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Trends in building and ductwork airtightness in Greece

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1 Introduction on the building market in Greece

According to the Hellenic Statistical Authority (www.statistics.gr) from 2018 to 2020, the number of building permits increased from 15,342 to 18,928 (approximately 23.4%) while the new buildable areas for the same period increased from 3,532,675 m² to 4,129281 m² (approximately 17.9%).

At the same time there is a large building stock (4,105,637 buildings) last recorded in 2011 of which 2,990,324 are residential. The rest are public buildings (schools, hospitals), shops and business premises, hotels, churches, etc.

Of the above total number of buildings, only 19,968 are timber framed, 34,868 are made of metal, 723,249 are made of stone and 2,368,696 are made of concrete and bricks.

The average primary energy consumption in Greek residential buildings is 306.55 kWh/m², in temporary accommodation buildings (hotels) it is 451.06 kWh/m², while in public buildings it is 791.32 kWh/m².

New buildings under construction are required to issue an energy certificate but there is no prevention, specification or requirement to check the airtightness of the building envelope.

2 Building airtightness

2.1 *Introduction*

In Greece, airtightness is not taken into account and the official instructions consider it as a given number around the perimeter of the envelope. In addition, the Association of Certified Energy Inspectors of Greece, in its official proposal to the Ministry of Energy and Climate Crisis for the improvement of the legal framework regarding the energy behavior of buildings, talking about the airtightness control, states the following (press type PSYPENEP 19/3/2020) [1]: *"Proposals for the adoption of German standards (DIN 4108-7) non-European (EN) and measurements with specialized and expensive equipment (blower-door) do not offer additional value to the Greek energy legislation (KENAK) since the airtightness is already given by the certification of the frames. If we apply in Greece the standards for airtightness measurements, there will be a problem for the Greek energy inspectors since the equipment is very expensive to acquire, they will not know how to use it and nobody knows who will train them to do so."*

In other words, the Greek energy inspectors consider that the airtightness testing method is only a German model for the northern climates and is not necessary in Greece. They claim that the standard DIN 4108-7 is only a German

standard and not a European one, so it is not suitable for Greece. Obviously, they believe that the airtightness is only a matter of windows and door frames and they consider the envelope fully airtight. Unfortunately, the problem regarding the airtightness of buildings is due to misconceptions and not due to a lack of knowledge. This unfortunately reflects the average Greek perception of the word **airtightness** which expresses a negative, unhealthy and poor-quality environment.

Here is the description mentioned in the form of Energy Inspection of Buildings of the Ministry of Environment, paragraph: 2.4.1.6 [2]: *"The airtightness of a building depends on the type of frames (opening, sliding, sliding, recessed), the quality of the cracks in the openings (presence of chillers), the assembly of the frames with the masonry, the type of frame (metal, synthetic), the surface and orientation of the frames, as well as the vents (eg combustion chambers) that may be present in the building. The unintentional ventilation that results from the penetration of air in the above ways depends on many components and therefore cannot be easily estimated. In practice, various empirical parameterized relationships are used to calculate air penetration. Measuring the airtightness of the openings of a building during the energy inspection is not easily possible. However, even in the cases of windows certified for their airtightness, the air penetration cannot be determined, since it also depends on the final position of the frames in the building shell, the possibility of ventilation, etc. "*

In the official technical directive of the Technical Chamber of Greece paragraph 4.4.2 [3]: *"Ventilation due to airtightness (air penetration)"* airtightness is divided into three descriptive categories, low, medium or high airtightness and depends only on the certificates that accompany the frames. Specifically for the building shell it is stated: *"For the calculations of ventilation due to airtightness the air penetration through the structural transparent external surfaces of the building shell is considered negligible and is taken equal to zero".*

For the calculation of the general losses, Table 3.23 of the Regulation on the Energy Performance of Buildings (KENAK) is taken into account (see paragraph 2.3), where standard values for air penetration from a vent are given for the calculation of the energy efficiency of the building and the corresponding Table 3.24 for "Typical air penetration values due to cracks per unit area and kind of window". That is to say, a value is theoretically calculated depending on the surface of the window, no real airtightness control is taken into account and everything is calculated in a conventional way through the above-mentioned tables. The reference made to the main entrance doors is typical: *"... the air penetration from the doors with a gap <1cm at the bottom in contact with the outside environment is taken to be zero, if the gap is>1cm it is taken to be 10m³/h."*

2.2 Requirements and drivers

There is no regulation or national directive except for windows which were introduced in 2010, and not any incentives in Greece to promote a good building airtightness. There is no testing method accepted so the only justifications are the above tables, and also no sanctions regarding the airtightness.

2.3 Building airtightness in the energy performance calculation

The building airtightness is an input to the energy calculation, but the values are just theoretical.

The following tables (3.23 and 3.24) are taken from the Regulation on Energy Performance of Buildings document (KENAK) and show the default values used for airtightness calculations.

