

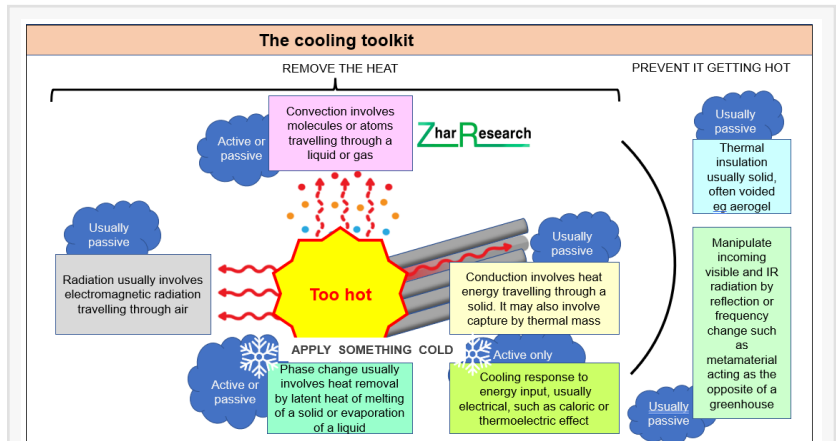
# Leading Developers in the Emerging Cooling Market

*Having caused global warming we use more air conditioning to keep cool, whilst aircon raises city temperatures by up to a further 3°C, so what can we do?*

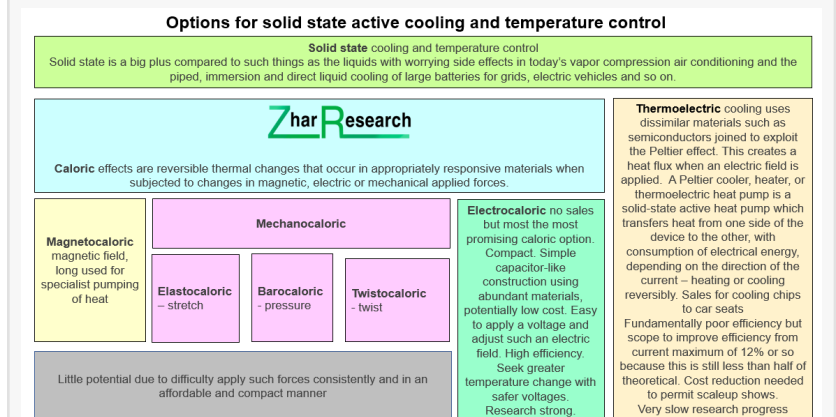
LONDON, ENGLAND, UNITED KINGDOM , July 31, 2023

/EINPresswire.com/ -- Having caused global warming, we use more air conditioning to keep cool. People are moving to cities and that aircon – too expensive for many - raises city temperatures by up to a further 3°C . The refrigerants used in air conditioning, refrigerators and freezers are being replaced with ones that do not damage the ozone layer or cause global warming but some of the new refrigerants have toxic precursors and by-products on wrongful disposal. Time for a Tesla of cooling.

When Tesla first appeared, the incumbents derided the cost of electric vehicles, missing the point that costs would tumble and new laws would make competitors give Tesla billions. The full cooling analysis is in new Zhar Research reports, "[Passive Cooling Materials and Devices: New Markets 2023-2043](#)" and "[Active Cooling: Large New Materials, Systems Markets 2023-2043](#)".



A simplified version of the cooling toolkit. Source Zhar Research report, "[Active Cooling: Large New Materials, Systems Markets 2023-2043](#)" [www.zharresearch.com](http://www.zharresearch.com).



Options for solid-state active cooling on current evidence but this situation may change radically. Source Zhar Research report, "[Active Cooling: Large New Materials, Systems Markets 2023-2043](#)" [www.zharresearch.com](http://www.zharresearch.com).

