Shell ENERGY

How partnerships can deliver

A NET-ZERO FUTURE FOR DATA CENTRES



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1. THE CHALLENGE OF DECARBONISING DATA

Our world runs on data

Our connected world runs on data, and we are creating more at an accelerating pace. Every second, we collectively add another 2,000 terabytes of data, enough to fill 20,000 average smartphones[1]. In fact, the world is forecast to create 180 zettabytes of data in 2025, nearly triple the figure generated in 2020[2].

The rapid adoption of cloud services, storage and backup means that all those bits and bytes are increasingly moving from PCs, mobile devices, and corporate mainframes to data centres. These vital facilities underpin key aspects of modern life, whether we are simply streaming a movie at home or running a complex global business. Data centres connect supply chains, enable collaboration and innovation, keep information secure, and increasingly keep society and the modern economy running.

Keeping business critical data secure and accessible 24/7 is very energy intensive. In fact, the world's data centres use about as much energy every year as the entire country of Italy[3]. That poses steep sustainability and business challenges including emissions, energy efficiency, usage of scarce resources like water and high operating costs. The energy trilemma, of energy security, affordability and sustainability, is very visible here.

An industry in the spotlight

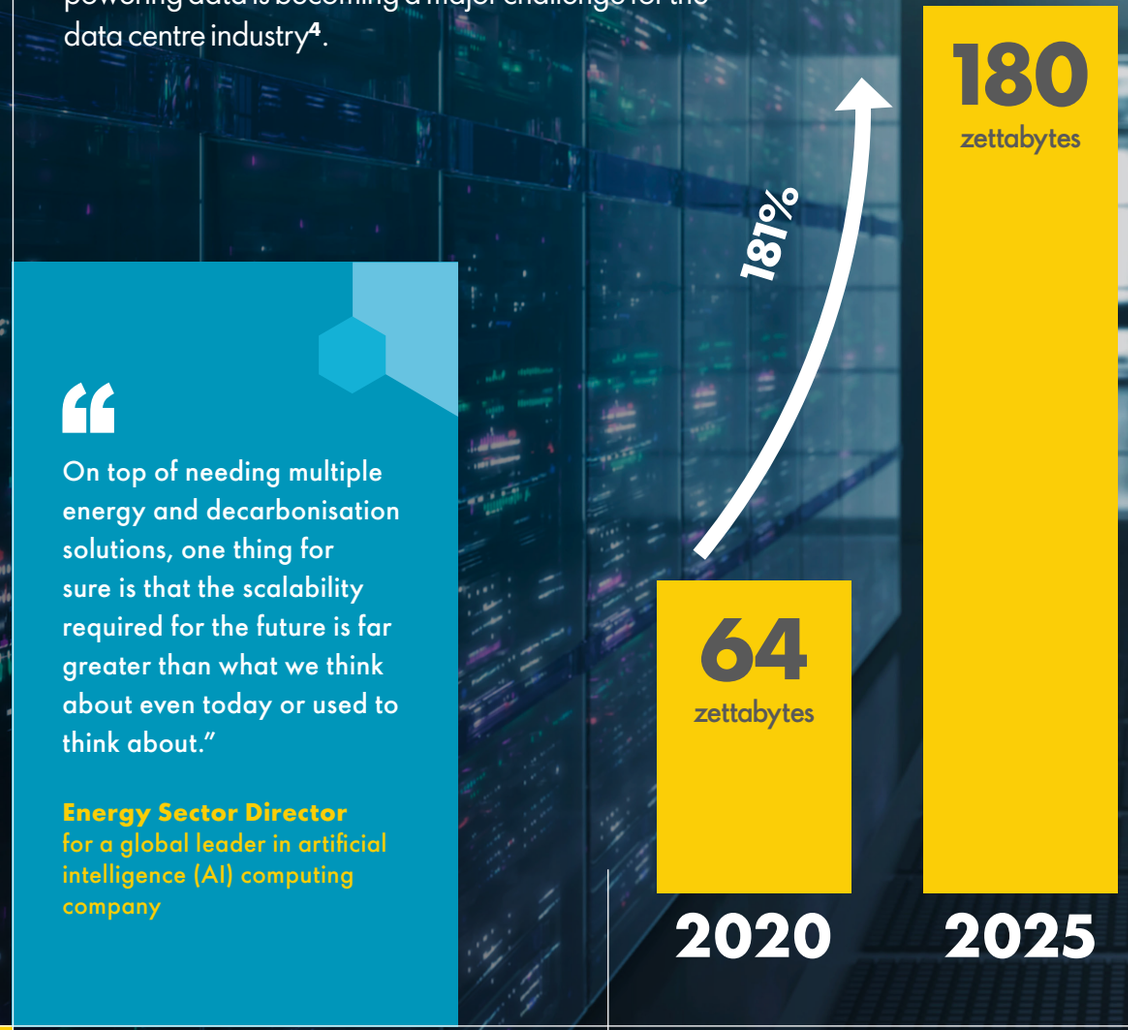
As the world strives to meet its climate goals, customers, investors, regulators, and the public, all expect the technology industry – which helps make progress possible – to also play its part in the transition towards net zero. As data centres, in particular, come under more scrutiny due to the industry growth and the scale and visibility of some data centres, decarbonisation is a prerequisite for further growth of the industry.

