



Grant Thornton

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# A Study of the Economic Benefits of Data Centre Investment in Ireland

IDA Ireland

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# Executive Summary

# Executive Summary

## Background

The growth in global data centre investment over the past decade has been strongly reflected in Ireland. Largely consisting of global and multinational companies financing capital-intensive projects, data centre investment has provided significant economic and employment benefits to the Irish economy. These benefits consist of both the initial capital investment and the ongoing operational expenditure which creates and sustains jobs across the wider economy.

However, the exact extent to which data centre construction and operation has benefitted the Irish economy has to date not been quantified.

This study, commissioned by IDA Ireland, identifies and outlines the significant economic and employment benefit that the data centre sector has made in Ireland. This study measures the economic activity stimulated by the expenditure of data centres since 2010 which then flows through the wider economy.

The insights contained within this study are based on data gathered via:

- A direct survey of data centres currently operating in Ireland featuring both quantitative and qualitative impact-related questions. In total 16 data centres provided survey responses.
- An extensive stakeholder consultation including interviewing representatives of other industries, government bodies, and data centre suppliers to canvass their views on the impacts of the industry.

The traditional measures of economic activity such as total expenditure and employment have been collated from survey responses which provide the direct benefits such as capital investment operational presence and expenditure and creation of employment. The benefits detailed in this report are specific to Ireland having been already adjusted to take account of expenditure and employment which relates to overseas or non-domestic suppliers and employees.

Further detailed analysis of these direct benefits using the nearest comparable CSO economic multiplier of 1.57 enables quantification of the indirect effects of data centre expenditure on the wider Irish economy.

## Key Findings



**€7.13 billion**

The economic contribution to Ireland of data centres since 2010



**1,000 / 90%**

The number of suppliers currently contracted with data centres operating in Ireland, with 90% of expenditure benefitting Irish companies



**5,700 / 2,900 / 2,800**

The number of Total FTEs, Construction specific FTEs and ongoing Operational FTEs supported by data centre investment on an average annual basis since 2010

## Large benefits to the Irish economy so far



### OVERALL ECONOMIC IMPACT

The total direct and stimulated (indirect) expenditure of the data centre industry in Ireland since the year 2010 is estimated to have been €7.13 billion. This is made up of four components:

**1. Construction – direct, 2. Operating – direct, 3. Construction – indirect and 4. Operating – indirect.**

(1) Data centre operators have invested a total of €2.96 billion on the construction of data centres in Ireland;

(2) A further €1.59 billion of operating expenditure has taken place over that period;

This gives a total estimated direct benefit of €4.54 billion. As that initial expenditure filters through the economy through business to business expenditure it has supported an additional €2.59 billion of indirect expenditure consisting of:

(3) €1.68 billion of indirect construction benefits; and

(4) €0.90 billion of indirect operating benefits.

This gives a total construction benefit of €4.54 billion\* (€2.96 billion + €1.59 billion) and an ongoing operational expenditure benefit of €2.59 billion\* (€1.68 billion + €0.90 billion).

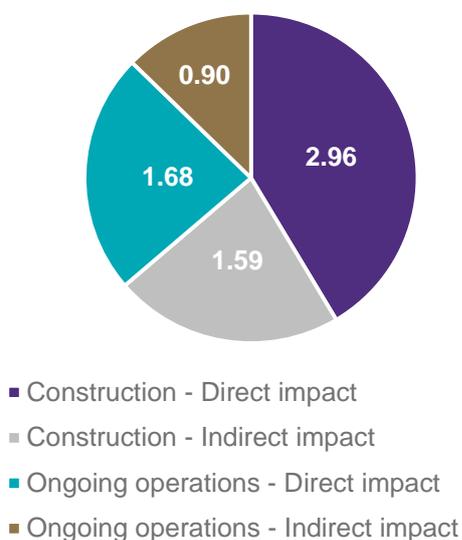
The majority of this investment by the data centre industry has occurred since 2010 as data centres have increased both in number and scale.

This significant investment has benefited suppliers across Ireland with the vast majority of the construction and operating expenditure taking place in Ireland with the use of Irish workers and suppliers. Almost 1,000 suppliers have been contracted by data centres with 77% domestically based, benefitting from 90% of the total expenditure. Enterprise Ireland and the IDA have played a key role organising introductions between new entrants to Ireland and local suppliers with the necessary core skillsets and experience.

This has generated new jobs, provided additional sources of income in Ireland and entailed significant trickle-down effects to the wider economy (multiplier effects), i.e. the effect of the data centre in supporting economic activity and employment in other industries such as retail trade, transport, accommodation, restaurants, housing and finance. These are detailed on Page 6.

Figure 1 Economic benefits

Economic benefits - € billions



\* may not add-up due to rounding

Source: Survey data and Grant Thornton calculations



## EMPLOYMENT

Data centre investment in Ireland creates and supports an estimated 5,700 full-time equivalent (FTE) roles on an average annual basis over the period studied. As with economic benefits, this is made up of four components:

**1. Construction – direct, 2. Operating – direct, 3. Construction – indirect and 4. Operating – indirect.**

- (1) These roles include 1,900 construction-related jobs, many at a time when Ireland’s construction industry was struggling to recover from the devastating impact of the economic downturn;
- (2) Operational expenditure directly employs a further 1,800 workers on an ongoing basis to facilitate the operation of Irish data centres annually. These roles are typically high-skilled, well-remunerated roles that require significant training and educational and professional qualifications;

As that initial expenditure filters through the economy through business to business expenditure it has indirectly supported a further estimated 2,000 roles annually across the economy through both capital and operational expenditure consisting of

- (3) 1,000 indirect construction roles; and
- (4) 1,000 operational roles.

This gives a total construction related FTE of 2,900 (1,900 + 1,000) and a further 2,800 (1,800 + 1,000) ongoing operational related FTEs on an average annual basis.

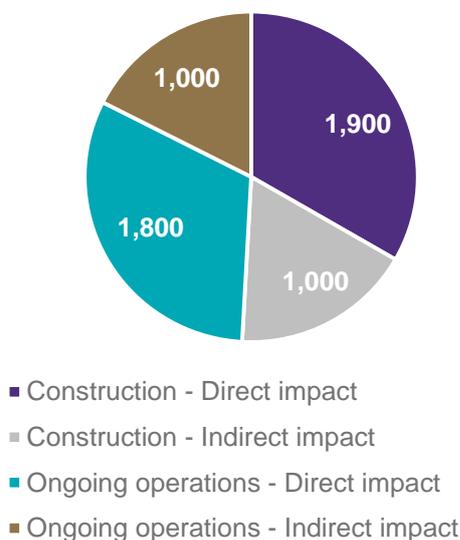
A large number of ancillary services and roles not directly related to data centre operation have been attracted following initial data centre investments. These include finance, operations, sales, customer support and software engineers. Survey responses strongly confirmed that many Irish based data centre operators see the physical location of their data centre operations as closely strategically linked to their overall activity and operations in Ireland i.e. the presence of data centres opens up the opportunity, and in some instances necessity, to locate other ancillary services in Ireland.

This has resulted in the employment of the companies which have large data centre investment in Ireland doubling from 4,000+ to almost 10,000 since 2010. While this employment is not all directly related to data centre investment, these investments support and embed the companies wider activities in Ireland.

As indicated on Page 7 'Exports', the CIF found that a further 6,600 FTEs were employed overseas on data centre projects at the time of a survey conducted in 2016 largely thanks to the experience, expertise and reputation developed from working with data centre owners and operators on projects in Ireland.

Figure 2 Annual average employment benefits

Annual average employment benefits - FTEs



Source: Survey data and Grant Thornton calculations



## SPILLOVER EFFECTS

In addition to the economic benefits quantified in this report, the analysis identified that data centres generate significant broader economic effects, which provide further long-lasting benefits to the Irish economy. These qualitative effects are dynamic in nature and drive enhancements in a number of areas outside of the direct data centre industry. **Some of these are listed below:**



## CREATION OF A DIGITAL ECOSYSTEM

The data centre industry is the newest and most visible of the many elements of the data industry and digital ecosystem that have been present in Ireland for decades and which is currently flourishing. The presence of a strong data centre industry in Ireland has resulted in ongoing investment in the infrastructure necessary to support the industry such as low latency fibre network connections to the US, the UK and Europe of which there are now 14 operational with more planned as well as the T-50 fibre ring around the M-50. This well-established telecommunication network has been attractive not just to the data centre industry but to the wider information and communications technology industry and other data-intensive industries such as bio-pharma research and finance services.

As a result, Ireland has developed a reputation and pedigree as one of the world's key digital hubs, creating a digital ecosystem which facilitates and supports the needs of multinational companies across a number of industries.



