Beodom

Performance of a geothermal system in a residential building in Belgrade

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The building

Amadeo

1st low-energy residential building in Serbia
604 net m², 12 apartments, moved in September 2009

Wall system / thermal bridges

- Monolithic walls with clay blocks (38cm thick)
- Thermal facade 4cm with lightweight mortar
- Thermal break on balconies

$U \approx 0.35\ W/m^2K$

Thermal insulation: roof/floor/pipes

- Pitched roof : mineral wool 20cm

  $U \approx 0.18\ W/m^2K$

- Floor : extruded polystyrene 10cm

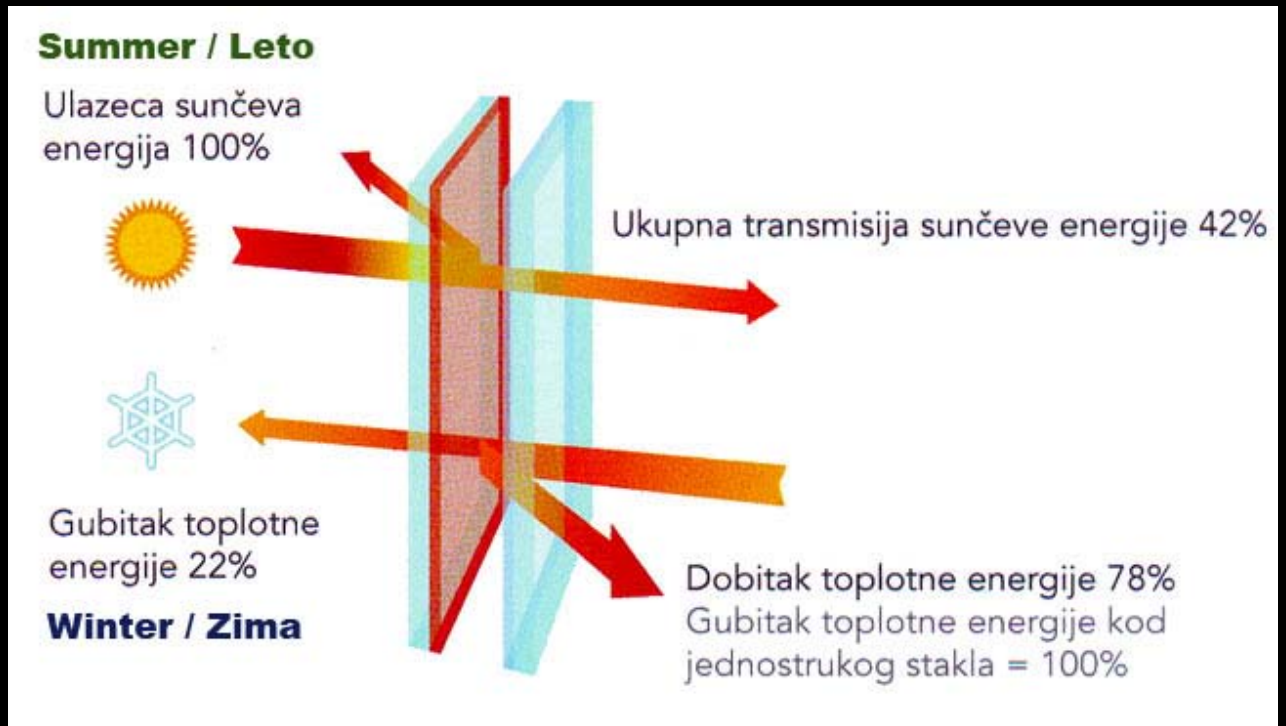
  $U \approx 0.36\ W/m^2K$

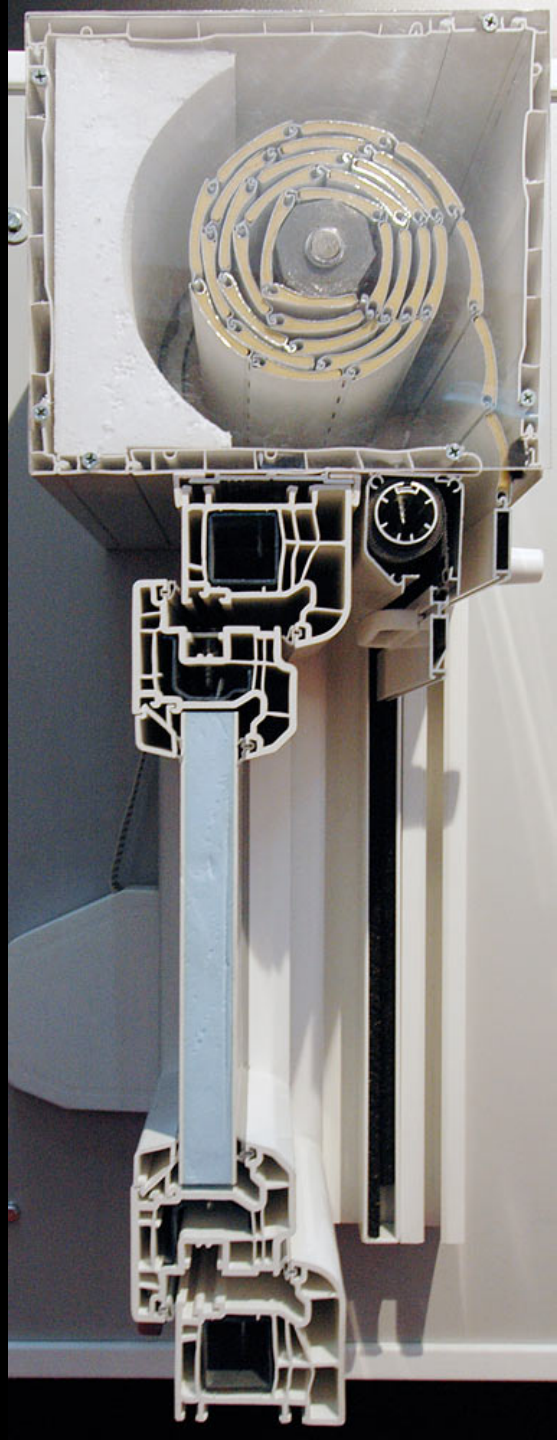
- Insulation of the pipes

Windows and shutters

Rolling shutter with thermal insulation
PVC-frame 5-chambers

Double-glazing, low-e, argon fill
U ≈ 1.20 W/m²K





The geothermal system

Amadeo geothermal system

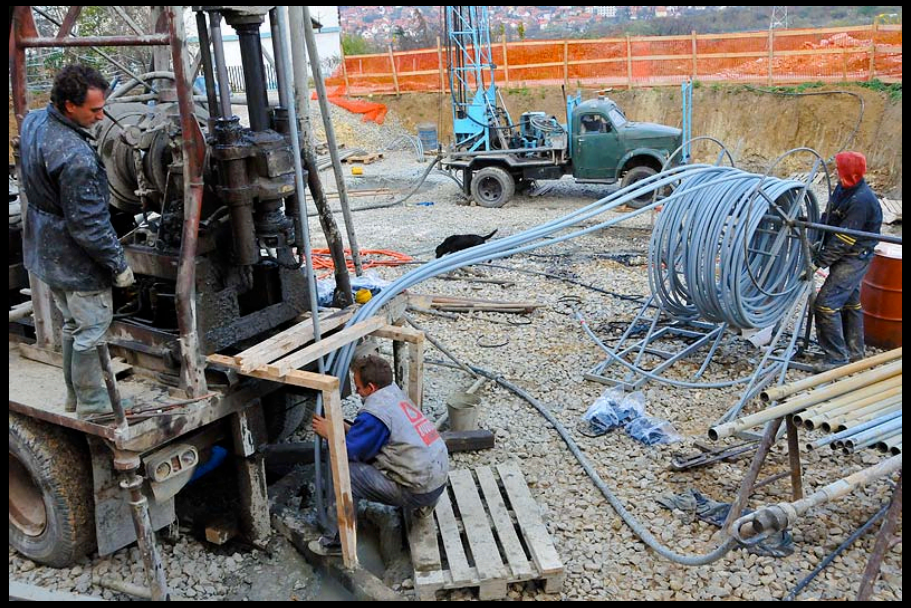
Grouping of the probes before connecting to the heat pump

