TECHNICAL REPORT: SIMULATIONS ON OPENSTUDIO AND ENERGYPLUS

TECHNICAL ENVIRONMENTAL SYSTEM -2017/2018
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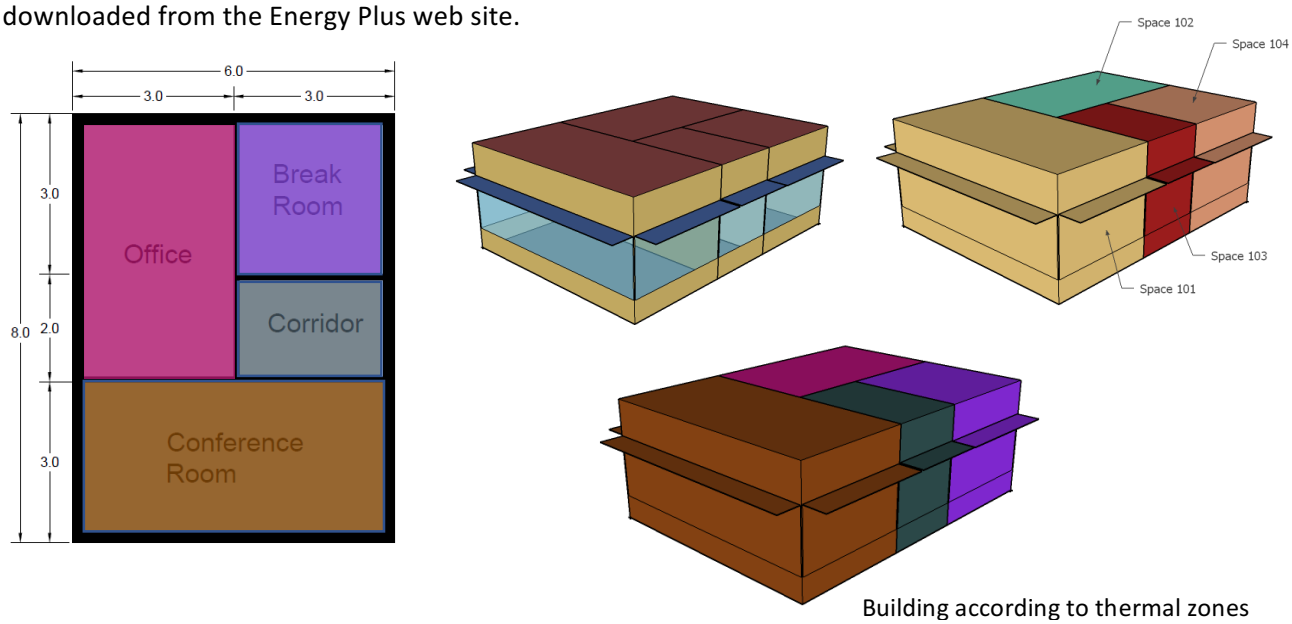
INTRODUCTION

The building analyzed is an office located in the city of Lecce in the southern part of Italy. Has an altitude of 49 meters above the sea level. It is a one floor building of 48 sqm with 4 spaces; the corridor, conference room, office and break room.

To introduce the project in the software, was re-draw in Sketch Up with the Open Studio plug-in tools, this consist in creating the space from diagram, inserting the number of floors and its height. All the surfaces must match so can be determine the solar and wind exposure of each wall, this is done with the *surface matching* tool. All the windows were inserted and located with a wall ratio from 0.5 and 0.6. There were added overhangs in all the surfaces except the north one. After the thermal zones were established according to the different spaces and functionality, as showed in the image.

According the location of the building, it was added the weather file, that was previously downloaded from the Energy Plus web site.



