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Etudes et Diagnostics Aérauliques & Acoustiques

Free-cooling and night ventilation

How to avoid overheating ?

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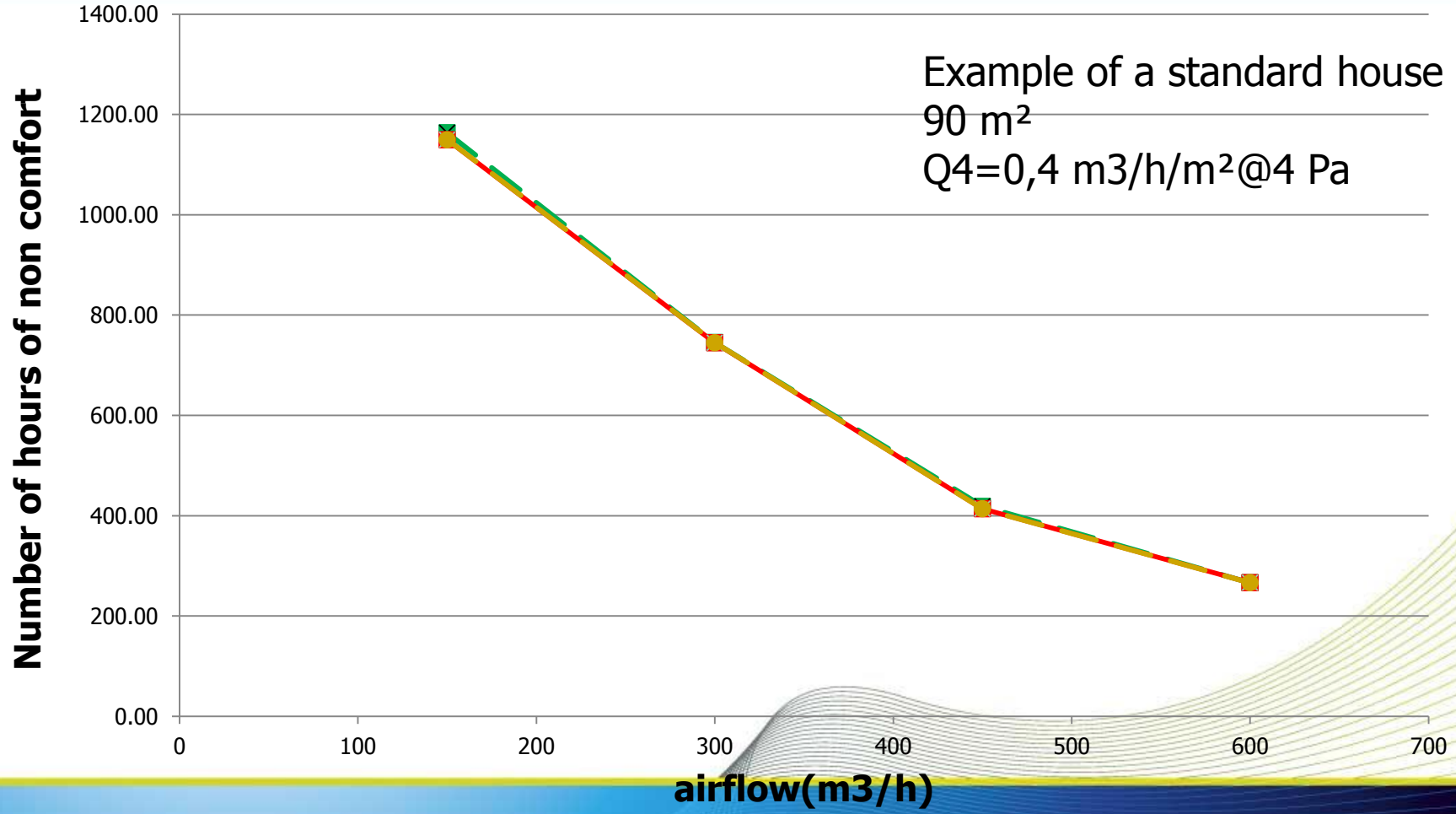
French Energy regulation

- From 2000 :
  - Indoor temperature without cooling
  - Compared to indoor temperature with a reference system
  - Weather file average on 30 years
- 2012 :
  - Weather file with extreme conditions
  - Adaptative comfort as in EN15251
  - Number of hours with non confortable temperature

French Energy regulation



Feasability of Free cooling

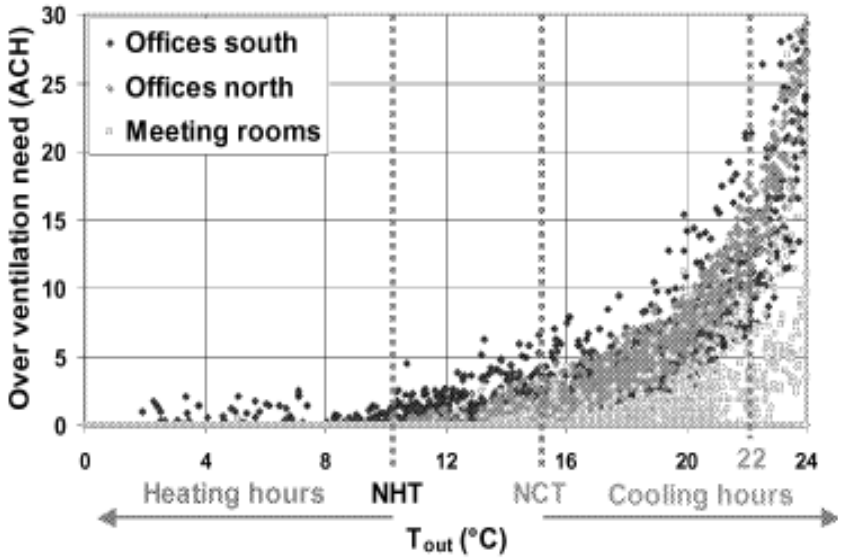


Figure 7. Additional ACH needed in the reference case.

