POLITECNICO
MILANO 1863

# Assignment Report

## Technical Environmental Systems

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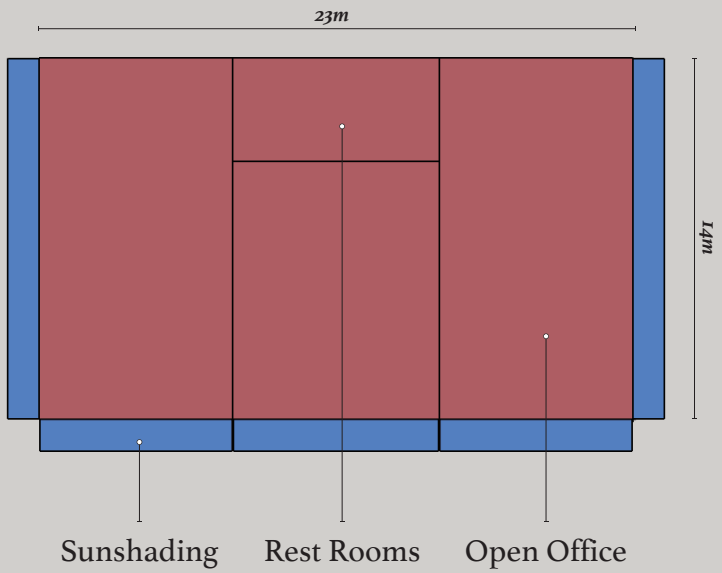
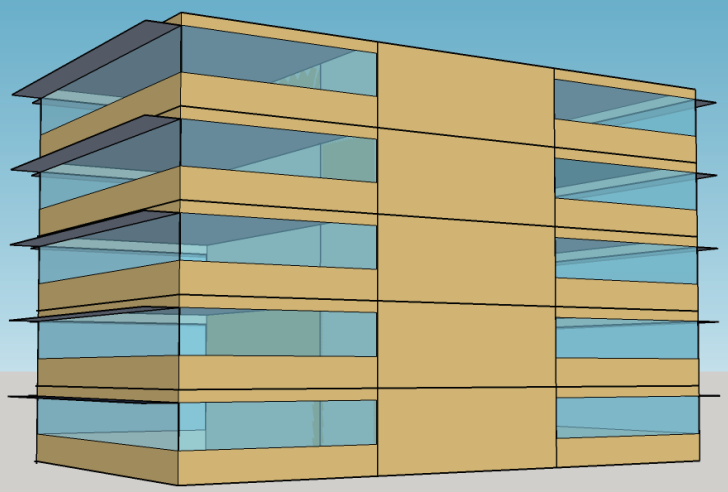
# Introduction

In this report, we considered the energy consumption of an office building, whose area is 1,610 m² with 5 floors mainly consisting of open offices and rest rooms. In terms of default condition, we took Beijing as basic city for building details. In order to have comparisons, we also took Oslo and Singapore as the other two objective cites which have quite different weather comparing with Beijing. In addition, we changed constructions of external walls to enhance the possibilites of sustainability. Here below is the building plan and information of the building we have chosen.

Building Type : Office
Area : 1,610 m²
Height : 15.2 m
Floors : 5
Location 1 :Beijing
Location 2 :Oslo
Location 3 :Singapore



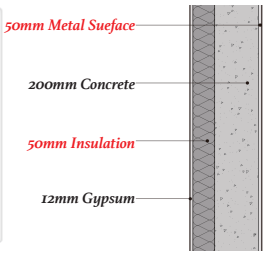



# Analysis 1_Beijing_Wall 1

Building Summary

| Information | Value | Units |
|---|---|---|
| Building Name | Building 1 | building_name |
| Net Site Energy | 673,822 | kBtu |
| Total Building Area | 3,466 | ft^2 |
| EUI (Based on Net Site Energy and Total Building Area) | 194.41 | kBtu/ft^2 |
| OpenStudio Standards Building Type | | |

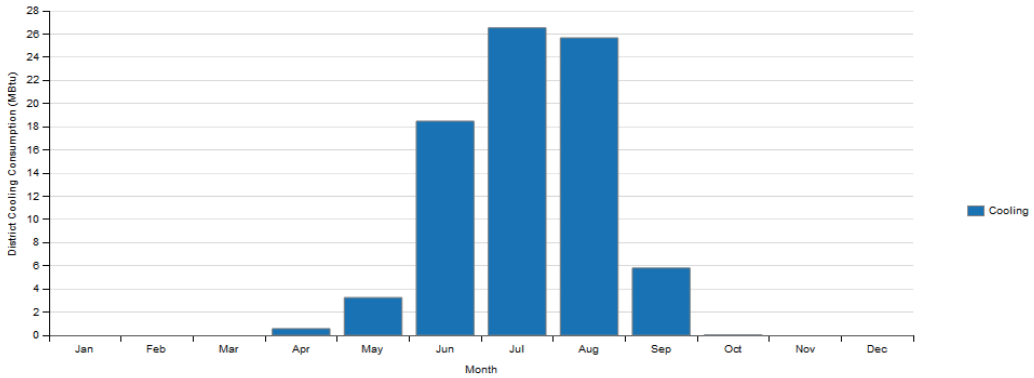
*External Wall Detail_Type 1*



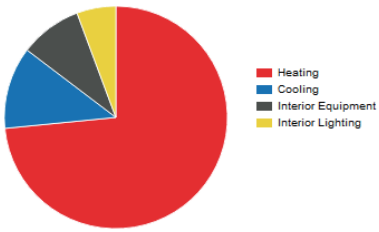

Weather Summary

| | Value |
|---|---|
| Weather File | Beijing Beijing CHN CSWD WMO#=545110 |
| Latitude | 39.80 |
| Longitude | 116.47 |
| Elevation | 103 (ft) |
| Time Zone | 8.00 |
| North Axis Angle | 0.00 |
| ASHRAE Climate Zone | |

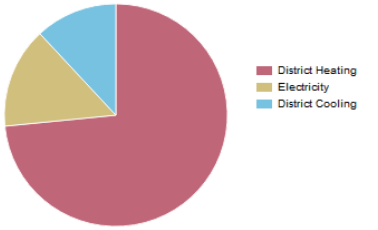
District Cooling Consumption (MBtu) - view table