Building according to thermal zones

Conference room	189.1 – 2009 – Office – conference – c21-3
Office	189.1 – 2009 – Office – Closed office – c21-3
Corridor	189.1 – 2009 – Office – Corridor – c21-3
Break Room	189.1 – 2009 – Office – Breakroom – c21-3

RESULTS

With all the information and model complete, the simulation was run giving the following results;

LECCE

Site and Source Energy

	Total Energy [GJ]	Energy Per Total Building Area [MJ/m2]	Energy Per Conditioned Building Area [MJ/m2]
Total Site Energy	37.49	781.11	781.11
Net Site Energy	37.49	781.11	781.11
Total Source Energy	105.44	2196.62	2196.62
Net Source Energy	105.44	2196.62	2196.62

	(KWH)	(KWH/m2)	(KWH/m2)
Total Site Energy	10413.889	216.975	216.975
Net Site Energy	10413.889	216.975	216.975
Total Source Energy	29288.8889	610.17	610.17
Net Source Energy	29288.8889	610.17	610.17

ZONE OVERVIEW

Zone Summary

	Area (ft^2)	Conditioned (Y/N)	Part of Total Floor Area (Y/N)	Volume (ft^3)	Multiplier	Gross Wall Area (ft^2)	Window Glass Area (ft^2)	Lighting (W/ft^2)	People (ft^2/person)	Plug and Process (W/ft^2)
THERMAL ZONE 1	193.75	Yes	Yes	1937.36	1.00	393.74	196.87	1.17	20.02	0.37
THERMAL ZONE 2	161.46	Yes	Yes	1614.59	1.00	262.42	82.02	0.99	210.54	0.64
THERMAL ZONE 3	64.58	Yes	Yes	645.91	1.00	65.66	32.83	0.45	999.97	0.16
THERMAL ZONE 4	96.88	Yes	Yes	968.68	1.00	196.87	49.19	1.08	20.02	4.46
Total	516.67			5166.54		918.59	360.91	1.01	33.58	1.2
Conditioned Total	516.67			5166.54		918.59	360.91	1.01	33.58	1.2
Unconditioned Total	0.0			0.0		0.0	0.0	0.0	0.0	0.0
Not Part of Total	0.0			0.0		0.0	0.0	0.0	0.0	0.0

	m2	Y/N	Y/N	m3	Multiplier	m2	m2	w/m2	m2/person	w/m2
Thermal Zone 1	17.99	yes	yes	54.85	1.00	36.57	18.28	12.59	1.85	3.98
Thermal Zone 2	15	yes	yes	45.72	1.00	24.37	7.61	10.65	19.55	6.88
Thermal Zone 3	5.99	yes	yes	18.29	1.00	6.1	3.05	4.84	92.90	1.72
Thermal Zone 4	9	yes	yes	27.42	1.00	18.28	4.56	11.62	1.85	48
Total	48			146.3		85.33	33.52	10.87	3.11	12.91
Conditioned Total	48			146.3		85.33	33.52	10.87	3.11	12.91

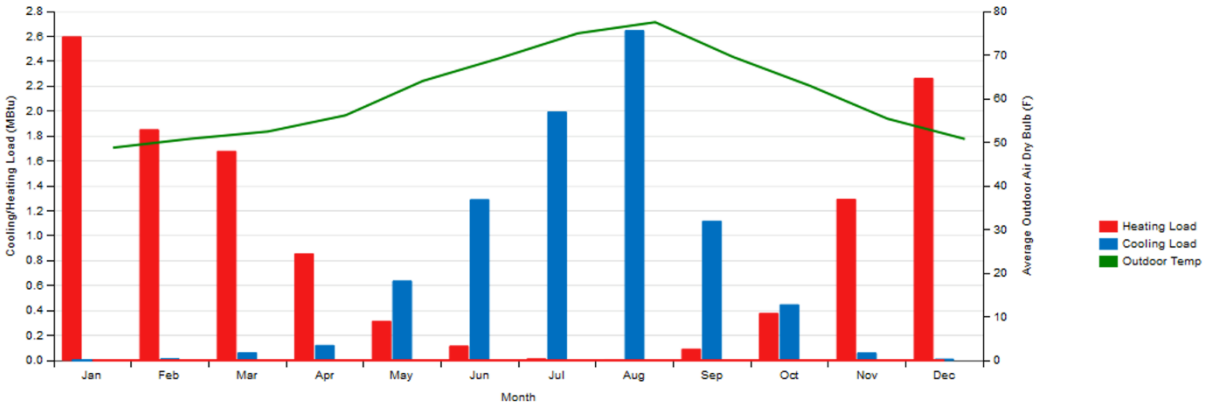
Unconditioned Total	0			0		0	0	0	0	0
Not part of total	0			0		0	0	0	0	0

