Case Study

Immersion Cooling | **Telecommunications**

Telefónica Puts Submer's Core Product Through the Toughest of Testing

Type of Solution

Submer's SmartPodXL+ with OCP and 19" servers

Availability

Madrid, Spain

Highlight

Telefónica proves that the SmartPod XL+ is efficient and sustainable while working under the worst climate conditions.

Industry

Telecommunications

Introduction

One of the **biggest telco operators and mobile network providers in the world**, Telefónica globally provides everything from fixed and mobile telephony, to broadband, to subscription television. Telefónica decided to run a pilot test with **Submer's SmartPod XL+**, which took place over the course of a month in Bellas Vistas, Madrid, presenting the added circumstances of a record-breaking hot summer. This project found this immersion cooling solution to have a maintained conventional level of reliability, high efficiency, and improved hardware (HW) performance.

The SmartPod

The Submer SmartPod product line was the very first OCP-compatible[1] immersion cooling system to hit the market. Available in both sizes (800 and 920mm depth) for the entire family X (21U/190U and <50kW), XL (44U/420U and <50kW), and XL+ (42U/390U and <100kW / 50kW Redundant), the SmartPod is a compact, modular LIC[2] solution with **up to 100kW heat dissipation capacity** and an mPUE as low as 1.03. Compatible with most of the market's IT HW and as a perfect fit for High-Density (HPC) solutions[3] and Edge[4], the SmartPod accommodates 21" and/or 19" HW. For more information on the pod, visit our product page.

Submer's SmartPod XL+

The use of the SmartPod's high heat dissipation capability entails a method of cooling IT equipment of greater energy efficiency than traditional methods such as chillers, air conditioners, and refrigerant gases. The PoC was based on the Submer's generated heat transfer from the IT equipment using **heat exchangers with water recirculation**, taking the heat outside to an **adiabatic dry-cooler**[5] installed on the roof.

Adiabatic Dry Cooler and Deck Water Pumps

Reliability

Telefónica carried out thermal capacity tests to check that the Submer cooling system would maintain the temperature of the coolant in the SmartPod **below the setpoint limit of 55º C and under maximum load conditions** of the equipment.

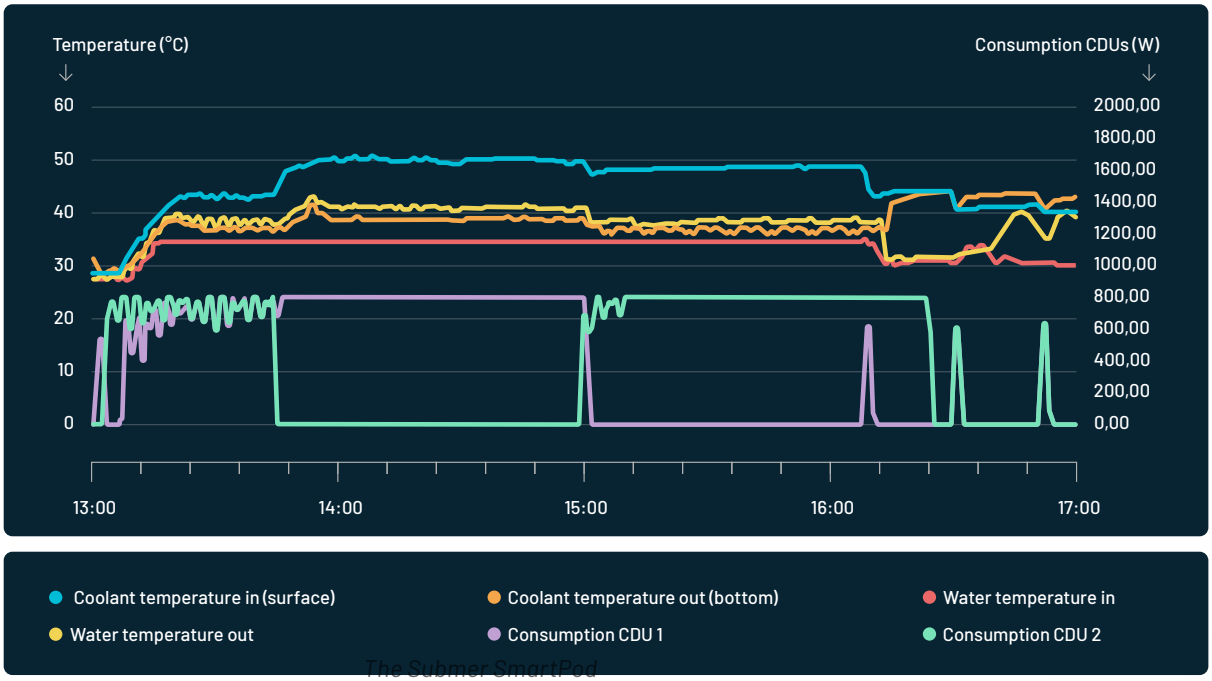
The conditions of the tests were as follows:

