BATIMENTS INTELLIGENTS ET BATIMENTS A ENERGIE PRESQUE NULLE

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Projets de recherche subsidiés par la Région Wallonne

Plan de l'exposé

- **Bâtiments à énergie presque nulle**
  - Système de ventilation et chauffage
  - Isolation, étanchéité, apports solaires
- **Bâtiments intelligents**
  - Ventilation
  - Contrôle des surchauffes et de l'éclairage
  - Conception et régulation du chauffage
- **Flexibilité énergétique**
  - Potentiel de déplacement des charges
  - Contrôle prédictif

Bâtiment « Nearly Zero Energy »

- **Bâtiment passif**
  - Demande énergétique très basse ≤ 15 kWh/m^2.an
  - Récupération des apports solaires et d'occupation
  - Eviction des surchauffes estivales

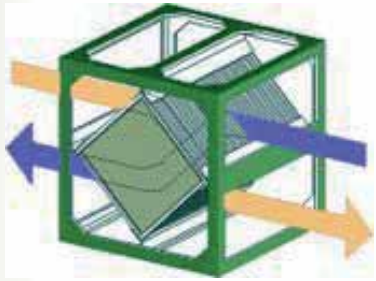
- **Bâtiments à énergie nulle ou positive**
  - Produit plus d'énergie qu'il n'en consomme
  - Sur une période lissée d'un an.

Maison passive

Surface de plancher chauffé : 232 m^2
Volume intérieur : 894 m^3
Surface vitrée: 44 m^2 dont 31 m^2 au Sud

U moyen:	0.17 W/m^2-K
Compacité:	V/A = 1.5 m
Isolation:	K19
DCC PHPP:	14 kWh/m^2.an
Etanchéité:	n_{50}= 0.32 vol/h

