

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

DELIVERABLE 2.1

REPORT PRESENTING THE 3 NZEB RENOVATION SCHEMES IN MESSINA, ITALY, FULLY DOCUMENTED WITH TECHNICAL AND ECONOMIC EVALUATION

Authors:

Alessandra Gugliandolo, Maria-Anna Segreto - ENEA



Co-funded by the Intelligent Energy Europe Programme of the European Union

CERtuS Grant Agreement Number IEE/13/906/SI2.675068



DELIVERABLE SUMMARY SHEET

	Deliverable Details				
Type of Document:	Deliverable				
Document Reference #:	D2.1				
Title:	Report presenting the 3 nZEB renovation schemes in Italy, fully documented with technical and economic evaluation				
Version Number:	5.0				
Preparation Date:	April 20, 2015				
Delivery Date:	August 4, 2015				
Author(s):	Alessandra Gugliandolo, Maria Anna Segreto				
Contributors:	Pasquale Tripodo, Vito Leotta, Giacomo Villari, Chiara Santonocito, Gianfranco Scipilliti, Stella Styliani Fanou				
Document Identifier:	CERtuS_WP2_D2.1_Italian renovation schemes				
Document Status:	Delivered				
Dissemination Level:	X PU Public				
	PP Restricted to other program participants				
	RE Restricted to a group specified by the Consortium				
	CO Confidential, only for member of the Consortium				
Nature of Document:	Report				

	Project Details			
Project Acronym:	CERtuS			
Project Title:	Cost Efficient Options and Financing Mechanisms for nearly Zero Energy Renovation of existing Buildings Stock			
Project Number:	IEE/13/906/SI2.675068			
Call Identifier:	CIP-IEE-2013			
Project Coordinator:	Stella Styliani FANOU, ENEA, Centro Ricerche Casaccia, Via Anguillarese, 301, 00123 S.Maria di Galeria (Roma), Italy styliani.fanou@enea.it			
Participating Partners:	 ENEA - Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile - Italy COMUNE MESSINA - Comune di Messina - Italy ERRENTERIA - Errenteriako udala - Spain CMC - camara municipal de coimbra - Portugal ALIMOS - Dimos Alimou - Municipality of Alimos - Greece ISR - Instituto de sistemas e robotica - Associacao - Portugal SINLOC – Sistema Inizative Locali S.p.A Italy ETVA VI PE - ETVA VI.PE. S.A Greece TECNALIA - Fundacion Tecnalia Research & Innovation - Spain EUDITI LTD - EuDiti - Energy and Environmental Design - Greece INNOVA BIC - INNOVA BIC - Business Innovation Centre - Italy AAU SBi - Aalborg University - Denmark ASSISTAL - Associazione Nazionale Costruttori di impianti e dei servizi di efficienza energetica ESCo e Facility Management- Italy 			
Funding Scheme:	Collaborative Project			
Contract Start Date:	March 1, 2014			
Duration:	30 Months			
Project website address:	www.certus-project.eu			



Deliverable D2.1: Short Description

The document presents three renovation schemes for Messina, Italy, with calculated energy performances and costs carried out through simulation software. The optimal renovation designed has been selected according overall energy efficiency, regulatory framework, comfort and visual impact of the solutions proposed

Keywords: Renovation plan, historic buildings, nZEB, energy efficiency, renewable energy, economic assessment, energy audit.

Revision	Date	Status	Reviewer	Organization	Description
V0.1	17/09/2014	Draft	Pello Larrinaga	TECNALIA	ТоС
V1.1	07/01/2015	Draft	Alessandra Gugliandolo	ENEA	Inclusion of simulations results
V1.2	10/04/2015	Draft	Alessandra Gugliandolo, Maria-Anna Segreto	ENEA	Update of results Zanca and Satellite
V1.3	10/04/2015	Draft	Alessandra Gugliandolo, Maria-Anna Segreto	ENEA	Update of results Zanca and Satellite
V1.4	15/05/2015	Draft	Alessandra Gugliandolo, Stella Styliani Fanou	ENEA	Contribution to final results
V1.5	26/05/2015	Draft	Vito Leotta, Pasquale Tripodo	Messina Municipality	Economic Evaluation
V1.6	29/05/2015	Draft	Alessandra Gugliandolo, Maria-Anna Segreto	ENEA	Contribution to final results
V1.7	12/06/2015	Draft	Vito Leotta, Pasquale Tripodo	Messina Municipality	Economic Evaluation
V1.8	17/06/2015	Draft	Vito Leotta, Pasquale Tripodo	Messina Municipality	Economic Evaluation
V2.0	26/06/2015	Advanced Draft	Alessandra Gugliandolo, Maria-Anna Segreto, Stella Styliani Fanou	ENEA	Update, merge and format
V2.1	03/07/2015	Advanced Draft	Alessandra Gugliandolo, Maria-Anna Segreto	ENEA	Update, merge and format
V2.2	07/07/2015	Advanced Draft	Vito Leotta, Pasquale Tripodo	Messina Municipality	Economic Evaluation



mic	Economic	Messina	Vito Leotta,	Advanced	14/07/2015	V2.3
tion	Evaluation	Municipality	Pasquale	Draft		
			Tripodo			
mic	Economic	Messina	Vito Leotta,	Advanced	21/07/2015	V2.4
tion	Evaluation	Municipality	Pasquale	Draft		
			Tripodo			
view	1 st Review	SBi	Kirsten	Advanced	24/07/2015	V3.0
			Thomsen	Draft		
view	2 nd Review	SBi	Jørgen Rose	Advanced	24/07/2015	V3.1
			-	Draft		
e reviev	Update	ENEA	Alessandra	Final	27/06/2015	V4.0
ents	comments		Gugliandolo,	Draft		
			Maria-Anna			
			Segreto			
e Economi	Update E	Messina	Vito Leotta,	Final	28/07/2015	V4.1
tion	Evaluation	Municipality	Pasquale	Draft		
			Tripodo			
e Economi	Update E	Messina	Vito Leotta,	Final	29/07/2015	V4.2
tion	Evaluation	Municipality	Pasquale	Draft		
			Tripodo			
e reviev	Update	ENEA	Alessandra	Final	03/08/2015	V4.3
ents	comments		Gugliandolo,	Draft		
			Maria-Anna			
			Segreto			
t, inclusion	Format, ii	ENEA	Stella Styliani	Final	07/08/2015	V.5
nal approval			, Fanou			
t, inc	Format, ii	ENEA	Segreto Stella Styliani		07/08/2015	V.5

Statement of originality

This deliverable contains original unpublished work except where clearly indicated otherwise. Acknowledgement of previously published material and of the work of others has been made through appropriate citation, quotation or both.



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ABBREVIATIONS AND ACRONYMS

Acronym	Definition
CFL	Compact Fluorescent Lamp
СНР	Combined Heat and Power
СОР	Coefficient Of Performance
EER	Energy Efficiency Ratio
ESCO	Energy Service Company
HVAC	Heating Ventilation Air Conditioning
LED	Light-Emitting Diode
nZEB	nearly Zero-Energy Building
PV	Photovoltaic
BACS	Building Automation Control System



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.



SUMMARY

Messina municipality is participating with three buildings, namely, the City Hall (Zanca Palace) and two municipal offices (Satellite Palace and Antonello da Messina Cultural Palace).

The aim of the renovation design is to achieve the nearly zero energy building standard, ensuring the comfort of the occupants, workers and visitors.

The design, detailed in the subsequent chapters, was developed along the requirements and constraints imposed by the Technical Department, the Physical Planning Department and the Superintendence of Cultural Heritage of the City of Messina.

The principal constraints to be observed are:

- (i) To maintain the historical memory and architectural building
- (ii) Do not change in full the working functions
- (iii) Do not interrupt the activities of workers and interfere as little as possible with the normal development of municipal activities.

Also in Italy has not yet entered into force legislation governing building design nZEB, should come into force in the year 2015.

Proposals for renewal concern the reduction of all energy consumption: lighting, heating / cooling, computer equipment and electronics. The analysis of the buildings has been carried out with: energy audits.

The software used is the Design Builder version v. 3.4.0.033, based on Energy Plus. The data for envelope materials, electronics and computing equipment, lighting, heating/cooling plants and management profiles of individual environments have been included using special schedules. Wherever experimental data were not available they have been referred to the values required by the regulations. Examined the conditions of the state of the simulation was then made of the state of the project, entering hypothesized renovation scheme. These interventions were extremely expensive, just because of the huge size of the building (13,500 sqm/ 90000 mc) but, at a later time, will be necessary to evaluate the investment payback.



MESSINA GENERAL INFORMATION

Messina is an Italian municipality with a population of 240,725, has an area of 211.23 km²; also called the "door of Sicily" and once Zancle and Messana, located in the North-Eastern part of Sicily (Capo Peloro), exactly on the Strait of Messina.

From sea level, within the same municipality, it is possible to climb up to 1,130 meters, through the hills above the city, to Mount Dinnammare (from the Latin "bimaris" two seas). From here the view extends on the two seas of the city, Sea Ionio (on the Strait of Messina) and the Tyrrhenian Sea.

Its marina is the first in Italy for number of passengers and the sixth for cruise traffic.

In 1908 an earthquake destroyed the city almost completely, causing the death of about half the city's population. Rebuilding started in 1912, and the modern city presents itself orderly and regular with wide and straight streets in direction north-south. In recent years, projects are underway aimed at the redevelopment of the city through works such as the waterfront or a new location for the train station.

With an Important and historic university, founded in 1548 by St. Ignatius of Loyola, Messina is a city with an economy based on services, trade, tourism and a significant industrial activity in naval shipbuilding.



FIGURE 1 - LOCALIZATION OF MESSINA IN ITALY

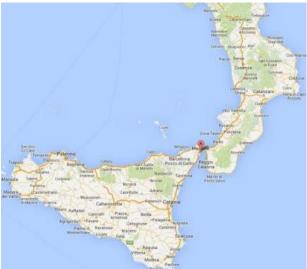


FIGURE 2 - LOCALIZATION OF MESSINA IN SICILY



FIGURE 3 - MESSINA VIEW FROM ABOVE



A. PALACE OF CULTURE – PALACULTURA ANTONELLO DA MESSINA

1. BUILDING GENERAL DESCRIPTION

1.1. LOCATION

Palacultura is a important building of Messina. The building is located near the marina of the city. The Palace of Culture (or more simply Palacultura) is a multifunctional center in the city of Messina, composed of three buildings, in which there are an auditorium, an outdoor theater, a library and an exhibition center located on the terrace.



FIGURE 4 - PALACULTURA

Made and designed in 1975 by engineer Aldo D'Amore and architect Fabio Baisle, after various events (such as the finding of some archaeological remains), it was completed only at the end of 2000. More precisely, April 16, 2009 were concluded the work started in 2005, after 30 years from the project. Located in the central part of the avenue Boccetta, which is for the city of Messina the first access road for motorists coming from the highways, it is therefore necessarily a visiting card on architecture that the city offers to visitors.



Deliverable D2.1 Report presenting the 3 nZEB renovation schemes in Italy, fully documented with technical and economic evaluation



FIGURE 5 - PALACULTURE FROM AVENUE BOCCETTA



FIGURE 6 - A PARTICULAR VIEW OF PALACULTURE

Table 1 presents the main location data of the building.

TABLE 1 - LOCATION DATA OF THE BUILDING

Address	European Union Square, 41 98122 Messina (ME), Italy
Coordinates	LAT. 38°11'51.91"N- LONG. 15°33'14.05"E
Google Maps	https://www.google.it/maps/place/38%C2%B011%2751.9%22N+15%C2%B033%2714.1%22 E/@38.1977494,15.5539167,2880m/data=!3m2!1e3!4b1!4m2!3m1!1s0x0:0x0!6m1!1e1

The building is located near the marina of the city. These figures show the location in the city map and aerial view.

Final



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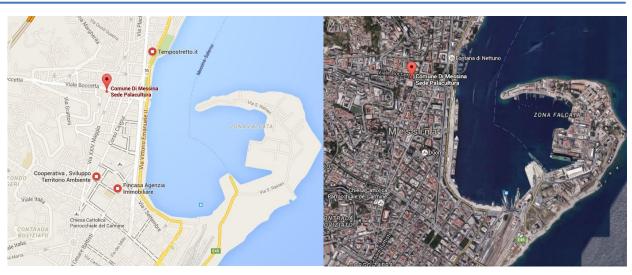


FIGURE 7 - LOCATION IN THE CITY (MAP)

FIGURE 8 - LOCATION IN THE CITY (AERIAL VIEW)

Degree days 707 5.0 °C Minimum temperature of project 3 m s.l.m. Altitude В **Climatic Zone** 121 Heating days Wind speed 2.8 m/s Wind zone 2 Province of Messina - Reggio di Calabria reference JUN JUL ОСТ NOV Average monthly JAN FEB MAR APR MAY AUG SEP DEC temperatures(°C) 11.7 12.0 13.2 15.7 19.2 23.5 26.4 26.5 24.2 20.3 16.6 13.3 JAN MAR APR MAY JUN AUG SEP NOV DEC Averages monthly FEB JUL OCT 7.2 10.8 15.2 20.3 24.4 27.3 27.2 24.6 19.0 12.9 8.9 6.6 raditions (MJ/m²) 10.8 12.9 12.9 9.9 9.2 9.7 14.2 13.2 10.3 11.5 11.8 14.0 8.6 11.1 12.7 13.6 13.8 14.3 15.3 14.9 12.6 10.7 8.2 13.6 5.4 7.9 10.5 13.4 15.6 17.1 17.2 16.2 13.1 9.3 6.7 5.0 2.7 4.2 9.7 12.5 14.5 8.2 5.1 3.2 2.4 6.6 14.1 11.8 2.4 3.2 4.3 5.9 8.4 10.2 9.5 6.8 4.6 3.6 2.6 2.2

TABLE 2 - DATA OF THE SYSTEM CONSIDERED



s Template	MESSINA
Site Location	
Latitude (")	38,20
Longitude (")	15,55
Site Details	
Elevation above sea level (m)	51,0
Exposure to wind	2-Normal
Site orientation (")	0
Ground	
Add ground construction layers to surfaces in c	contact with ground (separate constructions only)
Construction	Cultivated clay soil (0.5m)
⊠ Texture	GranulatedGray453M
Surface Reflection	
Surface solar and visible reflectance	0,20
Snow reflected solar modifier	1,00
Snow reflected daylight modifier	1,00
Monthly Temperatures	
Water Mains Temperature	
Precipitation Site Green Roof Irrigation	
Time and Daylight Saving	
Simulation Weather Data	
🕂 Hourly weather data	ITA_MESSINA_IGDG
Winter Design Weather Data	
Heating 99.6% coverage	
and the second secon	6.0
Outside design temperature (°C)	6,3 10,2
Wind speed (m/s)	0,0
Wind direction (")	0,0
O Heating 99% coverage	
Summer Design Weather Data	
Temperature Range Modifiers	
Design Temperatures	
● 99.6% coverage (based on dry-bulb temp.)	
Max dry-bulb temperature (°C)	32,2
Coincident wet-bulb temperature (*C)	22,8
Min dry-bulb temperature (°C)	27,1
O 99% coverage (based on dry-bulb temp.)	
O 98% coverage (based on dry-bulb temp.)	

FIGURE 9 - DATA FOR THE SIMULATION WITH DESIGN BUILDER SOFTWARE

Final



1.2. Shape And Orientation

This Palace is constituted from a building of 6 floors above ground. The dimensions are very different for each floor.

The next figure shows the road network near the studied area.

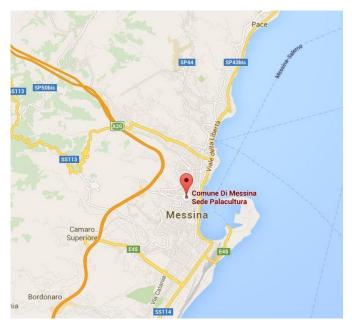


FIGURE 10 - ROAD NETWORK SCHEME

1.3. AREA AND VOLUME

The building has a total area of about 10,300 m^2 , this area is divided in different levels, which are however different in height and shape.

1.4. CURRENT USE

It consists of three buildings used to house offices for culture, the largest town public library, a museum, a theater with 850 seats with 4 audiences, orchestra pit and booths for television direction of events, an auditorium for music outdoors among the largest and most modern of Italy, and even an exhibition hall located on the terrace of the second body of the building.

The inverted pyramid structure was obtained by exploiting the considerable flexibility offered by materials such as concrete and steel, of course taking into account that Messina is a seismic zone of 1st category.

On the ground floor there is the access to the building with hall, reception of the theater. All rooms are now used as offices for culture, with the exception of the bathrooms, deposits and some offices of municipal councillors.





FIGURE 11 - HALL AND RECEPTION



FIGURE 12 - THEATER

On the first floors there are numerous municipal offices, meeting rooms, a museum, a public library bathrooms and archives.



FIGURE 13 - MUSEUM



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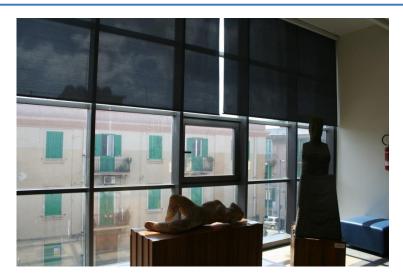


FIGURE 14 - AN ARTWORK OF THE MUSEUM

In the basement there are technical rooms and a garage for employees of the Palace of Culture. The building is usually busy for the public activities and on the occasion of the museum exhibitions or theater performances. The public activities of employees carried out only between 7h30 and 19h30. Public access depends on the type of service provided and is between 08h30 and 13h30 from Monday to Friday, also between 14h30 and 16h30 on Tuesday and Thursdays.

The building hosts about 200 employees and visitor numbers change according to the activities taking place at the palace.

For the simulation of Palace of Culture of Messina with Design Builder, the building was divided into 11 blocks (named 11,12,13,14,16,2,3,4,5,6,7). Windows are modelled individually and has been dimensioned according to data of the original design.

The following image shows the Home screen of the software.

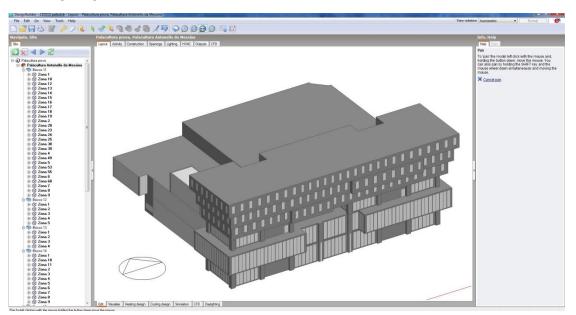


FIGURE 15 - HOME SCREEN OF THE SOFTWARE

The following figures show the floor plans of the blocks, as shown in the simulation software. Each floor is split into different areas, depending on the intended use. Therefore different usage profiles were created.



Block 11 consists of:

- Office Circulation
- Area for speculative office
- Theatre and Lecture space
- Area without any cooling or heating plant
- Office Toilet
- Office Meeting room
- Office Equipment

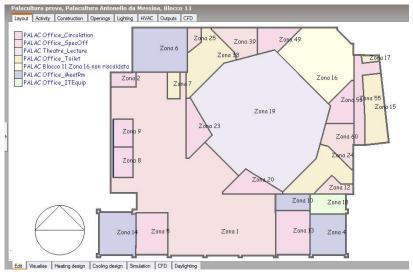


FIGURE 16 - PLAN OF BLOCK 11

Block 16 is the area intended for mobile stairs that connect the ground floor to the second floors the area of the:

Office Circulation

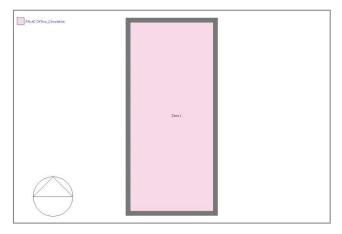


FIGURE 17 - PLAN OF BLOCK 16

Second floor is constituted by three blocks (12,13,14). Block 12 consists of:

- Office Circulation
- Office Toilet



Office Meeting room

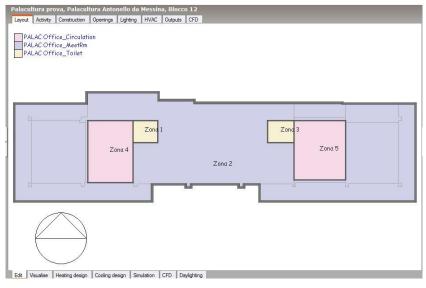


FIGURE 18 - PLAN OF BLOCK 12

Block 13 consists of:

- Office Circulation
- Office Toilet
- Office Meeting room

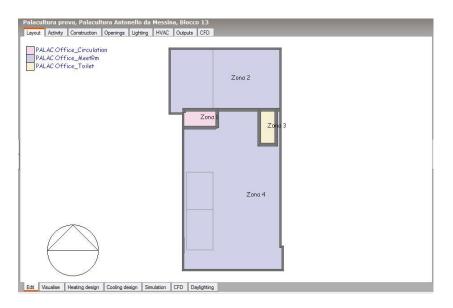


FIGURE 19 - PLAN OF BLOCK 13

Block 14 consists of:

- Office Circulation
- Area for speculative office
- Theatre and Lecture space

Area without any cooling or heating plant

- Office Toilet
- Office Equipment



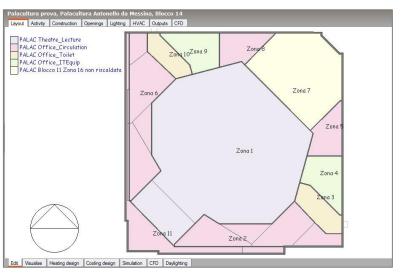


FIGURE 20 - PLAN OF BLOCK 14

Blocks 4 and 5 are in the same floor and have the same functional rooms:

- Office Typical
- Circulation

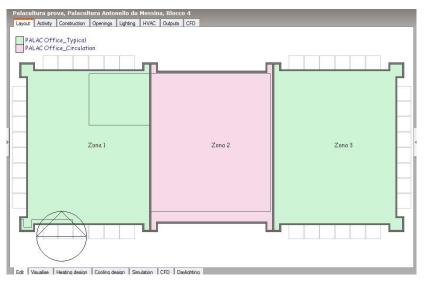


FIGURE 21 - PLAN OF BLOCK 4



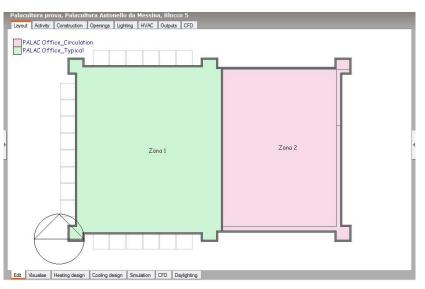
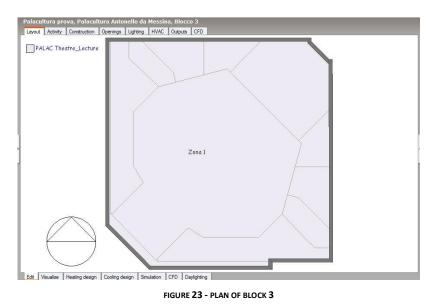


FIGURE 22 - PLAN OF BLOCK 5

Block 3 is the highest part of the area destined to the Theatre:

- Office Circulation
- Area for speculative office
- Theatre and Lecture space
- Area without any cooling or heating plant
- Office Toilet
- Office Equipment



Blocks 6, 7 and 2 are the top three floors of Culture Palace. Each floor has the geometry of a parallelepiped with a rectangular base, the dimensions of which increase from the floor below up to the highest one.

Blocks 6, 7 and 2 have the same functions:

- Office Circulation
- Office Toilet
- Office Meeting room



• Office Typical

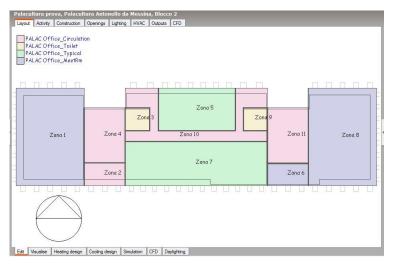


FIGURE 24 - PLAN OF BLOCK 2

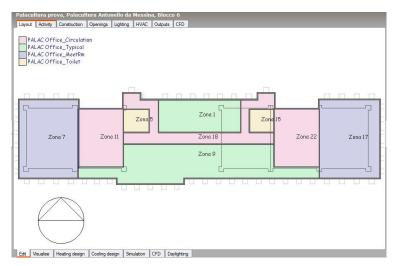


FIGURE 25 - PLAN OF BLOCK 6

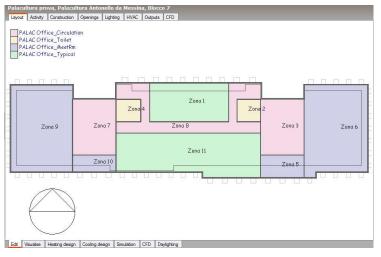


FIGURE 26 - PLAN OF BLOCK 7



2. CURRENT BUILDING CONDITIONS

2.1. CONSTRUCTIVE BUILDING CHARACTERISTICS

Palace of Culture respects the seismic regulations. It is a structure realized in steel and reinforced concrete, according to earthquake regulations in 2000 and does not meet any energy regulations still in force. The following figure presents the aerial view of the building.



FIGURE 27 - AERIAL VIEW OF THE BUILDING

On the ground floor there are the offices open to the public, the access to museum and the access to the theater. The first floor holds some administrative functions of the city of Messina and the library and all rooms of the museum. The other floors hold only administrative functions.



FIGURE 28 - ACCESS OF THE BUILDING



FIGURE 29 - ROOF OF THE BUILDING



The next figure shows the main facade orientation of the building, exposed to the North.

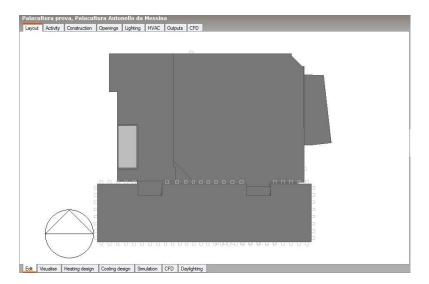


FIGURE 30 - ORIENTATION OF THE MAIN FAÇADE

2.1.1. Envelope Elements

The building is made of wide range of materials, mainly steel and concrete for the envelope. The walls are on the envelope, with the finishing plaster. The plaster has a low capacity, based on lime.



FIGURE 31 - FRONT OF PALACE OF CULTURE

FIGURE 32 - STAIR

2.1.2. WINDOWS

All the windows have single glazing with pvc frames. The doors have the same characteristics of the windows with the exception of 8 doors on the ground floor, which are in glass and metal.

All the windows have simple shutters. A few rooms have opaque cloth curtains the rest have no curtains.



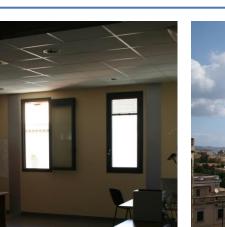






FIGURE 34 - EUROPEAN UNION SQUARE

All facades, specially on Boccetta Street, are not subject to any shading, as can be seen from the following figure.

Openings Lighting HVAC Outputs CFD										
Glazing Template										
Template	Template vetro di progetto									
External Windows	Template vero di progetto									
MGlazing type	Vetro esterno di progetto									
	Preferred height 1.5m, 30% glazed									
Dimensions	v referied height field, eere grazed									
Туре	0-None -									
Reveal	> 2									
Frame and Dividers	*									
Has a frame/dividers?										
Construction	UPVC window frame									
Dividers	÷									
Туре	1-Divided lite ·									
Width (m)	0,0200									
Horizontal dividers	1									
Vertical dividers	1									
Outside projection (m)	0,000									
Inside projection (m)	0,000									
Glass edge-centre conduction ratio	1,000									
Frame	0.0400									
Frame width (m)	0,0400									
Frame inside projection (m)	0,000									
Frame outside projection (m)	0,000 1,000									
Glass edge-centre conduction ratio	1,000									
Operation										
% Glazing area opens	5.0 🗢									
▼										
0 10 20 30 40	50 60 70 80 90 100									
😭 Operation schedule	PALAC Office_Occ									
🗊 Internal Windows	›									
Roof Windows/Skylights										
🗭 Glazing type	Vetro Copertura di progetto									
Layout	No roof glazing									
Dimensions Freme and Dividers	>									
Frame and Dividers Shading	>									
Operation										
Doors	×									
Vents	×									

FIGURE 35 - SCHEDULE OF WINDOWS



2.1.3. AIRFLOWS AND PATHOLOGIES

A previous study analysed the envelope with thermal imaging with an external air temperature of about 17°C.



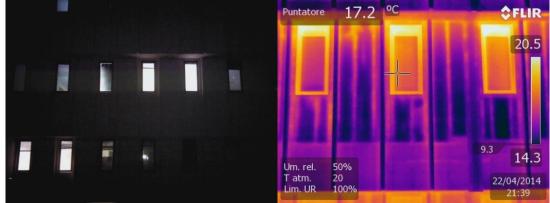


FIGURE 37 - THERMAL VIEW

The following figure shows the general image of the thermal performance of the envelope: the walls present a bad thermal performance.



FIGURE 38 - THERMAL VIEW

The next figures show the thermal losses of the windows. The windows, with single glazing and PVC frames, present insulation problems.



Deliverable D2.1 Report presenting the 3 nZEB renovation schemes in Italy, fully documented with technical and economic evaluation

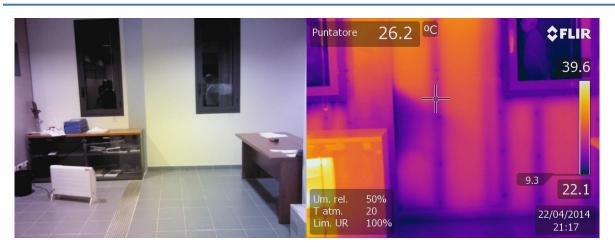


FIGURE 39 - THERMAL LOSSES IN THE WINDOWS AND WINDOW INVISIBLE TO THE NAKED EYE

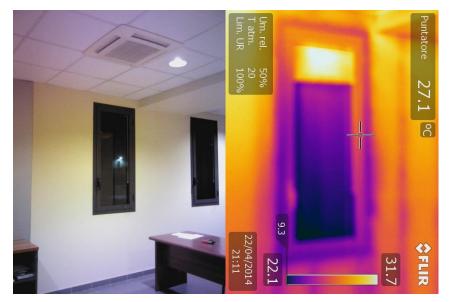


FIGURE 40 - THERMAL LOSSES IN THE WINDOWS AND WINDOW INVISIBLE TO THE NAKED EYE

The thermal losses due to thermal bridges in the corner of the room are also shown.



FIGURE 41 - THERMAL BRIDGES



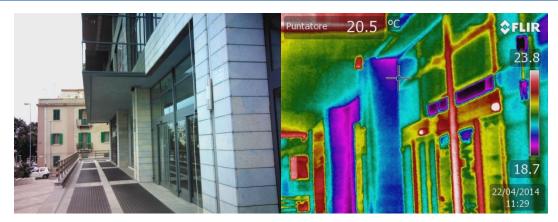


FIGURE 42 - THERMAL BRIDGES

Some characteristics of the building contribute to a bad thermal performance:

- The orientation is not good, due to this condition it is required an additional energy use for heating during the winter (mainly in the North areas). Also it is required more energy use during summer for cooling (mainly in the West areas where there is no protection from the direct solar radiation).
- The walls with high thermal inertia and large ceiling height provide advantages during the summer, but disadvantages during winter, since the building does not have users in the night period and weekends which leads to a high temperature decrease.
- The windows have low air-tightness, enabling a high level of air infiltration, which is not controllable, mainly during winter.
- The doors presents significant heat losses
- The building as a whole has a low energy performance

2.2. ENERGY SYSTEMS

2.2.1. HVAC

The HVAC is ensured with several ceiling mounted split, for the forced ventilation and air conditioning. Therefore, all split units are connected to a single hydronic heat pump.



FIGURE 43 - THERMOGRAPHY OF AN AIR CONDITIONER ON



Template		PA	LAC Spl	it + sepa	rate mec	chanical v	ventilat				
Туре		1-U	nitary sinc	ale zone							
System Availability											
😭 Schedule		On									
Mechanical Ventilation											
☑ On											
Outside air definition method		1-By	/zone								
Outside air (ac/h)		3,000 🗢									
	1	1000			T						
0 2 4 8 Min AHU Outside Air Requirement	8	10	12	14	16	18	20				
Chedule	-	PAI	AC Office				-				
Fans		TAL		5_000							
Fan operation mode		1-Cc	ontinuous								
Pressure rise (Pa)		400									
Total efficiency (%)		70									
Fan in air (%)		100									
Economiser (Free Cooling)											
Туре		1-N	one								
Heat Recovery											
🗖 On											
Heating											
✓ Heated				_							
Unitary heating fuel		1-EI	ectricity fr	om grid							
Unitary distribution loss		5,0	5.) -								
Local Heating Units											
Operation											
😭 Schedule		PAL	AC Office	e_Heat_S	etback						
-Cooling											
Cooled											
Unitary cooling fuel		1-EI	ectricity fr	om grid							
Supply Air Condition											
Unitary cooling CoP		1,68	0								
Unitary distribution loss		5,0									
Operation											

FIGURE 44 - HVAC TEMPLATE

PALAC Office_Occ	
2690	
0,000001000	
1-Cool-Reheat Heating Coil	
	2690 0,000001000

FIGURE 45 - HVAC TEMPLATE (HUMIDITY CONTROL)

The air circulation and renewal is ensured both naturally through the doors and windows as well as through the mechanical system. There is forced ventilation in every room.



☑ On	
Outside air definition method	1-By zone
Outside air (ac/h)	3,000 🗢
	6 7 8 9 10 11 12
Operation	
😭 Schedule	PALAC Office_Occ
Options	
Mixed Mode Zone Equipment	
Mixed mode on	
Wind and Rain	
COpening factor function wind speed c	Opening Factor Function of Wind Speed Curve
Close windows and vents when raining	3
Max wind speed (m/s)	40,0
Temperature Control	
	-100,0
Min outdoor temperature (*C)	-100,0 100,0
Min outdoor temperature (*C) Max outdoor temperature (*C) Enthalpy Control	
Min outdoor temperature (*C) Max outdoor temperature (*C) Enthalpy Control Min outdoor enthalpy (J/kg)	100,0
Min outdoor temperature (*C) Max outdoor temperature (*C) Enthalpy Control	100,0 20000
Min outdoor temperature (°C) Max outdoor temperature (°C) Enthalpy Control Min outdoor enthalpy (J/kg) Max outdoor enthalpy (J/kg)	100,0 20000
Min outdoor temperature (°C) Max outdoor temperature (°C) Enthalpy Control Min outdoor enthalpy (J/kg) Max outdoor enthalpy (J/kg) Dew Point Control	100,0 20000 30000
Min outdoor temperature (°C) Max outdoor temperature (°C) Enthalpy Control Min outdoor enthalpy (J/kg) Max outdoor enthalpy (J/kg) Dew Point Control Min outdoor dew point temperature (°C)	100,0 20000 30000 15,0
Min outdoor temperature (°C) Max outdoor temperature (°C) Enthalpy Control Min outdoor enthalpy (J/kg) Max outdoor enthalpy (J/kg) Dew Point Control Min outdoor dew point temperature (°C) Max outdoor dew point temperature (°C)	100,0 20000 30000 15,0
Min outdoor temperature (°C) Max outdoor temperature (°C) Enthalpy Control Min outdoor enthalpy (J/kg) Max outdoor enthalpy (J/kg) Dew Point Control Min outdoor dew point temperature (°C) Max outdoor dew point temperature (°C) Advanced	100,0 20000 30000 15,0 30,0
Min outdoor temperature (°C) Max outdoor temperature (°C) Enthalpy Control Min outdoor enthalpy (J/kg) Max outdoor enthalpy (J/kg) Dew Point Control Min outdoor dew point temperature (°C) Max outdoor dew point temperature (°C) Advanced	100,0 20000 30000 15,0 30,0 Mixed mode temperature control Minimum outdoor ventilation air schedule: Always

FIGURE 46 - HVAC TEMPLATE

2.2.2. LIGHTING

The building has many different types of lamps, all of fluorescent type.

Lighting Template			Pala	c Fluor	escen	t, com	pact	E,			
Seneral Lighting											
☑ On											
Lighting energy (W/m2)			24,	75 🜲							
0 2 4 6 8 10 12	14 16	18	20 22	24	28 28	30	32	34	38	38	40
Luminaire type			2-Surf	ace mo	unt						
Radiant fraction			0,720								
Visible fraction			0,180								
Convective fraction			0,100								
Lighting Control											
🗖 On											
🖉 Task and Display Lighting											
On On											
Gain (W/m2)			0,000								

FIGURE 47 - LIGHTING TYPE





FIGURE 48 - LIGHTING IN OFFICES



FIGURE 49 - PARTICULAR LIGHT IN THE MUSEUM



FIGURE 50 - LIGHTING IN MUSEUM AREAS



FIGURE 51 - LIGHTING IN CIRCULATION AREAS



FIGURE 52 - LIGHTING ON THE ROOF OF THE TEATHER



FIGURE 53 - LIGHTING IN AUDITORIUM



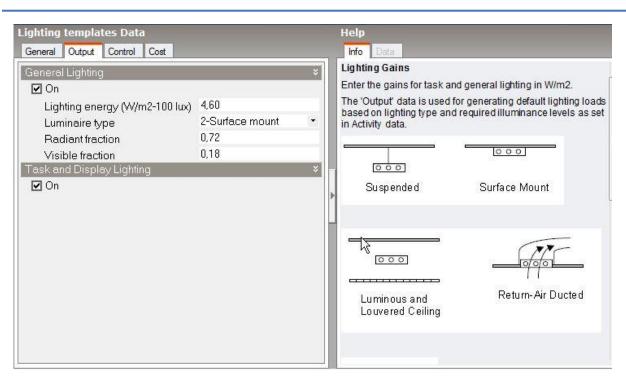


FIGURE 54 - LIGHTING TEMPLATE DATA

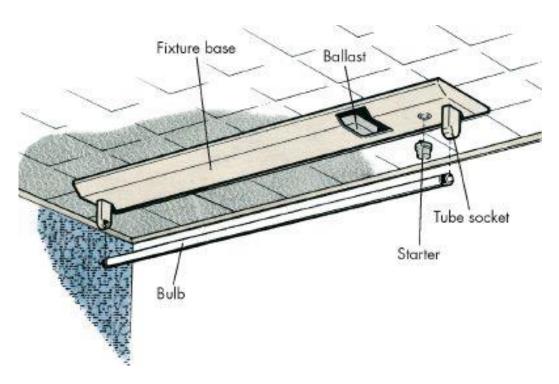


FIGURE 55 - AN EXAMPLE OF FLUORESCENT LAMP

Final



There is no mechanism to control lighting and installations are dated. During closed hours only emergency lighting is on.

TABLE 3 - LAMPS CALCULATION

Piano	Rounded Light Ø230mm 2x26W	Rounded Light Ø190mm 26W	Light at wall 100W	Square Suspended 2x26 W	Prismatic Light 1x18W	Prismatic Light 2x36W	Lamellar Light 4x18W	Prismatic Light 1x36W	Emergency lighting 24W	schermat a 28 W	Spotlight 90W	Spotlight 50W	Applique 75W		Light at wall 26W	Plafone lettura 58W		Suspended Spotlight75 W	External Lighting 70W	Light for the path 24W		
Height-4,75 - Garage					°C *	48	2		21							S2		s				
Height-1,25 -		e 18		8	9a - S		9		9.			e - 18				96		9	ş			
Deposit books and		13			4	93	6		14	4												
Technical rooms									. <u>0</u>			· · · · · ·					2					
Height 2,25) Hall -																						
Auditorium - Sala 70	6	54	21	. 115		13	4			22	35	41	14	18	4							
posti																						
Height 7,25)Reading																						
Room - Art Gallery -	4	40	19	120		9	4	9	29	36				6		32						
Room 140 seats		-							. <u>0</u>			· · · · · ·					2					
Height 12,25)																						
Auditorium Lighting-	6	42	11	. 27		6	4		10	0	25			3	37		18	36				
External Lighting																						
Height 15,85) Arena		4																	26	53		
Esterna		2.5																	20			
Height 15,85) Offices							4		9													
Height 19,45) Offices	100						4		9													
Height 23,05) Offices	130	23					4		9													
Height 27,00) Roof - Technical Rooms		32				14	l.		2									50				
TOTAL	333	298	51	262	4	183	32	9	103	58	60	41	14	27	41	32	18	36	26	53	1681	NUMBER
Total/partial number	52	26	100	52	18	72	72	36	24	28	90	50	75	80	26	58	150	75	70	24		
Watt Tot.Partial	17316	7748	5100	13624	72	13176	2304	324	2472	1624	5400	2050	1050	2160	1066	1856	2700	2700	1820	1272	85834,00	WATT TOT
j		10			18 ()		8		22	4		<u>i</u>				10		10				



2.2.3. ICT

All offices have computers and printers and in the basement there is a server room. There is an internal circuit for security.

There are photocopier machines, tv screens, video projectors and other electrical equipment used for the museum and the theater.

2.2.4. OTHERS

The building has lifts. The use of such lifts is massive because they serve both the public and employees.

Lift and other equipment connected to plugs such as individual electric heaters, vending machines, photocopier machines, computers and printers (when not connected to the UPSs) etc, were flagged as "other".

For calculating their consumption usage profiles have been created directly through the Design Builder software.

2.3. ENERGY CONSUMPTION & ENERGY GENERATION

2.3.1. ELECTRICITY CONSUMPTION

The building receives electricity in Low Voltage. Following a summary table of power consumption.

ELECTRICITY CONSUMPTION	kWh per year (2013)	r kWh per year (2014)								
Palace of Culture										
V.le Boccetta is. 373/374 - MESSINA		Survey performed on days in mid-June in 2014. Average consumption with average outdoor temperatures of 27 C during operation.								
Number of User - IT001E91358706	€ 153,957,82	507,259 kWh								

TABLE 4 - ELECTRICITY CONSUMPTION

There is a central generation for heating and cooling system. To set the calculation of the model the general information are:

TABLE 5 - GENERAL INF	ORMATION FOR SIMULATION

	Data
Weather File	** Messina - ITA IGDG WMO#=164200
HDD and CDD data source	Weather File Stat
Total gross floor area [m2]	13580.56
Principal Heating Source	District Heat

The following figures show the heat balance of Palace of Culture of Messina, divided according to the contribution types:



- Occupancy,
- Task Lighting,
- General Lighting,
- Computer + Equipment,
- Solar Gans Exterior Windows,
- Zone Sensible Heating,
- Zone Sensible Cooling.

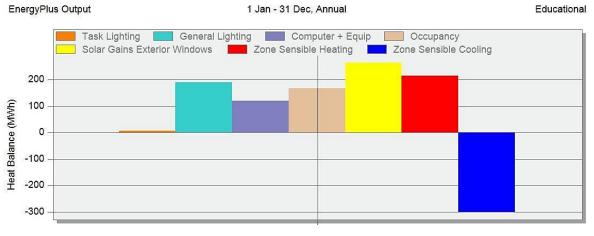
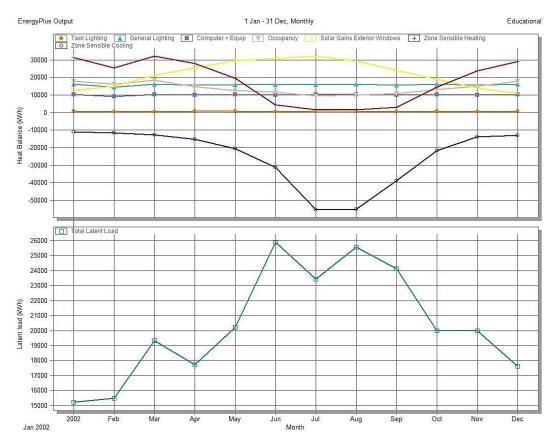
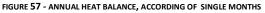


FIGURE 56 - ANNUAL HEAT BALANCE







The following figures show heat balance of Palace of Culture, divided according to the contribution types, during four months in particular January, April, July and September:

- Occupancy,
- Solar Gans Exterior Windows,
- Zone Sensible Heating,
- Zone Sensible Cooling.

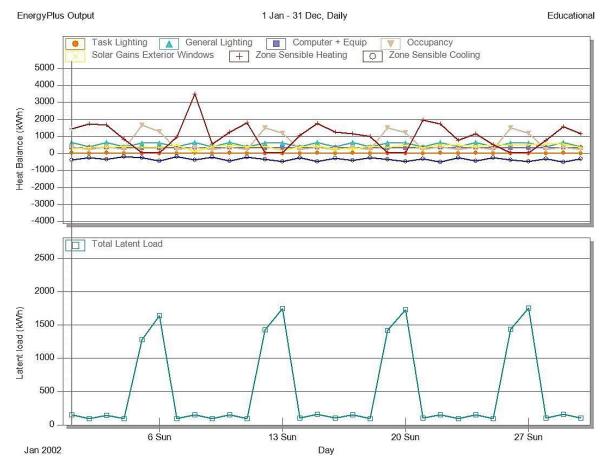


FIGURE 58 - HEAT BALANCE DURING JANUARY





FIGURE 59 - HEAT BALANCE DURING APRIL

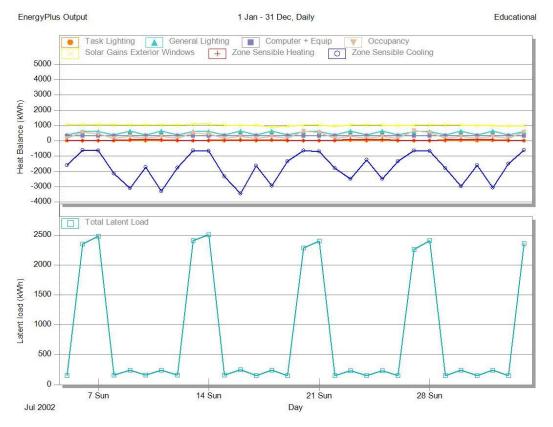


FIGURE **60** - HEAT BALANCE DURING JULY



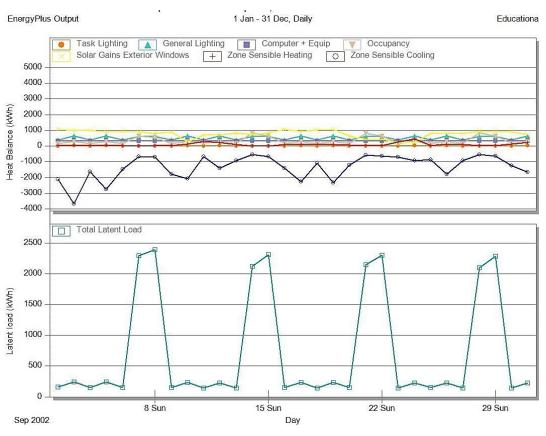


FIGURE 61 - HEAT BALANCE DURING SEPTEMBER

2.3.2. GAS/OIL CONSUMPTION

The building does not have any gas consumption.

2.3.3. RENEWABLE ENERGY SOURCES

The building does not have any RES plant.

2.3.4. OTHER GENERATION

Other data that influence thermal balance come from building envelope.

The considered data are:

- External air
- Internal Natural ventilation
- Mechanical Ventilation + Infiltration

Final



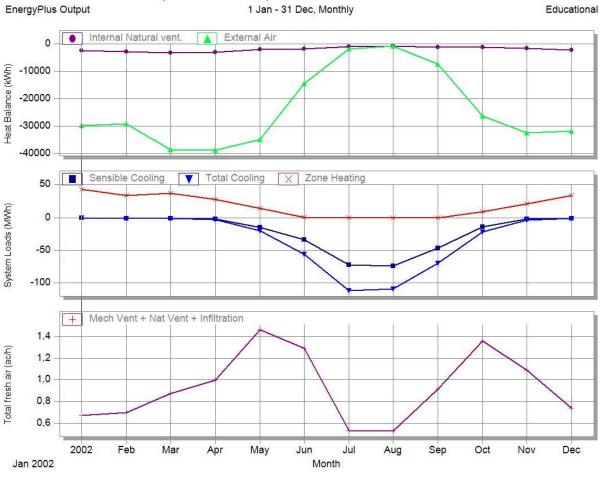


FIGURE 62 - ANNUAL HEAT BALANCE , ACCORDING OF SINGLE MONTHS

The following figures shows annual comfort value of Palace of Culture of Messina, divided according to the contribution types.

Final



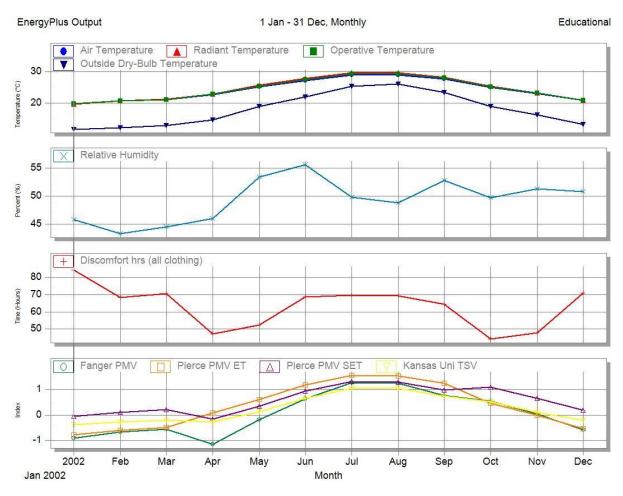




TABLE 6 - BUILDING AREA

	Area [m2]
Total Building Area	10274.89
Net Conditioned Building Area	10274.89
Unconditioned Building Area	0

In this building only electricity is consumed, as depicted by the following table

TABLE 7 - UTILITY USE PER TOTAL FLOOR AREA

	Electricity Intensity [kWh/m2]
HVAC	121.95
Total	121.95



	Electricity [kWh]	Natural Gas [kWh]	Additional Fuel [kWh]	District Cooling [kWh]	District Heating [kWh]	Water [m3]
Heating	223,362.48	0.00	0.00	0.00	0.00	0.00
Cooling	217,049.09	0.00	0.00	0.00	0.00	0.00
Interior Lighting	196,858.13	0.00	0.00	0.00	0.00	0.00
Exterior Lighting	0.00	0.00	0.00	0.00	0.00	0.00
Interior Equipment	120,275.15	0.00	0.00	0.00	0.00	0.00
Exterior Equipment	0.00	0.00	0.00	0.00	0.00	0.00
Fans	127,924.50	0.00	0.00	0.00	0.00	0.00
Pumps	0.00	0.00	0.00	0.00	0.00	0.00
Heat Rejection	0.00	0.00	0.00	0.00	0.00	0.00
Humidification	0.00	0.00	0.00	0.00	0.00	0.00
Heat Recovery	0.00	0.00	0.00	0.00	0.00	0.00
Water Systems	0.00	0.00	0.00	0.00	0.00	0.00
Refrigeration	0.00	0.00	0.00	0.00	0.00	0.00
Generators	0.00	0.00	0.00	0.00	0.00	0.00
Total End Uses	885,469.36	0.00	0.00	0.00	0.00	0.00

TABLE 8 - END USE CONSUMPTION

Note: Electricity appears to be the principal heating source based on energy usage.