- **A maximum thermal load of 50 kW**.
- Since the power of the IT equipment available did not equal 50 kW, 5 electric heating elements of 9 kW, each with self-regulation, were introduced into the SmartPod.
- The set point of the coolant fluid was set at a **maximum of 55ºC**.
- The inlet water temperature was set to be at a **maximum between 34-37ºC**.
- The electrical consumption and temperatures reached in fluids were registered by the network analyzers and the SmartPod CDU[6] sensors.
- The redundancy testings of the two CDUs, recorded the following measurements:

  Mode 1: With the 2 CDUs in operation.
  Mode 2: 1 CDU is turned off and cooled only with the other CDU.
  Mode 3: The turned off CDU is turned on and the one switched on is turned off.
  Mode 4: Turn on the two CDUs again and finish the test.

CDU Redundancy Test

DATE: **27 / 10 / 22**



The Submer SmartPod

The tests proved that Submer's immersion cooling technology **kept the temperature of the coolant stable**, even in extreme operation, **below the maximum target temperature of 55º C**, and with the maximum possible load of equipment inside, **dissipating 50 thermal kW**.

Telefónica found that the technical design of the SmartPod's associated equipment, such as the air cooler, water pumps, pipes, etc, favorably meets the needs of the system, but that in extreme weather conditions (such as during a Spanish summer), water and coolant must be used at 55ºC with the use of adiabatic cooling as support.

Finally, the system offers **100% redundancy thanks to the two CDUs** and can work with the CDUs together or either one on its own. Both were deemed capable of coping independently with the 50 kW thermal load of the SmartPod.

The Submer SmartPod

IT equipment and resistors

Efficiency

Of course, efficiency was an aspect at the very top of Telefónica's testing list; specifically, to obtain the **efficiency indexes** of Submer's immersion cooling solution. Since there are no differences in terms of power elements, such as the UPS[7], transformers, etc, between immersion cooling and traditional solutions, the focus lay on the cooling part.

As the SmartPod temperature cooling can usually be achieved without chillers, the temperatures of the IT load were achieved using **dry coolers with adiabatic systems**, which use a significant amount of water. For that, the team took this into account in their comparison, using the relationship between the cost of energy and water as 1,5 €/m3 vs 0,20 €/kW/h.

Test 1: Clamp Meter

To take the measurements, the team set the coolant to its **maximum limit of 55ºC** and the **activation temperature of the water vaporization in the dry cooler at 36ºC inlet temperature. This meant that if the water in the circuit entered at more than 36ºC**, the dry cooler would have sprayed water on its panels.

The test commenced with 5 resistors on plus, the load of traditional servers, then two were turned off 2 days later, then the other two, then the remaining. The weather conditions were unfavorable as you can see depicted on the graph below.

