

# TECHNICAL ENVIRONMENTAL SYSTEMS

GROUP-T2

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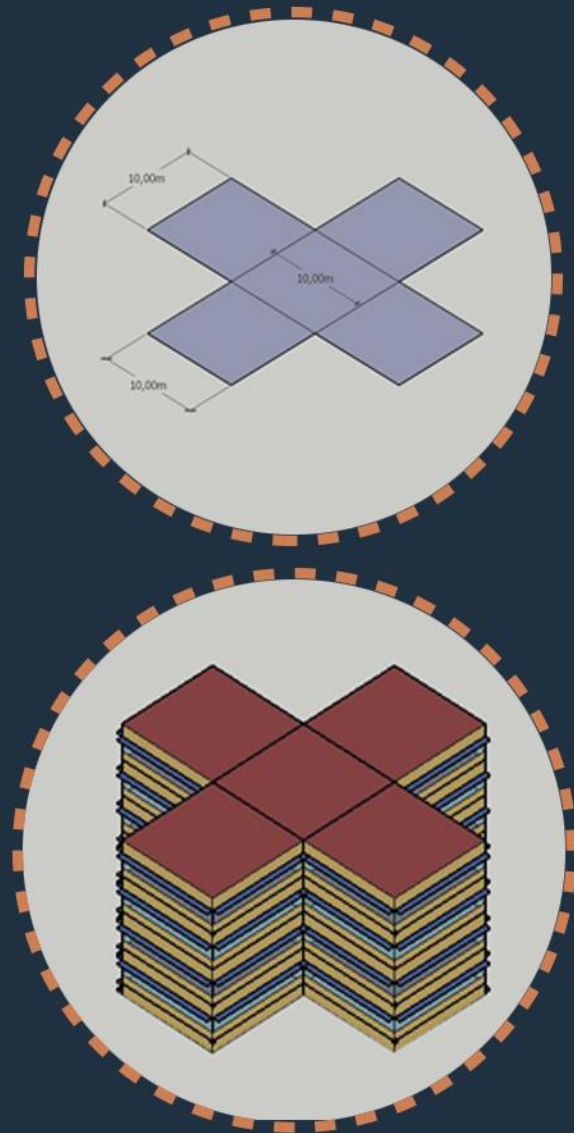


POLITECNICO DI MILANO  
2019

# BUILDING DESIGN CHARACTERISTICS

The building is designed with four floors, cross-shaped. Each floor is 4 meter high and 500 sq meter.

