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HOFBURG, VIENNA
DECARBONISATION THROUGH INNOVATION

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# Dual-source heat pumps integration

*Heat pumps in Positive Energy Districts – experiences, challenges and opportunities*

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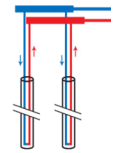
# Most widespread HP technologies

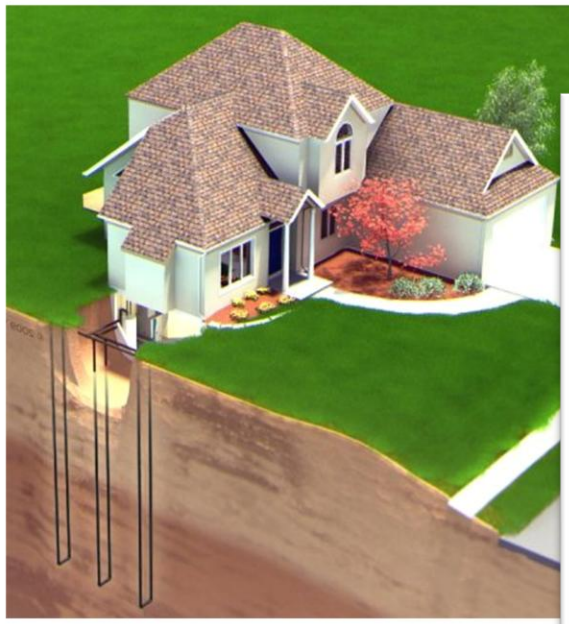
## Air-Source Heat Pumps (**ASHPs**)

Brine deposition

Performance influenced by outdoor conditions

## Ground-Source Heat Pumps (**GSHPs**)





Vertical Borehole Heat Exchangers (BHEs)

Drilling machine

- High investment costs
- Space for drilling
- Ground temperature drift

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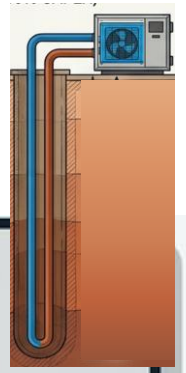
# Dual-source heat pumps (DSHPs): a suitable solution

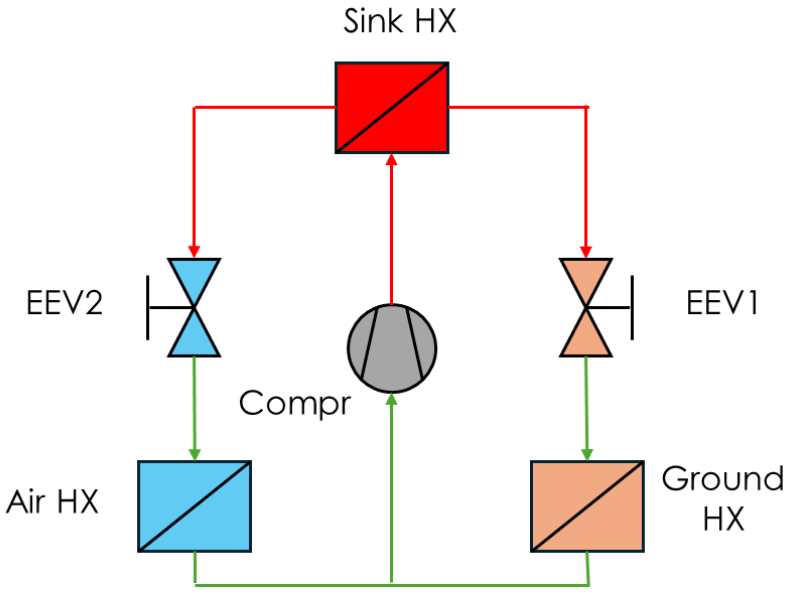
| | ASHP (Air-Source) | GSHP (Ground-Source) |
|---|---|---|
| Upfront CAPEX | Low | Prohibitive |
| Cold Weather Efficiency | Severe Drops | High & Stable |
| Defrost Penalty | High Energy Loss | None |
| Ground Thermal Stability | N/A | High Risk of Drift |

