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Copenhagen Economics

Finland's economic opportunities from data centre investments

A study prepared for Google

April 2017

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Alkusanat

Tämä raportti on kirjoitettu Googlen toimeksiannosta, ja sen tarkoituksena on tunnistaa ja mahdollisuuksien mukaan arvioida määrällisesti datakeskusten heijastusvaikutukset Suomen talouteen.

Raportti on kirjoitettu tiiviissä yhteistyössä Valtioneuvoston kanslian sekä Työ- ja elinkeinoministeriön kanssa.

Olemme kiitollisia saamistamme näkemyksistä ja kommenteista, jotka ovat tuoneet raportille lisäarvoa ja auttaneet saavuttamaan lopputuloksen, joka tuo lisäarvoa suomalaiseen päätöksentekoon ja lopulta myös edistää suomalaisten ihmisten ja yritysten etuja.

Kaikki raportin mielipiteet ja päätelmät ovat omiamme.

Tiivistelmä

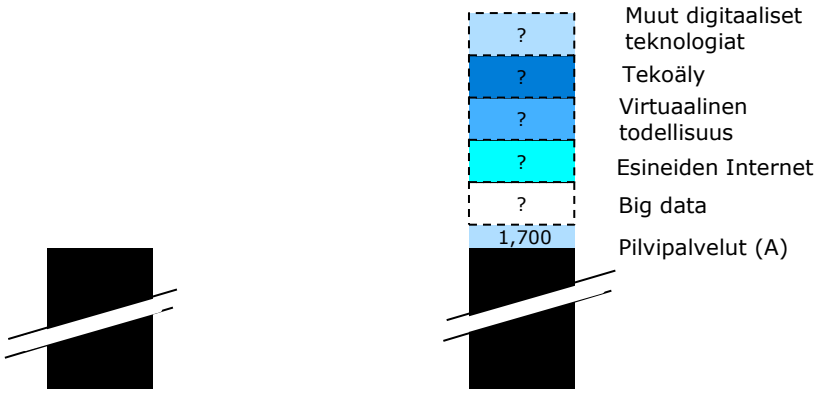
- **Datakeskukset ovat osa verkkoinfrastruktuuria.** Datakeskuksissa dataa säilytetään ja prosessoidaan turvallisesti ja tehokkaasti asiakkaiden, kuten kuluttajien ja yritysten, puolesta käyttämällä hyväksi pilvipalveluita ja muita tietoteknisiä ratkaisuja.
- Googlen investoinnit **Haminan datakeskukseen** ovat tuoneet yhteensä 660 miljoonan euron talousvaikutukset Suomeen vuosien 2009 ja 2015 välillä. Vuositasolla investointien suuruus on ollut noin 95 miljoonaa euroa, jonka lisäksi investoinnit ovat samalla ajanjaksolla tuoneet Suomeen yli 1600 työpaikkaa.
- **Heijastusvaikutus on taloudellinen ilmiö,** joissa yhden teollisuudenalan (esim. datakeskusten) toiminnot **luovat lisäarvoa läpi arvoketjun -** esimerkiksi lisäävät palveluntuottajien tuottavuutta ja hyödyttävät koko ketjua loppuasiakkaaseen asti.
- Suomi hyötyy jo nyt vahvasta datakeskusteollisuudesta, jonka lisäksi datakeskuksiin liittyy Suomessa merkittävä realisoitavissa oleva lisäpotentiaali.
- **Selvityksen keskeinen lopputulema on,** että mikäli Suomi onnistuu täysin realisoimaan datakeskusten heijastusvaikutukset, vuonna 2025 datakeskusteollisuuden kokonaisvaikutukset vastaavat vuositasolla 2,3 miljardia euroa ja 33 000 työpaikkaa.

Datakeskusten keskeinen rooli modernissa taloudessa
Datakeskukset ovat merkittävä osa modernia digitaalista taloutta ja digitalisaatiota. Monet tärkeistä talouden mullistavista innovaatioista ovat riippuvaisia datakeskuksista nojaten niiden tarjoamiin laskenta- ja tallennuspalveluihin. Nämä uudet digitaaliset palvelut muovaavat talouttamme ja uudistavat jo olemassa olevia ja vakiintuneita teollisuus- sekä palvelusektoreita.

On selvää, että digitalisaatiolla on merkittäviä positiivisia taloudellisia vaikutuksia. Datakeskukset niin Suomessa kuin ulkomaillakin tuovat edistyneet pilvipohjaiset palvelut ja niiden mukanaan tuomat edut kaikkien yritysten saataville, koosta riippumatta. Lisäksi datakeskukset mahdollistavat uudenlaisten dataintensiivisten tuotantotapoja ja elämää mullistavien palveluiden kuten esineiden internetin (*internet of things*), tekoälyn, big datan ja virtuaalitodellisuuden kehittämisen.

Vaikka tällä hetkellä kaikkia datakeskusten tuomia heijastusvaikutuksia ei voida täsmällisesti arvioida, yksin pilvipohjaisten palveluiden perusteella arvioimme, että kokonaisvaikutus taloudelle on suuruusluokaltaan 1,7 miljardia euroa.

Kuva 1 Datakeskusten heijastusvaikutukset suomalaisiin yrityksiin digitalisaation kautta



Lähde: Copenhagen Economics. Yksikkö: miljoonaa euroa

Pilvipalveluiden lisäksi heijastusvaikutukset toteutuvat myös muiden palveluiden ja teknologioiden kautta. Yllä olevassa kuvassa eriteltyjen palveluiden markkinan Suomessa on arvioitu olevan suuruudeltaan noin 7 miljardia euroa vuoteen 2025 mennessä. Koko markkinan arvo on pilvipalveluiden arvoa huomattavasti suurempi, mistä johtuen myös vaikutukset bruttokansantuotteeseen ovat pilvipalveluiden vaikutusta suuremmat. Koska näiden uusien teknologioiden ja palveluiden kehitys on tulevaisuudessakin riippuvaista datakeskuksista, tulevat datakeskusten heijastusvaikutukset näihin teknologioihin puolestaan olemaan merkittäviä.

Suomen datakeskusteollisuuden heijastusvaikutukset

Digitalisaation mukanaan tuomat innovaatiot itsessään tuovat Suomelle - kuten mille tahansa digitalisoituvalle taloudelle - merkittäviä mahdollisuuksia. Nämä tekniset innovaatiot ovat kuitenkin riippuvaisia datakeskusten tarjoamasta infrastruktuurista. Datakeskusinfrastruktuurin kehittämisen voidaankin arvioida tuovan Suomelle huomattavia lisämahdollisuuksia kasvun ja työllisyyden edistämiseen.

Suomella on useita strategisia etuja vahvan datakeskusteollisuuden ylläpitoon. Hallituksella on erillinen strategia datakeskuksiin liittyvien investointien edistämiseen. Lisäksi Suomen etuina ovat sekä hyvät kansainväliset tietoliikenneyhteydet sekä vakaa sääntely-ympäristö. Nämä vahvistavat entisestään Suomen rakenteellisia, datakeskusteollisuudelle suotuisia olosuhteita, kuten Suomelle ominainen ilmasto ja energian saatavuus.

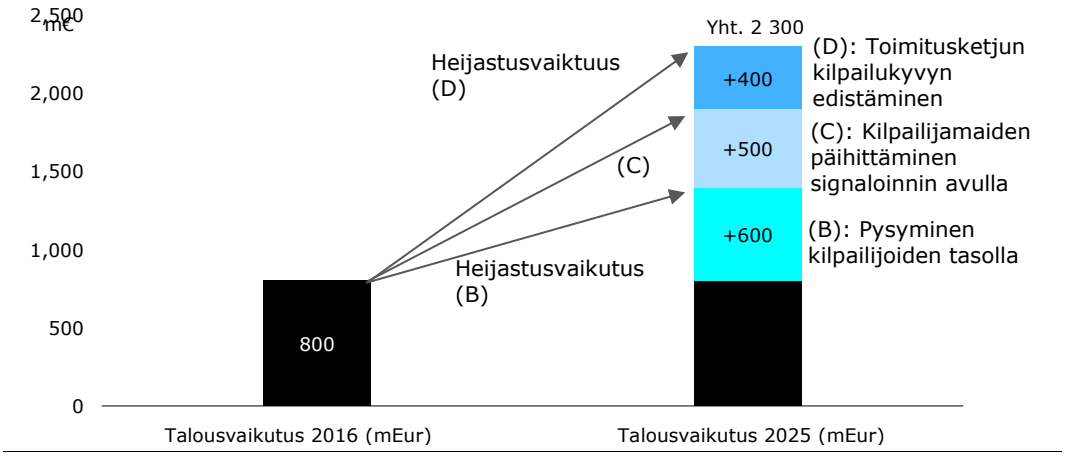
Suomi hyötyy jo nyt edellä mainituista panostuksista. Suomen datakeskusten taloudellinen kokonaisvaikutus vuonna 2016 oli lähes 800 miljoonaa euroa (sisältäen suorat ja epäsuorat vaikutukset) ja 11 200 työpaikkaa. Näiden lisäksi olemme arvioineet

kolme heijastusvaikutuskanavaa jotka tarjoavat mahdollisuuksia datakeskusteollisuuden taloudellisten vaikutuksen maksimointiin:

- Maltilliset uudistukset nykyisen datakeskusteollisuuden toimintaympäristöön ja puitteisiin Suomen kansainvälisen kilpailukyvyn ylläpitämiseksi ja datakeskustoimialan globaalin, keskimäärin 10% kasvunopeuden saavuttamiseksi – Heijastusvaikutus (B): ylimääräiset 600 miljoonaa euroa ja 8 400 työpaikkaa vuosittain vuoteen 2025 mennessä.
- Signaloinnin kehittäminen: suorien ulkomaalaisten sijoitusten houkuttelevuuden lisääminen, kilpailevien maiden päihittäminen ja globaalin keskitason ylittävän 15% kasvunopeuden saavuttaminen - Heijastusvaikutus(C): ylimääräiset 500 miljoonaa euroa ja 7 200 työpaikkaa vuosittain vuoteen 2025 mennessä.
- Kilpailukyvyn lisääminen datakeskusten toimitusketjussa, mukaan lukien tietotaidon ulkoisvaikutukset datakeskustoimittajille – Heijastusvaikutus(D): ylimääräiset 400 miljoonaa euroa ja 6 100 työpaikkaa vuosittain vuoteen 2025 mennessä.

Mikäli Suomi onnistuu realisoimaan ylläolevat heijastusvaikutukset kokonaisuudessaan, datakeskusteollisuuden taloudellinen kokonaisvaikutus nousee 2,3 miljardiin euroon ja 32 900 työpaikkaan vuosittain.

Kuvaaja 2 Suomen datakeskusteollisuuden heijastusvaikutukset toimittajien ja signaloinnin kautta



Lähde: Copenhagen Economics. Yksikkö: miljoonaa euroa

Seuraavat askeleet Suomen datakeskusteollisuudelle

Kansainvälinen datakeskusteollisuus kasvaa voimakkaasti ja Suomella on hyvä asema uusien datakeskusten houkuttelemiseksi. Suomi tarjoaa suotuisat olosuhteet datakeskuksille ja hyötyy myös itse näiden palveluiden olemassaolosta. Nämä hyödyt eivät kuitenkaan ole riippuvaisia pelkästään datakeskusten lukumäärästä, vaan on yhtä tärkeää, että päätöksentekijät maksimoivat Suomen datakeskusten mukanaan tuomat heijastusvaikutukset. Tällä tavoin Suomi saa parhaan mahdollisen taloudellisen edun jokaisesta datakeskuksesta, mukaan lukien uusien keskusten houkuttelu Suomeen.

Tämän potentiaalin saavuttaminen on mahdollista ottaen huomioon Suomessa jo olemassa oleva infrastruktuuri ja toimintaympäristö, mutta myös parannettavaa löytyy. Aloitteita vaaditaan niin EU:n tasolla, kuin myös valtakunnallisella ja paikallisella tasolla. Vaikka Suomi on hyvässä asemassa saavuttaakseen datakeskuksiin liittyvän potentiaalin maan korkean koulutustason, sääntely-ympäristön ja muiden tarvittavien resurssen puolesta, edessä on vielä työnsarkaa. Saavuttaakseen täyden hyödyn digitalisaation tuomista mahdollisuuksista suomalaisille yrityksille ja ihmisille täytyy olemassa olevia resursseja hyödyntää entistä paremmin.

Suomalaisilla päätöksentekijöillä on nyt mahdollisuus keskittää voimavaransa teollisuudenalaan, jossa Suomella on merkittäviä kilpailuetuja ja josta on mahdollista saada suuria taloudellisia hyötyjä rajoitetuin investoinnein. Valtaosa tarvittavista muutoksista on jo tehty, mutta täyden hyödyn datakeskuksista saavuttaakseen tulee Suomen koordinoida resurssit entistä paremmin. Tämä raportti tunnistaa ne toimenpiteet, joihin Suomen tulee keskittyä hyötyäkseen aiemmin tunnistetuista heijastusvaikutuksista parhaalla mahdollisimmalla tavalla ja maksimoidakseen datakeskusteollisuuden kasvu- ja työllisyysvaikutukset.

Taulukko 1 Toimenpiteet datakeskusten talousvaikutusten maksimoimiseksi esitettynä kunkin heijastusvaikutuksen mukaan

Haluttu heijastusvaikutus	€	Tärkeimmät toimenpiteet
(A) Heijastusvaikutukset suomalaisten yritysten digitalisaation myötä (muun muassa pilvipalvelut)	**1,7 mrd** euroa **2 400** työpaikkaa	• Edistää avointa ja kasvavaa digipalvelumarkkinaa EU-tasolla • Koordinoida akateemiset, kaupalliset ja hallinnolliset toimenpiteet digitalisaation edistämiseksi suomalaisissa teollisuus- ja palvelualan PK-yrityksissä • Taata näiden yritysten tietotekniset koulutustarpeet
(B) Pysyminen kilpailijoiden tasolla	**600mEur** **8 400** työpaikkaa	• Turvata nykyinen yksityisyys-, tekijänoikeus- ja tietosuojalainsäädäntö • Huolehtia paikallisten palvelutoimittajien kilpailykyvystä datakeskusteollisuudelle
(C) Signaloinnin kehittäminen: päihittää datakeskusteollisuuden globaali kilpailu kasvun ja ulkomaalaisten sijoitusten houkuttelevuuden lisäämisen avulla	**500mEur** **7 200** työpaikkaa	• Alentaa energiakustannuksia, saavuttaa top 5 -sijoitus globaalisti energiakustannusten houkuttelevuudessa • Suunnitella sijoitusvalmiita kohteita useille datakeskuksille ja yhdistää ne paikalliseen kaukolämpöverkkoon sekä edistää T&K-työtä näillä alueilla
(D) Kilpailukyvyn lisääminen datakeskusten toimitusketjussa, mukaan lukien tietotaidon ulkoisvaikutukset datakeskustoimittajille	**400mEur** **6 100** työpaikkaa	• Kohdennetut aloitteet paikallisten yritysten integroimiseksi datakeskusten toimitusketjuihin • Lisätä saatavilla olevien uusiutuvien energiamuotojen osuutta • Edistää suomalaisten datakeskusten palvelutoimittajien osaamisen käyttöä kehittyneen teollisuuden toimesta

Lähde: Copenhagen Economics

Preface

This study is prepared on request of Google. The objective of the study is to identify and, insofar as possible, quantify the ripple effects arising from data centres and contributing to the Finnish economy.

The study has been developed in close collaboration with the Finnish Prime Minister's Office and the Ministry of Economic Affairs and Employment.

