



Cost Efficient Options and Financing Mechanisms
for nearly Zero Energy Renovation
of existing Buildings Stock

ADDENDUM to D2.1-IT

***Report presenting the 12 nZEB
renovation schemes fully documented
with technical and economic evaluation***

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Short Description:

This addendum corrects and updates D2.1 – IT, providing additional and deeper information on the specific primary energy consumption in the three Italian pilot buildings and finally defining the potential for saving of energy after the updated measures used for the implementation of the 3 buildings.

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CERTUS PROJECT IN BRIEF

Southern European countries undergo a severe economic crisis. This hinders the compliance to the latest Energy Efficiency Directive, demanding strict energy efficiency measures for the public sector. Investments required to renovate public buildings and achieve nearly zero energy consumption have long payback times. So the interest of financing entities and ESCOs is small, especially when banks have limited resources. Many of the municipal buildings in Southern Europe require deep renovations to become nZEB and this should not be regarded as a threat but rather as an opportunity for the energy service and the financing sector.

The objective of the proposed action is to help stakeholders gain confidence in such investments and initiate the growth of this energy service sector.

Municipalities, energy service companies and financing entities in Italy, Greece, Spain and Portugal are involved in this project. The plan is to produce representative deep renovation projects that will act as models for replication. Twelve buildings in four municipalities in each country have been selected. The partners will adapt existing energy service models and procedures and will work out financing schemes suitable for the 12 projects. Consequently, the partners will create materials, such as guides and maxi brochures, suitable to support an intensive communication plan.

The plan includes four workshops with B2B sessions targeted to municipalities, ESCOs and financing entities. These actions shall be complemented by four training activities targeting municipal employees and the participation in international events targeting all 3 stakeholders. We expect that our action will have a significant impact by triggering investments in renovations to achieve nZEB and the uptake of the ESCO market in Southern European member states.

1. INTRODUCTION

This Addendum to the D2.1_IT titled *Report presenting the 12 nZEB renovation schemes fully documented with technical and economic evaluation* (year/version) is part of the work carried out in WP2 “*Technical and Economic Validation of the nZEB renovation schemes*”. It provides additional and deeper information on the specific primary energy consumption of the three Italian pilot buildings and finally defines the potential of energy saving resulting from the proposed options for deep renovation.

The results obtained in the aforementioned Report D2.1_IT include the thermal behavior of the 3 pilot buildings of the Municipality of Messina, Italy, namely Palazzo Zanca, Satellite and Palacultura which was carried out via simulations. Although the 3 building models were described in due details following the architectural drawings, the results from the energy audit pertinent to lighting, equipment and, building and systems operational profile were not taken into account. Also, other parameters which were needed, such as the users’ behavior, have been forgotten and omitted in the calculation code for some inexplicable reason.

In view of the need to deepen the achieved results, we have again proceeded on the 3 pilot buildings by carrying out and verifying the electric loads currently absorbed and also considering the behaviour of the users. The diagnostic method we followed refers to UNI 16247-2 which is already mandatory in Italy with the Decree 102 of 12/07/2014.

Consequently, we have again proceeded through the verification of the pre-intervention consumptions in the way hereinafter indicated for each individual building:

- Verification of energy consumption data, based on the Utility invoices of the last 3 years;
- Analysis of hourly electricity withdrawal curves for each pick-point of the building;
- Verification of the users’ physical presence in the three buildings, through data provided by the Municipality of Messina, based on the number of the active access points;
- Inspections, in particular for Palazzo Zanca and Palacultura in order to verify the installed equipment, the energy consumptions and the use of the rooms in accordance with their intended use. This last point in particular refers to Palacultura building where there are offices, conference rooms, areas for permanent exhibitions and a theater from about 800-900 seats.

The reconstruction of the consumptions were carried out with an approximation of over 95%, in line with the national regulations, and has been disaggregated between uses, equipments and occupant profile. Comparisons have been done with the Utility invoices of the annual average consumption of the buildings and the new scenarios are presented in the following pages.