TABLE 9 - END USE CONSUMPTION IN DETAIL

	Electricity [kWh]
Heating	223,362.48
Cooling	217,049.09
Interior Lighting	196,858.13
Interior Equipment	120,275.15
Fans	127,924.50
Total End Uses	885,469.36

Simulation data shows that the building has an electricity consumption of 885,469.36 kWh.

Parameters were assessed considering the following conversion factors:

- electricity to primary energy 2.174 (standard value approved for Italy)
- electricity to CO₂ emissions 510.00 g/kWh (average emissions associated with the electricity consumed in Italy during 2012, according ENEL environmental report 2012);



3. RENOVATION SCHEME

3.1. AIM OF THE RENOVATION PLAN

In Italy, the NZEBs (nearly zero energy buildings) don't meet national specific legislation but this is now being defined, according to Directive 2012/27/UE. NZEB design is aimed at achieving high performance standards in terms of energy and environment.

Specific attention should be devoted to the reduction of energy consumption of the building, guiding the design on three key areas:

- 1. Maximizing the building envelope passive behaviour
- 2. Use high efficiency systems
- 3. Use of systems for the renewable thermal energy exploitation and photovoltaic systems for the electricity production from solar sources.

The aim is to minimize energy contribution from the external electricity grid. The objective of the renovation plan is to achieve an average primary energy reduction between 75% and 80% of the current demand and to ensure that between 50% and 90% of the remaining energy consumtion is generated on site.

A building envelope is called passive if it is conformant to the following values:

- Thermal transmittance very low (0.0167/0.227 W/m²K)
- Low values of attenuation factor (<0.1), resulting in high phase shift values (>11.5 hours)
- Windows with transmittance less than 1.6 W/m²K
- System efficiency that can reduce by 70% the maximum solar radiation on transparent surfaces.

To achieve these aims some difficulties or constraints should be considered in the implementation.

The following global constraints were taken into account in the design of the renovation plan:

The buildings have an intensive utilization, receiving a large number of visitors, and are the working place for a large number of Municipal employees. Such activities cannot be interrupted since it is not easy to temporarily move the services to another building. Therefore, renovation options requiring major construction works needs a plan that takes into account the needs of both workers and visitors. For example, the renovation works may be performed in different steps by closing small areas in turn without hindering the normal daily activities.

The buildings have an intensive utilization, receiving a large number of visitors, and are the working place for a large number of Municipal employees. Such activities cannot be interrupted since it is not easy to temporarily move the services to another building. Therefore, renovation options requiring major construction works need a plan that takes into account the needs of both workers and visitors.



Planned integrations modify the architecture of the building, but without changing the functions. Being a historical building it was quite complicated inserting renewable sources and determining appropriate spaces to allocate them. Also, an intervention difficult to predict was that related to the new air conditioning system.

The assumptions for improvement have been inserted using the Design Builder software that simulates with Energy Plus Databases. Considering the environmental conditions of Messina, greater consumption for Palace of Culture, is by the use of electricity for cooling in the summer period, therefore it was decided to insert solutions also covering a constant ventilation of the building.

3.2. ENERGY DEMAND REDUCTION

3.2.1. OPAQUE ENVELOPE

An important task in the renewal plan is targeted to envelope. Where possible internal insulation will be added to the walls. The internal coat it will be possible with a new layer with high insulation value. In the state of the art, the walls are not properly put in place for an error due to the workers.

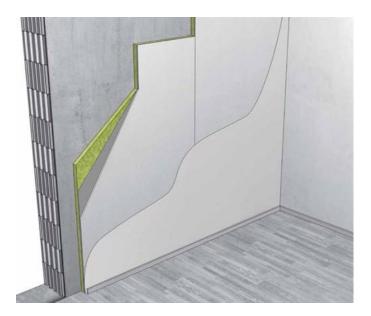


FIGURE 64- NEW LAYER AS INTERNAL INSULATION

The insertion of an internal insulation decreases the floor area of the building but it is the only possible solution in the case of a prospect with the external geometry as difficult as that of the Palace of Culture.

The renovation will be using panels of cork and plasterboard with a thickness up to 4 cm. Installation of an outer coat does not typically create particular problems in terms of physical and technical issues related to building physics. However, the installation of the inner coat requires careful attention to avoid the risk of formation of interstitial condensation, mould growth and/or the onset of potential events of decay of the structures.



The cork is self-expanded with a structure that can be described as "closed cell", it is rot-proof and therefore the risk of decay is almost insignificant. To understand the origin of this event we can start looking at the development of the internal temperatures to the wall under three different conditions: pre-intervention wall, wall with inner coat (4 and 6 cm) and with outer coat (4 and 6 cm).

Green roof has ancient historical precedent, such as the hanging gardens of Babylon, built by King Nabucondonosor, is a first strategy used in Eco-building to limit the environmental impact of the construction. This is one of the best known examples, it is recommended by all the associations that promote sustainable building for several reasons: it helps reduce a building's energy requirements and CO₂ emissions and brings many other economic and ecological benefits.

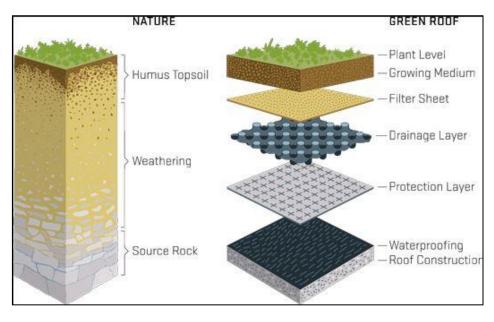


FIGURE 65 - GREEN ROOF

For example:

Temporarily it absorbs rainwater and releases it slowly to prevent flooding by overflowing of the sewer system and slows the obsolescence of the same due to the new urban settlements.

- It filters urban pollution and reduces carbon dioxide
- It filters polluted rainwater
- It cools the air by evaporation of water vapour
- It reduces wind speed
- It promotes the settlement of animals ecosystems
- It reduces noise transmission within the building
- It reduces the effect of "urban heat islands"
- It increases the thermal inertia of the roof
- It increases the thermal resistance of the roof
- It protects the waterproofing membrane and prolongs its life
- It is a tool of new architectural languages.





FIGURE 66 - RENDER OF THE GREEN ROOF

3.2.2. OPENINGS

At the state of art, all windows are in single glass with PVC frame. It is expected to replace all windows of Palace of Culture, inserting selective glasses and modifying PVC frames.

It is also important to study new forms of glass to optimize reflective surface and to insert new shading element.

Also, the existing glazing and frames (with U_g -value of 5.80 W/m²K and U_f -value of 2.8 W/m²K) will be replaced selective glazing and thermal break frame in PVC with total U_f -value 2.0 W/m²K and U_g value of 1.9 W/m²K, Regarding the frames is chosen to include window frames with thermal break, in this case the value of frame transmittance (U_f) improves. It is chosen to use windows with PVC frames. Glasses chosen are selective double glazing with air chamber 6/13 mm.





FIGURE 67 - PARTICULAR OF PVC FRAME

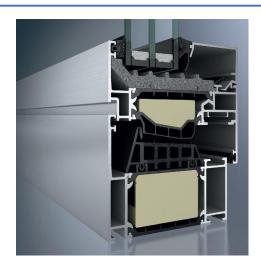


FIGURE 68 - EXAMPLE OF THERMAL BREAK



FIGURE 69 - ACTUAL REFLECTIVE SURFACE



FIGURE **72** - SKYLIGHT IN CIRCULATION AIR

FIGURE 70 - ACTUAL WINDOW



FIGURE 73 - SKYLIGHT IN THE STAIRWELL CENTRAL

FIGURE **71** - ACTUAL WINDOW AT FIRST FLOOR



FIGURE 74 - ENTRANCE DOOR

Final



3.2.3. SHADING

It was chosen to define as many shadings internal and external necessary to model the correct shading conditions. Shading types can be seen from the following table.

Shading		×
Window shading		
≣ Type	Blind with medium reflectivity slats	
Position	1-Inside	•
Control type	3-Schedule	+
Operation		×
😭 Operation schedule	Office_OpenOff_Occ	
Local shading		
≣Туре	1.0m Overhang	
🗊 Internal Windows		>>
Roof Windows/Skylights		**
🖪 Doors		»
📕 Vents		

FIGURE 75 - SHADING

/indow blinds Data		
General Slat data		
Slat Properties		
Blind-to-glass distance (m)	0,0500	
Slat orientation	Horizontal	
Slat width (m)	0,0250	
Slat separation (m)	0,0188	
Slat thickness (m)	0,0010	
Slat angle (")	45,0	
Slat conductivity (W/m-K)	0,900	
Minimum slat angle (")	0	
Maximum slat angle (*)	180	
Slat Beam Solar Properties		
Slat beam solar transmittance	0,000	
Slat beam solar reflectance, front side	0,500	
Slat beam solar reflectance, back side	0,500	
Slat Diffuse Solar Properties		
Slat diffuse solar transmittance	0,000	
Slat diffuse solar reflectance, front side	0,500	
Slat diffuse solar reflectance, back side	0,500	
Slat Beam Visible Properties		
Slat beam visible transmittance	0,000	
Slat beam visible reflectance, front side	0,500	
Slat beam visible reflectance, back side	0,500	
Slat Diffuse Visible Properties		
Slat diffuse Visible transmittance	0,000	
Slat diffuse visible reflectance, front side	0,500	
Slat diffuse visible reflectance, back side	0,500	
Slat IR (Thermal) Properties		
Slat hemispherical transmittance	0,000	
Slat hemispherical emissivity, front side	0,900	
Slat hemispherical emissivity, back side	0,900	
Openings		
Blind top opening multiplier	0,500	
Blind bottom opening multiplier	0,500	
Blind left-side opening multiplier	0,500	
Blind right-side opening multiplier	0,500	

FIGURE 76 - BLIND WITH MEDIUM REFLECTIVITY SLATS



3.2.4. OTHER STRATEGIES

The skylights in stairwells will be equipped with sensors that will govern the opening, according to the irradiation and the need for external ventilation.

3.3. ENERGY SYSTEMS

3.3.1. LIGHTING SYSTEM

It is expected to replace the existing lighting with LED lamps and, where it is possible (for example in meeting rooms or council room), with intelligent on/off system, to adapt the lighting depending on sunlight.

.ighting Template	Palac LED
General Lighting	
Lighting energy (W/m2)	17,75 🗢
0 2 4 6 8 10 12 14 16 1	8 20 22 24 26 28 30 32 34 36 38 40
Luminaire type	2-Surface mount
Radiant fraction	0,720
Visible fraction	0,180
Convective fraction	0,100
🔂 Lighting Control	
☑ On	
Control type	2-Linear/off
Min output fraction	0,100
Min input power fraction	0,100
Glare	
Lighting Area 1	
Lighting Area 2	
Fask and Display Lighting	
On International	
Gain (W/m2)	0,000

FIGURE 77 - LIGHTING TEMPLATE

Lighting templates Data			Help		
General Output Control Cost			Info Data		
General Lighting ✓ On Lighting energy (W/m2-100 lux) Juminaire type 2-Surface mount Radiant fraction 0.72 Visible fraction 0.18 Task and Display Lighting ☑ On		*	Lighting Gains Enter the gains for task and general lighting in W/m2. The 'Output' data is used for generating default lighting load based on lighting type and required illuminance levels as so in Activity data.		
			Luminous and Louvered Ceiling	1900	

FIGURE 78 - LIGTHING TEMPLATE



3.3.2. HVAC SYSTEM

Almost all working rooms, as well as all the receiving rooms, and the circulation area have an air conditioning system. In the renovation scheme the HVAC Template remain the same of the state of the art.



FIGURE **79 –** HVAC

3.4. RENEWABLE ENERGY SOURCES

The building is in a densely built area and district heating systems are not possible. The use of more environmental friendly HVAC systems was investigated but VRV appeared to be the most suitable choice.

The Variable Refrigerant Volume (VRV) HVAC System is a relatively new technology. New VRV systems offer high levels of energy efficiency, as well as flexibility. They operate quietly and provide the user full control of the environmental temperatures. While traditional HVAC systems are often limited to one condensing unit, one compressor and one evaporator, a VRV system can be designed to specifically meet the needs of the building. One condensing unit can be connected to several evaporators, each of which are individually controlled. In a traditional HVAC system, the system kicks on when a room is too warm or cold; however, a VRV system constantly adjusts the amount of refrigerant being sent to each evaporator and takes advantage of existing heat or cool air in the building. This varying speed allows the system to work only as needed in each area to maintain the comfort level. The result is a custom-designed HVAC system that keeps all areas of the building comfortable at a fraction of the energy cost.



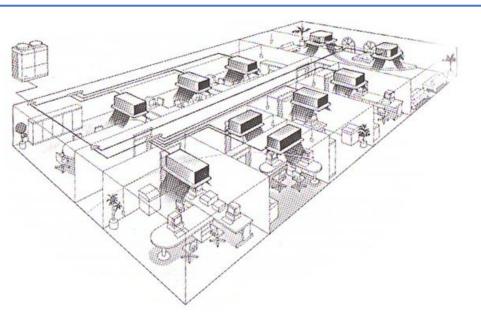


FIGURE 80 - VRV SYSTEM

Different proposals have been studied for renewable energy systems but in the end it was decided to use a photovoltaic system.

3.4.1. PV GENERATION SYSTEM

On the roof of the building will be installed a photovoltaic plant of 28 kW_p: this size ensures just over 40% of current consumption of electricity. The structure has four areas available for positioning the photovoltaic system.

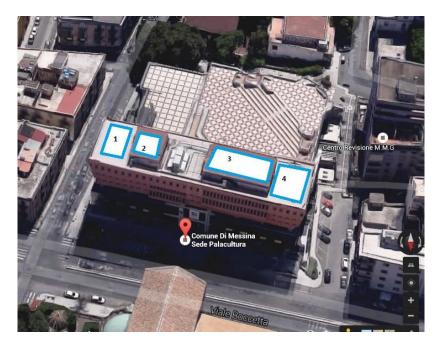
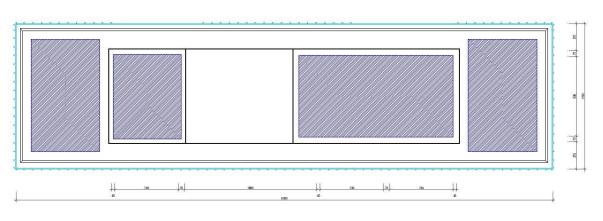
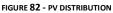


FIGURE **81** - FOUR AREAS AVAILABLE FOR THE PV SYSTEM INSTALLATION

The PV panels will be placed nearly due South with a fixed slope of 30° and azimuth of 0°. The system will be connected to the low voltage grid via three-phase power.







In Italy, to access the financial benefits for installing PV modules one must submit a request to the Energy Services Manager, GSE S.p.A. Therefore, it leads to compensation between the economic value associated to the electricity produced and fed into the grid and the theoretical economic value associated to withdrawn electricity and consumed in a period different from the one in which production takes place.

The calculation of the PV system was estimated by using Classic PVGIS, a piece of software developed by The Joint Research Centre of the European Commission in ISPRA, Italy.

To perform this calculation it is necessary to define some conditions:

TABLE ${\bf 10}$ - condition to simulation with classic pvgis

Optimal inclination angle is: 31 degrees
Annual irradiation deficit due to shadowing (horizontal): 0.1 %
<i>Location</i> : 38°11'38" North, 15°33'17" East, Elevation: 15 m a.s.l.,
Nominal power of the PV system: 28.0 kWp (crystalline silicon)
Estimated losses due to temperature and low irradiance: 9.9% (using local ambient temperature)
Estimated loss due to angular reflectance effects: 2.5%
Other losses (cables, inverter etc.): 14.0%
Combined PV system losses: 24.4%

The monthly and annual solar radiation in the area based on the classic PVGIS database is presented in the following table.

Final



Month	H _h	H _{opt}	H(90)	l _{opt}	T _D	T _{24h}
Jan	1,990	2,980	2,900	59	11.0	10.2
Feb	2,700	3,630	3,130	51	10.6	9.7
Mar	4,020	4,860	3,470	40	13.2	12.0
Apr	5,420	5,830	3,190	26	15.4	14.2
May	6,410	6,280	2,630	13	19.1	17.9
Jun	6,910	6,470	2,310	6	23.1	21.8
Jul	6,830	6,530	2,470	9	25.9	24.6
Aug	6,190	6,420	3,100	21	26.2	24.7
Sep	5,000	5,880	3,830	36	22.9	21.7
Oct	3,510	4,690	3,860	49	19.8	18.6
Nov	2,250	3,320	3,160	58	16.2	15.1
Dec	1,760	2,740	2,770	61	12.6	11.6
Year	4,430	4,980	3,070	31	18.0	16.8

Legend:

Hh: Irradiation on horizontal plane (Wh/m²/day)

Hopt: Irradiation on optimally inclined plane (Wh/m²/day)

H(90): Irradiation on plane at angle: 90 deg. (Wh/ m^2 /day)

lopt: Optimal inclination (deg.)

TD: Average daytime temperature (°C)

T24h: 24 hour average of temperature (°C)

SOURCE: CLASSIC PVGIS DATABASE (KWH/M2/MONTH) AT 30°

Month	E _d	Em			
Jan	63.28	1,963			
Feb	75.88	2,128			
Mar	99.12	3,080			
Apr	117.60	3,528			
Мау	124.32	3,864			
Jun	125.72	3,780			
Jul	125.44	3,892			
Aug	122.64	3,808			
Sep	115.36	3,444			
Oct	94.08	2,912			
Nov	68.60	2,058			
Dec	57.40	1,778			
Yearly average	99.12	3,020			
Total for year	Total for year 36,235				
Annual global radiation on the inclined surface = 1,950 kWh/m ²					
Ed: Average daily electricity production from the given system (kWh)					
Em: Average monthly electricity production from the given system (kWh)					

TABLE 12 - AVERAGE ELECTRICITY PRODUCTION



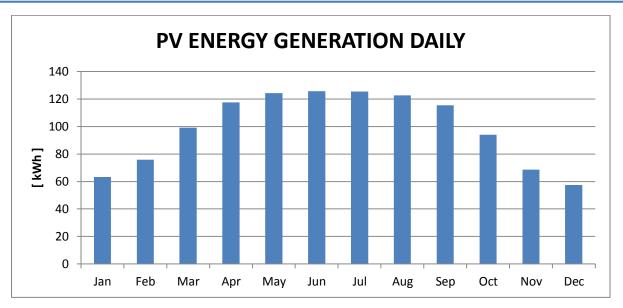


FIGURE 83 - DAILY ENERGY INJECTED INTO GRID FROM THE PV SYSTEM

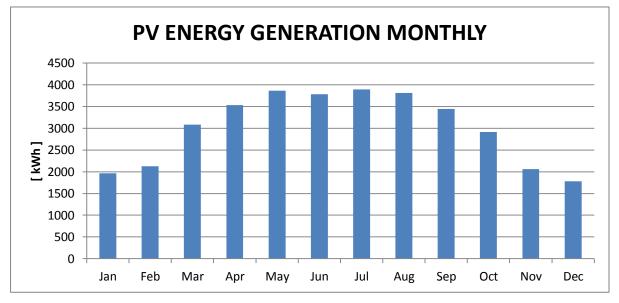


FIGURE 84 - MONTHLY ENERGY INJECTED INTO GRID FROM THE PV SYSTEM

3.5. ENERGY MANAGEMENT SYSTEM

To monitor the building electrical consumption of lighting, ventilation and HVAC system, a building automation control sensor (BACS) will be installed. The BACS improve occupant's comfort, efficient operation of building systems, and reduction of energy consumption and of operating costs.

The system will perform the following operations:

- Control each air conditioning unit separately to stabilize the desired internal air temperature and humidity in every office.
- Internal lighting control according to external irradiation and lux value in each room (Dimming lamps).

Final



- Daily scheduling of air conditioning and lighting to optimize their use.
- Management of the flow temperature according to the outdoor temperature.
- Identification of electrical equipment turned on beyond normal working hours.
- Error identification or warnings in case of electrical overloads.
- Control of windows and doors opening, to minimize the use of VRV plant.
- The BACS ensure values of humidity and temperature in agreement with the optimum comfort conditions, also through appropriate air exchange. They are also useful for energy saving both in terms of lighting and rooms conditioning.

3.6. TOTAL IMPACT OF THE RENOVATION SCHEME

3.6.1. ENERGY PERFORMANCE

The energy analysis of the building was carried out using the software Design Builder v. 3.4.0.033. The building was described in detail, through architectural drawings and with an illustrated report on the state of facts and photographic documentation.

The result with the new solution is as follows. In the renovation scheme it has a VRV system plant for heating, cooling and air circulation.

To set the calculation of the model the general information are:

TABLE 13 - GENERAL INFORMATION FOR SIMULATION

	Data
Weather File	** Messina - ITA IGDG WMO#=164200
HDD and CDD data source	Weather File Stat
Total gross floor area [m2]	13,580.56
Principal Heating Source	District Heating

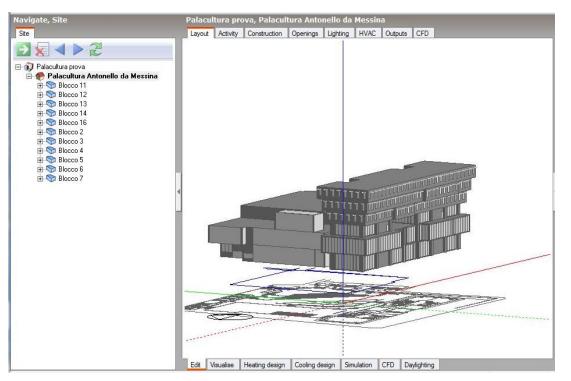
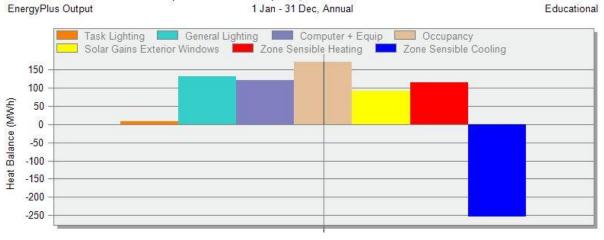


FIGURE 85 - EDIT SCHEME

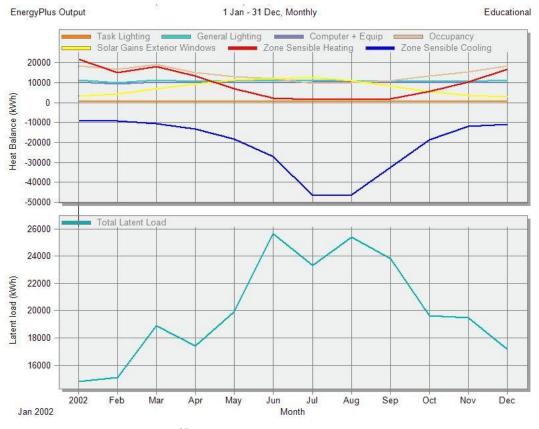


The following figures shows the heat balance of Palace of Culture Post renovation, divided according to the contribution types:

- Occupancy,
- Solar Gans Exterior Windows,
- Zone Sensible Heating,
- Zone Sensible Cooling.











Two following figures shows monthly total fuel use of Palace of Culture, divided according to the contribution of electricity.

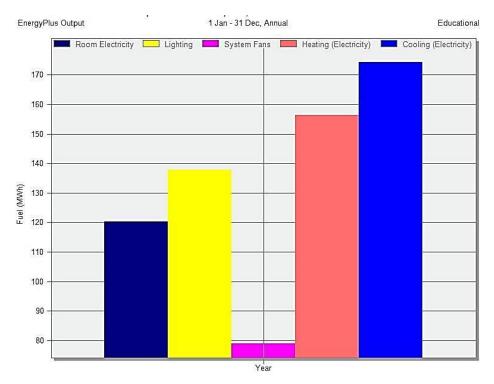


FIGURE 88 - ANNUAL USE OF FUEL TOTAL

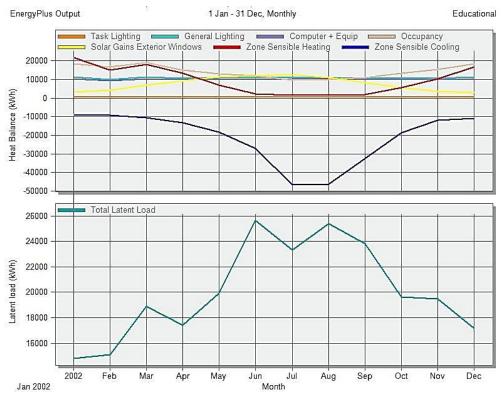


FIGURE 89 - MONTHLY USE OF FUEL TOTAL



3.6.2. Environmental Performance

The following table shows the consumption before and after the implementation of all the proposed interventions in the building.

TABLE 14 - BUILDING AREA

	Area [m2]
Total Building Area	10,274.89
Net Conditioned Building Area	10,274.89
Unconditioned Building Area	0.00

	Electricity	Natural	Additional	District	District	Water
	[kWh]	Gas [kWh]	Fuel [kWh]	Cooling	Heating	[m3]
				[kWh]	[kWh]	
Heating	156,457.77	0.00	0.00	0.00	0.00	0.00
Cooling	174,272.46	0.00	0.00	0.00	0.00	0.00
Interior Lighting	137,800.57	0.00	0.00	0.00	0.00	0.00
Exterior	0.00	0.00	0.00	0.00	0.00	0.00
Lighting						
Interior	120,275.15	0.00	0.00	0.00	0.00	0.00
Equipment						
Exterior	0.00	0.00	0.00	0.00	0.00	0.00
Equipment						
Fans	79,019.74	0.00	0.00	0.00	0.00	0.00
Pumps	0.00	0.00	0.00	0.00	0.00	0.00
Heat Rejection	0.00	0.00	0.00	0.00	0.00	0.00
Humidification	0.00	0.00	0.00	0.00	0.00	0.00
Heat Recovery	0.00	0.00	0.00	0.00	0.00	0.00
Water Systems	0.00	0.00	0.00	0.00	0.00	0.00
Refrigeration	0.00	0.00	0.00	0.00	0.00	0.00
Generators	0.00	0.00	0.00	0.00	0.00	0.00
Total End Uses	667,825.69	0.00	0.00	0.00	0.00	0.00

TABLE 15 - END USES CONSUMPTION

Note: Electricity appears to be the principal heating source based on energy usage.

TABLE 16 - END USE CONSUMPTION IN DETAILS

	Electricity [kWh]
Heating	156,457.77
Cooling	174,272.46
Interior Lighting	137,800.57
Interior Equipment	120,275.15
Fans	79,019.74
Total End Uses	667,825.69
Total End Uses - PV	627,825.69



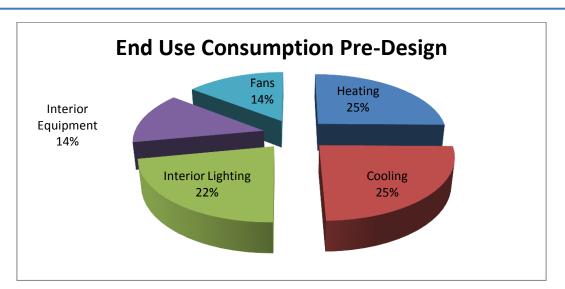


FIGURE 90 - END USE CONSUMPTION PRE DESIGN

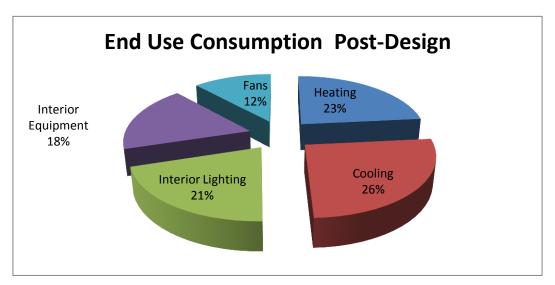


FIGURE 91 - END USE CONSUMPTION POST DESIGN

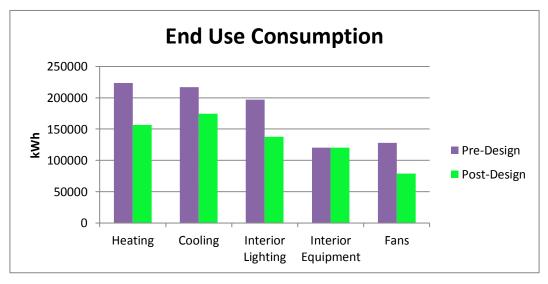


FIGURE 92 - END USE COMPARATION



4. ECONOMIC EVALUATION OF THE PROPOSED RENOVATION SCHEME

4.1. ASSUMPTIONS, COST FIGURES

The cost of the interventions is estimated based on current market prices of the equipment and the installation works. Special meetings with suppliers were held to present the project and request offers for the preliminary renovation design. Offers were collected and assessed.

For each intervention, the cost has been calculated as the sum of costs for equipment, installation, operation and maintenance. These values have been organised in an Excel file prepared by Sinloc, a partner of the CERtuS consortium (see deliverable D2.5). ANNEX H, gives the cost information.

The economic appraisal of the renovation design was performed by means of a tool produced by ETVA VIPE, also a partner of the consortium. A detailed description of the tool is presented in the deliverable D2.5. The appraisal can be performed only for the whole design. The tool also allows examining various financing schemes ranging from single financing source to multiple, combining bank loans, ESCOs, subsidies and municipality's own equity.

The data used for the calculations are tabulated below, divided according to the unit of measure concerned and the unit price

WORKINGS	VOICE	UNIT COST	U.M.	DIMENSION	соѕт
Building Envelope	INTERNAL INSULATION OF WALLS and COVER BLOCK ESCALATORS - GREEN ROOF	/	/	/	€ 354,210.00
Building envelope	PHOTOVOLTAIC PANELS PV PLANT	€ 2,000.00	kWp	28	€ 56,000.00
Windows	DOUBLE GLASS NEW WINDOWS + CURTAIN FILM	€ 650.00	sqm	320	€ 208,000,00
Plants	RELAMPING with LED (AUTOMATION CONTROL)	€ 200.00	units	1,681.0	€ 336,200.00
TOTAL WORK COST				€ 954,410.00	

TABLE 17 - DETAIL OF COST



Results

The following table gives the total savings, depending on the application for the renovation scheme, applied in full (with all suggested interventions).

TABLE $18-{\mbox{depending}}$ on the application for the renovation scheme applied in Full

ENERGY EFFICIENCY MEASURES		SAVINGS
Building Envelope	 INTERNAL INSULATION OF WALLS WALL AND COVER BLOCK CONCERNING ESCALATORS REPLACEMENT WINDOWS (FRAMES, GLASSES AND SHADING) GREEN ROOF 	• Following Table
Energy Systems	 LED lighting with automation control PV 	

TABLE 19 - END USES PRE DESIGN

	Electricity [kWh]
Heating	223,362.48
Cooling	217,049.09
Interior Lighting	196,858.13
Interior Equipment	120,275.15
Fans	127,924.5
Total End Uses	885,469.35

TABLE 20 - END USES POST DESIGN

	Electricity [kWh]
Heating	156,457.77
Cooling	174,272.46
Interior Lighting	137,800.57
Interior Equipment	120,275.15
Fans	79,019.74
Total End Uses	667,825.69



TABLE 21 - END USE SAVING

	SAVING [kWh]
Heating	29,95
Cooling	19,71
Interior Lighting	30
Interior Equipment	38,9
Fans	38,23
Total	31,71

End use post- design with Pv contribution = 667,825.69 - 36,235 = 631,590.69 kWh

END USE PRE DESIGN (kWh)	END USE POST DESIGN (kWh)	SAVING (%)
885,469.35	621 500 60	28,67
	631,590.69	(253,878.66 kWh)

The savings resulting from the interventions on envelope and plants is equal to 28.67%. The saving is so much content because it is a new building and can't be material changes to its geometry.

The traditional interventions are the use of new windows and to a system of thermal insulation for the facade.

In the evaluation of the lighting savings it was considered the average cost of the electricity. The lifetime was assessed considering the average hours of use for the lamps and its maximum total hours of operation. As can be seen in following table, with such conditions the renovation options ensures savings from maintenance of 4,687 \notin /year and has a simple payback period of 22.50 years.

TABLE 22: ECONOMIC PARAMETERS OF THE RENOVATION - LIGHTING

Energy Savings	59,058 kWh
Price - Saved Energy	0.18 €/kWh
Costs	336,200€
Potential savings from maintenance (post intervention)	4,687 €/year
Simple Payback	22.50 years
Lifetime	20 years
CO ₂ Savings	42.73 tons/year

In the evaluation of the PV generation it was considered the self-consumption of 90% of the energy, since in a working day during the time slots. As can be seen in following table, with such conditions it has a simple payback period of 9.81 years.



TABLE 23 - ECONOMIC PARAMETERS OF THE RENOVATION - PV

Energy Generation	36,235 kWh
Energy - Self-Consumption	90%
Energy - Injected Into Grid	10%
Price – Self-Consumption	0.18 €/kWh
Price - Injected Into Grid	0.06 €/kWh
Costs	56,000€
Simple Payback	9.81 years
Lifetime	30 years
CO ₂ Savings	23.78 tons/year

The following table presents the aggregation of the renovation option. As can be seen, the total of the renovation plan ensures savings of $12,019 \notin$ /year and has a simple payback period of 3.76 years.

TABLE 24 - ECONOMIC PARAMETERS OF THE RENOVATION - TOTAL

Energy Savings	253,878.66 kWh
Costs	954,410€
Savings	12,019 €/year
Simple Payback	20.88 years
CO ₂ Savings	142.32 tons/year



REFERENCES 1

- /1/ DesignBuilder Software Ltd specialises in developing high-quality, easy-to-use and affordable simulation software tools for assessing the environmental performance of building designs. <u>http://www.designbuilder.co.uk/</u>
- /2/ PVGIS, Photovoltaic Geographical Information System, a software developed by The Joint Research Centre of the European Commission in ISPRA, Italy. <u>http://re.jrc.ec.europa.eu/pvgis/apps4/pvest.php</u>
- /3/ CERtuS Deliverable D2.5 "Twelve economic evaluation reports"



5. ANNEX A: BUILDING DRAWINGS

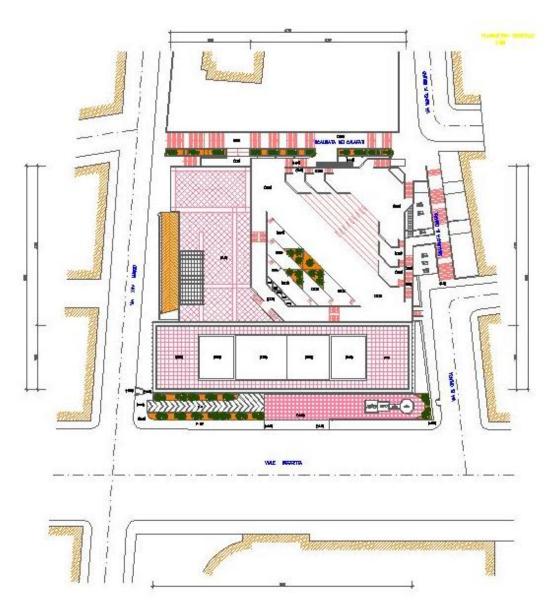


FIGURE 93 - GENERAL PLANT



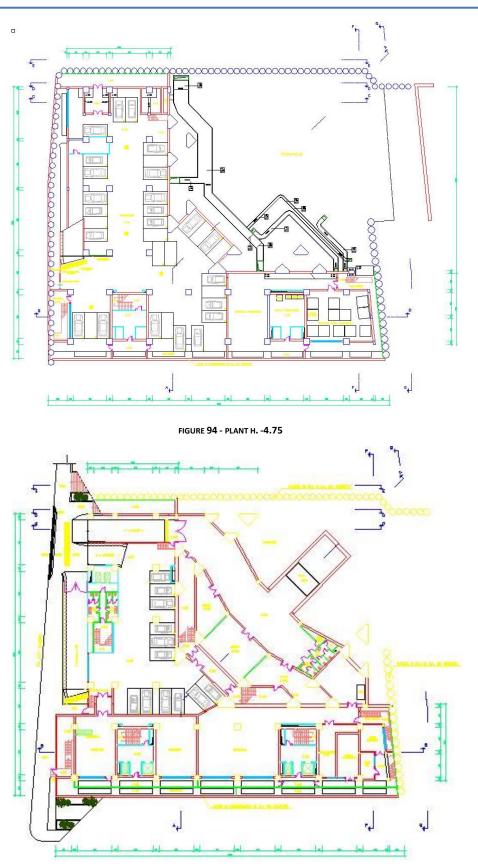
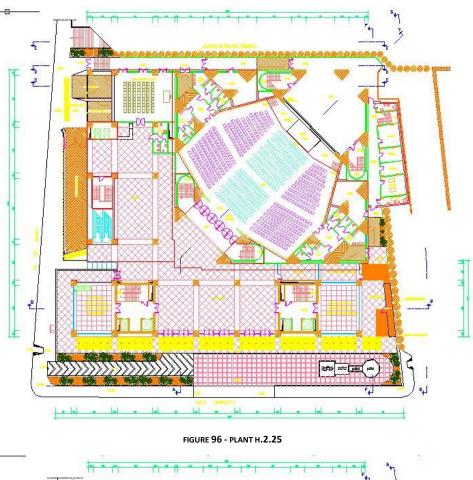


FIGURE 95 - PLANT H. -1.25





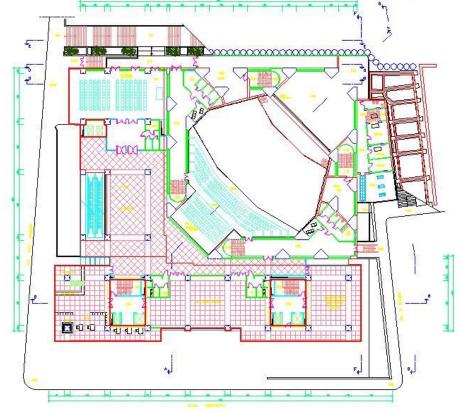


FIGURE 97 - PLANT H.7.25



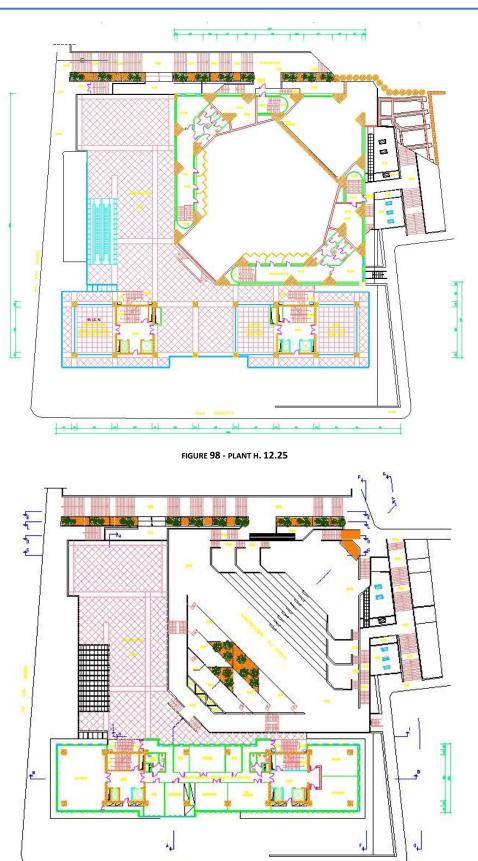


FIGURE 99 - PLANT H. 15.85



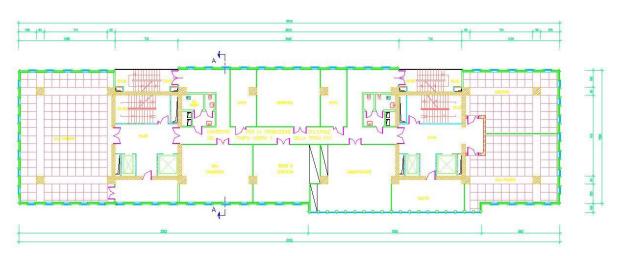


FIGURE 100 - PLANT H. 19.45

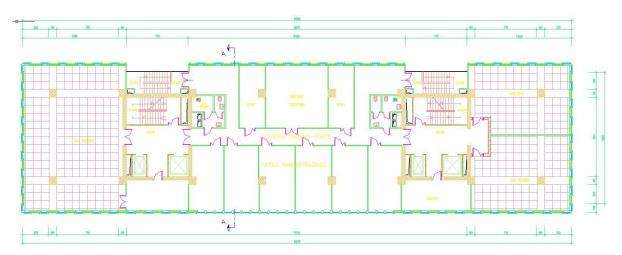


FIGURE 101 - PLANT H. 23.05

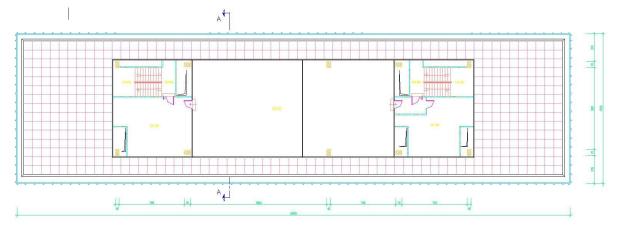


FIGURE 102 - PLANT H. 27.00

Final



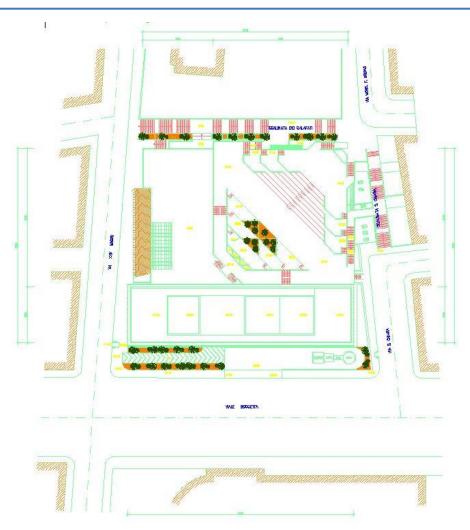


FIGURE 103 - ROOF PLAN

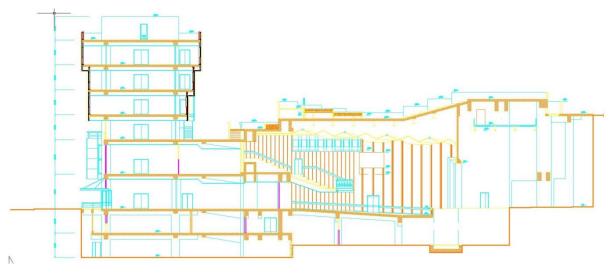


FIGURE 104 - CROSS SECTION A-A



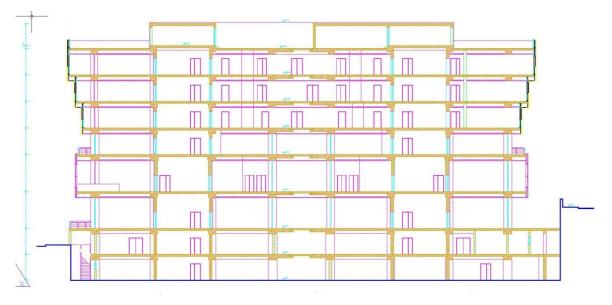


FIGURE 105 - CROSS SECTION B-B

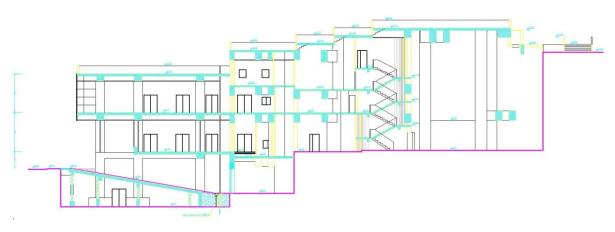


FIGURE 106 - CROSS SECTION C-C



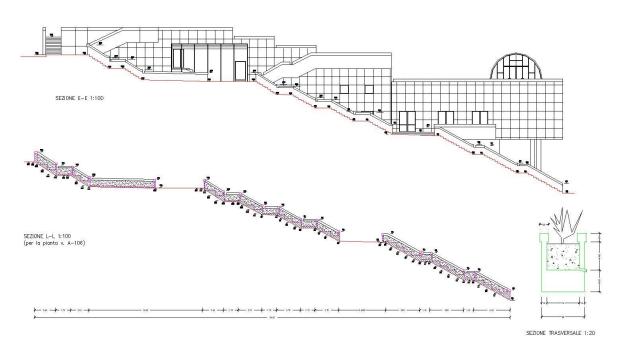


FIGURE 107 - CROSS SECTION D-D



Final

6. ANNEX B: BUILDINGS DESIGN



FIGURE 108 - RENDER OF THE GREEN ROOF



7. ANNEX C: DESIGN BUILDER PARAMETERS

TABLE 25 - GENERAL VALUE

	Value
Program Version and Build	EnergyPlusDLL-32 8.1.0.008, 30/06/2015 16:49
RunPeriod	PALACULTURA Enea
Weather File	Messina - ITA IGDG WMO#=164200
Latitude [deg]	38.20
Longitude [deg]	15.55
Elevation [m]	59.00
Time Zone	1.00
North Axis Angle [deg]	0.00
Rotation for Appendix G [deg]	0.00
Hours Simulated [hrs]	8760.00

TABLE 26 - END USES BY SUBCATEGORY

	Subcategory	Electricity [kWh]	Nat. Gas [kW h]	Additiona l Fuel [kWh]	District Cooling [kWh]	District Heating [kWh]	Water [m3]
Heating	General	156,457.77	0.00	0.00	0.00	0.00	0.00
Cooling	General	174,272.46	0.00	0.00	0.00	0.00	0.00
Interior Lighting	ELECTRIC EQUIPMENT#BI occo11:Zona9# GeneralLights	184.79	0.00	0.00	0.00	0.00	0.00
	ELECTRIC EQUIPMENT#BI occo11:Zona9#T askLights	56.00	0.00	0.00	0.00	0.00	0.00
	ELECTRIC EQUIPMENT#BI occo11:Zona1# GeneralLights	24,512.96	0.00	0.00	0.00	0.00	0.00
	ELECTRIC EQUIPMENT#BI occo11:Zona1#T askLights	1,640.44	0.00	0.00	0.00	0.00	0.00
	ELECTRIC EQUIPMENT#BI occo11:Zona23# GeneralLights	295.90	0.00	0.00	0.00	0.00	0.00
	ELECTRIC EQUIPMENT#BI occo11:Zona23# TaskLights	89.67	0.00	0.00	0.00	0.00	0.00
	ELECTRIC	10,638.74	0.00	0.00	0.00	0.00	0.00



EQUIPMENT#BI						
occo11:Zona19#						
GeneralLights						
ELECTRIC	1,683.85	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI						
occo11:Zona60#						
GeneralLights						
ELECTRIC	102.05	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI						
occo11:Zona60#						
TaskLights						
ELECTRIC	357.13	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI	557.15	0.00	0.00	0.00	0.00	0.00
occo11:Zona55#						
GeneralLights	400.00	0.00	0.00	0.00	0.00	0.00
ELECTRIC	108.22	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI						
occo11:Zona55#						
TaskLights						
ELECTRIC	928.74	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI						
occo11:Zona15#						
GeneralLights						
ELECTRIC	140.72	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI						
occo11:Zona15#						
TaskLights						
ELECTRIC	199.62	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI						
occo11:Zona8#						
GeneralLights						
ELECTRIC	60.49	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI	00.49	0.00	0.00	0.00	0.00	0.00
occo11:Zona8#T						
askLights	1 004 00	0.00	0.00	0.00	0.00	0.00
ELECTRIC	1,091.90	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI						
occo11:Zona24#						
GeneralLights						
ELECTRIC	166.25	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI						
occo11:Zona24#						
TaskLights						
ELECTRIC	271.33	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI						
occo11:Zona20#						
GeneralLights						
ELECTRIC	82.22	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI						



occo11:Zona20#						
TaskLights						
ELECTRIC EQUIPMENT#BI occo11:Zona12# GeneralLights	692.55	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo11:Zona12# TaskLights	41.97	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo11:Zona2# GeneralLights	45.30	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo11:Zona2#T askLights	35.44	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo11:Zona7# GeneralLights	230.08	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo11:Zona7#T askLights	34.86	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo11:Zona38# GeneralLights	1,176.89	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo11:Zona38# TaskLights	178.84	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo11:Zona16# GeneralLights	387.03	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo11:Zona16# TaskLights	117.28	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo11:Zona6# GeneralLights	0.00	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo11:Zona6#T	0.00	0.00	0.00	0.00	0.00	0.00



askLights						
ELECTRIC EQUIPMENT#BI occo11:Zona17# GeneralLights	70.79	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo11:Zona17# TaskLights	10.73	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo11:Zona25# GeneralLights	451.00	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo11:Zona25# TaskLights	27.33	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo11:Zona39# GeneralLights	1,598.80	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo11:Zona39# TaskLights	97.64	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo11:Zona49# GeneralLights	256.23	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo11:Zona49# TaskLights	77.64	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo11:Zona5# GeneralLights	441.88	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo11:Zona5#T askLights	133.90	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo11:Zona13# GeneralLights	506.03	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo11:Zona13# TaskLights	153.34	0.00	0.00	0.00	0.00	0.00