## CLUSTERING

An extension of the digital ecosystem has been the development of 'clusters', geographic concentrations of interconnected entities. Clustering has a number of benefits including increasing innovation, collaboration, knowledge sharing and other spillovers which enhance productivity and competitiveness e.g. Silicon Valley as a technology cluster. These benefits are derived from the presence of a concentrated base of potential customers, suppliers and resources including skilled labour. A key attraction for companies in data-intensive industries is to be in close proximity to both their own data but also those of suppliers and customers in order to increase efficiency in B2B and B2C transactions.

The clustering effect is seen in every key data centre location across the globe including London, Frankfurt, Amsterdam and Loudoun County, Virginia, and Dublin around the T-50 network is another example of this.



## EDUCATION

Data centres typically employ and train highly skilled individuals. The employment opportunities provided by data centre investment has seen data centres work with Irish educational institutions to develop courses that enhance the Government's STEM (Science, Technology, Engineering and Maths) strategy. The collaboration between IT Sligo and industry partners such as Google has resulted in the launching of a degree programme in data centre facilities engineers, the first of its kind in Europe.

The benefits of these this education and employment include knowledge spillovers where through labour mobility and interaction with local suppliers these skills, know-how and experiences spread far wider than just the data centre industry.

The Construction Industry Federation (CIF) confirmed that their members have been able to take their experiences and skills gained from data centre projects and utilise them within the supply chain for other sectors such as pharmaceuticals, medical technology and Agri-Food making Ireland more attractive and productive across a number of additional industries.



## EXPORTS

These experiences, skills and the relationships established through working with data centre owners and operators in Ireland have enabled Irish suppliers to expand their operations into global markets. Irish firms and workers have become leading suppliers to the industry as a whole with expertise recognised and trusted globally. In every key data centre market in the world, you will find Irish companies, contractors and workers designing, constructing and managing facilities.

A survey conducted in 2016 by the CIF of its members indicated that Irish companies were at the time engaged in data centre projects in England, The Netherlands, Finland, Belgium, Russia and Germany with a capital value of over €2.2 billion and direct employment of a further 6,600 Irish FTEs.

## Even larger benefits ahead

The data centre industry is continuing to develop in Ireland and a number of applications for planning permission are at various stages of approval. Industry commentators all forecast at least a doubling in size of Ireland's data centre industry in the next five years or so which is supported by the survey responses indicate that 93% of respondents anticipated increasing or maintaining their data centre investment in Ireland over the next decade. If these proposed developments materialise it would result in significant further economic contribution and job creation, potentially more than doubling the benefits seen to date.

With more people accessing the internet, with more businesses moving to online product and service provision, with the growth of the Internet of Things and connected devices and with the desire to create, store and analyse data in greater volumes, faster and in a more universally accessible manner than ever before the already exponential growth in data over recent years is just the beginning of a revolution that its impact will be felt globally.

Ireland is at the forefront of the data industry of which data centres are just one facilitating factor. Data centres provide significant direct economic and employment benefits but they also act as an enabler to unlocking far greater benefits across the €71 billion global technology services export industry and wider digital ecosystem.

Data and its storage and management present a significant opportunity for Ireland. As a key facilitator and participant in the wider data industry, Ireland is in a unique position to benefit even further than it already has from the exponential data growth and corresponding storage and investment requirements that are forecast to continue over the next decade.

# Why are data centres needed?

**This section provides information about data centres and their roles with regard to the Internet of Things and Big Data, the trends in data centre growth, and insights into the growth in data and stored data. As global trends emerge, Ireland’s policy and infrastructure decisions will be key components in securing Ireland’s position on the global stage.**

### 1.1 Introduction

The major consumer technology providers such as YouTube, Netflix, Amazon Music, WhatsApp, iTunes, depend on sophisticated large servers in data centres to work without interruption and geographical constraint. The key infrastructure required for data centres include uninterrupted power supplies, ventilation, data centre cooling systems, and network connectivity, which leads to specific requirements around stable energy supplies, high-speed communication networks and access to natural resources for cooling.

### 1.2 Types of data centres

Data centres can be categorised as enterprise data centres or collocation facilities as follows.

Enterprise data centres are owned and operated by organisations for their exclusive data needs but can also be utilised by large-scale operators providing Infrastructure as Service facilities to service the needs of their customers. These type of data centres tend to be used by organisations with larger data requirements, such as global technology companies. The enterprise category includes what are known as Hyper-scale Data Centres, typically built and operated by global corporations.

Colocation facilities describe shared data centre sites, which are used to process and store data for more than one organisation as part of a service offering. In general, colocation facilities are built and owned by colocation operators provide infrastructure including the physical space, cooling, power, bandwidth and security for the facilities. Colocation customers lease spaces within the facilities, usually providing their own IT equipment including servers and computer hardware.

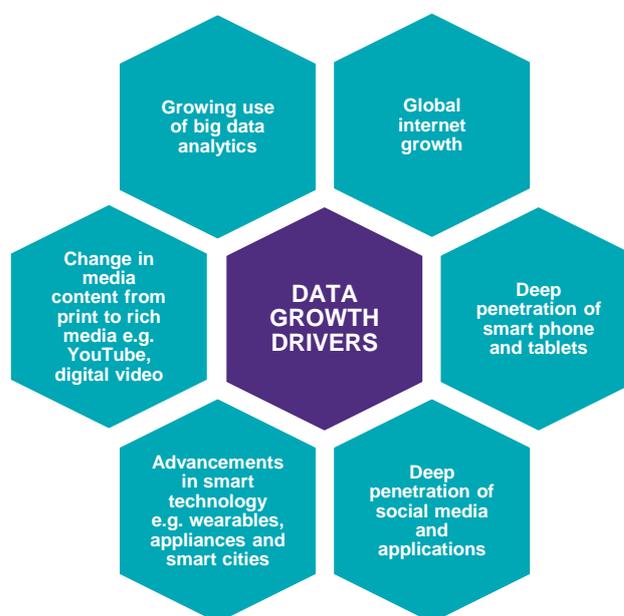
The third type of data centre is ‘Edge’ Data Centres. These are specialist data centres located near the final user of the data in order to reduce latency and improve the user experience. These are a key facilitator of the Internet of Things (IoT).

The choice of data centre type is dependent on the data requirements of organisations.

### 1.3 Role of data centres

Data centres are pivotal to the delivery of IT services to enable communications, networking and data storage to service the fast-paced growth in networked and internet-connected devices and applications, users and business processes in recent years. This has resulted in an exponential growth in Big Data, which together with the increased focus on data analytics, has added to the value and growth of data centres globally (Cisco 2016).

Figure 3 Drivers of data growth



Source: PWC 2017

### 1.4 Data trends

The rapidly-increasing data traffic from the Internet of Things and Big Data have been, and are expected to continue driving the increase in demand for data centres, which will be needed to communicate, process and store a large amount of data.

- Between 2013 and 2015, more data was created than in the entire previous history of the human race.
- In 2015, 1 trillion photos were taken with billions stored or shared online – 80% using smartphones of which there will be 6.1 billion globally by 2020.
- Smartphones will make up 12% of the 50 billion smart connected devices estimated to be in use, all developed to collect, analyse and share data.

#### The internet in 60 seconds...

- Twitter - 98,000+ tweets
- 11 million instant messages
- Google - 698,445 searches
- 168 million+ emails sent
- 217 new mobile web users
- 1,820 Terabyte of data created

Every Tweet, every Instagram picture, every email, every search and every video watched adds to this with more and more users wanting to store this data and make it accessible from anywhere, anytime.

But that data above is associated with the impact of the typical internet user who will contribute to just 1.5 Gigabyte of traffic/day.

Other connected devices and users will generate far greater volumes of traffic/data:



Autonomous vehicles – 4 Terabyte of data/day



Connected aeroplane – 5 Terabyte of data/day



Smart factory – 1 Petabyte of data/day



Cloud video providers – 750 Petabyte of video/day.

#### Data growth

Cisco Global Cloud Index estimated that by 2020, 600 Zettabytes of data will be generated by all people, machines, and things, up from 145 Zettabytes in 2015. This signifies an expected growth of 400% over 5 years. Consistent with the rise in big data, data stored in data centres has been forecasted to rise from 171 Exabytes in 2015, to 915 Exabytes by 2020. This represents a 40% CAGR (compound average growth rate, which calculates the smoothed average of growth over a period) (Cisco 2016).

Figure 4 Growth in stored data



Source: PWC 2017

With more people, businesses and devices creating and wanting to store more data than ever before data growth trends will continue to grow exponentially for years to come. That growth will create an even greater need for data centres and significant opportunities and requirements for further investment in their infrastructure.

**Why Ireland?**

This section provides an overview of the current data centre landscape in Ireland, future proposed projects, and some of the reasons why data centres are attracted to locating in Ireland.