2. PALACULTURA – COMPAIRING ENERGYPLUS RESULTS WITH UTILITY INVOICES CONSUMPTION

2.1. RESULTS FROM THE COMPARISON BETWEEN ORIGINAL SCENARIO AND THE NEW, REVISED ONE

Utility	Consumption (kWh) Original scenario	Consumption (kWh) New revised scenario	Difference (Kwh)	Difference (%)
Heating	223.362,48	59.096	164.266	278%
Cooling	217.049,09	48.240	168.809	350%
Interior lighting	196.858,13	133.153	63.705	48%
Exterior lighting	0	8.273	- 8.273	100%
Interior equipments	120.275,15	114.673	5.602	5%
Fans	127.924,50	53.571	74.353	139%
TOTAL	885.469,35	417.006	468.463	
Real consumption (based on the Utility invoices)	421.052			
Difference from the real actual scenario (%)	Original scenario 210%	New revised scenario 99,04%		




TABLE 1. RESULTS FROM THE COMPARISON BETWEEN ORIGINAL SCENARIO AND THE NEW, REVISED ONE

2.2. SUMMARY ASSESSMENT INTERVENTIONS PALACULTURA

The following Table 2, shows the distribution of PalaCultura's consumption. Values are estimated, based on the real consumption, billed by the energy provider through the analysis of installed power divided by lighting (internal and external), Equipment, Cooling, Heating and Fans.

The consumptions was disaggregated between uses by means of (i) electricity, (ii) natural gas, (iii) additional fuel, (iv) district cooling and (v) district heating.

	Electricity [kWh]	Natural Gas [kWh]	Additional Fuel [kWh]	District Cooling [kWh]	District Heating [kWh]	%
Heating	0.00	0.00	0.00	0.00	59,069	
Cooling	0.00	0.00	0.00	48,240	0.00	
Interior Lighting	133,150	0.00	0.00	0.00	0.00	
Exterior Lighting	8,337	0.00	0.00	0.00	0.00	
Interior Equipment	114,673	0.00	0.00	0.00	0.00	
Fans	53,571	0.00	0.00	0.00	0.00	
Total End Uses	309,670	0.00	0.00	0.00	59,069	
Total	417,006					
Current	421.052					99.04

TABLE 2. DISAGGREGATION OF PALACULTURA'S CONSUMPTION BETWEEN USES

2.3. LIGHTING

Reference area	Power [Watt] Pre-intervention	Total [kW] Pre-intervention	Power [Watt] Post-intervention	Total [kW] Post-intervention	Operational hours	Consumption pre-interventions [kWh]	Consumption post-interventions [kWh]	Savings post-interventions [kWh]	Savings post-interventions [tep]	Benefits post-interventions [€]	costs
-4.75 garage	1,777	1,777	889	0,89	8760	15,255	7,783	7,472	1.40	1620	4,442.50
-1.25 Store books & technical premises	3,880	3,880	1,940	1,940	2024	3,848	2,984	864	0.16	187	9,700
2.25 Atrium – auditorium-hall of 70 seats	15,600	15,600	6,240	6,240	1518	23,207	7,199	16,008	2.99	3471	31,200
7.25 Reading room, art gallery, hall 140 seats	10,257	10,257	5,129	5,129	8760	53,911	34,144	19,767	3.70	4286	25,642.50
12.25 Auditorium lighting - external	8,932	8,932	4,880	4,880	1518	13,288	7,408	5,880	1.10	1275	24,400
15.85 offices	3,461	3,461	1,731	1,731	2024	6,865	3,503	3,362	0.63	729	8,652,5
19.45 offices	3,903	3,903	1,952	1,952	2024	7,742	3,950	3,792	0.71	822	9,757,5
23.05 offices	4,069	4,069	2,030	2,030	2024	8,051	4,108	3,943	0.74	855	10,147,5
27 Roof & technical premises	1,338	1,338	669	669	2024						
		53,21		25,46		132,167	71,078	61,089	11,42	13,246	123,942.5

TABLE 3. ANALYSIS OF CONSUMPTION FOR LIGHTING AND SAVING ASSUMPTIONS

Table 3 shows the total power to be installed, divided by floor and room typology. Through the curve of the absorbed power and the investigation of the scenarios, the consumption of each homogeneous area has been calculated in order to determine the incidence of the savings obtained by replacing the existing lamps.