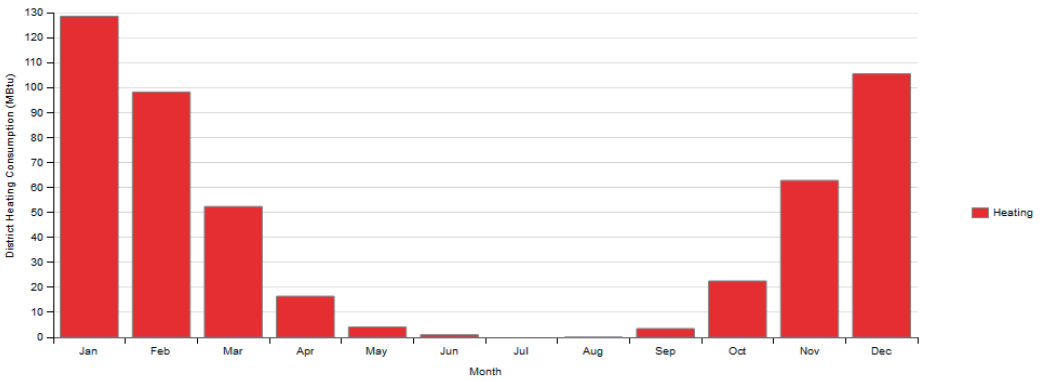

End Use - view table



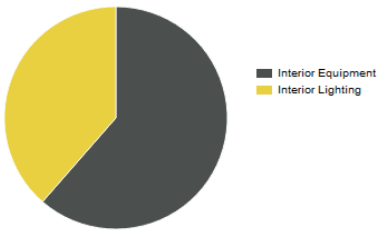

Energy Use - view table




District Heating Consumption (MBtu) - view table




EUI - Electricity - view table




*In this condition, the annual engergy consumption is about 673822 kBtu, which equals to 197497.1 kWh.*

*From the fan chart, we know that more than 70% of the engergy are used in the form of district heating. At the same time, district cooling and electricity are almost the same value.*

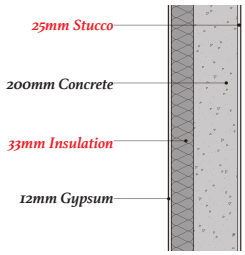
*From the other two bar charts, we analyse monthly value of energy consumption in cooling and heating. We can tell that both in winter and summer, the peak value goes to 130 kWh.v*

# Analysis 1_Beijing_Wall 2

Building Summary

| Information | Value | Units |
|---|---|---|
| Building Name | Building 1 | building_name |
| Net Site Energy | 637,284 | kBtu |
| Total Building Area | 3,466 | ft^2 |
| EUI (Based on Net Site Energy and Total Building Area) | 183.87 | kBtu/ft^2 |
| OpenStudio Standards Building Type | | |

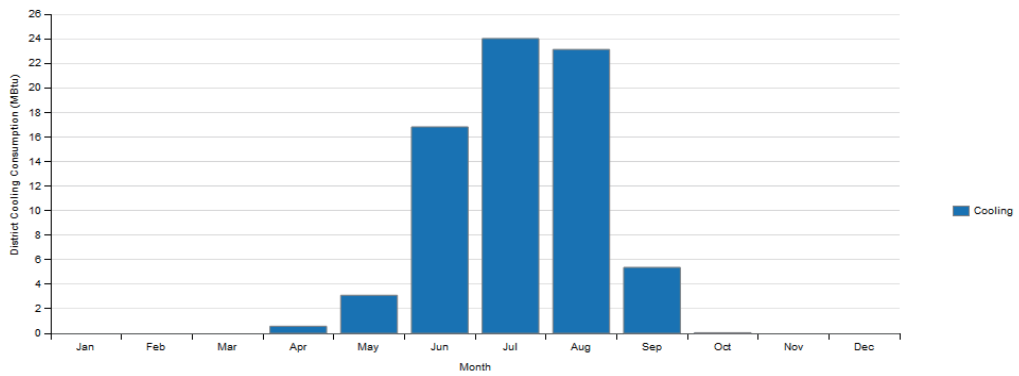
*External Wall Detail_Type 2*



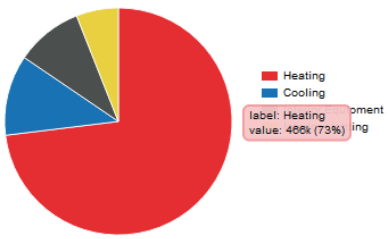

Weather Summary

| | Value |
|---|---|
| Weather File | Beijing Beijing CHN CSWD WMO#=545110 |
| Latitude | 39.80 |
| Longitude | 116.47 |
| Elevation | 103 (ft) |
| Time Zone | 8.00 |
| North Axis Angle | 0.00 |
| ASHRAE Climate Zone | |

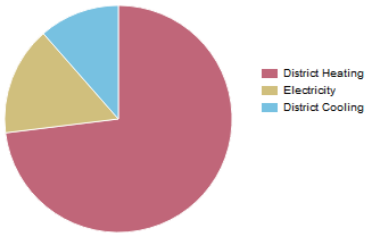
District Cooling Consumption (MBtu) - view table



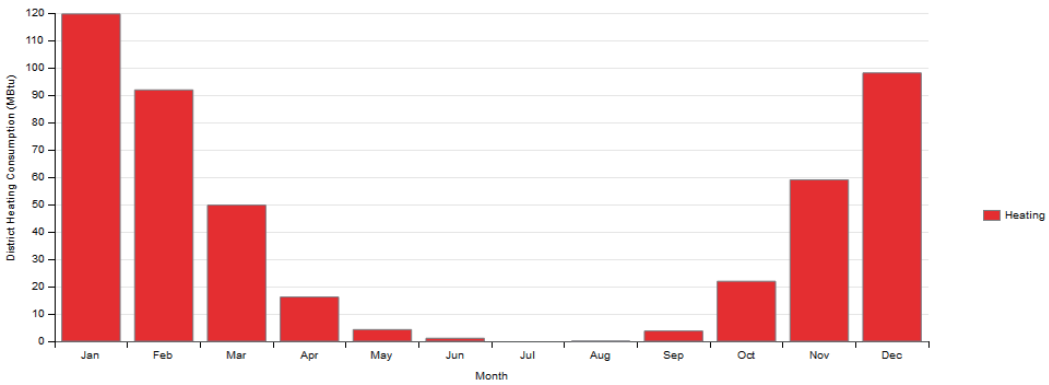

End Use - view table



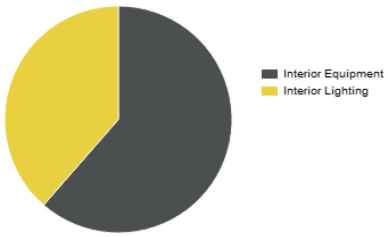

Energy Use - view table




District Heating Consumption (MBtu) - view table




EUI - Electricity - view table




*In this condition, the annual engergy consumption is about 637284 kBtu, which equals to 186787.8 kWh.*

