CAPTURING THE DATA CENTER OPPORTUNITY

HOW SWEDEN CAN BECOME A GLOBAL FRONT-RUNNER IN DIGITAL INFRASTRUCTURE
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CAPTURING THE DATA CENTER OPPORTUNITY

HOW SWEDEN CAN BECOME A GLOBAL FRONT-RUNNER IN DIGITAL INFRASTRUCTURE

ARVID WARRENSTEIN
FREDRIK LIND
OLOF SUNDSTRÖM
STEFAN A. DEUTSCHER
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**EXECUTIVE SUMMARY**

This report outlines the economic potential of digital infrastructure in general and that of data centers in particular. The report also describes how the data center industry could become a key component of Sweden’s economy over the coming decade. The contribution of the report is twofold: Firstly, it maps the industry landscape today and estimates the value of the data center opportunity to Sweden, in a full-potential scenario. Secondly, the report describes a set of key factors that should be fulfilled in order to attract digital infrastructure investments and recommends actions for Sweden to take in order to capture the potential of the data center industry.

The importance of digitization to the economic growth and prosperity of nations and regions is becoming increasingly clear. This is no less true for Sweden, which has a strong history of digitally enabled economic development. However, Sweden’s current and expected future trajectory when it comes to enabling digitization—and growing the data center industry—shows that Sweden is being challenged by other European nations.

- Already, digitization is a key driver of the Swedish economy. The size of the Internet’s share of the economy—the e-GDP—amounted to 8.4% of total Swedish GDP in 2015, and the future growth of e-GDP is expected to be more than four times the average GDP growth.

- Going forward, increased digitization will contribute value to all parts of society: business (for example, by facilitating Industry 4.0, the Internet of Things, and cloud computing), government (by enabling e-government), and individuals (by providing ubiquitous access to content).

- Sweden has historically had an exceptionally strong position in information and communications technology. To a large extent, this strong position has been supported by public and private investments in the underlying infrastructure—investments in
telecom networks in the 1980s and beyond, as well as large-scale rollouts of fiber broadband during the past two decades.

- However, when it comes to supporting the digital infrastructure, Sweden has seen a declining engagement. Investments as a share of e-GDP have shrunk from 40% in 2010 to 26% in 2015 and are projected to retract further to 20% in 2020. Going forward, Sweden needs to work to attract and enable investments in digital infrastructure, both domestically and from abroad.

- As for attracting one of the key components of the digital infrastructure, data centers, Sweden has a great starting point owing to strong connectivity, a cold climate, and reliable sources of renewable energy. Nevertheless, recent years have seen multiple countries inside and outside Europe take action in order to increase their attractiveness, while Sweden has moved at a slower pace.

Today’s data-center industry is already of significant value to Sweden, and owing to the nature of data center construction and operations, the industry is a source of noteworthy revenues to some of Sweden’s traditional primary industries (including construction and renewable energy). The total economic impact from the data center industry amounted to SEK 13 billion in 2015.

- In 2014, Sweden had an installed base of approximately 135 to 155 purpose-built data centers with a capacity of more than 300 kilowatts each. In 2015, the industry contributed an estimated SEK 2.8 billion in direct economic impact from the construction of new centers and SEK 3.4 billion from the operation of existing centers. An additional SEK 6.6 billion was created in the form of indirect and induced impact.

- In terms of employment impact, in 2015 the industry is estimated to have employed 2,100 full-time equivalent (FTE) staff within operations and 1,600 FTEs from construction. Additionally, employment opportunities amounting to 3,200 FTEs were created from induced and indirect impact of operations and construction combined.

In the full-potential scenario—where Sweden significantly expands its efforts targeted at enhancing digital infrastructure and creates an optimal environment for the data center industry, with a particular focus on global Internet companies and location-agnostic third-party providers—it is estimated that the total opportunity in 2025 could amount to approximately SEK 50 billion on a yearly basis, on the back of 14% average annual growth from 2015 onward.

- The direct impact of SEK 25 billion (slightly more than SEK 12 billion each from operations and construction) would represent 0.45% of GDP, which can be compared with today’s steel and metalworks industry (0.67% of GDP). In addition, about SEK 25 billion in indirect and induced impact will follow. The yearly contribution to the nation’s employment in this scenario is estimated at 27,000 jobs in total.
• In addition to the pure monetary and employment impacts, the establishment of a data center industry of this size in Sweden would bring with it multiple positive spin-off effects. These primarily include rejuvenating rural areas, as well as contributing to global multinational corporations clustering in Sweden with several associated benefits, including competence building, innovation, and export potential.

In order for Sweden to capture this opportunity, the country must increase its attractiveness for data center deployments. We recommend initiatives in four areas to achieve this.

• Ensure reliable and sustainable energy that is competitively priced.

• Treat digital infrastructure as a vital component of modern society.

• Vocalize the value proposition and the ambition to become a leader.

• Increase predictability in planning, permitting, and risk assessment.
As the digital era progresses, it is becoming increasingly clear just how important digitization will be to the future prosperity of industrialized nations such as Sweden. And while Sweden has long enjoyed a prominent position among the world’s most digitized nations, there are some indications that the country’s progress in this area is faltering. A key driver of digitization is digital infrastructure, and we see an opportunity for Sweden to fuel future digitization by attracting investments in digital infrastructure in general and data centers in particular.

The Digitization Imperative

Today, digitization is a vital driver of growth for the economy. In 2015, the Internet’s share of Sweden’s economy—the e-GDP—amounted to 8.4% of total GDP and was growing at more than 8% per year, which is more than four times higher than the overall GDP growth of 1.8% per year.1 (See Exhibit 1.) Moreover, a high level of digitization is now a key competitive advantage in many industries, and the digitization of society is becoming essential in order to ensure the competitiveness of the nation’s enterprises. (Small and midsize enterprises [SMEs] in the top quartile by level of digitization grew 150% faster than SMEs in the bottom quartile.2) As a result, recent government initiatives for innovation and productivity (for example, Industry 4.0) have embraced digital technology as a cornerstone.

