

COMSOL
CONFERENCE
2014 CAMBRIDGE

A Comsol simulation to comply with Zero Energy Building

September 2014

Directive 2010/31/EU

Article 9 (*Energy Performance Building Directive - EPBD recast*)
requires that:

“Member States shall ensure that by 31 December 2020 all new buildings are nearly zero-energy buildings and after 31 December 2018, new buildings occupied and owned by public authorities are nearly zero-energy buildings”.

Member States shall furthermore *“draw up national plans for increasing the number of nearly zero-energy buildings”* and *“following the leading example of the public sector, develop policies and take measures such as the setting of targets in order to stimulate the transformation of buildings that are refurbished into nearly zero-energy buildings”.*

What is a Zero Energy Building ?

A nearly zero-energy building is defined in Article 2 of the EPBD recast as:

“a building that has a very high energy performance. The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby”.

what about **ITALY** ??

The ENEA, the Italian National Agency for Energy, in its report RAEE 2012 (*Rapporto Annuale sull'Efficienza Energetica*) says that:

34.4 % of energy is consumed for **civil uses**

most of it for:

- ❖ HVAC plants (*Heating, Ventilation, Air Conditioning*)
- ❖ lighting

of buildings

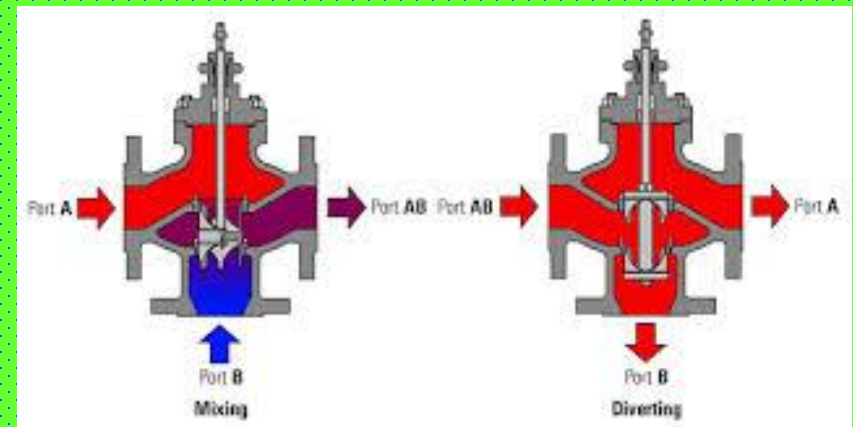
HOW IN ITALY DO WE CONTROL AND REGULATE HVAC PLANTS TO DIMINISH THE ENERGY USE IN BUILDINGS (and its bill !!)

Simply:

a) an outdoor temperature probe



b) a three-port valve



c) a control unit, with in-built control laws



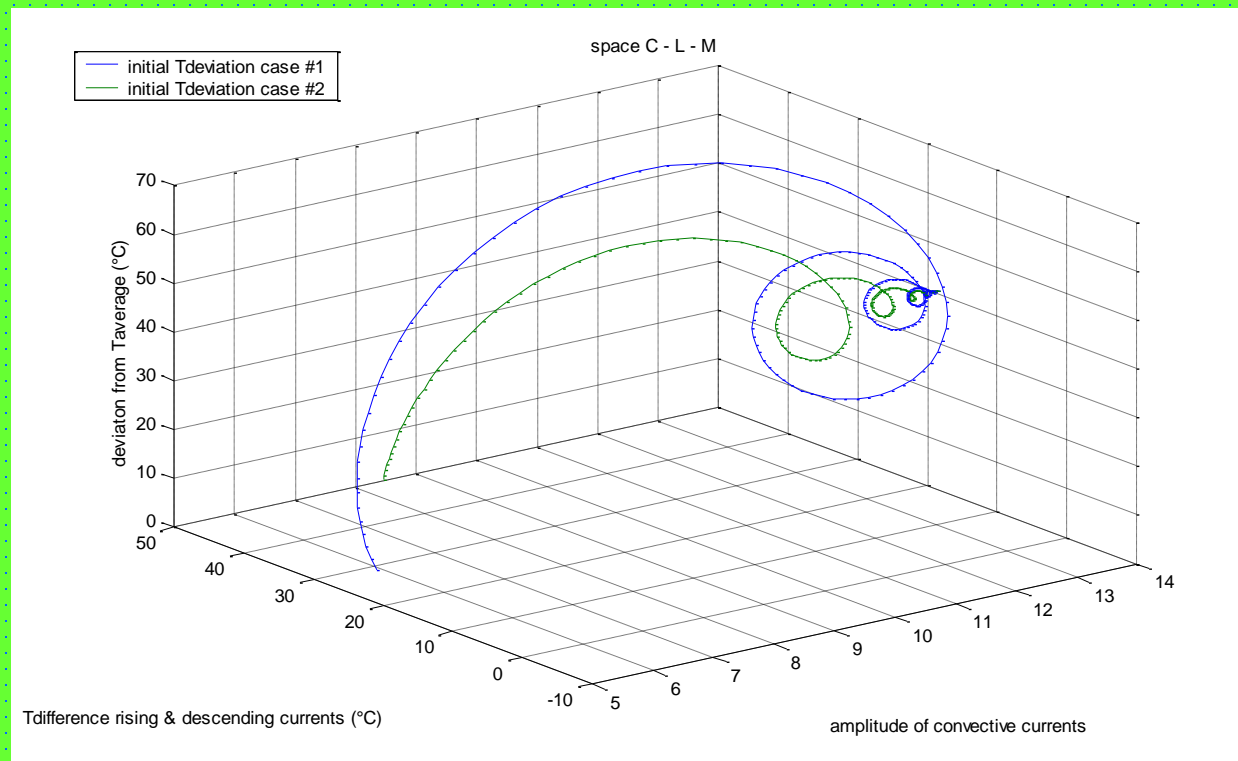
HOW DOES THIS CONTROL SYSTEM FUNCTION ???

1. The outdoor probe senses the air temperature
2. The control unit modifies accordingly the temperature of the HVAC fluids (*eg: water, air*) sent to terminals (*eg: fan coils, air control units, radiant panels, etc.*)
3. The temperature of fluids is regulated by the three-port valve.

and the SUN ??

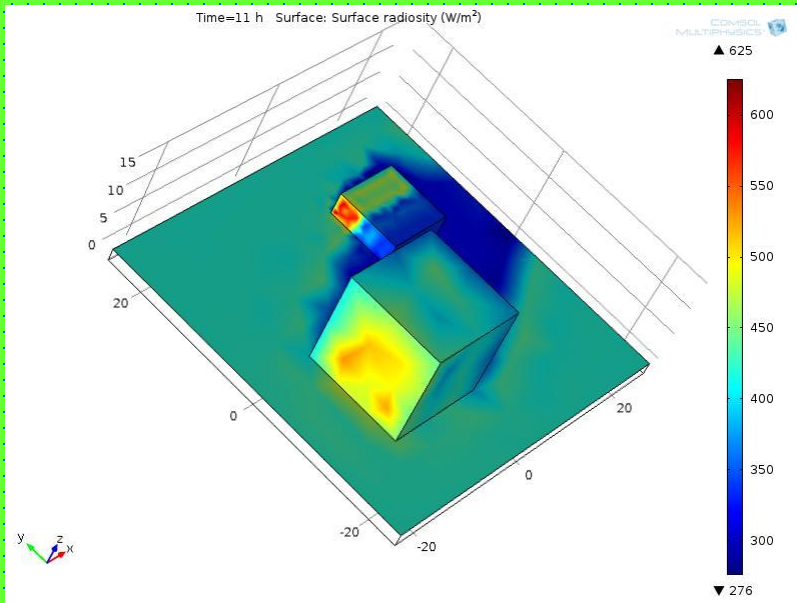
IT'S IMPORTANT TO START WITH REAL AND ACCURATE DATA

Lorentz tells us with his “strange attractors” theory that no matter the path you follow, if you start with reliable initial data the final results will approach with an high accuracy degree.

