



MEETING THE HIGH DEMANDS

OF HIGH PERFORMANCE COMPUTING



Landsvirkjun

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THE FUTURE OF DATA CENTERS

In today's increasingly digital world, data is growing at an incredible rate. In fact, it's estimated that the global datasphere will grow by more than 430% from 33 zettabytes in 2018 to more than 175 by 2025¹. And this pace will only accelerate further.

It's clear that the future of every business depends on data. And when it comes to data centers, making the right long-term investment is crucial. But as we saw in our white paper, **18 reasons why the future of data centers is Iceland**, there are a number of difficult considerations when deciding on a data center location.

It all comes down to securing a site that's sustainable, stable and able for the future. And for high performance computing (HPC) these factors are even more critical.

This white paper will therefore show how Iceland isn't only the **sustainable, stable and able** choice for data centers. It's ready to meet the increasingly high demands of high performance computing – now, and in the future.





A BETTER FUTURE WITH HPC

Developing life-saving medicines. Modeling climate change. Creating machines that think. Anticipating financial risks. Decoding consumer behaviors. Advanced scientific calculations and processes like these are essential to technological innovation and human progress. But they require tremendous processing power with an astronomical number of calculations needed to simulate and model complex scenarios.

Since HPC can run these highly complex calculations in parallel – making the process faster, more efficient and ultimately more reliable – it's becoming available for more industries and applications with the market set to be worth more than US \$49 billion by 2024 at a CAGR of 6%².

Via HPC, big data is now a reality. Today, businesses have the kinds of predictive analysis at their fingertips that before would have taken decades of experimentation to achieve through iterative and repetitive calculations. Ultimately, HPC allows for far more complex problem-solving and computer-intensive tasks in real time – accelerating the way to better innovations and solutions for the future.

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SUSTAINABLE HIGH PERFORMANCE

The main drawback of the near limitless potential of HPC to advance society is its impact on the environment. The mammoth amount of energy used to power and cool HPC facilities typically involves burning fossil fuels to generate electricity. And as the numbers of these systems increase, so do carbon emissions.

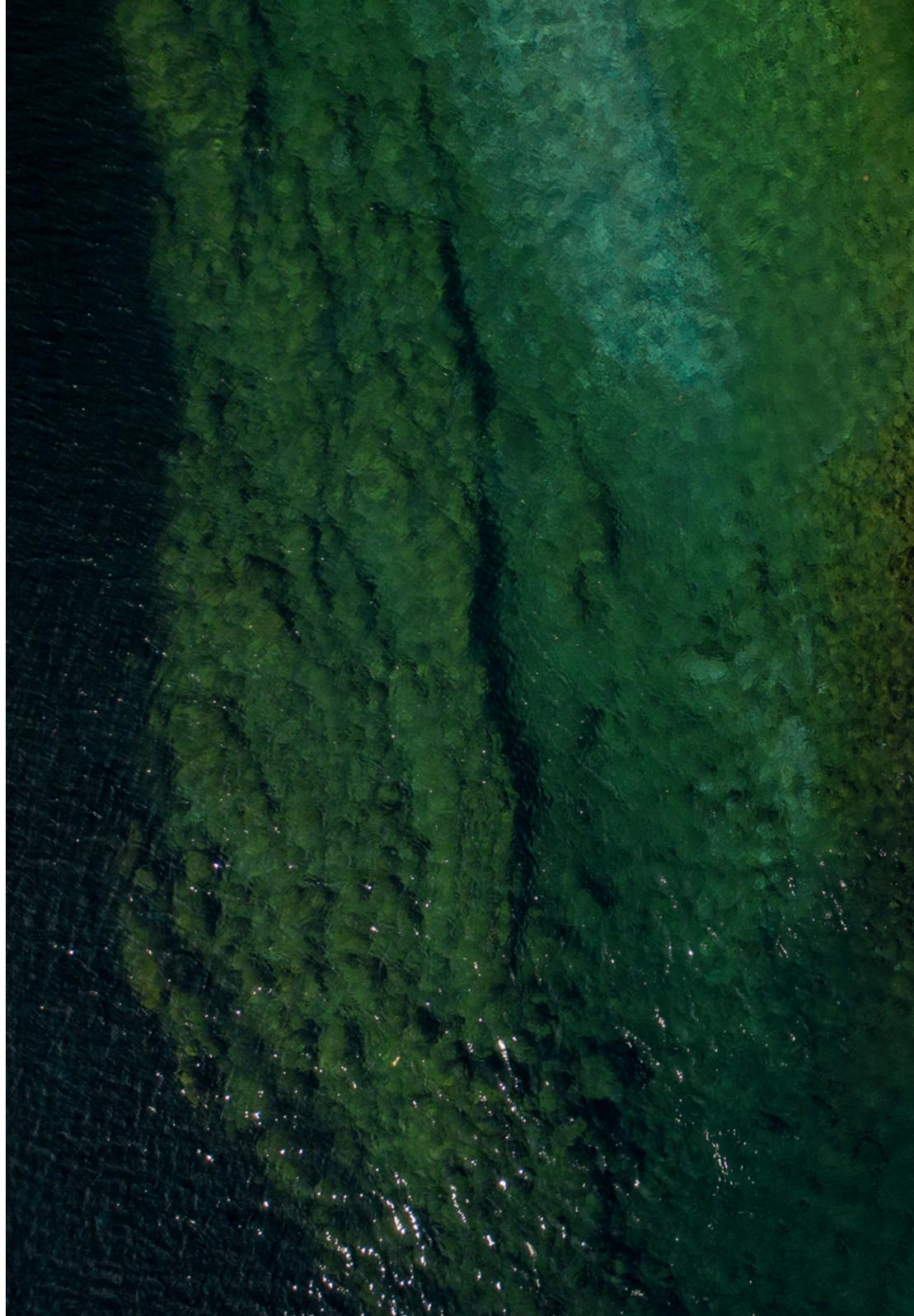
Today, sustainable utilization of natural resources is becoming a critical issue for everyone from governments and businesses to local communities. And the environmental impacts of using non-renewable resources like fossil fuels are for many now of greater concern than their growing scarcity.

