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| Technology<br>Transmission Characteristics | Aspect<br>Status on the ground | Country<br>Cyprus |
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## QUALICHECK STUDY CYPRUS - COMPLIANCE OF ENERGY PERFORMANCE CERTIFICATES: DIFFERENCES BETWEEN CALCULATED U-VALUES IN EPCS VERSUS ACTUAL U-VALUES

*Energy Performance Certificates (EPCs) in Cyprus are based on the calculated energy performance. The stated U-values in the EPCs, which are calculated before construction of a building, should be corrected after construction. There is no requirement to resubmit the EPC of a building and correct the U-values already stated in its EPC, after the building has been constructed.*

|   |   |                           |
|---|---|---------------------------|
| ✓ Residential buildings <input checked="" type="checkbox"/> | Non-residential buildings <input checked="" type="checkbox"/> | Specific buildings: ..... |
| ✓ New buildings <input checked="" type="checkbox"/>         | Existing buildings <input checked="" type="checkbox"/>        |                           |

### Context

The EU has issued specific directives to member states related to the Energy Performance of Buildings and the use of renewable energy in buildings. Cyprus has embedded into national law the aforementioned directives, by taking various measures, such as issuing relevant decrees. The latest decrees by the Cypriot Ministry of Energy, Commerce, Industry and Tourism (MCIT), came into effect on 11 December 2013 [1], according to which the new maximum specified heat transmission coefficients (U-values) for the external elements of the envelope of a building are as follows: external walls=0.72 W/m<sup>2</sup>K, external columns/ beams / shear walls= 0.72 W/m<sup>2</sup>K, external windows=3.23 W/m<sup>2</sup>K, external aluminium and wooden doors =3.23 W/m<sup>2</sup>K, external flat and inclined roofs=0.63 W/m<sup>2</sup>K, exposed slabs=0.63 W/m<sup>2</sup>K, and U<sub>m</sub> (U<sub>average</sub>) of a building=1.30 W/m<sup>2</sup>K.

In Cyprus, EPCs are issued only by qualified building energy assessors who are registered in a register which is kept by the Energy Service at the Ministry of Energy, Commerce, Industry and Tourism. Their qualifications and duties are defined in the relevant regulations. The “*Methodology for Calculating the Energy Efficiency of a Building*” and the “*Building Insulation Guide (2nd Edition)*” determine the method for calculating the energy performance of buildings, which must be followed by all the qualified building energy assessors. Also, the SBEMcy software program is used for calculating the energy performance of a building and issuing the EPC.

The EPC of a new building which undergoes major renovation must be submitted as part of its application for building permit and must be accompanied with recommendations for improving the energy efficiency of that building or building unit.

This means that in order to secure a building permit for a new building, you must have issued the Energy Performance Certificate (EPC). The EPC is one of the documents to be submitted to the Building Authorities together with the application for building permit.

However, the Cypriot EPCs are based on information given before the actual construction of a building, and there is no requirement to resubmit the EPC after construction and correct the U-values stated in the EPC after the building has been constructed.

### Objectives and problems addressed

Compliance with the decrees issued by MCIT is both essential and crucial. That is why the aim of this study is to examine whether the minimum requirements regarding the U-values of the new residential properties

in Cyprus are according to the decrees issued by the MCIT, both as they were declared in the buildings' EPCs, and as they were built on site, and to suggest improvements to the scheme.

The study focuses on the U-values of 27 new residential properties, located in the southern part of Cyprus (Figure 1). During the study, photographs of the examined buildings during construction phase and documents from suppliers regarding the U-values of specific elements were collected, site visits and inspections took place in order to gather information regarding their real construction, and communications with architects, constructors, and tenants, where possible, were conducted in order to verify the as-built situation of the examined construction elements that were declared in the EPCs. Moreover, a calculation of their U-values was conducted taking account of the as-built situation in order to check whether the buildings were built as designed, specified and declared regarding those specific elements.



Figure 1: Study conducted in the southern part of Cyprus.

