2	Deep retrofit with medium implementation rate	Deep retrofits, average renovation rate of around 12 million sqm (the equivalent of 150,000 dwellings, 3.4% of the total floor area) per year
S-DEEP3	Deep retrofit with slow implementation rate	Deep retrofits, average renovation rate of around 8 million sqm (the equivalent of 100,000 dwellings, 2.3% of the total floor area) per year
S-SUB	Suboptimal retrofit with medium implementation rate	Suboptimal retrofits, average renovation rate of around 12 million sqm (the equivalent of 150,000 dwellings, 3.4% of the total floor area) per year

Table 1-1: Summary of the scenarios covered by the research

The study focused on existing residential and public sector buildings, as those are the two sectors where most policy intervention/public support is warranted and where the highest social and political benefits can be found. New buildings are outside the scope of the study.

The research emphasised scenarios that support "deep" retrofits, which bring the buildings as close to passive house standards (i.e. a consumption of 15 kWh/m^2/year for heating) as realistically and economically feasible, but examined other scenarios for comparative purposes, too. The reason for this choice is the very substantial potential lock-in effect resulting from suboptimal renovations, which would be far from realising the total potential of Hungary's buildings (e.g., it has been estimated that households could reduce up to 67% of their heating energy consumption by 2030) and would severely jeopardise the meeting of Hungary's ability to attain ambitious GHG emission reduction long-term targets by 2050. Therefore it is important to channel economic resources in catalysing a renovation scenario that keeps long-term climate (and social) interests in the foreground rather than cherry-picks in a short-term economic optimisation framework. However, the suboptimal renovation scenario, which involves lower gains in energy efficiency, has also been included in the study together with the deep retrofit programme as a reference to show the differences between the effects of the two types of programmes.

The Hungarian building stock. **Table 1-2** and **Table 1-3** summarize the characteristics of the Hungarian residential and public building stock, together with the assumptions of space heating energy requirements and the fraction of floor area heated before and after renovation in the present model.

Residential Building Stock	**Historical and Protected Buildings**	**Traditional Multi-Family Homes Late 19th Century and Inter War Years (<1960)**	**Multi-Family Homes Industrial technology (Panel Buildings) to 1992**	**Single Family Homes to 1992**	**Single Family Homes 1993 -2010**	**Multi-Family Homes 1993-2010**
Fraction of Total Building Stock	7%	1%	2%	76%	12%	0.44%
Space Heating Energy Requirements (kWh/m2/a)	207	207	230	300	144	121
Fraction of floor area heated before retrofit	70%	70%	95%	70%	75%	85%
After Renovation –S-BASE Scenario						
Space Heating Energy Requirements (kWh/m2/a)	186	186	207	270	130	109
Fraction of floor area heated	70%	70%	95%	70%	75%	85%
After Renovation - S-DEEP Scenario(s)						
Space Heating Energy Requirements (kWh/m2/a)	35	25	25	30	30	25
Fraction of floor area heated	90%	90%	90%	90%	90%	90%
After renovation - S-SUB Scenario						
Space Heating Energy Requirements (kWh/m2/a)	124	124	138	180	86	73
Fraction of floor area heated	70%	70%	95%	70%	75%	85%

Table 1-2: Summary of characteristics of the Residential Building Stock

Public Building Stock	**Historical and Protected Buildings**	**Traditional Public Buildings (similar to MF)**	**Panel Public Buidlings (similar to MF)**	**Traditional Public Buildings (similar to SF)**	**New Public buildings (similar to SF)**	**New Public Buildings (similar to MF)**
Fraction of Total Building Stock	0.02%	0.24%	0.65%	0.13%	0.04%	0.13%
Space Heating Energy Requirements (kWh/m2/a)	207	207	230	300	144	121
Fraction of floor area heated before retrofit	70%	70%	95%	70%	75%	85%
After Renovation - S-BASE Scenario						
Space Heating Energy Requirements (kWh/m2/a)	186	186	207	270	130	109
Fraction of floor area heated	70%	70%	95%	70%	75%	85%
After Renovation - S-DEEP Scenario(s)						
Space Heating Energy Requirements (kWh/m2/a)	35	25	25	30	30	25
Fraction of floor area heated	90%	90%	90%	90%	90%	90%
After renovation - S-SUB Scenario						
Space Heating Energy Requirements (kWh/m2/a)	124	124	138	180	86	73
Fraction of floor area heated	70%	70%	95%	70%	75%	85%

Table 1-3: Summary of characteristics of the Public Building Stock

1.3 Methodology and key assumptions

The literature acknowledges several methodological approaches to analyse the impact of climate interventions on the labour market: direct estimates based on scaling up case studies, Input-Output analysis, computable general equilibrium model (CGEM) analysis and transfer of results from previous studies.

Among these, Input-Output analysis is the most widely utilised methodology employed for forecasting the direct, indirect and induced employment impacts of changes in the economy, including energy efficiency interventions. Input-Output tables allow the analysis of changes in the economic activity of all sectors generated by an intervention. Provided the labour intensity of each sector, estimates of the net employment effects (the balance of jobs created and destroyed) can be derived.

This study used a mixed approach to calculate the employment impact of energy-efficient retrofits. In order to estimate the *direct* effects in the construction sector, data from a number of *case studies* has been collected and *up-scaled*; for *indirect* and *induced* effects, the *Input-Output method* has been used. This mixed approach was chosen because Input-Output analysis, after a first detailed run at applying it, was deemed too crude to estimate direct effects, thus a bottom-up approach was believed to hold more precise estimates. The results of the IO research have been used to benchmark the bottom-up method. On the other hand, indirect and induced impacts can be better estimated by applying the Input-Output method.

The programme was assumed to start in 2011; impacts have been evaluated as a function of time, with special focus on analysis for the year 2020, a key year for the completion of several EU strategies (particularly in climate and employment). The report also projected the employment impacts in the medium and long term (up to 2100).

For the purposes of the study, all buildings of the Hungarian residential and public stock have been divided into classes. For each class and each scenario, a collection of data has been derived from case studies and literature: labour needed to perform renovations (divided by skill level), retrofit costs and energy savings obtained.

The labour needs have been up-scaled to the total residential and public building stock, in order to obtain the direct effects of each scenario on the construction sector.

For the direct negative effects in the energy sector, as well as the positive indirect and induced effects generated by the renovation programme, the total renovation investment costs and energy savings were calculated. These represent the increase of demand in the construction sector and the decrease in energy demand. Those values have then been entered into the Input-Output tables, returning as a result the indirect and induced (by additional disposable income from new jobs) changes in output for every sector of the economy. By multiplying these changes in output by the labour intensity in each sector (i.e. the number of Full-Time Equivalent, or FTE, workers employed per unit of output in each industry), the employment effects for all sectors have been determined.

The induced effects generated by additional disposable income available to families (or public building managers) as a consequence of the energy savings have also been obtained by entering the value for the additional disposable income into the Input-Output tables. However, that value depends on the structure of financing used to pay for the investments. This study assumed a “pay as you save” scheme, where 80% of the energy savings go towards the repayment of the loan, while the rest is available as additional disposable income. When the loan is completely repaid, all the savings become additional disposable income.

Since there is extremely limited experience with deep renovations in Hungary, but even worldwide, the study has incorporated technology (or here rather know-how) learning. A rate of decrease of deep renovation costs based on the learning factor has been integrated in the research. Especially in scenarios such as the ones envisaged by this study, firms and individuals improve their skills related to energy-efficient retrofit technologies and know-how; at the same time, with the increase in demand building materials quickly become mass-produced, thus generating price reductions due to economies of scale and positive learning effects. The assumption was that costs for baseline and suboptimal renovations would remain fixed throughout the period analysed, because the technologies for these types of retrofits is already mature and cannot benefit of significant reductions due to learning factors. On the other hand, costs for deep renovations would gradually decrease during the programme until becoming twice as much as current base renovation costs by 2040.

The research also applied a sensitivity analysis to a small number of key parameters (assumptions or sensitive data) to see the extent to which these parameters influence the final results.

