



2013 North American Data Center Cooling Customer Value Enhancement Award



FROST & SULLIVAN



50 Years of Growth, Innovation & Leadership

Customer Value Enhancement Award Data Center Cooling North America, 2013

Frost & Sullivan's Global Research Platform

Frost & Sullivan is in its 50th year in business with a global research organization of 1,800 analysts and consultants who monitor more than 300 industries and 250,000 companies. The company's research philosophy originates with the CEO's 360-Degree Perspective™, which serves as the foundation of its TEAM Research™ methodology. This unique approach enables us to determine how best-in-class companies worldwide manage growth, innovation and leadership. Based on the findings of this Best Practices research, Frost & Sullivan is proud to present the 2013 North American Customer Value Enhancement Award in Data Center Cooling to LiquidCool Solutions.

Significance of the Customer Value Enhancement Award

Key Industry Challenges

Data center cooling poses a major issue for national energy consumption, and at a more granular level, it plays a significant part in a company's operating costs. In a legacy data center, cooling costs can account for 50 percent of a data center's energy expenses. These systems typically use computer room air-conditioning (CRAC) units, which are most often coupled with a chilled water system that provides additional cooling to control hot spots and higher density racks (where there is a larger number of servers per rack). CRAC units often require a raised floor to be installed in the data center, to provide space for cables and airflow under the floor, as well as airflow containment walls or curtains to direct cold air. Cold air is blown up from below to server intakes, and waste heat is ejected. This well entrenched design approach drives very high levels of construction expense, complexity, and inefficiency. Chillers consume the bulk of data center cooling energy, and most new hyper-scale data centers have endeavored to eliminate them entirely. The climate at the location of the data center heavily influences the cost associated with cooling the facility; obviously data centers located in warmer climates are more difficult and expensive to cool.

Addressing these market needs, LiquidCool Solutions has developed a patented technology which involves sealing IT electronics in liquid-tight enclosures. Within these enclosures, all electronic components are bathed in a flow of electrically non-conductive (dielectric), non-toxic, non-corrosive fluid that carries all of the heat away through a central pumping system that can be remotely located from the electronics array; there are no moving parts in the enclosure. This approach eliminates the need for a raised floor and airflow containment; it works equally well in all climates, even in harsh environmental conditions with high particulate contaminant levels. Because of the closed system approach contaminants cannot reach the electronics, so there is no need for air filtration. Because there is no need for fans within the enclosure and because component operating

temperatures are lower, energy usage at the device level can be reduced by up to 25 percent. When reductions for the energy usage in computer room air conditioning and air handling are factored in, total energy consumption in the data center can be reduced by up to 40 percent. The elimination of the more common failure mechanisms for electronic devices through the adoption of this technology leads to longer service lives for the electronics. Devices cooled with this submersion technology experience lower thermally induced stress due to dampened temperature fluctuations, are not subject to the oxidation/corrosion phenomenon that air cooled devices experience, are not susceptible to electrostatic discharge events, have no moving parts to fail or propagate vibration, and generally operate at lower current and power levels. Very high rack power densities can be cooled without the need for auxiliary cooling systems, making this solution ideal for high-performance computing applications. Frost & Sullivan's research clearly shows that customer value is enhanced considerably by using this approach.

Key Benchmarking Criteria for the Customer Value Enhancement Award

The Frost & Sullivan Award for Customer Value Leadership is presented each year to the company with demonstrated excellence in value creation for customers. This Award recognizes the company's focus on enhancing the value that its customers receive by offering a truly innovative product platform, leading to market share growth and ultimately business expansion.

LiquidCool Solutions was recognized under specific criteria: price competitiveness, energy efficiency, solution reliability, ease-of-maintenance, and market penetration potential.

Factor 1: Product ROI and Environmental Conscientiousness

As indicated earlier, in a traditional data center cooling can amount to 30 to 50 percent of the total energy expenditure. Direct energy savings via LiquidCool Solutions' technology are between 70 and 95 percent of the costs to cool. LiquidCool Solutions enables a number of indirect savings such as the elimination of containment infrastructure, including raised floors and containment walls and curtains, and decommissioning CRAC units, chillers, and other active cooling infrastructure components. White space requirements can be reduced as well and repurposed or dedicated to additional server space; through the utilization of this technology, data center design and construction no longer need to be based on cooling infrastructure, as the entire cooling system is contained and compact. Additionally, server life can be extended through constant temperature maintenance and protection from contaminants, for both of these concerns Frost & Sullivan rates LiquidCool Solutions' product as best-in-class. In addition, waste heat can easily be captured, transported, and repurposed to provide hot water for building systems or as a source of heat during cold months where the reduction in energy usage directly translates into a reduction in carbon emissions.

For a new build, this product provides savings associated with the elimination of auxiliary cooling systems and the white space required for cooling infrastructure, it increases server

longevity, and it meets the design-build needs for efficient airflow; this technology implementation is more cost effective than traditional cooling systems in terms of both capital expenditure and operational expenditure, and can be scaled up or down to meet the needs of the installation. For a typical retrofit project that is able to capture only some of these savings, this technology can deliver an attractive return on investment within one year and provide substantial ongoing savings. The University of Minnesota Twin Cities Super Compute Institute has deployed LiquidCool Solutions' technology to cool a high performance cluster of servers, finding that it resulted in significant savings and improved performance.

