



Spark Cooling Campaign

Thermal Energy Storage in Phase Change Material to absorb the sun's impact and avoid overheating of street cabinets and network equipment.

Liberty Global

Liberty Global is one of the world's leading converged video, broadband and communication companies, with operations in six European countries under the consumer brands Virgin Media, Telenet and UPC.



Spark Cooling Campaign

As you have probably experienced, summers are getting hotter and hotter every year. The summer of 2018 set temperature records across Europe, but with this fantastic weather comes a challenge; heat! To improve the ultrafast network and increase customer experience, Liberty Global wish to reduced the temperature in a specific part of the network, the street cabinets.

Virgin Media

Virgin Media offers four multi award-winning services across the UK and Ireland: broadband, TV, mobile phone and landline. The company's dedicated, ultrafast network delivers the fastest widely available broadband speeds to homes and businesses. We're expanding this through our Project Lightning programme. Our interactive TV service brings live programmes, thousands of hours of on-demand programming and the best apps and games in a set-top box, as well as on-the-go for tablets and smartphones. We launched the world's first virtual mobile network, offering fantastic value and services to customers. We are also one of the largest fixed-line home phone providers in the UK and Ireland.



Street cabinets are

traditionally made from metal, and a mix of solar exposure and heat produced by amplifiers and nodes effectively creates an oven inside.

During initial investigations, in some cabinet's internal temperatures were recorded at higher than 65° Celsius however the investigation demonstrated that for cabinets with sun exposure, the internal temperature is double that of the atmospheric temperature during summer months, which can easily surpass 60° Celsius. If the equipment is operated at a higher temperature for long periods, the failure rate increases. Heat wears out electronic components, as explained by the Arrhenius effect equation; for every 10°C increase in operating temperature, the failure rate will double.

To improve the ultrafast network, Liberty Global started the Spark Cooling Campaign.



Tizzin and Partners

Tizzin

Delivers highly efficient Revolutionary Cooling Products for equipment rooms, based on Phase Change Materials, Free Air and Displacement technology without refrigerant. We help to reduce energy consumption and meet the sustainable ambitions with our already available, easy to use cooling solutions. Tizzin can supply a complete range of products and services for small and medium equipment rooms. From energy efficient cooling products to complete enclosures and turnkey solutions.

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Tizzin

Tizzin is a supplier of EDGE Facilities and manufacturer of air handling units based on Phase Change Material specially built for the worldwide telecom industry.

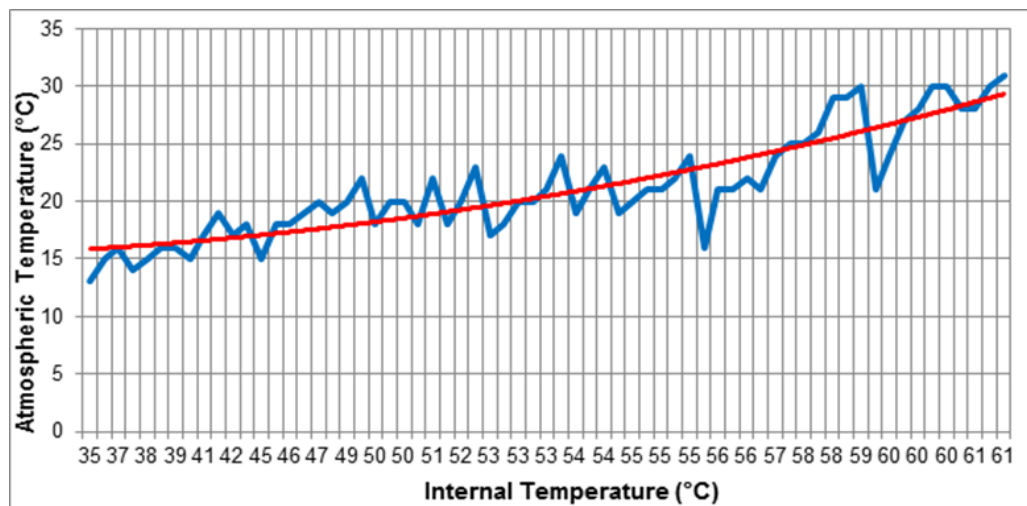
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The idea to use PCM to reduce the temperature in street cabinets

Tizzin and its partners have been involved in various cooling applications for the past ten years. Previous research has shown that Phase Change Material can be a possible solution for the internal temperature of street cabinets. Thermal Time Shifting by thermal energy storage in Phase Change Material (PCM) can best be compared to an electric battery or thermal battery. PCM uses the daily rhythm of day and night. You can charge the battery using heat during the day and discharge this heat at a later stage (over night).