1.4 Main findings

1.4.1 Energy and CO_2 savings, investments, cost savings, energy security benefits

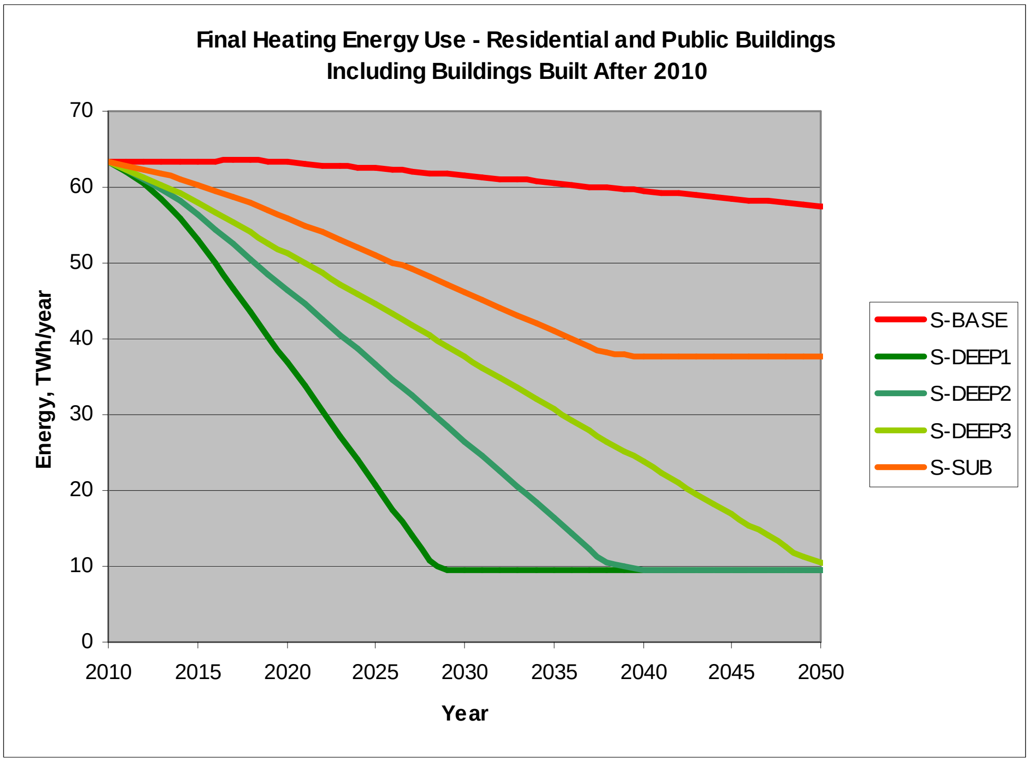

Fig. 1-2: Evolution of the final heating energy use of the Hungarian building stock for all scenarios considered in the study

Energy savings. Undoubtedly, the renovating scenarios – in particular those who involve deep retrofits – will generate substantial energy savings. **Fig. 1-2** shows the evolution of the final heating energy use for the whole building stock (including new buildings built after 2010) in each scenario. **A deep retrofits programme, at the end of its implementation, allows to save nearly 85% of the final heating consumed by Hungarian buildings in 2010**; a suboptimal programme would not go further than 40% of energy savings, while the savings obtained in a business-as-usual scenario are practically negligible.

Fig. 1-3 to **Fig. 1-7** show the evolution of heating energy use by the assumed categories of buildings (including new ones) in the Hungarian building stock until 2100, for all scenarios. The three categories that comprise the largest shares of the energy are the traditional multi-family, panel multi-family, and, above all, traditional single-family residential buildings. The graphs also show the different time needed to complete the renovation programme in the different scenarios: 17-18 years for the more intensive *S-*

DEEP1 scenario, 26 to 28 years for *S-DEEP2* and *S-SUB*, and around 40 years for the S-*DEEP3* scenario, which has a lower implementation rate.