Evolution of Coolant Temperature and Water Consumption in Relation to the IT Load

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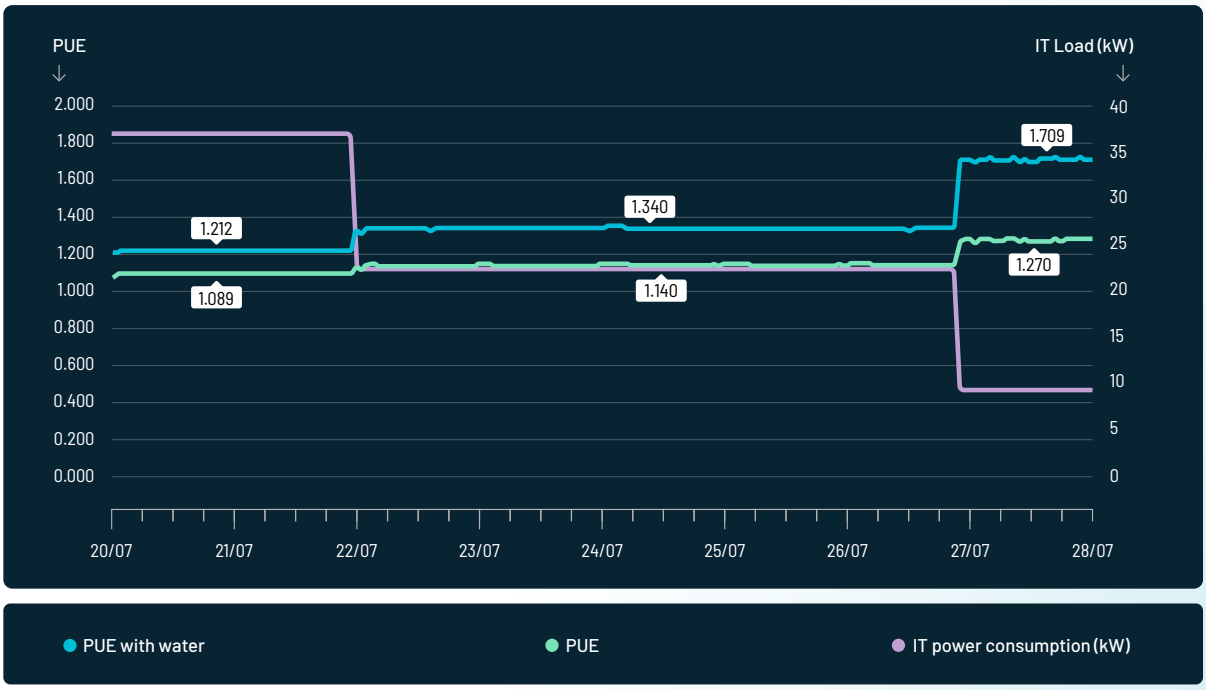

Average Water Consumption Test

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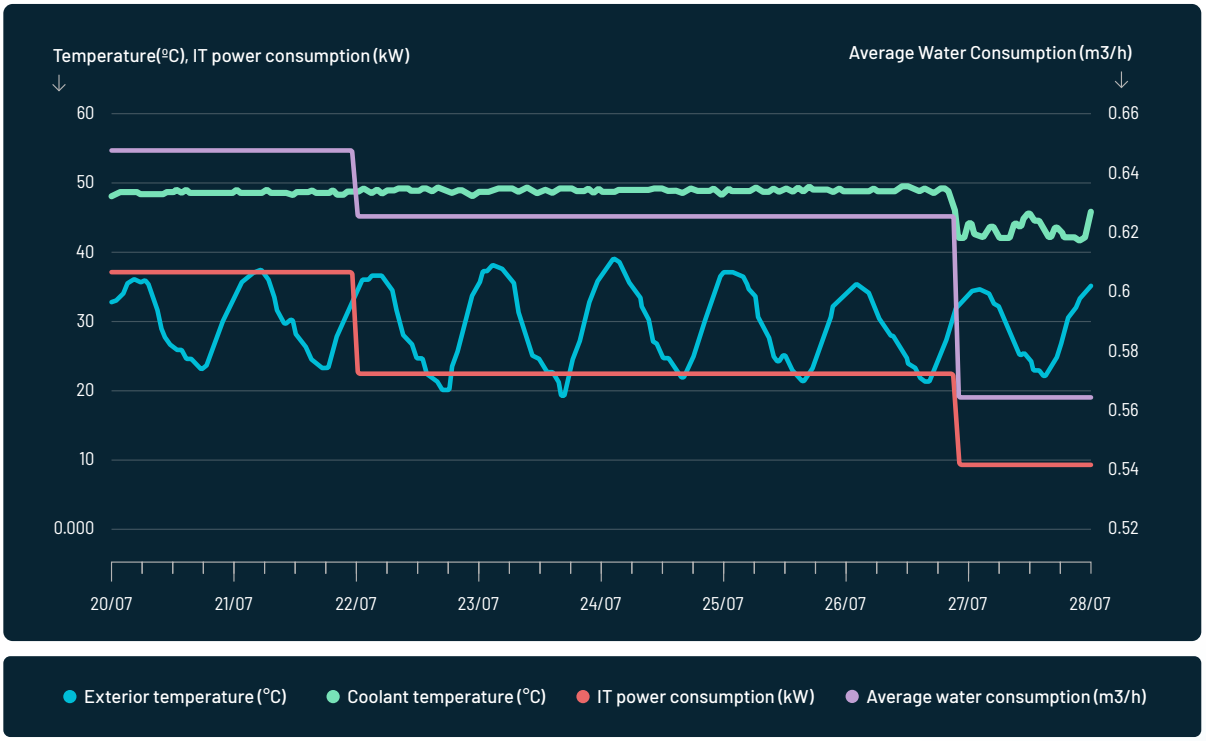


