

**BUILDING ANALYSIS**

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**TECHNICAL ENVIRONMENTAL SYSTEM**

SUBMITTED BY

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## BUILDING ANALYSIS INTRODUCTION

This report focuses on the Building Analysis by calculating the energy performance of a selected built form using 'Open Studio' software. The building chosen is an Office building with a set of rooms like Office Rooms, service core (Pantry, toilets), Corridor and staircase. The office has glass windows all along the 4 facades. The 3 sides of the building have an overhang as a shading device. All the floor plans of the Office building are shown in Figure 1.

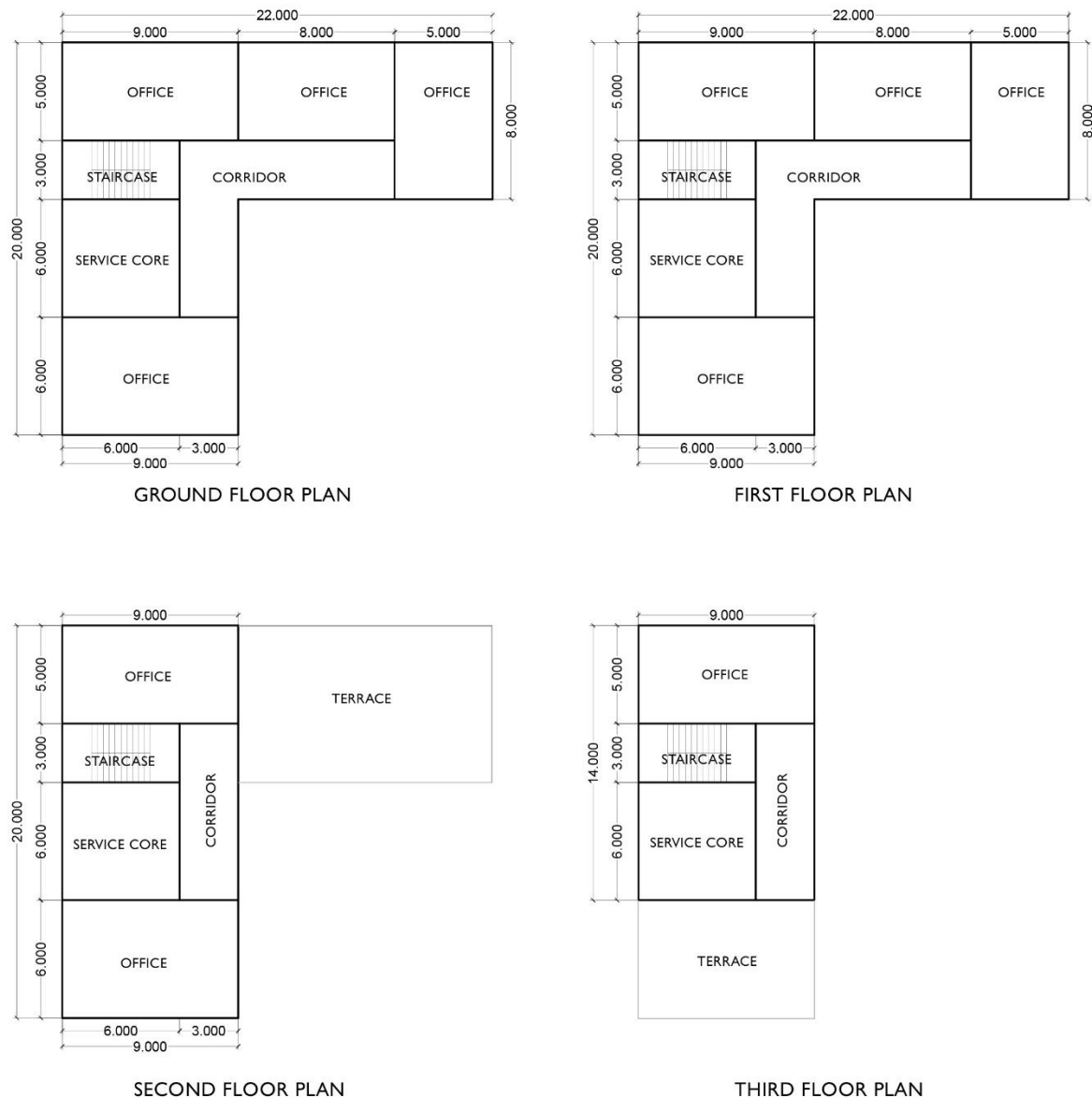


Figure 1

The different thermal zones in the building have been marked in different colours as shown in the Figure 2.

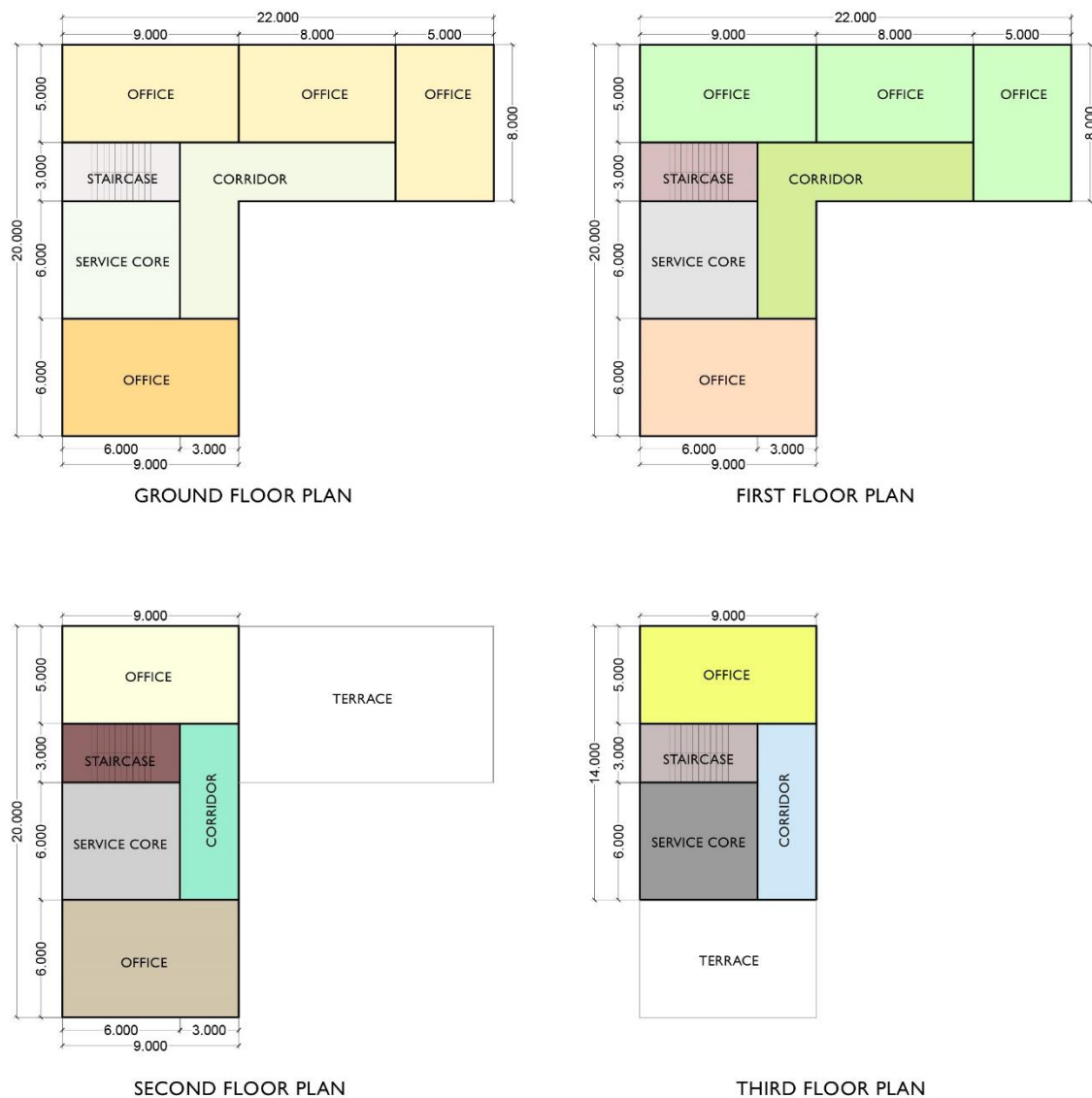


Figure 2

This building has been placed in 3 different cities of the world - **Sydney, Australia; Ahmedabad, India; Milan, Italy**. This model is then analysed using the software to calculate different parameters such as Cooling and Heating Loads, Energy Use and Site and source Energy.

The second step was to change the primary materials of the building and calculate the Energy Performance of the same built form in one of the above mentioned cities. The city of comparison was chosen as Milan, Italy. The alterations accommodated in the building design are further mentioned in the report.

Once the recalculations of the Energy performance were done, it was compared to the parameters that were Cooling and Heating Loads, Energy Use and Site and Source Energy. The results were examined and conclusion was made.

## CLIMATIC ZONES ANALYSIS

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### SYDNEY:

The climate of Sydney is humid subtropical, shifting from mild and cool in winter to warm and hot in the summer, with no extreme seasonal differences as the weather is moderated by proximity to the ocean, although more contrasting temperatures are recorded in the inland western suburbs. The city receives around 20 thunderstorms per year. During summer (December – February), average temperatures range from 18.6 - 25.8°C, and average humidity spikes to 65%. Autumn (March – May) is the mildest time of year in Sydney when the humidity drops and average temperatures fall between 14.6 - 22.2°C. Sydney's coolest months are June to August when average temperatures drop between 8.8 - 17°C. Sydney's rainfall is generally highest in June, with an average of 132 mm, while July is the coolest month when average daytime temperatures reach just 13°C. In spring (September – November), days are warmer but the humidity is not as high as summer. Average daily temperatures range from 11 - 23°C.

### AHMEDABAD:

Ahmedabad has a hot, semi-arid climate with marginally less rain than required for a tropical savanna climate. There are three main seasons: summer, monsoon and winter. Aside from the monsoon season, the climate is extremely dry. The weather is hot from March to June; the average summer maximum is 43 °C, and the average minimum is 24 °C. From November to February, the average maximum temperature is 30 °C, the average minimum is 13 °C, and the climate is extremely dry. Cold northerly winds are responsible for a mild chill in January. The southwest monsoon brings a humid climate from mid-June to mid-September. The average annual rainfall is about 800 mm.

### MILAN:

Milan has a humid subtropical climate. Winter (December to February) is cold, wet and gray. Temperatures often remain around freezing (0 °C) also in the daytime. There is a moderate amount of rainy days, even though the winter is relatively dry when compared with the other seasons. Snow usually falls at least once every year and the temperature rarely drops below -10 °C. Typically, from the second half of February, the temperature tends to increase, and highs exceed quite often 10 °C. Spring in Milan is initially unstable, and gradually becomes a pleasant season, especially from mid-April to late May, when there are many sunny days, with mild or pleasantly warm temperatures during the day. Summer, from June to August, is hot and muggy, and generally sunny. Autumn offers several nice days in September, and sometimes in early October, then quickly becomes cloudy and rainy. The first cold days typically occur in November. Overall, autumn is the rainiest season of the year. Although the number of rainy days is not too high, when it rains, the rain tends to last several hours, even the whole day.