In Cyprus, a building's U-values are declared at the submission of the building permit and are part of the process for obtaining building regulation approval. For this, calculations of the U-values for the external elements that comprise the envelope of a property, as well as its average U-value, are submitted to the responsible building authority. These calculations are based on the design drawings of the building permit. The calculated U-values are used in the SBEMcy software, for the issuance of its EPC. As part of this process, the build-up of all external construction elements must be specified and from this their U-value can be derived. The EPCs are issued only by qualified building energy assessors (QE) who are registered in a register which is kept by the Energy Service at the Ministry of Energy, Commerce, Industry and Tourism.

During the construction phase, responsible for monitoring the project is the supervising engineer engaged by the owner. The supervising engineer has a duty to verify that the building is built in accordance with the plans and specifications, and also has a duty to verify the good quality of the construction. On governmental view, there is a procedure to check whether the building is constructed in accordance with the approved plans for building permission, but there is no procedure to control energy performance issues related to the quality of the works. No Energy Audits take place during the construction phase regarding the EPC and the real construction of the building.

## Results of the study

For this study, 27 representative residential properties concerning the construction method of their elements were identified, and each building was extensively studied while information regarding the construction of their external elements was recorded.

### *Compliance of the U-values stated in the EPCs and the actual U-values*

The results regarding the elements examined in the 27 residential properties are as follows:

#### *External walls*

There are very small deviations between reported and actual U-values, which are due to a construction element like the coat cement being omitted. The study also showed that all of the examined new residential properties comply with the required U-value for the external walls.

#### *External columns/beams/shear walls*

There are deviations between reported and actual U-values, which most of the times are not so important, for example during calculation a construction element like the coat cement being omitted. However, sometimes the non-compliance is due to the use of less width of a material (e.g., extruded

polystyrene) than the width required. The study also showed that only 30% of the examined new residential properties do not comply but the deviations are in the range of 0.03-0.07 W/m<sup>2</sup>K regarding this specific characteristic. As for the pattern of causes for non-compliance, the study revealed that, in most cases, the causes are either lack of knowledge, which results in construction elements not to be taken into account, or not having the correct width.

#### *Windows*

There are not many deviations between reported and actual U-values for the windows, as they are limited to one or two windows in each of the properties that do not comply, which although calculated as double were actually single when those properties were built. However, this change is important as it affects the performance of the property. The study also showed that only in four of the properties, 14,82% of the examined new residential properties, the  $U_{max}$  degree requirement is not fulfilled for all windows. The deviations for those particular windows are in the range of 2.4 - 3 W/m<sup>2</sup>K. As for the pattern of causes for non-compliance, the study revealed that in most cases the causes are either the lack of knowledge which results in construction elements not being taken into account, or the need for simplification in the calculations of the EPC.

#### *Aluminium and wooden doors*

There are no deviations between reported and actual U-values for the aluminium and wooden doors. The study also showed that only 3.7% of the examined new residential properties do not comply with the requirement for the U-value of the wooden door with the deviations being only 0.017 W/m<sup>2</sup>K, and only 18.5% of the examined new residential properties do not comply with the requirement for the U-value of the aluminium door, with the deviations being in the range of 0.02-3.77 W/m<sup>2</sup>K. As for the pattern of causes for non-compliance, the study revealed that in most cases the causes are either the lack of knowledge which results in aluminium and wooden doors not being taken into account, or omission of insulation, especially in the aluminium doors.

#### *Flat and inclined roofs*

There are very small deviations between reported and actual U-values, which are due to a construction element like the coat cement being omitted. The study also showed that all of the examined new residential properties comply with the required U-value for the flat and inclined roofs.

#### *Exposed slabs*

There are deviations between reported and actual U-values for the exposed slabs, which in some instances are very important as they were not even taken into account by the QE. The study also showed that only 22% of the examined new residential properties do not comply but the deviations are in the range of 0.02-0.07 W/m<sup>2</sup>K regarding this specific characteristic. As for the pattern of causes for non-compliance, the study revealed that in most cases the causes are either the lack of knowledge which results in exposed slabs not being taken into account, or omission of construction elements like extruded polystyrene.

#### *Average U-value ( $U_m$ )*

There are deviations between reported and actual U-values, which are due to deviations between reported and actual U-values of elements of the external envelope of a building. The study also showed that all of the examined new residential properties comply with the required U-value for the  $U_m$ .