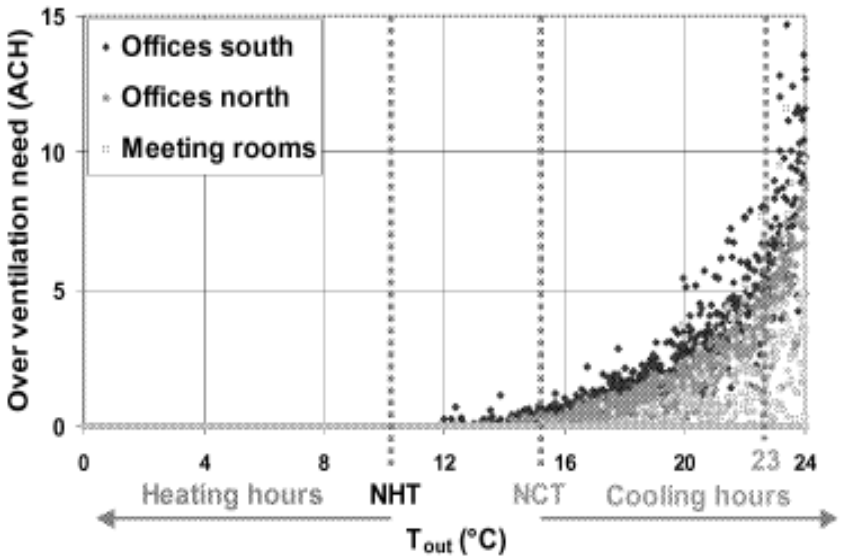
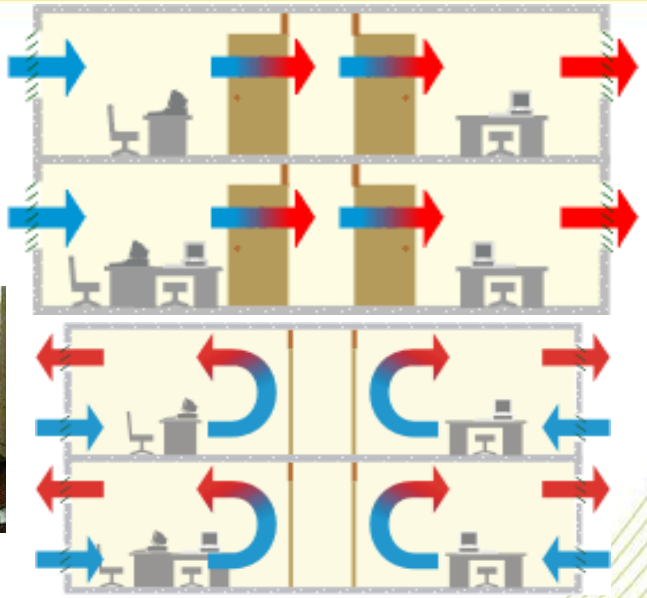


Figure 8. Additional ACH needed in the modified case.

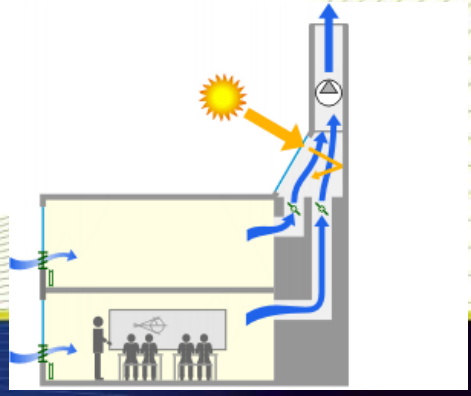
- Over-ventilation can only be efficient in an energy efficient building

Définitions

- Night over-ventilation : increase of flow in summer at night to fresh up buiding
  - Cross-flow
  - stack ventilation
  - Mechanical



- Free-cooling : increase of flow at mid-season to fresh up buiding
  - Commercial buildings : linked to high internal loads



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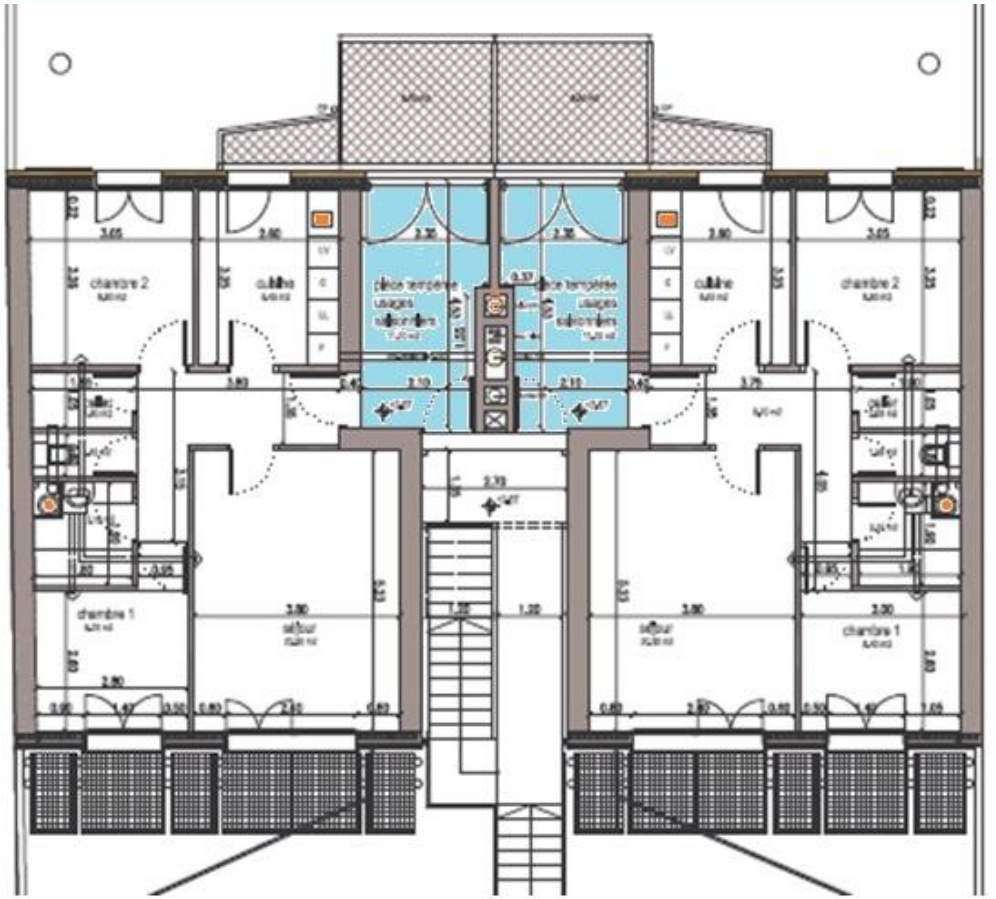
Example 1
Collective Dwelling

