18
REASONS WHY
THE FUTURE OF DATA CENTERS IS ICELAND

Landsvirkjun

WHAT DOES THE FUTURE HOLD?

In today's increasingly digital world, data is growing at an incredible rate. The future of almost every business depends on data. So, when it comes to data centers, making the right long-term investment is crucial. With a valuable data stockpile growing every second, everyone – from global tech giants to industry powerhouses – needs to be smart, considered and cautious where they store it.

Businesses need to know their data is safe, secure and stable. They need to be sure it's located in a place that's resource efficient and cost effective. And they need assurance that any new investment comes with little or no risk – now, and far into the future. Put simply, a business needs to have complete confidence in the country housing their data center. So they can be certain they have a sustainable solution ready to deliver sustainable operations.

When deciding on a data center location, there are a number of difficult considerations to be made. It all comes down to securing a site that's sustainable, stable and able. This white paper therefore aims to provide an overview of the key challenges when considering the future of your data center – and why Iceland is the **sustainable, stable and able** choice.

ICELAND IS SUSTAINABLE

Iceland has long been called “the land of fire and ice”. And it’s this unique blend of natural geology and northerly location that has given the country a strong and attractive sustainability profile.

Around the world, Iceland is well known for its 100% renewable energy generation. And its transition from fossil fuels to fully renewable has become an inspiration for other countries to replicate and increase their share of renewable energy.

But it’s not only renewable energy that makes Iceland sustainable. When combined with its wider utilization of natural resources, cool climate and long-term climate ambitions, it’s clear why the country has become a compelling choice for data centers with sustainability-focused operations.

1

RICH IN NATURAL RESOURCES

In the future, sustainable utilization of natural resources will be an increasingly critical issue for everyone from governments and businesses to local communities. Even today, the environmental impacts of using non-renewable resources like fossil fuels are for many of greater concern than their growing scarcity.

Iceland is rich in renewable natural resources. And the utilization of these resources plays a key factor in the long-term, sustainable success of the country's economy and society. These natural resources, including water, heat and wind, are in ample supply and help ensure continuously available energy throughout the country.

2

100% RENEWABLE ENERGY

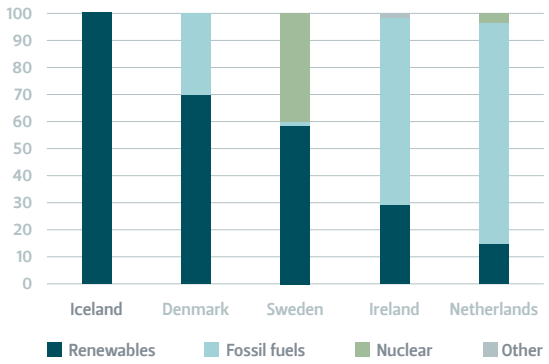
By 2030, data centers are expected to use between 3–13% of global electricity compared to just 1% in 2010[1]. Within this increasingly energy dependent industry, data center strategists and decision-makers are faced with the challenge of not only ensuring a reputable sustainability profile for their company but also meeting ever-more stringent carbon regulations.

Iceland's electricity generation is 100% renewable due to the utilization of hydro and geothermal energy sources together with an increasing volume of wind power. As an isolated energy system with no nuclear or fossil fuel generation, the country is therefore unaffected by grey power generation and its associated issues.

This means companies investing in Iceland for their data centers will have long-term access to a sustainable energy supply with significant savings in CO_2 emissions. These companies will also be protected from the effect of any shifts in carbon costs resulting from changes in either legislation of carbon market signals.

Ultimately, using 100% renewable energy means businesses can better meet KPIs for sustainability while demonstrating a long-term commitment to the future of the planet.

Percentage of generated renewable energy[2]



3

COOL CLIMATE CONSUMING LESS

It's estimated that cooling systems – including chillers, humidifiers and computer room air conditioning units – account for up to 45% of a data center's total energy consumption. In comparison, IT equipment typically accounts for 30%. This means 1kWh consumed by the IT equipment requires another 1kWh of energy to drive the cooling and auxiliary systems[3].

This cooling demand significantly increases the cost, complexity and environmental impact of a data facility, and in many cases represents its highest total expenditure.

Some cooling systems use water, and generating the electricity to sustain this cooling also requires water. So, the more energy used, the more water consumed. It's therefore essential to have resource-efficient cooling infrastructure, since any cost savings can have a dramatic impact on the overall profitability of a data center.

