SolX Energy Report

ThermX Technology

KLIMOR Gdynia Test Installation

Summary of the test results of SPLIT type air-conditioner and ThermX thermal collector installation in KLIMOR SERVICE building

Drafted by Eng. Robert Obrębski

Contents

SolX Energy report

KLIMOR Gdynia Test Installation

Test

The purpose of the test is to compare the air-conditioning unit performance in standard mode vs. with the addition of SolX Energy.

The SolX Energy panel is intended to significantly reduce consumption of the electricity used by the compressor (up to 70% on sun available days) by charging the cooling system with free energy generated via solar radiation.

It is assumed that through the period of maximum cooling load (hot sunny day) we get the highest level of recharged energy. Owing to this, the compressor can reduce its performance, and thus provide a reduction energy demand.

The SolX Energy test is continually in progress and optimizations concerning refrigerant charging are implemented on an ongoing basis.

Compared parameters:

- Electric energy consumption
- Execution of air-conditioner tasks (maintaining the required climate conditions in served rooms)
- Compressor operation time required to achieve the set parameters

Location

Thermal comfort air-conditioning system is installed in the KLIMOR SERVICE building in Gdynia.

Address:

Ul. Bolesława Krzywoustego 5
81-035 Gdynia
Pomeranian Voivodeship
POLAND

SolX Energy

KLIMOR SERVICE BUILDING

GDYNIA,
UL.BOLESŁAWA KRZYWOUSTEGO 5

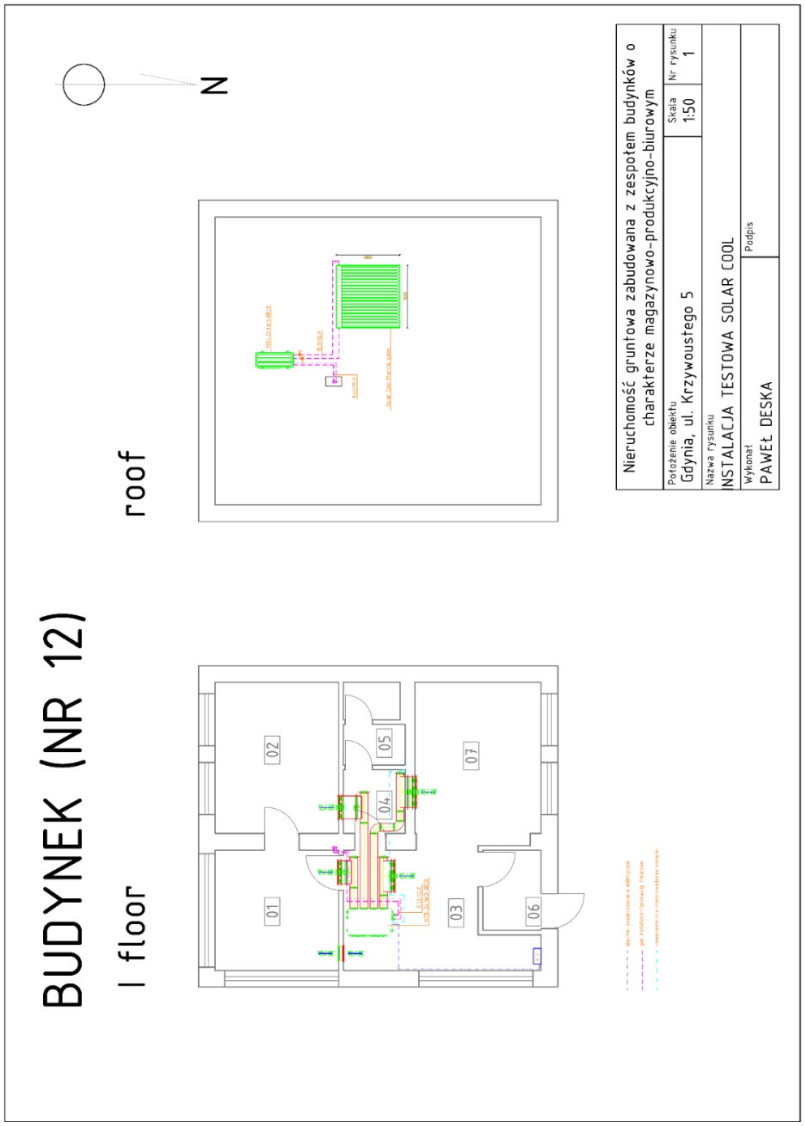
AIR-CONDITIONER
Inverter SPLIT duct type
Year of manufacture
2015

ThermX PANEL
SCL-SRP 20-pipe
Directional valve assembly

A built-up land property with a complex of warehousing, manufacturing and office type buildings. The area of test is a single-storey building with a flat roof with four live office's supported by the air-conditioner.

Test installation

There are in total seven people working in the building with seven work stations and standard office equipment.



