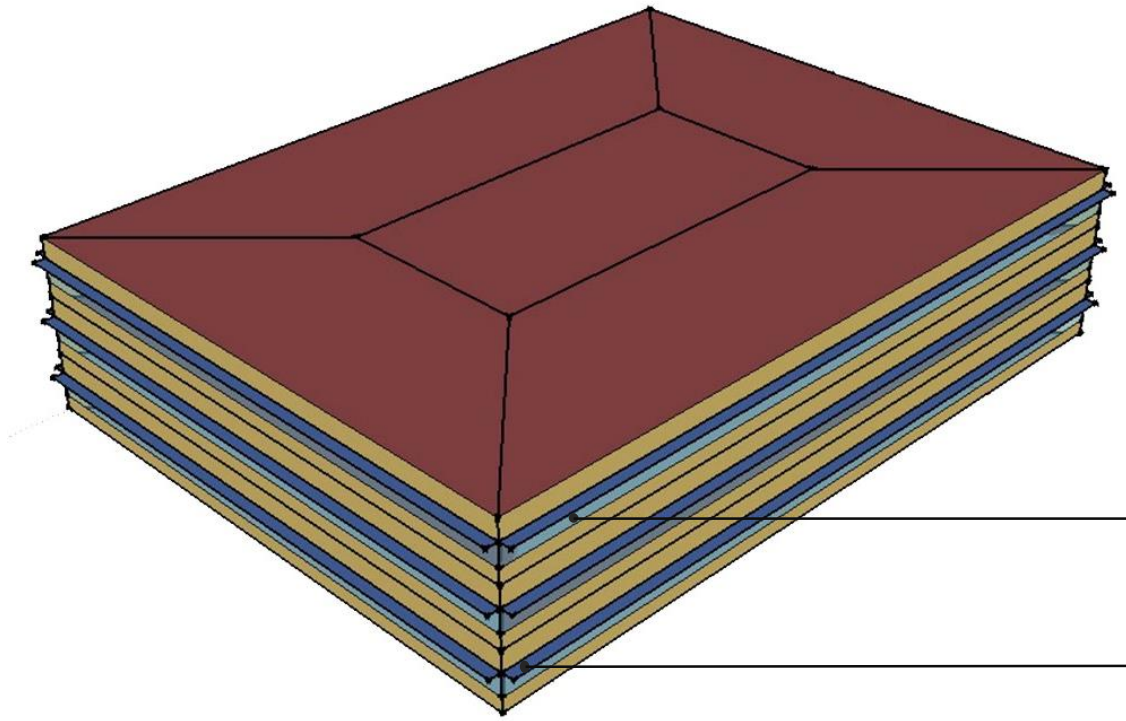
Technical Environmental System

Group: LI JUNJIE , HU LINXUE, GAN HUI , ZHANG XIAOXUAN

TARGET:

The exercise takes into consideration a building used for open offices located in the **Milan,Berlin,Roma** with the different material of walls to reduce the yearly heating consumption.

BUILDING CHARACTRASTICS



This is a 3-level building located in Milan, Italy, and height of it is 30.48m, area of each floor is 30x40m.

All sides of each floor have windows (1221mm high).

There are eaves above all windows, extruding 610mm.