#### *Correction of EPC U-values and actual U-values for elements not complying*

A question that arises is what should be the method for correcting the EPC calculated U-values and actual U-values for the external elements of the envelope of a building that do not comply with the regulations. Although there is in Cyprus a control framework regarding the calculations in the EPCs in order to submit to authorities for building permit, there is no control framework on site, which means that there is no procedure to control energy performance issues related to the quality of the works. To improve the situation, a control system is necessary and should embrace the phases of building design, construction, and handing over of the building.

Success or failure will strongly depend on the societal support regarding the EPC, and on peoples' understanding of its importance and of the need for compliance with the decrees concerning the energy performance of a building.

Comparison of calculated and as built U-values

External walls

The difference between the in the EPC calculated and the actual U-values for the external walls is presented in Figure 2. It needs to be noted that the deviations are very small, in the range of 0.01 W/m<sup>2</sup>K, regarding this specific characteristic.

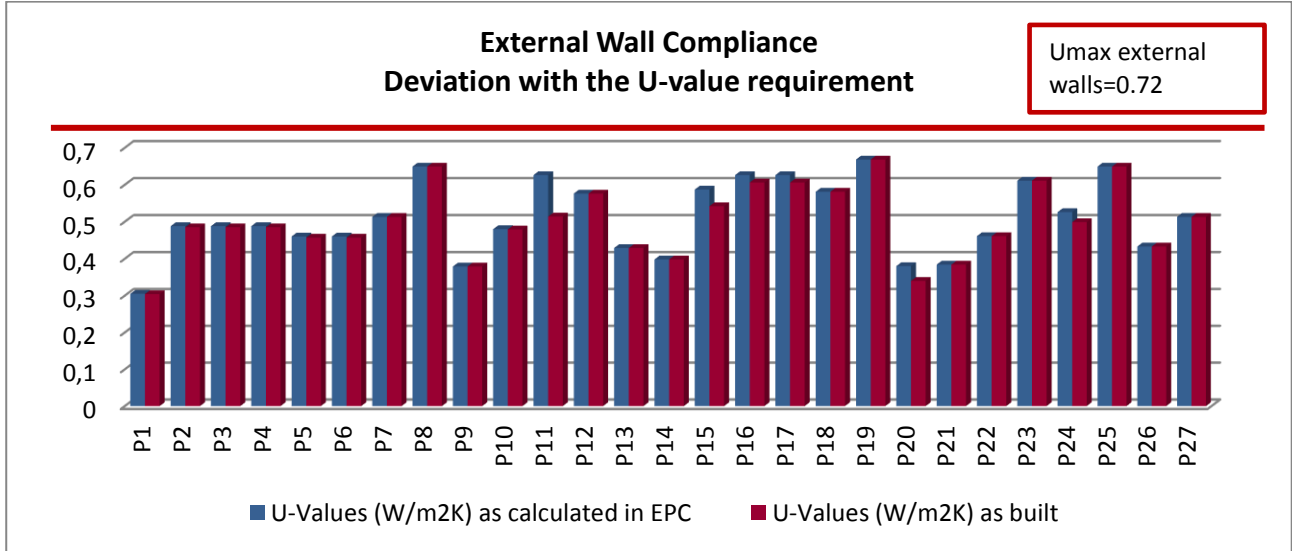


Figure 2: External Walls Compliance - Deviation with the U-value requirement.

External columns, beams and shear walls

The difference between the in the EPC calculated and the actual U-values for the external columns, beams and shear walls is presented in Figure 3. It needs to be noted that the deviations are very small, in the range of 0.03-0.07 W/m<sup>2</sup>K, regarding this specific characteristic.

