

# **FINAL REPORT**

**ENERGY PLUS & OPEN STUDIO  
BUILDING ENERGY ANALYSIS**

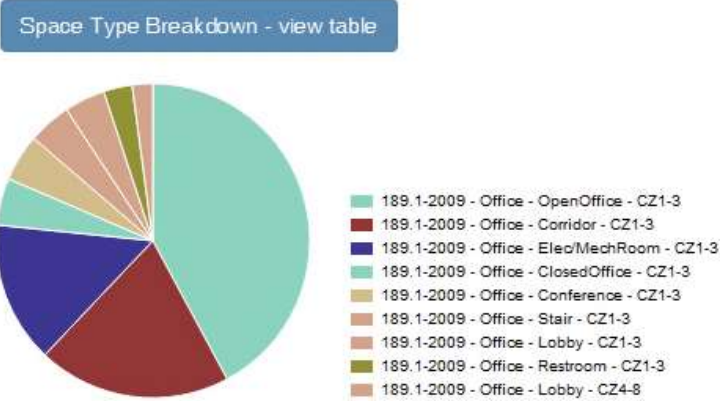
## **TECHNICAL ENVIRONMENTAL SYSTEMS**

**POLITECNICO DI MILANO  
PIACENZA**

**SANSKRITI JINDAL  
KARAN ANAND  
SHREY KAUSHIK**

1. BUILDING MODEL DESCRIPTION

INFORMATION	VALUE	UNIT
Total Building Area	1978.00	[m2]
Gross Roof Area	1878.00	[m2]
Gross Wall Area	3240.00	[m2]
Window Opening Area	636.00	[m2]
Gross Window-Wall Ratio	19.63	[%]



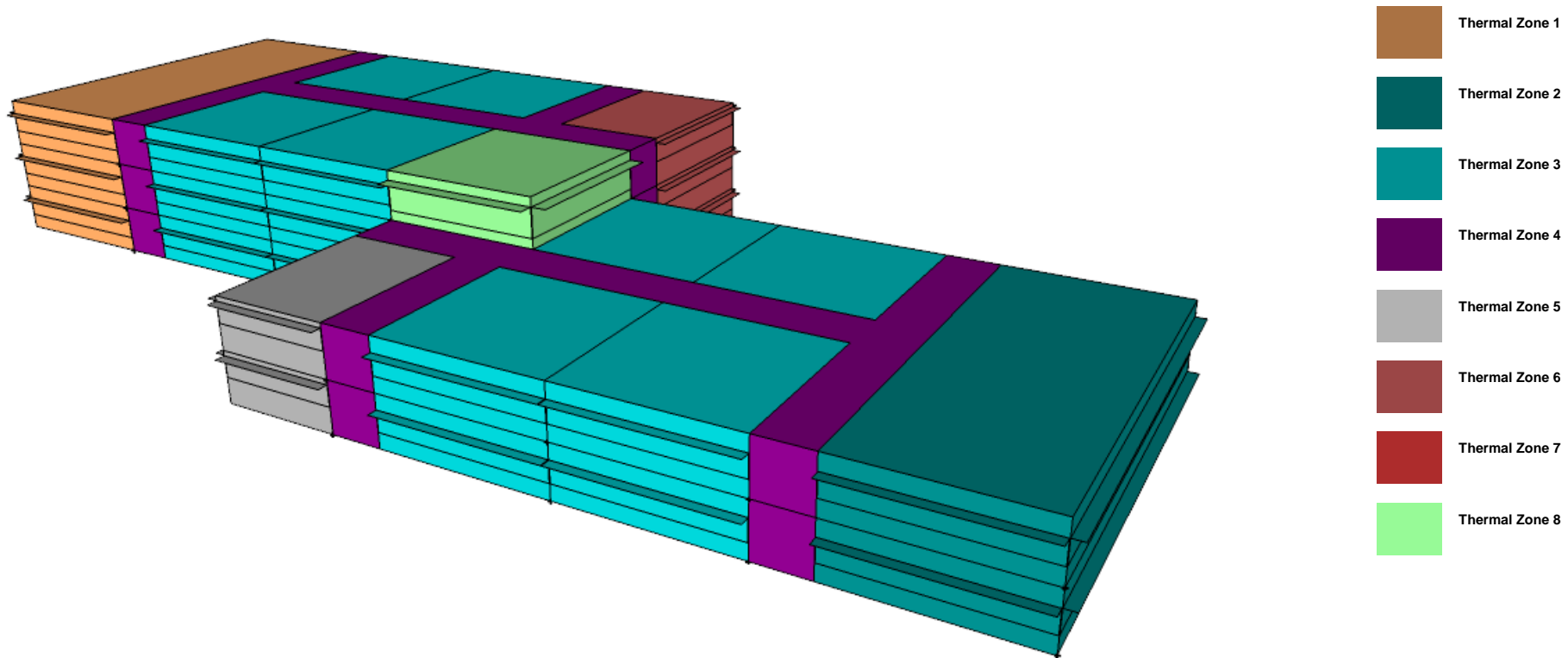
2. Site to Source Energy Conversion Factors

Type	Site – Source Conversion Factor
Electricity	3.167
District Cooling	1.056
District Heating	3.613

3. Locations under Consideration

S.No.	City	Country	Geographical Location		Type	Climatic Condition		
						Temperature (Average °C)	Precipitation (Average mm)	Relative Humidity (Average %)
			Latitude	Longitude		Max.	Min.	





**Fig. 3: Thermal Zones**

**The building is an office space.**

**It has in total of 8 Thermal Zones as presented.**

**Many spaces fall under same thermal zone (for maintaining same temperature)**

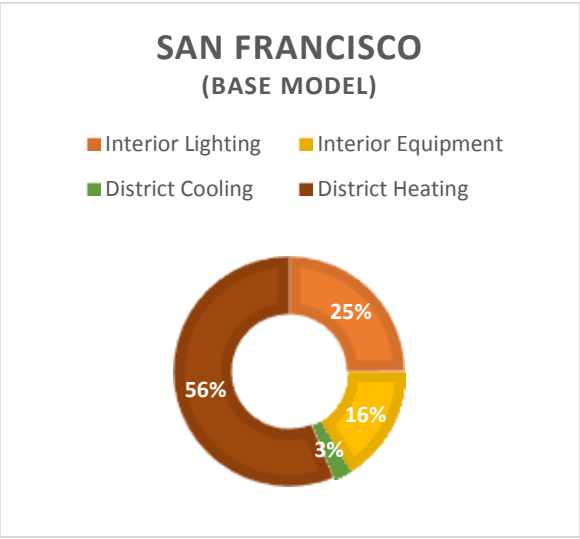
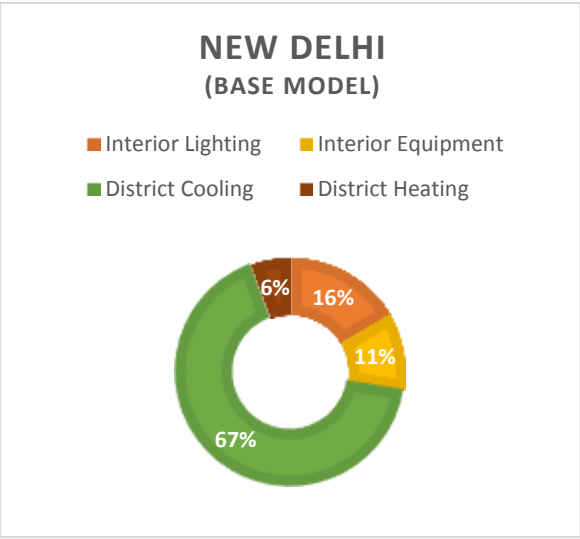
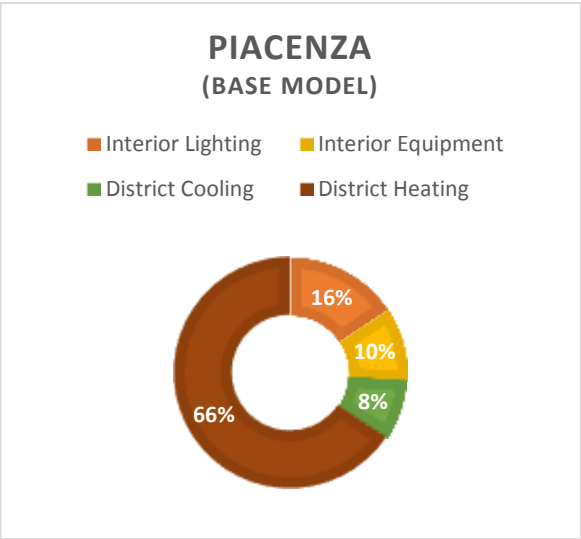
**Total building area is divided into three floors as shown with 1878 sq. m. on first and second floor and 989 sq. m. on third floor.**

**The building model is oriented with its main axis along East West Axis – to have maximum South Sun (being in Northern Hemisphere).**

5. Final Analysis Table

		PIACENZA ITALY	NEW DELHI INDIA	SAN FRANCISCO CALIFORNIA, USA
Base model	UNITS			
Electricity (Interior Lighting + Interior Equipment)	[GJ]	435.05	435.05	435.05
Conversion factor	---	3.167	3.167	3.167
Total Electricity Value	[GJ]	1377.80	1377.80	1377.80
District Heating	[GJ]	1097.44	89.03	592.16
Conversion factor	---	3.613	3.613	3.613
Total Heating Value	[GJ]	3965.05	321.67	2139.47
District Cooling	[GJ]	131.69	1061.34	26.00
Conversion Factor	---	1.056	1.056	1.056
Total Cooling Value	[GJ]	139.06	1120.78	27.46
		5481.92	2820.25	3544.73
TOTAL SOURCE ENERGY		5482.23	2819.90	3544.90

ANNUAL OVERVIEW

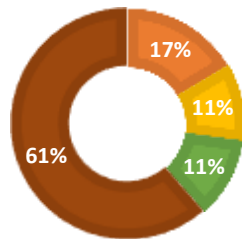


		PIACENZA ITALY	NEW DELHI INDIA	SAN FRANCISCO CALIFORNIA, USA
<b>First Alteration</b>		UNITS		
Electricity (Interior Lighting + Interior Equipment)	[GJ]	435.05	435.05	435.05
Conversion factor	---	3.167	3.167	3.167
Total Electricity Value	[GJ]	1377.80	1377.80	1377.80
District Heating	[GJ]	980.46	98.82	548.81
Conversion factor	---	3.613	3.613	3.613
Total Heating Value	[GJ]	3542.40	357.04	1982.85
District Cooling	[GJ]	180.88	1211.89	57.49
Conversion Factor	---	1.056	1.056	1.056
Total Cooling Value	[GJ]	191.01	1279.76	60.71
		5111.21	3014.60	3421.36
<b>TOTAL SOURCE ENERGY</b>		<b>5111.48</b>	<b>3014.20</b>	<b>3421.52</b>

## ANNUAL OVERVIEW

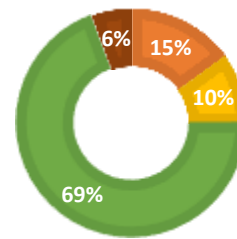
### PIACENZA (FIRST MODULATION)

■ Interior Lighting    ■ Interior Equipment  
■ District Cooling    ■ District Heating



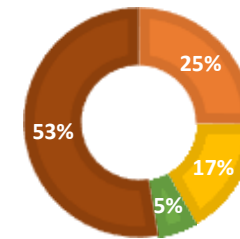
### NEW DELHI (FIRST MODULATION)

■ Interior Lighting    ■ Interior Equipment  
■ District Cooling    ■ District Heating