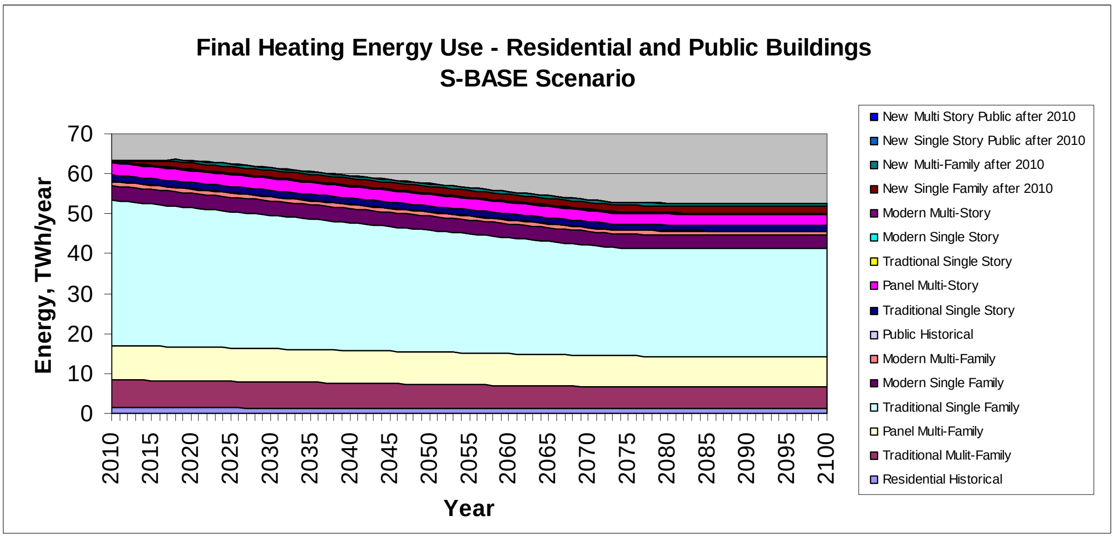

Fig. 1-3: Energy use for all categories of buildings - S-BASE scenario

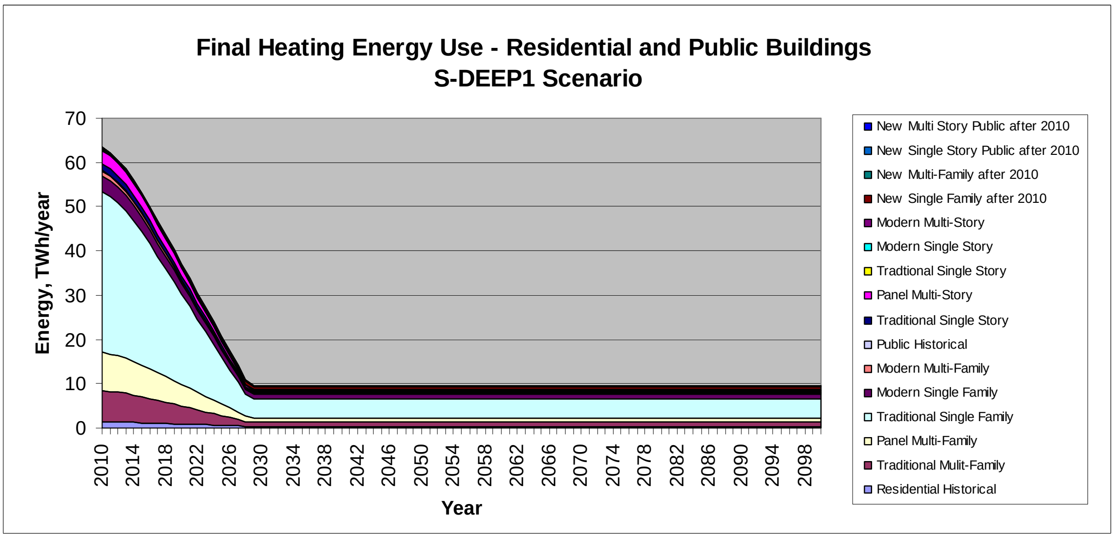

Fig. 1-4: Energy use for all categories of buildings - S-DEEP1 scenario

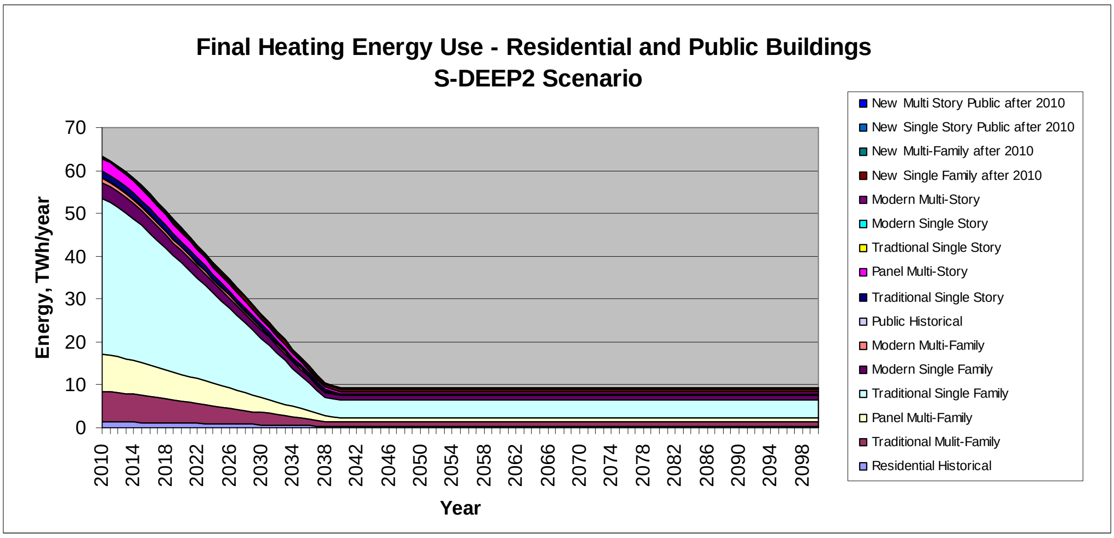

Fig. 1-5: Energy use for all categories of buildings - S-DEEP2 scenario

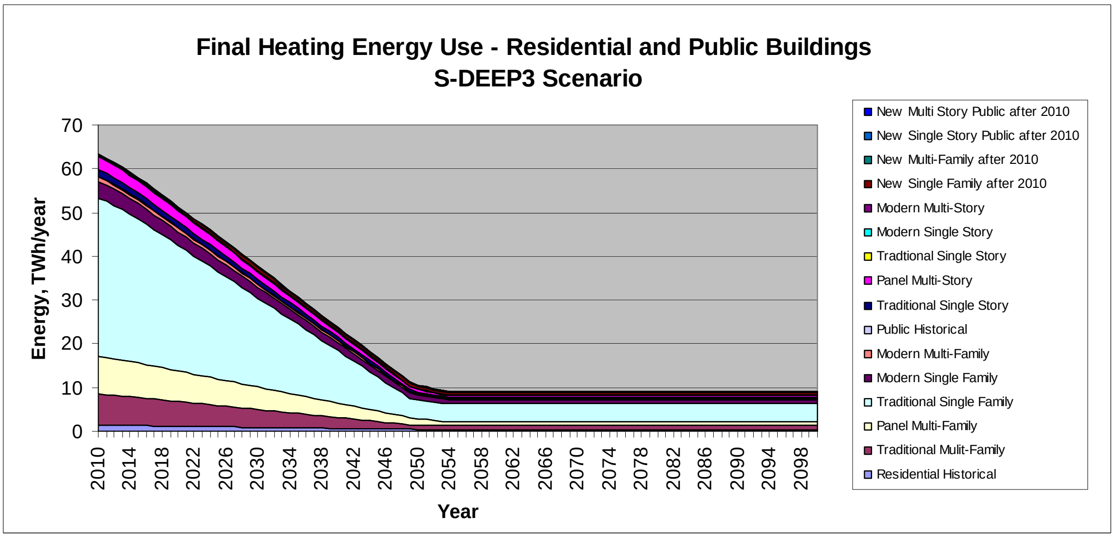

Fig. 1-6: Energy use for all categories of buildings - S-DEEP3 scenario

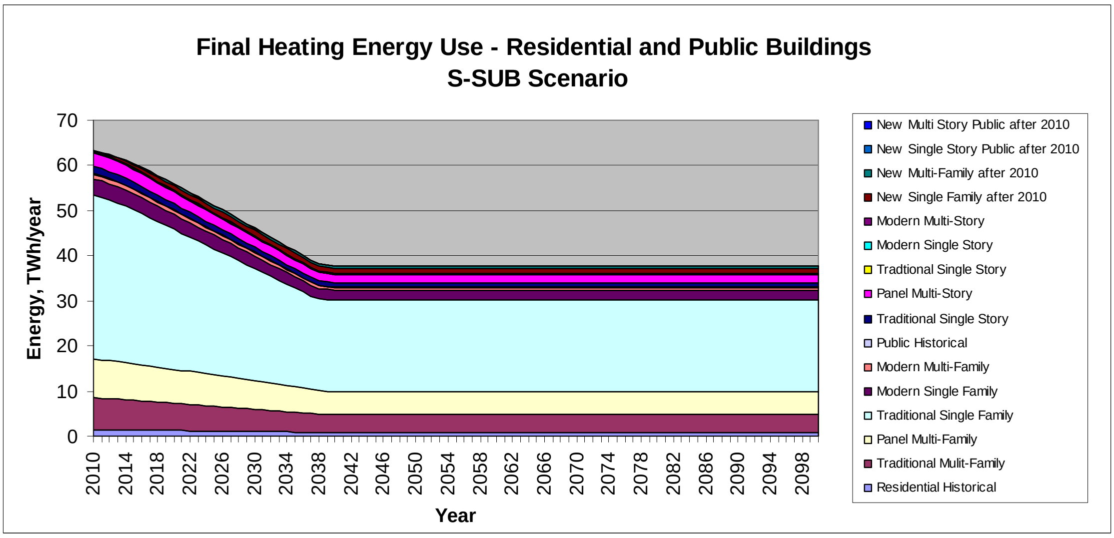

Fig. 1-7: Energy use for all categories of buildings - S-SUB scenario

Energy security. Most of Hungary's consumption of natural gas is ensured by imports, particularly from former Soviet countries. This situation creates a considerable energy dependency of Hungary towards gas producing nations, which can be an economic and political liability, as well as create a potential instability in the supply, especially considering the difficult situations experienced by Hungary in the last few years during gas supply disruptions as a result of Ukrainian-Russian gas disputes.

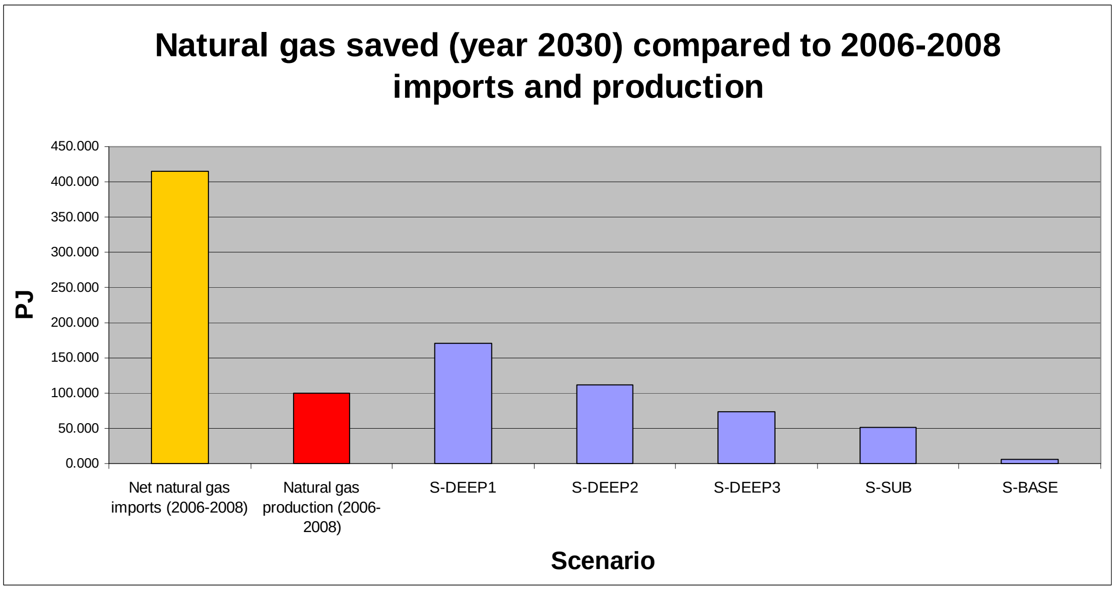

Fig. 1-8: Natural gas saved in the year 2030 by the retrofit scenarios, contrasted to 2006-2008 total imports and national production

A deep retrofit programme would allow Hungary to significantly reduce its natural gas imports and therefore improve its energy security. In 2030, as shown by **Fig. 1-8**, **natural gas savings will reach up to 39% of the natural gas imported in 2008** (for the *S-DEEP1* scenario), and will be in the same order of magnitude of the amount of natural gas produced in Hungary in 2008.

In addition, it is possible to calculate that on average for January – the peak month for imports and consumption, and thus the month of highest risk for energy security – **the proposed renovation programme could reduce gas imports by as much as 59%** (*S-DEEP1* scenario), 26% (*S-DEEP3* scenario) and 18% (*S-SUB* scenario) **of the natural gas imports recorded for that month in 2006-2008**.

<u>CO_2 savings.</u> CO_2 emissions will also be significantly reduced with respect to a business-as-usual evolution, as can be seen in **Fig. 1-9**. The figure also shows the extent of **CO_2 emissions "locked-in" by the implementation of a suboptimal renovation programme: at the end of the programme, 45% of the CO_2 emissions present in 2010**, emissions that would have been eliminated by deep retrofits, **still remain emitted by the Hungarian building stock**.

