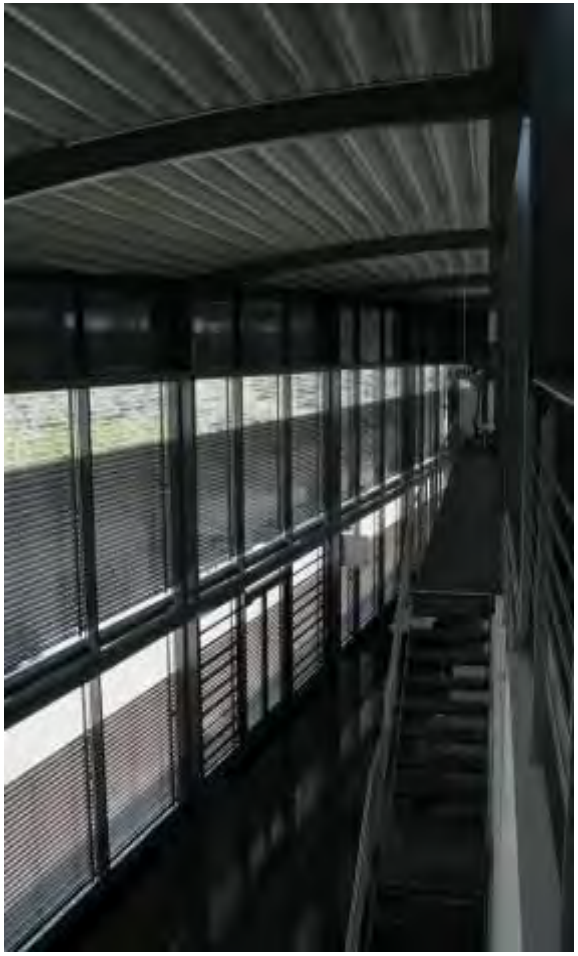

LowEx Retrofit of a Printing Workshop

Monitoring and Evaluation

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Refurbishment

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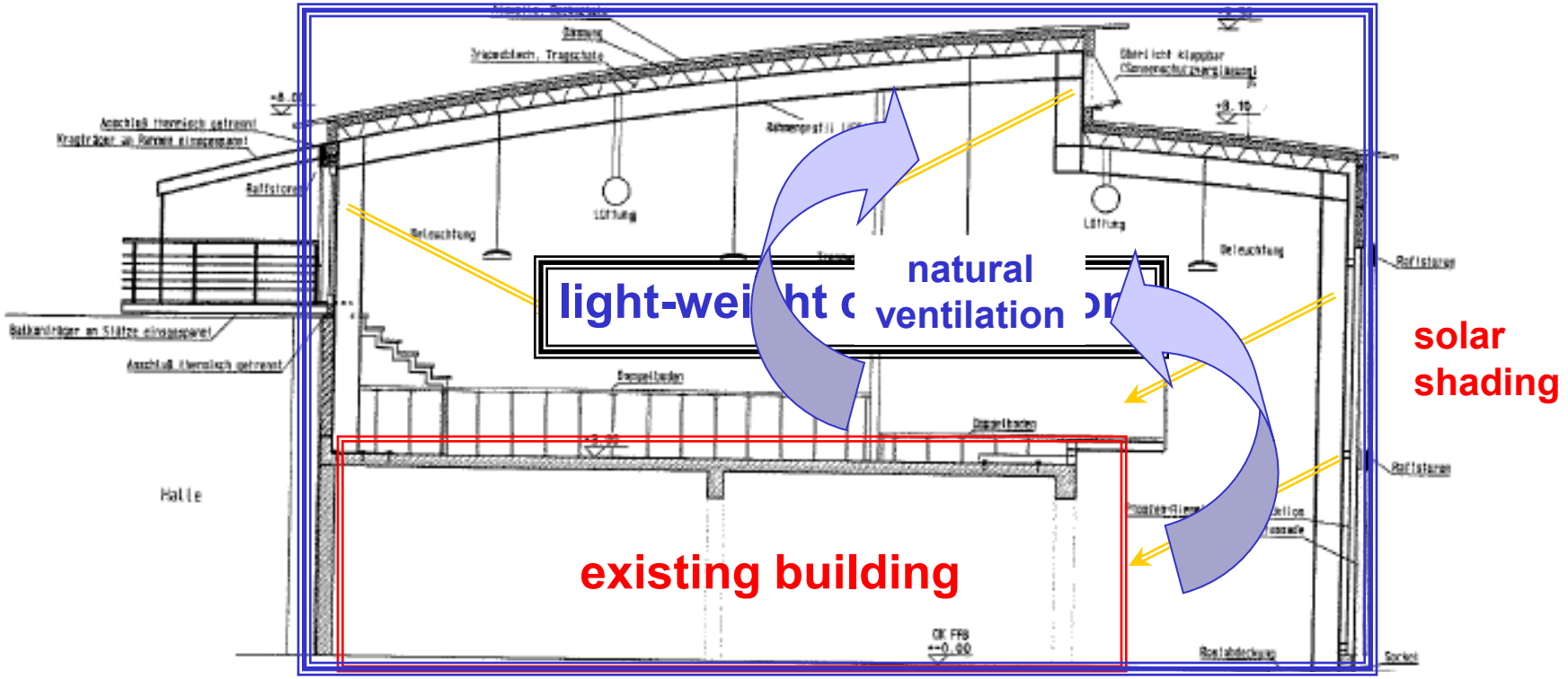
Before Refurbishment

- **typical commercial property from the 1970‘s**
- **common weak points**
  High energy demand (electricity and fuels), poor insulation, insufficient day lighting, unsatisfying air quality, inadequate room acoustics and thermal discomfort both in winter and in summer.

