Hydroleap

Re-imagining Water & Energy Efficiencies for Data Centers through Hydroleap's Proprietary Electrooxidation Technology (HL-EO-CT)

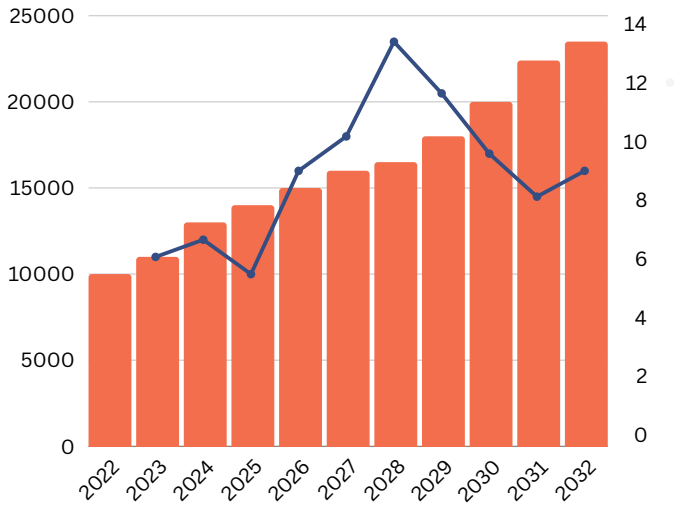
Growth Trends :
Global Data Center

The global data center market is expanding rapidly, driven by increasing cloud adoption, AI applications, and data localization requirements.

The market is projected to grow at a CAGR of 9.3% from 2023 to 2032, with hyperscale and colocation data centers fueling this expansion.

This surge intensifies demand for sustainable cooling technologies to manage rising energy and water consumptions.

Data Center Cooling market: Revenue Forecase, Global, 2022-2032
Revenue CAGR, 2023-2032 - 9.3%

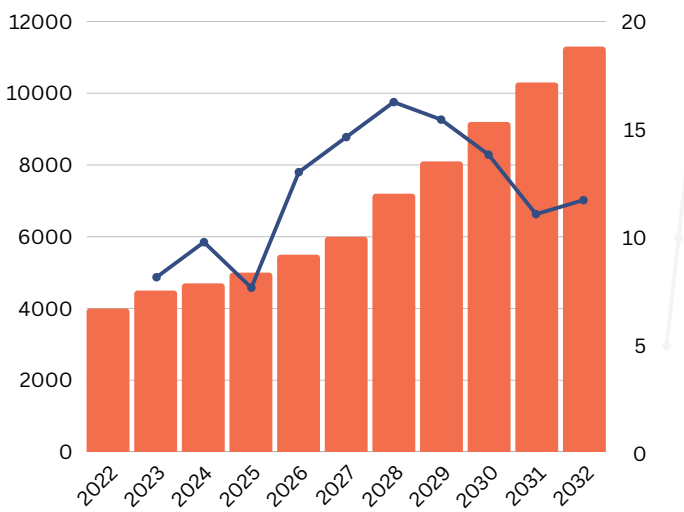


Southeast Asia Data Center

Southeast Asia's data center market mirrors global growth trends, with a projected CAGR of 11.7% from 2022 to 2032, driven by rapid digitalization and IoT proliferation.

This expansion places substantial pressure on infrastructure, particularly in energy and water consumption for cooling systems.

Data Center Cooling Market: Revenue Forecast, APAC, 2022-2032
Revenue CAGR, 2023-2032 - 11.7%



Implications of Data Center Growth

The rapid expansion of the data center industry presents growing environmental and operational challenges. Energy and water use are increasingly critical factors in how national and local authorities assess both existing facilities and new developments.

01 Cooling Demand & Water Consumption

Rising server densities generate more heat, intensifying the demand for cooling.

Most current systems rely heavily on water to manage thermal loads. Without efficient control, water consumption can strain local resources and elevate operational risks.

02 Environmental & Operational Impact

Beyond IT Load, cooling systems account for a substantial portion of total data center energy use; contributing to CO_2 emissions and negative environmental impacts.

Paired with rising utility costs and water scarcity, this proves the need for more sustainable solutions.

03 Need for Sustainable Solutions

As computational demands grow, so does the urgency to adopt technologies that enhance water and energy efficiency.