PCM (Phase Change Material) means that material changes phase from solid to liquid and back. During the phase change, the material collects thermal energy when it's melting and gives that back during crystallisation. We use Salhydrates as PCM, and for the application in the cabinets we changed the structure of the salhydrates to prevent segregation. PCM has a lifetime of around 30 years, requires no maintenance and can be used in many ways. In a 2014 research project, we combined different types of PCM in an isolation pack and placed it on the sides, door and roof of a cabinet. The result; PCM controlled the inside temperature significantly.

Tizzin, together with its partners submitted this idea to the Spark Cooling Campaign with the belief that we have a solution to reduced the temperature in the street cabinets.



Lab test

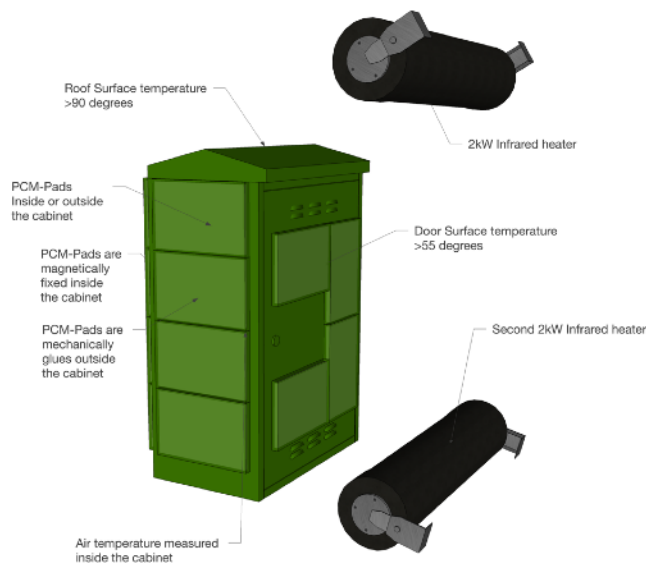
The idea is to use standard one size PCM-Cool Bricks in the same colour as the cabinet. The pads have magnetic strips for easy assembly, but if necessary, they can be glued to the cabinet with professional glue.

The glue procedure will be described in detail to guarantee maximum adhesion.

Requirements:

- No need for active cooling equipment
- Minimum installation time
- Secure from vandalism
- The solution works in both the grey and the green colour cabinets

Before the lab tests start, a comprehensive test plan describes the test protocol and procedures to determine the most appropriate test. The purpose of the lab test is to show that PCM can reduce the temperature in street cabinets. All tests are performed in a heating chamber with a small green cabinet. The aim is to reduce the temperature in the middle of the cabinet from 61° C to a maximum of 55° C with an internal heat load of 50 watt. The baseline data we used at the lab test is equivalent to a day in June with an ambient worst-case scenario. All baseline data is verified with input from Liberty Global and Virgin Media.



Thirty-six different lab tests were done at Energy Cool's heat chamber test facility in Denmark. The results of the lab tests corresponded with our expectations. Without PCM inside the cabinet, the air temperature in the middle of the cabinet is approximately three degrees higher than ambient temperature

