Single Family House, Protochori, Kozani, Greece

Project Documentation
Έγγραφα έργου

1. Abstract / Περίληψη

Single family house in Protochori, Kozani, Greece

1.1 Data of building / Δεδομένα κτιρίου

Year of construction/ Έτος κατασκευής	2016	**Space heating / Θέρμανση χώρου**	**11,00 kWh/(m²a)**
U-value external wall/ Τιμή-U εξωτερικού τοίχου	0,132 W/(m²K)		
U-value floor slab/ Τιμή-U εδαφόπλακας	0,259 W/(m²K)	**Primary Energy Renewable (PER) / Πρωτογενής Ενέργεια από Ανανεώσιμες πηγές (ΠΕΑ)**	25 kWh/(m²a)
U-value roof/ Τιμή-U οροφής	0,087 W/(m²K)	**Generation of renewable energy / Παραγωγή ανανεώσιμης ενέργειας**	5 kWh/(m²a)
U-value window/ Τιμή-U κουφώματος	0,78 W/(m²K) including thermal bridges	**Non-renewable Primary Energy (PE) / Πρωτογενής ενέργεια από μη Ανανεώσιμες Πηγές (PE)**	41 kWh/(m²a)
Heat recovery/ Ανάκτηση θερμότητας	82,3%	Pressure test n_{50} / Τεστ πίεσης n_{50}	0,30 h^{-1}
Special features/ Ειδικά χαρακτηριστικά	Solar collectors for hot water generation, heat recovery taking advantage of geothermal energy		

1.2 Brief Project Description

Single Family House, Protochori, 50100, Kozani

The project concerns the construction of a detached house, with a TFA=163.40m2, which was designed to reduce the requirement for a conventional heating or air conditioning system. The property is located in Protochori village, in the Prefecture of Kozani at a distance of 9km from the city of Kozani. It consists of a ground floor and a basement accessible by internal stairs. The building is freely located within the plot, with main openings to the southeast and southwest. The main functions are developed in the ground floor area which includes living room, dining room, kitchen, two bathrooms and three bedrooms. In the basement there are two bedrooms and storage spaces.

1.2 Σύντομη περιγραφή του έργου

Ισόγεια κατοικία με υπόγειο και στέγη, στο Πρωτοχώρι, 50100, Κοζάνη

Το έργο αφορά την κατασκευή μιας μονοκατοικίας, επιφάνειας TFA 163,40m^2, η οποία σχεδιάστηκε με σκοπό να μειωθεί η απαίτηση συμβατικού συστήματος θέρμανσης ή κλιματισμού. Το ακίνητο βρίσκεται στην Τ.Κ. Πρωτοχωρίου, στον Νομό Κοζάνης σε απόσταση 9km από την πόλη της Κοζάνης. Αποτελείται από ισόγεια κατοικία και υπόγειο χώρο προσβάσιμο με εσωτερική σκάλα. Το κτίριο είναι ελεύθερα τοποθετημένο μέσα στο οικόπεδο, με κύρια ανοίγματα νοτιοανατολικά και νοτιοδυτικά. Οι κύριες λειτουργίες αναπτύσσονται στον χώρο του ισογείου που περιλαμβάνει σαλόνι, τραπεζαρία, κουζίνα, δύο μπάνια και τρία υπνοδωμάτια. Στο υπόγειο βρίσκονται 2 υπνοδωμάτια και αποθηκευτικοί χώροι.

1.3 Responsible project participants / Συμμετέχοντες υπεύθυνοι για το έργο

Architect/ Αρχιτέκτονας	George Liakos / Alexia Chalkia www.liakosmelkat.gr
Implementation planning/ Σχεδιασμός υλοποίησης	George Liakos www.liakosmelkat.gr
Building systems/ H/M	Kampourlidis Ilias
Structural engineering/ Στατική Μηχανική	George Liakos www.liakosmelkat.gr
Building physics/ Φυσικός Κτιρίου	George Liakos www.liakosmelkat.gr
Passive House project planning/ Ενεργειακός Σχεδιασμός Passive House	George Liakos / Alexia Chalkia www.liakosmelkat.gr
Construction management/ Διαχείριση Κατασκευής	George Liakos www.liakosmelkat.gr

Certifying body/ Φορέας Πιστοποίησης	Stefan Pallantzas, Hellenic Passive House Institute
Certification ID/ ID Πιστοποίησης	19219_HPHI_PH_20181101_SP
Project-ID (www.passivehouse-database.org) ID Έργου (www.passivehouse-database .org)	4643

Author of project documentation / Συντάκτης του παρόντος εγγράφου	George Liakos

Date, Signature/
Ημερομηνία, Υπογραφή

Kozani, 13/07/2021

ΛΙΑΚΟΣ Δ. ΓΕΩΡΓΙΟΣ
ΔΙΠΛ. ΠΟΛΙΤΙΚΟΣ ΜΗΧΑΝΙΚΟΣ Α.Π.Θ.
MSc ΑΝΤΙΣΕΙΣΜΙΚΟΣ ΣΧΕΔΙΑΣΜΟΣ
ΤΕΧΝΙΚΩΝ ΕΡΓΩΝ
ΜΕΛΟΣ Τ.Ε.Ε. ΑΡ. ΜΗΤΡΩΟΥ 114857
ΤΗΛ. 6973066892

