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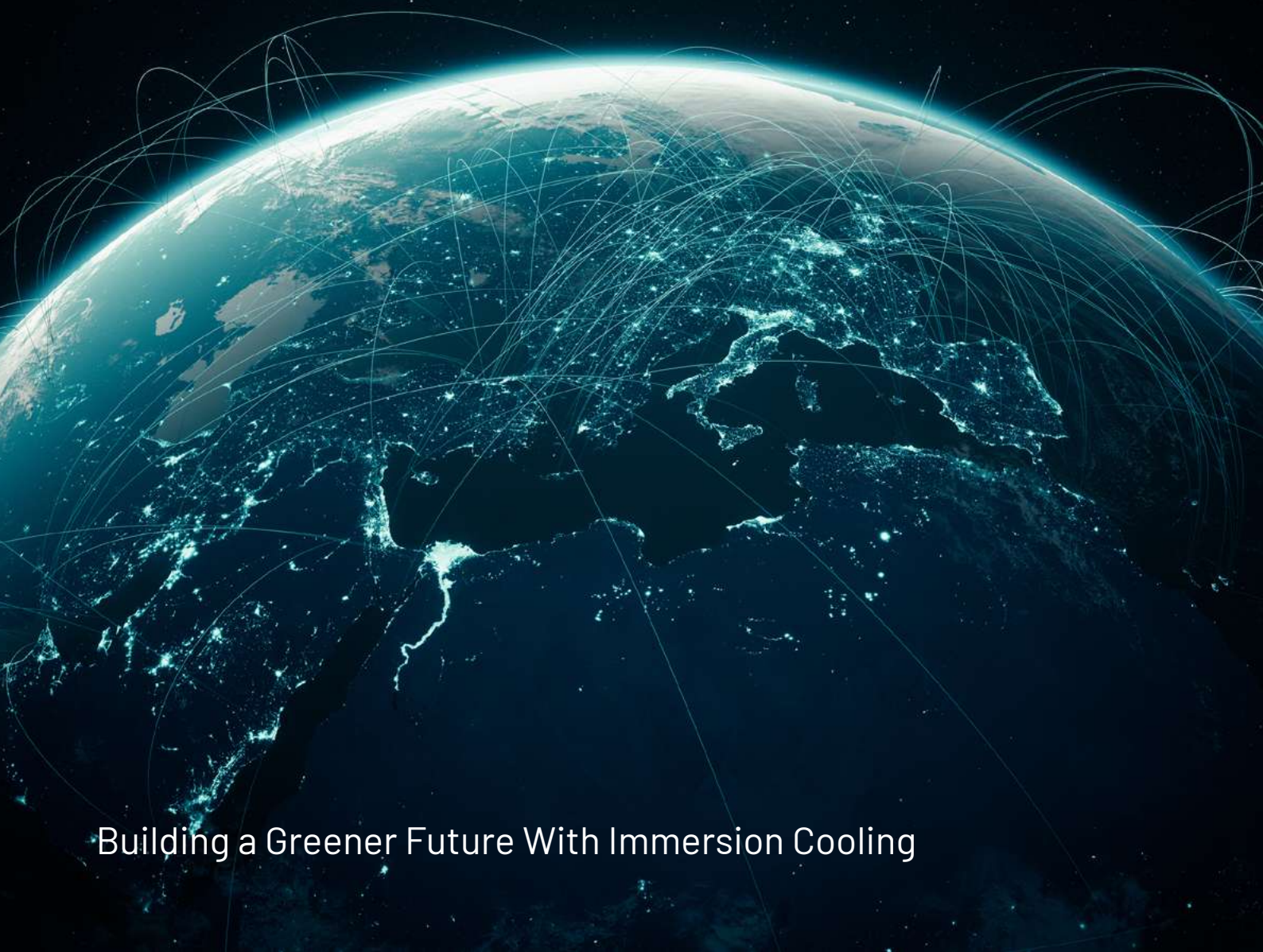
Sustainability With Substance

for Your Hyperscale Datacenter



Building a Greener Future With Immersion Cooling

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Introduction

Hyperscalers are at a critical crossroads. Business is booming and capacity is rising, set to triple by 2028 by Synergy Research Group's forecast[1]. Artificial Intelligence (AI) workloads are one of the key drivers proving a challenge of hyperscale proportions.