Iceland offers an ample supply of clean, sustainable water. And the country's unique temperate oceanic climate makes year-round ambient cooling of data centers not only possible but actually 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 centers to use the already cold air and water to provide cooling.

This ambient cooling offers potential savings of around 30%[4] on a data center's total energy cost, while further reducing costs and complexity in a facility's design. Iceland's naturally cool climate means that a data center here will actually require less water for cooling and heating than anywhere else in the world.

Average monthly temperature in °C[5]

	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

4

CARBON NEUTRAL BY 2040

Thanks to the sustainable nature of our business, our completely renewable energy sources, and our ambition to develop sustainable solutions, at Landsvirkjun, we aim to have an entirely carbon neutral business by 2025 and be carbon negative by 2030. Similarly, the nation as a whole is committed to making a difference in the global climate debate and aims to be carbon neutral no later than 2040.

ICELAND IS STABLE

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 will typically scrutinize these key factors.

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

In Iceland, the data center industry is well established and has been growing rapidly in recent years. A large reason why is the fact that the country is proven to mitigate risks, ensuring secure and stable operations for data centers – now, and in the future.

5

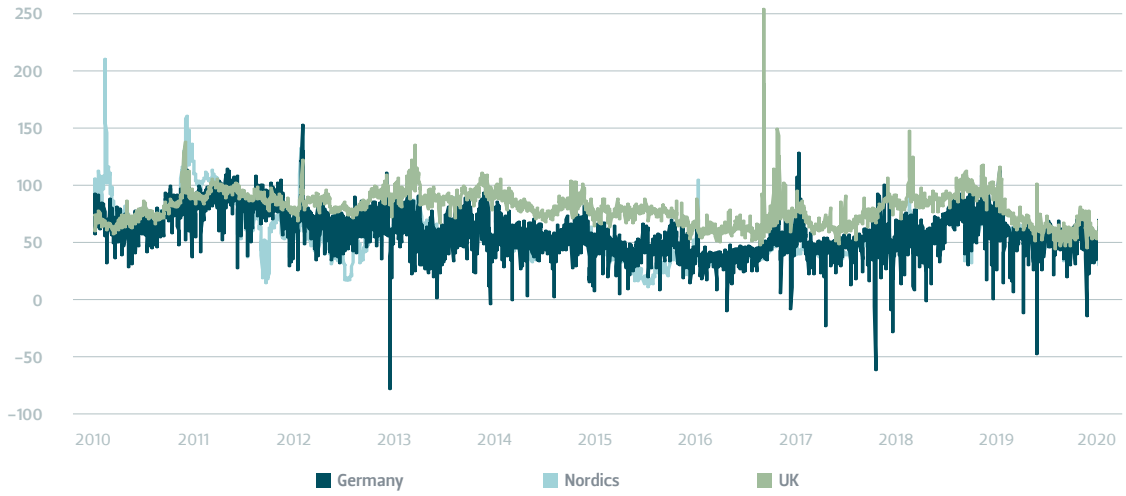
COMPETITIVE LONG–TERM ENERGY PRICES

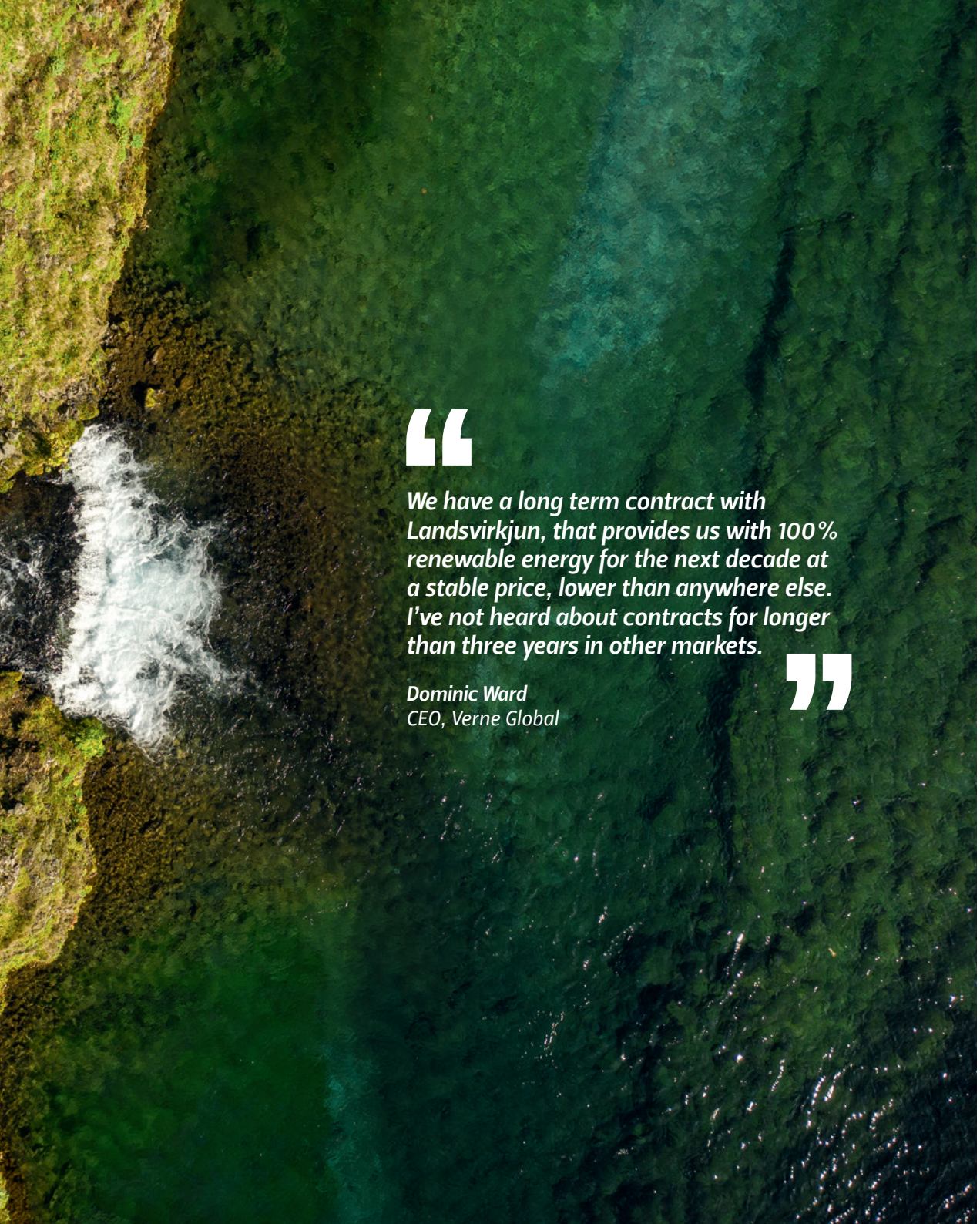
Energy prices make up a very large percentage of OPEX and fluctuate globally which makes them difficult to forecast.

Iceland has some of the most competitive energy prices in the Nordic/EMEA region.

Prices here can be fixed for many years, which makes long–term energy cost forecasting easy. For example, Landsvirkjun offers up to 12–year fixed price electricity contracts, as well as discounts for selected greenfield projects.

Day–ahead baseload prices from the Nord Pool power exchange and the EPEX power exchange

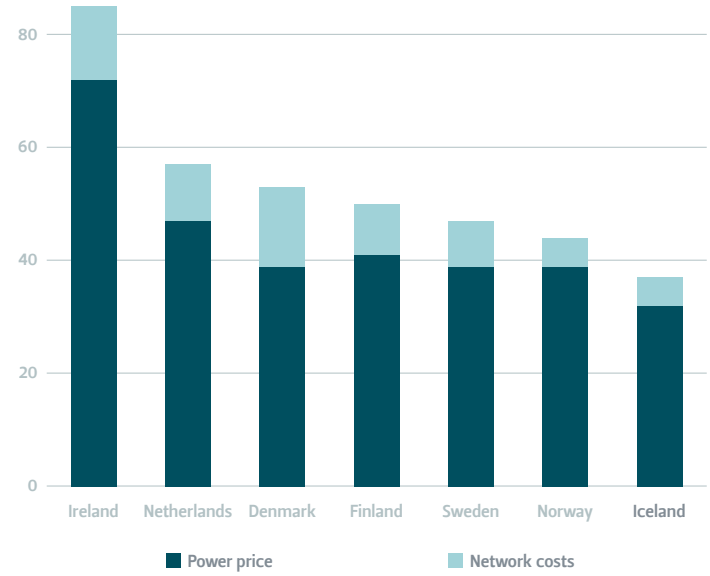




We have a long term contract with Landsvirkjun, that provides us with 100% renewable energy for the next decade at a stable price, lower than anywhere else. I've not heard about contracts for longer than three years in other markets.