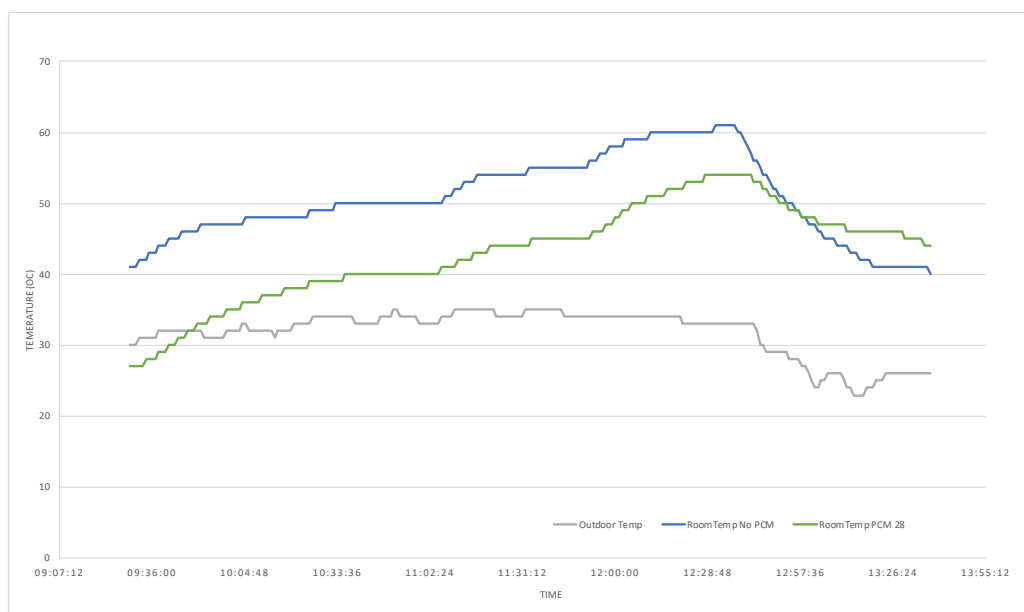
(50-75W site load). With maximum amounts of IR light (4kW) the door temperature is around 55°. With an outside cabinet temperature of 21°, full IR light and the PCM fixed on all sides of the cabinet, the temperature in the middle of the cabinet is reduced to around 42°.

The ambient temperature has to be increased to 30° in the middle of the cabinet without PCM to get to a temperature of 61°. This is with maximum IR light (4kW). The same test on a cabinet with PCM shows an 8° lower maximum

temperature inside the cabinet at the same measuring point.

The results indicate that in a controlled environment, Thermal Time Shifting by thermal energy storage in Phase Change Material meets the requirements of the Spark Cooling Campaign to reduce heat-related outages. We can take the next step with these results.

“Based on the assumption that the variables will be averaging with a higher number of cabinets, PCM will lower the temperature inside the cabinet”



Results of the lab tests

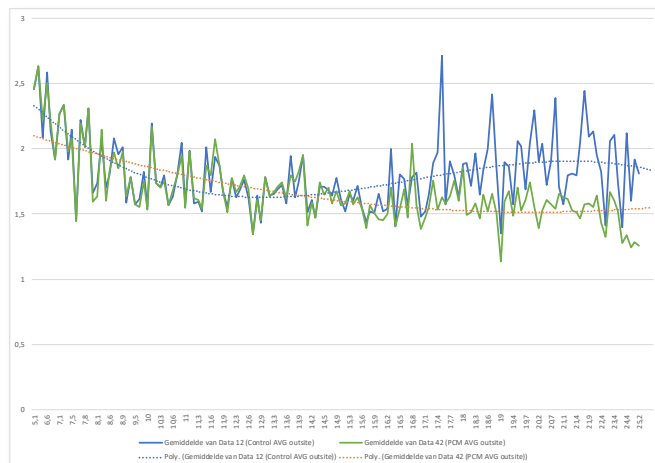
Field test

After an extensive evaluation, we started the production of a small batch of PCM-Cool Bricks for a field test at Virgin Media in the UK. The type of PCM selected for this test had a higher melting point than the ones used during laboratory testing. The field test was conducted in September 2019. In total 20 cabinets with temperature issues were equipped with PCM-Cool Bricks and data loggers. At the same time 14 other similar cabinets, with roughly the same



positioning and site load, but without PCM were also equipped with data loggers for reference. During this period all data was collected and validated together with the environmental temperature data from the region.