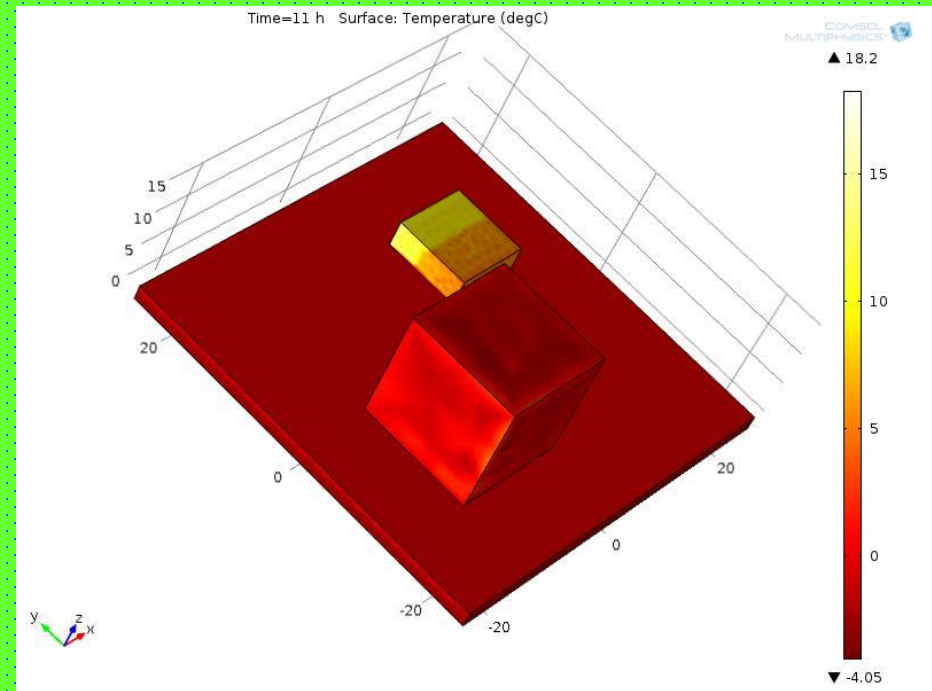


MODEL SIMULATION – February 15th, 2014

A very sophisticated *Comsol Multiphysics* “*Heat Transfer*” module is used to improve a very low-tech, basic control technology for HVAC plants.