## 2.1 Expected global growth of data centres

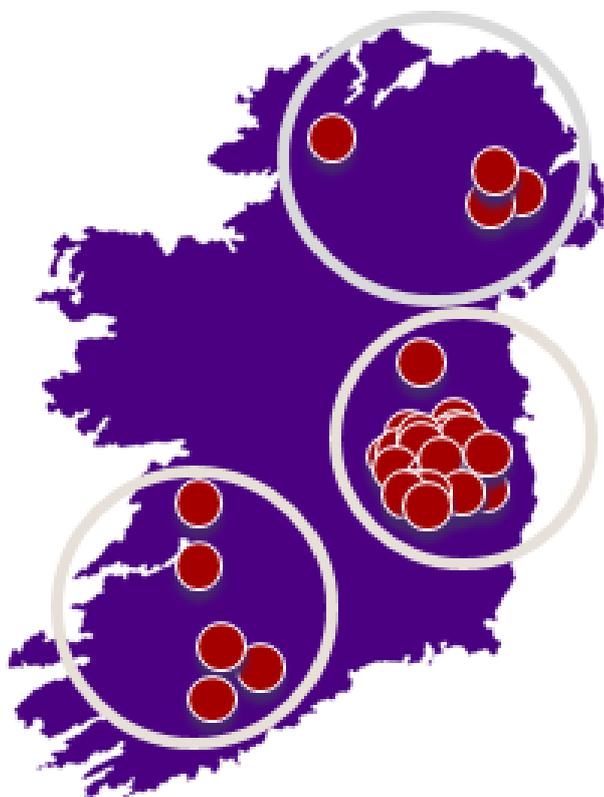
The need to process and store the rapidly expanding data traffic has resulted in the continual expansion of the global data centre market. Data centre construction to meet the demand for data centres is projected to increase by 8.32% CAGR over the period 2017 to 2021 (Research and Markets, 2017).

## 2.2 Ireland's competitive positioning

Ireland's positioning for attracting data centres in the face of internal competition is largely focused on the key requirements of the sector namely: skilled workforce; climate; advanced infrastructure and renewable energy sources. Ireland provides many of the industries requirements. Of these, survey respondents highlighted three key factors which heightened the appeal of Ireland as a location to invest.

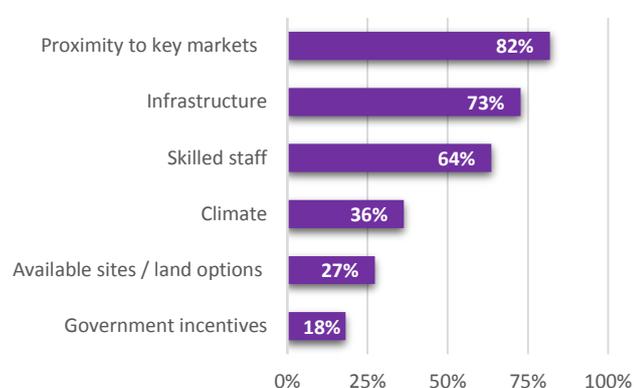
- proximity to key markets;
- availability of infrastructure; and
- availability of skilled staff.

Figure 5 Current data centre locations in Ireland



Source: Silicon Republic, 2016

Figure 6 Benefits of establishing data centre operations in Ireland



Source: Survey data

### Proximity to key markets

Ireland as a Member State of the European Union is subject to all the privileges and obligations of EU membership, and after the UK's exit from the EU will be the only natively English speaking country in the EU. Ireland, therefore, provides access to the largest single marketplace in the world.

Ireland is also strategically located between the US and Europe, which makes it an ideal connection point for communications and data transmission.

Equally, many multinational organisations require access to multiple platforms from multiple providers for their day-to-day operations to function successfully. The ability to access these quickly and securely provides significant advantages.

### Availability of infrastructure

Ireland has one of the most robust, reliable and stable grid systems in Europe. It also has a predictable repeatable load profile for a developed country, showing a reduction by night and peaks during the working day. Eirgrid's 2017-2026 All-Island Generation Capacity Statement report indicated that during the day the average load factor is approximately 4.4 GW. The same report highlighted that there is currently capacity on the system for more than 10 GW with further capacity increases being facilitated initially under EirGrid's 'Grid25' plan and the still in draft Grid Development Strategy.

In addition, Ireland has an abundance of renewable energy sources including wind energy, to meet energy demands of data centres which are increasingly looking to renewable energy sources for their operations.

Another key factor in Ireland's favour is the broad array of choices for transatlantic connectivity, as well as direct access to the UK and Europe. The Hibernia Atlantic provides high capacity subsea cable access from Ireland to the US, while the Emerald express, the largest low latency network across the Atlantic, links Ireland to Long Island/New York.

Connectivity from Ireland to the UK and Europe is currently supported by 14 undersea fibre cables.

Two further fibre cables have been announced, the Arctic Fibre and IFSC projects (Ireland France Subsea Cable).

Arctic Fibre will be bringing a new cable from Prudhoe Bay (Alaska) to Europe in 2018 and will 'tee' from this cable into Ireland via Cork. This new cable will connect Japan – Alaska – Canada – Western Europe with the shortest direct route. (Shorter routes give lower latencies, meaning higher speeds).

The IFSC project will connect France to Cork directly, and be made available to Dublin via multiple redundant routes. This new route bypasses London, to provide a direct connection to Europe, thereby improving transmission speed and overcoming potential Brexit related data transfer issues.

Within Dublin itself, the Dublin T50 broadband ring (MAN) is a 44 km multi-duct fibre-optic cable system which links all of the key business districts and business parks that are home to the various datacentres, telehouses and multinational corporations in Dublin and tying into the transatlantic cable system hubs in Dublin.

### Skilled staff

Ireland has a young, talented, multi-cultural workforce with strong technology skills. The education institutions work closely with employers to produce students with market-relevant technical skills and are heavily geared towards the requirements of the technology sector through the STEM agenda. Ireland's workforce has been ranked by the International Institute's Management Development IMD World Competitiveness Yearbook as third for skilled labour and first for flexibility and adaptability.

Ireland and Dublin, in particular, is also an attractive place for skilled workers from elsewhere in Europe, who are attracted by the prospect of good jobs at global companies and a safe living environment.

**What are the economic benefits of data centre investment to Ireland?**

This section provides an analysis of the economic impact of data centres on the Irish economy using information provided by survey responses (direct impact), along with Type I input-output analysis multipliers from the CSO (indirect impact) and additional information.

### 3.1 Economic benefits

#### Starting point – direct benefits

The building of data centres entails large capital expenditure on land acquisition, construction, infrastructure, network and equipment, which provide significant boosts to the local economy. In addition, data centres incur operational expenditure required for ongoing operations such as power, staffing, taxes, and other goods and services from suppliers such as maintenance and security.

This expenditure by the data centre itself is what is known as direct benefits. The data utilised in this report was collated from survey responses and adjusted for inflation using CSO consumer price index data. This was further adjusted to separate the proportion of expenditure which related to Irish based suppliers, which was estimated at 90% of total expenditure-based on survey responses.

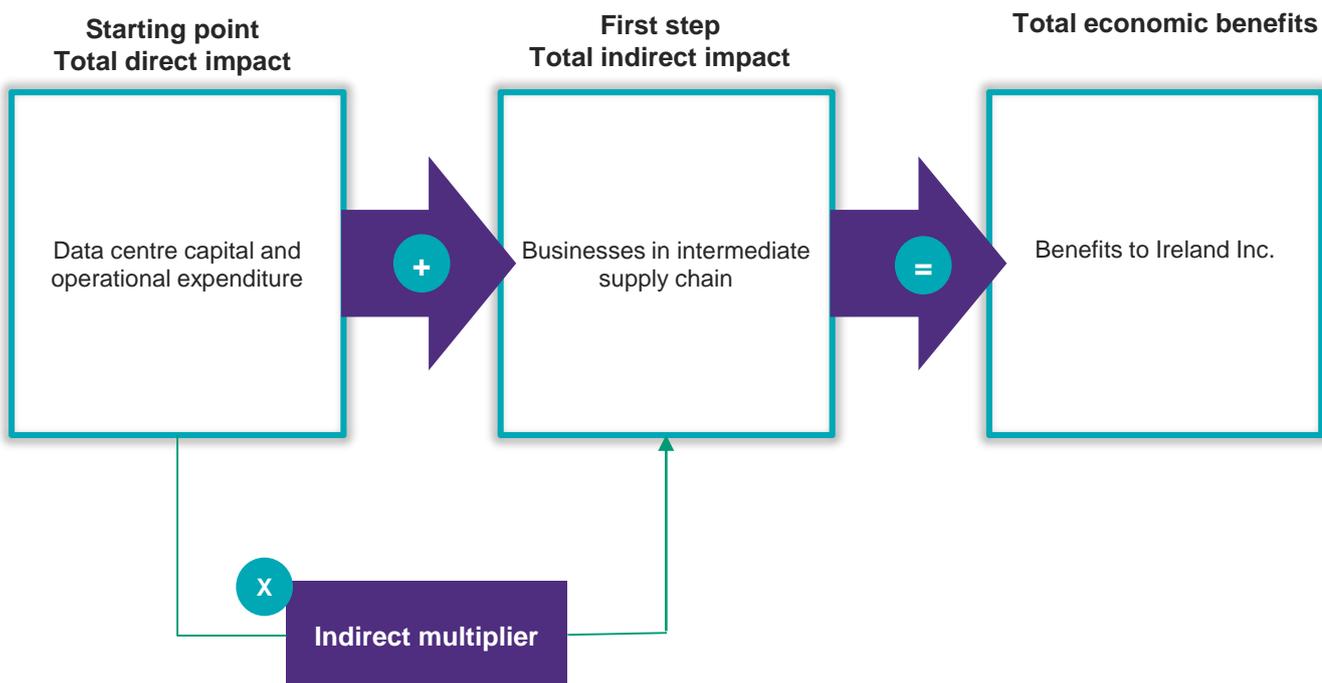
#### First-round effect – indirect benefits