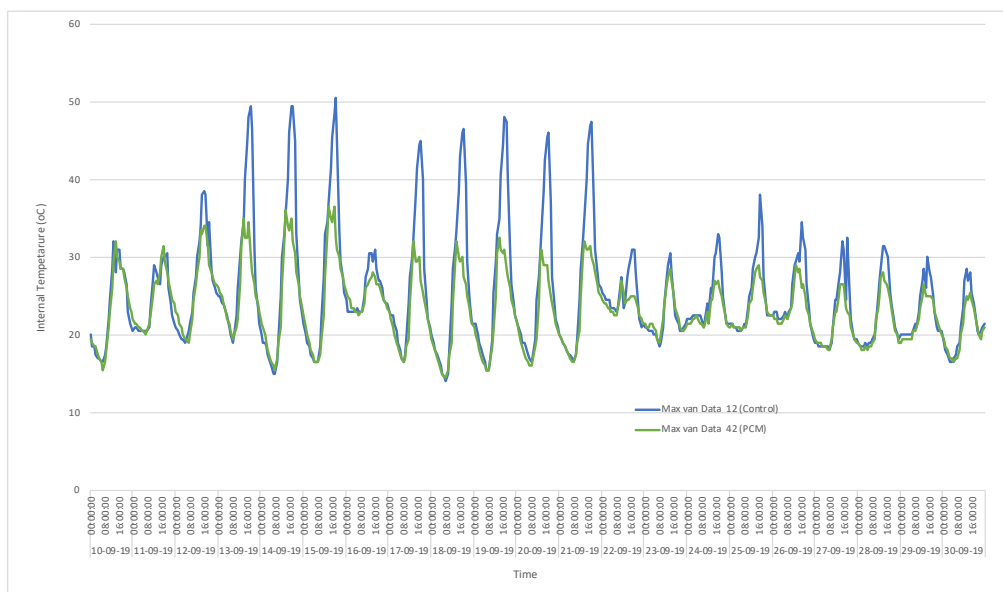
The investigation before the Spark Cooling Campaign demonstrated that in cabinets with high sun exposure, the internal temperature is double that of the atmospheric temperature during summer months. Our field test shows there is a relationship between the ambient temperature and the internal temperature, but this is highly dependent on the amount of internal heat load. The internal temperature is between 1.5 and two times the ambient temperature, for cabinets exposed to direct sun, with outliers up to well over 2.5 times the ambient temperature.



The internal temperature is between 1.5 and 2 times the ambient temperature.

During the field test, cabinets equipped with PCM-Cool Bricks and comparable reference cabinets were measured. The test clearly indicates that at higher ambient temperatures - including the sun's impact on the cabinets - the cabinets with PCM have a significantly lower indoor temperature than similar cabinet without PCM. This can be simply explained by the operation of the PCM. The Phase Change Material is used as a Thermal Energy Store to absorb the sun's energy and avoid overheating street cabinets and network equipment.

With all data collected during the lab & field tests and the total annual heat-driven fault tickets, a Break Even is possible under the two years