Maison passive

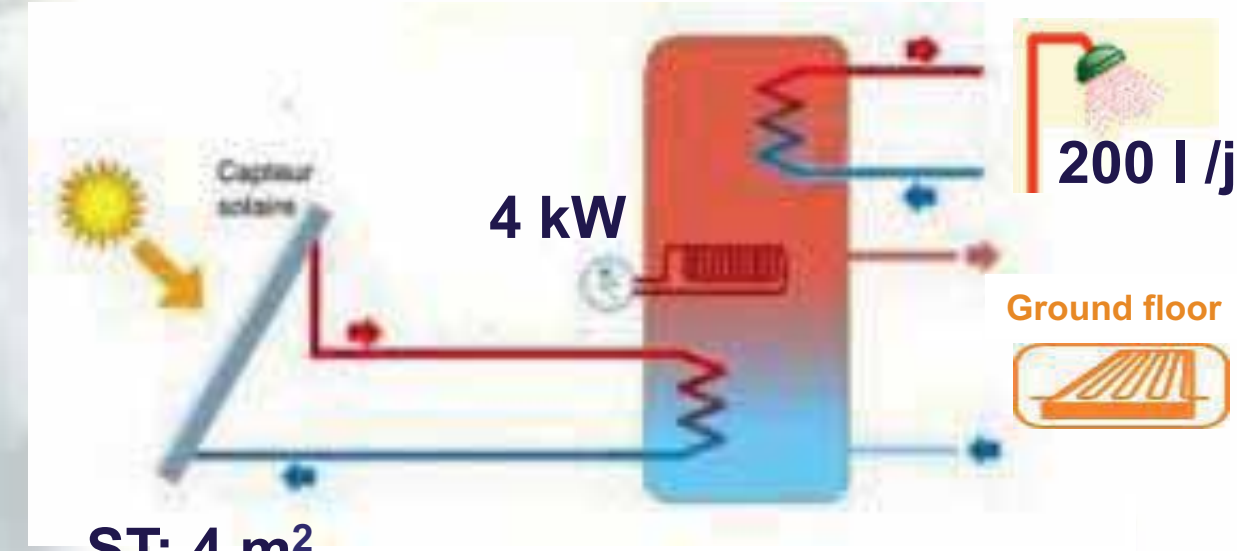


Ventilation : 0.45 x 385 m³/h
Récupération : 65 %
Echangeur sol

PV cell: 22.5 m² ⇨ 4.5 kW

First floor

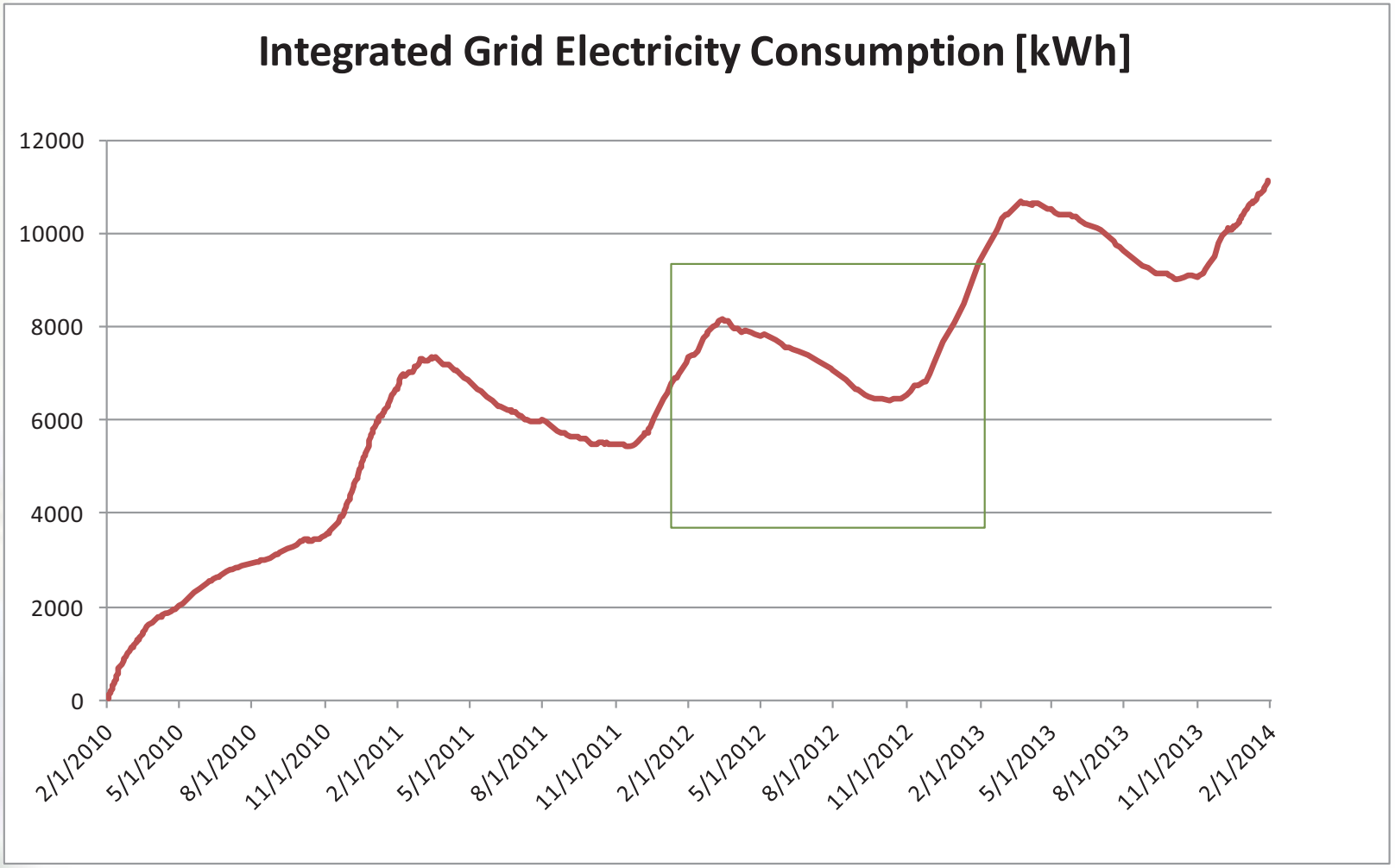
0.4 kW



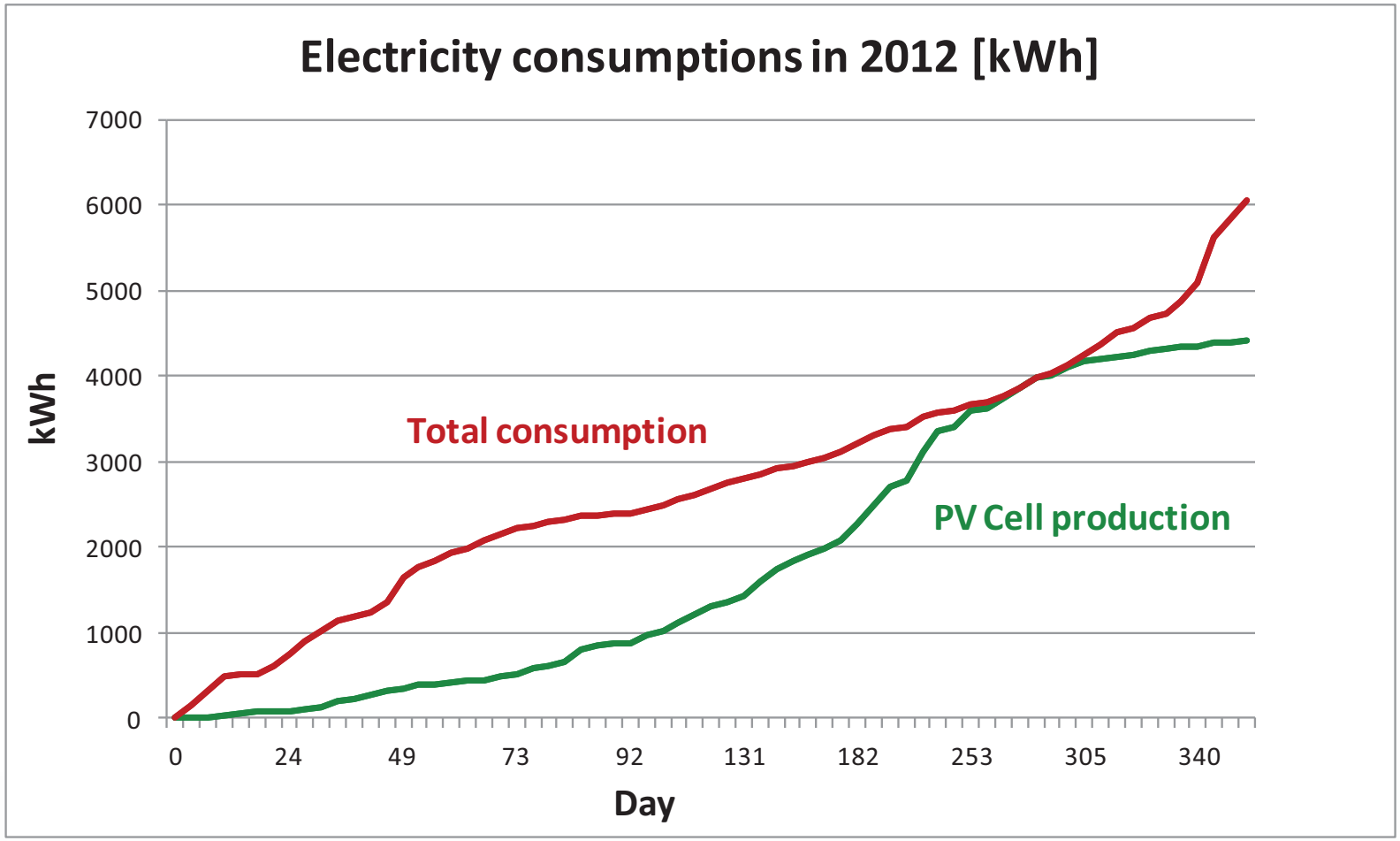
200 l /jour ⇨ 7kWh/jour

ST: 4 m²

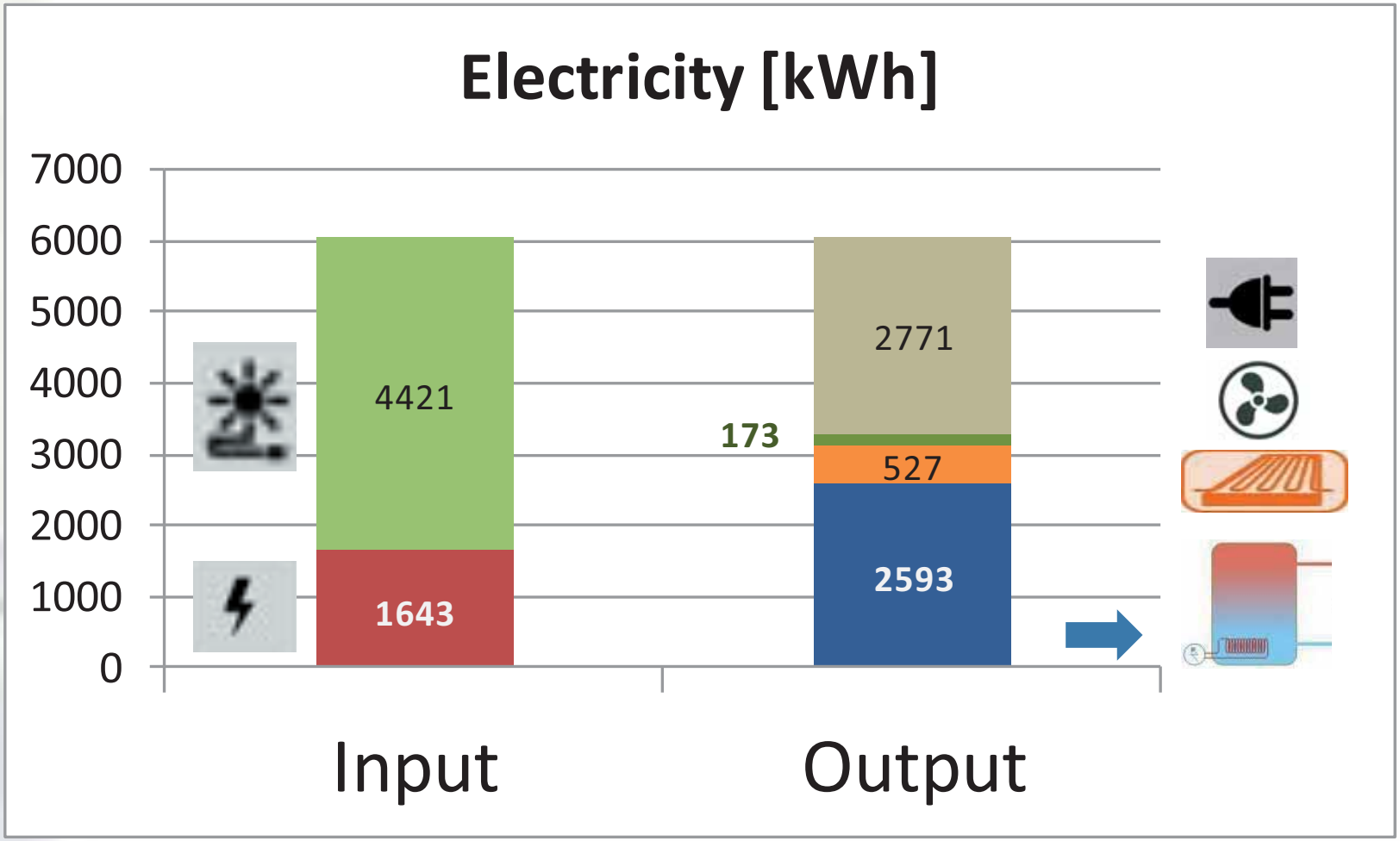
Maison passive – Bilan 2012



Maison passive – Bilan 2012

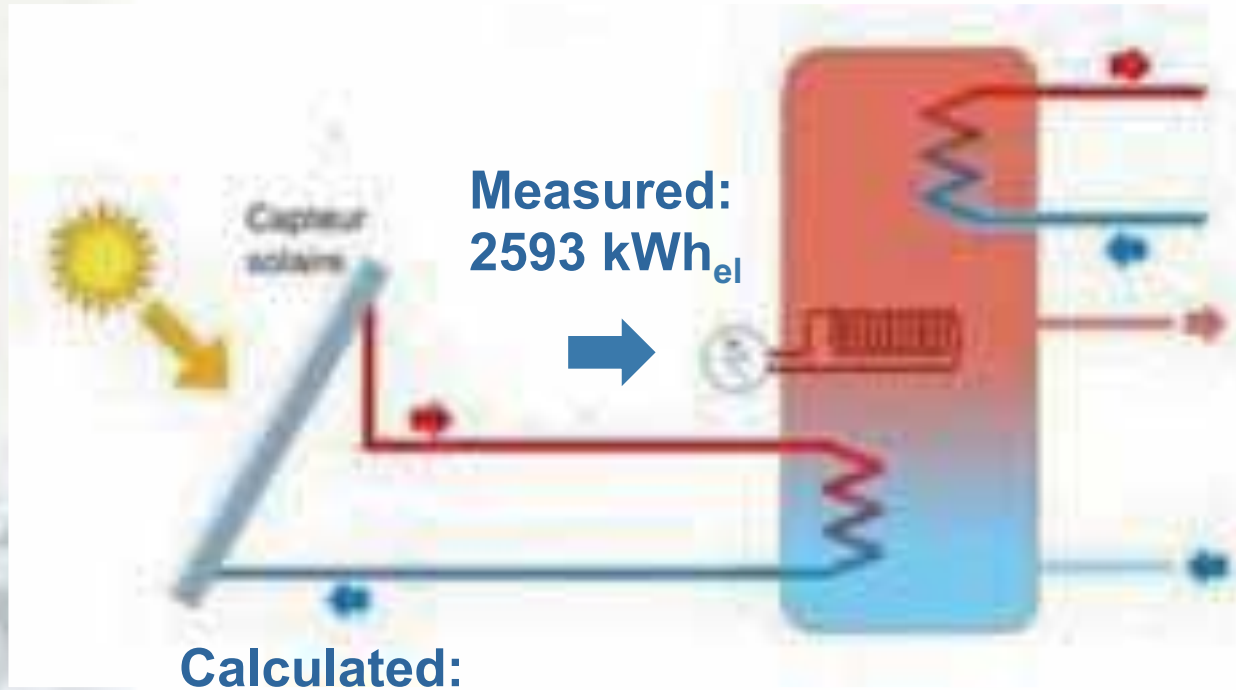


Maison passive – Bilan 2012



Production PV Cell
4421 kWh **>** **Demande électricité Ch. & ECS**
527 kWh + 2593 kWh

Maison passive – Bilan 2012



Measured:
527 kWh_{el}

Measured:
2593 kWh_{el}

Calculated:
2554 kWh_{th}

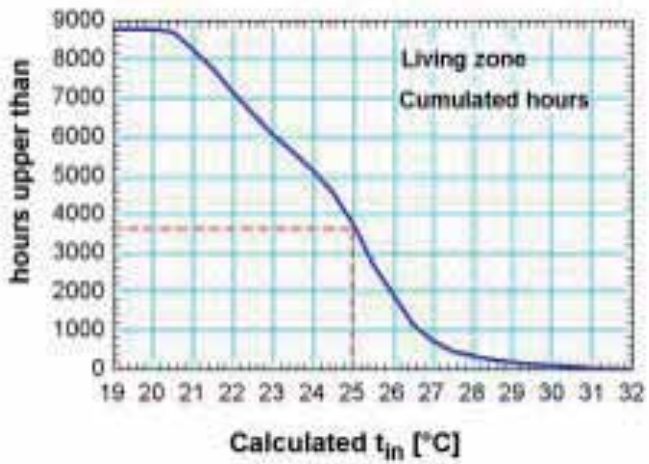
Calculated:
474 kWh_{th} (…1900 kWh_{th})

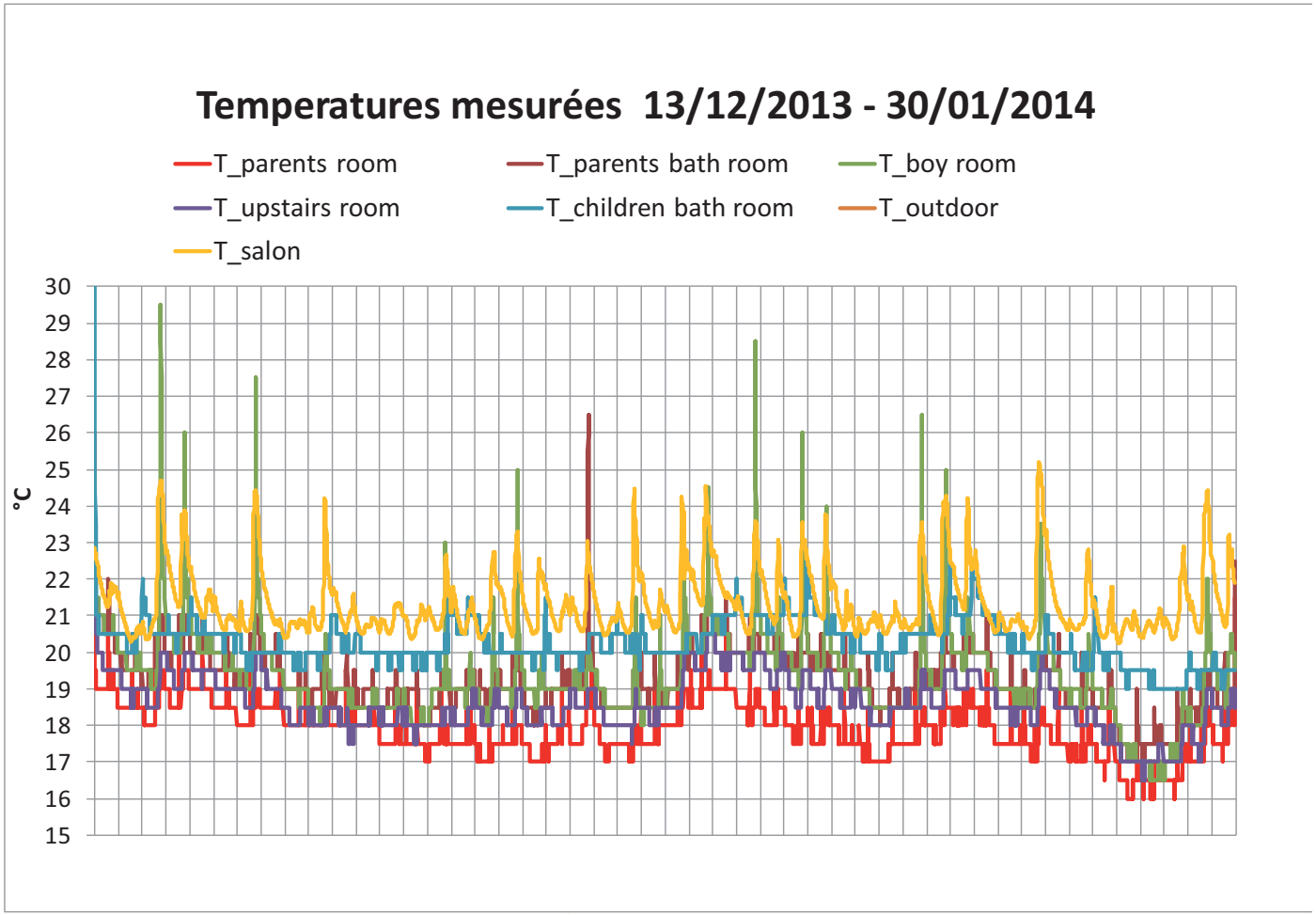
Calculated:
513 kWh_{th} (…1940 kWh_{th})

DCC occupation intermittente: 5 ⇨ 10 kWh/m² – an (sans ECS)