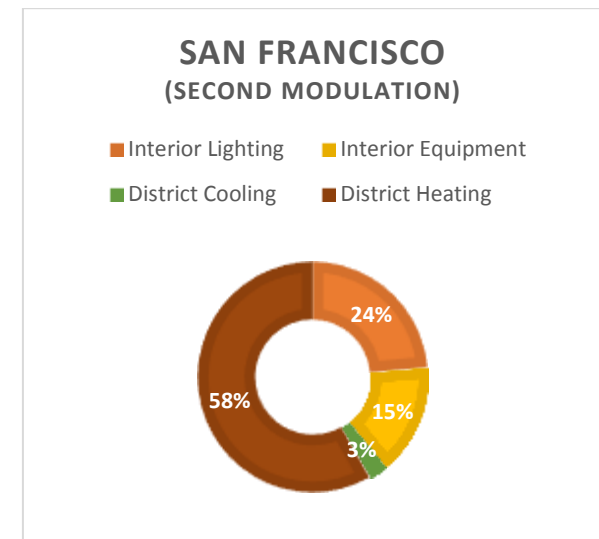
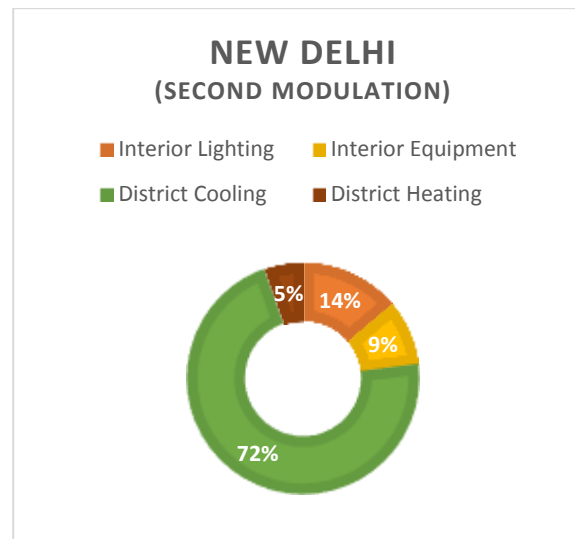
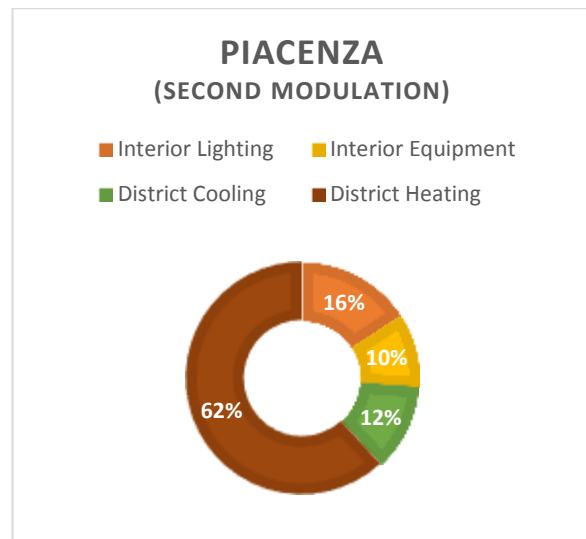
### SAN FRANCISCO (FIRST MODULATION)

■ Interior Lighting    ■ Interior Equipment  
■ District Cooling    ■ District Heating



		PIACENZA ITALY	NEW DELHI INDIA	SAN FRANCISCO CALIFORNIA, USA
<b>Second Alteration</b>	UNITS			
Electricity (Interior Lighting + Interior Equipment)	[GJ]	435.05	435.05	435.05
Conversion factor	---	3.167	3.167	3.167
Total Electricity Value	[GJ]	1377.80	1377.80	1377.80
District Heating	[GJ]	1026.94	102.07	645.98
Conversion factor	---	3.613	3.613	3.613
Total Heating Value	[GJ]	3710.33	368.78	2333.93
District Cooling	[GJ]	198.42	1354.09	28.84
Conversion Factor	---	1.056	1.056	1.056
Total Cooling Value	[GJ]	209.53	1429.92	30.46
		5297.67	3176.50	3742.19
<b>TOTAL SOURCE ENERGY</b>		<b>5297.94</b>	<b>3176.06</b>	<b>3742.39</b>

## ANNUAL OVERVIEW



**PIACENZA  
ITALY**

**NEW DELHI  
INDIA**

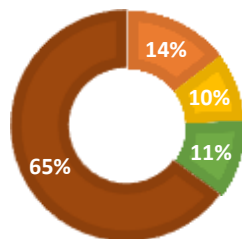
**SAN FRANCISCO  
CALIFORNIA, USA**

Third Alteration		UNITS			
Electricity (Interior Lighting + Interior Equipment)		[GJ]	435.05	435.05	435.05
Conversion factor		---	3.167	3.167	3.167
Total Electricity Value		[GJ]	1377.80	1377.80	1377.80
District Heating		[GJ]	1167.28	96.10	574.11
Conversion factor		---	3.613	3.613	3.613
Total Heating Value		[GJ]	4217.38	347.21	2074.26
District Cooling		[GJ]	195.63	1197.12	56.98
Conversion Factor		---	1.056	1.056	1.056
Total Cooling Value		[GJ]	206.59	1264.16	60.17
			5801.77	2989.17	3512.23
<b>TOTAL SOURCE ENERGY</b>			<b>5802.09</b>	<b>2988.79</b>	<b>3512.38</b>

## ANNUAL OVERVIEW

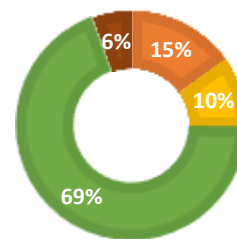
### PIACENZA (THIRD MODULATION)

■ Interior Lighting    ■ Interior Equipment  
■ District Cooling    ■ District Heating



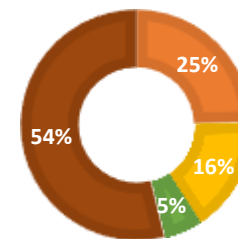
### NEW DELHI (THIRD MODULATION)

■ Interior Lighting    ■ Interior Equipment  
■ District Cooling    ■ District Heating



### SAN FRANCISCO (THIRD MODULATION)

■ Interior Lighting    ■ Interior Equipment  
■ District Cooling    ■ District Heating



PIACENZA

NEW DELHI

SAN FRANCISCO

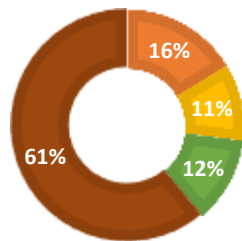


		ITALY	INDIA	CALIFORNIA, USA
<b>Fourth Alteration</b>	UNITS			
Electricity (Interior Lighting + Interior Equipment)	[GJ]	435.05	435.05	435.05
Conversion factor	---	3.167	3.167	3.167
Total Electricity Value	[GJ]	1377.80	1377.80	1377.80
District Heating	[GJ]	985.08	91.10	627.48
Conversion factor	---	3.613	3.613	3.613
Total Heating Value	[GJ]	3559.09	338.25	2267.09
District Cooling	[GJ]	192.74	1163.67	28.07
Conversion Factor	---	1.056	1.056	1.056
Total Cooling Value	[GJ]	203.53	1245.89	29.64
<b>TOTAL SOURCE ENERGY</b>		<b>5140.43</b>	<b>2935.78</b>	<b>3674.53</b>
		<b>5140.67</b>	<b>2935.41</b>	<b>3674.74</b>

## ANNUAL OVERVIEW

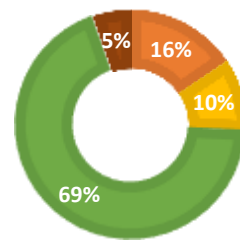
### PIACENZA (FOURTH MODULATION)

■ Interior Lighting    ■ Interior Equipment  
■ District Cooling    ■ District Heating



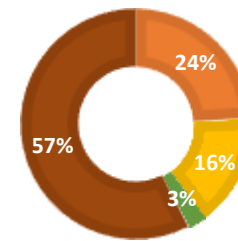
### NEW DELHI (FOURTH MODULATION)

■ Interior Lighting    ■ Interior Equipment  
■ District Cooling    ■ District Heating



### SAN FRANCISCO (FOURTH MODULATION)

■ Interior Lighting    ■ Interior Equipment  
■ District Cooling    ■ District Heating



## 6. CONCLUSION

### \*\*\*NOTE\*\*\*

For same building area and same orientation and similar climatic conditions, building model performs differently, thus leading to different values for **Heating and Cooling**, whereas **Total Electrical Consumption** remains same that involves **Interior Lighting** and **Interior Equipment loads**.

**Total Electricity Consumption Value constant for all Simulations =  $435.05 \text{ [GJ]} * 3.167 = 1377.80 \text{ [GJ]}$**

- As per the simulation performed on the designed building model taking into consideration different locations in the northern hemisphere and similar climatic conditions, it can be read that least amount of energy is consumed for heating and cooling the building at New Delhi, India.
- After changing wall properties, schedule (hours of operation) and roof properties also, building consumes least amount of energy at New Delhi.
- Thus, the designed building model shall perform best and save maximum amount of energy and cost if designed in New Delhi, than in Piacenza and San Francisco.

**BASE MODEL**

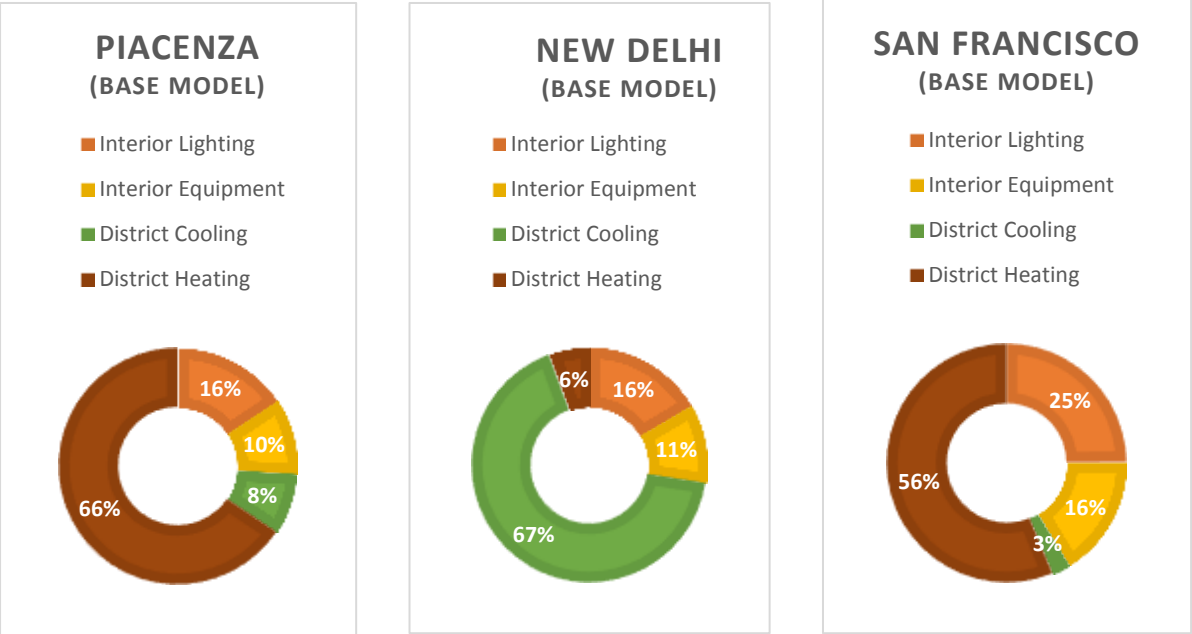
**ENVELOPE**

<b>Base Surface Construction</b>	ASHRAE 189.1-2009 ExtRoof IEAD ClimateZone 1	<b>Net Area</b> 1878.04
	ASHRAE 189.1-2009 ExtWall Mass ClimateZone 1	2603.99
<b>Sub-Surface Construction</b>	ASHRAE 189.1-2009 ExtWindow ClimateZone 1	636.01
	<b>Wall to Window Ratio</b>	<b>Total (%)</b> 19.63
	Gross Window-Wall Ratio	

**CONSTRUCTION DESCRIPTION**

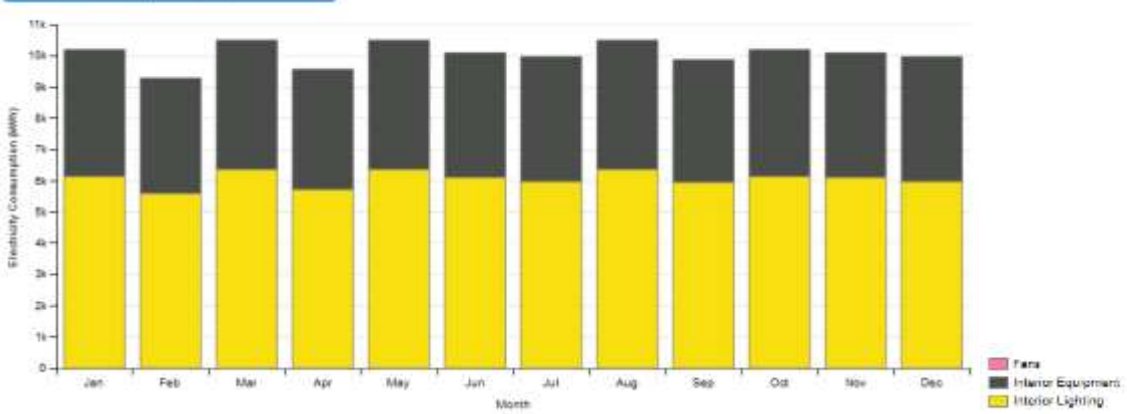
<b>189.1-2009 - CZ1 - Office</b>	ASHRAE 189.1-2009 ExtWall Mass ClimateZone 1	1IN STUCCO 8IN CONCRETE HW WALL INSULATION [31] 1/2IN GYPSUM
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**ANNUAL OVERVIEW**

