Monday, November 6, 2017,

# CASE STUDY
# THERMX® HVAC SOLAR SYSTEMS

## PROJECT BACKGROUND:

NORTIA CORPORATION (NORTIA) is a Catalan corporation composed of 372 companies, which include: real estate, hotel, corporate aviation, services, art and gaming (CIRSA GROUP). Its headquarters are located in Terrassa, Barcelona.

CRE SERVICES is a comprehensive provider of energy efficiency services, which aims to help its customers reduce their energy expenditure.

CRE SERVICES had detected the need for NORTIA to reduce its consumption derived from air conditioning in its facilities, and proposed the implementation of a solar energy system based on solar thermal capture to reduce the consumption of its climate equipment—provided that these have multi-compressor or variable regulation.

CRE SERVICES presented a project proposal for solar upgrading of HVAC equipment with THERMX® in the NORTIA facilities at the CIRSA GROUP Headquarters in Terrassa, Spain, based on the savings obtained through the patented THERMX® technology by SolX Energy, Ltd., through the exclusive distributor, SolXEnergy IBÉRICA®.

## THERMX® OPERATING PRINCIPLES:

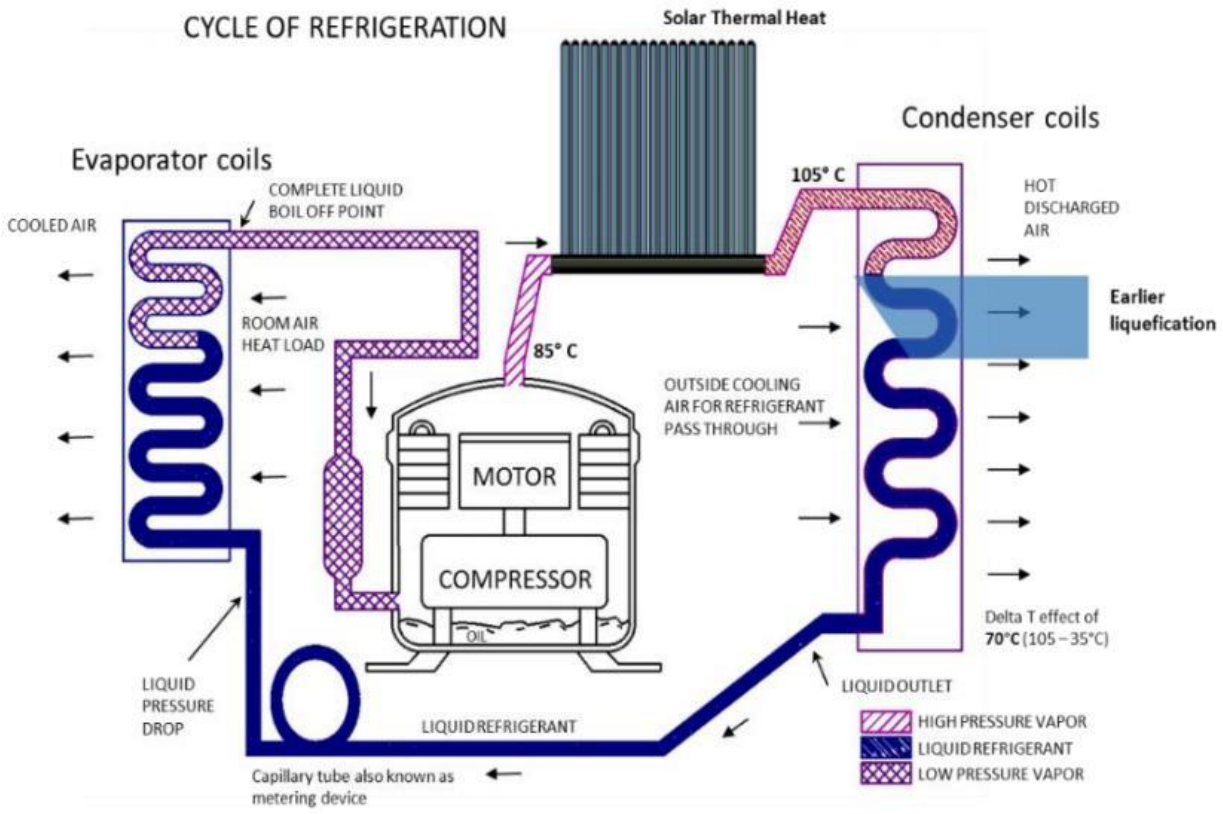
The ThermX® system is an energy efficiency element applicable to the vast majority of HVAC systems on the market for the generation of heating and cooling, provided that they are variable or multi-compressor equipment that work between 60% and 100% of designed capacity, whether it is a VRF system, chiller or industrial cold compressors, designed to modulate.

When the previous condition is fulfilled, ThermX® can be installed both onto new equipment and existing in-situ facilities (retrofitting).

The ThermX® system consists of a patented, passive system of capture and solar thermal distribution through specific panels specially designed for this purpose - to the refrigerant circuit after the compressors, reducing the compressor work load during the modulation.

ThermX® is based on the principal of contributing heat to the refrigeration circuit, that under normal conditions the compressor would have to generate, allowing for the modulation of the compressor or compressors downward. This process accelerates the transfer of heat at the condensation point, thus improving the amount of liquid flow through the expansion valve, reducing or even eradicating the presence of gas. As a result, the cooling capacity in the evaporator improves, thus achieving reductions in energy consumption.

The load decrease on the compressors causes a significant reduction in electricity consumption, with averages in Spain between 20% and 40%, and at maximum insolation from 60% to 70% of the maximum power demand and energy cost.




**Standard operating diagram of an air conditioning system assisted by THERMX®.*

**PROJECT DATA:**

i) EQUIPMENT TO BE UPGRADED:

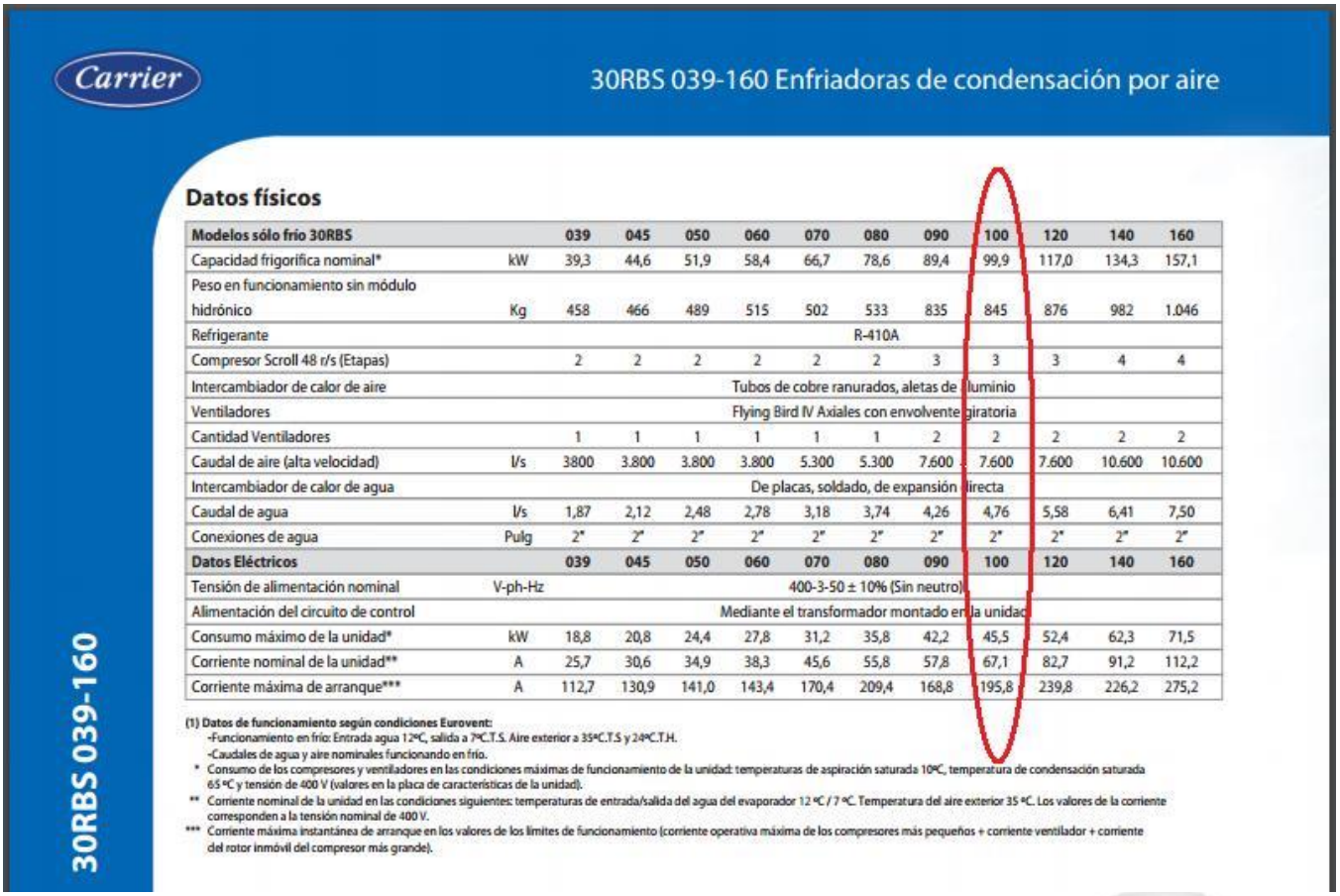
| | Manufacturer | Equipment | Model | Serial Number | Manufactured Date | Cooling Capacity Tons/Kw/ Btu´s | Number of Compressors |
|---|---|---|---|---|---|---|---|
| UNIT 1 | CARRIER | CHILLER | 30RBS-100-0258PEE | 12F109054 | 2011 | 100 | 3 |