We are grateful for extensive insights shared with us and helpful comments to increase the relevance of the study, so to achieve our purpose to contribute an analysis that is valuable to Finnish policymakers and ultimately to the interest of Finnish citizens and firms.

All findings and conclusions are our own.

Executive summary

- **Data centres are infrastructures** where data is stored securely and processed efficiently on behalf of users such as consumers and companies using cloud solutions and outsource computing and software tasks.
- Google's investment in the **Hamina data centre** has yielded an economic contribution of €660 m to the Finnish economy over the 2009-2015 period, equivalent to an annual average of €95 m and of 1,600 jobs supported per year over the same period.
- **Ripple effects are economic spillovers**, where the activity of one industry (e.g. data centres) can **generate added economic benefit across the value chain** – for example productivity benefits for its suppliers and for its users all the way to consumers.
- Finland already benefits from a **strong data centre industry**, its structural advantages and has **large potential yet to be realised**.
- **Headline result of this study**: If Finland can fully realise ripple effects from data centres, in 2025 the yearly economic contribution of its data centre industry will amount to EUR 2.3 bn and 33,000 jobs.

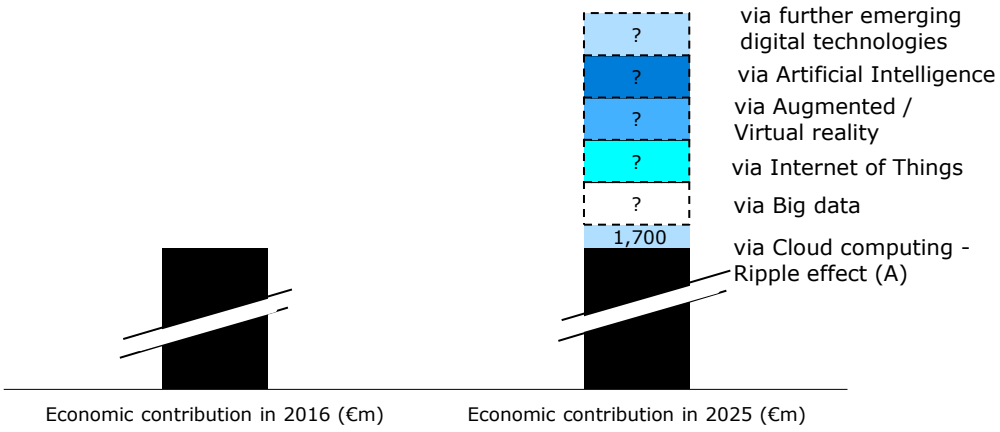
The important role of data centres in modern economies

Data centres are an important component of modern digital economies. They are a pillar of digital transformation, since many key innovations that revolutionise our economy rely on data centres for storing data, computing and the provision of digital services. These services are transforming our economies, renewing established manufacturing and service industries.

It is established that digitisation brings huge benefits to our economies. The data centres in Finland and worldwide enable cloud computing solutions that democratise access to advanced software solutions for firms of every size. Furthermore, data centres will play a key role in the provision of emerging technologies that rely on new data and new ways of using data to transform productive processes and our lives – such as the Internet of Things, Artificial Intelligence, Big Data and Augmented/Virtual reality.

While it is not possible at this stage to quantify all the ripple effects from data centres via digital innovation, we can estimate the effect via cloud computing at EUR 1.7 billion.

Figure 3 Data centre ripple effects to Finnish firms via digitisation



Source: Copenhagen Economics. Unit: EUR million

Moreover, it is clear that the ripple effect from the other channels is a major addition on top of the effect via cloud. The above technologies are estimated to have a large market value, corresponding to circa EUR 7 bn market size for Finland in year 2025: this is an order of magnitude larger than the market value of cloud – thus also their GDP contribution altogether will likely be correspondingly larger than cloud computing on its own. Since these emerging technologies do already and will in the future also rely fundamentally on data centre infrastructures, spill-overs from data centres to these technologies will also be major.

Ripple effects of the Finnish data centre industry via suppliers and signalling
The innovations described above are per se huge opportunities for Finland, as for any modern economy looking forward to digital transformation across all sectors of activity. Moreover, all these innovations will rely on infrastructure such as the one provided by data centres. Thus for Finland, the data centre infrastructure development brings an added opportunity to support growth and employment.

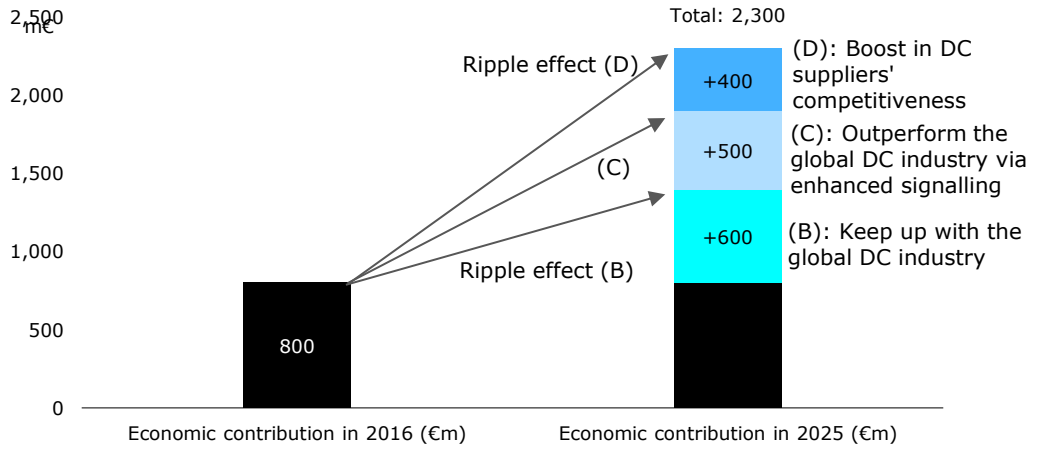
Finland has strategic advantages in fostering a strong data centre industry. The government has a data centre investment attraction strategy and complementary assets like international cable connections and a stable, advanced regulatory framework are part of the broader picture. This reinforces structural advantages due to climate and energy supply.

Finland is getting already today a good value out these efforts. The data centres in Finland provide in 2016 a close to EUR 800 million supported yearly economic contribution (direct, indirect and induced effects – year 2016), with 11,200 jobs supported. Moreover, we have quantified three ripple effect channels which provide a potential opportunity to maximise the economic contribution of the Finnish data centre industry:

- Moderate improvements to current framework conditions for data centre activity, so to defend Finland's global rank and achieve the global industry average expected 10% growth rate – Ripple effect (B): an additional EUR 600 million and 8,400 jobs per year, as of 2025
- Enhanced signalling: maximised FDI attractiveness, outperforming competing countries and improving Finland's global rank so to achieve 15% growth rate, i.e. above the global industry average – Ripple effect (C): an additional EUR 500 million and 7,200 jobs per year, as of 2025
- Increased competitiveness in the data centre supply chain, including knowledge spill-overs to data centre suppliers – Ripple effect (D): an additional EUR 400 million and 6,100 jobs per year, as of 2025

If Finland can succeed in realising the combined set of ripple effects to the full, in 2025 the yearly economic contribution of its data centre industry will amount to a yearly EUR 2.3 billion and 32,900 jobs.

Figure 4 Ripple effects of the Finnish data centre industry via suppliers and signalling



Source: Copenhagen Economics. Unit: EUR million

What next for Finland's opportunities from data centres?

The global data centre industry is booming and Finland is in a good position to attract more data centres. Finland provides favourable conditions and gets good benefits from hosting these facilities. But the benefits do not depend only on how many data centres we get in Finland. It is equally important that policy makers maximise the ripple effects opportunity that Finnish data centres enable. This way Finland will get the most economic benefit out of each data centre (including attracting even more over time).

Achieving this potential over the coming years is possible, given Finland's structural and policy assets but there is still large room for improvement: much work remains to be done. This will require a range of initiatives – at EU, national and local level. Finland has

its work cut out and can rise to the challenge thanks to its educational, resource and regulatory assets, yet better coordination is needed to make the most of this tremendous opportunity for the benefit of Finnish companies and ultimately citizens.

Finnish policymakers have the opportunity to make a focused bet in an area where Finland is winning and can consolidate gains with limited cost. Finland already has many key policies in place. But these measure are not sufficiently coordinated to exploit fully the ripple effects from data centres to Finland in both the short and long term. This study concludes by identifying areas where Finland can coordinate, refocus and strengthen its policies, so to foster the ripple effects identified and to maximise the growth and employment impact of the data centre industry to Finland.

Table 2 A ripple-based policy menu for Finland to maximise the economic contribution of data centres

Ripple effect desired	€	Key related policy areas
(A) Ripple effects to Finnish firms via digitisation (Cloud computing inter alia)	EUR **1,700m** **2,400** jobs	• Promote further an open and growing EU market for digitally powered services • Coordinated academic, commercial & policy efforts to further digital solutions for Finnish manufacturing & service SMEs • Digital skills programmes matching expected needs of manufacturing & service firms
(B) Keep up with the global data centre industry	EUR **600m** **8,400** jobs	• Preserve strong rule of law, privacy, copyright and data security regulation • Monitor the competitiveness of local suppliers to the data centre industry
(C) Enhanced signalling: outperforming the global data centre industry via organic growth and maximised FDI attractiveness	EUR **500m** **7,200** jobs	• Reduce energy costs, achieve top 5 attractive investment location in energy cost • Plan FDI-ready sites for multiple data centres feeding local district heating system and promote R&D in this area
(D) Increased competitiveness in the data centre supply chain, including knowledge spillovers to data centre suppliers	EUR **400m** **6,100** jobs	• Targeted initiatives increasing the integration of local firms in the data centre supply chain • Increase the share of renewable energy available • Foster application of skills from Finnish data centres' suppliers to serve advanced manufacturing industries

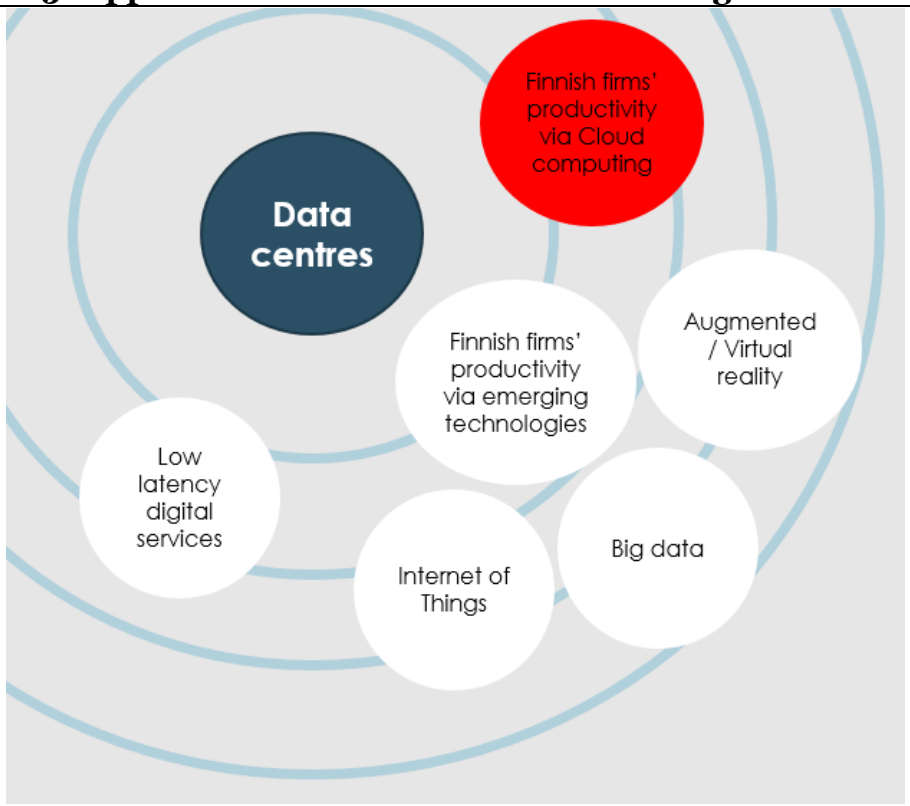
Source: Copenhagen Economics

Chapter 1

Introduction: data centres' ripple effects to all Finnish firms via digital transformation

The ripple effects identified throughout this report show a key contribution of the Finnish data centre industry to the economy mainly via its supply chain and signalling. However, in addition, unlike many other industries, the data centre industry also has significant ripple effects that relate to its downstream effect in promoting digitisation. Downstream refers to all the services and activities that rely upon the data centres. This is a complex chain of actors and includes several emerging technologies, which enriches the picture.

Figure 5 Ripple effects to all Finnish firms via digitisation



Source: Copenhagen Economics

The ripple effects identified in the figure above are potentially very large because data centres are key to supporting most of the pivotal technologies that constitute the digital

transformation. Digital services reduce the cost barriers for all types of firms to use advanced solutions to support and grow their manufacturing or service business. Technologies that give firms the ability to achieve lower costs and new, improved products and services have the effect of boosting productivity across the economy.

Some of these transformative technologies are already diffusing through the economy: cloud computing, still with a lot of potential untapped but also still emerging – such as the Internet of Things, Big Data and Augmented/Virtual reality. All of these rely on new data and new ways of using data to transform productive processes and our lives.

For cloud computing, where robust data is more available, we provide a quantification that confirms the large value of the downstream ripple effects from data centres due to digitisation. However, quantification is not possible for the emerging technologies – still they will likely have an impact altogether much larger than cloud computing in its own. For this to occur, the right set of skills is needed, matching understanding of the digital solutions available and the impact of application in each sector of the economy and each type of firm (large and small).

Moreover, the case of cloud computing shows that a strong domestic data centre industry is a lever to promote further digitisation, by stimulating the take up of more and more advanced digital solutions amongst those firms lagging behind in digitising, especially SMEs.

In conclusion, a full understanding of ripple effects of the data centre industry must include the breadth of the ripple effects from digitisation transforming our economy and society.

1.1 Data centres enable cloud-based digitisation, enhancing GDP

Digitisation is an opportunity for the whole economy. However, there are barriers that are affecting firms' ability and incentive to embrace greater digitisation. A study commissioned by the Nordic Council of Ministers on digitisation and automation in the manufacturing sector found that one of the most emphasised barrier to digitalisation by Nordic firms is the cost of implementing new technologies, Iris Group (2015). In particular, this is a key factor for the digitisation of SMEs.

This cost barrier to digitisation can be lowered via cloud computing, where computing power is offered and information stored in data centres accessible online as a service to clients in a pay-as-you-go manner. Often described as *software as a service* (SaaS) or referred to as *utility computing* as cloud computing allows firms to rent computing power (hardware and software) and storage from service providers and pay on demand as they do for other inputs such as energy and electricity, Etro (2009). And given the magnitude of data centres, the service provided is more powerful than the client reasonably ever could sustain itself. In practice, it involves a firm, e.g. a manufacturing firm, outsourcing

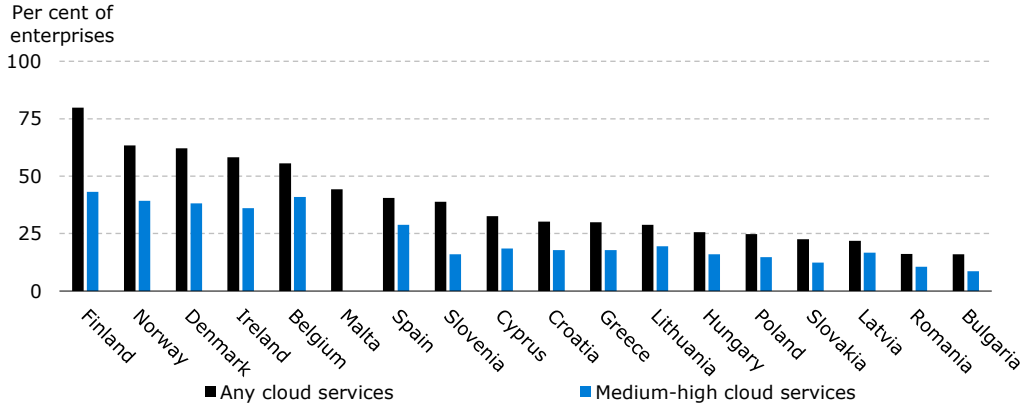
to a cloud computing provider the data storage, processing and running of software applications required for the manufacturing activity – instead of the manufacturing firm performing these tasks in-house.

