ENERGETIC SIMULATION OF A COMMERCIAL BUILDING

Technical environmental systems

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INTRODUCTION

Computer Modelling and Simulation of **how a building performs** in terms of energy consumption is extremely important for designers, users and especially developers. The key reason is to **understand the building condition** and run an analysis against utility bills with the **aim of reducing the energy consumption of the buildings and achieve a more sustainable and efficient design**.

In this presentation the software used for the energetic simulation are Sketchup, Open Studio and Energhy Plus. **Energy Plus** provides an integrated simulation for accurate temperature and comfort prediction, **Sketchup and Open Studio** is used for the creation of the commercial building model and for the enegetic simulation.
The simulation was performed in three different location (Milano, Tel Aviv and Helsinki) during the whole year in order to compare the different values in different climates using one type of wall design, instead for one city it's used three different types of wall design in order to find the most efficient choice.

The structure is a **commercial building with four floors**. The size of the plan is 30x40m composed by 4 shops, 1 corridor, 1 restroom, 1 breakroom and the stairs. The three design walls are made by concrete, the first one with no insulation, the second one with one layer of concrete and one of insulation, the third one with two layer of concrete and the insulation.

The aim of this simulation is to find the most efficient solution for the commercial building, so the design that has the less consumption of energy.

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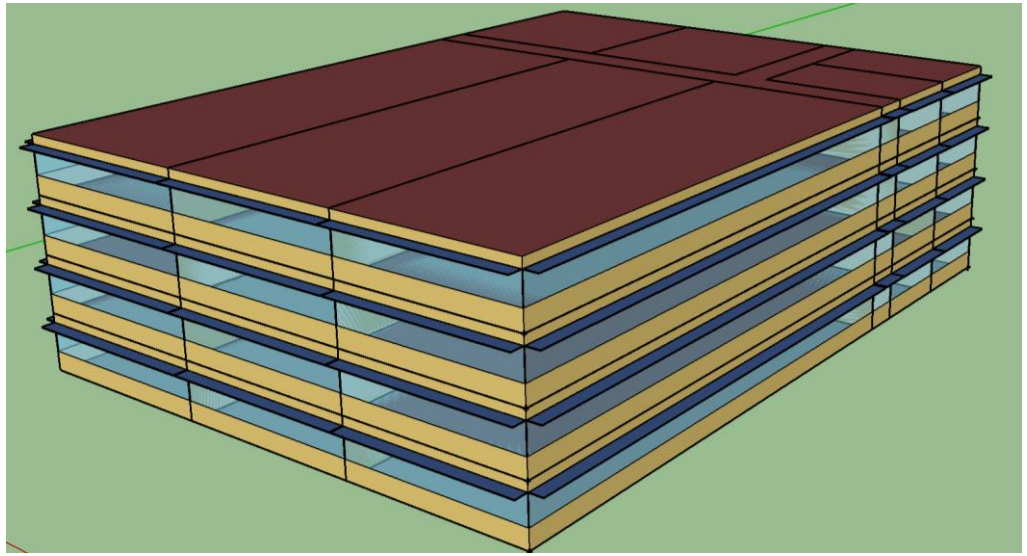
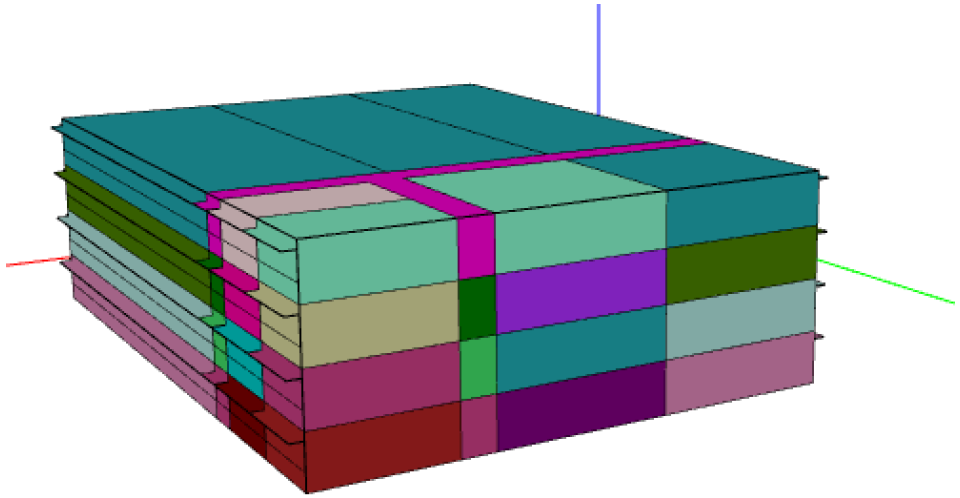
PLAN

