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Iceland as a Strategic Data Centre Location for Financial Services Firms

April 2017

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1 Executive Summary

Citihub Consulting works extensively with the world's largest and most innovative financial services firms. Each year – using our client and industry experiences - our Data Centre Intelligence Unit (DCIU) issues market reports analysing the colocation services market at key financial centres and across emerging markets.

Iceland is neither a major financial centre nor an emerging market. However, as many of our clients embark on aggressive programmes of transformation (both in terms of their technology and their real estate) there is a growing community of financial services firms hosting in Iceland and we feel strongly that the country should feature more frequently as a potential hosting location for applications and infrastructure that are latency tolerant or latency agnostic.

Interest in Iceland as a data centre location is not new. Many large banks considered building facilities there during the boom years, when the financial and social responsibility aspects of the decision process were less pressing. Since 2008 the priorities of financial services market have changed, and Iceland's fit to the new market dynamics has greatly improved its appeal. Citihub's research indicates a renewed interest in Iceland and this study demonstrates that the country is well positioned to become a major hosting centre for European and North American financial services firms.

This study uses an evaluation framework based on the key factors affecting the location strategy decision making process. Citihub's summary assessment is as follows:

Evaluation Criteria	Summary Analysis
Capability	**Outstanding**: By almost every measure Iceland is one of the best qualified hosting locations in the world and ranks highly in terms of data protection laws and legal frameworks, utility infrastructure, international connectivity, and skills.
Total Cost of Ownership	**Outstanding**: Highly competitive when compared with traditional European and North American hosting locations. Our TCO analysis suggests that for wholesale requirements Iceland may be as much as 50% cheaper (over a 7-year term) when compared with London and popular North American locations in New Jersey and Illinois.
Risk Profile	**Excellent:** Iceland's risk profile, both in terms of natural hazards and social/political/terror risks, is one of the lowest in the world. This low risk rating is often misunderstood or overlooked because of entrenched market perceptions. Furthermore, Iceland has one of the best secured – and price predictable - energy supplies of any developed country.
Connectivity	**Good**: Iceland has high-capacity and fully redundant submarine cable connectivity to both Europe and North America. Latency to London and Frankfurt is ~19ms and ~40ms to New York. Arrangements for redundant connectivity to the US and Canada could result in increased latency in the event of failure of the FARICE and DANICE cables.
Regulation	**Outstanding**: As a member state of the European Economic Area Iceland is fully compliant with all data protection and financial services regulation introduced by the European Commission.
Corporate Social Responsibility	**Outstanding**: Since Iceland generates 100% of its energy from renewables a peripheral benefit for large firms is the opportunity to make significant cuts to greenhouse gas emissions. Low ambient temperatures also offer the opportunity to achieve market leading energy efficiency.

Table 1: Evaluation Framework Based on the Key Factors Affecting the Location Strategy Decision Making Process

2 Background

The trend for outsourcing data centre operations is not new in Europe but we might still consider the industry to be in its adolescence. As much as 75% of all technical real estate within the financial services industry is still managed in-house. Historically the primary reasons for this have been (a) sunk investment in owned facilities built during the 2000s (b) the cost, operational risk and business disruption associated with migration and (c) a pervasive belief that in-house facilities reduce operational risk.

In recent years, several factors have changed attitudes towards outsourcing. Firstly, there is large-scale reconfiguration of real estate taking place at the largest financial centres with equipment moving out of on-site tech rooms into enterprise-class data centres. Most firms now recognise that decoupling data centres from 'people locations' reduces risk as well as providing for greater strategic flexibility for office space in future. Secondly, as financial services firms tackle continued pressure to reduce operating costs and improve capital positions many firms are actively seeking to exit owned facilities. Thirdly, and after years of stalled investment, many firms have mobilised large infrastructure transformation programmes to deliver next generation infrastructure strategies based on agile compute and hybrid cloud. These transformation programmes represent an ideal opportunity to consider alternate hosting strategies since they help to overcome migration hurdles.

The alignment of these factors suggests that – for many firms – there is an immediate opportunity to consider colocation options. Traditionally the focus of data centre sourcing activity in Europe has been on major metros (London, Amsterdam, Frankfurt and Paris). The same is true for North America with many financial services firms heavily concentrated in the tristate area (for New York) and a small number of locations for the secondary market of Chicago. Firms that look to outsource data centre capacity are finding that these locations are dominated by a small number of providers and (often) clustered in close proximity. This, potentially, represents a geographic and commercial concentration risk.

This paper explores Iceland as a hosting location of choice for financial services firms and with a specific focus on the cost and risk. However, the readers' attention is drawn to many of the peripheral benefits of hosting in Iceland, for example: best in class data privacy, close-to zero greenhouse gas emissions, energy security and permanent establishment rules.

3 Choosing a Hosting Location

At the point when a financial services firm recognises the economic, performance, flexibility and risk benefits from outsourcing its data centre then several (often competing) requirements must be considered:

Figure 1: Hosting Considerations for Financial Services

The purpose of this paper is to explore these requirements in detail and to evaluate the relative strengths of Iceland as a strategic location for the hosting of IT infrastructure.

4 Capability - Iceland

Iceland is located in the North Atlantic and has a total area of 103,000 square kilometres (England is 130,000 square kilometres).[1] Regular international flights to Keflavík put Iceland within approximately 3 hours flying time of major financial centres in Western Europe and 5 hours from New York.

Iceland is recognised as one the world's leading innovation led economies[2] and its culture, politics and economy embrace the values of a liberal democracy. As a member of the European Economic Area (EEA) the nation's political, legal and economic systems are tightly integrated with the European Union (EU). Most notably there is full alignment with EU data protection regulations and financial services regulations, and free movement of goods, services and labour with the EEA/EU.

As one of the world's most technologically advanced countries the World Economic Forum ranks Iceland as:

- #1 for the availability of international Internet connectivity.[3]
- #1 in the generation of electricity.[4]
- #1 by the penetration of secure Internet servers.[5] Demonstrating the significant concentration of international hosting already taking place in Iceland.
- #9 by the strength and relevance of its ICT laws.[6]
- #6 by the availability the latest technologies.[7]

Other studies reach similar conclusions:

- Boston Consultancy Group's 2015-2016 Data Centre Qualification Index ranks Iceland as the best qualified location in Europe and the 2nd best location globally (after the US);
- The IMD's World Competitiveness Yearbook 2016 ranks Iceland as the number one country in terms of basic infrastructure provision;
- The World Risk Index ranks Iceland as the 6th least vulnerable country in the world in terms of exposure to natural disasters and preparedness (see later sections);
- Artmotion's Data Privacy Report (2015) ranked Iceland as the 3rd best country globally for data protection and security. The study used independent data from the United Nations and World Economic Forum.

Iceland generates 100% of its electricity from renewable sources[8] making it unique in the developed world. Furthermore, Iceland has a modern and well developed grid system and currently utilises less than 10% of its current energy capacity. Some leading economies are currently operating with small reserve margins (e.g. UK) and are experiencing reliability issues associated with underinvestment in infrastructure (e.g. US).[9]

The country is populated by a highly skilled and well educated workforce. Eurostat estimates that Iceland has the highest proportion of its workforce employed in technology and knowledge intensive sectors in Europe.

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[1] http://www.iceland.is/the-big-picture/nature-environment/geography
[2] The World Economic Forum ranks Iceland as the 27th most competitive economy in the world and one of only 37 innovation led economies. See WEF Global Competitiveness Report 2016 for further details.
[3] Kbps/User - World Economic Forum, "**The Global Information Technology Report**", 2016 p109
[4] kWh/Capita - World Economic Forum, "**The Global Information Technology Report**", 2016 p109
[5] Per million of population – World Economic Forum, "**The Global Information Technology Report**", 2016 p109
[6] Ibid.
[7] Ibid.
[8] See: https://askjaenergy.com/iceland-introduction/iceland-energy-sector/
[9] Northbridge Energy Partners, "Mind the Gap: Energy Availability and the Disconnect with Data", 2016

5 Total Cost of Ownership

For the purposes of this paper the focus of TCO is on four areas of operational cost:

- **Space and Capacity**: the cost of secured physical space and the electrical/mechanical capacity allocated to it;
- **Power**: the cost of electricity;
- **Power Efficiency**: the relative efficiency of electrical/mechanical systems required for operation (especially cooling);
- **Connectivity**: the cost of connecting the hosting location.