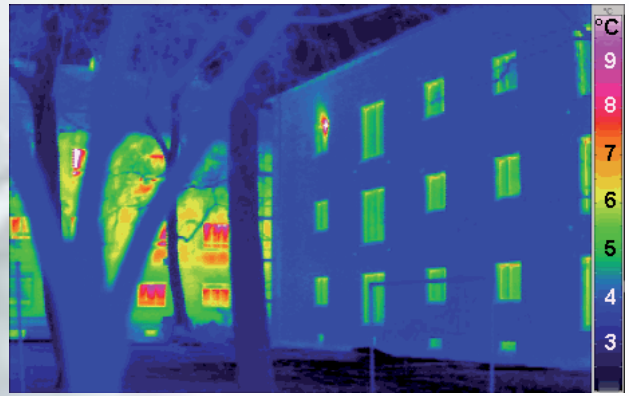
Apports solaires

Stores extérieurs: g = 0.22
Fermeture : t_{in} > 25°C – Eclairage OFF
Ouverture des fenêtres: t_{in} > 25°C

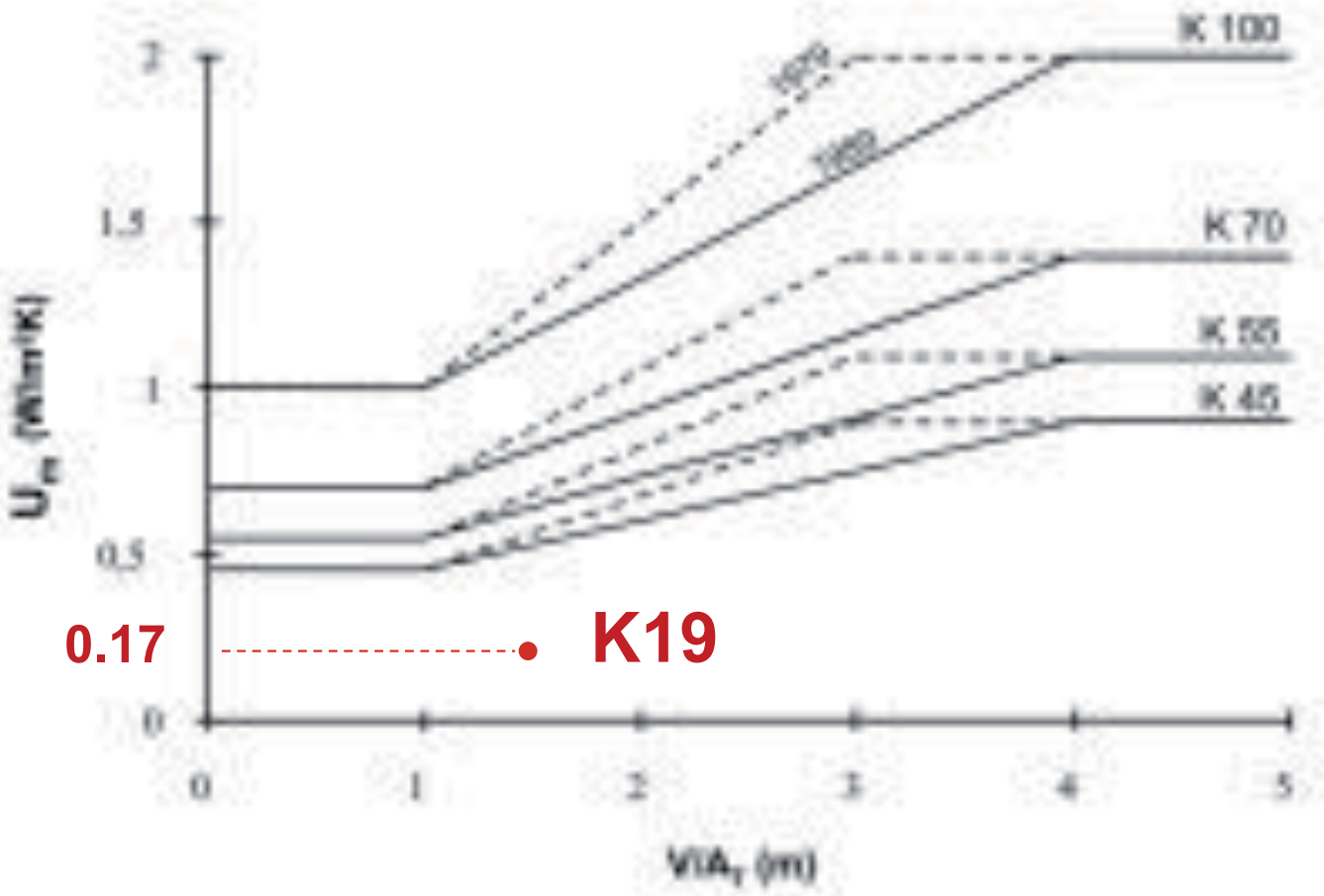




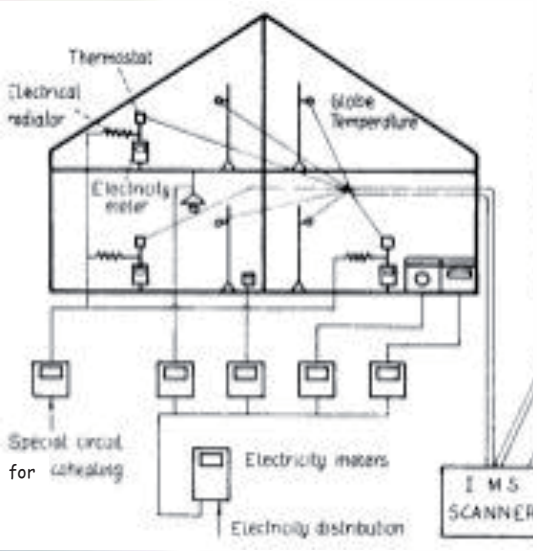
Niveau d'isolation K



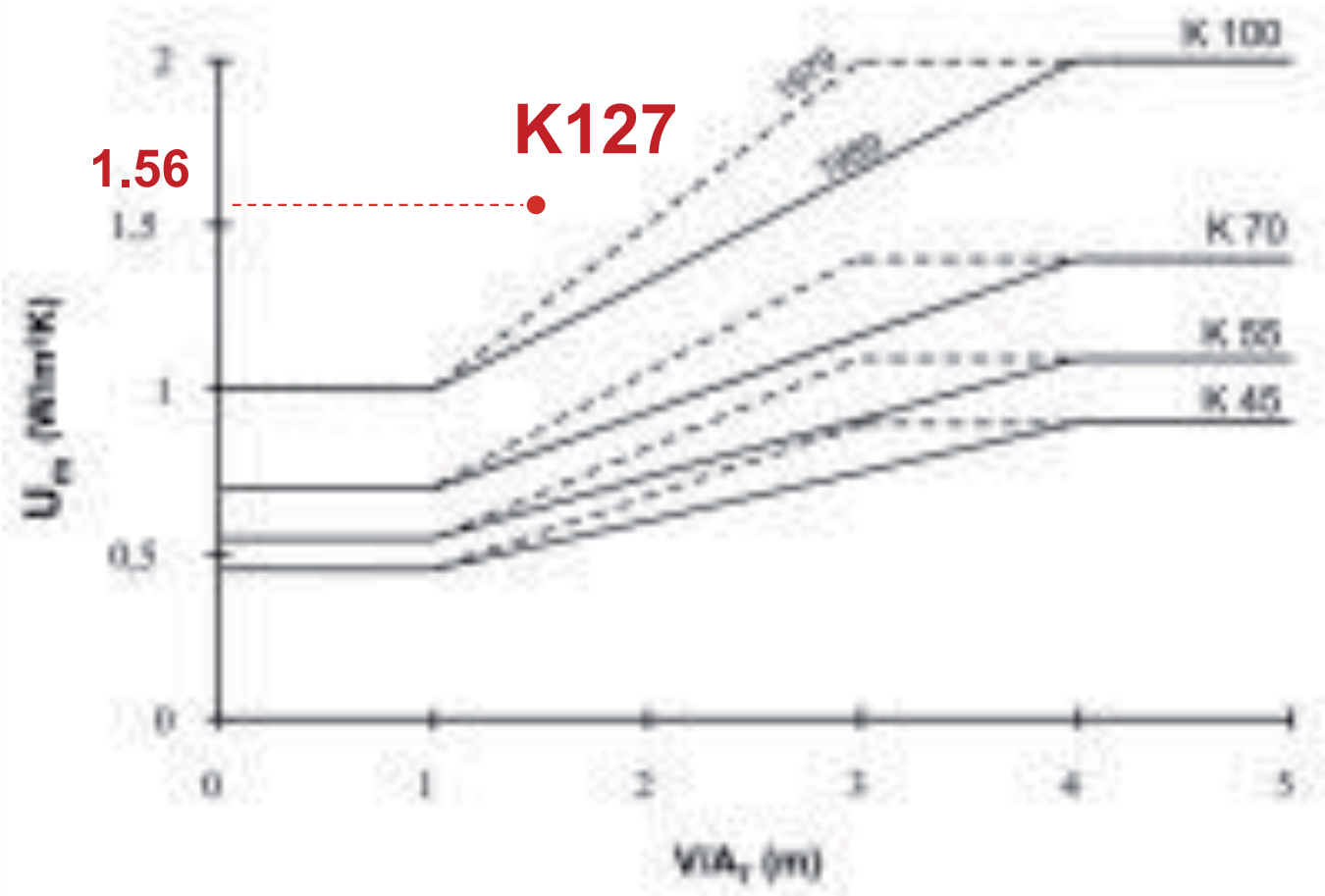
Depuis 1979 :
Niveaux K100, K70, K55, K45 et K35



Niveau d'isolation K

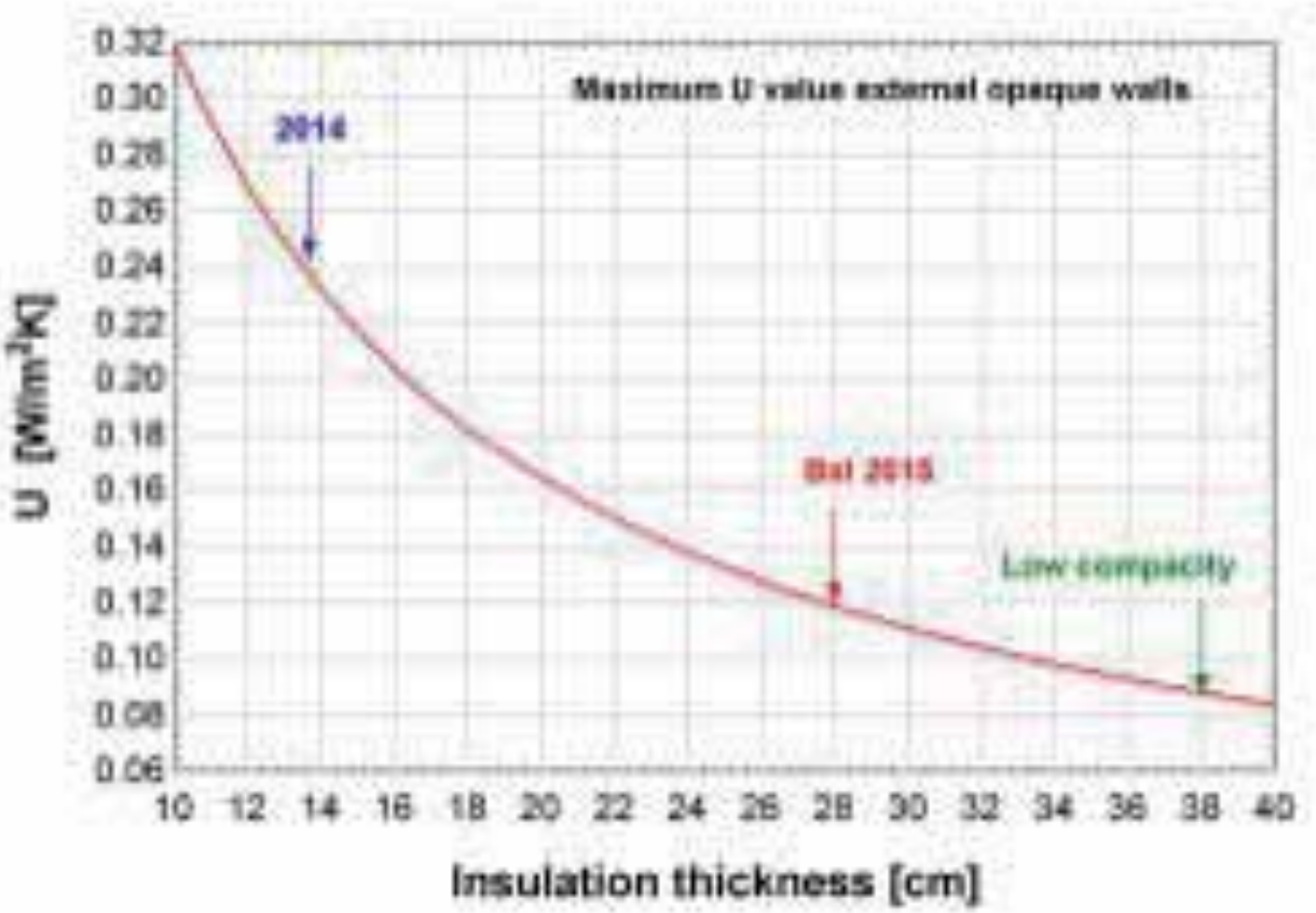


1970: 3 façades, 2 niveaux
Surface de plancher chauffé : 120 m2
Volume intérieur : 295 m3



