Benchmarking Study on Iceland as a Location for Data Centre Activity

A green window to the world
Dear Mr Hilmarsson

In accordance with your instructions as confirmed in the Engagement Letter, and further to the successful review meeting in your offices on May 9, we attach our final report on the results of our research on the benchmarking study on Iceland as a location for data centre activity.

Our principal findings and conclusions are set out in the attached report.

If you require any clarification or further information, please do not hesitate to contact Bert Kuypers on +32 2 710 95 67.

Yours faithfully
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Executive Summary
Benchmarking Study on Iceland as a Location for Data Centre Activity

- The planned connectivity upgrade incited the Invest in Iceland Agency (IIA) and several infrastructure providing organizations to initiate cooperation about a benchmark study of Iceland against US and UK as a location for different sorts of data centre activity as a specific type of establishment. PricewaterhouseCoopers (PwC) is engaged to provide assistance on this strategic exercise.

- A phased approach details (1) the current situation in Iceland, (2) specifies nowadays and upcoming needs in this respect, (3) positions the country against selected competing locations, (4) identifies weaknesses and advantages as a basis for unique selling points and (5) specifies the marketing strategy improvement options.

- Iceland hosts multiple companies that manage own data centres and provide hosting services for other companies, however not scalable to support large international clients. Existing data centre operations are geographically scattered and small in scale.

- The delivery of a second link to Europe is key to provide full redundancy and availability of international telecoms. Existing telecommunication services throughout Iceland are plentiful and reliable. Energy as well as hot and cold water provision are abundantly available in potential site options. Regarding the latter, the Keflavik Airport Area site is unique in the sense of the operational readiness of the site.

- Key concerns of IT executives are identified to be
  - the cost of power consumption of servers and cooling
  - the availability of cost attractive space
  - the increased need for secondary data centres for continuity and disaster recovery
Benchmarking Study on Iceland as a Location for Data Centre Activity

- the level of logical and physical security of data centre locations with good accessibility
- the requirement to obtain adequate latency levels to meet business-critical application service levels
- the need for consolidation of multiple small size, scattered data centres into a fewer central locations
- the adequate planning of growing server and storage demand

• An evaluation and pricing comparison of 4 scenarios provide the basis for a realistic, as well as scalable comparisons in view of the development options for Iceland. Next to the UK and USA, India is added as a 4th location in the benchmarking exercise. The analysis distinguishes between Cost and Quality of operating conditions as 2 clearly separate dimensions.

• The overall quality score for Iceland is 7.6 on a scale of 10, with the USA and UK making 8.3 and 8.1 respectively. India gets a 5.7 mark. The conclusions for Iceland on the individual location categories are encouraging:
  - Based on the selected location factors in the Geo-political Environment category, Iceland scores best when compared to the peer group.
  - The low score for Iceland in terms of general availability of IT staff is the single factor to explain the relative position in the People category.
  - The overall performance of Iceland with respect to the Technology location factor is good, though when compared to the USA and the UK, the country’s offer is less compelling for mobile investment projects dependent upon international telecommunication services.
  - In terms of the Transport & Infrastructure category, Iceland is almost at par with the UK and USA.
  - The assessment on the Investment Factors category reveals a supportive environment in Iceland.
Benchmarking Study on Iceland as a Location for Data Centre Activity

- The cost comparison for the benchmark concentrates on the operational expenditures for:
  - HR for standard IT grades and positions,
  - Power per kWh
  - Data centre co-location rental (cost to rent a space within the data centre per rack)
  - Infrastructure and building construction

  and the combination of the 4 components results in a favourable position of Iceland, especially thanks to the power and rental cost

- The combination of the quality scores of the 4 locations illustrates the favourable position of Iceland for the selected scenarios in the for a cost – quality comparison:
Benchmarking Study on Iceland as a Location for Data Centre Activity

• Identified strengths of the country relate to the ICT focus, the reliability of power supply and the low rental and facility management cost.

• Iceland should concentrate on marketing the country in terms of a location providing green power and natural cooling opportunities as well as a new location concept.

• The biggest identifiable threat is posed by the competition from emerging countries with low operational costs.

• In order to enhance the offer, tailored actions and activities should strengthen the situation in terms of available ICT talent, proof of data centre concept, international connectivity and perception of natural disaster risk.

• Next to raising awareness of the suitability of Iceland and the associated benefits, the upcoming marketing efforts by all involved partners in Iceland should first and foremost concentrate on dispelling the myths on seismological or volcanic activity but most importantly latency problems. A fact based data book with comparative information on the location will be imperative and should be part of a joined marketing strategy aimed at avoiding internal competition in a market with high degree of external competition.

• In addressing investors, the geographic search area should not be limited to the UK or USA, but could best start with current operators and users back-up and disaster recovery data facilities in the major business centres. A new Iceland-USA link would enable services for an increase of business markets, including certain financial and other real time activities. As a result, a more generic marketing strategy would be possible.
Background and Scope
The Government of Iceland has decided to further ensure the secure telecommunications link between Iceland and other countries by undertaking preparations for a **new undersea cable**.

Amongst others, in his address to the annual meeting of the Icelandic Chamber of Commerce, the Prime Minister of Iceland identifies the existence of a secure telecommunications connection as a prerequisite for foreign companies that contemplate the establishment of a venture in a new country.

The discussed connectivity upgrade **incited the Invest in Iceland Agency (IIA) and several infrastructure providing organizations in Iceland to initiate cooperation about a benchmark study** of Iceland against US and UK as a location for different sorts of data centre activity as a specific type of establishment.

The different parties involved see the construction of the new submarine system as a means of removing the main obstacle to a successful promotion of Iceland for this kind of FDI.

The Icelandic partners involved in this study requested PwC for tailored research on

- the current market situation for data centre operations in terms of demand and supply;
- A benchmarking study of Iceland against the USA and the UK with respect to relevant “product applications” and other parameters;
- A definition of the most competitive “product” niches for Iceland;
- Improvement opportunities regarding the competitive position of the country; and
- Guidance on typical prospects and potential customer types and required related marketing
Approach
Understanding the feasibility from the investor’s point of view

We offer a unique multi-disciplinary approach which differentiates by our:

- **demand-side approach** (the investor point of view) based on our more than 30 years of experience working with investors evaluating the location decision of their mobile investment projects,
- first hand experience by the PwC network as well as PwC Belgium with selection process assistance for data centre users in a variety of industries and sectors
- **objective and fact based** analysis,
- local presence in benchmarking locations by PwC offering the required local savvy

Our approach is balanced in the sense that it equally recognizes

- the specific requirements of the demand side, the users/providers of data centre services
- the unique offer of Iceland
- the resulting strengths where both sides meet

• the potential weaknesses that need addressed when matching supply and demand causes inconsistency
A phased approach to benchmarking the opportunity

Phase 1 details the **current situation** in Iceland in terms of data centre infrastructure, operations and players and as such quantifies the country’s position in this specialist field.

Phase 2 produces a specification of the **nowadays and identifiable upcoming needs** of the demand side in view of benchmarking the offer in Iceland against identified competing locations.

Phase 3 **positions Iceland** with regards to identified critical location factors and cost elements against the USA and the UK for selected operation types.

Phase 4 **identifies strengths and competitive advantages** as a basis for unique selling points, and weaknesses as a basis for enhancement recommendations.

Phase 5 specifies **marketing strategy improvement options** based on gathered intelligence on targets and industry players.
Study Results

Data centre activity in Iceland

Phase 1
Quantify Iceland as Data Centre Location

Phase 2
Specify Demand Side

Phase 3
Benchmark Iceland to Competitors (UK, USA)

Phase 4
Enhance the Supply where needed

Phase 5
Detail the Marketing Strategy
The Icelandic Partners

The study is performed on behalf of the **Invest In Iceland Agency** who themselves are representing a partnership of Icelandic businesses with formulated interest in taking a stake in any possible future project to deliver data centre services from Iceland.

These companies are as follows:

- **Siminn** – Provider of all telecommunication, mobile and internet services to private and corporate clients in Iceland. Siminn (previously named Landssíminn), is the former state-owned incumbent telecommunications operator in Iceland.

- **Vodaphone Iceland** – Provider (formerly known as Og Vodafone) of telecommunications services and part of the Icelandic IT company Teymi. Vodafone Iceland offers mobile, fixed-line and ADSL / internet services to individuals and companies.

- **Farice** – Supplier of intercontinental communication links and services and manages the link for the nations of Iceland and the Faeroe Islands.

- **Reykjavik Energy (OR), Hitaveita Suðurnesja (HS), and Landsvirkjun (LV):** These three are utilities companies, who produce and/or distribute electricity, geothermal water for heating, and/or cold water for consumption and fire fighting to respective regions in or the whole of Iceland.

