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OFFALY COUNTY COUNCIL

Data Centre Integration with Renewables and Hydrogen

Report and Action Plan – March 2023
Version: 76-1230 - Data Centres Report

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Executive Summary

This report for Offaly County Council demonstrates **why data centre operators should consider locating in the Midlands of Ireland.** Data centres are a key component of the global Internet infrastructure that underpins the digital revolution impacting every aspect of our daily lives. **The global data centre market continues to grow rapidly** and is concentrated in a few major hubs: important European markets include Dublin, Frankfurt, London, Amsterdam and Paris. For a host of strategic and financial reasons, data centre operators are increasingly looking to develop new facilities in locations away from these hubs, an involved and multi-faceted decision process. Conversely, there are multiple beneficial economic factors associated with data centre developments, so there is a positive opportunity for the Irish Midlands - the counties of Offaly, Longford, Westmeath and Laois - all less than 75 miles from the data centre hub of Dublin. The Midlands presents attractive benefits to data centre developers on the basis of:

- As increasing societal and governmental pressure requires the sector to improve environmental performance, **the region offers significant existing and planned renewable energy sources** for connectivity as dispatchable low-carbon generation which would not usually be available to data centres in a city location;
- **High voltage (400 kV) transmission lines and a natural gas transmission network**, which is necessary to provide data centres with highly secure and reliable energy infrastructure to maintain industry uptime metrics;
- **Extensive land-bank availability under direct local control** so that co-location, future expansion and conglomeration that builds the sector are relatively unconstrained, supported by favourable local planning conditions underpinned by a regional focus on cross-sector collaborative investment, economic development and funded innovation;
- **Superior climate conditions** with moderate weather systems and low temperature range, which reduces high operational costs associated with cooling and reduces risks associated with catastrophic geological and climatic events; and
- **Proximity to existing Irish markets** makes it possible for existing specialised, skilled staff to work at new sites with minimum relocation, while benefitting from improvements in quality of life away from urban centres.

Data centres are energy intensive and are consuming a large and growing share of Irish electricity, such that EirGrid has effectively issued a moratorium on further new build in Greater Dublin until at least 2028. In explaining why data centres should be located in the Midlands, this report develops the necessary location concept from a theoretical perspective, complemented by the pragmatic example of considering the specifics of the Rhode Green Energy Park development at Offaly.

Whilst data centres are becoming more and more efficient, the increased scrutiny concerning power consumption and other factors are explored in **Phase 1: Market Research**. Stakeholder engagement was conducted involving interviews with three categories of representatives: the data centres sector, renewable / infrastructure developers and governmental bodies including the utility providers. All stakeholders agreed that the development of new data centres in Ireland is challenging and subject to a protracted investment process, which presents many risks to securing a future for the sector in the vicinity of Rhode Green Energy Park. Stakeholders identified positive factors and provided encouragement for locating data centres and other energy intensive industries in the Midlands, though the challenges around infrastructure and the need to develop the necessary skills in the local workforce for data centres remain. However, the strong attractive factors of location with respect to energy networks and generation adjacent to Dublin have been acknowledged.

The **Phase 2: Technical Review** identifies the key technical requirements of data centres as a system and reviews current thinking in the potential for power saving through efficiency gains in the region of 10-30%.

With power grid constraints in the Dublin area that may take up to 10 years to resolve, developers of new data centres are looking for locations in other Irish regions, but also internationally. The continued drive for sustainability sees greater prioritisation of electrification of heat and transport in urban centres, which will only consume further grid connection capacity and reduce the opportunity for the essential connectivity required by the Data Centre sector.

The fundamental objectives of the report, to attract the first anchor data centre tenant and build a data centre sector in the vicinity of Rhode Green Energy Park, are presented in **Phase 3: Action Plan**. Responding to the challenges associated with attracting data centre investment to the Midlands, a clear set of necessary steps is detailed for this to become a realistic possibility. Key activities are presented, such as **promoting the Midlands as 'open for data centre business'** with clear presentation of regional strengths such as **timely access to local power sources and proximity to the Dublin hub**. The report concludes that the Midlands and the Rhode Green Energy Park have sufficient key factors to attract early 'anchor tenant' investors that, working in collaboration, could lower the barriers of market entry and provide a catalyst for future investment.

The key findings are that:

The Data Centre market is seeking new locations away from traditional hubs, based on requirements that are readily met by the Midlands of Ireland. The most important considerations include the necessary provision of telecommunications and energy utilities, which can be found in the region, though a degree of local investment and works is required to provide the necessary connectivity for telecommunications infrastructure and provision of back-up power from the gas utility network. Other positive considerations for the location of data centres in the Midlands include:

- Proximity to existing data centre market, suppliers and relevant personnel in Dublin.
- Availability of significant parcels of suitable land for development and future expansion lock-in, with favourable local planning and enterprise regimes / investment.
- Climate conditions and small risk of heat waves.

The Midlands region can provide the reliable, low-carbon sources of power generation required for data centres to meet necessary sustainability targets, building out from a long history of exporting surplus sustainably generated energy to the rest of the country. That surplus is expected to increase with significant local developments of solar photovoltaics and other new low-carbon generation sources providing a margin that could readily satisfy the local consumption requirements of a data centre market. Despite a recent directive from the Commission for Regulation of Utilities (CRU) mandating the Data Centre sector to provide energy back-up systems which could increase usage of fossil fuels and negatively impact carbon footprints, Data Centre operators choosing to locate in the Midlands will be able to access local sustainable low carbon energy developments as dispatchable generation.

Offaly's opportunity is to attract data centres based on partnerships underpinned by strong economic, innovation and / or green factors. Co-location of data centres with renewable energy generation and / or commercial heat offtakers, such as residential heating / nursing homes / commercial consumption, leisure centres / swimming pools, manufacturing heat applications (e.g. hydroponics and vertical farming) and tourism applications (such as an Eden Project biodome), offer a strong pathway to developing the data centre sector in the Midlands that reduces the burden of the full infrastructure upgrade required in a stand-alone data centre development scenario. Early 'anchor tenant' investors will be needed to drive initial infrastructure upgrade forward, and in doing so set up the basis for further investment in the area. Working in collaboration with the existing stakeholders and interests of the Rhode Green Energy Park or the recently announced Bord na Móna Green Energy Park project, provides potential opportunities for Data Centre operators to mitigate and share the risk in stepping away from the Dublin hub.

Introduction

Offaly County Council and Siemens have worked together to deliver a project: "Exploring Data Centre Integration with Renewable Energy and Green Hydrogen in the Midlands". Siemens was commissioned by Offaly County Council to carry out a high-level study that seeks to identify the challenges and opportunities for the development of data centres in the Midlands of Ireland, and at the Rhode Green Energy Park as a case study (see **Figure 1**), particularly from the perspective of integration with regional renewables and green hydrogen. The fundamental objective is to understand how Offaly County Council might prime the area of Offaly and the Midlands to attract data centres as a driver for regeneration, economic diversification and growth.

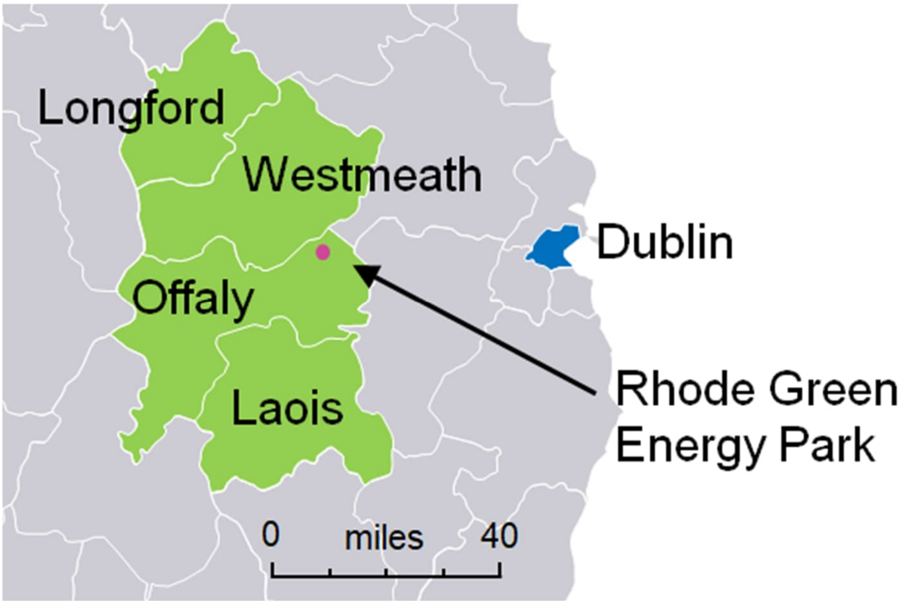

Figure 1: The Midlands of Ireland

The 30+ year history of data centre hubs can be linked to the concentration of telecommunications infrastructure in urban areas and proximity to major data users, including business, commerce and administration in capital cities. These markets have between 50-300 data centres, the installation often consuming up-to 30GWh[1] per annum, equivalent to the power consumption of over 7,000 Irish homes, according to Commission for Regulation of Utilities (CER) figures. The aggregation and clustering of data centres has a cumulative effect by attracting complementary investment in infrastructure and development of local skilled jobs. In recent years, all of these hubs have faced increasing barriers to continued growth and thus operators are looking elsewhere for development. Thus, Data Centre operators and regional stakeholders working in tandem can share the benefits of a new facility location, and alleviate the challenges that arise, including overcoming issues from being away from a traditional hub. The Midlands of Ireland is one such region that offers a number of attractive economic and social factors, and initiatives to encourage data centre operators to locate there.

[1] "Data Centres and Power: Factor or Fiction?", Intellect, 2013 accessible at https://pixl8-cloud-techuk.s3.eu-west-2.amazonaws.com/prod/public/04020e61-9ad8-4c6e-bcf0e2c2a5b63f59/Data-Centres-and-Power-2013.pdf

The existing situation in the Midlands of Ireland

The Midlands of Ireland consists of four counties – Laois, Offaly, Longford and Westmeath – located in the central area of Ireland. It has traditionally been a largely rural region in which agriculture and peat industries have been the most important parts of the economy. The peat industry has particular economic and social significance in the area as it provided high-carbon fuel to be burned for power generation, but this is now much reduced as Ireland looks to address climate change through reducing greenhouse gas emissions. For most of the last two decades, peat-fired power generation was supported by a Public Service Obligation (PSO) levy on electricity consumers to support the use of indigenous fuel, and this contributed to employment in the Midlands region. This support was phased out by the end of 2019 and saw all three of Ireland's peat-fired stations, all located in the Midlands, subsequently close.

Today, the Midlands has approximately 450 manufacturers employing 16,000 people out of a local workforce of 900,000[2]. Particular industries include food, ICT, engineering and MedTech sectors, along with an emergence of world class Research and Development (R&D) facilities and an emerging low-carbon / green enterprise sector in the region, supported by 14 third-level colleges providing the necessary skills that will continue to attract technology companies into the future. The "Midlands Regional Enterprise Plan to 2024" further recommends that the significant telecoms and technology related companies already located in the Midlands to form the basis of a Smart Connected Technologies Cluster to develop the region as an internationally recognised location for Telecommunications, which will generate its own organic growth and be attractive for new investors.

The land-base itself of 6,500km^2 is only 10% built-up, and with a favourable local government planning approach, can be considered very appealing for industrial development that requires unconstrained space to establish, grow and extend in maturity. The Midlands is very well connected with strong utility infrastructure connections in conjunction with the M4, M6, M6, M8 and M9 motorways, as well as railway and bus networks[3]. Thus, the Regional Enterprise Plan to 2024 for the Midlands further looks to position the Midlands as a region of choice for people to live, coordinated with a drive for continued development through smart specialisation in existing areas of regional strength in manufacturing and food.

Case Study: Rhode Green Energy Park

The Rhode and North Offaly communities have been directly affected by the closure of the nearby decommissioned peat-fired former Rhode Power Station, which amongst other things has directly affected the economic performance of the area with the cessation of peat harvesting, reduced employment in electricity generation and the knock-on down-turn to associated businesses. A number of initiatives with backing from the EU and Irish Government are looking to transform the region, for instance utilising the Just Transition Fund to create a stronger enterprise and employment base, provide alternative engagement to reduce migration and commuting to nearby Dublin, and to build a stronger regional identity.

This study is co-funded by the Just Transition Fund and North Offaly Development Fund (NODF). The North Offaly Development Fund is a community group with Rhode Green Energy Park as its flagship project. Chaired by Eugene Mulligan, the group has been working in close collaboration with Offaly County Council for a number of years to harness the potential of the site. Rhode Business Park is a developed site approximately 1 hour's drive from Dublin utilising the M6 Dublin to Galway motorway in the north of County Offaly.

[2] "Midlands Regional Enterprise Plan to 2024", Department of Enterprise, Trade and Employment, accessible at https://enterprise.gov.ie/en/publications/publication-files/midlands-regional-enterprise-plan-to-2024.pdf

[3] "Regional Impact – Midlands", Enterprise Ireland, accessible at https://strategy2022.enterprise-ireland.com/region/midlands/

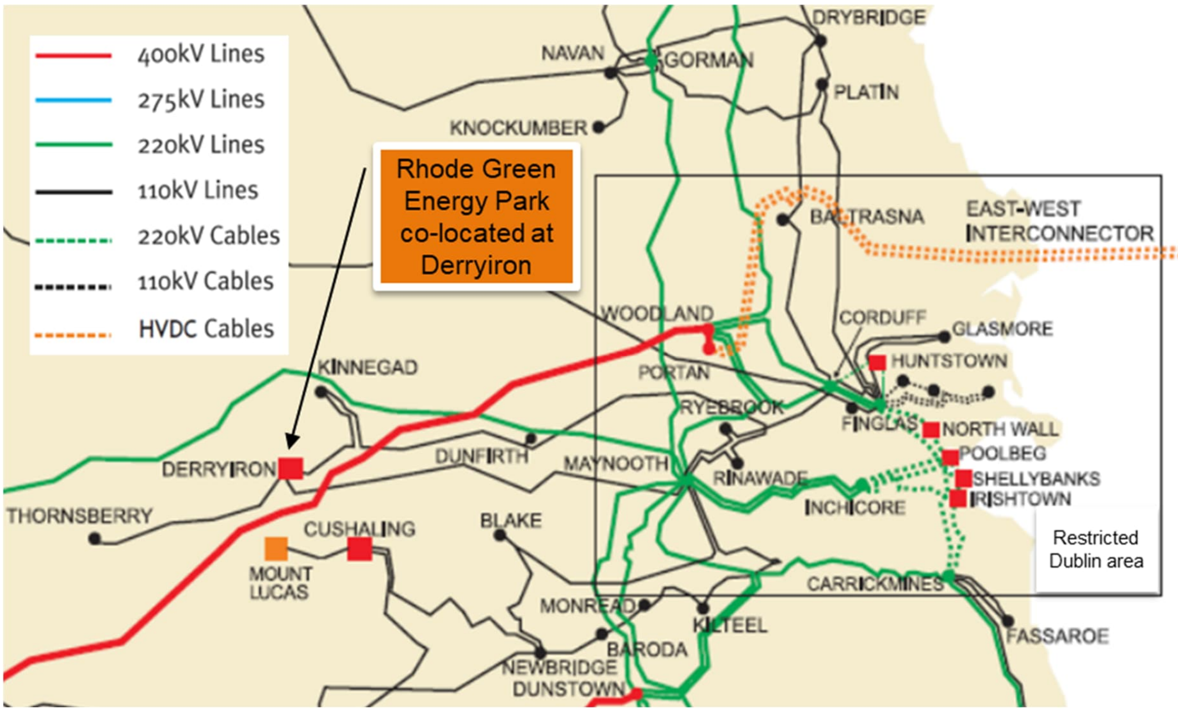

Figure 2: Electricity Infrastructure across Offaly and the Midlands

There is extensive power infrastructure within the region with a 400kV transmission backbone infrastructure and electrical substations located through Offaly and the Midlands, as shown in **Figure 2**, which reflected historically the need to transfer power across Ireland but also provide for evacuating the significant local power generation from the nearby decommissioned peat-fired former Rhode Power Station. Such legacy fossil-fuel generation sources are now being replaced with co-located power generator / supply tenants who are (or will be) providing in the majority low-carbon power, including:

- SSE Thermal's Rhode Power Station commenced operation in 2004 and provides 104MW to help maintain security of electricity supply in Ireland's all-island Single Electricity Market (SEM) by being available to operate on quick response to peaks in national energy demand; the plant consists of two 52MW gas / oil-fired turbines.
- Schwungrad's Flywheel Battery Storage plant commenced operation in November 2022 as an energy research centre for the development and testing of hybrid powered flywheel with plans to grow to 20MW capacity, and supported approximately 40 jobs during the construction phase of the project, as well as significant works from a number of local contractors.
- Proposed Garr Solar Farm by Neoen with 85MW capacity and 50MW battery storage, with permission granted by Offaly County Council in 2022 following success at the RESS 2[4] auctions in June 2022.
- Proposed Yellow River wind farm by SSE Renewables, a 29 turbine 105MW scheme that commenced construction in November 2022.
- Proposed Clonin North Solar Farm with 35MW capacity which recieved permission for development in 2017 by Offaly County Council and was subsequently successful at the RESS 2 auctions in June 2022. The project is currently progressing various permissions regarding size and connectivity.
- Proposed Biomass Gasification Plant by Newleaf Energy, with permission for development granted mid-2021 by Offaly County Council; this will provide up-to 15MW as renewable energy for grid support services and includes integrated carbon capture and utilisation technology.

[4] Renewable Electricity Support Scheme 2 (RESS 2) with more information available at https://www.gov.ie/en/publication/7f0bb-renewable-electricity-support-scheme-2-ress-2/

- Proposed Battery Energy Storage by RESL, with permission for development granted mid-2020 by Offaly County Council, with the 20MW system feeding into the 100kV Derryiron Substation.
- The proposed Bord na Móna Green Energy Park project built around a consented thermal power plant development with a total electricity generation capacity of 600MW.