Refurbishment Concept

Building Physics



No public funding.

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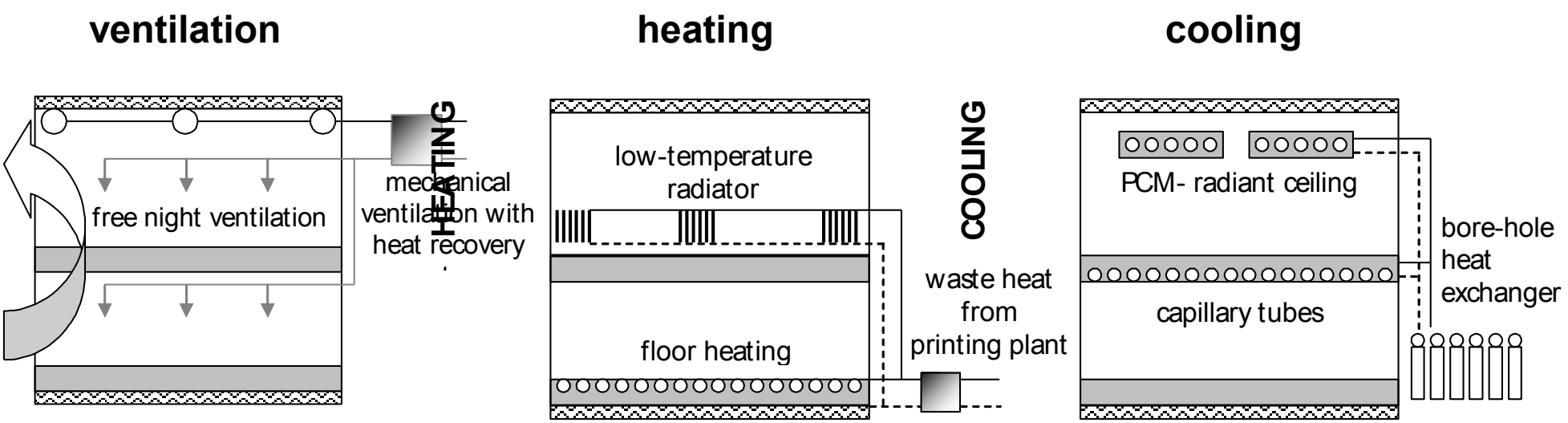
Refurbishment Concept

Heating – Cooling – Ventilation based on low-exergy systems



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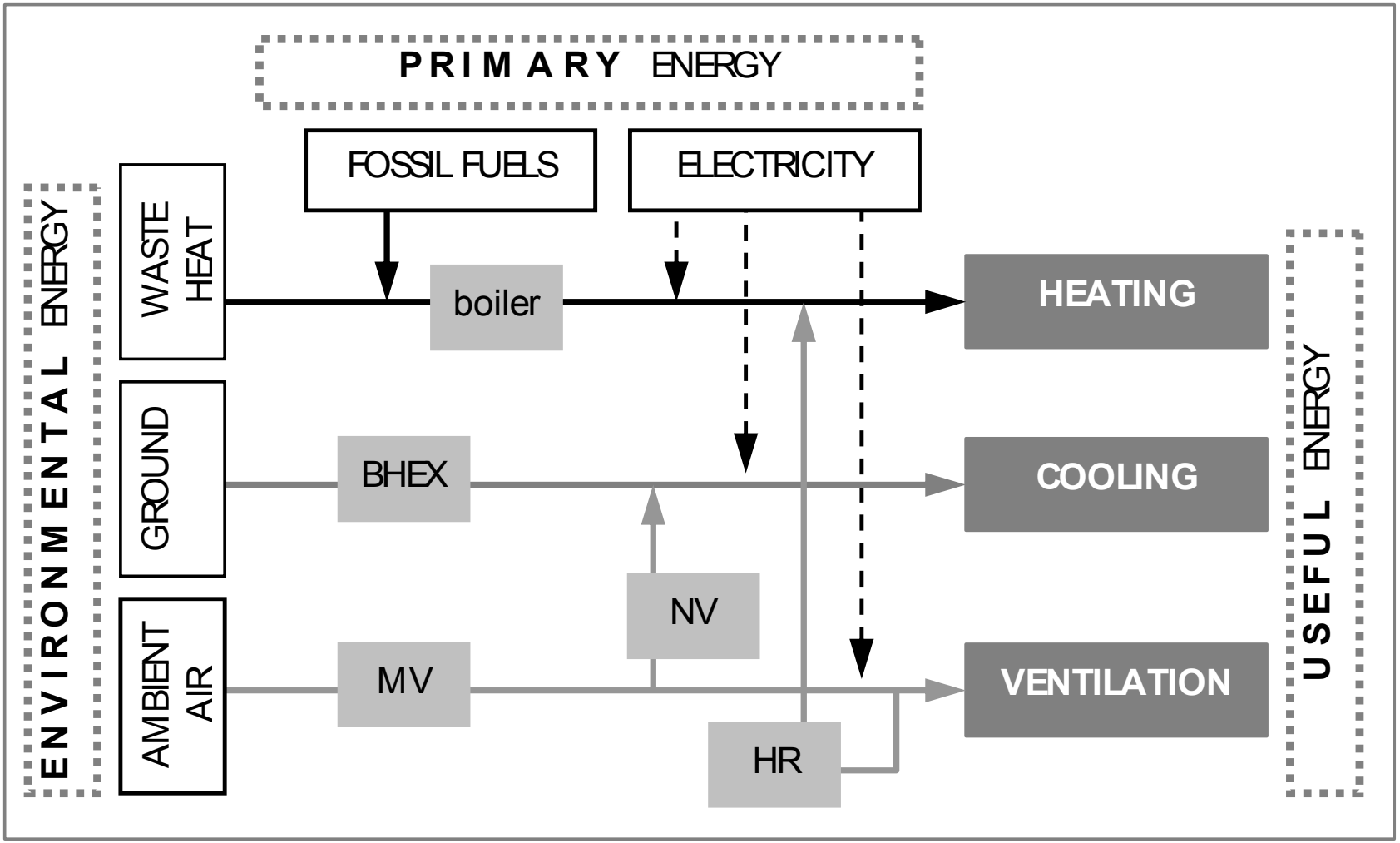

