Passivistas EnerPHit Project in Athens: One year overall measurements, one year of living

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1. Project Description

The project was an Energy retrofit of a typical 142m2 one family house of the 60s in Athens according to the Passivhaus standard. The goal was to minimize the need for conventional heating or air conditioning. According to the first PHPP calculation the building should have 11Kwh/m2a heating and 12Kwh/m2a cooling demand and a 51Kwh/m2a PER-Demand. The Project was certified as an EnerPHit Classic in February 2016 by PHI.

The building (Figure 1 and 2) is located in the Papagou Municipality and was built in 1964 on a 520 m2 corner plot, the two façades looking north-east and south-east. It consists of two units – a 98.80 m2 two-bedroom private residence on the ground floor and a separate semi-basement 43.60 m2 storage/boiler room; the second one will be converted into an office. The building's treated floor area (TFA) is 114.60 m2, and for the existing building, the following figures were calculated in PHPP:

- Heating demand 301 kWh/(m2a)
- Heating load 129 W/m2
- Cooling demand 77 kWh/(m2a)
- Cooling load 68 W/m2
- Estimated airtightness n50 5.00 /h

Figure 1: Before retrofit

Figure 2: After retrofit

According to (updated) PHPP calculations the energy balance of the building was the following (Figure 3).

Specific building characteristics with reference to the treated floor area

				Criteria	Alternative criteria	Fulfilled?[2]
	Treated floor area m²	114,6				
Space heating	Heating demand kWh/(m²a)	11	≤	15	-	yes
	Heating load W/m²	11	≤	-	-	
Space cooling	Cooling & dehum. demand kWh/(m²a)	11	≤	16	16	yes
	Cooling load W/m²	9	≤	-	11	
	Frequency of overheating (> 25 °C) %	-	≤	-		-
	Frequency excessively high humidity (> 12 g/kg) %	0	≤	10		yes
Airtightness	Pressurization test result n_{50} 1/h	0,6	≤	1,0		yes
Non-renewable Primary Energy (PE)	PE demand kWh/(m²a)	78	≤	-		-
Primary Energy Renewable (PER)	PER demand kWh/(m²a)	44	≤	45	44	yes
	Generation of renewable energy kWh/(m²a)	63	≥	60	59	

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

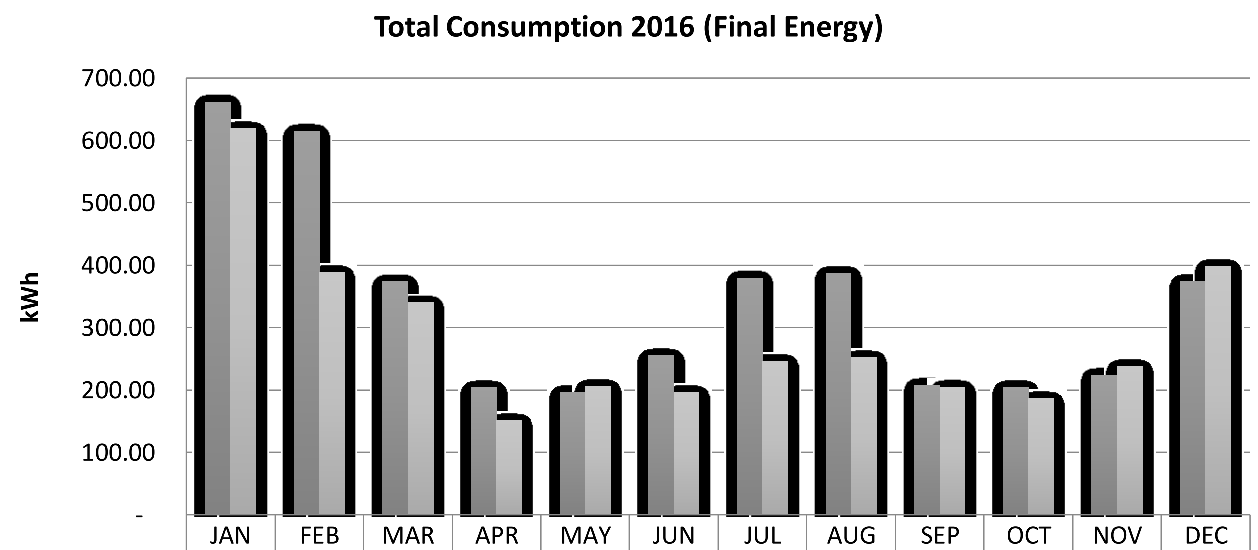
Figure 3: PHPP Energy Balance

With these results the building was certified by PHI as **EnerPHit** Classic in February 2016.