Chips – central processing units (CPUs) and graphics processing units (GPUs) – becoming more powerful, more power-hungry, and inevitably more heat-producing. This explains why energy and water consumption are on the up. And why we're seeing legislators from the US to Europe to Asia-Pacific regulating multiple issues, from carbon emissions and power usage effectiveness (PUE) to water consumption and heat reuse. While these directives are only set to get more stringent, they're not the only driver for a greener approach to datacenter operations.

Communities are more conscious of the impact of datacenters on the environment, and they're making their opinions known – for example, in Uruguay[2] and the Netherlands[3]. Companies are taking a closer look at their supply chains, and in an effort to comply with guidelines such as those from the OECD (Organization for Economic Co-operation and Development), they're choosing providers that are transparent and sustainable. Plus, hyperscalers have their own ambitious goals as they strive to be greener while delivering the immense performance requirements of today's and tomorrow's data workloads.

In this white paper, we'll explore the pressures hyperscalers face as enablers of our new world; where sustainability is the Holy Grail, but innovation requires performance at ever-higher levels, pushing resources to the limit and requiring smarter solutions. Plus, we'll see how immersion cooling – the way Submer does it – is a critical component of your sustainable, future-proofed datacenter strategy.

[1] https://www.srgresearch.com/articles/hyperscale-data-center-capacity-to-almost-triple-in-next-six-years-driven-by-ai
[2] https://www.theguardian.com/world/2023/jul/11/uruguay-drought-water-google-data-center
[3] https://www.techerati.com/news-hub/hyperscale-data-centres-under-fire-in-holland/

Assessing the Datacenter Impact

It's indisputable that datacenters are essential to our data-driven lives. But their increasing scale also presents a growing concern for the environment. Datacenters today are inefficient, consuming excess energy and water, valuable resources, and generating waste heat.

There's a need for change. As the Uptime Institute's 2023 Survey states: "Regulations aimed at datacenter energy use require urgent attention, investment, and action." Global electricity use by Amazon, Microsoft, Google, and Meta more than doubled between 2017 and 2021 to reach 72TWh,[2] with global datacenter electricity consumption in 2022 at around 1 to 1.5% of total global electricity demand.[4] And then there's water. It's estimated that a small 1MW datacenter can use around 25.5 million liters of it each year.[5]

Given the backdrop of climate change, government regulation is becoming stricter worldwide. The European Union (EU) Energy Efficiency Directive[6] requires datacenters of 500kW or above to report on energy performance. Within the EU, Germany is taking a lead, with the German Energy Efficiency Act mandating a PUE of 1.2 or less for new datacenters by 2026.[7] In the US, the New Energy Act covers energy-efficiency initiatives for the datacenter industry. Singapore, a major datacenter hub, recently lifted a three-year moratorium on builds, but with strict requirements for highly energy-efficient designs going forward.

> "To reduce the amount of energy used, environmental sustainability requirements for the industry may become mandatory and more stringent over the next decade. This shift may include introducing a carbon tax for companies that do not meet the requirement of net-zero emissions."

451 Research, June 2022

[4] https://www.iea.org/energy-system/buildings/data-centres-and-data-transmission-networks

[5] https://www.iea.org/energy-system/buildings/data-centres-and-data-transmission-networks

[6] https://smartwatermagazine.com/news/h2o-building-services/how-much-water-do-data-centres-use

[7] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ%3AJOL_2023_231_R_0001&qid=1695186598766

There's also pressure from communities, such as the protests seen in the Netherlands where groups including climate activists and farmers opposed new datacenter construction on environmental grounds[8].

So, with investment in new facilities well into the billions of dollars[9], – and in the face of legislation, community opposition, and environmental, social, and governance (ESG) targets – hyperscalers need to plot a sustainable path forward to ensure their very existence. There are many benefits to using sustainable practices in datacenter design and operation. The first, of course, is to reduce environmental impact. In addition, "sustainable datacenters can also save money through reduced energy and water consumption and can improve the reliability and performance of the infrastructure[11]", according to datacenter provider Iron Mountain.