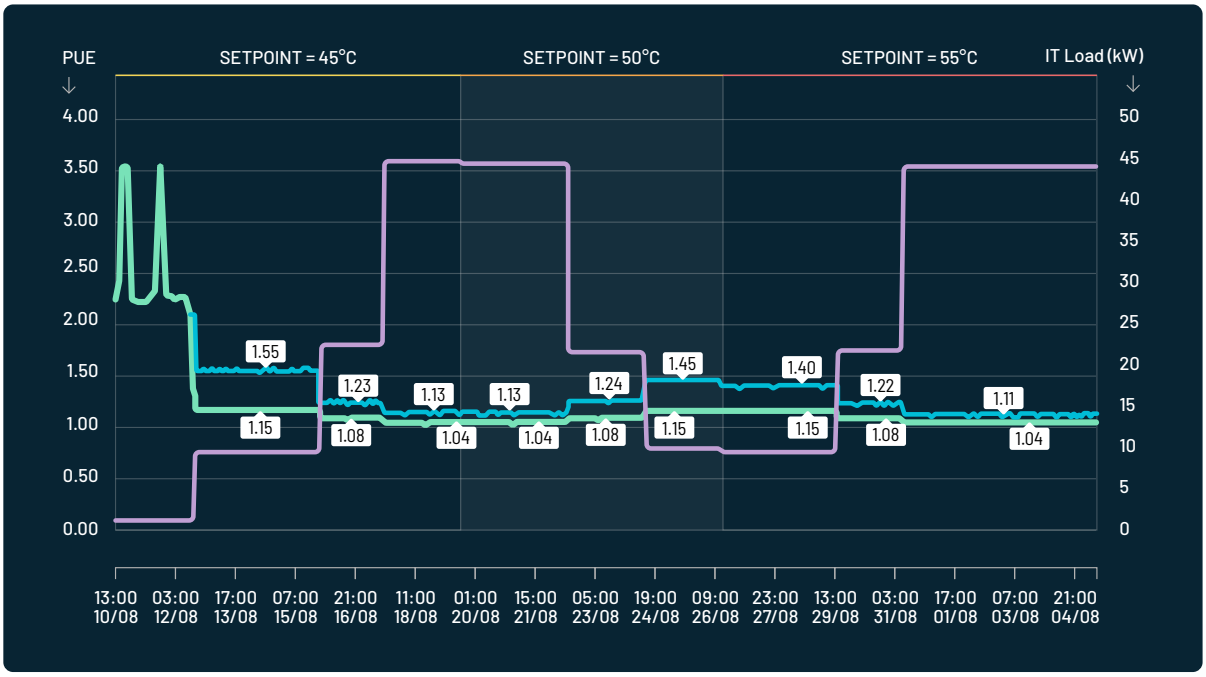
Test 2: Wibeees

Here, the analyzers were placed as in the above test but the load evolution plan to take the measurements was as follows:

- The coolant set point was varied with values of **45ºC, 50ºC, and 55ºC**.
- The load of the SmartPod was varied with the help of resistors: low load (~9kW), medium load (~22kW), and high load (~50kW).
- The activation temperature of the water vaporization in the dry cooler was set at **36ºC inlet temperature**.
- The amount of water spent by the dry cooler was monitored - the meter had no time discrimination so the consumption of each test was prorated by its same duration.

PUE Evolution in Function of IT Load

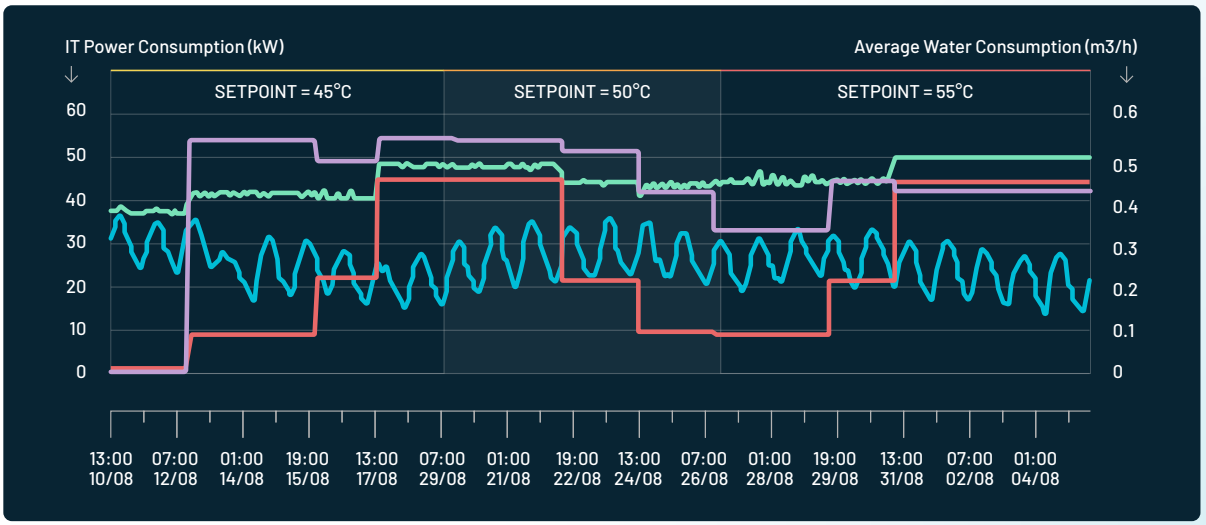
DATE:
10/08/22 to 04/09/22



PUE with water · PUE · IT power consumption (kW)

Evolution of the Coolant Temperature and Water Consumption in Function of the IT Load

DATE:
10/08/22 to 04/09/22



Exterior temperature (°C) · IT power consumption (kW) · Coolant temperature · Average water consumption (m3/h)

Efficiency Testing Summary

LOCATION:
Madrid, Spain

Test Number	1	2	3	4	5	6
Start	15-8-22 22:00	17-8-22 15:00	19-8-22 15:00	22-8-22 11:00	29-8-22 15:00	31-8-22 8:00
End	17-8-22 15:00	19-8-22 15:00	22-8-22 11:00	24-8-22 12:00	31-8-22 8:00	5-9-22 11:00
Duration (days)	2	2	3	2	2	5
Set Point (ºC)	45	45	50	50	55	55
PUE Average	1,08	1,04	1,04	1,08	1,08	1,04
WUE Average	1,23	1,13	1,13	1,25	1,22	1,11
Average kW Dissipation	22,25	44,74	44,70	21,52	21,58	44,40
Water Consumption (m3)	19,95	26,06	36,63	25,2	18	52,15
Room Temperature	27ºC	25ºC	29ºC	31ºC	27ºC	28ºC
External Temperature	31ºC	29ºC	35ºC	36ºC	32ºC	33ºC
Humidity	57%	54%	52%	51%	66%	56%

