

# edilportale<sup>®</sup> TOUR 2014

La mostra convegno in 18 tappe  
su Efficienza energetica,  
Luce e Ventilazione naturale,  
Acustica e Active House.

in collaborazione con **VELUX<sup>®</sup>**

partner **SCHÜCO** **ROCKWOOL** **KNAUF**

*Roma, 15 maggio 2014*

**Il protocollo Active House in clima mediterraneo:  
ricerche e sperimentazioni sviluppate nel laboratorio VeluxLAB al Politecnico di Milano**

**Marco Imperadori – Politecnico di Milano**



POLITECNICO DI MILANO

**VELUX**® lab



*Non è la specie più forte o la più intelligente a sopravvivere ma quella che si adatta meglio al cambiamento.*

*Charles Darwin, L'origine delle Specie, 1859*





*Net Zero Energy Emissions*

*Net Zero Energy Emissions*

*Net Zero Source Energy*

*Net Zero* **Site Energy**

*Net Zero* **Source Energy**

*Net Zero* **Source Energy**

**Net Zero Site Energy**

*Net Zero Site Energy*

*Net Zero* **Energy Costs**

*Net Zero* **Energy Emissions**

*Net Zero Energy Costs*

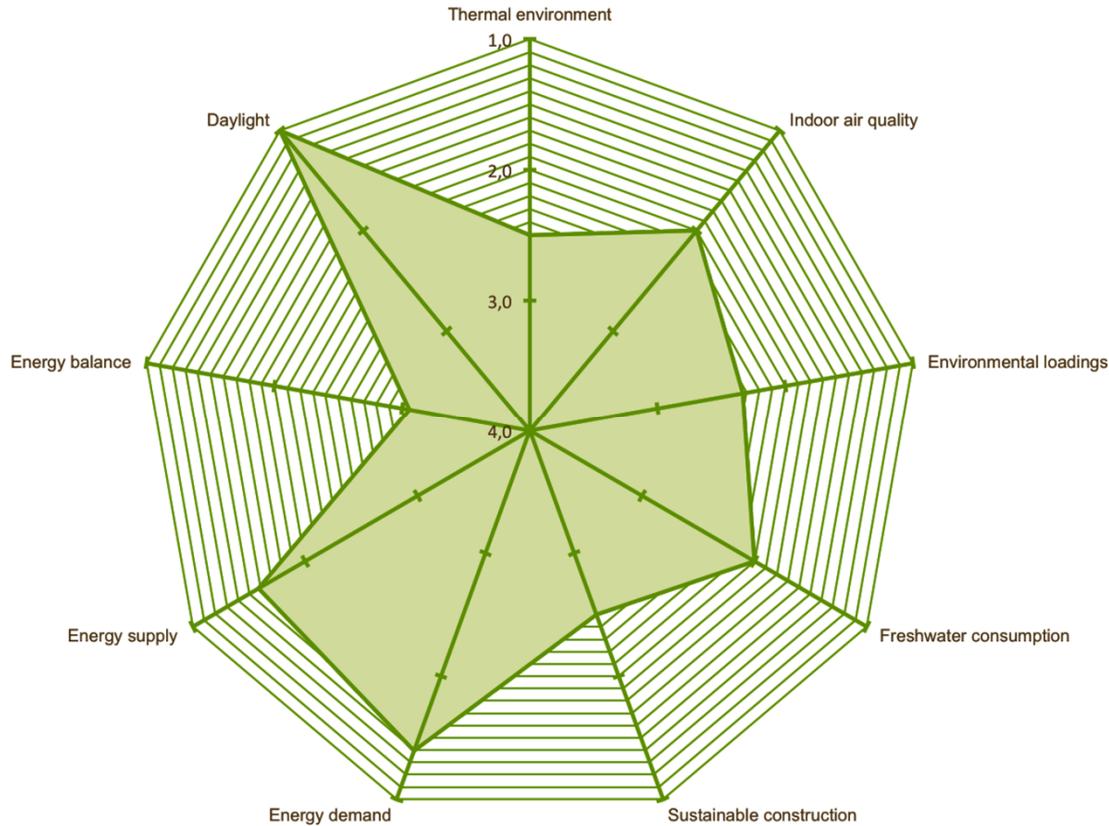
*Net Zero* **Energy Emissions**

*Net Zero* **Energy Costs**

*Net Zero Site Energy*



## Dati Radar

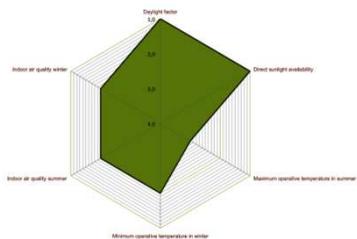


**activehouse**.INFO  
NETWORK AND KNOWLEDGE SHARING

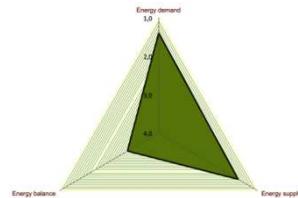
**Primo edificio italiano "Net Zero Energy" inserito in un campus universitario**

**Prima Active House registrata in Italia**

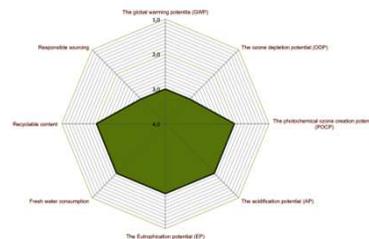
### Comfort



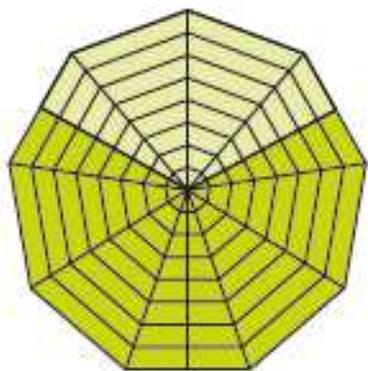
### Energia

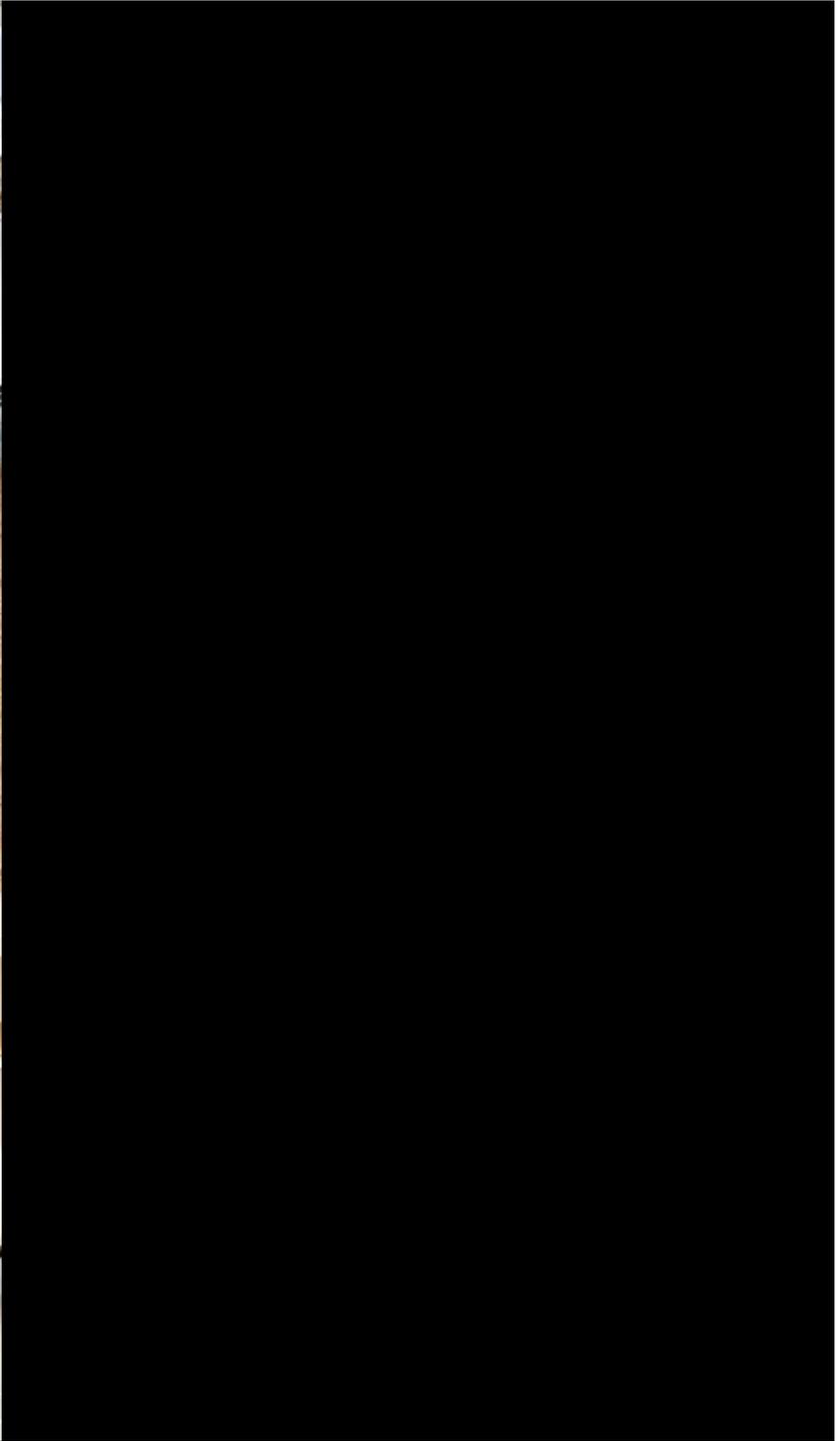


### Ambiente



# COMFORT





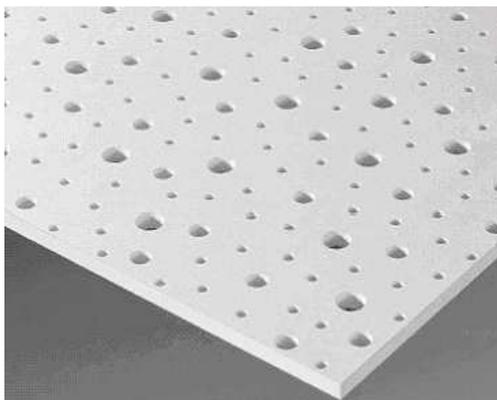
# Componenti



**Struttura in acciaio, solaio a pavimento in lamiera grecata e getto collaborante**



**Iper-isolamento in poliuretano, polistirene, in lana minerale e lana di legno**



**Pannello in gesso e zeolite KNAUF-CLEANEO**



**Vetrata triplo vetro basso emissivo. Serramento a taglio termico SCHÜCO**



**Finestre tetto VELUX ad alte prestazioni**

# Isolamento copertura

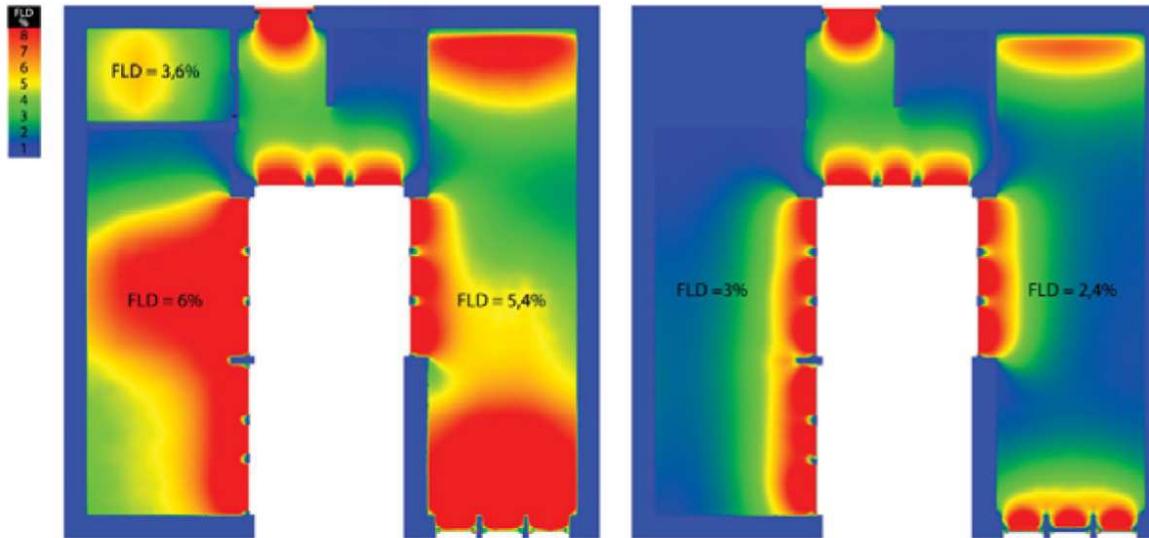


## Controsoffitto "Knauf-Cleaneo"

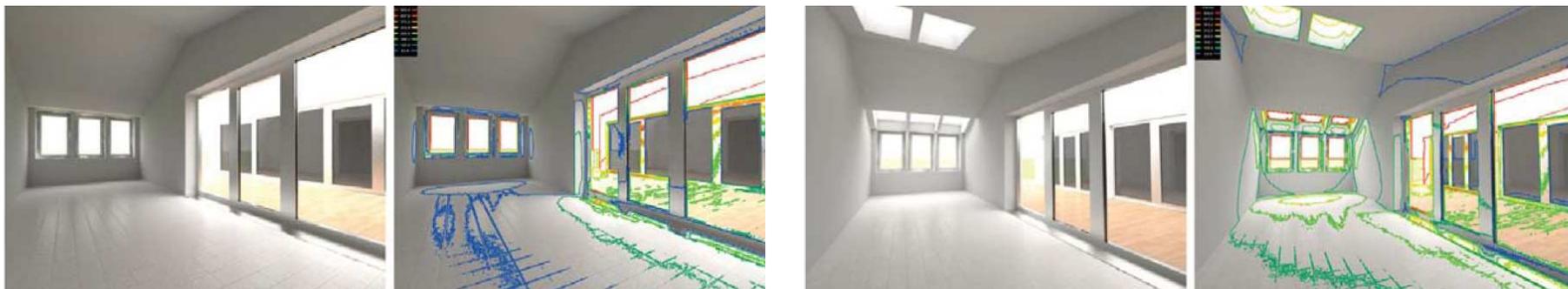




# Analisi illuminotecnica

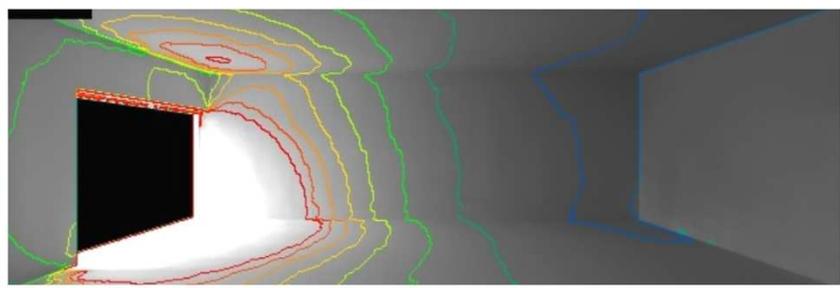


**Fattore medio di luce diurna e Rapporto aeroilluminante.** Nella situazione reale (a sinistra), la luce zenitale assicura alti valori di FLD e di RAI (0,10 minimo - Comune di Milano), rispetto alla situazione di studio (a destra) priva di aperture zenitali.