*From the fan chart, we know that more than 70% of the engergy are used in the form of district heating. At the same time, district cooling and electricity are almost the same value.*

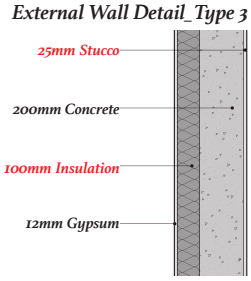
*From the other two bar charts, we analyse monthly value of energy consumption in cooling and heating. We can tell that both in winter and summer, the peak value goes to 120 kWh.*

# Analysis 1_Beijing_Wall 3

Building Summary

| Information | Value | Units |
|---|---|---|
| Building Name | Building 1 | building_name |
| Net Site Energy | 811,161 | kBtu |
| Total Building Area | 3,466 | ft^2 |
| EUI (Based on Net Site Energy and Total Building Area) | 234.04 | kBtu/ft^2 |
| OpenStudio Standards Building Type | | |

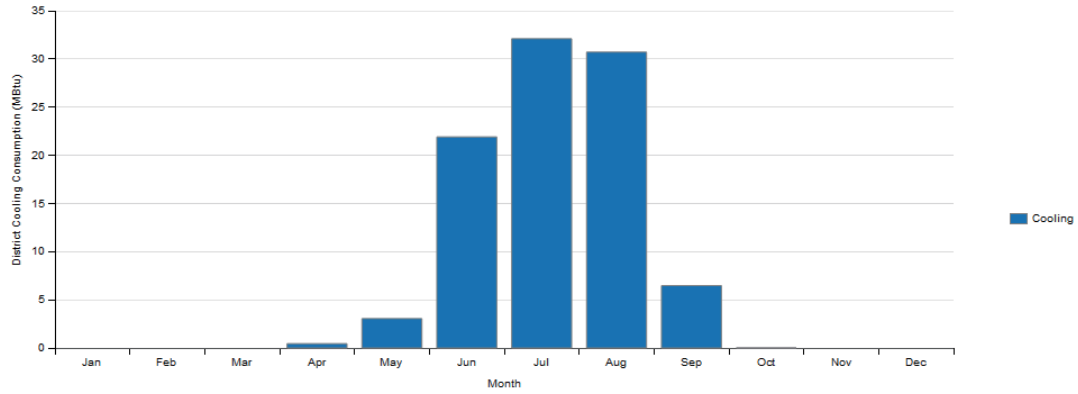
*External Wall Detail_Type 3*



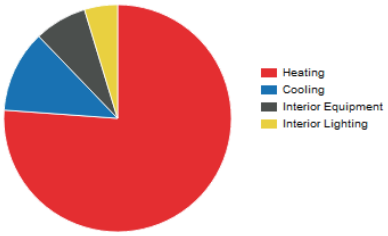

Weather Summary

| | Value |
|---|---|
| Weather File | Beijing Beijing CHN CSWD WMO#=545110 |
| Latitude | 39.80 |
| Longitude | 116.47 |
| Elevation | 103 (ft) |
| Time Zone | 8.00 |
| North Axis Angle | 0.00 |
| ASHRAE Climate Zone | |

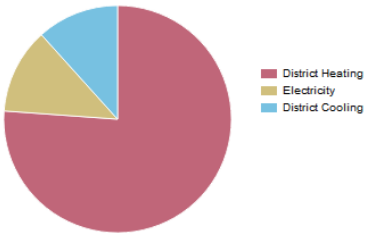
District Cooling Consumption (MBtu) - view table



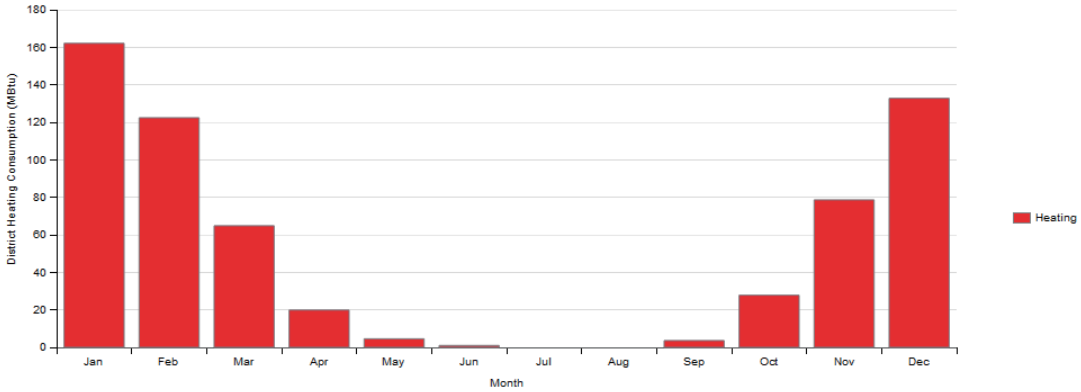

End Use - view table



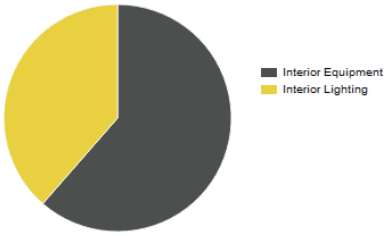

Energy Use - view table




District Heating Consumption (MBtu) - view table




EUI - Electricity - view table




*In this condition, the annual engergy consumption is about 811161 kBtu, which equals to 237751.1 kWh.*

*From the fan chart, we know that more than 75% of the engergy are used in the form of district heating. At the same time, district cooling and electricity are almost the same value.*

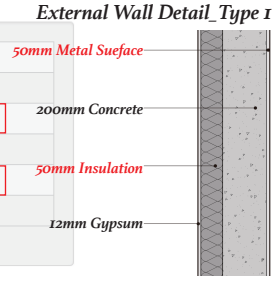
*From the other two bar charts, we analyse monthly value of energy consumption in cooling and heating. We can tell that both in winter and summer, the peak value goes to 160 kWh.*

# Analysis 2_Oslo_Wall 1

Building Summary

| Information | Value | Units |
|---|---|---|
| Building Name | Building 1 | building_name |
| Net Site Energy | 863,812 | kBtu |
| Total Building Area | 3,466 | ft^2 |
| EUI (Based on Net Site Energy and Total Building Area) | 249.23 | kBtu/ft^2 |
| OpenStudio Standards Building Type | | |

