POLITECNICO DI MILANO

SUSTAINABLE ARCHITECTURE AND LANDSCAPE DESIGN

TECHNICAL ENVIRONMENTAL SYSTEMS

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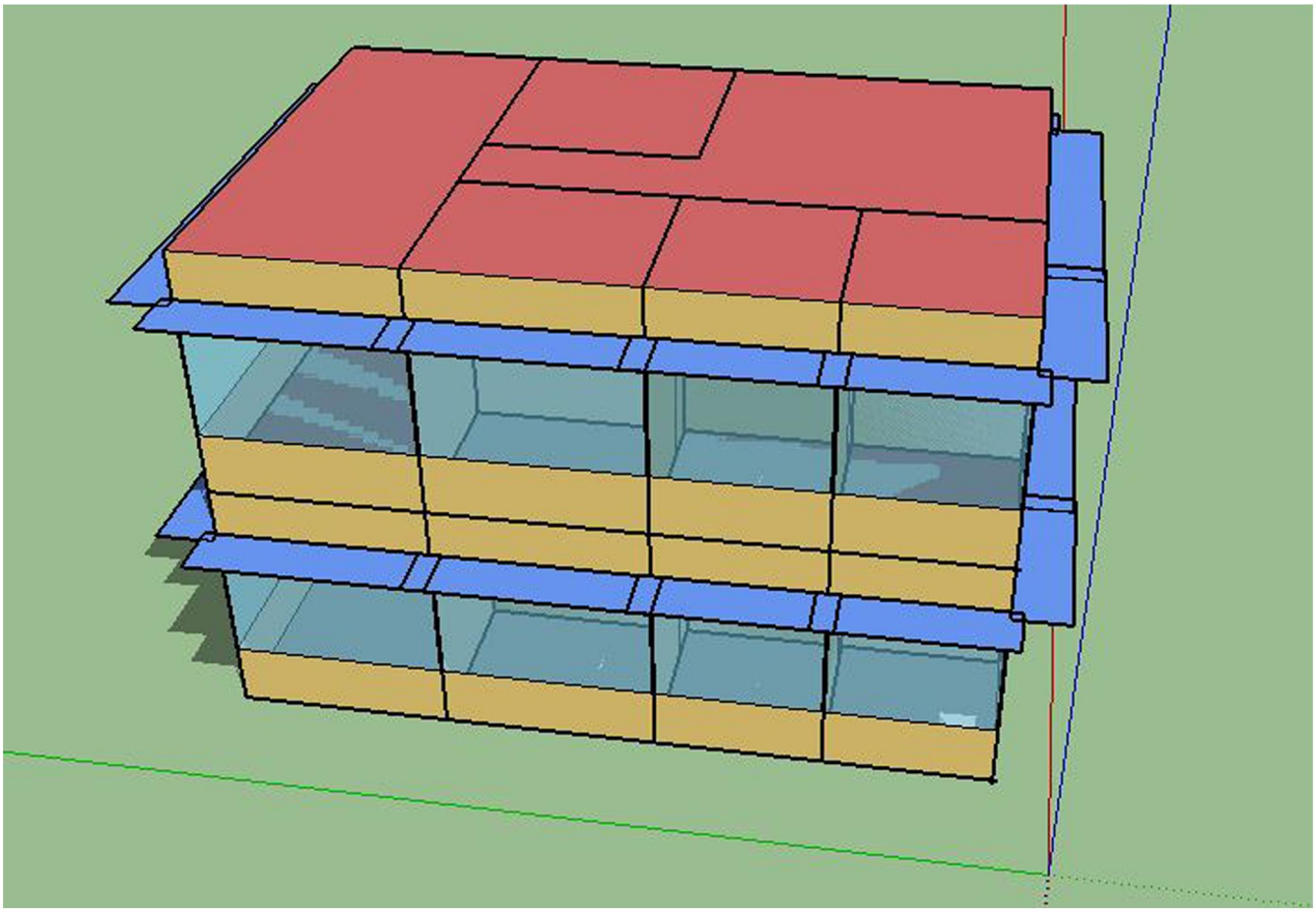
INTRODUCTION

For this project, a two floor office was designed in the Sketch-Up program, which includes a conference room, a corridor ,and offices, IT rooms.



SUMMARY

After the design process, the windows were created by using "surface matching tool" and "set window to wall ratio" orders in the program. Then to add external shadings to the building, all the surfaces except the North were chosen and the shadings were added by the ' add overhangs by projection "factor.
For the next step, different thermal zones were selected for adding specification. (for example conference room, IT room ,etc)
Other steps should be done in Openstudio program. So the program was launched. Then the weather data was added to .it. The next step is running the model
After reviewing the given results, schedule set and definitions .(were applied to each space (people, construction set
In conclusion the modified results, such as energy used, electricity consumption, etc, were given.

UNITS

UNIT CONVERTER	
Btu	1055.06 Joule
foot	0.3048 Metre
Ft^2	0.092 m^2
Btu/ft^2	11356.5 J/m^2

RESULTS

Model Summary

Building Summary

Information	Value	Units
Building Name	Building 1	building_name
Net Site Energy	180,028	kBtu
Total Building Area	1,033	ft^2
EUI (Based on Net Site Energy and Total Building Area)	174.22	kBtu/ft^2
OpenStudio Standards Building Type		

Weather Summary

	Value
Weather File	Piacenza - ITA IGDG WMO#=160840
Latitude	44.92
Longitude	9.73
Elevation	440 (ft)
Time Zone	1.00
North Axis Angle	-0.00
ASHRAE Climate Zone	