Despite the emergence of immersion cooling, over 95% of existing and new facilities still use water-based systems. This underscores the continued need to innovate water treatment and thermal management practices.

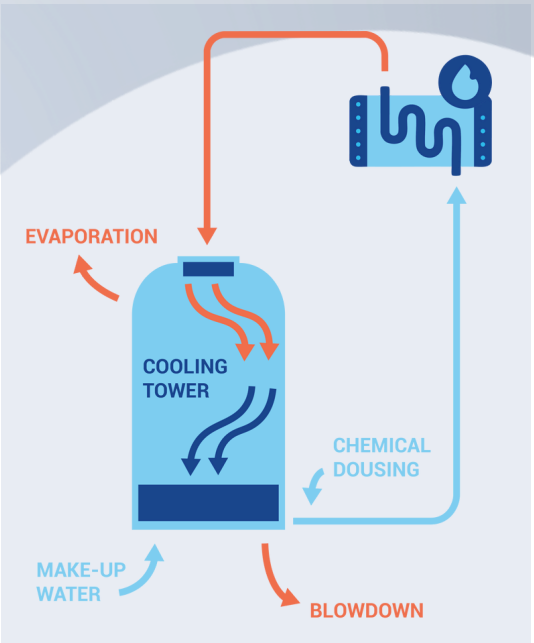
Data Centers and Cooling Towers

Cooling towers are widely used in data centers to manage heat by cooling water through air contact and evaporation (open-loop or closed-loop). While this system is common, it presents several challenges that affect both operational efficiency and environmental impact.

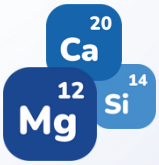
Basic Functionality of Cooling Towers:

Cooling towers operate by recirculating water that absorbs the heat from chillers and transfers it to the ambient air (open-loop) or water (closed-loop) within the cooling towers. A major part of water gets evaporated during this continuous process, thus the remaining water in the basin gets concentrated by the minerals and other water constituents. The evaporation rate can be different depending on the location and the weather.

The increase in mineral concentration of the recirculating water exposes various complexities which require utmost attention as if they were not maintained well, significant operational inefficiencies and economic impact will be inevitable.



Major Issues Impacting Cooling Tower Efficiency:



Scaling

The deposition of minerals reduces thermal efficiency.
Scaling occurs due to the precipitation of calcium and magnesium salts (e.g., calcium carbonate, magnesium carbonate) from hard water as it evaporates. Over time, these deposits accumulate on heat exchange surfaces, reducing thermal conductivity and increasing energy consumption.

Corrosion

Chemical imbalances accelerate the corrosion of system components.
Corrosion is primarily caused by pH imbalances and the presence of dissolved oxygen and other corrosive agents in the water. It weakens metal components, leading to higher maintenance costs and shorter equipment lifespan.

Biofilm

The growth of bacteria and algae decreases efficiency.
Biofilm forms when bacteria and algae adhere to surfaces and produce extracellular polymeric substances (EPS). This insulating layer reduces heat transfer efficiency and fosters further microbial growth, which can exacerbate not only further scaling and corrosion but also health and respiratory issues.

Existing Mitigation Methods

Blowdown
Regular removal of water from the system to prevent excessive mineral concentration and scaling. This leads to significant water wastage, with typical cycles of concentration (COC) ranging from 3 to 8.

Chemical Dosing
Adding chemical inhibitors to control scaling, corrosion, and biofilm has drawbacks:

- High operational and maintenance costs
- Frequent chemical use and handling.
- Chemical interactions that may lead to pH imbalances and increased corrosion.

Limitations:

Cycles of Concentration (COC) measures the efficiency of water use in cooling tower systems and is influenced by makeup water quality and treatment effectiveness. While a higher COC indicates better water efficiency, it is limited by practical thresholds to avoid issues such as scaling, corrosion, biofouling, and pH imbalances.

Due to evaporation and resulting concentration of impurities, water cannot be recirculated indefinitely without risking system damage.

In Singapore, COC is on average between 7-10 and in Indonesia and Malaysia between 3-6.

The Need for a Better Solution

- Providing better water quality to prevent scaling, corrosion, and biofilm.
- Reducing CO2 emissions and chemical usage.
- Lowering water and energy consumption.
- Cutting down operational costs, including maintenance and chemical expenses.

