Sketch up model and Open studio model simulation.

Luca Riccardi

Luca Peri

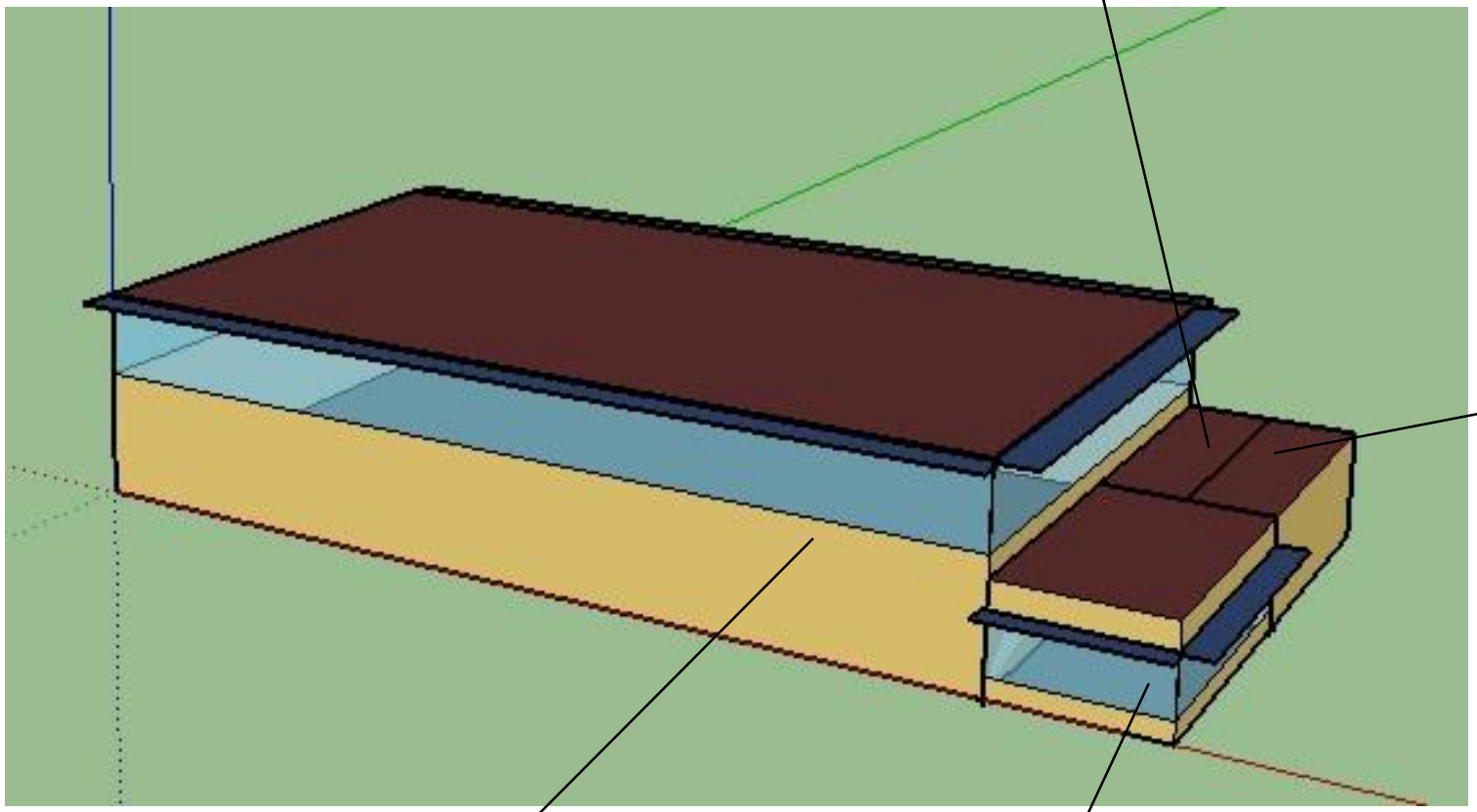
Enrico Russano

STEP 1 - Building design.

At first we designed a model of the building using Sketch Up software. In particular our building is a little warehouse, dedicated to the storage of general goods, composed of four different thermal zones with different dimensions (length, width, height [m]) :

- the main wharehouse (35x22x8)
- a break room for the employées (3x11x4)
- a logistics office, suited for the input/output planning of the goods (6x11x4)
- an electrical/mechanical room (3x11x4)

Thermal zones.



STEP 2 – Environmental Effects.

In order to understand how the environment and the technical precautions affects the thermical loads of the building, we ran five different simulations, varying two main parameters:

- the construction set
- the geographical area (so the weather data).

BASECASE DEFINITION.