Factor 2: Ruggedness and Climate-Neutrality

An IT device using LiquidCool Solutions technology is completely enclosed inside a rugged chassis, which protects delicate, valuable server components from environmental contamination. In particularly dusty, salty, or sandy climates, air filtration is a major concern for data center operators and this drives additional capital and operational expense for maintenance of the filtration system, energy costs to overcome the airflow impedance associated with the particulate filtration process and the need to provide humidity control. The technology employed by LiquidCool Solutions eliminates the need for air filtration systems in the data center, further reducing the number of infrastructure systems needed to operate the facility.

As mentioned earlier, climate factors heavily into data center operating costs. Cooling is much more problematic in a facility located in a humid, hot climate, and cooling system failures can have catastrophic results for businesses that rely heavily on their IT equipment to maintain operations and generate revenue streams. LiquidCool Solutions' technology works equally well in any climate and it has been tested for extended periods of time with exposure to ambient conditions ranging from 14 to 149 degrees Fahrenheit while being cooled with dielectric fluid at inlet temperatures ranging from 68 F to 113 F. Where cooling tower water is used as a heat exchange medium to cool the dielectric fluid, inlet water temperatures of up to 110 degrees Fahrenheit provide sufficient cooling for most applications.

This system is easy to transport and ship because the liquid is fully contained within the chassis. Servers cooled using LiquidCool Solutions' product can be located anywhere. The system is contained, and unlike air-cooled systems that rely heavily on fans, it is almost completely silent. Server racks can be located adjacent to office space without having a negative impact on worker comfort and productivity. These factors open markets for cooling that are prohibitively difficult or costly to cool using air-cooled systems.

Factor 3: Serviceability and Rack Density

The LiquidCool fluid connection solution is dripless, allowing for quick disconnects for easy installation and removal of units from racks as needed to accommodate reconfiguration

projects. LiquidCool Solutions' chassis is designed to be future-proof. When servers become obsolete, the old system can be removed and a new generation can be installed without having to change or replace cooling systems.

Extremely high rack power densities can be achieved using this cooling technology. The higher the rack density, (number of servers per square foot), the more powerful the computing applications can be. Data center densities are measured in kW per rack with a typical average today being around 7 kW per rack; LiquidCool Solutions can readily cool more than ten times that power density level. The paradigm shift will be toward finding appropriate ways to deliver enough power to the racks rather than how to provide cooling for the heat that is generated.

Factor 4: Reliability

A key benefit with LiquidCool Solutions is that major causes of server failure can be avoided using its technology. For example:

- Lower operating temperatures facilitate extended server life
- Fewer moving parts, compared to traditional cooling systems, means fewer cooling components that can fail
- Dielectric fluid prevents static buildup or electrical discharges that could damage components
- Oxidation, corrosion, and contamination are avoided through complete server isolation from corrosive agents and conditions

Extended (and ongoing) testing of high performance submersion cooled servers has shown absolutely no degradation of either server components or dielectric fluid. Over 80,000 server device-hours of testing have been completed to date under constant 100% processor loading, with zero system failures. The fluid properties of the dielectric coolant have been routinely monitored during these extended reliability tests and no degradation of electrical, thermal, or mechanical properties has been observed. Based on these ongoing studies and historical records for related applications of the base fluid, the service life of these cooling fluids are projected to be measured in decades rather than years.

Conclusion

LiquidCool Solutions' product addresses many of the major challenges that face today's data center cooling industry. This solution is unique in that it maximizes client value even in hostile environments. All users of LiquidCool Solutions' technology will enjoy cost savings, environmental conscientiousness, ease-of-service, and demonstrated reliability. It is for these reasons that LiquidCool Solutions has been recognized with Frost & Sullivan's 2013 North American Data Center Cooling Customer Value Enhancement Award.

Critical Importance of TEAM Research

Frost & Sullivan's TEAM Research methodology represents the analytical rigor of our research process. It offers a 360-degree view of industry challenges, trends, and issues by integrating all seven of Frost & Sullivan's research methodologies. Our experience has shown over the years that companies too often make important growth decisions based on a narrow understanding of their environment, leading to errors of both omission and commission. Frost & Sullivan contends that successful growth strategies are founded on a thorough understanding of market, technical, economic, financial, customer, best practices, and demographic analyses. In that vein, the letters T, E, A and M reflect our core technical, economic, applied (financial and best practices) and market analyses. The integration of these research disciplines into the TEAM Research methodology provides an evaluation platform for benchmarking industry players and for creating high-potential growth strategies for our clients.

Chart 1: Benchmarking Performance with TEAM Research



About Frost & Sullivan

Frost & Sullivan, the Growth Partnership Company, enables clients to accelerate growth and achieve best-in-class positions in growth, innovation and leadership. The company's Growth Partnership Service provides the CEO and the CEO's Growth Team with disciplined research and best-practice models to drive the generation, evaluation and implementation of powerful growth strategies. Frost & Sullivan leverages 50 years of experience in partnering with Global 1000 companies, emerging businesses and the investment community from more than 40 offices on six continents. To join our Growth Partnership, please visit <http://www.frost.com>.