Sizing Period Design Days

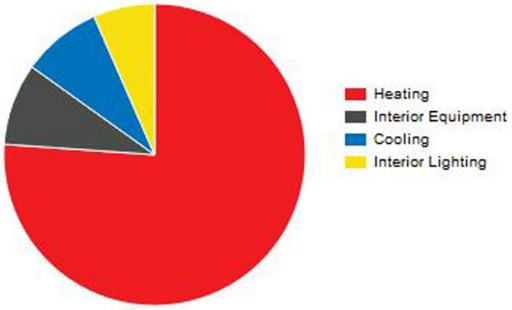
	Maximum Dry Bulb (F)	Daily Temperature Range (R)	Humidity Value	Humidity Type	Wind Speed (mph)	Wind Direction
PIACENZA ANN CLG .4% CONDNS DB=>MWB	91.58	21.42	72.86	Wetbulb [F]	5.14	90.0
PIACENZA ANN CLG .4% CONDNS DP=>MDB	81.32	21.42	73.4	Dewpoint [F]	5.14	90.0
PIACENZA ANN CLG .4% CONDNS ENTH=>MDB	86.54	21.42	32.2	Enthalpy [Btu/lb]	5.14	90.0
PIACENZA ANN CLG .4% CONDNS WB=>MDB	86.18	21.42	76.28	Wetbulb [F]	5.14	90.0
PIACENZA ANN HTG 99.6% CONDNS DB	21.02	0.0	21.02	Wetbulb [F]	4.47	250.0
PIACENZA ANN HTG WIND 99.6% CONDNS WS=>MCDB	42.44	0.0	42.44	Wetbulb [F]	19.91	250.0
PIACENZA ANN HUM_N 99.6% CONDNS DP=>MCDB	38.3	0.0	11.66	Dewpoint [F]	4.47	250.0

Unmet Hours Tolerance

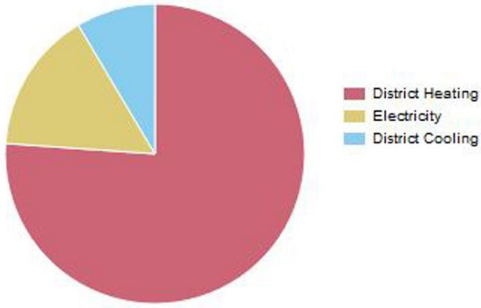
Tolerance for Time Setpoint Not Met	Temperature (F)
Heating	0.36
Cooling	0.36

