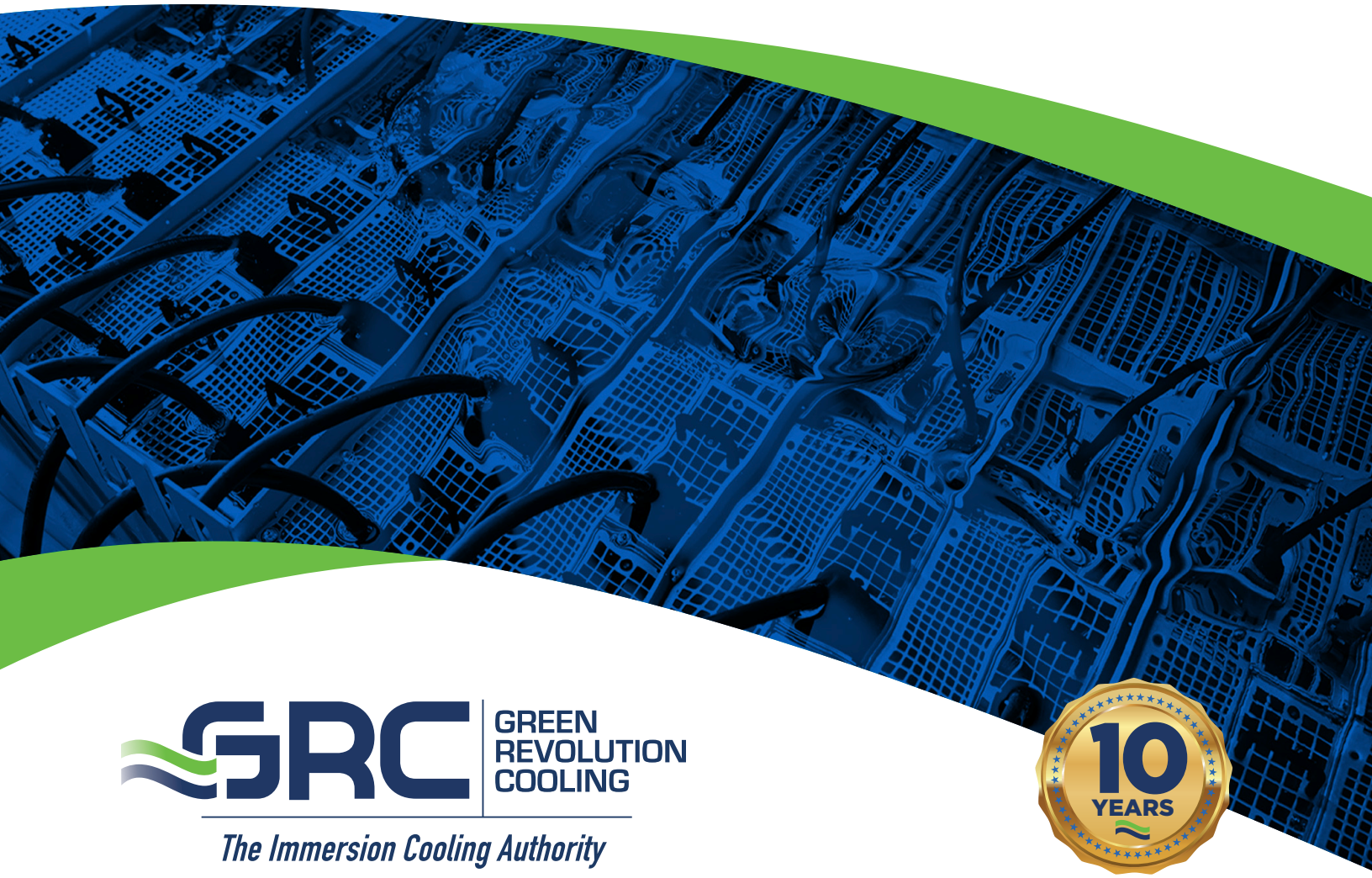
GUIDE

Guide to Data Center Sustainability Metrics with GRC's ICEraQ™

Going Beyond the Traditional Data Center

An analysis of how Green Revolution Cooling's (GRC) technology can help improve the Power, Carbon, and Water Usage Effectiveness (PUE, CUE, and WUE) even at some of the most efficient data centers.