# Dual-source heat pumps (DSHPs): a suitable solution

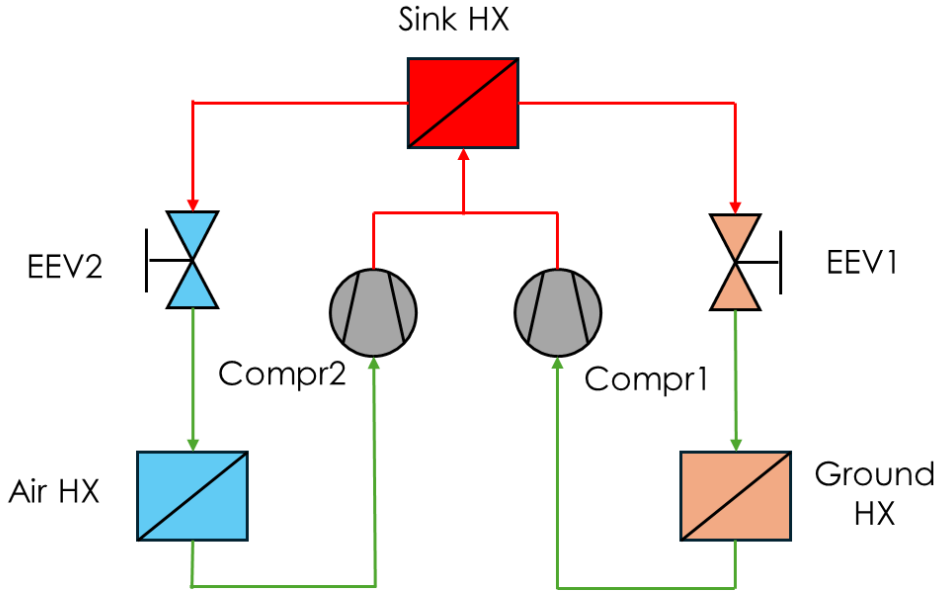


| | ASHP (Air-Source) | GSHP (Ground-Source) | DSHP (Dual-Source) |
|---|---|---|---|
| Upfront CAPEX | Low | Prohibitive | Optimized / Reduced |
| Cold Weather Efficiency | Severe Drops | High & Stable | High & Stable / High & Stable |
| Defrost Penalty | High Energy Loss | None | Bypassed / Equilibrium Maintained |
| Ground Thermal Stability | N/A | High Risk of Drift | Dynamic switching bypasses individual weaknesses, yielding high efficiency with managed costs. |

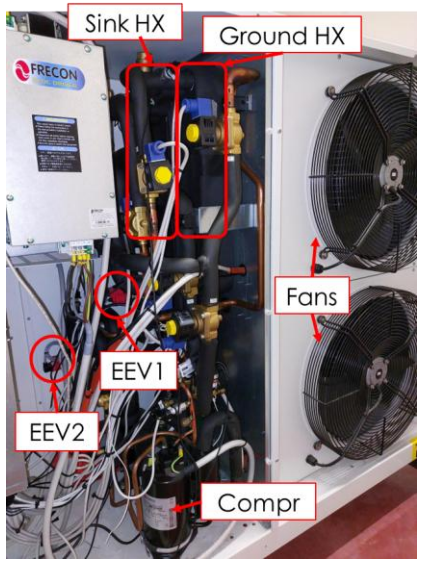
# Dual-source heat pumps: different configurations are possible




- **Two** compressors
- **Alternate** (Single operation) OR **simultaneous** exploitation of the external sources (Parallel operation)
- **Heat exchangers sized on a share of the maximum load (50-75%)**

