Low-carbon Building Innovation Trends and Policy Pespectives in Hungary between 2020 and 2030

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***Abstract:** Regarding the aspects of climate policy, the building sector in Hungary is one of the best performing industries. This means that the GHGs (Greenhouse Gasses) the sector emits can be decreased more effectively and at less cost than in the case of other sectors. This is no surprise in the European Union, since there is a continual demand on behalf of society to develop old and outdated buildings, thus modern technological solutions also inherently result in operating efficacy. The 'climate policy targeted' development of the built environment based on EU funds is thus one of the most popular developments amongst European Union Member States. Therefore, the aim of the present study is to assess the climate policy effects of the presently preferred strategy approach(es) between 2020 and 2030.*

1. INTRODUCTION

The building sector is linked to climate policy by means of the GHG emissions of the energy use of the building stock in the domestic, institutional, and business sectors. From the aspect of environmental protection, it is in the exceptional situation that it is the focus of most national developments due to the immense and cost effective possibilities for reducing GHG emissions arising from the enormous mass of these buildings. The essence of the above is that since a given unit of investment can result in much greater reductions than in the other sectors definitive in climate change, the developments that aim at reducing GHG emissions are generally implemented in this sector (for example, transport) [1].

The sector's developments in the past decades have shown positive trends, which can be attributed to several quickly changing aspects. First and foremost, continuous developments in technology and the constant need on behalf of society manifest as a result in themselves already

result in a fundamental improvement in efficacy [2]. In addition, outdated buildings passed their lifecycles in Central and Eastern European countries such as Hungary provide advantageous possibilities, since they are much cheaper to develop than systems operating with more developed technologies. However, in this case the issue arises that although they do enable the achievement of substantial results over the short term with the installation of simple heat insulation or replacing windows, these outdated systems cannot be further developed in a manner that ensures they reach the next stage of development. Thus, renovating an old prefabricated apartment building is obviously cheaper and more cost effective than doing the same with a modern passive house (with low GHG emissions), but the outdated heating systems used in the case of the former cannot be further developed, for instance to provide compliance with 'smart metering' [3].

The importance of this fact also has to be stressed because the modernization of the building stock is an issue important to the national economy. There are many people who criticize Hungary's present prefabricated housing renovation program (panel program), which follows the deep retrofit trend also popular in other parts of Europe [4]. The essence of the program in Western Europe is to provide new functions and rebuild the unused buildings found in city centers in Hungary, this process is concentrated on the renovation of the 40-50 year old prefabricated apartment buildings left over from the socialist era. Due to the lifecycle issues already deliberated above, more and more people are stressing the fact that new buildings should be built instead [5], although this requires a greater investment, such a program would be better suited for the long term and would provide a much better return [6].

Based on the above, the aim of our study is to review the present prefabricated housing renovation strategy by mapping the potential in developing the Hungarian building stock, and to then attempt to define the correct direction for the future in light of the results.

2. MATERIALS AND METHODS

The present study basically encompasses two periods. The first is the period between 2015 and 2020, for which we are already familiar with the regulative framework environment and valid measures. However, negotiations are still under way between the various Member States and European Union decision makers regarding the subsequent period of 2020-2030, which falls into the next EU program period. In order to develop this, it is necessary to be aware of the effects that the present trends can have on the meeting of the 2020 targets and how they contribute to the realization of climate policy targets. Despite the fact that forecasts show that the building sector is one of the best performing sectors regarding the reduction of GHG emissions [7], the rate of true potential does have to be assessed. This is required because unless those measures are defined that target the best utilization of available possibilities, the result could be severe losses in the area of overall welfare (even until 2020).

Since the main target of our study is the accurate mapping of present Hungarian building policy trends, the evaluation used studies that have previously already assessed these effects. Of these, the document entitled *'Employment Impacts of a Large-Scale Deep Building Energy Retrofit Programme in Hungary'* [8] prepared by the Central European University was the first. It primarily emphasized labor market effects but also contains a significant amount of conclusions pertaining to GHG emission reductions and energy efficiency.

The second is the Hungarian National Building Energy Strategy [9], which specifically deals with the long term issues of building energy.

