UPGREAT

Report on the analysis and evaluation of performance gaps and barriers for energy efficiency implementation methods

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Focus in Cyprus and Greece

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Report on the analysis and evaluation of performance gaps and barriers for energy efficiency implementation methods - Focus in Cyprus and Greece

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HELLENIC REPUBLIC National and Kapodistrian University of Athens

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ABSTRACT

Deep energy renovations (DER) in buildings are now required to satisfy the European Union's low carbon emission efficiency standards in order to confront the climate crisis and boost the economic recovery of Europe after the pandemic outbreak. Acknowledging the societal benefits of energy retrofits in buildings, European policies since 2002, focus on incentivizing building renovations paving the way for the green transition. Following this, various renovation approaches and several so-called "high performance" solutions to achieve energy efficiency appeared in the 2010s. As a consequence, inconsistencies have been identified between the hypothesized, computed, and predicted energy performance of building and the true state of the outcomes that are observed during the operation of the building that hamper the full exploitation of DERs' potential. Therefore, there are gaps and barriers for energy efficiency implementation methods that should be addressed in order to ensure reliable high energy efficiency standards. The aim of this report is to identify these gaps and barriers through a survey, with a focus on school buildings, addressed to white and blue collar stakeholder groups of the buildings sector from Cyprus and Greece.

Vassilis Duros & Margarita - Niki Assimakopoulos

UPGREAT – Upskilling Professionals for deep enerGy efficiency Renovations: A Tool for better schools

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Executive Summary

Deep energy renovations (DER) in buildings are now required to satisfy the European Union's low carbon emission efficiency standards in order to confront the climate crisis and boost the economic recovery of Europe after the pandemic outbreak. With annual energy renovation rates expected to double in the next 10 years, the building sector is expected to make a substantial change in achieving high energy efficiency goals by 2050. Construction sector and building experts are urged to upskill their workforce. This implies both, meeting the targets and learning to use innovative approaches and technological solutions to ensure high quality construction and to increase the energy performance of buildings. However, there are aspects that prevent the implementation of DER at a large extent.

Within this context, UPGREAT [Upskilling Professionals for deep enerGy efficiency REnovations: A Tool for better schools] project aims to identify gaps and barriers for energy efficiency implementation methods in Greece and Cyprus through a targeted survey for building experts related to technical, financial and policy issues that may pose challenges to further boost building renovations especially in schools. The survey methodology of assessing the experience of building experts in DER projects in order to identify gaps and barriers in energy efficiency implementation is the first level towards UPGREATs project scope which is the development, application and dissemination of a Total Training Toolkit – an educational package- through capacity building actions for different target groups involved with energy renovations in buildings.

The aim of this report is to identify gaps and barriers for energy efficiency implementation methods in buildings in Cyprus and Greece with a focus on school buildings. For the identification of the aforementioned gaps and barriers, a survey was conducted from April 2022 until September 2022, addressed to white and blue collars of the buildings sector from Cyprus and Greece and the results are presented in this report. The questions of the survey were appropriately formulated and categorized in order to achieve a better understanding of the most important barriers professionals face in the context of DER projects with regard to technical, financial and policy aspects of the retrofits.

Out of a total of 830 who opened the survey, 514 answered at least one DER specific question and were considered valid. However, for this report, responses from 501 participants are presented since the rest 13 were resided abroad from Cyprus or Greece. Most of the participants in both Cyprus and Greece were familiar with the concept of deep energy renovation with similar percentages which were slightly higher than 70% for both countries. The answers were similar in both countries concerning their experience in deep energy renovation, as they had either participated in such projects (36% Cyprus, 41% Greece) or although they had no experience, they were familiar with the concept (36% Cyprus, 39% Greece).

In summary, the main findings of this report are presented below with the results concerning school buildings being presented separately, decoupled from the general analysis in order to allow for deeper insights to be delivered.

❖ School buildings

Experience with deep energy renovations in schools

Participants were asked whether they had ever worked on a deep energy renovation project implemented in a school with the majority of respondents in both countries stating that they had no experience. According to those who had been involved in such a project though, in both countries, the main reason for renovation in a school was "Poor energy performance". Concerning barriers for the implementation of energy efficiency measures in the deep energy renovation of a school building, the two countries' divergent responses are noteworthy. Respondents in Cyprus place "Technical difficulties due to building characteristics" as their top barrier whereas in Greece most selected option was "Lack of funds or financial incentives". When it comes to the systems installed or upgraded more frequently as a result of a school’s DER, in Cyprus respondents reported that these were the "External envelope insulation" and the "Heating system" whereas in Greece were "Energy efficient windows" and "External envelope insulation".

General barriers for implementing deep energy renovations in schools

The responses of those surveyed in the two countries with regard to particular difficulties that were hard to overcome in the deep energy renovation of a school building diverged across the options given. For respondents in Cyprus, "Technical issues in the design phase" was a frequently mentioned particular difficulty hard to overcome during DER in schools while in Greece, "Technical issues in the construction phase" was highlighted as such. Survey respondents were also asked to indicate in order of preference the three barriers that mostly apply when undertaking DER in schools. The top three barriers in descending order for Cypriot respondents were "Economic / financial resources", "Lack of energy efficiency funding programs" and "User motivation / demand". Respondents in Greece selected "Economic / financial resources" "Lack of voluntary national deep energy renovation schemes for renovation of existing buildings" and as their third option "Lack of exemplary role of public buildings". Regarding the challenges faced when improving the building’s envelope, through insulation systems and energy efficient windows, the majority of respondents in Cyprus and Greece respectively ranked "Budget limitations" as their first choice. When it comes to challenges faced while installing renewable energy systems in the renovation of a school building, respondents in both countries placed the problem of "Budget limitations" in first place.

On the other hand, concerning the factors that could boost the market for deep energy renovation in school buildings, participants in Cyprus had "Improved financing solutions" as their first choice whereas participants in Greece had as their top choice "Consultancy / training". Regarding their level of agreement with options from a predefined list with gaps and barriers which appear during deep energy renovations, from the customer first demand to the final use-phase of the end user, participants in Cyprus and Greece agreed most with the option "Lack of financial incentives and funds" and disagreed in unison with the statement "There are no gaps or barriers and the whole chain is working".

Policy and financial barriers in schools

When considering the energy efficiency policies that support DER in school buildings, in Cyprus 50% of the respondents considered that "No specific targets for deep energy renovations in schools have been defined yet". On the contrary, in Greece the majority of the participants stated that "Very few ambitious policy packages have been defined but not enough development". According to participants in Cyprus, the most important gap in policy for the applicability of energy efficiency (EE) policies in school buildings was the "Poor national/regional legislative framework for renovation of existing buildings". On the other hand, participants in Greece considered "Poor overall ambition of the EE policies" as the most important gap in policy. Moreover, regarding the most prominent barriers for financing energy renovations in schools, almost one out of three survey respondents placed "Poor financial incentives" as their first choice.

On the efforts respondents have made in order to reduce construction costs during DERs in schools, participants from both countries selected as their first choice "Labour". Finally, almost all of the respondents in Cyprus stated that "Construction phase" required additional financial resources compared to a traditional project, whereas slightly more than half of the participants in Greece agreed by stating the same.

Barriers in products and solutions for deep energy renovations in schools

Regarding regional availability of products and technological solutions for DERs in schools, 50% of the respondents in Cyprus stated that "There is a wide variety of technical services on offer", as opposed to a slightly higher share of those surveyed in Greece who stated that "Yes, but the offer is limited, and prices are high". Finally, prominent product categories used in DERs of school buildings, according to the survey participants in Cyprus and Greece, were "Envelope products" and "Heating Systems".

Issues on comfort and indoor air quality in schools

The familiarity of those surveyed in both countries, with the concepts of "Thermal comfort" and "Indoor air quality" is clearly reflected in the survey. The vast majority of the participants from Cyprus and Greece, stated that they were aware of the two terms and how these apply in school buildings. In addition, according to the respondents, the parameters of thermal comfort or indoor air quality that had been measured in DERs of schools for a certain period of time, were "Indoor temperature", and "Indoor relative humidity" in both countries. In the renovation projects, the comfort issues that were taken mostly into account were "Thermal comfort" and "Indoor air quality" leaving on the side visual and acoustic comfort.

Regarding whether the students' opinion was taken into account before and after the energy renovation of a school building on various comfort aspects, the majority of respondents in both Cyprus and Greece answered either negatively or stated uncertain. However, for the thermal comfort parameter, participants from Greece stated that students’ opinion was heard before the deep energy renovation of the school.

❖ Deep energy renovations in buildings

General barriers for deep energy efficiency renovations implementation

The top selected particular difficulty faced in DER projects that were hard to overcome by the respondents in Cyprus was "Finding skilled actors" whereas those surveyed in Greece considered "Technical issues in the construction as a particular difficulty that was hard to overcome in DERs. When asked to indicate in descending order of preference the three barriers that mostly apply when undertaking DERs, most of the respondents in both Cyprus and Greece placed as their top two choices, those of "Economic / financial resources" and "User motivation / demand". The third choice for those surveyed in Cyprus was "Lack of voluntary national deep energy renovation schemes for renovation of existing buildings" while for the respondents in Greece was "Lack of energy efficiency funding programs". Regarding their level of agreement with options from a predefined list with gaps and barriers which appear during deep energy renovations, from the customer first demand to the final use-phase of the end user, in both countries respondents agreed mainly on a) "Building user's/owner's socioeconomic status" and b) "Lack of financial incentives and funds". When improving building’s envelope through insulation systems and energy efficient windows, survey participants in both countries, stated that they faced challenges with regard to "Budget limitations" and "Inadequate professional skills of installers". When it comes to challenges faced during the installation of renewable energy systems in DER projects, "Inadequate professional skills of installers" was the most frequent answer amongst Cypriot participants whereas respondents in Greece said that it was the "Budget limitations". On the other hand, when asked about the drivers that could boost the DER market, "Improved financing solutions" was the most selected option in both countries.

Policy and financial barriers

With regard to national energy efficiency policies that promote DERs, in both countries the majority of participants agreed that "Very few ambitious policy packages have been defined but not enough development". According to the survey, the most important policy gaps regarding the applicability of energy efficient (EE) policies in Cyprus were "Poor national/regional legislative framework for renovation of existing buildings" and "Lack of voluntary national deep energy renovation standards for renovating existing buildings". In Greece, respondents equally highlighted that there are "Poor national/regional legislative framework for renovation of existing buildings" and "Inadequate adaptation of EE policies". Moreover, one out of four of the respondents in Cyprus, considered "High capital costs and financial risk" as the most important barrier for the financing DERs in buildings. However, those surveyed in Greece, placed "Poor financial incentives" as their first choice. According to those surveyed in the two countries, most efforts to decrease construction costs were made with regard to "Labour" in Cyprus and on "Building materials" in Greece. Most respondents (in both countries stated that in the deep energy renovation of a building, the task which required additional resources compared to a traditional project was the "Construction Phase".

Barriers in products and solutions

With regard to regional availability of products and technological solutions, respondents from both countries replied that products and technological solutions are easily available for DERs in their regions however offer is limited, and prices are high. Furthermore, when asked which product category is the most prominent in their regions, there was a dispersion of responses between the two countries. In Cyprus "Cooling systems" stood out while in Greece "Envelope products".

Issues on comfort and indoor air quality

When asked if they are familiar with the terms of “Indoor Air Quality” and “Thermal Comfort” and how these two terms apply for a building, most participants in both countries answered in the affirmative. Moreover, regarding which parameter of indoor air quality or thermal comfort has been measured for a certain period of time in the DER projects they were involved, the majority of those surveyed in both countries said "Indoor temperature". Furthermore, with regard to the issues of comfort that were taken into consideration during a DER, "Thermal comfort" was the top selected option by respondents in both Cyprus and Greece.

Finally, when asked if the occupants were surveyed with regard to comfort aspects before and after the deep energy renovation, in relation to their overall perception of indoor air quality, visual comfort and acoustic comfort, most respondents in both countries said they were "Uncertain". On the contrary, with regard to thermal comfort, most participants in both countries answered positively confirming that occupants were surveyed before the renovation but most of them were uncertain if the occupants were surveyed after the DER was implemented.

1.Introduction

The main challenges we confront as a society are the climatic emergency and the socioeconomic crisis triggered by recent events—COVID-19 and the hydrocarbons crisis caused by conflicts. Climate change, financial struggles and the energy demand, highlight the benefits derived from energy efficiency in buildings as an effective strategy to reduce greenhouse gas emissions, to promote sustainability by consuming less natural resources, and to lower individual utility bills. According to the literature, energy use reductions in pretty standard retrofit projects range between 10% and 20%, whereas experience from completed projects worldwide demonstrates that reductions can surpass 50% with the retrofitted buildings reaching in a cost effective way the Passive House standard. Interestingly, a comprehensive study looking at the highly energy efficient Passive House standard by Johnston et al. showed that for a number of over 2000 dwelling units the calculated heating energy demand was in average in concordance with the consumptions whereas looking at the economics of potential energy savings also the “as is” consumption and demand before retrofit are of importance.

Acknowledging the societal benefits of energy retrofits in buildings, European policies since 2002, focus on incentivizing building renovations paving the way for the green transition. Following this, the appearance of various renovation approaches and several so-called "high performance" solutions to achieve energy efficiency have begun in the 2010s. As a consequence, several inconsistencies have been discovered between the hypothesized, computed, and predicted energy performance of buildings and the true state of the outcomes that are observed during the operation of the building. Therefore, there are gaps and barriers for energy efficiency implementation methods that should be identified in order to proceed given that existing buildings represent a huge potential for energy saving which is hard to exploit though. For example, in the case of schools, in Greece, most school buildings were built before 1990, dilapidated and poorly insulated. Upgrading thus effectively their performance depends not only on technical solutions but also on socio-economic factors (willingness and skills of stakeholders, regulation and incentives, norms and values). In the present report, the barriers are categorized and their impact is assessed

This introductory chapter aims to briefly juxtapose Energy Performance Certificates (EPC) declarations and the condition of the corresponding buildings as well as to map the existing knowledge on factors that hamper the implementation of energy efficiency measures in buildings. Therefore, it explores and summarizes the current situation of 21 buildings through the information provided from their Energy Performance Certificates and then categorizes and characterizes the most common barriers found in the literature and from onsite visits in the aforementioned buildings for implementing energy efficiency measures. These may be divided into five broad categories: financial, technical, social, legislative, and administrative barriers. Based on these categories, the questionnaire to assess their impact was developed and is presented in chapters “4. Deep energy renovation in schools” and “5. Deep energy renovation in buildings”.

1.1 Comparative assessment of collected Energy Performance Certificates to detect performance gaps

In order to evaluate the performance gaps and barriers for energy efficiency implementation methods and detect deficiencies, a comparative assessment of collected Energy Performance Certificates (EPCs) with onsite visits at case buildings was carried out. In total, 21 Energy Performance Certificates were collected from 15 schools, 2 police stations, 2 town halls and 2 office buildings. Out of these 21 EPCs, 12 are issued in Greece, 6 in Cyprus and 3 in Germany. The collected EPCs are listed in Annex II of this report. German case buildings follow the Passive House Standard principles, show significantly higher energy performance compared to the buildings located in Cyprus and Greece, although the climate is colder, and they are presented here as good practices that may be adopted in the Cypriot or Greek context.

Table 1 demonstrates the basic information on status and performance of buildings according to collected EPCs including the following: country, type of building, year of construction, final energy demand, final energy consumption and CO_2 emissions. In order to identify the performance gap, Table 1 also demonstrates the comparison between the final energy consumption and the final energy demand for each case building. There are cases with missing data, especially because of the inability to access the consumption bills or the buildings' personnel lack of information. In the absence of data, we may rely on the findings of a 2008 research[1] conducted by NKUA's Group of Building Environment Studies for school buildings in Greece. A typical school in Greece consumes 68 kWh/m^2/year of energy, of which 55 kWh/m^2/year is required for thermal reasons.

Table 1 Information on status and performance of buildings according to collected EPCs

Case study number	Country	Type of building	Year of construction	Final energy demand (EPC) kWh/m²/yr	Final energy consumption (Bills) kWh/m²/yr	Performance gap between EPCs and Consumption kWh/m²/yr	CO_2 emissions $KgCO_2/m^2yr$	Renovation	Final energy demand (EPC) kWh/m²/yr	CO_2 emissions $KgCO_2/m^2yr$
1	Cyprus	Police Station	1994	546	97.2	-448.8	159.24	Not yet		
2	Cyprus	Police Station	1985 and 2001 (extension)	860	170.30	-698.7	252.56	Not yet		
3	Cyprus	Town Hall	2001	385	130.58	-254.42	113.18	Not yet		
4	Cyprus	Office	1953	160	24.32	-135.68	47.09	Not yet		
5	Cyprus	Town hall	1993,2005, 2009	505	64.75	-440.25	148.44	Not yet		
6	Cyprus	Office	1953	213	40.43	-172.57	62.29	Not yet		
7	Greece	School	2021	68.7	61	-7.7	40.4	Not yet		
8	Greece	School	1989	126.6	24.56	-102.04	37.7	Not yet		
9	Greece	School	1999	122.8	54.6	-68.2	36.7	Not yet		
10	Greece	School	1993	154.2	68	-86.2	43.8	Not yet		
11	Greece	School	N/A	358.5	78	-280	92	Yes	35.2	12
12	Greece	School	1998	113.6	68	-45.6	33.5	Not yet		
13	Greece	School	2003	119.7	68	-51.7	36.2	Not yet		
14	Greece	School	1977	189.3	43.8	-145.5	43.2	Not yet		
15	Greece	School	1970	126.1	68	-58.1	35.6	Not yet		
16	Greece	School	N/A	122.9	68	-54.9	34.9	Not yet		
17	Greece	School	1952	122.2	68	-54.2	38.2	Not yet		
18	Greece	School	N/A	193.6	68	-125.6	57.8	Not yet		
19	Germany	School	2016	17	20	3		Yes	15.5	N/A
20	Germany	School	2020	51			34			
21	Germany	School	1970/74	25	49.8	24.8		Yes	24.7	N/A

Case buildings' construction elements vary from country to country and are also affected by the construction age. Case buildings in Cyprus are mostly made of concrete, brick, and plaster, with stone veneer in rare cases. Furthermore, there is no thermal insulation in the envelope and barely minor roof waterproofing. To reduce sun overheating, the glazing percentage is roughly 25%. A/Cs, heat pumps, and

[1] Report on Energy Saving in Greek Buildings, University of Athens, Athens 1/3/2008. (In Greek) http://www.sate.gr/nea/energy.pdf

solar panels for DHW are the most common heating and cooling technologies in Cyprus. In some cases, chillers or mechanical ventilation may also be encountered. The interior air quality and thermal comfort of the buildings do not match the standards, according to the envelope elements and HVAC systems installed. Only when mechanical ventilation functions, indoor air quality and thermal comfort appear to be satisfactory. Brick, reinforced concrete, and total or partial insulation are the most used building materials in Greece. The heating systems are mostly oil and natural gas boilers and cooling systems are A/C split units. According to the EPCs, the interior air quality and thermal comfort were assessed to be generally sufficient.

In Germany, the 3 cases built in concordance with the Passive House principles, show significantly lower energy consumption and demand compared to the Cypriot and Greek cases. Case 19, is a 2016 built school, with. concrete and wood being the main construction materials providing a solid clean cut to the building whereas marmoleum concrete flooring is laid on an area larger than 6,500 m². The building's atrium is the main source of incoming daylight and fresh air in the building. Six skylight bands in the atrium's ceiling allow diffused sunlight to enter into the hall giving a bright, airy appearance to the atrium, improving the atmosphere for the building users. These skylights are set back in light wells recessed into the expanded metal ceiling, making them look almost like light fixtures. Moreover, the large glazed areas in the roof allow warmth from the sun to enter the hall assisting to heat the building's pavilions and further add to environmental benefits. The heating needs of the building are covered by a pellet - fed biomass system which is installed in a separate building. On the contrary, during the hot days, warm air can escape through venting modules in the skylights whereas automated night cooling through the façade's panels as well as the use of thermal mass in the exposed concrete ceilings help to keep temperatures down and prevent overheating. The low cube shapes, apparent in the building's design and good thermal storage characteristics of the robust construction materials ensure decreased maintenance and low operating costs over time. The building's energy efficiency standard is evidenced by its compliance with the Passive House Institute's criteria for the primary energy demand.

Case 20 from performance perspective, was constructed according to the Passive House principles. It has low energy demand due to the high insulation level, the good triple pane timber windows, the adequate airtightness level of the construction and the mechanical ventilation with heat recovery. In order to keep the risk of overheating low, the school is equipped with automatic shading blinds and night ventilation. The mechanical ventilation is decentralized and there is one appliance per class room, including wall penetration while the architecture keeps the school minimal by integrating the ventilation system into a shelf unit, avoiding large ducts in the building. During the winter times the heat is provided through a combination of systems. There is an air to water heat pump heating system that works in collaboration with a natural gas boiler in order to cover the peak load. The inside of the building is in neutral colors ensuring concentration while the large windows let plenty of light into the room, and the architecture is committed to wood as a building material. Finally, Case 21, initially constructed in the 1970s and refurbished in 2018, was dismantled down to the reinforced concrete skeleton. A new building figure was created through additions and extensions, which also uses large parts of the existing supporting structure. Classrooms, natural sciences area, administration and auditorium were regrouped, and a canteen was added. The renovated building has adopted an energy-optimized design and follows the passive house principles with technologies and energy efficient measures similar to the previous two school building cases.

Back in Table 1, as it can be observed, the performance disparity is usually negative. That is, actual energy usage is lower than demand. This result might imply that the levels of comfort within the structures were not fulfilled. In cases where the sign is positive, a more intensive usage or higher room temperatures might be the reasons whereas another cause might be the precision of the computation, which has a maximum accuracy of 3 kWh/m^{2}a. It is important to point out that there might be various potential reasons for the deviations observed between demands based on EPCs and consumptions; especially for older buildings, the expected boundary conditions are not fulfilled in many cases (e.g. room temperature is lower) while in some other cases the thermal envelope's quality is low and in turn buildings cannot be heated properly. Another source is the building's operational patterns and the behaviour of the users. For example, the existence of unheated rooms, which are perhaps not used, reduces the consumption whereas on the contrary, overheated rooms increases the consumption. Another important point that should be stressed out is that EPCs are typically intended as a tool to make buildings comparable concerning their energetic properties. They are not intended to give a good picture of the real consumption during operation and in many cases the quality of input data is limited.

An influencing factor during the last years for the disparity between energy demand (EPC) and energy consumption (bills) is the COVID pandemic outbreak. On one hand, the outbreak caused a subsequent pause of activities in schools, since personnel was decreased throughout 2020-21 and remote education took place. On the other hand, a prevalent increased natural ventilation, by opening the windows, could be observed also in winter leading to significantly increased energy consumption for heating. However, in some cases the performance gap cannot be directly linked to the COVID-19 outbreak, not only because the period of metering readings/energy bills was not explicitly provided by the buildings' personnel, but also because the obtained energy bills were from previous years when various retrofitting and behavioral change measures were partially implemented to minimize energy demand/consumption as a result of the financial crisis Greece faced during those past years and affected Cyprus as well. The difference in these cases, was most likely caused by highly conservative assumptions about heat losses and the overall energy efficiency of the building during the certification issuance process.

Obviously, more reliable data, such as the final energy demand and consumption as opposed to estimates, details about the energy efficiency of the building's equipment as well as information about the performance of the materials the building was built together with indicators about the comfort levels of building users would make EPCs more inclusive. When the buildings' performance is compared to the performance of the German cases, refurbishment appears to be mandatory in the majority of the cases as there seems to be much space for improvement.

Nevertheless, it should be also noted that the observed performance gap has to be strategically handled before implementing any energy efficiency measures. On the one hand, if the consumption is lower than the demand because of usage patterns, the potential reduction of CO_2 emissions as well as the subsequent economic savings have to be directly linked to the reduced consumption. On the other hand, the demand should stand as a reference point not only in case of comparisons between buildings but also if a certain comfort level is to be achieved. However, it is uncertain if users who might accept reduced comfort levels at a given period of time, will feel adequately comfortable in future periods. Therefore, this also implies that the calculation of savings achieved by energy efficiency measures compared to the actual demand should be justified and a clear communication of this aspect from the building professionals to the building users is of high importance.

In the majority of the cases, it was obvious from onsite visits that energy efficiency upgrades should include exterior thermal insulation of the walls and roof, as well as roof waterproofing. Furthermore, the existing draughty doors or inefficient aluminum-framed single glazed windows should be replaced with new, high-efficient products. In addition, the existing energy systems and equipment (boilers, HVAC, lighting etc.) should be replaced with newer, energy efficient ones.

The reasons for the poor energy performance observed in most of the cases or for the inability of a refurbishment to take place till now may be summarized in i) the lack of direct funding or financial support in the form of incentives for energy upgrades in public buildings and especially in schools, ii) lack of robust policy strategies or initiatives aimed to achieve high energy efficiency standards in existing school buildings, as well as in iii) poor retrofitting interventions as a result of the scarcity of skilled building professionals in deep energy renovations. However, the investigation of the impediments should not be limited to the aforementioned three factors but a further breakdown of the barriers that prevented so far deep energy renovations to be implemented in the cases presented in this paragraph should be made. Therefore, with the assistance of literature, the barriers may be classified in five broad categories: financial, technical, social, legislative, and administrative.

1.2 Financial Barriers

"Economic barriers refer to difficulties in accessing credit, insufficient and unstable available funding, high risk for investors and financial institutions" (1,2), all of which will be examined thoroughly.

1.2.1 Lack of energy efficiency funding programs

Funding programs or else government and financial institution grants could be described as awards for a constructive project. It does not include loan guarantee but a transfer payment itself. Although, they include stringent compliance and reporting measures to ensure the money is well-spent from the grantee. If the funds are received in stages, these reports must continue during the grant period. Any accomplishments or failures also must be documented and submitted to the sponsoring agency according to various deadlines (3).

1.2.2 Long payback period

"Payback period is usually measured as the time from the start of production to recovery of the capital investment"(4), and shows how much time it takes for an investor to regain the amount of money they invested. The intervention procedures are not adequately profitable since both long period of time and low returns are required. If the payback period is extended, it takes more time for an investment to repay its initial price, becoming less profitable and riskier.

1.2.3 Lack of financial incentives

Inexistence of economic incentives such as tax exemptions and grants in order to encourage implementations like energy efficiency measures that would be extremely challenging to be completed otherwise. State and local financial incentives and programs would help in this case execute energy efficiency projects by lowering cost loads through public benefits funds, grants, loans (4).

1.2.4 Lack of credits

This barrier refers to the investors' disbelief to lend money or access services. That is due to the fact that there is distrust of the process. "Decision-makers don't trust current information or may dismiss known energy saving activities because they do not have the knowledge to determine their effectiveness. There is a lack of familiarity and trusted supply chains/contractors" (5).

1.2.5 High risks

Risk is related to the success of the energy efficiency retrofits. Identifying risk as a considerable barrier is important, since accurate estimates of the net costs of implementing such measures depend on future economic conditions in general, and on future energy prices and availability in particular. Studies among ventures have found that some may not even be able to reduce uncertainty to a calculated risk due to a lack of time and money to calculate the required estimates (6).

1.2.6 High prices

As far as the high price barrier is concerned, the discussion is about the retrofit costs. Focusing on insulation, choosing the right ventilation system, buying certified equipment and using LED lights for instance, are some procedures that could end up extremely costly to be implemented. However, the high costs for the implementations may be balanced with the reduction of the utility bills and with one other significant parameter. By implementing energy efficiency measures, emission of carbon dioxide decreases significantly. Thus, taxes regarding the over-emissivity of CO_2 that might apply will not be an issue anymore.

1.3 Technical Barriers

Technical barriers emerge in the design phase, in the construction phase and after the implementation of deep energy renovations projects in schools. Such barriers could not only refer to the available human resources and resources in general but also to the technical expertise, highly important in these projects (7). These difficulties will be examined below.

1.3.1 Lack of skilled actors

This barrier has to do with the role of all the personnel involved in these implementations. As far as the managers are concerned, a massive problem is the lack of awareness about the reason behind implementing deep energy renovations and the benefits that follow them. This can be due to the fact that the manager selection is not proper. For instance, it is more appropriate for an energy saving project to be supervised by an expert in this exact field. Thus, if the selection is not as mentioned, the limited expertise will be a hindrance. Secondly, lack of adequate training of the personnel, with respect to energy saving can obstruct the implementation of intervention. Moreover, regarding the staff's lack of awareness, some do ignore issues that are highly critical to the whole procedure leading to pure workmanship. Poor quality construction has a significant impact on the energy performance of buildings, thus becoming a significant barrier in deep energy renovations. Poor construction works could occur due to an individual issue or a combination of the issues of insufficient design details, inefficient use of quality assurance plan, or lack of knowledge or care of frontline workers (8). If the building fabric is constructed incorrectly, it may reduce the thermal performance of the envelope due to thermal bridging and excessive heat loss which will increase energy consumption. For instance, some procedures can be done in a rushed way, rendering them completely inadequate (7).

1.3.2 Availability of technical services

Technical services signify all services that are necessary to carry out individual, scattered site activities including conducting initial inspections, cost estimate preparation, maintenance, inspections, monitoring to survey actual performances etc. Technical services are services which are rendered by professionals like engineers (9). For instance, a mechanic who repairs cars is offering a technical service. In the case of energy efficiency measure implementation, the barrier refers to the wide variety of technicians that can complicate the whole procedure, thus delaying the implementations. On the contrary, limited availability of technical services in the region could also be an obstacle by lacking proper technicians for each task.

1.3.3 Availability products

In order to implement DER in schools, cost-effective products are vital. Regarding the retrofitting process, these could refer to air conditioners, fans, or ventilation systems in general which replace 'used' air with fresh air from outside and also insulation materials such as fiberglass that slows the spread of heat, cold, and sound in structures. Other products refer to those that end users are utilizing. These could refer to lighting equipment, computers and other appliances that are of great use in schools. All this wide variety of products is accessible. This characteristic has concluded in many different price tag levels depending on the energy efficiency class and consumption for the electronic equipment and on the U-value of each material, thus becoming a sticking point when opting for products(10). In a similar way as the previous barrier, a limited availability of products could also be a hindrance. This could happen in remote regions where not all the technological solutions can be implemented. For instance, in a village far from metropolitan areas, the difficulty of finding the proper equipment could be complicated and with the combination of all the barriers mentioned above, the whole procedure turns out to be extremely challenging.

1.3.4 Lack of time

Time pressure is a significant factor in construction projects. Firstly because of the penalty that can be applied for late delivery and secondly because contractors need to move to their next projects. Under time pressures, contractors may take shortcuts to finish work on-time. This can lower the quality of works and create defects in building components, which are connected with the risk of incorrect installation of the building's fabric and systems, concluding that time and effort required to obtain necessary information and implement measures is too high (8,11). This barrier is enhanced when implementing measures in schools, not only because the construction site is bigger than a typical residential house but also because the time margin that schools are not occupied are confined, enforcing any alterations to be taken place in holiday seasons.

1.3.5 Inaccurate design assumptions

This barrier exhibits any issues that might emerge during the design phase. Simulation assumptions should have firm roots in statistically significant studies of building stocks with similar characteristics to the building in question. If there are not, it is very difficult for the designer to accurately estimate the values of parameters in the design phase such as ICT power density, ICT usage schedules, or lighting power density which significantly affect the energy usage in institutional buildings (8). One other significant hinder is the inappropriate modeling of building elements (12). Before any intervention, a simulation model is usually applied to visualize the expected optimal performance of the building to be renovated. Thus, any ambiguities in the models can harden the whole procedure. More precisely, simulations are undertaken to test the HVAC design against a range of expected operational conditions and if the model is not properly structured, the result will differ (13).

1.3.6 Technical issues in the construction phase

Lack of construction quality can result in deviations from the design specifications, especially with regard to insulation and air-tightness (14). If insufficient attention is paid to the construction process, it becomes likely that flaws in the final building will arise and cause performance problems (15). Other issues in the construction phase are regarding the present site form, boundaries, conditions and neighboring properties in the school surroundings. These conditions may lead to restrictions. For example, if a school is located in an area where neighboring buildings are evaluated as historic or in a region that the space is limited, it can be extremely challenging to intervene in the available area in order to implement energy efficiency measures or place renewable sources of energy (16). In addition to that, there are difficulties to intervene in occupied sites, such as schools. It is easier to carry out work during holidays so to act in steps or pieces. The lack of long-term vision sometimes does not allow to make all the required work.

1.4 Social Barriers

In the case of deep energy renovation practices, it is more urgent to understand what is relevant when it comes to technological aspects for end users, including how they comprehend technological changes and how they evaluate their benefits and potential drawbacks (17). Some of the social barriers are listed below.

1.4.1 Lack of knowledgeable end users and facility managers

This barrier originates from the lack of education and information about energy efficiency renovations, and the perception, the feelings by the end users (by mentioning end users in this case, the school staff and students are considered) (17). Facility staff members do not have the resources or the understanding of the systems that they are operating. This is particularly true if new and emerging technologies are installed in the building. Also, the staff members are not paid very well. Thus, there is not much incentive for people who are either degree-qualified or have years of experience to act in a cost-efficient way (8). The low acceptance of new technologies can lead to latent mistrust towards professionals on these projects. It correlates with behavioural aspects towards available technological solutions and the possibility of purchasing and using new products. Thus, they are looking for long-lasting solutions that will be both economically and practically viable. Activities that raise awareness are key elements for the acceptance of energy efficiency renovations. These are the first crucial steps to provide knowledge on the importance of improving schools', and buildings' in general, energy efficiency through the application of the respective innovative technologies (18). As far as the facility managers are concerned and due to the inexistence of them, the task of maintaining the building is usually transferred to a third party facility manager who does not have the technical knowledge and the experience to deal with the high tech systems of modern buildings. Facility managers' main objective is to make sure that the facility is safe and operates in such a way that they do not get any complaints regarding thermal comfort.

1.4.2 Lack of exemplary role of public buildings

Public administration has a leading role to play in energy efficiency measures and it is important that successes and also failures are showcased in order to encourage individuals, organisations and businesses to implement them (5). Research indicates that although the general public is concerned about climate change and understands the need to take action, they want the government to take the lead in driving change (5). Thus, the engagement and leadership of local government in delivering change can have a particularly positive key effect in changing residents' behaviour and encouraging them to take individual actions.

1.4.3 Inertia

In short, inertia means that individuals and organizations are creatures of habit and established routines, which may make it difficult to create changes to such behaviors and habits (19). Individuals who argue to change within an organization may result in overlooking energy efficiency measures that are cost-effective. This is stated as an explanatory variable to the "energy performance gap" in buildings. This description may partially explain the failure of many energy users to take economically justifiable actions to save energy; energy efficiency also often begins with small commitments that later lead to greater ones (20,21). For instance, in the case of schools, no energy efficiency measure can be productive if there are difficulties in adapting relevant behavioral aspects (i.e. leaving the windows open when the HVAC system is enabled).

1.4.4 Correlation with areas' status

As studies suggest, there is a correlation of deep energy renovation projects with the socioeconomic status of the area where a school is located (22). In case of schools in more affluent neighborhoods, due to more available funds from other sources as well (i.e. from the parent association), implementation of energy efficiency measures is facilitated. Accordingly, in non-affluent neighborhoods where the fund availability is restricted, the whole procedure is hardened, rendering this as a barrier for these implementations.

1.5 Regulatory-Legislative barriers

Implementing energy efficiency policies is one of the most cost-effective instruments for overcoming barriers to energy efficiency. For this reason, energy efficiency policies have been essential elements of energy sector reform for many countries since the late 1970s (23). Legislative barriers refer to hinders that may emerge when implementing energy efficiency (EE) policies. In a similar way, regulatory barriers relate to the mispricing of energy (such as electricity and natural gas) as set by regulatory bodies. Historically, the price of electricity as set by regulators is frequently below its full economic cost including externalities. This mispricing creates an incentive to overconsume electricity as opposed to conservation or increased efficiency.

1.5.1 Poor overall ambition over EE policies

Energy efficiency policies and programs can help drive the implementation of projects that minimize or reduce energy use during the operation of a system or machine and/or production of a good or service. Regarding this barrier, all the hardships and mistrust that may emerge during the whole process can lead to insufficient desire for success in deep energy renovation progress by most actors. The hardships mentioned above can refer to government ineffective actions to promote the energy efficiency measures to raise public awareness and in the legislative system adopted by every country.

1.5.2 Poor national/regional legislative framework for renovation of existing buildings

This barrier is highly important when implementing energy efficiency measures in schools due to the fact that such buildings do usually pre-exist and there are many legislative barriers since additions are not always admitted by current regulations. Thus, if there are problems like inadequate renewable energy legislation and lack of sufficient legislation, the procedure will be complicated (17). This leads to developed legislative frameworks that cover and reduce financial risk.

1.5.3 Bureaucracy

The term "bureaucracy" refers to the excessive amount of paperwork necessary to be compliant with legal requirements, which is not tailored with respect to the capabilities of the company (7,24). Particularly, in the school interventions case, any delay in the decision making could obstruct the project due to the lack of time to implement energy efficiency measures.

1.6 Administrative barriers

Last but not least administrative barriers in deep energy renovation interventions do exist. These barriers refer to the lack of cooperation within all the involved actors but also to the inexistence of certification entities.

1.6.1 Lack of certification entities

This barrier refers to the lack of standardized measurement and verification. Absence of standard measurement and verification procedures can negatively impact demand response contract settlement, operational planning, and long-term resource planning. The certification body could do the actual inspection. The certification decision, i.e. the granting of the written assurance or "certificate", is based on the inspection report, possibly complemented by other information sources. Certification is always done by a third party. The verification is done, and the assurance is provided by a party without direct interest in the economic relationship between the supplier and buyer.

1.6.2 Lack of cooperation among actors

Poor interaction among various teams inhibits the development of innovative solutions that can be achieved from brainstorming (8). Because not only with inefficient collaboration the outcome will be worse, but also everyone will not have the chance to express their opinions about how to optimize the energy efficiency measures. Each group interacts with the campus differently, so each can bring different ideas. For instance, IT staff may have ideas about how to reduce energy in a computer lab. A cleaning crew can identify areas where lights and electricity are left on after classes. Maintenance staff may be able to find and fix drafty areas. Thus, in case of lacking cooperation, this advantage might not exist. So, the risks of installing new technologies can be maximized through ineffective communication between project managers, contractors, designers and commissioning agents.

2.Methodology

The purpose of this technical report is to identify technical, financial and policy gaps and barriers for energy efficiency implementation methods. For the identification of the aforementioned gaps and barriers, a survey was conducted from April 2022 until September 2022, addressed to white and blue collar professionals of the building sector from Cyprus and Greece. Three versions were prepared; one in Greek, one in English and third in hybrid form with German description on the informed consent section and English language in the main body in order for the survey to comply with the GDPR rules for the German speaking audience.

The survey was circulated from the end of March (English version) - beginning of April (Greek version) until the end of September 2022. The questionnaires were disseminated through i) by-weekly social media posts, ii) dissemination in international and national conferences, iii) blog articles in project's and EUKI's websites, iv) social media posts in project's and EUKI's social media and v) email's to the consortium's partners mailing lists.

Out of a total of 830 who opened the survey, 514 answered at least one DER specific question and were considered valid. However, for this report, responses from 501 participants are presented since the rest 13 reside and work abroad from Cyprus or Greece. Out of the 501 participants, 107 were from Cyprus and 394 were from Greece.

2.1 Questionnaire surveys and analysis methods

Online versions of the questionnaire surveys were created on LimeSurvey. The answers were processed using Microsoft Excel and IBM SPSS software.

The questions of the survey were divided into two broad categories, those concerning deep energy renovation in school buildings and those concerning general buildings (i.e apartments, offices).

The questionnaire included multiple-choice, dichotomous, and rating scale questions. In the first type of question the participants of the survey had some possible options to choose from, while in the second type they had only the options "Yes", "No", and "Uncertain". In the third type of questionnaire, respondents were asked about the level of agreement with statements from a predefined list; each option had a score which was used in the analysis of the results. Ranking type questions had to be placed from the highest to the lowest level of preference.

A two-proportion z-test was used for testing the proportions between the responses of participants from the two countries.

- The null hypothesis (Ho) for the test is that the proportions are the same.
- The alternate hypothesis (H1) is that the proportions are **not** the same.

Independent samples t-test was used to determine whether there is a statistically significant difference, in likert type questions, between the means of the two groups of respondents.

- The null hypothesis (Ho) for the independent t-test is that the population from the two unrelated groups are equal.
- The alternate hypothesis (H1) is that the population means from the two unrelated groups are **not** equal.

In both tests, a significance level to either reject or accept the alternative hypothesis is set at 0.05.

Furthermore, P-values are calculated to support or reject the null hypothesis.

- A small p (≤ 0.05) rejects the null hypothesis.
- A large p (>0.05) accepts the alternative hypothesis.

2.2 Data collection

The consortium disseminated the survey starting from April 2022 with a) by-weekly social media posts, b) dissemination in international and national conferences, c) blog articles in the project's and EUKI's platform d) social media posts in the project's and EUKI's social media and e) emails to the consortium's partners mailing lists. The target of 500 valid questionnaires was achieved not earlier than the end of September 2022.

The questionnaire was opened a total 830 times; however more than 300 entries were rejected as they were either invalid or not enough information was provided for a meaningful data analysis. More specifically, the valid questionnaires of those who answered at least one question about deep energy renovation were 514, of which 13 were from participants from Germany, who due to low participation were excluded from the survey as their input would not be representative of the German reality so to be included in the comparison with Cyprus and Greece. (Table 2).

Table 2 Number of respondents considered in the analysis

	Cyprus	**Greece**
Participants	107	394

The actual number of responses to individual questions for each country are tabulated in Annex I.

3.Demographics and Background

Respondent characteristics

Respondent demographics investigated through the questionnaires are gender, age, degree, work sector, profession and years of experience. The demographic characteristics of each country are further discussed below.

Gender

A larger proportion of males participated in the survey compared to females in both countries, with 60% in Cyprus and 68% in Greece being men. In both counties, a small percentage of participants did not state their gender or defined themselves as non-binary or in another way (< 4% of the total sample in both cases).

Age

The largest percentage (26%) of participants in **Cyprus** belonged to the 25-31 age group. Closely following, 25% of the respondents belonged to the age group of 36-46 and 24% belonged to the 25-31 age group. Nine per cent (9%) of participants were between 56-66 years old, and 7% in the 46-56 age group. A 4% was in the 18-25 age group and another 4% over 66 years old. In **Greece**, the largest share, 33%, belonged in the age range 36-46. Twenty-one per cent (21%) was between 31-36 whereas 16% belonged to the 25-31 age group. In addition, 15% were between 46-56 years old and 5% of the survey participants were in the age range of 56-66 years old. Finally, 2% were older than 66 years old.

Degree

The majority of respondents in **Cyprus**, that of 66%, had a master's degree and 15% had a bachelor's degree. Eight percent (8%) had a doctorate and 6% had a Technical/Vocational degree. Finally, 4% had attended some college/university with no degree, and only 1% had a high school degree or equivalent. In **Greece** the largest share of those surveyed, 54%, had a master's degree, followed by those who had a bachelor's degree with 23%. A much lower percentage of participants had a doctorate since only 8% had it. Furthermore, 9% of the participants in Greece had a Technical / Vocational degree. Moreover, only 3% in Greece stated that they were attending some college/university, but they had not had a degree by the time of the survey. Finally, 2% in Greece had a high school degree or equivalent.

Work sector

Forty percent (40%) of the total number of participants in **Cyprus** were employed in the private sector, while 19% were in the construction sector. Fifteen percent (15%) of the participants worked as a freelancer, and 10% in technical service in the public sector. Finally, 6% worked in academia and 10% in other sectors. Thirty percent (30%) in **Greece** worked as freelancers, and 28% in the private sector which were the most popular fields of work. Twenty-one percent 21% were employed in the construction sector, 11% in academia, whereas a 7% worked in technical services in the public sector.

Professions

The professions of those surveyed in **Cyprus** were; "Mechanical Engineer", 26% whereas "Energy Consultant" and "Architect" were selected by an equal 17% respectively. Moreover, 16% stated that they were "Physicists of the Built Environment" and 13% "Civil Engineers". Additionally, 7% of the participants equally selected "Electrical Engineer" and "RES installer and/or HVAC installer". Five percent (5%) were "General installers " and "Certified Passive House Designers/Consultants" respectively and finally, 3% were employed in a company that manufactures building envelope products, HVAC equipment or renewable energy. In **Greece** the professions of the respondents were 23% "Civil Engineers", 22% "Mechanical Engineers", 20% "Energy Consultants" and 17% "Architects". The profession "Physicist of the Built Environment" was selected by 11% of the participants in Greece. Nine percent (9%) were "Electrical Engineers" and 6% "Certified Passive House Designers/Consultants". Finally, 5% of the Greek sample was "Employed in a company that manufactures building envelope products, HVAC equipment or renewable energy" and only 3% and 2% were "General installers" and "RES installers and/or HVAC installers" respectively.

Years of experience

In **Cyprus** a big share of the participants, 30%, had 6 to 11 years of work experience and 27% had 0 to 6 years of experience. In addition, 22% had 11 to 16 years of work experience and 17% had more than 21 years. Only 4% had between 16-21 years of working experience. Twenty-six percent (26%) of participants in **Greece** had up to 6 years of experience and 22% had between 6 and 11 years. Twenty-one percent (21%) of the respondents stated that they have 11 to 16 years of experience and 16% had 16 to 21 years. Finally, 14% had more than 21 years of experience.