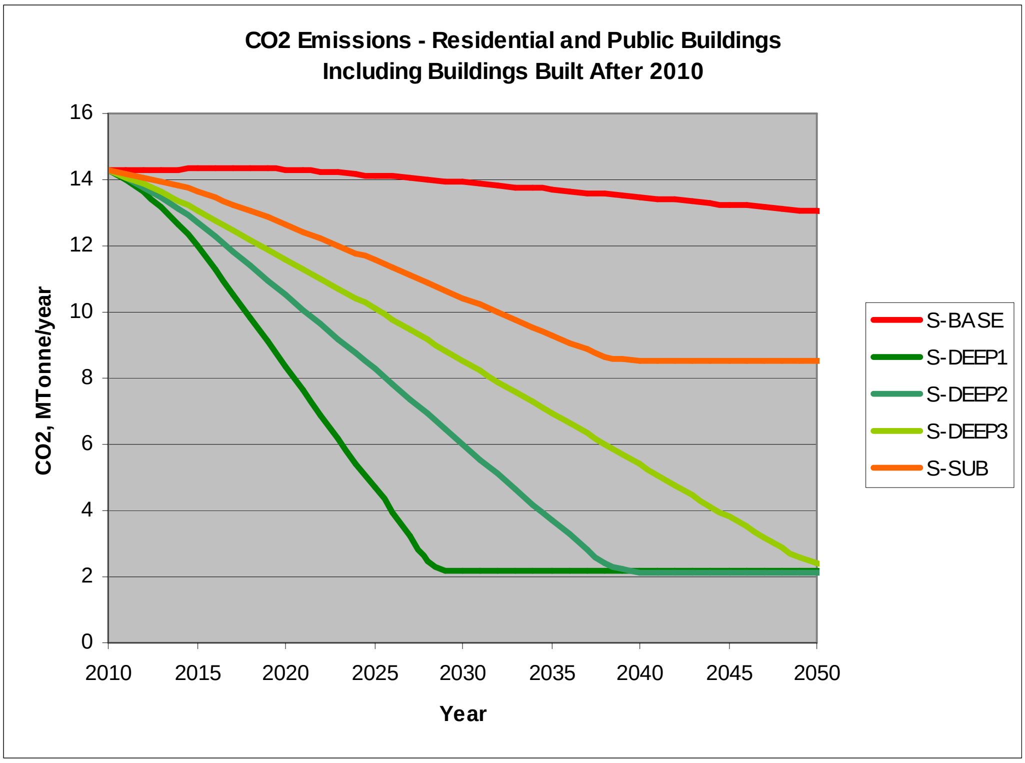

Fig. 1-9: CO_2 emission reductions of the Hungarian building stock for all scenarios considered in the study

<u>Investments and energy savings.</u> The estimates elaborated in this research show that the retrofit programmes considered will involve a considerable amount of investments,

but will also generate a consistent amount of energy expenditure savings. **Table 1-4** shows the investment needs in the year 2020 and the energy cost savings generated in 2020 by all dwellings renovated up to that year for all scenarios, while **Fig. 1-10** and **Fig. 1-11** visualise the trend for these two values for each scenario until the end of the programme and beyond. The values take into account a ramp-up period of five years, which the research assumed will be required by the construction industry to respond to the additional demand. All estimates have been calculated in Euros 2005, to discard inflation effects.

Scenario	**S-DEEP1**	**S-DEEP2**	**S-DEEP3**	**S-SUB**
Million Euros invested in 2020	3,506	2,104	1,402	1,040
Energy cost savings generated in 2020 by all dwellings renovated up to that point (MEUR)	1,234	740	493	344

Table 1-4: Investments and energy cost savings in the year 2020

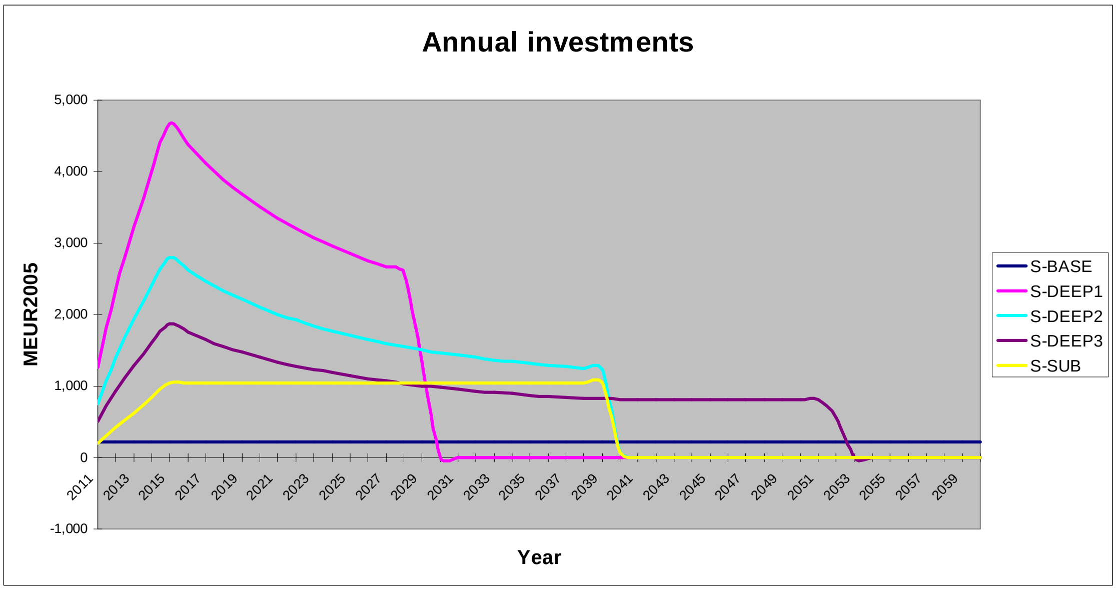

Fig. 1-10: Annual investment needs for the renovation scenarios until (and after) the end of the programme

While annual investments are quite high (they run up to 5 to 13% of the Hungarian national budget in 2009), up to 1.3 billion Euros of yearly financing could be available for the programme, partly by using EU funds and partly by redirecting energy subsidies, which are now used for other initiatives, less effective in terms of energy savings and CO_2 emissions reduction.

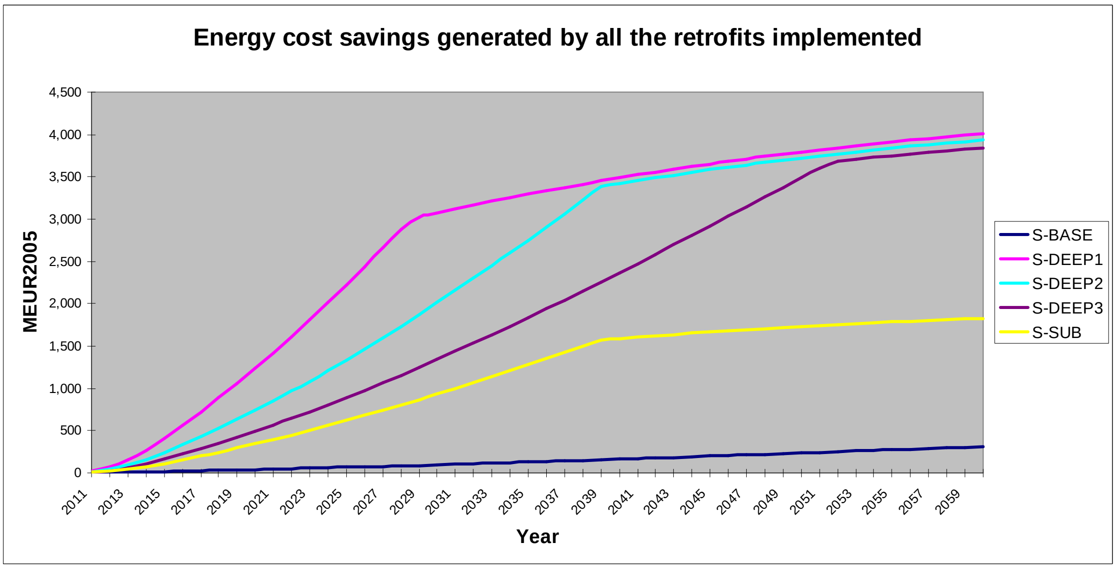

Fig. 1-11: Evolution of energy cost savings generated each year by all the retrofits implemented up to that point

As for energy cost savings, they are clearly highest for the deep renovation scenarios; they are much more modest for the suboptimal, and practically negligible for the baseline scenario. It is possible to compare investments and savings in each scenario: the comparison shows for each year how much money (in Euros 2005) is spent in renovation and how much is in turn saved by all the retrofits performed up to that year. **Fig. 1-12** shows this comparison for two scenarios (*S-DEEP3* and *S-SUB*).

