SIMULATION OF BUILDING ENERGY PERFORMANCE VIA OPENSTUDIO

TECHNICAL ENVIRONMENTAL SYSTEM

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PART 1

_INTRODUCTION

In this report, it has decided to consider the energy consuption of an office building, with at the basement a vending part. The area of the building is 500,00 m2 with 4 floors mainly consisting of open office and a corridor in the central part of the building, with a ground floor of vending. In addition, sunshades have been added to all the vertical surfaces, except for the North elevation, in order to increase the sustainability.
It has been decided to locate the building in three different city in this report, Santiago Chile, Stockholm and Auckland, in order to have different comparison and results, in terms of energy consuption.
It has been chosen Santiago Chile as basic city for building details, in terms of default condition. In order to have comparisons, it has been decided to locate the building also in Stockholm and in Auckland, which are at very different latitude, with a very different weather from Santiago Chile.
In addition, it has been decided to change the construction of external walls, in order to enhance the possibility of sustainability and at the end make a comparison between the three different walls in each different city.
In the figure 1 there are the measurement and the information of the building chosen.

_building type: OFFICE + VENDING
_area: 500m
_height: 16 m
_number of floors: (ground floor VENDING + 1-3 floors OFFICES)
_city 1: Santiago Chile
_city 2: Stockholm
_city 3: Auckland

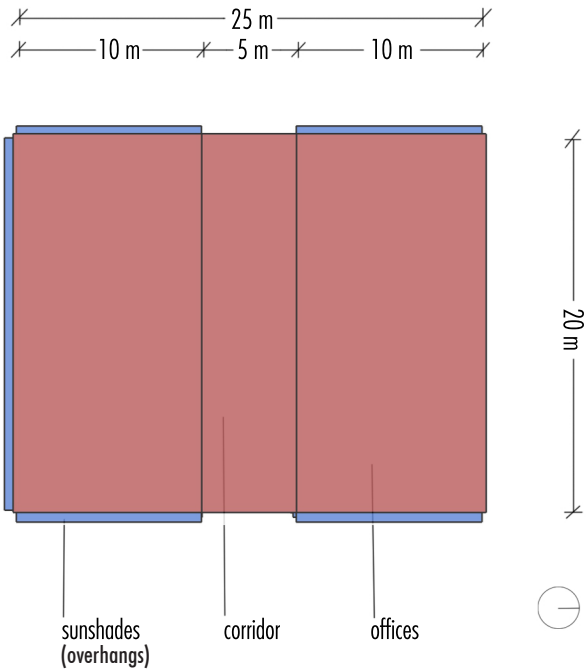


figure 1. top view

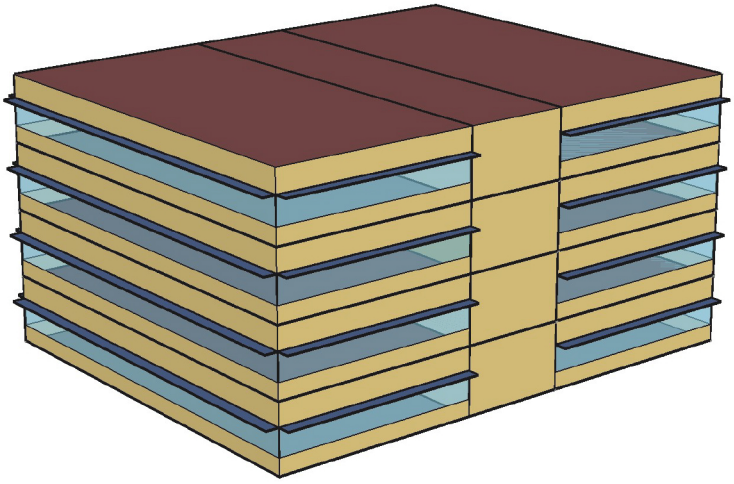


figure 2. view

_THERMAL ZONES AND OCCUPATION

The building has been also divided in different thermal zones, according to the different activities performed inside.
So three different thermal zones: first of all the one refered to the office activity (green part), secondly the one refered to the corridor part (brown part) and at the end the one refered to the vending part at the ground floor (blue part).

