

Cooling Electronics via Dielectric Fluid Immersion Patent Portfolio



Herb Zien- CEO

LiquidCool Solutions has developed and owns a patent portfolio that centers on cooling electronics via total immersion in a dielectric fluid. Our liquid cooling technology decouples electronics from the room, thereby eliminating fans. We combine a sealed enclosure and standard-size rack, a cost-effective approach that places special emphasis on scalability and rack management. Beyond providing superior energy savings, performance and reliability, LCS technology enables a broad range of unique applications not possible with any other air or liquid cooling systems.

Interview conducted by: Lynn Fosse, Senior Editor, CEOCFO Magazine

CEOCFO: Mr. Zien, what is LiquidCool Solutions? What have you developed?

Mr. Zien: LCS is primarily an IP licensing and technology applications firm. We have developed a series of patents relating to total immersion of electronics in a dielectric fluid. By way of background, the utility industry has been using dielectric fluids for cooling transformers for decades. Some years ago, the founders of LCS, formerly Hardcore Computing, implemented liquid cooling technology for the development of over-clocked gaming machines. No cooling technology dissipates heat produced by electronics more efficiently other than immersing all heat-generating components in the cooling fluid. Today, there are four companies that do this and LCS is one of those four.

CEOCFO: Would you please explain what the cooling fluid is?

Mr. Zien: Probably 98 percent of all datacenters are cooled by blowing air over the electronic equipment, then converting that energy to heat. One could surmise, if you put in 100 watts of energy, 98 watts turns into waste heat that needs to be rejected someplace. For desktop computers and laptops this heat is rejected to the room and hardly noticed except for the fan noise. For data centers, the rejected heat is a very large issue. Fans take a great deal of space and use far too much energy. By introducing air to the electronics, fans promote oxidation, corrosion and equipment failure. The best way to solve these problems is to eliminate fans altogether. LCS does this by using a dielectric fluid, a liquid that does not conduct electricity. Unlike water, which immediately shorts out electronics, a dielectric fluid has no negative effect. Our total immersion technology takes all of the electronic components, including processor chips, memory, power supply and all the components you see on a printed circuit board, and fully immerses them in fluid. The fluid then removes the heat by pumping it out of the room. Data center owners have been putting up with a very inefficient air cooling systems for a long time, an antiquated technology that is far too expensive in terms of energy cost, capital cost, space and reliability. This makes the movement away from air cooling and toward liquid cooling inevitable. The question is when.

CEOCFO: Is your system in use today? If so, where? How is it installed??

Mr. Zien: As I mentioned before, one of the keys is practicality: how to make liquid cooling user friendly. Frankly, one of the impediments has been that many of what we call the “embodiments,” shapes and sizes of the IT device and racks, have been impractical. Also, some approaches to liquid cooling impede maintenance and rack management. LCS servers, switches and storage take the form of standard size devices installed in standard size racks. The key is how to get them out of the rack to service them. First, the need for service is considerably reduced, because eliminating fans mitigates most of the root causes of mechanical and electrical failure. Even so, it is necessary to gain access to a device, for upgrades if nothing else, and LCS has come up with a method of quickly and neatly servicing rack-based IT equipment. There is no need for air circulation in the racks, and as a result it is possible to fit much more equipment in the same space. A typical rack, which is what we call a 42U rack, holds 42 IT devices. LCS can fit 64 in that same space. Increased rack density plus the elimination of fan units reduces the footprint of the data center by about fifty percent. In other words it is possible to make the data center half as big and provide the same compute capability.

CEOCFO: Is this being used today? Is it still in development?

Mr. Zien: LCS technology is being used today. Commercial products are available. We license this technology to other manufacturers and they embed it into their products. Some products cooled by LCS technology are available right now. There is a system at the University of Minnesota Supercomputing Institute that has been in service for several years.

There are several embodiments of LCS technology on display at the Microsoft Technology Center in Minneapolis. Other field installations were used to gather test data. In fact, there has been a considerable amount of testing over a period of three years on this technology. During this time LCS engineers collected millions of data points relating to various flow rates and fluid types. Among other things we learned that the dielectric fluid we use moves fourteen hundred times more heat than air on a volumetric basis and, as a result, the amount of energy we use to dissipate heat from a data center is about 98 percent less than a typical chiller/fan system. LCS now has 16 issued and 24 pending patents and, although products are commercially available now, we continue to expand our patent portfolio and hone our competitive advantage.

CEOCFO: *Where does the education process come in? How do you get the people who should know to understand what is going on and to make use?*

Mr. Zien: The people who call us are the early adopters. They either have a genuine curiosity or a special problem that can only be solved using innovative technology. The truth is, from an engineering point of view, using air to cool data centers never made sense. Air is an insulator. Everyone knows that. I learned in seventh grade science that cold air sinks and warm air rises, but most data centers today push cold air up through holes in the floor. These widely used design templates contradict fundamental principles of gravity, natural convection and common sense. Yes, it's possible to make air systems a bit better by tweaking them, but the reality is it's a really bad way to move heat around and there is a lot of heat to move. Data centers use about two percent of the total electrical energy generated in the world. Air cooling represents 40% of this energy, a huge waste considering LCS technology can reduce cooling energy by as much as 98%. Furthermore, LCS-cooled IT equipment can be located anywhere and there are circumstances where waste heat can be recycled. For example, it is possible to install a compute rack in a mechanical room of a hospital or engine room of a ship, and recapture energy to preheat hot water. Computers no longer need to be housed in a conditioned environment.

