

DIGITAL INFRASTRUCTURE AND ECONOMIC DEVELOPMENT

AN IMPACT ASSESSMENT OF FACEBOOK'S DATA
CENTER IN NORTHERN SWEDEN



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THE BOSTON CONSULTING GROUP

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PREFACE

THE BOSTON CONSULTING GROUP has analyzed the establishment of Facebook's large-scale data center in Luleå, Sweden—how it has affected the country economically and how it has contributed to the development of the country's digital infrastructure. The analysis and the conclusions presented in this report were independently developed by BCG using an academically grounded methodology, with detailed data inputs provided by Facebook.

Key topics and findings in this report include the following:

- Continued digitalization must be a key priority for Sweden if the country is going to enhance productivity and economic development. Investments in digital infrastructure, such as large-scale data centers, are an important contribution to this agenda.
- Facebook decided, after careful due diligence, to establish its first non-U.S. data-center site in northern Sweden in 2011, deploying leading innovation with regards to data center design and efficiency as well as the latest generation of server technology.
- The establishment of Facebook's data center is estimated to generate a total of SEK 9 billion in full economic impact (direct, indirect, and induced impacts) and to engage 4,500 full-time workers over the course of ten years nationwide; about half of the economic benefits will accrue locally. In 2012 alone, Facebook contributed as much as 1.5 percent of the local region's total economy. Furthermore, the establishment of Facebook's data center has laid the foundation for Sweden's competitive advantage in attracting additional data-center investments.
- Global data-center demand will continue to increase, with more than 60 new large data centers expected in western Europe by 2020. Sweden could compete for these investments and aspire to build a substantial data-center industry.

We hope that this report serves to illustrate the nature and magnitude of the data center opportunity for Sweden and to form the basis for continued discussions among ecosystem participants and national and local governments.

EXECUTIVE SUMMARY

DIGITAL INFRASTRUCTURE AND ECONOMIC Development: An Impact Assessment of Facebook's Data Center in Northern Sweden captures the importance of large-scale data centers to the Swedish economy and the opportunity they provide. The report illustrates the specific impact the establishment of Facebook's data center has had on economic development and job creation locally, as well as the implications for Sweden nationwide.

Continued digitalization must be a key priority for Sweden if the country is going to enhance productivity and economic development. Investments in digital infrastructure, such as large-scale data centers, are an important contribution to this agenda.

- Digitalization of the economy is key to driving long-term productivity gains in the Swedish economy and to sustaining relative competitiveness and economic development.
- Investment in the continued digitalization of society is key to drive economic development. Estimates project digitalization to contribute as much as one-third of GDP growth through 2018.
- As the world has become increasingly digitalized and connected, the Internet economy has continued to grow fast, reaching 7.8 percent of Swedish GDP in 2013. Swedish consumers are leading the growth, while private and government digital investments have tapered off.
- Large-scale data centers are forming the backbone of the global digital infrastructure together with telecom equipment and services. Explosive growth in data traffic and storage needs is driving significant investments in large-scale data centers, which are important for Sweden to attract.

Facebook decided, after careful due diligence, to establish its first non-U.S. data-center site in northern Sweden in 2011, deploying

leading innovation with regards to data center design and efficiency as well as the latest generation of server technology.

- Facebook, the world's largest social network and most popular website, is growing fast. Facebook's user base is increasingly global, with more than 80 percent of users outside North America. To meet the resulting data-capacity needs, Facebook is investing heavily in expanding its data-center footprint globally, locating its first non-U.S. site in northern Sweden.
- Geographical site selection is a key parameter in optimizing Facebook's digital infrastructure, and significant due diligence was conducted to secure an attractive site that fulfilled the company's economic, energy, climate, human-capital, and infrastructure needs.
- Facebook is also actively pursuing data center and server innovations that will enhance energy efficiency and maintain the smallest possible environmental footprint.

The establishment of Facebook's data center is estimated to generate a total of SEK 9 billion in full economic impact (direct, indirect, and induced impacts) and to engage 4,500 full-time workers over the course of ten years nationwide; about half of the economic benefits will accrue locally. In 2012 alone, Facebook contributed as much as 1.5 percent of the local region's total economy. Furthermore, the establishment of Facebook's data center has laid the foundation for Sweden's competitive advantage in attracting additional data-center investments.

- Building large-scale data centers, such as those at Facebook's Luleå site, requires significant direct investment—approximately SEK 4 billion over 18 months to bring each data center online. This expenditure does not include server or network refreshes. In Sweden specifically, about SEK 1.5 billion of domestic spending was invested in the initial data center, and an additional SEK 800 million of domestic spending is planned for the second one. Furthermore, when fully up and running, the pair of data centers is expected to cost SEK 316 million to operate, with 92 percent of that direct spending in the local area.
- The accumulated economic impact (direct, indirect, and induced impacts) on Sweden over the first ten years of construction and operation totals SEK 9 billion, of which half is impacting the Luleå region.
- Over the same ten-year period, an estimated total of 4,500 full-time-equivalent workers will be engaged. This estimate is based on direct, indirect, and induced impacts. In 2012, a total of 1,000 full-time workers were engaged nationally across all affected industries, of which half were employed in the Luleå region, contributing as much as 1.5 percent of the local region's total economy.
- The presence of Facebook has resulted in several other positive effects, specifically the emergence of a new ecosystem of infor-

mation and communications technology (ICT) companies, the establishment of regional support organizations, public and private investments in local infrastructure and utilities, a boost in regional publicity, an increase in the number of applications to Luleå Technical University, and the establishment of follow-on data centers nearby.

Global data-center demand will continue to increase, with more than 60 new large data centers expected in western Europe by 2020. Sweden could compete for these investments and aspire to build a substantial data-center industry.

- In the coming five to ten years, the continued digitalization of society will drive demand for building data centers globally. In western Europe, an incremental need for about 60 new large data centers is expected by 2020, with increasing flexibility in location choice.
- Sweden is well positioned as a data center location, ranking among the top three globally. De-averaging to specific regions, northern Sweden stands out with specific favorable characteristics, including access to stable and renewable energy sources, modern infrastructure, and a cold climate that is optimal for efficient cooling.
- Hosting data centers could turn out to become a substantial industry for Sweden, creating more economic benefits and jobs, while strengthening the digital infrastructure and ecosystem further.

On the basis of our research, we encourage further debate on how Sweden can sustain and accelerate its position as an attractive location for large-scale data-center operations, and thereby further strengthen the build-up of leading digital infrastructure.

DIGITAL SWEDEN

HOW IMPORTANT IS DIGITALIZATION for Sweden, and where does the country rank on a global scale? Continued digitalization must be a key priority for Sweden if the country is going to enhance productivity and economic development. The Internet economy, which currently represents almost 8 percent of GDP, is growing swiftly at a rate of about 10 percent per year. Sweden has ranked among the top three countries globally in terms of being a leading digital nation. However, private and public investments in digital infrastructure are starting to lag. Hence, attracting investments in digital infrastructure, such as large-scale data centers, are at the core of Sweden's digital agenda.

Digitalization Is a National Priority

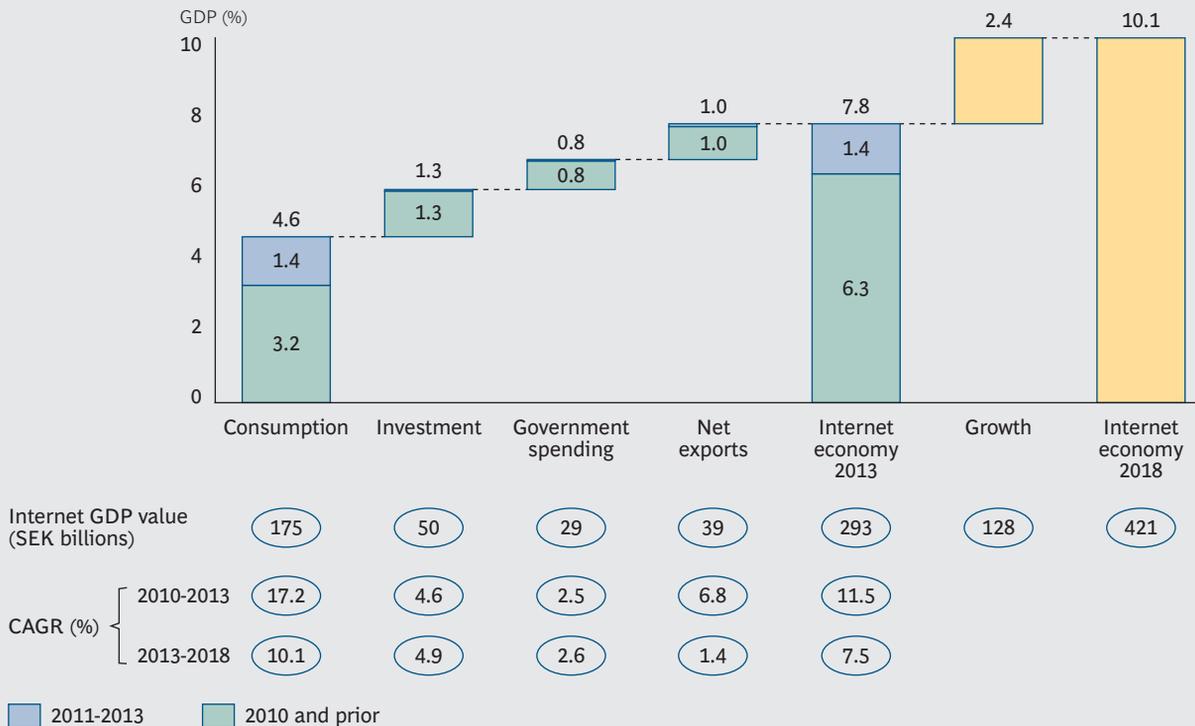
The digitalization of society is an important driver of economic productivity. Sweden has enjoyed high economic standards in the past half century, with healthy growth and a high GDP per capita relative to most other countries. Economic prosperity is not to be taken for granted, however. To sustain today's high standard of living, Sweden needs to invest in the future. As we noted in *National Strategy for Sweden: From Wealth to Well-Being* (BCG report, September 2013), continued digitalization is a key building block to enhance relative productivity and economic development.

For example, research shows that businesses that are more digitally mature grow faster and are more profitable, reflecting a relative competitive advantage. Governments that leverage digital processes more efficiently serve their citizens, having a greater impact at lower cost. And consumers are valuing digital services, increasingly moving online to shop and communicate with each other more efficiently. Hence, investment in the continued digitalization of society is key to drive economic development. Estimates project digitalization to contribute as much as one-third of GDP growth through 2018.¹

The Internet economy (e-GDP) makes up a large share of the Swedish economy and is growing rapidly both as a share of GDP and in absolute numbers. (See Exhibit 1.) In 2013, Internet sectors accounted for 7.8 percent of total GDP, or SEK 293 billion, and are expected to surpass 10 percent of GDP in 2018. This part of the economy has grown at a CAGR of 11.5 percent over the past four years and is expected to grow at a CAGR of 7.5 percent over the coming six years.

This calculation of rapid growth for the Internet economy is derived using the expenditure approach. This method takes into account Internet consumption, investment, government spending, and net exports. In Sweden, Internet consumption alone accounts for more than half of the Internet economy, is growing

EXHIBIT 1 | The Internet Economy Now Makes Up 7.8 Percent of Swedish GDP



Source: BCG analysis.
 Note: Numbers have been rounded.

fast, and is expected to reach two-thirds of e-GDP by 2018.

To date, the Swedish consumer alone is driving the digitalization of the economy, adopting new behaviors and growing increasingly connected across a rising number of devices and applications. More than half of the population has three or more online devices, and online consumption is being further fueled by new payment models and rising consumer trust. Entire sectors now have their products and services purchased predominately online; travel, media, and entertainment are at the forefront of this shift.² (See the sidebar “Key Digitalization Facts.”)