GRC GREEN REVOLUTION COOLING

The Immersion Cooling Authority

10 YEARS

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Introduction

A few years ago, the industry average PUE was well above 2.0, which meant that organizations spent more on keeping systems cool than they spent on powering the servers. But over the years, this PUE number has steadily dropped. This drop has primarily been driven by hyperscale operators who have taken prudent steps towards minimizing their environmental impact. The popularity of free air cooling and the increased flexibility of IT equipment to operate at higher temperatures, has facilitated PUEs of as low as 1.15. While it may seem like the low hanging fruit is gone, technologies like liquid immersion cooling promise to bring in the next wave of efficiency improvement. Given the massive scale and exponential growth of data centers, a further reduction to PUEs below 1.05 can have a huge impact on not just the operating costs but on the carbon footprint and on the water requirements for the data centers as well. This guide will look at how GRC's liquid immersion cooling technology can help your data center reduce energy and water consumption, cost effectively.

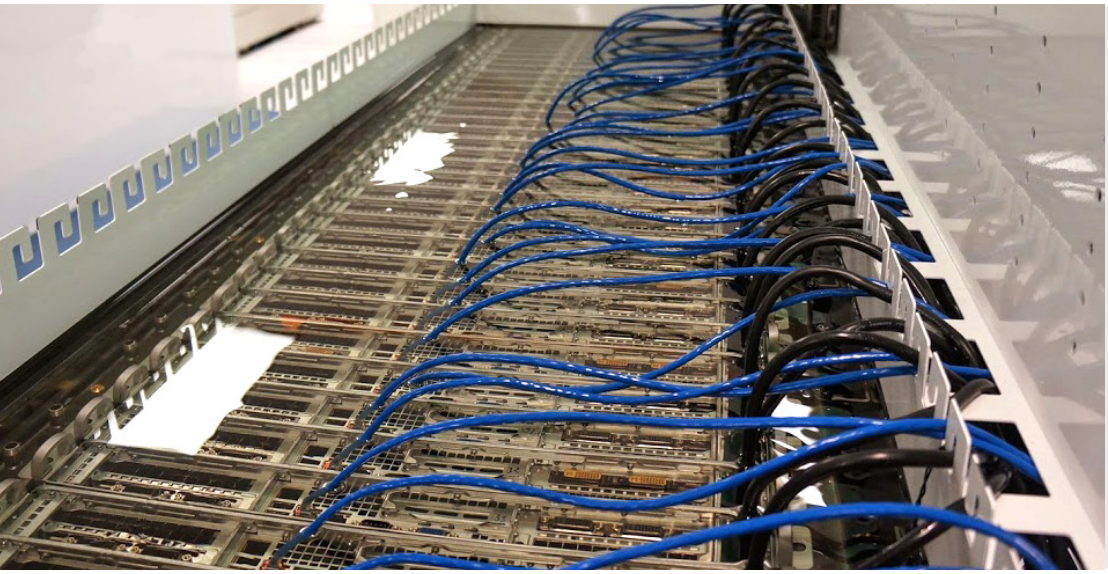
Intro to Liquid Immersion Cooling

Immersion cooling, as the name suggests is where entire servers are immersed in a dielectric coolant. Such methods of cooling have been used for nearly a century in electrical transformers and industrial capacitors. Similar applications of fluid immersion cooling in the world of HPC date back to as early as the 1980s[1]. But concerns regarding the cost, safety, and environmental impact of the coolants used led to limited adoption.