So, as we enter a time where the effects of climate change are being felt around the world, it's essential for HPC operators to do what they can to reduce their reliance on fossil fuel-generated electricity. Particularly when considering that in 2016 data centers accounted for 3% of global electricity consumption³ – a figure that's set to rise sharply in the coming years.

WHY ICELAND IS THE ANSWER

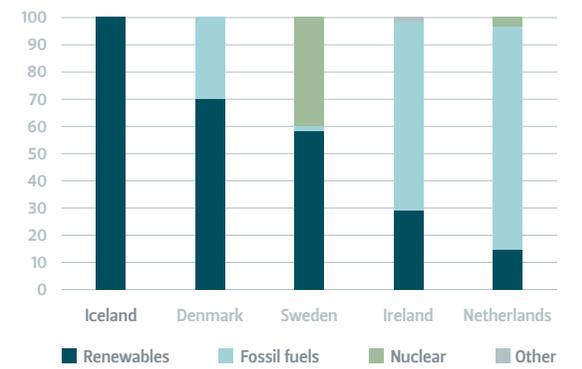
Iceland's unique mix of geology and its subpolar location has given the country a remarkable sustainability profile. First and foremost, the country is rich in renewable natural resources. And the utilization of these resources plays a key factor in the long-term, sustainable success of its economy and society. These natural resources, including water, heat and wind, are in ample supply and help ensure continuously available energy throughout the country.

Due to this utilization of hydro and geothermal energy sources, together with a growing number of wind turbines, Iceland's electricity generation is 100% renewable. And as an isolated energy system with no nuclear or fossil fuel generation, the country is unaffected by grey power generation and its associated issues. This means companies investing in Iceland for their HPC facility will have long-term access to a sustainable energy supply with significant savings in CO₂ emissions.





Percentage of generated renewable energy⁴







COST-EFFECTIVE COOLING

As well as being tremendous consumers of energy, HPC facilities generate an exceptional amount of heat. Even for the average data center, it's estimated that cooling systems – including chillers, humidifiers and computer room air conditioning units – account for up to 45% of its total energy consumption. This cooling demand significantly increases the cost, complexity and environmental impact of HPC facilities, and in many cases represents their highest total expenditure.

Iceland's unique temperate oceanic climate, however, makes year-round ambient cooling of HPC facilities not only possible but reliable.

The average daily high temperature in Reykjavik during July is just 13.5°C/56°F. And during the coldest winter months, the average low is -2°C/28°F, which is cool enough for data facilities to use the already cold air and water to provide cooling. This ambient cooling offers potential savings of around 30% on a data center's total energy cost.