Sweden is often featured as a best-in-class country when it comes to digital services and innovation, with many successful start-ups growing and becoming global. Skype, Spotify, Klarna, Mojang, King.com, and Rebtel are a few examples. Historically, the government has made strategic and large investments in digital infrastructure. In addition, telecom operators, such as TeliaSonera and Telenor Group, have made large investments in future

mobile networks, such as long-term evolution (LTE), which is actively supported by Ericsson. It is no surprise, therefore, that Sweden has ranked as a top-three nation globally when we have conducted our annual e-Intensity survey; in 2013, only South Korea and Denmark were ahead of Sweden. (See Exhibit 2.) The BCG e-Intensity Index is a measurement of a country’s Internet enablement, engagement, and expenditure.

Looking ahead, Sweden’s fervent, consumer-led digitalization will continue to drive significant e-GDP growth, but consumers need to be met halfway by the government and the private sector. Lagging investment in digital infrastructure and enablement—areas in which Sweden has historically led the charge globally—poses a threat to Sweden’s position as a leading digital nation.

Formerly the global leader in e-Intensity (2009), Sweden has fallen to third place in 2013, driven by a slowdown in business and government engagement, coupled with intense competition on the consumer side from other highly digital nations. (See Exhibit 3.) A

KEY DIGITALIZATION FACTS

The following statistics characterized online usage in Sweden in 2012:

- Roughly 90 percent of Swedes were connected to the Internet; more than half of the population owned a smartphone.¹
- Swedes spent an average of 24 hours per week online (10 hours on mobile devices).
- More than 50 percent of the population had more than three Internet-enabled devices.
- More than 70 percent of Swedes shopped online; 20 percent did so on a mobile device—a percentage that was

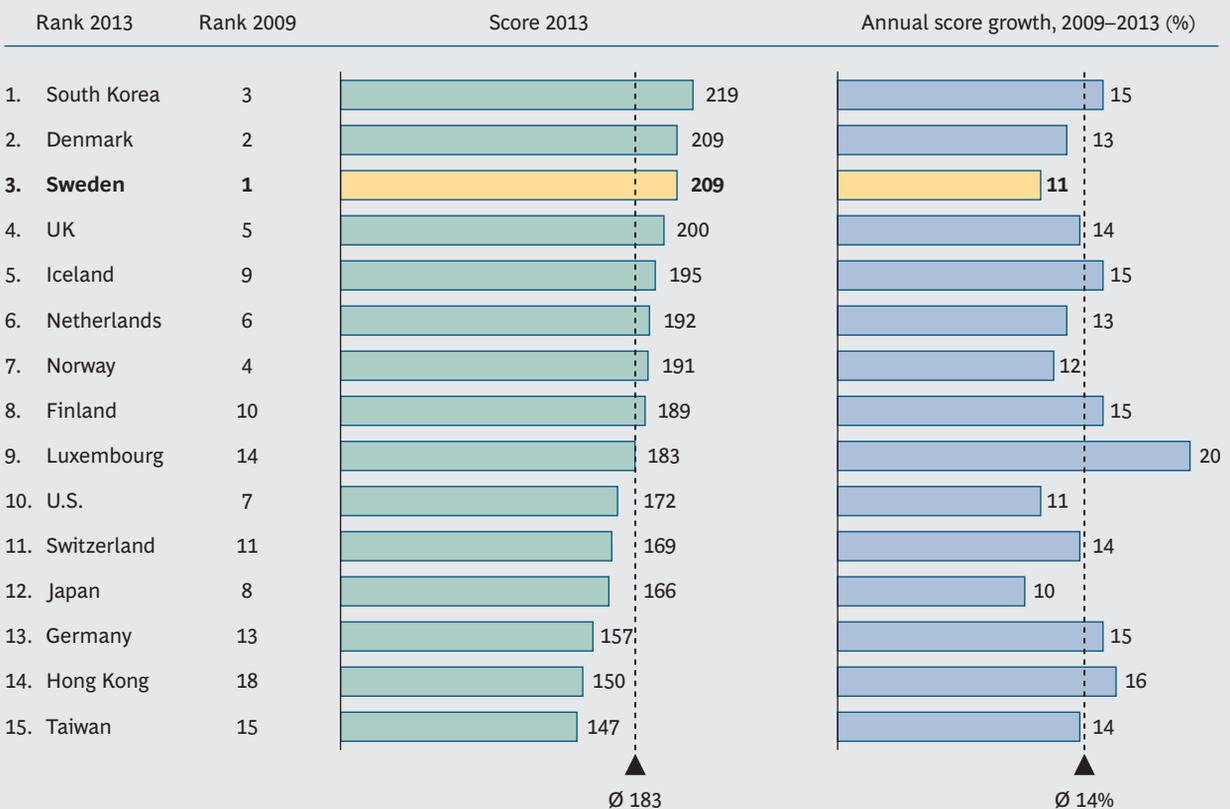
expected to climb to more than 40 percent in the coming years, driven by young consumers.

- Consumers considered digital media six times more valuable than traditional media.
- Companies' digital-marketing spending accounted for 25 percent of their total marketing budget, a percentage that was expected to reach 30 percent in three years.

NOTE

1. Statistics were compiled from the Internet Infrastructure Foundation and the BCG European Media Consumer Survey, November 2012.

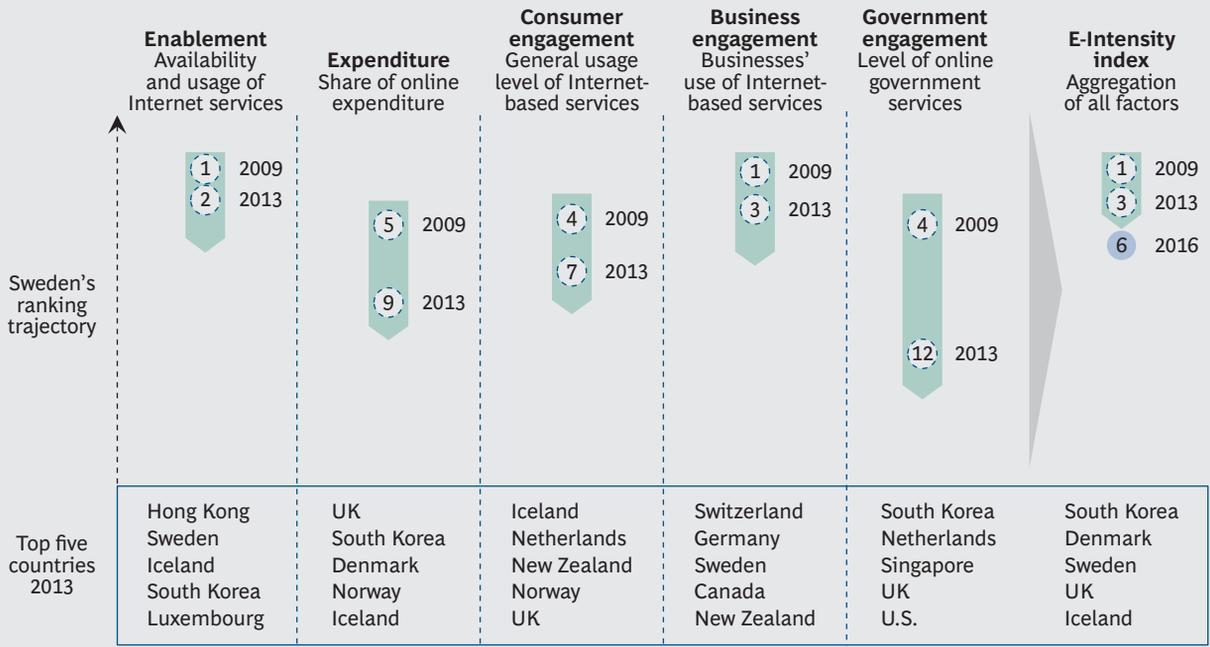
EXHIBIT 2 | Sweden Is Among the Global Leaders, but Others Are Catching Up Fast



Source: BCG e-Intensity Index.

Note: The BCG e-Intensity Index measures a country's Internet enablement, engagement, and expenditure. The index is updated on a yearly basis; minor changes in the methodology have been made since its inception. These changes may cause minor revisions to rankings shown in previous reports.

EXHIBIT 3 | Sweden Is on a Negative Trajectory in BCG's E-Intensity Index



○ Sweden's historic rank ► Current trajectory ● Sweden's estimated 2016 rank

Source: BCG e-Intensity Index.
 Note: 2016 rank has been estimated through extrapolating historical growth rates.

continuation of this trajectory could hasten Sweden's fall from leadership to an estimated sixth place globally by 2016. Changing this current trajectory must be a top national priority—one that is given even more attention and focus in the public debate.

Large-Scale Digital Infrastructure Is Key

Digital infrastructure is made up of the vast array of technologies, networks, and facilities that enable our increasingly digital culture. Crucial elements of digital infrastructure are data storage, management, access, and computation—the demand for which is escalating dramatically. Global Internet companies, content networks, third-party storage providers, and telecom operators are investing heavily to keep pace and expand data center footprints accordingly.

According to Cisco, global Internet traffic will reach 7.7 zettabytes per year by 2017, a three-fold increase in only five years. Approximately 75 percent of Internet traffic flows within data centers; the remainder reaches end users.

This swift expansion of global data traffic is being driven by the even more rapid growth of cloud traffic, forecasted to grow nearly five-fold over the same period and amount to more than two-thirds of all traffic by 2017.³ Among businesses and governments, cloud services continue to gain widespread use as they improve speed and operational efficiency. For end users, the cloud offers access to applications and content—such as e-mails, photos, and music—at all times, from anywhere, and from multiple devices.

Alongside the fast growth in traffic is a corresponding increase in the number of data centers. The supply is growing to meet demand, but improvements in workload efficiency and server density are also contributing to the increase. Around 200,000 data centers of all sizes are operational today, offering a combined installed capacity of 64 million square meters of server space.⁴ Capacity is expected to grow by about 10 percent annually, reaching 93 million square meters by 2017.⁵

This planned supply growth will be almost entirely driven by three factors: large-scale data centers, as major enterprises consolidate

capacity; the continued rapid growth of global Internet companies, a result of demand for cloud services from consumers and businesses; and small and medium-sized businesses increasingly outsourcing their storage to scalable third-party providers. (See Exhibit 4.) In fact, over the next few years, the number of traditional, mid-sized data centers with 25 to 100 racks is expected to slowly decline as aging facilities are discontinued or consolidated; capacity will migrate to large-scale centers.⁶

Global Internet companies, such as Facebook, Google, Apple, and Amazon, are the first and strongest drivers of capacity growth globally because of the rise in demand for cloud services from consumers and businesses—cloud services that provide storage (for an individual’s digital-photo album or a company’s data, for example) as well as access to real-time applications, such as those powered by Amazon Web Services. Global Internet companies are big-picture thinkers with global flexibility, typically consolidating storage in megasized data centers to capture scale advantages and locating facilities in optimal regions that have stable, lower-cost supplies of renewable energy.