ELECTRIC	1,041.00	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI						
occo11:Zona18#						
GeneralLights						
ELECTRIC	315.46	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI						
occo11:Zona18#						
TaskLights						
ELECTRIC	0.00	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI						
occo11:Zona14#						
GeneralLights	0.00			0.00		0.00
ELECTRIC	0.00	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI						
occo11:Zona14#						
TaskLights	0.00	0.00	0.00	0.00	0.00	0.00
ELECTRIC	0.00	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI						
occo11:Zona4#						
GeneralLights	0.00	0.00	0.00	0.00	0.00	0.00
ELECTRIC	0.00	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI						
occo11:Zona4#T						
askLights ELECTRIC	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI occo11:Zona10#						
GeneralLights						
ELECTRIC	0.00	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI	0.00	0.00	0.00	0.00	0.00	0.00
occo11:Zona10#						
TaskLights						
ELECTRIC	279.22	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI	275.22	0.00	0.00	0.00	0.00	0.00
occo11:Zona53#						
GeneralLights						
ELECTRIC	84.61	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI	0.01	5.00	0.00	0.00	0.00	0.00
occo11:Zona53#						
TaskLights						
ELECTRIC	421.97	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI						
occo12:Zona4#						
GeneralLights						
ELECTRIC	127.87	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI						
occo12:Zona4#T						
askLights						
ELECTRIC	457.86	0.00	0.00	0.00	0.00	0.00



EQUIPMENT#BI						
occo12:Zona5#						
GeneralLights						
ELECTRIC	138.74	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI	130.74	0.00	0.00	0.00	0.00	0.00
occo12:Zona5#T						
askLights						
ELECTRIC	0.00	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI	0.00	0.00	0.00	0.00	0.00	0.00
occo12:Zona2#						
GeneralLights						
ELECTRIC	0.00	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI	0.00	0.00	0.00	0.00		0.00
occo12:Zona2#T						
askLights						
ELECTRIC	165.91	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI						
occo12:Zona1#						
GeneralLights						
ELECTRIC	25.14	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI						
occo12:Zona1#T						
askLights						
ELECTRIC	177.73	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI						
occo12:Zona3#						
GeneralLights						
ELECTRIC	26.93	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI						
occo12:Zona3#T						
askLights						
ELECTRIC	110.33	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI						
occo13:Zona1#						
GeneralLights		0.07				
ELECTRIC	33.43	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI						
occo13:Zona1#T						
askLights	0.00	0.00	0.00	0.00	0.00	0.00
ELECTRIC	0.00	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI occo13:Zona4#						
GeneralLights						
ELECTRIC	0.00	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI	0.00	0.00	0.00	0.00	0.00	0.00
occo13:Zona4#T						
askLights						
ELECTRIC	221.82	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI		0.00	0.00	0.00	0.00	0.00



occo13:Zona3#						
GeneralLights ELECTRIC EQUIPMENT#BI occo13:Zona3#T askLights	33.61	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo13:Zona2# GeneralLights	0.00	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo13:Zona2#T askLights	0.00	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo14:Zona1# GeneralLights	11,068.19	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo14:Zona2# GeneralLights	802.88	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo14:Zona2#T askLights	243.30	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo14:Zona3# GeneralLights	506.81	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo14:Zona3#T askLights	77.45	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo14:Zona4# GeneralLights	1,445.30	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo14:Zona5# GeneralLights	260.64	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo14:Zona5#T askLights	78.98	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo14:Zona7#	384.09	0.00	0.00	0.00	0.00	0.00

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GeneralLights						
ELECTRIC EQUIPMENT#BI occo14:Zona8# GeneralLights	255.29	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo14:Zona8#T askLights	77.36	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo14:Zona9# GeneralLights	713.01	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo14:Zona10# GeneralLights	414.38	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo14:Zona10# TaskLights	63.22	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo14:Zona6# GeneralLights	832.33	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo14:Zona6#T askLights	252.22	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo14:Zona11# GeneralLights	635.56	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo14:Zona11# TaskLights	192.59	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo16:Zona1# GeneralLights	11.25	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo16:Zona1#T askLights	136.83	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo4:Zona3#G eneralLights	2,501.91	0.00	0.00	0.00	0.00	0.00



ELECTRIC EQUIPMENT#BI occo4:Zona2#G eneralLights	514.34	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo4:Zona2#Ta skLights	155.86	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo4:Zona1#G eneralLights	2,664.09	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo5:Zona2#G eneralLights	459.00	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo5:Zona2#Ta skLights	139.09	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo5:Zona1#G eneralLights	2,792.23	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo7:Zona8#G eneralLights	571.17	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo7:Zona8#Ta skLights	175.70	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo7:Zona2#G eneralLights	199.65	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo7:Zona2#Ta skLights	30.25	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo7:Zona3#G eneralLights	458.32	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo7:Zona3#Ta skLights	138.89	0.00	0.00	0.00	0.00	0.00
ELECTRIC	0.00	0.00	0.00	0.00	0.00	0.00



EQUIPMENT#BI						
occo7:Zona6#G						
eneralLights						
ELECTRIC	0.00	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI						
occo7:Zona6#Ta						
skLights						
ELECTRIC	5,824.55	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI						
occo7:Zona11#						
GeneralLights						
ELECTRIC	0.00	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI						
occo7:Zona5#G						
eneralLights						
ELECTRIC	0.00	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI						
occo7:Zona5#Ta						
skLights						
ELECTRIC	458.31	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI						
occo7:Zona7#G						
eneralLights						
ELECTRIC	138.88	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI						
occo7:Zona7#Ta						
skLights						
ELECTRIC	209.72	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI						
occo7:Zona4#G						
eneralLights						
ELECTRIC	31.78	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI						
occo7:Zona4#Ta						
skLights						
ELECTRIC	3,050.15	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI	,		,			
occo7:Zona1#G						
eneralLights						
ELECTRIC	0.00	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI	0.00		0.00	0.00	0.00	
occo7:Zona10#						
GeneralLights						
ELECTRIC	0.00	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI	0.00	0.00	0.00	0.00	0.00	0.00
occo7:Zona10#T						
askLights						
ELECTRIC	0.00	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI	0.00	0.00	0.00	0.00	0.00	0.00



occo7:Zona9#G						
eneralLights						
ELECTRIC EQUIPMENT#BI occo7:Zona9#Ta skLights	0.00	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo2:Zona4#G eneralLights	451.02	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo2:Zona4#Ta skLights	136.67	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo2:Zona3#G eneralLights	223.29	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo2:Zona3#Ta skLights	33.83	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo2:Zona10# GeneralLights	631.58	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo2:Zona10#T askLights	195.51	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo2:Zona5#G eneralLights	3,454.33	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo2:Zona9#G eneralLights	217.97	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo2:Zona9#Ta skLights	33.03	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo2:Zona11# GeneralLights	456.08	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo2:Zona11#T	138.21	0.00	0.00	0.00	0.00	0.00



askLights						
ELECTRIC	0.00	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI						
occo2:Zona8#G						
eneralLights						
ELECTRIC	0.00	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI						
occo2:Zona8#Ta						
skLights						
ELECTRIC	6,504.28	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI						
occo2:Zona7#G						
eneralLights						
ELECTRIC	126.79	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI						
occo2:Zona2#G						
eneralLights						
ELECTRIC	56.21	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI						
occo2:Zona2#Ta						
skLights	0.00	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI	0.00	0.00	0.00	0.00	0.00	0.00
occo2:Zona6#G						
eneralLights						
ELECTRIC	0.00	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI	0.00	0.00	0.00	0.00	0.00	0.00
occo2:Zona6#Ta						
skLights						
ELECTRIC	0.00	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI						
occo2:Zona1#G						
eneralLights						
ELECTRIC	0.00	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI						
occo2:Zona1#Ta						
skLights						
ELECTRIC	458.31	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI						
occo6:Zona11#						
GeneralLights						
ELECTRIC	138.88	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#BI						
occo6:Zona11#T						
askLights	E 01E 72	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI	5,815.72	0.00	0.00	0.00	0.00	0.00
occo6:Zona9#G						
eneralLights						
eneralLights						



Fi	n	al	

ELECTRIC 458.30 0.00 0.00 0.00 0.00 EQUIPMENT#BI	0.00
EQUIPMENT#BI	
occo6:Zona22#	
GeneralLights	0.00
ELECTRIC 138.88 0.00 0.00 0.00 0.00 EQUIPMENT#BI	0.00
occo6:Zona22#T	
askLights	
ELECTRIC 0.00 0.00 0.00 0.00 0.00	0.00
EQUIPMENT#BI	
occo6:Zona17#	
GeneralLights	
ELECTRIC 0.00 0.00 0.00 0.00 0.00	0.00
EQUIPMENT#BI	
occo6:Zona17#T	
askLights	0.00
ELECTRIC 522.10 0.00 0.00 0.00 0.00	0.00
EQUIPMENT#BI occo6:Zona18#	
GeneralLights	
ELECTRIC 159.91 0.00 0.00 0.00 0.00	0.00
EQUIPMENT#BI	0.00
occo6:Zona18#T	
askLights	
ELECTRIC 209.72 0.00 0.00 0.00 0.00	0.00
EQUIPMENT#BI	
occo6:Zona5#G	
eneralLights	
ELECTRIC 31.78 0.00 0.00 0.00 0.00	0.00
EQUIPMENT#BI occo6:Zona5#Ta	
skLights	
ELECTRIC 2,454.52 0.00 0.00 0.00 0.00	0.00
EQUIPMENT#BI	0.00
occo6:Zona1#G	
eneralLights	
ELECTRIC 199.65 0.00 0.00 0.00 0.00	0.00
EQUIPMENT#BI	
occo6:Zona15#	
GeneralLights	
ELECTRIC 30.25 0.00 0.00 0.00 0.00	0.00
EQUIPMENT#BI occo6:Zona15#T	
askLights	
ELECTRIC 0.00 0.00 0.00 0.00	0.00
EQUIPMENT#BI	0.00
occo6:Zona7#G	
eneralLights	
ELECTRIC 0.00 0.00 0.00 0.00 0.00	0.00



	EQUIPMENT#BI occo6:Zona7#Ta						
	skLights ELECTRIC EQUIPMENT#BI occo3:Zona1#G eneralLights	22,519.96	0.00	0.00	0.00	0.00	0.00
Exterior Lighting	General	0.00	0.00	0.00	0.00	0.00	0.00
Interior Equipment	ELECTRIC EQUIPMENT#BI occo11:Zona9#0 5	111.99	0.00	0.00	0.00	0.00	0.00
	ELECTRIC EQUIPMENT#BI occo11:Zona23# 05	179.33	0.00	0.00	0.00	0.00	0.00
	ELECTRIC EQUIPMENT#BI occo11:Zona19# 05	2,149.24	0.00	0.00	0.00	0.00	0.00
	ELECTRIC EQUIPMENT#BI occo11:Zona55# 05	216.44	0.00	0.00	0.00	0.00	0.00
	ELECTRIC EQUIPMENT#BI occo11:Zona8#0 5	120.98	0.00	0.00	0.00	0.00	0.00
	ELECTRIC EQUIPMENT#BI occo11:Zona20# 05	164.44	0.00	0.00	0.00	0.00	0.00
	ELECTRIC EQUIPMENT#BI occo11:Zona2#0 5	70.87	0.00	0.00	0.00	0.00	0.00
	ELECTRIC EQUIPMENT#BI occo11:Zona6#0 5	0.00	0.00	0.00	0.00	0.00	0.00
	ELECTRIC EQUIPMENT#BI occo11:Zona49# 05	155.29	0.00	0.00	0.00	0.00	0.00
	ELECTRIC EQUIPMENT#BI occo11:Zona5#0 5	267.80	0.00	0.00	0.00	0.00	0.00



ELECTRIC EQUIPMENT#BI occo11:Zona13# 05	306.68	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo11:Zona18# 05	22,081.88	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo11:Zona14# 05	0.00	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo11:Zona4#0 5	0.00	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo11:Zona10# 05	0.00	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo11:Zona53# 05	169.23	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo12:Zona4#0 5	255.74	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo12:Zona5#0 5	277.49	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo12:Zona2#0 5	0.00	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo13:Zona1#0 5	66.87	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo13:Zona4#0 5	0.00	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo13:Zona2#0 5	0.00	0.00	0.00	0.00	0.00	0.00
ELECTRIC	2,236.00	0.00	0.00	0.00	0.00	0.00



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EQUIPMENT#BI occo14:Zona1#0 5						
ELECTRIC EQUIPMENT#BI occo14:Zona2#0 5	486.60	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo14:Zona4#0 5	30,657.79	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo14:Zona5#0 5	157.96	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo14:Zona8#0 5	154.72	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo14:Zona9#0 5	30,224.51	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo14:Zona6#0 5	504.44	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo14:Zona11# 05	385.19	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo16:Zona1#0 5	273.67	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo4:Zona3#05	1,590.79	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo4:Zona2#05	311.72	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo4:Zona1#05	1,590.79	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo5:Zona2#05	278.18	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI	1,743.78	0.00	0.00	0.00	0.00	0.00



occo5:Zona1#05						
ELECTRIC EQUIPMENT#BI occo7:Zona8#05	351.41	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo7:Zona3#05	277.77	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo7:Zona6#05	0.00	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo7:Zona11#0 5	3,386.17	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo7:Zona5#05	0.00	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo7:Zona7#05	277.76	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo7:Zona1#05	1,736.96	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo7:Zona10#0 5	0.00	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo7:Zona9#05	0.00	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo2:Zona4#05	273.35	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo2:Zona10#0 5	391.02	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo2:Zona5#05	1,970.76	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo2:Zona11#0 5	276.41	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI occo2:Zona8#05	0.00	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#BI	3,798.72	0.00	0.00	0.00	0.00	0.00



	occo2:Zona7#05						
	ELECTRIC EQUIPMENT#BI occo2:Zona2#05	112.42	0.00	0.00	0.00	0.00	0.00
	ELECTRIC EQUIPMENT#BI occo2:Zona6#05	0.00	0.00	0.00	0.00	0.00	0.00
	ELECTRIC EQUIPMENT#BI occo2:Zona1#05	0.00	0.00	0.00	0.00	0.00	0.00
	ELECTRIC EQUIPMENT#BI occo6:Zona11#0 5	277.76	0.00	0.00	0.00	0.00	0.00
	ELECTRIC EQUIPMENT#BI occo6:Zona9#05	3,405.18	0.00	0.00	0.00	0.00	0.00
	ELECTRIC EQUIPMENT#BI occo6:Zona22#0 5	277.76	0.00	0.00	0.00	0.00	0.00
	ELECTRIC EQUIPMENT#BI occo6:Zona17#0 5	0.00	0.00	0.00	0.00	0.00	0.00
	ELECTRIC EQUIPMENT#BI occo6:Zona18#0 5	319.83	0.00	0.00	0.00	0.00	0.00
	ELECTRIC EQUIPMENT#BI occo6:Zona1#05	1,401.96	0.00	0.00	0.00	0.00	0.00
	ELECTRIC EQUIPMENT#BI occo6:Zona7#05	0.00	0.00	0.00	0.00	0.00	0.00
	ELECTRIC EQUIPMENT#BI occo3:Zona1#05	4,549.49	0.00	0.00	0.00	0.00	0.00
Exterior Equipment	General	0.00	0.00	0.00	0.00	0.00	0.00
Fans	General	79,019.74	0.00	0.00	0.00	0.00	0.00
Pumps	General	0.00	0.00	0.00	0.00	0.00	0.00
Heat Rejection	General	0.00	0.00	0.00	0.00	0.00	0.00
Humidifica tion	General	0.00	0.00	0.00	0.00	0.00	0.00
Heat Recovery	General	0.00	0.00	0.00	0.00	0.00	0.00
Water	General	0.00	0.00	0.00	0.00	0.00	0.00



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Systems							
Refrigerati on	General	0.00	0.00	0.00	0.00	0.00	0.00
Generator s	General	0.00	0.00	0.00	0.00	0.00	0.00

TABLE 27 - TABULAR VIEW FOR TEMPERATURE AND PRECIPITATION PER MONTH

		Temperature		Precipitation
Months	Normal	Warmest	Coldest	Normal
January	12.3°C	14.4°C	10.1°C	10
February	12.2°C	14.7°C	9.8°C	9
March	13.5°C	16.1°C	10.9°C	8
April	15.4°C	18.3°C	12.5°C	8
Мау	19.5°C	22.5°C	16.4°C	3
June	23.6°C	26.8°C	20.4°C	1
July	26.7°C	30.0°C	23.4°C	1
August	27.3°C	30.5°C	24.2°C	2
September	24.5°C	27.5°C	21.5°C	5
October	20.5°C	23.2°C	17.8°C	8
November	16.4°C	18.7°C	14.1°C	10
December	13.7°C	15.8°C	11.6°C	10



lel Options Data		-	
ta Advanced Heating Design Cooli	ng Design Simulation Display Drawing tools	Block Project details	
ata Options			
Model options template			Draw building + standard data
cope			
Scope			Whole building Analyse the whole building.
Zone	Zone+shading	Building	
instruction and Glazing Data			
Construction and glazing data		-	General construction templates Construction default data is selected from a list.
Pre-design		General	
Toor/slab/ceiling representation			1-Combined
Zone volume calculations			
Internal floor constructions not s	ubtracted from zone volume		
Ground floor construction is bel	ow ground and is not subtracted from zone	e volume	
External floor constructions not	subtracted from zone volume		
ins Data			
Gains data			Early gains
	—		Internal gains are separated into various categories (e.g. occupancy, lighting, computing etc.)
Lumped	Early	Detailed	
Occupancy latent gains			1-Dynamic calculation
ighting gain units			1-Watts per m2
ning			
Fiming			Schedules
Typical workday		Schedules	Timing is defined using the schedules and profiles mechanism which allows each day of the week to have a differe
	anay	ochequies	
Internal gains operate with occurs	ancy		
Internal gains operate with occup			
AC			Compared IB/AC
		~	Compact HVAC HVAC systems are defined parametrically and modelled within EnergyPlus using Compact HVAC descriptions
AC	Compact	Detailed	
AC HVAC Simple		Detailed	
AC IVAC simple IVAC sizing		Detailed	HVAC systems are defined parametrically and modelled within EnergyPlus using Compact HVAC descriptions
AC HVAC		Detailed	HVAC systems are defined parametrically and modelled within EnergyPlus using Compact HVAC descriptions
AC IVAC Simple IVAC sizing tural ventilation		Detailed Calculated	HVAC systems are defined parametrically and modelled within EnergyPlus using Compact HVAC descriptions 3-Autosize Calculated ventilation
AC NAC Simple IVAC sizing fural ventilation Natural ventilation			HVAC systems are defined parametrically and modelled within EnergyPlus using Compact HVAC descriptions 3-Autosize Calculated ventilation

FIGURE 109 - MODEL OPTIONS DATA

Model Options - Building and Block		
Model Options Data		
Data Advanced Heating Design Cooling Design Simulation I	Display Drawing tools Block Project details	
Simplification		×
Merge zones of same activity		
Merge zones connected by holes		
Merge zones by selection		
Lump similar windows on surface		
Lump similar cracks on surface		
Lump similar construction elements (research option)		
Triangulate		
Generate fully enclosed zones		
Show block connection surfaces in Navigator		
Model 'semi-exterior unconditioned' zones as simple Re	value to outside	
R-value to outside (m2-K/W)	0,1800	
Natural Ventilation		*
Model airflow through holes and virtual partitions		
Calculated		*
Wind factor	1,00	
Discharge coefficient for open windows and holes Modulate opening areas	0,650	
Scheduled		×
Airflow through internal openings		
Lighting		×
Working plane height (m)	0,800	
Daylighting method	1-Detailed	-
Filters		*
Exclude surface elements smaller than (m2)	0,050000	
Component Block		×
Fraction two largest areas	0,80	
Flat component block surface selection	2-Lowest	•

FIGURE 110 - MODEL OPTIONS DATA



del Options	2012	C. I. D. :	C. L.	D: 1		- China I	D. i. d. i. d.	
ata Advance		Cooling Design	Simulation	Display	Drawing tools	Block	Project details	
inter design	100270-00							
Winter desig					10-WinterDes	iqnDay		_
	or 7/12 and Typica	al workday Sch	edules					
Genera								
Occupa								
Lighting								
Equipm								
Heating								
Cooling	demand							
HVAC	191. P. 1							
	ventilation demar	nd						
DHW				_		_		
sloulation Or								
alculation Op				-	1-EnorayDlug			
Simulation m	nethod	_	_		1-EnergyPlus 1-Airtompore	turo		
Simulation m Temperature	nethod e control	ntilation (infiltrat	ion ic elwe		1-Air tempera	ture	_	
Simulation m Temperature CExclude a	nethod e control Il zone natural ver		ion is alway		1-Air tempera	ture		
Simulation m Temperature Exclude a Exclude a	nethod e control Il zone natural ver Il zone mechanica		ion is alway		1-Air tempera	ture		
Simulation m Temperature Exclude a Exclude a stem Sizing	nethod e control Il zone natural ver Il zone mechanica		ion is alway	/s includ	1-Air tempera ed)	ture		
Simulation m Temperature Exclude a Exclude a stem Sizing Design marg	nethod e control Il zone natural ver Il zone mechanica		ion is alway	/s includ	1-Air tempera	ture	_	
Simulation m Temperature Exclude a Exclude a stem Sizing Design marg utput	nethod e control II zone natural vei II zone mechanici gin	al ventilation	-	/s includ	1-Air tempera ed) 1,20	ture		
Simulation m Temperature Exclude a Exclude a stem Sizing Design marg utput	nethod e control Il zone natural ver Il zone mechanica	al ventilation	-	/s includ	1-Air tempera ed) 1,20	ture	_	
Simulation m Temperature Exclude a Exclude a stern Sizing Design marg utput Include un	nethod e control II zone natural vei II zone mechanici gin	al ventilation	-	/s includ	1-Air tempera ed) 1,20	ture		
Simulation m Temperature Exclude a Exclude a stern Sizing Design marg Design marg utput Include un Report	hethod e control II zone natural ver II zone mechanici gin roccupied zones i	al ventilation	-	/s includ	1-Air tempera ed) 1,20	ture		
Simulation m Temperature Exclude a Exclude a stem Sizing Design marg utput Include un Report dvanced General Sol	hethod e control II zone natural ver II zone mechanici gin loccupied zones i	al ventilation	-	vs includ • and avi	1-Air tempera ed) 1,20	ture		
Simulation m Temperature Exclude a Exclude a stem Sizing Design marg utput Include un Report Avanced General Sol Temperat	hethod e control Il zone natural ver Il zone mechanici gin ioccupied zones i ution ure convergence	al ventilation	-	vs includ	1-Air tempera ed) 1,20 erages	ture		
Simulation m Temperature Exclude a Exclude a stem Sizing Design marg utput Include un Report Avanced General Sol Temperat	hethod e control II zone natural ver II zone mechanici gin loccupied zones i	al ventilation	-	vs includ	1-Air tempera ed) 1,20 erages 0,000200	ture		
Simulation m Temperature Exclude a Stem Sizing Design margutput Include un Report dvanced General Sol Temperat Loads cor Convection	hethod e control Il zone natural ver Il zone mechanici gin ioccupied zones i ution ure convergence	al ventilation in block and bu (deltaC)	-	rs includ	1-Air tempera ed) 1,20 erages 0,000200	ture		

FIGURE 111 - MODEL OI	PTIONS DATA
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	splay Drawing tools Block Project detai	15
ımmer Design Day		
Day	15	
Month	Jul	
Day of week	9-SummerDesignDay	
alculation Options		
Simulation method	1-EnergyPlus	
Temperature control	1-Air temperature	
Exclude all zone natural ventilation (infiltration is always ir	icluded)	
Exclude all zone mechanical ventilation		
vstem Sizing		
Design margin	1,30	
Sizing method	1-ASHRAE	
plar		
Include all buildings in shading calcs		
Model reflections and shading of ground reflected solar		
Solar distribution	2-Full exterior	
utput		
Include unoccupied zones in block and building totals an	d averages	
Report		
lvanced		
General Solution		
Inside face surface temperature convergence criteria	0,0020	
Temperature convergence (deltaC)	0,0020	
Loads convergence (W)	0,0020	
Convection		
Inside convection algorithm	6-TARP	
Outside convection algorithm	6-DOE-2	
Shading		
Maximum number of 'shadow overlaps'	15000	
Polygon clipping algorithm	1-Sutherland Hodgman	
Other		

FIGURE 112 - MODEL OPTIONS DATA



Model Options Data		
Data Advanced Heating Design Cooling Design Simulation Display Drawing tools Block Project	t details	
Simulation Options		*
From		*
Start day	1	
Start month	Jan	•
To		×
End day	31	
End month	Dec	•
Calculation Options		×
Simulation method	1-EnergyPlus	-
Time steps per hour	2	
Temperature control	1-Air temperature	•
Solar		×
Include all buildings in shading calcs		
Model reflections and shading of ground reflected solar		
Solar distribution	2-Full exterior	•
Shadowing interval (days)	20	
Advanced		»
Output		×
Building and block output of zone data		
Include unoccupied zones in block and building totals and averages		
Zone environmental and comfort reports	1-All periods	
Graphable Outputs		×
Surface heat transfer		
Environmental		
Comfort		
🗹 Internal gains including solar		
Energy, HVAC etc		
🗹 Latent loads		
🗹 Fresh air supply		
Temperature distribution		
Detailed Daylight Outputs		»
Summary Annual Reports		»
Summary Monthly Reports		»>
Miscellaneous Outputs		×
HVAC system temperatures		
VAC system mass flow rates		
VAC system humidity ratios		
SQLite output		
Z DXF model output		
Construction and surface details		
RDD file		
Time Setpoints not Met Tolerances		*
Tolerance for time heating setpoint not met	0,20	
Tolerance for time cooling setpoint not met	0,20	
i dierance for time cooling setpoint not met	0,20	

FIGURE 113 - MODEL OPTIONS DATA

Ilacultura prova, Palacultura Antonello da Messina ayout Activity Construction Openings Lighting HVAC Ou	tputs CFD
(g ,Activity Template	
,sk Template	PALAC Office_Typical
Sector 🖉	Office
Zone multiplier	1
Include zone in thermal calculations	
Include zone in Radiance daylighting calculation	ns
Building Total Floor Areas	
00 Occupancy	
Density (people/m2)	0,0538 🗢
0 0.5 1 1.5	2 2.5 3 3.5 4
Chedule	PALAC Office Occ
e Metabolic	
👘 Holidays	
III Environmental Control	
Heating Setpoint Temperatures	
Heating (°C)	21,1 🗢
	14 16 18 20 22 24 28 28 30
Heating set back (°C)	12.8
Cooling Setpoint Temperatures	
Cooling (°C)	23,9 🗢
-10 -8 -6 -4 -2 0 2 4 6	8 10 12 14 18 18 20 22 24 28 28 30
Cooling set back (°C)	28,0
Humidity Control Ventilation Setpoint Temperatures	
Minimum Fresh Air	
Lighting	

FIGURE 114 - PALCE OF CULTURE ACTIVITY SCHEDULE



General /	All Gains	Occupancy	Other Gains	DHW	Environmental control
Occupan	cy detai	ls			
Density	(people	e/m2)		0,053	8
Latent fr	action			0,500	0
Metabo	lic Hea	t			
o Me	etabolic	rate		Light	office work
Metal	polic fac	ctor (0.85 for v	women, 0.75	0,90	
Metal Workda			women, 0.75	0,90	
			women, 0.75	0,90	_
Workda	ay profil		women, 0.75	0,90	14 15 16 17 18 19 20 21 22 23 24
Workda On at Off at	ay profile <mark>7:00</mark>		women, 0.75	0,90 10 11 12 13 5	1 14 15 16 17 18 19 20 21 22 23 24
Workda On at Off at	y profil 7:00 <mark>19:00</mark> / week		women, 0.75	10 11 12 13	14 15 16 17 18 19 20 21 22 23 24

FIGURE 115 - PALCE OF CULTURE OCCUPANCY

General All Gains Occupancy	Other Gains DHW Environmental control
Computers	
🗖 On	
Office Equipment	
🗹 On	
Load (W/m2)	10,00
Radiant fraction	0,200
Workday profile	
On at 7:00 🗢	
Offat 19:00 💠 0 1 2 3	4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Schedules	
😭 Schedule	PALAC Office_Occ
Miscellaneous	
🗖 On	
Catering	
🗖 On	
Process	
🗖 On	
General Lighting	
🗹 On	
Workday profile	
On at 🛛 7:00 🜲	
Offat 19:00 \$ 0 1 2 3	4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
O S R S S S S S S S	
Schedules	

FIGURE 116 - PALCE OF CULURE OTHER GAINS



ctivity templates Data		
General All Gains Occupancy Other Gains	DHW Environmental control	
Cooling		
Set point temperature (°C)	23,889	
Cooling set back (°C)	28,000	
Workday profile	*	
On at 6:00 🌲		
Offat 20:00 \$ 0 1 2 3 4 5 6 7 8	9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24	
Schedules	8	
😭 Operation	PALAC Office_Cool_Setback	
Heating	*	
Set point temperature (°C)	21,111	
Set back temperature (°C)	12,778	
Workday profile	*	
On at 6:00	9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24	
Schedules	*	
😭 Schedule	PALAC Office_Heat_Setback	
/entilation Set Point Temperatures	*	
Natural Ventilation	*	
Nat. vent. set point (°C)	22,000	
Mechanical Ventilation	*	
Mech. vent. set point (°C)	10,000	
ighting	*	
Target Illuminance (lux)	538	
Default display lighting density (W/m2)	0,000	
/entilation Fresh Air	×	
Min fresh air (l/s-person)	8,000	
Mech vent per area (l/s-m2)	1,000	

FIGURE 117 - PALACE OF CULURE OFFICE ENVIRONMENTAL CONTROL



Deliverable D2.1 Report presenting the 3 nZEB renovation schemes in Italy, fully documented with technical and economic evaluation

8. ANNEX D: RENOVATION OPTION MATRIX BY SINLOC

TABLE 28 - ECONOMIC EVALUATION OF INTERVENTIONS

					1				Work ti	ming		CAPEX									
							or size of		or size of		Start date	Final date	Construction Period	Compulsory connection with other technologies/ layers	Specify which technologies are needed to realize this layer	Specify which technologies can be realized only after this layer		Investment	cost	Investment payback period (preliminary)	Lifetime (year of replacement - revamping)
Renovation options	Турез	Technologies / Layers	Code	Unit of measure	Value	dd/mm/yy	dd/mm/yy	Months	res/No	code/codes (ascending	Code/codes (ascending order)	Unit of measure	Unit cost	Value cak ulated	Years	tears					
			7						-												
	Ventilation system	Heat recovery Heating pumps with geothermal sonde Georthermal heat pumps []	8 9 5 10 11																		
Casing Building skin	External insulation - Internal insulation Shielding elements	New facades INTERNAL INSULATION OF WALLS and COVER BLOCK ESCALATORS - GREEN ROOF	12 13 14	sqm	500	x	x	12	Yes		19	total	€ 354'210,00	€ 354'210	38,10	50					
	Bioclimatic	[]	15																		
Windows	Windows Glass windows Glass windows	[] PVC [] Double glass NEW WINDOWS + curtain film Triple glass	16 17 18 19 20	sqm	320	X	x	6	Yes	12		€/mq	€ 650,00	€ 208'000,00	12,81	30					
		[]	21																		
Lighting systems (internal)	Replacement of lamps (and luminaries, ballast)	LED Internal RELAMPING	22 23	units	1681	x	х	4	No			€/unit	€ 200,00	€ 336'200	22,50	20					
Lighting systems (external)	Replacement of lamps (and luminaries, ballas	t LED	24 25																		
Renewable energy	Biomass Solar	Biomass heating systems Photovoltaic panels PV PLANT Solar thermal panels	26 27 27	KWp	28	x	x	6	No			€/KWp	€ 2'000,00	€ 56'000	9,81	30					
Control systems	Thermal Lighting	Automatic regolation of internal temperature Thermostatic valves Individual thermal energy consumption accounting Light flux regulators (internal) Light flux regulators (external)	28 29 30 31 32																		
			33 34 35 36																		



TABLE 29 - ECONOMIC EVALUATION OF INTERVENTIONS

									OPEX						
	1	Energy co	onsumption	(after each sing	gle energ	y renovatio	on option)			ement and ord nance contracts			Extraordinary ma	intenance	
									Cost of components	Cost of personnel	Total	Frequency	Cost of intervention	Cost of personnel	Total
Renovation options	Source 1	Unit of measure	Consumption/year	¢/year	Source 2	Unit of measure	Consumption/year	€⁄year	¢/year	C/year	¢/year	years	ÿ	Gývear	J
Casing Building skin	no				no				€ 3'719	€ 6'907	€ 10'626	10	€ 17'500	€ 1'500	€ 32'50
Windows	no				no				€ 1'456	€ 2'704	€ 4'160	10	€ 17'500	€ 1'500	€ 32'50
Lighting systems (internal)	electric	KWHe	137'800	€ 24'804,00	no				€1'177	€ 2'185	€ 3'362	7	€ 10'000	€ 100	€ 10'70
Lighting systems (external)										-					
Renewable energy	no				no				€ 980	€ 1'820	€ 2'800	5	€ 7'000	€ 3'000	€ 22'00
Control systems											ļ				



TABLE 30 - ECONOMIC EVALUATION OF INTERVENTIONS

Building skin								SAVING	iS			1			
Renovation options rest, tijl volutation volume rest, tijl volutation vo				Potentia	ıl energy sa	vings expec	ted from	the interver	ntion			from ma	intenance		
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$			Electric	energy consu	nption			Therma	al energy	consumption					
Image: state	Renovation options	%, flist year	kWhe/year, first year	%, last year	kWhe ⁄year, last year	Decrease characteristics (linear, nonlinear, etc.)	%, first year	kWhe ⁄year, fiist year	%, last year	kWhe/year, last year	Decrease characteristics (linear, nonlinear, etc.)	*	C/year	*	Equivalent tons/year
Building skin Image: Skin skin skin skin skin skin skin skin s															
I2,5% 54'841 10,0% 44'041 linear 20% € 7'332 11,23% 37,08 Lighting systems (internal) 30,1% 59'058 28,0% 54'880 linear 0 </th <th></th> <th>12,5%</th> <th>54'841</th> <th>11,0%</th> <th>48'445</th> <th>linear</th> <th></th> <th></th> <th></th> <th></th> <th></th> <th>0%</th> <th>€O</th> <th>11,73%</th> <th>38,732</th>		12,5%	54'841	11,0%	48'445	linear						0%	€O	11,73%	38,732
Lighting systems (internal) Image: Constraint of the systemsystems (internal) Image: Constrater (i	Windows														
30,1% 59'058 28,0% 54'880 linear 25% € 4'687 29,0% 42,73 Lighting systems (external)		12,5%	54'841	10,0%	44'041	linear						20%	€ 7'332	11,23%	37,08
Renewable energy 100,0% 36'235 75,0% 27'176 linear Image: Control of the state of the s	Lighting systems (internal)	30,1%	59'058	28,0%	54'880	linear						25%	€ 4'687	29,07%	42,73
100,0% 36'235 75,0% 27'176 linear 0% € 0 87,50% 23,78	Lighting systems (external)								-						
Control systems	Renewable energy	100,0%	36'235	75,0%	27'176	linear						0%	€0	87,50%	23,78
	Control systems														



B. CITY HALL - ZANCA PALACE

9. BUILDING GENERAL DESCRIPTION

9.1. LOCATION

Palazzo Zanca is the municipal building of Messina. The building is located at the same place of the historic town hall building, which was destroyed twice before by earthquakes in 1783 and then definitively in 1908. Rebuilt after the earthquake of 1908, its construction is part of the reconstructions plan of the city, that relocated public buildings nearby the sea.

It is the first building designed and built according to the first anti-seismic regulations, drawn up in 1909. This figure shows the front facade of the building.



FIGURE 118 - PALAZZO ZANCA

The project suffered from numerous changes and additions by the local building committee. Significant difficulties have been reported concerning the choice of coating material: the natural stone was too expensive, so they chose to use a cement mixture, similar in appearance to natural stone but cheaper.



FIGURE 119 - PALAZZO ZANCA





FIGURE 120 - EXCAVATIONS PALAZZO ZANCA

The reconstruction works began in December 1914 under the direction of Antonio Zanca, a famous architect from Palermo. His history is recent but very complicated. The reconstruction was initiated in 1914 and completed in 1924 after several changes, both stylistic and structural. There were two main constraints: firstly, the building had to respect the seismic regulations; secondly, it had to be simple, representative, and inspired by the past. Antonio Zanca worked about twelve or more years on this project and in the end he did not get paid. He designed the entire building from structure to interior. The building style is neoclassical and covers an area of about 12,000 m2; Palazzo Zanca is the temple of Italian cement for architectural experimentation. Table 1 presents the main location data of the building.

Address	European Union Square, 41 98122 Messina (ME), Italy
Coordinates	LAT. 38°11'10.46"N - LONG. 15°33'38.93"E
Google Maps	https://www.google.it/maps/@38.19355,15.556405,17z/data=!3m1!4 b1!4m2!3m1!1s0x13144e787d10204b:0x7b452af4ef65eb61

The building is located on the seafront, near the marina of the city. These figures show the location in the city map and aerial view.



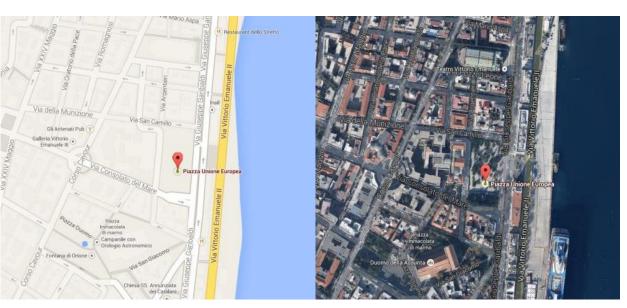


FIGURE 121 - LOCATION IN THE CITY (MAP)

FIGURE 122 - LOCATION IN THE CITY (AERIAL VIEW)

TABLE 32 - DATA OF THE SYSTEM CONSIDERED

Degree days	707											
Minimum	5.0 °C	5.0 °C										
temperature of												
project												
Altitude	3 m s.	B m s.l.m.										
Climatic Zone	В											
Heating days	121											
Wind speed	2.8 m/	8 m/s										
Wind zone	2	2										
Province of	Messi	Messina - Reggio di Calabria										
reference												
Average monthly	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
temperatures(°C)	11.7	12.0	13.2	15.7	19.2	23.5	26.4	26.5	24.2	20.3	16.6	13.3
Averages monthly	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	ОСТ	NOV	DEC
raditions (MJ/m²)	7.2	10.8	15.2	20.3	24.4	27.3	27.2	24.6	19.0	12.9	8.9	6.6
	10.8	12.9	12.9	11.5	9.9	9.2	9.7	11.8	14.0	14.2	13.2	10.3
	8.6	11.1	12.7	13.6	13.6	13.8	14.3	15.3	14.9	12.6	10.7	8.2
	5.4	7.9	10.5	13.4	15.6	17.1	17.2	16.2	13.1	9.3	6.7	5.0
	2.7	4.2	6.6	9.7	12.5	14.5	14.1	11.8	8.2	5.1	3.2	2.4
	2.4	3.2	4.3	5.9	8.4	10.2	9.5	6.8	4.6	3.6	2.6	2.2



_	_	_	_	

Final

Template	MESSINA
ite Location	
atitude (")	38,20
ongitude (")	15,55
ite Details	- Constant -
levation above sea level (m)	51,0
xposure to wind	2-Normal
ite orientation (")	0
around	
Add ground construction layers to surfaces in c	contact with ground (separate constructions only)
Construction	Cultivated clay soil (0.5m)
⊠ Texture	GranulatedGray453M
Surface Reflection	
Surface solar and visible reflectance	0,20
Snow reflected solar modifier	1,00
Snow reflected daylight modifier	1,00
Monthly Temperatures	
Vater Mains Temperature	
Precipitation	
ite Green Roof Irrigation ime and Daylight Saving	
imulation Weather Data	
Hourly weather data	ITA_MESSINA_IGDG
/inter Design Weather Data	HAEInebon + Eldeba
Heating 99.6% coverage	
Outside design temperature (*C)	6,3
Wind speed (m/s)	10,2
Wind direction (")	0,0
Heating 99% coverage	
ummer Design Weather Data	
emperature Range Modifiers	
)esign Temperatures	
Max dry-bulb temperature (°C)	32,2
Coincident wet-bulb temperature (*C)	22,8
Min dry-bulb temperature (°C)	27,1
O 99% coverage (based on dry-bulb temp.)	
O 98% coverage (based on dry-bulb temp.)	
O 99.6% coverage (based on wet-bulb temp.)	

FIGURE $\boldsymbol{123}$ - data for the simulation with design builder software



9.2. Shape And Orientation

This building is constituted from a building of 2 floors above ground. The dimensions are the same for each floor.

It is possible attach a road network scheme and a urban setting of the studied area.



FIGURE 124 - ROAD NETWORK SCHEME

FIGURE 125 - URBAN SETTING OF STUDIED AREA

9.3. AREA AND VOLUME

The building has a total area of about 13,500 m^2 (about 7,000 m^2 to plan) and a volume of about 55,000 m^3 .

9.4. CURRENT USE

Palazzo Zanca is a municipal building, in which there are multiple functions of public utility.

On the ground floor there is the access to the building with hall and reception. All rooms are now used as municipal offices, with the exception of the bathrooms, deposits and some offices of municipal councillors.





FIGURE 126 - GROUND FLOOR

On the first floors there are numerous municipal offices, Mayor's and assessors rooms, municipal council hall, reception hall, a bar, bathrooms and archives.



FIGURE 127 - RECEPTION HALL NAMED "HALL OF FLAGS"

In the basement there are large rooms and many of them are intended for systems and server rooms.

The building is usually busy between 0h00 and 24h00 from Monday to Sunday, because here is the registry office of the city, but the public activities of employees carried out only between 7h30 and



19h30. Public access depends on the type of service provided and is between 08h30 and 13h30 from Monday to Friday, also between 14h30 and 16h30 on Tuesday and Thursdays.

The building hosts about 750 employees and it is visited by an large number of visitors.

For the simulation of Palazzo Zanca with Design Builder, the building was divided into 8 blocks (named 1,2,4,5,6,10,11,12).

The size of the windows is not real but has been dimensioned according to the percentage of openings per square meter of wall surface.

The following image shows the Home screen of the software.

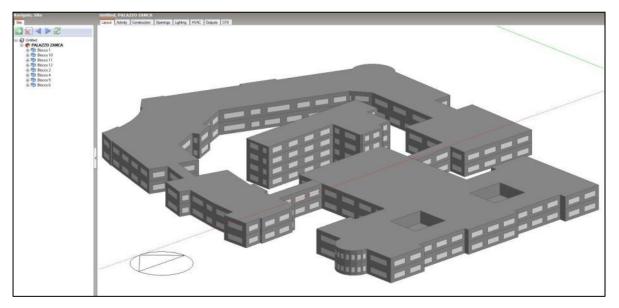


FIGURE 128 - HOME SCREEN OF THE SOFTWARE

The following figures show the floor plans of the blocks, as shown in the simulation software, that have been determined by different areas, depending on the intended use. Therefore different usage profiles were created.

For the Palazzo Zanca, historical building, there are: block 1 and block 4 at the ground floor; block 2 and block 6 at the first floor.

For the modern building, built in the seventies and placed in centre of the monumental excavations, there are: blocks 5,10,11,12.

Block 1 has:

- Zanca Office Typical
- Zanca Circulation
- Zanca Office Toilet
- Zanca Office Meeting room
- Office Tea





FIGURE 129 - PLAN OF BLOCK 1

Block 4 has:

- Zanca Office Typical
- Zanca Circulation
- Zanca Office Toilet

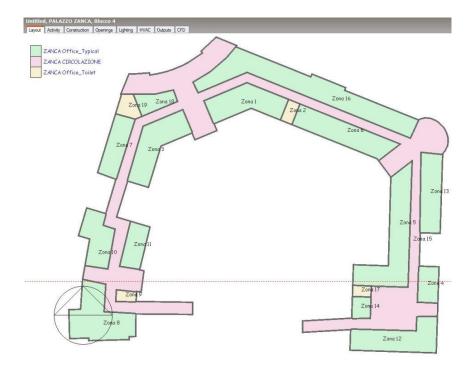


FIGURE 130 - PLAN OF BLOCK 4



Block 2 has:

- Zanca Office Typical
- Zanca Circulation
- Zanca Office Toilet

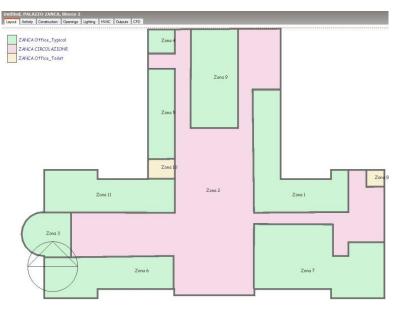


FIGURE 131 - PLAN OF BLOCK 2

Block 6 has:

- Zanca Office Typical
- Zanca Circulation
- Zanca Office Toilet

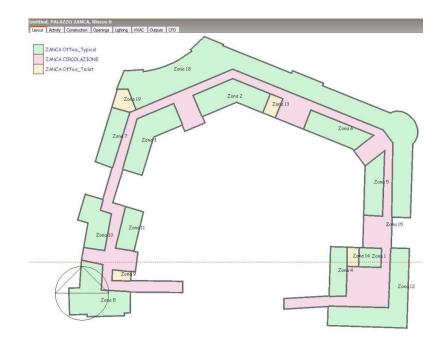


FIGURE 132 - PLAN OF BLOCK 6



Blocks 5, 10, 11, 12 have the same functional rooms in each floor:

- Zanca Office Typical
- Zanca Circulation
- Zanca Office Toilet

Intilided, PALAZZO ZANECA, Blocco S Lavot Aetwy Construction Openings Lighting HVAC Outputs CFD ZANCA CIRCOLAZIONE ZANCA Office_Typical			
ZANCA Office_Toilet	Zond I		
	Zona 4	Zona 3	
		Zana 5	
\bigcirc	Ļ	L	
FIGUE	RE 133 - PLAN OF BLOCK 5		



FIGURE 134- PLAN OF BLOCK 10



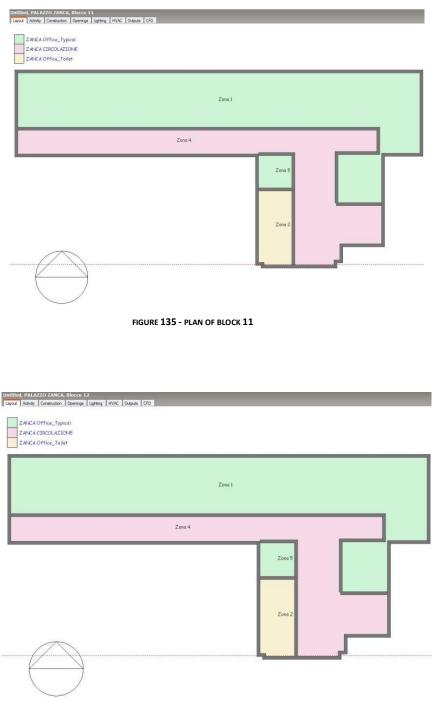


FIGURE 136 - PLAN OF BLOCK 12



10. CURRENT BUILDING CONDITIONS

10.1. CONSTRUCTIVE BUILDING CHARACTERISTICS

Palazzo Zanca respects the seismic regulations, which were written in the early twentieth century, after the earthquake of 1908, that destroyed completely the city of Messina. The building structure was built according to the "Hennebique" system in reinforced concrete (Portland cement), commonly used for the reconstruction of the city of Messina. The diameter of the "smooth irons" is 25 mm.

The pavilions 1, 2 and 5 are a continuous system of masonry in reinforced concrete (0,60-0,80 m), conversely, the pavilions 3 and 4 are a frame system (pillar 0,60 x 0,60 m) with bricks, as infill wall.

The external part of the envelope is in "fake stone", used mainly for decorations in "Liberty Style".

The following figure presents the site plan of the building.

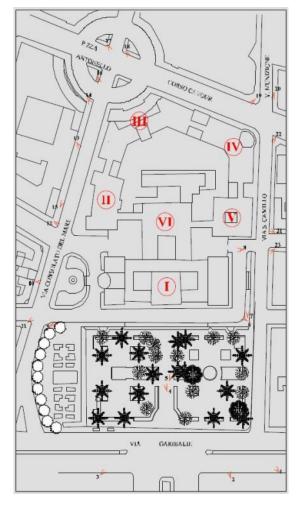


FIGURE 137 - SITE PLAN

On the ground floor there are the offices open to the public, the electoral offices and finally the municipal archives.



On the first floor are administrative functions of the city of Messina and the rooms of the Mayor and Municipal Council.

