Case Study summary

IEA-ECBCS Annex 48

Heat Pumping and Reversible Air Conditioning

Italy Case Study N°5: A shopping mall with a water loop HP system

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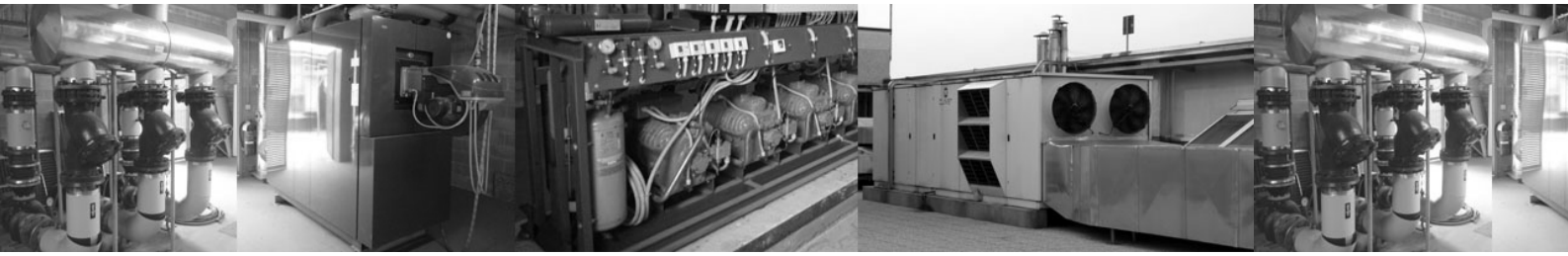
Contribution of Politecnico di Torino

Introduction

This case study compares two different HVAC systems installed in two buildings of similar destination (shopping centre), size (14.000 m^2 of conditioned area), and design loads (4500 kW heating, 2330 kW cooling). In both cases, the large supermarket area is conditioned with an all-air system, while the stores in the shopping mall area served by dedicated units.

Summary

- Location: Caselle, Torino, Italy
- Building sector: Shopping centre
- Gross net area: 14.000 m²
- Heating design load: 4500 kW
- Cooling design load: 2330 kW



Background

As far as plants suitable for shopping centre air conditioning are concerned, it is possible to obtain energy synergies allowing to get significant operational savings. The use of waste heat deriving from refrigeration plants can be profitably used to heat environments and to produce hot water for hygienic-sanitary use both with traditional and, even more profitably, with advanced plants.

General concepts

In the conventional “base case”, hot water is produced with two gas-fired boilers, while chilled water is produced with two electrical water chillers with screw compressors. The hot / cold water is distributed to the AHUs of the all-air system and to the dedicated units of the shops, which may be either roof-top units or small ducted units depending on size and location.
In the “optimized case”, a water loop HP system is present. Heat input to the water loop is provided by heat recovered from the food refrigeration equipment condensers, or by a backup gas fired boiler; heat rejection from the water loop is achieved with evaporative cooling towers. The water loop is connected to 62 distributed HP units, which again may be either AHUs with DX decks, roof-top units, or small ducted units (depending on size and location).

Gas condensing Boiler

Technical data of the system:

Water loop connecting:

- 2 gas boilers
- 9 roof-top units
- 2 chillers for alimentary refrigeration
- 49 small ducted units

HVAC system:

