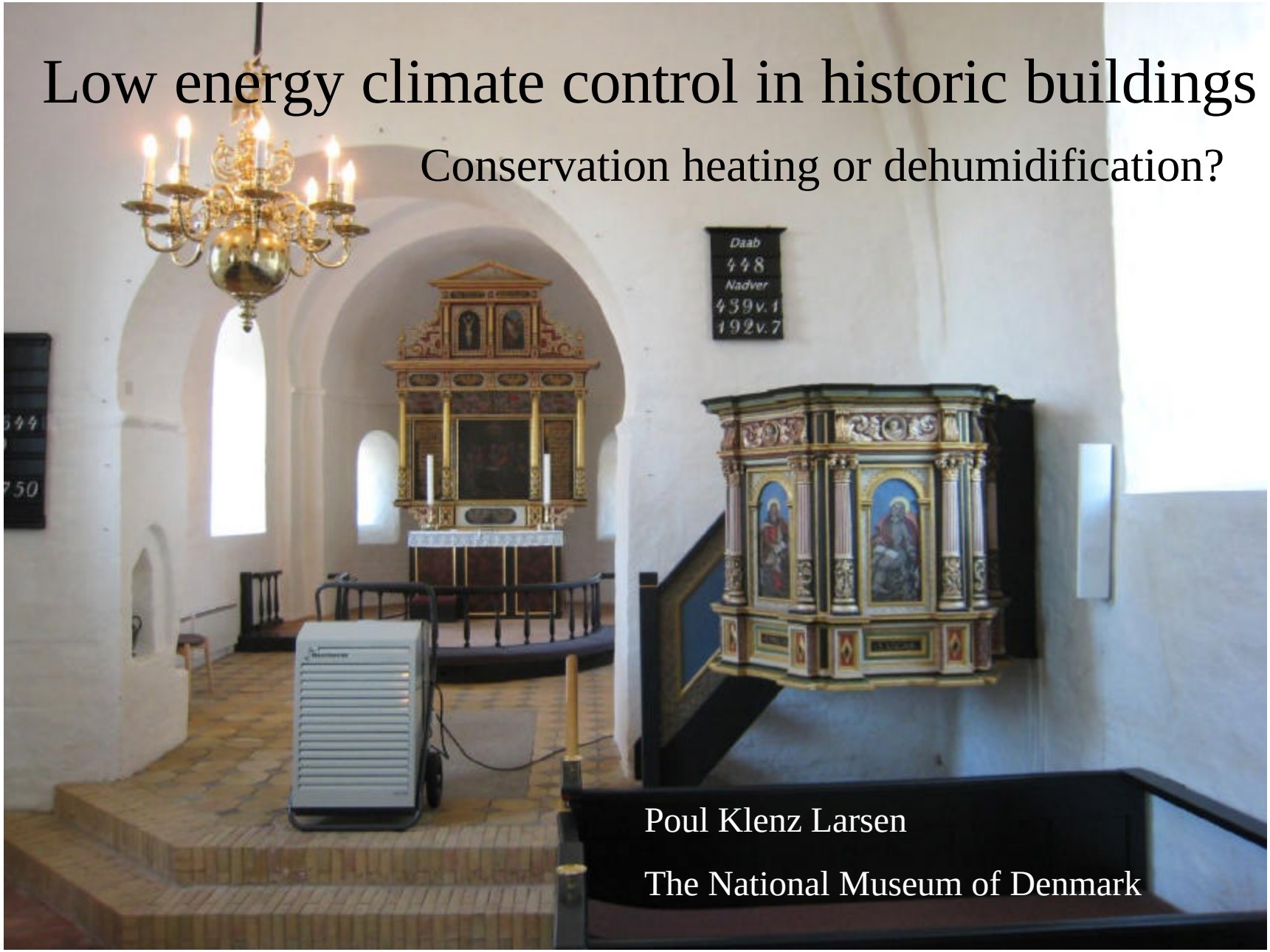
Low energy climate control in historic buildings

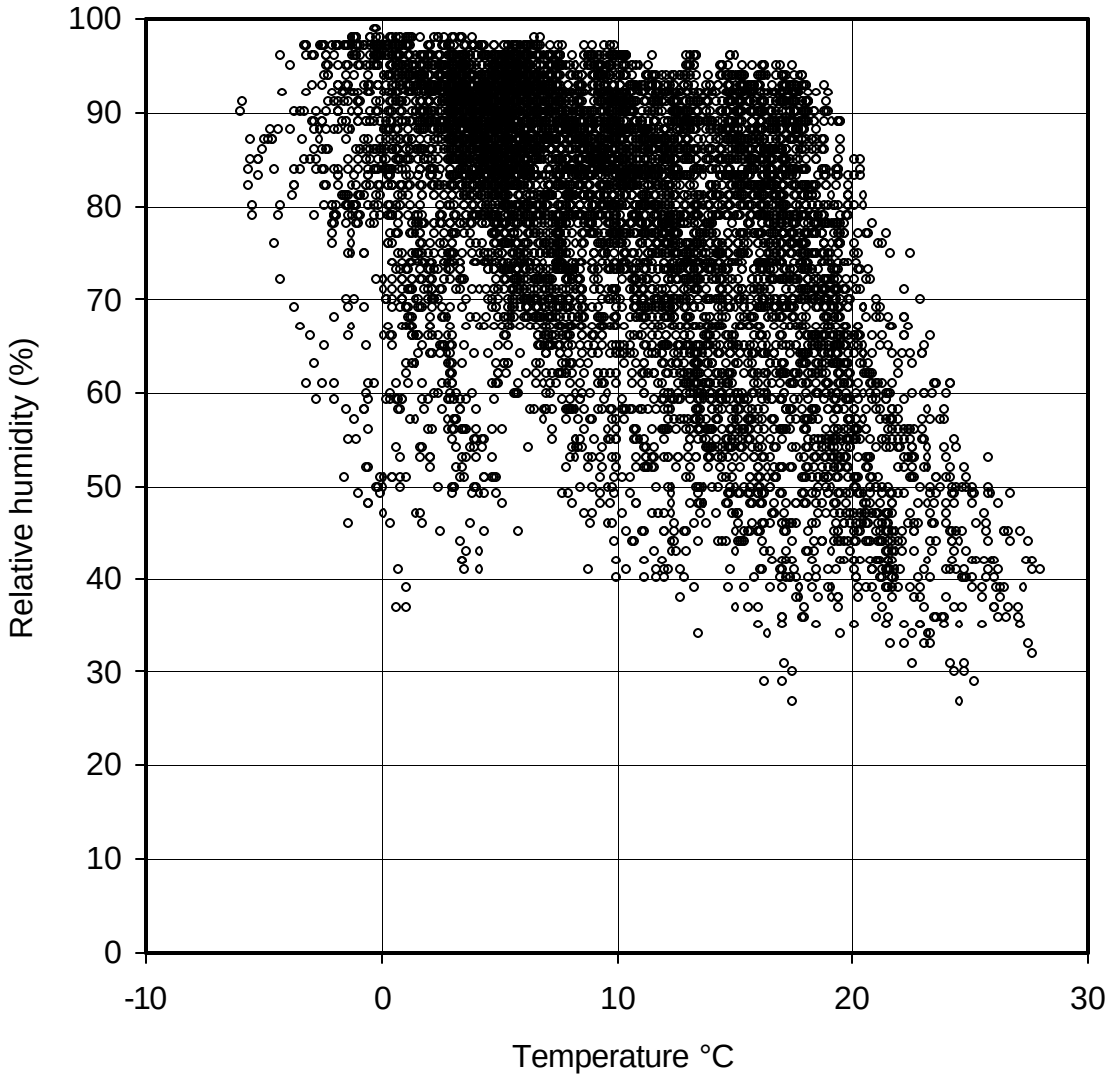
Conservation heating or dehumidification?



