Feasibility Study for a Neighbourhood Energy Management System in Trento

Abstract

Industry and tertiary sector activities show interesting opportunities of recovering waste heat from productive processes and auxiliary equipment operation. In reduced scale, this kind of activities are widespread distributed in urban and suburban areas so that thermal energy could be easily integrated in local district heating network instead of being wasted in the environment.
Waste heat from industry and tertiary sector activities in the Madonna Bianca neighbourhood (Trento South) has been mapped and quantified in order to assess if it is recoverable in the low temperature water loop as useful thermal energy for the heating and domestic hot water (DHW) demand of the 3 residential buildings (the "Towers") studied in STARDUST.

Key points

- **Waste heat recovery analysis from industry/tertiary activities in Madonna Bianca District**
- **Almost 10GWh/year of potential waste thermal energy to be recovered around Madonna Bianca Towers**
- **Preliminary study to investigate the re-use of waste heat through a low temperature district water loop**

Mapping industry/tertiary activities nearby Madonna Bianca Towers

A list of about 40 companies/activities has been obtained combining the results found both through Trento province Chamber of Commerce for Industry, Agriculture and Handicraft and Google Maps®. A shorter list has been extracted (10 records) considering the distance to the Towers and the area of the productive site. The detected production/activity sectors are shopping malls/supermarket, wine cellars/ wine production, fruit and vegetable transformation and leisure centres/ swimming pools.
In order to identify the best heat recovery opportunities, the typical productive processes and the use of auxiliary devices have been studied within the above-mentioned sectors and, aiming at directly contacting energy/facility managers, a sector specific questionnaire has been prepared. The monitoring data of the refrigeration units of a shopping mall close to the Towers have been obtained through the survey whereas the other activities energy consumptions have been characterized reviewing articles and sector study reports.

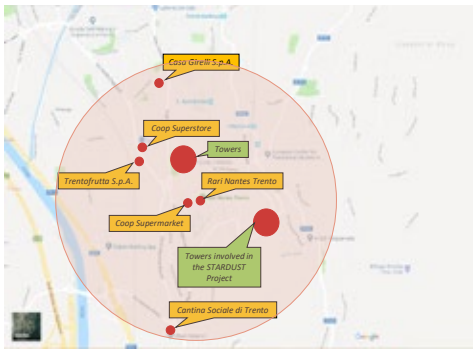

Figure 1 - Location of interesting activities for waste heat recovery in the Madonna Bianca area.

Quantification of potential waste thermal energy

The potential waste thermal energy available to be recovered within 1.5 km radius around the Towers amounts to almost 10 GWh per year. More than half of this value could be derived from a food sector company (fruit and vegetable transformation). Many steps of the productive process are based on refrigeration so that electricity specific consumptions and typical Coefficient of Performance (COP) values have been used in order to calculate the waste heat at the chiller condensers. Nevertheless, the potential thermal energy could be even higher since many treatments (e.g., pasteurization) use water at high temperature (up to 95 °C); the quantification of these additional sources would however require a specific study. Similarly, waste thermal energy from wine production companies has been evaluated considering that up to 70% of total energy consumptions are due to temperature control in many processes (e.g., fermentation) and hence to refrigeration units operation. Anyway, the highest contribution to the district water loop would be concentrated during the grape harvesting season (from late August to October). As for the swimming pool close to the Towers, according to previous studies the energy demand for cooling is negligible compared to the demand for heating and keeping the pool water between 25 and 27 °C. Nevertheless, the thermal energy recovery is apparently more interesting for internal energy savings than for matching the Towers heating and DHW production energy demand.
Finally, almost 20% of the potential waste thermal energy in Madonna Bianca area could be derived from "shopping malls/ supermarkets" activities. More in detail,