_thermal zone 1 (offices)
_thermal zone 2(corridor)
_thermal zone 3 (vending

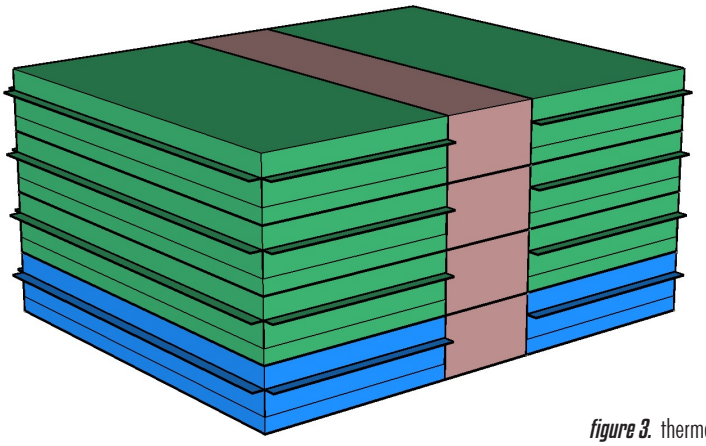


figure 3. thermal zones

It has been also decided to add informations about the occupation of each zone, making differences between weekdays and weekend and between the different zone according to the activity performed inside each one (figures below).

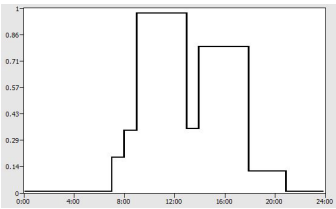


figure 4. office occupation weekdays (mon-fri)

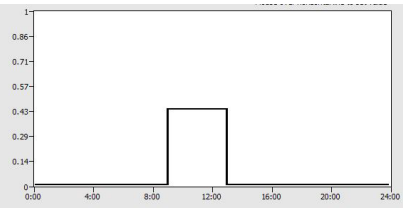


figure 5. office occupation saturday

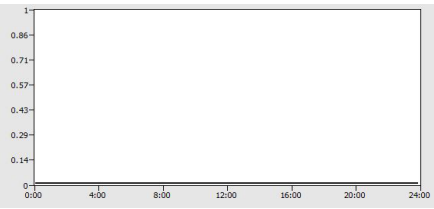


figure 6. office occupation sunday

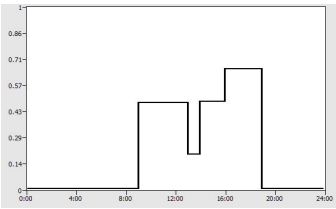


figure 7. vending occupation weekdays (mon-fri)

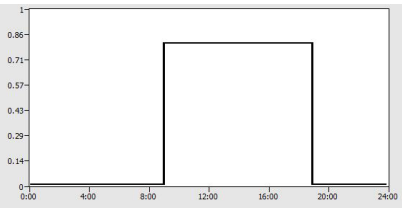


figure 8. vending occupation saturday

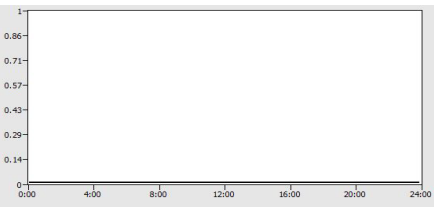


figure 9. vending occupation sunday

In addition, it has been decided to add informations about the use of light for each zone, making differences between weekdays and weekend and between the different zone according to the activity performed inside each one (figures below).

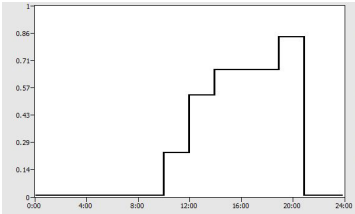


figure 10. office light weekdays (mon-fri)

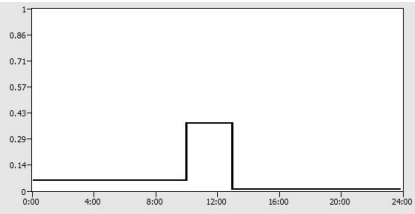


figure 11. office light saturday

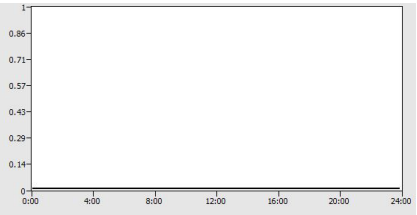


figure 12. office light sunday

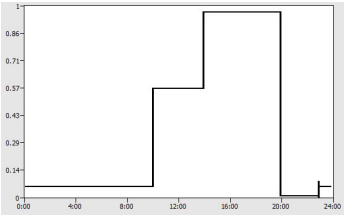


figure 13. corridor light weekdays (mon-fri)

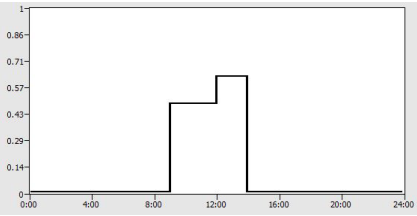


figure 14 corridor light saturday

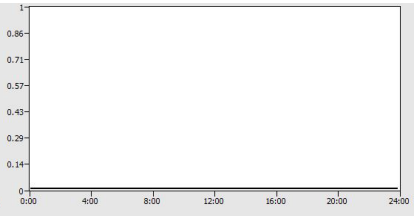


figure 15. corridor light sunday

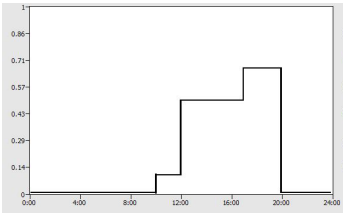


figure 16. vending light weekdays (mon-fri)