A benchmarking analysis method was selected for the general evaluation of the building development scenarios between 2020 and 2030, as this method (which is fundamentally a level-comparison method) is the simplest for analyzing the temporal and spatial characteristics of the climate policy sector. In essence, it allows present and future development environments to be evaluated on the basis of the system of conditions developed by the authors and their assigned indices. The methodology is basically aimed at designating an optimal state (or best practice, as the case may be) to which the selected systems can then be fitted [10]. The procedure had to be specified for the purposes of the analysis to ensure that it can be interpreted for the analysis of climate policy processes. The scenarios described by Hungarian building strategies were made quantifiable, in accordance with the requirements of the European Union Climate Policy [11]:

– *increasing the ratio of renewable energy sources in the sector,*

– *increasing energy efficiency, and*

– *decreasing CO_2 emissions.*

The studies analyzed the *technological, environmental, and financial* dimensions of the building sector along the lines of the above 3 main dimensions, assigning 3 indicators to each of the above dimensions. The study framework developed by the study are pictured in Tables 1, 2, and 3.

Dimensions	Code	Status indicators	Code	Performance indicators (defining the method of development)
ASPECTS OF THE RATIO OF RENEWABLE ENERGY				
Technological	RS1	A specific study and the general characteristics of the applied energy mix	RP1	Changes in the use of expendable resources: the increase or decrease in the ratio of fossil energy source usage in the examined sector between 2020 and 2030
Technological	RS2	The general standard and improvability of technical equipment	RP2	The state of the technical standard and the ratio of environmentally friendly technologies
Technological	RS3	The ratio and characteristics of renewable energy source utilization	RP3	The possibilities for utilizing renewable energy sources in the sector and the possibilities for increasing their rate within the sector
Environmental	RS4	The characteristics of participation in a waste energy reuse system	RP4	Renewable energy system support, classified according to roles
Environmental	RS5	Results/relations between emissions/imissions benchmarks	RP5	Ratio of the potential for decreasing emissions levels as compared to the other ESD sectors
Environmental	RS6	The rate/level of environmental management and the general sectoral attributes of environmental management systems	RP6	The effects of the EPC (Energy Performance Certificate) on the outlook for reduction in the building sector

Financial	RS7	To what extent does the ratio of the sector within the ESD influence the country's position on the quota market (AEA)	RP7	Evaluation of activity (characteristics of carbon financing)
	RS8	The intensity/activity of environmental policy and climate policy regulation	RP8	The effects of regulation on emissions
	RS9	Resource efficiency complexity: labor market effects and effects on employment	RP9	Study of job creation effects and the description of its significance

Table 1. Indicator group 1 of the building sector benchmarking analysis

Abbreviations: 'RS1 - 9:' status indicators of the ratio of renewable energy, according to dimensions; 'RP1 - 9:' performance indicators of the ratio of renewable energy, according to dimensions

As also made apparent by Table 1, the specific renewable indicators created by the study can be classified into two groups: *Renewable Status Indicators (RS 1-9)* and *Renewable Performance Indicators (RP 1-9)*. The essence of developing *Status Indicators* is to define points within the sector whose change could be important regarding the sector's future climate policy development possibilities. However, this is a static index that primarily sheds light on the areas that might require change. The performance indicator group provides an answer to the question of how the intervention should take place. Thus, the *Performance Indicators* basically make it possible to define the direction and possible degree of the changes to the processes shown by the *Status Indicators*.

As mentioned earlier, the two important periods of the study are that between 2010 and 2020 and that between 2020 and 2030. This differentiation was primarily necessary because analyzing the processes that take place between 2020 and 2030 would not have provided a suitable direction, as there would have been no comparison for the hypotheses (which can be subsequently corrected in light of possible changes).

The analyses for the 2010-2020 period make the types of problems that can arise in planning in the case of long term planning apparent. The main conclusion of the analysis was that reviews of the defined 10 year plans conducted at least every 5 years are unavoidable if the correct development courses are to be adhered to.

The study therefore compared the expected results of the Hungarian building renovation programs and building energy strategy with the climate targets set for 2020 and 2030, respectively. Estimates made by experts in the field were then used to determine whether they are suitable for achieving these goals. The indicators included in the tables fundamentally aim at enabling the localization of the degree of externalities (not monetized effects) compounded in the sector [12, 13].