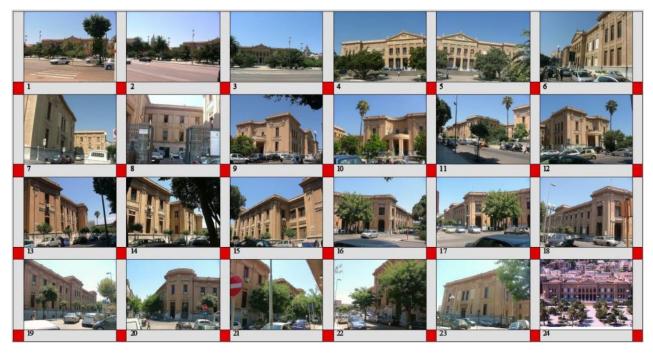


FIGURE 138 - OPTICAL CONES

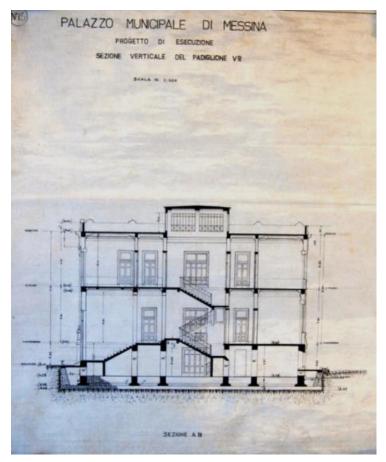


FIGURE 139 - ARCHITECTURAL SECTION OF PALAZZO ZANCA

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The next figure shows the main facade orientation of the building, exposed to the North.

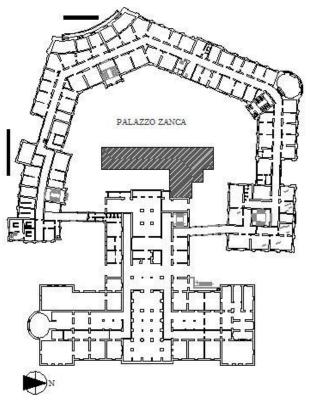


FIGURE 140 - ORIENTATION OF THE MAIN FAÇADE

10.1.1. Envelope Elements

The palace is a courtyard building, divided in five pavilions: in the main pavilion, T pavillon, the most important activities of the towns council takes place; in the pavillon 2, 3, 4, 5 other administrative functions are housed.

Antonio Zanca chose for his palace a Neo-Renaissance classic style , where ornaments, in fake stone, are tied to local traditions.



FIGURE 141 - FRONT OF PALAZZO ZANCA



In the figure above, the allegorical figures on the tympanum represent the Peloro's queen with two sirens (Comiso's stone); dolphins on the capitals represent the marine origin of the city ; allegories representing the prows of ships represent too the origin of the city (Comiso's stone).

The main façade is inspired by the Parthenon.

Directly on site were realized casts to build ornate, capitals, allegorical figures, shelves and frames.



FIGURE 142 - EXAMPLE OF PALAZZO ZANCA ORNATES

On the façade, sculptures can be seen linked to the symbolism of the city, and also many headstones that commemorate most important events. The elevation of Via San Camillo show two bas-reliefs depicting Dina and Clarenza, two female legendary characters in the history of Messina.

10.1.2. WINDOWS

All the windows have single glazing with wooden frames. The doors have the same characteristics of the windows with the exception of 3 doors on the ground floor, which are in glass and metal.

All the windows have simple shutters (Figure 32). Almost all rooms have opaque cloth curtains, dark in color.



FIGURE 143 - WINDOWS WITH SHUTTERS



The steady shading is ensured by other buildings in Via San Camillo and by the evergreen trees in Via Consolato del Mare.

The front façade facing European Union Square is not subject to any shading, as can be seen from the following figure.



FIGURE 144 - EUROPEAN UNION SQUARE

Windows of ground floor are the same of the first floor, with a fixed fanlight. The extra height is 60 cm (outer frame).

	TABLE 33 - WINDOWS			
FLOOR	WINDOW	NUMBER		
FIRST	F9	SEE DRAWING		
TOT. DIMENSION (sqcm)	HIGH h	width I		
35,090	242	145		
HEIGHT WOOD FRAME (HOR.)	HEIGHT WOOD FRAME (VERT.)	THICKNESS FRAME		
12	8	5		
Wood Area	Single glass Area of 3 mm	% Glasses		
7,352	27,738	79.5%		
FLOOR	WINDOW	NUMBER		
FIRST	F9.1	SEE DRAWING		
TOT. DIMENSION (sqcm)	HIGH h	width l		
35,500	250	142		

TABLE 33 - WINDOWS



HEIGHT WOOD FRAME (HOR.)	HEIGHT WOOD FRAME (VERT.)	THICKNESS FRAME			
18	18	5			
Wood Area	Single glass Area of 3 mm	% Glasses			
14,112	21,388	60.25%			
FLOOR	WINDOW	NUMBER			
FIRST	F8	SEE DRAWING			
TOT. DIMENSION (sqcm)	HIGH h	width l			
41,664	248	168			
HEIGHT WOOD FRAME (HOR.)	HEIGHT WOOD FRAME (VERT.)	THICKNESS FRAME			
18	18	5			
Wood Area	Single glass Area of 3 mm	% Glasses			
14,976	26,688	64.06%			
FLOOR	WINDOW	NUMBER			
FIRST	F8.1	SEE DRAWING			
TOT. DIMENSION (sqcm)	HIGH h	width l			
72,416	248	292			
HEIGHT WOOD FRAME (HOR.)	HEIGHT WOOD FRAME (VERT.)	THICKNESS FRAME			
18	18	5			
Wood Area	Single glass Area of 3 mm	% Glasses			
19,440	52,976	73.16%			
FLOOR	WINDOW	NUMBER			
FIRST	F7	SEE DRAWING			
TOT. DIMENSION (sqcm)	HIGH h	width l			
60,021	247	243			
HEIGHT WOOD FRAME (HOR.)	HEIGHT WOOD FRAME (VERT.)	THICKNESS FRAME			
18	18	5			
Wood Area	Single glass Area of 3 mm	% Glasses			
17,640	42,381	70.61%			
FLOOR	WINDOW	NUMBER			
FIRST	F1	SEE DRAWING			
TOT. DIMENSION (sqcm)	HIGH h	width l			
31,200	240	130			
HEIGHT WOOD FRAME (HOR.)	HEIGHT WOOD FRAME (VERT.)	THICKNESS FRAME			
12	15	5			
Wood Area	Single glass Area of 3 mm	% Glasses			
10,320	20,880	66.92%			

Final



FLOOR	WINDOW	NUMBER			
FIRST	F1.1	SEE DRAWING			
TOT. DIMENSION (sqcm)	HIGH h	width l			
38,100	300	127			
HEIGHT WOOD FRAME (HOR.)	HEIGHT WOOD FRAME (VERT.)	THICKNESS FRAME			
12	15	5			
Wood Area	Single glass Area of 3 mm	% Glasses			
12,048	26,052	68.38%			
	· · · · · · · · · · · · · · · · · · ·				
51.00D	WINDOW metal frame fixed 8				
FLOOR	cm	NUMBER			
FIRST	F stair A (short)	SEE DRAWING			
TOT. DIMENSION (sqcm)	HIGH h	width l			
20,000	250	80			
HEIGHT FRAME (HOR.)	HEIGHT FRAME (VERT.)	THICKNESS FRAME			
0	0	0			
Area	Single glass Area of 3 mm	% Glasses			
0	20,000	100.00%			
	· · · · · · · · · · · · · · · · · · ·				
FLOOR	WINDOW metal frame fixed 8	NUMBER			
FLOOR	cm	NOIVIBER			
FIRST	F stair A (large)	SEE DRAWING			
TOT. DIMENSION (sqcm)	HIGH h	width l			
35,000	250	140			
HEIGHT FRAME (HOR.)	HEIGHT FRAME (VERT.)	THICKNESS FRAME			
0	0	0			
Area	Single glass Area of 3 mm	% Glasses			
0	35,000	100.00%			
FLOOR	WINDOW metal frame fixed 8	NUMBER			
	cm				
FIRST	F stair B (short)	SEE DRAWING			
TOT. DIMENSION (sqcm)	HIGH h	width l			
31,000	250	124			
HEIGHT FRAME (HOR.)	HEIGHT FRAME (VERT.)	THICKNESS FRAME			
0	0	0			
Area	Single glass Area of 3 mm	% Glasses			
0	31,000	100.00%			
FLOOR	WINDOW metal frame fixed 8 cm	NUMBER			
FIRST	F stair B (large)	SEE DRAWING			



TOT. DIMENSION (sqcm)	HIGH h	width l
36,250	250	145
HEIGHT FRAME (HOR.)	HEIGHT FRAME (VERT.)	THICKNESS FRAME
0	0	0
Area	Single glass Area of 3 mm	% Glasses
0	36,250	100.00%
FLOOR	WINDOW	NUMBER
FIRST	F8.2	SEE DRAWING
TOT. DIMENSION (sqcm)	HIGH h	width I
58,764	249	236
HEIGHT WOOD FRAME (HOR.)	HEIGHT WOOD FRAME (VERT.)	THICKNESS FRAME
18	18	5
Wood Area	Single glass Area of 3 mm	% Glasses
17,460	41,304	70.29%
	· · · ·	
FLOOR	WINDOW	NUMBER
FIRST	Stair B top glass	13
TOT. DIMENSION (sqcm)	HIGH h	width l
22,400	140	160
HEIGHT WOOD FRAME (HOR.)	HEIGHT WOOD FRAME (VERT.)	THICKNESS FRAME
12	12	5
Wood Area	Single glass Area of 3 mm	% Glasses
7,200	15,200	67.86%
FLOOR	WINDOW metal frame fixed 8	NUMBER
FLOOR	cm	NOWIDER
FIRST	F stair C (short)	SEE DRAWING
TOT. DIMENSION (sqcm)	HIGH h	width l
217.5	375	0.58
HEIGHT FRAME (HOR.)	HEIGHT FRAME (VERT.)	THICKNESS FRAME
0	0	0
Area	Single glass Area of 3 mm	% Glasses
0	218	100.00%
FLOOR	WINDOW metal frame fixed 8	NUMBER
	cm	
FIRST	F stair C (large)	SEE DRAWING
TOT. DIMENSION (sqcm)	HIGH h	width l
79,500	375	212
HEIGHT FRAME (HOR.)	HEIGHT FRAME (VERT.)	THICKNESS FRAME



Area	Single glass Area of 3 mm	% Glasses
0	79500	100,00%

FLOOR	WINDOW	NUMBER
FIRST	F1.2	SEE DRAWING
TOT. DIMENSION (sqcm)	HIGH h	width l
43,250	250	173
HEIGHT WOOD FRAME (HOR.)	HEIGHT WOOD FRAME (VERT.)	THICKNESS FRAME
18	18	5
Wood Area	Single glass Area of 3 mm	% Glasses
15,228	28,022	64.79%
FLOOR	WINDOW	NUMBER
FIDOT	F10	
FIRST	F10	SEE DRAWING
TOT. DIMENSION (sqcm)	HIGH h	width l
TOT. DIMENSION (sqcm)	HIGH h	width l
TOT. DIMENSION (sqcm) 50,400	HIGH h 360	width l 140
TOT. DIMENSION (sqcm) 50,400 HEIGHT WOOD FRAME (HOR.)	HIGH h 360 HEIGHT WOOD FRAME (VERT.)	width l 140 THICKNESS FRAME
TOT. DIMENSION (sqcm) 50,400 HEIGHT WOOD FRAME (HOR.) 12	HIGH h 360 HEIGHT WOOD FRAME (VERT.) 15	width l 140 THICKNESS FRAME 5



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FIGURE 145 - GROUND FLOOR PLANT OF WINDOWS



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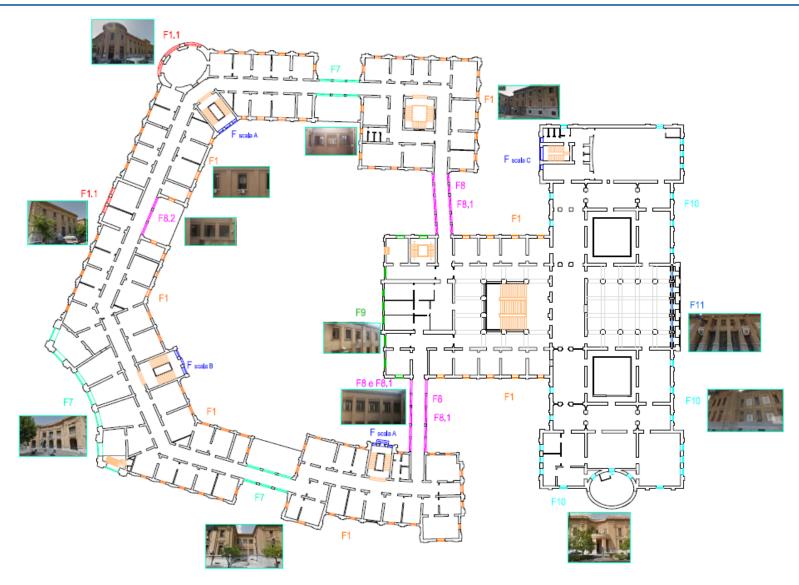


FIGURE 146 - FIRST FLOOR PLANT OF WINDOWS

Final



10.1.3. AIRFLOWS AND PATHOLOGIES

Detail	Alteration	Pathogen	Failure consequence
	1- Discolouration	At the expense of components of the material, the parameters that define the color.	Natural variation
	2- Crumbling	The natur is usually physical, suach as rising damp or crystallization of salts (thesis supported by the proximity to the coast)	Presence of cavities of variable size and shape, called alveoli, often interconnected and with non-uniform distribution
	3- Colonization biological	Poor site care	Presence detectable with evidence on the surfaces (algae, fungi, lichens, mosses, plants)
	4- Lack	The absence of human intervention	Loss of three- dimensional elements
	7- Anthropogenic deterioration	Inappropriate placement of cables, technological, lack of maintenance, inappropriate use of building materials.	Change of conservation state of property or of the context in which it is inserted.
	5- Formation of saline substances due water loss	Cohesion problems	Superficial formation crystalline or powdery or filamentous, usually whitish.
	11- Dietachent	Solution of continuity of material	Solution of continuity between layers of a plaster, both between themselves and with respect to the substrate, which preludes, in general, to the fall of the layers themselves.

TABLE 34 - AIRFLOWS AND PATHOLOGIES



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	7- Anthropic decay	Vandalistic graffiti - Improper placement of technological elements	Change of conservation state of property of the context.
	9- Stain	Presence of particular natural material components (concentration of pyrite in the marble) and presence of foreign materials (water, oxidation products of metallic materials)	Color change on the surface.
1	8- Gap	Loss of continuity of the surface.	Concrete cover spalling.
	10- Pitting	Sometimes caused by microorganisms present in the stone that feed on carbon	Formation of blind hol
(12)	12- Fracturing or cracking	Solution of continuity	Mutual displacement of parts
	13- corrosion of iron bars	Variazione delle condizioni igrometriche standard : (T ~25°C ; UR ~ 50%, ; Pres. ~ 1 bar)	Alteration of the colours, and the structural strength of the material, thickening of the surface and drilling of parts of the same. Rust.

A previous study analysed the envelope with thermal imaging with an external air temperature of about 17°C.

The following figure shows the general image of the thermal performance of the envelope: the walls present a good thermal performance.

Final





FIGURE 147 - THERMAL VIEW

The next figures show the thermal losses of the windows. The windows, with single glazing and wood frames, present insulation problems, aggravated by aging.



FIGURE 148 - THERMAL LOSSES IN THE WINDOWS AND WINDOW INVISIBLE TO THE NAKED EYE

The thermal losses due to thermal bridges in the corner of the room are also shown.

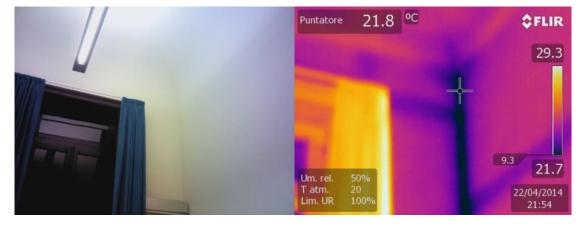


FIGURE 149 - THERMAL BRIDGES



Some characteristics of the building contribute to a bad thermal performance:

- The orientation is bad, requiring additional energy consumption with heating during the winter (mainly in the north areas) and with cooling during the summer (mainly in the west areas without any direct protection from the direct radiation).
- The walls with high thermal inertia and large ceiling height provide advantages during the summer, but disadvantages during winter, since the building does not have users in the night period and weekends which leads to a high temperature decrease.
- The windows have a low level of airtightness, enabling a high level of air infiltration, which is not controllable and undesirable, mainly during the winter.
- The doors are old and have a high thermal transmittance.
- The building presents many pathologies, such as condensation and mould growth.

10.2. ENERGY SYSTEMS

10.2.1. HVAC

The HVAC is ensured with several heat pumps, which have been installed gradually over the years. Therefore, there are several different types of equipment with different characteristics and performance. In total, there is at least one split in every room and the total number is summarized in the following table.



FIGURE 150 - THERMOGRAPHY OF AN AIR CONDITIONER ON

Almost all the areas of permanent use have HVAC, being the control ensured locally with individual control units. It is therefore an obsolete plant, splits have more than fifteen years now, and their efficiency is reduced.



TABLE 35 - HEAT PUMPS AND AHU CALCULATION

Heat Pumps and AHU calculation						
Туре	Type Thermal Power Reference Area BTU/H				Number	тот.
Heat pump	9,000.00	Offices - first floor	42	378,000.00		
Heat pump	12,000.00	Offices - first floor	26	312,000.00		
AHU	24,000.00	Council locals	1	24,000.00		
Heat pump	207,670.00	Local council/mayor/cabinet office/salon of the flags/bar/	includes many split	207,670.00		
Heat pump	18,000.00	Offices first floor accounting - protocol	1	18,000.00		
Heat pump	18,000.00	Offices first floor accounting - director	1	18,000.00		
Heat pump	9,000.00	Offices ground floor	48	432,000.00		
Heat pump	12,000.00	Offices ground floor	30	360,000.00		
Heat pump	24,000.00	Offices URP ground floor	1	24,000.00		
			BTU/hr	1,773,670.00		
			KW thermal	519.83		

The air circulation and renewal is ensured naturally through the doors and windows. There aren't systems of forced ventilation in rooms.

10.2.2. LIGHTING

In the building there are 2 different types of lamp: incandescent and fluorescent.



FIGURE 151 - LIGHTING IN ROOMS

FIGURE 152 - LIGHTING IN ALL AREAS

FIGURE 153 - LIGHTING IN CIRCULATION AREAS

Final



There is no mechanism to control lighting and plants are dated. During close time only emergency lighting is on.

Туре	Power	Power Reference Area		тот.
	(Watt)			
GROUND FLOOR				-
Fluorescent 2x58	116.00	Offices ground floor	177	20,532.00
Fluorescent 2x36	72.00	Services and circulation ground	115	8,280.00
		floor		
Fluorescent 1x54	54.00	All ground floor	280	15,120.00
Fluorescent 2x58	116.00	Offices CED	30	3,480.00
Fluorescent 2x58	116.00	Offices URP/Anagrafe	30	3,480.00
Fluorescent 2x36 72.00 Stairs and entrances ground		Stairs and entrances ground	35	2,520.00
		floor		
FIRST FLOOR				
Fluorescent 1x54	54.00	Rooms: administration. mayor.	526	28,400.00
		council. salons		
Incandescence	150.00	Council room	84	12,600.00
1x150				
Incandescence	60.00	Council room	39	2,340.00
1x60				
Fluorescent 2x58	116.00	Offices - first floor	209	24,244.00
Fluorescent 2x36	72.00	Services and circulation first	80	5,760.00
		floor		

TABLE 36 - LAMPS CALCULATION

10.2.3.Ic⊤

Most of the offices and rooms have computers and printers and there is a room with servers and an internal circuit of building for security.

There are photocopier machines. tv-screens. video projectors in some rooms and equipment for the exclusive use of the bar.

10.2.4. OTHERS

The building has 5 lifts. The usage rate of the lifts is high since they serve rooms with much public and employee attendance. but the contribution to total consumption is negligible.

Lifts and other small appliances connected to plugs such as individual electric heaters. vending machines. photocopier machines. computers and printers (when not connected to the UPSs). etc. were flagged as "other".



For calculating the energy consumption usage profiles have been created directly through the Design Builder software for individual electric equipment.

10.3. Energy Consumption & Energy Generation

10.3.1. ELECTRICITY CONSUMPTION

The building receives electricity in Low Voltage. Following a summary table of power consumption.

ELECTRICITY	kWh per year	kWh per year 2012	kWh per year 2014
CONSUMPTION	2013		
Zanca Palace			Survey performed on
Via S. Camillo. 5 - Messina			days in mid-June in
			2014.
			Average consumption
			with average outdoor
			temperatures of 27 C
			during operation.
IT001E96237725	2,886 kWh	1,789 kWh	
Via S. Camillo. SN - Messina			
IT001E00239947	1,482,357 kWh	1,500,548 kWh	

TABLE 37 - ELECTRICITY CONSUMPTION

There is not a central system for heating and cooling. but there are many emission systems (split). different in shape. performance. brand and model.

To set the calculation of the model the general information are:

TABLE 38 - GENERAL INFORMATION FOR SIMULATION

	Data
Weather File	Messina - ITA IGDG WMO#=164200
HDD and CDD data source	Weather File Stat
Total gross floor area [m2]	13,580.56
Principal Heating Source	District Heat

TABLE 39 - ENERGY USE INTENSITY - ELECTRICITY

	Electricty [MJ/m ²]
Interior Lighting	281.50
Space Heating	0.00
Space Cooling	0.00
Fans-Interior	0.00
Service Water Heating	0.00
Receptacle Equipment	86.51
Miscellaneous	0.00
Subtotal	368.01



TABLE 40 - UTILITY USE PER TOTAL FLOOR AREA

	Electricity Intensity [kWh/m2]	Natural Gas Intensity [kWh/m2]	Additional Fuel Intensity [kWh/m2]	District Cooling Intensity [kWh/m2]	District Heating Intensity [kWh/m2]	Water Intensity [m3/m2]
Lighting	78.19	0.00	0.00	0.00	0.00	0.00
HVAC	0.00	0.00	0.00	92.38	19.89	0.00
Other	24.03	0.00	0.00	0.00	0.00	0.00
Total	102.23	0.00	0.00	92.38	19.89	0.00

TABLE 41 - END USE CONSUMPTION

	Electricity	Natural	Additional	District	District	Water
	[kWh]	Gas	Fuel [kWh]	Cooling	Heating	[m3]
		[kWh]		[kWh]	[kWh]	
Heating	0.00	0.00	0.00	0.00	270,143.40	0.00
Cooling	0.00	0.00	0.00	1,254,508.77	0.00	0.00
Interior	1,061,927.55	0.00	0.00	0.00	0.00	0.00
Lighting						
Exterior	0.00	0.00	0.00	0.00	0.00	0.00
Lighting						
Interior	326,353.11	0.00	0.00	0.00	0.00	0.00
Equipment						
Total End	1,388,280.66	0.00	0.00	1,254,508.77	270,143.40	0.00
Uses						
Total	2,912,932.83					

TABLE 42 - END USE PERCENTAGE

	Percent [%]
Interior Lighting	36.46
Space Heating	9.27
Space Cooling	43.07
Fans-Interior	0.00
Service Water Heating	0.00
Receptacle Equipment	11.20
Miscellaneous	0.00

Final



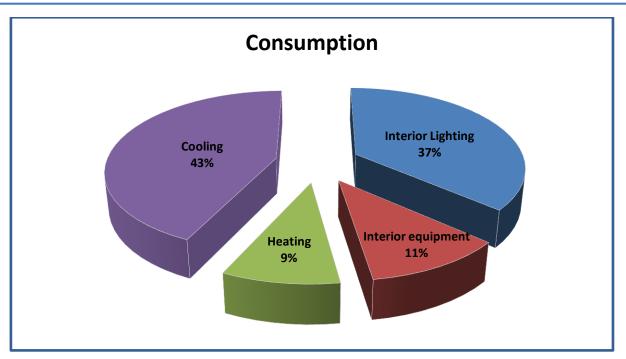


FIGURE 154 - DISAGGREGATION OF ELECTRICITY CONSUMPTION BETWEEN USES

The following figures show the heat balance of Palazzo Zanca. divided according to the contribution types:

- General Lighting.
- Computer + Equipment.
- Occupancy.
- Solar Gans Exterior Windows.
- Zone Sensible Heating.
- Zone Sensible Cooling.

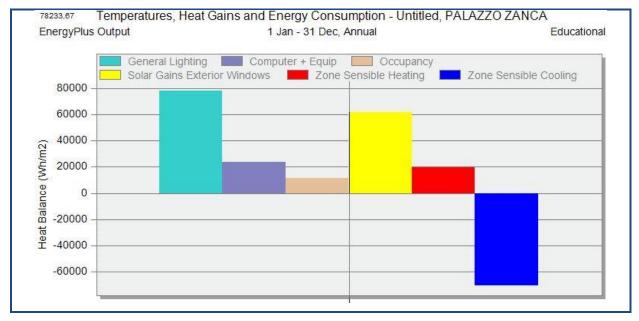


FIGURE 155 - ANNUAL HEAT BALANCE





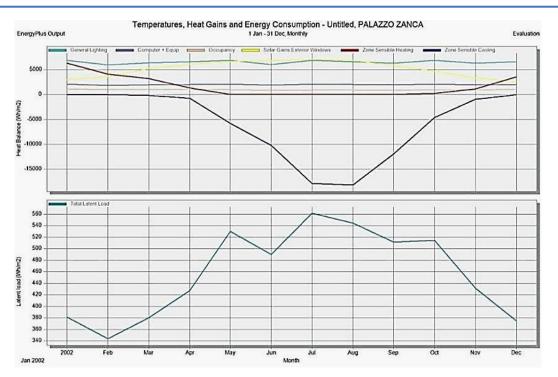


FIGURE 156 - ANNUAL HEAT BALANCE. ACCORDING OF SINGLE MONTHS

Two following figures show the monthly total fuel use of Palazzo Zanca. divided according to the contribution types:

- Room Electricity.
- Lighting.
- Auxiliary Energy.
- Heating (Electricity).
- Cooling (Electricity).

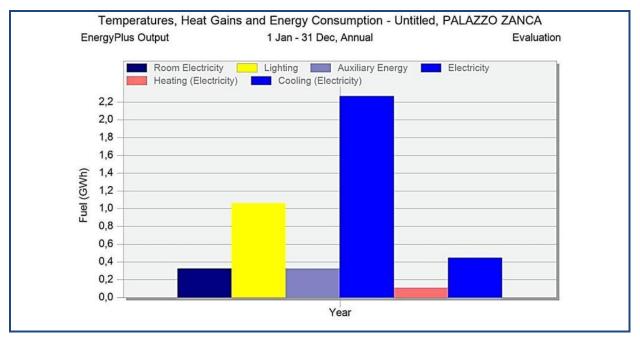


FIGURE 157 - ANNUAL USE OF FUEL TOTAL



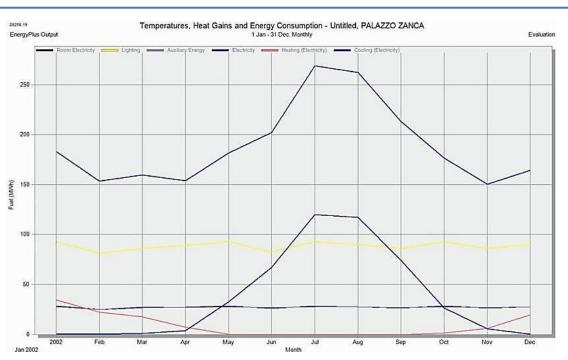


FIGURE 158 -MONTHLY USE OF FUEL TOTAL

The following figures show heat balance of Palazzo Zanca. divided according to the contribution types. during four months in particular January. April. July and September:

- General Lighting.
- Computer + Equipment.
- Occupancy.
- Solar Gans Exterior Windows.
- Zone Sensible Heating.
- Zone Sensible Cooling.

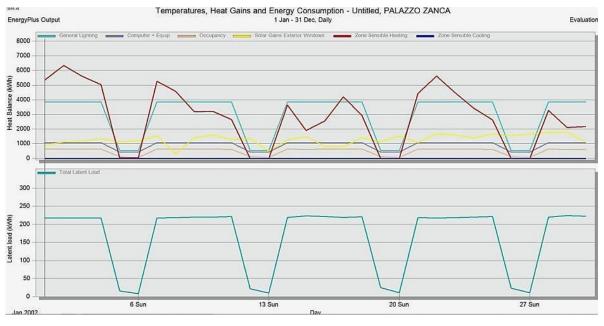


FIGURE 159 - HEAT BALANCE DURING JANUARY

Final



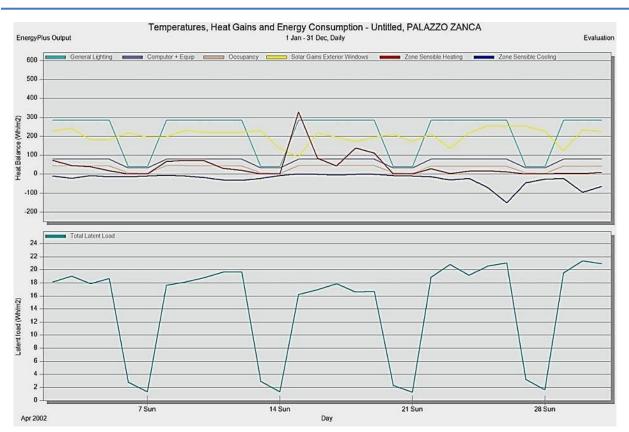


FIGURE 160 - HEAT BALANCE DURING APRIL

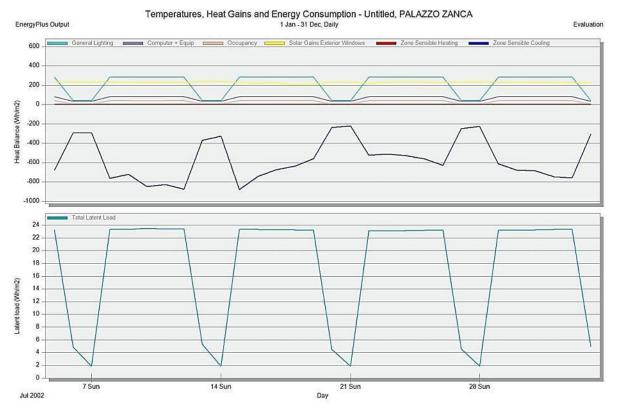


FIGURE 161 - HEAT BALANCE DURING JULY







FIGURE 162 - HEAT BALANCE DURING SEPTEMBER

10.3.2. GAS/OIL CONSUMPTION

The building does not have any gas consumption.

10.3.3. RENEWABLE ENERGY SOURCES

The building does not have any RES plant.

10.3.4. OTHER GENERATION

Other data that influence thermal balance come from building envelope.

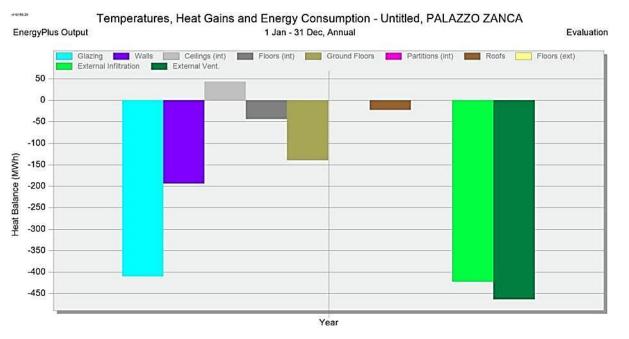
Considered data are:

- Glazing
- Walls
- Ceilings (internal)
- Floors (internal)
- Ground floors
- Partitions (internal)

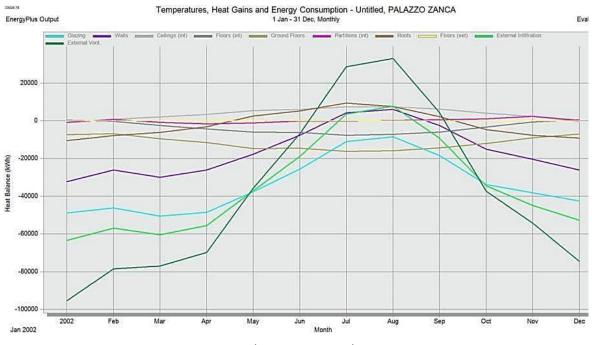


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- Roofs
- Floors (external)
- External infiltration
- External ventilation











The following figures shows heat balance (fabric and ventilation) of Palazzo Zanca. divided according to the contribution types. during four months in particular January. April. July and September.

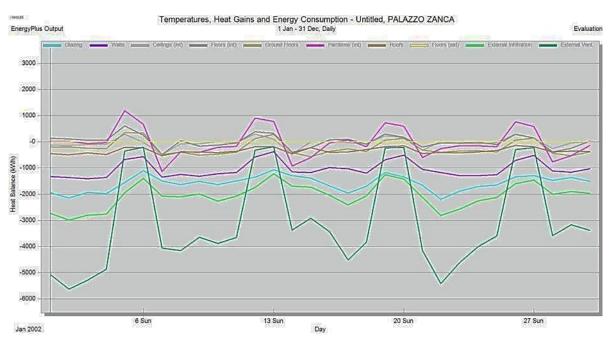


FIGURE 165 - HEAT BALANCE DURING JANUARY (FABRIC AND VENTILATION)

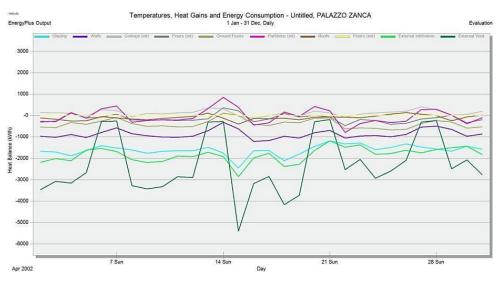


FIGURE 166 - HEAT BALANCE DURING APRIL (FABRIC AND VENTILATION)





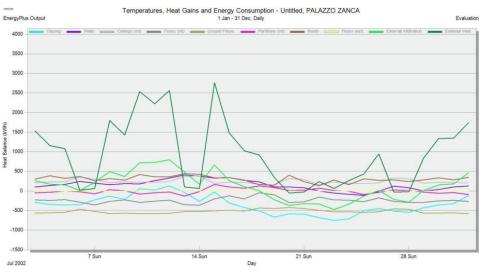
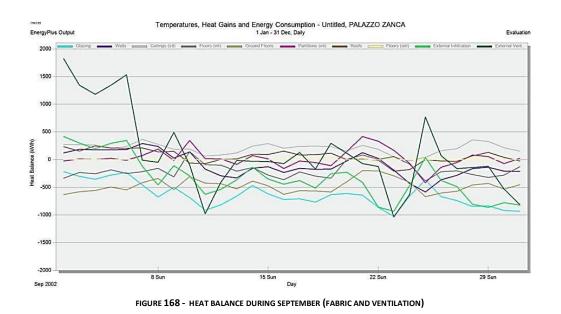


FIGURE 167 - HEAT BALANCE DURING JULY (FABRIC AND VENTILATION)



10.3.5. Final Energy Consumption And Co_2 Emissions

In this building only electricity is consumed. as depicted in the following table.

	Electricity Intensity [kWh/m2]	Natural Gas Intensity [kWh/m2]	Additional Fuel Intensity [kWh/m2]	District Cooling Intensity [kWh/m2]	District Heating Intensity [kWh/m2]	Water Intensity [m3/m2]
Lighting	78.19	0.00	0.00	0.00	0.00	0.00
HVAC	0.00	0.00	0.00	92.38	19.89	0.00
Other	24.03	0.00	0.00	0.00	0.00	0.00
Total	102.23	0.00	0.00	92.38	19.89	0.00

TABLE 43 - UTILITY USE PER TOTAL FLOOR AREA



	Electricity [kWh]	Natural Gas [kWh]	Additional Fuel [kWh]	District Cooling [kWh]	District Heating [kWh]	Water [m3]
Heating	0.00	0.00	0.00	0.00	270,143.40	0.00
Cooling	0.00	0.00	0.00	1,254,508.77	0.00	0.00
Interior Lighting	1,061,927.55	0.00	0.00	0.00	0.00	0.00
Interior Equipment	326,353.11	0.00	0.00	0.00	0.00	0.00
Total End Uses	1,388,280.66	0.00	0.00	1,254,508.77	270,143.40	0.00
Total	2,912,932.83					

TABLE 44 - END USE CONSUMPTION

Simulation data shows that the building has electricity consumption of 2,912,932.83 kWh and below percentages are summarized percentages of individual consumption.

TABLE 45 - END USE PERCENTAGE

	Percent [%]
Interior Lighting	36.46
Space Heating	9.27
Space Cooling	43.07
Receptacle Equipment	11.20

The last Table presents the main energy parameters of the building which were considered as baseline. Such parameters were assessed considering the following conversion factors:

- electricity to primary energy 2.174 (standard value approved for Italy);
- electricity to CO₂ emissions 510.00 g/kWh (average emissions associated with the electricity consumed in Italy during 2012 according ENEL environmental report 2012);

11. RENOVATION SCHEME

11.1. AIM OF THE RENOVATION PLAN

In Italy, the NZEBs (nearly zero energy buildings) don't meet national specific legislation but this is now being defined, according to Directive 2012/27/UE. NZEB design is aimed at achieving high performance standards in terms of energy and environment.

Specific attention should be devoted to the reduction of energy consumption of the building. Guiding the design on three key areas:

- Maximizing the building envelope passive behaviour
- Use high efficiency systems



• Use of systems for the renewable thermal energy exploitation and photovoltaic systems for the electricity production from solar sources.

The aim is to minimize energy contribution from the external electricity grid. The objective of the renovation plan is to achieve an average primary energy reduction between 75% and 80% of the current demand and to ensure that between 50% and 90% of the consumed energy is generated on site.

A building envelope is called passive if it is conformant to the following values:

- Thermal transmittance very low (0.0167/0.227 W/m²K)
- Low values of attenuation factor (<0.1). resulting in high phase shift values (>11.5 hours)
- Windows with transmittance less than 1.6 W/m²K
- System efficiency that can reduce by 70% the maximum solar radiation on transparent surfaces.

To achieve these aims some difficulties or constraints should be considered in the implementation.

The following global constraints were taken into account in the design of the renovation plan:

- Since the building is inscribed on the List of building constrained by the Superintendence of Cultural Heritage. Several strong restrictions are applied in the renovation of such building due to the protection rules. Since it is not possible to implement any change in the building envelope able to cause any visual impact or modify historical integrity of the building. Therefore. The renovation option with a high visual impact is not possible.
- The buildings have an intensive utilization. Receiving a large number of visitors and are the working place for a large number of Municipal employees. Such activities cannot be interrupted since it is not easy to temporarily move the services to another building. Therefore, renovation options requiring major construction works need a plan that takes into account the needs of workers and visitors.

Planned integrations modify the architecture of the building, but without changing the functions. Being a historical building it was quite complicated inserting renewable sources and determining appropriate space to allocate them. An intervention difficult to predict was that related to the new air conditioning system.

The assumptions for improvement have been inserted using the Design Builder software that simulates with Energy Plus Databases. For Zanca Palace, considering the environmental conditions of Messina, greater consumption is by the use of electricity for cooling in the summer period, therefore it was decided to insert solutions also covering a constant ventilation of the building.

11.2. ENERGY DEMAND REDUCTION

11.2.1. OPAQUE ENVELOPE

An important task in the renewal plan is targeted to the building envelope. Among the actions planned, there is the facades renovation. it is planned to ensure the safety of unsafe parts (eg unsafe



cornice) and, where necessary, make injections with binding materials. Another change concerns the reconstruction of the plaster of the facades, using a thermal insulation plaster. UNI EN 998-1 "Mortars for internal and external" defines insulating plaster as "a mortar with guaranteed performance with specific insulating properties". According to UNI EN 998-1 mortar must ensure thermal values of I (thermal conductivity) of less than 0.1 W/mK, then with high insulating performance. There are plasters with better performance but with the same texture and the same color of plaster used previously.

Obviously, it is expected to remove from prospects all present compressors and restore the facades in its entirety. Envelope treated with these plasters improves their transmittance value.

Among other interventions there is the waterproofing of the roof, by a fibre-reinforced bituminous membrane under the floor



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Detail	Alteration	Pathogen	Failure consequence	Solution
	1- Discolouration	At the expense of components of the material. the parameters that define the color.	Natural variation	Cleaning with water spray: is a spray low pressure water spray at room temperature by means of hydraulic spray nozzles.whose effectiveness is due to the ability of small particles of water to penetrate the surface deposits. for this reason should be carefully assessed the distance between the nozzle and the surface to be cleaned.
	2- Crumbling	The natur is usually physical. suach as rising damp or crystallization of salts (thesis supported by the proximity to the coast)	Presence of cavities of variable size and shape. called alveoli. often interconnected and with non- uniform distribution	 On the surface is applied by brush a biocidal product and is removed with a soft bristle brush and with the aid of a scalpel Cleaning the surface deposit. with application of gel supporting tablets soaked in organic solvents and / or of a saturated solution of ammonium carbonate Removal of defective grout. performed during previous interventions. which have lost their conservative function Grouting of injuries. fractures. lacks to be made with the application of mortar made of hydraulic lime and aggregates suitable for color and grain size Surface protection to be made with polysiloxane applied by spray or brush.
	3- Colonization biological	Poor site care	Presence detectable with evidence on the surfaces (algae. fungi. lichens. mosses. plants)	Extirpation braking: extirpation mechanics that does not alter the materials from which mansory; all species tree and herbaceous plants will be uprooted in the winter. Chemical weeding: is the operation of the control and elimination of natural vegetation that should be conducted with great care by using chemicals to complete extirpation of mechanical intervention.



4- Lack	The absence of human intervention	Loss of three- dimensional elements	Integration of concrete respecting the existing masonry, always taking care to highlight the new integration than the existing material, form, colour or application technique.
7- Anthropogenic deterioration	Inappropriate placement of cables. technological. lack of maintenance. inappropriate use of building materials.	Change of conservation state of property or of the context in which it is inserted.	 Deleting previous intervention. Cleaning with spray of water at low pressure. Reinstatement according to the type of degradation
5- Formation of saline substances due water loss	Cohesion problems	Superficial formation crystalline or powdery or filamentous. usually whitish.	Cleaning with water spray - Are used ion exchange resins to maintain the washing water continuously deionized and therefore with greater solvent power. The project, aimed at the elimination of salts. is believed to be managed with the achievement of the neutral pH.
11- Dietachent	Solution of continuity of material	Solution of continuity between layers of a plaster. both between themselves and with respect to the substrate. which preludes. in general. to the fall of the layers themselves.	Scraping with soft brushes, degraded surface layer, limiting it to those parts detached or flaking, avoiding nicking less superficial layers of plaster. The parts of plaster possibly very degraded, now damaged seriously, will be removed also only superficially. Consolidating, by impregnating the structural basis of ethyl silicate. Application can be done or by brush or spraying. product is passed repeatedly until saturation and excess will be removed with washes at the base of dolituion solvent.



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	7- Anthropic decay 9- Stain	Vandalistic graffiti - Improper placement of technological elements Presence of particular natural material components (concentration of pyrite in the marble) and presence of foreign materials (water. oxidation products of metallic materials)	Change of conservation state of property of the context. Color change on the surface.	Cleaning with gel. to be chosen according to the type of material to be treated and the type of paint or ink to remove; can be applied directly on graffiti by spray or by brush.
622	8- Gap	Loss of continuity of the surface.	Concrete cover spalling.	<i>Cleaning of irons, their coating and finally rebuild missing parts.</i>
	10- Pitting	Sometimes caused by microorganisms present in the stone that feed on carbon	Formation of blind hol	A preventive treatment with HNO3 ~ 10% produces a passive layer. Pitting resistance. Defusing of pitting: intervention of foreign ions and repassivation of the surface.
(P)	12- Fracturing	Solution of	Mutual	Plastering with lime mortar doped epoxy. Superficially making a
e e	or cracking	continuity	displacement of	seal using lime mortar free from soluble salts possibly loaded
			parts	with acrylic resin. For the exterior finish is used as aggregate, powder made from the same material that you have to fill. It is
				good that the intervention of grouting includes both filling the
				gaps of greater extent both the slots of smaller dimensions, as
				it may facilitate the penetration of water.

Final



Deliverable D2.1 Report presenting the 3 nZEB renovation schemes in Italy, fully documented with technical and economic evaluation

	13- corrosion of iron bars	Variation of conditions humidity standards: (T ~25°C ; UR ~ 50%. ; Pres. ~ 1 bar)	Alteration of the colours, and the structural strength of the material, thickening of the surface and drilling of parts of the same. Rust.	Cleaning of the irons, their coating and finally rebuild missing parts. The removal of oxides from rusted iron is very important, and can be done by sandblasting or by careful brushing irons leading them to the white metal. Once cleaned up the iron, you can proceed to the application of protective products. This is typically slurries passivating applicable brush.
--	-------------------------------	---	--	---

Final



11.2.2. OPENINGS

At present, all windows are in single glass with hardwood frames. It is expected that all windows of Zanca Palace will be replaced, inserting selective glasses and modifying wood frames.

It is also important to study new forms of glass to optimize reflective surface.



FIGURE 169 - ACTUAL REFLECTIVE SURFACE



FIGURE 170 - ACTUAL WINDOW



FIGURE 171 - ACTUAL WINDOW AT FIRST FLOOR



FIGURE 172 - SKYLIGHT IN LATERAL STAIRWELL

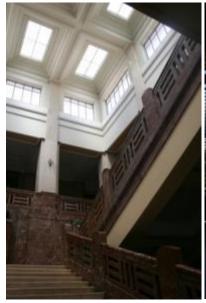


FIGURE **173** - SKYLIGHT IN THE STAIRWELL CENTRAL



FIGURE 174 - ENTRANCE DOOR



For the frames there are tree hypotheses:

 Choosing frames with a thermal break and clothing them with a layer made from old frame, in this case the U-value of the frame (U_f) is significantly improved.

2 - Restoring the old window frames

appropriate technologies, but in this case U-values of the frames

workers

and

specialized

 (U_f) remain the same.

by



FIGURE 175 - FIRST HYPOTHESIS OF CHANGE OF WINDOWS FRAME



FIGURE 176 - ACTUAL WINDOWS FRAME

3 - Using windows with Corten steel frames, also used for historic buildings in Venice. Glasses are selective double glazing with air chamber 6/13 mm.



FIGURE 177 - EXAMPLE OF CORTEN STEEL WINDOWS IN HISTORICAL BUILDING



Hypothesis 3 has been chosen for the simulation that provides for total replacement of the old frames.

🔐 Glazing Template	÷
	ZANCA Vetrate
👕 External Windows	×
🕼 Glazing type	ZANCA Dbl LoE Spec Sel Clr 6mm/13mm Air
D Layout	Preferred height 1.5m, 30% glazed
Dimensions	*
Туре	3-Preferred height
Window to wall %	30,00 🗢
0 10 20 30 40	1 1 1 1 1 1 1 50 60 70 80 90 100
Window height (m)	1,50
Window spacing (m)	5,00
Sill height (m)	0,80
Reveal	»
Frame and Dividers	*
Has a frame/dividers?	
Construction	ZANCA corten window frame (with thermal break)
Dividers	*
Туре	1-Divided lite
Width (m)	0.0200
Horizontal dividers	1
Vertical dividers	1
Outside projection (m)	0,000
Inside projection (m)	0,000
Glass edge-centre conduction ratio	1,000
Frame	× • • • • • • • • • • • • • • • • • • •
Frame width (m)	0,0400
Frame inside projection (m)	0,000
Frame outside projection (m)	0.000
Glass edge-centre conduction ratio	1.000 »
Internal Windows	" 》
Roof Windows/Skylights	
Doors	33
Vents	>> >> *
Internal	*
Vent type	Grille, small, light slats
Auto generate	
Ventarea (m2)	0,0900
Vent spacing (m)	5,00
Vent height above floor (m)	0,20
Operation	¥
😭 Operation schedule	Office_OpenOff_Equip

FIGURE 178 - WINDOWS TEMPLATE



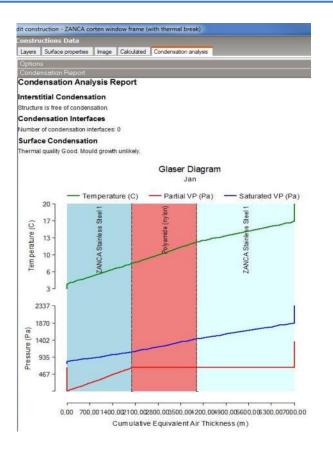


FIGURE 179 - GLASER DIAGRAM OF CORTEN STEEL WINDOWS

nstru	ictions Data	
Layers	Surface properties Image Calculated	Condensation analysis
nners	urface	
Conv	vective heat transfer coefficient (W/m2-	К) 5,846
Rad	iative heat transfer coefficient (W/m2-K) 1.847
Surfe	ace resistance (m2-K/W)	0,130
Duter s	urface	
Conv	vective heat transfer coefficient (W/m2-	K) 23,290
Rad	iative heat transfer coefficient (W/m2-K) 1,710
Surfa	ace resistance (m2-K/W)	0,040
No Bri	dging	
U-Va	alue surface to surface (W/m2-K)	2,174
R-Va	alue (m2-K/W)	0,630
U-V	alue (W/m2-K)	1,587
With B	ridging (BS EN ISO 6946)	
Km -	Internal heat capacity (KJ/m2-K)	0,0000
Upp	er resistance limit (m2-K/W)	0,630
Lowe	er resistance limit (m2-K/W)	0,630
U-Va	alue surface to surface (W/m2-K)	2,174
R-Va	alue (m2-K/W)	0,630
U-V	alue (W/m2-K)	1,587

FIGURE 180 - CORTEN STEEL WINDOWS CONSTRUCTION DATA

structions Data	
ers Surface properties Image Calculated Condensa	tion analysis
neral	
lame ZANCA corten window frame (wit	h thermal break)
ource	DesignBuilder
Category	Window frames
Region	US General
Iculation Settings	
/ers	
lumber of layers	3
Dutermost layer	
SMaterial	ZANCA Stainless Steel 1
Thickness (not used in thermal calcs) (m)	0,0200
.ayer 2	
SyMaterial	Polyamide (nylon)
Thickness (m)	0,0400
Bridged?	
nnermost layer	
SyMaterial	ZANCA Stainless Steel 1
Thickness (not used in thermal calcs) (m)	0,0300

FIGURE 181 - DETAIL OF CORTEN STEEL FRAME

FIGURE 182 - PARTICULAR OF CORTEN STEEL FRAME



11.2.3. SHADING

There is no fixed or mobile shading. because they integrate poorly with the historical memory of the building.