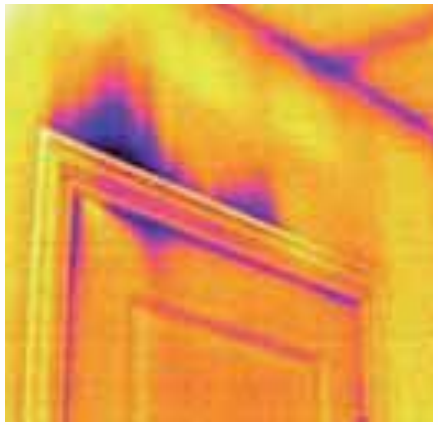
Niveau d'isolation

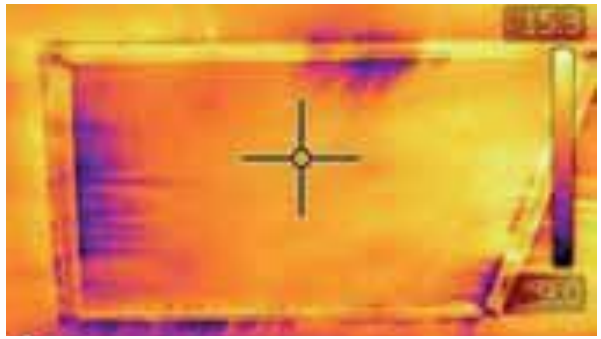
Conductivité isolant: 0.034 W/m²-K

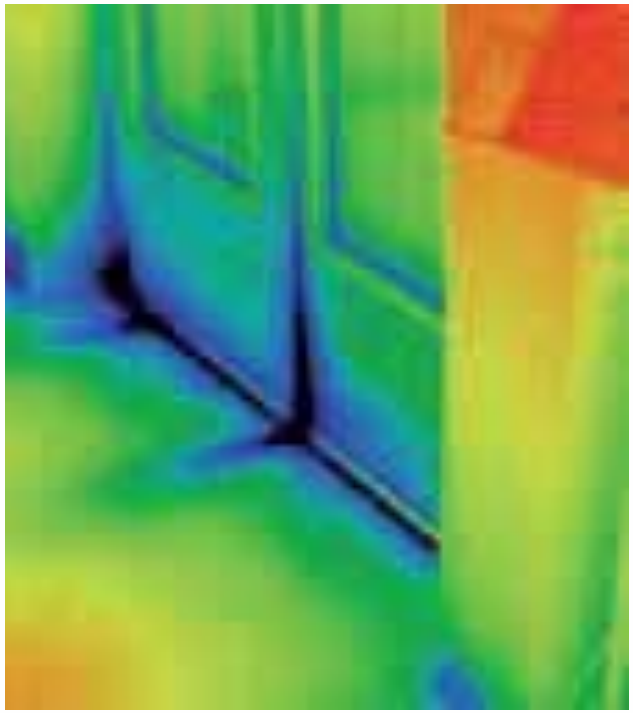


Infiltration d'air

Châssis
Trappes
Prises électriques …

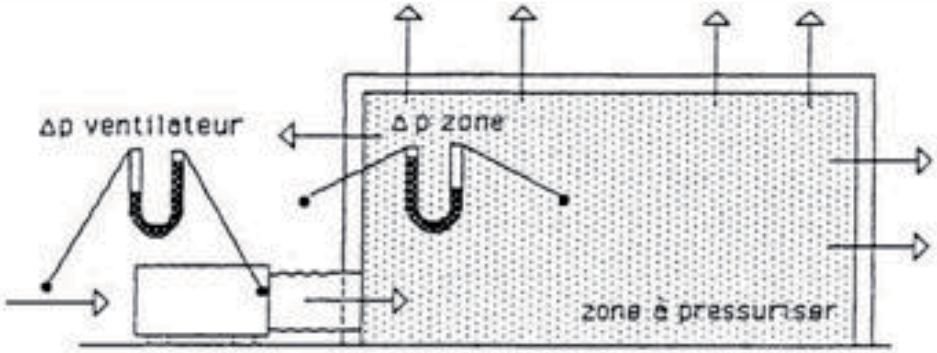


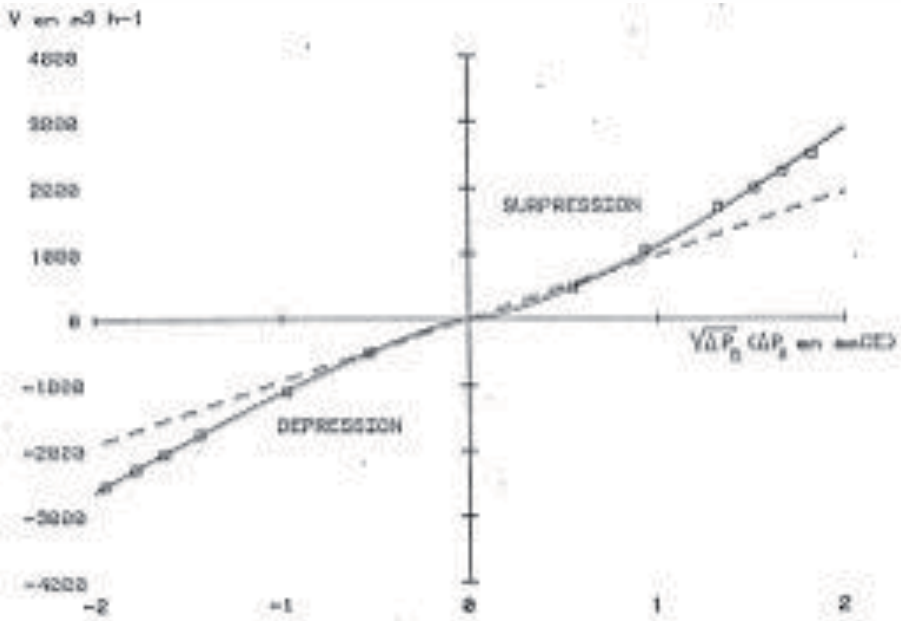




Infiltrométrie

Porte soufflante / Blower door test





1970: n_{50}= 10 vol/h

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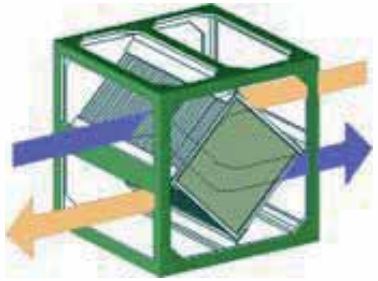
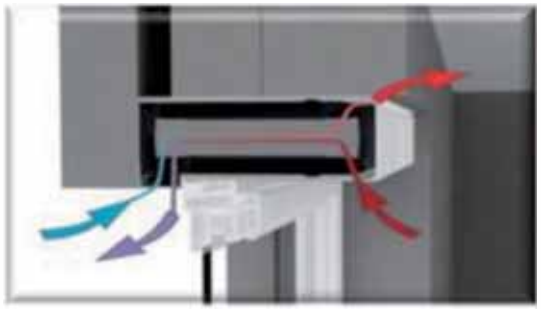
Ventilation double flux - récupération

