PARK INNOWACJI I PRZEMYSŁU

# Research report

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| Customer | ALPHA Construction AG |
| Subject of the study | The impact of PSC Systems products on the thermal properties of the barrier |
| Test period | 15.05.2018 – 30.07.2018 |
| Order # | 01/05/2018 |

Michał Marciniak
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# 1. Description of the testing post

The test container consists of two measuring chambers (Fig.1). The chambers are separated from each other by a wall made of OSB boards, filled with mineral wool. OSB boards were screwed on both sides with drywall (fig. 4). In each chamber, 4 temperature sensors and cameras were installed: industrial and thermal imaging. It is possible to:

- temperature control in both chambers,
- registration of electricity consumption needed for the heating / cooling process,
- registration of the temperature prevailing in both chambers
- recording the image from both chambers.

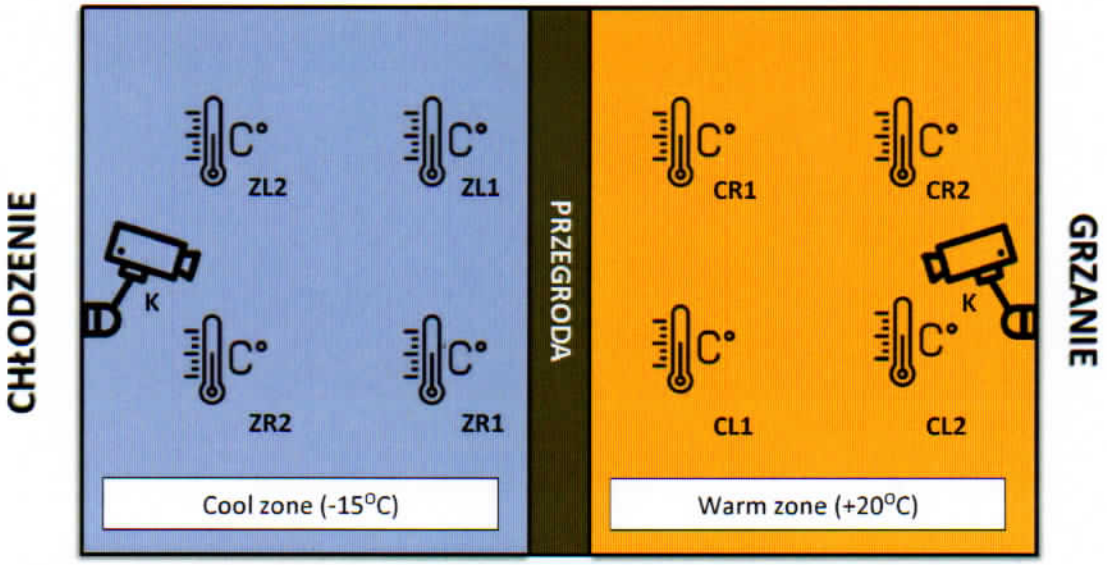


Figure 1 - Sketch of the test stand

K - camera stand (industrial camera and thermal imaging camera)