Table 3.23:

Type	Air penetration (m³/h)
Fireplace chimney, wood or oil heater chimney or other combustion stove	20
Ventilation boxes, e.g., for use with gas appliances	10
Doors with a margin at the bottom> 1.0 cm and in contact with the external environment	10

Πίνακας 3.24. *Τυπικές τιμές διείσδυσης αέρα λόγω ύπαρξης χαραμάδων ανά μονάδα επιφανείας και είδος κουφώματος.* Typical air penetration values due to the presence of cracks per surface unit and type of window.
Table 3.24

Type of opening (glazing, doors, etc.) Είδος ανοίγματος (υαλοστάσια, πόρτες κ.ά.)	Air penetration (m³/h) Διείσδυση του αέρα	
	Door Πόρτα	Window Παράθυρο
	[m³/h/m²]	[m³/h/m²]
Windows with wooden frame without certification Κουφώματα με ξύλινο πλαίσιο χωρίς πιστοποίηση		
Single glazed window, non-airtight, recessed, superimposed, opening. Κούφωμα με μονό υαλοπίνακα, μη αεροστεγές, χωνευτό, επάλληλο, ανοιγόμενο. Frame without glass (door) and without airtightness. Κούφωμα χωρίς υαλοπίνακα (πόρτα) και χωρίς αεροστεγανότητα.	11,8	15,1
Double glazed window, superimposed sliding, with brushes, recessed Κούφωμα με διπλό υαλοπίνακα, επάλληλα συρόμενο, με ψήκτρες, χωνευτό.	9,8	12,5
Opening window, with double glazing, without certification. Ανοιγόμενο κούφωμα, με διπλό υαλοπίνακα, χωρίς πιστοποίηση. Frame without glass (door), with airtightness not certified. Κούφωμα χωρίς υαλοπίνακα (πόρτα), με αεροστεγανότητα μη πιστοποιημένη.		
Frames with metal or PVC frame without certification Κουφώματα με μεταλλικό ή συνθετικό πλαίσιο χωρίς πιστοποίηση		
Single glazed window, non-airtight, recessed, superimposed, opening. Κούφωμα με μονό υαλοπίνακα, μη αεροστεγές, χωνευτό, επάλληλο, ανοιγόμενο. Frame without glass (door) and without airtightness. Κούφωμα χωρίς υαλοπίνακα (πόρτα) και χωρίς αεροστεγανότητα.	7,4	8,7
Double glazed window, superimposed sliding, with brushes, recessed. Κούφωμα με διπλό υαλοπίνακα, επάλληλα συρόμενο, με ψήκτρες, χωνευτό. Opening window, with double glazing, without certification. Ανοιγόμενο κούφωμα, με διπλό υαλοπίνακα, χωρίς πιστοποίηση. Frame without glass (door), with airtightness not certified. Κούφωμα χωρίς υαλοπίνακα (πόρτα), με αεροστεγανότητα μη πιστοποιημένη.	5,3	6,8
Frames with metal, PVC or wooden frame certified according to EN 12207 (*) Κουφώματα με μεταλλικό, συνθετικό ή ξύλινο πλαίσιο με πιστοποίηση κατά EN 12207(*)		

Air permeability class based on the total surface of the window: Κλάση αεροπερατότητας με βάση τη συνολική επιφάνεια του κουφώματος:		
	1	7,7
	2	4,1
	3	1,4
	4	0,5

2.4 *Building airtightness test protocol*

There is not any official qualification scheme for airtightness testers, only the seminars made by the company Aerosteganotita[1]. It is only for residential buildings and they teach engineers to perform recommended tests. Until now they have about 10 qualified testers. They are architects or engineers; they do not have the equipment therefore they have to rent it and airtightness measurement is not their main activity. Mostly they are getting the qualification just to increase their knowledge.

There are not any national guidelines to perform airtightness tests, and not any specifications regarding the equipment.

[1] www.aerosteganotita.gr

2.5 *Building airtightness tests performed*

2.5.1 Tested buildings

Newly constructed Lidl buildings are mainly inspected as required by their specifications. However, in many cases the testing procedures followed are difficult to be confirmed in buildings larger than 7,000 m³ since there is not any official guideline. This practice leads to incorrect results for the building's airtightness performance. New buildings and those that undergo a renovation are not usually inspected except in cases of failure where the owner will request the test to be conducted. In addition, mechanical ventilation is not widespread in Greek construction and is not required by the building regulations.

2.5.2 Database

The only available field database on building airtightness levels achieved is made by Aerosteganotita since 2011 and present the following results for the tests performed:

- on 52 existing buildings built between 1967 and 2015: ranging from n_{50}=3.8 to 14.58 ACH with an average of 6.49 ACH
- on 34 refurbished buildings built between 1960 and 2010: ranging from n_{50}=0.9 to 6.45 ACH with an average of 3.43 ACH
- on 14 new buildings built between 2017 and 2021 (mostly residential and some large-scale buildings as for the supermarket chain LIDL establishments): ranging from n_{50}=0.98 to 8.89 ACH with an average of 2.44 ACH.

