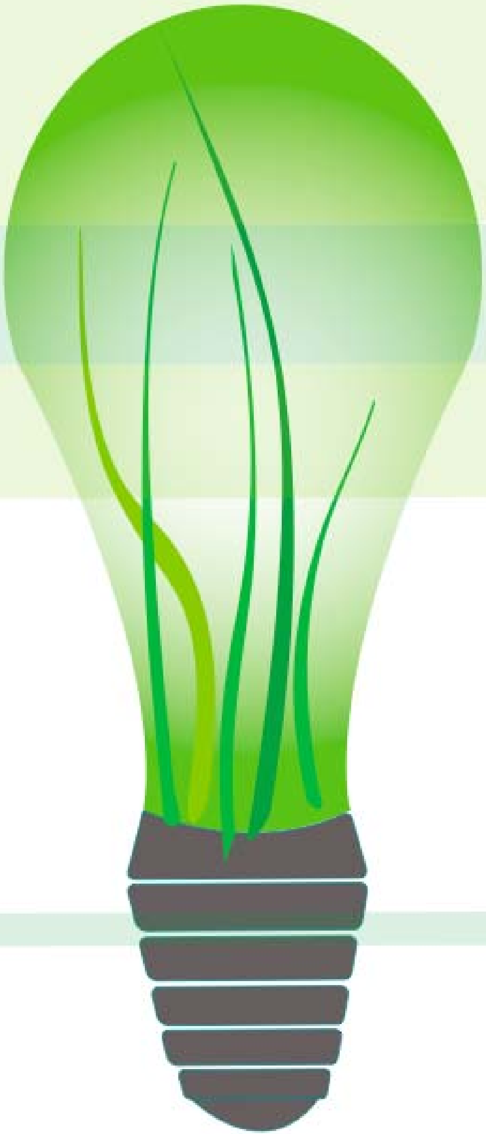
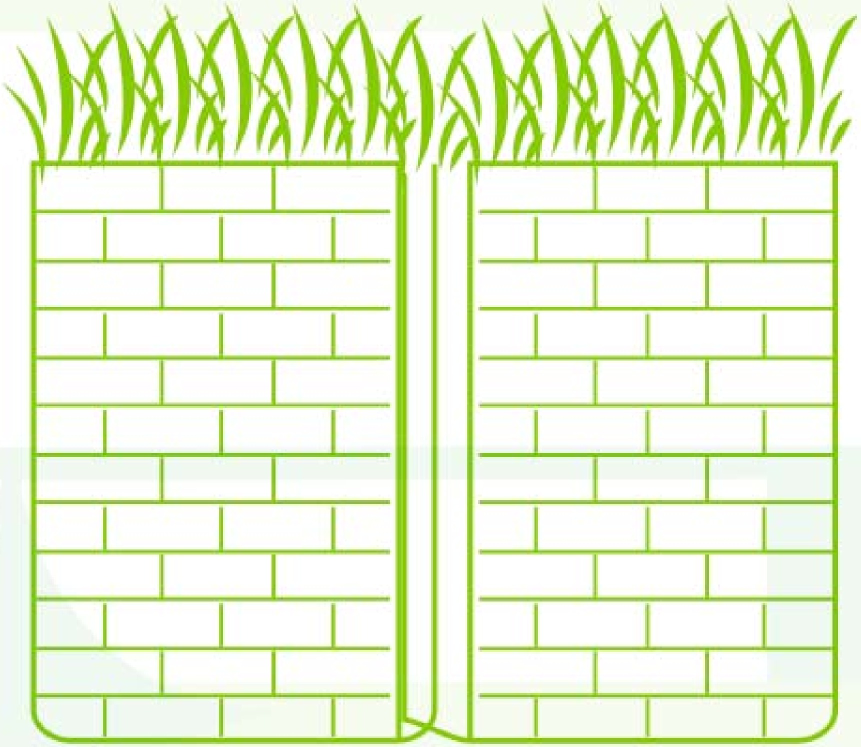


The role that plays **geothermy** in the **Sustainable Development** for new building construction