L1, L2, R1, R2 – temperature sensors

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# TESTING POST

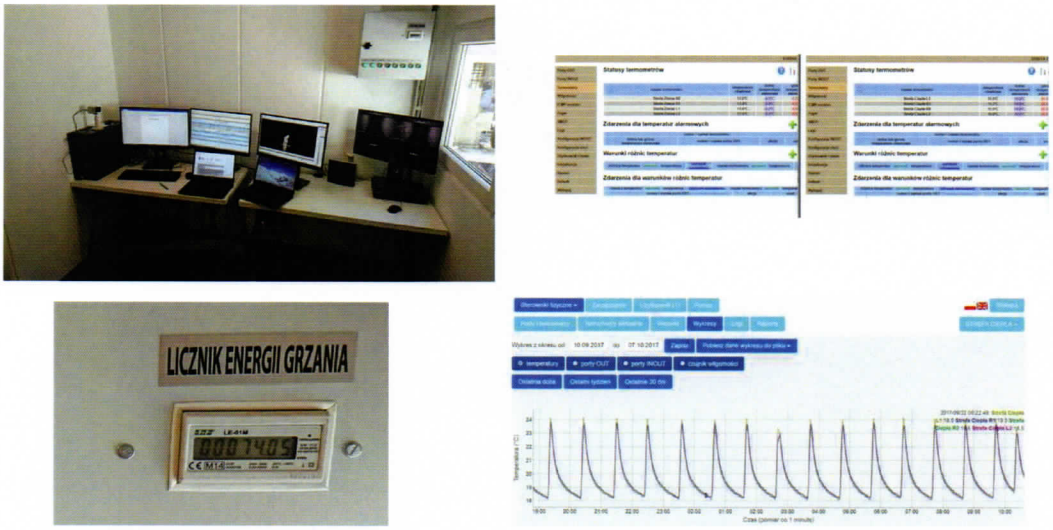


Figure 2 - Preview of the test bench

# TESTING POST

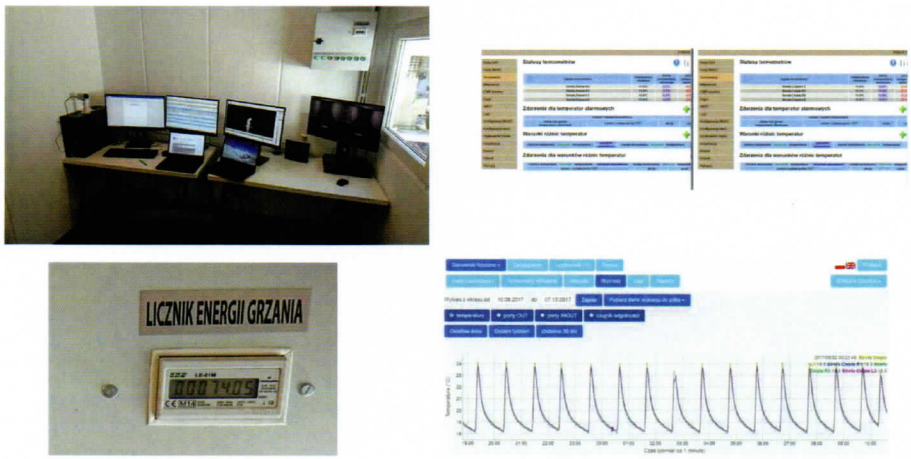


Figure 3 - Photographs of research station divisions

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**BARIER**

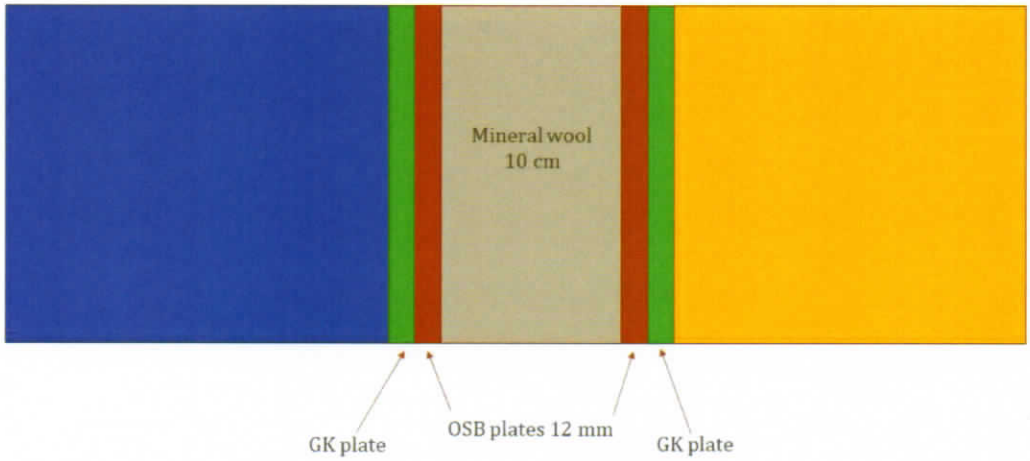


Figure 4 - Sketch of the partition cross-section between the hot and cold zones

1 - drywall with a thickness of 12 mm

2 - OSB board with a thickness of 12 mm

3 - mineral wool with a thickness of 10 cm

## 2. Description of test equipment

**Thermal imaging camera Optris® PI 640**

| Technical data | |
|---|---|
| Technical data | 640 x 480 piksels |
| Detector | FPA, uncooled (17 µm x 17 µm) |
| Temperature range: | -20 ... +100°C; |
| The spectral range: | 7.5 - 13 µm |
| Optical resolution | 382 x 288 px |

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| Thermal sensitivity (NETD) | 75 mK |
| lenses (FOV) | 33° x 25°/f = 19 mm;<br>60° x 45°/f = 10 mm;<br>90° x 66°/f = 7 mm |
| Maximum refresh rate | 32 Hz |
| Accuracy | ±2°C or ±2% of the read |
| Interface type | USB 2.0 |
| Signal interface (PIF) | input 0-10V, digital input, output 0-10V |
| Signal interface | -40°C ... 70°C |
| Operating conditions of the device | Temperature: 0°C ... 50°C;<br>Relative humidity: 20-80%, without condensation |
| Power | Camera powered from USB |
| Resistance to vibrations, impacts | 25G, IEC 68-2-29 / 2G, IEC 68-2-6 |
| Tripod mounting thread | 1/4-20 UNC |
| Level of security | IP 67 (NEMA 4) |
| Dimensions | 46 mm x 56 mm x 90 mm |
| Weight | 320g (with the lens) |

Table 1 - Thermal camera parameters Optris® PI 640