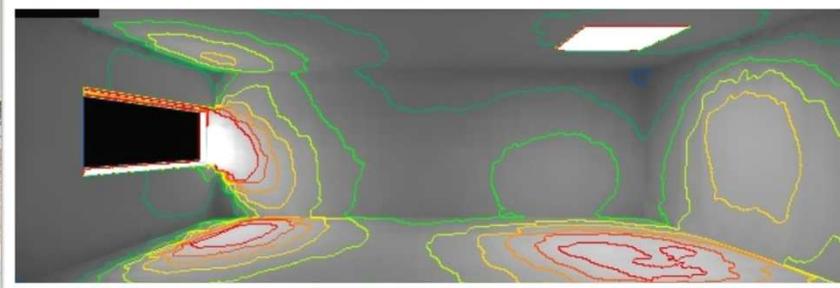


**Luminanza.** Il confronto della luminanza (21 Giugno - h 12:00) fra la situazione reale (in presenza di lucernari) e di studio (in assenza di lucernari), mostra come la luce zenitale renda i valori più omogeneamente distribuiti all'interno dei locali. Inoltre, il fenomeno dell'abbagliamento è ben controllato dai sistemi di schermatura posti all'esterno.

## Distribuzione della luce con aperture zenitali



6m<sup>2</sup> superficie vetrata  
154 lux medi



4m<sup>2</sup> superficie vetrata (-33%)  
225 lux medi (+45%)

## Agua de MARMORE



Team:

Luigi Ferrario  
Camilla Massironi  
Alice Schinella



Fig. 3.4.57

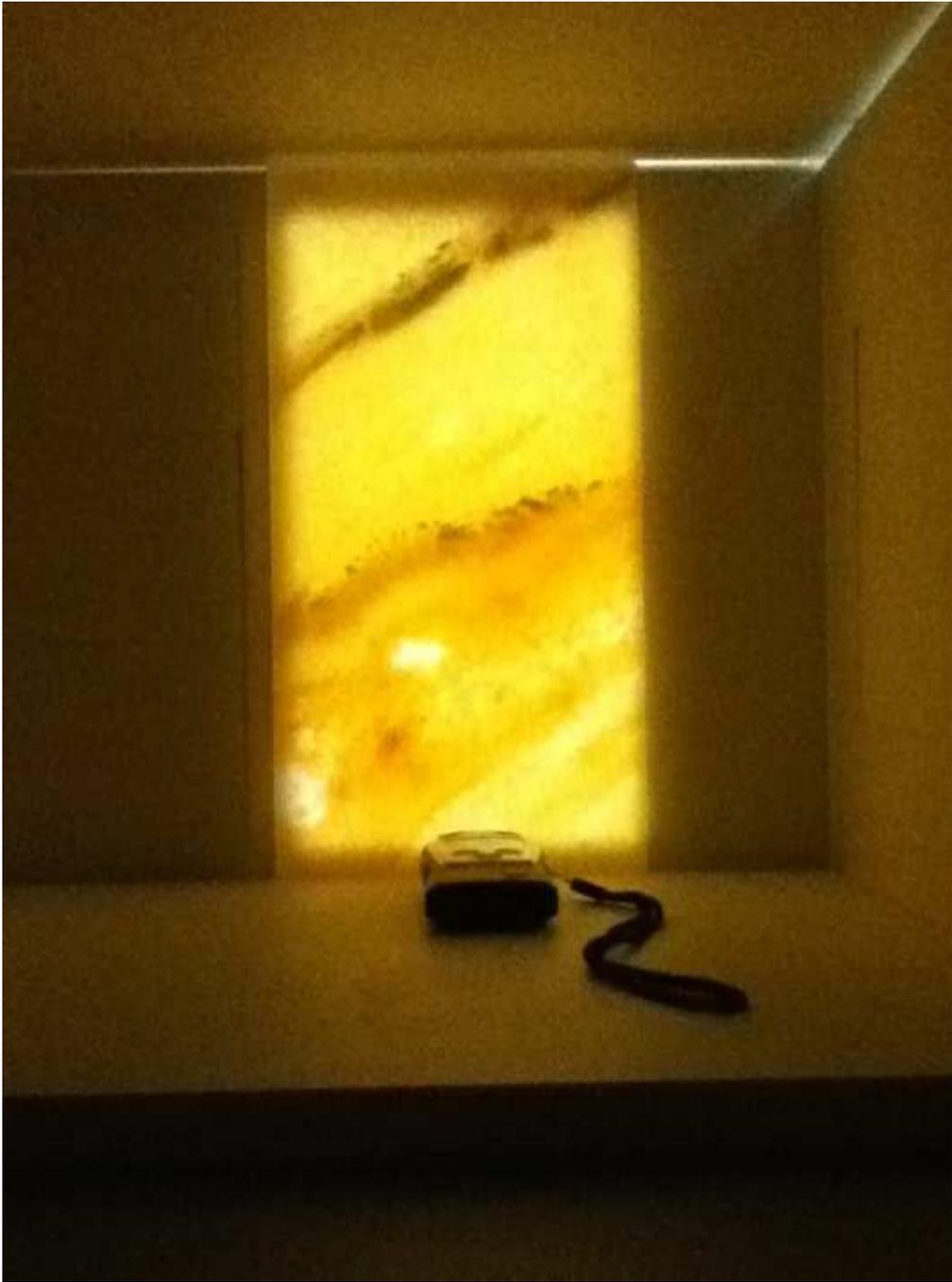


Fig. 3.4.58



Fig. 3.4.59





Supreme Court Singapore (Norman Foster)

Facciata Taltos

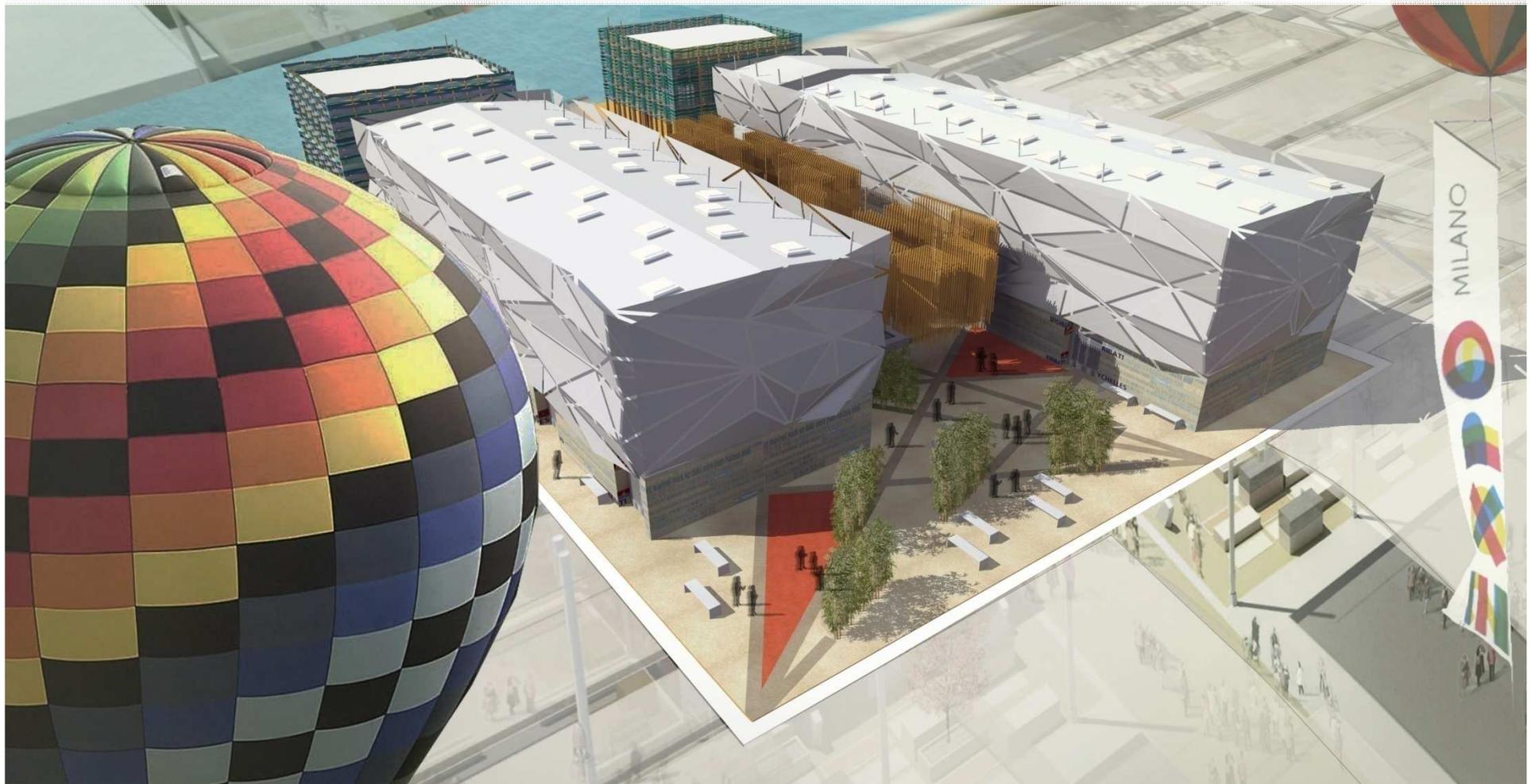


Fig 34.77

Fig 34.78

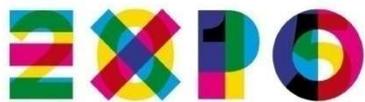
## Il Cluster "Island, sea and food"

## RYTHM OF DISCOVERY



Team:

Giuliana Iannacone  
Andrea Vanossi  
Paola Trivini  
Valentina Gallotti  
Chiara Valsecchi