Although not considered in this paper, the reader should note that there is an increasing trend for financial services firms to include the capital benefits associated with the disposal of in-house facilities within an overall business case.

Using the three metrics below, Citihub assesses that Iceland represents the best value hosting location within the European Economic Area and North America:

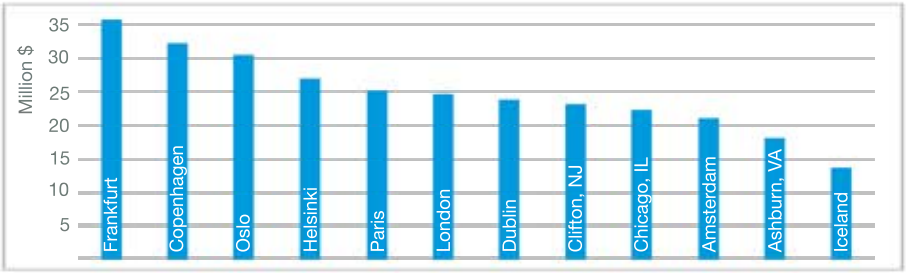

Figure 2: 7 Year TCO Hosting Cost - 1MW of IT Load Inclusive of Space, Power and PUE Charges (Source: Citihub DCIU 2016)[10]

Citihub assesses that Iceland represents the best value hosting location of any advanced economy.

Iceland's low cost is achieved because of:

Power Cost: There is a huge resource pool of geothermal and hydroelectric energy that is comparatively low-cost, as well as being pollution and emissions free. Long-term projections suggest that Iceland will benefit from low price inflation for electricity and since the energy source for generation operates on geological timescales we might consider it to be secure (effectively) for all time. The same may not be true for countries where fossil fuels are the primary energy source and where electricity costs might be subject to swings in prices and/or interruptions to supply in the medium-long-term.

- **Climate**: Mean annual temperatures in the Reykjavík region range between -1.5C (January) and 10.3C (July). Data centres benefit from free cooling and the low ambient temperatures all year around thus greatly improving energy efficiency and reducing cost and emissions.

- **Space/Capacity Costs**: Build costs (capex) in Iceland may be substantially reduced because of the availability of free cooling. In the case of third party providers this is reflected in competitive space/capacity charges.

[10]Citihub's DCIU assembles cost and price data from client RFP processes and blind shopping studies.

6 Risk

6.1 Regulator Posture

Regulatory compliance and the management and mitigation of business impacting risks are a mandatory factor in the decision-making process for most decisions in the financial services industry.

Financial regulators rarely define specific requirements for risk assessment or mitigation. Instead common regulatory wording focuses on assurance that regulatory, legal and client obligations can be maintained in a timely fashion, putting the onus on the financial institution to assess their own risks in light of its individual obligations (See Appendix A – for reference documents):

- **CFTC**: "…enable the timely recovery and resumption of operations and the fulfilment of each obligation and responsibility…"
- **HKMA**: "…services can be resumed in accordance with the business recovery requirements."
- **FCA**: "A firm … can continue to function and meet its regulatory obligations in the event of unforeseen interruption"
- **FINRA**: "Each plan must at a minimum address: … Critical business constituent, bank, and counter-party impact; … Regulatory reporting; ...assure customers' prompt access to their funds and securities"
- **MAS**: "Failing which, institutions may compromise its business obligations, which may result in significant financial losses and potentially lead to a contagion effect on the financial system."
- **TOCOM**: "Disqualifying conditions - …deemed not to have sufficient business continuity"
- **US** (FINRA, the SEC and CFTC Joint Advisory): "Firms should consider time-sensitive regulatory requirements."

Citihub assesses that the selection of Iceland is fully complementary with the regulatory and legal requirements of firms operating in the European Union and the United States.

6.2 Natural Hazards

Perceived volcanic and tectonic risks are often cited by buyers as an unacceptable risk. However, analysis by the University of Stuttgart and Bündnis Entwicklung Hilft (BEH)[11] confirms that Iceland is one of the lowest risk countries (in terms of exposure to impacting natural and environmental hazards), ranking it #6 globally. Furthermore, the study also ranks Iceland as one of the most prepared countries in terms of resilience of its infrastructure and preparedness for natural disasters. PWC shares this opinion and has ranked Iceland as one of the four lowest risk locations for Data Centres globally.[12]

Therefore, Iceland compares very favourably compared to other European countries and the US. In an 'all risks' scenario the analysis shows a very low exposure risk to natural disasters (see figure 3).

The majority of data centres in Iceland are located on the Reykjanes peninsula. This gives optimum proximity to power stations, the international airport, Reykjavík and the vast majority of skilled workers in Iceland. NATO housed mission critical HQ operations (including an airport and munitions facility) on

[11] See World Risk Index, University of Stuttgart - http://www.unistuttgart.de/ireus/Internationales/WorldRiskIndex/
[12] Invest in Iceland, "Data Centers in Iceland and Natural Disaster Risk", accessed at http://www.invest.is/files/invest.is/publications/natural-disaster-risk.pdf

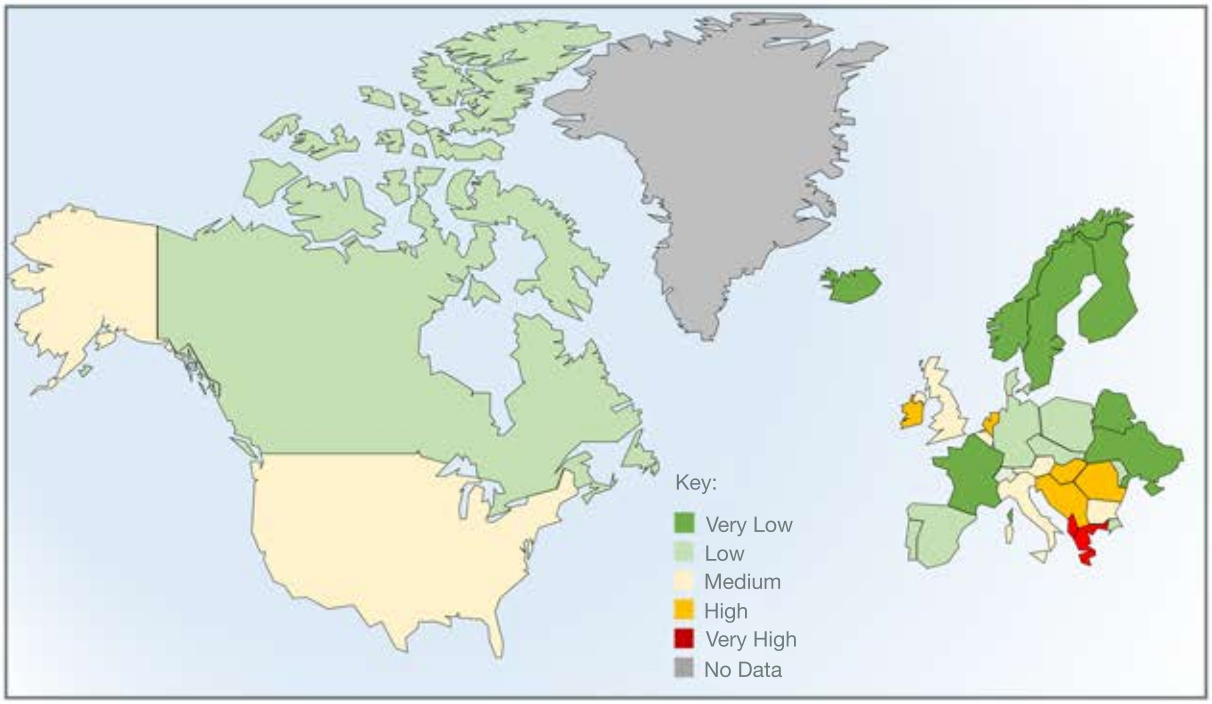

Figure 3: Exposure Risk to Natural Disasters (Source: ArcGIS, University of Stuttgart)

the Reykjanes peninsula until 2004. The area is predominantly bedrock and has a low earthquake risk rating – for example Keflavík carries the same 50-year risk as North-East New Jersey (USGS).