Historically, Sweden has been in the forefront in the digitization race and has long been considered one of the world’s most prominent nations in information and communications technology (ICT). Indeed, in 2015, Sweden was number seven in the annual BCG e-Intensity Index, which measures the penetration of Internet technology in society. Sweden also does well across most other recognized indexes of digitization and IT preparedness, such as the World Economic Forum’s Networked Readiness Index.3

However, when it comes to the digital infrastructure that forms the backbone of Sweden’s successes, there is a notion that the country is living on old merits. By deprioritizing this area, Sweden risks its position as a future digital front-runner.

And the stakes are high. Should Sweden manage to claim a prominent position in global digitization going forward, the economic development potential is substantial. The Boston Consulting Group’s research suggests that if Sweden fully embraces emerging digital technologies (including fully enabling the sharing economy and Industry 4.0), the country’s GDP growth over the coming ten years may increase by more than 40%, placing Sweden among the fastest-growing economies in the world.4 (See Digitizing Europe: Why Northern European Front-runners Have to Drive Digitization of the EU Economy, BCG report, May 2016).
Infrastructure Will Drive Digitization

Sweden’s strong position in ICT has traditionally been supported by large investments in the underlying infrastructure. Sweden was among the first nations to realize the critical importance of telecom networks to ICT development, and relatively early deregulation of the telecom industry was accompanied by large investments from both the private sector and the government (primarily through Televerket/Telia). This led to, among other things, Sweden having the first fully automatic mobile network in 1981 and the first 4G network in 2009. Sweden’s government together with the private sector have also been exceptionally active in promoting and funding the rollout of broadband and fiber, especially in rural areas, leading to one of the world’s highest broadband-penetration rates.

However, in recent years, investments have been contributing surprisingly little to the digitization of Sweden. In fact, the future growth of the Internet economy is projected to be driven almost entirely by consumers. (See Exhibit 2.) Government spending is becoming a small and stagnant part of Swedish e-GDP, and private investment is growing at just above overall GDP growth (from a small base). Looking ahead, this increasing reliance on consumer spending to drive the Internet economy may well lead to Sweden falling behind in ICT development. In Digitizing Europe: Why Northern European Front-runners Have to Drive Digitization of the EU Economy, we highlighted the fact that if Sweden continues on its current trajectory, by 2020 the country will drop down to twelfth place in the BCG e-Intensity Index (from first place in 2009 and seventh place in 2015), outpaced by better performers such as the Netherlands, China, and Taiwan. Taking a closer look, it becomes clear that the subindex government engagement (measuring the government’s role in actively promoting digitization) has been contributing less and less to Sweden’s overall score since 2012, especially compared with top performers, such as those mentioned above. (See Exhibit 3.)

In order to secure the country’s future as a digital front-runner, Sweden needs to attract, and create conditions for, further investments in digital infrastructure. And although Sweden has always been active in supporting the rollout of broadband and fiber, another key part of the digital infrastructure has historically received less attention from decision makers: data centers.
The Hardware Underpinning the Digital Age

Digital infrastructure is the hardware (for example, servers, fiber-optic cables, and routers) and software (programs that interpret signals and automate the infrastructure) that support the networking, computing, and storage that enable the delivery of Internet services.

In essence, the Internet consists of a global network of cables that connects servers hosting content (for example, a Web page or a music file) to user devices that present the content. On a small scale, a server may be a computer in a closet, but businesses such as Microsoft and Google will have hundreds of thousands of dedicated servers. Data centers are specialized facilities where large numbers of these servers are stored in racks, with redundant connections to electricity grids and Internet service providers (ISPs).

A typical connection between a consumer and a data center has multiple layers. (See Exhibit 4.) A user is connected to a router,
which is connected by a cable to the ISP network. In this case, the ISP is a tier-two provider, and as such, it is in turn connected to a tier-one provider, which owns part of the Internet backbone (the bundles of fiber-optic cables that connect the parts of the world together).

The term data center is broad and may encompass everything from ten servers in a modified office, outfitted with cooling and connectivity, to a purpose-built facility with more than 100,000 servers. Two main categorizations of the data center landscape are relevant:

- **Data Center Capacity.** Capacity is usually measured in megawatts, although other common metrics include square meters, number of racks, and number of servers.

- **Data Center Owner or Operator.** The main owners and operators of data centers are primarily enterprises (such as Ericsson, Volvo, and KnCMiner), third-party providers (such as Telia Carrier, IP-Only, NTT Group, Equinix, IBM, Level 3 Communications, and Rackspace), and global Internet companies (such as Google, Facebook, Amazon.com, Microsoft, and Apple).6

These categorizations are interdependent, with the largest data centers typically being owned by global Internet companies and the smallest data centers being owned by SMEs. (See Exhibit 5.)

### Data Center Location-Selection Parameters

How is Sweden positioned for attracting data center businesses? There are many factors for a company to consider when deciding on a location for a data center, and these factors may differ depending on the type of owner and application. Sweden does well across the majority of parameters owing to intrinsic characteristics, such as stable access to renewable energy, superior connectivity, and a cold climate. However, there is room for improvement.

When considering where to locate a new data center, a company may consider four overarching categories of factors:

- **Cost.** The top countries for data center deployment often meet all of the technical needs of the operator, and these countries may indeed end up competing on cost. Since electricity makes up the lion’s share of total operating cost, the price per kilowatt is often cited as one of the main factors overall. Other important cost items include corporate tax and labor costs.