In order to have a reference case to compare with, we made a basecase, running with default construction set for external walls (189.1-2009 CZ1 Office) with the Rome weather data.

Weather data - parametrical study.

To study how the environment affects our building loads, we chose two places that differ consistently whith each other concerning the environmental conditions: Oslo and AbuDhabi. As we expected the variations of the cooling and heating consumptions were massive. Referring to the Annual Overview results we found out the following percentages:

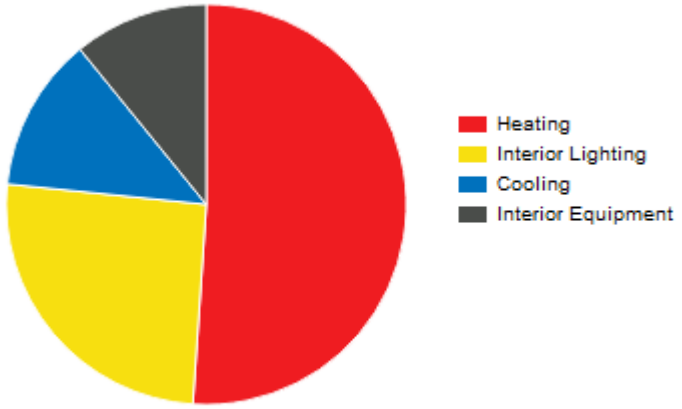
- Rome (basecase)
- AbuDhabi
- Oslo

Consumptions Rome.

End Uses

	Electricity [GJ]	Natural Gas [GJ]	Additional Fuel [GJ]	District Cooling [GJ]	District Heating [GJ]	Water [m3]
Heating	0.00	0.00	0.00	0.00	174.85	0.00
Cooling	0.00	0.00	0.00	42.78	0.00	0.00
Interior Lighting	87.47	0.00	0.00	0.00	0.00	0.00
Exterior Lighting	0.00	0.00	0.00	0.00	0.00	0.00
Interior Equipment	37.25	0.00	0.00	0.00	0.00	0.00
Exterior Equipment	0.00	0.00	0.00	0.00	0.00	0.00
Fans	0.00	0.00	0.00	0.00	0.00	0.00
Pumps	0.00	0.00	0.00	0.00	0.00	0.00
Heat Rejection	0.00	0.00	0.00	0.00	0.00	0.00
Humidification	0.00	0.00	0.00	0.00	0.00	0.00
Heat Recovery	0.00	0.00	0.00	0.00	0.00	0.00
Water Systems	0.00	0.00	0.00	0.00	0.00	0.00
Refrigeration	0.00	0.00	0.00	0.00	0.00	0.00
Generators	0.00	0.00	0.00	0.00	0.00	0.00
Total End Uses	124.73	0.00	0.00	42.78	174.85	0.00

Annual Overview - Rome.



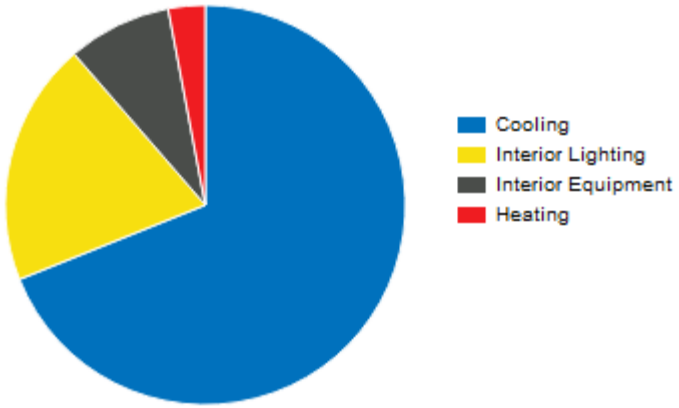
- Cooling 16%
- Heating 51%

Consuptions AbuDhabi.

End Uses

	Electricity [GJ]	Natural Gas [GJ]	Additional Fuel [GJ]	District Cooling [GJ]	District Heating [GJ]	Water [m3]
Heating	0.00	0.00	0.00	0.00	13.23	0.00
Cooling	0.00	0.00	0.00	306.13	0.00	0.00
Interior Lighting	87.47	0.00	0.00	0.00	0.00	0.00
Exterior Lighting	0.00	0.00	0.00	0.00	0.00	0.00
Interior Equipment	37.25	0.00	0.00	0.00	0.00	0.00
Exterior Equipment	0.00	0.00	0.00	0.00	0.00	0.00
Fans	0.00	0.00	0.00	0.00	0.00	0.00
Pumps	0.00	0.00	0.00	0.00	0.00	0.00
Heat Rejection	0.00	0.00	0.00	0.00	0.00	0.00
Humidification	0.00	0.00	0.00	0.00	0.00	0.00
Heat Recovery	0.00	0.00	0.00	0.00	0.00	0.00
Water Systems	0.00	0.00	0.00	0.00	0.00	0.00
Refrigeration	0.00	0.00	0.00	0.00	0.00	0.00
Generators	0.00	0.00	0.00	0.00	0.00	0.00
Total End Uses	124.73	0.00	0.00	306.13	13.23	0.00