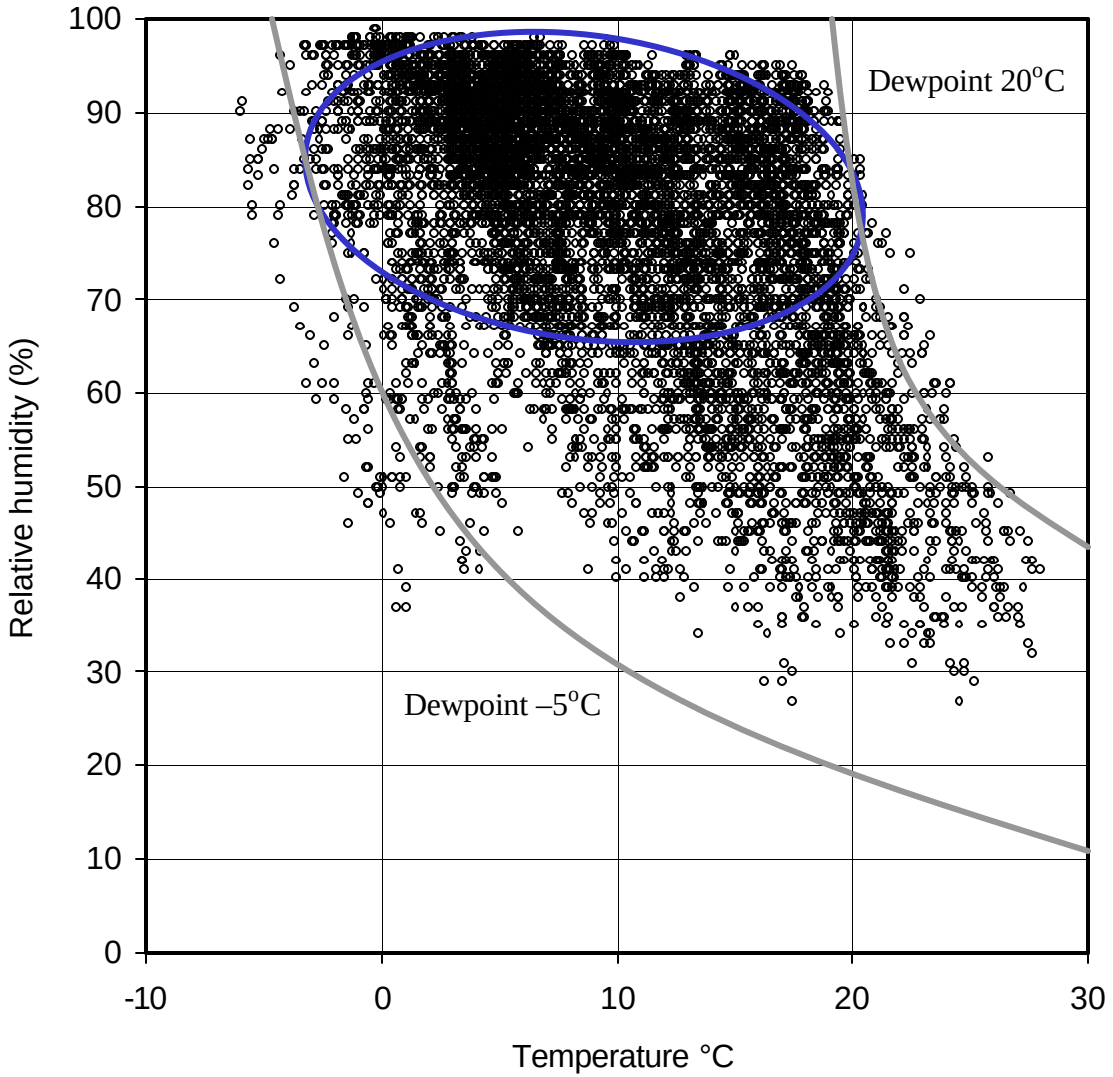
Poul Klenz Larsen

The National Museum of Denmark

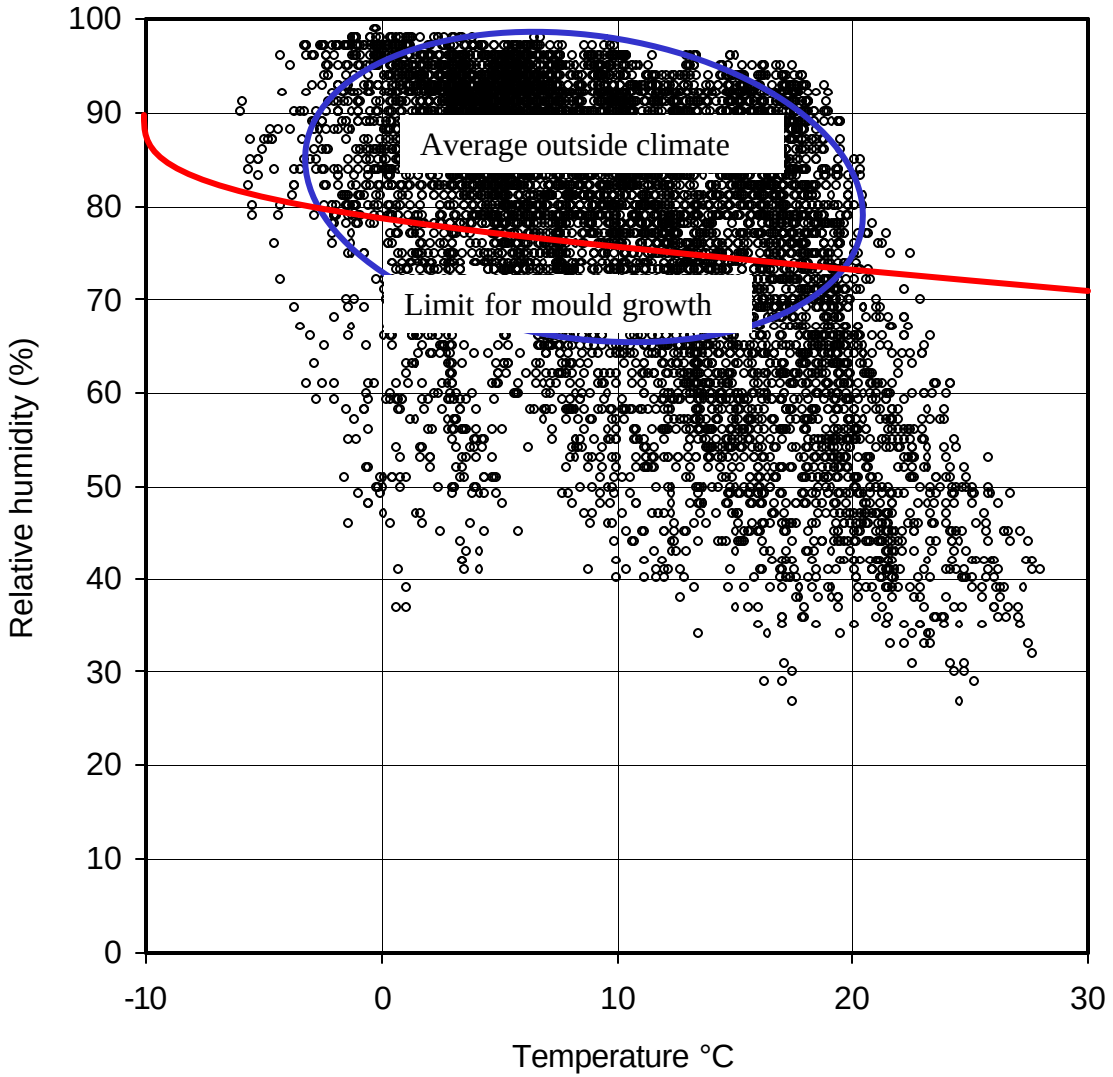
The natural climatic conditions for Denmark



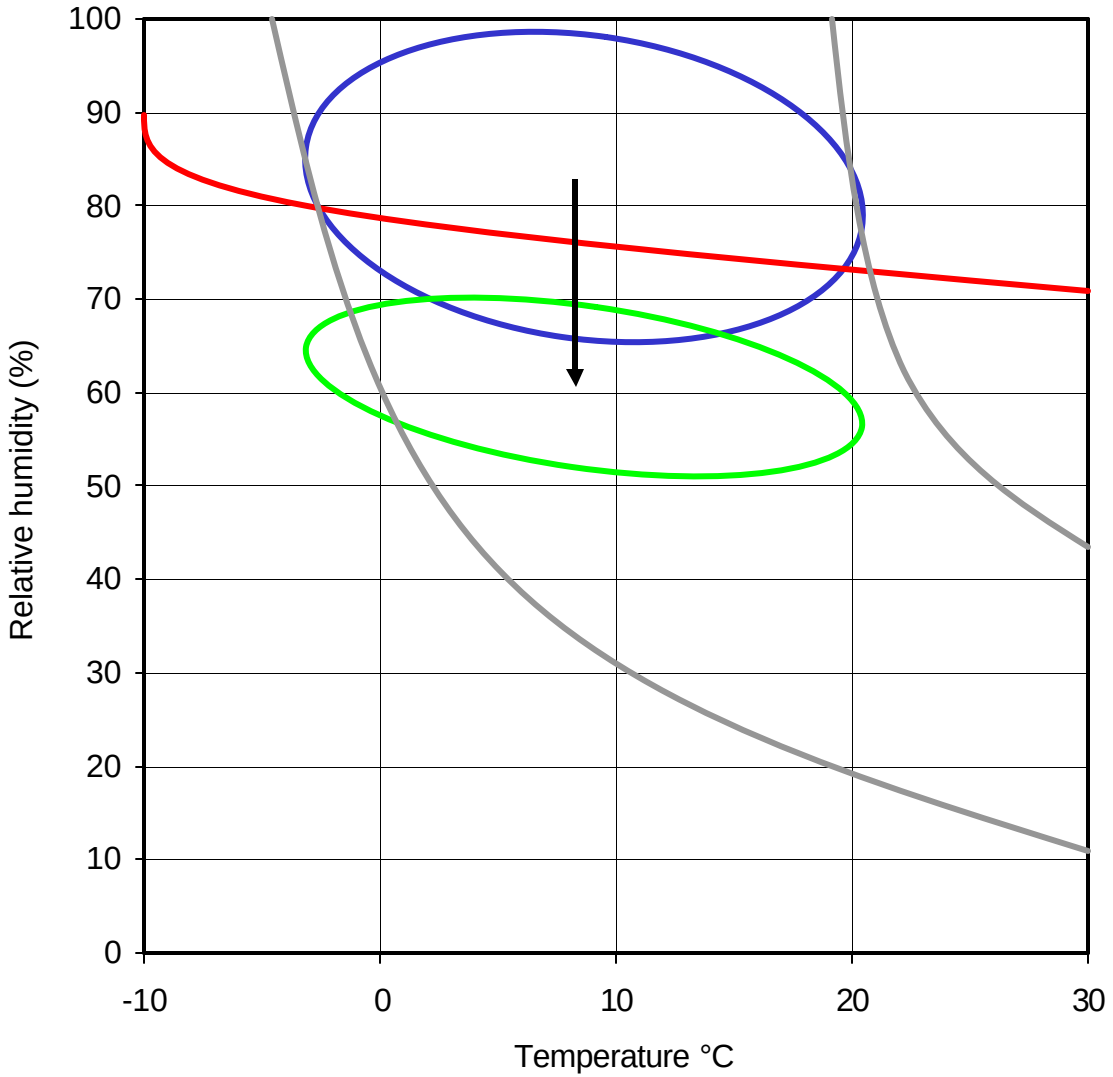
The climate is mild and humid: $0^oC < T < 20^oC$. $70\% < RH < 100\%$



