ChannelConnect

IMMERSION COOLING: FROM NICHE TO NECESSARY STANDARD

Whitepaper | April 2025

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Target audience and reading guide

This report is intended for IT service providers, data center operators, cloud providers, system integrators and other organizations active in the IT infrastructure market. Policymakers and sustainability officers concerned with energy consumption and the sustainability of data centers can also find relevant insights.

The white paper offers a combination of market trends, technical background information, and practical insights into immersion cooling.

- In Chapters 1 through 3, we outline the general context, the issues surrounding traditional cooling, and the technological innovation behind immersion cooling.
- In Chapter 4 we present market data and growth figures, with graphs and analysis.
- Chapter 5 looks ahead to new applications in the edge market and the role that immersion cooling can play in these.
- Chapter 6 discusses practical experiences of RNT Rausch and iXora, based on real-world applications and tests.
- In Chapter 7 we discuss the barriers and accelerators that influence the adoption of immersion cooling.

Readers with a specific interest in market developments can start directly with Chapter 4, while technical readers will also benefit from Chapter 3 on system structure.

1. MANAGEMENT SUMMARY

The data center industry is facing fundamental choices. Demand for computing power is exploding, driven by AI, big data, and cloud applications, while power and space availability are under pressure and sustainability requirements are becoming increasingly stringent.

Immersion cooling - where servers are immersed in a dielectric fluid—offers a promising alternative. The technology enables higher power densities, significantly reduces power consumption, and extends the lifespan of IT equipment.

The global immersion cooling market is growing rapidly. According to market analyses, **the total market size will rise** from approximately $522 million in 2024 to an expected $12 billion in 2033. In the Netherlands, the market is even growing by almost 20% annually, partly driven by grid congestion, stricter sustainability regulations, and the strong rise of edge computing.

Key benefits of immersion cooling include:

- Reduction of Power Usage Effectiveness (PUE) to values around 1.04 or lower
- Reduction of energy consumption for cooling by up to 75%
- Extending the lifespan of hardware components by 40–100%
- Possibility of reusing residual heat

iXora and RNT Rausch play a key role in this with compact, modular solutions that are suitable for both datacenters and edge environments.

In this report, we map the most important trends, figures, practical insights, and market perceptions surrounding immersion cooling. It offers IT service providers, data center managers, and decision-makers concrete tools to determine how and when immersion cooling can be deployed strategically.

2. INTRODUCTION: WHY IMMERSION COOLING?

Data centers are the backbone of the digital economy. Cloud applications, AI workloads, video streaming, and data analytics require increasingly powerful hardware—and that presents significant challenges.

Every increase in computing power leads to increased energy consumption and heat production. Traditional air cooling, which removes heat through fans, air conditioning, and advanced airflows, has physical and economic limitations.

Air transports heat much less efficiently than liquid, requiring increasingly more energy and space to keep cooling systems running. Furthermore, air circulation causes dust accumulation, vibration, and wear, leading to faster hardware failure.

At the same time, the pressure for sustainability is increasing significantly. Governments are imposing stricter emissions regulations, customers are demanding environmentally friendly IT, and energy prices continue to rise. In the Netherlands, grid congestion is even leading to a stagnation in new data center initiatives.

Organizations are thus confronted with a triple challenge:

- More computing power needed
- Less energy and space available
- More legislation and regulations regarding sustainability

Radical alternative

Immersion cooling offers a radical alternative. This technology immerses servers in a specially developed dielectric fluid that doesn't conduct electricity and dissipates heat extremely efficiently. This eliminates the need for fans or air conditioning, significantly reducing infrastructure footprint. The benefits are immediately apparent: lower energy consumption, higher rack density, extended hardware lifespan, and reduced operational risks.

Although immersion cooling has been around for some time, recent technological innovation has led to:

- Better fluids with longer life
- More compact, modular designs
- Lower costs per unit
- Greater market acceptance, partly due to the rise of AI and edge computing

In the following chapters, we'll delve deeper into the figures, market trends, technical benefits, and practical experiences surrounding immersion cooling.

3. THE TECHNOLOGY: COMPACT, MODULAR AND WHISPER-QUIET

Immersion cooling is based on a simple yet revolutionary technique: servers are completely immersed in a specially developed dielectric fluid that immediately dissipates the heat produced.

There are two main types of systems:

- **Single-phase immersion cooling:** The fluid remains liquid and transfers heat to a heat exchanger or cooling tower.
- **Two-phase immersion cooling:** The liquid boils at a low temperature, absorbs heat and then condenses again in a closed circuit.

In both cases, heat is dissipated much more efficiently than with air cooling, and no fans or air conditioning are needed to keep servers at operating temperature.

The advantages of immersion cooling over traditional cooling include:

- Increased rack density (more capacity in less space)
- Extended life of hardware components
- Less dust accumulation and vibration damage
- Lower operating costs and energy consumption
- Silent operation, ideal for sensitive environments
- Can be used in industrial environments (>40 degrees Celsius, humid, dusty)

iXora innovations: modular and scalable
While many immersion cooling solutions use large tanks or full baths, iXora opted for a modular design. The system consists of a chassis with cassettes that house one to four servers, each with its own fluid circuit and heat exchanger, fitting into any standard 19-inch server rack.

Khaled Aziz (iXora):
"We noticed that traditional immersion cooling tanks often lead to practical and logistical problems: they're too heavy for raised floors, difficult to maintain, and require extensive installations. Our modular solution offers maximum scalability and flexibility, and is easy to implement within existing environments."