HVAC LOAD PROFILES

Monthly Load Profiles - view table

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Outdoor Air Dry Bulb (F)	48.8	50.8	52.4	56.2	64.1	69.3	75.0	77.5	69.6	62.9	55.4	50.7
Cooling Load (MBtu)	0.0	0.01	0.06	0.12	0.64	1.29	1.99	2.65	1.12	0.45	0.06	0.01
Heating Load (MBtu)	2.6	1.85	1.68	0.85	0.31	0.11	0.01	0.01	0.09	0.38	1.29	2.26

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cooling Load(KWH)	0	0.0029	0.0175	0.0351	0.1875	0.3780	0. 5832	0.7766	0. 3282	0. 1318	0.0175	0.0029
Heating Load(KWH)	0. 7619	0.5421	0.4923	0.2491	0.0908	0.0322	0.0029	0.0029	0.0263	0.1113	0.3780	0.6623



SPACE TYPE SUMMARY

189.1-2009 - Office - BreakRoom - CZ1-3
(1 spaces and 1 thermal zones)

Definition	Value	Unit	Inst. Multiplier
189.1-2009 - Office - BreakRoom - CZ1-3 People Definition	0.0500	people/ft^2	1.0
189.1-2009 - Office - BreakRoom - CZ1-3 Electric Equipment Definition	4.4600	W/ft^2	1.0
189.1-2009 - Office - BreakRoom - CZ1-3 Lights Definition	1.0800	W/ft^2	1.0
189.1-2009 - Office - BreakRoom - CZ1-3 Infiltration	0.0595	cfm/ext surf area ft^2	
189.1-2009 - Office - BreakRoom - CZ1-3 Ventilation (outdoor air method Sum)	15.0000	cfm/person	

Value	Unit
0.0046	People/m2
48.00704	W/m2
11.62502	W/m2
0.0280	L/S
7.0792	L/S

189.1-2009 - Office - ClosedOffice - CZ1-3
(1 spaces and 1 thermal zones)

Definition	Value	Unit	Inst. Multiplier
189.1-2009 - Office - ClosedOffice - CZ1-3 People Definition	0.0048	people/ft^2	1.0
189.1-2009 - Office - ClosedOffice - CZ1-3 Electric Equipment Definition	0.6400	W/ft^2	1.0
189.1-2009 - Office - ClosedOffice - CZ1-3 Lights Definition	0.9900	W/ft^2	1.0
189.1-2009 - Office - ClosedOffice - CZ1-3 Infiltration	0.0595	cfm/ext surf area ft^2	
189.1-2009 - Office - ClosedOffice - CZ1-3 Ventilation (outdoor air method Sum)	20.0000	cfm/person	

Value	Unit
0.00044	People/m2
6.8889	W/m2
10.6562	W/m2
0.0280	L/S
9.4389	L/S

189.1-2009 - Office - Conference - CZ1-3
(1 spaces and 1 thermal zones)

Definition	Value	Unit	Inst. Multiplier
189.1-2009 - Office - Conference - CZ1-3 People Definition	0.0500	people/ft^2	1.0
189.1-2009 - Office - Conference - CZ1-3 Electric Equipment Definition	0.3700	W/ft^2	1.0
189.1-2009 - Office - Conference - CZ1-3 Lights Definition	1.1700	W/ft^2	1.0
189.1-2009 - Office - Conference - CZ1-3 Infiltration	0.0595	cfm/ext surf area ft^2	
189.1-2009 - Office - Conference - CZ1-3 Ventilation (outdoor air method Sum)	20.0000	cfm/person	

Value	Unit
0.0046	People/m2
0.3982	W/m2
12.59	W/m2
0.0280	L/S
9.4389	L/S

189.1-2009 - Office - Corridor - CZ1-3
(1 spaces and 1 thermal zones)