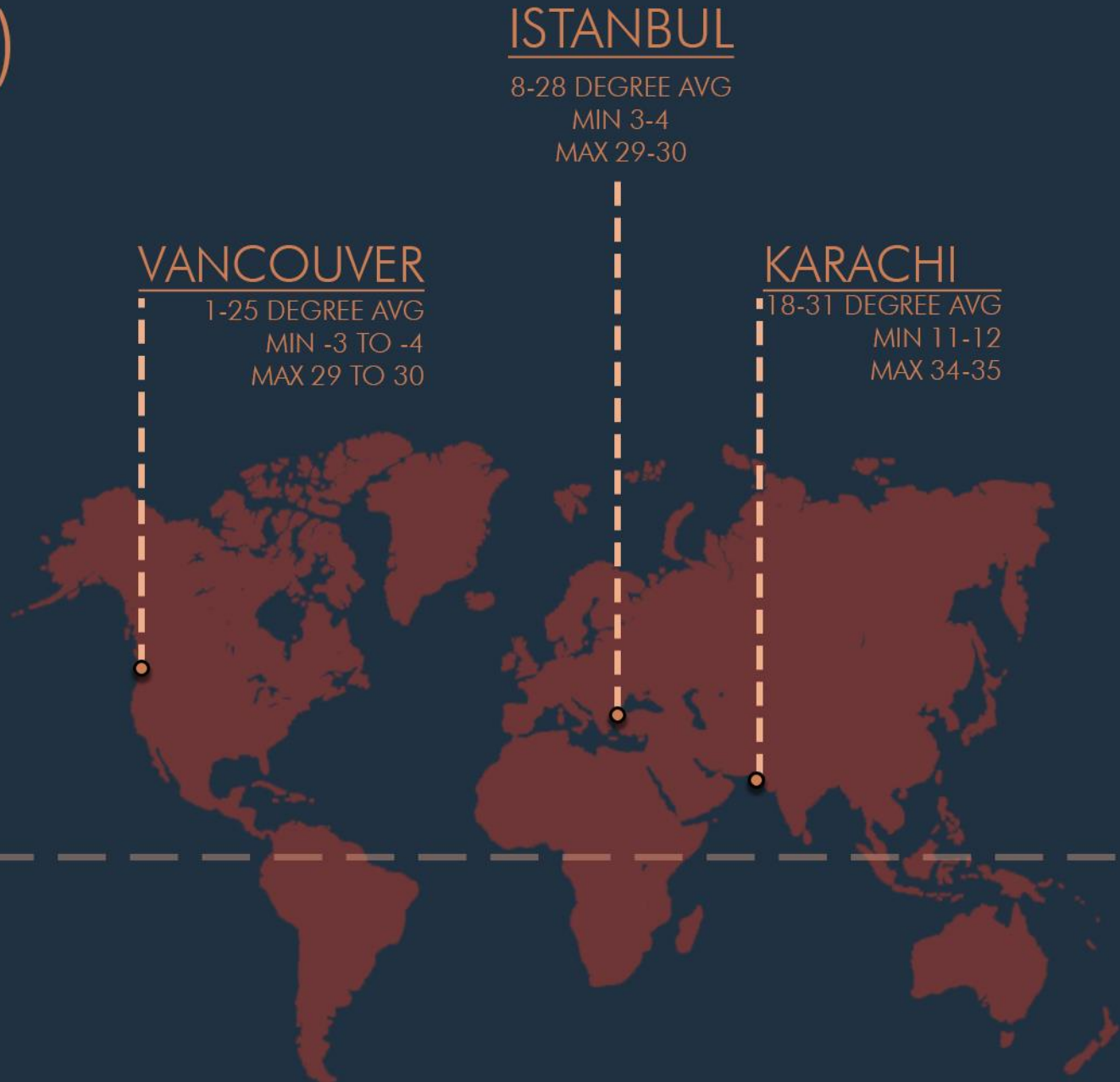
The purpose of the building is the business center. The central part consists of a staircase and the corridor. Around the central part the office rooms are located. Each room has three facades.



# LOCATION (CITIES)

## AVERAGE WEATHER DATA

## EQUATOR



# THE LAYERS AND U-VALUES OF THE WALLS

## WALL LAYERS

	STUCCO	CONCRETE	INSULATION	GYPSUM BOARD
<b>WALL 1</b>	2,5 cm	20 cm	2,54 cm (XPS)	1,25 cm
<b>WALL 2</b>	2,5 cm	20 cm	6 cm (rockwool)	1,25 cm
<b>WALL 3</b>	2,5 cm	20 cm	8 cm (rockwool)	1,25 cm

## U-VALUE CALCULATIONS

What is U-value?

The U-factor is the coefficient of heat transfer, which simply means it is a measure of the ability of an assembly to transfer thermal energy through its thickness. An assembly's U-factor is the inverse of the assembly's maximum R-value.

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$$U = \frac{1}{R_1 + R_2 + R_3 + \dots}$$

## BASE CASE DATA and SENSITIVITY ANALYSIS

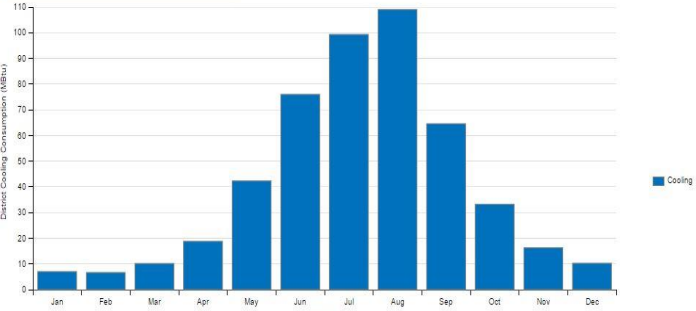
	R-VALUE ( $\text{m}^2\text{K/W}$ ) ( stucco, concrete, wall ins., gypsum board)	U-VALUE ( $\text{W/m}^2\text{K}$ )	ISTANBUL <sub>heating</sub> (kWh)	ISTANBUL <sub>cooling</sub> (kWh)
<b>WALL 1</b>	$0.03 + 0.037 + 0.12 + 0.079 + 0.66 + 0.12$	0.956	85661	144644
<b>WALL 2</b>	$0.03 + 0.037 + 0.12 + 0.079 + 1.32 + 0.12$	0.586	80169	143552
<b>WALL 3</b>	$0.03 + 0.037 + 0.12 + 0.079 + 1.76 + 0.12$	0.465	79014	143308