Buildings are engineered to withstand seismic risks using structural seismic safety factors such as highly specified compressive concrete. The utility supply networks within Iceland are similarly engineered for redundancy and using seismic resistant overhead transmission systems and with all critical plant protected by hardened structures. It should also be noted that, unlike other tectonic zones, the tectonic plates are moving apart and therefore earthquakes are of relatively low magnitude.[13]

The Reykjanes peninsula is located away from volcanoes. The prevailing winds blow west to east (away from the peninsula) and interference from eruptions is extremely uncommon. As a result Keflavík international airport was fully operational during the 2010 Eyjafjallajökull eruption.

During the eruption there was no interruption to key services: power, telecoms and transportation systems operated as normal.

Buyers of data centre capacity have grown comfortable with the fact that many risks can be acceptably mitigated. For example, primary hosting locations in both East London and Amsterdam are in low-lying areas and rely on flood defences and structural mitigations that protect property and utility supplies. Iceland is no different in this regard. Well adapted mitigations for seismic and volcanic risks are designed in to all aspects of the built environment and infrastructure.

[13] "Location Risk in Iceland: Perception vs. Reality", Landsvirkjun

It should also be noted that seismic zones are well mapped and monitored[14] and there is a good degree of long-term predictability for major volcanic events.[15] The same cannot be said of locations where other types of catastrophe occur, often without much notice. For example, e.g. Hurricane Sandy demonstrated that huge areas can be devastated without much warning and with long-term impact to property, utility supply and fuel replenishment.

In every risk study that Citihub has reviewed Iceland ranks amongst the lowest risk countries in the world both in terms of exposure to natural hazards and its preparedness in the event of major incidents.

6.3 Social and Political Risk

Iceland is recognised as one the world's leading innovation driven economies.[16] Its culture, politics and economy embrace the values of liberal democracy and the nation's political, legal and economic systems are tightly integrated with the European Union (EU) and European Economic Area (EEA):

- **Government and Legal System**: Since 1944 Iceland has been a stable parliamentary democratic republic. Its legal system is underpinned by a strong, independent judicial branch with excellent data protection and bankruptcy protections. The World Economic Forum ranks Iceland's institutions very highly and ahead of other European countries (e.g. UK, Germany and France);

- **International Framework**: Iceland is a founding member of the 31 state European Economic Area (EEA). As a member of the EEA Iceland implements all EU data protection, commercial and human rights legislation and is bound by law to the principles of free movement of goods, services, capital and people. Iceland has Double Taxation Treaties with most major economies;

- **Energy Security**: Iceland is a net energy exporter and has a supply of geothermal and hydro electricity that is attractive in terms of cost, environmental sustainability, and security of supply.

[14] See - 11th World Conference on Earthquake Engineering Paper 710, "**The mapping of seismic hazard using stochastic simulation and geographic information systems**", R. Sigbjornsson, G Baldvinsson and H. Thrainsson.
[15] Nature Geoscience, "**Hydrogeochemical precursors**", S. E. Ingebritsen and M. Manga, Macmillan Press 2014
[16] The World Economic Forum ranks Iceland as the 27th most competitive economy in the world and one of only 37 innovation led economies. See WEF Global Competitiveness Report 2016 for further details.

6.4 **Terrorist Risk**

While we might reasonably consider that the developed nations of Europe and North America carry relatively low risk of systemic social/political failure, the same is not true of their exposure to terrorist risks. Global risk and analytics leader, Aon, estimates that approximately 20% of all global terror attacks during 2015 were targeted at critical infrastructure[17] and ranks Iceland as one of the lowest risk countries in the world:

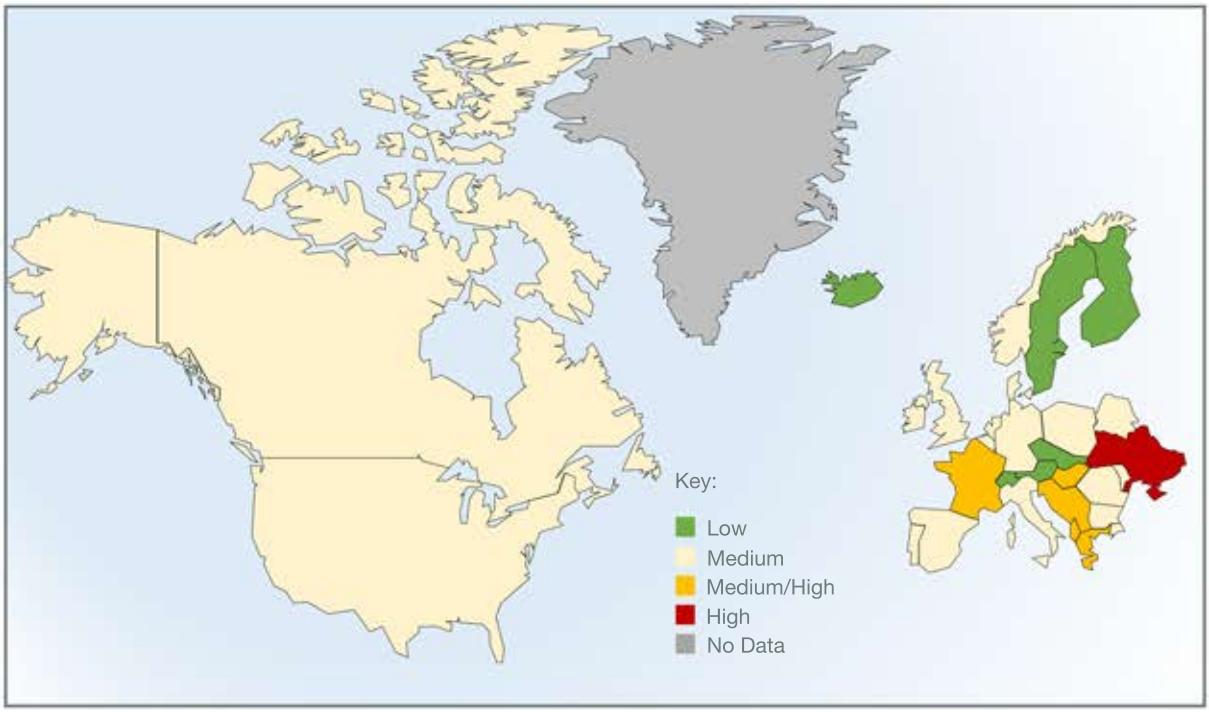

Figure 4: Aon Terror Risk Assessment – 2015 (adapted)

Even contained or isolated terror attacks often become metro-wide events and are almost always focused on cities with large financial centres. The potential for very large-scale events cannot be ignored and might increasingly be executed in tandem across multiple European/North American locations. It must be assumed that any such attack could seriously impact business operations across one (or more) cities for a sustained period.

Citihub's assessment is that there is increasing concentration risk in the most popular European data centre locations. For example, the Slough Trading Estate is an area of just 1.97km2, but houses approximately 50% of the colocation capacity of London and the Home Counties and the in-house facilities of financial services firms.

[17] Aon, "Terrorism and Political Violence Risk Map", 2016. The report identifies 470 terror attacks with 83 of these attacks being directed at critical infrastructure.

Iceland's physical separation from major European data centre markets (London, Amsterdam, Frankfurt, Dublin and Paris) could help reduce the concentration risk that arises from reliance on colocation and carrier hubs that might be impacted by one or more metro-wide incidents.

Metro-wide and simultaneous attacks across major financial centres should be considered as a realistic scenario when assessing risk. Iceland is considered to be amongst the lowest risk countries and geographic separation could help to reduce concentration risk.

6.5 Provider Risk

The European colocation markets are now dominated by a very small number of providers and consolidation continues. Citihub's assessment is that the scale of this consolidation is no longer in the interest of end-users and longer-term could represent a systemic risk to multiple industry verticals.

The barriers to entry to the market are now so high that we should not expect to see any major competition introduced to the market for the foreseeable future. Iceland has several independent operators with good quality facilities and planned investments will expand these options further.

