SHC SOLAR HEATING & COOLING PROGRAMME INTERNATIONAL ENERGY AGENCY

International Energy Agency
Energy Conservation in Buildings and Community Systems Programme

NET ZEB TASK 40 /ANNEX 52

The challenge of designing Net Zero Energy Buildings in Tropical Climates

The Reunion experience

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UNIVERSITY OF REUNION ISLAND
Opening up to the outside world

piment

NZEB design :
How to meet the low/zero energy target ?

1st question : what is a NZEB ?

NZEB Energy performance < 50% standard building

Balance between the overall **VERY LOW** energy consumption and the RE supply on a certain timescale

Main idea : use of passive solutions as much as possible
The NZEB can be easily compared to a sailing boat

How to design low energy buildings ?

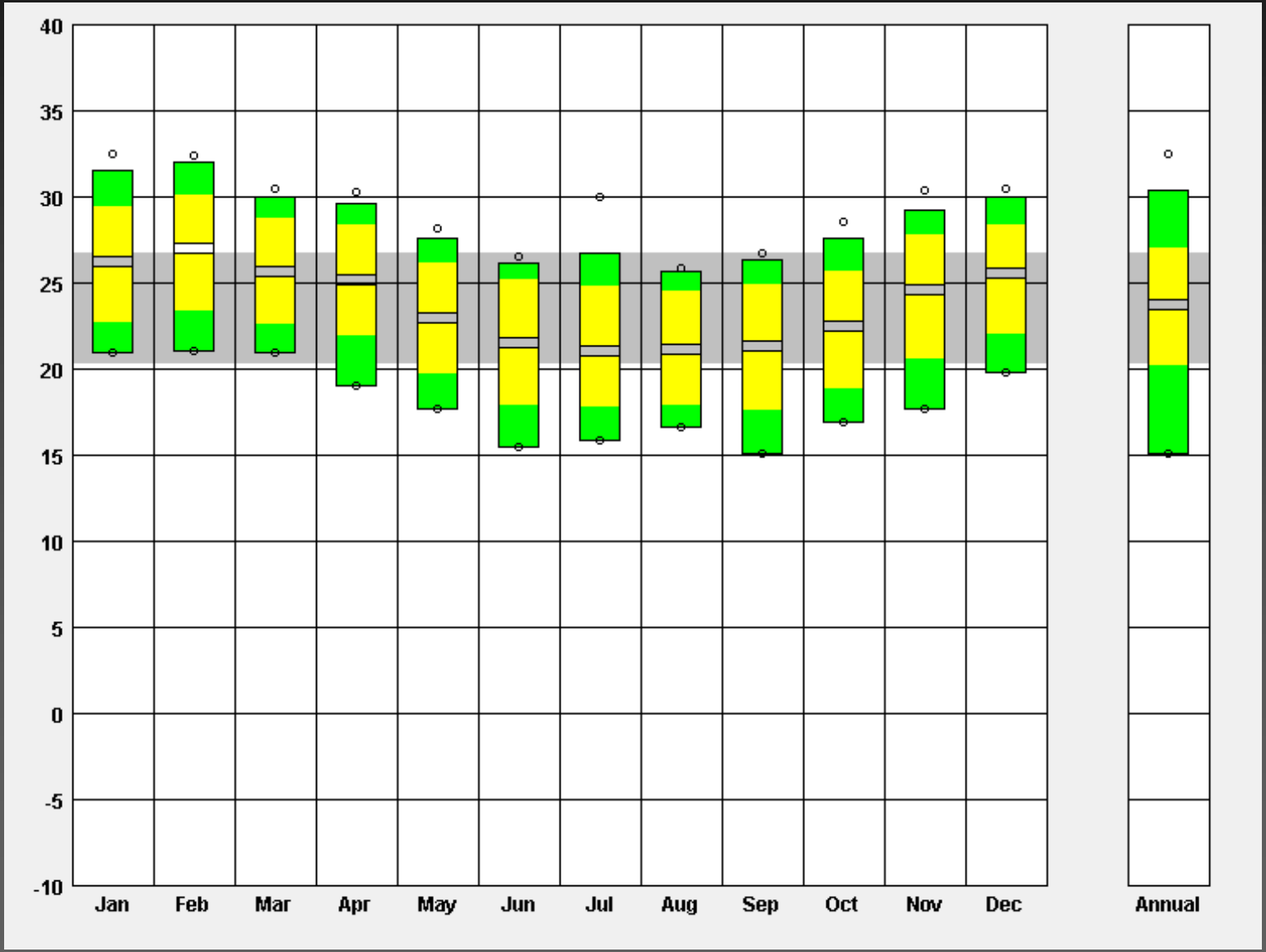
- Good knowledge of the climate
- Surroundings (vegetation around the building)
- Passive design (insulation, solar shadings, natural ventilation, daylighing)
- Innovative or alternative solutions sets
- Energy efficiency of systems (better COP, EE light bulbs etc.)