Offaly County Council and NODF have recognised there are several key opportunities for the further strategic development of Rhode Business Park, and commissioned a report delivered by RPS Group delivered in November 2020, "Rhode Green Energy Park – Opportunity Assessment Report". This identified three strategic opportunities emerging as the most promising ways to develop the site:

- *Strand 1: Energy decarbonisation/ innovation hub built around renewable energy, hydrogen and electricity system integration.*
- *Strand 2: Eco-Industrial Park model whereby large-scale energy intensive employment – for example data centres, agri-food, horticulture, bio-economy – developed around the electricity and heat resources available.*
- *Strand 3: Educational/ Innovation/ Centre of Learning for renewables and electricity grid: to improve awareness within the community of how the energy transition is happening.*

With Strands 1 and 2 considered complementary and possible to advance at the same time, the combination of local data centre development on the back of renewable energy, hydrogen and electricity system integration, and partnering with innovative industrial / technology developers has been taken forward for consideration.

What does success look like?

The "Rhode Green Energy Park – Opportunity Assessment Report" by RPS Group in November 2020 identified that '**for the park to be successful, it will need to take advantage of the characteristics and opportunities that are unique to Rhode**' and concluded '**that a data centre would be an ideal anchor industry for the Park**'. In particular, it suggested that '**if a connection to the gas grid was made to serve a data centre at Rhode, it would open a number of opportunities for existing and proposed companies in the Park**' and '**it could also make investment in hydrogen technology and biomethane very attractive at this location.**'

Thus, the opportunity to attract and secure the development of a data centre at Rhode Green Energy Park is considered in three phases on the basis of more generally encouraging sector growth in the Irish Midlands by answering:

- **Phase 1: Market Drivers – what data centres will bring to the Midlands:** How have data centres and the sector developed in Ireland and Internationally? Does the growing renewables market and sector innovation have a role? How can this be applied to attracting data centre development? Answers to this question were gained through stakeholder engagement, assessment of data and energy systems, best practise and case studies.
- **Phase 2: Technical Review – how to support data centres in the Midlands:** What are the component parts of data centres with respect to their requirements of the local area: considering data centre taxonomy, energy consumption, necessary infrastructure, utilities, economic and societal resources? What is the role for leading-edge technologies such as Green Hydrogen, including medium-term innovations and how these align with requirements of the data centre sector evolving to meet future need?
- **Phase 3: Action Plan – how to attract data centres to the Midlands:** What are the activities that Offaly County Council and regional stakeholders should undertake to secure an 'anchor' data centre in the region? How should the data centre sector be further developed in the Midlands to secure a long-term future?

Phase 1: Market Drivers to Attract Data Centres to the Midlands

What is required to prime the data centre market?

A review was conducted to identify how data centres and the sector have already developed in Ireland and internationally, seeking the key factors that can be applied to attracting data centres to the Midlands. Stakeholder engagement was also conducted to understand the key implications for Offaly County Council, but also to cross-correlate the findings and understand the relative importance to form evidence for later recommendations and Action Planning. To apply this to a practical example, the market drivers are also considered from the perspective of development at Rhode Green Energy Park.

The Market for Data Centres

Historically, concentrations of data centre installations ('Hot Spots') emerged where the early network infrastructure existed – typically near academic centres, financial centres and undersea fibre nodes. The first data centre hub developed in Ashburn in Virginia, USA where one of the first Internet eXchange Points (IXP) became established in the late 1990s.

In Europe, the FLAP-D markets (Frankfurt, London, Amsterdam, Paris and Dublin) emerged during the early 2000s. FLAP-D hubs were dominated by co-location and cloud sectors, due to physical proximity to many commercial and industrial clients. Financial Centres such as London and Frankfurt were well positioned to become data centre hot-spots due to the financial sector's need for fast data transmission, as well as a number of other factors summarised in **Figure 3**.

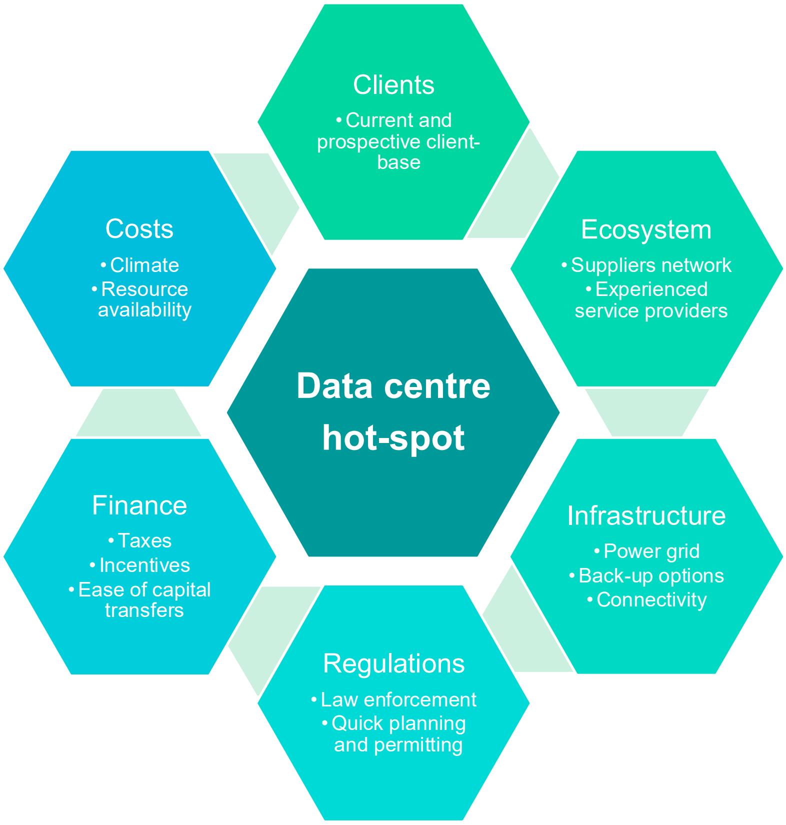

Figure 3: Client - Infrastructure - Ecosystem feedback loop of location factors

Connectivity was an important catalyst for Amsterdam, which became an early node for the Internet in Europe - initially developed through academic cooperation. Dublin's entry point was due to many subsea fibre connections from the US – and Dublin is also the European HQ for Google, and one of the main European processing Centres for Meta (previously Facebook), Microsoft and Amazon.

FLAP-D emerged where there was also demand for data centre services coming from corporate headquarters. There is a strong positive feedback loop observed, where initial investment in the sector can trigger an agglomeration effect thanks to service ecosystems and efficiencies of scale when it comes to network infrastructure, as well as benefits from low-latency inter-connections between the data centres.

Some de-concentration is expected in future with respect to:

- Wider infrastructure development reaching geographical or other constraint limits;
- Know-how diffusion coupled with reducing barriers to mobility; and
- Infrastructure capacity limits in current hot-spots including in response to societal and government pressures.

The trend for data centres to develop away from Dublin and other hot-spots has the potential to stimulate a number of associated skilled jobs in the host region, and otherwise brings a range of benefits to the economy.

Data Centres: Enabling high-paid jobs and skills for the community

The Technology sector has been a significant success story for Ireland over the last 40 years, particularly in its contributions to the Irish economy, estimated by Ireland's Central Statistics Office to account in 2021 for EUR 52 billion (16%) of gross value add (GVA) and employing 140,000 people, with sector growth of 40%

over the last five years[5]. By comparison, the well-known tourism trade for Ireland is estimated to generate between EUR 5.6 billion to EUR 7.3 billion and supports around 325,000 jobs[6]. The economic benefits deriving from the growth of the sector are not just delivered directly in-country – for instance, it is estimated that in 2020 alone, based on experience gained in Ireland, Amazon Web Services spent EUR 228 million with Irish contractors on data centres outside Ireland[7]; in other words, global Data Centre names are delivering International schemes with the assistance of (and benefit to) Irish companies and personnel.

In 2018, Grant Thornton reported that between 2010 and 2018 the total economic impact of data centres was EUR 7.13 billion with an average annual 5,700 roles created or supported annually, see **Figure 4** below.

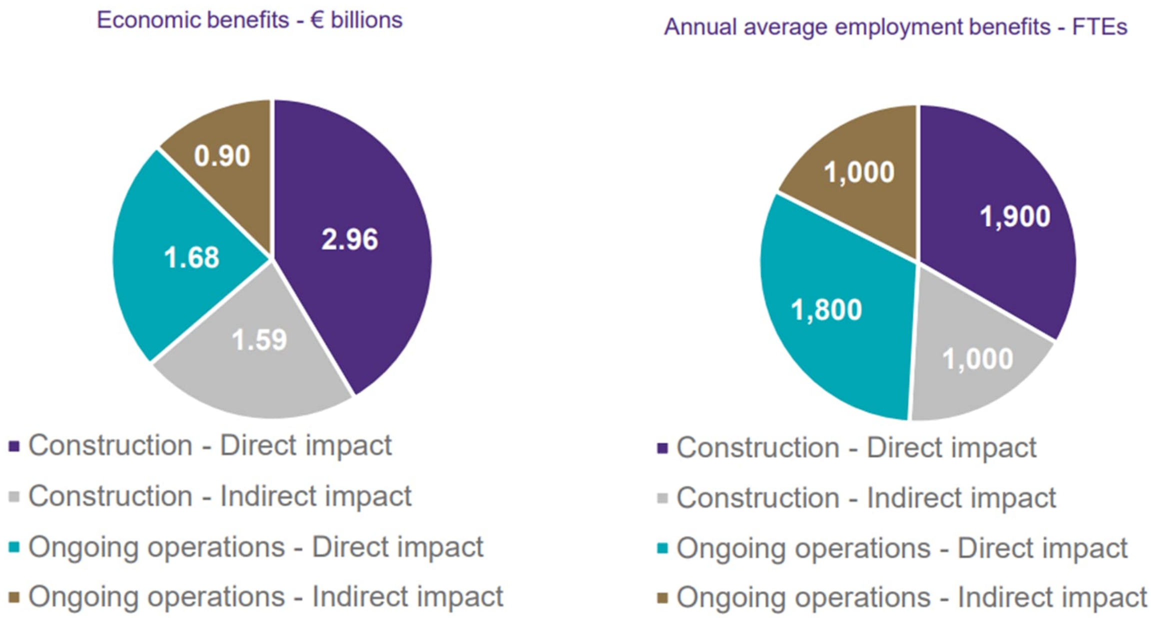

Figure 4: Economic and employment benefits of data centres to Ireland (2010 – 2018)[8]

In terms of supply chain, almost 1,000 suppliers have been contracted by data centres with 77% based in Ireland, who benefit from 90% of the total expenditure. Further, a survey conducted in 2016 by the Construction Industry Federation (CIF) 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 EUR 2.2 billion and direct employment of a further 6,600 Irish full-time employees[8]. According to Ireland's Industrial Development Agency (IDA), companies that operate data

[5] "Government Statement on the Role of Data Centres in Ireland's Enterprise Strategy", Government of Ireland, July 2022 accessible at https://enterprise.gov.ie/en/publications/publication-files/government-statement-on-the-role-of-data-centres-in-irelands-enterprise-strategy.pdf

[6] "Policy: Tourism", Government of Ireland, 10 July 2019 accessible at https://www.gov.ie/en/policy/3fcc3a-tourism/

[7] "Submission by IDA Ireland to the Commission for the Regulation of Utilities (CRU) Consultation on 'Proposed Direction to the System Operators related to Data Centre Grid Connection", IDA Ireland, July 2021 accessible at https://www.cru.ie/wp-content/uploads/2021/11/CRU21124ao-IDA-Ireland-Response-to-CRU21060.pdf

[8] "A Study of the Economic Benefits of Data Centre Investment in Ireland", IDA Ireland / Grant Thornton, May 2018 accessible at https://us.v-cdn.net/6034073/uploads/3LS31ZVNRPGX/ida-ireland-economic-benefits-of-data-centre-investment-final-may182018.pdf

centres in Ireland account for 16,000 direct employees, but when contractor numbers are factored in, that number reaches 27,000[9].

The development of new data centres and ultimately a hub in the Midlands would easily share these direct, indirect and export benefits. Initiatives outside of Dublin are already happening, with a EUR 1.2 billion investment in a 'large' data centre for Ennis, County Clare by Art Data Centres Ltd[10] receiving planning permission in August 2022 despite environmental-related protests[11]. Developers claim the data centre will create 250 permanent and 1,200 temporary jobs during construction.

Sharing economic benefits of data centre sector growth

The International data centre sector is growing and is expected to continue growth well into the next decade. Total power consumed by data centres in Europe doubled in the period 2010-2020 and under a worse-case scenario could double again by 2030, exceeding 160 TWh/a as per **Figure 5**.

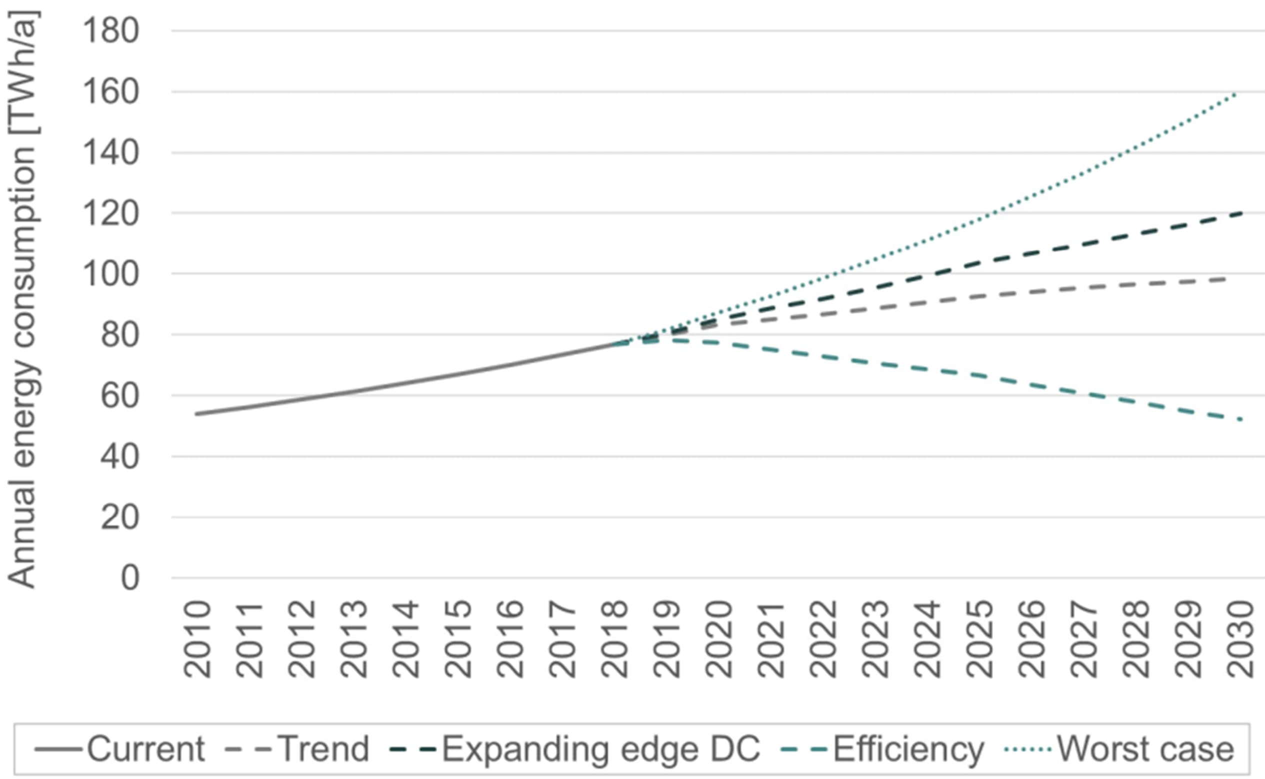

Figure 5: Possible scenarios for the energy demand of data centres in the EU28 until 2030[12]

[9] See footnote 5 on page 12.

[10] "Art Data Centres plan in County Clare expands to €1.2bn", DCD, 16th July 2021 accessible at https://www.datacenterdynamics.com/en/news/art-data-centres-plan-in-county-clare-expands-to-12bn/

[11] "Protests continue, as €450m Ennis data center is approved under Ireland's new policy", DCD, 10th August 2022 accessible at https://www.datacenterdynamics.com/en/news/protests-continue-as-450m-ennis-data-center-is-approved-under-irelands-new-policy/

[12] "Energy-efficient Cloud Computing Technologies and Policies for an Eco-friendly Cloud Market", European Commission / Environment Agency Austria and Borderstep Institute, May 2020 accessible at https://ec.europa.eu/newsroom/dae/document.cfm?doc_id=71330

Similar growth is possible in Ireland, where the share of national power consumption is already at approximately 14% according to the Central Statistics Office, with the potential to reach more than 30% in 2030 according to EirGrid[13]. This growth is controversial: already Irish data centres consume more metered electricity than rural homes (12% in 2021) and the growth trajectory indicates they will soon consume more than the 21% consumed by urban homes. By way of comparison, the average share of power consumption in the EU was 2.7% in 2018 and is projected to increase to 3.2% by 2030[14].

Ireland's Data Centre Market

In the fast-moving Information Technology sector, Ireland has a long history of success with data centres, with the focus of development being Dublin. For instance, Microsoft's first "mega-data centre" opened in 2009 - their first such facility outside of the US and chosen because of geological stability, proximity to high-speed fibre and affordable energy rates. Further, the centre was able to use ambient air or "free cooling almost 100% of the time" so that it was the most energy-efficient build by Microsoft at the time[15].

By the end of 2018, there were 53 data centres in operation in Ireland, reflecting a capital investment spend of over US$ 1 billion at the time. This also saw Dublin surpassing London by taking 25% of the European market, based on some 16 data centres becoming operational that year, and a further 28 in development. Figures from the IDA showed that the hosting industry was found to have created 2,800 jobs in Ireland as of May 2018[16].