Annual Overview

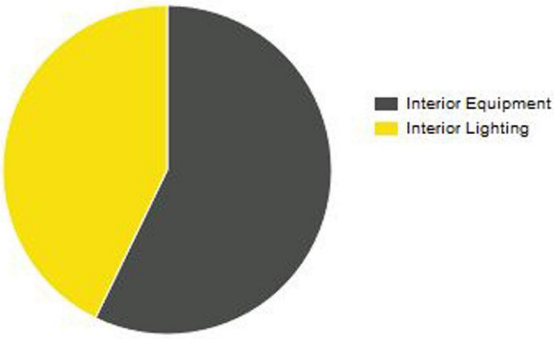
End Use - view table



Energy Use - view table

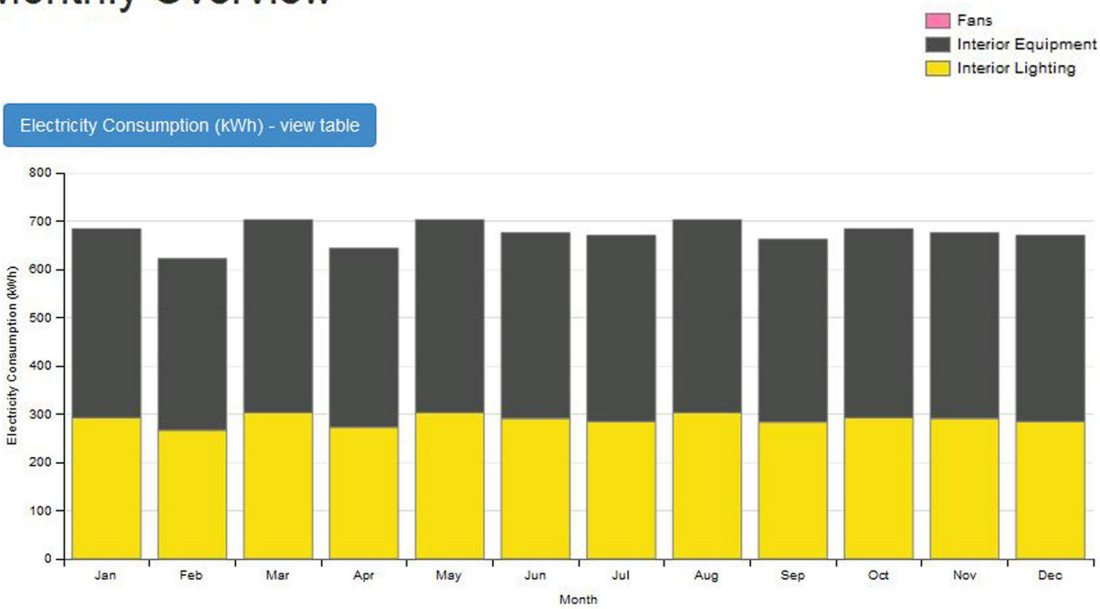


EUI - Electricity - view table

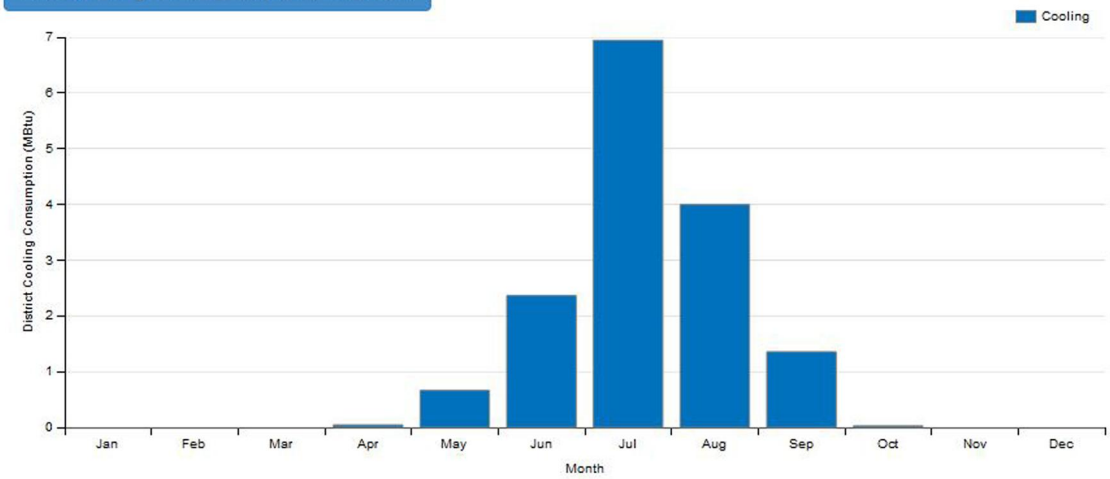


Monthly Overview

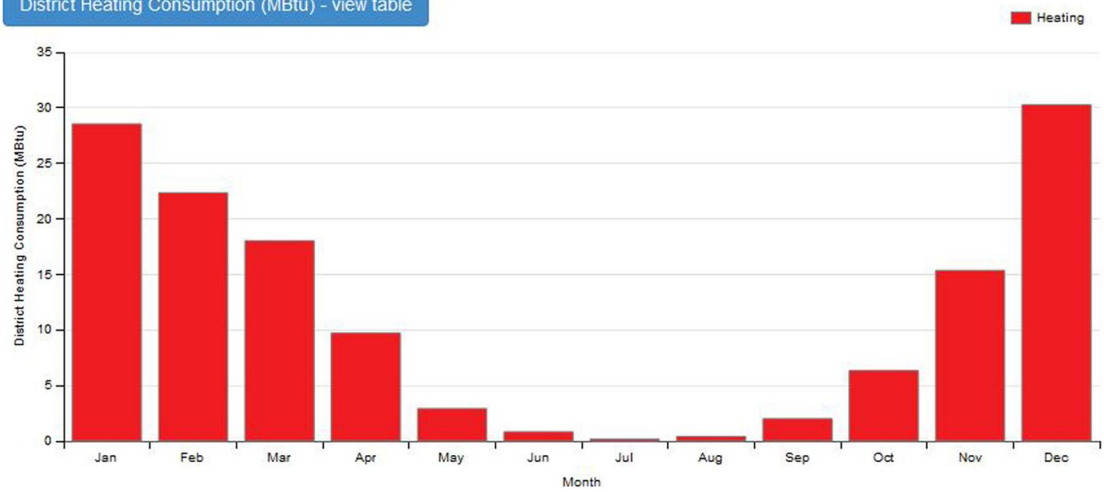
Electricity Consumption (kWh) - view table



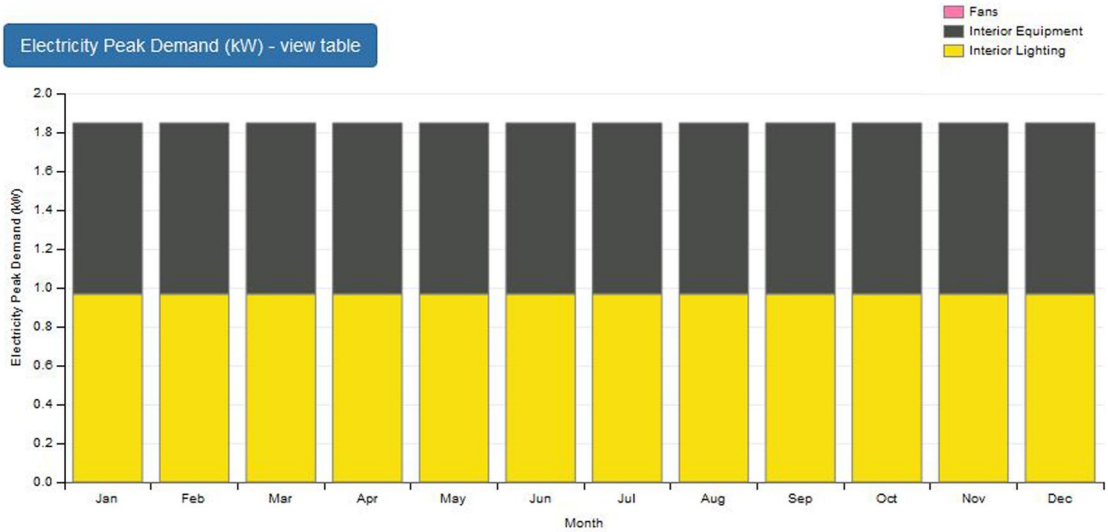
District Cooling Consumption (MBtu) - view table



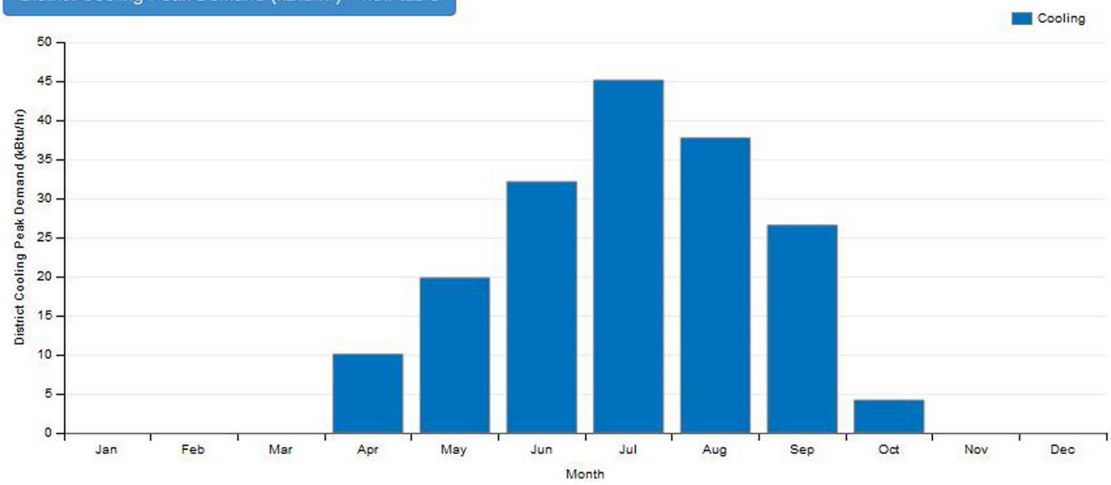
District Heating Consumption (MBtu) - view table