“Air cooling is yesterday’s news. It was a bad idea to start with and, from an engineer’s perspective, I do not understand why the industry still clings to it. With LCS technology it is possible to reduce energy use, save space, reduce maintenance, and increase reliability, all at a lower upfront cost. The fact that LCS technology can cool one hundred kilowatts per rack is just an added bonus.” - Herb Zien

CEOCFO: *Are your efforts toward the manufacturers to include it? Would you explain what your role is?*

Mr. Zien: Manufacturers we are working with intend to use LCS technology to differentiate themselves from their competitors. The benefits to their customers can take several forms. The LCS-cooled product might cost less or last longer. The value proposition might be greater efficiency or silent operation. For example, LCS is talking to a company that makes baggage scanners for airports. It turns out that baggage scanners burn out after about a year or two because airports are dusty. Dust builds up on the boards and they overheat. By decoupling electronics from the room, LCS eliminates that problem. We also find that some end users are demanding that their suppliers consider LCS technology to meet their specialized requirements, especially those that have a problem that cannot be solved the conventional way. There are two categories: high performance computing and harsh environment electronics. High performance computers bump against thermodynamic limits and cannot use air to cool anymore. As well, electronics deployed in harsh environments, where air pollution causes rapid degradation, can no longer use air for cooling. In both situations, the isolation of the boards from the surrounding air is a key to the value proposition.

CEOCFO: *What are your next steps?*

Mr. Zien: There are five significant differentiators that distinguish LCS from companies promoting air cooling or other liquid cooling technologies. One of them is that we get rid of the fans. Fans are completely eliminated in the IT device chassis, rack, data processing room and mechanical equipment room; that has a major impact on cost, efficiency and reliability. A second differentiator is that LCS technology can cool any electronics: servers, switches, solid-state storage, electric vehicle battery packs, inverters, power supplies, wherever heat must be dissipated, and take any shape or size. On the small end of the spectrum LCS was approached by an electric vehicle manufacturer to cool inverters with a system that fits under the hood of a car. On the large end we are working on a design for a one megawatt prefabricated data module in a space that would otherwise require three modules. Third, LCS technology can reduce data center energy use by 40% and space requirements by 50%, and the upfront capital cost is lower than existing cooling systems. Fourth, LCS is not a manufacturer and we do not compete with firms already operating in the industry. Rather, LCS licenses our proprietary technology to manufacturers so they can better serve their existing customers and gain a competitive advantage to attract new customers. Fifth, with 16 issued and 24 pending patents, our IP moat is wide and deep. Our next step is capitalizing on these differentiators to increase the number of channel partners that take LCS technology to market.

CEOCFO: *Are you funded for everything you would like to do?*

Mr. Zien: There has been significant investment in the company over the past five years from private equity funds and individuals. Our immediate goal is to generate licensing fees by developing close working relationships with channel

partners that will introduce LCS technology to their markets. If we were to raise more capital the funds would be used to open offices on both Coasts and expand marketing activities.

CEOCFO: *How do you deal, personally and as a company, with frustration and knowing that you really have something that could make such a positive change and it is such a long, arduous process to, hopefully, actually get it in use?*

Mr. Zien: That is a good question. It is not enough to have better technology. You also have to have a plan to make people aware that it exists and is practical. One of the biggest challenges is that prototypes can be expensive because we make them in such small quantities and frankly, we make them ourselves. It is difficult to get people to buy into the idea that LCS-cooled equipment could actually be less expensive if made in large quantities by commercial fabricators than the equipment they are using now. That is the most difficult part; how to get people to bridge the gap on understanding. Our answer is to approach the market by solving problems that no one else in the world can solve, where cost is less of an issue. For example, LCS offers the best solution by far for cooling prefabricated data center modules, and the only practical solution for cooling electronic equipment deployed in harsh environments. If the US Navy needs a computing device for a submarine that uses space sparingly, runs silently and recycles waste energy to preheat hot water for the crew, LCS offers the only practical solution. We will start with those tough assignments and work our way back to quotidian applications as volume picks up and costs drop.

CEOCFO: *What should people take away when reading about LiquidCool Solutions?*

Mr. Zien: We were talking about some of the differentiators between LCS and others in the liquid cooling business. The first thing that I think they should take away is that air cooling is yesterday's news. It was a bad idea to start with and, from an engineer's perspective, I do not understand why the industry still clings to it, even for low-power equipment. Smart people have spent a great deal of time and capital making air cooling "less worse." But the sun is setting on this obsolete technology and liquid cooling is coming. With LCS technology it is possible to reduce energy use, save space, reduce maintenance, increase reliability, all at a lower upfront cost. The fact that LCS technology can cool one hundred kilowatts per rack is just an added bonus.

BIO: Herb Zien is CEO of LiquidCool Solutions, a research and development company with an extensive patent portfolio for technologies related to total liquid submersion and directed flow cooling of electronics. Herb has over 30 years of experience in project development, engineering management, power generation and energy conservation. He has been responsible for the development of numerous steam and power production projects, as well as the acquisition and sale of energy-related businesses.

Previously Herb was cofounder of ThermalSource, LLC, a firm that grew to become the largest owner and operator of District Energy Systems in the US, where he was principally responsible for project development and internal growth initiatives.

Herb received a Bachelor of Science degree in Mechanical Engineering and a Master of Science degree in Thermal Engineering from Cornell University, and a Master of Science degree in Management from the Massachusetts Institute of Technology where he was editor of the *Sloan Management Review*.

Articles written by Herb include *Energy Star Data Center: A Missed Opportunity*, published in the November-December 2010 issue of *Mission Critical* magazine; *PUE's Shortcomings*, published in the March-April 2011 issue of *Mission Critical* magazine; and *Liquid Cooled Data Centers Have Finally Arrived*, published in the Sep-Oct 2011 issue of *BICSI News Magazine*.



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