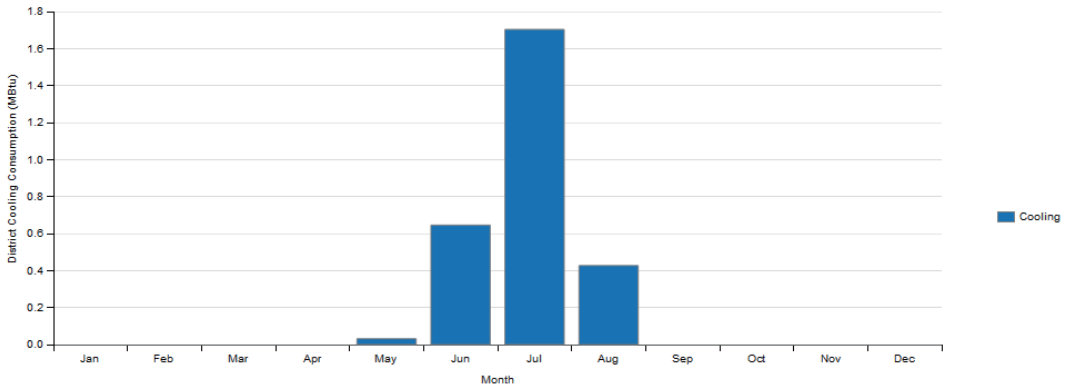
*External Wall Detail_Type 1*



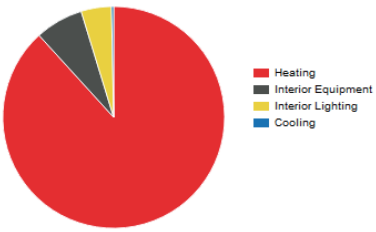

Weather Summary

| | Value |
|---|---|
| Weather File | OSLO/FORNEBU - NOR IWEC Data WMO#=014880 |
| Latitude | 59.90 |
| Longitude | 10.62 |
| Elevation | 56 (ft) |
| Time Zone | 1.00 |
| North Axis Angle | 0.00 |
| ASHRAE Climate Zone | |

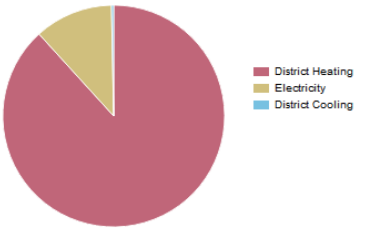
District Cooling Consumption (MBtu) - view table



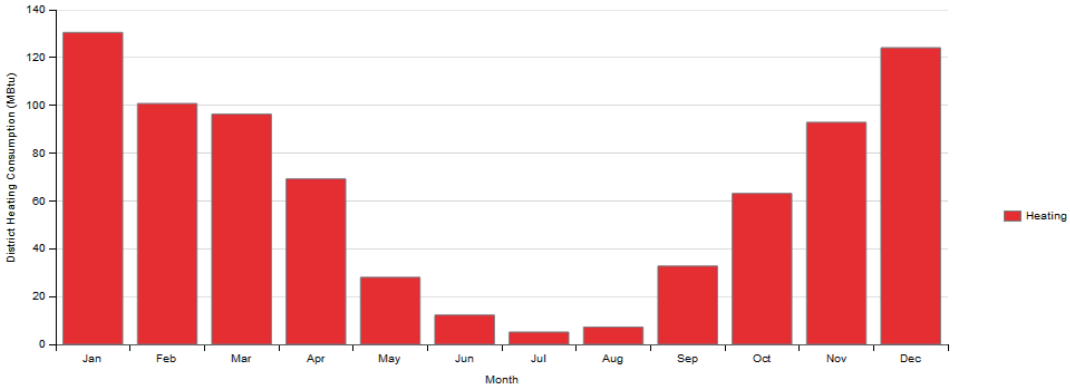

End Use - view table



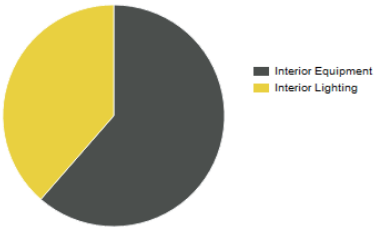

Energy Use - view table




District Heating Consumption (MBtu) - view table




EUI - Electricity - view table




*In this condition, the annual engergy consumption is about 863812 kBtu, which equals to 253183.1 kWh.*

*From the fan chart, we know that more than85% of the engergy are used in the form of district heating. At the same time, district cooling is almost zero.*

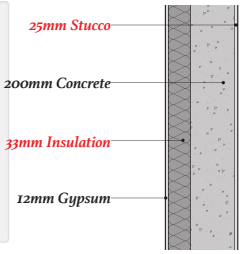
*From the other two bar charts, we analyse monthly value of energy consumption in cooling and heating. We can tell that both in winter and summer, the peak value goes to 130 kWh.*

# Analysis 2_Oslo_Wall 2

Building Summary

| Information | Value | Units |
|---|---|---|
| Building Name | Building 1 | building_name |
| Net Site Energy | 808,118 | kBtu |
| Total Building Area | 3,466 | ft^2 |
| EUI (Based on Net Site Energy and Total Building Area) | 233.16 | kBtu/ft^2 |
| OpenStudio Standards Building Type | | |

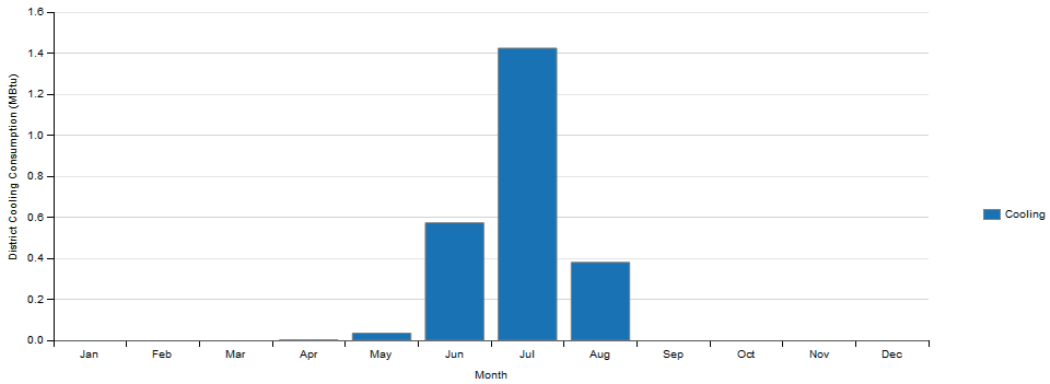
*External Wall Detail_Type 2*



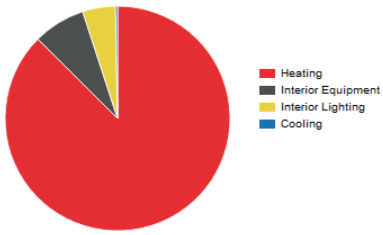

Weather Summary

| | Value |
|---|---|
| Weather File | OSLO/FORNEBU - NOR IWEC Data WMO#=014880 |
| Latitude | 59.90 |
| Longitude | 10.62 |
| Elevation | 56 (ft) |
| Time Zone | 1.00 |
| North Axis Angle | 0.00 |
| ASHRAE Climate Zone | |

