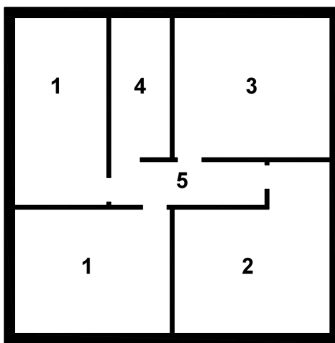
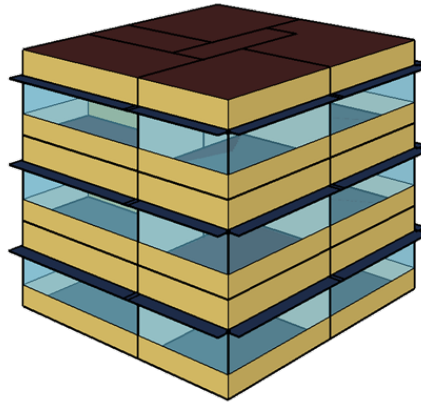
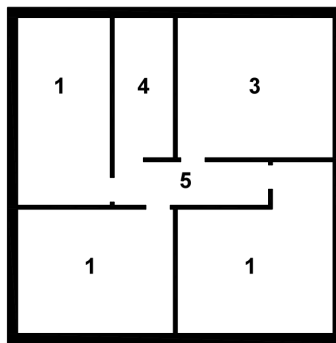


TECHNICAL ENVIRONMENTAL SYSTEM REPORT

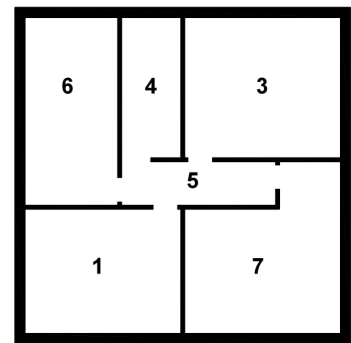
The apartment is a single building of three floors and is located in Piacenza suburb. The aim of this report is to show the climate behaviour of the building in Piacenza and in others two cities (London and Cairo), like if it was built there. Besides, for each city we set up a process of four different *Construction sets*, from the simplest and less performing one, to a better one in terms of transmittance, sustainability and quality of materials. The building occupies an area of 300m².



Ground Floor



Floor 1



Floor 2

Thermal zones	
1	Living room (RestRoom) Bedrooms (RestRoom)
2	Kitchen (BreakRoom)
3	Bathroom (Mech/Elec Room)
4	Stairs
5	Corridor
6	Storage
7	Studio (Closed office)

Weather data summary			
Location	Piacenza	London	Cairo
Latitude	45° 2' 51'' N	51° 30' 30'' N	30° 03' 45'' N
Longitude	9° 42' 1'' E	-0° 7' 32 O	31° 14' 58'' E
Elevation meters above sea	134	35	23
Time zone	UTC +1	UTC +0	UTC +2
Climate zone *	6	4	2

* Site from where we took the Climate zones for our sample cities in the *Weather data summary*.
<https://www.slideshare.net/hookc/climate-zones-25593170>

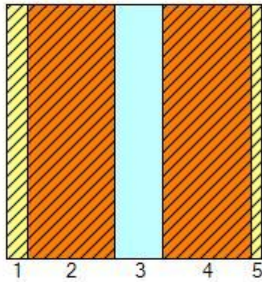
PIACENZA OPTION 01 (Existing situation)

EXTERNAL WALL CONSTRUCTION (31 cm)

The building site is $94513,89 \text{ kW/h}$. The EUI value is $315,05 \text{ kWh/m}^2$.

The perimeter walls of the building have a thickness of 24 cm and they consist of the following stratigraphy.

Structure description



1	Plaster	1 IN Stucco
2	Wall	Brick 1
3	Air gap	Camera non ventilata
4	Wall	Brick 1
5	Plaster	1/2in Gypsum

	s [m]	ρ [kg/m ³]	λ [W/mK]	c [J/kgK]	μ [-]	M _s [kg/m ²]	R [m ² K/W]	S _D [m]	a [m ² /Ms]
							0,04		
1	0,025	1858,0	0,692	837,0	20,0	47,0	0,04	0,51	0,445
2	0,110	581,8	0,550	900,0	1,0	64,0	0,20	0,11	1,050
3	0,060	1,0	0,327	1004,2	1,0	0,1	0,18	0,06	0,000
4	0,110	581,8	0,550	900,0	1,0	64,0	0,20	0,11	1,050
5	0,013	784,9	0,160	830,0	10,0	10,0	0,08	0,13	0,246
							0,13		