The second major drivers of capacity growth in the data center market are third-party facilities,

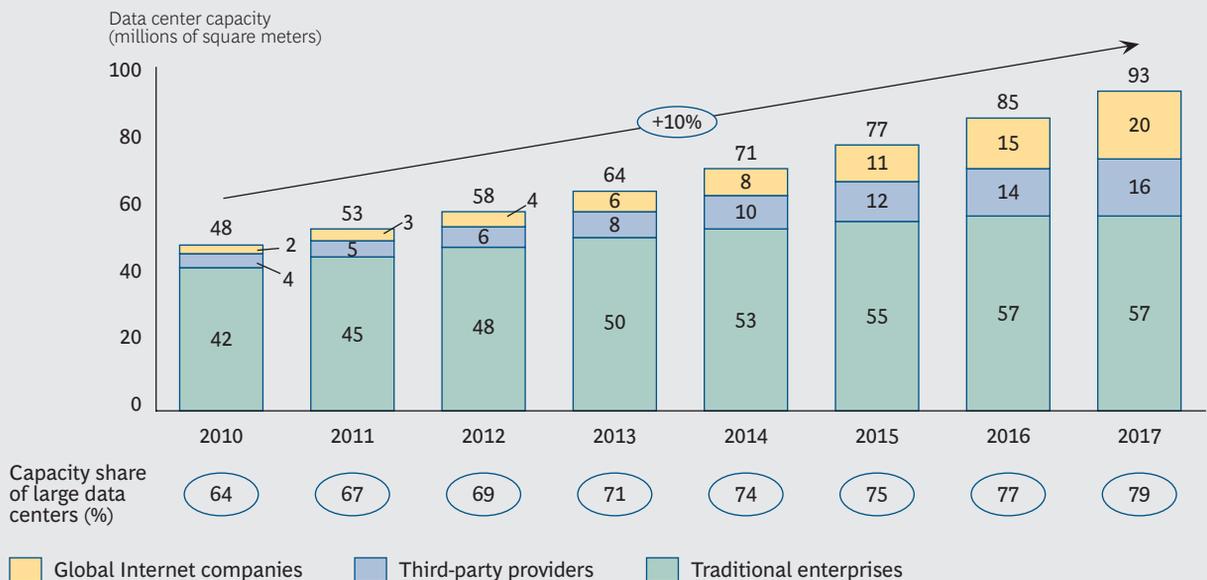
which encompass a diverse variety of providers that offer facilities outfitted with only basic server equipment, sophisticated colocation spaces, or high-margin services and computing. By outsourcing, small and medium-sized companies are able to protect against demand fluctuations, manage investment risk, and work within the capital constraints on IT budgets. Furthermore, colocation and wholesale providers can pass along scale advantages and navigate an increasingly complex regulatory and environmental landscape.⁷

Large-scale data centers constitute a core part of digital infrastructure and should be a clear priority for Sweden to maintain digital leadership.

NOTES

1. Forecasted e-GDP growth as a share of forecasted nominal GDP growth.
2. Consumer Barometer 2013.
3. Cisco Global Cloud Index, 2012.
4. Installed capacity includes all data-center sizes, but it excludes server closets and server rooms. Data center capacity is defined by IDC as the total square meters inside the cooling envelope.
5. IDC Data Center Forecast.
6. BroadGroup; IDC; Cisco.
7. BroadGroup.

EXHIBIT 4 | Global Internet Companies and Third-Party Providers Are Driving Growth



Sources: IDC; BroadGroup; Cisco; BCG analysis.

Note: IDC defines data center capacity as the total square meters inside the cooling envelope, including the space used for server racks and power supplies and the space between racks. Data center capacity does not include the space for heat, ventilation, air-conditioning, and backup power, except for rare exceptions when these items are inside the cooling envelope. Numbers have been rounded.

FACEBOOK AND ITS DATA CENTERS

HOW DOES FACEBOOK THINK about its data-center expansion strategy? The world's largest social network is growing fast, with more than 80 percent of its user base outside North America. After careful due diligence, Facebook's first nondomestic data center was launched in northern Sweden in 2011. At the core of the company's strategy are data center and server innovations that will enhance energy efficiency and maintain the smallest possible environmental footprint.

The data center in Luleå was the first one to be built outside the company's backyard.

Connecting the World

Facebook was launched in February 2004 in Mark Zuckerberg's dorm room at Harvard University using only a single server. Currently, Facebook connects 1.28 billion active users per month, of which 1 billion users are active monthly using mobile devices. Despite starting as a social network for U.S. universities, Facebook today has active users all over the world; approximately 80 percent of the daily 757 million users are outside the U.S. and Canada. Facebook has evolved from using one server to hundreds of thousands of serv-

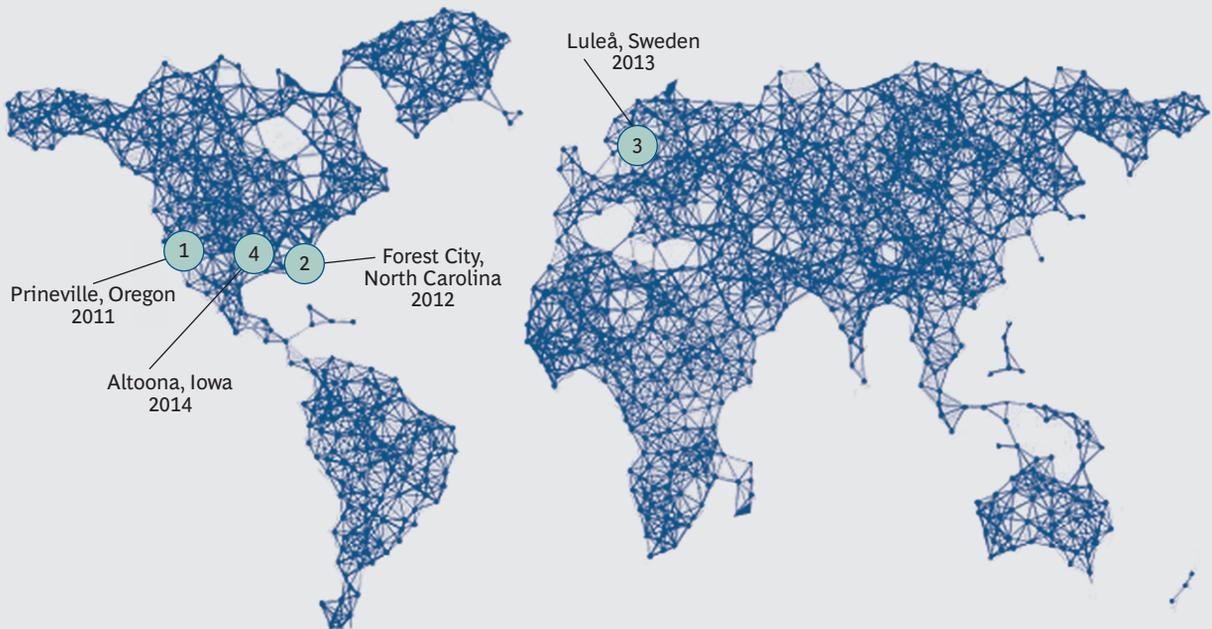
ers, which are housed in enormous data centers that, until recently, were scattered only throughout the U.S. The data center in Luleå, Sweden, was the first Facebook data center to be built outside the company's domestic backyard. (See Exhibit 5.)

Facebook is currently the world's most popular website. Each day, there are more than 4.75 billion content items shared on Facebook, including status updates, wall posts, photos, videos, and comments, as well as more than 201.6 billion friend connections, 6 billion "likes," and 7.8 trillion messages. More than 400 billion photos have been uploaded to Facebook, with another 350 million added each day.

Facebook's Expanding Footprint

As Facebook's user base, content depth, and range of applications have expanded, its data center capacity has grown multifold in parallel. Like many budding enterprises, Facebook started out by leasing data center space, but the company soon turned to custom builds of enormous scale. The first data center Facebook owned was built in Prineville, Oregon, in 2011. It was closely followed by another in Forest City, North Carolina, in 2012. Facebook's first international installment in Luleå, Sweden, came online in 2013 to more directly handle the storage and computing needs of an increasingly global user base. In

EXHIBIT 5 | Facebook's Social Graph Is Powered by Data Centers That Are Mostly in the U.S.



Source: Facebook's Social Graph, 2014.

parallel, Facebook has continued to expand domestically by building a data center in Altoona, Iowa.

Data Center Innovation

Facebook has invested heavily in tackling the challenge of optimally scaling its data storage and computing infrastructure. Although initially emphasizing design efficiency and transparency, the company increasingly focused on renewable energy and speed of deployment.

Efficient. The first data center that Facebook owned in Oregon was designed from the ground up by a small team at Facebook's Palo Alto headquarters. The project also resulted in Facebook building its own servers, power supplies, server racks, and battery backup systems. This approach allowed Facebook to customize the whole process and to maintain control over every part of the system, vastly reducing energy demands, eliminating unnecessary server hardware, and simplifying the construction and operation of the data center.¹

Each data center has its own Facebook page, where users can track power-usage effectiveness (PUE), water-usage effectiveness (WUE), and humidity, all of which are measured in

real time. During the past 12 months, the Luleå center boasted a PUE of 1.09, compared with an industry average PUE of 1.8.² The PUE in Luleå is trending even lower than it is in the Oregon and North Carolina locations, aided by the cold local climate, which minimizes the airflow needed for cooling.

Open. To continue making strides in server efficiency development, Facebook launched the Open Compute Project Foundation in April 2011. The project is based on the same principles that were employed in the construction of the Oregon data center, during which Facebook offered full public access to and use of the specifications of its patented technologies, with the aim of starting a collaborative dialogue. The Open Compute community of engineers is growing rapidly. Its mission is to continue the design and adoption of the most efficient servers, storage, and data-center hardware designs for scalable computing.³

Green. Facebook's Luleå facility runs on 100 percent renewable energy, sourced from hydroelectric stations on the nearby Lule River. Hydropower is free from the emissions and environment challenges of coal, gas, or nuclear power. Facebook's commitment to

100 percent renewable energy at its Luleå facilities was highlighted appreciatively in a 2014 report by Greenpeace, *Clicking Clean: How Companies are Creating the Green Internet*. The newest data center in Altoona, Iowa, will be equally sustainable, operating off 100 percent renewable wind power and contributing to substantial investments in new renewable energy in the state.⁴

Rapid. Through the Open Compute Project, a growing number of participants are developing new ways to improve data center design to maximize efficiency, reduce the amount of materials used, and decrease construction time. In January 2014, the Rapid Deployment Data Center (RDDC) concept was showcased at the Open Compute Summit. RDDC takes the sort of modular and lean construction principles often seen in vehicle and furniture manufacturing and applies them to the scale of a Facebook data center. Facilities are assembled on-site from premade, modular sections, allowing construction to take place in approximately half of the normal time and with substantially less environmental disturbance, waste, and land excavation.⁵ The second Luleå data center, currently under construction, will be the first Facebook data center to employ the RDDC approach.

Of all of the aforementioned areas, Facebook's Luleå facilities are leading the way in global data-center innovation.

NOTES

1. Open Compute Project.
2. Data Center Knowledge.
3. Open Compute Project.
4. Greenpeace.
5. Open Compute Project.

IMPACT ASSESSMENT OF SWEDISH INVESTMENTS

GIVEN THE LARGE INVESTMENT required to build and operate a data center, how substantial is the total economic impact locally and nationally? Countrywide, the establishment of Facebook's data center is expected to generate SEK 9 billion in full economic impact (direct, indirect, and induced impacts) and to engage 4,500 full-time workers over the course of ten years; about half of the economic benefits will accrue locally. In 2012 alone, Facebook contributed as much as 1.5 percent of the local region's economy. The establishment of the data center has also contributed strongly to Sweden's competitive advantage in attracting additional data-center investments.

Facebook in Northern Sweden

In March 2010, Facebook kicked off its search for a European data-center location by conducting an extensive desktop analysis of 15 candidate countries. Each country was initially evaluated on the basis of power and fiber-optic availability, climate, and the tax and legal environments. From the list of 15 countries, 8 were short-listed. The company performed additional due diligence that focused on a detailed examination of costs and incentives, as well as power and land availability at the specific site locations under consideration.

Business Sweden played a key role in this process by visiting Silicon Valley in 2009 to

discuss Sweden as a possible location for future data-center investments. In the months that followed, The Swedish Data Center Initiative continued to play a coordinating role in site selection, helping regional teams package their offerings and communicate with Facebook.

Facebook's data center is expected to engage 4,500 full-time workers over ten years.

In Sweden, 22 potential locations were initially assessed. Throughout 2010, Facebook visited eight of these, touring the sites and meeting with local municipalities, electricity providers, and construction companies. The list of locations was then reduced to four: Luleå, Östersund, Ludvika, and Västerås.