Then, Renewable Energy

IEA Task 40/Annex 52 : 19 Countries involved

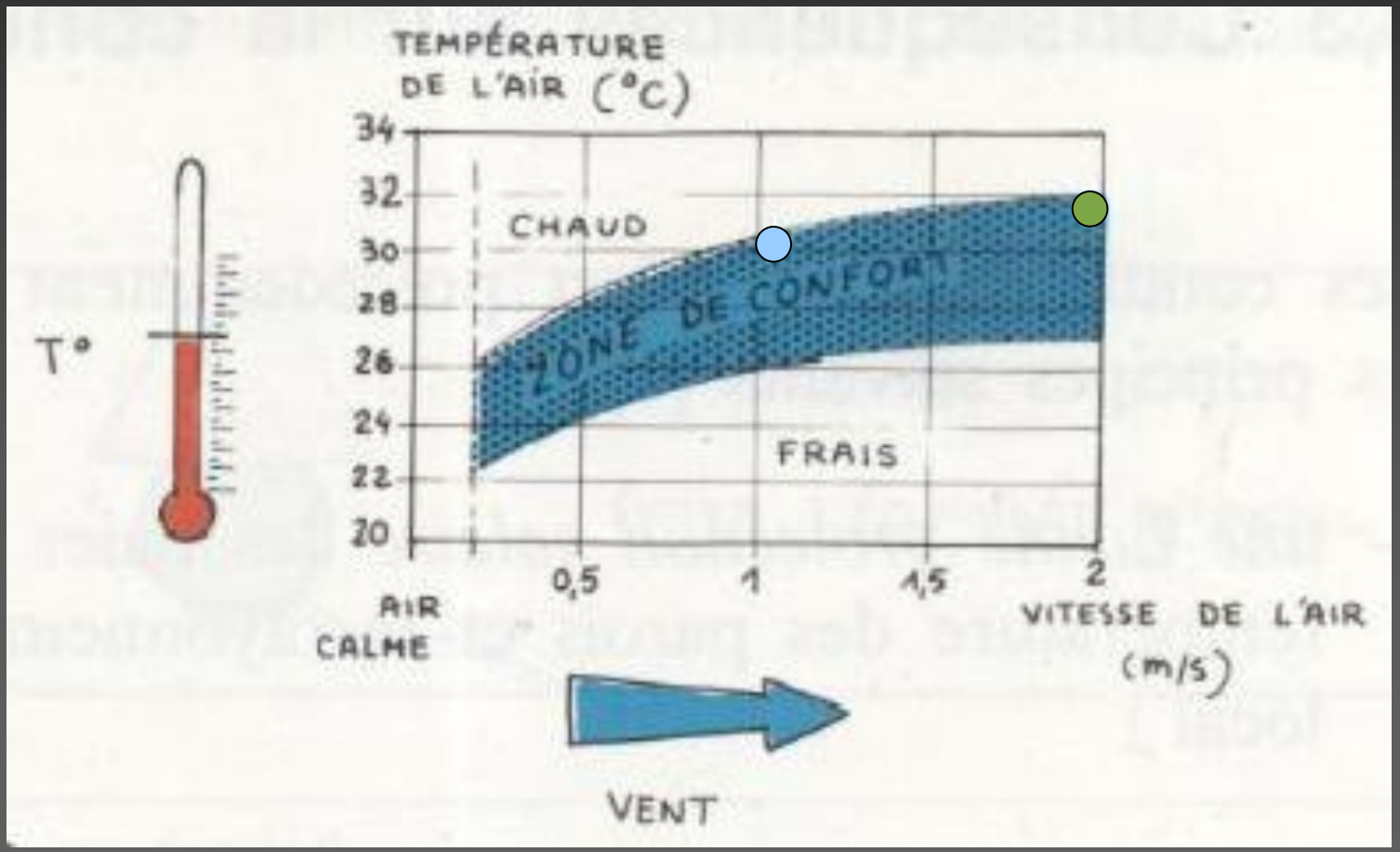
Towards Net Solar Energy Buildings

The climate of La Reunion

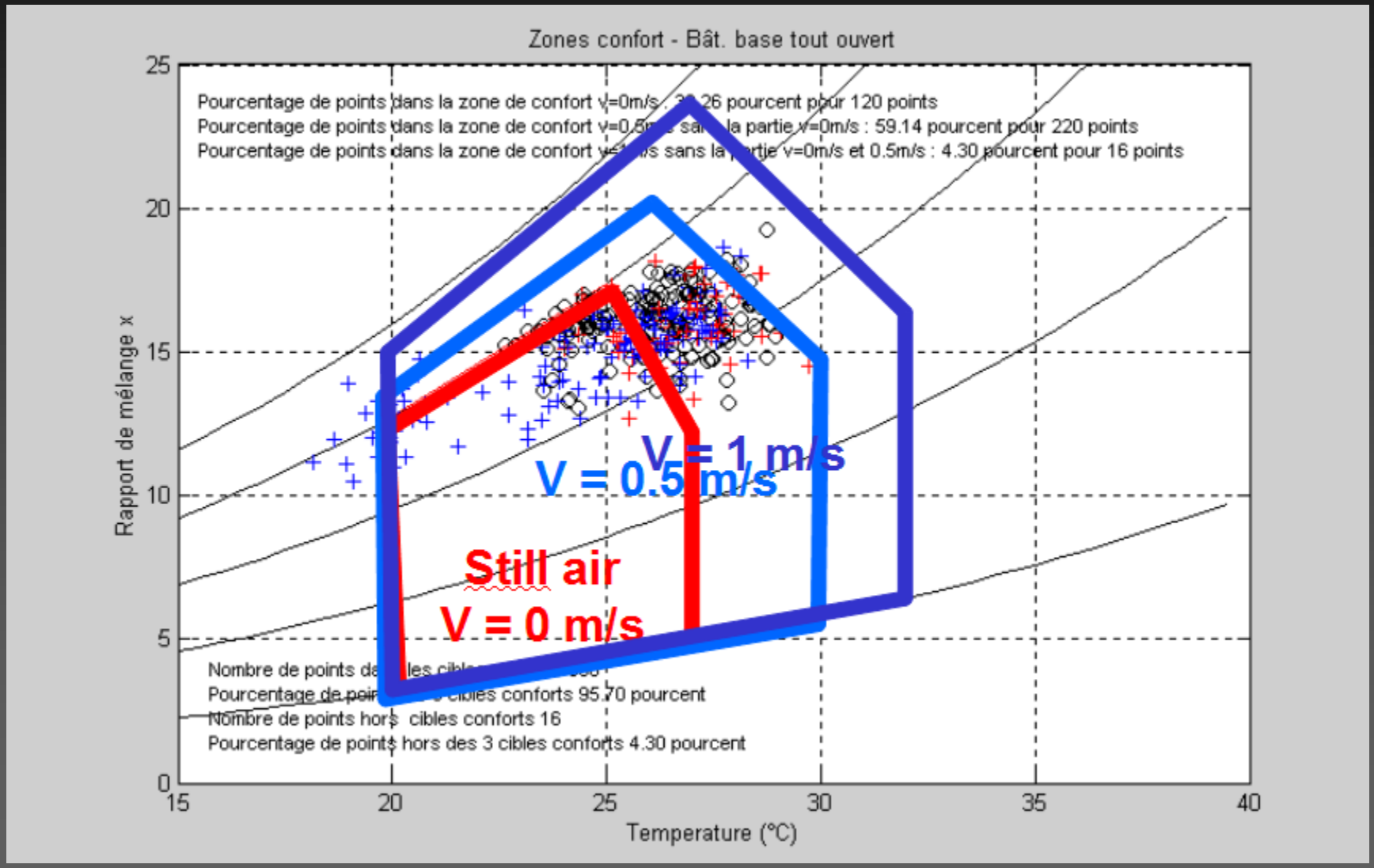


Thermal comfort in tropical climates/hot summer countries

- Two main principles :
  - Solar protection
  - Cross natural ventilation



A very simple tool to assess the thermal comfort : the Givoni's comfort zones



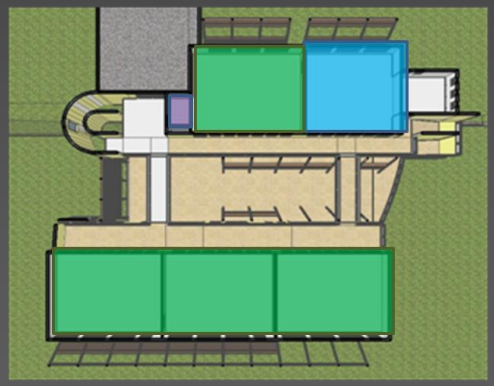
« ENERPOS » – 1st NZEB built in the French overseas territories

Requirements at the brief stage :

- Compliance with the PERENE guidelines
- Mandatory passive solutions : cross natural ventilation
- Limitation of the air-conditioning period to 3 months
- Artificial lighting density < 7 W/m²
- Energy consumption < 80 kWh/m².yr

ENERPOS– La Reunion

- Net floor area : 681 m² (7 classrooms + offices)
- 2 buildings / two floors
- BIPV roofs : 49 kWp/370 m²
- Completion : July 2008
- Building Cost : 1600€/m² (gross floor area)
- Architect : T Faessel-Bohe
- Energy consultants : IMAGEEN (La Reunion)
- Sustainable design consultants : TRIBU (Paris)



