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#### RaeGuard™ specific benefits:

- Retain heat and maintain pool temperature
- Reduce heating cost by up to 57%
- Pay back the cost of a cover within 1 year
- Works on both indoor and outdoor pools
- 6+ years expected lifespan
- Available with reinforcing weave

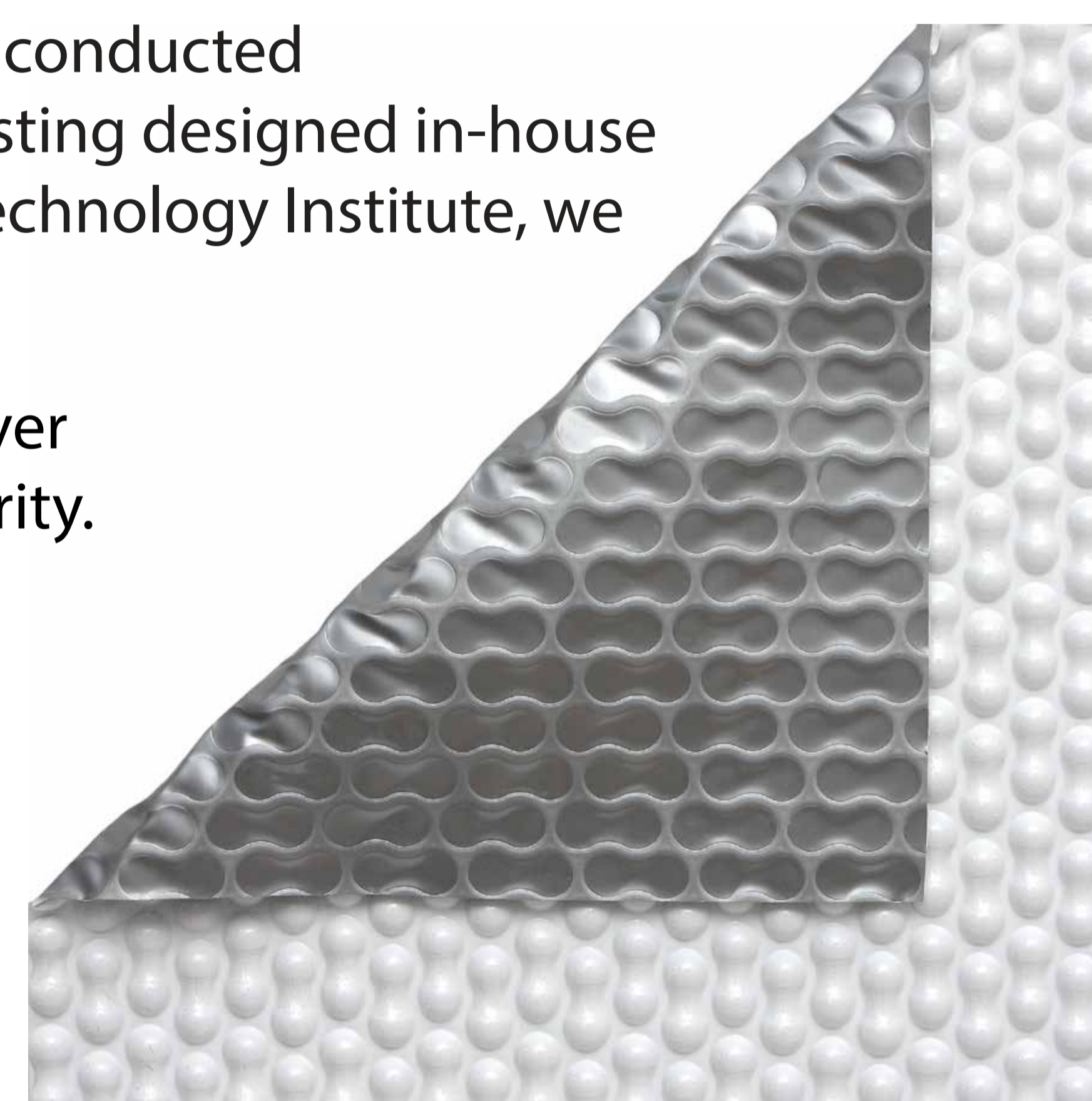
#### General cover benefits:

- Eliminate water evaporation by 98% +
- With GeoBubble™ technology
- Reduce debris contamination
- Reduce the pool's carbon footprint

The testing and development of our new RaeGuard™ pool covering material has been conducted continuously behind the scenes since early 2019. Whether this be through bespoke testing designed in-house or using specialist spectrographic equipment at the University of Surrey's Advanced Technology Institute, we have been rigorously testing and improving RaeGuard™ since its conception.

The brief was simple, to produce a cost effective, high performance heat retention cover specifically for use on heated pools - where locking the heat in is the number one priority. Wasting no time, the team set to work designing and developing our first RaeGuard™ prototype. Two years and four subsequent versions later, we are pleased to present our solution:

### RaeGuard™ - A high-performance heat retention pool cover with GeoBubble™ Technology



#### Pigment selection

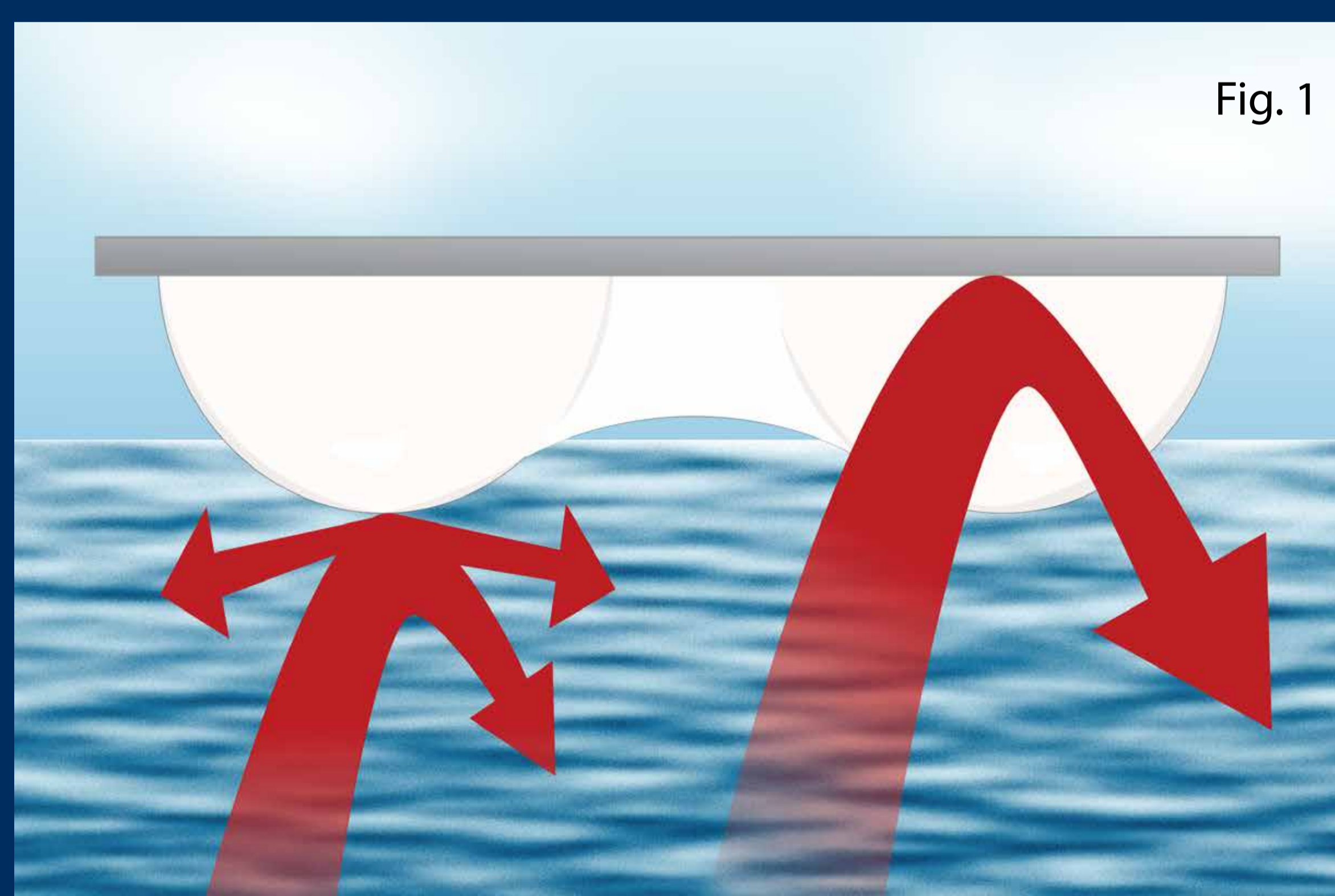
The aim with RaeGuard™ was always to put functionality at the forefront of its design. As such we have only included pigments and additives which directly contribute to the performance and longevity of the material.