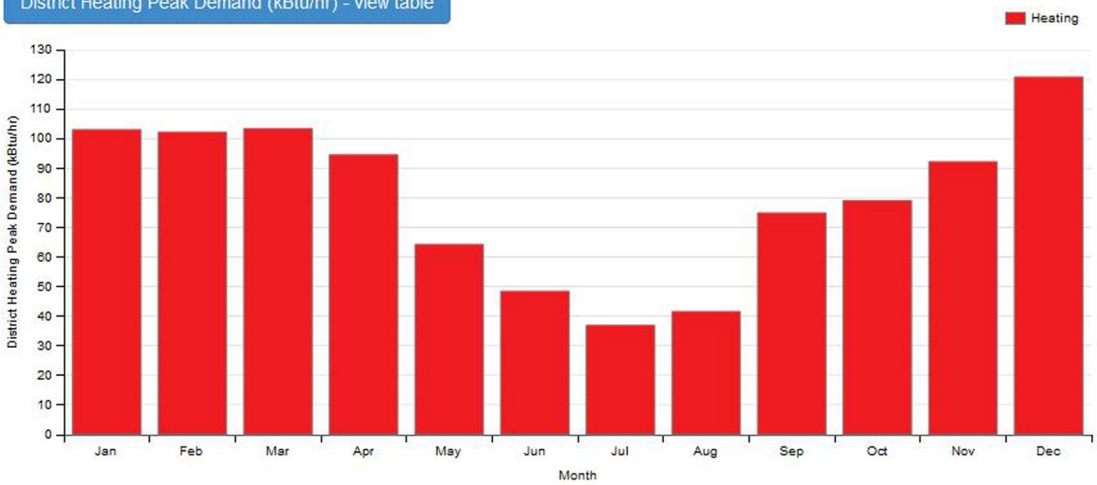
Electricity Peak Demand (kW) - view table



District Cooling Peak Demand (kBtu/hr) - view table



District Heating Peak Demand (kBtu/hr) - view table



Envelope

Base Surface Constructions

Construction	Net Area (ft^2)	Surface Count	R Value (ft^2*h*R/Btu)
ASHRAE 189.1-2009 ExtRoof IEAD ClimateZone 1	1,033	6	19.96
ASHRAE 189.1-2009 ExtWall Mass ClimateZone 1	1,722	20	5.76

Sub Surface Constructions

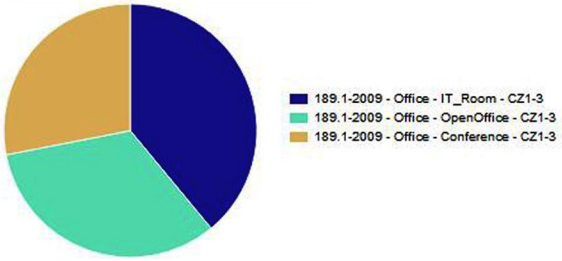
Construction	Area (ft^2)	Surface Count	U-Factor (Btu/ft^2*h*R)
ASHRAE 189.1-2009 ExtWindow ClimateZone 1	1,722	20	

WWR & Skylight Ratio

Description	Total (%)	North (%)	East (%)	South (%)	West (%)
Gross Window-Wall Ratio	50.0	50.0	50.0	50.0	50.0
Gross Window-Wall Ratio (Conditioned)	50.0	50.0	50.0	50.0	50.0
Skylight-Roof Ratio	0.0				

Space Type Breakdown

Space Type Breakdown - view table



Space Type Summary

189.1-2009 - Office - Conference - CZ1-3
(2 spaces and 1 thermal zones)

Definition	Value	Unit	Inst. Multiplier
189.1-2009 - Office - Conference - CZ1-3 People Definition	0.0500	people/ft^2	1.0
189.1-2009 - Office - Conference - CZ1-3 Electric Equipment Definition	0.3700	W/ft^2	1.0
189.1-2009 - Office - Conference - CZ1-3 Lights Definition	1.1700	W/ft^2	1.0
189.1-2009 - Office - Conference - CZ1-3 Infiltration	0.0595	cfm/ext surf area ft^2	
189.1-2009 - Office - Conference - CZ1-3 Ventilation (outdoor air method Sum)	20.0000	cfm/person	

189.1-2009 - Office - IT_Room - CZ1-3
(8 spaces and 4 thermal zones)

Definition	Value	Unit	Inst. Multiplier
189.1-2009 - Office - IT_Room - CZ1-3 People Definition	0.0050	people/ft^2	1.0
189.1-2009 - Office - IT_Room - CZ1-3 Electric Equipment Definition	1.5600	W/ft^2	1.0
189.1-2009 - Office - IT_Room - CZ1-3 Lights Definition	0.9900	W/ft^2	1.0
189.1-2009 - Office - IT_Room - CZ1-3 Infiltration	0.0595	cfm/ext surf area ft^2	
189.1-2009 - Office - IT_Room - CZ1-3 Ventilation (outdoor air method Sum)	0.0500	cfm/floor area ft^2	

189.1-2009 - Office - OpenOffice - CZ1-3
(2 spaces and 1 thermal zones)

Definition	Value	Unit	Inst. Multiplier
189.1-2009 - Office - OpenOffice - CZ1-3 People Definition	0.0052	people/ft^2	1.0
189.1-2009 - Office - OpenOffice - CZ1-3 Electric Equipment Definition	0.7100	W/ft^2	1.0
189.1-2009 - Office - OpenOffice - CZ1-3 Lights Definition	0.9900	W/ft^2	1.0
189.1-2009 - Office - OpenOffice - CZ1-3 Infiltration	0.0595	cfm/ext surf area ft^2	
189.1-2009 - Office - OpenOffice - CZ1-3 Ventilation (outdoor air method Sum)	20.0000	cfm/person	