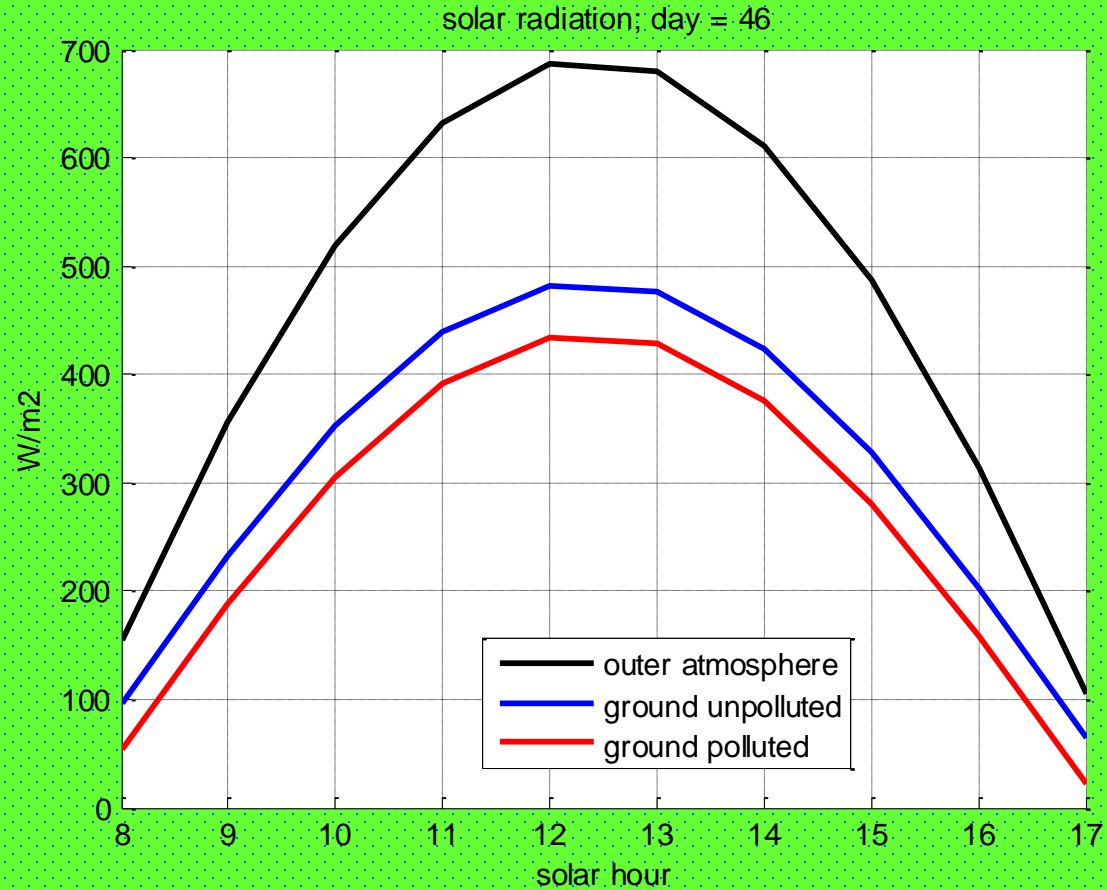


$T_{\text{outdoor}} = 0^{\circ} \text{ degC}$



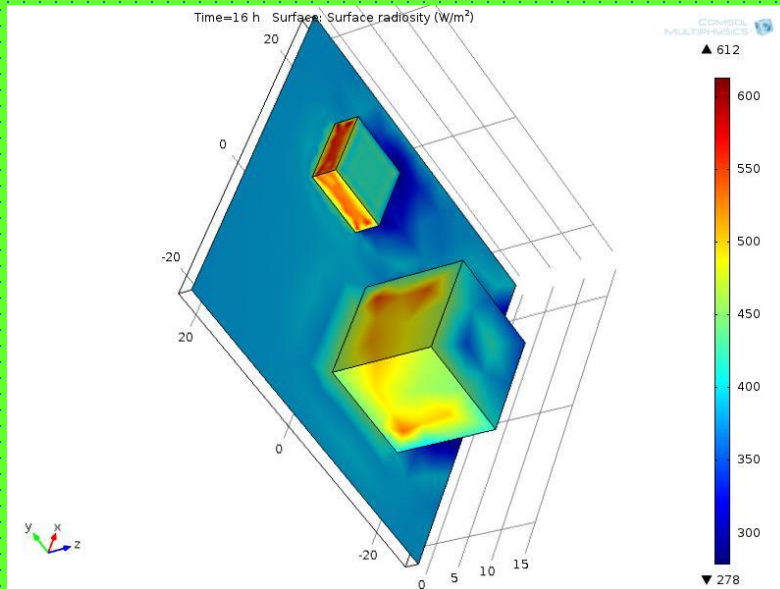
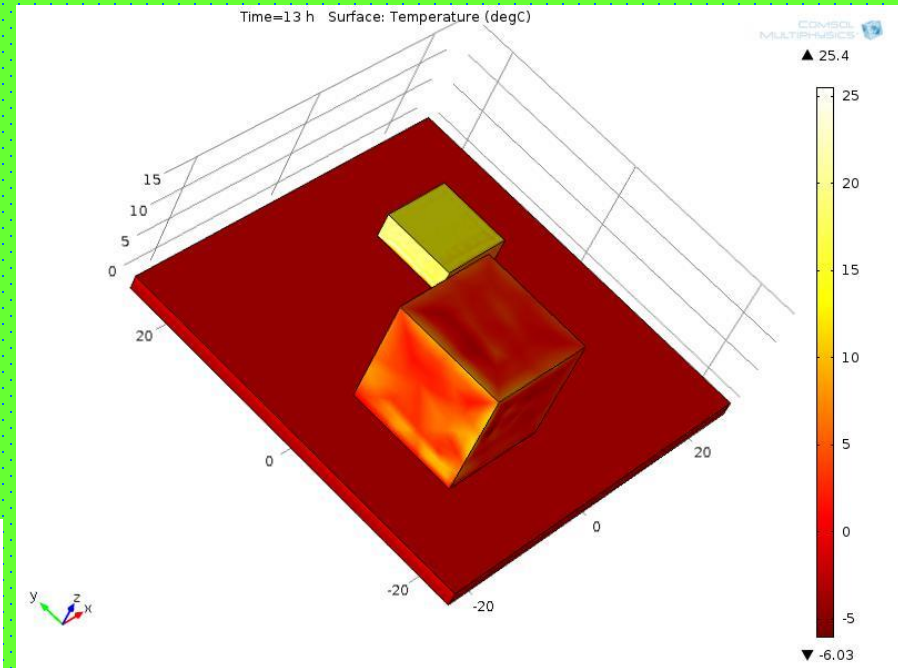