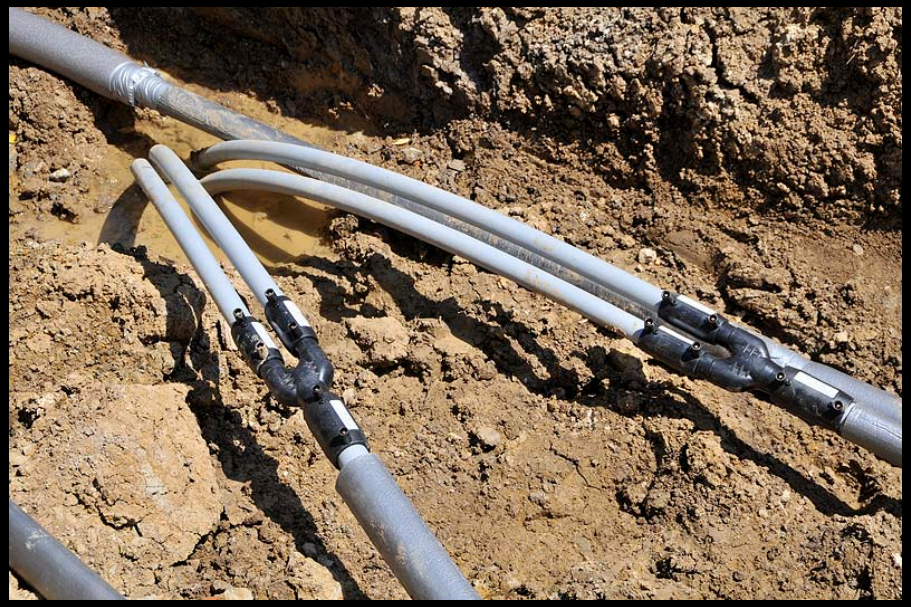
Vaillant GeoTHERM VWS 300/2 geothermal heat pump and storage buffer