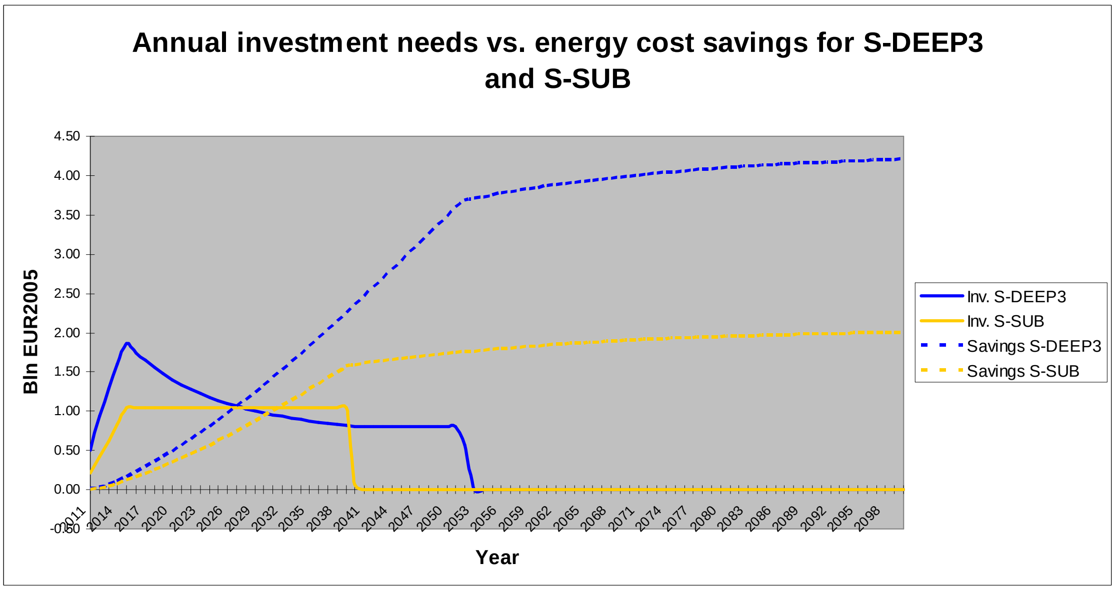

Fig. 1-12: Compared retrofit investment needs and energy cost savings, S-DEEP3 and S-SUB

The graph illustrates quite plainly that the annual total national investment needs in the renovation programmes are initially higher than the annual cost savings obtained at first through the reduction of energy consumption; however, **the energy savings increase fast** (as every year, the savings from the dwellings retrofitted in the current year are added to the savings from all the dwellings previously renovated) **and eventually outstrip the investment costs by far**, especially for deep renovation scenarios.

It is also possible to calculate the cumulative investment needs, by adding all the investments into the programme, and compare them with the cumulative energy cost savings obtained thanks to the retrofits. The results (undiscounted) can be seen in **Table 1-5**, for the years 2025, 2050 and 2075. The total cumulative investments for the scenarios can be seen in 2075, when all programmes will be completed; the cumulative savings eventually outstrip the cumulative investment needs.

Cumulative investments vs. cumulative savings (Billion Euros)	2025	2050	2075
S-DEEP1			
Cumulative investments	50.47	59.83	59.83
Cumulative savings	14.13	97.00	197.73
S-DEEP2			
Cumulative investments	30.29	50.05	50.05
Cumulative savings	8.48	80.56	179.39
S-DEEP3			
Cumulative investments	20.20	42.20	43.58
Cumulative savings	5.65	59.56	156.06
S-SUB			
Cumulative investments	13.53	28.17	28.17
Cumulative savings	3.94	37.43	83.34

Table 1-5: Cumulative investment needs compared with cumulative energy cost savings

1.4.2 Employment impacts

Direct impacts in construction. All the scenarios will engender remarkable net employment benefits in virtually all sectors of the economy, but in particular in the construction sector. Direct impacts in construction, divided by skill level, can be seen in **Table 1-6** and **Fig. 1-13** for 2020.

Thousands FTE	S-BASE	S-DEEP1	S-DEEP2	S-DEEP3	S-SUB
(Million EUR invested in 2020)	224	3,506	2,104	1,402	1,040
professionals	0	27	16	11	3
skilled labour	5	43	26	17	24
unskilled labour	2	21	13	8	4
Direct labour involved: total	8	91	54	36	31

Table 1-6: Direct labour impacts in construction, divided by skill level

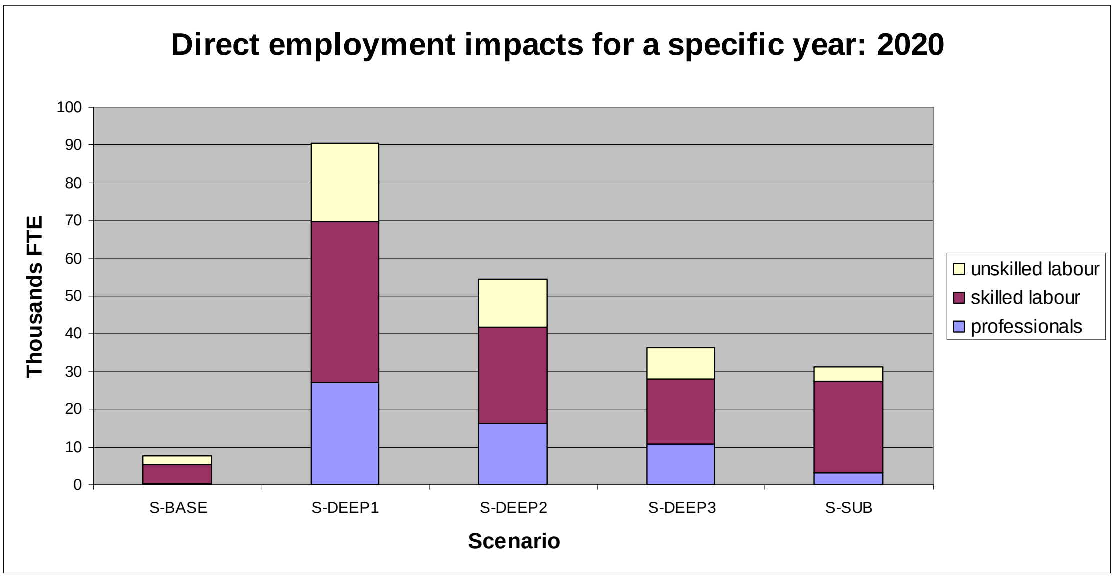

Fig. 1-13: Direct employment impacts in construction by skill level in 2020

The direct impacts can be compared to the direct employment impacts of the same amount of annual capital invested in other activities: **Fig. 1-14** shows a comparison with investments in infrastructural development (e.g. building highways). The figure attests that **renovation activities are much more labour-intensive than other types of construction activities such as road building**.

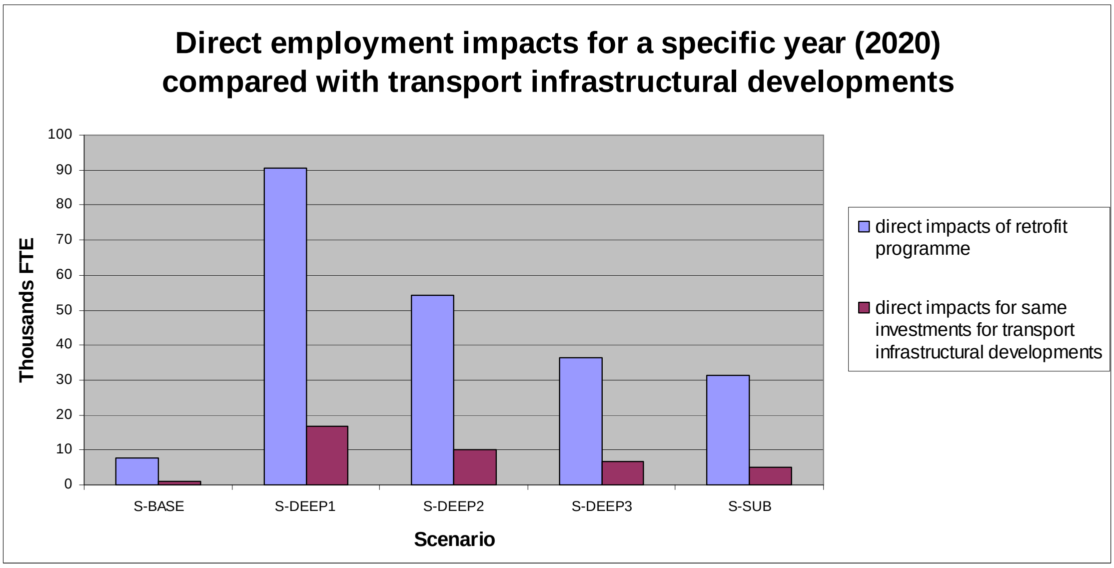

Fig. 1-14: Direct employment impacts of the renovation scenarios in 2020 compared with impacts of other types of investment of equal value (here transport infrastructural development)

The study also evaluated the evolution of the direct impacts throughout the years. **Fig. 1-15** displays the trend of total direct employment effects for all scenarios. The graph displays the initial ramp-up period, when many additional workers will need to be added to the market (and potentially trained), followed by a decrease caused by the learning factor. The rate of renovation is reflected in the timeline for the end of the programme: the smaller the rate, the longer it takes to complete the renovation of the entire building stock.