2.4. HVAC SYSTEM

A new HVAC will be installed. It will be equipped with a BMS system which in addition to controlling the building's internal environment could be linked to motion detectors, in order to optimize the use of the air conditioning system according to the presence in the building

2.5. EQUIPMENT

With reference to the existing equipment the planned actions are of three types:

- Staff training for rational use of office equipment;
- Purchases regulated by the GPP - Green Public Procurement model- providing primacy of evaluation for products with the best energy class;
- Implementation of verification systems and other minor but significant measures (i.e.: possibly posting off PC outside the office hours)

EQUIPMENTS				
PRE-INTERVENTION	Equipments consumption (calculated)		kWh	114,673
POST-INTERVENTION	GPP	Total Consumptions equipments	kWh	34,402
		Savings post interventions	kWh	80,271
		Cost-effective intervention	%	05/10
		Savings on the consumptions	€	14,448.74

TABLE 4. ANALYSIS OF CONSUMPTION FOR EQUIPMENTS AND SAVING ASSUMPTIONS

2.6. PV PLANTS

A PV system will be installed on the roofs of Palacultura; it is estimated that this system of about 28 kWp capacity has an expected production amounted to 39,200 kWh / year. Such a plant, although it can not guarantee energy efficiency in the proper sense of the term, makes a significant contribution to the reduction of electricity supply

Characteristics of PV modules		
Installable power	kWp	28
Expected production	kWh	29,200
Cost of the system	€	50,400
Expected savings	€	7,056
PBT		7.14
VAN	€	76,167.74
TIR	%	12.72

TABLE 5. ANALYSIS OF CONSUMPTION FOR PV PLANTS AND SAVING ASSUMPTIONS

2.7. SUMMARY OF INTERVENTIONS AND OVERALL EFFICIENCY AS A RESULT OF THE RENOVATION OPTIONS


 PALACULTURA		Utilities	Annual total electricity consumption pre-intervention kWh	Annual total electricity consumption post-intervention kWh	%
Annual Total Electricity consumption (based on Utility Invoices):			421,052		
INTERVENTIONS	Electricity to primary energy	Lighting	133,153	71,078	47%
		HVAC	107,336	80,502	25%
		Fans	53,573	33,091	38%
		Equipments	114,673		70%
		Total Utilities		219,072	48%
	RES	Total PV System	0	39,200	18%
TOTAL Electricity demand from the grid				179,872	57%

TABLE 6. COMPARISON REGARDING CONSUMPTIONS AND SAVINGS IN PRIMARY ENERGY BEFORE AND AFTER THE RENOVATION. ALSO, THE PROPOSED PV SYSTEM PRODUCES 39,200 KWH/ YEARLY, WHICH MEANS THAT 18% OF THE TOTAL END USE ANNUAL ELECTRICITY CONSUMPTION WILL BE COVERED BY RENEWABLE ENERGY SOURCES.

2.8. FINAL CONSUMPTION VALUES PRE- AND POST-INTERVENTIONS

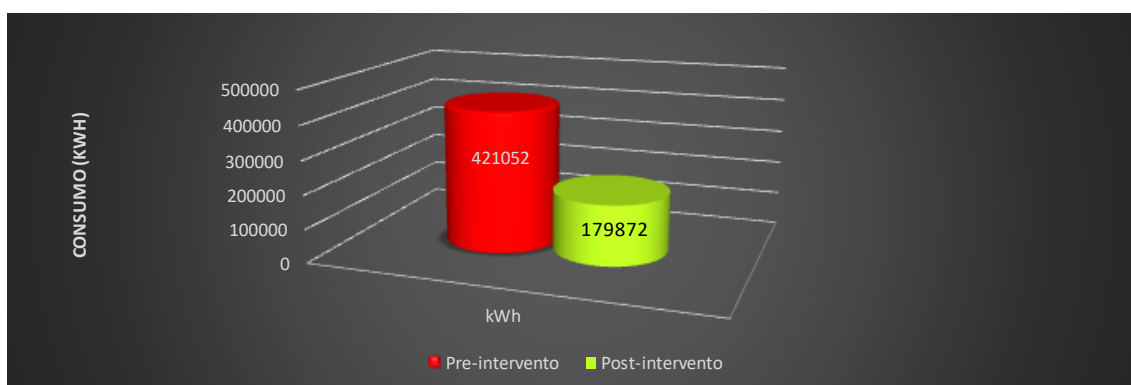


FIGURE 1. THE GRAPH ABOVE HIGHLIGHTS THE FINAL CONSUMPTION VALUES PRE- AND POST- THE PROPOSED INTERVENTION. AS IT IS SHOWN ON THE GRAPH IS CONSIDERED ACHIEVABLE A REDUCTION OF ELECTRICITY CONSUMPTION OF 57% IN TOTAL PRIMAY ENERGY.