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At the Construction Site

Ventilation + Heating

ventilation opening solar shading

heat recovery from printing machine

floor heating sytem

pressure test of the hydronic system

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At the Construction Site

Cooling System

drilling machine

bore-hole heat exchanger

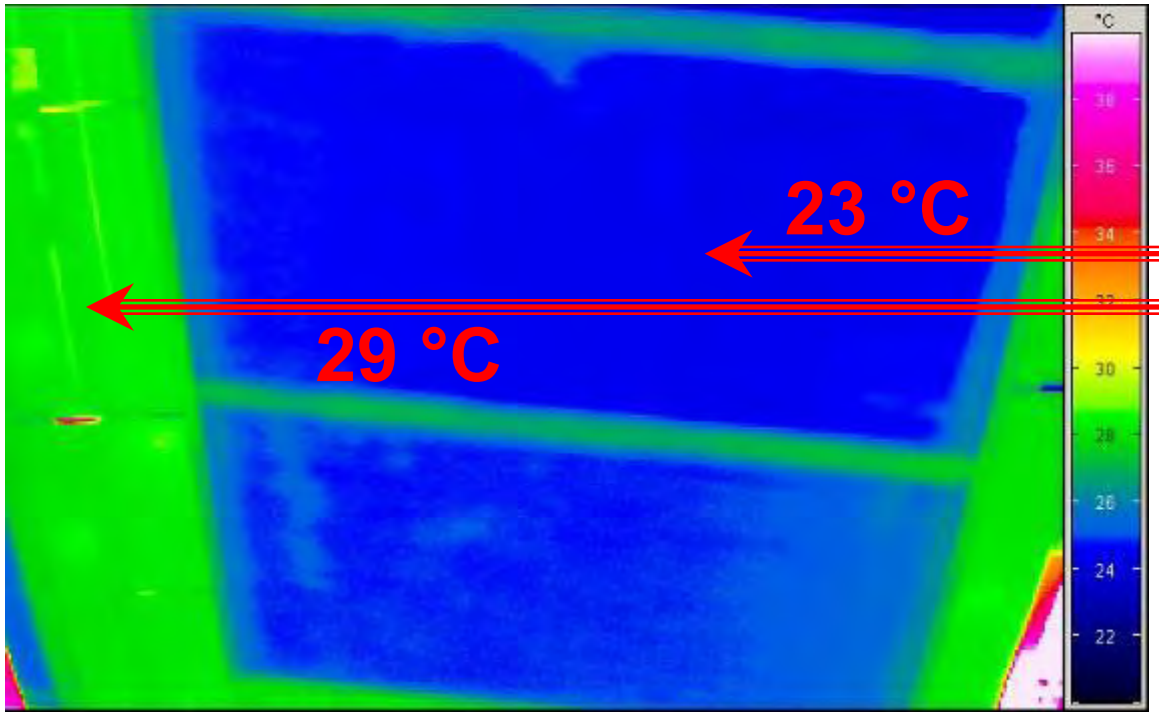
capilary-tube cooling system

radiant-cooling sytem with phase change material

Long-term monitoring of building and plant performance as well as thermal comfort since May 2007 (high-time resolution)

At the Construction Site

Cooling System



radiant-cooling sytem with phase change material

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Monitoring: Useful heating energy