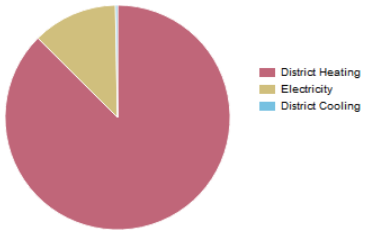
District Cooling Consumption (MBtu) - view table



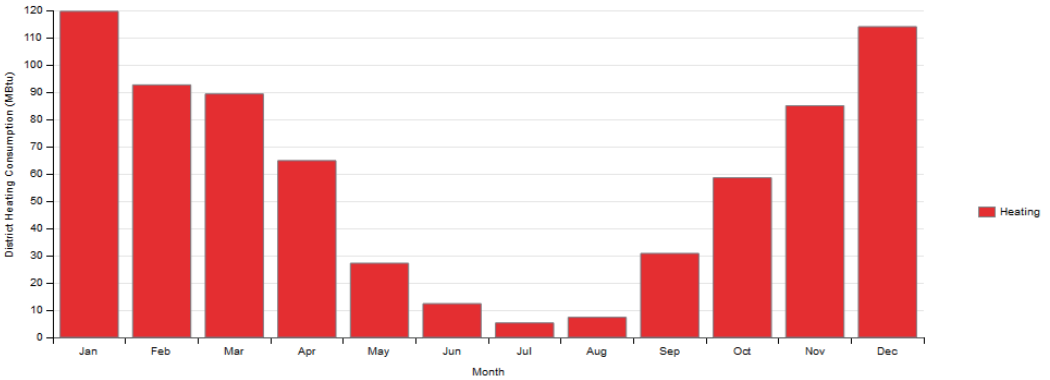

End Use - view table



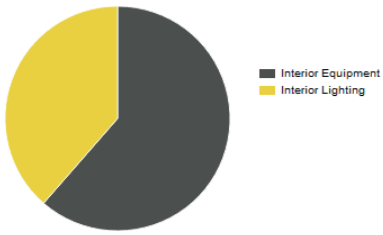

Energy Use - view table




District Heating Consumption (MBtu) - view table




EUI - Electricity - view table




*In this condition, the annual engergy consumption is about 808118 kBtu, which equals to 236859.2 kWh.*

*From the fan chart, we know that more than85% of the engergy are used in the form of district heating. At the same time, district cooling is almost zero.*

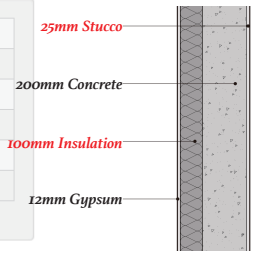
*From the other two bar charts, we analyse monthly value of energy consumption in cooling and heating. We can tell that both in winter and summer, the peak value goes to 120 kWh.*

# Analysis 2_Oslo_Wall 3

Building Summary

| Information | Value | Units |
|---|---|---|
| Building Name | Building 1 | building_name |
| Net Site Energy | 1,070,540 | kBtu |
| Total Building Area | 3,466 | ft^2 |
| EUI (Based on Net Site Energy and Total Building Area) | 308.87 | kBtu/ft^2 |
| OpenStudio Standards Building Type | | |

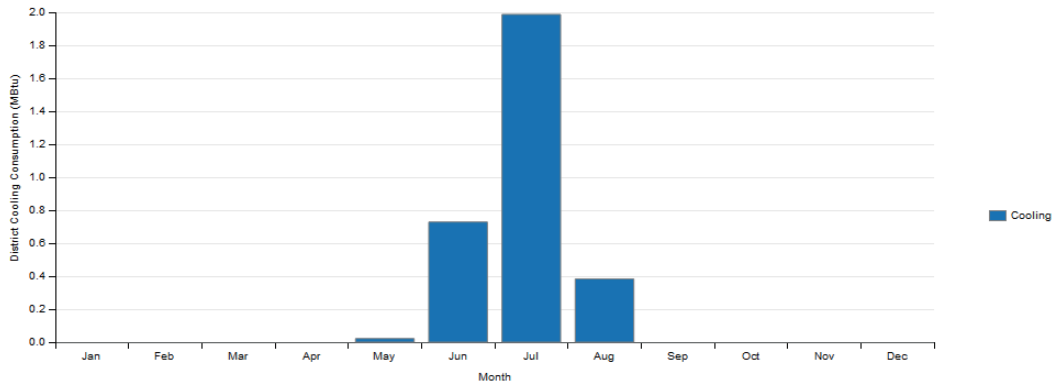
*External Wall Detail_Type 3*



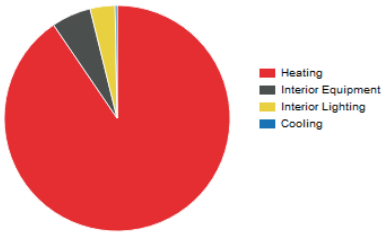

Weather Summary

| | Value |
|---|---|
| Weather File | OSLO/FORNEBU - NOR IWEC Data WMO#=014880 |
| Latitude | 59.90 |
| Longitude | 10.62 |
| Elevation | 56 (ft) |
| Time Zone | 1.00 |
| North Axis Angle | 0.00 |
| ASHRAE Climate Zone | |

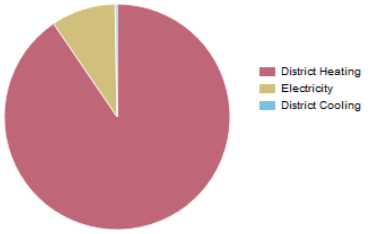
District Cooling Consumption (MBtu) - view table