Air-conditioner

The system used for test purposes - an inverter SPLIT type air-conditioner was installed, providing a capacity of: Q_{ch}= 8,5 kW
Q_g= 9,7 kW.

Description	Power supply	Capacity (min-med-max)	Energy coefficient	SEER (average)	SCOP (average)	Airflow	Operating temperature	Sound pressure level	Dimensions H/W/D		Weight	
	V~, Hz, Ph	cool/heat	cool/heat				cool/heat		net	gross	net	gross
		kW	kW	W/W	W/W	m³/h	°C	db(A)	mm	mm	kg	kg
Indoor unit	220-240, 50, 1	2,8-7,0-8,5/ 3,2-7,6-9,7	A++/A	6,7	3,8	1700/1400/1250	-15~50 -15~24	46/43/40	920/635/270	1135/655/350	28	31,5
Outdoor unit												

ThermX panel

Solar panel gathering energy gain from solar radiation. 1 piece of SolX Energy SCL-SRP 20-pipe type solar panel, installed on the compressor discharge line.

Panel specifications:

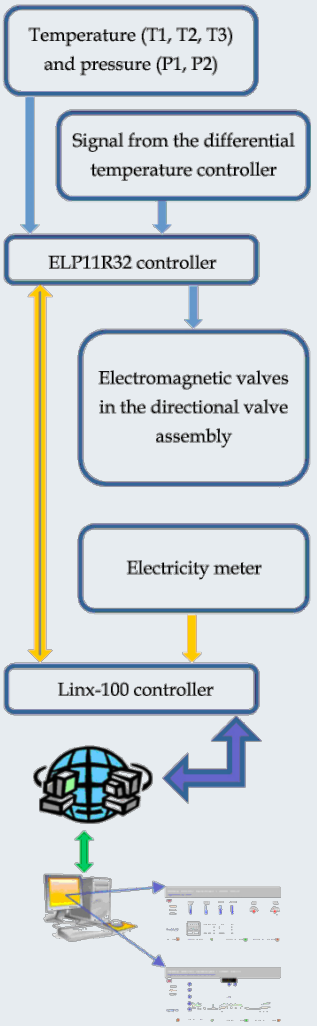
SCL-SRP 20 panel dimensions			Exchanger pipes dimension		Weight
Height H [mm]	Width W [mm]	Length L [mm]	Length L [mm]	Diameter [mm]	[kg]
120	1620	1640	1500	47	61

The Solar collector is installed on the system frame, type: SCL-RM 20.

As the installation is used for both heating and cooling the building and the design includes an application of directional valve assembly, equivalent to SCL-SDV 1. Installation of the directional valve assembly was made on the fitting connecting the outdoor unit with the ThermX panel.

Control and monitoring

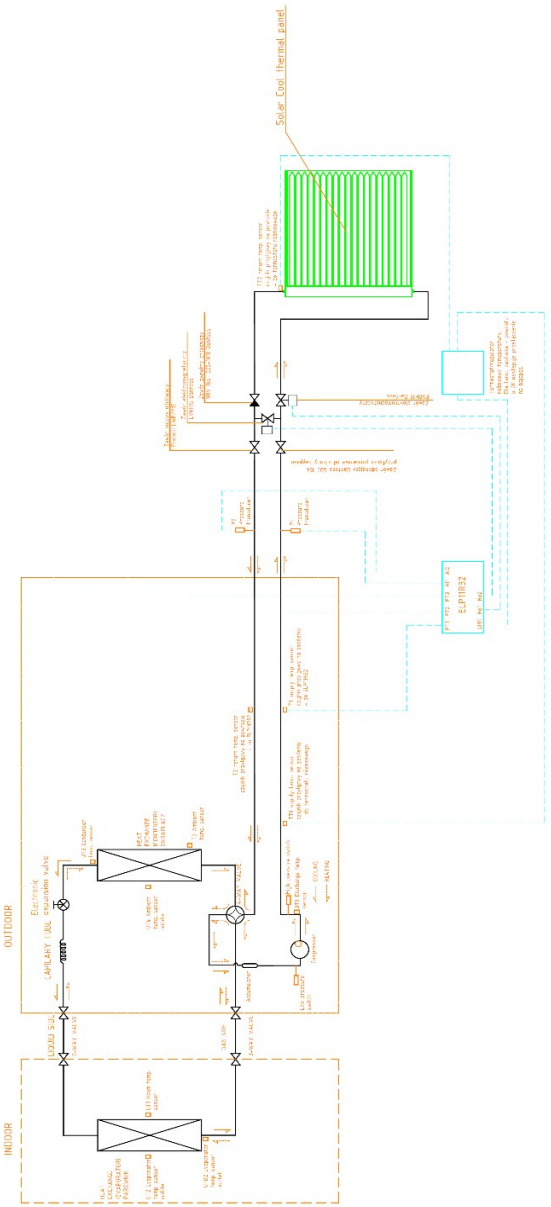
• • •



Control and monitoring system

The installation was fitted with a control and monitoring system. The system consists of:

- Freely programmable controller ELP11R32
- 3 temperature sensors PT1000
- 2 pressure transducers CAREL SPKT*R0
- Electricity meter
- Thermostat/differential temperature controller
- Control module / WEB server Loytec Linx-100



Readings from the temperature and pressure sensors are sent to the ELP11R32 controller. The built in application transmits values from the sensors to Linx-100 controller via MODBUS RTU (RS485) communication protocol.