Dominic Ward
CEO, Verne Global

Electricity prices (EUR/MWh) 2019 for consumption of 70–150 GWh per year[6]



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CONTINUOUSLY AVAILABLE ENERGY

Access to stable, affordable and reliable energy is a growing challenge for businesses all over the world. As reliance on fossil fuel diminishes, and demand for renewable sources of energy increases, countries must also innovate ways to store energy and have a dependable backup in order to generate electricity when needed.

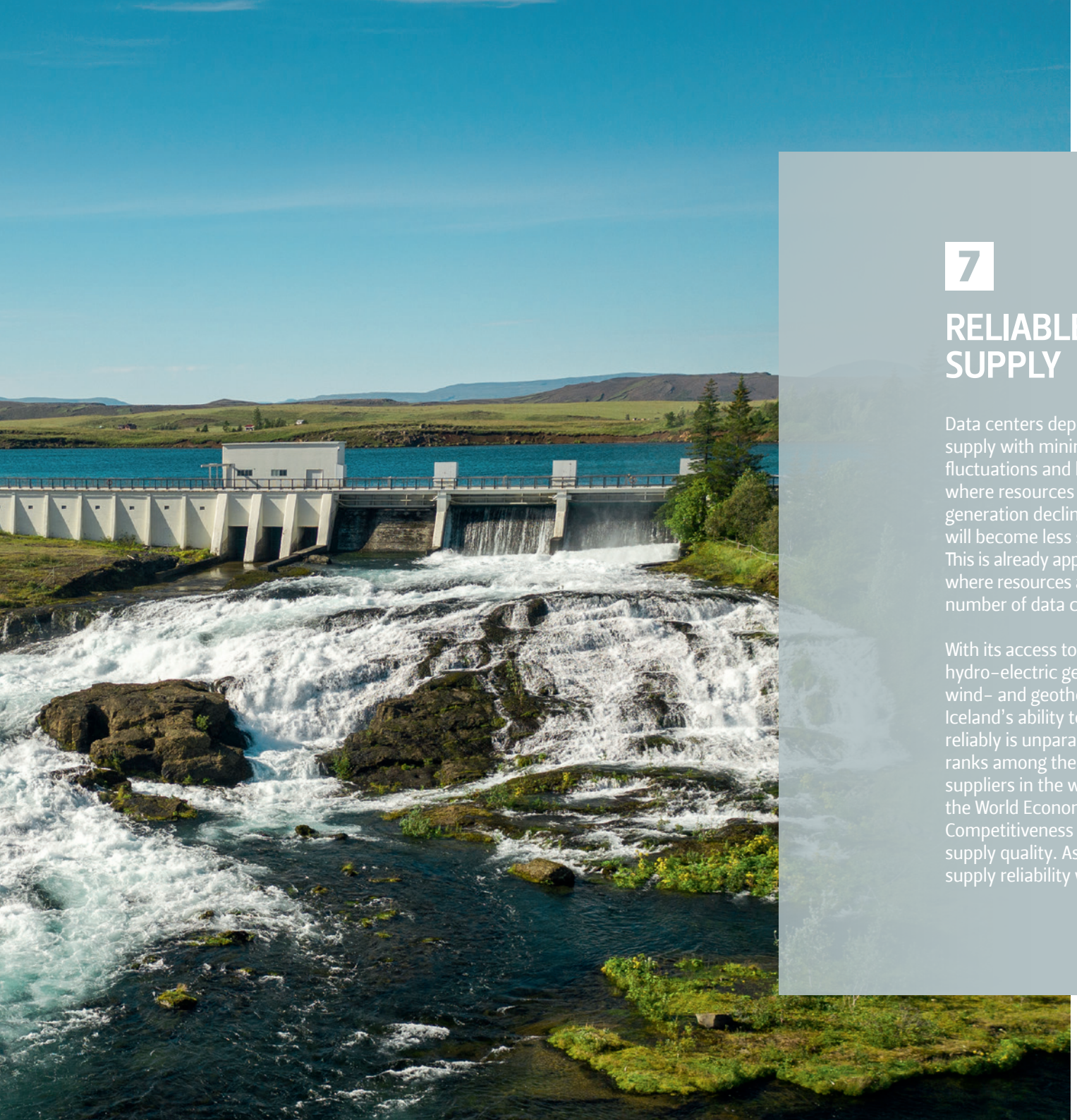
Primarily powered by hydro and geothermal energy, Iceland is fortunate to have an abundant source of both. This makes the country ideal for energy-intensive businesses like data centers. In Iceland you can be sure of continuous access to clean and renewable energy every day of the year. In fact, Iceland's transmission grid has been developed to meet the needs of power-intensive industries such as aluminum smelters, which require consistent high levels of electrical energy – and this we provide using 100% renewable energy.

