Heat Recovery at the Building Scale

Passive and active heat recovery approaches

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Domestic waste water heat recovery

- Passive – Drain water heat recovery with DW-HX
- Active – Collected waste water heat recovery with heat pump
Passive Wastewater Heat Recovery
Active Wastewater Heat Recovery
Passive Wastewater Heat Recovery

Active Wastewater Heat Recovery
Passive HR: NEST - Installation
Passive HR: NEST - Installation

local mode
Passive HR: NEST - Installation

Local mode

Matched flow mode
Passive HR: NEST - Results
Passive HR: NEST - Results

- Shower Outlet Temperature
- Joulia Grey Water output
- Cold Water
- Energy removed from Hot Water
- Joulia Grey Water input
- Preheated Water
- Cold Water Flow
- Energy gain from Cold Water

- Experimental points (ΔT=7°C-10°C)
- Documentation (ΔT=7°C)
- Documentation (ΔT=10°C)
Passive Wastewater Heat Recovery

Active Wastewater Heat Recovery
Active HR: System Model
Active HR: System Model
Active HR: System Model

Domestic Hot Water System

GW Tank

HP Evaporator

HP Condenser

DHW Tank

Space Heating Buffer Tank

Ambient Air ($T_{amb}$, $m_{HP}$)

City Water

Wastewater

$m_{DHW}$

$m_{SH}$

8
Active HR: System Model
Active HR: Domestic Hot Water System

- Stochastic simulation of single water consumption events
- Plumbing layout and pipe losses
- Real water consumption schedules and loads
Active HR: Scenario Tree

Climate

Outside air T
Outside air RH

Rome
Helsinki
Geneva

39 kWh/m² y

B2 (1983)
88 kWh/m² y

Low
2 adults 1 child

Coldest
Median
Warmest

High
5 adults
Active HR: Scenario Tree

Climate

- Outside air T
- Outside air RH

- Rome
- Helsinki
- Geneva

Building

- SH Load
- Heating Curve

  - 39 kWh/m² y

- B2 (1983)
  - 88 kWh/m² y
Active HR: Scenario Tree

**Climate**
- Outside air T
- Outside air RH
- Rome
- Helsinki
- Geneva

**Building**
- SH Load
- Heating Curve
- B1 (2003): 39 kWh/m² y
- B2 (1983): 88 kWh/m² y

**DHW**
- DHW Load
- Low: 2 adults 1 child
- High: 5 adults
Simulation Week

Active HR: Scenario Tree

<table>
<thead>
<tr>
<th>Climate</th>
<th>Outside air T</th>
<th>Rome</th>
<th>Helsinki</th>
<th>Geneva</th>
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<tbody>
<tr>
<td></td>
<td>Outside air RH</td>
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<th>DHW</th>
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<th>Low</th>
<th>High</th>
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<th>Median</th>
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Active HR: Results (1/2)
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<table>
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<tr>
<th>City</th>
<th>Average COP Increase [%]</th>
<th>Average Electricity Savings [kWh/week]</th>
<th>Average Electricity Savings [kWh/year]</th>
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</thead>
<tbody>
<tr>
<td>Geneva</td>
<td>19.7</td>
<td>8.8</td>
<td>460</td>
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<tr>
<td>Rome</td>
<td>29.3</td>
<td>10.1</td>
<td>525</td>
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<tr>
<td>Helsinki</td>
<td>12.2</td>
<td>7.6</td>
<td>395</td>
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Active HR: Results (2/2)
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Conclusions

- Domestic hot water systems are an increasingly significant share of the total energy consumption in buildings – passive and active heat recovery systems increase their efficiency.
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  **30’000-60’000 tons CO₂**
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  **200 GWh/a electricity savings**
  **20’000 tons CO₂**