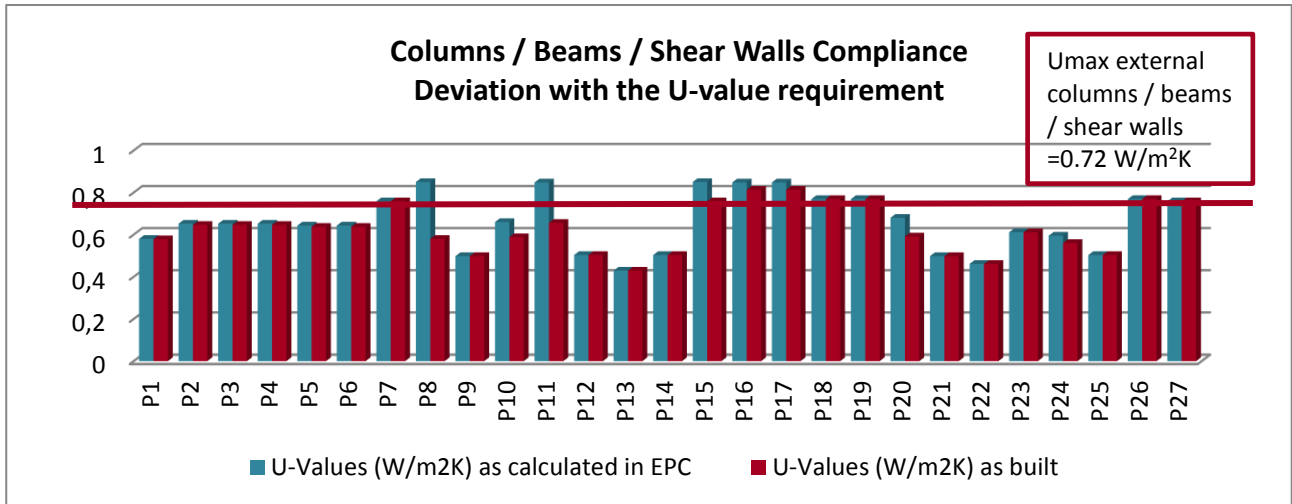


Figure 3: Columns / Beams / Shear Walls Compliance - Deviation with the U-value requirement.

Windows

The difference between the in the EPC calculated and the actual U-values for the windows is presented in Figure 4. It needs to be noted that the deviations for the windows that do not fulfil the requirement are in the range of 2.4 - 3 W/m<sup>2</sup>K.

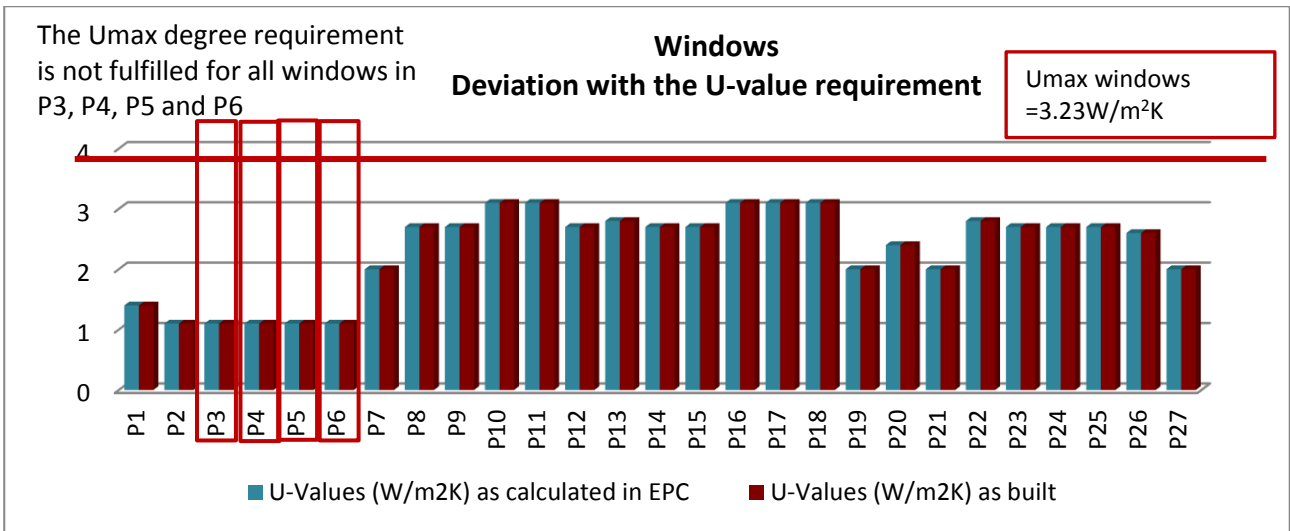


Figure 4: Windows Compliance - Deviation with the U-value requirement.

