High
Efficiency
Solutions.

CAREL

success story

Extra savings with CAREL retail sistema

where

Azzano Decimo, PN (I)
ASPIAG (Spar International)
- Eurospar supermarket

what

"Excellent" supermarket:
- refrigeration systems designed and installed by FriulFrigo Codroipo (UD)

why

- Comparative performance tests;
- latest energy saving initiatives in a real working environment

"Excellent" EUROSPAR supermarket

Aspiag, CAREL and FriulFrigo have combined their expertise in an ambitious project to measure, using a scientific approach and rigour, how power consumption of food storage refrigerator can be reduced in a modern "green" supermarket.

The primary objective focused the customer's need to assess the extra costs and time needed to pay back the investment.

The aim was to measure how and to what extent each individual solution contributed to the savings and what effect the combined use of the different solutions had once the installation was operating.

As regards the refrigeration systems, commercially available solutions had been previously considered, rejecting those that could not guarantee an adequate return.

The strict test protocol, managed by the CAREL Thermodynamic Research Centre, ensured a significant quantity of data was acquired.

The supermarket opened in November 2009 and continues to generate precious feedback on different operating seasons and modes.

What then makes this project different from the simple application of new solutions?

A conventional field test generally allows ample margin for interpretation, as each installation is only partly comparable, even when the supermarkets are similar:
- at Eurospar in Azzano X, on the other hand, design forecasts, laboratory tests and real results were able to be compared in different normal operating conditions;
- each function can be activated and deactivated individually to measure its effectiveness, repeating the checks more than once with the same load conditions;
- no "over" optimisation was adopted, with super-experts focusing on each detail for months just to demonstrate performance that is unachievable in "real supermarkets"
- the tests in fact used standard configurations. When any parameters changed the measurements were repeated.

The most interesting results show how, through careful choice of the components and good installation of the systems, significant savings can be achieved even with limited effort and low additional costs.

Friul FRIGO

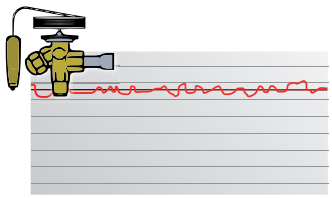
EUROSPAR

carel.com

"Traditional" supermarket

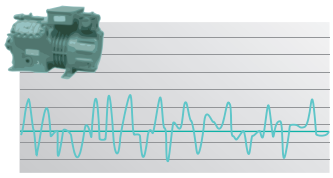
An installation featuring mechanical thermostatic valves, two compressor racks without capacity control or inverters, and no special procedures for pressure set point control was chosen as a typical "traditional" supermarket.

Mechanical valve



Condensing pressure needs to be maintained constant in order to not have to recalibrate the expansion valves in the refrigeration units due to their low adaptability

No inverter



Imprecise suction pressure control due to the absence of cooling capacity modulation devices (ON/OFF compressors)

Eurospar supermarket (ASPIAG) in Azzano X

Site specifications

- Surface area: 1500 m²
- Medium temperature showcases: 15
- Low temperature showcases: 11
- Medium temp. cold rooms: 6
- Low temperature cold rooms: 2

Medium temperature rack:

- 3 compressors in total
- 1 inverter driven compressor (35 – 100%)
- Total capacity 100 kW
- Condenser coil with 6 inverter driven fans

Low temperature rack:

- 3 compressors in total
- 1 inverter driven compressor (35 – 100%)
- Total capacity 50 kW
- Subcooling heat exchanger
- Condenser coil with 4 inverter driven fans

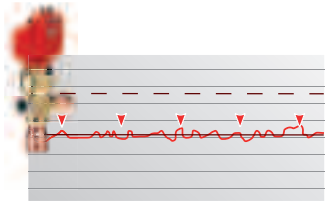
CAREL controllers

Compressor racks: pRack pR100
showcases/cold rooms: MPXPRO step3
expansion valves: E2V
supervisor: PlantVisorPRO Touch Hyper

"Advanced" supermarket

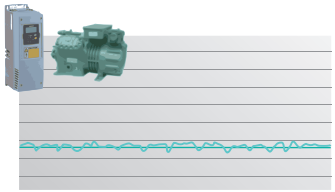
"Advanced" supermarket was the name given to the installation adopting electronic expansion valves on the refrigeration units and where possible adjusting compressor speed by inverter. Moreover, the condensing pressure does not need to be maintained constant given the possibility of the electronic valves to work with variable pressure differences.