3.1 Familiarization with the concept of deep energy renovation

Participants were asked if they were familiar with the concept of deep energy renovation or retrofitting. A definition of the Deep Energy Renovation concept given by BPIE[2] recently, 2021, was provided to the respondents. According to that definition, Deep Energy Renovation can be formulated as: "*Deep renovation is a process capturing, in one or, when not possible, a few steps, the full potential of a building to reduce its energy demand, based on its typology and climatic zone. It achieves the highest possible energy savings and leads to a very high energy performance, with the remaining minimal energy needs fully covered by renewable energy. Deep renovation also delivers an optimal level of Indoor Environmental Quality to the building occupants*."

The results are illustrated in Figure 1.

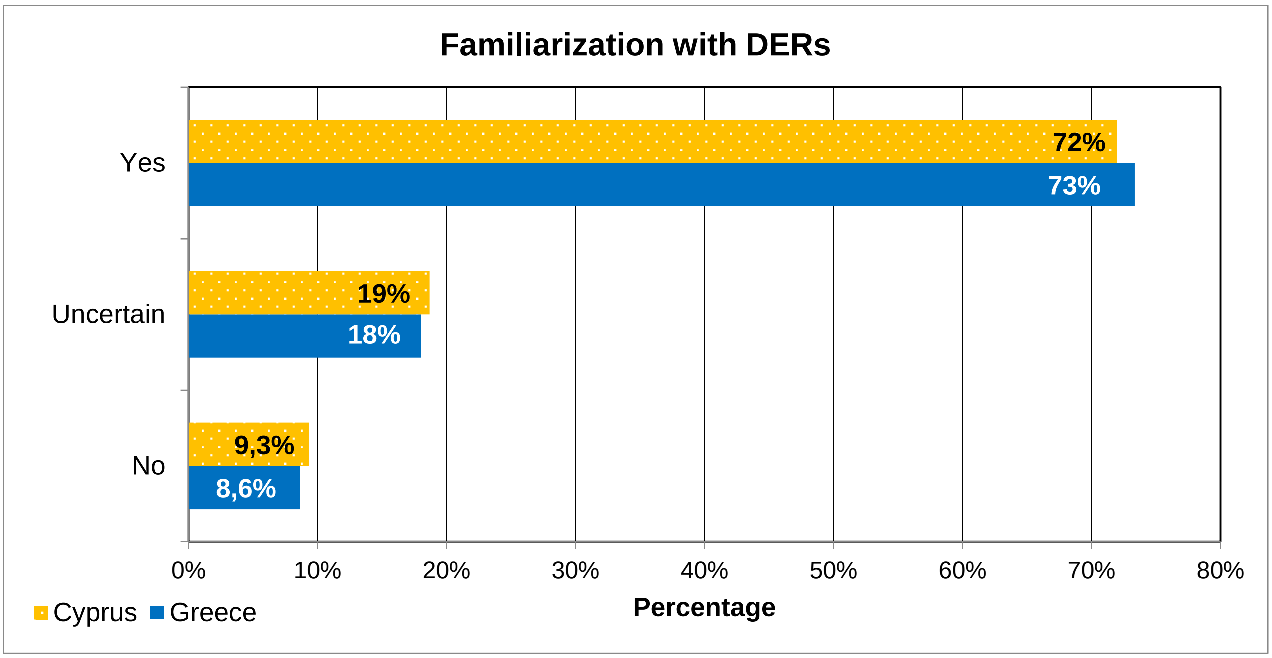


Figure 1 Familiarization with the concept of deep energy renovation

In Cyprus, the positive reply of those surveyed was 72% and in Greece 73%, the negative was slightly less than 9% in Greece and slightly more than 9% in Cyprus. Eighteen percent (18%) of the participants in Greece and 19% in Cyprus were not sure if they knew the subject of study.

[2] BPIE (Buildings Performance Institute Europe) (2021). Deep Renovation: Shifting from exception to standard practice in EU Policy. https://www.bpie.eu/publication/deep-renovation-shifting-from-exception-to-standard-practice-in-eu-policy/

3.2 Expertise in the implementation of deep energy renovation

Participants were asked about the level of their expertise in the implementation of deep energy renovations. The results are presented in Figure 2.

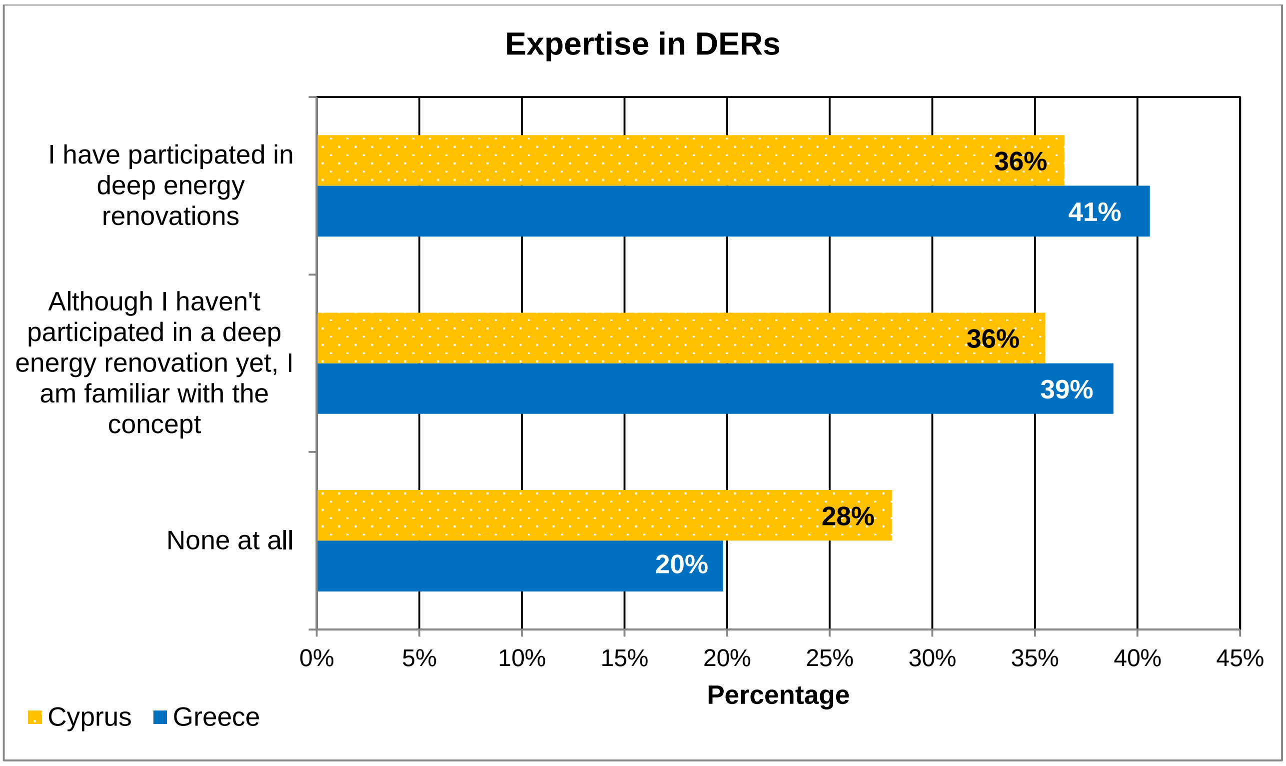


Figure 2 Expertise in the implementation of deep energy renovation

According to the survey results, in Cyprus (36%) and in Greece (41%) respondents replied that "I have participated in deep energy renovations". On the contrary, 36% participants from Cyprus answered "Although I haven't participated in a deep energy renovation yet, I am familiar with the concept" as did respondents in Greece with 39%. Finally, 28% of those surveyed in Cyprus as well as 20% in Greece have no specialization in deep energy renovations. No statistically significant differences between the responses given in the two counties were found.

4. Deep energy renovation in schools

This chapter presents the analysis on the deep energy renovation of school buildings, derived from the questionnaire responses in Cyprus and Greece. More specifically, the reasons behind a deep energy renovation implementation, and the difficulties encountered by those who carried out the energy renovation of a school building are explored. In addition, the policy gaps and policy decisions affecting deep energy renovations are investigated whereas the categories of products mostly used in deep energy renovations of school buildings and their availability are presented. Finally, respondents' awareness on issues related to comfort during deep energy renovations is assessed.

4.1 Experience with energy renovations in schools

An analysis is presented in this subsection on whether the questionnaire respondents from both countries have been, or are currently working on a project concerning the deep energy renovation of a school building. In addition, there is a presentation of the main reasons why the renovation was implemented, the difficulties faced in the execution of the renovation, as well as what systems were upgraded or installed during the deep energy renovation of the school building.

4.1.1 Experience on implementing deep energy renovations on school buildings

Respondents were asked if they have worked sometime in the past or they were currently working on the deep energy renovation of a school. The results are presented in Figure 3.

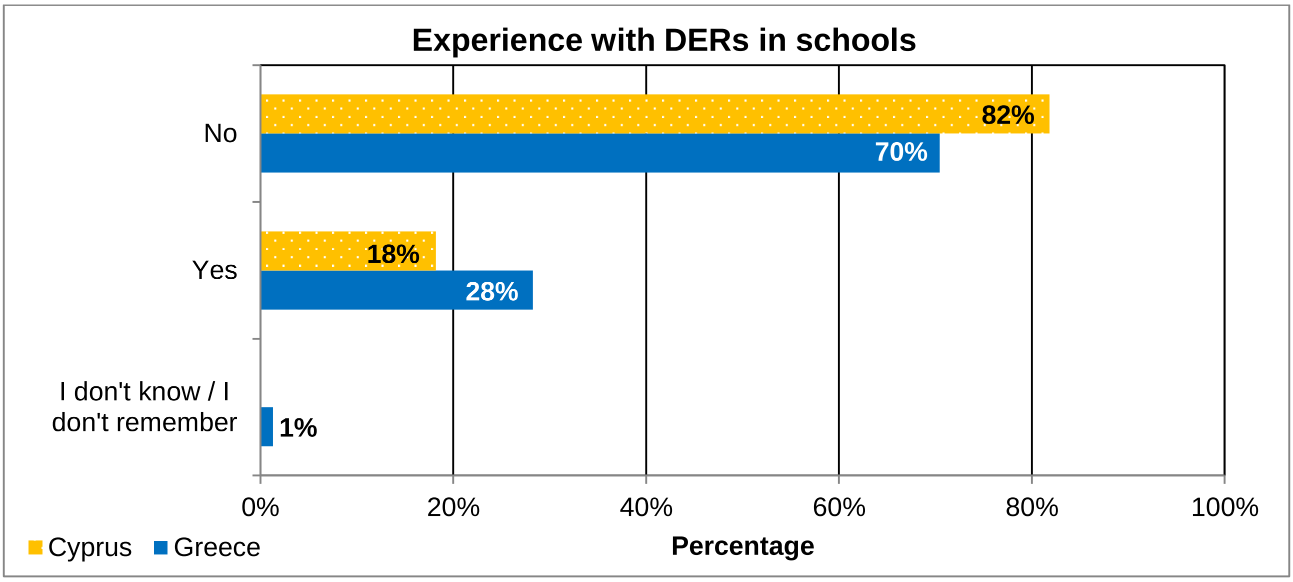


Figure 3 Experience on implementing deep energy renovations on school buildings

In **Cyprus** 82% responded negatively and 18% positively. In **Greece** 70% responded negatively and 28% positively. A statistically significant difference of 12% was recorded (z=2.002, p=0.023) in the option "No" between responses in the two countries. A difference of ten percent (10%) was also found in the "Yes" response, however it was not statistically significant.

4.1.2 Main reason for deep energy renovation in schools

Respondents with experience on school renovations were asked what was the main reason the school building was renovated. The results are illustrated in Figure 4.

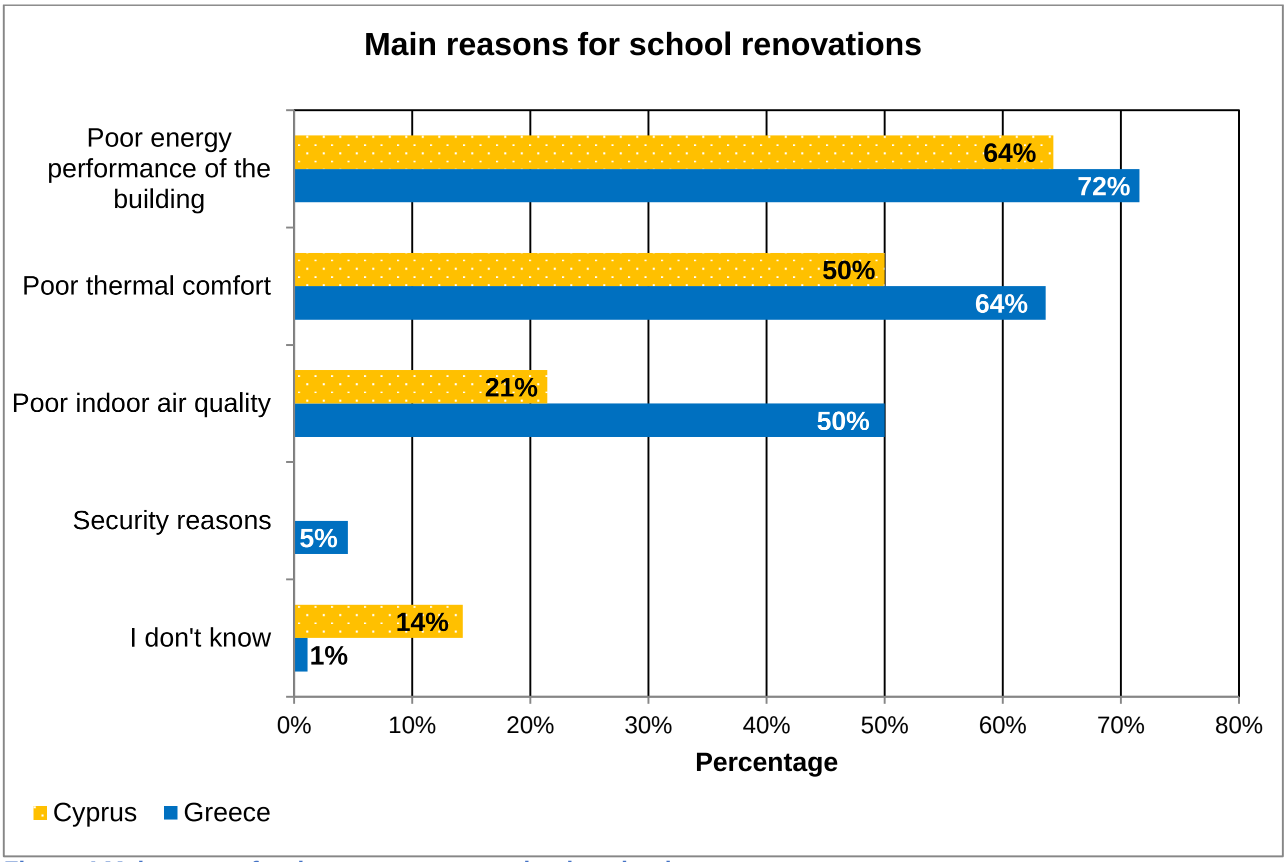


Figure 4 Main reason for deep energy renovation in schools

In **Cyprus** 64% stated that the main reason was the poor energy efficiency of the building. The second reason according to 50% was poor thermal comfort. The next 21% stated that it was about poor indoor air quality. Fourteen percent (14%) had no answer as they didn't know the main reason for the school building renovation.

In **Greece**, 72% replied that the main reason was the building's poor energy efficiency, followed by 64% selecting "Poor thermal comfort" and 50% choosing "Poor indoor air quality". No one of the Greek respondents considered security reasons, whereas 1% did not know.

A statistically significant difference of 29% was observed in the selection "Poor indoor air quality" (z= -1.992, p=0.023) and a deviation of 13% in the " I don't know" option (z=2.704, p=0.003).

4.1.3 Barriers for the implementation of energy efficiency measures in schools

The next question was about the barriers respondents had encountered when implementing energy efficiency measures in the school renovation project they were involved in. The results are presented in Figure 5.

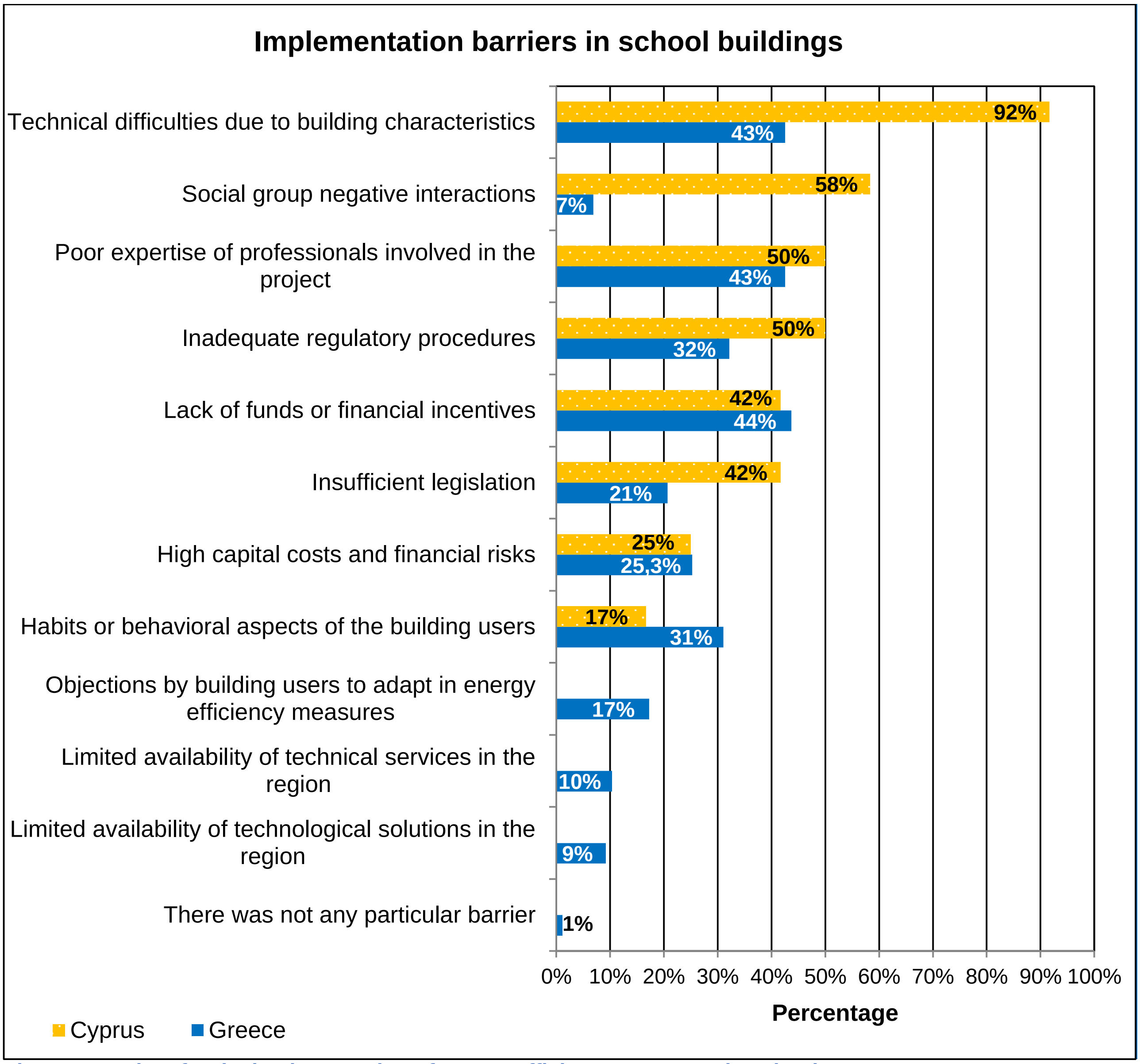


Figure 5 Barriers for the implementation of energy efficiency measures in schools

In **Cyprus**, the most popular answer that gathered 92% was "Technical difficulties due to building characteristics" followed by a considerably lower percentage of "Social group negative interactions" with 58%. Third in line of preference was "Poor expertise of professionals involved in the project" which had the same percentage as "Inadequate regulatory procedures" that was 50%. In addition, 42% of the participants in Cyprus considered that "Lack of funds or financial incentives" was a barrier in carrying out a deep energy renovation of school buildings, as it was the case with "Insufficient legislation" (42%). Finally, 25% agreed that "High capital costs and financial risks" was a barrier, as did 17% of the participants from Cyprus who stated that "Habits or behavioral aspects of the building users" was an obstacle.

In **Greece**, the most popular answer was "Lack of funds or financial incentives" with 44% followed by the option "Technical difficulties due to building characteristics" with a similar percentage of 43%. A 43% selected considered "Poor expertise of professionals involved in the project" as a barrier for the implementation of energy efficiency measures in schools. In addition, 32% of the Greek participants selected "Inadequate regulatory procedures" and "Habits or behavioral aspects of the building users" with a similar percentage of 31% as barriers. Finally, 25% considered "High capital costs and financial risks" and 21% "Insufficient legislation" to be barriers for the implementation of energy efficiency measures in schools.

It is worth noting that in the options "Objections by building users to adapt in energy efficiency measures", "Limited availability of technical services in the region" and "Limited availability of technological solutions in the region" only the participants in Greece responded, with the percentages being 17%, 10% and 9% respectively, as none of the participants in Cyprus considered these issues as a barrier when implementing energy efficiency in school buildings.

Statistically significant differences between the responses given in the two countries were found in the following items: in the option "Social group negative interactions" with a difference of 51% (z=4.946, p<0.01) and in "Technical difficulties due to building characteristics" (z=3.193, p<0.01) with the difference between the responses in the two countries being 49%. On the contrary, a difference of 21% was observed in the "Insufficient legislation" without being statistically significant though.

4.1.4 Upgraded or installed systems for the energy renovation

Survey participants were asked what systems were installed or upgraded as a result of the energy renovation in the school building. The results are illustrated in Figure 6.

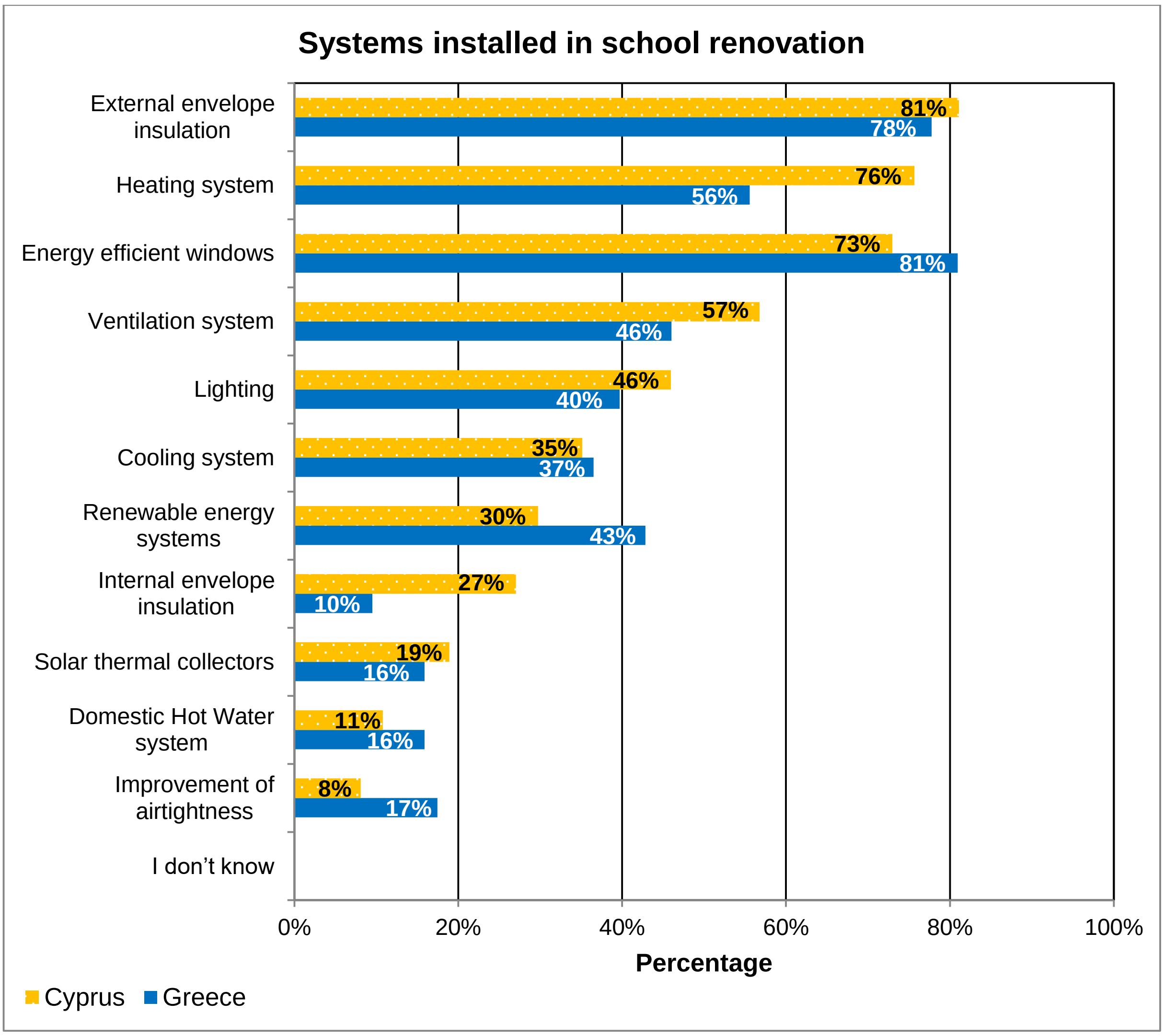


Figure 6 Upgraded or installed systems for the energy renovation

In **Cyprus,** those surveyed mostly chose "External envelope insulation" (81%) and "Heating system" (76%) as well as "Energy efficient windows" which was selected by a 73%. The next options had lower percentages compared to the previous ones as "Ventilation system" had 57% and "Lighting" 46% with "Cooling system" 35%. The share of individuals who reported an installation or upgrade of "Renewable energy systems" was 30%, while those who chose "Internal envelope insulation" was 27% for Cyprus. Furthermore, the "Solar thermal collectors" had a response rate of 19% whereas the option "Domestic Hot Water System" was selected by a percentage of 11%. The "Improvement of airtightness" option had an even lower response rate, that of 8%.

In **Greece** the majority of participants, 81%, stated that "Energy efficient windows" were installed or upgraded followed by "External envelope insulation" with 78%. The options "Heating systems" (56%), "Ventilation system" (46%), as well as the “Renewable energy systems” (43%) received a lower rate of preference compared to the two top choices. The options "Lighting" and "Cooling system" gathered about similar percentages, with 40% and 37% respectively. Finally, participants from Greece answered in the affirmative, with much lower percentages than before, to the following options "Improvement of airtightness" with 17%, "Solar thermal collectors" and "Domestic hot water system" both with 16% and with 10% for the installation of "Internal envelope insulation".

Statistically significant differences between the responses given in the two countries were observed with regard to the "Heating system" with a 20% difference (z=2.012, p=0.022) and to the "Internal envelope insulation" with a 17% difference (z=2.305, p=0.011). In addition, a 13% difference was recorded with regard to the "Renewable Energy Systems" choice without being statistically significant though.

4.2 General barriers for deep energy efficiency renovations implementation in schools

This subchapter presents the challenges that the participants of the two countries had to face and were difficult to overcome during the deep energy renovation of a school building in general, as well as specifically regarding the insulation of the school building's envelope and the installation of renewable energy systems. Furthermore, the drivers that could boost the market of energy renovation are listed.

4.2.1 Difficulties hard to overcome during the deep energy renovation in schools

Survey participants were asked if there was any particular difficulty that was hard to overcome during the deep energy renovation of school buildings. The results are presented in Figure 7.

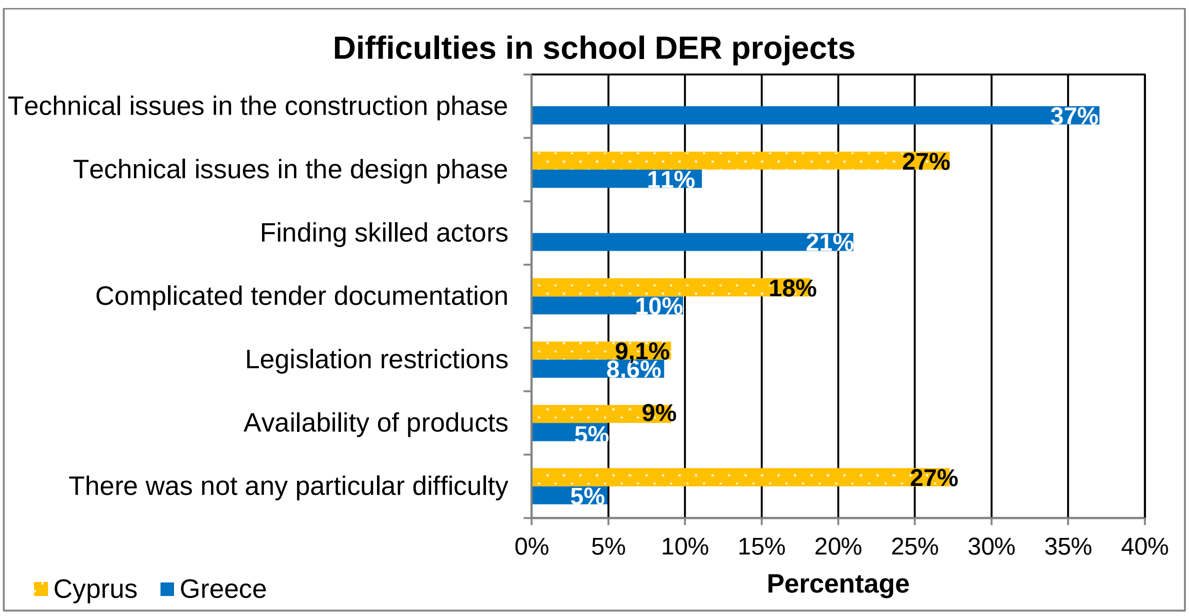


Figure 7 Difficulties hard to overcome during the deep energy renovation in schools

The highest percentage for **Cyprus** was recorded in the two following responses: "Technical issues in the design phase" and "There was not any particular difficulty" as they both reached 27%. Eighteen percent of the respondents (18%) in Cyprus agreed with the option "Complicated tender documentation" regarding the difficulty in implementing the deep energy renovation of a school building. The difficulties of "Legislation restrictions" and "Availability of products" have been selected by a slightly higher percentage than 9% respectively.

The highest percentage occurred amongst participants in **Greece** was 37% in the option "Technical issues in the construction phase" which is a statistically significant difference (z= -2.459, p=0.007) when compared to Cyprus' 0%. It is also worth noting that when asked to answer whether they could "Find skilled actors", 21% of the respondents in Greece considered this as a challenge difficult to deal with in a deep energy renovation project implemented in schools, while in Cyprus none of the survey participants selected this option. The difficulties "Technical issues in the design phase" and "Complicated tender documentation" gathered similar percentages as they received 11% and 10% respectively. Finally, "Legislation restrictions" was chosen by a slightly lower share than 9% with the option "Availability of products" having attracted 5% of the participants from Greece.

4.2.2 The 3 barriers which make the deep energy renovation in existing school building difficult

Survey participants from both countries were asked to select, in order of preference, starting from the most important and in descending order, those three barriers that mostly apply in their country and make the implementation of deep energy renovation in school buildings difficult. The results are illustrated in Figure 8. Data labels for percentages lower or equal to 2% are omitted from the figures.

In total, 66% of the respondents in both Cyprus and Greece reported that "Economic / financial resources" was one of the top-three obstacles in the implementation of deep energy renovation in school buildings. " Lack of voluntary national deep energy renovation schemes for renovation of existing buildings" and " Lack of exemplary role of public buildings" were also important difficulties, placed in the first three ranking positions by 38% and 35% of the respondents' total sample, respectively.

In general, respondents from both countries found difficulties in the implementation of deep energy renovation in school buildings for all the twelve listed barriers, however the ranking differs across the two counties.

In **Cyprus**, 72% of the respondents mentioned "Economic / financial resources" as one of their top-three obstacles that made the implementation of deep energy renovation on existing school buildings difficult. " Lack of energy efficiency funding programs" and " User motivation / demand" were also placed in the top-three positions by 54% and 45% of respondents, respectively.

In **Greece**, 66% of those surveyed selected "Economic / financial resources " as one of their top-three obstacles, followed by the " Lack of voluntary national deep energy renovation schemes for renovation of existing buildings" and " Lack of exemplary role of public buildings" as their most important barriers with 38% and 35% accordingly, that created difficulties in the implementation of deep energy renovation in school buildings.

Statistically significant differences were observed per ranking with regard to the following options:
In Rank 1, "Lack of exemplary role of public buildings" 14% difference (18% Cyprus, 4% Greece, z=1.987, p=0.023).
In Rank 2, "Lack of energy efficiency funding programs" 26% difference (45% Cyprus,19% Greece z=2.032, p=0.021).
In Rank 3, "Administrative issues" 14% difference (18% Cyprus, 4% Greece, z=1.969, p=0.024).

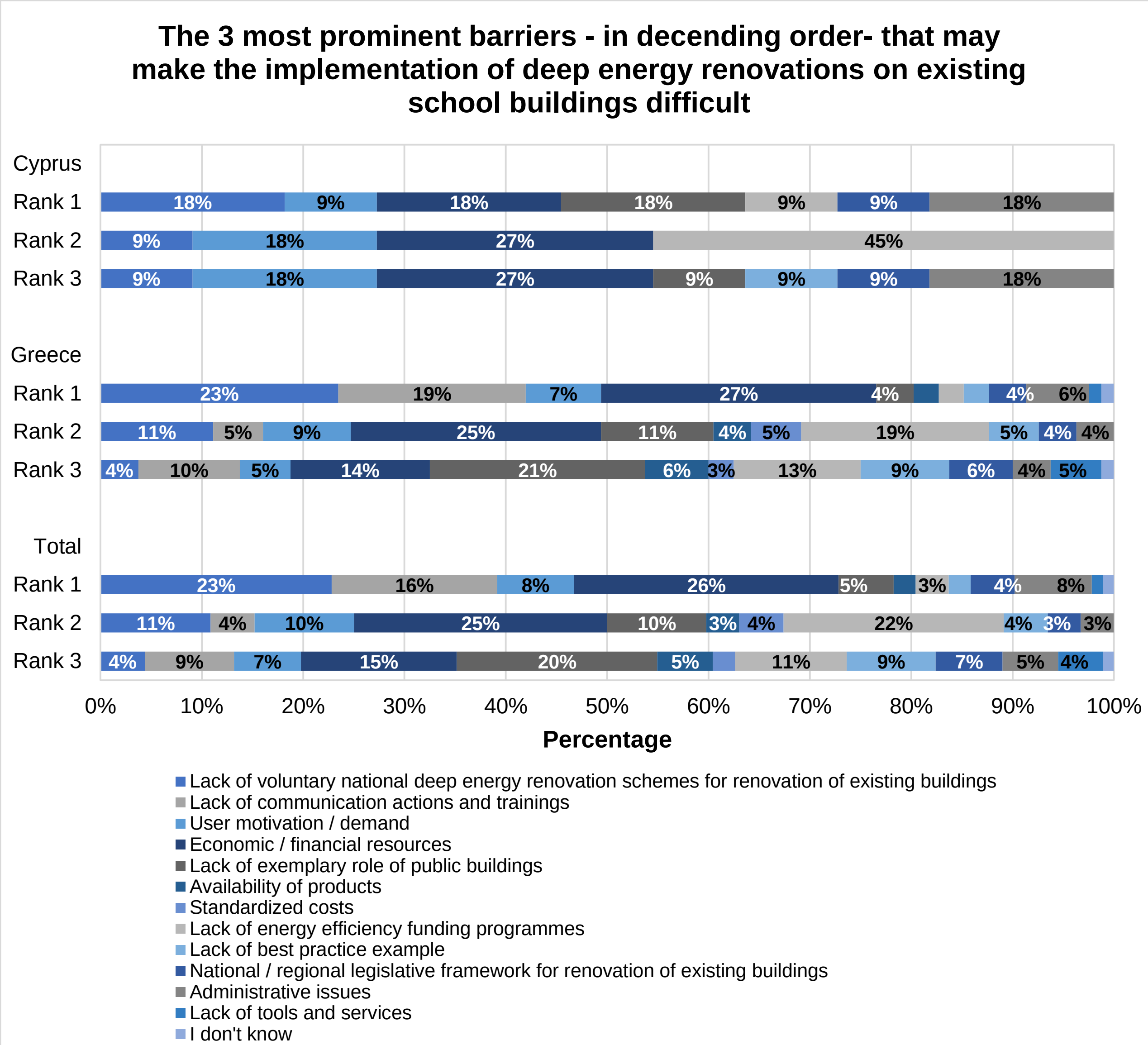


Figure 8 The 3 most important barriers -in descending order- which make deep energy renovations in existing school buildings difficult

4.2.3 Drivers that boost the deep energy renovation market in schools

Participants were asked about the drivers that could boost the deep energy renovation market for school buildings in their country. The results are presented in Figure 9.

Most survey participants from **Cyprus** selected "Improved financing solutions" as the most important aspect with 73% followed by "Clear technical guidelines on DERs" with a lower percentage of 57%."More ambitious renovation obligations" was selected by 38% of those surveyed in Cyprus. When asked to choose whether "Consultancy / training" and "Emphasizing the role of DERs in improved Indoor Air Quality and health" was a driver that would enhance deep energy renovation in schools 30% and 29.7% respectively, answered in the affirmative to both of these options, with 22% of the participants in Cyprus having also chosen "Upgrading the skills of professionals for DERs" as a factor. Finally, slightly more than 16% of the respondents in Cyprus, selected "Raising societal awareness on DERs to increase support" as a driver that could boost deep energy renovations in schools.

The case does not seem to be the same in **Greece**, as the first most popular answer was "Consultancy / training" which gathered 65% followed by "Improved financing solutions" with 51% and "More ambitious renovation obligations" with a 40%, similar to Cyprus. In addition, when participants from Greece were asked to select "Upgrading the skills of professionals for DERs", 35% answered in the affirmative, while slightly less than 30% chose "Emphasizing the role of DERs in improved Indoor Air Quality and health".

It is worth noting that although 14% of those surveyed in Cyprus chose "New business models", in Greece almost a double percentage, 30%, was recorded for this option. Finally, 19% of the participants in Greece stated that "Robust legislation" could boost deep energy renovation. The "Raise societal awareness on DERs to increase support " option gathered almost 16% whereas "Further boost of DERs is not possible" was chosen only by participants from Greece, by a small percentage of 2%.

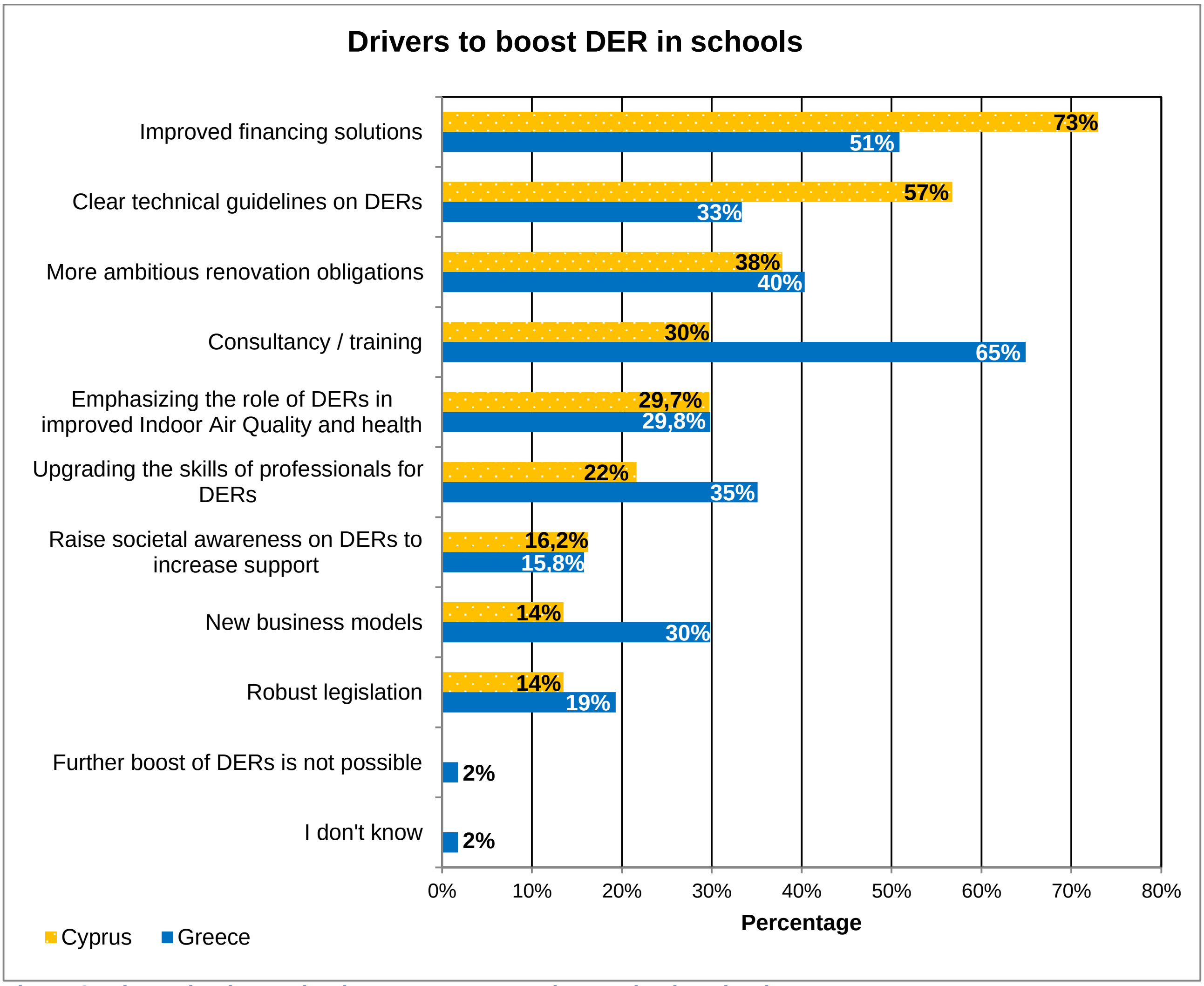


Figure 9 Drivers that boost the deep energy renovation market in schools

Statistically significant differences were observed in the following statements about the drivers that could boost the deep energy renovation market in school projects:

- "Consultancy / training" with a 35% difference (30% Cyprus, 65% Greece $z=-3.333$, $p<0.1$)
- "Clear technical guidelines on DERs" with a difference of 24% (57% Cyprus, 33% Greece $z=2.244$, $p= 0.012$)
- "Improved financing solutions" with a 22% difference (73% Cyprus 51% Greece $z=2.133$, $p= 0.016$)

4.2.4 Gaps and barriers during the deep energy renovation in schools

Respondents were asked about the level of agreement, if at all, with given statements. Results are on 1 to 5 scale (1= Strongly disagree, 2=Disagree, 3=Neither agree nor disagree 4=Agree, 5=Strongly agree).

Participants were asked, based on their experience, what are the gaps and barriers they had encountered when implementing a deep energy renovation (DER) of a school building, from the initial to the final phase of the renovation. Mean values (M) over 3.5 indicate agreement with the statement. A low standard deviation (SD) indicates that given answers tend to be close to mean value, while high standard deviation indicates that the given answers are spread out over a wider range of values. An independent samples t-test was used to determine whether the differences in the mean values recorded between the two countries are statistically significant. P-values smaller than 0.05 indicate statistically significant differences. The results are illustrated in Figure 10 and described in Table 3.