11.2.4. OTHER STRATEGIES

The skylights in stairwells will be equipped with sensors that will govern the opening, according to the irradiation and the need for external ventilation.

11.3. ENERGY SYSTEMS

11.3.1. LIGHTING SYSTEM

It is expected to replace the existing lighting with LED lamps and. where it is possible (for example in meeting rooms or council room), with intelligent on/off system. to adapt the lighting depending on sunlight.

Layout Activity Construction Openings Lighting	HVAC Outputs CFD	
G. Lighting Template		×
Template	Zanca LED	
🗢 General Lighting		×
🗹 On		
Lighting energy (W/m2)	<mark>4,68</mark>	
0 2 4 6 8 10 12 14 16 18	20 22 24 26 28 30 32 34 36 38 40	
😭 Schedule	Office_Light	
Luminaire type	3-Recessed	•
Radiant fraction	0,370	
Visible fraction	0,180	
Convective fraction	0,450	
_ <mark>₀</mark> 2Lighting Control		×
🗹 On		
Control type	1-Linear	•
Min output fraction	0,100	
Min input power fraction	0,100	
Glare		¥
Maximum allowable glare in	22,0	
View angle rel. to y-axis (")	0,0	
Lighting Area 1		×
% Zone covered by Lighting Lighting Area 2	80,0	>>
Stask and Display Lighting		>>
Exterior Lighting		*
Design level (W)	100,000	
Construction (VV)	On	
Control option	2-Schedule + override off in daytime	•

FIGURE 183 - LIGHTING TEMPLATE



11.3.2. HVAC SYSTEM

Almost all working rooms. as well as all the receiving rooms. and the circulation area have an air conditioning system. It is expected to insert a false ceiling in all circulation area and. where possible in all rooms of the building. The results are: decrease net height to be heated and creation of a channel for heating and lighting plants.

Layout Activity Construction Openings Light	hting HVAC Outputs CFD	
G HVAC Template		×
Template	Italy	
Mechanical Ventilation		*
<mark>⊘</mark> n		
Outside air definition method	1-By zone	•
Outside air (ac/h)	3,000 🗢	
	10 12 14 16 18 20	
Operation		×
😭 Schedule	Office_OpenOff_Equip	
Auxiliary Energy		*
Auxiliary energy (kWh/m2)	18,00	
Heating		×
Heated		
Fuel	1-Electricity from grid	•
Heating system CoP	5,050	
Туре		»>
Operation		*
😭 Schedule	TM33_Cooling_Annual	
*Cooling		×
Cooled		
Fuel	1-Electricity from grid	•
Cooling system CoP	6,500	
Supply Air Condition		>>
Operation		*
😭 Schedule	TM33_Cooling_Annual	
K DHW		×
🗖 On		
🔉 🔉 Natural Ventilation		*
🗖 On		
Air Temperature Distribution		×
Distribution mode	1-Mixed	•

FIGURE 184 - HVAC TEMPLATE

11.4. RENEWABLE ENERGY SOURCES

The building is in a densely built area and district heating systems are not available. The use of more environmental friendly HVAC systems was investigated but VRV appeared to be the most suitable choice. Different proposals have been studied for renewable energy systems but in the end it was decided to use a photovoltaic system.

It is also thought to include wind energy as a renewable energy but the Superintendent did not like this type of intervention, because it would alter building architecture.



11.5. PV GENERATION SYSTEM

On the roof of the building a photovoltaic plant of 61 kW_p will be installed: this value ensures just over 40% of current consumption of electricity. The structure has six areas available for positioning the photovoltaic system.



FIGURE 185 - SIX AREAS AVAILABLE FOR THE PV SYSTEM INSTALLATION

The PV panels will be placed nearly due South with a fixed slope of 30° and azimuth of 0°. The system will be connected to the low voltage grid via three-phase power.

In Italy, to access to the financial benefits for installing PV modules one must submit a request to the Energy Services Manager, GSE S.p.A. Therefore, it leads to compensation between the economic value associated to the electricity produced and fed into the grid and the theoretical economic value associated to withdrawn electricity and consumed in a period different from the one in which production takes place. The calculation of the PV system was estimated by using Classic PVGIS, a piece of software developed by The Joint Research Centre of the European Commission in ISPRA. Italy.

To make this calculation it is necessary to define some conditions:

Optimal inclination angle is: 31 degrees
Annual irradiation deficit due to shadowing (horizontal): 0.1 %
Location: 38°11'38" North. 15°33'17" East. Elevation: 15 m a.s.l
Nominal power of the PV system: 61.0 kWp (crystalline silicon)
Estimated losses due to temperature and low irradiance: 9.9% (using local ambient temperature)
Estimated loss due to angular reflectance effects: 2.5%
Other losses (cables. inverter etc.): 15.0%
Combined PV system losses: 25.3%



The monthly and annual solar radiation in the area based on the classic PVGIS database is presented in the following table.

Month	H _h	H _{opt}	H(90)	I _{opt}	T _D	T _{24h}
Jan	1,990	2,980	2,900	59	11.0	10.2
Feb	2,700	3,630	3,130	51	10.6	9.7
Mar	4,020	4,860	3,470	40	13.2	12.0
Apr	5,420	5 <i>,</i> 830	3,190	26	15.4	14.2
Мау	6,410	6,280	2,630	13	19.1	17.9
Jun	6,910	6,470	2,310	6	23.1	21.8
Jul	6,830	6,530	2,470	9	25.9	24.6
Aug	6,190	6,420	3,100	21	26.2	24.7
Sep	5,000	5,880	3,830	36	22.9	21.7
Oct	3,510	4,690	3,860	49	19.8	18.6
Nov	2,250	3,320	3,160	58	16.2	15.1
Dec	1,760	2,740	2,770	61	12.6	11.6
Year	4,430	4,980	3,070	31	18.0	16.8

TABLE 47 - SOLAR RADIATION AT THE AREA OF MESSINA

Legend:

Hh: Irradiation on horizontal plane (Wh/m²/day)

Hopt: Irradiation on optimally inclined plane (Wh/m²/day)

H(90): Irradiation on plane at angle: 90deg. (Wh/m²/day)

lopt: Optimal inclination (deg.)

TD: Average daytime temperature (°C)

T24h: 24 hour average of temperature (°C)

SOURCE: CLASSIC PVGIS DATABASE (KWH/ M²/MONTH) AT 30°

TABLE 48 - AVERAGE ELECTRICITY PRODUCTION

Month	Ed	Em	
Jan	153.72	4,770.2	
Feb	186.66	5,227.7	
Mar	253.15	7,808.0	
Apr	275.11	8,235.0	
Мау	300.12	9,272.0	
Jun	317.2	9,516.0	
lul	328.18	10,187.0	
Aug	319.64	9,882.0	
Sep	258.03	7,747.0	
Oct	222.65	6,893.0	
Nov	172.02	5,166.7	
Dec	136.64	4,239.5	
Yearly average	244	7,412.0	
Total for year 88,944.0			
Annual global radiation on the inclined surface = 1,960 kWh/m ²			
Ed: Average daily electricity production from the given system (kWh)			
Em: Average monthly electricity production from the given system (kWh)			



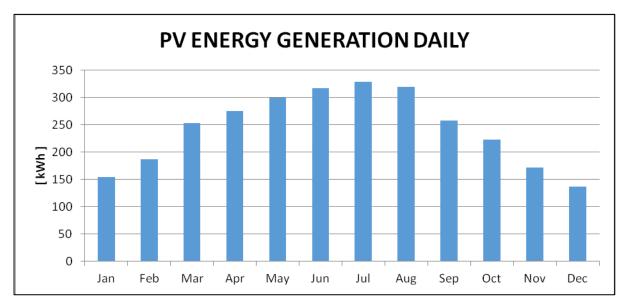


FIGURE 186 - DAILY ENERGY INJECTED INTO GRID FROM THE PV SYSTEM

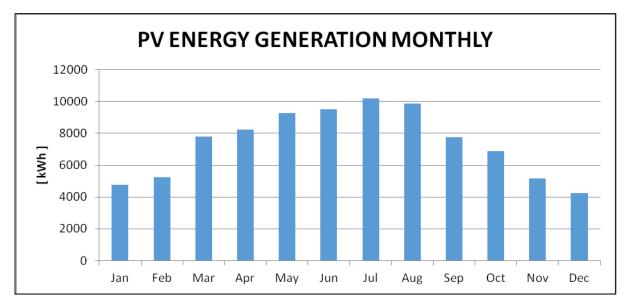


FIGURE 187 - MONTHLY ENERGY INJECTED INTO GRID FROM THE PV SYSTEM

Final



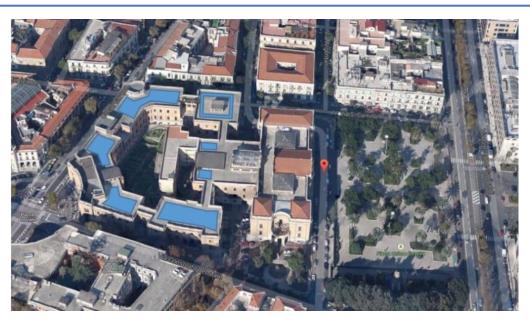


FIGURE 188 - PV PANELS INSTALLED ON THE ROOF

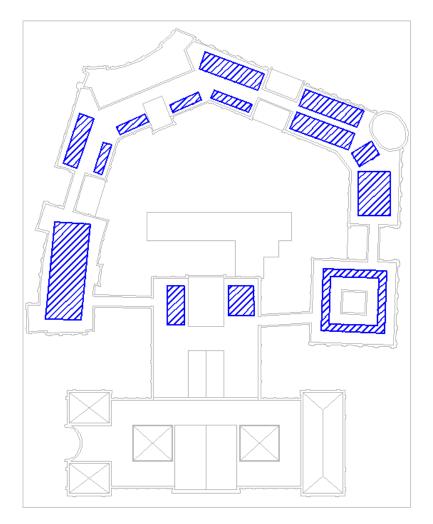


FIGURE 189- PV DISTRIBUTION



11.6. ENERGY MANAGEMENT SYSTEM

To monitor the building electrical consumption of lighting, ventilation and HVAC system, a building automation control sensors (BACS) will be installed. The BACS improve occupant's comfort, efficient operation of building systems, and reduction of energy consumption and of operating costs.

The system will perform the following operations:

- Control each air conditioning unit separately to stabilize the desired internal air temperature and humidity in every office.
- Internal lighting control according to external irradiation and lux value in each room (Dimming lamps).
- Daily scheduling of air conditioning and lighting to optimize their use.
- Management of the flow temperature according to the outdoor temperature.
- Identification of electrical equipment turned on beyond normal working hours.
- Error identification or warnings in case of electrical overloads.
- Control of windows and doors opening, to minimize the use of VRV plant.

The BACS ensure therefore values of humidity and temperature in agreement with the optimum comfort conditions, and also ensures appropriate levels of air exchange. They are also useful for energy saving both in terms of lighting and rooms conditioning.

11.7. TOTAL IMPACT OF THE RENOVATION SCHEME

11.7.1. ENERGY PERFORMANCE

The energy analysis of the building was carried out using the software Design Builder v. 3.4.0.033. The building was described in detail, through architectural drawings and with an illustrated report on the state of facts and photographic documentation.

The result with the new solution is as follows. In the renovation scheme it has a VRV system plant for heating, cooling and air circulation.

To set the calculation of the model the general information are:

	Data	
Weather File	** Messina - ITA IGDG WMO#=164200	
HDD and CDD data source	Weather File Stat	
Total gross floor area [m2]	13,580.56	
Principal Heating Source	District Heat	

TABLE 49 - GENERAL INFORMATION FOR SIMULATION



TABLE 50 - BUILDING AREA

	Area [m ²]
Total Building Area	11,876.95
Net Conditioned Building Area	11,876.95
Unconditioned Building Area	0.00

The following figures shows the heat balance of Palazzo Zanca Post-design. divided according to the contribution types:

- General Lighting.
- Computer + Equipment.
- Occupancy.
- Solar Gans Exterior Windows.
- Zone Sensible Heating.
- Zone Sensible Cooling.

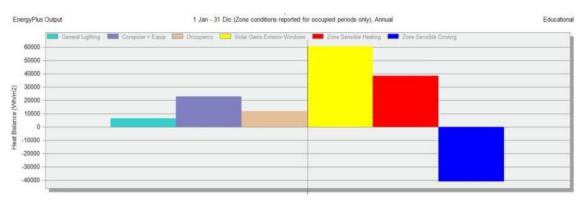
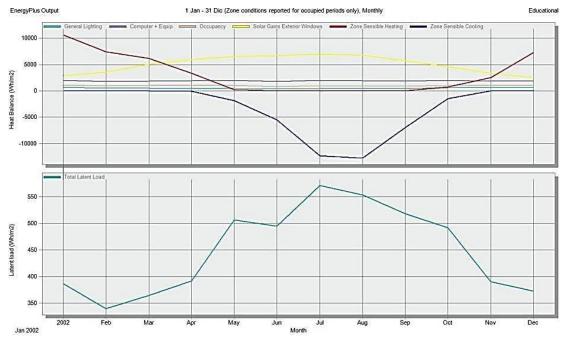


FIGURE 190 - ANNUAL HEAT BALANCE

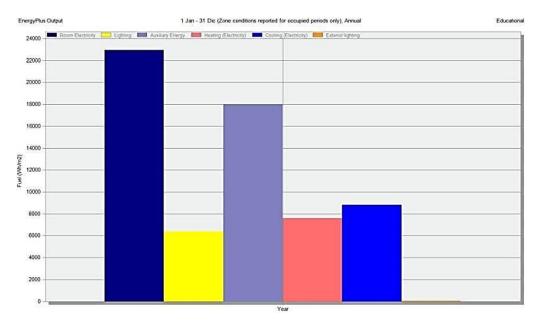




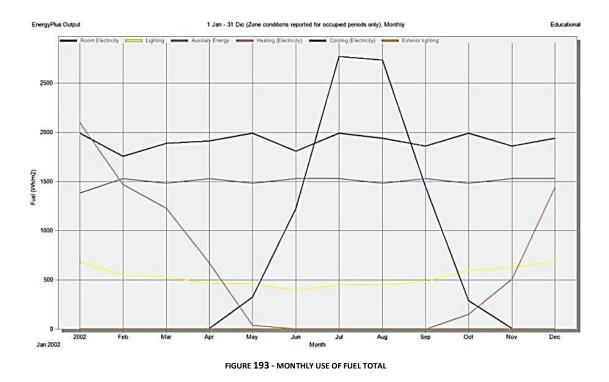


Two following figures shows monthly total fuel use of Palazzo Zanca.divided according to the contribution types:

- Room Electricity.
- Lighting.
- Auxiliary Energy.
- Heating (Electricity).
- Cooling (Electricity).









Other data that influence thermal balance come from building envelope.

Considered data are:

- Glazing
- Walls
- Ceilings (internal)
- Floors (internal)
- Ground floors
- Partitions (internal)
- Roofs
- Floors (external)
- External infiltration
- External ventilation

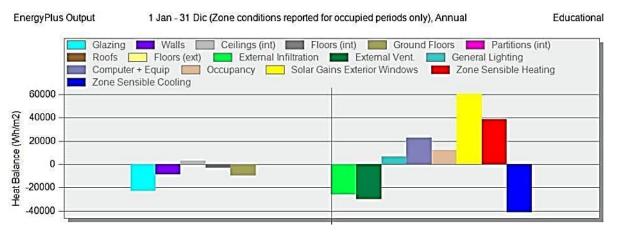


FIGURE 194 - HEAT BALANCE ACCORDING OPAQUE ELEMENT OF ENVELOPE

11.7.2. Environmental performance

The following table shows the consumption before and after the implementation of all the proposed interventions in the building.

	Electricity Intensity [kWh/m2]	Natural Gas Intensity [kWh/m2]	Additional Fuel Intensity [kWh/m2]	District Cooling Intensity [kWh/m2]	District Heating Intensity [kWh/m2]	Water Intensity [m3/m2]
Lighting	6.40	0.00	0.00	0.00	0.00	0.00
HVAC	0.00	0.00	0.00	57.21	38.38	0.00
Other	22.92	0.00	0.00	0.00	0.00	0.00
Total	29.32	0.00	0.00	57.21	38.38	0.00

TABLE 51 - UTILITY USE PER TOTAL FLOOR AREA



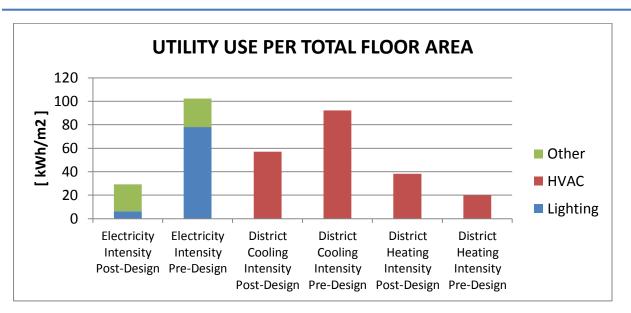


FIGURE 195 - UTILITY USE PER TOTAL FLOOR AREA PRE/POST-DESIGN

	Electricity	Natural	Additional	District	District	Water [m3]
	[kWh]	Gas	Fuel	Cooling	Heating	
		[kWh]	[kWh]	[kWh]	[kWh]	
Heating	0.00	0.00	0.00	0.00	455,813.14	0.00
Cooling	0.00	0.00	0.00	679,470.83	0.00	0.00
Interior	75,530.09	0.00	0.00	0.00	0.00	0.00
Lighting						
Exterior	435.90	0.00	0.00	0.00	0.00	0.00
Lighting						
Interior	272,247.54	0.00	0.00	0.00	0.00	0.00
Equipment						
Exterior	0.00	0.00	0.00	0.00	0.00	0.00
Equipment						
Fans	0.00	0.00	0.00	0.00	0.00	0.00
Pumps	0.00	0.00	0.00	0.00	0.00	0.00
Heat Rejection	0.00	0.00	0.00	0.00	0.00	0.00
Humidification	0.00	0.00	0.00	0.00	0.00	0.00
Heat Recovery	0.00	0.00	0.00	0.00	0.00	0.00
Water Systems	0.00	0.00	0.00	0.00	0.00	0.00
Refrigeration	0.00	0.00	0.00	0.00	0.00	0.00
Generators	0.00	0.00	0.00	0.00	0.00	0.00
Total End Uses	348,213.53	0.00	0.00	679,470.83	455,813.14	0.00

TABLE 52 - END USE CONSUMPTION

Note: District heat appears to be the principal heating source based on energy usage.



	Electricity [kWh]	District Cooling [kWh]	District Heating [kWh]
Heating	0.00	0.00	455,813.14
Cooling	0.00	679,470.83	0.00
Interior Lighting	75,530.09	0.00	0.00
Exterior Lighting	435.90	0.00	0.00
Interior Equipment	272,247.54	0.00	0.00
Total End Uses	348,213.53	679,470.83	455,813.14
Total value	1,483,497.50		

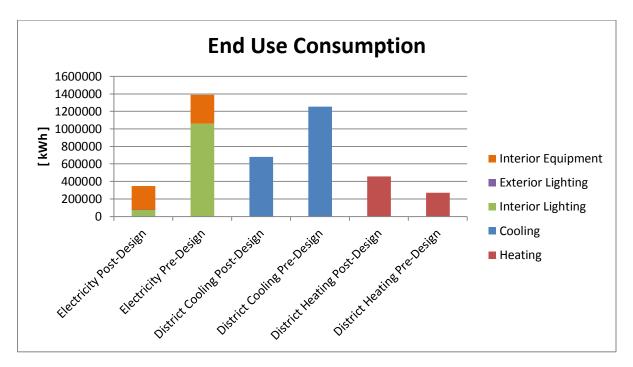


FIGURE 196 - END USE CONSUMPTION PRE/POST-DESIGN



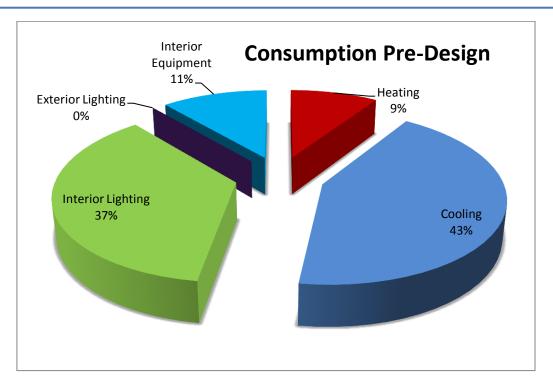


FIGURE 197 - CONSUMPTION PRE-DESIGN

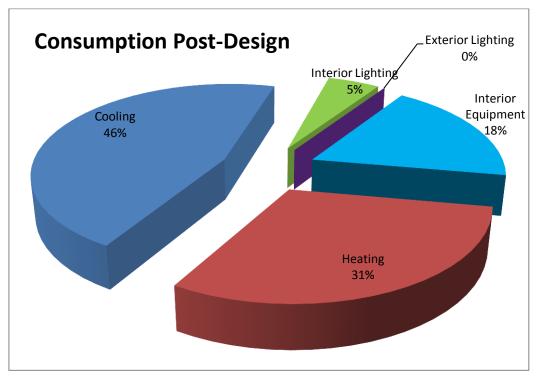


FIGURE 198 - CONSUMPTION POST-DESIGN

The energy consumption for heating increased because in the state of facts the heating is not present in circulation areas while in the renovation scheme is present in the entire building.

Final



12. ECONOMIC EVALUATION OF THE PROPOSED RENOVATION SCHEME

12.1. Assumptions, Cost Figures

The cost of the interventions is estimated based on current market prices of the equipment and the installation works. Special meetings with suppliers were held to present the project and request offers for the preliminary renovation design. Offers were collected and assessed.

For each intervention, the cost has been calculated as the sum of costs for equipment, installation, operation and maintenance. These values have been organised in an Excel file prepared by Sinloc, a partner of the CERtuS consortium (see deliverable D2.5). ANNEX H. gives the cost information.

The economic appraisal of the renovation design was performed by means of a tool produced by ETVA VIPE, also a partner of the consortium. A detailed description of the tool is presented in the deliverable D2.5. The appraisal can be performed only for the whole design.

The tool also allows to examine various financing schemes ranging from single financing source to multiple, combining bank loans, ESCOs, Subsidies, municipality's own equity.

The data used for the calculations are tabulated below, divided according to the unit of measure concerned and the unit price

WORKINGS	VOICE	U.M.	Value	Unit Cost	COST
Plants	Compression heat pumps -				
	VRV system - OFFICES AREAS	KW	918.08	€ 428	€ 393,361
Plants	Compression heat pumps -				
	VRV system - NEW				
	CIRCULATION AREAS	KW	786.92	€ 704	€ 553,846
Plants	Compression heat pumps -				
	VRV system - OFFICES AREAS	KW	590	€ 428	€ 252,793
Building	Horizontal structures on roofs				
envelope	- False Ceiling OFFICE AREAS	MQ	5,166	€ 47.30	244,352
Building	Horizontal structures on roofs				
envelope	- False Ceiling CIRCULATION				
	AREAS	MQ	1,599	€ 47.30	75,633
Building					
envelope	Double glass	MQ	1,321	€ 1,150.00	1,519,150
Plants	Internal Relamping	units	1,605	€ 200.00	€ 321,000
Plants	Photovoltaic panels	KWp	61	€ 2,000.00	€ 122,000
Sensors	BACS	unit	1	€ 25,000.00	€ 25,000
			TOTAI	WORK COST	€ 3.507.135

TABLE 54 - DETAIL OF THE COST



12.2. RESULTS

The proposals cover both the envelope that heating and electrical systems.

ENERG	SAVINGS		
Building Envelope	*table saving post renovation		
Energy Systems	HVAC = 23% Lighting = 93%		
RES	PV system		

TABLE 55 - HEAT BALANCE STATE OF ART

Glazing (Wh/m ²)	Year	-23,014.10
Walls (Wh/m2)	Year	-8,729.33
Ceilings (int) (Wh/m2)	Year	3,101.76
Floors (int) (Wh/m2)	Year	-3,113.00
Ground Floors (Wh/m2)	Year	-9,506.93
Partitions (int) (Wh/m2)	Year	-0.92
Roofs (Wh/m2)	Year	-237.85
Floors (ext) (Wh/m2)	Year	0.00

TABLE 56 - HEAT BALANCE RENOVATION SCHEME

Glazing (Wh/m2)	Year	-30,217
Walls (Wh/m2)	Year	-14,290.39
Ceilings (int) (Wh/m2)	Year	3,195.08
Floors (int) (Wh/m2)	Year	-3,208.52
Ground Floors (Wh/m2)	Year	-10,277.13
Partitions (int) (Wh/m2)	Year	4.03
Roofs (Wh/m2)	Year	-1,640.73
Floors (ext) (Wh/m2)	Year	-0.01



TABLE 57 - SAVINGS POST RENOVATION (ENVELOPE)

		%
Glazing (Wh/m2)	Year	23.84
Walls (Wh/m2)	Year	38.91468322
Ceilings (int) (Wh/m2)	Year	2.920740639
Floors (int) (Wh/m2)	Year	2.977073542
Ground Floors (Wh/m2)	Year	7.494310182
Partitions (int) (Wh/m2)	Year	122.8287841
Roofs (Wh/m2)	Year	85.50340397
Floors (ext) (Wh/m2)	Year	100
	SAVINGS	48.05952995

TABLE 58 - SAVINGS POST RENOVATION (TOTAL)

		%
Glazing (Wh/m2)	Year	23.83724
Walls (Wh/m2)	Year	38.91468
Ceilings (int) (Wh/m2)	Year	2.920741
Floors (int) (Wh/m2)	Year	2.977074
Ground Floors (Wh/m2)	Year	7.49431
Partitions (int) (Wh/m2)	Year	122.8288
Roofs (Wh/m2)	Year	85.5034
Floors (ext) (Wh/m2)	Year	100
	SAVINGS	26.89653

PV SAVING TOTAL = 88,944.0 kWh

End Use with Pv contribution = 1,483,497.50 - 88,944.0 = 1,394,553.50 kWh

END USE PRE DESIGN (kWh)	END USE POST DESIGN (kWh)	SAVING (%)
2 012 022 82		52.13
2,912,932.83 1,394,553.50	1,394,333.30	(1,518,379.33 kWh)

The savings resulting from the interventions on envelope and plants is equal to 52.13%. The savings is contained because it had to implement the HVAC system throughout the building entering where not present (for example in the corridors).

This project involves the need to air-condition a larger area by 43% compared to the air-conditioned state of the art. The traditional interventions are the use of new windows.

In the evaluation of the lighting savings it was considered the average cost of the electricity. The lifetime was assessed considering the average hours of use for the lamps and its maximum total hours of operation. As can be seen in following table, with such conditions the renovation options ensures savings from maintenance of $4,737 \notin$ /year and has a simple payback period of 1.99 years.

Final



TABLE 59: ECONOMIC PARAMETERS OF THE RENOVATION - LIGHTING

Energy Savings	986,397 kWh
Price - Saved Energy	0.18 €/kWh
Costs	321,000 €
Potential savings from maintenance (post intervention)	4,737 €/year
Simple Payback	1.99 years
Lifetime	20 years
CO ₂ Savings	653.14 tons/year

In the evaluation of the HVAC savings it was considered the cost of the electricity during the midpeak period. The savings for VRV are divided into 3 different values and it is possible view them in the Sinloc matrix in attachment (Chapter 16-Annex I)

In the evaluation of the PV generation it was considered the self-consumption of 90% of the energy, since in a working day during the time slots. As can be seen in following table, with such conditions it has a simple payback period of 8.71 years.

TABLE 60 - ECONOMIC PARAMETERS OF THE RENOVATION - PV

Energy Generation	88,944 kWh
Energy - Self-Consumption	90%
Energy - Injected Into Grid	10%
Price – Self-Consumption	0.18 €/kWh
Price - Injected Into Grid	0.06 €/kWh
Costs	122,000 €
Simple Payback	8.71 years
Lifetime	30 years
CO ₂ Savings	58.37 tons/year

The following table presents the aggregation of the renovation option. As can be seen, the total of the renovation plan ensures savings of $55,256 \notin$ /year and has a simple payback period of 12.83 years.

TABLE 61: ECONOMIC PARAMETERS OF THE RENOVATION - TOTAL

Energy Savings	1,518,379.33 kWh
Costs	3,507,135 €
Potential savings from maintenance (post intervention)	55,256 €/year
Simple Payback	12.83 years
CO ₂ Savings	991.48 tons/year

Final



REFERENCES 2

- /1/ DesignBuilder Software Ltd specialises in developing high-quality, easy-to-use and affordable simulation software tools for assessing the environmental performance of building designs. <u>http://www.designbuilder.co.uk/</u>
- /2/ PVGIS, Photovoltaic Geographical Information System, a software developed by The Joint Research Centre of the European Commission in ISPRA, Italy. <u>http://re.jrc.ec.europa.eu/pvgis/apps4/pvest.php</u>
- /3/ CERtuS Deliverable D2.5 "Twelve economic evaluation reports"



13. ANNEX A: BUILDING DRAWINGS

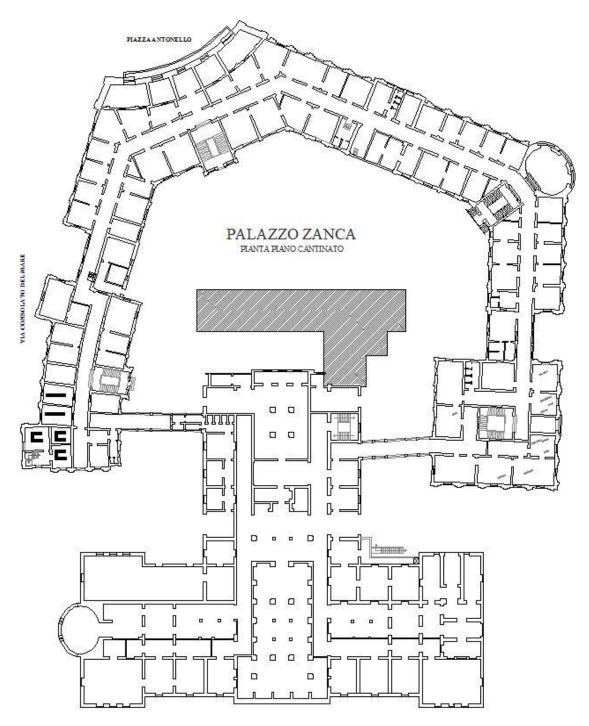


FIGURE 199 - BASAMENT FLOOR PLAN



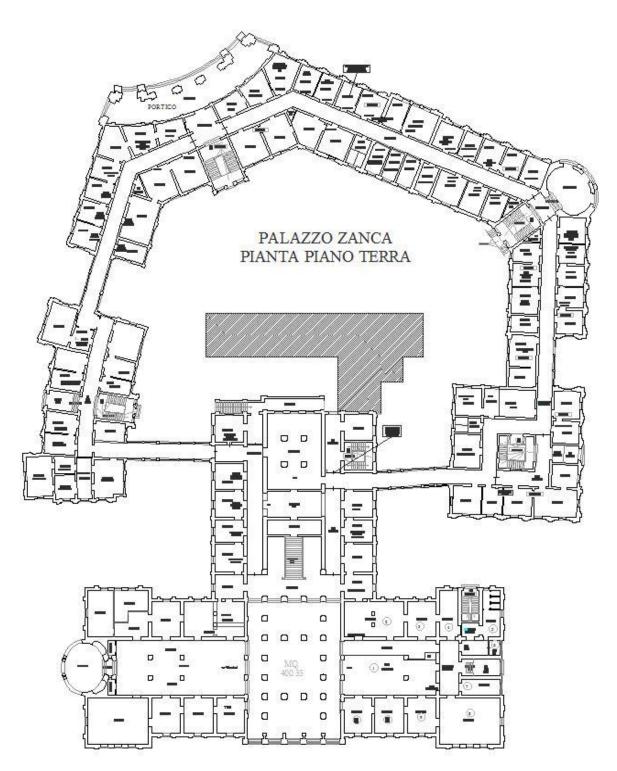


FIGURE 200 - GROUND FLOOR PLAN



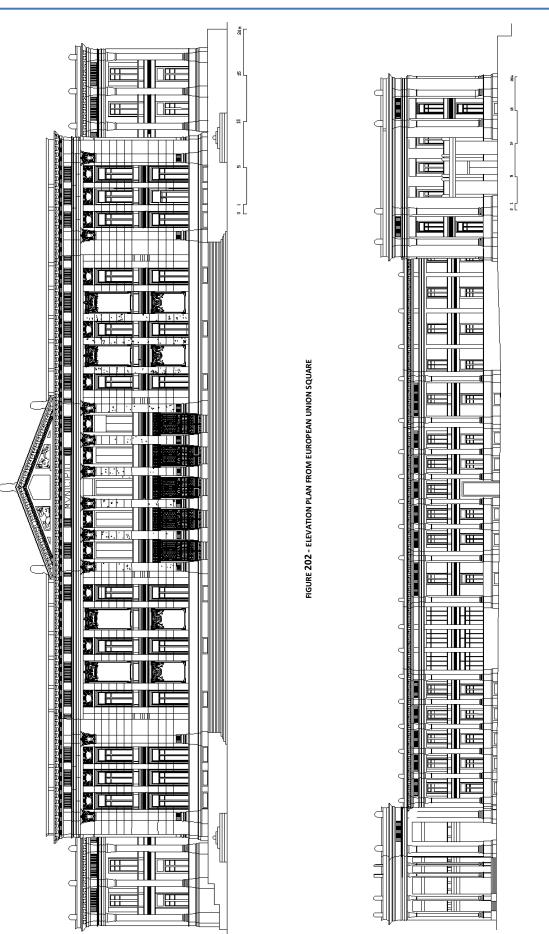


FIGURE 201 - FIRST FLOOR PLAN

Final



Deliverable D2.1 Report presenting the 3 nZEB renovation schemes in Italy, fully documented with technical and economic evaluation





Deliverable D2.1 Report presenting the 3 nZEB renovation schemes in Italy, fully documented with technical and economic evaluation

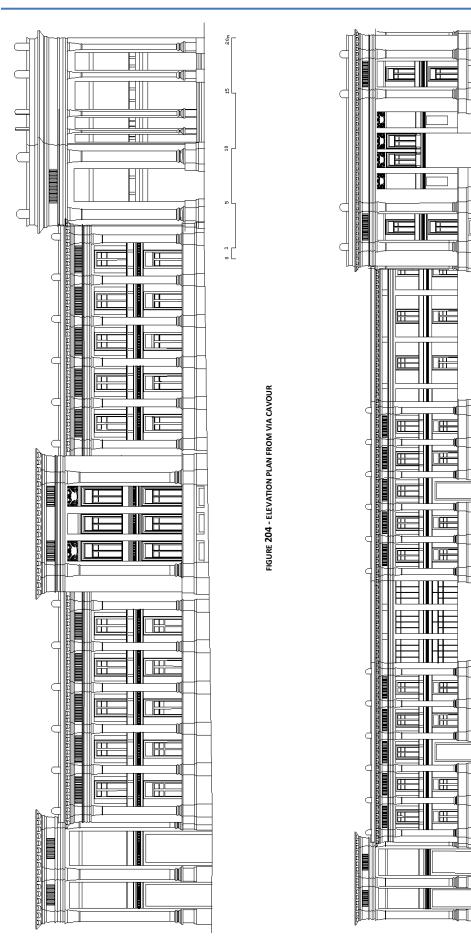


FIGURE 205 - ELAVUATION PLAN FROM VIA SAN CAMILLO



14. ANNEX B: BUILDINGS DESIGN



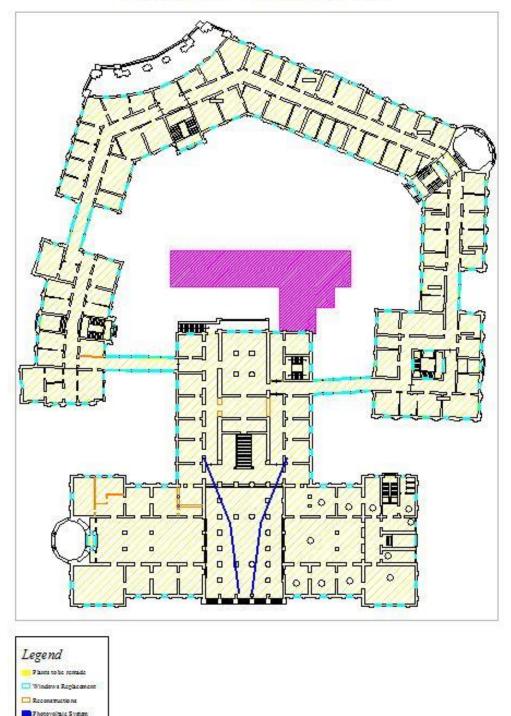


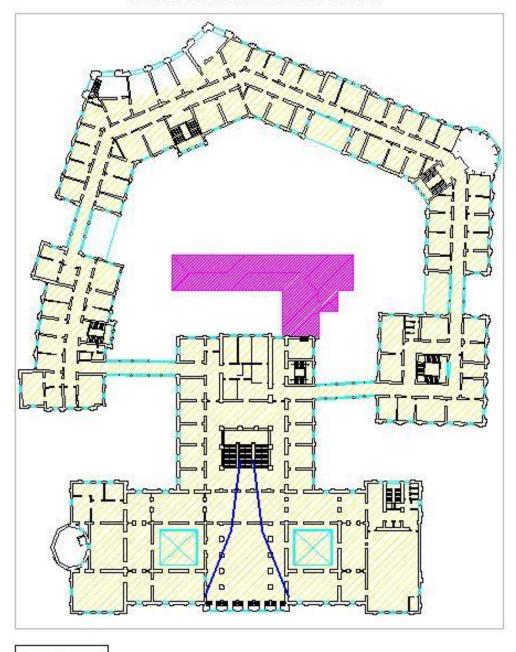
FIGURE 206 - GROUND FLOOR BUILDING DESIGN

Forced ventilation



Deliverable D2.1 Report presenting the 3 nZEB renovation schemes in Italy, fully documented with technical and economic evaluation

PALAZZO ZANCA - FIRST FLOOR PLAN





🗆 Win dove Replacement

- Zaconstructions
- The prokan System

De.

read ventilation

FIGURE 207 - FIRST FLOOR BUILDING DESIGN



PALAZZO ZANCA - PV DISTRIBUTION

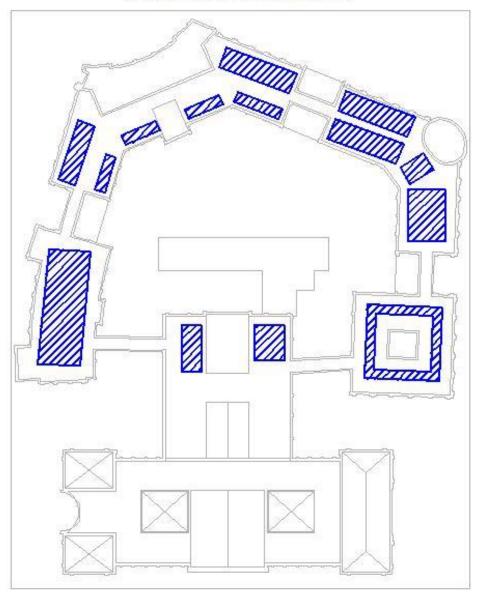




FIGURE 208 - PV DISTRIBUTION ON THE CEILING



15. ANNEX C: DESIGN BUILDER PARAMETERS

TABLE 62 - GENERAL VALUE

	Value
Program Version and Build	EnergyPlusDLL-32 8.1.0.008.
RunPeriod	PALACULTURA Enea
Weather File	Messina - ITA IGDG WMO#=164200
Latitude [deg]	38.20
Longitude [deg]	15.55
Elevation [m]	59.00
Time Zone	1.00
North Axis Angle [deg]	0.00
Rotation for Appendix G [deg]	0.00
Hours Simulated [hrs]	8,760.00

TABLE 63 - TABULAR VIEW FOR TEMPERATURE AND PRECIPITATION PER MONTH

		Temperature		Precipitation
Months	Normal	Warmest	Coldest	Normal
January	12.3°C	14.4°C	10.1°C	10
February	12.2°C	14.7°C	9.8°C	9
March	13.5°C	16.1°C	10.9°C	8
April	15.4°C	18.3°C	12.5°C	8
May	19.5°C	22.5°C	16.4°C	3
June	23.6°C	26.8°C	20.4°C	1
July	26.7°C	30.0°C	23.4°C	1
August	27.3°C	30.5°C	24.2°C	2
September	24.5°C	27.5°C	21.5°C	5
October	20.5°C	23.2°C	17.8°C	8
November	16.4°C	18.7°C	14.1°C	10
December	13.7°C	15.8°C	11.6°C	10

aeneral /	All Gains	Occupancy	Other Gains	DHW	Environmental control	
Occupan	cy detail	ls				
Density	(people	e/m2)			0,0700	
Latent fr	27 - S - S				0,5000	
Metabo	olic Heat	t				
O Me	etabolic	rate			Light office work	
		ctor (0.85 for v	vomen, 0.75	childr	0,90	
				CONTRACTOR AND A		
	ay profile	e				
	ay profile <mark>7:00</mark>	e \$			_	
Workda			3 4 5 6 7	8 9 10	11 12 13 14 15 16 17 18 19 20 21	1 1 1 22 23 24
Workda On at Off at	7:00	¢ \$ 0 1 2	3 4 5 6 7	8 9 10	11 12 13 14 15 16 17 18 19 20 21 5	22 23 24
Workda On at Off at	7:00 15:00 ; / week		3 4 5 6 7	1 1 1 8 9 10		22 23 24

FIGURE 209 - ZANCA OFFICE OCCUPANCY



Activity template General All Gains

Workday profil

7:00

19:00

On at

Off at

Schedules 11 Schedule \$

٠

Miscellaneous 🗆 On Catering 🗋 On Process 🗖 On General Ligh 🗹 On

Office Equipment 🗹 On

🗹 On

Vity	templat	es Dai	a			
neral	All Gains	Occu	ipancy	Other Gains	DHW	Environmental control
mput	ers					
🛛 On						
Loa	d (W/m2)				0,00
Rac	liant frac	tion				0,200
Wo	rkday pr	ofile				
Or	n at 7:0	0 🜲		1		
Of	fat 19:	00 🗢	0 1 2	3 4 5 8 7	7 8 9 10	11 12 13 14 15 16 17 18 19 20 21 22 23 24
Sch	edules					
(i	Sched	ule				Office_CellOff_Equip
fice E	quipmer	nt				
On						
Loa	d (W/m2	:)				9,00
Rac	liant frac	tion				0,200
Wo	rkday pr	ofile				
Or	at 7:0	0 🜲		1		
Of	fat 15:	00 🗢	0 1 2	3 4 5 8 7	7 8 9 10	11 12 13 14 15 16 17 18 19 20 21 22 23 24
Sch	edules					
G	Sched	ule				RestPub_Circulation_Equip
And in case of the local division of the loc	PROPERTY OF TAXABLE					

RestPub_Circulation_Cool

0 1 2 3 4 5 8 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

FIGURE 210 - ZANCA OFFICE OTHER GAINS



tivity templates Data	
ieneral All Gains Occupancy Other Gains DI	HW Environmental control
ooling	
Set point temperature (°C)	23,889
Cooling set back (°C)	28,000
Workday profile	*
On at 24:00 🜲	
Offat 0:00 \$ 0 1 2 3 4 5 6 7 8	9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Schedules	3
😭 Operation	RestPub_EatDrink_Light
leating	5
Set point temperature (°C)	21,111
Set back temperature (°C)	12,778
Workday profile	
On at 24:00 🜲	
On at 24:00	9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
	9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Offat 0:00 \$ 0 1 2 3 4 5 6 7 8	9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 RestPub_FoodPrep_Occ
Off at 0:00 ♀ 0 1 2 3 4 5 6 7 8 Schedules Mark Schedule 'entilation Set Point Temperatures	1
Offat 0:00 ⇒ 0 1 2 3 4 5 6 7 8 Schedules ∰ Schedule	1
Off at 0:00 ◆ 0 1 2 3 4 5 6 7 8 Schedules Mark Schedule (entilation Set Point Temperatures Natural Ventilation Nat. vent. set point (*C)	RestPub_FoodPrep_Occ
Off at 0:00 ◆ 0 1 2 3 4 5 6 7 8 Schedules Mark Schedule (entilation Set Point Temperatures Natural Ventilation	RestPub_FoodPrep_Occ
Off at 0:00 ⇒ 0 1 2 3 4 5 6 7 8 Schedules Schedule entilation Set Point Temperatures Natural Ventilation Nat. vent. set point (°C) Mechanical Ventilation Mech. vent. set point (°C)	RestPub_FoodPrep_Occ
Off at 0:00 ⇒ 0 1 2 3 4 5 6 7 8 Schedules Finit Schedule fentilation Set Point Temperatures Natural Ventilation Nat. vent. set point (*C) Mechanical Ventilation Mech. vent. set point (*C) ighting	RestPub_FoodPrep_Occ
Off at 0:00 ⇒ 0 1 2 3 4 5 6 7 8 Schedules (C) Schedule (E) Schedule (entilation Set Point Temperatures Natural Ventilation Nat. vent. set point (*C) Mechanical Ventilation Mech. vent. set point (*C) ighting Target Illuminance (lux)	RestPub_FoodPrep_Occ
Off at 0:00	RestPub_FoodPrep_Occ
Off at 0:00 ⇒ 0 1 2 3 4 5 6 7 8 Schedules (C) Schedule (E) Schedule (entilation Set Point Temperatures Natural Ventilation Nat. vent. set point (*C) Mechanical Ventilation Mech. vent. set point (*C) ighting Target Illuminance (lux)	RestPub_FoodPrep_Occ

FIGURE 211 - ZANCA OFFICE ENVIRONMENTAL CONTROL

TABLE 64 - END USES BY SUBCATEGORY

	Subcategory	Electricity [kWh]	Natural Gas [kWh]	Additional Fuel [kWh]	District Cooling [kWh]	District Heating [kWh]	Water [m3]
Heating	General	0.00	0.00	0.00	0.00	270,143. 40	0.00
Cooling	General	0.00	0.00	0.00	1,254,50 8.77	0.00	0.00
Interior Lighting	ELECTRIC EQUIPMENT#Bloc co2:Zona3#Gener alLights	6,634.96	0.00	0.00	0.00	0.00	0.00
	ELECTRIC EQUIPMENT#Bloc co2:Zona2#Gener alLights	101,924.37	0.00	0.00	0.00	0.00	0.00
	ELECTRIC EQUIPMENT#Bloc co2:Zona7#Gener alLights	26,463.63	0.00	0.00	0.00	0.00	0.00
	ELECTRIC EQUIPMENT#Bloc co2:Zona5#Gener alLights	8,177.93	0.00	0.00	0.00	0.00	0.00
	ELECTRIC	16,008.15	0.00	0.00	0.00	0.00	0.00



EQUIPMENT#Bloc						
co2:Zona9#Gener						
 alLights						
ELECTRIC	19,565.16	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Bloc						
co2:Zona1#Gener						
alLights						
ELECTRIC	1,805.88	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Bloc						
co2:Zona10#Gene						
ralLights						
ELECTRIC	16,477.63	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Bloc						
co2:Zona11#Gene						
ralLights						
 ELECTRIC	15,657.92	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Bloc	-,					
co2:Zona6#Gener						
alLights						
ELECTRIC	977.74	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Bloc	577.74	0.00	0.00	0.00	0.00	0.00
co2:Zona8#Gener						
alLights						
 ELECTRIC	2,118.91	0.00	0.00	0.00	0.00	0.00
	2,110.91	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Bloc						
co2:Zona4#Gener						
 alLights	0.407.74					0.00
ELECTRIC	3,437.71	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Bloc						
co4:Zona18#Gene						
 ralLights						
ELECTRIC	92,810.32	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Bloc						
co4:Zona15#Gene						
 ralLights						
ELECTRIC	10,029.13	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Bloc						
co4:Zona1#Gener						
alLights						
ELECTRIC	24,376.78	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Bloc						
co4:Zona16#Gene						
ralLights						
ELECTRIC	12,864.36	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Bloc	,	0.00	0.00	0.00	0.00	5.00
co4:Zona8#Gener						
alLights						
ELECTRIC	1,150.58	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Bloc	1,100.08	0.00	0.00	0.00	0.00	0.00
co4:Zona9#Gener						
alLights	2 059 22	0.00	0.00	0.00	0.00	0.00
	2,058.23	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Bloc						
co4:Zona14#Gene						
ralLights						