Finland leads in cloud adoption in Europe though statistics are incomplete

Finnish enterprise are front runners in terms of cloud computing. According to the EU's Digital and Economy and Society Index, a very large share of Finnish firms use cloud services, larger than what is the case for firms in the rest of the EU. However, much remains to be done, since the process of digitalisation is far from complete. Finnish policy-makers must be aware that statistics of Finland's performance can only provide a partial picture, due to the following caveats.

1. SMEs in Finland (as elsewhere) do not adopt cloud computing to the same extent as large enterprises. 80 per cent of large Finnish large firm buy cloud computing services, compared to 52 per cent of SMEs (Source Eurostat, see figures below).
2. Statistics count any firm adopting at least one cloud solution but digitisation requires multiple cloud solutions. The 2013 EU-average number of cloud solution per business stood at 1.19, IDC (2014).
3. Many Finnish firms use cloud solutions for relatively simple tasks (e.g. emails) but not higher value-adding applications. Finland is not that far ahead if we look at firms that purchase medium-high sophisticated cloud services.
4. The EU is not the only relevant benchmark. By 2020, key Asian economies are expected to overtake Finland (and all Europe) in digitisation, BCG (2016).

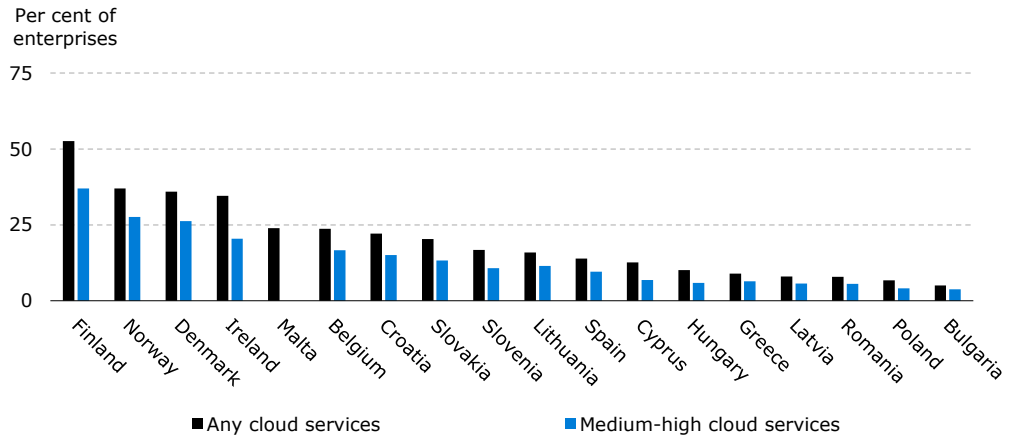
Figure 6 Large Finnish firms buy cloud computing services used over the internet



Note: The figure shows the share of large enterprises (250 persons employed or more) that buy Cloud Computing services used over the internet. The Financial sector is excluded. Cloud computing refers to purchased ICT services that have all of the following characteristics: are delivered from servers of service providers; can be easily scaled up or down; can be used on-demand by the user without human interaction with the service provider; are paid for, either per user, by capacity used, or they are pre-paid. Firms that purchase Medium-high sophisticated cloud services includes enterprises that purchase at least one of following cloud computing services: Hosting of the enterprise's database; accounting software applications; CRM software, computing power. Countries with missing data excluded. 2015 data.

Source: Copenhagen Economics using data from EU Commission' Digital Economy and Society Index

Figure 7 Finnish SMEs buy cloud computing services used over the internet



Source: Copenhagen Economics using data from EU Commission' Digital Economy and Society Index

Cloud computing, using data centres, leads to a productivity ripple effect

Unlike earlier forms of IT solutions, cloud computing is not just for large firms but there are cloud solutions suited for different types and sizes of businesses. Cloud allows SMEs to obtain at an affordable price sophisticated applications and systems, previously the prerogative of large firms only. In particular, firms can adopt this scalable service on-demand and thereby avoid having to invest large up-front costs necessary for hardware and software equipment. Thus, cloud computing transforms large fixed costs into small variable costs. Thus, cloud computing is amongst the "flatteners" that level the global playing field for firms across a variety of industries (Friedman, 2005). This promotes faster digitisation, entrepreneurship and innovation in sectors where IT costs are a constraint on developing new businesses (Etro, 2009).

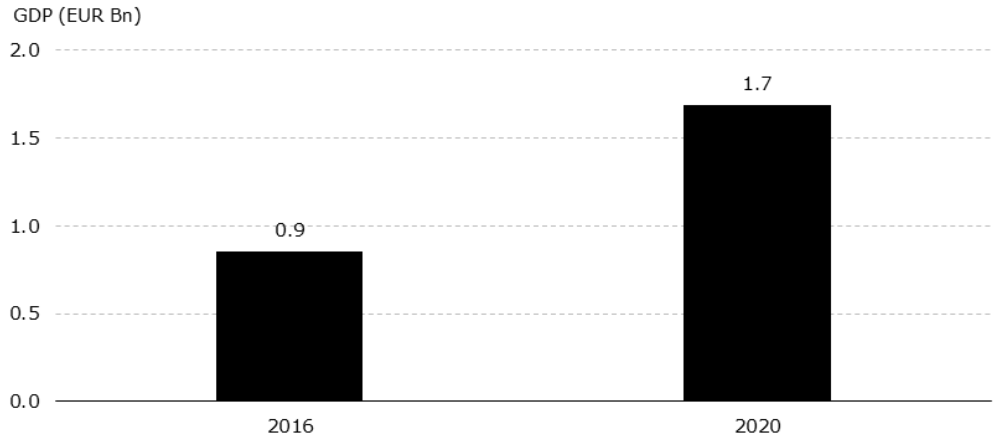
Table 3 Revenue and profit growth attributed to cloud

Revenue growth attributed to cloud adoption	% of respondents	**Profit growth** attributed to cloud adoption	% of respondents
1% to 4%	15%	1% to 4%	32%
5% to 9%	36%	5% to 9%	32%
10% to 19%	23%	10% to 19%	13%
20% to 29%	15%	20% to 29%	13%
30% to 49%	8%	30% to 49%	4%
50% or more	-	50% or more	2%
Don't know	4%	Don't know	4%

Source: IDC (2014), based on interviews with 100 European companies

Cloud users perceive benefits of cost efficiency but also scalability, innovation, business expansion and gaining economic benefits of digitisation sooner, IDC (2014).

Figure 8 Cloud adoption: Economic contribution to Finland



Note: The figure is based on the baseline case and the EU-wide estimate for net new GDP. The optimistic case estimate for year 2020 is EUR 2.6 billion, or 1.1% of GDP.

Source: Copenhagen Economics based on IDC (2014)

As a result, cloud computing is a key driver of productivity growth

By supporting cloud computing, data centres contribute to this broader ripple effect, which has a large impact to Finland. In a study for the European Commission, IDC (2014) finds that cloud computing will stimulate growth and create jobs. The above study estimated that the impact of cloud is a net new yearly EU-wide GDP of 0.7 per cent in the year 2020. In Finland, this is equivalent to a net new yearly GDP of EUR 1.7 bn in the year 2020. In employment terms, the IDC (2014) estimate corresponds to 2,400 jobs to Finland yearly, as of 2020.

Finally, considerable positive externalities of cloud are the energy savings due to the greater scale of data processing activities and higher utilisation of computing resources – which can contribute significantly to decreasing carbon emissions.

In conclusion, there are large economic benefits associated with further adoption of digitisation and cloud computing throughout the economy. As discussed below, cloud computing relies on data centres, which is where the storage and processing of the distributed (cloud) computing take place.

1.2 The data centre industry is key to the full adoption of cloud and emerging technologies

The internet is global, and it is possible for firms that use cloud computing to involve the services of a data centre located somewhere else in the world. Global connectivity has long enabled this. At the same time, we have identified that proximity is a factor that – in the

current industrial context – promotes the faster take up of cloud services and digitisation of manufacturing and service firms throughout the economy.

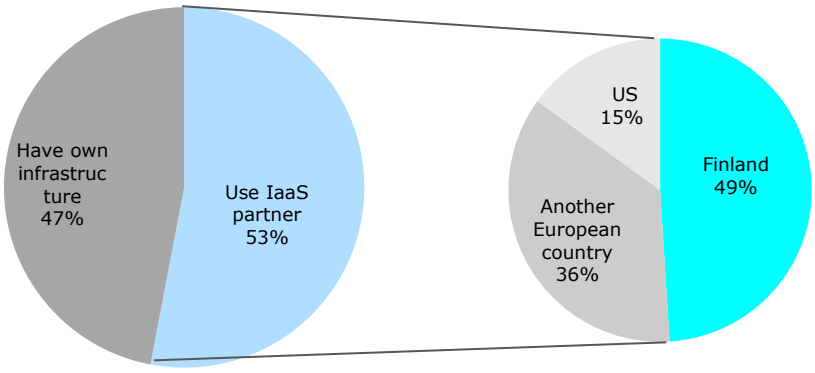
For this reason, a strong domestic data centre industry enables an efficient and diversified supply of data centre services in proximity to firms using cloud computing. While this is not a necessary requirement for cloud computing – it is today a distinct advantage in promoting the adoption of cloud computing, especially for SMEs. In fact, awareness and skills are key, especially to promote adoption amongst SMEs. Insufficient knowledge about cloud computing is a prominent barrier Europe-wide. Proximity to vendors of cloud solutions can promote the dissemination of knowledge about applications, about end user sectors embracing cloud services and about the role of data centres.

The role of proximity to a strong domestic data centre industry

Finnish cloud providers do use Finnish data centres to a large extent, which confirms that proximity is a relevant factor in the decision of actors in the middle of the cloud computing provision chain. According to the IT industry analyst firm the METISfiles, there are more than 125 cloud providers in Finland. Software as a Service (SaaS, a form of cloud computing) is the most popular segment where these suppliers are active (62 per cent). Another key segment is Infrastructure as a Service, IaaS (36 per cent).[1] Out of all Finnish SaaS providers:

- 47 per cent have their own infrastructure.
- 53 per cent use an IaaS partner; of these 49 per cent are located in a Finnish data centre, cf. Figure 9.

Figure 9 Characteristics of Finnish SaaS providers

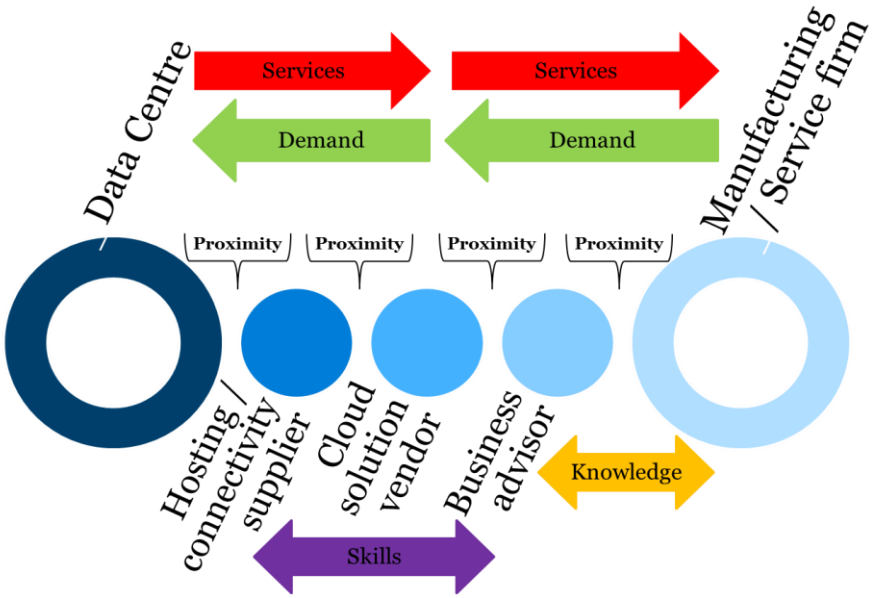


Source: Copenhagen Economics based on the METISfiles. 2016. "Top 125 Finnish Public Cloud Providers" http://www.themetisfiles.com/2016/02/top-125-finnish-public-cloud-providers/

While end users do not always interact directly with the data centre services provider, they are linked via intermediaries : (i) hosting suppliers, (ii) cloud solution vendors and (iii) industry business advisors. This is displayed in a stylised manner in the figure below.

[1] One of the reasons for the wide cloud use in Finland is the strong penetration of software as a service (SaaS) – SaaS accounts for 90 per cent of the Finnish cloud services market (ComputerWeekly.com, 2015).

Figure 10 Cloud computing service provision chain, from data centres to end users



Source: Copenhagen Economics

Finnish firms (large or small; manufacturing or service firms) demand increasingly advanced IT solutions for their businesses. These firms also rely on advisors (private consultants, branch organisation or public sector resources) so to address business challenges, reap opportunities and find new solutions, whether IT related or not. The business advisors exchange knowledge with the manufacturing or service firms and help match needs with business solutions available, including IT solutions.

In turn, business expert advisors – in an increasing digital economy – interact with vendors so to understand what solutions are available and emerging and to convey the end users' needs. Vendors provide a range of IT solutions to firms, including cloud-based solutions, often in the form of integrated solutions. In turn, cloud vendors rely on hosting and / or connectivity services that they package together as part of the integrated solutions that they offer. Ultimately data centres supply the storage and processing services underpinning cloud services. These relationships help convey skills across the value chain.

The impulse to further digitisation due to proximity to a strong domestic data centre industry is – at least in the short run – an opportunity to diffuse cloud computing further among Finnish firms lagging behind, especially SMEs and sectors not leading in digitisation. At the same time, the magnitude of this opportunity may decrease over time as firms become more familiar with cloud computing and awareness and skills related to digital enterprise solutions diffuse farther across sectors of the economy.

What can be inferred about the total ripple effect from data centres via digitisation?
In this section, we have focused on the case of cloud computing and explained the role played by data centres in enabling a fuller adoption of cloud solutions, for the benefit of all Finnish firms.

Cloud computing is a relatively well known class of digital services but is not the only advanced solution that can allow firms to achieve lower costs and new, improved products and services have the effect of boosting productivity across the economy. We have identified several transformative technologies that are in an emerging phase:

- Internet of Things
- Big Data
- Augmented/Virtual reality

All of these emerging technologies have a notable feature: it is expected that each of these technologies will add value to its users relying on new data and new ways of using data to transform productive processes and our lives. Thus, similarly as in the case of cloud computing, for these emerging technologies data centres are expected to play a pivotal enabler role.