Here Comes ICEraQ

GRC has brought to the data center market an industrial scale, liquid immersion, micro-modular racked-based cooling solution called The ICEraQ. The ICEraQ uses a proprietary dielectric coolant called ElectroSafe, which is a non-toxic, eco-friendly fluid that is a good conductor of heat but not electricity, making it ideal for the cooling of IT equipment. Electrosafe works with servers from any manufacturer, such as Dell, HP, Supermicro, IBM, Intel, SGI, Quanta, and more. The ICEraQ consists of four major components; a horizontal rack, the Coolant Distribution Unit (CDU), the control system, and a cooling tower*. Our ICEraQ is a horizontal rack which comes in 42U or 52U, fiiled with our Electrosafe coolant. Electrosafe captures heat produced by IT equipment and transfers it to a warm water loop via heat exchangers in the CDU.

*Low water use options available in climates where the design dry bulb temperature does not exceed 90°F / 35°C.



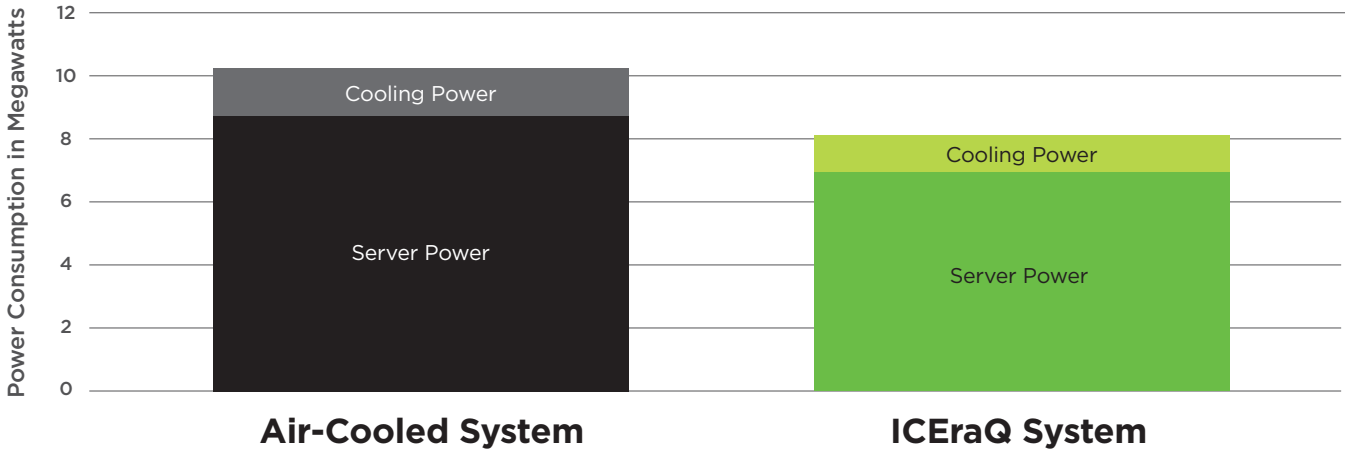
GRC's ICEraQ cooling system in action

Energy Savings

The ICEraQ yields a mechanical PUE of 1.02-1.03. This extremely efficient cooling is enabled by the use of the ElectroSafe coolant that has superior heat conductivity and 1,200 times the heat capacity of air (by volume). The superior heat conductivity means that ElectroSafe is much more efficient in both extracting heat from the equipment and subsequently expelling it out of the data hall. For example, ElectroSafe at 100˚F is as effective at maintaining optimal core temperatures as is air at 70˚F. Further, maintaining ElectroSafe at 100˚F requires significantly less energy than cooling water to 45˚F for air cooling.[1]

Furthermore, the ICEraQ allows reduction in the power consumed by servers as well. This server power reduction is driven by the removal of server fans, and through superior thermal management allowing servers to run cooler. This improvement in energy efficiency directly translates into a lower carbon foot print and reduction in the water required for cooling the data center.