Annual Overview - AbuDhabi



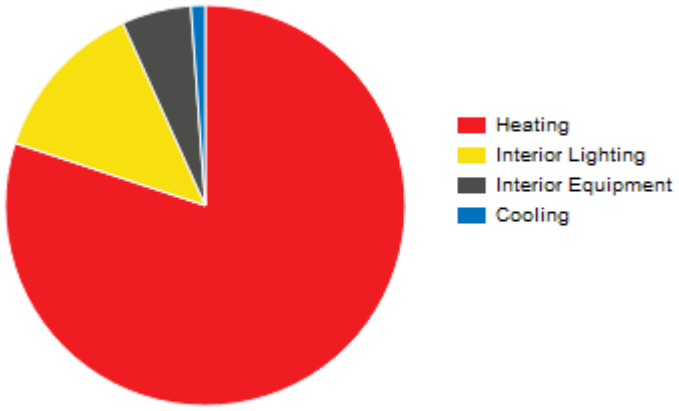
- Cooling 69%
- Heating 3%

Consumptions Oslo

End Uses

	Electricity [GJ]	Natural Gas [GJ]	Additional Fuel [GJ]	District Cooling [GJ]	District Heating [GJ]	Water [m3]
Heating	0.00	0.00	0.00	0.00	530.85	0.00
Cooling	0.00	0.00	0.00	7.61	0.00	0.00
Interior Lighting	87.47	0.00	0.00	0.00	0.00	0.00
Exterior Lighting	0.00	0.00	0.00	0.00	0.00	0.00
Interior Equipment	37.25	0.00	0.00	0.00	0.00	0.00
Exterior Equipment	0.00	0.00	0.00	0.00	0.00	0.00
Fans	0.00	0.00	0.00	0.00	0.00	0.00
Pumps	0.00	0.00	0.00	0.00	0.00	0.00
Heat Rejection	0.00	0.00	0.00	0.00	0.00	0.00
Humidification	0.00	0.00	0.00	0.00	0.00	0.00
Heat Recovery	0.00	0.00	0.00	0.00	0.00	0.00
Water Systems	0.00	0.00	0.00	0.00	0.00	0.00
Refrigeration	0.00	0.00	0.00	0.00	0.00	0.00
Generators	0.00	0.00	0.00	0.00	0.00	0.00
Total End Uses	124.73	0.00	0.00	7.61	530.85	0.00

Annual Overview - Oslo



- Cooling 1%
- Heating 80%

Wall construction set - parametrical study.

To study how the construction set of the walls varies the cooling/heating loads and the resulting energy consumptions, we made three different wall constructions:

- Basecase : Default 189.1-2009 ExtWall MassClimateZone [1IN Stucco, Wall Insulation [31], 1/2IN Gypsum, F08 Metal surface] Rvalue=5.09
- Mod1 : OurModifiedExtWall2_mass ClimateZone 1 [1IN Stucco, Wall Insulation [31], G01a 19mm gypsum board, MAT-CC05 4 HW Concrete] Rvalue=5.75
- Mod2: OurModifiedExtWall3_mass ClimateZone 1 [1IN Stucco, Wall Insulation [40], G01a 19mm gypsum board, F04 Wall air space resistance, 8IN Concrete HW, G05 25mm wood] Rvalue=13.80

Respectevely to these different stratigraphies, the heating and cooling consumptions are:

- Basecase: Cooling 16%, Heating 51%
- Mod1: Cooling 10%, Heating 52%
- Mod2: Cooling 10%, Heating 53%

Rome WallMod1 consumptions.