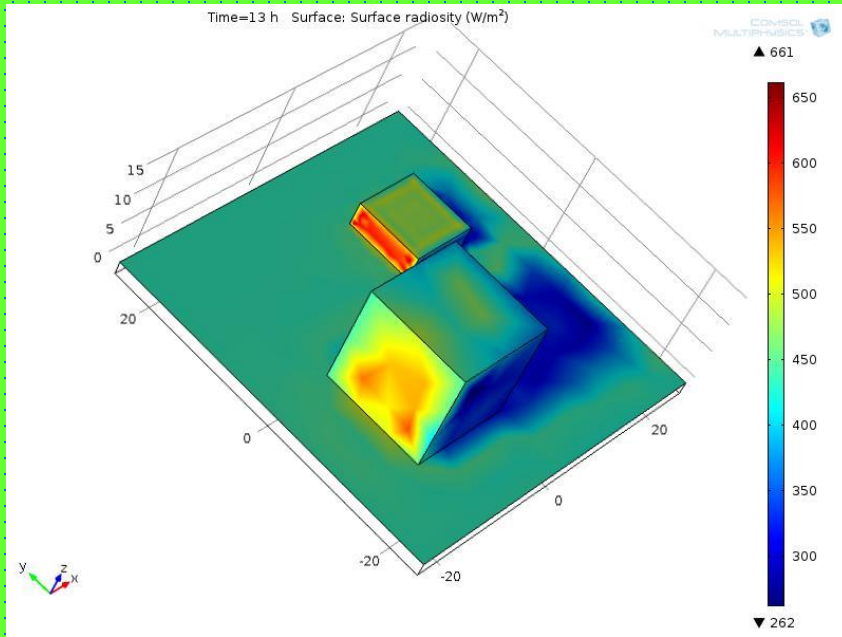
Note: the big bloc is not a building, but it is used simply to cast shadow on the small building behind.