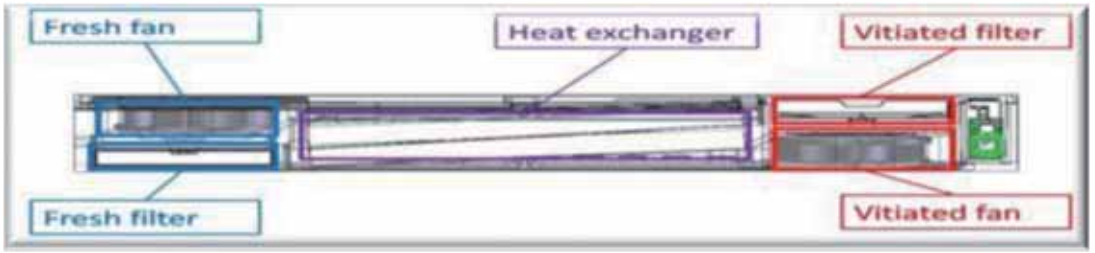
Centralisée



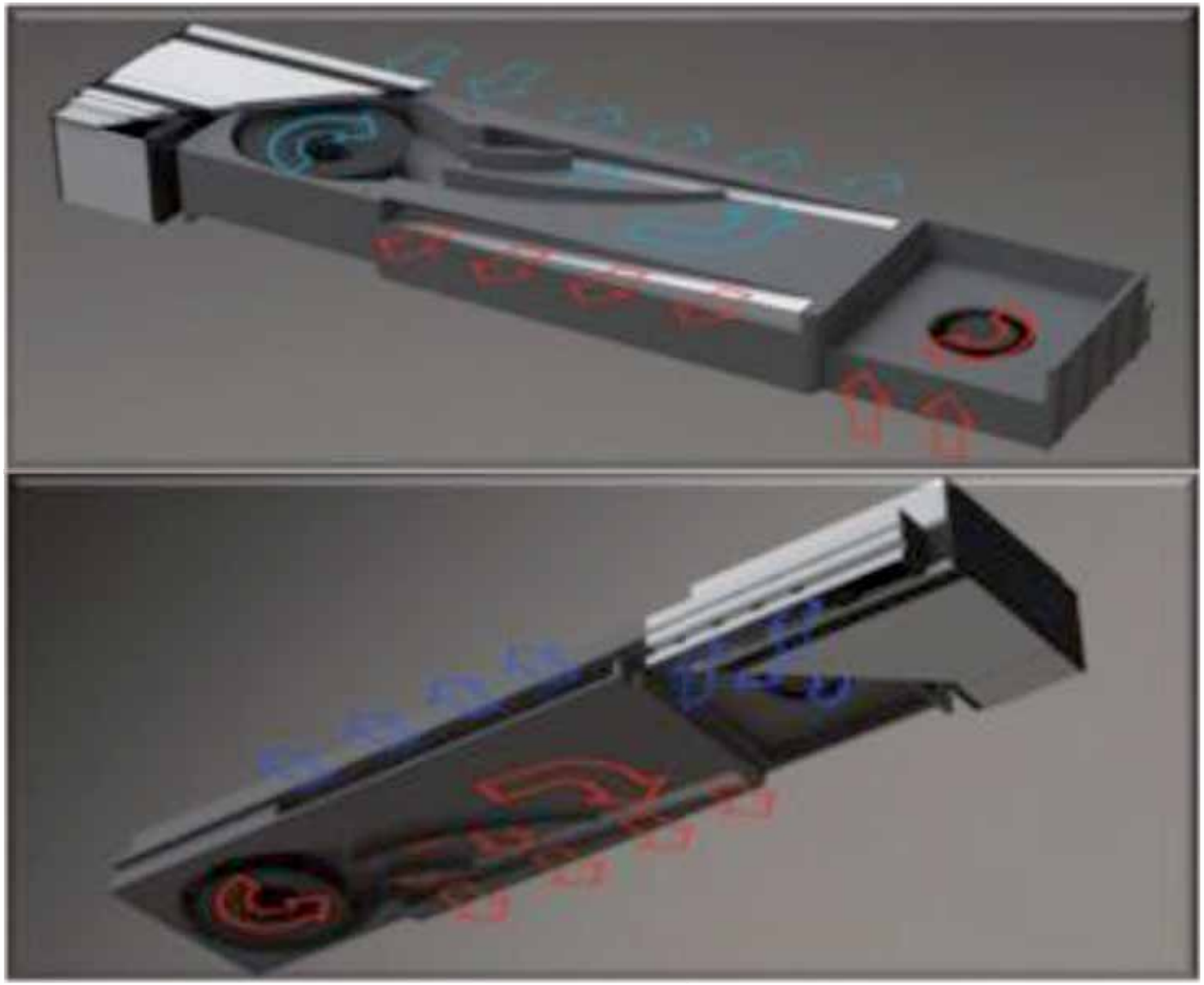
Décentralisée



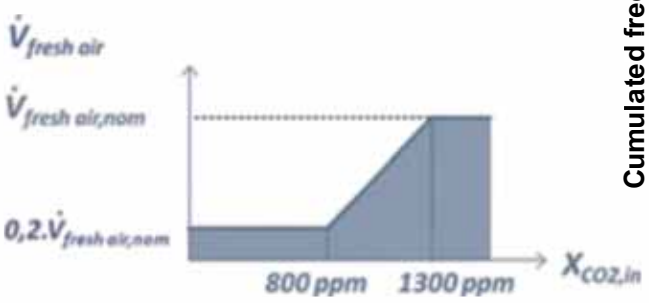
Pas de gainage
Régulation du débit par zone