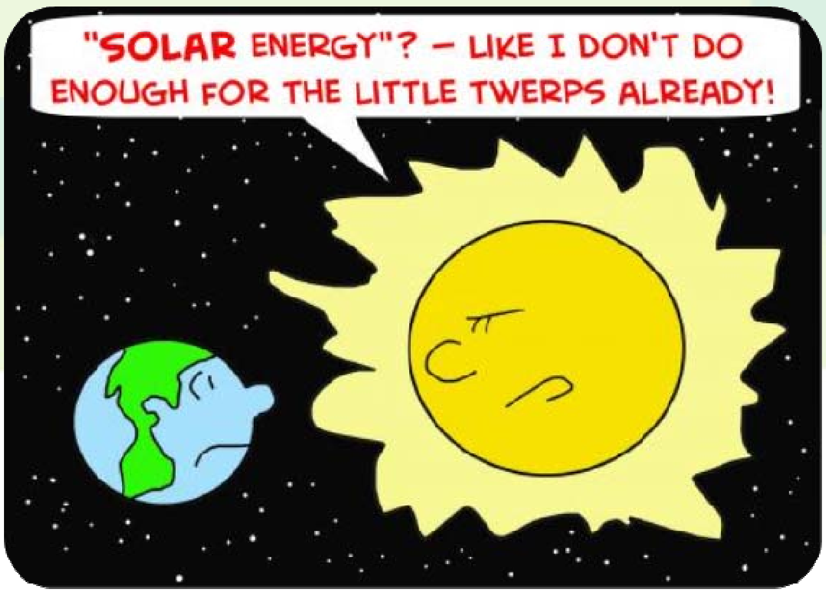
Michel Guillaume – Guillaume Donnet

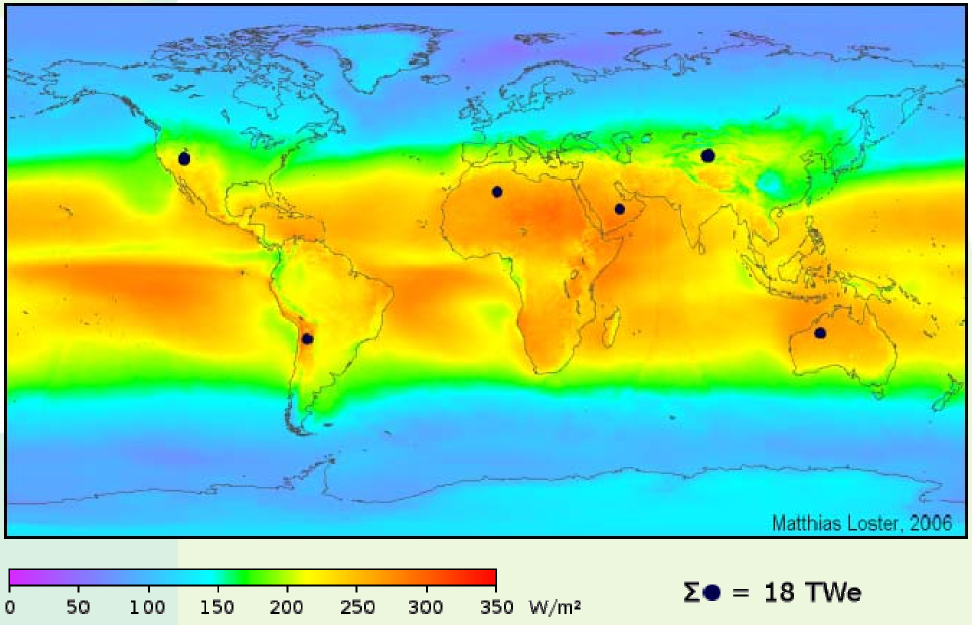
Presentation scheme