Electronic valve



Pressure control can be exploited in the colder periods, lowering the suction pressure

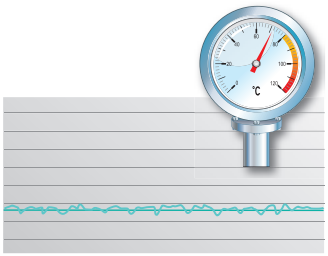
Inverter



Suction pressure control is continuous and precise

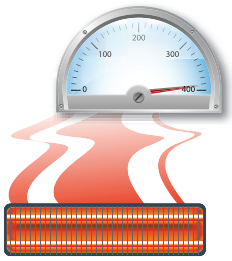
Fixed suction set point

The suction pressure set point is always kept constant, regardless of demand from the units.
Consequently, the compressor rack set point may be excessively and unnecessarily low compared to the climatic conditions



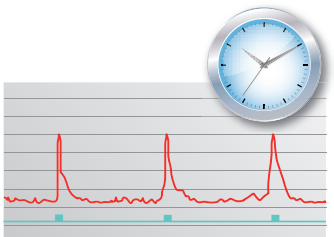
Anti-sweat heaters with fixed duty cycle

The anti-sweat heaters are set to operated at stable output (typically at 100%).
This involves a waste of electricity at all times when less heating of the showcase glass would be sufficient.



Scheduled defrosts

The defrost times are based on fixed schedules or time intervals regardless of actual ice formation. Often the number of defrosts is chosen erring on the side of caution and is higher than necessary.



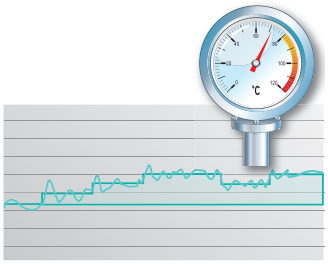
"Excellent" supermarket

In the "excellent" supermarket several modifications are applied to system operation so as to increase energy efficiency. A real installation was chosen for conducting detailed power consumption measurements so as to evaluate the energy saving associated with the technological improvements adopted:

- floating suction pressure;
- smart anti-sweat heater modulation;
- "Skip defrost" function to optimise defrosts.

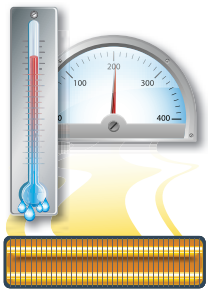
It's important to note that application of the technology distinguishing the "advanced" supermarket from the "excellent" supermarket involved little additional cost in percentage terms.
Floating evaporation pressure is in fact an additional function available for PlantVisorPRO, while once having chosen the MPXPro as the unit controller, the "skip defrost" function and self-adaptive anti-sweat heater modulation simply need to be enabled and configured, for practically no extra cost.

Floating suction pressure



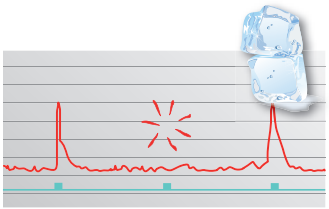
The suction pressure set point varies according to demand from the showcases.
The algorithm identifies the critical units that require higher performance from the compressor rack and control is adjusted accordingly.
In this way, the compressor rack consumes no more than necessary at any given time, completely automatically.

Anti-sweat heaters with self-adaptive algorithm



The anti-sweat heaters are controlled with a variable duty cycle. Output is in fact is carefully adjusted according to room temperature and humidity and the unit glass and frame temperature. In addition, a special algorithm is available to estimate the glass temperature and the dew point: this means heater operation can be adapted to current conditions without having to install other probes on the refrigerated showcases.

Skip Defrost



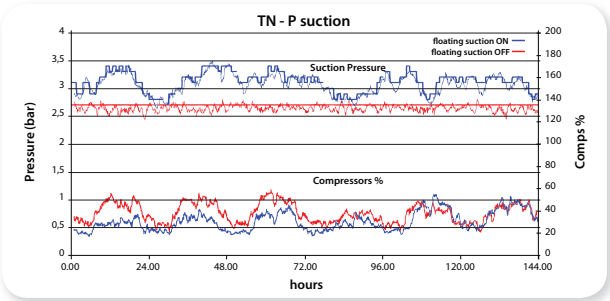
Unnecessary defrosts can be avoided based on the duration of previous defrosts.
The duration of a defrost depends on the amount of ice formed on the coil, and based on the previous durations and other fine-tuning parameters, up to a maximum of three consecutive defrosts can be skipped.