1st floor

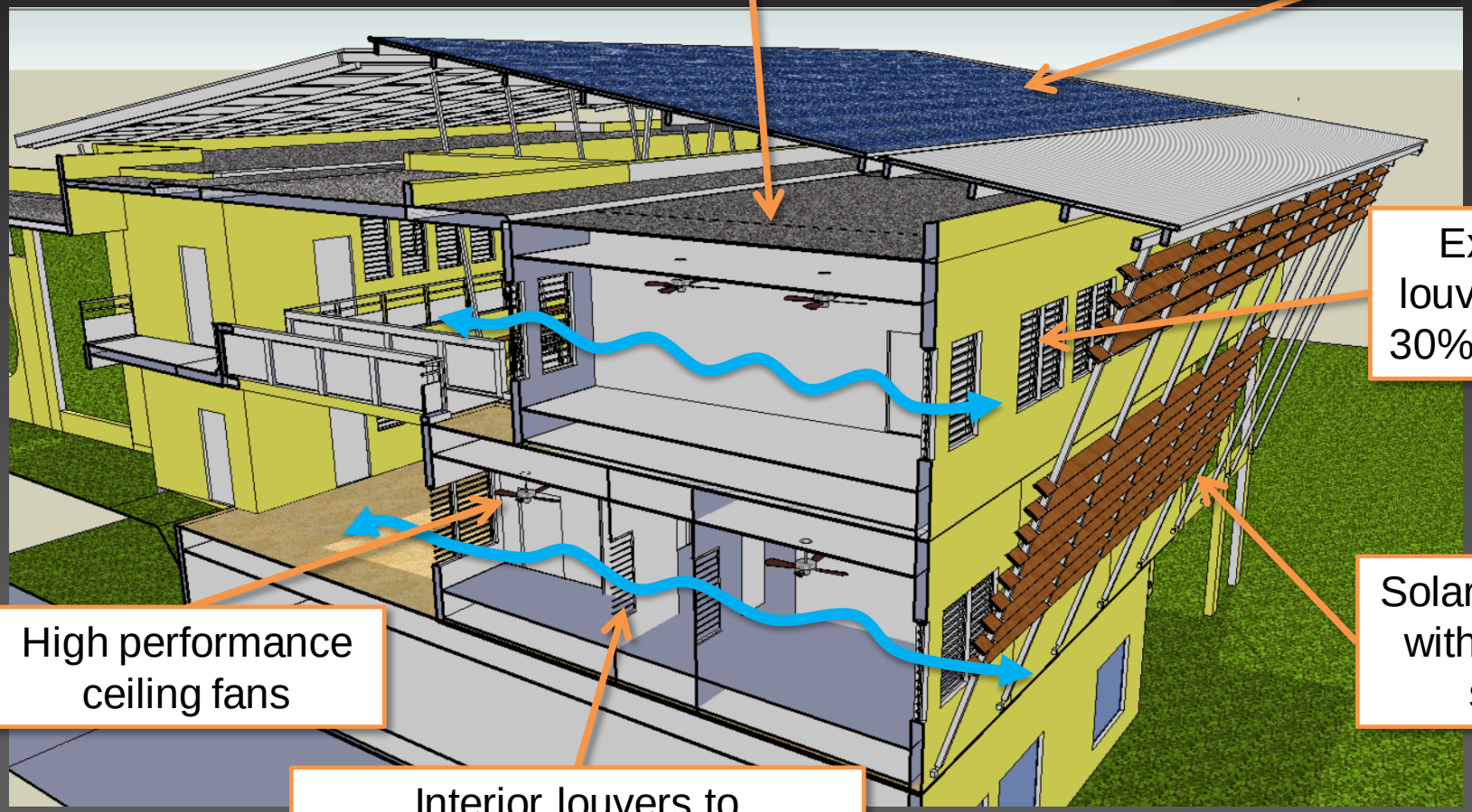
2nd floor

Air-conditioning (VRV) + Ceiling fans

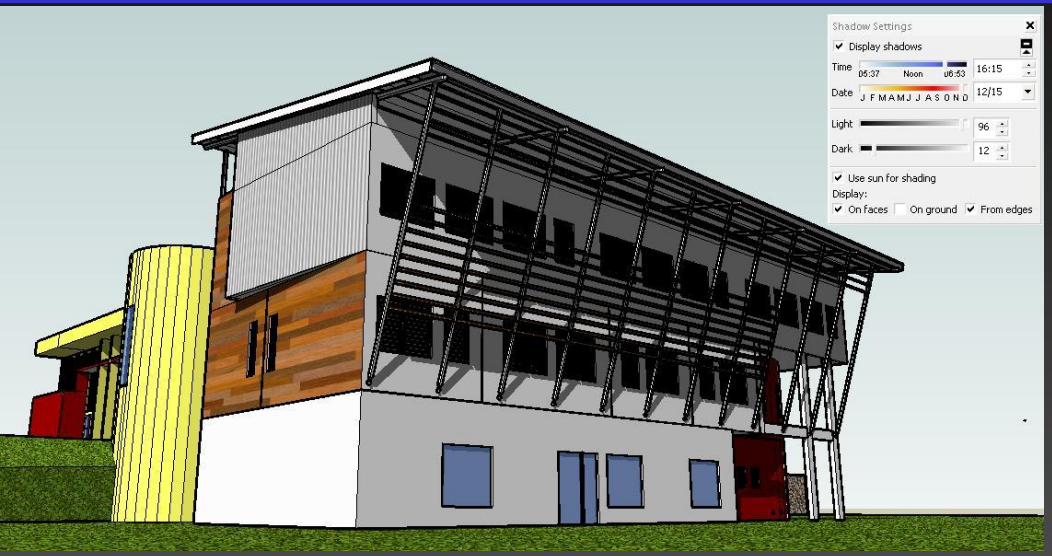
Celing fans

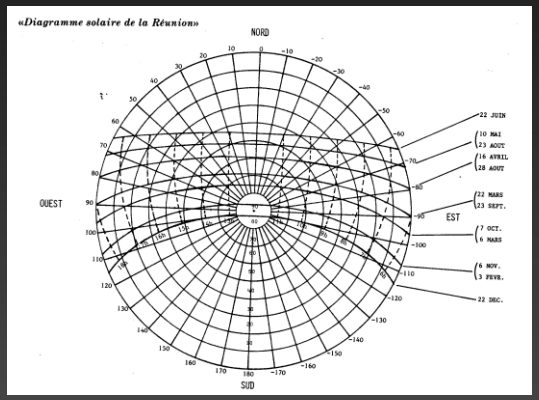
Air-conditioning (split systems)