3. PALAZZO ZANCA – COMPAIRING ENERGYPLUS RESULTS WITH UTILITY INVOICES CONSUMPTION

3.1. RESULTS FROM THE COMPARISON BETWEEN ORIGINAL SCENARIO AND THE NEW, REVISED ONE


Utility	Consumption (kWh) Original scenario	Consumption (kWh) New rivised scenario	Difference (Kwh)	Difference (%)
Heating	270,143.40	120,350.00	149,793.40	124.46%
Cooling	1,254,508.77	166,250.00	1,088,258.77	654.59%
Interior lighting	1,061,927.55	547,094.00	514,833,55	94.10%
Exterior lighting	0.00	83,720.00	-83,720	-100.00%
Interior equipments	326,353.11	486,625.00	-160,271.89	-32.94
TOTAL	2,912,932.83	1,404,039.00	1,508,893.83	107.47%
Real consumption (based on the Utility invoices)	1,409,143.80			
Difference from the real actual scenario (%)	Original scenario 206.72%	New rivised scenario 99,64%		

TABLE 7. RESULTS FROM THE COMPARISON BETWEEN ORIGINAL SCENARIO AND THE NEW, REVISED ONE

3.2. SUMMARY ASSESSMENT INTERVENTIONS PALAZZO ZANCA

The following Table 8 shows the distribution of palazzo Zanca's consumption. Values are estimated, based on the real consumption, billed by the energy provider through the analysis of installed power divided by lighting (internal and external), Equipment, Cooling, Heating and Fans.

The consumptions was disaggregated between uses by means of (i) electricity, (ii) natural gas, (iii) additional fuel, (iv) district cooling and (v) district heating.

	Electricity [kWh]	Natural Gas [kWh]	Additional Fuel [kWh]	District Cooling [kWh]	District Heating [kWh]	%
Heating	0.00	0.00	0.00	0.00	120,350	
Cooling	0.00	0.00	0.00	166,250	0.00	
Interior Lighting	547,094	0.00	0.00	0.00	0.00	
Exterior Lighting	83,720	0.00	0.00	0.00	0.00	
Interior Equipment	486,625	0.00	0.00	0.00	0.00	
Fans	53,571	0.00	0.00	0.00	0.00	
Total End Uses	1,117,439	0.00	0.00	0.00	59,069	
Total	1,404,039			166,250	120,350	99.64%
Current	1,404,144					100.00%

TABLE 8. DISAGGREGATION OF PALAZZO ZANCA'S CONSUMPTION BETWEEN USES

3.3. LIGHTING

Reference area	Power [Watt] Pre-intervention	N°	Total [kW] Pre-intervention	Power [Watt] Post-intervention	Total [kW] Post-intervention	Operational hours	Consumption pre-interventions [kWh]	Consumption post-interventions [kWh]	Savings post-interventions [kWh]	Savings post-interventions [tep]	Benefits post-interventions [€]	costs	
Ground floor	Offices	116	237	27.492	64	15.168	2,530	69,555	38,375	31,180	5.83	6,761	75,840
	Services areas and corridors	72	115	8.28	36	4.14	8,760	72,533	27,562	44,970	8.41	9,751	20,700
	Staircases, entrance hall	54	280	15.12	30	8.4	8,760	132,451	55,924	76,527	14.31	16,593	42,000
		72	35	2.52	36	1.26	8,760	22,075	8,389	13,687	2.56	2,968	6,300
1 st floor	Offices	116	209	24.244	64	13.376	2,530	61,337	33,841	27,496	5.14	5,962	66,880
	Services areas and corridors	72	80	5.76	36	2.88	8,760	50,458	19,174	31,284	5.85	6,783	14,400
	Council room	150	84	12.6	30	2.52	3,552	44,755	8,951	35,804	6.70	7,763	12,600
		60	39	2.34	10	0.39	3,552	8,312	1,385	6,926	1.30	1,502	1,950
	rooms	54	526	28.404	30	15.75	2,530	71,862	39,923	31,929	5.97	6,925	78,900
			1,605	126.76	63.914		533,338	233,525	299,813	56.07	65,008	319,570	

TABLE 9. ANALYSIS OF CONSUMPTION FOR LIGHTING AND SAVING ASSUMPTIONS

Table 9 shows the total power to be installed, divided by floor and room typology. Through the curve of the absorbed power and the investigation of the scenarios, the consumption of each homogeneous area has been calculated in order to determine the incidence of the savings obtained by replacing the existing lamps.

3.4. HVAC SYSTEM

A new HVAC will replace the existing one. Three scenarios were investigated.