Charateristic design:

- N° of floor: 4
- Height of each floor: 3 m
- Window wall ratio: 0,5
- Offset above floor: 1 m
- Overhangs projection factors: 0,5m

MODEL





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Cities: Helsinki, Milan, Tel Aviv

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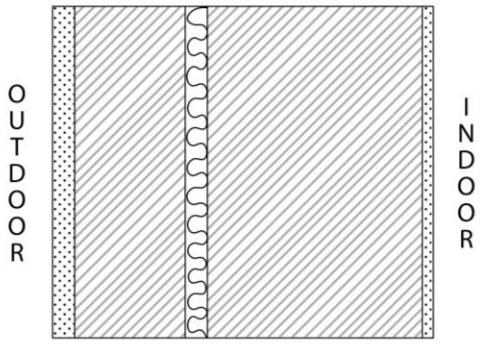
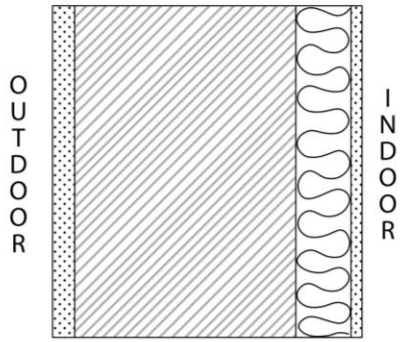
Design Wall Type



Type 1 _ Small Insulation

OUTDOOR
- PLASTER 2 cm
- CONCRETE 10 cm
- AIR GAP 2 cm
- CONCRETE 20 cm
- PLASTER 1 cm

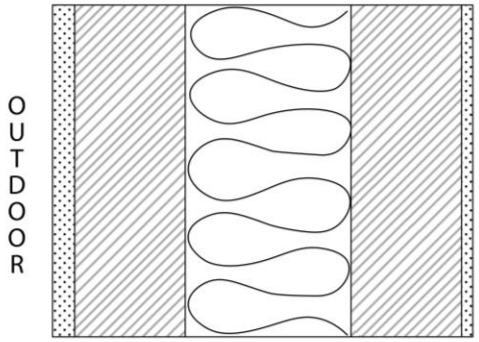
INDOOR



Type 2 _ Layer + Insulation

OUTDOOR
- PLASTER 2 cm
- CONCRETE 20 cm
- INSULATION 5 cm
- GYPSUM 1 cm

INDOOR



Type 3

OUTDOOR
- PLASTER 2 cm
- CONCRETE 10 cm
- INSULATION 15 cm
- CONCRETE 10 cm
- PLASTER 1 cm

INDOOR

Cities – Weather data

Tel Aviv

	January	February	March	April	May	June	July	August	September	October	November	December
Avg. Temperature (°C)	13.5	14	15.9	18.6	21.1	23.4	26.2	27	25.5	22.9	19	14.8
Min. Temperature (°C)	8.7	9	10.1	12.7	15.6	18.3	21.2	22.1	20.2	17	13.4	9.9
Max. Temperature (°C)	18.3	19.1	21.8	24.5	26.7	28.6	31.3	32	30.9	28.8	24.7	19.7
Avg. Temperature (°F)	56.3	57.2	60.6	65.5	70.0	74.1	79.2	80.6	77.9	73.2	66.2	58.6
Min. Temperature (°F)	47.7	48.2	50.2	54.9	60.1	64.9	70.2	71.8	68.4	62.6	56.1	49.8
Max. Temperature (°F)	64.9	66.4	71.2	76.1	80.1	83.5	88.3	89.6	87.6	83.8	76.5	67.5
Precipitation / Rainfall (mm)	134	88	53	13	4	0	0	0	1	19	96	154