Signal from the differential temperature controller is send to the ELP11R32 controller. The built in application transmits value to Linx-100 controller via MODBUS RTU (RS485) communication protocol.

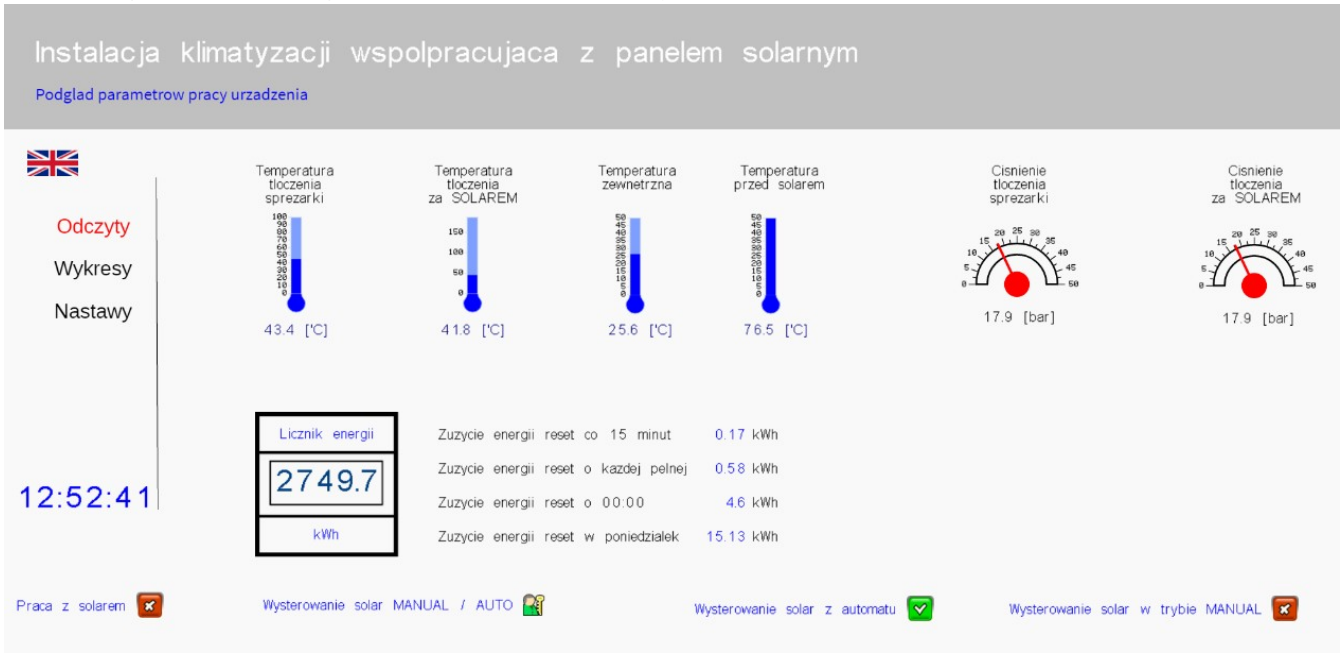
ELP11R32 controller controls operation of the electromagnetic valves in the directional valve assembly, dependent upon the values set by the operator:

- MANUAL control – operator turns on or off the ThermX panel operation
- AUTO control – in heating mode electromagnetic valves turn on or off the Solar Cool panel operation, depending on the signal from the differential temperature controller. If the refrigerant temperature after ThermX is higher than the refrigerant temperature before ThermX for $\Delta T \geq 5°C$ → operation of the ThermX panel is enabled (energy output from the ThermX panel). If the refrigerant temperature after ThermX panel is not higher than the refrigerant temperature before ThermX panel for $\Delta T \geq 5°C$ → ThermX panel disconnection (no energy output from the ThermX panel).