Dr Peter Harrop, CEO of Zhar Research says, "The certainty is global warming will not be

reversed for a very long time. People seek more cooling as part of raising living standards and in places like India, where 50°C excursions are becoming more common, it can be a matter of life and death. Despite the financial and human costs, the incumbents are not working enthusiastically on the many alternatives that are potentially cheaper and cause less or no heating. The situation is wide open for a Tesla in the cooling industry.”

So what are these alternatives? Zhar Research paints this picture. None

have refrigerants. Most are passive – needing no power at all and causing no heating. However, many are active and these are mostly solid state and a few use benign liquids not under pressure. There will be no one-size-fits-all. For example, thermoelectric cooling is solid state and good for cooling the imminent 1kW microprocessors but it is proving tough to rid thermoelectrics of materials with toxic by-products and make it scale economically.

Scale up a bit on that to include the hotter smartphones and other devices arriving and medical dressings that cool. Here emerging passive cooling options include heat sinks, heat pipes, vapor chambers, metamaterials and hydrogel. Largest still and we get to the big money on vehicles, buildings and infrastructure. Here we must consider Passive Daytime Radiative Cooling PDRC, Insulated Cooling with Evaporation, Radiation ICER, Janus JET, Anti-Stokes and various conductive, convective and phase change options – all passive. Add to that active cooling reinvented as electrocaloric, barocaloric, mechanocaloric, electrochemical, phase change, direct liquid cooling, optofluidic, radiative electrochromism, switchable and multimode optofluidics, switchable phase-change reflection and active window cooling to name just a few.

Zhar Research identifies the best candidates for new multi-billion-dollar businesses and the leading developers, many of them startups. However, it is too early to pick a technology with the most revenue and a developer with the best prospects.

Dr Harrop adds, “Clearly buildings will remain the largest value market for cooling and combined solutions including heat insulation and ancient breeze-trapping and convective designs have a place. Sometimes cooling the person rather than the surrounding makes sense and many new technologies are arriving for just that. Active cooling is often stronger and very low-cost electricity from solar power on windows, driveways, vehicles and more will make active cooling economically viable as long as it does not cook our cities. Nevertheless, it is unacceptable to have conventional aircon tripling by 2050, 4.5 billion air conditioning units worldwide consuming 13% percent of all electricity if not improved. Cooling of buildings currently accounts for roughly

**SWOT appraisal of Passive Daytime Radiative Cooling PDRC**

New arrival PDRC cools an object on the earth by emitting thermal infrared radiation to the cold universe through the atmospheric window (8–13 μm). SkyCool Systems is a startup that is commercializing radiative cooling technologies. SkyCool panels have been applied to some buildings in California, reducing energy costs. The company has received a grant from the California Energy Commission for further application opportunities. 3M developed selectively-emissive passive radiative cooling film applied through pilot programs that are still open. Tested on bus shelters, it achieved 10–20% energy savings when deployed on SkyCool panels. Radiative even for cooling apparel and a primary reason why we see radiative cooling dominating passive cooling markets eventually. Technology readiness level 1-4.

Strengths	Weaknesses
<ul style="list-style-type: none"> <li>No power needed</li> <li>Stronger effect than simple radiative heat loss</li> <li>PDRC has been tested and applied for indoor space cooling, outdoor urban cooling, solar cell efficiency, power plant condenser cooling, among other applications.</li> <li>Precursor materials are often low cost, commonplace.</li> </ul>	<ul style="list-style-type: none"> <li>Difficult to implement and usually requires complicated structural designs, such as photonic crystals, fragile aerogels and metamaterials, which are neither cost-effective nor scalable and can have limited life in the envisaged structural, open-air applications, particularly many of the proposed polymer versions lacking strength, UV stability etc.</li> <li>Getting a low temperature just under your roof is one thing. Cooling your house is quite another.</li> <li>Cost, size. Must face in one direction – to space.</li> <li>Weakened by condensation, rain, humidity, cloud cover. Intermittency</li> </ul>
Opportunities	Threats
<ul style="list-style-type: none"> <li>Combine PDRC, reflection and thermal insulation in one structural composite</li> <li>Reduce cost</li> <li>Self-switching versions such as heating and cooling</li> <li>Viable colored versions</li> <li>Huge variety of potential uses - cooling water, aircon, chemical industry, long duration energy storage, apparel. Integrate with a building's HVAC or refrigeration system.</li> </ul>	<ul style="list-style-type: none"> <li>Passive cooling alternatives at lower cost</li> <li>Active cooling alternatives that are more effective and have lower total cost of ownership TCO</li> <li>Tough to avoid optimal PDRC involving heat absorption</li> <li>"Overcooling" is cited as a side effect of PDRCs that may be problematic, especially when PDRCs are applied in high-population areas with hot summers and cool winters, characteristic of temperate zones, where most of us live.</li> </ul>