- Heating power: 4500 kW
- Cooling power: 2330 kW

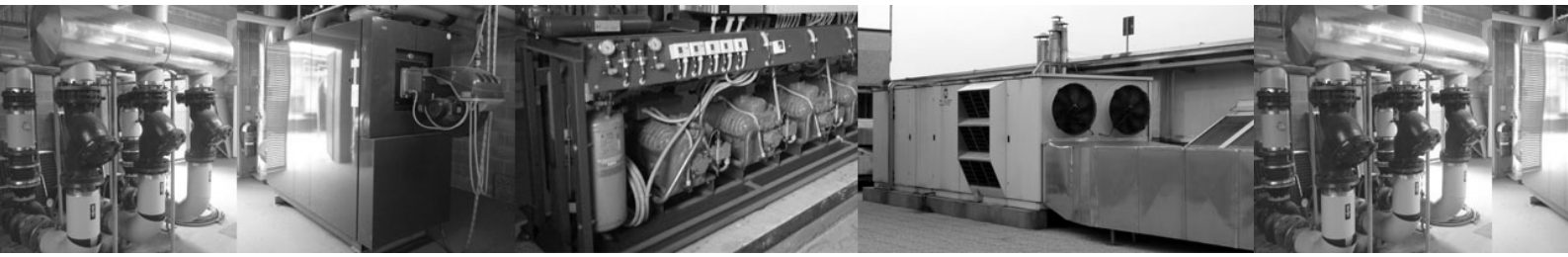
Roof-top serving supermarket zone

Advantages

- High efficiency in building characterized by opposite thermal loads (typically shopping mall)
- Stable COP due to water condensing

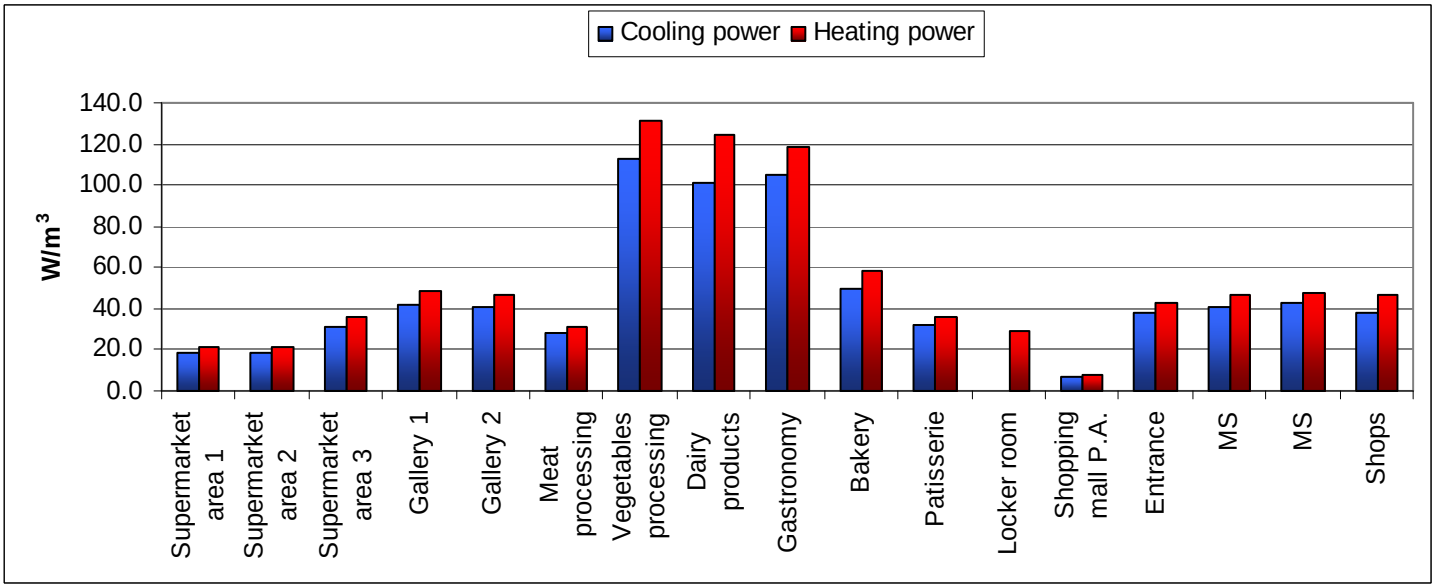
Drawbacks

- Higher installation cost than traditional system
- Not possible as retrofit installation
- Control strategy has to be very accurate



Design specifications

Shopping centre are characterized by contemporary presence of zone thermal loads of different sign and magnitude. The graph shows the design heating and cooling power for the different zones of the supermarket centre.