75% of organizations will have implemented a datacenter infrastructure sustainability program driven by cost optimization and stakeholder pressures by 2027, up from less than **5%** in 2022.[10]

Gartner

[8] https://sustainablefutures.linklaters.com/post/102ir6a/the-new-german-energy-efficiency-act-implications-for-data-centers-and-other-com

[9] https://www.techerati.com/news-hub/hyperscale-data-centres-under-fire-in-holland/

[10] https://www.datacenterknowledge.com/buildconstruction/hyperscalers-2024-where-next-world-s-biggest-data-center-operators#close-modal

[11] https://www.gartner.com/en/newsroom/press-releases/2023-05-02-gartner-predicts-75-percent-of-organizations-will-have-implemented-a-data-center-infrastructure-sustainability-program-by-2027

[9] https://blog.datacentersystems.com/the-importance-of-sustainable-data-centers-why-it-matters-for-the-environment-and-your-organization

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Hyperscalers' Carbon Reduction Goals

2040 aws

AWS Climate Pledge plots path to net zero by **2040**.

2030 Google

Google committed to net zero by **2030**.

2030 Meta

Meta committed to net zero across value chain by **2030**.

2030 Microsoft

Microsoft has committed to carbon neutrality by **2030**, addressing both direct and indirect emissions.

Datacenter Sustainability Challenges

Getting to a greener cloud requires understanding what's going on in the datacenter, specifically the key considerations – use of energy and water, heat capture, and hardware lifecycles – in the sustainability landscape.

3.1 Hardware

Optimizing hardware is a top priority for hyperscalers. The rise in chip density and general compute, distributed heat flux workloads, and increasingly hot DIMMs, FPGAs, and many other components means cooling needs are growing exponentially. The impact on total cost of ownership (TCO) is inescapable, and it's why hyperscalers need cooling technologies that ensure the entire IT estate can be properly and efficiently cooled. Rather than refreshing hardware every 3 to 5 years as is typical, hyperscalers must look to new immersion cooling technology that enables them to keep hardware at peak condition for longer, outlasting several IT generations and future-proofing facilities.

3.2 Energy

We've touched on PUE. This is the most commonly used measurement to show how efficient a datacenter is. More precisely, it is the ratio of total amount of energy used by a datacenter facility to the energy delivered to computing equipment. So the lower the PUE, the more efficient the datacenter.

According to the Uptime Institute, while PUE gains have been made over the years (dropping significantly from 2.5 in 2007 to 1.67 in 2014), PUE has remained flat for the 4 years leading up to 2023.[12]

A lower PUE can be achieved through efficient cooling systems. As for reducing energy consumption, investment in areas such as datacenter design, best practices, and new technology is required.

The global average PUE of datacenters has remained flat from 2019 to **2023.**

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3.3 Water

Water usage has historically been a lower priority when it comes to tracking datacenter sustainability, but it's increasingly important as the scale of water use in cooling facilities has grown and water has become more of a scarce resource. Most of the water consumed in the datacenter is for cooling the environment. Water usage effectiveness (WUE) is calculated as the ratio between water used at the datacenter and electricity delivered of the IT hardware.

Along with environmental impacts, the cost of water is also a major concern for hyperscalers. At its San Antonio, Texas datacenter, Microsoft found that, when risk-adjusted, the true cost of the water it was using was 11 times more than it was paying.[13]

Water replenishment schemes are one way that hyperscalers are addressing their water consumption. And most (AWS, Meta, Microsoft) have pledged to be water positive by 2030 or have water stewardship goals in place (Google). But without addressing cooling, massive reliance on water will remain a significant environmental issue. And cost.

AWS, Meta, and Microsoft are committed to being water-positive by **2030.**

> "The datacenter industry has the unique opportunity to be a catalyst for meaningful water stewardship action. While the path(s) toward sustainability is uncertain, bold environmental commitments are driving innovation and engaging stakeholders and investors." [14]

451 Research, June 2022

[12] https://www.businesswire.com/news/home/20230718020841/en/Uptime%E2%80%99s-13th-Annual-Global-Data-Center-Survey-Shows-Widening-Range-of-Challenges

[13] https://oerc.ox.ac.uk/case-studies/the-true-cost-of-water-guzzling-data-centres/

[14] https://www.watertechonline.com/water-reuse/article/14215042/data-center-water-sustainability-and-stewardship

3.4 Heat Reuse

Energy efficiency is a key goal for the smart, sustainable datacenter – and within this, heat reuse is a critical component with potential great implications for carbon emissions. As we've seen, datacenters create a lot of heat – a typical datacenter campus generates enough to power a mid-sized city.[15] In the EU, the Energy Efficiency Directive requires datacenters to recycle waste heat, and heat reuse schemes have gained some traction. For example, district heating initiatives capture waste heat and transfer it via heat exchangers to be reused in other buildings or facilities. These initiatives not only benefit the environment and communities but also positively impact TCO through potential revenue generation for hyperscalers.