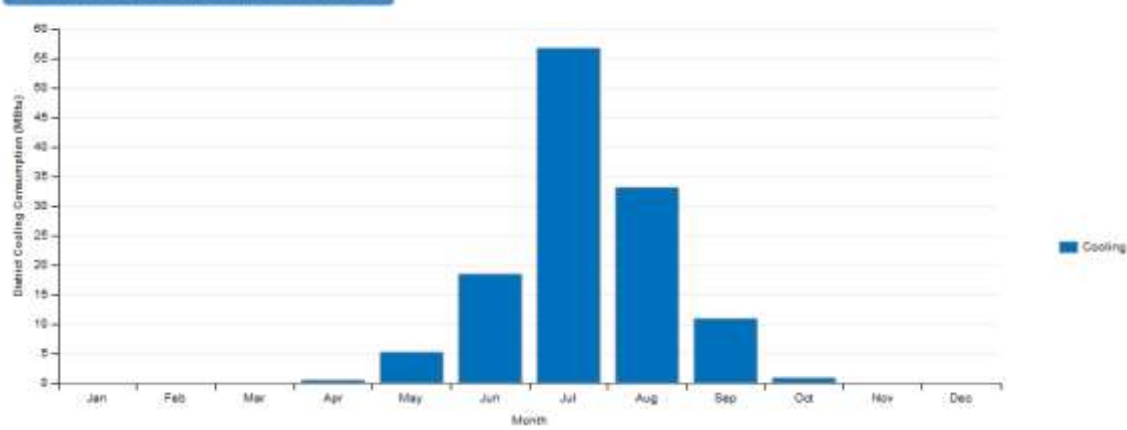


MONTHLY OVERVIEW

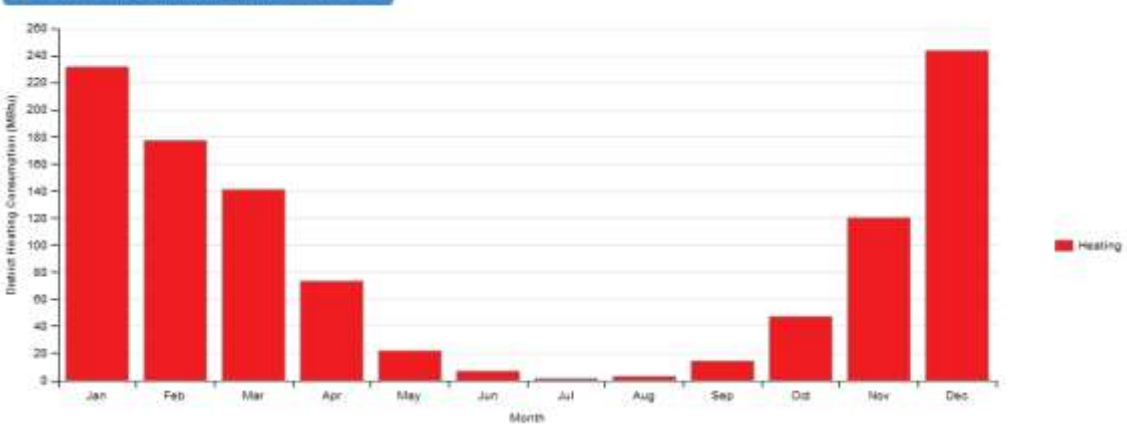
Electricity Consumption (kWh) - view table



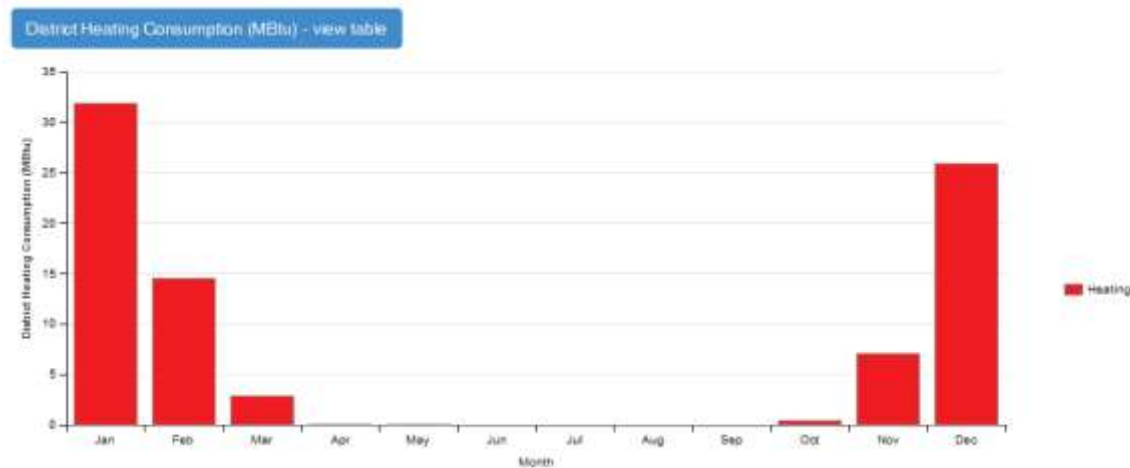
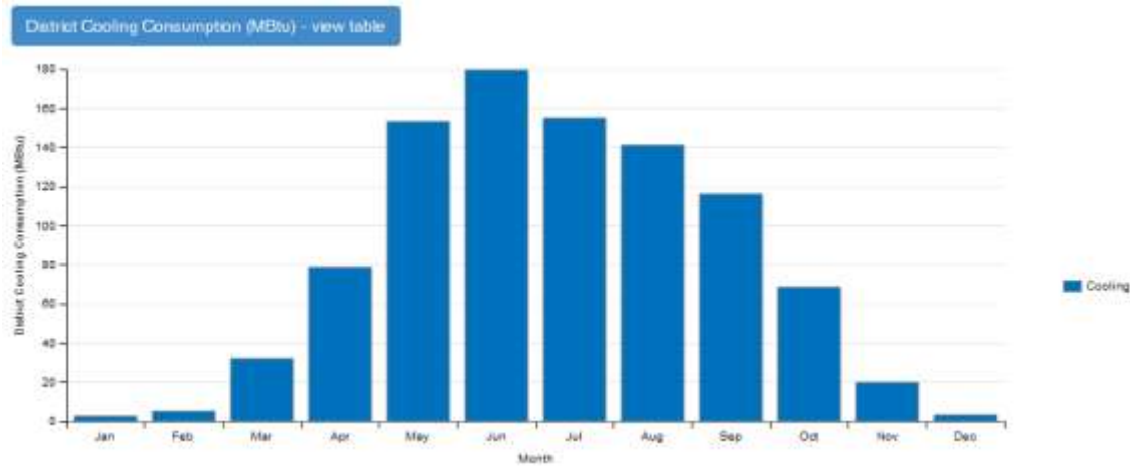
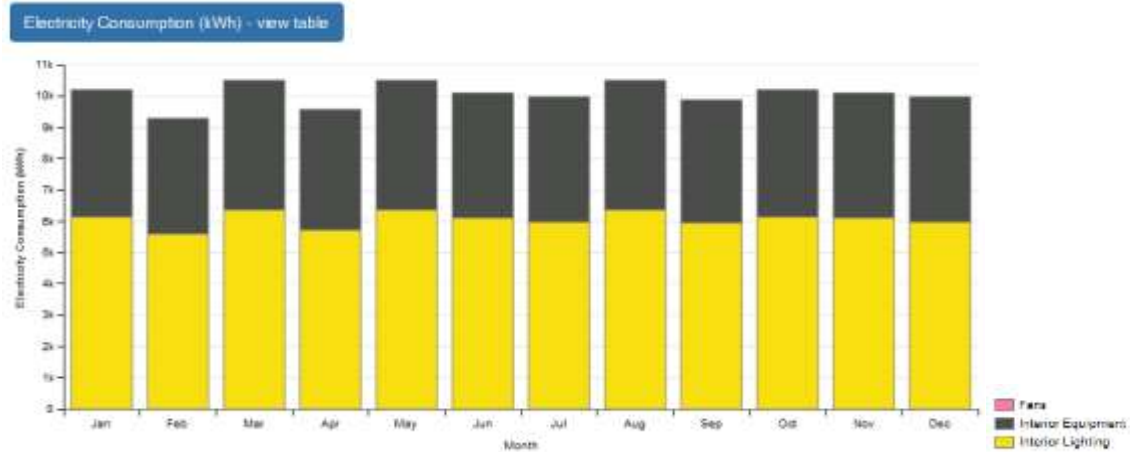
District Cooling Consumption (MBtu) - view table



District Heating Consumption (MBtu) - view table

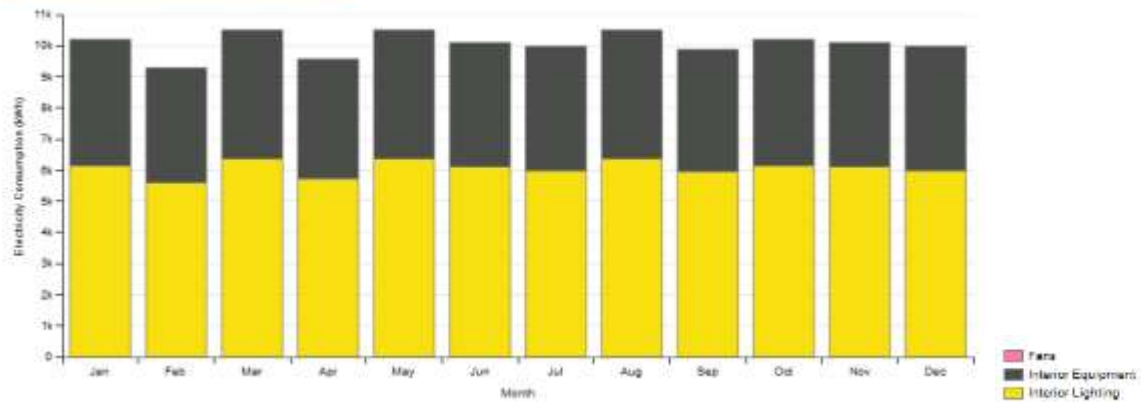


MONTHLY OVERVIEW

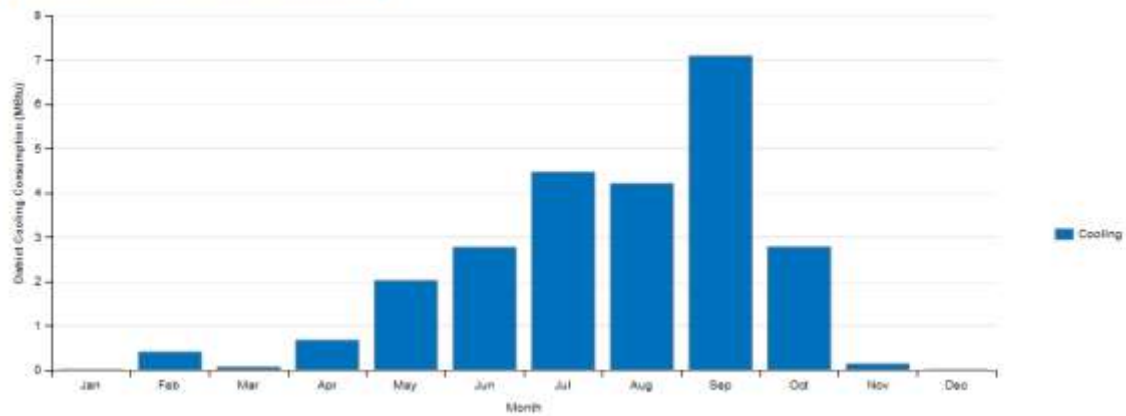


## MONTHLY OVERVIEW

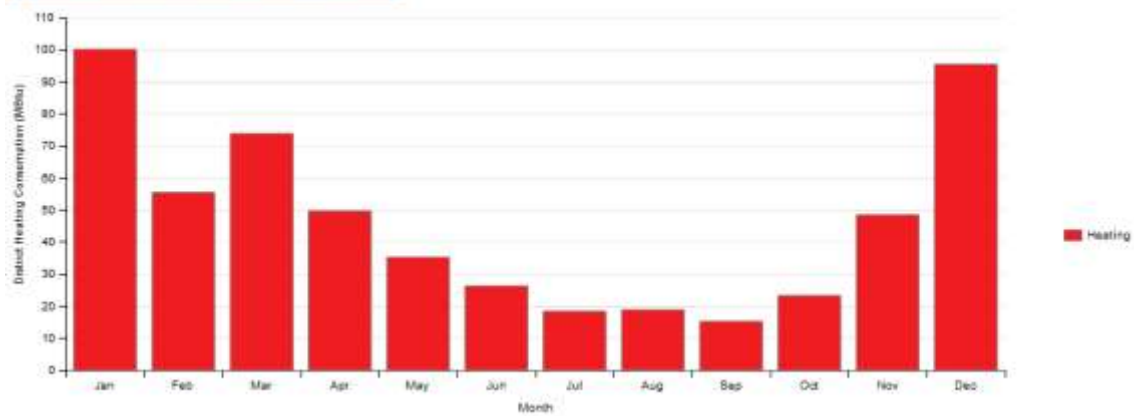
Electricity Consumption (kWh) - view table