By working with compact modules, companies can expand gradually and maintain more easily. Faulty units can also be easily replaced without shutting down entire systems.

Vincent van der Linden (RNT Rausch):
"With the modular approach, we can apply immersion cooling in places where traditional solutions are simply not practical, such as offshore installations or small edge locations. We can also now provide server and storage solutions in locations where there are no data center facilities at all. We only need power and water supply and drainage."

These innovations make immersion cooling more accessible to a wider range of organizations, both in traditional data centers and in new, challenging locations.

4. FIGURES AND TRENDS: MARKET GROWTH, ENERGY CONSUMPTION AND USE CASES

The global growth and technological advancements in immersion cooling are impressive. The combination of energy savings, increased rack density, and extended hardware lifespans is driving more and more organizations to seriously consider this technology.

Market growth worldwide

Figure 1 shows the global immersion cooling market growth between 2024 and 2033. The market is expected to grow from approximately $522 million in 2024 to $12 billion in 2033, driven by the growing need for sustainable IT solutions and increasing AI and HPC workloads.

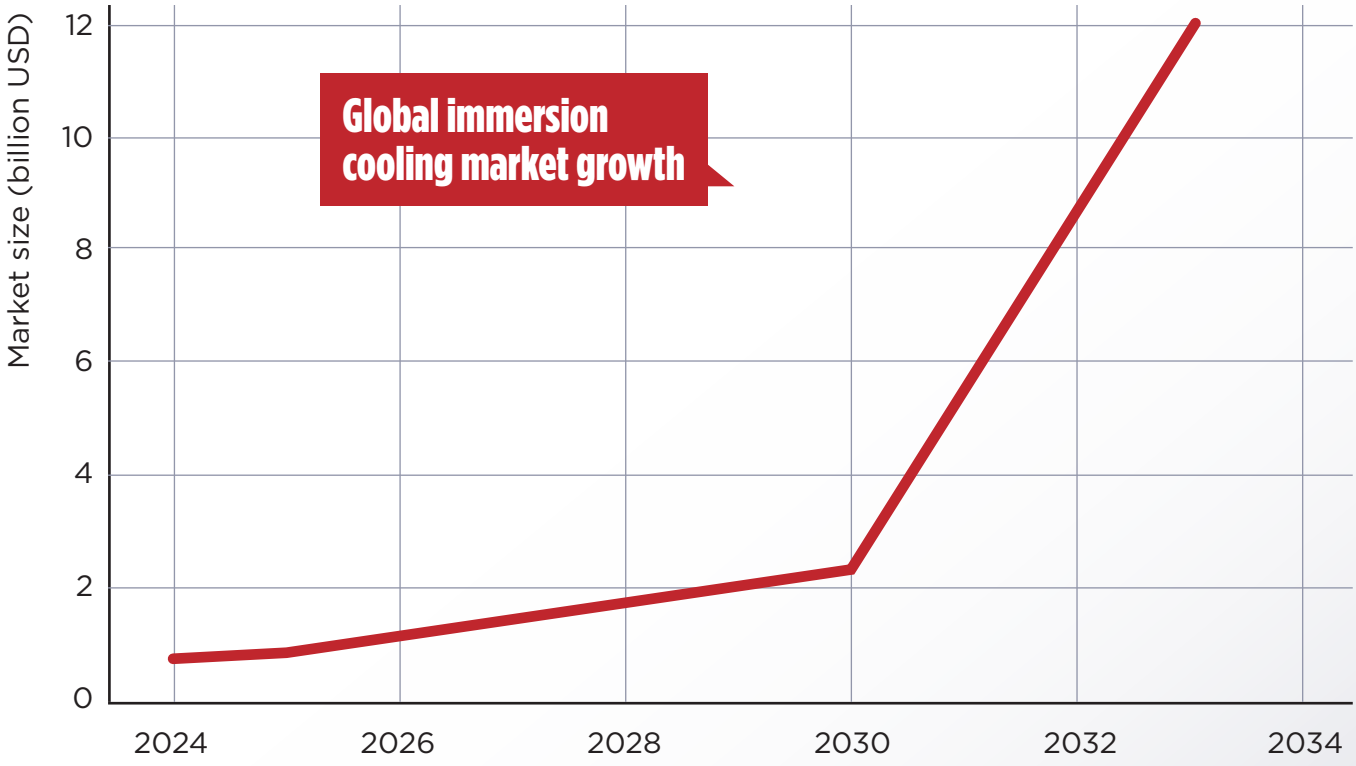

Figure 1

Growth by region

Figure 2 shows that the Netherlands is one of the fastest growing markets in Europe with a CAGR of 19.9%, followed by China, Germany and the United Kingdom.