Table 3 Mean values and standard deviations of perceived level of information on level of agreement about gaps and barriers regarding deep energy renovation implementation - Sample per country

	Cyprus		Greece		Difference in mean value	% Difference in mean value	p value
	MEAN	SD	MEAN	SD			
Undervaluing the benefits of DER and lack of interest to invest in DER	3,92	0,44	3,59	0,95	0,33	33%	0,022
Social group negative interactions	3,25	0,91	2,82	1,03	0,43	43%	0,059
Uncertainties on DER investments	2,92	0,97	3,40	0,97	0,48	48%	0,016
Too long payback periods or limited payback expectations	2,92	1,02	3,32	0,94	0,40	40%	0,055
Lack of financial incentives and funds	4,06	0,83	3,88	0,90	0,18	18%	0,335
High capital costs and financial risks	3,28	1,11	3,75	0,84	0,47	47%	0,033
Lack of trusted sources of information on DER	3,00	0,96	3,36	0,99	0,36	36%	0,077
Difficulties in adapting to new technologies	3,42	0,81	3,40	0,93	0,02	2%	0,913
Difficulties in adapting relevant behavioral aspects	3,61	0,64	3,58	0,90	0,03	3%	0,964
Poor expertise and skills of professionals in the renovation market	3,50	0,85	3,42	1,08	0,08	8%	0,747
Lack of skilled workforce	3,39	0,93	3,44	1,10	0,05	5%	0,781
Lack of integrated approach among actors	3,22	0,83	3,57	1,06	0,35	35%	0,091
Lack of sufficient legislation	3,42	0,84	3,33	1,06	0,09	9%	0,596
Legislative and regulatory barriers - bureaucracy	3,83	0,74	3,69	0,94	0,14	14%	0,390
Building complexity discourage from DER implementation	3,31	0,79	3,18	1,07	0,12	12%	0,477
Lack of certification entities	2,94	0,89	2,76	1,02	0,18	18%	0,275
Lack of monitoring to survey actual performances	3,08	1,00	3,24	1,02	0,15	15%	0,455
Poor maintenance after the DER	3,25	1,00	3,44	0,98	0,19	19%	0,318

	Cyprus		Greece		Difference in mean value	% Difference in mean value	p value
	MEAN	SD	MEAN	SD			
Lack of inventory for public buildings at municipal / regional level	3,33	1,10	3,58	0,85	0,25	25%	0,211
There are no gaps or barriers and the whole chain is working	1,53	0,61	1,91	1,08	0,38	38%	0,057

The survey participants in **Cyprus** agreed on "Lack of financial incentives and funds" (M=4.06, SD=0.83), "Undervaluing the benefits of DER and lack of interest to invest in DER" (M=3.92, SD=0.44), on "Legislative and regulatory barriers - bureaucracy" (M=3.83, SD=0.74) and on "Difficulties in adapting relevant behavioral aspects" (M=3.61, SD=0.64). On the other hand, they disagreed with the statement "There are no gaps or barriers and the whole chain is working" (M=1.53, SD=0.61).

In **Greece,** participants mostly agreed with the following statements: "Lack of financial incentives and funds "(M=3.88, SD=0.90), with "High capital costs and financial risks"(M=3.75, SD=0.84) and with "Legislative and regulatory barriers - bureaucracy" (M=3.69, SD=0.94). On the contrary, respondents disagreed that "There are no gaps or barriers and the whole chain is working" (M=1.91, SD=1.08).

Statistically significant differences between the two countries were found in the following items:

- "Uncertainties on DER investments" with 48% difference in the mean value (2.92 Cyprus, 3.40 Greece, t=2.468, p=0.016)
- "High capital costs and financial risks" with 47% difference in the mean value (3.28 Cyprus, 3.75 Greece, t=-2.179, p=0.033)
- "Undervaluing the benefits of DER and lack of interest to invest in DER" with 33% difference in the mean value (3.92 Cyprus, 3.59 Greece, t=-2.338, p=0.022)

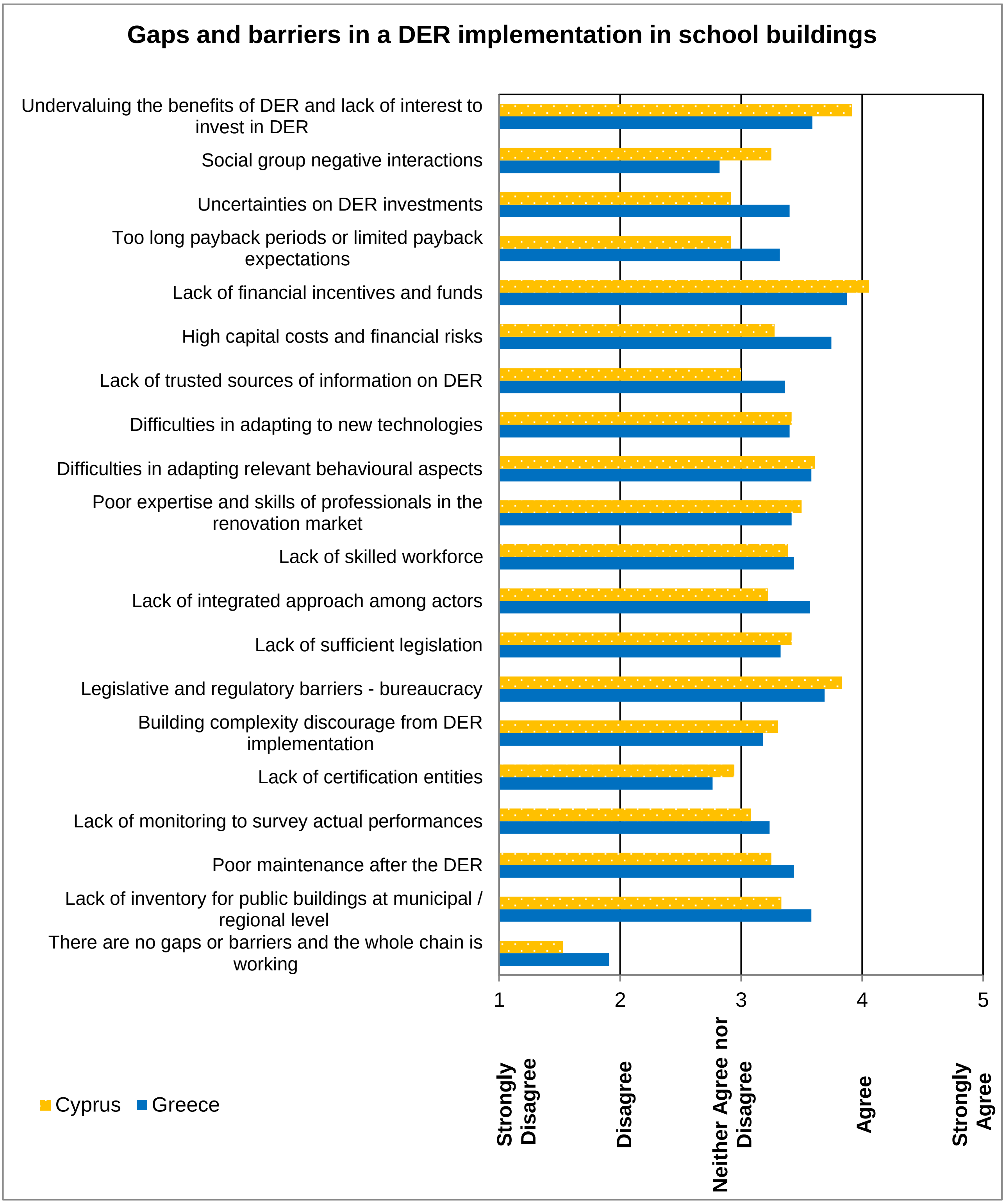


Figure 10 Gaps and barriers during the deep energy renovation in schools

4.2.5 Challenges faced when improving a school building's envelope

Survey participants were asked if they had faced challenges when improving the school building's envelope through insulation and energy efficient windows during the deep energy renovation. The results are illustrated in Figure 11.

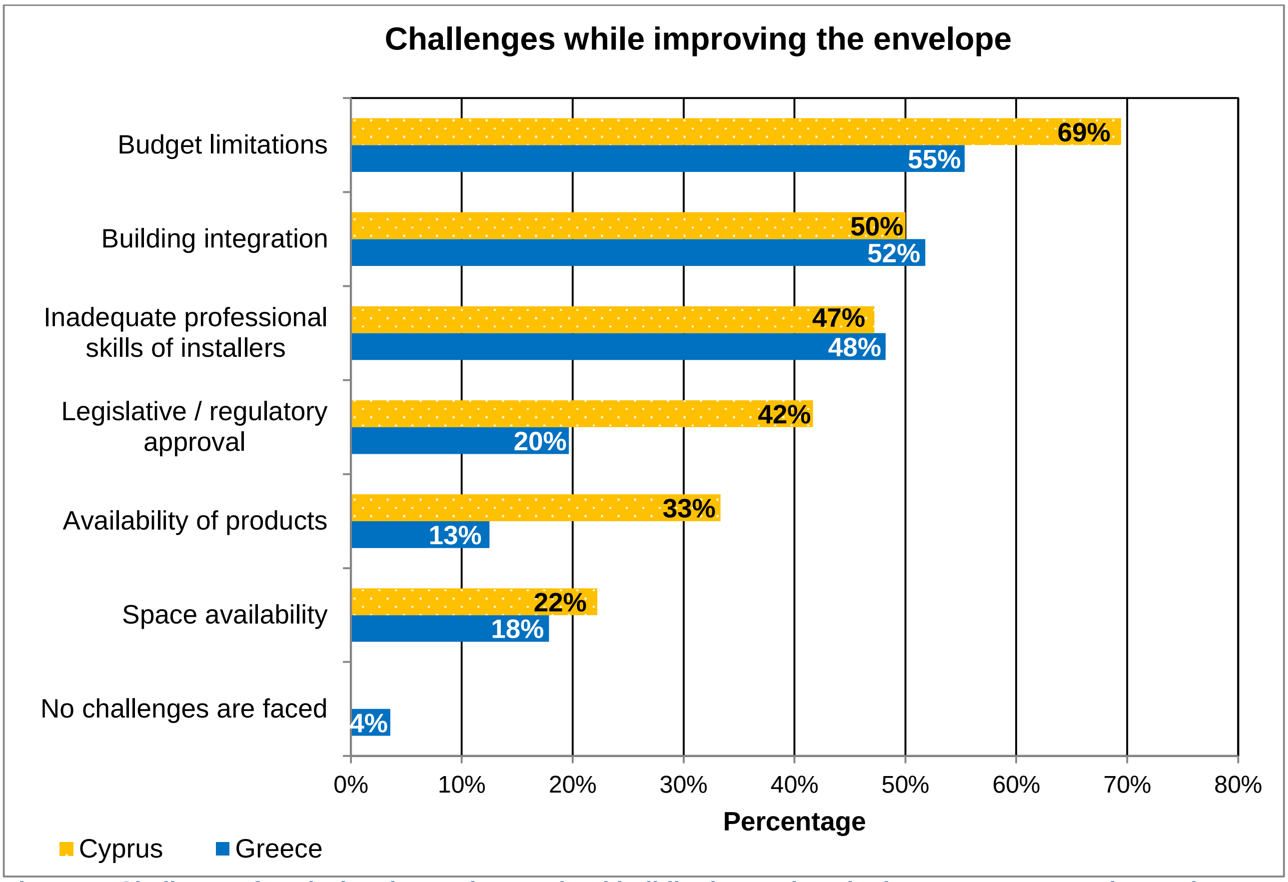


Figure 11 Challenges faced when improving a school building's envelope in deep energy renovation projects

In **Cyprus**, the most common response was "Budget limitations" with 69% The second in order of preference was the option "Building integration" which gathered half the percentage of those who participated in the survey for Cyprus (50%) and the third option was "Inadequate professional skills of installers" which was seen as a difficulty by 47% of the respondents. Furthermore, the option "Space availability" gathered 22%, a percentage very low compared to the previous choices.

The participants in **Greece**, highlighted "Budget limitations" as the first choice with 55% and "Building integration" as the second choice with a little more than half of the participants, that of 52%. This was followed by the option "Inadequate professional skills of installers" which, as in Cyprus, was a significant difficulty encountered, with 48% of the respondents selecting this option.

It is worth noting that the option "Legislative / regulatory approval" was chosen by 42% of participants from Cyprus, but only 20% of Greek respondents answered that they faced this difficulty when improving the envelope of a school building. In addition, the "Availability of products" option had a fairly high response in Cyprus with 33% compared to 13% in Greece. Finally, only 4% of the respondents in Greece answered that they had not experienced any difficulties, while in Cyprus this percentage is zero.

Statistically significant differences between the two countries were observed in the adversity of "Legislative / regulatory approval" with 22% difference ($z=2.289$, $p=0.011$) and in the "Availability of products" with 20% ($z=2.409$, $p=0.008$).

4.2.6 Challenges faced when installing renewable energy systems

Respondents were asked about the challenges they faced when installing renewable energy systems in deep energy renovation projects carried out in school buildings. The results are presented in Figure 12.

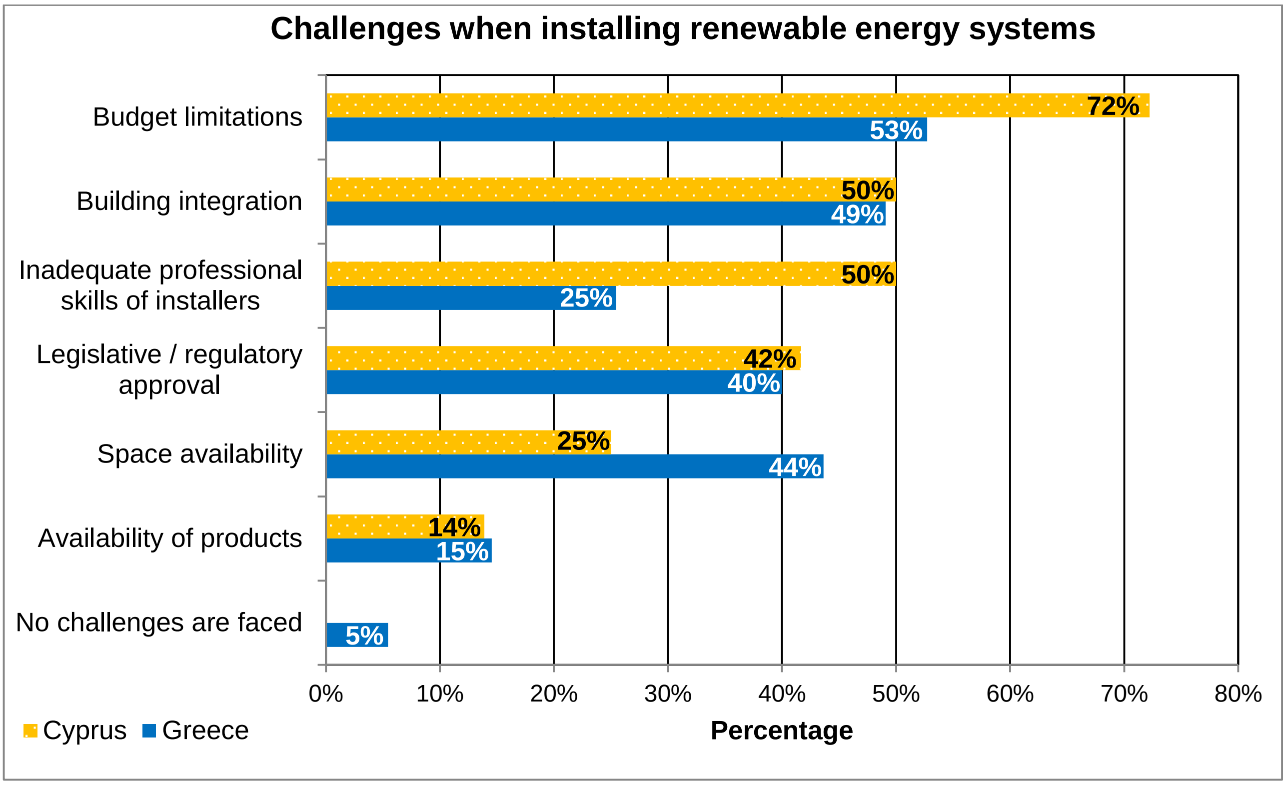


Figure 12 Challenges faced when installing renewable energy systems in school

The option with the highest response in **Cyprus** was "Budget limitations" which gathered a high percentage (72%). Participants in Cyprus equally agreed that "Building integration" and "Inadequate professional skills of installers" were major difficulties they faced when installing renewable energy systems, with exactly the same rates of 50%. With a lower percentage compared to the previous ones, 42%, the participants from Cyprus have chosen "Legislative / regulatory approval" to be one of the difficulties encountered.

In **Greece** the most selected choice of those surveyed was the same as in the case when improving the building's envelope, "Budget limitations", and collected 53%, followed by "Building integration" with 49%. Interestingly, quite a difference in the percentages between the two countries is noted in the response "Inadequate professional skills of installers" as 50% of the participants in Cyprus confronted it, with only 25% of the participants from Greece having done so. The same diversity existed with regard to the "Space availability" option which 44% of the respondents in Greece selected while in Cyprus 25% chose this. Finally, 5% of those surveyed in Greece stated that they faced no challenges when installing renewable energy systems in school buildings.

A statistically significant difference was observed in the share of respondents between the two countries, that faced a challenge in finding "Inadequate professional skills of installers" with a difference of 25% (CY:25%, GR: 50%, z=2.398, p=0.008). In Cyprus, 1 out of 2 respondents considered it difficult to find skilled professionals to install renewable energy systems in schools possibly due to the small pool market of qualified professionals on this field.

4.3 Policy and financial barriers in school

Firstly, this section provides an analysis of the gaps and barriers in policies with regard to the deep energy renovation of a school building. Secondly, the financial barriers faced by the survey participants and where efforts were made in order to reduce construction costs are mentioned. Finally, data are provided on where additional financial resources were needed in deep energy renovation projects in school buildings compared to a traditional project.

4.3.1 Energy efficiency policies in regard with deep energy renovation in schools

Survey participants were asked how they consider the energy efficiency policies in their countries regarding the encouragement of deep energy renovation for existing school buildings. The results are illustrated in Figure 13.

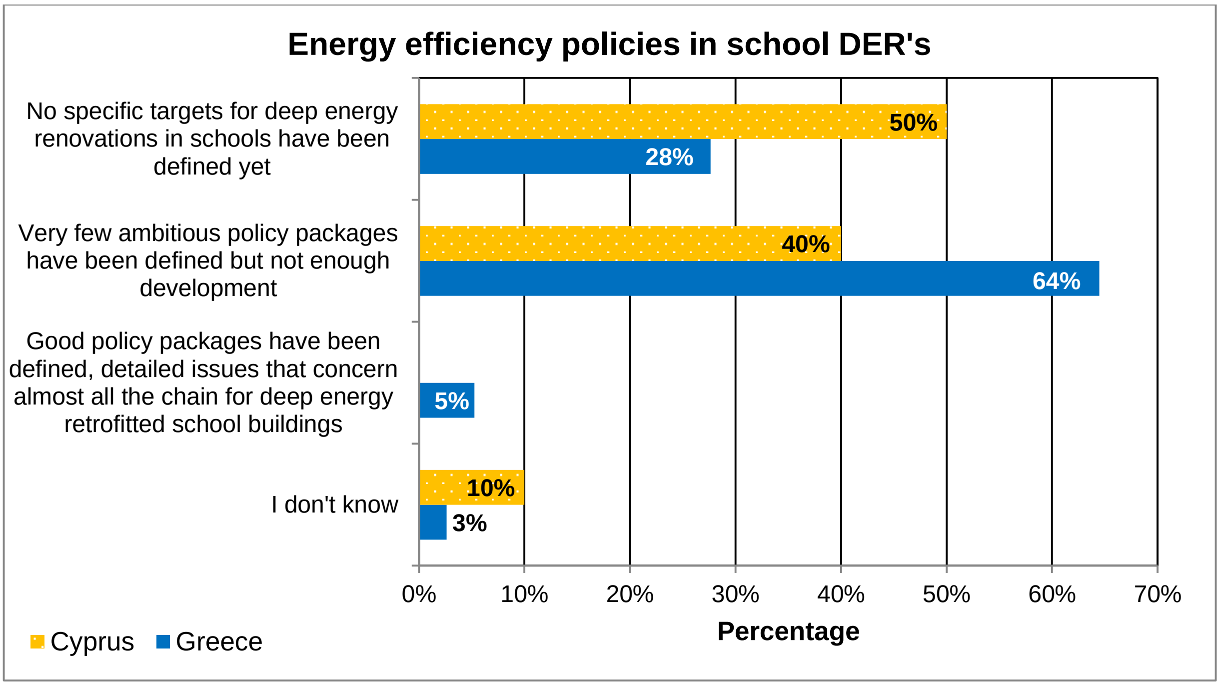


Figure 13 Energy efficiency policies in regard with deep energy renovation in schools

The first place among the options given in Cyprus with 50% is occupied by the answer "No specific targets for deep energy renovations in schools have been defined yet", which in Greece is the second most popular answer with 28%. In addition, participants in Cyprus responded positively with 40% to the next option "Very few ambitious policy packages have been defined but not enough development", while the majority of the responders from Greece supported this view with 64%. Finally, the option "Good policy packages have been defined, detailed issues that concern almost all the chain for deep energy retrofitted school buildings" was selected by a 5% in Greece and none in Cyprus. Ten percent (10%) in Cyprus and 3% stated that they didn’t know if energy efficiency policy packages have defined in their country.

4.3.2 Gaps for the applicability of energy efficiency policies in schools

Survey participants were asked to select the most important gap in their country's policy regarding the implementation of energy efficiency (EE) policies in school buildings. The results are presented in Figure 14.

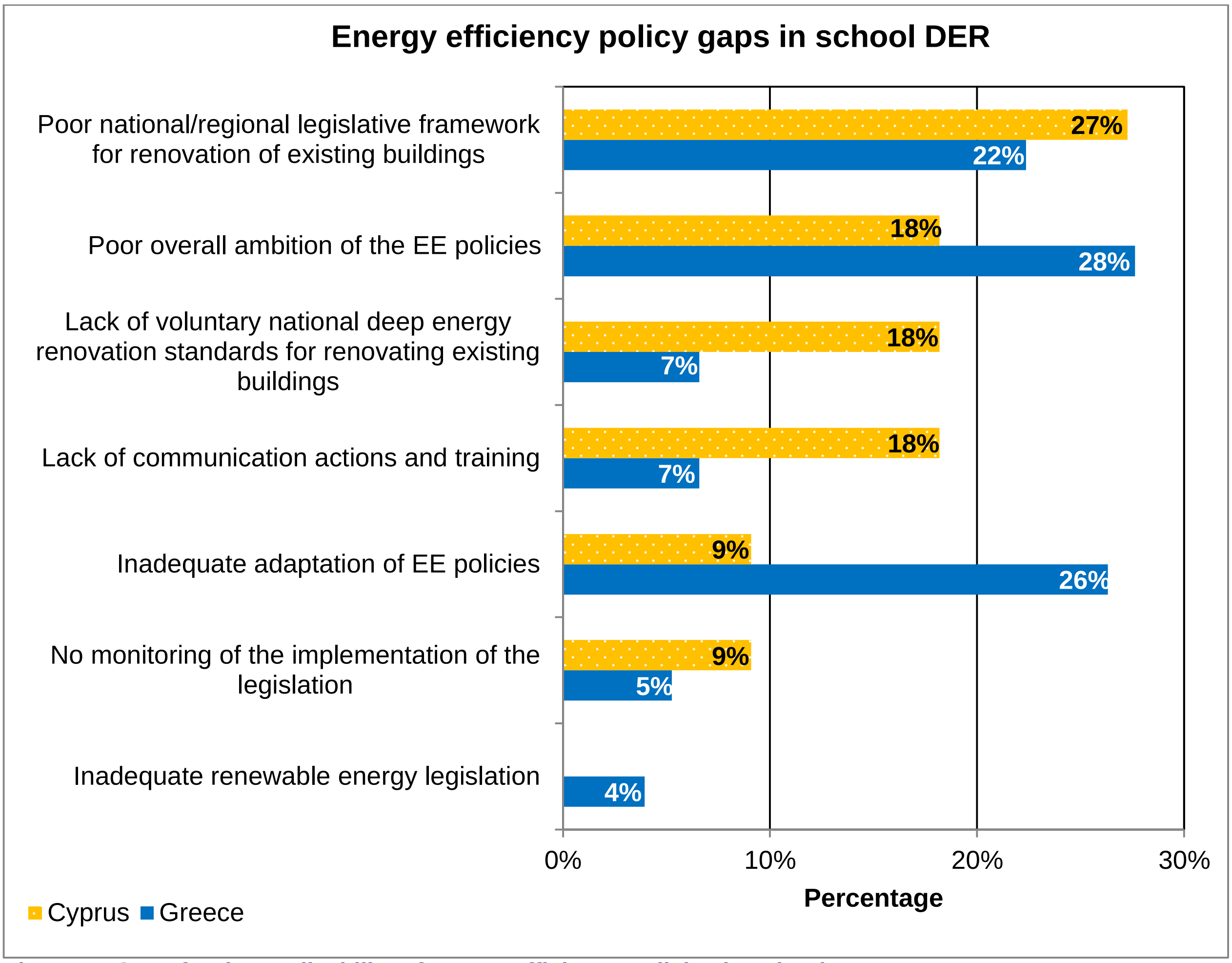


Figure 14 Gaps for the applicability of energy efficiency policies in schools

In **Cyprus**, the option "Poor national/regional legislative framework for renovation of existing buildings" was the most popular, selected by 27%, the highest percentage compared to the other options. The next three choices which were "Poor overall ambition of the EE policies", "Lack of voluntary national deep energy renovation standards for renovating existing buildings" and "Lack of communication actions and training" were chosen by 18% respectively.

In **Greece,** respondents' views were slightly different, as the most popular choice was "Poor overall ambition of the EE policies" with 28%, followed by "Inadequate adaptation of EE policies" with 26%, which was in complete contrast to Cyprus' 9%. Third in line, participants from Greece chose "Poor national/regional legislative framework for renovation of existing buildings" with 22%. It is worth noting that less than half of the participants from Greece compared to those from Cyprus selected "Lack of voluntary national deep energy renovation standards for renovating existing buildings" and "Lack of communication actions and training" as policy gaps for the implementation of energy efficiency policies in school buildings, since a share of 7% selected them compared to 18% in Cyprus.

Finally, 9% of the respondents in Cyprus and 5% in Greece stated that "No monitoring of the implementation of the legislation" is a policy gap, as well as the option "Inadequate renewable energy legislation" which was selected only by Greek participants with a percentage of 4%.

Notable differences between the two countries were found in the option "Inadequate adaptation of EE policies" with 17%, and in "Lack of voluntary national deep energy renovation standards for renovating existing buildings", "Lack of communication actions and training" with 11% in both, but they are not statistically significant.

4.3.3 Prominent barriers for financing energy renovation in schools

Survey participants were asked about the most prominent barrier for financing energy renovation of school buildings in the two countries. The results are presented in Figure 15.

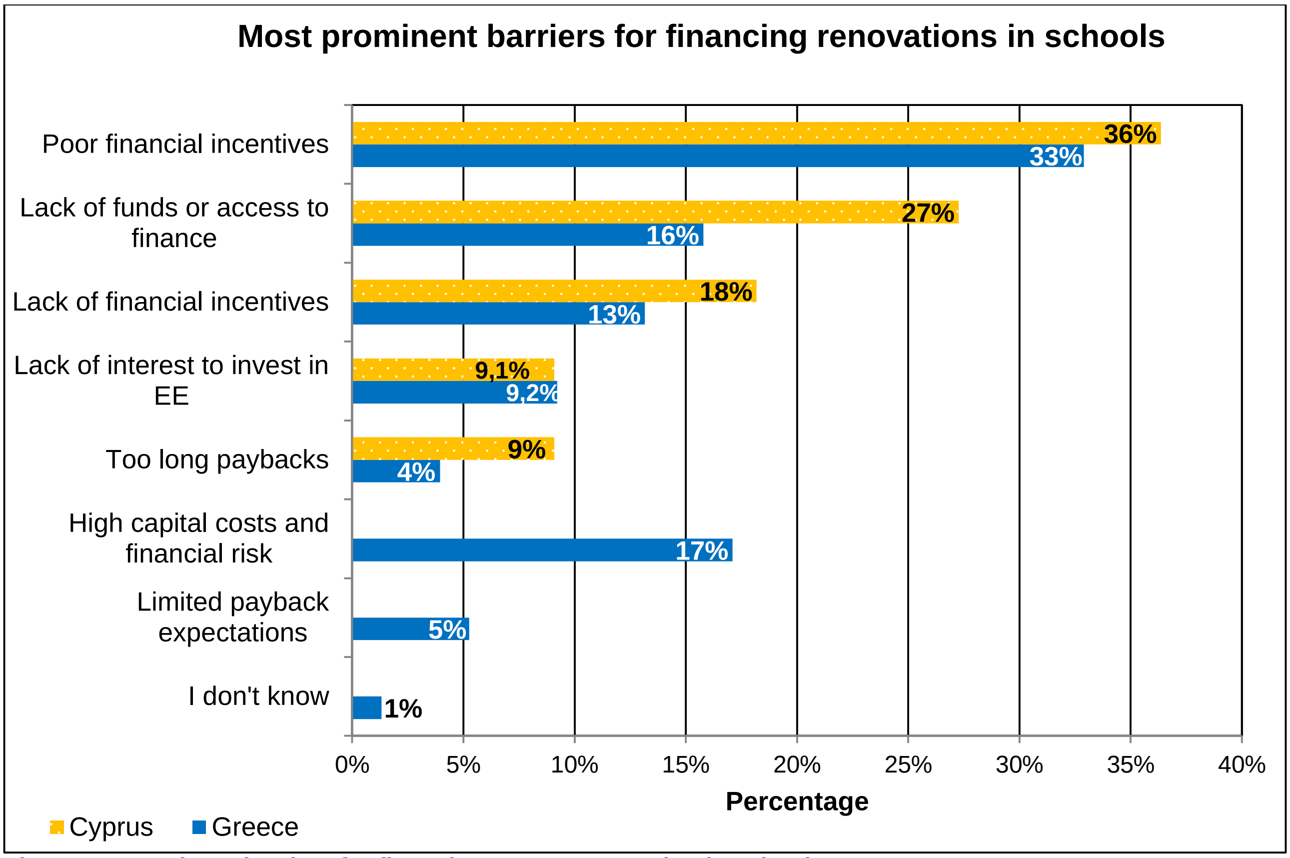


Figure 15 Prominent barriers for financing energy renovation in schools

In **Cyprus** the most prominent barrier respondents considered as their top preference was the "Poor financial incentives", which received the highest percentage compared to all the others, that of 36%."Lack of funds or access to finance" was second with 27%, followed by "Lack of financial incentives" with 18%. However, 9% of the respondents in Cyprus seemed to consider "Lack of interest to invest in EE" and "Too long paybacks" respectively to be important barriers in financing a school building energy renovation.

Thirty-three percent (33%) of the participants in **Greece** considered "Poor financial incentives" to be the most prominent barrier for financing building energy renovations in schools. The option "High capital costs and financial risk" came second in the preferences but with a much lower percentage, that of 17%, however it is worth noting that none of the participants in Cyprus selected it as a barrier. Some other barriers to financing energy renovations in school buildings, according to the participants in Greece were "Lack of funds or access to finance" (16%) and "Lack of financial incentives" (13%) as well as "Lack of interest to invest in EE" (9%).

Finally, it is noteworthy that 5% of those surveyed in Greece thought that "Limited payback expectations" was a barrier to financing, while no participant from Cyprus did not state so, as it gathered zero percent.

4.3.4 Cost reducing efforts in construction while deep energy renovating schools

Participants were asked about the sectors where more efforts were made in order construction costs to be reduced while deep renovating a school building. The results are presented in Figure 16.

In **Cyprus**, respondents stated that they had made efforts to reduce construction costs with regard to "Labour" and "Equipment", which received almost identical percentages, with the first having a slightly lower rate of 39% and the second 39%.

In **Greece** the most popular responses were the same, with "Labour" receiving a slightly higher rate that of 39% followed by "Equipment" with 31%.

Considerable differences in the percentages of the two countries are recorded in the next options of the questionnaire as 31% of the participants from Cyprus considered that "Costs have been optimized across the whole project" with the responders from Greece agreeing by 20%. As well as in the option "Building materials" which participants in Greece selected it with 27% while in Cyprus with 14%. In addition, there was the "Renewable Energy Systems" selection where the percentages are different between the two countries since in Cyprus received 11% and in Greece twice as much, 22%. Finally, few participants from Greece considered that "No particular attention has been given to reduce costs" as only 2% responded to this option, in contrast to the zero percentage in Cyprus. However, these differences are not statistically significant.

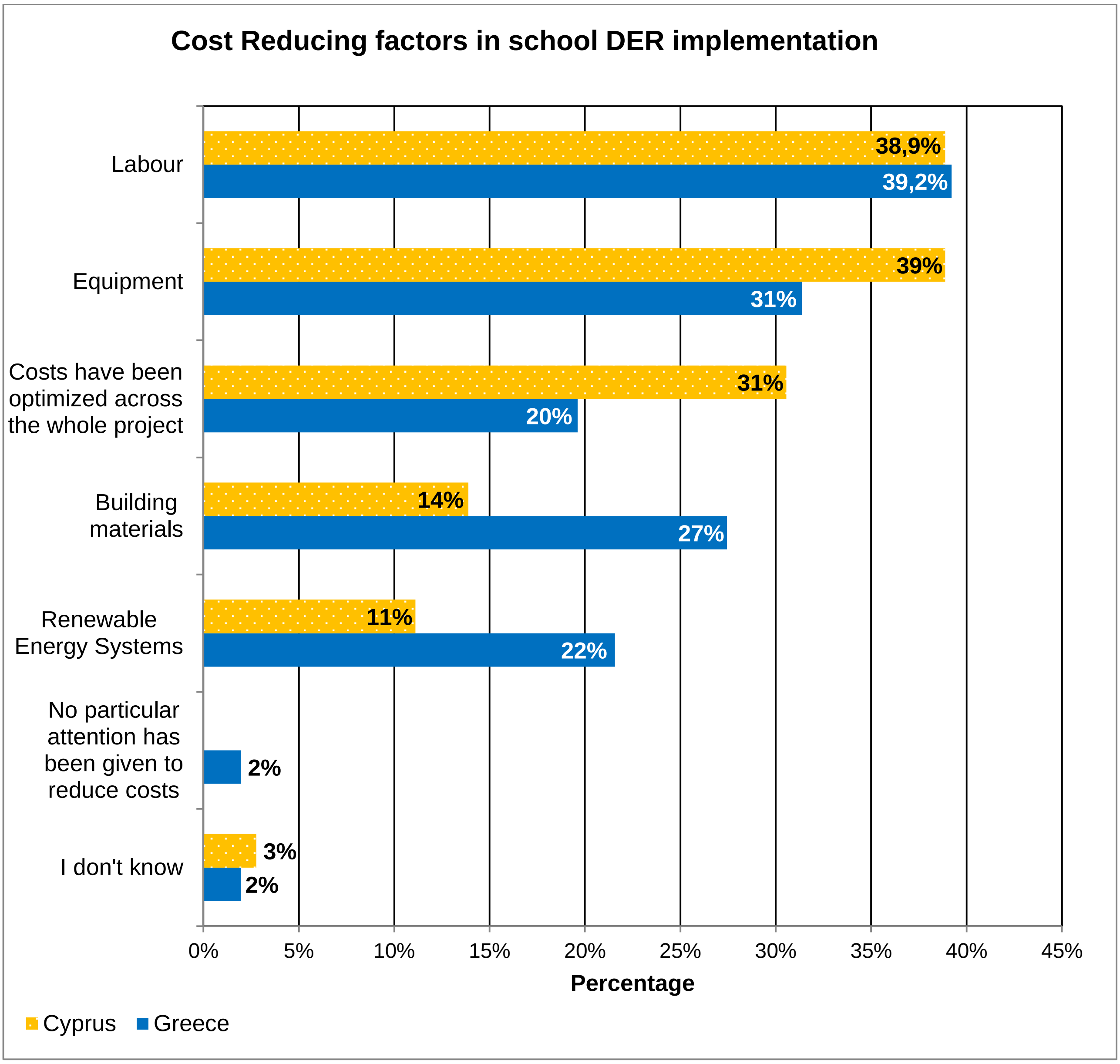


Figure 16 Cost reducing efforts in construction while deep energy renovating schools

4.3.5 Deep energy renovation’s additional resources compared to a traditional project in schools

Participants were asked to answer which of the tasks carried out during the deep energy retrofitting of a school building required more financial resources compared to a traditional project. The results are presented in Figure 17.

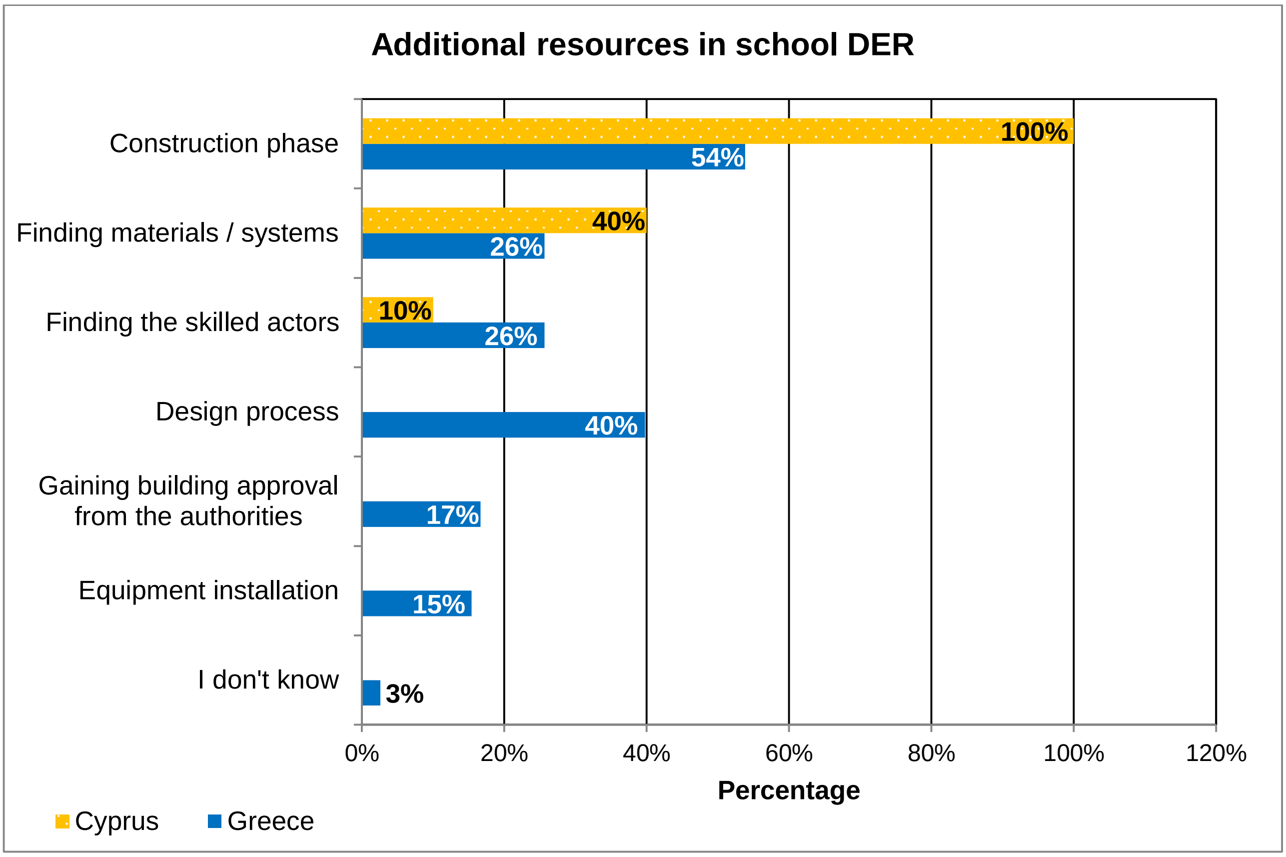


Figure 17 Deep energy renovation’s additional resources compared to a traditional project in schools

The absolute majority of those surveyed in **Cyprus** agreed that further financial resources were needed during the "Construction phase" as this was 100%. The option "Finding materials / systems" was chosen by 40%, while the alternative "Finding the skilled actors" was chosen by only 10% of Cyprus’ participants.

In **Greece**, the majority of respondents answered that during the "Construction phase" they needed additional financial support, as the percentage of 54% was the highest compared to the others. Second in the order of preferences for the participants in the survey from Greece, was the answer "Design process" with 40%. The options "Finding materials / systems" and "Finding the skilled actors" gathered 26% each.

Finally, it is worth noting that the following responses received a clear response only in **Greece** as no one in Cyprus considered them to be a requirement for additional financial resources:

- Design process: 40%
- Gaining building approval from the authorities: 17%
- Equipment installation: 15%

Statistically significant differences were observed in the share of participants from the two countries, in the "Construction phase" option with 46% (z=2.795, p=0.003) and in the "Design process" with a 40% difference (z=-2.477, p=0.006). In contrast, in the questionnaire options "Gaining building approval from the authorities" and "Equipment installation" there were 17% and 15% differences respectively, but these differences were not statistically significant.

4.4 Barriers in products and solutions for deep energy renovations in school

In the following paragraphs, the most important categories of products for the implementation of the deep energy renovation of a school building are presented, as well as whether the products and technological solutions for deep energy renovations are easily available in the two countries.

4.4.1 Availability of products and technological solutions for deep energy renovation in schools

Participants were asked about whether products and technological solutions are easily available for deep energy renovation in school buildings in their regions. The results are illustrated in Figure 18.

Fifty percent (50%) in **Cyprus** selected "Yes, there is a wide variety of technical services on offer" while 40% agreed with the option "Yes, but the offer is limited and the prices are high". Finally, the option "No, there is a limited offer and for some buildings many imported products from other EU countries are installed" was selected by 10% in Cyprus.

In **Greece**, the most popular option was "Yes, but the offer is limited, and prices are high", which received 55%, followed by "Yes, there is a wide variety of technical services on offer", which gathered 28%. It is worth noting that 9% of participants from Greece have chosen "No, but there is a good offer in other regions in my country" as opposed to 0% in Cyprus.

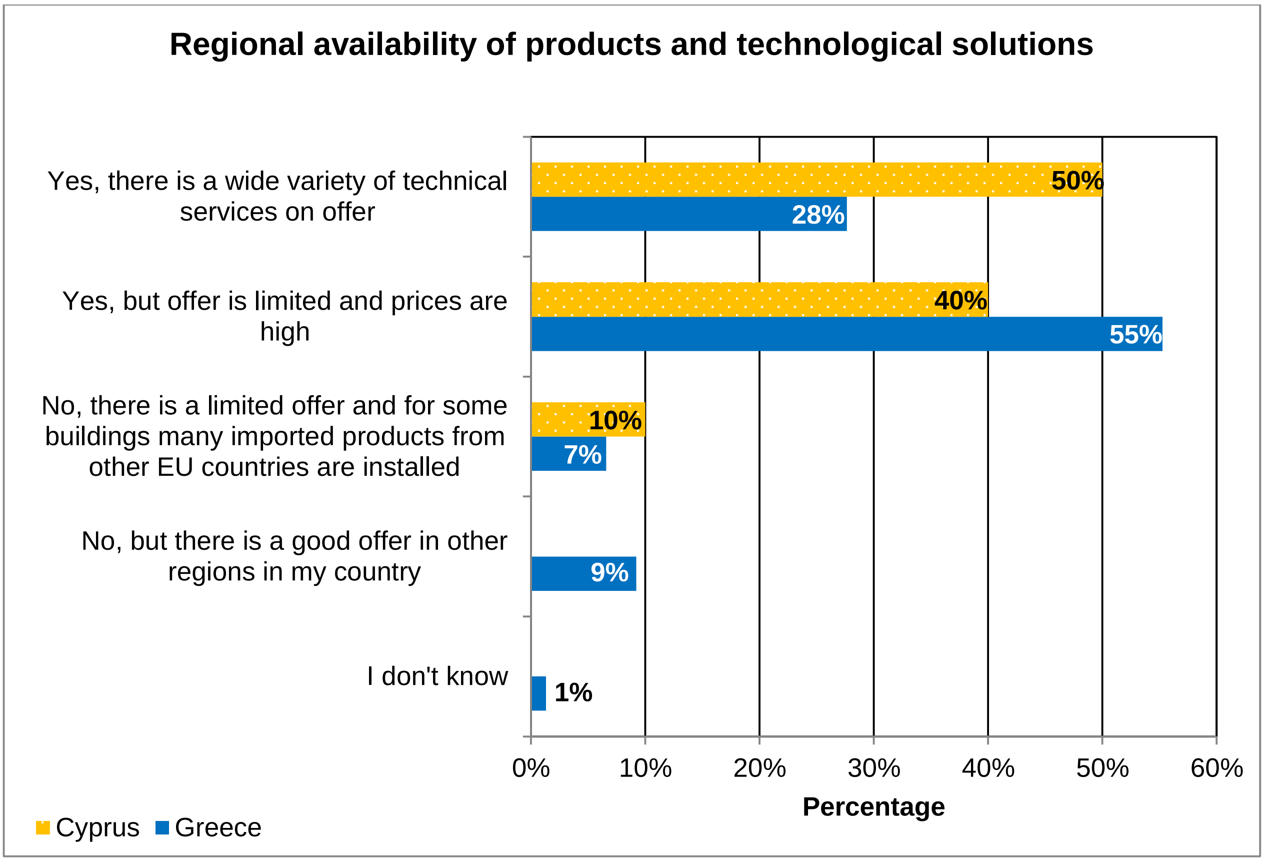


Figure 18 Regional availability of products and technological solutions for deep energy renovation in schools

4.4.2 Prominent product categories for deep energy renovation in schools

Participants were asked to indicate the most prominent categories of products used in deep energy renovation in school buildings. The results are presented in Figure 19.