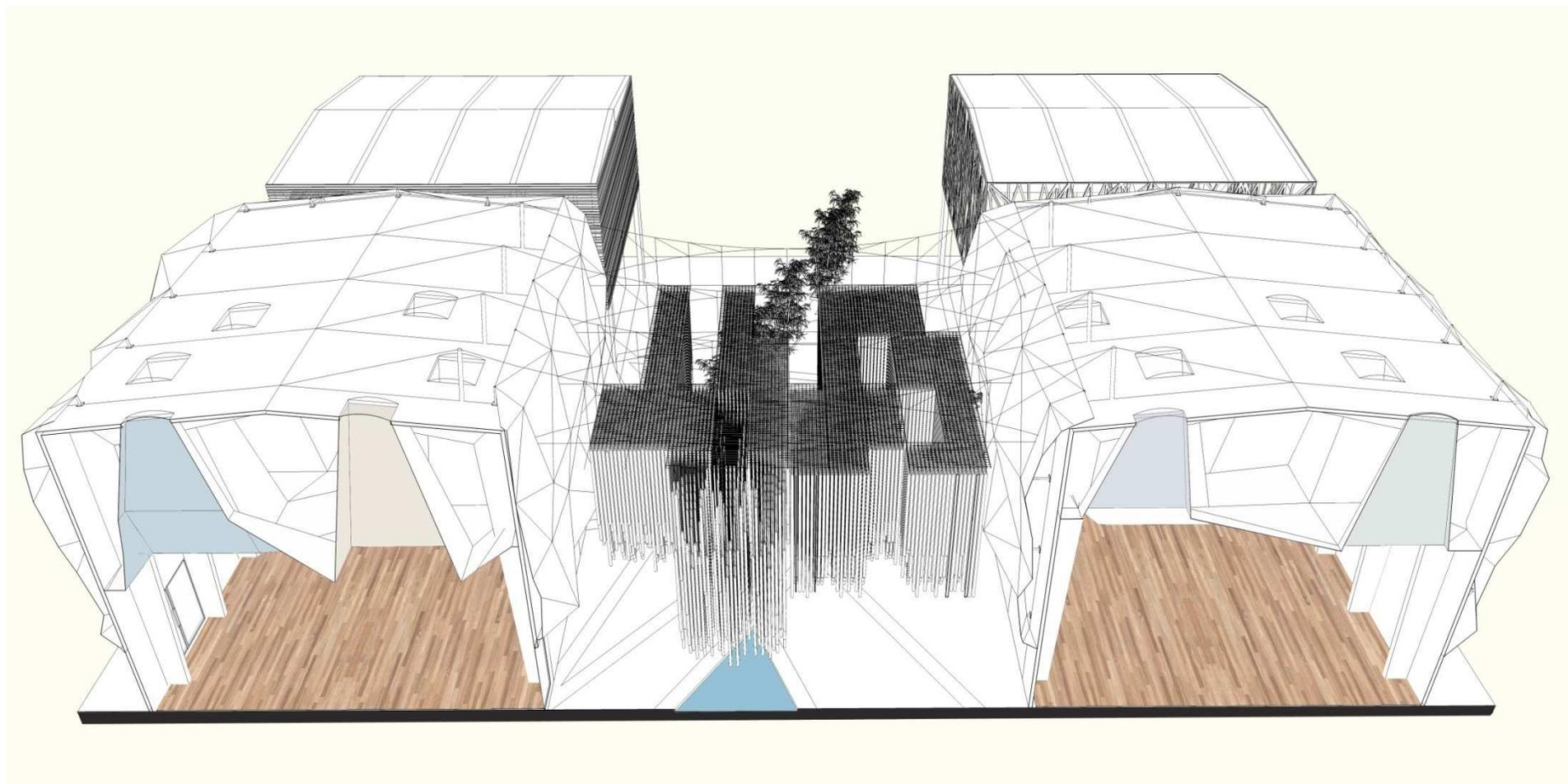


MILANO 2015

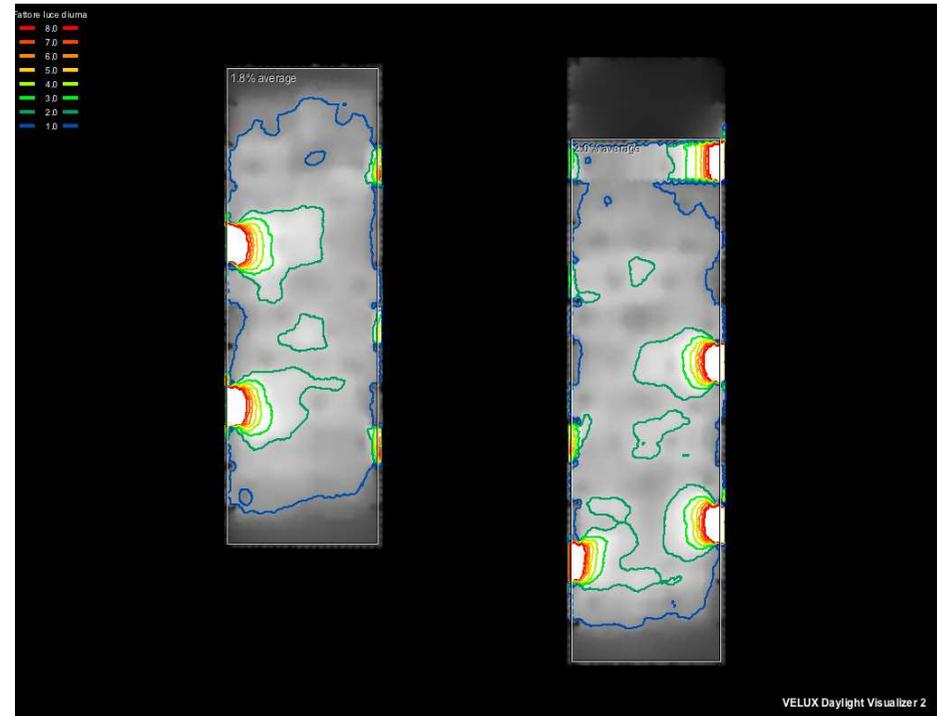
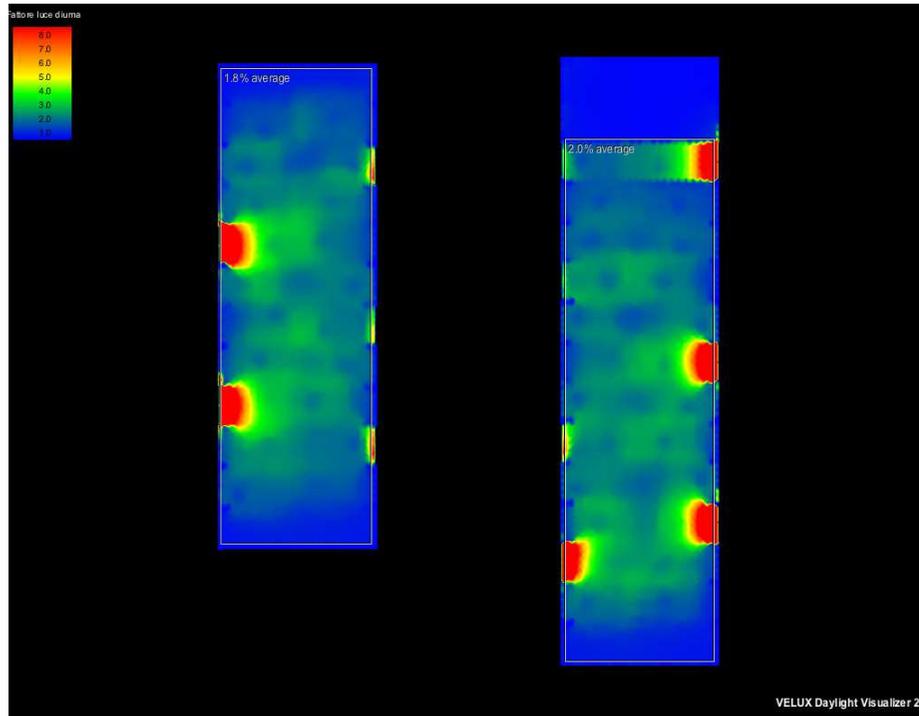
NUTRIRE IL PIANETA  
ENERGIA PER LA VITA

# Analisi illuminotecnica

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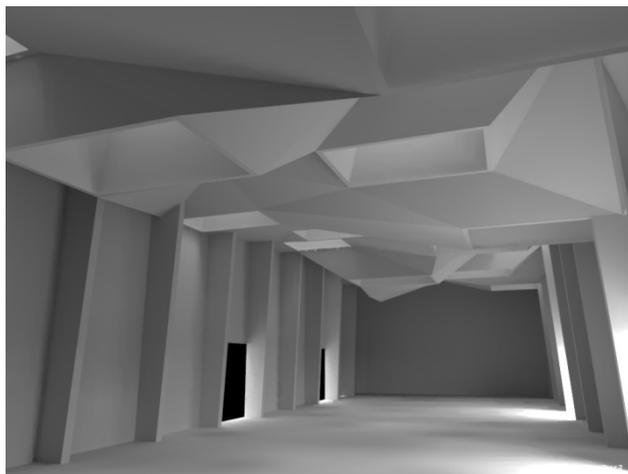
# Analisi illuminotecniche



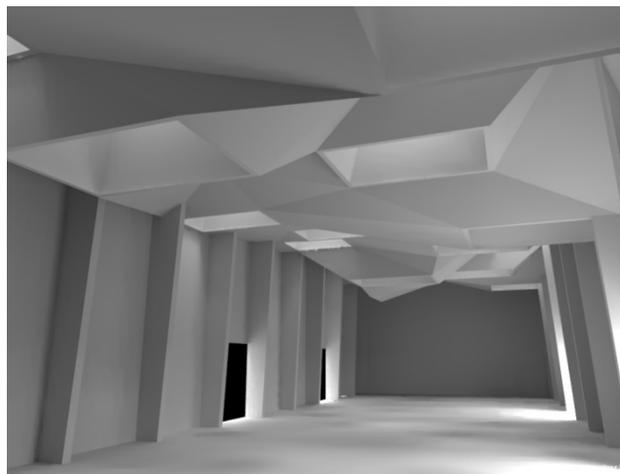
## FATTORE MEDIO DI LUCE DIURNA ( $F^{mld}$ )

Le simulazioni consentono di rilevare buoni valori di  $F^{mld}$  con una distribuzione omogenea della luce al di sotto dei "Vulcani di luce" nonostante questi siano elementi puntuali. Si verifica quindi il corretto funzionamento del controsoffitto nel diffondere la luce diretta.

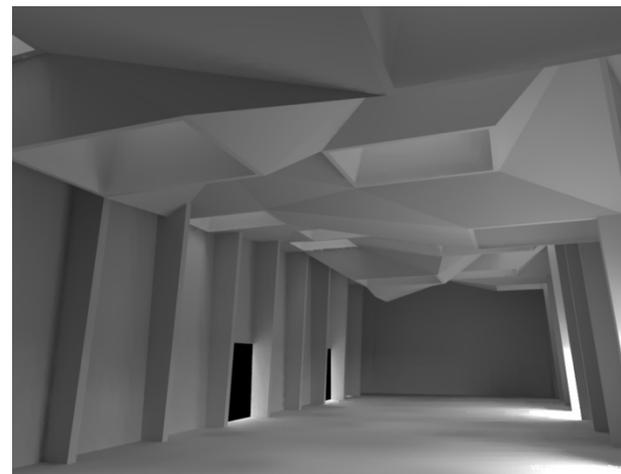
## Analisi illuminotecniche



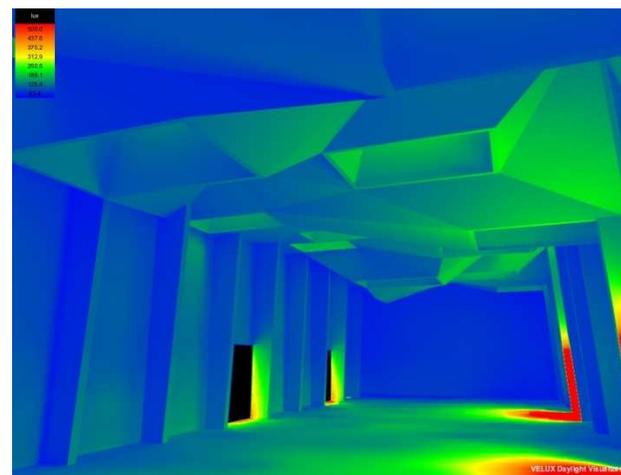
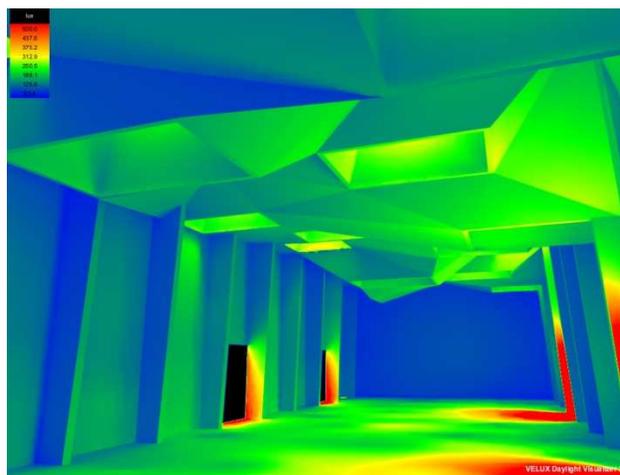
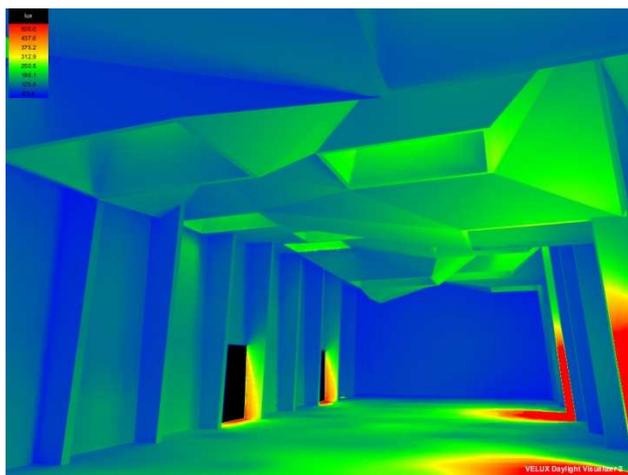
21 aprile



21 giugno



21 ottobre



### **ILLUMINANZA** - Padiglione EST - Cielo parzialmente coperto

In condizioni di cielo coperto è possibile verificare ottimi livelli di illuminamento dell'intero spazio espositivo con valori di illuminanza omogenei e prossimi ai 250 lux. È quindi possibile verificare l'efficacia dei "Vulcani di luce" anche in condizioni meteo meno favorevoli.

a building and the complement to a life  
attractive as intensity of Tokyo.



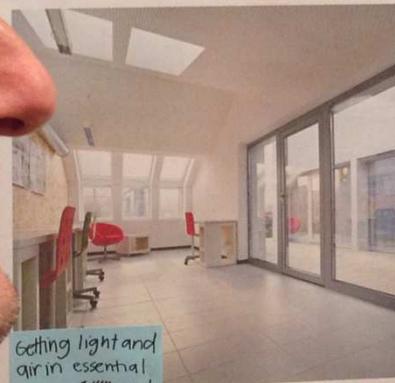
Prof. Ing. Marco Imperadori  
Rector's Delegate For East

VELUXlab is the first Italian Nearly Zero Energy Building. It is placed in Bovisio Campus of Politecnico di Milano and it represents a study case of high energy efficiency building, integrating in the future scenario required by the European Directive 2010/31/EU. VELUXlab was born as a Mediterranean Model Home for VELUX, called Anika, designed by J.A. Cantalejo and R.A. Ronda from ACXTI/OCS studio.

It personalized the prototype of energy efficiency building for the Mediterranean Region and it is the result of an important architectural and performance retrofit. The renovation was led by Atalier2 with the supervision of Professor Imperadori and Professor Morra from Politecnico di Milano. The collaboration between Politecnico di Milano and VELUX Italia gave the opportunity to create a new lab, a sort of test building, where it is possible to develop the experimental research on going in the University in this way VELUXlab became itself an experimental laboratory in the building.

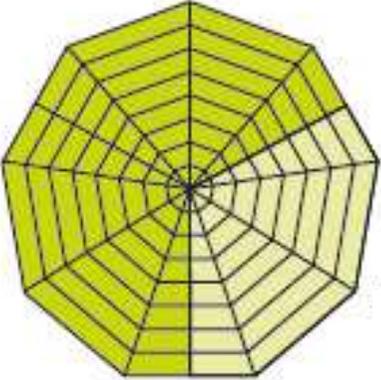
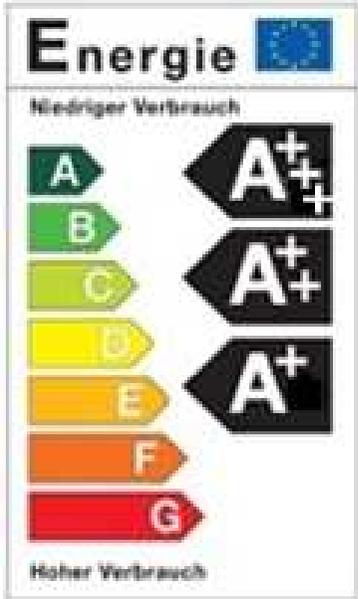
40% of energy consumption. Innovative solutions and a climate control system coupled with an energy storage system, makes VELUXlab the first Italian nearly Zero Energy Building in the University Campus.

# VELUXlab : innovation between ART and SCIENCE



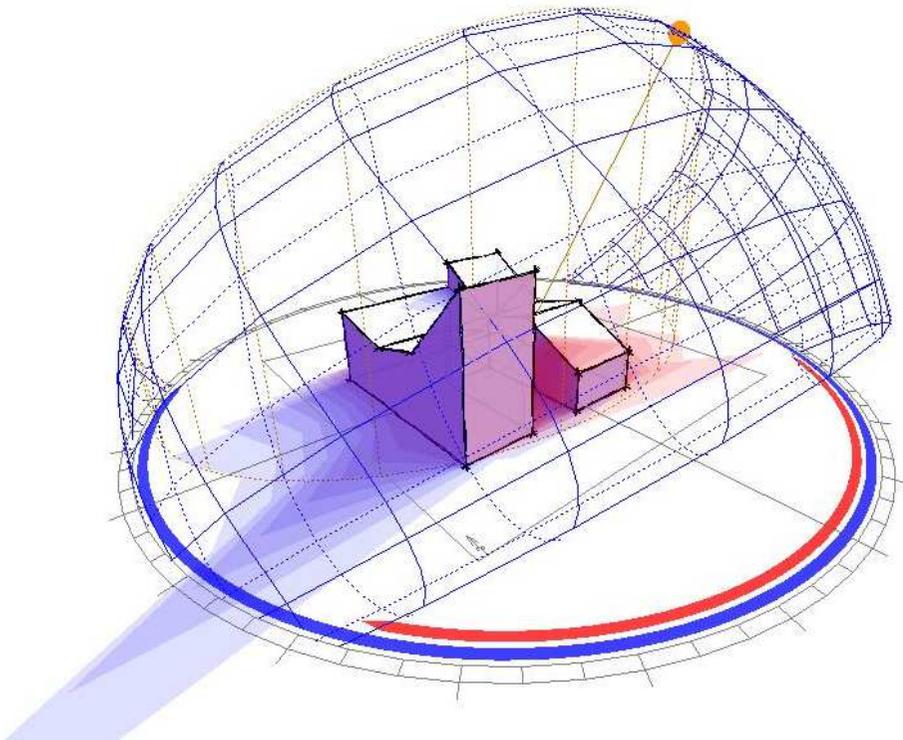
Getting light and air in essential in low ~~density~~ and dense urban systems → velux / roofspace simple yet key (S)