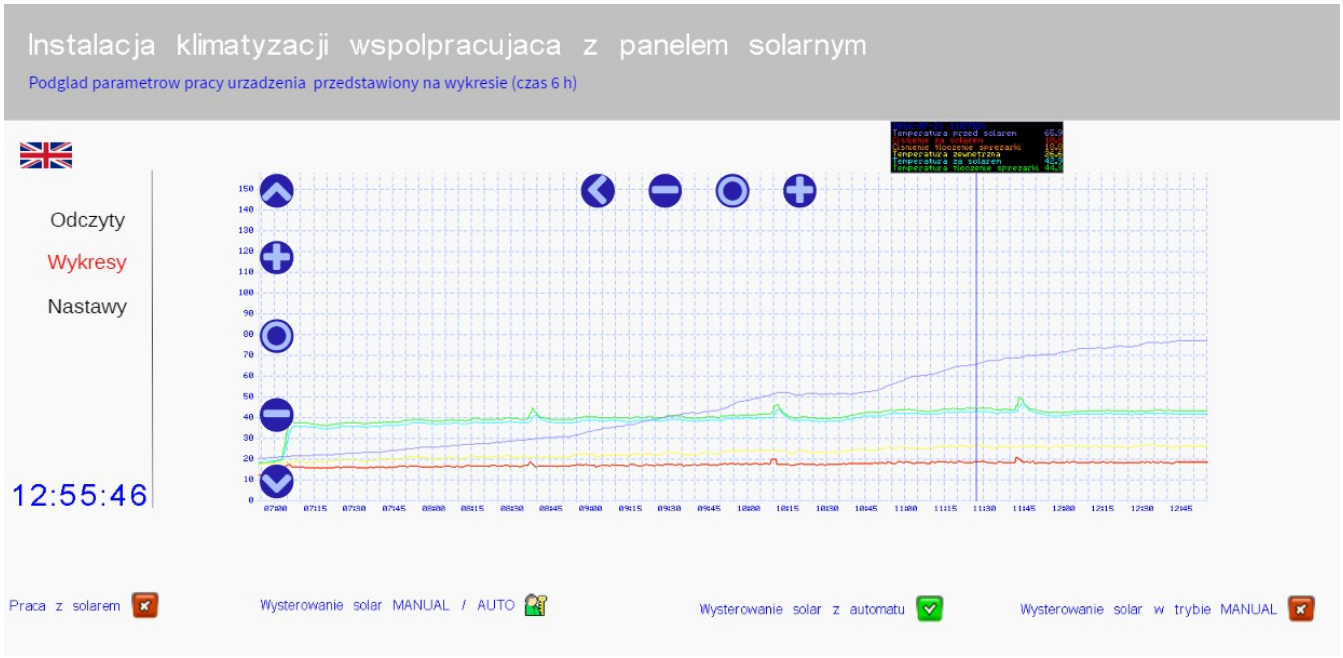
Value from the electricity meter is transmitted to the Linx-100 controller via MODBUS RTU (RS485) communication protocol.

The Linx-100 controller has implemented application together with visualization. It is connected to the internet network what enables remote monitoring and control of the system.

Monitoring view – readings from the sensors and system operational status



Monitoring view – readings from the sensors plotted on the graph (time trend) and system operational status



Parameters indicated on the graph:

- Date / time
- Compressor discharge temperature [°C]
- Temperature sensor before ThermX [°C]
- Temperature sensor after ThermX [°C]
- Outdoor air temperature [°C]
- Refrigerant pressure before ThermX [bar]
- Refrigerant pressure after ThermX [bar]

Access to the visualization:

- From the computer connected to internet (no connection with internal KLIMA-THERM network) after typing in the browser address tab: http://www.loytec.com/lweb802/?project=klimor%20solar%20grafika.lweb2&address=78.133.140.28&port=80#lvisPage

Test results

The system operates in normal mode for the office rooms operated from Monday through to

Friday. Throughout a number of weeks, the ThermX system is enabled and disabled.

The comparison includes system operational parameters in equal time periods.

Cooling operation tested from 2016-03-28 to 2016-07-20.

At the time:

- Operation with running ThermX system: 2016-06-21 ÷ 2016-07-11 (21 days)
- Operation with turned off ThermX system: 2016-03-28 ÷ 2016-06-20 (85 days) and 2016-07-12 ÷ 2016-07-20 (9 days)