## BUILDING SUMMARY

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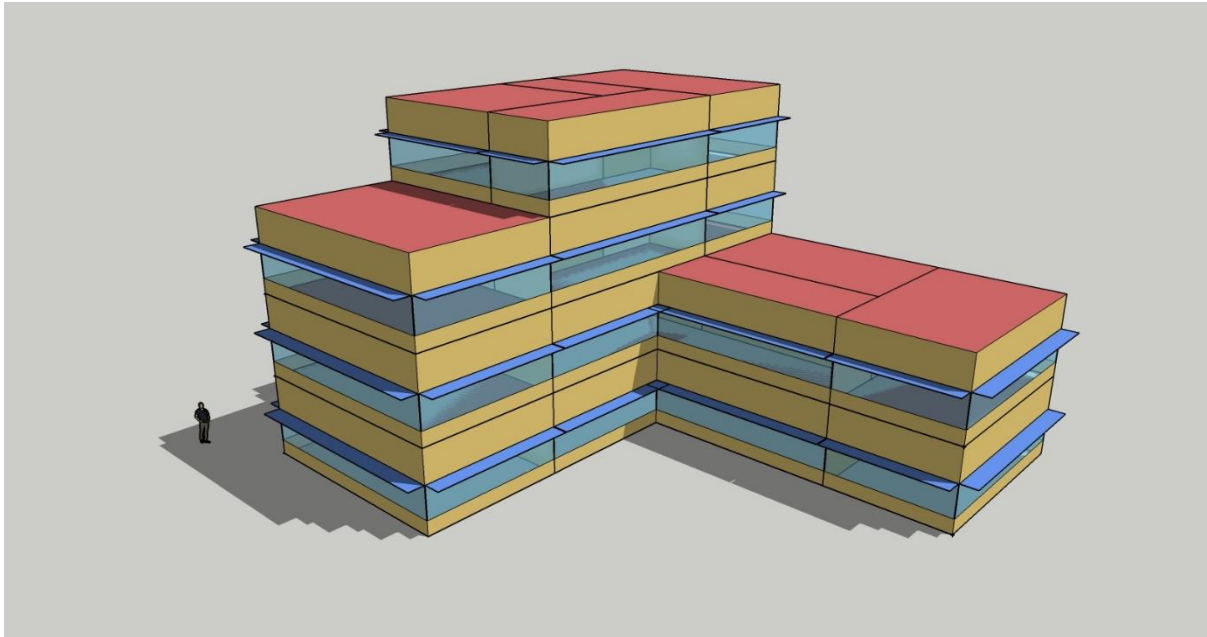


Figure 3

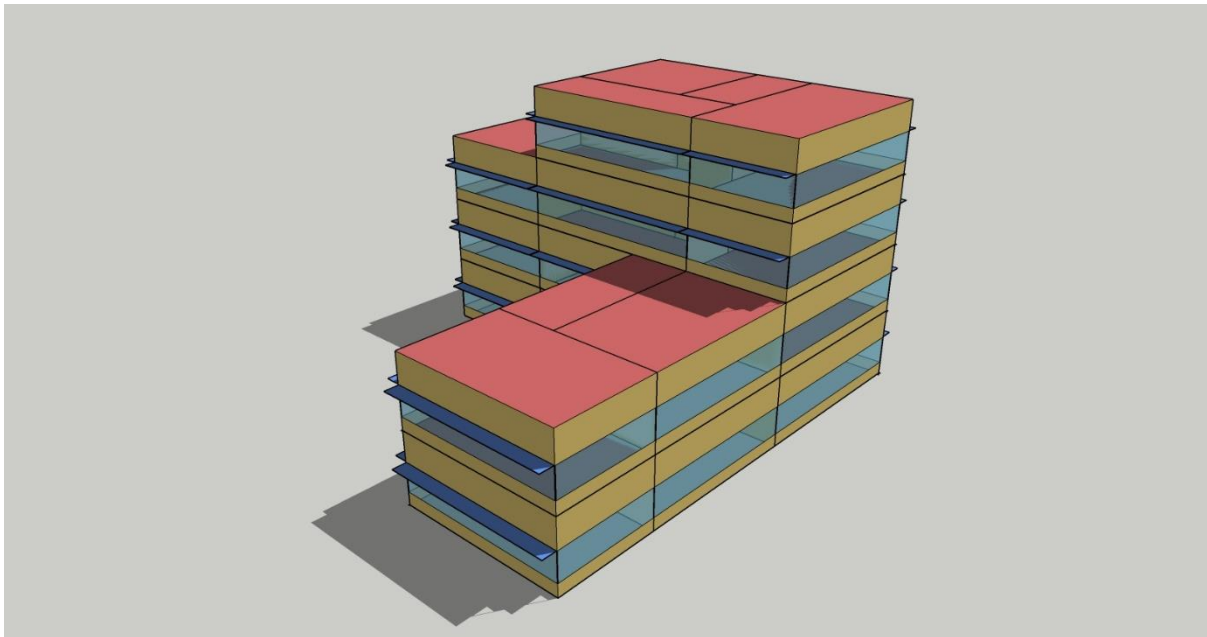


Figure 4

BUILDING: Office building, Sydney

INFORMATION	VALUE	UNITS
Net site energy	375	GJ
Total building area	874	m <sup>2</sup>
Energy Use Intensity (Net Site Energy/Total Building Area)	0.4290	GJ/m <sup>2</sup>

BUILDING: Office building, Ahmedabad

INFORMATION	VALUE	UNITS
Net site energy	838.93	GJ
Total building area	874	m <sup>2</sup>
Energy Use Intensity (Net Site Energy/Total Building Area)	0.959	GJ/m <sup>2</sup>

BUILDING: Office building, Milan

INFORMATION	VALUE	UNITS
Net site energy	663.47	GJ
Total building area	874	m <sup>2</sup>
Energy Use Intensity (Net Site Energy/Total Building Area)	0.759	GJ/m <sup>2</sup>

## MATERIALS APPLIED

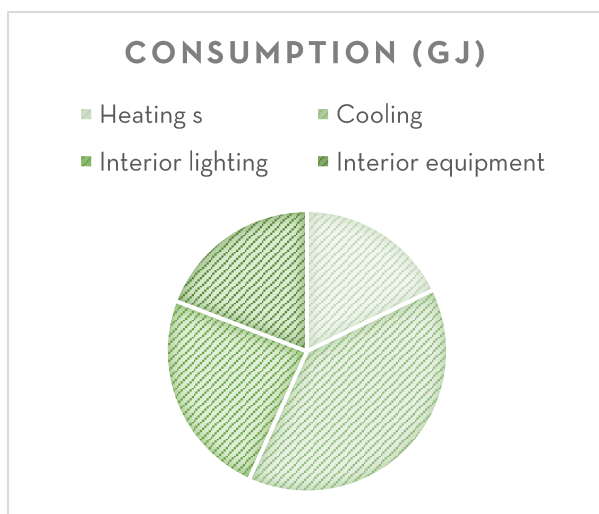
Walls (outside to inside): 1" stucco, 8" concrete HW, Wall insulation [36], 1/2" Gypsum

Windows: Theoretical Glass [202]

Roof (outside to inside): Roof membrane, roof insulation [21], metal decking

## ENERGY USE

SYDNEY:



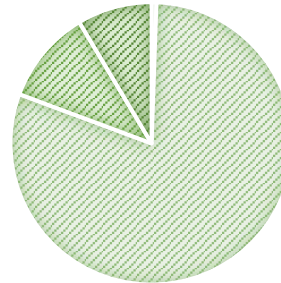
END USE	CONSUMPTION (GJ)
Heating	66.78
Cooling	146.16
Interior lighting	90.32
Interior equipment	71.85

## AHMEDABAD:

END USE	CONSUMPTION (GJ)
Heating	4.63
Cooling	672.07
Interior lighting	90.32
Interior equipment	71.85

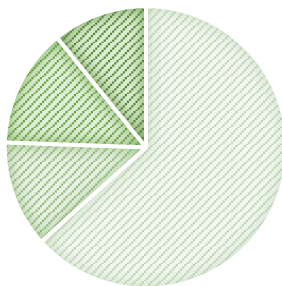
### CONSUMPTION (GJ)

- Heating a
- Cooling
- Interior lighting
- Interior equipment



### CONSUMPTION (GJ)

- Heating m
- Cooling
- Interior lighting
- Interior equipment



## MILAN:

END USE	CONSUMPTION (GJ)
Heating	420.23
Cooling	81.07
Interior lighting	90.32
Interior equipment	71.85

## SITE AND SOURCE ENERGY

### SYDNEY:

	TOTAL ENERGY [GJ]	ENERGY PER TOTAL BUILDING AREA [MJ/M2]	ENERGY PER CONDITIONED BUILDING AREA [MJ/M2]
Total site energy	375.10	429.18	429.18
Net site energy	375.10	429.18	429.18
Total source energy	909.17	1040.24	1040.24
Net source energy	909.17	1040.24	1040.24

## AHMEDABAD:

	TOTAL ENERGY [GJ]	ENERGY PER TOTAL BUILDING AREA [MJ/M <sup>2</sup> ]	ENERGY PER CONDITIONED BUILDING AREA [MJ/M <sup>2</sup> ]
Total site energy	838.93	959.87	959.87
Net site energy	838.93	959.87	959.87
Total source energy	1240.01	1418.77	1418.77
Net source energy	1240.01	1418.77	1418.77

## MILAN:

	TOTAL ENERGY [GJ]	ENERGY PER TOTAL BUILDING AREA [MJ/M <sup>2</sup> ]	ENERGY PER CONDITIONED BUILDING AREA [MJ/M <sup>2</sup> ]
Total site energy	663.47	759.12	759.12
Net site energy	663.47	759.12	759.12
Total source energy	2117.61	2422.90	2422.90
Net source energy	2117.61	2422.90	2422.90

## RECALCULATING THE ENERGY PERFORMANCE

As mentioned above the city we chose for the recalculation of the energy performance by using different materials is Milan, Italy.