The silver and white pigments within RaeGuard™ have been selected such that they optimally reflect and scatter back the thermal energy lost from a pool, maximising heat retention and greatly reducing radiative energy loss.

This thermal energy is emitted as mid-infrared radiation from the surface of a pool, which the pigments within RaeGuard™ are targeted to interact with based upon particle size. The silver layer directs back the majority of this radiation via specular reflection whilst the white layer scatters back remaining radiation, as illustrated in Figure 1 (right).

The efficacy of each pigment to reflect the targeted mid-infrared region was determined via specialist FTIR analysis, using spectrographic equipment at the University of Surrey's Advanced Technology Institute.

A number of pigments of varying concentration were evaluated for their ability to reflect mid-infrared radiation, with the best performing being put forward for formulation and combined with our unique additive UV stabiliser package.

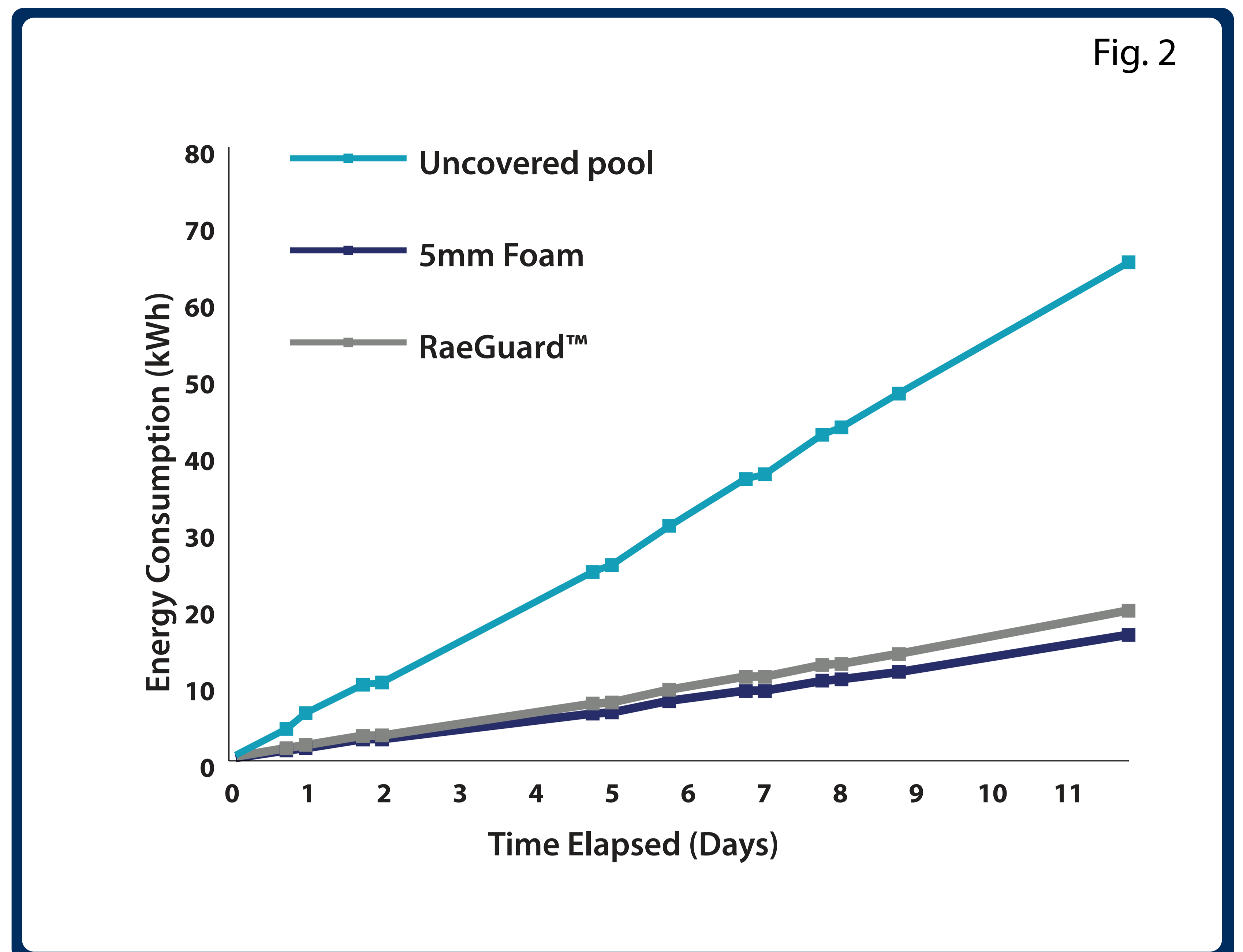


## Heat Retention testing

Our tests have shown that a heated pool held at 28.0°C and covered with RaeGuard™ will see a reduction in heating costs by up to 57%, when compared to an equivalent pool left uncovered. This represents around 90% of the performance of a standard 5mm foam.