MEETING THE HIGH DEMANDS OF HPC

Verne Global delivers high performance computing (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 CO_2 emissions annually. Learn more at **verneglobal.com**



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RELIABLE POWER SUPPLY

Data centers depend on a reliable electricity supply with minimal risk of interruptions, fluctuations and blackouts. As we enter a period where resources commonly used for electricity generation decline, some markets and locations will become less suitable for data centers. This is already apparent in some mainland markets where resources are unable to keep up with the number of data centers being constructed.

With its access to an abundant supply of existing hydro-electric generated electricity, as well as wind- and geothermal-produced energy, Iceland's ability to supply clean, green energy reliably is unparalleled. The country consistently ranks among the most reliable electricity suppliers in the world and takes first place in the World Economic Forum's 2019 Global Competitiveness and fifth place on electricity supply quality. As of 2019, Iceland's electricity supply reliability was at 99.983%.

8

POLITICAL STABILITY

Political instability can impact any business, but the considerable long-term investment required to establish and run data centers makes them especially vulnerable. Whether related to internal issues or international relations, instability poses risks to security and operations in general. This is why a nation's political character is integral to the investment decision-making process.

Iceland is a highly developed, modern democracy. It's one of the few countries in the world with no history of armed conflict, violent demonstrations, terrorism or international tensions. In terms of data center operation, this overall political stability mitigates the risks of sudden shutdowns, complete closures and threats to staff welfare.

Thanks to its developed and progressive society, excellent international standing and peaceful relations, Iceland is ranked one of the world's most stable political environments. In fact, in relation to political risk, the 2020 FM Global Resilience Index ranks Iceland as the third most resilient country in the world after New Zealand and Singapore.

FM GLOBAL RESILIENCE INDEX 2020[7]

1. New Zealand 100
2. Singapore 99.2
3. Iceland 96.6
4. Luxembourg 95.5
5. Switzerland 94.8
6. Malta 93.4
7. Brunei 91.1
8. Norway 89.8
9. Portugal 89.5
10. Japan 87.4

9

NATURE IN BALANCE

One of the prime concerns for organizations planning a new data center is environmental stability. Minimizing the risk of natural hazards affecting investment, property and lives is therefore paramount.

Iceland's reputation for seismic activity is renowned, however the presumed widespread scale is inaccurate. Covering an area of some 103,000 km^2, volcanic activity is confined to isolated zones and has little or no impact on the generation and transmission of electric power.

Indeed, even when taking seismic activity into consideration, the 2016 Cushman & Wakefield report still identified Iceland as the location in the world with the lowest risk to the establishment of data centers. Furthermore, the 2020 Global Resilience Index finds Iceland the country most capable of mitigating natural risks as part of the construction design. In other words, when you choose Iceland to locate your data center, you're selecting a country better able than any other to mitigate the already small risk of exposure to natural hazards.

> *Iceland is an ideal location due to its proximity to both US and Europe. All sites have a risk profile, and you ideally want to mitigate your risk with a different profile. Due to the stable environment and low risk profile, Iceland is one of the safest places for data center operations.*
>
> *Árni Jensen*
> *Chief Business Officer, Etix Everywhere*

Top 10 ranking of lowest risk to the establishment of data centers[8]