before and after retrofit

reduction of heating energy by 50%

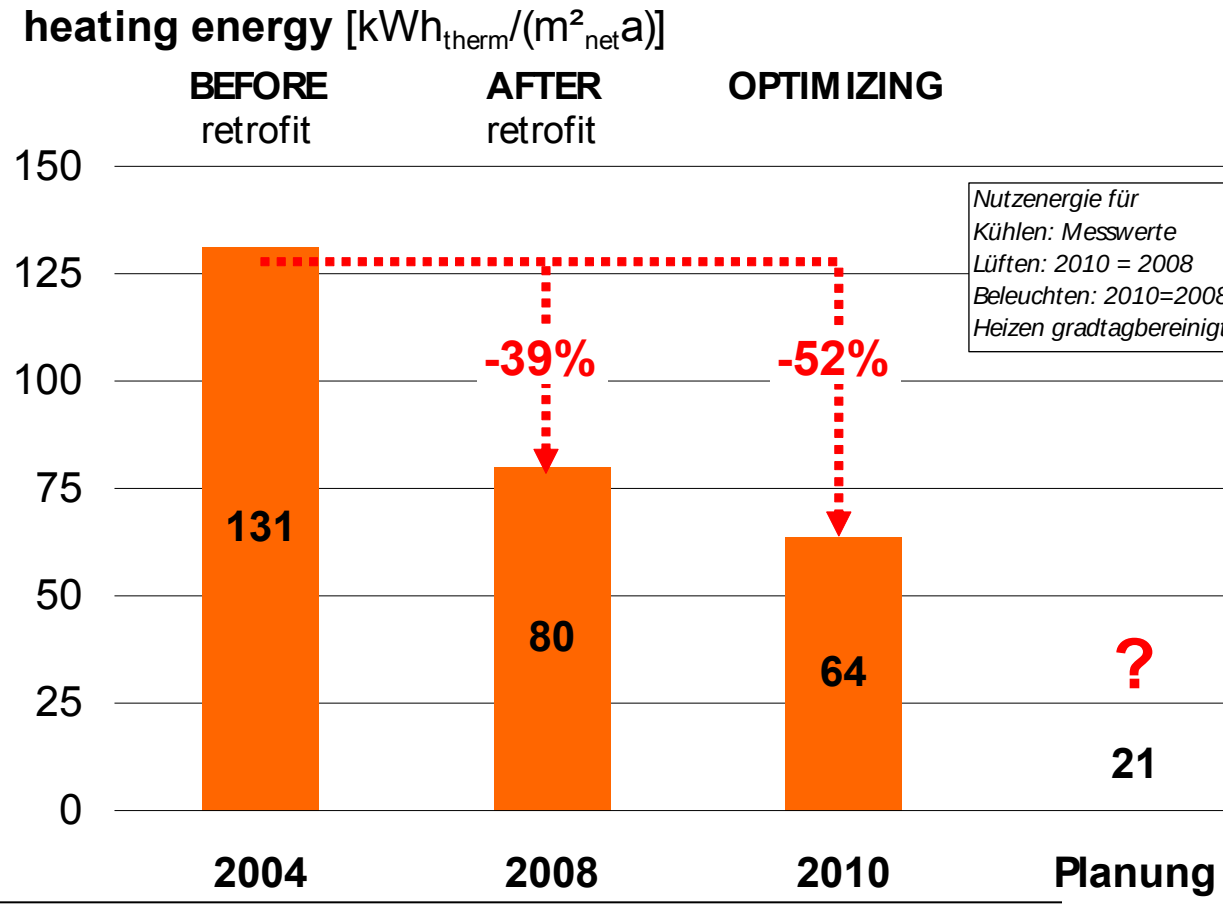
→ high potential of use of waste heat

→ HR with 65%

→ building envelop in high quality but not passive house standard

→ **quality assurance**

building was refurbished by a general contractor



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Monitoring of end energy: heating-cooling-ventilation