Now, Dublin is a cloud computing hub with big cloud providers such as Google, Amazon Web Services, IBM and Microsoft. According to Mordor Intelligence, the Ireland data centre market was valued at US$ 2.27 billion in 2020 and is expected to reach US$ 3.27 by 2026.

From such early agglomeration, Ireland is still considered a pre-eminent destination for data centre developments. A report in May 2022 by Arizton found that, in Western Europe, Ireland is expected to be the fastest-growing hyperscale market during the period to 2027. However, the increased concern over grid issues has seen 21 new data centres planned for outside the greater Dublin area, of which 16 are large-scale, with locations roughly 80km away at Louth, Meath, Kildare, Kilkenny and Wicklow[17]. At the time of writing, RTE stated that there are currently about 70 data centres operational in Ireland with 65 in the greater Dublin area.

[13] "The rise and rise of data centres in Ireland", RTE, 17th August 2022 accessible at https://www.rte.ie/brainstorm/2022/0815/1315804-data-centres-ireland-electricity-energy-resources-climate-change

[14] "Green and Digital: study shows technical and policy options to limit surge in energy consumption for cloud and data centres", European Commission, 9th November 2020 accessible at https://commission.europa.eu/news/green-and-digital-study-shows-technical-and-policy-options-limit-surge-energy-consumption-cloud-and-2020-11-09_en

[15] "Microsoft opens €341m data centre in Dublin", John Collins writing in the Irish Times, 25th September 2009 accessible at https://www.irishtimes.com/business/microsoft-opens-341m-data-centre-in-dublin-1.744888

[16] "Dublin is now Europe's largest data hosting cluster", Irish Times, 28th February 2019 accessible at https://www.irishtimes.com/business/technology/dublin-is-now-europe-s-largest-data-hosting-cluster-1.3808500

[17] "Dublin ban sees 21 new data centres planned outside city", Business Post, 17th December 2022 accessible at https://www.businesspost.ie/news/dublin-ban-sees-21-new-data-centres-planned-outside-city/

Irish Policy on data centres

The latest and most relevant data centre document from the Irish Government is the Government Statement on the Role of Data Centres in Ireland's Enterprise Strategy[18] in July 2022. The document's aim is to enable both digitalisation and decarbonisation and recognises that "*...data centres are core digital infrastructure and play an indispensable role in our economy and society*."

From the perspective of promoting sustainable data centre development in the Midlands, the following points and conclusions are derived:

- Economic impact
  The Government has a preference for data centre developments associated with strong economic activity and employment.
- Grid capacity and efficiency
  The Government has a preference for data centre developments that make efficient use of the electricity grid, using available capacity and alleviating constraints.
- Renewables additionality
  The Government has a preference for data centre developments that can demonstrate the additionality of their renewable energy use in Ireland.
- Co-location or proximity with future-proof energy supply
  The Government has a preference for data centre developments in locations where there is potential to co-locate a renewable generation facility or advanced storage with a data centre, supported by Corporate Power Purchase Agreements, private wire or other arrangement.
- Decarbonised data centres by design
  The Government has a preference for data centre developments that can demonstrate a clear pathway to decarbonise and ultimately provide net zero data services.
- SME access and community benefits
  The Government has a preference for data centre developments that provide opportunities for community engagement and assisting Small-and-Medium Enterprises (SMEs), both during the construction phase and throughout a data centre's lifecycle.

Of perhaps greater impact, the Commission for Regulation of Utilities (CRU) published a decision regarding the future regulation of the electrical connection of data centres in Ireland, entitled "Direction to the System Operators related to data centre grid connection processing" with reference CRU/21/124. This Consultation was built out on the basis of the significant growth in demand by data centres presenting concerns for the security of Ireland's electricity grid. From three proposals considered in public consultation, the intermediate approach was selected on the basis of the necessary value of allowing the data centre market to continue to grow in Ireland, but placing emphasis on how they must contribute to the stability of the electricity grid. The electrical system operators EirGrid and ESB Networks are now required to apply criteria on a case-by-case basis for new or existing applications being processed, to consider without priority:

- The location of the data centre with respect to whether it is within a "constrained" or "unconstrained" region of the electricity system; and
- The ability of the data centre to provide flexibility in their demand by reducing consumption when requested to do so by the relevant System Operator in times of system constraint.

[18] "Government Statement on the Role of Data Centres in Ireland's Enterprise Strategy", Government of Ireland, July 2022 accessible at https://enterprise.gov.ie/en/publications/government-statement-on-role-of-data-centres-in-enterprise-strategy.html

EirGrid has responded to the CRU requirement by indicating that the integration of renewables will be considered favourably when considering connection applications from energy-intensive sectors, with the Ireland Capacity Outlook 2022-2031 (October 2022) stating:

> *"Offers of new connections will be contingent upon the ability of the data centre applicant to bring onsite dispatchable generation (and/or storage) with a capacity equivalent to or greater than their demand. This does not constitute a moratorium for data centres but according to CRU's direction, EirGrid can 'determine whether a connection offer can be made within the system stability and reliability needs of the electricity network.' It also means that any new data centre demand must also bring equivalent capacity with it which would be intended to largely offset any further growth in data centre."*

This is seen by the market as an effective ban on the development of new facilities in Greater Dublin until at least 2028, which of course favours development of data centres in the adjacent area of the Midlands with both extensive electrical capacity at transmission levels, but also significant renewable connection. Further, it may be noted that EirGrid also signalled the use of particular technical requirements that favour new renewable deployments for onsite generation during post-consultation engagement under the Data Centre Forum:

- Run hours: generation should not be limited by fuel reserves, environmental licensing, regulatory obligations, or technical limitations.
- Export: sites will have an installed generation capacity that is higher than their Maximum Import Capacity (MIC).
- Capacity Market exclusion: avoids double counting as awarded capacity will not be considered as data centre back-up for new connections.

EirGrid is not currently driving the discussions around storage technologies to form a significant part of the solution in the near-term. As an example, storage is considered not to provide the same level of benefit to security of supply when compared to gas generation, and current storage technologies are generally not able to sustain output for lengthy periods. An additional MIC is required for charging the storage unit, and the impact this load will have in addition to the data centre load itself must be considered in the connection application process. Should proposals be brought forward that address the above, then EirGrid has indicated it will discuss these on a case-by-case basis.

Ireland's Power Market

Back-up power is now one of the primary considerations for new Data Centre locations in Ireland due to CRU recommendations for establishing the necessary utility grid connections; the preference of Data Centre operators is for the utilisation of the gas grid to supply on-site engines for back-up, rather than utilisation of locally-stored fuels or other storage technologies. Currently, there is insufficient gas infrastructure in Offaly to provide back-up data centre load, but the nearest gas bulk transmission line located approximately 12km north of Rhode could be developed to bring the necessary gas capacity to address this. A gas connection to the Derrygreenagh CCGT power plant proposed by Bord na Móna under their Green Energy Park scheme should be the subject of further consideration, with a later connection at the Rhode Green Energy Park that further establishes gas infrastructure in the area.

Irish Power Grid

The Irish electrical grid has limited interconnections with other grids. Its peak demand in 2022 is 7.5 GW and a typical day demands 5 GW – comparable to Greater London or Paris). Connected data centres have a reserved capacity of 1 GW (see **Figure 6**), using approximately 14% of the annual demand.

Figure 6: Capacity of data centres grid connections in Ireland as of November 2021[19]

A further 1 GW of data centres are contracted for new connections and 99% of existing and contracted load is located in the greater Dublin area. The demand from data centres is forecasted to increase further and exceed 30% in 2026 (see **Figure 7**).

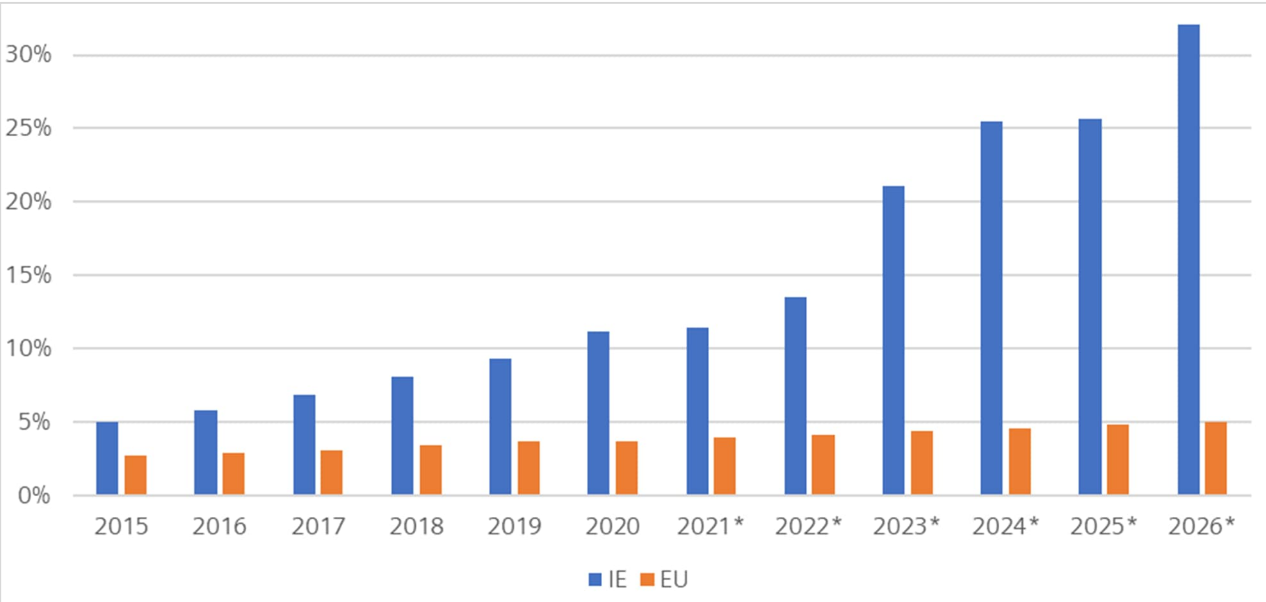

Figure 7: Share of data centres in total electricity consumption[20]

[19] Compiled from data in "CRU Direction to the System Operators related to Data Centre grid connection processing – decision", 23 November 2021 accessible at https://www.cru.ie/wp-content/uploads/2021/11/CRU21124-CRU-Direction-to-the-System-Operators-related-to-Data-Centre-grid-connection-processing.pdf

[20] Compiled utilising data from CSO (2020), JRC (2020) and CBRE Research (2022)

The Irish electricity grid is generally well managed. Key Performance Indicators (KPIs) of grid stability such as Loss of Load Expectation (LOLE) and System Average Interruption Duration Index (SAIDI) are similar to those in other European countries, despite Ireland having a higher baseload and more interconnectors. However, both the CRU and EirGrid identified data centre concentration in Dublin as an acute issue. EirGrid in their 2021 consultation "Shaping our Electricity Future" set out four scenarios of future developments:

1. Generation-Led
2. Developer-Led
3. Technology-Led
4. Demand-Led

It was acknowledged that a real-life scenario is likely to be a mix of the above.

The CRU issued a decision CRU/21/124 in November 2021 (resulting from consultation CRU/21/060) that advises the system operators to require all new data centre connections to meet additional requirements in the following areas:

1. Regional constraints: The location of each data centre applicant with respect to whether they are within a constrained or unconstrained region of the electricity system.
2. Dispatchable generation/storage: The ability of each data centre applicant to bring onsite dispatchable generation (and/or storage) equal to or greater than their demand, which meets appropriate availability, to support security of supply.
3. Flexibility of generation: The ability of each data centre applicant to provide flexibility in their demand by reducing consumption when requested through the use of dispatchable on-site generation (and/or storage).
4. Flexibility of demand: The ability of each data centre applicant to provide flexibility in their demand by reducing consumption when requested to do so by EirGrid in times of system constraint, in order to support security of supply.

Case Study: Bringing the Data Centre market to Rhode Green Energy Park

Offaly County Council and Siemens have worked together to carry out a high-level study that seeks to identify the challenges and opportunities for development of data centres at the Rhode Green Energy Park and more generally on a regional basis, particularly from the perspective of integration with regional renewables and green hydrogen. The fundamental objective is to understand how Offaly County Council might prime the area of Offaly and the Midlands to attract data centres as a driver for regeneration, economic diversification and growth.

Stakeholder Engagement

Stakeholder engagement was planned in three formats: workshops, surveys and in-depth interviews, which were conducted with three groups of stakeholders that are important for the integration of renewables and data centres:

- data centre sector;
- renewables and storage sector; and
- infrastructural and regulatory bodies.

The study has been enriched by coordinating and discussing preliminary results with a team from RPS delivering, in parallel, a study focusing on hydrogen generation and utilisation potential in Offaly County. Their findings steered the project into outlining the parameters and feasibility of a future pilot plant, due to the lack of a larger market for hydrogen. In consideration of the known difficulties in storing hydrogen, the team worked with an assumption that the gas network will become available and viable for hydrogen injection.

Summary of inputs from Stakeholder Interviews

Data Centre sector stakeholders	Main messages
• **Host in Ireland** • **Cloud Infrastructure** • **T5 Data Centres** • **Equinix** • **Kilon Holdings**	• The data centre sector is international; it will not only be the Irish regions who will compete for new data centres experiencing significant barriers to opening in Dublin. • It is generally observed that all areas of concentrated data centre location Internationally are experiencing 'significant' pushback that is creating limitations to growth. • There is a strong positive feedback loop for data centre concentration (fibre networks synergies, specialised workforce and services ecosystems). • There is pressure to power the sector with renewable energy systems, but it is mostly achieved by virtual Power Purchase Agreements (PPAs) with power supplied through the grid. There is currently little to no experience amongst data centre operators with real life connection to and integration with intermittent sources, long-term storage and energy export. • New approaches to data centre energy provision must consider that when providing energy generation capacity over and above meeting the data centre needs, then there is the risk of extra administrative activity under energy supply licensing regulations, etc.

Renewables and storage investors	Main messages
• **Bord na Mona** • **SSE RE** • **NEOEM** • **Lumcloon Energy**	• Renewables planning is a slow process in the Irish regulatory landscape, but it is well established and investors have now learned to navigate the system. • Grid connections and land availability are the main factors bringing investors to certain areas. • Onshore wind and solar will continue to grow for the next few years but most of the "good" locations have been already identified. • Curtailment of power production is becoming an issue and storage is increasingly needed but most new storage projects are focused on grid services (e.g. DS3 programme) than on energy trading. • PPAs are proved to be a good financing tool but public auctions often offer better business cases than private commercial arrangements.

Regulatory / policy / utility stakeholders	Main messages
• **IDA** • **EirGrid** • **ESB** • **GNI** • **ESRI/UCD**	• Resilient and flexible infrastructure provision is important and underpins Irish economic performance, which will drive a series of investment initiatives in the Midlands relevant to data centres. • The power grid around Dublin is constrained and the Midlands are considered to be electrically adjacent, which brings additional scrutiny to new connections planned in the region. • Gas network development is considered a prerequisite for most data centre investors and hydrogen investors. • Work is underway to prepare for wider adoption of hydrogen in the gas grid but currently there is a limit of a 0.5% mix which curbs interest in such innovative project deployment. • The means to address flexibility are not currently being considered from a policy / utility perspective, though the next regulatory reviews are likely to focus on management of applications such as non-firm flexible access connections, interconnectivity of multiple energy sources as a microgrid and utilisation of local networks / infrastructure.

The interview structure employed in this study may be found in APPENDIX A.

Decision factors and location analysis

The societal, market and sector challenges and opportunities associated with the above principles are now examined for data centres, identifying the strengths and weaknesses for data centre developments in the Midlands and Offaly, along with a comparison with International markets. The benefits and problems informing the choice of location within the single regulatory market is dictated by the following factors, with reference to how these affect the Irish Midlands and Offaly:

Parameter	Description	Offaly/Midlands situation
Power availability	Primary system power for data centres is delivered via the utility electricity grid, informed by availability of capacity, amount of investment needed to connect and grid stability. Secondary systems for alternative power and back-up have similar considerations that constrain location, for instance the positive factor of close location to the utility gas grid to power the data centre during blackout.	The Irish electricity and distribution grids have a relatively sparse location in the rural Irish Midlands, so that the capacity is relatively small and there are limited interconnection for redundancy, so that the necessary levels of reliability demanded by the data centre sector may be questioned. EirGrid and ESB Networks are successfully keeping outage parameters only slightly below achievements of the best European grids but perhaps not providing the same level of confidence to the sector as location of facilities in the Dublin region, though network constraints are also causing issues.

Phase 1: Market Factors

Parameter	Description	Offaly/Midlands situation
Telecommunications network infrastructure	The primary function of data centres is the timely supply of digital information which requires high quality infrastructure – typical needs are fibre connections, availability of dark fibre, IXPs in the area, distance from other data centre clusters – all these factors translate to the target of reduced latency in data provision.	The Midlands do not have extensive telecommunications infrastructure when compared to Dublin, which often got surplus infrastructure thanks to past internet booms and high population.
Skilled workforce	The construction and maintenance of data centres require a variety of skilled trades underpinned by appropriate education and training; the ability of the host community to provide both the temporary and permanent jobs, either through direct location and hosting of the personnel or incoming term provision of skills from other regions is important.	The Midlands have schooling and post-education study / skills development, though these are not focussed to supply the data centre market due to low population density of this rural region. Suitable talent can be imported from Dublin on a temporary basis, but also on a post-COVID-19 pandemic population trend seeing skilled professionals consider to move away from urban areas. Ireland as a whole is ranked below world-leading countries in skills training.
Availability of green energy **(PPA & REC opportunities)**	Being powered by green energy is a valuable differentiator and an important requirement of many data centre operators. Green credentials can be obtained by proxy through certificates or PPAs, but of course direct investment in renewable provision is also considered. Availability is linked to the country's regime for provision of renewable power.	Ireland may be considered to be an early adopter of renewables power technology connection to the grid, with continued significant increasing investment in renewables and political will to unlock the market for years to come. Competition to Ireland in this regard is fierce with many other European countries also focussing on the renewable energy sector. The effect and forecasts are similar across the countries of focus.
Lack of natural disasters	Floods, hurricanes, poor weather systems and other natural disasters are very challenging to critical infrastructure such as data centres.	Ireland's temperate climate and geographical characteristics provide an advantage in this consideration, with the country at low risk of such natural disasters.
Climate conditions	Cooling is an important operating expenditure for operators. Temperatures below 15-18°C allow for effective cooling using ambient air, significantly lowering costs.	With average summer temperature below 16°C, Ireland's weather of relatively low temperatures is good for Data Centre energy efficiency.
Investment incentives	Welcoming atmosphere, enabling infrastructure, investment, guidelines and tax rebates and incentives are all important factors for business wanting to invest in global markets.	Ireland, and the Midlands specifically, have an impressive history of attracting investments and nurturing entrepreneurship.