All these partners have **expressed interest** in having Iceland supply the data centre services if the outcome of the study should indicate significant market potential.

Some of these companies have expressed **strong belief** in the position of Iceland in this international market segment, even to the extent that they may go alone in developing this service should others not feel the need.

From an operational perspective, all partners individually have expressed – based on previous research or expert opinion - that there is a **good case for allowing an existing supplier** to either lease a custom built premises or manage a facility on behalf of an Icelandic managed entity.
The existing data centre landscape in Iceland

Currently within Iceland there are **multiple companies** that manage their **own data centres** and several of these **also host systems for other companies** as a service.

The **services** provided by these data centres are as yet **not scalable to support large international clients** in terms of both human resources and physical infrastructure.

**Total existing space known to be used as hosted data centre operations** within Iceland, at this time amounts to approximately **3,500m²**.

The aggregated **operational floor space** of existing **scattered** data centres in Iceland is **small**, especially when put in perspective to the fact that a large international data centre would look to start at 1,000m² and use several floors or buildings, possibly totalling up to 20,000m² or more.

Technology developments have resulted in the increasing use of high-density racks with reduced space requirements. Nevertheless the existing data centre operation in Iceland measured by physical space use, is **indicative for the fact that the country so far has not landed large scale international data centre operations**.
Building blocks for data centre operations exist in Iceland

Dependency of capturing a large market is related to Farice and the delivery of a second link to Europe. Once in place full redundancy will ensure full availability of international telecoms.

The Farice service is available to any carrier wishing to buy bandwidth, allowing potential data centre operators to have multiple suppliers.

Existing telecommunication services throughout Iceland are plentiful and reliable. These are in the process of constant improvement and of the highest modern standards.

Regarding energy all three interested companies have the ability to deliver supplies to any part of the island.

Services including hot and cold water are also abundantly available as part of the required utility supply.

As part of the study PwC surveyed potential locations within Iceland to allow us to better define the comparable scenarios.

These locations were all located within a range of 50km of Reykjavik and at different states of development.

Brownfield development sites are plentiful and several local communities currently have projects underway.

Greenfield development is also available but suitability of locations is limited by the available infrastructure.

Greenfield development has been defined as not a problem by both the telecommunication and power companies as should a greenfield site need it, infrastructure can be in place within months dependent on the location.
Building blocks for data centre operations exist in Iceland

Three sites were pre-selected by the Invest in Iceland Agency for detailed survey, with a fourth site added at a later stage.

Each one has different characteristics:
• three of the locations are in pre-development phase, and
• one location is already provides for the necessary infrastructure and utility supplies.

Survey site 1: Ölfus Industrial Area
• Situated near the port of Thorlákshöfn, distance to Reykjavik 51km (45 minutes drive).
• Accessibility strongly dependent on weather conditions (during site survey, due to a snowstorm the road to Ölfus had to be closed).
• Existing infrastructure with small offices and middle industry.
• New infrastructure for offices, hotel and eventually data centres is dependent on official approval and potential partners. Exact spot for data centre not assigned yet.
• Lead-time after final approval is 18 months.
Building blocks for data centre operations exist in Iceland

Survey site 2: **Esjumelar**

- Situated 20km from Reykjavik, near the fjord Kollafjörður.
- Good accessibility from Reykjavik.
- On one side of the road there is existing small infrastructure with few offices and small industry. The other side is planned for small offices. Behind it, two zones for industrial purpose lack the necessary infrastructure.
- The site is equipped with utility and fibre optic access.
- No exact spot for data centres is located yet, due to absence of complete developed infrastructure.

Survey site 3: **Keflavik Airport Area site**

- Former site of the US Navy set up in the 1960’s, with residential housing, sports infrastructure, and to be office buildings near Keflavik Airport (< 5 km).
- Proposed building is a full option bunker.
- Two large capacity generators with fuel supply for 30 days are available, maintained and operational.
- Transforming costs for operational data centre are high.
- Difficult to access, insufficient air conditioning and power supply.
Building blocks for data centre operations exist in Iceland

Survey site 3: **Keflavik Airport Area site** (continued)

- All attractive benefits towards future partners are available such as: complete building and road infrastructure with power and fibre optic utilities on site. However, only companies with severe access and security requirements would take this building in consideration.

- The surrounding development site has potential locations for building one or more data centres with floor space of 10,000m² or more.

Survey site 4: **Geitháls**

- Situated 16km out of Reykjavik, on the outskirts of the south-eastern side of the city. (15 min drive from downtown). Good accessibility

- Owned by the city of Reykjavik.

- Existing infrastructure in the immediate vicinity (high-tension power to Landsnet substation, water supply, telecommunications)

- Greenfield with landfill zones, however planning permission for industrial use granted.

- Complete site preparation program required including upgrade of access road.

- No exact spot for data centres is located yet, due to pending master plan for the area.
Building blocks for data centre operations exist in Iceland

In terms of the existing international telecoms facilities, an older submarine cable, Cantat-3, became operational in 1994. Cantat-3 lies between Canada on the west side, Denmark, Germany and the United Kingdom on the east side, with spur connections to Iceland and the Faroe Islands.

Due to the high resilience of the Cantat-3 cable, outages through the 1st and 2nd quarter of 2007 have been resolved and full service resumed.

Towards the end of the last millennium it became clear that a new submarine cable was needed for Iceland and the Faroe Islands. Internet traffic was increasing approx. 100% per year at the time.

The submarine fibre optic cable, Farice-1; between Iceland, the Faroe Islands and Scotland was laid in the period June-September 2003.

The cable system was delivered as operational by Pirelli in November 2003.

Farice hf began selling its services to customers on January 15th 2004

Although full availability of satellite connections exists, very little or no satellite services are used due to low demand for this type of connectivity.
Building blocks for data centre operations exist in Iceland

- Over 3,000 km including Backhauls
- 2 fibre pairs
- DWDM technology
- Up to 360 Gbit/s on each pair
- 14 amplifiers
The existing and planned International Telecoms facilities

The latency numbers of the existing international telecoms facilities below are those including backhauls (terrestrial parts) of the systems:

- **Farice-1** (existing system)
  - Reykjavik-London: 37mS

- **Other transaltantic**
  - New York - London: 63mS

- **Eurice**
  - Iceland-Ireland or UK: 26-30mS

- **TBD**
  - Cable via Greenland or Canada due 2008

Future plans for Iceland and the Faroe Islands

A new cable system is needed in the near future for Iceland and the Faroe Islands, mainly for redundancy.

The following main options are being explored:
- A cable from Iceland to
  - UK or Ireland
  - Faroe Islands - UK
  - Faroe Islands - Shetlands - UK mainland
  - Faroe Islands - Netherlands
Study Results

Data centre industry

Phase 1
Quantify Iceland as Data Centre Location

Phase 2
Specify Demand Side

Phase 3
Benchmark Iceland to Competitors (UK, USA)

Phase 4
Enhance the Supply where needed

Phase 5
Detail the Marketing Strategy
A data centre

A data centre is a **facility** used to house mission critical computer systems and associated components.

It generally **includes environmental controls** (air conditioning, fire suppression, etc.), redundant and / or backup **power supplies**, redundant **data communications connections** and **high security**.

The main purpose of a data centre is running the applications that handle the core business and operational data of the organization.

A building that is constructed or rebuilt for data centres can also be known as a **carrier hotel, co-location centre** or **internet data centre**. Telecom hotels typically house hundreds of servers for web hosting organizations, large enterprises and other service organizations.

While a **data centre has many servers**, it also has **people**, with operators sitting at consoles, putting paper in printers and moving disks and tapes from one place to another.

Another approach is the **server farm**; this is a group of **network servers** that are housed in one location. A server farm provides bulk **computing for specific applications** such as web site hosting. In a server farm, in terms of manning, server farms generally **only see a person** when an installation or repair was performed. A server farm is typically a room with hundreds or even thousands of rack-mounted servers.

A data centre can occupy **one room**, of a building, **one or more floors**, or an **entire building**.
A data centre

Most of the equipment is in the form of **servers** racked up into **19 inch rack cabinets**, which are usually placed in single rows forming corridors between them.

Servers **differ greatly in size** from 1U servers to huge storage silos which occupy many tiles on the floor. This allows people access to the front and rear of each cabinet.

1U represents one rack unit of space. A Rack Unit is 1.75 inches in height (44.49 mm).