6.6 Energy Security

Key data centre markets in the UK, Germany and US all face significant challenges in respect of energy generation and distribution. The UK is close to capacity with a reserve margin of only 0-4% (2016/2017) with the grid experiencing increasing numbers of outages.[18] Germany's generation system is in disarray as the balance of generating capacity shifts to renewables and fossil fuel powered generating stations become uneconomical. The current policy response is one of subsidy and regulation to protect the system.[19] In the US many aging coal power stations have to be retired at a time of uncertainty in respect of federal policy towards renewables. Between 2008 and 2014 the number of recorded outages rose from 2,169 to 3,634 respectively.[20]

In contrast, Iceland has a highly reliable generation system and distribution grid and has high available capacity (only 10% is utilised). Iceland's geographic isolation essentially means that its grid is stranded; thus protecting capacity against exports or external pressures. Consumer demand for additional power can be satisfied very quickly.

[18] See North Bridge Energy Partners, "**Mind The Gap: Energy Availability and the Disconnect with Data**", 2015
[19] Ibid.
[20] Ibid.

Shifting patterns of investment, subsidy and the variability of fossil fuel costs and taxes mean that it may be harder to predict long-term energy prices. Since a small shift in electricity pricing has a large impact on operating costs this should be a primary consideration for all data centre managers. Iceland's Landsvirkjun Power Company can commit to multi-decades contracts guaranteeing long-term stability and predictable budgets.

6.7 Legal & Tax Framework

Many developed countries have ambiguous rules and tax policies relating to the relationship between IT infrastructure and the creation of a Permanent Establishment (PE) requiring a local legal entity. In October 2016 Iceland passed Law nr. 112/2016 that contains a definition of a permanent establishment for income tax purposes in Iceland. It should be noted that the law states that:

- The definition of the OECD Tax Model Convention is used to interpret the concepts;
- A foreign company's control of computer servers and related computing equipment to carry our preparatory or auxiliary activities does not on its own constitute a PE. 'Control' may be through either lease or ownership of equipment;
- Icelandic 'service providers' may benefit because the VAT act states that providing services to entities without a PE in Iceland may be exempt from VAT.

The law provides clear statements of what constitutes control and a permanent establishment. This may be advantageous for many financial services firms. Furthermore, and taken in conjunction with other Icelandic taxation arrangements, there may be opportunities for cloud and IT service providers.

7 Telecoms and Connectivity

7.1 Connectivity between Iceland and Financial Centres

Although Iceland is geographically separated from Europe and North America it has excellent cable connectivity. Readers should refer to the whitepaper "International Data Connectivity in Iceland" issued by Landsvirkjun (the National Power Company) for a detailed assessment of this connectivity.

At a high-level connectivity to major financial centres is as follows:

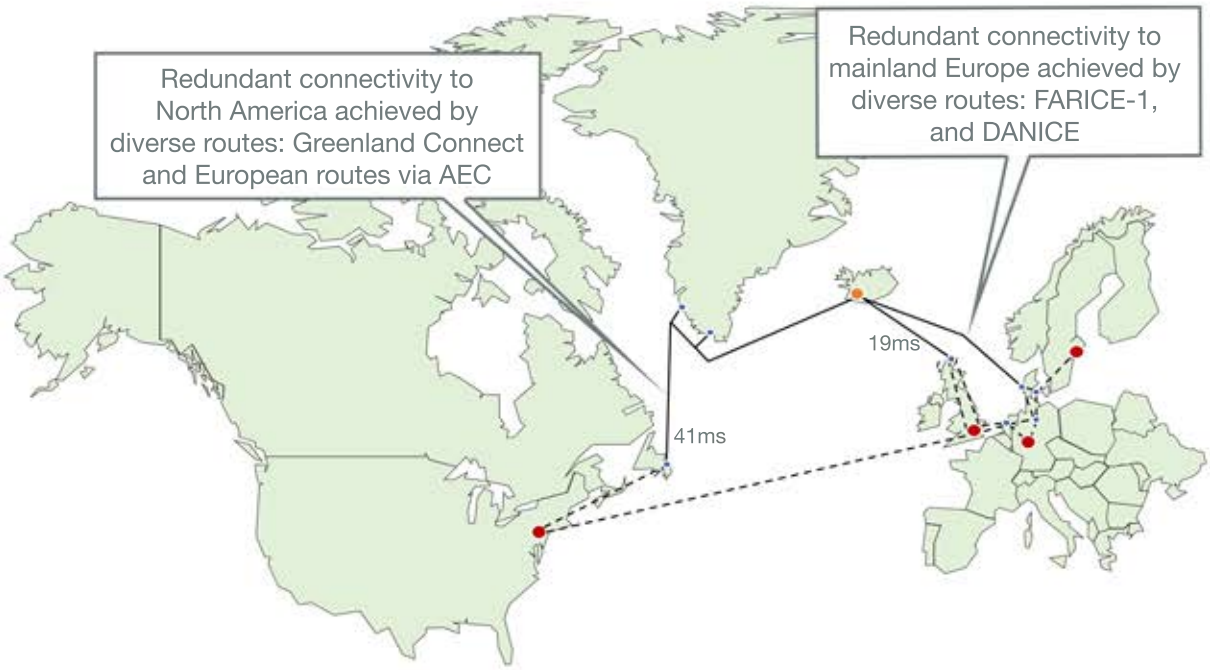

Figure 5: Submarine Cable Schematic View

7.2 Detailed View of Submarine Cable Connectivity

In summary Iceland has vast capacity delivered through three undersea cable systems:

Cable System	Route	Capacity (2016)
FARICE-1	Westerly European route connecting Iceland to the UK via Dunnet Bay. From Dunnet Bay there are diverse terrestrial routes to London. London peering points are cross-connected with diverse routes to Amsterdam. 13 years of non-cut operational service.[21]	11 Terabits
DANICE	Easterly European route connecting Iceland to Denmark via Blaaberg. There are diverse onward routes (a) via Copenhagen (two diverse routes), Hamburg and Frankfurt and then to Amsterdam (b) Hamburg and Amsterdam. Amsterdam peering points are cross connected with diverse routes to London. Hamburg routes are diverse and physically separated. 9 years of non-cut operational service.	34.4 Terabits
Greenland Connect	Westerly route to North America via Greenland and New Foundland. Redundant connectivity can be delivered via the FARICE/DANICE system and then onwards to North America via the AEC system. No planned outages in prior 36 months.	17.2 Terabits

Table 2: Detailed View of Submarine Cable Connectivity

[21] Farice Network Availability and Performance Report – January 2017-02-27

The FARCIE-1 and DANICE systems are in themselves fully redundant with multiple redundant routes through the main financial centres and European peering/transit hubs:

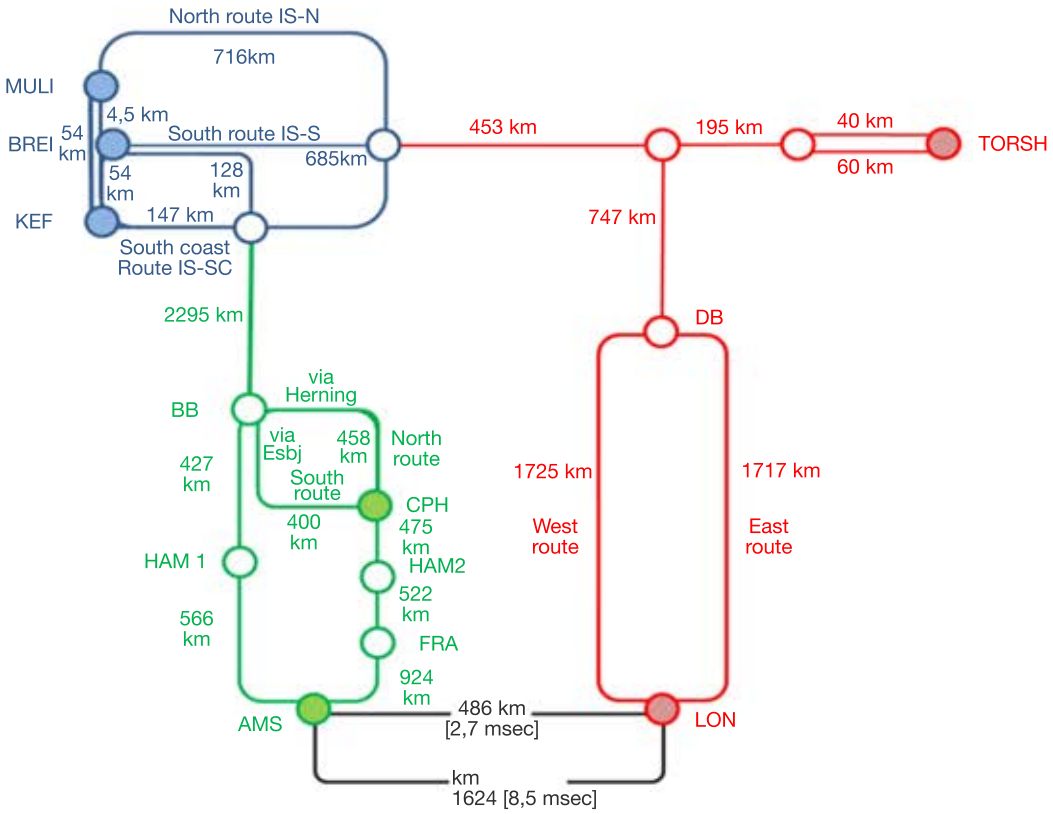

Figure 6: FARICE/DANICE System (Source: www.farice.is)

A full range of international network connectivity options (WDM, SDH, Ethernet) are delivered by multiple international providers including BT, Vodafone, COLT and Level-3.