The materials are:

Walls (outside to inside): 1" stucco, 8" concrete HW, 1/2" Gypsum

Windows: Theoretical Glass [202]

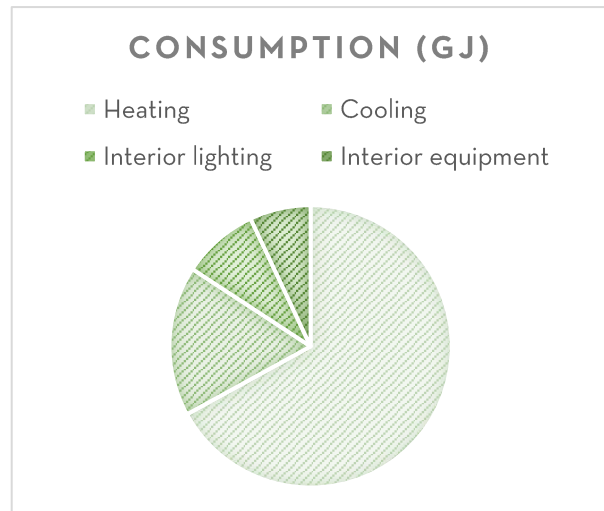
Roof (outside to inside): Roof membrane, metal decking

INFORMATION	VALUE	UNITS
Net site energy	1027.81	GJ
Total building area	874	m <sup>2</sup>
EUI (Net Site Energy/Total Building Area)	1.175	GJ/m <sup>2</sup>



## ENERGY USE

END USE	CONSUMPTION (GJ)
Heating	688.69
Cooling	176.95
Interior lighting	90.32
Interior equipment	71.85



## SITE AND SOURCE ENERGY

	TOTAL ENERGY [GJ]	ENERGY PER TOTAL BUILDING AREA [MJ/M2]	ENERGY PER CONDITIONED BUILDING AREA [MJ/M2]
Total site energy	1027.81	1175.98	1175.98
Net site energy	1027.81	1175.98	1175.98
Total source energy	3188.85	3648.57	3648.57
Net source energy	3188.85	3648.57	3648.57

The materials are:

Walls (outside to inside): 1" stucco, 8" concrete HW, OS Wall insulation [300mm], 1/2" Gypsum, 1" stucco

Windows: Theoretical Glass [221]

Roof (outside to inside): Roof membrane, roof insulation [21], metal decking, GO5 25mm Wood

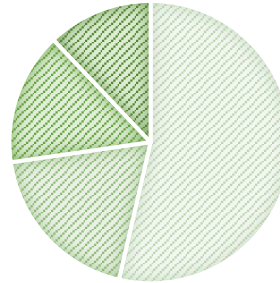
INFORMATION	VALUE	UNITS
Net site energy	594.58	GJ
Total building area	874	m <sup>2</sup>
EUI (Net Site Energy/Total Building Area)	0.68	GJ/m <sup>2</sup>

## ENERGY USE

END USE	CONSUMPTION (GJ)
Heating	318.73
Cooling	113.67
Interior lighting	90.32
Interior equipment	71.85

### CONSUMPTION (GJ)

- Heating
- Cooling
- Interior lighting
- Interior equipment



## SITE AND SOURCE ENERGY

	TOTAL ENERGY [GJ]	ENERGY PER TOTAL BUILDING AREA [MJ/M2]	ENERGY PER CONDITIONED BUILDING AREA [MJ/M2]
Total site energy	594.58	680.30	680.30
Net site energy	594.58	680.30	680.30
Total source energy	1785.29	2042.67	2042.67
Net source energy	1785.29	2042.67	2042.67

## CONCLUSION

In this report, we have analysed one built form in 3 different cities around the world, that is, Sydney, Ahmedabad and Milan with default materials and according to the people's activities in different seasons during weekdays and weekends. Thus, the designed building model shall perform best and save maximum amount of energy and cost if designed in Sydney, than in Milan and Ahmedabad.

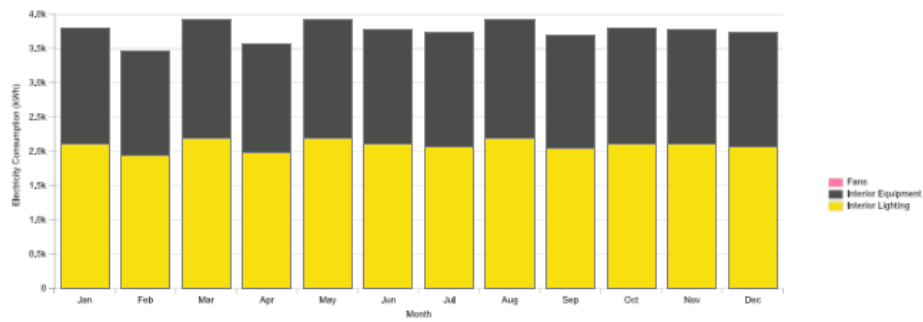
Furthermore, the energy performance of the same built form has also been reviewed with different set of building materials in one of the previously analysed city, that is, Milan.

When we reviewed the same building in Milan with or without insulation, it was recorded that by altering the materials there are changes in the heating and cooling consumptions of the building. The heating consumption increases without the insulation in the walls while it decreases with the use of insulations. Also, the net site energy changes too. It increases without the insulation and decreases with the insulation.

Hence, it can be concluded that the same built form in the same location can require more energy or less energy depending on the building materials used and can be made more comfortable in the interior spaces by altering few aspects of the design construction.

# SYDNEY

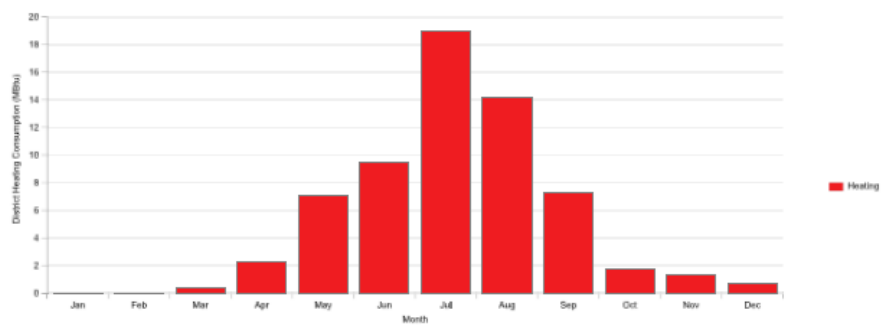
## Electricity Consumption (kWh)



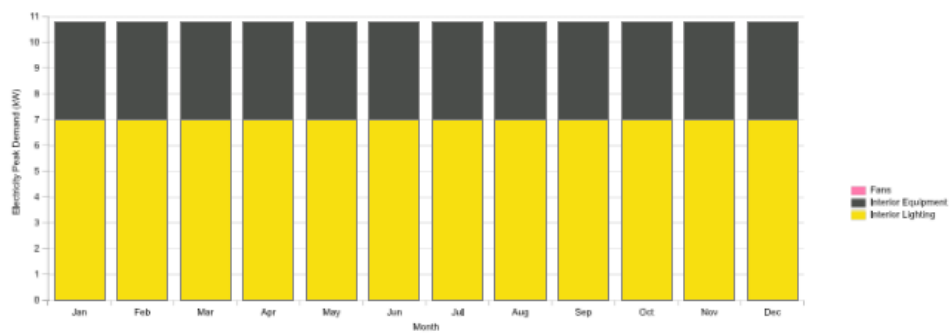
## District Cooling Consumption (MBtu)



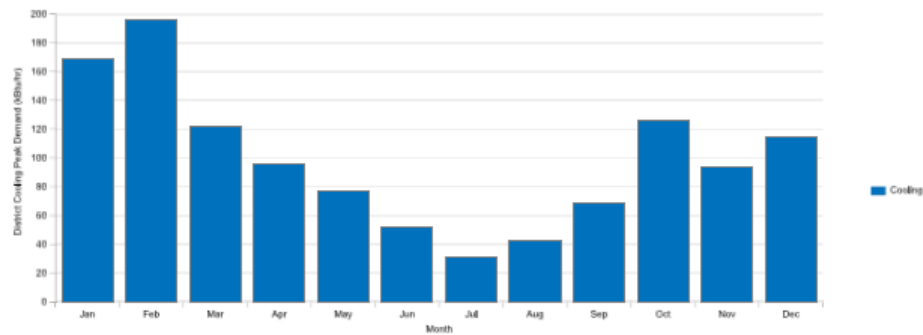
## District Heating Consumption (MBtu)



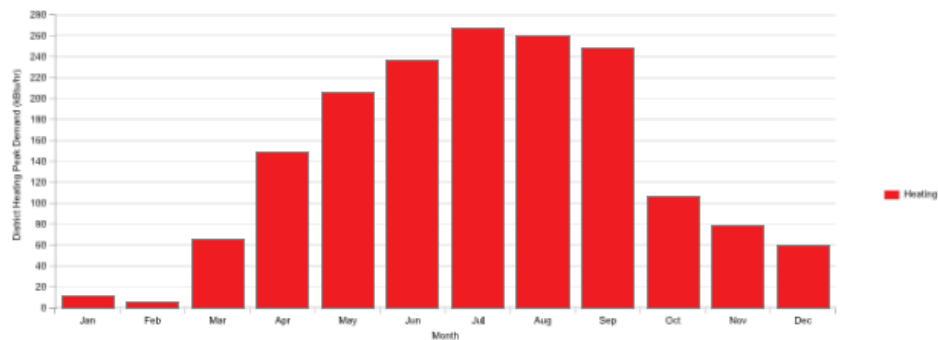
## Electricity peak Demand (kW)



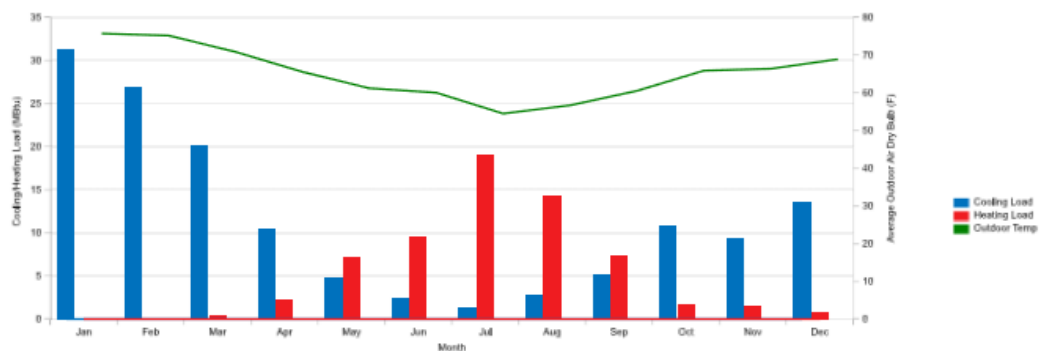
## District Cooling Peak Demand (kBtu/hr)