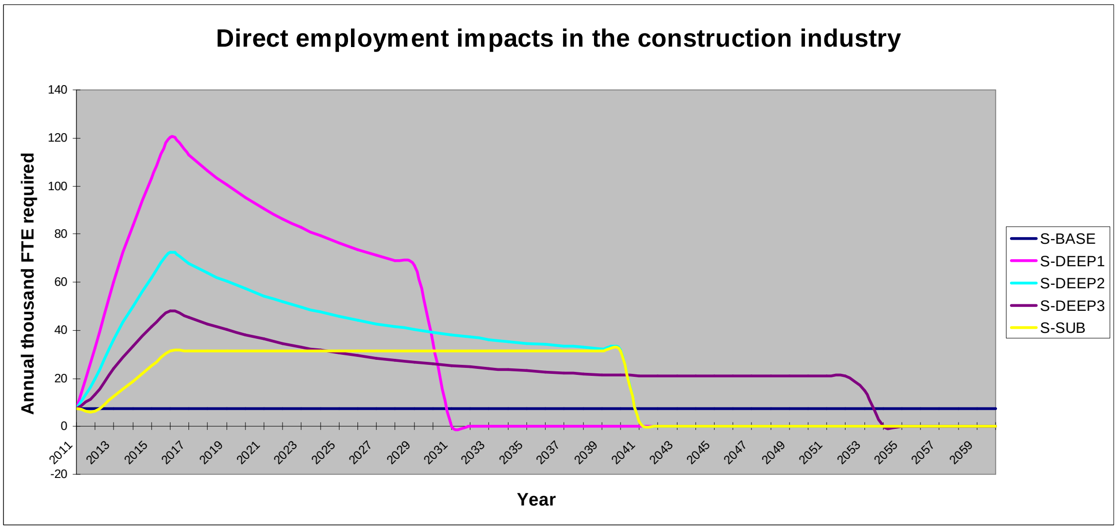

Fig. 1-15: Evolution of direct employment impacts in construction

<u>Total employment impacts.</u> **Table 1-7** summarizes the direct, indirect and induced employment impacts in Hungary in 2020 for all scenarios. The table separates the two types of induced impacts listed in **Section 1.1**: those generated by the additional jobs created by the investment in construction and the lost jobs caused by the reduced demand in energy, and the induced impacts fuelled by the energy cost savings. The results of the total (direct, indirect and induced) impacts are also displayed graphically in **Fig. 1-16**. The figures show that **several tens of thousands of jobs could be created in 2020 by the deep renovation scenarios, ranging from 52,000 jobs in the S-DEEP3 scenario to the 131,000 jobs created by the more intensive S-DEEP1 scenario.**

Thousands FTE	**S-BASE**	**S-DEEP1**	**S-DEEP2**	**S-DEEP3**	**S-SUB**
Million EUR invested in 2020	224	3,506	2,104	1,402	1,040
Direct impacts on construction sector	8	91	54	36	31
Direct impacts on energy supply sector	0	-3	-2	-1	-1
Indirect impacts from investments in construction	2	29	18	12	9
Induced impacts from additional jobs created by investments in construction	1	21	13	9	6
Indirect impacts from reduced demand for energy	0	-6	-4	-2	-2
Induced impacts from lost jobs created by reduced demand for energy	0	-5	-3	-2	-1
Induced impacts from energy savings	1	4	2	1	1
Total net employment impacts in 2020	11	131	78	52	43

Table 1-7: Summary of employment impacts for all scenarios in 2020

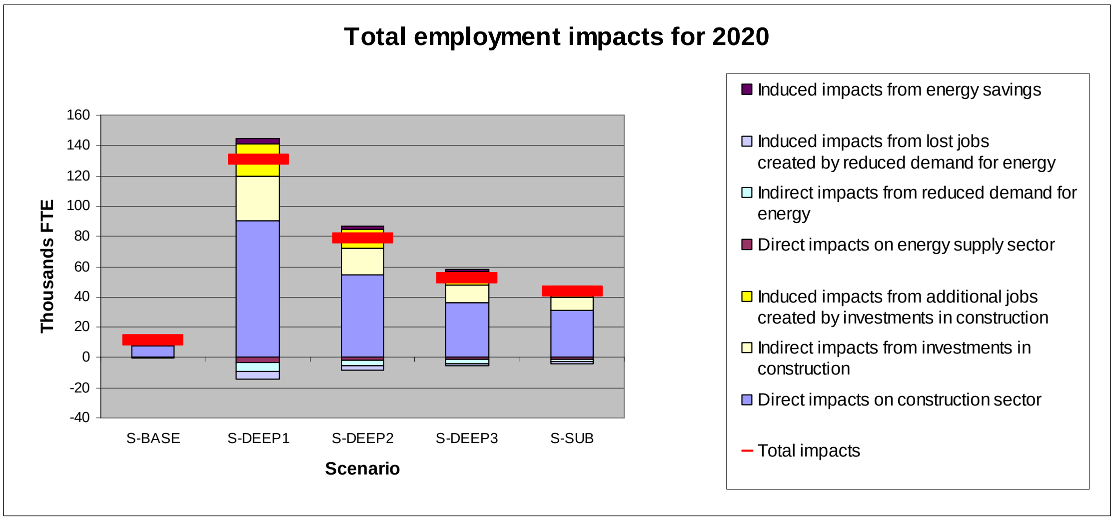

Fig. 1-16: Total (direct and indirect) impacts for the renovation scenarios. The net impact is marked with the red crossing line.

The findings demonstrate that deep renovations are one of the most employment intensive interventions for climate change mitigation or other economic recovery attempts. For instance, **Fig. 1-17** compares the employment intensity of deep renovations in Hungary to other selected results from the literature.

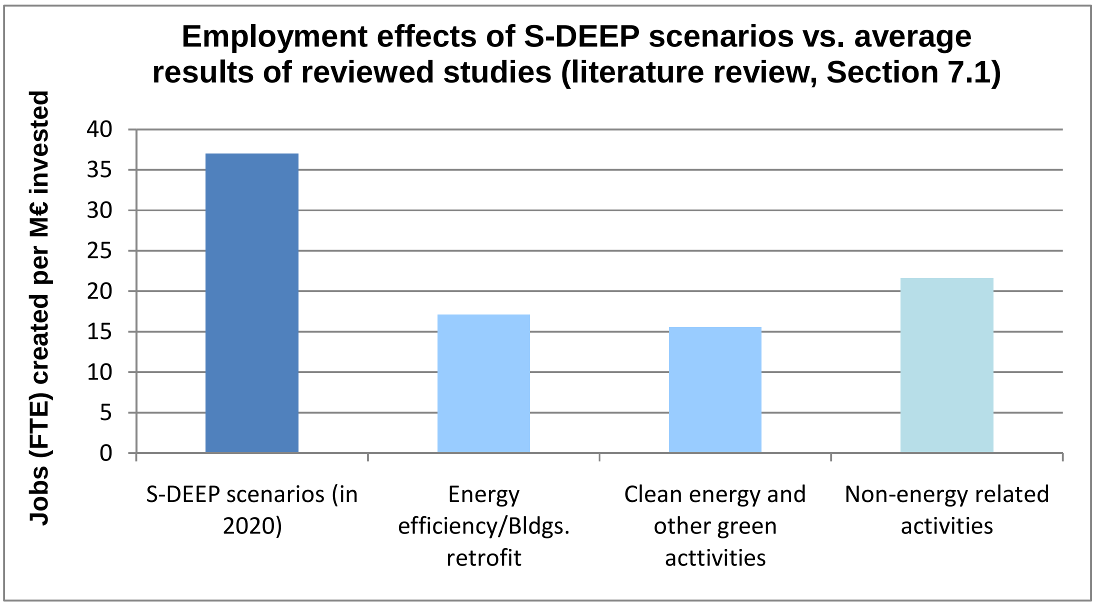

Fig. 1-17: Comparison of employment effects of S-DEEP scenarios (in FTE per million Euro invested) with other climate, energy and non-energy related interventions

As presented in **Fig. 1-17**, **the results obtained in *S-DEEP* scenarios are above the averages reported by previous studies in Western Europe and the USA.** Part of the explanation resides in the fact that in economies in transition (as is the case of Hungary) the labour intensity of the economy is typically higher than in other regions as the cost of labour is lower and often more affordable than automated means of production.