District Cooling Consumption (MBtu) - view table



District Heating Consumption (MBtu) - view table



FIRST MODULATION

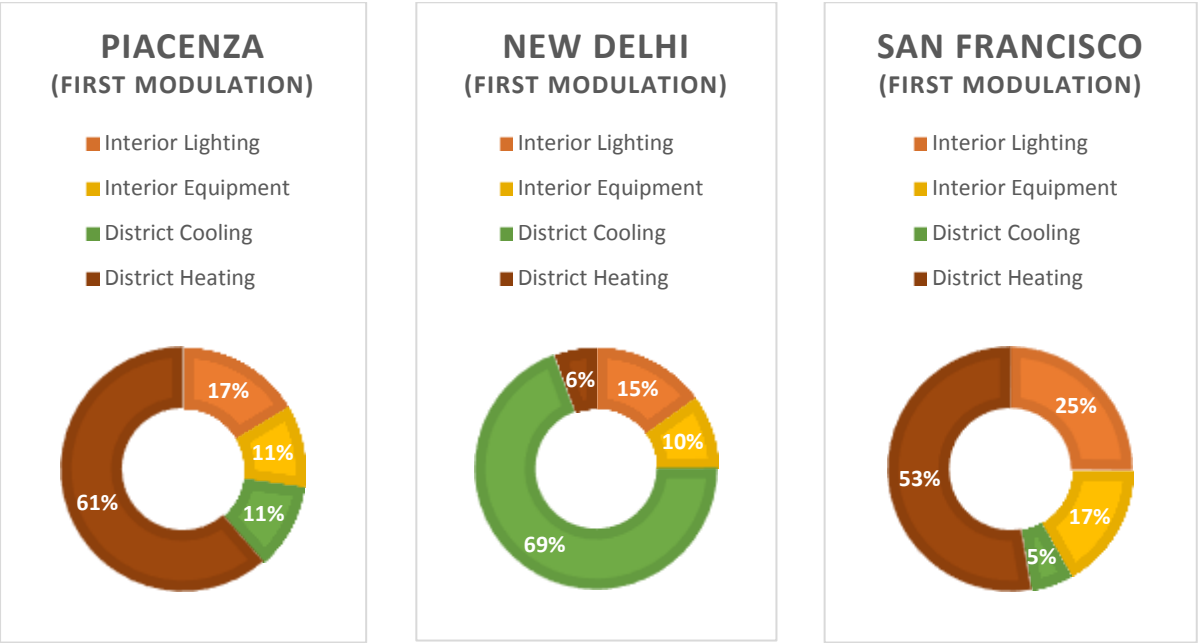
ENVELOPE

Base Surface Construction	ASHRAE 189.1-2009 ExtRoof IEAD ClimateZone 1	Net Area
	MyConstruction- ExtWall Mass ClimateZone4	1878.04
Sub-Surface Construction		2603.99
Wall to Window Ratio	ASHRAE 189.1-2009 ExtWindow ClimateZone 1	636.01
	Gross Window-Wall Ratio	Total (%)
		19.63

CONSTRUCTION DESCRIPTION

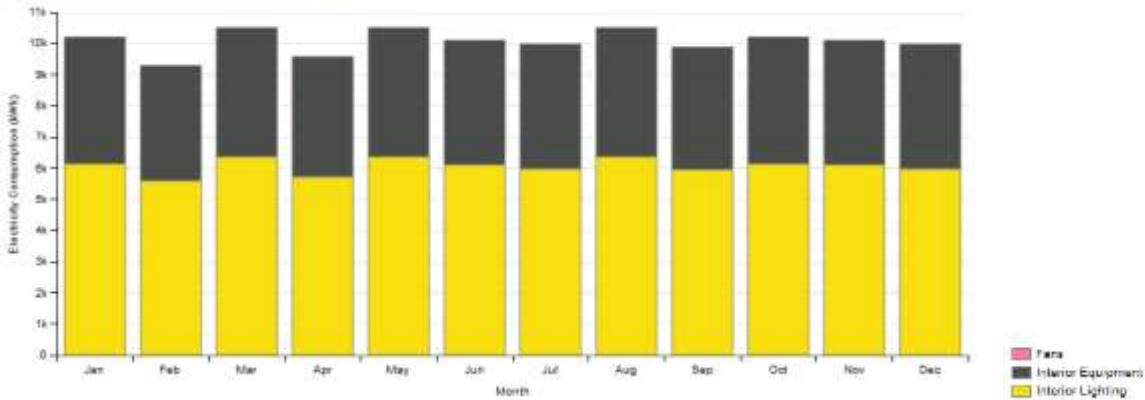
My Construction Set-1 - CZ1 - Office 1	MyConstruction- ExtWall Mass ClimateZone4	1IN STUCCO 8IN CONCRETE HW 2 WALL INSULATION [44] 1/2IN GYPSUM
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ANNUAL OVERVIEW

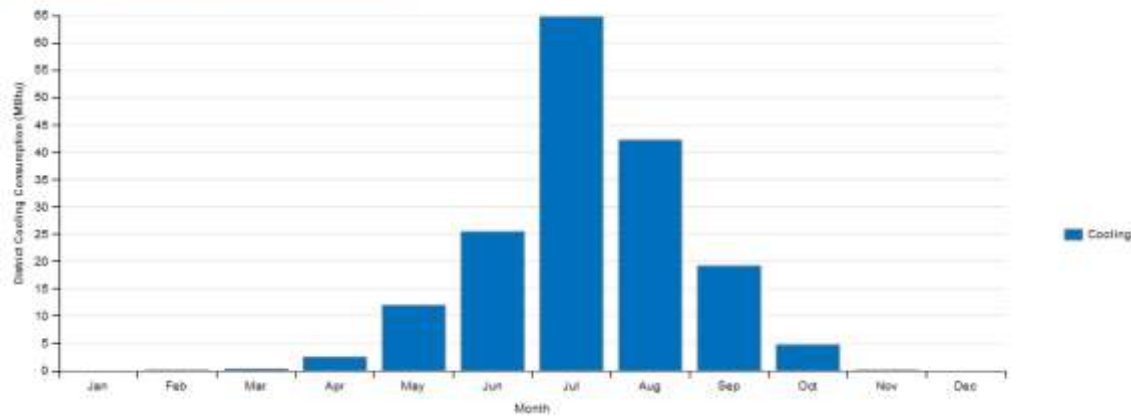


MONTHLY OVERVIEW

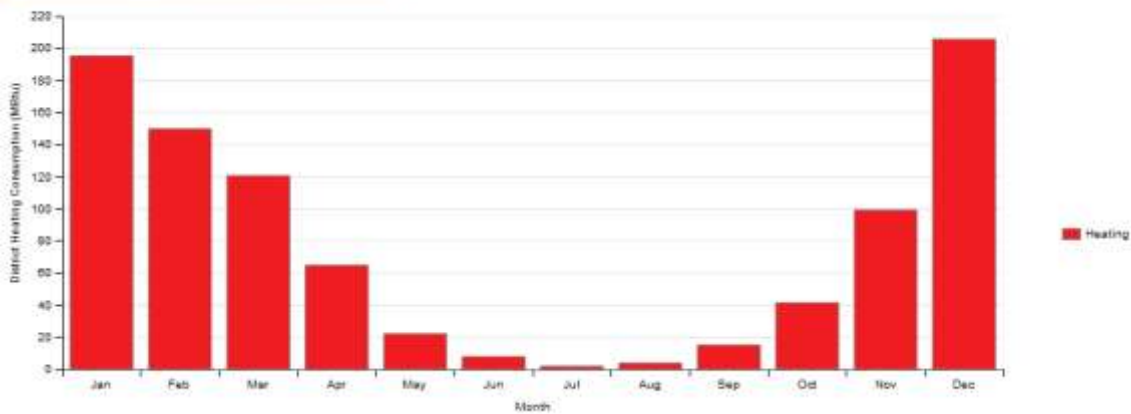
Electricity Consumption (kWh) - view table



