



POLITECNICO
MILANO 1863

TES Project Commercial Building

Group W4

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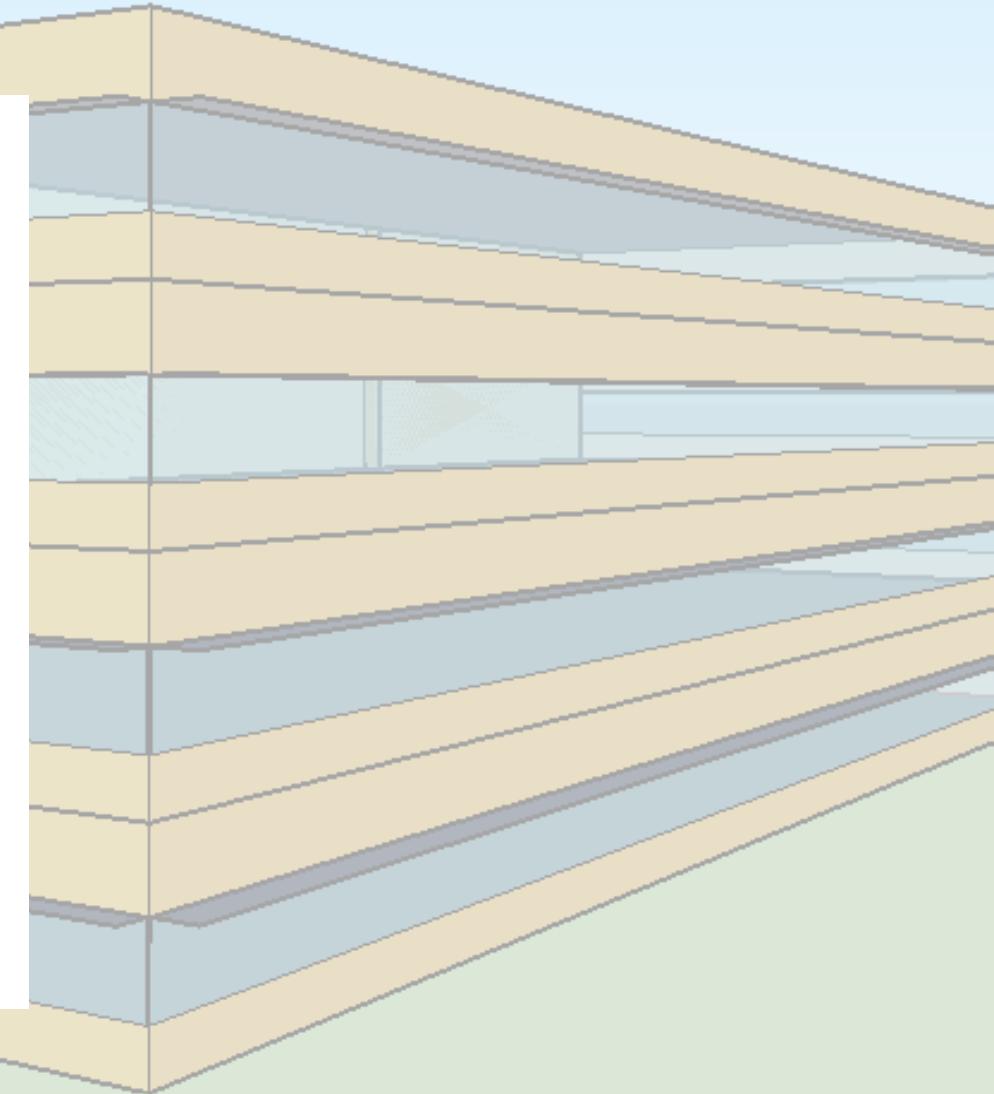
Outline

Introduction:

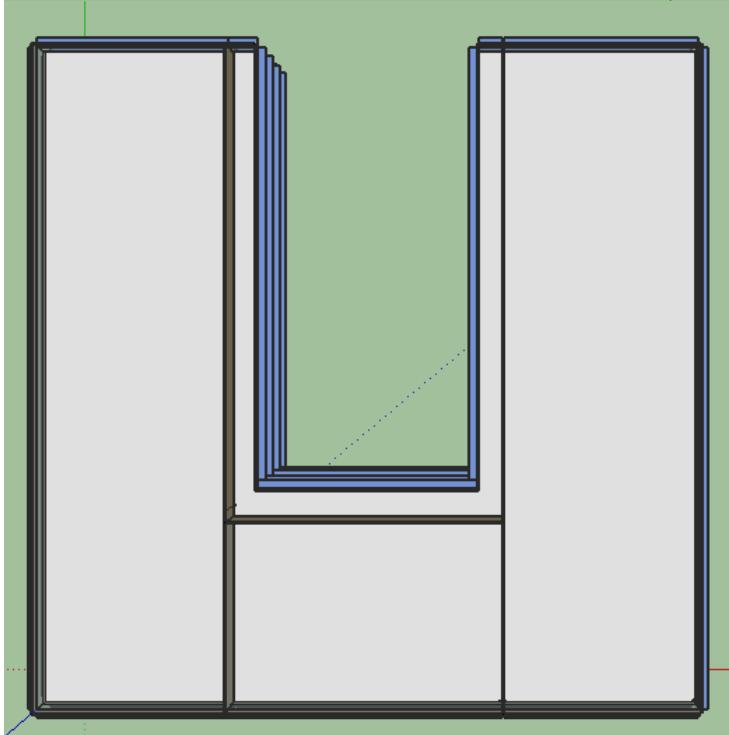
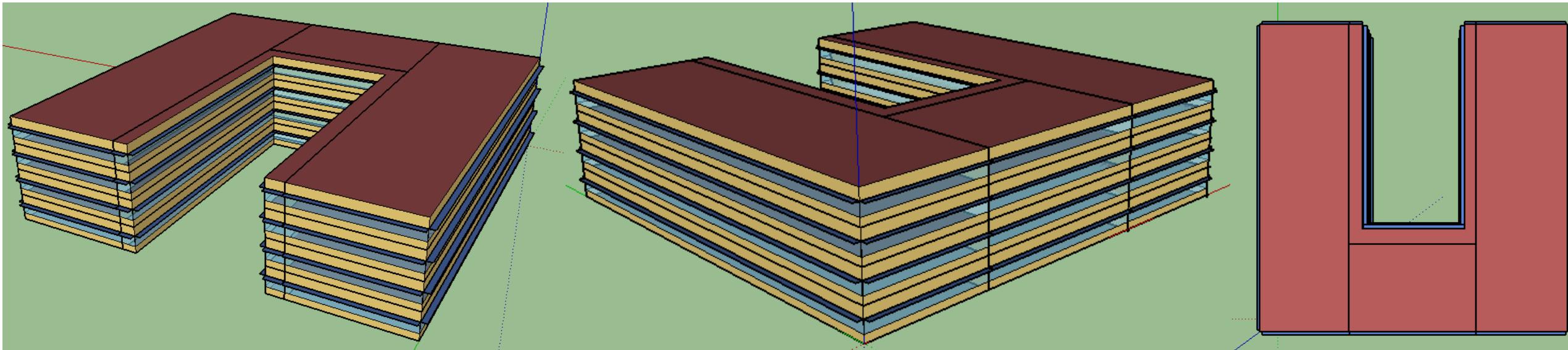
- Building Geometry + Functions Layout
- Chosen Locations
- Chosen Walls + Walls Characteristics

Simulation:

- Wall One + Observations
- Wall Two + Observations
- Wall Three + Observations

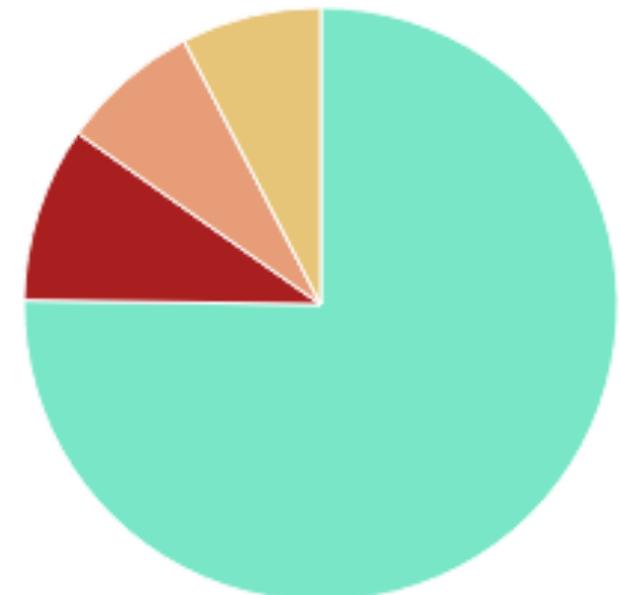


Commercial Building - Building Geometry



Number of Stories: 4
Base Case Location: Kuwait
Functions: Open offices,
Conference Rooms, Break Rooms
and Corridors.