There are many challenges to designing, building, and operating a sustainable and cost-efficient data centre. The benefits of different uninterruptible power supply (UPS) systems, hot and cold aisles, and the topics of circularity and e-waste have been broadly discussed by industry experts. To an energy provider and data centre customer such as Shell Energy, several of these stand out, especially: sourcing renewable power, using that power efficiently and resiliently, and keeping servers cool while conserving water. Solving each of these challenges requires collaboration and co-innovation with a complex network of stakeholders.

Let's look at how Shell and our partners are tackling some of the challenges facing data centres – including our own high-performance computing facilities in Houston and Amsterdam.

GLOBAL DATA DEMAND WILL NEARLY TRIPLE BY 2025

Demand for digital services and data is growing exponentially. Since 2010, the number of internet users worldwide has more than doubled, while global internet traffic has expanded 20-fold. In spite of rapid improvements in energy efficiency, the impact of powering data is becoming a major challenge for the data centre industry[4].



> "On top of needing multiple energy and decarbonisation solutions, one thing for sure is that the scalability required for the future is far greater than what we think about even today or used to think about."
>
> **Energy Sector Director** for a global leader in artificial intelligence (AI) computing company

2. SECURING RENEWABLE ENERGY

The energy trilemma

Estimates vary but the overall information and communication technology industry – including all computers, devices and networks – is thought to account for over 5% of global energy consumption[5], with data centres using about 1-2% worldwide[6]. On top of this already large footprint, investment in the data centre industry is forecast to grow by 160% by 2025[7]. This is faster than the growth in renewable energy capacity, which is expected to increase by 'only' 60% over that time[8] [9].

Finding a balance between energy security, affordability, and sustainability – the energy trilemma – is one of the key challenges industries and economies face today. Tackling it requires new ways of thinking and rapid-scale innovation. For an industry with a track-record in driving change and working closely with the energy providers, it is an opportunity to accelerate decarbonisation – both for the tech industry itself and other sectors.

The growth figures mentioned above underscore the challenge of securing renewable energy for computing power, especially for energy that is both additional to and generated within the same grid. In some cases, it is possible to add renewable energy sources on-site. However, the need for stable power at scale, which requires additional flexibility sources combined with site specifics and costs, often means that adding power from renewable sources to the grid is still the most effective solution in many cases. Other options like renewable hydrogen produced on-site in combination with fuel cells, are still several years away from commercial scalability for data centre applications. Limited access to a broad range of renewable and lower-carbon energy resources further emphasises the need for continued energy efficiency that can be gained through new technologies in areas like hardware, software and cooling.