Helsinki

	January	February	March	April	May	June	July	August	September	October	November	December
Avg. Temperature (°C)	-5.5	-5.8	-2.3	3.3	9.7	14.7	17	15.8	10.7	5.9	0.9	-3.1
Min. Temperature (°C)	-8.2	-8.6	-5.4	-0.1	5.5	10.6	13.2	12.3	7.7	3.5	-1.2	-5.6
Max. Temperature (°C)	-2.7	-3	0.8	6.7	14	18.9	20.8	19.3	13.8	8.4	3	-0.5
Avg. Temperature (°F)	22.1	21.6	27.9	37.9	49.5	58.5	62.6	60.4	51.3	42.6	33.6	26.4
Min. Temperature (°F)	17.2	16.5	22.3	31.8	41.9	51.1	55.8	54.1	45.9	38.3	29.8	21.9
Max. Temperature (°F)	27.1	26.6	33.4	44.1	57.2	66.0	69.4	66.7	56.8	47.1	37.4	31.1
Precipitation / Rainfall (mm)	44	33	33	37	36	47	72	78	71	72	70	57

Milan

	January	February	March	April	May	June	July	August	September	October	November	December
Avg. Temperature (°C)	1.9	4.3	8.7	13	17.6	21.1	23.8	22.8	19.3	13.4	7.7	3.3
Min. Temperature (°C)	-0.8	0.9	4.3	7.9	12.1	15.8	18.3	17.8	14.7	9.5	4.6	0.6
Max. Temperature (°C)	4.7	7.8	13.1	18.2	23.1	26.5	29.3	27.8	24	17.4	10.8	6
Avg. Temperature (°F)	35.4	39.7	47.7	55.4	63.7	70.0	74.8	73.0	66.7	56.1	45.9	37.9
Min. Temperature (°F)	30.6	33.6	39.7	46.2	53.8	60.4	64.9	64.0	58.5	49.1	40.3	33.1
Max. Temperature (°F)	40.5	46.0	55.6	64.8	73.6	79.7	84.7	82.0	75.2	63.3	51.4	42.8
Precipitation / Rainfall (mm)	55	62	79	92	94	97	67	90	78	118	110	71

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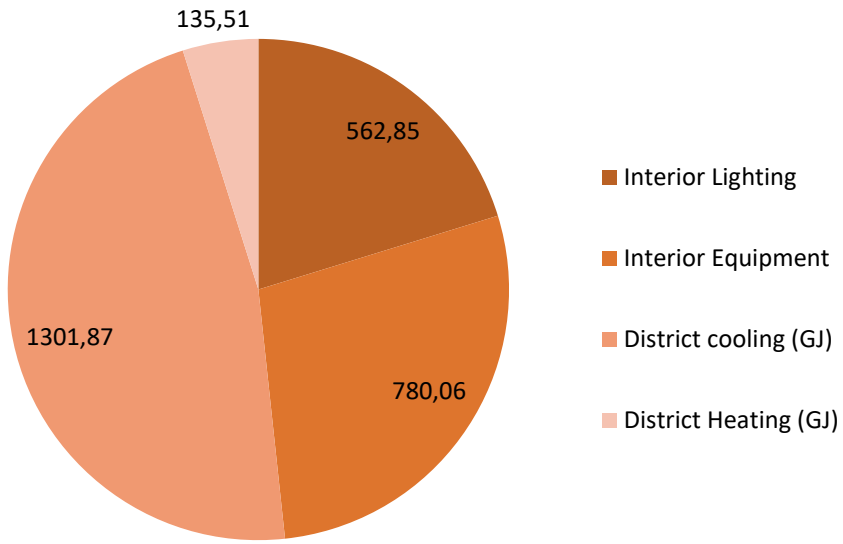
First Location - TEL AVIV

Design Wall 1

Tel Aviv has a **mediterrean climate** and enjoys plenty of sunshine throughout the year. Most precipitation falls in the form of rain between the months of October and April, with intervening dry summers. The average annual temperature is 20.9 °C (69.6 °F), and the average sea temperature is 18–20 °C (64–68 °F) during the winter, and 24–29 °C (75–84 °F) during the summer. The city averages 528 millimetres (20.8 in) of precipitation annually.