Example : IVRY Collective Dwelling

- Owner : Habitats Solidaires (social)
- Architect : C. Binetruy
- Energy designer : TCEP
- Ventilation : ALLIE AIR

- 398 m², 6 dwellings
- 2 floors + ground
- North /South wood frame
- East/West brick



Ivry : ventilation

- Central supply and exhaust
- Double skin ducts with joints, 50mm insulation (add. cost 10 k€)
- Sound attenuator (25 dB(A) global & 20 dB @ 250 Hz in bedrooms)

	Nominal	Boost
airflow (m3/h)	630	1020
Avail.Pressure (Pa)	150*	150*
Fan absorbed power (W)	143	281
Sound Power level (Lw) dB(A)	-	76

560 W in over-ventilation

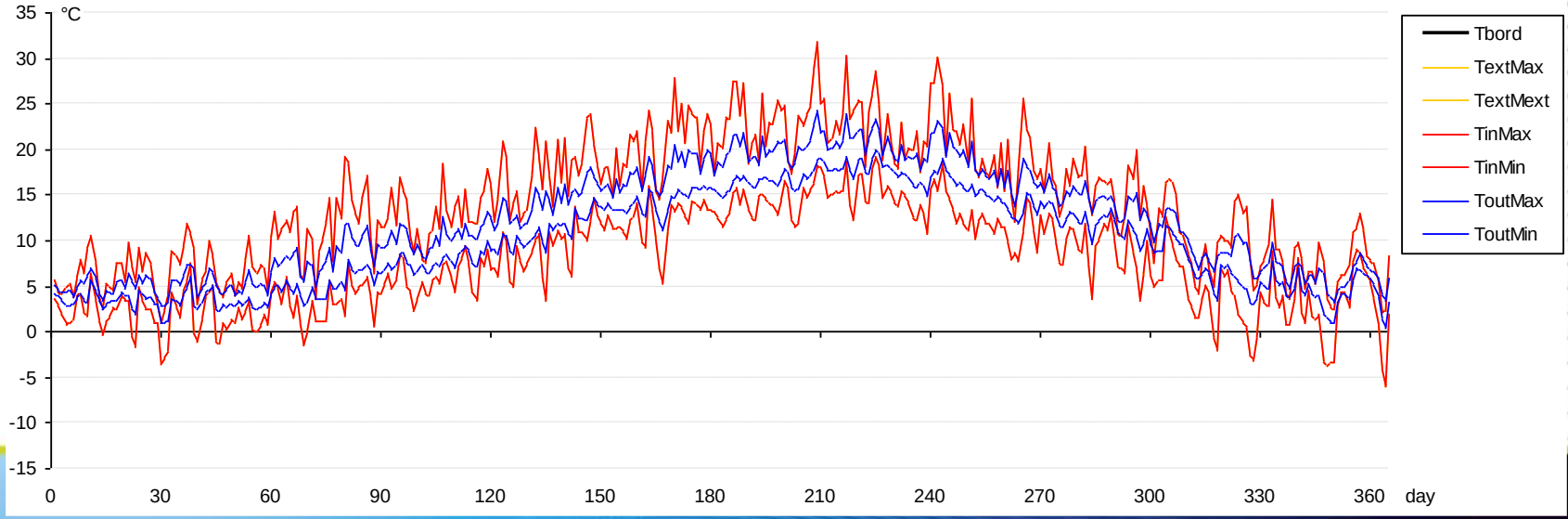
Ivry : ground heat exchanger

NOT CHOSEN

- 70m
- D400 mm
- depth : 1m

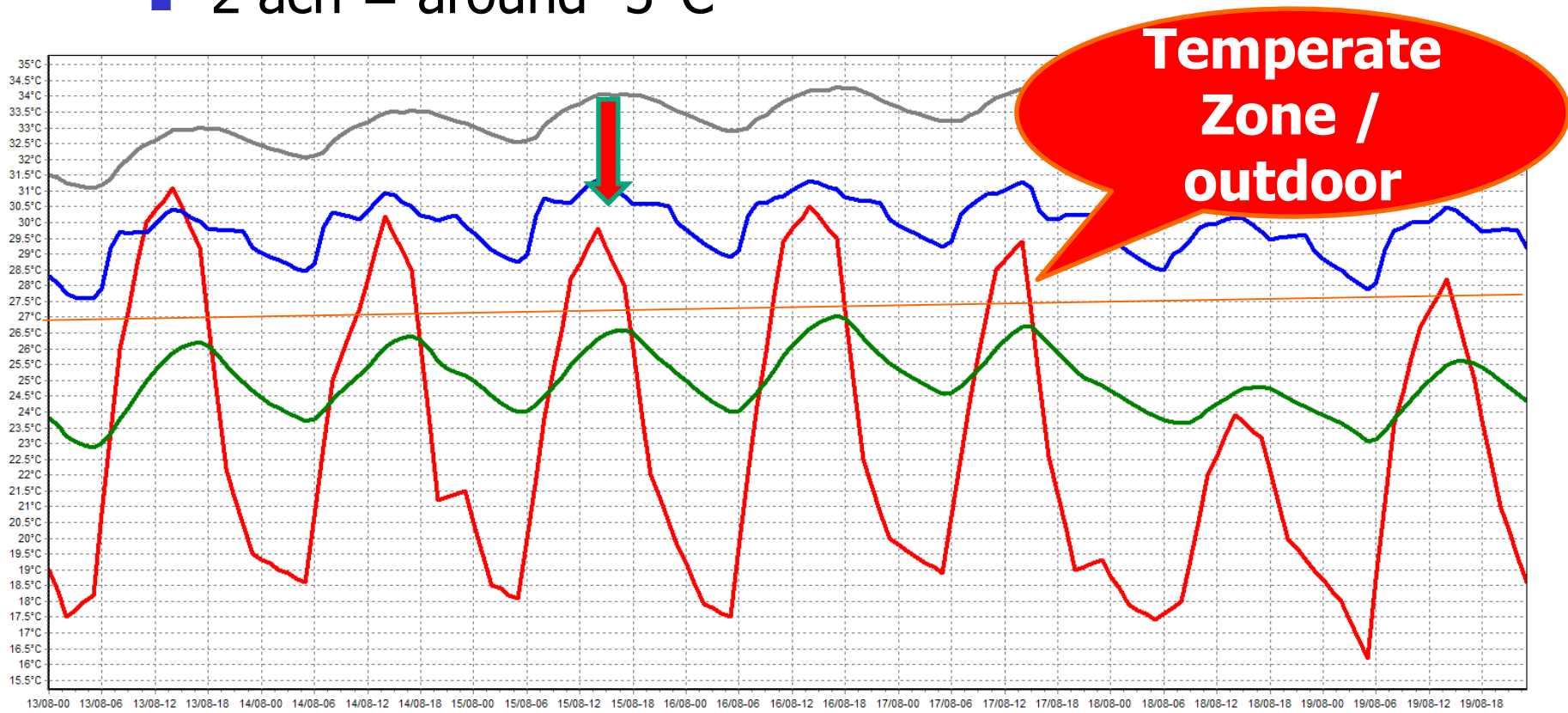
	Temperature after ground exchanger °C	
	Mini	Maxi
June	11,2	20,5
July	14,8	24,2
Aug	14,9	23,9
Sept	11,9	21,9