THE BASE CASE					
			ISTANBUL		
			WALL 1	WALL 2	WALL 3
HEATING CONSUMPTION	OpenStudio Results	kBtu	292,288	273,549	269,607
		kWh	85661	80169	79014
	EnergyPlusResults	GJ	308.38	305.1	284.45
COOLING CONSUMPTION	OpenStudio Results	kBtu	493,547	489,822	488,988
		kWh	144644	143552	143308
	EnergyPlusResults	GJ	520.72	518.64	515.91

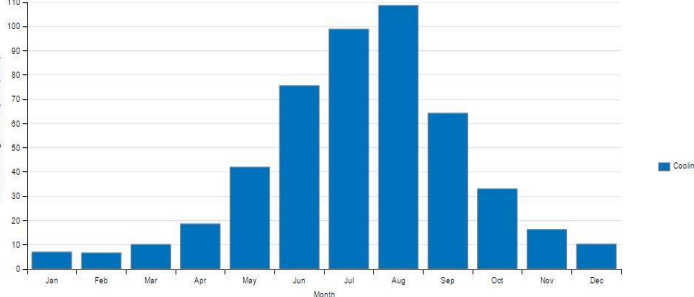
# ISTANBUL MONTHLY DATA

## HEATING & COOLING

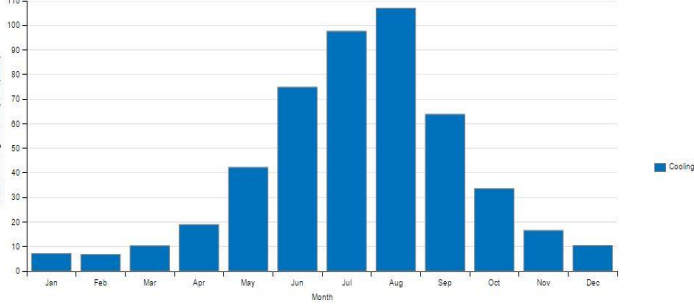
District Cooling Consumption (MBtu) - view table



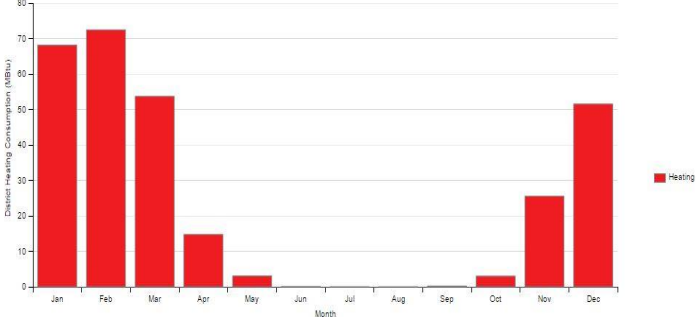
District Cooling Consumption (MBtu) - view table



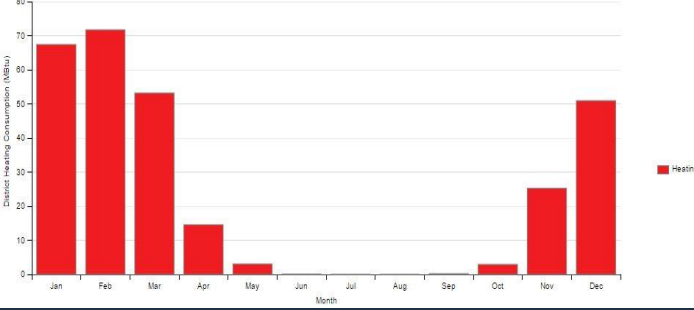
District Cooling Consumption (MBtu) - view table



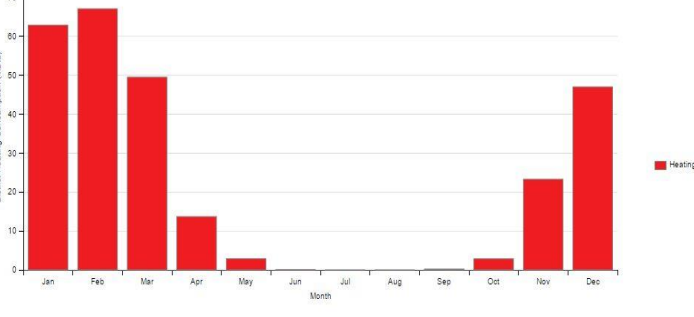
District Heating Consumption (MBtu) - view table