Definition	Value	Unit	Inst. Multiplier
189.1-2009 - Office - Corridor - CZ1-3 People Definition	0.0010	people/ft^2	1.0
189.1-2009 - Office - Corridor - CZ1-3 Electric Equipment Definition	0.1600	W/ft^2	1.0
189.1-2009 - Office - Corridor - CZ1-3 Lights Definition	0.4500	W/ft^2	1.0
189.1-2009 - Office - Corridor - CZ1-3 Infiltration	0.0595	cfm/ext surf area ft^2	
189.1-2009 - Office - Corridor - CZ1-3 Ventilation (outdoor air method Sum)	0.0500	cfm/floor area ft^2	

Value	Unit
0.00009	People/m2
1.7222	W/m2
4.8437	W/m2
0.0280	L/S
0.0235	L/S

Knowing the energy data of the building in Lecce, the building was placed in two different cities with the objective of comparing the energy consumption.

BOGOTÁ

Site and Source Energy

	Total Energy [GJ]	Energy Per Total Building Area [MJ/m2]	Energy Per Conditioned Building Area [MJ/m2]
Total Site Energy	29.97	624.45	624.45
Net Site Energy	29.97	624.45	624.45
Total Source Energy	92.67	1930.55	1930.55
Net Source Energy	92.67	1930.55	1930.55

	(KWH)	(KWH/m2)	(KWH/m2)
Total Site Energy	8325	173.45	173.45
Net Site Energy	83.25	173.45	173.45
Total Source Energy	25741	536.26	536.26
Net Source Energy	25741	536.26	536.26

ZONE OVERVIEW

Zone Summary

	Area (ft^2)	Conditioned (Y/N)	Part of Total Floor Area (Y/N)	Volume (ft^3)	Multiplier	Gross Wall Area (ft^2)	Window Glass Area (ft^2)	Lighting (W/ft^2)	People (ft^2/person)	Plug and Process (W/ft^2)
THERMAL ZONE 1	193.75	Yes	Yes	1937.36	1.00	393.74	196.87	1.17	20.02	0.37
THERMAL ZONE 2	161.46	Yes	Yes	1614.59	1.00	262.42	82.02	0.99	210.54	0.64
THERMAL ZONE 3	64.58	Yes	Yes	645.91	1.00	65.66	32.83	0.45	999.97	0.16
THERMAL ZONE 4	96.88	Yes	Yes	968.68	1.00	196.87	49.19	1.08	20.02	4.46
Total	516.67			5166.54		918.59	360.91	1.01	33.58	1.2
Conditioned Total	516.67			5166.54		918.59	360.91	1.01	33.58	1.2
Unconditioned Total	0.0			0.0		0.0	0.0	0.0	0.0	0.0
Not Part of Total	0.0			0.0		0.0	0.0	0.0	0.0	0.0

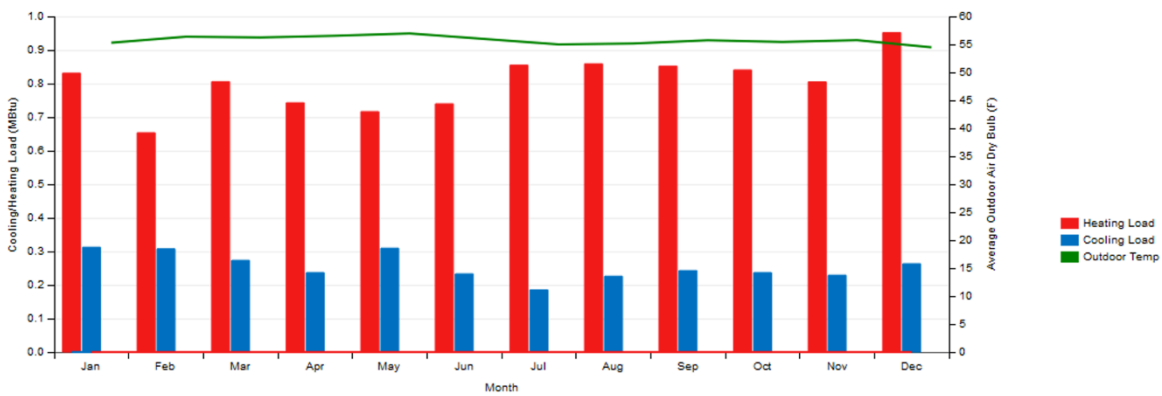
	m2	Y/N	Y/N	m3	Multiplier	m2	m2	w/m2	m2/person	w/m2
Thermal Zone 1	17.99	yes	yes	54.85	1.00	36.57	18.28	12.59	1.85	3.98
Thermal Zone 2	15	yes	yes	45.72	1.00	24.37	7.61	10.65	19.55	6.88
Thermal Zone 3	5.99	yes	yes	18.29	1.00	6.1	3.05	4.84	92.90	1.72
Thermal Zone 4	9	yes	yes	27.42	1.00	18.28	4.56	11.62	1.85	48
Total	48			146.3		85.33	33.52	10.87	3.11	12.91
Conditioned Total	48			146.3		85.33	33.52	10.87	3.11	12.91
Unconditioned Total	0			0		0	0	0	0	0
Not part of total	0			0		0	0	0	0	0