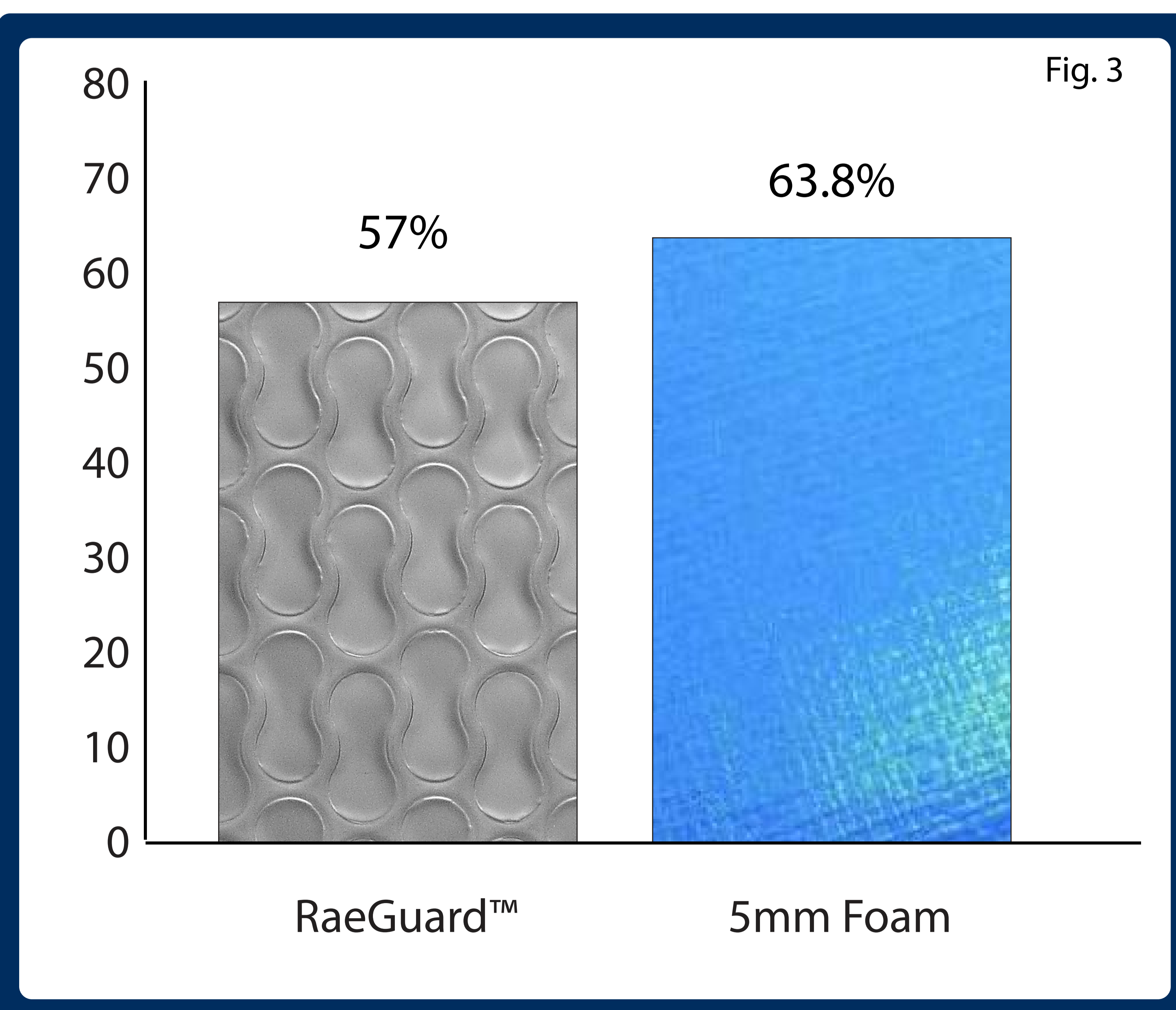
The tests in question were conducted on a series of 4 identical insulated indoor pools, of which 3 were covered and one left exposed to act as a control. The objective of these tests was to mimic the conditions of a typical indoor pool enclosure environment and monitor the energy required to maintain them at 28.0°C, as is common for most heated pools.

These pools were made from fibreglass, had dimensions of 1.0m X 1.5m and were filled to a depth of 0.8m. Each pool was fitted with a 1kW, 220v electric heating element with the thermostat set to heat the water to 28°C. A filter was added to each pool to ensure that there was good mixing and that the water temperature of the pool was homogenous. The heating element for each of the test pools was connected to its own power meter, which was read twice daily and the data used to produce a plot of cumulative energy consumption over time.



Multiple iterations of this test were conducted to allow us to see how a selection of pool cover materials performed. Testing of this kind was conducted at each stage of our prototyping process, which allowed us to compare how each material change that we implemented impacted on heat retention performance. This continuous improvement process has allowed us to tweak and optimise the performance of RaeGuard™ and gives us great confidence in its energy saving potential.

Each test was conducted over a number of days before being repeated, with the covering of each pool being cycled for each repeat. This allowed us to gather repeated test data to produce a mean energy consumption value for each material tested, whilst nullifying any positional bias any of the test pools may have had. An example of one such test cycle has been included in figure 2 above for illustrative purposes.



The data collected allowed for us to directly compare how after repeated testing, the energy consumption of a pool covered with RaeGuard™ differed to a) an uncovered control pool b) a pool covered with a traditional 5mm foam cover. It was found that a pool covered by RaeGuard™ saw an energy saving of 57% compared to an uncovered control pool, and a pool covered by a 5mm foam saw an energy saving of 64%. From this it was determined that covering a pool with RaeGuard™ will offer 90% of the performance compared to covering a pool with a 5mm foam.

Figure 3: Bar Chart illustrating the difference between RaeGuard™ and a standard 5mm foam heat retention cover in terms of reduction of heating costs.

## Thermal Image Analysis

To visually represent how effective RaeGuard™ is at retaining heat, a test was devised whereby a covered container was filled with hot water and photographed using a thermal imaging camera.

Thermal images differ to ordinary photos in that regular colours have been replaced to represent the temperature at different locations within the image. Darker colours represent cooler regions of the photos whilst brighter regions represent warmer regions.