As Southeast Asia's data centre industry continues to mature and more countries position themselves as digital infrastructure hubs, long-term water planning is becoming increasingly important.

Governments are reassessing regulations to reduce pressure on water resources—Johor, for example, has signalled that operators must incorporate both sustainable energy and water strategies for development approvals. In April 2025, we noted AirTrunk announced a partnership with Johor Special Water (JSW) to develop a recycled water supply for its campuses, a significant step into public works as an operator with major development plans.

In parallel, the Johor government has also rolled out a five-year plan to build three new reservoirs and water treatment plants.

As an industry, it is essential that we begin prioritising water sustainability

Advancements in recycling technologies will play a key role in ensuring long-term operational resilience and environmental responsibility.

Vivian Wong, Senior Analyst, DC Byte

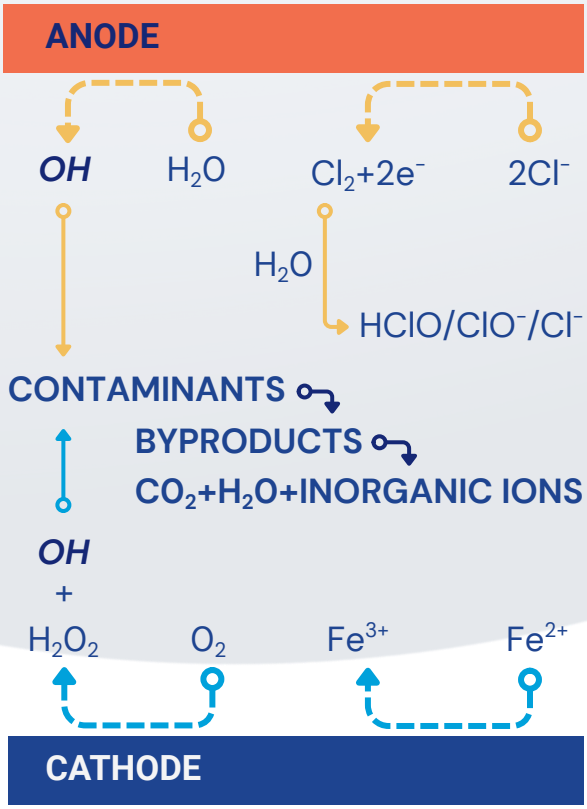
Electrooxidation as a Treatment Solution

Electrooxidation is an advanced water treatment method that uses electrically generated oxidants to degrade organic contaminants, control microbial growth, and prevent biofouling in cooling tower systems. By leveraging reactive species such as hydroxyl radicals and active chlorine:

- It effectively reduces chemical usage and minimizes scaling and corrosion risks.
- Approach is chemical-free
- Enhances system efficiency, extends equipment lifespan, and supports lower water and energy consumption.

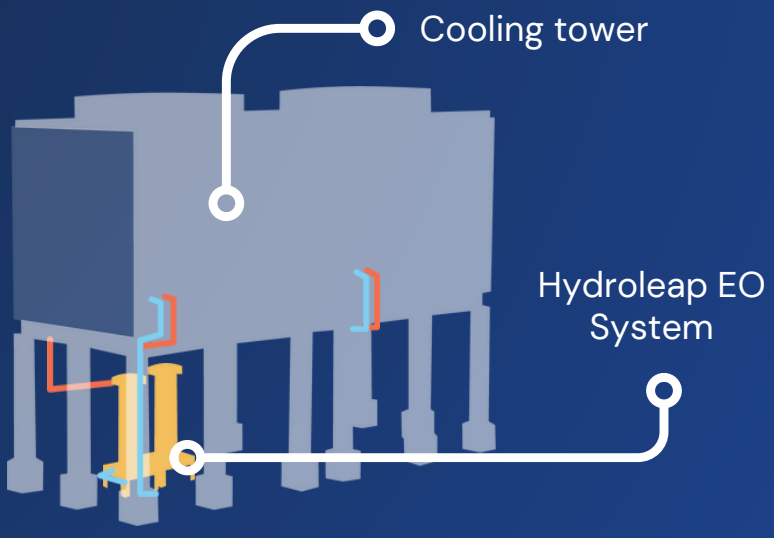
Hydroleap's electrooxidation (EO-CT), which is designed for cooling tower applications:

- degrades organic contaminants, suppress microbial growth, and reduce biofouling.
- supports reduced dependence on conventional chemical treatments.