However, a more precise quantification of the data centre ripple effect mediated via these emerging technologies is at this stage not possible, due to information limitations due to their emerging nature. Nonetheless, it is clear that the ripple effect from these channels is a major addition on top of what was discussed for cloud. The above three technologies are estimated to have a large market value[2], corresponding to circa EUR 7 bn market size for Finland in year 2025: this is an order of magnitude larger than cloud.

In conclusion, looking at the cloud case in insightful as it allows us to assess how data centres' economic activity has a ripple effect via digitisation, however it must not be forgotten that other, emerging technologies also rely fundamentally on data centres and these will likely have an impact altogether much larger than cloud computing on its own.

1.3 Benefits of a strong domestic data centre industry for low latency digital services

A particular type of benefit due to proximity to a strong data centre industry is the ability to run applications and deliver services to end users with a much reduced latency – compared to a scenario where the data has to travel farther to be processed at a distant data centre. This can be particularly important for high tech applications.

Latency is a time interval between the stimulation and response. In a network connection, two-way latency is the measure of the time lag between sending and receiving information. A further indicator related to latency is jitter, which is the variation in latency as

[2] BCG (2016), based on Gartner, IBM, IDC, Markets & Markets.

measured in the variability over time of the packet latency across a network.[3] Thus, to have no jitter, a network would need to have constant latency, which can allow a more reliable use of time-sensitive information exchanged.

While for many applications the latency difference is not noticeable, for some sectors, the proximity advantage can be expected to play a significant role in promoting firms. Applications where this may be an advantage could be for instance within the branch of telemedicine or the fintech sector.

The intuition behind this advantage is that, for example, in medical procedures such as remote surgery, it is important not to "skip a beat". In remote surgery procedures the information exchanged (thus subject to latency) includes one way the video feed from the patient and information on pressure of the surgical instruments (haptic feedback). Information going the other way includes the command instructions from the surgeon to the robotic equipment in contact with the patient.

Much progress has been made in the testing of remote surgery,[4] and some tests have included also long distance surgery.[5] However these pioneering tests seem to have been so far confined only to some simpler surgical procedures (incl. laparoscopy) – the same procedures where robotised equipment is increasingly used in on-site surgeries. Keeping low levels of latency is likely to be even more relevant for procedures that are more difficult to perform; this may include also procedures for which at the moment there is less use of robotic apparatus, but in that case the availability of low latency remote surgery could promote the use of robotic equipment itself to a broader set of, even more complex, surgical procedures.

In the financial technology (fintech) sector, many revolutions have been underway. The degree of automation and then the speed of trading has increased dramatically over the past decades and even the past years. Moreover, besides trading, broader applications of innovations in financial services involve a more extensive use of data analytics.[6]

While internet connectivity today has progressed significantly and enables a variety of generic applications, it is a valuable question whether Finnish firms (incl. start-ups) can provide these or new applications while gaining competitive advantage from low latency vis à vis international peers, due to the combination of:

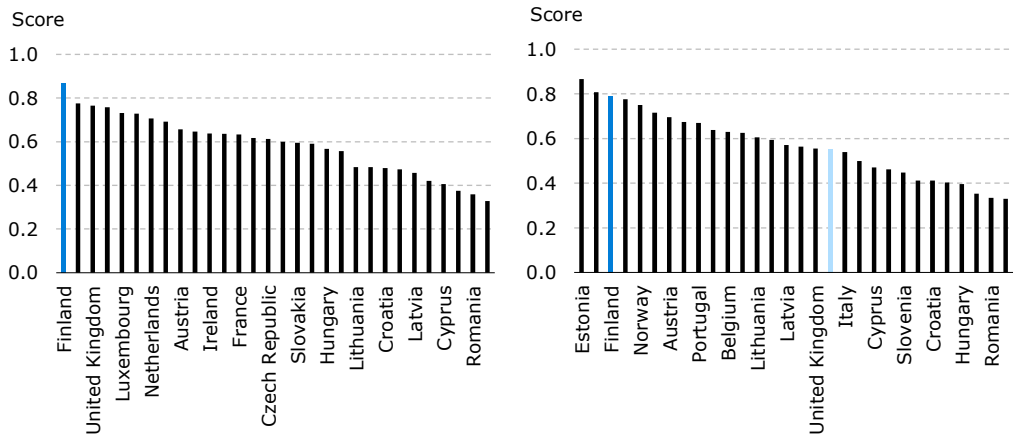
- Proximity to a strong domestic data centre industry.
- State of the art connectivity via international links to key markets.
- Advanced internet access networks present domestically.

3 Comer (2008)
4 Lum et. al (2009).
5 ZDNet (2015) Remote robotic surgery is both practical and safe, http://www.zdnet.com/article/remote-robotic-surgery-is-both-practical-and-safe/
6 http://www.harringtonstarr.com/financial-sector-will-benefit-big-data/

1.4 A domestic data centre industry can promote further public sector digitisation

Just as in the private sector, digitisation is also a key source of efficiency improvements in the public sector, as well as greater effectiveness via innovative solutions and modes of provision of public services. Finland is performing well in terms of public sector digitisation and ranks third in digital public services in EUs Digital Economy and Society Index (2016), cf. the left panel in Figure 11.

Figure 11 Finland is a front runner in terms of public sector digitalisation



Note: The figure shows the aggregate score received by each country in the sub-index *Digital Public Services* in the EUs *Digital Economy and Society Index*, 2016 and The figure shows the aggregate score received by each country in the sub-index *Human Capital* in the EUs *Digital Economy and Society Index*, 2016. The first sub-index measures performance in terms of eGovernment (the level of development of a country's eGovernment services) (67 per cent) and eHealth (33 per cent), while the latter measures performance in terms of basic skills and usage (50 per cent) and advanced skills and development (50 per cent). The score ranges from zero (worst) to 1 (best).

Source: Copenhagen Economics using data from EU Commission' Digital Economy and Society Index

However, there is still room for further improvement and the Finnish Government has included digitalisation of public services as part of its Strategic Programme.[7] Cloud computing can unlock greater efficiency in large part of the public sector including healthcare (e.g. in the supply of information and technologies in remote areas), education and the activity of any branch of the public sector experiencing periodic usage peaks.[8]

One complication is that the public sector is an "industry" with many specificities. Its scope and modus operandi vary significantly between countries, even within the relatively homogeneous EU. Each country has its own way to deliver public services and use digital solutions. Digitisation progress is a common theme across the European public sectors, however no size fits all.

7 Government Publications 12/2005: "Finland, a land of solutions: Strategic Programme of Prime Minister Juha Sipilä's Government".

8 Etro (2009).

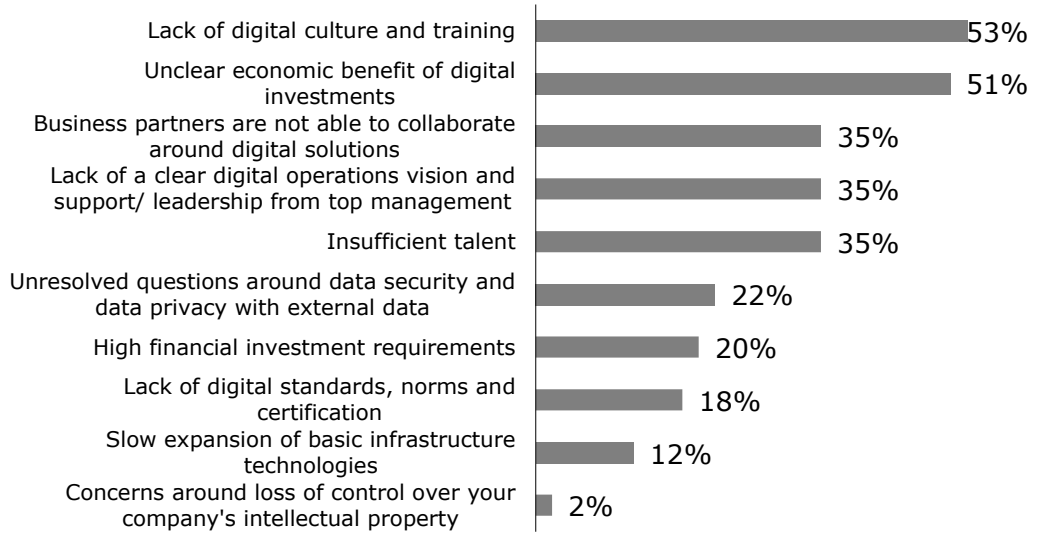
This heterogeneity makes the public sector a challenging area to serve. For these reasons, proximity to a strong domestic data centre industry (and cloud solution vendors and expert advisors) can play a role in breaking down barriers to digitisation in the public sector. This is because these barriers reflect cultural specificity, regulatory understanding, sensitive country specific processes and expectations on the provision of public services.

Historically this means that digital frontrunner public sectors like the Finnish one have invested in their own data centre facilities (incl. ad hoc private cloud solutions, dedicated to the public sector applications). Indeed, currently public sector data centres account for roughly 50 per cent of the capacity in the Finnish data centre industry, measured in square meters. However, in the next three to five years, it is expected that this share will be reduced to just over 30 per cent as the use of private cloud service providers and the commercial data centres will increase (Invest in Finland, 2016).

1.5 A domestic data centre industry enhances digital skills

Finland is a European frontrunner in terms of digital skills and this is an important source of advantage. Yet, the lack of digital culture and training is still seen the main barrier to digitalisation. In particular, PWC (2016) has identified the following main barriers to digitisation.

Figure 12 Barriers to digitisation in Finland



Note: The figure shows the distribution of survey answers to the question "Where are the biggest challenges or inhibitors for building digital operations capabilities in your company?" The survey was conducted among 54 industrial companies with headquarters in Finland during the period November – December 2015. The size of the respondent companies represent the standard distribution of different industrial companies in Finland. The survey was conducted by TNS Emnid.

Source: Copenhagen Economics, based on PWC (2016).

While high financial investment requirements are a barrier being overcome via cloud computing and the pay-per-use model, a more persistent point relates to talent and in particular lack of digital culture and training. The Finnish data centre plays a role in reducing this barrier over time. The data centre industry supports the fostering of enhanced digital skills via skill building among employees.

The Finnish data centre industry counts a number of well-known multinational companies like Google, Microsoft and Yandex. It is thus more internationalised than many other industrial sectors in Finland. As established in the economic literature, investment and activity by multinational delivers a ripple effect to the host country via several spillover channels.

First, multinational companies attract some of the most productive workers and they pay a wage premium to retain the employees (see Fosfuri, Motta and Rønde, 2001).[9] *Second*, multinational companies improve the knowledge of their employees: 75% of the observed wage premium in foreign firms can be explained by the selection of employees, while the remaining 25 per cent is due to other factors, including learning effects (Malchow-Møller et al., 2013). An example of skill building associated with the data centre industry is the case of Antti Saarela, examined in Annex.

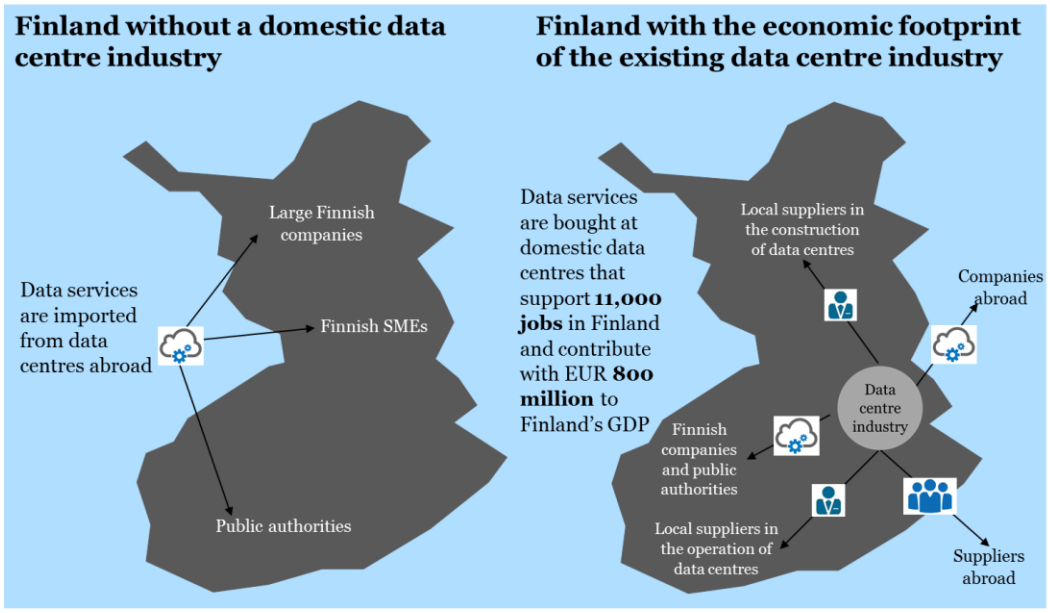
[9] Multinational companies generally comprise large amounts of technical, operational and managerial knowledge, which allows them to establish themselves in markets across the world and compete successfully against local firms. Markusen (1995) refers to such assets as 'knowledge capital', which includes factors such as superior production processes, technology, management techniques or marketing and advertisement campaigns.

Chapter 2

Data centres already have a strong footprint on the Finnish economy

Although the data centre industry in Finland is relatively young, it brings already substantial benefits to the Finnish economy. In 2015, the services in the data centre industry alone represented 0.18 per cent of the Finnish GDP, comparable to the size of the textiles industry (0.17 per cent of GDP in 2014) and mining and quarrying (0.19 per cent of GDP in 2014). Taking into account both Finnish suppliers to the construction and operation of the data centres into account, the industry supports around a total 11,200 jobs in Finland and adds almost EUR 800 million yearly to the Finnish GDP in 2016.

Figure 13 The footprint of data centres on the Finnish economy



Source: Copenhagen Economics

2.1 Data centres are key infrastructural facilities

Data should be regarded as one of the key utilities of the 21st century. Information and communication technologies are considered the most important general purpose technology that underpins activity throughout the economy, just like the steam engine and electricity networks have revolutionised over time the modern economy and powered waves of industrial revolutions. A data centre is a digital infrastructure project that stores, manages and processes digital information on a network of high-performance computers, known as servers. These servers provide services to Internet users throughout Finland,

Europe and around the world. Data centres thus enable the transition to an efficient, digitally enabled future.

Data centres share the systemic characteristics of a traditional infrastructure project, for example transport hubs. Transport infrastructure is used to move people and goods nationally and worldwide and helps all sectors of our economy function efficiently. As a result, these infrastructures help goods and services to be made available for private households and businesses. In the same way, approximately 1,170 data centres in Finland underpin a range of data-driven services across government, business and society.

There are more than 1,000 public data centres in Finland, which provide services to the central and local governments, cf. Figure 14. The number of private data centres is significantly smaller (120 data centres), but the private data centres nevertheless account for 55 per cent of the total capacity in the Finnish data centre industry. Some of the private data centres are corporate data centres that use their capacity to serve customers within the organisation. These corporate data centres are mainly located in large and medium-sized companies. The other data centres include both the internet companies (serving users globally) and those third-party data centre providers that lease their capacity to serve external customers. These data centres are by far the largest and include some large multinational internet companies, such as Google.

Figure 14 Data centre services providers, customers and players

	Data centre service provider group	Customer base	Key players
1050 **public** data centres (45% of m2 capacity)	Local government and municipalities	• Internal customers • Public administration	• Cities and municipalities "Tieara"
	Central government and state organisations	• Internal customers • Public administration	• State organisations • "Tori"
120 **private** data centres (55% of m2 capacity)	End user organisations maintaining captive data centres	• Internal customers • Capacity for own use	• 'All' large and medium sized companies
	Private companies offering data centre services in commercial data centres	• External customers • Capacity resold to others, incl. telecom industry	• Third-party providers (e.g. Hetzner Online, Telecity Group)
	Internet companies	• Capacity used to supply internet services	• Global Internet companies (e.g. Google, Microsoft, Yandex)

Note: If the telecom operators' own data centres were included, the capacity of the private data centres would be 10-15 per cent higher.