- **Connectivity.** Depending on the type of customers targeted, data centers may have various tolerances for latency. Latency is affected as much by a country’s proximity to key markets as its fiber infrastructure.

- **Time to Market.** Data centers are the infrastructure behind the rapidly evolving

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**EXHIBIT 4 | The Typical User Is Connected to a Data Center Through Multiple Layers of Networks**

Source: BCG analysis.
Note: Illustrative connection; details may differ.
digital economy. As such, six months squandered applying for permits may mean a significant financial loss.

- **Risk.** Data centers are built to be in service for periods ranging from 20 to 30 years. Operators have to ensure that there is minimal risk of downtime, a cost increase, or both during this time period.

**BCG’s Data Center Qualification Index.** The Data Center Qualification Index ranks countries on the basis of twelve quantifiable factors that affect the choice of data center location (each factor slotting into one of the overarching categories mentioned above). In BCG’s Data Center Qualification Index, Sweden placed sixth, compared with third place in the 2013 Cushman & Wakefield Data Center Risk Index report. (See Exhibit 6.) However, Sweden is shown in fourth place on the basis of imminent tax reforms, which are discussed below.

In the index, factors are weighted on the basis of their importance—energy cost, international bandwidth, and ease of doing business have the largest impact. Looking at Sweden’s number six ranking by factor, and accounting for the weighting, it becomes clear that these would also be the main levers for improving the country’s ranking.

Although Sweden placed relatively low on bandwidth in the index, industry experts do not believe that this is an issue for data center operators considering Sweden—the country has enough capacity for many more large data centers. In fact, as the index measures total international bandwidth, smaller countries are somewhat disadvantaged. In reality, as alluded to earlier, the top five or six countries have an infrastructure that is more than sufficient for data center deployment.

However, when it comes to energy cost, Sweden placed nine out of fifteen countries in the 2015 index, and industry experts cite Sweden’s high electricity tax for data centers as the single most important lever for increasing the country’s attractiveness toward data centers. Of particular interest is the fact that Sweden placed last out of the five Nordic countries, which in many cases compete for the same business.

In May 2014, the Swedish government commissioned an inquiry into the sector neutrality of the industrial energy tax in Sweden. In October 2015, a proposal for legislation was handed over to the government. Among other things, the proposal urged that data centers should be eligible for industrial energy taxation. The report has been well received by interest groups, and should the proposal be passed into law as expected, it would take effect on January 1, 2017. The proposal represents a 35% to 40% reduction in the price of electricity for data centers with a capacity of more than 0.5 megawatt (excluding cooling capacity).
equipment), which would result in Sweden having the second-lowest price in the Nordic countries (albeit tied with Norway after its 2016 change to data center taxation) and lifting the country to fourth place in the Data Center Qualification Index.

The last of the three major factors is ease of doing business. Sweden looses out on this measure mainly owing to inefficiencies in two submetrics: paying taxes and dealing with construction permits. (As a comparison, securing the average construction permit in Sweden takes four-and-a-half times as long as it does in Singapore, which follows best practices. The permit is also seven times as expensive as it is in Singapore, and Swedish quality control is at approximately 70% of Singapore’s.)

Although the Data Center Qualification Index gives a comprehensive view of the quantifiable factors affecting data center location selection, there are three main qualitative considerations that may be discussed separately: location, regulation, and political focus and marketing.

Location. Naturally, the data center’s location in relation to the market it is serving is the main factor affecting latency—no amount of infrastructure investment will likely warrant placing a high-frequency trading robot far away from the relevant exchange. A similar argument can be made for bandwidth-intensive services, such as video streaming or gaming, which should locate servers close to the end users. Nevertheless, depending on the application, different types of data centers may have different demands for a location.

Enterprises managing their own data centers will often want to keep them close to the corporate headquarters, as this facilitates management and maintenance. At the other end of the spectrum, global Internet companies often have no preference with regard to where their data centers are located, as long as they are on the right continent (this is often called being “location agnostic”).

As for third-party providers, colocation players will, by the same logic that governs enterprises, often want to be located close to the customers they serve, although there are exceptions. For example, Hydro 66 chose to build in Boden in order to take advantage of the readily available renewable-energy sources. Other types of third-party providers (such as managed hosting and DCaaS companies) have more freedom in their location choice and may have different needs depending on the applications of their customers. For example, financial services and gaming applica-
tions are dependent on low latency and therefore relative proximity, whereas e-mail services are not. Overall, as new developments are made in virtualization and traffic load management, third-party providers will increasingly see the benefit of keeping only the most data-heavy traffic close to population centers, while moving the bulk of traffic to locations with more intrinsic advantages (such as low-priced and stable renewable energy as well as a cold climate).

Given the relatively long distances from Sweden to the large European population centers, the data center capacity that Sweden will be able to attract from the rest of Europe will likely be that of location-agnostic operators.

Regulation. As privacy concerns over data management have arisen during the past few years, the regulatory outlook has become an increasingly important factor when assessing a market’s suitability for data centers. (See the sidebar “The Regulatory Environment Influences the Selection of a Data Center’s Location.”) By all accounts, Sweden is considered a relatively good choice in this regard.

Political Focus and Marketing. More and more, governments are realizing the value of the data center opportunity. However, recent years have seen some do more than others in order to entice data center business, and it is clear that the degree to which a government shows interest in this opportunity is a key factor in attracting data center owners.

Generally, interest shown from a political level has two main effects: it shows commitment and it indicates that the country will, if anything, become a more attractive location as time passes. It can also be used to articulate specific benefits that locating in the country provides.