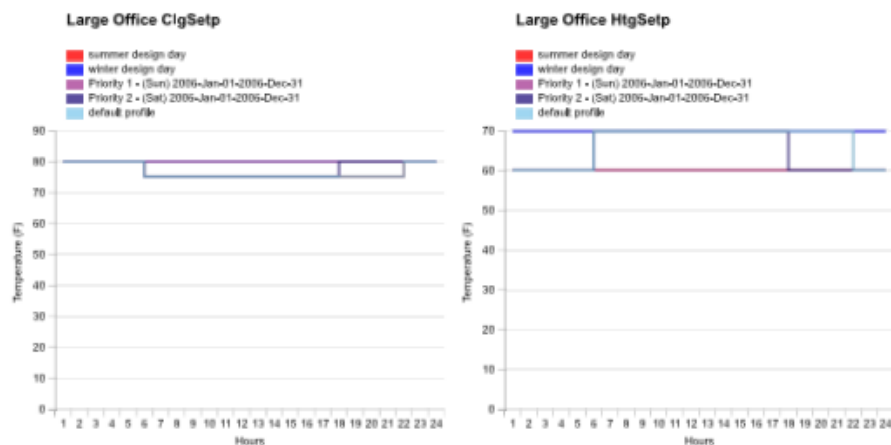
## District Heating peak Demand (kBtu/hr)



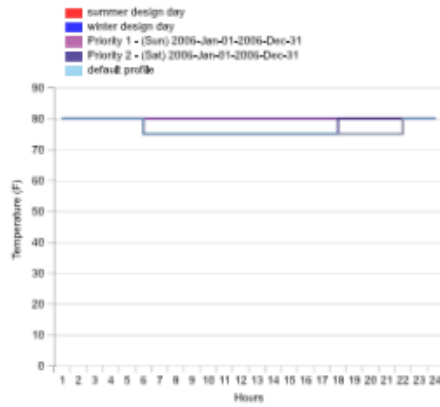
## HVAC Load Profiles: Monthly



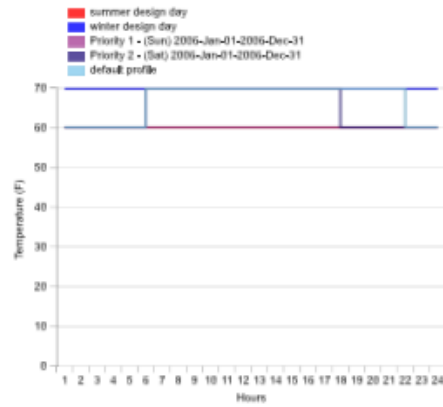
## Schedule Overview



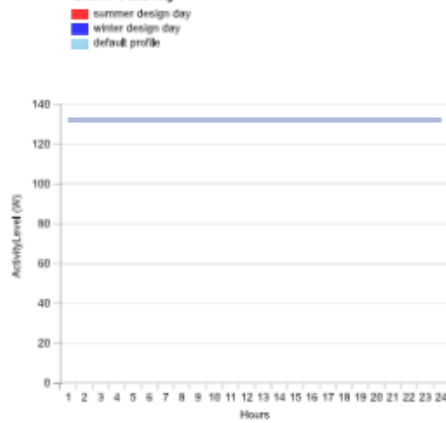
Medium Office CtgSetp



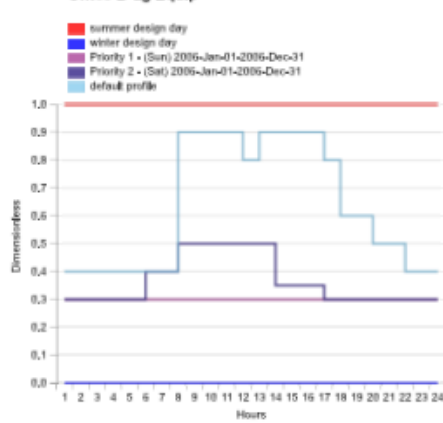
Medium Office HtgSetp



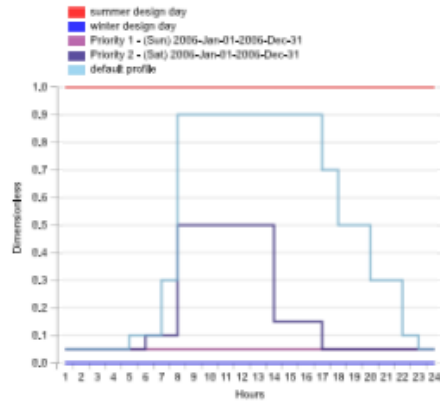
Office Activity



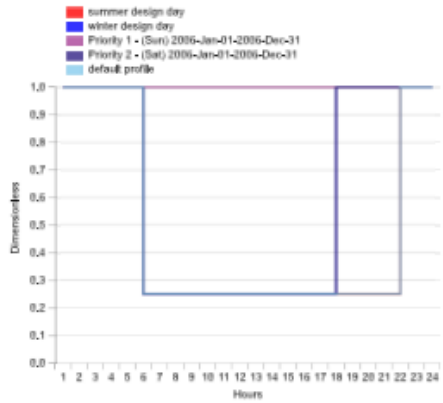
Office Bldg Equip



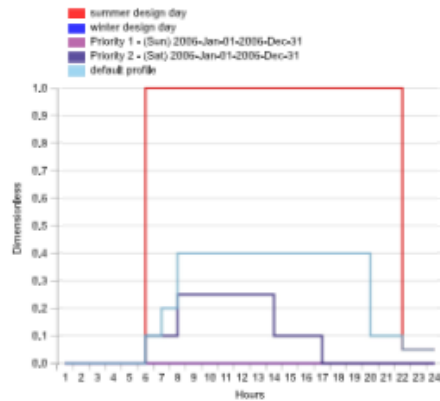
Office Bldg Light



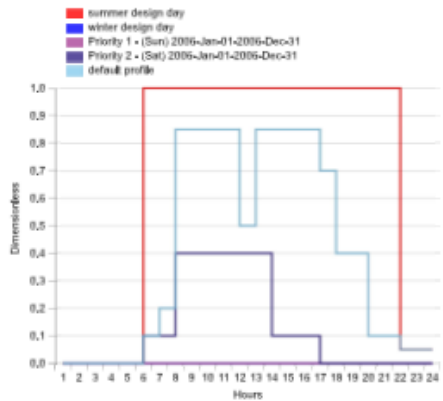
Office Infil Quarter On

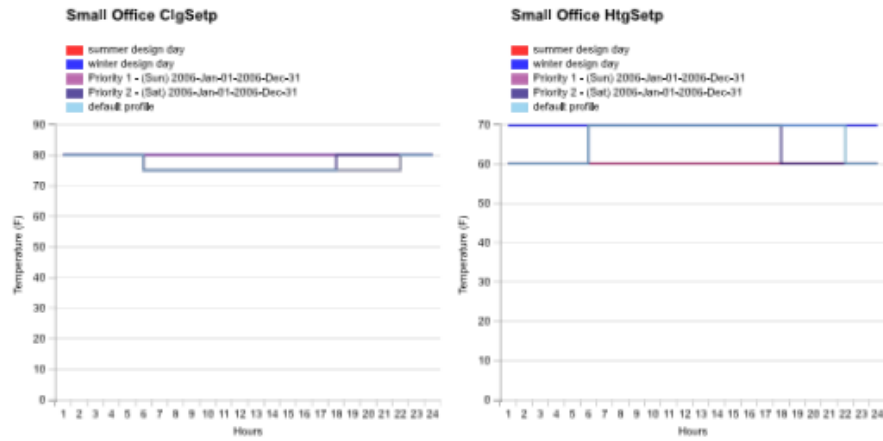


Office Misc Occ



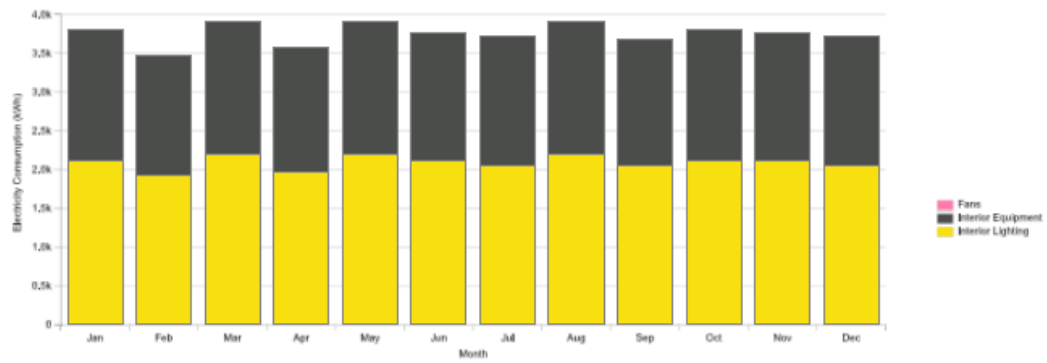
Office Work Occ



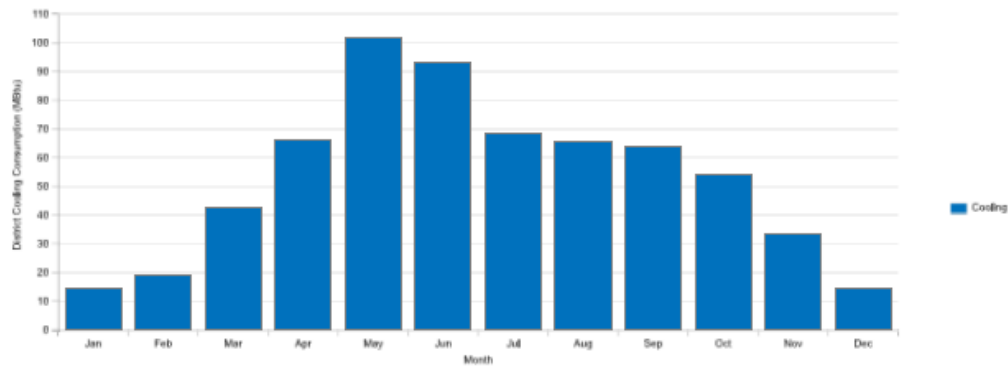


## AHMEDABAD

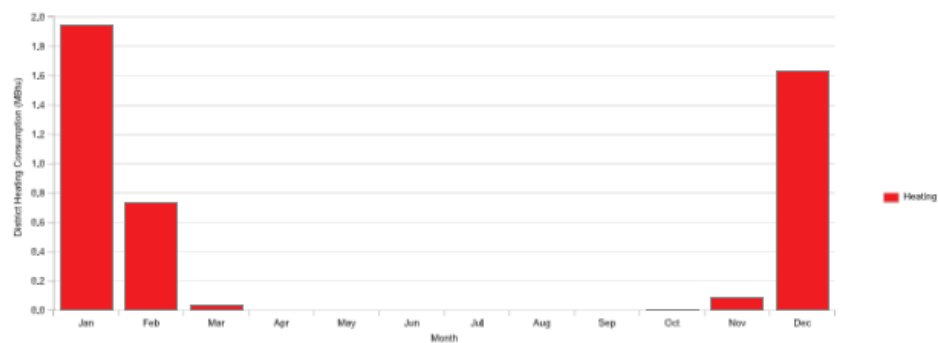
### Electricity Consumption (kWh)