District Cooling Consumption (MBtu) - view table

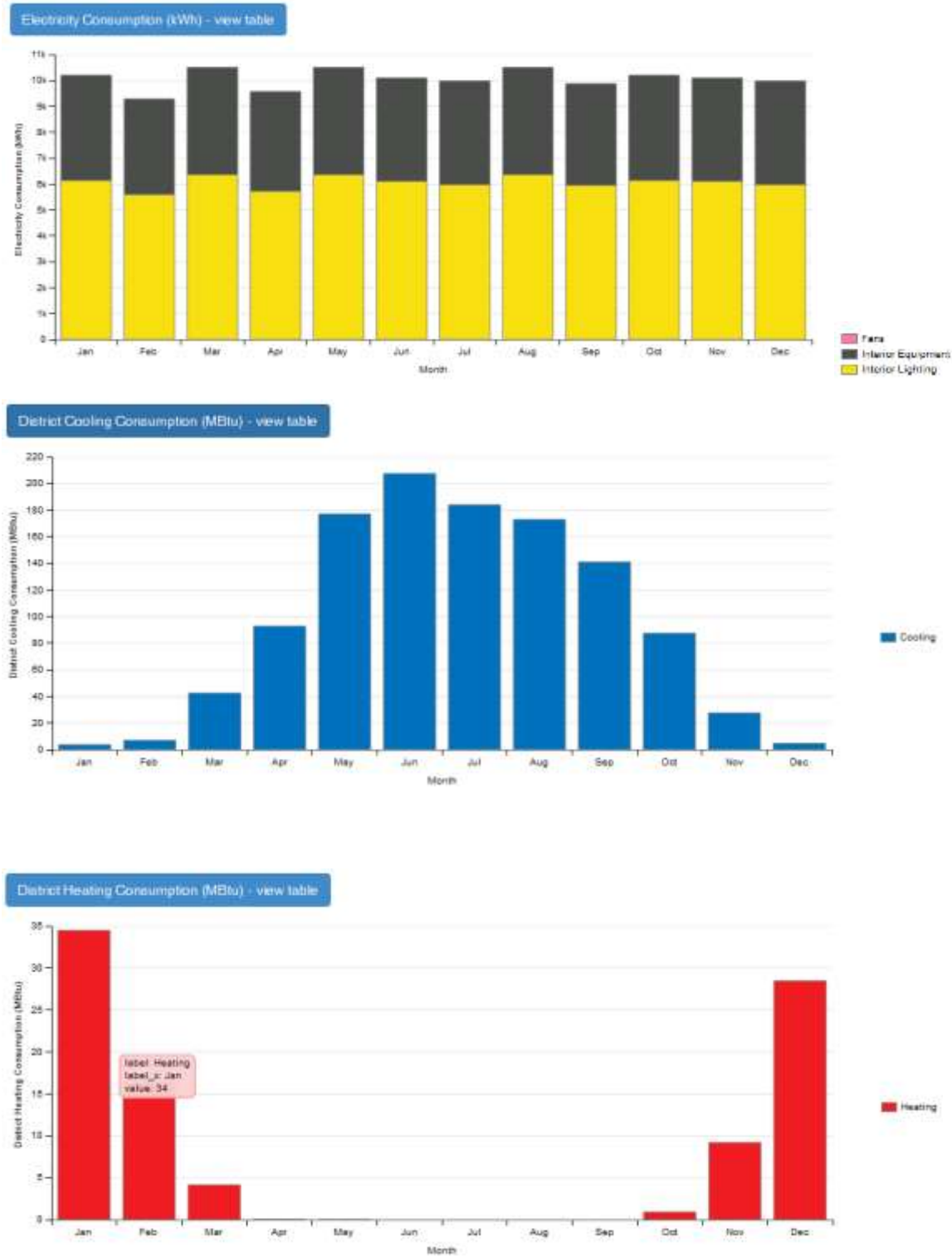


District Heating Consumption (MBtu) - view table



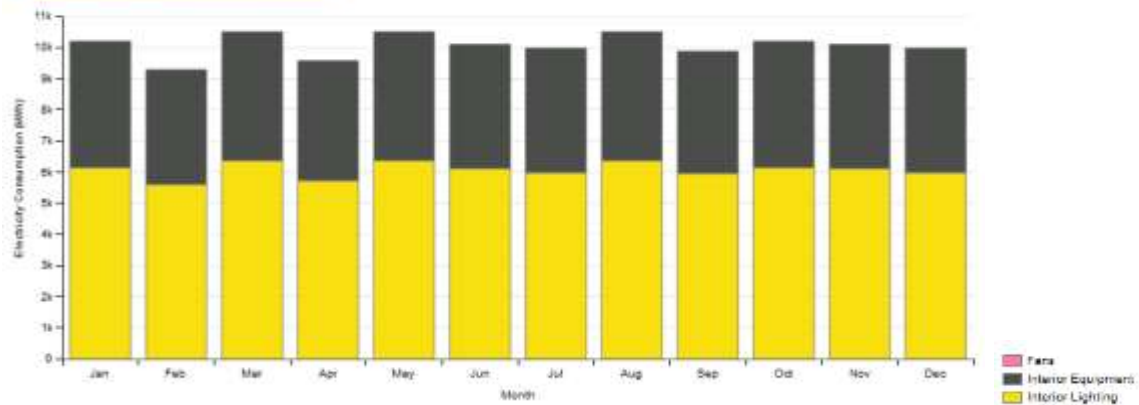


MONTHLY OVERVIEW

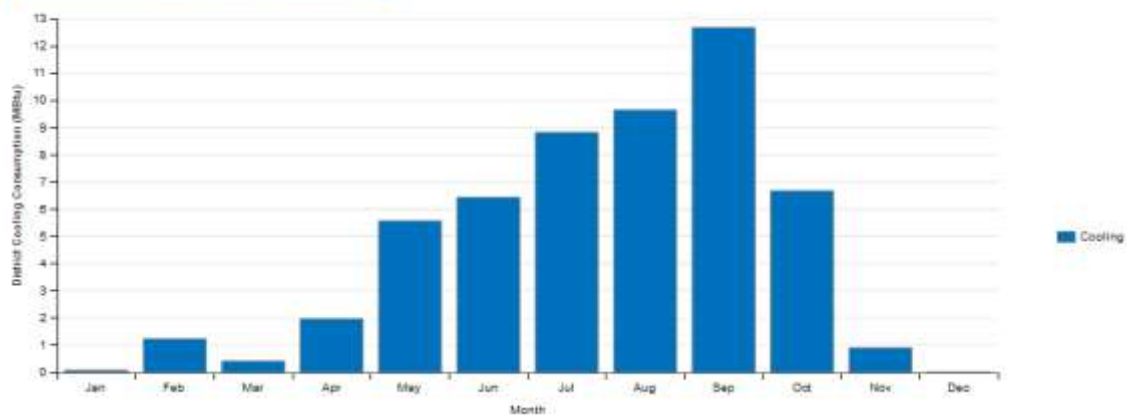


## MONTHLY OVERVIEW

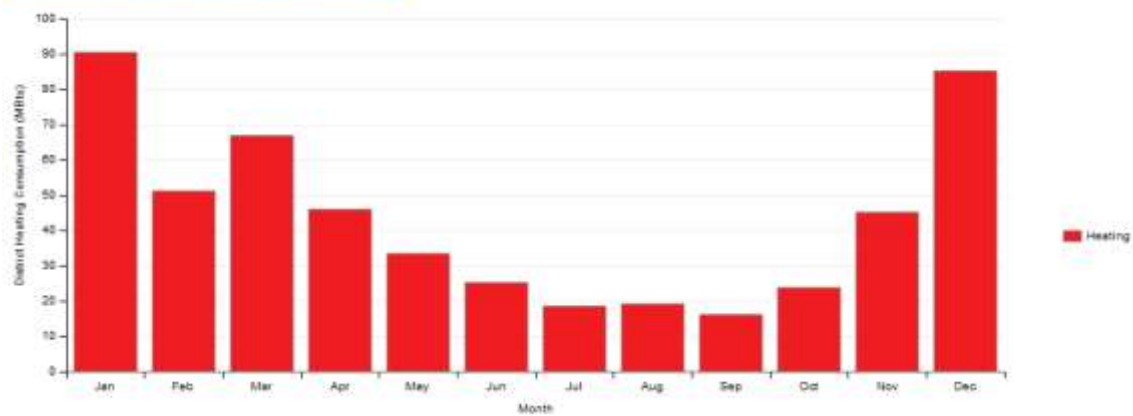
Electricity Consumption (kWh) - view table



District Cooling Consumption (MBtu) - view table



District Heating Consumption (MBtu) - view table



## SECOND MODULATION

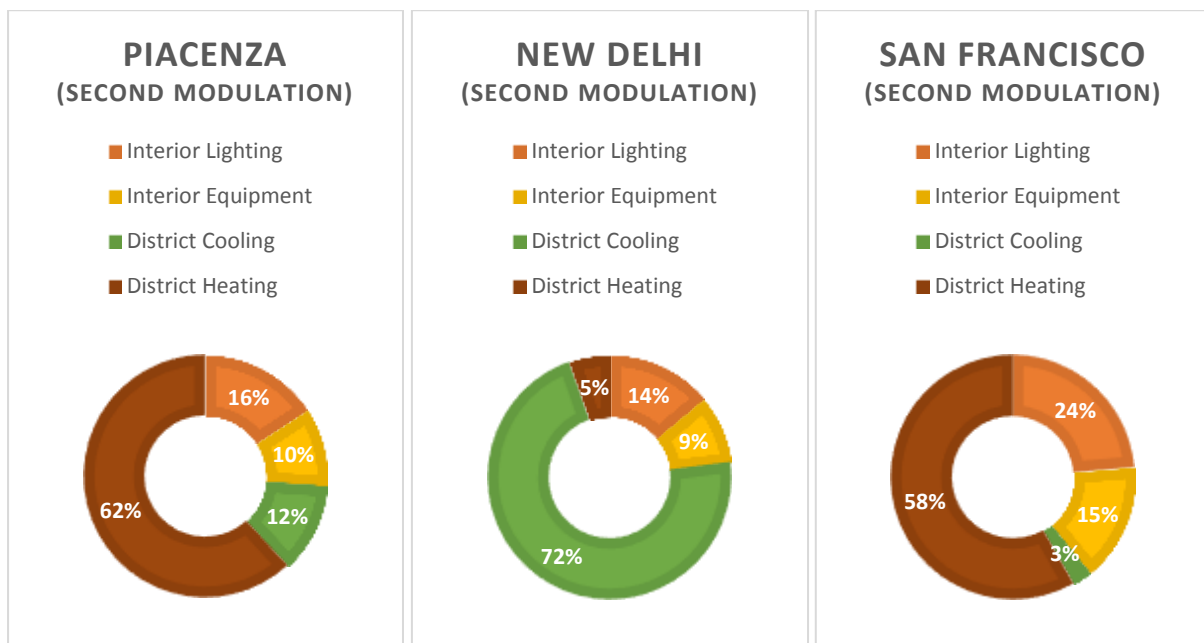
### ENVELOPE

<b>Base Surface Construction</b>	ASHRAE 189.1-2009 ExtRoof IEAD ClimateZone 1	<b>Net Area</b>
	MyConstruction- ExtWall Mass ClimateZone4	1878.04
<b>Sub-Surface Construction</b>		2603.99
<b>Wall to Window Ratio</b>	ASHRAE 189.1-2009 ExtWindow ClimateZone 1	636.01
	Gross Window-Wall Ratio	<b>Total (%)</b>
		19.63

### CONSTRUCTION DESCRIPTION

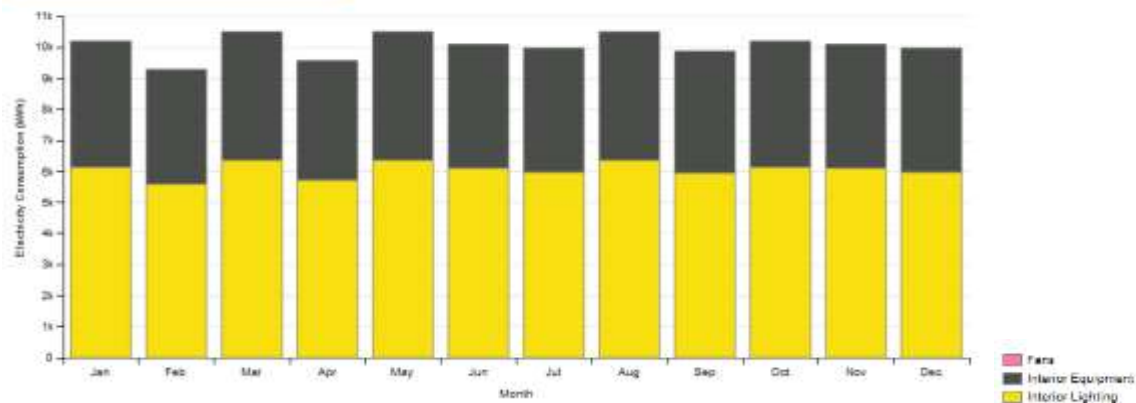
<b>My Construction-2 Set-1 - CZ1 - Office 2</b>	My ExtWall2 Mass ClimateZone 4	MAT-CC05 4 HW CONCRETE 8IN Concrete HW Wall Insulation [42] 1/2IN Gypsum
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### ANNUAL OVERVIEW

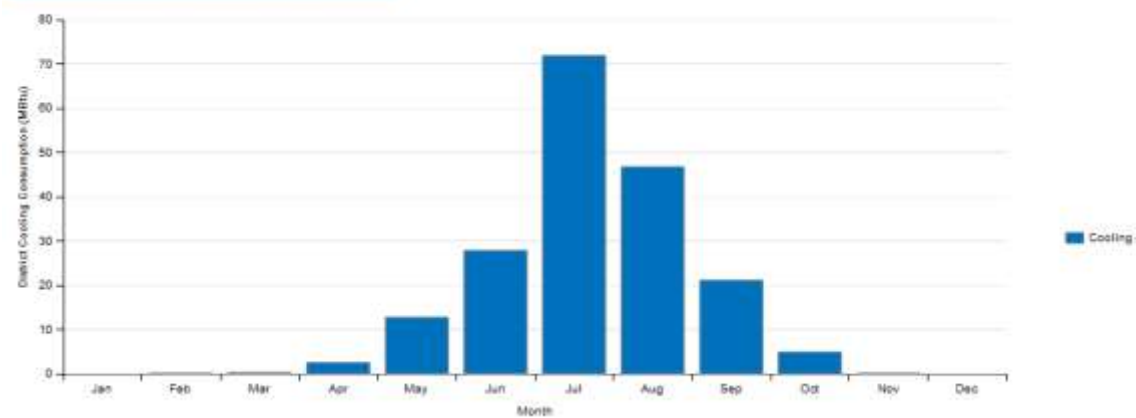


MONTHLY OVERVIEW

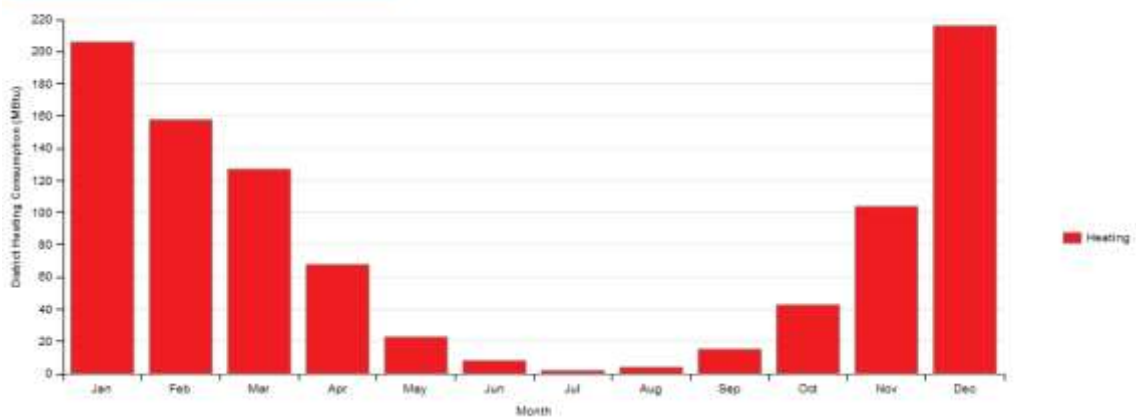
Electricity Consumption (kWh) - view table