Dimensions	Code	Status indicators	Code	Performance indicators (defining the method of development)
ASPECTS FOR INCREASING ENERGY EFFICIENCY				
Technological	ES1	The ratio of electrical energy use in total energy use	EP1	The ratio of electrical energy used by the building sector
Technological	ES2	The degree of consumption of ETS sectors	EP2	Share of district heating
Technological	ES3	The degree/rate of possible clean tech applications	EP3	The application of clean tech in only the renovated building stock (excluding new buildings)
Environmental	ES4	The intensity of input utilization within the sector	EP4	Building sector energy use
Environmental	ES5	Optimization level of building	EP5	Ratio of zero energy buildings and buildings that use energy effectively
Environmental	ES6	Level of energy loss	EP6	Decrease of dependency on energy imports
Financial	ES7	Cost effectiveness parameters of increasing energy efficiency	EP7	Ratio of cost effective potential for reduction
Financial	ES8	Characteristics of increases in eco-efficiency	EP8	Rates of investments/savings
Financial	ES9	The significance of regulatory elements in production processes	EP9	Change in the reduction resulting from regulation

Table 2. Indicator group 2 of the building sector benchmarking analysis

Abbreviations: 'ES 1 - 9:' status indicators of the energy efficiency aspect, according to dimensions; 'EP 1 - 9:' performance indicators of the energy efficiency aspect, according to dimensions

Dimensions	Code	Status indicators	Code	Performance indicators (defining the method of development)
THE ASPECTS OF CO_2 REDUCTION LEVELS				
Technological	CS1	The intensity of GHG emissions in light of the given technology	CP1	GHG emissions based on the evaluation of the available technical variants
Technological	CS2	The possibility of introducing low-carbon technologies to the sector	CP2	The ratio of applicability of available low-carbon technologies
Technological	CS3	Composition/volume index of characteristic GHGs	CP3	Changes in CO2 reduction rates

Environmental	CS4	Environmental characteristics of GHG emissions	CP4	Description of GHG environmental characteristics and their evaluation from the aspect of the expected measures
	CS5	Environmental regulations/ norms, thresholds/consistency	CP5	Do regulations support or hinder the meeting of environmental policy targets
	CS6	The level of environmental risks in emissions	CP6	The characteristics and nature of adaptation measures
Financial	CS7	The characteristics/level of participation in total GHG emissions	CP7	The ratio of total CO2 emissions in all sectors subject to the regulation
	CS8	Typical costs of GHG reduction per unit of CO_{2e}	CP8	CO_2e reduction cost index in the examined sector
	CS9	The nature of the contribution to the meeting of GHG climate policy targets	CP9	Volume and efficiency calculations

Table 3. Indicator group 3 of the building sector benchmarking analysis

Abbreviations: 'CS 1 - 9:' status indicators of the aspect of reducing CO_2 emissions, according to dimensions; 'CP 1 - 9:' performance indicators of the aspect of reducing CO_2 emissions, according to dimensions

2.1. Interpreting externalities in climate policy research

During the course of the present study, the term externalities was not used as customary in traditional economic analyses (as a specific index of the rate of environmental problems) but rather as a complex system of measurement that influences the success of the development. The externalities taken into consideration by the study include the manifestation of all those positive and negative environmental, economic, and social features that influence the development of or the ability to develop the local building sector but that are generally not taken into account by decision makers [14]. These externalities were identified by stressing the contradictions experienced on the market and the factors that arise during developments and support or possibly hinder those. The evaluation framework developed by the authors therefore primarily dealt with the degree to which a given indicator contributes to the achievement of climate policy targets within a sector. Each of the 9 indicators of the three evaluation system categories illustrated in Tables 1, 2, and 3 (financial, environmental, and technological) were allocated a value [(-2), (-1), (0), (1), (2)] depending on whether they over-performed or under-performed according to the reviewed index. It should be stressed that although the accumulation of positive externalities naturally assumes a more beneficial state than the accumulation of negative factors (since it indicates a structure that is at least worthy of continued development), that is not the optimal level of balance. The optimal level of these systems (best practice) is always indicated by 0, meaning that the most beneficial system is that which has a value close to 0.