Electricity consumption

Reading of meter at the beginning of test: **1943.53 [kWh]**

Reading of meter at the end of test: **2743.99 [kWh]**

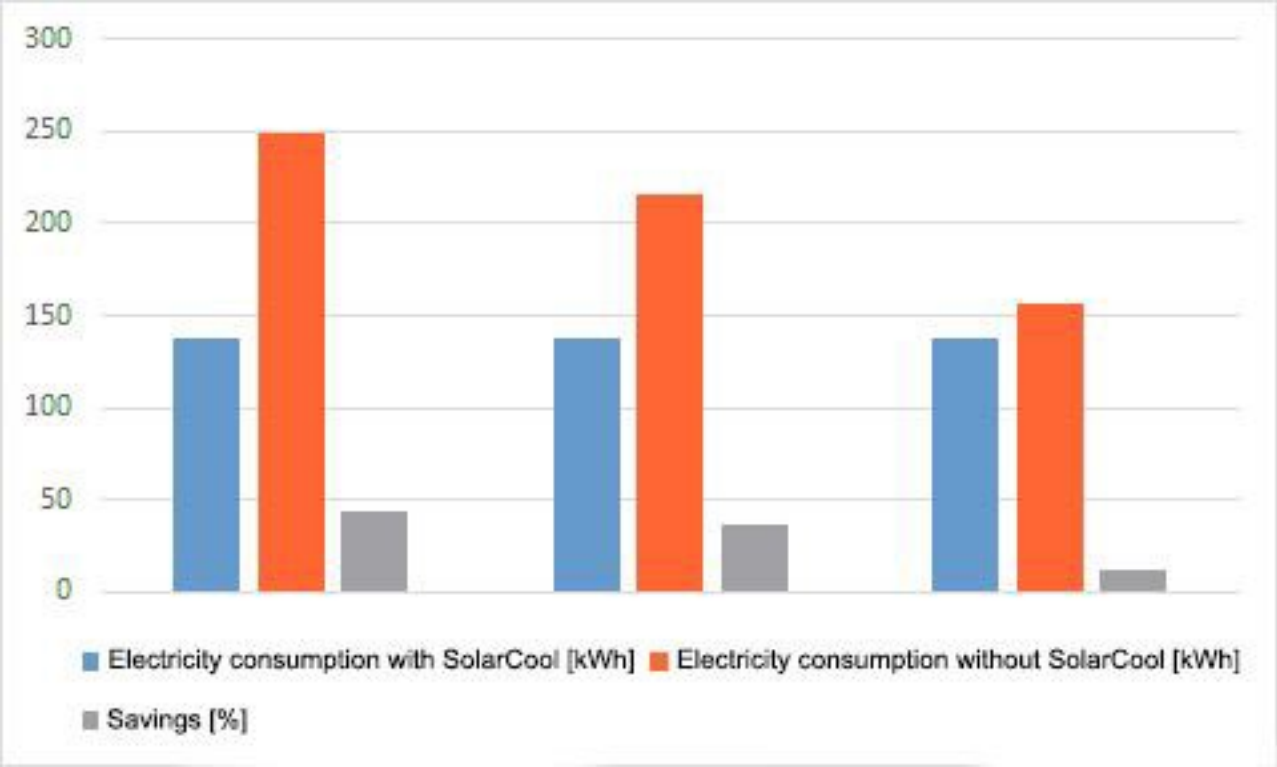
Depending on the weather conditions as well as the heat load of the rooms, daily electricity consumption varies from 1 [kWh] to 25.5 [kWh].

The below table shows detailed comparison in three-week periods:

Period of operation with ThermX			**Period of operation without ThermX**			**Number of test days**	**Savings [%]**
Start	**End**	**Consumption [kWh]**	**Start**	**End**	**Consumption [kWh]**		
2016-06-21	2016-07-11	138.02	2016-04-12	2016-05-02	248.68	21	**44.50**
			2016-04-05	2016-04-25	215.85	21	**36.05**
			2016-03-09	206-04-18	156.74	21	**11.95**

The system with the active ThermX panel indicates electricity consumption savings at the level 11 ÷ 44%. A very good result, having regard to the fact that system operation without ThermX was implemented in periods of lower heat loads in rooms (i.e. spring months).

The largest energy savings are indicated in consecutive periods = similar operation conditions.