2. Views of the Passive Single Family House in Protochori, Kozani

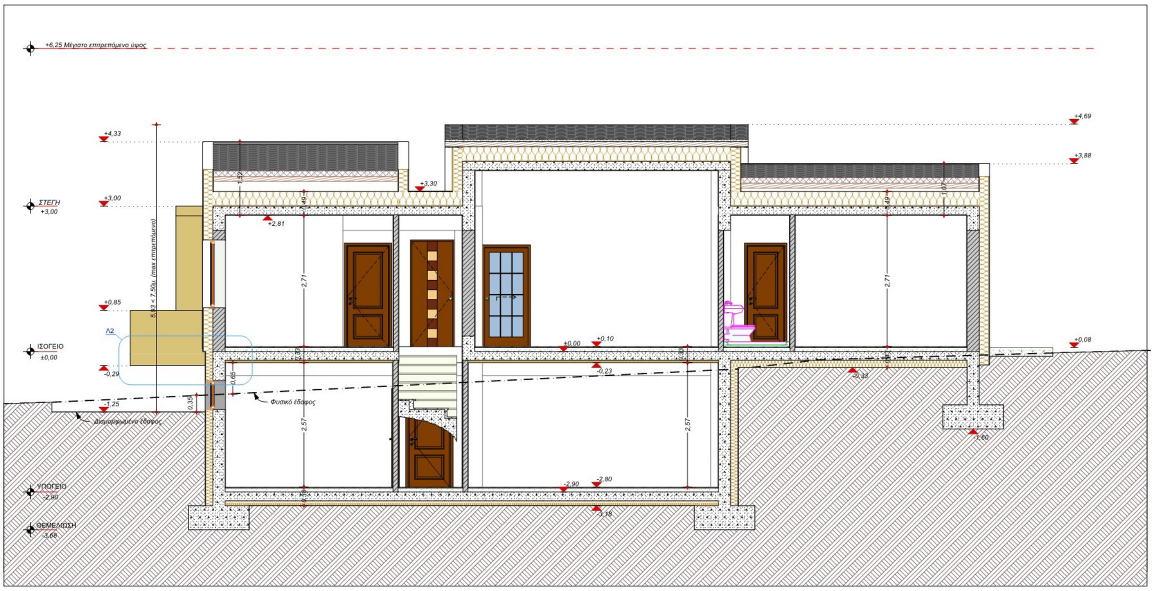
Picture 1. East view of the building

Picture 2. South view of the building

Picture 3. Southwest view of the building

Picture 4. Northwest view of the building

3. Sectional drawing of the Passive Single Family House in Protochori, Kozani

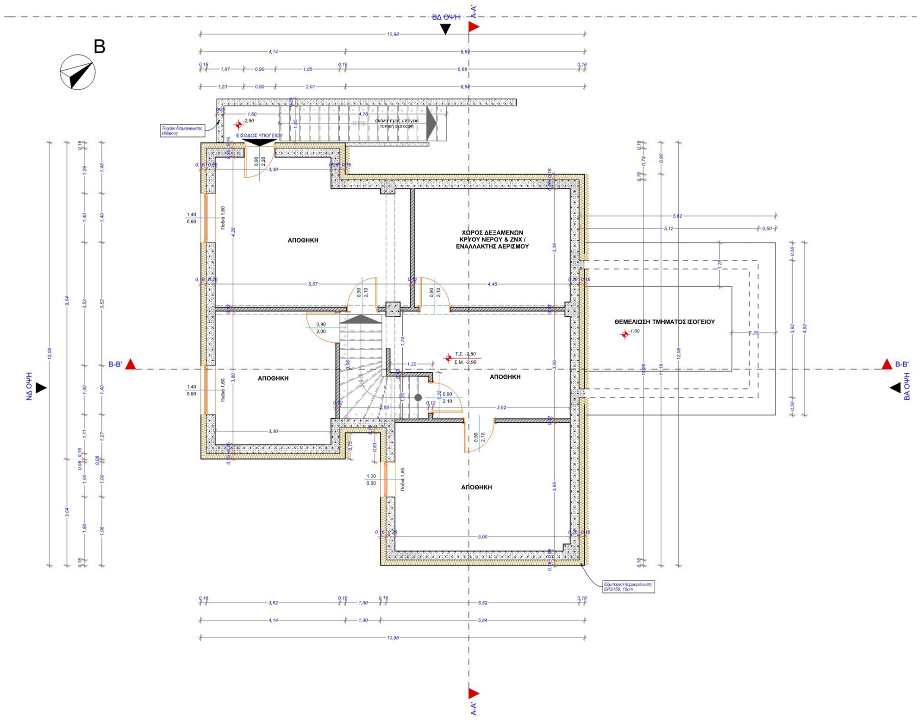


TOMH B-B'