Some equipment such as mainframe computers and storage devices are often as big as the racks themselves, and are placed alongside them.
A data centre

Lastly we see a rise in **unattended data centre operation**, with the use of tape and optical libraries that automatically mount the appropriate disk and tape volume, the data centre increasingly does not require human intervention.
Key concerns of the industry

Concerns within the data centre industry focus on 3 main areas:

1. **Cost**
2. **Availability**
3. **Security**

When looking at moving or relocating an existing data centre **accessibility** also comes in as a fourth stringent requirement.

A further concern to heads of IT is **latency**, as it causes issues on wide area networks (WAN) by resulting in increased delays and under-utilisation of links.

Other noticeable trends associated with data centre management relate to **consolidation** and **growth**.

Next to these main points a number of additional challenges and often strategic change drivers appear on the radar screen of data centre managers: Talent availability, scalability and flexibility for instance.

Though discussed as individual concerns of IT executives and data centre managers, the related results of change are often **interconnected** and occur in cascade. Prospective solutions on one front hold potential to mitigate change needs on other dimensions too.
Key concerns of the industry

Though the term location covers different meanings in IT and data centre context, the fundamental meaning of the *Location, Location, Location* adage is applicable in response to the identified change drivers of the data centre industry.

Cost, availability, security, accessibility, latency, consolidation and growth potential, *all are influenced by the exact location* of the centre. When confronted with the option or need to locate or relocate, IT heads can take advantage of the particular strengths and enablers in specific locations.

In the *Use Best Practices to Design Data Centre Facilities* report, Gartner delves into specific guidelines on achieving a high level of flexibility and scalability in the data centre.

The *best practice report* addresses amongst others site location and building selection. Gartner list the decision making elements a company should look at when deciding where to relocate or build a new data centre and related to site selection states that the location of the data centre will greatly affect security, operational efficiency and operating costs.

The report distinguishes between location and site as two different geographical layers, site being at the most detailed level.

In terms of *location selection*, Garner reports decision criteria which to a large extent are not different from the requirements of other mobile investment projects:

- Labour market
- Staff retention/defection issues
- Public incentives
- Communication infrastructure
- Electrical services
- Taxes (personal property)
- Proximity to public transport
- Quality of life
- Security and public safety
- Operational considerations
Key concerns of the industry

Clearly the decision criteria in the Gartner list are not prioritized and depending on the type and set-up, the importance can significantly differ.

When touching upon the criteria for the site candidates, the report amongst other lists the following criteria:

- reasonable commuting distance for employees, support vendors and other constituents
- ample area for parking, water and fuel storage
- space for delivery truck access
- and a location away from high-risk areas
- adequately serviced plots for all critical utilities, including power and water
- a site plan with areas for building and parking lot expansion
- local codes, building ordinances and zoning restrictions that will not impede planned data centre operations, such as the operation of diesel generators.

In terms of critical location factors the data centre industry is hence imposing no new requirements upon the supply side. The importance of specific elements however shifts, with cost, availability, security and accessibility receiving more attention.
Cost: Power consumption of servers

With **data centres consuming more power** and having ever increasing needs for cooling, finding a location that can supply both of these requirements **cheaply, efficiently** and at **no impact to the environment** is a great attraction.

**Migration to more electrically-efficient platforms** is another effective strategy for reducing power consumption.

Most data centres have low density servers that are 3-5 years old. These servers normally draw the same or less power per server than today’s blade servers and are physically much larger per server. **Migration to modern blade servers** from legacy servers on a server-by-server basis does not reduce the total **power consumption** and may even raise it as such migration will permit higher packing densities for servers.

Moreover, the **power consumption for cooling will increase drastically:**

- blades do not create more heat than equivalent 1U servers, but
- they do create heat in a smaller area which gives rise to heat removal problems

This observable fact creates the false perception that blades create excess heat. The increased power consumption is nevertheless a fact due to higher packing density.
A recent survey conducted on behalf of AMD by Stanford University has shown the following results; in 2005, the total **power consumption of US servers was 0.6% of overall** US electricity consumption.

**When cooling equipment is added**, that number doubles to 1.2%. Some firms have had to install additional air conditioning and power supplies every few years to cope with the increasing energy needs of servers.

Some analysts say power management will be the number one problem for IT managers over the next few years.

Between 2000 and 2005, **server electricity use grew at a rate of 14% each year**, meaning that it more than doubled in five years.

The 2005 estimate shows that servers and associated equipment burned through 5 million kW of power, which cost US businesses roughly 2 billion Euro.

This consumption volume represents the output of five 1 GW power plants.

If current trends continue, server electricity usage will jump 40% by 2010, driven in part by the rise of cheap blade servers, which increase overall power use faster than larger ones.

However, it is **difficult to predict** what will happen as data centres **increasingly** standardize on **power-efficient chips**.
Cost: Power consumption of servers

According to an official US survey, data centre power requirements are increasing an average of 8% per year.

Power requirements of the top 10% of data centres are growing at over 20%.

Based on a survey conducted by APC, the total cost of ownership for a rack of servers is between 61,500€ to 115,000€ per rack, and recurring power consumption accounts for 20% of that investment.

During a recent conference on “The need to address Cooling and Power issues in tomorrow’s Data Centres” featuring speakers from HP, IBM, APC, TYCO, The Uptime Institute and EDS, the main theme to all presentations was “cheap power is gone forever”.

Power consumption in data centres is at an all time high and although new blade systems use no more power, they do require a different approach to cooling, also if as designed, a greater density of systems are deployed per rack, more CRAC units and very careful planning of the data centre is required.

Failure to use professional companies in this design will result in poor performance, bad utilization of infrastructure and high costs in power and hardware.

This industry statement underpins the fact that the search for attractive power rates is increasingly important. In response, all major manufacturers of data centre related hardware are focusing on the
Cost: Power consumption of servers

devlopment of servers reducing power consumption. To switch to this next generation of hardware is however expensive as additional products and technologies are being added.
Cost: Power consumption of cooling

The cost of cooling can be up to **45% of the total operating cost** for a data centre. As a consequence, alternative means of cooling are always being investigated:

- Using existing reliable and proven methods but at a heavily reduced cost would be an attractive proposition.
- Finding alternatives to certain aspects of these methods to further reduce power requirements and costs is also an important goal.

According to APC; as a general rule, approximately half of the energy used in a data centre goes to the IT loads. The other half goes to the network-critical physical infrastructure equipment including power equipment.

This means that for each kW of IT load the 10 year electricity cost is approximately 15,500€.

Over a **lifespan of 10 years**, the cumulative electricity cost for a **200kW data centre** amounts as such to just over **3,000,000€**.

Evidence is however growing that data centres are being **over-designed for electrical capacity**, because of concerns about meeting the incremental power and cooling demands of modern server equipment (such as blade servers).
Cost: Availability of cost attractive space

As one of the most clearly identifiable cost components, rental charges for data centre space play a major role in choosing a location.

Traditionally, the ability to access high capacity bandwidth, ideally supplied by multiple providers, drove data centres into the core of high population density areas.

Typical locations in Europe that attracted both captive as well as third party data centres are London, Amsterdam, Frankfurt, Paris, Dublin and Brussels.

Spiralling rents in these large European cities are forcing many companies to look at hosting locations many miles from their operational premises. The situation is similar in the USA where growth is no longer in New York or other tiers 1 cities, yet more likely in tier 2 and 3 locations.

The driving forces are space and power restrictions. As a result, it is unlikely that current operators will open new facilities in these places, or that other companies will try to enter these data centre markets.

A study in the USA by Princeton, N.J., location consultants, The Boyd Company Inc. lists of the top data centre cities in the USA. As seen, no major USA cities or financial centres are listed. This is inline with the rising costs of locating data centres.
Availability

Business **demand for higher availability** is increasing across all industries, to the extent that availability is identified as one of the **top challenges** of IT directors.

As an immediate consequence, the **setting up of secondary data centres for continuity and disaster recovery** is a clearly noticeable trend. Back-up capacity is created either by repurposing an existing data centre, or by building new facilities.

Secondary and tertiary data centres are often built **at significant distance** from the primary data centre with assumptions about a potential disaster’s reach continuously being adjusted.

Since **9/11** and post-**Katrina** more companies now require off-site disaster recovery facilities, secure storage and secondary locations mirroring their main data centres. Insulation from natural and man-made disasters as part of availability is key.

In regards to **data centre types**, the Uptime Institute has established **four levels of fault tolerance** for data centres.

**Tier 1** is the lowest level, and **Tier 4** is the highest, with complete multiple-path electrical distribution, power generation and UPS systems.