Source: Copenhagen Economics based on Invest in Finland (2016)

A closer look inside a data centre

Data centres are complex systems with many mechanical, electrical and controls components, as well as networking equipment and communication links. Data centres host a large number of servers, which are high-performance computers that run all the time. They are the core of the data centres, cf. Figure 15.

Figure 15 Inside a Google data centre

Note: *On the left:* Blue LEDs on this row of servers tell Google that everything is running smoothly. *On the right:* Colourful pipes carry water for cooling in and out of the data centre. The blue pipes supply cold water and the red pipes return the warm water back to be cooled. The pictures are from Google's data centres in Georgia and Oregon.

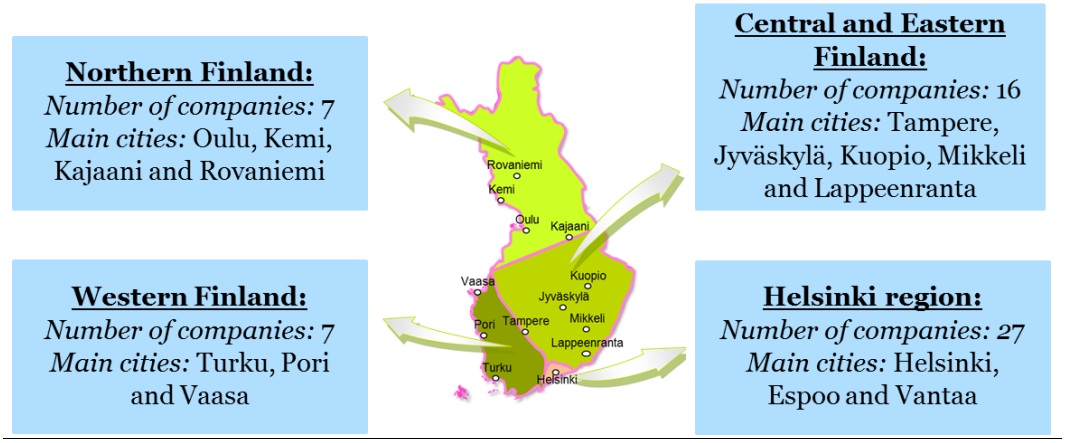
Source: Google

The Google data centre in Hamina helps provide services to Internet users throughout Finland, Europe and globally. Similarly so, data centres belonging to other companies and the public sector help process the information flows enabling the manufacture of goods and provision of services for citizens throughout Finland, Europe and globally – depending on the purpose of the organisation using the data centre directly or indirectly.

The jobs at a data centre facility include positions in management, mechanical and electrical maintenance and repair, IT and systems technicians, plumbing and water management, and hardware operations; these are the experts who receive, setup, install and manage the physical hardware.

Data centres are located throughout Finland. Large data centres are also distributed across Finland but are more concentrated in the greater Helsinki region, cf. Figure 16.

Figure 16 Location of large data centres owned by Finnish organisations



Source: Invest in Finland

Before the present study, there was little publicly available information about the number of jobs supported by the Finnish data centre industry. Employees in the public administration's data centres and in the corporate data centres are likely to have other responsibilities than maintaining the servers and ensuring that data services are stable and secure. In the commercial data centres, this is the core responsibility, and we would therefore expect the number of jobs in these centres to reflect the jobs required for the core data services provided by data centres.

2.2 The data centre industry contributes to Finland's GDP

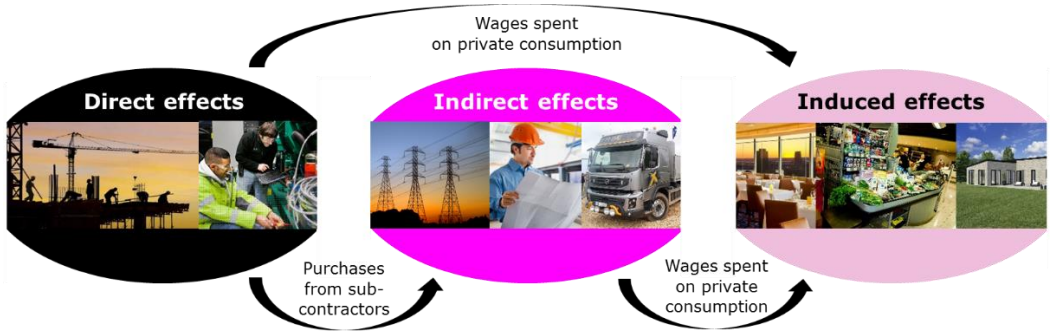
The construction of the data centres generates a significant number of jobs for Finnish construction companies, and the increased activity in these companies will entail significant trickle-gown effects to the rest of the economy (multiplier effects). Data centres can be large infrastructures. As an example, Google alone has spent a total of 800 million EUR on the construction of the Google data centre in Hamina up until now.

Any economic activity generates an impact up the value chain of supplier companies, which ultimately, diffuses throughout the economy. This is also the case for the data centre industry.

We have developed an estimate of the economic impact on the Finnish economy, arising from the expenditure from the Finnish data centre industry. We have based our analysis on three complementary sources. A first input is information relative to the expenditure at Google's Hamina data centre. A second input is data from Statistics Finland on the input / output table which details how supply chains are integrated across the Finnish economy – reflecting the pattern of economic activity across industries in Finland. A third input is information from Invest in Finland on the Finnish data centre industry, its scale, composition and evolution.

Based on the above inputs, we have built an economic model (input / output model) that measures the economic impact to Finland supported by the data centre industry. Using our analytical framework, we capture the data centre impacts on the Finnish economy via three distinct effects; direct, indirect and induced effects, see Figure 17. The detailed definition and method to calculate these effects is reported in a separate Annex.

Figure 17 Direct, indirect and induced effects of the Finnish data centre throughout the Finnish economy



Source: Copenhagen Economics

The direct effect includes the economic impact supported directly by data centres and their key construction contractors. The directly supported jobs in operations include positions in management, mechanical and electrical maintenance and repair, IT and systems technicians, plumbing and water management, and hardware operations.

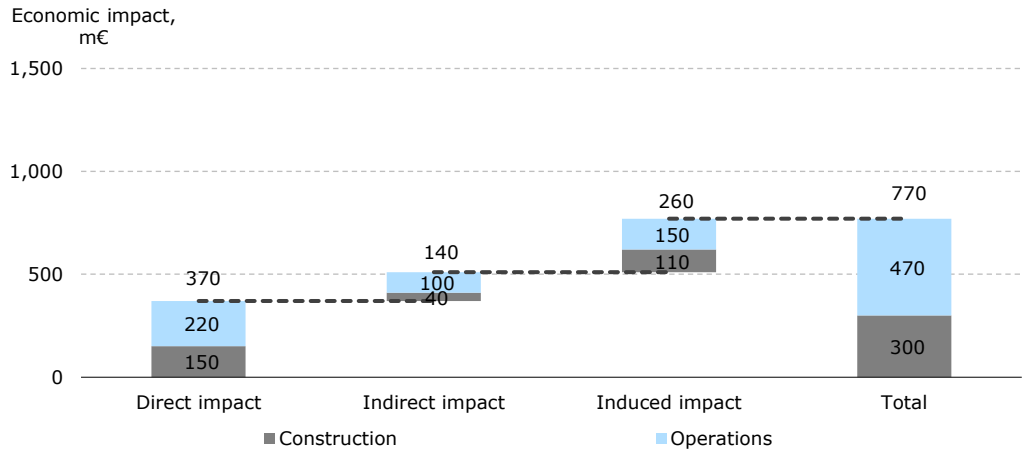
The indirect effect includes the economic impact on suppliers, which is also supported by data centres' purchases of domestic goods and services. The indirectly supported jobs include positions in security, catering, cleaning and in the construction and supply industries, as well as at suppliers in upstream industries across the economy.

We refer to *the induced effect* as the supported economic impact that occurs when employees at data centres and their supplier industries spend their wages throughout the economy. The *induced* jobs are primarily service-related jobs in industries such as retail trade, transport, accommodation, restaurants, housing and finance.

Different parts of the economy each play a role in composing the Finnish GDP. The direct contribution associated with the data centre expenditure (the direct effect) is EUR 370m (equivalent to 0.18 per cent of GDP). The role that this expenditure plays in underpinning other industries' GDP contribution amounts to EUR 140m (the indirect effect).

Our results show that, when considering the direct and indirect effects together, the Finnish data centre expenditure has so far supported an estimated economic contribution of EUR 510 million expected for the year 2016. Induced effects bring an additional EUR 260 million. Thus the data centre industry's total supported economic contribution to Finland (direct, indirect and induced effects) for the year 2016 is close to EUR 800 million.

Figure 18 Economic impact of Finnish data centres, year 2016



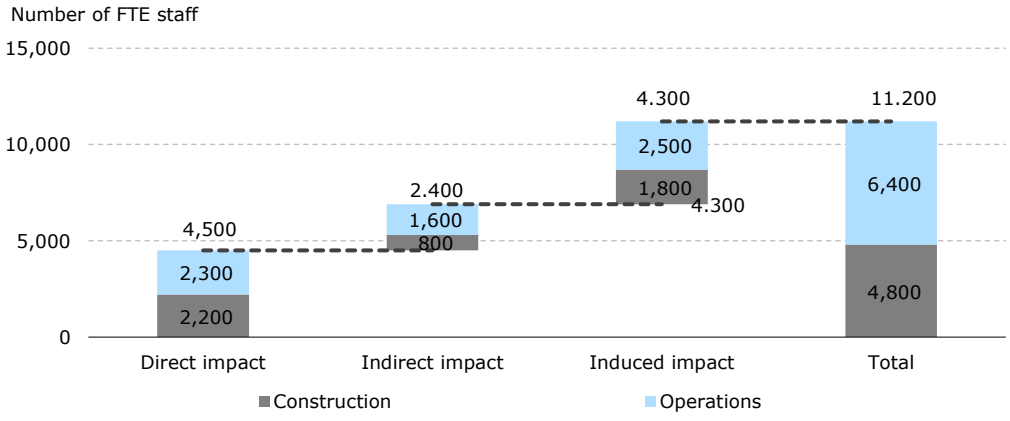
Note: The figure shows the estimated supported impact on Finland's gross domestic product (GDP) of the construction and operation of Google's data centre.

Source: Copenhagen Economics, based on data from Statistics Finland, Google and Invest in Finland

2.3 The data centre industry supports jobs in Finland

The economic activity associated with the establishment and operation of data centres brings an employment impact to Finland, such as jobs at companies that supply goods and services to the data centres, including communications infrastructure, ICT equipment and business services.

Figure 19 Employment impacts of Finnish data centres, year 2016



Note: The figure shows the estimated supported impact on employment in Finland of the construction and operation of Google's data centre.

Source: Copenhagen Economics, based on data from Statistics Finland, Google and Invest in Finland

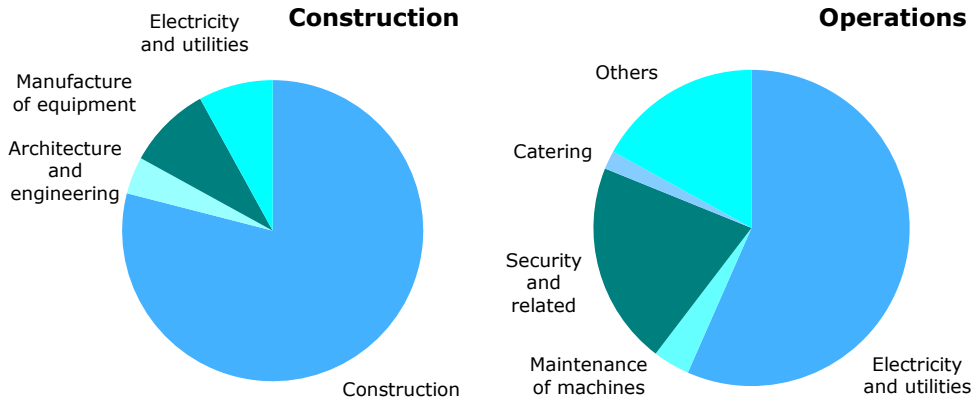
The above table shows our estimate of the employment contribution from the Finnish data centre industry in 2016 – based on the ongoing pattern of growth in the data centre stock (and related construction activity), together with the operation of the existing stock of data centres in Finland.

We further our analysis by assessing what industries are being supported by data centre activities. We focus first on the effect of construction activity, then of the operations of data centres.

For the year 2016, we estimate that the data centre industry *construction* expenditure supports close to 5,000 jobs in Finnish construction companies, their domestic suppliers and supported employment. This includes direct, indirect and induced effects of the construction expenditure. These jobs are distributed across the Finnish economy. The composition is detailed in the left chart in Figure 20.

In a similar manner, the *operational activity* of the Finnish data centre industry in year 2016 supports 6,400 jobs in Finnish service, maintenance and utility companies. This includes direct, indirect and induced effects of the operational expenditure. These jobs are distributed across the Finnish economy. The composition is detailed in the right chart in Figure 20.

Figure 20 Distribution of employment supported, by industry



Source: Copenhagen Economics, based on data from Statistics Finland, Google and Invest in Finland

Chapter 3

Case study: The Google data centre in Hamina

Since 2009, Google has invested EUR 800m in the Hamina data centre, as part of its construction and operation so far. Considering direct, indirect and induced effect of this expenditure, the economic contribution of the Hamina data centre to the Finnish economy since its inception amounts to an average of EUR 95 million per year and a total of EUR 660 million over the entire period. Moreover, the combined impact on employment of direct, indirect and induced effects totals 650-3,200 jobs per year, with an annual average of 1,600 jobs per year over the entire period.

Box 1 Google's data centre in Hamina Finland

In March 2009 Google purchased the Summa Mill from the Finnish paper company Stora Enso in order to convert this into a data centre. In the first phase of the project Google invested an initial €200 million and was completed in September 2011. During this phase, more than 2,000 individuals from 50 different companies, many of which were Finnish companies or even local companies, had contributed to the project.

Phase II of the data centre, which involved the restoration and conversion of a machine hall, was announced in 2012 with an additional investment of €150 million. This part of the project would provide work for approximate 500 engineers and construction workers.

In November 2013, an additional EUR 450 million expansion was announced, bringing the total amount of investment to Hamina data centre to EUR 800 million. A little more than half of this spending was on imported goods and services from abroad (see Appendix).