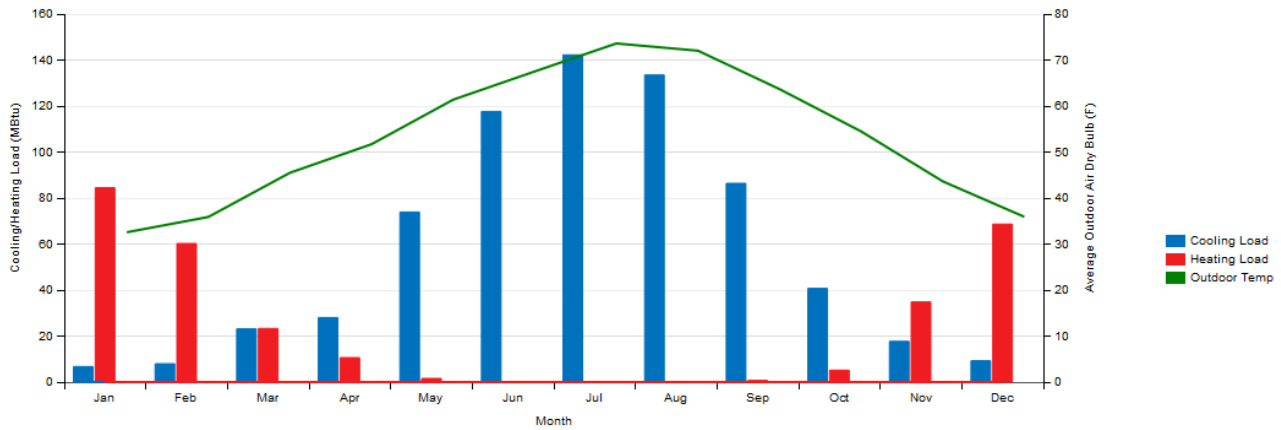
BASE CASE

Yearly energy load

base case	
heating(GJ)	cooling(GJ)
305.95	725.19

Monthly energy load

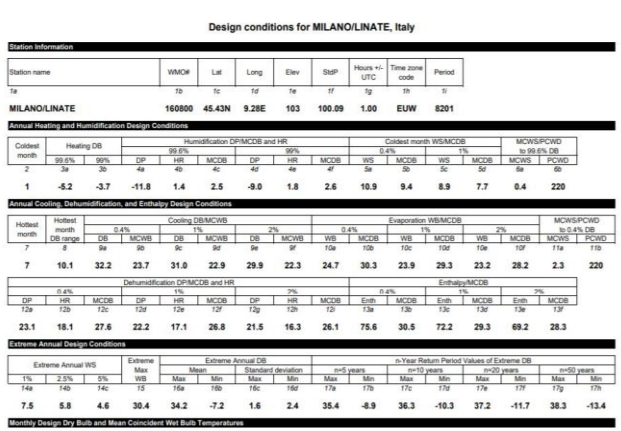
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Outdoor Air Dry Bulb (F)	32.6	35.9	45.5	51.7	61.4	67.5	73.6	72.0	63.7	54.5	43.6	35.9
Cooling Load (MBtu)	6.75	7.98	23.13	28.05	73.92	117.65	142.24	133.5	86.39	40.73	17.72	9.28
Heating Load (MBtu)	84.5	60.25	23.31	10.64	1.59	0.25	0.01	0.01	0.73	5.18	34.84	68.67



THREE CITIES WE CHOSE

THREE CITIES WE CHOSE

Via:2005 ASHRAE Handbook



Design conditions for MILANO/LINATE, Italy

Station Information

Station name	WMO#	Lat	Long	Elev	StdP	Hours +/- UTC	Time zone code	Period
MILANO/LINATE	160800	45.43N	9.28E	103	100.09	1.00	EUW	8201

Annual Heating and Humidification Design Conditions

Coldest month	Heating DB 99.6%	Heating DB 99%	Humidification DP/MCDB and HR 99.6% DP	Humidification DP/MCDB and HR 99.6% HR	Humidification DP/MCDB and HR 99.6% MCDB	Humidification DP/MCDB and HR 99% DP	Humidification DP/MCDB and HR 99% HR	Humidification DP/MCDB and HR 99% MCDB	Coldest month WS/MCDB 0.4% WS	Coldest month WS/MCDB 0.4% MCDB	Coldest month WS/MCDB 1% WS	Coldest month WS/MCDB 1% MCDB	MCWS/PCWD to 99.6% DB MCWS	MCWS/PCWD to 99.6% DB PCWD
1	-5.2	-3.7	-11.8	1.4	2.5	-9.0	1.8	2.6	10.9	9.4	8.9	7.7	0.4	220

Annual Cooling, Dehumidification, and Enthalpy Design Conditions

Hottest month	Hottest month DB range	Cooling DB/MCWB 0.4% DB	Cooling DB/MCWB 0.4% HR	Cooling DB/MCWB 0.4% MCWB	Cooling DB/MCWB 1% DB	Cooling DB/MCWB 1% HR	Cooling DB/MCWB 1% MCWB	Cooling DB/MCWB 2% DB	Cooling DB/MCWB 2% HR	Cooling DB/MCWB 2% MCWB	Evaporation WB/MCDB 0.4% WB	Evaporation WB/MCDB 0.4% MCDB	Evaporation WB/MCDB 1% WB	Evaporation WB/MCDB 1% MCDB	Evaporation WB/MCDB 2% WB	Evaporation WB/MCDB 2% MCDB	MCWS/PCWD to 0.4% DB MCWS	MCWS/PCWD to 0.4% DB PCWD
7	10.1	32.2	23.7	31.0	22.9	29.9	22.3	24.7	30.3	23.9	29.3	23.2	28.2	2.3	220			

Dehumidification DP/MCDB and HR 0.4% DP	0.4% HR	0.4% MCDB	1% DP	1% HR	1% MCDB	2% DP	2% HR	2% MCDB	Enthalpy/MCDB 0.4% Enth	0.4% MCDB	1% Enth	1% MCDB	2% Enth	2% MCDB
23.1	18.1	27.6	22.2	17.1	26.8	21.5	16.3	26.1	75.6	30.5	72.2	29.3	69.2	28.3