THE SUN RADIATION MODEL – February 15°, 2014



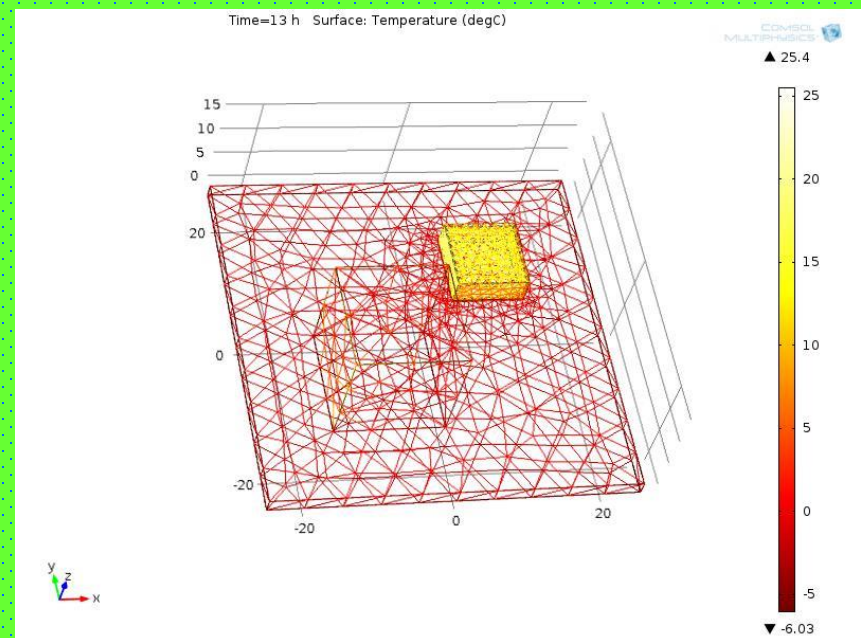
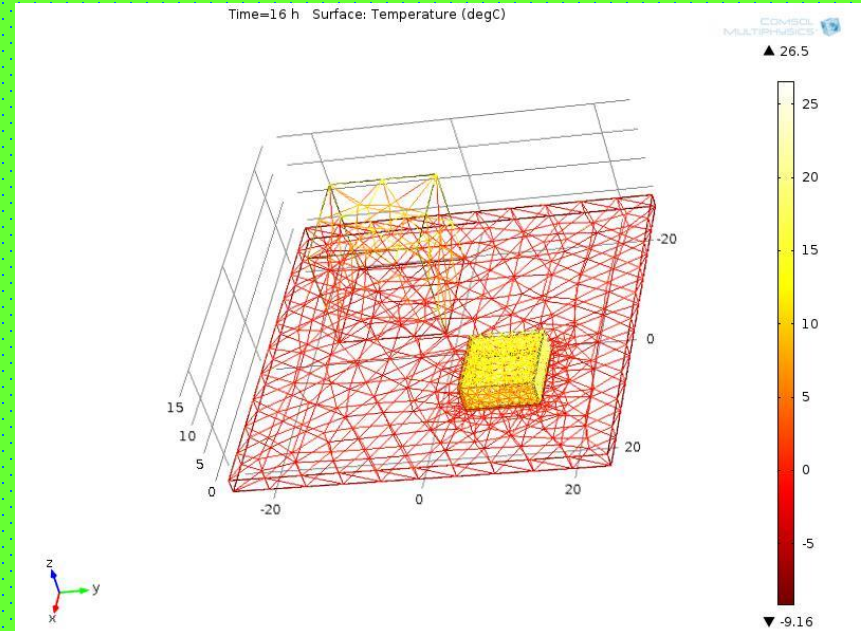
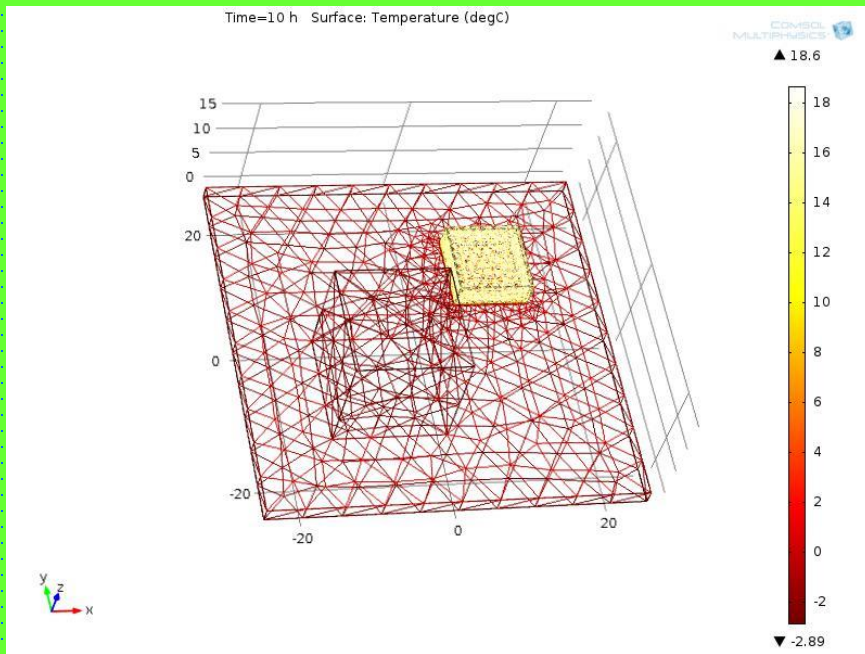
pollution: dust 400 $\#/cm^3$