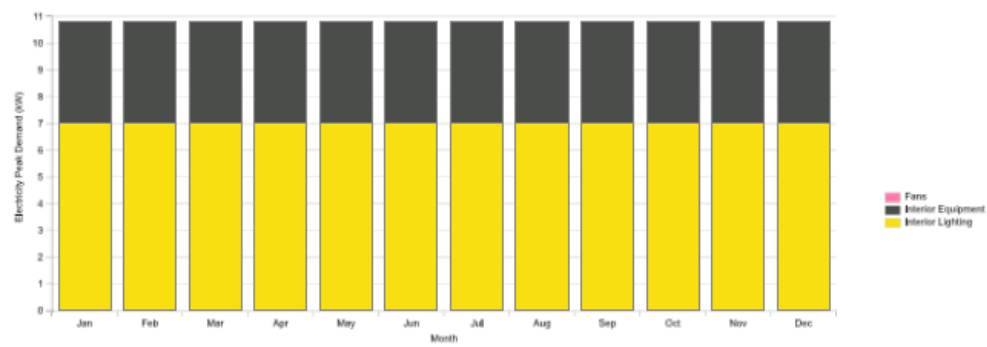
### District Cooling Consumption (MBtu)



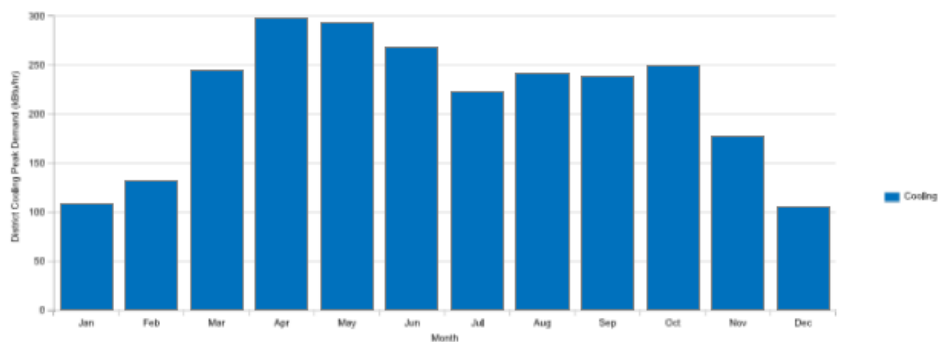
### District Heating Consumption (MBtu)



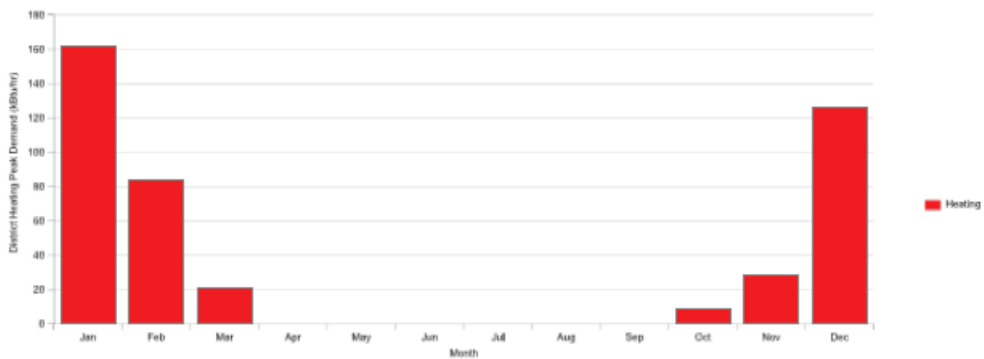
## Electricity peak Demand (kW)



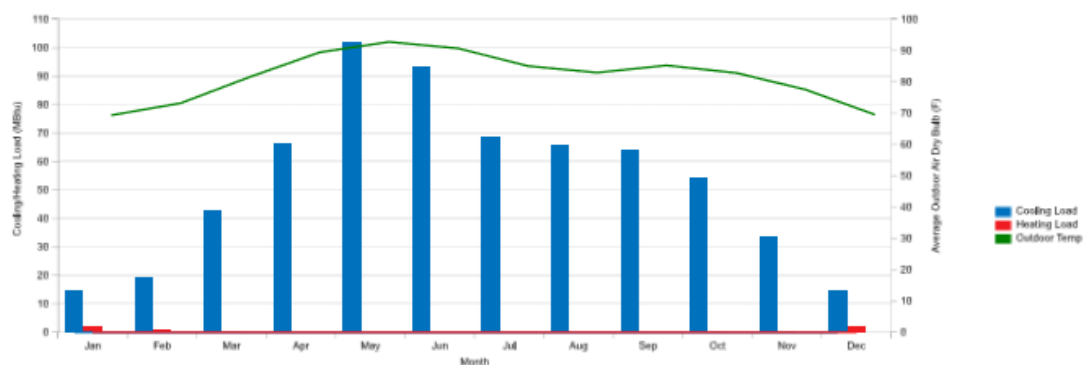
## District Cooling Peak Demand (kBtu/hr)



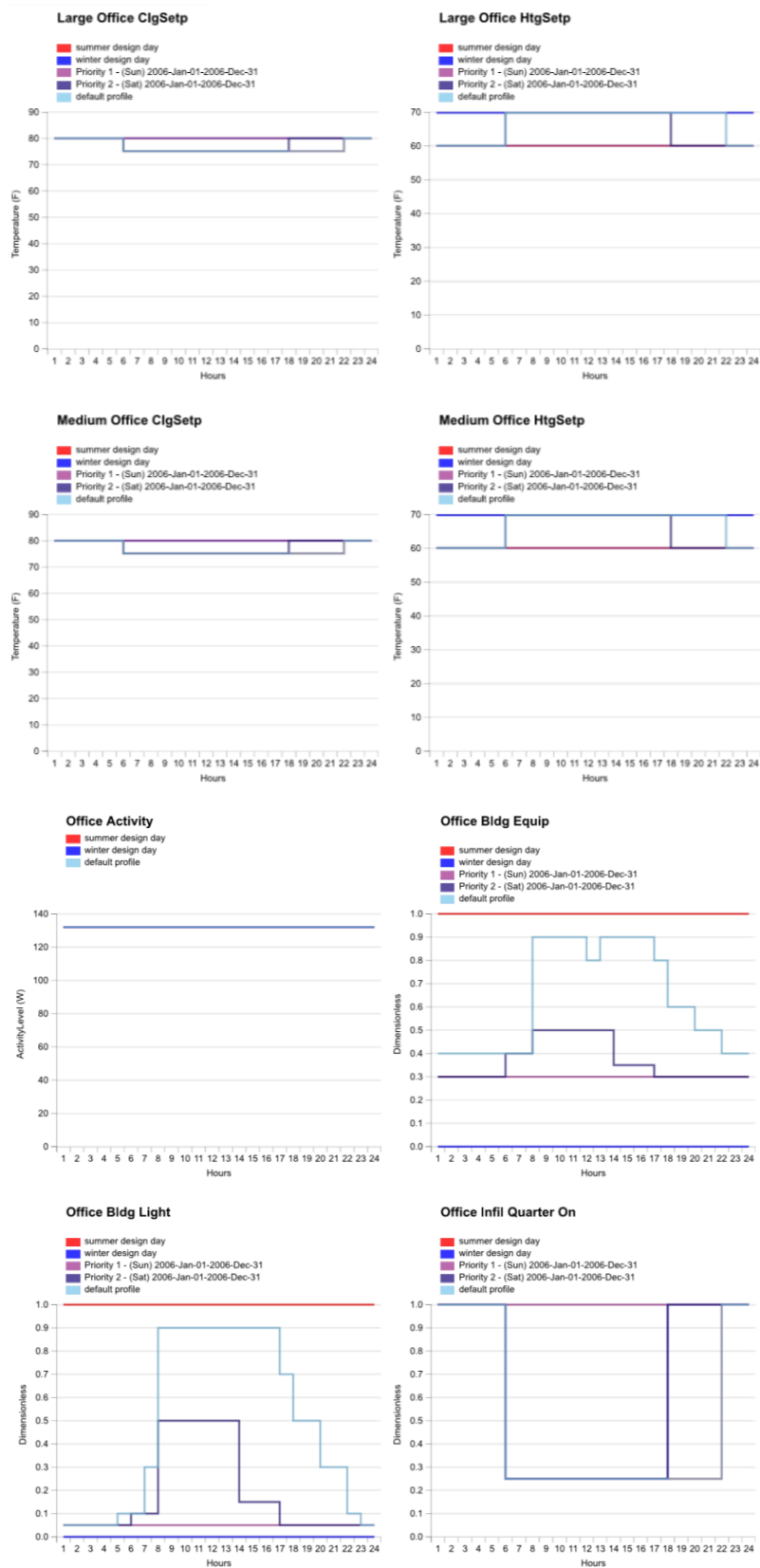
## District Heating peak Demand (kBtu/hr)