District Cooling Consumption (MBtu) - view table

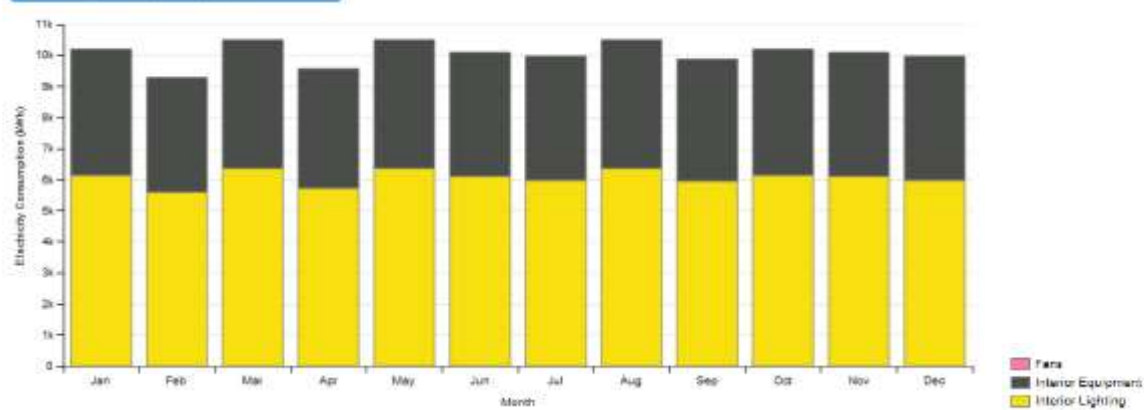


District Heating Consumption (MBtu) - view table

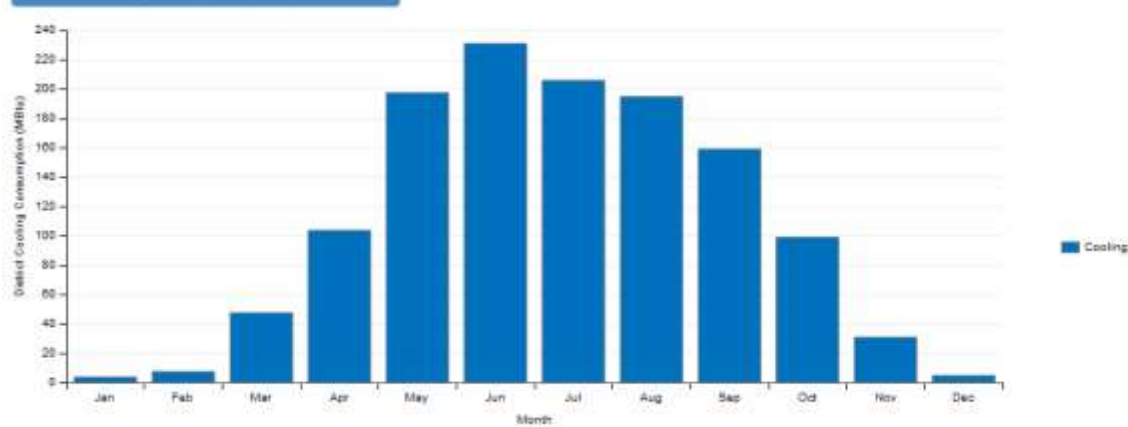


MONTHLY REPORT

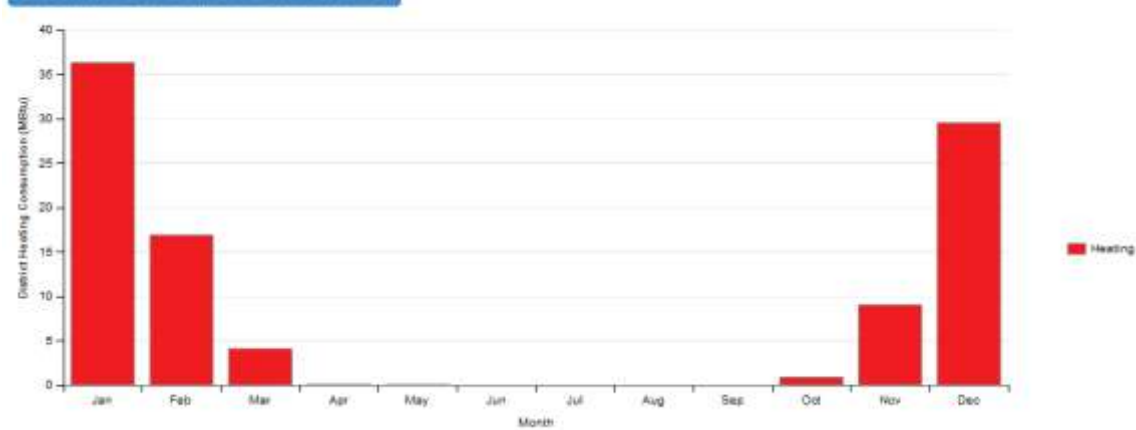
Electricity Consumption (kWh) - view table



District Cooling Consumption (MBtu) - view table

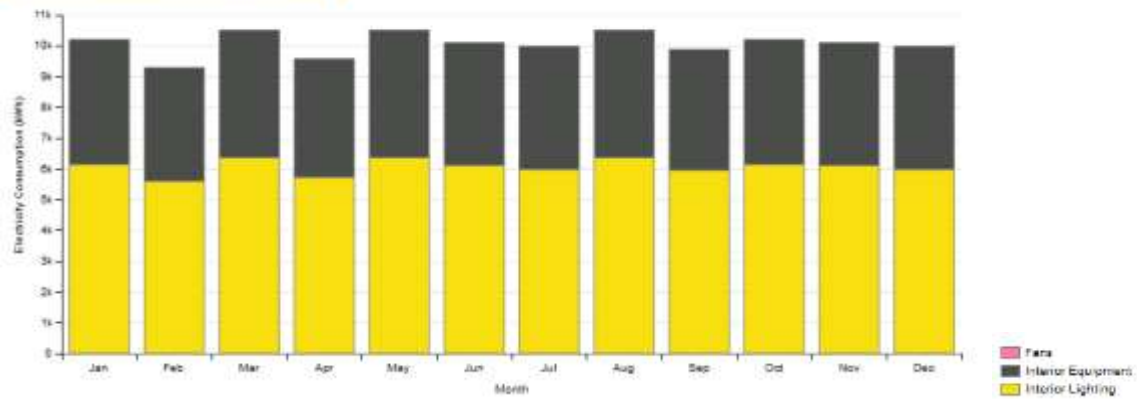


District Heating Consumption (MBtu) - view table

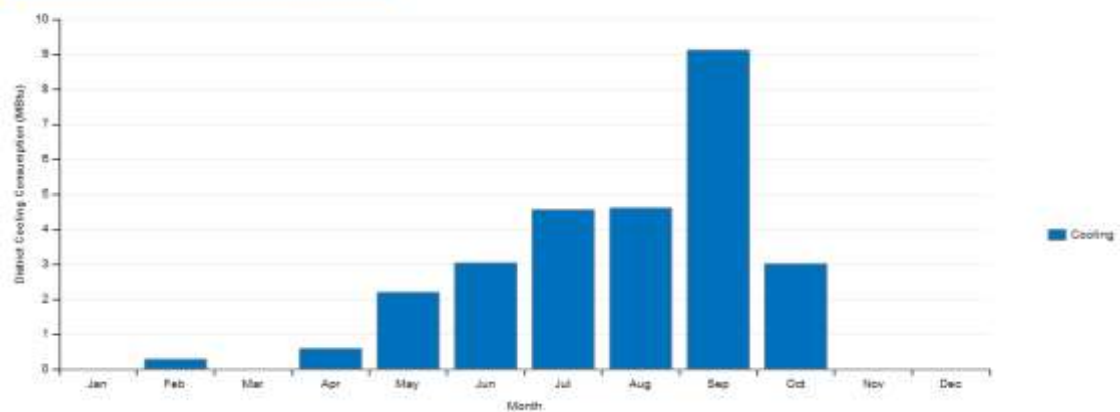


## MONTHLY REPORT

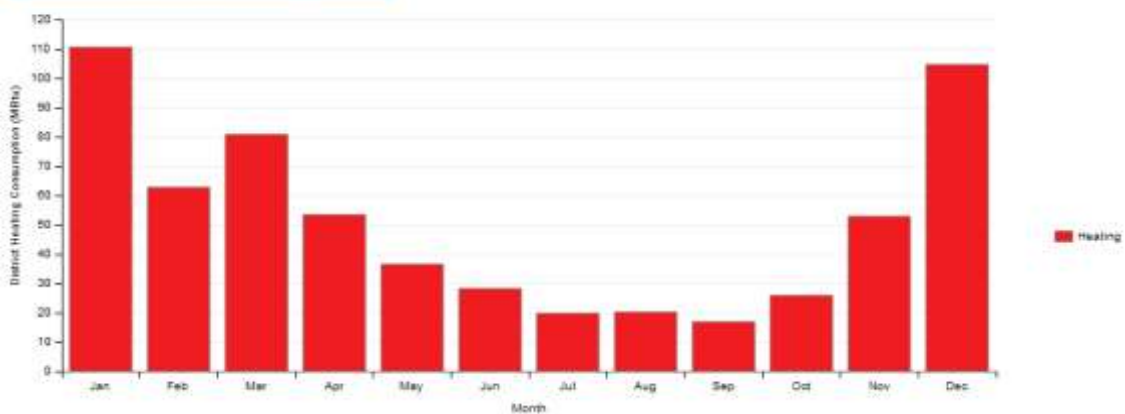
Electricity Consumption (kWh) - view table



District Cooling Consumption (MBtu) - view table



District Heating Consumption (MBtu) - view table



## THIRD MODULATION

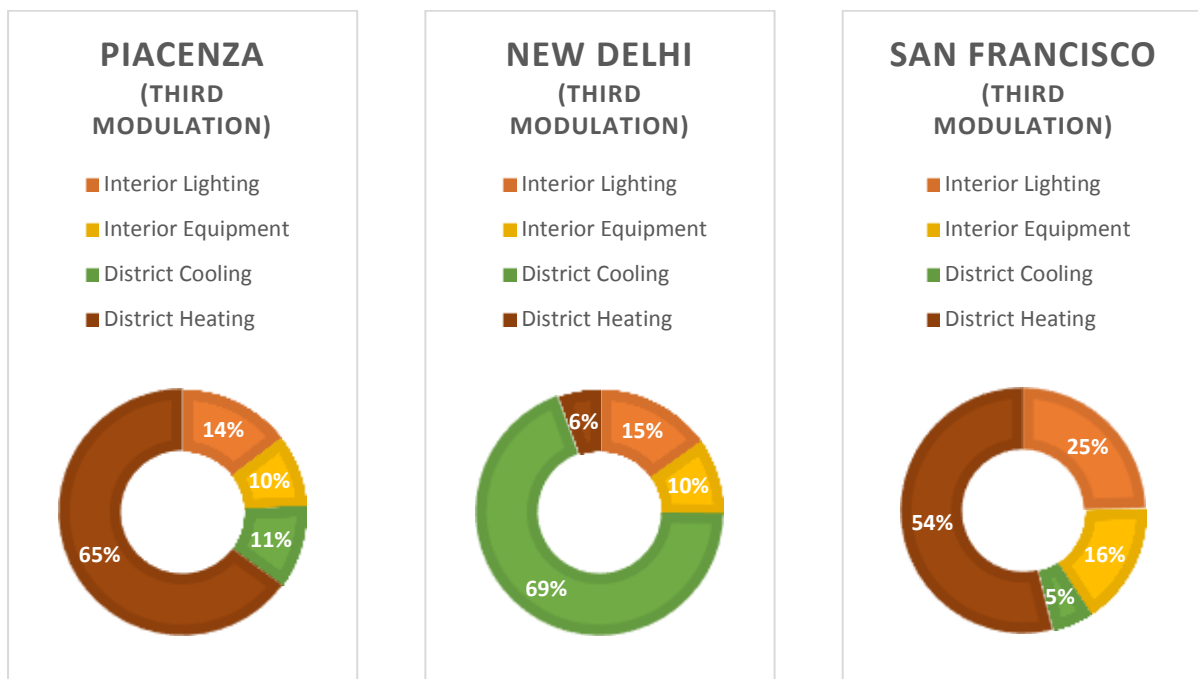
### ENVELOPE

<b>Base Surface Construction</b>	ASHRAE 189.1-2009 ExtRoof IEAD ClimateZone 1	<b>Net Area</b>
	My ExtWall2 Mass ClimateZone 4	1878.04
<b>Sub-Surface Construction</b>	ASHRAE 189.1-2009 ExtWindow ClimateZone 1	636.01
<b>Wall to Window Ratio</b>	Gross Window-Wall Ratio	<b>Total (%)</b>
		19.63