2. The one year results

The Project was ready in late October 2015 and since then we monitor all data concerning internal temperature, humidity and Co2 concentration in several areas, external temperature and all electricity consumptions for heating, cooling, lighting and the rest of electrical appliances.

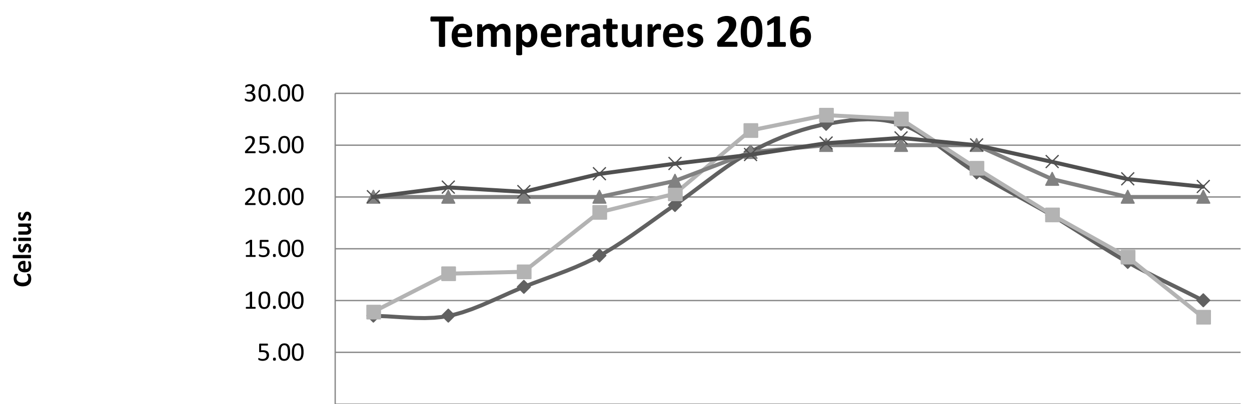
In the following graph (Figure 4) you can see the total monthly consumption predicted by PHPP and the one measured. Generally the measured consumptions were very close to PHPP calculations. There was only a difference in February (it was announced as the hottest February since measurements are made globally) and in the two months of summer, which was not as warm as usual.



	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
PHPP	661.8	615.2	373.8	203.5	196.2	255.0	379.6	386.8	207.6	203.8	224.1	374.6
MEASURED	619.3	388.5	339.8	151.3	205.9	195.5	246.4	251.8	204.6	186.1	237.6	398.3

Figure 4: Total Consumption 2016

Also the temperatures measured inside and outside the building were very close to the ones used in PHPP (Figure 5). Lowest temperature during winter was 20°C and highest temperature measured in summer was 25,70°C. Again here we can see that February was extremely warmer than normal (+4°C in average). During summer the average external temperatures were close to the phpp data, but the hot peaks were lower.



	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
EXT.TEMP PHPP	8.53	8.53	11.33	14.33	19.23	24.33	27.03	27.03	22.33	18.23	13.73	10.03
EXT. TEMP MEASURED	8.90	12.60	12.80	18.50	20.30	26.40	27.90	27.50	22.80	18.30	14.20	8.40
INT TEMP PHPP	20.00	20.00	20.00	20.00	21.57	24.30	25.00	25.00	25.00	21.74	20.00	20.00
INT TEMP MEASURED	20.00	20.90	20.50	22.20	23.20	24.10	25.20	25.70	25.00	23.40	21.70	21.00

Figure 5: Monthly internal and external temperatures 2016

During winter 2015-16 we used air pre-heating (direct electric) through the ventilation system to heat the house. The system worked properly and consumption was in line the PHPP calculations. According to PHPP the total final energy for heating should have been 1.285 kWh and the measured energy was 984,19 kWh. The main reason of the difference was the warm February. In the residence the heating period started at Dec,16th and ended at Feb,17th. In the office the heating period started at Jan,17th and ended at the end of March. During heating period the average temperature in the residence was between 19,4°C and 21,1°C. There were no differences in several rooms. Thermal imaging showed that there were no cold surfaces or visible thermal bridges (Figures 6 and 7).