365 days : daily min/max



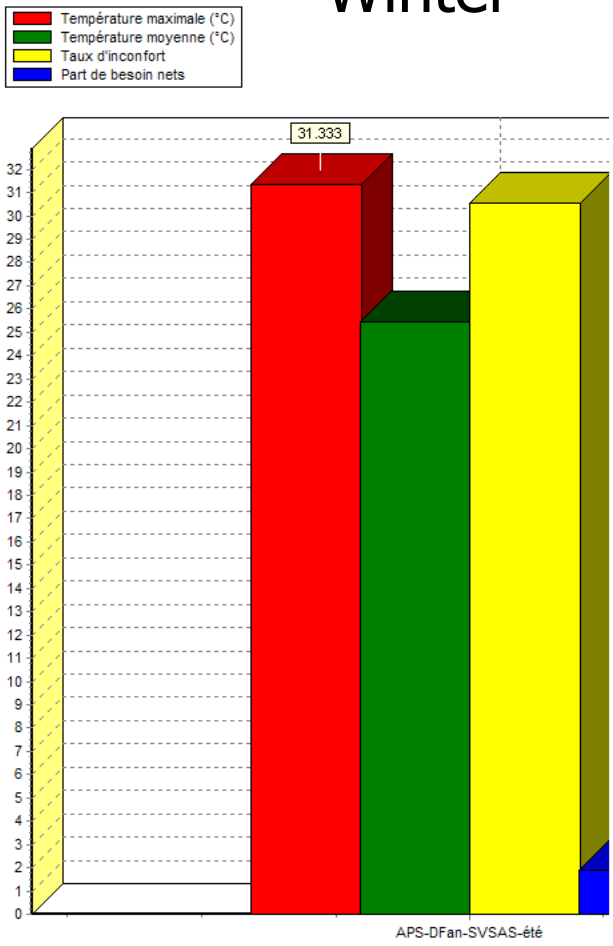
Ivry Over-ventilation

- Simulations on Pleiades Comfie
- 2 ach = around -3°C

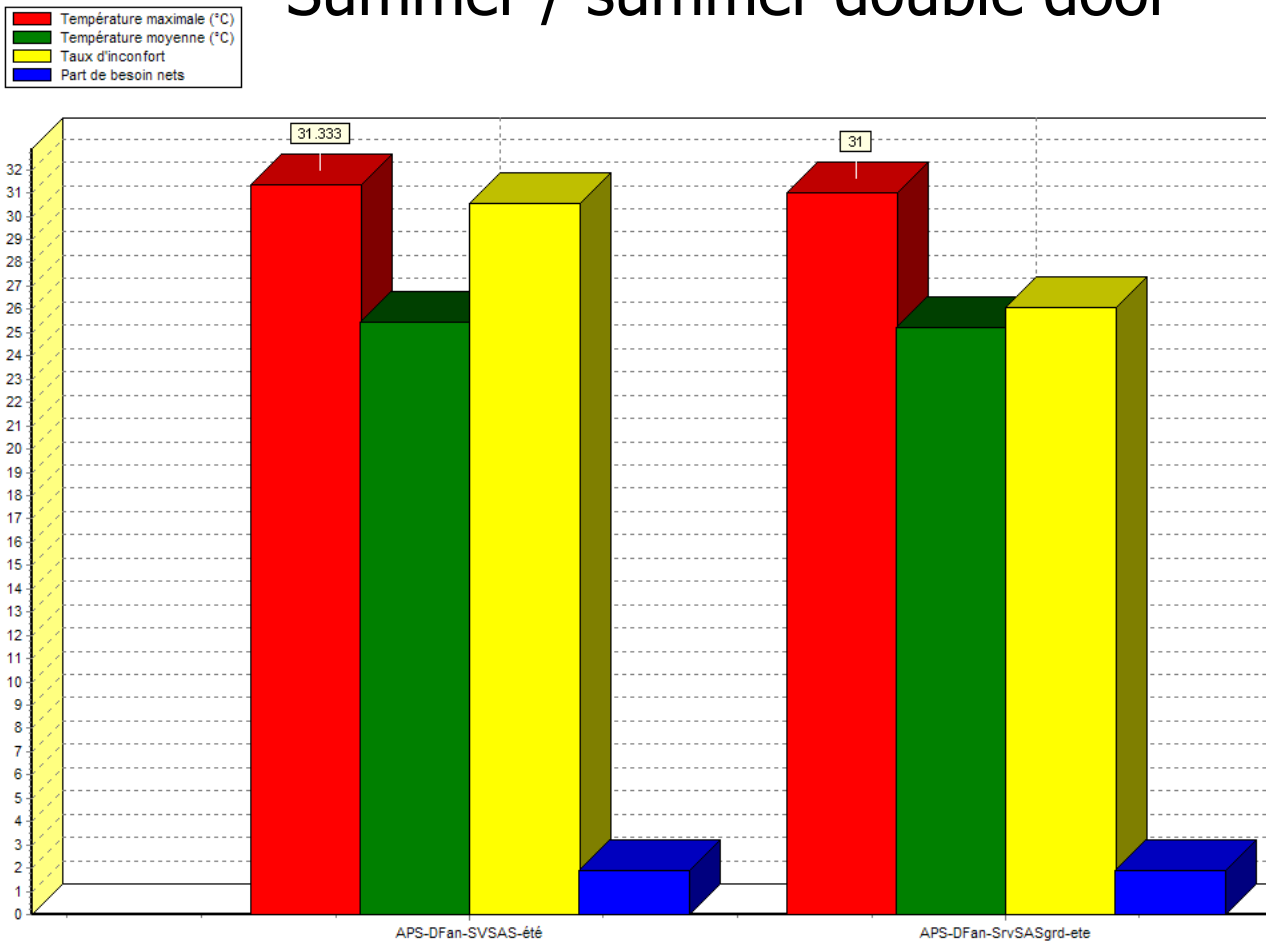


Impact of the temperate zone

Winter



Summer / summer double door