- 189.1-2009 - Office - OpenOffice - CZ1-3
- 189.1-2009 - Office - Corridor - CZ1-3
- 189.1-2009 - Office - BreakRoom - CZ1-3
- 189.1-2009 - Office - Conference - CZ1-3



Building Operations & Definitions

We proposed some parameters for our building where:

Operation Hours:

8 am till 3 pm - High Occupancy

3 pm till 7 pm - Low Occupancy - Shift Change

7 pm Till 4 am - High Occupancy

4 am till 8 am - Low Occupancy - Shift Change

Break Times:

1 pm till 2 pm

11 pm till 12 am

Lighting Loads:

Florescent lights 500 lumens per m²

8.3 Watts per m²

Occupancy Load: (person/m²)

Break Room : 0.5m²

Conference Room : 1.39m²

Open Office : 0.8m²

Corridor : 9.3m²

Radiation Loads: (watts/person)

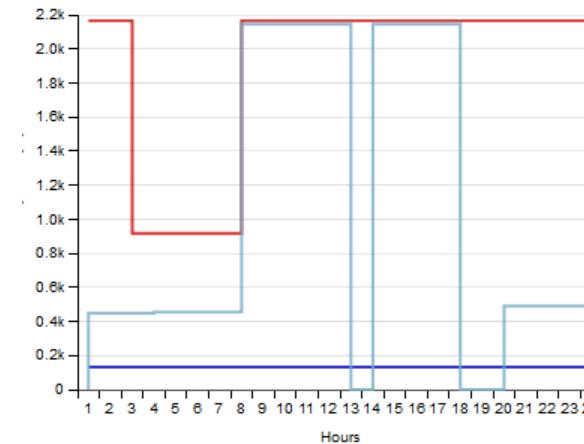
Kuwait- 2176 watts

Russia - 854 watts

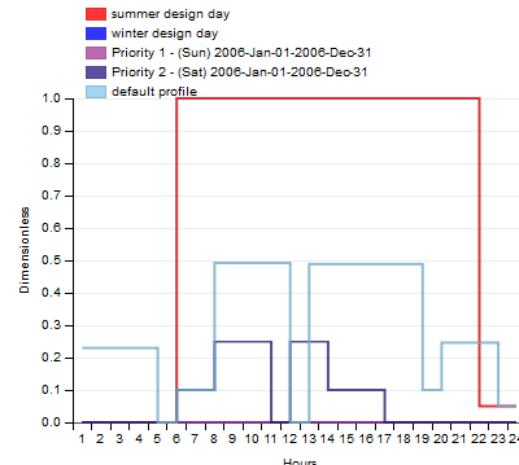
Sri Lanka - 56 watts

Egypt - 172 watts

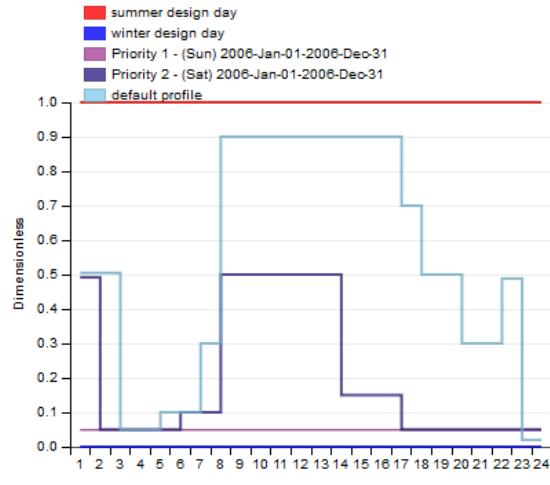
Office Activity - Base Case - Kuwait



Office Misc Occ - Base Case - Kuwait



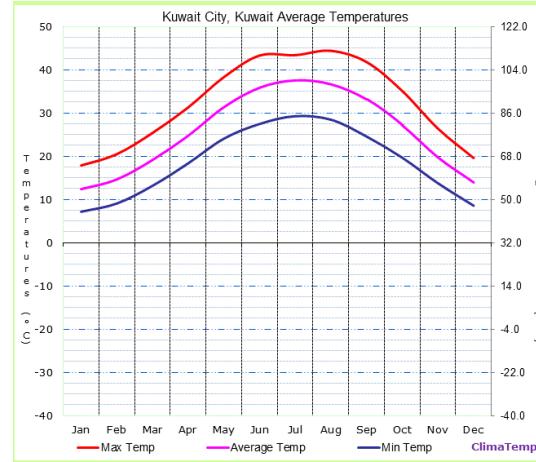
Office Bldg Light - Base Case



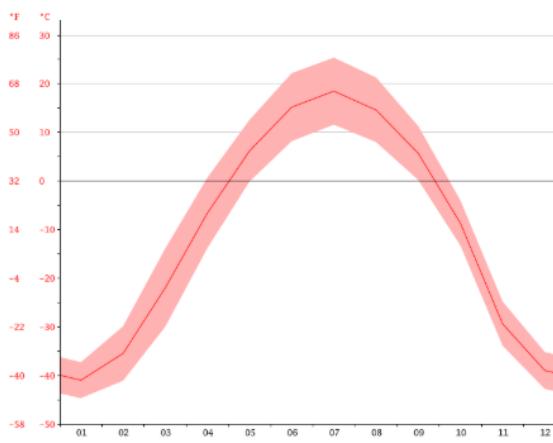
Chosen Locations

We chose 3 Different Locations + Base Case

Hottest Location: Kuwait, UAE

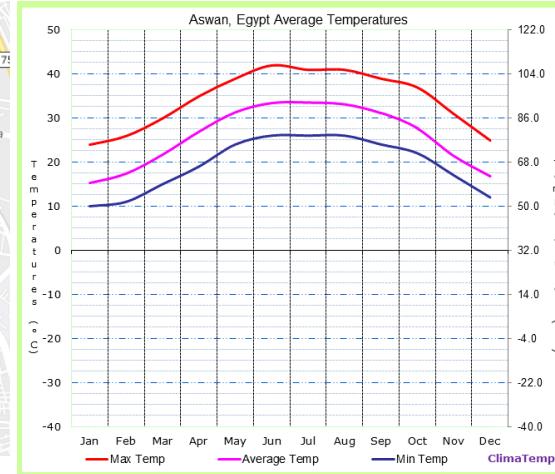


Coldest Location: Yakutsk , Russia

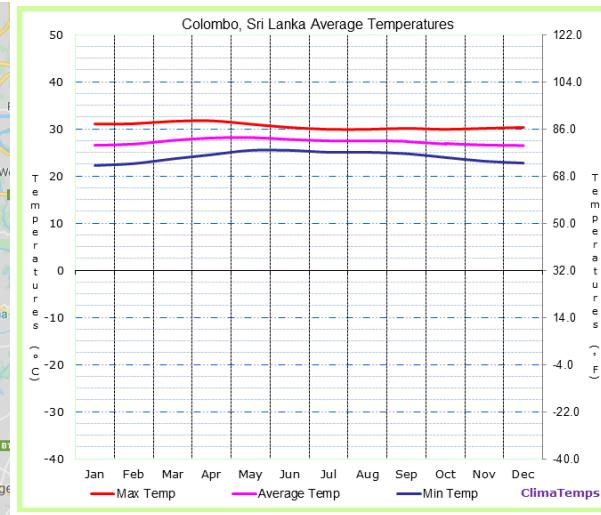


The warmest month of the year is July, with an average temperature of 18.5 °C. January has the lowest average temperature of the year. It is -41.0 °C.

Driest Location: Aswan, Egypt



Highest Humidity: Colombo, Sri Lanka



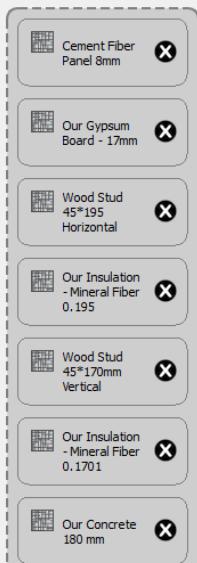
Chosen Walls & Characteristics

U-Value Calculated

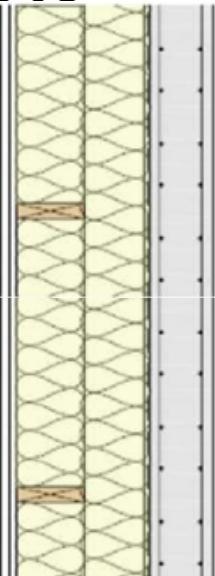
1 m².K/W = 5.678 hr·ft²·°F/Btu

We had to convert by multiplying by 5.678

Wall One - Concrete



Cement fibre panel 8 mm
Sealing joint 2 mm
Wooden bolt 28*45 mm
Gypsum board 17 mm
Horizontal wooden stud 45*195 mm
Insulation (mineral wool) 195 mm
Vertical wooden stud 45*170 mm
Insulation (mineral wool) 170 mm
Plastic foil
Concrete 180 mm



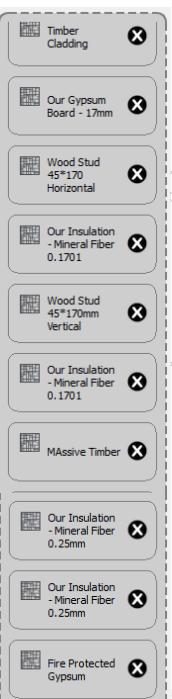
Construction	Net Area (ft ²)	Surface Count	R Value (ft ² ·h·R/Btu)
ASHRAE 189.1-2009 ExtRoof IEAD ClimateZone 1	16.953	4	19.96
Wall One - Base Case	18.898	48	65.27

$$R = 65.27 = 11.49 \text{ K./watt}$$

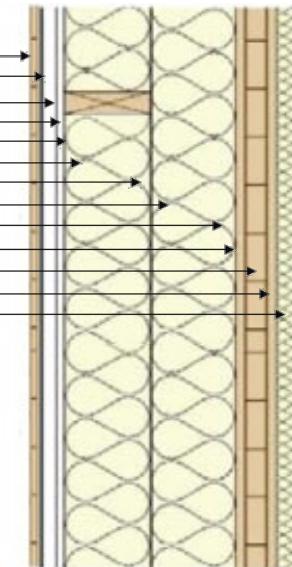
$$U = 0.087 \quad Q = \frac{\Delta T}{R} = \frac{293 - (-283)}{11.49} = 50.13 \text{ W}$$

This wall type works best in Russia because the heat transfer is reduced through the walls. We don't need this type of wall in Colombo because the temperature there is moderate and the insulation will be useless.