#### Wooden and aluminium doors

The difference between the in the EPC calculated and the actual U-values for the wooden doors is presented in Figure 5, where it seems that there are no deviations between these values. Moreover, only in one case the wooden doors were higher than the maximum U-value for the wooden doors, with a very slight deviation of 0.017 W/m<sup>2</sup>K.

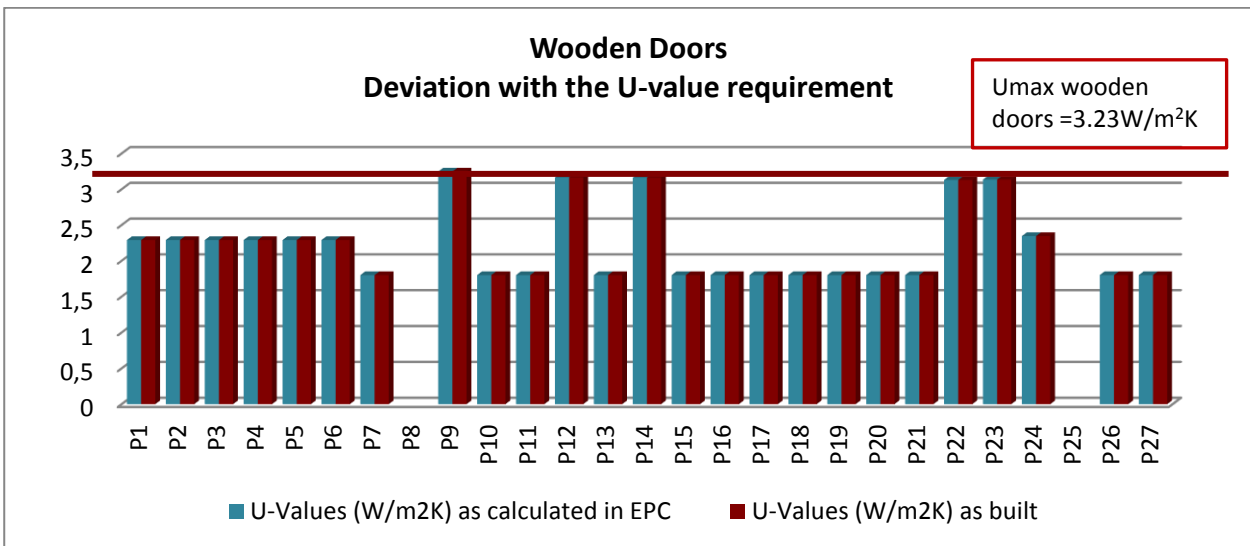


Figure 5: Wooden Doors Compliance - Deviation with the U-value requirement.

The difference between the in the EPC calculated and the actual U-values for the aluminium doors is presented in Figure 6, where it seems that there are no deviations between these values. Moreover, in four cases the aluminium doors were higher than the maximum Uvalue for the aluminium doors with a very slight deviation of 0.02 W/m<sup>2</sup>K. However, in one case they were much higher, as they presented a deviation of 3.77 W/m<sup>2</sup>K.