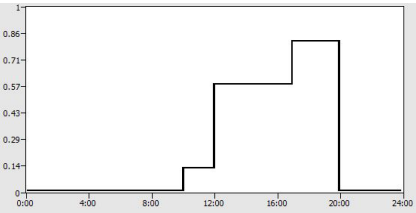


figure 17. vending light saturday

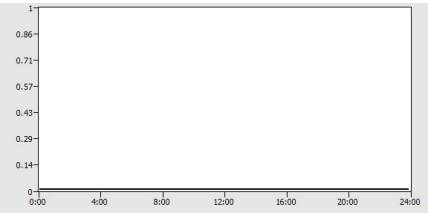


figure 18. vending light sunday

PART 2

_ANALYSIS 1_THE SAME BUILDING IN THE THREE DIFFERENT CITIES CHOSEN

In this analysis, it has decided to consider the same building, with the same construction for external walls (in this case the one called "wall 1"), located in the three different cities chosen, Santiago Chile, Stockholm and Auckland.

figure 19. cities chosen

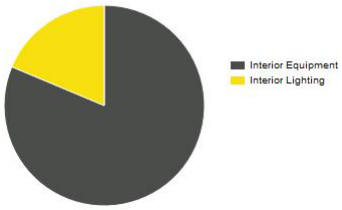


figure 20. EUI-electricity-view table

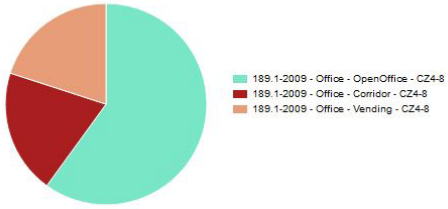


figure 21. space type breakdown-view table

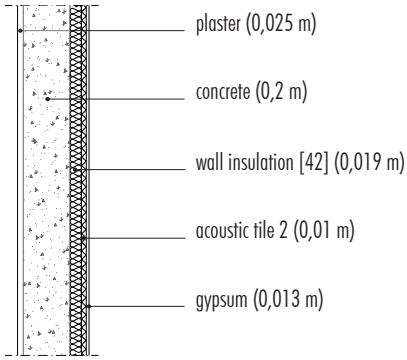


figure 22. construction wall 1

_ANALYSIS 1_SANTIAGO CHILE_WALL 1

Building Summary

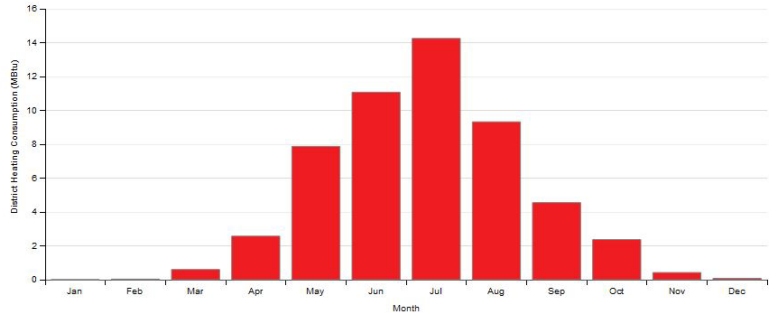
Information	Value	Units
Building Name	Building 1	building_name
Net Site Energy	661,150	kBtu
Total Building Area	9,688	ft^2
EUI (Based on Net Site Energy and Total Building Area)	68.25	kBtu/ft^2
OpenStudio Standards Building Type		

Weather Summary

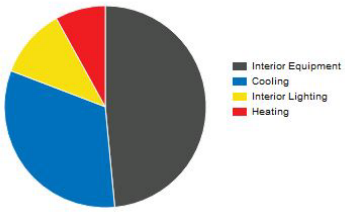
	Value
Weather File	SANTIAGO - CHL IWEC Data WMO#=855740
Latitude	-33.4
Longitude	-70.8
Elevation	1562 (ft)
Time Zone	-4.0
North Axis Angle	-0.00
ASHRAE Climate Zone	