HVAC LOAD PROFILES

Monthly Load Profiles - view table

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Outdoor Air Dry Bulb (F)	55.3	56.4	56.2	56.5	57.0	56.0	55.0	55.2	55.7	55.4	55.8	54.5
Cooling Load (MBtu)	0.31	0.31	0.27	0.24	0.31	0.23	0.19	0.23	0.24	0.24	0.23	0.26
Heating Load (MBtu)	0.83	0.65	0.81	0.74	0.72	0.74	0.85	0.86	0.85	0.84	0.8	0.95

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cooling Load(KWH)	0.0908	0.0908	0.0791	0.0703	0.0908	0.0674	0.0556	0.0674	0.0703	0.0703	0.0674	0.0761
Heating Load(KWH)	0.2432	0.1904	0.2373	0.2168	0.2110	0.2168	0.2168	0.2520	0.2168	0.2461	0.2344	0.2784



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189.1-2009 - Office - BreakRoom - CZ1-3 Lights Definition	1.0800	W/ft^2	1.0
189.1-2009 - Office - BreakRoom - CZ1-3 Infiltration	0.0595	cfm/ext surf area ft^2	
189.1-2009 - Office - BreakRoom - CZ1-3 Ventilation (outdoor air method Sum)	15.0000	cfm/person	

Value	Unit
0.0046	People/m2
48.00704	W/m2
11.62502	W/m2
0.0280	L/S
7.0792	L/S

189.1-2009 - Office - ClosedOffice - CZ1-3
(1 spaces and 1 thermal zones)

Definition	Value	Unit	Inst. Multiplier
189.1-2009 - Office - ClosedOffice - CZ1-3 People Definition	0.0048	people/ft^2	1.0
189.1-2009 - Office - ClosedOffice - CZ1-3 Electric Equipment Definition	0.6400	W/ft^2	1.0
189.1-2009 - Office - ClosedOffice - CZ1-3 Lights Definition	0.9900	W/ft^2	1.0
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Value	Unit
0.00044	People/m2
6.8889	W/m2
10.6562	W/m2
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189.1-2009 - Office - Corridor - CZ1-3 Ventilation (outdoor air method Sum)	0.0500	cfm/floor area ft^2	

Value	Unit
0.00009	People/m2
1.7222	W/m2
4.8437	W/m2
0.0280	L/S
0.0235	L/S

CALGARY

Site and Source Energy

	Total Energy [GJ]	Energy Per Total Building Area [MJ/m2]	Energy Per Conditioned Building Area [MJ/m2]
Total Site Energy	84.95	1769.79	1769.79
Net Site Energy	84.95	1769.79	1769.79
Total Source Energy	294.75	6140.61	6140.61
Net Source Energy	294.75	6140.61	6140.61

	(KWH)	(KWH/m2)	(KWH/m2)
Total Site Energy	8325	173.45	173.45
Net Site Energy	83.25	173.45	173.45
Total Source Energy	25741	536.26	536.26
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ZONE OVERVIEW

Zone Summary

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Not Part of Total	0.0			0.0		0.0	0.0	0.0	0.0	0.0

	m2	Y/N	Y/N	m3	Multiplier	m2	m2	w/m2	m2/person	w/m2
Thermal Zone 1	17.99	yes	yes	54.85	1.00	36.57	18.28	12.59	1.85	3.98
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HVAC LOAD PROFILES