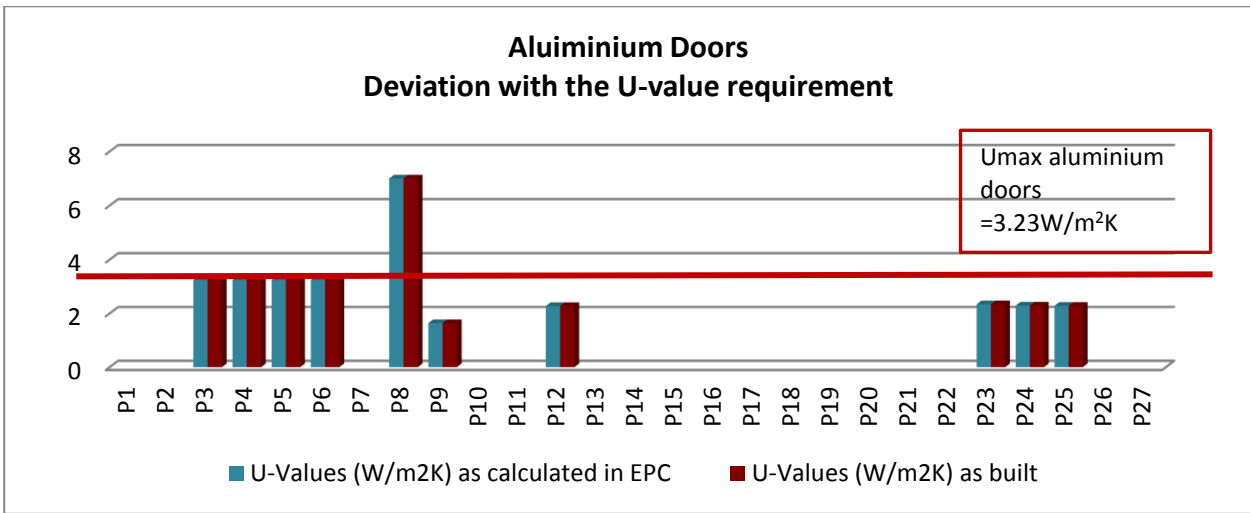


Figure 6: Aluminium Doors Compliance - Deviation with the U-value requirement.

#### Flat and inclined roofs

The difference between the in the EPC calculated and the actual U-values for the flat and inclined roofs is presented in Figures 7 and 8, respectively. It needs to be noted that the deviations are in the range of 0.2 W/m²K or less regarding this specific characteristic, but both calculated and actual values comply with the regulations.

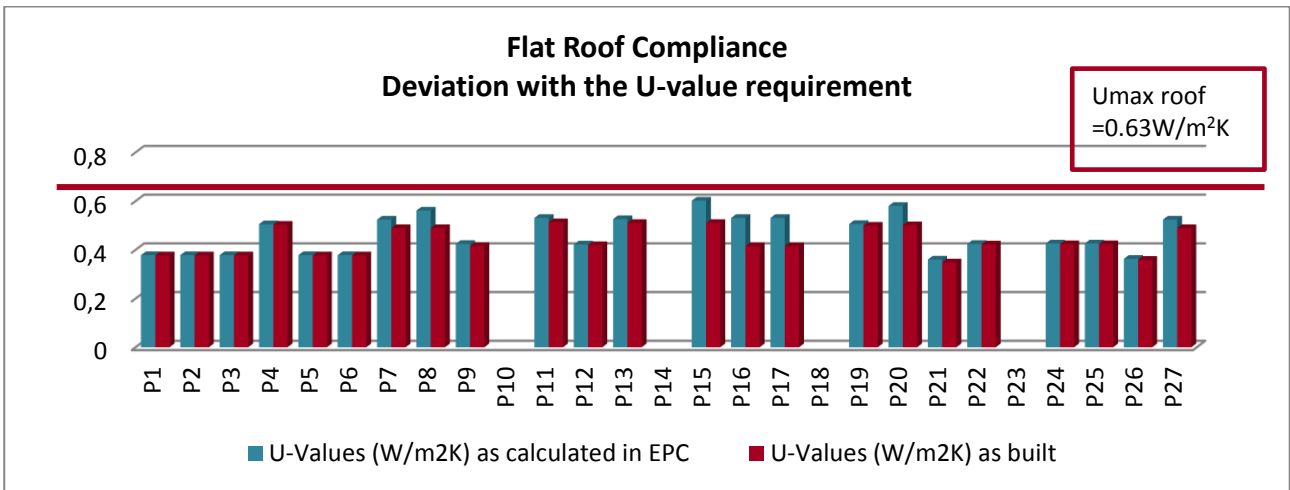


Figure 7: Flat roofs Compliance - Deviation with the U-value requirement.