An ICEraQ System Uses Less Power than the Servers Alone in an Air-Cooled System



Emissions Reduction

On average, one kilowatt-hour of electricity purchased in the United States generates about 1 pound of carbon dioxide[3]. Comparing the carbon footprint of an extremely efficient traditional data center (avg. PUE = 1.21), and an ICEraQ enabled data center (avg. PUE = 1.09) of similar computing capacity reveals an annual Carbon emissions reduction of over 10,000 metric tons per annum, a 21% improvement over what is considered an extremely efficient facility.

The reduction in power directly relates to lower Scope-2 and Scope-1 (from diesel generators) emissions on the CDP (Carbon Disclosure Project), helping organizations achieve better scores on the CDP and reach their carbon reduction goals.

Further, the improved energy efficiency and the resulting decrease in carbon emissions, can give organizations access to energy efficiency grants and programs offered by local utilities, or state and federal governments.

21% Reduction in Carbon Emissions

	AIR-Cooled System	ICEraQ
Servers	24,000	24,000
Avg Serve Power	350 W	280 W
IT Power	8.4 MW	7.392 MW
Cooling Overhead	15%	3%
Electrical Overhead	6%	6%
Effective PUE	1.21	1.09
Total Facility Power	10.16 MW	8.06 MW
Energy Consumption (Yr)	89 Million kWh	70 Million kWh
Carbon Emissions (Yr)	50 Million $kgCO^2$ eq	39 Million $kgCO^2$ eq
Reduction w/ ICEraQ		21%
Effective CUE	0.68	0.61 $kgCO^2$ eq/kWh

CUE or Carbon Usage Effectiveness is a metric defined by Green Grid[4]. CUE is defined as follows:

$$CUE = \frac{\text{Total } CO^2 \text{ Emissions caused by the total Data Center Energy}}{\text{IT Equipment Energy}}$$

Water Savings

Apart from the indirect water savings related with the generation of electricity, the ICEraQ also helps directly reduce the water use and requirements at the data center.

> *"Water is tomorrow's big problem. The water consumption (in data centers) is super embarrassing. It just doesn't feel responsible. We need designs that stop using water."*
>
> *-Amazon's James Hamilton*

The ICEraQ enables the use of a hybrid cooling tower or an adiabatic dry cooler, both of which only require additional water when ambient temperature crosses a set point (85˚ – 95˚F). Taking the same example as above, in a data center supporting 24,000 servers the ICEraQ helps save close to 300 million Liters or 80 million Gallons of water annually, that's close to 90% reduction in water consumption. Certain climates allow for the use of dry coolers in place of cooling towers, thereby reducing water consumption to zero. Examples of such installations include VSC in Vienna, PIC in Barcelona, and the US Air Force.

89% Annual Water Consumption Savings

	Traditional	ICEraQ
Total Facility Power	10.16 MW	8.06 MW
Daily Site Water Usage*	908,400 L	101,270 L
Energy Source Water (Yr)**	160 Million L	127 Million L
Site Water Usage (Yr)	332 Million L	37 Million L
Site Water Savings (Yr)		89%
WUE (Site)	4.51 L/kWh	0.57 L/kWh
WUE (Source)	6.68 L/kWh	2.53 L/kWh

*Based on James Hamilton's estimate[5]

**US average of 1.88 L/kWh

WUE or Water Usage Effectiveness is a metric defined by the Green Grid[6]. It can be defined as follows:

$$WUE = \frac{\text{Annual Energy Source Water Usage + Annual Site Water Usage}}{\text{IT Equipment Energy}}$$

Conclusion

Liquid immersion cooling can drastically improve your data center's Power, Carbon, and Water Usage Effectiveness, giving you a head start on your sustainability goals. GRC is supplying industrial-grade liquid cooling solutions to data centers around the world, taking megawatts of power off the grid, increasing server performance and reliability, while reducing the near and long term costs of owning and operating a data center.

References

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To Learn More About How GRC Can Help You Cut Carbon Emissions and Water Consumption While Lowering Build and Operating Costs

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