The first one is to replace the current heating and cooling equipment with a centralized air conditioning system, by keeping the already existing ceiling panels, without any kind of

building intervention. The intervention, although less expensive, has a very long pay back time, since the volumes to be air-conditioned are always the original ones and this creates considerable energy waste.

The second scenario is to replace the current equipment with a centralized air conditioning system and the whole ceiling panel of the offices with a new one. This intervention, even if more expensive than the previous one, allows to obtain a greater efficiency by reducing the volume of air conditioning area by about 30%.

The third scenario is to replace the existing equipments with a more systematic intervention which includes: (i) the replacement of the ceiling panels of the areas dedicated to offices – as foreseen in the previous scenario- and (ii) the placement of ceiling panels in the corridors, which currently are not air conditioned. This solution improves the comfort conditions inside the building, but generates greater costs both in terms of intervention and maintenance.

The three scenarios are depicted in the 3 following tables.

Pre - intervention	Estimated consumptions	Heating	kWh	120,350
		Cooling	kWh	166,250

Post –intervention Scenario 1 (replacement of the equipment)	SAVINGS		%	15
	Building volume		mc	28,413
	Intervention cost		€	700,000.00
	Consumption post-intervention	Heating	kWh	102,298
		Cooling	kWh	141,313
	Savings	Heating	€	3,249.45
		Cooling	€	4,488.75
		TOTAL	tep	8.04
		€	8,462	

TABLE 10. SCENARIO 1

Post –intervention Scenario 2 (replacement of the equipment and the ceiling panel of the offices)	SAVINGS		%	38.65
	Building volume		mc	19,630.8
	Intervention cost		€	950,000.00
	Consumption post-intervention	Heating	kWh	73,840
		Cooling	kWh	102,002
	Savings	Heating	€	8,371.76
		Cooling	€	11,564.65
		TOTAL	tep	20.71
		€	21,800	

TABLE 11. SCENARIO 2

Post –intervention Scenario 3 (replacement of the equipment and placement of ceiling panels to the corridors)	SAVINGS		%	22.29
	Building volume		mc	25,707
	Intervention cost		€	1,310,000.00
	Consumption post-intervention	Heating	kWh	93,529
		Cooling	kWh	129,200
	Savings	Heating	€	4,827.75
		Cooling	€	6,669.00
		TOTAL	tep	11.94
		€	12,572	

TABLE 12. SCENARIO 3

The tables 10, 11 and 12 show and compare consumptions, savings, costs and payback of the three scenarios investigated for the replacement of the HVAC system

3.5. EQUIPMENTS

With reference to the existing equipment the planned actions are of three types:

- Staff training for rational use of office equipment;
- Purchases regulated by the GPP - Green Public Procurement model- providing primacy of evaluation for products with the best energy class;
- Implementation of verification systems and other minor but significant measures (i.e.: possibly posting off PC outside the office hours)

EQUIPMENTS				
PRE-INTERVENTION	Equipments consumption (calculated)		kWh	486,625
POST-INTERVENTION	GPP Green Public Procurement	Total Consumptions equipments	kWh	299,288
		Savings post interventions	kWh	187,338
		Higher cost of the service	%	05/10
		Savings on the consumptions	€	33,720.75

TABLE 13. ANALYSIS OF CONSUMPTION FOR EQUIPMENTS AND SAVING ASSUMPTIONS

3.6. PV PLANTS

A PV system will be installed on the roofs of Palazzo Zanca; it is estimated that this system of about 126 kWp capacity has an expected production amounted to 176,400 kWh / year. Such a

plant, although it can not guarantee energy efficiency in the proper sense of the term, makes a significant contribution to the reduction of electricity supply.

Characteristics of PV modules		
Installable power	kWp	126
Expected production	kWh	176,400
Cost of the system	€	226,800
Expected savings	€	31,752
PBT		7.14
VAN	€	342,754.85
TIR	%	12.72

3.7. SUMMARY OF INTERVENTIONS AND OVERALL EFFICIENCY AS A RESULT OF THE RENOVATION OPTIONS


		Utilities	Annual total electricity consumption pre-intervention kWh	Annual total electricity consumption post-intervention kWh	%
Annual Total Electricity consumption (based on Utility Invoices):			1,409,144		
INTERVENTIONS	Electricity to primary energy	Lighting	533,338	233,525	56%
		HVAC	286,600	175,842	39%
		Equipments	486,625	299,288	38%
		Total Utilities		708,654	50%
	RES	Total PV System	0	176,400	25%
TOTAL Electricity demand from the grid				532,254	62%

TABLE 14. COMPARISON REGARDING CONSUMPTIONS AND SAVINGS IN PRIMARY ENERGY BEFORE AND AFTER THE RENOVATION. ALSO, THE PROPOSED PV SYSTEM PRODUCES 176,400 KWH/YEARLY, WHICH MEANS THAT 25% OF THE TOTAL END USE ANNUAL ELECTRICITY CONSUMPTION WILL BE COVERED BY RENEWABLE ENERGY SOURCES.