Parameter	Description	Offaly/Midlands situation
Law enforcement	Enforcing contracts, chasing fraud, physical security of assets and low crime rates.	Ireland scores well in this category, however other countries that are active in the data centre market score similarly or better.
Tax structure	Tax structure encompasses the level of taxation of profits, labour, stability of the regulations, tax incentives, and other fees required to operate in the country.	Ireland's corporate income tax is one of the lowest in the EU, which played a role in the success of attracting investment. Ongoing minimal income tax policy is discussed internationally but it is likely to remain competitive.
Logistics & accessibility	Physical access of goods and staff is important for all businesses. data centres operate largely in a virtual space but still need some level of logistics and accessibility.	Offaly and Midlands do not score very well in terms of connectivity. There are some links to the Dublin area but, in general, the density of links between population Centres and logistic Centres is lower in Ireland than in the best European countries.
Local supplier markets	Local know-how for supplying products and services, with a local ecosystem that gains experience with each new job provided.	Supplier markets and workforce for data centres are concentrated in Dublin, but the Midlands could make use of this in some cases. It would be possible to have a positive economic impact if there were local service companies with experience in the sector.
Local clients base	Data centres are a global business and often services are delivered across the borders, but some data centre business is based on close location to the client. Technically, proximity offers lower latency but also might be easier to process from administrative point of view.	In terms of local client base, larger economies have an advantage over Ireland, and specifically the Midlands. Ireland is home to many global or European HQs, which gives it a strong position relative to its population size and contributes to GDP per capita.
Low cost of energy	Cost of electricity for industrial/commercial businesses varies significantly between countries, even if wholesale markets tend to have some price convergence. This is due to different taxation and tariff structures.	Irish prices are reported to be in middle of the range (€0.07-0.16/kWh) with €0.11/kWh. All energy systems are undergoing transformation, which will require significant investment which will affect the prices in the future.
Land and construction costs	Securing planning permission, the costs of lease/purchasing and the cost of labour and building materials can have some impact on the decision about locating a new data centre. In the EU the biggest variability can be found in costs of obtaining land, but favourable conditions for development and the availability of land assets are also key.	Ireland's land prices are relatively high compared to population density. Irish Government and the regional public authorities are working closely around the economic development of the Midlands, and are of the opinion that the Data Centre sector will see the opportunity to develop and flourish in the region under the conditions of extensive land asset availability and a proactive approach to planning / development.

Offaly and the Midlands region must compete across all aforementioned dimensions with a wide range of locations, most important of which are the UK, Germany, Netherlands, France and Scandinavia. Offaly and the Midlands have a number of positive factors to for data centres compared to an average location in Ireland, however when comparing with the best established locations, there are some low scoring areas, as shown below in the heat map (**Figure 8**).

	Offaly	Midlands	Ireland	UK	Germany	Netherlands	France	Scandinavia
Power availability	7	7	7	8	9	8	9	8
Network infrastructure	2	4	6	8	9	9	6	7
Skilled workforce	3	4	7	7	9	9	6	9
Green energy PPA opportuniti	5	5	5	6	6	4	4	9
Lack of natural disasters	6	6	6	7	8	4	8	8
Climate conditions	9	9	9	8	4	6	3	7
Investment incentives	8	8	8	4	3	5	2	3
Law enforcement	7	7	7	7	8	8	6	9
Tax structure	8	8	8	7	6	7	5	6
Logistics & accessibility	4	5	6	7	8	8	8	7
Local supplier markets	2	3	8	8	6	9	7	9
Local clients base	2	4	6	8	9	7	9	7
Low cost of energy	6	6	6	4	5	8	8	9
Land and construction costs	9	9	8	5	6	4	6	4
Overall:	5.2	5.8	6.8	7.0	7.4	7.2	6.4	[illegible]

Sliding Scale: Zero / Low — Medium — High

Figure 8: Qualitative assessment of data centre markets

Please see APPENDIX B for assessment parameters

Phase 1 Analysis

The market for data centre services is largely a global one. Many of the services can be provided in any location within the network of interconnected hubs. Dublin is one of these hubs and building on that is a reasonable direction of regional development for the Midlands. Some services are more localised – clients of colocation data centres often require low latency and proximity to providers. With multiple corporate headquarters in Ireland, some demand for local data centres will remain even if the conditions for new investment will be less favourable than elsewhere.

The recent decisions by the CRU and communications by the System Operators that present challenges for location in Dublin are otherwise an opportunity for elsewhere in the country, or otherwise abroad. Ireland is experiencing some grid limitations slightly earlier than the rest of the continent, but this creates an opportunity to create experience and know-how among local Irish suppliers, which will be in demand elsewhere in the future including for the export of know-how.

For the Midlands, the opportunity to create resilient data centres capable of operating off-the-grid or respond to the grid's quickly changing requirements, are two directions in the connectivity of low-carbon generation as identified when engaging stakeholders. The former approach is more technically difficult and goes against the regulatory push; the latter is technically easier but may be slow due to reliance on co-operation with the regulators and network operators. Data centre operations do not employ many people directly. Indirectly however, it impacts significantly the productivity of people using it and creates an ecosystem of suppliers of equipment and services.

The market opportunity of attracting data centres to the Midlands and Rhode Green Energy Park is clear, but the technical requirements of the industry are extensive and demanding, so that a number of these factors must be considered, primed and developed to secure the regional and local benefits.

Phase 2: Technical Review

What is a data centre and what does it need?

Having established the key Market Drivers for data centre operators in engaging with the Midlands of Ireland, the necessary technological requirements of the sector also need to be understood in order to create the appropriate regional foundations to attract the appropriate development. To facilitate this, an understanding of the key components of data centres and their requirements is presented. As a fundamental building-block in society's digitalisation, data centres have evolved as a secure repository of digital information accessible over the Internet. Their key value propositions are:

1. Driving down the cost of secure data storage by moving from physical location to digital co-location. This enhances cyber security and significantly reduces the emissions from computing, typically using 67% less energy than traditional on-premises servers to do the same amount of work[21].

2. Data and applications can be accessed in a timely manner from anywhere in the world. Data only has value if it can be sourced and processed securely at the point of time of enquiry. This has also unlocked significant cultural and societal change, in that people have been facilitated to work and socialise from home.

3. Security is a multi-factor concern - amongst others: avoiding physical compromise of the servers; meeting Service-Level Agreements in the availability of data and access performance; addressing hostile cyber-security challenges.

These value points drive the technical performance of data centres and the necessary technical infrastructure requirements to support them. As a growing sector over 40 years of delivery that is continuing to develop and innovate, a clear typology and general specification has emerged. In understanding these technical components of a data centre and the means to address these requirements, we can then consider how the Midlands of Ireland, and the Rhode Green Energy Park specifically, can act to attract the sector by providing the required technical performance in the supplying infrastructure and utilities.

Data Centre Function and Requirements

Data centres are purposefully designed for their function and data processing scale. The size of a data centre is typically measured by its white-space area or power capacity. New data centres are generally constructed in a 10 MW to 200 MW range, with the lower end considered a mid-tier and the upper end often referred to as hyperscale. Power capacity ranges and corresponding categorisation of data centres are shown in **Figure 9**.

[21] "Saving Energy in Europe by Using Amazon Web Services", S&P Global Market Intelligence, October 2021 accessible at https://assets.aboutamazon.com/b0/3e/b0fc6b8a4a85b38ac65a3fbc584c/11061-aws-451research-advisory-bw-cloudefficiency-eu-2021-r5-final-corrected-data.pdf

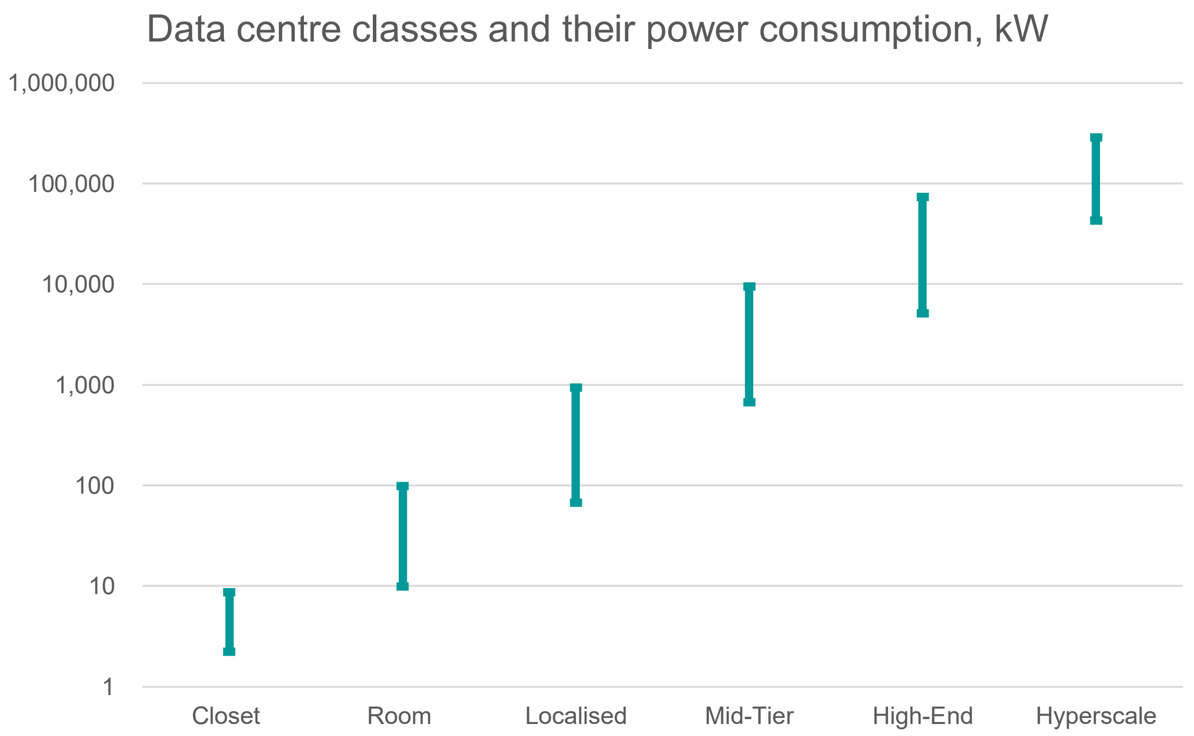

Figure 9: Data centre scale bands

The characteristics of data centres typically involve the following factors:

- Number of tenants – often the operator of data centre is its sole user (or tenant) but colocation service is a major category of data centres, where end-users outsource the operations to a specialised company. Sharing of the data centre also happens in the telecommunications and academic sectors.
- Availability requirements – depending on how critical hosted services are, tenants have a range of expectations regarding acceptable downtimes of data centres, and these are underpinned by Service-Level contracts.
- Latency – speed at which the data can be down- and up-loaded to the data centre is a significant requirement for many users. Overall speed is a result of the quality of the fibre connection and the physical distance between the data centre and its users.
- Processing focus – different tenants have different data processing needs, with some requiring large amounts of data storage / archiving, while others use the concentrated bulk IT processing power for heavy computation resources.

Characteristics of data centre types is summarised in the table below:

	Hyperscale	Colocation	Telco	Enterprise	Government	HPC[22]
Tenants	Single	Multiple	Single/ multiple	Single	Single	Single
Availability	Tier0 - Tier4	Tier3	Tier2-Tier3	Tier3	Tier3	Tier2 - Tier3
Size	Large	Med-large	Small - med	Small - big	Small - big	Small – med
Latency / Proximity	Low-high	Low	Low-high	Low-v.high	Low-v.high	Med-v.high
Focus	Capacity / Performance	Capacity	Capacity	Mixed	Mixed	Performance
Flexibility / Scalability	High	High	Med-High	Low-Med	Low-Med	Low
Example companies	Google, Microsoft, Amazon, Apple, Meta	Equinix, Interxion, Maincubes, Global Switch	Atos, IBM, hp, Equinix, Tata, Amazon	Companies	Central, local government, public agencies	Universities, research institutes

Data Centre KPIs

Key Performance Indicators for data centres provide methods to compare operations between locations and operators. They cover all the supporting domains that data centres use:

Category	Key Performance Indicator
Energy	PUE - Power usage effectiveness REF - Renewable energy factor ERF - Energy Reuse Factor CER - Cooling Efficiency Ratio ITEEsv - IT Equipment Energy Efficiency for servers
Emissions	CUE - Carbon Usage effectiveness
Water Usage	WUE - Water usage effectiveness
Server Utilisation	ITEUsv – IT Equipment Utilization for servers

[22] High Performance Computing – computationally intensive simulations or data processing often require dedicated Data Centres to house the supercomputers used.

The KPIs have been standardised almost simultaneously globally; within the EU, these fall under ISO/IEC 30134 and EN 50600-4 standards. The most tracked and established KPI is the PUE, which represents the ratio of overall energy consumption to the IT-equipment consumption; a perfect '1' scored is achieved when every kilowatt of energy coming into the data centre would be used only to power the IT hardware. The best data centres reach PUE of around 1.1, with an average typically achieving between 1.5 and 1.6.

Data Centre Trends

Data centre design, development and operations is a dynamic sector with numerous emerging trends that include:

- New KPIs – TUE, WUE and CUE
  Criticism of the industry standard PUE is that while trying to achieve sustainability targets and net-zero, the metric doesn't capture impact at the rack level – the application of the UPS figures out of 'infrastructure power' to 'IT power' can improve the number, yet this can be considered 'creative accountancy' which doesn't address performance. The industry is now considering Total-Power Usage Effectiveness (TUE) which accounts for the impact of rack-level ancillary components such as server cooling fans, power supply units and voltage regulators. Alternatives that consider environmental impact are also being utilised such as WUE (Water Usage Effectiveness) and CUE (Carbon Usage Effectiveness) to illustrate the reduction in key environmental resources that efficient data centres use[23].
- 24/7 renewable energy / hourly green certificates
  Renewable Energy Certificates (RECs) are widely used but are increasingly facing the charge of 'greenwashing' if they are the main or only component of a renewable or low-carbon energy strategy for a datacentre, particularly considering the low cost of RECs relative to the overall cost of electricity. Recommendations in the market are to consider direct Power Purchase Agreements (PPAs) which guarantee physical delivery of electricity on the local grid, or otherwise virtual/financial PPAs. Operators are also suggested to consider retail or "green tariff" renewable energy contracts in conjunction with a renewable developer, particularly because these have a lower risk due to shorter terms and the developer or retailer carries most of the financial risk. Further, datacentre operators have the size and technical capabilities to lead the demand for PPAs, growing a market for other companies.[24]
- Information Battery / processing time shifting
  The idea of 'Information Batteries' builds upon the existing established activity of shifting data centre processing time: schedulers already optimise the flow of data through data centres, and bulk computation can be applied to times of surplus renewables power availability or in reduced in response to utility demand response. However, Information Batteries work to a concept of conducting bulk calculations speculatively then storing the results for when they are needed later. This achieves the offset of power demand when it might otherwise be needed – making that unrequired energy available in the power system (like a battery) because the calculations have effectively been conducted previously. Suggested examples might be the transcoding of videos or

Phase 2: Technical Review

[23] "Is PUE too long in the tooth?", DCD, 1st March 2022 accessible at https://www.datacenterdynamics.com/en/analysis/is-pue-too-long-in-the-tooth/

[24] "Renewable energy for data centers: Renewable energy certificates, power purchase agreements and beyond", Uptime Institute, 12th February 2021 accessible at https://uptimeinstitute.com/renewable-energy-for-data-centers

training machine-learning algorithms, allowing the data centre's information-battery manager decide when to run[25].