**Uniwnet RST4R3 controller with thermocouples connected to it**

The RST4R3 controller is designed for remote temperature measurement. Thanks to the built-in external temperature sensors, the RST4R3 controller allows on-line observation and archiving of measurements. The RST4R3 controller provides six independent OUT output ports with a load capacity of 2A and a voltage of up to 120V. The status of each port can be controlled manually or automatically according to the following conditions set by the user:

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- reaching the upper or lower alarm temperature of any of the connected thermometers;
- availability, availability or change of availability of any computer in the network, based on ICMP (ping);
- periodically or at a defined date and time;
- • the status of enabling or disabling any of the four input ports INOUT.

Four independent ports are connected to the front panel of the RST4R3 controller for connecting thermometers or operating switches. For the INOUT ports configuration as input ports, the RST4R3 driver supports port on and off actions, allowing to generate user-defined events. The measured temperature values are presented in daily, weekly and monthly charts.

Basic parameters:

- support for 6 independent devices, using the OUT ports;
- support for up to 8 temperature sensors, using the INOUT ports;
- support for up to 4 two-state input ports, using the INOUT ports;
- event handling depending on the measured temperature;
- obtaining the appropriate temperature difference on the two thermometers indicated;
- event handling depending on the date and time or periodically;
- logs from performed operations;
- rescue mode in network and firewall configuration that protects against loss of remote control;
- large input voltage range 7-25V;
- power via POE (Power Over Ethernet).

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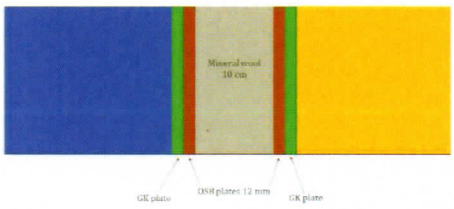
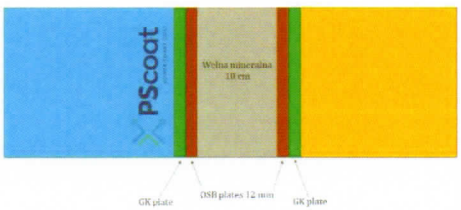
Additional parameters in the software version:

- access to measured temperatures using the XML protocol;
- humidity sensor support;
- control panels management of multiple controllers using the WebClient interface;

## 3. Description of the test method

The test consists in creating climatic conditions as close as possible to those prevailing in winter: outside - 15 ° C and in a living room + 20 ° C. The purpose of the test is to determine how the use of PSC products affects the heat transfer through the test barrier. The tests were carried out on a test partition in the following variants:

1. Plasterboard (GK) on both sides - without using the system PSC
2. Plasterboard (GK) on both sides - covered with the PSC system from the cold side
3. Plasterboards (GK) on both sides + from the cold side: foamed polystyrene 10 cm without using the PSC system
4. Plasterboard (GK) on both sides - covered with the PSC system from the cold side mand PSC Paint on the worm side.

| BARRIER | BARRIER |
|---|---|
|  |  |
| Version: GK | version: PSC |

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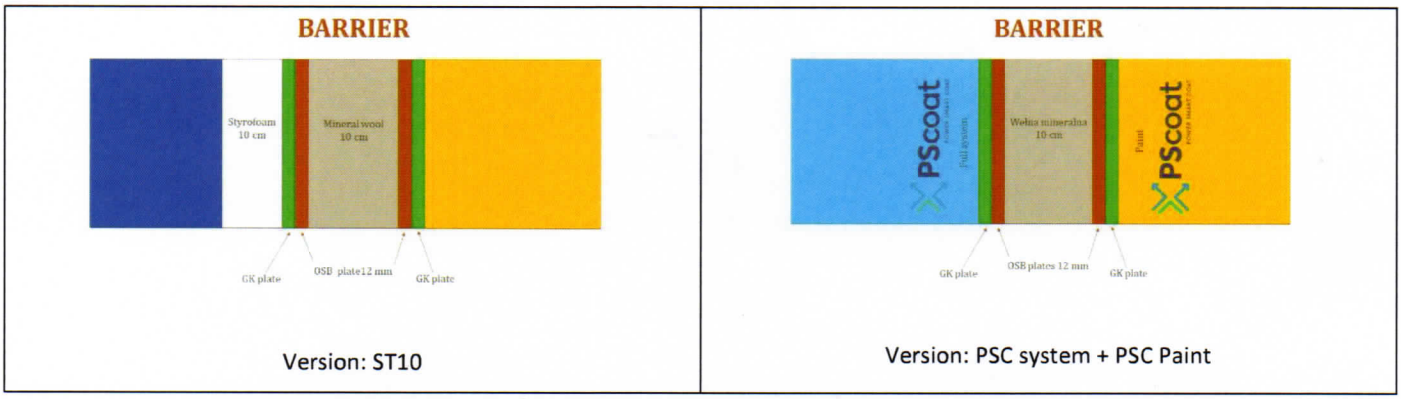


Figure 5 - Sketch of cross-sections between hot and cold zones - variants

**Samples for testing:**

PSC insulation system:

- Undercoating
- Thermal layer
- Facade paint

All system components are water-borne products. The total thickness of the full system layer is 0.35 mm, and the thickness of the PSC Paint layer is 0.1 mm.

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|---|---|
| Test samples | System PSC |
| Sampling point | The client has provided the samples personally to the testing point |
| Date and time of receipt of samples for testing | 28-05-2018, 10:00 |
| Leading the project | Michał Marciniak |

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# 4. Study

## A. Research on power consumption

### The purpose of the study

The aim of the study is to determine the impact of the use of PSC series products on the consumption of electricity necessary to maintain the temperature in the hot zone - simulation of savings resulting from the use of PSC series products.

### Conditions and description of the test

The test consisted in maintaining the average temperature in hot zones for 24 hours (20° C) and cold (-15° C). Simulator was brought to stable thermal conditions in both zones and then maintained for a total period of 24 hours. The costs of maintaining the temperature in the cold zone were not measured - the stability of "external" conditions was assumed, while the consumption of electricity necessary to maintain the temperature in the hot zone was the subject of this study. Measurements of electricity consumption and temperature were made using the apparatus described in point 2.