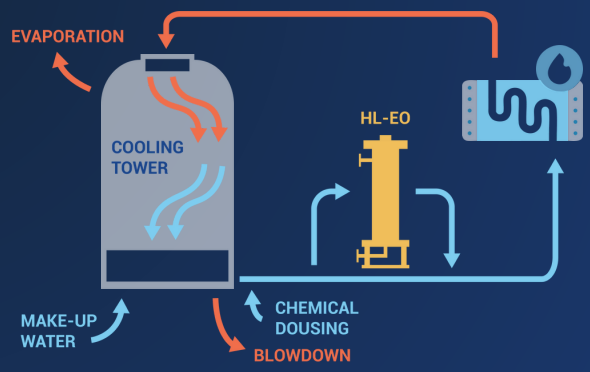


HL-EO-CT System Performance

Hydroleap's electrooxidation system utilizes proprietary electrode materials and specialized coatings that enhance performance and durability. This promotes a softer form of scale deposition, which is easier to remove and less disruptive to operations. The system operates within 0.2 to 0.3 kWh per cubic meter and is designed for easy integration. It is fully automated and capable of 24/7 operation with minimal intervention.



Case study – Cooling Tower



Water Usage Effectiveness

Chemical Usage Effectiveness

70-80% Blowdown Water Saving

5-15% Energy Saving on Chillers & Pumps

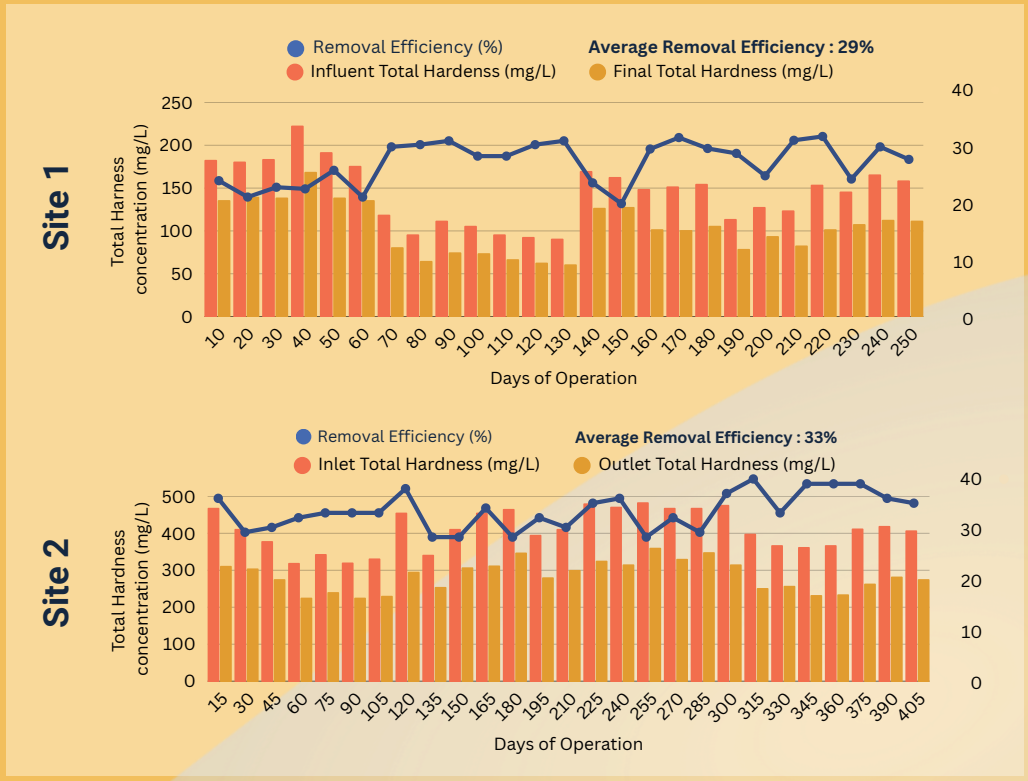
50-80% Chemical Saving

Performance Validation: Hydroleap's EO System in Action

Hydroleap's Electrooxidation system (HL-EO-CT) has been implemented in operational environments where the system has demonstrated measurable improvements in cooling tower water quality, by reducing total hardness and bacterial levels which are critical factors affecting scaling, biofouling, and overall system maintenance.