ELECTRIC	3,739.94	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Bloc						
co4:Zona4#Gener						
alLights						
ELECTRIC	1,070.43	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Bloc						
co4:Zona17#Gene						
ralLights						
 ELECTRIC	7,165.87	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Bloc						
co4:Zona10#Gene						
ralLights						
 ELECTRIC	4,627.13	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Bloc						
co4:Zona11#Gene						
ralLights						
 ELECTRIC	16,108.02	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Bloc	-,					
co4:Zona5#Gener						
alLights						
ELECTRIC	8,518.55	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Bloc	-,					
co4:Zona13#Gene						
ralLights						
 ELECTRIC	2,303.12	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Bloc	_)00011_	0.00	0.00	0.00	0.00	0.00
co4:Zona19#Gene						
ralLights						
 ELECTRIC	10,734.40	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Bloc	10,75 11 10	0.00	0.00	0.00	0.00	0.00
co4:Zona3#Gener						
alLights						
 ELECTRIC	1,423.07	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Bloc	_,		0.00	0.00	0.00	0.00
co4:Zona2#Gener						
alLights						
ELECTRIC	11,551.00	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Bloc	11,001.00	0.00	0.00	0.00	0.00	0.00
co4:Zona6#Gener						
alLights						
ELECTRIC	10,858.46	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Bloc	20,000,110	0.00	0.00	0.00	0.00	0.00
co4:Zona12#Gene						
ralLights						
ELECTRIC	6,372.54	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Bloc	0,07 210 4	0.00	0.00	0.00	0.00	5.00
co4:Zona7#Gener						
alLights						
ELECTRIC	8,177.93	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Bloc	-)_//	0.00	0.00	0.00	0.00	0.00
co1:Zona5#Gener						
alLights						
ELECTRIC	78,242.44	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Bloc		0.00	0.00	0.00	0.00	5.00
co1:Zona1#Gener						
COLLONGING CHCI						



alLights						
ELECTRIC EQUIPMENT#Bloc co1:Zona9#Gener alLights	16,008.15	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Bloc co1:Zona12#Gene ralLights	8,370.56	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Bloc co1:Zona10#Gene ralLights	1,805.88	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Bloc co1:Zona14#Gene ralLights	16,907.68	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Bloc co1:Zona6#Gener alLights	14,078.52	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Bloc co1:Zona2#Gener alLights	5,547.83	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Bloc co1:Zona7#Gener alLights	5,535.88	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Bloc co1:Zona8#Gener alLights	6,069.01	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Bloc co1:Zona13#Gene ralLights	1,844.29	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Bloc co1:Zona15#Gene ralLights	1,612.48	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Bloc co1:Zona3#Gener alLights	25,418.19	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Bloc co1:Zona4#Gener alLights	2,118.91	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Bloc co6:Zona8#Gener alLights	12,864.36	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Bloc	79,054.66	0.00	0.00	0.00	0.00	0.00



Image: constraint of the section of the sec							
ELECTRIC EQUIPMENT#BIO co6:20na9#Gener altights 1,150.58 0.00 0.00 0.00 0.00 0.00 EQUIPMENT#BIO co6:20na9#Gener altights 4,988.47 0.00 0.00 0.00 0.00 0.00 EQUIPMENT#BIO co6:20na1#Gene raltights 16,064.68 0.00 0.00 0.00 0.00 0.00 ELECTRIC Co5:20na1#Gene raltights 16,064.68 0.00 0.00 0.00 0.00 0.00 ELECTRIC Co5:20na1#Gene raltights 7,165.87 0.00 0.00 0.00 0.00 0.00 EQUIPMENT#BIO co6:20na1#Gene raltights 4,627.13 0.00 0.00 0.00 0.00 0.00 EQUIPMENT#BIO co6:20na5#Gener altights 6,587.61 0.00 0.00 0.00 0.00 0.00 EQUIPMENT#BIO co6:20na5#Gener altights 2,303.12 0.00 0.00 0.00 0.00 0.00 EQUIPMENT#BIO co6:20na1#Gene raltights 1,697.93 0.00 0.00 0.00 0.00 0.00 EQUIPMENT#BIO co6:20na1#Gene raltights 1,697.93 0.00 0.00 <	co6:Zona15#Gene						
EQUIPMENTHBIOC co620na9%Gener altights Image: second							
co6:2on99fGener allights col col col col col EQUIPMENTABIOC co6:2on44fGener allights 4,988.47 0.00 0.00 0.00 0.00 0.00 0.00 EQUIPMENTABIOC co6:2on124/Gene co6:2on124/Gene co6:2on124/Gene co6:2on124/Gene co6:2on114/Gene co6:2on114/Gene co6:2on114/Gene rallights 16,064.68 0.00 0.00 0.00 0.00 0.00 EQUIPMENTABIOC co6:2on114/Gene co6:2on114/Gene rallights 7,165.87 0.00 0.00 0.00 0.00 0.00 0.00 EQUIPMENTABIOC co6:2on114/Gene rallights 4,527.13 0.00 0.00 0.00 0.00 0.00 0.00 0.00 EQUIPMENTABIOC co6:2on114/Gene rallights 4,527.13 0.00 0.00 0.00 0.00 0.00 0.00 EQUIPMENTABIOC co6:2on114/Gene rallights 54,685.25 0.00 0.00 0.00 0.00 0.00 0.00 EQUIPMENTABIOC co6:2on134/Gener rallights 10,734.40 0.00 0.00 0.00 0.00 0.00 0.00 EQUIPMENTABIOC co6:2on34/Gener rallights 10,973.40 0.00		1,150.58	0.00	0.00	0.00	0.00	0.00
Image: set in the set							
ELECTRIC EQUIPMENTHBIOC co6:Zona406Gener alLights 4,988.47 0.00							
EQUIPMENT#Bloc co62ona14/Gener alLights Image: Constant of the second seco	 -						
co6:Zona4#Gener alLights constant constant <thconstant< th=""> constant consta</thconstant<>		4,988.47	0.00	0.00	0.00	0.00	0.00
allights out out out out out EQUIPMENTHBIOC co6:Zona12/#Gene rallights 7,165.87 0.00 0.00 0.00 0.00 0.00 EQUIPMENTHBIOC co6:Zona10/#Gene rallights 7,155.87 0.00 0.00 0.00 0.00 0.00 EQUIPMENTHBIOC co6:Zona11/#Gene rallights 4,627.13 0.00 0.00 0.00 0.00 0.00 EQUIPMENTHBIOC co6:Zona11/#Gene rallights 6,587.61 0.00 0.00 0.00 0.00 0.00 EQUIPMENTHBIOC co6:Zona1#Gene rallights 6,587.61 0.00 0.00 0.00 0.00 0.00 EQUIPMENTHBIOC co6:Zona1#Gene rallights 54,685.25 0.00 0.00 0.00 0.00 0.00 EQUIPMENTHBIOC co6:Zona1#Gene rallights 10,734.40 0.00 0.00 0.00 0.00 0.00 EQUIPMENTHBIOC co6:Zona1#Gene rallights 10,679.3 0.00 0.00 0.00 0.00 EQUIPMENTHBIOC co6:Zona1#Gene rallights 1,697.93 0.00 0.00 0.00 0.00 <td< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td></td<>							
ELECTRIC EQUIPMENT#BIOC co6:20n12H2Gene rallights 16,064.68 0.00							
EQUIPMENT#Bloc co6:20n12#Gene ralLights Image: Constant of the second seco							
co6:Zona12#Gene rallights col col <td></td> <td>16,064.68</td> <td>0.00</td> <td>0.00</td> <td>0.00</td> <td>0.00</td> <td>0.00</td>		16,064.68	0.00	0.00	0.00	0.00	0.00
Initiality Initiality <thinitiality< th=""> Initiality Initiali</thinitiality<>							
ELECTRIC EQUIPMENT#Bloc co6:Zona10#Gene ralLights 7,165.87 co 0.00 0.00 0.00 0.00 0.00 EQUIPMENT#Bloc co6:Zona11#Gene ralLights 4,627.13 0.00 0.00 0.00 0.00 0.00 EQUIPMENT#Bloc co6:Zona11#Gene ralLights 4,627.13 0.00 0.00 0.00 0.00 0.00 EQUIPMENT#Bloc co6:Zona11#Gene ralLights 6,587.61 0.00 0.00 0.00 0.00 0.00 EQUIPMENT#Bloc co6:Zona18#Gener alLights 54,685.25 0.00 0.00 0.00 0.00 0.00 EQUIPMENT#Bloc co6:Zona18#Gener ralLights 2,303.12 0.00 0.00 0.00 0.00 0.00 ELECTRIC Co6:Zona18#Gener ralLights 10,734.40 0.00 0.00 0.00 0.00 0.00 EQUIPMENT#Bloc co6:Zona3#Gener alLights 1,697.93 0.00 0.00 0.00 0.00 0.00 EQUIPMENT#Bloc co6:Zona3#Gener alLights 1,697.93 0.00 0.00 0.00 0.00 0.00 EQUIPMENT#Bloc co6:Zona3#Gener alLights 2,625.73 0.00							
EQUIPMENT#Bloc co6:Zona10#Gene ralLights 4,627.13 0.00 0.00 0.00 0.00 0.00 ELECTRIC CO0:Zona1#Gene ralLights 4,627.13 0.00 0.00 0.00 0.00 0.00 EQUIPMENT#Bloc co6:Zona5#Gener alLights 6,587.61 0.00 0.00 0.00 0.00 0.00 EQUIPMENT#Bloc co6:Zona5#Gener alLights 54,685.25 0.00 0.00 0.00 0.00 0.00 EQUIPMENT#Bloc co6:Zona18#Gener alLights 2,303.12 0.00 0.00 0.00 0.00 0.00 EQUIPMENT#Bloc co6:Zona18#Gener alLights 10,734.40 0.00 0.00 0.00 0.00 0.00 EQUIPMENT#Bloc co6:Zona3#Gener alLights 1,697.93 0.00 0.00							
co6:Zona10#Gene ralLights com com com com com EQUIPMENT#Bloc co6:Zona11#Gene ralLights 4,627.13 0.00 0.00 0.00 0.00 0.00 EQUIPMENT#Bloc co6:Zona5#Gener alLights 6,587.61 0.00 0.00 0.00 0.00 0.00 0.00 EQUIPMENT#Bloc co6:Zona5#Gener alLights 6,587.61 0.00 0.00 0.00 0.00 0.00 EQUIPMENT#Bloc co6:Zona18#Gene ralLights 54,685.25 0.00 0.00 0.00 0.00 0.00 EQUIPMENT#Bloc co6:Zona18#Gene ralLights 10,734.40 0.00 0.00 0.00 0.00 0.00 EQUIPMENT#Bloc co6:Zona3#Gener alLights 10,734.40 0.00 0.00 0.00 0.00 0.00 EQUIPMENT#Bloc co6:Zona3#Gener alLights 1,697.39 0.00 0.00 0.00 0.00 0.00 EQUIPMENT#Bloc co6:Zona3#Gener alLights 1,697.39 0.00 0.00 0.00 0.00 0.00 EQUIPMENT#Bloc co6:Zona3#Gener alLights 7,634.41 0.00 0.00 0.00<		7,165.87	0.00	0.00	0.00	0.00	0.00
Index							
ELECTRIC EQUIPMENTABIOC co6:Zona11#Gene allights 4,627.13 0.00							
EQUIPMENT#Bloc co6:Zona11#Gene ralLights Image: construct of the second se							
co6:Zona11#Gene ralLights cos cos <td></td> <td>4,627.13</td> <td>0.00</td> <td>0.00</td> <td>0.00</td> <td>0.00</td> <td>0.00</td>		4,627.13	0.00	0.00	0.00	0.00	0.00
Indication Indicat							
ELECTRIC EQUIPMENT#Bloc co6:Zona5#Gener altights 6,587.61 0.00							
EQUIPMENT#Bloc co6:Zona5#Gener alLights instant set set set set set set set set set se							
cco6:Zona5#Gener alLights com com <thcom< td="" th<=""><td></td><td>6,587.61</td><td>0.00</td><td>0.00</td><td>0.00</td><td>0.00</td><td>0.00</td></thcom<>		6,587.61	0.00	0.00	0.00	0.00	0.00
Image: series of the series							
ELECTRIC EQUIPMENT#Bloc co6:Zona13#Gene rallights 54,685.25 0.00							
EQUIPMENT#Bloc co6:Zona18#Gene ralLights cos							
co6:Zona18#Gene rallights com com com com ELECTRIC EQUIPMENT#Bloc co6:Zona19#Gene rallights 2,303.12 0.00 0.00 0.00 0.00 0.00 EQUIPMENT#Bloc co6:Zona19#Gene rallights 10,734.40 0.00 0.000 0.000 0.000 0.000 EQUIPMENT#Bloc co6:Zona3#Gener allights 10,734.40 0.00 0.000 0.000 0.000 0.000 EQUIPMENT#Bloc co6:Zona3#Gener allights 10,734.40 0.00 0.000 0.000 0.000 0.000 EQUIPMENT#Bloc co6:Zona2#Gener allights 10,734.40 0.00 0.000 0.000 0.000 EQUIPMENT#Bloc co6:Zona2#Gener allights 10,734.40 0.00 0.000 0.000 0.000 EQUIPMENT#Bloc co6:Zona2#Gener rallights 1,697.93 0.00 0.000 0.000 0.000 EQUIPMENT#Bloc co6:Zona1#Gener rallights 1,697.93 0.00 0.000 0.000 0.000 EQUIPMENT#Bloc co6:Zona6#Gener allights 7,634.41 0.00 0.000 0.000 0.000 EQUIPMENT#Bloc co6:Zona6#Gener all		54,685.25	0.00	0.00	0.00	0.00	0.00
Image: second							
ELECTRIC EQUIPMENT#Bloc co6:Zona19#Gene ralLights 2,303.12 0.00							
EQUIPMENT#Bloc co6:Zona19#Gene ralLights instant for the second sec	 -						
cco6:Zona19#Gene ralLights Image: Comment of the second of t		2,303.12	0.00	0.00	0.00	0.00	0.00
Image: second							
ELECTRIC EQUIPMENT#Bloc co6:Zona3#Gener alLights 10,734.40 0.00							
EQUIPMENT#Bloc co6:Zona3#Gener alLights instant set in the							
co6:Zona3#Gener alLights inclusion inclusion inclusion inclusion inclusion inclusion EQUIPMENT#Bloc 9,934.19 0.00 0.00 0.00 0.00 inclusion inclusion EQUIPMENT#Bloc co6:Zona2#Gener alLights inclusion inc		10,734.40	0.00	0.00	0.00	0.00	0.00
Image: second							
ELECTRIC EQUIPMENT#Bloc co6:Zona2#Gener alLights 9,934.19 0.00							
EQUIPMENT#Bloc co6:Zona2#Gener							
Co6:Zona2#Gener alLights Image: Cofe constant of the sector of the		9,934.19	0.00	0.00	0.00	0.00	0.00
alLights Image: sector se							
ELECTRIC EQUIPMENT#Bloc co6:Zona13#Gene ralLights 1,697.93 0.00							
EQUIPMENT#Bloc co6:Zona13#Gene ralLightsImage: Constant of the sector of the sect	-						
co6:Zona13#Gene ralLightsendendendendendendELECTRIC7,634.410.000.000.000.000.00EQUIPMENT#Bloc co6:Zona6#Gener alLights0.00EQUIPMENT#Bloc co6:Zona6#Gener alLights0.000.000.000.00EQUIPMENT#Bloc EQUIPMENT#Bloc2,625.730.000.000.000.000.000.00		1,697.93	0.00	0.00	0.00	0.00	0.00
ralLights Image: Constraint of the symbol of t							
ELECTRIC EQUIPMENT#Bloc co6:Zona6#Gener alLights 7,634.41 0.00							
EQUIPMENT#Bloc co6:Zona6#Gener alLightsImage: Constant of the second secon							
co6:Zona6#Gener alLights		7,634.41	0.00	0.00	0.00	0.00	0.00
alLights Image: Constraint of the system Image: Constand of the system							
ELECTRIC 2,625.73 0.00							
EQUIPMENT#Bloc							
		2,625.73	0.00	0.00	0.00	0.00	0.00
co6:Zona1#Gener							
alLights all	alLights						
ELECTRIC 1,374.46 0.00							



co6:2 EQU co6:1 EQU co5:1 EQU co5:1	PMENT#Bloc ona14#Gene ralLights ELECTRIC PMENT#Bloc Zona7#Gener	6,372.54	0.00	0.00	0.00	0.00	0.00
EQU CO5:: EQU CO5:: EQU CO5:: EQU CO5:: EQU CO5:: EQU CO5:: EQU	ralLights ELECTRIC PMENT#Bloc	6,372.54	0.00	0.00	0.00	0.00	0.00
co6: EQU co5:	ELECTRIC PMENT#Bloc	6,372.54	0.00	0.00	0.00	0.00	0.00
co6: EQU co5:	PMENT#Bloc	6,372.54	0.00	0.00	0.00		
co6: EQU co5:						0.00	0.00
EQU co5: EQU co5: EQU co5: EQU co5: EQU	cona/#Gener						
co5: EQU co5: EQU co5: EQU co5: EQU co5: EQU co5: EQU co5:							
co5: EQU co5: EQU co5: EQU co5: EQU co5: EQU co5: EQU co5:	alLights						
co5: EQU co5: EQU co5: EQU co5: EQU co5: EQU co5: EQU co5:	ELECTRIC	14,985.12	0.00	0.00	0.00	0.00	0.00
EQU co5: EQU co5: EQU co5: EQU	PMENT#Bloc						
CO5:: EQU CO5:: EQU CO5:: EQU	Zona4#Gener						
CO5:: EQU CO5:: EQU CO5:: EQU	alLights						
CO5:: EQU CO5:: EQU CO5:: EQU	ELECTRIC	662.36	0.00	0.00	0.00	0.00	0.00
EQU co5: EQU co5: EQU	PMENT#Bloc						
CO5: EQU CO5: EQU	Zona3#Gener						
CO5: EQU CO5: EQU	alLights						
CO5: EQU CO5: EQU	ELECTRIC	13,353.56	0.00	0.00	0.00	0.00	0.00
EQU co5:	PMENT#Bloc						
co5:	Zona1#Gener						
co5:	alLights						
co5:	ELECTRIC	814.78	0.00	0.00	0.00	0.00	0.00
EQU	PMENT#Bloc						
	Zona5#Gener						
	alLights						
	ELECTRIC	1,766.75	0.00	0.00	0.00	0.00	0.00
	PMENT#Bloc						
co5:	Zona2#Gener						
	alLights						
	ELECTRIC	39,768.88	0.00	0.00	0.00	0.00	0.00
EQU	PMENT#Bloc	,					
	Zona1#Gene						
	ralLights						
	ELECTRIC	11,559.55	0.00	0.00	0.00	0.00	0.00
EOU	PMENT#Bloc	,					
	Zona4#Gene						
	ralLights						
	ELECTRIC	814.78	0.00	0.00	0.00	0.00	0.00
FOU	PMENT#Bloc	014.70	0.00	0.00	0.00	0.00	0.00
	Zona5#Gene						
	ralLights						
	ELECTRIC	1,766.75	0.00	0.00	0.00	0.00	0.00
EOU	PMENT#Bloc	1,700.75	0.00	0.00	0.00	0.00	0.00
	Zona2#Gene						
	ralLights						
	ELECTRIC	39,768.88	0.00	0.00	0.00	0.00	0.00
ГОЧ	PMENT#Bloc	35,700.00	0.00	0.00	0.00	0.00	0.00
	Zona1#Gene						
		11 550 55	0.00	0.00	0.00	0.00	0.00
FOU		11,559.55	0.00	0.00	0.00	0.00	0.00
	PMENT#Bloc						
co11	Zona4#Gene						
	ralLights	044.70	0.00	0.00	0.00	0.00	0.00
	ELECTRIC	814.78	0.00	0.00	0.00	0.00	0.00
co11	ELECTRIC PMENT#Bloc	814.78	0.00	0.00	0.00	0.00	0.00
	ELECTRIC	814.78	0.00	0.00	0.00	0.00	0.00



	ELECTRIC EQUIPMENT#Bloc co11:Zona2#Gene ralLights	1,766.75	0.00	0.00	0.00	0.00	0.00
	ELECTRIC EQUIPMENT#Bloc co12:Zona1#Gene ralLights	39,768.88	0.00	0.00	0.00	0.00	0.00
	ELECTRIC EQUIPMENT#Bloc co12:Zona4#Gene ralLights	11,559.55	0.00	0.00	0.00	0.00	0.00
	ELECTRIC EQUIPMENT#Bloc co12:Zona5#Gene ralLights	814.78	0.00	0.00	0.00	0.00	0.00
	ELECTRIC EQUIPMENT#Bloc co12:Zona2#Gene ralLights	1,766.75	0.00	0.00	0.00	0.00	0.00
Exterior Lighting	General	0.00	0.00	0.00	0.00	0.00	0.00
Interior Equipment	ELECTRIC EQUIPMENT#Bloc co2:Zona3#05	3,223.40	0.00	0.00	0.00	0.00	0.00
	ELECTRIC EQUIPMENT#Bloc co2:Zona2#05	8,886.56	0.00	0.00	0.00	0.00	0.00
	ELECTRIC EQUIPMENT#Bloc co2:Zona7#05	12,856.60	0.00	0.00	0.00	0.00	0.00
	ELECTRIC EQUIPMENT#Bloc co2:Zona5#05	3,973.01	0.00	0.00	0.00	0.00	0.00
	ELECTRIC EQUIPMENT#Bloc co2:Zona9#05	7,777.10	0.00	0.00	0.00	0.00	0.00
	ELECTRIC EQUIPMENT#Bloc co2:Zona1#05	9,505.17	0.00	0.00	0.00	0.00	0.00
	ELECTRIC EQUIPMENT#Bloc co2:Zona10#05	398.22	0.00	0.00	0.00	0.00	0.00
	ELECTRIC EQUIPMENT#Bloc co2:Zona11#05	8,005.19	0.00	0.00	0.00	0.00	0.00
	ELECTRIC EQUIPMENT#Bloc co2:Zona6#05	7,606.95	0.00	0.00	0.00	0.00	0.00
	ELECTRIC EQUIPMENT#Bloc co2:Zona8#05	215.60	0.00	0.00	0.00	0.00	0.00
	ELECTRIC EQUIPMENT#Bloc co2:Zona4#05	1,029.41	0.00	0.00	0.00	0.00	0.00



ELECTRIC EQUIPMENT#Bloc co4:Zona18#05	1,670.11	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Bloc co4:Zona15#05	8,091.92	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Bloc co4:Zona1#05	4,872.37	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Bloc co4:Zona16#05	11,842.76	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Bloc co4:Zona8#05	6,249.78	0.00	0.00	0.00	0.00	0.00
 ELECTRIC EQUIPMENT#Bloc co4:Zona9#05	253.72	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Bloc co4:Zona14#05	999.93	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Bloc co4:Zona4#05	1,816.94	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Bloc co4:Zona17#05	236.04	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Bloc co4:Zona10#05	3,481.33	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Bloc co4:Zona11#05	2,247.96	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Bloc co4:Zona5#05	7,825.62	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Bloc co4:Zona13#05	4,138.49	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Bloc co4:Zona19#05	507.86	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Bloc co4:Zona3#05	5,215.00	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Bloc co4:Zona2#05	313.80	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Bloc co4:Zona6#05	5,611.72	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Bloc co4:Zona12#05	5,275.27	0.00	0.00	0.00	0.00	0.00
ELECTRIC	3,095.92	0.00	0.00	0.00	0.00	0.00

Final

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EQUIPMENT#Bloc						
co4:Zona7#05						
ELECTRIC	3,973.01	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Bloc	3,973.01	0.00	0.00	0.00	0.00	0.00
co1:Zona5#05						
 ELECTRIC	6,821.78	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Bloc	0,021.70	0.00	0.00	0.00	0.00	0.00
co1:Zona1#05						
 ELECTRIC	7,777.10	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Bloc	,,,,,,,,,	0.00	0.00	0.00	0.00	0.00
co1:Zona9#05						
ELECTRIC	4,066.60	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Bloc	.,					
co1:Zona12#05						
 ELECTRIC	398.22	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Bloc						
co1:Zona10#05						
ELECTRIC	3,921.81	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Bloc						
co1:Zona14#05						
ELECTRIC	6,839.65	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Bloc						
co1:Zona6#05						
ELECTRIC	2,695.25	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Bloc						
co1:Zona2#05						
ELECTRIC	2,689.45	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Bloc						
co1:Zona7#05						
ELECTRIC	3,518.17	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Bloc						
 co1:Zona8#05						
ELECTRIC	160.80	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Bloc						
 co1:Zona13#05						
ELECTRIC	355.57	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Bloc						
co1:Zona15#05						
ELECTRIC	12,348.70	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Bloc						
co1:Zona3#05	1 020 44	0.00	0.00	0.00	0.00	0.00
ELECTRIC	1,029.41	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Bloc						
co1:Zona4#05	6 240 70	0.00	0.00	0.00	0.00	0.00
	6,249.78	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Bloc co6:Zona8#05						
ELECTRIC	6,892.60	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Bloc	0,692.00	0.00	0.00	0.00	0.00	0.00
co6:Zona15#05						
ELECTRIC	253.72	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Bloc	255.72	0.00	0.00	0.00	0.00	0.00
co6:Zona9#05						
ELECTRIC	2,423.50	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Bloc	2,423.50	0.00	0.00	0.00	0.00	0.00



-							
CO63	Zona4#05						
	ELECTRIC 1ENT#Bloc 20na12#05	7,804.56	0.00	0.00	0.00	0.00	0.00
	ELECTRIC 1ENT#Bloc 20na10#05	3,481.33	0.00	0.00	0.00	0.00	0.00
	ELECTRIC 1ENT#Bloc 20na11#05	2,247.96	0.00	0.00	0.00	0.00	0.00
	ELECTRIC 1ENT#Bloc 20na5#05	3,200.40	0.00	0.00	0.00	0.00	0.00
	ELECTRIC 1ENT#Bloc 20na18#05	26,567.26	0.00	0.00	0.00	0.00	0.00
	ELECTRIC 1ENT#Bloc 20na19#05	507.86	0.00	0.00	0.00	0.00	0.00
	ELECTRIC 1ENT#Bloc 20na3#05	5,215.00	0.00	0.00	0.00	0.00	0.00
	ELECTRIC 1ENT#Bloc 20na2#05	4,826.24	0.00	0.00	0.00	0.00	0.00
	ELECTRIC 1ENT#Bloc 20na13#05	374.41	0.00	0.00	0.00	0.00	0.00
	ELECTRIC 1ENT#Bloc 20na6#05	3,708.96	0.00	0.00	0.00	0.00	0.00
	ELECTRIC 1ENT#Bloc 20na1#05	1,275.64	0.00	0.00	0.00	0.00	0.00
	ELECTRIC 1ENT#Bloc 20na14#05	303.09	0.00	0.00	0.00	0.00	0.00
	ELECTRIC 1ENT#Bloc 220na7#05	3,095.92	0.00	0.00	0.00	0.00	0.00
EQUIPM	ELECTRIC 1ENT#Bloc 220na4#05	1,306.52	0.00	0.00	0.00	0.00	0.00
EQUIPM	ELECTRIC 1ENT#Bloc 20na3#05	321.79	0.00	0.00	0.00	0.00	0.00
EQUIPM	ELECTRIC 1ENT#Bloc 20na1#05	6,487.44	0.00	0.00	0.00	0.00	0.00
EQUIPM	ELECTRIC 1ENT#Bloc 20na5#05	395.84	0.00	0.00	0.00	0.00	0.00
	ELECTRIC 1ENT#Bloc 20na2#05	389.59	0.00	0.00	0.00	0.00	0.00



EQUIPMENT#Bloc co10:Zona1#05	0.00 0.00 0.00 0.00 0.00 0.00 0.00
co10:Zona1#05	0.00
ELECTRIC EQUIPMENT#Bloc co10:Zona4#05 1,007.85 0.00 </th <th>0.00</th>	0.00
EQUIPMENT#Bloc co10:Zona4#05 Image: Constraint of the second	0.00
cc010:Zona4#05	0.00
ELECTRIC EQUIPMENT#Bloc co10:Zona5#05 395.84 0.00 <th>0.00</th>	0.00
EQUIPMENT#Bloc co10:Zona5#05 Image: Colored base in the colored ba	0.00
cc10:Zona5#05	0.00
ELECTRIC EQUIPMENT#Bloc co10:Zona2#05 389.59 0.00 <th>0.00</th>	0.00
EQUIPMENT#Bloc co10:Zona2#05 Image: Constraint of the second	0.00
EQUIPMENT#Bloc co10:Zona2#05 Image: Constraint of the second	0.00
cc010:Zona2#05 Image: Constraint of the sector	0.00
ELECTRIC EQUIPMENT#Bloc co11:Zona1#05 13,274.85 0.00<	0.00
EQUIPMENT#Bloc co11:Zona1#05 Image: Constraint of the constrai	0.00
co11:Zona1#05 Image: Constraint of the sector	
ELECTRIC EQUIPMENT#Bloc co11:Zona4#05 1,007.85 0.00 </th <th></th>	
EQUIPMENT#Bloc co11:Zona4#05 Image: Constraint of the second	
co11:Zona4#05 Image: Coline of the sector of t	0.00
ELECTRIC 395.84 0.00	0.00
EQUIPMENT#Bloc co11:Zona5#05Image: Constraint of the sector of the sect	0.00
Co11:Zona5#05 Image: Colored State Sta	
ELECTRIC 389.59 0.00	
EQUIPMENT#Bloc co11:Zona2#05Image: Constraint of the second seco	0.00
co11:Zona2#05 Image: Colored C	0.00
ELECTRIC 13,274.85 0.00 0.00 0.00 0.00 0 EQUIPMENT#Bloc 13,274.85 0.00 0.00 0.00 0.00 0	
EQUIPMENT#Bloc	
	0.00
co12:Zona1#05	
	0.00
EQUIPMENT#Bloc	
co12:Zona4#05	
ELECTRIC 395.84 0.00 0.00 0.00 0.00 0.00 0	0.00
EQUIPMENT#Bloc	
co12:Zona5#05	
	0.00
EQUIPMENT#Bloc	
co12:Zona2#05	
	0.00
Equipment	0.00
	0.00
(simple)	0.00
	0.00
	0.00
Rejection 0.00	0.00
	0.00
ion	0.00
	0.00
Recovery Contract Con	
	0.00
Systems	0.00
Refrigerati General 0.00 0.00 0.00 0.00 0	
on on on one of the other of the other of the other of the other o	0.00
Generators General 0.00 0.00 0.00 0.00 0.00 0	0.00



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16. ANNEX D: RENOVATION OPTION MATRIX BY SINLOC

TABLE 65 - ECONOMIC EVALUATION OF INTERVENTIONS

									Work timin	9		1		CA	PEX	
				Installed power or size of interventio n			t Final date		Compulsory connection with other technologies layers	Specify which technologies are needed to realize this layer	Specify which technologies can be realized only after this layer		Investmen	t cost	Investment payback period (preliminary)	Lifetime (year of replacement revamping)
Renovation options	Турез	Technologies / Layers	Code	Unit of measure	Value	ddimmtyy	ddimmlyy	Months	YestNo	Codelcodes (ascending order)	Codecodes (ascending order)	Unit of measure	Unit cost	Value calculated per share of use	Years	Years
	11.1	Cogeneration	2	125-7	010 4					10.05		102133		1.000010004		
	Heating pumps Heating pumps	Compression heat pumps - VRV system - DFFICES AREAS Compression heat pumps - VRV system - NEW ORCULATION AV	3	KW	918,1 786,9		X	12 12	Yes Yes	18-25 19-25	41 41	KW		393'361 553'846	15,59 n.a.	25 25
	Replacement of cooling plants	High-efficiency air conditioners	5		-									•		
	Cooling pumps Replacement of water heating systems	Compression heat pumps - VRV system - DIFFICES AREAS Solar thermal	67	KW	590	X	X	12	Yes	18-25	41	i KW	1 428	1252'793	4,56	25
	Replacement of water reading systems		8									ł				
	Insulation of distribution networks	Î_Î	9													
	Ventilation system	Heat recovery	10 11													
	Formation system	2	12									1				
		Heating pumps with geothermal sonde Georthermal heat pumps	13													
Casing	External insulation		14 15			-	-									
Building skin	Internal insulation	[]	16													
	Shielding elements	Fixed/mobile/combined vertical structures Horizontal structures on roofs - False Ceiling DFFICE AREAS	17 18	MQ	5166		X	12	Yes		3-6	MO	147.30	244'352	15.37	40
		Horizontal structures on roofs - False Ceiling CIFICULATION AREA			1599			12	Yes		4	MO		75'633	no	40
		Horizontal structures on floors	20													1
	Bioclimatic	[] []	21 22													
Windows	Windows	PVC	23													
	Glass windows	[] Double glass	24 25	MO	1321	<u> </u>		12	Yes		3-4-6	IIN ACT	11150,00	1'519'150	71.69	40
	Glass windows	Triple glass	26	INICA	1321			12	105		340	INC	11130,00	1313130	1,00	40
		[]	27													
Lighting systems (internal)	Replacement of lamps (and luminaries	LED Internal Relamping	28 29	units	1605	X	X	4	No			Punit	200,00	1321000	1,99	20
Lighting systems (external)	Replacement of lamps (and luminaries, balla		30				ļ									
Renewable energy	Biomass	Biomass heating systems	31 32													
non-addre chergy	Solar	Photovoltaic panels	33	KWP	61	X	X	6	No		·	V KWp	12'000,00	122'000	8,71	30
	Therese	Solar thermal panels	34													
Control systems	Thermal	Automatic regolation of internal temperature Thermostatic valves	35 36 37 38				-					-				
		Individual thermal energy consumption accounting	37									1				
	Lighting	Light flux regulators (internal)	38													
	Control System	Light flux regulators (external) BACS	39 40	unit	1	X	X	2	Yes	3-4-6		Rupit	1 25'000,00	25'000	no	20
	Sound System		41	- SH HC	-	1		~	103			P Sa Inc	120 000,00	20000		



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TABLE 66 - ECONOMIC EVALUATION OF INTERVENTIONS

									OPEX												SAV	INGS						
	Ene	gy con	sumption	(after each option)		energy	renov	ation	ordinary	anagement v maintena ontracts		Ext	raordinary m	naintenance	1.7		Potent	ial energ	gy savings ex	pected	from the	e interve	ention		saving mainte (p	ential gs from enance ost ention)		ential ngs of O2
									component s	personne I	Total	Frequenc	interventio n	personne I	Total	E	lectric ener	gy consi	umption		Thermal	energy	consum	ption				
Renovation options	Source 1	Unit of measure	Consumption/year	lyvear	Source 2	Unit of measure	Consumption/year	lyear	llyear	llyear	Vyear	years	_	llyear	_	%, first year	k Whelyear, first year	%, last year	k Whelyear, last year Decrease Decrease flimear.	%, first year	kWhelyear, first year	%, last year	kWhelyear, last year	Decrease characteristics (linear, nonlinear, etc.)	*	lyear	%	Equivalent tonstyear
			245'437,8	44'178,8					12'754	1 5'114	17'867	7	16'154	I 1'615	127'462	3,6%	1 3	3,3%	8'910 linear	1					40%	123'553	32	% 6,992
	electric	KWHe	210'375,3	37'867,55	no		-	-	13'877	17'200	111077	7	127'692	12'538	1 45' 462		n.a.		linear							n.a).	
	electric	KWHe	679'471	122'304,75	no				11770	13'286	15'056	7	I 16'154	1'615	127'462	15,4%	192'737	14,5%	181'830 linear						40%	121'678	152	% 140,5
																												-
																												-
																												-
											-																	
Casing																												
Buildingskin										-				-														-
	no				no				1 855 1 265	11588 1492	12'444		120'000		140'000				83'242 linear						0% 0%	10		66,26
	no				no		-		263	1492	1756	10	17'000	FTUUU	17'000		not applicat	ie is linke	d to a new equip	ment					0/6	10	0,0/	•
Windows																												
	no				no		-		12'659	14'937	17'596	10	1 20'000	12'000	1 40'000	10,1%	93'448	9,0%	83'242 linear			-			10%	15'288	9,62	66,26
								-																				
Lighting systems (internal)	alachi	-4074	75'530,1	13'595,42					11'124	12'087	13'210		14'000	11000	117000	1306.0%	COC'200	1000.0%	755'301 linear						25%	14/707	1153,02	652
Lighting systems (external)	electric	INW/He	75 530,1	1 15 333,42	no				1 1 124	12 087	13210		14000	11000	1 11 000	1506,074	386 337	1000,0%	700 out linear						23/6	14/3/	1103,07	• 003,1
Renewable energy							-															-						-
	no				no		-		1 2'135	13'965	1 6'100	5	17'000	13'000	1 22'000	100,0%	88944	75,0%	66708 linear						0%	10	87,5	\$ 58,37
Control systems																												
	no				no				1263	488	1750	3	1750	1500	12'250		pot applicat	la is links	d to a new equip	ment					0%	10	0,0	
	r 10				no		-		1203	1 400	1750	3	1400	1000	12 230		посаррисар	ie is inike	u to a new equip	anera.		-			0/8	10	0,0	•



C. SATELLITE PALACE

17. BUILDING GENERAL DESCRIPTION

17.1. LOCATION

Palazzo Satellite is the municipal building of Messina. The building is located in the historic center of the city, near the central station.

This figure shows the front facade of the building.



FIGURE 212 - PALAZZO SATELLITE

The building has no architectural value and in the original design was designed to residences.



FIGURE 213 - PALAZZO SATELLITE



The building includes many functions of municipal government, including the Local Health Unit, the municipal Police management and several Municipal Departments.

Building style is modern and the total area is 6,874.93 m², Palazzo Satellite is an example of a frame structure made of reinforced concrete. The walls are made of mansory and the floors are in slab and masonry. Table 1 presents the main location data of the building.

Address	Republic Square, 1 98122 Messina (ME), Italy
Coordinates	LAT. 38°11'10.50"N - LONG. 15°33'38.67"E
Google Maps	https://www.google.it/maps/place/@38.186251,15.560743,17z/data=!4m2!3m1!1s0
	x13144e706cf26d71:0x3fc19b5ae161ada1

TABLE 67 - LOCATION DATA OF THE BUILDING

		-				
These figures	chourtho	lacation i	n tha	ait in man	a a n d	a arial view
These ligures	snow me	юсанопт	n me	CILV MAI) and	aeriai view.
	00					



FIGURE 214 - LOCATION IN THE CITY (MAP)

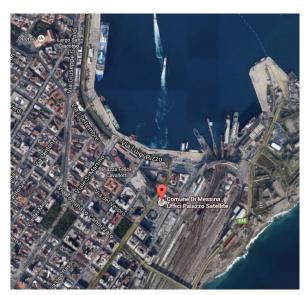


FIGURE 215 - LOCATION IN THE CITY (AERIAL VIEW)

Degree days	707
Minimum	5.0 °C
temperature of	
project	
Altitude	3 m s.l.m.
Climatic Zone	В
Heating days	121
Wind speed	2.8 m/s
Wind zone	2
Province of	Messina - Reggio di Calabria

TABLE 68 - DATA OF THE SYSTEM CONSIDERED

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reference												
Average monthly	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	ОСТ	NOV	DEC
temperatures(°C)	11.7	12.0	13.2	15.7	19.2	23.5	26.4	26.5	24.2	20.3	16.6	13.3
Averages monthly	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	ОСТ	NOV	DEC
raditions (MJ/m²)	7.2	10.8	15.2	20.3	24.4	27.3	27.2	24.6	19.0	12.9	8.9	6.6
	10.8	12.9	12.9	11.5	9.9	9.2	9.7	11.8	14.0	14.2	13.2	10.3
	8.6	11.1	12.7	13.6	13.6	13.8	14.3	15.3	14.9	12.6	10.7	8.2
	5.4	7.9	10.5	13.4	15.6	17.1	17.2	16.2	13.1	9.3	6.7	5.0
	2.7	4.2	6.6	9.7	12.5	14.5	14.1	11.8	8.2	5.1	3.2	2.4
	2.4	3.2	4.3	5.9	8.4	10.2	9.5	6.8	4.6	3.6	2.6	2.2

Q Location Template		
Template	MESSINA	
Site Location		
Latitude (")	38,20	
Longitude (")	15,55	
🔊 Site Details		
Elevation above sea level (m)	51,0	
Exposure to wind	2-Normal	
Site orientation (*)	0	_
Ground		
Add ground construction layers to surfaces i	in contact with ground (separate constructions only)	
Construction	Cultivated clay soil (0.5m)	
☑ Texture	GranulatedGray453M	
Surface Reflection		
Surface solar and visible reflectance	0,20	
Snow reflected solar modifier	1,00	
Snow reflected daylight modifier	1,00	_
Monthly Temperatures		
Water Mains Temperature		
Precipitation		
Site Green Roof Irrigation		
Time and Daylight Saving Simulation Weather Data		
A Hourly weather data	ITA_MESSINA_IGDG	
Winter Design Weather Data	T A_MESSINA_IGBG	
⊙ Heating 99.6% coverage		
Outside design temperature (°C)	6,3	
Wind speed (m/s)	10,2	
Wind direction (*)	0,0	
O Heating 99% coverage		
🔅 Summer Design Weather Data		
Temperature Range Modifiers		
Design Temperatures		
⊙ 99.6% coverage (based on dry-bulb temp.)		
Max dry-bulb temperature (°C)	32,2	
Coincident wet-bulb temperature (*C)	22,8	
Min dry-bulb temperature (°C)	27,1	
O 99% coverage (based on dry-bulb temp.)		
O 98% coverage (based on dry-bulb temp.)		
O 99.6% coverage (based on wet-bulb temp.)		
C 55.577 Coverage (based on wer baib (Bhip.)		

FIGURE **216** - DATA FOR THE SIMULATION WITH DESIGN BUILDER SOFTWARE

Final



17.2. SHAPE AND ORIENTATION

This building is constituted of 5 floors above ground. The dimensions are the same for each floor.

17.3. AREA AND VOLUME

The building has a total area of about 6,870 $\,m^2$ (about 1,350 $\,m^2$ to plan) and a volume of about 18,550 $\,m^3$.

17.4. CURRENT USE

Palazzo Satellite is a municipal building, in which there are multiple functions of public utility.

On the ground floor is access to the building and also a hall and reception. All rooms are now used as municipal offices, with the exception of bathrooms and deposits.



FIGURE 217 - GROUND FLOOR

On the first floor there are the same functions as for the others floors except ground floor, in which there are also some retail areas (stores).

The basement floor has small rooms and many of them are intended for systems and server rooms.

The building usually has occupation between 0h00 and 24h00 from Monday to Sunday, because of the municipal police management, but the public activities of employees are carried out only between 7h30 and 19h30. Public access depends on the type of service provided and is between 08h30 and 13h30 from Monday to Friday, also between 14h30 and 16h30 on Tuesday and Thursdays.

The building has about 200 employees and it is visited by an indeterminate number of public.

For the simulation of Palazzo Satellite with Design Builder software, the building was divided into 5 blocks (named 1,2,4,5).

The size of the windows are not optimal but has been dimensioned according to the percentage of openings per square meter of wall surface, i.e. the building originally meant for housing.



The following image shows the Home screen of the software.

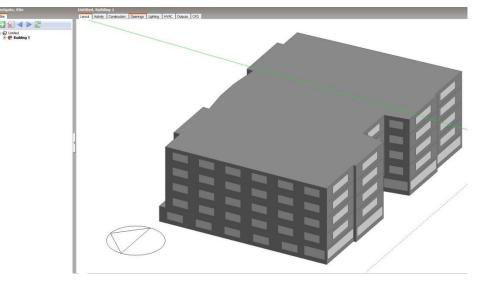


FIGURE 218 - HOME SCREEN OF THE SOFTWARE

The following figures show floor plans of the blocks, as shown in the simulation software. Floors are divided into different areas, depending on the intended use and different usage profiles were created for each area.

For the Palazzo Satellite there are: block 1 refers on the first floor, block 2 on the second floor, block 3 on the third floor, block 4 on the fourth floor and block 5 on the ground floor.

For Block 1 it has:

- Satellite Office Typical
- Satellite Circulation
- Satellite Unoccupied area
- Satellite Office Toilet



FIGURE 219 - PLAN OF BLOCK 1



For Block 2 it has:

- Police Office Typical
- Satellite Circulation
- Satellite Unoccupied area
- Satellite Office Toilet



FIGURE 220 - PLAN OF BLOCK 2

For Block 3 it has:

- Satellite Office Typical
- Satellite Circulation
- Satellite Unoccupied area
- Satellite Office Toilet

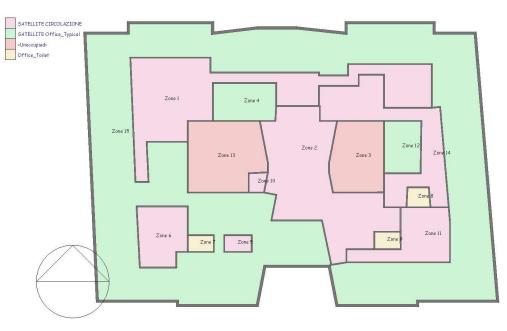


FIGURE 221 - PLAN OF BLOCK 3



For Block 4 it has:

- Satellite Office Typical
- Satellite Circulation
- Satellite Unoccupied area
- Satellite Office Toilet

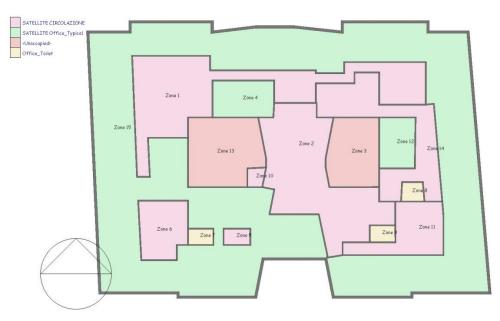


FIGURE 222 - PLAN OF BLOCK 4

For Block 5 it has:

- Satellite Office Typical and Police Office Typical
- Satellite Circulation
- Satellite Unoccupied area
- Satellite Office Toilet
- Retail

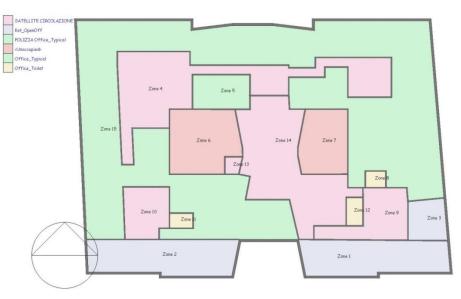


FIGURE 223 - PLAN OF BLOCK 5



18. CURRENT BUILDING CONDITIONS

18.1. CONSTRUCTIVE BUILDING CHARACTERISTICS

Palazzo Satellite observes the seismic codes. The building structure was built according to the frame system in reinforced concrete, commonly used for Messina buildings.

Not much information have been found on the original design of the building, because it was built by a private contractor and then sold to the municipality, which has made it a public building.

18.1.1. Envelope Elements

For the modeling of the actual state of the building a template is defined for the characteristics of the building envelope. The template is divided into internal partitions (vertical and horizontal), external partitions (opaque and glazed).

Construction Template	
😼 Template	Project construction template
Construction	
😋 External walls	Satellite parete
Below grade walls	Satellite parete
SFlat roof	Project flat roof
Pitched roof (occupied)	Project pitched roof
Pitched roof (unoccupied)	Project unoccupied pitched roof
jInternal partitions	Project partition
Semi-Exposed	
Semi-exposed walls	Project semi-exposed wall
Semi-exposed ceiling	Project semi-exposed ceiling
Semi-exposed floor	Project semi-exposed floor
Floors	
Ground floor	Project ground floor
External floor	Project external floor
🤿 Internal floor	Project internal floor
Sub-Surfaces	
Internal Thermal Mass	
Component Block	

FIGURE 224 - CONSTRUCTION TEMPLATE

Following figure shows the characteristics of the partitions (external and some of internal).



constructions Data		
	ation analysis	
General		
Name Satellite parete		
Source		
Category	Walls	-
Region	ITALY	
Calculation Settings		()
Layers		
Number of layers	5	
Outermost layer		
Implementation (Second Second	Gypsum Plastering	
Thickness (m)	0,0200	
Bridged?		
Layer 2		
Implementation and the second	Mattoni forati	
Thickness (m)	0,1000	
Bridged?		
Layer 3		
Address Addres	Air gap 5mm	
Thickness (not used in thermal calcs) (m)	0,0500	
Layer 4		
SyMaterial (Mattoni forati	
Thickness (m)	0,1000	
Bridged?		
Innermostlayer		
Interial States and American States and Americ	Gypsum Plastering	
Thickness (m)	0,0200	
Bridged?		

FIGURE 225 - CONSTRUCTION DATA OF PARTITION

18.1.2. WINDOWS

All the windows have single glazing with aluminium frames. The doors have the same characteristics as the windows with the exception of some doors on the ground floor, which are only in metal.



FIGURE 226 - DOOR ON THE GROUND FLOOR

All the windows have rolling shutters in PVC. Only some rooms have transparent cloth curtains, light in color.





FIGURE 227 - WINDOWS WITHOUT SHUTTERS

The fixed shading is ensured by other building in Via Tommaso Capra, by the evergreen trees in Via La Farina. The front façade on Repubblic Square is subject to some shading, as can be seen from the following figure.



FIGURE 228 - EUROPEAN UNION SQUARE

The windows of the ground floor are the same as for other floors.



ilazing Template	Single glazing, clear, no shading
xtemal Windows	
)Glazing type	Sgl Clr 3mm
Layout	Preferred height 1.5m, 30% glazed
Dimensions	
Туре	3-Preferred height
Window to wall %	29,00 🗢
0 10 20 30 40	50 60 70 80 90 1
Window height (m)	1,50
Window spacing (m)	5,00
Sill height (m)	0.80
Reveal	
rame and Dividers	
Has a frame/dividers?	
Construction	Aluminium window frame (no break)
Dividers	
Туре	1-Divided lite
Width (m)	0,0200
Horizontal dividers	1
Vertical dividers	1
Outside projection (m)	0,000
Inside projection (m)	0,000 1,000
Glass edge-centre conduction ratio	1,000
Frame width (m)	0.0400
Frame inside projection (m)	0,000
Frame inside projection (m)	0,000
Glass edge-centre conduction ratio	1,000
Shading	

FIGURE 229 - GLAZING TEMPLATE

18.1.3. AIRFLOWS AND PATHOLOGIES

A previous study analysed the envelope with thermal imaging with an external air temperature of about 17°C.

The following figure shows the general image of the thermal performance of the envelope. As can be seen the walls present a good thermal performance.



FIGURE 230 - THERMAL VIEW



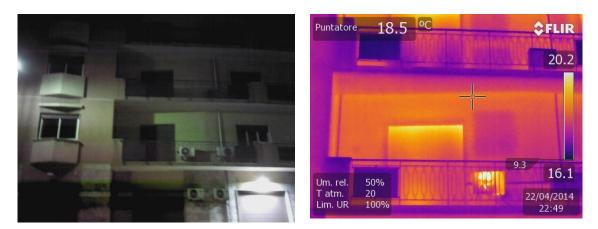


FIGURE 231 - THERMAL VIEW

The following figure shows the thermal losses in the windows. The windows, with single glazing with aluminium frames, present insulation problems, aggravated by aging.