See below the images that we took of three different materials when covering hot water:

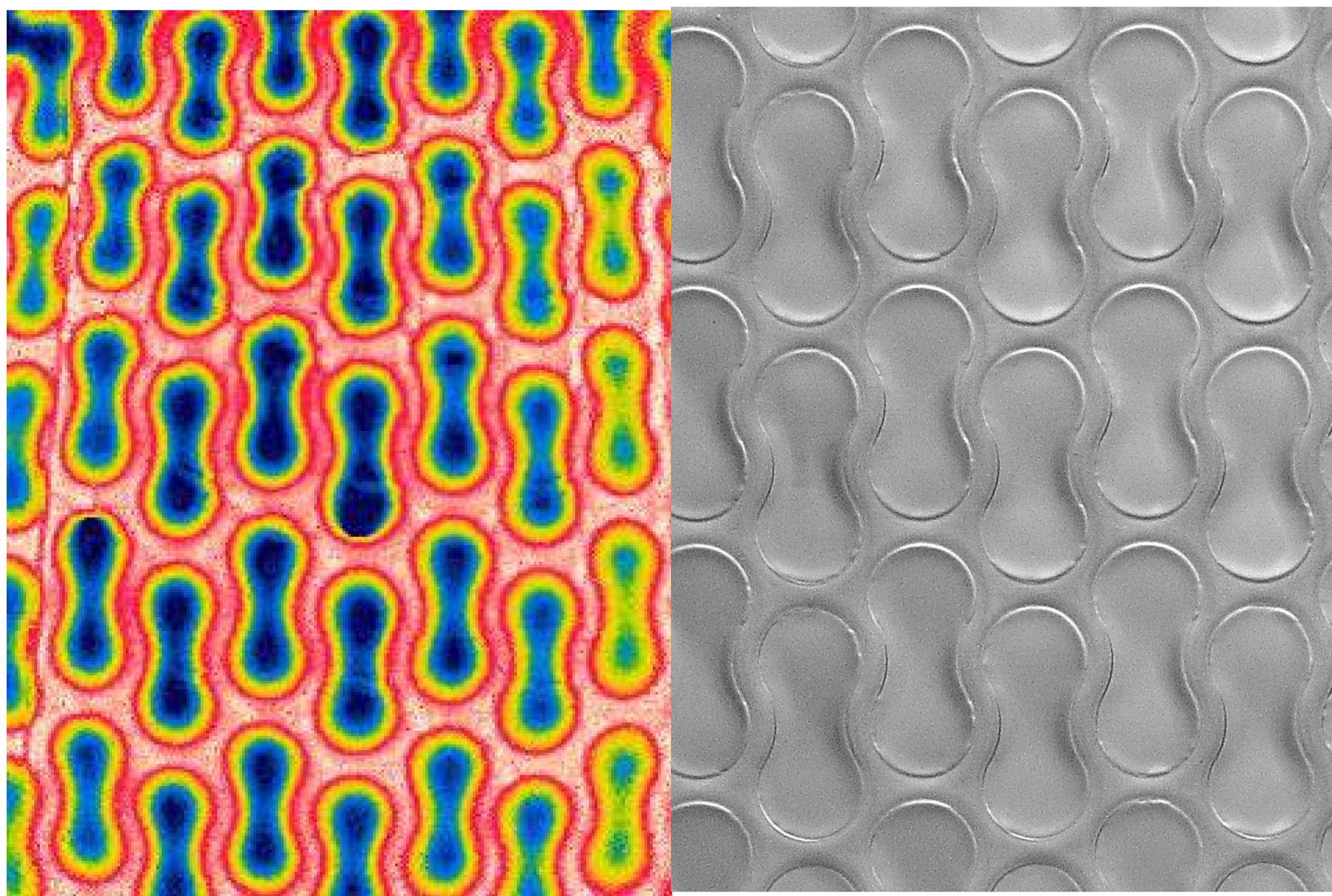


Figure 4. Thermal image (left) and regular image (right) of RaeGuard™

In the RaeGuard™ thermal image it can be seen that the bubble regions are much cooler than the land (flat area between bubbles). This is due to a combination of factors, primarily the insulating effect of the GeoBubble™ air cell as well as the reflect and scatter effect of the silver and white pigments within RaeGuard™.

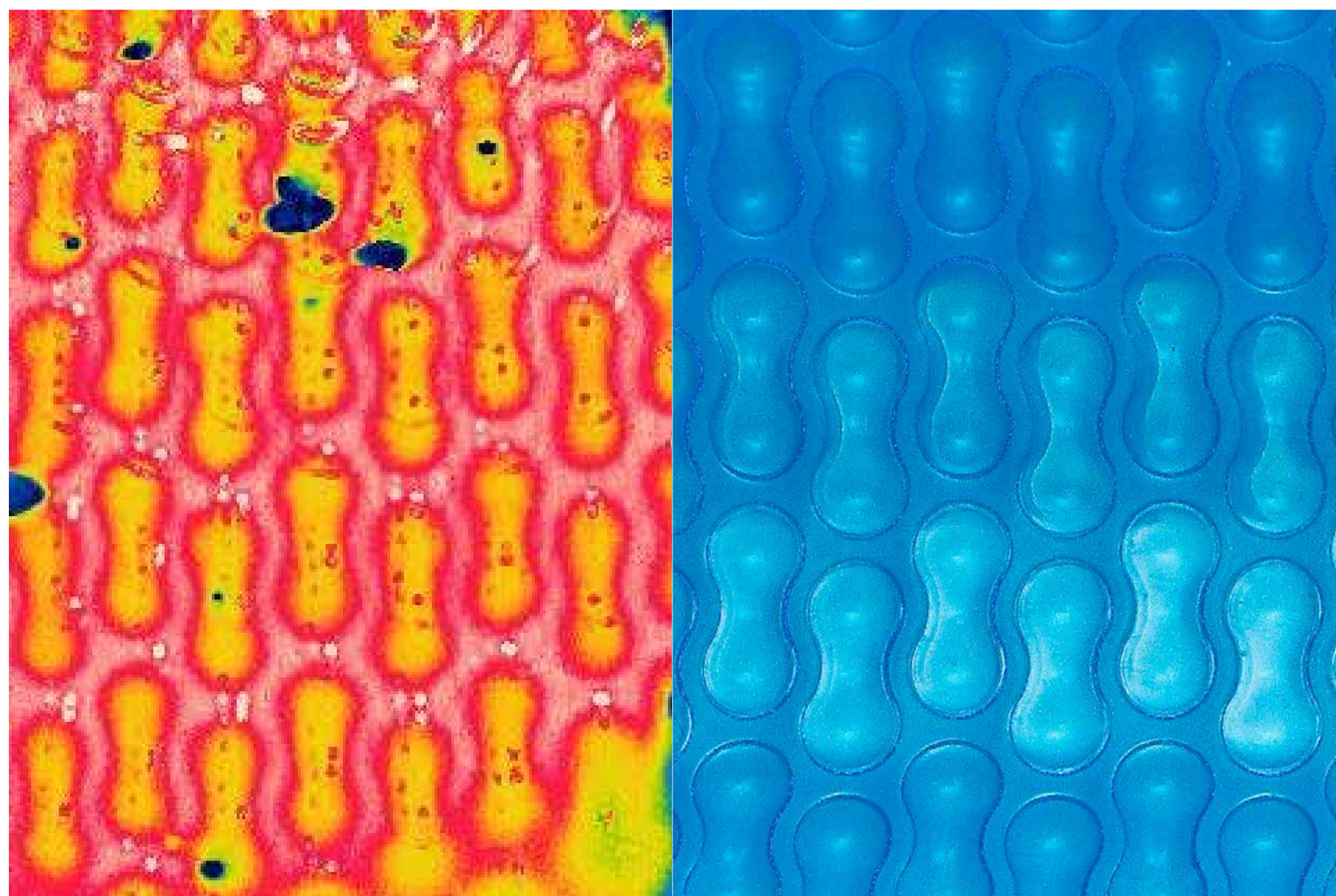


Figure 5. Thermal image (left) and regular image (right) of Light Blue

In the Light Blue thermal image, we can see that the bubble regions are still cooler than the land, however much more heat is making its way through the cover when compared to RaeGuard™. This is because traditional solar covers have been designed to be highly transmissive to thermal energy and do not contain any of the reflective pigments found in RaeGuard™.