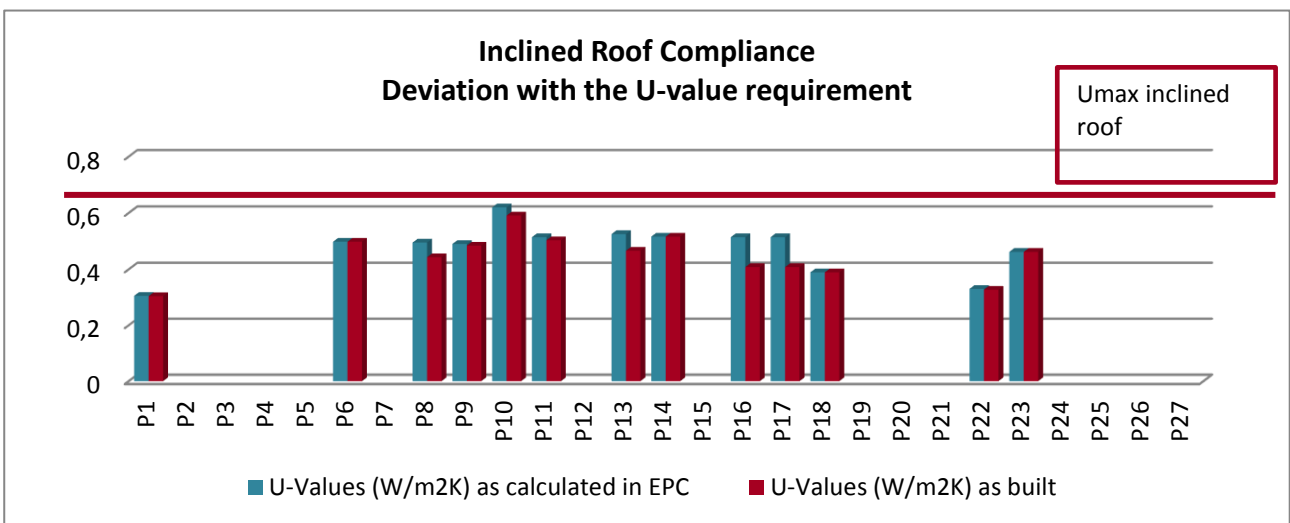


Figure 8: Inclined roofs Compliance - Deviation with the U-value requirement.

### Exposed slabs

The difference between the in the EPC calculated and the actual U-values for the exposed slabs is presented in Figure 9. It needs to be noted that the deviations are very small, in the range of 0.02-0.07 W/m<sup>2</sup>K, regarding this specific characteristic.

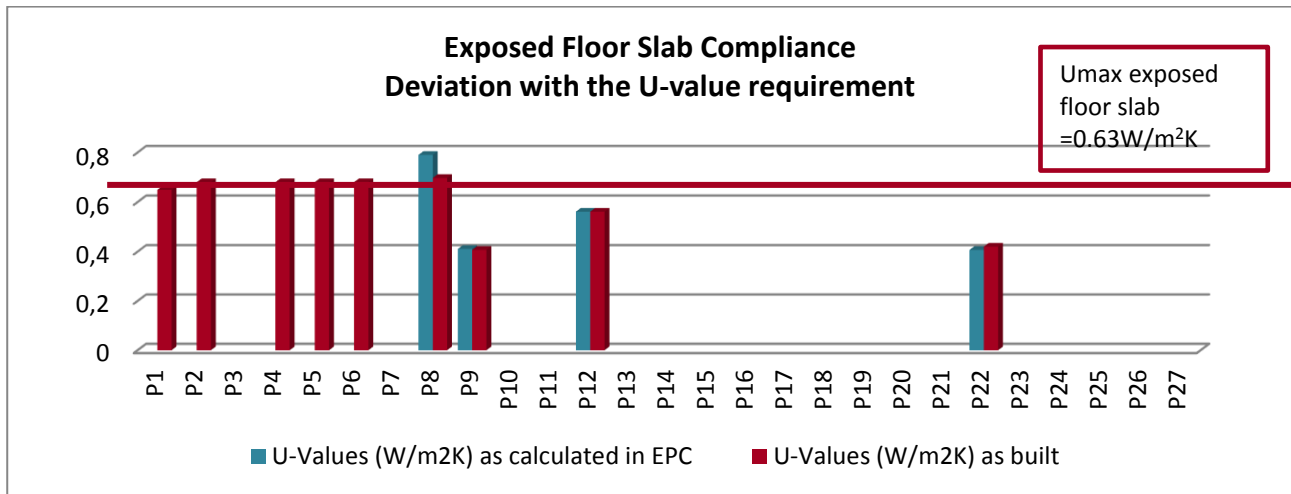


Figure 9: Exposed slabs Compliance - Deviation with the U-value requirement.