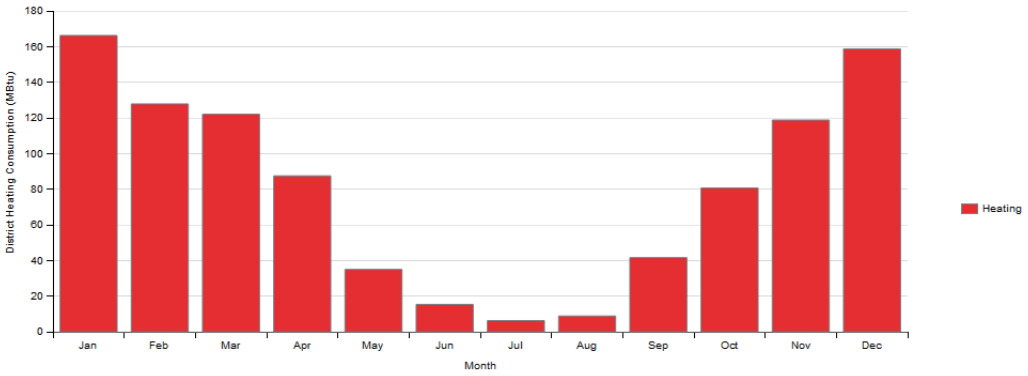

End Use - view table



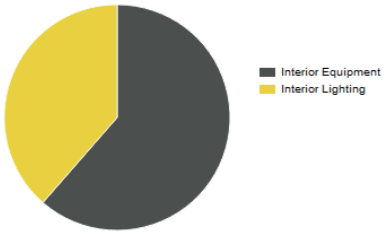

Energy Use - view table




District Heating Consumption (MBtu) - view table




EUI - Electricity - view table




*In this condition, the annual engergy consumption is about 1070540 kBtu, which equals to 313775.1 kWh.*

*From the fan chart, we know that more than 90% of the engergy are used in the form of district heating. At the same time, district cooling is almost zero.*

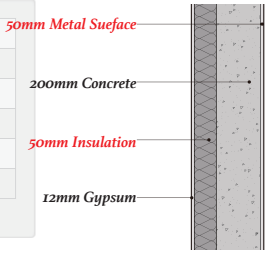
*From the other two bar charts, we analyse monthly value of energy consumption in cooling and heating. We can tell that both in winter and summer, the peak value goes to 165 kWh.*

# Analysis 3_Singapore_Wall 1

Building Summary

| Information | Value | Units |
|---|---|---|
| Building Name | Building 1 | building_name |
| Net Site Energy | 497,642 | kBtu |
| Total Building Area | 3,466 | ft^2 |
| EUI (Based on Net Site Energy and Total Building Area) | 143.58 | kBtu/ft^2 |
| OpenStudio Standards Building Type | | |

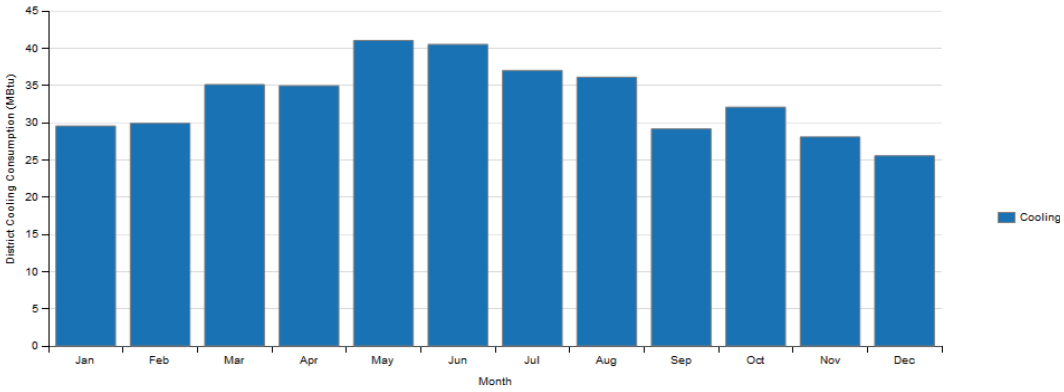
*External Wall Detail_Type 1*



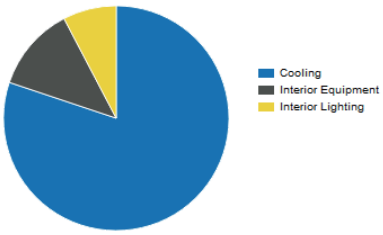

Weather Summary

| | Value |
|---|---|
| Weather File | SINGAPORE - SGP IWEC Data WMO#=486980 |
| Latitude | 1.37 |
| Longitude | 103.98 |
| Elevation | 52 (ft) |
| Time Zone | 8.00 |
| North Axis Angle | 0.00 |
| ASHRAE Climate Zone | |

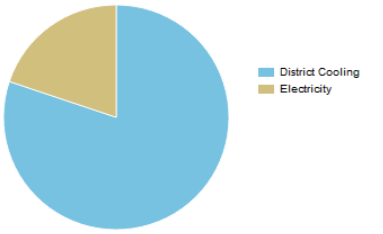
District Cooling Consumption (MBtu) - view table



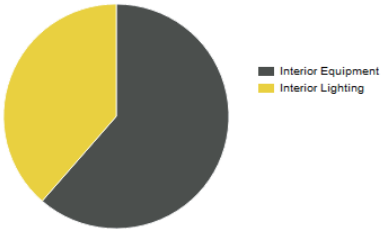

End Use - view table




Energy Use - view table




EUI - Electricity - view table




*In this condition, the annual engergy consumption is about 497642 kBtu, which equals to 145858.8 kWh.*

*From the fan chart, we know that more than 80% of the engergy are used in the form of district cooling. At the same time, district heating is almost zero.*

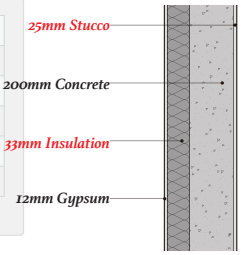
*From the other bar chart, we just can analyse monthly value of energy consumption in cooling . We can tell that in summer, the peak value goes to 40 MBtu.*

# Analysis 3_Singapore_Wall 2

Building Summary

| Information | Value | Units |
|---|---|---|
| Building Name | Building 1 | building_name |
| Net Site Energy | 463,928 | kBtu |
| Total Building Area | 3,466 | ft^2 |
| EUI (Based on Net Site Energy and Total Building Area) | 133.85 | kBtu/ft^2 |
| OpenStudio Standards Building Type | | |