Wall Two - Wood



Wooden Panels 12mm
Sealing Joint 2mm
Vertical wooden bolt 28*95mm
Gypsum board 17mm
Horizontal wooden stud 45*170mm
Insulation (mineral wool) 170mm
Vertical wooden stud 45*170mm
Insulation (mineral wool) 170mm
Plastic foil
Massive timber
Vertical wooden bolt 45*45mm
Insulation (mineral wool) 45mm
Gypsum board, fire protective



Construction	Net Area (ft ²)	Surface Count	R Value (ft ² ·h·R/Btu)
ASHRAE 189.1-2009 ExtRoof Metal ClimateZone 6	16.953	4	30.48
Wall Two - Aswan	18.898	48	69.50

$$R = 69.50 = 12.24 \text{ K / watt}$$

$$U = 0.082 \quad Q = \frac{\Delta T}{R} = \frac{293 - (-283)}{12.24} = 47 \text{ W}$$

It works best in Aswan and Kuwait because the heat transfer is reduced through the walls. Even though the heat transfers through wood and bearing walls are nearly the same, the wood load bearing wall cannot be used in humid locations (ex. Russia)

Wall Three - Metal



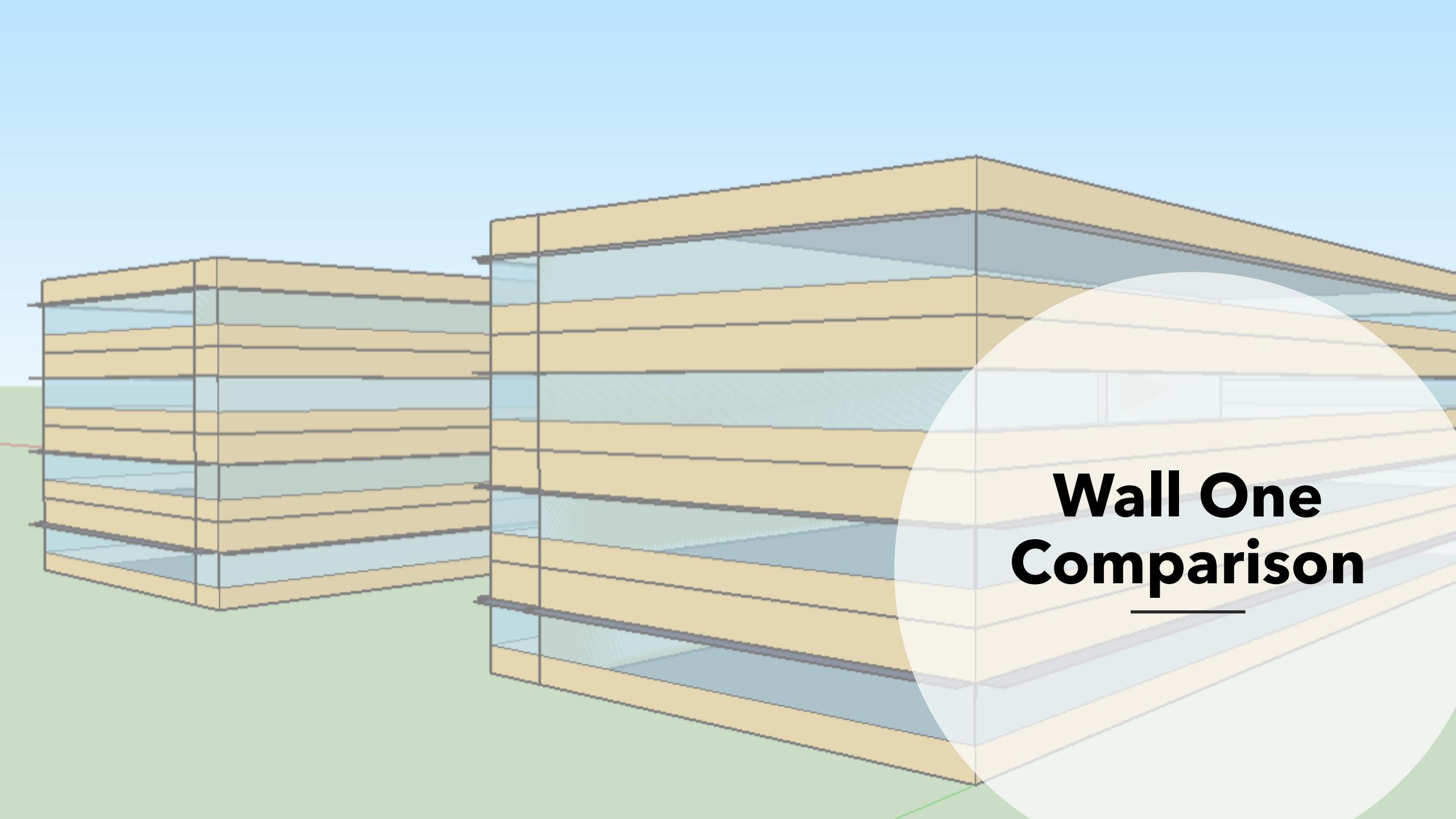
Aluminum Cladding
Drained cavity
Exterior rigid insulation — extruded polystyrene, expanded polystyrene, isocyanurate, rock wool, fiberglass
Membrane or trowel-on or spray applied drainage plane, air barrier and vapor retarder
Non paper-faced exterior gypsum sheathing, plywood or oriented strand board (OSB)
Uninsulated steel stud cavity
Gypsum board
Latex paint or vapor semi-permeable textured wall finish

Construction	Net Area (ft ²)	Surface Count	R Value (ft ² ·h·R/Btu)
ASHRAE 189.1-2009 ExtRoof IEAD ClimateZone 1	16.953	4	19.96
Wall Three	18.898	48	25.43

$$R = 25.43 = 4.48 \text{ K / watt}$$

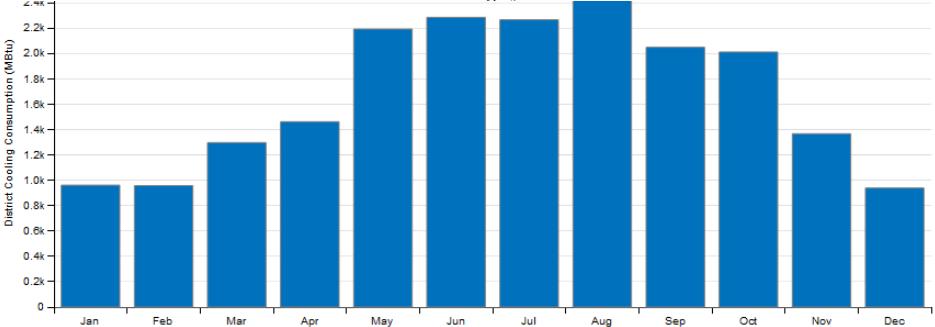
$$U = 0.22 \quad Q = \frac{\Delta T}{R} = \frac{293 - (-283)}{120.28} = 128.57 \text{ W}$$

This wall works in Colombo because the outdoor temperature is 26 C which is good.
To make it work better in other locations, the steel stud cavity should be insulated.

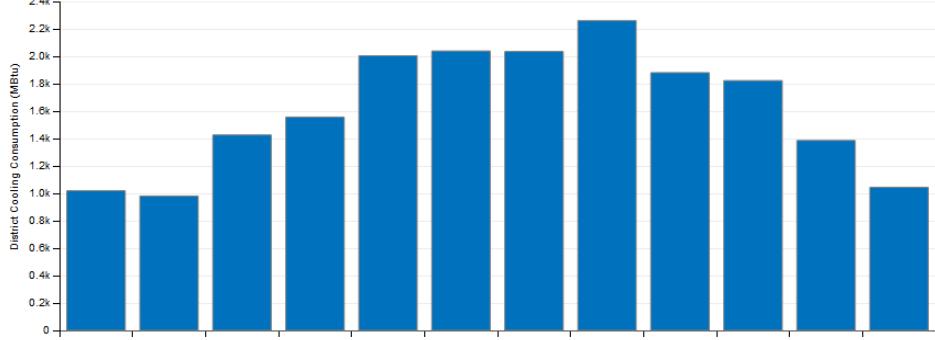


Wall One Comparison

Kuwait



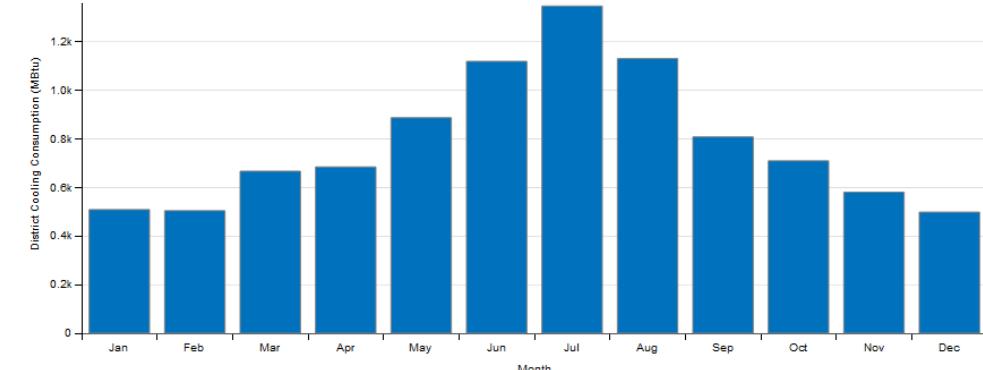
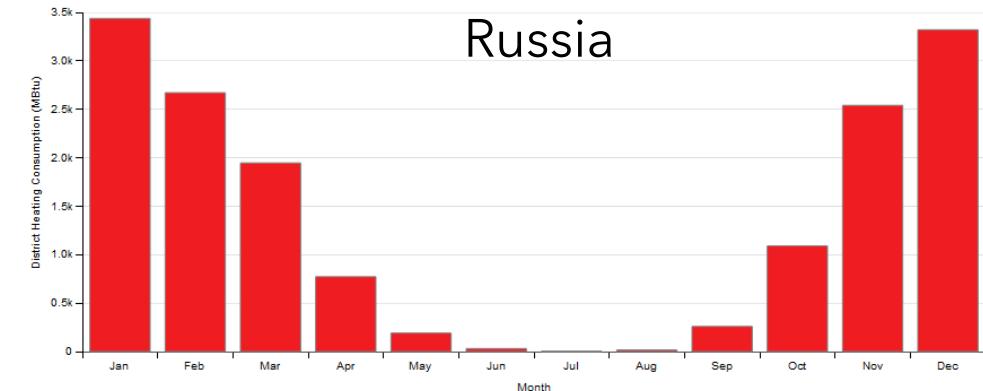
Aswan



Observations

The wall works best in Russia due to the high resistance and the high humidity resistance of the concrete.