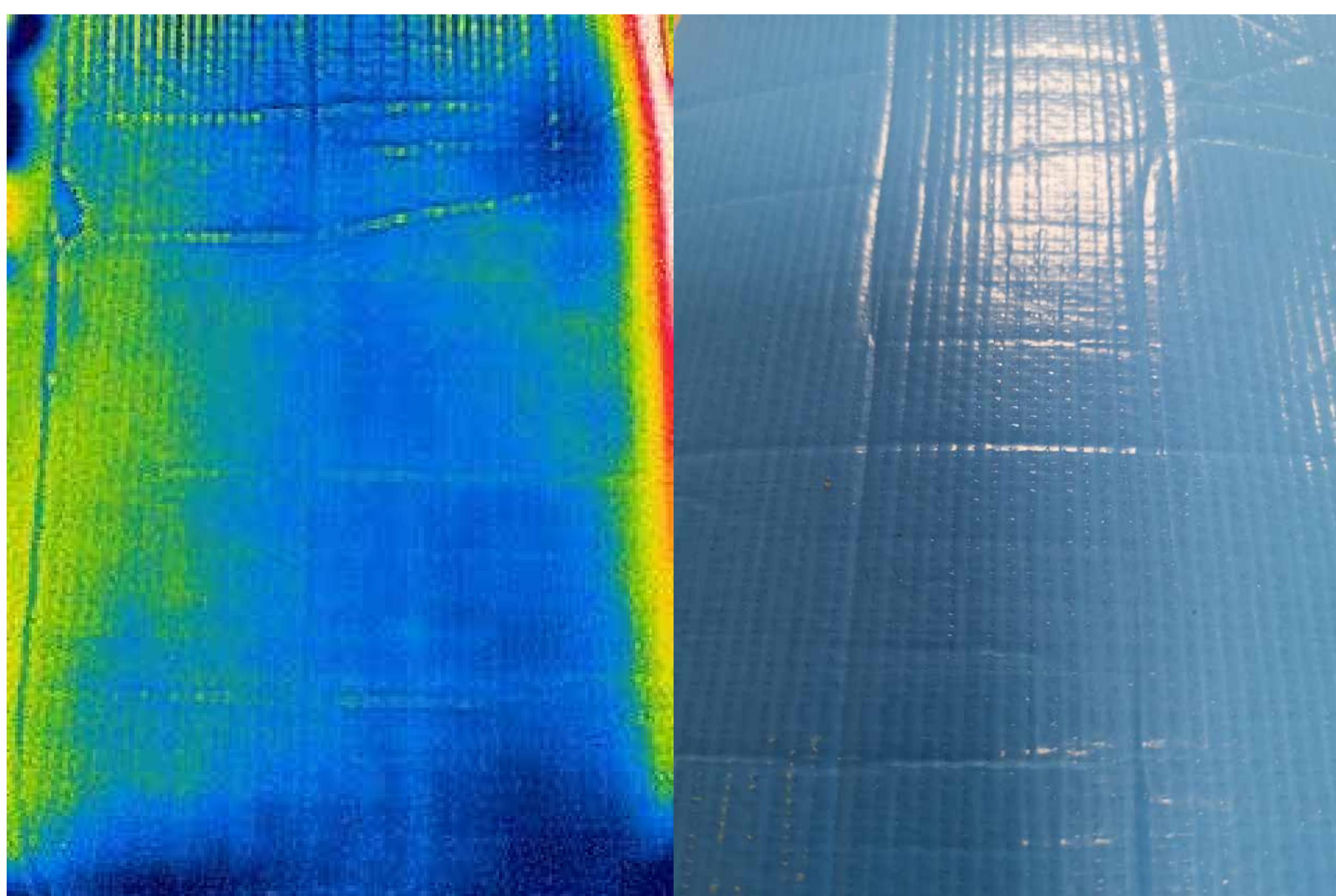


Figure 6. Thermal image (left) and regular image (right) of 5mm Foam

In the 5mm foam thermal image it can be seen that the temperature across the material is a lot more consistent than any bubble material, this is because the foam has a homogenous profile and composition. Note that in the RaeGuard™ thermal image the bubble regions are a similar colour to the foam. This gives us an indication that the heat retention properties are similar, explaining how a RaeGuard™ cover can offer 90% of the performance of a 5mm foam cover.

## In Situ Testing

As part of our testing process, we reached out to several pool owners, both indoor and outdoor, who we believed would benefit from a new RaeGuard™ cover. We replaced their existing cover and asked them to monitor how their pool experience changed in the weeks that followed.

Below is a testimonial from the estate manager of a school in Kent, who oversees the maintenance of a 14m x 20m pool used by students daily:

*"Our new cover has been a massive improvement on our old, waterlogged foam cover. It is so much easier to take off and on, which we do multiple times a day. We have found that the pool is holding its temperature much better than before, and there is no noticeable heat loss overnight.*

*We have also noticed we are using up far less chlorine than previously, the clarity of the water has improved and we are dedicating a lot less time to keeping the pool clean."*