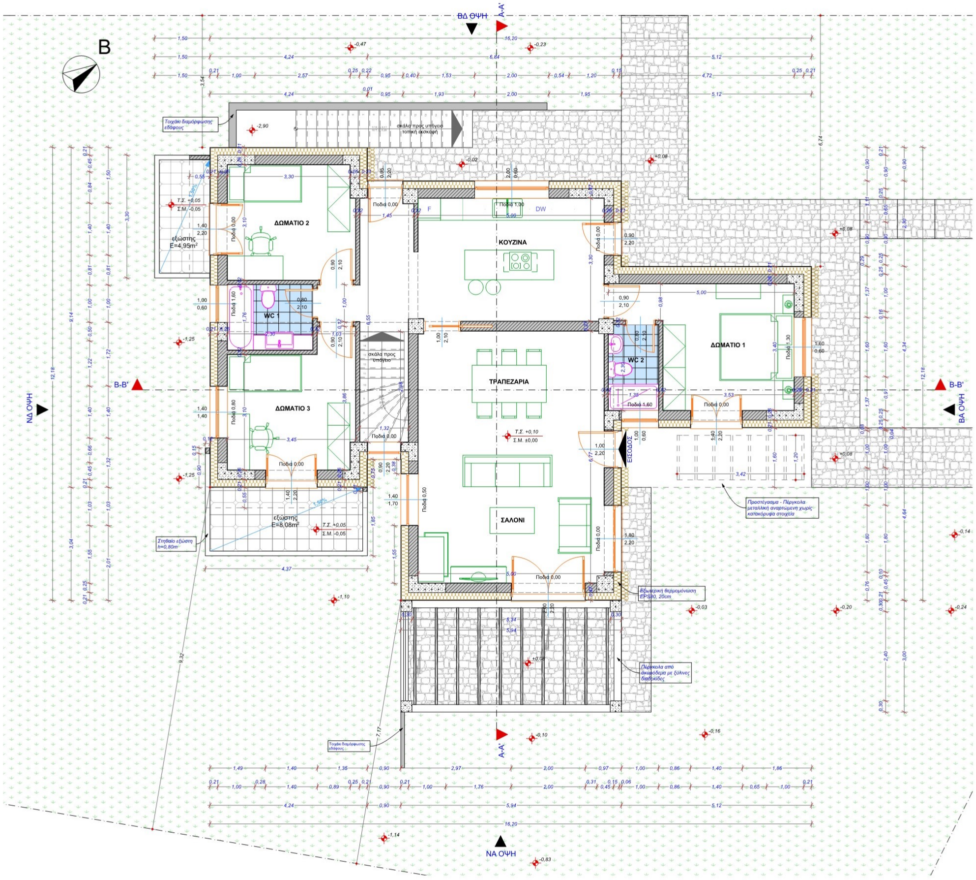
Picture 5. Cross section of the residence

The drawing shows a cross section of the single family house in Protochori. The insulation of the exterior walls, roof, floor and basement is uninterrupted. Most of the basement exterior walls are below ground level.

4. Floor plans of the Passive Single Family House in Protochori, Kozani



Picture 6. Basement Floor plan



Picture 7. Ground Floor plan

The detached house consists of two floors, the ground floor and the basement. The basement floor plan is shown on Picture 6 and it includes two bedrooms, the utility room and storage areas. The ground floor plan is shown on Picture 7 and consists of the living room, the dining room, the kitchen, two bathrooms and three bedrooms. The main entrance of the building is located on the northeast. The two floors are connecting with interior stair. The house has a complex outline, which implies an increased thermal envelope area and losses through the envelope, which had to be covered with a thicker insulation layer.

5. Construction details of the envelope

5.1 Exterior wall assembly

The building is constructed with reinforced concrete frames (slabs, columns and beams) and 25cm thick brick walls, lime plastered from the inside. The building is thermally insulated, with external insulation of 20cm thick EPS80 with λ=0,031W/mK, all around its perimeter. The exterior brick wall assembly has a U-value= 0,102 W/m2K and the concrete sections a U-value= 0,148 W/m2K.

Picture 8. Placement of the exterior insulation of the thermal envelope

5.2 Basement exterior wall and floor slab assembly

The insulation of the basement walls and the basement floor slab has been placed externally, with EPS200 that had a thickness of 14cm in the walls and 10cm below the slab. The interruption between floor and slab insulation has been taken into account as thermal bridge in PHPP. The U-value of the external concrete wall of the basement is 0,222 W/(m2K) and for the basement slab is 0,300 W/(m2K).

Picture 99. Basement wall insulation

Picture 10. Placement of insulation below the basement floor slab

5.3 Roof/ Ceiling

The roof consists of three independent parts. Each part consists of the concrete ceiling slab, the insulation layer and a wooden roof construction with concrete roof tiles. The insulation layer is EPS80 with λ=0,031W/mK and 35cm thickness and is uninterrupted with the external walls insulation, with thermal bridge free design. The roof assembly has a U-value = 0,087 W/(m2K).