ii) USAGE AND CONSUMPTION DATA:

| Annual Consumption (kWh) | Usage (hrs/day) | Usage 2 (days/year) | kWh Price (total) | Hot gas discharge line size |
|---|---|---|---|---|
| - | 12 | 270 | XXXX | 35mm |

*If the annual consumption is not expressed, the one posted by the manufacturer will be used.*
*The price kWh (total) is hidden by request of the client.*

iii) TECHNICAL SHEETS OF THE EQUIPMENT TO BE SOLARIZED:



Carrier

30RBS 039-160 Enfriadoras de condensación por aire

30RBS 039-160

**Datos físicos**

| Modelos sólo frío 30RBS | | 039 | 045 | 050 | 060 | 070 | 080 | 090 | 100 | 120 | 140 | 160 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Capacidad frigorífica nominal* | kW | 39,3 | 44,6 | 51,9 | 58,4 | 66,7 | 78,6 | 89,4 | 99,9 | 117,0 | 134,3 | 157,1 |
| Peso en funcionamiento sin módulo hidrónico | Kg | 458 | 466 | 489 | 515 | 502 | 533 | 835 | 845 | 876 | 982 | 1.046 |
| Refrigerante | | R-410A | | | | | | | | | | |
| Compresor Scroll 48 r/s (Etapas) | | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 4 | 4 |
| Intercambiador de calor de aire | | Tubos de cobre ranurados, aletas de aluminio | | | | | | | | | | |
| Ventiladores | | Flying Bird IV Axiales con envolvente giratoria | | | | | | | | | | |
| Cantidad Ventiladores | | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 |
| Caudal de aire (alta velocidad) | l/s | 3800 | 3.800 | 3.800 | 3.800 | 5.300 | 5.300 | 7.600 | 7.600 | 7.600 | 10.600 | 10.600 |
| Intercambiador de calor de agua | | De placas, soldado, de expansión directa | | | | | | | | | | |
| Caudal de agua | l/s | 1,87 | 2,12 | 2,48 | 2,78 | 3,18 | 3,74 | 4,26 | 4,76 | 5,58 | 6,41 | 7,50 |
| Conexiones de agua | Pulg | 2" | 2" | 2" | 2" | 2" | 2" | 2" | 2" | 2" | 2" | 2" |
| **Datos Eléctricos** | | **039** | **045** | **050** | **060** | **070** | **080** | **090** | **100** | **120** | **140** | **160** |
| Tensión de alimentación nominal | V-ph-Hz | 400-3-50 ± 10% (Sin neutro) | | | | | | | | | | |
| Alimentación del circuito de control | | Mediante el transformador montado en la unidad | | | | | | | | | | |
| Consumo máximo de la unidad* | kW | 18,8 | 20,8 | 24,4 | 27,8 | 31,2 | 35,8 | 42,2 | 45,5 | 52,4 | 62,3 | 71,5 |
| Corriente nominal de la unidad** | A | 25,7 | 30,6 | 34,9 | 38,3 | 45,6 | 55,8 | 57,8 | 67,1 | 82,7 | 91,2 | 112,2 |
| Corriente máxima de arranque*** | A | 112,7 | 130,9 | 141,0 | 143,4 | 170,4 | 209,4 | 168,8 | 195,8 | 239,8 | 226,2 | 275,2 |

**(1) Datos de funcionamiento según condiciones Eurovent:**
-Funcionamiento en frío: Entrada agua 12ºC, salida a 7ºC.T.S. Aire exterior a 35ºC.T.S y 24ºC.T.H.
-Caudales de agua y aire nominales funcionando en frío.

* Consumo de los compresores y ventiladores en las condiciones máximas de funcionamiento de la unidad: temperaturas de aspiración saturada 10ºC, temperatura de condensación saturada 65 ºC y tensión de 400 V (valores en la placa de características de la unidad).

** Corriente nominal de la unidad en las condiciones siguientes: temperaturas de entrada/salida del agua del evaporador 12 ºC / 7 ºC. Temperatura del aire exterior 35 ºC. Los valores de la corriente corresponden a la tensión nominal de 400 V.

*** Corriente máxima instantánea de arranque en los valores de los límites de funcionamiento (corriente operativa máxima de los compresores más pequeños + corriente ventilador + corriente del rotor inmóvil del compresor más grande).

iv) INSTALLATION DATA FOR SOLAR EQUIPMENT:

According to the study conducted by SolX Energy IBÉRICA® of the customer's Carrier chiller, the diameter of its discharge line requires the installation of a total of 5 ThermX® Vacuum Solar Collectors, a number of distributors in the refrigerant lines to adequately guarantee the flow of the refrigerant through the collectors and a specific insulation to guarantee that there is no loss in the lines.

Given that the available surface area is lower than that required for the installation of the collectors, a support assembly is designed based on a metallic structure forming a network of UPN's welded together to raise the installation of the collectors above the existing facilities.

It has been established that the optimum position of the collectors is at 5º, maximizing the influence of the solar collection due to the orientation and they are calculated - given this special configuration with the reinforcements and anchors to guarantee the wind resistance according to the formula:

$$F=P \times S \times Sen(a)^2$$

v) THERMX® SOLAR COLLECTOR TECHNICAL SHEET:

**Unit Description**

The **ThermX®** solar panel is a non-mechanical spectrum, nfra-red, thermal absorption collector. The panel is of the "heat pipe" variety, which is applied by the transfer method, within the heat exchange process of the collector.

The **ThermX®** heat pipe consists of a sealed copper / tube that is compatible with the internal working fluid. Connected to the heat pipe is a flap of corrugated copper absorption, which runs along the pipe. The solar tube around the heat pipe and the fin is of the evacuated tube variety - composed of two layers - while the space between the layers has the air evacuated. The heat pipe is partially filled with a working fluid and then sealed. The mass working fluid is chosen so that the heat pipe contains steam and liquid over the temperature range and depends on the gravitational force for cycling through the heating, cooling and reheating phases.

Although thermal solar panels like this one are common and well established in the market, this panel has been modified for use in the loop / refrigerant cycle of residential and commercial HVAC systems, as well as in freezing and refrigeration systems. They allow a simple connectivity to both the system that are incorporated, as well as others, by means of braising.

*Note: The solar collector panel is not charged with refrigerant from the factory.*

**Product Placement**

The solar collector panels can be mounted in several places, assuming maximum exposure to direct and indirect sunlight is considered. The panels must be mounted between a minimum of 20° and a maximum of 80°, with an optimum performance of approximately 60°. The panels can be installed singularly, or in arrays of series and parallel configurations, which is determined by system size, engineering and best practices. Panels must be installed in accordance with local wind lift and load requirements.

**Mounting Options**

The panels can be installed on the roofs, including but not limited to: asphalt, tiles, concrete, built up / modified and EPDM, or at ground level, on foundation cushions. Frame can be fixed by direct anchor or ballast. Under certain circumstances, it may be placed on top of the HVAC / R equipment. All roof penetrations will be water sealed according to best practices. Floor cushions will be designed and developed by local building regulations.

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**Composition**

A. Workflow

The working fluid inside the copper heat pipe is a mixture of glycol and distilled water.

B. Evacuated Tube Collector

1. The glass is made of low iron soda lime, which provides a clear water appearance. The fins of the copper tube are coated with TiNOx, which is a recyclable buffer finish composed of titanium, titanium carbide and copper. Therefore, there is no hazardous material handling necessary in case of breakage. The absorption rate of TiNOx is 95% and the glass transmission rate is 92%, providing high solar efficiency. The glass is hermetically sealed to the inner copper heat pipe, with an internal vacuum level of 1.45 X 10 -6 PSI. All combined, the twenty tubes provide a collective surface of 24 $ft^2$.