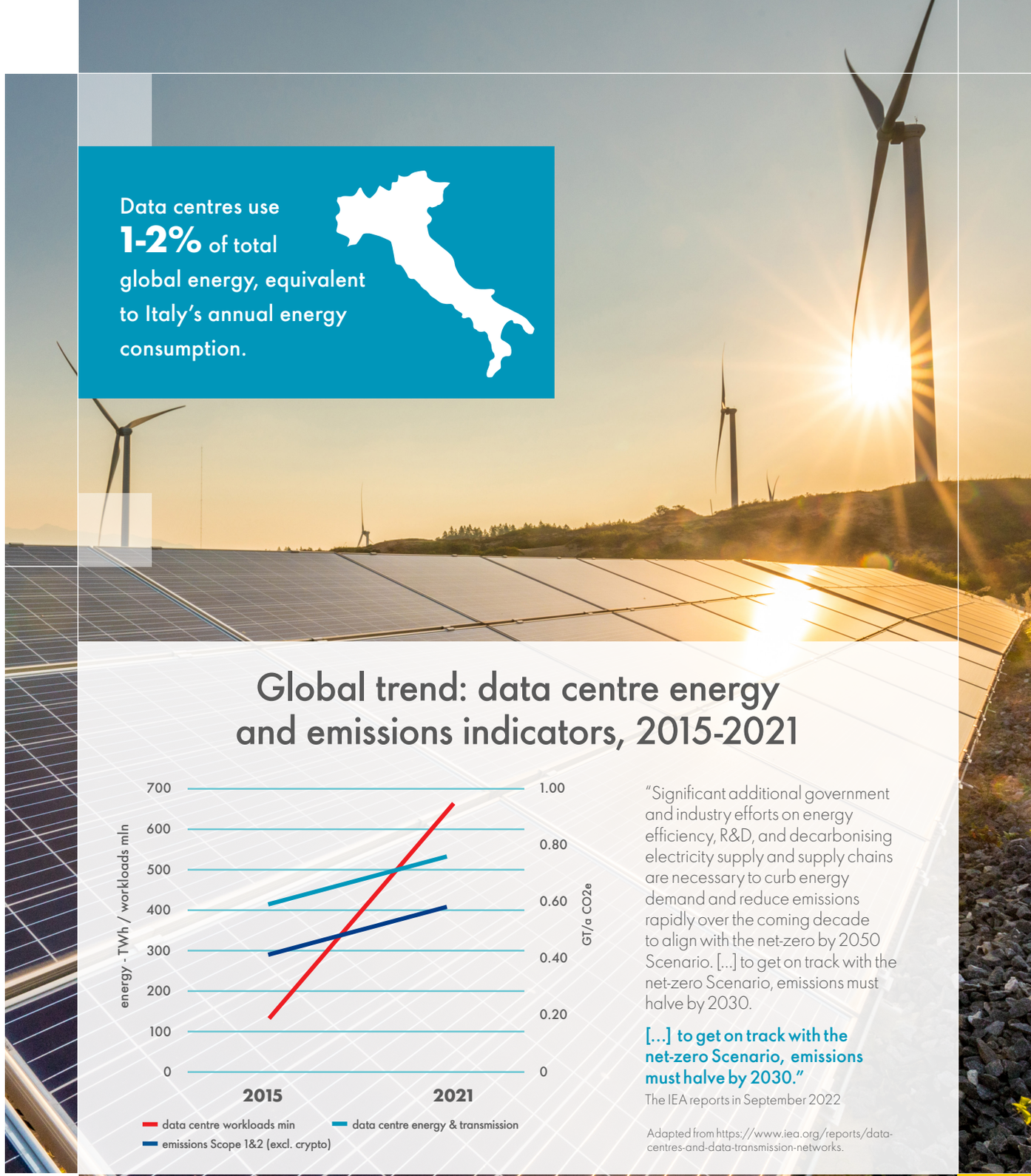
Facing up to the challenge

At Shell, we are facing the issues discussed here first-hand for our own data hosting and energy needs as well as those of our customers, and we are tackling them through a combination of innovation and collaboration.

For instance, to power our new co-located high performance computing (HPC) centre in Hosuton, Texas, we:

1) minimise energy usage by testing and deploying the latest technological solutions including immersion cooling;
2) procure renewable electricity directly from Shell Energy; and
3) use credits from Shell's portfolio of independently verified carbon credits to help compensate for any remaining unavoidable emissions.

Shell's deep experience in energy sales and trading, as well as dealing with governments, regulators and utilities, helps enable the right environment for reliable, long-term power purchase agreements for renewable energy. This deep expertise and breadth of capabilities is why leading companies in the technology industry and beyond are working with us to jointly solve these challenges.



Global trend: data centre energy and emissions indicators, 2015-2021

"Significant additional government and industry efforts on energy efficiency, R&D, and decarbonising electricity supply and supply chains are necessary to curb energy demand and reduce emissions rapidly over the coming decade to align with the net-zero by 2050 Scenario. [...] to get on track with the net-zero Scenario, emissions must halve by 2030.

[...] to get on track with the net-zero Scenario, emissions must halve by 2030."

The IEA reports in September 2022

Adapted from https://www.iea.org/reports/data-centres-and-data-transmission-networks.