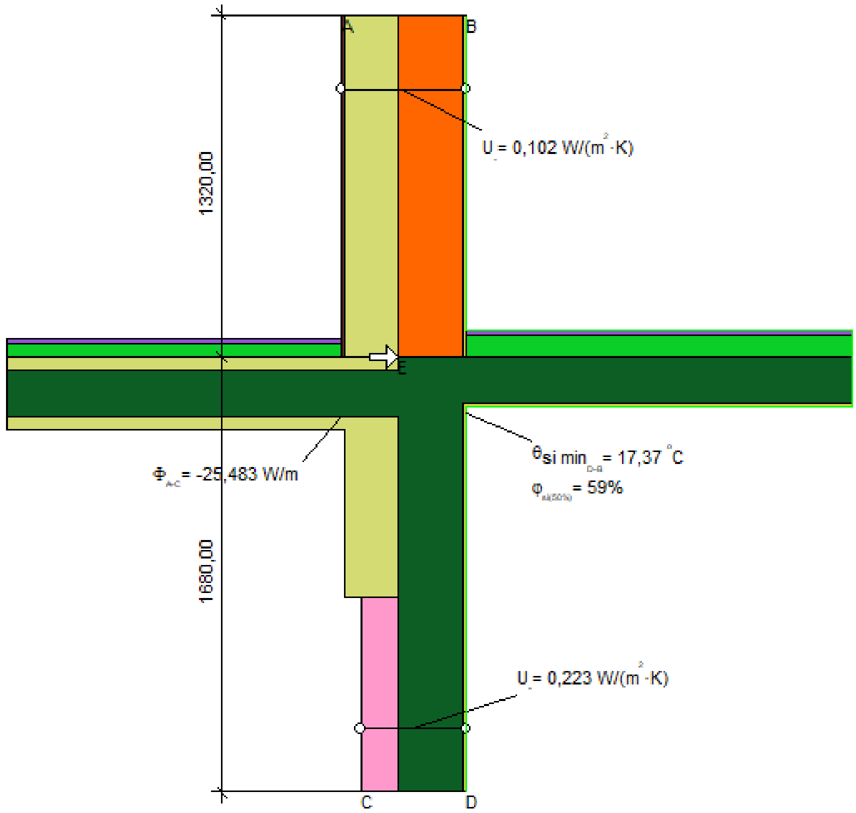
Picture 11. Ceiling roof detail

Picture 12. Roof construction

5.4 Thermal Bridges

All existing thermal bridges have been calculated and designed to have the least impact on heating or cooling demand of the building and the ψ -values are entered in PHPP.
For example, the up and down surfaces of the balconies were covered with EPS80 with 5cm thickness and the thermal bridge ψ-value is calculated 0,34W/mK. Additionally, the shading components were constructed with lightweight dry wall construction above the insulation.

Picture 13. Balcony insulation



$$\Psi_{A\text{-}E\text{-}C} = \frac{\Phi}{\Delta T} - U_1 \cdot b_1 - U_2 \cdot b_2 = \frac{25{,}483}{30{,}000} - 0{,}102 \cdot 1{,}320 - 0{,}223 \cdot 1{,}680 = 0{,}341 \text{ W/(m·K)}$$

Material	λ[W/(m·K)]
Concrete, reinforced (with 2% of steel)	2,500
Peripor	0,033
Plaster, cement, sand	1,000
Plaster, lime, sand	0,800
Sto-EPS Lambda White 031	0,031
Sto-Silco K	0,700
Tiles (other), ceramic/porcelain	1,300
KEBE K250	0,080

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]
Exterior, normal		-10,000	0,040
Interior, normal, horizontal		20,000	0,130
Soil		-10,000	0,001
Symmetry/Model section	0,000		

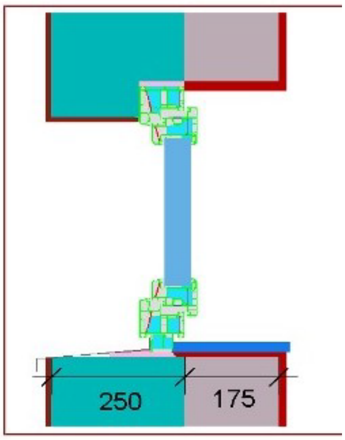
Picture 1410. Balcony thermal bridge

Picture 15. Shading construction

5.5 Windows installation details

The placement of the windows was designed to minimize thermal bridges to achieve the Passive House Standard. Windows were hung on the external side of the brick walls, inside the insulation layer. The frames are Aluplast energeto 8000 foam inside with Uf=0,79W/(m²K) and triple insulated glazing Planitherm XN 4:/18/4/18/:4 with Ug=0,50W/(m²K) and g-value=0,54 with Swisspacer ultimate glazing spacer.

Installation



Installation based thermal bridge $\Psi_{instal.}$ in Passive House suitable walls

Position		EIFS
Bottom	[W/(mK)]	0.027
Side/Top	[W/(mK)]	0.003
$U_{W,instal.}$	[W/(m²K)]	0.83

Picture 16. Details of the installation of the windows

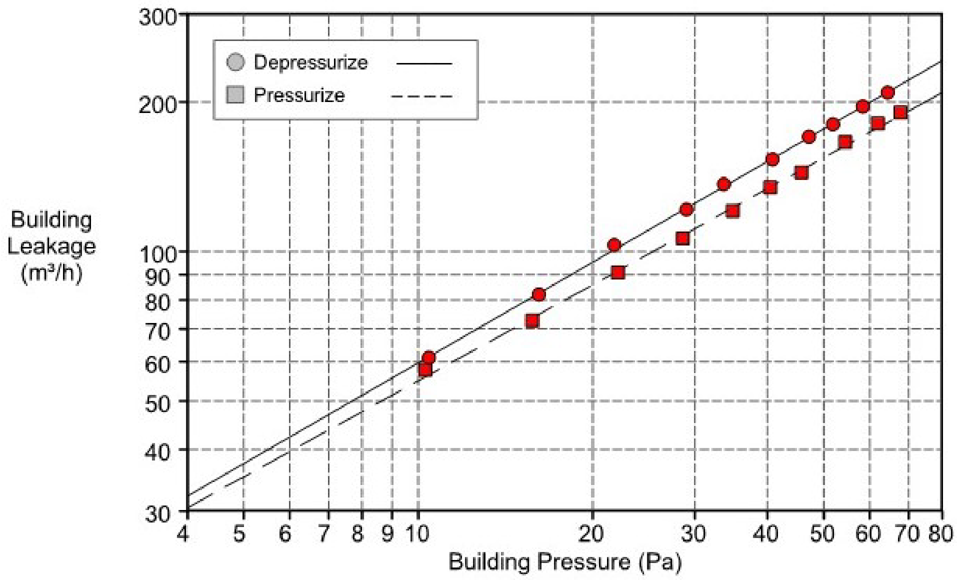
Picture 117. Window installation

6. Description of the airtight envelope; documentation of the pressure test result

The airtightness is essential in the construction of a passive house, so that the uncontrolled heat losses are minimized. The basic blower door test system includes three components: a calibrated fan, a door panel system, and a pressure measuring device. The blower door fan is used to blow air into or out of the building, creating either a positive or negative pressure differential between the inside and outside of the building. This pressure differential forces air through all holes and penetrations in the building enclosure. The tighter the building (e.g., fewer holes), the less air is needed from the blower door fan to create a change in building pressure. For a Passive House project, the goal is to achieve n_{50}= 0,60h^{-1} or lower at a pressure of 50 Pa.