2. Damaged collector pipes are not user repairable, but are easily replaceable by a simple user removal and reinstallation procedure. This is very beneficial for several reasons: because there is no refrigerant gas through the manifold pipe, no gas is lost in case of vandalism or acts of God. Second, because the coolant loop is closed and separated from the manifold tubes, there is no need to shut down the primary system, in case a replacement is necessary. Third, the overall loss of efficiency increase of a broken pipe is nominal. It must be replaced by a certified technician.

C. Frame

Frame and assembly segments are created from continuous, durable, 6063 T5 aluminum strangled profiles. These sections hold the head of an M8 screw, which is used during assembly. Specialized clamps that allow the placement of pipes and the collector are included in the frame and have an adjustable width depending on the structural needs of the building. The supports are made of stainless steel, as well as the mounting bolts and screws. The kit weighs 13 pounds.

D. Multiples

The inner collector houses a series of insulated copper vessels, in which the solar collector tubes are inserted. Conductive

paste is installed in the factory container. The copper vessels are fixed to a primary copper transport pipe, through which the refrigerant enters and exits. The copper transport pipe is constructed of nominal copper coolant, and serves to absorb the solar heat collected from the heat pipes and transfers it to the coolant via the conduction of the receptacles.

**Installation**

a. Assembly: assembly required. Instructions provided.

b. Installation kits: Kits are available for both tilt-mounted and recessed specifications. Standardized engineering certificates available.

c. Welding: HVAC/R standards, recommended 15% Sil-Fos.

d. The use of nitrogen and a vacuum pump should be used for pressure testing and ensure a leak-free installation as per standard HVAC/R practices.

**Dimensions**

**ThermX®** collector: 58.25" width, X 77.75" long, X 3.75" depth.
Solar Collector Weight... 117 lbs.
Gross weight with mounting kit... 130 lbs.

**Ratings**

The ThermX® solar collector is prepared to withstand 1 "hail, according to the TUV-21208924
Solar Keymark (011 7S 904 R)
MSC approved
IBC, ASCE-7 & CBC certified to 140 mph

**Warranty**

All elements of the ThermX® solar collector panel are guaranteed for a period of twenty 20 years of operation.

The expected lifetime of the **ThermX®** Solar Panel collector will exceed (30) thirty years.

Extended warranty for **ThermX®** systems are available. Consult your regional distributor.

**Regional Master Dealer**

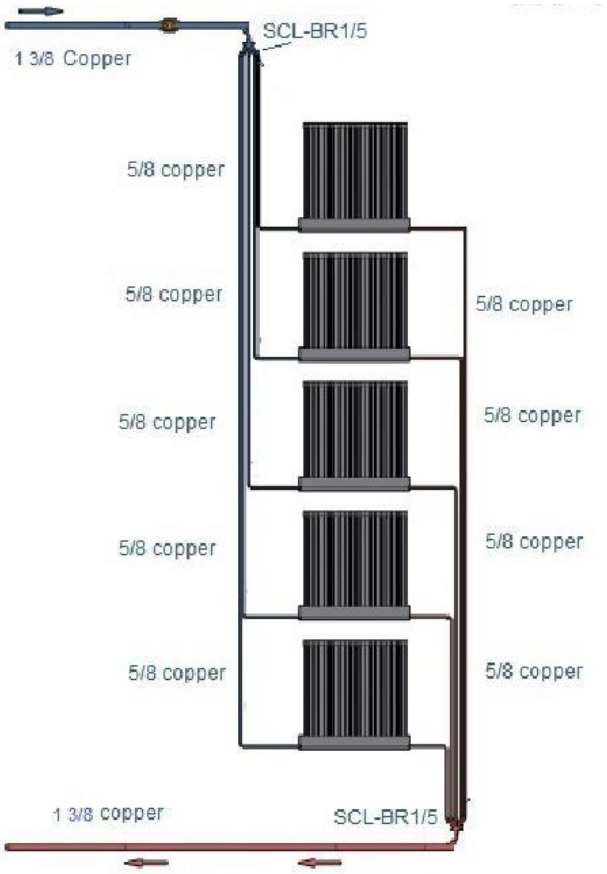
**SOLXEnergy IBÉRICA®** (SPAIN & PORTUGAL)

*Bionic Earthenware Pitcher Corp SL*
*C/ Miquel Vives, 26 3-3 08222 Terrassa*
*Barcelona (Spain)*

*http://www.creservices.es/SOLXEnergy*
*info@creservices.es*

vi) ASSEMBLY DESIGN:

The **ThermX®** system requires a modification in the refrigeration line of the installation. The derivation is made to the solar collectors in the discharge line of the compressor or compressors according to the following scheme:




**The measures represented only correspond to this specific project of the CIRSA chiller and should not be used as a general assembly guide.*

vii) MONITORING SYSTEMS:

Although only one kWh consumption analyzer is required for the demonstration, it is established that two independent measurement systems will be used to test the results obtained from September 6, 2017, and to elaborate the equipment's baseline consumption.

The PickData monitoring system, in charge of the CIRCONTROL Group, composed of the PickVPN analyzer, super-immunized toroids and a 3G communication system, and the PickData EVO software for the monitoring of the totalized hourly consumption in kWh, the maximum power demanded and the climogram. (http://www.pickdata.es) (http://www.circutor.es)

The SGClima system, run by the company Indoorclima, at the forefront of parameterization and remote control of HVAC systems, will provide monitoring of the circuit and the effective performance of the machine (instant COP) by means of temperature probes and calorie counter.
(http://www.indoorclima.es)

viii) METEOROLOGICAL AND OBSERVATION EQUIPMENT:

Meteorological data has been automatically taken, at 30 minutes intervals, from the PARC AGRARI-SABADELL meteorological station, accessible through the Meteorological Service of Catalonia, through its Meteocat portal.

(http://www.meteo.cat/observacions/xema/dades?codi=XF)

For sky observations and presence of cloudiness, only for reference and to help the better understanding of meteorological data, a web camera of public access has been used and available for the observation and preparation of climatological studies, consisting of a fixed plane of the sky at 12:00h, in the vicinity of the test.

contact: Mr. Jaume Torres
email: jaumeto63@gmail.com
phone: 93 721 77 81

ix) STARTING THETHERMX® SYSTEM:

After the installation and after the verification and technical suitability of the same by a technical team composed of CIRSA, CRE SERVICES and SOLXEnergy IBÉRICA®, we proceeded to supplement the installation of the client with the gas necessary for the operation of the THERMX® system and its placement underway on October 13, 2017.

**Delete Duplicate:** After the installation, verification, and technical suitability by a technical team composed of CIRSA, CRE SERVICES and SOLXEnergy IBÉRICA®, we proceed to supplement the installation of the client with the gas necessary for the operation of the ThermX® system and to put it underway on October 13, 2017.

x) CIRSA ThermX® INSTALLATION IMAGES:

*General view of THERMX solar thermal installation.*

*inspection and control visit of the manufacturer of the HVAC equipment.*

## REPRESENTATION OF THE CONSUMER DATA OF THE CHILLER:

The total consumption data per hour of the chiller, collected by PICK VPN, are exported to a CSV (Excel type document), in order to analyze more effectively and have the following format:

| Date | Time | Carrier 100Kw consumption in CIRSA Terrassa (kWh) |
|---|---|---|
| Monday, 2017 Sep 18, 00:00 | 0:00 | 0,00 |
| Monday, 2017 Sep 18, 01:00 | 1:00 | 0,00 |
| Monday, 2017 Sep 18, 02:00 | 2:00 | 0,00 |
| Monday, 2017 Sep 18, 03:00 | 3:00 | 0,00 |
| Monday, 2017 Sep 18, 04:00 | 4:00 | 0,00 |
| Monday, 2017 Sep 18, 05:00 | 5:00 | 0,00 |
| Monday, 2017 Sep 18, 06:00 | 6:00 | 0,00 |
| Monday, 2017 Sep 18, 07:00 | 7:00 | 27,17 |
| Monday, 2017 Sep 18, 08:00 | 8:00 | 16,62 |
| Monday, 2017 Sep 18, 09:00 | 9:00 | 7,17 |
| Monday, 2017 Sep 18, 10:00 | 10:00 | 7,84 |
| Monday, 2017 Sep 18, 11:00 | 11:00 | 7,37 |
| Monday, 2017 Sep 18, 12:00 | 12:00 | 7,58 |
| Monday, 2017 Sep 18, 13:00 | 13:00 | 7,97 |
| Monday, 2017 Sep 18, 14:00 | 14:00 | 7,65 |
| Monday, 2017 Sep 18, 15:00 | 15:00 | 7,93 |
| Monday, 2017 Sep 18, 16:00 | 16:00 | 7,88 |
| Monday, 2017 Sep 18, 17:00 | 17:00 | 8,06 |
| Monday, 2017 Sep 18, 18:00 | 18:00 | 7,95 |
| Monday, 2017 Sep 18, 19:00 | 19:00 | 4,02 |
| Monday, 2017 Sep 18, 20:00 | 20:00 | 0,00 |
| Monday, 2017 Sep 18, 21:00 | 21:00 | 0,00 |
| Monday, 2017 Sep 18, 22:00 | 22:00 | 0,00 |
| Monday, 2017 Sep 18, 23:00 | 23:00 | 0,00 |
| Tuesday, 2017 Sep 19, 00:00 | 0:00 | 0,00 |
| Tuesday, 2017 Sep 19, 01:00 | 1:00 | 0,00 |
| Tuesday, 2017 Sep 19, 02:00 | 2:00 | 0,00 |
| Tuesday, 2017 Sep 19, 03:00 | 3:00 | 0,00 |
| Tuesday, 2017 Sep 19, 04:00 | 4:00 | 0,00 |
| Tuesday, 2017 Sep 19, 05:00 | 5:00 | 0,00 |
| Tuesday, 2017 Sep 19, 06:00 | 6:00 | 0,00 |
| Tuesday, 2017 Sep 19, 07:00 | 7:00 | 18,10 |
| Tuesday, 2017 Sep 19, 08:00 | 8:00 | 6,99 |
| Tuesday, 2017 Sep 19, 09:00 | 9:00 | 7,83 |