Test installation 9

Tables with test results

Detailed data 21-06-2016 /01-08-2016

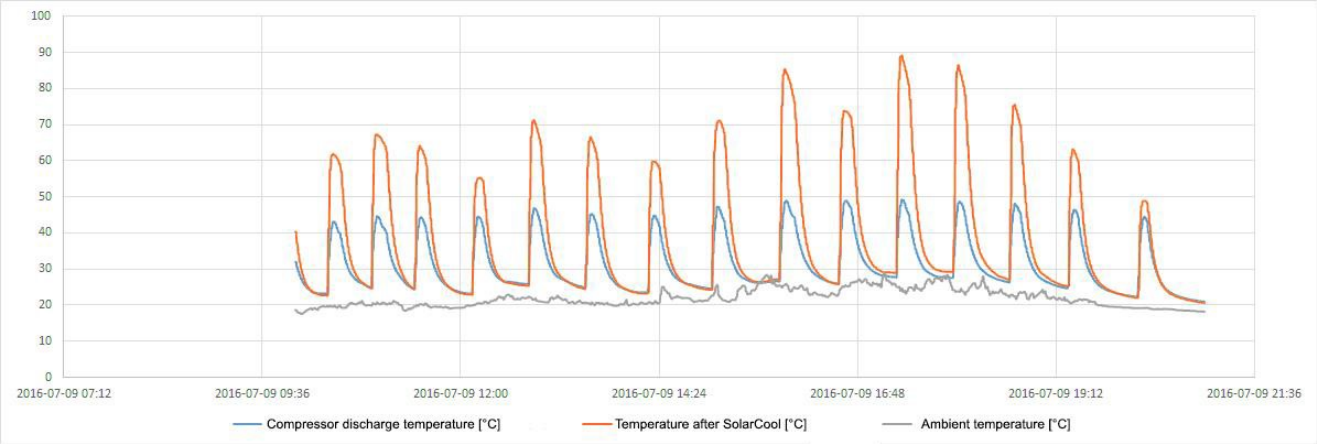
DAY OF THE WEEK	DATE	READING	DAILY CONSUMPTION
Monday	2016-08-01	2818,80005	4,58008
Sunday	2016-07-31	2814,21997	5,35986
Saturday	2016-07-30	2808,86011	7,19019
Friday	2016-07-29	2801,66992	9,15991
Thursday	2016-07-28	2792,51001	10,18994
Wednesday	2016-07-27	2782,32007	11,23999
Tuesday	2016-07-26	2771,08008	9,03003
Monday	2016-07-25	2762,05005	1,44995
Sunday	2016-07-24	2760,6001	1,57007
Saturday	2016-07-23	2759,03003	2,63013
Friday	2016-07-22	2756,3999	9,48999
Thursday	2016-07-21	2746,90991	2,91992
Wednesday	2016-07-20	2743,98999	5,41992
Tuesday	2016-07-19	2738,57007	3,04004
Monday	2016-07-18	2735,53003	2,33008
Sunday	2016-07-17	2733,19995	1,07983
Saturday	2016-07-16	2732,12012	2,42017
Friday	2016-07-15	2729,69995	1,34985
Thursday	2016-07-14	2728,3501	4,12012
Wednesday	2016-07-13	2724,22998	4,47998
Tuesday	2016-07-12	2719,75	3,83008
Monday	2016-07-11	2715,91992	3,57983
Sunday	2016-07-10	2712,34009	3,17017
Saturday	2016-07-09	2709,16992	5,52002
Friday	2016-07-08	2703,6499	4,44995
Thursday	2016-07-07	2699,19995	1
Wednesday	2016-07-06	2698,19995	2,84985
Tuesday	2016-07-05	2695,3501	4,29004
Monday	2016-07-04	2691,06006	4,93994
Sunday	2016-07-03	2686,12012	7,46021
Saturday	2016-07-02	2678,65991	12,09985
Friday	2016-07-01	2666,56006	5,59009
Thursday	2016-06-30	2660,96997	6,21997
Wednesday	2016-06-29	2654,75	7,33008
Tuesday	2016-06-28	2647,41992	8,35986
Monday	2016-06-27	2639,06006	7,75
Sunday	2016-06-26	2631,31006	10,88013
Saturday	2016-06-25	2620,42993	16,02002
Friday	2016-06-24	2604,40991	11,65991
Thursday	2016-06-23	2592,75	6,37012
Wednesday	2016-06-22	2586,37988	4,8999
Tuesday	2016-06-21	2581,47998	3,58008

Weekly data 29-03-2016 ÷ 20-06-2016

DAY OF THE WEEK	DATE	READING
Monday	2016-06-20	2577,8999
Tuesday	2016-06-14	2549,22998
Monday	2016-05-02	2324,29004
Tuesday	2016-04-26	2254,66992
Monday	2016-04-25	2235,22998
Tuesday	2016-04-19	2127,20996
Monday	2016-04-18	2126,97998
Tuesday	2016-04-12	2075,6001
Sunday	2016-04-10	2048,88989
Tuesday	2016-04-05	1995,82996
Monday	2016-04-04	1992,67004
Tuesday	2016-03-29	1943,53003