# ENERGIA

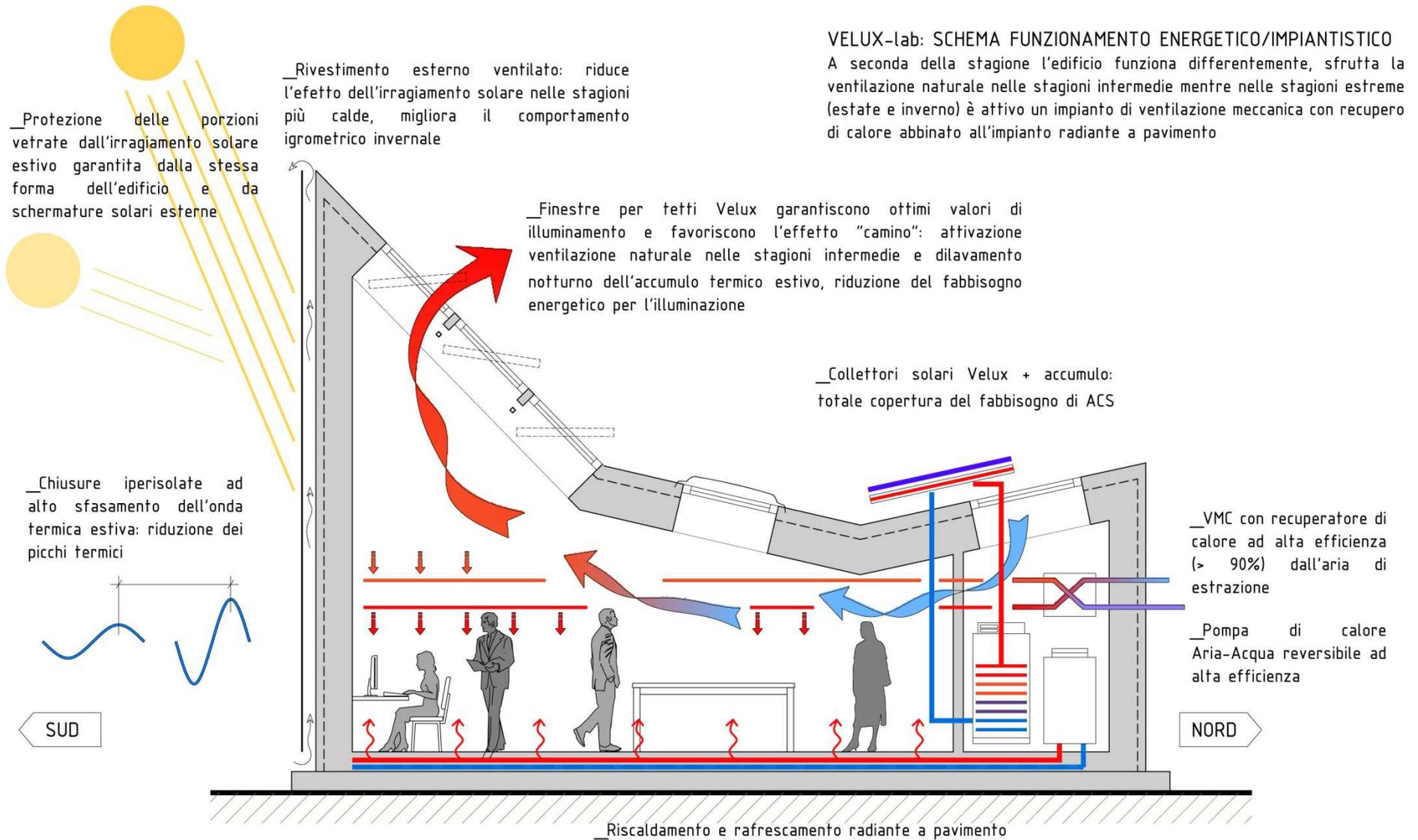


**VeluxLAB:**

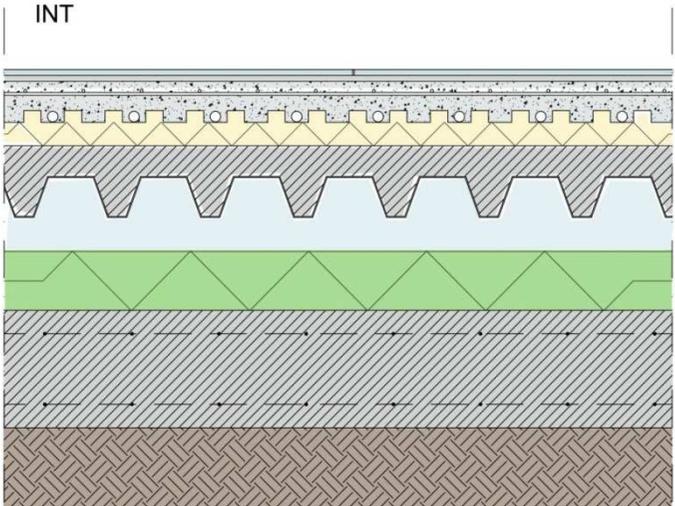
- \_ ottimizzazione luce e ventilazione naturale  
calcolo FLD
- \_ ottimizzazione energetica
- \_ Rilevazione dati continua



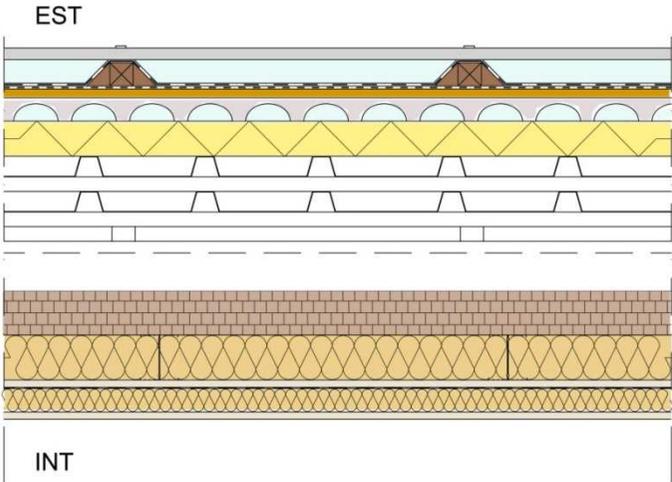
# Schema energetico



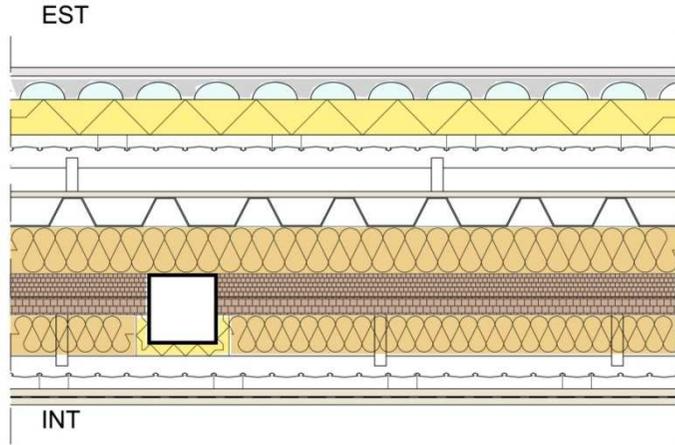
# Prestazioni



▲ **Solaio controterra U = 0.214 W/m2K**  
Ground floor slab



▲ **Copertura U = 0.133 W/m2K**  
Roof



▲ **Chiusura esterna U = 0.124 W/m2K**  
External wall



## Installazione finestre



## Impianti



Ventilazione meccanica (portata massima 470 m<sup>3</sup>/h) con recuperatore di calore (>90%)

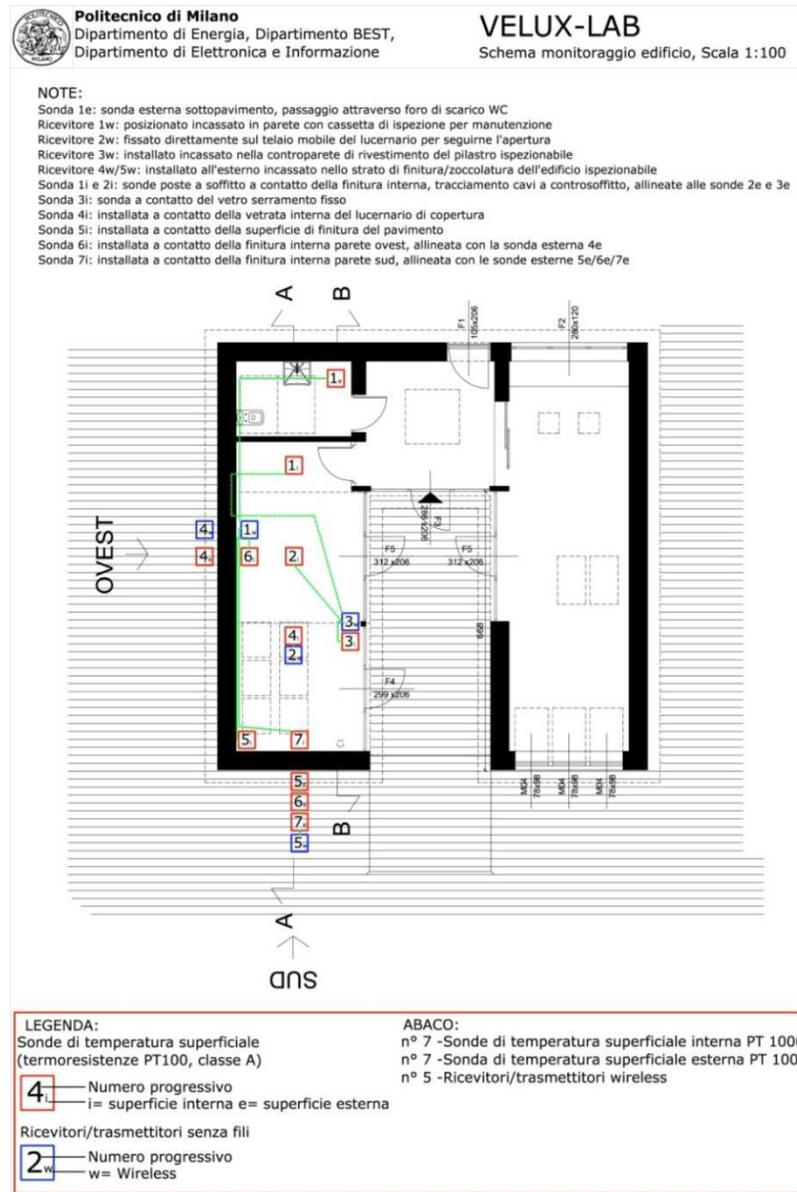


Riscaldamento (90 W/m<sup>2</sup>) e raffrescamento (30 W/m<sup>2</sup>) radiante a pavimento

Pompa di calore aria-acqua (7 kW per riscaldamento, 6.1 kW per il raffrescamento). Solare termico (3 collettori solari, 160 l serbatoio di accumulo)



# Sistema di monitoraggio Wireless



# Sistema di monitoraggio Wireless

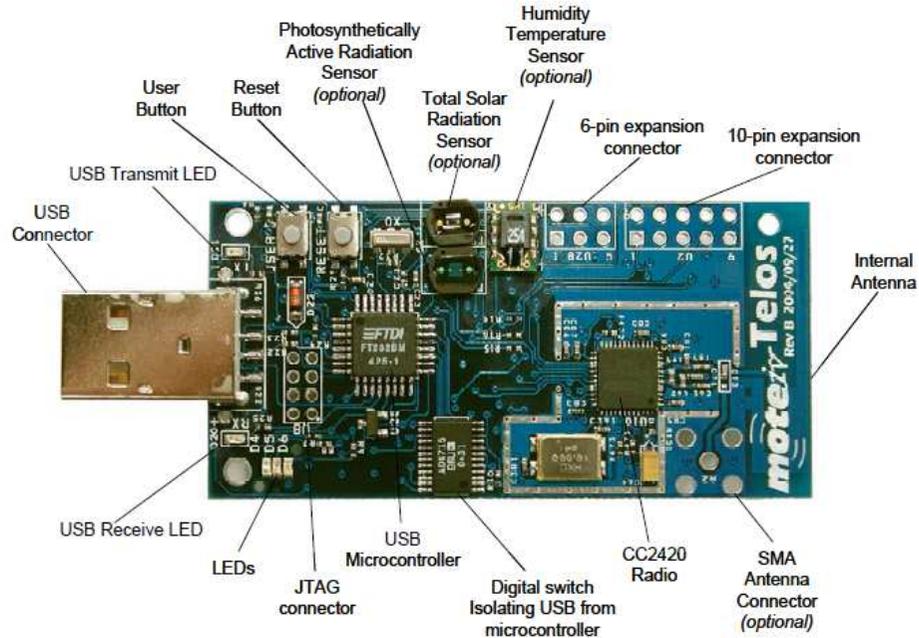
Rete di sensori wireless (WSN):

**\_Nodi** realizzati mediante dispositivi **TelosB** ai quali è stata collegata una scheda di acquisizione dati progettata ad hoc (< 0,1 ° C di errore nella lettura della temperatura) utilizzando sonde PT1000.

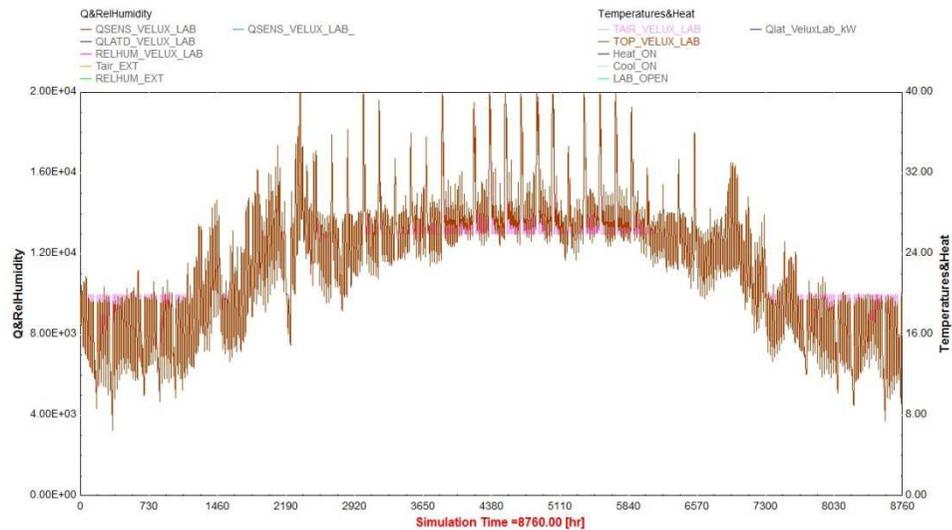
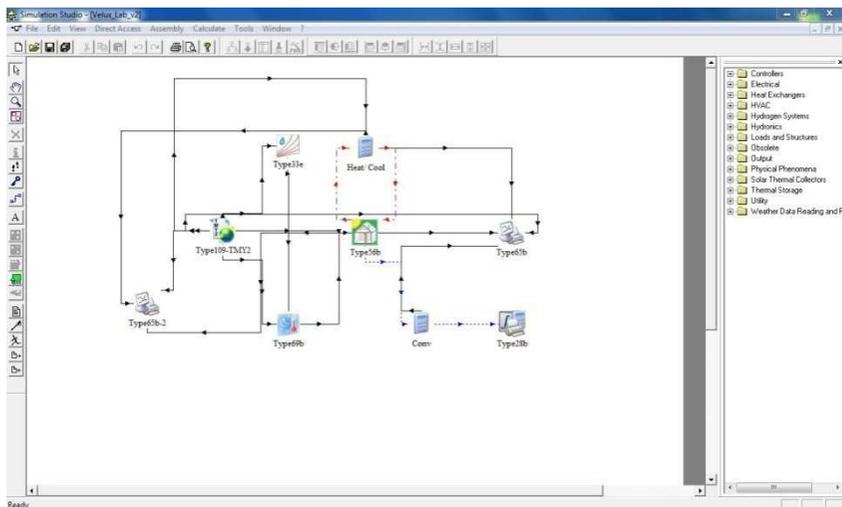
**\_Software** messo a punto dal **dipartimento DEI del Politecnico di Milano**.