Data centres, through their direct capital and operational expenditure purchase intermediate goods and services from downstream businesses (their suppliers). In increasing demand for their suppliers' goods and services, data centres generate increased indirect demand further down the supply chain (their suppliers' suppliers). This is the first round effect / indirect benefits in the diagram above.

Indirect benefits, therefore, refer to the increase in business-to-business activity resulting from data centre investment and activities.

The indirect multiplier is taken from the CSO published input-output analysis tables. The figure used is 1.57 which relates to the Technology sector. This has then been benchmarked against comparable reports on data centres from around Europe and was found to be an appropriate and conservative estimate.

Figure 7 Economic benefits



Source: Grant Thornton

### 3.2 Direct benefits

#### Capital expenditure – the investment in building the data centre

Capital expenditure describes spending incurred in building a physical asset such as a data centre. A data centre build is a complex process, generally involving land acquisition, through to design and construction, and assembly of infrastructure, IT and other equipment.

The direct benefits from a data centre provide an economic boost to the local economy by generating an immediate demand for wide-ranging services from IT specialists, to services in mechanical and electronic engineering, architecture, construction, infrastructure, logistic, security, IT equipment and building supplies.

The capital expenditure of data centres surveyed has contributed almost €3.0 billion to the domestic economy since 2010.

Table 1 Total capital expenditure (domestic)

	€ (million)
Land acquisition	148
Construction	1,299
Property, plant and equipment	1,103
Professional fees	361
Others	45
<b>Total capital expenditure</b>	<b>2,956</b>

Source: Survey data

In addition to contributing to the Irish economy, a portion of the capital expenditure was spent on overseas suppliers which contributes to the economies of Ireland’s trading partners. This report estimates that the total capital expenditure on non-domestic suppliers was €316 million.

#### Operational Expenditure – the investment in operating the data centre

The operational expenditure incurred during the day to day business of data centres typically include costs relating to data centre staff (employees and contractors), IT and network services, facilities management, maintenance of machines, security, and utilities (mostly power). Some data centres may also incur costs on operating leases on equipment, land and building, as well as other costs such as license and/or management fees etc.

The operational expenditure of data centres has contributed almost €1.6 billion to the domestic economy since 2010.

Table 2 Total operational expenditure (domestic)

	€ (million)
Total staff costs	482
Utilities	571
Maintenance	184
Operating leases	275
Others	75
<b>Total operational expenditure</b>	<b>1,587</b>

Source: Survey data

The analysis estimated that the total capital expenditure on non-domestic suppliers was €170 million.

### 3.3 Indirect benefits

Results show total indirect benefits to the domestic economy of €2.6 billion. This figure represents the total impact on intermediate goods and services which resulted from the direct capital and operational expenditure of the data centres.

Table 3 Total indirect benefits (domestic)

	€ (million)
Capital expenditure	1,684
Operational expenditure	905
<b>Total indirect benefits</b>	<b>2,589</b>

Source: Survey data

### 3.4 Employment benefits of data centres

As highlighted above, data centre investment in Ireland leads to a direct employment benefit both in the construction phase and on an on-going basis across various operational roles including Technicians, Engineers, Managers, Security Personnel, Software Developers and Health and Safety Personnel.

The results from the survey participants show that taken as a whole, data centre investment has led to the creation of an estimated 5,700 FTEs in Ireland on an average annual basis.

An estimated 1,900 FTEs in construction-related roles were created directly by data centre investment annually. Many of these roles came at a time when the construction industry was struggling to recover from the economic downturn and played a significant role in sustaining firms during this period.

In addition to construction-related roles, a further 1,800 FTEs have been directly created on an ongoing annual basis by the operational expenditure of the data centre industry. These jobs, as highlighted in Figure 13, are largely high-skilled roles requiring tertiary level education and professional qualifications and therefore high-value.

As with expenditure benefits, it is possible to use a similar approach to examining the overall impact which data centre investment has had on job creation in Ireland through indirect demand.

A further estimated additional 2,000 FTEs have been supported indirectly by the investment, both capital expenditure and operational expenditure, of data centres annually. Of this, 1,000 FTEs are supported on an ongoing basis by data centre operational expenditure.

## Summary

As highlighted above, data centre investment in Ireland has led to significant economic and employment benefits. €7.13 billion has been invested in Ireland through capital and operational expenditure on a direct and indirect basis.

This has led to a direct employment benefit both in the construction phase and on an on-going basis across various operational roles including Technicians, Engineers, Managers, Security Personnel, Software Developers and Health and Safety Personnel.

The results from the survey participants show that an estimated 3,700 FTEs in total (1,900 construction and 1,800 operations) were created directly by data centre investment. As with expenditure benefits, it is possible to use a similar approach to examine the overall impact which data centre investment has had on job creation in Ireland through indirect demand.

A further estimated additional 2,000 FTEs have been created indirectly (1,000 construction and 1,000 operations).

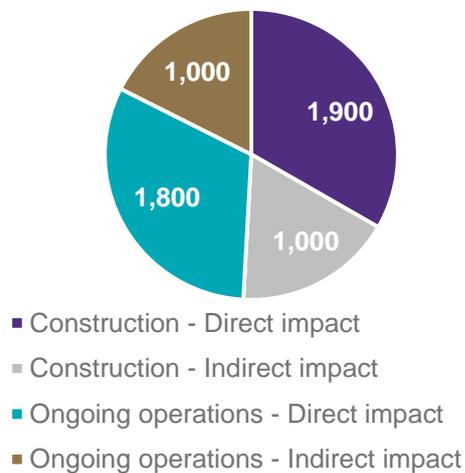
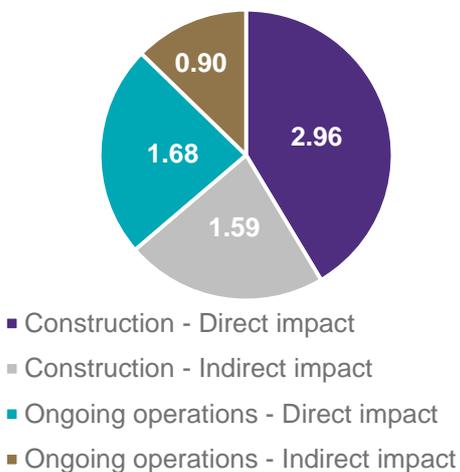
While the operational related and supported roles are ongoing, the construction roles by their nature are linked to the period of construction. This analysis considers FTEs to be on an average annual basis providing a total of 5,700 roles created or supported annually over the seven-year period this analysis takes into account.

Figure 8 Total economic benefits (domestic)

Figure 9 Total annual average employment benefits (domestic)

Economic benefits - € billions

Annual average employment benefits - FTEs



Source: Survey data and Grant Thornton calculations

**What other benefits does  
data centre investment  
bring?**

**Data centres are a catalyst to a wide range of quantifiable economic benefits including additional employment and further expenditure. The industry also provides significant non-quantifiable benefits to the wider society. This section examines these qualitative benefits in more detail.**

### 4.1 Digital technology and productivity

Data centres enhance the digital capacity for Big Data usage. This, in turn, has a flow-on effect on the economy by enabling digital media, mobile computing, virtual learning, e-commerce, e-health and other e-government services.

Productivity describes the efficiency by which inputs are converted to outputs. This is expressed as the output to inputs used in a production process, whereby the input is generally expressed in terms of labour, capital and materials. Progress in technology is a key driver of productivity improvements often being the catalyst for significant jumps forward. The influence of the digital economy on productivity has been no different, driving multifold productivity increases by enhancing the reach, speed and types of communication channels between businesses, government and households.