While this is no new idea (there are around 60 heat recapture projects currently in action around Europe[16]), reusing heat waste at scale is challenging to implement. Not least because of the new partnerships and technology it requires, as well as the fact datacenters are often located in remote areas.

[15] https://www.achrnews.com/articles/146987-data-centers-get-larger-hotter-making-them-attractive-sources-of-heat#:~:text=Heat%20Centers,power%20a%20mid%2Dsized%20city.

[16] https://uptimeinstitute.com/resources/research-and-reports/heat-reuse-a-management-primer

The heat reuse process centers on the Heat Recovery Unit (HRU) within the Heat Recovery System. This transfers heat to the application of choice, whether heating, hot water, radiant floor, or other. The HRU guarantees optimal energy recovery, and works by receiving the heat generated on IT devices and hardware, and, if needed, increasing the supply temperature, depending on the application requirement.

Heat Reuse in Action: Excess Heat Transformation with W.E. District & RISE

Submer provides modular immersion cooling pods for W.E. District – a coalition of nine European companies that aims to demonstrate that district heating can be built using renewable energy sources – and Research Institutes of Sweden (RISE). The project will capture heat generated by a datacenter in Luleå, Sweden, and repurpose it for the local district heating in the area. The generated electricity will be used to power the datacenter itself.

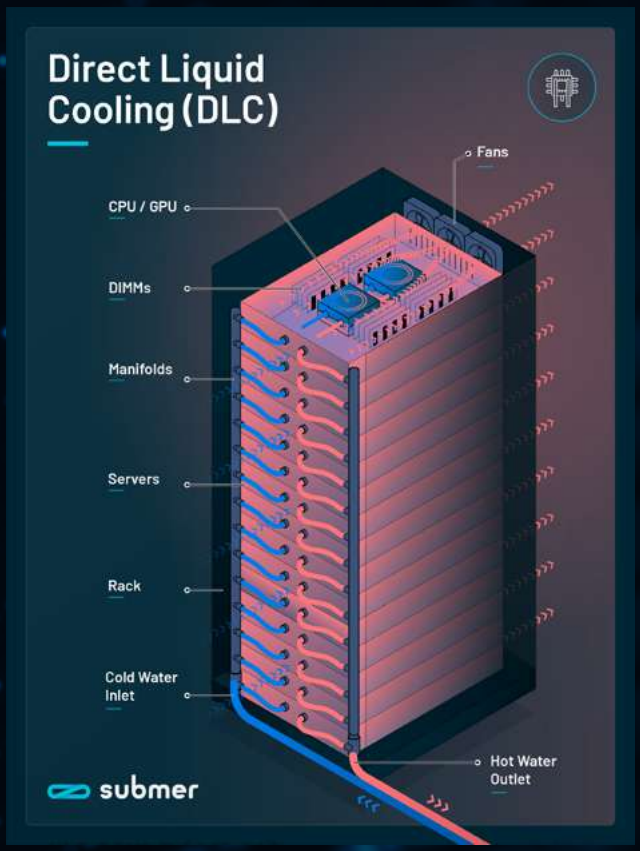
The Game-Changing Cooling Technologies on Offer

As datacenters have grown bigger and hotter, cooling technology has become more and more important for future-proofing hyperscaler sustainability. The transition from air cooling has been driven by the need to handle chips with greater thermal design power (TDP). Today, air cooling is already largely inefficient. Soon, it will be entirely ineffective without the addition of technologies like direct liquid cooling (DLC) or partial immersion cooling.

4.1 Direct Liquid Cooling (DLC)

Also known as DTC (Direct to chip) cooling, DLC marks the next phase in cooling technology, offering numerous benefits for datacenter sustainability. With the capability to effectively manage chips with a thermal design power (TDP) of 400W and above, DLC involves circulating liquid directly over hardware components, including entire servers, to efficiently dissipate heat.