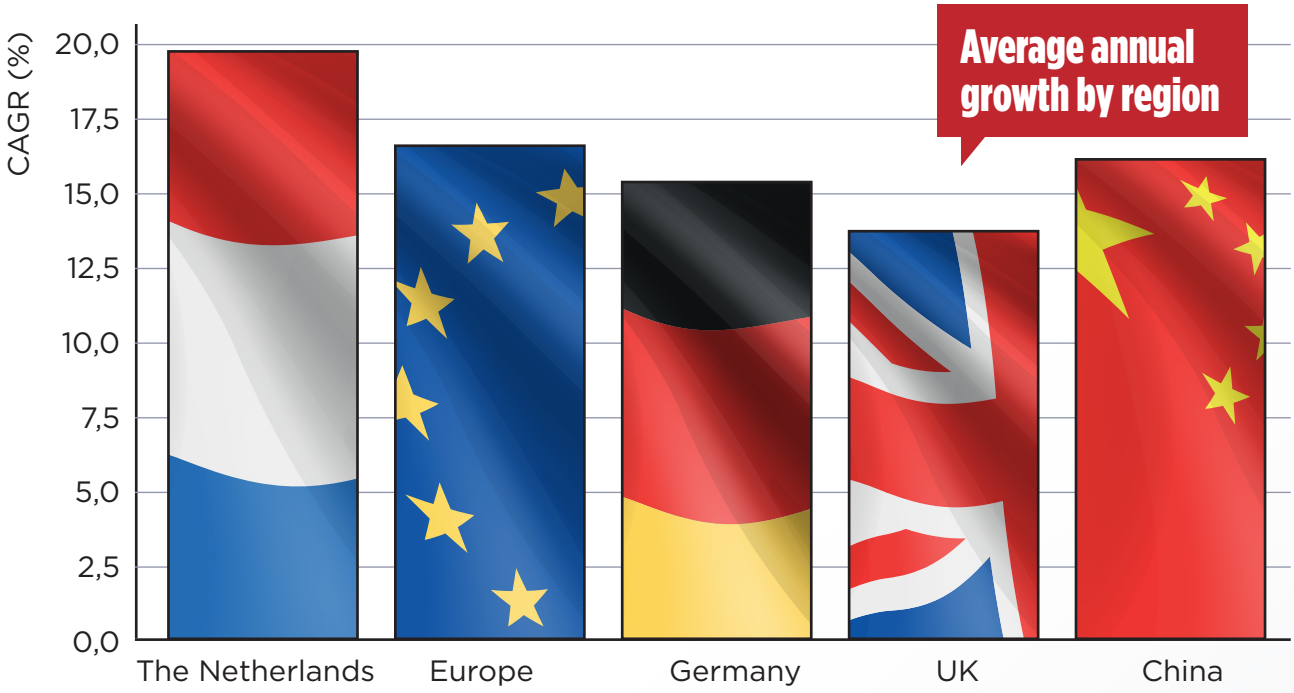

Figure 2

Energy efficiency and PUE improvement
One of the key benefits of immersion cooling is the improvement in Power Usage Effectiveness (PUE). Traditional air cooling systems attribute approximately 40% of their PUE to cooling, while with immersion cooling, this can drop to just 10%.

Figure 3 compares the share of cooling in total PUE between traditional air cooling and immersion cooling.

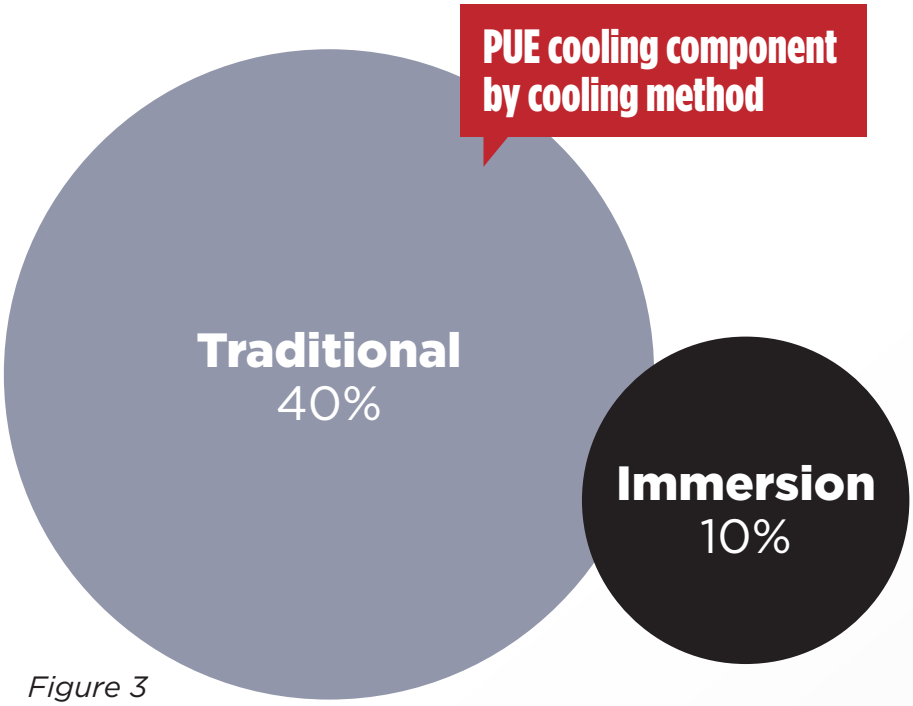

Figure 3

Increasing server density
Figure 4 shows how immersion cooling dramatically increases server density: from an average of 20 kW per rack to values exceeding 100 kW per rack. This enables more compact and efficient data center designs.