SWOT appraisal of PDRC. Source Zhar Research report, "Passive Cooling Materials and Devices: New Markets 2023-2043" [www.zharresearch.com](http://www.zharresearch.com).

10% of global energy consumption and it is the fastest-growing end use of energy in the building sector. In particular, solving the retrofit problem is more important than fitting reinvented cooling technology on the much smaller number of new buildings.”

What'll be the impact on suppliers of traditional vapor compression cooling materials when a Tesla arrives? In the old car industry, those supplying lubricants, anti-freeze and diesel engines have had modest success in pivoting to supply electric vehicle needs such as electric motors such as Cummins. Nonetheless, Tesla prefers to see most parts as key enabling technology best kept in-house, including cooling its motors, batteries and control electronics. Lessons for those supplying refrigerants, pumps and piping systems for cooling buildings and white goods?”

Harrop surmises that, “The Tesla of cooling may be an expert in what is variously called structural electronics, multipurpose smart materials and multifunctional composites. Not necessarily a startup for that is the world of DuPont, 3M, Asahi Kasei and other giants nowadays. Indeed, an outer layer of a building or window may be self-cleaning, self-healing and have other attributes beyond cooling. See Zhar Research report, “Self-Healing Engineering Markets, Technology 2024-2044”.

To bring these megatrends alive, let us consider two of the many breakthroughs in 2023. Solar panels are increasingly put on lakes because that cooling sharply increases their output. No water available? Well, India's TriNANO Technologies has just announced a nanocoating for solar modules that lowers the panel temperature by 2-3°C compared to non-coated panels. It also increases power generation by up to 4% owing to its light trapping, anti-reflection and self-cleaning properties. A 10MW solar power plant with nanocoated panels would generate additional yearly power of 720MWh – in India garnering an extra \$20,737 per year. These results have been verified by three independent institutes worldwide and the dry process can be applied to existing panels.

PDRC materials need to combine a high solar reflectance to reduce solar energy gain and a high infrared emittance to increase radiative heat loss. If they are used as fabrics, the materials need additional properties such as flexibility and breathability. Tough one, but this year [Harbin Institute of Technology, China](#), announced such a magical fabric based on cotton polyester fiber dipped in precursor solution made by grinding barium sulfate, titania or silica with polyvinylidene difluoride (PVDF) and N-methyl pyrrolidone (NMP) microparticles. This metafabric reached temperature drops of up to 12.6 °C. That means passively-cooling hats, apparel, tents and car covers are in the frame.

Dr Peter Harrop  
Zhar Research  
+44 7850 258317

[email us here](#)

Visit us on social media:

[LinkedIn](#)

---

This press release can be viewed online at: <https://www.einpresswire.com/article/646578245>

EIN Presswire's priority is source transparency. We do not allow opaque clients, and our editors try to be careful about weeding out false and misleading content. As a user, if you see something we have missed, please do bring it to our attention. Your help is welcome. EIN Presswire, Everyone's Internet News Presswire™, tries to define some of the boundaries that are reasonable in today's world. Please see our Editorial Guidelines for more information.

© 1995-2023 Newsmatics Inc. All Right Reserved.