This method represents a substantial improvement over conventional air cooling, resulting in reduced energy consumption, lower carbon emissions, and enhanced sustainability. It also holds promise for heat reuse, further maximizing its environmental benefits.

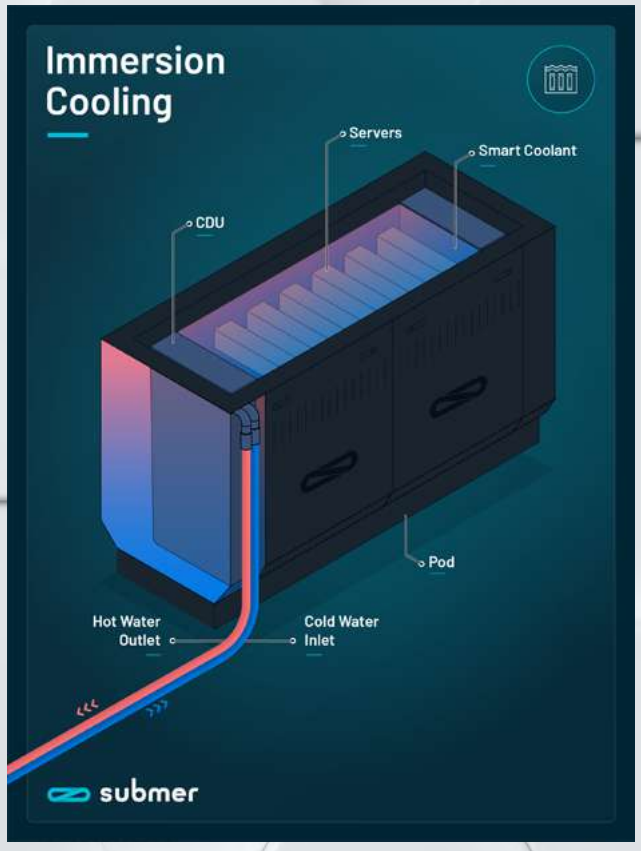


Despite its advantages, DLC presents certain limitations that must be considered. While offering superior cooling performance, it is not a complete solution as it relies on air cooling to manage components that are not compatible with DLC.

Up to 60% of components may still require traditional air cooling methods and while DLC represents a significant step forward in datacenter sustainability, it would benefit from further innovation and optimization in cooling technology.

4.2 Single-Phase Immersion Cooling

Immersion cooling represents the most energy-efficient way to cool at scale. By submerging hardware in a specially formulated dielectric coolant, heat is transferred directly from components. This method has high heat dissipation capacity, is safe to use, and is compatible with any IT hardware. It's a game-changer for datacenter sustainability and provides competitive TCO advantages: no overhaul of infrastructure required, support of multi-vendor hardware, and significant energy savings once operational.



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4.3 Two-Phase Immersion Cooling

While it provides heat dissipation capacity similar to single-phase, two-phase immersion cooling requires complex filtration systems and expensive fluid. Most significantly, it uses poly-fluorinated alkyl substances (PFAS), which are toxic, bioaccumulative chemicals that can't be broken down by natural processes. As a result, the two-phase system, while effective at cooling, is problematic because it poses an environmental and health risk. This is why the manufacture and use of two-phase cooling are subject to regulations across the globe. The European Chemicals Agency has proposed restrictions on PFAS. 3M is set to halt production of the chemicals in 2025. And in both the US and Europe, the scale of contamination is being regularly tracked.

This supports the choice of single-phase immersion cooling as the technology of choice for the datacenter.

> "I believe there's been more energy around immersion cooling in the last year that I've heard in a very long time,"
> "I think the time is now."

Zane Ball, Corporate VP and General Manager Datacenter Engineering and Architecture, Intel

> "Air cooling is not enough. That's what's driving us to immersion cooling [...] Liquid cooling enables us to go denser, and thus continue the Moore's Law trend at the datacenter level."

Christian Belady, Distinguished Engineer and Vice President, Microsoft Datacenter Advanced Development Group

Submer: Leading Immersion Cooling Innovation

Born from years of experience in traditional datacenters and a passion for a greener future, Submer has developed immersion cooling technology that's transforming datacenter sustainability by addressing energy efficiency, carbon emissions, water management, and circularity.