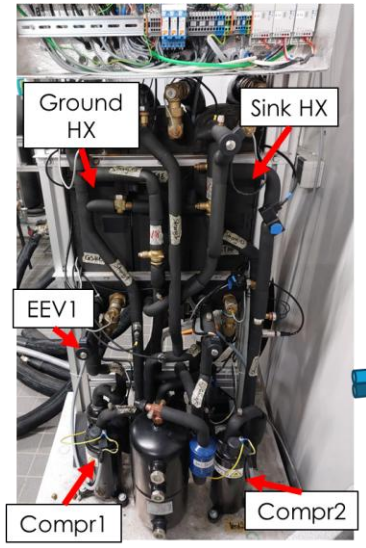


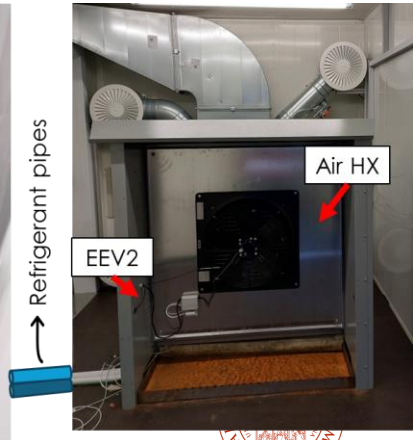

- **Single** compressor
- **Alternate** exploitation of the external sources
- **Heat exchangers sized on the maximum load**




*Prototype developed at University of Bologna (Italy)*

Despite the heat pump configuration, **the main element in dual-source heat pumps is the source-selection control logic**!