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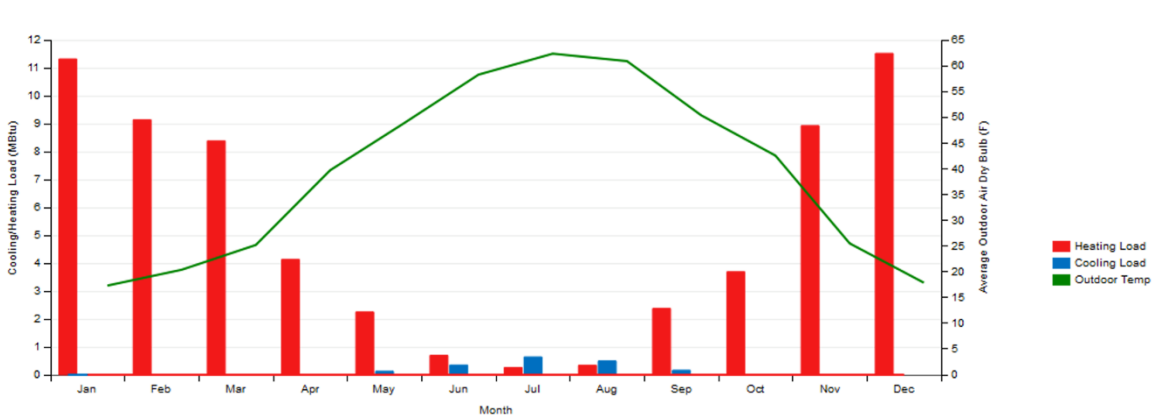
Average Outdoor Air Dry Bulb (F)	17.3	20.4	25.2	39.7	48.9	58.3	62.3	60.9	50.4	42.6	25.5	17.9
Cooling Load (MBtu)	0.0	0.0	0.0	0.01	0.13	0.35	0.64	0.5	0.16	0.0	0.0	0.0
Heating Load (MBtu)	11.32	9.14	8.38	4.13	2.25	0.7	0.26	0.34	2.38	3.69	8.93	11.52

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cooling Load(KWH)	0	0	0	0.00293	0.0381	0.1025	0. 1875	0.1464	0. 0468	0	0	0
Heating Load(KWH)	3.3175	2.6786	2.4559	1.2602	0.6594	0.2051	0.0762	0.0996	0.6975	1.0814	2.6171	3.3761



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Value	Unit
0.0046	People/m2
0.3982	W/m2
12.59	W/m2
0.0280	L/S
9.4389	L/S

189.1-2009 - Office - Corridor - CZ1-3
(1 spaces and 1 thermal zones)

Definition	Value	Unit	Inst. Multiplier
189.1-2009 - Office - Corridor - CZ1-3 People Definition	0.0010	people/ft^2	1.0
189.1-2009 - Office - Corridor - CZ1-3 Electric Equipment Definition	0.1600	W/ft^2	1.0
189.1-2009 - Office - Corridor - CZ1-3 Lights Definition	0.4500	W/ft^2	1.0
189.1-2009 - Office - Corridor - CZ1-3 Infiltration	0.0595	cfm/ext surf area ft^2	
189.1-2009 - Office - Corridor - CZ1-3 Ventilation (outdoor air method Sum)	0.0500	cfm/floor area ft^2	