MODEL SIMULATION – February 15th, 2014



MODEL SIMULATION – February 15th, 2014

The evolution of indoor air temperature



$T_{\text{indoor}}=20^{\circ} \text{ degC}$

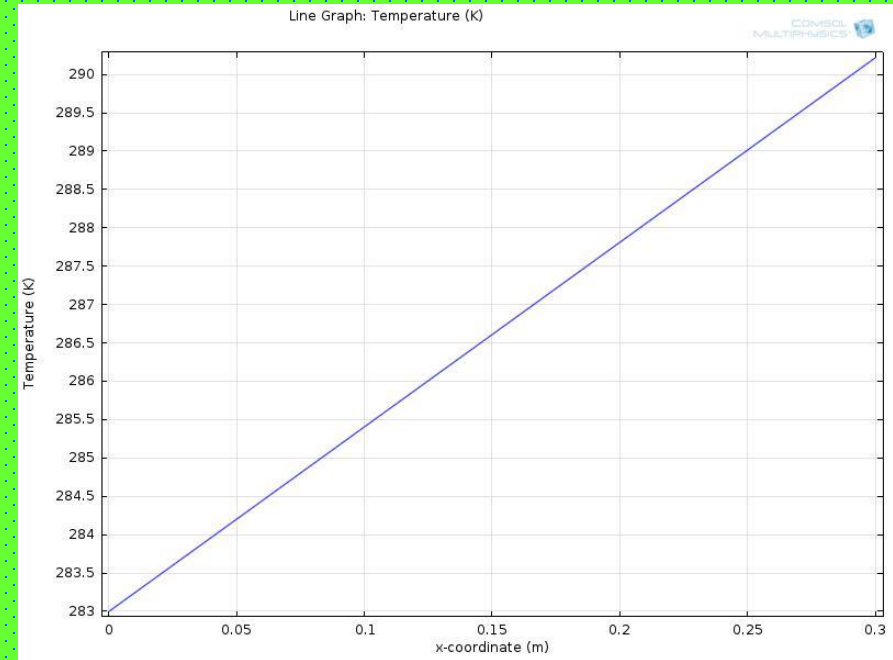
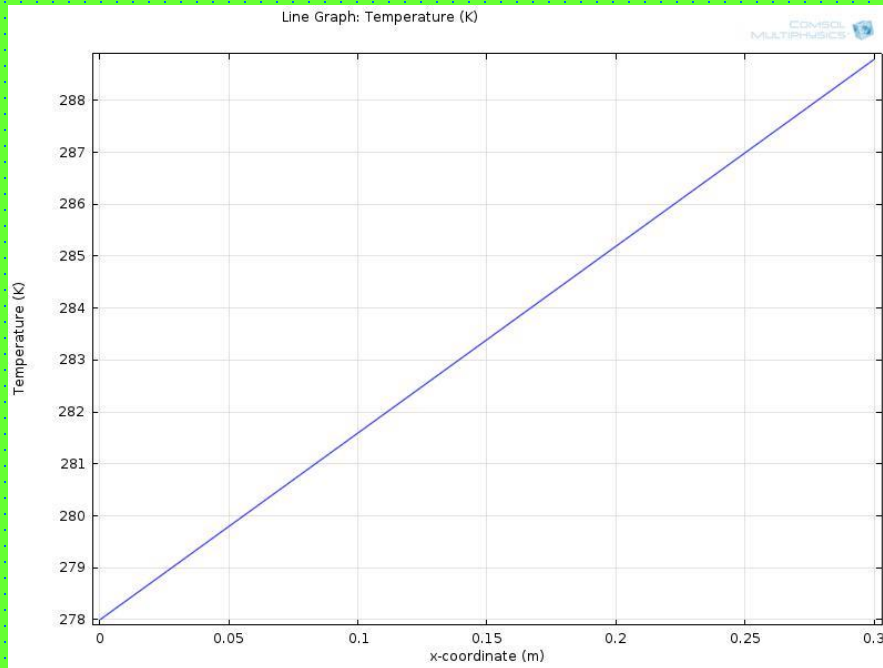
DATA OBTAINED WITH THE SIMULATION ARE VERIFIED ON THE SPOT.

With the help of a common infrared thermometer the wall surface temperature are measured ,to check if parameters (*eg: emittance*) used in simulation are correct or must be modified.



(Photo courtesy of Reale Mutua Assicurazioni of Turin)

Comsol simulation gives the temperature of wall surfaces due to radiation



The warming of the internal surface of the wall allows a reduction of the indoor air temperature, keeping the same ambiente comfort.

To exploit the solar radiation energy the new control system is enriched with:

d) a solaprobe



e) a radiometer



CONCLUSIONS

The study has brought the development, started in 2007, of a new type of control including the measure of the sun radiation energy .

Italian patents 0001374569-2006; 0001383570-2007-0001405239 & EU 0816844.7EP (pending)

Until now 25 systems have been installed, most on buildings in Milan, starting from 2007, with other 4 will start from October 2014.