Interior Lighting Summary

Interior Lighting Summary

	Zone	Lighting Power Density (W/ft^2)	Total Power (W)	Schedule Name	Scheduled Hours/Week (hr)	Actual Load Hours/Week (hr)	Return Air Fraction	Consumption (kWh)
THERMAL ZONE 5 189.1-2009 - OFFICE - CONFERENCE - CZ1-3 LIGHTS	THERMAL ZONE 5	1.17	339.25	OFFICE BLDG LIGHT	61.85	61.85	0.0000	1094.44
THERMAL ZONE 2 189.1-2009 - OFFICE - IT_ROOM - CZ1-3 LIGHTS	THERMAL ZONE 2	0.99	80.87	OFFICE BLDG LIGHT	61.85	61.85	0.0000	261.11
THERMAL ZONE 3 189.1-2009 - OFFICE - IT_ROOM - CZ1-3 LIGHTS	THERMAL ZONE 3	0.99	80.87	OFFICE BLDG LIGHT	61.85	61.85	0.0000	261.11
THERMAL ZONE 4 189.1-2009 - OFFICE - IT_ROOM - CZ1-3 LIGHTS	THERMAL ZONE 4	0.99	103.44	OFFICE BLDG LIGHT	61.85	61.85	0.0000	333.33
THERMAL ZONE 4 189.1-2009 - OFFICE - IT_ROOM - CZ1-3 LIGHTS	THERMAL ZONE 4	0.99	103.44	OFFICE BLDG LIGHT	61.85	61.85	0.0000	333.33
THERMAL ZONE 6 189.1-2009 - OFFICE - IT_ROOM - CZ1-3 LIGHTS	THERMAL ZONE 6	0.99	133.56	OFFICE BLDG LIGHT	61.85	61.85	0.0000	430.56
THERMAL ZONE 1 189.1-2009 - OFFICE - OPENOFFICE - CZ1-3 LIGHTS	THERMAL ZONE 1	0.99	337.2	OFFICE BLDG LIGHT	61.85	61.85	0.0000	1088.89

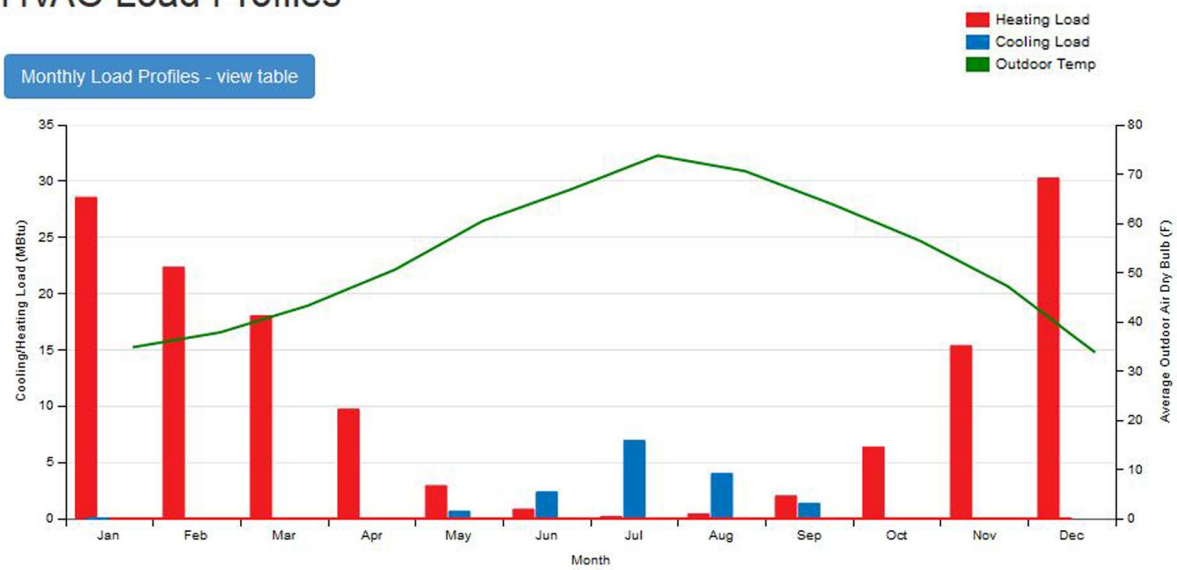
Plug Loads Summary

Electric Plug Load Consumption

	Electricity Annual Value (kWh)
InteriorEquipment:Electricity:Zone:THERMAL ZONE 5	508.33
InteriorEquipment:Electricity:Zone:THERMAL ZONE 2	602.78
InteriorEquipment:Electricity:Zone:THERMAL ZONE 3	602.78
InteriorEquipment:Electricity:Zone:THERMAL ZONE 4	772.22
InteriorEquipment:Electricity:Zone:THERMAL ZONE 6	997.22
InteriorEquipment:Electricity:Zone:THERMAL ZONE 1	1144.44

HVAC Load Profiles

Monthly Load Profiles - view table



Zone Conditions

Temperature (Table values represent hours spent in each temperature range)

Zone	Unmet Htg (hr)	Unmet Htg - Occ (hr)	< 56 (F)	56-61 (F)	61-66 (F)	66-68 (F)	68-70 (F)	70-72 (F)	72-74 (F)	74-76 (F)	76-78 (F)	78-83 (F)	>= 88 (F)	Unmet Clg (hr)	Unmet Clg - Occ (hr)	Mean Temp (F)
THERMAL ZONE 1	0	0	0	2078	775	253	3055	709	487	1256	68	79	0	0	0	68.0 (F)
THERMAL ZONE 2	0	0	0	2248	664	211	3220	516	438	1265	82	116	0	0	0	68.0 (F)
THERMAL ZONE 3	0	0	0	2000	737	260	3135	648	499	1284	92	105	0	0	0	68.2 (F)
THERMAL ZONE 4	0	0	0	2037	747	253	3117	638	497	1282	89	100	0	0	0	68.1 (F)
THERMAL ZONE 5	0	0	0	2412	659	206	3168	583	399	1187	53	93	0	0	0	67.6 (F)
THERMAL ZONE 6	0	0	0	1972	771	269	2992	711	541	1345	84	75	0	0	0	68.2 (F)

Humidity (Table values represent hours spent in each Humidity range)