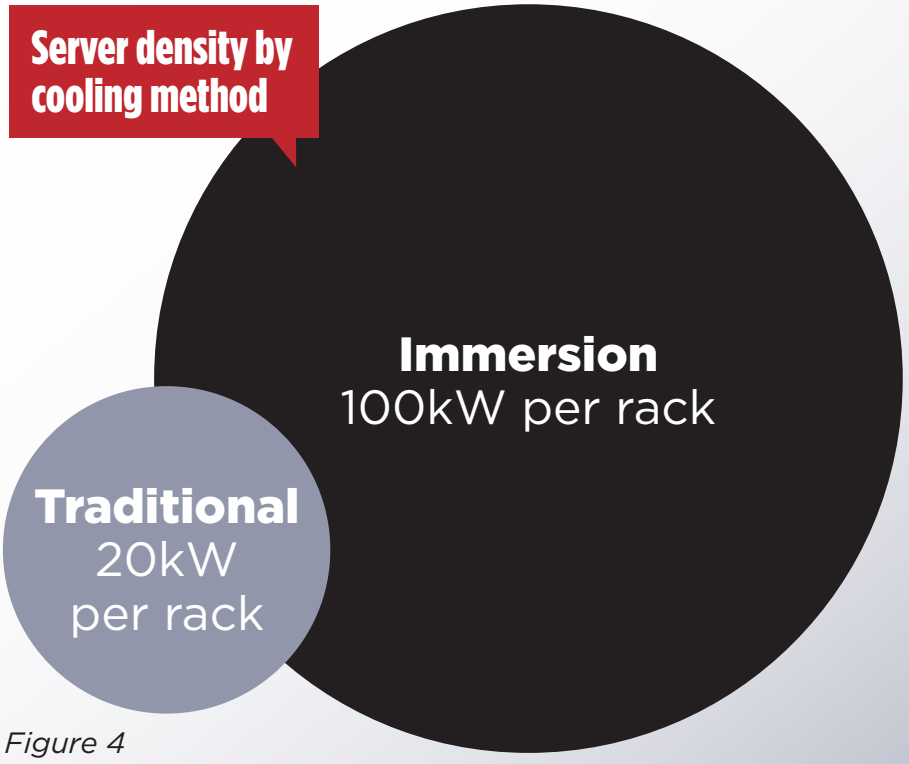

Figure 4

Expected adoption by segment

Finally, Figure 5 shows the expected adoption of immersion cooling by segment in 2030. The technology will become particularly dominant in AI/ML, HPC, and edge computing.

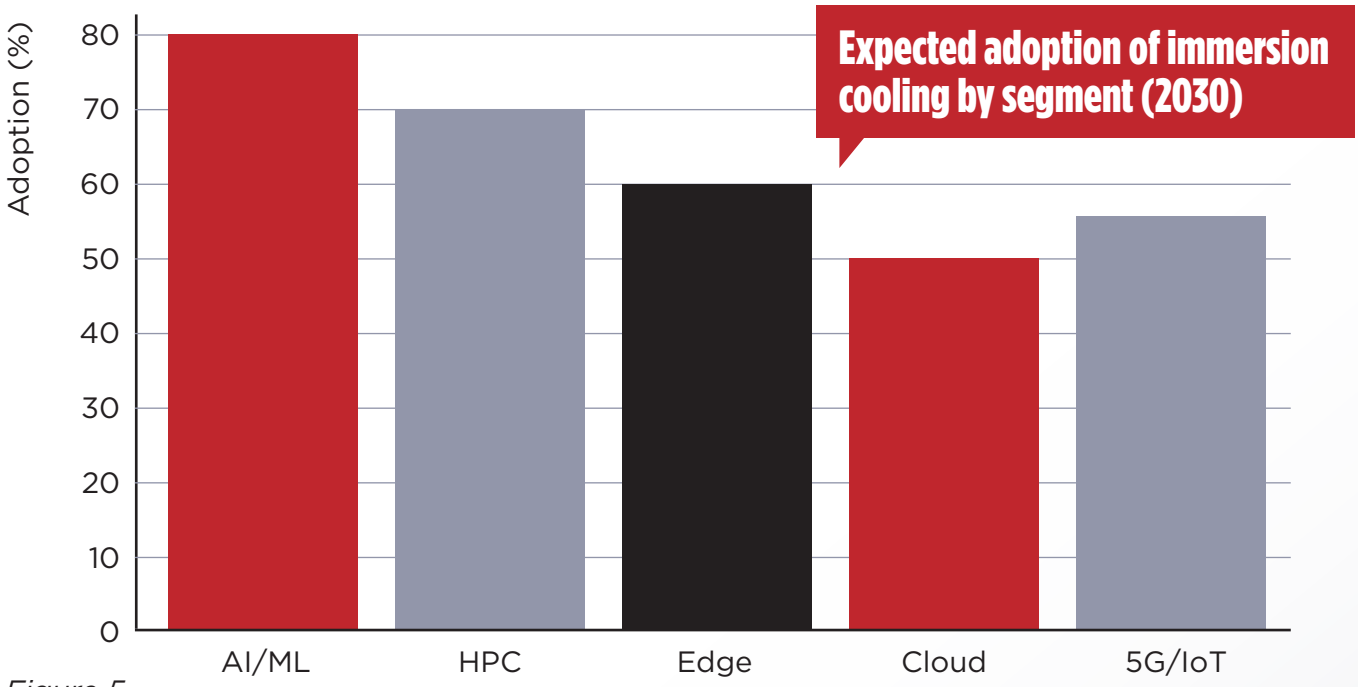

Figure 5

Practical applications of immersion cooling

The first three use cases are already relevant today:

- **AI Training Centers:** Companies that train complex AI models, such as deep learning algorithms for medical image analysis or language models, use immersion cooling to support high server densities and reduce energy costs.
- **High Performance Computing (HPC):** Universities and research institutions that run large simulations (such as climate models or molecular dynamics) choose immersion cooling to increase the reliability and performance of their clusters.
- **Edge locations:** In locations such as offshore wind farms, production plants, and television studios, compact immersion systems are used to reliably cool servers without air displacement, vibration, or dust problems (see Chapter 5).

The figures and trends clearly demonstrate that immersion cooling is increasingly being used in a wide range of applications, from AI and HPC to edge computing. The rise of edge computing, in particular, where computing power is shifting to the edge of the network, is creating new opportunities and new demands for cooling solutions. In the next chapter, we'll delve deeper into the role immersion cooling can play in this rapidly growing market.