District Heating Consumption (MBtu) - view table



District Heating Consumption (MBtu) - view table





# HEATING AND COOLING CONSUMPTIONS + PRICES FOR COUNTRIES

ALL OPEN STUDIO RESULTS AND ANNUAL PRICE FOR COUNTRIES

			ISTANBUL			VANCOUVER			KARACHI		
			WALL 1	WALL 2	WALL 3	WALL 1	WALL 2	WALL 3	WALL 1	WALL 2	WALL 3
HEATING CONSUMPTION	OpenStudio Results	unit									
		kBtu	292,288	273,549	269,607	476,705	448,678	442,640	4,606	4,843	4,900
		kWh	85661	80169	79014	139708	131494	129724	1349	1419	1436
COOLING CONSUMPTION	OpenStudio Results	kBtu	493,547	489,822	488,988	228,822	228,528	228,414	1,478,860	1,447,639	1,440,748
		kWh	144644	143552	143308	67061	66974	66941	433411	424261	422241
Unit price			0.111 U.S. Dollar per kWh			0.829 us dollars kWh			0.056 U.S. Dollar kWh		
Price			0.111	0.111	0.111	0.829	0.829	0.829	0.056	0.056	0.056
Heating Price			\$ 9,508.37	\$ 8,898.76	\$ 8,770.55	\$ 115,817.93	\$ 109,008.53	\$ 107,541.20	\$ 75.54	\$ 79.46	\$ 80.42
Cooling Price			\$ 16,055.48	\$ 15,934.27	\$ 15,907.19	\$ 55,593.57	\$ 55,521.45	\$ 55,494.09	\$ 24,271.02	\$ 23,758.62	\$ 23,645.50
Sum Price			\$ 25,563.86	\$ 24,833.03	\$ 24,677.74	\$ 171,411.50	\$ 164,529.97	\$ 163,035.29	\$ 24,346.56	\$ 23,838.08	\$ 23,725.91

# WALL TYPE-1

(STUCCO 2.5CM – CONCRETE 20CM –INSULATION 2.54CM (XPS)- GYPSUM BOARD 1.25CM)

ISTANBUL  
(\$25,563.86)

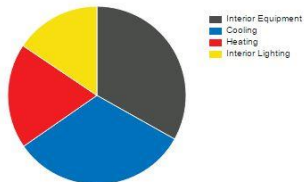
KARACHI  
(\$24,346.56)

VANCOUVER  
(\$171,411.50)

## Annual Overview

End Use - view table

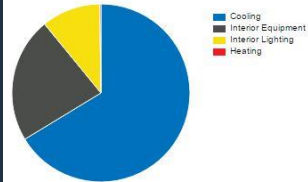
End Use	Consumption (kBtu)
Heating	292,288
Cooling	493,547
Interior Lighting	238,803
Exterior Lighting	0
Interior Equipment	507,983
Exterior Equipment	0
Fans	0
Pumps	0
Heat Rejection	0
Humidification	0
Heat Recovery	0
Water Systems	0
Refrigeration	0
Generators	0



## Annual Overview

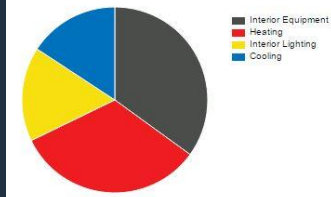
End Use - view table

End Use	Consumption (kBtu)
Heating	4,606
Cooling	1,478,860
Interior Lighting	238,803
Exterior Lighting	0
Interior Equipment	507,983
Exterior Equipment	0
Fans	0
Pumps	0
Heat Rejection	0
Humidification	0
Heat Recovery	0
Water Systems	0
Refrigeration	0
Generators	0



End Use - view table

End Use	Consumption (kBtu)
Heating	476,705
Cooling	228,822
Interior Lighting	238,803
Exterior Lighting	0
Interior Equipment	507,983
Exterior Equipment	0
Fans	0
Pumps	0
Heat Rejection	0
Humidification	0
Heat Recovery	0
Water Systems	0
Refrigeration	0
Generators	0





# WALL TYPE-2

(STUCCO 2.5CM – CONCRETE 20CM –INSULATION 6CM (ROCKWALL)- GYPSUM BOARD 1.25CM)