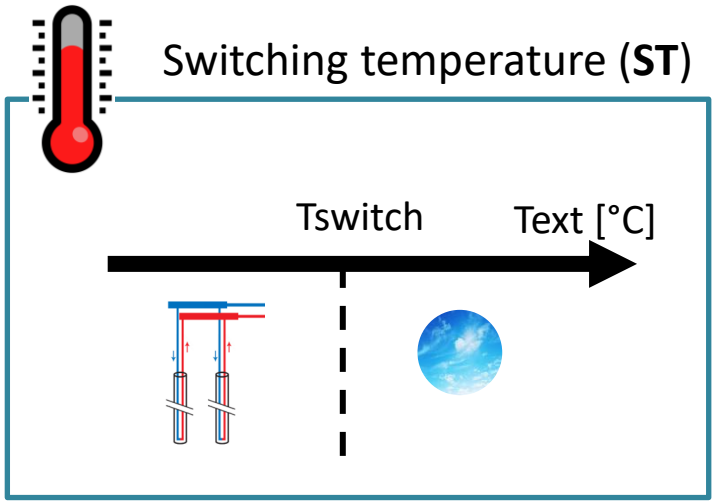


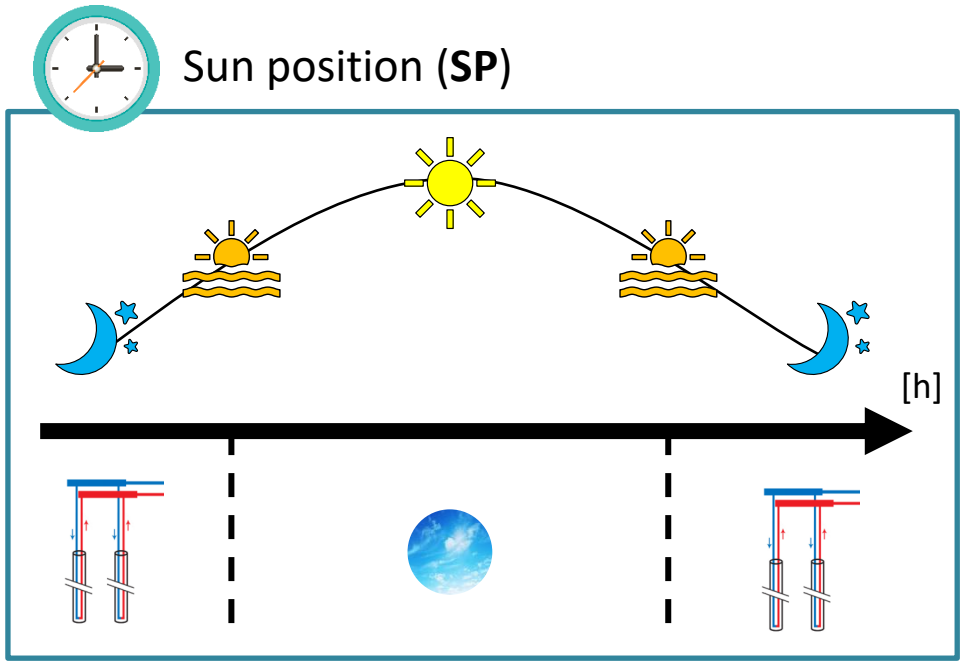

*Prototype developed at TH Ingolstadt (Germany)*

# Dual-source heat pumps: different source selection logics are possible

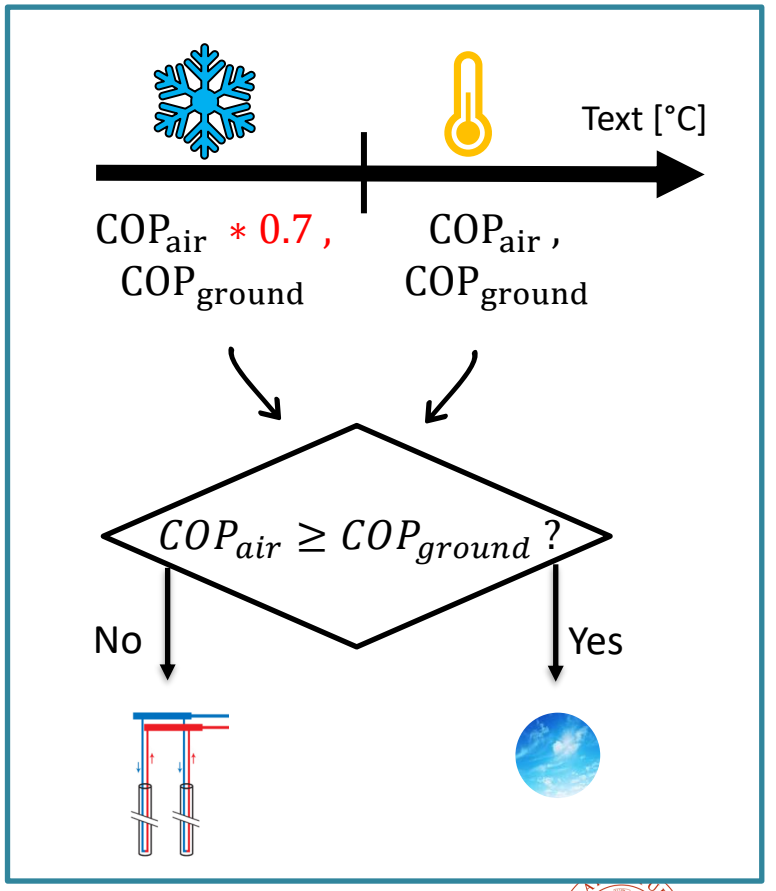
Switching temperature (**ST**)




Sun position (**SP**)




Predicted Coefficient of Performance (**PCOP**)