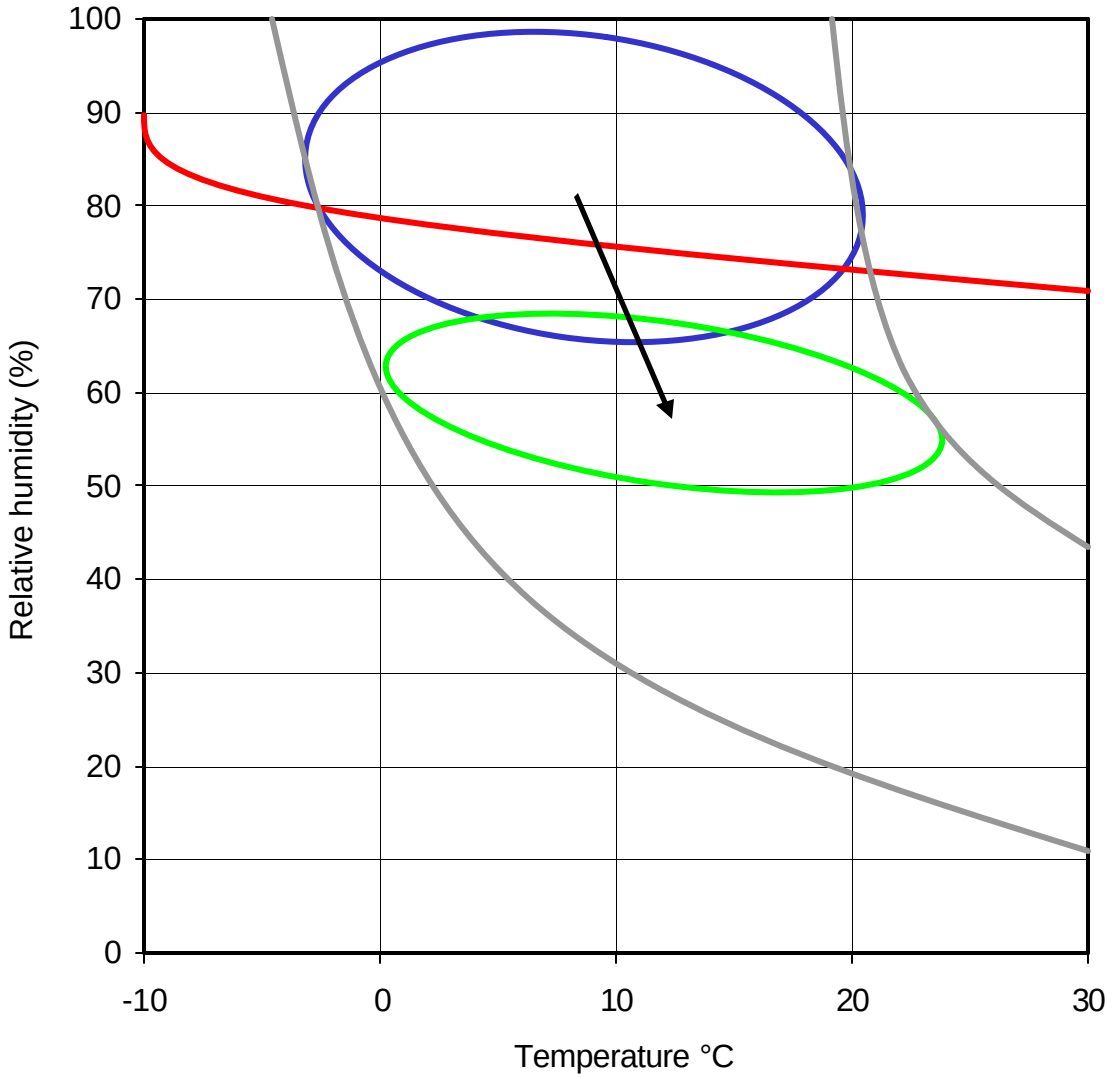
Ventilation alone will not prevent biological degradation.



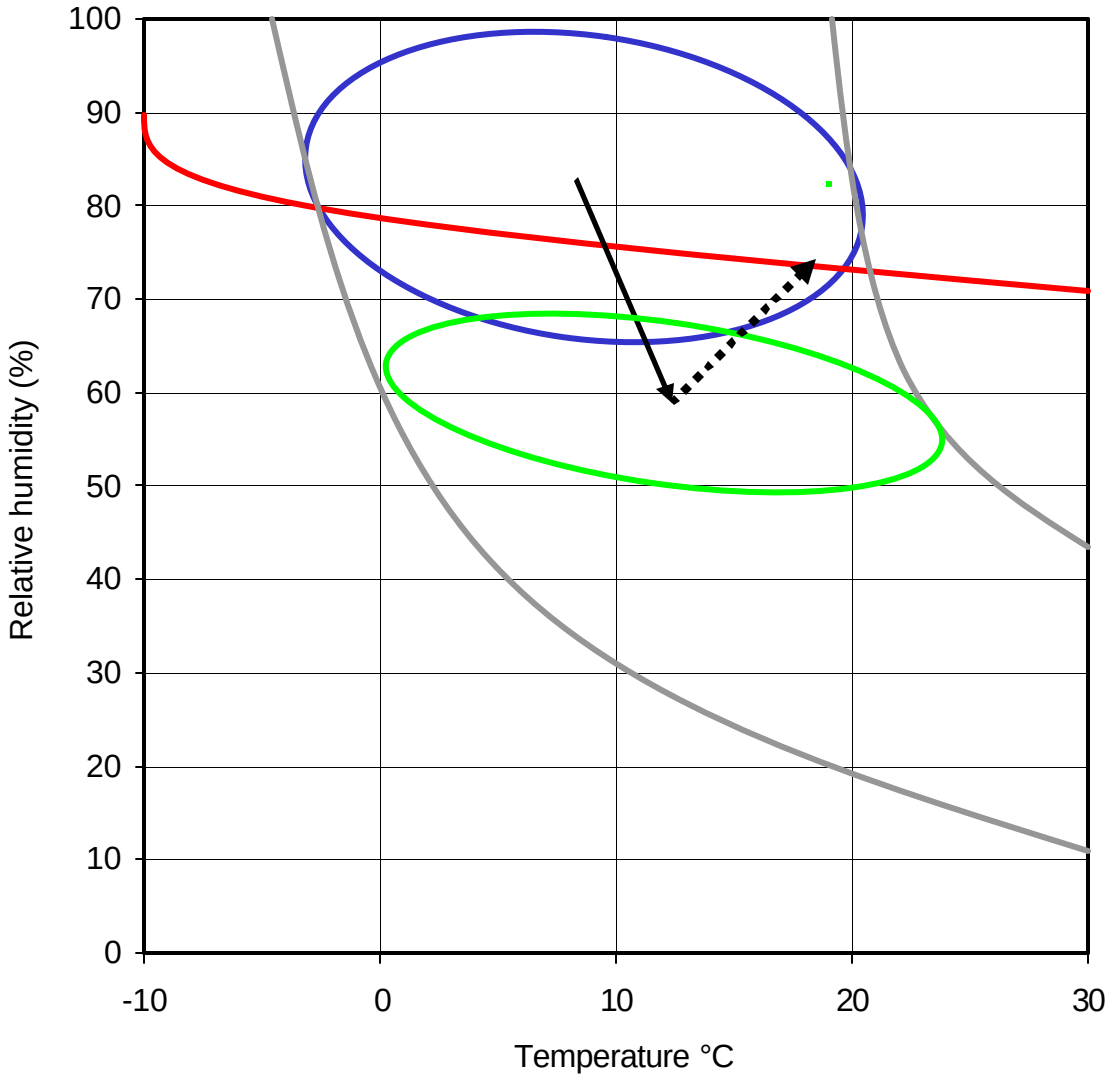
Reduce RH by removing water vapour. Dehumidification