figure 23-24. summaries

District Heating Consumption (MBtu) - view table



End Use - view table



Energy Use - view table

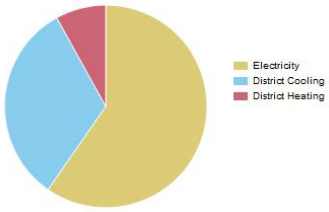


figure 25-26. end and energy use

District Cooling Consumption (MBtu) - view table

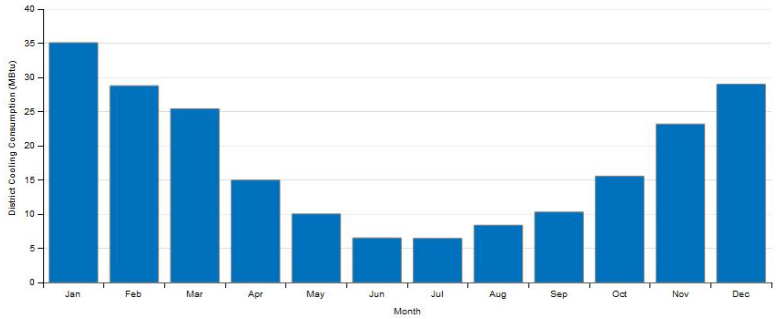


figure 27-28. district consuptions

In this conditions, in Santiago de Chile, the net energy of the building, so the annual energy consuption is about 661,150 kBtu (equivalent to 193763,94 kWh).
From the chart 26, it can be shown that more of the 60% of the energy is used in the form of electricity, while district cooling is quite the three times the district heating.
In the other two charts (27-28) the value of energy consuption is shown montly, in heating and cooling. These values are shown with the unity of measurement of MBtu, corrisponding to 0.29307 Kilowatt-Hour (kWh). The peak value in summer goes to 10,257 487 456 kWh, while in winter goes to 4,102 994 982 4 kWh.

ANALYSIS 1_STOCKHOLM_WALL 1

Building Summary

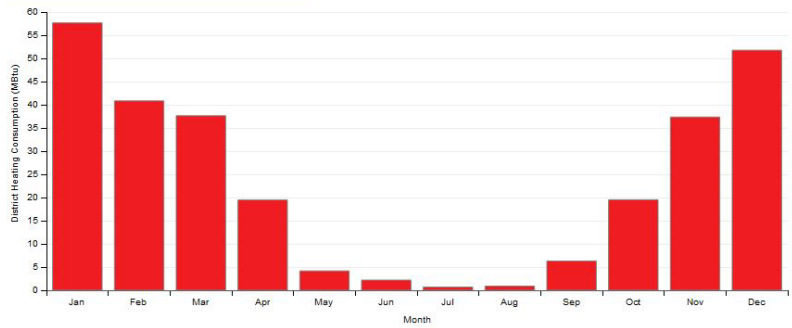
Information	Value	Units
Building Name	Building 1	building_name
Net Site Energy	762,604	kBtu
Total Building Area	9,688	ft^2
EUI (Based on Net Site Energy and Total Building Area)	78.72	kBtu/ft^2
OpenStudio Standards Building Type		

Weather Summary

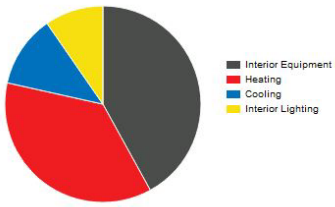
	Value
Weather File	STOCKHOLM_ ARLANDA - SWE IWEC Data WMO#=024600
Latitude	59.65
Longitude	17.95
Elevation	200 (ft)
Time Zone	1.00
North Axis Angle	-0.00
ASHRAE Climate Zone	

figure 29-30. summaries

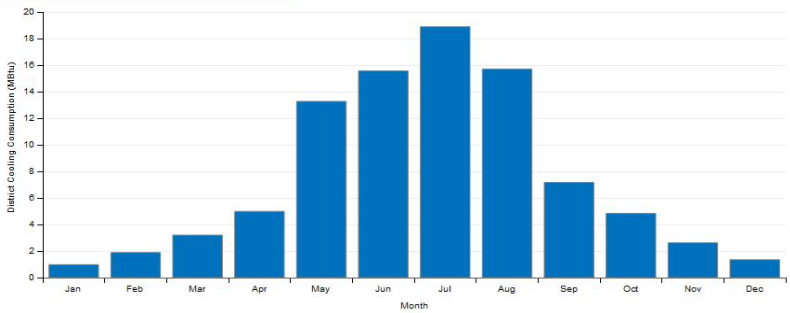
District Heating Consumption (MBtu) - view table



End Use - view table



District Cooling Consumption (MBtu) - view table



Energy Use - view table

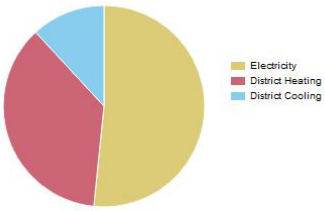


figure 31-32. end and energy use

figure 33-34. district consuptions

In this conditions, in Stockholm, the net energy of the building, so the annual energy consuption is about 762604 kBtu (equivalent to 223497,17 kWh).