In addition, it is key that stakeholders in a country (for example, construction companies, utilities, investment agencies, and municipalities) organize themselves in their marketing efforts toward interested parties. In the fast-moving industry that is digital infrastructure, it is clear that even a country with convincing intrinsic characteristics has to put in significant marketing efforts to keep up and remain relevant.

**THE REGULATORY ENVIRONMENT INFLUENCES THE SELECTION OF A DATA CENTER’S LOCATION**

Growing transnational data flows, an increased focus on national security amid increasing global geopolitical tensions, and rising concerns about personal privacy have recently promoted reviews of data-protection regulation around the world. For data centers that handle personal information flows, future regulatory actions in this space may have a major impact on operations. Recent years have seen multiple examples of how regulation affects where companies locate their data centers:

- Until recently, the Safe Harbor Privacy Principles legal framework provided the means for transfers of personal data between a country within the European Union (EU) and the U.S. by enabling U.S. companies to comply with privacy laws in the EU by way of self-certification. However, in October 2015, the framework was invalidated following a customer complaint. Without Safe Harbor, companies storing user data would be forced to either keep one data center in the EU and one in the U.S. or to work their way around the law by way of, for example, Model Contract Clauses. However, in February 2015, the European Commission and the U.S. announced that they had reached a replacement agreement called “Privacy Shield,” which is estimated to be put in place in April 2016.

- In Russia, the “On Personal Data” law was expanded in 2014, requiring personal data to be physically stored in the country. In order to comply with the law, global Internet companies such as Google are forced to keep some of their servers in Russia.
1. E-GDP is the sum of the consumption of Internet-related products and services, online retail spending (including from abroad), and private investment in information and communications technology (ICT) (including telecom equipment), as well as government spending on ICT, Internet-related subsidies, and exports of ICT equipment (minus equivalent imports).


3. Sweden also performed well in the ICT Development Index (IDI), the Web Index, and the Digital Economy and Society Index (DESI).


5. In Sweden, government spending made up 8.4% of e-GDP in 2015, compared with 17.8% in Denmark and 16.5% in the UK.

6. Including colocation, managed hosting, and data center as a service (DCaaS); governments are similar to enterprise owners for all practical intents.

7. The index does not take into account the location of the countries (in this report, the regional factor is discussed in a separate section), which has great effect on latency. Had this been accounted for, it is likely that countries such as Iceland, which is distant from large populations, would have dropped in ranking, while countries such as the Netherlands would have gained significantly.

8. The factors used in BCG’s Data Center Qualification Index parallel those used in Data Centre Risk Index, Source8, hurleypalmerflatt, and Cushman & Wakefield, 2013 (see http://www.cushmanwakefield.com/-/media/global-reports/data-centre-risk-index-2013.pdf).

9. In the index in Exhibit 6, no other changes from the 2015 baseline have been included except the Swedish tax reform (for example, the index excludes lowered taxes in Norway).

10. Electricity cost may be less important to some third-party providers as they may pass on this cost to their customers.


12. Colocation is the term for a type of third-party business model centered around providing more or less fully outfitted data centers where customers can place their servers.
THE VALUE OF DATA CENTERS TO SWEDEN

How does Sweden as a country benefit from the data center industry? Apart from apparent benefits such as tax contributions, the construction and operation of data centers creates significant revenues for Sweden’s core industries—in 2015, the data center industry had a total economic impact of SEK 13 billion.

Creating Economic Impact Across Industries

In public debate, the data center opportunity is occasionally written off as employing too few people and being too narrow in its economic impact, creating revenue for only international IT companies. However, this perspective fails to take into account the construction phase and, more important, the broader supply-chain impact of data center operations. In fact, the data center industry creates significant value for some of Sweden’s largest companies. (See Exhibit 7.)

Being an industry in a strong growth phase, a large share of the annual economic impact created by the data center industry is attributable to new construction. Building a data center is similar to constructing a large warehouse and requires similar inputs in terms of design and construction. As much as 10% of revenue from building new data centers is attributable to traditional construction work. Basic mechanical and electrical engineering makes up about 25% of revenue. As a result, data center construction is becoming increasingly important for large Swedish employers, such as NCC, ÅF, and Bravida. At the same time, large multinationals, such as Siemens and Schneider Electric, are establishing teams that focus on data centers in Sweden to serve this growing market.

Data centers have been described as the factories of global technology and Internet companies, and although operating existing data centers is indeed not particularly labor intensive, significant operational costs are expended on utilities, creating economic impact and employment further down the supply chain. The energy sector in particular will benefit from 40% to 50% of the total operational spending, driving growth for some of Sweden’s main utility companies. (As a bonus, many data-center operators are particularly interested in renewable energy, as evidenced by the new buildings constructed by Facebook and Google most recently.)

An Emerging Industry

What is the size of the data center industry today? BCG estimates that there were 135 to 155 purpose-built data centers of significant size in Sweden in 2014. (See Exhibit 8.) There were also approximately 3,000 server rooms (or small data centers). A majority of the larger data centers were located in Stockholm.
and the counties of Norrbotten, Skåne, and Västra Götaland. In terms of economic impact, our analysis shows that in 2015, the construction and operation of purpose-built data centers generated upward of SEK 13 billion in full economic impact (the sum of direct, indirect, and induced impact) and engaged an estimated 7,000 full-time workers.1

The direct economic impact from the data center industry represented about 0.15% of GDP in 2015, implying that this relatively young sector is already comparable to the size of the textile manufacturing industry (0.11% of 2014 GDP) and to the airline industry (0.22% of 2013 GDP).

Calculating Total Economic Impact. In 2015, new data-center building across Sweden generated SEK 2.8 billion in direct impact for suppliers, such as providers of construction and installation services. In addition, the operation of the installed base of data centers generated SEK 3.4 billion, a large part of which was spent on electricity.