Value	Unit
0.00009	People/m2
1.7222	W/m2
4.8437	W/m2
0.0280	L/S
0.0235	L/S

LECCE MODIFIED

COMPARISON

Lecce initial materials

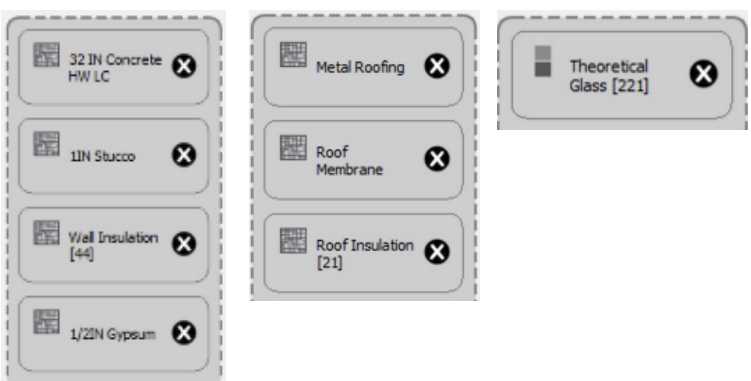
Site and Source Energy

	Total Energy [GJ]	Energy Per Total Building Area [MJ/m2]	Energy Per Conditioned Building Area [MJ/m2]
Total Site Energy	37.49	781.11	781.11
Net Site Energy	37.49	781.11	781.11
Total Source Energy	105.44	2196.62	2196.62
Net Source Energy	105.44	2196.62	2196.62

Lecce with modified materials

Site and Source Energy

	Total Energy [GJ]	Energy Per Total Building Area [MJ/m2]	Energy Per Conditioned Building Area [MJ/m2]
Total Site Energy	33.55	698.91	698.91
Net Site Energy	33.55	698.91	698.91
Total Source Energy	83.08	1730.80	1730.80
Net Source Energy	83.08	1730.80	1730.80



It was decided to change the materials of the model in order to improve the thermal transmission and lower the energy consumption. As the tables show, the total site energy consumption pass from 37.49 GJ to 33.55 GJ, saving 3.94 GJ.

It was also changed the materials in the walls, windows and roof. Since the window percentage in the walls was very big, it was noticed that it played an important role in the thermal conductivity. Therefore, it was decided to modify the glass in order to improve the energy consumption of the building.

ZONE OVERVIEW

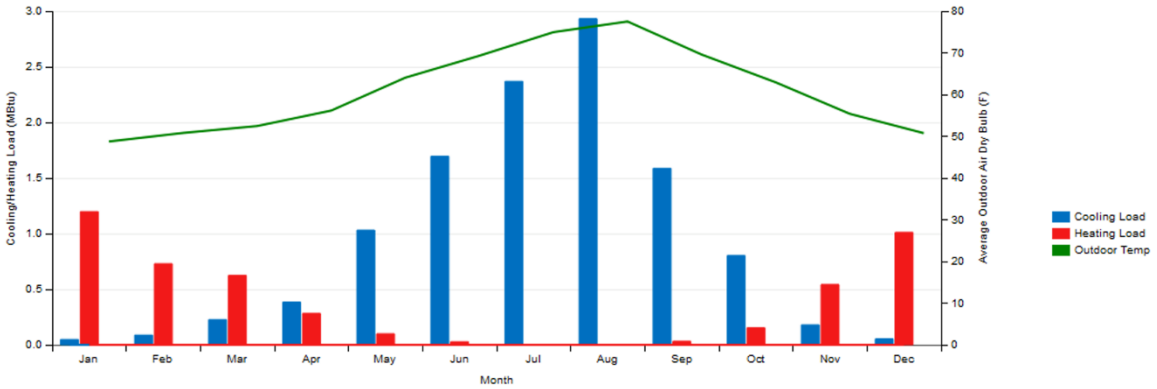
Zone Summary

	Area (ft^2)	Conditioned (Y/N)	Part of Total Floor Area (Y/N)	Volume (ft^3)	Multiplier	Gross Wall Area (ft^2)	Window Glass Area (ft^2)	Lighting (W/ft^2)	People (ft^2/person)	Plug and Process (W/ft^2)
THERMAL ZONE 1	193.75	Yes	Yes	1937.36	1.00	393.74	196.87	1.17	20.02	0.37
THERMAL ZONE 2	161.46	Yes	Yes	1614.59	1.00	262.42	82.02	0.99	210.54	0.64
THERMAL ZONE 3	64.58	Yes	Yes	645.91	1.00	65.66	32.83	0.45	999.97	0.16
THERMAL ZONE 4	96.88	Yes	Yes	968.68	1.00	196.87	49.19	1.08	20.02	4.46
Total	516.67			5166.54		918.59	360.91	1.01	33.58	1.2
Conditioned Total	516.67			5166.54		918.59	360.91	1.01	33.58	1.2
Unconditioned Total	0.0			0.0		0.0	0.0	0.0	0.0	0.0
Not Part of Total	0.0			0.0		0.0	0.0	0.0	0.0	0.0