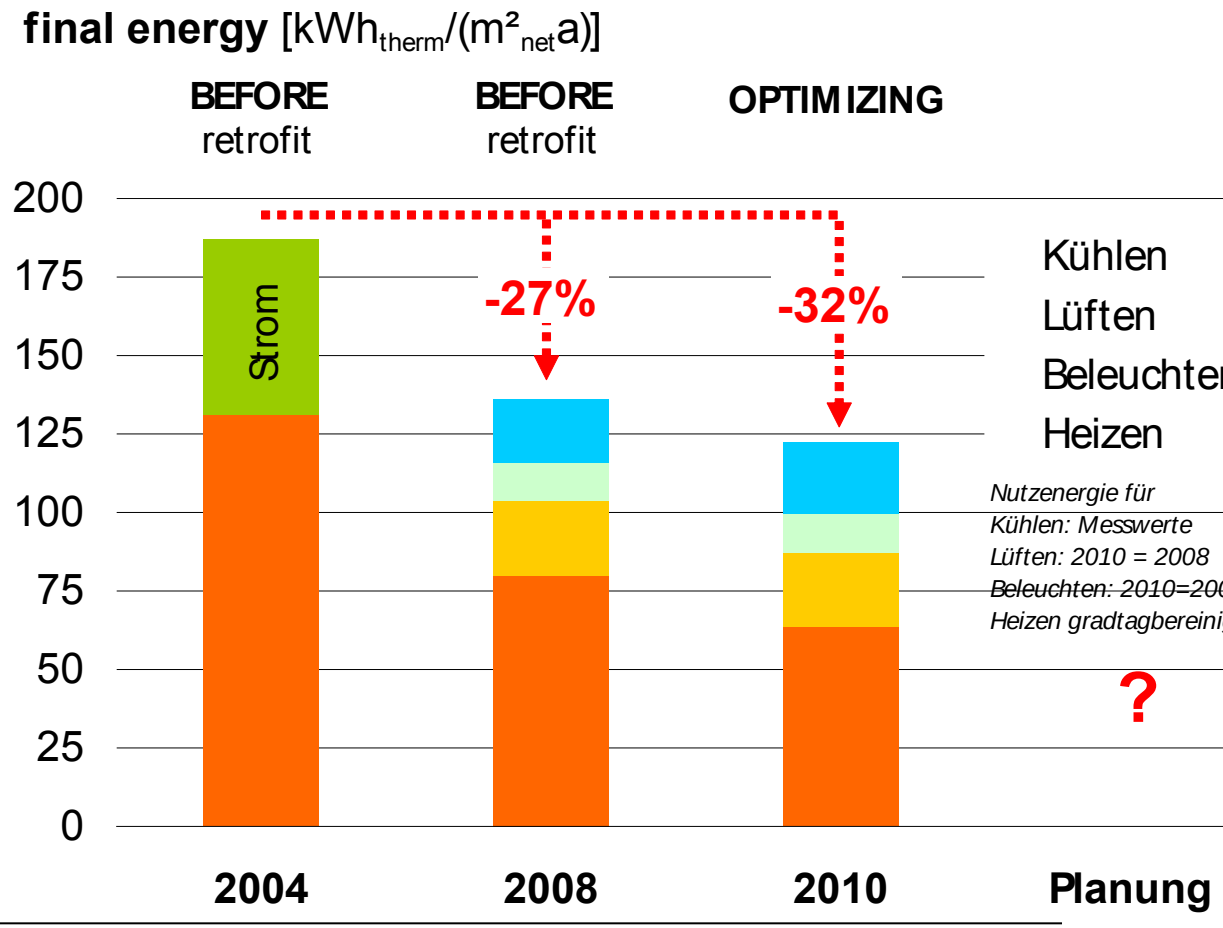
before and after retrofit

Reduction of final energy by 32 %

→ building operation

→ hydraulics

→ **quality assurance**



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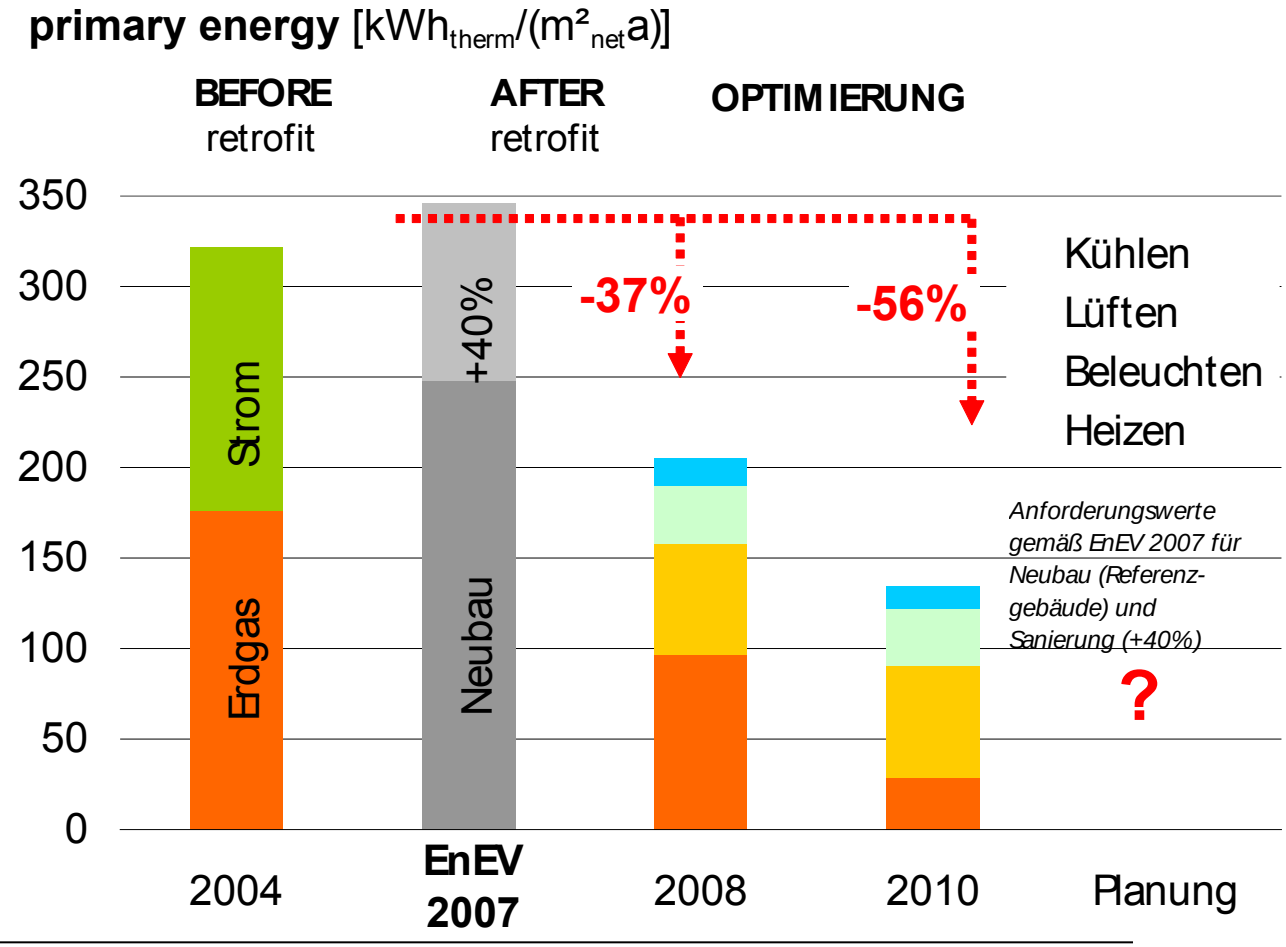
Monitoring of primary energy: heating-cooling-ventilation