Connection of the vertical geothermal probes to the undergound parking

5 vertical geothermal probes going 100m underground

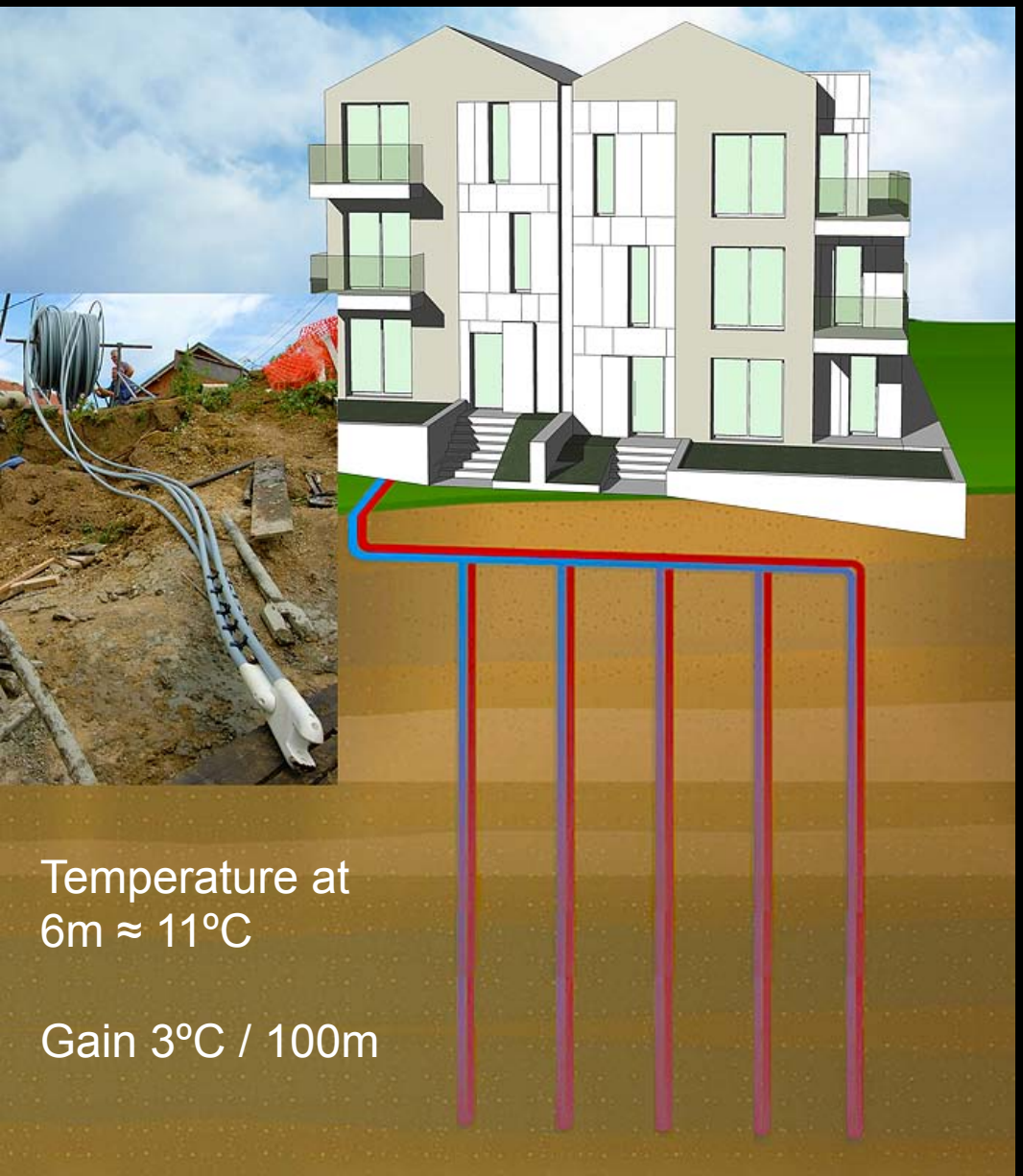
Energy source





- 5 vertical probes, 100m depth, 2 loops for each probe
- 5 probes x 2 loops x 200 meters (100 meters down + 100 meters up) = 2 km
- Closed loop circuit circulating glycol

Energy source



- Energy gain for vertical probes (depending on the ground structure):

  50 to 90 W/m

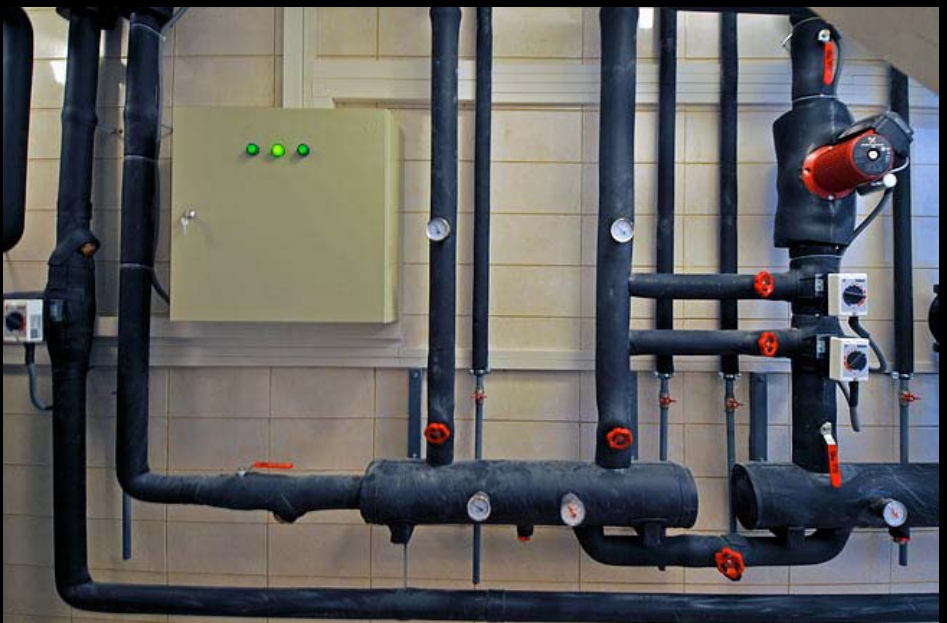
- Energy gain for one 100m probe:

  5 to 9 kW

- In Amadeo, 5 probes output over 30kW of energy from the ground

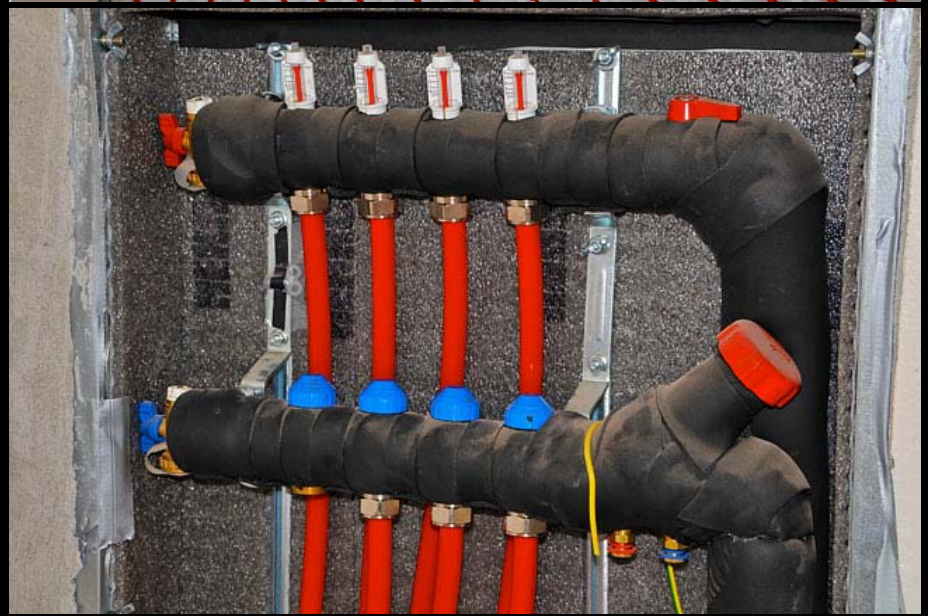
Energy production and storage

- Geothermal heat pump : Vaillant GeoTHERM VWS 300/2, delivering 30kW
- Storage buffer with a capacity of 750 liters
- Additional electric resistance



Energy distribution

- Hydronic radiant low-temperature underfloor heating and cooling system
- Heat transmission via radiation (like the sun) and convection (air movement)
- Water circulates at 25-30°C