Zone	< 30 (%)	30-35 (%)	35-40 (%)	40-45 (%)	45-50 (%)	50-55 (%)	55-60 (%)	60-65 (%)	65-70 (%)	70-75 (%)	>= 80 (%)	Mean Relative Humidity (%)
THERMAL ZONE 1	1391	869	664	819	992	738	821	635	530	517	409	49.2 (%)
THERMAL ZONE 2	1705	820	688	1025	873	730	636	530	475	507	394	47.7 (%)
THERMAL ZONE 3	1632	827	714	994	902	714	750	588	548	509	344	47.5 (%)
THERMAL ZONE 4	1632	824	708	1007	881	725	738	574	532	512	368	47.6 (%)
THERMAL ZONE 5	1050	885	749	712	727	687	697	765	685	542	474	52.7 (%)
THERMAL ZONE 6	1601	830	677	951	987	772	758	571	546	487	345	47.6 (%)

Zone Overview

Zone Summary

	Area (ft^2)	Conditioned (Y/N)	Part of Total Floor Area (Y/N)	Volume (ft^3)	Multiplier	Gross Wall Area (ft^2)	Window Glass Area (ft^2)	Lighting (W/ft^2)	People (ft^2/person)	Plug and Process (W/ft^2)
THERMAL ZONE 1	340.57	Yes	Yes	8939.55	1.00	894.05	447.03	0.99	190.52	0.71
THERMAL ZONE 2	81.7	Yes	Yes	2143.95	1.00	474.9	237.45	0.99	199.99	1.56
THERMAL ZONE 3	81.7	Yes	Yes	2143.95	1.00	226.69	113.34	0.99	199.99	1.56
THERMAL ZONE 4	104.52	Yes	Yes	2742.54	1.00	289.98	144.99	0.99	199.99	1.56
THERMAL ZONE 5	289.98	Yes	Yes	7610.66	1.00	1268.85	634.42	1.17	20.02	0.37
THERMAL ZONE 6	134.87	Yes	Yes	3540.65	1.00	289.98	144.99	0.99	199.99	1.56
Total	1033.34			27121.66		3444.45	1722.23	1.04	56.51	0.95
Conditioned Total	1033.34			27121.66		3444.45	1722.23	1.04	56.51	0.95
Unconditioned Total	0.0			0.0		0.0	0.0	0.0	0.0	0.0
Not Part of Total	0.0			0.0		0.0	0.0	0.0	0.0	0.0

Zone Sensible Cooling and Heating Sensible Sizing

	Heating/Cooling	Calculated Design Load	Design Load With Sizing Factor	Calculated Design Air Flow (ft^3/min)	Design Air Flow With Sizing Factor (ft^3/min)	Date/Time Of Peak	Outdoor Temperature at Peak Load (F)	Outdoor Humidity Ratio at Peak Load (lbWater/lbAir)
THERMAL ZONE 1	Cooling	0.81 (ton)	0.93 (ton)	497.94	572.1	8/21 14:45:00	91.58	0.01
THERMAL ZONE 1	Heating	21.33 (kBtu/h)	26.66 (kBtu/h)	576.34	720.42	1/21 06:00:00	21.02	0.0
THERMAL ZONE 2	Cooling	0.47 (ton)	0.54 (ton)	288.17	330.55	8/21 16:45:00	89.01	0.01
THERMAL ZONE 2	Heating	10.28 (kBtu/h)	12.85 (kBtu/h)	277.57	347.5	1/21 06:00:00	21.02	0.0
THERMAL ZONE 3	Cooling	0.38 (ton)	0.43 (ton)	230.96	264.86	8/21 17:30:00	87.51	0.01
THERMAL ZONE 3	Heating	6.26 (kBtu/h)	7.83 (kBtu/h)	169.51	211.89	1/21 06:00:00	21.02	0.0
THERMAL ZONE 4	Cooling	0.46 (ton)	0.53 (ton)	281.81	324.19	8/21 17:30:00	87.51	0.01
THERMAL ZONE 5	Heating	26.47 (kBtu/h)	33.09 (kBtu/h)	716.18	894.17	1/21 06:00:00	21.02	0.0
THERMAL ZONE 6	Cooling	0.32 (ton)	0.37 (ton)	197.06	226.72	8/21 15:15:00	91.26	0.01
THERMAL ZONE 6	Heating	8.38 (kBtu/h)	10.48 (kBtu/h)	226.72	283.93	1/21 06:00:00	21.02	0.0

Outdoor Air

Average and Minimum Outdoor Air During Occupied Hours

	Average Number of Occupants	Nominal Number of Occupants	Zone Volume (ft^3)	Avg. Mechanical Ventilation (ach)	Min. Mechanical Ventilation (ach)	Avg. Infiltration (ach)	Min. Infiltration (ach)	Avg. Simple Ventilation (ach)	Min. Simple Ventilation (ach)
THERMAL ZONE 1	1.0	1.79	8940	0.0	0.0	0.165	0.002	0.123	0.0
THERMAL ZONE 2	0.16	0.41	2144	0.0	0.0	0.31	0.004	0.118	0.002
THERMAL ZONE 3	0.16	0.41	2144	0.0	0.0	0.172	0.002	0.118	0.002
THERMAL ZONE 4	0.2	0.52	2743	0.0	0.0	0.172	0.002	0.118	0.002
THERMAL ZONE 5	5.58	14.5	7611	0.0	0.0	0.244	0.003	0.694	0.002
THERMAL ZONE 6	0.26	0.67	3541	0.0	0.0	0.143	0.002	0.118	0.002

Site and Source Summary

Site and Source Energy

	Total Energy (kBtu)	Energy Per Total Building Area (kBtu/ft^2)	Energy Per Conditioned Building Area (kBtu/ft^2)
Total Site Energy	180028.4	174.2	174.2
Net Site Energy	180028.4	174.2	174.2
Total Source Energy	598811.9	579.5	579.5
Net Source Energy	598811.9	579.5	579.5