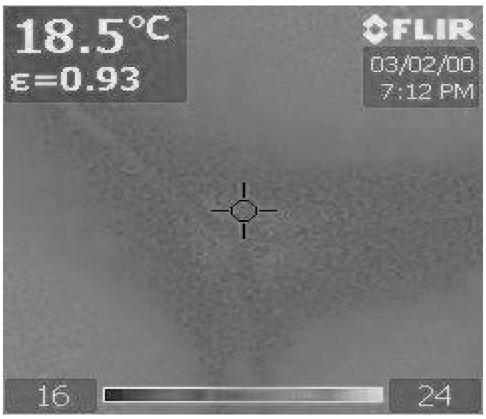


Figure 6: Internal Wall

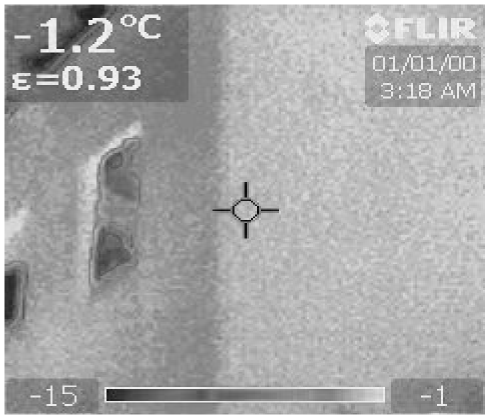


Figure 7: External Wall

On the 30th of March the designed 2kW split unit for cooling was installed in the living room of the residence. The cooling period for the residence started at June 19th and ended at September 9th.

The total energy used for the cooling of the building was 158,92 kWh and the average temperature of the residence (living room) was 25,01°C. The average temperature in the bedroom was 0,5°C higher, but still comfortable. The average temperature in the office was 1,5°C lower.

On August,7th a second 2kW split unit was installed in the office.

The Total Energy measured during the 4 months (1/6-30/9) was 898,45 kWh and this comparing to the PHPP calculation (1.229,15 kWh) was much better. We believe that this has to do with the better performance of the split units.

Figure 8: The installed Minisplit

Main conclusion is that, yes, we can cool a 95m2 residence with a single 2KW split unit without serious issues.

We are expecting now to drastically reduce the heating costs during winter 2016-2017 by using the same units for the heating. The updated PHPP now shows that the overall final energy consumption for the whole year will be 3.409,50 kWh or 29,75 kWh/m2, nearly 20% lower than last year.

The results of December 2016, although it was a very cold month, show that the use of the minisplit for heating the building is fantastic! In order to see the difference we took a cold day of January 2016 and a similarly cold day of December 2016 and compare the results. Although the December day was colder, the internal temperature never dropped under 20°C

Figure 9: External and internal temperatures in Jan16 (using direct heating) and Dec16 (using the Minisplit)

The difference in consumption was over 35% (9,4kWh compared to 14,8kWh), as you can see in Figures 10 and 11.