End Uses

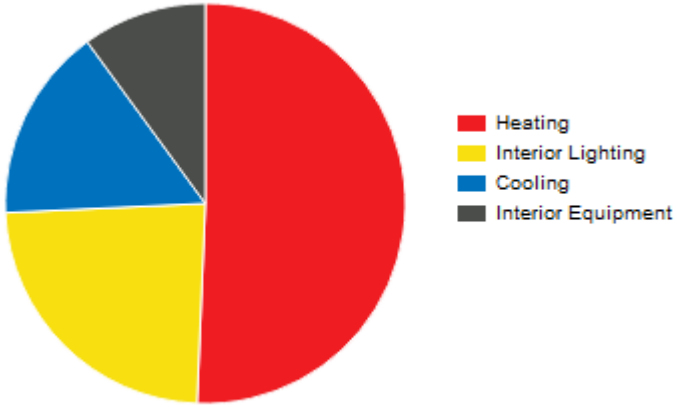
	Electricity [GJ]	Natural Gas [GJ]	Additional Fuel [GJ]	District Cooling [GJ]	District Heating [GJ]	Water [m3]
Heating	0.00	0.00	0.00	0.00	187.82	0.00
Cooling	0.00	0.00	0.00	58.19	0.00	0.00
Interior Lighting	87.47	0.00	0.00	0.00	0.00	0.00
Exterior Lighting	0.00	0.00	0.00	0.00	0.00	0.00
Interior Equipment	37.25	0.00	0.00	0.00	0.00	0.00
Exterior Equipment	0.00	0.00	0.00	0.00	0.00	0.00
Fans	0.00	0.00	0.00	0.00	0.00	0.00
Pumps	0.00	0.00	0.00	0.00	0.00	0.00
Heat Rejection	0.00	0.00	0.00	0.00	0.00	0.00
Humidification	0.00	0.00	0.00	0.00	0.00	0.00
Heat Recovery	0.00	0.00	0.00	0.00	0.00	0.00
Water Systems	0.00	0.00	0.00	0.00	0.00	0.00
Refrigeration	0.00	0.00	0.00	0.00	0.00	0.00
Generators	0.00	0.00	0.00	0.00	0.00	0.00
Total End Uses	124.73	0.00	0.00	58.19	187.82	0.00

Rome-WallMod2 consumptions.

End Uses

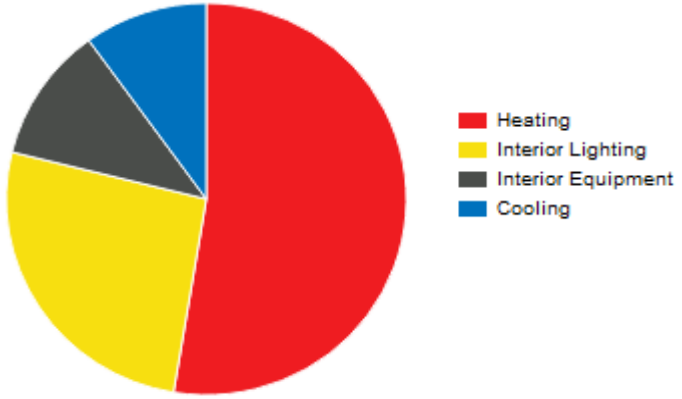
	Electricity [GJ]	Natural Gas [GJ]	Additional Fuel [GJ]	District Cooling [GJ]	District Heating [GJ]	Water [m3]
Heating	0.00	0.00	0.00	0.00	175.51	0.00
Cooling	0.00	0.00	0.00	33.31	0.00	0.00
Interior Lighting	87.47	0.00	0.00	0.00	0.00	0.00
Exterior Lighting	0.00	0.00	0.00	0.00	0.00	0.00
Interior Equipment	37.25	0.00	0.00	0.00	0.00	0.00
Exterior Equipment	0.00	0.00	0.00	0.00	0.00	0.00
Fans	0.00	0.00	0.00	0.00	0.00	0.00
Pumps	0.00	0.00	0.00	0.00	0.00	0.00
Heat Rejection	0.00	0.00	0.00	0.00	0.00	0.00
Humidification	0.00	0.00	0.00	0.00	0.00	0.00
Heat Recovery	0.00	0.00	0.00	0.00	0.00	0.00
Water Systems	0.00	0.00	0.00	0.00	0.00	0.00
Refrigeration	0.00	0.00	0.00	0.00	0.00	0.00
Generators	0.00	0.00	0.00	0.00	0.00	0.00
Total End Uses	124.73	0.00	0.00	33.31	175.51	0.00

Results.



WallMod1.

- Cooling 10%
- Heating 52%



WallMod2.

- Cooling 10%
- Heating 53%

OBSERVATIONS.

From the annual Overview Results we noted that the environmental conditions affects a lot the thermal loads of the building and consequently the technical asset of the HAVAC design system; In AbuDhabi we will need a plant designed to guarantee a consistent refrigeration power request while in Oslo the system must be able to produce a large amount of heat, during the year.

For what concerns the structure of the external walls, the percentages didn't change as much as we expexted. This might be due to several reasons: the change of the single external wall, instead of the all opaque surfaces is "negligeable"; the simulation with the changing walls ran in a mild climate region (Rome), in more severe climatic conditions the difference could be more important (DeltaT increases); the basecase wall is already a good starting point so a further improvement cannot make us obtain a remarcable improvement.