7.3 Latency Requirements of Financial Services Firms

Latency requirements for financial services firms vary considerably and are a function of every aspects of the firm's business strategy and architectural strategy. One-size never fits all and each firm, and indeed each line of business within a firm, can have different requirements. However, many financial services firms are working to reduce dependencies on technology that dictates a location strategy that requires distributed infrastructure and proximity to consumer communities.

Citihub identifies with five generic latency groupings:

Tier	Characteristics/Observations
Tier 4: Latency Agnostic <500ms	• Applications/services that deliver to many consumers via a browser or desktop. • Performance and user experience unaffected by high latency. • Batch processing. • High-performance or computational grid.
Tier 3: Latency Tolerant <100ms Location Tolerant	• Applications/services that deliver to many consumers via a browser or desktop. • Standard enterprise applications and common off-the shelf applications (COTS). • Applications that must integrate data from multiple sources. • Increasingly aligned with commodity architectures and hybrid cloud.
Tier 2: Latency Sensitive <20ms Location Limited	• Applications where latency is important but not critical. • Zero data loss resilience is a common dependency. • Distances can be extended by application and infrastructure tuning.
Tier 1: Low Latency <1-5ms Venue Dependent	• Execution focused applications. Not always necessary to beat the market but must participate in liquidity events. • Requires direct feed access and high speed security. • Hardware accelerated and scaled out architectures.
Tier O: Ultra-Low Latency < 100µs Colocated at Venue	• Clients and business strategy that have a direct correlation between latency and revenue. Typically arbitrage related. • Colocated within the venue. • Minimal security (ACL).

Table 3: Five Generic Latency Groupings

These translate to:

Latency	Capital Markets	Retail Banking	Asset Mgmt Treasury	Insurance	Intermediary Firms
500ms Tier 4 Latency Agnostic	**Middle & back office (non-UI)** • Clearing, settlement & payment systems • Ledger • Other batch systems **Productivity Tools** • Email, Collaboration Tools	**Middle & back office (non-UI)** • Clearing, settlement & payment systems • Loan Processing • Ledger • Other batch systems **Productivity Tools** • Email, Collaboration Tools	**Middle & back office (non-UI)** • Clearing, settlement & payment systems • Ledger • Other batch systems **Productivity Tools** • Email, Collaboration Tools	**Analytics** • Catastrophe & Risk modelling • Marketing • Reporting • Legal Document Management **Productivity Tools** • Email, Collaboration Tools	**Middle & back office (non-UI)** • Clearing, settlement & payment systems • Ledger • Batch systems **Productivity Tools** • Email, Collaboration Tools
100ms Tier 3 Latency Tolerant	**Customer Facing** • Web/service portals • VDI **Middle & back office (UI)** • Ops & control platforms • Trade & Risk management • Grid computing • ERP, CRM & workflow	**Customer Facing** • Web/service portals • Branch systems (back-end) • Point of sale terminals • ATM **Branch & central ops (UI)** • Ops systems • ERP, CRM & workflow	**Customer Facing** • Web/service portals • VDI **Front, middle & back office (UI)** • Trading, Ops & control • ERP, CRM & workflow • Grid compute	**Customer Facing** • Web/service portals • Intermediary interfaces **Front & back office (UI)** • Sales, Ops, underwriting, actuarial, claims • Legacy COTS	**Customer Facing** • Web/service portals **Front & back office (UI)** • Ops & control platforms • email, office utilities
20ms Tier 2 Latency Sensitive	• Algo trading using sell-side EMS • FX & fixed income pricing • Agency brokerage • Block trading • Risk trading	• Local file system • Zero data loss applications	• Local file system • Zero data loss applications	• Local file system • Zero data loss applications	• Local file system • Zero data loss applications
5ms Tier 1 Low Latency	• FX arbitrage • Fixed income arbitrage • Algo Trading (buy-side) using proprietary OMS • Dark Pools • Prime Brokerage				
100µs Tier 0 Ultra Low Latency	• Cash Equity & Derivative Market Making • Direct Market Access • Statistical Arbitrage • Option Pricing • Option Trading • Prime Brokerage				

Table 4: Latency Ranges and Types of Use Case

7.4 Latency between Iceland and Financial Centres

Latency between Reykjavík and key financial centres is as follows:

Reykjavík/To	Latency
London	19ms
Frankfurt	18ms
Paris	21ms
New York	40ms

Table 5: Latency Between Reykjavík and Key Financial Centres (Source: Landsvirkjun (National Power Company) – numbers rounded)

Iceland is, therefore, capable of hosting and connecting applications requiring Tier 3 and Tier 4 level latency and which make up the bulk of the IT infrastructure of most financial services firms. Many latency sensitive applications in Tier 2 may also be suitable depending on use case.

Iceland has multiple and individually diverse submarine cable systems that deliver a high level of availability and full redundancy. Latency to most European cities and North American locations supports a large percentage of financial services systems.

8 Corporate Social Responsibility

8.1 CSR in the context of Financial Services

More than 40 countries have mandatory emissions reporting programmes in place.[22] Governments have focused their efforts on compelling the largest emitters and the largest (typically listed) enterprises to report on, and then improve their emissions footprint through the Greenhouse Gas Protocol (GHGP) and using ISO 14064 as a measurement standard across the supply and value chains. Emissions fall into three scope categories:

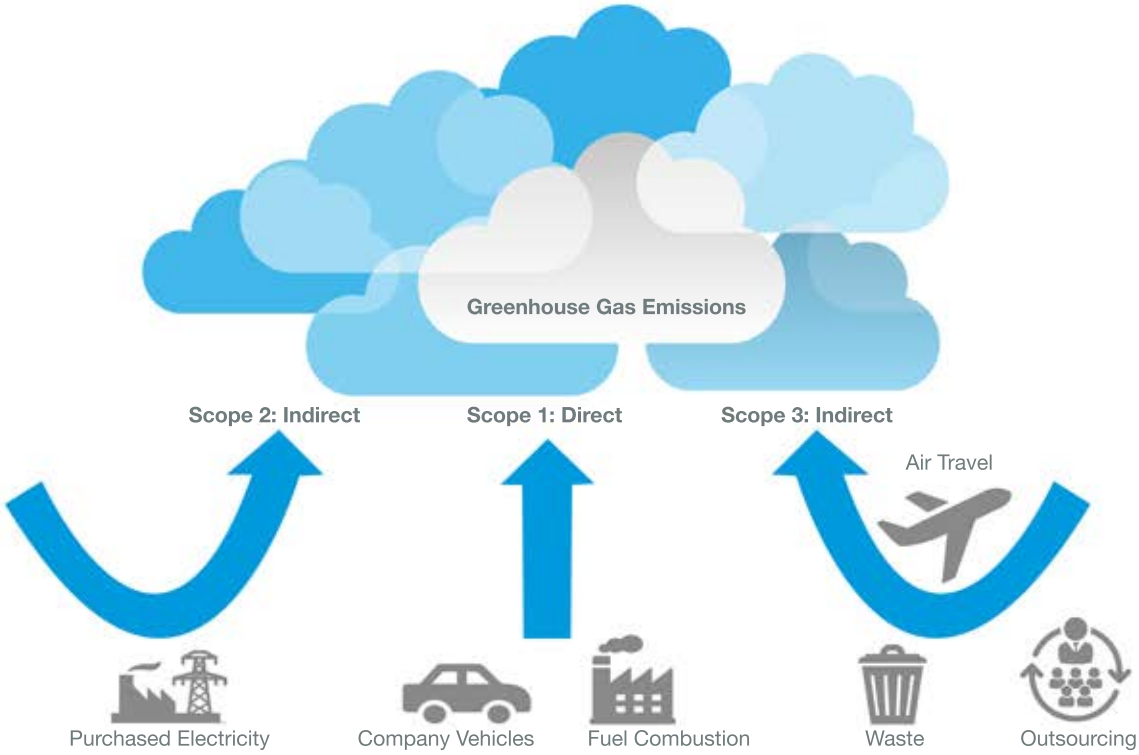

Figure 7: GHGP Emission Scope

Transparency has compelled financial institutions to establish unprecedented improvement programmes to reduce and offset emissions as well as investment mandates that preclude participation in large emission producing investments. Reductions of emissions have been achieved through:

- Improved energy efficiency across real-estate and operations (scope 2);
- Purchasing and generation of electricity from renewable sources (scope 1 and scope 2);
- Reducing corporate travel, most notably air travel (scope 1 and scope 3);
- Working with outsourcing partners to reduce indirect emissions (scope 3);
- Offsetting.

[22] World Resources Institute, "Mandatory Greenhouse Gas Reporting Programs", May 2015

Leading financial services firms remain committed to reducing the carbon emissions generated through their business operations. However, the most significant cuts to emissions were made early in the cycle, and most firms are now engaged in aggregating marginal gains to make further improvements. The chart below highlights the slowing progress of seven global financial institutions:

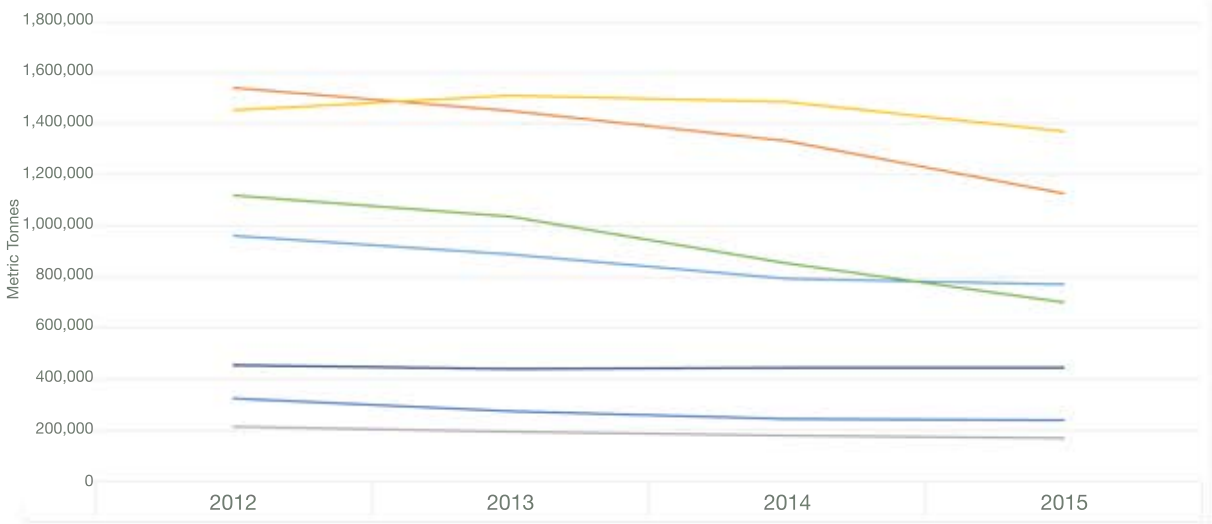

Figure 8: Major FS Firms - CO2 Emissions Trend

As gains stabilise, the realisation of further improvement is complex to implement and yield only small improvements in the overall footprint. Citihub analysis suggests that the data centre operations of large financial services firms account for 25-35% of their total greenhouse gas emissions:[23]

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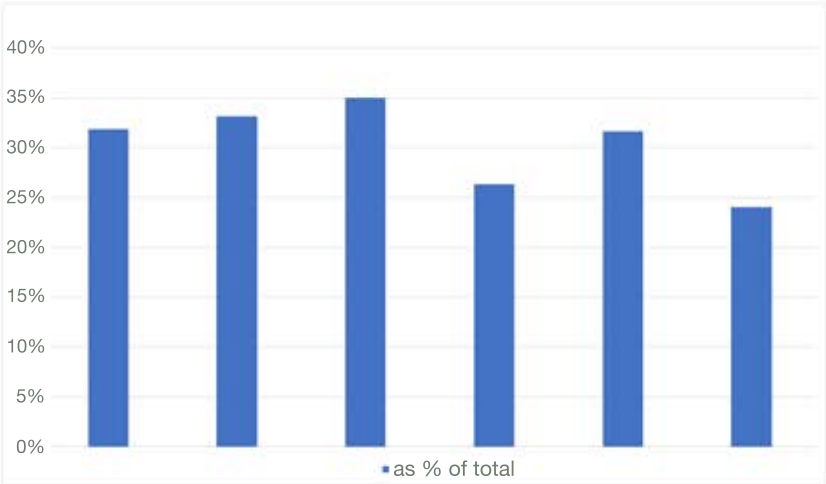


Figure 9: Data Centre CO2 Emissions of Major Financial Services Firms as % of Total

[23]Citihub analysed the GHGP and energy consumption disclosures of major financial firms and estimated the percentage of energy allocated to data centre operations. These were then benchmarked against publicly available and proprietary data sets to validate the estimates.

8.2 The Impact of Location

It is important to note that there is a direct correlation between location strategy and greenhouse gas emissions. Large variances between locations result from:

- The primary source of energy used to generate electricity has a considerable bearing on the 'conversion factor' or the amount of CO2 emitted to produce a kWh of electricity;
- The ability of the climate to deliver free cooling and consistently low ambient temperatures impacts PUE.

The graph below demonstrates the variance between popular data centre and hosting locations:

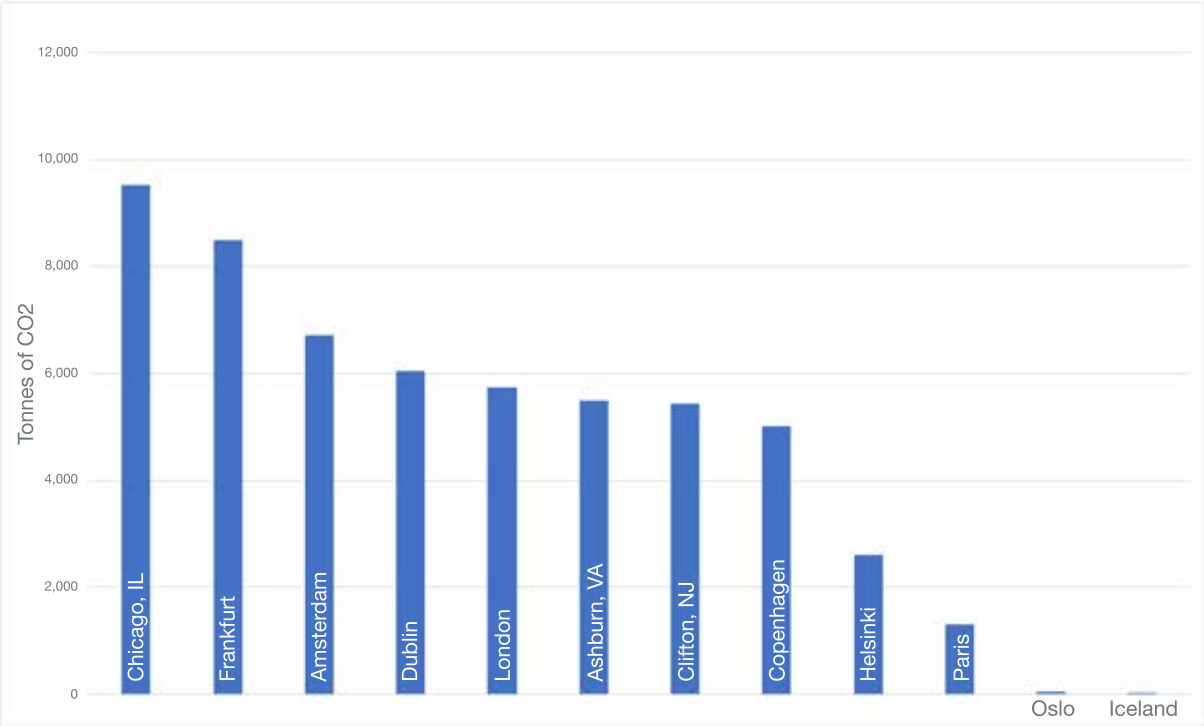


Figure 10: Annual CO2 Emmissions - 1MW of IT Load (inclusive of PUE uplift)