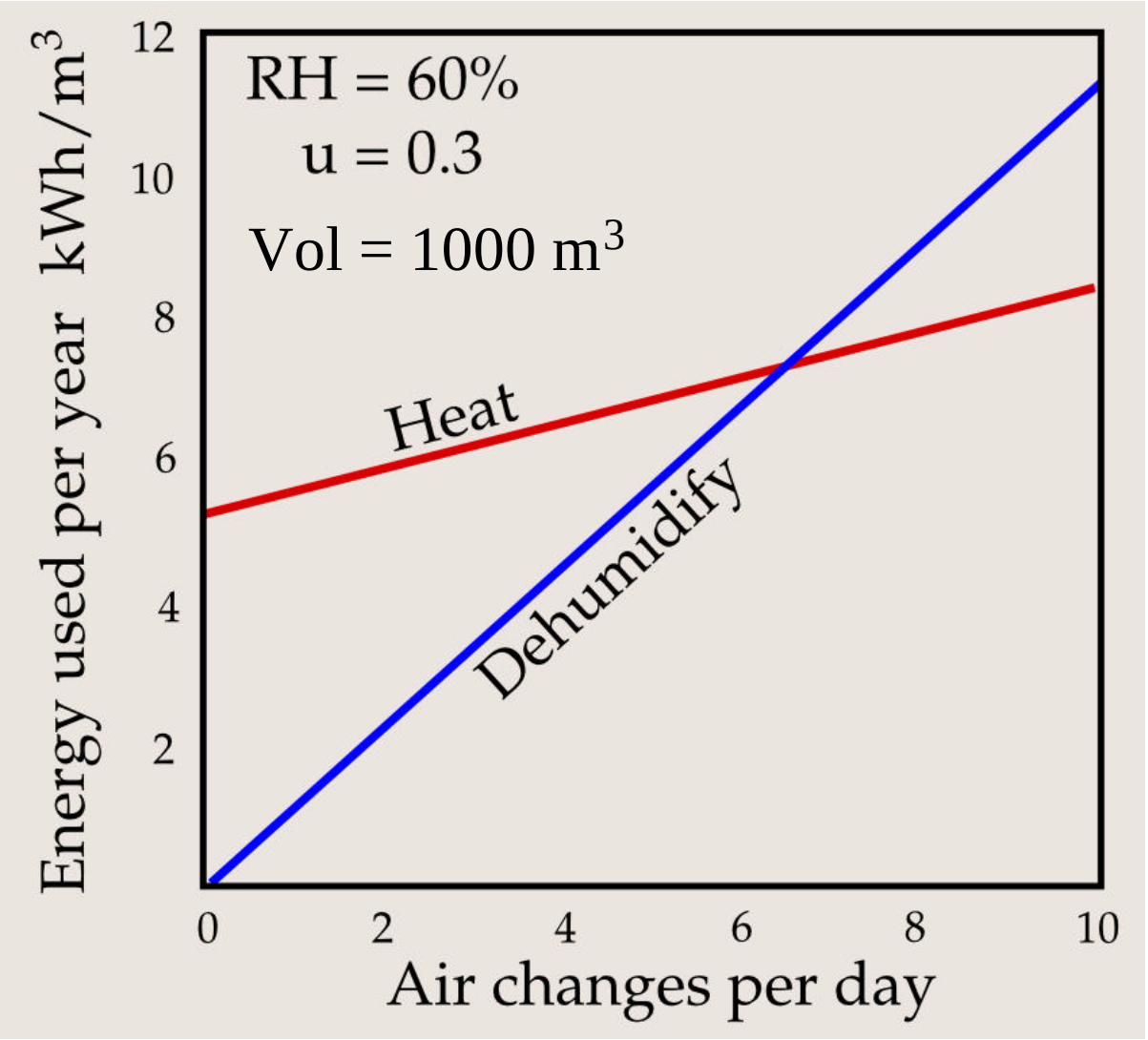
Reduce RH by variable temperature. Conservation heating



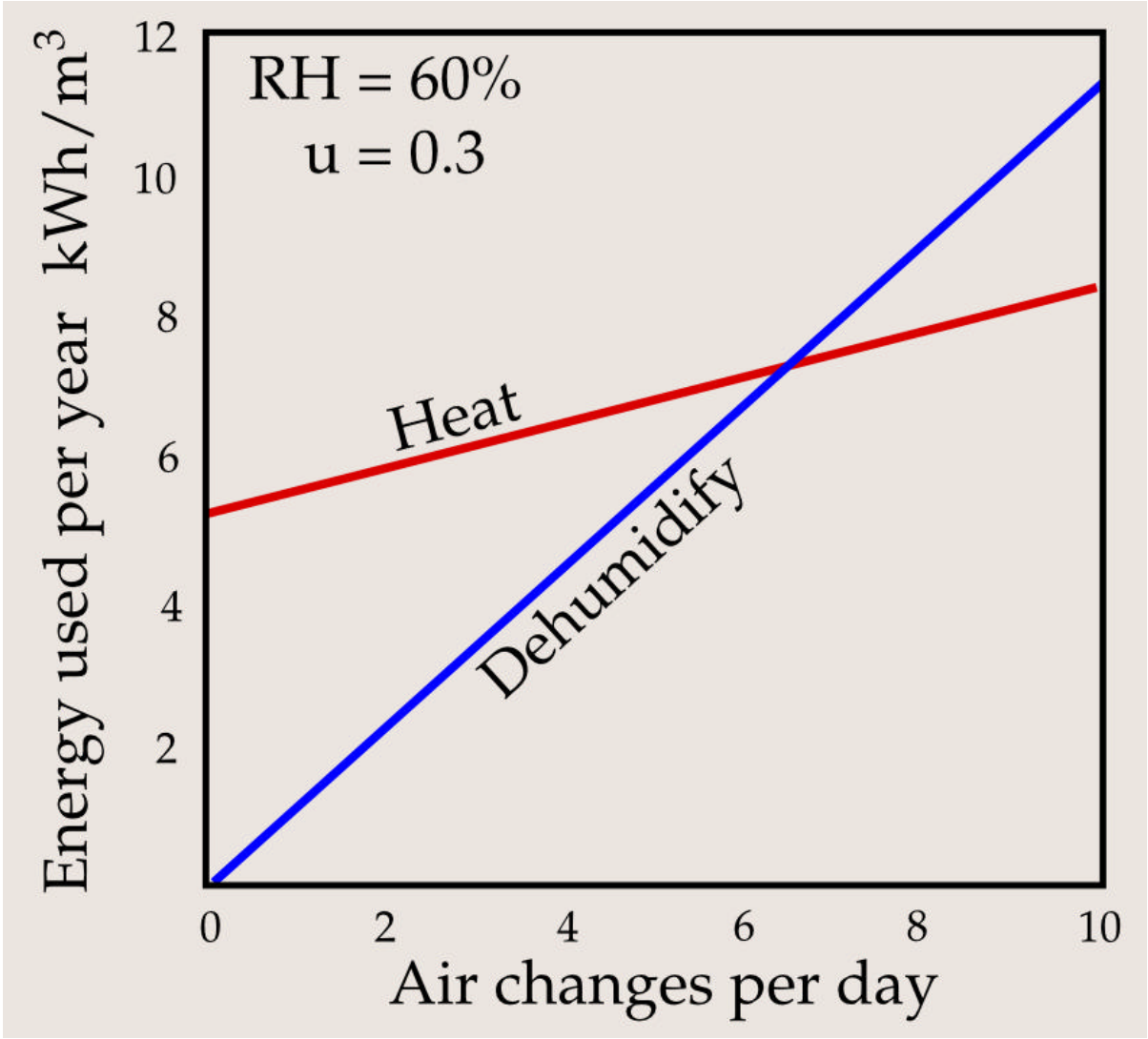
Evaporation from walls or floor due to heating



Which way of climate control is the most energy-efficient?