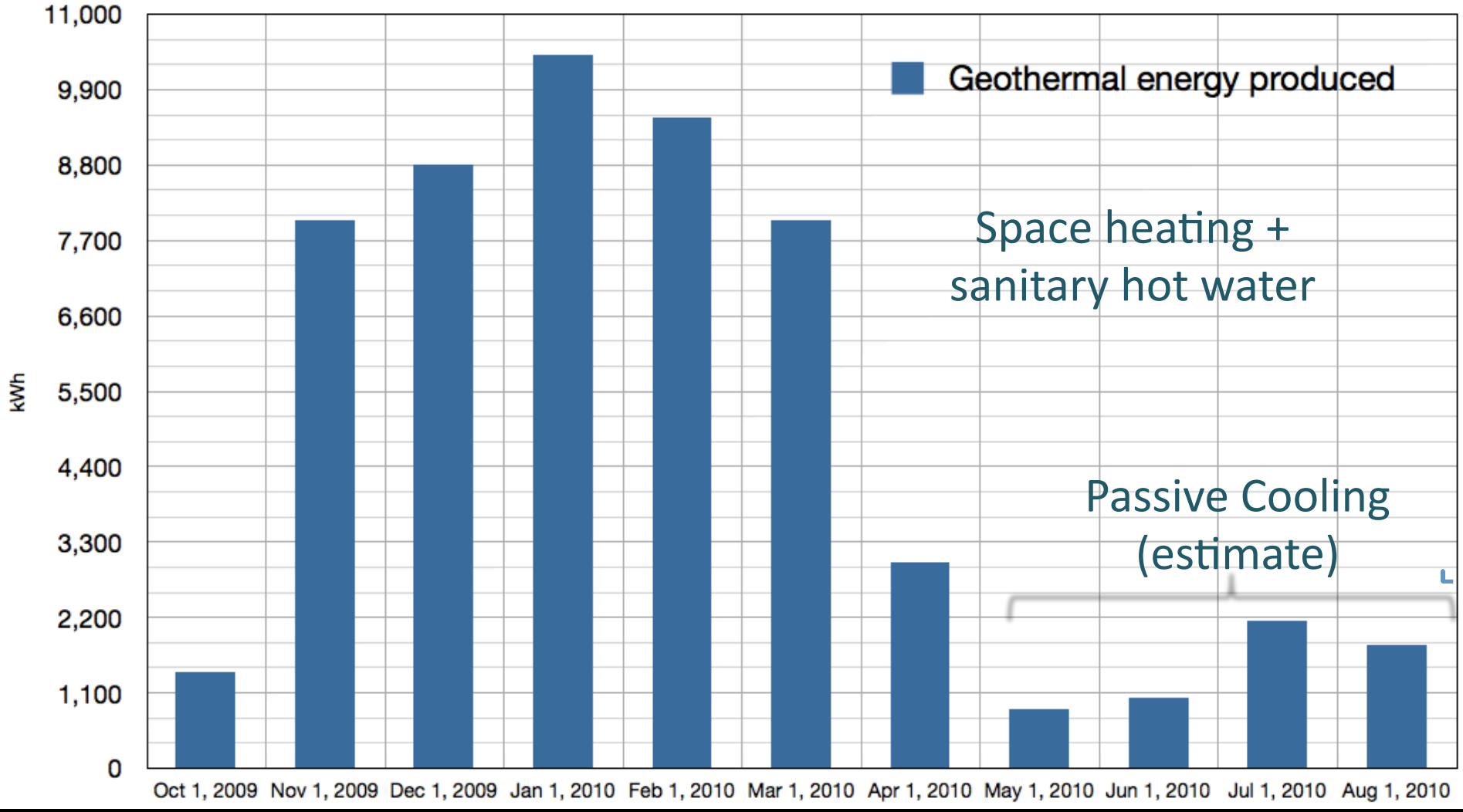


Geothermal and solar production of sanitary hot water

- 12 solar collectors (26m²)
- 2 water cylinders of 500 liters each (1000 liters)
- Geothermal as secondary energy