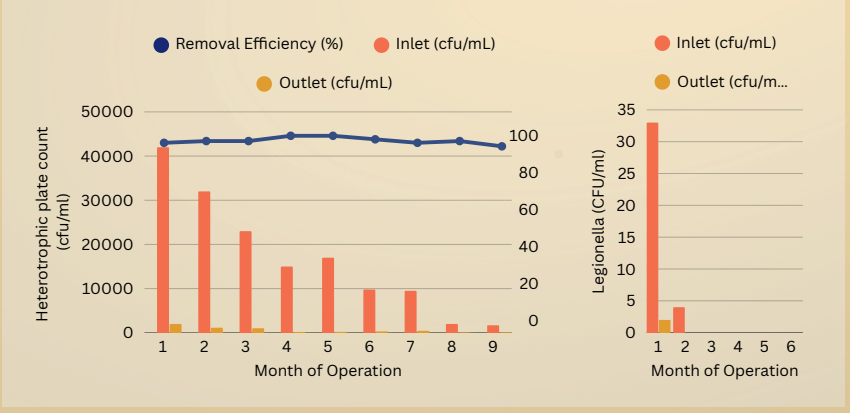
1. Up to 40% Reduction in Total Hardness

Scaling, which is caused by the accumulation of calcium and magnesium salts, is reduced by up to 40% by HL-EO-CT, minimizing scaling risks and enhancing heat exchange efficiency.



2. Effective Bacterial Control

Cooling tower water is prone to biofilm formation, which not only degrades system performance but also increases operational costs. HL-EO-CT technology disrupts bacterial growth through an advanced oxidation process, significantly improving water hygiene.



Together with a local startup, Hydroleap, AWS has piloted and deployed a water recycling system in Singapore, with plans to scale this across the Asia-Pacific region.

Hydroleap developed a unique electrooxidation technology which was customised to improve the efficiency of AWS cooling towers, helping us meet our water efficiency goals.

"This ongoing collaboration between Hydroleap and AWS, which started nearly two years ago, has helped us to improve and fine-tune our patented electrooxidation technology to be an effective tool for meeting AWS's water efficiency goals," said Mohammed Sherafatmand (PhD), founder and chief executive officer of Hydroleap.

"Now, with the available data from the existing projects, we can unleash the potential impact we can make together across the Asia-Pacific region and even globally."

An excerpt from *Amazon Web Services. (2024, March 21). 4 ways AWS is innovating on water sustainability in Singapore*

What separates Hydroleap from the competition?

What sets Hydroleap apart is a unique combination of proprietary technology, operational efficiency, and proven performance. Our patented electrodes and coatings, along with a reactor design that encourages soft, easily removable scale deposition, ensure long-term reliability and minimal maintenance.

Low energy consumption

Automated and easy to integrate systems

Strong track record of successful deployments

Sustainable approach

Integrated & Compact:

Uniquely combines scale removal and biofouling control in one reactor, unlike multi-stage alternatives.

Superior Water Efficiency:

Cuts blowdown water loss by up to 80%, minimizing wastewater.

Effective Biofouling Control:

Unlike polymer-based methods, Reactive Oxygen Species (ROS) offer a direct oxidation process, eliminating biofilm and microbial contamination.

Energy Efficient:

Improves cooling system efficiency, delivering 5-15% energy savings in Chillers by reducing scaling and biofouling.

Validated Cycle of Concentration (COC) Enhancement:

Achieves a 50-140% improvement, balancing operational feasibility and water conservation.

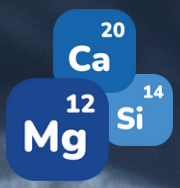
Low Maintenance:

Proprietary electrodes together with advanced power distribution and monitoring have made HL-EO-CT to be a fully automated system with only requirement for scales to be removed every 2-3 months.

Chemical Reduction:

Cuts chemical usage by 50-70%, significantly reducing environmental impact and the reliance on hazardous water treatment additives.

Resolution of Core Problem Statements



Scaling

- HL-EO-CT induces reduction reactions at the cathode, leading to the precipitation of calcium carbonate ($CaCO_3$) and magnesium carbonate ($MgCO_3$) on the proprietary electrode surfaces instead of heat exchange surfaces.
- The alkaline environment around the cathode also promotes the precipitation of silicon oxide (SiO_2), further preventing scale buildup.