### The research results

The results of the study are presented in tabular form and in the chart below. Savings between individual versions of partitions have been included in the absolute dimension - referring to savings to the base partition.

| | | | |
|---|---|---|---|
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| version of the partition | consumption within 24h [kW] | Savings |
|---|---|---|
| GK | 6,58 | - |
| PSC | 4,38 | 33,43% |
| ST10 | 4,48 | 31,91% |
| PSC + Paint PSC | 4,08 | 37,99% |

Table 2 Results of the electricity consumption test

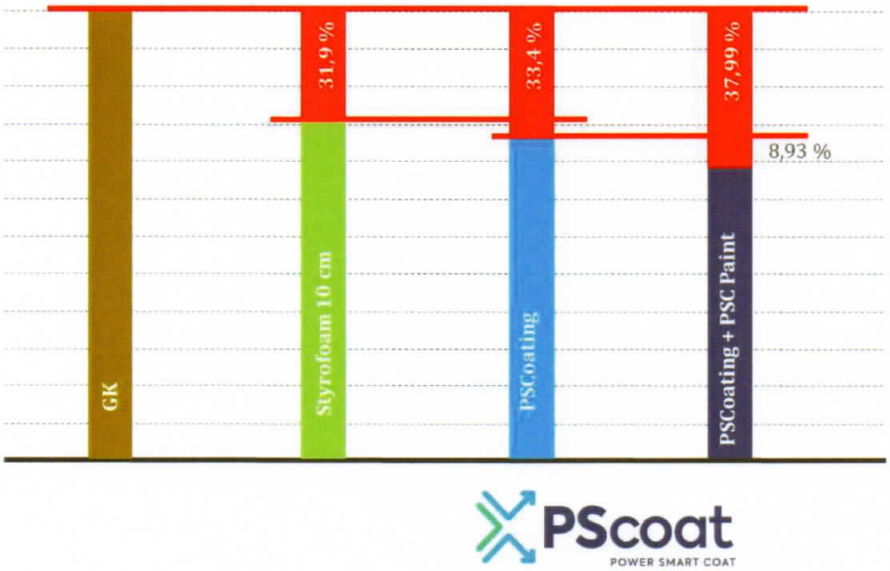


Fig. 6 Electricity consumption graph - savings in absolute terms

# B. Thermal tests

## The purpose of the study

The purpose of the test is to determine the impact of the use of PSC series products on the temperature in the hot zone. The simulation allows to determine the possibility of obtaining a higher temperature while maintaining constant heating expenses - obtained thanks to the PSC series products.

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## Conditions and description of the test

The course of the test assumed the set temperature in the hot (20 ° C) and cold (-15° C) zones, and then the test assumed switching off the heating in the hot zone, maintaining constant conditions in the cold zone. The study consisted in observing the process of cooling of the hot zone in repeated 8-hour cycles. The costs of maintaining the temperature in the cold zone were not measured - the stability of "external" conditions was assumed, while the observation of the course of temperature changes in the unheated hot zone was the subject of this study. Temperature measurements were made using the apparatus described in point 2.

## The research results

The results of the study are presented in tabular form and in the chart below. Savings between individual versions of partitions have been included in the absolute dimension - referring to savings to the base partition.

| | GK | PSC | ST 10 |
|---|---|---|---|
| Temperature - the beginning of the test | 22,43 | 21,3 | 22,43 |
| Temperature - end of the test | 8,3 | 11 | 10,7 |
| The temperature drop | 14,13 | 10,3 | 11,73 |
| The temperature difference compared do GK | n/d | 3,83 | 2,4 |
| The advantage over the 1st variant of the barrier | | 27,11% | 16,99% |