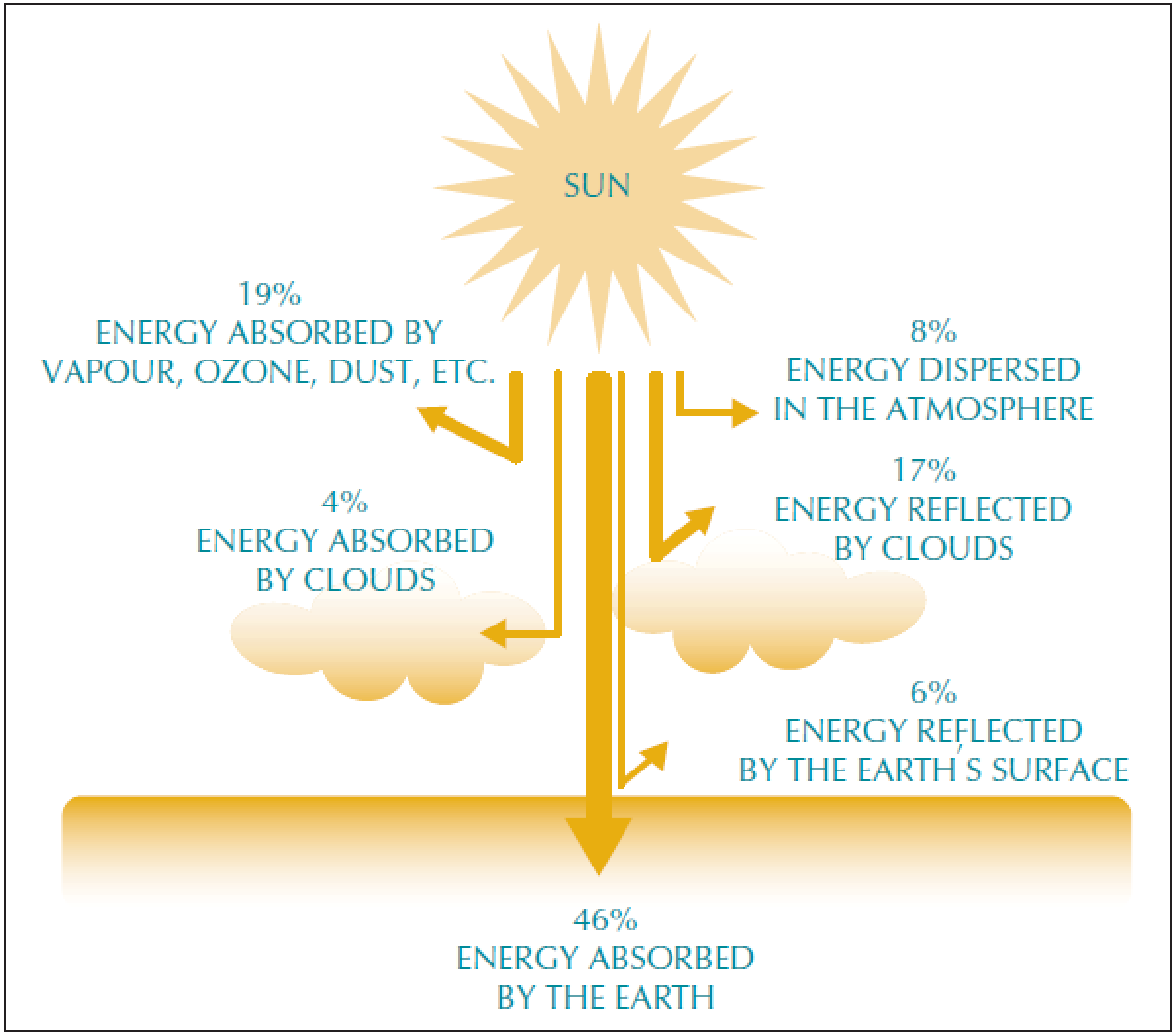
- Introduction
- How does it work?
- Scope and decision tool
- Presentation of several projects
- Conclusions