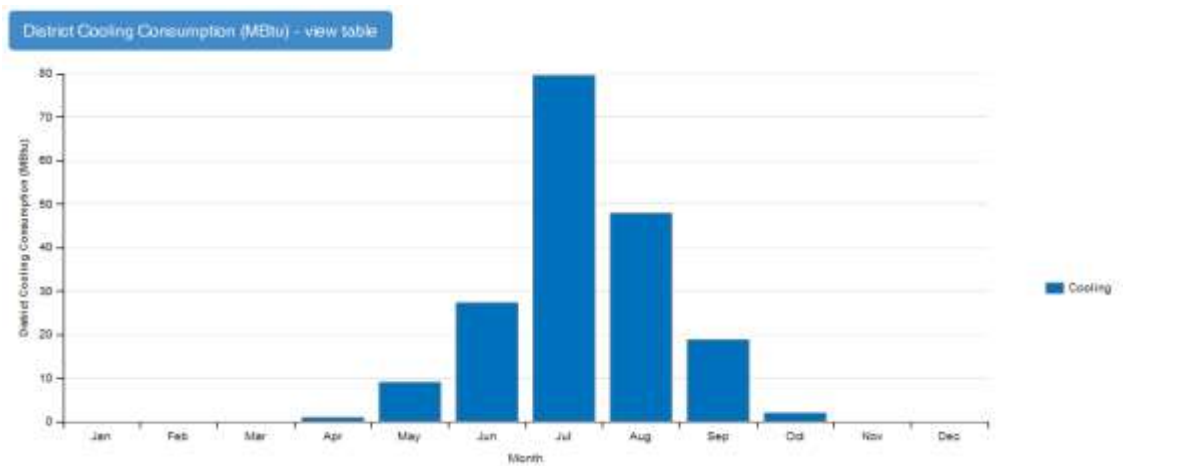
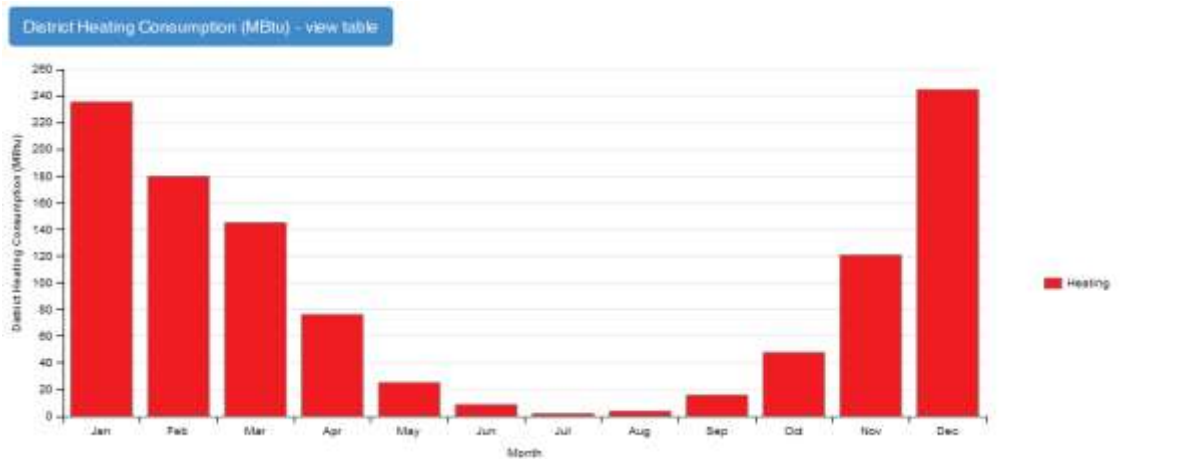
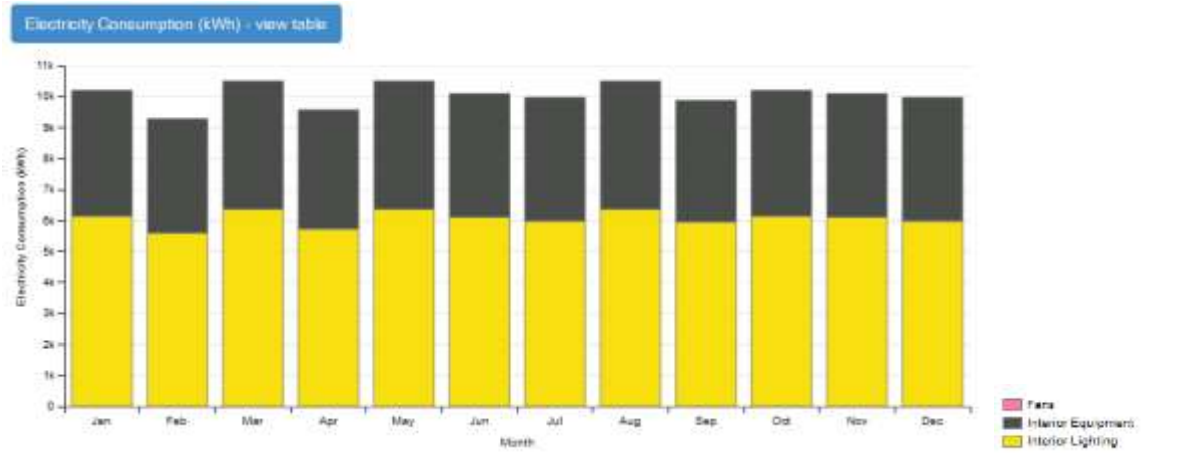
### CONSTRUCTION DESCRIPTION

<b>MyConstruction2Set1-CZ1-Office 2</b>	My ExtWall2 Mass ClimateZone 4	MAT-CC05 4 HW CONCRETE 8IN Concrete HW Wall Insulation [42] 1/2IN Gypsum
<b>My Schedule Set 1 - ClosedOffice - CZ1-3</b>	My building Large Office Bldg Occ 1	Priority1 -----  Priority2 8 am – 12 pm default 8 am – 6 pm
<b>My Schedule-1 - Conference - CZ1-3</b>	Large Office Bldg Occ-conference	Priority1 -----  Priority2 8 am. – 12 pm default 2 pm – 6 pm
<b>My People Definiton -1 - ClosedOffice - CZ1-</b>	1.2 m <sup>2</sup> /person	
<b>People Definition2- Office - Conference - CZ1-3</b>	0.434800 people / m <sup>2</sup>	

### ANNUAL OVERVIEW



MONTHLY OVERVIEW



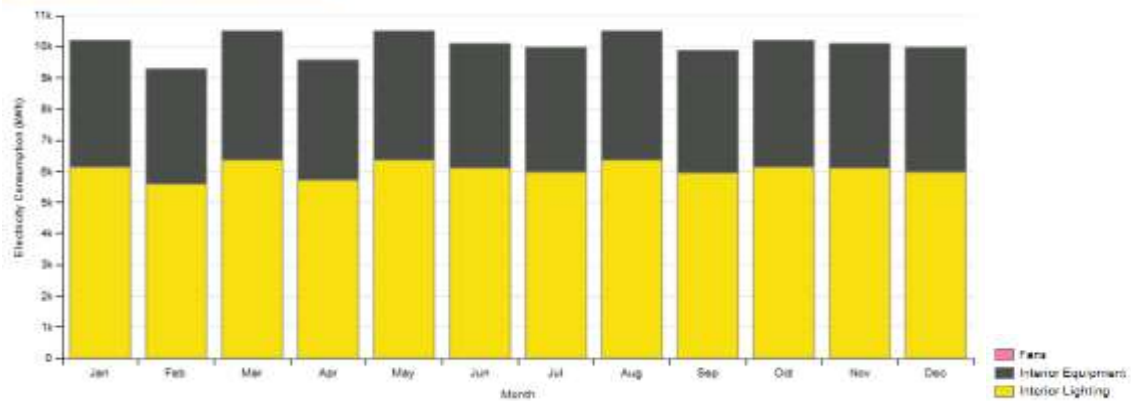


MONTHLY OVERVIEW

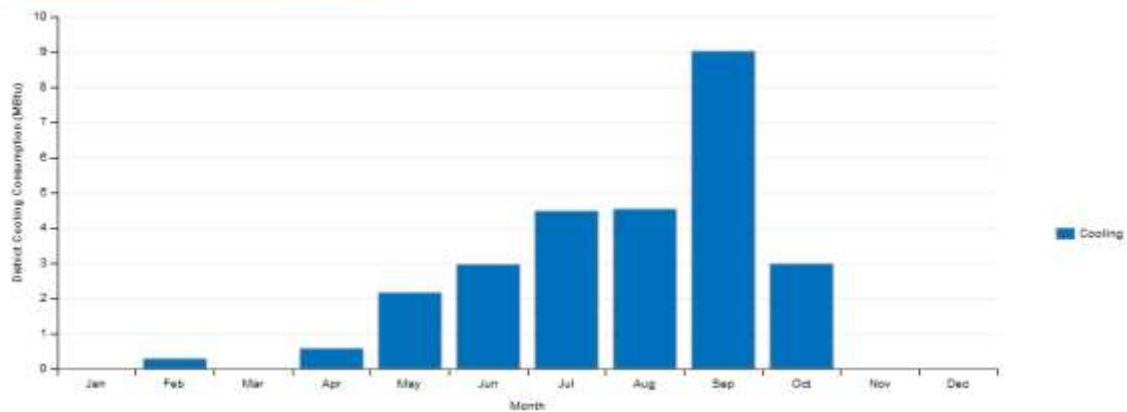


## MONTHLY OVERVIEW

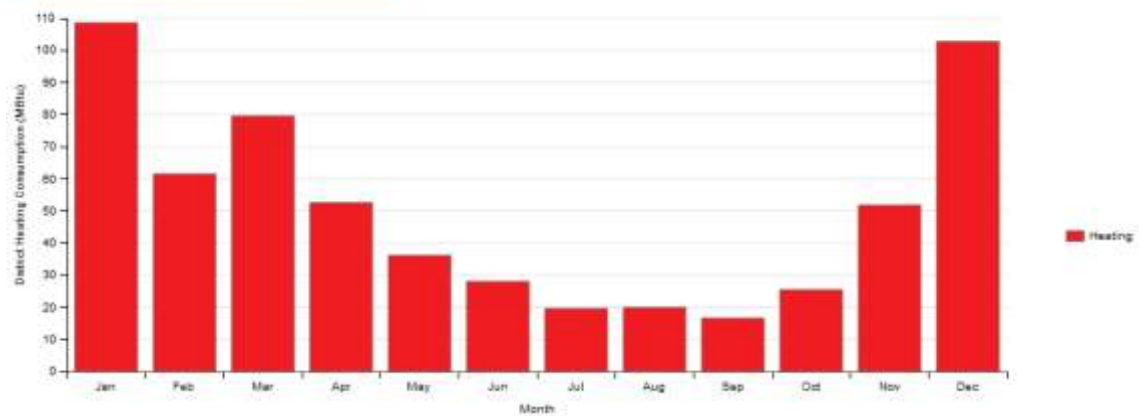
Electricity Consumption (kWh) - view table