The model contained in this research also allowed to estimate the total employment impacts in the short and medium term, as can be seen from **Fig. 1-18**. As with the direct impacts, the initial increase is due to the ramp-up period, while the subsequent decrease reflects the lower needs of labour due to the learning factor.

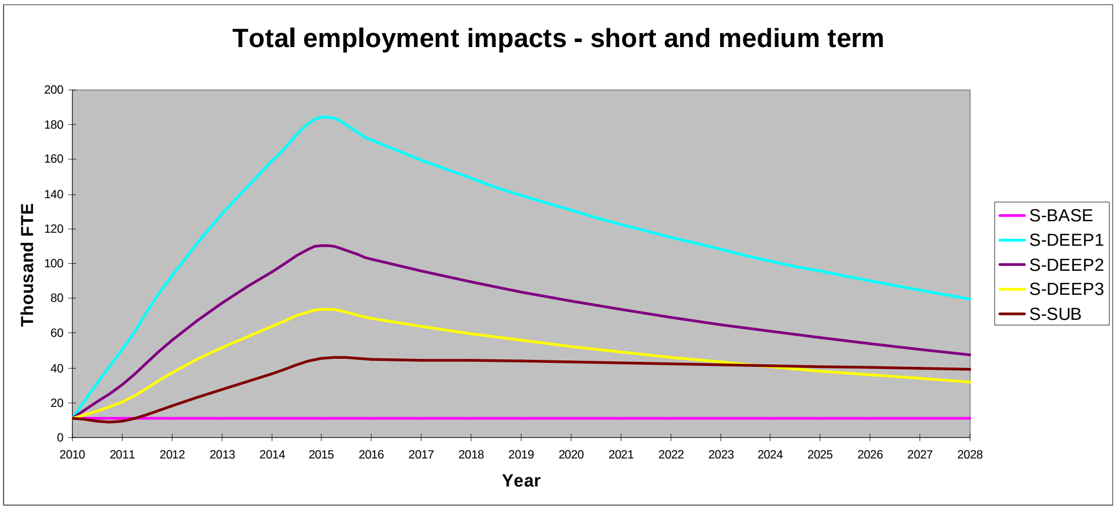

Fig. 1-18: Short and medium term view of the net employment impacts in the different scenarios

Effects on the different sectors of Hungarian economy. **Table 1-8** and **Fig. 1-19** show the total net employment impacts in 2020 of the retrofit scenarios in all sectors of the Hungarian economy. The only sector where the impact is negative is – unsurprisingly – the energy sector (here called “electricity, gas and water supply”), while the major net benefits (apart from construction) can be seen in community and social services (which is a very labour-intensive sector) and manufacturing (a sector which will make a big contribution for the supply of materials for the renovations to the construction industry).

Thousands FTE	S-BASE	S-DEEP1	S-DEEP2	S-DEEP3	S-SUB
Agriculture, hunting, forestry and fishing	0.1	0.5	0.3	0.2	0.2
Mining and quarrying	0.0	0.7	0.4	0.3	0.2
Manufacturing	0.7	10.5	6.3	4.2	3.2
Electricity, gas and water supply	-0.1	-3.1	-1.8	-1.2	-0.8
Construction	7.7	91.8	55.1	36.7	31.7
Wholesale and retail trade, restaurants and hotels	0.3	3.6	2.2	1.4	1.1

Thousands FTE	S-BASE	S-DEEP1	S-DEEP2	S-DEEP3	S-SUB
Transport, storage and communications	0.3	4.2	2.5	1.7	1.3
Finance, insurance, real estate and business services	0.5	5.8	3.5	2.3	1.8
Community, social and personal services	1.5	16.7	10.0	6.7	5.0
Total net employment impact in 2020, all sectors	11.0	130.7	78.4	52.3	43.4

Table 1-8: Net direct and indirect employment impacts on all sectors of the economy by 2020

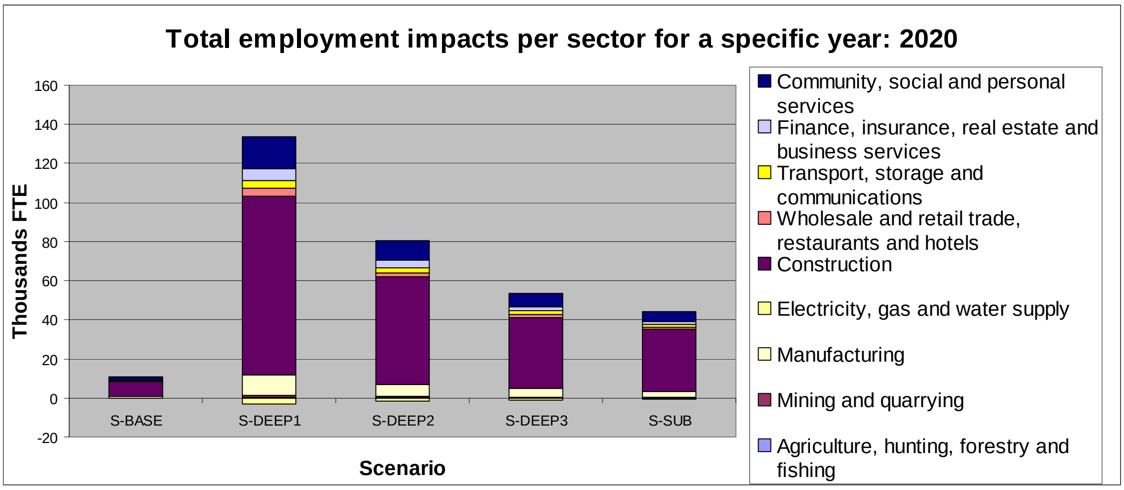

Fig. 1-19: Total effects of the increase in demand in construction per macro-sector

Qualitatively, a number of observations have to be made concerning the employment impacts in the Hungarian labour market for all retrofit scenarios.

Geographic distribution of employment effects. A programme focusing on the improvement of energy efficiency in the building sector is more likely to have direct **employment benefits in the construction industry distributed throughout the country**, as the buildings to renovate are not concentrated in any geographical region. Renovations are usually conducted by local small and medium size enterprises (SMEs), so they will be the major direct beneficiaries of a large-scale building retrofit programme. Furthermore, the supplementary income arising from the additional wages in the construction sector plus the energy savings will be spent by households living all over the country in a wide range of goods and services produced in many different regions.

Therefore it is expected that a large share of the jobs generated will be local and decentralised rather than centralised, and unlikely to be “exported” outside of the Hungarian borders.

Temporal durability of employment effects. The magnitude of the programme considered in this study is such that the **direct and indirect employment effects will proceed throughout several decades**, and the decrease of jobs in the energy sector will certainly be countervailed by direct, indirect and induced effects of the programme.

Potential bottlenecks: supply of labour, materials and skill level implications. The results show that in the intensive refurbishment period the construction industry will need a vast amount of new workers. The question might then arise if there is a sufficient supply, in the required locations and skill level, of workers in Hungary to satisfy this demand. The model used in this research assumed a ramp-up period during which the construction industry adapts to the new demand and responds to a possible shortage of supply in workers or skill.

The demand for workers will be spread across all skill levels: from construction entrepreneurs, to college-trained professionals, skilled and unskilled workers. While the supply of entrepreneurs and professionals is perhaps easier, issues may arise for the supply of skilled and unskilled workers. In principle, unskilled workers can be supplied by the unemployed and inactive Hungarian labour force; in practice, the skills of the unemployed and inactive may differ from those needed in the programme, and these workers may have high reservation wages (i.e. a high minimal wage for which they would be willing to work).

Special attention should also be paid to the sectors manufacturing the construction materials and equipment (e.g., triple-pane windows, heat exchangers, advanced thermal insulation, etc.) needed for deep renovations. As in the case of skilled labour, the demand for such intermediate inputs would grow substantially as a result of the programme. If the supply does not react at the required pace (i.e., new producers entering the market, existing companies starting new production lines, etc.), materials would become another bottleneck that may increase the costs of deep renovation.

Effects on costs of wage changes and workers' productivity. Wages will respond to the increase in demand for workers, and they will increase as firms compete for the scarce skills. This may increase the costs of retrofit projects and slow down the rate of renovations and the output of upstream industries. In addition, such a general wage increase can have adverse effects on the whole labour market, as the production costs increase in many industries. On the other hand, the model forecasts that the costs of renovation will decrease and the productivity of workers grow as a consequence of economies of scale and the learning factor. In balance, these phenomena may suggest that a more gradual renovation programme has a less negative impact on the supply of labour from these perspectives.