Introduction



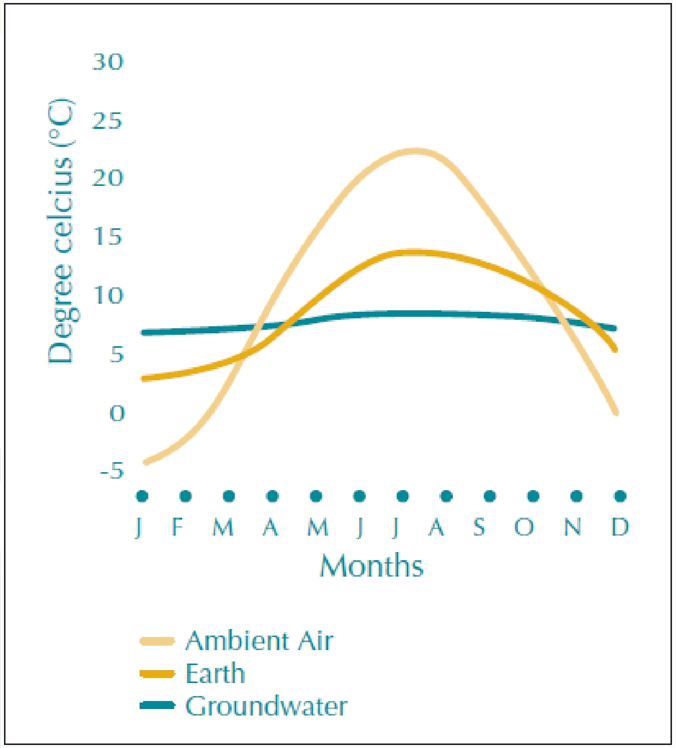


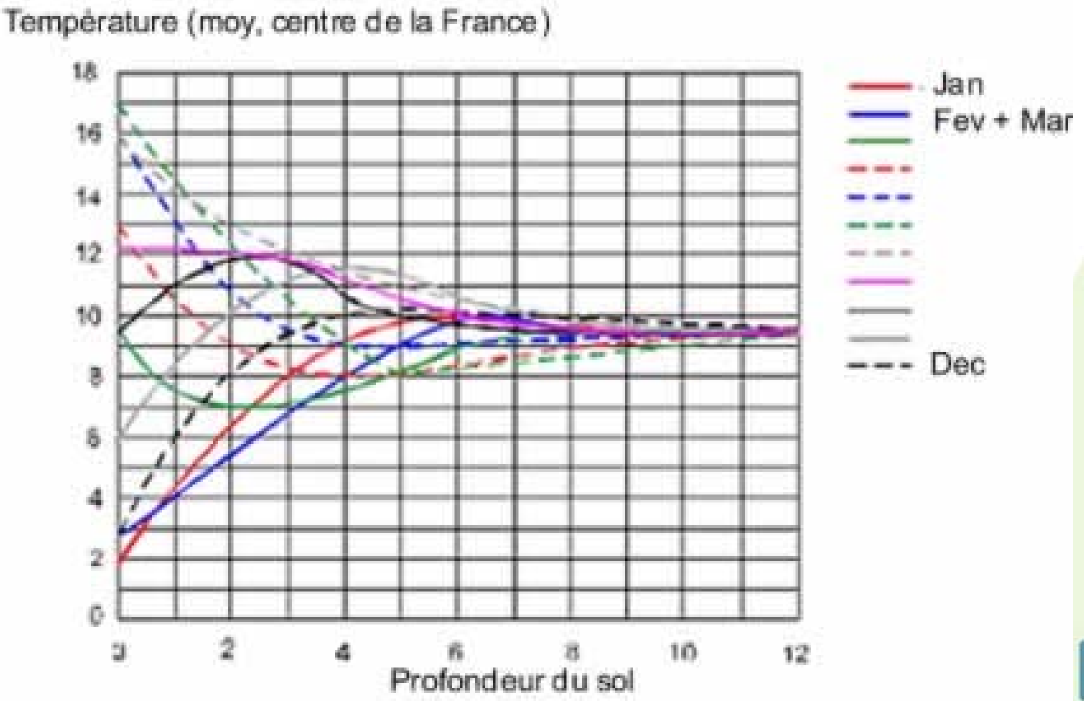
Introduction



Introduction

- Available **locally** and **great amount**
- Ground temperature **varies less** than air temperature





How does it work?

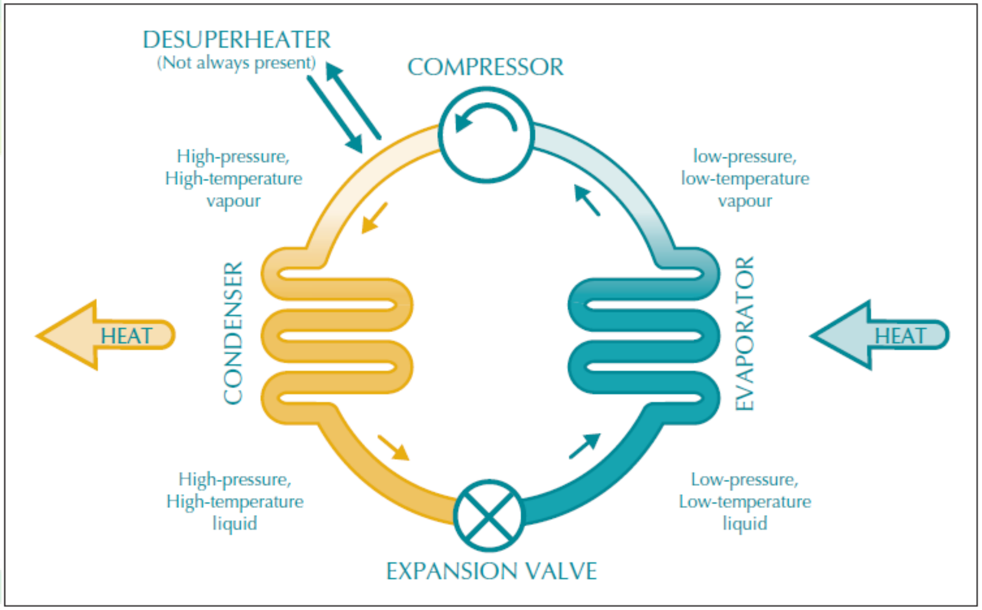
- A **g**eothermal **h**eat **p**ump (GHP) is able to collect heat from the ground (low temperatures) in order to pump/reuse it at higher temperatures