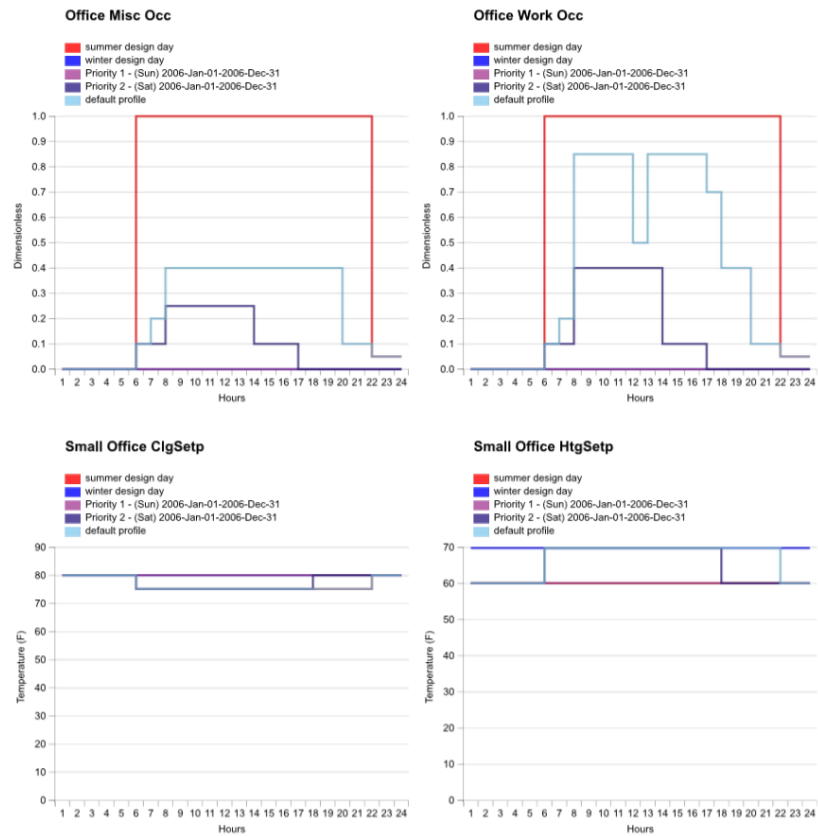
## HVAC Load Profiles: Monthly



## Schedule Overview

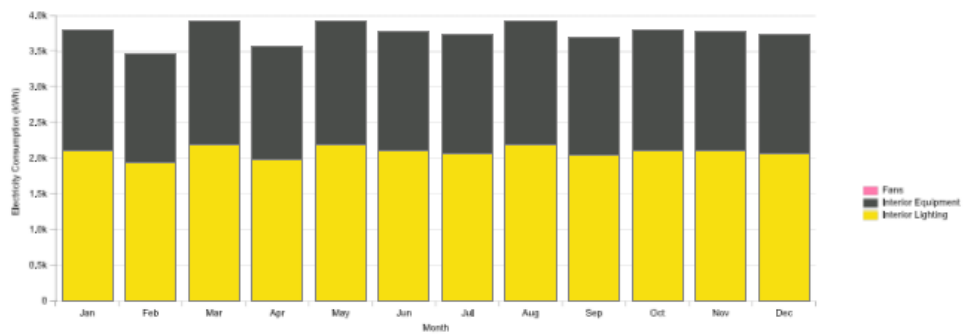




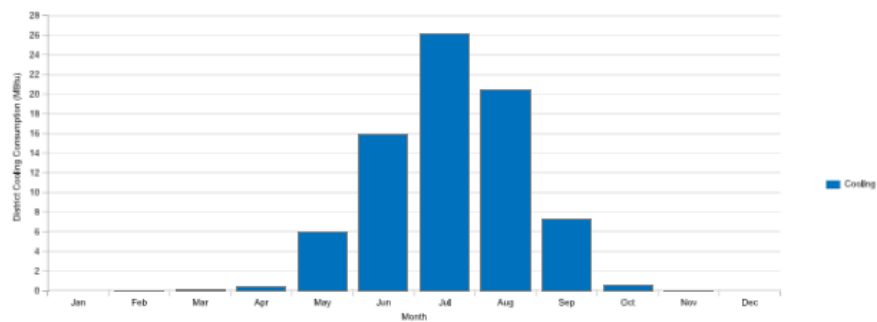


## MILAN

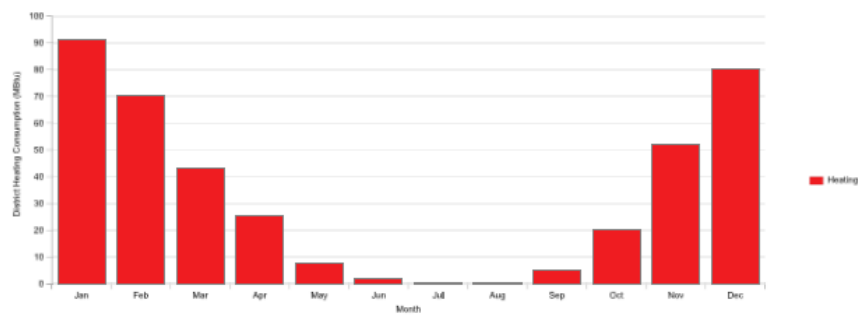
### Electricity Consumption (kWh)



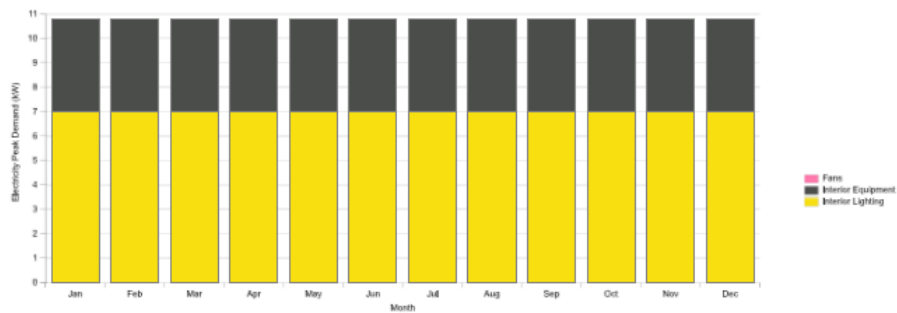
### District Cooling Consumption (MBtu)



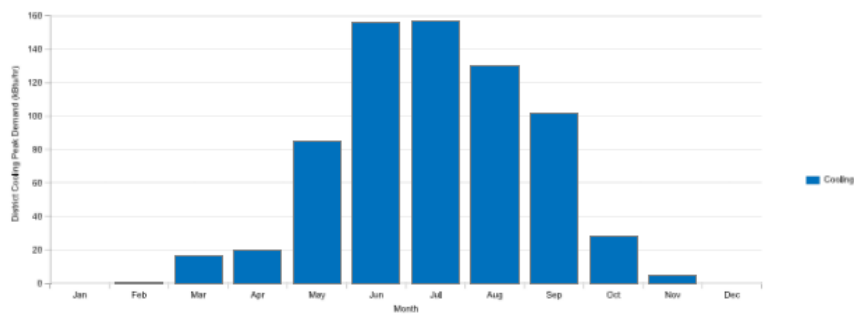
# District Heating Consumption (MBtu)



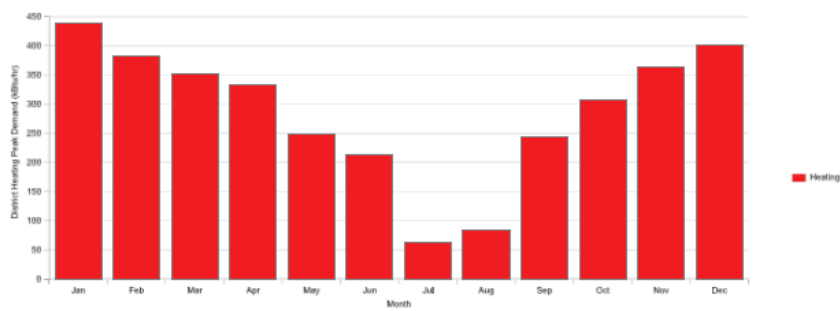
# Electricity peak Demand (kW)



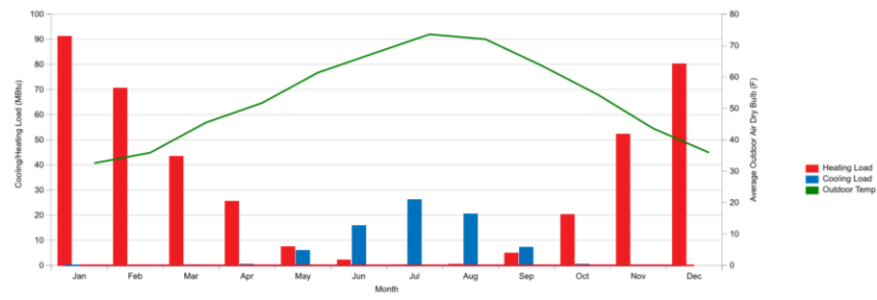
# District Cooling Peak Demand (kBtu/hr)



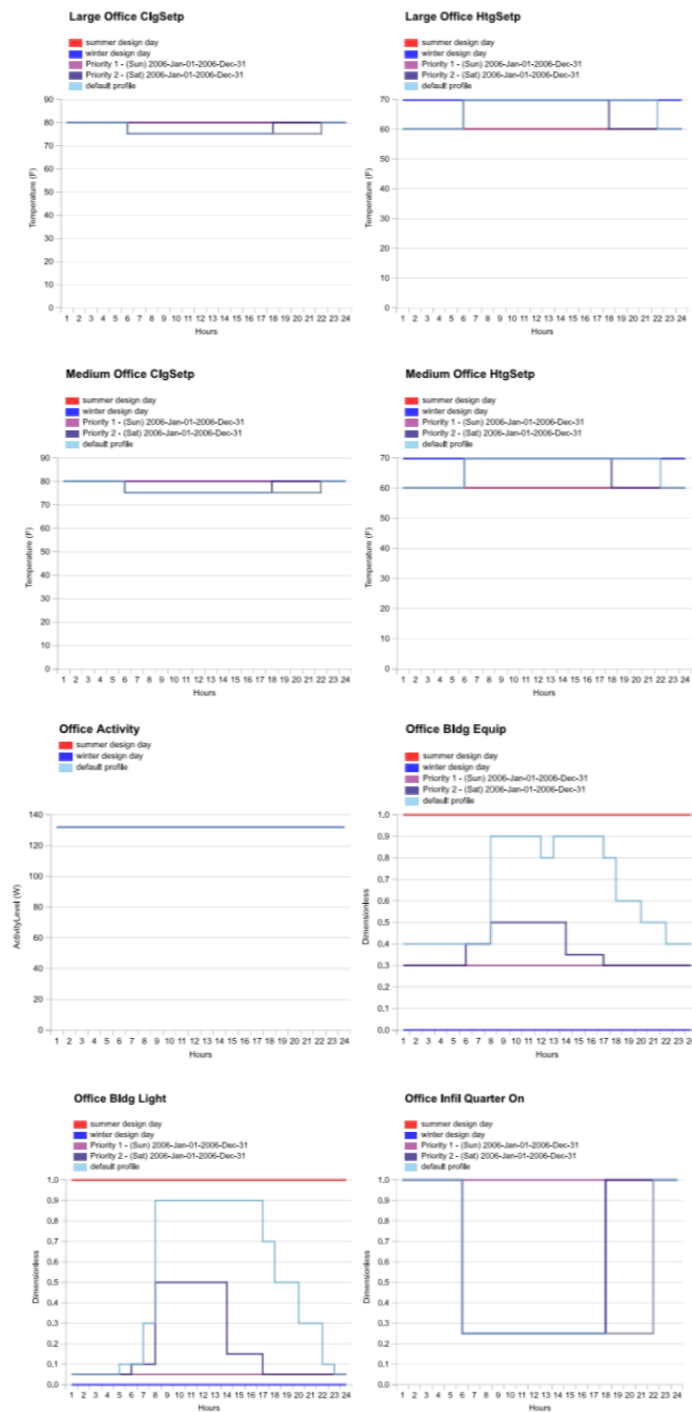
# District Heating peak Demand (kBtu/hr)