I sensori installati:

- **14 Sonde di temperatura** superficiale **PT 1000 classe A** con elemento sensibile al Platino per il monitoraggio dell'involucro
- **6 Sonde di temperatura** superficiale **PT 1000 classe A** con elemento sensibile al Platino e **3 contatori elettrici** dedicati per il monitoraggio dell'impianto
- **7 Micro Data-logger** wireless **TelosB** a cui sono collegati i sensori di temperatura

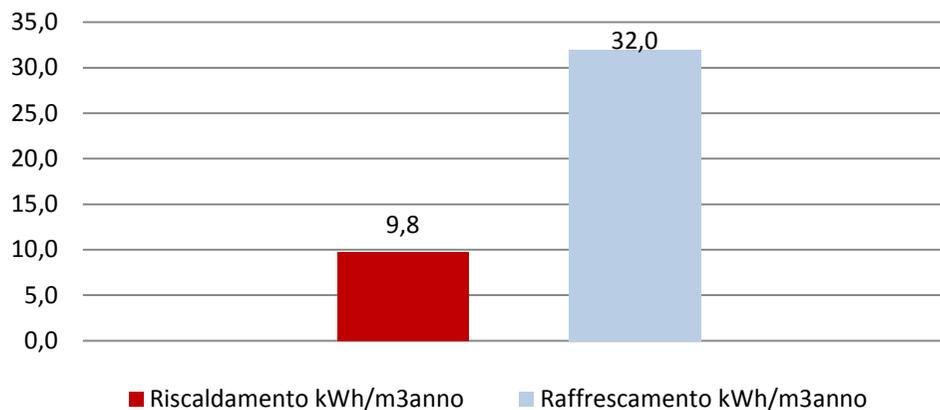


# Simulazioni energetiche e sistema di servizi

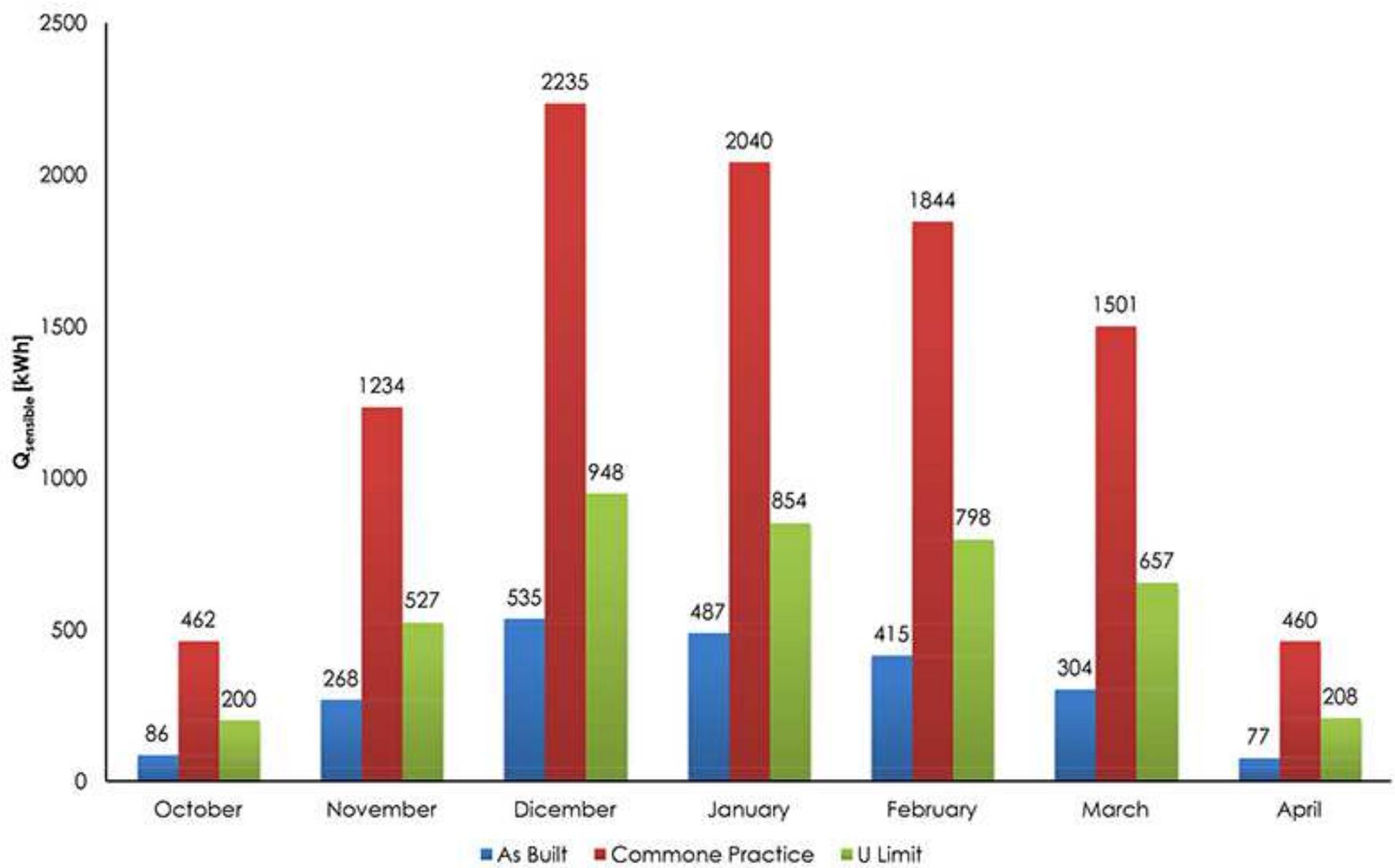


Valutazione energetica dell'edificio mediante simulazioni energetiche in regime dinamico svolte con il software **TRNSYS**.

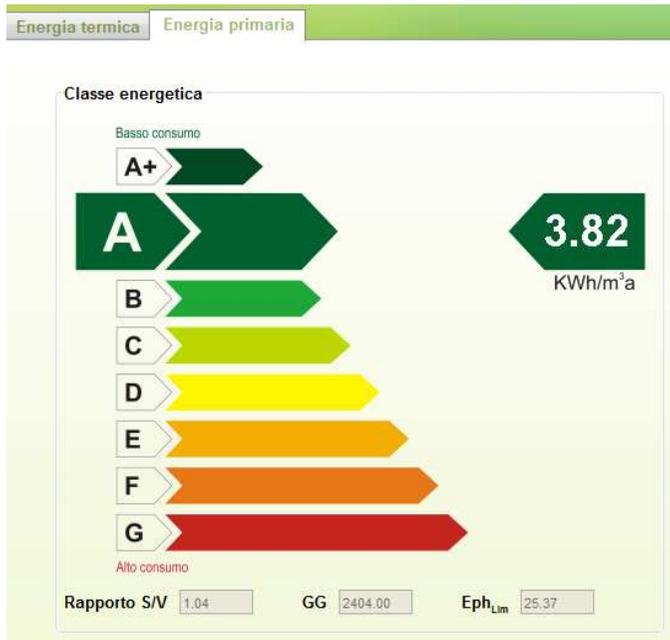
## Fabbisogno energetico senza apporti energetici da fonti rinnovabili



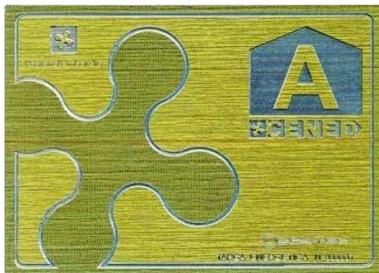
# Fabbisogno energetico mensile \_ VeluxLAB Campagna sperimentale inverno 2013



# Certificazione CENED+



**VELUXlab** si inserisce nello scenario futuro degli **Edifici ad Energia Quasi Zero** (Nearly Zero Energy Building) previsto a partire dal 2020 dalla **direttiva europea 2010/31/UE** ed è inserito nel progetto più ampio, voluto dal Politecnico di Milano, chiamato "**Campus Sostenibile**", azione primaria del Politecnico nell'anno del suo 150° anniversario.



## Comfort and Energy Assessment of the First Italian Nearly Zero Energy Building in a University Campus

M. IMPERADORI<sup>1</sup>, M. SAUCHELLI<sup>1</sup>, A. BRAMBILLA<sup>1</sup>, N. FALCONE<sup>1</sup>, C. ZANELLO<sup>1</sup>, V.A. ZORZI<sup>1</sup>

<sup>1</sup>Department of Architecture, Built Environment and Construction Engineering, Politecnico di Milano, Milan, Italy

**ABSTRACT:** The aim of the work proposed in this paper is to test and evaluate the dry stratified construction technology for building envelope in warm climate (such as in Milan, Italy), showing the actual comfort and energy assessment of the first Italian Nearly Zero Energy Building in a University campus. Analyses are conducted on the VELUXlab building, recently opened within the Politecnico di Milano (Italy). VELUXlab is an experimental laboratory coming from a deep energetic and technological retrofit done on the VELUX Atika model home. During the construction phase an innovative wireless sensors network has been installed, including 14 surface temperature sensors on the building envelope. Here is proposed a comparative analysis between the actual data recorded and the theoretical data analysed through dynamic energy simulations. Further analyses are conducted in order to compare VELUXlab data with the data of average existing Italian buildings, and with the theoretical data referring to the minimum requirements suggested by Italian regulations for new buildings.

**Keywords:** NZEB, thermal comfort analysis, dynamic thermal modelling

### INTRODUCTION

VELUXlab is the first Italian NZEB in a University campus. It is placed in Bovisa Campus of Politecnico di Milano and it is a prototype and a case study for the future buildings. The recent European Directive 2010/31/EU states that, by the end of the 2020, all the new buildings shall be "nearly zero energy". Actually there are no clear suggestions about these new type of constructions [1, 2], and a real example of their peculiarities and features could be a concrete way to make architects aware about the needs of a sustainable design and to provide a sample to follow. In 2011 Velux, the worldwide leader in roof windows, in collaboration with Politecnico di Milano and the design firm Atelier2, converted the demo-house Atika into an experimental laboratory with very low energy request and very high energy efficiency. Thanks to dynamic simulations it was possible to calibrate the intervention in order to minimize the energy needs of the lab, keeping as much as possible the old materials. New technological layers were added in order to optimize the building for the warm climate of Milan. The building envelope was designed as a multi-layer dry construction, based on the duo structure/envelope, and the adopted technology was studied and defined in order to represent a feasible possible solution for zero-energy buildings in Mediterranean region [3, 4]. Furthermore, during the construction phase, an innovative wireless sensors network was installed.

In this paper first results about VELUXlab behaviour are proposed, concerning both energy consumption and indoor environmental quality. A comparison between

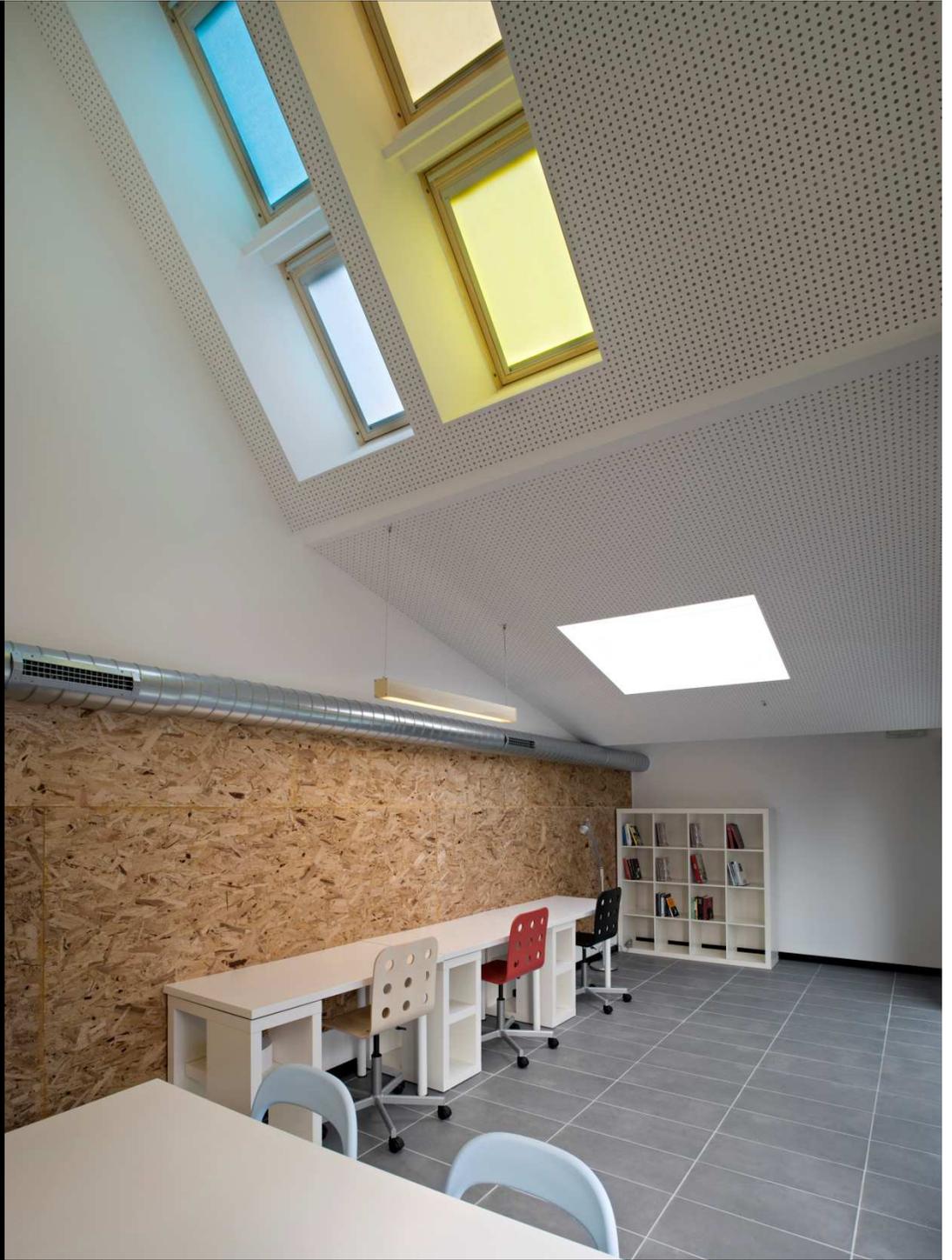
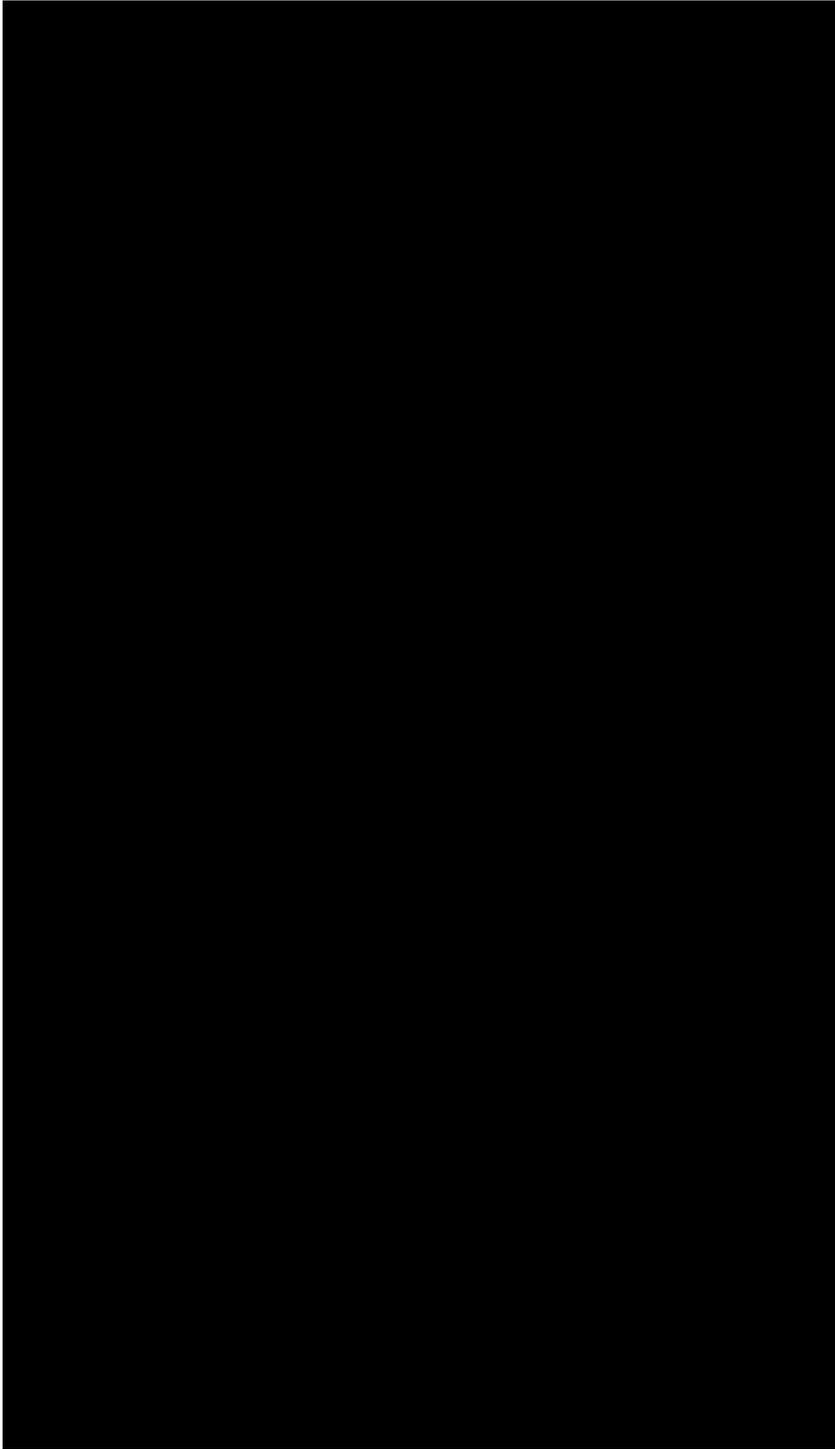
the data recorded by the sensors during the first year and the theoretical data obtained from the dynamic simulations is addressed in order to understand how much a NZEB behaviour is affected by external and unpredictable interferences. Studies show that, for other NZEBs, during their real life, due to the assumptions and simplifications of the virtual model, the energy consumed is more than the predicted one [5, 6, 7]. In this paper analyses are conducted on VELUXlab in order to quantify and evaluate the real performances of the building. This is the first step to define a nearly zero energy building optimized for Mediterranean climate through the evaluation and comprehension of its real operative performances.