Test procedure

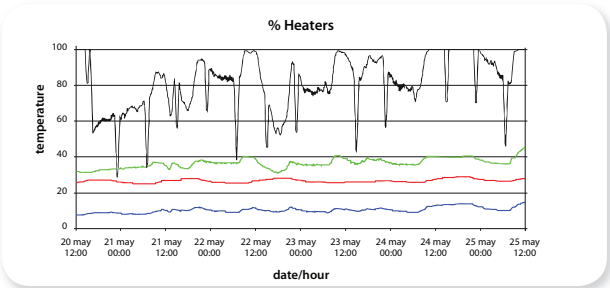
The trials were carried out so as to acquire data that was as comparable as possible, consequently the "advanced" supermarket was chosen as the benchmark for operation: all the refrigeration units are fitted with electronic expansion valves, the racks have inverters on the first compressor and condensing pressure can adapt to the outside temperature even in colder periods. The electronic controller parameters not relating directly to the different technologies being tested were kept constant, so as to allow direct comparison of the tested function and corresponding energy savings.
The compressor racks operated with the same condensing pressure set point.

The trials lasted several months, alternating "advanced" supermarket and "excellent" supermarket mode at weekly intervals, then comparable periods were selected as regards the outside climatic conditions and consequently the energy savings were calculated.

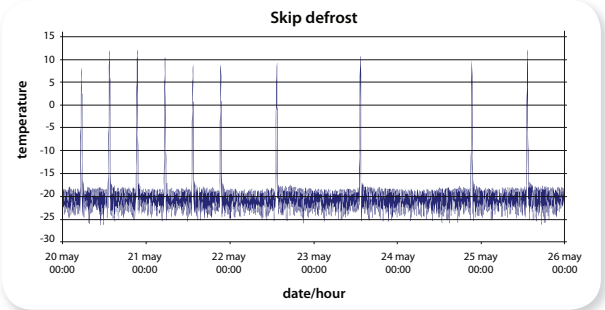
Data was sampled every 5 minutes.



when the floating suction pressure function is active, evaporation pressure is optimised according to desired performance (day/night, winter/summer) and consequently only the capacity strictly needed is required from the compressor rack



the relationship between humidity and percentage of anti-sweat heater activation can be seen, with an average well below the "typical" 100%



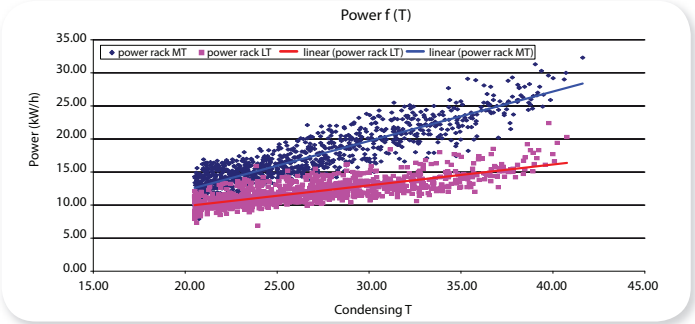
over a period of 6 days it can be seen that up to 7 defrosts were avoided

Results

The tests lasted ten months, during which time operation alternated between periods in "advanced supermarket" mode and periods in which the technologies being tested were activated. The results were averaged out, taking into consideration the entire test period, excluding maintenance, malfunctions or other tests. In addition, two representative periods were chosen in which the outside temperature was almost constant, so as to directly compare real periods in which specific technology was or was not used. Finally, each technology was allocated a corresponding share of the energy savings measured.

Overall results

Taking into consideration only the actual test periods, a linear model was used to plot the relationship between power consumption and condensing temperature. Power consumption was then assessed based on this relationship and the number of operating hours with each technology, obtaining the results shown in the table.