FIGURE 232 - THERMAL LOSSES IN THE WINDOWS AND WINDOW INVISIBLE TO THE NAKED EYE

This figure shows the thermal losses due to thermal bridges in the corner of the room.



FIGURE 233 - THERMAL BRIDGES



Some characteristics of the building contribute to a bad thermal performance:

- The orientation is not optimal, requiring additional energy consumption with heating during the winter (mainly in the north areas) and with cooling during the summer (mainly in the west areas without any direct protection from the direct radiation).
- The walls with high thermal inertia and large ceiling height provide advantages during the summer, but disadvantages during winter, since the building does not have users in the night period and weekends which leads to a high temperature decrease.
- The windows have bad leak tightness, enabling a high level of air infiltration, which is not controllable and undesirable, mainly during the winter.
- The doors are old and poorly insulated.
- The building presents many pathologies, such as condensation or mould growth.



18.2. ENERGY SYSTEMS

18.2.1. HVAC

The HVAC is ensured with several heat pumps, which were installed gradually over the years. Therefore, there are several types of equipment with different characteristics and performance. In total, there is at least one split in every room and the total number is summarized in the following table.



FIGURE 234 - THERMOGRAPHY OF AN AIR CONDITIONER ON

Almost all the areas of permanent use have HVAC, where the control is local with units of individual control.

Heat Pumps calculation					
Thermal Power BTU/H	9,000	12,000			
Ground Floor	10	24			
First Floor	4	29			
Second Floor	8	28			
Third Floor	3	30			
Fourth Floor	4	30			
Total	29	141			

TABLE 69 - HEAT PUMPS CALCULATION

The air circulation and renewal is ensured naturally through the doors and windows. There are no systems of forced ventilation in rooms.

18.2.2. LIGHTING

The building has the same types of fluorescent lamps in all rooms and they are adjacent to the ceiling.





FIGURE 235 - LIGHTING IN CIRCULATION AREA

There is no mechanism to control lighting and plants are dated. During hours when the building is not open to the public there are only lamps for emergency lighting.

TABLE 70 - LAMPS CALCULATION

LAMPS CALCULATION								
LAMPS	2X18	4X18	2X36	2X58				
Basement Floor	3	2	43					
Ground Floor	49	7	21	17				
First Floor	49	5	22	3				
Second Floor	47	5	33	3				
Third Floor	46	5	34	3				
Fourth Floor	46	5	35	3				
Emergency stairs		20						
Total	240	49	188	29				

18.2.3. ICT

Most of the offices and rooms have computers and printers and there is a room with servers and an internal circuit for building security.

There are photocopier machines, tv screens, video projectors in some rooms and equipment for the exclusive use of the bar.

18.2.4. OTHERS

The building has 3 lifts. The usage rate of lifts is high since they serve rooms with a significant amount of public and employee visits. In the calculation of the energy consumption, the contribution of the 3 lifts are, however negligible.



Lifts and other small appliances connected to plugs such as individual electric heaters, vending machines, photocopier machines, computers and printers (when not connected to the UPSs), etc. were considered as "others" in the modelling.

For calculating their consumption usage profiles have been created directly through the Design Builder software.

18.3. ENERGY CONSUMPTION & ENERGY GENERATION

18.3.1. ELECTRICITY CONSUMPTION

The building receives electricity in Low Voltage. Following a summary table of power consumption.

ELECTRICITY CONSUMPTION	kWh per year 2013	kWh per year 2012	kWh per year 2014
Republic Square, 1 - Messina			Survey performed on days in mid-June in 2014. Average consumption with
IT001E96239138	9,143 kWh	4,187 kWh	average outdoor temperatures of 27 C during
IT001E96239124	711 kWh	0 kWh	operation.
IT001E96239123	1,482,357 kWh	1;500,548 kWh	

TABLE 71 - ELECTRICITY CONSUMPTION

There is not a central unit for heating and cooling, but there are many emission systems (split), different in shape, performance, brand and model.

To set the calculation of the model the general information fixed are:

TABLE 72 - GENERAL INFORMATION FOR SIMULATION

	Data
Weather File	** Messina - ITA IGDG WMO#=164200
HDD and CDD data source	Weather File Stat
Total gross floor area [m2]	6,874.93
Principal Heating Source	District Heating

TABLE 73- UTILITY USE PER CONDITIONED FLOOR AREA

	Electricity Intensity [kWh/m2]	Natural Gas Intensity [kWh/m2]	Additional Fuel Intensity [kWh/m2]	District Cooling Intensity [kWh/m2]	District Heating Intensity [kWh/m2]	Water Intensity [m3/m2]
Lighting	136.10	0.00	0.00	0.00	0.00	0.00
HVAC	0.00	0.00	0.00	126.16	1.29	0.02
Other	35.46	0.00	0.00	0.00	0.00	0.00
Total	171.56	0.00	0.00	126.16	1.29	0.02



TABLE 74 - UTILITY USE PER TOTAL FLOOR AREA

	Electricity Intensity [kWh/m2]	Natural Gas Intensity [kWh/m2]	Additional Fuel Intensity [kWh/m2]	District Cooling Intensity [kWh/m2]	District Heating Intensity [kWh/m2]	Water Intensity [m3/m2]
Lighting	124.00	0.00	0.00	0.00	0.00	0.00
HVAC	0.00	0.00	0.00	114.95	1.17	0.02
Other	32.31	0.00	0.00	0.00	0.00	0.00
Total	156.31	0.00	0.00	114.95	1.17	0.02

TABLE 75 - END USE CONSUMPTION

	Electricity [kWh]	Natural Gas [kWh]	Additional Fuel [kWh]	District Cooling [kWh]	District Heating [kWh]	Water [m3]
Heating	0.00	0.00	0.00	0.00	2,714.76	0.00
Cooling	0.00	0.00	0.00	790,256.80	0.00	0.00
Interior Lighting	852,503.17	0.00	0.00	0.00	0.00	0.00
Exterior Lighting	0.00	0.00	0.00	0.00	0.00	0.00
Interior Equipment	222,119.61	0.00	0.00	0.00	0.00	0.00
Water Systems	0.00	0.00	0.00	0.00	5,349.45	143.97
Refrigeration	0.00	0.00	0.00	0.00	0.00	0.00
Generators	0.00	0.00	0.00	0.00	0.00	0.00
Total End Uses	1,074,622.78	0.00	0.00	790,256.80	8,064.20	143.97

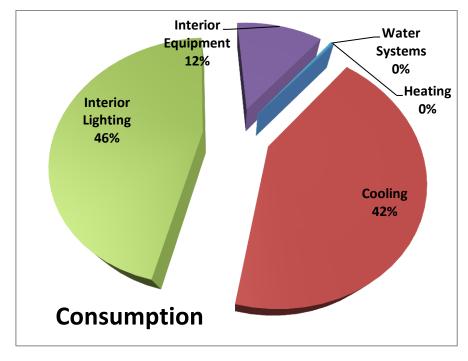
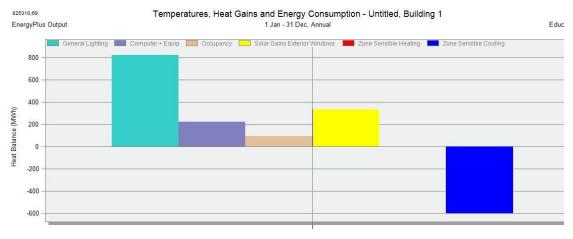


FIGURE 236 - DISAGGREGATION OF ELECTRICITY CONSUMPTION BETWEEN USES

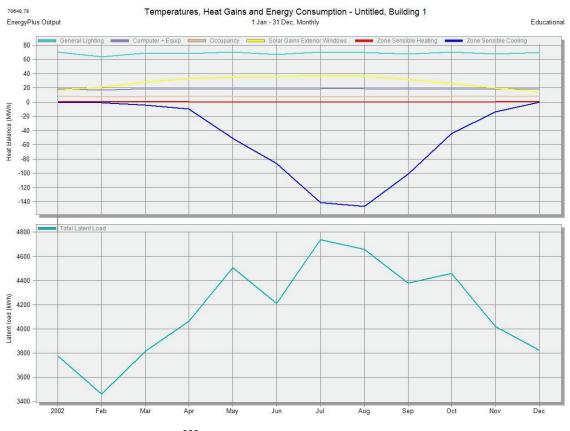


The following figures shows the heat balance of Palazzo Zanca, divided according to the contributions:

- General Lighting,
- Computer + Equipment,
- Occupancy,
- Solar Gans Exterior Windows,
- Zone Sensible Heating,
- Zone Sensible Cooling.











Two following figures shows monthly total fuel use of Palazzo Zanca, divided according to the contributions:

- Room Electricity,
- Lighting,
- Auxiliary Energy,
- Heating (Electricity),
- Cooling (Electricity).

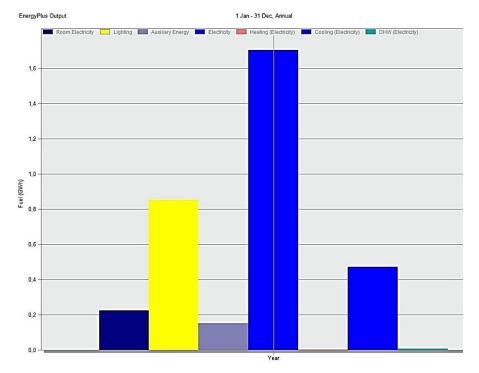
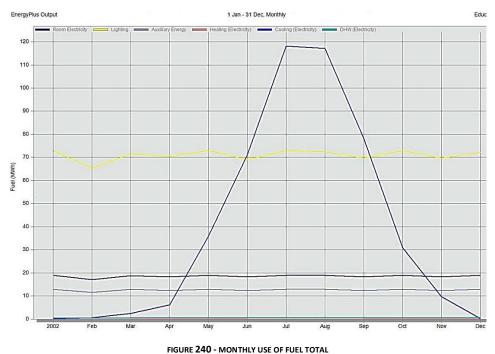


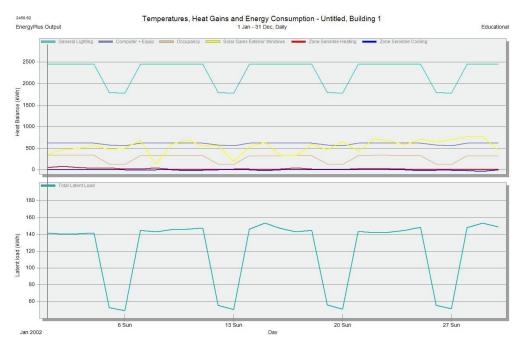
FIGURE 239 - ANNUAL USE OF FUEL TOTAL



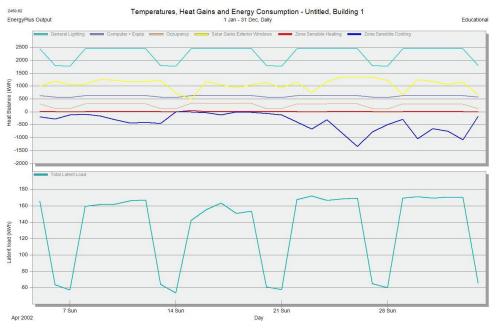


Four following figures shows heat balance of Palazzo Zanca, divided according to the contributions, during four months in particular January, April, July and September:

- General Lighting,
- Computer + Equipment,
- Occupancy,
- Solar Gans Exterior Windows,
- Zone Sensible Heating,
- Zone Sensible Cooling.



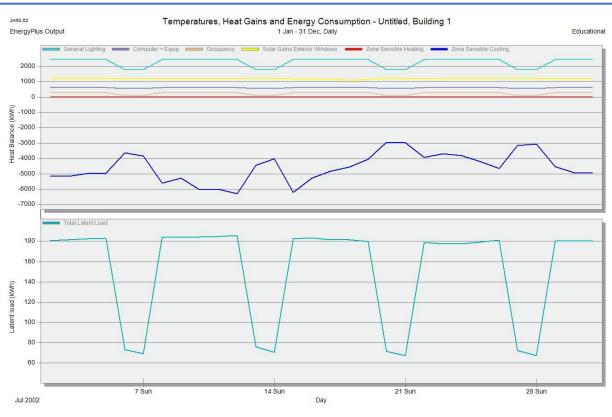




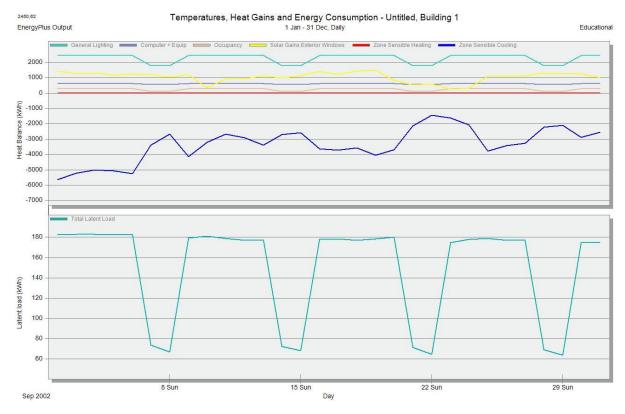
















18.3.2. GAS/OIL CONSUMPTION

The building does not have any gas consumption.

18.3.3. RENEWABLE ENERGY SOURCES

The building does not have any RES plant.

18.3.4. OTHER GENERATION

Other data that influence thermal balance come from building envelope.

Considered data are:

- Glazing
- Walls
- Ceilings (internal)
- Floors (internal)
- Ground floors
- Partitions (internal)
- Roofs
- Floors (external)
- External infiltration
- External ventilation

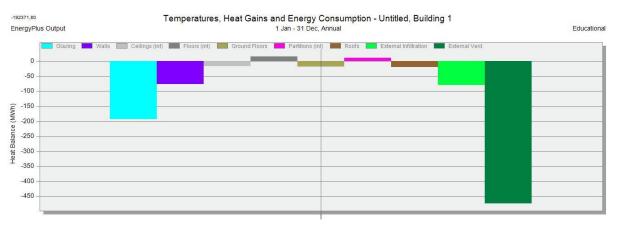


FIGURE 245 - ANNUAL HEAT BALANCE (FABRIC AND VENTILATION)





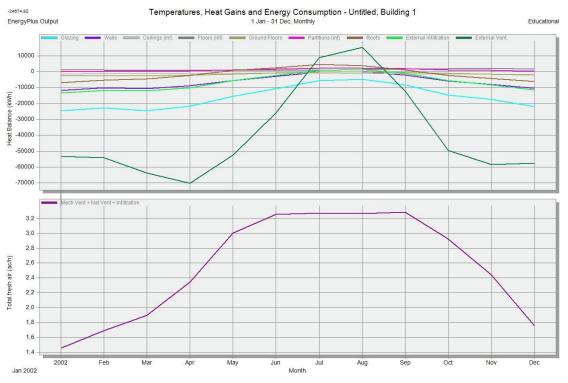
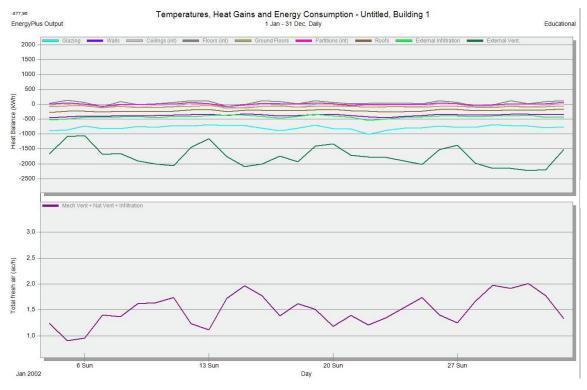


FIGURE 246 - ANNUAL HEAT BALANCE (FABRIC AND VENTILATION), ACCORDING OF SINGLE MONTHS

Four following figures shows heat balance (fabric and ventilation) of Palazzo Zanca, divided according to the contributions, during four month in particular January, April, July and September.









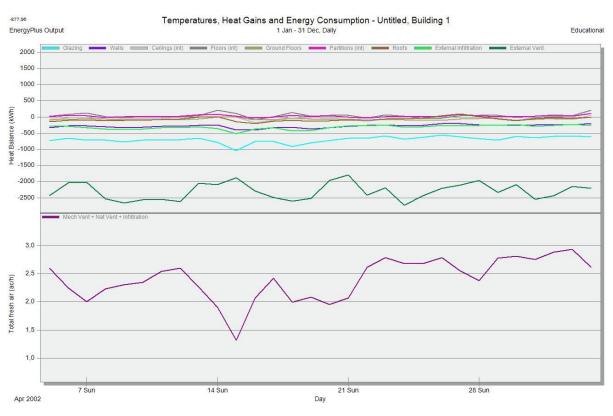


FIGURE 248 - HEAT BALANCE DURING APRIL (FABRIC AND VENTILATION)

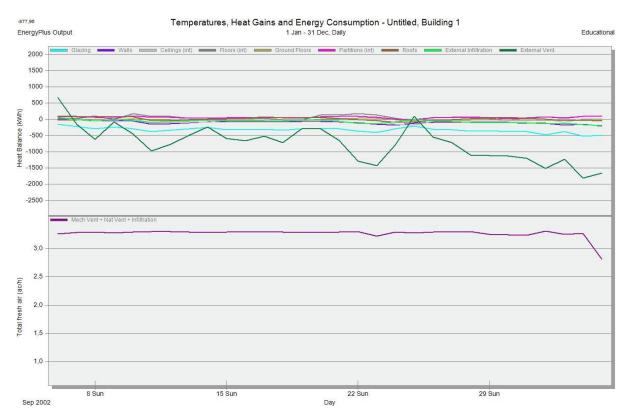


FIGURE 249 - HEAT BALANCE DURING SEPTEMBER (FABRIC AND VENTILATION)



$18.3.5.\,Final$ energy consumption and CO_2 emissions

In this building you only have electricity consumption.

TABLE 76 - BUILDING AREA

	Area [m ²]
Total Building Area	6,874.93
Net Conditioned Building Area	6,806.64
Unconditioned Building Area	68.29

As it can see in the section on electricity consumption are deduced the following data.

	Electricity [kWh]	District Cooling [kWh]	District Heating [kWh]	Water [m ³]
Heating	0.00	0.00	0.07	0.00
Cooling	0.00	434,108.33	0.00	0.00
Interior Lighting	111,437.37	0.00	0.00	0.00
Interior	187,364.76	0.00	0.00	0.00
Equipment				
Water Systems			5,349.45	143.97
Total End Uses	298,802.13	434,108.33	5,349.45	143.97
Total	738,403.94			

TABLE 77 - END USE CONSUMPTION

Simulation shows that the building has electricity consumption of 738,403.94 kWh and below percentages are summarized percentages of individual consumption.

TABLE 78 - END USE PERCENTAGE

	Percent [%]
Interior Lighting	15
Heating	1
Cooling	59
Interior Equipment	25



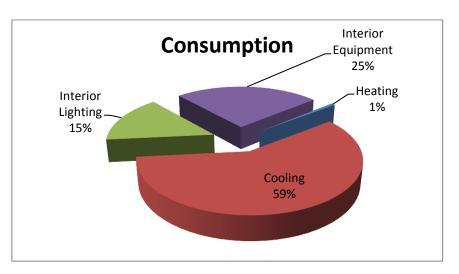


FIGURE 250 - DISAGGREGATION OF ELECTRICITY CONSUMPTION BETWEEN USES

The last Table presents the main energy parameters of the building which were considered as baseline. Such parameters were assessed considering the following conversion factors:

- electricity to primary energy 2,174 (standard value approved for Italy);
- electricity to CO₂ emissions 510,00 g/kWh (average emissions associated with the electricity consumed in Italy during 2012, according ENEL environmental report 2012);

19. RENOVATION SCHEME

19.1. AIM OF THE RENOVATION PLAN

In Italy, the nZEB (nearly zero energy buildings) don't meet national specific legislation but this is now being defined, according to Directive 2012/27/UE. NZEB design is aimed at achieving high performance standards in terms of energy and environment.

Specific attention should be devoted to the reduction of energy consumption of the building, guiding the design on three key areas:

- Maximizing the building envelope passive behaviour
- Use high efficiency systems
- Use of systems for the renewable thermal energy exploitation and photovoltaic systems for the electricity production from solar sources.

The aim is to minimize energy removal from external electricity grid. The objective of the renovation plan is to achieve an average primary energy reduction between 75% and 80% of the current demand and to ensure that between 50% and 90% of the consumed energy is generated.

A building envelope is called passive if it is conforms to the following values:

- Thermal transmittance very low (0,0167/0,227 W/m²K)
- Low values of attenuation factor (<0,1), resulting in high phase shift values (>11,5 hours)
- Windows with transmittance less than 1,6 W/m²K



• System efficiency that can reduce by 70% the maximum solar radiation on transparent surfaces.

To achieve these aims it should be considered if there are some difficulties or constraints in the implementation of a design that concerns the building.

The following global constraints were taken into account in the design of the renovation plan:

- The neighborhood is the core of an intense traffic flow hosts many activities including train station, bus station, port for transit trade and military port; so it is very important that the renovation of the building does not interrupt normal activities.
- The building has an intensive utilization, receiving a large number of visitors, and <u>is</u> the working place for a large number of Municipal employees and such activities cannot be interrupted since it is not easy to temporarily move the services to another building. Therefore, for renovation options requiring major construction works it will be necessary to draw up a renovation plan that takes into account the needs of both workers and visitors.

Integrations are planned distinctly to change the architecture of the building, but without changing the functions. An intervention difficult to predict was that relating to the new air conditioning system centralized to be included, because at the time the building does not have one, but there are only so many split air conditioner in each single room.

To achieve the goal of NZEB it is considered a methodology that would optimize the design considering energy efficiency, energy conservation, functionality, technological risks and actual costs. Under consideration is an electronic control system for heating, cooling and lighting.

The assumptions for improvement have been inserted using the Design Builder software that simulates with Energy Plus Databases. For Satellite Palace, considering the environmental conditions of Messina, the main energy consumption is by the use of electricity for cooling in summer period, therefore it was decided to insert solutions also covering a constant ventilation of the building.

19.2. ENERGY DEMAND REDUCTION

19.2.1. OPAQUE ENVELOPE

An important role in the renewal plan is targeted to the building envelope. Among the actions planned, there is the facade renovation, it is planned to ensure the safety of unsafe parts (eg parapets unsafe) and, where necessary, to do an important refurbishment. Another change concerns the reconstruction of the plaster of the facades, using a thermal insulation plaster. There are plasters with better performance but with the same texture and the same color of plaster used previously.

Obviously it is expected to remove from prospects all compressors present and restore the facades in its entirety; envelope treated with these plasters reduces their thermal transmittance.

Among other interventions there is waterproofing of the roof, so it is expected to enter under the floor of a fiber-reinforced bituminous membrane.





FIGURE 251 - SATELLITE DESIGN

19.2.2. OPENINGS

At the state of fact, all windows are in single glass with metal frame. It is expected to replace all windows of Satellite Palace, inserting selective glasses and modifying PVC frames.

It is also important to study new form of glass to optimize reflective surface.



FIGURE 252 - ACTUAL REFLECTIVE SURFACE IN CIRCULATION AREA



Deliverable D2.1 Report presenting the 3 nZEB renovation schemes in Italy, fully documented with technical and economic evaluation

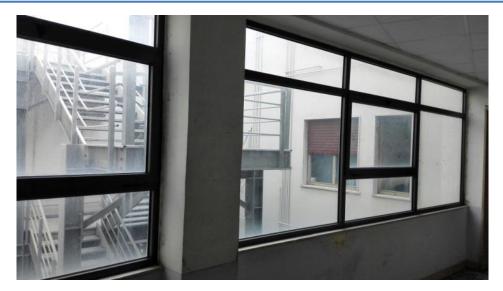


FIGURE 253 - ACTUAL WINDOW AT FIRST FLOOR



FIGURE 254 - ACTUAL REFLECTIVE SURFACE IN OFFICES

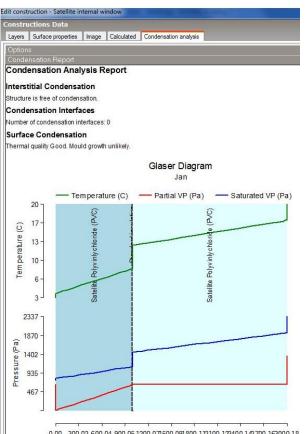
Regarding the frames is chosen to include window frames with a thermal break , in this case the value of frame transmittance (U_f) significantly improves. It is however chosen for the simulation that provides for total replacement of the old frames. It is chosen to use windows with PVC frames. Glasses chosen are selective double glazing with air chamber 6/13 mm.



Activity Construction Openings Lighting	HVAC Outputs CFD
Glazing Template	
Template	Template satellite240415
External Windows	Template satemet to its
🕜 Glazing type	Copy of Dbl LoE Spec Sel Clr 6mm/13mm
Layout	Preferred height 1.5m, 30% glazed
Dimensions	
Туре	3-Preferred height
Window to wall %	30,00 🗢
	50 60 70 80 90 10
Window height (m)	1,50
Window neight (m) Window spacing (m)	5.00
Sill height (m)	0,80
Reveal	
Outside re∨eal depth (m)	0,000
Inside reveal depth (m)	0,000
Inside sill depth (m)	0,000
Frame and Dividers	
Has a frame/dividers?	
Construction	Satellite internal window
Dividers	
Frame	
Frame width (m)	0,0400
Frame inside projection (m)	0,000
Frame outside projection (m)	0,000
Glass edge-centre conduction r	atio 1,000
nal Assessed Interaction	
Shading Window shading	
	Blind with medium reflectivity slats
☑ Window shading	1-Inside
Window shading	
Window shading	1-Inside 3-Schedule
Window shading	1-Inside
 ✓ Window shading Type Position Control type Operation	1-Inside 3-Schedule Office_OpenOff_Occ
 ✓ Window shading Type Position Control type Operation (1) Operation schedule ✓ Local shading Type 	1-Inside 3-Schedule
 ✓ Window shading Type Position Control type Operation Coperation Coperation schedule ✓ Local shading Type nternal Windows	1-Inside 3-Schedule Office_OpenOff_Occ
Type Position Control type Operation ∰ Operation schedule ✓ Local shading	1-Inside 3-Schedule Office_OpenOff_Occ

FIGURE 255 - GLAZING TEMPLATE





onstru	ctions Data				
Layers	Surface properties	Image	Calculated	Condensa	tion analysis
Inner si	urface				
Conv	∕ective heat transt	ier coeff	icient (W/m	2-K)	5,846
Radi	ative heat transfe	r coeffic	ient (W/m2-	К)	1,847
Surfa	ice resistance (m	2-K/W)			0,130
Outer s	urface				
Conv	ective heat transf	ier coeff	icient (W/m	2-K)	23,290
Radi	ative heat transfe	r coeffic	ient (W/m2-	К)	1,710
Surfa	ice resistance (m	2-K/W)			0,040
No Brid	dging				
U-Va	due surface to sur	face (W	//m2-K)		1,717
R-Va	lue (m2-K/W)				0,753
	alue (W/m2-K)				1,329
With Br	idging (BS EN IS	O 6946)			
Km -	Internal heat capa	acity (Ku	l/m2-K)		0,0000
Uppe	er resistance limit	(m2-K∕\	∀)		0,752
Lowe	er resistance limit	(m2-K/V	V)		0,753
U-Va	due surface to sur	face (W	//m2-K)		1,717
R-Va	lue (m2-K/W)				0,752
U-Va	alue (W/m2-K)				1,329

0.00 300.02 600.04 900.05 1200.071500.091800.112100.122400.142700.163000.18 Cum ulative Equivalent Air Thickness (m)

FIGURE 256 - GLASER DIAGRAM OF CORTEN STEEL WINDOWS

onstructions Data		
ayers Surface properties Image Calculated Condens	ation analysis	
General		
Name Satellite internal window		
Source	DesignBuilder	
Category	Window frames	
Region	US General	
Calculation Settings		
Layers		
Number of layers	3	
Outermost layer		
SyMaterial	Satellite Polyvinlychloride (PVC)	
Thickness (not used in thermal calcs) (m)	0,0200	
Layer 2		
Sy Material	Standard insulation	
Thickness (m)	0,0073	
Bridged?		
Innermost layer		
SyMaterial	Satellite Polyvinlychloride (PVC)	
Thickness (not used in thermal calcs) (m)	0,0400	

FIGURE 258 - DETAIL OF FRAME

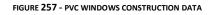




FIGURE 259 - PARTICULAR OF PVC FRAME

19.2.3. Shading

It has been chosen to enter all shadings both internal and external as can be seen from the following table.



Shading		*
Window shading		
≣ Type	Blind with medium reflectivity slats	
Position	1-Inside	•
Control type	3-Schedule	+
Operation		×
😭 Operation schedule	Office_OpenOff_Occ	
Local shading		
≣Туре	1.0m Overhang	
🗊 Internal Windows		>>
Roof Windows/Skylights		>>
🖪 Doors		» » »
Vents		**

FIGURE 260 - SHADING

Vindow blinds Data		
General Slat data		
Slat Properties		
Blind-to-glass distance (m)	0,0500	
Slat orientation	Horizontal	2
Slat width (m)	0,0250	
Slat separation (m)	0,0188	
Slat thickness (m)	0,0010	
Slat angle (")	45,0	
Slat conductivity (W/m-K)	0,900	
Minimum slat angle (")	0	
Maximum slat angle (")	180	
Slat Beam Solar Properties		
Slat beam solar transmittance	0,000	
Slat beam solar reflectance, front side	0,500	
Slat beam solar reflectance, back side	0,500	
Slat Diffuse Solar Properties		
Slat diffuse solar transmittance	0,000	
Slat diffuse solar reflectance, front side	0,500	
Slat diffuse solar reflectance, back side	0,500	
Slat Beam Visible Properties		
Slat beam visible transmittance	0,000	
Slat beam visible reflectance, front side	0,500	
Slat beam visible reflectance, back side	0,500	
Slat Diffuse Visible Properties		
Slat diffuse Visible transmittance	0,000	
Slat diffuse visible reflectance, front side	0,500	
Slat diffuse visible reflectance, back side	0,500	
Slat IR (Thermal) Properties		
Slat hemispherical transmittance	0,000	
Slat hemispherical emissivity, front side	0,900	
Slat hemispherical emissivity, back side	0,900	
Openings		
Blind top opening multiplier	0,500	
Blind bottom opening multiplier	0,500	
Blind left-side opening multiplier	0.500	

FIGURE 261 - BLIND WITH MEDIUM REFLECTIVITY SLATS



19.2.4. OTHER STRATEGIES

The skylights in stairwells will be equipped with sensors (BACS) that will govern the opening, according to the irradiation and the need for ventilation.

19.3. ENERGY SYSTEMS

19.3.1. LIGHTING SYSTEM

It is expected to replace the existing lighting with the introduction of LED lamps and, where possible, to insert intelligent on/off systems, which adapt depending sunlight.

ighting Template	
💡 Template	Satellite LED
General Lighting	
On On	
Lighting energy (W/m2)	<mark>4,35</mark>
0 2 4 6 8 10 12 14	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
😭 Schedule	Office_OpenOff_Light
Luminaire type	3-Recessed
Radiant fraction	0,370
Visible fraction	0,180
Convective fraction	0,450
SPLighting Control	
☑ On	
Control type	1-Linear
Min output fraction	0,100
Min input power fraction	0,100
Glare	00.0
Maximum allowable glare ir	ndex 22.0 0.0
View angle rel. to y-axis (*) Lighting Area 1	0,0
% Zone covered by Lighting	a Aros 1 80.0
Lighting Area 2	
Fask and Display Lighting	
On	

FIGURE 262 - LIGHTING TEMPLATE

19.3.2. HVAC SYSTEM

Almost all working rooms, as well as all the rooms receiving the circulation areas have air conditioning systems. It is expected to insert a false ceiling in all circulation areas and, where possible in all rooms of the building. The result is a decrease in the net height of the rooms to be heated and creation of a channel for heating and lighting installations.



ayout Activity Constructi	ion Openings Lighting HVAC Outputs CFD	
& HVAC Template		×
Template	Satellite Italy	
Mechanical Ventila	tion	×
🗖 On		
🐨 Auxiliary Energy		»
💧 Heating		×
Heated		
Fuel	1-Electricity from grid	-
Heating system	1 CoP 5,050	
Туре		**
Operation		×
🔛 😭 Schedule	e Office_Circulation_Heat	
*Cooling		×
Cooled		
Fuel	1-Electricity from grid	•
Cooling system		
Supply Air Con	dition	**************************************
Operation		×.
Chedule Schedule	e Office_Circulation_Cool	×
		*
On De Normalia		×
Natural Ventilation		*
On		
🗊 Air Temperature Di	Istribution	»

FIGURE 263 - HVAC TEMPLATE

19.4. RENEWABLE ENERGY SOURCES

The building is in a densely built area and district heating is not available. The use of more environmentally friendly HVAC systems was investigated but VRV appeared to be the most suitable choice. Having studied different proposals for renewable energy systems in the end it was decided to use a photovoltaic system.

It is also thought to include wind energy as a renewable energy but the technical department did not like this type of intervention, because it would influence the view from adjacent buildings.

19.4.1. PV GENERATION SYSTEM

On the roof of the building three photovoltaic plants of 60 kW_p, 50 kW_p e 45 kW_p will be installed. This ensures just over 30% of current consumption of electricity. The structure has two areas available to position the photovoltaic system, one on the roof and other on the facade. The PV panels will be placed almost due South with a fixed slope of 30° and azimuth of 0°. The system will be connected to the low voltage grid via three-phase power.





FIGURE 264 - AREAS AVAILABLE FOR THE PV SYSTEM INSTALLATION

A photovoltaic system uses photovoltaic modules to absorb solar energy and convert it into electricity for the daily needs. When it produces more energy than it consumes, the excess is entered into the power grid. It is a mechanism that allows for economically exploiting the electricity produced in excess by the PV system.

In Italy, to access the financial benefits of the net metering it must submit a request to the Energy Services Manager, GSE S.p.A. Therefore, it leads to compensation between the economic value associated to the electricity produced and fed into the grid and the theoretical economic value associated to withdrawn electricity and consumed in a period different from the one in which production takes place.

The calculation of the PV system was estimated using Classic PVGIS, software developed by The Joint Research Centre of the European Commission in ISPRA, Italy.

The monthly and annual solar radiation in the area based on the classic PVGIS database is presented in the following table.

Month	H _h	H _{opt}	H(90)	I _{opt}	T _D	T _{24h}
Jan	1,990	2,980	2,900	59	11.0	10.2
Feb	2,700	3,630	3,130	51	10.6	9.7
Mar	4,020	4,860	3,470	40	13.2	12.0

TABLE 79 - SOLAR RADIATION AT THE AREA OF MESSINA



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Apr	5,420	5,830	3,190	26	15.4	14.2
May	6,410	6,280	2,630	13	19.1	17.9
Jun	6,910	6,470	2,310	6	23.1	21.8
Jul	6,830	6,530	2,470	9	25.9	24.6
Aug	6,190	6,420	3,100	21	26.2	24.7
Sep	5,000	5,880	3,830	36	22.9	21.7
Oct	3,510	4,690	3,860	49	19.8	18.6
Nov	2,250	3,320	3,160	58	16.2	15.1
Dec	1,760	2,740	2,770	61	12.6	11.6
Year	4,430	4,980	3,070	31	18.0	16.8
				·		

Legend:

Hh: Irradiation on horizontal plane (Wh/m²/day)

Hopt: Irradiation on optimally inclined plane (Wh/m²/day)

H(90): Irradiation on plane at angle: 90deg. (Wh/m²/day)

lopt: Optimal inclination (deg.)

TD: Average daytime temperature (°C)

T24h: 24 hour average of temperature (°C)

SOURCE: CLASSIC PVGIS DATABASE (KWH/ M²/MONTH) AT 30°

TABLE 80 - CONDITION TO SIMULATION WITH CLASSIC PVGIS

Estimated losses due to temperature and low irradiance: 10.7%
Estimated loss due to angular reflectance effects: 5.8%
Other losses (cables, inverter etc.): 15.0%
Combined PV system losses: 28.5%

TABLE $\boldsymbol{81}$ - annual global radiation on the surface

Month	E _d	E _m
Jan	110.5	3,420
Feb	118	3,300
Mar	128.5	3,980
Apr	114	3,420
May	88	2,725
Jun	73.5	2,205
Jul	78.5	2,430
Aug	103	3,185
Sep	134.5	4,035
Oct	139.5	4,330
Nov	116.5	3,500
Dec	104	3,225
Yearly average	109.04	3,312.,92
Total for year 39,755		
Annual global radiation on the surface = 1,950 kWh/m ²		
Ed: Average daily electricity production from the given system (kWh)		
Em: Average monthly electricity production from the given system (kWh)		



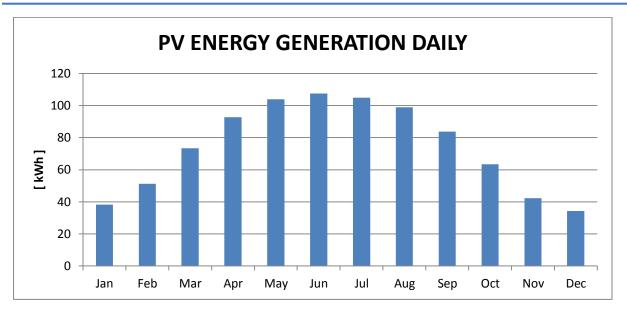


FIGURE 265 - DAILY ENERGY INJECTED INTO GRID FROM THE PV SYSTEM

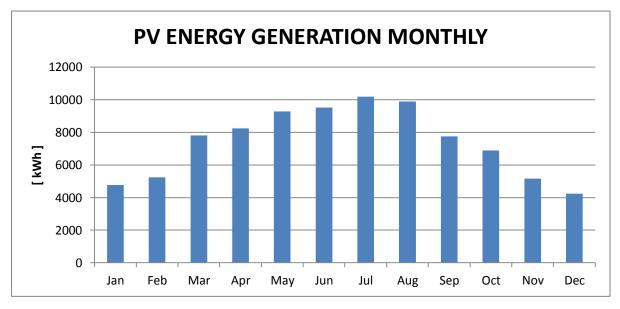


FIGURE 266 - MONTHLY ENERGY INJECTED INTO GRID FROM THE PV SYSTEM

The PV System on the east façade has 45 $kW_{\rm p}$ and the following data are used for the calculation:

TABLE $\boldsymbol{82}$ - CONDITION TO SIMULATION WITH CLASSIC PVGIS

Estimated losses due to temperature and low irradiance: 12.7%
Estimated loss due to angular reflectance effects: 4.3%
Other losses (cables, inverter etc.): 15.0%
Combined PV system losses: 29.0%



TABLE 83 - ANNUAL GLOBAL RADIATION ON THE SURFACE

Month	E _d	E _m	
Jan	38.25	1,183.5	
Feb	51.30	1,431	
Mar	73.35	2,277	
Apr	92.70	2,785.5	
Мау	103.95	3,226.5	
Jun	107.55	3,226.5	
lul	104.85	3,253.5	
Aug	99.00	3,064.5	
Sep	83.70	2,515.5	
Oct	63.45	1,966.5	
Nov	42.30	1,273.5	
Dec	34.20	1,062	
Yearly average	74.55	2,272.125	
Total for year27,265.5			
Annual global radiation on the surface = 1,950 kWh/m ²			
Ed: Average daily electricity production from	Ed: Average daily electricity production from the given system (kWh)		
Em: Average monthly electricity production fr	om the given system (kWh)		

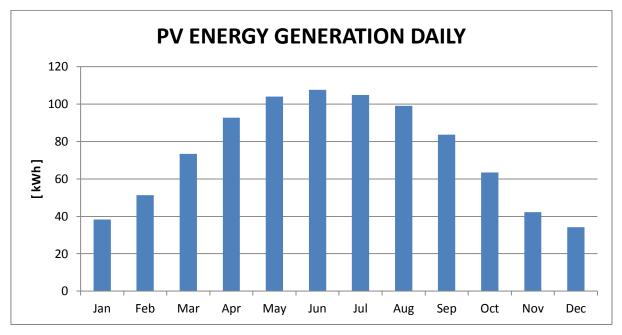


FIGURE 267 - DAILY ENERGY INJECTED INTO GRID FROM THE PV SYSTEM



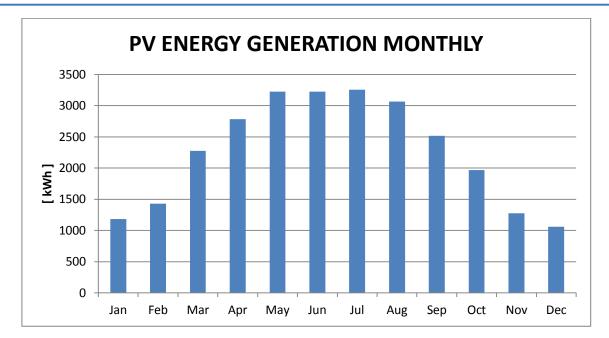


FIGURE 268 - MONTHLY ENERGY INJECTED INTO GRID FROM THE PV SYSTEM

The PV System on the roof has 60 kW_p and the following data are used for the calculation:

TABLE 84 - CONDITION TO SIMULATION WITH CLASSIC PVGIS

Estimated losses due to temperature and low irradiance: 9.8%
Estimated loss due to angular reflectance effects: 2.7%
Other losses (cables, inverter etc.): 15.0%
Combined PV system losses: 25.4%

TABLE 85 - ANNUAL GLOBAL RADIATION ON THE SURFACE

Month	E _d	E _m
Jan	130.80	4,044.00
Feb	161.40	4,518.00
Mar	216.60	6,720.00
Apr	264.60	7,920.00
May	285.60	8,880.00
Jun	292.80	8,760.00
lul	290.40	9,000.00
Aug	279.00	8,640.00
Sep	253.20	7,620.00
Oct	200.40	6,180.00
Nov	142.20	4,260.00
Dec	118.20	3,660.00
Yearly average	208.70	6,683.5
Total for year 80,202		
Annual global radiation on the surface = 1,950 kWh/m² Ed: Average daily electricity production from the given system (kWh) Em: Average monthly electricity production from the given system (kWh)		



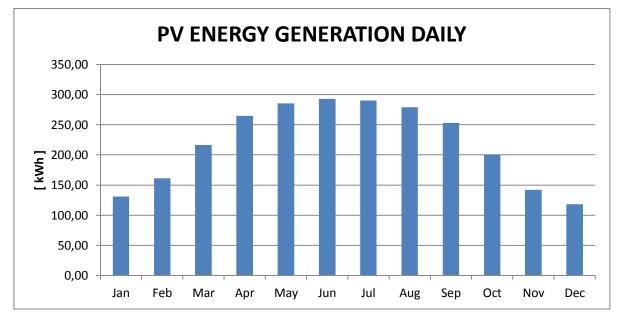


FIGURE 269- DAILY ENERGY INJECTED INTO GRID FROM THE PV SYSTEM

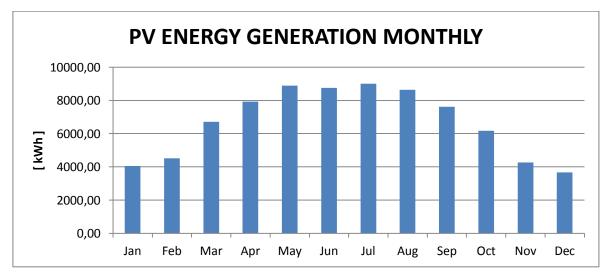


FIGURE 270 - MONTHLY ENERGY INJECTED INTO GRID FROM THE PV SYSTEM



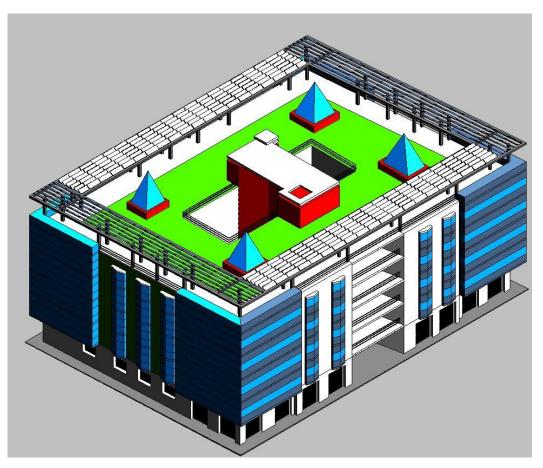


FIGURE 271 - PV PANELS INSTALLED



FIGURE 272- EXAMPLE OF PV DISTRIBUTION, LIKE SATELLITE PV DISTRIBUTION ON THE ROOF

19.5. ENERGY MANAGEMENT SYSTEM

To monitor the building electrical consumption of lighting, of ventilation and of HVAC system, building automation control sensors (BACS) will be installed. The BACS are improved occupant comfort, efficient operation of building systems, and reduction in energy consumption and operating costs.



The system will perform the following operations:

- Control for each air conditioning unit separately to maintain in every office the desired internal air temperature and humidity stables.
- Internal lighting control according external irradiation and lux value in each room (Dimming lamps).
- Daily scheduling of air conditioning and lighting to optimize their use.
- Management of the flow temperature according to the outdoor temperature.
- Identification of electrical equipment turn on beyond normal working hours.
- Identification errors or alarms in case of electrical overloads.
- Control of windows and doors opening, to minimize the use VRV plant.

The BACS ensure therefore values of humidity and temperature in agreement with the optimum comfort conditions for the employees, also by administering appropriate air exchanges. They are also useful for energy saving both in terms of lighting and rooms conditioning.

19.6. TOTAL IMPACT OF THE RENOVATION SCHEME

19.6.1. ENERGY PERFORMANCE

The energy analysis of the building was carried out using the software Design Builder v. 3.4.0.033. The building was described in detail, following through architectural drawings and with an illustrated report on the state of fact and photographic documentation.

The result for the new solution is described in the following. In the renovation scheme it has a VRV system plant for heating, cooling and air circulation.

To set the calculation of the model the general information fixed are:

	Data
Weather File	** Messina - ITA IGDG WMO#=164200
HDD and CDD data source	Weather File Stat
Total gross floor area [m2]	6874.93
Principal Heating Source	District Heating

TABLE 86 - GENERAL INFORMATION FOR SIMULATION

The following figures shows the heat balance of Palazzo Satellite Post-design, divided according to the contributions:

- General Lighting,
- Computer + Equipment,
- Occupancy,
- Solar Gans Exterior Windows,
- Zone Sensible Heating,
- Zone Sensible Cooling.



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Final

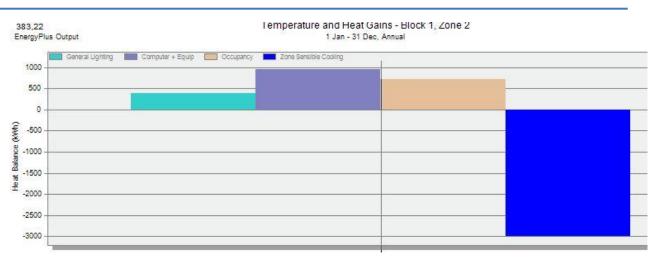


FIGURE 273 - ANNUAL HEAT BALANCE

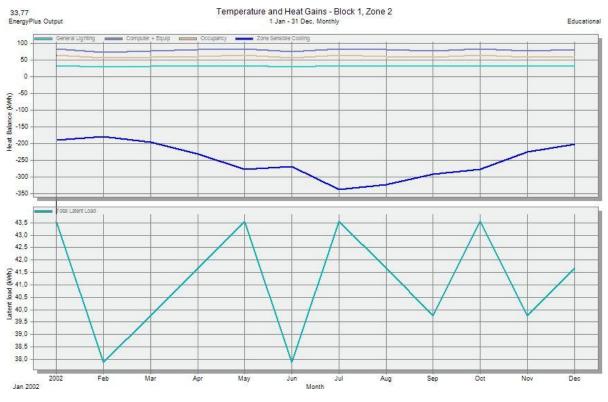


FIGURE 274 - ANNUAL HEAT BALANCE ACCORDING SINGLE MONTH

Two following figures shows annual heat balance of Palazzo Satellite, divided according to the contributions:

- RoCeilings
- Floors
- Partitions
- General Lighting
- Computer + Equipment
- Occupancy



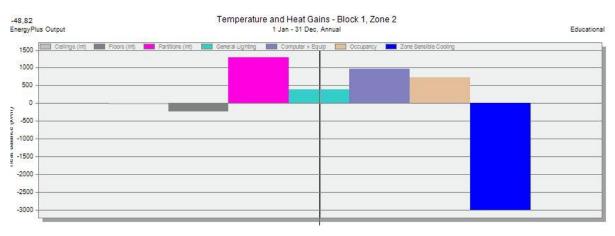


FIGURE 275 - ANNUAL CONTRIBUTION OF ENVELOPE

19.6.2. Environmental Performance

The following table shows the initial and the final consumption after implementing all the proposed interventions in the building.