Many castles, manor houses and churches are not frequently used



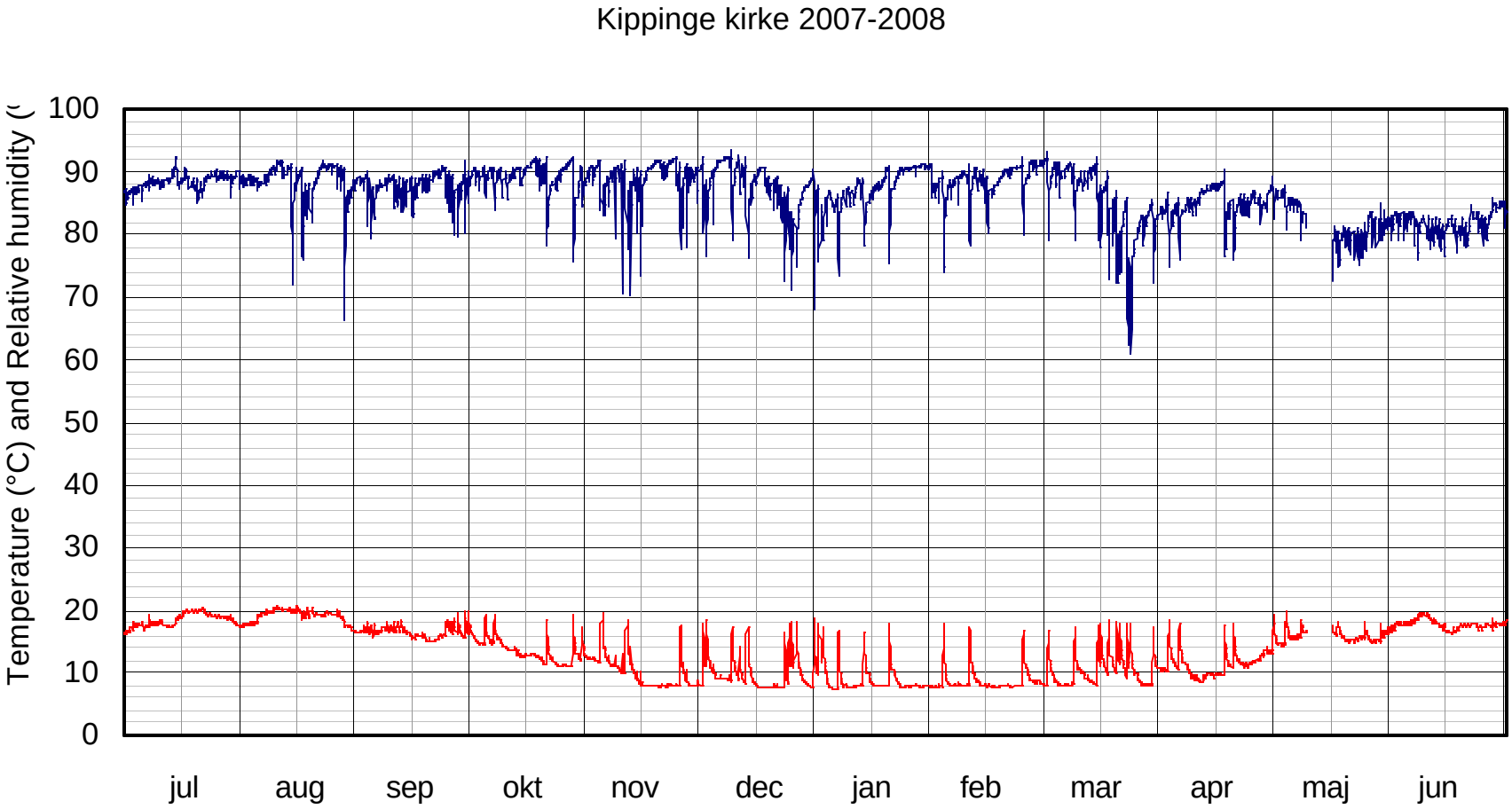
Kippinge church, Falster. 13th century masonry structure

The church has electrical radiant heating in the pews

The church has intermittent heating.

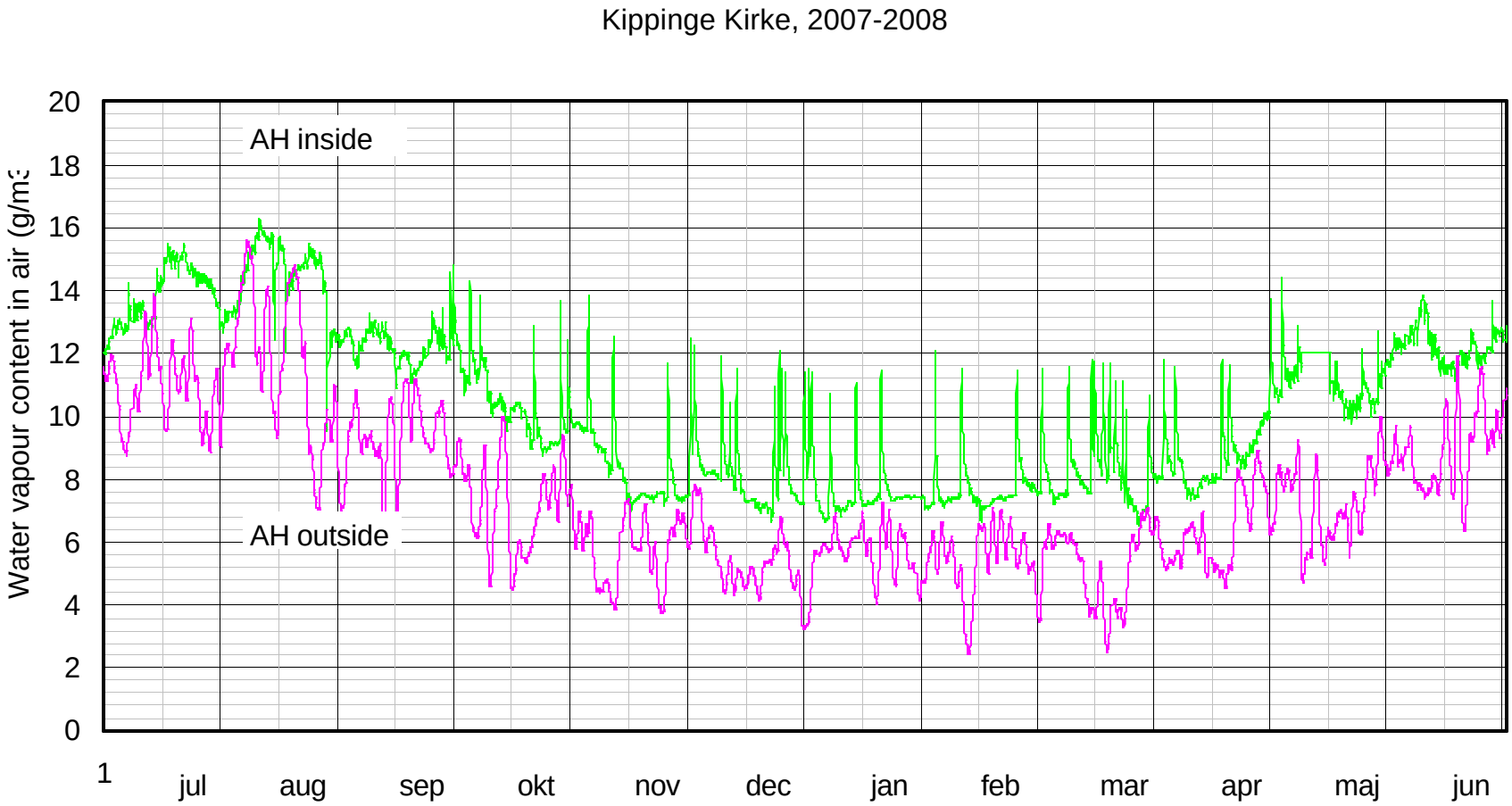
The temperature in winter is 8°C and up to 20°C in summer

The relative humidity is 70-90%



The water vapour content of the inside air is always higher than outside due to evaporation from the floor and walls