*Representation of the data obtained in Excel by Pick VPN

**REPRESENTATION OF DATA FROM THE WEATHER STATIONPARC AGRARI - SABADELL:**

The meteorological data taken at intervals of 30 min, are also exported to a CSV (Excel type document), in order to analyze more effectively and have the following format:

| Day | Universal Time (add two hours in summer and one hour in winter for local time) | Average Temperature (ºC) | Maximum Temperature (ºC) | Minimum Temperature (ºC) | Relative Humidity (%) | Precipitation (mm) | Atmospheric pressure (hPa) | Solar radiation (W/m2) |
|---|---|---|---|---|---|---|---|---|
| 18-09-17 | 00:00 - 00:30 | 15,2 | 15,4 | 15,0 | 75 | 0 | 1017,7 | 0 |
| 18-09-17 | 00:30 - 01:00 | 15,2 | 15,3 | 15,1 | 74 | 0 | 1017,4 | 0 |
| 18-09-17 | 01:00 - 01:30 | 15,0 | 15,2 | 14,9 | 73 | 0 | 1017,0 | 0 |
| 18-09-17 | 01:30 - 02:00 | 15,2 | 15,5 | 15,0 | 70 | 0 | 1016,7 | 0 |
| 18-09-17 | 02:00 - 02:30 | 15,5 | 15,6 | 15,4 | 68 | 0 | 1016,8 | 0 |
| 18-09-17 | 02:30 - 03:00 | 15,5 | 15,6 | 15,5 | 69 | 0 | 1016,6 | 0 |
| 18-09-17 | 03:00 - 03:30 | 15,6 | 15,6 | 15,5 | 68 | 0 | 1016,4 | 0 |
| 18-09-17 | 03:30 - 04:00 | 15,5 | 15,6 | 15,4 | 69 | 0 | 1016,4 | 0 |
| 18-09-17 | 04:00 - 04:30 | 15,6 | 15,7 | 15,5 | 70 | 0 | 1016,3 | 0 |
| 18-09-17 | 04:30 - 05:00 | 15,6 | 15,7 | 15,6 | 71 | 0 | 1016,2 | 0 |
| 18-09-17 | 05:00 - 05:30 | 15,7 | 15,9 | 15,6 | 71 | 0 | 1016,3 | 0 |
| 18-09-17 | 05:30 - 06:00 | 16,0 | 16,0 | 15,9 | 71 | 0 | 1016,2 | 3 |
| 18-09-17 | 06:00 - 06:30 | 16,0 | 16,1 | 16,0 | 71 | 0 | 1016,4 | 18 |
| 18-09-17 | 06:30 - 07:00 | 16,1 | 16,2 | 16,1 | 72 | 0 | 1016,3 | 37 |
| 18-09-17 | 07:00 - 07:30 | 16,3 | 16,3 | 16,2 | 71 | 0 | 1016,4 | 49 |
| 18-09-17 | 07:30 - 08:00 | 16,4 | 16,5 | 16,3 | 70 | 0 | 1016,5 | 105 |
| 18-09-17 | 08:00 - 08:30 | 16,7 | 17,2 | 16,5 | 68 | 0 | 1016,6 | 144 |
| 18-09-17 | 08:30 - 09:00 | 17,6 | 18,1 | 17,0 | 65 | 0 | 1016,5 | 342 |
| 18-09-17 | 09:00 - 09:30 | 16,5 | 17,6 | 15,2 | 74 | 1,3 | 1017,0 | 52 |
| 18-09-17 | 09:30 - 10:00 | 15,4 | 16,3 | 15,0 | 88 | 0 | 1016,9 | 272 |
| 18-09-17 | 10:00 - 10:30 | 16,3 | 16,6 | 16,0 | 84 | 0 | 1016,8 | 287 |
| 18-09-17 | 10:30 - 11:00 | 17,1 | 17,6 | 16,6 | 78 | 0 | 1016,8 | 459 |
| 18-09-17 | 11:00 - 11:30 | 18,1 | 18,9 | 17,7 | 69 | 0 | 1016,5 | 691 |
| 18-09-17 | 11:30 - 12:00 | 19,0 | 19,5 | 18,7 | 67 | 0 | 1016,1 | 808 |
| 18-09-17 | 12:00 - 12:30 | 19,2 | 19,8 | 18,7 | 68 | 0 | 1015,8 | 557 |
| 18-09-17 | 12:30 - 13:00 | 18,6 | 18,7 | 18,5 | 69 | 0 | 1015,6 | 184 |
| 18-09-17 | 13:00 - 13:30 | 19,2 | 20,0 | 18,5 | 67 | 0 | 1015,4 | 511 |
| 18-09-17 | 13:30 - 14:00 | 19,5 | 19,8 | 19,3 | 65 | 0 | 1015,2 | 216 |
| 18-09-17 | 14:00 - 14:30 | 19,9 | 20,1 | 19,5 | 63 | 0 | 1015,2 | 314 |
| 18-09-17 | 14:30 - 15:00 | 19,3 | 19,6 | 19,0 | 66 | 0 | 1015,2 | 456 |
| 18-09-17 | 15:00 - 15:30 | 18,5 | 19,1 | 18,2 | 69 | 0 | 1015,4 | 176 |
| 18-09-17 | 15:30 - 16:00 | 18,5 | 18,8 | 18,3 | 70 | 0 | 1015,6 | 293 |
| 18-09-17 | 16:00 - 16:30 | 18,1 | 18,4 | 17,9 | 72 | 0 | 1015,9 | 180 |
| 18-09-17 | 16:30 - 17:00 | 17,5 | 17,9 | 17,3 | 75 | 0 | 1016,4 | 58 |
| 18-09-17 | 17:00 - 17:30 | 17,2 | 17,3 | 17,0 | 77 | 0 | 1016,8 | 48 |
| 18-09-17 | 17:30 - 18:00 | 16,9 | 17,0 | 16,9 | 78 | 0 | 1017,1 | 8 |
| 18-09-17 | 18:00 - 18:30 | 16,9 | 16,9 | 16,8 | 79 | 0 | 1017,5 | 0 |
| 18-09-17 | 18:30 - 19:00 | 16,8 | 16,9 | 16,8 | 80 | 0 | 1018,1 | 0 |
| 18-09-17 | 19:00 - 19:30 | 16,8 | 16,9 | 16,8 | 79 | 0 | 1018,5 | 0 |
| 18-09-17 | 19:30 - 20:00 | 16,8 | 16,9 | 16,8 | 79 | 0 | 1019,0 | 0 |
| 18-09-17 | 20:00 - 20:30 | 16,8 | 16,9 | 16,8 | 79 | 0 | 1019,3 | 0 |
| 18-09-17 | 20:30 - 21:00 | 16,8 | 16,8 | 16,7 | 80 | 0 | 1019,5 | 0 |
| 18-09-17 | 21:00 - 21:30 | 16,7 | 16,8 | 16,6 | 80 | 0 | 1019,6 | 0 |
| 18-09-17 | 21:30 - 22:00 | 16,4 | 16,6 | 16,3 | 83 | 0 | 1019,8 | 0 |
| 18-09-17 | 22:00 - 22:30 | 16,0 | 16,2 | 15,7 | 85 | 0 | 1019,8 | 0 |
| 18-09-17 | 22:30 - 23:00 | 15,6 | 15,8 | 15,4 | 87 | 0 | 1019,7 | 0 |
| 18-09-17 | 23:00 - 23:30 | 15,0 | 15,4 | 14,5 | 89 | 0 | 1019,8 | 0 |
| 18-09-17 | 23:30 - 00:00 | 14,9 | 15,1 | 14,5 | 90 | 0 | 1019,9 | 0 |

*Representation of the data obtained in Excel from the Meteorological Service of Catalonia

For the treatment of posterior data, weighted time averages of each of the 30-minute intervals will be established.