NZEB : ENERPOS



Use of Sketchup to optimize the solar shadings





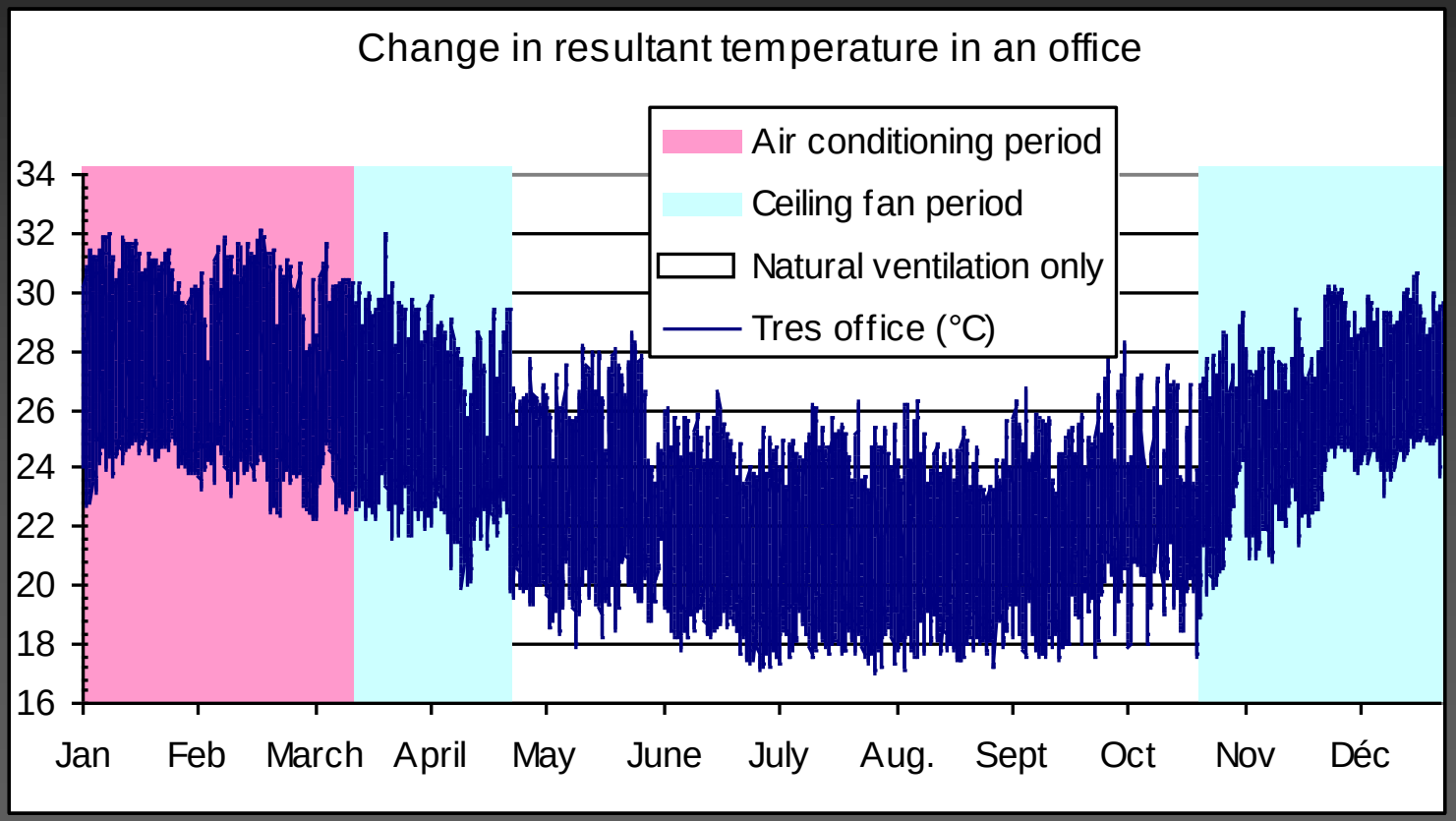
Pre-sizing by using the local solar diagram

Optimization of solar shadings by using Google Sketchup

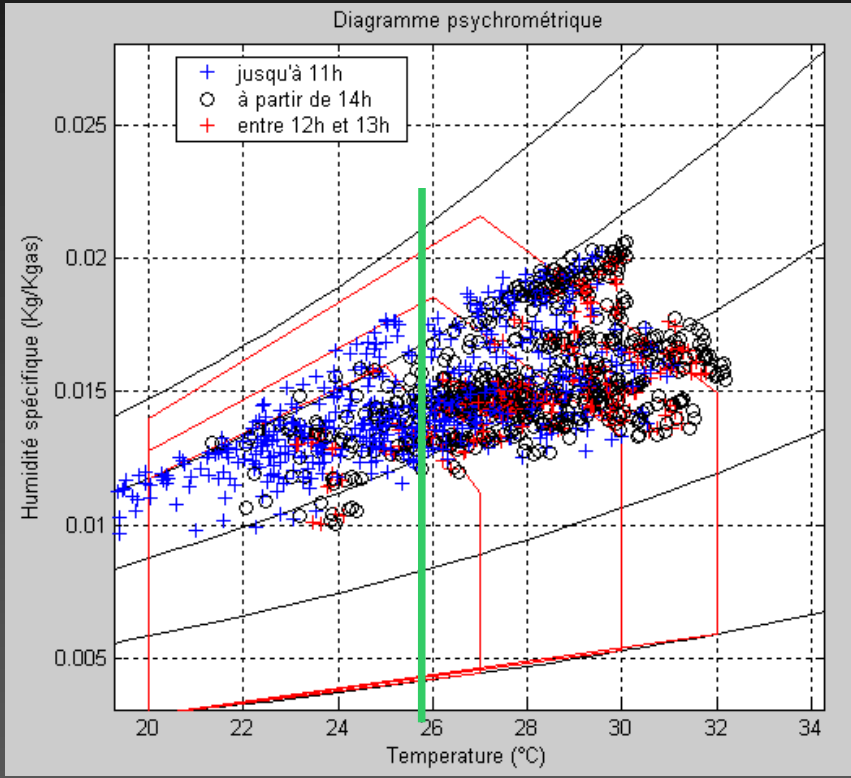
Validation : Picture and modeling view of the South-West façade in December.