Looking further ahead into the future, Iceland is set to build upon its already strong sustainability profile by becoming completely carbon neutral as a nation no later than 2040. And at Landsvirkjun, we aim to have an entirely carbon neutral business by 2025 and be carbon negative by 2030.

Average monthly temperature in °C⁵

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Reykjavik, Iceland	0.7	0.4	0.9	3.4	6.7	9.8	11.7	11.1	8.5	4.6	2.2	0.6
Tromsø, Norway	-3.3	-3.2	-2	1.6	6	9.3	12.6	11.5	7.8	3.3	0	-1.8
Dublin, Ireland	5.3	5.5	6.6	8.1	10.7	13.2	15.2	15	13	10.3	7.4	5.4
Luleå, Sweden	-8.4	-9.2	-4.6	0.7	7	12.8	16.2	14.4	9.1	2.8	-3	-6.5
Billund, Denmark	1.1	1.2	3.2	7.3	11.1	13.8	16.5	16.3	13	8.8	4.7	1.7
Amsterdam, Netherlands	3.7	4.1	6.5	9.7	13.1	15.5	17.8	17.7	15	11.3	7.2	4.1
Oslo, Norway	-2.6	-2	1.2	6.4	11.4	15.2	17.9	16.9	12.4	6.6	2.2	-2
Helsinki, Finland	-4.8	-5.4	-2.3	4.3	10.2	14.3	18.2	16.1	11.8	6.2	1.9	-1.9
London, England	5.8	5.4	8	9.7	13	15.8	18.8	18.5	15.8	12.8	8.7	7.4
Stockholm, Sweden	-1.6	-1.5	1.3	6.7	11.7	15.6	19.2	17.8	13.2	7.6	3.6	0
Frankfurt, Germany	1.9	2.8	6.5	10.2	14.2	17.7	20.2	19.8	14.9	10.3	5.4	2.4
Paris, France	5.3	5.9	9.1	12	15.5	18.5	20.5	20.3	17.4	13.3	8.5	5.6

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SECURING LONG-TERM STABILITY

Stable power. Stable environment. Stable costs. Stable connectivity. And stable regulation. When considering the long-term stability of a country or location, data center strategists typically scrutinize these key factors. And for HPC operators, these concerns will only be amplified in the search for the most optimal environment.

Accurately assessing risk is an integral part of the site selection for any kind of data center. Because downtime for commercial operations can have significant direct financial costs and immeasurable effects on a firm's reputation.

Access to stable, reliable and continuous energy supply is one of the biggest concerns for businesses. Particularly as the reliance on fossil fuels diminishes and the demand for renewable sources of energy increases. The cost of this energy is also a huge concern since energy prices make up a large percentage of OPEX. And, as they fluctuate globally, they're often difficult to forecast.

Environmental stability is also paramount for HPC facilities since any risk of natural hazards can affect investment, property and ultimately lives.

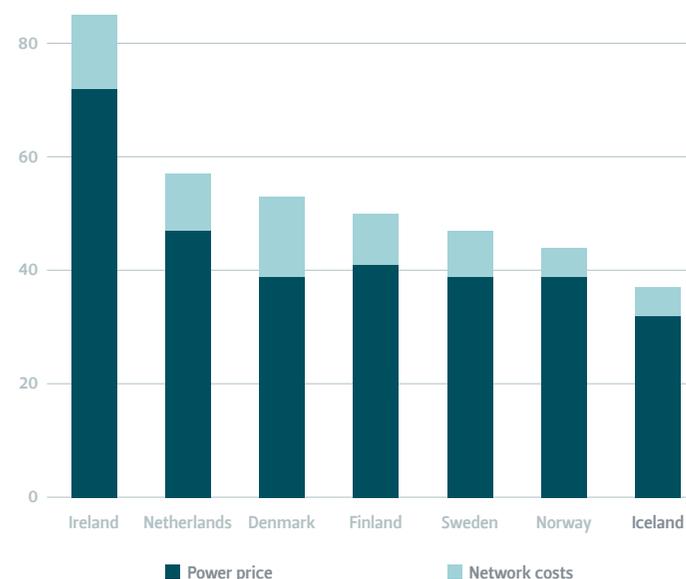
And with the incredible processing capabilities needed for demanding HPC systems and applications, securing long-term low latency is essential.