Chicago has a high conversion factor because the state generates 43% of its electricity from coal[24] and because of the hot summer months (average July highs approach 30C[25]). The Netherlands has lagged other European countries in renewable electricity generation while low conversion factors in France are achieved by Nuclear generation which carries its own risks and pollution challenges.

Iceland combines (almost) emissions free electricity with excellent climate conditions to deliver excellent cost results and low emissions.

[24]eGrid, 2014
[25]http://www.usclimatedata.com/climate/chicago/illinois/united-states/usil0225

8.3 Cost and Emission Efficiency - Alternatives

In terms of data centre operations there are a limited number of options available to financial institutions in order to reduce emissions:

- Efficiency gains in the power consumption and the effective utilisation of IT equipment (e.g. servers and storage);
- Efficiency gains in the PUE of the existing data centre portfolio;
- Purchasing (or onsite generation) of renewable energy in existing locations;
- A location strategy that aligns with wider corporate objectives (e.g. cost reduction) and delivering optimum emissions efficiency.

When considering the relative complexity of implementation, the impact that can be achieved on net emissions and the scale of the financial returns, it should be noted that IT optimisation initiatives and a change in hosting location might be complementary in terms of their execution; the ability to reduce cost and have the largest impact on greenhouse gas emissions.

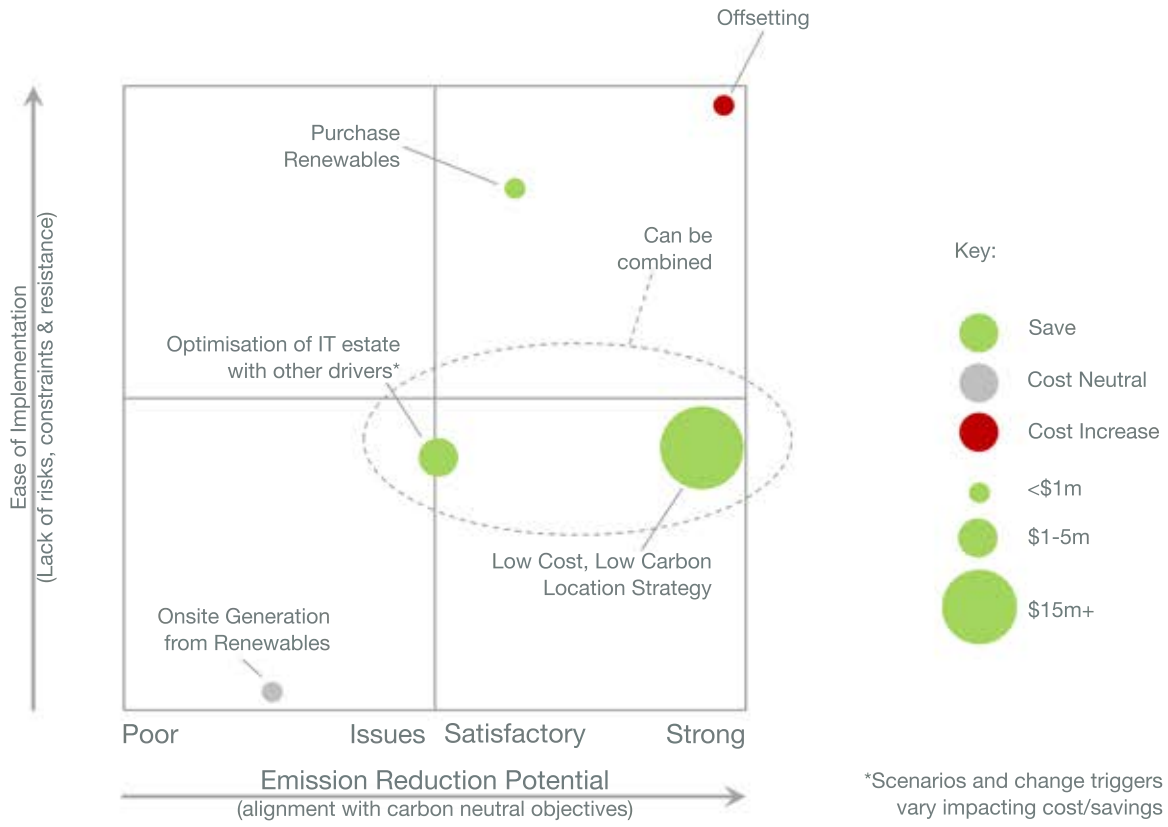


Figure 11: Ease of Implementation vs. GHG Reduction Opportunity

9 Regulation and Privacy

9.1 Legal Framework

As an EEA member state, Iceland has implemented a national data protection framework that meets the requirements of EU Directive 95/46/EU (the Data Protection Directive) as well as the General Data Protection Regulation (GDPR) which comes into force on the 25th May 2018. Cross border data transfers to/from other EEA/EU member states can be handled in the same way as they would be domestically.

The subject of GDPR and its requirements are well explained by white papers issued by the big law firms. In summary, the new regulation introduces:

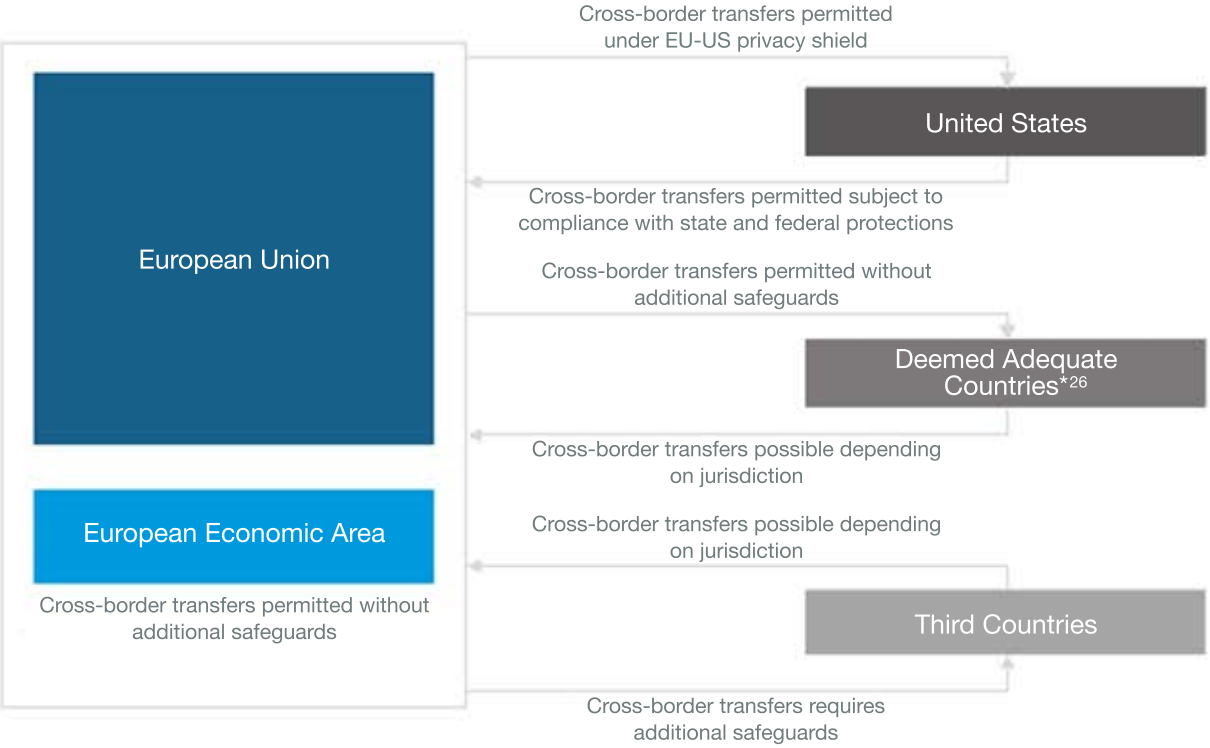
- Expanded territorial reach that compels data processors outside of the EU/EEA to comply with the GDPR protections and requirements;
- Compliance accountability including maintained controls, regular data protection impact assessments, and the implementation of data protection by design (e.g. data minimisation);
- Direct obligations for domestic and cross border data processors;
- Explicit consent of the data subject for sensitive data and a process that is easy to withdraw consent;
- Data breach notification as soon as practicably possible and, where possible, within 72 hours;
- The removal of self-assessment (permitted by some member states) of equivalence of third party countries. Demonstrations of equivalence are evaluated and approved by the EU Commission.