Corrosion

- By maintaining a balanced pH and alkalinity, HL-EO-CT minimizes corrosive conditions.
- The reduction in chemical dosing eliminates pH fluctuations typically caused by chemical additives.

Biofilm

- HL-EO-CT process generates hydroxyl radicals (•OH) and free chlorine in situ, both of which are highly effective disinfectants.
- These oxidizing agents break down organic matter and destroy microbial cells, preventing biofilm formation and maintaining clean surfaces.

Differences in System Integration and Operations

Issues with system integration and performance are not uncommon with any system and technology. Proprietary features that the HL-EO-CT system possesses help ensure simplicity in integration and savings for the various types of buildings, especially data centers:

PROVEN TECHNOLOGY	PLUG-AND-PLAY INTEGRATION	SUSTAINABILITY FOCUS
Backed by successful deployments in multiple data centers in APAC, Hydroleap's EO system delivers measurable improvements in efficiency and cost savings.	The side-line treatment process can be easily retrofitted into existing cooling tower setups or installed in new facilities with minimal disruption.	By reducing water, energy, and chemical consumption, Hydroleap supports data centers in meeting their environmental targets.

The End Result
5 Key Points

Better Water Quality

- 35-50% removal of hardness (calcium, magnesium), silica, and alkalinity in the cooling tower water
- 20% removal of TDS (Total dissolved solids) or conductivity
- Elimination of waterborne pathogens and microbes

Energy Efficiency

- Improved PUE (Power Usage Effectiveness) through 5-15% energy savings in chillers by scale reduction and fouling prevention thereby improving heat exchange
- Low power consumption (less than 0.3 kWh/m3)

Water Savings

- Increased COC (Cycle of Concentration) by 50%-140%, reducing water wastage
- Up to 80% reduction in blowdown water, significantly improving WUE (Water Usage Effectiveness)

Environmental Impact

- 50-70% reduction of chemical usage
- 30-50% reduction in CO2 emissions due to power savings

Operational Cost Savings

Total OPEX savings of 50-60% (excluding manpower), achieved through:

- Reduced water consumption
- Reduced energy consumption
- Reduced chemical consumption

Competitive Landscape: Hydroleap EO vs. Alternative Solutions

While chemical treatments remain widespread, electrochemical and physical alternatives vary in effectiveness. The data below compares HL-EO-CT with reverse osmosis, ion exchange, and other electrochemical methods.

HL-EO-CT vs. Reverse Osmosis (RO) & Ion Exchange (IX)

The global data center market is expanding rapidly, driven by increasing cloud adoption, AI applications, and data localization requirements.

The market is projected to grow at a CAGR of 9.3% from 2023 to 2032, with hyperscale and colocation data centers fueling this expansion.

This surge intensifies demand for sustainable cooling technologies to manage rising energy and water consumptions.

Feature/Priority	Reverse Osmosis (RO)	Ion Exchange (IX)	HL-EO-CT
CAPEX	Benchmark	10-20% lower vs. RO	50-70% lower vs. RO
OPEX	Benchmark	0-5% lower vs. RO	60-75% lower vs. RO
Scale Removal	Benchmark (>95%)	>90%	35-50%
Disinfection	Not effective	Not effective	Very effective
Water Recovery	50-60%	90-95%	>98%
Power consumption	3-3.5kWh/m3		<0.3 kWh/m3

- **Footprint:** HL-EO-CT requires 60-70% smaller footprint compared to RO and IX
- **Brine/Side Waste:** Both RO generates a large volume of brine waste. It means not only the water recovery is significantly lower compared to HL-EO-CT, but also, the cost of brine disposal is substantial. IX's water recovery is much better than RO but still lowers than HL-EO-CT.
- **Ease of Operation & Maintenance:** HL-EO-CT is fully automated and does not require any manpower to operate it and the only maintenance is to physically remove the precipitated scaling from electrodes which happens only every 3 months, while RO requires dedicated operator and regular maintenance, chemical cleaning and etc.

Competitive Landscape: Hydroleap EO vs. Alternative Solutions

HL-EO-CT vs. Other Electrochemical Methods

While electrochemical treatment for cooling towers is not a new concept, few systems have demonstrated long-term, consistent performance in operational data centers. HL-EO-CT has been observed to perform reliably for over three years of continuous use. Key advancements from research and development include proprietary electrodes, specialized coatings, and a system design that delivers sustained scale control and disinfection with low power consumption and minimal maintenance.