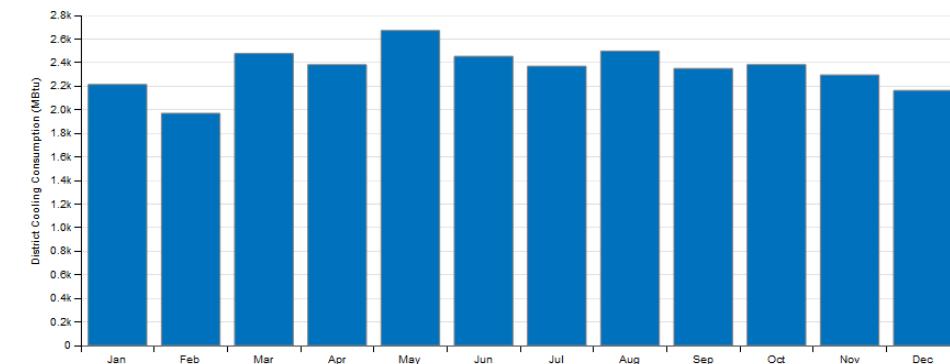
Russia



Colombo

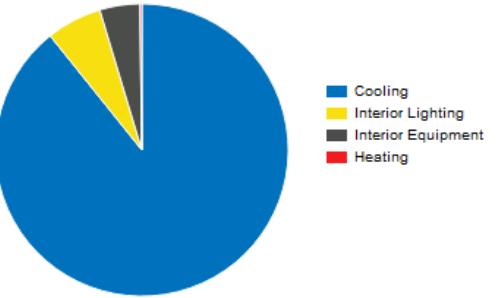
No Heating Consumption for Colombo

The wall is not needed in Colombo due to the moderate weather there, so no need for the high thermal resistance.



EAp2-18. End Use Percentage

	Percent [%]
Interior Lighting	6.12
Space Heating	0.20
Space Cooling	89.25
Fans-Interior	0.00
Service Water Heating	0.00
Receptacle Equipment	4.44
Miscellaneous	-0.00



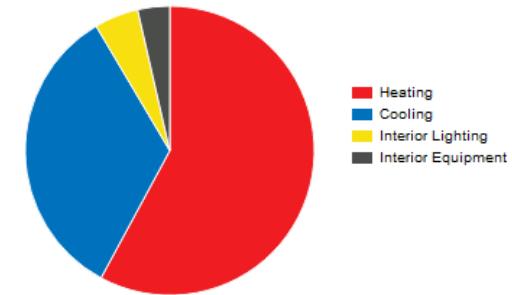
Kuwait

Observations

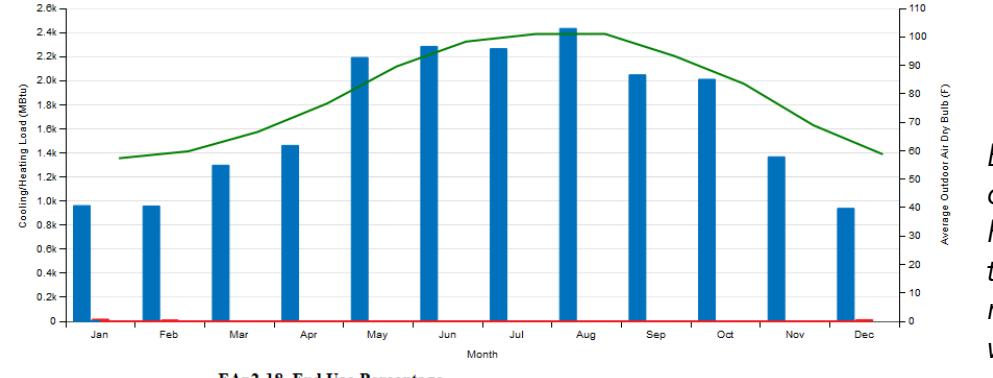
End use percentage is low or moderate in Russia due to the effective thermal resistance of the wall to the cold Weather there.

EAp2-18. End Use Percentage

	Percent [%]
Interior Lighting	4.93
Space Heating	57.89
Space Cooling	33.61
Fans-Interior	0.00
Service Water Heating	0.00
Receptacle Equipment	3.57
Miscellaneous	-0.00



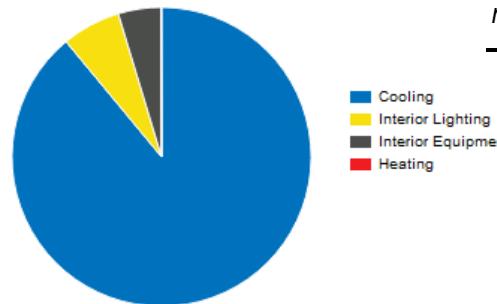
Russia



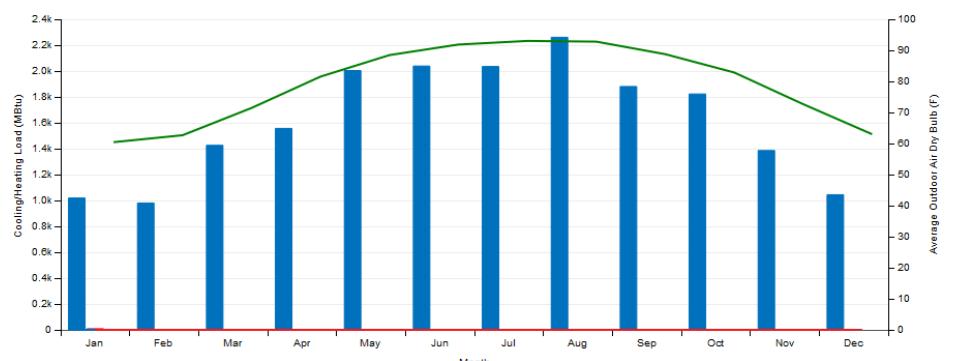
End use in Kuwait and Aswan cities are high compared to Russia and Colombo due to the hot climate there which needs a more effective wall with higher thermal resistance.

EAp2-18. End Use Percentage

	Percent [%]
Interior Lighting	6.34
Space Heating	0.08
Space Cooling	88.99
Fans-Interior	0.00
Service Water Heating	0.00
Receptacle Equipment	4.60
Miscellaneous	-0.00



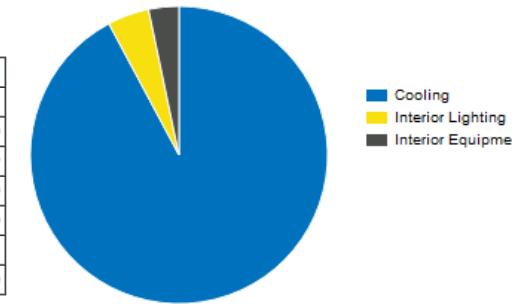
Aswan



End use in Colombo is high due to the very high humidity there which can't be resisted by the wall material. So the wall is not effective.

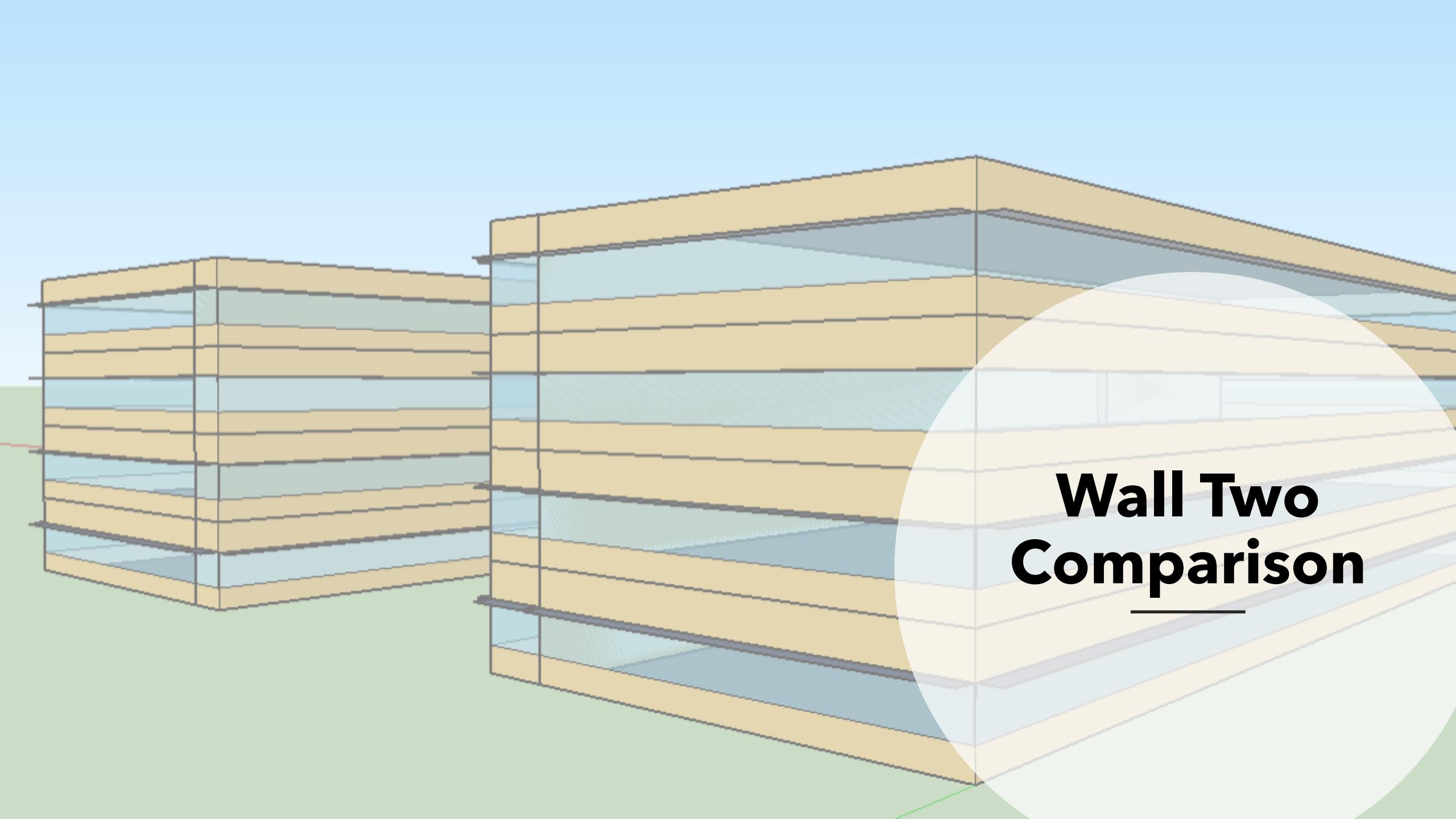
EAp2-18. End Use Percentage

	Percent [%]
Interior Lighting	4.53
Space Heating	0.00
Space Cooling	92.19
Fans-Interior	0.00
Service Water Heating	0.00
Receptacle Equipment	3.28
Miscellaneous	-0.00