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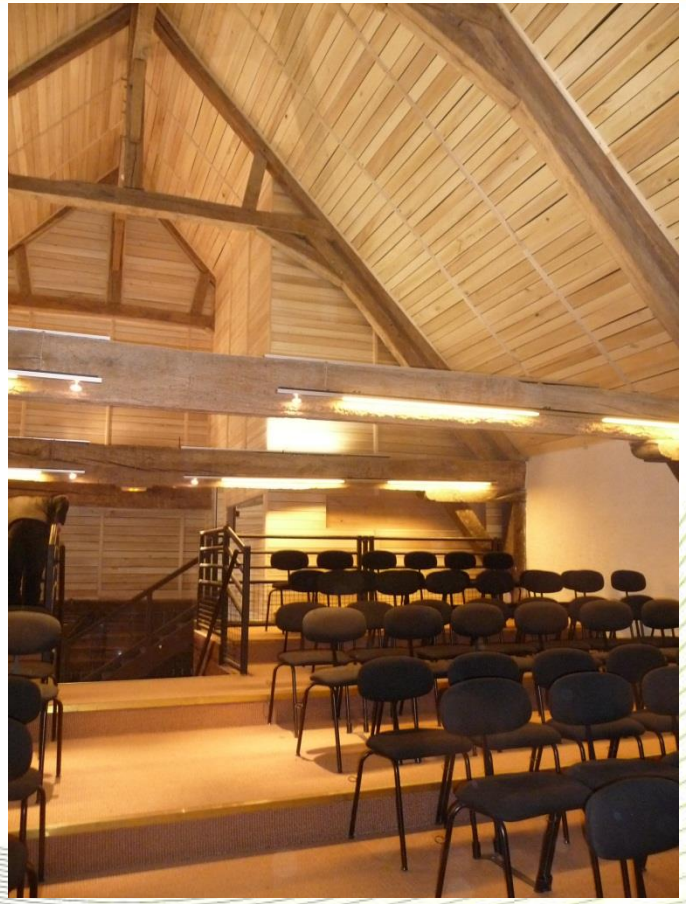
Example 2
Theater

Theater

- National Monuments
- Architect : Sill
- La Bergerie, Vic Nohant (France)
- Classical concert

- Runs in summer at night and afternoon
- 410 occupants, 12 kW lighting
- 24 dB(A) & 20 dB @ 250 Hz