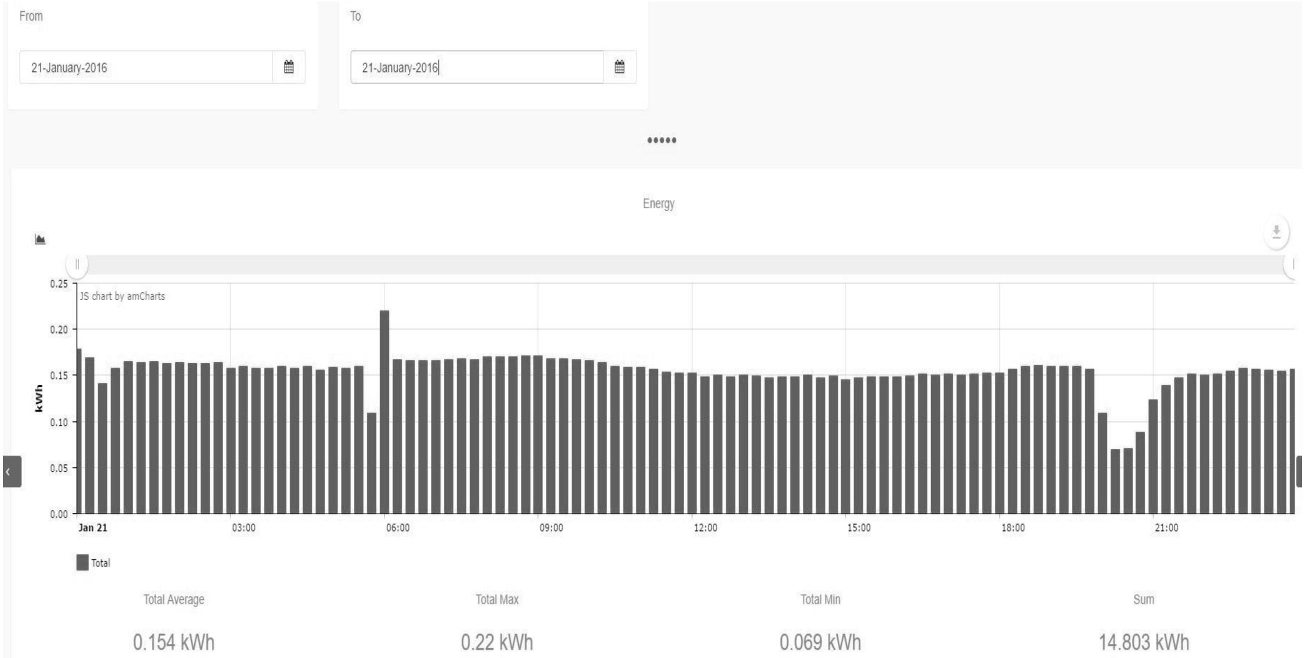


Figure 10: Heating consumption (direct electricity) in January 2016

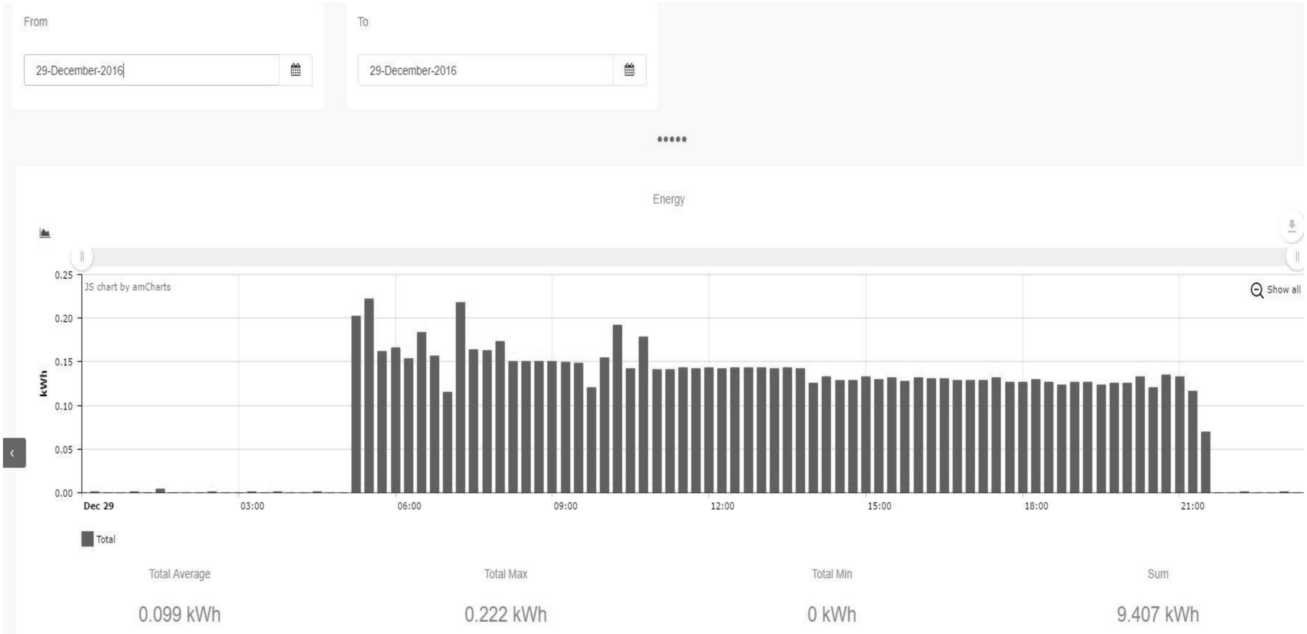


Figure 11: Heating consumption (Mini Split) in December 2016

Finally in January 2017 the designed PV-system of 14 panels (3,5 kWp) was installed on the roof of the building. It is expected to cover all the electricity needs of the building and so this will be an EnerPHit Plus Building, the first in the Mediterranean area.