### BUILDING STOCK ANALYSIS

In order to comprehend which is the level of improvement introduced with the project, a comparison between VELUXlab and the existing building stock is proposed. The comparative analysis refers to CENED certificated buildings in Lombardia (a region in the north of Italy), where VELUXlab is placed, to figure out strengths and weak points of the intervention.

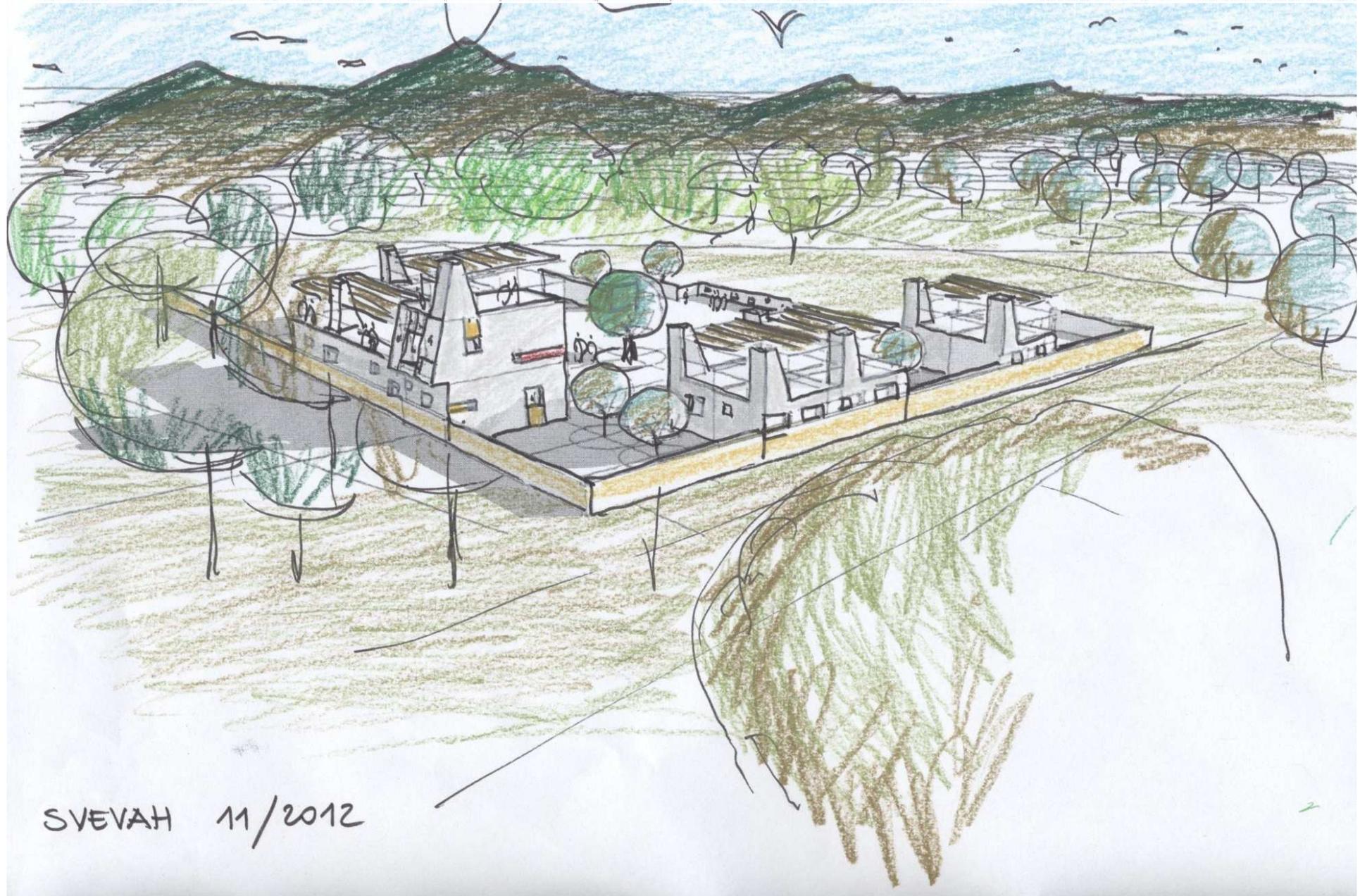
The European Directive 2002/91/CE was emanated with a double purpose: a reduction of the energy consumption with limited emissions of GHG and the respect of the responsibilities taken with the Kyoto Protocol, reducing at the same time the dependency of the EU from the external fossil fuel sources.

The Directive leaves the responsibility to create the certification system to a National or Regional level,

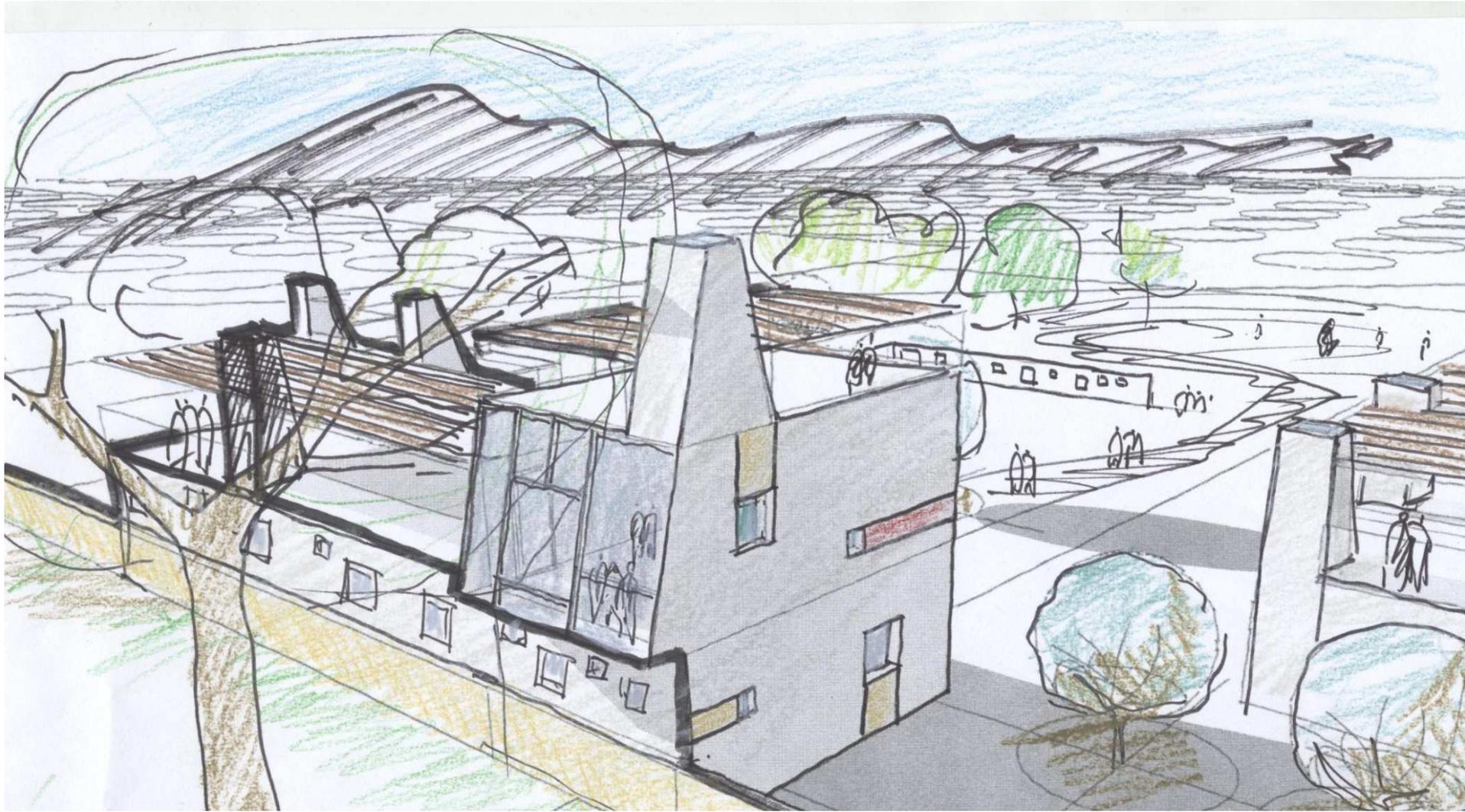
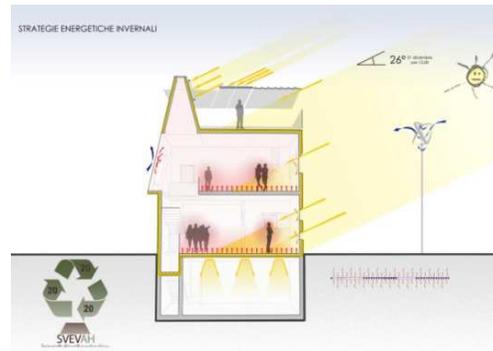
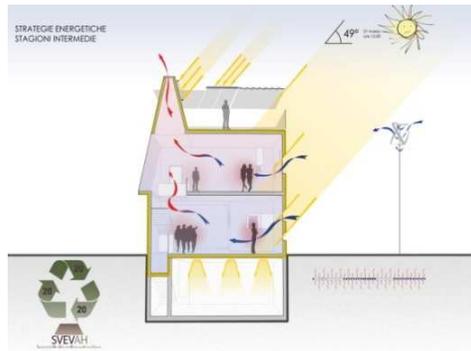
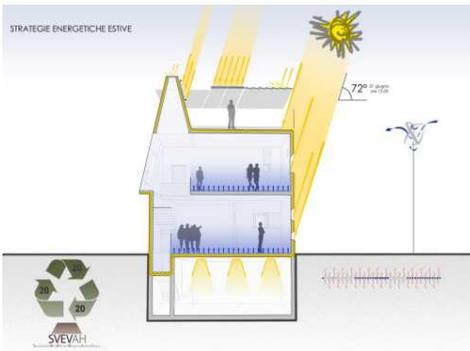


**SvevAH**

**Arianna Brambilla (Politecnico di Milano – Aalborg University )**



SVEVAH 11/2012



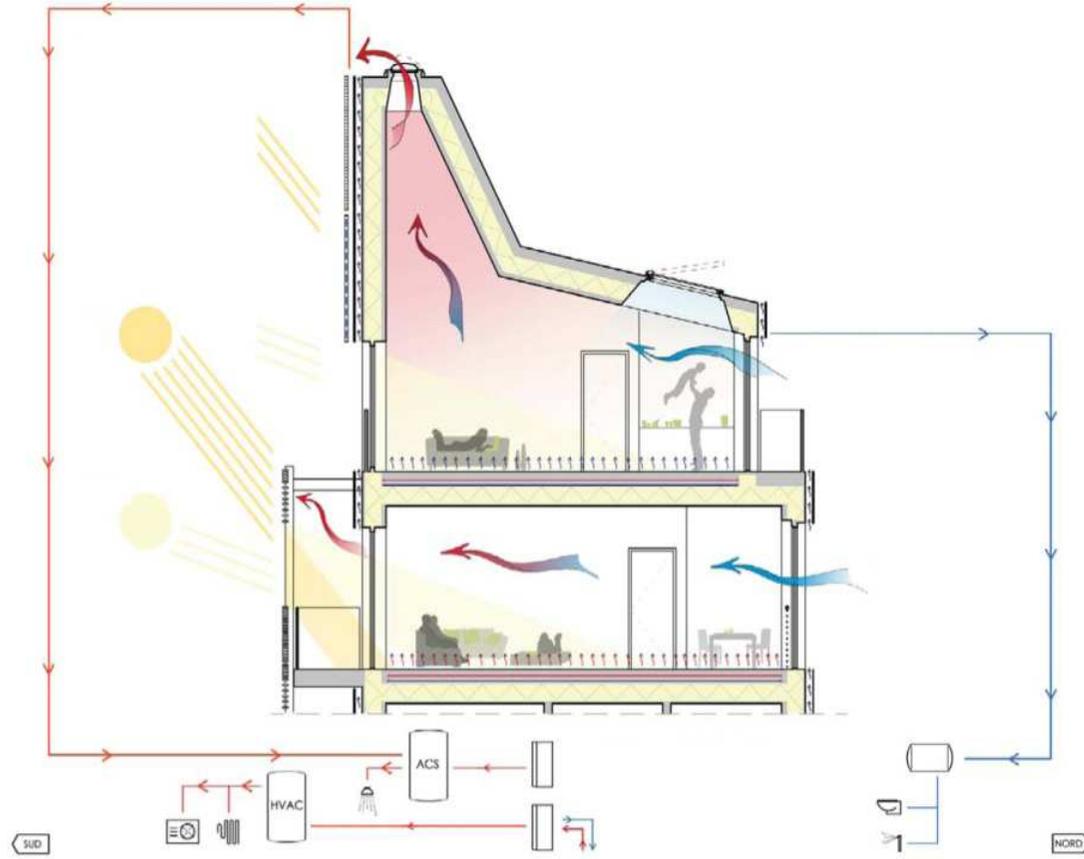
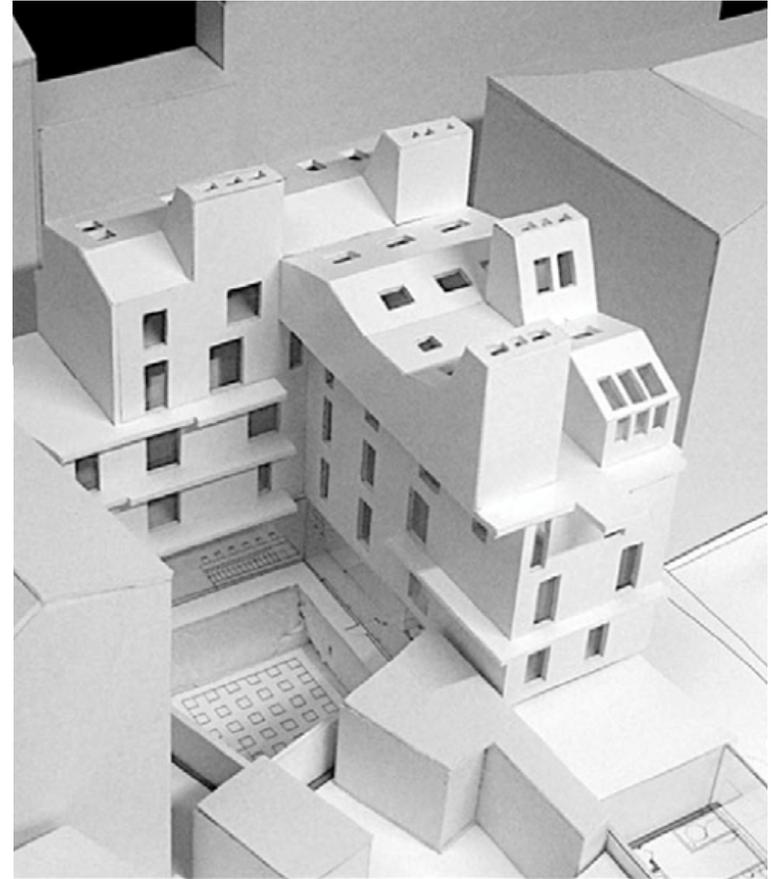
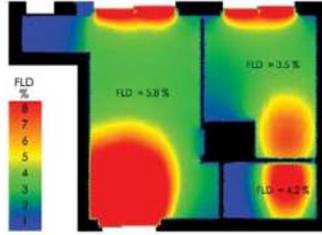
# BrerAH