Extreme Annual Design Conditions

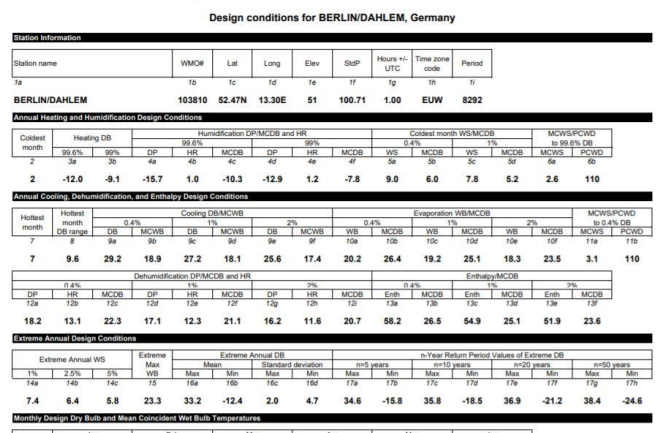
Extreme Annual WS 1%	Extreme Annual WS 2.5%	Extreme Annual WS 5%	Extreme Max WB	Extreme Annual DB Mean Max	Extreme Annual DB Mean Min	Extreme Annual DB Standard deviation Max	Extreme Annual DB Standard deviation Min	n-Year Return Period Values of Extreme DB n=5 years Max	n=5 years Min	n=10 years Max	n=10 years Min	n=20 years Max	n=20 years Min	n=50 years Max	n=50 years Min
7.5	5.8	4.6	30.4	34.2	-7.2	1.6	2.4	35.4	-8.9	36.3	-10.3	37.2	-11.7	38.3	-13.4

Monthly Design Dry Bulb and Mean Coincident Wet Bulb Temperatures

%	Jan DB	Jan MCWB	Feb DB	Feb MCWB	Mar DB	Mar MCWB	Apr DB	Apr MCWB	May DB	May MCWB	Jun DB	Jun MCWB
0.4%	13.7	7.5	18.2	11.6	21.8	13.3	24.2	15.6	29.9	20.7	32.1	23.0
1%	11.8	7.0	16.3	10.4	20.6	12.8	23.2	15.2	28.9	20.0	31.1	22.7
2%	10.2	6.1	14.9	9.1	19.5	12.4	22.1	14.4	27.8	19.2	30.2	22.1

%	Jul DB	Jul MCWB	Aug DB	Aug MCWB	Sep DB	Sep MCWB	Oct DB	Oct MCWB	Nov DB	Nov MCWB	Dec DB	Dec MCWB
0.4%	34.0	24.9	34.1	24.5	29.9	21.3	25.1	18.6	17.2	12.5	12.0	8.2
1%	33.1	24.6	33.1	23.9	29.0	21.2	23.9	18.0	16.1	12.0	11.0	7.9
2%	32.2	24.1	32.2	23.4	28.0	20.7	22.8	17.3	15.1	11.8	10.1	7.7

Milano	
Summer Design Day	21 Jul
Cooling DB 0.4%	32.2°C
Winter Design Day	21 Jan
Heating DB 99.6%	-5.2°C



Design conditions for BERLIN/DAHLEM, Germany

Station Information

Station name	WMO#	Lat	Long	Elev	StdP	Hours +/- UTC	Time zone code	Period
BERLIN/DAHLEM	103810	52.47N	13.30E	51	100.71	1.00	EUW	8292

Annual Heating and Humidification Design Conditions

Coldest month	Heating DB 99.6%	Heating DB 99%	Humidification DP/MCDB and HR 99.6% DP	Humidification DP/MCDB and HR 99.6% HR	Humidification DP/MCDB and HR 99.6% MCDB	Humidification DP/MCDB and HR 99% DP	Humidification DP/MCDB and HR 99% HR	Humidification DP/MCDB and HR 99% MCDB	Coldest month WS/MCDB 0.4% WS	Coldest month WS/MCDB 0.4% MCDB	Coldest month WS/MCDB 1% WS	Coldest month WS/MCDB 1% MCDB	MCWS/PCWD to 99.6% DB MCWS	MCWS/PCWD to 99.6% DB PCWD
2	-12.0	-9.1	-15.7	1.0	-10.3	-12.9	1.2	-7.8	9.0	6.0	7.8	5.2	2.6	110

Annual Cooling, Dehumidification, and Enthalpy Design Conditions

Hottest month	Hottest month DB range	Cooling DB/MCWB 0.4% DB	Cooling DB/MCWB 0.4% MCWB	Cooling DB/MCWB 1% DB	Cooling DB/MCWB 1% MCWB	Cooling DB/MCWB 2% DB	Cooling DB/MCWB 2% MCWB	Evaporation WB/MCDB 0.4% WB	Evaporation WB/MCDB 0.4% MCDB	Evaporation WB/MCDB 1% WB	Evaporation WB/MCDB 1% MCDB	Evaporation WB/MCDB 2% WB	Evaporation WB/MCDB 2% MCDB	MCWS/PCWD to 0.4% DB MCWS	MCWS/PCWD to 0.4% DB PCWD
7	9.6	29.2	18.9	27.2	18.1	25.6	17.4	20.2	26.4	19.2	25.1	18.3	23.5	3.1	110