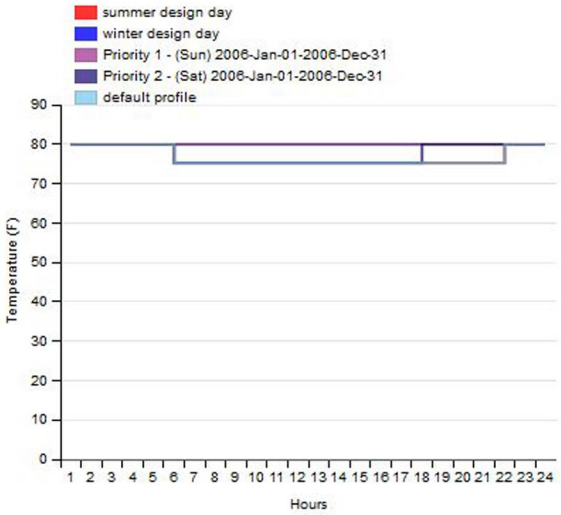
Site to Source Energy Conversion Factors

	Site=>Source Conversion Factor
Electricity	3.167
Natural Gas	1.084
District Cooling	1.056
District Heating	3.613

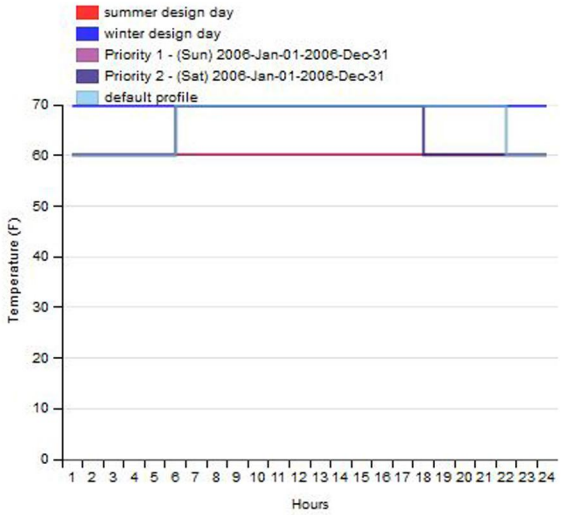
Schedule Overview

Schedule Overview - view table

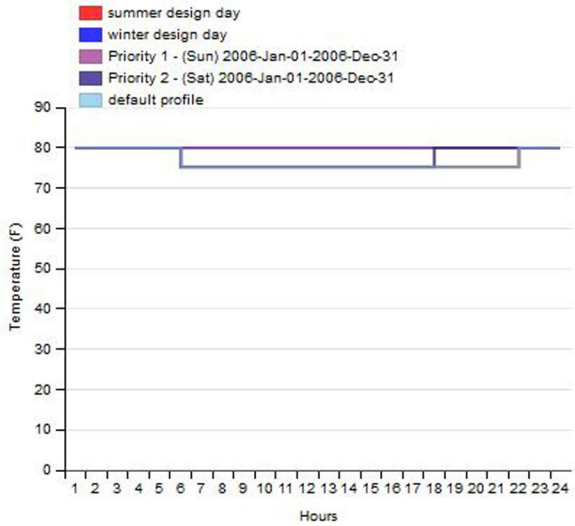
Large Office ClgSetp



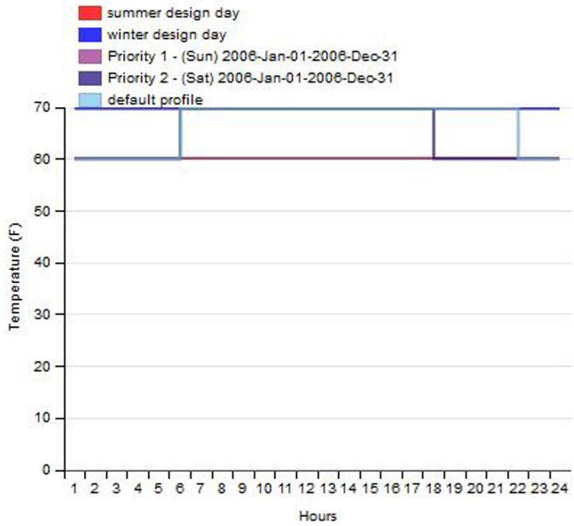
Large Office HtgSetp



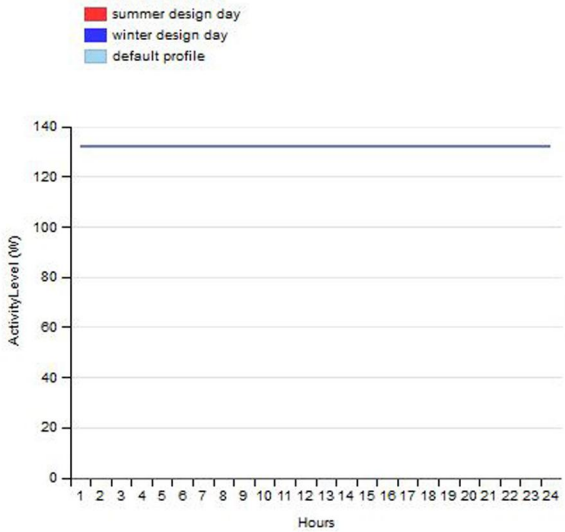
Medium Office ClgSetp



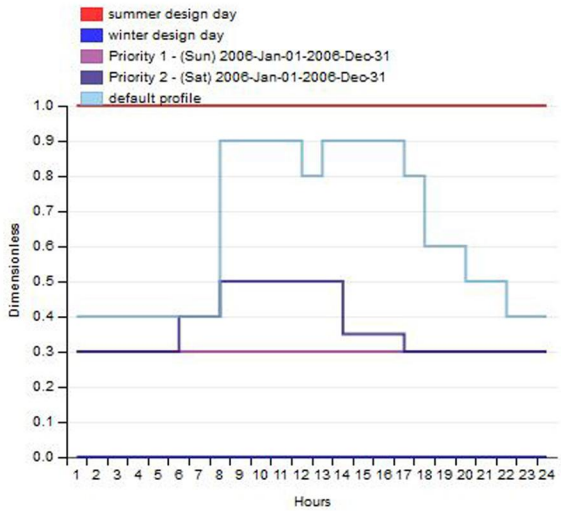