Nearly a year later, following extensive due diligence and a lengthy approvals process, Facebook's first choice of Luleå was confirmed and made public. Ultimately, local nuances drove the final choice within Sweden, including the size and experience of the surrounding labor market, local teaming and investment support, and proximity to Luleå Technical University (LTU), a strong technical school. (See the sidebar "Why Luleå, Sweden?")

WHY LULEÅ, SWEDEN?

There are seven key reasons why Facebook decided to locate its data center in Luleå:

- A reliable power grid
- Renewable energy
- Robust fiber infrastructure
- Cold climate
- Low risk for natural disasters
- National commitment and investment
- Local competence and an ICT-trained workforce

A Significant Impact on the Local Economy

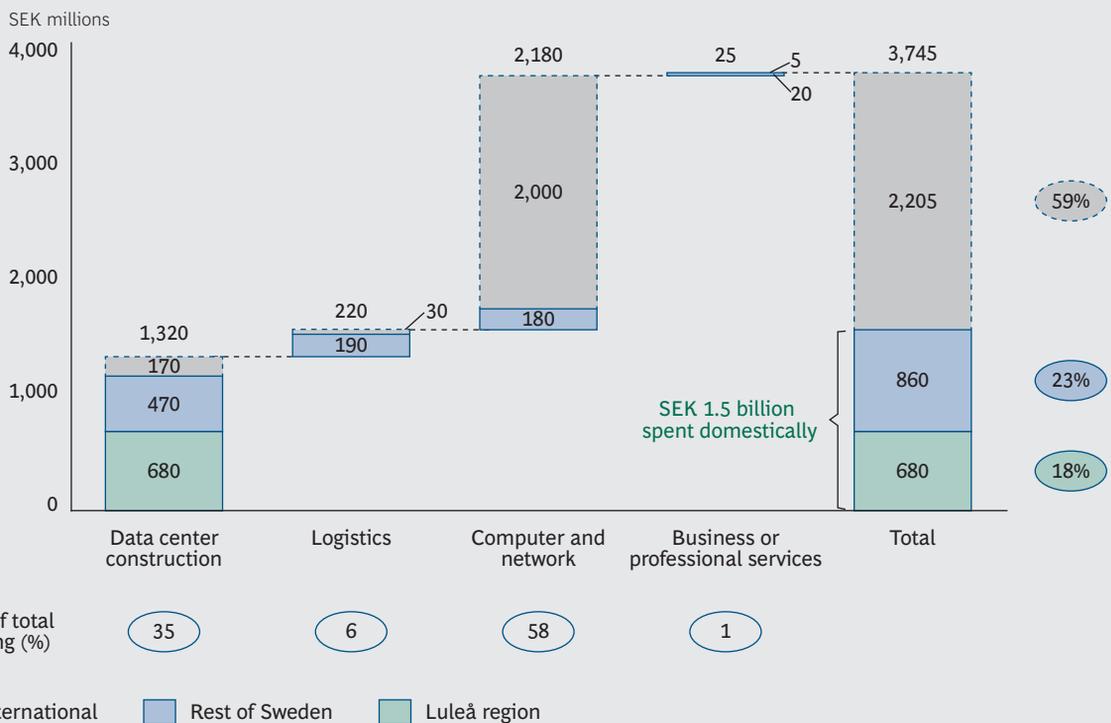
The establishment of Facebook's data center in Luleå meant a substantial amount of investment, which peaked during the construction stage. The company's investment in data center operations, and its reinvestment in computer servers and network equipment, is expected to continue in perpetuity, however.

Construction. In June 2013, the first Facebook data center in Luleå went live after 18 months of construction and a substantial investment of about SEK 3.8 billion, not

including server or network refreshes. (See Exhibit 6.) Although the majority of server equipment was imported from abroad, the vast majority of nonserver spending was in Sweden. The SEK 1.5 billion of domestic spending primarily paid for construction work and related supplies, as well as mechanical and electrical work, logistic services, and support professionals.

Major pieces of construction work were completed by Swedish companies NCC, Bravida, and Skanska, with more than half of the expenditure made in the local Luleå region. The

EXHIBIT 6 | Facebook Spent SEK 3.75 Billion on Its First Data Center and SEK 1.5 Billion Locally



Sources: Facebook data; BCG analysis.
Note: Numbers have been rounded.

major vendor contracts typically sourced construction materials and subcontractors locally, as well as the machines, trailers, cranes, and other site-related equipment. More likely to be imported, from the rest of Sweden or internationally, were design services, specialized or supervisory staffing, and select imported materials, such as a steel superstructure from Finland.

Furthermore, the hundreds of thousands of construction man-hours required for a project of this scale were filled to a large extent by local employees, with payroll spending also accruing in the Luleå region. For the minority of job functions that had to be sourced from outside the area, the workers were often housed locally for several months at a time, receiving per diem allowances and local accommodations, which generated immediate additional spending for food, lodging, and retail purchases.

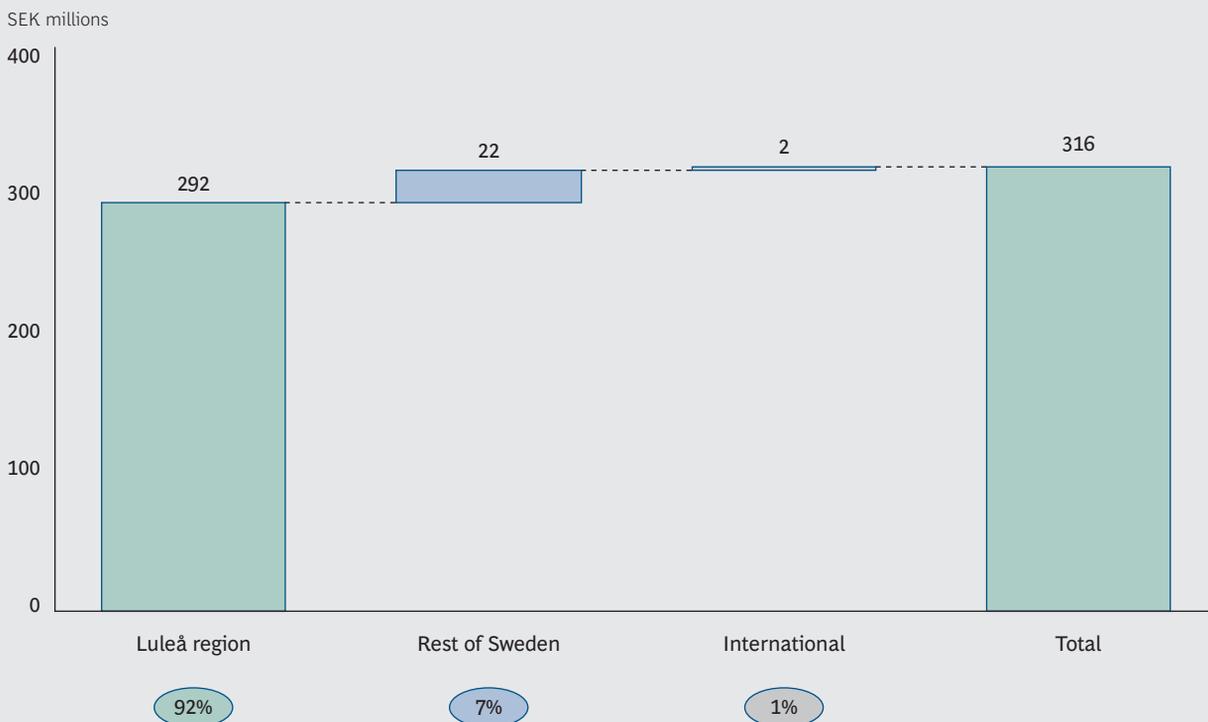
Construction of the second data center in Luleå began in April 2014 and is already showcasing the first use of the RDDC modular-construction concept, which will greatly

improve the speed of deployment and minimize environmental disruption. For the second data center, an estimated SEK 800 million of direct domestic investment is anticipated to fund the construction of office and facility buildings, mechanical and electrical work, logistics, and cabling infrastructure.¹

Operations. When all phases of both data centers are operating at steady state levels in 2018, annual operating expenses are expected to be about SEK 316 million. And unlike the construction phase, this direct investment is sustainable long term, benefiting the area going forward. (See Exhibit 7.) About 65 percent of the ongoing cost will be related to hydroelectric energy, which powers the server halls and is generated locally by Vattenfall. Facilities management, security, and Facebook personnel make up about 30 percent of the cost. Across the board, operating spending is expected to be almost entirely in the Luleå area, contributing SEK 292 million (92 percent of the total) to the local economy on a steady, annual basis.

For each of the aforementioned categories of direct spending—construction of the first and

EXHIBIT 7 | Facebook Will Invest About SEK 316 Million Annually in Operations



Sources: Facebook data; BCG analysis.

Note: Based on operations being fully ramped up for both data centers by 2018. Numbers have been rounded.

second data centers, as well as ongoing operations—it is critical to recognize that the money funding these expenditures comes almost entirely from outside Sweden. Facebook’s revenues, 89 percent of which came from advertising in 2013, are inherently global. Thus, this substantial direct investment in Luleå specifically, and in Sweden generally, represents a net gain to the country of more than SEK 4 billion in the first ten years.

Impact Assessment. In addition to the categories of direct spending mentioned earlier, Facebook’s investments generate further economic impact through spillover. Therefore, to completely assess the impact of Facebook’s investment on Sweden, we should consider this broader re-circulation of the core investment through interdependent industries and households that are part of the local and national economy.

This full economic impact is estimated using standard econometric modeling, typically referred to as the expenditure approach owing to its mathematical foundation of detailed, firsthand cost data across sectors for a given project or investment, which in this case is the construction and operation of a large-scale global data center. (See the Appendix for details.)

Using this methodology, the direct-spending impact of a given project is augmented by the

following two categories of spillover effects. (See Exhibit 8.)

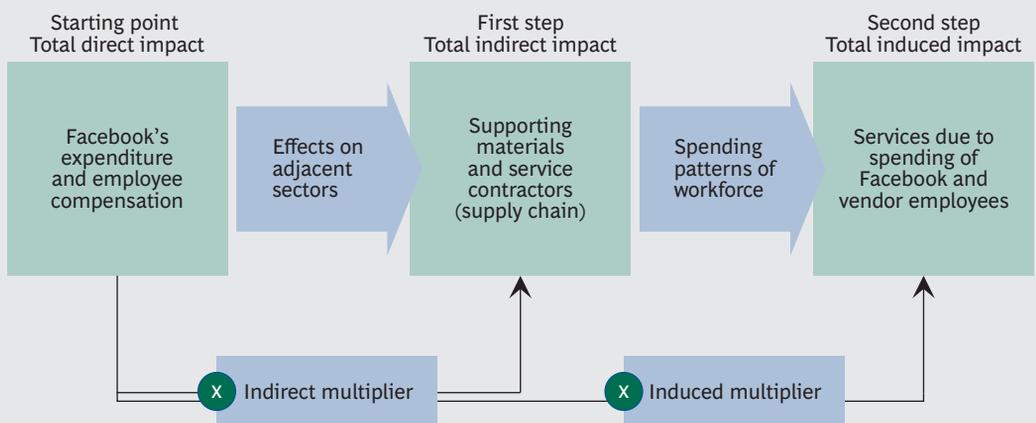
- **Indirect Impact.** Also known as supply chain impact, indirect impact measures the intermediate supply-chain elements that go into the production of a good or service and that are sourced locally or nationally. For example, Facebook’s spending on local IT services would yield indirect impact through the goods and services (such as office supplies and travel services) used by the IT companies themselves to fulfill the service.
- **Induced Impact.** This results from the payroll expenditures made by Facebook and its supporting vendors. Payroll expenditures boost household income and drive additional consumption in the area, typically in categories such as retail, travel, and lodging.

To summarize and easily compare indirect and induced effects, it is common to quote economic multipliers, which provide a simple quantification of economic linkage—the larger the multiplier, the more a given investment impacts other sectors in the local or national economy.

$$\text{Type I multiplier} = [\text{direct}] + [\text{indirect}]$$

$$\text{Type II multiplier} = [\text{direct}] + [\text{indirect}] + [\text{induced}]$$

EXHIBIT 8 | Total Economic Impact Is Derived from Direct, Indirect, and Induced Spending



Source: BCG analysis.