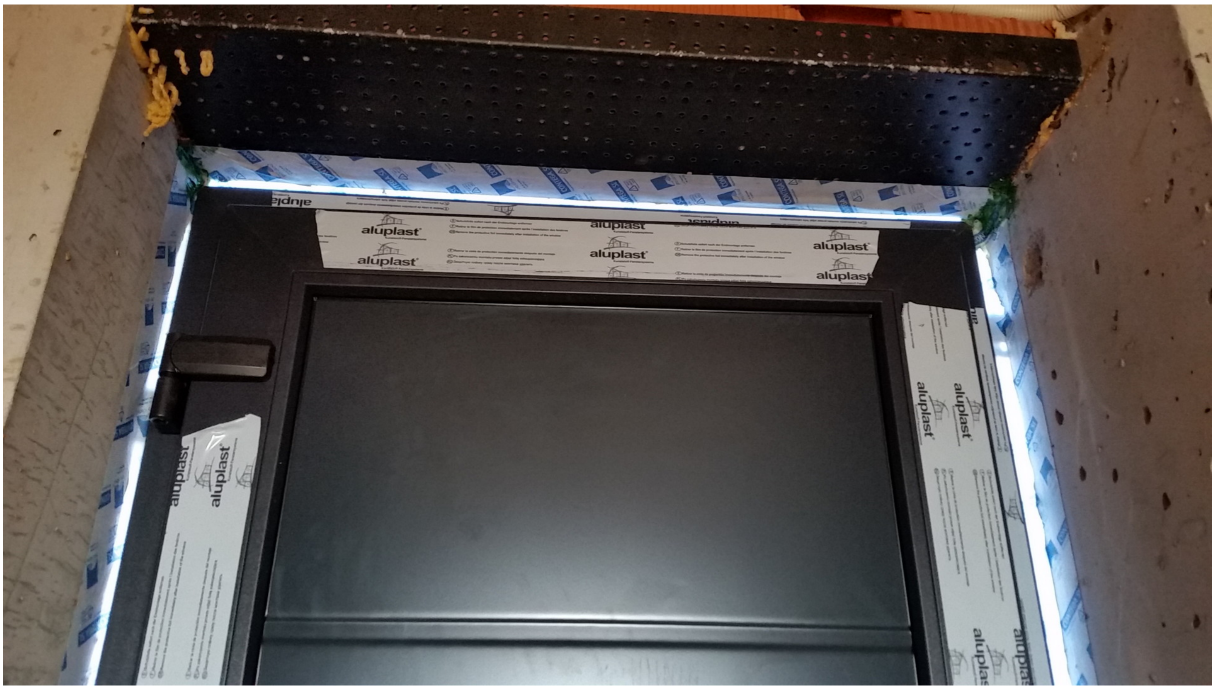
The blower door test was performed after finishing the internal airtightness layer (plastering) and it showed the excellent performance of n_{50}=0,31 1/h.

	Depressurization	Pressurization	Average
Test Results at 50 Pascals:			
V50: m³/h Airflow	177 (+/- 0.9 %)	155 (+/- 1.6 %)	166
n50: 1/h (Air Change Rate)	0.33	0.29	0.31
w50: m³/(h*m² Floor Area)	0.95	0.83	0.89
q50: m³/(h*m² Envelope Area)	0.30	0.26	0.28
Leakage Areas:			
Canadian EqLA @ 10 Pa (cm²)	66.7 (+/- 1.6 %)	61.4 (+/- 3.0 %)	64.1
cm²/m² Surface Area	0.11	0.10	0.11
LBL ELA @ 4 Pa (cm²)	34.8 (+/- 2.6 %)	32.9 (+/- 5.0 %)	33.9
cm²/m² Surface Area	0.06	0.05	0.06
Building Leakage Curve:			
Air Flow Coefficient (Cenv) (m³/h/Paⁿ)	12.6 (+/- 4.3 %)	12.5 (+/- 8.1 %)	
Air Leakage Coefficient (CL) (m³/h/Paⁿ)	12.7 (+/- 4.3 %)	12.5 (+/- 8.1 %)	
Exponent (n)	0.673 (+/- 0.012)	0.642 (+/- 0.023)	
Correlation Coefficient	0.99975	0.99904	
Test Standard:	EN 13829		
Test Mode:	Depressurization and Pressurization		
Type of Test Method:	B		
Regulation complied with:	Passive House Standard n50 ≤ 0.6 1/h		