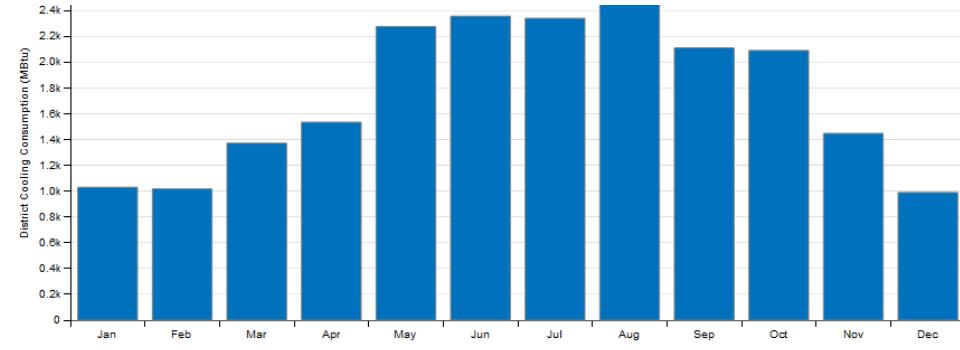
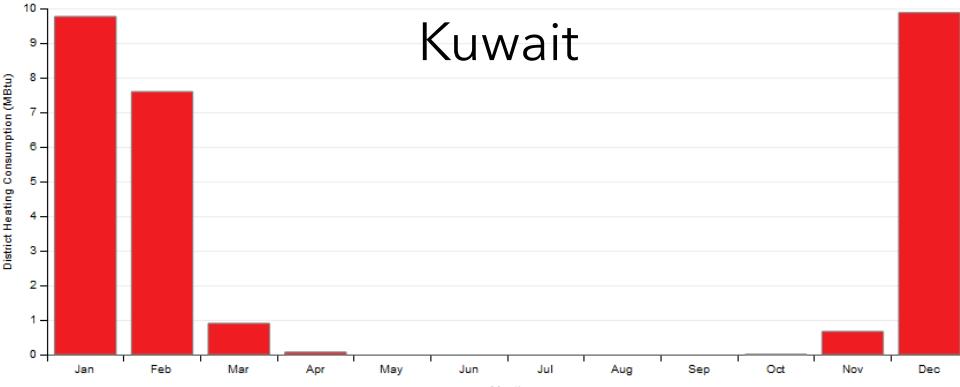
Colombo



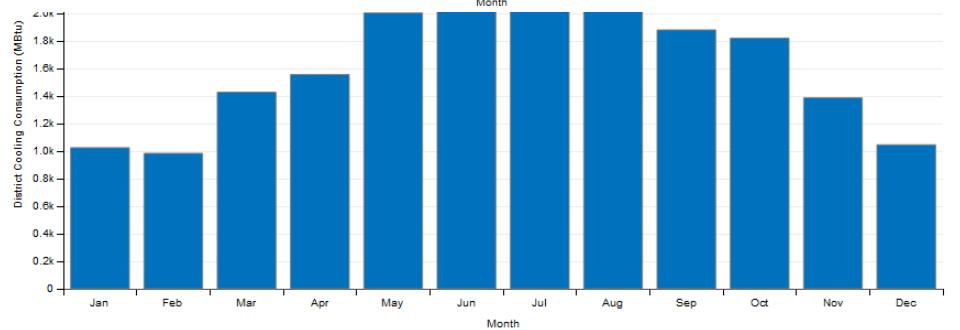


Wall Two Comparison

Kuwait



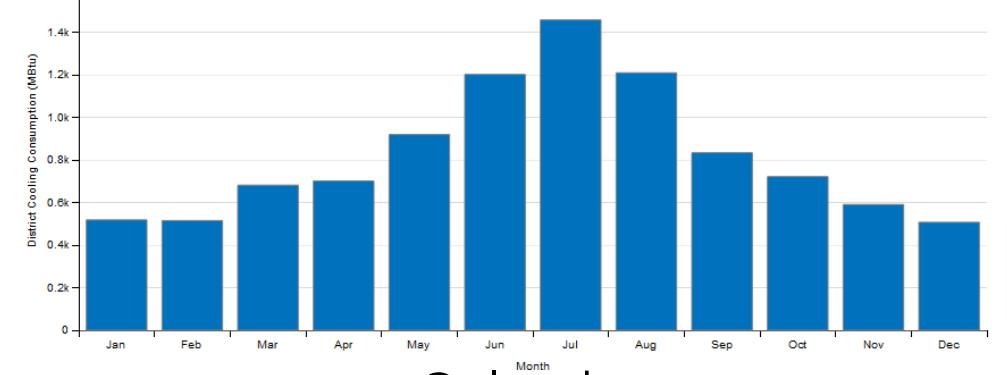
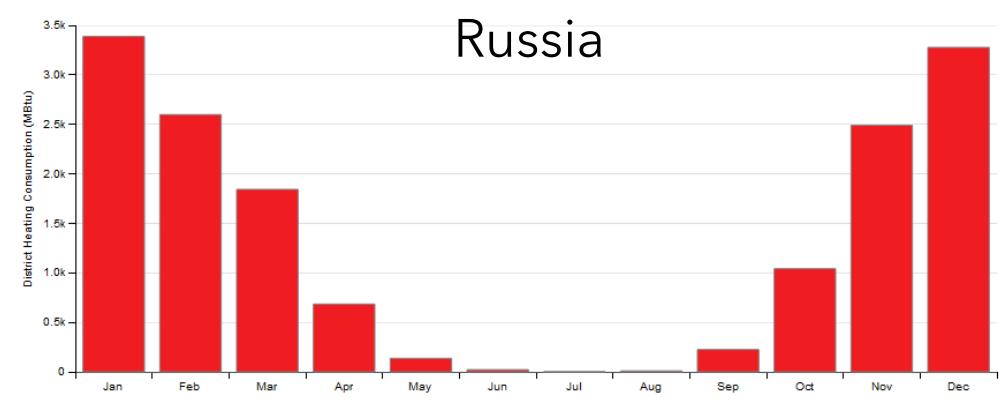
Aswan



Observations

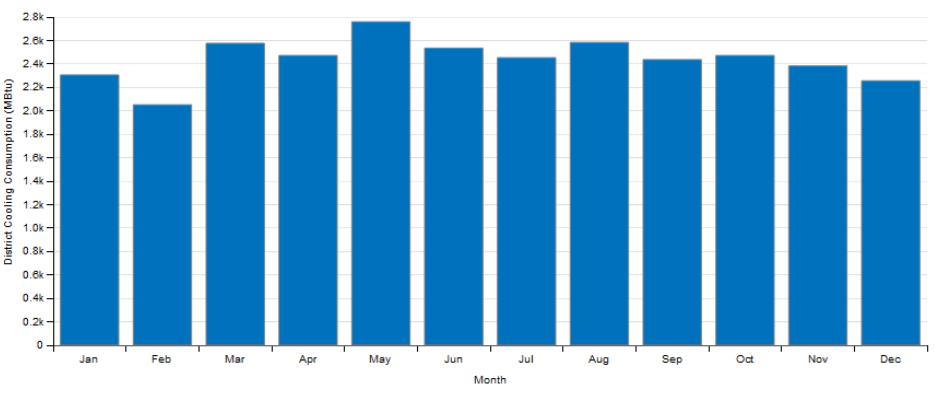
The wall is effective in Russia as for thermal resistance but it's not recommended as the wood is not suitable in humid areas.

Russia



Colombo

No Heating Consumption for Colombo

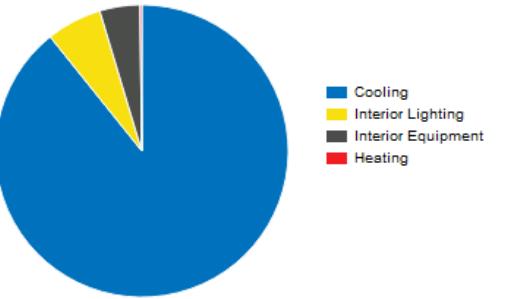


The wall is not suitable for Colombo because it's made wood which is not suitable for humid areas as well as the high thermal resistance which is not needed for Colombo's moderate weather.

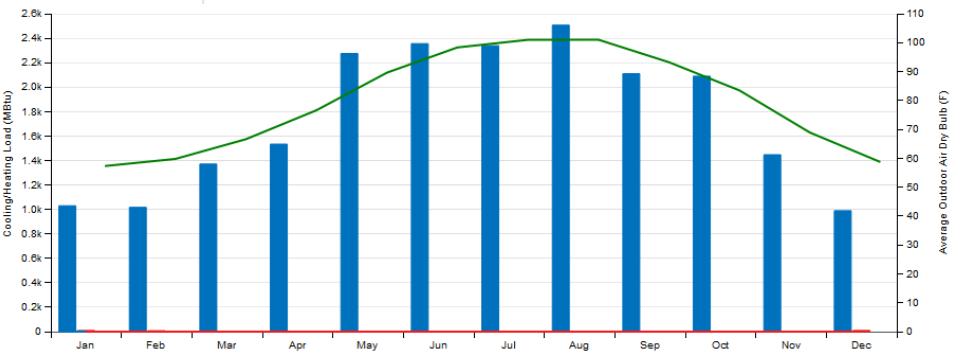
Kuwait

EAp2-18. End Use Percentage

	Percent [%]
Interior Lighting	5.90
Space Heating	0.12
Space Cooling	89.70
Fans-Interior	0.00
Service Water Heating	0.00
Receptacle Equipment	4.28
Miscellaneous	-0.00



Cooling
Interior Lighting
Interior Equipment
Heating

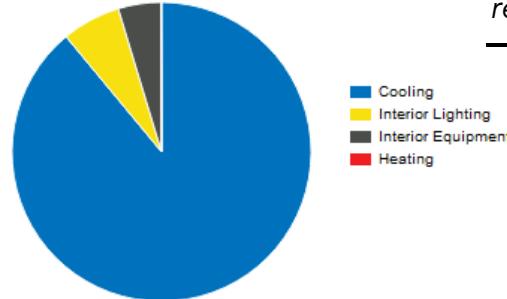


End use in Kuwait and Aswan cities are high compared to Russia and Colombo due to the hot climate there which needs a more effective wall with higher thermal resistance.