**Ross, Estate Manager – Dulwich Prep  
Cranbrook, UK**



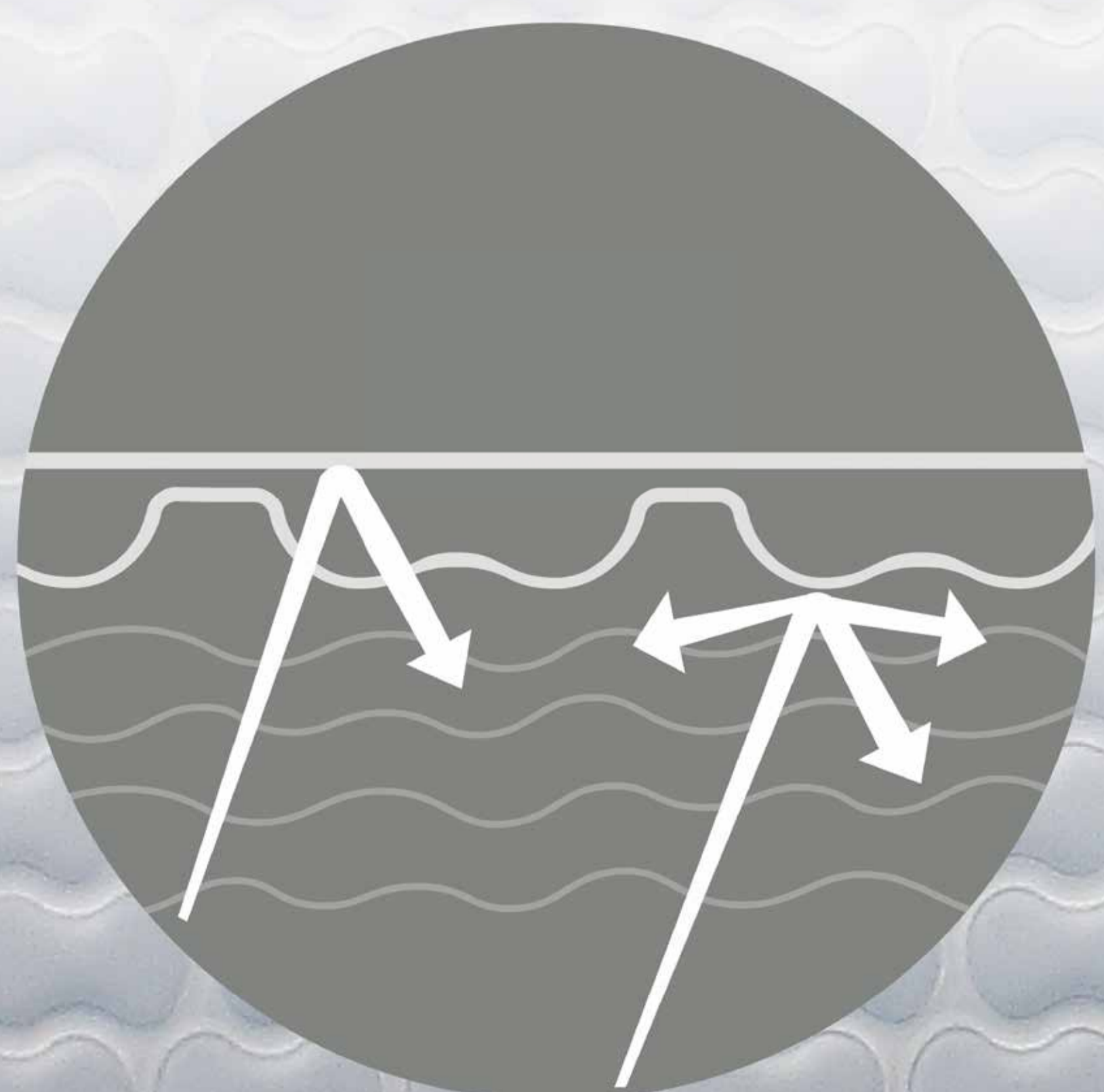
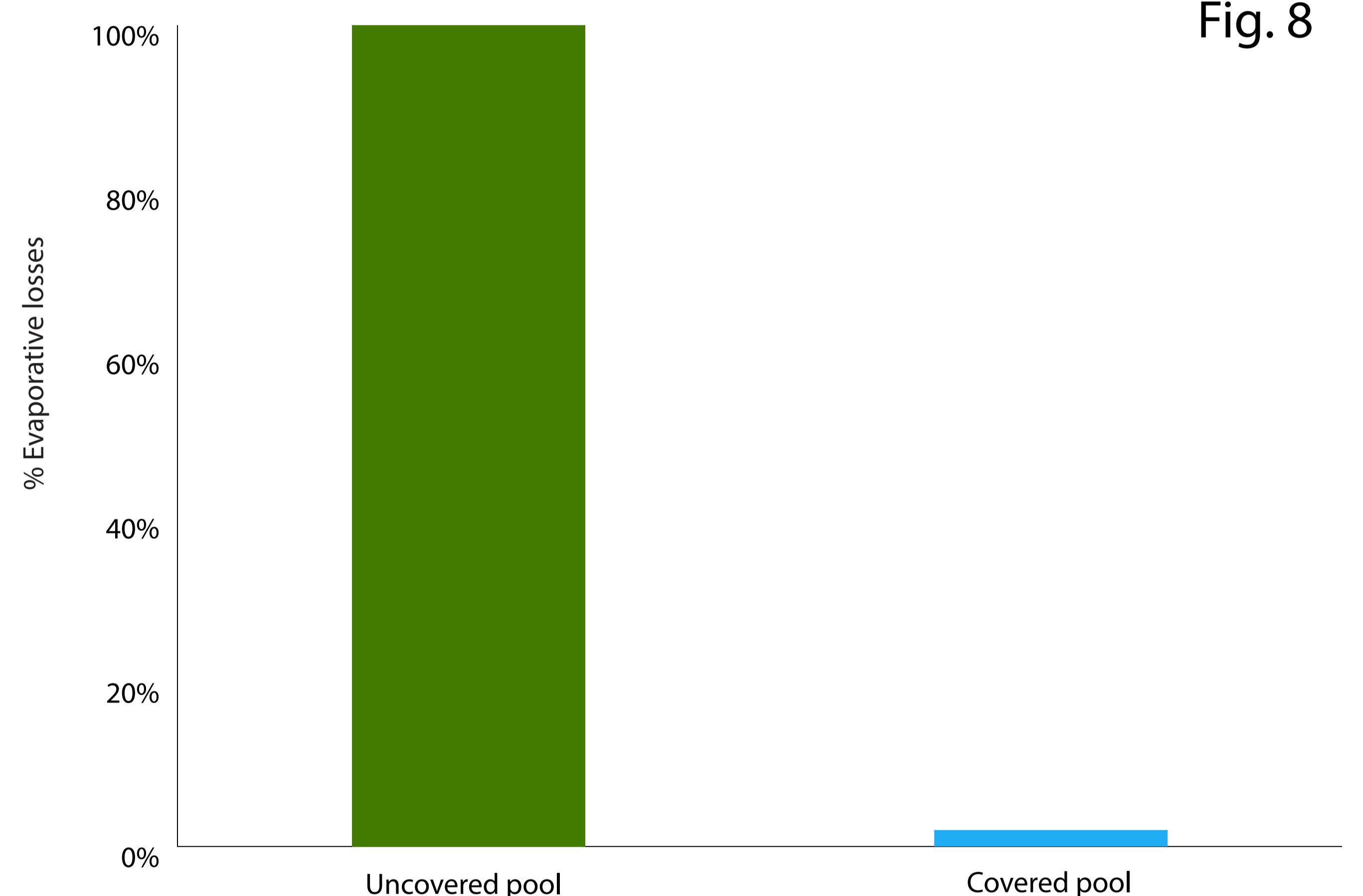
## Evaporation Prevention

By providing a physical barrier to evaporation, GeoBubble™ covers have the ability to eliminate evaporation by up to 98%. This is key to retaining heat as energy is conserved when evaporation can no longer occur.