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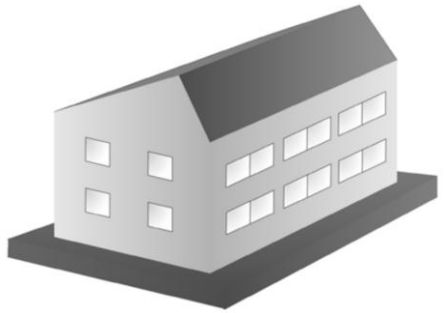
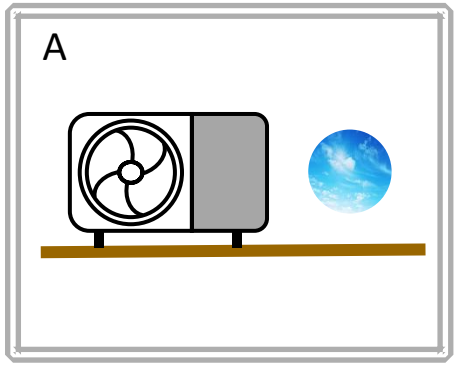
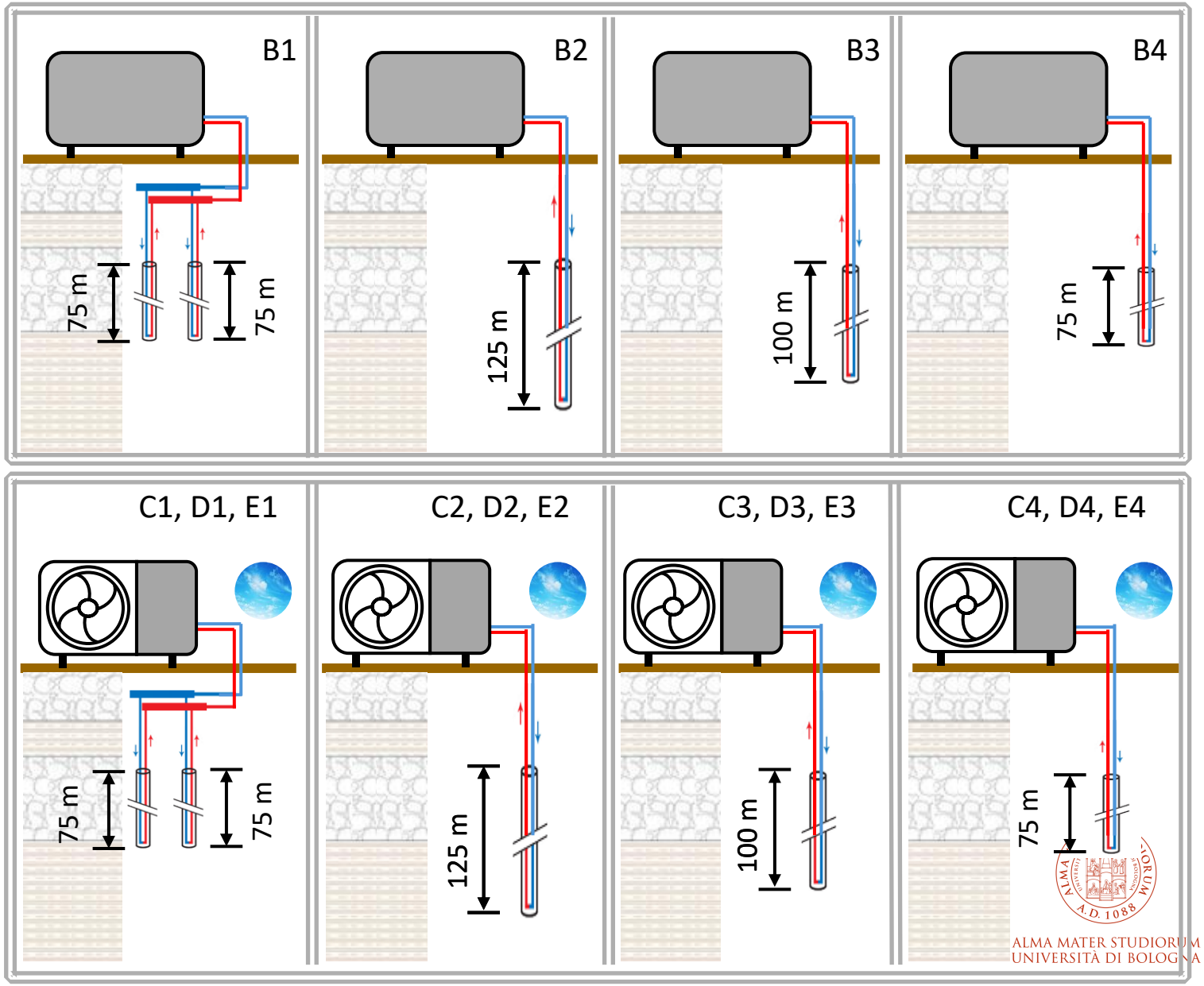
# Dual-source heat pumps: a case study