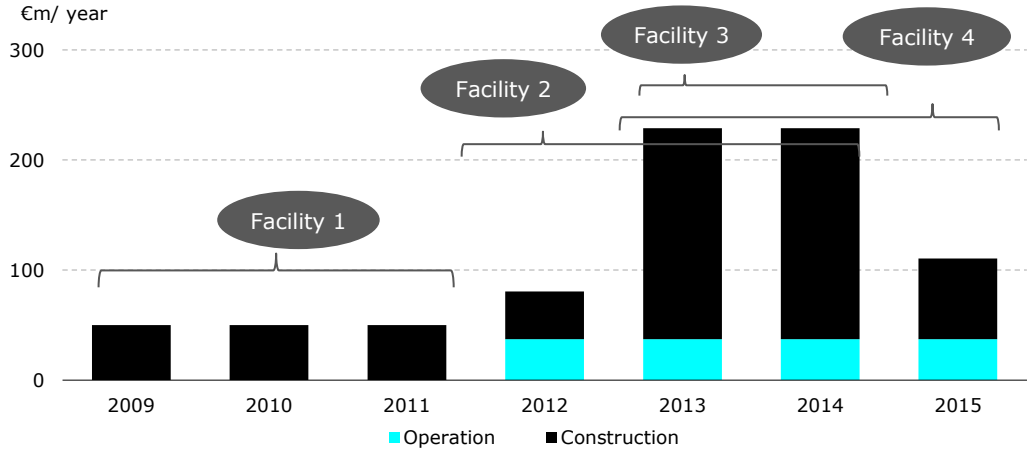
Source: Copenhagen Economics based on https://www.google.com/about/datacenters/inside/locations/hamina/

3.1 The investment in building the data centre

Google initiated the construction of its first facility in Finland in 2009. The facility now serves Google users across Europe and around the world. To meet the increasing demand for its Internet services, Google expanded with three more facilities at the same location from 2012-2015.

The establishment of these facilities involved substantial investments. Since 2009, Google had invested a total of EUR 650 million in construction activities, see figure below.

Figure 21 Google's expenditure at the Hamina data centre



Note: 2015-prices. The amount of expenditure has varied year by year and the figure represents a stylised view, showing an average across the duration of construction (3-year construction for facility 1, 2 and 4 and 2-year construction for the third facility) and assuming a constant scale of operation during the period in which only the first facility was operational (2012–2014).

Source: Copenhagen Economics, based on data from Google

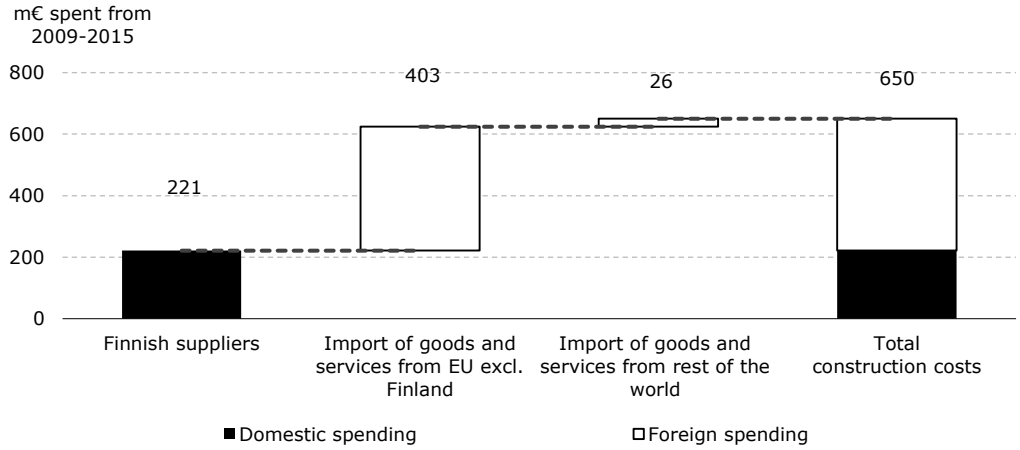
The majority of Google's spending has been on Finnish construction work and related supplies, most often imported from other EU countries, as well as mechanical and electrical work, logistic services and support professionals. Google spent EUR 429 million of the total construction costs of EUR 650 million on imported equipment from abroad and EUR 221 million on domestic supplies – reflecting the resource availability in Finland, cf. Figure 22.

3.2 The operation of the data centre

On top of the construction expenditure, Google has spent EUR 150 million on operations at the facilities since the start of operations around 2009. A large share of Google's domestic operational expenses are labour costs. Furthermore, Google's domestic operational spend includes a large component which is related to water and power supply, as well as a share dedicated to purchases of other domestic goods and services such as security, transport and repair of machinery and equipment.

Adding together the construction and operation expenditure, Google's total expenditure over the period sums up to EUR 800 million, as shown in Figure 21.

Figure 22 Google's construction expenditure, by expenditure type



Note: 2015-prices. Labour and capital costs include: wages, amortisation and gross surplus. Domestic goods and services include all materials and services from Finland.

Source: Copenhagen Economics, based on data from Google

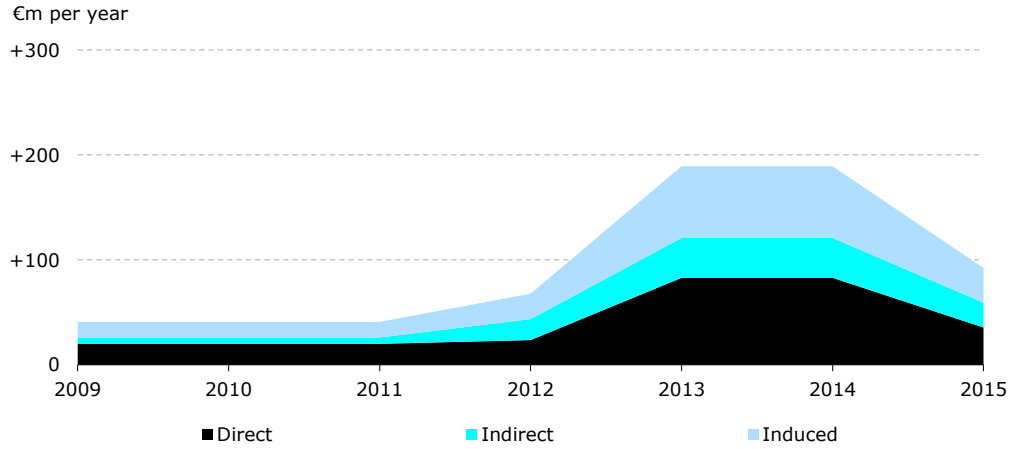
3.3 The GDP contribution of the data centre

To analyse the economic impact of the investment including both the construction period and the operation period, we have conducted a comprehensive economic analysis using detailed data from the World Input Output Database (WIOD), the Finnish national statistics office, data from Google about its expenditure on the Hamina data centre and combined it with our own economic model tools (so-called input-output model). Therefore, the results capture the impact of the Google activities at this data centre, though not the impact of any other Google activities in Finland.

Our results show that when considering the direct and indirect effects together, the four Google facilities have already supported an estimated GDP contribution of EUR 60 million on average per year since 2009. Induced effects have brought an additional EUR 35 million per year on average, adding up to EUR 95 million per year and a total of EUR 660 million over the entire period.

The yearly impact varies over time depending on the intensity of construction and the phasing in of the operations, see Figure 23.

Figure 23 GDP contribution supported by the Google data centre



Note: 2015-prices. The figure shows the estimated supported impact on Finland's gross domestic product (GDP) of the construction and operation of Google's data centre. This is based on the same time profile as in Figure 21.

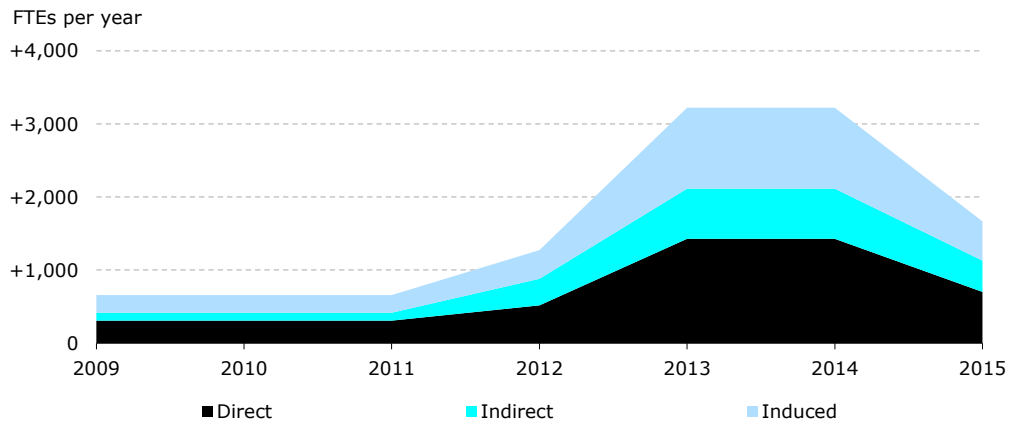
Source: Copenhagen Economics, based on data from Statistics Finland, Google and Invest in Finland

3.4 The employment impact of the data centre

Over the past few years, the direct and indirect employment impact of the Google data centre has ranged between 400 and 2,100 jobs per year. This effect has fluctuated due to the varying intensity of construction work required to build and expand the data centre site from one to two complex buildings.

Induced effects have brought an additional 200 to 1,100 jobs per year, again depending on the intensity of construction work. The combined effect of direct, indirect and induced effects totals 650-3,200 jobs per year, with an annual average of 1,600 jobs per year over the entire period, cf. Figure 24.

Figure 24 Employment supported by the Google data centre



Note: The figure shows the estimated supported impact on employment in Finland of the construction and operation of Google's data centre.

Source: Copenhagen Economics, based on data from Statistics Finland, Google and Invest in Finland

3.5 Outreach programs

Through outreach programs and partnerships with educational institutions, the Google Hamina data centre also helps promote digital skills more broadly. As discussed in the next chapter, maintaining and expanding digital skills for the needs of industry is key for Finland to make the most of the digitisation opportunity.

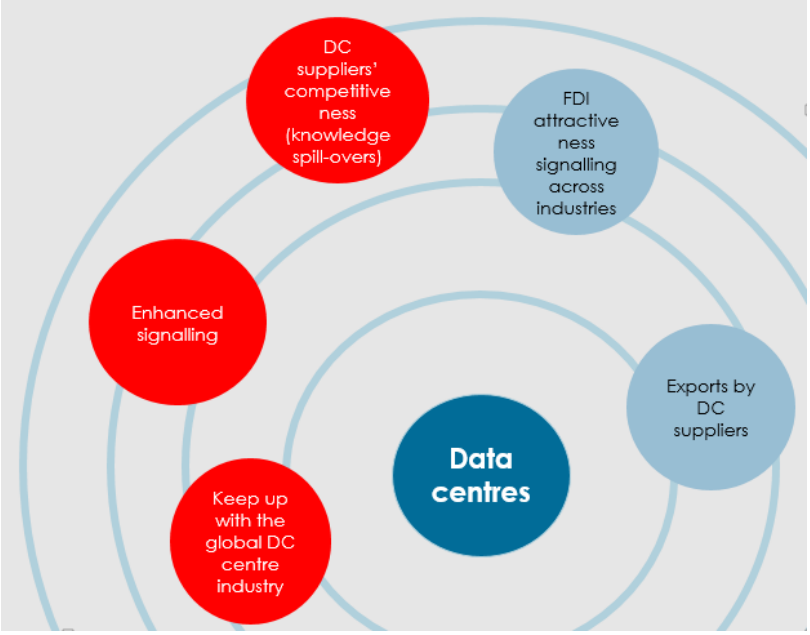
We describe in Annex several examples of outreach programs carried out by Google at the Hamina data centre.

Chapter 4

Ripple effects on data centres' supply chain and signalling effects

The previous chapters have shown that Finland is getting good value out of its data centre policies. Moreover, we have identified five further ripple effect channels which provide a potential opportunity to maximise the economic contribution of the Finnish data centre industry. The first three are quantifiable, while the last two are more difficult to quantify at this stage:

Figure 25 Ripple effects via DC suppliers and signalling



Note: The effects shown in red are those that this study not only identifies but also quantifies

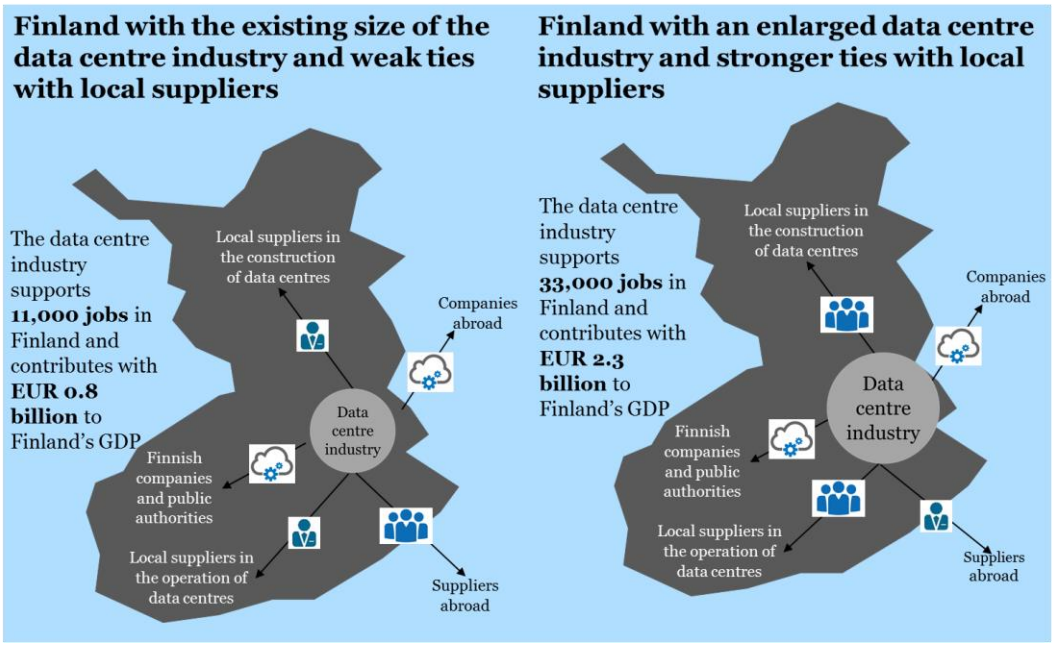
Source: Copenhagen Economics

Demand for data centre services is expected to grow by 10 per cent annually over the next decade. The good framework conditions for data centres combined with the ripple effects from the existing data centres give Finland good opportunities for attracting more data centres and increasing the future footprint of the industry.

If Finland succeeds in expanding its data centre industry by 15 per cent annually and establishing closer ties between the data centres and Finnish suppliers, the industry could

support an estimated 33,000 jobs in Finland and make a yearly economic contribution of EUR 2.3 billion in 2025.

Figure 26 The potential footprint of data centres in 2025



Source: Copenhagen Economics

Reaching this potential requires that Finland nurtures the supply chain benefits of data centre investments and keeps focusing on the basic attraction factors for data centres. Chapter 4 lists some policy recommendations that can help Finland succeed.