District Cooling Consumption (MBtu) - view table



District Heating Consumption (MBtu) - view table



## FOURTH MODULATION

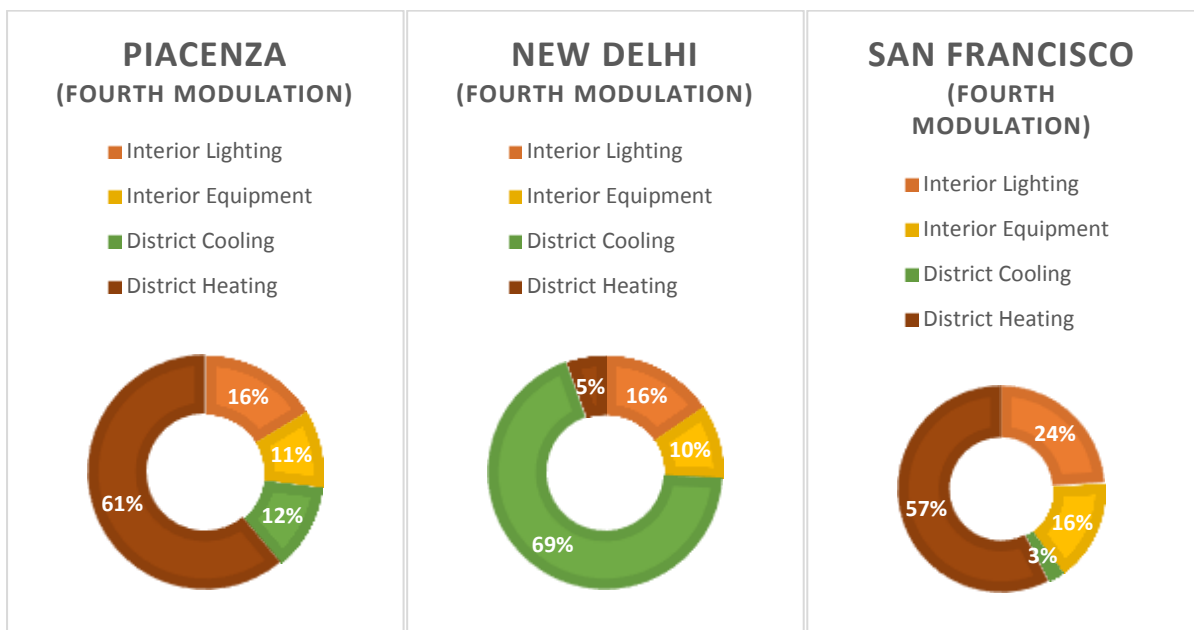
### ENVELOPE

<b>Base Surface Construction</b>	My ExtRoof IEAD ClimateZone 2	<b>Net Area</b>
	My ExtWall2 Mass ClimateZone 4	1878.04
<b>Sub-Surface Construction</b>		2603.99
<b>Wall to Window Ratio</b>	ASHRAE 189.1-2009 ExtWindow ClimateZone 1	636.01
	Gross Window-Wall Ratio	<b>Total (%)</b>
		19.63

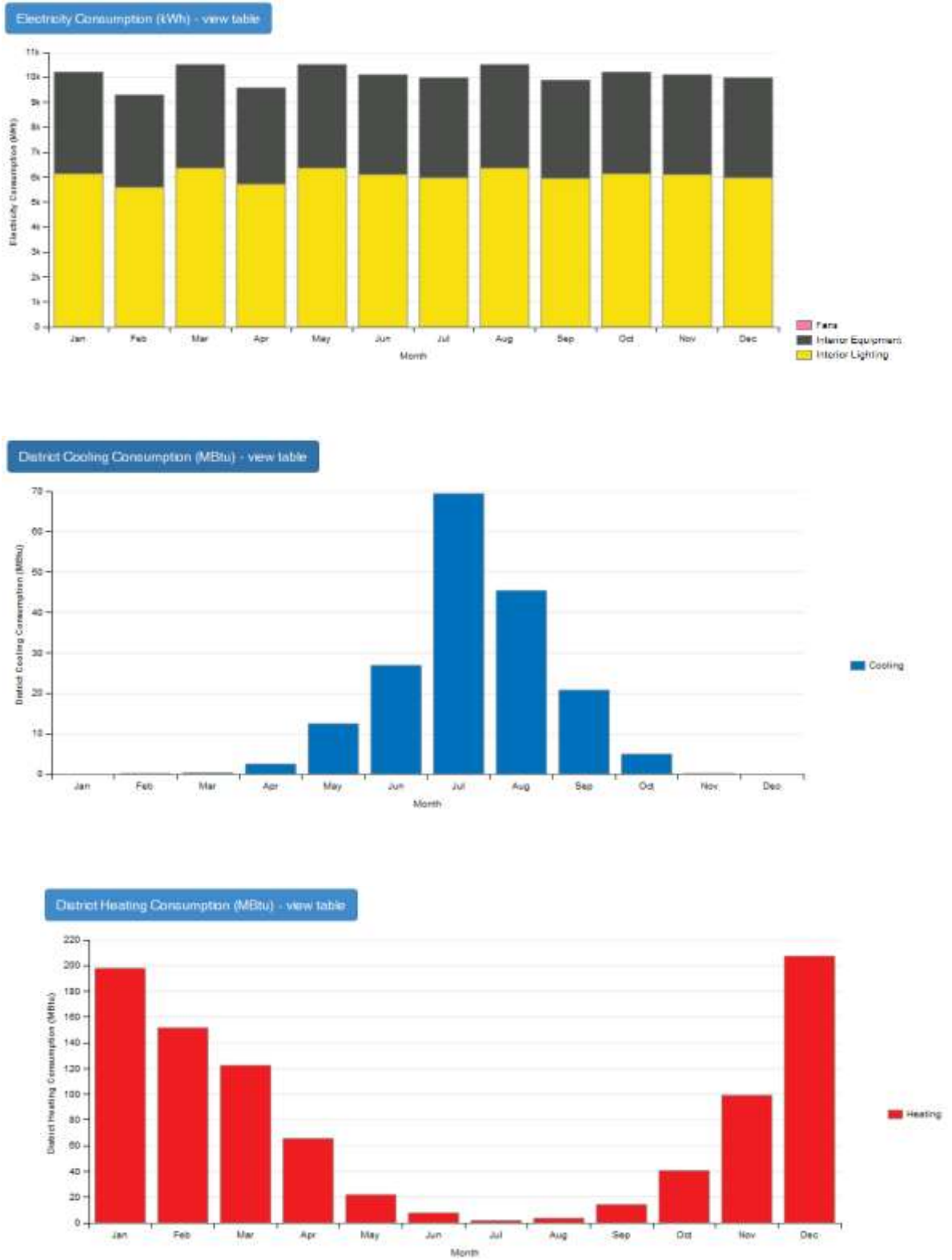
### CONSTRUCTION DESCRIPTION

<b>MyConstruction2Set1-CZ1-Office 2</b>	My ExtWall2 Mass ClimateZone 4	MAT-CC05 4 HW CONCRETE 8IN Concrete HW Wall Insulation [42] 1/2IN Gypsum “
<b>My Construction-3 Set-1 - CZ1 - Office 3</b>	My ExtWall2 Mass ClimateZone 4 My ExtRoof IEAD ClimateZone 2	Roof Membrane 2 Roof insulation [26] 1 F16 acoustic tile 1
<b>My Schedule Set 1 - ClosedOffice - CZ1-3</b>	My building Large Office Bldg Occ 1	Priority1 -----  Priority2 8 am – 12 pm default 8 am – 6 pm Priority1 -----
<b>My Schedule-1 - Conference - CZ1-3</b>	Large Office Bldg Occ-conference	  Priority2 8 am. – 12 pm default 2 pm – 6 pm
<b>My People Definiton -1 - ClosedOffice - CZ1-</b>	1.2 m <sup>2</sup> /person	
<b>People Definition2- Office - Conference - CZ1-3</b>	0.434800 people / m <sup>2</sup>	

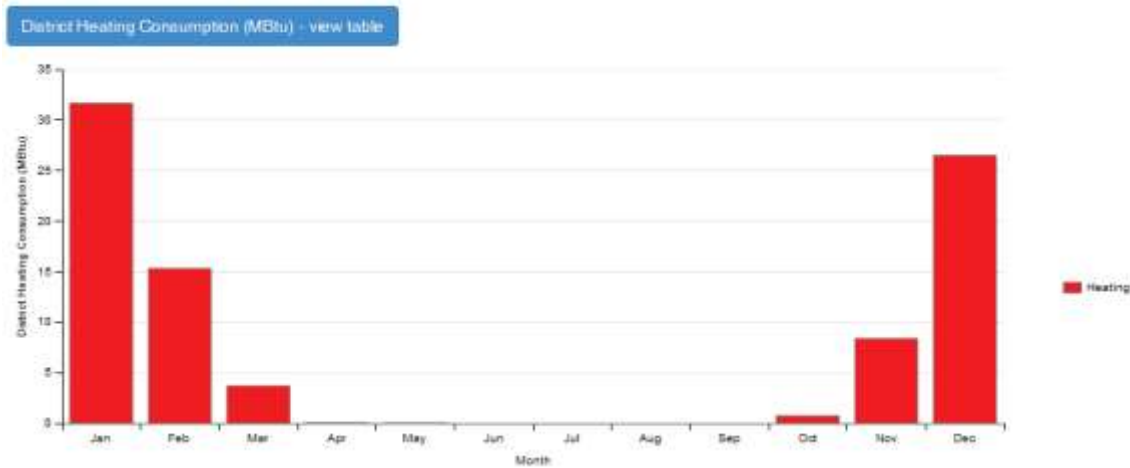
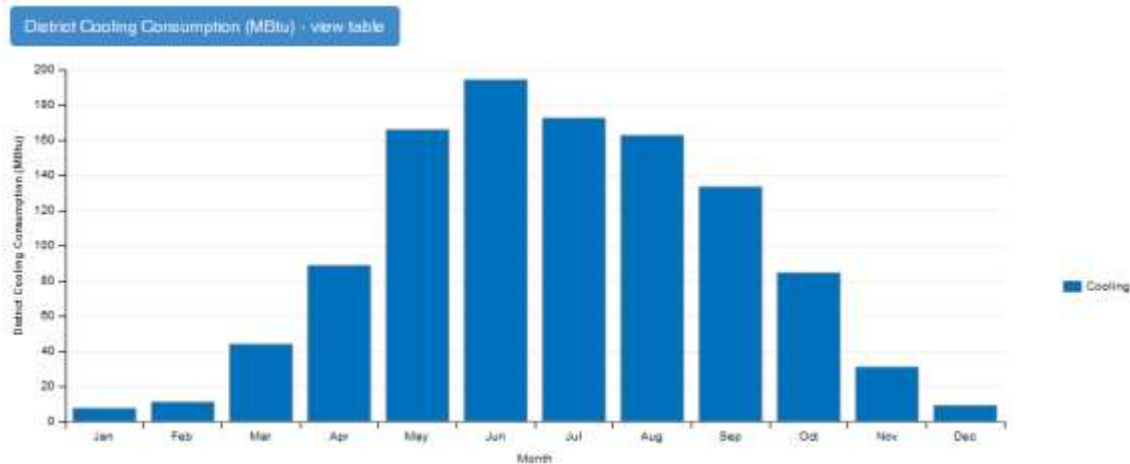
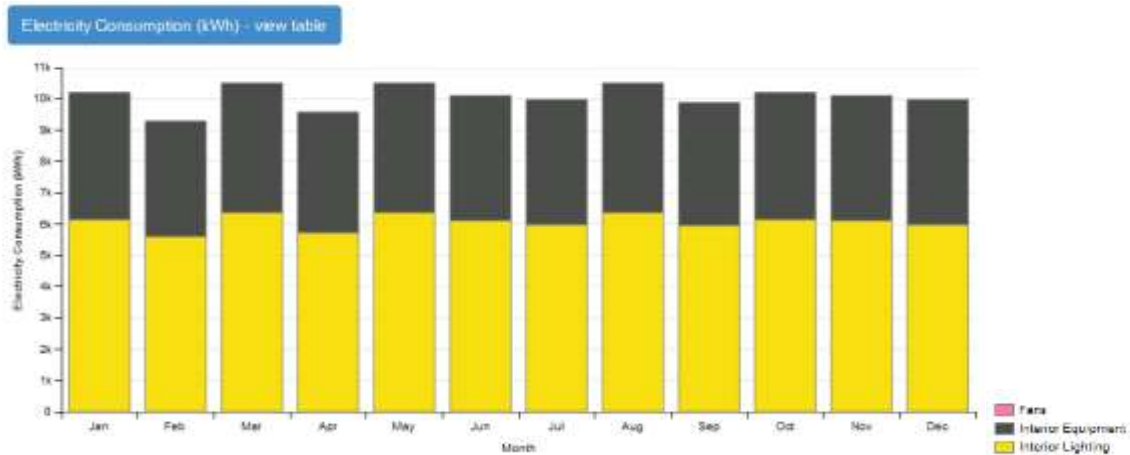
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