WHY ICELAND IS THE ANSWER

In Iceland, the data center and HPC industry is already well established and in recent years has been growing rapidly. A large reason why is the fact that the country is proven to mitigate risks in energy, environment, costs, connectivity, regulation and more – ensuring secure and stable operations for HPC facilities, now and in the future.

When it comes to energy, investors in Iceland are assured both long-term price stability and reliable supply of renewable energy. HPC operators are incredible energy consumers, yet those in Iceland can depend on 100% carbon neutral indigenous energy production and some of the most competitive energy prices in the Nordic/EMEA region, which can be fixed for many years. On top of this, further energy savings are made thanks to the country's continuous free cooling due to its subpolar location.

Electricity prices (EUR/MWh) 2019 for consumption of 70–150 GWh per year⁶





VERNE GLOBAL

CASE

Verne Global delivers HPC solutions for a range of global businesses, including BMW, Volkswagen, Earlham Institute, DeepL and ThreatMetrix. The company operates a 600,000 square meter, ISO 27001-certified technical site close to Keflavik in southwest Iceland. All of which has been designed and engineered from the ground up to cater for HPC and intensive GPU infrastructures for AI and machine learning.

Due to Verne Global's demanding HPC power needs – as with many other data centers based in Iceland – the country's exceptional power-availability, robust network and 100% renewable energy made it the ideal choice. For Verne Global, together with its HPC partners, Iceland delivers abundant, scalable power combined with long-term fixed pricing and optimized cooling.

Using data center space at Verne Global, BMW Group reported an impressive 82% reduction of operating cost in their HPC clusters compared to operating in Germany. Shifting the computer load to Iceland's hydro and geothermal based power further saved BMW around 3,750 tons of CO₂ emissions annually. Learn more at [verneglobal.com](https://www.verneglobal.com)

ADVANIA DATA CENTERS

CASE

Technology company Advania Data Centers operates one of Europe's largest data center campuses in Iceland. With its purpose-built colocation facilities, the company manages a range of computing environments, including AI, HPC and blockchain, across a number of industries around the world.

Advania's high-density facilities for AI and HPC combine the optimal conditions for cost and operational efficiency, with extremely power-efficient operations, competitive and predictable energy prices, carbon neutral energy sources, and a power density of up to 40kW per air cooled rack. Its Tier 1 data centers offer a PUE from 1.03 while its Tier 3 data centers offer a PUE of 1.10.

Delivering high performance, reliability, security and energy efficiency, Advania partners with some of the world's leading enterprises for their HPC operations. These include NUMECA International for its advanced analysis in computational fluid dynamics, and the Institute of Global Health for its groundbreaking research into COVID-19 transmission. Learn more at advaniadc.com





MITIGATING NATURAL RISKS

Much is often made of Iceland's seismic activity, however these locations are confined to isolated zones and the risk of events is extremely low. In fact, Iceland has the world's lowest risk of natural disasters. And, according to the 2020 Global Resilience Index⁷, Iceland is the country most capable of mitigating natural risks as part of the construction design. This means Iceland is better able than any other country to reduce the already small risk of exposure to natural hazards.

Iceland is also ranked highly in terms of digital competitiveness thanks to its reliable international connectivity and low latency network. Currently, Iceland delivers latency numbers between 17 and 20 milliseconds, depending on the destination. And the country's anticipated fiber project will reduce this further to between 10 and 15 milliseconds.

Top 10 ranking of lowest risk to the establishment of data centers by Cushman and Wakefield⁸

2016 rank	Region	Index score (100 = best)	Country
1	EMEA	100.0	Iceland
2	EMEA	96.21	Norway
3	EMEA	90.26	Switzerland
4	EMEA	90.19	Finland
5	EMEA	89.92	Sweden
6	Americas	85.07	Canada
7	APAC	84.50	Singapore
8	APAC	83.23	Korea. Rep.
9	EMEA	79.81	United Kingdom

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ENSURING FUTURE ABILITY

A sustainable and stable location for HPC operations won't mean much if there isn't the right support network in place in terms of people, processes and incentives. A diverse and talented workforce is crucial to ensuring quality performance and efficient operations. But in highly specialized fields like IT, finding qualified candidates can prove challenging.

It's been well documented that the IT and data industries are suffering from an ageing workforce and issues in staff retention. And when it comes to high performance computing, the need for a highly-educated and technologically-ready workforce is essential to meet the growing demands of industry and society.