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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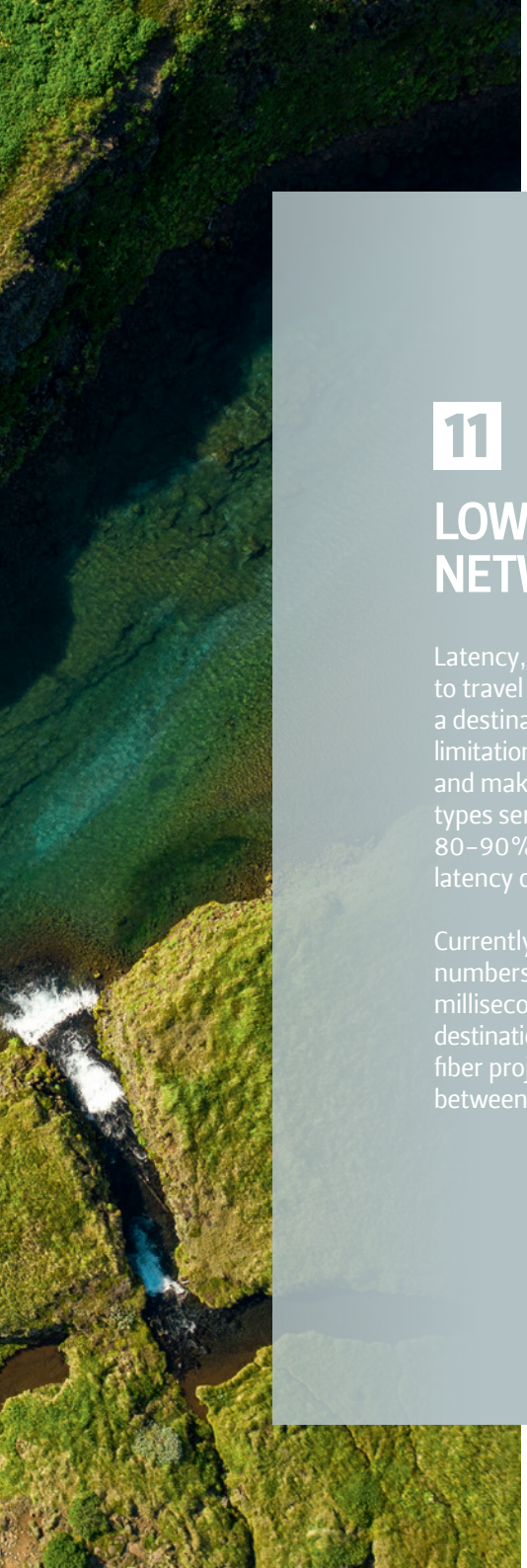
INTERNATIONAL CONNECTIVITY

Data center strategists tend to choose locations closer to their end customers. In the European region, this means mainland Europe. Nonetheless, Iceland has excellent submarine cable connections to Europe and the recent announcement of the proposed submarine cable to the continent will ensure sufficiently redundant fiber connections.

Farice, the Icelandic international cable provider, is even open to third-party investment. This gives hyperscale data center operators an outstanding opportunity to join the project and insert its own cables cost efficiently, while ensuring lower latency. The project is expected to be completed in 2022. Learn more at **farice.is**

International cable connectivity

SUBMARINE CABLES	CAPACITY 2016
FARICE-1	11 TERABITS/S
DANICE	34.4 TERABITS/S
GREENLAND C.	17.2 TERABITS/S



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LOW LATENCY NETWORK

Latency, the time it takes for data to travel from the data center to a destination and back, creates limitations on processing capabilities and makes different application types sensitive to it. However, 80–90% of applications are not latency dependent[9].

Currently, Iceland delivers latency numbers between 17 and 20 milliseconds, depending on the destination. The country's anticipated fiber project will reduce this to between 10 and 15 milliseconds.

Iceland network latency

Glasgow 13.0 ms	**Frankfurt** 17.5 ms	**Zurich** 20.0 ms	**Milan** 22.0 ms	**Bucharest** 33.0 ms
Copenhagen 14.9 ms	**Amsterdam** 17.8 ms	**Munich** 20.5 ms	**Marseille** 25.0 ms	**Halifax** 33.7 ms
Hamburg 15.1 ms	**London** 18.9 ms	**Warsaw** 21.6 ms	**Prag** 25.0 ms	**New York** 40.6 ms
Berlin 17.4 ms	**Poznan** 19.6 ms	**Paris** 21.8 ms	**Budapest** 26.0 ms	

Comparison	Amsterdam	London	New York	Halifax
Hamina	14.8 ms	18.3 ms	51.3 ms	48.7 ms
Lulea	16.0 ms	18.7 ms	52.5 ms	49.1 ms
Reykjavík	17.9 ms	18.9 ms	40.6 ms	33.7 ms

ICELAND IS ABLE

A sustainable and stable site for a data center won't mean much if there isn't the right support network in place. From having a modern and diverse labor market to an attractive business environment, companies are also seeking an investable proposition for people.

Iceland is world-renowned for its high quality of life, strong economic development, and technical innovation. And, as a result, is continually ranked as one of the most civilized and socially advanced countries in the world.

When it comes to ability, a young, educated and internationally-minded workforce, combined with high site availability and favorable business conditions, makes Iceland an increasingly convincing prospect for data centers.