For example, if SEK 1 million is directly invested across one or more sectors, it might yield SEK 700,000 of indirect impact and SEK 600,000 of induced impact, summarized by a Type I multiplier of 1.7x and a Type II multiplier of 2.3x.

Although the calculations themselves are conducted on disaggregated spending data, the final multipliers are typically reported across sectors as a single blended value for easy comprehension.

Total Economic Impact. For the construction of the first data center, Facebook's SEK 1.5 billion of domestic spending generated an estimated SEK 1 billion in indirect impact nationwide, for a Type I multiplier of 1.7x, and about SEK 900 million in induced impact, for a Type II multiplier of 2.3x, yielding a full impact of about SEK 3.5 billion countrywide, spread across the construction period from 2011 through 2013.

In the Luleå area specifically, the indirect impact is somewhat limited, because of the ability of a relatively small regional economy to provide the needed goods and services. Induced impact, however, is more confined to the Luleå area, owing to the local nature of the construction workforce and the relative isolation of the area, situated about 900 kilometers north of Stockholm. The employment of hundreds of laborers for the 18-month construction phase spurred significant induced spending, with slightly more than half benefiting regional establishments and the remainder "leaking" to Sweden more broadly.

In the peak construction year, 2012, we estimate the full economic impact of Facebook's activities to be about SEK 800 million in the Luleå area alone, equating to a substantial 1.5 percent of the gross regional product (GRP) for Luleå FA for the year.^{2,3}

Looking ahead to the construction of the second data center, the Type I and Type II multipliers are expected to be very similar to the multipliers for the first center (1.7x and 2.3x, respectively), the result of a similar industrial composition (construction, logistics, and so on).

Finally, once both data centers are operational, ongoing expenses will also generate spillover effects but with lower multipliers than those for the construction period. This is because the industries involved—primarily energy and to a lesser extent facilities management and security—have less economic interdependency, and thus, lower multiples.

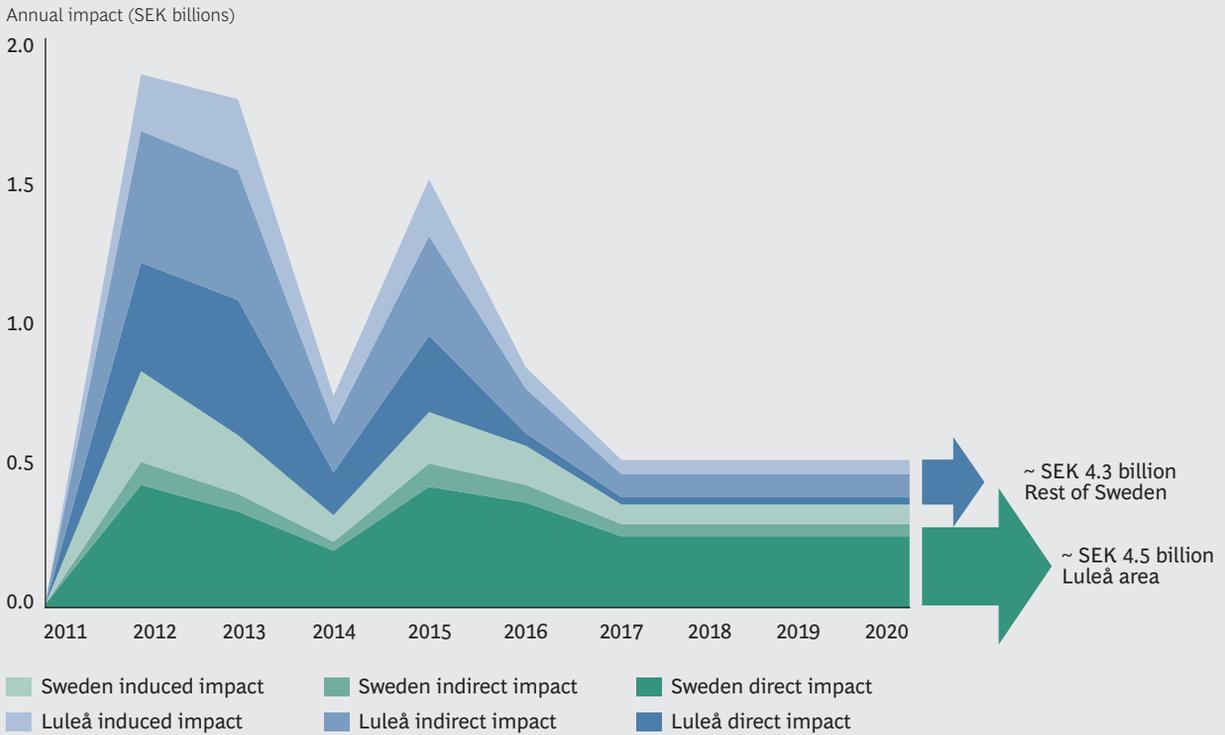
The employment of hundreds of laborers spurred significant induced spending.

The SEK 316 million in direct annual operational spending is expected to generate an additional SEK 130 million of indirect impact (Type I multiplier of 1.4x) and a further SEK 130 million of induced impact (Type II multiplier of 1.8x). In total, the estimated operational impact is nearly SEK 600 million annually, with a substantial 74 percent accruing locally in the Luleå area. Comparing this local impact again with the GRP of Luleå FA, Facebook's operations will account for an estimated 0.75 percent of GRP in 2018, with similar contributions expected in the years following.

Ten Years in Sweden. The overall monetary impact of the establishment of Facebook's data center in Luleå can best be described in summation over a ten-year horizon, capturing the construction and initial operations of both data centers. In just under ten years since breaking ground in the fall of 2011, the accumulated impact will have reached SEK 9 billion—slightly more than half of which will hit the local region specifically. (See Exhibit 9.) This is the result of more than SEK 4 billion in direct investment, plus additional indirect and induced impacts—a Type I multiplier of 1.6x and a Type II multiplier of 2.1x overall.

The broader impact within construction phases is more leaking to Sweden as a whole, while the impact of ongoing operations mostly accrues locally. Thus, as the Luleå data centers continue operations beyond 2020, the regional share of the total impact will continue to climb higher each year: 52 percent in

EXHIBIT 9 | By 2020, Facebook’s Total Impact on Sweden Will Reach About SEK 9 Billion



Sources: Facebook data; BCG analysis.

2020, 53 percent in 2021, 54 percent in 2022, and so on.

Generating Local Employment

The construction of Facebook’s first data center in Luleå generated a surge in local employment from 2012 through 2013. The city will see another surge during the construction of the second data center from 2014 through 2016. Finally, a stream of steady employment will be created to operate the data centers on an ongoing basis. (See Exhibit 10.)

During the first construction phase, construction laborers, contractors, and subcontractors benefited the most from direct job creation, with the vast majority of workers living locally in Luleå or commuting short distances to the site. Interviews indicate that up to 10 percent of the workers were freshly hired to meet the unusually high demand from Facebook’s construction, and many were retained following project completion. In addition to basic construction labor, specialists—such as cement professionals, HVAC installers, structural engineers, and supervising staff—

were also needed. However, such specialists were more likely to have been flown in, mostly from other areas of Sweden.⁴

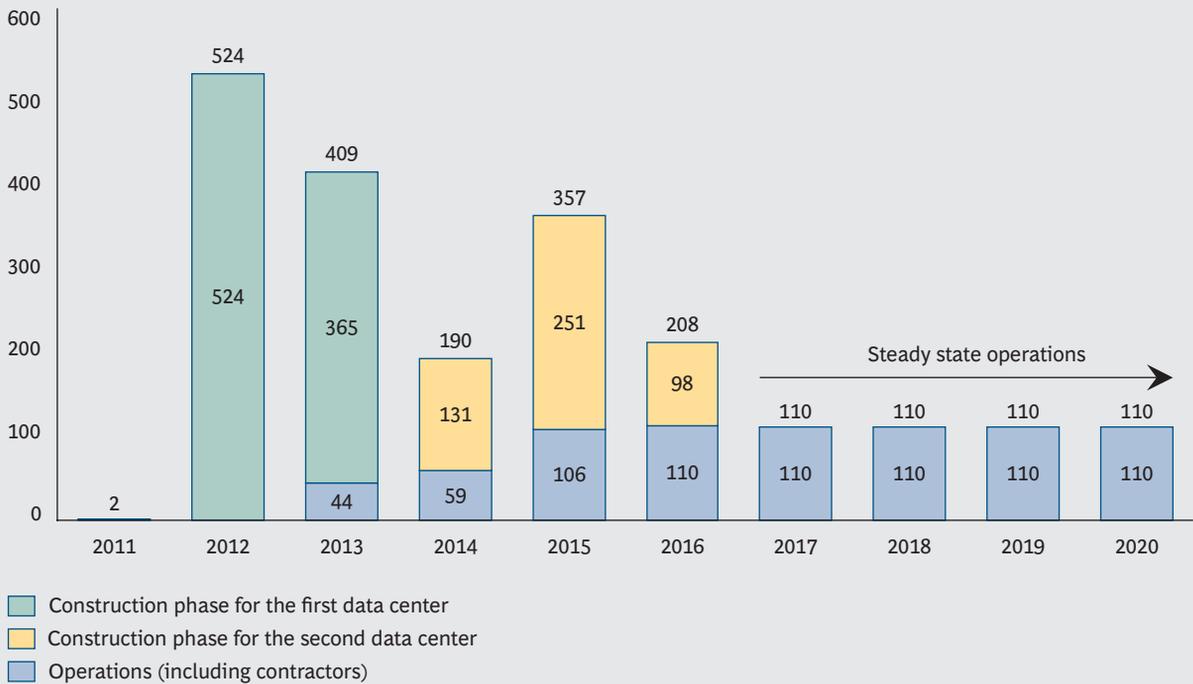
For 2012, the peak year of construction for the first data center, the full direct employment created in Sweden is estimated to have been more than 500 full-time-equivalent (FTE) jobs. The workers who filled these positions were core construction laborers, mechanical and electrical engineers, and logistics specialists, among others. During the full construction period, this number would reach about 900 FTEs overall.

Although the day-to-day operation of data centers is less demanding than construction from a labor standpoint, the two centers combined will require about 120 FTEs each year, in perpetuity. This includes Facebook employees and contractors providing IT maintenance, logistics, network servicing, facilities management, and security and janitorial services.

The numbers presented here are calculated estimations of the number of employees re-

EXHIBIT 10 | During Peak Construction, Facebook Created About 500 Full-Time Jobs in Sweden

Domestic full-time employees required to produce Facebook's direct spending



Sources: Facebook data; SCB employment data; BCG analysis.

Note: All full-time employees calculated as full-year equivalents: 40 hours per week for 48 weeks per year.

quired to produce Facebook's direct spending across all affected sectors, year by year, and counted as FTEs working 40 hours a week, 48 weeks per year. These calculated estimates are based on actual employment data collected by the Swedish government indicating the number of hours worked within a given sector and matched to the actual output generated by the corresponding sector.⁵ Thus, it is possible to estimate the employment required, industry by industry, to meet the direct needs of Facebook over time. Although this method of estimation is more consistent and comprehensive than manual counting, it is, of course, a calculated estimate. Thus, we have complemented our mathematical modeling with a more qualitative understanding of employment impact, derived from interviews with Facebook, its largest vendors, and community leaders.

Much like expenditure impact, the full employment impact of establishing a data center and running its operations goes beyond direct job creation. Using a similar expenditure-based impact model, we can estimate the additional employees required to produce the indirect or supply chain

inputs, as well as the induced expenditure by Facebook and vendor employees. The magnitude of indirect and induced job creation is similarly dependent on the relative regional and national insulation of a given industry, as well as the human capital required to produce various types of products and services.