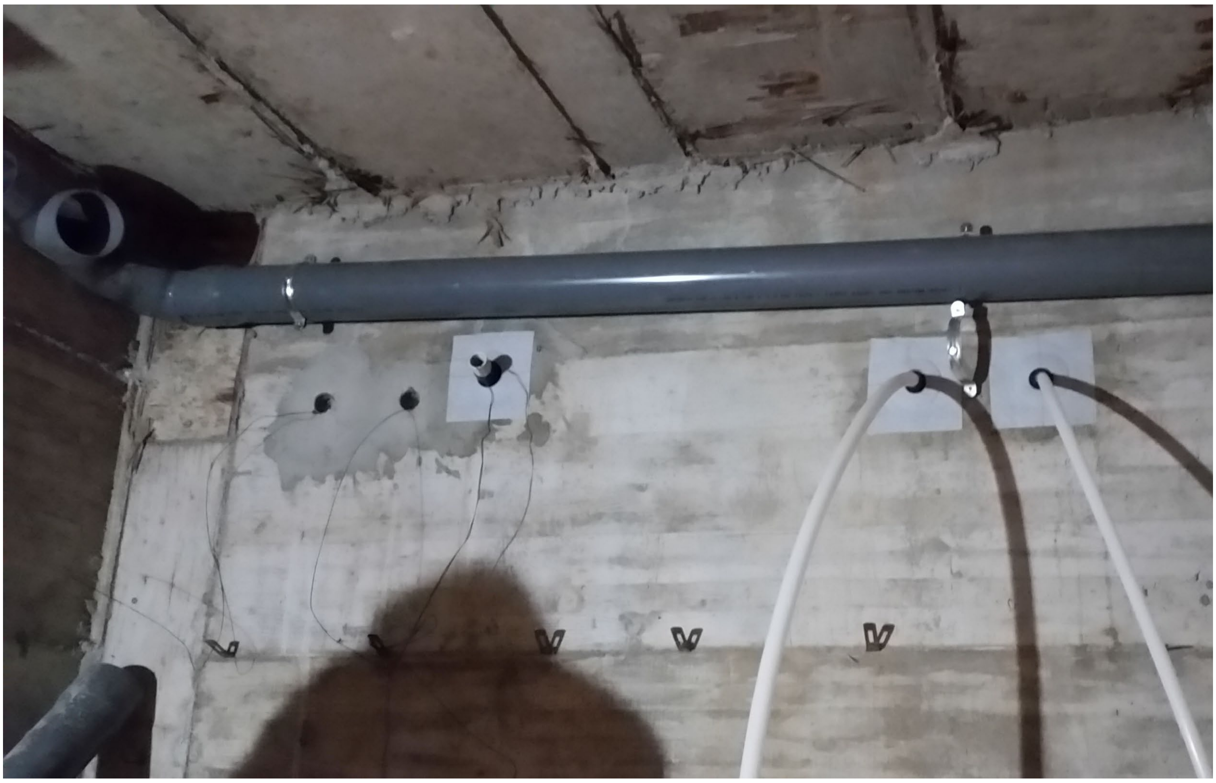


Picture 12. Blower Door Test Results

In order to achieve the airtightness goal, the airtightness layer was the internal plaster. The windows were sealed in their perimeter with special airtightness tapes, all the connections of ducts to the thermal envelope with airtightness collars and special airtight electrical junction boxes were installed.