5. THE POWER OF THE EDGE: NEW APPLICATIONS, NEW LOCATIONS

The rise of edge computing is changing the demands placed on IT infrastructures. Centralized, perfectly conditioned datacenters are no longer the norm: computing power and data storage increasingly need to be located close to the source – in locations that are difficult to access and subject to extreme environmental conditions.

In these environments, immersion cooling offers unique benefits:

- **Compact:** Systems can be built closer together without overheating.
- **Robust:** No moving fans, no dust problems, no vibration damage.
- **Energy-efficient:** No complex air conditioning required; heat can be dissipated directly via liquid cooling.
- **Low noise:** Essential for use in quiet work environments such as media studios or medical locations.

Vincent van der Linden (RNT Rausch):
"Especially in edge environments, you quickly see that traditional air cooling reaches its limits. With closed immersion solutions, we can even offer server capacity in an industrial greenhouse or offshore platform without worrying about cooling, dust, heat, or noise."

Khaled Aziz (iXora):
"Immersion offers new possibilities for heat recovery. Think of heating systems for buildings or greenhouses that use residual heat from servers."

Rapid growth of edge computing

The edge market is growing rapidly. According to IDC, approximately half of all new IT infrastructure now takes place outside traditional data centers. Furthermore, an estimated 80% of all data is created and processed at the edge of the network. Investments in edge computing are increasing by an average of 15% annually.

This trend highlights the need for robust, compact and energy-efficient cooling solutions — a role that immersion cooling is ideally suited to fill.

	Source and context
80% of all data will be created and processed outside traditional data centers by 2025.	IDC FutureScape 2023: Worldwide Datacenter 2025 Predictions.
By 2025, 50% of new IT infrastructure will be deployed to edge locations.	IDC Edge Computing Forecast.
Investments in edge computing will grow by an average of 15% per year through 2027.	IDC Worldwide Edge Spending Guide.

Source: IDC FutureScape and Worldwide Edge Spending Guide, accessed April 2025.

The demand for robust, efficient edge solutions is expected to continue to increase in the coming years, partly due to the rise of AI, 5G and IoT applications.

6. INSIGHTS FROM RNT RAUSCH AND IXORA

The collaboration between iXora and RNT Rausch stemmed from a shared vision: to make immersion cooling suitable for practical, realistic IT environments. The companies combine modular hardware with robust, energyefficient systems that function optimally even outside the traditional data center.

Vincent van der Linden (RNT Rausch):
"We provide many solutions for edge environments such as factories, ships, and wind farms. In these environments, vibration, dust, and limited space are major challenges. With closed immersion solutions, we can tackle these problems in one go."

Khaled Aziz (iXora):
"Our design focuses on simplicity and scalability. Compact cassettes, no moving parts like fans, a long-life fluid, and leak-free, easy maintenance of the individual components. This makes the system suitable for a wide range of applications and easy to manage."

Efficiency improvement in practice
In internal testing with the HRM4P platform, immersion cooling showed significant efficiency improvements compared to traditional air cooling.

Figure 6 shows the measured efficiency improvement under different workloads.

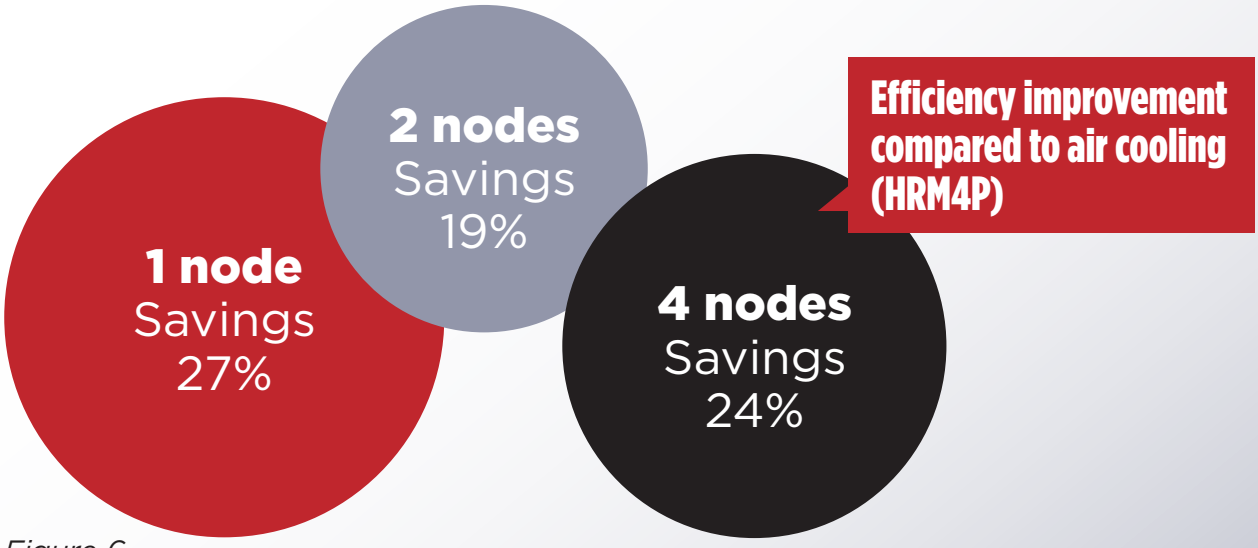

Figure 6

Extending hardware lifespan

In addition to energy savings, immersion cooling also offers benefits for the hardware itself. Drives, motherboards and power supplies stay significantly cooler, vibration-free and dust-free, significantly extending their lifespan.