Using this methodology, over the course of the construction of the first data center (from 2012 through 2013), it is estimated that Facebook generated approximately 500 additional jobs in Sweden—measured as FTEs for one full year (full-year equivalents)—in order to produce all of the domestically sourced supply-chain inputs. In addition, approximately 400 jobs were required to produce the induced spending from Facebook and vendor salaries, with about half of that impact sourced locally in the Luleå region. Overall, this means that the full national-employment impact of constructing the first data center was approximately 1,800 jobs—about double the direct impact alone.

The full impact of annual operations is measured similarly: 120 direct jobs for Facebook

and on-site contractors, as previously described, an additional 66 jobs to create indirect inputs (for example, utilities and accounting), and 69 more to cater to the induced spending (for example, retail). This yields a full impact of 255 jobs per year, a Type II multiplier of 2.1x for the direct impact alone, with 70 percent of the full employment impact occurring in the local region.

If we again look at the full impact over the course of ten years through 2020, Facebook will have directly created 2,200 jobs, two-thirds of them locally in Luleå, with a full impact of 4,500 full-year equivalents throughout the broader national economy, including supply chain and induced effects. (See Exhibit 11.)

A Ripple Effect

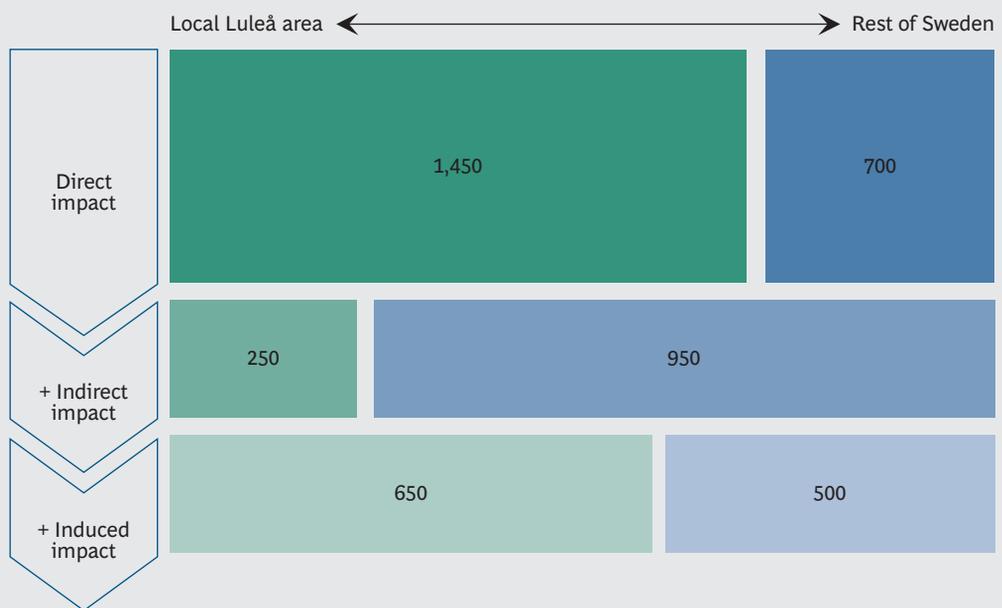
In addition to the clear economic and employment impact, the establishment of Facebook’s data center in Luleå has nonquantifiable but equally important effects on the region. The Node Pole, a regional business organization, had reported leading indicators of broader impact only one year after construction—intangible effects, such as heavy publicity that put Luleå “on the map,” and more

tangible ones, such as attracting supporting vendors to the region.

Emerging Ecosystem. Luleå, already an established hub for information and communication technology (ICT) companies, has seen a recent acceleration into what many have dubbed a “digital industrial era” in the region. Facebook’s firsthand need of advanced support services motivated the recent establishment of local branches of multiple international service companies, including Fusion-io (big data and cloud applications), EMC (storage), and Milestone (IT solutions). Cygate, a major subsidiary of Telia, is opening an office in Luleå with 5 to 10 employees, and the large IT company Atea has recently acquired a Luleå company with 90 employees to locally position itself in the outsourcing sector.⁶

Furthermore, after only ten months of construction, The Node Pole reported a 25 percent increase in the number of new companies opening in the Luleå Science Park, an IT hub that already has more than 3,000 people and is equidistant from LTU and Facebook. These preliminary signs point to a broader, much-anticipated trend: ICT businesses clustering in the area in order to partner with or provide services to Facebook.

EXHIBIT 11 | By 2020, Facebook Will Have Engaged 4,500 Full-Year Workers in Sweden



Sources: Facebook data; SCB employment data; BCG analysis.

Strong Foundation. On an equally tangible level, the establishment of Facebook's data center has demanded substantial investments in local infrastructure. For example, telecom operator TeliaSonera announced a major investment in laying a new high-capacity fiber cable, stretching 1,250 kilometers from Luleå to Örebro and connecting the region to the Internet backbone. The investment is worth SEK 370 million and is intended to contribute to strengthening local fiber and mobile network connectivity. The project will also make the region more attractive to global Internet companies looking to establish data centers.⁷

Business and infrastructure gains have been further complemented by regional cooperation, drawing together a range of business, academic, and government stakeholders to support local development. A notable example is The Node Pole itself, which encompasses the municipalities of Luleå, Piteå, and Boden. The Node Pole cooperates with the Luleå Business Agency and has a close partnership with Business Sweden.⁸ Furthermore, Facebook's Community Action Grant Program works to foster local collaboration by awarding grants for projects that leverage technology for a community's benefit. In the first round of grants in 2014, Facebook awarded approximately SEK 500,000 to local organizations.

Regional Publicity. Additionally, the impact from publicity has been outstanding: more than 1,500 articles globally announcing Luleå's selection for Facebook's data center, as well as enthusiastic discussions of the technology employed and the smart use of Sweden's chilly climate.⁹ Relative to peers, Facebook is very open about the internal mechanics of the data center and its open-source equipment. This transparency has furthered the publicity impact, as management widely and openly discusses the Luleå data centers at international technical conferences and has provided tours to key industry and government stakeholders.

Knowledge Base. The boost in regional publicity can be further seen through an all-time-high application volume to Luleå Technical University. Since construction

began in 2011, overall application volume has increased by almost 20 percent—the highest growth of any university in Sweden.¹⁰ Administrators cite Facebook's strong international brand as a huge driver of interest, particularly in IT engineering fields, many of which have seen applications increase by more than 100 percent during that same time frame. Ultimately, the added interest in and demand for IT education in the area contributes to a durable foundation of skilled labor in Luleå, feeding the growing demand from clustering ICT employers.

Furthermore, the area is benefiting from skill-building in data center construction. Since completing the first data center, Swedish construction company NCC has created a special division with expertise in data center construction, which is actively marketing its experience with Facebook to solicit further data-center construction projects.

Each of these effects—a proficient ICT-skilled workforce, a baseline of infrastructure and support services, and a government and business community with deep topic expertise—are not easily quantifiable on an individual level. However, they contribute to a virtuous cycle that makes the Luleå area increasingly attractive for establishing ICT companies and data centers.

NOTES

1. Facebook data, 2014; vendor interviews, 2014.
2. Luleå FA encompasses Luleå, Boden, Älvsbyn, and Piteå.
3. The GRP of Luleå FA is from SCB.
4. Facebook data, 2014; vendor interviews, 2014.
5. SCB employment data.
6. The Node Pole; Cygate; Atea.
7. The Node Pole.
8. Tillväxtverket, 2013.
9. The Node Pole.
10. The Swedish Council for Higher Education.

AN OPPORTUNITY FOR SWEDEN TO GROW ITS DATA-CENTER INDUSTRY

HOW LARGE IS THE data center opportunity going forward, and how is Sweden positioned to win? Global data-center demand will continue to increase, with more than 60 new large data centers expected in western Europe by 2020. Sweden could compete for these investments and aspire to build a substantial data-center industry.

Increasing Competition for Digital Investments

As enterprises and third-party providers hasten investments to keep up with expanding data traffic, the landscape is increasingly shifting towards larger-scale, purpose-built facilities with a focus on operational cost and efficiency. IT research firm Gartner forecasts the addition of about 250 large-scale data centers globally by 2017, with about 30 located in western Europe. Gartner defines “large” to be more than 15,000 square feet or 500 racks.¹ Even among this group, Facebook’s two Luleå data centers are truly giants—only a handful of these new centers will rival Facebook’s data centers in size.²

Considering Facebook’s time line for researching and constructing its Luleå facilities, it is fair to assume that the preparations for many of these forecasted investments are already under way. However, the forecast for 2020 effectively doubles the number of large data centers expected in western Europe to

60, the majority of which are yet to be allocated geographically. This more medium-term view represents, at the highest level, the pool of opportunity for Sweden.

Over this same time frame, the due diligence process that defines data center geographic placement is fundamentally changing. Historically, data storage has rested at the bottom of the IT value chain, receiving little attention, particularly from traditional enterprises. But looking ahead, capacity growth will be heavily driven by global Internet companies and third-party storage providers that view IT investment as a business cornerstone, a major capital expenditure, and a substantial part of their ongoing cost and regulatory responsibility.³

This shifting landscape has begun to change the focus from the traditional location strongholds of France, Germany, the Netherlands, the UK, and the U.S.—and specifically, from the major urban western European hubs of Amsterdam, Frankfurt, London, and Paris—to whatever country and city can host facilities that are larger, greener, and less expensive to operate.

Many global Internet companies, such as Facebook, had historically housed their data domestically but have begun to expand their footprint globally. Although Oracle, for example, opted for traditional locations in the

Netherlands and the UK, more recent placements by marquee global Internet companies were less traditional: Google and Yandex located data centers in Finland, for example, and Facebook chose Sweden.

Furthermore, third-party providers, which have historically preferred tight control over facilities and close proximity to clients, are slowly shifting toward more regional or even global models, as they, too, yield to cost and capacity pressures. Colocation providers and wholesale operators have been traditionally constrained by latency concerns. Therefore, they have opted for close connections to ensure an uncompromised user experience. Although some functions such as trading, media streaming, gaming, and real-time business applications are highly sensitive to latency, there are others such as cloud storage, e-mail, social networking, and chat functions that are rather insensitive. Thus, a shift toward a more segmented mentality among third-party providers allows for consideration of more outlying

data-center locations, rather than defaulting to the needs of the most demanding functions.⁴

The Potential to Become a Global Leader

In an increasingly flexible supply landscape, Sweden is well positioned to capture a disproportionate share of the 60 new large-scale data centers expected in western Europe by 2020. In fact, the most recent edition of the Data Centre Risk Index has placed Sweden as third in the world for data center locations. (See Exhibit 12.) The Data Centre Risk Index is compiled annually by a trio of real estate, engineering, and IT firms that rate 30 countries using a weighted series of risk factors that affect data center operation.⁵

Sweden scores strongly or at least moderately along all dimensions, with the exception of labor cost. Most significant in the index are energy cost, international bandwidth, and ease of doing business, which combine for

EXHIBIT 12 | Sweden Ranks Third Globally in the Data Centre Risk Index for 2013

Overall rank and trajectory, 2013	Energy cost		Ease of doing business		Political stability		Corporate tax		Education	
	International bandwidth	Natural disasters	Energy security	Sustainability	Labor cost					
U.S. (1) →	3	1	3	29	20	17	30	20	1	18
UK (2) →	21	2	5	12	15	23	12	26	13	16
Sweden (3) ↑	15	10	10	3	3	15	11	4	9	26
Germany (4) ↓	19	4	15	9	8	20	25	15	16	25
Canada (5) →	4	11	13	23	2	1	19	10	2	20
Hong Kong (6) ↑	27	3	2	16	10	29	4	28	23	9
Iceland (7) ↓	8	29	11	18	20	8	8	1	7	21
Norway (8) ↑	13	19	4	15	1	6	19	3	12	30
Finland (9) →	11	22	8	1	3	30	13	7	15	24
Qatar (10) ↓	1	30	21	2	12	7	2	30	19	28

Source: Data Centre Risk Index, 2013.