Picture 139. Windows airtight installation

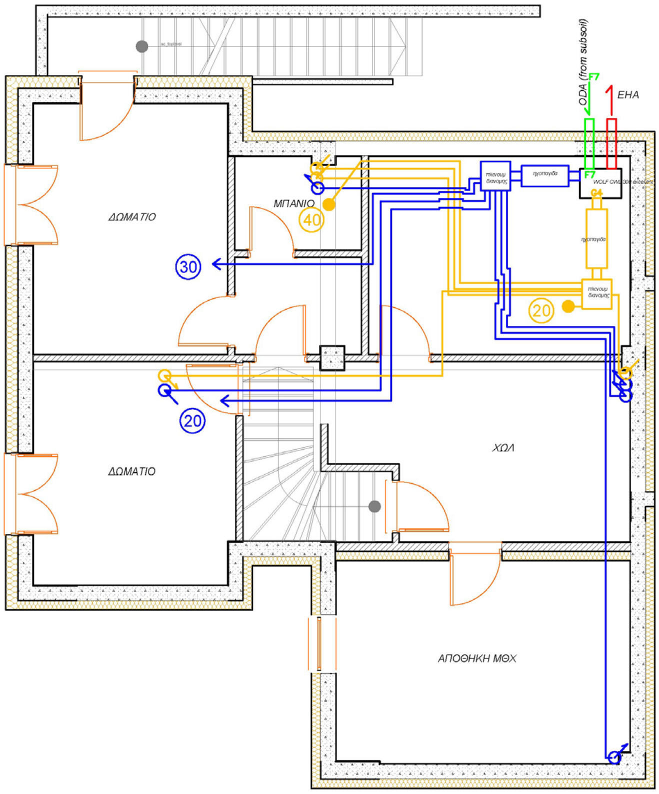


Picture 20. Sealing collars on ducts

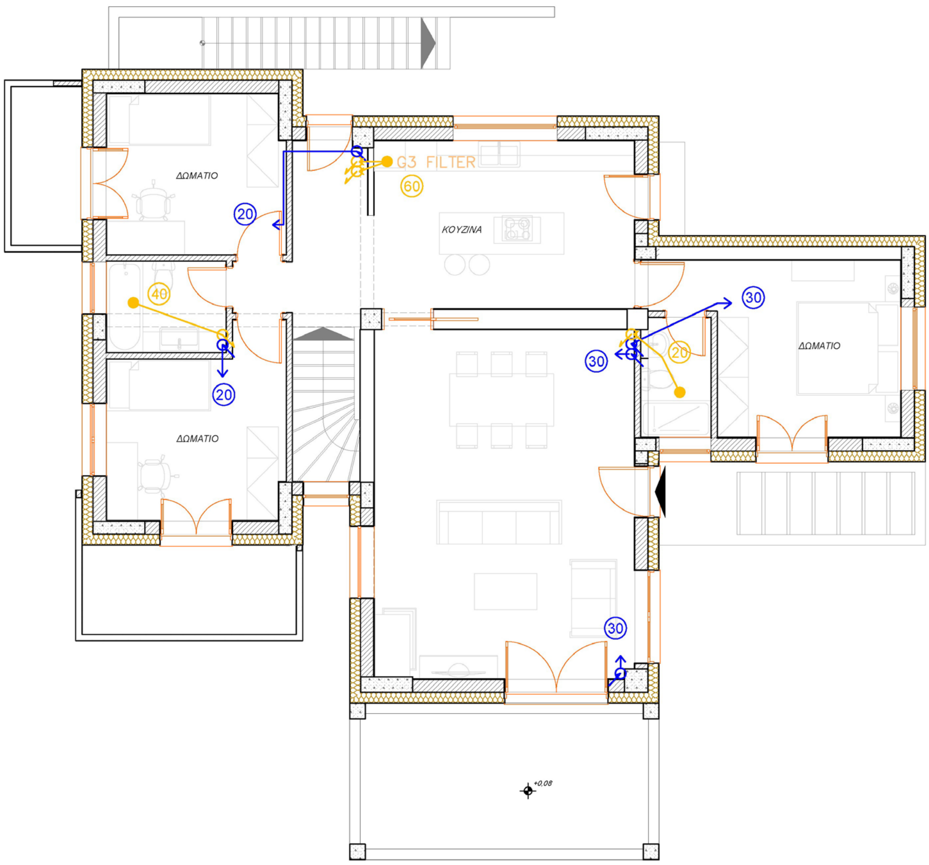
Picture 21. Airtight electrical junction boxes

7. Planning of ventilation ductwork

In order to reduce heat losses through ventilation, a dual-flow mechanical ventilation system with high efficiency air-to-air heat exchanger unit was installed. The normal air-flow is 130m^3/h. The unit is WOLF CWL-300 Excellent with effective heat recovery rate 82,3%. It is important to mention that the outdoor air is preheated by a ground heat exchanger, that is 40m long and minimum 1,50m deep.



Picture 22. Basement ventilation plan



Picture 23. Ground floor ventilation plan

Picture 24. Geothermal heat exchanger

Picture 25. Ventilation unit

8. Building services (heating, cooling, DHW)

The heating and cooling demand is covered by two air conditioners split unit, DAIKIN model FDXS25F, 3,2kW each and COP=4,00. Each split unit is connected with ducts, that supply air in all rooms. One unit covers the heating needs of bedrooms 2 and 3, W.C.1, hallway and kitchen and the second one covers the heating needs of bedroom 1, W.C.2 and the living room.
The heating demands are alternatively covered by an airtight fireplace Lotus Unico in the living room.

For the domestic hot water, a 500lt water tank has been installed in the basement with 6m^2 solar panels on the roof of the building which covers 87% of the building DHW demands. The remaining demands are covered with a 4kW electric water heater.

Picture 26. Split unit air condition

Picture 27. Fireplace with airtight installation

Picture 28. DHW installation

9. PHPP calculations

All the building data have been imported to the PHPP v9 planning program, verifying that the Passive House Classic certification criteria are met.

Passive House Verification

Building:	Ισόγεια κατοικία με υπόγειο και στέγη / Single Family Hou		
Street:	Protochori		
Postcode/City:	50100	Protochori Kozani	
Province/Country:	Western Macedonia	GR-Greece	
Building type:	Detached single family house		
Climate data set:	ud---00-GR0005(a)-Kozani		
Climate zone:	4: Warm-temperate	Altitude of location:	680 m
Home owner / Client:	Pogiatzis Nikolaos - Chatzimichali Stella		
Street:	Protochori		
Postcode/City:	50100	Protochori Kozani	
Province/Country:	Western Macedonia	GR-Greece	

Architecture:	George Liakos / Alexia Chalkia		**Mechanical engineer:**	Kampourlidis Ilias	
Street:	Irakleitou 1		Street:		
Postcode/City:	50132	Kozani	Postcode/City:	50200	Ptolemaida
Province/Country:	Western Macedonia	GR-Greece	Province/Country:	Western Macedonia	GR-Greece
Energy consultancy:	George Liakos / Alexia Chalkia		**Certification:**	Stefan Pallantzas	
Street:	Irakleitou 1		Street:	Anastaseos 112	
Postcode/City:	50132	Kozani	Postcode/City:	GR-15669	Papagou
Province/Country:	Western Macedonia	GR-Greece	Province/Country:	Attiki	GR-Greece

Year of construction:	2014	Interior temperature winter [°C]:	20,0	Interior temp. summer [°C]:	25,0
No. of dwelling units:	1	Internal heat gains (IHG) heating case [W/m²]:	2,4	IHG cooling case [W/m²]:	2,4
No. of occupants:	3,0	Specific capacity [Wh/K per m² TFA]:	204	Mechanical cooling:	x