before and after retrofit



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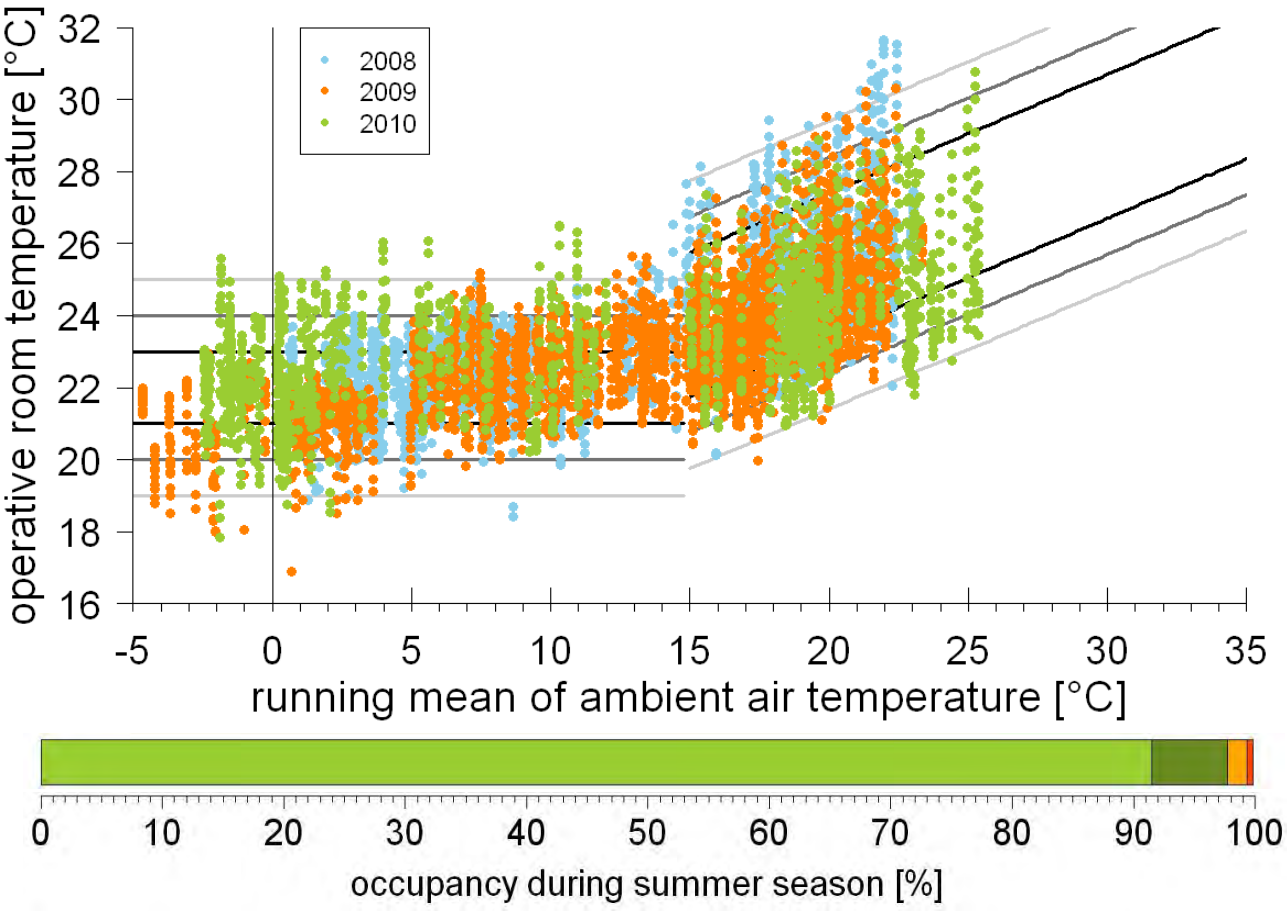
Thermal Comfort

European Guideline EN 15251:2007-08

building
allocated to
comfort class II



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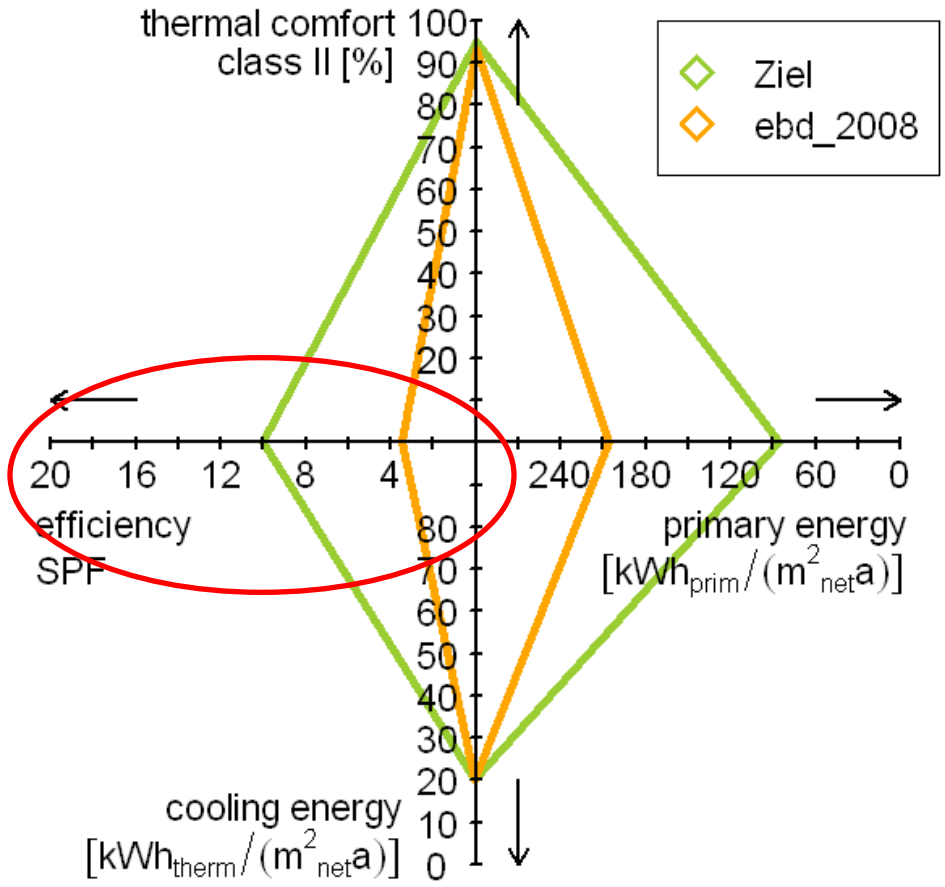
Building and Plant Performance