3. DRIVING ENERGY EFFICIENCY

For the power-intensive data centre industry, energy security and efficiency are fundamental to operate sustainably and increasingly also for a license to operate. With the growing demand for energy in an energy market under pressure, data centres are focusing on deploying efficiency solutions, and smart tools and methods for energy management.

PUE: when less is more

Power usage effectiveness (PUE) is an indicator used to determine the energy performance of a data centre. PUE is obtained by calculating the ratio of the total amount of power entering a data centre by the power used to run the IT equipment within it. The ideal ratio is 1.0, meaning you are not wasting any energy at all and all energy is used for computing. Lowering PUE through, for example, more effective cooling methods saves energy and cost. Some older data centres can have a PUE of 2.0 or even higher, which means that for every watt used by a chip for computing, another watt is for cooling that chip and other 'overhead'. The latest data centres can boast a PUE of around 1.1 thanks to a combination of new cooling technologies, software and hardware. Bringing PUE down in the right way is a crucial part of reducing emissions and, in many cases, also water usage.

Energy efficiency and energy management

High-efficiency lighting, heating ventilation and air conditioning and innovative liquid cooling systems are other ways to drive energy efficiency.

The first two are common strategies for many other industries that system operators prioritise next to the implementation of energy management and load-control systems. The third element, liquid cooling, is a solution specifically relevant for data centres.

Thanks to energy management submetering systems, operators now have real-time visibility into equipment-level diagnostics and performance verification. These systems ensure the facilities' optimal performance in energy consumption. All together, these and other digital solutions and modular infrastructure technologies help operators minimise losses in energy usage.

It is common to see large numbers of servers sitting idle at any given time, while some machines use only 10-15% of their capacity. To address this under-utilisation, data centre owners and operators are increasingly using modular infrastructure technologies and new redundant power system architectures that can ensure system flexibility between traditional, new, and emerging workloads. They also turn to a range of smart controls or intelligent rack protocol data units as well as virtualisation software, AI, and machine learning to monitor energy and water usage, temperature and humidity, and peak demand cycles. By intelligently managing power loads, distributing compute tasks more evenly, and maximising utilisation rates, these systems can drive double-digit reductions in overall energy consumption[10].



> "We are beyond the point where you can air cool your data centre when doing high-performance computing. Immersion cooling has more than a thousand times the thermal capacity of air by volume. It's the difference between using a fan and jumping in a cold pool. We are at the point where it's clear we need to do it, now the question is how are we going to do it?"
>
> **David Baldwin**
> High-Performance Computing Manager, Shell

As better and faster data analysis brings new insights, it also introduces a new challenge: rapid growth in data-intensive applications demand greater compute power and constant uptime. In one example, training an AI language model required running more than 500 high-end processors for nine days, consuming nearly 28,000 kWh of electricity – about as much as three average U.S. households in a year[11]. In addition, these latest chips are so powerful that they are hitting the limits of traditional air-cooling methods.

The new frontier: immersion cooling

This leads us to the new frontier of data centre performance and efficiency: immersion cooling. Embraced by HPC enthusiasts, crypto miners and professional gaming companies, immersion cooling is now grabbing the attention of enterprise users. This method of liquid cooling uses safe, non-conductive cooling solutions with advanced thermal properties that can cut energy use by up to 48% while boosting processor performance up to 40%[12]. This allows for possible increases in chip and rack density, delivering more computing and uptime while minimising data latency, virtually eliminating water consumption and lowering the data centre CO_2 footprint by up to 30%[12].