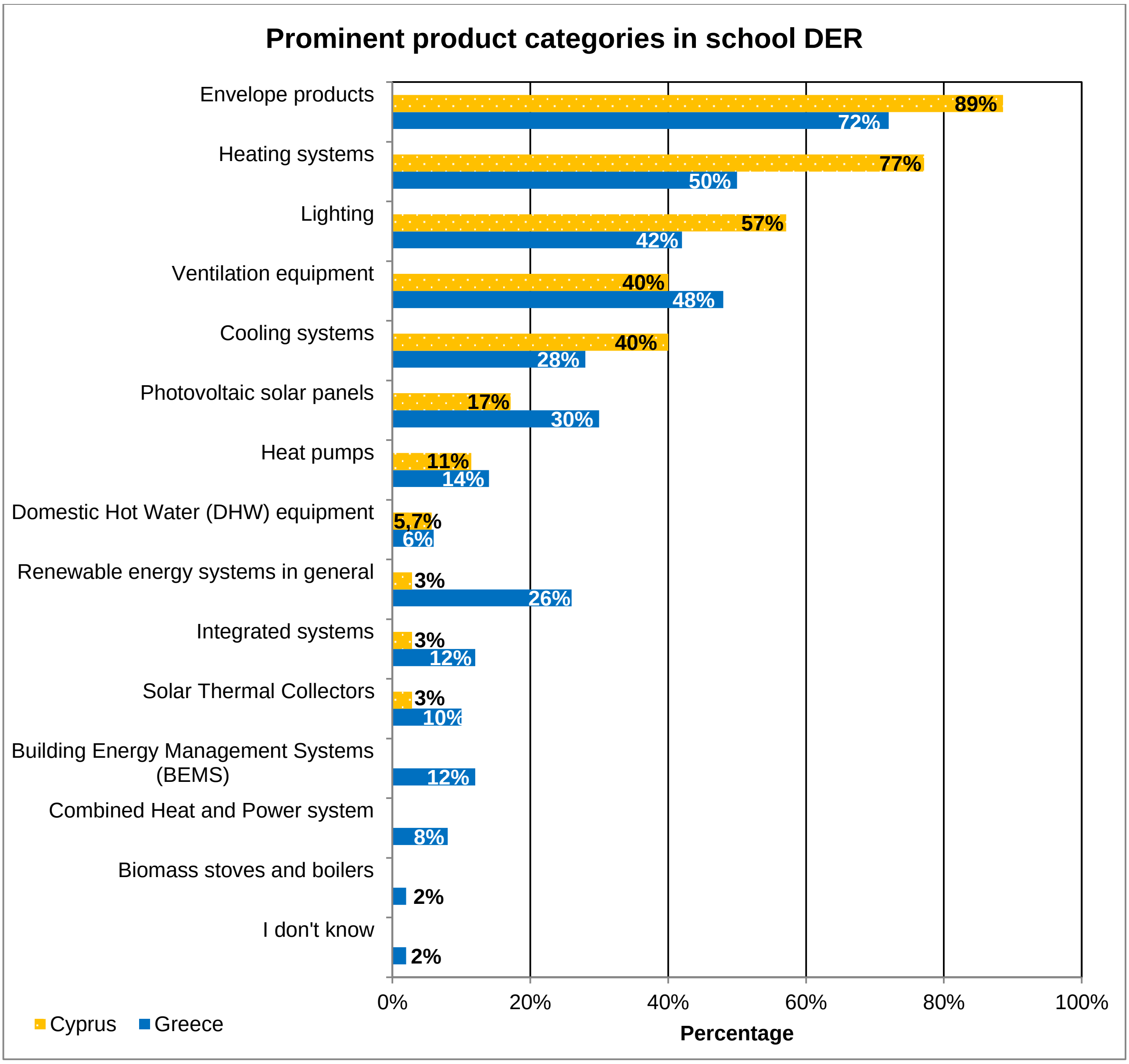


Figure 19 Prominent product categories for deep energy renovation in schools

The choice of "Envelope products" was the most important in **Cyprus** with 89% followed by "Heating Systems" with 77%," Lighting" with 57%. Last but not least, "Ventilation equipment" and "Cooling systems" received forty percent (40%) respectively.

In **Greece** the most popular answer for the most prominent products used in the deep energy renovation of a school building was "Envelope products" with 72%, followed by "Heating systems" which gathered half of the total percentage (50%). Participants from Greece also selected "Ventilation equipment" and "Lighting" with 48% and 42% respectively, as well as "Photovoltaic solar panels" with 30%.

It is worth noting that when participants were asked to choose whether they used "Renewable energy systems in general" during the deep energy renovation of a school building, 26% of participants from Greece made this choice and only 3% in Cyprus did so.

Finally, only the participants from Greece selected the following, as Cyprus had zero percentages:

- Building Energy Management Systems (BEMS) (12% Greece)
- Combined Heat and Power system (8% Greece)
- Biomass stoves and boilers (2% Greece)

Statistically significant differences were observed in the following product categories, "Heating systems" with a 27% difference ($z=2.527$, $p<0.01$), "Renewable energy systems in general" with a 23% difference ($z=-2.831$, $p<0.01$) and "Building Energy Management Systems (BEMS)" with a difference of 12% ($z=-2.126$, $p=0.017$).

4.5 Issues of comfort and indoor air quality in schools

This sub-chapter is about the aspects of comfort. More specifically, whether the participants were familiar with the concepts of indoor air quality, and thermal, visual and acoustic comfort and if they had measured these parameters for a certain period of time.

4.5.1 Awareness and familiarization with "indoor air quality" and "thermal comfort" concepts

Participants from both countries were asked about their familiarity with the concepts of indoor air quality and thermal comfort. The results are presented in Figure 20.

In **Cyprus** the absolute majority of 100% answered in the affirmative that they were aware what "Thermal comfort" was and how this applies in a school building. A fairly similar percentage of 91% answered that they knew what "Indoor air quality" was and how it applies in a school building. In addition, 82% of participants from Cyprus answered "Yes" when asked if during the deep energy renovation, a device measuring any thermal comfort parameter was installed. Less than half of the participants in Cyprus, (45%) also answered positively that a system of mechanical ventilation was installed in the deep energy renovation in school buildings. However, 27% responded positively on whether a building air tightness check had been carried out in the deep energy renovation of a school building. Finally, 36% of respondents in Cyprus answered "Yes" to whether a device measuring indoor air quality was installed in the deep energy renovation of a school building. The low percentages of the last two responses, highlight the need for more measurements of those aspects.

In **Greece**, a high percentage of the responses given, that of 88%, were familiar with "Indoor air quality" concept and how it applies to a school building, as well as 87% were aware of "Thermal comfort" and how it applies in a school building. Fifty-nine percent (59%) of the respondents in Greece answered in the affirmative that a system of mechanical ventilation was installed in a school building during a deep energy renovation, which is comparable to the 53% of those who claimed that a device measuring indoor air quality was installed. Furthermore, 53% answered that a device that measures a thermal comfort parameter was installed in a school building. Finally, 43% of the participants in the survey in Greece answered positively that during the deep energy renovation of a school building there was a check for the building's air tightness.

Statistically significant differences in the responses of the participants in the two countries were observed when they were asked whether there was any check on the building's air tightness with a difference of 32% while they selected the answer "Uncertain" (none in Cyprus, 32% Greece, $z=-2.210$, $p=0.014$) and whether a thermal comfort device was installed with a difference of 28% while they chose the answer "No" (none in Cyprus, 28% Greece, $z=-2.019$, $p=0.022$).

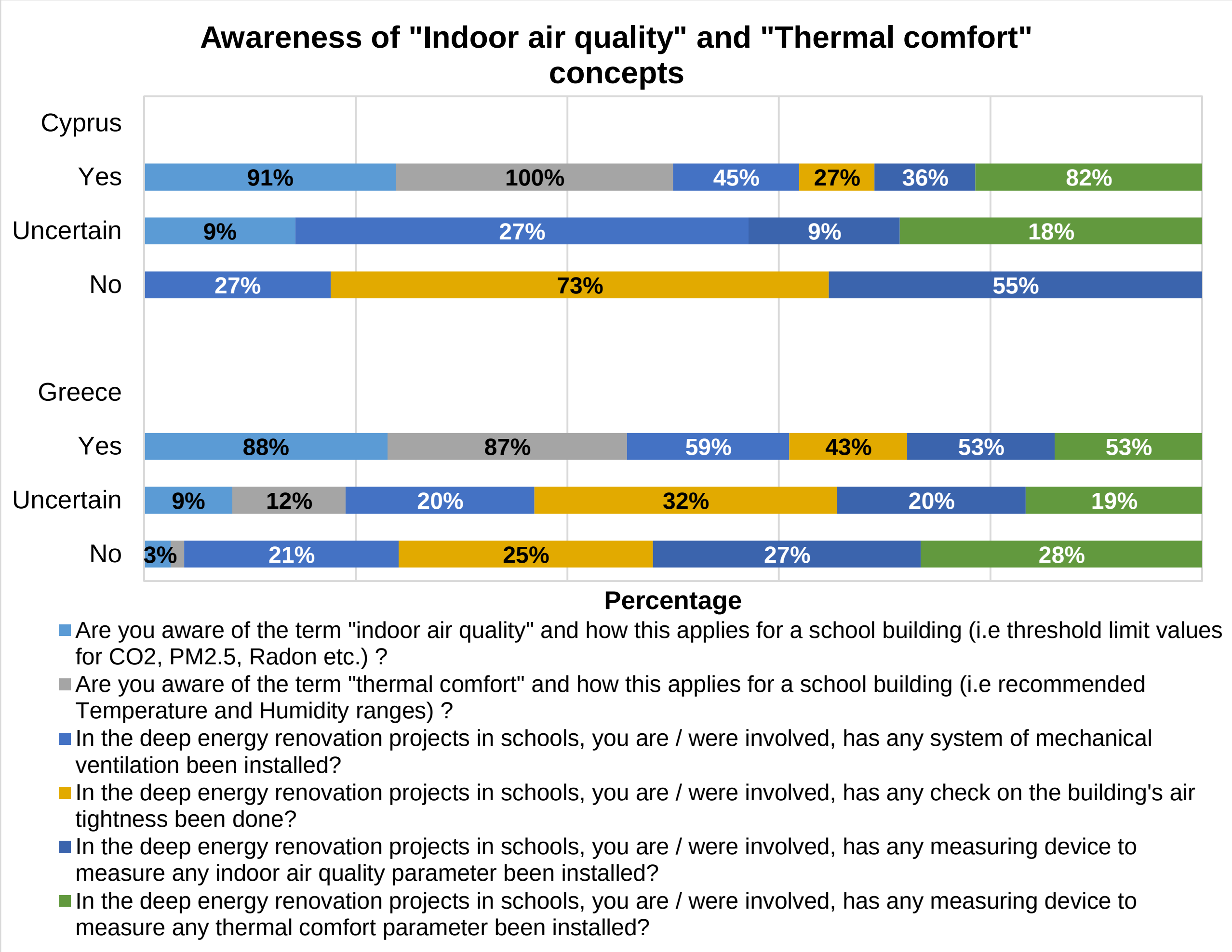


Figure 20 Awareness and familiarization with "indoor air quality" and "thermal comfort" concepts

4.5.2 Parameters of indoor air quality or thermal comfort measured in the deep energy renovation in schools

Survey participants were asked to answer which parameter of air quality or thermal comfort has been measured for a period of time. The results are presented in Figure 21.

First in the preferences for **Cyprus** with a very high rate of 94% was "Indoor temperature" and second was "Indoor relative humidity" with 84%. In addition, participants from Cyprus selected "CO_2 concentration" and "Flow ventilation" with 44% and 41% respectively. Eventually, 19% in Cyprus selected "Particulate Matter and / or Volatile Organic Compounds" as a parameter that has been measured for a period of time.

The rank of preferences of respondents in **Greece** appear to be the same as those mentioned regarding Cyprus since the most popular parameter that was measured during the deep energy renovation of a school building was "Indoor temperature" which gathered 83% of participants' choices whereas the second most popular, "Indoor relative humidity" gathered 81%. The options "CO_2 concentration", "Flow ventilation" and "Particulate Matter and / or Volatile Organic Compounds" were chosen by 47%, 36% and 28% respectively.

Finally, it is interesting to note that 8% of the survey participants from Greece did not know or did not remember if they measured any parameter during the deep energy renovation of a school building. No statistically significant differences between the two countries were observed.

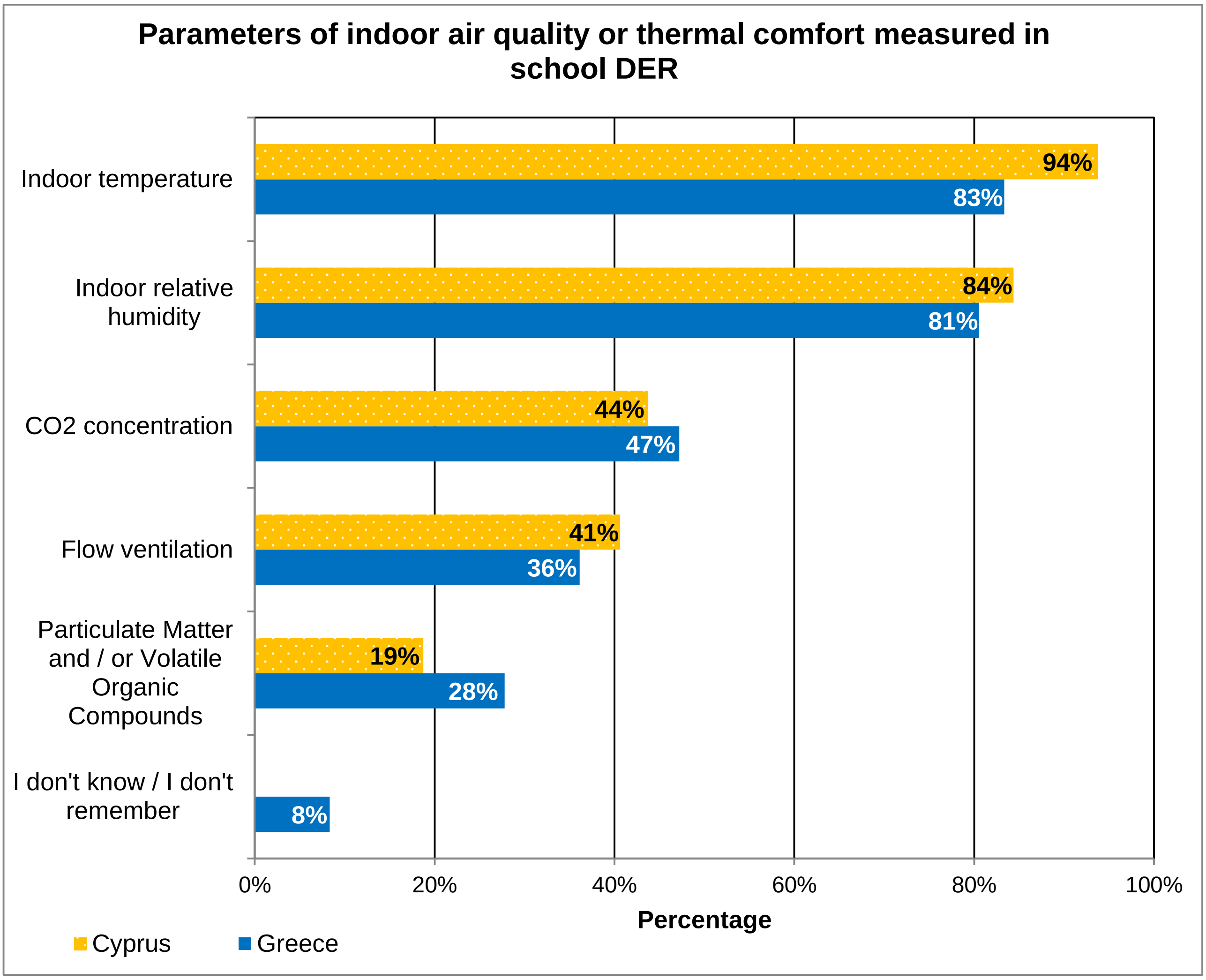


Figure 21 Parameter of indoor air quality or thermal comfort measured in the deep energy renovation in schools

4.5.3 Issues in terms of comfort considered in the deep energy renovation in schools

Survey participants were asked about the comfort issues they have taken into account in the deep energy renovation of school buildings. The results are illustrated in Figure 22.

The most popular answer in **Cyprus** was "Thermal comfort" which was selected by 92% of those surveyed while the second most popular chosen option was "Indoor air quality" with 69%. The "Visual comfort" choice gathered a relatively low 19% compared to the previous ones, and "Acoustic comfort" received 8%.

Respondents in **Greece** had as first choice "Thermal comfort" with 80% and as second choice "Indoor air quality" with 66%. Twenty-eight percent (28%) stated that "Visual comfort" was considered in the deep energy renovation of a school building, as well as "Acoustic comfort" which gathered 18%.

In addition, the fact that no comfort issue was taken into account was answered by only 4% of participants from Greece. However, it is worth noting that 10% of those surveyed in Greece did not know or did not remember if any issues in terms of comfort had been taken into account in deep energy renovations in schools. No statistically significant differences between the two countries were observed.

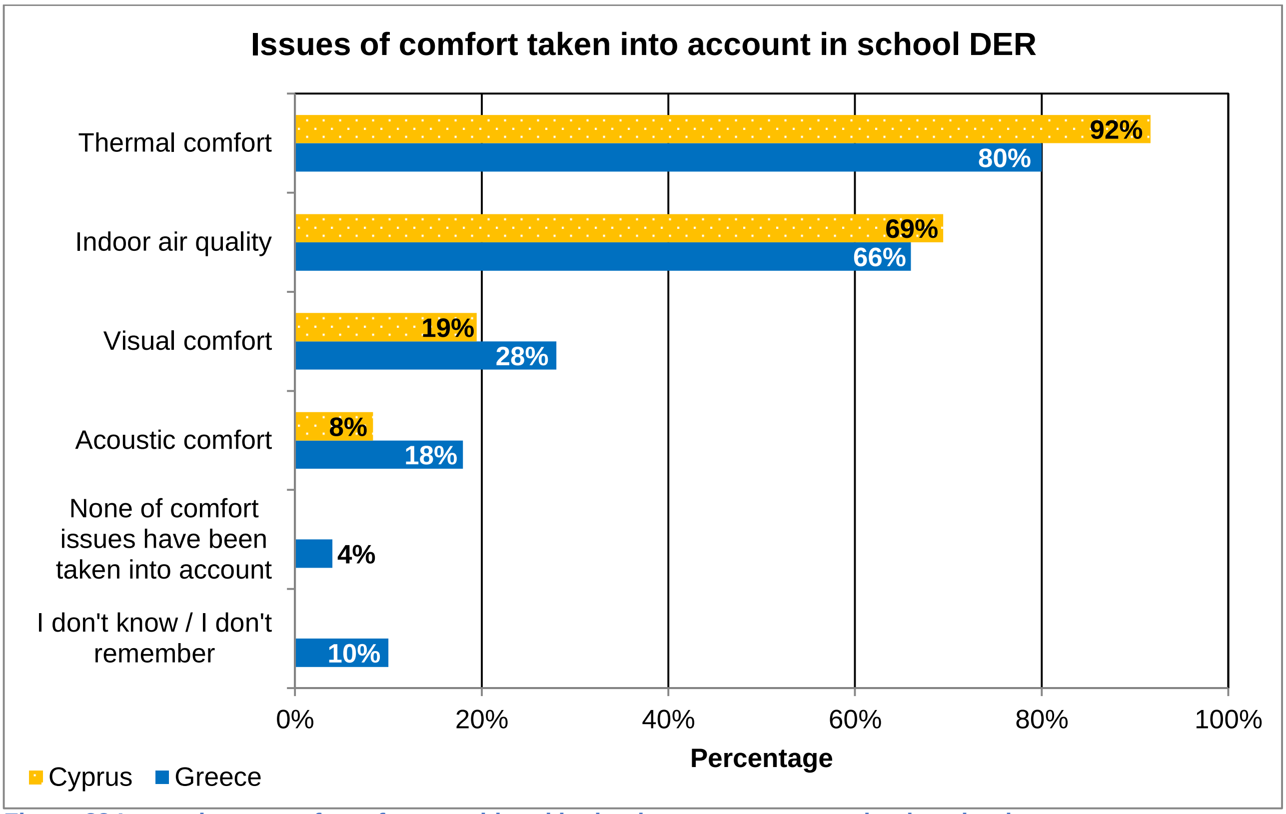


Figure 22 Issues in terms of comfort considered in the deep energy renovation in schools

4.5.4 Students' perception regarding any of the comfort aspects

The survey participants were asked if students studying in a school that had undergone a deep energy renovation, were surveyed about any comfort aspects. The results are presented in Figure 23.

Participants in **Cyprus** were asked if students were surveyed *before* the deep energy renovation of a school building, about their overall perception of comfort aspects. Twenty- seven percent (27%) answered in the affirmative about "Thermal comfort". With the same rates as those of 9%, the respondents selected the option "Yes" about "Indoor air quality", "Acoustic" and "Visual comfort" in all cases.

When survey respondents in Cyprus questioned if they asked students' opinion *after* the deep energy renovation with regard to their perception of indoor air quality as well as to thermal, visual and acoustic comfort, the following were recorded. The majority of respondents, 73%, provided negative answers regarding "Indoor air quality" and with 64% equally responded "No" with regard to "Thermal", "Visual" and "Acoustic comfort" about the perception of the students *after* the deep energy renovation of the school building. It is noteworthy that 9% of the participants selected "Yes" regarding "Thermal comfort" and none of those surveyed in Cyprus asked students' opinion about "Visual", "Acoustic comfort" and "Indoor air quality" aspects after the deep energy renovation.

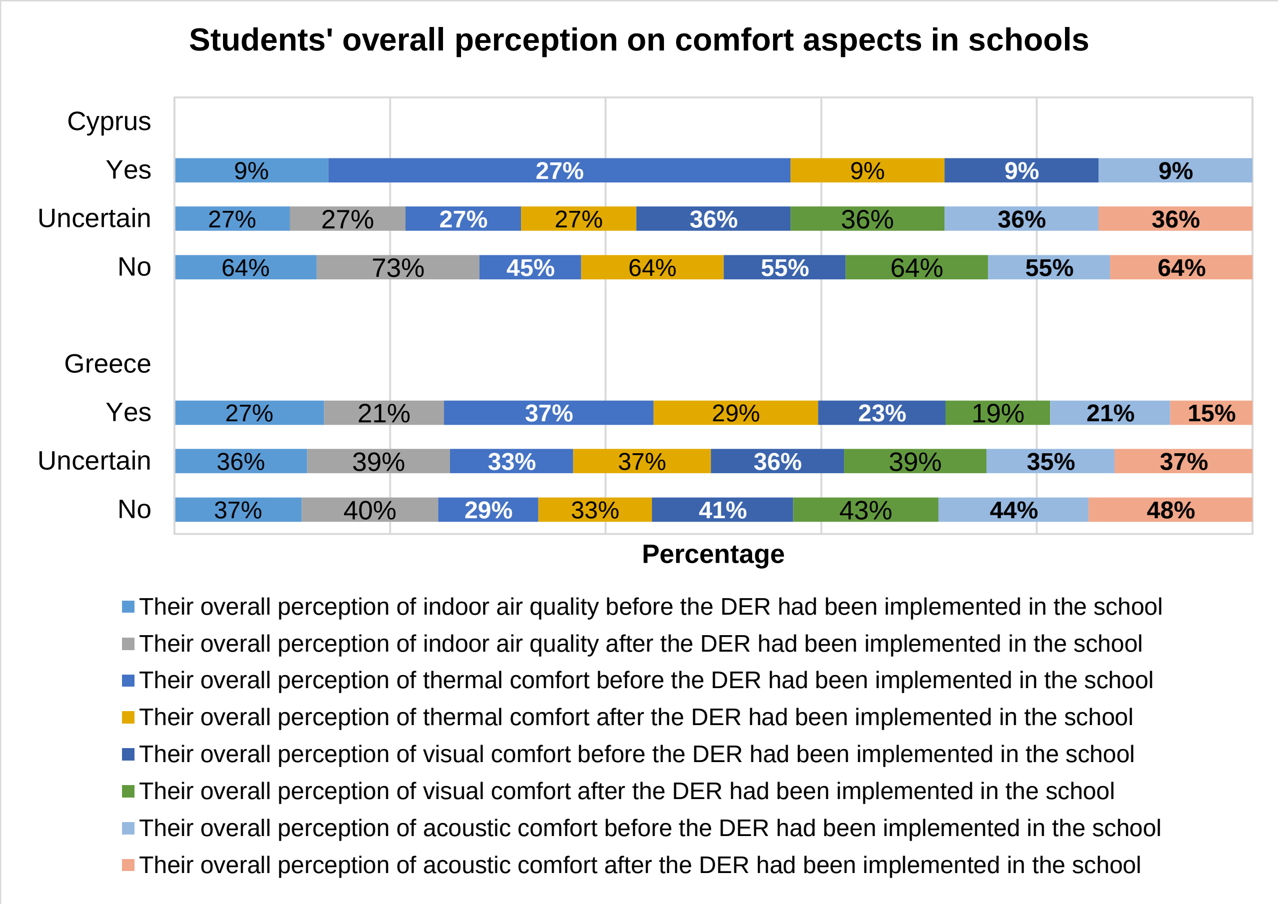


Figure 23 Students' perception regarding any of the comfort aspects

The responses given in **Greece** about whether the students' perception of "Thermal comfort" and "Indoor air quality" was surveyed ***before*** the DER had been implemented in the school building, ranked "Yes" with 37% and with 27% respectively. Less than one fourth of the participants in Greece did survey students about their opinion of "Visual comfort" (23%) and of "Acoustic comfort" (21%).

Survey participants in Greece were also asked whether they considered the opinion of the students about certain comfort aspects ***after*** the deep energy renovation of the school building. "Thermal comfort" gathered positive responses by 29%, followed by "Indoor air quality" with 21%. Respondents in Greece selected "Yes" about "visual comfort" with the rate of 19% and lastly students' perception of "Acoustic comfort" was surveyed by 15% according to the participants in Greece.

The results of the responses of the participants in the two countries above indicate the need to include the students' opinion on the aforementioned aspects of comfort in order to make the DER as efficient as possible.

5. Deep energy renovation in buildings

Chapter 5 presents the analysis of the data collected from the responses of the participants in Cyprus and Greece with regard to deep energy renovation (DER) of buildings other than schools. Difficulties encountered by the participants when renovating a building such as finding skilled actors or about the availability of products as well as the efforts participants had to make in order for a renovation to be realized are presented coupled with information on the policy gaps and financial barriers faced during a deep energy renovation. Finally, participants' awareness levels on parameters related to comfort aspects such as indoor air quality and thermal comfort are also explored.

5.1 General barriers for deep energy efficiency renovations implementation

An overview of the difficulties that the respondents of the two countries had to face and were hard to overcome during the deep energy renovation of a building is presented in this sub-chapter, as well as specifically regarding the insulation of a building's envelope and the installation of renewable energy systems. Moreover, the drivers that could boost the market of energy renovation are presented.

5.1.1 Difficulties hard to overcome in a deep energy renovation

Survey participants were asked if there was any particular difficulty that was hard to overcome during the deep energy renovation The results are presented in Figure 24.

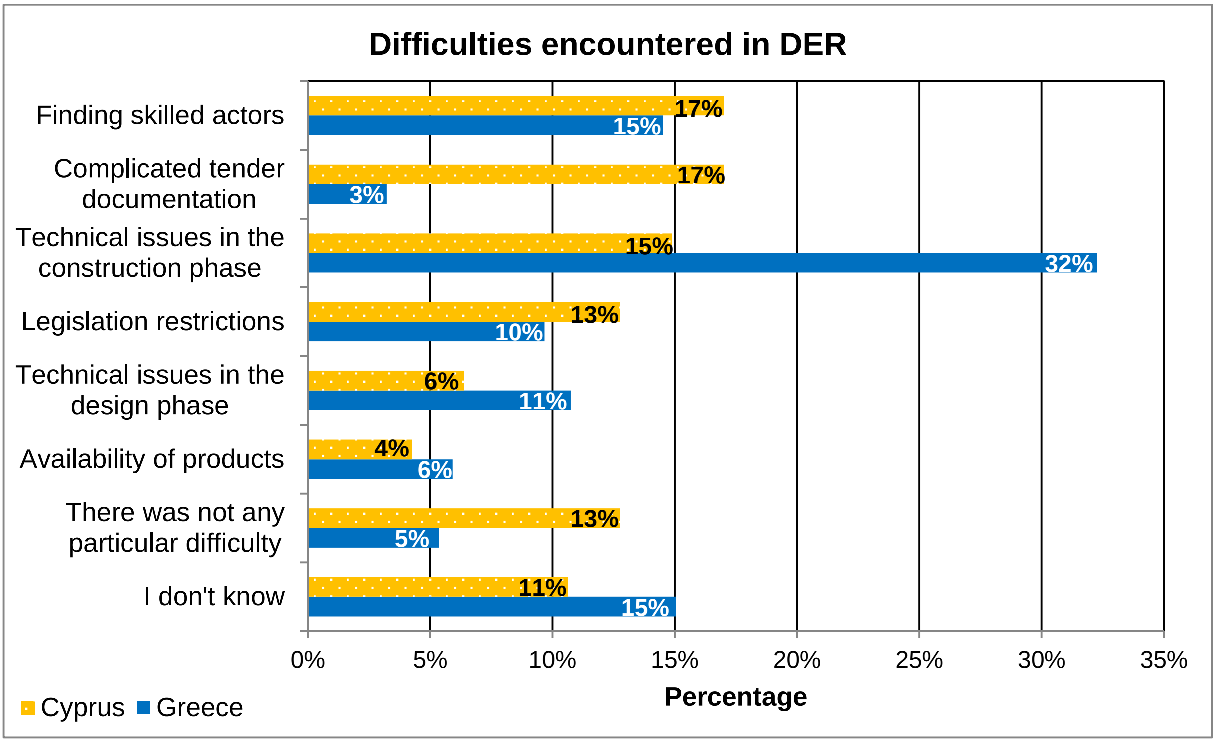


Figure 24 Challenges to overcome in a deep energy renovation

The respondents in **Cyprus** stated that the main difficulties they faced during deep energy renovations were "Finding skilled actors" and "Complicated tender documentation" with a rate of 17% in both cases. Subsequently, participants in Cyprus selected the option "Technical issues in the construction phase" with a rate of 15%, as well as "Legislation restrictions" with 13%. In addition, the option "There was not any particular difficulty" had a response rate of 13%. The difficulties "Technical issues in the design phase" and

"Availability of products" gathered 6% and 4% respectively. An 11% of the participants chose "I don't know".

The participants of the survey in **Greece** highlighted "Technical issues in the construction phase" with 32% as the main difficulty they encountered during the energy renovation of a building. As their second difficulty they selected "Finding skilled actors" with 15%. The choices "Technical issues in the design phase" and "Legislative constraints" received similar percentages, 11% and 10% respectively. Eventually, the options "Availability of products" and "Complicated tender documentation" gathered lower rates, those of 6% and 3% accordingly. Five percent (5%) reported "There was not any particular difficulty" in the deep energy renovation projects they were involved in.

Statistically significant differences in the responses of participants from the two countries were observed with regard to "Technical issues in the construction phase" with a difference of 17% (15% Cyprus, 32% Greece $z=-3.566$, $p<0.01$) and "Complicated tender documentation" with a difference of 14% (17% Cyprus, 3% Greece, $z=2.779$, $p=0.003$).

5.1.2 Three most important barriers which make the implementation of a deep energy renovation difficult

Survey participants in both countries were asked to select in order of preference, starting from the most important and in descending order, those three barriers that mostly apply in their countries and make the implementation of deep energy renovations on existing buildings difficult. The results are presented in Figure 25. Data labels for percentages lower or equal to 2% are omitted from the figures.

The ranking of barriers when choosing, was the same for both countries. They were able to choose three out of twelve predefined options (see Figure 25) along with an "I don't know" option. In total, 71% of the respondents in both Cyprus and Greece stated that "Economic / financial resources" was one of the top-three barriers in the implementation of deep energy renovation in buildings. "User motivation / demand" and "Lack of energy efficiency funding programs" were also important difficulties, placed in the first three ranking positions by 43% and 34% of the respondents, respectively.

In general, respondents in both countries found difficulties in the implementation of deep energy renovation in buildings for all the twelve barriers, however the ranking differs across the two counties.

In **Cyprus**, 64% of the respondents mentioned "Economic / financial resources" as one of their top-three barriers that made the implementation of deep energy renovation on existing buildings difficult. "User motivation / demand " and "Lack of voluntary national deep energy renovation schemes for renovation of existing buildings" were also placed in the top-three positions by 48% and 31% of respondents, respectively.

In **Greece**, 72% of those surveyed selected "Economic / financial resources " as one of their top-three obstacles, followed by the "User motivation / demand" and "Lack of energy efficiency funding programs" with 40% and 35% respectively, as their most important barriers that created difficulties in the implementation of deep energy renovation in buildings.

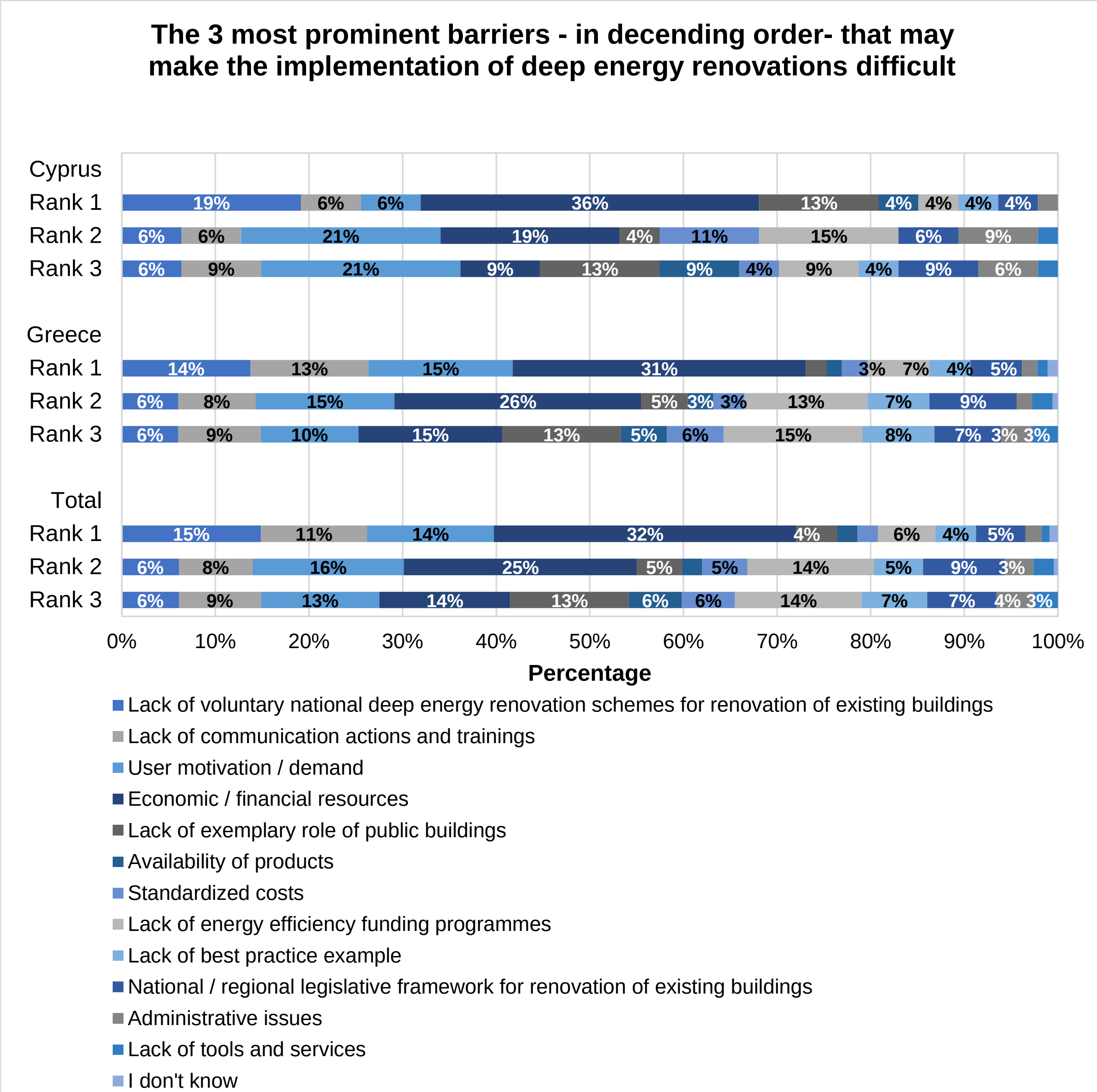


Figure 25 Three barriers -in a descending order- which make the implementation of a deep energy renovation difficult

The following statistically significant difference were observed per ranking with regard to the following options:

In Rank 1 "Lack of exemplary role of public buildings" with a difference of 11% (13% Cyprus, 2% Greece, z=3.161, p<0.01).

In Rank 2 "Standardized costs" with a difference of 8% (11% Cyprus, 3% Greece, z=2.098, p=0.018) and "Administrative issues" with a difference of 7% (9% Cyprus, 2% Greece, z=2.436, p<0.01).

In Rank 3 "User motivation / demand" with a difference of 11% (21% Cyprus, 10% Greece, z=1.992, p=0.023).

5.1.3 Drivers that boost the deep energy renovation market

Respondents were asked about the drivers that could boost the deep energy renovation market in renovation projects in their country. The results are presented in Figure 26.

The majority of those surveyed in **Cyprus** selected "Improved financing solutions" as their first choice with 70%. The second driver was "New business models" which had a percentage of 44%. Subsequently, the next three drivers that could boost the market, gathered similar percentages as "Consultancy / training" received 43%,"Clear technical guidelines on DERs" and "Upgrading the skills of professionals for DERs" both received 38%. In addition, 28% of participants in Cyprus stated that "More ambitious renovation obligations" is a way to empower the deep energy renovation market, as well as "Robust legislation" which gathered 20%. Finally, the choices "Raise societal awareness on DERs to increase support" and "Emphasizing the role of DERs in improved Indoor Air Quality and health" were selected with lower percentages, 13% and 11% respectively.

The most popular choice among the responses given in **Greece** as a factor to boost the deep energy renovation market was "Improved financing solutions" which collected 73% and "Consultancy/ training" followed with 47%. The next two options had similar percentages as "Clear technical guidelines on DERs" and "Upgrading the skills of professionals for DERs" gathered 40% and 39% respectively. "Robust legislation" was preferred by 36% of the participants from Greece and "More ambitious renovation obligations" by 35%. Furthermore, the options "New business models" and "Raise societal awareness on DERs to increase support" gathered similar percentages, 31% and 30% correspondingly. Finally, another driver that would enhance the deep energy renovation market was "Emphasizing the role of DERs in improved Indoor Air Quality and health" which was selected by 20% of those surveyed.

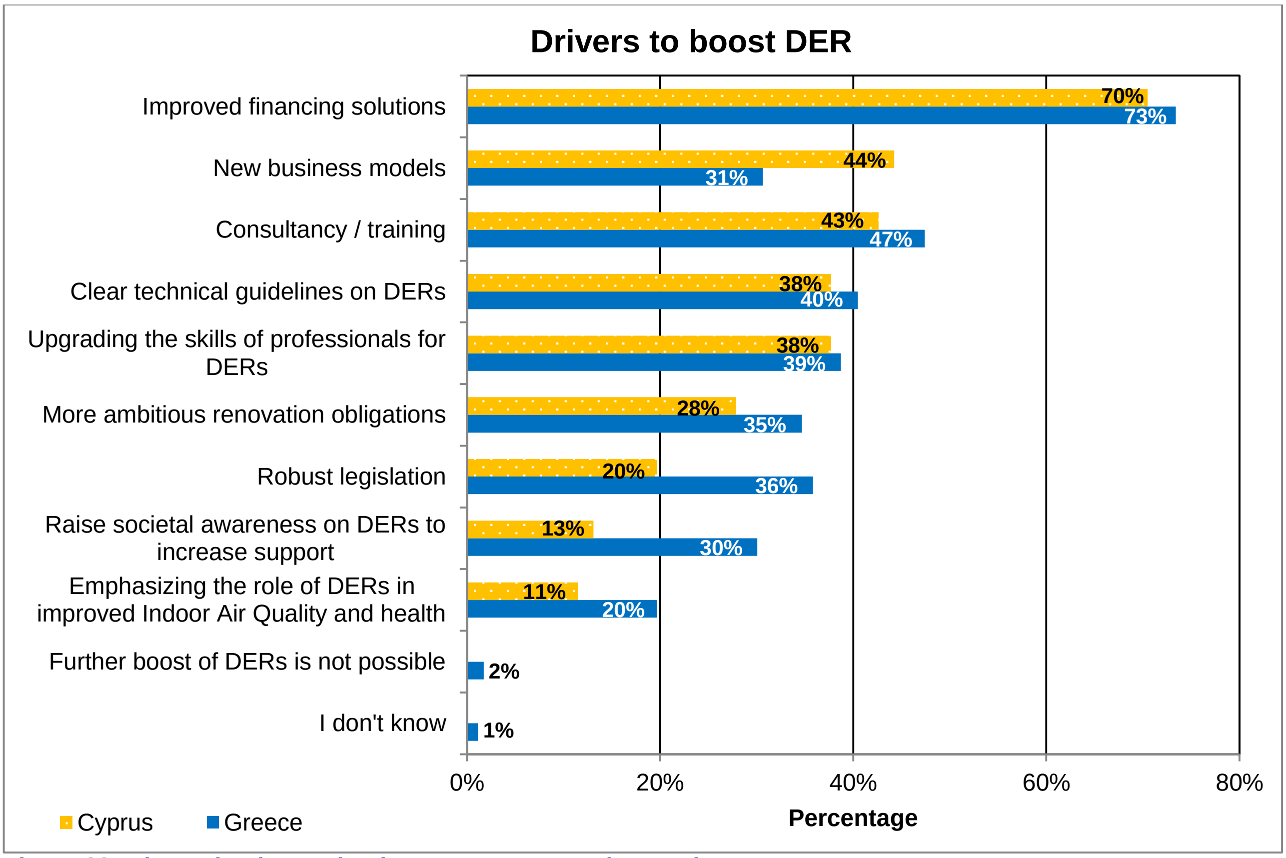


Figure 26 Drivers that boost the deep energy renovation market

Statistically significant differences were observed in the selections of the participants of the two countries regarding the drivers that could enhance deep energy market renovation, first in "Raise societal awareness on DERs to increase support" with a difference of 17% (13% Cyprus, 30% Greece, z=-2.606, p=0.005) and in "Robust legislation" with a difference of 16% (20% Cyprus, 36% Greece z=-2.335, p=0.01).

5.1.4 Gaps and barriers while implementing a deep energy renovation

The participants in the survey were asked about the gaps and barriers when carrying out a deep energy renovation of a building, regarding the whole chain from the customer's first demand up to the final use-phase of the end-user. Respondents were asked about the level of agreement, if at all, with given statements. Results are on 1 to 5 scale (1= Strongly disagree, 2=Disagree, 3=Neither agree nor disagree 4=Agree, 5=Strongly agree). The higher the mean value (M) the greater the agreement with the statement. Mean values(M) over 3.5 indicate agreement with the statement. A low standard deviation (SD) indicates that given answers tend to be close to mean value, while high standard deviation indicates that the given answers are spread out over a wider range of values. An independent sample t-test was used to determine whether the differences in the mean values recorded between the two countries are statistically significant. P-values smaller than 0.05 indicate statistically significant differences in the mean value. The results are illustrated in Figure 27 and described in Table 4.

In **Cyprus** the survey respondents agreed most that "Lack of financial incentives and funds" (M=3.90, SD=0.77) is a barrier for the implementation of deep energy renovations. They also agreed on that the "Building user's / owner's socioeconomic status "(M=3.82, SD=0.83) is another important factor which pose a challenge for the realisation of deep energy renovations. "High capital costs and financial risks "(M=3.79, SD=0.73) and "Lack of skilled workforce " (M=3.62, SD=1) were among the four statements respondents agreed more with. On the other hand, they disagreed on the option "There are no gaps or barriers and the whole chain is working " (M=1.66, SD=0.83).

The respondents in **Greece**, agreed most on that the most important gap and barrier for implementing a deep energy renovation was "Building user's / owner's socioeconomic status"(M=4.19, SD=0.81). Second in line was "Lack of financial incentives and funds"(M=4.08, SD=0.86). Respondents in Greece showed high confidence that "Legislative and regulatory barriers - bureaucracy"(M=3.9, SD=0.84) as well as "High capital costs and financial risks "(M=3.86, SD=0.85) make up gaps for the implementation of deep energy renovations. Finally, they also agreed that "Lack of integrated approach among actors "(M=3.8, SD=0.80) and "Lack of sufficient legislation" (M=3.74, SD=0.86) hold DERs back. On the contrary, as seen in Cyprus, the participants disagreed on the statement that "There are no gaps or barriers and the whole chain is working " (M=1.71, SD=0.96).