Overall, taking into account the two aforementioned tests, the water meter, CDU sensors, dry cooler, and weather checks, the results reflect that:

- **the higher the IT load, the better PUE**
- **the water consumption of the dry cooler is influenced more by the outside temperature than by the IT load**
- with the 50 kW dry cooler and 50 kW load, the **coolant temperature cannot be kept below than 48ºC in summer conditions**
- with the contribution of water, the consumption of the non-IT part is only slightly dependent on the outside temperature; however, without water input, non-IT consumption is highly dependent on temperature changes
- the coolant temperature remains very stable (between 45-55ºC) for each test, which enables better reutilization; **the greater the load, the greater the stability**

Hardware Performance

With HW performance testing came multiple objectives. The main objective was to **determine whether the performance of the equipment was affected to any extent by varying the temperature of the coolant**. The Telefónica team also aimed to monitor the temperature reached inside the equipment (mainly the CPU) to determine how they behave when reaching temperatures higher than usual in air cooling environments. Then, to compare the results with the usual operating values in air cooling. Lastly, to detect any potential drawbacks of this type of solution, taking into account how the operation and maintenance by Telefónica's IT technical experts at their datacenter.

And so, to obtain an accurate reading of the HW performance, Telefónica:

Stressed servers with **coolant temperatures between 45ºC and 55ºC**

- Monitored the temperature of the CPUs of the equipment
- Measured the performance of equipment in different load profiles, **between 45ºC and 55ºC**
- Compared the data with that of equipment under air cooling

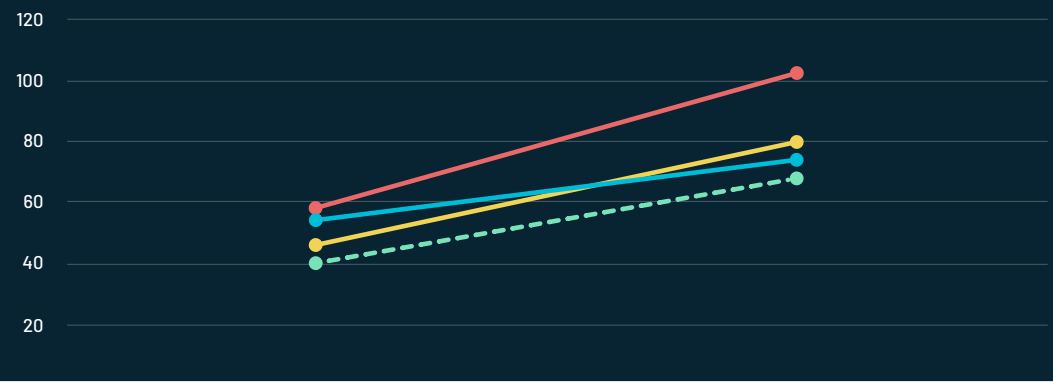
To do so, the following equipment was required:

- An HP DL380 Gen10 piece of IT HW
- Two Fujitsu pieces of IT HW, in a chassis with the capacity for four blades
- Two items of IT HW from the company 2CRSI, one standard and one based on Open Compute standards
- A chassis from Hypertec with the capacity for 6 blades
- A Netapp storage cabinet, model AFF-250 adapted in collaboration with the manufacturer, eliminating fans and modifying the BIOS[8] to avoid auto-shutdown when detecting the absence of this cooling element

The servers used were standard servers (HP, Fujitsu) and servers based on Open Compute designs, both certified and adapted to immersion cooling. The monitoring was conducted with **the servers at rest, at maximum performance, and performance at 80% of their capacity** i.e. the expected value of usual operation. Above this value is where the first warnings of high CPU consumption are generated.

Ambient Temperature Measured by Server IAW Load

SETPOINT = 55 °C



	Fujistu 1 & 2	2 CRSI 19	2 CRSI 21	Air cooling
WITHOUT LOAD	57	46	55	40
100%	103	80	74	69

In this aspect, Telefónica concluded that the **processing capacity does not vary** in immersion cooling and there were **savings of 5% in IT** compared to traditional solutions.