**DESCRIPTION AND SINGULARITIES OF THE PROJECT:**

The air conditioning system of the CIRSA building headquartered in Terrassa, Barcelona (Spain) is composed of two water chillers, a 100KW Carrier (object of this study) and a second chiller, as a reinforcement of the system for the months of maximum demand.

During the months in which we have carried out the tests of this study, only the Carrier chiller of 100Kw remains operative against the total demand of the building, turning off the other one. Its consumption is also requested and monitored, to guarantee that there is no corruption in the data, resulting in a constant of 0.14kWh since the start of the monitoring.

The chiller sends water at 7ºC to the hydraulic circuit to the indoor units (fan coils). The setpoint temperature is variable under the curve established in the BMS control system of the building, according to the outside temperature and with a minimum of 7°C, the pump remains constant in primary and secondary to 50% and finally, the water returns up to a 2,000-liter lung tank.

During the comparative study, the following records are considered:

- Solar hours registered (ThermX® on): From 10am to 4pm.
- After Winter time change (>): 9am to 3pm.

Note: No more daily hours are recorded due to a shadow effect on the panels after 4pm (summer time).

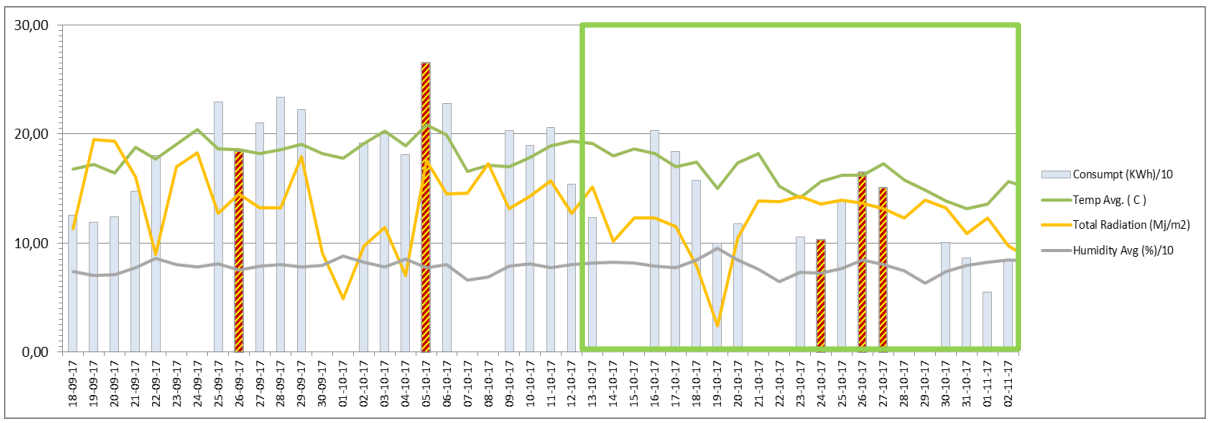
CRE SERVICES, through the use of ThermX® technology from SOLXEnergy IBÉRICA®, aims to obtain savings results between 30% and 40% of the CIRSA chiller during the pilot test.

Two independent companies, PICKDATA, S.L., of the CIRCUTOR and INDOORCLIMA group, S.L. They will ensure the quality and accuracy of the data obtained.

Given the climatic instability present in Catalonia during the month of September 2017, it is established to compare days with each other, with the condition of being one "solar" and the other not. These days must present very similar conditions to each other, so that the variation between average and maximum temperatures is lower than 3ºC and in percentage of relative humidity of the air is, which at most is of 10%.

It is intended to eliminate (as far as possible) the human factor and, therefore, it is desirable to ensure that the internal demand of the building is as stable as possible. Since the setpoint temperatures of the different floors and areas of the building cannot be blocked, CIRSA agrees to keep the air conditioning ON during the pilot test, expecting at least to have similar and comparable weather conditions between the two of them.

## WEATHER GRAPHIC FROM 18/09/2017 THROUGH 02/11/2017:




*Graphical representation of the Average Temperature, Humidity, Solar Radiation and Electric Consumption data from 09/18/2017 to 02/11/2017.*

The information inside the green box, from 09/13/2017 to 02/11/2017, corresponds to the data after the ThermX® installation has been commissioned and the beginning of the tests and benchmarking.

The vertical bars represent the daily total consumption in kWh. Of these, the striped color bars correspond to days with incidents of pausing, or tests of the installation during the study, being therefore outside of it.

The values of Electric Consumption and Humidity have been divided by ten to be able to represent them more clearly for the reader and in a single graph.

## COMPARABLE DAYS AND EXCEPTIONS FOR THE THERMX® EVALUATION:

**A) Comparatives of days with stable internal demand.**

I) October 12 VS. October 13.

II) October 12 VS. November 01.

**B) Comparisons of days with unstable internal demand.**

III) October 09 VS. October23.

IV) October 25 VS. October23.

**C) Most usual exceptions to the operation of ThermX®:**

V) October23 VS. October30.

VI) October10 VS. October17.

VII) October13 VS. September11.

### D) Comparatives of days with stable internal demand:

I) October 12 vs. October 13, 2017, both Holidays.

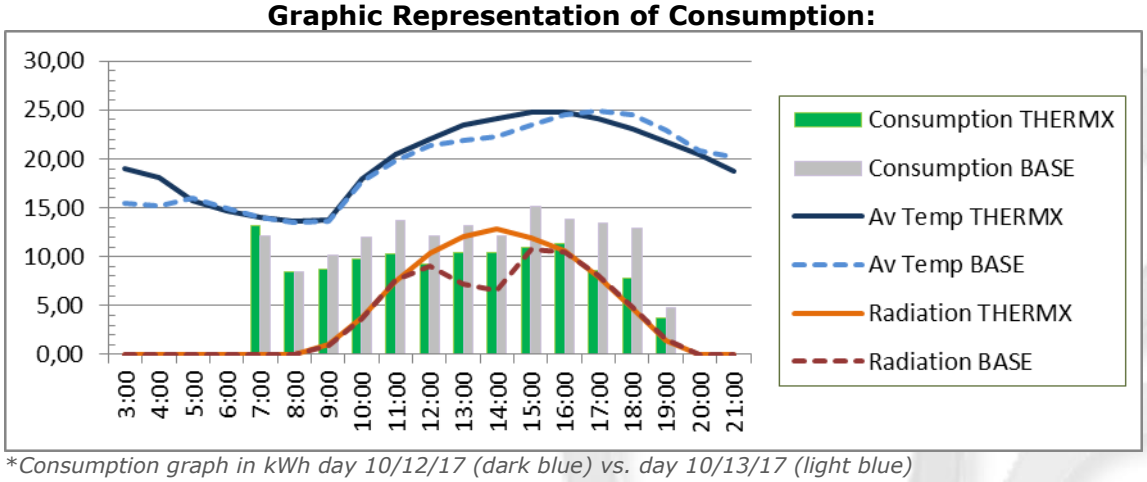
Fulfilling the conditions of the study, an initial series of days comparable to each other is established, precisely because it fulfills the condition of being holidays, without personnel present in the building, and therefore keeps the interior temperature set point stable.



| | THERMX® | WITHOUT THERMX® |
|---|---|---|
| **Time** | **10/13/2017** Fall – (kWh) | **10/12/2017** Fall – (kWh) |
| 9:00 | - | - |
| 10:00 | 9,24 | 12,17 |
| 11:00 | 10,41 | 13,20 |
| 12:00 | 10,48 | 12,19 |
| 13:00 | 10,95 | 15,08 |
| 14:00 | 11,30 | 13,86 |
| 15:00 | 8,61 | 13,43 |
| 16:00 | 7,79 | 12,96 |
| 17:00 | 3,70 | 4,79 |
| 18:00 | 0,00 | 0,00 |
| 19:00 | 0,00 | 0,00 |
| 20:00 | - | - |
| 21:00 | - | - |
| | **Friday – Holiday** | Holiday |
| Total kWh | 72,48 | 97,67 |
| Median Temp.: | 19,1 | 19,1 |
| Max Temp.: | 25,3 | 25,5 |
| Humidity %: | 81,0% | 80,0% |
| Radiation (Mj): | 15.1 | 12.7 |
| **Average Savings:** | | **- 25.84%** |
| Observations: | Stable Internal Demand | Stable Internal Demand |

*Data collected by PICKDATA

**Graphic Representation of Consumption:**




*Consumption graph in kWh day 10/12/17 (dark blue) vs. day 10/13/17 (light blue)*