Note: Box width is indicative of weighting of individual criteria. The three smallest categories (weighted as approximately 3 percent together) are not shown. The trajectory is based on the change from the 2012 rank.

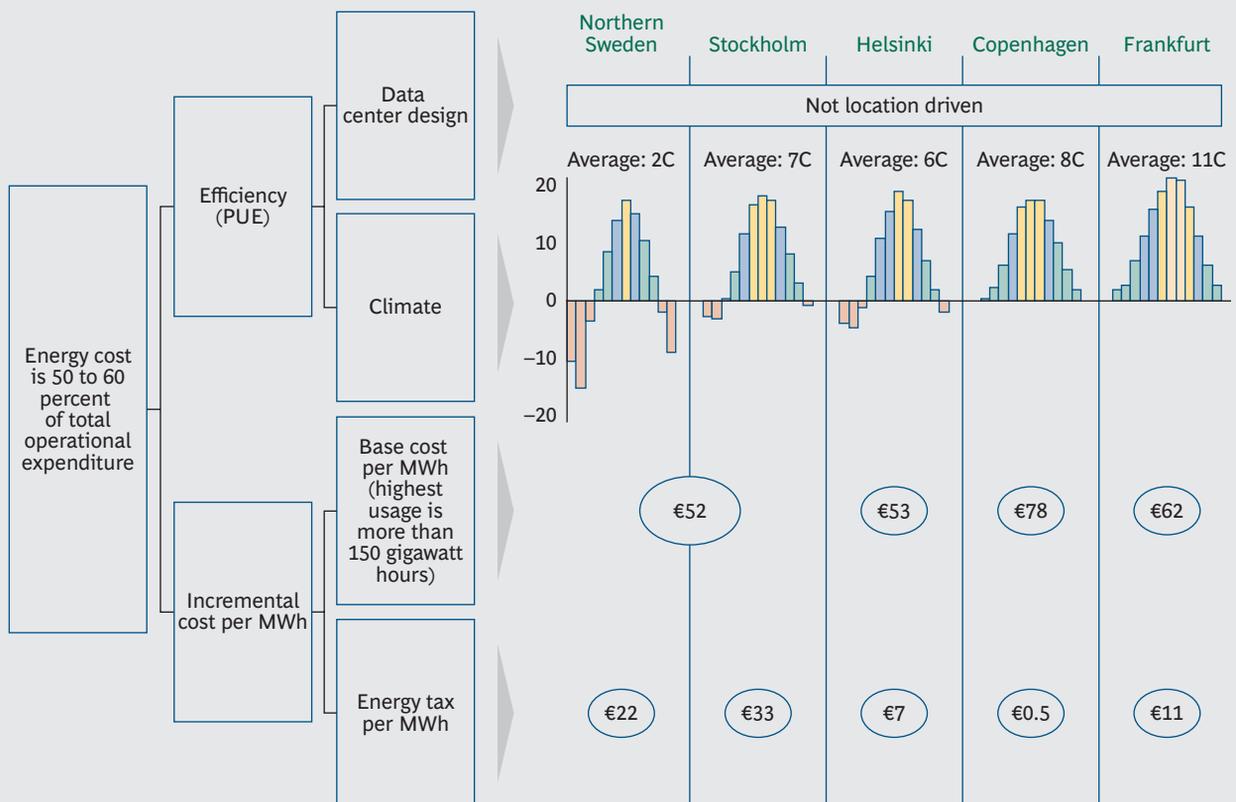
60 percent of the weighting. Sweden places in the top half for each of these anchor elements, but the country truly outshines its peers in the grouping of metrics around operational security—natural disasters, political stability, and to a lesser extent, energy security. Additionally, Sweden is a leader in sustainability, measured as the share of energy from renewable sources.

Although location due diligence begins at this sort of macro level, a final investment decision comes down to the intricacies of the local environment. Northern Sweden, in particular, offers an even more attractive environment than Sweden more broadly. The north's environment is characterized by a stable abundance of nearby renewable energy, discounted energy taxes, a persistently cold climate to aid in server cooling, and an ICT-trained workforce. Northern Sweden's hydroelectric power, in addition to being fully re-

newable, offers the more predictable long-term pricing that investors crave.

Often most significant in the decision process, particularly for global Internet companies, is the long-term cost of energy, which typically makes up at least 50 percent of ongoing operational expense for large centers—about 65 percent in the case of Facebook's Luleå facility. The cost of energy is driven by the incremental cost per megawatt hour (MWh) (both base cost and taxes) and efficiency (PUE), which is partially driven by local climate. (See Exhibit 13.) At a base level, Sweden's industrial energy prices are among the lowest in Europe, particularly for large industrial buyers using more than 150 gigawatt hours annually. (See Exhibit 14.) Thus, if electricity taxes were reduced to the EU minimum level, northern Sweden, with its low base-energy prices and climate-driven efficiency, could provide data center operators

EXHIBIT 13 | Northern Sweden Has a Base-Energy Cost and Efficiency Advantage

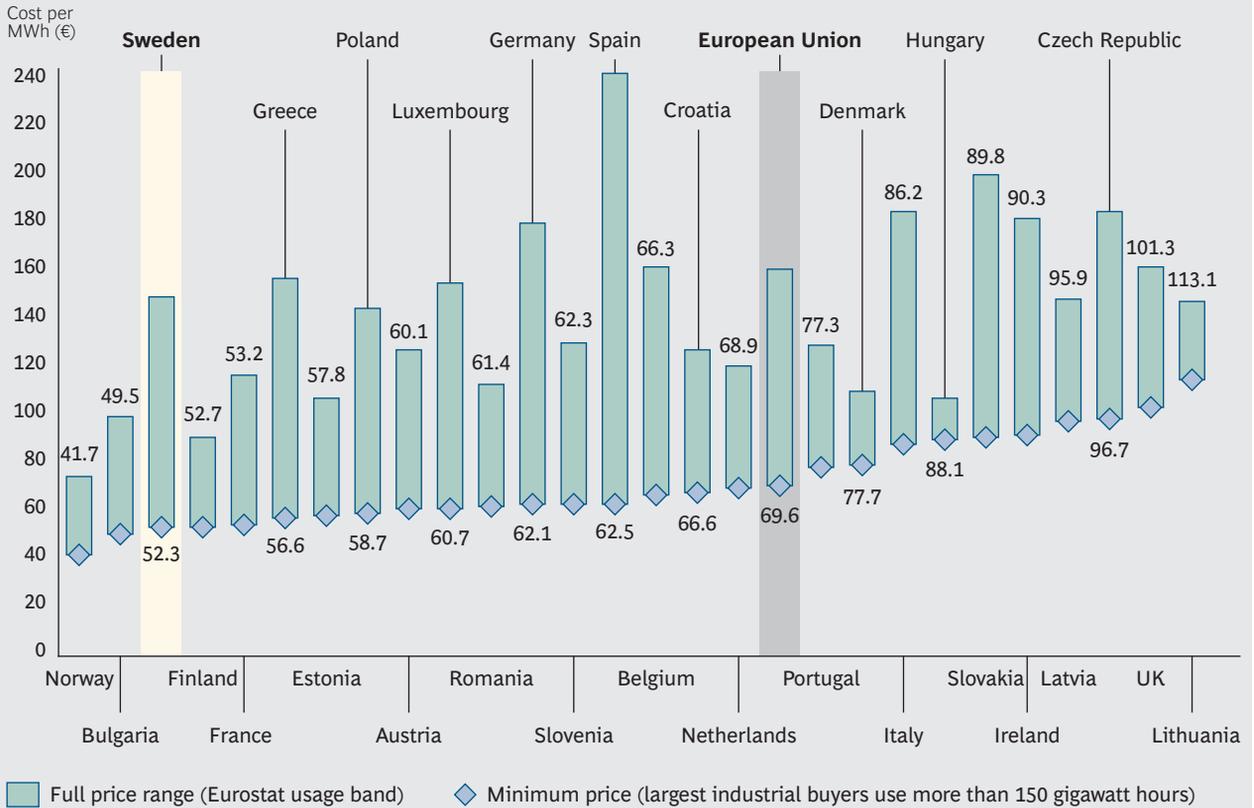


Sources: Eurostat; Finnish Ministry of Finance; European Commission; press releases.

Note: Finnish tax change was effective April 2014; contingent on power usage over 5 MW. Danish tax change was effective January 2014 (Act no 903/2013); minimum tax contingent on eligibility for tax repayment and deduction of input VAT. Frankfurt tax rate is based on German tax for business use from the European Commission, 2014.

EXHIBIT 14 | Sweden Is at the Low End of Pretax Electricity Pricing for the Largest Buyers

Range of industrial energy prices by EU country, excluding all taxes and VAT, 2013



Source: Eurostat, Q2 2013.

with an operating cost that rivals what most other countries in mainland Europe can offer.

However, while Sweden's base-energy costs are relatively low compared with those of its peers, the addition of electricity tax can erode that competitive advantage when compared with some potential alternatives, particularly its closely comparable Nordic neighbors. Taxation is one input over which countries have full discretionary control, however. Sweden should exercise its control, because as competition for major data-center investments intensifies, peer countries are exercising their control to push themselves to the top of location screenings.

For example, effective January 2014, Denmark lowered rates for qualified users to the minimum level allowed of €0.5 per MWh through a rather complex repayment and deduction system.⁶ Similarly, Finland amended its law on the tax on electricity for large data

centers, classifying them as industrial users and cutting the tax rate from €17 per MWh to only €7 per MWh, effective as of April 2014.⁷

In Sweden, however, large data-center operation is not yet classified as an industrial activity; thus, operators are paying €22 per MWh in the north and €33 per MWh in the remainder of the country. Approximately 55,000 manufacturing sites throughout Sweden, however, pay a mere €0.56 per MWh owing to their industrial classification—well beneath Finland's amended level and on par with Denmark's.⁸ The nature and concept of Swedish industry is changing rapidly, and Facebook's consumption of energy rivals that of many traditional industrial users but with much less detrimental effect on the environment. Clearly, Sweden needs to quickly reform and lower its electricity tax to remain globally competitive with other countries and support the growth of a new emerging digital industry. In fact, in May 2014, the Swedish Finance minister, Anders Borg,

announced the government’s intention to lower energy taxes for service companies in order to encourage the establishment of additional data centers.⁹