Average over 6 months			
March-August 2010	Excellent	Advanced	Saving
duration	62 days	102 days	
outside temp.	19, 3 °C	19.3 °C	
power consumption in operating hours	32.7 kW	36.3 kW	10 %

Specific results

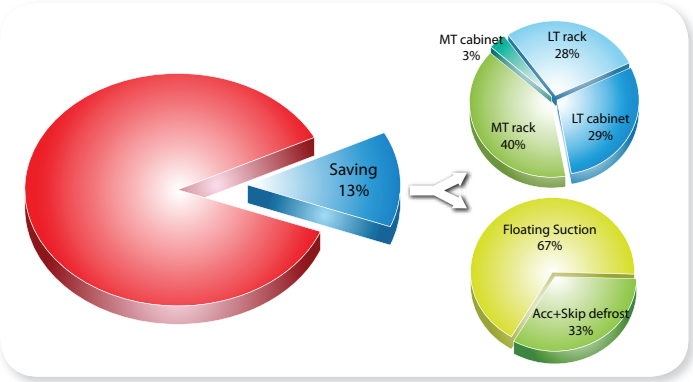
By focusing on periods in which the outside temperature was almost constant, specific comparison was made between "advanced" and "improved" operation. Winter data are better than summer data due to the different effectiveness of the "floating suction" function and the humidity conditions.

test 1 - duration 144 h			
May 2010	Excellent	Advanced	Saving
outside temp.	20.7 °C	19.9 °C	
consum.- inverter ON	4729 kWh	5457 kWh	13 %

test 2 - duration 456 h			
July-August 2010	Excellent	Advanced	Saving
outside temp.	24.2 °C	24.9 °C	
consum.- inverter ON	18133 kWh	19660 kWh	8 %

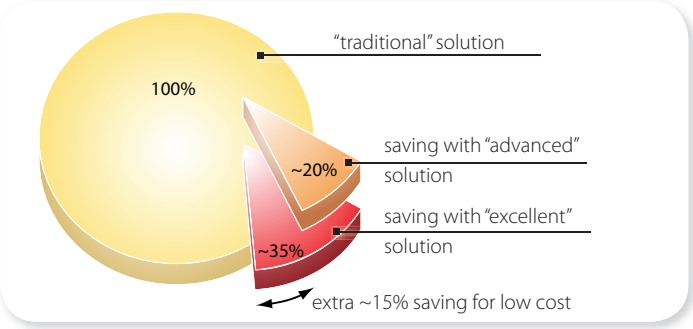
Allocation of energy saving

The graph clearly illustrates the sub-division of energy saving contributions attributable to each technology.



Conclusions

In light of CAREL's other experiences with energy saving and based on the results of the numerous tests carried out in Azzano X, some general conclusions can be drawn.
The changeover from "traditional" supermarket to "advanced" supermarket involves the installation of electronic valves, with corresponding controllers on the units and inverters to drive the compressors.
This choice thus implies an initial cost that is justified by the power consumption savings achievable, statistically estimable to be 20%. Starting from this solution, already advanced in itself, the "excellent" supermarket allows further savings between 10 and 15%, for practically no extra cost, as the technology is already available in the MPXPRO controllers or as an additional plugin for the PlantVisorPRO supervisor.



ref. ASHRAE journal February 2009

+4000010EN - 1.0 - 11.02.2011

Headquarters ITALY

CAREL INDUSTRIES HQs
Via dell'Industria, 11
35020 Brugine - Padova (Italy)
Tel. (+39) 0499 716611
Fax (+39) 0499 716600
carel@carel.com

Sales organization

CAREL Asia - www.carel.com
CAREL Australia - www.carel.com.au
CAREL China - www.carel-china.com
CAREL Deutschland - www.carel.de
CAREL France - www.carelfrance.fr
CAREL Iberica - www.carel.es
CAREL India - www.carel.in
CAREL HVAC/R Korea - www.carel.com
CAREL Russia - www.carelrussia.com
CAREL South Africa - www.carelcontrols.co.za
CAREL Sud America - www.carel.com.br
CAREL U.K. - www.careluk.co.uk
CAREL U.S.A. - www.carelusa.com

Affiliates

CAREL Czech & Slovakia - www.carel-cz.cz
CAREL Korea (for retail market) - www.carel.co.kr
CAREL Ireland - www.carel.com
CAREL Thailand - www.carel.co.th
CAREL Turkey - www.carel.com.tr