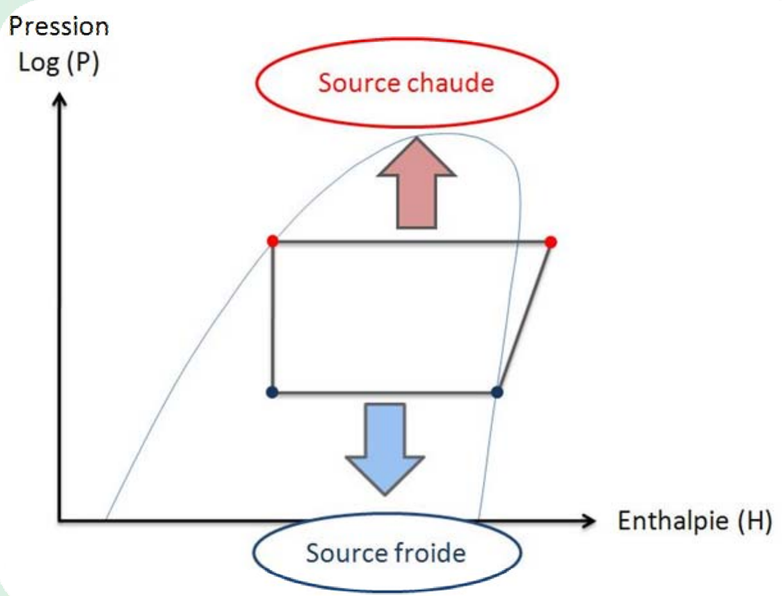
⇒ **Savings** from 30 à 70% on heating

20 à 50% on climatisation

How does it work?

- Heating /cooling mode





- COP varies between 2 and 5
- SPF varies between 2 and 4

Types of GHP

- Fluids (loop – distribution)
  - Water-Air
  - Water-Water
- Types of exchanger
  - GCHP (Ground)
  - GWHP (Groundwater)
  - SWHP (Surface Water)

Ground-coupled Heat Pumps

- Vertical Exchanger
  - **40 to 60 W per drilling meter** (type of ground)
  - Large buildings
  - minimal disruption of the landscaping desired
  - Little land available for GHX
- Horizontal Exchanger
  - **24 W/m² of burried collector surface**
  - Less expensive
  - Requires more area
  - Small buildings and residential sector

GHP all over the world...

- Seventies: GWHP in the residential sector
- Eighties, closed loops
- 28 GW (thermal) supplying 72 TWh (annual growth of 10%)
- More than1 million GHP system installed
  - 46% vertical closed loop
  - 38% horizontal closed loop
  - 16% GW

GHP all over the world

- The technology is mature but high initial cost
  - 200% conventional system (residential)
  - 20-40% more than constant volume, single zone rooftop units
  - 20% more than multizone or central two-pipe chilled water arrangements

CFE

GHP all over the world

BUT

lower life-cycle costs than conventional systems due to their **efficiency** and lower **maintenance** requirements

GHP all over the world

- Trends
  - Residential
    - **high-end residential constructions** where the higher initial costs do not constitute a large fraction of the project
  - Non-residential
    - Pay-back less than 5 years not required
    - Surface available

Scope of a project

1. Define the future needs of the building (kWh/m²/y) PE
2. Available surface for the project
3. Weather forecasts and geothermal data
4. Type of exchanger
5. Design of GHP with regards to the economical optimum (HP – supplemental heating?)
6. $C_{pcg} < C_{autre}$ (financial helps)
7. Impact on the E-level of a building?