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<th>Tier 3</th>
<th>Tier 4</th>
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<tr>
<td>Single path for power and cooling distribution; no redundant components — less than 28.8 hours downtime/year</td>
<td>Single path for power and cooling distribution; redundant components — less than 22.0 hours of downtime/year</td>
<td>Multiple power and cooling distribution paths, but only one path active; redundant components; concurrently maintainable — less than 1.6 hours of downtime/year</td>
<td>Multiple active power and cooling distribution paths; redundant components; fault tolerant — less than 0.4 hour of downtime/year</td>
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</table>

**Source:** Uptime Institute

The **tier level will drive the design specifications** for the new data centre. The higher the tier level, the higher the investment level for building construction and environmental equipment.
Availability

The **tier level will drive the design specifications** for the new data centre. The higher the tier level, the higher the **investment level** for building construction and environmental equipment.

Tier level or fault tolerance will be determined by the criticality of data centre operations.

In the financial industry, high availability and fault tolerance (that is, typically Tier 3 and Tier 4) are required to support 24x7 financial transaction activities and funds exchanges.

For other organizations (such as universities) a lower fault tolerance is acceptable.

The following is a summary of **representative site availability expectations** for each of the tier levels described above. The availability percentages can be considered characteristic of the operating experiences of a representative number of sites within each tier classification.

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<thead>
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<th>Tier</th>
<th>Availability</th>
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<tr>
<td>Tier I</td>
<td>28.8 hours and 99.67%</td>
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<tr>
<td>Tier II</td>
<td>22.0 hours and 99.75%</td>
</tr>
<tr>
<td>Tier III</td>
<td>1.6 hours and 99.98%</td>
</tr>
<tr>
<td>Tier IV</td>
<td>0.4 hours and 99.99%</td>
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Security & Accessibility

Security, both logical and physical is a must have situation when looking for or running a data centre.

Having a location with low crime, no civil unrest, very limited unemployment and a high level of education all ads up to good marks.

The physical sitting of the data centre also should be secure.

Logical security comes with human resources, the choice of hardware and the telecommunications provider.

Access is also an important criteria.

Good accessibility of a location is often expressed in terms "It's a reasonable day trip to send an IT exec on a plane."

Beyond the accessibility of the location to own specialist staff or users, data centre operators strongly consider accessibility to key vendors as well and pronounce a preference for cities that have a precedent for data centres. The presence of other data centres is taken for proof that vendors will have gravitated to the area.

Globalization in this respect is inducing operators to assess the extent to which visa can be easily obtained for citizens from for instance India or Singapore.
Latency

Latency is the term used to describe the time it takes for a data packet to traverse a network. In other words, the term refers to the amount of time in nanoseconds between a request to read the memory, and when it is actually output.

When critical business processes are delivered via the web, business performance is synonymous with application performance and the effects of latency can seriously impact the bottom line.

Gartner predicts that through the year 2007, 90% of organizations that do not address latency issues will not meet business-critical application service levels.
Consolidation

Analysis of specialist data on corporate IT investments and displacement of capital goods, shows an apparent trend of consolidation and centralisation of IT resources, including data centres.

IT directors typically refer to topics such as regulatory compliance or the increasing cost and complexity of IT. The reasons for consolidation can be many but mostly it comes down to cost and efficiency. Sub reasoning can be that the company has outgrown its existing facilities or utilities.

Specifically, the industry sees the consolidation of multiple small size, scattered data centres into a fewer central locations, or one centre by geography. The clear objective is to achieve better results in terms of networking, redundancy, computing, storage and management as a result of enhanced grouped capacity.

In view of data storage activity, this trend has significant impacts as centralized data is more easily backed up and controlled for compliance.
Growth

Demand for data centre resources has generated tremendous growth for servers and storage.

The former group has seen an average year-on-year volume growth of close to 11% whereas the median annual growth for storage capacity even doubles these figures for the last two years.

These excessive growth rate is putting at risk past data centre infrastructure investments in environmental control, power, and space.

Data centre operators struggle to find balance between space consuming low-density racks and particularly heat generating and power-consuming high-density racks.

Gartner state that data centre demands will change significantly during the next decade. Information flow and processing needs will increase, driven by large businesses' requirements to evaluate their business environments faster and more accurately.

It is seen worldwide that the server market continues to grow at a healthy rate, with blade servers and x86 showing the greatest strength according to the 2006 worldwide server report just released from Gartner.

Worldwide server shipments totalled 8.2 million units in 2006, an 8.9% increase from the 7.5 million shipped the previous year. In terms of value, revenue in 2006 was 40.5 billion Euro, up 2% from 2005.

Of the top 10 vendors in server shipments worldwide, Rackable Systems had the highest growth, with a 68% increase for the year.

Blade servers continue to be a high-growth market for everyone in that business, up 36.5% in 2006.
Four data centre types for evaluation

For the purposes of this study we have defined **4 scenarios to evaluate and compare** pricing, standards and requirements.

In terms of their key characteristics, the 4 scenarios are listed below:

1) Captive (single company) centre up to 150m²
   - Small single company services managing one or two servers per company.
   - Office hours support only on a limited basis.
   - Customer IT staff would perform basic functions and applications would tend to be of a basic small office type.
   - Storage and backup facilities of low capacity overall systems management performed ad hoc.
   - Power requirements and utilities low and varying.

These 4 scenarios represent realistic, as well as scalable comparisons in view of the development options for Iceland and are easy to price and compare.

A full scale large data centre may be up to 20,000m² with thousands of servers. However the added value of researching this type of mobile investment is deemed low seen the current situation – both in Iceland and in terms of perceived appetite in the industry for greenfield locations.

All details as listed below are based on **requirements to operate and maintain a data centre service** supplying the functions as detailed in the scenarios.

Additional HR and management functions when not listed, would be provided as part of the data centre service partners.
Four data centre types for evaluation

2) Medium size centre – 300m²
- Centre that provides services for individual companies where their data centre is located within a caged environment and support is presented on an “as required” package.
- The main clients would be local companies with easy access to the site. The packages would allow for self maintenance and support.
- For international clients, equipment would be of low value and in general be used in a backup or disasters recovery function.
- Support and operations would be provided by the data centre team, and in a test or real world scenario a client IT specialist may come to the data centre location.

3) Large hosting only centre- 800m²
- This type centre provides data storage, web hosting, and backup facilities for a wide range of clients.
- Support would be required only to maintain the operational environment and equipment is of mainly high density and storage devices.
- Customers would require no access to the data centre on a regular basis as their primary usage is remote access.
Four data centre types for evaluation

4) Large size full hosting centre – 800m²
- Data centre that also provides data storage, web hosting, and backup facilities for a wide range of clients, but operational systems and live data possessing would occur 24x7.
- Clients would require full support of all systems, O/S and applications.
- Network access support would also be managed by the data centre operator.
- Clients may also require access and operational facilities during disaster recovery operations.

For all scenarios certain criteria would be standard but not always necessary.

Premises rental (size dependant)
- Data Centre
- Office space
- Storage
- Car Parking
- Kitchen and shower and other HR related facilities

Insurances
- Personnel
- Building
- Hardware
- Software
- Liability
Four data centre types for evaluation

The different scenarios are evaluated and priced in terms of required infrastructure investments based on market intelligence gathered in the field by a subject matter expert company.

Added to this figure are the required investments in network components and servers.

The infrastructure estimates are based on:
- Comparison of HP and Dell server solutions
- Redundant Cisco network equipment
- End user/list prices

The use of HP references is supported by the fact that:
- Market prices are comparable
- HP is best documented (prices, consumption, dissipation, …)

All prices are based on international market rates. A discount of between 15% and 40% would be excepted at purchase.
Four data centre types for evaluation

**Type 1: Investment estimate: 3,476k€**

**Data Racks 19 inch:**
- 13 cabinets low density
- 7 cabinets high density
- 3 cabinets with routing and switching equipment & telephony
- 2 cabinets for patching

**Cabling**
- Backbone fibre optic cabling (estimate: 80 cables)
- Horizontal copper cabling UTP Cat 6A (estimate: 160 cables)

**Safety & Security**
- Limited and registered access
- Intrusion detection
- Fire detection
- Fire extinguishing Pro-inert gas (keeps equipment intact)

**Raised floor** fully installed

**Painting** (dust limiting measure)

**Data Racks 19 inch:**
- 23 with active equipment
- Power provision = 25 Amps max. per rack
- Each rack can generate up to 13,000 BTU

**Air-conditioning considering**
- 780,000 BTU = 240 KVA

**Resulting Power requirements** (fully equipped)
- Generator set (400 KVA) including 500 l fuel tank
- Electrical power installation (400 KVA) including
  - High Tension cabinet
  - Transformer
  - Low Tension cabinet
- 22 UPS units of each 6000 VA (132 KVA)
  - 10 min with full load
  - without additional battery pack