Setting up HPC operations in a new country is also a daunting prospect. It can be a costly, time-heavy process if the chosen location doesn't have the right natural environment or institutions to ensure a business is up and running quickly.

It's also crucial to have the right long-term incentives in place. This means any country chosen as a location must be able to support the establishment of a business by sharing the financial risk, giving it the best possible chance for the future.

WHY ICELAND IS THE ANSWER

Iceland has an open, international and efficient economy. There's little bureaucracy, processes are short, and its institutions are designed to support the rapid set-up of both small start-ups and large international corporations. Due to this open and attractive business environment, the HPC industry in Iceland is already thriving.

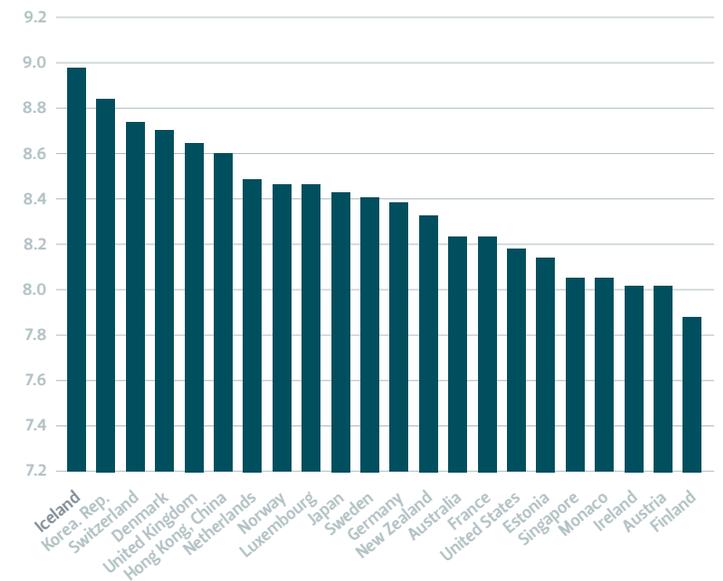
The country has long demonstrated an ability to develop and train high-quality ICT and engineering staff. And with an already diverse workforce, the nation's decision to establish a data center and HPC environment has resulted in a focus on developing home-grown talent that's able to support the industry's successful development.

In fact, the World Economic Forum's Global Competitiveness Report 2019 ranked the skills of Iceland's future workforce ninth in the world, and in 2017, the International Telecommunications Union rated Iceland as the world's best ICT environment.





International Telecommunications Union's ICT environment ranking 2017⁹



THE RIGHT INCENTIVES

In support of its highly-educated and technologically-ready workforce, Iceland is also known for its favorable taxes and regulations. At 20%, Iceland has some of the EU's – and the world's – lowest corporate tax rates. And it gives businesses the opportunity to negotiate terms individually, based on the company's influence on the overall economy.

In addition, Iceland has an incentive scheme specifically designed for innovative companies; the objective of which is to improve and foster research and development. As part of this scheme, companies undertaking R&D projects can apply for a tax credit to the Icelandic Centre for Research (Rannís). The aid is 20% of the project cost, limited to ISK 100 or 150 million per year – depending on the nature of cost items – and is administered as an income tax reimbursement.





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POWER THE FUTURE IN ICELAND

The development of digital society is accelerating at an incredibly rapid pace. This means it's becoming ever-more difficult to predict how the world will be in the next two to three years, let alone foresee a full decade into the future. Choosing the right location for your HPC operations is therefore a uniquely challenging investment.

But with its unmatched energy profile, optimal environment and technologically-ready workforce, the future is bright for supercomputers in Iceland.

With long-term access to a renewable and reliable energy supply, it's clear that Iceland is sustainable for the future. With our secure and low-risk environment, the country is reassuringly stable for the future. And with our strong aptitude for business and innovation, we're ready and able for the future.

So, whether your business is bioscience discoveries or building the cities of tomorrow, come and power the future in Iceland – the sustainable, stable and able choice for high performance computing.

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ABOUT LANDSVIRKJUN

Landsvirkjun generates renewable energy at competitive prices. The company is owned by the Icelandic State and has over 55 years of experience generating electricity from hydro and geothermal power sources.

Landsvirkjun is Iceland's largest generator of electricity, currently operating 18 renewable hydro and geothermal power stations. Landsvirkjun's mission is to maximise value creation from energy sources entrusted to the company in a sustainable and efficient manner.

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