Figure 7 shows the average operating temperature of CPUs and GPUs with air cooling versus immersion cooling. With air cooling, the temperature of CPUs and GPUs is on average 20–25°C higher than with immersion cooling. This higher temperature creates more thermal stress and increases the risk of failure.

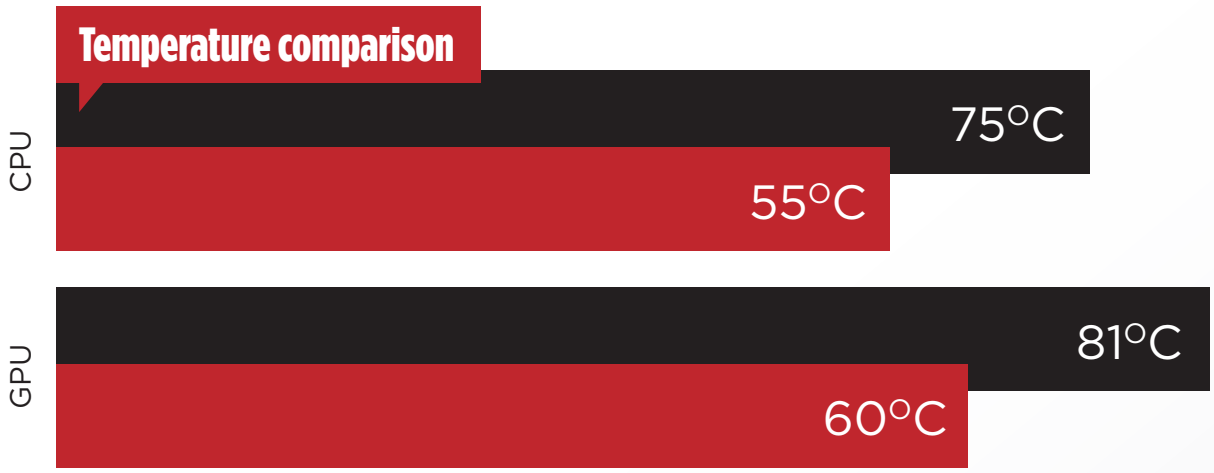

Figure 7

Figure 8 shows the annual failure rates of CPUs and GPUs with air cooling versus immersion cooling. Immersion cooling reduces failure rates by half or more by keeping components operating under stable, cool conditions.

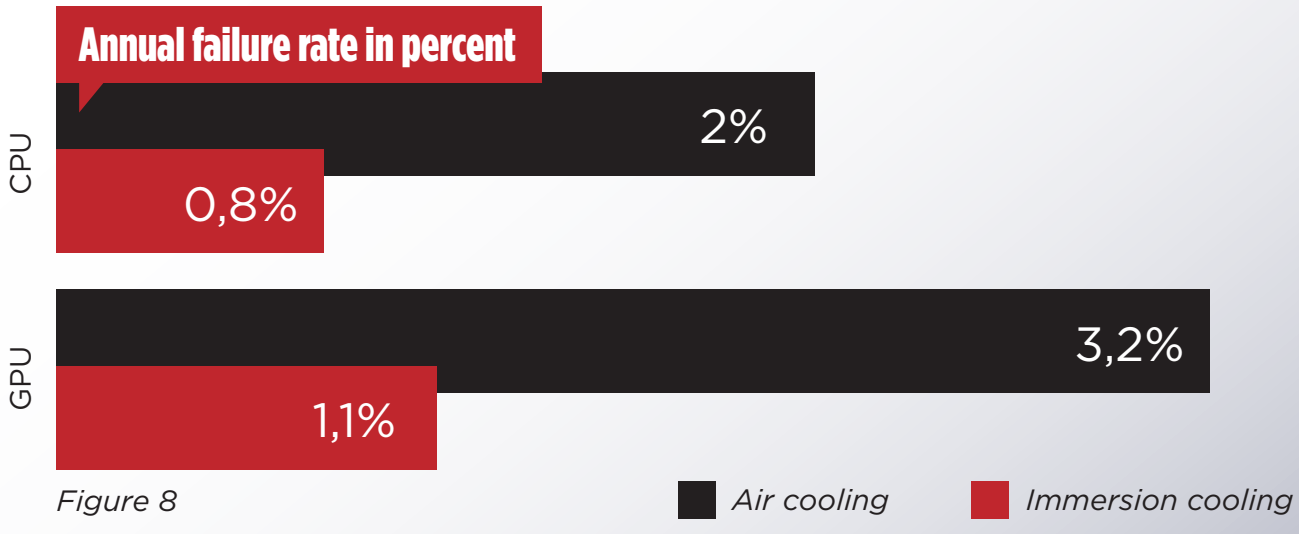

Figure 8

Figure 9 shows a comparison of annual energy consumption per rack for air cooling and immersion cooling. Assuming an average consumption of 24 kW per rack, energy consumption with traditional air cooling is approximately 210,240 kWh per year, compared to 157,680 kWh with immersion cooling. This represents an energy savings of more than 25% per rack.