II) **October 12 vs. November 01, both Holidays.**

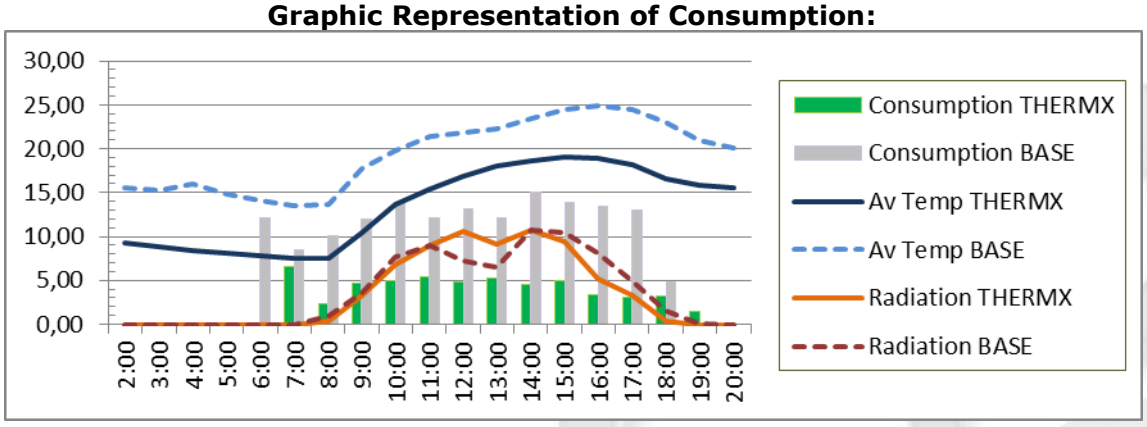
This data table are holidays, with no staff present in the building, and therefore interior temperatures remain relatively stable. In this case it does not comply with the temperature conditions, but it is included for comparison purposes of the previous case.



| | ThermX® | WITHOUT ThermX® |
|---|---|---|
| **Time** | **11/01/2017 Fall – (kWh)** | **10/12/2017** Fall – (kWh) |
| 6:00 | **6,60** | 0 |
| 7:00 | **2,39** | 12,07 |
| 8:00 | **4,71** | 8,50 |
| 9:00 | **5,02** | 10,10 |
| 10:00 | **5,37** | 12,04 |
| 11:00 | **4,79** | 13,69 |
| 12:00 | **5,20** | 12,17 |
| 13:00 | **4,60** | 13,19 |
| 14:00 | **4,91** | 12,18 |
| 15:00 | **3,43** | 15,08 |
| 16:00 | **3,08** | 13,85 |
| 17:00 | **3,28** | 13,43 |
| 18:00 | **1,43** | 12,96 |
| 19:00 | **0** | 4,79 |
| 20:00 | **0** | 0 |
| 21:00 | **0** | 0 |
| | **Friday – Holiday** | Holiday |
| Total kWh | **72,48** | 134,21 |
| Average Temp: | **13,6** | 19,1 |
| Max Temp.: | **19,5** | 25,5 |
| Humidity %: | **82,4%** | 80,0% |
| Radiation (Mj): | **6.8** | 12.,7 |
| **Average Savings:** | | **- 35.60%** |
| Observations: | Stable Internal Demand | Stable Internal Demand |

*Data collected by PICKDATA

**Graphic Representation of Consumption:**




*Consumption graph in kWh day 11/01/17 (green bars) vs. day 10/12/17 (gray bars)

**E) Comparisons of days with unstable internal demand:**

III) **October 09 VS. October 23, 2017 - workday.**

Compared two working days with variable internal demand, fulfilling the requirements of the study. **Improve the COP by 39%.**

| Time | ThermX® 10-23-17 SUMMER | WITHOUT ThermX® 10-09-17 SUMMER |
|---|---|---|
| 9:00 | **5,604** | 12,034 |
| 10:00 | **7,301** | 14,982 |
| 11:00 | **8,039** | 18,003 |
| 12:00 | **7,99** | 17,108 |
| 13:00 | **8,678** | 18,258 |
| 14:00 | **8,764** | 17,013 |
| 15:00 | **9,218** | 19,61 |
| 16:00 | **9,392** | 18,416 |
| 17:00 | **10,366** | 16,804 |
| 18:00 | **10,108** | 14,228 |
| 19:00 | **3,441** | 4,765 |
| 20:00 | **0** | 0 |
| 21:00 | **0** | 0 |
| | **kWh** | kWh |
| Total kWh | **88,901** | 171,221 |
| Average Temp.: | **14,70** | 17,15 |
| Max Temp.: | **21,25** | 22,75 |
| Humidity %: | **68,66** | 75,39 |
| Radiation (Mj): | **14,28** | 13,13 |

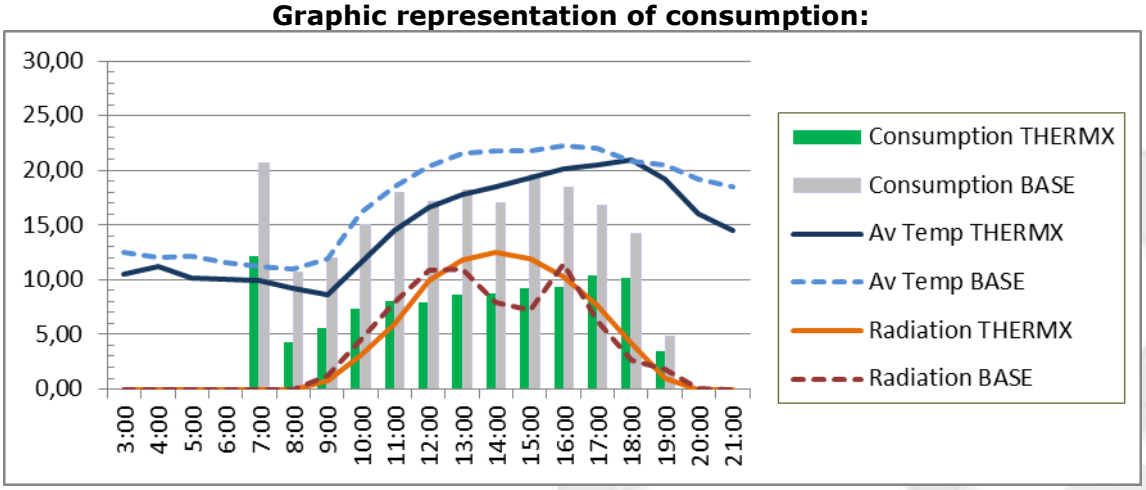


**Average Savings:** **- 48.08%**

Observations: Internal Unstable Demand — Internal Unstable Demand

*Data collected by PICKDATA

**Graphic representation of consumption:**




*Consumption graph in kWh day 10/23/17 (green bars) vs. day 10/09/17 (gray bars)*

IV) **October 25 VS. October 23, 2017- workday.**

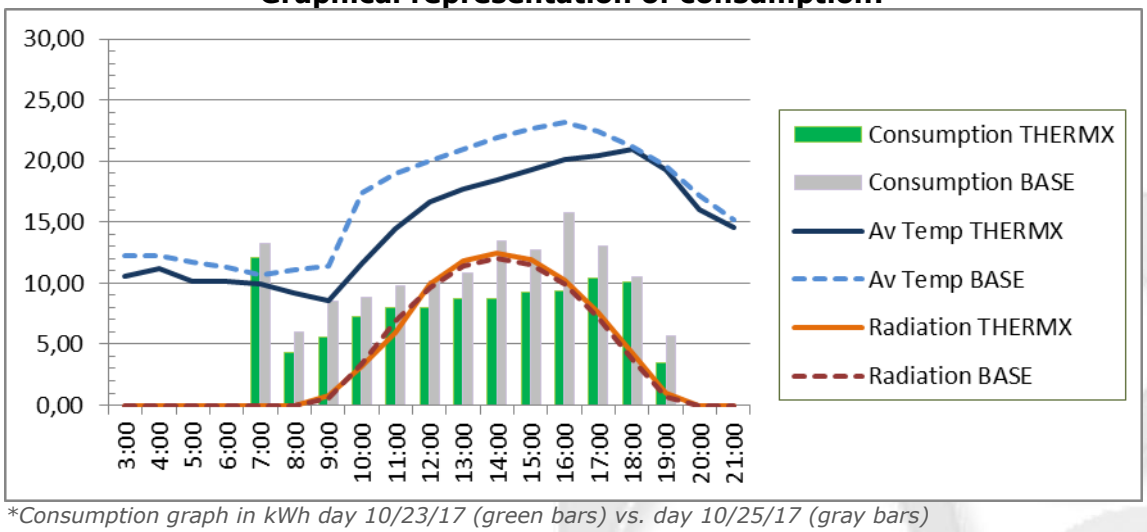
Compared two working days with variable internal demand, fulfilling the requirements of the study. **Improve the COP by 10%.**