Team:

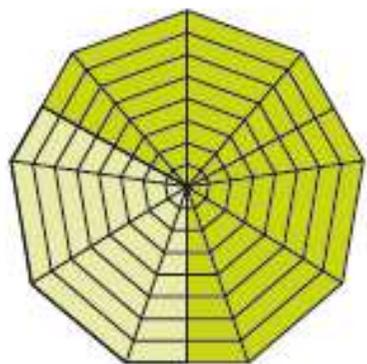
Nicola Falcone  
Chiara Zanello  
Valentina Zorzi







# AMBIENTE



# VELUXlab: Cantiere

Riuso dell' edificio



Bilbao 2007



Roma 2008



Milano, Rho Fiera, 2009



Politecnico di Milano, Campus Bovisa, 2011



1° Agosto 2011, h 6:00  
Politecnico di Milano, Campus Bovisa



VeluxLAB: inizio del cantiere



4 mesi di lavoro:  
Più di 20.000 viti, 100 m<sup>3</sup> di isolamento

# Materiali

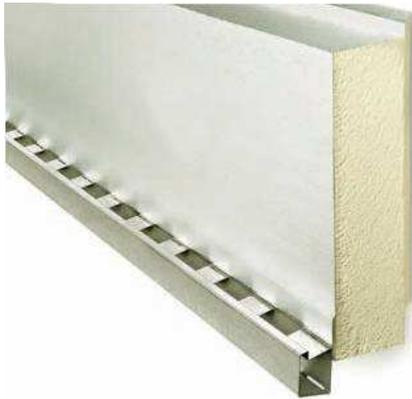
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**Pannelli isolanti in fibra di legno**



**Pannelli isolanti in lana di roccia**



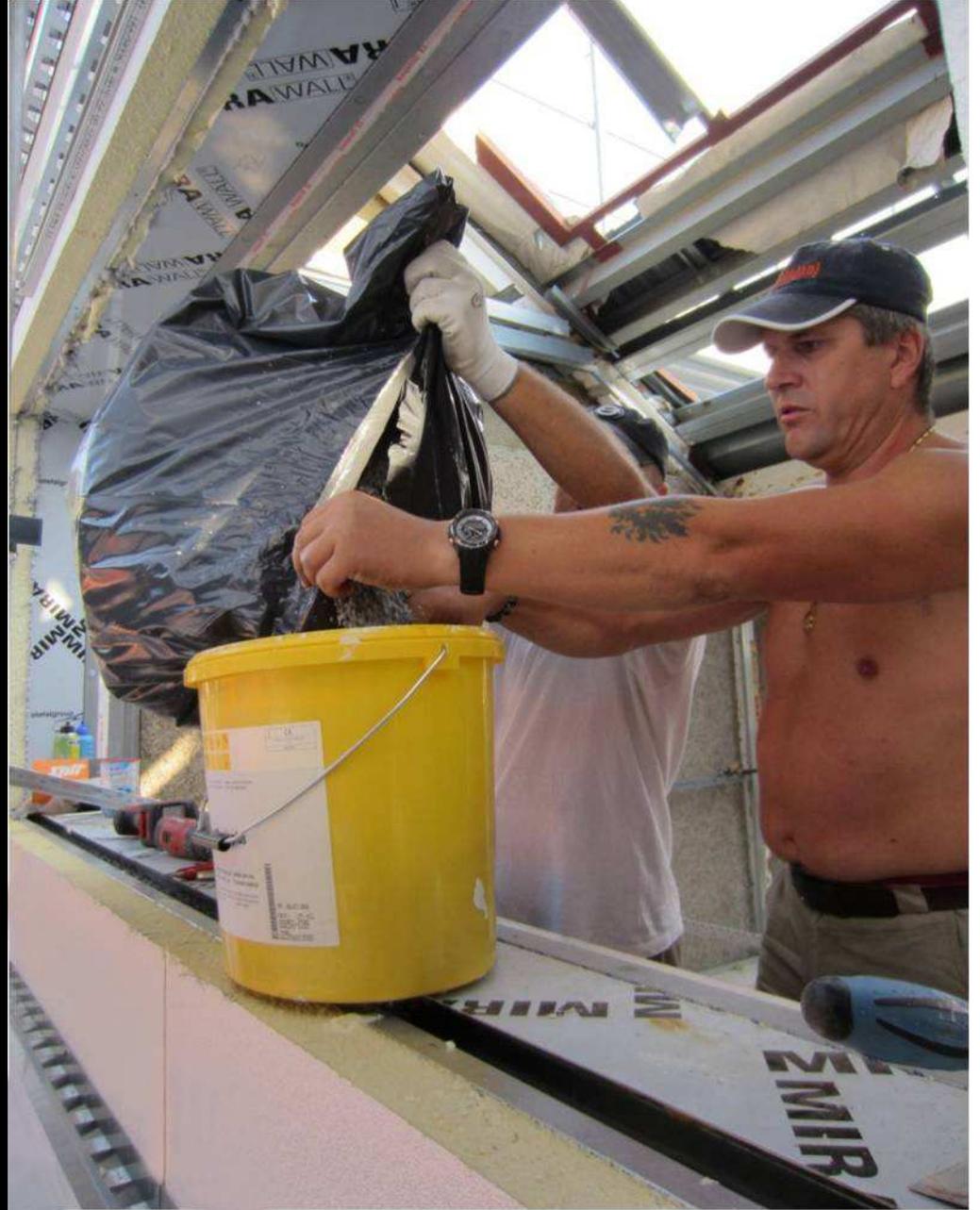
**Sistema isolante composto in poliuretano**



**Polistirene sbriciolato**



**Pannelli in OSB**



## Isolanti interni in lana di roccia



## Installazione impianto fotovoltaico



### Caratteristiche impianto fotovoltaico:

**9 pannelli (1652x994 mm) ovvero 14,8 mq.**

**Potenza di picco nominale: 2,16 kWp**

**Produzione stimata: 2688 kWh/anno**

**Compensazione: >90% del fabbisogno dell'edificio**



Il sistema di fissaggio sopra il dogato di alluminio garantisce la ventilazione del pannello (il pannello surriscaldandosi perde circa 0,5% di efficienza per ogni grado di temperatura)

# Esperimento Drone





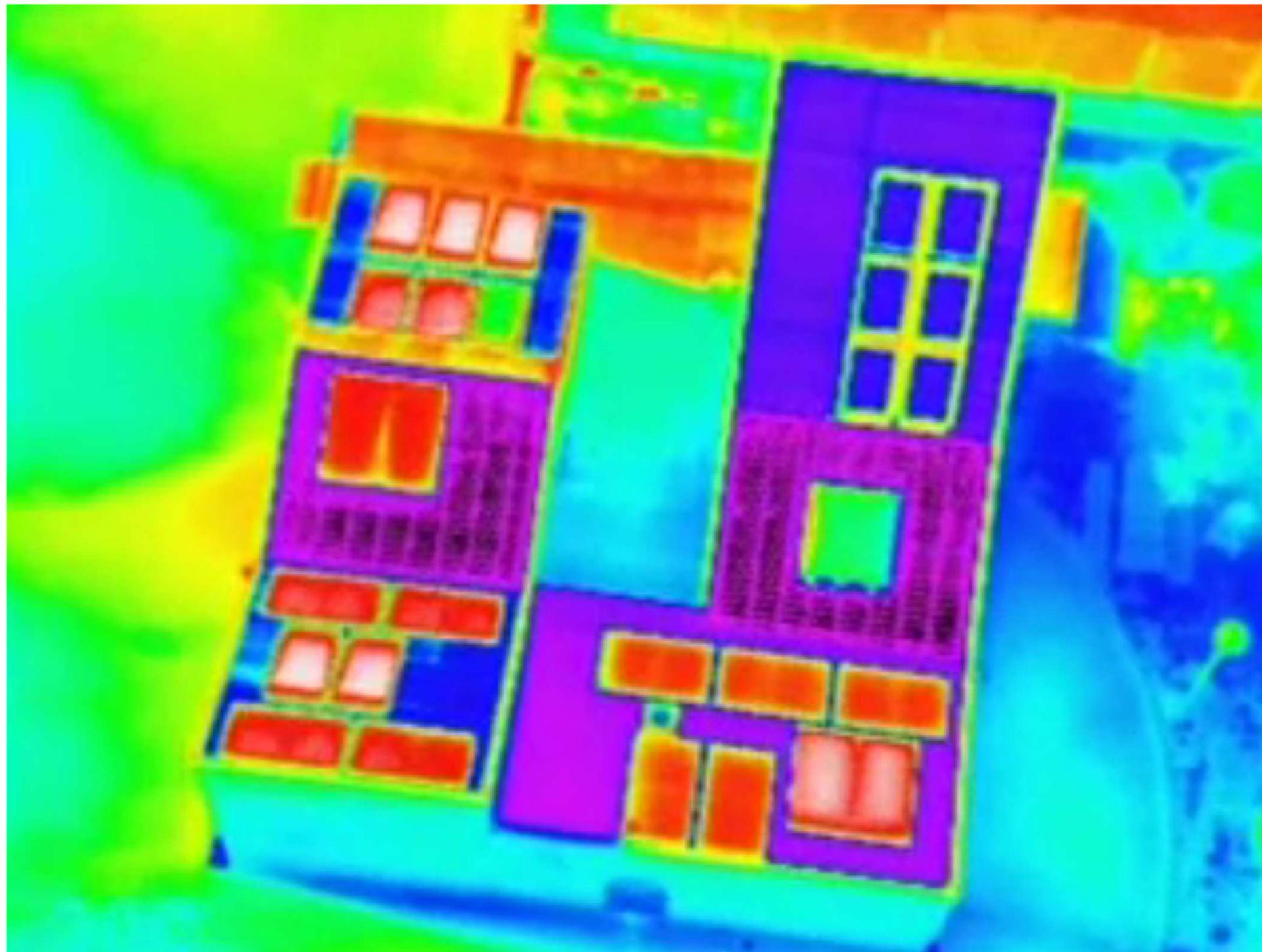


POLITECNICO DI MILANO  
**VELUX lab**





POLITECNICO DI MILANO  
**VELUX lab**



## Prima Active House a Bergamo – Maison Verte

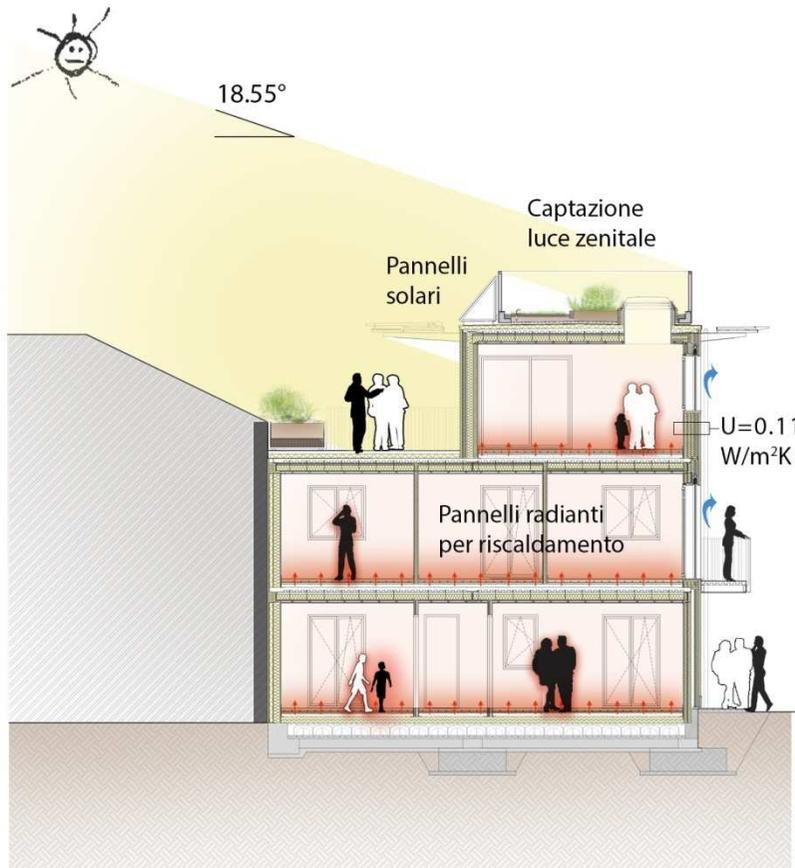


# Schema energetico

## SCHEMATIC DESIGN

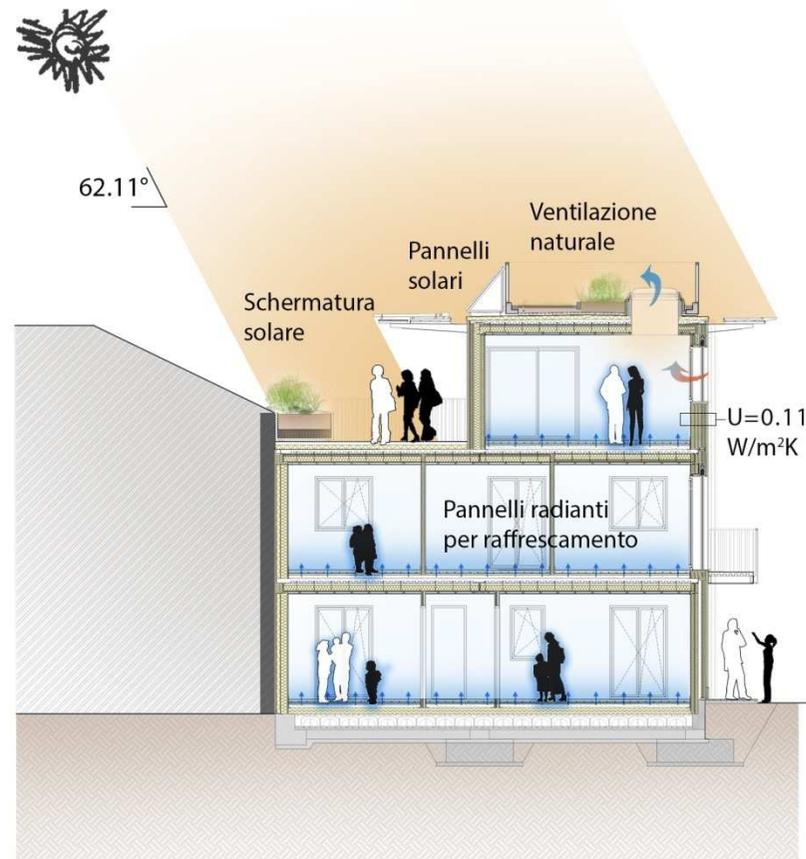
### Strategie energetiche invernali

- Iperisolamento con strati differenziati di isolante nelle chiusure opache
- Termotrasmittanza chiusure opache  $0.11 \text{ W/m}^2\text{K}$
- Pannelli radianti a pavimento per riscaldamento
- Captazione luce zenitale
- Pannelli solari termici
- Tetto giardino