Gas temperature

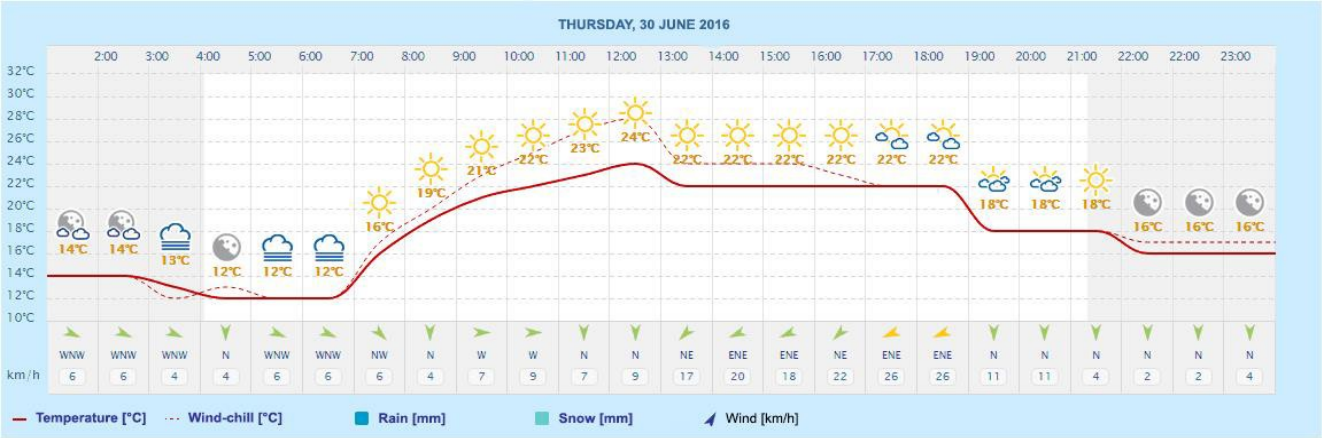
The ThermX panel successfully achieves the task of increasing the refrigerant temperature. In periods of intense sunlight, the refrigerant gas temperature difference before and after ThermX during compressor operation varies in range of $\Delta T = 6 \div 40$ °C.