	Electricity Intensity [kWh/m ²]	Natural Gas Intensity [kWh/m ²]	Additional Fuel Intensity [kWh/ m ²]	District Cooling Intensity [kWh/ m ²]	District Heating Intensity [kWh/ m ²]	Water Intensity [m ³ / m ²]
Lighting	16.37	0.00	0.00	0.00	0.00	0.00
HVAC	0.00	0.00	0.00	63.78	0.79	0.02
Other	27.53	0.00	0.00	0.00	0.00	0.00
Total	43.90	0.00	0.00	63.78	0.79	0.02

TABLE 87 - UTILITY USE PER CONDITIONED FLOOR AREA

TABLE 88 - UTILITY USE PER TOTAL FLOOR AREA

	Electricity Intensity [kWh/ m ²]	Natural Gas Intensity [kWh/ m ²]	Additional Fuel Intensity [kWh/ m ²]	District Cooling Intensity [kWh/ m ²]	District Heating Intensity [kWh/ m ²]	Water Intensity [m ³ / m ²]
Lighting	16.21	0.00	0.00	0.00	0.00	0.00
HVAC	0.00	0.00	0.00	63.14	0.78	0.02
Other	27.25	0.00	0.00	0.00	0.00	0.00
Total	43.46	0.00	0.00	63.14	0.78	0.02



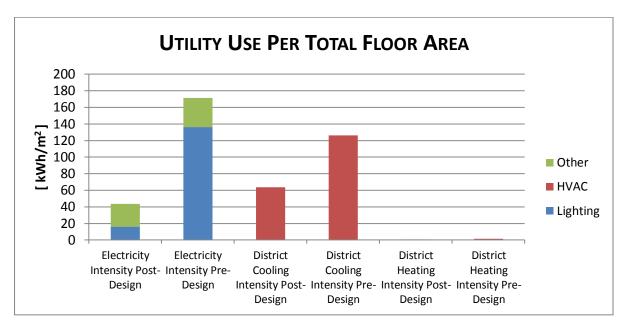
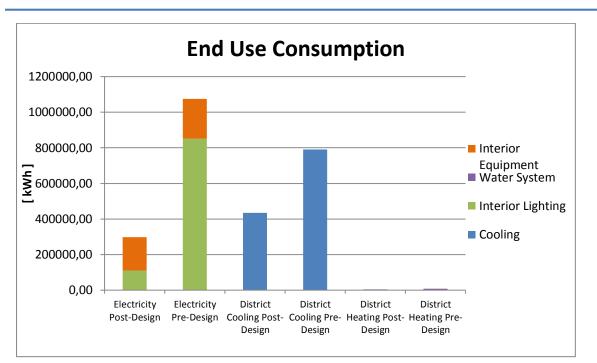


FIGURE 276 - UTILITY USE PER TOTAL FLOOR AREA PRE/POST-DESIGN

	Electricity [kWh]	District Cooling [kWh]	District Heating [kWh]	Water [m3]
Heating	0.00	0.00	0.07	
Cooling	0.00	434,108.33	0.00	
Interior Lighting	111,437.37	0.00	0.00	
Water Systems	0.00	0.00	5,349.45	143.97
Interior Equipment	187,364.76	0.00	0.00	
Total Source Energy End	298,802.13	434,108.33	5,349.51	143.97
Use Components				







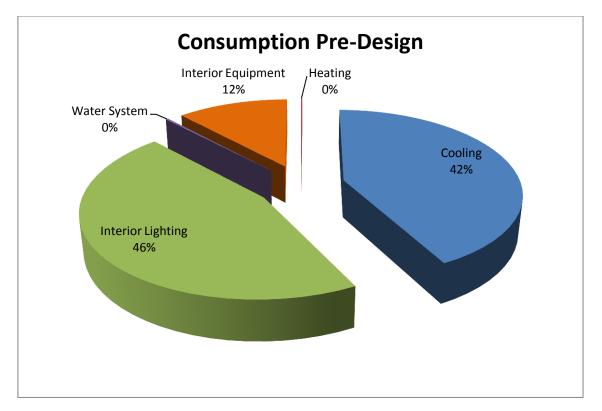


FIGURE 278 - CONSUMPTION PRE-DESIGN

Final





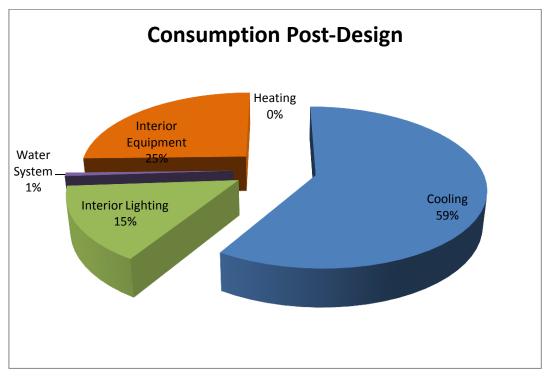


FIGURE 279 - CONSUMPTION POST-DESIGN

The energy consumption for interior equipment increased because the control system, for the building, were not present before the renovation.

With appropriate modifications on the envelope, heating consumption is near zero.



20. ECONOMIC EVALUATION OF THE PROPOSED RENOVATION SCHEME

20.1. Assumptions, Cost Figures

The cost of the interventions is estimated based on current market prices of the equipment and the installation works. Special meetings with suppliers were held to present the project and request offers for the preliminary renovation design. Offers were collected and assessed.

For each intervention, the cost has been calculated as the sum of costs for equipment, installation, operation and maintenance. These values have been organised in an Excel file prepared by Sinloc, a partner of the CERtuS consortium (see deliverable D2.5). ANNEX H, gives the cost information.

The economic appraisal of the renovation design was performed by means of a tool produced by ETVA VIPE, also a partner of the consortium. A detailed description of the tool is presented in the deliverable D2.5. The appraisal can be performed only for the whole design. The tool also allows to examine various financing schemes ranging from single financing source to multiple, combining bank loans, ESCOs, subsidies, municipality's own equity.

The data used for the calculations are tabulated below, divided according to the unit of measure concerned and the unit price

WORKINGS	VOICE	UNIT COST	U.M.	DIMENSION	COST
Building	EXTERNAL WALL –	€ 869.69	sqmx	1,190.0	€ 1,014,929.00
envelope	GREEN WALL		sqcm		
Building	NEW PV COVER SHELTER	€ 266.67	sqm	1,350.0	€ 360,000.00
envelope					
Building	WATERPROOFING	€ 869.69	sqm	363,702	€ 316,308
envelope	FOUNDATIONS AND				
	FOUNDATIONS				
	STRUCTURAL				
	RENOVATION				
Plants	BACS	€ 20,000.00	total	1	€ 20,000.00
Plants	VRV SYSTEM	€ 1,408.45	KW	355	€ 500,000.00
Plants	RELAMPING	€ 200.00	units	506.0	€ 101,200.00
Plants	PV plant	€ 2,000.00	kWp	155	€ 310,000.00
		ΤΟΤΑ	L WORK	COST	€ 2,622,437.00

TABLE 90 - COST DESIGN



20.2. RESULTS

The proposals cover both the envelope that heating and electrical systems.

Building Envelope	 External Wall Demolition New Internal Layout Thermal Insulation Cover Waterproofing Foundations Replacement Windows New Curtain Wall Green roof and green wall 	*table saving post renovation
Energy Systems	VRV SystemLED lightingBACS	
RES	PV system (roof and walls)	

TABLE 91 - END USE CONSUMPTION PRE DESIGN

	Electricity [kWh]	District Cooling [kWh]	District Heating [kWh]
Heating	0	0	2,714.76
Cooling	0	790,256.8	0
Interior Lighting	852,503.17	0	0
Interior Equipment	222,119.61	0	0
Total End Uses	1,074,622.78	790,256.8	2,714.76

TABLE 92 -END USE CONSUMPTION POST DESIGN

	Electricity [kWh]	District Cooling [kWh]	District Heating [kWh]
Heating	0	0	0.07
Cooling	0	434,108.33	0
Interior Lighting	111,437.4	0	0
Interior Equipment	187,364.8	0	0
Total End Uses	298,802.1	434,108.33	0.07

TABLE 93 - SAVING WITHOUT PV

	Saving without PV (%)
Heating	99.99742
Cooling	45.06744
Interior Lighting	86.,92822
Interior Equipment	15.64691
Total End Uses	61.91



PV SAVING TOTAL = 147,222.5 kWh (3 PV Systems)

END USE PRE DESIGN (kWh)	END USE POST DESIGN (kWh)	SAVING (%)
		68.63944
1,867,594.34	585,688.03	(1,281,906.31 kWh)

The saving are significant (69%) because 3 Photovoltaic systems have been installed. The green roofs and green wall are considered as renewable and environmentally friendly types of intervention. The traditional interventions are the use of new windows and to a system of thermal insulation for the facade.

In the evaluation of the lighting savings it was considered the average cost of the electricity. The lifetime was assessed considering the average hours of use for the lamps and its maximum total hours of operation. As can be seen in following table, with such conditions the renovation options ensures savings from maintenance of 2,508 \notin /year and has a simple payback period of 0.8 years.

TABLE 94: ECONOMIC PARAMETERS OF THE RENOVATION - LIGHTING

Energy Savings	741,066 kWh
Price - Saved Energy	0.18 €/kWh
Costs	101,200€
Potential savings from maintenance (post intervention)	2508 €/year
Simple Payback	0.8 years
Lifetime	20 years
CO ₂ Savings	517.67 tons/year

In the evaluation of the HVAC savings it was considered the cost of the electricity during the midpeak period. As can be seen in following table, with such conditions the renovation options ensures savings from maintenance of 23,667 \notin /year and has a simple payback period of 11.96 years.

TABLE 95: ECONOMIC PARAMETERS OF THE RENOVATION - HVAC

Energy Savings	106,844 kWh
Price - Saved Energy	0.18 €/kWh
Costs	500,000 €
Potential savings from maintenance (post intervention)	23,667 €/year
Simple Payback	11.96 years
Lifetime	25 years
CO ₂ Savings	75.63 tons/year



In the evaluation of the PV generation it was considered the self-consumption of 90% of the energy, since in a working day during the time slots. As can be seen in following table, with such conditions it has a simple payback period of 9.77 years.

TABLE 96 - ECONOMIC PARAMETERS OF THE RENOVATION - PV

Energy Generation	201,500 kWh
Energy - Self-Consumption	90%
Energy - Injected Into Grid	10%
Price – Self-Consumption	0.18 €/kWh
Price - Injected Into Grid	0.06 €/kWh
Costs	310,000 €
Simple Payback	9.77 years
Lifetime	30 years
CO ₂ Savings	132.23 tons/year

The following table presents the aggregation of the renovation option. As can be seen, the total of the renovation plan ensures savings of $26,175 \notin$ /year and has a simple payback period of 11.37 years.

TABLE 97: ECONOMIC PARAMETERS OF THE RENOVATION - TOTAL

Energy Savings	1,298,714 kWh
Costs	2,622,437 €
Savings	26,175 €/year
Simple Payback	11.37 years
CO ₂ Savings	905.85 tons/year



REFERENCES 3

- /1/ DesignBuilder Software Ltd specialises in developing high-quality, easy-to-use and affordable simulation software tools for assessing the environmental performance of building designs. <u>http://www.designbuilder.co.uk/</u>
- /2/ PVGIS, Photovoltaic Geographical Information System, a software developed by The Joint Research Centre of the European Commission in ISPRA, Italy. <u>http://re.jrc.ec.europa.eu/pvgis/apps4/pvest.php</u>
- /3/ CERtuS Deliverable D2.5 "Twelve economic evaluation reports"



Deliverable D2.1 Report presenting the 3 nZEB renovation schemes in Italy, fully documented with technical and economic evaluation

21. ANNEX A: BUILDING DRAWINGS

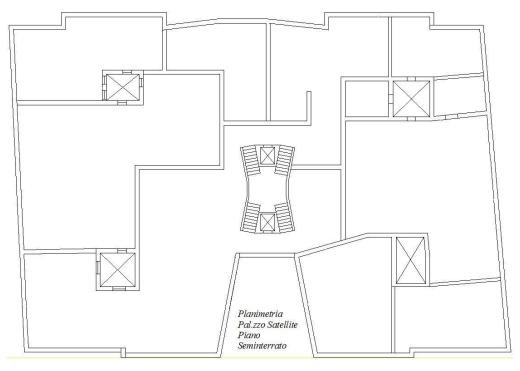


FIGURE 280 - BASAMENT FLOOR

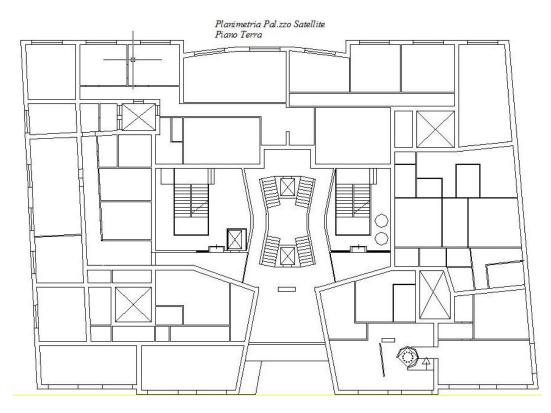


FIGURE 281 - GROUND FLOOR



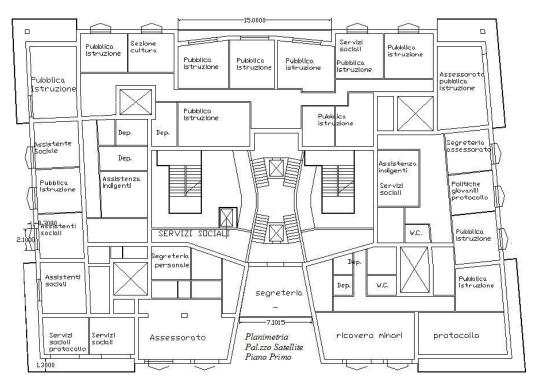


FIGURE 282 - FIRST FLOOR

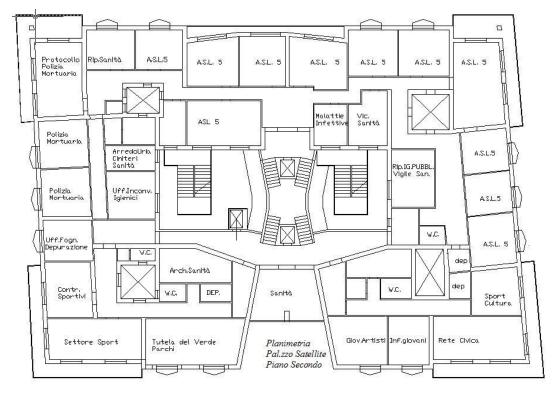


FIGURE 283 - SECOND FLOOR



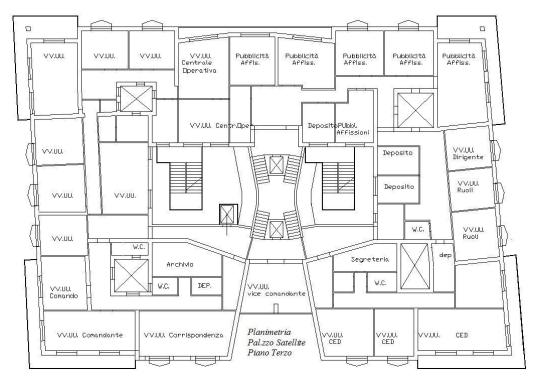


FIGURE 284 - THIRD FLOOR

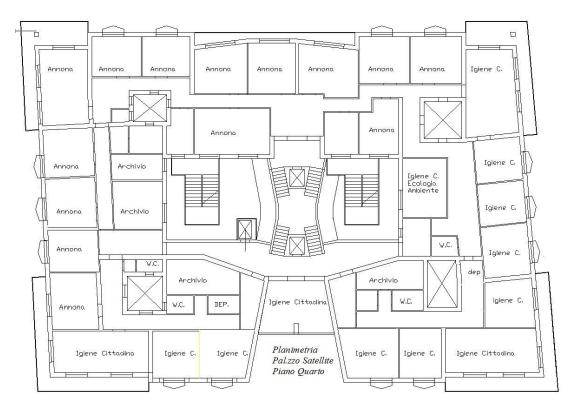


FIGURE 285 - FOURTH FLOOR

Final



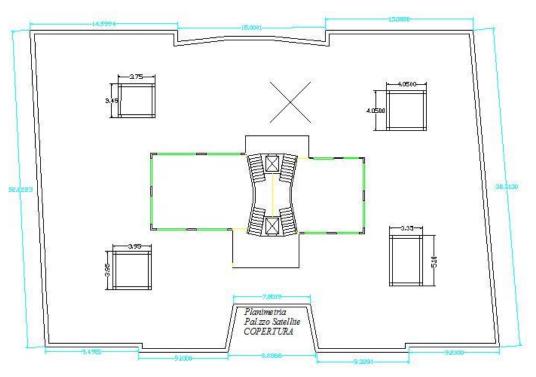


FIGURE 286 - COVER FLOOR

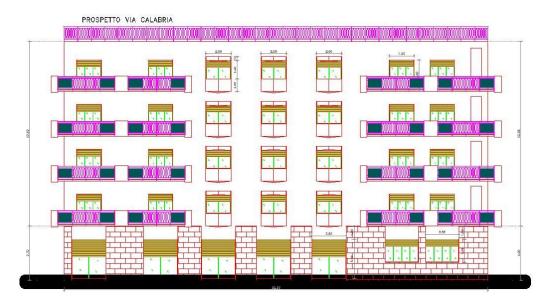


FIGURE 287 - FRONT DESIGN



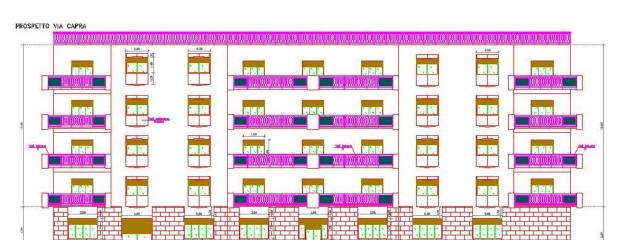


FIGURE 288 - FRONT DESIGN

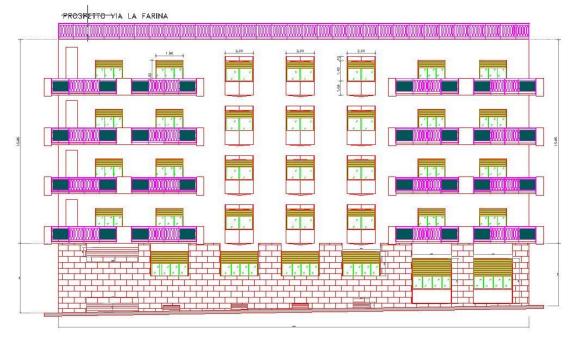


FIGURE 289 - FRONT DESIGN





FIGURE 290 - FRONT DESIGN



Deliverable D2.1 Report presenting the 3 nZEB renovation schemes in Italy, fully documented with technical and economic evaluation

22. ANNEX B: BUILDINGS DESIGN

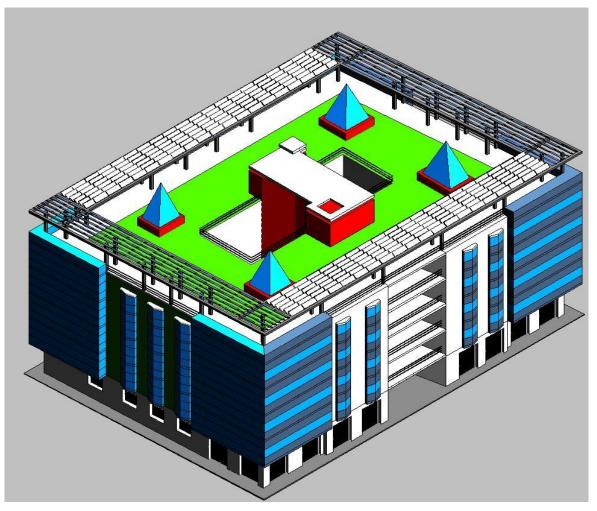


FIGURE 291 - RENDER



23. ANNEX C: DESIGN BUILDER PARAMETERS

TABLE 98 - GENERAL VALUE

	Value
Program Version and Build	EnergyPlusDLL-32 8.1.0.008, 30/06/2015 16:49
RunPeriod	PALACULTURA Enea
Weather File	Messina - ITA IGDG WMO#=164200
Latitude [deg]	38.20
Longitude [deg]	15.55
Elevation [m]	59.00
Time Zone	1.00
North Axis Angle [deg]	0.00
Rotation for Appendix G [deg]	0.00
Hours Simulated [hrs]	8,760.00

TABLE 99 - END USES BY SUBCATEGORY

	Subcategory	Electricity [kWh]	Natur al Gas [kWh]	Additio nal Fuel [kWh]	District Cooling [kWh]	District Heating [kWh]	Water [m3]
Heating	General	0.00	0.00	0.00	0.00	0.07	0.00
Cooling	General	0.00	0.00	0.00	434108 .33	0.00	0.00
Interior Lighting	ELECTRIC EQUIPMENT#Block5:Zone 9#GeneralLights	130.90	0.00	0.00	0.00	0.00	0.00
	ELECTRIC EQUIPMENT#Block5:Zone 3#GeneralLights	263.30	0.00	0.00	0.00	0.00	0.00
	ELECTRIC EQUIPMENT#Block5:Zone 15#GeneralLights	16,786.81	0.00	0.00	0.00	0.00	0.00
	ELECTRIC EQUIPMENT#Block5:Zone 4#GeneralLights	422.10	0.00	0.00	0.00	0.00	0.00
	ELECTRIC EQUIPMENT#Block5:Zone 6#GeneralLights	278.94	0.00	0.00	0.00	0.00	0.00
	ELECTRIC EQUIPMENT#Block5:Zone 14#GeneralLights	381.02	0.00	0.00	0.00	0.00	0.00
	ELECTRIC EQUIPMENT#Block5:Zone 7#GeneralLights	199.69	0.00	0.00	0.00	0.00	0.00
	ELECTRIC EQUIPMENT#Block5:Zone 5#GeneralLights	973.99	0.00	0.00	0.00	0.00	0.00
	ELECTRIC EQUIPMENT#Block5:Zone 1#GeneralLights	817.87	0.00	0.00	0.00	0.00	0.00
	ELECTRIC EQUIPMENT#Block5:Zone	12.02	0.00	0.00	0.00	0.00	0.00



12#Conorallights						
13#GeneralLights ELECTRIC	13.67	0.00	0.00	0.00	0.00	0.00
	13.67	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Block5:Zone						
8#GeneralLights						
ELECTRIC	19.02	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Block5:Zone						
12#GeneralLights						
ELECTRIC	98.13	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Block5:Zone						
10#GeneralLights						
ELECTRIC	14.24	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Block5:Zone		0.00	0.00	0.00	0.00	0.00
11#GeneralLights						
	880.88	0.00	0.00	0.00	0.00	0.00
	880.88	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Block5:Zone						
2#GeneralLights						
ELECTRIC	4,747.32	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Block1:Zone						
1#GeneralLights						
ELECTRIC	966.91	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Block1:Zone						
4#GeneralLights						
ELECTRIC	383.22	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Block1:Zone	505.22	0.00	0.00	0.00	0.00	0.00
2#GeneralLights						
	224.02	0.00	0.00	0.00	0.00	0.00
ELECTRIC	221.03	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Block1:Zone						
14#GeneralLights						
ELECTRIC	18,188.67	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Block1:Zone						
15#GeneralLights						
ELECTRIC	278.66	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Block1:Zone						
13#GeneralLights						
ELECTRIC	0.00	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Block1:Zone	0.00	0.00	0.00	0.00	0.00	0.00
 3#GeneralLights						
ELECTRIC	783.27	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Block1:Zone						
12#GeneralLights						
ELECTRIC	12.16	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Block1:Zone						
10#GeneralLights						
ELECTRIC	14.93	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Block1:Zone	1.000	0.00	0.00	0.00	0.00	0.00
8#GeneralLights						
	122.22	0.00	0.00	0.00	0.00	0.00
ELECTRIC	122.32	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Block1:Zone						
11#GeneralLights						
ELECTRIC	15.01	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Block1:Zone						
9#GeneralLights						
ELECTRIC	16.25	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Block1:Zone						'
5#GeneralLights						



ELECTRIC	101.77	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Block1:Zone						
6#GeneralLights						
ELECTRIC	14.24	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Block1:Zone						
7#GeneralLights						
ELECTRIC	420.65	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Block2:Zone	120100	0.00	0.00	0.00	0.00	0.00
1#GeneralLights						
	000.01	0.00	0.00	0.00	0.00	0.00
ELECTRIC	966.91	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Block2:Zone						
4#GeneralLights						
ELECTRIC	383.22	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Block2:Zone						
2#GeneralLights						
ELECTRIC	221.03	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Block2:Zone	0	0.00	0.00	0.00	0.00	0.00
14#GeneralLights						
ELECTRIC	18,184.28	0.00	0.00	0.00	0.00	0.00
	18,184.28	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Block2:Zone						
15#GeneralLights						
ELECTRIC	278.66	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Block2:Zone						
13#GeneralLights						
ELECTRIC	199.69	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Block2:Zone						
3#GeneralLights						
ELECTRIC	104.04	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Block2:Zone	104.04	0.00	0.00	0.00	0.00	0.00
12#GeneralLights						
ELECTRIC	12.16	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Block2:Zone						
10#GeneralLights						
ELECTRIC	14.93	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Block2:Zone						
8#GeneralLights						
ELECTRIC	122.32	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Block2:Zone	122.52	0.00	0.00	0.00	0.00	0.00
11#GeneralLights						
	45.04	0.00	0.00	0.00	0.00	0.00
ELECTRIC	15.01	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Block2:Zone						
9#GeneralLights						
ELECTRIC	16.25	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Block2:Zone						
5#GeneralLights						
ELECTRIC	101.77	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Block2:Zone						
6#GeneralLights						
	14.24	0.00	0.00	0.00	0.00	0.00
ELECTRIC	14.24	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Block2:Zone						
7#GeneralLights						
ELECTRIC	420.65	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Block3:Zone						
1#GeneralLights						
ELECTRIC	966.91	0.00	0.00	0.00	0.00	0.00



EQUIPMENT#Block3:Zone						
4#GeneralLights						
ELECTRIC	383.22	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Block3:Zone	505.22	0.00	0.00	0.00	0.00	0.00
2#GeneralLights						
ELECTRIC	221.03	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Block3:Zone	221.03	0.00	0.00	0.00	0.00	0.00
14#GeneralLights						
ELECTRIC	18,184.86	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Block3:Zone	10,104.00	0.00	0.00	0.00	0.00	0.00
15#GeneralLights						
ELECTRIC	278.66	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Block3:Zone	278.00	0.00	0.00	0.00	0.00	0.00
13#GeneralLights						
ELECTRIC	199.69	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Block3:Zone	199.09	0.00	0.00	0.00	0.00	0.00
3#GeneralLights	702.27	0.00	0.00	0.00	0.00	0.00
	783.27	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Block3:Zone						
12#GeneralLights	12.16	0.00	0.00	0.00	0.00	0.00
ELECTRIC	12.16	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Block3:Zone						
10#GeneralLights			0.00			0.00
ELECTRIC	14.93	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Block3:Zone						
8#GeneralLights						
ELECTRIC	122.32	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Block3:Zone						
11#GeneralLights						
ELECTRIC	15.01	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Block3:Zone						
9#GeneralLights						
ELECTRIC	16.25	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Block3:Zone						
5#GeneralLights						
ELECTRIC	101.77	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Block3:Zone						
6#GeneralLights						
ELECTRIC	14.24	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Block3:Zone						
7#GeneralLights						
ELECTRIC	420.65	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Block4:Zone						
1#GeneralLights						
ELECTRIC	966.91	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Block4:Zone						
4#GeneralLights						
ELECTRIC	383.22	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Block4:Zone						
2#GeneralLights						
ELECTRIC	221.03	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Block4:Zone					2.00	
14#GeneralLights						
ELECTRIC	17,938.74	0.00	0.00	0.00	0.00	0.00
EQUIPMENT#Block4:Zone		0.00	0.00	0.00	0.00	0.00



	15#GeneralLights						
	ELECTRIC	278.66	0.00	0.00	0.00	0.00	0.00
	EQUIPMENT#Block4:Zone	270.00	0.00	0.00	0.00	0.00	0.00
	13#GeneralLights						
	ELECTRIC	199.69	0.00	0.00	0.00	0.00	0.00
	EQUIPMENT#Block4:Zone	199.09	0.00	0.00	0.00	0.00	0.00
	3#GeneralLights	702.27	0.00	0.00	0.00	0.00	0.00
	ELECTRIC	783.27	0.00	0.00	0.00	0.00	0.00
	EQUIPMENT#Block4:Zone						
	12#GeneralLights						
	ELECTRIC	12.16	0.00	0.00	0.00	0.00	0.00
	EQUIPMENT#Block4:Zone						
	10#GeneralLights						
	ELECTRIC	14.93	0.00	0.00	0.00	0.00	0.00
	EQUIPMENT#Block4:Zone						
	8#GeneralLights						
	ELECTRIC	122.32	0.00	0.00	0.00	0.00	0.00
	EQUIPMENT#Block4:Zone						
	11#GeneralLights						
	ELECTRIC	15.01	0.00	0.00	0.00	0.00	0.00
		13.01	0.00	0.00	0.00	0.00	0.00
	EQUIPMENT#Block4:Zone						
	9#GeneralLights						
	ELECTRIC	16.25	0.00	0.00	0.00	0.00	0.00
	EQUIPMENT#Block4:Zone						
	5#GeneralLights						
	ELECTRIC	101.77	0.00	0.00	0.00	0.00	0.00
	EQUIPMENT#Block4:Zone						
	6#GeneralLights						
	ELECTRIC	14.24	0.00	0.00	0.00	0.00	0.00
	EQUIPMENT#Block4:Zone						
	7#GeneralLights						
Exterior	General	0.00	0.00	0.00	0.00	0.00	0.00
Lighting							
Interior	ELECTRIC	327.95	0.00	0.00	0.00	0.00	0.00
Equipment	EQUIPMENT#Block5:Zone	02/100	0.00	0.00	0.00	0.00	0.00
Equipment	9#05						
	ELECTRIC	1,359.14	0.00	0.00	0.00	0.00	0.00
		1,559.14	0.00	0.00	0.00	0.00	0.00
	EQUIPMENT#Block5:Zone						
	3#05	27.000.00	0.00	0.00	0.00	0.00	0.00
	ELECTRIC	27,668.93	0.00	0.00	0.00	0.00	0.00
	EQUIPMENT#Block5:Zone						
	15#05						
	ELECTRIC	1,057.53	0.00	0.00	0.00	0.00	0.00
	EQUIPMENT#Block5:Zone						
	4#05						
	ELECTRIC	954.60	0.00	0.00	0.00	0.00	0.00
	EQUIPMENT#Block5:Zone						
	14#05						
	ELECTRIC	1,736.52	0.00	0.00	0.00	0.00	0.00
	EQUIPMENT#Block5:Zone	,					
	5#05						
	ELECTRIC	4,379.61	0.00	0.00	0.00	0.00	0.00
	EQUIPMENT#Block5:Zone	.,575.01	0.00	0.00	0.00	0.00	0.00
	1#05						
	ELECTRIC	30.12	0.00	0.00	0.00	0.00	0.00
	ELECTRIC	50.12	0.00	0.00	0.00	0.00	0.00



EQUIPMENT#Block5:Zone 13#05						
ELECTRIC EQUIPMENT#Block5:Zone 8#05	86.64	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Block5:Zone 12#05	120.53	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Block5:Zone 10#05	245.85	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Block5:Zone 11#05	90.22	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Block5:Zone 2#05	4,505.43	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Block1:Zone 1#05	4,702.20	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Block1:Zone 4#05	1,723.90	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Block1:Zone 2#05	960.13	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Block1:Zone 14#05	553.77	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Block1:Zone 15#05	8,677.84	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Block1:Zone 12#05	775.82	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Block1:Zone 10#05	30.47	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Block1:Zone 8#05	94.59	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Block1:Zone 11#05	306.47	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Block1:Zone 9#05	95.09	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Block1:Zone 5#05	40.71	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Block1:Zone 6#05	254.98	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Block1:Zone	90.22	0.00	0.00	0.00	0.00	0.00



7#05						
ELECTRIC EQUIPMENT#Block2:Zone 1#05	1,053.90	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Block2:Zone 4#05	1,340.81	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Block2:Zone 2#05	960.13	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Block2:Zone 14#05	553.77	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Block2:Zone 15#05	30,372.43	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Block2:Zone 10#05	30.47	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Block2:Zone 8#05	94.59	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Block2:Zone 11#05	306.47	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Block2:Zone 9#05	95.09	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Block2:Zone 5#05	40.71	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Block2:Zone 6#05	254.98	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Block2:Zone 7#05	90.22	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Block3:Zone 1#05	1,053.90	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Block3:Zone 4#05	1,723.90	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Block3:Zone 2#05	960.13	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Block3:Zone 14#05	553.77	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Block3:Zone 15#05	39,050.27	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Block3:Zone 12#05	1,396.48	0.00	0.00	0.00	0.00	0.00



Deliverable D2.1 Report presenting the 3 nZEB renovation schemes in Italy, fully documented with technical and economic evaluation

ELECTRIC EQUIPMENT#Block3:Zone 10#05	30.47	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Block3:Zone 8#05	94.59	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Block3:Zone 11#05	306.47	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Block3:Zone 9#05	95.09	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Block3:Zone 5#05	40.71	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Block3:Zone 6#05	254.98	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Block3:Zone 7#05	90.22	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Block4:Zone 1#05	1,053.90	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Block4:Zone 4#05	1,723.90	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Block4:Zone 2#05	960.13	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Block4:Zone 14#05	553.77	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Block4:Zone 15#05	39,050.27	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Block4:Zone 12#05	1,396.48	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Block4:Zone 10#05	30.47	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Block4:Zone 8#05	94.59	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Block4:Zone 11#05	306.47	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Block4:Zone 9#05	95.09	0.00	0.00	0.00	0.00	0.00
ELECTRIC EQUIPMENT#Block4:Zone 5#05	40.71	0.00	0.00	0.00	0.00	0.00
ELECTRIC	254.98	0.00	0.00	0.00	0.00	0.00



	EQUIPMENT#Block4:Zone						
	6#05						
	ELECTRIC	90.22	0.00	0.00	0.00	0.00	0.00
	EQUIPMENT#Block4:Zone						
	7#05						
Exterior	General	0.00	0.00	0.00	0.00	0.00	0.00
Equipment							
Fans	General	0.00	0.00	0.00	0.00	0.00	0.00
Pumps	General	0.00	0.00	0.00	0.00	0.00	0.00
Heat	General	0.00	0.00	0.00	0.00	0.00	0.00
Rejection							
Humidificatio	General	0.00	0.00	0.00	0.00	0.00	0.00
n							
Heat	General	0.00	0.00	0.00	0.00	0.00	0.00
Recovery							
Water	DHW Block5:Zone3	0.00	0.00	0.00	0.00	111.35	3.00
Systems							
	DHW Block5:Zone5	0.00	0.00	0.00	0.00	4,510.18	121.39
	DHW Block5:Zone1	0.00	0.00	0.00	0.00	358.81	9.66
	DHW Block5:Zone2	0.00	0.00	0.00	0.00	369.11	9.93
Refrigeration	General	0.00	0.00	0.00	0.00	0.00	0.00
Generators	General	0.00	0.00	0.00	0.00	0.00	0.00

TABLE $\boldsymbol{100}$ - TABULAR VIEW FOR TEMPERATURE AND PRECIPITATION PER MONTH

		Temperature		Precipitation
Months	Normal	Warmest	Coldest	Normal
January	12.3°C	14.4°C	10.1°C	10
February	12.2°C	14.7°C	9.8°C	9
March	13.5°C	16.1°C	10.9°C	8
April	15.4°C	18.3°C	12.5°C	8
Мау	19.5°C	22.5°C	16.4°C	3
June	23.6°C	26.8°C	20.4°C	1
July	26.7°C	30.0°C	23.4°C	1
August	27.3°C	30.5°C	24.2°C	2
September	24.5°C	27.5°C	21.5°C	5
October	20.5°C	23.2°C	17.8°C	8
November	16.4°C	18.7°C	14.1°C	10
December	13.7°C	15.8°C	11.6°C	10



el Options Data	and the second			
a Advanced Heating Design Coo	oling Design Simulation Display Drawing	tools Block Project details		
ta Options				
PModel options template			Draw building + standard data	
ope				
Scope			Whole building Analyse the whole building.	
Zone	Zone+shading	Building		
nstruction and Glazing Data				
Construction and glazing data		-	General construction templates Construction default data is selected from a list.	
Pre-design		General		
loor/slab/ceiling representation			1-Combined	
Zone volume calculations				
Internal floor constructions not	t subtracted from zone volume			
Ground floor construction is be	elow ground and is not subtracted from	zone volume		
External floor constructions no	ot subtracted from zone ∨olume			
ins Data				
Gains data			Early gains	
			Internal gains are separated into various categories (e.g. occupancy, lighting, computing etc.)	
Lumped	Early	Detailed		
			1-Dynamic calculation	
ccupancy latent gains				
			1-Watts per m2	
ighting gain units			1-Watts per m2	
ighting gain units ning		_	Schedules	
ighting gain units ning fiming				rent pr
ighting gain units Timing ypical workday		Schedules	Schedules	rent p
ighting gein units Irining Ypical workday Internal gains operate with occu	pancy	Schedules	Schedules	erent pr
ighting gain units ling /Iming ypical workday Internal gains operate with occu AC	pancy	Schedules	Schedules Timing is defined using the schedules and profiles mechanism which allows each day of the week to have a diffe	erent pr
ighting gain units ing Iming ypisal workday Internal gains operate with occu AC	pancy	Schedules	Schedules Timing is defined using the schedules and profiles mechanism which allows each day of the week to have a diffe	erent pr
ighting gain units ning Timing lypical workday] Internal gains operate with occu AC	pancy Compact	Schedules	Schedules Timing is defined using the schedules and profiles mechanism which allows each day of the week to have a diffe	erent pr
ighting gain units ining iriming ypisal workday [Internal gains operate with occu AC Simple	•		Schedules Timing is defined using the schedules and profiles mechanism which allows each day of the week to have a diffe	erent pr
ighting gain units ining firming ypiest workday Internal gains operate with occu AC VAC Simple IVAC sizing	•		Schedules Timing is defined using the schedules and profiles mechanism which allows each day of the week to have a diffe Compact HVAC HVAC systems are defined parametrically and modelled within EnergyPlus using Compact HVAC descriptions	erent pr
Decupancy latent gains lighting gain units ning Triming Price workday I Internal gains operate with occu AC simple MAC sign function Natural ventilation	•		Schedules Tming is defined using the schedules and profiles mechanism which allows each day of the week to have a differ Compact HVAC HVAC systems are defined parametrically and modelled within EnergyPlus using Compact HVAC descriptions 3-Autosize Calculated ventilation	
ighting gain units ining firming ypical workday Internal gains operate with occu AC AC VAC Simple IVAC sizing tural ventilation	•		Schedules Timing is defined using the schedules and profiles mechanism which allows each day of the week to have a different Compact HVAC HVAC systems are defined parametrically and modelled within EnergyPlus using Compact HVAC descriptions 3-Autosize	
ighting gain units inng filming ypical workday Internal gains operate with occu AC iVAC Simple IVAC sizing tural ventilation Istural ventilation	•	Detailed	Schedules Tming is defined using the schedules and profiles mechanism which allows each day of the week to have a differ Compact HVAC HVAC systems are defined parametrically and modelled within EnergyPlus using Compact HVAC descriptions 3-Autosize Calculated ventilation	

FIGURE 292 - MODEL OPTIONS DATA

del	Options D	ata							
ata	Advanced	Heating Design	Cooling Design	Simulation	Display	Drawing tools	Block	Project details	
imp	dification								
	derge zone:	s of same activi	ity						
	derge zone:	s connected by	holes						
۸ 🗆	/lerge zone:	s by selection							
	ump simila	r windows on su	ırface						
	.ump simila	r cracks on surf	ace						
	ump simila	r construction el	lements (resea	rch option)					
רם	Friangulate								
•	Generate ful	ly enclosed zor	nes						
V	Show bloc	ck connection s	urfaces in Navi	gator					
v N	/lodel 'semi	-exterior uncon	ditioned' zones	as simple	R-value f	o outside			
F	R-value to or	utside (m2-K/W)		0	,1800			
atu	ral Ventilatic	on							
		w through holes	and virtual par	titions					
Ca	lculated								
۰V	Vind factor					,00			
Discharge coefficient for open windows and holes						,650			
			en mildono di	u noies					
E] Modulate	oefficient for op opening areas		u noies					
Sc] Modulate heduled	opening areas		unores			_		
Sc] Modulate heduled] Airflow thro			u noies			-		
Sc Sc] Modulate heduled] Airflow thro	opening areas ough internal op							
Sc Sc ghti] Modulate heduled] Airflow thro ing prking plane	opening areas ough internal op height (m)			10	,800			
Sc Sc ghti Wc Da] Modulate heduled] Airflow thro ing prking plane ylighting me	opening areas ough internal op height (m)			10	,800 -Detailed		_	
Sc Sc ghti Wc Day] Modulate heduled] Airflow thro ing orking plane ylighting me s	opening areas ough internal op height (m) thod	enings	u noies	1	-Detailed			
Sc Sc ghti Wc Day Iter Exc] Modulate heduled] Airflow thro ing prking plane ylighting me s clude surfac	opening areas ough internal op height (m) thod e elements sm	enings		1				
Sc Sc ghti Day iter Exc om] Modulate heduled] Airflow thro ing orking plane ylighting me s	opening areas bugh internal op height (m) sthod e elements sm k	enings		1	-Detailed			

FIGURE 293 - MODEL OPTIONS DATA



odel Options Data		
Data Advanced Heating Design Cooling Design Simu	ulation Display Drawing tools Block Project details	
Winter design day		- 8
Winter design day	10-WinterDesignDay	•
Operation for 7/12 and Typical workday Schedule	es	
🗹 General		
Cccupancy		
🗖 Lighting		
🗖 Equipment		
🗹 Heating demand		
🗹 Cooling demand		
I HVAC		
Natural ventilation demand		
☑ DHW		
Calculation Options		3
Simulation method	1-EnergyPlus	
Temperature control	1-Air temperature	
Exclude all zone natural ventilation (infiltration is	always included)	
Exclude all zone mechanical ventilation		
System Sizing		
Design margin	1,20	
Dutput		2
Include unoccupied zones in block and building	j totals and averages	
Report		18
General Solution		
	0,000200	11
Temperature convergence (deltaC)	0.000200	
Loads convergence (W)	0,000200	
Inside convection algorithm	6-TARP	
Outside convection algorithm	6-DOE-2	2
Other		- 2
□ 'Surfaces within zone' treated as adiabatic		

FIGURE 294 - MODEL OPTIONS DATA

Data Advanced Heating Design Cooling Design Simulation Di	splay Drawing tools Block Project deta	ils
Summer Design Day		
Day	15	
Month	Jul	
Day of week	9-SummerDesignDay	
Calculation Options		
Simulation method	1-EnergyPlus	
Temperature control	1-Air temperature	
Exclude all zone natural ventilation (infiltration is always in	ncluded)	
Exclude all zone mechanical ventilation		
System Sizing		
Design margin	1,30	
Sizing method	1-ASHRAE	
Solar		
Include all buildings in shading calcs		
Model reflections and shading of ground reflected solar		
Solar distribution	2-Full exterior	
Dutput		
Include unoccupied zones in block and building totals and	d averages	
Report		
Advanced		
General Solution		
Inside face surface temperature convergence criteria	0,0020	
Temperature convergence (deltaC)	0,0020	
Loads convergence (W)	0,0020	
Convection		
Inside convection algorithm	6-TARP	
Outside convection algorithm	6-DOE-2	
Shading		
Maximum number of 'shadow overlaps'	15000	
Polygon clipping algorithm	1-Sutherland Hodgman	
Pulydon clipping algoninin		

FIGURE 295 - MODEL OPTIONS DATA



	Project details	
nulation Options		
From	1	
Start day		
Start month	Jan	
To	31	
End day	Dec	
End month Iculation Options	Dec	
Simulation method	1-EnergyPlus	
Fime steps per hour	2	
Time steps per hour Femperature control	1-Air temperature	
lar		
Include all buildings in shading calcs		
Model reflections and shading of ground reflected solar		
Solar distribution	2-Full exterior	
Shadowing interval (days)	20	
Ivanced		
tiout		
Building and block output of zone data		
Include unoccupied zones in block and building totals and averages		
Zone environmental and comfort reports	1-All periods	
Graphable Outputs		
Surface heat transfer		
Environmental		
Comfort		
Internal gains including solar		
Energy, HVAC etc		
☑ Latent loads		
✓ Fresh air supply		
Temperature distribution		
Detailed Daylight Outputs		
Summary Annual Reports		
Summary Monthly Reports		
Miscellaneous Outputs		
HVAC system temperatures		
HVAC system mass flow rates		
HVAC system humidity ratios		
SQLite output		
☑ DXF model output		
Construction and surface details		
RDD file		
Time Setpoints not Met Tolerances		
Tolerance for time heating setpoint not met	0,20	
	0.20	

FIGURE 296 - MODEL OPTIONS DATA



24. ANNEX D: RENOVATION OPTION MATRIX BY SINLOC

TABLE 101 - ECONOMIC EVALUATION OF INTERVENTIONS

				0				¥ 9	Work t	iming		CAPEX								
				Installed power or size of intervention		Start date	Final date	Construction Period	Compulsory connection with other technologies/ layers	Specify which technologies are needed to realize this layer	Specify which technologies can be realized only after this layer	s Investment cost			Investment payback period (preliminary)	Lifetime (year of replacement - revamping)				
Renovation options	Types	Technologies / Layers		Unit of measure	Value	dd/mm/yy	dd/mm/yy	Months	Yes /No	Code /codes (ascending onter)	Code Kodes (ascending otter)	Unit of measure	Unit cos t	Value calculated	fears	Years				
	Cooling pumps	Compression heat pumps - VRV system - OFFICES AREAS	4	KW	355	X	Х	12	Yes	13-16-17	37	€/KW	€ 1'408,45	€ 500'000	11,96	25				
	Replacement of water heating systems	Solar thermal	5																	
		[]																		
	Insulation of distribution networks	[]	7																	
	Montilation custom	Hant success																		
	Ventilation system	Heat recovery	9																	
		Heating pumps with geothermal sonde Georthermal heat pump																		
		r a																		
Casing	External insulation	New facades - External wall, windows, green wall	12	sam	1190	х	х	18	Yes		4	£/sam	€ 869,69	€ 1'014'929	41,33	60				
Building skin	Internal insulation	[]	14					1												
	Shielding elements	Fixed/mobile/combined vertical structures	15							ที่อาเอาการกรางการการการการการกรางการกรางการการการการการการการการการการการการการก										
		Horizontal structures on roofs - NEW PV COVER SHELTER	16	sqm	1350	х	Х	10	Yes		4	€/sqm	€ 266,67	€ 360'000	37,33	60				
		Horizontal structures on floors - WATERPROOFING FOUNDATIONS																		
Casing		and FOUNDATIONS STRUCTURAL RENOVATION	17	sqm	363,7	х	х	10	Yes		4	€/sqm	€ 869,69	€ 316'308	104,56	60				
	Bioclimatic	[]	18																	
		[]	19																	
Windows	Windows	PVC	20																	
		[]	21																	
	Glass windows Glass windows	Double glass	22 23																	
	Glass windows	Triple glass	23																	
lighting systems (internal)	Replacement of lamps (and luminaries, ballast)	LED	25																	
ing in the systems (incention)	hepideentent of lamps (and lammaries, bandst)	Internal Relamping	26	units	506	X	X	3	No			€/unit	€ 200,00	€ 101'200	0,80	20				
Lighting systems (external)	Replacement of lamps (and luminaries, ballas		27																	
177.0 378.000 A 380.0			28																	
Renewable energy	Biomass	Biomass heating systems	29											-						
	Solar	Photovoltaic panels	30	KWp	155	X	Х	6	No			€/KWp	€ 2'000,00	€ 310'000	9,77	30				
		Solar thermal panels	31																	
Control systems	Thermal	Automatic regolation of internal temperature	32																	
		Thermostatic valves	33												1					



TABLE 102 - ECONOMIC EVALUATION OF INTERVENTIONS

	OPEX											SAVINGS																	
		Energy co	onsumptio	n (after each :	single ener	gy renovati	on option))	Labor/Manage maintena	ement and ord			Extraordinary ma	intenance	Potential energy savings expected from the intervention										from ma	Potential savings from maintenance (post intervention)		Il savings CO2	
									Cost of components	Cost of personnel	Total	Frequency	Cost of intervention	Cost of personnel	Total		Electric	energy con	sumption			Therma	l energy	consumption					
Renovation options	Source 1	Unit of measure	Consum ption/year	C/year	Source 2	Unit of measure	Cons um ption/year	C/year	Cytear	¢/year	¢/year	years	J	Cytear	J	%, first year	kWhe/year, fiist year	%, last year	kWhe/year, last year	Decrease characteristics (linear, nonlinear, etc.)	%, fiist year	kWhe/year, flist year	%, last year	kWhe/year, last year	Decrease characteristics (linear, nonlinear, etc.)	*	Cývear	*	Equivalent tons /year
	electri	c KWHe	434'108	€ 78'139,	44 no			ļ	€ 3'500	€ 6'500	€ 10'000	7	€ 15'000	€ 1'500	€ 25'500	13,5%	106'844	12,0%	94'831	linear						40%	€ 23'667	12,89	% 75,63
Casing Building skin	no				no				€ 7'105	€ 13'194	€ 20'299	10	€ 25'000	€ 3'000	€ 55'000	18,0%	142'459	16,5%	130'392	linear						0%	€O	17,39	% 102,33
	no				no				€ 4'410	€ 8'190	€ 12'600		€ 15'000		€ 30'000					linear						0%	€O		% 40,18
	no				no				€ 2'214	€ 4'112	€ 6'326	15	€ 10'000	€ 1'000	€ 25'000	2,25%	17'807	2,00%	15'805	linear						0%	€O	2,19	% 12,60
Windows																													
Lighting systems (internal)																													
Lighting systems (external)	electri	c KWHe	111'437	€ 20'058,	66 no			-	€ 708	€ 1'316	€ 2'024	7	€ 2'000	€ 500	€ 5'500	87%	741'066	75%	639'377	linear						25%	€ 2'508	81,09	% 517,67
Renewable energy	no				no				€ 5'425	€ 10'075	€ 15'500	5	€ 15'000	€ 4'000	€ 35'000	100%	201'500	75%	151'125	linear						0%	€0	87,59	6 132,25
Control systems									1																				



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