Cooling System



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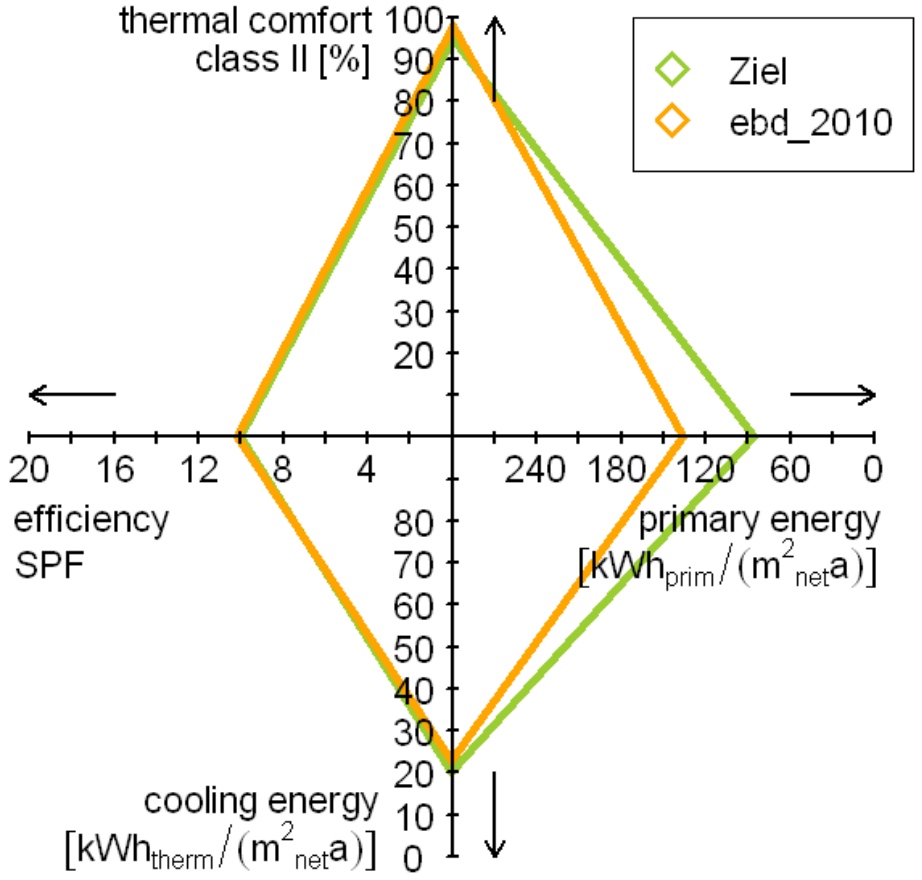
Building and Plant Performance

Cooling System

consequent reduction of auxilliary energy

replacement of primary pump

implementation of revised control and operation strategies



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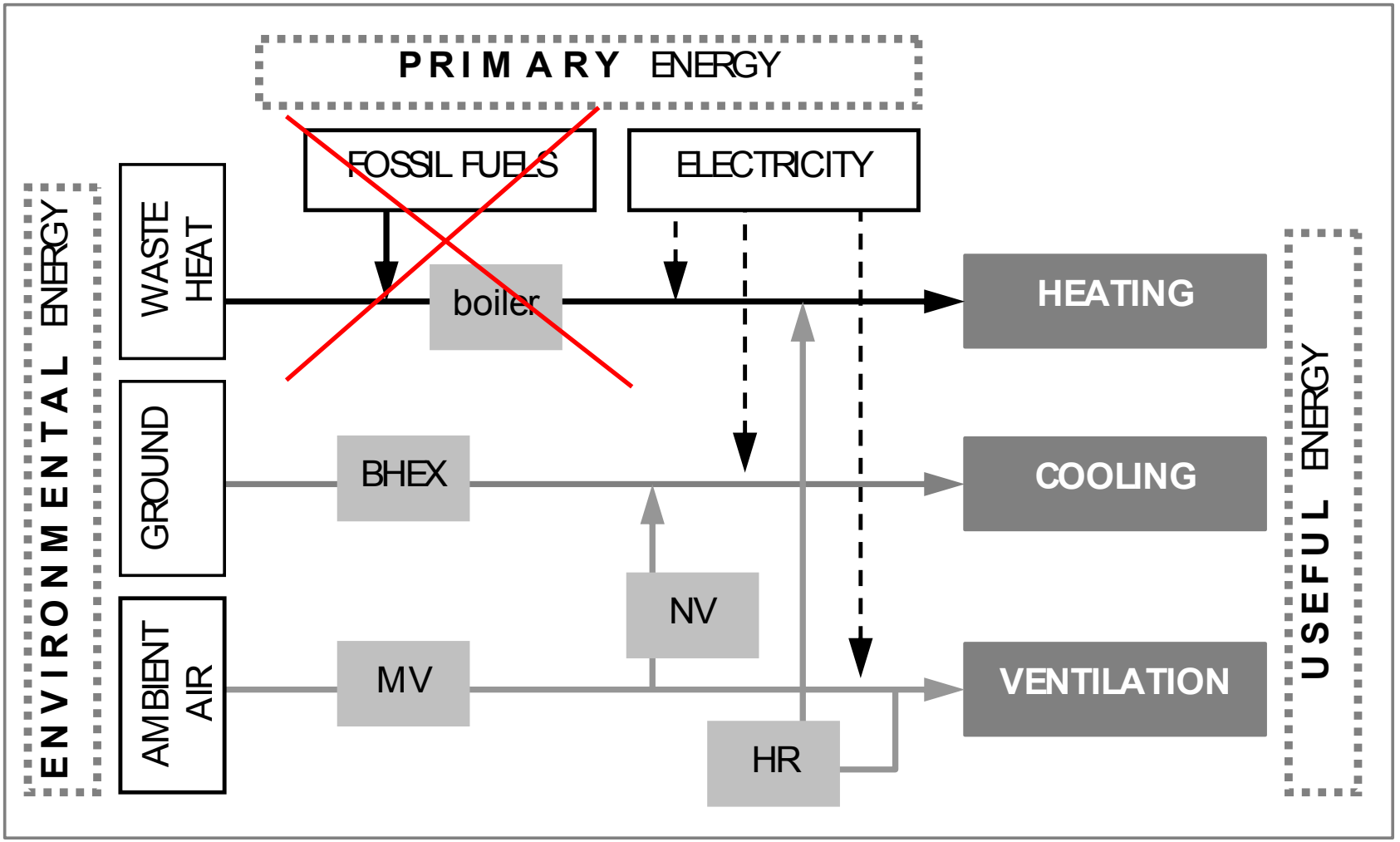