Legend

s	Thickness
ρ	Density
λ	Conductivity
c	Specific Heat
α	Vapour Resistance
M _s	Mass Surface
R	Thermal Resistance

Stationary parameters

Total thickness	0,318	m
Mass surface	185,0	kg/m ²
Mass surfaces without plaster	128,1	kg/m ²
Resistance	0,87	m ² K/W
Transmittance U	1,150	W/m ² K

Annual Overview

EXISTING SITUATION		
ELECTRICITY	[kWh]	16711,11
HEATING	[kWh]	59475,00
COOLING	[kWh]	18327,78

Energy Use

EXISTING SITUATION		
ELECTRICITY	[kWh]	52927,78
DISTRICT HEATING	[kWh]	214902,78
DISTRICT COOLING	[kWh]	19347,22

District Cooling Consumption [kWh]

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOT
EXISTING SOLUTION	0,00	12,81	95,35	336,06	1404,76	2833,39	6647,00	4383,28	2082,32	494,24	38,13	0,47	18327,81

District Heating Consumption [kWh]

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOT
EXISTING SOLUTION	13009,03	9909,81	7825,33	4059,28	1097,47	246,40	48,08	114,64	677,10	2408,63	6367,86	13711,08	59474,72

Energy Summary

EXISTING SITUATION		
	TOTAL ENERGY [kWh]	ENERGY PER TOTAL BUILDING AREA [kWh/mq]
TOTAL SITE ENERGY	94513,89	315,05
TOTAL SOURCE ENERGY	287177,78	957,26

Considerations

Given the current composition of the walls and with the help of the program it was possible to note how the building requires a high energy input for its normal operation. After these considerations, we tried to make changes just in the stratigraphy of the walls in order to reduce heat loss of the building, offering a new solution to the problem.

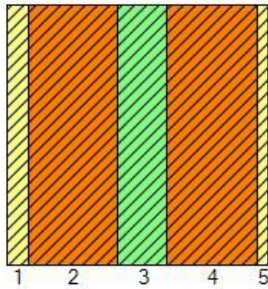
PIACENZA OPTION 02

The second option is assumed to intervene with a thermal spray insulation in the air gap between the two brick walls, while leaving unchanged the stratigraphic roof and floor composition.

EXTERNAL WALL CONSTRUCTION (32 cm)

The new stratigraphy adopted for the perimeter walls with the filling of 6.0 cm of insulation doesn't change the thickness of the perimeter walls of 32 cm, so that it is composed.

Structure description



1	Plaster	1 IN Stucco
2	Wall	Brick 1
3	Foam insulation	Spray foam insulation
4	Wall	Brick 1
5	Plaster	1/2in Gypsum

	s [m]	ρ [kg/m ³]	λ [W/mK]	c [J/kgK]	μ [-]	M _s [kg/m ²]	R [m ² K/W]	S _D [m]	a [m ² /Ms]
							0,04		
1	0,025	1858,0	0,692	837,0	20,0	47,0	0,04	0,51	0,445
2	0,110	581,8	0,550	900,0	1,0	64,0	0,20	0,11	1,050
3	0,060	25,0	0,034	1464,0	30,0	1,5	1,76	1,80	0,929
4	0,110	581,8	0,550	900,0	1,0	64,0	0,20	0,11	1,050
5	0,013	784,9	0,160	830,0	10,0	10,0	0,08	0,13	0,246
							0,13		

Legend

s	Thickness
ρ	Density
λ	Conductivity
c	Specific Heat
α	Vapour Resistance
M _s	Mass Surface
R	Thermal Resistance

Stationary parameters

Total thickness	0,318	m
Mass surface	186,0	kg/m ²
Mass surfaces without plaster	129,5	kg/m ²
Resistance	2,45	m ² K/W
Transmittance U	0,408	W/m ² K

Annual Overview

		EXISTING SITUATION	OPTION 02
ELECTRICITY	[kWh]	16711,11	16711,11
HEATING	[kWh]	59475,00	56102,78
COOLING	[kWh]	18327,78	17919,44

Energy Use

		EXISTING SITUATION	OPTION 02
ELECTRICITY	[kWh]	52927,78	52927,78
DISTRICT HEATING	[kWh]	214902,78	202719,44
DISTRICT COOLING	[kWh]	19347,22	18916,67

District Cooling Consumption [kWh]