Statistically significant differences between the responses given in two countries were found in the following items:

- "Lack of inventory for public buildings at municipal / regional level" with a difference of 57% (3.02 Cyprus, 3.59 Greece, $t=-4.031$, $p<0.01$)
- "Lack of monitoring to survey actual performances" with a difference of 50% (3.13 Cyprus, 3.63 Greece, $t=-3.652$, $p<0.01$)
- "Building user's / owner's socioeconomic status" with a difference of 37% (3.82 Cyprus, 4.19 Greece, $t=-3.343$, $p<0.01$)
- "Legislative and regulatory barriers - bureaucracy" with a difference of 33% (3.57 Cyprus, 3.90 Greece, $t=-2.762$, $p=0.006$)

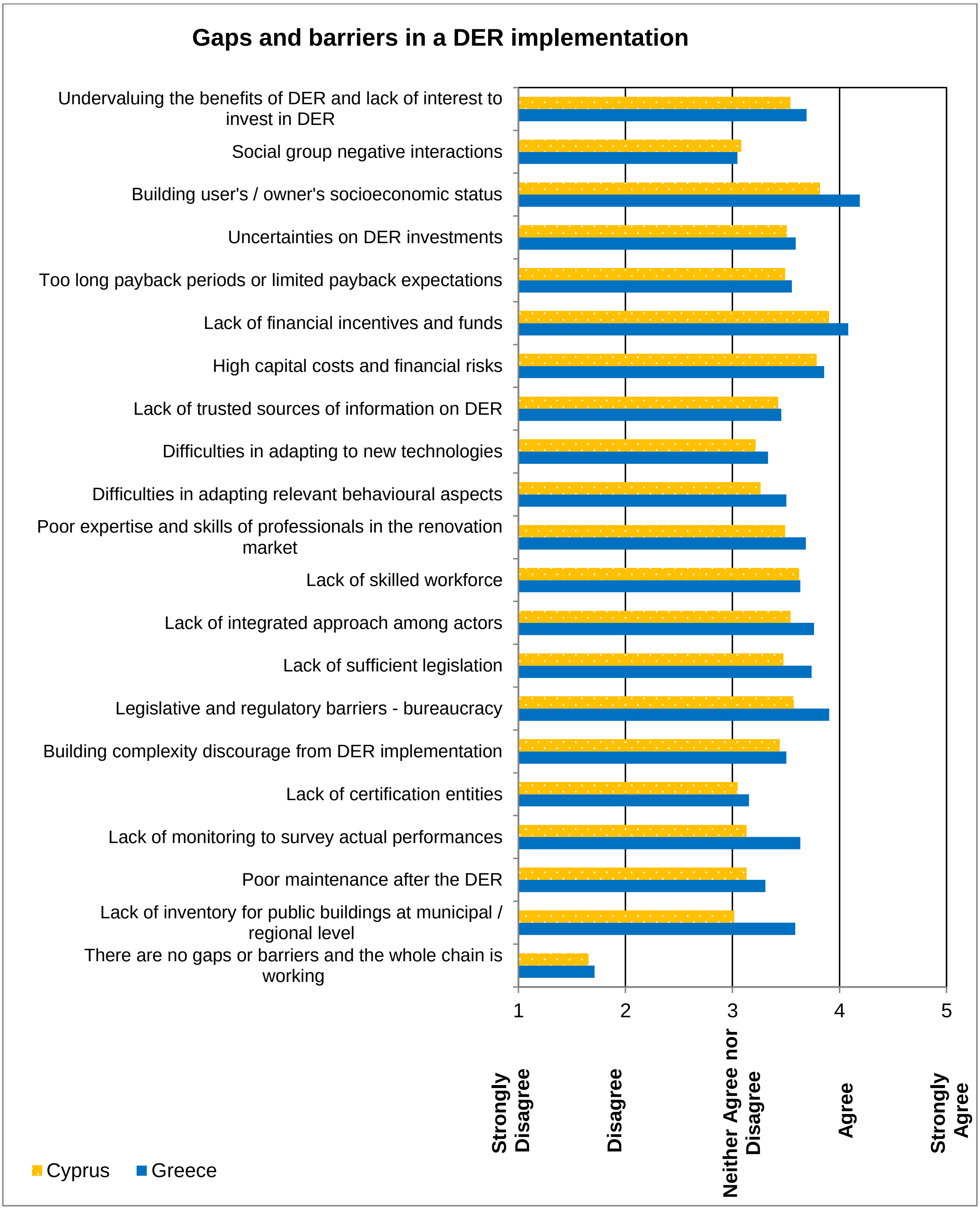


Figure 27 Gaps and barriers while implementing a deep energy renovation

Table 4 Mean values and standard deviations of perceived level of information on level of agreement about gaps and barriers regarding deep energy renovation implementation - Sample per country

	Cyprus		Greece		Difference in mean value	%Difference in mean value	p value
	MEAN	SD	MEAN	SD			
Undervaluing the benefits of DER and lack of interest to invest in DER	3,54	0,91	3,69	0,88	0,15	15%	0,353
Social group negative interactions	3,08	1,04	3,05	0,97	0,03	3%	0,611
Building user's / owner's socioeconomic status	3,82	0,83	4,19	0,81	0,37	37%	0,001
Uncertainties on DER investments	3,51	0,83	3,59	0,86	0,08	8%	0,571
Too long payback periods or limited payback expectations	3,49	0,89	3,56	0,91	0,06	6%	0,630
Lack of financial incentives and funds	3,90	0,77	4,08	0,86	0,18	18%	0,162
High capital costs and financial risks	3,79	0,73	3,86	0,85	0,07	7%	0,366
Lack of trusted sources of information on DER	3,43	0,94	3,46	1,01	0,03	3%	0,987
Difficulties in adapting to new technologies	3,22	1,04	3,33	0,99	0,11	11%	0,460
Difficulties in adapting relevant behavioural aspects	3,26	0,93	3,50	0,88	0,24	24%	0,077
Poor expertise and skills of professionals in the renovation market	3,49	1,04	3,69	1,05	0,19	19%	0,305
Lack of skilled workforce	3,62	1,00	3,63	1,03	0,01	1%	0,871
Lack of integrated approach among actors	3,54	0,99	3,76	0,80	0,22	22%	0,123
Lack of sufficient legislation	3,48	0,91	3,74	0,86	0,26	26%	0,059
Legislative and regulatory barriers - bureaucracy	3,57	0,88	3,90	0,84	0,33	33%	0,006
Building complexity discourage from DER implementation	3,44	0,89	3,50	0,96	0,06	6%	0,609
Lack of certification entities	3,05	0,96	3,15	0,92	0,10	10%	0,481
Lack of monitoring to survey actual performances	3,13	0,94	3,63	0,92	0,50	50%	0,000
Poor maintenance after the DER	3,13	0,87	3,31	0,80	0,18	18%	0,156
Lack of inventory for public buildings at municipal / regional level	3,02	1,02	3,59	0,91	0,57	57%	0,000
There are no gaps or barriers and the whole chain is working	1,66	0,83	1,71	0,96	0,05	5%	0,734

5.1.5 Challenges faced when improving a building's envelope in deep energy renovation

Survey participants were asked if they had faced challenges when improving the building's envelope through insulation and / or energy efficient windows during the deep energy renovation. The results are presented in Figure 28.

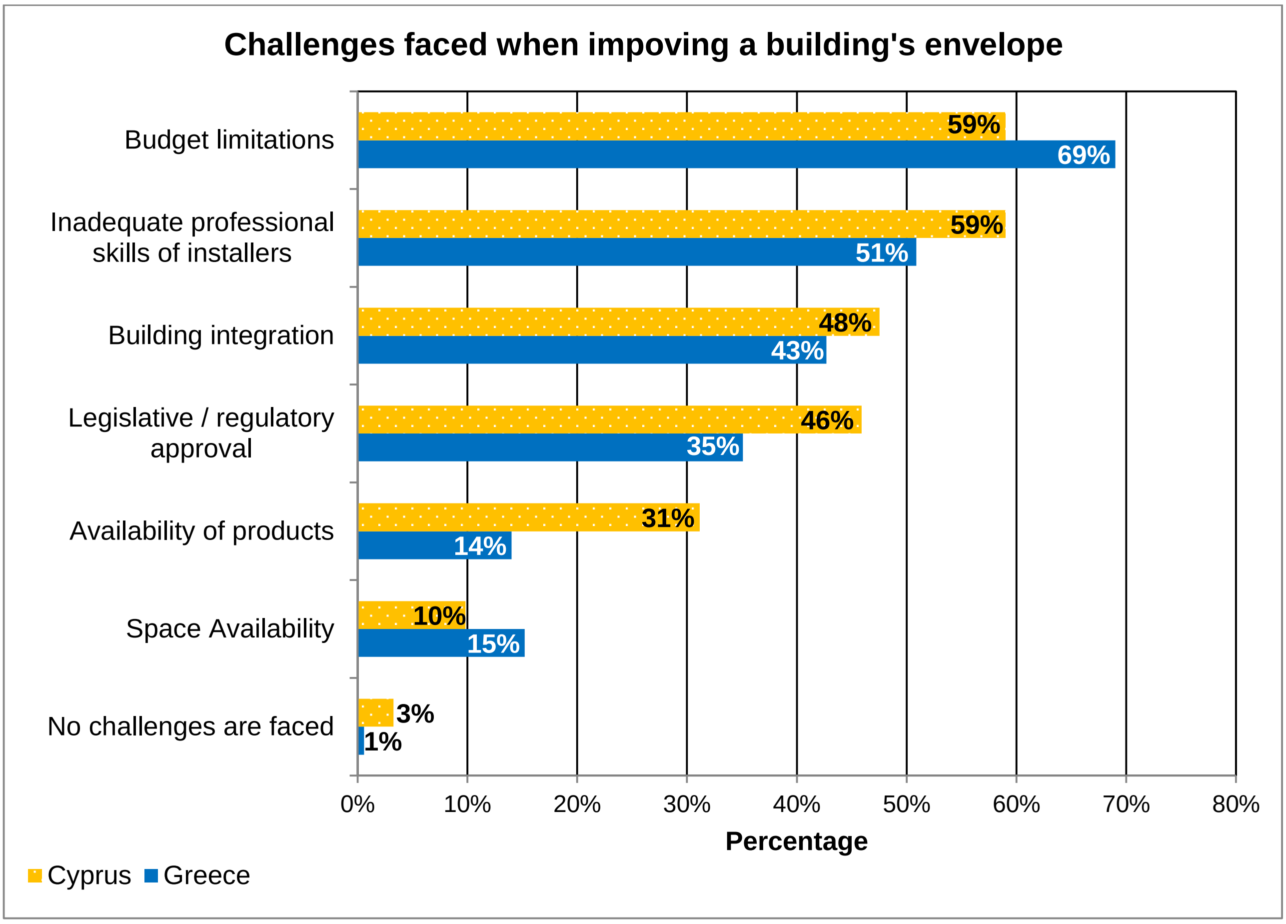


Figure 28 Challenges faced when improving a building's envelope in deep energy renovation

The most common responses in **Cyprus** were "Budget limitations" and "Inadequate professional skills of installers" which scored 59% in both cases. Participants also responded that they faced "Building integration" and "Legislative / regulatory approval" challenges with 48% and 46% respectively. In addition, the "Availability of products" was also seen as a challenge, which gathered 31% while "Space Availability" received 10%.

In **Greece**, the most popular challenge faced was "Budget limitations" with 69% whereas the second most popular was "Inadequate professional skills of installers" with 51%. Third in the order of challenges was the option "Building integration" with 43%, followed by "Legislative / regulatory approval" with 35%. Eventually, 15% of the participants in Greece were confronted with the "Space Availability" problem when improving the building envelope and / or energy efficient windows during a deep energy renovation project. "Availability of products" received 14%.

A statistically significant difference of 17% was observed in the difficulty of "Availability of products" (31% Cyprus, 14% Greece, z=2.953, p=0.002).

5.1.6 Challenges faced when installing renewable energy systems

Respondents were asked about the challenges they faced when installing renewable energy systems in deep energy renovation projects. The results are illustrated in Figure 29.

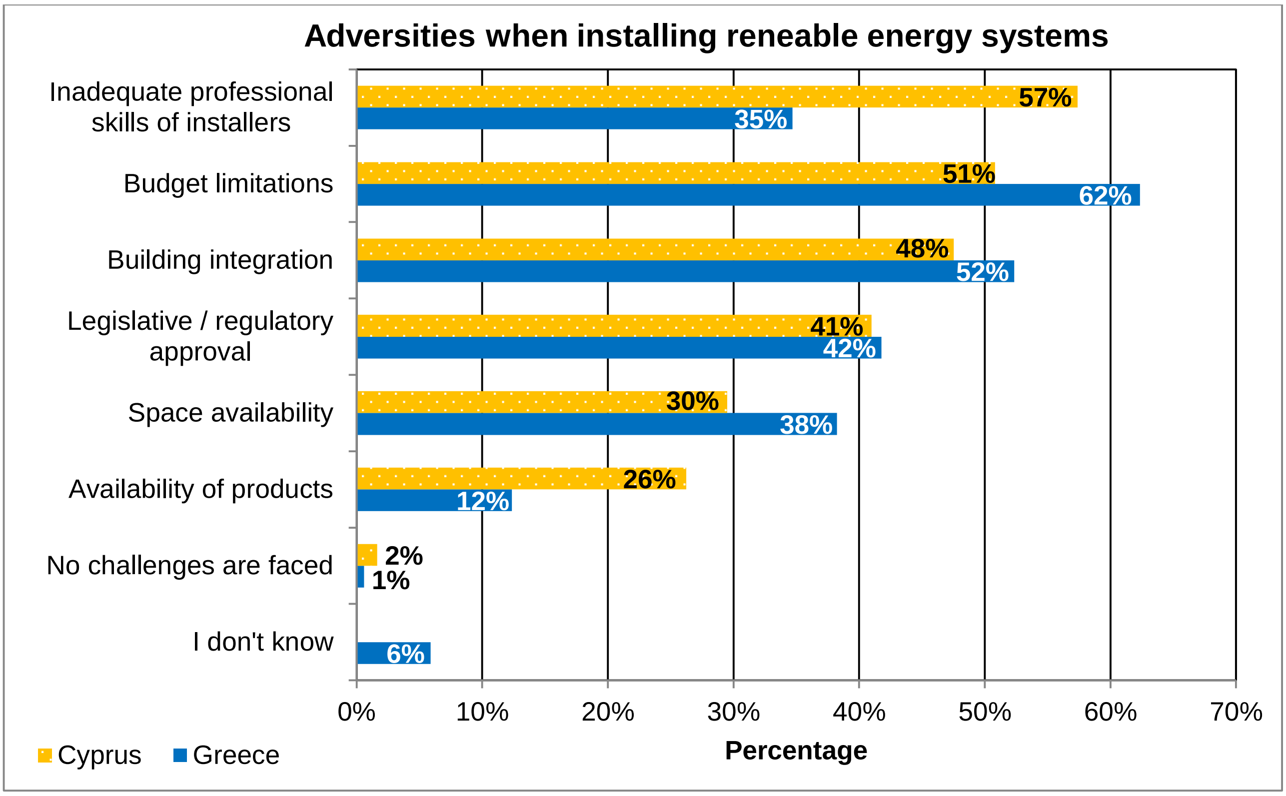


Figure 29 Challenges faced when installing renewable energy systems

The option with the highest response in **Cyprus** was "Inadequate professional skills of installers" which was selected by 57%, while second was "Budget limitations" with 51%. "Building integration" was selected by almost half of the respondents, 48%. Another challenge faced by the survey participants in Cyprus was the "Legislative / regulatory approval" as it received 41%. With lower percentages, "Space availability" and "Availability of products" were also selected with 30% and 26% respectively.

In **Greece**, unlike those mentioned above, the most popular option with 62% was "Budget limitations" and the second most popular was "Building integration" with 52%. "Legislative/regulatory approval" and "Space availability" with the respective percentages of 42% and 38% were also some of the challenges encountered when installing renewable systems during the energy renovation of a building. In addition, participants in Greece selected "Inadequate professional skills of installers" with 35% whereas 12% considered that "Availability of products" was a challenge when carrying out a project.

Finally, the participants who stated that they did not face any challenges were only 2% in Cyprus and 1% in Greece.

Statistically significant differences were observed between the responses given in two countries "Inadequate professional skills of installers" with a difference of 22% (57% Cyprus, 35% Greece, $z=3.092$, $p<0.01$) and in "Availability of products" with a difference of 14% (26% Cyprus, 12% Greece, $z=2.535$, $p=0.006$).

5.2 Policy and financial barriers

The difficulties related to policy gaps and financial barriers in the deep energy renovation of a building are listed in this sub-chapter. Specifically, participants' consideration on the national energy efficiency policies regarding the encouragement of deep energy renovations, the gaps related to energy efficiency policies, the most prominent barriers for financing building energy renovations as well as where additional efforts were made to reduce construction costs are all explored. Finally, it is also questioned which tasks required additional financial resources when implementing a deep energy renovation compared to a traditional project.

5.2.1 Encouragement of deep energy renovations: Energy efficiency policies

Survey participants were asked how they consider the energy efficiency policies in their countries regarding the encouragement of deep energy renovations in existing buildings. The results are presented in Figure 30.

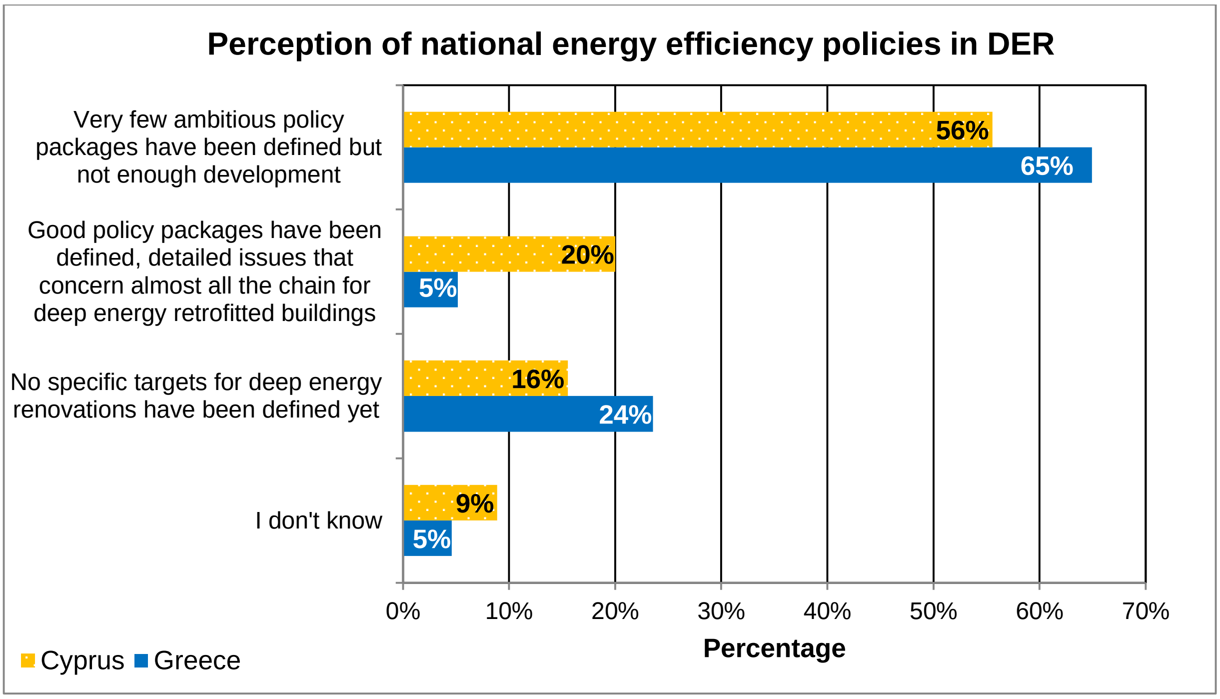


Figure 30 Participants' consideration on the energy efficiency policies regarding encouragement of deep energy renovation in existing buildings

Respondents in **Cyprus** stated that "Very few ambitious policy packages have been defined but not enough development" in Cyprus with 56%, while 20% reported that "Good policy packages have been defined, detailed issues that concern almost all the chain for deep energy retrofitted buildings". Sixteen percent (16%) of the participants in Cyprus stated "No specific targets for deep energy renovations have been defined yet".

In **Greece**, the majority of respondents, 65%, stated that "Very few ambitious policy packages have been defined but not enough development" whereas 24% considered that "No specific targets for deep energy renovations have been defined yet". Interestingly, a small share of 5% of respondents in Greece reported that "Good policy packages have been defined, detailed issues that concern almost all the chain for deep energy that concern almost all the chain for deep energy retrofitted buildings ".

It is noteworthy that 9% from the participants in Cyprus and 5% in Greece stated that they didn't know if energy efficiency policy packages were defined in their country.

A statistically significant difference was observed between responses in the two countries regarding energy efficiency policy in those who stated "Good policy packages have been defined, detailed issues that concern almost all the chain for deep energy" with a difference of 15% (20% Cyprus, 5% Greece, z=3.228, p<0.01).

5.2.2 Policy gaps for the applicability of energy efficiency policies

Survey participants were asked to select the most important gap in their country's policy regarding the implementation of energy efficiency (EE) policies. The results are illustrated in Figure 31.

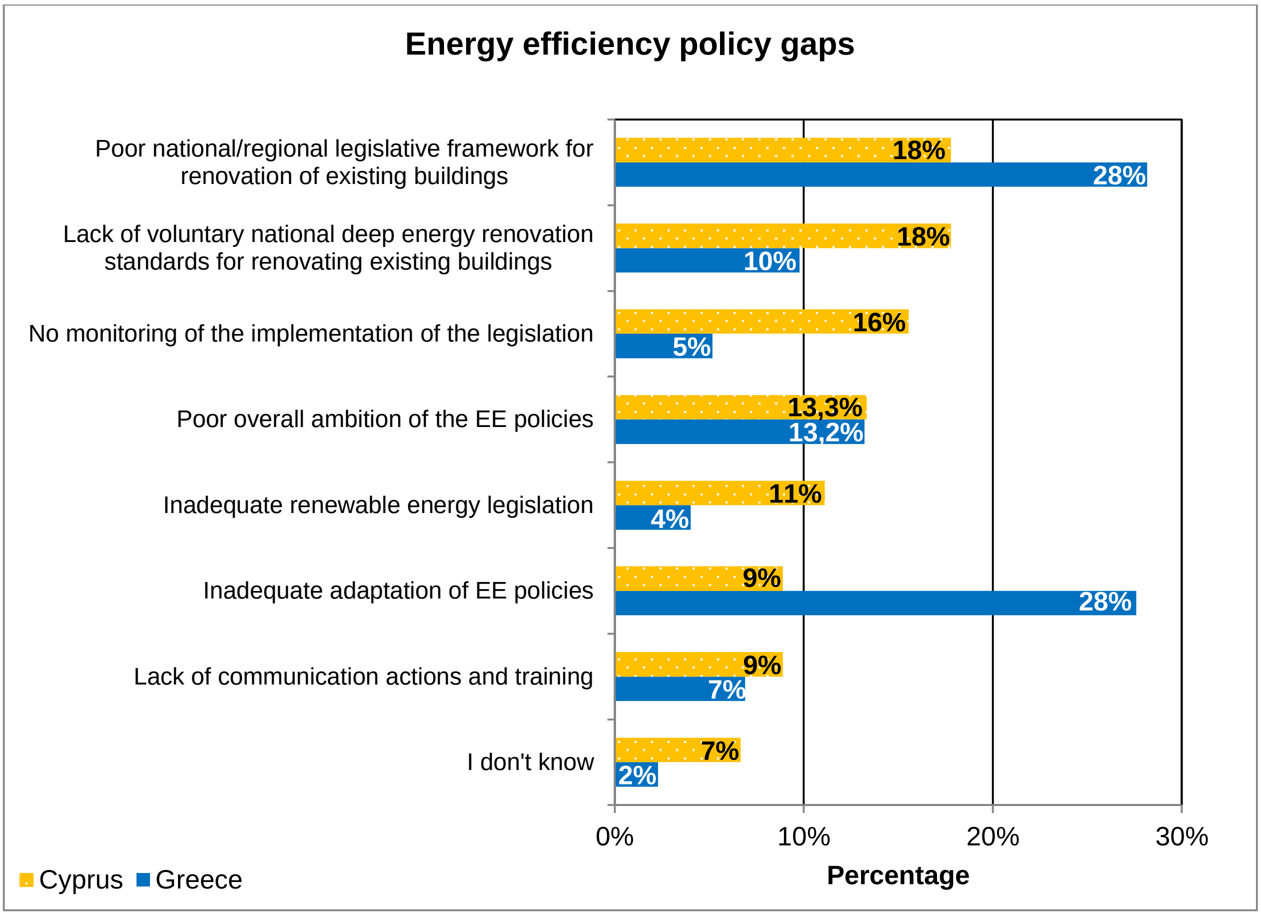


Figure 31 Gaps for the applicability of energy efficiency policies

The option "Poor national/regional legislative framework for renovation of existing buildings" received 18% in **Cyprus**, as did "Lack of voluntary national deep energy renovation standards for renovating existing buildings". The option "No monitoring of the implementation of the legislation" was selected by 16% of the participants while slightly higher than 13% considered "Poor overall ambition of the EE policies" as a gap in Cyprus. The two following choices, "Inadequate renewable energy legislation", "Inadequate adaptation of EE policies", gathered similar percentages, 11% and 9% respectively. Nine percent (9%) of the participants in Cyprus stated that the "Lack of communication actions and training" was another policy gap.

In **Greece**, the results of the survey seem to be slightly different to those mentioned for Cyprus as a 28% of the respondents considered that the two most important policy gaps in the implementation of energy efficiency were "Poor national/regional legislative framework for renovation of existing buildings" and "Inadequate adaptation of EE policies". A bit higher share than thirteen percent (13.2%) stated that the "Poor overall ambition of the EE policies" was another policy gap, as was the "Lack of voluntary national deep energy renovation standards for renovating existing buildings", which accounted for 10%. The options "Lack of communication actions and training" and "No monitoring of the implementation of the legislation" had corresponding percentages of 7% and 5%. Finally, 4% selected "Inadequate renewable energy legislation" as a policy gap.

Statistically significant differences in the responses of the participants in the two countries were observed in the following policy gaps, "Inadequate adaptation of EE policies" with a difference of 19% (9% Cyprus, 28% Greece, z=-2.627, p=0.004) and "No monitoring of the implementation of the legislation" with a difference of 11% (16% Cyprus, 5% Greece, z=2.386, p=0.009).

5.2.3 Prominent barriers for financing energy renovation

Survey participants were asked about the most prominent barrier for financing energy renovation of buildings in their countries. The results are presented in Figure 32.

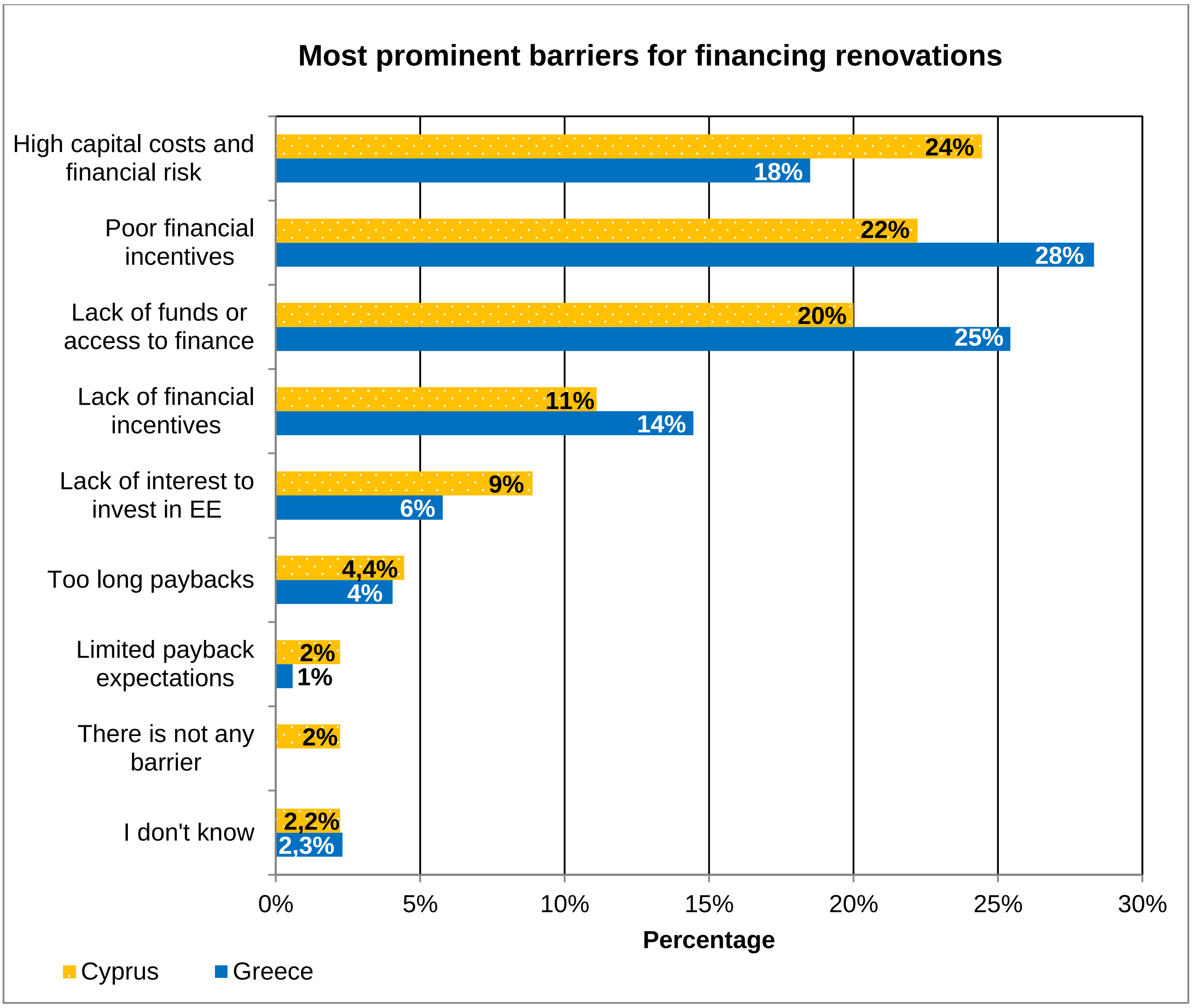


Figure 32 Prominent barriers for financing energy renovation

In **Cyprus,** respondents considered as the most prominent barrier "High capital costs and financial risk", with 24% while "Poor financial incentives" followed with 22%. The choice of "Lack of funds or access to finance" was selected by 20% as the third most important financial barrier. Furthermore, 11% of the respondents in Cyprus chose "Lack of financial incentives" as a barrier, followed by "Lack of interest to invest in Energy Efficiency" with 9%. Finally, slightly higher than 4% considered "Too long paybacks" as a prominent barrier for financing energy retrofits whereas a small share of 2% chose the "Limited payback expectations" option.

Those surveyed in **Greece** reported as the most important financial barrier for energy renovations "Poor financial incentives" with 28%, followed by "Lack of funds or access to finance" with 25%. Third and fourth in the row were "High capital costs and financial risk" with 18%, and "Lack of financial incentives" with

14%. Moreover, "Lack of interest to invest in Energy Efficiency" and "Too long paybacks" gathered lower percentages, 6% and 4% respectively.

Last but not least, only 2% of the participants in Cyprus considered that "There is not any barrier" for the financing of energy renovations of buildings, while this share in Greece was 9%.

A statistically significant difference of 2% was observed between the two countries in the option "There is not any barrier" (2% Cyprus, 0% Greece, z=1.965, p=0.025). In contrast, there were differences in "Poor financial incentives" (22% Cyprus, 28% Greece) and "High capital costs and financial risk" (24% Cyprus, 18% Greece) with a difference of 6% in both, as well as in "Lack of funds or access to finance" (20% Cyprus, 25% Greece) with a difference of 5%, yet they were not statistically significant.

5.2.4 Efforts to reduce construction costs

Survey participants were asked about their efforts in order to reduce construction costs while deep renovating a building. The results are illustrated in Figure 33.

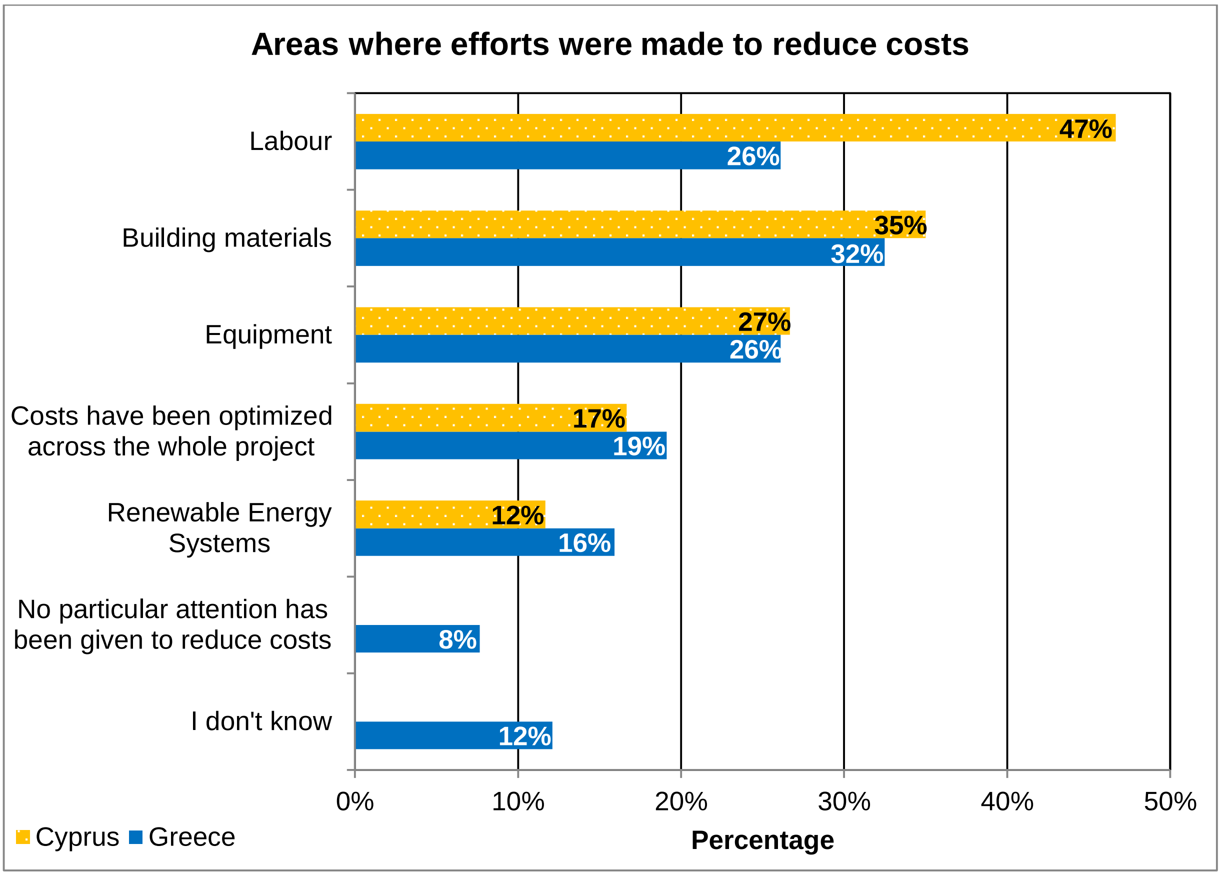


Figure 33 Cost reducing efforts in construction while deep energy renovating buildings

In **Cyprus,** respondents reported that they mostly made efforts to reduce costs with regard to "Labour" with 47%. "Building materials" was another area where they made efforts to cut expenses with 35%, followed by "Equipment" with 27%. Seventeen percent (17%) of the survey participants in Cyprus claimed that "Costs have been optimized across the whole project" and 12% stated that they tried to reduce costs in "Renewable Energy Systems".

Those questioned in **Greece**, reported that they tried to reduce costs with regard mainly to "Building materials" with 32%, with an equal share of 26% stating that they made efforts to reduce costs with regard to "Labour" and "Equipment". Slightly less than one out of five respondents stated "Costs have been optimized across the whole project" (19%) whereas 16% made efforts to reduce construction costs with regard to "Renewable Energy Systems". It is worth noting that 8% from those surveyed in Greece did not give any particular attention to reducing costs in contrast to 0% in Cyprus.

Statistically significant differences in the responses of participants in the two countries were observed in the option "Labour" with a difference of 21% (47% Cyprus, 26% Greece, z=2.981, p=0.002) and in "No particular attention has been given to reduce costs" with a difference of 8% (0% Cyprus, 8% Greece, z=-2.203, p=0.014).

5.2.5 Additional resources required in a deep energy renovation compared to a traditional project

Participants were asked to answer which of the tasks carried out during the deep energy renovation of a building required more financial resources compared to a traditional project. The results are illustrated in Figure 34.

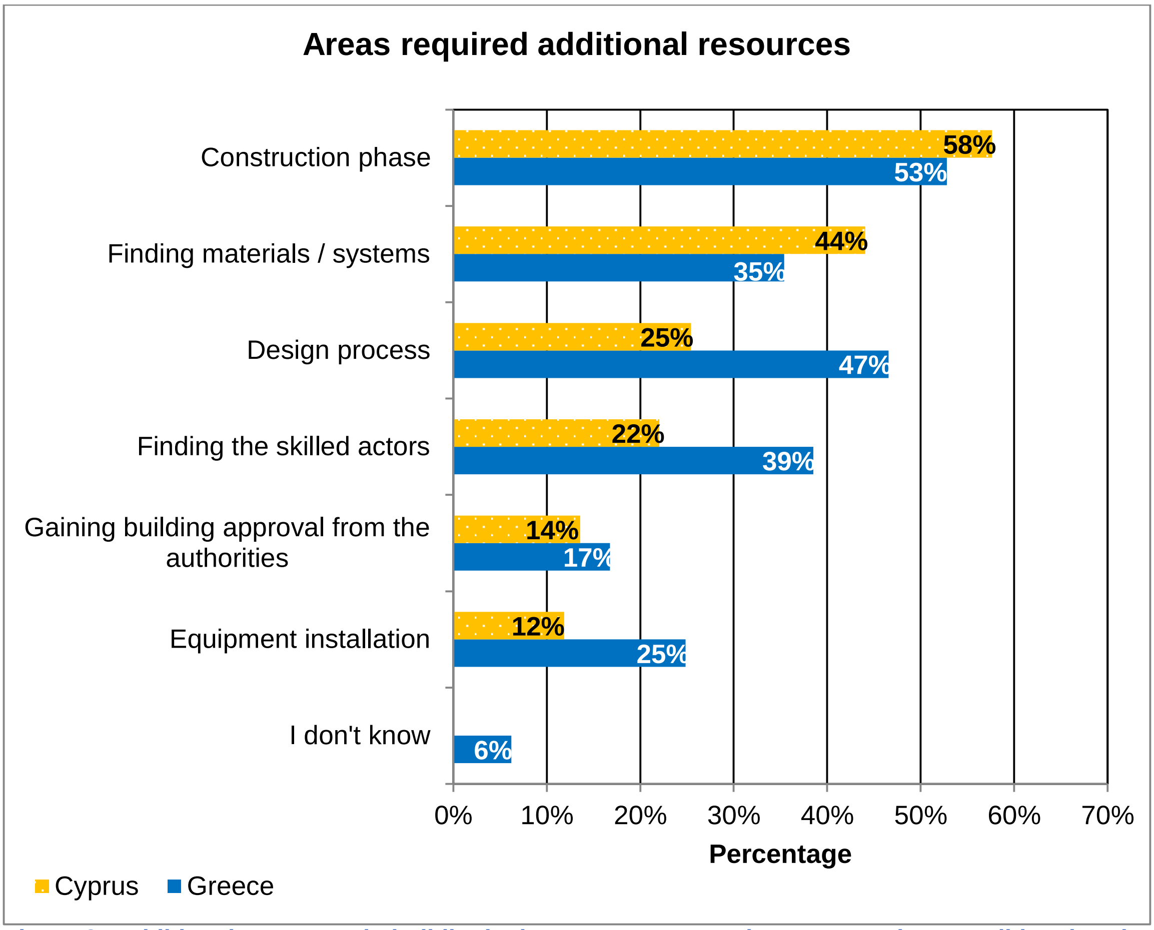


Figure 34 Additional resources in building's deep energy renovation compared to a traditional project

The majority of the respondents in **Cyprus** answered that additional financial resources were required during the "Construction Phase" as it collected 58% of the total percentage. The option "Finding materials / systems" was selected by 44%, whereas the answer "Design process" received 25%. Twenty-two percent (22%) stated that additional financial resources were required in "Finding the skilled actors". The options "Gaining building approval from the authorities" and "Equipment installation" were selected by 14% and 12% of respondents respectively.

In **Greece**, one out of two respondents (53%) answered that the "Construction phase" required additional resources when compared to a traditional project followed by the "Design process" with 47%. Thirty-nine percent (39%) of the participants considered that "Finding the skilled actors" was another parameter that required additional resources as this was also the case for 35% with regard to "Finding materials/systems".

Furthermore, 25% of those surveyed in Greece reported that the "Equipment installation" was one of the tasks that required additional resources during the deep energy renovation in a building compared to a traditional project. Lastly, the option "Gaining building approval from the authorities" gathered 17% of the total.

Statistically significant differences between the survey participants in the two countries were observed with regard to the "Design process"; 22% difference (25% Cyprus, 47% Greece, $z=-2.828$, $p=0.002$), in "Finding the skilled actors"; 17% difference (22% Cyprus, 39% Greece, $z=-2.284$, $p=0.011$) and finally in "Equipment installation" with a difference of 13% (12% Cyprus, 25% Greece, $z=-2.081$, $p=0.019$).

5.3 Barriers in products and solutions

In this sub-chapter, the barriers in products and technological solutions are investigated. Participants were firstly asked about the availability of products and technological solutions in their region and secondly they were requested to indicate prominent product categories for deep energy renovation projects in their regions. Their answers were recorded and they are presented in the following paragraphs.

5.3.1 Availability of products and technological solutions for deep energy renovation

Participants were asked whether products and technological solutions are easily available for deep energy renovation in buildings in their regions. The results are presented in Figure 35.

In **Cyprus** almost half of the respondents (51%) stated "Yes, but offer is limited, and prices are high". In addition, the option "Yes, there is a wide variety of technical services on offer" was selected by 27% of the participants in Cyprus. The answers "No, there is a limited offer and for some buildings many imported products from other EU countries are installed" and "No, but there is a good offer in other regions in my country" were chosen by 11% and 7% of the participants respectively.

In **Greece**, survey participants responded in a similar way compared to those in Cyprus. Sixty percent (60%) stated "Yes, but offer is limited, and prices are high" regarding the availability of products and technological solutions in Greece. Fifteen percent (15%) of those surveyed responded that "Yes, there is a wide variety of technical services on offer". In addition, 11% replied that "No, but there is a good offer in other regions in my country", and 9% that "No, there is a limited offer and for some buildings many imported products from other EU countries are installed" regarding the question posed to them.

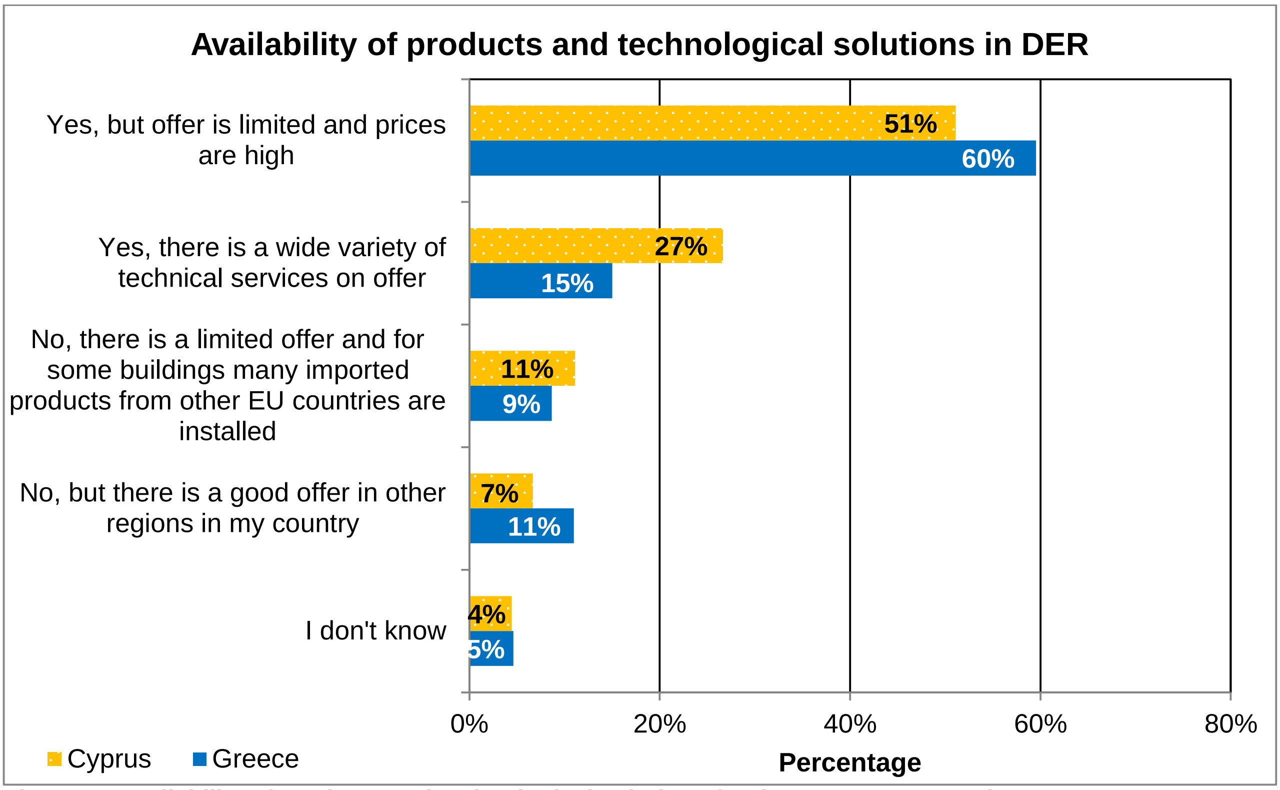


Figure 35 Availability of products and technological solutions for deep energy renovation

5.3.2 Prominent product categories for deep energy renovation

Participants were asked to indicate prominent categories of products used in deep energy renovation of a building in their regions. The results are illustrated in Figure 36.