The accumulation of negative factors denotes a structure that is fundamentally faulty in its operation and into which financial sources should not be invested, as they will not provide a return over the long term (within their respective lifecycles). Contrarily, the accumulation of positive externalities always means that there is untapped potential present. As a result, that is the direction investments should take to ensure these possibilities are not left unused [15].

3. RESULTS

The result of the benchmarking study makes it unequivocal which obstacles to using resources or best practices we can encounter in the three dimensions (technological, environmental, financial) of the studied areas. The detailed results of the benchmarking study are summarized in Table 4. The table highlights 3 factors that were each separately considered important in the interest of a comprehensive analysis. Of these, the first (*'Net positive externalities'*), indicated with a letter *'A,'* is the mathematical sum of the externalities. The value denoted as *'B'* (*'Total externalities ABS'*) is the absolute value of the number of externalities in the given sector. Finally, index *'C'* provides a sum of the ratio of net positive externalities (A) within the total number of externalities (B). The technological dimension included the study of changes to the technological state, while the environmental dimension dealt with the effects that the various regulations or measures can have on the sector. Finally, the financial dimension tracked the effect of the various types of support available for developing buildings.

Dimensions		ASPECTS OF THE RATIO OF RENEWABLE ENERGY		ASPECTS FOR INCREASING ENERGY EFFICIENCY		THE ASPECTS OF CO_2 REDUCTION LEVELS	
		2010/2020	2020/2030	2010/2020	2020/2030	2010/2020	2020/2030
Technological	1	-2	0	-2	0	0	1
	2	0	2	0	1	0	1
	3	0	1	2	2	1	2
Environmental	4	-1	-1	1	2	-2	-1
	5	2	2	-2	0	0	1
	6	1	2	1	2	0	0
Financial	7	0	2	2	2	1	2
	8	-2	0	-2	1	2	2
	9	2	-1	0	1	1	2
A: Net positive externalities $\sum (1;9)$		0	7	0	11	3	10

B: Total externalities ABS (1;9)	10	11	12	11	7	13
C: The ratio of net positive external effects within total external effects	0%	64%	0%	100%	43%	77%

Table 4. Evaluation of the building sector benchmarking analysis

Explanation: A: Net positive externalities $\sum$ (1;9): the number of positive externalities within the various aspects in 2020 and 2030, respectively, if no directed climate policy developments take place outside of BAU; B: Total externalities ABS (1;9): the absolute value of the total number of externalities; C: The ratio of net positive external effects within total external effects; expressed as a percentage, it indicates the dimension of improvability in the studied area.

In general, it can be stated that the results of the benchmarking study shows that the building sector does not generate a substantial amount of externalities in the 2010-2020 period, as a result of which it does not require any substantial measures targeting emissions reductions. The aspect of CO_2 reduction, a critical development factor, is an exception, since the European Union designated this factor as a main priority, with international climate targets (Kyoto Protocol) focusing mainly on reducing GHG emissions. Thus, it is interesting that these two sub-systems (renewable energy and energy efficiency), which decision makers believe should create a balance in the CO_2 equation through harmonious operations, still fail to fulfil this function. The reason is that the national commitments for 2020 fail to meet the levels of possible commitments, allowing countries to fulfil their EU targets without conducting any significant developments in the sector [16]. The positive externalities apparent in the CO_2 aspect call attention to the fact that the sector contains significant potentials for speeding up low carbon developments, which however cannot be implemented without increasing voluntary GHG reduction commitments. (Note: It is public knowledge that Hungary, contrary to other EU Member States, did not make any additional commitments for GHG reductions for 2020.)