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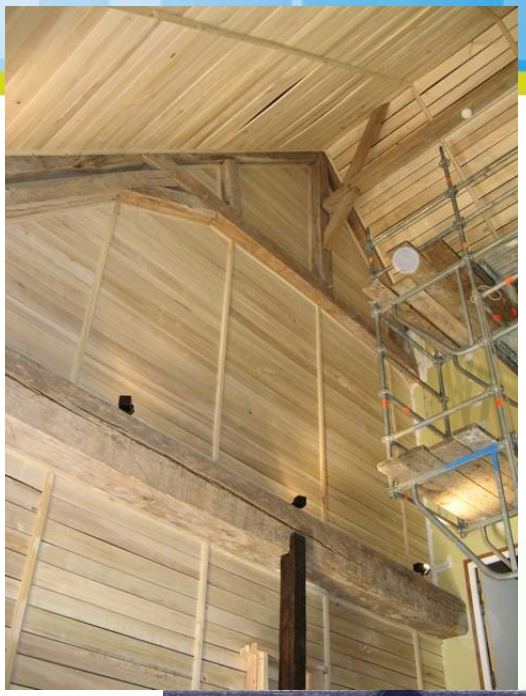
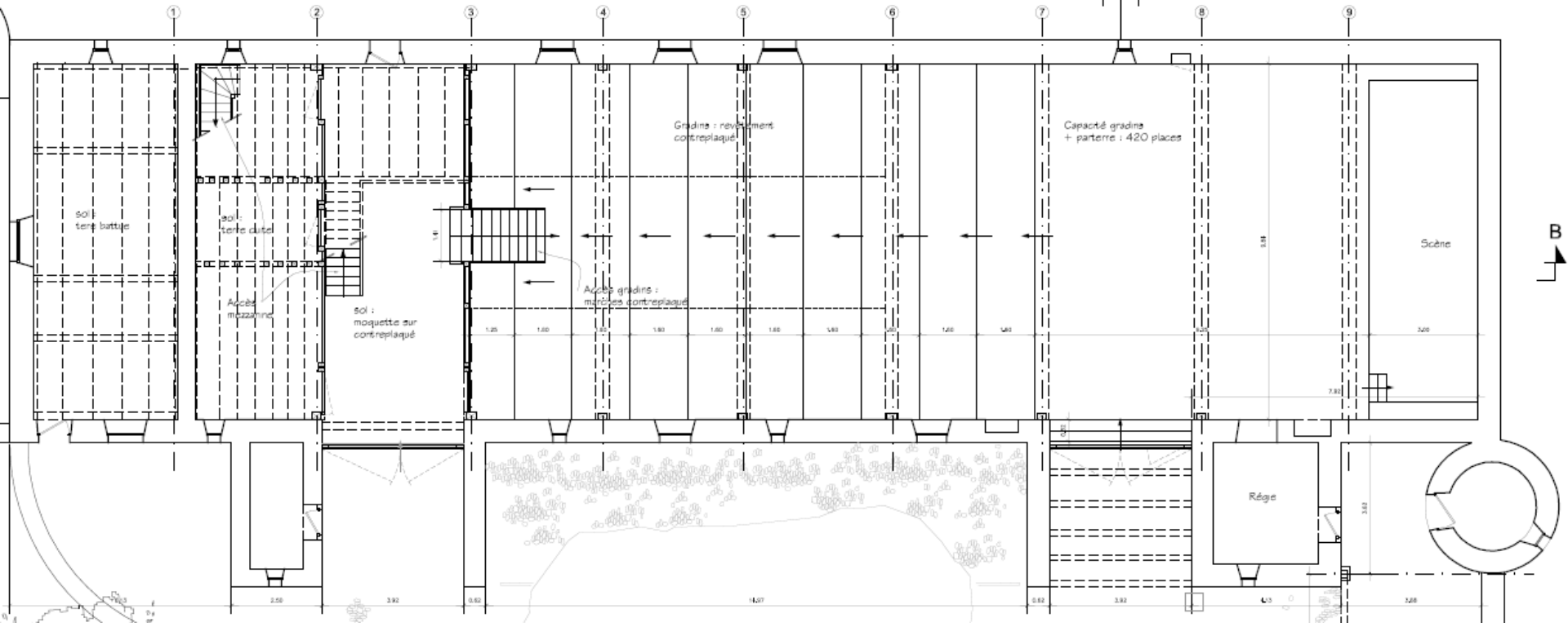
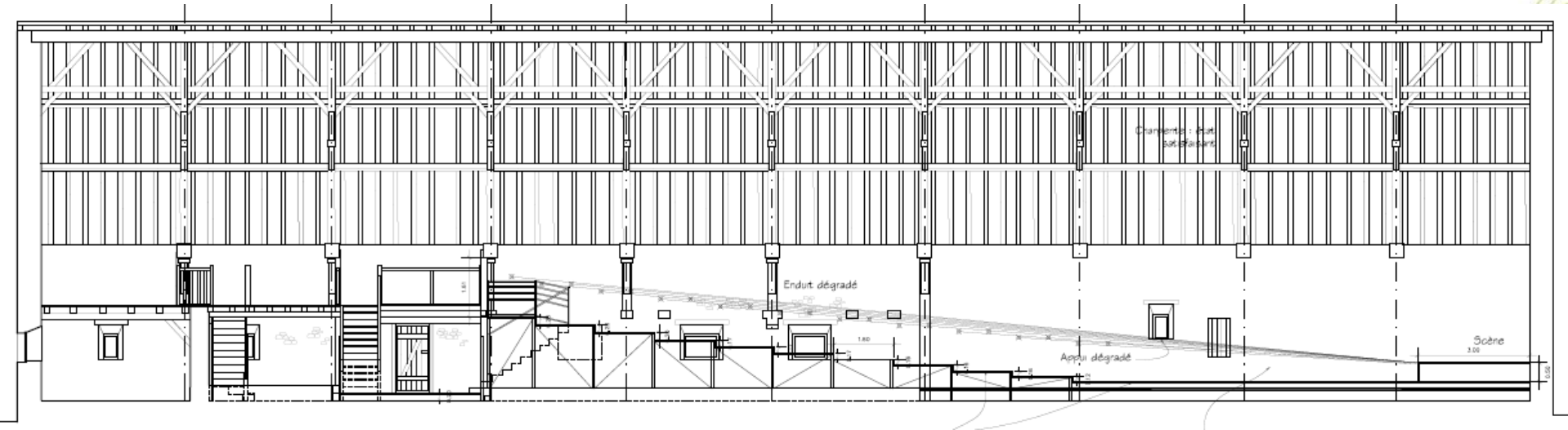
Theater