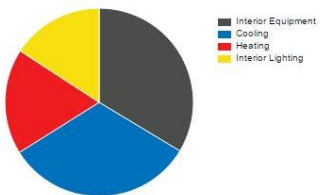
ISTANBUL  
(\$24,833.03)

KARACHI  
(\$23,838.08)

VANCOUVER  
(\$164,529.97)

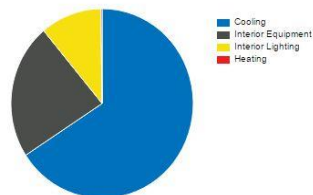
End Use - view table

End Use	Consumption (kBtu)
Heating	273,549
Cooling	489,822
Interior Lighting	238,803
Exterior Lighting	0
Interior Equipment	507,983
Exterior Equipment	0
Fans	0
Pumps	0
Heat Rejection	0
Humidification	0
Heat Recovery	0
Water Systems	0
Refrigeration	0
Generators	0



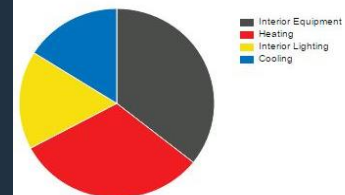
End Use - view table

End Use	Consumption (kBtu)
Heating	4,843
Cooling	1,447,639
Interior Lighting	238,803
Exterior Lighting	0
Interior Equipment	507,983
Exterior Equipment	0
Fans	0
Pumps	0
Heat Rejection	0
Humidification	0
Heat Recovery	0
Water Systems	0
Refrigeration	0
Generators	0



End Use - view table

End Use	Consumption (kBtu)
Heating	448,678
Cooling	228,528
Interior Lighting	238,803
Exterior Lighting	0
Interior Equipment	507,983
Exterior Equipment	0
Fans	0
Pumps	0
Heat Rejection	0
Humidification	0
Heat Recovery	0
Water Systems	0
Refrigeration	0
Generators	0



# WALL TYPE-3

(STUCCO 2.5CM – CONCRETE 20CM –INSULATION 8CM (ROCKWALL)- GYPSUM BOARD 1.25CM)  
BEST FOR ALL THREE LOCATIONS

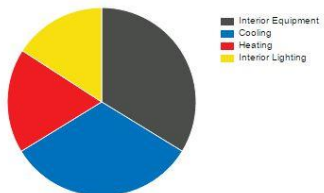
ISTANBUL  
(\$24,677.74)

KARACHI  
(\$23,725.91)

VANCOUVER  
(\$163,035.29)

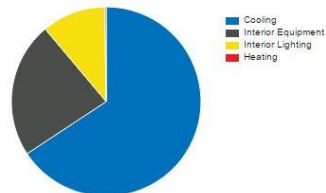
End Use - view table

End Use	Consumption (kBtu)
Heating	269,607
Cooling	488,988
Interior Lighting	238,803
Exterior Lighting	0
Interior Equipment	507,983
Exterior Equipment	0
Fans	0
Pumps	0
Heat Rejection	0
Humidification	0
Heat Recovery	0
Water Systems	0
Refrigeration	0
Generators	0



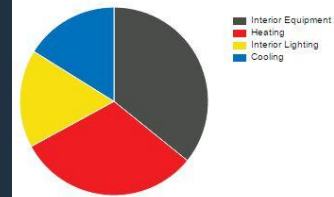
End Use - view table

End Use	Consumption (kBtu)
Heating	4,900
Cooling	1,440,748
Interior Lighting	238,803
Exterior Lighting	0
Interior Equipment	507,983
Exterior Equipment	0
Fans	0
Pumps	0
Heat Rejection	0
Humidification	0
Heat Recovery	0
Water Systems	0
Refrigeration	0
Generators	0