3.8. FINAL CONSUMPTION VALUES PRE- AND POST-INTERVENTIONS



FIGURE 2. THE GRAPH ABOVE HIGHLIGHTS THE FINAL CONSUMPTION VALUES PRE- AND POST- THE PROPOSED INTERVENTION. AS IT IS SHOWN ON THE GRAPH IS CONSIDERED ACHIEVABLE A REDUCTION OF ELECTRICITY CONSUMPTION OF 62% IN TOTAL PRIMARY ENERGY.

4. PALAZZO SATELLITE – COMPAIRING ENERGYPLUS RESULTS WITH UTILITY INVOICES CONSUMPTION

4.1. RESULTS FROM THE COMPARISON BETWEEN ORIGINAL SCENARIO AND THE NEW, REVISED ONE

Utility	Consumption (kWh) Original scenario	Consumption (kWh) New rivised scenario	Difference (Kwh)	Difference (%)
Heating	2,714.76	67,377.00	-64,662.24	-95,97%
Cooling	790,256.80	45,843.00	744,413.80	1,623.83
Interior lighting	852,503,17	105,904.89	746,598.28	704,97%
Interior equipments	222,119,61	121,511.71	100,607.90	82,80%
TOTAL	1,867,594.34	340,636.60	1,526,957.74	448.27
Real consumption (based on the Utility invoices)	343,920.00			
Difference from the real actual scenario (%)	Original scenario 543,03%	New rivised scenario 99,05%		



TABLE 15. RESULTS FROM THE COMPARISON BETWEEN ORIGINAL SCENARIO AND THE NEW, REVISED ONE

4.2. SUMMARY ASSESSMENT INTERVENTIONS SATELLITE PALACE

The following Table 16 shows the distribution of Satellite's Palace consumption. Values are estimated, based on the real consumption, billed by the energy provider through the analysis of the installed power divided by lighting (internal), Equipment, Cooling and Heating.

The consumptions was disaggregated between uses by means of (i) electricity, (ii) natural gas, (iii) additional fuel, (iv) district cooling and (v) district heating.

	Electricity [kWh]	Natural Gas [kWh]	Additional Fuel [kWh]	District Cooling [kWh]	District Heating [kWh]	%
Heating	0.00	0.00	0.00	0.00	67,377	
Cooling	0.00	0.00	0.00	45,843	0.00	
Interior Lighting	105.905	0.00	0.00	0.00	0.00	
Interior Equipment	121,512	0.00	0.00	0.00	0.00	
Total End Uses	227,417	0.00	0.00	45,843	67,377	
Total	340,637					
Current	343,920					99.05

TABLE 16. DISAGGREGATION OF SATLLITE'S PALACE CONSUMPTION BETWEEN USES

4.3. LIGHTING

Reference area	Power [Watt] Pre-intervention	N°	Total [kW] Pre-intervention	Power [Watt] Post-intervention	Total [kW] Post-intervention	Operational hours	Consumption pre-interventions [kWh]	Consumption post-interventions [kWh]	Savings post-interventions [kWh]	Savings post-interventions [tep]	Benefits post-interventions [€]	costs
Basement floor	3,348	100	3.35	1,674	1,674	1,741	5,829	2,914	2,914	0.54	631.94	8,370.00
Ground floor	5,752	202	5.75	2,706.00	2,71	8,760	50,388	18,015	32,372	6.05	7,019.23	13,530.00
First floor	4,056	168	4.06	1,998.00	2.00	2,856.1	11,584	4,337	7,247	1.36	1,571.46	9,990.00
Second floor	4,776	186	4.78	2,358.00	2.36	2,537.5	12,119	4,547	7,572	1.42	1,641.77	11,790.00
Third floor	5,352	186	5.35	2,376.00	2.38	2,537.5	13,581	6,029	7,552	1.41	1,637.41	11,880.00
Fourth floor	4,884	188	4.88	2,412.00	2.41	2,537.5	12,393	4,652	7,742	1.45	1,678.61	12,060.00
Emergency stairs	0.00	0.00	0.00	0.00	0.00		0,00	0,00	0.00	0,00	0,00	0,00
TOTAL	28,162	1,030	28.168	13,524	13.524		105,894	40,495	65,339	12,23	14,180.42	67,620.00