It is worth mentioning that some customized solutions can reach considerably higher temperatures so the lifetime of the equipment must be guaranteed by the manufacturer.

Telefónica is of the opinion that, in order to optimize the efficiency of this solution, it should be used only for processing and in high density and that the access and operation of the IT layer are possible for specific HW solutions and not so for traditional HW.

Conclusion

In summation, immersion cooling has proved itself to be a sustainable and innovative solution that eliminates the need for cooling gases (maintaining traditional reliability values (Tier III[9])) and can **reduce non-IT consumption by 75%**.

The energy savings presented by the SmartPod XL+ could mean a **return on investment in less than 5 years**. While looking at just the price of a unique server may seem expensive, this is reimbursed in the long run.

The solution is only viable with specific HW (very good for the OCP) however the current costs imply a dealbreaker for these solutions. The increase in cost must be limited in 10% for ROI to become inferior to the life span of the HW (5 years).

As for the facilities, the increase in Capex is moderate, and tends to be optimized as the cost of the SmartPod is covered.

Telefónica finds the SmartPod to be ideal for Edge solutions, as it is compact and, thanks to the improvement of the PUE, allows for the optimization of the use of the electrical connections for IT. Projects such as these, which demand these high densities, could be the trigger that this technology needs to open up opportunities within Telefónica for High Performance Computing (HPC).

What's more, the findings show a lot of promise for the possibility of heat recovery for other uses.

"Sustainability is a basic pillar to guarantee the viability of any business or project. Without innovation, we would not be able to guarantee sustainability. Immersion cooling technology shows us that we are on the right track."

Pablo Casado, Head of Global Data Center & Core Sites at Telefónica

Next Steps

Telefónica deems it important that procurement is initiated to fine-tune the cost of the IT HW and ensure that the lifetime risk is passed on to the manufacturer.

In its pipeline, Telefónica is working towards a European EDGE project, its Nabiax Alcalá Phase 1 ground floor expansion area, and expanding in Hispanic America with some HW upgrades.

About Submer

Founded in 2015, Submer provides best-in-class technology, enabling data centers around the world to leverage the power of immersion cooling for HPC, hyperscale, data centers, Edge, AI, DL and blockchain applications. Submer is headquartered in Barcelona and with offices in Virginia and Palo Alto, California. For more information, visit submer.com.

About Telefónica

Telefónica is one the largest telecommunications service providers in the world. The company offers fixed and mobile connectivity as well as a wide range of digital services for residential and business customers. With more than 383 million customers, Telefónica operates in Europe and Latin America. Telefónica is a 100% listed company and its shares are traded on the Spanish Stock Market and on those in New York and Lima.

Glossary

Term	Definition
1 OCP-compatible	The Open Compute Project is an organization that shares designs of datacenter products and best practices among companies. It's a community in which collaborators contribute designs for hardware technology so that the industry can keep up with compute infrastructure growth. Nowadays, it's also very focused on immersion cooling.
2 LIC	Liquid Immersion Cooling i.e. the method of submerging computer components or full servers in a thermally conductive, dielectric liquid.
3 High-Density (HPC) solutions	High performance computing solutions are specially designed to efficiently handle high densities.
4 Edge	Edge computing happens in small facilities close to the application itself.
5 Adiabatic dry cooler	A dry cooler is a heat-transfer device that uses air to remove excess heat into the atmosphere, typically with a heat exchanger and fans. Adiabatic functions may use water to cool down on extreme temperatures.
6 CDU	The cooling distribution unit is the "brain" of Submer's immersion cooling solutions. Within it, you can find a pump system, heat exchanger, and Programmable Logic Controller (PLC), amongst other electronics.
7 UPS	Uninterruptible Power Supply.
8 BIOS	The Basic Input/Output System which performs hardware initialization.
9 Tier III	Datacenters are typically rated from between 1 and 4 (4 being the best), based on the reliability and performance of their electrical systems and infrastructure.

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