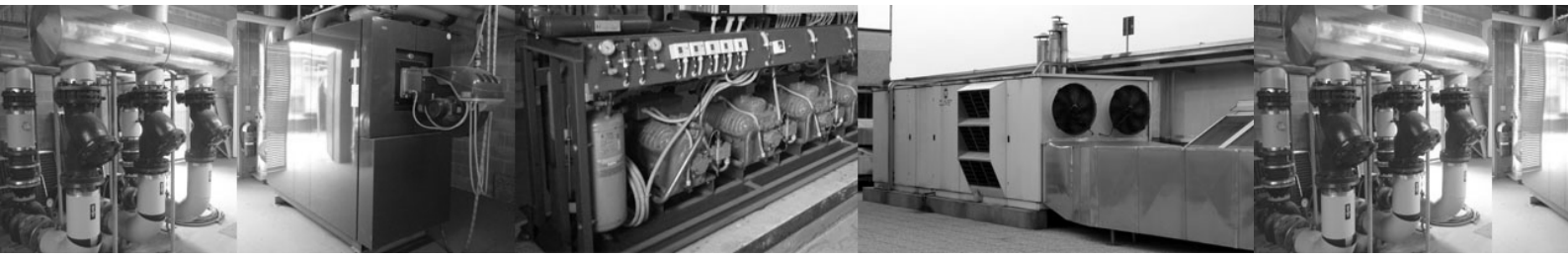


Food refrigeration

Due to the high cooling load needed for food refrigeration, a high amount of thermal energy has to be released to the condensers. The water loop system recovers this thermal input and deliver it to the units that are functioning in heating mode, e.g. those serving the supermarket zone. Operation of food refrigeration is critical, for this reason the condensers have two heat sink circuit in parallel, one to the water loop and one to air cooled heat exchangers. BMS open the connection between condensers and water loop when its temperature is between 10°and 30°C.

Alimentary refrigeration chiller

Air exchangers of alimentary refrigerators condensing circuit

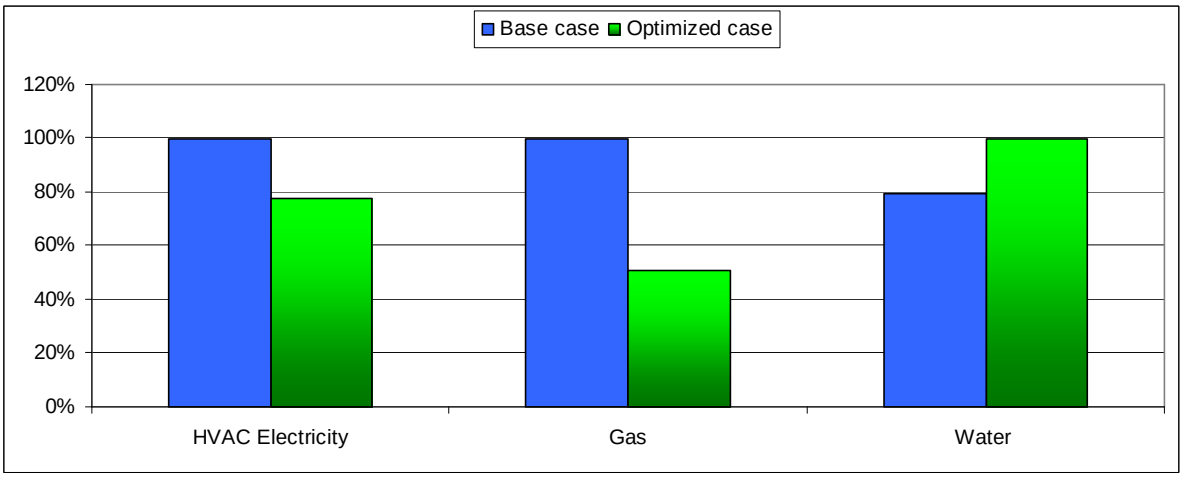


Consumption comparison

The optimized case, characterized by the water loop, showed high energy savings in gas and electricity. On the other hand, the consumption of water, raised about 25% due to the presence of evaporative towers.

	HVAC Electricity (kWh)	Gas (m^3)	Water (m^3)
Base case	2'406'322	174'600	19'000
Optimized case	1'871'815	88'127	24'000

Consumption comparison



Relative consumption comparison

Conclusion

Data acquired shows that high potential savings are possible using a water loop HVAC system. Economical analysis, made by the building owner, demonstrates that the extra-cost, needed for a water loop installation, has a simple pay back period of about 3.5 years.

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Literature

IEA-ECBCS Annex 48 website: http://www.ecbcs-48.org

Article: G. Gianni, M. Oliva, Water loop heat pump system integrated with heat recovery system. Techincal and economical comparison with a traditional system, AICARR Conference, Tivoli 08-09 October 2009.