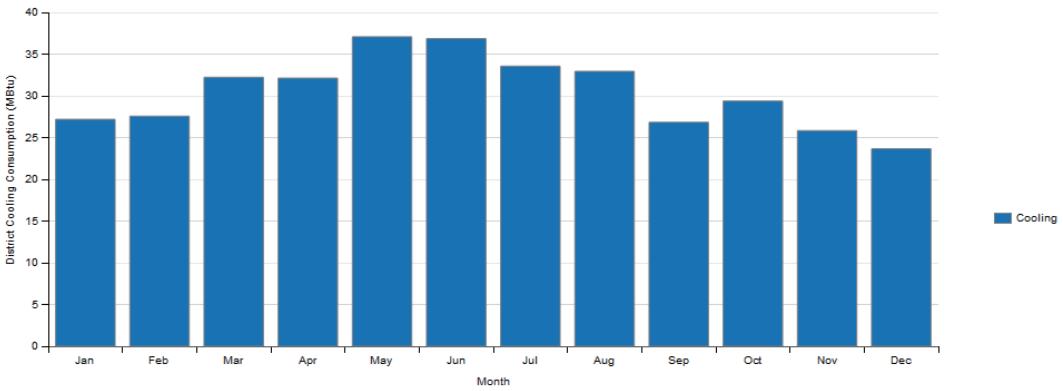
*External Wall Detail_Type 2*



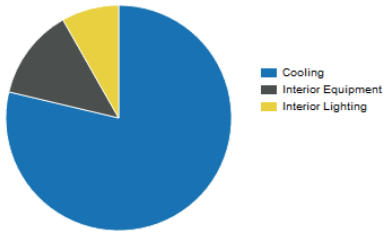

Weather Summary

| | Value |
|---|---|
| Weather File | SINGAPORE - SGP IWEC Data WMO#=486980 |
| Latitude | 1.37 |
| Longitude | 103.98 |
| Elevation | 52 (ft) |
| Time Zone | 8.00 |
| North Axis Angle | 0.00 |
| ASHRAE Climate Zone | |

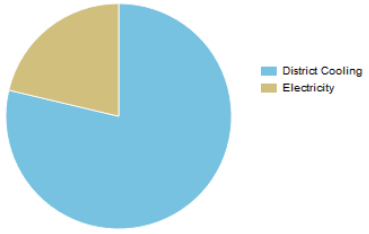
District Cooling Consumption (MBtu) - view table



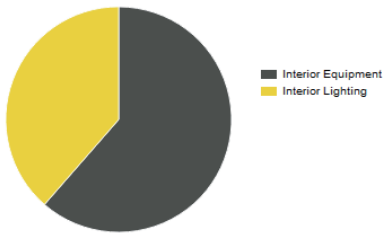

End Use - view table




Energy Use - view table




EUI - Electricity - view table




*In this condition, the annual engergy consumption is about 463928 kBtu, which equals to 135977.2 kWh.*

*From the fan chart, we know that more than 80% of the engergy are used in the form of district cooling. At the same time, district heating is almost zero.*

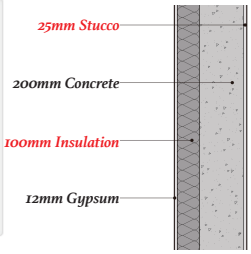
*From the other bar chart, we just can analyse monthly value of energy consumption in cooling . We can tell that in summer, the peak value goes to 36 MBtu.*

# Analysis 3_Singapore_Wall 3

Building Summary

| Information | Value | Units |
|---|---|---|
| Building Name | Building 1 | building_name |
| Net Site Energy | 569,903 | kBtu |
| Total Building Area | 3,466 | ft^2 |
| EUI (Based on Net Site Energy and Total Building Area) | 164.43 | kBtu/ft^2 |
| OpenStudio Standards Building Type | | |

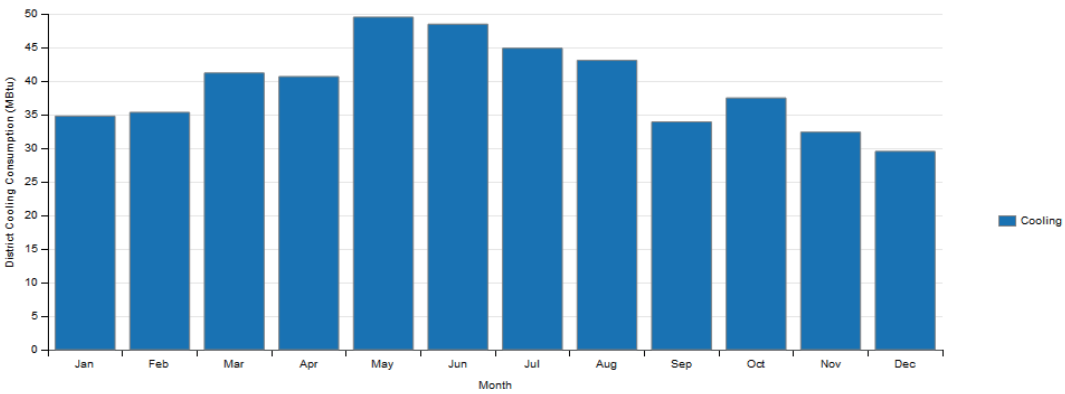
*External Wall Detail_Type 3*



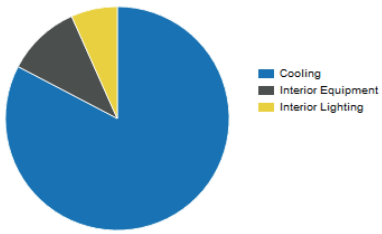

Weather Summary

| | Value |
|---|---|
| Weather File | SINGAPORE - SGP IWEC Data WMO#=486980 |
| Latitude | 1.37 |
| Longitude | 103.98 |
| Elevation | 52 (ft) |
| Time Zone | 8.00 |
| North Axis Angle | 0.00 |
| ASHRAE Climate Zone | |

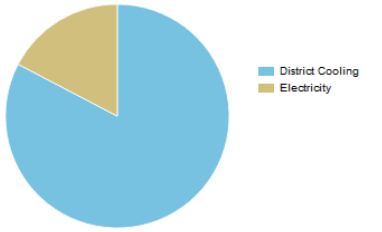
District Cooling Consumption (MBtu) - view table