Change in operative temperature in an office during a typical year *(results from Energy+/Design Builder)*

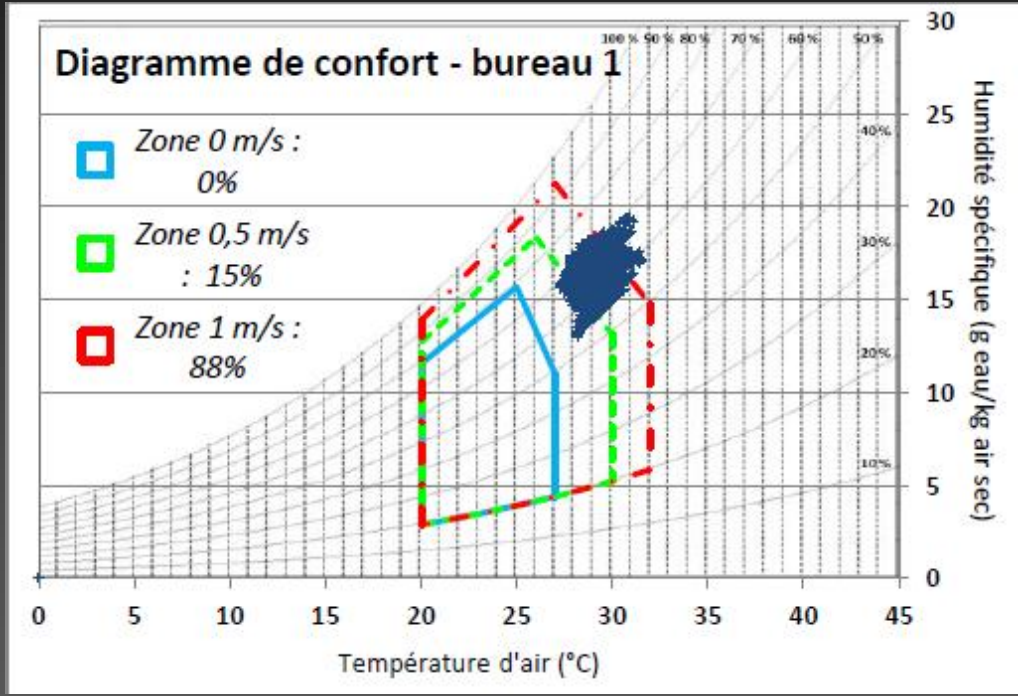
- Transition natural ventilation /air fans : Ta > 28°C and V=0,5 $m.s^{-1}$
- Transition air fans/air-conditioning : Ta > 30°C and V=1 $m.s^{-1}$



Number of hours of discomfort -



Office Design stage



Office Measurements March 2011


Jerome Balleydier


BiPV Roofs
370 m²/49 kWp


Jerome Balleydier


Jerome Balleydier

ENERPOS
Energy performance

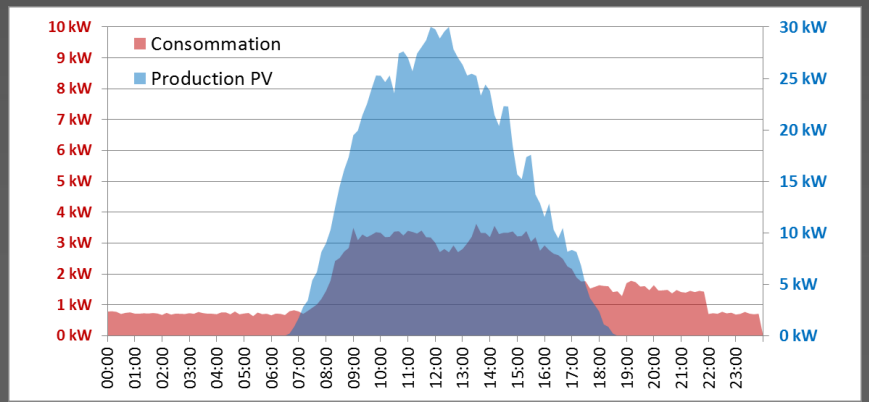
- **End uses**

Index kWh/m²nfa.y	Indoor lighting	Outdoor lighting	Ceiling fans	AC	Plug loads	Lift	Total
ENERPOS	2	1	1.6	2.2	6.6	1	14.4
Standard building	14	8	0	80.0	35.0	3	140.0