From the chart 32, it can be shown that the 50% of the energy is used in the form of electricity, while district heating is quite the three times the cooling heating.

In the other two charts (33-34) the value of energy consuption is shown montly, in heating and cooling. These values are shown with the unity of measurement of MBtu, corrisponding to 0.29307 Kilowatt-Hour (kWh). The peak value in summer goes to 5,275 279 263 1 kWh, while in winter goes to 16,118 908 859 5 kWh.

ANALYSIS 1_AUCKLAND_WALL 1

Building Summary

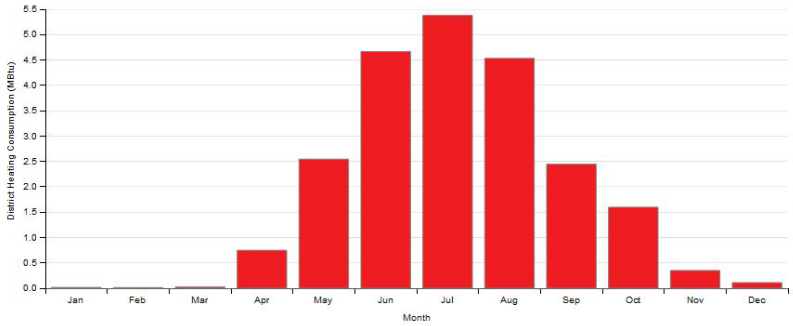
Information	Value	Units
Building Name	Building 1	building_name
Net Site Energy	615,370	kBtu
Total Building Area	9,688	ft^2
EUI (Based on Net Site Energy and Total Building Area)	63.52	kBtu/ft^2
OpenStudio Standards Building Type		

Weather Summary

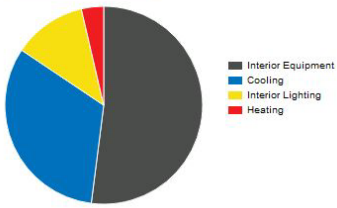
	Value
Weather File	Auckland Auckland New Zealand TMY2 NIWA 1962 C74082 WMO#=931190
Latitude	-37.0
Longitude	174.79
Elevation	108 (ft)
Time Zone	12.00
North Axis Angle	-0.00
ASHRAE Climate Zone	

figure 35-36. summaries

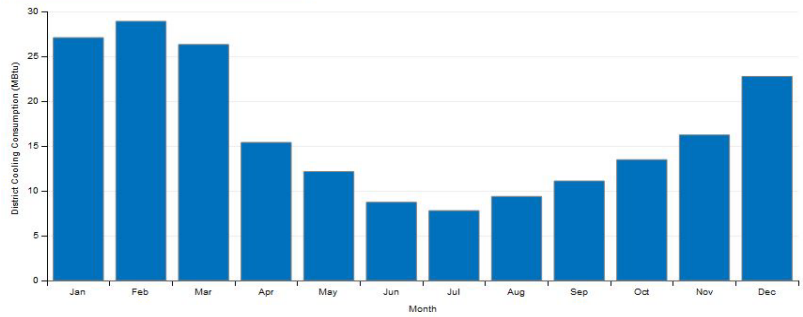
District Heating Consumption (MBtu) - view table



End Use - view table



District Cooling Consumption (MBtu) - view table



Energy Use - view table

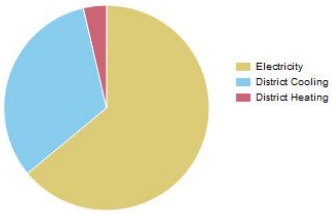


figure 39-40. end and energy use

figure 37-38. district consuptions

In this conditions, in Auckland the net energy of the building, so the annual energy consuption is about 615370 kBtu (equivalent to 180347,14 kWh).

From the chart 40, it can be shown that the 60% of the energy is used in the form of electricity, while district heating is very low comparet to cooling heating.

In the other two charts (37-38x) the value of energy consuption is shown montly, in heating and cooling. These values are shown with the unity of measurement of MBtu, corrisponding to 0.29307 Kilowatt-Hour (kWh). The peak value in summer goes to 8,205 989 964 8 kWh, while in winter goes to 1,611 890 885 9 kWh.

_ANALYSIS 1_CONCLUSIONS

At the end of this report two different comparisons can be shown, the first one at the end of the analysis 1 and the second one at the end of the analysis 2.
In particular the first comparison is between datas based on the same building but located in different cities at different latidudes and with different weather. Thanks to this comparison it can be shown how the weather conditions influences the results of energy consuption.

ENERGY CONSUPTION

		HEATING	COOLING
CITIES	SANTIAGO CHILE	53,485	213,354
	STOCKHOLM	278,497	90,450
	AUCKLAND	22,425	199,288

figure 41. comparison same wall in different cities

Infact, according to these consideration, the results of heating and cooling are so different from one city to each others.
In particular, the values of cooling is higher in Santiago Chile than in the other cities, while the value of heating in Stockholm is incredible high.
In addition, the values of heating and cooling are more different the ones to each other in Santiago Chile and Auckland, instead of in Stockholm.