In addition to these direct expenditures, a full-impact assessment should consider the re-
circulation of economic impact further down the supply chain, as well as the increased household spending induced by paying workers. This impact was estimated using econometric input-output modeling, wherein the total impact is the sum of the direct spending and two categories of spillover effects:

- **Indirect Impact.** Also known as supply chain impact, this is the impact created by the direct suppliers to the data center industry, as they, too, spend money on their supplies.

- **Induced Impact.** This is the impact generated in industries such as retail and travel as a result of the increase in total household income created by the establishment of new business.

Using this methodology, it was estimated that in 2015, the data center industry generated an indirect impact of SEK 3.4 billion from operations and construction combined. Furthermore, suppliers’ payroll expenses resulted in induced impact from operations of SEK 1.5 billion and SEK 1.7 billion from construction. (See Exhibit 9.)

**Employment Impact.** In addition to the economic impact, the data center industry also contributes with significant employment opportunities. In 2015, the data center industry directly employed about 2,100 full-time equivalent (FTE) staff in operations, and approximately 1,600 FTEs in construction. However, while this report measures employment opportunities in terms of FTEs, data center work, due to its nature, is often a part-time responsibility of a corporate IT role, and as such, the number of people actually working with data centers may be many times the FTE number. (This is especially true for colocation players that may have hundreds of people working at a facility.)

To add to this, similarly to the economic impact, the data center opportunity will have indirect employment impact further back in the supply chain, as well as create induced employment in industries such as retail. In 2015, indirect and induced impact amounted to approximately 3,200 FTEs, counting both operations and construction.

**Note**
1. Some spending will be outside of Sweden and that has not been included in this estimate of the market size. This includes IT spending (such as on servers), for which Sweden has no relevant suppliers. It also includes interest income from financing, as a large share of the companies in question will not finance using Swedish banks. Furthermore, real estate was left out of the total impact.
A LARGE OPPORTUNITY AHEAD

I F S W E D E N W O R K S T O make the country and its legislation more attractive for data center owners, what would the data center opportunity be worth to the nation? The full-potential scenario puts the economic impact in Sweden at as much as SEK 50 billion during 2025, with the industry by then employing 27,000 FTEs.

A New Primary Industry for Sweden
This future scenario puts the direct impact of the data center industry at approximately SEK 25 billion—the equivalent of 0.45% of projected 2025 GDP. This is comparable to the steel and metalworks industry in 2013. The 14% average growth that the industry may experience from 2015 through 2025 is driven by the worldwide market growth in new data-center building and operational spending, but it also assumes a significant market share increase motivated by policy and regulatory changes. Hence, it should not be viewed as a forecast. Instead, it illustrates what is there for the taking if Sweden decides to make this a priority.

Gaining Market Share. Today, Sweden accounts for 3% to 4% of new building in Western Europe in terms of capacity (the Nordic countries account for 7% to 8% in total). With continued government and local support, and specific target initiatives as outlined in our recommendations, Sweden would likely be able to become the clear leader in the Nordic region (by offering superior time to market, lower costs, and estimable connectivity), while at the same time presenting clear benefits (in terms of climate, cost, and risk), compared with Northern and Central European locations, such as the UK, Ireland, the Netherlands, Luxembourg, and Germany. In this scenario, Sweden on its own would be able to capture upward of 8% of the total newly constructed capacity in the Western European market by 2020.

The Economic Impact. Such an aggressive growth in market share would result in a direct economic impact of about SEK 12 billion from new building in 2025 and, additionally, about SEK 12 billion from operations. In this scenario, the annual growth rate from 2015 through 2025 would average 14%, and while the growth rate decreases over time, the stagnation is slower compared with that of the total European new-building market, owing to an increase in the share of location-agnostic data-center owners over time (as described above) and the ever-growing energy consumption of the installed base.

By 2025, at 0.45% of total GDP, the data center industry would be a core contributor to the Swedish economy, comparable to today’s primary industries, such as the steel and metalworks industry (0.67% of 2013 GDP),
the pulp and paper industry (0.83% of 2013 GDP), and the education sector (0.96% of 2014 GDP). (See Exhibit 10.)

In addition to direct impact, indirect and induced impact from both construction and operations will contribute about SEK 25 billion in 2025. (See Exhibit 11.)

Creating Employment. In addition to the pure monetary benefits, the data center sector would create about 27,000 jobs, measured in FTEs, in Sweden by 2025. In total, the industry will have a direct employment impact of approximately 14,000 FTEs and about 12,500 additional FTEs in indirect and induced impact. (See Exhibit 12.)

A Positive Feedback Loop
In addition to the pure economic and employment impact, an increase in data center deployments in Sweden would have a broader impact in terms of positive spin-off effects for society in general and the ICT sector in particular. Significant effects would be seen both on the national level and in local areas where data centers are built.

On a national level, a data center cluster will be created with the associated benefits in terms of encouraging new start-ups, attracting multinational corporations (MNCs) in adjacent industries, and increasing workforce competency. The increased presence of global players in the digital infrastructure and cloud industries will also provide easier access to new markets for Swedish innovations and technology exports.

Today, many data centers (especially those of hyperscale size) are being built in sparsely populated areas. Considering the benefits of this practice from an economic and risk-avoidance perspective, it is likely to continue into the future. For a smaller community that manages to attract a large or hyperscale data center, there are multiple potential benefits to be had:

- **Jobs.** A hyperscale data center and its suppliers require a workforce with some level of specialist education. Attracting such jobs to a region that may otherwise be suffering from relatively high unemployment and depopulation owing to urbanization can have great impact on a community.