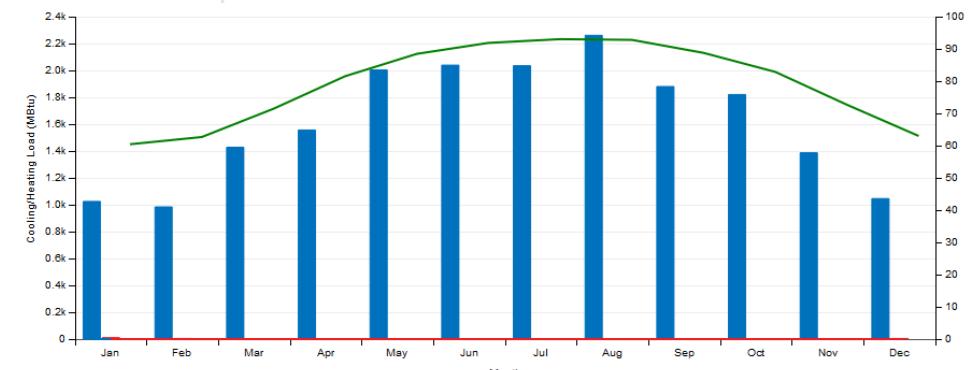
Aswan

EAp2-18. End Use Percentage

	Percent [%]
Interior Lighting	6.33
Space Heating	0.09
Space Cooling	88.98
Fans-Interior	0.00
Service Water Heating	0.00
Receptacle Equipment	4.59
Miscellaneous	-0.00



Cooling
Interior Lighting
Interior Equipment
Heating



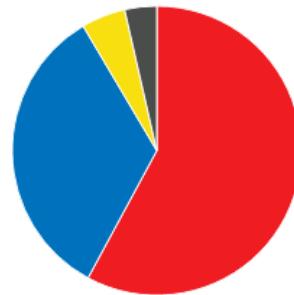
Observations

End use percentage is low or moderate in Russia due to the effective thermal resistance of the wall to the cold Weather there.

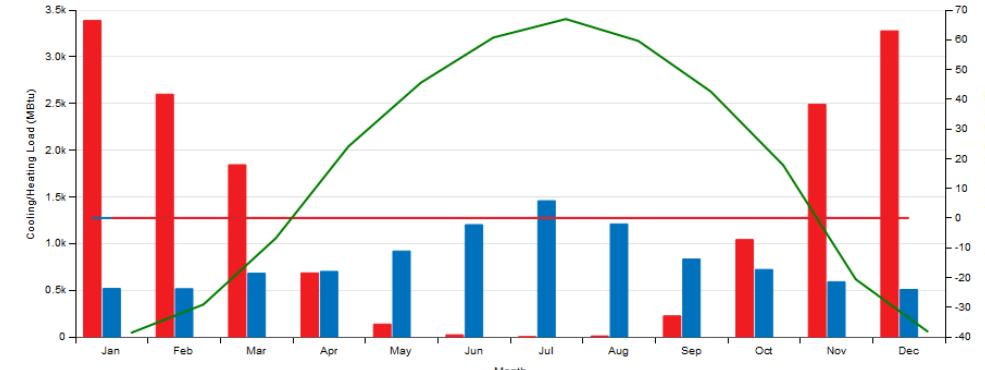
Russia

EAp2-18. End Use Percentage

	Percent [%]
Interior Lighting	4.96
Space Heating	56.20
Space Cooling	35.25
Fans-Interior	0.00
Service Water Heating	0.00
Receptacle Equipment	3.59
Miscellaneous	-0.00



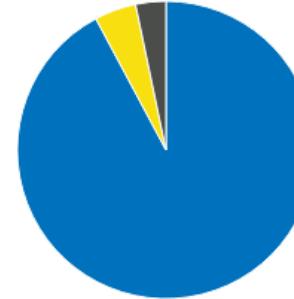
Heating
Cooling
Interior Lighting
Interior Equipment



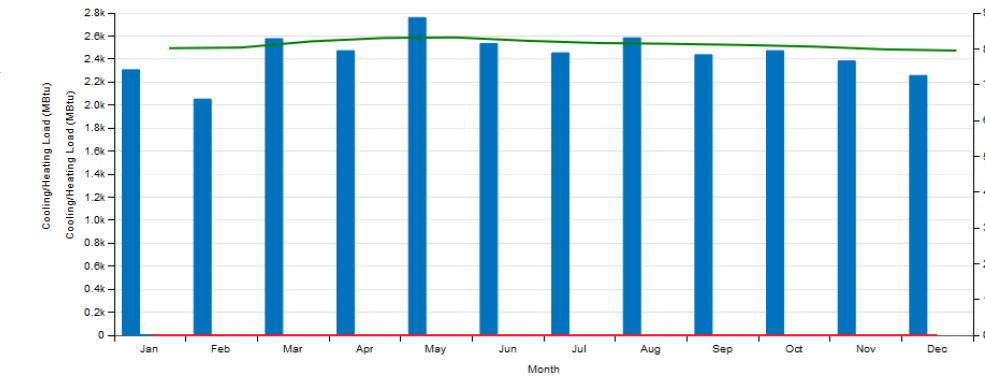
Colombo

EAp2-18. End Use Percentage

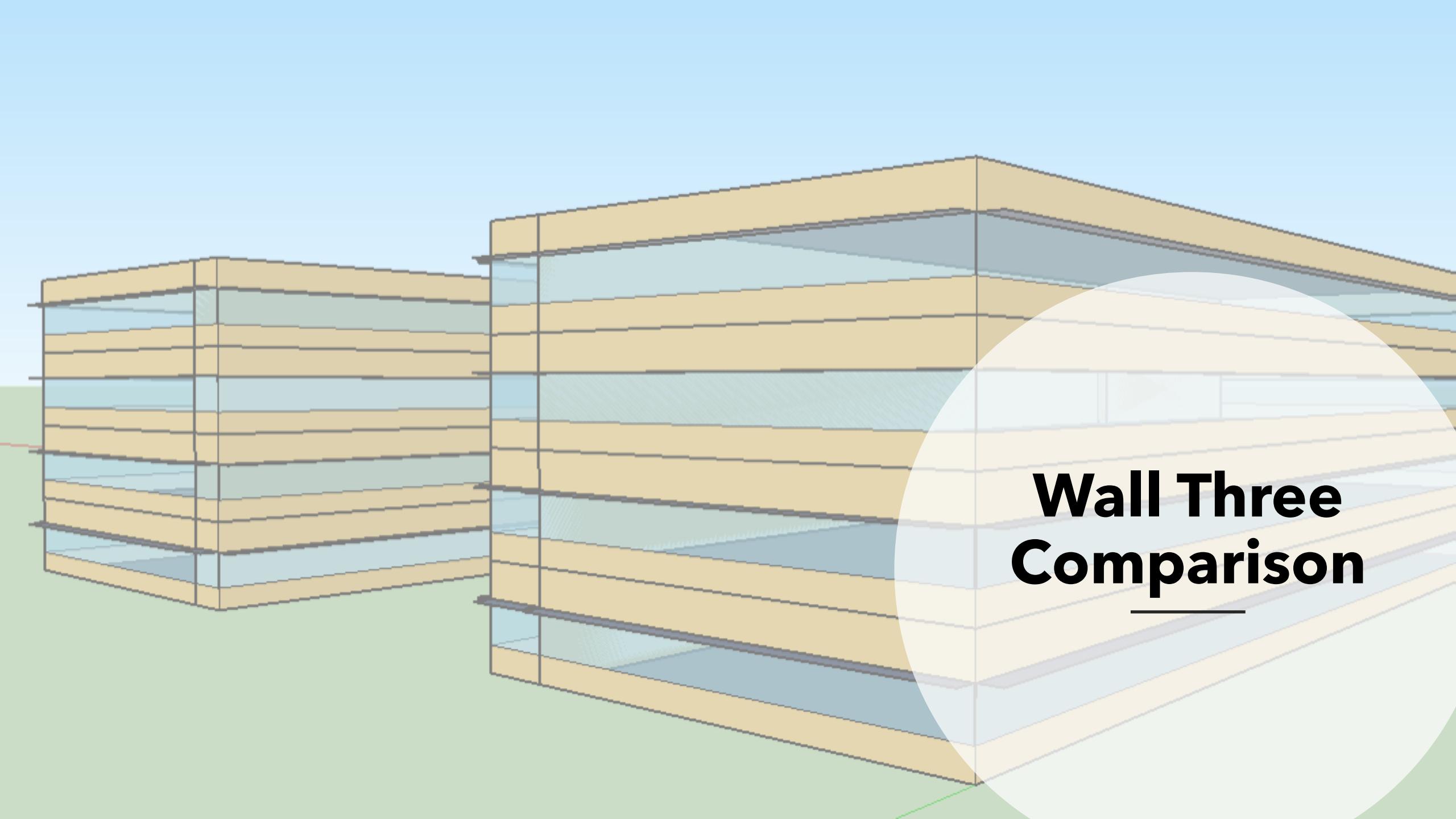
	Percent [%]
Interior Lighting	4.37
Space Heating	0.00
Space Cooling	92.45
Fans-Interior	0.00
Service Water Heating	0.00
Receptacle Equipment	3.17
Miscellaneous	-0.00



Cooling
Interior Lighting
Interior Equipment

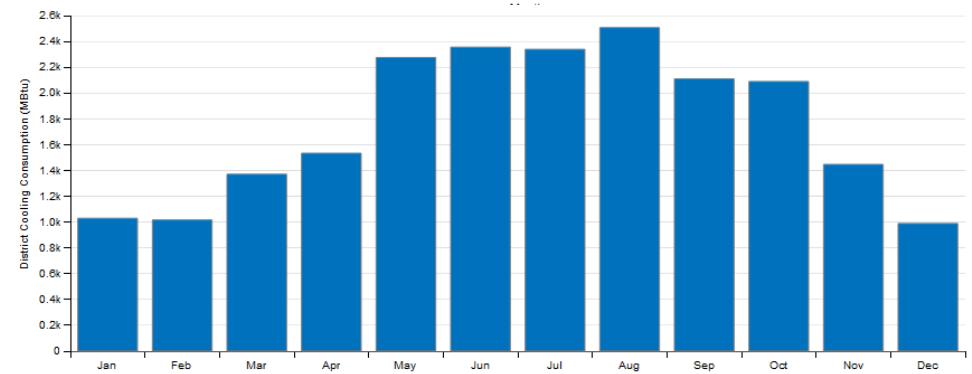


End use in Colombo is high due to the very high humidity there which can't be resisted by the wall material. So the wall is not effective.