Inflow of foreign workers. Should the Hungarian workforce fail to be able to fill the job vacancies needed for the retrofit projects, foreign workers may need to fill in these vacancies. While new immigration could revitalize the Hungarian society and give a boost to its stagnant demography, there could also be negative impacts reflected in a growth of illegal immigration, or an increase in grey labour.

Considerations on the energy sector. The energy sector has a low labour intensity and a high number of employees per company. Job losses in that sector are likely to be lumpy, and mostly take place in the case of plant closures. In fact, the *S-DEEP* scenarios pose a collateral question on the future of district heating (DH) systems once the dwellings connected to a DH plant are renovated to a high efficiency level.

Realistically, the job losses in the energy sector estimated by the model used in this study are likely to be overestimated, both because Input-Output systems assume a linear relationship between the output and the amount of employees of each sector (which is not the case in the energy industry) and because the energy that is not needed in the domestic market – at least the one which is produced in Hungary – might also be exported, if the sector is efficient enough to compete on the world market.

Furthermore, negative impacts in the energy sector might be attenuated by the so-called *rebound effect*, where an increase in energy demand is caused by the reduction of the per-unit price of energy services and the increased disposable income available to consumers generated by energy-efficiency measures; i.e., a portion of the saved energy costs will in fact be spent on other services requiring energy input (such as larger homes, refrigerators, etc), thus lowering the negative impact on the energy industry but also reducing the avoided energy consumption and GHG emissions estimated for the programme.

Real estate market. Retrofitted buildings have a number of advantages that make them more attractive to buyers of the housing rental and sale markets. The value and rentability and thus the price of the building will likely increase as a result of the intervention, which provides an additional financial incentive for households to participate in the programme and for maintaining the energy efficiency gains achieved with the renovation; they will not only be saving money but will also be able to sell or rent their property at a better price.

Financing of the programme. While this study has not defined in detail a financing scheme and avoided dealing with these aspects, it is an issue that any serious attempt to apply the programme must take into consideration. The vast majority of Hungarian households may not dispose of sufficient up-front capital to invest in a deep retrofit of their house; therefore, a financing formula has to be devised in order to make such a programme viable. Several possibilities can be considered – allocations from the general consumption budget, resources obtained from a loan, grants or private savings, etc. – but it is believed that “pay as you save” schemes (where the upfront costs of the refurbishment are financed by a third party, an obligation to repay is linked to the property over an extended number of years and the repayments are calculated to be less than the energy savings obtained) would be particularly fit for the programme in Hungary.

In fact, the employment effects also depend on the types of financing for the programme. A relatively simple pay-as-you-save scheme has been defined in the model used in this study, in order to estimate the induced effects of energy savings. The scheme assumed the contribution of the State to be an interest-free loan that allows property owners or managers to repay only the principal of the loan.

The provision of an interest-free loan by the State may of course exert additional pressure on the already constrained budget of the Hungarian government. To avoid an increase in government expenditure, two complementary alternatives for re-channelling existing budget allocations can be thought of: on one hand, the use of a series of EU funds already available to Hungary (estimated between 160 to 490 million Euros yearly), and on the other hand the redirection of more than 800 million Euros of energy subsidies, which often provide incentives for energy consumption or enhance the financial profitability of carbon-intensive technologies and expensive mitigation alternatives.

1.5 Conclusion and recommendations

The study has demonstrated that **up to 85% of Hungarian heating energy use**, and the corresponding CO2 emissions, **can be avoided by a consistent and wide-spread deep retrofit programme** in the country. This, in turn, can substantially improve on the country's energy security: by 2030 **a deep renovation scenario could save up to 39% of annual natural gas imports** (2006-2008 average), and up to **59% of natural gas import needs in** the most critical month from the perspective of energy security – **January** (2006-2008 averaged values).

At the same time, the research has also highlighted the important risk related to less ambitious renovation programs. If renovations aim at keeping today's retrofit depth such as the one implemented by existing ÖKO, Panel and similar programmes (i.e. reducing around 40% of present energy use in existing buildings on average), this results in a significant lock-in effect. This **sub-optimal renovation scenario** saves only approximately 40% of final heating energy use, **locking in approximately 45% of 2010 building heating-related emissions at the end of the programme, around 22% of 2010 total national emissions**. This means that reaching ambitious mid-term climate targets, such as the often quoted 75 – 85% reductions that are needed by 2050, will become extremely difficult, and expensive, to achieve.

The realisation of a suboptimal rather than a deep renovation scenario also results in other compromises, too, such as in terms of energy security enhancements. Instead of saving up to 39% of national natural gas imports, it saves just over 10%; and the peak consumption (January import needs) is reduced merely by 18% as opposed to the 59% reduction in the deep scenarios.

With regard to the employment effects, the results of the study clearly indicate that **adopting a high efficiency retrofitting standard close to passive house would result in substantially higher employment benefits,** than the business-as-usual (not aimed at reducing energy consumption, *S-BASE* scenario) and sub-optimal renovation (the currently applied technology in ÖKO, Panel and similar State-supported programmes, *S-SUB* scenario) alternatives.

In particular, the study has demonstrated that a large-scale, **deep renovation programme in Hungary could create by 2020 up to 130,000 net new jobs**, as opposed to 43,000 in the suboptimal scenario. These figures include the workforce losses in the energy supply sector – which will likely be hit especially hard in district heating in the deep renovation scenarios. It is important to highlight that up to 38% of the employment gains are due to the indirect effects on other sectors that supply the construction industry and the induced effects from the increased spending power of higher employment levels.

As highlighted above, the study has demonstrated that from a socio-economic and environmental perspective it is important that the government supports a deep renovation program rather than a suboptimal one. However, let us examine how the three deep renovation scenarios compare.

Strictly from an employment benefit perspective, **the *S-DEEP1* scenario brings the best results: 131,000 jobs** as opposed to the 78,000 of *S-DEEP2* and 52,000 of S-DEEP3 – the scenarios aiming at equally ambitious renovation levels, but with less pushed implementation rates (150,000 and 100,000 dwelling-equivalent per year, as opposed to 250,000 in the *S-DEEP 1*). However, **the corresponding annual investment needs are also significantly higher** (up to **4.5 billion Euros/year** for *S-DEEP1* in the initial phase of the programme as opposed to 2 billion for *S-DEEP3*, and 2.8 billion vs. 1 billion towards the concluding phases of the programme). These are substantial figures. While it may be possible to free up and allocate so much capital for the purpose, similarly to a large “shock” to the labour market, more significant re-channelling and drastic changes in both material and labour markets would have more negative effects, as described in the study. Therefore a more gradual, longer-term implementation of a deep renovation programme is desirable from these perspectives.

The research has also found that **redirecting the current energy subsidies** and **making a wise use of available EU funds** would make available around **1 billion euros per year**, an amount that by itself practically **covers during the first years of the programme the full annual costs of renovating Hungarian buildings at a rate of 100,000 units per year** (*S-DEEP3* scenario).

In addition, from a total cost perspective a more gradual implementation of a deep renovation program is much more attractive. Due to the relative inexperience with deep renovation know-how and technologies, initially these will undoubtedly will be more expensive than after a learning period when experience accumulates and more mature markets and competitive supply chains are established. As a result, a **more aggressive renovation programme** (i.e., 250,000 renovated per year instead of 150,000 or 100,000) **results in higher overall costs** (undiscounted) of renovating the Hungarian building stock: 60 billion Euros for *S-DEEP 1*, 50 for *S-DEEP-2*, and 44 for *S-DEEP3*. On the other hand the implementation of a more aggressive programme would result in a faster harvesting of energy saving benefits: by 2050, the total accumulated undiscounted benefits of *S-DEEP1* would amount to 97 billion Euros, whereas *S-DEEP2* and *S-DEEP3* would have produced 80 and 60 billion Euros of energy savings respectively.

On the qualitative aspects of the new jobs created, it is believed that the length of the programme ensures that the employments created are long-term, and the fact that the whole building stock is considered for renovation implies that the new jobs are likely to be distributed throughout the country as renovations are usually carried out by local small and medium enterprises spread throughout the country.

To create the conditions for a smooth implementation of the programme, the public administration should be decisively involved in the planning and the financing of the retrofit programme, to promote initiatives that would reduce the risks of supply bottlenecks (such as labour, material or finance supply) and in making sure that the renovations deliver the expected energy savings, so as to ensure the financial practicability of the intervention.

To sum up, decision-makers of today's Hungary have the possibility to unlock the potential for creating additional jobs while greatly reducing the energy costs of households and public buildings, Hungary's gas dependency and making further contributions to mitigate climate change. Between the two options presented, the results indicate that deep (i.e., passive house-type) renovations are recommended as compared to suboptimal. High efficiency renovations create more jobs, save more energy, reduce more emissions and decrease to a larger extent the energy dependency of the nation.