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HIGHLY SKILLED WORKFORCE

In highly specialized fields like IT, finding qualified candidates can prove challenging anywhere a business is located. Today, the IT and Data industries are already suffering from an ageing workforce and issues in staff retention[10].

A diverse, talented workforce is crucial to ensuring quality performance and efficient operations. Iceland has demonstrated its ability to develop and train high quality ICT and engineering staff. With an diverse workforce, the nation's decision to establish a data center environment has resulted in focusing on developing home-grown talent able to support the successful development on the industry.

The 2019 World Economic Forum Global Competitiveness Report ranks the skills of Iceland's future workforce ninth in the world, and in 2017, the International Telecommunications Union ranked Iceland as the world's best ICT environment. Furthermore, Iceland is one of the countries with the highest GDP per capita[11], which is often a measure of productivity.

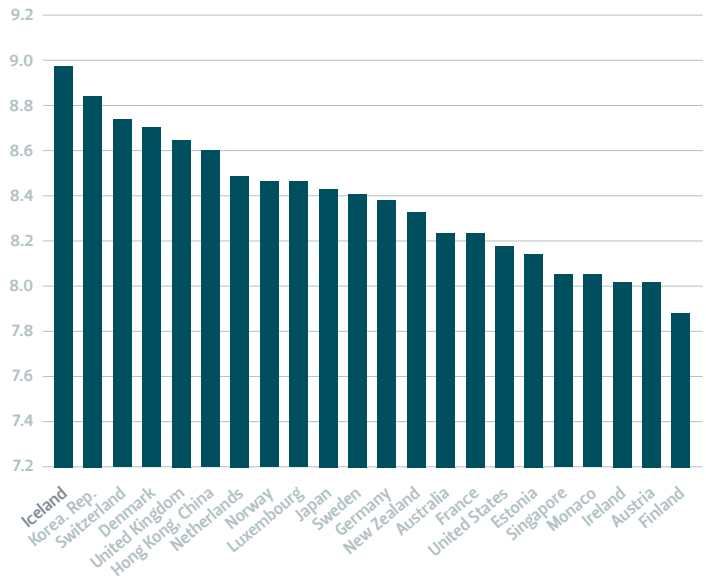
> *Iceland has a fantastic history of engineering and we are super proud of our talent – a highly trained, flexible and international workforce. This has enabled us to outperform our peers. Our customers are continuously making statements about how fantastic our people are.*
>
> *Dominic Ward*
> *CEO, Verne Global*

As Reykjavík DC was to be one of the few Tier III – native datacenters in Iceland, we needed partners dedicated to quality and protocol from the first stages of construction to the final opening and operation. This is why we chose an international leader to do the design and engineering of the modular and future–proof Reykjavík DC.

As a result, the site is easily expandable (one module being 500 sq meters) with a lead time of just seven months. The competence, creativity and agility of the Icelandic workforce and companies we hired in this process has been paramount to our success.

Anastasia Alexandersdóttir
Business Development Specialist,
Opin Kerfi/Reykjavik DC

International Telecommunications Union's ICT environment ranking 2017[12]



13

HIGH SITE AVAILABILITY

Finding the right location for your data center can be challenging as it needs to be somewhere where construction work can begin quickly and with resources readily available.

One of Europe's most sparsely populated nations, Iceland offers an extensive range of ideal sites, including ready-to-build sites for construction. Dedicated site selection tours are a good place to start.

Landsvirkjun offers a site selection tour with key partners, including Farice and Invest in Iceland. Contact us for more information.

Example of available sites for building data centers[13]

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IDEAL INTERNATIONAL LOCATION

For global corporations, along with the location of the data center, it's also important to be situated in an area that is easily accessible.

Located between North America and Europe, Iceland is serviced by several airlines. Flight times from the US west coast are around 8.5 hours, and from the east coast around five hours, and most data centers are within easy reach of the capital area's Keflavik airport.

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ATTRACTIVE EXPAT DESTINATION

When it comes to living standards, Iceland is often placed amongst the highest scoring countries in international comparative studies on factors such as happiness, openness and gender equality.

According to the OECD Better Life Index[14], Iceland ranks at the top in jobs and earnings, environmental quality and social connections. And above average in income and wealth, subjective well-being, health status, personal security and civic engagement, as well as education and skills.