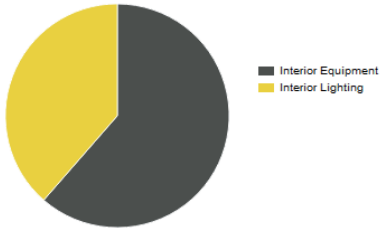

End Use - view table




Energy Use - view table




EUI - Electricity - view table



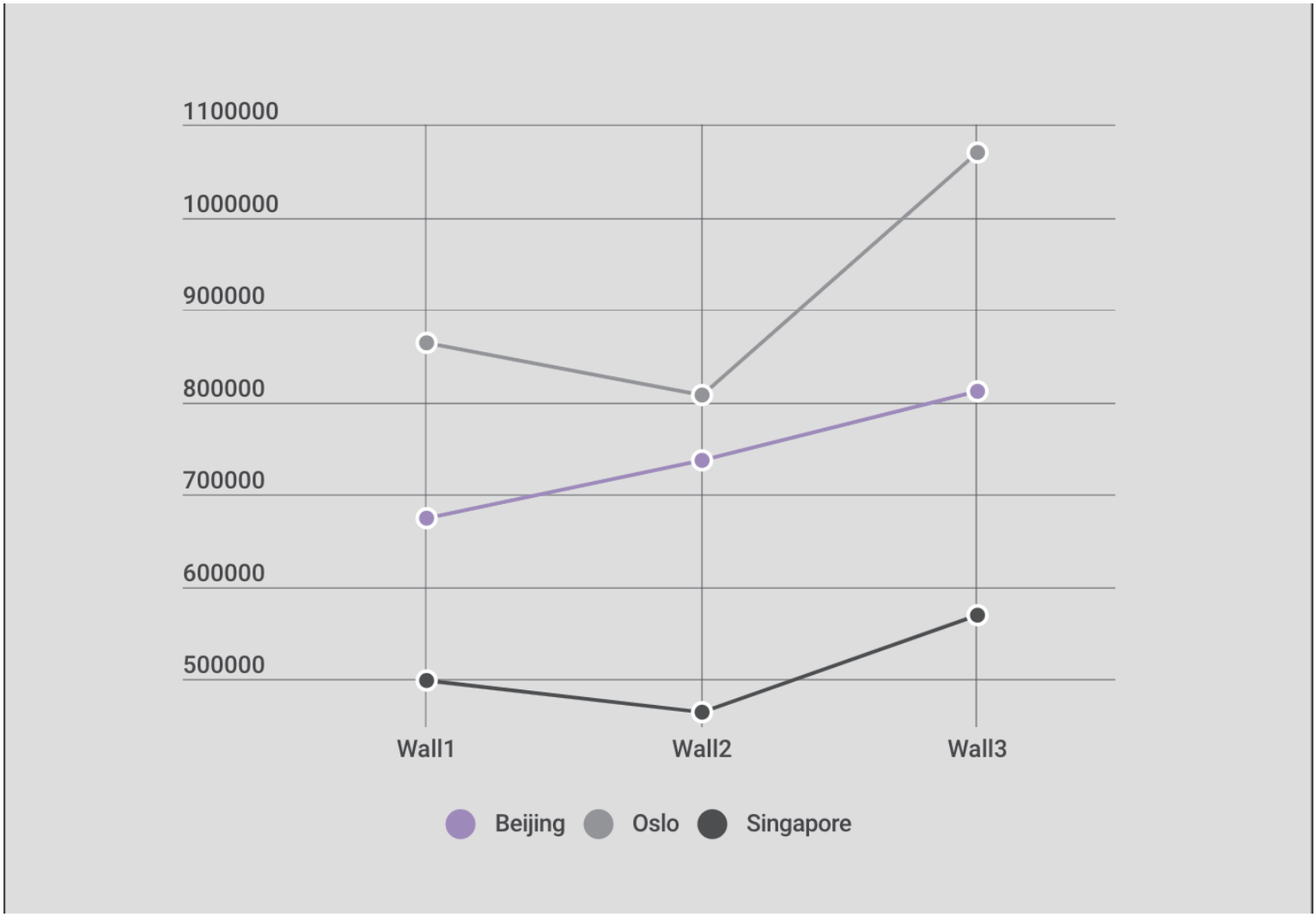

*In this condition, the annual engergy consumption is about 569903kBtu, which equals to 167038.5 kWh.*

*From the fan chart, we know that more than 85% of the engergy are used in the form of district cooling. At the same time, district heating is almost zero.*

*From the other bar chart, we just can analyse monthly value of energy consumption in cooling . We can tell that in summer, the peak value goes to 50 MBtu.*

# Comparision

*Here below is the chart of annual energy consumption in different conditions.*




| Decreasing Energy Consumption by Changing Walls (Units,kWh) | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Wall-1 | Wall-2 | Wall-3 | Difference-1(Value) | Difference-1(Percentage) | Difference-2(Value) | Difference-2(Percentage) |
| Beijing | 197497.1 | 186787.8 | 237751.1 | 10709.3 | 5.42% | -40254 | -20.38% |
| Oslo | 253183.1 | 236859.2 | 313775.1 | 16323.9 | 6.45% | -60592 | -23.93% |
| Singapore | 145858.8 | 135977.2 | 167038.5 | 9881.6 | 6.77% | -21179.7 | -14.52% |

**Difference-1 is decreasing energy consumption while comparing Wall-2 with wall-1.*
**Difference-2 is decreasing energy consumption while comparing Wall-3 with wall-2.*

| Increasing Energy Consumption by Changing Cities (Units,kWh) | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Beijing | Oslo | Singapore | Difference-3(Value) | Difference-3(Percentage) | Difference-4(Value) | Difference-4(Percentage) |
| Wall-1 | 197497.1 | 253183.1 | 145858.8 | -55686 | -28.20% | 51638.3 | 26.15% |
| Wall-2 | 186787.8 | 236859.2 | 135977.2 | -50071.4 | -26.81% | 50810.6 | 27.20% |
| Wall-3 | 237751.1 | 135977.2 | 167038.5 | 101773.9 | 42.81% | 70712.6 | 29.74% |

**Difference-3 is increasing energy consumption while comparing Oslowith Beijing.*
**Difference-4 is increasing energy consumption while comparing Singapore with Beijing.*

*After all the analysis, we can have at least two kinds of comparisions.*

*The first one is to compare data based on the same type of wall but indifferent cities, which shows how the weather condition infulences the value of energy consumption. In this case, Singapore has the least energy consumption.*

*The second one is to compare data based on different types of walls but in the same city, which shows how the building constructions affect the value of energy consumption. In this case, building constructed by wall type 2 has the least energy consumption because that kind of construction has stucco surface and thickness insulation.*