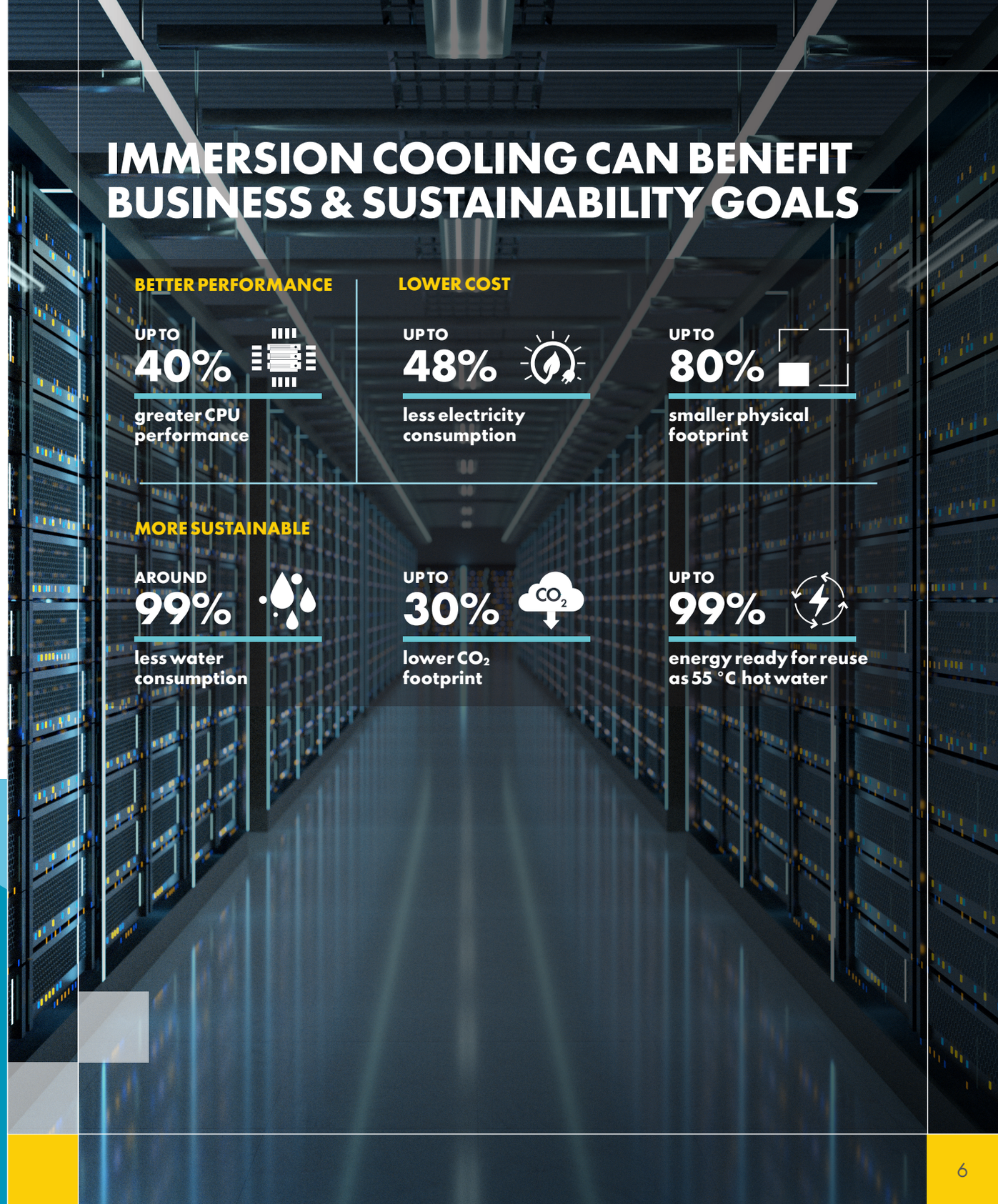
Shell implemented this solution using its own (single-phase) cooling liquids at our Amsterdam HPC cluster. We are partnering with a variety of equipment manufacturers to scale and commercialise this technology to meet the needs of today's and tomorrow's data centres so they can continue to grow and operate sustainably.

Cutting back on waste water

An important added benefit of immersion cooling is vastly reduced water usage, by up to 99% as compared to water-intensive cooling methods deployed by many data centres today. A large data centre with such traditional cooling can use up to 5 million gallons of water a day, the same amount used by a town of 50,000 people[13]. This is increasingly a factor for operators seeking to open facilities in rural, arid regions that are concerned about diverting this precious resource away from homes, farmers and other parts of society.



> "Innovation is absolutely critical for success. There's an inextricable linkage between sustainability and innovation as they operate together. That's something we are beginning to see with immersion cooling."
>
> **Innovation Executive**
> for a global Top 5 hyperscale cloud company



4. CASE STUDY: BUILDING SHELL'S NET-ZERO HPC DATA CENTRE OF THE FUTURE

Shell's ambition is to become a net-zero emissions energy business by 2050[14], and the HPC team in Shell IT are contributing to that goal. The team undertook a project to move our legacy data centre in Houston to a new high-efficiency facility run by Skybox Datacenters. The migration took place over 10 days in early 2021 and involved 4,000 servers, 100 petabytes of data, and countless miles of network cable. We chose the Skybox facility because it is purpose-built for the kind of HPC required by the large integrated energy company that we are. It is set up for energy efficiency, low-carbon electricity, and immersion cooling of the servers, which Shell is piloting at the location using our own single-phase fluids. Our operation there draws power from Shell Energy North America, which provides low-carbon energy solutions to large businesses.