CAPEX: Similar

Footprint: Similar

Scale Removal:
HL-EO-CT consistently removes 35-50% while the competition has similar removal efficacies but drops drastically within a few weeks due to solid-scale precipitation instead of soft-scale precipitation (Hydroleap's Patent).

Disinfection:
HL-EO-CT achieves disinfection within the same reactor while the majority of the competitors use consumable polymers to achieve that.

Brine/side waste:
HL-EO-CT does not have liquid waste stream, and the only solid disposal occurs every 2-3 months when the cathodes are getting cleaned. Solid waste is considered a general waste. In comparison, the competitors have a continuous stream of liquid discharge.

Ease of Operation & Maintenance:
Due to Hydroleap proprietary electrodes and power distribution, the scales formation on the surface of the cathodes are predictable and easily removable but the competition struggles with the cleaning procedures as they require high manpower and even chemicals to do that.

In Summary

Hydroleap's HL-EO-CT electrooxidation reactor is redefining cooling tower water treatment for data centers by combining **superior performance, ease of operation, and sustainability in one compact, automated solution.**

Unlike traditional systems such as reverse osmosis (RO) or ion exchange (IX),

HL-EO-CT

- delivers 50–75% lower CAPEX and OPEX,
- uses 60–70% less space, and
- eliminates the need for hazardous brine disposal.

Its patented design integrates **scale removal, corrosion control, and active disinfection** into a **single** reactor—

- cutting chemical use by up to 70%,
- reducing water blowdown by 80%, and
- improving chiller energy efficiency by 5–15%.

Compared to other electrochemical methods, HL-EO-CT stands out for its long-term stability and performance, having operated reliably for over three years in live data center environments. Proprietary electrodes, advanced coatings, and a system architecture designed for soft-scale precipitation (not solid-scale) ensure consistent 35–50% removal efficacy without the performance degradation seen in competitors.

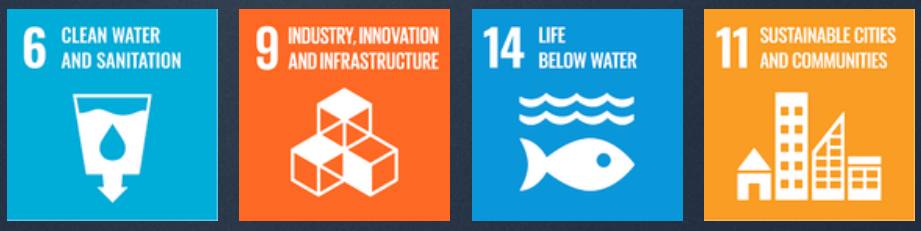
Where others require consumable polymers and frequent chemical maintenance, Hydroleap's system delivers in-situ disinfection using reactive oxygen species (ROS) and only requires simple, quarterly scale removal.

Hydroleap

About Hydroleap

Hydroleap is a leading technology company headquartered in Singapore specializing in advanced water and wastewater treatment solutions. Equipped with patented electrochemical technologies and over 8+ years of R&D, we have a proven track record of delivering innovative solutions to world-class customers across various industries, including data centers, manufacturing, and desalination. Hydroleap is backed by various institutional investors such as Antares Ventures, Sinarmas Group, Economic Development Board of Singapore (EDB), SEEDs Capital, Mitsubishi Electric, UntroD Capital, State Government of Victoria, Wavemaker Partners, 500 Global and SparkLabs Cultiv8.

Hydroleap is proud to align its innovations with the United Nations Sustainable Development Goals, particularly SDG 6 (Clean Water and Sanitation), SDG 9 (Industry, Innovation and Infrastructure), SDG 11 (Sustainable Cities and Communities), and SDG 14 (Life Below Water).



Hydroleap's mission

To revolutionize cooling systems by providing sustainable, chemical-free, and energy-efficient solutions. We are committed to supporting data centers in achieving their sustainability and climate goals through our proprietary electrooxidation technology (HL-EO-CT), which significantly reduces water usage, energy consumption, and chemical usage.

Hydroleap

Partner with us to **revolutionize** your water and cooling systems for a more sustainable future.

Contact Information

For more information or to discuss how Hydroleap can support your cooling tower or water treatment needs, please contact us:

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