	Electricity(GJ)	Natural gas (GJ)	Additional Fuel (GJ)	District cooling (GJ)	District Heating (GJ)
Heating	0	0	0	0	135,51
Cooling	0	0	0	1301,87	0
Interior Lighting	562,85	0	0	0	0
Interior Equipment	780,06	0	0	0	0

Interior Lighting	Interior Equipment	District cooling (GJ)	District Heating (GJ)
562,85	780,06	1301,87	135,51



TOTAL ENERGY CONSUMPTION **2780,29 GJ**

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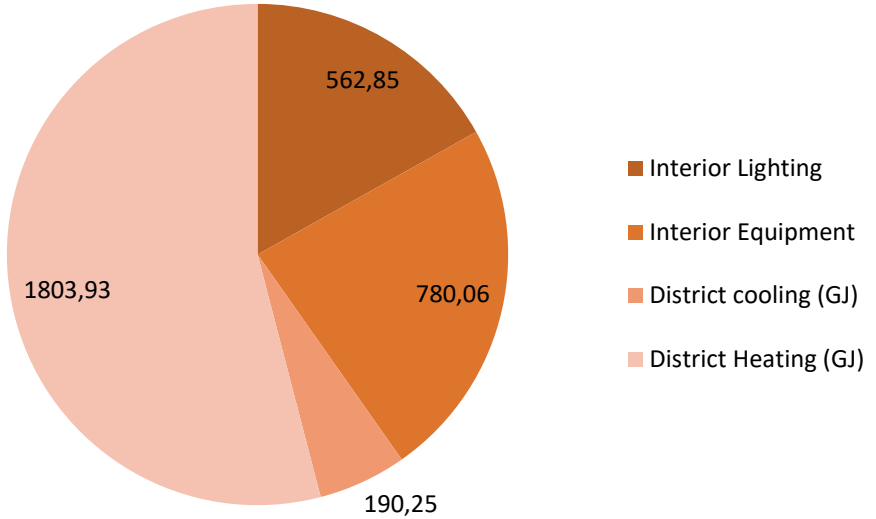
Second Location - HELSINKI

Design Wall 1

Helsinki has a **humid continental climate** similar. Owing to the mitigating influence of the Blatic Sea and North Atlantic current, temperatures during the winter are higher than the northern location might suggest, with the average in January and February around −5 °C (23 °F).

	Electricity(GJ)	Natural gas (GJ)	Additional Fuel (GJ)	District cooling (GJ)	District Heating (GJ)
Heating	0	0	0	0	1803,93
Cooling	0	0	0	190,25	0
Interior Lighting	562,85	0	0	0	0
Interior Equipment	780,06	0	0	0	0

Interior Lighting	Interior Equipment	District cooling (GJ)	District Heating (GJ)
562,85	780,06	190,25	1803,93



TOTAL ENERGY CONSUMPTION **3337,09 GJ**

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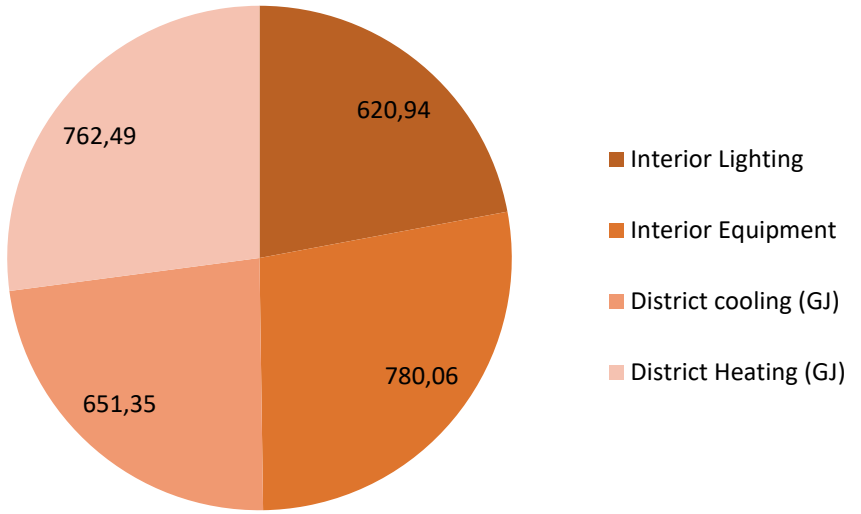
Third Location - Milan

Design Wall 1

Milan has a **humid subtropical climate**, according to the Köppen climate classification, or a temperate oceanic climate, according to the Trewartha climate classification. Milan's climate is like much of Northern Italy's inland plains, with hot, sultry summers and cold, foggy winters.