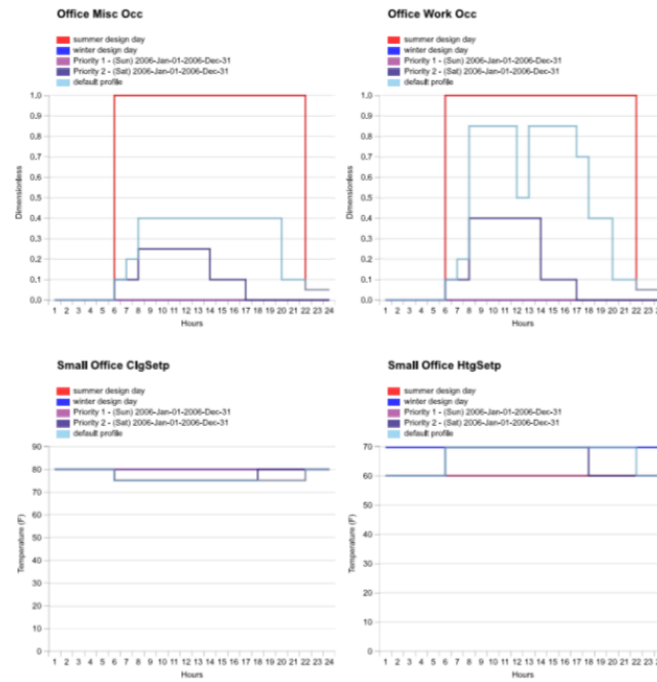


## HVAC Load Profiles: Monthly



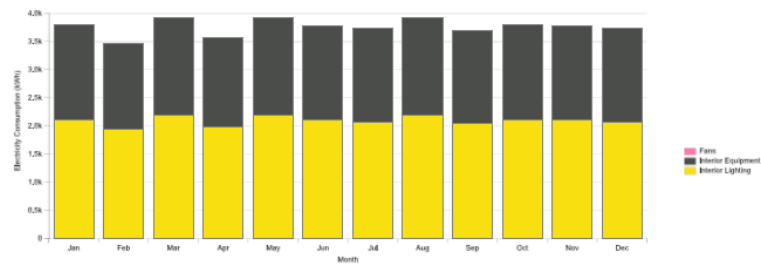
## Schedule Overview



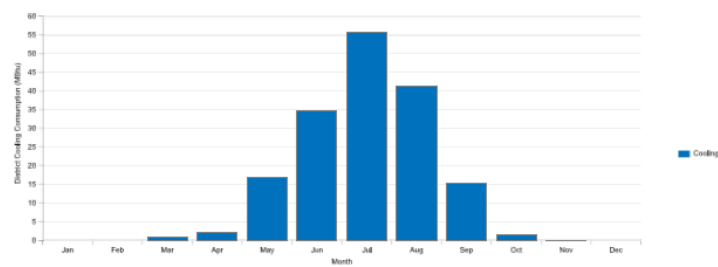


## CASE 1: MILAN WITHOUT INSULATIONS

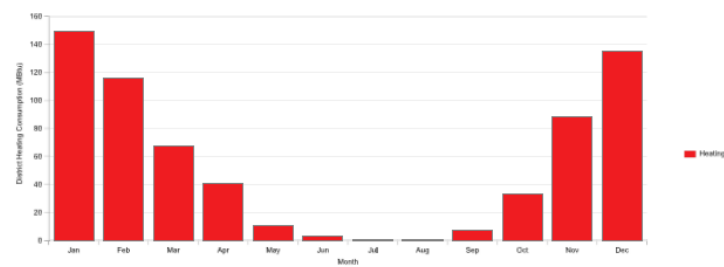
### Electricity Consumption (kWh)



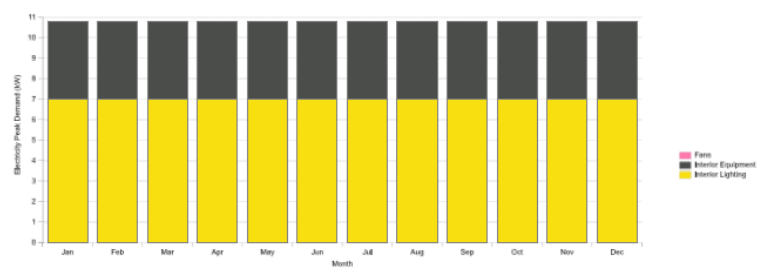
### District Cooling Consumption (MBtu)



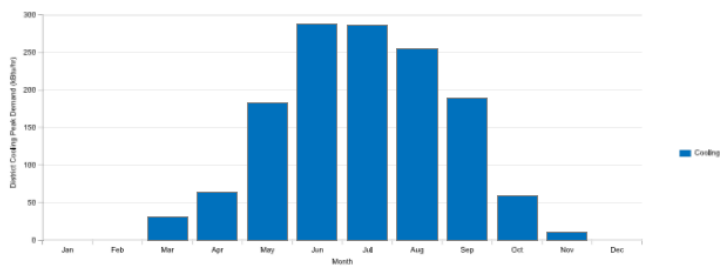
### District Heating Consumption (MBtu)



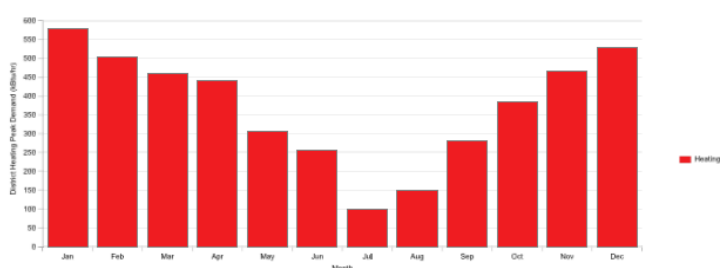
Electricity peak Demand (kW)



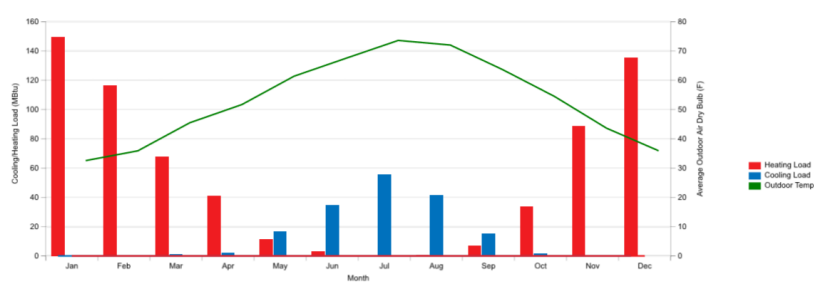
District Cooling Peak Demand (kBtu/hr)



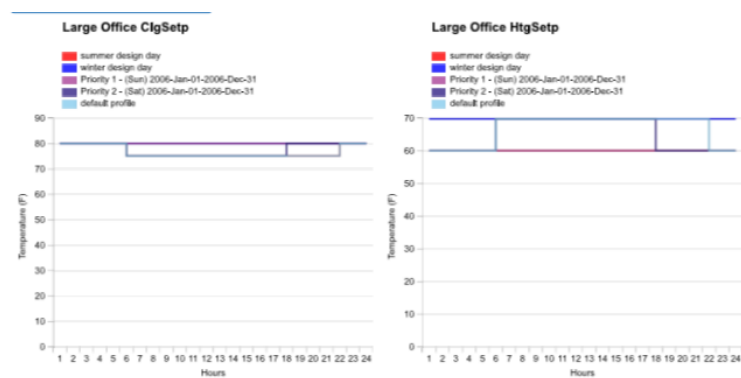
District Heating peak Demand (kBtu/hr)

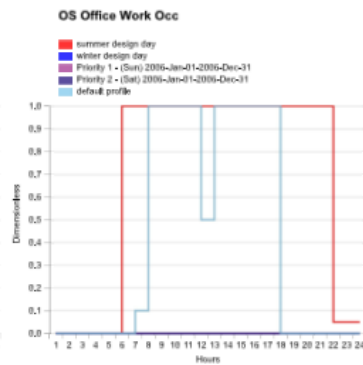
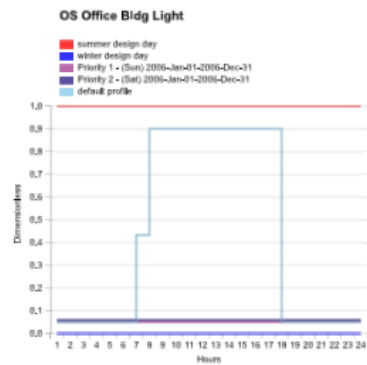
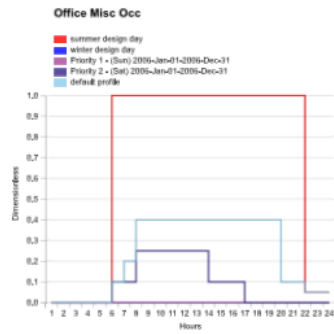
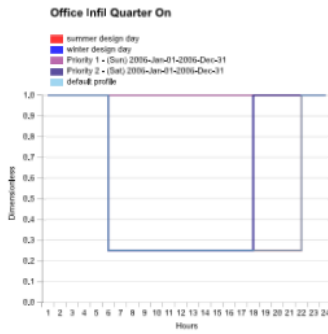
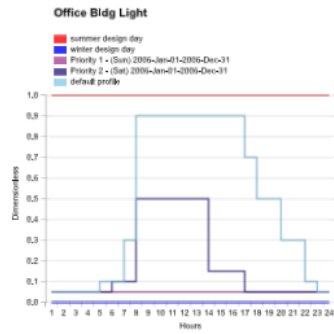
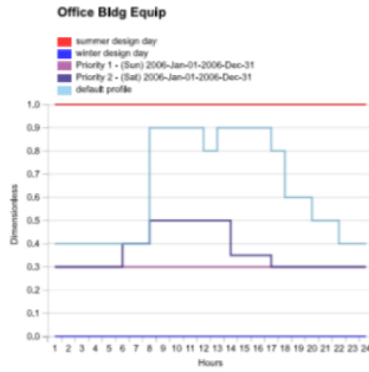
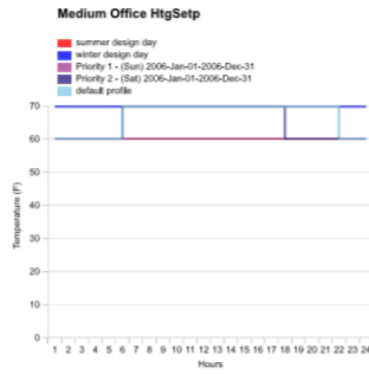
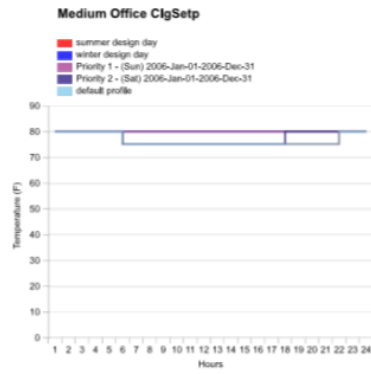