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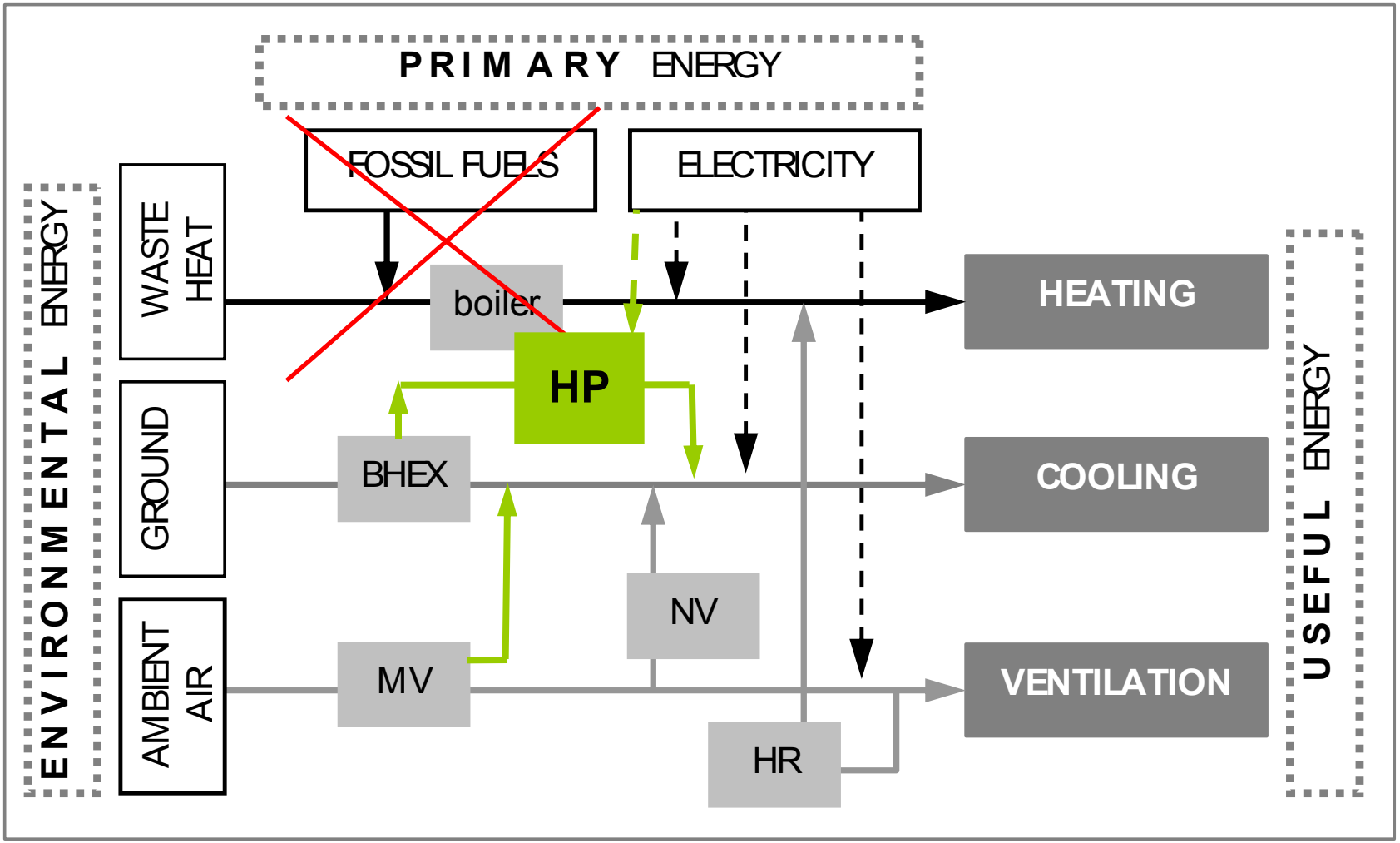

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Conclusions

Low-energy concept successfully realized in refurbishment project

- useful heating energy and total primary energy use reduced by 56%
- good indoor environment (visual and thermal).
- building envelope in high quality.
- Phase Change Material in light-weight construction.
- hybrid ventilation system with free night ventilation.
- TABS with (direct) ground cooling
- use of waste heat
- operation and control algorithms improved
- upgrade of heat-pump system including reversible mode in summer


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