The 2020-2030 period shows a completely different overall picture. The details of Table 4 have to be studied to provide an accurate analysis of this fact. It becomes apparent that the rate of externalities in the sector (*Index B*) does not show any significant changes in either of the three main categories and merely shows a tendency to have positive values (*Index A*). This shows that after the 2020 target is met, the sector will have a vast amount of untapped potential by 2030 resulting from technological developments. At the beginning of the methodology part, it was noted that such effects are generally a result of failing to implement developments or measures in the present that would be the driving force for technological developments [17]. These missed opportunities can result in serious deadweight for society over the long term [18]. In the case of Hungary and the countries of the former Soviet bloc, the reason for this is primarily the preference of the prefabricated housing renovation trend instead of building new homes and public buildings. However, the detailed study broken down according to research aspects should also be taken into account to get a clearer picture.

3.1. Evaluation of research aspects

The aspects of the renewable energy ratio: the technological characteristics group proved to be the most important dimension in this aspect: in it, the accumulation of externalities moved by a value of 5 in the positive direction (the total externality accumulation of the aspect in 2030 is illustrated in Figure 1.). This obviously does not come as a great surprise in light of the fact that political decision makers prefer expanding the present system of nuclear energy, which in theory can provide cheap electricity to homes as well. As a result, many developments will be foregone over the long term that would push the building sector in the direction of utilizing renewable energy sources. However, the stance that Hungary has committed itself to developing Nearly Zero-Energy Buildings (hereinafter: NZEB), which, similarly to passive houses, use only very low levels of energy (and thus have low GHG emissions) seems contradictory. Another feature of NZEBs is that the little energy that they do require are provided by renewable energy sources. Hungary has come to an agreement with the EU that it will build only NZEBs after 2020, the performance of which commitment seems rather unlikely.
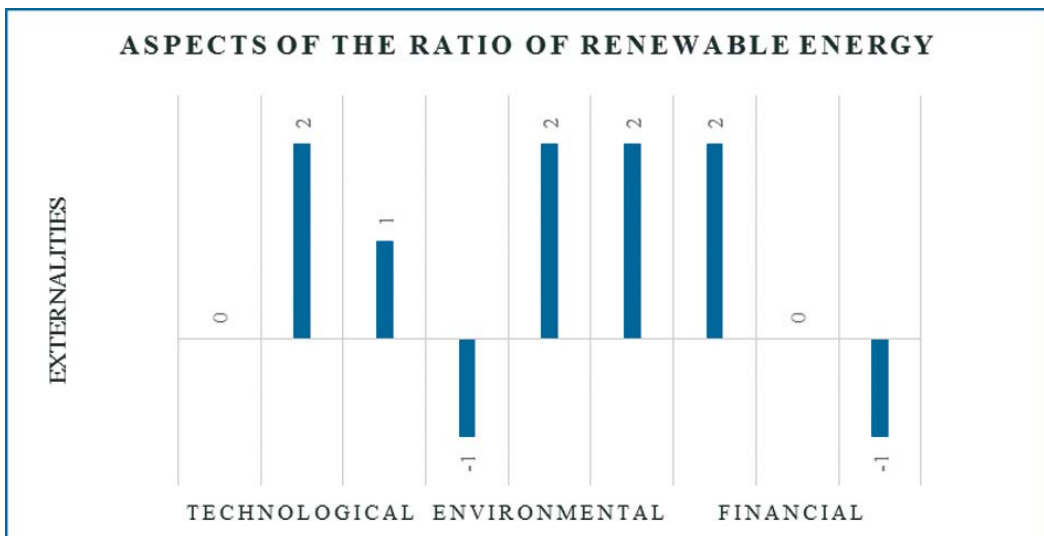

Figure 1. The number of externalities within the renewable energy aspect in 2030

The aspects of increasing energy efficiency: this aspect basically deals with an area where the failure to utilize available potential is not surprising. The reason is that in 2015, the economic policy legislators declared that Hungary will not be spending significant amounts on increasing energy efficiency, since the country can meet the European Union's targets for 2020 without taking any serious measures.