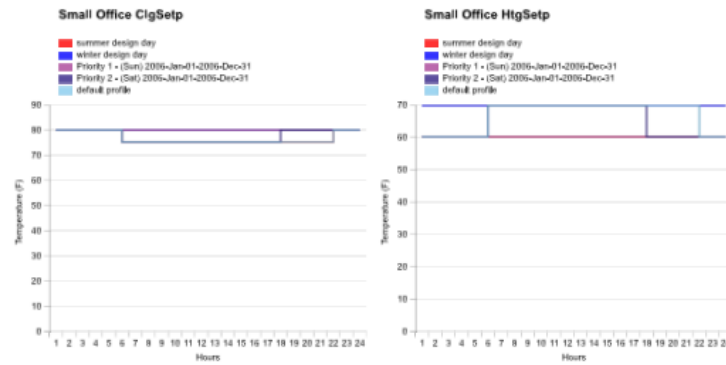
HVAC Load Profiles: Monthly



Schedule Overview

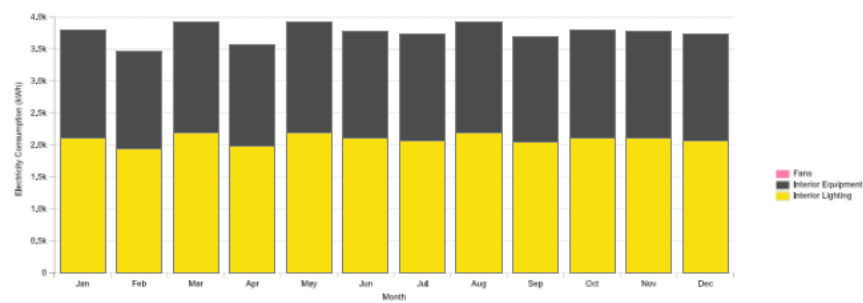




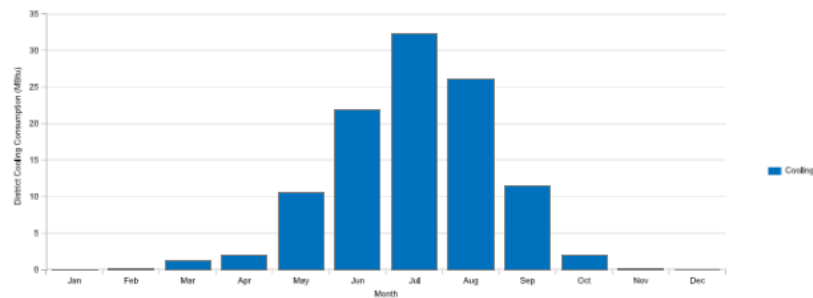


## CASE 2: MILAN WITH INSULATIONS

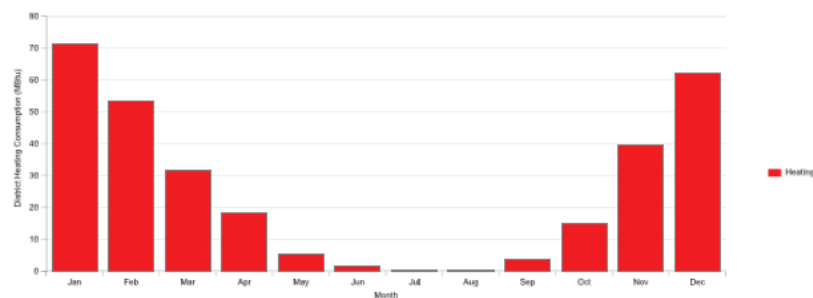
### Electricity Consumption (kWh)



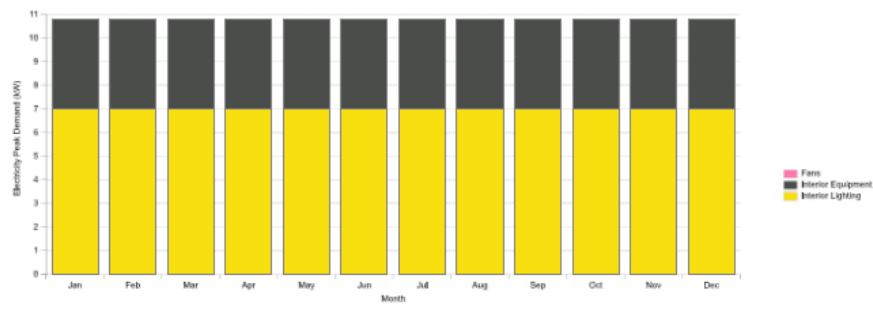
### District Cooling Consumption (MBtu)



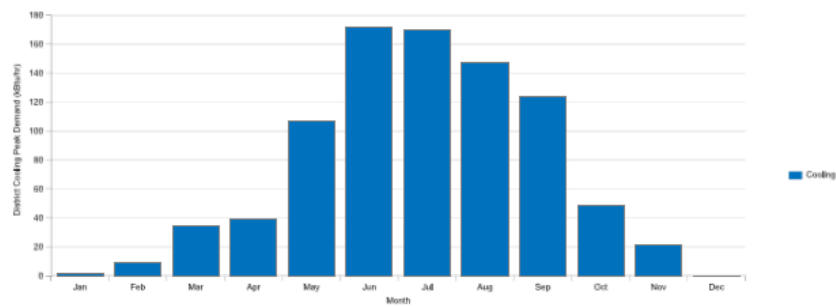
### District Heating Consumption (MBtu)



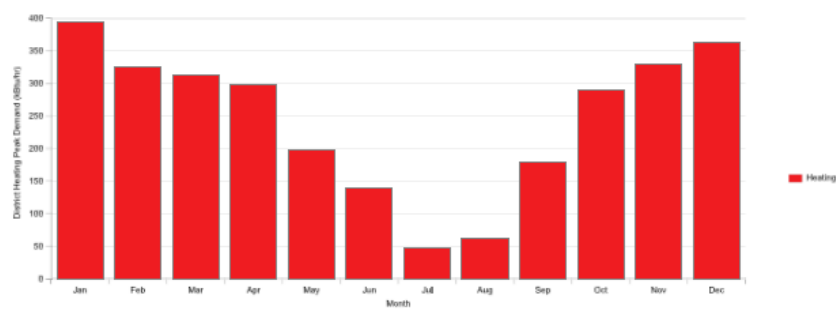
## Electricity peak Demand (kW)



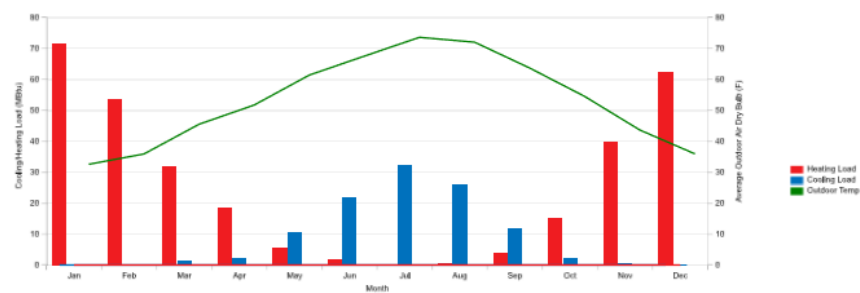
## District Cooling Peak Demand (kBtu/hr)



## District Heating peak Demand (kBtu/hr)

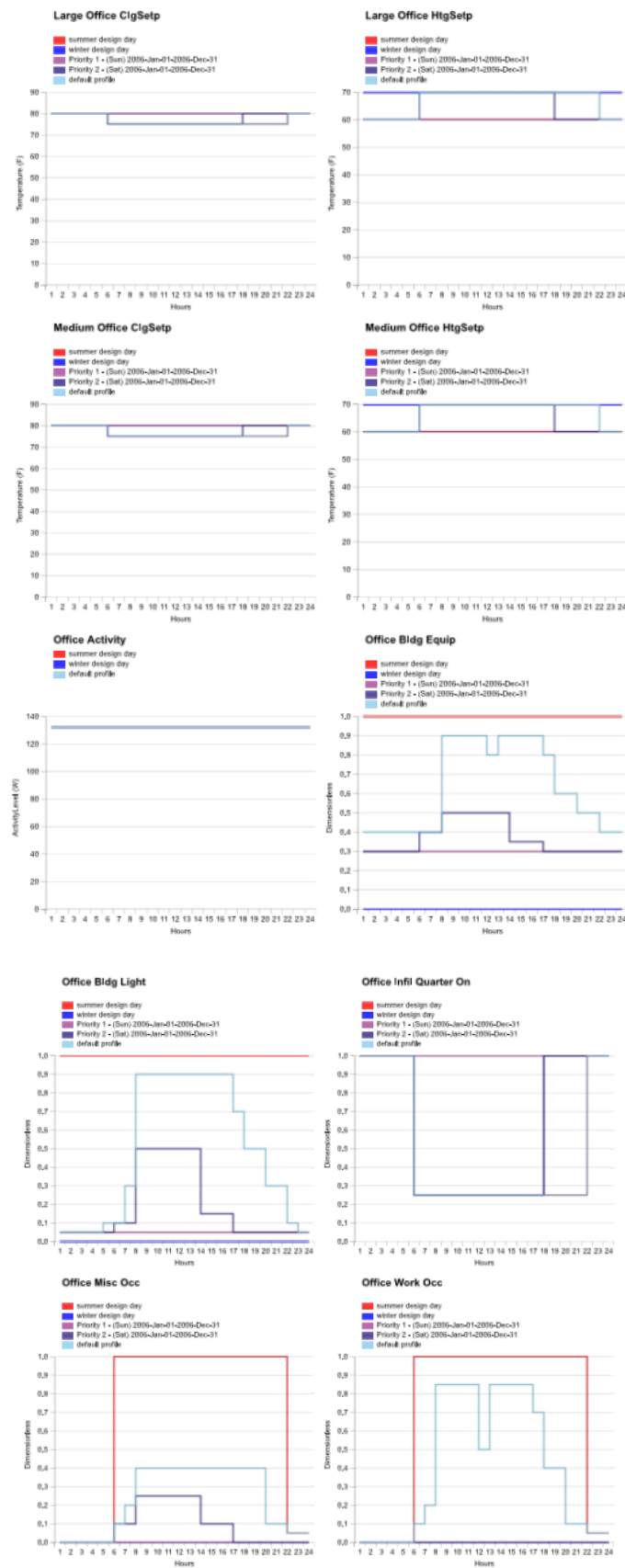


## HVAC Load Profiles: Monthly

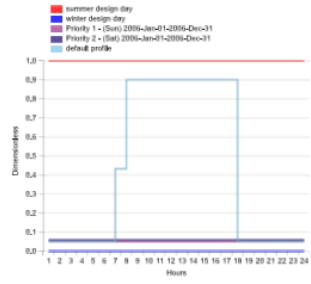




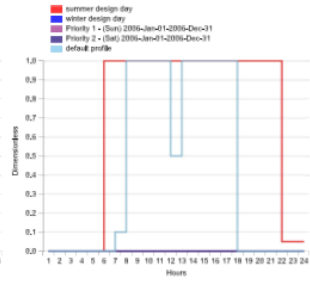
# Schedule Overview



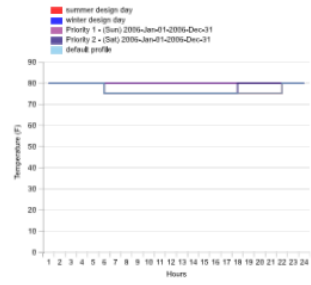
OS Office Bldg Light



OS Office Work Occ



Small Office CtgSetp



Small Office HtgSetp