	Electricity(GJ)	Natural gas (GJ)	Additional Fuel (GJ)	District cooling (GJ)	District Heating (GJ)
Heating	0	0	0	0	762,49
Cooling	0	0	0	651,35	0
Interior Lighting	620,94	0	0	0	0
Interior Equipment	780,06	0	0	0	0

Interior Lighting	Interior Equipment	District cooling (GJ)	District Heating (GJ)
620,94	780,06	651,35	762,49



TOTAL ENERGY CONSUMPTION **2814,84 GJ**

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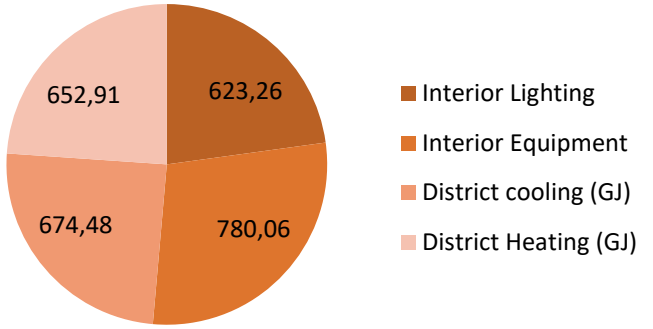
MILAN - Design wall 2	Electricity(GJ)	Natural gas (GJ)	Additional Fuel (GJ)	District cooling (GJ)	District Heating (GJ)
Heating	0	0	0	0	652,91
Cooling	0	0	0	674,48	0
Interior Lighting	623,26	0	0	0	0
Interior Equipment	780,06	0	0	0	0

Interior Lighting	Interior Equipment	District cooling (GJ)	District Heating (GJ)
623,26	780,06	674,48	652,91

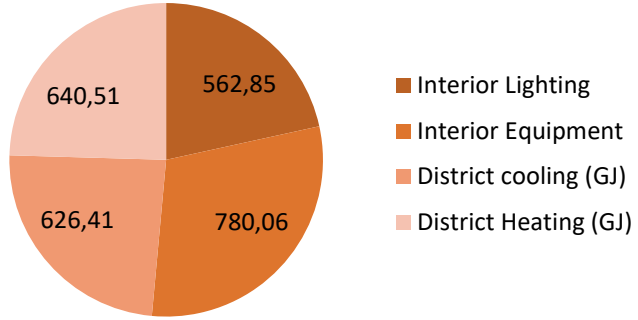
TOTAL ENERGY CONSUMPTION **2730,71 GJ**



MILAN - Design wall 3	Electricity(GJ)	Natural gas (GJ)	Additional Fuel (GJ)	District cooling (GJ)	District Heating (GJ)
Heating	0	0	0	0	640,51
Cooling	0	0	0	626,41	0
Interior Lighting	562,85	0	0	0	0
Interior Equipment	780,06	0	0	0	0

Interior Lighting	Interior Equipment	District cooling (GJ)	District Heating (GJ)
562,85	780,06	626,41	640,51

TOTAL ENERGY CONSUMPTION **2609,83 GJ**



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CONCLUSION

- **For the total energy consumption** we can see that **the city location plays an important factor** because it's clear that in the city of Helsinki that has a rigid temperature the consumption of energy is greater than the two others city that have a warmer climate

- In term of energy consumption for cooling Tel Aviv, a tropical city consumes the major of energy, while Helsinki consumes more in term of heating and Milan that has a temperature climate has more or less equal value for heating and cooling

- Concerning the **different types of wall** in the city of Milan it's clear how the less energy consumption is related to the design wall 3 that is the most performed wall with 2 layer of concrete and one of insulation and the higher is the wall with no insulation (design wall 1)

- **The less value of energy consumption** is referred to the city of Tel Aviv with the type of wall without insulation

	Tel Aviv	Helsinki	Milan
Desing wall 1	**2780,29**	3337,09	2814,84
Desing wall 2			2730,71
Desing wall 3			**2609,83**

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