Table 4 shows that the two most important dimensions were the environmental and the financial dimensions, where the accumulation of positive externalities jumped by a value of 4 from one period to the next. As a result of this change Figure 2 shows the high level of externality aggregation regarding the two mentioned dimensions in 2030. This therefore indicates that the absence of regulation and support (financing) targeting increased efficiency end up squandering long term possibilities that would be easy to make use of in the present but will be difficult in the future [19, 20]. In summary, there is a contradiction between the realization

of the set goals and the preparations required for doing so, as the construction of the NZEBs mentioned above requires serious planning and resource allocation. However, the present political stance (which prefers nuclear developments) does not seem to indicate support becoming available for building *low-carbon buildings.*
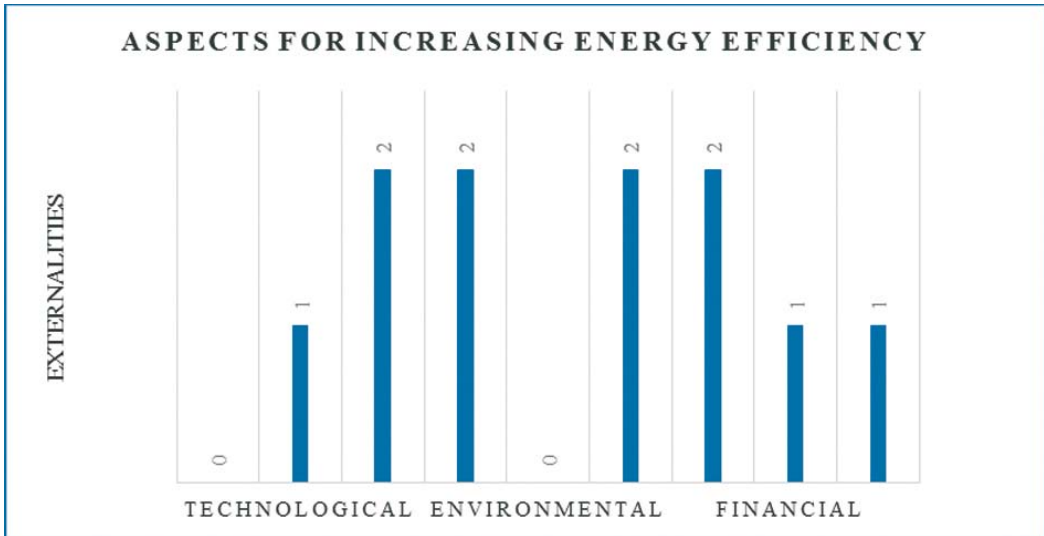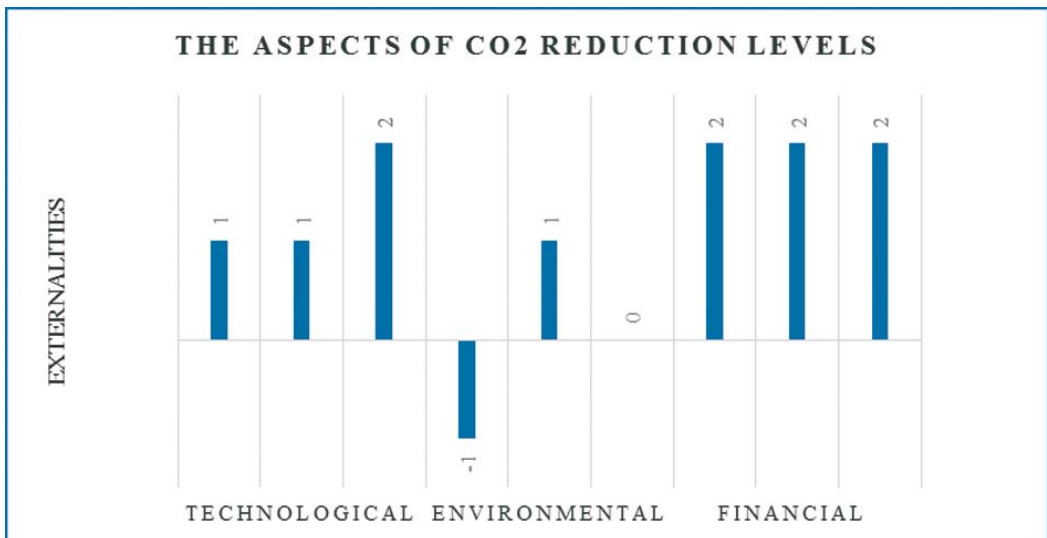