#### Digital ecosystem

Ireland has been at the forefront of the evolution of the digital ecosystem and has built a pedigree as a hub for global companies across a number of sectors built up over a number of decades. The variety of data centres choosing to locate in Ireland, combined with a large number of wider technology and other data-intensive industries including:

- nine of the top ten worldwide Information and Communications Technology corporations;
  - all of the top ten pharmaceutical corporations;
  - more than 50% of the world's leading financial services firms; and
  - sixteen of the top twenty global software companies
- indicates Ireland's status as a global digital hub.

The decisions of global business leaders to choose to maintain a European base in Ireland greatly enhances Ireland's reputation as one of the world's key digital hubs and helps to attract ancillary service providers, and suppliers to both the data centre industry and other sectors that can benefit from that digital infrastructure and ecosystem.

Survey results support this with 73% of respondents highlighting the infrastructure of Ireland as a key attraction and indicating that their decision to locate activities not directly related to data centres was influenced by their existing data centre investment.

The presence of market-leading companies demonstrates to others that Ireland understands the needs of multinational companies including their digital and networking requirements and is equipped to meet them.

Figure 10 Dublin – A Global Digital Hub



Source: IDA Ireland

## 4.2 FDI attraction effect

The presence of a large number of data centres signals a safe institutional and political environment, advanced infrastructure capabilities and a highly skilled workforce.

### Attraction effects on adjacent industries and ancillary services

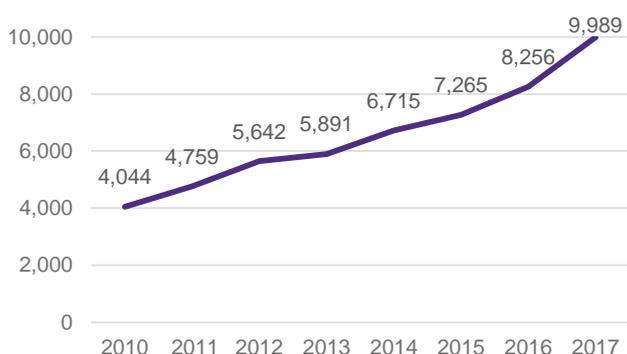
A large data centre industry located in Ireland increases the attraction for related industries to also locate in Ireland, in order to service and interact with the data centres. This brings in employment opportunities, as well as introducing new knowledge and skills which gets diffused to the data centre and other industries requiring skills similar to data centres.

Data centres also support and attract other ancillary services within their own corporations e.g. back office functions, sales, marketing and finance leading to secondary employment as a result of the critical support facility being located nearby.

Survey responses indicated that many Irish based data centre operators see the physical location of their data centre as closely strategically linked to their overall activity and operations in Ireland i.e. the presence of data centres opens up the opportunity, and in some instances necessity, to locate other ancillary services in Ireland.

The benefits of this are shown by the more than doubling of FTEs since 2010 in the companies which have large data centre investment in Ireland. While this employment may not be directly related to data centre investment, these investments support and embed the companies wider activities in Ireland.

Figure 11 Hyper-scale employment



Source: IDA data

### Broader signalling effects

For some multinational ICT companies, Ireland may not have been considered as a potential investment location. Hosting big data centres for well-known global and multinationals has lifted Ireland's profile as a world-class IT hub, as well as broadly signalling itself as an ideal location for FDI, which promotes job creation and productivity growth.

FDI is typically driven by a number of motivational factors: efficiency-seeking, market-seeking, resource-seeking and strategic.

- **Efficiency-seeking FDI** through lowering input costs. By increasing the size of the local market, suppliers are able to lower the costs of production through economies of scale. This attracts further FDI from companies which use the same production factors.
- **Market-seeking FDI** by raising the income and living standards in the domestic economy. By increasing the market potential of the country, foreign companies are more likely to establish themselves in the country in order to serve the local market.
- **Resource-seeking FDI** who are dependent on sourcing skilled labour and technology. By increasing the skills and know-how of its labour force, as well as an advanced technological environment, companies who require highly skilled labour and advanced technologies will be attracted to investing in the country.
- **Strategic FDI** undertakes investment decisions on a host of strategic reasons. The presence of FDI from similar companies signals Ireland to be an attractive destination for similar strategic reasons (e.g. attractive tax rate, access to European markets, highly skilled labour, advanced technology, stable infrastructure etc.). Hence, these 'me too' investments follow initial FDI flows.

Ireland has established itself as a hub for a number of industries to locate including financial services, medical technology, bio-pharmaceuticals etc. and ICT is another of those industries. Key players in Cloud Computing, Software As A Service, FinTech and Payments, Information Services and Digital Content have chosen to locate in Ireland attracted by the same benefits and features that data centres are attracted to.

As data centres increase Ireland's global profile further and advertise it as a location capable of meeting each of these motivational factors so Ireland's status as a preferred FDI destination is enhanced.

Figure 12 Ancillary services



Source: Survey data

### 4.3 Clustering

Clusters describe geographic concentrations of interconnected entities such as businesses, suppliers and associated organisations (e.g. educational institutions).

The close proximity of businesses enabled by clustering increases innovation, collaboration, knowledge sharing and spillovers, which increase productivity and the competitiveness of firms in the cluster e.g. Silicon Valley as a technology cluster.

The formation of a cluster is highly dependent on the ability for the location to provide the right business environment such as access to the right infrastructure including transport, utilities, labour force, communications network, legal system and tax incentives. As highlighted in the survey results, Ireland benefits from being able to offer these incentives with infrastructure and skilled labour scoring highly in terms of attractiveness and government policy and business conditions being referenced as well.

This type of clustering effect is also seen in other key data centre locations across the globe such as London, Frankfurt, Amsterdam and Loudoun County Virginia. A key driver of this clustering in the data industry is the need for business to business (B2B) companies' data to 'talk to one another' and be shared across organisations. This can be done more effectively and efficiently when the data is stored in nearby proximity to one another.

Clustering tends to be self-reinforcing, as once a cluster emerges and is recognised as such it tends to attract more companies. Advantages of clustering effects include:

#### **Potential customer base**

For suppliers, a cluster offers a concentrated base of potential customers, compared to an isolated location. This lowers the risk of entry, as the customers are more easily identifiable and accessible. In addition, clusters tend to be based on industry-specific and draw on similar inputs, e.g. technology cluster

Ireland is soon to be the only native English speaking country in the European Union and provides direct access to the world's largest single trading block. It acts as an important strategic conduit between the USA, where many data centre owners are based and Europe where many of the data centres' customers are located.

The evidence for clustering can be seen from the high density of data centres around the M50 in Dublin. The clustering phenomenon was attributed to two main factors, one being the availability of electrical power, the other being access to a strong telecommunications fibre network.

The cluster effect can also be observed through the growth of intermediate suppliers to service data centres as evidenced by the consultations with the CIF and their members where they confirmed the tailoring of service offerings to meet data centres requirements.

Clustering can be seen as a key rationale for data centres' decision to locate in Ireland and provides an ecosystem that similarly attracts others.

### 4.4 Spillover effects

In economics, spillover effects are events in one context that occur because of something else in a seemingly unrelated context. The spillover potential is high in the Irish data centre context.

#### Knowledge spillovers

Data centres and the wider digital ecosystem within Ireland is a specialised, geographically concentrated industry and as such is ideally positioned to stimulate growth through knowledge spillovers.

Knowledge spillovers occur when an economic activity results in the transfer of knowledge to other parties external to the activity. Knowledge spillovers result in the diffusion of know-how across other firms or between firms and their suppliers. Knowledge spillovers generate economic and societal benefits by increasing productivity and innovation at a price below the value of the knowledge.

#### FDI and knowledge spillover

FDI is considered a major source of knowledge spillover through the following:

**Labour mobility and turnover** – multinationals tend to staff their local subsidiaries with local labour and train them with skills and know-how to enable them to perform their roles. When these workers leave these companies to work for another firm, they bring their knowledge and know-how with them to their new place of employment. Labour mobility enables knowledge spillovers between companies, industries and regions.

**Market competition** – to protect their market share, market competitors may start to emulate a new entrant in order to compete. This is particularly true in a highly innovative market such as data centres where technology moves rapidly. This causes the know-how to spread between firms in the industry, as well as firms outside of the industry.

**Market transactions with local firms** – multinationals generally require a more advanced and efficiency level of goods and services in their production. Multinationals often work with local suppliers through a combination of training and technical assistance in enabling the suppliers to meet the multinationals' requirements.