GDPR introduces a tiered structure of penalties that allows authorities to fine firms up to 4% of their annual revenues or EUR20m (whichever is the greater).

The reader should note that – over and above the baseline requirements of GDPR - the "Icelandic Modern Media Initiative" (IMMI), a set of thirteen separate pieces of media related legislation, specifically protects individuals through the complete prohibition of disclosure requests by foreign governments or law enforcement organisations.

The harmonised data protection laws of the EU/EEA mean that the personal data of EU citizens can be transferred to Iceland and secured/processed in the same way as it would be domestically.

Firms wishing to transfer data to Iceland from the United States have no limitations in respect of cross border transfers but must comply with the relevant state and federal laws that help to ensure privacy and security of personal data.



*Adequacy (under Directive 95/46/EC) extends to personal data only and not data stored/processed for the purposes of law enforcement. Deemed adequate countries are: Andorra, Argentina, Canada, Faeroe Islands, Guernsey, Israel, Isle of Man, Jersey, New Zealand, Switzerland and Uruguay.

Figure 12: Analysis of Locations and Compliance with EU GDPR

9.2 Implications of the UK's Exit from the European Union (Brexit)

The long-term impact of Brexit on the UK's data protection equivalence is by no means certain. Since failure to be deemed as 'adequate' would be catastrophic across all sectors of the UK's service economy it must be hoped this objective is central to Her Majesty's Government's exit strategy. However, we should consider the following risks:

- The UK is about to begin a lengthy and unpredictable process of complex negotiation to leave the EU. The outcome is uncertain and issues affecting the financial services industry and sovereignty over security related matters (and therefore privacy) could be highly emotive for both sides;
- Equivalence at the end of negotiations would not guarantee that the status quo could be maintained in the long term. Political factors, demands for sovereignty and a desire to de-align the UK from – what some perceive as – burdensome regulation might negatively impact UK data protection and privacy laws;
- Any uncertainty about future equivalence may encourage UK based 'data processors' of the data of EU citizens to relocate processing operations inside the EU/EEA. This will likely include uncertainty in respect of the EU-US Privacy Shield.

[26] For deemed adequate countries see:
http://ec.europa.eu/justice/data-protection/international-transfers/adequacy/index_en.htm

10 Summary

It is Citihub Consulting's assessment that financial services firms that are setting data centre strategies or evaluating new hosting locations should consider Iceland for applications that are latency tolerant or latency agnostic. The basis of this recommendation is based on Iceland:

- Being a member state of the EEA and as such has excellent access to the European Market;
- Having excellent overall capability in terms of its legal framework, utilities and telecommunications infrastructure (including submarine cable connectivity), and access to skills positions;
- Low cost and highly reliable energy supplies underpinned by long-term cost predictability and access/security
- Being a low-risk environment, both in terms of natural hazards and human risk;
- Having the lowest cost hosting location in Europe and North America, offering significant opportunities for cost reduction;
- Offering significant peripheral benefits in terms of:
    - Reducing greenhouse gas emissions;
    - World class data privacy protections;
    - Well defined rules in respect of permanent establishment requirements.

11 Regulator References & Further Reading

Regulatory Authority	Document Title	Relevant Section	URL
Monetary Authority of Singapore	Technology Risk Management Guidelines	All	http://www.mas.gov.sg/~/media/MAS/Regulations%20and%20Financial%20Stability/Regulatory%20and%20Supervisory%20Framework/Risk%20Management/TRM%20Guidelines%20%2021%20June%202013.pdf
	Notice 644 – Notice on TRM	All	http://www.mas.gov.sg/~/media/MAS/Regulations%20and%20Financial%20Stability/Regulations%20Guidance%20and%20Licensing/Commercial%20Firms/Regulations%20Guidance%20and%20Licensing/Notices/Notice%20MAS%20644.pdf
	BCP Guidelines	All	http://www.mas.gov.sg/~/media/MAS/Regulations%20and%20Financial%20Stability/Regulatory%20and%20Supervisory%20Framework/Risk%20Management/BCMGuidelines.pdf
	FinTech – Harnessing its Power, Managing its Risks	All	http://www.mas.gov.sg/News-and-Publications/Speeches-and-Monetary-Policy-Statements/Speeches/2016/FinTech-Harnessing-its-Power-Managing-its-Risks.aspx
	Outsourcing Guidelines	All	http://www.mas.gov.sg/~/media/MAS/Regulations%20and%20Financial%20Stability/Regulatory%20and%20Supervisory%20Framework/Risk%20Management/Outsourcing20Guidelines.pdf
Hong Kong Monetary Authority	General Principles for Technology Risk Management	All	http://www.hkma.gov.hk/media/eng/doc/key-functions/banking-stability/supervisory-policy-manual/TM-G-1.pdf
	Business Continuity Planning	All	http://www.hkma.gov.hk/media/eng/doc/key-functions/banking-stability/supervisory-policy-manual/TM-G-2.pdf
	Supervisory Policy Manual – Outsourcing	All	http://www.hkma.gov.hk/media/eng/doc/key-functions/banking-stability/supervisory-policy-manual/SA-2.pdf

Regulatory Authority	Document Title	Relevant Section	URL
UK Financial Conduct Authority	Senior management arrangements, systems and controls	SYSC 12	https://www.handbook.fca.org.uk/handbook/SYSC.pdf
	Outsourcing	SYSC 8	
	Finalised Guidance 16/5 - Guidance for firms outsourcing to the 'cloud' and other third-party IT services	All	http://www.fca.org.uk/static/fca/article-type/news/fg16-5.pdf
Dubai Financial Services Authority	The DFSA Rulebook – General Module	Gen 5	http://dfsa.complinet.com/net_file_store/new_rulebooks/d/f/DFSA1547_1843_VER360.pdf
US: SEC, FINRA and CFTC	Business Continuity Planning	All	https://www.sec.gov/about/offices/ocie/jointobservations-bcps080720
	Interagency Paper on Sound Practices to Strengthen the Resilience of the U.S. Financial System	All	https://www.sec.gov/news/studies/34-47638.htm
US: FINRA	Rule 4370. Business Continuity Plans	All	http://finra.complinet.com/en/display/display_main.html?rbid=2403&element_id=8625
US: CFTC	Code of Financial Regulations	17 Part 39 17 Part 45.3	https://www.law.cornell.edu/cfr/text/17/part-39 https://www.law.cornell.edu/cfr/text/17/45.3
Tokyo Commodity Exchange	Market Rules	Article 88	https://www.tocom.or.jp/kitei/documents/MarketRules201604.pdf

Regulatory Authority	Document Title	Relevant Section	URL
Japan	Ordinance for Enforcement of the Commodities Futures & Exchange Act	Article 66	http://www.meti.go.jp/policy/commerce/b00/pdf/b0000007.pdf
Australian Prudential Regulatory Authority	Outsourcing Involving Shared Computing Services (Including Cloud)	All	http://www.apra.gov.au/AboutAPRA/Documents/Information-Paper-Outsourcing-Involving-Shared-Computing-Services.pdf

Table 6: Regulator References & Further Reading