Figure 2. The externality aggregation of the energy efficiency aspects in 2030

The aspects of CO_2 reduction: the last aspect shows the greatest ratio of change in externalities. According to the results presented by Table 4, the value of externalities will increase from 7 in the 2010-2020 period to 13 by 2030. Similarly to renewable energy sources, the greatest change in externalities between the two periods takes place in the technological dimension. This indicator unequivocally shows that developments in technological conditions can pose a serious obstacle in the sustainable development and operation of the building sector. The tendency towards the optimal value is apparent in the case of the environmental dimensions, leading to the conclusion that there is no need for a substantial rethink of sectoral regulations until either 2020 or 2030. The detailed benchmarking analysis also justified this result, as, based on the performed studies, it led to the conclusion that the mandatory EU regulations fundamentally determine all the conditions that, if kept, ensure that climate policy targets can be met.

The bigger problem is the performance of economic conditions or costs: the utilization of support funds. In this field, it can be seen that several developments would be implemented in the 2010-2020 period that would require larger amounts of development funds, but still might not be performed (for example, the development of a smart metering system). By 2030, this deficit in development will only grow, which unequivocally shows that although there are possibilities available for reducing GHG emissions over the long term, the allocation of funds is still necessary in order to provide for their utilization (Figure 3).

THE ASPECTS OF CO2 REDUCTION LEVELS

EXTERNALITIES

TECHNOLOGICAL   ENVIRONMENTAL   FINANCIAL

It is important to stress that the full internalizing of positive externalities (maximally using available possibilities) would presumably result in over-performance in the sector in the climate policy area; as a result, the industry would have no trouble attaining climate policy goals and in fact could even undertake additional commitments.

Regardless, the present processes also indicate that potentials will not be suitably utilized, which could result in deadweight for citizens [21].

The reason behind this is that there are several sectors within climate policy (for example, transport and agriculture) that do not necessarily have such possibilities for development, and so their negative characteristics would have to be offset by the better performing sectors. It is thus safe to say that good performance cannot be overdone in the building sector, since achieving the maximum performance is necessary for all industries.

4. CONCLUSION

The fundamental aim of the present study was to assess how the building sector can contribute to Hungary's meeting of climate policy targets set by the European Union. The study mainly focused on one issue: that of modernizing the building stock. According to the trends that are presently preferred, this process is to take place with the renovation of old buildings. However, several experts declare that this approach can result in grievous financial, social, and environmental losses over the long term. The authors feel that the construction of new buildings in place of the old ones would be more expedient than the use of the present general prefabricated apartment building renovation programs, as the old buildings are at the end of (or, in many cases, past) their lifecycles; in addition, there is practically no financial benefit in these types of investments. An accurate cost-benefit analysis that deals with the financial return of these two possibilities and their environmental and social effects is required to assess this issue in the future.

The relations that can be established on the basis of the benchmarking studies provide a good indication of which areas the cost-benefit analyses should concentrate on as well as which

are the vulnerable and sensitive points in the system's long term development.

First of all, it becomes apparent that although the present trends do indeed guarantee optimal operations for the sector until 2020, the 2020-2030 period will have significant amounts of untapped development potential. In the field of energy efficiency, it can be seen that the lack of compulsory performance has resulted in central source-based support for energy efficiency programs not even being included in economic policy plans. Although the reason for this is clear (the present study also proves that Hungary will still meet the EU's climate policy targets), the country ends up holding the sector's development possibilities back and slowing the rate of modernization. According to the results of the study, the renewable energy developments taking place in the building sector are significantly limited by the nuclear energy program. In addition, the program bases the energy use of buildings after 2025 not on self-sufficiency, but on the electrical energy generated by nuclear power plants.

There are a number of contradictions between the previously undertaken European Union commitments and present financial preferences. The meeting of the Nearly Zero-Energy Building commitments for the post-2020 period is utterly impossible with the present building development concepts. Accurate cost-benefit analyses are necessary to obtain a clear picture of the positive and negative characteristics of the various development alternatives, of the nature of the possible developments for the 2020-2030 period, and of the possibilities for utilizing climate funding (totaling several billion HUF). The resource characteristics that describe a sector's general performance and that were defined in the above benchmarking studies could form an excellent basis for the cost-benefit analyses.

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