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOT
EXISTING SOLUTION	0,00	12,81	95,35	336,06	1404,76	2833,39	6647,00	4383,28	2082,32	494,24	38,13	0,47	18327,81
OPTION 02	0,00	18,49	112,17	358,14	1403,18	2753,47	6393,81	4243,28	2062,03	523,01	51,49	0,96	17920,06

District Heating Consumption [kWh]

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOT
EXISTING SOLUTION	13009,03	9909,81	7825,33	4059,28	1097,47	246,40	48,08	114,64	677,10	2408,63	6367,86	13711,08	59474,72
OPTION 02	12198,42	9319,14	7403,58	3893,06	1104,93	255,77	52,53	121,07	676,72	2296,08	5941,81	12839,94	56103,06

Energy Summary

		EXISTING SITUATION		OPTION 02	
		TOTAL ENERGY [kWh]	ENERGY PER TOTAL BUILDING AREA [kWh/mq]	TOTAL ENERGY [kWh]	ENERGY PER TOTAL BUILDING AREA [kWh/mq]
TOTAL SITE ENERGY		94513,89	315,05	90736,11	302,45
TOTAL SOURCE ENERGY		287177,78	957,26	274563,89	915,21

Total Energy before: 315,05 kWh/m2



Total Energy after 02: 302,45 kWh/m2

Considerations

With the new composition of the walls and keeping the same roof and floor of the existing situation you can see that the building still needs a high energy intake to cover their own needs. By comparing this new solution with the existing one you can see that for the annual cooling energy consumption is lower than the existing situation of the building (17919,44 kWh), and the heating value has a significant decrease (56102,78 kWh).

In the light of these considerations and comparisons we tried to propose further changes in the stratigraphy of the walls to reduce heat loss of the building.

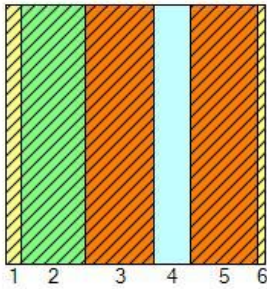
PIACENZA OPTION 03

The third option is assumed to intervene with an insulation panel (CELENIT F2/C) on the external brick wall, while leaving unchanged the stratigraphic roof and floor composition.

EXTERNAL WALL CONSTRUCTION (42 cm)

The new stratigraphy adopted for the perimeter walls with the new 10 cm insulation panel changes the thickness of the perimeter walls of 42 cm, so that it is composed.

Structure description



1	Plaster	1 IN Stucco
2	Natural insulation	CELENIT F2/C
3	Wall	Brick 1
4	Air Gap	Camera non ventilata
5	Wall	Brick 1
6	Plaster	1/2in Gypsum

	s [m]	ρ [kg/m ³]	λ [W/mK]	c [J/kgK]	μ [-]	M _s [kg/m ²]	R [m ² K/W]	S _D [m]	a [m ² /Ms]
							0,04		
1	0,025	1858,0	0,692	837,0	20,0	47,0	0,04	0,51	0,445
2	0,105	160,0	0,045	1900,0	5,0	16,8	2,33	0,53	0,148
3	0,110	581,8	0,550	900,0	1,0	64,0	0,20	0,11	1,050
4	0,060	1,0	0,327	1004,2	1,0	0,1	0,18	0,06	0,000
5	0,110	581,8	0,550	900,0	1,0	64,0	0,20	0,11	1,050
6	0,013	784,9	0,160	830,0	10,0	10,0	0,08	0,13	0,246
							0,13		

Legend

s	Thickness	α	Vapour Resistance
ρ	Density	M _s	Mass Surface
λ	Conductivity	R	Thermal Resistance
c	Specific Heat		

Stationary parameters

Total thickness	0,423	m
Mass surface	201,8	kg/m ²
Mass surfaces without plaster	144,9	kg/m ²
Resistance	3,20	m ² K/W
Transmittance U	0,312	W/m ² K

Annual Overview

		EXISTING SITUATION	OPTION 03
ELECTRICITY	[kWh]	16711,11	16711,11
HEATING	[kWh]	59475,00	55436,11
COOLING	[kWh]	18327,78	17813,89

Energy Use

		EXISTING SITUATION	OPTION 03
ELECTRICITY	[kWh]	52927,78	52927,78
DISTRICT HEATING	[kWh]	214902,78	200313,89
DISTRICT COOLING	[kWh]	19347,22	18805,56

District Cooling Consumption [kWh]

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOT
EXISTING SOLUTION	0,00	12,81	95,35	336,06	1404,76	2833,39	6647,00	4383,28	2082,32	494,24	38,13	0,47	18327,81
OPTION 03	0,00	19,66	114,93	360,64	1392,88	2729,93	6330,78	4222,64	2052,99	532,86	54,29	1,08	17812,67