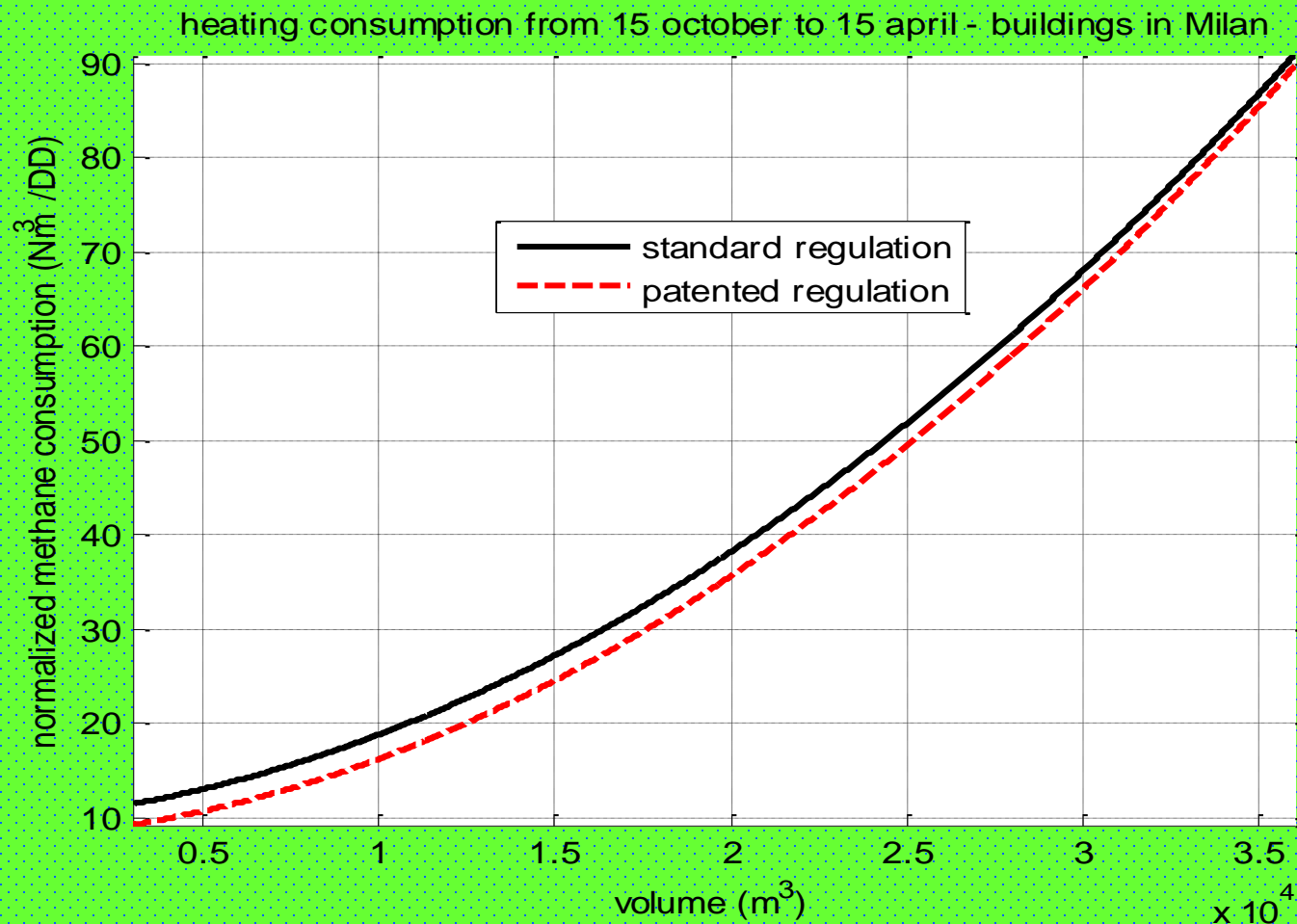
All the systems operate on HVAC plants of buildings, most of the 60's and the 70's.

Saving has been attained, certified by the lecture of energy meters and a real diminution of the bills !

Energy saving : some winter heating data

Energy savings of primary energy (*natural gas burnt in furnaces for winter heating*) shown in the graphic have been calculated interpolating comparisons of consumes of the HVAC plants of 14 (fourteen) buildings in Milan equipped with standard control (before) and advanced control (after)

Consumes with advanced controls are measured from 2007 (*included*) until 2013 (*included*).





A special thank to
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for the permission to reproduce its data
and pictures.

Thank you.

dr. ing. Franco Bruno
viale Lombardia 38
20090 – Buccinasco (MI)
tel (+39) 02-4884.3873
fax (+39) 02-4884-3745
mob. (+39) 338-6094508
bruno_franco@libero.it