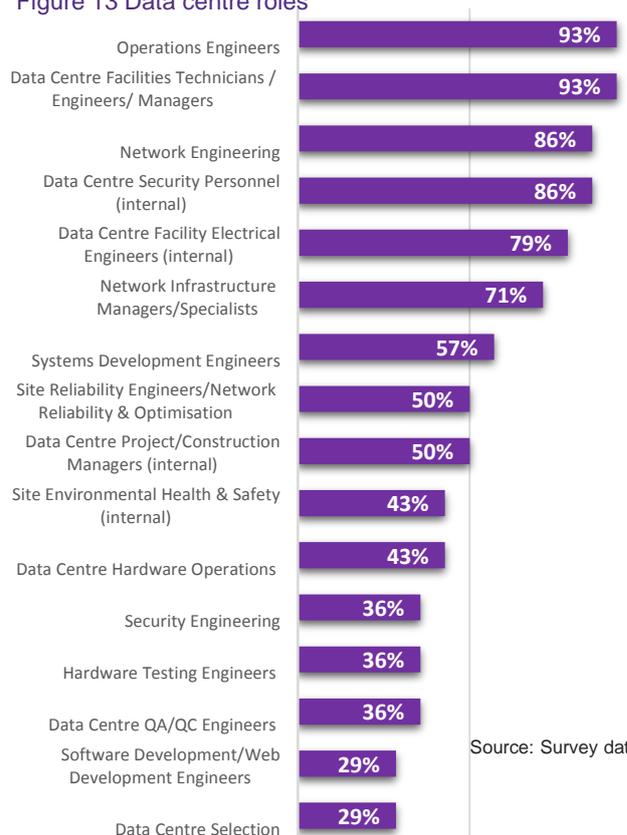
### Spillover effect of data centre roles and training

Data centres train and employ highly skilled individuals in their operations. Data Centres also train their staff to provide them with the skills and know-how needed to undertake their advanced technical roles. As seen in Section 4.2 FDI and knowledge spillovers, knowledge spillovers occur when the data centre staff collaborate with suppliers in building and operating the data centre. Labour mobility causes additional spillover effects, as staff move to other sectors of the economy.

Where there has been an increasing emphasis on moving the Irish economy towards high skill value-added sectors, data centres play an important role in contributing towards this aim.

Figure 13 illustrates the importance of data centres in providing demand for advanced software engineering and networking skills. Other roles employed by data centres include efficiency experts, IT process staff, and service staff.

Figure 13 Data centre roles



Source: Survey data

Percentage of surveys respondents who have staff carrying out these functions

### Training

Most data centres provide on the job training (77% of respondents) for their staff and contractors. Most respondents also indicated that they provide additional training including sponsoring external National Framework of Qualification (NFQ) technical courses and non-NFQ technical courses and facilitating and developing training courses internally, while others offer specialist critical supply training.

### Links to education providers

Data centres help elevate the level of advanced STEM (Science, Technology, Engineering and Maths) skills highlighted as essential in the Government's 'Success through STEM' strategy, through working with education institutions in developing courses in these areas. An example of these partnerships is the IT Sligo launching, in collaboration with data centre industry partners such as Google, a degree programme in data centre facilities engineering, aimed at servicing the growing and highly specialised data centre sector with skilled graduates – the first of its kind in Europe.

These measures result in knowledge uplifts, as students attain a higher level of skills and knowledge in these areas. It also enhances the knowledge base of the economy through the impact on the types and uptake of courses offered at educational institutions. Further knowledge spillovers occur when the students apply their skills while working for employers across various industries.

### Graduate programmes

Several of the data centres also offer graduate programmes, with a total of 43 graduate intakes annually.

### Internships

Data centres also engage with education providers for work placements and internships with one respondent offering 6, 9 and 11-month rotations for students to build a pipeline of staff for the following year by providing students with the experience and exposure to the data centre, its culture and work practices. Another offers two types of internship, comprising:

- an operations internship covering facilities, customer service, and control and information management; and
- a marketing internship covering all aspects of the marketing and sales function.

## 4.5 Increase local suppliers' skills, productivity and competitiveness

Many of the owners and operators of data centres in Ireland are large multinational and global companies who when they enter a local market significantly increase demand in that domestic market. The exposure to new innovative ideas and the opportunity to develop an experience of different requirements and techniques provides learning for domestic firms. Over time, the skills and knowledge gained from working with data centres may lead to new business opportunities for local suppliers who:

- apply their knowledge and experience to Irish based data centres, or similar projects in other sectors across Ireland;
- can use a larger market to enjoy economies of scale and intensified competition to become more competitive; and
- may export their experienced and proven services overseas using their skills, increased productivity and competitiveness, to service data centres and similar projects in those countries.

This is supported by overseas studies which found clients to be the most important source of knowledge for exporting firms in the UK high technology sector, followed by suppliers, technical/industry standards and competitors. (UK Government Office for Science, 2013)

### Use of local suppliers

Enterprise Ireland confirmed that when a global data centre operator was looking to set up operations in Ireland the company was keen to meet with local suppliers ranging from construction and engineering to food and drink and training providers. The Government agency, in conjunction with the IDA, facilitated an introductory session consisting of a portfolio of local and specialist suppliers from across Ireland that could meet the client's requirements.

The survey results confirmed the significant use of local suppliers. Of the c1,000 suppliers currently engaged by data centres across Ireland, 77% were locally based with 90% of total expenditure going to Irish companies. The use of local suppliers provides a direct benefit financially to the economy but also allows those suppliers to develop experience, innovate, become more productive and grow.

### **Data centres increase the level of technical or other skills in the local suppliers**

Data centres require a high quality of goods and services in their construction and production and are often willing to work closely with local suppliers to ensure their services and products meet the required standards. Through this data centres have helped to develop Irish suppliers' understanding of the high levels of sophistication and significant complexities involved in planning and building successful facilities. This knowledge transfer has enabled suppliers to deliver similar projects in other sectors.

The CIF confirmed that their members have been able to take their experiences and skills gained from data centre projects and utilise them within the supply chain for other associated or complementary functions in other sectors such as pharmaceuticals, medical technology and Agri-Food including innovating for off-site packaged construction solutions. This makes Ireland both more attractive and more productive across a number of sectors.

### **Data centres improve the productivity of the economy and enhance the export potential for local suppliers**

A larger market can provide opportunities for some existing local suppliers to benefit from significant economies of scale and act as a spur to greater competition. With intensified competition, the more productive suppliers will gain market share increasing the overall level of productivity in the country. This may also present opportunities for some Irish companies to grow outside of the domestic market.

Consultations with a number of companies identified that the skills and relationships established through working with global data centre owners and operators have enabled them to expand their operations into global markets including the US, UK, Europe, Singapore, Australia and the Middle East, in construction, electrical and mechanical engineering and project management. This export capacity has been aided by the perceived flexibility and strong work ethic of the Irish workforce e.g. willingness to travel and ability to deliver projects with a quick turnaround and to a high standard, especially in mainland Europe.

Irish firms have become leading suppliers to the industry with expertise recognised and trusted globally. This expertise is being developed in Ireland and exported abroad. In every key data centre market globally you will find Irish companies, contractors and workers designing, constructing and managing facilities having developed experience in the domestic market.

A survey conducted in 2016 by the CIF of its members indicated that Irish companies were at the time engaged in data centre projects in England, The Netherlands, Finland, Belgium, Russia and Germany. These projects had an estimated total capital value of over €2.2 billion and direct employment of a further 6,600 Irish FTEs.

Case Studies for two such suppliers have been included on Page 27.

## Case study 1 – Engineering services

### Mercury Engineering

Mercury is an Irish based engineering firm which provides planning, design, construction and commissioning services to data centres across Europe, Nordics, the Middle East and Russia. Mercury has worked with data centres for 18 years, with its first data centre project in 1999.

Core services provided by the company include mechanical, electrical, IT and fire protection services.

In 2017, 63% of the company's turnover was from datacentres construction. This has risen by 30% and 39% since 2015 and 2016 respectively.

In the coming year, the company is projecting that 65% of their turnover will be delivered by their Hyper-scale and Enterprise datacentre divisions, with approximately three-quarters of this coming from supporting existing clients with their new ventures. This has enabled the company to hire more staff, for example, the Enterprise Datacentre division has increased their headcount by 60% in a year.

Mercury hires a high level of apprentices in servicing their data centre projects. The level of efficiency required for these projects has also enabled them to invest in LEAN training to its workforce, from apprenticeship to management levels.

Mercury's initial work with data centres has enabled the company to export their services to other countries including England and the Isle of Man, Sweden, The Netherlands, Germany and Austria. To date, the company has worked on data centre projects in 11 countries.

During the recessionary years, data centre investments helped to sustain the company's revenue. "We were lucky enough to work on several key projects across a range of sectors in which we were not affected by the global recession. A definitive strategy enabled long-term sustainability in Mercury. As of now we are seeing a steady increase in FDI and we hope to be involved in a fair amount of it" says Chief Operating Officer Eoin Vaughan.

## Case study 2 – Energy services

### Hanley Energy

Hanley has been providing critical power and monitoring services for data centres since 2009.

Currently, 80% of the company's turnover is data centre related, with 60% of its data centres services located in Ireland, with the rest located overseas.

Its work with data centres enabled the company to grow 10 fold since 2009.