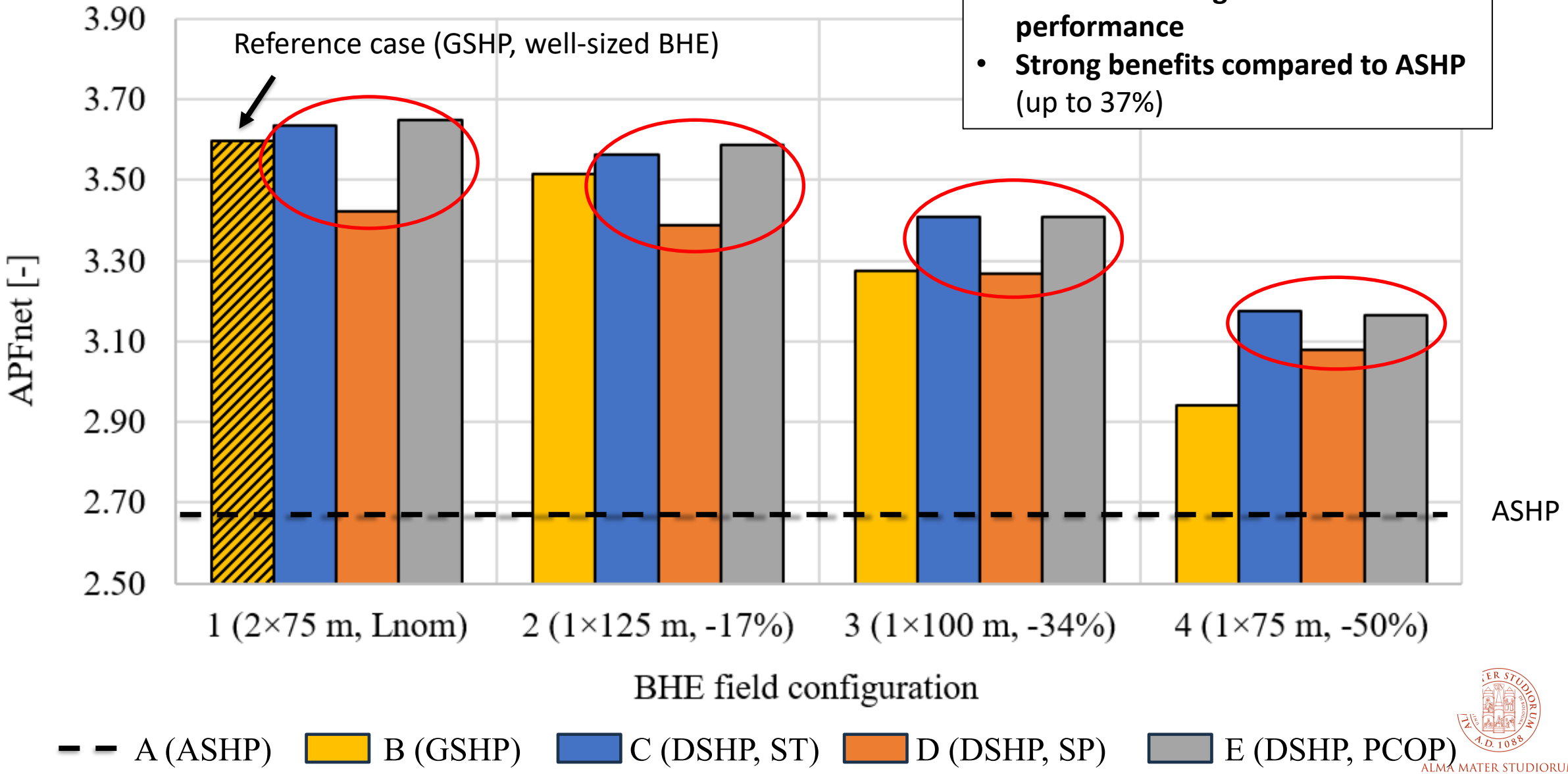

**Studied configurations:**

- **A**: Air-source heat pump (ASHP)
- **B**: Ground-source heat pump (GSHP)
- Dual-source heat pump (DSHP) with:
  - **ST source-selection logic (C)**
  - **SP source-selection logic (D)**
  - **PCOP source-selection logic (E)**

- **1**: Well-sized BHE field (150 m)
- **2**: Undersized BHE field (125 m, -15%)
- **3** Undersized BHE field (100 m, -33%)
- **4**: Undersized BHE field (75 m, -50%)