Table 4 - Comparative results of zone cooling in different partition variants

| | | | |
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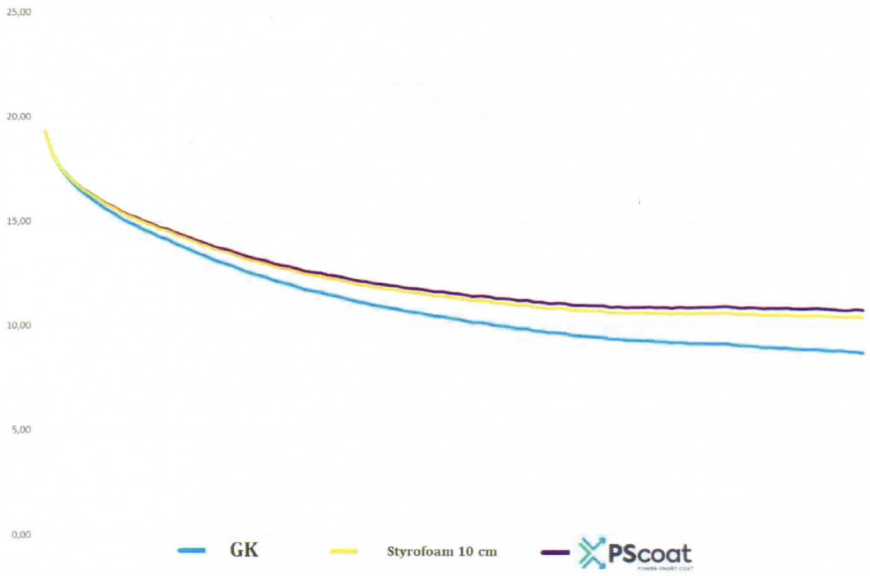


Figure 7 - Cooling zone diagram in the barrier variant without using insulation and using PSC products and 10 cm thick styrofoam - the entire cooling process

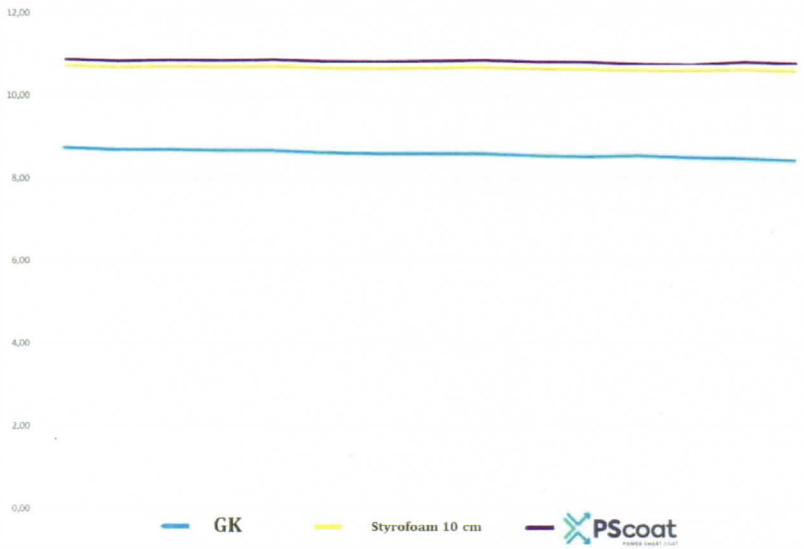


Figure 8 - Cooling zone diagram in the barrier variant without using insulation and using PSC products and 10 cm thick Styrofoam – temperature stabilization

| | | | |
|---|---|---|---|
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| | PSC | PSC + Paint PSC |
|---|---|---|
| Temperature - the beginning of the test | 21,3 | 22,09 |
| Temperature - end of the test | 11 | 12,24 |
| The temperature drop | 10,3 | 9,5 |
| The temperature difference | n/d | 0,8 |
| The advantage over the 1st variant of the barrier | | 7,97 % |