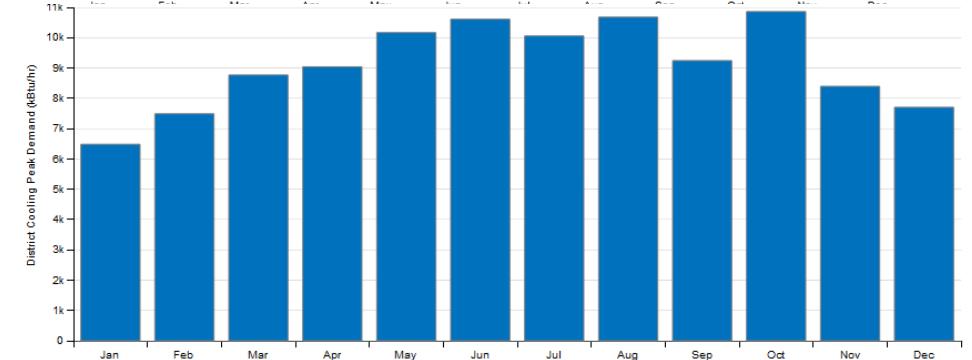
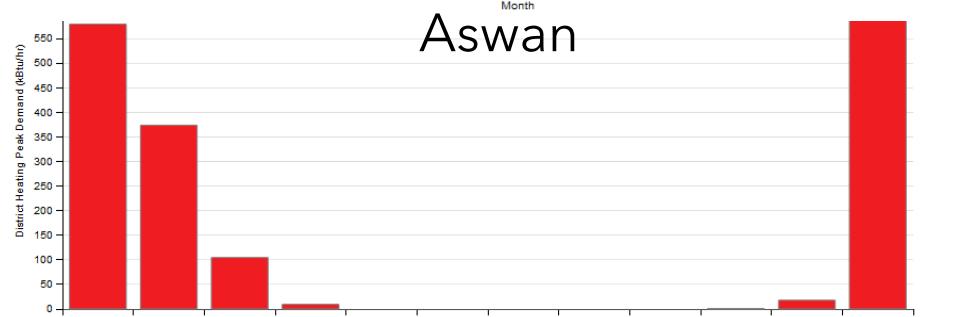


Wall Three Comparison

Kuwait



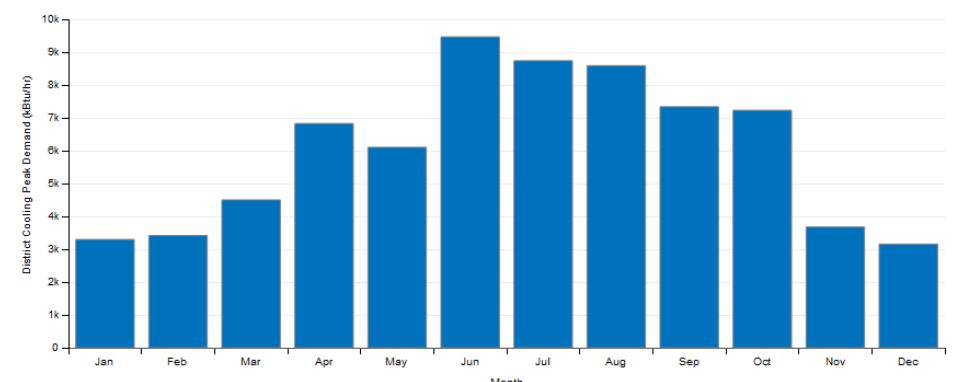
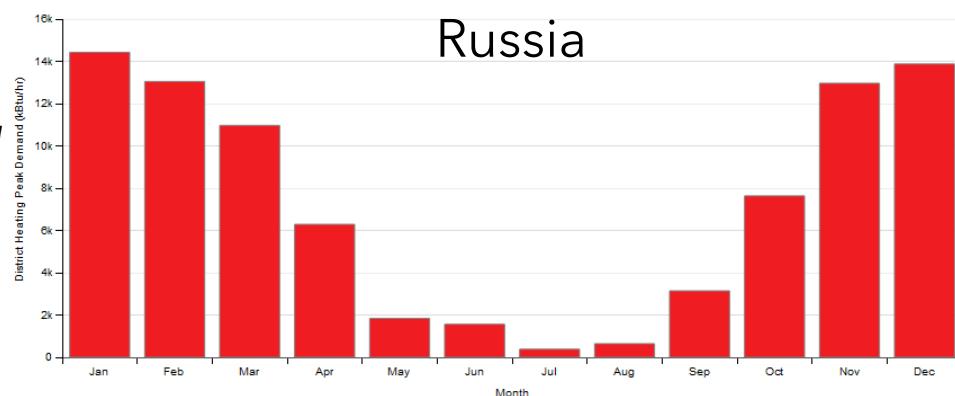
Aswan



Observations

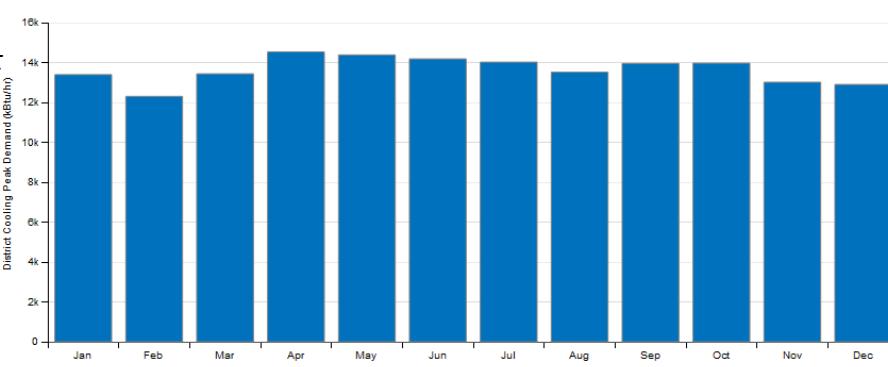
The wall is not effective in Russia due to it's low thermal resistance as well as the aluminum material doesn't work good as a thermal resistor in cold climates due to it's high thermal conductivity.

Russia



Colombo

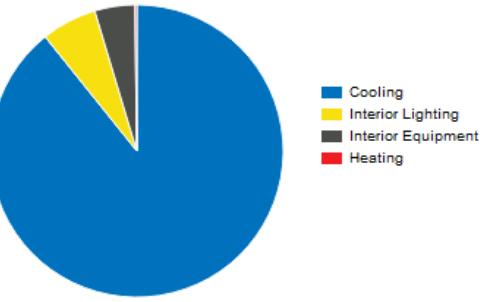
No Heating Consumption for Colombo



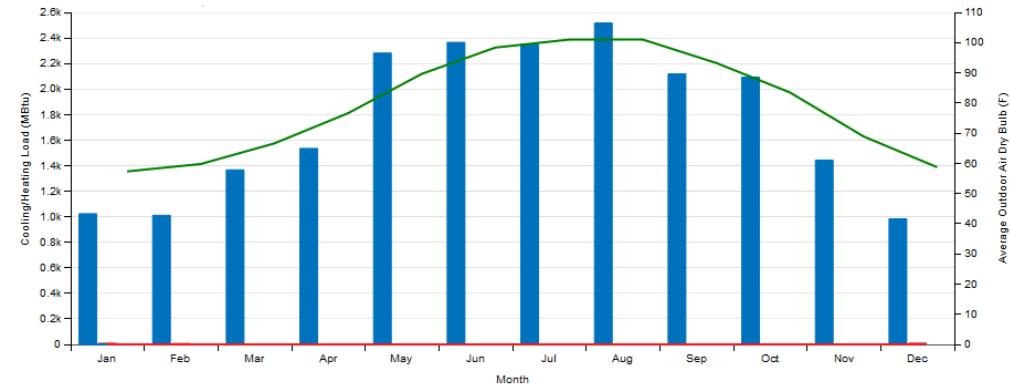
The wall is suitable for Colombo's moderate weather as it doesn't need a high thermal resistance wall while it's not totally fine for humid areas as the aluminum material doesn't resist humidity. So it's recommended to use a wall with the same insulation and thickness while using a different outer material other than the aluminum for higher humidity resistance.