**Earthing** (grounding, bonding)

**Light & emergency light**
Data Racks 19 inch:
- 28 cabinets low density
- 13 cabinets high density
- 6 cabinets with routing and switching equipment & telephony
- 3 cabinets for patching

Cabling
- Backbone fibre optic cabling (estimate: 160 cables)
- Horizontal copper cabling UTP Cat 6A (estimate: 320 cables)

Safety & Security
- Limited and registered access
- Intrusion detection
- Fire detection
- Fire extinguishing Pro-inert gas (keeps equipment intact)

Raised floor fully installed
Painting (dust limiting measure)
Four data centre types for evaluation
Type 3 and 4: Investment estimate: 27,049k€

Data Racks 19 inch:
- 120 cabinets low density
- 60 cabinets high density
- 15 cabinets with routing and switching equipment & telephony
- 5 cabinets for patching

Cabling
- Backbone fibre optic cabling (estimate: 400 cables)
- Horizontal copper cabling UTP Cat 6A (estimate: 800 cables)

Safety & Security
- Limited and registered access
- Intrusion detection
- Fire detection
- Fire extinguishing Pro-inert gas (keeps equipment intact)

Raised floor fully installed
Painting (dust limiting measure)

Data Racks 19 inch:
- 195 with active equipment
- Power provision = 25 Amps max. per rack
- Each rack can generate up to 13,000 BTU

Air-conditioning considering
- 5,200,000 BTU = 1,6 MVA

Resulting Power requirements (fully equipped)
- Generator set (2 MVA) including 2,500 l fuel tank
- Electrical power installation (2,2 MVA) including
  - High Tension cabinet
  - Transformer
  - Low Tension cabinet
- 180 UPS units of each 6000 VA (1 MVA)
  - 10 min with full load
  - without additional battery pack

Earthing (grounding, bonding)
Light & emergency light
**Study Results: Phase 2: Specify Demand Side**

### Four data centre types for evaluation

All figures and prices are taken from actual market data and vendors price lists.

Import duties and other local taxes need to be taken into consideration.

The difference between scenario 3 and 4 is related to the required manning to provide full hosting services. From a capital investment perspective, both scenarios are similar. A slightly larger rental space may be required for scenario 4 to accommodate the additional headcount over scenario 3.

<table>
<thead>
<tr>
<th>Power &amp; Heat</th>
<th>150 m²</th>
<th>300 m²</th>
<th>800 m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Active Racks</td>
<td>23</td>
<td>48</td>
<td>195</td>
</tr>
<tr>
<td>Max. Dissipation [kBTU]</td>
<td>780</td>
<td>1,742</td>
<td>5,200</td>
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<tr>
<td>Avg. Dissipation [kBTU]</td>
<td>334</td>
<td>656</td>
<td>2,830</td>
</tr>
<tr>
<td>Power Consumption [kVA]</td>
<td>130</td>
<td>256</td>
<td>1,085</td>
</tr>
<tr>
<td>Airco [kVA]</td>
<td>240</td>
<td>530</td>
<td>1,600</td>
</tr>
<tr>
<td>UPS [kVA]</td>
<td>132</td>
<td>264</td>
<td>1,000</td>
</tr>
<tr>
<td>Electrical Power [kVA]</td>
<td>400</td>
<td>800</td>
<td>2,200</td>
</tr>
<tr>
<td>Genset [kVA]</td>
<td>400</td>
<td>800</td>
<td>2,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Infrastructre Estimate</th>
<th>150 m²</th>
<th>300 m²</th>
<th>800 m²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>682 k€</td>
<td>1,247 k€</td>
<td>3,138 k€</td>
</tr>
<tr>
<td>Network &amp; Servers</td>
<td>2,794 k€</td>
<td>5,420 k€</td>
<td>23,911 k€</td>
</tr>
<tr>
<td>Total Estimated Value</td>
<td>3,476 k€</td>
<td>6,667 k€</td>
<td>27,049 k€</td>
</tr>
</tbody>
</table>
Study Results

Iceland versus competing locations

- Phase 1: Quantify Iceland as Data Centre Location
- Phase 2: Specify Demand Side
- Phase 3: Benchmark Iceland to Competitors (UK, USA)
- Phase 4: Enhance the Supply where needed
- Phase 5: Detail the Marketing Strategy
Qualitative criteria for the benchmark

Mobile investment projects strive to identify the best acceptable combined cost-quality location in view of the project and its specific requirements.

Based on PwC experience in assessing locations for data centre operations, a list of critical location factors is drafted allowing to compare the offer in Iceland to the situation in the USA and the UK.

To the benchmark of qualitative location factors for the 3 countries, comparable data for India is added allowing for comparison to one of the global hotspots in IT services and IT enabled services where possible.

Though the region in Iceland is constrained to the larger Reykjavik area, no specific selection is made with regards to the benchmark locations. The benchmark however does not neglect the significant differences arising from regional variation in the UK and the USA and takes into account blended data where possible and concentrates on existing data centre location where required.
Qualitative criteria for the benchmark

<table>
<thead>
<tr>
<th>Categories</th>
<th>Weight</th>
<th>Factors</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geo-political environment</td>
<td>15</td>
<td>Political stability</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Financial and economic stability</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ease of setting up a business</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Corporate taxation</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Natural disaster risk</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Environmental awareness</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Time zone</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
<td><strong>Category score</strong></td>
<td><strong>100</strong></td>
</tr>
<tr>
<td>People</td>
<td>20</td>
<td>General availability of IT staff</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td></td>
<td>English language skills</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Labour relations</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ability for foreign nationals to locate/work</td>
<td>25</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
<td><strong>Category score</strong></td>
<td><strong>100</strong></td>
</tr>
<tr>
<td>Technology</td>
<td>35</td>
<td>In country ICT services</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Presence of international telecommunication services</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Availability of hardware and other systems</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reliability of power supply</td>
<td>30</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
<td><strong>Category score</strong></td>
<td><strong>100</strong></td>
</tr>
<tr>
<td>Transport/Infrastructure</td>
<td>20</td>
<td>International air access</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Transport infrastructure in major cities</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Physical security and confidentiality of electronic data</td>
<td>35</td>
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<tr>
<td></td>
<td></td>
<td>Expansion possibilities</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Disaster recovery facilities plan</td>
<td>10</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
<td><strong>Category score</strong></td>
<td><strong>100</strong></td>
</tr>
<tr>
<td>Investment Factors</td>
<td>10</td>
<td>Qualifying data centre space</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Importance of local market</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Contractual guarantees</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Long term business plan and ease of mobility of investments</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Quality and presence of existing facilities</td>
<td>35</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
<td><strong>Category score</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

5 main location categories have been identified out of which the Technology category is the most important one, in followed by People and Transport/Infrastructure at similar level.

In terms of individual location factors, Presence of international telecommunication services, Reliability of power supply, and General availability of IT staff are most importance in terms of location selection for data centre operations.
Qualitative criteria for the benchmark

Based on the selected location factors in this category, **Iceland scores best** when compared to the peer group.

**Except for natural disaster risk**, where the UK scores better, the situation in Iceland result in better or equally good scores on each of the other factors.

Seen the relatively high attributed weights, especially the attractive situation in terms of corporate taxation, natural disaster risk, and environmental awareness are to be noted.
Qualitative criteria for the benchmark

This number on general employment being low to any standard in the comparison, the free availability in the labour market is moreover quoted to be close to non-existing.

The overall good scores for Iceland on the other location factors in the category is apparent. In terms of competitive position, the country however does not benefit from this performance as both the UK and the USA provide for an equally good business environment in this respect.

The low score for Iceland in terms of general availability of IT staff is the single factor to explain the relative position in the People category.

The total number of persons employed in the ICT industry in Iceland is 6,145 based on Statistics Iceland.
Qualitative criteria for the benchmark

The limited number of international links was identified to be the limiting factor for good performance of Iceland in the international competitive game for data centre operations. The new Farice cable will clearly take away stress in this respect. Yet in the overall benchmark to the UK and the USA, the connectivity of Iceland remains fragile.

The overall performance of Iceland with respect to the Technology location factor is **good**, though when compared to the USA and the UK, the country’s **offer is less compelling for** mobile investment projects dependent upon **international telecommunication services**.
Qualitative criteria for the benchmark

Compared to the USA and the UK, only the score on disaster recovery facilities plan is lower.

Based on international and domestic transport infrastructure, the situation in terms of physical security and confidentiality of electronic data, possibilities to expand data centre operations over time and the existence of disaster recovery facilities plan, **Iceland’s score is close to the Western benchmark locations.**
Qualitative criteria for the benchmark

In case of withdrawal decision of service or investment.