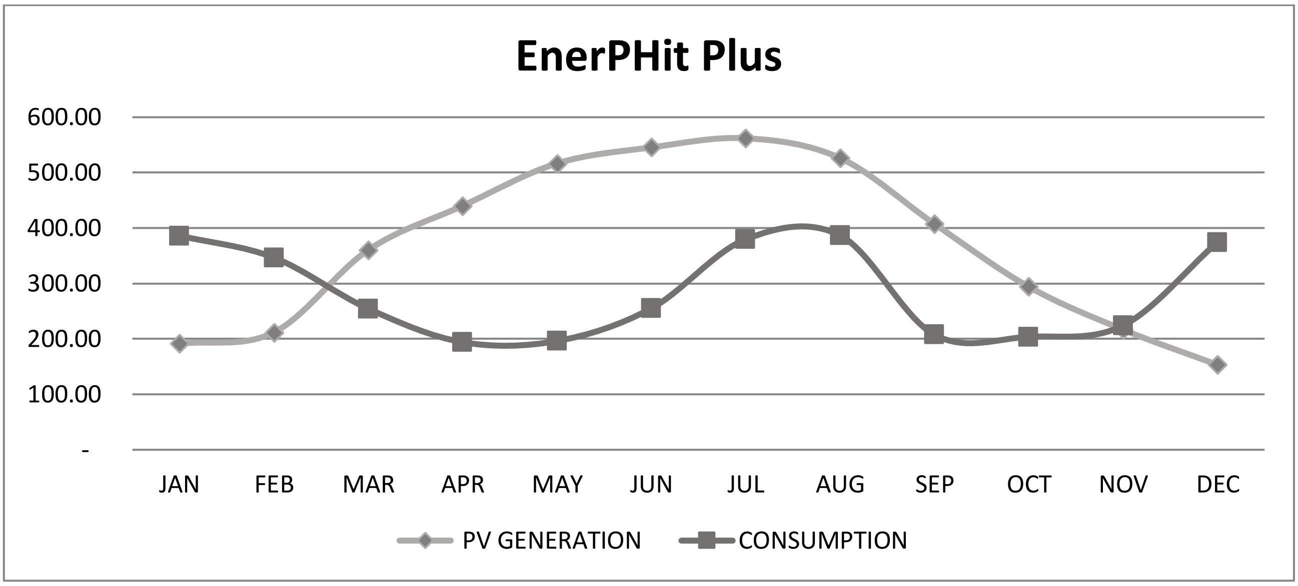


Figure 12: PV Generation and Consumption in 2017 (according to PHPP)

3. Conclusion

This project was developed by the Passivistas Team and HPHI in order to increase the dissemination of the passive house standard in Greece. The social impact of the project was enormous. More than 1.500 people visited the project till now, 10 CEPH courses were organized in the office, 65 new Passive House Designers were certified and over 10 new PH and EnerPhit projects started in Greece.

The way of design and step-by-step implementation, and the subsequent monitoring and metering of the project promotes collaborative processes among executives of HPHI, certified passive building designers, engineers and technicians from all sectors and commercial and technical department of companies manufacturing and marketing passive house components. It offers to every citizen through open public data all the information required on how to drastically save energy in their house while improving the quality of life and at the same time contributes substantially to the fight against global warming.

References

www.passivistas.com

https://www.facebook.com/passivistas/

https://twitter.com/passivistas

http://www.buildup.eu/en/practices/cases/passivistas-house-project-retrofit-towards-nzeb-2020

http://www.passivhausprojekte.de/#d_4539

Summary

Passivistas:TheHouseProject is a stepping stone on the road to the Mediterranean NZEB. This first year of living and using the building showed us that we are on the right way. Adapting the Passive House concept and using the PHPP tool give us all we need to reach the NZEB building of the 2020.

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