PART 3

_ANALYSIS 2_DIFFERENT EXTERNAL WALLS IN THE SAME CITY

In this part, it has decided to consider three different construction for external walls, in order to comparise them in each city chosen. In this way it has been possible understanding the difference in terms of healting and cooling at different conditions. In the figures 42-44 there are the three different stratigraphy chosen.

figure 41. cities chosen for the comparisons

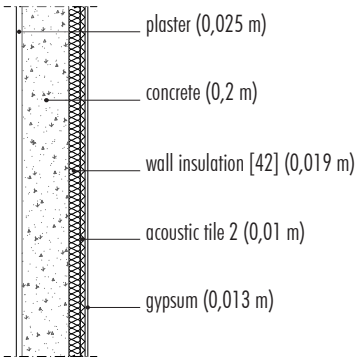


figure 42 external wall 1

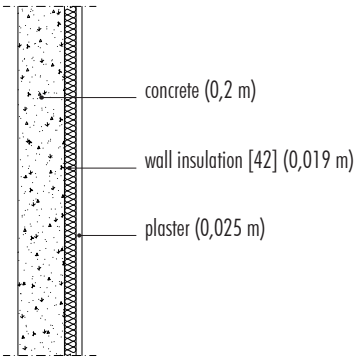


figure 43. external wall 2

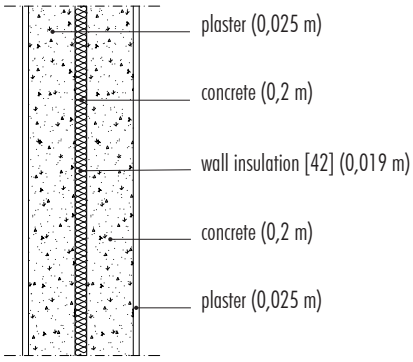


figure 44. external wall 3

_ANALYSIS 2_SANTIAGO CHILE_WALL 1, WALL 2, WALL 3

Building Summary

Information	Value	Units
Building Name	Building 1	building_name
Net Site Energy	660,505	kBtu
Total Building Area	9,688	ft^2
EUI (Based on Net Site Energy and Total Building Area)	68.18	kBtu/ft^2
OpenStudio Standards Building Type		

figure 45. building summary wall 1

Building Summary

Information	Value	Units
Building Name	Building 1	building_name
Net Site Energy	653,482	kBtu
Total Building Area	9,688	ft^2
EUI (Based on Net Site Energy and Total Building Area)	67.46	kBtu/ft^2
OpenStudio Standards Building Type		

figure 46. building summary wall 2

Building Summary

Information	Value	Units
Building Name	Building 1	building_name
Net Site Energy	644,487	kBtu
Total Building Area	9,688	ft^2
EUI (Based on Net Site Energy and Total Building Area)	66.53	kBtu/ft^2
OpenStudio Standards Building Type		