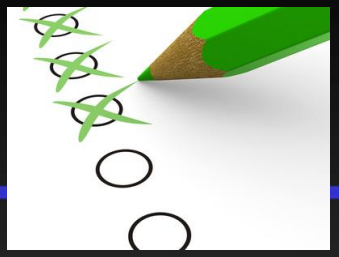
- **PV production and low consumption**

PV : 105 kWh/m²nfa.y

Consumption : 14.4 kWh/m²nfa.y



Thermal comfort survey

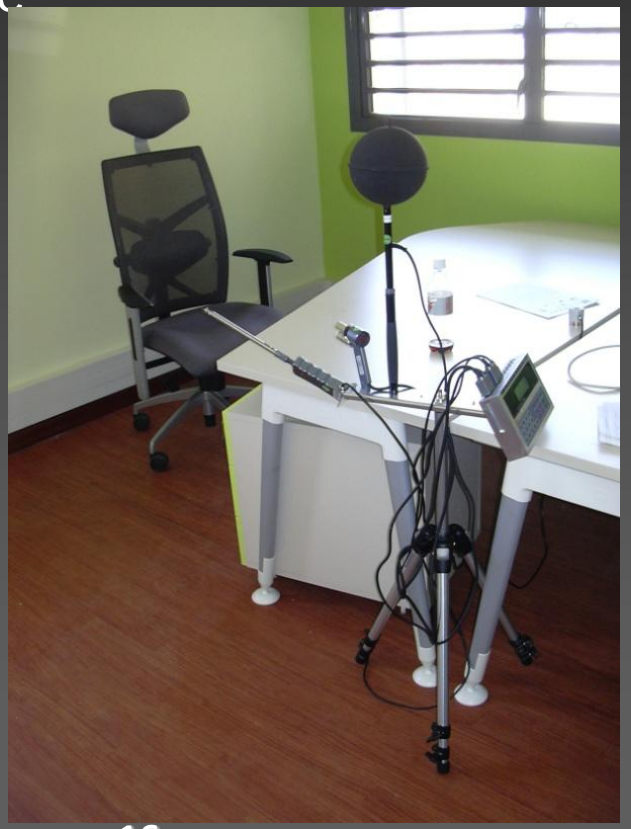


Survey

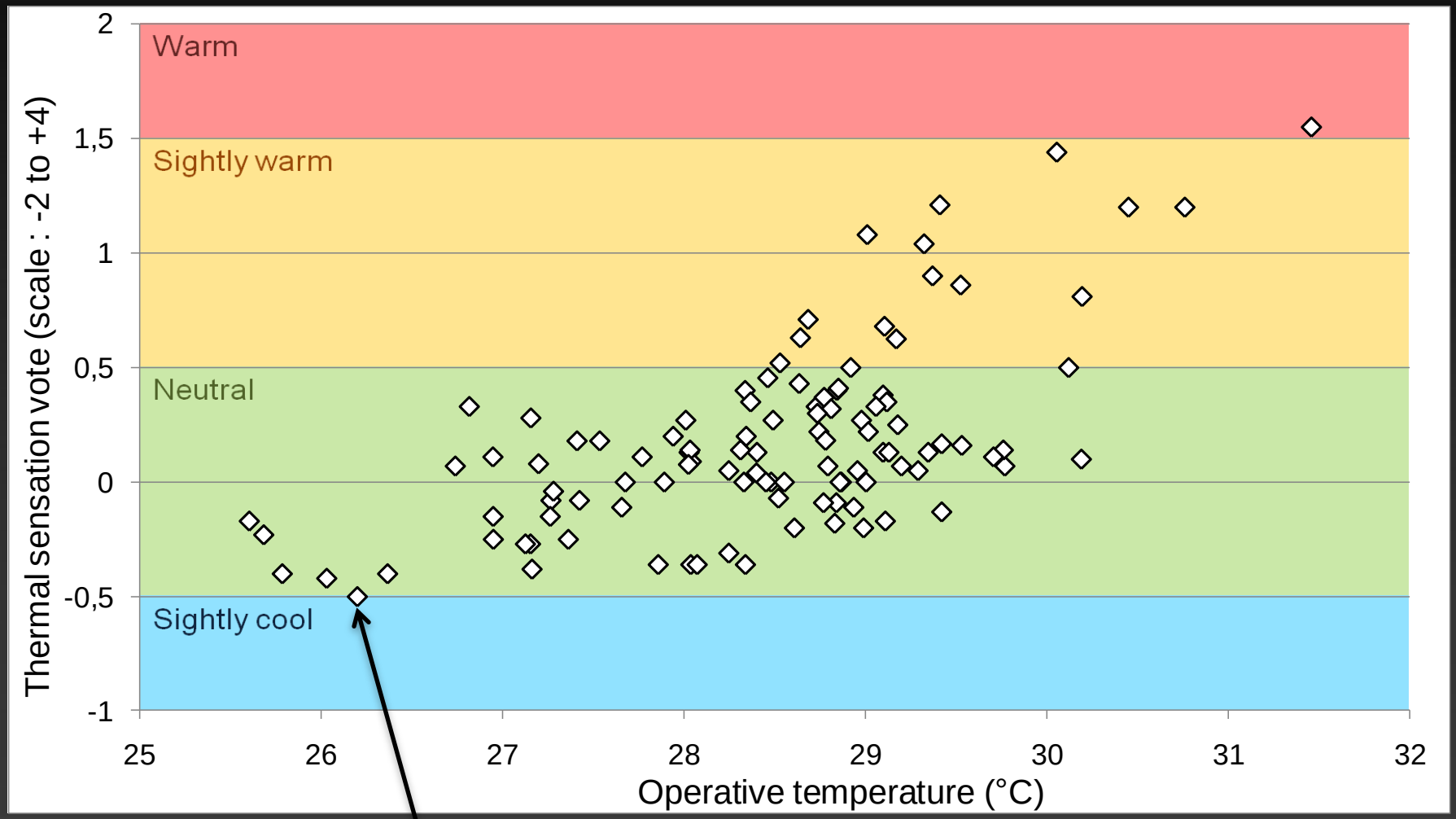
- Personnal information
- Thermal comfort at the *beginning* of the exposure
- Thermal comfort at the *end* of the exposure