- **New Enterprises.** A new large data center in the area brings with it an ecosystem of suppliers—perhaps resulting in multiple

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**EXHIBIT 10 | The Data Center Industry’s Economic Impact Is Comparable to Sweden’s Primary Industries**

<table>
<thead>
<tr>
<th>Industries’ share of Swedish GDP</th>
<th>2014</th>
<th>2015</th>
<th>2013</th>
<th>2025</th>
</tr>
</thead>
<tbody>
<tr>
<td>Textile manufacturing</td>
<td>0.11%</td>
<td>0.15%</td>
<td>0.22%</td>
<td>0.45%</td>
</tr>
<tr>
<td>Data center</td>
<td>0.15%</td>
<td>0.22%</td>
<td>0.45%</td>
<td>0.67%</td>
</tr>
<tr>
<td>Airline 2013</td>
<td>0.67%</td>
<td>0.45%</td>
<td>0.67%</td>
<td>0.83%</td>
</tr>
<tr>
<td>Data center 2025</td>
<td>0.45%</td>
<td>0.45%</td>
<td>0.67%</td>
<td>0.96%</td>
</tr>
<tr>
<td>Steel and metalworks 2013</td>
<td>0.45%</td>
<td>0.45%</td>
<td>0.67%</td>
<td>0.96%</td>
</tr>
<tr>
<td>Pulp and paper 2013</td>
<td>0.67%</td>
<td>0.45%</td>
<td>0.67%</td>
<td>0.96%</td>
</tr>
<tr>
<td>Education 2014</td>
<td>0.96%</td>
<td>0.96%</td>
<td>0.96%</td>
<td>0.96%</td>
</tr>
</tbody>
</table>

Sources: SCB; BCG analysis.
Note: Numbers have been rounded.
new start-ups, the opening of local offices by MNCs, and large investments. When Google established its data center in Hamina, Finland, the company joined the local investment agency in a concerted effort to find domestic suppliers and increase local participation in the project.

- **Marketing the Region.** Mentions in the media in relation to the development of cutting-edge technology by large multinationals, such as Google and Apple, is invaluable publicity for a small community. For example, Luleå University of Technology experienced more than a 100% increase in applications to multiple IT and engineering programs after news of Facebook’s data-center deployment was released.

The spin-off effects from creating an ICT cluster can be clearly seen in Ireland, a country that has attracted a disproportionate amount of foreign direct investment (FDI) owing to its strong position in IT. However, as with the case of Ireland, this positive feedback loop may need to be put in motion by political efforts. Ireland has long benefited from a low corporate-tax rate and great efforts by the government and the investment authority in attracting FDI.

**Competing for the Opportunity**

To reiterate, this opportunity will not be realized if Sweden remains passive, as the country has been during the past years. Competition for data center business is intensifying. In Europe, Sweden will need to outperform other up-and-coming Nordic countries, as well as more established powerhouses in Central and Northern Europe. In order to capture the market share that this opportunity assumes, Sweden will need to look at what others are doing to attract data centers—and beat that. (See the sidebar “As Competition...”)

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**EXHIBIT 11 | The Economic Impact from Data Centers May Reach SEK 50 Billion by 2025**

<table>
<thead>
<tr>
<th>Year</th>
<th>Operations induced</th>
<th>Operations direct</th>
<th>Construction induced</th>
<th>Construction direct</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>9</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2012</td>
<td>10</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2013</td>
<td>11</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2014</td>
<td>13</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2015</td>
<td>11</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2016</td>
<td>9</td>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2017</td>
<td>16</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2018</td>
<td>21</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2019</td>
<td>25</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2020</td>
<td>29</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2021</td>
<td>33</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2022</td>
<td>36</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2023</td>
<td>40</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2024</td>
<td>44</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2025</td>
<td>49</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**Sources:** Gartner; BroadGroup; Technavio; Ovum; BCG analysis.

**Note:** The economic impact does not include IT equipment, interest income from financing, or real estate; the impact only includes purpose-built data centers (that is, excluding server rooms). The estimate of historical numbers is based on an analysis of key players in Sweden. Numbers have been rounded.

*Maximum-potential scenario, assuming Sweden works to provide an optimum environment for data centers.*
for Data Centers Mounts, Other Countries Have Made Policy Changes.

**Targeting the Right Segments.** Going forward, Sweden will keep having a base of enterprise data-center deployments from Swedish companies and may also see some new building from location-agnostic MNCs.

Nevertheless, looking at Sweden’s characteristics as a data center market, and the key strengths and weaknesses of the country’s offering, it is clear that the main drivers of future growth will be global Internet companies and location-independent third-party providers. These are also by far the most attractive segments, representing a majority of future growth for the data center market. (See the sidebar “Cloud Computing Is Driving Change in the Data Center Industry.”)

Global Internet companies are showing great interest in the Nordic countries already (Facebook is in Sweden, Apple is in Denmark, and Google and Yandex are in Finland). And as cloud computing and virtualization gain even more ground, third-party providers as a group will become more free to base their location selection on factors other than the proximity to their clients.

**Note**
1. Hyperscale data centers have a capacity of more than 10 megawatts.
Traditionally, data centers have been placed in proximity to large population centers and commerce hubs in order to obtain low latency. This is a primary reason for the success of countries such as the UK, Belgium, the Netherlands, and Luxembourg in attracting data centers.

However, as the industry has become more location agnostic, new players have taken notice of the significant data-center opportunity. As a result, competition among nations is growing increasingly fierce, with multiple countries having launched tailored initiatives to increase their attractiveness in the past few years.