Medium Office HtgSetp



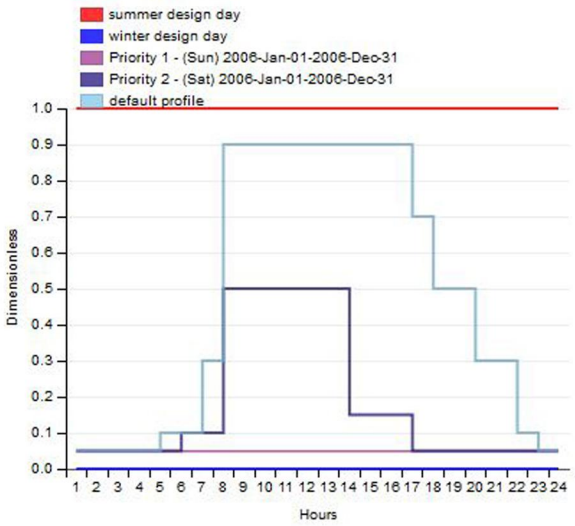
Office Activity



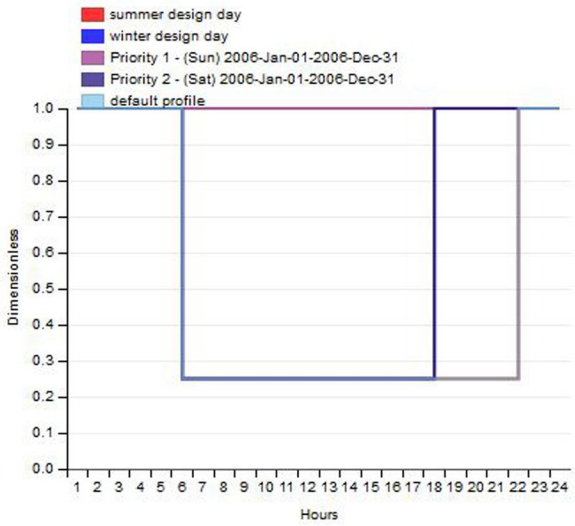
Office Bldg Equip



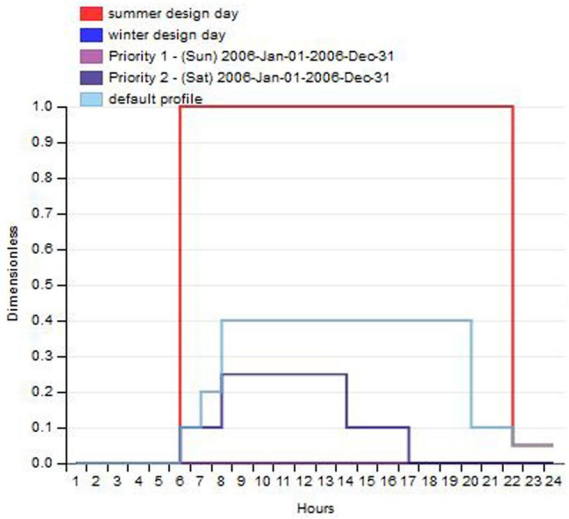
Office Bldg Light



Office Infil Quarter On



Office Misc Occ



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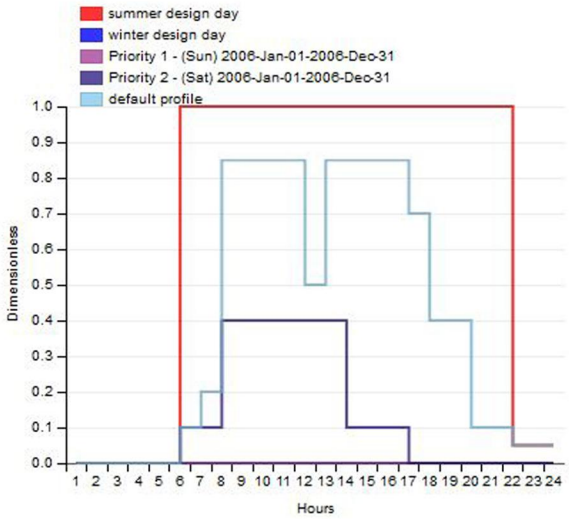
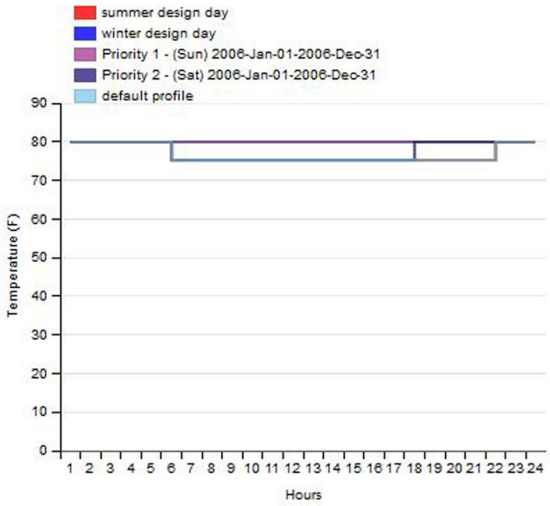
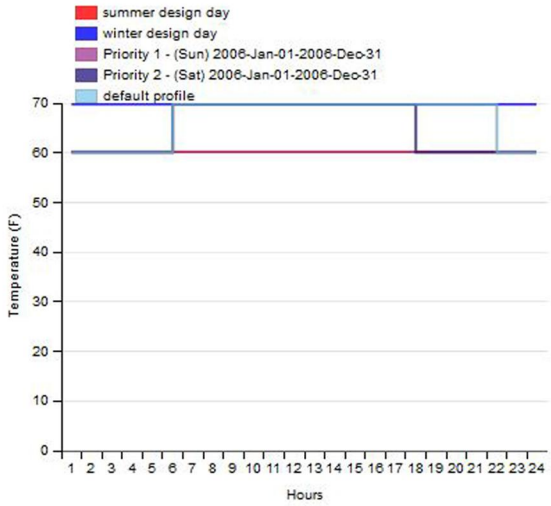


Small Office ClgSetp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