- Distributed resiliency
  The Uptime Institute categorises data centre resiliency into four main types. The basic definition is traditional single-site resilience, which has the downside that no matter how much one data centre is protected, there is still a risk from issues particular to that zone or region. Improvements to resilience can be made through 'linking' two or more sites in a region or zone to achieve a higher level of availability; this is further extended through 'distributed' site resilience where two or more independent sites use a shared internet or Virtual Private Network to reduce or eliminate vulnerability on a local or regional level, and also enables reduced investment in physical redundancy. The current limit of the practise is 'cloud-based resilience' whereby distributed, virtualized applications are distributed across multiple data centres but this reflects the need for significant IT investment, multiple sites and a lot of bandwidth[26].
- Liquid cooling and other innovations to manage waste heat
  Data centres are understood to discard 98% of the electricity they use as excess heat, so measures to repurpose waste heat from servers have already been considered for a number of years. A variety of cooling technologies are used to keep the electronic components in the data centre operating within acceptable temperature and humidity ranges. More efficient cooling might be a component in improving the options for re-use of waste heat, and liquid cooling is currently considered because it can be installed on data centre devices that need it most. It is more efficient than air at transferring heat away from emitting sources and can support greater equipment densities, as well as items that generate higher-than-average heat, such as high-density and edge computing data centres. Liquid cooling and future systems and technologies include[27]:
  - Liquid immersion cooling - this method places the entire electrical device into dielectric fluid in a closed system which absorbs the heat emitted by the device, turns it into vapour and condenses it, helping the device to cool down.
  - Direct-to-chip liquid cooling - this method uses flexible tubes to bring non-flammable dielectric fluid directly to components generating most heat; again, the fluid absorbs the heat by turning into vapour and it away from the equipment through the same tube.
  - Geothermal cooling uses a closed-loop pipe system with water or another coolant that runs through vertical wells underground to take advantage of the near-constant temperature of the Earth below surface level to provide cooling.
  - Evaporative cooling, or swamp cooling, takes advantage of the drop in temperature that occurs when water is exposed to moving air and begins to vaporize and change to a gas. A fan draws warm data centre air through a water- or coolant-moistened pad, and as the liquid evaporates, the air is chilled and pushed back into the data centre. It can cost a fraction of an air-cooled HVAC system and works best in low-humidity climates.
  - Solar cooling converts heat from the sun into cooling that can be used in data centre air cooling systems. The system collects solar power and uses a thermally driven cooling

[25] "Information Batteries: Storing Opportunity Power with Speculative Execution", Jennifer Switzer and Barath Raghavan, 1st November 2021 referenced in "Time-shifted computing could slash data center energy costs by up to 30%", Ars Technica, 2nd August 2022 accessible at https://arstechnica.com/science/2022/02/time-shifted-computing-could-slash-data-center-energy-costs-by-up-to-30/

[26] "Distributed Resiliency Part One: Cloud Availability", Future-tech, 25th January 2018 accessible at https://www.future-tech.co.uk/distributed-resiliency-part-one-cloud-availability/

[27] "Data center cooling systems and technologies and how they work", by Julia Borgini of Spacebarpress Media, 3 May 2022 accessible at https://www.techtarget.com/searchdatacenter/tip/Data-center-cooling-systems-and-technologies-and-how-they-work

process to decrease the air temperature in a building. This is useful in areas with a lot of sunlight or data centres looking to supplement their current cooling with a more environmentally friendly method.

- KyotoCooling is an enhancement of the free cooling method that uses a thermal wheel to control hot and cold airflows across the data centre. Internal hot air is vented to the outside as the wheel rotates; the outside air then cools the wheel and the air that is drawn back into the facility. This technique is claimed to use between 75% to 92% less power to run than computer room air handing (CRAH) systems, reduces carbon dioxide emissions and eliminates the need for water in the cooling system.

Technologies are available which claim up-to 99% of heat recapture, and an example using modular immersion cooling pods is being trialled on a datacentre in Luleå, Sweden that will repurpose the heat for the local district heating in the area, complemented by renewable electricity to power the datacentre itself[28].

All the developments provide important improvements, although these tend to have a quantitative effect rather than a qualitative one. The basic requirements are expected to remain the same for years to come, and most of the gains in energy efficiencies in most cases will be used for expansion and additional equipment, effectively increasing the density of IT load rather than reducing local energy consumption.

Power Supply Elements

There are three categories of the source of power supplied to data centres:

1) **Grid supply:** Stable power is typically best sourced from the local or regional utility electricity operator where the data centre is located; these are usually connected through UPS systems that increase stability for very short interruptions and allow time for the start-up of back-up power systems.
2) **Alternative supply:** Typically, data centre operators are addressing decarbonisation of their power supply either through direct connection to renewable power sources such as wind or solar, or through the specification in their energy purchase contracts with energy supply companies of green energy sources, for instance through Corporate Power Purchase Agreements (CPPAs)[29].
3) **Back-up power:** Given the critical high-availability service requirements demanded by the market, data centre operators look to secondary back-up power provision under extended problems with grid supply stability or brown / blackouts. Typical back-up power is supplied by onsite oil or gas fired engines, such that a connection into a utility supply is an important consideration in the location of data centres. They are subject to minimal usage, thus they typically have minimal impact on the overall carbon footprint of the energy consumed by the data centre and the operator's environmental performance.

There are also considerations in the data centre market for the Alternative Supply and Back-up Power to be made available to provide services back into the energy utilities or local energy network, as a means of providing extra revenue and mitigating ecological criticism of data centre operations. This is problematic however, given the fundamental operating requirement to provide energy to the data centre at critical times could indeed compromise necessary and / or contractual provision through such secondary flexibility services arising at the same time.

[28] "Heat in your datacenter: How to transform your biggest loss into a gain", Submer, 16th March 2022 accessible at https://submer.com/blog/heat-re-use-in-datacenters-from-a-loss-to-a-gain/

[29] Irish Government is still developing the relevant policies around the purchase of renewable energy through supply contracts, see https://www.gov.ie/en/publication/a0d2e-renewable-electricity-corporate-power-purchase-agreements-roadmap/

Flexibility Services

Flexibility services are not very common in the data centre sector, even though there is significant potential for utilising infrastructure that in many cases is already present. Historically, data centre operators focused on increasing availability and making sure their operations were uninterrupted. Within electrical grids with significant use of thermal power plants, flexibility services were made available to data centres with relative ease and at low cost. In modern renewable-based grids, many of these services need to be provided by alternative assets, which can include equipment installed directly at data centre sites. An overview of the potential of flexibility services is presented in the table below.

	UPS	Time shifting	Location shifting	Back-up generation	Back-up battery
Deployment	Very common	Pilot projects	Applicable only for the biggest data centres	Very common	Rare
Capacity availability	Up to 100%	Up to 30 (Max. 50)%	Up to 30 (Max. 50)%	Up to 100%	Up to 100%
Operational timeframe	Minutes	Hours	Hours	Days	Hours (1-2-12)
Facilitating mechanism	Ancillary services (freq. reg.)	Energy/capacity market	Energy/capacity market	Energy/capacity market	Energy/capacity market and ancillary services
Other notes		Requires additional data processing prioritisation layer	Must operate across multiple locations	Limited availability of low-carbon fuels	Active participation in flexibility reduces resilience

Renewables Provision

The Sustainable Energy Authority Ireland (SEAI) notes that the EU's Renewable Energy Directive and subsequent policies promote the growth of renewable energy in Ireland, with mandatory targets and criteria to be met by Ireland in 2030 and the interim. The country achieved a renewable energy share (RES) of 13.5% in 2020 against a target for at least 16% of gross final energy consumption (GFC), so that Ireland was obligated to acquire statistical transfers of renewable energy from other EU Member States to compensate for the shortfall. The country's National Energy and Climate Plan (NECP) 2021 -2023 presents an overall RES target of 34.1% in 2030 against the REDII binding EU-wide target of 32%.

Ireland's Government has set the target to fully decarbonise the economy by 2050, which will necessitate a major shift towards clean, renewable energy plant which continues to present significant opportunities in the market. This is further driven by the target to achieve 70% of electricity from renewable energy sources by 2030, though only 13.5% was achieved according to the SEAI for 2020 against a target of 16%. Currently 90% of the total renewable energy generation coming from 4.3GW of installed wind energy in 2021. Solar PV deployment across the country may be considered to be lagging with 706MW grid connected by end-2019 and providing less than 1% of all renewable energy in Ireland.

The current options for data centres to include renewable energy in the supply mix may be considered as:

1. Direct connection into a renewable generation project, considering wind, solar or even nuclear generation; the decarbonisation benefit facilitated by considering data centre operation could also be improved through smart grid projects powered by renewables, but also offering to provide waste heat into such schemes;
2. Purchasing offsets through the data centre operator making payments into projects to match emissions; and / or
3. Contracting energy from renewables sources to match energy consumption through renewable sources elsewhere on the grid (or even abroad).

Microgrid

Microgrids are an established technology system that have been successfully deployed and operated within traditionally centralised power systems. In the electrical domain, they are defined within boundaries of connecting multiple loads, distributed energy resources (DERs) and storage, which are then integrated utilising a range of platforms implementing specific control capabilities. While the balance of driving factors and the details of a particular microgrid solution may differ from place to place, microgrids have emerged as a flexible architecture that can meet the wide-ranging needs of a wide variety of different applications. They have typically comprised local low-voltage and even medium-voltage distribution systems, with developments being to interconnect renewables and more complex resources such as buildings, heat systems and the mobility domain (e.g. Vehicle-to-Grid) in order to satisfy the demands of regionalised or localised energy consumers, as per **Figure 10**.

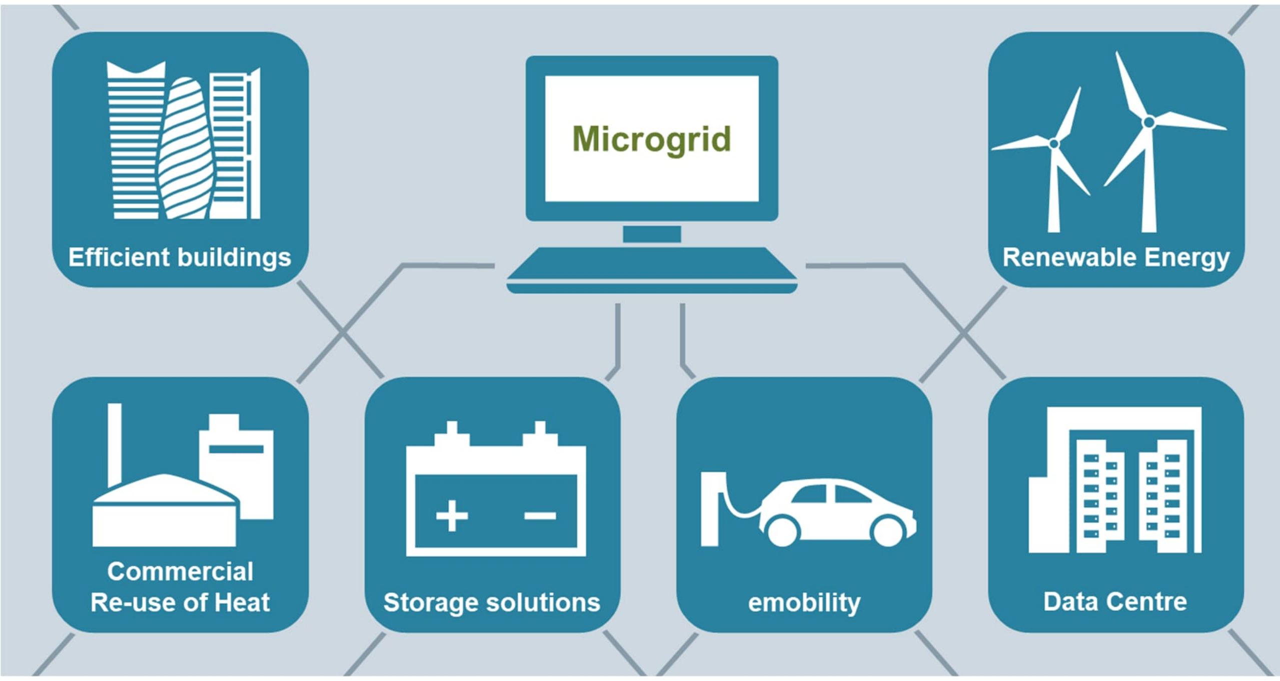

Figure 10: Disparate, Multi-Vector Resources can be connected as a Microgrid

Driven by utility restructuring, improved DER technologies and the economic risks that accompany the construction of massive generating facilities and transmission infrastructure, companies that generate electricity have been gradually shifting to smaller, decentralised units over time. This transition is driven by a range of DER benefits such as:

- deferral of investments in the utility networks;
- supply management (e.g. voltage control or VAR reactive power supply, power quality, etc.);
- the opportunity to obtain revenues by providing ancillary services;
- environmental emissions benefits;
- reduction in system losses;
- energy production savings;
- enhanced reliability; and
- wide application possibilities.

These benefits can also accrue to Data Centre developers working in combination with a microgrid developer / operator. From this, three fundamentals that define a microgrid can be seen to have emerged:

1. It is possible to identify the part of the system comprising a microgrid as distinct from the rest of the infrastructure, network or utility;
2. The resources connected to a microgrid are controlled in concert with each other rather than with distant resources; and
3. The microgrid can function regardless of whether it is connected to the larger grid or not, with such systems operated in a semi-autonomous way if interconnected to the grid, or in an autonomous way (islanding mode) if disconnected from the main grid.

Microgrids can incorporate multiple resources that can collectively be presented to the utility network as a typical customer or small generator or combination thereof, in order to remove perceived challenges to integrating new and large sources of demand like data centres, in part by offsetting these against local distributed resources. This 'Smart' approach can be termed Multi-Vector (power generation / demand, heat, electrical vehicle loads, etc.) and really is only realisable through the application of advanced ICT solutions that would be appealing to the forward-thinking data centre sector looking to innovative solutions for securing and managing load, while considering environmental savings. Such a development of a coordinating microgrid might also be seen as a further step toward a circular economy, so that energy is more efficiently utilised, waste / excess consumption is reduced or better managed, and greater transparency of the ecosystem across different energy types provides for better control with associated transfer of benefits to the participants.

Advanced microgrid systems can be used to balance power between a data centre and a local grid. Microgrid systems use weather and market forecasts to plan renewable generation and storage scheduling and can be linked in clusters to achieve synergies between locally operating assets. Worldwide, this technology started as a back-up control strategy for grids operating in small islands and other remote areas. It has increasingly been adopted within large power grids to optimise resource consumption and emissions on industrial and commercial campuses. Irish regulators and network operators have been slow to encourage and adopt the technology, instead requiring flexible generation assets to be controlled centrally by the entities responsible for wider grid stability.

According to discussions with the stakeholders, currently the Irish technical framework does not provide a clear path to establishing microgrids, but such networks do exist in other countries and technology to deliver solutions is mature. There are three main scenarios when considering microgrid operation and control:

- Owner / Operator is local System Operator
- Owner / Operator a private entity or entities
- Owner / Operated by a dedicated public body

A System Operator's primary objective is to provide a stable power supply in all connected areas. This makes them best suited for implementing advanced control strategies to address any shortcomings of existing infrastructure. At the same time, the egalitarian aspect of their objectives often cools down ambition to spearhead innovative projects in certain areas to avoid allegations of unequal treatment of areas under their care.

The application of microgrid technologies might be an attractive factor for the Midlands to bring data centres to operate in conjunction with other regional stakeholders. Presenting the challenges and requirement of interested industrial partners, combined with awareness of technical solutions options, can unlock processes within the organisation and enable the creation of a microgrid system integrating local renewables with new investor's demand. There are a number of key factors why a microgrid approach to the Rhode Green Energy Park may be particularly appealing to new data centre operators:

- Coordinating the energy supply and demand of the multiple coalescing and interested parties as potential development partners in the area, including the multiple renewable projects, existing and interested industrial and other offtaker partners;
- Better integration between the primary and back-up sources of power for the data centre in coordination with the power and gas utilities, providing greater confidence in meeting the stringent reliability figures; and
- Novel scheme applications can be attractive to grant and innovation funding being unlocked through enterprise in the Midlands area, helping to mitigate construction costs and operational risk.

Further information on application of Microgrid can be found in APPENDIX C.

Waste Heat Re-use by Data Centres

Recent findings by Siemens in collaboration with Grundfoss showed that data centre operators can promote new projects and offer long-term waste heat supplies to heat network operators, or other parties that may be interested in utilising waste heat (e.g., hospitals or university campuses, agriculture or aquiculture). Recent examples show a positive trend where data centres and District Heat Network (DHN) operators have agreed ten-year contracts, subject to certain exit clauses which deliver predictable economic and sustainable results for both parties.

Data centre operators can benefit from:

- Savings in operational costs of cooling systems. It is estimated that the savings accruing to a 10 MW data centre can exceed €1M annually, depending on the geographical location.
- Further savings in the CAPEX and OPEX of traditional cooling plants due to the heat network taking the base cooling load and reducing their need for heat rejection plant.
- Reusing heat from data centres is profitable even without subsidies, and will always provide a better result than heat pumps using ambient heat.

Due to lack of scale, DHNs are more common in areas with high population density. Data centres need cooling, and waste heat generated in the process can be used for space and hot water heating. Reusing waste heat provides savings in cooling energy consumption, and otherwise can be re-used for other purposes such as residential / commercial environment heating, leisure centres / swimming pools, manufacturing heat applications such as hydroponics and vertical farming. Achieving such developments would essentially form the building blocks for a circular economy around heat. This could provide an opportunity for stand-alone data centres to connect to third parties to supply waste heat.

Developing a heating network that utilises waste heat from data centres provides opportunities to decarbonise heating systems in the area. An example has been developed in South Dublin (Tallaght District Heating Scheme[30]), with further detail provided in Case Study #2 on page 37. DHNs are, in most cases, best suited to densely populated urban areas where there is an opportunity to maximise the number of

[30] Codema - Tallaght District Heating Scheme [link]

connections per unit of pipeline[31]. Although heat networks focus on the thermal energy aspect, most of the current developments operate under a gas-fired engine which generates both heat and electricity. This can be an opportunity to supply constant electricity to a major load point such as a data centre via a private wire. A lack of population density in the Midlands might render DHNs as challenging to deploy. However, having access to Just Transition Fund or other Irish Government and EU development funds which target energy transformation can significantly improve the economic viability of such developments.

Hydrogen and Data Centres

The utilisation of Hydrogen as an energy vector is receiving considerable international attention in its offering as a potential keystone in the large-scale decarbonisation of the energy sector. This is because hydrogen can be a clean alternative to carbon-based fossil fuels for utility energy provision, but could also fuel vehicles and heating, as well as convert industry consumption to lower-carbon emissions. In principle, hydrogen can be distributed and utilised in a lot of existing gas utility infrastructure. Many see that the acceleration towards green hydrogen supply from renewable sources as a positive means to address climate change, transforming society and providing significant economic opportunities if successfully adopted.

The Green Hydrogen market is extremely early stage, with projects driven by grant-funding and research interests as opposed to achieving successful commercial returns. The ultimate goal would be to deliver at a large scale, but this would need the utility of heat and hydrogen cleanly generated and economically delivered, coordinated through a market framework in which supplier and consumer are appropriately financially served.