EAp2-18. End Use Percentage

	Percent [%]
Interior Lighting	5.90
Space Heating	0.12
Space Cooling	89.71
Fans-Interior	0.00
Service Water Heating	0.00
Receptacle Equipment	4.28
Miscellaneous	-0.00

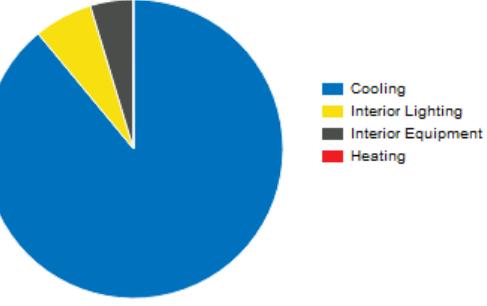


Kuwait

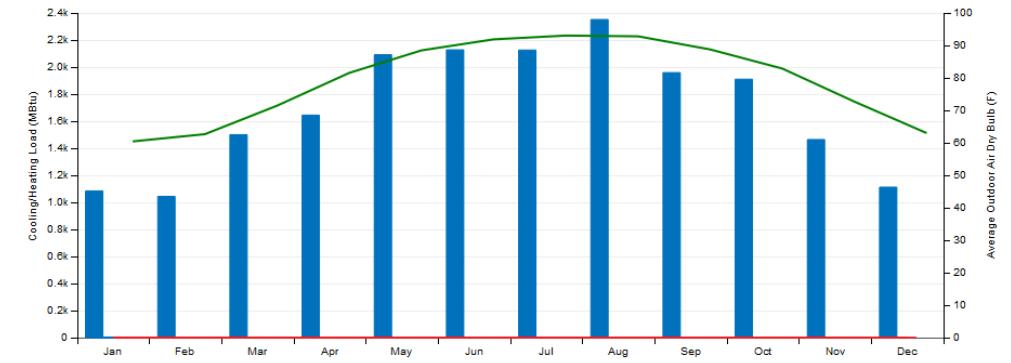


EAp2-18. End Use Percentage

	Percent [%]
Interior Lighting	6.07
Space Heating	0.04
Space Cooling	89.48
Fans-Interior	0.00
Service Water Heating	0.00
Receptacle Equipment	4.40
Miscellaneous	-0.00



Aswan



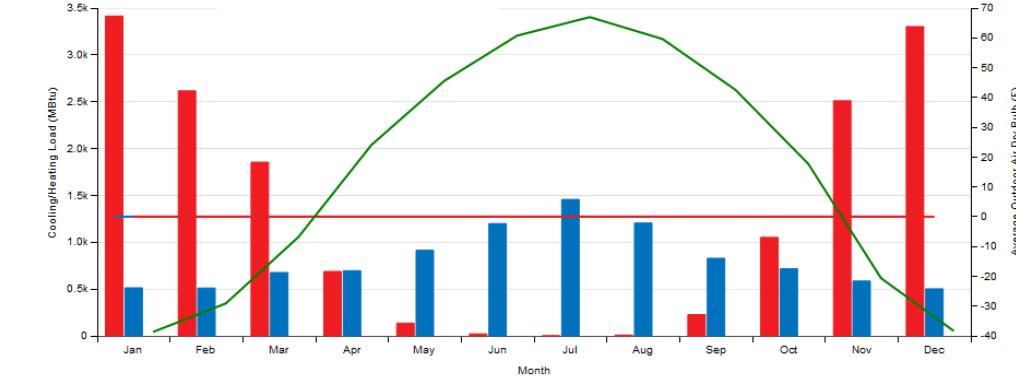
Observations

End use percentage is higher compared to other walls due to the higher thermal conductivity of the wall.

Russia

EAp2-18. End Use Percentage

	Percent [%]
Interior Lighting	4.94
Space Heating	56.48
Space Cooling	34.99
Fans-Interior	0.00
Service Water Heating	0.00
Receptacle Equipment	3.59
Miscellaneous	-0.00

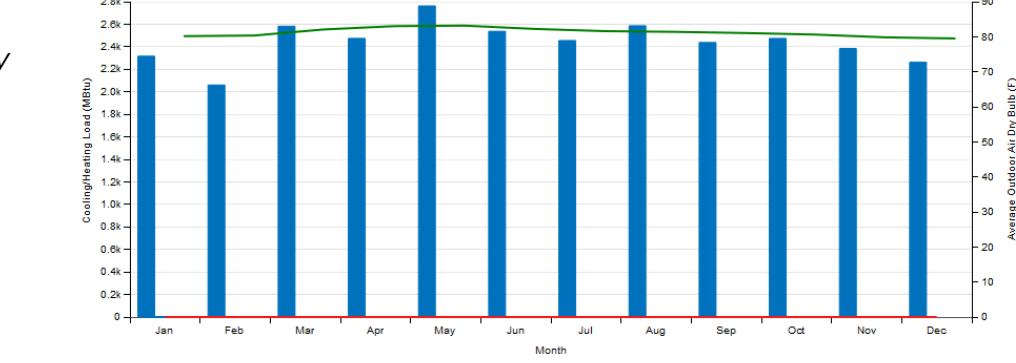


End use in Kuwait and Aswan cities are high compared to Russia and Colombo due to the hot climate there which needs a more effective wall with higher thermal resistance.

Colombo

EAp2-18. End Use Percentage

	Percent [%]
Interior Lighting	4.37
Space Heating	0.00
Space Cooling	92.46
Fans-Interior	0.00
Service Water Heating	0.00
Receptacle Equipment	3.17
Miscellaneous	-0.00



End use in Colombo is high due to the very high humidity there which can't be resisted by the wall material. So the wall is not effective.

Thank You.



Back Up

Wall One – Russia

Site and Source Energy

	Total Energy [GJ]	Energy Per Total Building Area [MJ/m2]	Energy Per Conditioned Building Area [MJ/m2]
Total Site Energy	29668.34	4709.26	4709.26
Net Site Energy	29668.34	4709.26	4709.26
		12789.29	12789.29
		12789.29	12789.29

EAp2-6. Energy Use Summary

	Process Subtotal [GJ]	Total Energy Use [GJ]
Electricity	1060.26	2522.39
Natural Gas	0.00	0.00
Additional	0.00	27145.95
Total	1060.26	29668.34

Wall One – Aswan

EAp2-6. Energy Use Summary

	Process Subtotal [GJ]	Total Energy Use [GJ]
Electricity	1060.26	2522.39
Natural Gas	0.00	0.00
Additional	0.00	20542.79
Total	1060.26	23065.18

	Process Subtotal [GJ]	Total Energy Use [GJ]
Net Source Energy	29719.20	4717.33

Site and Source Energy

Building Area [m2]	Energy [GJ]
3661.14	
3661.14	
4717.33	

Wall One – Colombo

EAp2-6. Energy Use Summary

	Process Subtotal [GJ]	Total Energy Use [GJ]
Electricity	1060.26	2522.39
Natural Gas	0.00	0.00
Additional	0.00	29777.81
Total	1060.26	32300.20

	Total Energy [GJ]	Energy [GJ]
Total Site Energy	32300.20	32300.20
Net Site Energy	32300.20	5127.02
Total Source Energy	39423.86	6257.76
Net Source Energy	39423.86	6257.76

Wall Two – Kuwait

EAp2-6. Energy Use Summary

	Process Subtotal [GJ]	Total Energy Use [GJ]
Electricity	1060.26	2522.39
Natural Gas	0.00	0.00
Additional	0.00	22254.23
Total	1060.26	24776.63

Net Site Energy	24776.63	3932.80
Total Source Energy	31559.39	5009.43
Net Source Energy	31559.39	5009.43

Wall Two – Aswan

EAp2-6. Energy Use Summary

	Process Subtotal [GJ]	Total Energy Use [GJ]
Electricity	1060.26	2522.39
Natural Gas	0.00	0.00
Additional	0.00	20559.56
Total	1060.26	23081.95

Net Site Energy	29748.46	4721.98	4721.98
Total Source Energy	29748.46	4721.98	4721.98
Net Source Energy	29748.46	4721.98	4721.98

Wall Two – Colombo

EAp2-6. Energy Use Summary

	Process Subtotal [GJ]	Total Energy Use [GJ]
Electricity	1060.26	2522.39
Natural Gas	0.00	0.00
Additional	0.00	30899.27
Total	1060.26	33421.66

	Area [MJ/m2]	Energy Per Conditioned Building Area [MJ]
5305.03		5305.03
5305.03		5305.03
6445.67		6445.67
6445.67		6445.67

Wall Two – Aswan

EAp2-6. Energy Use Summary

	Process Subtotal [GJ]	Total Energy Use [GJ]
Electricity	1060.26	2522.39
Natural Gas	0.00	0.00
Additional	0.00	20559.56
Total	1060.26	23081.95

Net Site Energy	29748.46	4721.98	4721.98
Total Source Energy	29748.46	4721.98	4721.98
Net Source Energy	29748.46	4721.98	4721.98

Wall Two – Russia

Site and Source Energy

	Total
Total Site Energy	
Net Site Energy	
Total Source Energy	
Net Source Energy	

EAp2-6. Energy Use Summary

	Process Subtotal [GJ]	Total Energy Use
Electricity	1060.26	2522.39
Natural Gas	0.00	0.00
Additional	0.00	2698.00
Total	1060.26	2950.39

EAp2-6. Energy Use Summary

	Process Subtotal [GJ]	Total Energy Use [GJ]
Electricity	1060.26	2522.39
Natural Gas	0.00	0.00
Additional	0.00	22276.69
Total	1060.26	24799.08

Building Area [MJ/m2]	Energy Per Conditioned Building Area [GJ]	Site and Source Energy
3936.36		
3936.36		
5012.47		
5012.47		

EAp2-6. Energy Use Summary

	Process Subtotal [GJ]	Total Energy Use [GJ]
Electricity	1060.26	2522.39
Natural Gas	0.00	0.00
Additional	0.00	27048.98
Total	1060.26	29571.37

Wall Three – Kuwait

Wall Three – Russia

Wall Three – Aswan

Wall Three – Colombo

Source Energy

EAp2-6. Energy Use Summary

	Process Subtotal [GJ]	Total Energy Use [GJ]
Electricity	1060.26	2522.39
Natural Gas	0.00	0.00
Additional	0.00	21548.64
Total	1060.26	24071.03

Site and Source Energy

EAp2-6. Energy Use Summary

	Process Subtotal [GJ]	Total Energy Use [GJ]
Total Site Energy	334	
Net Site Energy	334	
Total Source Energy	406	
Net Source Energy	406	

Conditioned Building