The existing data centre operations in Iceland are well functioning, though small to international standard. More importantly, there is no identified need for larger operations based on local demand and as a consequence, limited qualifying free data centre space is identified. Regulatory as well as business commitment is recognized to be supportive.

This location category covers a number of enabling factors in terms of existence of qualifying physical-technical space, in terms of market and proof of concept and equally so the perceived strength of commitment of these enabling factors over the longer run. Finally the category assesses the ease of mobility of investments.
Study Results: Phase 3: Benchmark Iceland to Competitors

Qualitative criteria for the benchmark

Overall Quality Score

- Geo-political environment
- People
- Technology
- Transport/Infrastructure
- Investment Factors

Iceland: 7.6
USA: 8.3
UK: 8.1
India: 5.7
Cost components for the benchmark

PwC have analysed the operational costs and market data within Iceland, UK and the USA for the following:
- HR for standard IT grades and positions,
- Power per kWh
- Data centre co-location rental (cost to rent a space within the data centre per rack)
- Infrastructure and building construction

In addition we have added a comparison of the current cost of locating services to India for all of the above factors.

This shows areas where competition would not be viable against costs, but there are major advantages over India in the field of security and data protection agreements.

The differences in the aggregated cost for the above named cost components will need to be complemented with the cost for telecommunications. The analysis as such identifies the cost bracket for this utility.
Cost components for the benchmark

The **four scenarios differ in terms of required HR:**

- **The smallest centre (scenario 1)** employs no more than 7 persons and
- **The largest centre in the most labour intensive variant (scenario 4 - Large size full hosting centre)** is based on a total workforce of 24 full time equivalents (FTE)

1) **Captive (single company) centre up to 150m²**
   - 3 Operators rotating shifts max 12 hours per day
   - 2 Back office (1 ops manager, 1 senior analyst)
   - 1 Data centre manager
   - 1 Administrator

2) **Medium size centre – 300m²**
   - 5 Operators rotating shifts
   - Back office (2 ops managers, 2 seniors analysts, 1 support Desk)
   - 1 Data centre manager
   - 1 Senior business manager
   - 2 Administrators

3) **Large hosting only centre- 800m²**
   - 5 Operators rotating shifts
   - Back office (2 ops managers, 2 seniors engineers/analysts, 2 support desk)
   - 1 Data centre manager
   - 1 Senior business manager
   - 2 Administrators (one senior performing HR functions)

4) **Large size full hosting centre – 800m²**
   - 6 Operators rotating shifts
   - Back office (2 ops managers, 3 seniors engineers/analysts, 3 junior engineer/analysts, 3 support desk agents)
   - 2 Data centre managers
   - 1 Senior business manager
   - 1 Marketing
   - 1 HR
   - 4 Facilities and building support staff
   - 2 Administrators
Cost components for the benchmark

Based on
- total annual cash remuneration data from Watson Wyatt for the individual profiles in the USA, the UK and India,
- Findings from the 2006 annual salary survey by the Commercial Workers' Union of Reykjavik for profiles in Iceland
- Applicable add-on costs for social security contributions in the different countries
the total cost to company is calculated in each of the locations.

<table>
<thead>
<tr>
<th>Total annual cost to company of data centre workforce</th>
<th>Iceland</th>
<th>USA</th>
<th>UK</th>
<th>India</th>
</tr>
</thead>
<tbody>
<tr>
<td>All data in €</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data centre type 1</td>
<td>451,584</td>
<td>353,251</td>
<td>370,107</td>
<td>80,689</td>
</tr>
<tr>
<td>Data centre type 2</td>
<td>894,921</td>
<td>655,030</td>
<td>701,270</td>
<td>150,820</td>
</tr>
<tr>
<td>Data centre type 3</td>
<td>971,335</td>
<td>693,582</td>
<td>740,483</td>
<td>156,743</td>
</tr>
<tr>
<td>Data centre type 4</td>
<td>1,528,620</td>
<td>1,096,583</td>
<td>1,159,789</td>
<td>240,842</td>
</tr>
</tbody>
</table>
Cost components for the benchmark

Power consumption is based on applicable tariffs for industrial use and consumption patterns for low density racks.

Electrical power is sold in units of energy called kilowatt-hours (kW-hr), which is the amount of energy delivered in one hour at a power level of 1,000 Watts (1 kW). The distinction between power and energy is very important for the economic analysis. Power capacity costs are those associated with the systems that deliver energy and increase with the design power level of the system.

Tariffs for Green Power are used where available and feasible. With details from the US National Renewable Energy Laboratory (NREL) Technical Report we have seen, accurate prices for environmentally friendly options are not easily obtained in the USA. There are multiple companies offering Green Power but distribution is limited, and in the case of outages backup supplies are fed from standard sources.

Often data centre rack rentals include a limited power consumption. Overuse is then charged, for instance at around £160 (≈ 235€) per month per amp in London.

Taking into account specifics on power consumption in the benchmark locations, the study has produced the following comparative price for 24x7 usage during 30 operational days per low density rack:

- Iceland = € 62.40
- UK = €194.45
- USA = €118.43
- India = €158.00
Cost components for the benchmark

The total annual power cost in the benchmark locations per scenario hence corresponds to:

<table>
<thead>
<tr>
<th>Total annual power cost</th>
<th>Iceland</th>
<th>USA</th>
<th>UK</th>
<th>India</th>
</tr>
</thead>
<tbody>
<tr>
<td>All data in €</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data centre type 1</td>
<td>112,320</td>
<td>213,174</td>
<td>350,010</td>
<td>234,400</td>
</tr>
<tr>
<td>Data centre type 2</td>
<td>224,640</td>
<td>426,348</td>
<td>700,020</td>
<td>568,800</td>
</tr>
<tr>
<td>Data centre type 3</td>
<td>599,040</td>
<td>1,136,928</td>
<td>1,866,720</td>
<td>1,516,800</td>
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<tr>
<td>Data centre type 4</td>
<td>599,040</td>
<td>1,136,928</td>
<td>1,866,720</td>
<td>1,516,800</td>
</tr>
</tbody>
</table>
Cost components for the benchmark

In the UK, London being the main area of business and the seat of government, a lot of major companies have their own or manage data centre locations within the M25 motorway (London ring road). Rental prices in this area are between £800 (1,175€) and £1000 (1,470€) per rack per month.

Even the cheaper environments in the north of the country only reduce the rental to between £400 (590€) and £600 (880€) per rack (equivalent to 1m²) per month.

In order to come to realistic comparison, taking into account changes in the data centre industry in eg the UK and based on input from actual users in each in Iceland, the USA and the UK, per month per m² rental cost have nevertheless been calculated to be:

- Iceland = €210
- UK = €380
- USA = €329
- India = €360

Based on the different scenarios, these rental charges translate into the below total annual rental cost by type:

<table>
<thead>
<tr>
<th>Data centre type</th>
<th>Iceland</th>
<th>USA</th>
<th>UK</th>
<th>India</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>378,000</td>
<td>592,200</td>
<td>684,000</td>
<td>648,000</td>
</tr>
<tr>
<td>2</td>
<td>756,000</td>
<td>1,184,400</td>
<td>1,368,000</td>
<td>1,296,000</td>
</tr>
<tr>
<td>3</td>
<td>2,016,000</td>
<td>3,158,400</td>
<td>3,648,000</td>
<td>3,456,000</td>
</tr>
<tr>
<td>4</td>
<td>2,016,000</td>
<td>3,158,400</td>
<td>3,648,000</td>
<td>3,456,000</td>
</tr>
</tbody>
</table>
Cost components for the benchmark

The estimated value of equipment and infrastructure is provided in the introduction session of the 4 scenarios.

The total cost on infrastructure is estimated
- at 682k€ for scenario 1
- at 1,247k€ for scenario 2
- at 3,138k€ for scenario 3 and 4

Detailed assessment of the components shows that in a going concern, on average, each year 20% of this total would be recurring cost.

The network and servers value is significantly higher:
- 2,794k€ for scenario 1
- 5,420k€ for scenario 2
- 23,910k€ for scenario 3 and 4

These components, in going concern, see replacement every 3 years.

Spread out over the years, the total annual cost for this components totals as depicted in the below table.