Hydrogen production as of 2020 sees approximately 95% produced from fossil fuels by steam reforming of natural gas, partial oxidation of methane, and coal gasification ('Brown Hydrogen'). Other methods of hydrogen production include biomass gasification and electrolysis of water. The latter can be done directly with any source of electricity, such as from solar, wind or hydro power and is therefore significantly more sustainable and contributes to decarbonisation (and is often termed 'Green Hydrogen'). However, there are still significant barriers to achieving clean, widespread use of hydrogen, as identified by the International Energy Authority (2019)[32], and thus the drivers for use of green hydrogen converted to electricity for supply or backup data centres is still limited:

- Hydrogen is almost entirely supplied from natural gas and coal, with approximately 70 million tonnes produced annually for uses in oil refining, ammonia production and methanol. Thus the potential incentive of hydrogen as a clean fuel providing electricity supply to a data centre is not supported by the market, equipment or supply from the perspective of immaturity in the application.
- The development of hydrogen infrastructure is slow and holding back widespread adoption, which primarily arises from issues of the lack of coordinated market and the associated high prices. However, the established market for non-green hydrogen could facilitate trial implementations for data centres that could develop pathways to convert to green hydrogen.
- Producing hydrogen from low-carbon energy is costly at the moment, although IEA's analysis finds that the cost of producing hydrogen from renewable electricity could fall 30% by 2030. In circumstances where the superposition of a number of enabling factors arise with judicious location of data centre development, a level of early adoption of the bulk amounts of green hydrogen might become economic in the mid-term but would still be highly risky.
- Regulations currently limit the development of a clean hydrogen industry, with existing regulations and common international standards either acting as a barrier or being insufficiently developed to support the industry. The Irish Government is at an early stage of development for a hydrogen

[31] Codema – District Heating potential [link]
[32] "The Future of Hydrogen – Seizing today's opportunities", iea, June 2019 accessible at: https://www.iea.org/reports/the-future-of-hydrogen

strategy, with the Department of the Environment, Climate and Communications (DECC) still only recently indicating it is in the process of formulation of the policy with the formal commencement of a public consultation in July 2022.

It should be noted that at the end of July 2022, Bord na Móna submitted a planning application for a 2MW pilot-scale Hydrogen Electrolysis Plant within its existing Mountlucas Wind Farm, located some 10km from Rhode Green Energy Park[33]. At the indicated scale of production of green hydrogen, this would likely be insufficient for any data centre requirement except a basic level of backup provision.

Best Practice and Case Studies

Nordic countries are known for active industrial policies – they are also significant players in the data centre sector. Nordic countries have stable power grids, highly skilled workforce attributed to high quality schools and life-long upskilling programmes, developed district heating schemes, and competitive utility markets (including power, district heating, and networking) where third-party access in all infrastructure networks was introduced early on. Success has also been complemented by public bodies taking an active role through tax incentives, subsidies, investment and the promotion of public-private partnerships. The following table addresses the full range of success factors in attracting initial data centre developments and then build-out as a hub.

Country	Success factors	Flagship / Anchor Data Centre
Netherlands	Highest density of data centres in terms of per capita and per area Central location within Europe with good early connectivity Extensive network of connections between cities (and overall high density of population)	Hosts Google in Eemshaven, Hollands Kroon and further Data Centre planned in Hoogkerk Hosts Microsoft in Hollands Kroon Facebook data centre considered in Zeewolde (contested by local community and may be abandoned)
Sweden	Has long-standing know-how with early investment in data processing beginning in the 1960s	Hosts Facebook data centre in Lulea
Denmark	Well connected with undersea cables Wind power pioneer	Hosts Facebook in Odense Hosts Google in Fredericia Hosts Apple in Viborg (though development of a second location has been halted)
Finland	Introduced dedicated energy tariffs for data centres above 5MW Subsidised fibre connections in remote areas	Hosts Google since 2011 in Hamina
Norway	Abundant hydropower – green and low cost "Norway as a Data Centre Nation" 2018 strategy Innovative waste heat re-use in aquaculture	

[33] "Bord na Mona submits proposal for Offaly pilot hydrogen plant2, Arnes Biogradlija in Energy News, 22nd August 2022 accessible at: https://energynews.biz/bord-na-mona-submits-proposal-for-offaly-pilot-hydrogen-plant/

Case Study #1: Renewable energy supply to data centre

The local authority of Saucats near Bordeaux, France invited Engie to undertake a novel development of a data centre to be integrated with a 1GW solar photovoltaic farm, hydrogen electrolysers and batteries. The 20 MW data centre is expected to occasionally use some electricity from the grid, even though it is designed with battery and hydrogen storage (the latter supplied by the electrolysers). The design also incorporates re-use of waste heat for local agriculture. It is one of the most ambitious projects showing a real-life integration, transitioning away from the current common practice. It is part of a research project called Horizeo, managed by Engie and NEOEN (who is also an investor in Offaly's Garr PV project). Further detail on the scheme is provided in promotional material as per **Figure 11**, below.

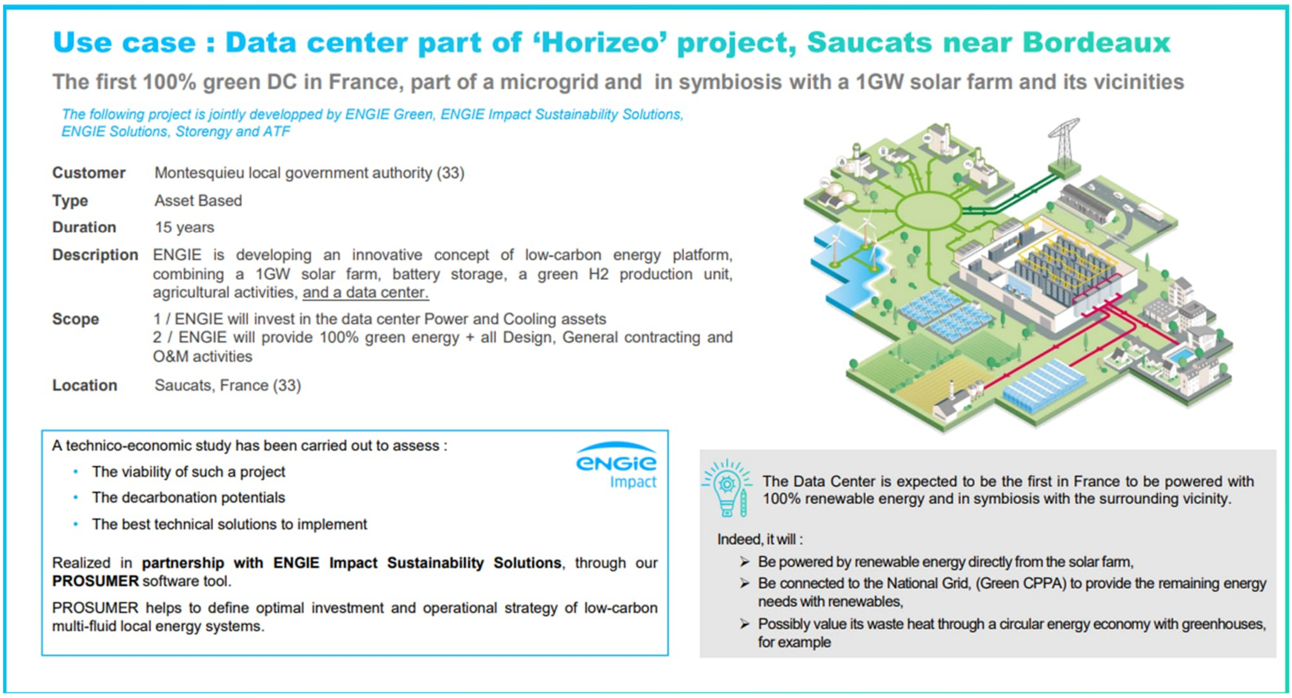

Figure 11: Data centre case study

Case Study #2: District Heating from Data Centres in South Dublin

An emerging trend in energy efficient data centre operation is waste heat re-use, which could be utilised for agricultural or district heating purposes. One of the largest and most ambitious projects in waste heat re-use is happening in Dublin, where a new district heating network was designed to get most of its heat from heat pumps using waste heat. Low-grade heat is planned to come from data centres (approximately 200MW of heat capacity), together with other industrial waste heat and re-used heat from transformer substations (20 and 1.2MW)[34]. The scheme is shown in **Figure 12**.

[34] "Transition Roadmap for Developing District Heating in South Dublin", Codema, May 2019 accessible at https://www.nweurope.eu/projects/project-search/heatnet-transition-strategies-for-delivering-low-carbon-district-heat/library/transition-roadmap-for-developing-district-heating-in-south-dublin

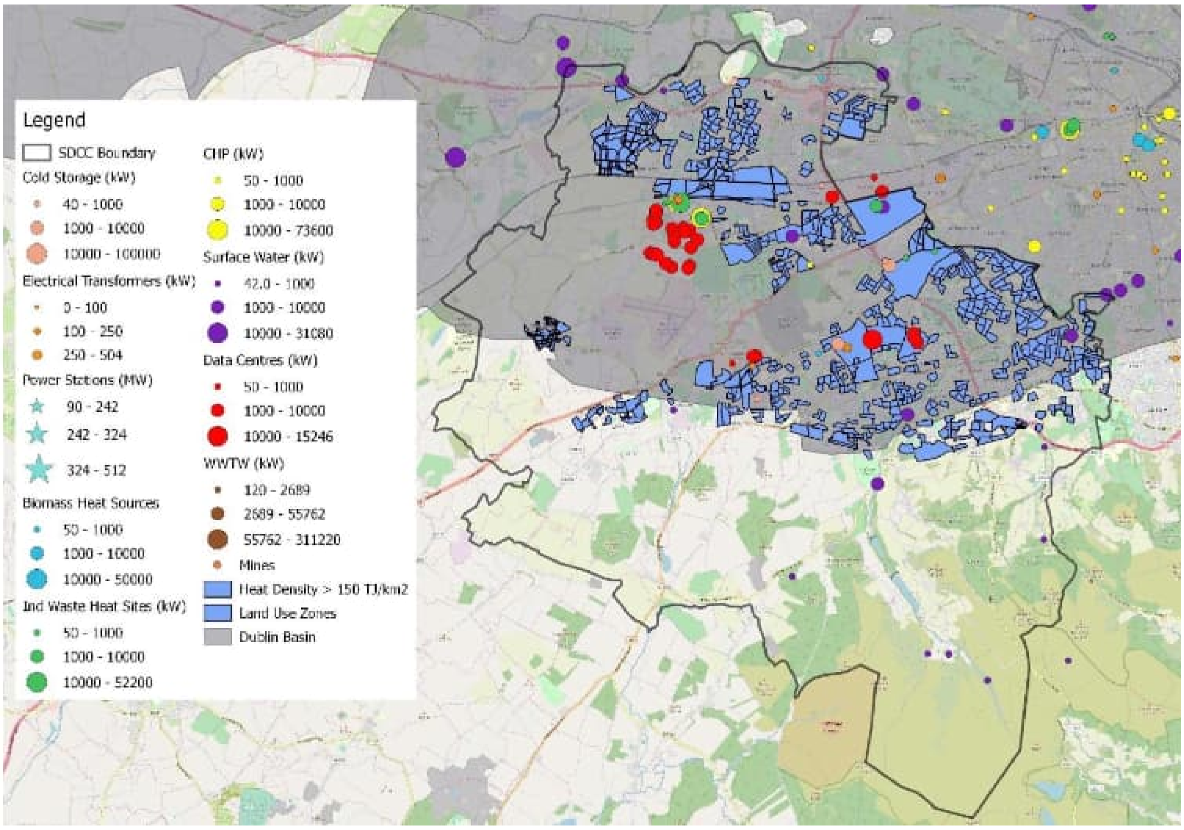

Figure 12: Map of district heating scheme in Dublin - red dots represent data centres

Case Study #3: Data Centre heat supply for industrial applications

A collaborative project between Swedish EcoDataCenter and circular industry player WA3RM will focus on sharing excess heat to enable food production through large-scale cultivation, though only limited details have been shared at this time. The partners argue that such current projects are usually on a small scale, and want to set standards for industrial-scale vegetable and fish farming. The concept for the scheme is shown in **Figure 13**.

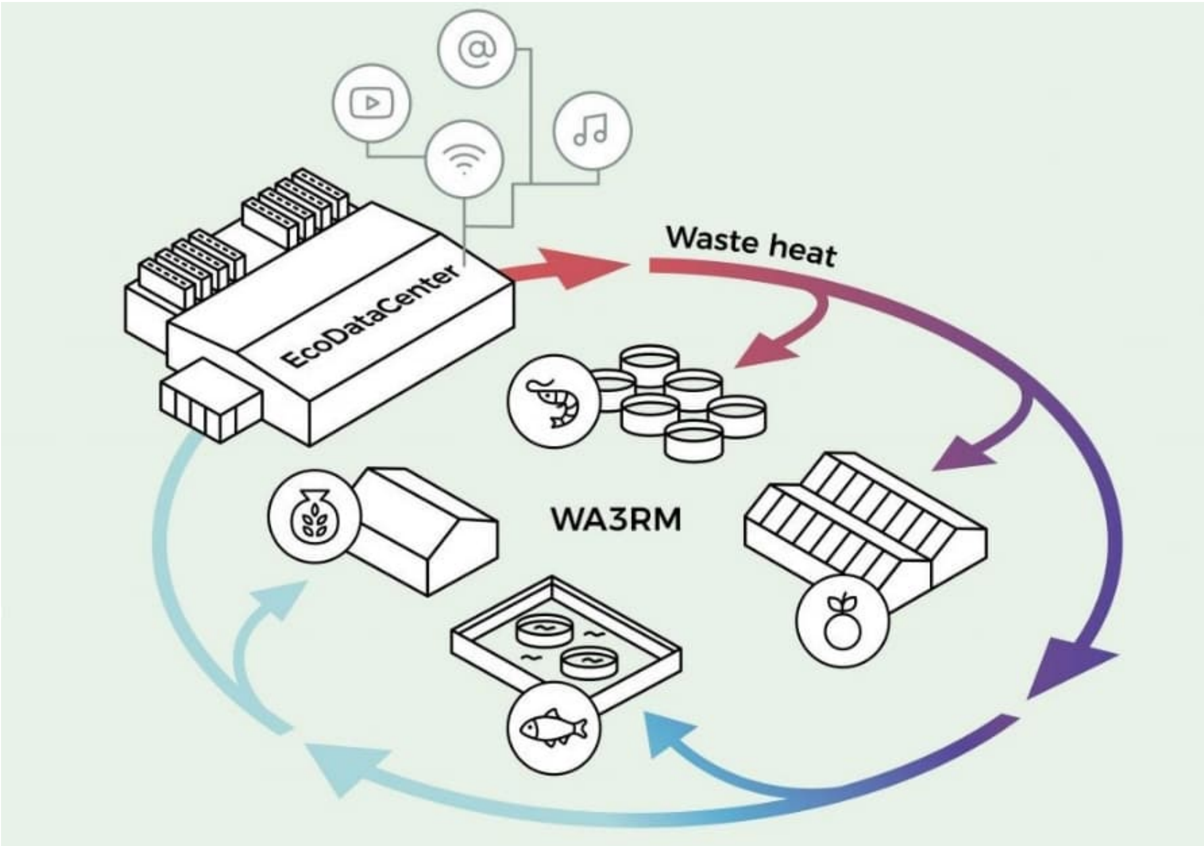

Figure 13: EcoDataCenter and WA3RM projected circular heat usage[35]

Heat reuse for food production is not a new concept. Several examples are listed below:

- Scheduled for operation in 2023, Hima Seafood is building the world's biggest land-based trout farm less than a kilometre from Green Mountain's data centre in Norway and will use the excess heat.
- TeleCity developed a scheme in Paris in 2010.
- Crypto provider UnitedCorp proposed greenhouses for a dome-shaped facility in Quebec in 2019.
- Digital Crossroad in Indiana has a data centre that includes a test centre for agricultural robots[36].

Phase 2 Analysis

The data centre sector in Ireland is now required to move operations outside of a constrained Dublin region, which as of 2022 is home to 99% of Ireland's data centres. Data centres consume more than 14% of electricity in Ireland, and increasing constraints on the network risk utilising emergency back-up systems more frequently, which will mean increased use of the fossil fuels that have traditionally been used to power them. This might drive an increase in the carbon footprint of data centres, given that minimisation has been a key area of concern for most developers and operators under pressure from the market and politicians. No single technology can currently substitute back-up systems that are required to operate continuously for 3-4 days, and possibly longer. A mix of technologies that include low-carbon renewable generation, batteries

[35] Diagram reproduced from https://www.datacenterdynamics.com/en/news/ecodatacenter-to-reuse-heat-in-fish-farms-and-greenhouses/

[36] Examples from https://www.hortidaily.com/article/9467759/ecodatacenter-to-reuse-heat-in-fish-farms-and-greenhouses/

and classic systems, and integrated by microgrid systems, could potentially help maintain grid stability while keeping emissions low, however that is not recognised in current policies.

In summary:

1. **Data centre demands for high-reliability and large power volumes do not accord with supply by renewables alone**, as the intermittency of large-scale wind or solar farms does not provide sufficient energy at periods of low generation. Thus, directly connected renewables can never be the prime power supply to a data centre without either significant reliance on utility energy supply and / or some means of storage to maintain uptime / redundancy.

2. **Hydrogen as an energy source is not yet a relevant economic opportunity for data centres** given the immaturity of the green hydrogen market and limited supply. Opportunities may arise for early-stage technical feasibility demonstrations supported by research objectives and grant funding, but this will not unlock mainstream application in the short-term or medium-term.

3. By comparison, **the market and political drive to decarbonise data centre operations will more readily unlock opportunities to utilise waste heat through District Heat Networks or other nearby consumption** such as residential / commercial environment heating, leisure centres / swimming pools, manufacturing heat applications such as hydroponics and vertical farming. This will be a factor in the consideration of operators in their deployment of new infrastructure, particularly where the stacking of benefits through integration into a microgrid with renewables might unlock complex coordinated projects that might be considered for the Midlands and Rhode Green Energy Park.

Phase 3: Action Plan to bring Data Centres to the Midlands

Case Study: What is required to secure an 'anchor' data centre developer for Rhode?