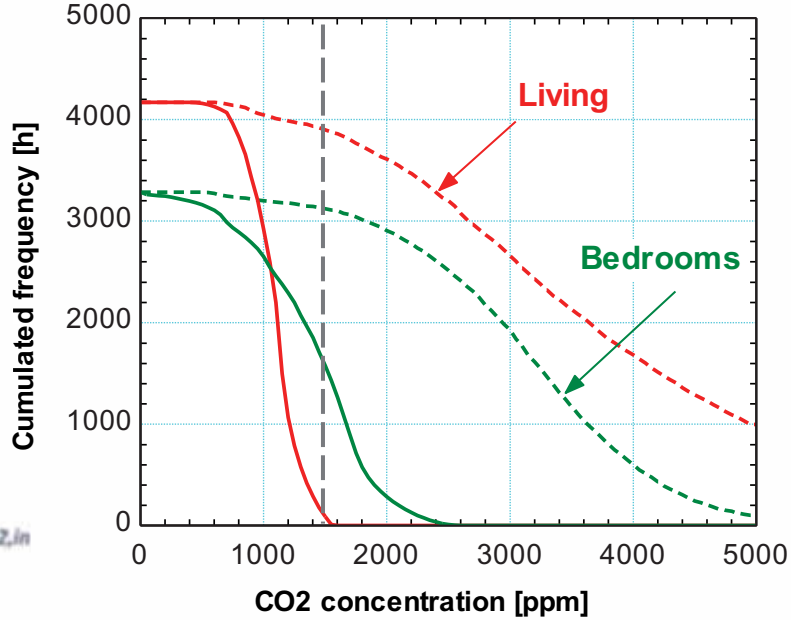


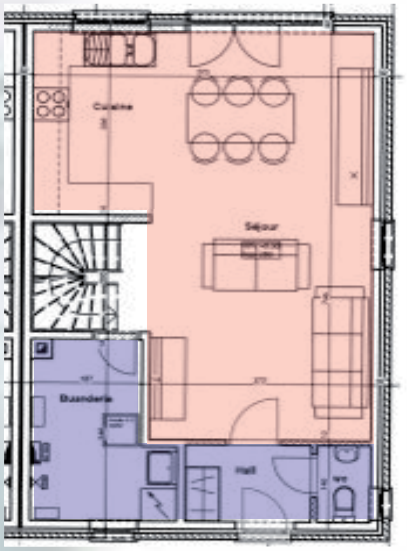
Ventilation décentralisée

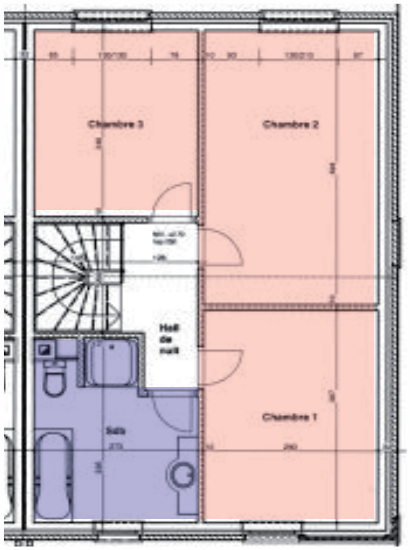


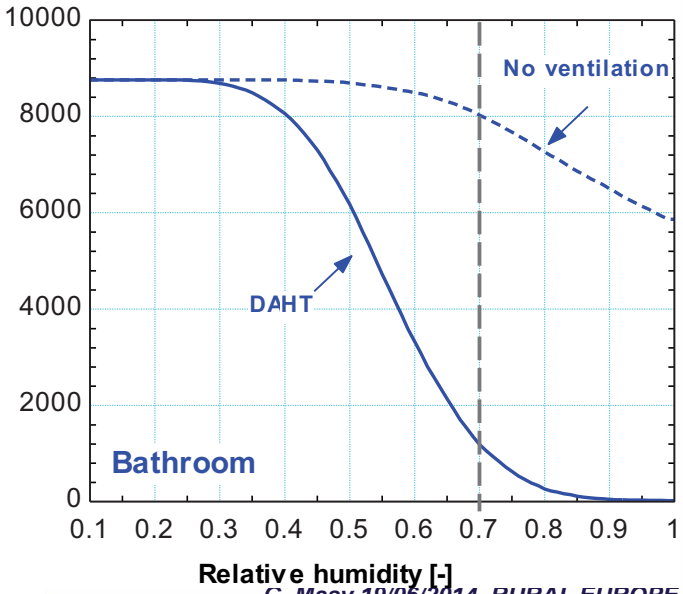
Ventilation: régulation du débit





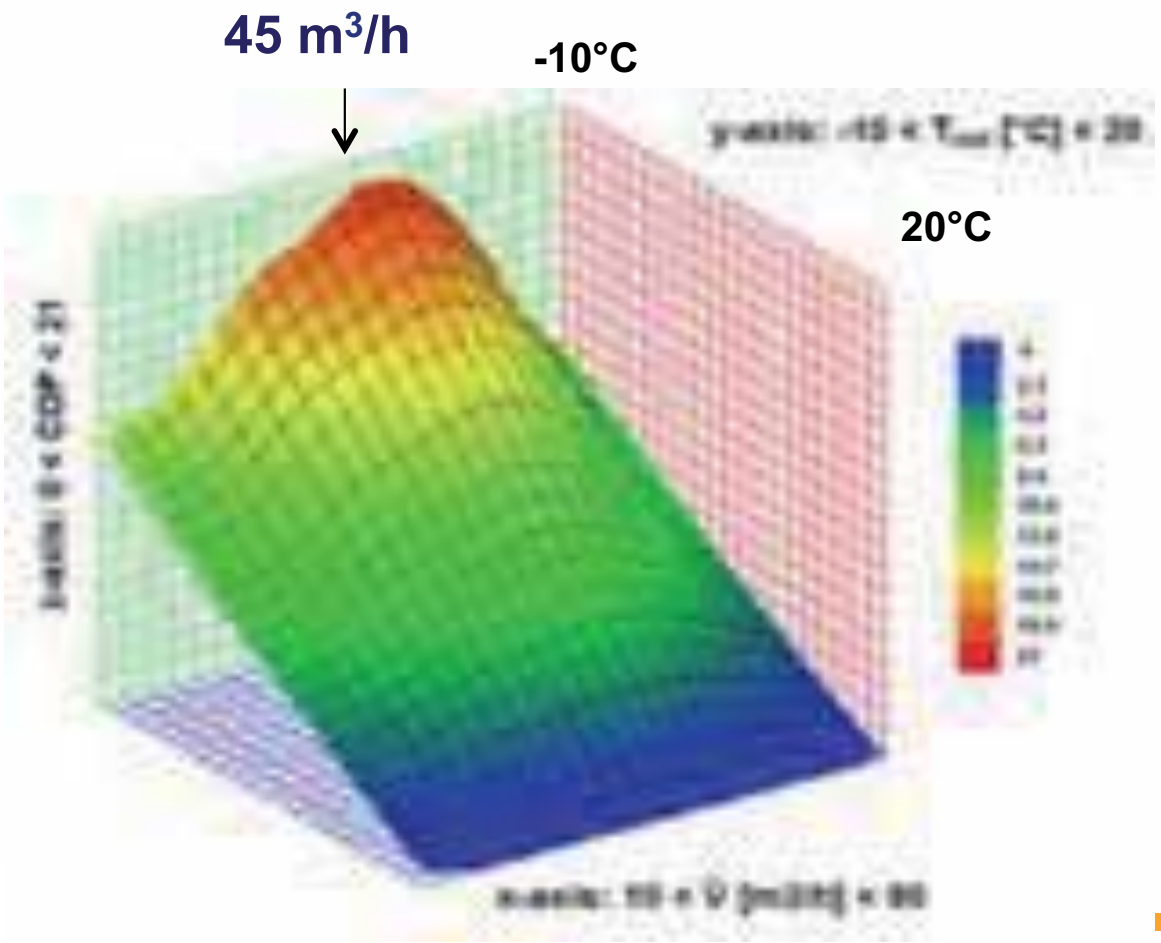




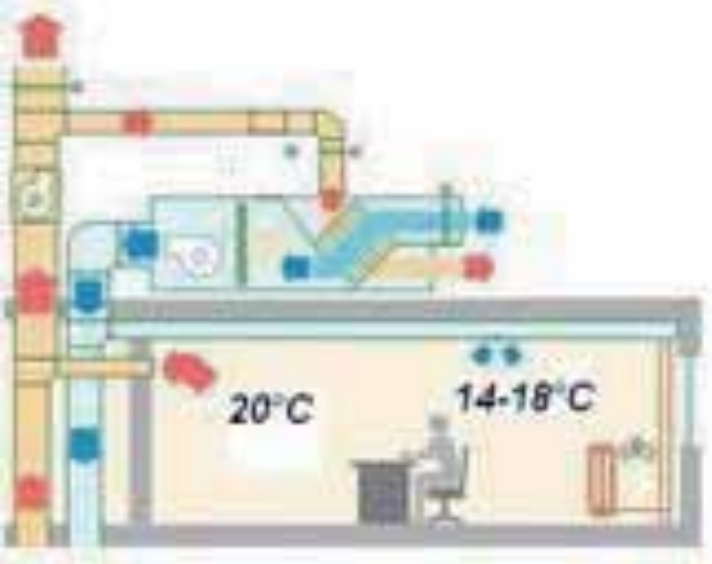


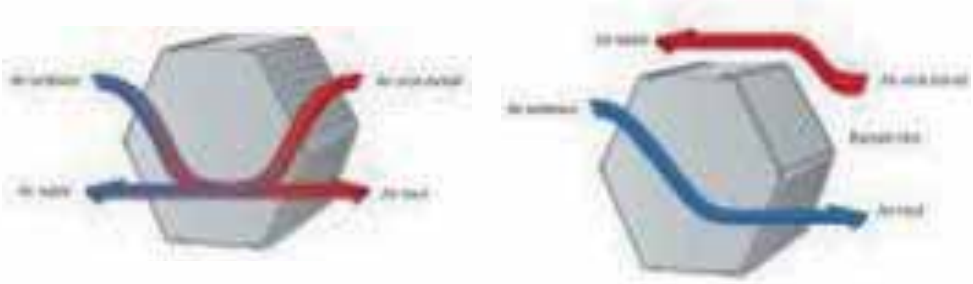
Ventilation: optimisation du débit

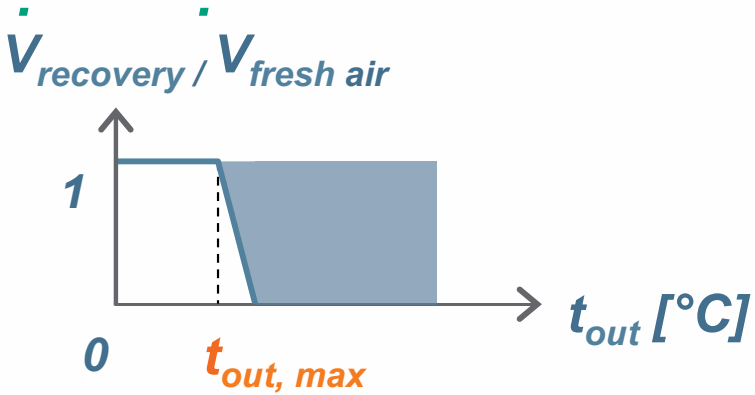
COP = Chaleur récupérée /
puissance électrique consommée par les ventilateurs