<table>
<thead>
<tr>
<th>Total annual cost to infrastructure, network, and servers</th>
<th>Iceland</th>
<th>USA</th>
<th>UK</th>
<th>India</th>
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<tbody>
<tr>
<td>All data in €</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Data centre type 1</td>
<td>1,067,788</td>
<td>1,067,788</td>
<td>1,067,788</td>
<td>1,067,788</td>
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<tr>
<td>Data centre type 2</td>
<td>2,056,084</td>
<td>2,056,084</td>
<td>2,056,084</td>
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<tr>
<td>Data centre type 3</td>
<td>8,597,790</td>
<td>8,597,790</td>
<td>8,597,790</td>
<td>8,597,790</td>
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<tr>
<td>Data centre type 4</td>
<td>8,597,790</td>
<td>8,597,790</td>
<td>8,597,790</td>
<td>8,597,790</td>
</tr>
</tbody>
</table>
Cost components for the benchmark

The combination of the 4 detailed cost components results in a favourable position for Iceland, especially thanks to the power and rental cost.

The cost difference between Iceland and a UK or USA location is biggest in scenarios 1 and 2 and smallest in scenario 4.
The combination of the quality scores of the 4 locations and the most conservative input from scenario 4 allow for a cost – quality comparison:
Study Results

Guidance and Planning

Phase 1
Quantify Iceland as Data Centre Location

Phase 2
Specify Demand Side

Phase 3
Benchmark Iceland to Competitors (UK, USA)

Phase 4
Enhance the Supply where needed

Phase 5
Detail the Marketing Strategy
Study Results: Phase 4: Enhance the Supply where Needed

SWOT

Strengths

• **ICT focus**
  - High ICT diffusion and quality
  - ICT clustering
  - Private and government commitment

• **Reliability power supply**
  - World number 1 in energy supply

• **Low rental and facility management cost**
  - Current data centres are housed in low occupancy cost buildings

Opportunities

• **Green power**
  - Marketing instrument with high future potential along growing environmental awareness

• **Natural cooling**
  - Cost and effort saving in design

• **New location concept**
  - International undiscovered territory
  - Enabling opportunities for strong image/profile building

Weaknesses

• **Limited ICT workforce base**
  - Small demographic community
  - Low unemployment rate
  - However highly skilled and qualitative education

• **Proof of concept**
  - Absence of reasonable scale data centres and international providers

• **International connectivity**
  - Risk factor in contingency plan data centre operators
  - Latency issues for North American market

• **Perception on natural disaster risk**
  - Negative influence on data centres location attractiveness

Threats

• **Competition from emerging countries with low operational costs**
Strengths

**ICT focus**
By almost any international comparative assessment focussing on IT competitiveness of the society and the IT use of the population, Iceland scores best in class. The familiarity of Iceland with IT technologies and the common and applied use, should be exploited to the country’s benefit as an area of opportunity.

**Reliability power supply**
See statement Green power.

**Low rental and facility management cost**
Another area of growing concern is disaster recovery, with data centre location costs rising, having a large facility with mostly redundant systems is an expensive item to any business. By ensuring rental and facility management costs in Iceland are low for specific business areas such as disaster recovery, backup facilities and development hardware, this becomes attractive for many types of customers.
Weaknesses

**Limited ICT workforce base**
Although of high quality and modern standard in their IT capabilities, the overall workforce is small in absolute numbers and completely utilized.

**Proof of concept**
As of yet Iceland has an unproven ability to deliver international data centre services. Current services available are small scale and catering to the domestic market players, therefore the country lacks proof of ability to ramp up the services to volumes and capacities as required by large multinationals. Moreover, the domestic nature of the traffic and data volumes has not stressed the international connectivity issue in terms of pricing and latency.

**International connectivity**
The major point of concern is connectivity and the speeds available. With all USA traffic currently routing via the UK, it will put off many companies that don’t want to suffer loss of speed. If required the recommendation would be to invest in a new high speed direct link to the US or Canada.

**Perception on natural disaster risk**
Iceland suffers no more natural disasters than other countries located in a fault zone. Nevertheless the country is often associated with volcanoes and ice flows.
For any location to be retained as final destination during an international site selection exercise, the importance is equally in making it to the long list as it is in surviving the different deselection steps. The perception of being a high risk location in terms of natural disasters may well discount Iceland at the early start of the process.
Using publicly available data, it is very easy to show Iceland as a secure environment in this context too. The need to broadcast these findings in specialist magazines and during industry specialized seminars will be key to success.
Opportunities

Green power
When we look at the advantage of reliable and low cost energy within Iceland, this element clearly stands out as a large benefit. The predictions by industry analyst Gartner clearly capture the trends as described and allows understanding the strong position of the country in this respect: “By 2008, 50% of current data centres will have insufficient power and cooling capacity to meet the demands of high-density equipment.”

Iceland provides a clear and attractive offer to the question where the power and cooling issue can be managed at attractive cost and without operational impacts in terms of growth and stability.

The greenfield approach that is possible in this respect allow deploying design principles, power and cooling technologies, management systems, and processor innovations to address this power problem in the short and long term and at the same time provides for an environment without penalties on the capital costs for designing and building a centre that will be scalable over time to meet the power and cooling challenge.
Opportunities

Natural cooling
With new liquid cooling systems, within the rack, A/C low and high speed fans to manage hot and cold aisles, more and more thought and professional resources are required when planning, building or re designing a data centre.

Advances in UPS and rack designs have allowed for greater use of space, more efficient cooling and lower power consumption.

With new processors and hard drives appearing on a regular basis the manufacturers would have us believe that power consumption is falling fast and so cost should also follow. Unfortunately, the internal fans, and other devices that go to make up a server remain the same and so consume as much power as always. Add to this the greater heat density more specialized racks are required and of course the cost of these in some cases is double from a standard.

With Iceland having plentiful supplies of low cost green power, cold air/water as well as hot water, the benefits to large data centre operators would soon pay back.

The opportunity to use natural cooling in Iceland is of high value to these operators.

In Euro terms, the cost saving can be as high as 300,000€ for normal density racks and an 800m² operation, and even go up to more than double in case of extreme high density.

The ability to reduce the power cost on cooling should best be demonstrated in a sensitivity analysis as the ability to introduce this element may be questioned by some operators. Nevertheless this option is a clear add-on to the attractively priced and plentiful availability of power as it lowers the total consumption, takes away the risk of meeting the maximum capacity later in time and allows for even further green image building.
### Study Results: Phase 4: Enhance the Supply where Needed

**Opportunities**

#### Calculation based on kW/Rack information

<table>
<thead>
<tr>
<th>Data centre size in square meters</th>
<th>800</th>
<th>300</th>
<th>150</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Power per rack (kW/Rack)</td>
<td>5.45</td>
<td>5.06</td>
<td>7.45</td>
</tr>
<tr>
<td>Total number of Racks</td>
<td>392</td>
<td>134</td>
<td>62</td>
</tr>
</tbody>
</table>

#### High Efficiency UPS system

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</thead>
<tbody>
<tr>
<td>Total Input Power required with high efficiency UPS (kW)</td>
<td>3,945</td>
<td>1,300</td>
<td>948</td>
</tr>
</tbody>
</table>

*Note: Power required for cooling is calculated as 40% of total electrical power. (Data center and UPS)*

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</tr>
</thead>
<tbody>
<tr>
<td>Electrical Power without cooling (kW)</td>
<td>2,986</td>
<td>995</td>
<td>742</td>
</tr>
<tr>
<td>Electrical Power for cooling (kW)</td>
<td>959</td>
<td>304</td>
<td>205</td>
</tr>
<tr>
<td>Chilled water capacity at chilled water supply</td>
<td>2,986</td>
<td>995</td>
<td>742</td>
</tr>
</tbody>
</table>

#### Traditional normal efficiency UPS

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</tr>
</thead>
<tbody>
<tr>
<td>Total Input Power required with traditional UPS (kW)</td>
<td>4,150</td>
<td>1,365</td>
<td>992</td>
</tr>
<tr>
<td>Electrical Power without cooling (kW)</td>
<td>3,133</td>
<td>1,042</td>
<td>774</td>
</tr>
<tr>
<td>Electrical Power for cooling (kW)</td>
<td>1,017</td>
<td>323</td>
<td>218</td>
</tr>
<tr>
<td>Chilled water capacity kW at chilled water supply</td>
<td>4,150</td>
<td>1,365</td>
<td>992</td>
</tr>
</tbody>
</table>

#### Added value for Green solutions (4.5 ISK/kWh - 0.051 €/kWh)

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</thead>
<tbody>
<tr>
<td>Savings per year on Energy cost by the use of high efficiency UPS ISK</td>
<td>8,175,412</td>
<td>2,591,375</td>
<td>1,753,384</td>
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<tr>
<td>Savings per year on Energy cost by the use of free cooling ISK</td>
<td>27,019,753</td>
<td>8,579,297</td>
<td>5,788,059</td>
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<tr>
<td>Savings per year on Energy cost by the use of high efficiency UPS Euro</td>
<td>92,546</td>
<td>29,335</td>
<td>18,848</td>
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<tr>
<td>Savings per year on Energy cost by the use of free cooling UPS Euro</td>
<td>305,866</td>
<td>97,118</td>
<td>65,521</td>
</tr>
</tbody>
</table>
Opportunities

New location concept
Large IT companies who want to further develop their service offering into the field of data centre management and storage, will be attracted by Iceland as the location allows them to offer a new location concept, attracting new business and enhancing their image by building on cost attractive, green supplies.