Table 5 - Comparative results of cooling zones in different partition variants

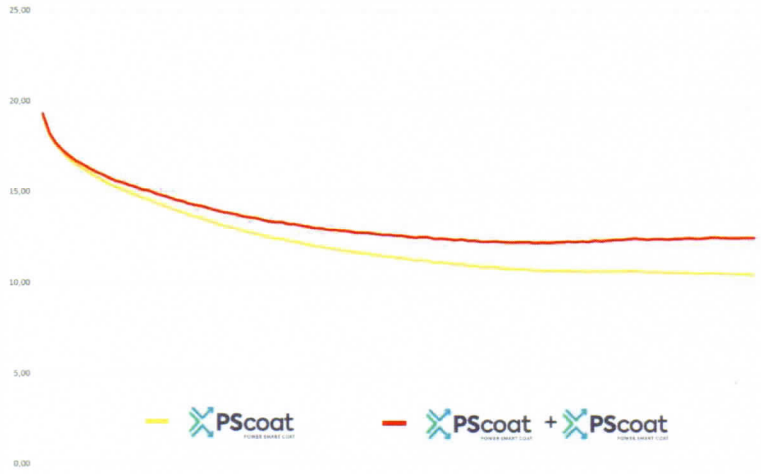


Figure 9 - Cooling diagram of zones in the partition variant with the use of PSC products on the cold side - in the version without application and using PSC paint from the warm side - the entire cooling process

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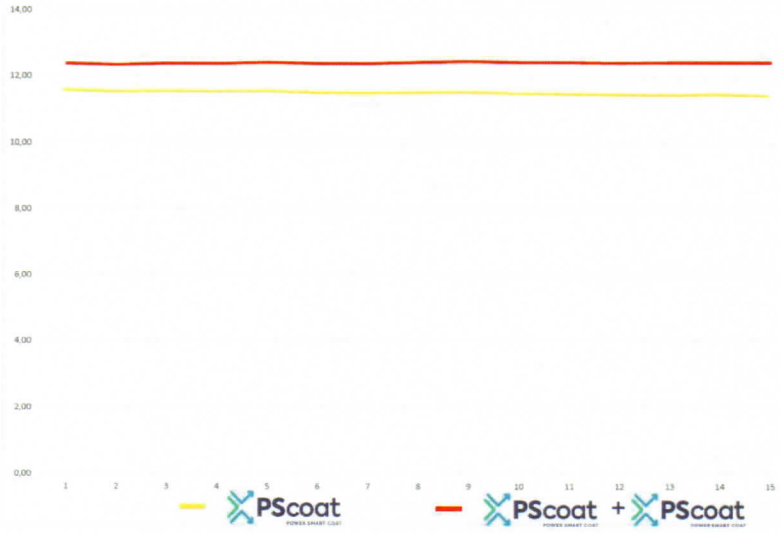


Figure 10 - Cooling diagram of zones in the partition variant with the use of PSC products on the cold side - in the version without application and using PSC paint from the warm side - temperature stabilization

# C. Conclusions from the research

**Electricity consumption test**

1. The use of PCS series products saves about 30% heating expenses.
2. The use of PCS series products saves heating expenses at a level slightly more effective than 10 cm styrofoam with a heat transfer coefficient of lambda 0.044 [W / mK] .
3. The use of PSC paint, which is part of the PSC System from the warm side of the barrier (using a complete PSC system from the cold side), allowed for additional savings of 9% of the energy consumed.

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**Thermal examination**

1. The use of products from the PSC series allows to obtain benefits at the level of 25% in relation to the non-insulated divider.
2. The use of PCS series products allows to obtain a temperature increase at a level better than 10 cm styrofoam with a heat transfer coefficient lambda 0.044 [W / mK].
3. The use of PSC paint, which is an element of the PSC System on the warm side of the barrier, allowed for a temperature increase of 8%.

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| Date of report | 30 June 2018 roku |
| authorized by (name, surname, signature) | Michał Marciniak<br>Michał Marciniak<br>Członek Zarządu<br>Zespół Analiz<br>Centrum Badawczo-Rozwojowego<br>Parku Innowacji i Przemysłu<br>Park Innowacji i Przemysłu Sp. z o.o.<br>ul. Francuska 13/7<br>40-027 Katowice<br>NIP: 9542748952 |