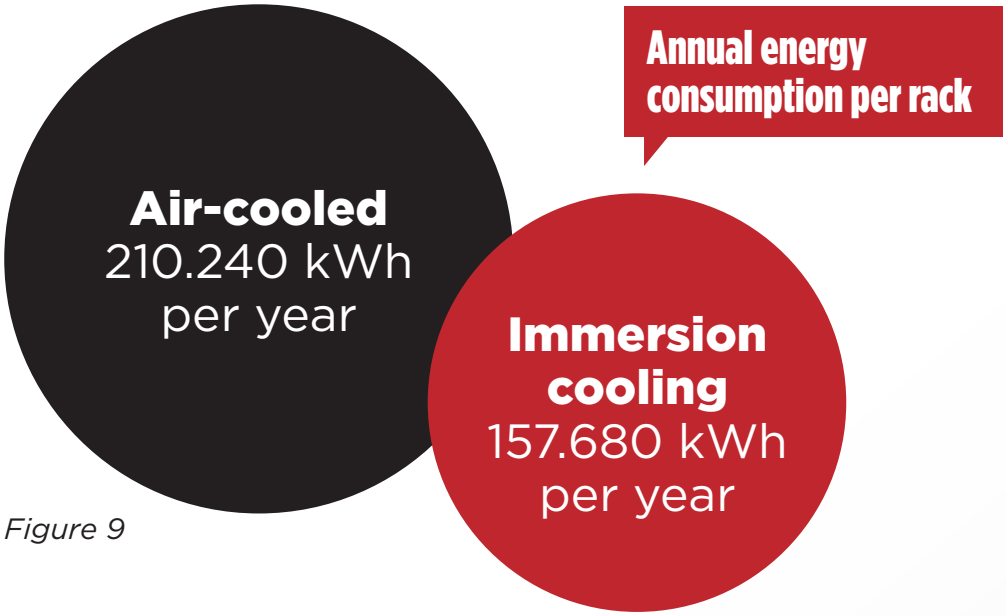

Figure 9

With air cooling, a rack produces nearly 59 tons of CO2 emissions annually, compared to 44 tons with immersion cooling. This represents a savings of 14.7 tons of CO2 per rack per year. This equates to:

- 350,000 km of electric driving
- The annual consumption of 23 electric cars
- Approximately 9 return flights Amsterdam–New York
- The annual CO2 absorption of 735 trees

7. BARRIERS AND ACCELERATORS TO ADOPTION

Although immersion cooling has matured as a technology, many organizations still face barriers to adoption. Key obstacles include vested interests in traditional cooling systems and the fact that many data centers base their business models on high energy consumption.

Vincent van der Linden (RNT Rausch):
"Data centers are often measured by PUE, but that figure doesn't account for the inefficiencies within the servers themselves. If you increase the air temperature, your PUE drops, but your server fans run faster, and you still consume more power."

Khaled Aziz (iXora):
"Many organizations don't fully realize that higher temperatures can significantly shorten the lifespan of their hardware. Immersion cooling maintains stability, even when the ambient temperature rises."

Responsibility for implementation
A key question in the adoption of immersion cooling is: who should take responsibility? Figure 10 shows how the market assesses these responsibilities: customers, data centers, and cloud providers each play a role.

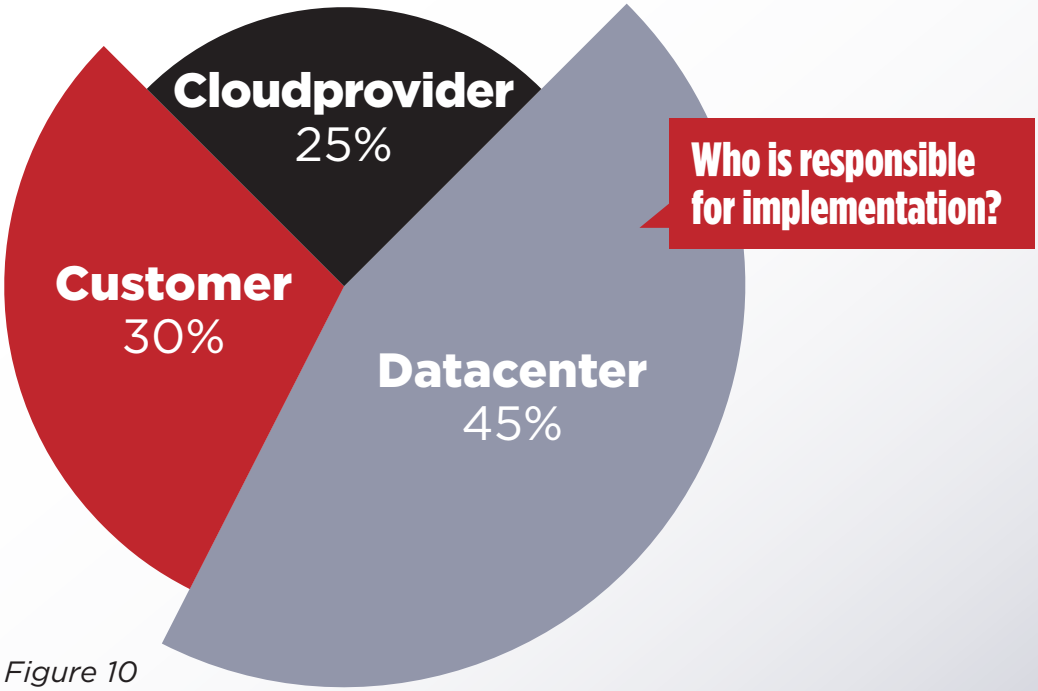

Figure 10

Key drivers for adoption

At the same time, there are strong incentives to accelerate the adoption of immersion cooling. Cost savings, sustainability goals, legislation, and the ability to utilize residual heat all play a role.

Figure 11 shows which motives organizations consider most important in their decision to use immersion cooling.