Based on the first two phases of the project, the Market Research and Technical Review, recommendations for the necessary activities to attract a data centre deployment at Rhode Green Energy Park, Offaly and more generally for the Midlands are presented. This section provides an overview of the challenges to attract data centre development and how these challenges can be overcome by presenting the key actions needed to be undertaken. In addition, an Action Plan for attracting and benefitting from the high-value data centre sector to the Rhode Green Energy Park and Midlands region is provided, clearly indicating the necessary stepwise progression and timescales to achieve the desired outcome. There is no one likely successful routemap, so a number of options including microgrids and heat networks are presented that will encourage data centres through drivers such as the energy decarbonisation transition and regional innovation digital / industrial sector growth. The step-wise progression offers 'no regrets' in providing the necessary basis for a wide variety of facets of local economic development, with benefits and stimulation to other commercial sectors, not just data centres.

In consideration of the findings from the previous Phases, the sequential priorities for data centre operators in selecting a location to develop a new data centre are as follows:

- Develop and reinforce telecoms provision
- Security of electricity supply
- Provision of alternative supply and backup
- Creation of Unique Selling Point(s) to create interest in a data centre development

Develop and Reinforce Telecoms Provision

Rhode Green Energy Park and the Midlands have only limited links to dark fibre networks. Data centre tenants often require access to multiple networks that offer full separation and guaranteed low latency connections to other data centres. It should be mentioned that it is not necessary for all infrastructure to be installed at the same time or within the timeframe of a single development. As an example, when a trench is being excavated for fibre lines to be installed underground, allowances could be made to consider later installation of gas pipework and/or underground electrical cables at a later date. Although this does not save re-excavation costs when the additional infrastructure is to be installed, it solves spacing issues, permitting processes and ensures that wider areas can benefit from the enabling infrastructure. A parallel example might be to consider the feasibility of extending into the Midlands the T-50 Telecoms Network that bounds Dublin, as this could provide an opportunity for connecting data centres using technology already adopted in the market.

Security of Electricity Supply

Local electricity consumption in Offaly has been relatively steady since 2015, varying between 281GWh/a and 306GWh/a, and corresponding to average load of approximately 35MW - equivalent to one large or a few big data centres, but less than one hyperscale data centre. Demand is expected to grow due to electrification of heating and transport.

There is currently a margin of renewable electricity generation in Offaly, even when considering only operational sources and is similar to the current total demand in Offaly (30-40MW) as can be seen in left hand side of **Figure 14**.

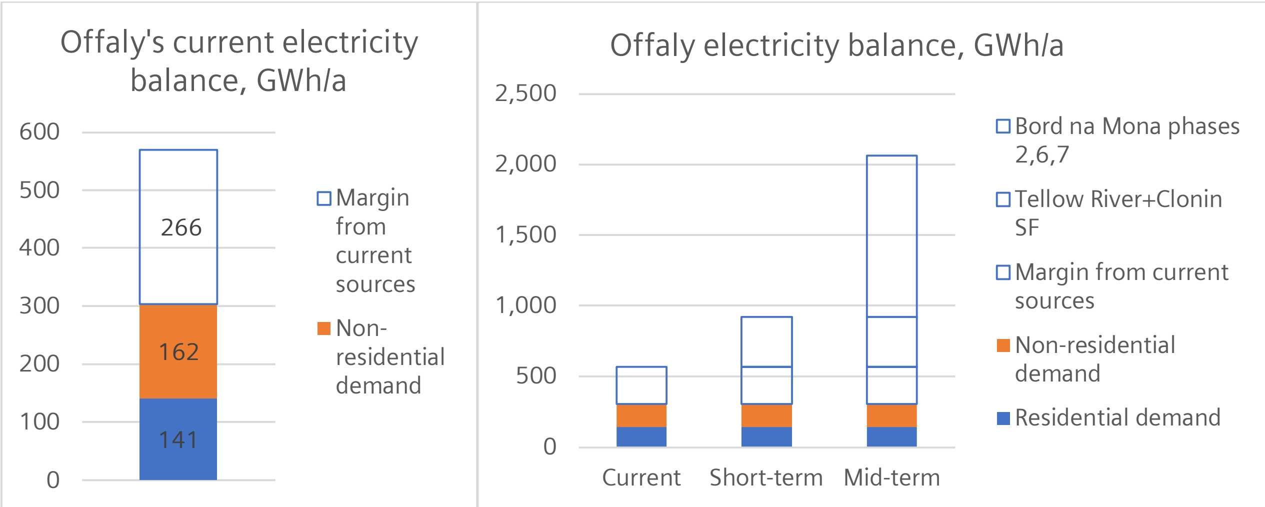

Figure 14: Charts showing annual energy surplus in the area

Offaly renewable energy projects provide local electricity supply that exceeds local energy demand, and the energy surplus is forecasted to grow in future. However, there are factors that may limit the development of data centres in Offaly County, such as the current Derryiron substation has a total capacity of a hyperscale data centre. Smaller data centres may be accommodated but creating a cluster or attracting the largest users would require an upgrade of the electrical infrastructure.

Provision of alternative supply and backup

Gas Network Infrastructure

Data centres require dependable back-up power, typically utilising local gas-fired engines that will fully support operations under sustained grid blackout, supported by appropriate equipment to facilitate a seamless switchover from the electricity utility: a 2020 survey of the sector presented data which shows that outages are becoming increasingly expensive events for firms to overcome, with one in six operators claiming their outage had cost them more than $1M[37]. The use of fossil fuels in back-up systems has not, so far, been viewed as a sustainability problem (including oil-fired generation more typically found in US and Asia data centre markets).

Although gas is an important aspect of back-up power, the aim of this report is to investigate integration of renewables with data centres to drive forward a transition to sustainable development and operation of data centres. Therefore, this section is examining the options of microgrids and heat networks that Offaly County Council should consider for the Midlands. As mentioned earlier in the report, despite the fact that there is currently not widely spread gas infrastructure in Offaly, with the nearest gas transmission line approximately 12km north of Rhode, there is potential to gradually bring the gas capacity within the county. As previously mentioned, a gas connection to the Derrygreenagh CCGT power plant would be a good first step that should

[37] "Costs incurred by 'major' datacentre outages continue to rise, Uptime Institute research shows", computerweekly.com, 30 July 2020 accessible at https://journal.uptimeinstitute.com/uptime-institute-10th-annual-data-center

be investigated, with a later connection at the Rhode Green Energy Park that further establishes gas infrastructure in the area.

Renewables Developments

Co-location of energy generation projects with data centres are among the Irish Government priorities and are presented earlier in the report. As can be seen below, the Rhode Green Energy Park and the Midlands are already well positioned to drive this forward with numerous renewable and non-renewable developments underway. Offaly and neighbouring counties are considered electrically adjacent to the Dublin region, which does introduce some limits on the availability of new grid connections. At the same time, the physical proximity to Dublin enables relatively good connectivity potential and an opportunity to borrow from the existing talent pool. The Midlands has traditionally also been the backbone of power generation and energy generation, which remains an important sector in Offaly through the energy transition, with multiple renewable projects planned, developed and already operational.

Exemplar active renewable projects from Offaly County are presented in the table below:

Project	Technology	Capacity, MW
Current (Rhode Green Energy Park):		
Phase 1: Mt Lucas	Wind	160
Biomass Gasification Plant	Biomass	10
Lumcloon BESS	Storage	100
Shannonbridge A	Storage	100
Advanced (RESS auctions won):		
Clonin North Solar Farm	PV	35
Yellow River Windfarm	Wind	100
Planned (Bord na Mona, SSE, Lumcloon):		
Phase 2: Edenderry PP	Biomass	120
Phase 6: Derrygreenagh	Wind	200
Phase 7: Ballydermont (partially in Offaly)	Wind	300
Garr Neoen	PV and Storage	85 + 50
Shannonbridge and Lumcloon expansions	Storage	163

Non-renewable projects:

Project	Technology	Capacity, MW
Rhode:		
SSE thermal peaking plant at Rhode	OCGT	104
Edennderry PP (to be converted to biomass)	Peat	120

Phase 3: Action Plan

Project	Technology	Capacity, MW
Bord na Móna:		
Derrygreenagh planned PP	CCGT	480
Derrygreenagh planned PP	OCGT	120
Lumcloon:		
Castlelost (in Westmeath, bordering Offaly)	OCGT	275

Microgrids

To avoid limitations regarding new grid connections, there is a range of routes that can be followed over the medium to long term. Currently, the System Operators are responsible for securing grid stability across the entirety of the Republic of Ireland, and they have the final decision on implementing regulations to meet relevant targets. Working together with the System Operators is, in most cases, the easiest way forward for new investment. In some cases, where the utility operators are focusing on priorities that are not aligned with the investment envisioned or prove to have limited resources, it is possible to establish an independent Distribution Network Operator (i-DNO) – a partially independent electrical network that can manage its load regardless of limitations of the larger, national grid. Microgrid technology allows load balancing and generation, which cooperates with the main grid.

Attracting power storage facilities should increase grid stability and reduce pressure on data centres to use their back-up equipment to stabilise the grid and incurring additional carbon emissions that adversely impact an operator's green KPIs. Further, the Midlands and Offaly (especially Shannonbridge) have been identified as areas with high potential for power storage in a study commissioned by Wind Energy IE[38]. A possible innovation scheme to consider would look towards the development of a 100% renewable microgrid that could provide power to newly established investors, underpinned by an arms-length i-DNO to protect investors.

Action Plan

Next Steps

The situation of new data centres in Ireland is dynamic and complex. The development of new investment is already moving outside of the Dublin region, due to electric grid limitations. The Rhode Green Energy Park and the Midlands region are in a strong position to accommodate the data centre market thanks to:

- Existing and planned renewable energy sources for a shared application risk, perhaps under a Microgrid application.
- High voltage (400 kV) transmission lines nearby – the only two 400 kV lines in Ireland, for primary power connection; plus gas utility connection nearby for back-up requirements.
- Availability of significant parcels of suitable land for development and future expansion lock-in, with favourable local planning and enterprise regimes / investment.
- Proximity to existing data centre market, suppliers and relevant personnel in Dublin.
- Climate conditions and small risk of heat waves.

[38] "Bridging the Gap – Towards a zero-carbon power grid", Wind Energy Ireland / Baringa / tnei, July 2022 accessible at https://windenergyireland.com/images/files/bridging-the-gap-a4-report-final.pdf

At the same time, there are factors working against the Midlands area:

- Electrical adjacency to Dublin – one of the objectives of moving demand outside of Dublin is to limit loading of transmission lines coming from the west, which may not be achieved if there is not enough stable generation inbetween Midlands and Dublin.
- Limited fibre network infrastructure and connectivity into the gas utility network will require investment.
- Local workforce has limited experience with the data centre sector and the resources with appropriate skill levels may be fewer in number due to low population density in the region.

A high-level action plan is presented in **Figure 15**.

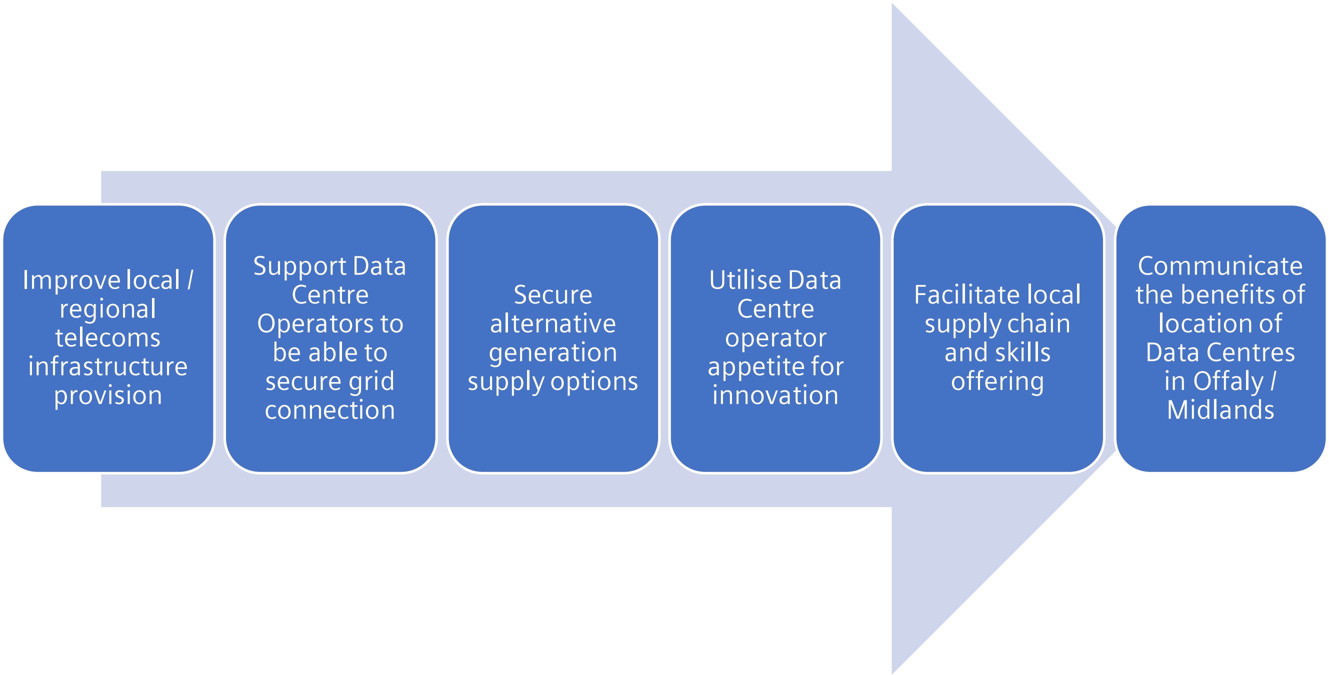

Figure 15: High-level action plan

Additional details on each of the steps to implement the action plan are below:

Opportunities / Challenges and Key Actions

In considering the findings from the previous Phases, the following table presents the key actions required to be taken forward as well as considerations and restrictions on attracting and creating a data centre market at Rhode Green Energy Park and the Midlands.

Key Activity	Opportunity / Challenge	Actions for Offaly County Council (OCC)
Develop and Reinforce Telecoms Provision (for detail on the requirements, see page 41)	Improvement of local and regional telecoms infrastructure provision to meet requirements of data centre developers	1. OCC to engage with eir (the Irish telecommunications operator) and other fixed-wire telecoms providers to promote Offaly / Midlands data centre interests in development of fibre-optic network infrastructure. 2. OCC to examine council activities, policies and procedures to ensure alignment for facilitating development of local telecoms infrastructure (e.g. Local Plan, Economic Development, etc.)

Key Activity	Opportunity / Challenge	Actions for Offaly County Council (OCC)
		3. OCC to conduct feasibility and technical study to examine extending key broadband infrastructure to key potential data centre locations.
Security of Electricity Supply (for detail on the requirements, see page 41)	Supporting data centre operators to meet the CRU / EirGrid criteria for securing grid connection in Offaly and Midlands region: 1. Regional constraints 2. Dispatchable generation / storage 3. Flexibility of generation 4. Flexibility of demand	4. OCC to engage with EirGrid and ESB Networks to publish regional constraint information for consideration in data centre applications. 5. OCC to continue / extend engagement with renewables and storage investors to promote developments in Offaly and Midlands region. 6. OCC to maintain register of utility infrastructure information, renewables and storage developments in Offaly and Midlands region for provision to appropriate interested parties.
Provision of alternative supply and backup (for detail on the requirements, see page 42)	Securing alternative generation supply options for data centre operators in Offaly and Midlands region, considering local provision of: • Gas network infrastructure • Renewables developments • Microgrid connectivity	7. As per Action 2, but extended to consider council activities aligned to facilitating development of local power / utility infrastructure and renewables connectivity (e.g., Local Plan, Economic Development, energy / decarbonisation / climate change strategy etc.) 8. OCC to engage with Bord na Móna to promote Offaly / Midlands data centre interests in development of gas network infrastructure. Consider feasibility and technical study to examine extending a Gas Transmission spur to serve the R400 corridor and enabling infrastructure. 9. OCC to investigate and publish grant funding and subsidy regimes that can be made available to local renewables developments / connectivity. 10. OCC to engage EirGrid, ESB and energy developers to promote microgrid adoption, policy development and project initiatives as relevant to Offaly and the Midlands deployment.
Creation of Unique Selling Points to create interest in data centre development	Utilise data centre operator appetite for innovation to attract novel data centre deployments considering: • Waste heat recovery • Green hydrogen • Biomethane • Innovative storage / power concepts already permitted for Rhode Green Energy Park	11. As per Action 6 and Action 9, but extended with specific reference to energy efficiency initiatives, waste heat reduction / management / re-use, and green hydrogen scheme (supply and consumption). Note that national and international calls relating to industry may also be applicable to data centre applications. 12. OCC to engage and broker meetings between owners of operational assets (such as large energy users) and early-stage development projects to create opportunities for relationships based-on take-off of energy or otherwise shared

Phase 3: Action Plan

Key Activity	Opportunity / Challenge	Actions for Offaly County Council (OCC)
		resources (e.g. co-location, virtual / physical PPAs, collaborative innovation investment, etc.)
Creation of Unique Selling Points to create interest in data centre development (continued)	Facilitate the local supply chain and skills offering for alignment to data centre construction and operation in Offaly / Midlands	13. OCC to engage with education and training organisations such as: ○ Technological University of the Shannon: Midlands Midwest (TUS) ○ Maynooth University ○ UCD Energy Institute to find ways to develop and promote local skills and training provision for data centre deployment. 14. As per Action 12, but identify and engage with local supply chain and representative organisations (including those in Dublin but with potential outreach to Offaly / Midlands) to develop and promote supply chain offerings for data centre deployment. 15. As per Action 7, but extended to consider council activities aligned to supply chain development and local education / skills.
	Articulate a clear differentiated identity for Offaly as a leader in renewables and green technology; build-on communications regarding history in energy projects, extensive development land assets and favourable planning policies supporting same	14. OCC to commission a data centre portfolio or prospectus to present the opportunities, benefits and facilitated activities offered for development in Rhode Green Energy Park, Offaly and the Midlands. 15. OCC to focus on encouraging small to medium data centres (5MW – 20MW) to locate/establish themselves in the area as current infrastructure may sufficiently support limited capacity in the short- to medium-term. 16. OCC to consider establishing Rhode Green Energy Park as a Strategic Development Zone (SDZ) or utilise other regulatory exemptions to create favourable planning backdrop to incentivise energy enterprise developments.