Decision tool – types of needs

- The installation of a GHP is optimal when
  - Heating **and** climatisation needs
  - Climates where **great temperature variations** occur
  - New constructions or replacement of old systems

Decision tool

Prevailing needs	Heating	Climatisation	Mixed
Price of electricity	Low	High	Low except peaks
Price of fossile energy	High	-	-

- If the heating and climatisation needs greatly differ, the HX should be designed with the smallest load + supplemental system

Decision tool: financial helps

Brussels		Flanders		Wallonia	
Individuals	Enterprises	Individuals	Enterprises	Individuals	Enterprises
750 €					
	Tax reduction		Tax reduction		Tax reduction
1500 €	30,00%	2770 €	15,50%	1500 €	13,50%
2250 €				2250 €	
max 30%	max 200000 €	max 40%			

Decision tool: total annual cost

$$C_{pcg} < C_{cc}$$

$$C_{pcg} = \sum (a.I)_{pcg} + \kappa_{Epcg} \cdot \frac{Q_{chaud,pcg}}{SPF_{chaud}} + \kappa_{Epcg} \cdot \frac{Q_{froid,pcg}}{SPF_{froid}}$$

$$+ \kappa_{E,supchaud} \frac{Q_{supchaud}}{\eta_{supchaud}} + \kappa_{E,supfroid} \frac{Q_{supfroid}}{\eta_{supfroid}} + constante$$

$$C_{cc} = \sum (a.I)_{chaud+froid} + \kappa_{E,chaud} \frac{Q_{chaud}}{\eta_{chaud}} + \kappa_{E,froid} \frac{Q_{froid}}{\eta_{froid}} + constante$$

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Decision tool: E-level

$$E = 100 \times \frac{\text{Consumption of primary energy (computed)}}{\text{Reference value}}$$

E90 = +/- 195 kWh/m²/y EP
E75 = +/- 155 kWh/m²/y EP
E45 = +/- 95 kWh/m²/y EP

Case study

- Galt house East hotel:

Case study

- Galt house East hotel:
  - 88.320 m² / 6.000 kW_{th} (HP) installed
  - World's largest installation
  - Next to another Galt House Hotel (with conventional heating)

    => Easy to compare

Case study

- Operating mode:
  - Use of groundwater
  - heating through several loops distributed in the building.
  - Use of water tanks
  - Water is tranferred to another well.

Case study

- Initial cost:
  - 310 euros / kW
    - vs. 410 – 620 euros / kW for conventional system. (compressor, boiler, VAV)
  - frees 2.323 m² of rental area
    - Comparison with the other GHEH

Case study

- Use:
  - 18000 euros saved every month on energy bill
  - Lower maintenance
  - No failures

Case study

- DFS (Hessen, Germany)
  - 57.000 m² of building offices
  - Global consumption target: 100 kWh/m²/year
  - Site located next to protected groundwater well, use is forbidden

Case study

- Operation:
  - Closed loops (no use of groundwater)
  - Pure water within the pipes
    - Frozen if < 4 degrees at the evaporator of the HP
  - $P_{heating}$ = 330 kW, P_{clim} = 340 kW
    - 154 drills of 70 m depth, spaced by 5 m each
    - COP value: 6 (water at 30 degrees)
    - Emission through ceiling
  - HP linked to urban network (supplying 30% of annual heating needs)
  - 20% of HVAC is supplied by a back-up system

Case study

- Remarks:
  - Profitable compared to existing efficient solution of urban heating network
  - Could be implemented on site where groundwater is protected
  - If pure water is used, the filling of the boreholes should have a high conductivity

Case study

- Rest home
- Surface: 1500 m²
- Heating power: 90kW
- Cooling power: 5kW (120m²)
- HTW with thermal panes
- Annual consumption: 160 MWh

Case study

- Two cases:
- GHP designed with 100% of the power

  13 boreholes of 100m
- GHP designed with 50% of the power => 80% of the needs are filled

  6 boreholes
- Comparison with a conventional solution (gas boiler and rooftop units)

CFE

Case study

- SPF 3.5

GHP Rest Home	13 boreholes	6 boreholes
Investment (euros) HTVA	131000	61500
Simple Pay-back time	28	12
Simple pay-back with financial helps	**19,7**	**8,5**

CFE

Case study

- Impact on the E-level
  - 1 point E corresponds to +/- 2.2 kWh/m²/y EP

GHP Rest Home	**13 boreholes**	**6 boreholes**
Primary energy reduction	30 kWh/m²/an	24 kWh/m²/an
E-level reduction	**13**	**10**
Simple pay-back time	28	12
Pay-back time with financial helps	19,7	8,5

CFE

Conclusions

- High growing potential
- Pay-back times are high
- Price of utilities is determinant (long term)
- Impact on the EPB-certificate
- No feed-back on long-term thermal imbalances

Sources: Retscreen International; « La géothermie » Jean Lemale, Dunod; Sustainable Energy Utilisation, KTH, Stockholm

Pour de plus amples informations :

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