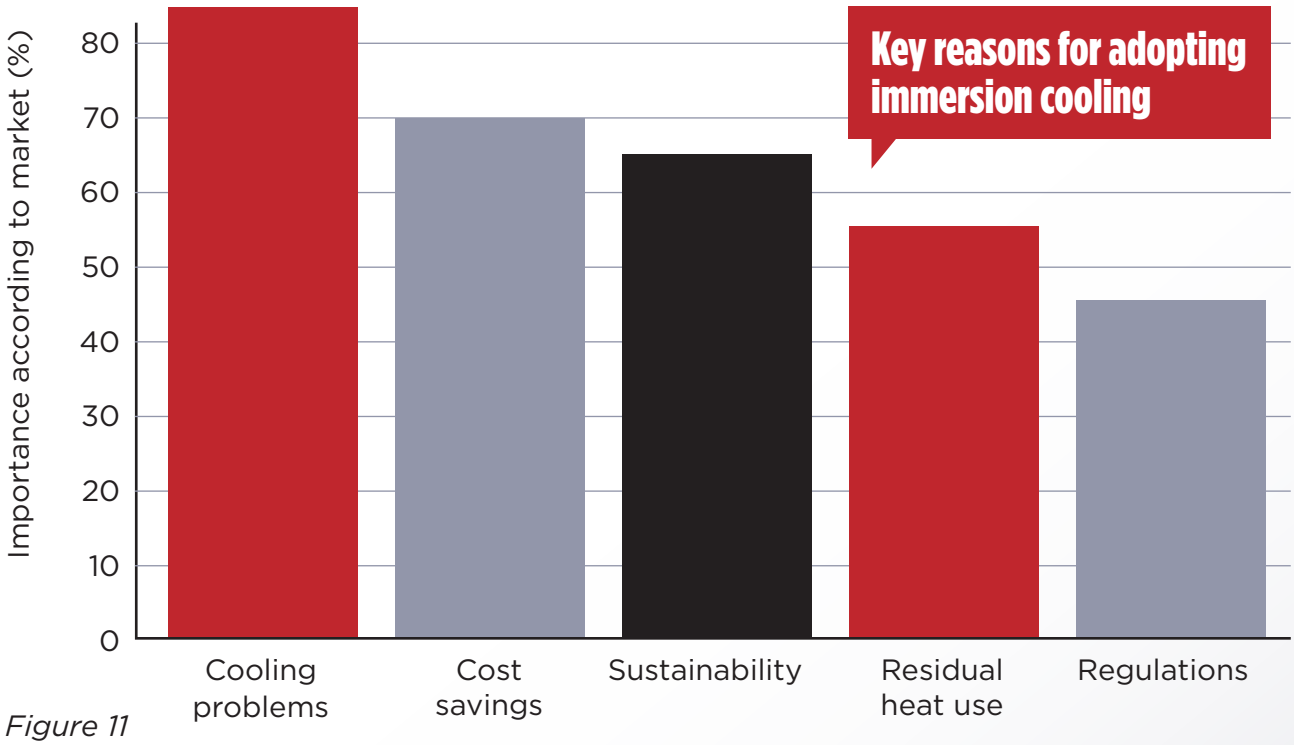

Figure 11

8. CONCLUSION: FROM PIONEER TO STANDARD

Immersion cooling is rapidly evolving from a niche solution to a fully-fledged, future-proof technology within the data center world. The combination of technological advantages—higher energy savings, increased server density, extended hardware lifespan, and robustness in extreme environments—is making it increasingly attractive for both traditional data centers and edge locations.

Market trends support this development: global adoption of immersion cooling is growing strongly, and the expected increase in edge computing is creating new application areas where traditional cooling techniques fall short.

In addition, societal pressure for sustainability, rising energy costs and stricter regulations make it necessary for organizations to invest in more efficient, sustainable IT infrastructures.

Vincent van der Linden (RNT Rausch):
"The technological case for immersion cooling has been made. What follows now is awareness and acceleration in the market."

For organizations looking to reduce energy consumption, increase the reliability of their IT environments, and prepare for the explosive growth of AI, edge, and data processing, immersion cooling offers a proven route to future-proof infrastructures.

9. ABOUT THIS REPORT

This report was compiled by ChannelConnect in collaboration with external experts and market parties, including RNT Rausch and iXora. The white paper is based on a combination of market analysis, field measurements, and expert interviews conducted in the first and second quarters of 2025.

The figures, graphs and insights included in the report are taken from sources including IDC, Allied Market Research, Perplexity.ai, as well as internal documents from RNT Rausch and iXora.

While every care has been taken in compiling this report, no rights can be derived from its contents. ChannelConnect and the parties involved accept no liability for any inaccuracies or omissions.

For more information about this publication or for questions about immersion cooling, please contact ChannelConnect.

RNT Rausch *is a German technology pioneer with over 25 years of experience in the high-tech server and storage industry. The company specializes in designing and building customized server and storage solutions tailored to specific business needs. RNT Rausch collaborates with leading technology partners such as AMD, Cloudian, Intel, Seagate, and iXora to deliver high-quality solutions. The company serves a wide range of partners and its customers, including SMEs, data centers, and service providers worldwide.*

iXora *is a Dutch manufacturer of immersion cooling solutions, specializing in the energy-efficient cooling of high-performance IT infrastructures. The company combines in-depth technical expertise with a strong focus on sustainability, helping organizations significantly reduce their energy consumption and environmental footprint. In collaboration with renowned technology partners and integrators such as RNT Rausch, iXora makes its solutions widely applicable within data centers, enterprises, and research institutions. Headquartered in the Netherlands, iXora supports customers throughout Europe and beyond.*

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