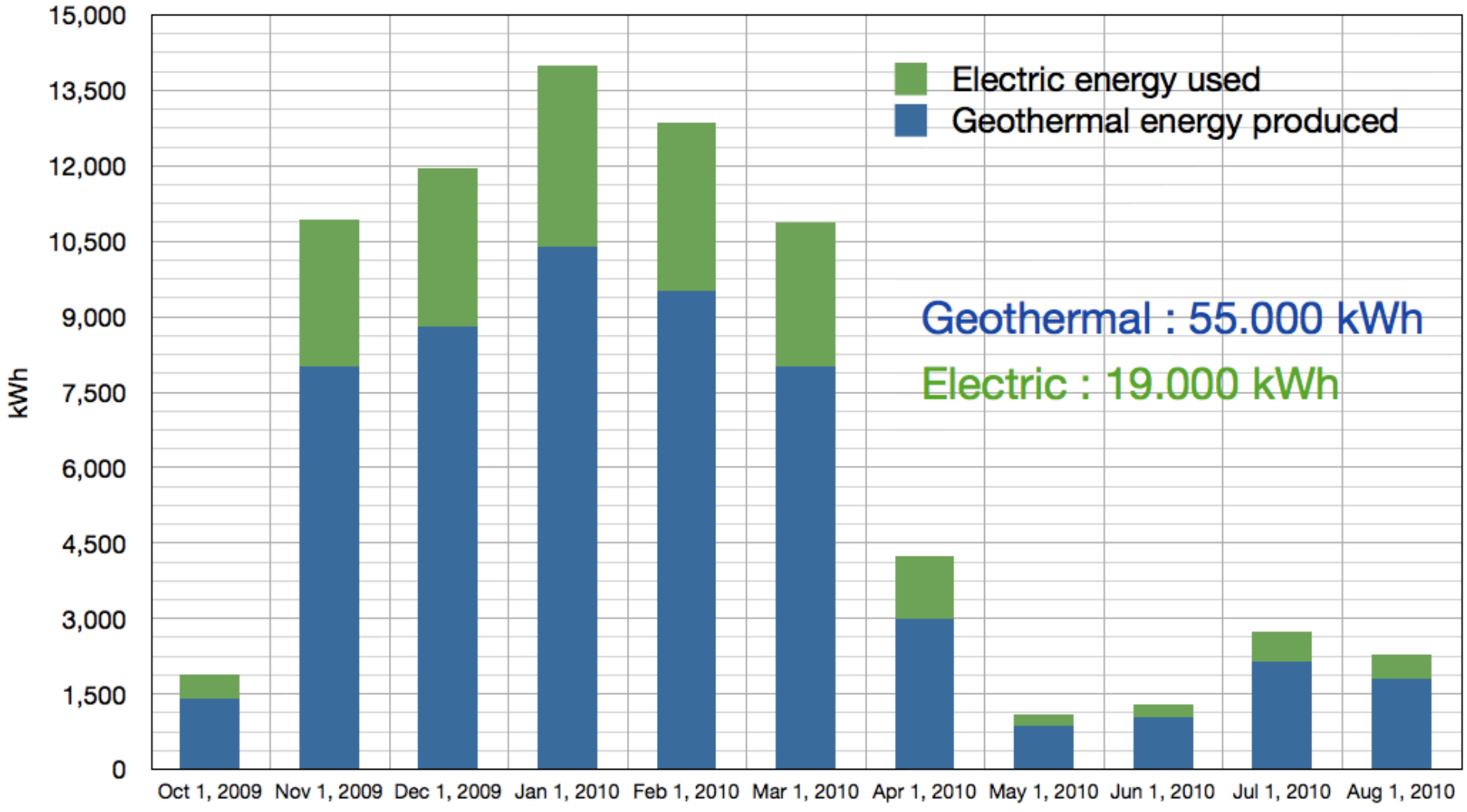
The performance

Energy gain from the ground



49.230 kWh of geothermal energy produced over the heating season

Total energy use



On one year : 31 kWh of electric energy per m^2 (heating-cooling)

Coefficient of Performance (COP)

$$\text{COP (heating)} = \frac{\text{Total energy output}}{\text{Electric energy used to run the heat pump}}$$

- Electric energy use :
  - Running the heat pump
  - Running all the circulation pumps
- Average COP over the heating season
  - Not distinguishing circulation pumps : 3.8
  - Removing 1/6 for circulation pumps : 4.3

Cost for tenants

On January 2010, the coldest month

- geothermal energy : 10.400 kWh
- electric energy : 3.600 kWh
- cost for the building (604m^2) : 18.000 DIN
- cost per apartment : 1.500 DIN

On average per month (heating / cooling) :

- cost for the building : 8.400 DIN
- cost per apartment : 700 DIN

Saving (assuming the same distribution with underfloor heating)

Total energy used for heating in kWh :	67.000 kWh
Cost with the geothermal system :	89.000 DIN
All electric (5 DIN/kWh) :	335.000 DIN
Saving :	246.000 DIN
Gas heating (10kWh/m^3, 32 DIN/m^3) :	214.000 DIN
Saving :	125.000 DIN

+ advantage for cooling and safe from energy price rise

Conclusion

- Energy efficiency of the building is the most important factor
- Good distribution : underfloor heating = less energy spent
- Education of the tenants
- Geothermal system very economical
- ROI hard to calculate

www.beodom.com