Dehumidification DP/MCDB and HR 0.4% DP	0.4% HR	0.4% MCDB	1% DP	1% HR	1% MCDB	2% DP	2% HR	2% MCDB	Enthalpy/MCDB 0.4% Enth	0.4% MCDB	1% Enth	1% MCDB	2% Enth	2% MCDB
18.2	13.1	22.3	17.1	12.3	21.1	16.2	11.6	20.7	58.2	26.5	54.9	25.1	51.9	23.6	

Extreme Annual Design Conditions

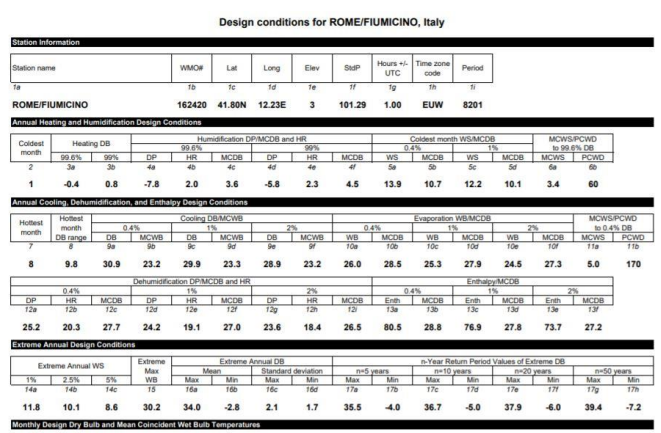
Extreme Annual WS 1%	Extreme Annual WS 2.5%	Extreme Annual WS 5%	Extreme Max WB	Extreme Annual DB Mean Max	Extreme Annual DB Mean Min	Extreme Annual DB Standard deviation Max	Extreme Annual DB Standard deviation Min	n-Year Return Period Values of Extreme DB n=5 years Max	n=5 years Min	n=10 years Max	n=10 years Min	n=20 years Max	n=20 years Min	n=50 years Max	n=50 years Min
7.4	6.4	5.8	23.3	33.2	-12.4	2.0	4.7	34.6	-15.8	35.8	-18.5	36.9	-21.2	38.4	-24.6

Monthly Design Dry Bulb and Mean Coincident Wet Bulb Temperatures

%	Jan DB	Jan MCWB	Feb DB	Feb MCWB	Mar DB	Mar MCWB	Apr DB	Apr MCWB	May DB	May MCWB	Jun DB	Jun MCWB
0.4%	11.5	8.9	14.1	9.7	17.1	10.5	22.7	13.0	27.0	16.6	30.4	18.8
1%	10.2	8.2	12.4	8.6	15.5	9.7	21.3	12.8	26.0	16.0	28.8	18.0
2%	9.2	7.4	10.5	7.9	13.8	9.0	19.7	12.0	25.0	15.5	27.2	17.4

%	Jul DB	Jul MCWB	Aug DB	Aug MCWB	Sep DB	Sep MCWB	Oct DB	Oct MCWB	Nov DB	Nov MCWB	Dec DB	Dec MCWB
0.4%	31.8	20.1	32.1	20.3	26.0	18.2	21.4	15.8	13.2	10.7	11.9	9.6
1%	30.4	19.5	30.2	20.1	24.6	17.4	19.9	14.6	12.5	10.4	11.1	8.9
2%	29.4	19.0	28.6	19.2	23.4	16.8	18.6	14.0	11.8	9.9	10.5	8.7

Berlin	
Summer Design Day	21 Jul
Cooling DB 0.4%	29.2°C
Winter Design Day	21 Jan
Heating DB 99.6%	-12°C



Design conditions for ROME/FIUMICINO, Italy

Station Information

Station name	WMO#	Lat	Long	Elev	StdP	Hours +/- UTC	Time zone code	Period
ROME/FIUMICINO	162420	41.80N	12.23E	3	101.29	1.00	EUW	8201

Annual Heating and Humidification Design Conditions

Coldest month	Heating DB 99.6%	Heating DB 99%	Humidification DP/MCDB and HR 99.6% DP	Humidification DP/MCDB and HR 99.6% HR	Humidification DP/MCDB and HR 99.6% MCDB	Humidification DP/MCDB and HR 99% DP	Humidification DP/MCDB and HR 99% HR	Humidification DP/MCDB and HR 99% MCDB	Coldest month WS/MCDB 0.4% WS	Coldest month WS/MCDB 0.4% MCDB	Coldest month WS/MCDB 1% WS	Coldest month WS/MCDB 1% MCDB	MCWS/PCWD to 99.6% DB MCWS	MCWS/PCWD to 99.6% DB PCWD
1	-0.4	0.8	-7.8	2.0	3.6	-5.8	2.3	4.5	13.9	10.7	12.2	10.1	3.4	60