figure 47. building summary wall 3

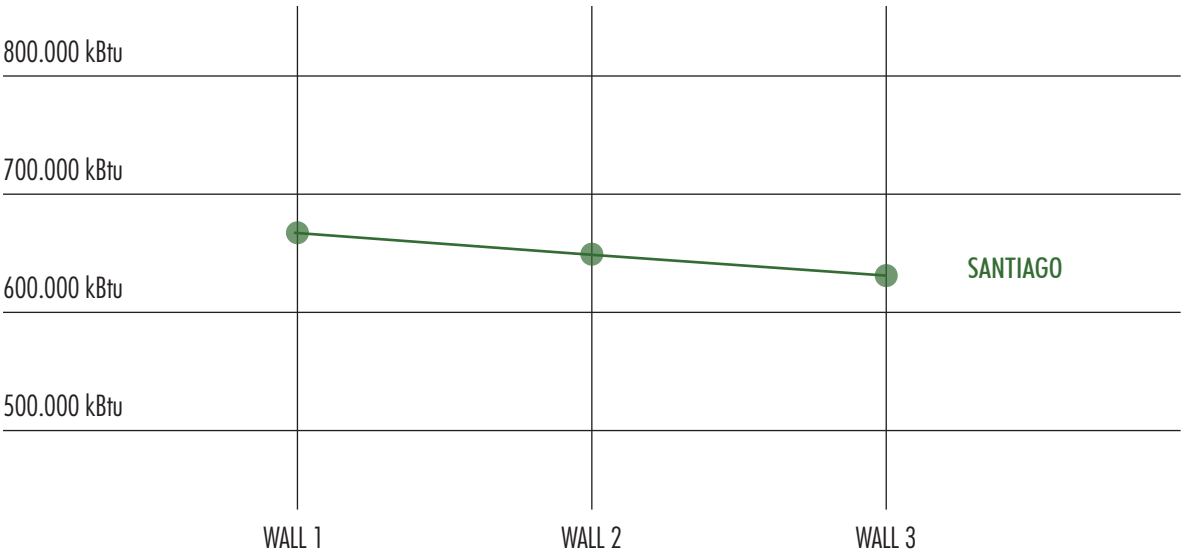


figure 48. annual energy consuption comparison

_ANALYSIS 2_STOCKHOLM_WALL 1, WALL 2, WALL 3

Building Summary

Information	Value	Units
Building Name	Building 1	building_name
Net Site Energy	762,604	kBtu
Total Building Area	9,688	ft^2
EUI (Based on Net Site Energy and Total Building Area)	78.72	kBtu/ft^2
OpenStudio Standards Building Type		

figure 49. building summary wall 1

Building Summary

Information	Value	Units
Building Name	Building 1	building_name
Net Site Energy	769,504	kBtu
Total Building Area	9,688	ft^2
EUI (Based on Net Site Energy and Total Building Area)	79.43	kBtu/ft^2
OpenStudio Standards Building Type		

figure 50. building summary wall 2

Building Summary

Information	Value	Units
Building Name	Building 1	building_name
Net Site Energy	756,292	kBtu
Total Building Area	9,688	ft^2
EUI (Based on Net Site Energy and Total Building Area)	78.07	kBtu/ft^2
OpenStudio Standards Building Type		

figure 51. building summary wall 3

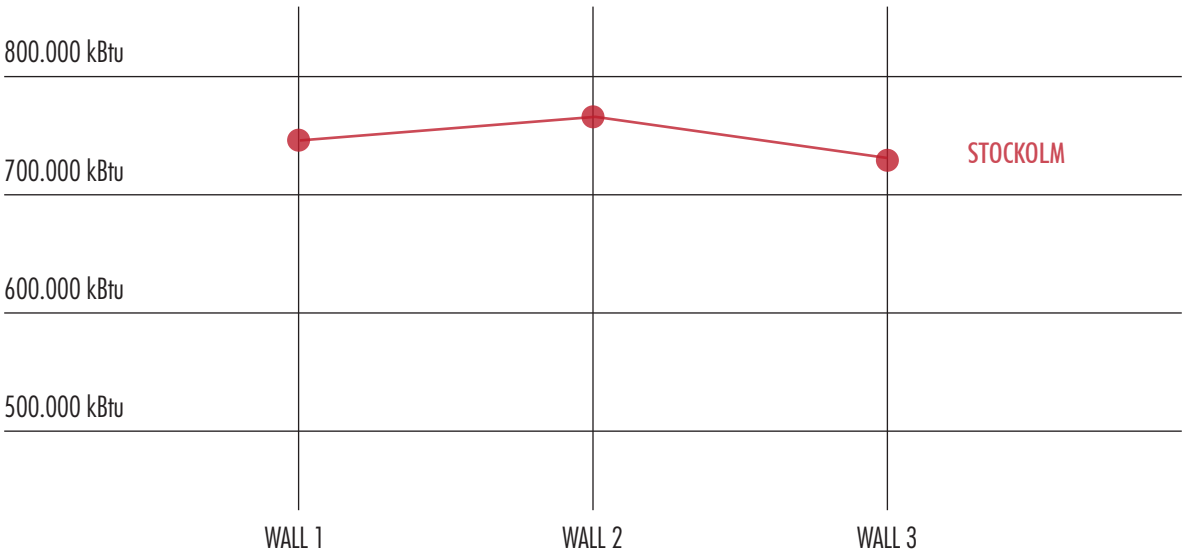


figure 52. annual energy consuption comparison

_ANALYSIS 2_AUCKLAND_WALL 1, WALL 2, WALL 3

Building Summary

Information	Value	Units
Building Name	Building 1	building_name
Net Site Energy	615,370	kBtu
Total Building Area	9,688	ft^2
EUI (Based on Net Site Energy and Total Building Area)	63.52	kBtu/ft^2
OpenStudio Standards Building Type		

figure 53. building summary wall 1

Building Summary

Information	Value	Units
Building Name	Building 1	building_name
Net Site Energy	608,119	kBtu
Total Building Area	9,688	ft^2
EUI (Based on Net Site Energy and Total Building Area)	62.77	kBtu/ft^2
OpenStudio Standards Building Type		

figure 54. building summary wall 2

Building Summary

Information	Value	Units
Building Name	Building 1	building_name
Net Site Energy	603,523	kBtu
Total Building Area	9,688	ft^2
EUI (Based on Net Site Energy and Total Building Area)	62.30	kBtu/ft^2
OpenStudio Standards Building Type		