### Strategie energetiche estive

- Inerzia termica delle chiusure opache
- Termotrasmittanza chiusure opache  $0.11 \text{ W/m}^2\text{K}$
- Pannelli radianti a pavimento per raffrescamento
- Ventilazione naturale/VMC
- Pannelli solari termici
- Schermatura della radiazione solare
- Tetto giardino



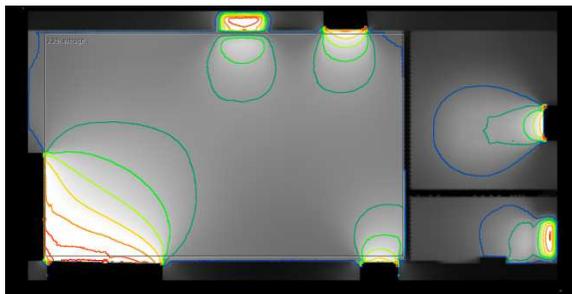
# Analisi illuminotecniche

## Fattore medio di luce diurna.

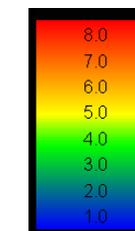
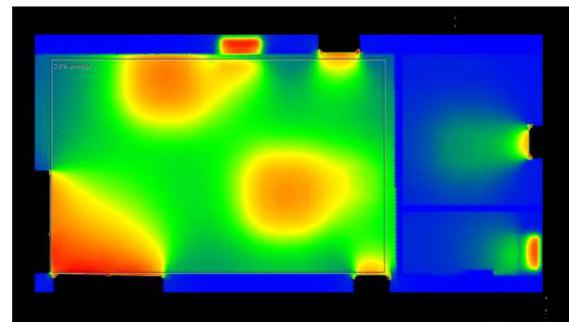
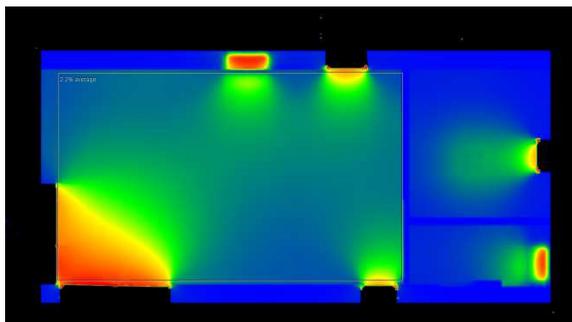
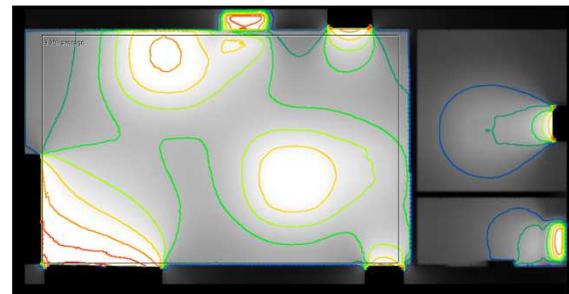
Nella situazione con i cupolini (a sinistra), la luce zenitale assicura alti valori di FLD con una distribuzione omogenea della luce rispetto alla situazione senza cupolini (a destra) priva di aperture zenitali.



FLDm= 2,2% situazione senza cupolini



FLDm= 3,8% situazione con cupolini

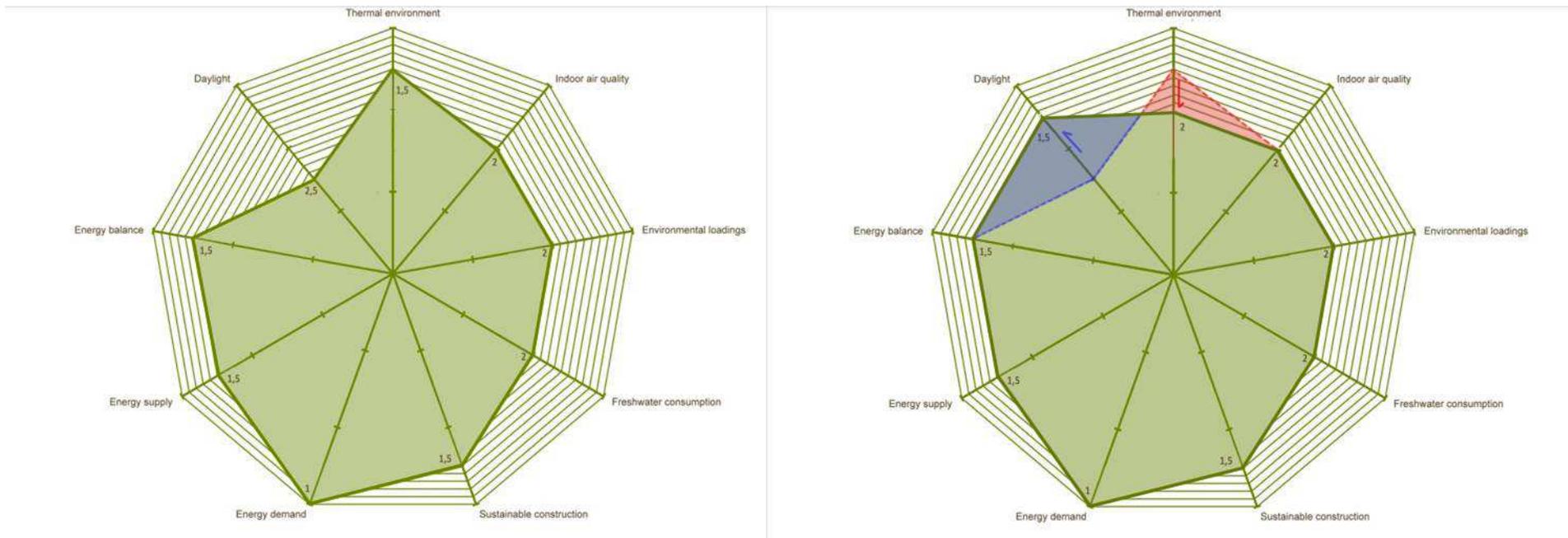




# Validazione Active House

Situazione senza cupolini  
Parametro Daylight= 2,5

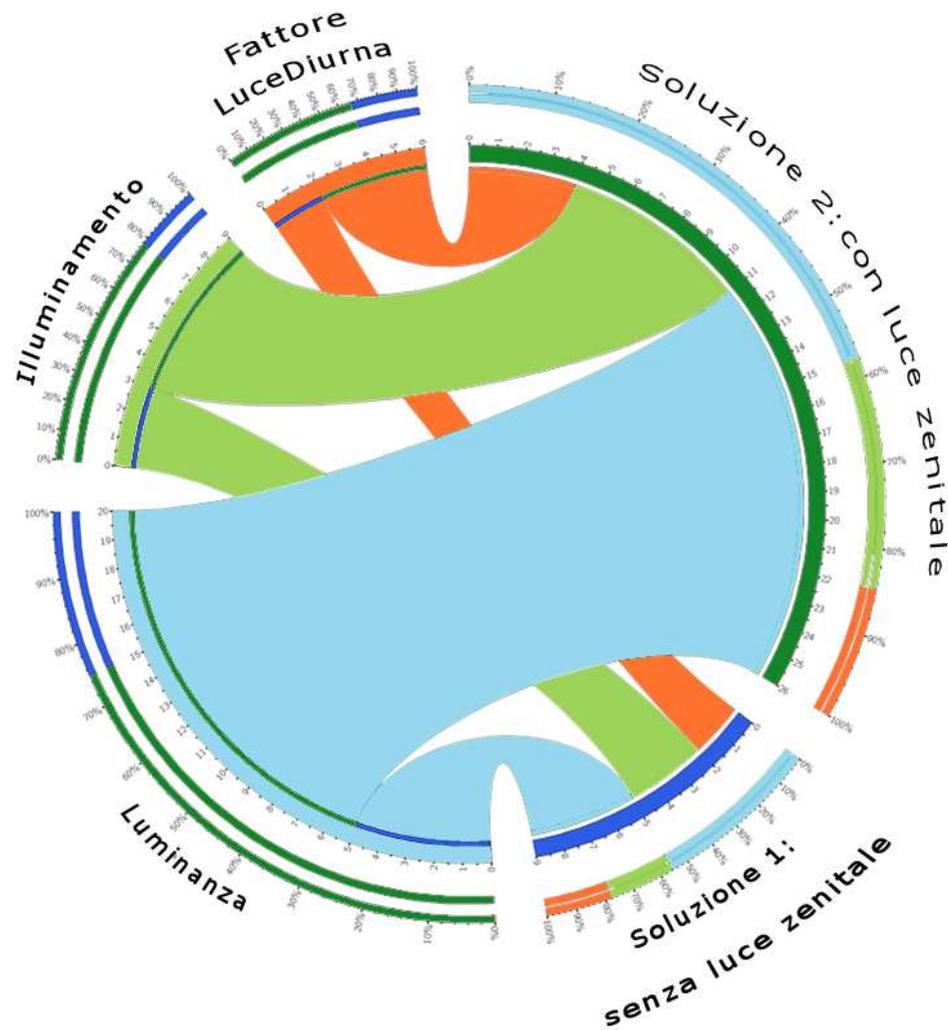
Situazione con cupolini  
Parametro Daylight= 1,4



## Dati Radar di progetto.

Radar Active House realizzato in fase progettuale come strumento per l'ottimizzazione e l'individuazione delle criticità. Variazione del parametro di Daylight nella situazione senza aperture zenitali (sinistra) rispetto alla soluzione con i cupolini (destra)

# Analisi comfort interno

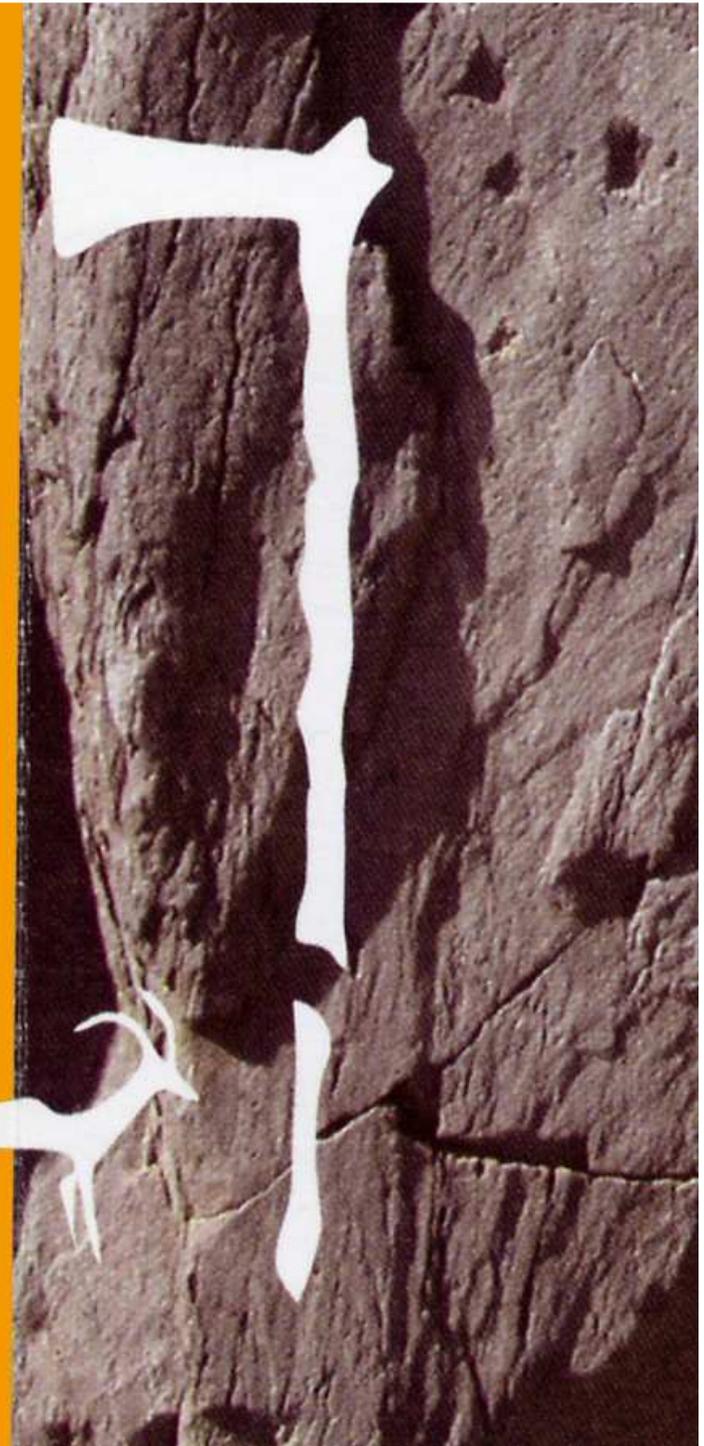


DATA	SOL1	SOL2
FLD	2.2	3.8
ILLUMINAMENTO	255.2	689.3
LUMINANZA	4.6	15.4

Analisi della differente incidenza dei parametri di comfort luminoso (FLD, Illuminamento, Luminanza) nella situazione senza aperture zenitali (SOL1) rispetto alla soluzione con i cupolini (SOL2)

*Il sole è nuovo ogni giorno ...*

*Eraclito*







*Si sente la necessità assoluta di muoversi.*

*E soprattutto di muoversi in una direzione particolare.*

*Una doppia necessità: muoversi e sapere in che direzione.*

*D.H. LAWRENCE, Mare e Sardegna*



