PROGETTO DOTTORATO DI RICERCA 2014: 
“Heat recovery from geothermal wastewater with a low-temperature district heating network”

AGGIORNAMENTO DOPO IL PRIMO SEMESTRE
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Summary

Wastewater energy and heat demand in Abano Terme

1. Amount of discharged wastewater
2. Heat from wastewater vs. heat demand of residential buildings
3. Supply temperature for district heating substations
4. Conclusions

Integrating heat pumps into a LTDH network

1. Difference of energy consumptions among residential users
2. Centralized vs. distributed solution
3. The system: low-temperature loop with district heat pumps

What has been done so far

What has to be done

1. Next 6 months
2. Final objective
Wastewater energy and heat demand in Abano Terme (1)

- Average annual amount over years 2006-2013: 7,8 Mmc (data from BIOCE);
- Extraction of wastewater not constant over the year (peaks in middle seasons and decrease in summer);
- Discharge temperature of approx. 41(±5)°C (from a sample of 10 hotels).
Wastewater energy and heat demand in Abano Terme (2)

- Assuming to cool down the wastewater from 41°C to 26°C ($\Delta T = 15°C$), we get a specific heat content of 17,5 kWh/mc
  \(\Rightarrow\) **UNEXPLOITED ENERGY POTENTIAL** ≅ 136500 MWh

- Heat demand of residential building stock in the Municipality of Abano Terme has been estimated with data from P.A.E. Provincia di Padova
  \(\Rightarrow\) **RESIDENTIAL HEAT DEMAND** ≅ 129000 MWh
Wastewater energy and heat demand in Abano Terme (3)

Supply temperature for heating and DHW

Temperature of available heat is not sufficient to supply any users due to:

- **Minimum supply temperature of 50°C** for Domestic Hot Water (necessary for both new and old buildings);
- Even without the DHW supply, radiator-based HVAC systems in existing buildings need higher temperatures (around 70°C) in winter in order to meet thermal comfort requirements.

**NEED OF A HEAT PUMP!**
Wastewater energy and heat demand in Abano Terme (4)

Conclusions

- The amount of available heat can be compared to the heat demand of the residential building stock, but heat pumps must be used.

- Hotels are concentrated in the central area of the town. Thus, the heat source is close to the potential users!

- The buildings are different and have different needs.
Integrating heat pumps into a LTDH network (1)

DIFFERENT..
- Energy consumption;
- Supply temperature;
- Heat load pattern.

HOTELS

Heat

Users

Blocks from 1960s
Old detached houses
Public administration buildings
Blocks from 1970s
Multi-dwelling building from 1980s
New low-energy buildings
Semi-detached houses from 1990s
## Integrating heat pumps into a LTDH network (2)

<table>
<thead>
<tr>
<th>CONFIG/OBJECTIVE</th>
<th>Efficiency</th>
<th>Affordability</th>
<th>Reliability</th>
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<tbody>
<tr>
<td><strong>Centralized</strong></td>
<td>- Most of the piping is at medium temperature;</td>
<td>+ Economies of scale (one machine for all users);</td>
<td>- Low (breakdown in main heat pump affects supply of all users).</td>
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<td>(one heat pump for all users)</td>
<td>- Same control for users with different needs.</td>
<td>+ Limited switching cost for users.</td>
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<td><strong>Distributed</strong></td>
<td>+ Most of the piping is at low temperature;</td>
<td>- High overall investment cost of the system;</td>
<td>+ Good (breakdown in a heat pump does not affect other users).</td>
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<tr>
<td>(one heat pump for each user)</td>
<td>+ Optimized control for each user.</td>
<td>- High switching cost for users;</td>
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<tr>
<td><strong>Grouped</strong></td>
<td>+ Trade-off between above solutions (both in control and heat losses).</td>
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<td>(one heat pump for each group of users)</td>
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<td>+ Further investment in smart technologies could be driven by clusters of consumers.</td>
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Integrating heat pumps into a LTDH network (3)
What has been done so far..

**WASTEWATER**
- Data collection on wastewater volumes discharged by hotels;
- Estimate of wastewater energy potential;

**DISTRICT HEATING**
- Structure of a dynamic model for district heating networks;
- Developing the concept of LTDH with district heat pumps.

**HEAT PUMPS**
- Preliminary analysis of different heat pump layouts;

**USERS**
- Estimate of heat demand of the residential building stock.
What has to be done.. (1)

**WASTEWATER**
- Measure wastewater mass flow rates to get daily profiles of heat source availability.

**DISTRICT HEATING**
- Develop further the dynamic model for district heating networks, and integrate heat pump behavior with time-dependent loads.

**HEAT PUMPS**
- M.Sc. Thesis project to get performance curves of customized heat pumps for LTDH at Hiref S.p.A.

**USERS**
- Develop models to simulate dynamic behavior of heat loads (different building types).
What has to be done.. (2)

FINAL OBJECTIVES

1) Simulate the dynamic system made up by multiple heat sources, district heating loop, district heat pumps and final users.

2) Compare the efficiency of the system to the current situation (gas boilers) and to the centralized district heating concept both in terms of overall primary energy consumption and economic costs.
GRAZIE
PER L’ATTENZIONE!