District Heating Consumption [kWh]

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOT
EXISTING SOLUTION	13009,03	9909,81	7825,33	4059,28	1097,47	246,40	48,08	114,64	677,10	2408,63	6367,86	13711,08	59474,72
OPTION 03	12039,00	9201,33	7341,92	3865,06	1119,23	259,33	53,98	122,65	673,39	2268,18	5851,25	12641,89	55437,22

Energy Summary

		EXISTING SITUATION		OPTION 03	
		TOTAL ENERGY [kWh]	ENERGY PER TOTAL BUILDING AREA [kWh/mq]	TOTAL ENERGY [kWh]	ENERGY PER TOTAL BUILDING AREA [kWh/mq]
TOTAL SITE ENERGY		94513,89	315,05	89961,11	299,87
TOTAL SOURCE ENERGY		287177,78	957,26	272044,44	906,82

Total Energy before: 315,05 kWh/m2



Total Energy after 03: 299,87 kWh/m2

Considerations

With the new composition of the walls and keeping the same roof and floor of the existing situation you can see that the building still needs a high energy intake to cover their own needs. By comparing this new solution with the existing one you can see that for the annual cooling energy consumption is still lower than the existing situation of the building (17813,89 kWh), and the heating value has a further decrease (55436,11 kWh).

In the light of these considerations and comparisons we tried to propose another last change in the stratigraphy of the walls to increase the performance of the building.

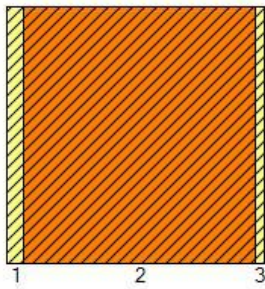
PIACENZA OPTION 04

The fourth option is assumed to intervene with a thermal spray insulation in the air gap between the two brick walls, while leaving unchanged the stratigraphic roof and floor composition.

EXTERNAL WALL CONSTRUCTION (32 cm)

The new stratigraphy adopted for the perimeter walls with the filling of 6.0 cm of insulation doesn't change the thickness of the perimeter walls of 32 cm, so that it is composed.

Structure description



1	Plaster	1 IN Stucco
2	Wall	Brick2 Poroton
3	Plaster	1/2in Gypsum

	s [m]	ρ [kg/m ³]	λ [W/mK]	c [J/kgK]	μ [-]	M _s [kg/m ²]	R [m ² K/W]
							0,04
1	0,025	1858,0	0,692	837,0	20,0	47,0	0,04
2	0,350	809,4	0,071	1000,0	40,0	283,3	4,92
3	0,013	784,9	0,160	830,0	10,0	10,0	0,08
							0,13

Legend

s	Thickness
ρ	Density
λ	Conductivity
c	Specific Heat
α	Vapour Resistance
M _s	Mass Surface
R	Thermal Resistance

Stationary parameters

Total thickness	0,388	m
Mass surface	340,3	kg/m ²
Mass surfaces without plaster	283,3	kg/m ²
Resistance	5,21	m ² K/W
Transmittance U	0,192	W/m ² K

Annual Overview

		EXISTING SITUATION	OPTION 04
ELECTRICITY	[kWh]	16711,11	16711,11
HEATING	[kWh]	59475,00	54886,11
COOLING	[kWh]	18327,78	18169,44

Energy Use

		EXISTING SITUATION	OPTION 04
ELECTRICITY	[kWh]	52927,78	52927,78
DISTRICT HEATING	[kWh]	214902,78	198322,22
DISTRICT COOLING	[kWh]	19347,22	19180,56

District Cooling Consumption [kWh]

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOT
EXISTING SOLUTION	0,00	12,81	95,35	336,06	1404,76	2833,39	6647,00	4383,28	2082,32	494,24	38,13	0,47	18327,81
OPTION 04	0,09	25,62	133,84	398,38	1462,31	2770,34	6349,08	4257,14	2123,54	580,15	65,84	1,84	18168,19

District Heating Consumption [kWh]

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOT
EXISTING SOLUTION	13009,03	9909,81	7825,33	4059,28	1097,47	246,40	48,08	114,64	677,10	2408,63	6367,86	13711,08	59474,72
OPTION 04	11837,72	9076,81	7266,58	3871,11	1163,56	277,61	63,21	136,11	713,12	2271,13	5756,06	12453,47	54886,38