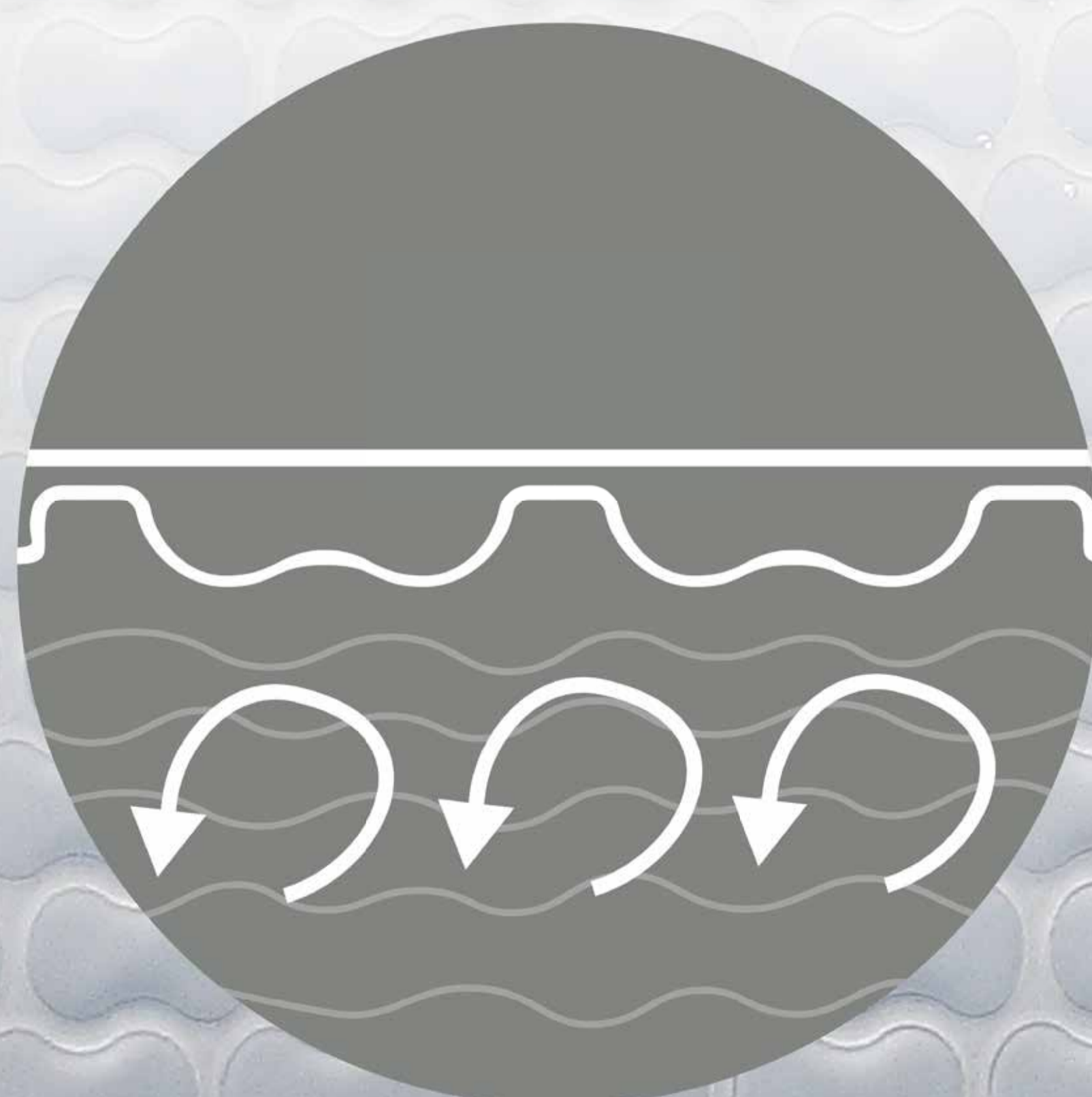
To investigate a GeoBubble™ cover's ability to curb evaporation, tests were conducted using two unheated outdoor pools, each measuring 1.0 x 1.5 x and filled with 0.4m of water. One pool was covered with RaeGuard™, the other left uncovered to act as a control.

The tank covered with RaeGuard™ showed a 98% reduction in evaporation when compared to the uncovered pool. This equated to a saving of approximately 32,000 litres per year for an average sized outdoor pool of 4m x 8m.

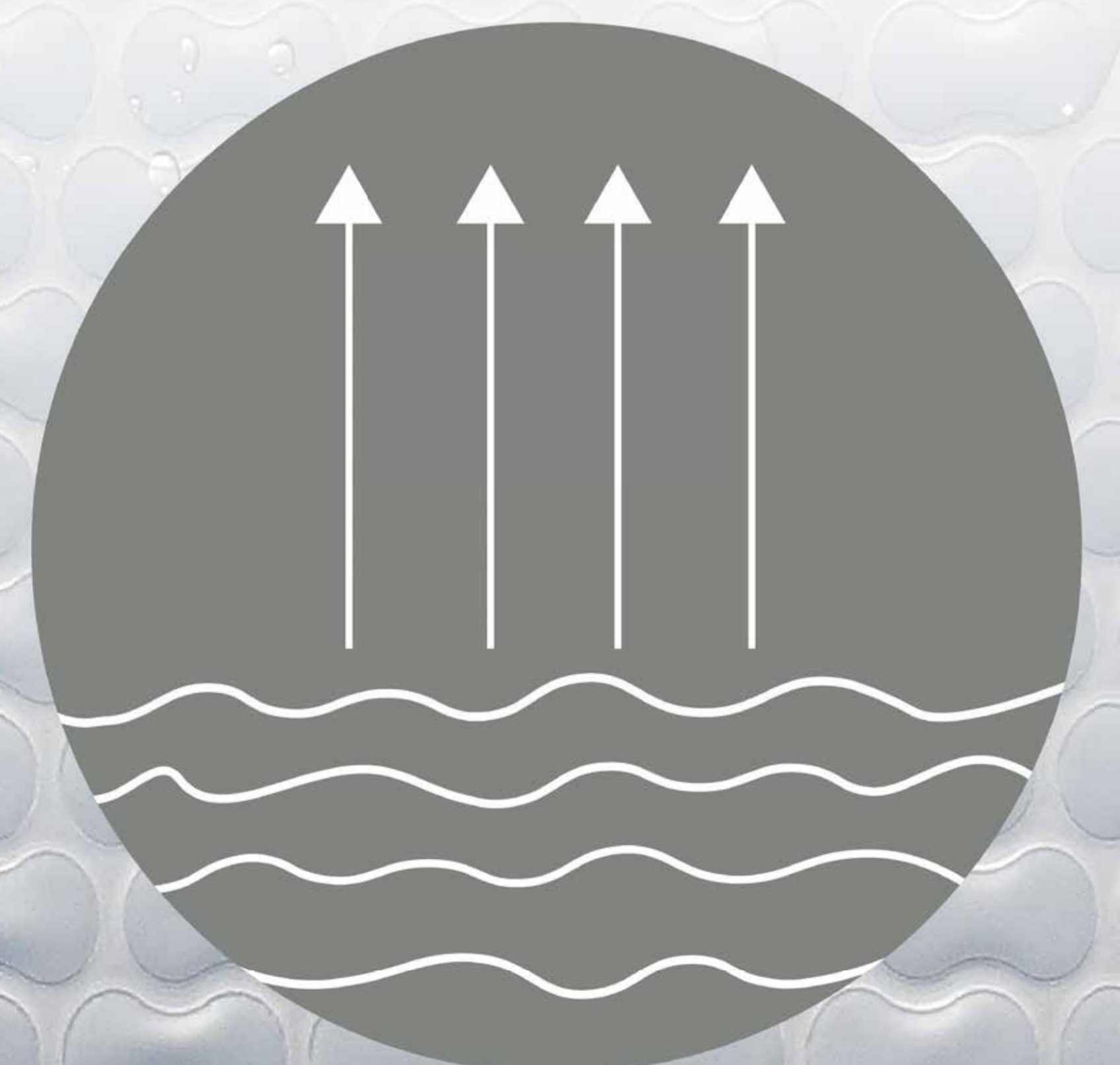
This saving would be considerably higher in hotter climates and in areas subject to high winds. A GeoBubble™ cover eliminates almost all water evaporation, saving significantly on water consumption. In addition to this, by removing the evaporative cooling effect that occurs when water is converted to vapour a pool will retain heat for longer.