Timescales

Figure 16 illustrates the aforementioned areas of focus and endeavours to provide a high-level timeline for completing the action plan. The first two steps of the action plan are assumed to take place in the short-term future and are essential to establish the interest of early investors. This is crucial, as early investors and initial infrastructure that comes with that will set the basis for continued investment over the medium term, leading to the creation and operation of a comprehensive market for the Rhode Green Energy Park and the Midlands in the longer term. This is complemented by the latest Government Statement on the Role of Data Centres in

Ireland's Enterprise Strategy[39]: *"Outside of Dublin, there may also be opportunities to develop additional grid capacity where private investment can co-deliver grid connection, electricity generation and demand opportunities, perhaps alongside fibre optics / telecoms infrastructure, in strategically and environmentally suitable locations close to significant national infrastructure"*

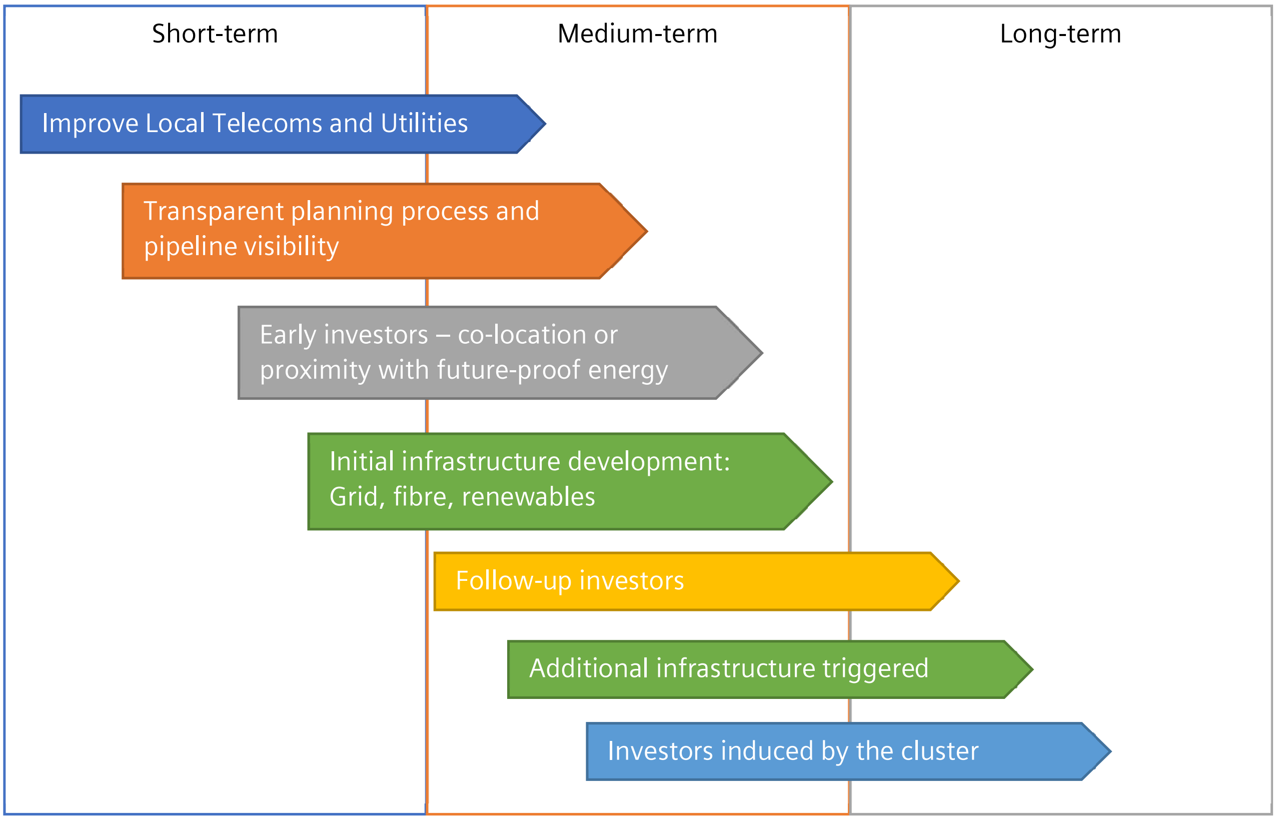

Figure 16: Short, medium and long-term areas of focus as per the action plan

[39] Government of Ireland, July 2022. Government Statement on the Role of Data Centres in Ireland's Enterprise Strategy.

Phase 3 Conclusion

The global economy is a complex network of interconnections. Attracting high-value services into a specific region requires flexibility and responsiveness to the needs of investors. Rhode Green Energy Park and the Midlands region can provide a compelling offer to the data centre sector, with green power infrastructure, a proven history of energy management and proximity to the Greater Dublin area. Integrating renewables with the new demand can be achieved with or without active participation of the local System Operator, using advanced microgrid technologies.

Overall, there are multiple attractive economic factors associated with data centre developments, and so as the market seeks to expand outside of Dublin to adjacent regions, there is considered to be a positive opportunity for the Midlands on the basis of:

- As increasing societal and governmental pressure requires the sector to improve environmental performance, **the region offers significant existing and planned renewable energy sources** for connectivity as dispatchable low-carbon generation which would not usually be available to data centres in a city location;
- **High voltage (400 kV) transmission lines and a natural gas transmission network**, which is necessary to provide data centres with highly secure and reliable energy infrastructure to maintain industry uptime metrics;
- **Extensive land-bank availability under direct local control** so that co-location, future expansion and conglomeration that builds the sector are relatively unconstrained, supported by favourable local planning conditions underpinned by a regional focus on cross-sector collaborative investment, economic development and funded innovation;
- **Superior climate conditions** with moderate weather systems and low temperature range, which reduces high operational costs associated with cooling and reduces risks associated with catastrophic geological and climatic events; and
- **Proximity to existing Irish markets** makes it possible for existing specialised, skilled staff to work at new sites with minimum relocation, while benefitting from improvements in quality of life away from urban centres.

At the same time there are factors working against the Midlands area:

- Electrical adjacency to Dublin – one of the objectives of moving demand outside of Dublin is to limit loading of transmission lines coming from the west, which may not be achieved if there is not enough stable generation inbetween Midlands and Dublin.
- Limited fibre network infrastructure and connectivity into the gas utility network will require investment.
- Local workforce has limited experience with the data centre sector and the resources with appropriate skill levels may be fewer in number due to low population density in the region.

Although the infrastructure challenges as elaborated within this report are in some cases quite significant, a project-by-project approach is emphasised here. The actions within the report are in line with the Government's Principles for Sustainable Data Centre Development. However, it should be noted that this is an initial high-level action plan and more in-depth master-planning and analysis is recommended to examine options in more detail.

The findings of this report are in line with the Irish Government guidance[40] which clearly state that co-location of data centres with different infrastructure developments is the way forward:

- ***"…data centres in regional locations could be located near to renewable generation to reduce their burden on the grid and ensure that they consume renewable energy when available"***
- ***"…a preference for data centre developments in locations where there is the potential to co-locate a renewable generation facility or advanced storage with the data centre, supported by a Corporate Power Purchase Agreements, private wire or other arrangement"***
- ***"…the availability of high-capacity transmission system infrastructure, renewable energy generation and existing gas grid in parts of the Midlands may make the region suitable for 'energy park' type developments."***

[40] "Government Statement on the Role of Data Centres in Ireland's Enterprise Strategy", Government of Ireland, July 2022 accessible at https://enterprise.gov.ie/en/publications/publication-files/government-statement-on-the-role-of-data-centres-in-irelands-enterprise-strategy.pdf

APPENDIX A

Survey

The team prepared a short survey for the data centre sector to quantify the trends on the Irish market. It contained 10 questions, seeking participant's preferences and experience.

The questions asked[41]:

- What would be your ranking of factors influencing location choice for a new data centre?
- How do you rank Irish regions in terms of overall attractiveness for new data centre location?
  - We received too little responses to the survey to analyse it in a meaningful way
- What support from the local authorities would have significant impact on your location decisions? Help with the last-mile infrastructure? Planning process hand-holding? Coordination and clustering of like-minded investors?
- How does the decision of CRU (CRU/21/124) on requirements for new data centre connection affect your investment plans?
  - the decision effectively puts forward a requirement that new data centre grid connections shall provide flexibility of demand and ability to export energy to the grid when needed)
- What technologies/concepts do you have experience with?
  - Exporting power to the grid? Providing system services to the grid (e.g. freq. regulation)?
  - Demand response? Batteries (30+minutes, not UPS)?
  - Renewable fuels for classic back-up systems? Microgrids?
- What is your preferred technology for back-up systems? (ranked from most to least preferred)
- What type of organisation do you represent?
- How big is your organisation's operations in Ireland?
  - As a proxy for the size, provide the number of data centre projects in the pipeline (currently operational + planned)

[41] Full survey online [link]

APPENDIX B

Qualitative data centre comparison – methodology

Criteria	Assessment	Source
Power availability	SAIDI WB	https://govdata360.worldbank.org/indicators/h2d96dbda?country=IRL&indicator=42570&countries=DEU,DNK,GBR,NOR,SWE,FRA,NLD&viz=line_chart&years=2014,2019
Network infrastructure	IXPs	https://www.internetexchangemap.com/#/
Skilled workforce	GCI 4.0: Pillar 6: Skills, Rank	https://govdata360.worldbank.org/indicators/h2c1f4c1d?country=IRL&indicator=41538&countries=GBR,FRA,DEU,NLD&viz=line_chart&years=2017,2019
Green energy PPA opportunities	RES-E	https://ec.europa.eu/eurostat/web/energy/data/shares
Lack of natural disasters	World Risk Index,	https://en.wikipedia.org/wiki/List_of_countries_by_natural_disaster_risk
Climate conditions	avg summer tempreature in the capital, deg C	wikipedia
Investment incentives	Foreign direct investment, net inflows, % of GDP, three-year average	https://tcdata360.worldbank.org/indicators/h74138810?country=IRL&indicator=40540&viz=line_chart&years=2013,2015
Law enforcement	Rule of law	https://tcdata360.worldbank.org/indicators/hf5cdd4dc?country=BRA&indicator=370&viz=line_chart&years=1996,2020
Tax structure	Paying taxes: Profit tax, % of profit	https://tcdata360.worldbank.org/indicators/ha38aa5d6?country=BRA&indicator=438&viz=line_chart&years=2005,2019
Logistics & accessibility	Transport infrastructure	https://tcdata360.worldbank.org/indicators/trade.fac.infr?country=IRL&indicator=331&countries=NLD,GBR,SWE&viz=line_chart&years=2007,2018
Local supplier markets	DCs per capita	https://datacentercatalog.com/
Local clients base	Total GDP	wikipedia
Low cost of energy	Cost for industries	DDA - State of the Dutch Data Centers 2020.pdf
Land and construction costs	Agricultural land price	https://ec.europa.eu/eurostat/en/web/products-eurostat-news/-/ddn-20211130-2

APPENDIX C

Independent private DNO

Microgrid and smart infrastructure is a mature technology offering standardised interoperability options. In theory, a microgrid or an independent distribution network can be created by a third-party contractor. There is a proven business model of i-DNOs operating in limited areas and providing energy supply of high standard for limited fees, independently to the designated DNO in the area.

Private investment can come directly from the future operator of the network, or from grants and loans. Typically, operators undertaking such a task would have experience in the utilities business and can share some required resources and know-how with other regions, even if the local network is delivered through a dedicated entity (Special Purpose Vehicle - SPV)

Independent public DNO

Privately owned investors are often highly risk averse and expect that much of the operational risk is managed externally by the public partner, while often enabling investors to benefit from a wide range of opportunities. To avoid disproportional risk attribution, local authorities can create a public entity or a public-private joint venture to deliver a specific task of supplying essential services to the community.

Direct involvement of public authorities in a project can secure local interests but might encounter a steep learning curve if there is limited experience and know-how available in the local market. Know-how could be brought to the project through consulting services or a joint-venture partner.

Regulatory options of microgrids

Regulatory frameworks for microgrids cooperating with larger grids is limited. Globally, there are examples of microgrid deployments with[42] and without[43] formal regulatory permit. The argument for resistance coming from the DNOs is that the microgrid objectives duplicate functionality of a DNO in a sense that it provides balancing of power and stability of supply. As such, the objectives have established and regulated ways of operation and introduction of areas following different rules can be challenged by regulatory bodies, clients with and without opportunity to join.

Analysis provided by Smart Electric Power Alliance (SEPA) provides the following guidance to enable utilities participation in local microgrid projects[44]:

1. Customers served by third-party owned microgrids are granted the same quality of service and rights as non-participating utility customers.
2. Microgrid developments should increase electric reliability and security, while not negatively impacting non-participating customers.
3. Rate recovery of utility-owned microgrid assets relies on an evaluation of how the microgrid benefits non-participating customers.

The above SEPA document also provides a classification of microgrids that differentiates the levels of regulatory scrutiny associated with them[44]:

[42] Gtm – Shared Utility-Customer Microgrid [link]
[43] Utility Drive – Baltimore Microgrid proposal rejection [link]
[44] SEPA – The Role of Microgrids in the Regulatory Compact [link]

1. A single customer microgrid is located behind-the-meter or point of common coupling that serves one customer or building's load and acts as a single controllable entity. Generally speaking, these customers are considering a microgrid for reliability or resilience reasons because they are in an area with reliability issues or at the end of a radial feeder where added resilience capability is beneficial.
2. A campus microgrid is similar to a single customer microgrid except it serves multiple buildings that can be contiguous or non-contiguous. Universities, hospitals, and military bases are common examples. In these examples, customers value cost savings, sustainability/ renewable energy benefits, and reliability and resilience benefits.
3. Multi-Customer Microgrids can serve multiple users' loads that are on contiguous or non-contiguous properties. The ownership, operation and/or management of the microgrid assets vary between the customers and the third-party. Examples include mixed-use real estate development and data centres. Benefit value drivers are the same for campus style microgrids but may vary across customers.

SEPA recommended the following approach when establishing microgrids:

1. Understand the full regulatory landscape and its implications on microgrid business models and benefits.
2. Explore ownership/operation structures and cost recovery mechanisms with consideration to microgrid type/design.
3. Determine the role resilience can play as a microgrid value component in the existing regulatory framework.
4. Ensure regulatory policies and designations for microgrids are fair for all customers.

Microgrids as presented in this report are an option worth considering to resolve the electrical security of supply and grid infrastructure issues related with data centre developments. It is suggested that Offaly and the Midlands should consider them in more detail in a separate study along with the commercial aspects they come with. The figure below presents in a graph the aforementioned options from Public Authority to end user.

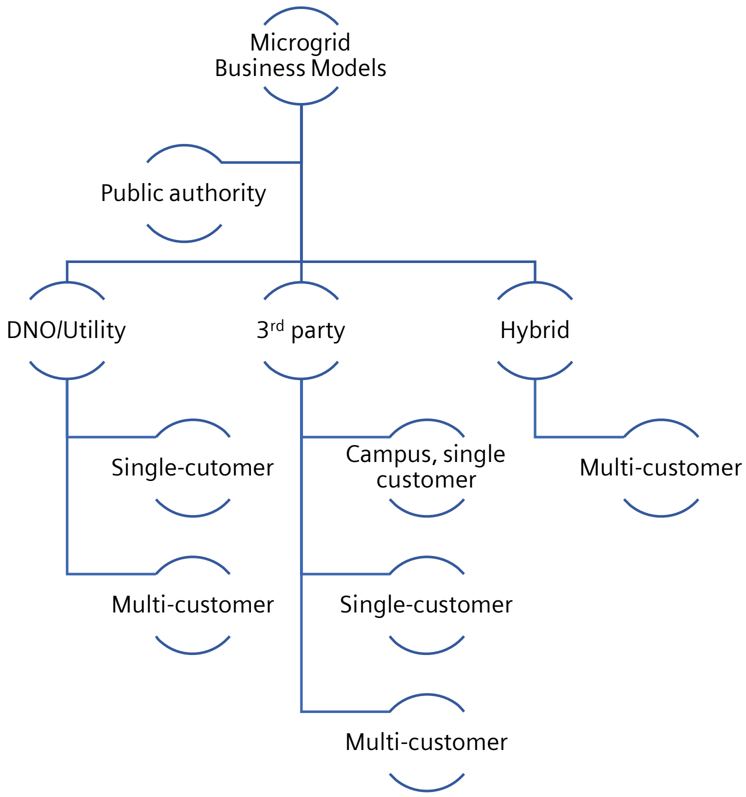

Figure C-1: Pathways from business model to customer

Subsidy and Grant Funding

SEAI Community Grant is a programme targeting a wide range of energy efficiency interventions, many of which are targeting private homes and thermal insulation. Its scope includes public and commercial sectors, supporting such measures as:

- Integration of Control Systems
- Integration of Renewable Energy Sources[45]

Creating a microgrid-based independent DNO constitutes integration of control systems and RES, therefore the actions described above could be supported by the programme.

Evaluation of grant applications happens in four categories: Value for Money, Community & Partnership, Quality & Delivery, and Innovation[46].

[45] SEAI – Community Grants Overview [link]
[46] SEAI – Community Grants Criteria [link] https://www.seai.ie/grants/community-grants/overview/

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For more information, please contact:

Address
Energy Business Advisory
Siemens Power Technologies International (PTI)
Siemens plc
Sir William Siemens House
Princess Road
Manchester
M20 2UR
United Kingdom

Internet www.siemens.com
Telephone +44 (0)161 446 5000

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