Annual Cooling, Dehumidification, and Enthalpy Design Conditions

Hottest month	Hottest month DB range	Cooling DB/MCWB 0.4% DB	Cooling DB/MCWB 0.4% MCWB	Cooling DB/MCWB 1% DB	Cooling DB/MCWB 1% MCWB	Cooling DB/MCWB 2% DB	Cooling DB/MCWB 2% MCWB	Evaporation WB/MCDB 0.4% WB	Evaporation WB/MCDB 0.4% MCDB	Evaporation WB/MCDB 1% WB	Evaporation WB/MCDB 1% MCDB	Evaporation WB/MCDB 2% WB	Evaporation WB/MCDB 2% MCDB	MCWS/PCWD to 0.4% DB MCWS	MCWS/PCWD to 0.4% DB PCWD
8	9.8	30.9	23.2	29.9	23.3	28.9	23.2	26.0	28.5	25.3	27.9	24.5	27.3	5.0	170

Dehumidification DP/MCDB and HR 0.4% DP	0.4% HR	0.4% MCDB	1% DP	1% HR	1% MCDB	2% DP	2% HR	2% MCDB	Enthalpy/MCDB 0.4% Enth	0.4% MCDB	1% Enth	1% MCDB	2% Enth	2% MCDB
25.2	20.3	27.7	24.2	19.1	27.0	23.6	18.4	26.5	80.5	28.8	76.9	27.8	73.7	27.2	

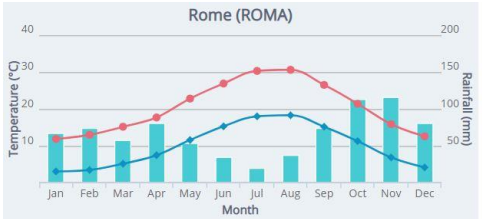
Extreme Annual Design Conditions

Extreme Annual WS 1%	Extreme Annual WS 2.5%	Extreme Annual WS 5%	Extreme Max WB	Extreme Annual DB Mean Max	Extreme Annual DB Mean Min	Extreme Annual DB Standard deviation Max	Extreme Annual DB Standard deviation Min	n-Year Return Period Values of Extreme DB n=5 years Max	n=5 years Min	n=10 years Max	n=10 years Min	n=20 years Max	n=20 years Min	n=50 years Max	n=50 years Min
11.8	10.1	8.6	30.2	34.0	-2.8	2.1	1.7	35.5	-4.0	36.7	-5.0	37.9	-6.0	39.4	-7.2

Monthly Design Dry Bulb and Mean Coincident Wet Bulb Temperatures

%	Jan DB	Jan MCWB	Feb DB	Feb MCWB	Mar DB	Mar MCWB	Apr DB	Apr MCWB	May DB	May MCWB	Jun DB	Jun MCWB
0.4%	16.8	13.6	17.0	12.8	20.2	13.6	22.0	14.9	27.1	18.4	30.1	21.0
1%	16.1	13.2	16.2	12.3	18.9	13.3	21.0	14.8	26.1	18.4	29.2	20.9
2%	15.3	12.6	15.8	12.0	17.9	12.8	20.1	14.4	25.1	18.7	28.5	20.8

%	Jul DB	Jul MCWB	Aug DB	Aug MCWB	Sep DB	Sep MCWB	Oct DB	Oct MCWB	Nov DB	Nov MCWB	Dec DB	Dec MCWB
0.4%	32.5	24.0	32.8	23.4	29.8	21.9	26.2	19.9	21.8	17.0	18.1	15.1
1%	31.6	23.6	31.8	23.3	28.8	21.8	25.2	20.3	20.9	17.5	17.2	14.7
2%	30.9	23.4	31.0	23.4	28.1	22.2	24.9	20.3	20.1	16.9	16.9	14.5



Roma	
Summer Design Day	21 Aug
Cooling DB 0.4%	30.9°C
Winter Design Day	21 Jan
Heating DB 99.6%	-0.4°C

THREE CITIES ANALYSIS

Yearly energy load

Monthly energy load

MILAN

base case	
heating(GJ)	cooling(GJ)
305.95	725.19

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Outdoor Air Dry Bulb (F)	32.6	35.9	45.5	51.7	61.4	67.5	73.6	72.0	63.7	54.5	43.6	35.9
Cooling Load (MBtu)	6.75	7.98	23.13	28.05	73.92	117.65	142.24	133.5	86.39	40.73	17.72	9.28
Heating Load (MBtu)	84.5	60.25	23.31	10.64	1.59	0.25	0.01	0.01	0.73	5.18	34.84	68.67