Background: data centre industry growth trend and location attractiveness

Global data traffic is growing fast and the need for data centre capacity is growing accordingly. The capacity of the global data centre industry has grown by 10 per cent annually from 2010 up until today, and this growth should be expected to continue in the next decade.[10] The growth of the global data centre industry will spread throughout the data centres supply chain: the data centre construction market is expected to grow worldwide at a yearly rate over 10 per cent, while the broader data centre solutions market is expected to grow 12 per cent per year up to 2020.[11]

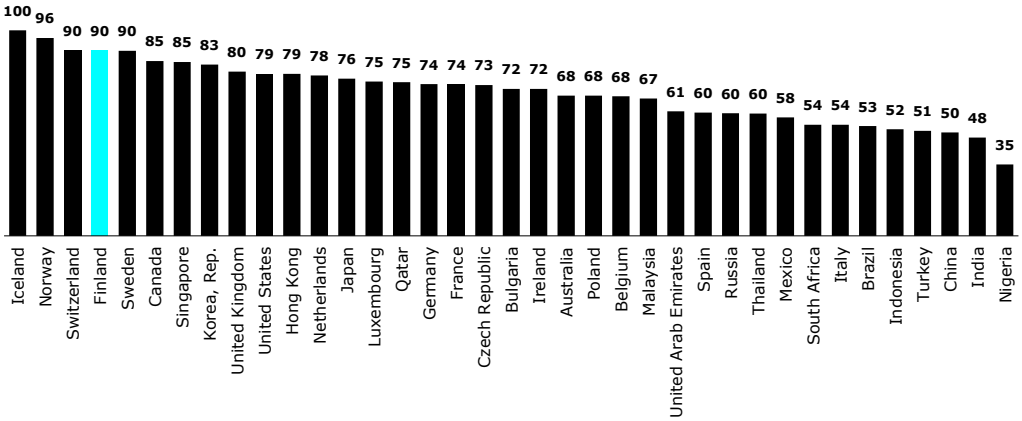
According to the 2016 *Data Centre Risk Index*, Finland is the 4th most attractive country for data centre investments only outperformed by Iceland, Norway and Switzerland, see Figure below. This index reflects factors such as electricity costs, international internet

10 Cisco Global Cloud Index (2012) and IDC Data Center Forecast. Cited in Boston Consulting Group (2014).

11 The data centre construction market growth is estimated at 10.93% per year for the period 2014 to 2019, based on a 2015 report from Research and Markets. http://www.researchandmarkets.com/reports/3145253/global-data-center-construction-market-2015-2019#relb0. The data centre solutions market is estimated at a yearly 11.75 by Markets6Markets, http://www.marketsandmarkets.com/PressReleases/data-center-construction.asp.

bandwidth, ease of doing business, corporate tax rates, political stability, sustainability, risk of natural disaster, energy security, income and water availability. The Finnish Government is very active in pursuing data centre investment opportunities from foreign investors and showcases positively the structural advantages that Finland can offer.

Figure 27 Finland is the 4th most attractive data centre location

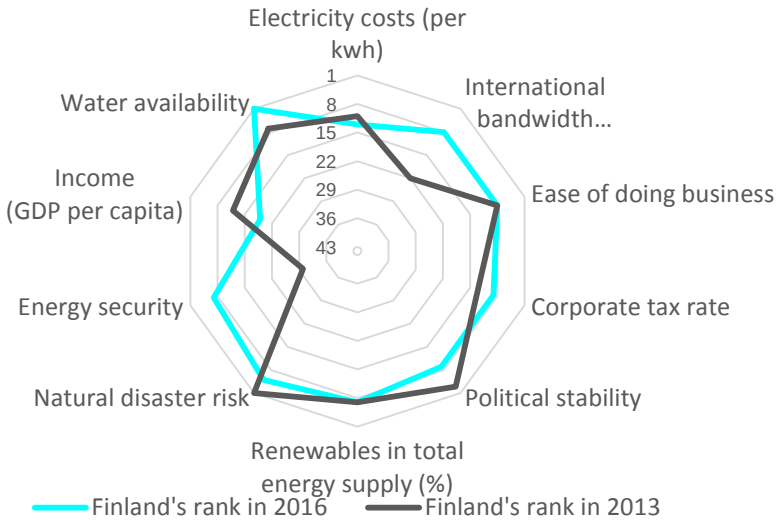


Note: The figure shows the ranking of all 37 countries included in the 2016 Data Centre Risk Index. Based on the underlying 10 risk factors, each country is attributed a score between zero and 100, where larger scores indicate a more attractive environment for data centre investments.

Source: Copenhagen Economics based on data from Cushman and Wakefield (2016)

The top-ranking position by Finland is based on some areas of world-class (e.g. water availability and a low natural disaster risk), combined with indicators presenting signs of weakness (e.g. relatives low income and high electricity costs), see Figure 28

Figure 28 Finland's attractiveness for data centres



Note: A rank of 1 reflects the best performance.

Source: Copenhagen Economics based on data from Cushman and Wakefield (2016, 2013)

Finland is thus in a good position to attract more data centres but competition is tough and other Nordic countries are also attractive locations for data centre investments. The ripple effects from the existing data centres help Finland benefit more from its attractive climate. The main ripple effects from the data centres via suppliers and signalling are described in the following sections.

4.1 Keeping up with the global data centre industry growth

To assess this ripple effect we look at a scenario where Finland makes moderate improvements to its current framework conditions for data centre activity. In doing so, Finland is able to keep up with the expected growth rate in the global data centre industry (10% per year) – but no more than that.

However, it is only the private portion of the Finnish data centre industry that can be expected to follow this growth part (rather than data centres owned by the public sector). We base this as the growth scenario. Given that the private company owned data centres are 55% of the industry, this reduces the effective growth rate in the scenario we have estimated.

Thus, while it is a conservative scenario, it requires action from Finnish policymakers to keep up via improvements in the conditions for data centre activity. In such a scenario, the construction and operation of the new data centres will support an additional **8,400 jobs** and increase the annual GDP contribution of the data centre industry by **EUR 600m** in 2025.

A further closely related impact is that when large multinational data centres enter the Finnish market and purchase input from local construction companies and suppliers of design, ventilation and cooling, electrical and pumping systems, security and all other input to the daily operation of the data centres, they increase the size of the local market.

A larger market may allow some of the Finnish suppliers to benefit from economies of scale, attract new suppliers and spur competition. With intensified competition, the more productive suppliers will gain market share at the expense of less productive companies. This will strengthen the ecosystem around the data centres. The availability of highly productive local suppliers will reinforce Finland expanding its data centre industry in years to come and fulfil its potential being one of the most attractive locations for data centres.

4.2 Enhanced signalling: outperforming the global data centre industry growth

The recent growth and presence of multinational data centres in Finland signals to other data centres that Finland is an attractive place for data centres. Such signalling effects will make it more likely that Finland succeeds in *increasing* its market share so that the private data centre part of industry grows by more than 10 per cent.

In this scenario, Finland outperforming the global data centre industry via organic growth and policy actions that maximise data centre FDI attractiveness. We estimate this scenario by increasing by 50% in relative terms the growth rate in the previous scenario. Thus we base it on a setup where the private portion of the Finnish data centre industry grows by 15 per cent instead of 10 per cent.

We find that in this scenario, the enlarged data centres industry with closer ties to local suppliers will support an additional **7,200 jobs** and increase the annual GDP contribution of the data centre industry by **EUR 500m** in 2025.

4.3 Increased competitiveness of domestic suppliers

Google and other large multinationals' data centres hold technical, operational and managerial knowledge that can improve the productivity of Finnish suppliers through knowledge spillovers.[12] Google's intensive focus on training both its own employees and the suppliers' staff working at the data centre, for example, is an important channel for this type of spillover to the Finnish economy.

The experience gained from constructing and operating the existing data centres will make local suppliers more competitive when the new data centres are going to be established in Finland. *Sakki*, a local company that contributed to the construction of the Google data centre, finds that the deeper understanding of the volume of materials required for a data centre will make it easier for them to plan and price new projects, see

[12] The knowledge spillovers from the large multinational data centres may in some case stretch beyond the suppliers but may also benefit other Finnish companies that hire former data centre employees or in other ways interact with the data centres through formal or informal networks.

Annex. The use of local suppliers in the establishment of new data centres should therefore be expected to increase.

In the construction of the data centre in Belgium, Google imported 34 per cent of the required goods and services, whereas 60 per cent of the goods and services used in the construction of the Hamina data centre were imported. More generally, a comparison of the impact of the construction and operation of data centres across European countries shows that the footprint of the Hamina data centre is – given its expenditure – small relative to data centres in other countries.[13] While total expenditures of EUR 1 million invested at the Hamina data centre supports **7.5 jobs**, the same investment supports on average **8.1 jobs** in other European data centres.

If Finland succeeds in establishing closer ties between the new data centres and local suppliers so that less imports are being used in the construction and operation of the new data centres, an additional of **6,100 jobs** per year can be supported by an enlarged data centre industry in Finland and the GDP contribution will increase by **EUR 400m** in 2025.

4.4 The data centre industry helps attract broader foreign investments

The size of the current data centre industry will not only increase Finland's chances of being the preferred location of new data centres. Foreign companies outside the data centre also respond to the signal from the data centre industry that Finland is an attractive investment location. This ripple effect covers both:

- **Signalling effects on companies on adjacent industries**. By increasing the market for local suppliers, the data centre industry makes it more attractive for foreign suppliers and their suppliers to locate in Finland. Likewise, the increased productivity and competitiveness of local suppliers make Finland more attractive for companies in adjacent industries that use the same skills and infrastructures as the data centre industry. For example, pharmaceutical and other precision manufacturing industries require a controlled production environment and supplier skills similar to data centres
- **Broader signalling effects of the data centre industry**. For some companies, Finland may not immediately come to mind as a potential investment location, but hosting a big company like Google, Facebook, Apple and Amazon sends signals to other multinational companies that Finland is an attractive location for large companies – even outside the data centre industry and the ICT sector more broadly.

Signalling effects can thus help Finland attract more Foreign Direct Investments (FDI).[14] The signalling effect of Google, for example, is acknowledged by Cursor whose main task is to develop and attract new businesses to the Kotka-Hamina region, see Annex.

[13] The other data centres are Google's data centre in Belgium, Facebook's in Luleå, Prineville and Forest City.
[14] Interview with Severi Keinälä, Head of Division, Enterprise and Innovation Department.

FDI adds to a country's total private investments, supports job creation and enhances productivity growth. FDI can this help accommodate some of the key challenges for the Finnish identified by OECD: slow productivity growth, increasing investment gap and slow growth of startups/SMEs.[15]

Like most other countries, Finland has established an investment promotion agency that has as its key focus to attract more FDI inflows. The presence of Google and other large foreign data centres in Finland gives Invest in Finland and other actors in the field of investment promotion a good show case to present to other multinational companies that they are in dialogue with.

The broader signalling effects of the data centre industry on FDI inflows to Finland have not been quantified in this report because they are very difficult to disentangle from other factors that make Finland attractive for foreign investors. In a recent study for the European Commission, for example, we thus find that Finland has the most attractive investment climate within the EU.[16]

4.5 Productivity spillovers increase local suppliers' competitiveness in export markets

Over time, the benefits of the data centre industry to local suppliers can become even larger if the increased productivity of local suppliers enables them to start exporting and become more international. An example of this is the Finnish company *Fiber Highway*, see Annex. Being a supplier to the Google site in Hamina has allowed the company to grow from five to 15 employees, and the specialised knowledge and training offered by Google have opened new business opportunities for the company in the Finnish data centre industry. The company also expects that the Google experience will make it easier for them to export their services to international clients in other countries.[17]

There are several multinational data centres present in Finland, such as Google, Yandex, Hetzner, Microsoft and the Telecity Group. These multinational companies have data centres in many other countries, and being a successful supplier to their sites in Finland may over time allow the Finnish suppliers to seek business opportunities in sites in other countries. The familiarity with internationally applicable health and safety procedures gained from being a supplier to Google in Finland, for example, will make it easier for *Kerabit Pro* to go abroad and work on similar projects for Google sites in other countries, see Annex.

The ripple effect via local suppliers' increased internationalisation may be significant in the longer term but will take time to materialise. As the impact is likely to be limited in the shorter term, this impact has not been quantified in this study.

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15 See OECD (2016), OECD Economic Surveys: Finland.

16 Copenhagen Economics (2016), Towards a FDI Attractiveness Scoreboard, a study commissioned by DG Growth at the European Commission.

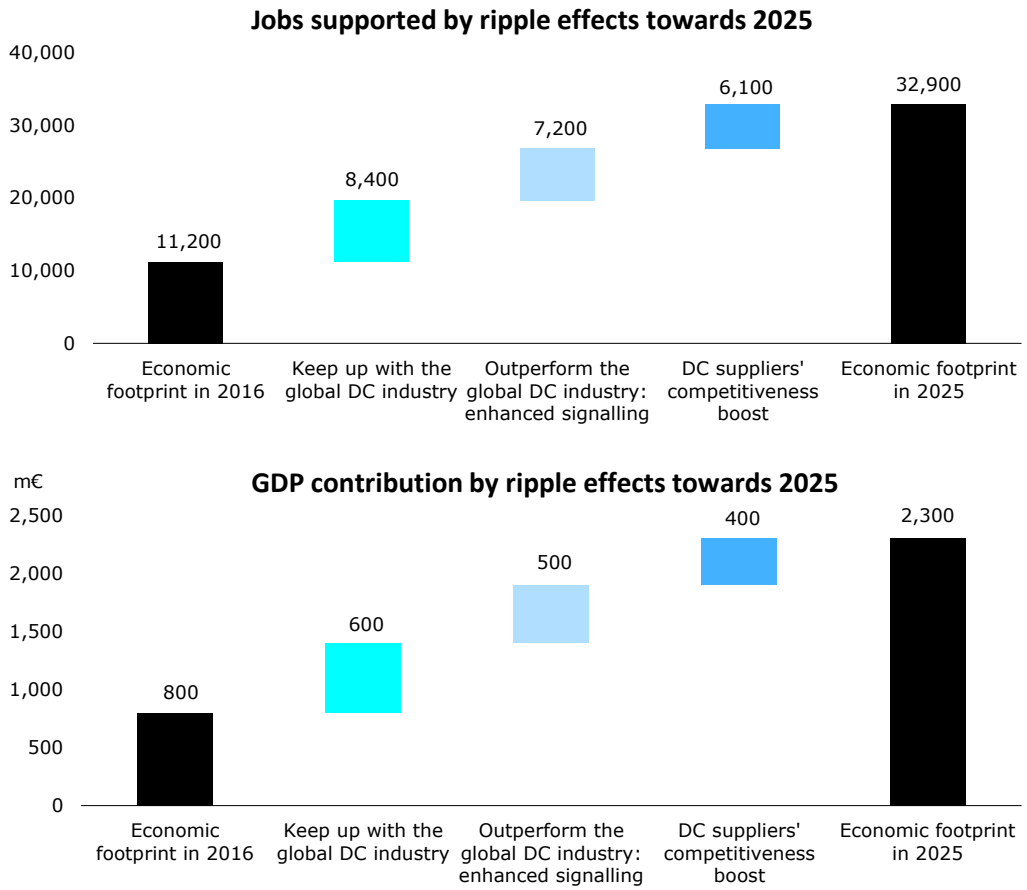
17 Empirical evidence from other countries also find that multinational companies can increase exports among their domestic suppliers (e.g. Kneller and Pisu (2007) for the UK). One ways in which such a positive impact can occur is via transfer of information from the multinational company to its local suppliers regarding foreign tastes and markets (Aitken et. al. 1997).

4.6 Conclusion: Ripple effects will increase the future footprint of the Finnish data centre industry

The ripple effects identified in this report will increase the footprint of the Finnish data centre industry in the years to come. The ripple effects have increased the *productivity* and *competitiveness* of Finnish suppliers, which will make it more attractive for new data centres to locate in Finland and easier for local suppliers to accommodate the needs for input in the construction and operation of the data centre industry. The size of the data centre also *signals* to other data centres that Finland is an attractive location for data centre investments. This makes it easier for the Finnish data centre industry to grow and for Finland to gain a larger share of the global data centre industry.

A data centre industry that grows by 15 per cent per year and uses local suppliers to the same extent as other European data centres will make an annual contribution to Finland's GDP of **EUR 2.3 billion** and support **33,000 jobs** in Finland.

Figure 29 Ripple effects of the data centre industry



Note: Jobs are measured as full time equivalents (FTEs). The figures include both the direct, indirect and induced impacts supported by the construction and operation of the Finnish data centres.