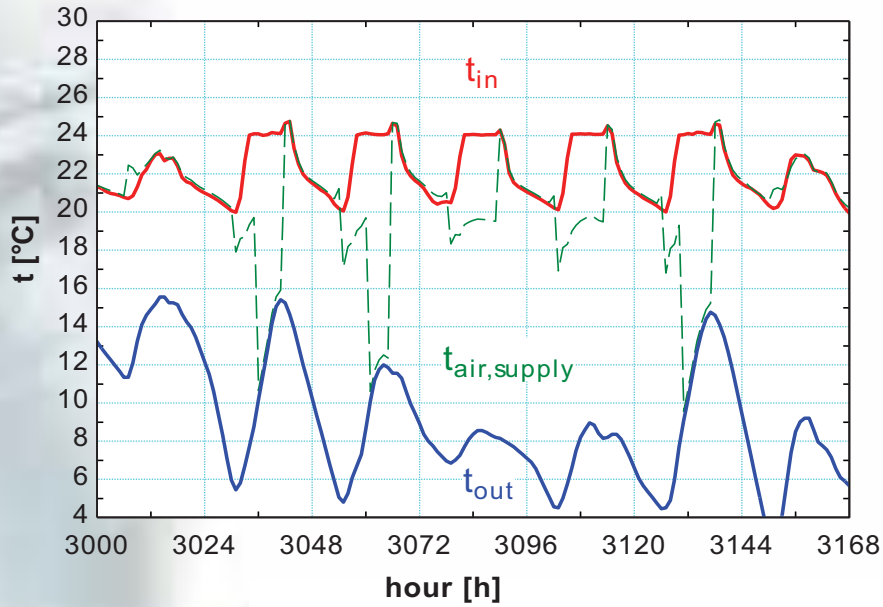


Ventilation: régulation

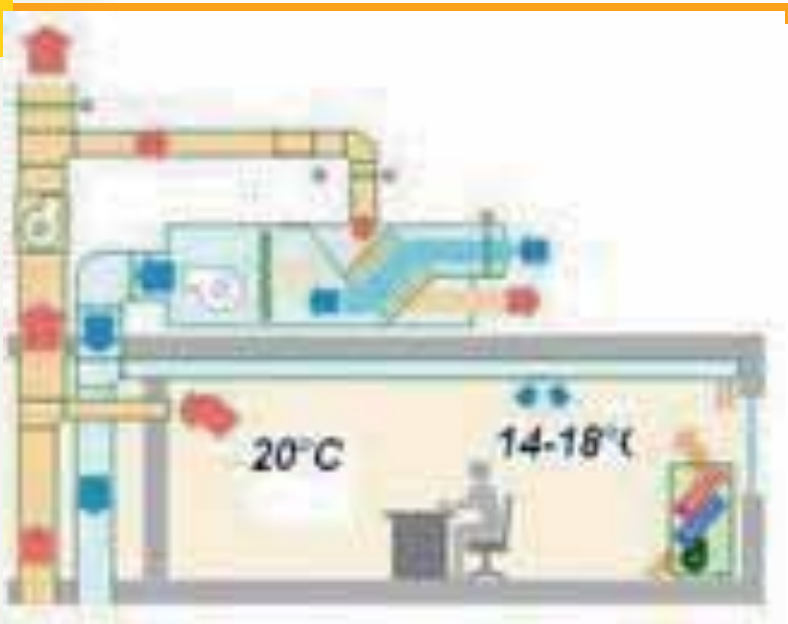


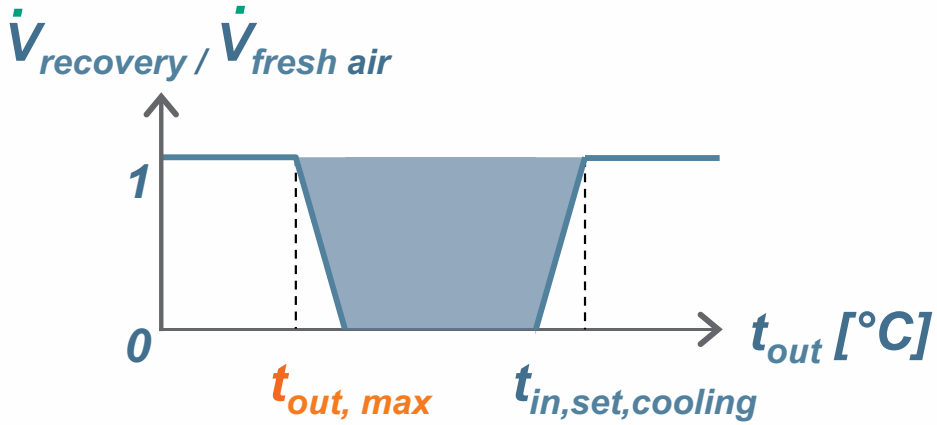


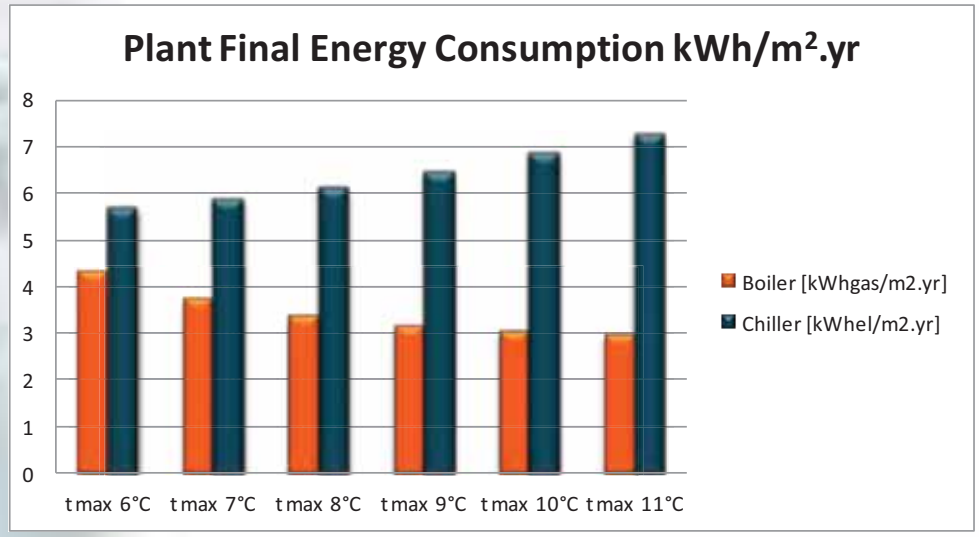


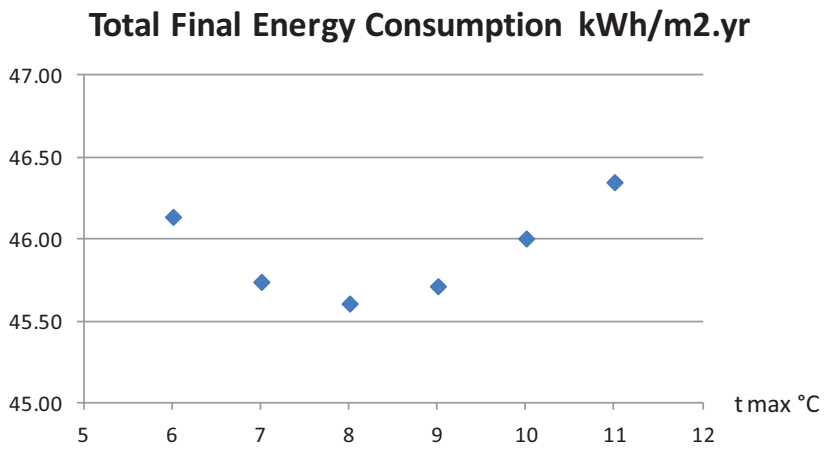


Ventilation: régulation

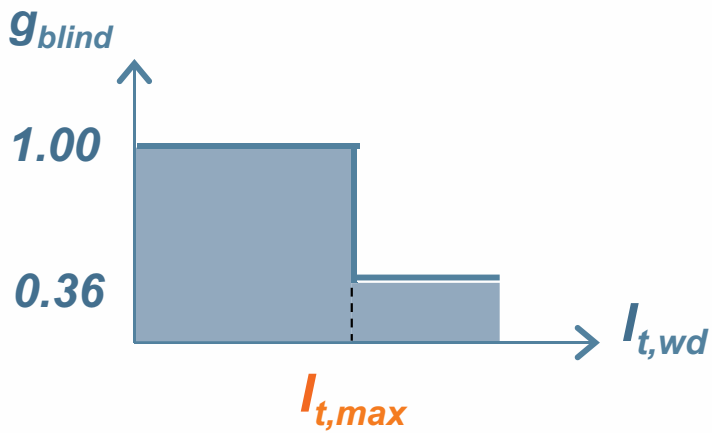


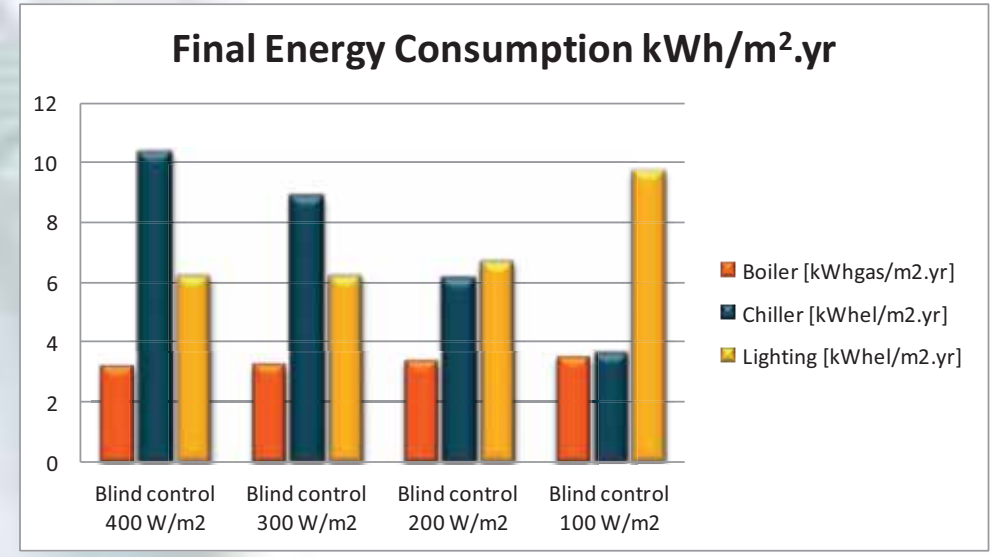


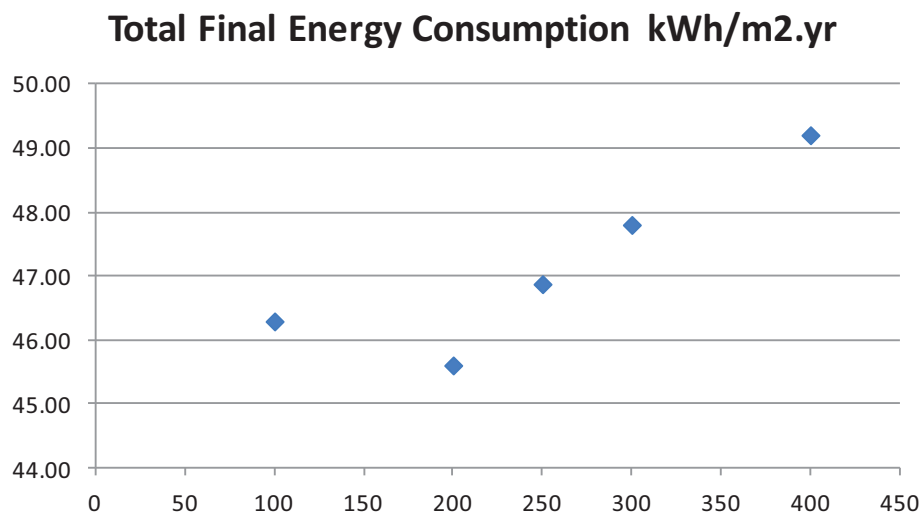




Contrôle des stores extérieurs



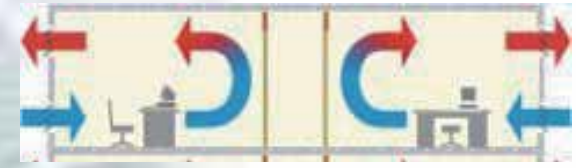


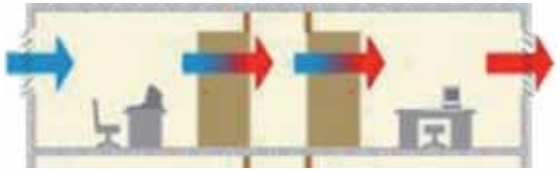


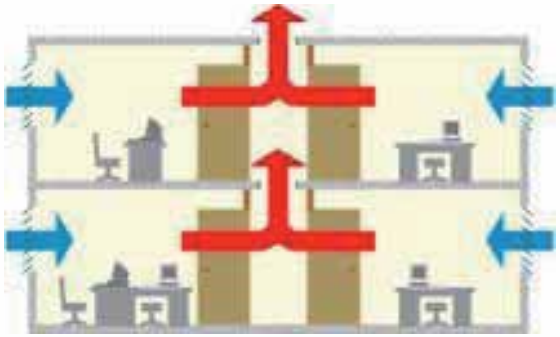
Contrôle de la ventilation intensive

Ventilation intensive d'été:

- Latérale
- Transversale
- Par effet de cheminée
- Par ventilation mécanique

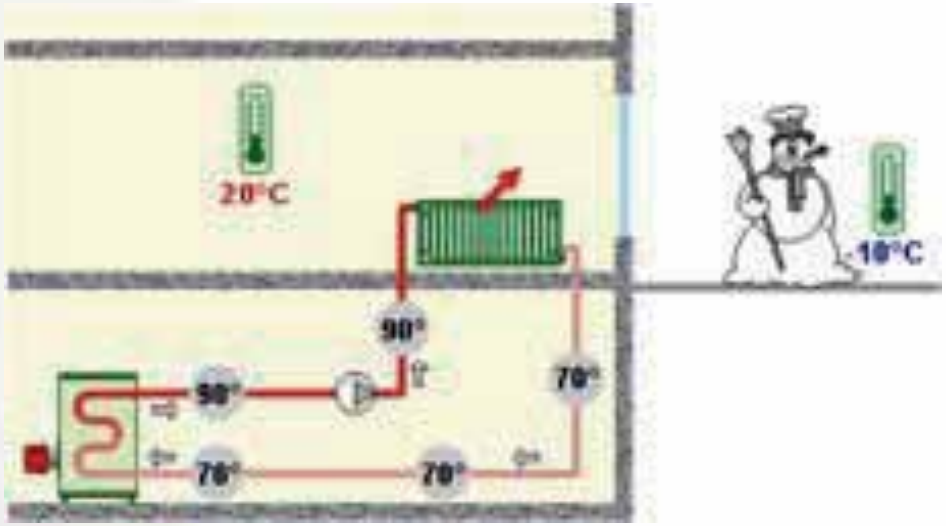


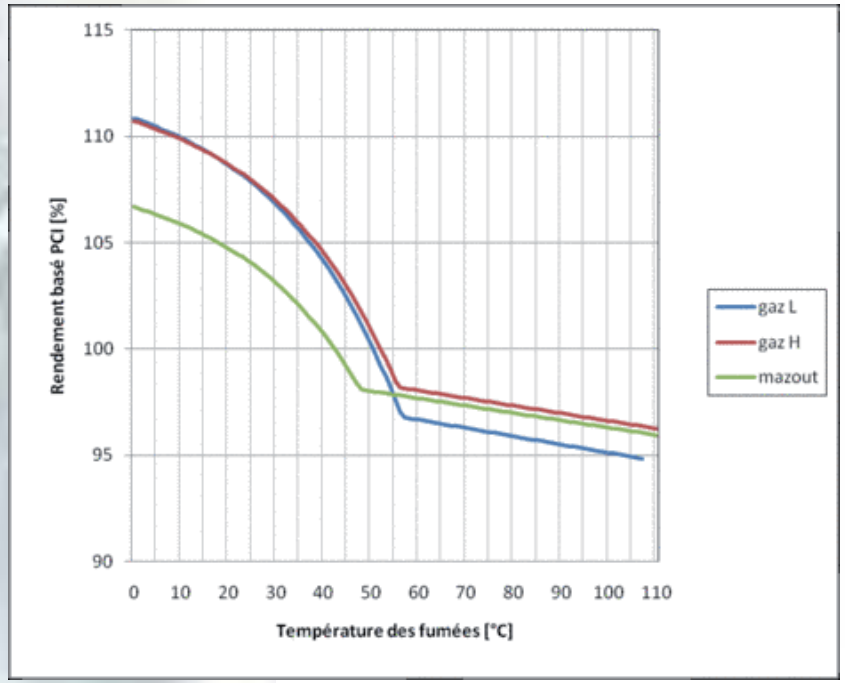




Référence: http://energie.wallonie.be > energie +

Conception - régulation du chauffage





Régime nominal:

- 90/70 °C
- 75/65 °C
- 50/40 °C
- Plancher chauffant: 40/30 °C

$$\dot{Q} = \dot{m}_w . c_w . \left(t_{depart} - t_{retour} \right)$$

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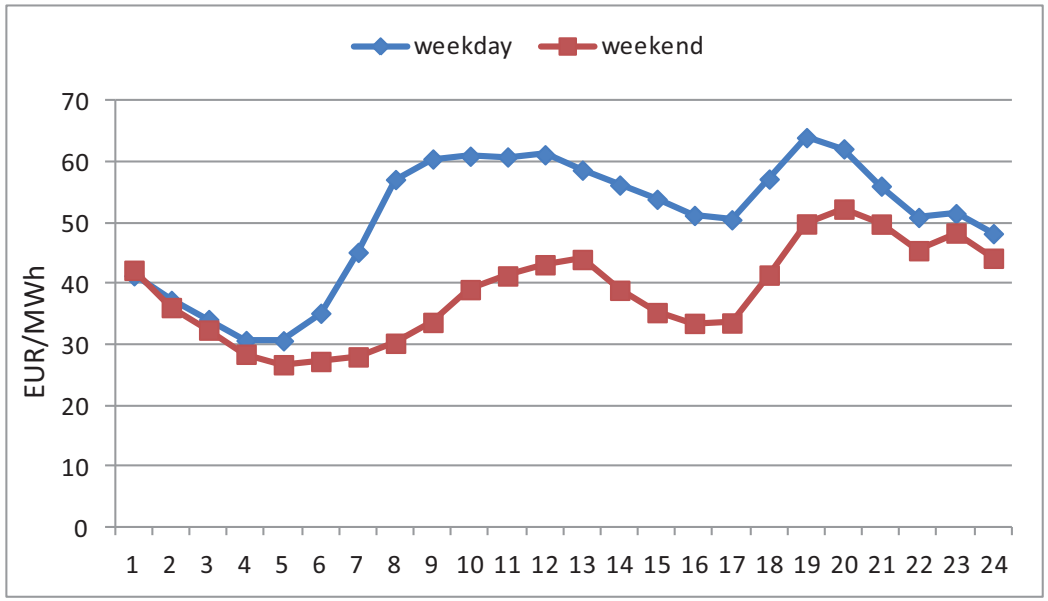
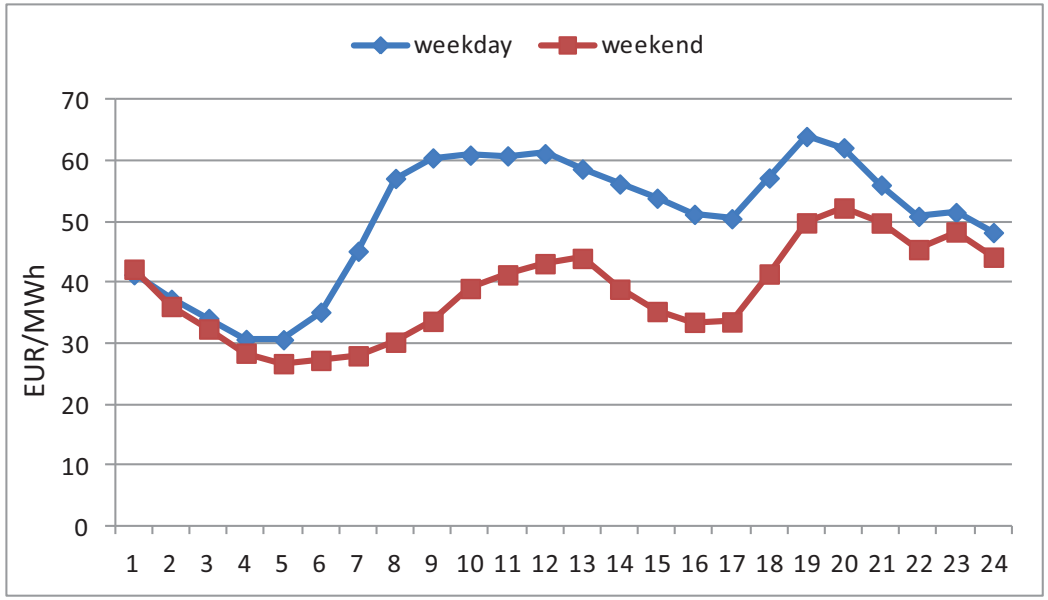
Profil de consommation et de coût