Servicing data centres has broadened the skills base throughout the company through the addition of senior engineers across electrical, mechanical and software disciplines. The growth in the data centre sector has also enabled the company to accelerate their R&D strategy so that Hanley now has a dedicated R&D department with multiple ongoing projects.

The company believes that the community benefits of data centre investments are strong. While Hanley is involved at the infrastructure stage, once built the facilities have to be staffed, maintained and kept up to date with technology advancements. Hanley notes that colleges are now running courses in Data Centre Operations.

The expected impact of the data centre industry on Hanley, as well as business in Ireland, is forecast to be high over the next 1-5 years. Data centres are currently expediting their growth strategy globally, and working on framework agreements with their suppliers to support that.

### 4.6 Contribution to sustainable energy

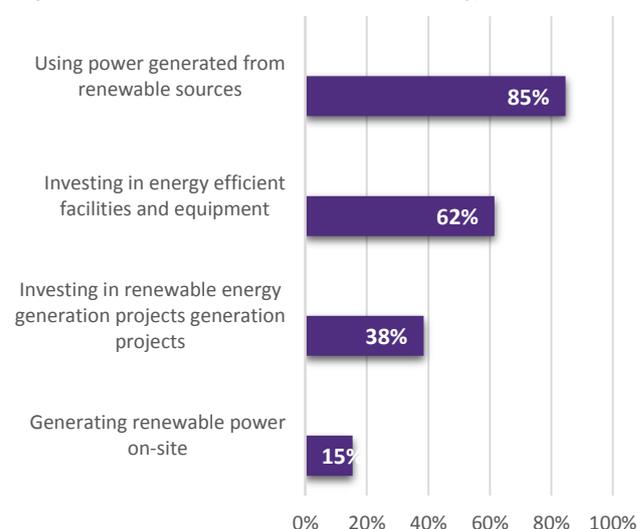
The availability of a secure, reliable and sustainable source of energy is a key factor for data centres. 'Uptime', the proportion of time that a data centre is operational, is a key industry measure that is used to categorise data centre performance. Higher performing data centres have a greater proportion of 'uptime' and have energy back-ups and redundancies in place to ensure this. As a result, a significant portion of a data centre's operational expenditure is energy related. Operators have therefore been at the forefront of improving energy efficiency in their data centres with Power Usage Effectiveness (PUE – the measure of additional power consumed by a facility over and above that required purely to power the IT equipment e.g. cooling, lighting, power transference etc.) continuing to fall. This has been achieved through a number of measures including:

- increasingly efficient servers;
- utilising technology that can operate at higher temperatures;
- managing airflow;
- water cooling and recycling; and
- waste heat recovery and reuse.

Data centres have established a clear preference and priority that utilisation of energy should come from renewable energy sources. This commitment makes a significant contribution to policy formation and supports the renewable energy industry by creating demand for renewable energy and providing greater certainty and reducing the risk for investors in new renewable infrastructure.

- Google is the world's largest renewable power customer purchasing 3 GW or over 50% of its total power requirements from renewable sources.
- Facebook has contracted with Brookfield Renewable Energy last year to source renewable sources of generation for its Clonee data centre and was the first major internet company to commit to be 100% renewably powered.
- Microsoft has entered into a 15-year deal with General Electric (GE) to purchase 100% of the energy produced from a 37MW wind farm in Kerry as part of their goal to use 50% renewable energy by 2018.

Figure 14 Contribution to sustainable energy in Ireland



Source: Survey data

\*Most firms undertook a combination of the 4 renewable initiatives above.

- Apple earned the title of greenest tech company in the world for the 3<sup>rd</sup> consecutive year.
- Amazon has a long-term commitment to be 100% renewable energy powered and is the second largest purchaser of renewable energy globally.

By choosing to purchase energy from renewable energy sources, data centres are also contributing to the achievement of Ireland's EU 2020 targets of 16% of final energy use to be from renewable sources by 2020 and creating the market for future renewable energy generation growth.

All the data centres consulted through the survey indicated they are taking steps to make a positive contribution to further the development of Ireland's renewable energy sector, as indicated below.

All data centre respondents in the survey were undertaking investments in renewables, with most (77%) respondents investing across two or more of the initiatives. As illustrated in the chart above, 85% of the respondents are already investing in power from renewable sources, with a further 15% generating renewable energy on-site.

The positive contributions made by data centres on the renewables sector in Ireland were highlighted in discussions with the Commission for Regulations of Utilities (CRU), who agreed that data centres were providing significant demand for renewables investment and through their willingness to pay a premium for guaranteed, traceable renewable energy.

In addition, the CRU noted that Eirgrid All-Island Generation Capacity Statement 2016-2025 highlighted that the power generating industry has been experiencing spare capacity since the economic downturn, with demand not yet returning to 2008 levels. In this context, data centres have been highly important in the industry, as they have provided a demand for this spare capacity in the grid and contributed towards connection fees and revenues etc.

#### 4.7 Countercyclical benefits

The CIF highlighted that demand from the global data centre industry is not aligned with Ireland's domestic economic cycle and so still provides significant demand for services from their clients and other industries even if the wider economy is in decline. This is particularly important for the construction and ancillary industries whose greatest challenge is the cyclical nature of demand.

The start of this period of growth of data centre investment in Ireland coincided with the downturn in the Irish economy.

Suppliers, as part of the stakeholder consultations, highlighted the invaluable role data centres played in sustaining elements of the Irish economy over this period.

An engineering firm highlighted the role data centres have played helping them sustain the company during the recessionary times "We were lucky enough to work on several key projects across a range of sectors in which we were not affected by the global recession".

The background consists of several overlapping circles in various shades of purple, ranging from a deep, dark purple to a lighter, lavender hue. The circles are positioned in a way that they create a sense of depth and movement, with some appearing to be in front of others. The overall effect is a modern, abstract design.

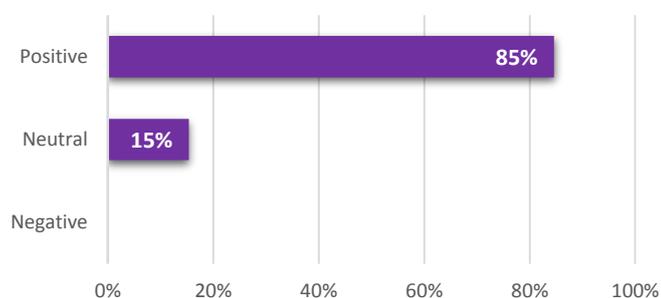
# **What is the future of data centre investment in Ireland?**

This section examines the outlook for data centre investment in Ireland for the next decade, as well as the expected impact on data centres investment in Ireland using information provided by data centres.

### Future investment prospects

Research suggests that there is a significant pipeline of proposed data centre projects potentially coming online in the next five years which could see data centre investment in Ireland more than double from that seen to date. What is clear is that investment and therefore economic impact has been trending up in Ireland for a number of years and looks likely to continue. This is borne out by the survey results.

Figure 15 Outlook for data centre investment in Ireland



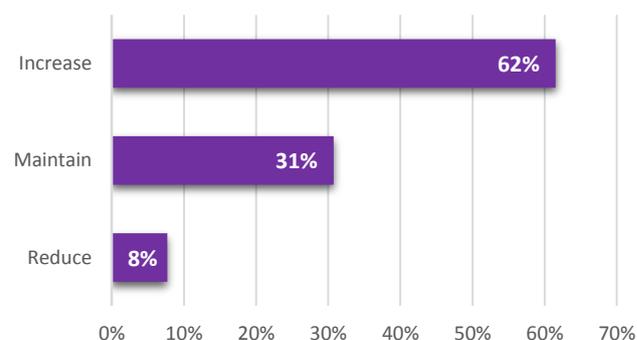
Source: Survey data

The survey results showed 85% of survey respondents expect the outlook for future data centre investments in Ireland to be positive, while only 15% believe it will be neutral.

Key reasons provided for the positive outlook included:

- Physical location - suitable weather for cooling machines, only English speaking country in EU after Britain's exit, proximity to the US;
- Trend - foresee ongoing investments from own company (refer to below), as well as from the data centre industry generally, due to continued growth in demand for data centres as well as cloud-based technologies, IT services, Internet of Things and Big Data;
- Institutional factors - geopolitically safe and stable with attractive foreign investment incentives; and
- Favourable factors of production - skilled workforce, availability of energy, access to technology.