**REFLECT**



**INSULATE**



**ELIMINATE**

## What is GeoBubble™ technology?



The GeoBubble™ material has a geometric bubble shape developed specifically for swimming pool covers, increasing the material's longevity and boosting overall performance.

Traditional bubble designs exhibit excessive thinning at the corners resulting in a far more vulnerable material susceptible to premature degradation.

The smoother shape of the patented GeoBubble™ technology eliminates these weak points with a material 50% thicker at its thinnest points than those using the traditional bubble designs. With the inclusion of a larger air cell profile and addition of a structural arch to withstand air expansion and prevent bubble collapse, combined with Plastipack's UV anti-oxidising additive packages, the material's lifespan has been increased by over 25%.

RaeGuard™ joins our high-performance Guard range of products and is suitable for both indoor and outdoor use. RaeGuard™ covers are warranted for 6 years when installed on a chemically balanced and well-maintained pool.

*Figure 9. RaeGuard™ pool cover material is immediately recognisable by its Reflective Silver top surface and Titanium White bubble layer. These pigments were specially selected for their reflective properties.*

Find out more at  
[www.geobubble.co.uk/raeguard](http://www.geobubble.co.uk/raeguard)

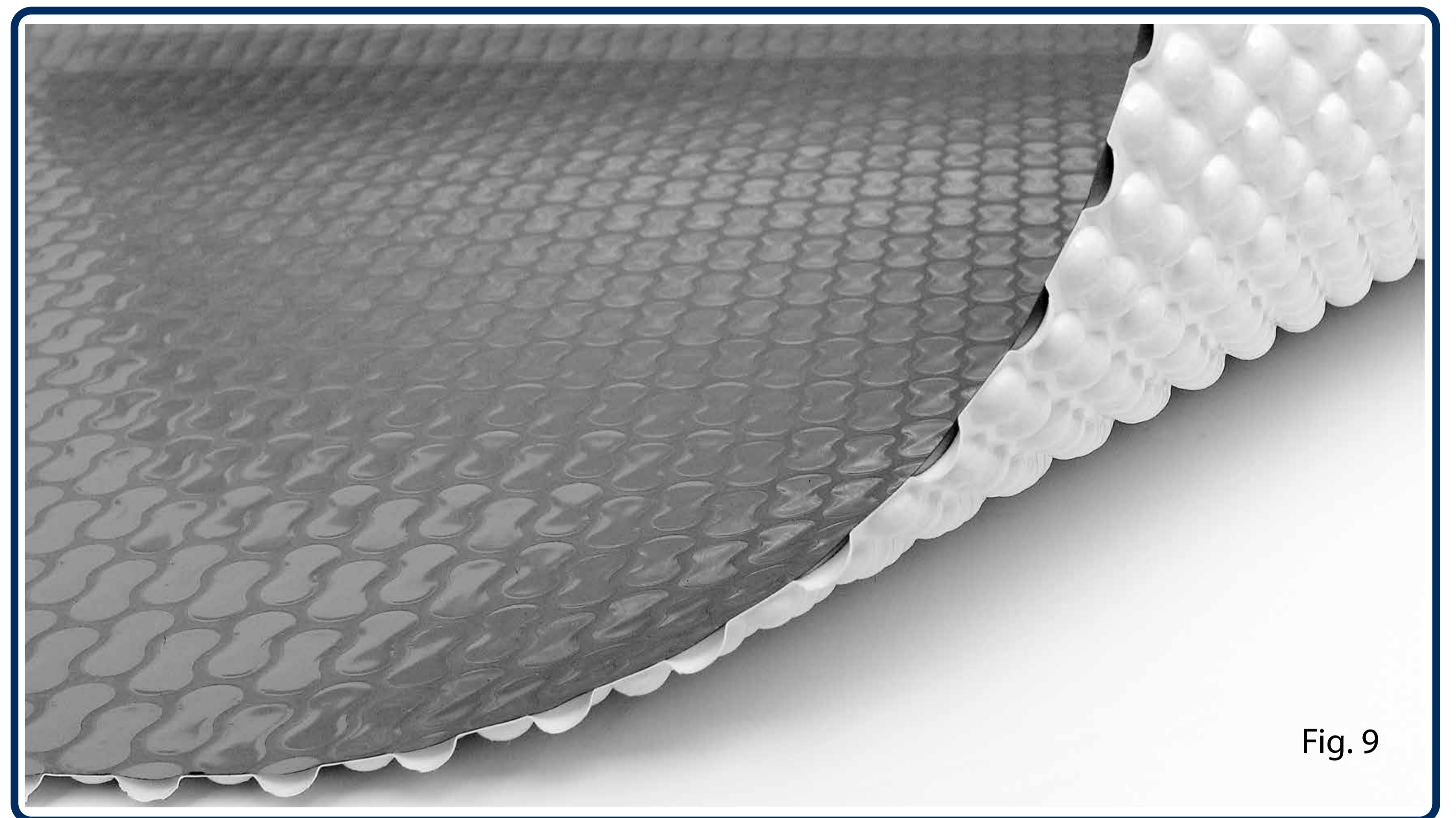


Fig. 9



RaeGuard™ material uses scientifically proven techniques and innovations like the GeoBubble™ to make the product a resource saving material. All testing was carried out using strict scientific methods, to ensure the findings of this report are accurate. To see more information about CoolGuard™ covers please visit [www.plastipack.co.uk/raeguard.php](http://www.plastipack.co.uk/raeguard.php)

CoolGuard™, EnergyGuard™, Sol+Guard™ and VapourGuard™ materials are manufactured by Plastipack Limited. EnergyGuard™ is a Registered Community Trademark No. 007290241. © Illustrations are copyright Plastipack Limited. Patent applied for EnergyGuard™ No. 0820440.6, CoolGuard™ No. 0820437.2, Sol+Guard™ No. 820435.6 and GeoBubble™ No. PCT/GB2010/001851