1
2
3
4
5
6
7
8
9
sol :
terre battue
sol :
terre battue
Accès
mezzanine
sol :
moquette sur
contreplaqué
Gradins : revêtement
contreplaqué
Accès gradins :
marches contreplaqué
Capacité gradins
+ parterre : 420 places
Scène
B
Régie


Charpente : bois
apparent
Enduit dégradé
Appui dégradé
Scène

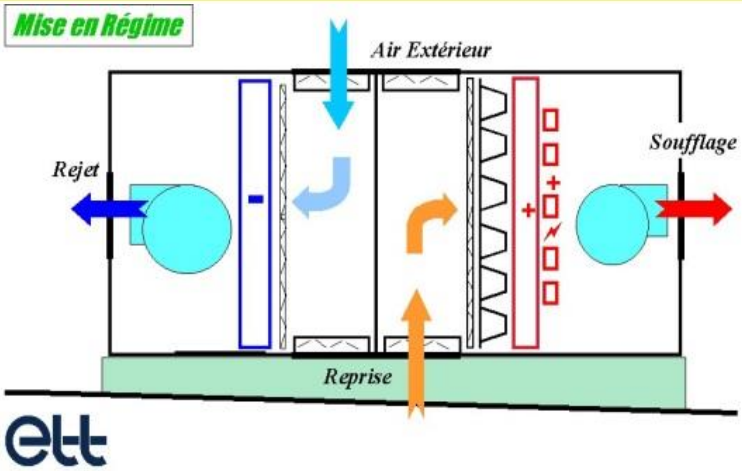
Theater

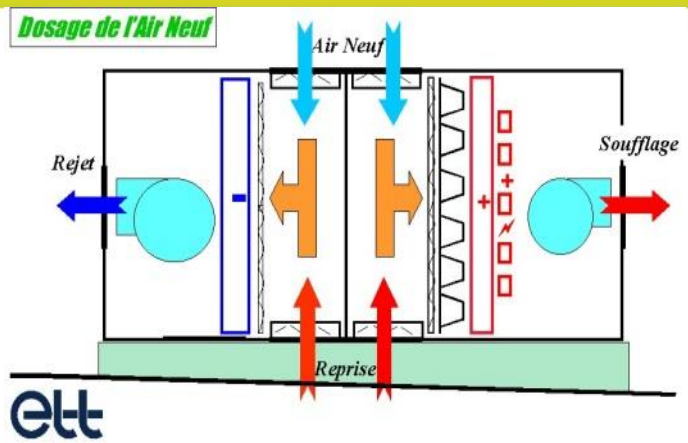
- Displacement ventilation
  - Free cooling on a longer period
  - IAQ ++
- Supply underseats and on scene
  - Floor diffusers
- Exhaust on the ceiling (on top of scene and opposite)

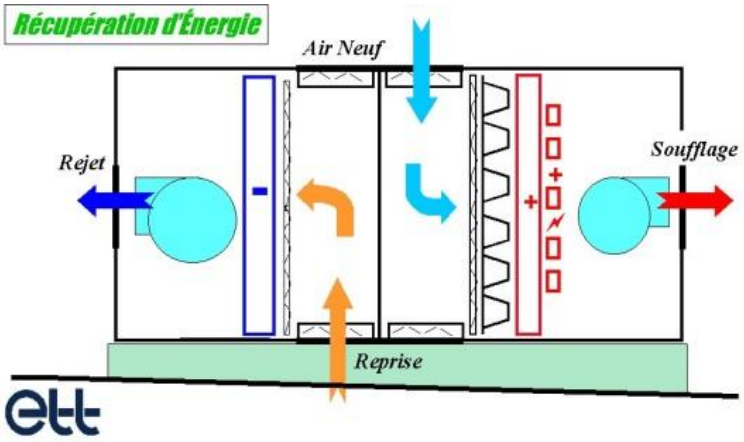
Theater

- Supply and exhaust unit, with exhaust Air Heat Pump ETT, 20000 m3/h,
- Temperature controled by airflow
- EER=4,5 (for the same price AHU+chiller+ control EER=3,9)
- Cooling Power = 56 kW @ Text=30°C
- Heating Power = 56 kW @ Text=10°C, COP 7,5, HRU inc., CO^2 control
- No apparent chiller outside, technical room acoustically treated
- Free cooling = 23% of the need on a summer season (and 50% in case of night show)

Airflow control







- Constant supply Temperature (/ direct expansion)
- Control outdoor air flow
- COP improved
- Free cooling

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Example 3 Supermarket in Portugal