Heating events further increase evaporation

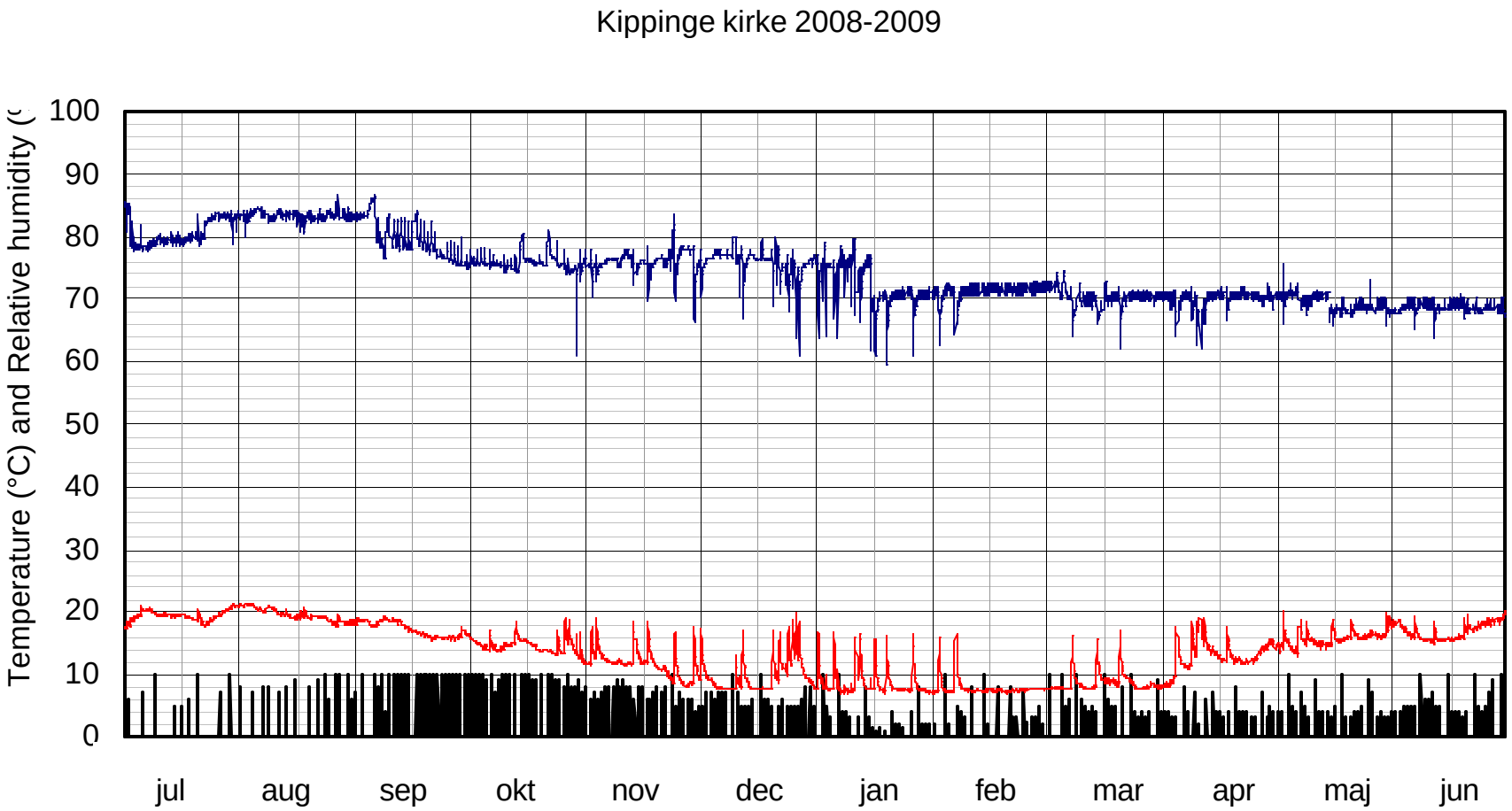


A dehumidfier was introduced to control the RH

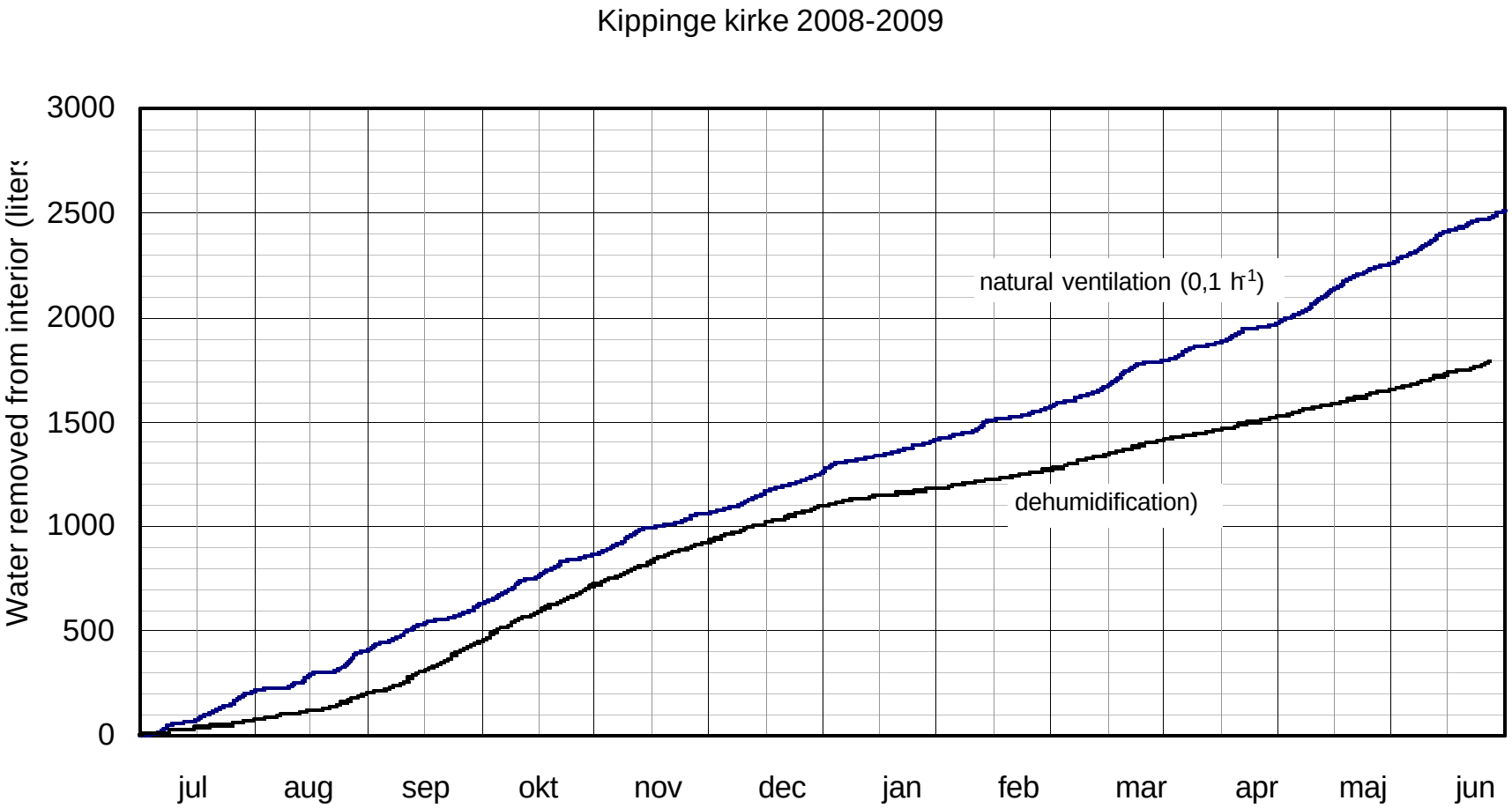
The dehumidifier removed 1800 liter water in one year.

The energy consumption for the dehumidifier was 3000 kWh

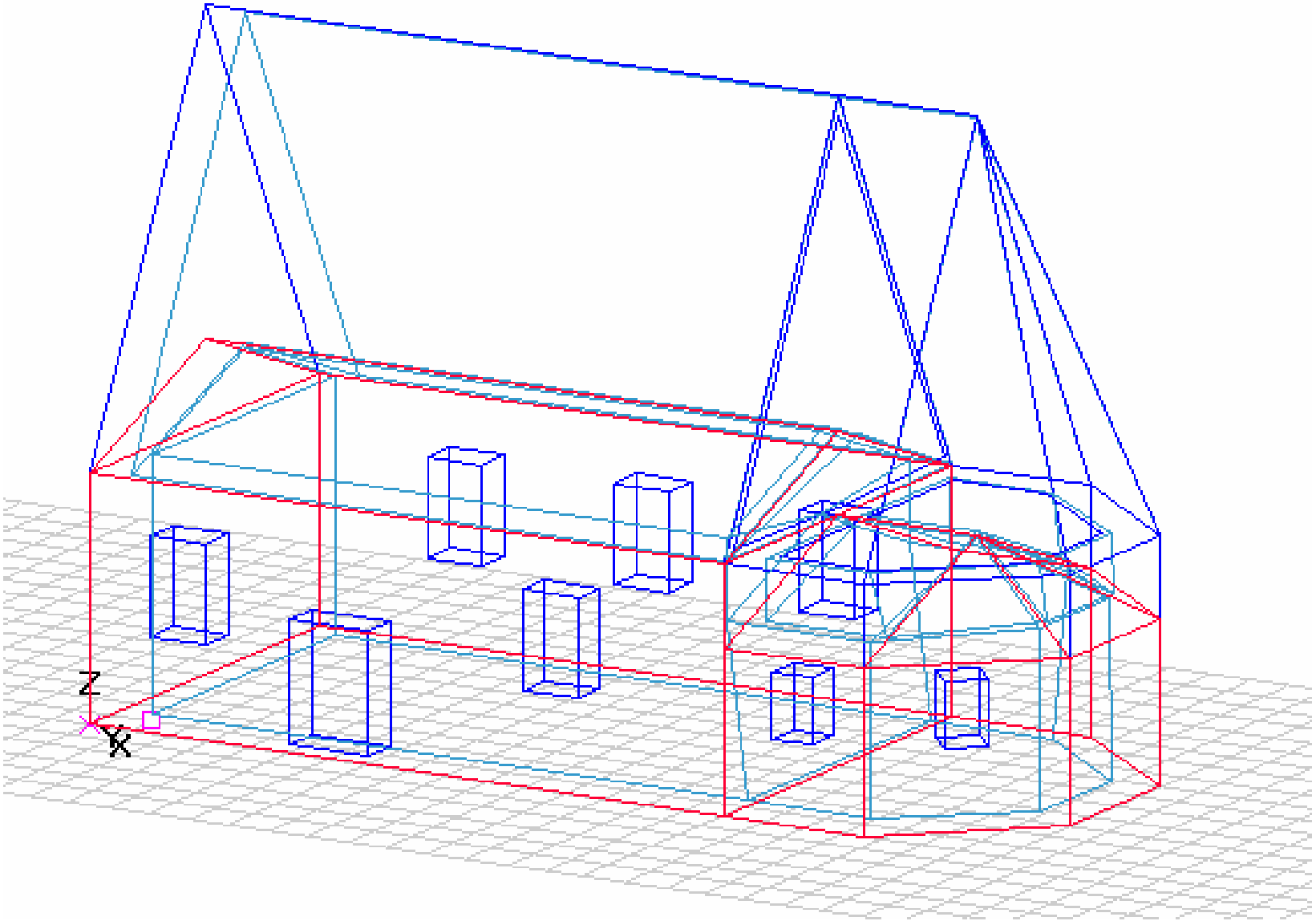
The energy use for heating was 20.000 kWh