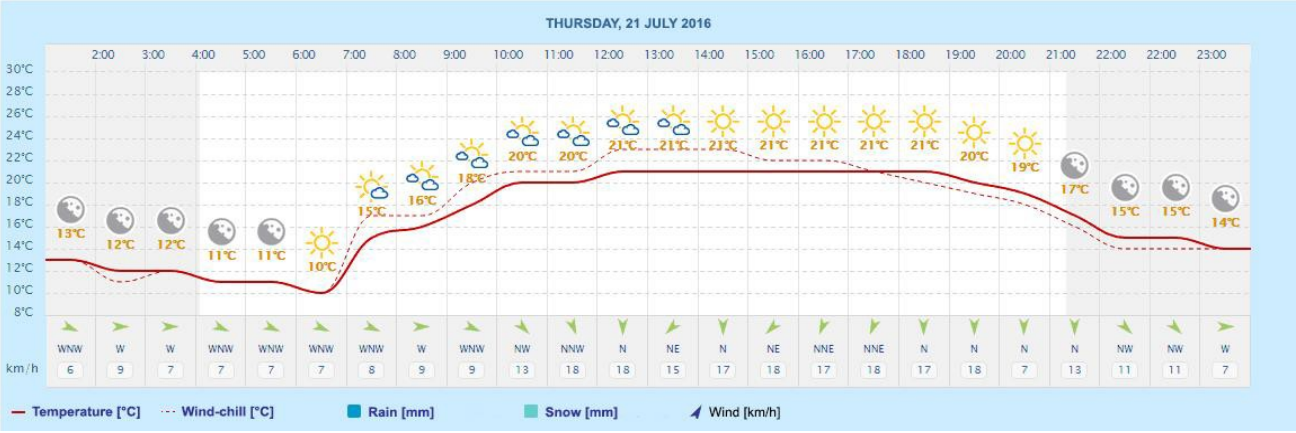


Systems comparison for representative days 30.06.2016 and 21.07.2016

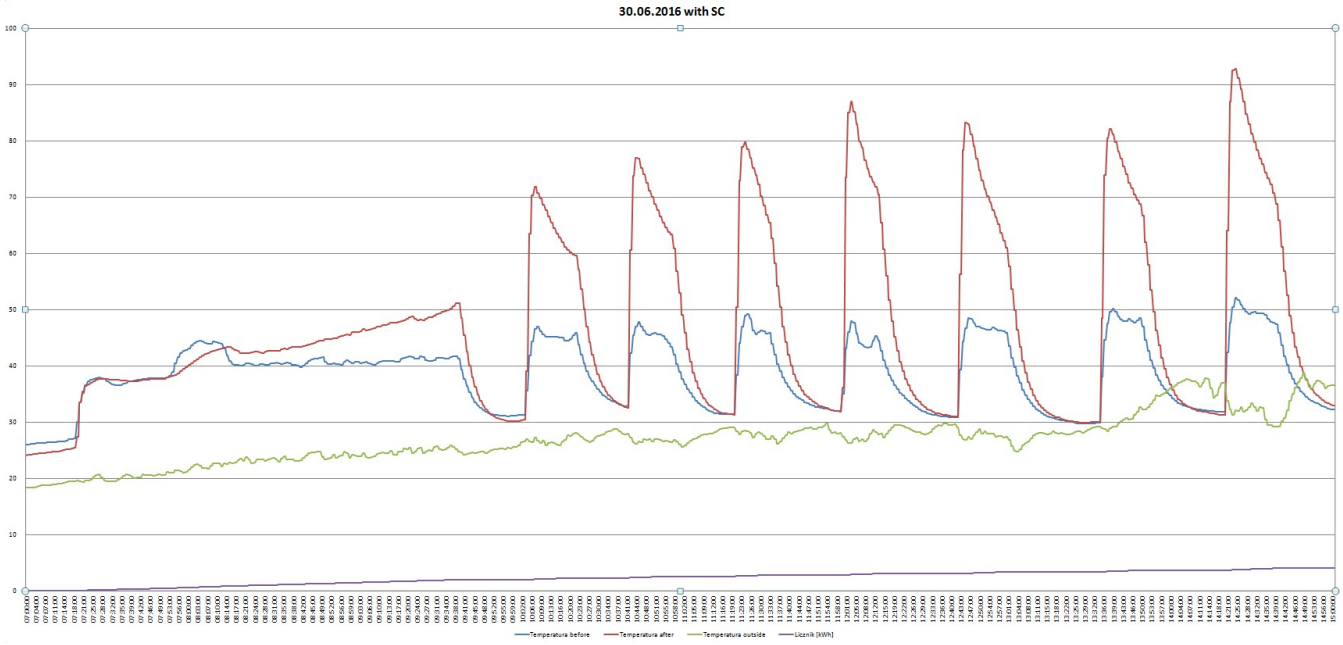
Characteristics of compared days

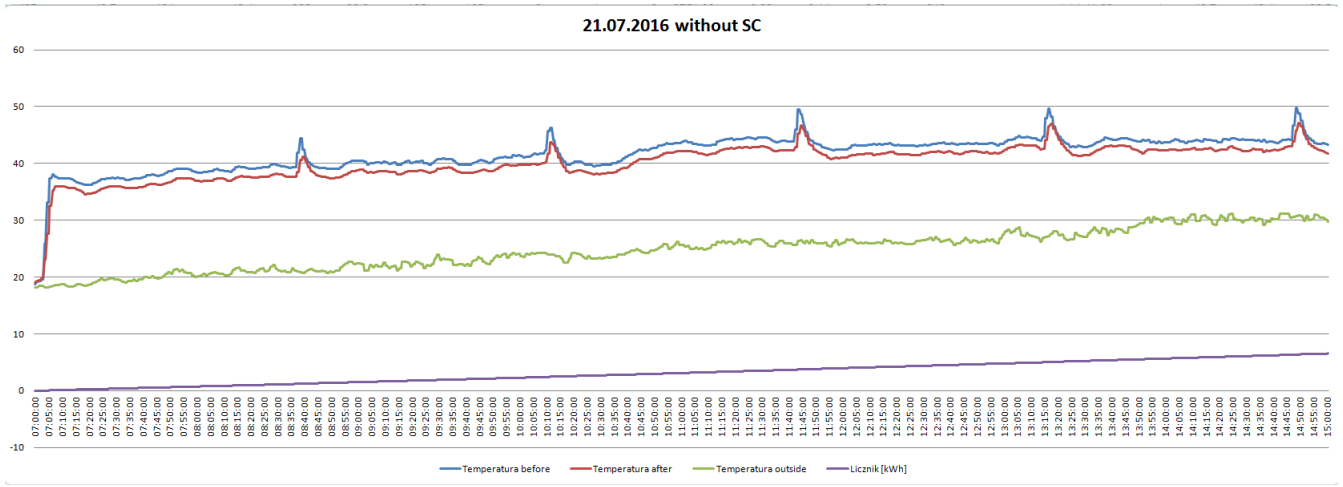
According to the archival weather data, two days with similar temperature and insolation parameters were selected. 30.06.2016 – operation with active ThermX panel; 21.07.2016 – with disabled ThermX installation. Both fall within the working day – Thursday. Only the rooms operating hours were selected for the comparison - 7÷15. The graphs below show strong sunlight (slightly stronger in case of 30.06, when the unit operated with ThermX).





Operation graph for 7:00-15:00





Electricity consumption for the compared days

Electricity consumption in the compared period:

For the installation operating with ThermX – 4.00 kWh For

the installation operating without ThermX – 6.53 kWh

Energy demand within the given period was reduced by 2.53kWh – or 39%.

Compressor operation time for the compared days

Compressor operation time in the given period:

For the installation operating with ThermX – 4 hours 18 minutes

For the installation operating without ThermX – 8 hours

Compressor operation demand within the given period was reduced by 3 hours and 42 minutes, that is – or 46.25%.

Summary

The tests clearly indicate savings achieved by the installation equipped with The ThermX panel. The basic benefit is the reduction of installation operating costs in the insolation period. The higher the value of insolation, the greater savings are achieved by the tested installation.

An additional asset of operation of the installation equipped with ThermX panel is the reduction of compressor operation time by over 45%. That significantly influences the life time of the machine. In this case also the following reliance can be observed: the higher the value of insolation, the shorter the compressor operation time.