| | ThermX® | WITHOUT ThermX® |
|---|---|---|
| **Time** | **10-23-17 SUMMER** | **10-25-17** SUMMER |
| 9:00 | **5,604** | 8,494 |
| 10:00 | **7,301** | 8,846 |
| 11:00 | **8,039** | 9,738 |
| 12:00 | **7,99** | 10,197 |
| 13:00 | **8,678** | 10,839 |
| 14:00 | **8,764** | 13,425 |
| 15:00 | **9,218** | 12,691 |
| 16:00 | **9,392** | 15,772 |
| 17:00 | **10,366** | 13,011 |
| 18:00 | **10,108** | 10,464 |
| 19:00 | **3,441** | 5,706 |
| 20:00 | **0** | 0 |
| 21:00 | **0** | 0 |
| | **kWh** | kWh |
| Total kWh | **88,901** | 119,183 |
| Average Temp.: | **14,70** | 16,92 |
| Max Temp.: | **21,25** | 23,60 |
| Humidity %: | **68,66** | 71,89 |
| Radiation (Mj): | **14,28** | 13,91 |
| **Average Savings:** | | **-25.41%** |
| Observations: | Unstable Internal Demand | Unstable Internal Demand |



*Data collected by PICKDATA

**Graphical representation of consumption:**




*Consumption graph in kWh day 10/23/17 (green bars) vs. day 10/25/17 (gray bars)*

### E) E) Common exceptions to the operation of ThermX®:

V) **October 23 VS. October 30, 2017, Low demand and performance.**

In should be noted a **low average outdoor ambient temperature leads to a very low demand**. Compared to the working days with variable internal demand, fulfilling the requirements of the study, the demand is so low that both days **work with one stage and there is hardly any improvement except for an improvement in the COP of +26%.**

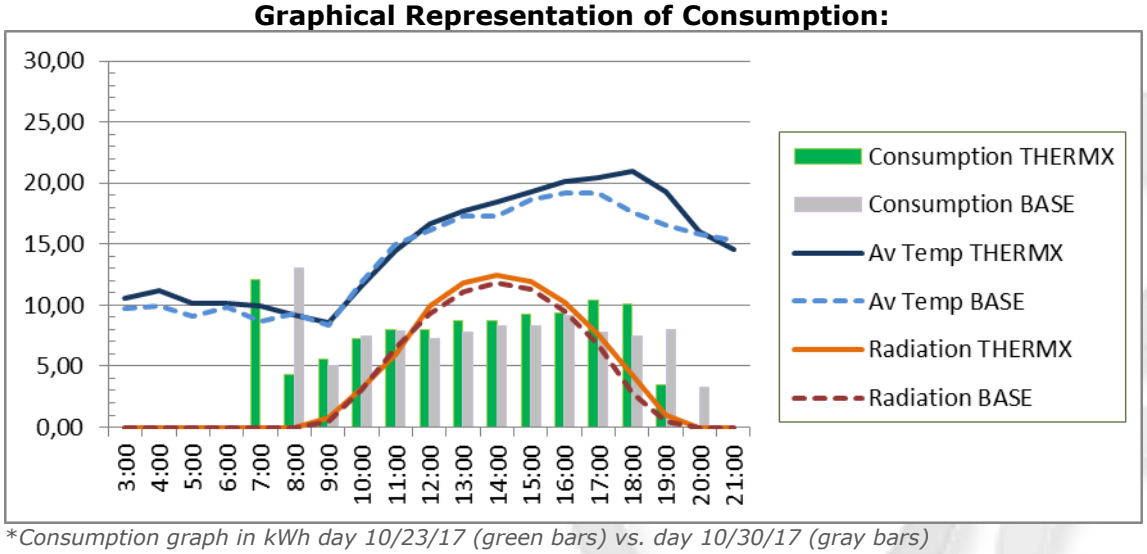
| Time | THERMX® 10-23-17 SUMMER | WITHOUT THERMX® 10-30-17 WINTER |
|---|---|---|
| 9:00 | **5,604** | 7,421 |
| 10:00 | **7,301** | 7,868 |
| 11:00 | **8,039** | 7,295 |
| 12:00 | **7,99** | 7,75 |
| 13:00 | **8,678** | 8,28 |
| 14:00 | **8,764** | 8,336 |
| 15:00 | **9,218** | 9,175 |
| 16:00 | **9,392** | 7,804 |
| 17:00 | **10,366** | 7,513 |
| 18:00 | **10,108** | 7,996 |
| 19:00 | **3,441** | 3,244 |
| 20:00 | **0** | 0 |
| 21:00 | **0** | 0 |
| | **kWh** | kWh |
| Total kWh | **88,901** | 82,682 |
| Average Temp: | **14,70** | 13,94 |
| Max Temp.: | **21,25** | 19,60 |
| Humidity %: | **68,66** | 70,29 |
| Radiation (Mj): | **14,28** | 13,19 |
| **Average Savings:** | | **+7.52%** Unstable Internal Demand |
| Observations: | **Unstable Internal Demand** | |



Chiller Performance:
**24%**

*Data collected by PICKDATA

**Graphical Representation of Consumption:**




*Consumption graph in kWh day 10/23/17 (green bars) vs. day 10/30/17 (gray bars)*

## VI) **October 10 VS. October 17, 2017, Low solar radiation**

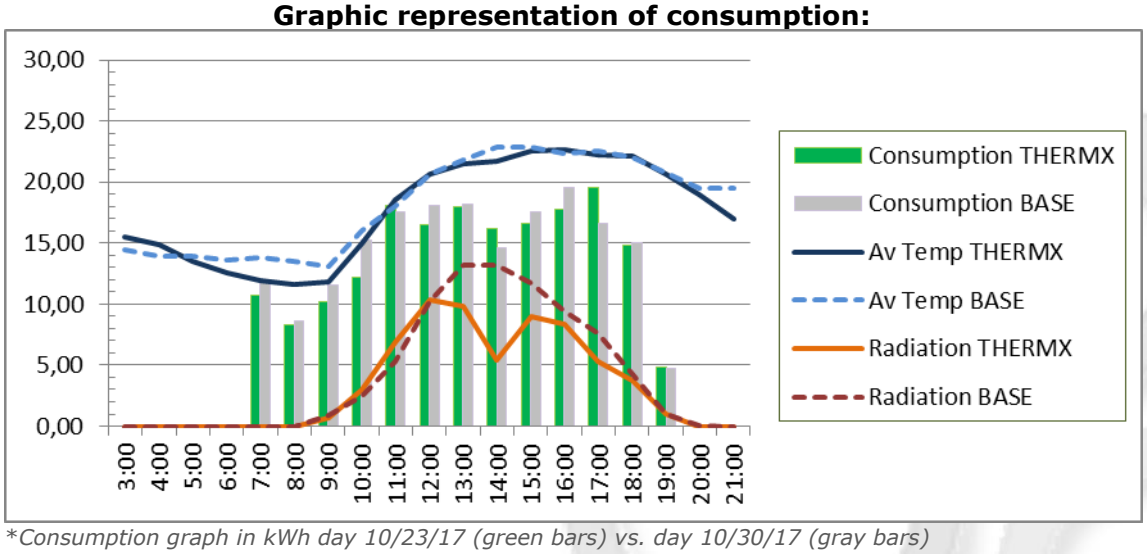
The more solar radiation, the more savings. Compared two work days with variable internal demand, fulfilling the requirements of the study. **Radiation is particularly low in the central hours due to the presence of cloudiness**, negatively affecting the functioning of ThermX®. There is no improvement of the COP.

| Time | ThermX® **10-17-17 SUMMER** | WITHOUT ThermX® **10-10-17** SUMMER |
|---|---|---|
| 9:00 | **10,223** | 11,613 |
| 10:00 | **12,151** | 15,285 |
| 11:00 | **18,104** | 17,556 |
| 12:00 | **16,51** | 18,038 |
| 13:00 | **18,004** | 18,211 |
| 14:00 | **16,143** | 14,619 |
| 15:00 | **16,593** | 17,541 |
| 16:00 | **17,759** | 19,573 |
| 17:00 | **19,572** | 16,6 |
| 18:00 | **14,851** | 15,017 |
| 19:00 | **4,833** | 4,783 |
| 20:00 | **0** | 0 |
| 21:00 | **0** | 0 |
| | **kWh** | kWh |
| Total kWh | **164,743** | 168,836 |
| Average Temp.: | **17,66** | 18,17 |
| Max Temp.: | **23,30** | 23,60 |
| Humidity %: | **74,45** | 78,45 |
| | | 14,31 |
| Radiation (Mj): | **11,47** | |
| **Average Savings:** | | **-2.42%** |
| Observations: | Unstable Internal Demand | Unstable Internal Demand |