Thermal comfort parameters measurements (1 min)

- Air temperature (°C)
- Black globe temperature (°C)
- Air humidity (%)
- Air velocity (m/s)
- Illuminance (Lux)



Results : 1700 surveys / 600 students



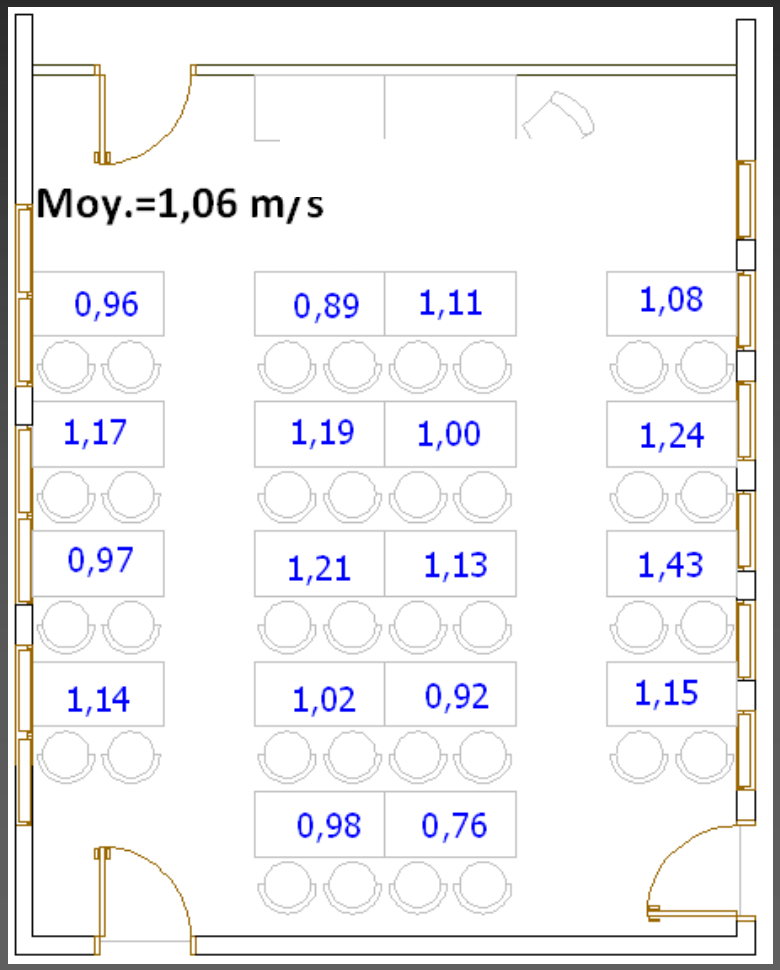
Each dot represents a 2 hours session (average of the votes of approx. 20 students)

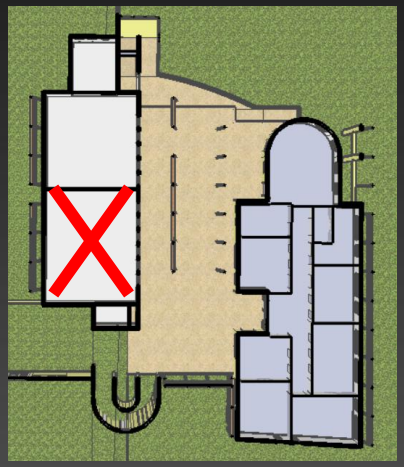
Ventilation

Ceiling fans

- 1 fan / 10 m^2
- Commands
  - Individual for offices
  - Grouped (2 or 4) for classrooms
- P_{fan} = 70 W (measured)

Air velocity in classrooms





Conclusion

- ENERPOS is 10 times less consuming than a standard building
- Thermal and visual comfort of the occupants thanks to **passive design**
- Air-conditioning can be avoided even during the hottest days in all classrooms
- Daylight autonomy ≈ 90%

To get active people in a passive building rather than the opposite

20

Lessons learned

NZEB are narrow buildings for daylighting and cross ventilation (14 max)

No air-conditioning is technically feasable in a tropical climate

Crucial role of the ceiling fan

Innovative Solution sets

- Narrow buildings
- Cross natural ventilation and solar protection
- Indoor louvers

Back to the roots ?

Thank your for attention

Questions