TABLE 17. ANALYSIS OF CONSUMPTION FOR LIGHTING AND SAVING ASSUMPTIONS

Table 17 shows the total power to be installed, divided by floor. Through the curve of the absorbed power and the investigation of the scenarios, the consumption of each homogeneous area has been calculated in order to determine the incidence of the savings obtained by replacing the existing lamps.

4.4. HVAC SYSTEM

A new AC will be installed. This will be a system which serves multiple spaces from one base location. The distribution does not require construction work. The installation requires long pay-back time.

Pre - intervention	Estimated consumptions	Heating	kWh	67,377
		Cooling	kWh	45,843

Post –intervention Scenario 1 (replacement of the equipment)	SAVINGS		%	15
	Building volume		mc	6,870
	Intervention cost		€	500,000.00
	Consumption post-intervention	Heating	kWh	40,426
		Cooling	kWh	27,426
	Savings	Heating	€	4,851.14
		Cooling	€	3,300.70
		TOTAL	tep	8.47
		€	8,914	

TABLE 18. ANALYSIS OF CONSUMPTION FORHVAC AND SAVING ASSUMPTIONS

4.5. EQUIPMENTS

With reference to the existing equipment the planned actions are of three types:

- Staff training for rational use of office equipment;
- Purchases regulated by the GPP - Green Public Procurement model- providing primacy of evaluation for products with the best energy class;
- Implementation of verification systems and other minor but significant measures (i.e.: possibly posting off PC outside the office hours)

EQUIPMENTS				
PRE-INTERVENTION	Equipments consumption (calculated)		kWh	121,512
POST-INTERVENTION	GPP	Total Consumptions equipments	kWh	91,642
		Savings post interventions	kWh	29,870
		Higher cost of service	%	05/10
		Savings on the consumptions	€	5,376.64

TABLE 19. ANALYSIS OF CONSUMPTION FOR EQUIPMENTS AND SAVING ASSUMPTIONS

4.6. PV PLANTS

A PV system will be installed on the roofs of Satellite palace; it is estimated that this system of about 120 kWp capacity has an expected production amounted to 168,000 kWh / year. Such a plant, although it can not guarantee energy efficiency in the proper sense of the term, makes a significant contribution to the reduction of electricity supply

Characteristics of PV modules		
Installable power	kWp	120
Expected production	kWh	168,000
Cost of the system	€	215,000
Expected savings	€	30,240
PBT		7.50
VAN	€	315,740.12
TIR	%	11.83

TABLE 20. ANALYSIS OF CONSUMPTION FOR PV PLANTS AND SAVING ASSUMPTIONS

WORKINGS	VOICE	UNIT COST	U.M.	DIMENSION	COST
Building envelope	EXTERNAL WALL – GREEN WALL	€ 869,69	sqm x sqcm	1.190,00	€ 1.034.931,10
Building envelope	NEW PV COVER SHELTER	€ 266,67	sqm	1.350,00	€ 360.004,50
Building envelope	WATERPROOFING FOUNDATIONS AND FOUNDATIONS STRUCTURAL RENOVATION	€ 869,69	sqm	363,70	€ 316.307,99
Plants	BACS	€ 20.000,00	total	1,00	€ 20.000,00
Plants	VRV SYSTEM	€ 1.408,45	KW	355,00	€ 499.999,75
Plants	RELAMPING	€ 65,65	units	1.030,00	€ 67.619,50
Plants	PV plant	€ 1.800,00	kWp	120,00	€ 216.000,00
TOTAL WORK COST					€ 2.514.862,84

TABLE 21. SUMMARY ESTIMATE OF THE INTERVENTIONS

4.7. SUMMARY OF INTERVENTIONS AND OVERALL EFFICIENCY AS A RESULT OF THE RENOVATION OPTIONS


 SATELLITE		Utilities	Annual total electricity consumption pre-intervention kWh	Annual total electricity consumption post-intervention kWh	%
Annual Total Electricity consumption (based on Utility Invoices):			343,920		
INTERVENTIONS	Electricity to primary energy	Lighting	105,894	40,495	62%
		HVAC	113,220	67,932	40%
		Equipments	121,512	91,642	25%
		Total Utilities		200,068	42%
	RES	Total PV System	0	168,00	84%
TOTAL Electricity demand from the grid				32,068	91%