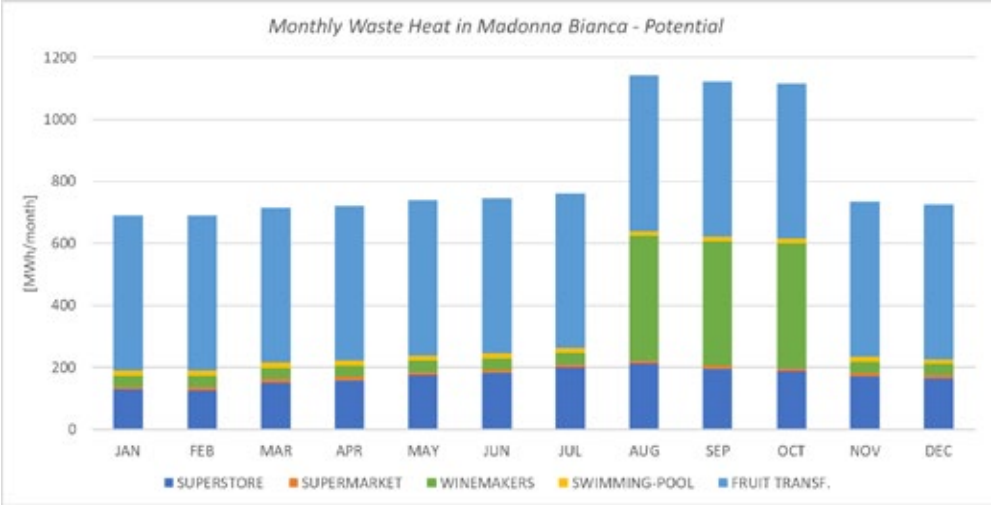

Figure 2 - Monthly distribution of waste heat energy from each type of activity in the Madonna Bianca area.

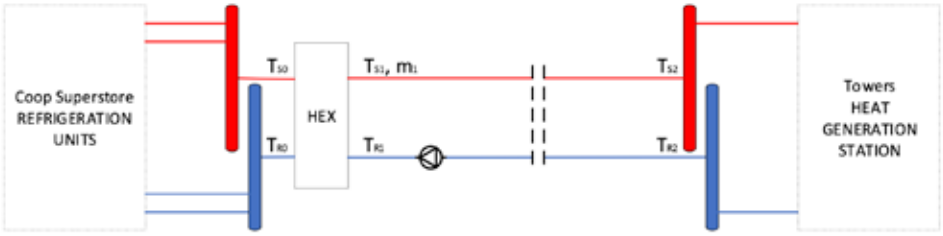

Figure 3 - Connection layout between waste heat source (shopping centre) and utility (Towers).

the shopping mall refrigeration units could provide up to 2 GWh per year of condensation thermal energy which is so far partially used for internal purposes (e.g., hot water for dressing room). The available energy shows daily and seasonal typical variations respectively due to daily working hours (from 6:00 to 24:00) and to seasonal thermal excursion (highest between January and August), but it is still interesting to match with the Towers thermal energy demand.

Feasibility analysis

Using exclusively the results obtained for the shopping mall and making some hypotheses for the plant lay-out to pick up the heat and deliver it to the low temperature district water loop in Madonna Bianca, a technical feasibility study and a preliminary economic analysis have been performed for two scenarios defined according to the distance between the waste energy source and the user (the 3 Towers studied within the Stardust project are 1 km far from the shopping mall whereas the 3 closest Towers are 400 m far). The components to be installed between the shopping mall condensation units and the heat generation station of the district water loop have been defined together with the hypothetical path of the piping (PEAD or pre-insulated) in order to calculate thermal losses and pressure drops and consequently to evaluate the investment costs and operation and maintenance costs. Considering a 195 kW heat exchanger installed just after the condensers of the shopping mall refrigeration units, 6570 system operation hours (from 6:00 to 24:00) and 30 °C as the water temperature out of the above-mentioned heat exchanger, in both scenarios the potential recovered heat could partially or totally meet the whole energy demand of the considered buildings (1200 MWh per year for 3 Towers) and the mismatch could be easily covered thanks to a possible additional geothermal field. Concerning the investments (if IRR = 5%), the pay-back time is about 8 years for the pre-insulated steel pipes hydraulic network serving the 1 km-far Towers. The PEAD pipes make this scenario´s pay-back time increase up to more than 25 years (useful life of the system) because of the higher thermal losses and pressure drops corresponding respectively to lower energy savings for the Towers and higher operating costs. In the 400 m-far Towers scenario, the pay-back time is about 3 years for both piping types basically because of the shorter distance. The attraction towards this kind of investment can be even higher because incentives for energy efficiency improvement, as the national “white certificates” neglected in this analysis, could further reduce the pay-back time.

Figure 4 - Plausible route of the duct between the shopping centre and the towers under study in the Stardust project.

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Learn more about STARDUST project:
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