Source: Copenhagen Economics based on Statistics Finland, Statistics Belgium, Boston Consulting Group (2014), RTI (2014) and EcoNorthwest (2013)

Chapter 5

Policy initiatives to increase benefits from the data centre industry

Finland has a large and growing data centre industry, but the economic opportunities from the data centre industry are far from exhausted. The promise is greater. In this chapter, we describe some policy initiatives that will help Finland increase its benefits from the data centre industry. We have grouped the policy recommendations under four headlines, as shown in Figure 30. The costs of these policy initiatives, while not quantified in this report, is expected to be limited, and must reasonably be seen as a proportionally cost-efficient way to enhance growth and employment.

Figure 30 Policy recommendations

Source: Copenhagen Economics

5.1 Promote the digitisation spillovers through the economy

In this study, we have identified that digitisation is an ongoing opportunity as well as a challenge even for a frontrunner country such as Finland. In particular, cloud computing is key to reduce barriers to digitisation, especially for SMEs.

Figure 31 Policy recommendations: Promote the digitisation spillovers through the economy

1. Adopt a strategy to seize the digitisation ripple effects arising from data centres and cloud computing
2. National coordinator of academic, commercial & policy efforts to further the application of innovative digital enterprise solutions for the benefit of Finnish manufacturing & service SMEs
3. Foster skills programmes in universities and tech colleges matching expected needs of manufacturing & service firms' staff adopting digital solutions
4. Launch an investigation into whether Finnish firms in specific sectors can exploit low latency for competitive advantage vis à vis international peers

Source: Copenhagen Economics

Cloud computing solutions always require data centres, which is where data is stored and processed to deliver the services to the end user location. It is known that a company using cloud computing can use data centres located anywhere in the world, but as previously discussed, proximity and trust – while not absolute barriers – are an advantage to promote further digitalisation, especially for SMEs. As a result, a strong domestic data centre industry can foster greater adoption of cloud computing and digitisation across the firms which have not yet done so or not to a broad extent. The Government resolution on data utilisation is a key stepping stone.[18]

On top of existing policies, Finland will benefit from a specific national strategy focusing on the digitisation ripple effects from the combination of data centres and cloud computing. This initiative neatly dovetails with the broader framework of earlier digital agenda efforts and an Industry 4.0-like approach. However the key aspect that we encourage is a specific focus on Finland to seize the ripple effect possibilities.

Via this focused initiative, Finland could set an overarching goal, a big push to ensure that all Finnish companies are digitised by 2018, so to further the application of cloud computing solutions for the benefit of Finnish SMEs across manufacturing and service industries.

> ***Policy initiative 1:*** *Finland must have all Finnish companies digitised by 2018. To reach this, Finland should adopt a specific strategy to seize the digitisation ripple effects arising from the combination of data centres and cloud computing.*

Digitisation is not a straightforward, linear process and success requires the matching of solutions (like cloud computing) to the processes of different types of manufacturing and

[18] Ministry of Transport and Communications, https://www.lvm.fi/en/-/government-resolution-increases-data-utilisation

service firms. To promote greater digitisation, cloud computing is key, yet the needs of end users can be complex and diverse. Besides cloud, digitisation opportunities will come from emerging technologies such as the Internet of Things, Big Data and Augmented/Virtual reality. All of these will be based on new data and larger, complex computing applications – increasing further the reliance of our manufacturing and service firms on data centres.

Existing business advisors and solution vendors can play a role in the matching of needs and solution, however it is likely that a public policy coordinated support can help maximise the benefits for Finnish firms of proximity to a strong domestic data centre industry. SMEs are in particular an area where a clear gap exists between current adoption (even if high for European standards) and the full potential ahead.

The first step is for the Finnish public sector players to play a more pivotal role in ensuring that the chain of provision of cloud computing serves the needs of all Finnish firms – whatever their sector and their size. Finland has a strong tradition and track record of multi-stakeholder initiatives (e.g. in research, with joint risk funding and in Triple Helix collaboration programmes) involving a mix of public and private sector efforts.

Thus we recommend that Finnish authorities assign a national coordinator with a mandate to maximise the ripple effects from the combination of data centres and new digital enterprise technologies (e.g. cloud computing, internet of things, big data and augmented/virtual reality inter alia). This person or entity could have a direct reporting to the executive part of the Government and the task to coordinate already ongoing initiatives and projects but also to initiate required cooperation between academic, commercial and policy efforts (national/local). Inter alia, the coordinator should have three data centre tasks:

- Monitor the ecosystems around Finnish data centres and develop clear targets for each of these.
- Monitor and encourage the ongoing evolution in the public sector use of digital technologies and the underlying data centres.
- Coordinate ongoing initiatives and a clear mandate to execute the detailed proposed initiatives identified below in this chapter.

Policy initiative 2: *Finland should appoint a national responsible coordinator (a CIO) tasked to bring together academic, commercial and national/regional policy efforts to further the application of innovative digital enterprise solutions for the benefit of Finnish SMEs across manufacturing and service industries.*

It takes two to tango: developments in cloud computing and other emerging digital enterprise solutions for the needs of Finnish firms are not enough if the end users themselves are not able and aware of how to deploy them to grow their business.

Thus, as a second, parallel step, the knowledge base of end user industries could be maintained and enhanced. Here, the role of existing skilled staff (for instance those previously

employed by large firms such as Nokia / Microsoft Mobile) can be pivotal to allow large and small Finnish industry and service firms to benefit from advanced digital solutions.

Therefore, we encourage steps to make end users able to benefit from knowledge spillovers – by making them gain a greater absorptive capacity to make their businesses benefit from digital innovations.

Policy initiative 3: *Finland could foster skills programmes in universities and technical colleges that match the expected needs of manufacturing and service firms staff managing the adoption of digital solutions across business areas.*

Furthermore, as outlined in chapter 4, there are some specific industries and emerging applications where low latency can provide a competitive advantage for firms (including start-ups) wishing to embark in delivering new services.

Proximity to data centres can be an important factor to achieve low latency connections and data transfer supporting these innovative applications. This can complement the infrastructural advantages deriving from advanced international connectivity, such as the Baltic sea cable that has been recently inaugurated.[19] This Northern Digital Highway or C-Lion1 submarine fibre-optic cable has been described as the largest-capacity connection in the world.[20] The combined effect of proximity to a strong domestic data centre industry, the advanced international connectivity and developed national connectivity networks can jointly provide competitive advantage for new ventures developing yet to be envisaged applications leveraging these resources.

Policy initiative 4: *Finland could launch an investigation into how Finnish firms in specific sectors can exploit low latency for competitive advantage vis à vis international peers.*

5.2 Nurture supply chain benefit of data centre investments

The benefits of an enlarged data centre industry will not materialise automatically, and the footprint of the data centre industry on the Finish economy will be limited if the data centres do not use any Finnish suppliers.

19 http://cinia.fi/en/news/cinia-connects-equinix-data-centers-frankfurt-and-helsinki

20 http://www.zdnet.com/article/helsinki-to-frankfurt-in-20-milliseconds-the-baltic-cable-thats-breaking-data-speed-records/

Figure 32 Policy recommendations: Nurture supply chain benefit of data centre investments

5. Analyse and monitor the competitiveness of local suppliers to the data centre industry

6. National coordinator to work with representatives from the data centre industry to develop targeted initiatives increasing the integration of local firms in the data centre supply chain

7. Foster export from existing suppliers to Finnish data centres towards serving other national markets' data centre industries

8. Foster application of skills from Finnish data centres' suppliers to serve other manufacturing industries

Source: Copenhagen Economics

Invest in Finland manages a formalised growth program that is specifically targeted for developing and promoting data centre investment opportunities. As part of the program, Invest in Finland provides training and consultation for site owners (cities, municipalities or private), bring local commercial operators together with the aim of establishing so-called 'Datacenter Campuses' for the available sites, execute marketing campaigns, and organise sales & promotion events both locally and globally.[21]

However, and in addition, increasing the footprint of the data centre industry would benefit from an increased focus on the supply chain serving the construction and operation of the data centre industry – so to enhance the share of Finnish supply and lower the share of imports.

Invest in Finland could strengthen the initiatives to support the supply chains around the data centres and improve the competitiveness of local suppliers to the data centre industry. To design these initiatives and ensure their effectiveness, it is important first to analyse *why* the local suppliers in Finland are being used less than local suppliers in other European countries.

> ***Policy initiative 5:*** *Finland could analyse and monitor the competitiveness of local suppliers to the data centre industry.*

Moreover, data centres themselves are also interested in finding stable, local suppliers, and Google actively searches for local suppliers for the Hamina data centre, see Annex.

Invest in Finland could therefore coordinate initiatives to strengthen the footprint of the data centre industry with representatives from the industry.

[21] Interview with Mr. Toni Mattila, Senior Advisor at Finpro, Invest in Finland. The interview was carried out 9th August 2016.

Policy initiative 6: *Finland's national coordinator on data centres ripple effects could collaborate with representatives from the data centre industry to develop targeted initiatives increasing the integration of local firms in the data centre supply chain.*

The experience gained from supplying goods and services to Google has opened new business opportunities abroad for Finnish suppliers. So far, none of the suppliers have managed to turn this opportunity into real business. This could indicate that further initiatives to promote export are required.

Policy initiative 7: *Finland could carry out and coordinate initiatives that foster export from existing suppliers to Finnish data centres towards serving other national markets' data centre industries.*

Finally, the skills of companies in the supply chain for data centres are not specific only to data centres. As found in our previous study (Copenhagen Economics, 2015), suppliers to the Belgian data centre industry were able to use the same skills to:

- Support construction activity in other infrastructure projects domestically and abroad
- Install complex systems to enable controlled environments in a production facility. (precision climate control, piping, electrical and security systems), which is used in manufacturing industries.
- Maintain and upgrade the same type of complex systems, with certification complying with the highest quality standards.

Policy initiative 8: *Finland could carry out and coordinate initiatives that foster application of skills from existing suppliers to Finnish data centres towards serving domestic manufacturing industries and exports.*

5.3 Infrastructure: keep focusing on the basics for data centres

Besides the regulatory environment, a range of other factors also influence Finland's ability to attract more data centres. Finland ranks as the 4th most attractive location for data centres. Since, 2013, Finland has improved its position in terms of international bandwidth, water availability and security of energy supply. Finland has structural advantages in this field, yet the balance can be tilted by small changes.

Figure 33 Policy recommendations: Infrastructure: keep focusing on the basics for data centres

9. Reduce energy costs and have as a key goal to be among the top-5 most attractive investment locations measured in terms of energy costs

10. Increase the share of renewables and have as a key goal to be among the top-5 most attractive investment locations measured in terms of access to renewable energy

11. Plan FDI-ready data centre sites for cooperative input to district heating system and promote R&D in this area

Source: Copenhagen Economics

Thus Finland – to defend and improve its position compared to peers – could continue to focus on areas where indicators show some relative disadvantage. These indicators include energy costs, which are a key factor. Thus, it could be valuable for policy makers to strive to bring down energy costs.

Reducing electricity costs can make a significant contribution to Finland's attractiveness for data centres, because operational energy consumption accounts for around 30 per cent of the total data centre facility costs.[22] Therefore, Finnish policy makers could implement initiatives that will significantly improve Finland's rank as the 13th most attractive country – while considering the policy costs and environmental consequences.

Policy initiative 9: *Finland could reduce energy costs and have as a key goal to be among the top-5 most attractive investment locations in terms of energy costs.*

Data centres demand not only access to cheap and secure energy but also want the energy to be clean in order to reduce the environmental costs of their activities. For example, the Google data centre in Hamina gets its energy fully green and this is currently produced in Sweden because of the country's abundance of clean energy at low costs.[23] Google is a frontrunner in sustainability and energy efficiency yet is not unique amongst the data centre industry in its demand for clean energy, with analysts expecting fast growth in demand for renewables for all data centres.[24] Data centre energy demand has two key advantages: (i) its predictability and (ii) negative correlation with instances when power markets are imbalanced, such as days with cold, calm spells – these are also days when advanced data centres require less power and benefit most from natural cooling.[25] Thus, Finnish policy makers could implement initiatives that will increase the share of renewables in total energy supply, considering benefits and costs of such a transformation.

22 Interview by IT analyst Andy Lawrence from the 451 Research Group.
23 Source: Google.
24 See key trends expected for the data centre industry for 2016 at http://www.datacenterdynamics.com/content-tracks/design-build/ten-data-center-predictions-for-2016/95409.fullarticle
25 Google has applied machine learning to model its Power Usage Efficiency and shared this model, allowing close prediction of power use, https://www.google.dk/about/datacenters/efficiency/internal/

Policy initiative 10: *Finland could increase the share of renewables in total energy supply and have as a key goal to be among the top-5 most attractive investment locations measured in terms of access to renewable energy.*

Data centres produce heat. One attempt in Finland is a single data centre initiative to collect and distribute the heat from the server activity and turn it into district heating for a local community. It is unclear how successful this unilateral attempt has been. Economies of density imply that the coordinated, proximity siting of multiple data centres provides the best chances that the heat from these facilities can be harvested so that it can be conveyed to power a local community. To maximise benefits, density and planning neighbouring data centres are key and so is cooperation between companies, local authorities and universities in researching innovative technology and organisational models.

Policy initiative 11: *Finland could plan FDI-ready data centre sites designed so that multiple data centres can cooperatively feed the local district heating system and promote R&D in this area.*

5.4 A front-running Finland in a well functioning EU market

For multinational companies to make large-scale investments in expanding the Finnish data centre industry, they need to be able to serve Internet users across the EU (and globally). To serve the interests of the data centres, Finnish policy makers could pay close attention to the development of the market for digitally powered services and work with EU representatives and institutions.

Figure 34 Policy recommendations: A front-running Finland in a well functioning EU market

12. Promote further an open and growing European market for digitally powered services

13. Build an advanced comprehensive strategy for optimising signalling effects from large multinational data centres

14. Preserve its strong rule of law, with advanced privacy, copyright and data security regulation

Source: Copenhagen Economics

Key EU policy areas include the Data Protection Reform; European Cloud Strategy and Data Infrastructure; and Free Flow of Data Initiative. In particular, policy makers could work proactively to:

- Ensure that the rapid growth of the EU Digital Single Market is prioritised and that the open nature of the Digital Single Market is safeguarded and strengthened so to function effectively and without intra-EU barriers.

- Implement reforms to the market for digitally powered services in a way that enables the most digitally productive countries, like Finland, to preserve and grow their role as a hub for a bigger, more efficient and successful European digital economy.

Policy initiative 12: *Finnish policy makers could work to promote further an open and growing European market for digitally powered services.*

International investments require careful management and Finland is experienced and has track record in doing so. Policy coherence and consistency is key to maximise the consolidated impact of specific investment promotion initiatives and policies at all levels, including EU, national and regional policies.

The signalling effect from large multinational companies will be stronger for companies that attach high importance to the same structural features as the data centres, and Finland could increase focus on these companies. These include:

- Firms operating data centres for own purposes, for internet applications or third party use; and
- A wider set of players active in the ICT industries and attracted to the ICT skills and in the Finnish workforce and supporting policies; and
- Multinational corporations across industries, which appreciate the infrastructure (including connectivity) and knowledge base available in Finland, to serve EU and global markets.

Policy initiative 13: *Finland could build an advanced comprehensive strategy for optimising signalling effects from large multinational data centres.*

Finally, to support greater digitisation and investment at all layers of the value chain, it is valuable for Finland to maintain privacy and copyright state of the art regulation. A strong rule of law and sensible approach to security in data processes is an important asset for Finland.

Policy initiative 14: *Finland could preserve its strong rule of law, with advanced privacy, copyright and data security regulation.*

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