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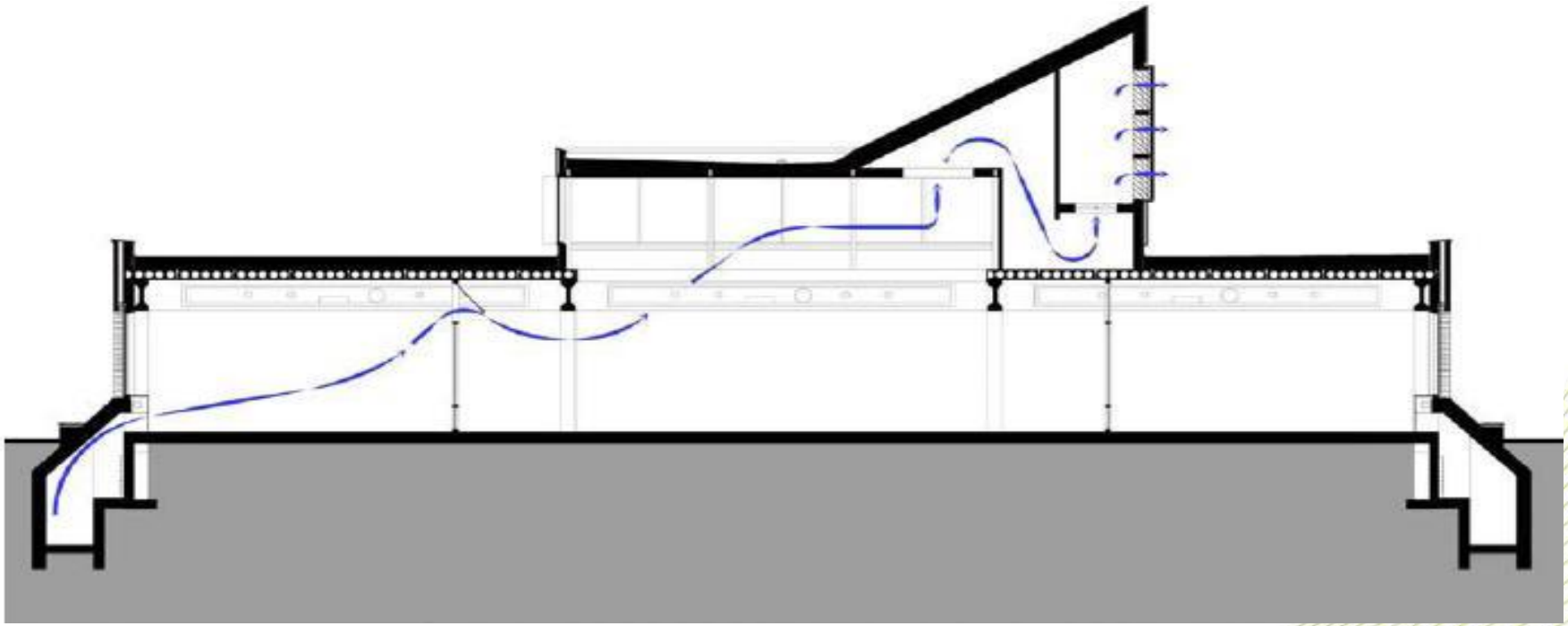
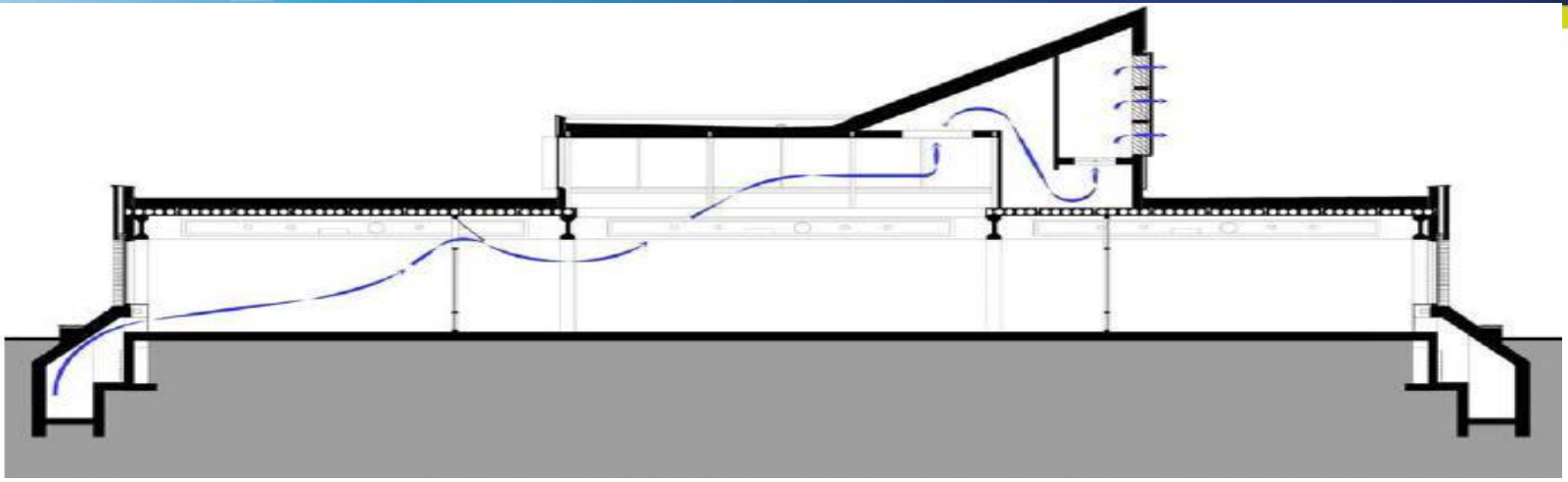
Supermarket Portugal



Results



- **Passive overnight ventilation -7,4% of cooling energy**
- **Mechanical assistance (Tout<Tin-4 et Tout>24°) : -10,6% of cooling energy**
- **Overall : – 20% of cooling energy (which was 50% of the overall building energy)**

Atriums and high rise commercial buildings

- Combination of passive stack (atrium) and mechanical (sides)
- Prefer natural air movement (ie associate with displacement ventilation),
- Use free cooling whenever it’s possible

Design rules

1. High building thermal inertia (mass)
2. Plan air transfer for 4 to 8 ach in average (inlet, transfer, exhaust)
3. Define Zones to take into account uses and loads
4. Enthapic control (humidity+temperature) is better than just temperature control
5. Bypass both flows (pressure drop in HRU)

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Summary

- Use building architecture
- Check uses, orientation
- Plannify summer and mid season running to avoid overheating…