Figure 16 Existing data centre's planned investment in Ireland over the next decade



Source: Survey data

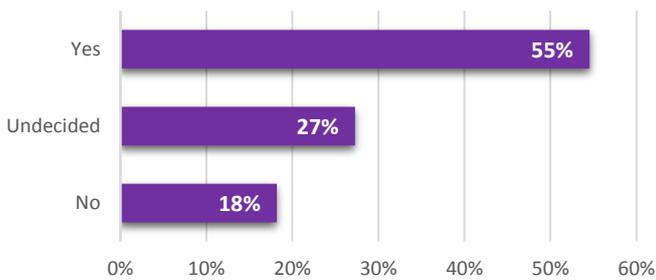
According to the survey, 62% of data centre respondents expected to increase their data centre investment in Ireland in the next decade, while 31% were looking to maintain their investments at existing levels. Only 8% of the companies indicated plans to reduce their investments in Ireland.

Amongst the respondents planning to increase their investment in Ireland, the reasons cited were:

- anticipated growth in customer demand. This was the most commonly cited reason;
- effects of Brexit on UK based firm needing a presence in both jurisdictions of the UK and the EU and the impact of GDPR; and
- need for ongoing investment to ensure that the current sites remain cost-effective and efficient.

For the companies planning to maintain their investments, the availability of power was viewed as a key potential constraint, while a colocation facility respondent cited the impact of the Public Cloud and the reduced wholesale requirements of hyper-scales that have been increasingly focused on building and operating their own facilities.

Figure 17 Will Brexit positively impact on your company's investment in Ireland?



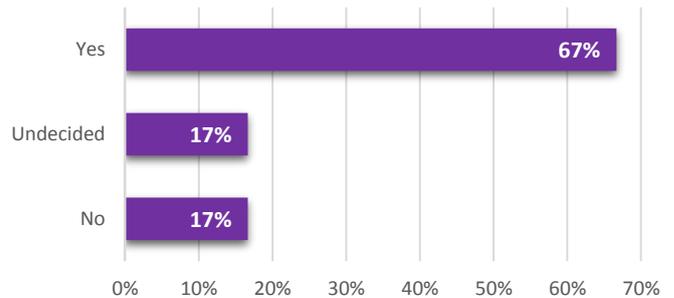
Source: Survey data

Majority of the respondents expected that Brexit will positively impact on their investments in Ireland.

The primary reason for data centres looking to increase their investments was in anticipation of companies setting up in Ireland in order to serve the EU market in the event of Brexit, as indicated by 31% of the respondents. For example, one of the respondents indicated that they have had a lot of enquiries from global banks interested in taking wholesale space in their first building, most of whom have cited Brexit as the key reason.

Other reasons cited for plans to increase data centre investment in Ireland were data protection (GDPR) and tax considerations.

Figure 18 Will there be a positive Brexit impact on data centre investment in Ireland generally?



Source: Survey data

Most of the respondents to the study believed that Brexit will positively impact on data centre investment in Ireland in general.

Several of the companies surveyed believed that the certainty provided by Ireland on data privacy (GDPR) would be a key factor and that further investment will be driven by UK companies needing a presence in an English speaking country in EU.

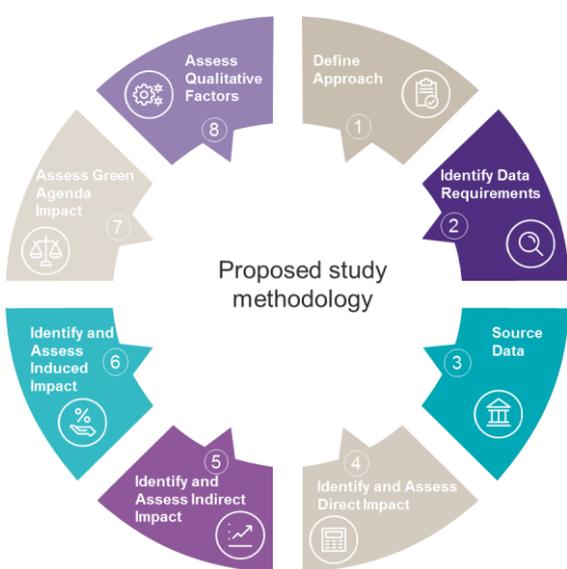
# Appendix

# Our methodology

## Our methodology

This section outlines the methodology used in undertaking the study. There are essentially eight steps in the methodology undertaken, as pictured below

Figure 19 Proposed study methodology



## Economic Model Methodology

The methodology applied can be simplified into two broad stages as described below:

1. Collation of direct expenditure data of data centres currently operating in Ireland.
2. Development and use of input-output models to estimate the wider effects of the industry on the economy as a whole.

### 1. Collation of industry expenditure

The methodology used in estimating the direct expenditure within the industry is discussed in the main body of the report. It consisted of providing an extensive and detailed survey to all of the data centres currently operating in Ireland and asking them to complete it with the relevant data directly.

The survey covered areas such as detailed breakdowns of capital and operating expenditure, employment levels, energy usage, size of facility etc. The collation of this information serves two purposes.

First as an end in itself, but also as the starting point input to the model which generate estimates of multiplier activity in the rest of the economy.

The method used to calculate this type of flow-on effect is described below.

## 2. Modelling

The multiplier methodology described below is used extensively by Grant Thornton in assessing both the impact of a given sector or industry on the national economy or the economic impact of a new development in a given location.

The model is based on the latest input-output analysis tables sourced from the CSOs website. The model details what proportion of its inputs each industrial sector sources from other sectors when producing an extra unit of output.

The principle behind a multiplier effect is that a change in economic activity will have knock-on effects for the rest of the economy. These effects can be assumed to take place through two channels:

- Supply chain linkages (B2B effects) – if industry demand increase it can be assumed production will increase to match. This expansion requires more raw materials and associated services from other industries. In turn, these other industries will require more raw materials and associated services from their own suppliers and will increase production accordingly (indirect effect)
- Consumer or wage effects (B2C effects) – an increase in an organisation’s activity will result in a higher wage bill either through higher salaries or more staff. A proportion of this additional money will be spent in the economy. This rise in consumer demand will result in increased production of goods and services increasing expenditure further (induced effect)

These are calculated using multipliers which show by how much an additional €1 of expenditure will lead to an increase in the wider economy.

While Type I multipliers (indirect effect) are produced by the CSO showing the linkages between industries, Type II multipliers (induced effect) are not.

In order to conduct this analysis a CSO Type I multiplier was used but benchmarked it against other European reports for data centre industry economic contribution. Type II multipliers were not used in order to ensure estimates of benefits were conservative.

### Consultations

We have consulted with individuals across a number of organisations, including:

- Data centres
- Government and semi-state bodies
- Industry representatives
- Suppliers and customers of data centres

### Limitations

As a simplification of any industry, an economic model of this type can only ever be expected to represent an approximation of a real-life outcome. The model relies upon information provided by stakeholders as well as data published by the Central Statistics Office. The latest available data on which to base our analysis includes input-output tables from 2012. It is possible that industry linkages have changed since their publication.

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# Glossary

Name	Equal to	Size in Bytes
Bit	1 bit	1/8
Nibble	4 bits	1/2 (rare)
Byte	8 bits	1
Kilobyte	1,024 bytes	1,024
Megabyte	1,024 kilobytes	1,048,576
Gigabyte	1,024 megabytes	1,073,741,824
Terrabyte	1,024 gigabytes	1,099,511,627,776
Petabyte	1,024 terrabytes	1,125,899,906,842,624
Exabyte	1,024 petabytes	1,152,921,504,606,846,976
Zettabyte	1,024 exabytes	1,180,591,620,717,411,303,424

Term	Definition
Big Data	data sets that are so voluminous and complex that traditional data processing application software are inadequate to deal with them.
Big Data Analytics	the process of examining large and varied data sets i.e. big data - to uncover hidden patterns, unknown correlations, market trends, customer preferences and other useful information that can help organizations make more-informed business decisions.
Cloud	an information technology paradigm that enables ubiquitous access to shared pools of configurable system resources and higher-level services that can be rapidly provisioned with minimal management effort, often over the Internet.
Clustering effect	a geographic concentration of interconnected businesses, suppliers, and associated institutions in a particular field. Clusters are considered to increase the productivity with which companies can compete, nationally and globally.
Colocation	managed facility service for use by third parties to store their data.
Connected devices	an electronic device, generally connected to other devices or networks via different wireless protocols such as Bluetooth, NFC, Wi-Fi, 3G, etc., that can operate to some extent interactively and autonomously.
Data	information in digital form that can be transmitted or processed e.g. everything from an email to a personal information stored online via a video streamed from the internet.
Data centre	the physical location where data is stored
Edge	where we access the data, distributed data infrastructure designed to facilitate the deployment of the Internet of Things.
Hyper-scale	large companies typically household name corporations that manage and operate their own data facilities to a significant scale.
Internet of Things	the network of physical devices, vehicles, home appliances and other items embedded with electronics, software, sensors, actuators, and network connectivity which enables these objects to connect and exchange data.
Social Media	websites and apps that facilitate the creation and sharing of information, ideas, career interests and other forms of expression via virtual communities and networks.
Spillover effect	economic events in one context that occur because of something else in a seemingly unrelated context