The values represent the average quality of constructions in Greece where it is not required to follow any regulation and no airtightness test repetitions are made.

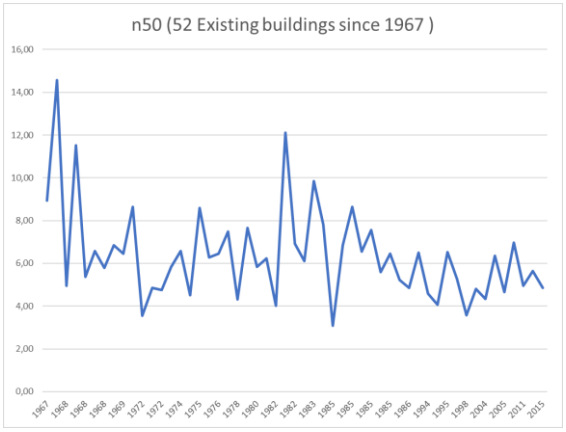

Figure 1: Results of the airtightness tests performed on 52 existing buildings built between 1967 and 2015

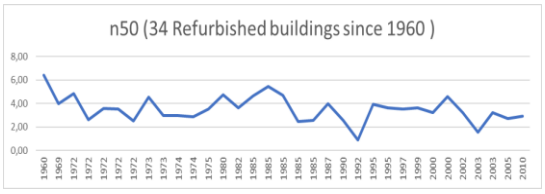

Figure 2: Results of the airtightness tests performed on 34 refurbished buildings built between 1960 and 2010

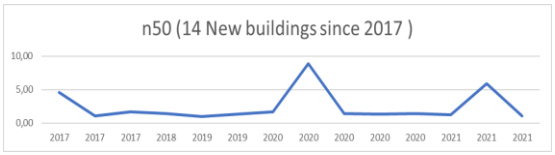

Figure 3: Results of the airtightness tests performed on 14 new buildings between 2017 and 2021

2.6 *Guidelines to build airtight*

At the time of this writing there are no plans to develop guideline/standards in Greece to introduce airtightness targets for the building industry.

2.7 *Conclusion*

Nothing has changed in the last years regarding airtightness in Greece, only negative reactions to this approach. We need to promote building airtightness in Greece and compare to other Mediterranean countries since it is believed that the airtightness is needed only to northern European countries. We need to explain the impact in terms of energy use, long-term performance, quantified impact in terms or indoor environmental quality, impact of interzonal infiltrations, impact on construction.

There is not any regulation foreseen on airtightness and in the following years it is expected to keep building bad quality buildings.

3 Ductwork airtightness

There are no specific test guidelines for ductwork airtightness. It is stated that the airtightness of the channels is required and their proper sealing is recommended in the technical specifications for the contractors.
The official Hellenic Technical Specification in effect since 2009 [4] provides the standards for airducts of metallic sheets in public projects. The document is based on several European ductwork standards (EN 12237, EN1505, EN 1506) and defines the manufacturing methods. Regarding the quality control requirements for receipt, it is stated that a visual inspection must be performed.
Regarding the tightness of the ducts, it is stated that a comparative measurement of the supplied amount of air must be made between vents and fans.
In 2022 a new draft is published [5] for the updated version of the 2009 Technical Specification. The document describes the manufacturing methods with more details, but still, there are not any specifications regarding the airtightness. The only difference from the previous version is that the PITOT method is described as a testing method to confirm the correct airflow.
However, the practice of checking the airtightness of the ducts is not widespread. Therefore, these measurements are not in demand, consequently there are not enough professionals to offer this technique.

4 Key documents

[1] “Proposals to improve the institutional framework related to the energy performance of buildings” press type PSYPENEP 19/3/2020, Panhellenic Association of Certified Energy Inspectors: http://psypenep.gr/προτάσεις-βελτίωσης-του-σχετικού-με-τ

[2] Energy Inspection of Buildings of the Ministry of Environment, paragraph: 2.4.1.6: https://www.buildingcert.gr/entypo.pdf

[3] Technical directive of the Technical Chamber of Greece paragraph 4.4.2: https://ypen.gov.gr/wp-content/uploads/2021/03/TOTEE-1.pdf

[4] 2009 Hellenic Technical Specification for airducts of metallic sheets: https://sate.gr/html/pdfDocuments/04-07-01-01.pdf

[5] 2022 Hellenic Technical Specification for airducts of metallic sheets – Draft: https://elot.gr/sites/default/files/migfiles/ETEP_04-07-01-01_DT1_STG4.pdf

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