figure 55. building summary wall 3

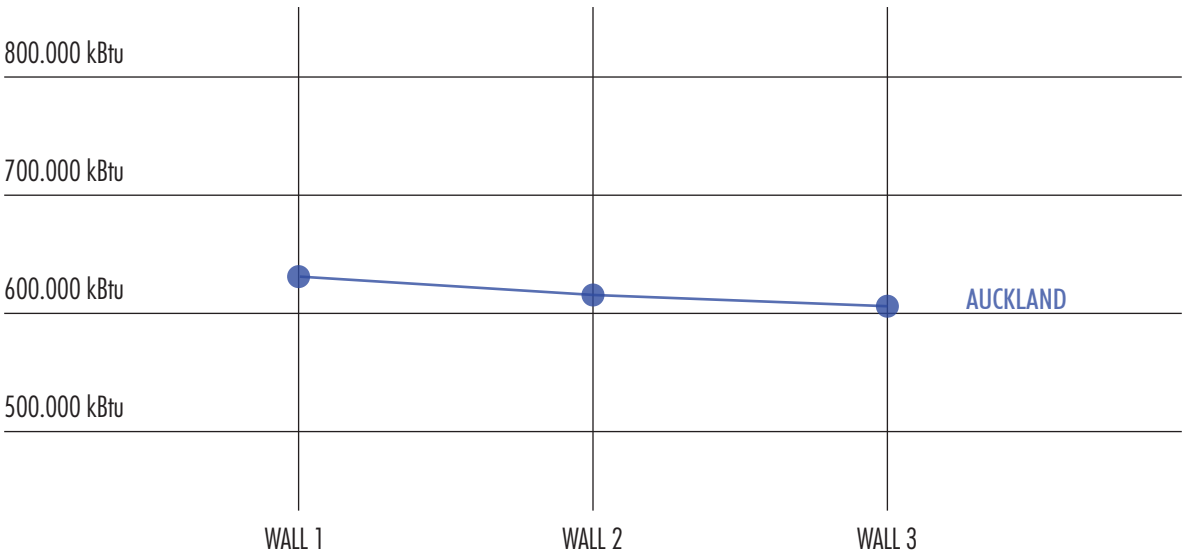


figure 56. annual energy consuption comparison

_ANALYSIS 2_CONCLUSIONS

Here below there is the second comparison, mentioned before.
The three different construction for external walls can be used to underlinehow the building construction affect the value of energy consuption.
In this report the wall 3 has the least energy consuption, thanks to its construction, made of two layer of concrete, with a layer of insulation in between.

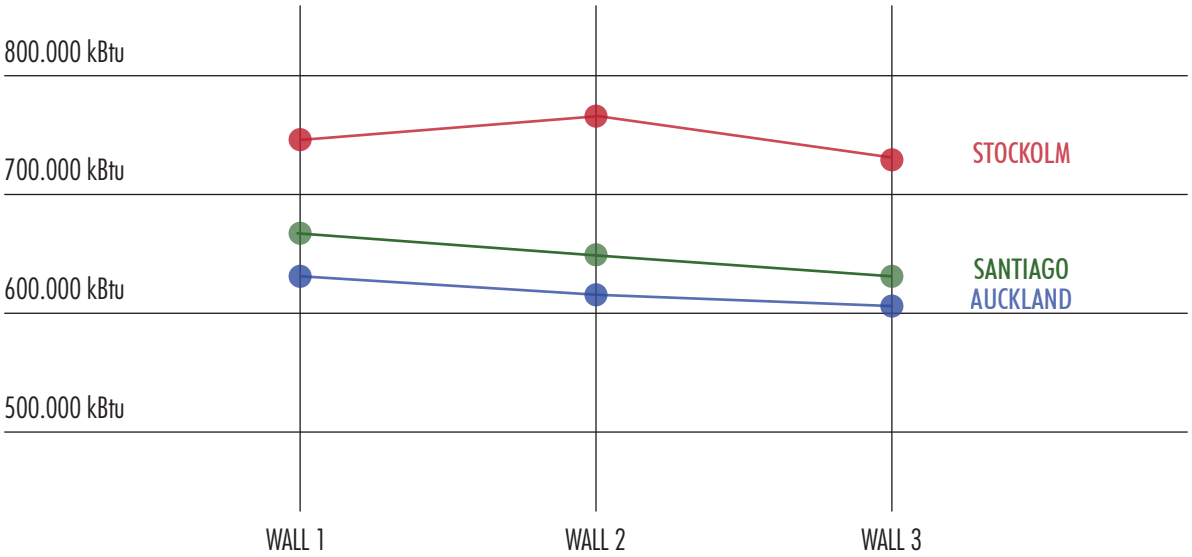


figure 57. final comparison