Specific building characteristics with reference to the treated floor area

					Criteria	Alternative criteria	Fullfilled?[2]
	Treated floor area	m²	163,4				
Space heating	Heating demand	kWh/(m²a)	11	≤	15	-	yes
	Heating load	W/m²	11	≤	-	10	
Space cooling	Cooling & dehum. demand	kWh/(m²a)	4	≤	15	15	yes
	Cooling load	W/m²	8	≤	-	10	
	Frequency of overheating (> 25 °C)	%	-	≤	-		-
	Frequency of excessively high humidity (> 12 g/kg)	%	0	≤	10		yes
Airtightness	Pressurization test result n_{50}	1/h	0,3	≤	0,6		yes
Non-renewable Primary Energy (PE)	PE demand	kWh/(m²a)	41	≤	-		-
Primary Energy Renewable (PER)	PER demand	kWh/(m²a)	25	≤	60	60	yes
	Generation of renewable energy (in relation to projected building footprint area)	kWh/(m²a)	5	≥	-	-	

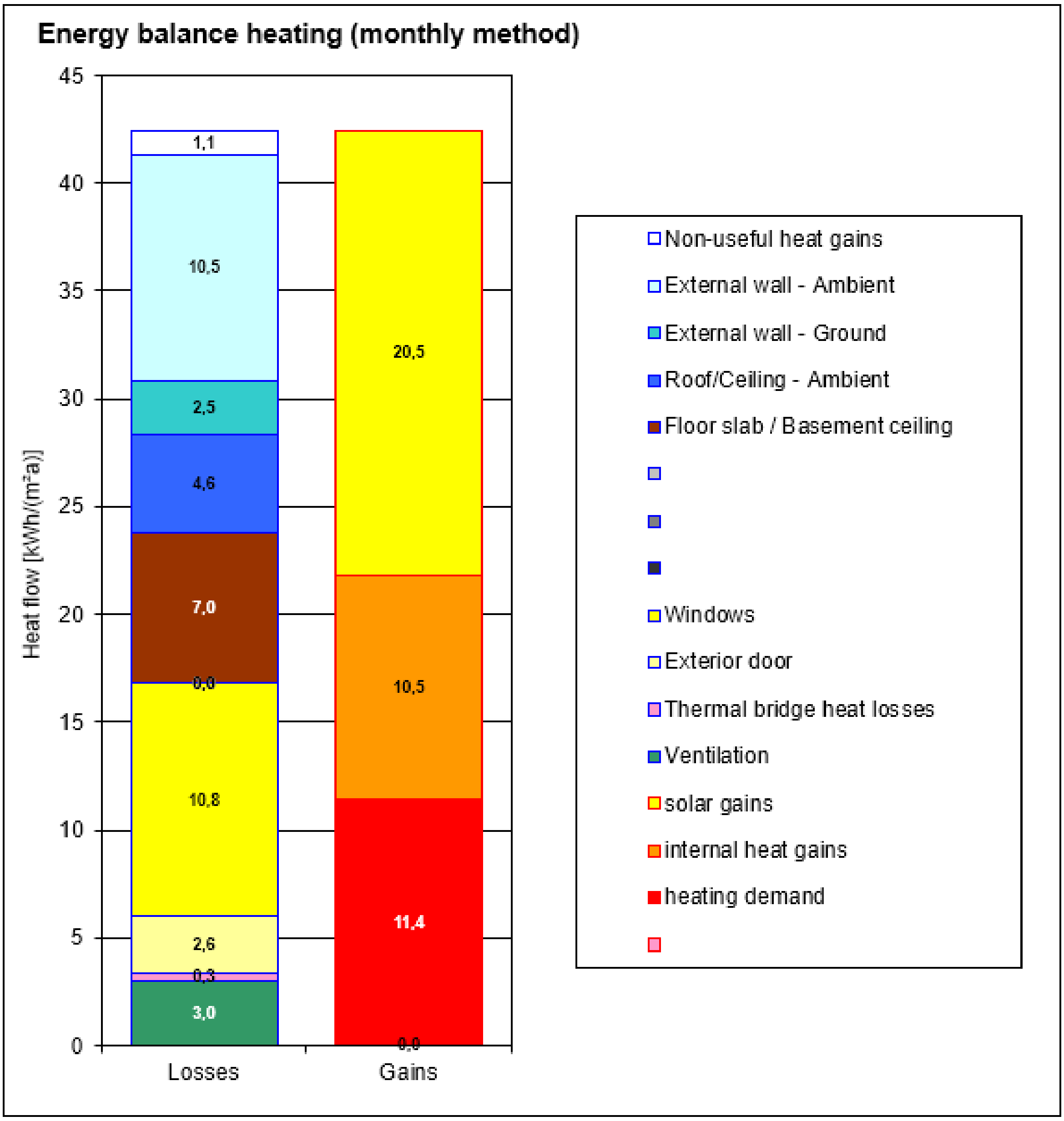
[2] Empty field: Data missing; '-': No requirement

I confirm that the values given herein have been determined following the PHPP methodology and based on the characteristic values of the building. The PHPP calculations are attached to this verification.

Passive House Classic? yes

Task:	First name:	Surname:	Signature:
2-Certifier	Stefan	Pallantzas	
Certificate ID	Issued on:	City:	
	02/11/18	Athens	

Picture 29. Verification worksheet of the PHPP v9.



Picture 30. The heating demand balance of the single-family house in Protochori, Kozani, calculated by the PHPP

Most of the heating losses are caused by the windows and the external walls to the ambient. On the contrary most of the heat gains come from the windows and the internal heat gains account for about one third. The remaining heating demand is about 11,4kWh/(m2a).

10. Construction costs

Total building cost (VAT and taxes included): 130.000 €
The landscaping works are not included.
The cost for the building was only 5% more than the current standard building cost in Greece.

11. References

- Passive House Data Base: https://passivehouse-database.org/index.php?lang=en#d_4643
- Video presentation: https://www.youtube.com/watch?v=o4LmG74wu0Y