TABLE 22. COMPARISON REGARDING CONSUMPTIONS AND SAVINGS IN PRIMARY ENERGY BEFORE AND AFTER THE RENOVATION. ALSO, THE PROPOSED PV SYSTEM PRODUCES 168,00 KWH/ YEARLY, WHICH MEANS THAT 84% OF THE TOTAL END USE ANNUAL ELECTRICITY CONSUMPTION WILL BE COVERED BY RENEWABLE ENERGY SOURCES.

4.8. FINAL CONSUMPTION VALUES PRE- AND POST-INTERVENTIONS

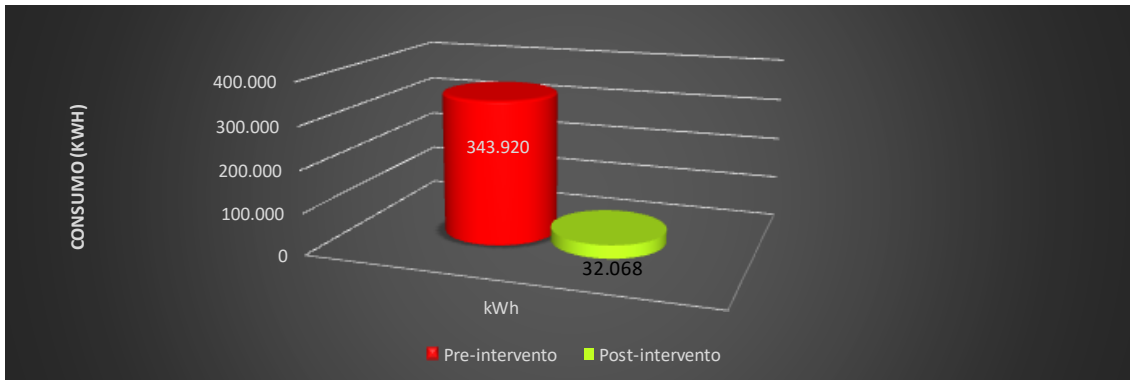





FIGURE 3. THE GRAPH ABOVE HIGHLIGHTS THE FINAL CONSUMPTION VALUES PRE- AND POST- THE PROPOSED INTERVENTION. AS IT IS SHOWN ON THE GRAPH IS CONSIDERED ACHIEVABLE A REDUCTION OF ELECTRICITY CONSUMPTION OF 91 % IN TOTAL PRIMAY ENERGY.

5. CONCLUSIONS

	ZANCA PALACE, listed building		
	Building Type	City hall/ multiple purpose use	
	Year of Construction	1914	
	Area / Volume	13,500 m ² (about 7.000 m ² to floor) / 95.000 m ³	
ENERGY EXPENDITURE PRE- AND POST-RENOVATION			
Energy consumption pre- renovation (kWh/year)	Energy consumption pre- renovation/m ² (kWh/m ² yearly)	Energy consumption post renovation (kWh/year)	Energy consumption post renovation/m ² (kWh/m ² yearly)
1,404,039	105	532,254	39

	PALACE OF CULTURE “Antonello Da Messina”		
	Building Type	Multifunctional center	
	Year of Construction	1975	
	Area / Volume	10,300 m ²	
ENERGY EXPENDITURE PRE- AND POST-RENOVATION			
Energy consumption pre- renovation (kWh/year)	Energy consumption pre- renovation/m ² (kWh/m ² yearly)	Energy consumption post renovation (kWh/year)	Energy consumption post renovation/m ² (kWh/m ² yearly)
885,469	86	179,872	17

	SATELLITE PALACE		
	Building Type	Municipal Offices	
	Year of Construction	1970	
	Area / Volume	6,870 m ² (about 1,350 m ² to floor) / 18,550 m ³	
ENERGY EXPENDITURE PRE- AND POST-RENOVATION			
Energy consumption pre- renovation (kWh/year)	Energy consumption pre- renovation/m ² (kWh/m ² yearly)	Energy consumption post renovation (kWh/year)	Energy consumption post renovation/m ² (kWh/m ² yearly)
340,637	50	32,068	4.66

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