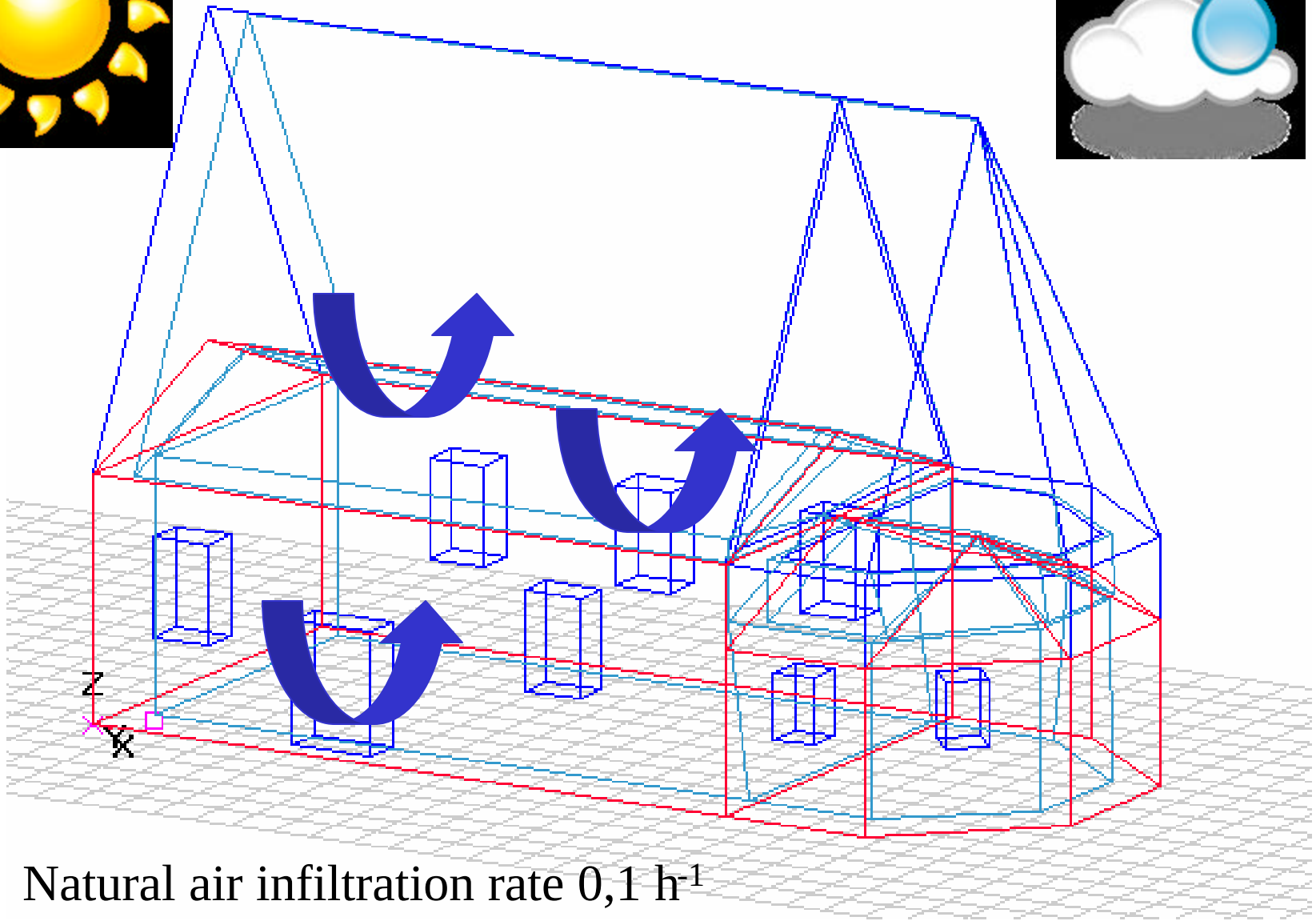
A permanent ventilation of 0,1h^{-1} would remove an equal amount of moisture, but the heat loss would be larger.