In **Cyprus,** "Cooling systems" was selected as a prominent product category for the majority of the respondents, selected by 66% followed by "Envelope products" with 63%. "Heating systems" was chosen by 59%, "Heat pumps" by 44% whereas "Photovoltaic solar panels" and "Lighting" were also chosen by a big share of those surveyed; 31% and 25% respectively.

For the vast majority (77%) of participants in **Greece** a prominent product category was the "Envelope products" while "Heating systems" was also highly selected (60%). "Cooling systems" and "Heat pumps" were also placed among the prominent product categories with 57% and 56% respectively. Finally, "Photovoltaic solar panels" and "Domestic Hot Water (DHW) equipment" were chosen by 46% and 42% of those questioned in Greece.

It is also important to note that the products "Building Energy Management Systems (BEMS)" and "Combined Heat and Power system" were selected only by participants in Greece, with 14% and 7% respectively.

Statistically significant differences were observed with regard to "Domestic Hot Water (DHW) equipment" with a difference of 25% ($z=-3.381$, $p<0.01$), "Solar Thermal Collectors" with 23% ($z=-3.228$, $p<0.01$) and "Integrated systems" with a difference of 16% ($z=-2.530$, $p=0.006$). Furthermore, a statistically significant difference of 14% was observed in both "Envelope products" ($z=-2.069$, $p=0.019$) and "Building Energy Management Systems (BEMS)" ($z=-3.089$, $p=0.001$). In addition, statistically significant difference of 15% was observed in the options "Photovoltaic solar panels" ($z=-2.049$, $p=0.020$) and "Ventilation equipment" ($z=-2.378$, $p=0.009$). Another statistically significant difference of 10% was observed with regard to "Biomass stoves and boilers" ($z=-2.330$, $p=0.010$) whereas a statistically significant difference of 7% was also found in the product category "Combined Heat and Power system" ($z=-2.073$, $p=0.019$).

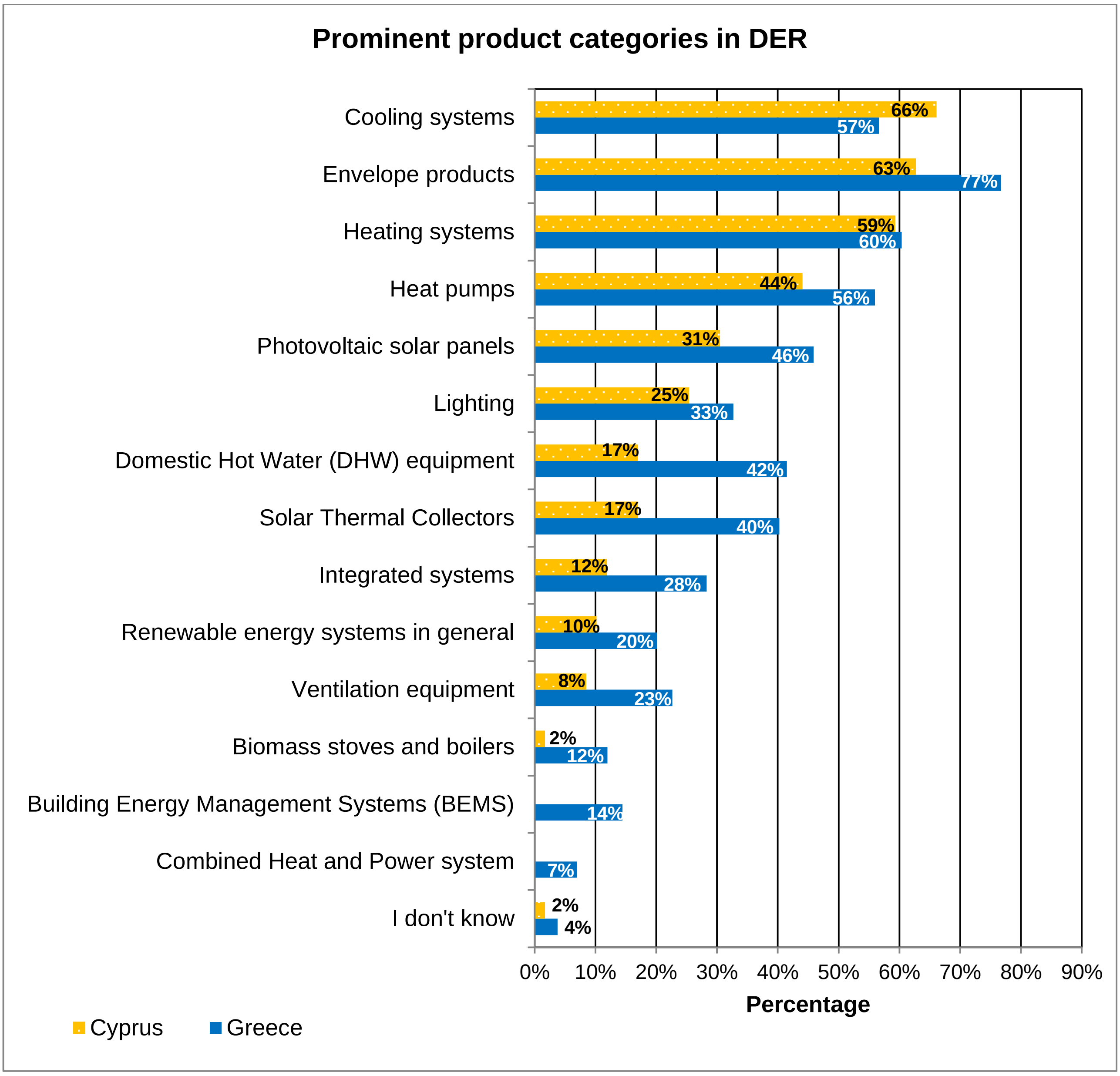


Figure 36 Prominent product categories for deep energy renovation

5.4 Issues on comfort and indoor air quality

In this subchapter, issues on comfort and indoor air quality are explored. More specifically, the familiarity and awareness of those surveyed with the concepts of "indoor air quality" and "thermal comfort" is investigated, whereas the respondents were asked which parameter, if any, parameters related to the two aforementioned concepts has been measured for a period of time in the projects they were involved. Subsequently, survey participants were asked which issues in terms of comfort have been taken into account in the projects they were involved in and whether the building's occupants were surveyed either before or after the renovation, with regard to comfort aspects.

5.4.1 Awareness and familiarity with the concepts of "indoor air quality" and "thermal comfort"

Survey participants in both countries were asked about their familiarity with the concepts of indoor air quality and thermal comfort and how these two apply for a building. In addition, they were asked if any measuring device to measure any related parameters with these two concepts had been installed in the deep energy renovation projects they were involved in. They were also asked if in the projects they had been involved, any system of mechanical ventilation had been installed or if any check on the building's air tightness had been done. The results are illustrated in Figure 37.

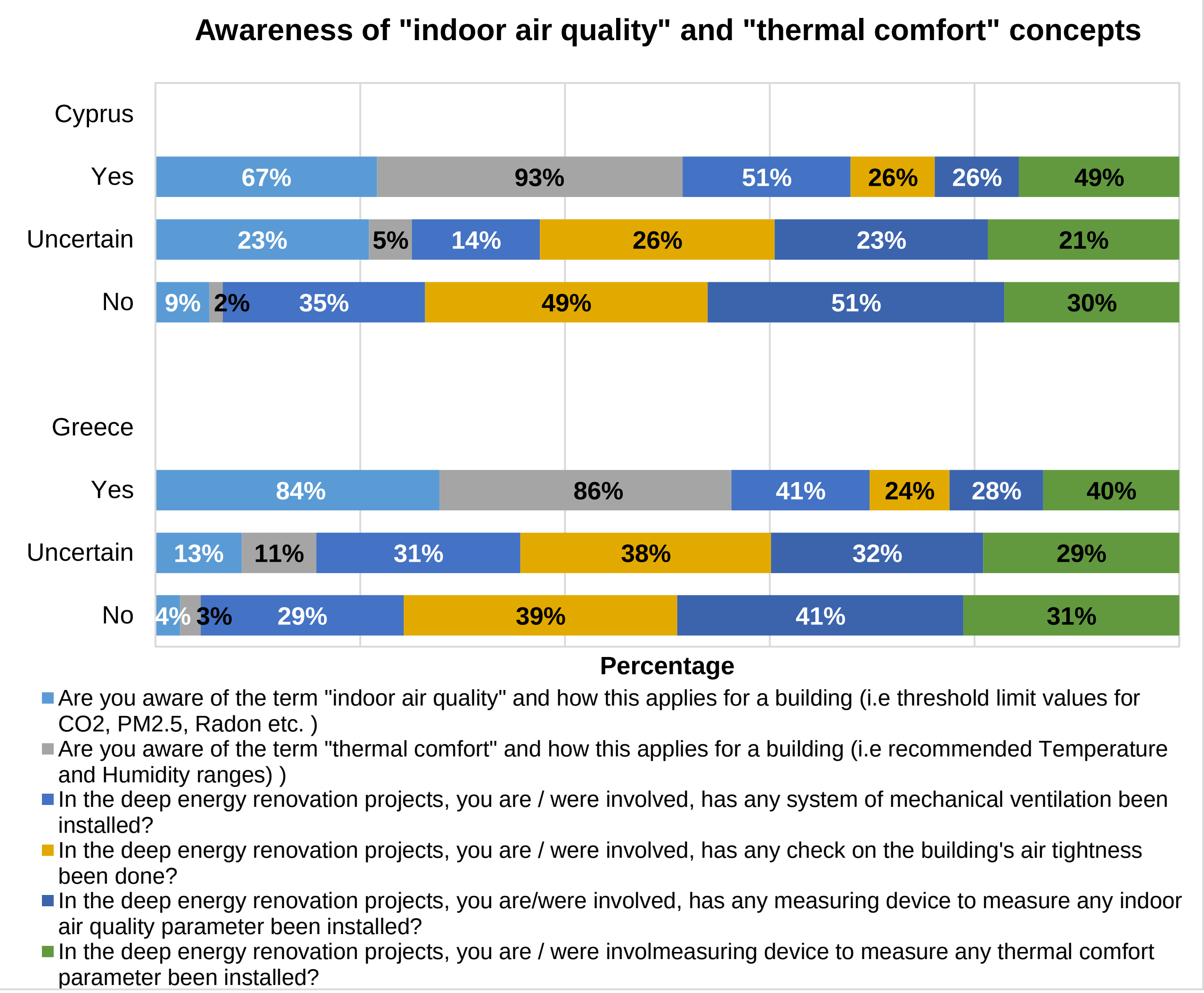


Figure 37 Awareness and familiarity with the concepts of "indoor air quality" and "thermal comfort"

In **Cyprus** the majority of those surveyed, 93%, answered in the affirmative that they were aware of the term "Thermal comfort" and how this applies for a building. In addition, 67% of the participants selected "Yes" on whether they were familiar with the "Indoor air quality" term and how this applies for a building. Furthermore, almost half of the total percentage, 51%, of participants in Cyprus answered positively that a mechanical ventilation system was installed and 26% chose "Yes" to whether a check has been made on building's air tightness in deep energy renovation projects they were part of. In addition, 49% replied "Yes" to the question whether a device measuring any thermal comfort parameter had been installed in the deep energy renovation project they were involved while almost half this share, 26%, positively replied on whether a device measuring any indoor air quality parameter has been installed in the deep energy renovation project they were involved.

In **Greece**, a very high percentage of respondents answered in the affirmative as to whether they knew the concepts of "thermal comfort" and “indoor air quality” and how these apply for buildings, as 86% and

84% said "Yes" respectively. Forty-one percent (41%) stated that a mechanical ventilation system had been installed in the deep energy renovation projects they had participated in while slightly less than one out of four (24%) reported that a check had been made on the building's air tightness. Regarding measuring devices, 28% reported that a device had been installed to measure parameters of indoor air quality and 40% to measure parameters of thermal comfort.

Statistically significant differences were observed with regard to those who were “Uncertain” if a mechanical ventilation device was installed with a difference of 17% (14% Cyprus, 31% Greece, z=-2.185, p=0.014) and with those who said “Yes” in the question if they were aware of the indoor air quality and how this applies for a building with a difference of 17% (67% Cyprus, 84% Greece, z=-2.371, p=0.009).

5.4.2 Parameters of indoor air quality or thermal comfort measured in deep energy renovation projects

Survey participants were asked to answer which parameter of indoor air quality or thermal comfort has been measured for a period of time in the deep energy renovation projects they were involved. The results are presented in Figure 38.

In **Cyprus,** "Indoor temperature" was selected by the vast majority of those surveyed, 81%, while "Indoor relative humidity" was chosen by 67%. The parameter "CO_2 concentration" was selected by 30% followed by “Flow “ventilation” with 26%. Finally, 2% stated that "Particulate Matter and / or Volatile Organic Compounds" was measured for a certain period of time.

The majority of participants, 70% in **Greece**, reported that "Indoor temperature" was measured for a period of time in the deep energy renovation projects they were involved, followed by "Indoor relative humidity" with 64%. The parameters "CO_2 concentration" and "Flow ventilation" gathered 38% and 25% respectively. The option "Particulate Matter and / or Volatile Organic Compounds", received a higher share (14%) compared to Cyprus.

It is noteworthy that those who did not know or did not remember which indoor air quality or thermal comfort parameters were measured constituted 9% of the participants in Cyprus and 23% in Greece.

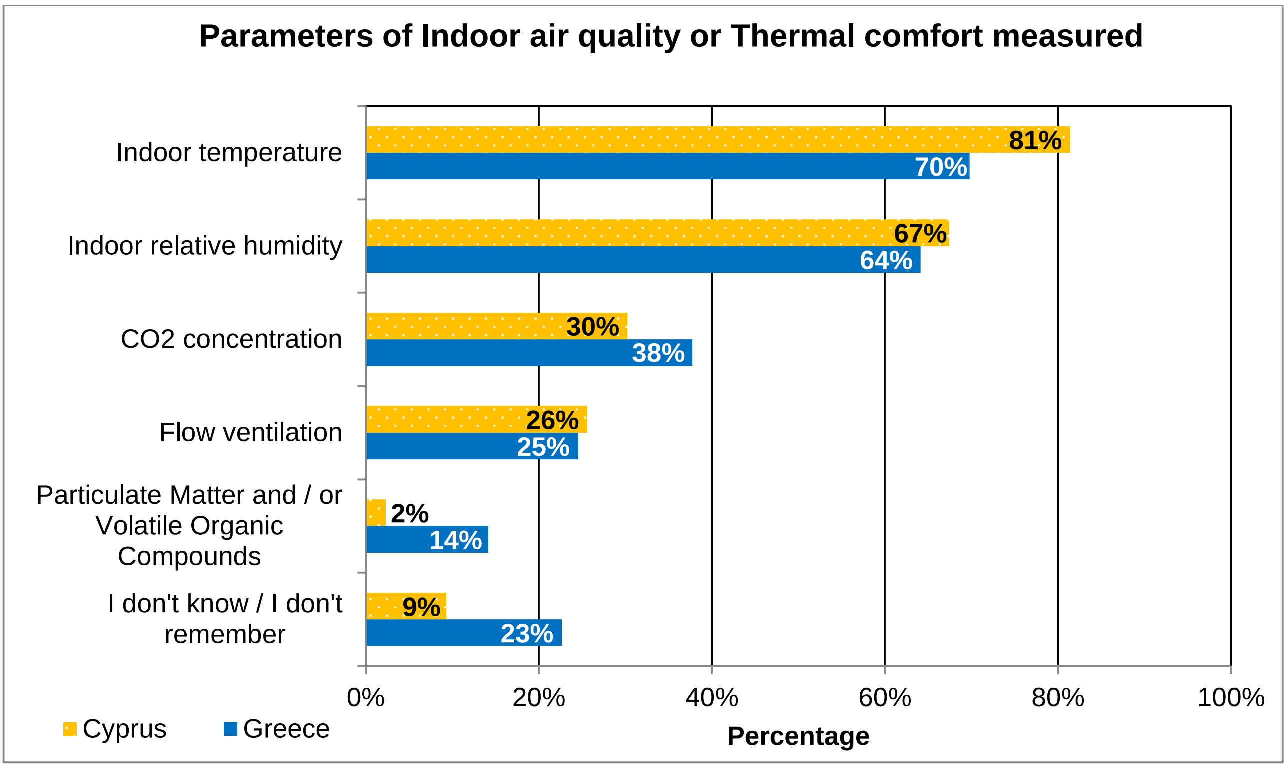


Figure 38 Parameters of indoor air quality or thermal comfort measured in deep energy renovation project

A statistically significant difference of 12% was observed in the parameter "Particulate Matter and / or Volatile Organic Compounds" (z=-2.113, p=0.017).

5.4.3 Issues in terms of comfort considered in deep energy renovation projects

Survey participants were asked what issues in terms of comfort have been taken into account in the deep energy renovation projects they were involved in. The results are illustrated in Figure 39.

The most popular answer in **Cyprus** was "Thermal comfort", which was selected by 90% of the participants whereas the option "Indoor air quality" was second in preference with 47%. Moreover, "Acoustic" and "Visual comfort" received 22% and 19% respectively.

According to the answers given in **Greece**, the one issue in terms of comfort that was taken into account in deep energy renovation more than others was "Thermal comfort" which was chosen by 74%. Forty-six percent (46%) of respondents stated that they took into account "Indoor air quality" while "Acoustic" and "Visual comfort" were taken into account by 34% and 30% of the respondents respectively.

A small share of those surveyed in both Cyprus and Greece stated that "None of comfort issues have been taken into account" as participants in both countries selected this option with slightly more than 3% (Cyprus 3.4% and 3.3% Greece). Interestingly, a share of participants in both countries reported "I don’t know / I don’t remember" on what issues in terms of comfort had been taken into account in the deep energy renovation projects they were involved with 5% in Cyprus and with a relatively high share in Greece, that of 18%.

Statistically significant difference of 16% was observed with regard to the option "Thermal comfort" (90% Cyprus, 74% Greece, z=2.502, p=0.006) as well as with regard to those who did not know or did not remember if any issues in terms of comfort had been taken into account in deep energy renovations (5% Cyprus, 18% Greece, z=-2.419, p=0.008)

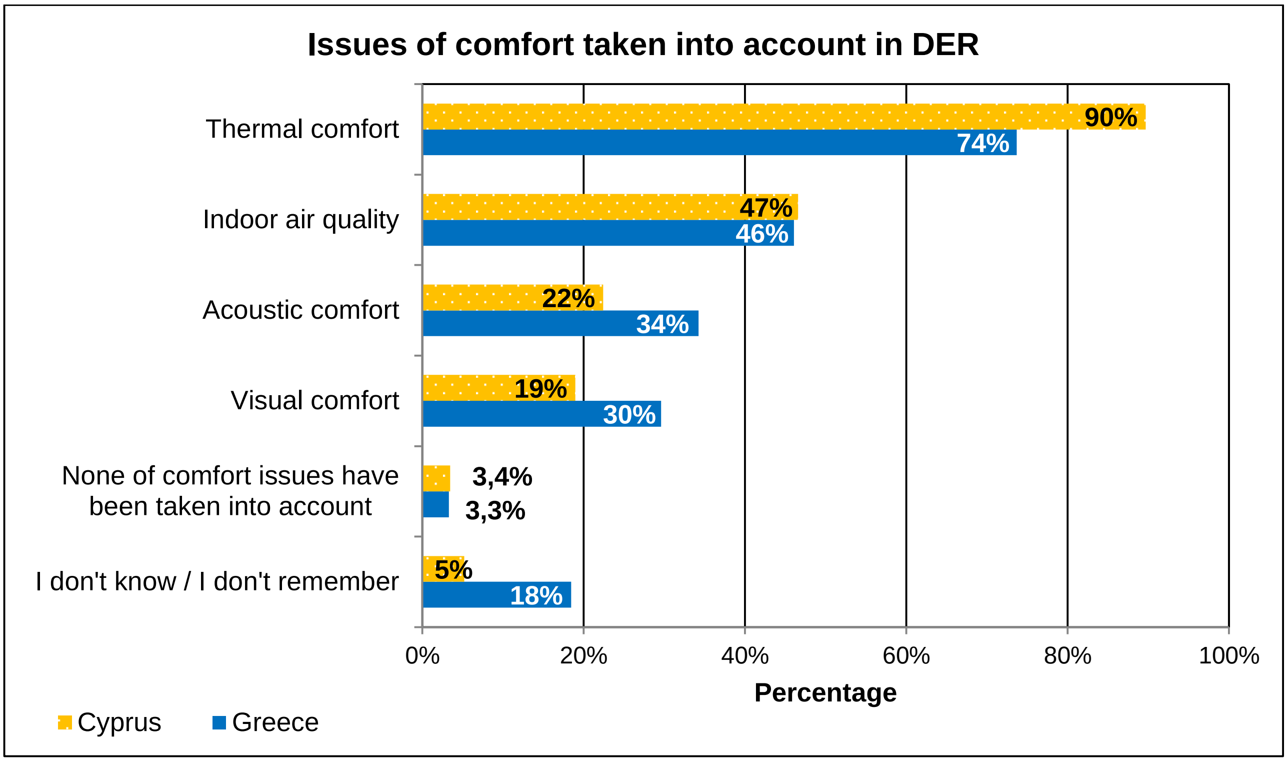


Figure 39 Issues in terms of comfort considered in deep energy renovation projects

5.4.4 Overall perception about comfort aspects

Participants in both countries were asked if occupants of buildings that had undergone a deep energy renovation were surveyed with regard to their overall perception of indoor air quality or thermal, visual, and acoustic comfort before and after the renovation. The results are presented in Figure 40.

When survey participants in **Cyprus** were questioned if they took into account the opinion of residents *before* the energy renovation of a building about the "Thermal comfort" aspect, 47% stated "Yes". Regarding "Acoustic comfort" and "Indoor air quality" 26% and 21% answered in the affirmative respectively. Finally, on the aspect of "Visual comfort " 12% stated "Yes".

When survey respondents in Cyprus questioned if they asked occupants' opinion *after* the deep energy renovation with regard to their perception of "Thermal comfort", 37% chose "Yes". Furthermore, about "Acoustic comfort" and "Indoor air quality" 21% and 16% answered positively respectively and 12% selected "Yes" with regard to the "Visual comfort" aspect.

In **Greece**, regarding whether respondents surveyed the residents *before* the implementation of deep energy renovation in a building, 44% selected "Yes" about the aspect of "Thermal comfort". With lower rates, 26% and 24% followed the "Acoustic " and "Visual comfort" respectively. Finally, 31% of those surveyed answered in the affirmative about the "Indoor air quality" aspect.

Regarding whether they asked occupants' opinion *after* the deep energy renovation, participants in Greece selected "Yes" with 34% and 25% about "Thermal comfort" and "Indoor air quality" respectively. Twenty- one percent (21%) of those surveyed answered in the affirmative about "Acoustic comfort" and 16% about the aspect of "Visual comfort".

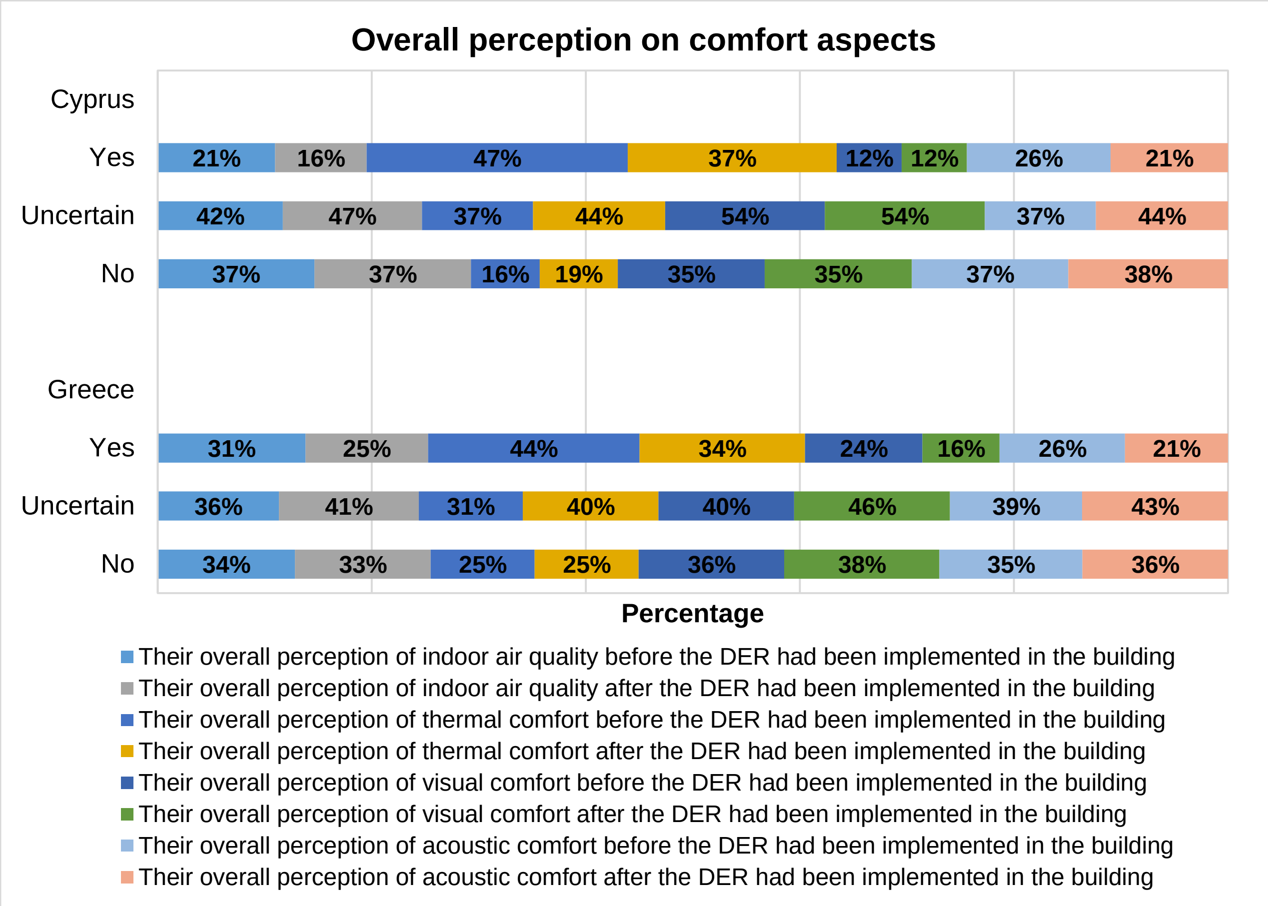


Figure 40 Overall perception about comfort aspects

6.Discussions and Conclusions

Within the framework of UPGREAT [Upskilling Professionals for deep enerGy efficiency REnovations: A Tool for better schools] project, a targeted survey for building experts has been implemented, aiming to identify gaps and barriers for energy efficiency implementation methods to further boost building renovations especially in schools. This research leads to a better understanding of the impediments to the application of energy-efficient solutions in buildings. Deep energy renovations are complex and should be treated as such. As a result, a barrier occurs in a certain social setting where various actors continually engage and discuss which solutions to accept and which to reject. According to the report, progress toward more energy-efficient buildings is hampered by building professionals' inadequate knowledge, as well as a lack of innovative financial services. These problems are exacerbated by poor legislative frameworks and bureaucratic procedures, which create hurdles that are only likely to be overcome with tremendous personal effort from building professionals. To solve this equation, it would need a mix of training, financial motivation and organization as well as sophisticated policy making based on a thorough understanding of each actor and how they engage.

Consequently, there is a critical need to upgrade building professionals’ skills not only on the technical aspects of a deep renovation but also to train them on the impact of energy prices on project profitability and how this is communicated to the end users. As a matter of fact, for example a project's capital cost can often be reduced with appropriate mechanical design and the avoidance of superfluous cooling loads. According to the literature, for the case of a deep renovated office building, the first year alone might yield productivity improvements equal to 90 seconds per office worker every day, which would pay back a small investment in a better HVAC system (or in its design). Avoidable existing energy expenditures might be similar to a large share of the entire capital cost of the building, increasing its market worth appropriately.

Building professionals can have a major impact towards achieving high energy efficiency targets in the building sector. In order to map the gaps and barriers faced by professionals involved in the deep energy renovation of schools and buildings in general, the National and Kapodistrian University of Athens (NKUA) in cooperation with the Hellenic Institute of Passive House Institute, Cyprus Energy Agency and the Da-Di-Werk municipal enterprise in Darmstadt - Dieburg, Germany, conducted this research, the data of which were presented in the previous chapters. Five hundred and one (501) practitioners and blue collars of the building sector located in Cyprus and Greece participated in the survey. Three hundred and ninety-four from Greece and one hundred and seven from Cyprus. In addition, the survey was divided into two major categories, the first one related to the experience of participants in deep energy renovation of school buildings and the other one related to those who had experience with renovation of existing buildings. In summary, the main results per section of interest is presented below.

Familiarization and expertise in DERs

The majority of participants in both Cyprus and Greece were familiar with the concept of deep energy renovation with similar percentages which were slightly higher than 70% in both countries (72% Cyprus, 73% Greece). In both countries the responses were similar regarding their experience in deep energy renovation, as participants had either taken part in such projects (36% Cyprus, 41% Greece) or although they hadn’t participated in a deep renovation project, they were familiar with the process (36% Cyprus, 39% Greece).

Deep energy renovation in school buildings

Experience with energy renovation in schools

Participants were asked about whether they had worked on a deep energy renovation project that was carried out in a school; the highest percentages were "No" with 82% in Cyprus and with 70% in Greece. The main reason for renovation in a school building according to the participants in both countries was "Poor energy performance", with a share of 64% in Cyprus and a slightly higher, 72% in Greece.

Regarding the barriers for implementing energy efficiency measures in a school's deep energy renovation, the divergent responses recorded in the two countries was noteworthy. Those surveyed in Cyprus ranked "Technical difficulties due to building characteristics" as an important barrier 92%, followed by "Social group negative interactions" with 58% followed by "Poor expertise of professionals involved in the project" and "Inadequate regulatory procedures" with 50% each. In Greece, the top three selected options received similar percentages; "Lack of funds or financial incentives" received 44% whereas "Technical difficulties due to building characteristics" and "Poor expertise of professionals involved in the project" 43% respectively.

The systems installed or upgraded as a result of the renovation, according to the participants in Cyprus were "External envelope insulation" with 81%, "Heating system" and "Energy efficient windows" with 76% and 73% respectively. Those located in Greece replied "Energy efficient windows" 81%, "External envelope insulation" 78% and "Heating system" 56%.

General barriers for deep energy efficiency renovations implementation in schools

Participants' responses on the issues that were difficult to manage in the deep energy renovation of a school building, diverged significantly across the options given. Respondents in Cyprus mostly selected with 27% the option " Technical issues in the design phase" while in Greece respondents placed as their first option among the choices given "Technical issues in the construction phase" with a percentage of 37%, followed by "Finding skilled actors" with 21%.

Respondents were asked to rank in order of importance the three barriers they faced when implementing deep energy renovation of school buildings. The most important ones in the responses given in Cyprus were "Economic / financial resources" (72%), " Lack of energy efficiency funding programs" (54%) and " User motivation / demand" (45%). In Greece participants chose "Economic / financial resources" (66%) " Lack of voluntary national deep energy renovation schemes for renovation of existing buildings" (38%) and finally " Lack of exemplary role of public buildings" with 35%.

Moreover, regarding the factors that could boost the market for deep energy renovation in school buildings, participants in Cyprus placed as their first choice "Improved financing solutions" with 73% and as second choice "Clear technical guidelines on DERs" with 57%. Those surveyed in Greece selected as their first choice "Consultancy / training" with 65% and as second choice "Improved financing solutions" with 51%.

With regard to the gaps and barriers that had been encountered during the deep energy renovation from the initial to the final stage, participants in Cyprus mostly agreed with the option "Lack of financial incentives and funds" and with "Undervaluing the benefits of DER and lack of interest to invest in DER". In Greece, participants agreed on the barriers of "Lack of financial incentives and funds" and "High capital costs and financial risks". Respondents in both countries unanimously disagreed that "There are no gaps or barriers and the whole chain is working".

Concerning the adversities in improving the energy performance of a school building envelope, participants in both Cyprus with 69% and in Greece with 55% ranked "Budget limitations" as their first choice. The same is seen with regard to the installation of renewable energy systems in the renovation of a school building. Participants in both countries unanimously ranked in the first place the issue of "Budget limitations" (72% Cyprus, 53% Greece) and in the second place "Building integration" (50% Cyprus, 49% Greece).

Policy and financial barriers in schools

In Cyprus regarding the energy efficiency policies that encourage deep energy renovation in school buildings, 50% of the respondents stated that "No specific targets for deep energy renovations in schools have been defined yet" while in Greece 64% of the participants told that "Very few ambitious policy packages have been defined but not enough development".

The most important policy gap for the applicability of energy efficiency policies in school buildings, according to 27% of the participants in Cyprus, was the "Poor national/regional legislative framework for renovation of existing buildings", an option which in Greece received 22% of the total responses. Twenty-eight percent (28%) of the participants in Greece claimed that "Poor overall ambition of the energy efficiency policies" was more important, while this choice gathered 18% of those surveyed in Cyprus. It is noteworthy that in Greece 26% of the participants considered "Inadequate adaptation of energy efficiency policies" as a policy gap while 9% in Cyprus claimed it to be a policy gap.

With regard to the barriers for financing energy renovations in schools, the first choice among participants in Cyprus and Greece with 36% and 33% respectively, was "Poor financial incentives". The second choice of those surveyed in Cyprus with 27% was "Lack of funds or access to finance" which in Greece scored 16%, placed in the third place. Interestingly, a difference between the responses given in the two countries was observed in the option "High capital costs and financial risk" since 17% of those surveyed in Greece chose it as a barrier while in Cyprus none of the respondents selected it.

Respondents in both countries placed "Labour" with 39% on the top of their preference when asked where they had made efforts to reduce construction costs while deep renovating a school. An equal percentage in Cyprus (39%) selected the option "Equipment" while in Greece this recorded 31%. Furthermore, 31% and 20% of those surveyed in Cyprus and in Greece respectively, stated that "Costs have been optimized across the whole project".

The absolute majority (100%) of the participants in Cyprus considered that additional financial resources compared to a traditional project were required during the "Construction phase", while in Greece slightly higher than half of the participants (54%) selected this option. In Greece, respondents stated that additional financial resources were also required for the "Design process", "Gaining building approval from the authorities" and "Equipment installation" with the respective percentages being 40%, 17% and 15%.

Barriers in products and solutions for deep energy renovations in schools

Concerning the regional availability of products and technological solutions for energy renovation in schools, 50% of the participants in Cyprus stated that "There is a wide variety of technical services on offer". In Greece, 55% of the respondents replied that although products are available, the offer is limited, and prices are high.

The prominent product categories used in the energy renovation of school buildings according to the respondents in Cyprus were "Envelope products" (89%), "Heating Systems" (77%) and "Lighting" (57%). In Greece those were "Envelope products" (72%), "Heating systems" (50%) and "Ventilation equipment" (48%).

Issues on comfort and indoor air quality in schools

The familiarity of the participants in both countries with the concepts of "Thermal comfort" and "Indoor air quality" was reflected in the survey. Hundred percent (100%) and 91% in Cyprus, stated that they were aware of these terms respectively and how they apply in a school building. The same holds for respondents in Greece with 87% and 88% respectively.

Indoor temperature was the most selected parameter of indoor air quality or thermal comfort that has been measured for a period of time in energy renovation projects of school buildings receiving 94% of the responses in Cyprus and 83% in Greece, with "Indoor relative humidity" being chosen as the second most important parameter with 84% and 81% of the participants in Cyprus and Greece respectively.

The comfort issues taken into account in the renovation projects were "Thermal comfort" (92% in Cyprus and 80% in Greece) and "Indoor air quality" (69% in Cyprus and 66% in Greece). These were followed by "Visual Comfort" with 19% of those surveyed in Cyprus and 28% in Greece.

Participants in both countries were asked whether they surveyed students with regard to any comfort aspects before and after the energy renovation of a school building. With shares bigger than 45% respondents in Cyprus stated that they hadn't surveyed students before or after the renovation about their overall perception on indoor air quality, thermal, visual and acoustic comfort indicating that the majority of those surveyed in Cyprus hadn't asked students about their comfort level when they were inside the building either before or after the renovation was completed. In Greece, bigger shares of respondents reported that they consulted students' opinion about their overall perception of comfort before and after the renovation. Those are: thermal comfort (before: 37%, after: 29%), indoor air quality (before: 27%, after:21%), visual (before: 23%, after:19%) and acoustic comfort (before: 21%, after:15%).

Deep energy renovations in buildings

General barriers for deep energy efficiency renovations implementation

The main difficulties encountered by the participants in Cyprus were "Finding skilled actors" and "Complicated tender documentation" with 17% in both cases. On the other hand, respondents in Greece placed first in their preferences the option "Technical issues in the construction phase" with 32% while their second particular difficulty they had to overcome in order to successfully implement a deep energy renovation was to find skilled actors (15%).

Participants were asked to select the three most important barriers that apply in their country and make the implementation of deep energy renovation in buildings difficult. In Cyprus, the results in order of importance were a) "Economic / financial resources" with 64% b) "User motivation / demand " with 48% and c) "Lack of voluntary national deep energy renovation schemes for renovation of existing buildings" with 31%. In Greece the preferences of the participants, were similar for the first two choices, as the most prominent barriers were a) "Economic / financial resources " with 72% b) "User motivation / demand" 40% whereas their third most important barrier was c) "Lack of energy efficiency funding programs" with 35%.

Moreover, with regard to the drivers that could boost the market for deep energy renovation in buildings, "Improved financing solutions" was highly selected in both countries with shares of 70% in Cyprus and 73% in Greece. The second driver in Cyprus was "New business models" with 44%, while in Greece this was "Consultancy/training" with 47%.

Participants in both countries agreed most on a) "Building user's/owner's socioeconomic status" b) "Lack of financial incentives and funds" and c) "High capital costs and financial risks" in terms of the difficulties and gaps they faced from the beginning to the final stage of renovation. Participants in both countries also disagreed with the statement that 'There are no gaps or barriers and the whole chain is working'.

Referring to the challenges encountered when improving the building's envelope through insulation and energy windows, "Budget limitations" and "Inadequate professional skills of installers" was highlighted by respondents in both countries. In Cyprus these options were equally selected by 59% while in Greece they received 69% and 51% respectively. These two were followed, again in both countries, by "Building integration" (48% in Cyprus and 43% in Greece).

With regard to the challenges faced during the installation of renewable energy systems in deep energy renovation of buildings, according to participants in Cyprus the main challenge aroused was "Inadequate professional skills of installers" with 57%. Second was "Budget limitations" with 51%, followed by "Building integration" with 48%. On the contrary, those surveyed in Greece placed as their top challenge faced "Budget limitations" with 62%, followed by "Building integration" with 52% and third "Legislative/regulatory approval" with 42%.

Policy and financial barriers

Concerning the energy efficiency policies that encourage deep energy renovations in existing buildings, most participants in both countries stated that "Very few ambitious policy packages have been defined but not enough development" with 56% and 65% in Cyprus and Greece respectively. Lower percentages but not negligible though, 20% of those surveyed in Cyprus and 5% in Greece reported that "Good policy packages have been defined, detailed issues that concern almost all the chain for deep energy".

The most important policy gaps for the applicability of energy efficient policies in Cyprus were "Poor national/regional legislative framework for renovation of existing buildings" and "Lack of voluntary national deep energy renovation standards for renovating existing buildings" selected by 18% both. In Greece, participants placed equally as their top choices "Poor national/regional legislative framework for renovation of existing buildings" and "Inadequate adaptation of EE policies" with 28%.

"High capital costs and financial risk" with 24% was identified as the most prominent barrier for financing deep energy renovation in buildings among participants in Cyprus, followed by "Poor financial incentives" and "Lack of funds or access to finance" with 22% and 20% respectively. In Greece, most of those surveyed, 28%, selected "Poor financial incentives" as the most prominent barrier for financing energy retrofits followed by "Lack of funds or access to finance" and "High capital costs and financial risk" with 25% and 18% respectively.

According to the participants in Cyprus, the most efforts in order to reduce construction costs while deep renovating a building were made in "Labour" with 47%, followed by "Building materials" with 35%. In Greece, the first choice of those surveyed was "Building materials" with 32% and second were equally placed " with 26% "Labour" and "Equipment. Additional financial resources were considered necessary by the participants in both Cyprus and Greece, during the "Construction Phase" as this option received 58% and 53% respectively.

Barriers in products and solutions

Respondents in both countries stated with 51% and 60% in Cyprus and Greece respectively, that products and technological solutions for deep energy renovations are available in their region but offer is limited, and prices are high. When participants were asked about the most prominent product categories in building energy renovation, the answers were relatively spread across all product categories. The most prominent products according to the participants in Cyprus were "Cooling systems" with 66%, "Envelope products" with 63% and "Heating systems" with 59%. In Greece slightly over three quarters (77%) of respondents chose "Envelope products", followed by "Heating systems" with 60% and "Cooling systems" with 57%.

Issues on comfort and indoor air quality

On the question about respondents' familiarity with the concepts of indoor air quality and thermal comfort, the majority of those surveyed in both Cyprus and Greece stated that they were aware of these concepts. More specifically, for thermal comfort 93% of the participants in Cyprus and 86% in Greece answered that they were aware of the concept and how this applies for a building. For the concept of indoor air quality these shares were 67% in Cyprus and 84% Greece. Furthermore, when asked to answer whether a measuring device was installed for any indoor air quality parameter, 26% of the participants in Cyprus and 28% in Greece stated "Yes". Moreover, regarding the installation of a measuring device for thermal comfort, 49% and 40% in Cyprus and Greece respectively answered in the affirmative.

Regarding which parameter of indoor air quality or thermal comfort was measured for a period of time, 81% of the participants in Cyprus and 70% in Greece chose "Indoor temperature", as well as "Indoor relative humidity" with 67% and 64% in Cyprus and Greece respectively.

Among the issues in terms of comfort that have been taken into account during the deep energy renovation of a building, "Thermal comfort" was selected as participants' top answer in both Cyprus and Greece with 90% and 74% respectively. "Indoor air quality" emerged as the second issue taken into account with similar percentages among the responses given in both countries, those of 47% in Cyprus and 46% Greece.

Finally, participants in both countries were asked whether they took into account the opinion of building occupants on comfort aspects before and after deep energy renovation. In Cyprus those surveyed answered in the affirmative about thermal comfort with 47% before and 37% after the renovation. With lower rates, participants selected "Yes" about the aspects of acoustic comfort (before: 26%, after: 21%), indoor air quality (before: 21%, after: 16%) and visual comfort (before: 12%, after: 12%). A similar picture was presented in Greece, since those surveyed answered affirmatively about thermal comfort parameter with 44% before and 34% after the deep energy renovation was implemented. Regarding indoor air quality, acoustic and visual comfort the option "Yes" before the renovation was selected by 31%, 26% and 24% accordingly, and after the renovation the responses given in the affirmative were 25% indoor air quality, 21% acoustic comfort and 16% visual comfort.