### Average U-value (U<sub>m</sub>)

The difference between the in the EPC calculated and the actual U-values for the U<sub>m</sub> is presented in Figure 10. It needs to be noted that the deviations are in the range of 0.02-0.50 W/m<sup>2</sup>K, regarding this specific characteristic.

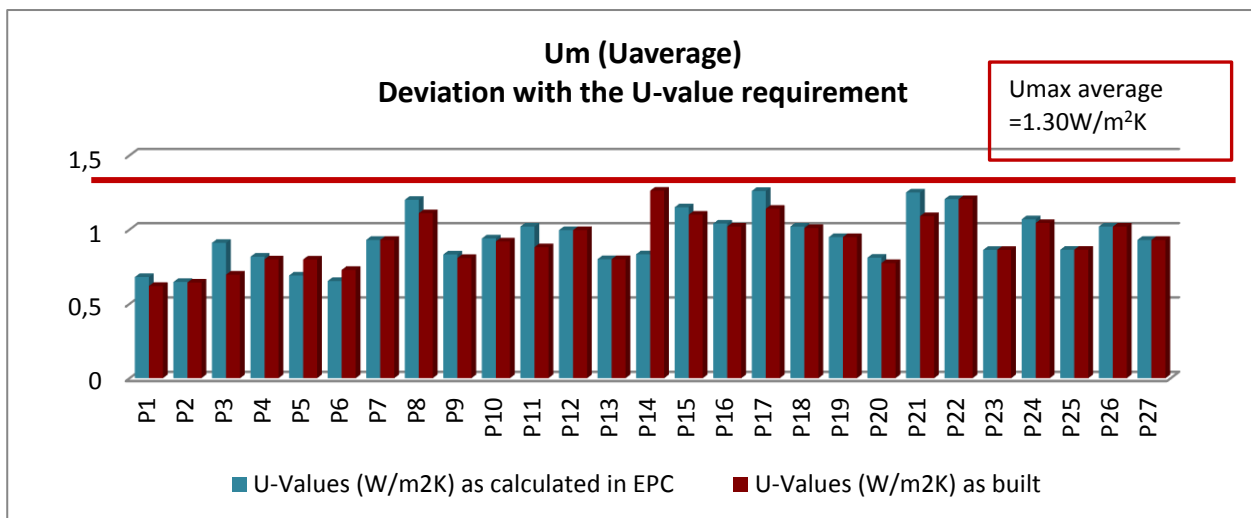


Figure 10: U<sub>m</sub> Compliance - Deviation with the U-value requirement.

### Conclusions and remarks

The objective of this study is to investigate the compliance of the U-values stated in the EPC and the as-built U-values regarding the external elements of the envelope of a building, in order to evaluate compliance with the EPC scheme. The study, which is based on calculations, EPCs (measurements) and interviews, examined and evaluated 27 residential properties.

The methodology for correcting the EPC calculated U-values and the actual U-values for the elements that do not comply, is to introduce a control system that should embrace the phases of building design, construction, and handing-over of the building.

Success or failure will strongly depend on the societal support regarding the EPC, and on peoples' understanding of its importance and of the need for compliance with the decrees concerning the energy performance of a building.

## References

- [1] Κ.Δ.Π.432 \_2013 - Energy Performance of Buildings Regulation (Minimum Energy Performance of Buildings Requirements) Decree 2013
- [2] Κ.Δ.Π.433 \_2013 - Energy Performance of Buildings Regulation (Recommendations for the improvement of the Energy Performance of Buildings and Energy Performance of Buildings Certificate) Decree 2013.

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