BERLIN

berlin	
heating(GJ)	cooling(GJ)
480.76	439.87

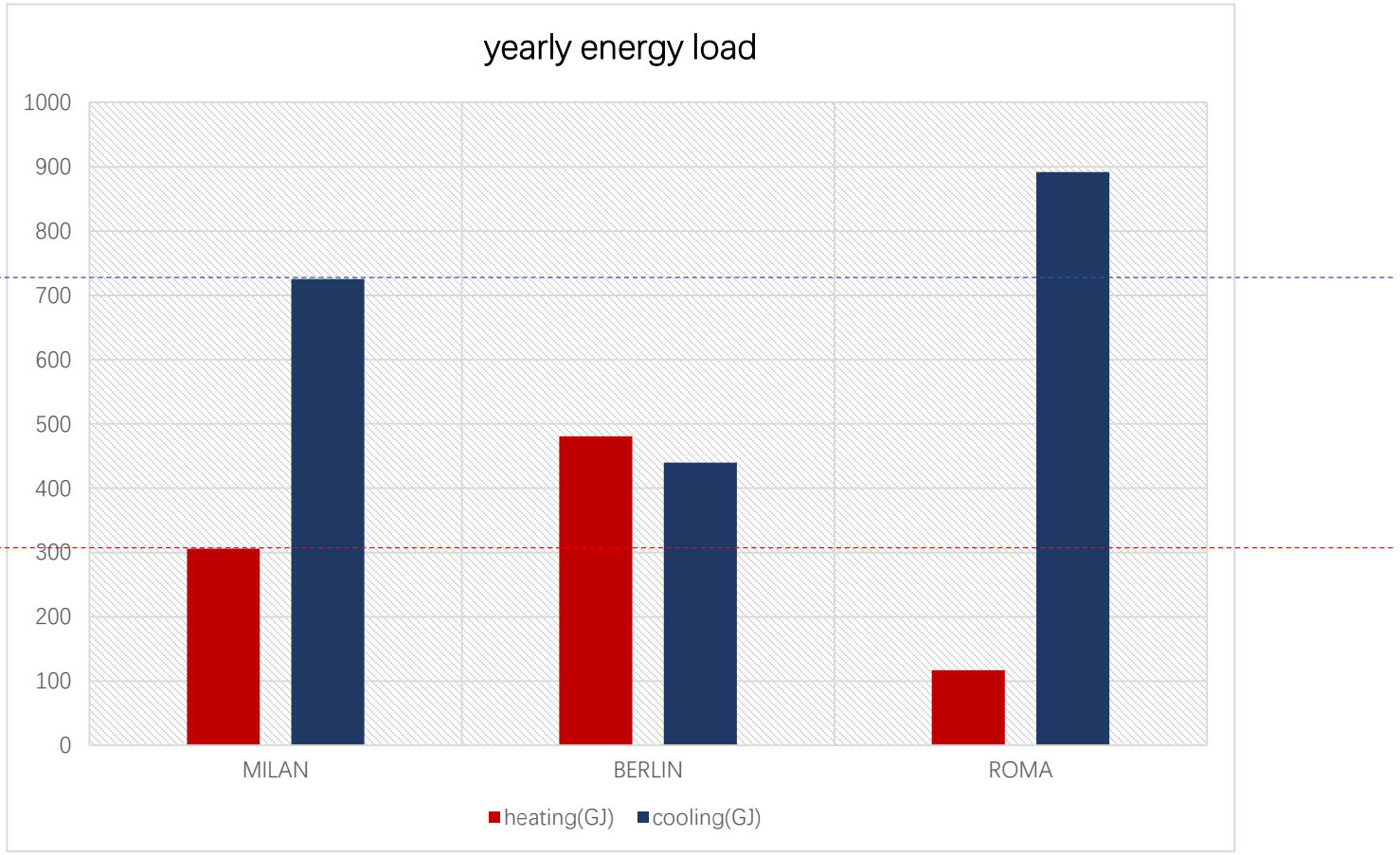
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Outdoor Air Dry Bulb (F)	35.4	32.5	41.7	47.0	57.2	63.6	66.4	65.2	59.0	50.4	40.0	36.4
Cooling Load (MBtu)	6.31	4.29	12.81	20.16	49.34	71.9	81.34	85.26	44.66	23.63	10.72	6.49
Heating Load (MBtu)	94.49	92.83	56.99	26.04	8.62	1.22	0.81	0.83	3.17	18.75	61.89	90.02

ROMA

roma	
heating(GJ)	cooling(GJ)
117.19	892.00

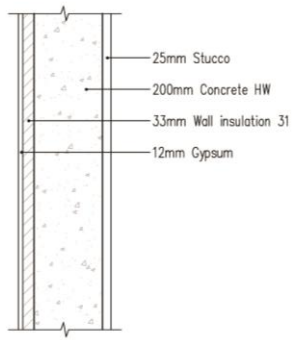
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Outdoor Air Dry Bulb (F)	44.6	46.9	50.7	55.5	62.4	68.9	74.1	73.7	69.3	62.2	55.9	48.2
Cooling Load (MBtu)	16.86	19.55	29.3	38.19	82.99	115.19	146.85	149.92	113.34	74.58	38.5	20.18
Heating Load (MBtu)	36.64	23.74	13.74	4.92	0.83	0.08	0.0	0.02	0.12	1.47	6.29	23.22