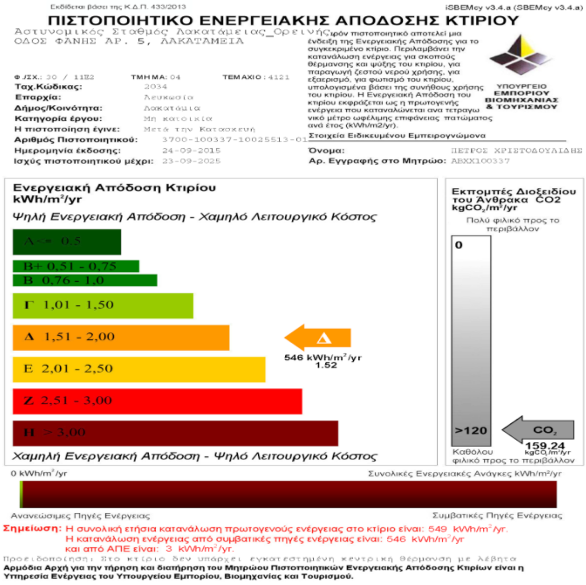
Annex I

Questions	Cyprus	Greece
Familiarization with DERs	107	394
Expertise in DERs	107	394
Experience with DERs in schools	77	308
Main reasons for school renovations	14	88
Implementation barriers in school buildings	12	87
Systems installed in school renovation	37	63
Difficulties in school DER projects	11	81
The 3 most prominent barriers-in descending order-that may make the implementation of deep energy renovations on existing school buildings difficult	11	81
Drivers to boost DER in schools	37	57
Gaps and barriers in a DER implementation in school buildings	36	56
Challenges while improving the envelope	36	56
Challenges when installing renewable energy systems	36	55
Energy efficiency policies in school DER's	10	76
Energy efficiency policy gaps in school DER	11	76
Most prominent barriers for financing renovations in schools	11	76
Cost Reducing factors in school DER implementation	36	51
Additional resources in school DER	10	78
Regional availability of products and technological solutions	10	76
Prominent product categories in school DER	35	50
Awareness of "Indoor air quality" and "Thermal comfort" concepts	11	75
Parameters of indoor air quality or thermal comfort measured in school DER	32	36
Issues of comfort taken into account in school DER	36	50
Student's overall perception on comfort aspects in schools	11	75
Difficulties encountered in DER	47	186
The 3 most prominent barriers-in descending order-that may make the implementation of deep energy renovations difficult	47	182
Drivers to boost DER	61	173
Gaps and barriers in a DER implementation	61	169
Challenges faced when improving a building's envelope	61	171
Adversities when installing renewable energy systems	61	170
Perception of national energy efficiency policies in DER	45	174
Energy efficiency policy gaps	45	174
Most prominent barriers for financing renovations	45	173
Areas where efforts were made to reduce costs	60	157
Areas required additional resources	59	161
Availability of products and technological solutions in DER	45	173
Prominent product categories in DER	59	159
Awareness of "Indoor air quality" and "Thermal comfort" concepts	43	170
Parameters of Indoor air quality or Thermal comfort measured	43	106
Issues of comfort taken into account in DER	58	152
Overall perception on comfort aspects	43	169

Annex II

EPCs from Cyprus

1.Lakatamia Police Station



Εκδίδεται βάσει της Κ.Δ.Π. 433/2013 iSBEMcy v3.4.a (SBEMcy v3.4.a)

ΠΙΣΤΟΠΟΙΗΤΙΚΟ ΕΝΕΡΓΕΙΑΚΗΣ ΑΠΟΔΟΣΗΣ ΚΤΙΡΙΟΥ

Αστυνομικός Σταθμός Λακατάμειας_Ορεινής
ΟΔΟΣ ΦΑΝΗΣ ΑΡ. 5, ΛΑΚΑΤΑΜΕΙΑ

Φ/ΣΧ.: 30 / 11Ε2 ΤΜΗΜΑ: 04 ΤΕΜΑΧΙΟ: 4121
Ταχ.Κώδικας: 2034
Επαρχία: Λευκωσία
Δήμος/Κοινότητα: Λακατάμια
Κατηγορία έργου: Μη κατοικία
Η πιστοποίηση έγινε: Μετά την Κατασκευή
Αριθμός Πιστοποιητικού: 3700-100337-10025513-01
Ημερομηνία έκδοσης: 24-09-2015
Ισχύς πιστοποιητικού μέχρι: 23-09-2025

Το παρόν πιστοποιητικό αποτελεί μια ένδειξη της Ενεργειακής Απόδοσης για το συγκεκριμένο κτίριο. Περιλαμβάνει την κατανάλωση ενέργειας για σκοπούς θέρμανσης και ψύξης του κτιρίου, για παραγωγή ζεστού νερού χρήσης, για εξαερισμό, για φωτισμό του κτιρίου, υπολογισμένα βάσει της συνήθους χρήσης του κτιρίου. Η Ενεργειακή Απόδοση του κτιρίου εκφράζεται ως η πρωτογενής ενέργεια που καταναλώνεται ανα τετραγωνικό μέτρο ωφέλιμης επιφάνειας πατώματος ανά έτος (kWh/m2/yr).

ΥΠΟΥΡΓΕΙΟ ΕΜΠΟΡΙΟΥ ΒΙΟΜΗΧΑΝΙΑΣ & ΤΟΥΡΙΣΜΟΥ

Στοιχεία Ειδικευμένου Εμπειρογνώμονα
Όνομα: ΠΕΤΡΟΣ ΧΡΙΣΤΟΔΟΥΛΙΔΗΣ
Αρ. Εγγραφής στο Μητρώο: ΑΒΧΧ100337

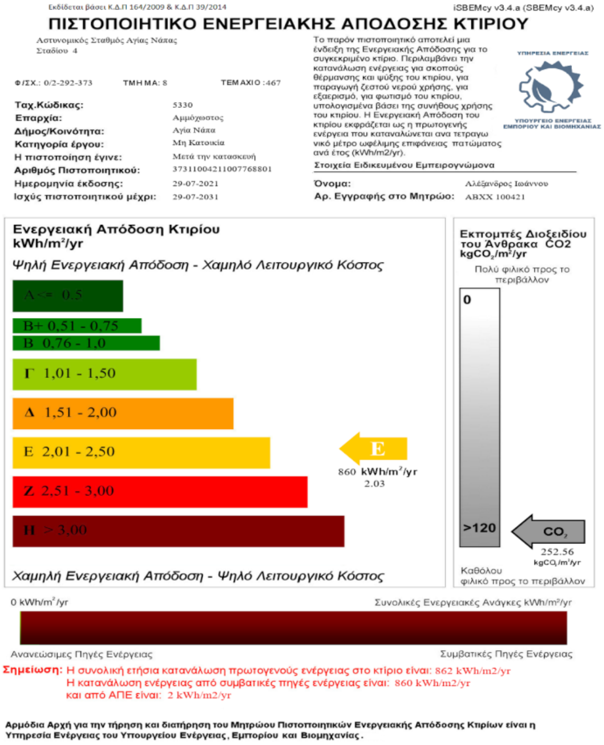
Ενεργειακή Απόδοση Κτιρίου $kWh/m^2/yr$
Ψηλή Ενεργειακή Απόδοση - Χαμηλό Λειτουργικό Κόστος
A <= 0.5
B+ 0,51 - 0,75
B 0,76 - 1,0
Γ 1,01 - 1,50
Δ 1,51 - 2,00
Ε 2,01 - 2,50
Ζ 2,51 - 3,00
Η > 3,00
Δ
546 $kWh/m^2/yr$
1.52
Χαμηλή Ενεργειακή Απόδοση - Ψηλό Λειτουργικό Κόστος

Εκπομπές Διοξειδίου του Άνθρακα CO2 $kgCO_2/m^2/yr$
Πολύ φιλικό προς το περιβάλλον
0
>120
CO_2
159.24 $kgCO_2/m^2/yr$
Καθόλου φιλικό προς το περιβάλλον

0 $kWh/m^2/yr$ Συνολικές Ενεργειακές Ανάγκες $kWh/m^2/yr$
Ανανεώσιμες Πηγές Ενέργειας Συμβατικές Πηγές Ενέργειας

Σημείωση: Η συνολική ετήσια κατανάλωση πρωτογενούς ενέργειας στο κτίριο είναι: 549 $kWh/m^2/yr$.
Η κατανάλωση ενέργειας από συμβατικές πηγές ενέργειας είναι: 546 $kWh/m^2/yr$
και από ΑΠΕ είναι: 3 $kWh/m^2/yr$.
Προειδοποίηση: Στο κτίριο δεν υπάρχει εγκατεστημένη κεντρική θέρμανση με λέβητα
Αρμόδια Αρχή για την τήρηση και διατήρηση του Μητρώου Πιστοποιητικών Ενεργειακής Απόδοσης Κτιρίων είναι η Υπηρεσία Ενέργειας του Υπουργείου Εμπορίου, Βιομηχανίας και Τουρισμού.

2. Ayia Napa Police Station



Εκδίδεται βάσει Κ.Δ.Π 164/2009 & Κ.Δ.Π 39/2014 iSBEMcy v3.4.a (SBEMcy v3.4.a)

ΠΙΣΤΟΠΟΙΗΤΙΚΟ ΕΝΕΡΓΕΙΑΚΗΣ ΑΠΟΔΟΣΗΣ ΚΤΙΡΙΟΥ

Αστυνομικός Σταθμός Αγίας Νάπας
Σταδίου 4

Φ/ΣΧ.: 0/2-292-373 ΤΜΗΜΑ: 8 ΤΕΜΑΧΙΟ: 467
Ταχ.Κώδικας: 5330
Επαρχία: Αμμόχωστος
Δήμος/Κοινότητα: Αγία Νάπα
Κατηγορία έργου: Μη Κατοικία
Η πιστοποίηση έγινε: Μετά την κατασκευή
Αριθμός Πιστοποιητικού: 37311004211007768801
Ημερομηνία έκδοσης: 29-07-2021
Ισχύς πιστοποιητικού μέχρι: 29-07-2031

Το παρόν πιστοποιητικό αποτελεί μια ένδειξη της Ενεργειακής Απόδοσης για το συγκεκριμένο κτίριο. Περιλαμβάνει την κατανάλωση ενέργειας για σκοπούς θέρμανσης και ψύξης του κτιρίου, για παραγωγή ζεστού νερού χρήσης, για εξαερισμό, για φωτισμό του κτιρίου, υπολογισμένα βάσει της συνήθους χρήσης του κτιρίου. Η Ενεργειακή Απόδοση του κτιρίου εκφράζεται ως η πρωτογενής ενέργεια που καταναλώνεται ανα τετραγωνικό μέτρο ωφέλιμης επιφάνειας πατώματος ανά έτος (kWh/m2/yr).

ΥΠΗΡΕΣΙΑ ΕΝΕΡΓΕΙΑΣ
ΥΠΟΥΡΓΕΙΟ ΕΝΕΡΓΕΙΑΣ ΕΜΠΟΡΙΟΥ ΚΑΙ ΒΙΟΜΗΧΑΝΙΑΣ

Στοιχεία Ειδικευμένου Εμπειρογνώμονα
Όνομα: Αλέξανδρος Ιωάννου
Αρ. Εγγραφής στο Μητρώο: ΑΒΧΧ 100421

Ενεργειακή Απόδοση Κτιρίου $kWh/m^2/yr$
Ψηλή Ενεργειακή Απόδοση - Χαμηλό Λειτουργικό Κόστος
A <= 0.5
B+ 0,51 - 0,75
B 0,76 - 1,0
Γ 1,01 - 1,50
Δ 1,51 - 2,00
Ε 2,01 - 2,50
Ζ 2,51 - 3,00
Η > 3,00
Ε
860 $kWh/m^2/yr$
2.03
Χαμηλή Ενεργειακή Απόδοση - Ψηλό Λειτουργικό Κόστος

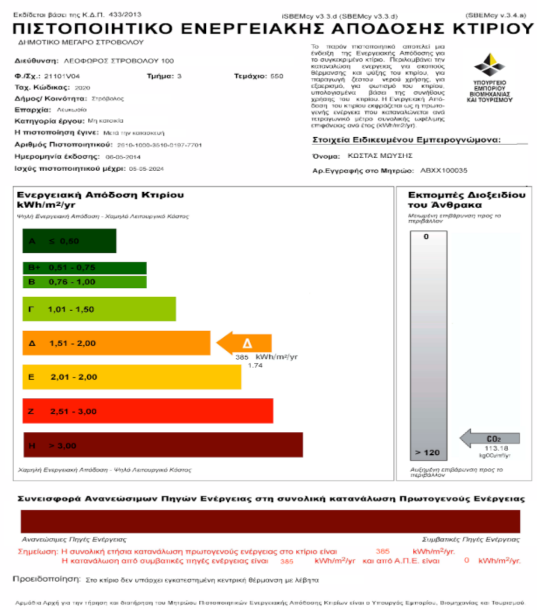
Εκπομπές Διοξειδίου του Άνθρακα CO2 $kgCO_2/m^2/yr$
Πολύ φιλικό προς το περιβάλλον
0
>120
CO_2
252.56 $kgCO_2/m^2/yr$
Καθόλου φιλικό προς το περιβάλλον

0 $kWh/m^2/yr$ Συνολικές Ενεργειακές Ανάγκες $kWh/m^2/yr$
Ανανεώσιμες Πηγές Ενέργειας Συμβατικές Πηγές Ενέργειας

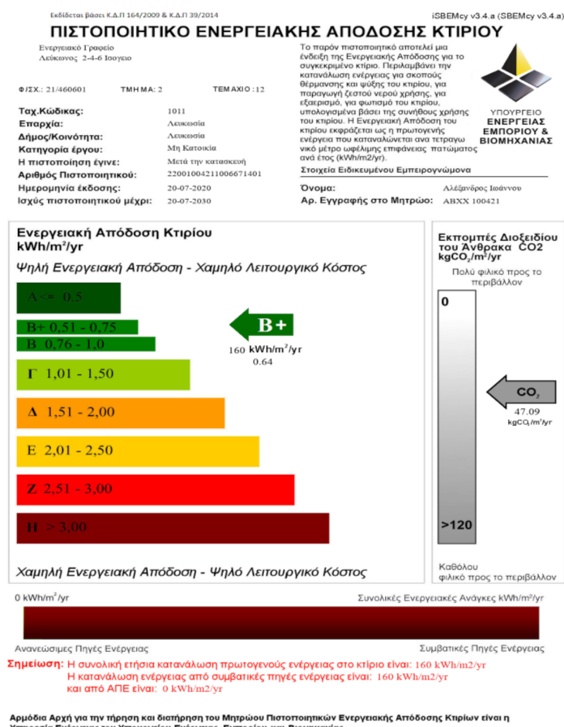
Σημείωση: Η συνολική ετήσια κατανάλωση πρωτογενούς ενέργειας στο κτίριο είναι: 862 kWh/m2/yr
Η κατανάλωση ενέργειας από συμβατικές πηγές ενέργειας είναι: 860 kWh/m2/yr
και από ΑΠΕ είναι: 2 kWh/m2/yr

Αρμόδια Αρχή για την τήρηση και διατήρηση του Μητρώου Πιστοποιητικών Ενεργειακής Απόδοσης Κτιρίων είναι η Υπηρεσία Ενέργειας του Υπουργείου Ενέργειας, Εμπορίου και Βιομηχανίας.

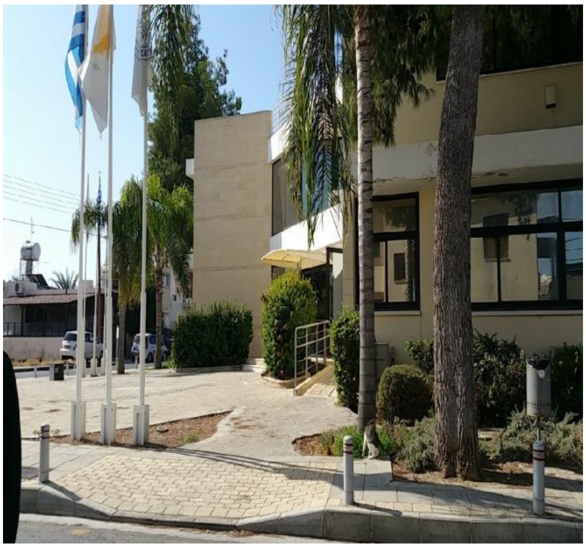
3. Strovolos Municipality

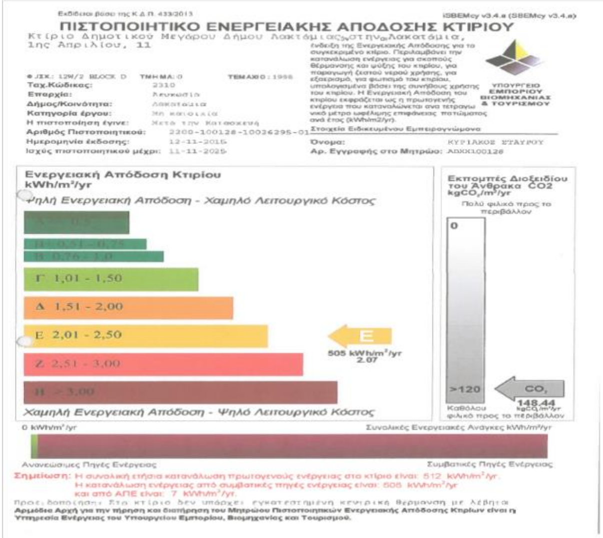


4. Cyprus Energy Agency Offices (Lefkonos 2-4-6)



5. Lakatamia Municipality





Εκδίδεται βάσει της Κ.Δ.Π. 433/2013 — iSBEMcy v3.4.a (SBEMcy v3.4.a)

ΠΙΣΤΟΠΟΙΗΤΙΚΟ ΕΝΕΡΓΕΙΑΚΗΣ ΑΠΟΔΟΣΗΣ ΚΤΙΡΙΟΥ

Κτίριο Δημοτικού Μεγάρου Δήμου Λακτάμιας, στην Λακατάμια, 1ης Απριλίου, 11

ένδειξη της Ενεργειακής Απόδοσης για το συγκεκριμένο κτίριο. Περιλαμβάνει την κατανάλωση ενέργειας για σκοπούς θέρμανσης και ψύξης του κτιρίου, για παραγωγή ζεστού νερού χρήσης, για εξαερισμό, για φωτισμό του κτιρίου, υπολογισμένα βάσει της συνήθους χρήσης του κτιρίου. Η Ενεργειακή Απόδοση του κτιρίου εκφράζεται ως η πρωτογενής ενέργεια που καταναλώνεται ανά τετραγωνικό μέτρο ωφέλιμης επιφάνειας πατώματος ανά έτος (kWh/m2/yr).

ΥΠΟΥΡΓΕΙΟ ΕΜΠΟΡΙΟΥ ΒΙΟΜΗΧΑΝΙΑΣ & ΤΟΥΡΙΣΜΟΥ

Φ/ΣΧ.: 12W/2 BLOCK D — ΤΜΗΜΑ: 0 — ΤΕΜΑΧΙΟ: 1998

Ταχ.Κώδικας:	2310
Επαρχία:	Λευκωσία
Δήμος/Κοινότητα:	Λακατάμια
Κατηγορία έργου:	Μη κατοικία
Η πιστοποίηση έγινε:	Μετά την Κατασκευή
Αριθμός Πιστοποιητικού:	2200-100128-10026295-01
Ημερομηνία έκδοσης:	12-11-2015
Ισχύς πιστοποιητικού μέχρι:	11-11-2025

Στοιχεία Ειδικευμένου Εμπειρογνώμονα

Όνομα:	ΚΥΡΙΑΚΟΣ ΣΤΑΥΡΟΥ
Αρ. Εγγραφής στο Μητρώο:	ABXX100128

Ενεργειακή Απόδοση Κτιρίου kWh/m²/yr

Ψηλή Ενεργειακή Απόδοση - Χαμηλό Λειτουργικό Κόστος

Γ 1,01 - 1,50
Δ 1,51 - 2,00
Ε 2,01 - 2,50
Ζ 2,51 - 3,00

Ε — 505 kWh/m²/yr — 2.07

Χαμηλή Ενεργειακή Απόδοση - Ψηλό Λειτουργικό Κόστος

Εκπομπές Διοξειδίου του Άνθρακα CO2 $kgCO_2/m^2/yr$

Πολύ φιλικό προς το περιβάλλον — 0 — >120 — Καθόλου φιλικό προς το περιβάλλον

CO_2 148.44 $kgCO_2/m^2/yr$

0 kWh/m²/yr — Συνολικές Ενεργειακές Ανάγκες kWh/m²/yr

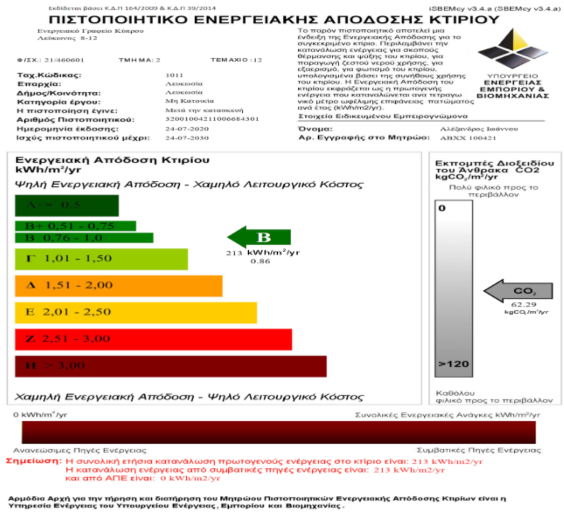
Ανανεώσιμες Πηγές Ενέργειας — Συμβατικές Πηγές Ενέργειας

Σημείωση: Η συνολική ετήσια κατανάλωση πρωτογενούς ενέργειας στο κτίριο είναι: 512 kWh/m²/yr.
Η κατανάλωση ενέργειας από συμβατικές πηγές ενέργειας είναι: 505 kWh/m²/yr
και από ΑΠΕ είναι: 7 kWh/m²/yr.

Προειδοποίηση: Στο κτίριο δεν υπάρχει εγκατεστημένη κεντρική θέρμανση με λέβητα

Αρμόδια Αρχή για την τήρηση και διατήρηση του Μητρώου Πιστοποιητικών Ενεργειακής Απόδοσης Κτιρίων είναι η Υπηρεσία Ενέργειας του Υπουργείου Εμπορίου, Βιομηχανίας και Τουρισμού.

6. Cyprus Energy Agency Offices 2



Εκδίδεται βάσει Κ.Δ.Π 164/2009 & Κ.Δ.Π 39/2014 — iSBEMcy v3.4.a (SBEMcy v3.4.a)

ΠΙΣΤΟΠΟΙΗΤΙΚΟ ΕΝΕΡΓΕΙΑΚΗΣ ΑΠΟΔΟΣΗΣ ΚΤΙΡΙΟΥ

Ενεργειακό Γραφείο Κύπρου
Λεύκωνος 8-12

Το παρόν πιστοποιητικό αποτελεί μια ένδειξη της Ενεργειακής Απόδοσης για το συγκεκριμένο κτίριο. Περιλαμβάνει την κατανάλωση ενέργειας για σκοπούς θέρμανσης και ψύξης του κτιρίου, για παραγωγή ζεστού νερού χρήσης, για εξαερισμό, για φωτισμό του κτιρίου, υπολογισμένα βάσει της συνήθους χρήσης του κτιρίου. Η Ενεργειακή Απόδοση του κτιρίου εκφράζεται ως η πρωτογενής ενέργεια που καταναλώνεται ανά τετραγωνικό μέτρο ωφέλιμης επιφάνειας πατώματος ανά έτος (kWh/m2/yr).

ΥΠΟΥΡΓΕΙΟ ΕΝΕΡΓΕΙΑΣ ΕΜΠΟΡΙΟΥ & ΒΙΟΜΗΧΑΝΙΑΣ

Φ/ΣΧ.: 21/460601 — ΤΜΗΜΑ: 2 — ΤΕΜΑΧΙΟ: 12

Ταχ.Κώδικας:	1011
Επαρχία:	Λευκωσία
Δήμος/Κοινότητα:	Λευκωσία
Κατηγορία έργου:	Μη Κατοικία
Η πιστοποίηση έγινε:	Μετά την κατασκευή
Αριθμός Πιστοποιητικού:	32001004211006684301
Ημερομηνία έκδοσης:	24-07-2020
Ισχύς πιστοποιητικού μέχρι:	24-07-2030

Στοιχεία Ειδικευμένου Εμπειρογνώμονα

Όνομα:	Αλέξανδρος Ιωάννου
Αρ. Εγγραφής στο Μητρώο:	ABXX 100421

Ενεργειακή Απόδοση Κτιρίου kWh/m²/yr

Ψηλή Ενεργειακή Απόδοση - Χαμηλό Λειτουργικό Κόστος

Α <= 0.5
Β+ 0,51 - 0,75
Β 0,76 - 1,0
Γ 1,01 - 1,50
Δ 1,51 - 2,00
Ε 2,01 - 2,50
Ζ 2,51 - 3,00
Η > 3,00

B — 213 kWh/m²/yr — 0.86

Χαμηλή Ενεργειακή Απόδοση - Ψηλό Λειτουργικό Κόστος

Εκπομπές Διοξειδίου του Άνθρακα CO2 $kgCO_2/m^2/yr$

Πολύ φιλικό προς το περιβάλλον — 0 — >120 — Καθόλου φιλικό προς το περιβάλλον

CO_2 62.29 $kgCO_2/m^2/yr$

0 kWh/m²/yr — Συνολικές Ενεργειακές Ανάγκες kWh/m²/yr

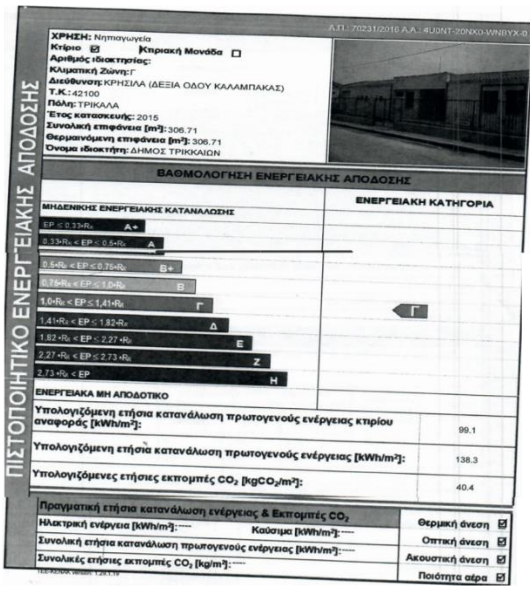
Ανανεώσιμες Πηγές Ενέργειας — Συμβατικές Πηγές Ενέργειας

Σημείωση: Η συνολική ετήσια κατανάλωση πρωτογενούς ενέργειας στο κτίριο είναι: 213 kWh/m2/yr
Η κατανάλωση ενέργειας από συμβατικές πηγές ενέργειας είναι: 213 kWh/m2/yr
και από ΑΠΕ είναι: 0 kWh/m2/yr

Αρμόδια Αρχή για την τήρηση και διατήρηση του Μητρώου Πιστοποιητικών Ενεργειακής Απόδοσης Κτιρίων είναι η Υπηρεσία Ενέργειας του Υπουργείου Ενέργειας, Εμπορίου και Βιομηχανίας.

EPCs from Greece

7. 8th-25th Kindergarten of Trikala



ΠΙΣΤΟΠΟΙΗΤΙΚΟ ΕΝΕΡΓΕΙΑΚΗΣ ΑΠΟΔΟΣΗΣ

Α.Π.: 70231/2016 Α.Α.: 4U0NT-20NX0-WNBYX-0

ΧΡΗΣΗ: Νηπιαγωγεία
Κτίριο ☑ Κτιριακή Μονάδα ☐
Αριθμός ιδιοκτησίας:
Κλιματική Ζώνη: Γ
Διεύθυνση: ΚΡΗΣΙΛΑ (ΔΕΞΙΑ ΟΔΟΥ ΚΑΛΑΜΠΑΚΑΣ)
Τ.Κ.: 42100
Πόλη: ΤΡΙΚΑΛΑ
Έτος κατασκευής: 2015
Συνολική επιφάνεια [m²]: 306.71
Θερμαινόμενη επιφάνεια [m²]: 306.71
Όνομα ιδιοκτήτη: ΔΗΜΟΣ ΤΡΙΚΚΑΙΩΝ

ΒΑΘΜΟΛΟΓΗΣΗ ΕΝΕΡΓΕΙΑΚΗΣ ΑΠΟΔΟΣΗΣ

ΕΝΕΡΓΕΙΑΚΗ ΚΑΤΗΓΟΡΙΑ

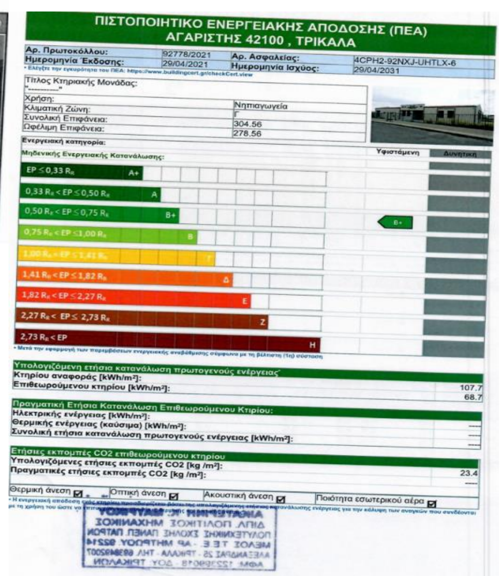
ΜΗΔΕΝΙΚΗΣ ΕΝΕΡΓΕΙΑΚΗΣ ΚΑΤΑΝΑΛΩΣΗΣ
EP ≤ 0,33·R_R A+
0,33·R_R < EP ≤ 0,5·R_R A
0,5·R_R < EP ≤ 0,75·R_R B+
0,75·R_R < EP ≤ 1,0·R_R B
1,0·R_R < EP ≤ 1,41·R_R Γ
1,41·R_R < EP ≤ 1,82·R_R Δ
1,82·R_R < EP ≤ 2,27·R_R E
2,27·R_R < EP ≤ 2,73·R_R Z
2,73·R_R < EP H
ΕΝΕΡΓΕΙΑΚΑ ΜΗ ΑΠΟΔΟΤΙΚΟ

Γ

Υπολογιζόμενη ετήσια κατανάλωση πρωτογενούς ενέργειας κτιρίου αναφοράς [kWh/m²]:	99.1
Υπολογιζόμενη ετήσια κατανάλωση πρωτογενούς ενέργειας [kWh/m²]:	138.3
Υπολογιζόμενες ετήσιες εκπομπές CO_2 [$kgCO_2/m^2$]:	40.4

Πραγματική ετήσια κατανάλωση ενέργειας & Εκπομπές CO_2
Ηλεκτρική ενέργεια [kWh/m²]: ---- Καύσιμα [kWh/m²]: ----
Συνολική ετήσια κατανάλωση πρωτογενούς ενέργειας [kWh/m²]: ----
Συνολικές ετήσιες εκπομπές CO_2 [kg/m²]: ----
Θερμική άνεση ☑
Οπτική άνεση ☑
Ακουστική άνεση ☑
Ποιότητα αέρα ☑

Pre-retrofit



ΠΙΣΤΟΠΟΙΗΤΙΚΟ ΕΝΕΡΓΕΙΑΚΗΣ ΑΠΟΔΟΣΗΣ (ΠΕΑ)
ΑΓΑΡΙΣΤΗΣ 42100 , ΤΡΙΚΑΛΑ

Αρ. Πρωτοκόλλου:	92778/2021	Αρ. Ασφαλείας:	4CPH2-92NXJ-UHTLX-6
Ημερομηνία Έκδοσης:	29/04/2021	Ημερομηνία Ισχύος:	29/04/2031

• Ελέγξτε την εγκυρότητα του ΠΕΑ: https://www.buildingcert.gr/checkCert.view

Τίτλος Κτηριακής Μονάδας:	"---------"
Χρήση:	Νηπιαγωγεία
Κλιματική Ζώνη:	Γ
Συνολική Επιφάνεια:	304.56
Ωφέλιμη Επιφάνεια:	278.56

Ενεργειακή κατηγορία: Υφιστάμενη / Δυνητική
Μηδενικής Ενεργειακής Κατανάλωσης:
EP ≤ 0,33 R_R A+
0,33 R_R < EP ≤ 0,50 R_R A
0,50 R_R < EP ≤ 0,75 R_R B+
0,75 R_R < EP ≤ 1,00 R_R B
1,00 R_R < EP ≤ 1,41 R_R Γ
1,41 R_R < EP ≤ 1,82 R_R Δ
1,82 R_R < EP ≤ 2,27 R_R E
2,27 R_R < EP ≤ 2,73 R_R Z
2,73 R_R < EP H

B+

• Μετά την εφαρμογή των παρεμβάσεων ενεργειακής αναβάθμισης σύμφωνα με τη βέλτιστη (1η) σύσταση

Υπολογιζόμενη ετήσια κατανάλωση πρωτογενούς ενέργειας	
Κτηρίου αναφοράς [kWh/m²]:	107.7
Επιθεωρούμενου κτηρίου [kWh/m²]:	68.7
Πραγματική Ετήσια Κατανάλωση Επιθεωρούμενου Κτιρίου:	
Ηλεκτρικής ενέργειας [kWh/m²]:	----
Θερμικής ενέργειας (καύσιμα) [kWh/m²]:	----
Συνολική ετήσια κατανάλωση πρωτογενούς ενέργειας [kWh/m²]:	----
Ετήσιες εκπομπές CO2 επιθεωρούμενου κτηρίου	
Υπολογιζόμενες ετήσιες εκπομπές CO2 [kg /m²]:	23.4
Πραγματικές ετήσιες εκπομπές CO2 [kg /m²]:	----

Θερμική άνεση ☑ Οπτική άνεση ☑ Ακουστική άνεση ☑ Ποιότητα εσωτερικού αέρα ☑

Post-retrofit

8. 31st Elementary School of Trikala

ΠΙΣΤΟΠΟΙΗΤΙΚΟ ΕΝΕΡΓΕΙΑΚΗΣ ΑΠΟΔΟΣΗΣ

Α.Π.: 16440/2015 Α.Α.: 0W1YU-M7VL6-2K50X-9

ΧΡΗΣΗ: Πρωτοβάθμιας εκπαίδευσης
Κτίριο ☑ Τμήμα κτιρίου ☐
Αριθμός ιδιοκτησίας:
Κλιματική Ζώνη: Γ
Διεύθυνση: (31ο ΔΗΜΟΤΙΚΟ ΣΧΟΛΕΙΟ) ΣΟΥΛΙΟΥ 0
Τ.Κ.: 42100
Πόλη: ΤΡΙΚΑΛΑ
Έτος κατασκευής: 1989
Συνολική επιφάνεια [m²]: 1669.31
Θερμαινόμενη επιφάνεια [m²]: 1669.31
Όνομα ιδιοκτήτη: ΔΗΜΟΣ ΤΡΙΚΚΑΙΩΝ

ΒΑΘΜΟΛΟΓΗΣΗ ΕΝΕΡΓΕΙΑΚΗΣ ΑΠΟΔΟΣΗΣ

ΕΝΕΡΓΕΙΑΚΗ ΚΑΤΗΓΟΡΙΑ

ΜΗΔΕΝΙΚΗΣ ΕΝΕΡΓΕΙΑΚΗΣ ΚΑΤΑΝΑΛΩΣΗΣ
EP ≤ 0,33·R_R A+
0,33·R_R < EP ≤ 0,5·R_R A
0,5·R_R < EP ≤ 0,75·R_R B+
0,75·R_R < EP ≤ 1,0·R_R B
1,0·R_R < EP ≤ 1,41·R_R Γ
1,41·R_R < EP ≤ 1,82·R_R Δ
1,82·R_R < EP ≤ 2,27·R_R E
2,27·R_R < EP ≤ 2,73·R_R Z
2,73·R_R < EP H
ΕΝΕΡΓΕΙΑΚΑ ΜΗ ΑΠΟΔΟΤΙΚΟ

Δ

Υπολογιζόμενη ετήσια κατανάλωση πρωτογενούς ενέργειας κτιρίου αναφοράς [kWh/m²]:	75.2
Υπολογιζόμενη ετήσια κατανάλωση πρωτογενούς ενέργειας [kWh/m²]:	126.6
Υπολογιζόμενες ετήσιες εκπομπές CO_2 [$kgCO_2/m^2$]:	37.7

Πραγματική ετήσια κατανάλωση ενέργειας & Εκπομπές CO_2
Ηλεκτρική ενέργεια [kWh/m²]: ---- Καύσιμα [kWh/m²]: ----
Συνολική ετήσια κατανάλωση πρωτογενούς ενέργειας [kWh/m²]: ----
Συνολικές ετήσιες εκπομπές CO_2 [kg/m²]: ----
Θερμική άνεση ☑
Οπτική άνεση ☑
Ακουστική άνεση ☑
Ποιότητα αέρα ☑

9. 7th Junior High School of Trikala

ΠΙΣΤΟΠΟΙΗΤΙΚΟ ΕΝΕΡΓΕΙΑΚΗΣ ΑΠΟΔΟΣΗΣ

Α.Π.: 16105/2015 Α.Α.: B5MDF-J4F46-TU766-S

ΧΡΗΣΗ: Δευτεροβάθμιας εκπαίδευσης
Κτίριο ☑ **Τμήμα κτιρίου** ☐
Αριθμός ιδιοκτησίας:
Κλιματική Ζώνη: Γ
Διεύθυνση: (7ο ΓΥΜΝΑΣΙΟ ΤΡΙΚΑΛΩΝ) ΣΥΡΟΥ 50
Τ.Κ.: 42100
Πόλη: ΤΡΙΚΑΛΑ
Έτος κατασκευής: 1999
Συνολική επιφάνεια [m^2]: 2089.38
Θερμαινόμενη επιφάνεια [m^2]: 2089.38
Όνομα ιδιοκτήτη: ΔΗΜΟΣ ΤΡΙΚΚΑΙΩΝ

ΒΑΘΜΟΛΟΓΗΣΗ ΕΝΕΡΓΕΙΑΚΗΣ ΑΠΟΔΟΣΗΣ

	ΕΝΕΡΓΕΙΑΚΗ ΚΑΤΗΓΟΡΙΑ
ΜΗΔΕΝΙΚΗΣ ΕΝΕΡΓΕΙΑΚΗΣ ΚΑΤΑΝΑΛΩΣΗΣ	
$EP \leq 0{,}33 \cdot R_R$ A+	
$0{,}33 \cdot R_R < EP \leq 0{,}5 \cdot R_R$ A	
$0{,}5 \cdot R_R < EP \leq 0{,}75 \cdot R_R$ B+	
$0{,}75 \cdot R_R < EP \leq 1{,}0 \cdot R_R$ B	
$1{,}0 \cdot R_R < EP \leq 1{,}41 \cdot R_R$ Γ	
$1{,}41 \cdot R_R < EP \leq 1{,}82 \cdot R_R$ Δ	Δ
$1{,}82 \cdot R_R < EP \leq 2{,}27 \cdot R_R$ Ε	
$2{,}27 \cdot R_R < EP \leq 2{,}73 \cdot R_R$ Ζ	
$2{,}73 \cdot R_R < EP$ Η	
ΕΝΕΡΓΕΙΑΚΑ ΜΗ ΑΠΟΔΟΤΙΚΟ	

Υπολογιζόμενη ετήσια κατανάλωση πρωτογενούς ενέργειας κτιρίου αναφοράς [kWh/m^2]:	76.1
Υπολογιζόμενη ετήσια κατανάλωση πρωτογενούς ενέργειας [kWh/m^2]:	122.8
Υπολογιζόμενες ετήσιες εκπομπές CO_2 [$kgCO_2/m^2$]:	36.7

Πραγματική ετήσια κατανάλωση ενέργειας & Εκπομπές CO_2	
Ηλεκτρική ενέργεια [kWh/m^2]:---- Καύσιμα [kWh/m^2]:----	Θερμική άνεση ☑
Συνολική ετήσια κατανάλωση πρωτογενούς ενέργειας [kWh/m^2]:----	Οπτική άνεση ☑
Συνολικές ετήσιες εκπομπές CO_2 [kg/m^2]:----	Ακουστική άνεση ☑
	Ποιότητα αέρα ☑

10. 6th Kindergarten of Trikala

ΠΙΣΤΟΠΟΙΗΤΙΚΟ ΕΝΕΡΓΕΙΑΚΗΣ ΑΠΟΔΟΣΗΣ

Α.Π.: 16462/2015 Α.Α.: H0Q39-CEKNJ-K0TVY-W

ΧΡΗΣΗ: Νηπιαγωγεία
Κτίριο ☑ **Τμήμα κτιρίου** ☐
Αριθμός ιδιοκτησίας:
Κλιματική Ζώνη: Γ
Διεύθυνση: (6ο ΝΗΠΙΑΓΩΓΕΙΟ) ΠΑΡΟΔΟΣ ΠΑΤΟΥΛΙΑΣ 0
Τ.Κ.: 42100
Πόλη: ΤΡΙΚΑΛΑ
Έτος κατασκευής: 1993
Συνολική επιφάνεια [m^2]: 180.84
Θερμαινόμενη επιφάνεια [m^2]: 180.84
Όνομα ιδιοκτήτη: ΔΗΜΟΣ ΤΡΙΚΚΑΙΩΝ

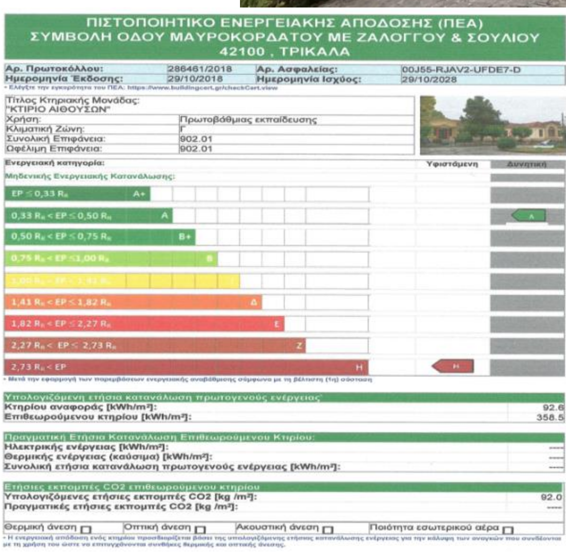
ΒΑΘΜΟΛΟΓΗΣΗ ΕΝΕΡΓΕΙΑΚΗΣ ΑΠΟΔΟΣΗΣ

	ΕΝΕΡΓΕΙΑΚΗ ΚΑΤΗΓΟΡΙΑ
ΜΗΔΕΝΙΚΗΣ ΕΝΕΡΓΕΙΑΚΗΣ ΚΑΤΑΝΑΛΩΣΗΣ	
$EP \leq 0{,}33 \cdot R_R$ A+	
$0{,}33 \cdot R_R < EP \leq 0{,}5 \cdot R_R$ A	
$0{,}5 \cdot R_R < EP \leq 0{,}75 \cdot R_R$ B+	
$0{,}75 \cdot R_R < EP \leq 1{,}0 \cdot R_R$ B	
$1{,}0 \cdot R_R < EP \leq 1{,}41 \cdot R_R$ Γ	
$1{,}41 \cdot R_R < EP \leq 1{,}82 \cdot R_R$ Δ	Δ
$1{,}82 \cdot R_R < EP \leq 2{,}27 \cdot R_R$ Ε	
$2{,}27 \cdot R_R < EP \leq 2{,}73 \cdot R_R$ Ζ	
$2{,}73 \cdot R_R < EP$ Η	
ΕΝΕΡΓΕΙΑΚΑ ΜΗ ΑΠΟΔΟΤΙΚΟ	

Υπολογιζόμενη ετήσια κατανάλωση πρωτογενούς ενέργειας κτιρίου αναφοράς [kWh/m^2]:	91.1
Υπολογιζόμενη ετήσια κατανάλωση πρωτογενούς ενέργειας [kWh/m^2]:	154.2
Υπολογιζόμενες ετήσιες εκπομπές CO_2 [$kgCO_2/m^2$]:	43.8

Πραγματική ετήσια κατανάλωση ενέργειας & Εκπομπές CO_2	
Ηλεκτρική ενέργεια [kWh/m^2]:---- Καύσιμα [kWh/m^2]:----	Θερμική άνεση ☑
Συνολική ετήσια κατανάλωση πρωτογενούς ενέργειας [kWh/m^2]:----	Οπτική άνεση ☑
Συνολικές ετήσιες εκπομπές CO_2 [kg/m^2]:----	Ακουστική άνεση ☑
	Ποιότητα αέρα ☑

11. 5th primary school of Trikala



ΠΙΣΤΟΠΟΙΗΤΙΚΟ ΕΝΕΡΓΕΙΑΚΗΣ ΑΠΟΔΟΣΗΣ (ΠΕΑ)
ΣΥΜΒΟΛΗ ΟΔΟΥ ΜΑΥΡΟΚΟΡΔΑΤΟΥ ΜΕ ΖΑΛΟΓΓΟΥ & ΣΟΥΛΙΟΥ
42100 , ΤΡΙΚΑΛΑ

Αρ. Πρωτοκόλλου:	286461/2018	Αρ. Ασφαλείας:	00J55-RJAV2-UFDE7-D
Ημερομηνία Έκδοσης:	29/10/2018	Ημερομηνία Ισχύος:	29/10/2028

Τίτλος Κτηριακής Μονάδας: "ΚΤΙΡΙΟ ΑΙΘΟΥΣΩΝ"	
Χρήση:	Πρωτοβάθμιας εκπαίδευσης
Κλιματική Ζώνη:	Γ
Συνολική Επιφάνεια:	902.01
Ωφέλιμη Επιφάνεια:	902.01

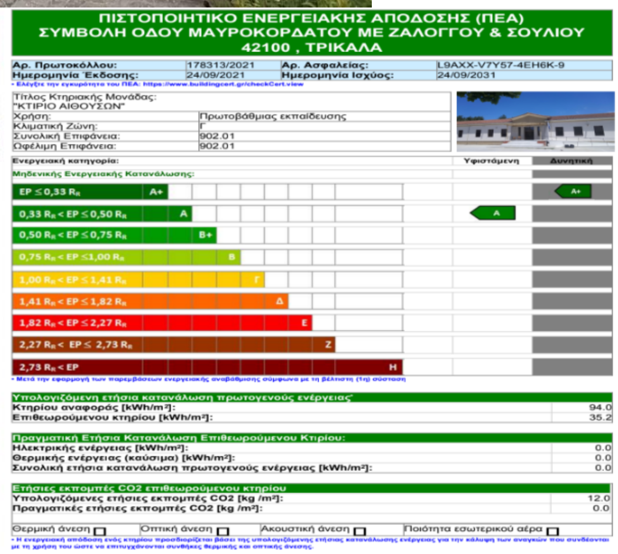
Ενεργειακή κατηγορία:	Υφιστάμενη	Δυνητική
Μηδενικής Ενεργειακής Κατανάλωσης:		
EP ≤ 0,33 R_R A+		
0,33 R_R < EP ≤ 0,50 R_R A		A
0,50 R_R < EP ≤ 0,75 R_R B+		
0,75 R_R < EP ≤ 1,00 R_R B		
1,00 R_R < EP ≤ 1,41 R_R Γ		
1,41 R_R < EP ≤ 1,82 R_R Δ		
1,82 R_R < EP ≤ 2,27 R_R E		
2,27 R_R < EP ≤ 2,73 R_R Z		
2,73 R_R < EP H	H	

Υπολογιζόμενη ετήσια κατανάλωση πρωτογενούς ενέργειας	
Κτηρίου αναφοράς [kWh/m²]:	92.6
Επιθεωρούμενου κτηρίου [kWh/m²]:	358.5

Πραγματική Ετήσια Κατανάλωση Επιθεωρούμενου Κτιρίου:	
Ηλεκτρικής ενέργειας [kWh/m²]:	----
Θερμικής ενέργειας (καύσιμα) [kWh/m²]:	----
Συνολική ετήσια κατανάλωση πρωτογενούς ενέργειας [kWh/m²]:	----

Ετήσιες εκπομπές CO2 επιθεωρούμενου κτηρίου	
Υπολογιζόμενες ετήσιες εκπομπές CO2 [kg /m²]:	92.0
Πραγματικές ετήσιες εκπομπές CO2 [kg /m²]:	----

Θερμική άνεση ☐ Οπτική άνεση ☐ Ακουστική άνεση ☐ Ποιότητα εσωτερικού αέρα ☐



ΠΙΣΤΟΠΟΙΗΤΙΚΟ ΕΝΕΡΓΕΙΑΚΗΣ ΑΠΟΔΟΣΗΣ (ΠΕΑ)
ΣΥΜΒΟΛΗ ΟΔΟΥ ΜΑΥΡΟΚΟΡΔΑΤΟΥ ΜΕ ΖΑΛΟΓΓΟΥ & ΣΟΥΛΙΟΥ
42100 , ΤΡΙΚΑΛΑ

Αρ. Πρωτοκόλλου:	178313/2021	Αρ. Ασφαλείας:	L9AXX-V7Y57-4EH6K-9
Ημερομηνία Έκδοσης:	24/09/2021	Ημερομηνία Ισχύος:	24/09/2031

• Ελέγξτε την εγκυρότητα του ΠΕΑ: https://www.buildingcert.gr/checkCert.view

Τίτλος Κτηριακής Μονάδας: "ΚΤΙΡΙΟ ΑΙΘΟΥΣΩΝ"	
Χρήση:	Πρωτοβάθμιας εκπαίδευσης
Κλιματική Ζώνη:	Γ
Συνολική Επιφάνεια:	902.01
Ωφέλιμη Επιφάνεια:	902.01

Ενεργειακή κατηγορία:	Υφιστάμενη	Δυνητική
Μηδενικής Ενεργειακής Κατανάλωσης:		
EP ≤ 0,33 R_R A+		A+
0,33 R_R < EP ≤ 0,50 R_R A	A	
0,50 R_R < EP ≤ 0,75 R_R B+		
0,75 R_R < EP ≤ 1,00 R_R B		
1,00 R_R < EP ≤ 1,41 R_R Γ		
1,41 R_R < EP ≤ 1,82 R_R Δ		
1,82 R_R < EP ≤ 2,27 R_R E		
2,27 R_R < EP ≤ 2,73 R_R Z		
2,73 R_R < EP H		

• Μετά την εφαρμογή των παρεμβάσεων ενεργειακής αναβάθμισης σύμφωνα με τη βέλτιστη (1η) σύσταση

Υπολογιζόμενη ετήσια κατανάλωση πρωτογενούς ενέργειας	
Κτηρίου αναφοράς [kWh/m²]:	94.0
Επιθεωρούμενου κτηρίου [kWh/m²]:	35.2

Πραγματική Ετήσια Κατανάλωση Επιθεωρούμενου Κτιρίου:	
Ηλεκτρικής ενέργειας [kWh/m²]:	0.0
Θερμικής ενέργειας (καύσιμα) [kWh/m²]:	0.0
Συνολική ετήσια κατανάλωση πρωτογενούς ενέργειας [kWh/m²]:	0.0

Ετήσιες εκπομπές CO2 επιθεωρούμενου κτηρίου	
Υπολογιζόμενες ετήσιες εκπομπές CO2 [kg /m²]:	12.0
Πραγματικές ετήσιες εκπομπές CO2 [kg /m²]:	0.0

Θερμική άνεση ☐ Οπτική άνεση ☐ Ακουστική άνεση ☐ Ποιότητα εσωτερικού αέρα ☐

• Η ενεργειακή απόδοση ενός κτηρίου προσδιορίζεται βάσει της υπολογιζόμενης ετήσιας κατανάλωσης ενέργειας για την κάλυψη των αναγκών που συνδέονται με τη χρήση του ώστε να επιτυγχάνονται συνθήκες θερμικής και οπτικής άνεσης.