HVAC LOAD PROFILES

Monthly Load Profiles - view table

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Outdoor Air Dry Bulb (F)	48.8	50.8	52.4	56.2	64.1	69.3	75.0	77.5	69.6	62.9	55.4	50.7
Cooling Load (MBtu)	0.05	0.09	0.23	0.38	1.03	1.7	2.37	2.93	1.59	0.8	0.18	0.05
Heating Load (MBtu)	1.2	0.73	0.62	0.28	0.1	0.03	0.0	0.0	0.03	0.15	0.54	1.01



SPACE TYPE SUMMARY

189.1-2009 - Office - BreakRoom - CZ1-3
(1 spaces and 1 thermal zones)

Definition	Value	Unit	Inst. Multiplier
189.1-2009 - Office - BreakRoom - CZ1-3 People Definition	0.0500	people/ft^2	1.0
189.1-2009 - Office - BreakRoom - CZ1-3 Electric Equipment Definition	4.4600	W/ft^2	1.0
189.1-2009 - Office - BreakRoom - CZ1-3 Lights Definition	1.0800	W/ft^2	1.0
189.1-2009 - Office - BreakRoom - CZ1-3 Infiltration	0.0595	cfm/ext surf area ft^2	
189.1-2009 - Office - BreakRoom - CZ1-3 Ventilation (outdoor air method Sum)	15.0000	cfm/person	

189.1-2009 - Office - ClosedOffice - CZ1-3
(1 spaces and 1 thermal zones)

Definition	Value	Unit	Inst. Multiplier
189.1-2009 - Office - ClosedOffice - CZ1-3 People Definition	0.0048	people/ft^2	1.0
189.1-2009 - Office - ClosedOffice - CZ1-3 Electric Equipment Definition	0.6400	W/ft^2	1.0
189.1-2009 - Office - ClosedOffice - CZ1-3 Lights Definition	0.9900	W/ft^2	1.0
189.1-2009 - Office - ClosedOffice - CZ1-3 Infiltration	0.0595	cfm/ext surf area ft^2	
189.1-2009 - Office - ClosedOffice - CZ1-3 Ventilation (outdoor air method Sum)	20.0000	cfm/person	

189.1-2009 - Office - Conference - CZ1-3
(1 spaces and 1 thermal zones)

Definition	Value	Unit	Inst. Multiplier
189.1-2009 - Office - Conference - CZ1-3 People Definition	0.0500	people/ft^2	1.0
189.1-2009 - Office - Conference - CZ1-3 Electric Equipment Definition	0.3700	W/ft^2	1.0
189.1-2009 - Office - Conference - CZ1-3 Lights Definition	1.1700	W/ft^2	1.0
189.1-2009 - Office - Conference - CZ1-3 Infiltration	0.0595	cfm/ext surf area ft^2	
189.1-2009 - Office - Conference - CZ1-3 Ventilation (outdoor air method Sum)	20.0000	cfm/person	

189.1-2009 - Office - Corridor - CZ1-3
(1 spaces and 1 thermal zones)

Definition	Value	Unit	Inst. Multiplier
189.1-2009 - Office - Corridor - CZ1-3 People Definition	0.0010	people/ft^2	1.0
189.1-2009 - Office - Corridor - CZ1-3 Electric Equipment Definition	0.1600	W/ft^2	1.0
189.1-2009 - Office - Corridor - CZ1-3 Lights Definition	0.4500	W/ft^2	1.0
189.1-2009 - Office - Corridor - CZ1-3 Infiltration	0.0595	cfm/ext surf area ft^2	
189.1-2009 - Office - Corridor - CZ1-3 Ventilation (outdoor air method Sum)	0.0500	cfm/floor area ft^2	

CONCLUSION

The building was analyzed in different cities located in different positions according to the equator line to understand the energy consumption. The objective was to identify which where the weak points in the building that weren't adequate to have an energy saving. Once identified, new materials were proposed lowering the energy consumption this where insulation in the roof, insulation in the walls and windows.

SOURCES

- SKETCHUP MAKER 2016
- ENERGYPLUS
- OPENSTUDIO