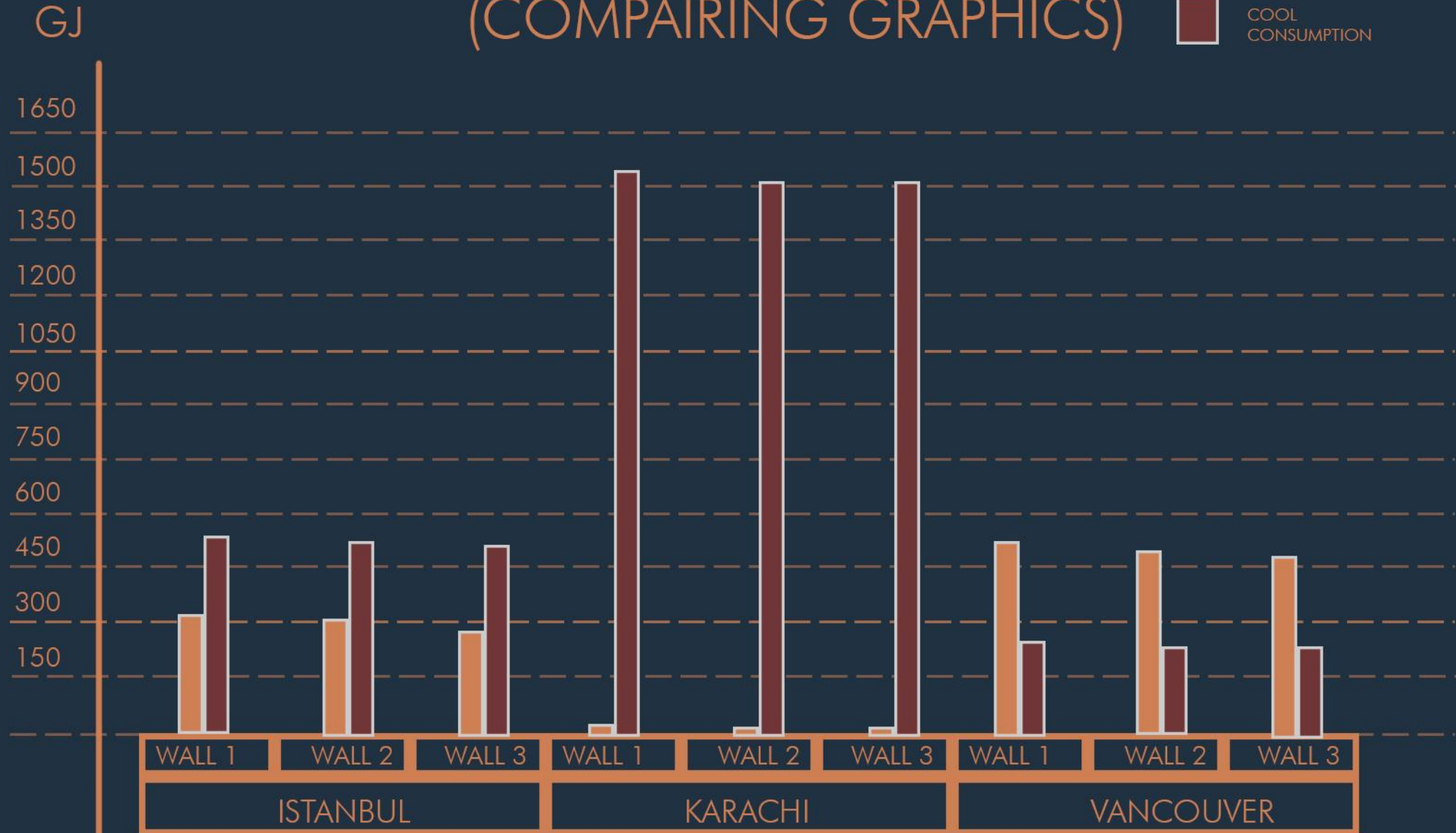
End Use - view table

End Use	Consumption (kBtu)
Heating	442,640
Cooling	228,414
Interior Lighting	238,803
Exterior Lighting	0
Interior Equipment	507,983
Exterior Equipment	0
Fans	0
Pumps	0
Heat Rejection	0
Humidification	0
Heat Recovery	0
Water Systems	0
Refrigeration	0
Generators	0



ENERGY PLUS RESULTS (COMPARING GRAPHICS)											
		unit	ISTANBUL			VANCOUVER			KARACHI		
			WALL 1	WALL 2	WALL 3	WALL 1	WALL 2	WALL 3	WALL 1	WALL 2	WALL 3
HEATING CONSUMPTION	EnergyPlusResults	GJ	308.38	305.1	284.45	502.95	473.38	467.01	4.86	5.11	5.17
COOLING CONSUMPTION	EnergyPlusResults	GJ	520.72	518.64	515.91	241.42	241.11	240.99	1560.28	1527.34	1520.07

# ENERGY PLUS RESULTS (COMPAIRING GRAPHICS)



# THANK-YOU



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2019