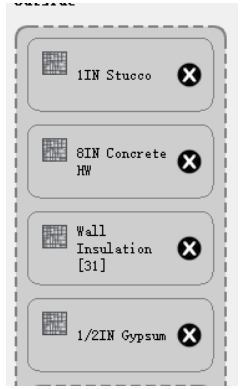
THREE CITIES ANALYSIS

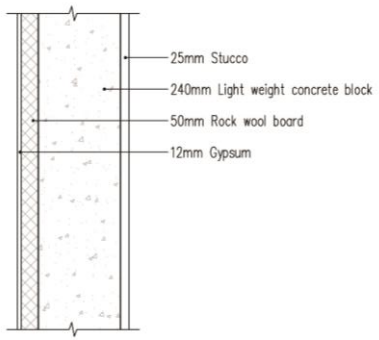


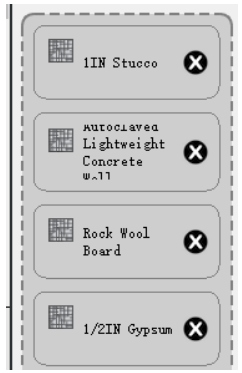
From the table we can see between the 3 cities,Milan is the most energy-intensive to use heating.Next is Milan and the least is Roma. In Berlin,heating load is the majority,but the different is not so significant.In Milan,cooling load is higher than cooling.In the contrary, in Roma,the cooling load is the majority,nearly 9 times than heating load.

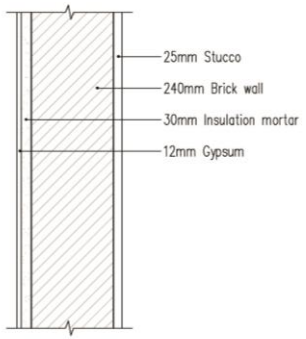
WALL Components and U-Value

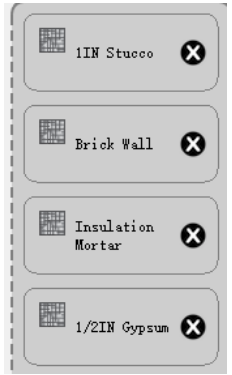












BASE CASE(ASHRAE 189.1-2009 ClimateZone1)

layer	Thickness (m)	Conductivity λ (W/m.℃)	R（㎡℃/W)	U(W/㎡℃)=1/R total
1IN Stucco	0.0253	0.6918	0.03657	
8IN Concrete HW	0.2033	1.7296	0.11754	
Wall Insulation 31	0.0337	0.0432	0.78009	
1/2IN Gypsum	0.0127	0.16	0.07938	
R total			1.01358	
U=1/R total				0.9866

2NEW CASE 1

layer	Thicknes s/(m)	Conductivity λ (W/m.℃)	R（㎡℃/W)	U(W/㎡℃)=1/R total
1IN Stucco	0.0253	0.6918	0.03657	
lightweight concrete block	0.24	0.2	1.2	
Rock Wool Board	0.05	0.036	1.38889	
1/2IN Gypsum	0.0127	0.16	0.07938	
R total			2.70484	
U=1/R total				0.36971

NEW CASE 2

layer	Thicknes s(m)	Conductivity λ (W/m.℃)	R（㎡℃/W)	U(W/㎡℃)=1/R total
1IN Stucco	0.0253	0.6918	0.036571	
Brick Wall	0.24	1.1	0.218182	
Insulation Mortar	0.03	0.08	0.375	
1/2IN Gypsum	0.0127	0.16	0.079375	
R total			0.709128	
U=1/R total				1.4102

THREE WALLS ANALYSIS

Yearly energy load

Monthly energy load

BASE CASE

base case	
heating(GJ)	cooling(GJ)
305.95	725.19

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Outdoor Air Dry Bulb (F)	32.6	35.9	45.5	51.7	61.4	67.5	73.6	72.0	63.7	54.5	43.6	35.9
Cooling Load (MBtu)	6.75	7.98	23.13	28.05	73.92	117.65	142.24	133.5	86.39	40.73	17.72	9.28
Heating Load (MBtu)	84.5	60.25	23.31	10.64	1.59	0.25	0.01	0.01	0.73	5.18	34.84	68.67