In addition, its vibrant cultural scene, supporting social welfare system and highly developed language skills, together with geothermal lagoons, geysers, glaciers and waterfalls in close proximity, make Iceland an appealing country to live in.

The Icelandic government has also created a number of attractive incentives for foreign experts. On fulfilling specific conditions, for example, just 75% of income is taxable for the first three years of employment.

Find out more at **invest.is/why-iceland/competitive-government-incentives**

16

OPEN BUSINESS ENVIRONMENT

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

Iceland has an open, international and efficient economy. There is little bureaucracy, processes are short, and everything is designed to support the rapid set up of both small start-ups and large international corporations.

Currency risk fluctuation, especially during the building phase, can influence CAPEX, and also OPEX when it comes to services such as IT. To reduce currency fluctuation risks, Landsvirkjun offers its contracts in USD or other negotiated currency.

In 2020, The World Bank ranked Iceland as the 26th easiest place to do business. The country also ranked 14th on the 2018 IMD & Transparency International ranking of least corrupt countries in the world.

17

FAVORABLE TAXES AND REGULATIONS

Any country chosen as a location must be able to support the establishment of a business by sharing the financial risk to give it the best possible chance for the future.

In general, Iceland offers a favorable environment for businesses with its low corporate tax (20%, which is among the lowest in the EU), availability of land, educated workforce, reliable renewable energy and connectivity, and general efficiency in a European legislative framework. This business environment also gives companies the opportunity to negotiate terms individually based on their influence on the overall economy and the merits of the investment in question.

As a member of the European Economic Area, Iceland adheres to the European State Aid Rules. These allow, among other things, for regional incentives for new direct investment in defined areas. In Iceland, all the regions outside the capital area are generally eligible for regional investment aid.

Applications for incentives and investment agreements can be submitted to the Ministry of Industries and Innovation for general review. Investment agreements, with defined incentives, are subject to legislative authorization from the Parliament and approval from the EFTA Surveillance Authority.

THE RIGHT INCENTIVES

According to Act 41/2015, Regional Incentives apply to all regions outside the capital area. The incentives are attractive and include authorization to fix an income tax ceiling at just 15% for 10 years, and fully depreciate real estate, equipment and moveable assets. Companies can also reduce both the rate of property tax and the general social security charge by 50% and be granted exemption from customs and duties for construction materials, machinery, equipment and other capital goods. The state and municipalities area are able to lease a site for the project at reduced rates.

18

FAST AND EFFICIENT CONSTRUCTION

Once you select a site, you'll want the data center to be constructed as fast and efficiently as possible. Building scalable and custom designed centers is a major long-term investment and demands a significant construction workforce.

Iceland has a proven history of mobilizing large workforces able to ensure efficient and quality work on large-scale builds. Such projects include:

ETIX BLÖNDUÓS
Based in the northern part of Iceland, Etix Blönduós is a large scale HPC and Data Storage campus. It combines innovative design, outstanding efficiency and performance in order to minimize its environmental footprint and reduce the facility's Total Cost of Ownership. This sustainable campus was constructed over a nine month timeframe from greenfield to full operations.

"With robust power delivery, renewable energy from a nearby hydropower plant, and by employing an efficient, environmentally friendly design, the Blönduós site is a truly sustainable and cost-effective option."

Björn Brynjúlfsson
Chief Executive Officer
Etix Blönduós

THEISTAREYKIR GEOTHERMAL STATION
Commencing in 2015, the construction reached its peak in 2016/2017 when the project employed 240 workers on site. The first phase was completed at the end of 2017 when the first turbine was installed. In 2019, the project received a Gold Award from the International Association of Project Management Associations (IPMA).

We're really impressed by the speed and quality of construction here in Iceland. It's something that we don't really see anywhere else – from scratch to final construction in just a couple of years. It's very impressive.

Niklas Pedersen,
Country Manager Iceland
IBM

POWER THE FUTURE IN ICELAND

The choice of a data center's location is influenced by myriad factors. But it's not only about the immediate considerations of whether a site is right for your business. It's imperative to look further ahead into the future to see where your operations can best grow and thrive for the long term.

Digital society is accelerating at an incredibly rapid pace. So it's becoming increasingly 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 data center location therefore is a uniquely challenging investment.

That's why Iceland strives to be the sustainable, stable and able choice for the future. 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 come and power the future in Iceland.

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14. **OECD BETTER LIFE INDEX**
http://www.oecdbetterlifeindex.org/countries/iceland

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.

For more information, or to discuss the future of your data centers, get in touch with us at:

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