The Nordic countries in particular have woken up to this opportunity, fueled by the latest line of data center deployments from large players, such as Google, Facebook, Apple, and Yandex, in the region. Below are some examples of such initiatives:

- Finland promotes the data center industry as a national priority. Former Finnish prime minister Alexander Stubb explicitly mentioned the government’s intent of transforming Finland into an international data-traffic hub. Furthermore, Mr. Stubb initiated a governmental program that works to actively promote a Northeast Passage Arctic Cable connecting Asia with Europe through Finland.

  In January 2016, Cinia Group (a telco wholly owned and funded by the Finnish government) completed a submarine fiber cable connecting Finland and Germany. This was done with the explicit goal of increasing Finland’s attractiveness to data centers.

- Ireland has long had a great concentration of ICT activities, and today, the country is one of the foremost ICT hubs globally. This clustering effect has resulted in a skilled workforce, significant Internet-backbone infrastructure, and a professionalism in marketing the country and managing foreign direct investment in general.

  In recent years, Ireland has channeled these advantages in a bid for attracting data centers, strongly vocalizing its clear value proposition as a low-risk country with a clear proof of concept.

- In Iceland, Landsvirkjun, the national power company, offers some of the lowest industrial energy prices available in fixed contracts of up to 12 years. Such terms allow companies to forecast operational costs with high accuracy. Furthermore, the company has commissioned a report from BroadGroup in an effort to support its view that Iceland has a cost advantage over other Nordic countries.

- In 2015, it was announced that Apple is building a hyperscale data center in Denmark. In a deal with the Danish government, Apple was registered in the so-called “procesliste,” exonerating the company from paying taxes for carbon dioxide emissions.

- In mid-2015, Norway proposed a change in electricity taxes for data centers. From 2016 onward, data centers will benefit from the same reduced tax rate that traditional industries do, reducing taxes by almost 97%.
Cloud computing, a technology providing customers with the opportunity to remotely store and process data in third-party data centers, has been growing rapidly during the past few years. The popularity stems from cloud technology providing superior ease of use for enterprises with lower demands for customization, often on a pay-as-you-go model. Cloud computing spares enterprises large capital expenses and often maintains or lowers operational expense owing to the scale that cloud providers can build.

Today, the cloud market consists of large global Internet companies, such as Amazon Web Services, Google Cloud Platform, or Microsoft Cloud, as well as companies in the third-party provider segment. (See the exhibit below.) When it comes to infrastructure, the global Internet companies will often support their services primarily with hyperscale data centers, whereas smaller cloud-computing companies, owing to their lack of scale, may rent space at colocation providers.

Looking forward, the dynamics of the cloud market is set to force the data center industry to become more location agnostic, owing to three main mechanics. Firstly, server huggers in the enterprise segment will move capacity from their in-house data centers to colocation providers at an increasing rate, keeping ownership of their servers. Secondly, a share of the enterprise users will leapfrog colocation providers, get rid of their servers, and turn to cloud services (which are inherently more location agnostic than a colocation provider). Finally, the cloud market is set for consolidation, which would create additional scale and see part of cloud capacity move to the location-agnostic global Internet companies.

Global Internet Companies and Third-Party Providers Are Driving Data Center Deployment

Sources: IDC; BroadGroup; Cisco; BCG analysis.
Note: Only includes white space. Numbers have been rounded.
FOUR RECOMMENDATIONS TO CAPTURE THE DATA CENTER POTENTIAL

Sweden is already an attractive market for companies looking to deploy state-of-the-art technologies and is seen as an up-and-coming location for building data centers. However, in order to pull ahead of its competitors in Northern and Central Europe, progress needs to be made in multiple areas. BCG recommends initiatives in four areas for increasing Sweden’s attractiveness for data center deployments.

Ensure Reliable and Sustainable Energy That Is Competitively Priced
Swedish policy makers should ensure that the future energy supply in Sweden will be reliable and carbon neutral. Furthermore, the price of electricity for data centers must be aligned with the price in the other Nordic countries. The Nordic countries have a well-functioning, highly transparent, and competitive electricity market, and the EU minimum tax rate available to energy-intensive industry is not available to data centers in Sweden. The current proposal for new energy-tax legislation for data centers is a tremendous step in the right direction, and swift implementation will eliminate this significant hurdle to data center investments, but Sweden must also make sure this balance is maintained going forward.

Additionally, there is a need for a review of the taxation policy regarding energy production for own consumption (such as wind and bio energy). Owners of hyperscale data centers, especially global Internet companies, are showing increasing interest in moving up the supply chain and producing their own electricity in order to gain increased control over cost and risk.

Treat Digital Infrastructure as a Vital Component of Modern Society
Highly developed digital infrastructure is a critical component of both the public sector and private enterprise. In the coming decade, digitization of society will be a key driver of progress. In business, digitization will enable technological advancement, such as the Internet of Things, and drive productivity by way of Industry 4.0, for example. In government, existing processes will be facilitated by e-government. Individuals will experience ubiquitous high-speed access to ever more content.

Therefore, in the same way that the government makes investments in railways and road work, Sweden should explore ways of using public support in order to create an attractive environment for data centers. Many relevant initiatives will also have positive secondary effects on society.

Examples of public support would be for the government to partner with companies that create jobs in struggling regions, to use policy...
to encourage waste heat reuse (such as district heating and greenhouses as well as other industrial applications) for data centers (increasing society-wide energy efficiency in the process), to make digital infrastructure facilities eligible for energy-efficiency grants, and to provide additional support for transformative educational and research programs (for example, by funding collaborative research on topics such as the Internet of Things, cloud computing, and big data).

Vocalize the Value Proposition and the Ambition to Become a Leader
Perception is important in attracting large-scale technology investments such as data centers. Global Internet companies looking to construct new data centers are investing for the very long term, and they need to make an assessment of how conditions for their business will develop over time. The tolerance for risk is low, reflecting the criticality of seamless data-center operations to the success of these companies. Companies make their decisions after a fierce competition among countries that involves the concerted effort of officials from the national government as well as local municipalities. Politicians who describe data centers as a key driver for future prosperity increase confidence in the long-term viability of Sweden as an option.