NEW CASE 1

new case 1	
heating(GJ)	cooling(GJ)
270.92	716.78

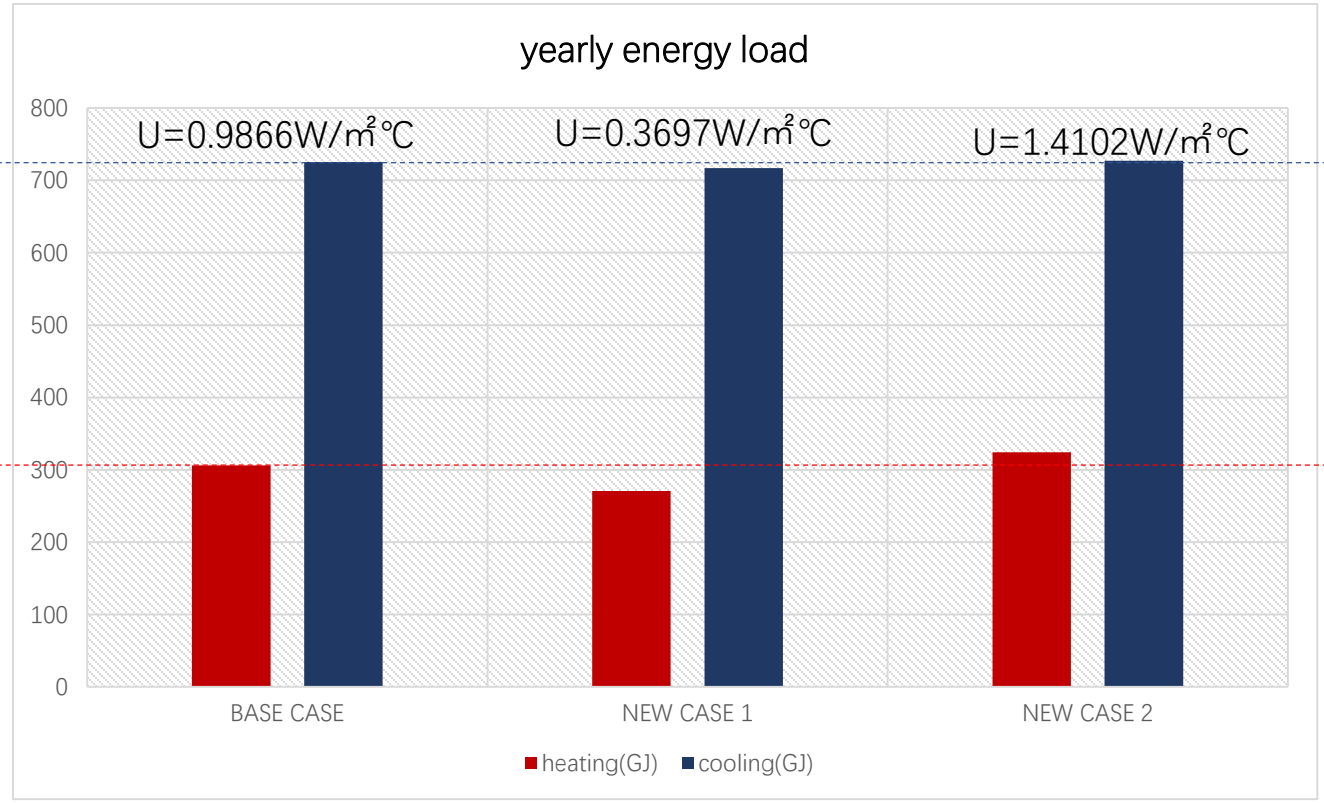
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Outdoor Air Dry Bulb (F)	32.6	35.9	45.5	51.7	61.4	67.5	73.6	72.0	63.7	54.5	43.6	35.9
Cooling Load (MBtu)	6.9	8.13	23.46	28.34	73.47	115.81	138.26	130.48	85.4	41.66	18.02	9.46
Heating Load (MBtu)	75.31	53.28	21.08	9.29	1.43	0.26	0.02	0.01	0.77	4.7	30.36	60.28

NEW CASE 2

New case 2	
heating(GJ)	cooling(GJ)
324.36	727.10

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Outdoor Air Dry Bulb (F)	32.6	35.9	45.5	51.7	61.4	67.5	73.6	72.0	63.7	54.5	43.6	35.9
Cooling Load (MBtu)	6.67	7.89	22.68	27.5	73.52	118.28	144.21	134.92	86.76	40.01	17.54	9.19
Heating Load (MBtu)	89.78	64.28	24.12	11.13	1.56	0.2	0.01	0.01	0.63	5.3	37.15	73.27

THREE WALLS ANALYSIS



According to the difference of U-value,we can know the more lower U-value of the the wall can help reduce the energy load. So heating and cooling load is also affected by other facade components.Actunally a energy-saving building,window,roof and floor material is also another factor that have high impact on HVAC load.

From the results,we can find don't have the obvious differces with the cooling,but in the part of heating,Case1 is a better solution to choose.