*Data collected by PICKDATA

**Graphic representation of consumption:**




*Consumption graph in kWh day 10/23/17 (green bars) vs. day 10/30/17 (gray bars)*

## VII) **October 13 VS. September 11, 2017, Summer/Winter Holidays**

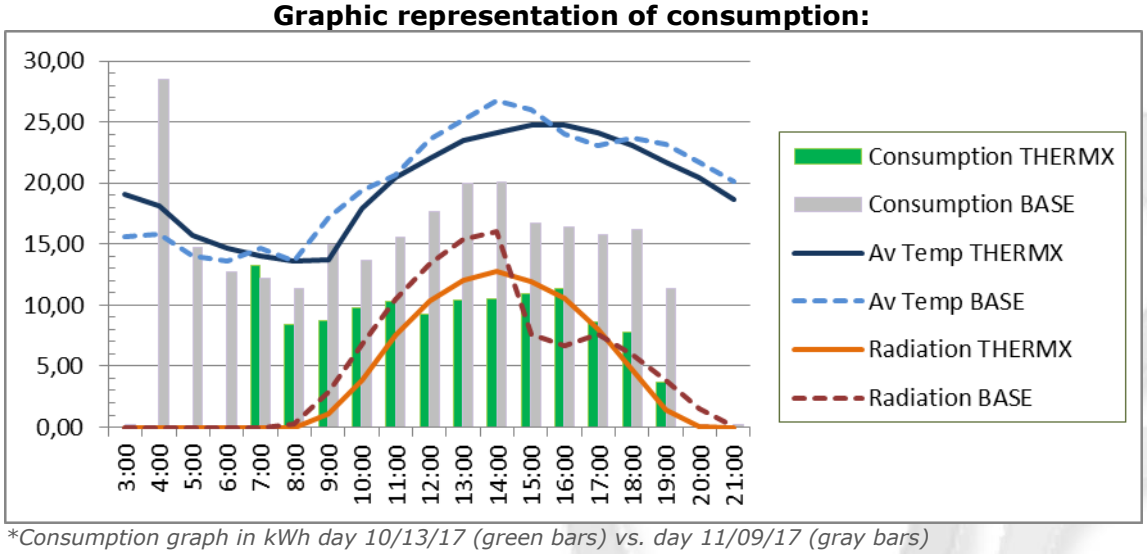
For comparative purposes, the ThermX® savings potential is shown during the summer months between two holidays with stable internal demand, despite the different humidity conditions. **By equalizing humidity, savings would skyrocket for equal average and maximum temperature conditions, easily reaching 60%. Improve the COP by 11%.**



| | ThermX® | WITHOUT ThermX® |
|---|---|---|
| **Time** | **13/10/2017 Fall – (kWh)** | **11/09/2017** Summer – (kWh) |
| 9:00 | - | - |
| 10:00 | **9,24** | 17,70 |
| 11:00 | **10,41** | 19,95 |
| 12:00 | **10,48** | 20,13 |
| 13:00 | **10,95** | 16,69 |
| 14:00 | **11,30** | 16,37 |
| 15:00 | **8,61** | 15,81 |
| 16:00 | **7,79** | 16,15 |
| 17:00 | **3,70** | 11,40 |
| 18:00 | **0,00** | 0,00 |
| 19:00 | **0,00** | 0,00 |
| 20:00 | - | - |
| 21:00 | - | - |
| | **Friday - Holiday** | **WITHOUT ThermX®** (Holiday) |
| Total kWh | **72,48** | 134,21 |
| Average Temp: | **19,1** | 19,9 |
| Max Temp: | **25.3** | 28.3 |
| Humidity %: | **81,0%** | 64,0% |
| Radiation (Mj): | **15.1** | 17,7 |
| **Average Savings:** | | **- 48.78%** |
| Observations: | Internal Stable Demand | Internal Stable Demand |

*Data collected by PICKDATA

**Graphic representation of consumption:**




*Consumption graph in kWh day 10/13/17 (green bars) vs. day 11/09/17 (gray bars)*

## COMPARATIVE DATA ACCORDING TO INDOORCLIMA:

The following data has been taken, treated and interpreted directly by CIRSA through its own monitoring system, independent and external to CRE SERVICES. Although the readings are very similar between the measuring equipment, they are not exact due to their tolerances. In addition, this includes the measures collected between 10am and 4pm, not like CRE SERVICES, which covers full days.

| | Averages | |
|---|---|---|
| | **BASE** | **ThermX®** |
| Electrical kwh | 81,6 | 62,2 |
| Thermal kwh | 368,8 | 315,3 |
| Calculated COP | 4,5 | 5,1 |
| **COP Improvement** | | **12%** |
| Avg. Temp. | 21,4 | 20,2 |
| | | -5% |
| Day Degrees | 2,3 | 0,8 |

| | Averages | |
|---|---|---|
| | **BASE** | **ThermX®** |
| Electrical kwh | 86,7 | 62,1 |
| **Savings kWh** | | **-28%** |
| Avg. Web Temp. | 17,0 | 16,3 |
| | | -5% |
| Radiation | 13,9 | 14,1 |
| | | 1% |

*Data collected by INDOORCLIMA

### A) Building with activity (unstable demand)

| | Monday BASE | Monday ThermX® | Wednesday BASE | Monday ThermX® | Monday BASE | Monday ThermX® | Tuesday BASE | Tuesday ThermX® |
|---|---|---|---|---|---|---|---|---|
| | 09-oct | 23-oct | 25-oct | 23-oct | 30-oct | 23-oct | 10-oct | 17-oct |
| Electrical kWh | 104,5 | 50 | 67 | 50 | 47 | 50 | 91,4 | 98 |
| Thermal kWh | 505 | 337 | 321 | 266 | 251 | 337 | 395 | 411 |
| Calculated COP | 4,8 | 6,7 | 4,8 | 5,3 | 5,3 | 6,7 | 4,3 | 4,2 |
| COP Improvement | | **39%** | | **10%** | | **26%** | | **-3%** |
| Avg. Temp. | 21,8 | 17,5 | 21,3 | 17,5 | 17 | 17,5 | 21,5 | 22,4 |
| | | -20% | | -18% | | 3% | | 4% |
| Degrees per day / base 19 | 2,8 | -1,5 | 2,3 | -1,5 | -2 | -1,5 | 2,5 | 3,4 |

*Data collected by INDOORCLIMA

### B) Building without activity (stable demand)

| | L. Festivo BASE | V. Puente ThermX® | J. Festivo BASE | V. Puente ThermX® |
|---|---|---|---|---|
| | 11-sep | 13-oct | 12-oct | 13-oct |
| Electrical kWh | 101 | 62 | 79 | 62 |
| Thermal kWh | 396 | 271 | 345 | 271 |
| Calculated COP | 3,9 | 4,3 | 4,4 | 4,3 |
| COP Improvement | | **11%** | | **0%** |
| Avg. Temp. | 24,6 | 23,2 | 22,2 | 23,2 |
| | | -6% | | 5% |
| Degrees per day / base 19 | 5,6 | 4,2 | 3,2 | 4,2 |

*Data collected by INDOORCLIMA

**STUDY CONCLUSIONS:**

After the study about the functioning of ThermX®, the savings for a specific time period (month of October), an approximate to the potential savings in a summer scenario (September 2017, under the influence of the anticyclonic conditions more typical of the month of August) and the potential problems that may affect the correct functioning of the system.

The results, taking into account both measurement systems are:

| | INDOORCLIMA (CIRSA) | | | PICKDATA (CRE SERVICES) | | | |
|---|---|---|---|---|---|---|---|
| COP | With ThermX® | Data Sheet | Without ThermX® | Stable Demand | | Unstable Demand | |
| Calculated | 5,1 | 3,09 | 4,5 | 12oct VS. 13oct | 12oct VS. 1nov | 9oct VS. 23oct | 25oct VS. 23oct |
| ThermX® COP | **13%** | **64%** | | 25,84% | 35,60% | 48,08% | 25,41% |
| Avg. Savings kWh | **28%** | | | **33.73%** | | | |

We can conclude that, during the period included in the study:

**The savings obtained with ThermX® is between 28% and 31% in October, complying with the owners original projection of 20% to 30% year-to-year.**

In Barcelona, November 6, 2017

| | |
|---|---|
| NORTIA CORPORATION (CIRSA) | CRE SERVICES VALLES, SL |
| D. Enrique Perez Abad.<br>Efficiency Energy Manager | D. Sebastia Serra García<br>Technical Manager |
| Independent Controller | PICKDATA, SL (Grupo CIRCONTROL) |
| D. Juan Jose Priego García<br>AENOR Certified Energy Manager | D. Joan Comellas<br>Technical Manager |