An Attractive Business Case for Sweden

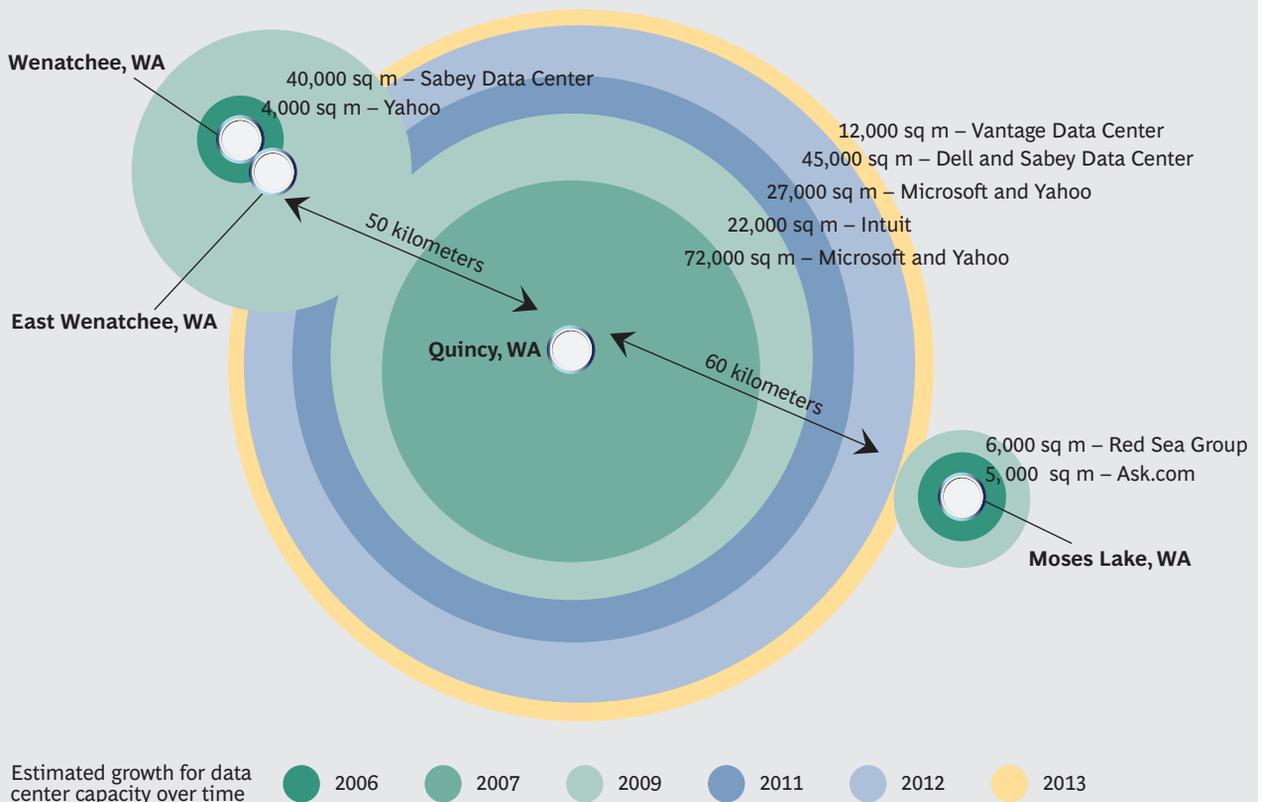
Given Sweden’s attractive national and regional characteristics, there is undoubtedly a strong opportunity to draw a disproportionate share of upcoming large-scale data-center investments to form a dominant ICT cluster in northern Sweden.

Furthermore, Sweden can leverage the establishment of Facebook’s data centers in Luleå to catalyze this growth, leaning upon Facebook’s thorough due diligence to bolster confidence among other data-center actors. In fact, a Stockholm-based Bitcoin miner company, KnCMiner, established a data center in Boden, only 16 kilometers from Facebook’s site in Luleå. Despite being Swedish, KnCMin-

er scanned globally for the optimal data-center location, but the company ended up in its backyard after careful due diligence, citing access to stable, renewable energy and a cold climate as key reasons.¹⁰ Following the same rationale, Hydro66, a UK-based colocation provider, recently unveiled its new data center in Boden, targeting the global wholesale and enterprise marketplace. Following these examples, if Sweden were to secure five more large-scale data centers by 2020, even at half the scale of one Facebook facility, the full economic impact would reach a magnitude of SEK 13 billion by 2030.

The cluster effect described above is not a novel concept; in fact, it has already taken place at numerous locations globally. In the U.S., central Washington, western North Carolina, and central Iowa have each witnessed a rapid growth of data center capacity as companies cluster around an initial major establishment. (See Exhibit 15.) Washington drew Yahoo, Microsoft, and Dell, while North Caro-

EXHIBIT 15 | A Data Center Cluster Was Amassed in Central Washington in Five Years



Source: Washington Research Council, 2013.
 Note: Sq m = square meter.

lina attracted Google, Apple, Facebook, Wipro, and Disney. Iowa drew Microsoft, Google, and Facebook. At a macro level, clustering can be location driven. For example, the East and West Coasts in the U.S. benefit from better intercontinental connectivity. However, in choosing specific regions for sites, large data-center actors value the due diligence conducted by their peers, trusting the regional capabilities and infrastructure, acknowledging a skilled and flexible talent pool, and benefiting from the network of supporting vendors and suppliers in the area.

However, in order to secure Sweden's position at the forefront of the data center industry, a clear strategy is required to address uncertainty or potential risk for major investors. Long-term energy cost, in particular, is a key decision criterion in choosing a location—not only the cost today but also a low-risk, secure expectation over a horizon of 10 to 20 years.

With Facebook's highly publicized choice to establish its data center in Luleå—boosting the local economy and setting the stage for an emerging digital ecosystem—Sweden is well positioned to attract further data-center investment and build the foundation for a new digital industry. Sweden should continue

to work actively in support of this development, taking deliberate steps to bolster cooperation from central and local governments, build out critical infrastructure, strengthen an already stable and green energy supply, and secure long-term electricity-tax competitiveness.

NOTES

1. Approximately 1,394 square meters.
2. Gartner *Forecast: Data Centers, Worldwide, 2010–2017, 2Q13 Update*.
3. BroadGroup.
4. BroadGroup.
5. The Data Centre Risk Index, 2013, Cushman & Wakefield; hurleypalmerflatt; Source8.
6. Denmark's parliament recently passed Act no 903/2013, which amends the Electricity Tax Act.
7. Finnish Ministry of Finance, press release, February 2014.
8. Eurostat, 2H 2013; Vattenfall, 2014.
9. Dagens Industri, May 19, 2014.
10. The Node Pole.

CONCLUDING THOUGHTS

THE PRIMARY OBJECTIVE OF our analysis was to understand the impact—on the economy and on the digital infrastructure—of the establishment of Facebook’s large-scale data center in Luleå in northern Sweden.

In this report, we conclude that the establishment of Facebook’s data center has generated and will continue to generate significant positive effects on the Swedish economy—a full impact of an estimated SEK 9 billion during the first ten years. In addition, broader societal effects are clearly visible: an emerging ICT cluster, the building of infrastructure, an improvement in regional publicity, and a more knowledgeable workforce. By understanding the decision process and rationale behind Facebook’s choice, as well as the underlying industry dynamics, we can further conclude that Sweden has a unique opportunity to form a leading cluster and attract additional data-center investments.

On this basis, we encourage further debate on how Sweden can accelerate and sustain its position as an attractive location for large-scale data-center operations. In particular, the following questions should be addressed:

- *How can the government and the private sector more strategically prioritize the business potential in building a substantial data-center cluster and industry in Sweden?*
Through Business Sweden, The Node

Pole, and the engagement of local municipalities and companies, Sweden has already built a strong ecosystem that is proactively working to attract new investments. How can these actors more strategically work together to strengthen Sweden’s relative advantage? What national and local initiatives are needed to secure a business climate that supports critical cooperation and innovation?

- *Is there an opportunity to better segment and prioritize potential global and regional colocation data-center players with a unique and strong Swedish value proposition?*
Sweden is advantaged by its cold climate, an abundance of renewable energy, a modern infrastructure, and vibrant business and digital communities. How can Sweden build on these strengths by better segmenting and prioritizing the data center landscape and by focusing efforts on the most relevant and attractive opportunities? What are the key decision criteria behind site location? How can a targeted marketing campaign be used to create awareness?
- *Can Sweden further increase its competitiveness as a host for large-scale data-center investments and operations by reviewing its energy taxation policy?*
Operating a data center consumes vast amounts of energy, often amounting to 50 to 60 percent of total

operational costs. With a cold climate, robust connection, and renewable energy sources, Sweden has a great foundation upon which to build; however, with an energy tax rate that's higher than many other countries, Sweden risks losing in relative competitiveness. How can proper energy-taxation policy be developed to bridge this gap? What is the optimal tax rate that would tip the scale in favor of more investments and ultimately help companies make a business case for Sweden?

- *What can be done to further accelerate the building of a world-class supply chain and ecosystem supporting large-scale data centers?* As evidenced by Facebook's decision to locate in Luleå and by Sweden's top-three position in the global Data

Centre Risk Index, the country has a lot of momentum. How can this position be strengthened even further? What key infrastructure development should be prioritized? What research and development activities should be funded? How can Sweden accelerate the virtuous circle by expanding the existing ecosystem and knowledge base?

If these challenges and opportunities are addressed, Facebook's site will likely prove to be the first of many large-scale data centers clustering throughout Sweden. In an accelerating digital era, hosting the core infrastructure will be a key driver of economic growth and prosperity positively impacting the whole country. Sweden should act on this opportunity to build a new industry for the future.

APPENDIX

IMPACT MODELING METHODOLOGY AND DATA SOURCES

The impact assessment presented in this report is rooted in input-output (I/O) analysis, which systematically captures the interdependence of a country's industrial sectors and the extent to which individual sector inputs are produced domestically. The core mechanics of our model were built using national I/O tables. These tables are consistently structured and can be obtained from government entities, such as SCB for Sweden.

A common and very precise form of I/O modeling is the expenditure approach, which leverages firsthand data that can be disaggregated in great detail and mapped to industrial sectors. The analysis offered in this report incorporated hundreds of line items of construction and operational expenditure data, which was provided directly by Facebook. Such detail allowed for a very high level of granularity.

For the assessment at a local level, it is necessary to also have regional coefficients that measure the sector-by-sector interdependence and propensity to import in a smaller, more finite region. For our analysis, the I/O model was "regionalized" using coefficients for Luleå FA provided by the Stockholm office of WSP Global. For household consumption patterns at a local level in Luleå FA, the local share of the full national induced impact has been estimated.

Detailed Overview of Indirect and Induced Impacts

Using the methodology described above, the direct-spending impact of a given project is augmented by the following two categories of spillover effects:

- *Indirect Impact.* Also known as supply chain impact, indirect impact measures the intermediate supply-chain elements that go into the production of a good or service and that are sourced locally or nationally. The supply chain inputs required for a given direct investment are estimated by disaggregating overall expenditure and analyzing the precise sector-by-sector interdependence of each line item, defined in national I/O tables.

For example, spending in the construction industry demands indirect input of architectural and engineering services, wood and metal products, and shipping and warehousing services, among other items. Furthermore, the I/O tables take into account the relative insulation of specific industries in the country. Although computer products, for example, have approximately 60 percent imported inputs originating outside Sweden, the construction industry is far more domestically insulated, with about 20 percent imported inputs. Thus, the supply chain impact in Sweden is greater for an

equivalent amount of spending on construction.

- *Induced Impact.* This results from payroll expenditures, such as those made by Facebook and its supporting vendors. Payroll expenditures boost household income and drive additional consumption in the area. Induced impact flows to the local and national economies according to an expenditure equation of typical household consumption, which is led by food, lodging, and retail purchases, among other items. The induced impact tends to be more localized than supply chain inputs, particularly for a relatively isolated region such as Luleå, which is situated about 900 kilometers north of the Swedish capital of Stockholm.

Employment Calculations

The direct employment values presented in this report are calculated estimations of the number of employees required to produce Facebook's direct spending across all affected sectors, year by year, and counted as FTEs working 40 hours a week, 48 weeks per year. These calculated estimates are based on actual employment data collected by the Swedish government (provided by SCB) indicating the number of hours worked in a given sector and matched to the actual output generated by the corresponding sector. Thus, it is possible to estimate the employment required, industry by industry, to meet the direct needs of Facebook over time.

Although this method of estimation is more consistent and comprehensive than manual counting, it is, of course, a calculated estimate. Thus, we have complemented our mathematical modeling with a more qualitative understanding of employment impact, derived from interviews with Facebook, its largest vendors, and community leaders.

Full employment impact, including indirect and induced impact, is again derived on the basis of industry-by-industry labor requirements according to hourly government employment data (as described earlier for direct employment estimations), but this time it was matched to economic I/O relationships.

For example, construction work requires about 88 percent of a FTE worker to produce SEK 1 million of final output in a year, plus another 40 percent of a FTE worker to produce the domestically sourced indirect inputs needed. Computer equipment, which is both less domestically insulated and less labor intensive, requires only 40 percent of a FTE worker to produce SEK 1 million of final output in a year, plus another 24 percent of a FTE worker to produce the domestic indirect inputs needed. Thus, Facebook's domestic spending on construction goes much further from a job-creation standpoint than the same amount spent in computer equipment. Both, however, would generate fewer jobs than the same SEK 1 million spent on restaurants or hotels, for example, which are even more labor intensive.

NOTE TO THE READER

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