Consommations agrégées de 20 maisons

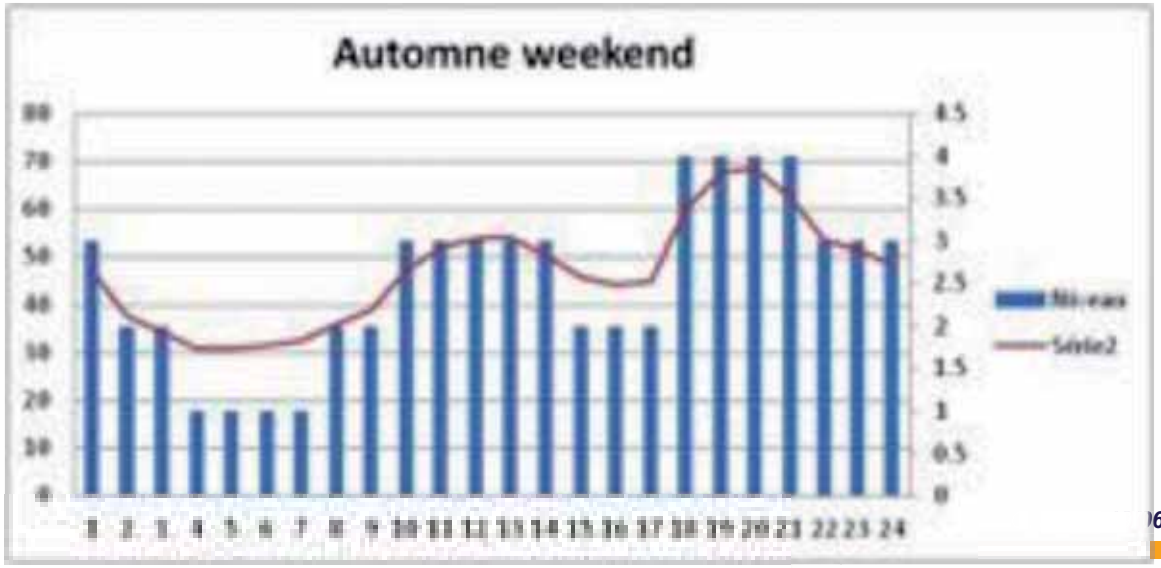


Coût de l'électricité sur le marché spot

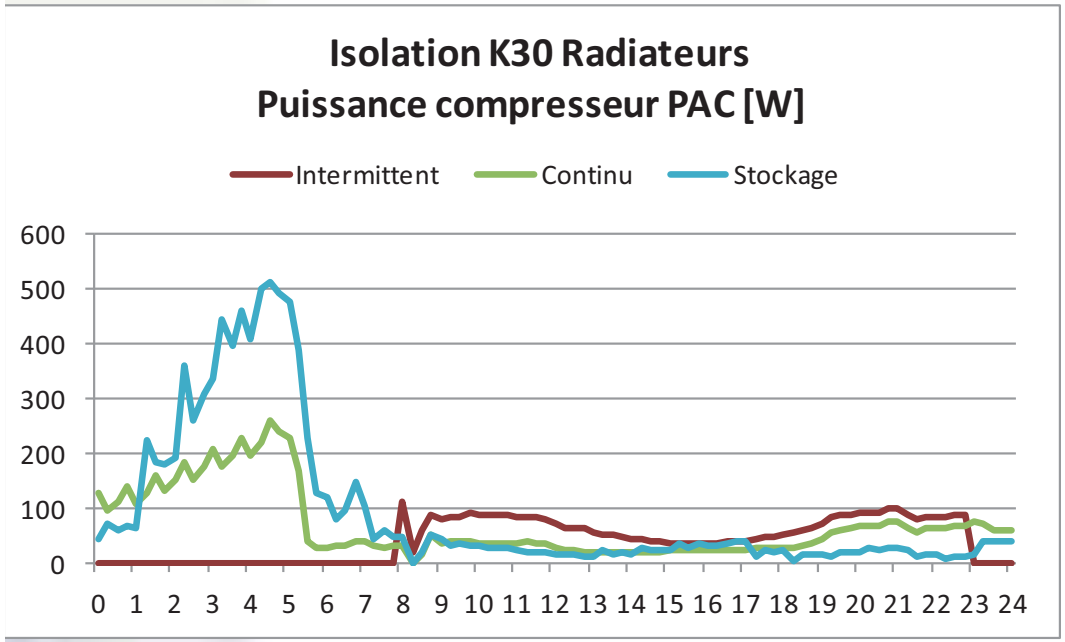
Profil de coût

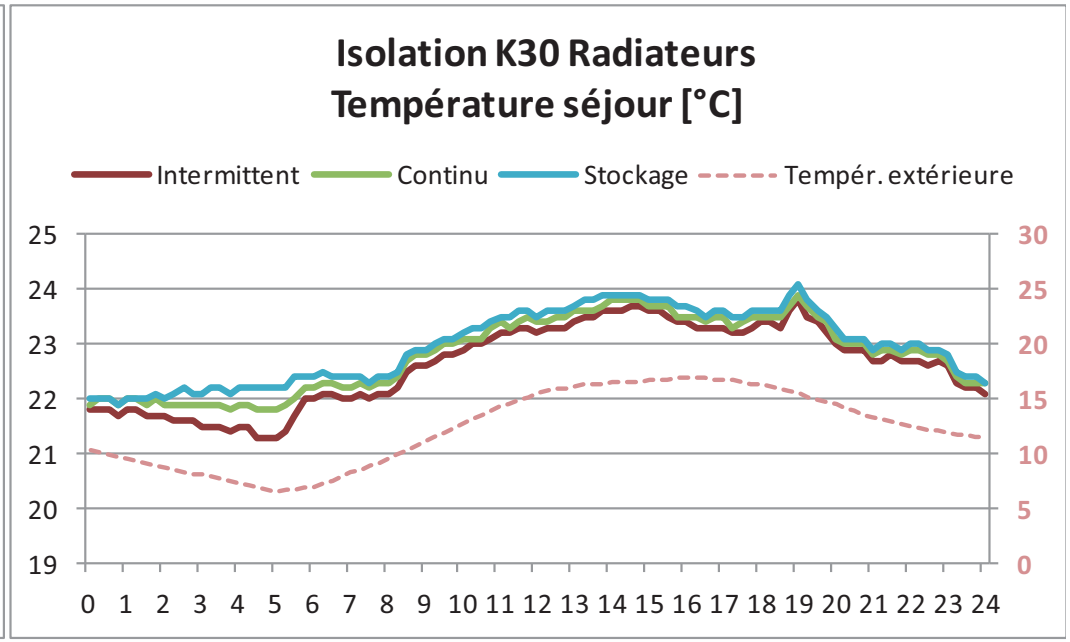


Coût de l'électricité sur le marché spot



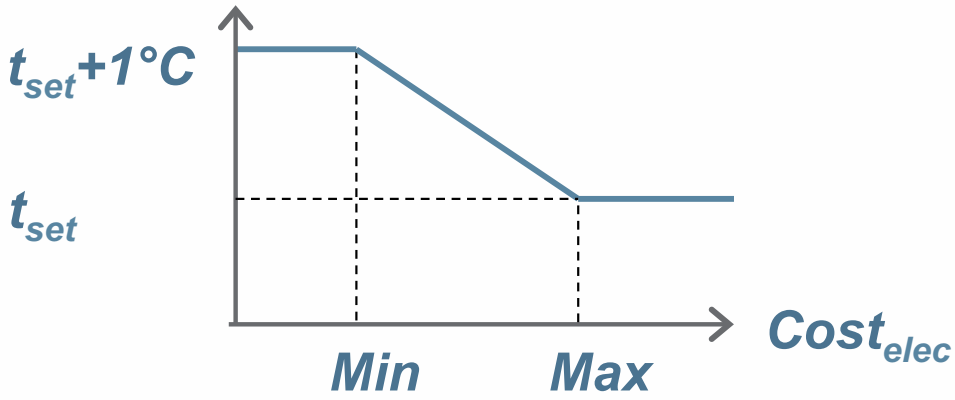
Flexibilité





Flexibiliser la demande:

- Pompe à chaleur
- Stockage thermique
- Contrôle prédictif



Flexibilité

$$Flexibility = \frac{E_{cw,\max} - E_{cw}}{E_{cw,\max} - E_{cw,\min}}$$

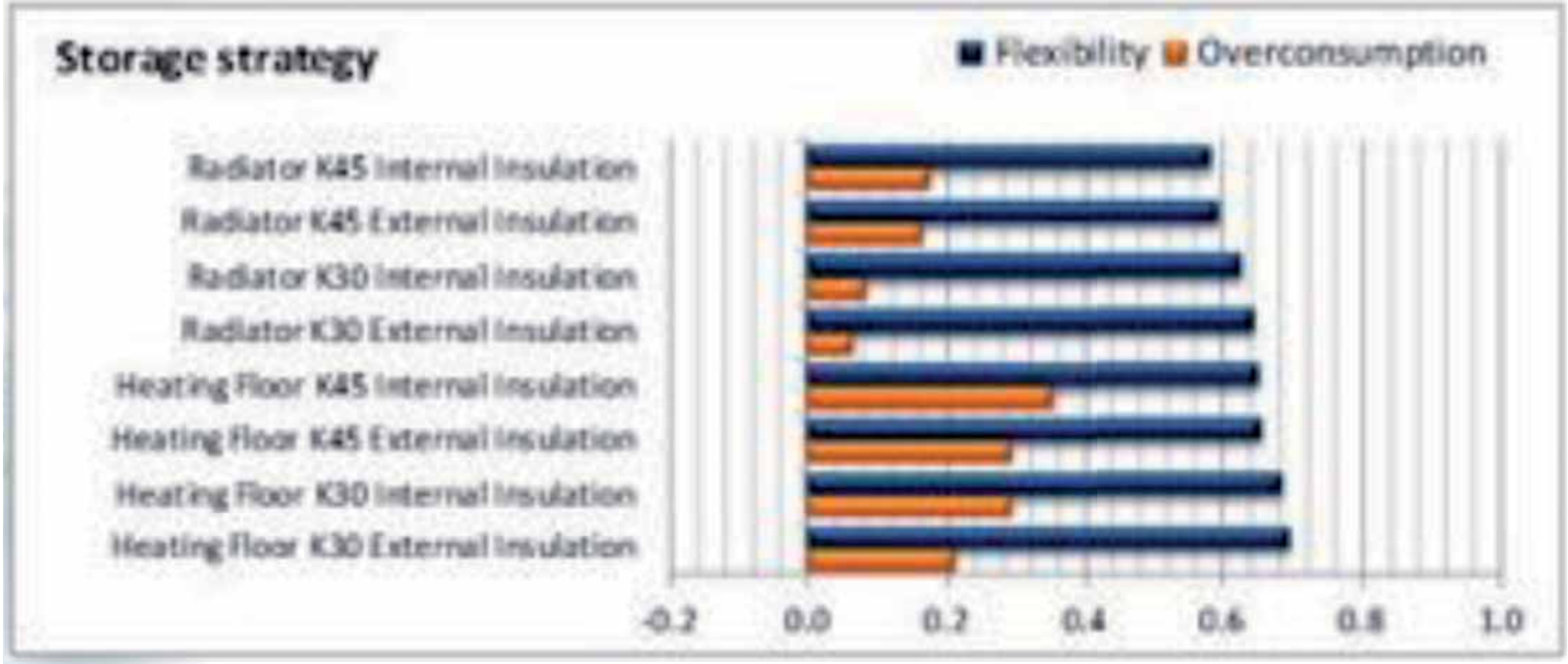
100% de l'électricité au coût max journalier *-> flexibilité = 0*
100% de l'électricité au coût min journalier *-> flexibilité = 1*

$$Overconsumption = \frac{E - E_{static}}{E_{static}}$$

E_{static} : consommation d'énergie d'un bâtiment de même niveau d'isolation sans masse thermique

Flexibilité

Occupation journalière:7 h - 22 h *Consigne de température flexible : +/- 1°C*



Conclusions

Bâtiments performants:

- A énergie presque nulle: Compacité, isolation, étanchéité, apports solaires
- Intelligents: Contrôle de la ventilation, des protections solaires, de l'éclairage
- Flexibles à l'égard du réseau: isolation et masse thermique

Perspectives:

- Comportement des occupants
- Rénovation
- Transport
- Préfabrication/ Démontabilité