Energy Summary

	EXISTING SITUATION		OPTION 04	
	TOTAL ENERGY [kWh]	ENERGY PER TOTAL BUILDING AREA [kWh/mq]	TOTAL ENERGY [kWh]	ENERGY PER TOTAL BUILDING AREA [kWh/mq]
TOTAL SITE ENERGY	94513,89	315,05	89776,67	299,22
TOTAL SOURCE ENERGY	287177,78	957,26	270430,56	901,43

Total Energy before: 315,05 kWh/m2



Total Energy after 03: 299,22 kWh/m2

Considerations

With the new composition of the walls and keeping the same roof and floor of the existing situation you can see that the building still needs a high energy intake to cover their own needs. By comparing this new solution with the existing one you can see that for the annual cooling energy consumption is lower than the existing situation of the building (18169,44 kWh), and the heating value has a decrease (54886,11 kWh).

FINAL ENERGY SUMMARY

Annual Overview

		EXISTING SITUATION	OPTION 02	OPTION 03	OPTION 04
ELECTRICITY	[kWh]	16711,11	16711,11	16711,11	16711,11
HEATING	[kWh]	59475,00	56102,78	55436,11	54886,11
COOLING	[kWh]	18327,78	17919,44	17813,89	18169,44

Energy Use

		EXISTING SITUATION	OPTION 02	OPTION 03	OPTION 04
ELECTRICITY	[kWh]	52927,78	52927,78	52927,78	52927,78
DISTRICT HEATING	[kWh]	214902,78	202719,44	200313,89	198322,22
DISTRICT COOLING	[kWh]	19347,22	18916,67	18805,56	19180,56

District Cooling Consumption [kWh]

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOT
EXISTING SOLUTION	0,00	12,81	95,35	336,06	1404,76	2833,39	6647,00	4383,28	2082,32	494,24	38,13	0,47	18327,81
OPTION 02	0,00	18,49	112,17	358,14	1403,18	2753,47	6393,81	4243,28	2062,03	523,01	51,49	0,96	17920,06
OPTION 03	0,00	19,66	114,93	360,64	1392,88	2729,93	6330,78	4222,64	2052,99	532,86	54,29	1,08	17812,67
OPTION 04	0,09	25,62	133,84	398,38	1462,31	2770,34	6349,08	4257,14	2123,54	580,15	65,84	1,84	18168,19

District Heating Consumption [kWh]

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOT
EXISTING SOLUTION	13009,03	9909,81	7825,33	4059,28	1097,47	246,40	48,08	114,64	677,10	2408,63	6367,86	13711,08	59474,72
OPTION 02	12198,42	9319,14	7403,58	3893,06	1104,93	255,77	52,53	121,07	676,72	2296,08	5941,81	12839,94	56103,06
OPTION 03	12039,00	9201,33	7341,92	3865,06	1119,23	259,33	53,98	122,65	673,39	2268,18	5851,25	12641,89	55437,22
OPTION 04	11837,72	9076,81	7266,58	3871,11	1163,56	277,61	63,21	136,11	713,12	2271,13	5756,06	12453,47	54886,38

Energy Summary

	EXISTING SITUATION		OPTION 02		OPTION 03		OPTION 04	
	TOTAL ENERGY [kWh]	ENERGY PER TOTAL BUILDING AREA [kWh/mq]	TOTAL ENERGY [kWh]	ENERGY PER TOTAL BUILDING AREA [kWh/mq]	TOTAL ENERGY [kWh]	ENERGY PER TOTAL BUILDING AREA [kWh/mq]	TOTAL ENERGY [kWh]	BUILDING AREA [kWh/mq]
TOTAL SITE ENERGY	94513,89	315,05	90736,11	302,45	89961,11	299,87	89776,67	299,22
TOTAL SOURCE ENERGY	287177,78	957,26	274563,89	915,21	272044,44	906,82	270430,56	901,43

Conclusions

Thanks to the comparative tables between the existing solution and the three new options you may notice that there is a substantial difference between the four different solutions, comparing for each hypothesis, the total site energy and total energy source. Both Total Site and Total Source Energy become lower and lower passing through the existing situation until the fourth option. You can also notice that the isolation in the third proposed option (insulation panel Celenit) results a substantial improvement in reducing both the values for the total site energy that for the total source energy, implying lower energy consumption and therefore a lower cost of energy production.

Plus study with PAN software in Piacenza case

	Description	Stationary Transmittance [W/m ² K]	Periodic Transmittance [W/m ² K]
1	option 1	1,150	0,784
2	option 2	0,408	0,230
3	option 3	0,312	0,069
4	option 4	0,192	0,002