In the search for cost attractive locations catering to the power intensive industries, Iceland is the single country in the world that provides best in class business environment conditions in combination with attractively priced green power supply. To be amongst the first data centre operators to use this unique offer, would enhance the product positioning of these operators. During times of rising costs, environmental concerns and increasing pullback from offshoring to emerging countries, Iceland can position itself as a viable alternative.

Keflavik Airport facilities
With the existing infrastructure available in Keflavik Airport, a superb opportunity exists for readily available back-up power, UPS housing, and highly secure archive facility. This would enable large cost savings with the construction of a new purpose built facility. The value of this opportunity should be advanced in terms of marketing and product positioning.
Competing from emerging countries with low operational costs
Increasingly data centre capacity is coming online in countries such as India and China, more often provided by local rather than international service providers.

Data centre customers often mistake the low cost, emerging market prices for IT development and IT enabled services in these countries for similar price structures for data centre activities. Where the former group is talent based, data centre operations however are infrastructure and capital goods intensive and dependent upon external service providers, ie utility companies.

Experience shows, for these customers often not to have a complete or correct picture of the total cost structure in these emerging markets. The questions remains open whether this ambiguity is created on purpose or is related to shortcomings in these markets in terms of power supply and reliability, connectivity and other utility services.

The ability to do a direct comparison between Iceland and for instance India turned out to be virtually impossible due to the multiple structures in these emerging market pricing arrangements.

However, despite the fact that customers are already pulling back from these emerging markets, many are still seeking the services and so these merging countries dispose a potential risk to Iceland based service providers in terms of winning business.
Recommendations

Though the theoretical assessment indicates a high potential market, Iceland is in a position of weakness because there are no single large operational data centres and hence no proof of operational feasibility and readiness.

Potential solutions to overcome this weakness are in building such capacity to showcase the ability and feasibility.

As there is no added value in building data centre space of similar size and likes of the existing infrastructure, a larger scale development would be required, speculating for future growth.

Ideally the concept should be based on a campus like environment or a multi-layer building consolidating local data centres, including for the main current domestic users.

Subsequently the infrastructure and availability should be subject to an audit for publication, next to release of latency figures for new international connectivity to both the USA and Europe.

Provided the project partners opt for a hosting scenario, they should then address local data centre companies and the Icelandic Government in terms of client portfolio expansion, and only then look at smaller international data centre service providers.

This phased growth path is required as a big bang approach is unlikely to succeed in Iceland because of the lack of legacy.

Having said this, if a large player such as Convansys or CTC would effectively be interested in running an operation in a newly constructed data centre, a fast track could be possible because these international operators bring experience, client base and expertise, and potentially even staff.
Recommendations

To enable meeting the requirements of large operators, the building of a campus in a dedicated area is recommended. This should consist of buildings of 5,000m² or more.

Data centre operators are highly interested in locating data services in scalable and cost attractive locations, in order to meet their future expansion and reduce IT budgets. A phased campus development meets these conditions.

Independently of the exact timing for laying the new Eurice cable, the campus or data centre location can and should be prepared as this enables services to be up and running much faster and shows commitment.

The decision on when the site preparation should start is not only important in terms of creating the image of operational readiness, but is also influential to the desired start of operations for potential customers.

While corporations may be attracted by existing, speculatively built space, they might equally want to impose their own construction architects and design. Established operators may even wish to manage the construction process themselves.

Therefore, a safe recommendation is to make available basic ground infrastructure (road, WAN end points, power substation and hot & cold water supply) up to the border of the selected campus site.

Moreover, governmental legislation, immigration and permits should be aligned with the initiative and should not block the development once started. The situation in Iceland however seems supportive and welcoming in this respect.
Address investor issues

There is a clearly identified need to dispel the myths:
- Seismological activity
- Volcanic activity
- Latency problems

The first and most important element of a successful marketing strategy to attract data centre operations to Iceland, is to raise awareness of the suitability of the location and the benefits that can be gained. Ideally these strengths are put in comparison to the concerns of data centre owners as covered in Phase 2.

Most suitable platforms in this respect are:
- IT industry publications
- Web forums
- IT as well as business related seminars and events

The potential benefits of operating in Iceland should be clearly demonstrated first to the business leaders as they drive the organisation’s need to reduce costs.

Presented with a potential solution in Iceland, these business leaders would in turn pass on the responsibility to their direct reports for gaining a detailed assessment. This crucial step for handing over of intelligence on Iceland is not controlled by any of the partners in Iceland. Therefore, Iceland should not only follow up with the leaders themselves, but should organise for proactive investigation, direct communication, and targeted information exchange with those empowered with the research.

A fact based data book with comparative information will be imperative at this stage. The key objective should be to put forward one face. There is a clear need to avoid multiple marketing strategies by various potential providers in Iceland at this conjunction. In other words the partners involved in the process should sell Iceland as a preferred location. Within the fact book, should be a list of service offerings from all partners.

It is a must to avoid internal competition in a market with high degree of external competition.
Address investor issues

The geographic search area should not be limited, and should include companies anywhere in Europe and the USA that are lured by the identified attractions of Iceland as a data centre location.

Active marketing should be directed at current operators and users in the mayor business centres of Europe and the USA. The chances of relocating main data centre of such companies to Iceland is limited. However, as a significant number of them are blocked from expansion and plagued by rising costs in their existing back-up and disaster recovery data facilities, this group should be actively approached.

Financial institutions do not wish long delays in processing times and so latency issues would only position Iceland for archive services in financial markets. Using this information, the marketing strategy should be focussed towards the this type of facility and address the potential in relocating to Iceland.

With provision of an Iceland-USA link, latency would be reduced and services enabled for an increase of business markets, including certain financial and other real time activities. As a result, a more generic marketing strategy would be possible.

Another advantage would be an expanded range of data centre operations and services from an Iceland based provider.

As some customers wish to have several carriers while others tie themselves to individual suppliers, the increased capacity in international connectivity would attract more carriers which in turn would attract more customers. A tailored marketing effort towards these carriers will be required, along with early publication showing firm intentions to put in the Iceland-USA cable.
Conclusions
Appendixes
## List of sources

<table>
<thead>
<tr>
<th>Company</th>
<th>Contact</th>
<th>Input</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual Internet – VI UK</td>
<td>Peter Rees</td>
<td>Overview of the data centre scene in the UK</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pricing information</td>
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<tr>
<td></td>
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<td>General concerns and trends</td>
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<tr>
<td>HP Belgium</td>
<td>Geert Kuijken</td>
<td>Overview on rack cooling</td>
</tr>
<tr>
<td></td>
<td></td>
<td>New server technologies</td>
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<td></td>
<td>Advances in processes</td>
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<tr>
<td>LCL Belgium</td>
<td>Christian Creemers</td>
<td>Data centre expertise</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vision on future requirements in cooling and power</td>
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<td>Google USA</td>
<td>Public relations</td>
<td>Goals on IT environment</td>
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<td>Future vision on data centre set-up</td>
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<td>Integrated Network Solutions</td>
<td>Luc Standaert</td>
<td>On-site survey</td>
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<tr>
<td>Belgium</td>
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<td>Data centre infrastructure pricing information</td>
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## Appendix 1

### List of sources

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<tr>
<th>Company</th>
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</thead>
<tbody>
<tr>
<td>Covansys USA &amp; India</td>
<td>Sunil Varghese</td>
<td>Strategic options related to data centre Build – Operate – Transfer model</td>
</tr>
<tr>
<td>APC (American Power Conversion) Benelux</td>
<td>Jack Hack</td>
<td>Energy pricing, Power consumption and requirements, Cooling requirements, Data centre design strategies</td>
</tr>
</tbody>
</table>
Appendix 2
List of main reference documentation

Organisation
Gartner
Cisco System
AMD
US Department of Energy
UK Department of the Environment
McKinsey
European Union Library
Stanford University
Contacts

PricewaterhouseCoopers Enterprise Advisory
Woluwe Garden
Woluwedal 18
B-1932 Sint-Stevens-Woluwe
Belgium

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