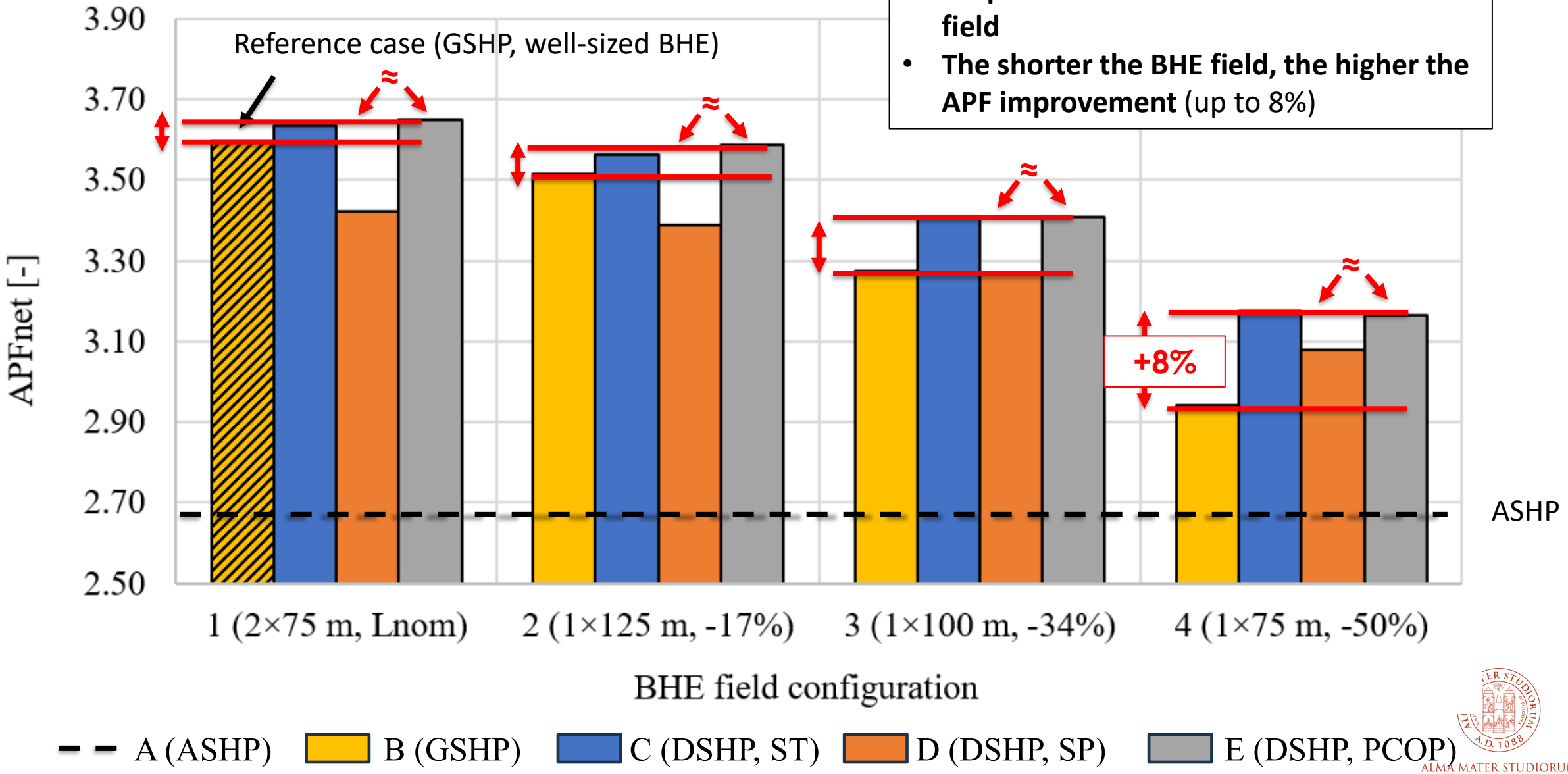
# Dual-source heat pumps: a case study

- **SP logic is the least effective one**
- **ST and PCOP logics have similar performance**
- **Strong benefits compared to ASHP** (up to 37%)



# Dual-source heat pumps: a case study

- **A DSHP with ST or PCOP logics outperforms a GSHP with the same BHE field**
- **The shorter the BHE field, the higher the APF improvement** (up to 8%)



# Dual-source heat pumps: conclusions

- DSHPs are a suitable solution which can outperform an equivalent GSHP up to 8%
- DSHP performance strongly depends on the source-selection logic

**Outlook for DSHPs in PEDs:**

- Higher seasonal efficiency, lower operating costs, reduced emissions
- Improved resilience and flexibility
- Better integration with district energy systems (e.g., see Papieri Cham in Switzerland)
- Potential for smaller infrastructure sizing
- Support for sector coupling and smart energy management

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# *Thanks for your attention!*

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