Results cabinet with and without PCM

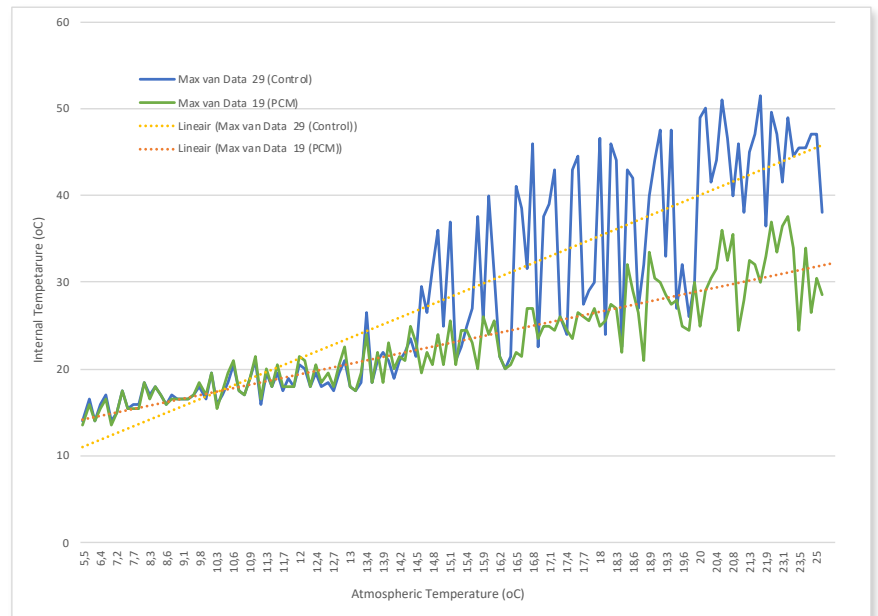
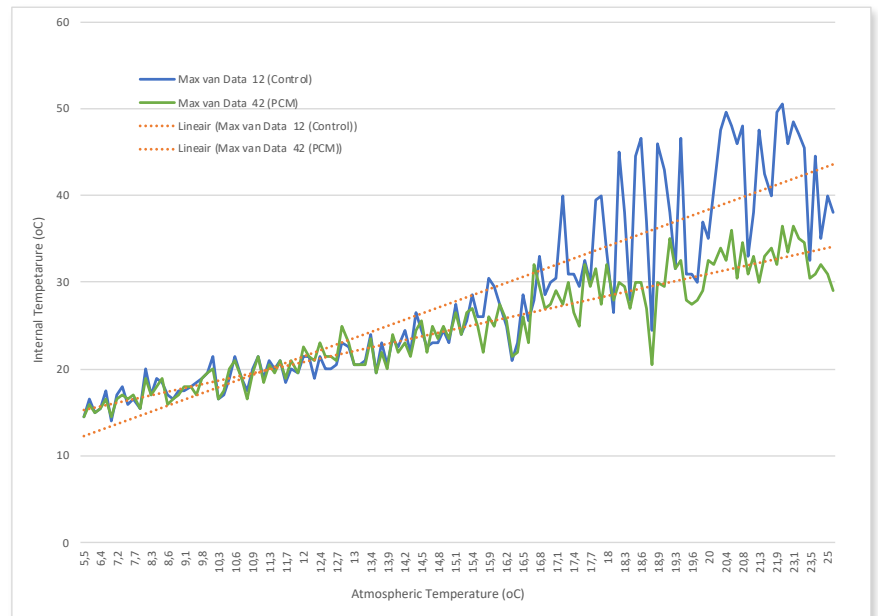
Energy Cool

Energy Cool produces a number of unique products specially designed for use in the telecom, fibre, radio, track and energy industries that use technical spaces. The products have some of the world's lowest energy and CO₂ consumption, as well as significantly reduced carbon footprint and low noise levels, all to ensure a better environment for the benefit of all. The products are designed to provide more reliable systems, less maintenance and thus less environmental impact. The systems are modular "Plug and Play" units, ensuring a flexible capacity expansion that can be carried out continuously if the need changes over time. Energy Cool takes pride in working with our partners to develop customised solutions that create a win-win for our partners and the environment. Challenge us gladly.
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PCM Technology

PCM Technology was founded in 2014 by two companies already long active in the PCM industry. We have more than 15 years' experience in the PCM world with a lot of concepts. Climate ceilings, datacenter cooling systems, floor heating systems and heat storage tanks are a few of them but for us the biggest markets. All these concepts are using less energy than the same without PCM. PCM is the best solution to cool or heat rooms or processes in a passive way and save energy.
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Two examples with the indoor temperature for the cabinet with PCM and the reference cabinets.

Summary:

- PCM is an alternative to active cooling equipment. No active equipment such as fans or ventilation holes were added during the field test. Phase Change Material has a lifetime of at least 30 years and requires no maintenance.
- Minimum installation time of about 15 minutes (without specific knowledge, a brief instruction is sufficient)
- The PCM-Cool Brick works on all colours, materials and types of street cabinets. Both inside and outside the cabinets. During the field test, 90% of Cool Bricks is placed inside the cabinet.
- The Cool Bricks are available with professional double-sided tape, magnets or in a metal housing and can be adjusted to your requirements.