In this area, Sweden is trailing other European countries. Sweden’s politicians often mention ICT as a core contributor to the country’s future growth, but they seem unaware of the fact that Sweden is at risk of falling behind when it comes to attracting investments in digital infrastructure.

In terms of message, national marketing should brand Sweden as the digital front-runner it is and clarify the value this brings to investors: a tech-savvy and fast-adopting population, a world-class network infrastructure, a large ICT-competent workforce, a favorable political climate, and broad business engagement in digitization (spanning start-ups to MNCs). When marketing Sweden, it should be made clear that Sweden is a hub for digital content, where investments in digital applications beyond data centers (such as big data, the Internet of Things, cloud computing, and technology related to Industry 4.0) have great prospects for scalability. Indeed, many parallel developments in ICT technology could serve as examples promoting Sweden—notably, Telia Carrier and Ericsson’s recent decision to launch 5G in Stockholm by 2018 is a great example of Sweden’s prominence in the sector.

Increase Predictability in Planning, Permitting, and Risk Assessment
As a last point, Sweden and its municipalities should focus on increasing the ease of doing business in order to decrease the average time to market of data center investments.

As is, any company intending to construct a data center in Sweden will have to go through a fairly complex due-diligence process assessing risks, determining costs, and estimating the time to market. This will often involve multiple permit processes. These processes may be complex and unfamiliar to foreign investors and, therefore, are often critical in order for the project to finish on time.

Hence, we suggest launching initiatives on both national and local levels to increase transparency and predictability for industrial projects involving infrastructure permitance processes. In particular, the target for these simplifications should be permits dealing with general construction, utilities and generators, and environmental issues. Naturally, a large share of the responsibility for policy making as well as execution lies with municipalities and regional authorities, so there exists a large opportunity to share best practices across the country.
In order to arrive at the value of the data center industry to Sweden, we used input-output analysis with the expenditure approach.

Direct Impact
Our estimation of the expenditure produced by the building of new data centers in Sweden is based on a combination of top-down and bottom-up methodology.

For the top-down methodology, we leveraged forecasts of market size and growth for Europe and the Nordic countries provided by external market-research firms. Sweden’s market share of today’s total market was then estimated by way of a bottom-up approach, rooted primarily in analyses of electricity consumption and hardware shipments or the installed base. Market share estimates were also then verified by experts.

The growth of Sweden’s market share in the full-potential scenario is a combination of growth, due to capturing a larger share of new building in Europe, and a shift toward more of the new building in Europe becoming location agnostic (our estimates show that approximately 40% of new-building capacity in Europe was location agnostic in 2015, a share that will increase to about 60% by 2025, mainly driven by the increased penetration of cloud services). Additionally, operational expenditure was estimated as a percentage of new-building expenditure, using financial data for key players and the electricity consumption of data centers in Sweden today.

Indirect and Induced Impact
In order to capture the full economic impact of the data center industry in Sweden, we leveraged the commonly used economic model of input-output analysis. Input-output models are based on the analysis of direct expenditure data to estimate the additional impact of a given industry on other sectors. (See Exhibit 13.) More specifically, the direct impact is augmented by two categories of spillover effects:

- **Indirect Impact.** Also known as supply chain impact, this measures the economic impact of products and services used in the supply chain that supports a given industry. This is done by assigning a multiple to the effect that various sectors have on each other, as defined by national input-output tables (provided by SCB). As an example, spending on installation services requires direct input of tools, components, and so on.

- **Induced Impact.** This measures the economic impact resulting from payroll spending attributable to the industry. Sectors that benefit from this impact include retail, food, and lodging.
Employment Calculations

Employment estimates are derived from the economic impact and are based on SCB employment data (the numbers of hours worked) by sector, normalized by economic output per sector. These estimates have then been augmented with economic input-output relationships.

The Internet Economy and E-GDP

In order to capture the context that the data center industry operates in, and as a means of quantifying the advance of digitization, we repeatedly refer to the measure known as e-GDP. It measures the economic contribution of the Internet to the overall GDP and provides a basis for discussing the Internet economy in terms that are commonly understood by a broad audience, have a monetary value attached to them, and offer a way to compare the Internet economy across regions.

Similarly to the economic impact of data centers described above, e-GDP is calculated using input-output modeling and by looking at expenditures on Internet products and services. The main components of e-GDP are the contributions of consumers, businesses, and government entities to the Internet economy. More specifically, e-GDP is made up of consumption from private households, investment, government spending, and net exports. (See Exhibit 14.)
NOTE TO THE READER

About the Authors
Arvid Warrenstein is a consultant in the Stockholm office of The Boston Consulting Group. Fredrik Lind is a senior partner and managing director in the firm’s Stockholm office. Olof Sundström is a principal in BCG’s Stockholm office. Stefan A. Deutscher is a principal in the firm’s Berlin office.

For Further Contact
This report was prepared by BCG’s Technology, Media & Telecommunications practice. If you would like to discuss the content of this report, please contact one of the authors.

Arvid Warrenstein
Consultant
BCG Stockholm
+46 73 079 44 05
warrenstein.arvid@bcg.com

Fredrik Lind
Senior Partner and Managing Director
BCG Stockholm
+46 73 347 03 80
lind.fredrik@bcg.com

Olof Sundström
Principal
BCG Stockholm
+46 70 647 64 72
sundstrom.olof@bcg.com

Stefan A. Deutscher
Principal
BCG Berlin
+49 170 334 1272
deutscher.stefan@bcg.com