Pre retrofit

Post retrofit

12. 4th High School of Trikala

ΠΙΣΤΟΠΟΙΗΤΙΚΟ ΕΝΕΡΓΕΙΑΚΗΣ ΑΠΟΔΟΣΗΣ

Α.Π.: 16100/2015 Α.Α.: P7YQ5-T3FRR-X4642-A

ΧΡΗΣΗ: Δευτεροβάθμιας εκπαίδευσης
Κτίριο ☑ **Τμήμα κτιρίου** ☐
Αριθμός ιδιοκτησίας:
Κλιματική Ζώνη: Γ
Διεύθυνση: (4ο ΛΥΚΕΙΟ ΤΡΙΚΑΛΩΝ) ΖΗΝΟΔΟΤΟΥ 4
Τ.Κ.: 42100
Πόλη: ΤΡΙΚΑΛΑ
Έτος κατασκευής: 1999
Συνολική επιφάνεια [m²]: 2015.46
Θερμαινόμενη επιφάνεια [m²]: 2015.46
Όνομα ιδιοκτήτη: ΔΗΜΟΣ ΤΡΙΚΚΑΙΩΝ

ΒΑΘΜΟΛΟΓΗΣΗ ΕΝΕΡΓΕΙΑΚΗΣ ΑΠΟΔΟΣΗΣ

	ΕΝΕΡΓΕΙΑΚΗ ΚΑΤΗΓΟΡΙΑ
ΜΗΔΕΝΙΚΗΣ ΕΝΕΡΓΕΙΑΚΗΣ ΚΑΤΑΝΑΛΩΣΗΣ	
EP ≤ 0,33·R_R A+	
0,33·R_R < EP ≤ 0,5·R_R A	
0,5·R_R < EP ≤ 0,75·R_R B+	
0,75·R_R < EP ≤ 1,0·R_R B	
1,0·R_R < EP ≤ 1,41·R_R Γ	
1,41·R_R < EP ≤ 1,82·R_R Δ	Δ
1,82·R_R < EP ≤ 2,27·R_R E	
2,27·R_R < EP ≤ 2,73·R_R Z	
2,73·R_R < EP H	
ΕΝΕΡΓΕΙΑΚΑ ΜΗ ΑΠΟΔΟΤΙΚΟ	

Υπολογιζόμενη ετήσια κατανάλωση πρωτογενούς ενέργειας κτιρίου αναφοράς [kWh/m²]:	74.9
Υπολογιζόμενη ετήσια κατανάλωση πρωτογενούς ενέργειας [kWh/m²]:	113.6
Υπολογιζόμενες ετήσιες εκπομπές CO_2 [kgCO_2/m²]:	33.5

Πραγματική ετήσια κατανάλωση ενέργειας & Εκπομπές CO_2	
Ηλεκτρική ενέργεια [kWh/m²]:---- Καύσιμα [kWh/m²]:----	Θερμική άνεση ☑
Συνολική ετήσια κατανάλωση πρωτογενούς ενέργειας [kWh/m²]:----	Οπτική άνεση ☑
Συνολικές ετήσιες εκπομπές CO_2 [kg/m²]:----	Ακουστική άνεση ☑
	Ποιότητα αέρα ☑

13. 3rd High School of Trikala

ΠΙΣΤΟΠΟΙΗΤΙΚΟ ΕΝΕΡΓΕΙΑΚΗΣ ΑΠΟΔΟΣΗΣ

Α.Π.: 16102/2015 Α.Α.: ECQE8-A1LPL-DNH4V-R

ΧΡΗΣΗ: Δευτεροβάθμιας εκπαίδευσης
Κτίριο ☑ **Τμήμα κτιρίου** ☐
Αριθμός ιδιοκτησίας:
Κλιματική Ζώνη: Γ
Διεύθυνση: (3ο ΛΥΚΕΙΟ ΤΡΙΚΑΛΩΝ) ΜΕΤΕΩΡΩΝ 57
Τ.Κ.: 42100
Πόλη: ΤΡΙΚΑΛΑ
Έτος κατασκευής: 2003
Συνολική επιφάνεια [m²]: 2514.69
Θερμαινόμενη επιφάνεια [m²]: 2514.69
Όνομα ιδιοκτήτη: ΔΗΜΟΣ ΤΡΙΚΚΑΙΩΝ

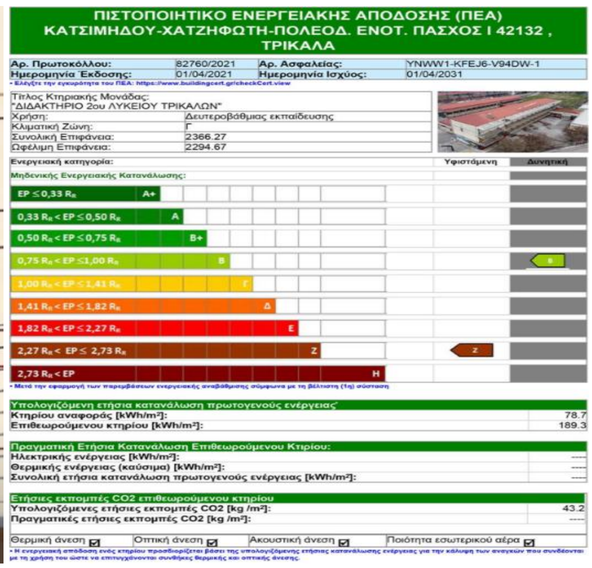
ΒΑΘΜΟΛΟΓΗΣΗ ΕΝΕΡΓΕΙΑΚΗΣ ΑΠΟΔΟΣΗΣ

	ΕΝΕΡΓΕΙΑΚΗ ΚΑΤΗΓΟΡΙΑ
ΜΗΔΕΝΙΚΗΣ ΕΝΕΡΓΕΙΑΚΗΣ ΚΑΤΑΝΑΛΩΣΗΣ	
$EP \leq 0{,}33 \cdot R_R$ A+	
$0{,}33 \cdot R_R < EP \leq 0{,}5 \cdot R_R$ A	
$0{,}5 \cdot R_R < EP \leq 0{,}75 \cdot R_R$ B+	
$0{,}75 \cdot R_R < EP \leq 1{,}0 \cdot R_R$ B	
$1{,}0 \cdot R_R < EP \leq 1{,}41 \cdot R_R$ Γ	
$1{,}41 \cdot R_R < EP \leq 1{,}82 \cdot R_R$ Δ	Δ
$1{,}82 \cdot R_R < EP \leq 2{,}27 \cdot R_R$ Ε	
$2{,}27 \cdot R_R < EP \leq 2{,}73 \cdot R_R$ Ζ	
$2{,}73 \cdot R_R < EP$ Η	
ΕΝΕΡΓΕΙΑΚΑ ΜΗ ΑΠΟΔΟΤΙΚΟ	

Υπολογιζόμενη ετήσια κατανάλωση πρωτογενούς ενέργειας κτιρίου αναφοράς [kWh/m²]:	78.3
Υπολογιζόμενη ετήσια κατανάλωση πρωτογενούς ενέργειας [kWh/m²]:	119.7
Υπολογιζόμενες ετήσιες εκπομπές CO_2 [kgCO₂/m²]:	36.2

Πραγματική ετήσια κατανάλωση ενέργειας & Εκπομπές CO_2	
Ηλεκτρική ενέργεια [kWh/m²]:---- Καύσιμα [kWh/m²]:----	Θερμική άνεση ☑
Συνολική ετήσια κατανάλωση πρωτογενούς ενέργειας [kWh/m²]:----	Οπτική άνεση ☑
Συνολικές ετήσιες εκπομπές CO_2 [kg/m²]:----	Ακουστική άνεση ☑
	Ποιότητα αέρα ☑

14. 2nd High School of Trikala



ΠΙΣΤΟΠΟΙΗΤΙΚΟ ΕΝΕΡΓΕΙΑΚΗΣ ΑΠΟΔΟΣΗΣ (ΠΕΑ)
ΚΑΤΣΙΜΗΔΟΥ-ΧΑΤΖΗΦΩΤΗ-ΠΟΛΕΟΔ. ΕΝΟΤ. ΠΑΣΧΟΣ Ι 42132 , ΤΡΙΚΑΛΑ

Αρ. Πρωτοκόλλου:	82760/2021	Αρ. Ασφαλείας:	YNWW1-KFEJ6-V94DW-1
Ημερομηνία Έκδοσης:	01/04/2021	Ημερομηνία Ισχύος:	01/04/2031

• Ελέγξτε την εγκυρότητα του ΠΕΑ: https://www.buildingcert.gr/checkCert.view

Τίτλος Κτηριακής Μονάδας: "ΔΙΔΑΚΤΗΡΙΟ 2ου ΛΥΚΕΙΟΥ ΤΡΙΚΑΛΩΝ"	
Χρήση:	Δευτεροβάθμιας εκπαίδευσης
Κλιματική Ζώνη:	Γ
Συνολική Επιφάνεια:	2366.27
Ωφέλιμη Επιφάνεια:	2294.67

Ενεργειακή κατηγορία:	Υφιστάμενη	Δυνητική
Μηδενικής Ενεργειακής Κατανάλωσης:		
$EP \leq 0{,}33\ R_R$ A+		
$0{,}33\ R_R < EP \leq 0{,}50\ R_R$ A		
$0{,}50\ R_R < EP \leq 0{,}75\ R_R$ B+		
$0{,}75\ R_R < EP \leq 1{,}00\ R_R$ B		B
$1{,}00\ R_R < EP \leq 1{,}41\ R_R$ Γ		
$1{,}41\ R_R < EP \leq 1{,}82\ R_R$ Δ		
$1{,}82\ R_R < EP \leq 2{,}27\ R_R$ Ε		
$2{,}27\ R_R < EP \leq 2{,}73\ R_R$ Ζ	Ζ	
$2{,}73\ R_R < EP$ Η		

• Μετά την εφαρμογή των παρεμβάσεων ενεργειακής αναβάθμισης σύμφωνα με τη βέλτιστη (1η) σύσταση

Υπολογιζόμενη ετήσια κατανάλωση πρωτογενούς ενέργειας	
Κτηρίου αναφοράς [kWh/m²]:	78.7
Επιθεωρούμενου κτηρίου [kWh/m²]:	189.3

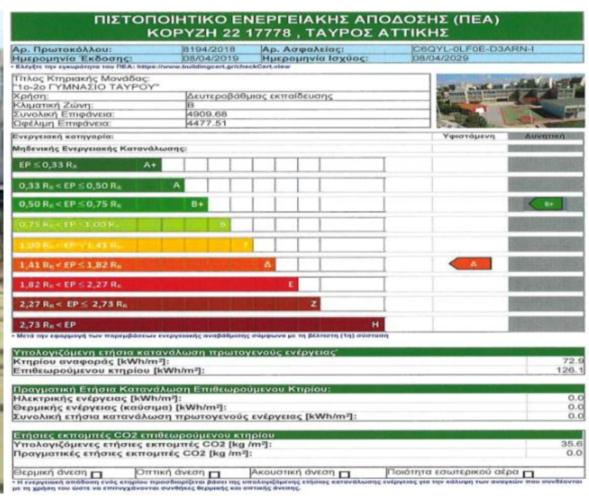
Πραγματική Ετήσια Κατανάλωση Επιθεωρούμενου Κτιρίου:	
Ηλεκτρικής ενέργειας [kWh/m²]:	----
Θερμικής ενέργειας (καύσιμα) [kWh/m²]:	----
Συνολική ετήσια κατανάλωση πρωτογενούς ενέργειας [kWh/m²]:	----

Ετήσιες εκπομπές CO2 επιθεωρούμενου κτηρίου	
Υπολογιζόμενες ετήσιες εκπομπές CO2 [kg /m²]:	43.2
Πραγματικές ετήσιες εκπομπές CO2 [kg /m²]:	----

Θερμική άνεση ☑ Οπτική άνεση ☑ Ακουστική άνεση ☑ Ποιότητα εσωτερικού αέρα ☑

• Η ενεργειακή απόδοση ενός κτηρίου προσδιορίζεται βάσει της υπολογιζόμενης ετήσιας κατανάλωσης ενέργειας για την κάλυψη των αναγκών που συνδέονται με τη χρήση του ώστε να επιτυγχάνονται συνθήκες θερμικής και οπτικής άνεσης.

15. 1st-2nd Gymnasium of Tavros



ΠΙΣΤΟΠΟΙΗΤΙΚΟ ΕΝΕΡΓΕΙΑΚΗΣ ΑΠΟΔΟΣΗΣ (ΠΕΑ)
ΚΟΡΥΖΗ 22 17778 , ΤΑΥΡΟΣ ΑΤΤΙΚΗΣ

Αρ. Πρωτοκόλλου:	8194/2018	Αρ. Ασφαλείας:	C6QYL-0LF0E-D3ARN-I
Ημερομηνία Έκδοσης:	08/04/2019	Ημερομηνία Ισχύος:	08/04/2029

• Ελέγξτε την εγκυρότητα του ΠΕΑ: https://www.buildingcert.gr/checkCert.view

Τίτλος Κτηριακής Μονάδας: "1ο-2ο ΓΥΜΝΑΣΙΟ ΤΑΥΡΟΥ"	
Χρήση:	Δευτεροβάθμιας εκπαίδευσης
Κλιματική Ζώνη:	B
Συνολική Επιφάνεια:	4909.68
Ωφέλιμη Επιφάνεια:	4477.51

Ενεργειακή κατηγορία:	Υφιστάμενη	Δυνητική
Μηδενικής Ενεργειακής Κατανάλωσης:		
$EP \leq 0{,}33\ R_R$ A+		
$0{,}33\ R_R < EP \leq 0{,}50\ R_R$ A		
$0{,}50\ R_R < EP \leq 0{,}75\ R_R$ B+		B+
$0{,}75\ R_R < EP \leq 1{,}00\ R_R$ B		
$1{,}00\ R_R < EP \leq 1{,}41\ R_R$ Γ		
$1{,}41\ R_R < EP \leq 1{,}82\ R_R$ Δ	Δ	
$1{,}82\ R_R < EP \leq 2{,}27\ R_R$ Ε		
$2{,}27\ R_R < EP \leq 2{,}73\ R_R$ Ζ		
$2{,}73\ R_R < EP$ Η		

• Μετά την εφαρμογή των παρεμβάσεων ενεργειακής αναβάθμισης σύμφωνα με τη βέλτιστη (1η) σύσταση

Υπολογιζόμενη ετήσια κατανάλωση πρωτογενούς ενέργειας	
Κτηρίου αναφοράς [kWh/m²]:	72.9
Επιθεωρούμενου κτηρίου [kWh/m²]:	126.1

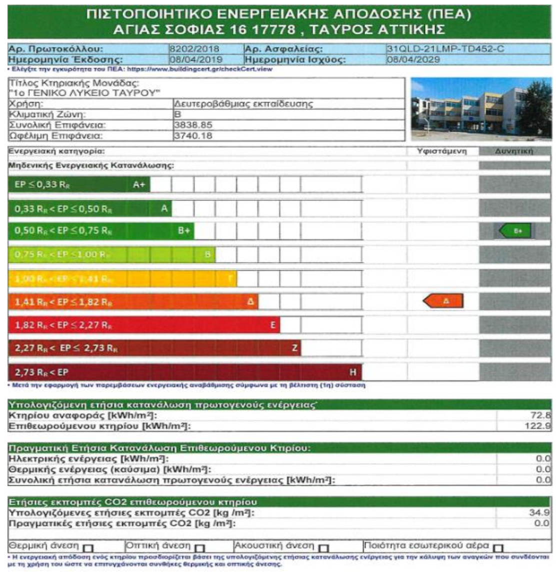
Πραγματική Ετήσια Κατανάλωση Επιθεωρούμενου Κτιρίου:	
Ηλεκτρικής ενέργειας [kWh/m²]:	0.0
Θερμικής ενέργειας (καύσιμα) [kWh/m²]:	0.0
Συνολική ετήσια κατανάλωση πρωτογενούς ενέργειας [kWh/m²]:	0.0

Ετήσιες εκπομπές CO2 επιθεωρούμενου κτηρίου	
Υπολογιζόμενες ετήσιες εκπομπές CO2 [kg /m²]:	35.6
Πραγματικές ετήσιες εκπομπές CO2 [kg /m²]:	0.0

Θερμική άνεση ☐ Οπτική άνεση ☐ Ακουστική άνεση ☐ Ποιότητα εσωτερικού αέρα ☐

• Η ενεργειακή απόδοση ενός κτηρίου προσδιορίζεται βάσει της υπολογιζόμενης ετήσιας κατανάλωσης ενέργειας για την κάλυψη των αναγκών που συνδέονται με τη χρήση του ώστε να επιτυγχάνονται συνθήκες θερμικής και οπτικής άνεσης.

16. 1st High School of Tavros



ΠΙΣΤΟΠΟΙΗΤΙΚΟ ΕΝΕΡΓΕΙΑΚΗΣ ΑΠΟΔΟΣΗΣ (ΠΕΑ)
ΑΓΙΑΣ ΣΟΦΙΑΣ 16 17778 , ΤΑΥΡΟΣ ΑΤΤΙΚΗΣ

Αρ. Πρωτοκόλλου:	8202/2018	Αρ. Ασφαλείας:	31QLD-21LMP-TD452-C
Ημερομηνία Έκδοσης:	08/04/2019	Ημερομηνία Ισχύος:	08/04/2029

• Ελέγξτε την εγκυρότητα του ΠΕΑ: https://www.buildingcert.gr/checkCert.view

Τίτλος Κτηριακής Μονάδας: "1ο ΓΕΝΙΚΟ ΛΥΚΕΙΟ ΤΑΥΡΟΥ"	
Χρήση:	Δευτεροβάθμιας εκπαίδευσης
Κλιματική Ζώνη:	Β
Συνολική Επιφάνεια:	3838.85
Ωφέλιμη Επιφάνεια:	3740.18

Ενεργειακή κατηγορία:		Υφιστάμενη	Δυνητική
Μηδενικής Ενεργειακής Κατανάλωσης:			
$EP \leq 0,33 R_R$	A+		
$0,33 R_R < EP \leq 0,50 R_R$	A		
$0,50 R_R < EP \leq 0,75 R_R$	B+		B+
$0,75 R_R < EP \leq 1,00 R_R$	B		
$1,00 R_R < EP \leq 1,41 R_R$	Γ		
$1,41 R_R < EP \leq 1,82 R_R$	Δ	Δ	
$1,82 R_R < EP \leq 2,27 R_R$	E		
$2,27 R_R < EP \leq 2,73 R_R$	Z		
$2,73 R_R < EP$	H		

• Μετά την εφαρμογή των παρεμβάσεων ενεργειακής αναβάθμισης σύμφωνα με τη βέλτιστη (1η) σύσταση

Υπολογιζόμενη ετήσια κατανάλωση πρωτογενούς ενέργειας*	
Κτηρίου αναφοράς [kWh/m²]:	72.8
Επιθεωρούμενου κτηρίου [kWh/m²]:	122.9

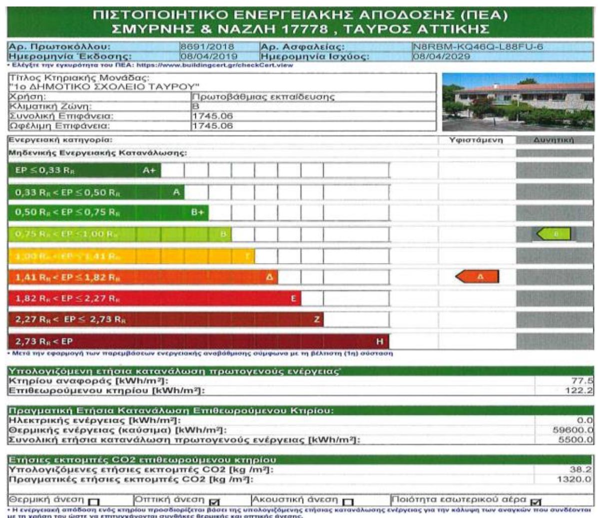
Πραγματική Ετήσια Κατανάλωση Επιθεωρούμενου Κτιρίου:	
Ηλεκτρικής ενέργειας [kWh/m²]:	0.0
Θερμικής ενέργειας (καύσιμα) [kWh/m²]:	0.0
Συνολική ετήσια κατανάλωση πρωτογενούς ενέργειας [kWh/m²]:	0.0

Ετήσιες εκπομπές CO2 επιθεωρούμενου κτηρίου	
Υπολογιζόμενες ετήσιες εκπομπές CO2 [kg /m²]:	34.9
Πραγματικές ετήσιες εκπομπές CO2 [kg /m²]:	0.0

Θερμική άνεση ☐ Οπτική άνεση ☐ Ακουστική άνεση ☐ Ποιότητα εσωτερικού αέρα ☐

• Η ενεργειακή απόδοση ενός κτηρίου προσδιορίζεται βάσει της υπολογιζόμενης ετήσιας κατανάλωσης ενέργειας για την κάλυψη των αναγκών που συνδέονται με τη χρήση του ώστε να επιτυγχάνονται συνθήκες θερμικής και οπτικής άνεσης.

17. 1st Elementary School of Tavros



ΠΙΣΤΟΠΟΙΗΤΙΚΟ ΕΝΕΡΓΕΙΑΚΗΣ ΑΠΟΔΟΣΗΣ (ΠΕΑ)
ΣΜΥΡΝΗΣ & ΝΑΖΛΗ 17778 , ΤΑΥΡΟΣ ΑΤΤΙΚΗΣ

Αρ. Πρωτοκόλλου:	8691/2018	Αρ. Ασφαλείας:	N8RBM-KQ46Q-L88FU-6
Ημερομηνία Έκδοσης:	08/04/2019	Ημερομηνία Ισχύος:	08/04/2029

• Ελέγξτε την εγκυρότητα του ΠΕΑ: https://www.buildingcert.gr/checkCert.view

Τίτλος Κτηριακής Μονάδας: "1ο ΔΗΜΟΤΙΚΟ ΣΧΟΛΕΙΟ ΤΑΥΡΟΥ"	
Χρήση:	Πρωτοβάθμιας εκπαίδευσης
Κλιματική Ζώνη:	Β
Συνολική Επιφάνεια:	1745.06
Ωφέλιμη Επιφάνεια:	1745.06

Ενεργειακή κατηγορία:		Υφιστάμενη	Δυνητική
Μηδενικής Ενεργειακής Κατανάλωσης:			
$EP \leq 0,33 R_R$	A+		
$0,33 R_R < EP \leq 0,50 R_R$	A		
$0,50 R_R < EP \leq 0,75 R_R$	B+		
$0,75 R_R < EP \leq 1,00 R_R$	B		B
$1,00 R_R < EP \leq 1,41 R_R$	Γ		
$1,41 R_R < EP \leq 1,82 R_R$	Δ	Δ	
$1,82 R_R < EP \leq 2,27 R_R$	E		
$2,27 R_R < EP \leq 2,73 R_R$	Z		
$2,73 R_R < EP$	H		

• Μετά την εφαρμογή των παρεμβάσεων ενεργειακής αναβάθμισης σύμφωνα με τη βέλτιστη (1η) σύσταση

Υπολογιζόμενη ετήσια κατανάλωση πρωτογενούς ενέργειας*	
Κτηρίου αναφοράς [kWh/m²]:	77.5
Επιθεωρούμενου κτηρίου [kWh/m²]:	122.2

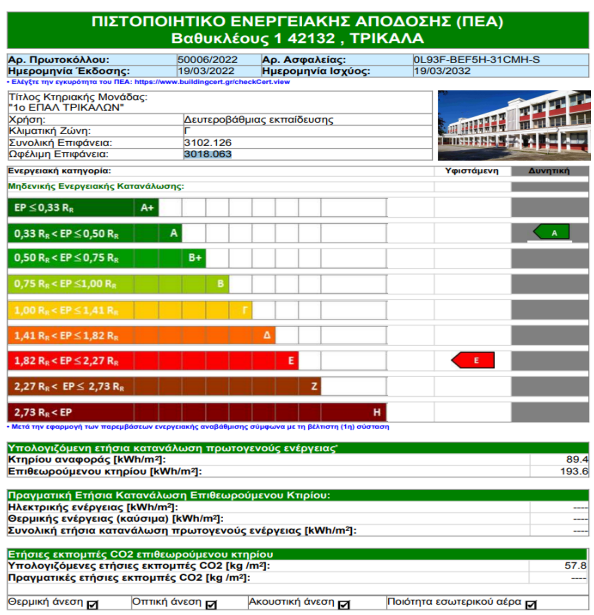
Πραγματική Ετήσια Κατανάλωση Επιθεωρούμενου Κτιρίου:	
Ηλεκτρικής ενέργειας [kWh/m²]:	0.0
Θερμικής ενέργειας (καύσιμα) [kWh/m²]:	59600.0
Συνολική ετήσια κατανάλωση πρωτογενούς ενέργειας [kWh/m²]:	5500.0

Ετήσιες εκπομπές CO2 επιθεωρούμενου κτηρίου	
Υπολογιζόμενες ετήσιες εκπομπές CO2 [kg /m²]:	38.2
Πραγματικές ετήσιες εκπομπές CO2 [kg /m²]:	1320.0

Θερμική άνεση ☐ Οπτική άνεση ☑ Ακουστική άνεση ☐ Ποιότητα εσωτερικού αέρα ☑

• Η ενεργειακή απόδοση ενός κτηρίου προσδιορίζεται βάσει της υπολογιζόμενης ετήσιας κατανάλωσης ενέργειας για την κάλυψη των αναγκών που συνδέονται με τη χρήση του ώστε να επιτυγχάνονται συνθήκες θερμικής και οπτικής άνεσης.

18. 1o Technical High School of Trikala



ΠΙΣΤΟΠΟΙΗΤΙΚΟ ΕΝΕΡΓΕΙΑΚΗΣ ΑΠΟΔΟΣΗΣ (ΠΕΑ)
Βαθυκλέους 1 42132 , ΤΡΙΚΑΛΑ

Αρ. Πρωτοκόλλου:	50006/2022	Αρ. Ασφαλείας:	0L93F-BEF5H-31CMH-S
Ημερομηνία Έκδοσης:	19/03/2022	Ημερομηνία Ισχύος:	19/03/2032

• Ελέγξτε την εγκυρότητα του ΠΕΑ: https://www.buildingcert.gr/checkCert.view

Τίτλος Κτηριακής Μονάδας: "1ο ΕΠΑΛ ΤΡΙΚΑΛΩΝ"	
Χρήση:	Δευτεροβάθμιας εκπαίδευσης
Κλιματική Ζώνη:	Γ
Συνολική Επιφάνεια:	3102.126
Ωφέλιμη Επιφάνεια:	3018.063

Ενεργειακή κατηγορία:		Υφιστάμενη	Δυνητική
Μηδενικής Ενεργειακής Κατανάλωσης:			
$EP \leq 0,33 R_R$	A+		
$0,33 R_R < EP \leq 0,50 R_R$	A		A
$0,50 R_R < EP \leq 0,75 R_R$	B+		
$0,75 R_R < EP \leq 1,00 R_R$	B		
$1,00 R_R < EP \leq 1,41 R_R$	Γ		
$1,41 R_R < EP \leq 1,82 R_R$	Δ		
$1,82 R_R < EP \leq 2,27 R_R$	E	E	
$2,27 R_R < EP \leq 2,73 R_R$	Z		
$2,73 R_R < EP$	H		

• Μετά την εφαρμογή των παρεμβάσεων ενεργειακής αναβάθμισης σύμφωνα με τη βέλτιστη (1η) σύσταση

Υπολογιζόμενη ετήσια κατανάλωση πρωτογενούς ενέργειας*	
Κτηρίου αναφοράς [kWh/m²]:	89.4
Επιθεωρούμενου κτηρίου [kWh/m²]:	193.6

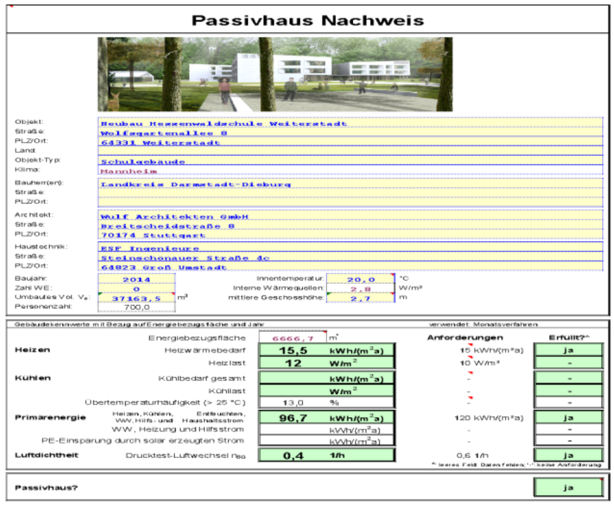
Πραγματική Ετήσια Κατανάλωση Επιθεωρούμενου Κτιρίου:	
Ηλεκτρικής ενέργειας [kWh/m²]:	----
Θερμικής ενέργειας (καύσιμα) [kWh/m²]:	----
Συνολική ετήσια κατανάλωση πρωτογενούς ενέργειας [kWh/m²]:	----

Ετήσιες εκπομπές CO2 επιθεωρούμενου κτηρίου	
Υπολογιζόμενες ετήσιες εκπομπές CO2 [kg /m²]:	57.8
Πραγματικές ετήσιες εκπομπές CO2 [kg /m²]:	----

Θερμική άνεση ☑ Οπτική άνεση ☑ Ακουστική άνεση ☑ Ποιότητα εσωτερικού αέρα ☑

EPCs from Germany

19. Hessenwald School, Weiterstadt



Passivhaus Nachweis

Objekt:	Neubau Hessenwaldschule Weiterstadt
Straße:	Wolfsgartenallee 8
PLZ/Ort:	64331 Weiterstadt
Land:	
Objekt-Typ:	Schulgebäude
Klima:	Mannheim
Bauherr(en):	Landkreis Darmstadt-Dieburg
Straße:	
PLZ/Ort:	
Architekt:	Wulf Architekten GmbH
Straße:	Breitscheidstraße 8
PLZ/Ort:	70174 Stuttgart
Haustechnik:	ESF Ingenieure
Straße:	Steinschönauer Straße 4c
PLZ/Ort:	64823 Groß Umstadt

Baujahr:	2014	Innentemperatur:	20,0	°C
Zahl WE:	0	Interne Wärmequellen:	2,8	W/m²
Umbautes Vol. V_e:	37163,5 m³	mittlere Geschosshöhe:	2,7	m
Personenzahl:	700,0			

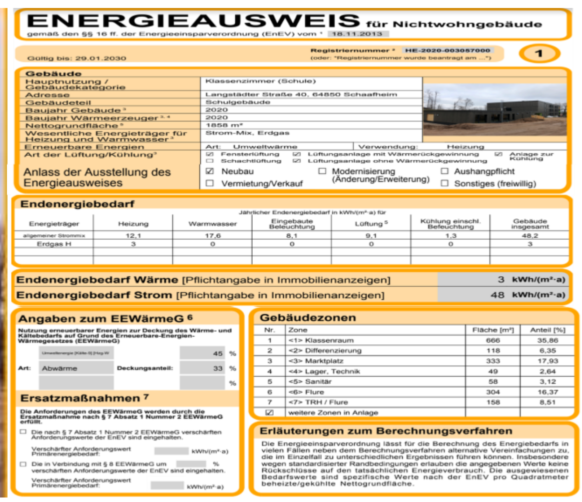
Gebäudekennwerte mit Bezug auf Energiebezugsfläche und Jahr — verwendet: Monatsverfahren

				Anforderungen	Erfüllt?^
	Energiebezugsfläche	6666,7	m²		
Heizen	Heizwärmebedarf	15,5	kWh/(m²a)	15 kWh/(m²a)	ja
	Heizlast	12	W/m²	10 W/m²	-
Kühlen	Kühlbedarf gesamt		kWh/(m²a)	-	-
	Kühllast		W/m²	-	-
	Übertemperaturhäufigkeit (> 25 °C)	13,0	%	-	-
Primärenergie	Heizen, Kühlen, Entfeuchten, WW, Hilfs- und Haushaltsstrom	96,7	kWh/(m²a)	120 kWh/(m²a)	ja
	WW, Heizung und Hilfsstrom		kWh/(m²a)	-	-
	PE-Einsparung durch solar erzeugten Strom		kWh/(m²a)	-	-
Luftdichtheit	Drucktest-Luftwechsel n_{50}	0,4	1/h	0,6 1/h	ja

^ leeres Feld: Daten fehlen; '-': keine Anforderung

Passivhaus? ja

20. Eichwaldschule Class room building



ENERGIEAUSWEIS für Nichtwohngebäude
gemäß den §§ 16 ff. der Energieeinsparverordnung (EnEV) vom ¹ 18.11.2013

Gültig bis: 29.01.2030 — Registriernummer ² HE-2020-003057000 (oder: "Registriernummer wurde beantragt am ...") — 1

Gebäude

Hauptnutzung / Gebäudekategorie	Klassenzimmer (Schule)
Adresse	Langstädter Straße 40, 64850 Schaafheim
Gebäudeteil	Schulgebäude
Baujahr Gebäude ³	2020
Baujahr Wärmeerzeuger ³ ⁴	2020
Nettogrundfläche ³	1858 m²
Wesentliche Energieträger für Heizung und Warmwasser ³	Strom-Mix, Erdgas
Erneuerbare Energien	Art: Umweltwärme — Verwendung: Heizung
Art der Lüftung/Kühlung ³	☑ Fensterlüftung ☑ Lüftungsanlage mit Wärmerückgewinnung ☑ Anlage zur Kühlung ☐ Schachtlüftung ☑ Lüftungsanlage ohne Wärmerückgewinnung
Anlass der Ausstellung des Energieausweises	☑ Neubau ☐ Modernisierung (Änderung/Erweiterung) ☐ Aushangpflicht ☐ Vermietung/Verkauf ☐ Sonstiges (freiwillig)

Endenergiebedarf

Jährlicher Endenergiebedarf in kWh/(m²·a) für

Energieträger	Heizung	Warmwasser	Eingebaute Beleuchtung	Lüftung ⁵	Kühlung einschl. Befeuchtung	Gebäude insgesamt
allgemeiner Strommix	12,1	17,6	8,1	9,1	1,3	48,2
Erdgas H	3	0	0	0	0	3

Endenergiebedarf Wärme [Pflichtangabe in Immobilienanzeigen]	3 kWh/(m²·a)
Endenergiebedarf Strom [Pflichtangabe in Immobilienanzeigen]	48 kWh/(m²·a)

Angaben zum EEWärmeG ⁶

Nutzung erneuerbarer Energien zur Deckung des Wärme- und Kältebedarfs auf Grund des Erneuerbare-Energien-Wärmegesetzes (EEWärmeG)

Art:		Deckungsanteil:	
	Umweltenergie (Kälte-0) (Hzg-W)		45 %
	Abwärme		33 %
			%

Ersatzmaßnahmen ⁷

Die Anforderungen des EEWärmeG werden durch die Ersatzmaßnahme nach § 7 Absatz 1 Nummer 2 EEWärmeG erfüllt.

☐ Die nach § 7 Absatz 1 Nummer 2 EEWärmeG verschärften Anforderungswerte der EnEV sind eingehalten.
Verschärfter Anforderungswert Primärenergiebedarf: kWh/(m²·a)

☐ Die in Verbindung mit § 8 EEWärmeG um % verschärften Anforderungswerte der EnEV sind eingehalten.
Verschärfter Anforderungswert Primärenergiebedarf: kWh/(m²·a)

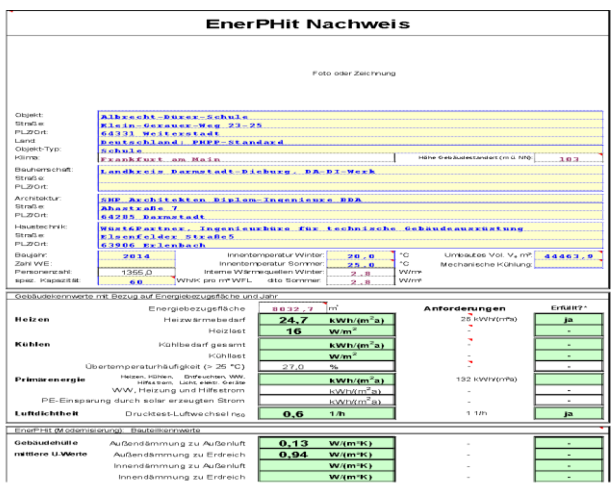
Gebäudezonen

Nr.	Zone	Fläche [m²]	Anteil [%]
1	<1> Klassenraum	666	35,86
2	<2> Differenzierung	118	6,35
3	<3> Marktplatz	333	17,93
4	<4> Lager, Technik	49	2,64
5	<5> Sanitär	58	3,12
6	<6> Flure	304	16,37
7	<7> TRH / Flure	158	8,51
☑	weitere Zonen in Anlage		

Erläuterungen zum Berechnungsverfahren

Die Energieeinsparverordnung lässt für die Berechnung des Energiebedarfs in vielen Fällen neben dem Berechnungsverfahren alternative Vereinfachungen zu, die im Einzelfall zu unterschiedlichen Ergebnissen führen können. Insbesondere wegen standardisierter Randbedingungen erlauben die angegebenen Werte keine Rückschlüsse auf den tatsächlichen Energieverbrauch. Die ausgewiesenen Bedarfswerte sind spezifische Werte nach der EnEV pro Quadratmeter beheizte/gekühlte Nettogrundfläche.

21. Albrecht Dürer School, Weiterstadt



EnerPHit Nachweis

Foto oder Zeichnung

Objekt:	Albrecht-Dürer-Schule
Straße:	Klein-Gerauer-Weg 23-25
PLZ/Ort:	64331 Weiterstadt
Land:	Deutschland; PHPP-Standard
Objekt-Typ:	Schule
Klima:	Frankfurt am Main — Höhe Gebäudestandort (m ü. NN): 103
Bauherrschaft:	Landkreis Darmstadt-Dieburg, DA-DI-Werk
Straße:	
PLZ/Ort:	
Architektur:	SHP Architekten Diplom-Ingenieure BDA
Straße:	Ahastraße 7
PLZ/Ort:	64285 Darmstadt
Haustechnik:	Wüst&Partner, Ingenieurbüro für technische Gebäudeausrüstung
Straße:	Eisenfelder Straße5
PLZ/Ort:	63906 Erlenbach

Baujahr:	2014	Innentemperatur Winter:	20,0 °C	Umbautes Vol. V_e m³:	44463,9
Zahl WE:		Innentemperatur Sommer:	25,0 °C	Mechanische Kühlung:	
Personenzahl:	1355,0	Interne Wärmequellen Winter:	2,8 W/m²		
spez. Kapazität:	60 Wh/K pro m² WFL	dito Sommer:	2,8 W/m²		

Gebäudekennwerte mit Bezug auf Energiebezugsfläche und Jahr

				Anforderungen	Erfüllt?*
	Energiebezugsfläche	8032,7	m²		
Heizen	Heizwärmebedarf	24,7	kWh/(m²a)	25 kWh/(m²a)	ja
	Heizlast	16	W/m²	-	-
Kühlen	Kühlbedarf gesamt		kWh/(m²a)	-	-
	Kühllast		W/m²	-	-
	Übertemperaturhäufigkeit (> 25 °C)	27,0	%	-	-
Primärenergie	Heizen, Kühlen, Entfeuchten, WW, Hilfsstrom, Licht, elektr. Geräte		kWh/(m²a)	132 kWh/(m²a)	
	WW, Heizung und Hilfsstrom		kWh/(m²a)	-	-
	PE-Einsparung durch solar erzeugten Strom		kWh/(m²a)	-	-
Luftdichtheit	Drucktest-Luftwechsel n_{50}	0,6	1/h	1 1/h	ja

EnerPHit (Modernisierung): Bauteilkennwerte

Gebäudehülle mittlere U-Werte	Außendämmung zu Außenluft	0,13	W/(m²K)	-	-
	Außendämmung zu Erdreich	0,94	W/(m²K)	-	-
	Innendämmung zu Außenluft		W/(m²K)	-	-
	Innendämmung zu Erdreich		W/(m²K)	-	-

Table of Figures

Tables

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National and Kapodistrian
University of Athens

HELLENIC
PASSIVE HOUSE
INSTITUTE

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Climate Initiative
EUKI

on the basis of a decision
by the German Bundestag

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