Advanced analytics allow the team to spot issues before they become serious. Smart controls, virtualisation software, and AI help to intelligently manage workloads, distributing compute tasks more evenly and maximising utilisation rates. The facility regularly sees utilisation rates of 80-90%, compared to 30% or less for many other data centres. This cutting-edge centre also acts as a laboratory where we can test new technologies with our partners as well as innovative solutions like 24/7 renewable power. It has given us valuable insights into how we can support a wide range of data centre operators and customers on their journey to net-zero emissions.



Skybox: an HPC data centre of the future

4,000 servers

100 petabytes of data

Skybox new cutting-edge data centre facility is set up for high-performance, high-efficiency and maximising utilisation rates.

Utilisation rates

5. THE POWER OF ENERGY & TECH PARTNERSHIPS

A complex value chain

As we have seen from the challenges described above, in today's data-powered economy, it is more important than ever for businesses to continue innovating in order to operate sustainably and profitably across every industry. The climate challenge drives home the reality that a partnership mentality is required. Industries, governments and companies cannot operate in silos: no one can go at it alone. One company's Scope 3 emissions are another company's Scope 1&2. Customers are also suppliers and vice versa. In the field of technology, data centres are only one part of a complex value chain that comprises an ecosystem of hardware manufacturers, infrastructure and software providers, hosting, design and installation companies, energy and energy management providers, and of course the end users. Driving decarbonisation in such an ecosystem requires deep collaboration and innovation. The breadth of the challenge can only be met with an equal breadth of partnerships.

Collaboration and co-innovation as critical success factors

Companies of all kinds are keen to help build the energy system of tomorrow. It is no longer about producing power centrally and transmitting it. The future will be much more decentralised. Utility- and district-scale solar generation, battery enabled energy storage, biofuels, hydrogen and other low-carbon energy solutions, all playing a role. Stakeholders with different areas of expertise coming together to accelerate innovation and adoption of new technologies is what will help decarbonise industries and the economy at large.

At Shell, we are proud to work and co-innovate with leading companies in the technology sector and other industries. As we strive together to reduce emissions and help the tech industry reach net zero, we build robust collaborations that also help us to improve our solutions.



> “Nobody can drive all of this change by themselves. It is not only about partnerships between corporations, but also with governments and throughout society. There has to be a common understanding that says these are global challenges, so let's go forward and work together.”
>
> Extracted from “CogX London, June 2022”
>
> **Sjors van de Rijt**
> Head of Sustainability
> Partnerships Energy & Tech, Shell



SOURCES

1. Based on average smartphone storage capacity of 100GB as reported by Android Authority, March 20, 2021

2. Data Creation and Replication Will Grow at a Faster Rate than Installed Storage Capacity, according to the IDC Global DataSphere and StorageSphere Forecasts, March 24, 2021

3. https://www.statista.com/statistics/263455/primary-energy-consumption-of-selected-countries/

4. https://www.iea.org/reports/data-centres-and-data-transmission-networks

5. Information & Communication could consume up to 20% of electricity in 2030 (enerdata.net)

6. Data Centres and Data Transmission Networks – Analysis - IEA

7. Global Data Center Market Research 2021-2025 | Market Impact Analysis due to COVID-19 | Technavio | Business Wire

8. https://www.iea.org/reports/renewables-2021/executive-summary

9. https://www.reuters.com/article/us-climate-change-renewables

10. Project Finance Newswire, June 2021, p. 38. The article cites an AI system in a Google data centre that reduced the energy used in cooling by 40% and overall energy consumption by 15%

11. Energy consumption of AI poses environmental problems (techtarget.com)

12. De Azevedo, E., Wang, L., Veeralinga Shivaprasad, P., &; Wei, T. A NEW IMMERSION COOLING FLUID to enable low-carbon data centres (No. 30 ed., Vol. 09, pp. 50-55, Tech.)

13. https://www.nbcnews.com/tech/internet/drought-stricken-communities-push-backagainst-data-centers

14. Shell's operating plan, outlook and budgets are forecasted for a ten-year period and are updated every year. They reflect the current economic environment and what we can reasonably expect to see over the next ten years. Accordingly, they reflect our Scope 1, Scope 2 and Net Carbon Footprint (NCF) targets over the next ten years.



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