A computer simulation was performed to test the humidity control

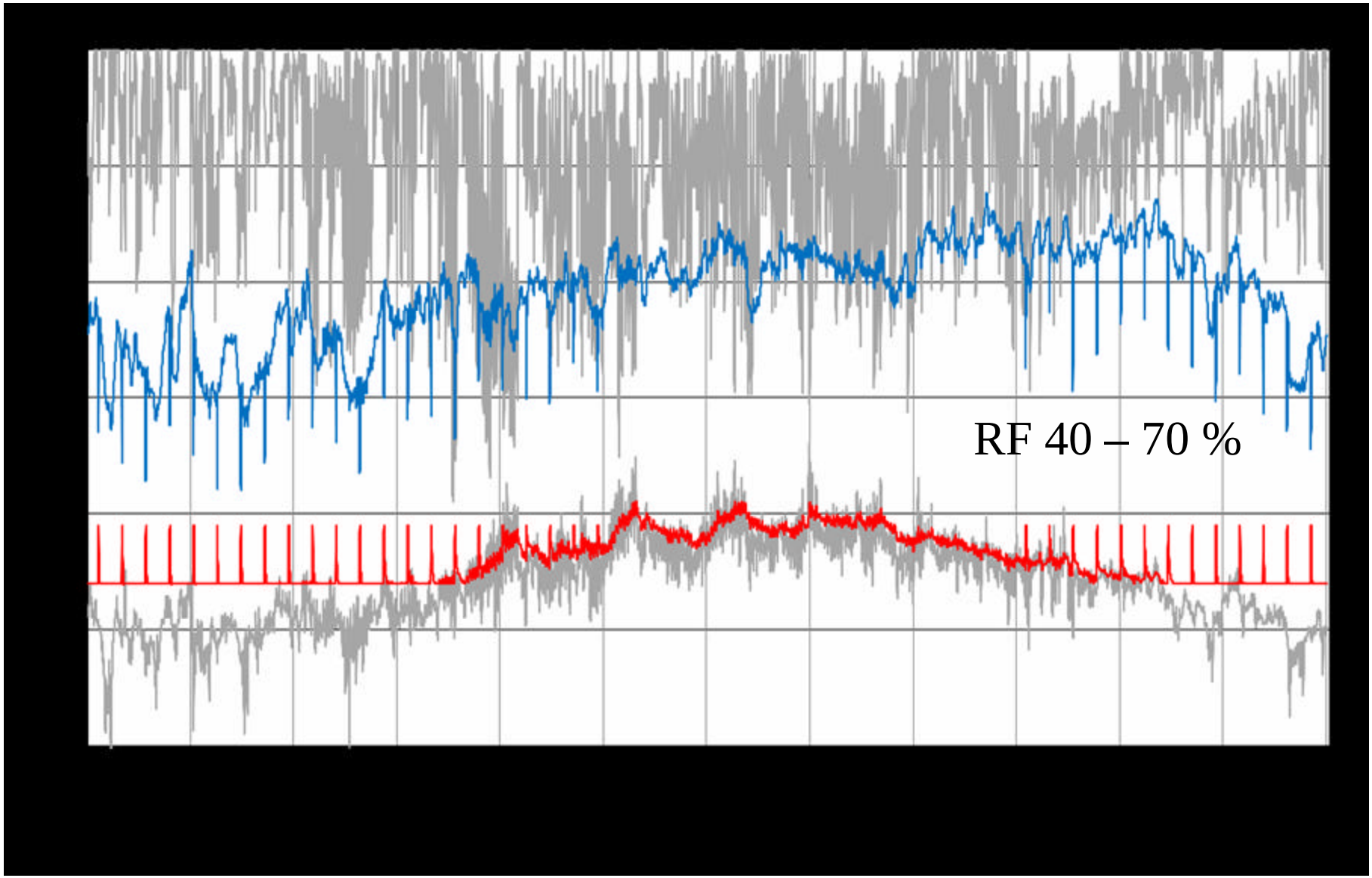


Outside climativ conditions

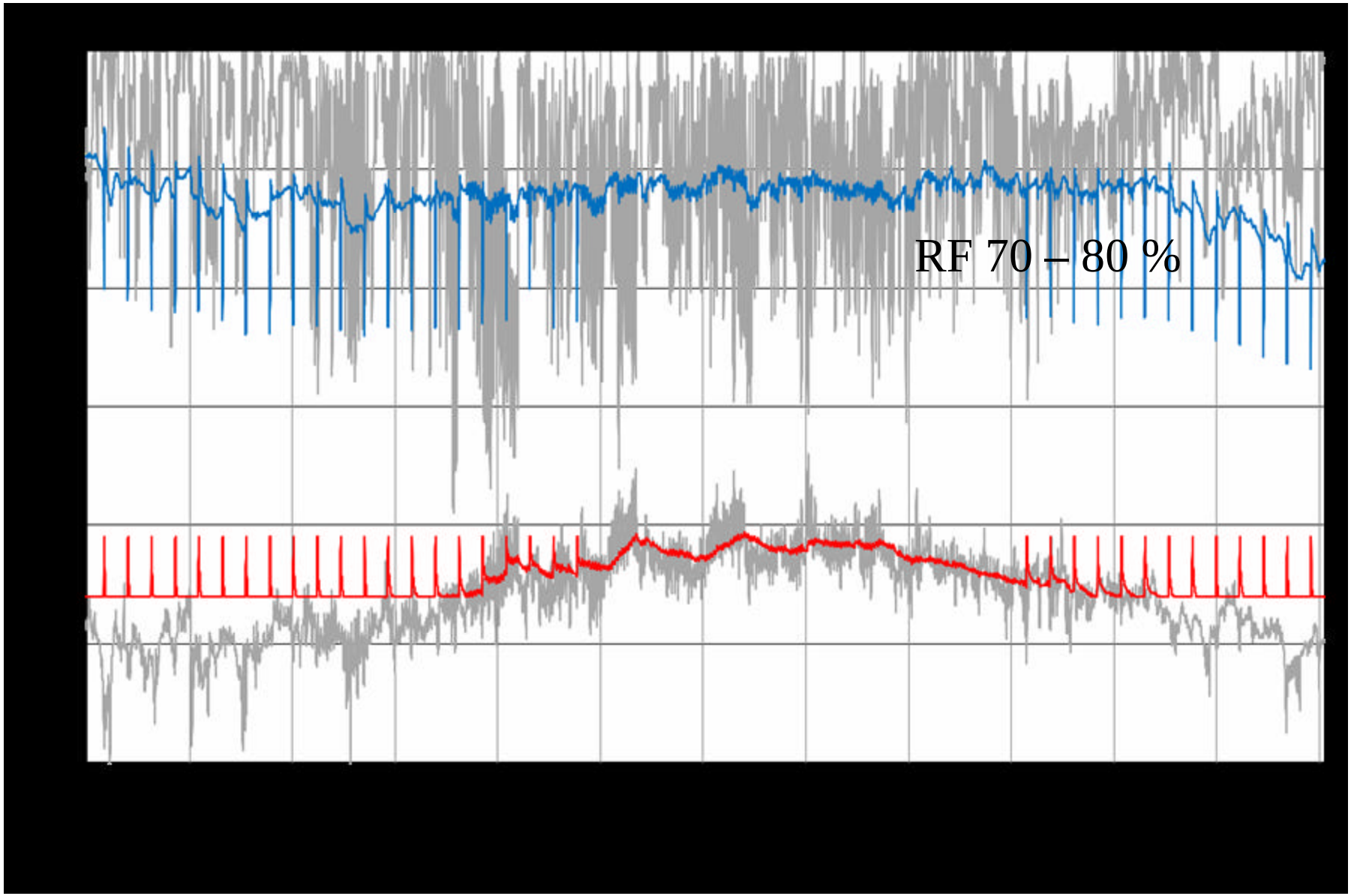


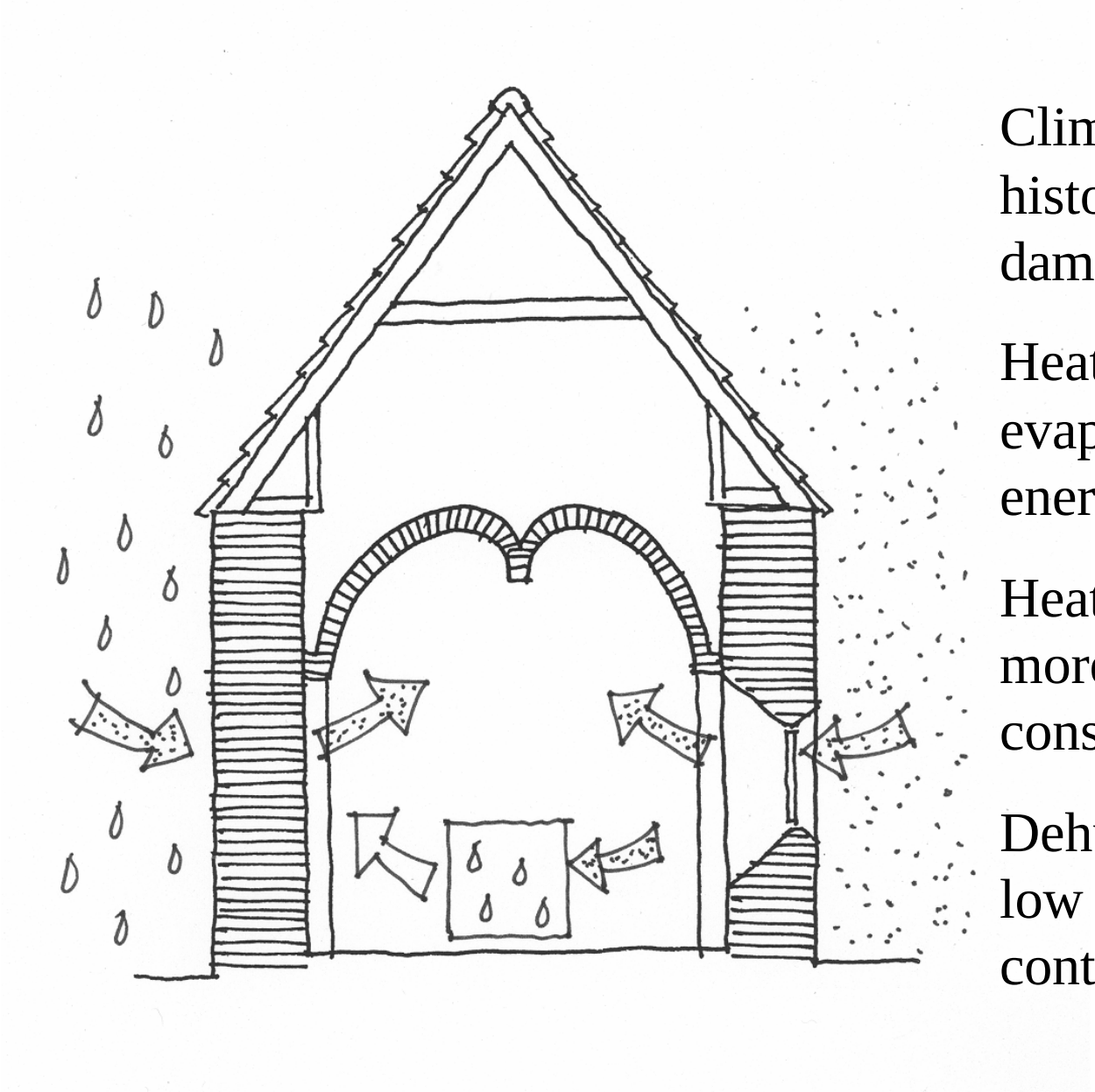
Natural air infiltration rate 0,1 h^{-1}

Simulation with low moisture content in masonry walls



Simulation with high moisture content in masonry walls





Climate control in a historic building with damp walls:

Heating accelerates evaporation – not energy efficient.

Heating + ventilation is more energy consuming

Dehumidification is low energy climate control

Use dehumidification instead of conservation heating