- A unique 3-stage heat transfer approach: Heat from hardware is transferred to the coolant; from coolant to water; and from water to any number of possibilities for reuse.
- Ground-breaking Forced Convection Heat Sink (FCHS) technology means we're one step closer to cooling 1000W+ chips.[17]
- PUE of less than 1.10, reducing servers' energy consumption by over 5%, with less leakage current and no fans, and helping hyperscalers meet energy efficiency targets.
- Transforming water management, with reduction in both direct (cooling, facilities, humidification) and indirect (energy, water treatment) water consumption.
- Providing a boost to hardware lifespans – no moving parts, no dust, no vibrations – and easy integration to heat reuse solutions, increasing circularity.
- Immersion cooling is resilient to higher environmental temperatures and leads to reduced emissions, while dry coolers and closed-loop water circuits mitigate water wastage.
- Proven reliability as seen at Telefonica's datacenter in Madrid that experienced record-breaking temperatures, but maintained 100% redundancy, improved hardware performance, and a PUE of below 1.08.

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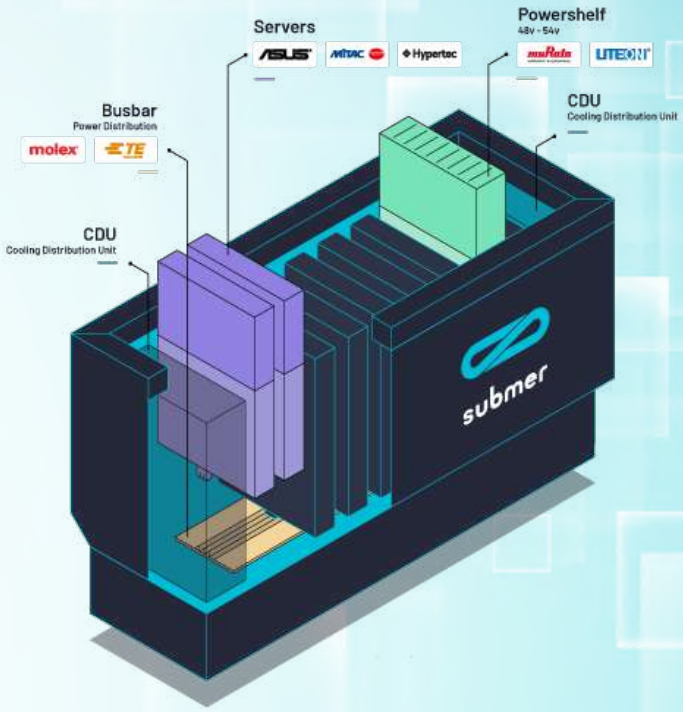

SmartPod EVO: Plug & Play Immersion at Scale

- Efficient and sustainable
- Easy to deploy
- Smooth and predictable IT operations
- The easiest path to immersion cooling!

SmartCoolant

Our in-house developed synthetic dielectric fluid tailor-made for immersion cooling. Readily biodegradable, it has a Global Warming Potential (GWP) of 0 and a projected lifespan of 10 to 15 years.

Submer: Part of Your Sustainable Supply Chain

At Submer, we're not just cooling experts; we're a strong link in your sustainable supply chain.

- Equipment aligned with the EU Taxonomy technical screening criteria for sustainability, enabling datacenter operators to meet their own sustainability requirements
- 2 out of 3 investors are impact investors
- A top-100 impact company

[17] Intel and Submer Illuminate the Path to Immersion Cooling for 1000W TDP

Conclusion: Cooling Our Data-Driven Future

Datacenter sustainability matters to us all. To continue benefiting from data-driven experiences and solutions, we need the performance that large-scale datacenters give us. But we need to get there in the greenest way possible. This is evidenced by hyperscalers' sustainability pledges, governments' evolving regulation, and community action and concern.

The challenge before hyperscalers today is balancing performance and sustainability.

At Submer, we're cooling experts - but adopting our immersion cooling solutions doesn't mean going at it alone. We're here to support you in using our technology as part of your sustainability strategy, so that, together, we can create climate-resilient datacenters that can power a digital tomorrow.

Discover all you need to know about our immersion cooling solutions here.


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