Ireland's Data Hosting Industry

2018 Q3 Update

"Irish Data Centres, an Industry of Substance"

Host In Ireland

bitpower energy solutions

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2018 Q3 Update

November 2018

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Foreword

Our Q3 update report for 2018 highlights the continued growth of the data centre industry in Ireland.

Green energy remains a priority for the industry and we have been encouraged over the previous quarter by the proactive approach stakeholders in the renewable energy sector have taken to ensure Ireland can continue to deliver on its renewable energy commitments.

In response to a recent report by Baringa, Host In Ireland was proud to join seven other renewable focused organisations in calling for the Minister for Communications, Climate Change and Environment to target 70% renewable energy for Ireland by 2030. Host In Ireland note the report in stating it would be possible for 70% of the industries energy to be supplied by renewable sources and we remain positive that this will be the case.

Just this quarter Facebook completed a new facility in Clonee employing 300 full-time workers. The site consists of two buildings, with one under construction and a further two undergoing planning permission. The facility is fully powered by renewable energy with Facebook now actively considering investing directly into renewable power to ensure all of its facilities are self-sustainable.

In addition, companies such as Google, Microsoft and Amazon have committed and, in some cases, already achieved securing 100% in renewable energy sources for their data centres in Ireland. We recognise the strategic need for Ireland to continue on the path of renewable energy as a key driver of growth for the hosting industry in Ireland and we will continue to support policy and initiatives that boost Ireland's renewable capacity.

A positive Q.3 outcome for the data centre industry globally was underscored with the publication of two recent reports by property investment bodies JLL and CBRE with Ireland continuing to see investment momentum increase substantially over the previous 12 months.

Dublin Metro, when compared to its European neighbours continues to see growth from both expansions of existing market players and new entrants at a time when competition has never been higher in the industry.

Part of this success is down to Ireland's cost competitiveness in the construction of data centres as highlighted by a recent report by Turner and Townsend, a global project management company. With Zurich ranking the highest cost to build data centres in EMEA, Dublin Metro ranks a comfortable 14th out of 32 cities in terms of build cost, more competitively placed than London, Amsterdam, Copenhagen and Frankfurt. The report also revealed that Dublin Metro ranks among the top 5 cities in Europe as a place to host digital assets.

In other developments, the potential to recoup waste heat from data centres and distribute it to local homes and business is now being tested in Ireland through a pilot scheme run by South Dublin County Council. The first district heating tender in South Dublin will allow low grade waste heat from a local data centre to be reused for the first-time in Ireland. In taking waste and converting it to energy, this will ensure data centres contribute to the new circular economy model.

We recognise that the greenest energy is energy that is not used, as part of our Q3 update report we have taken the opportunity to highlight the continuing efficiency being delivered by the modern data centre including those in Ireland.

This Q3 report update is a Host in Ireland[i] report with technical input and qualification from Bitpower[ii] to examine the opportunities and risks associated with the digital asset hosting industry in Ireland.

By providing the most timely and accurate update on data centre activity in the Irish market, we believe that this baseline will act as a useful reference for policymakers. This will be beneficial to Ireland as we look to continue our leadership in the creation, retention and exporting of digital products for the long term.

Garry Connolly

President & Founder – Host In Ireland

Host In Ireland

Content of this Update - Q3 2018

This Q3 2018 supplement builds on previous updates to our "Ireland's Data Hosting Industry" series.

We have seen the opening of some new large facilities in Q3, most notably by Facebook who have gone live at their Clonee campus. The colocation wholesale model has evolved to help meet the demand of hyperscales.

There have been some national developments around the energy system as it adopts to facilitate higher renewable energy penetrations and to meet increases in demand. We discuss these developments.

The energy use in data centres continues to attract attention across all regions in which they operate. EirGrid's recent Generation Capacity Statement[iii] suggests that, by 2027, up to 31% of Ireland's electricity use could be feeding data centres. Our analysis indicates that today it is around 6%, but this could double in four to five years. Where it goes by 2027 depends on a number of factors, including uptake of allocated power.

Energy Efficient Design Special

For this update we have prepared a special analysis of the evolution of energy efficiency in data centres. Since the first such facilities began to appear in the 2000's, efficiency has improved significantly. We look at the technologies that made this possible and look to the future for the next wave of efficiency improvements.

Will it be technology improvements or processes and management that matter? Our analysis of past improvements demonstrates that the future will be a mix of systems, processes, and technology.

In particular we take a focused look at methodologies for efficient design. We assess a new SEAI-supported standard (EXEED) aimed at structuring how to manage design teams and decision making for improved energy performance from design to operation. Already being adopted by Irish data centre operators, this approach helps deliver future-proofed data centre facilities.

We hope this edition provides a useful snapshot of the continued development of Ireland's data Industry as we move towards the end of 2018.

David McAuley
Founder & CEO – Bitpower

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Data Market Developments in Q3 2018

There is now a total of 48 data centres in Ireland, with 540 MW of grid-connected power capacity. These reside mostly in the Dublin Metro area. This represents an increase of 57 MW with the opening of two new facilities. If the smaller, private facilities are excluded, this equates to about **520 MW of cloud and managed services** capacity.

While Hyperscale remains the dominant datacentre type, with 74% of capacity, the colocation wholesale market has grown from almost zero to 11% in the past 3 years. The map on the following page demonstrates the clusters of hyperscale and colocation facilities.

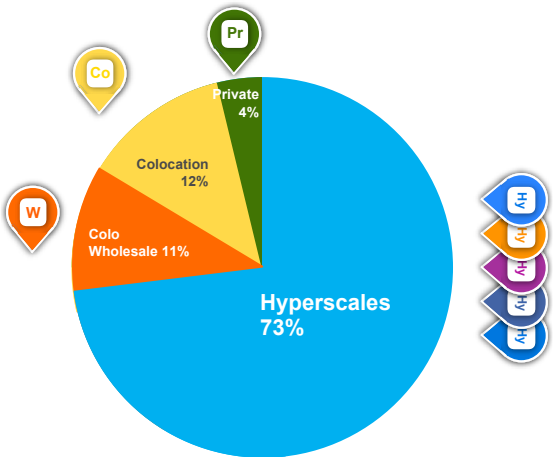


Figure 1 - Relative scale of digital hosting types in Ireland in 2018.

Private Data Centres

This sector accounts for smaller facilities not explicitly leasing-out space in their buildings. They provide internet services for business and have a regional spread. We are unaware of any significant construction growth in this this quarter, though dedicated facilities are likely to appear in the near future to support new technology innovations. Remains at 20 MW total.

Hyperscale Data Centres

Facebook opened their new data centre facility in Clonee in September 2018. Developed over thirty months with more than 1,000 workers on site, this new facility is designed to be highly efficient, and there is more expansion to come.

Microsoft, Amazon, and Google also have operational facilities in the greater Dublin area. They all have active expansion plans.

Colocation Wholesale

The trend in wholesale-type builds continues, with established colocation providers and new entrants submitting plans for large facilities capable of supporting wholesale customers. The K2 Datacentres facility in Ballycoolin commenced operation in Q3. These facilities are in the 15 to 25 MW scale range.

Colocation Data Centres

Colocation provide the glue to hold the clusters together. In 2018, Digital Realty commenced construction of their new facility at Profile Park. Equinix received planning permission for a new facility in Blanchardstown. Keppel DC continue to upgrade their Parkwest site, and InterXion have been granted planning permission for their fourth Dublin facility, having only recently opened their third.

Q3 2018
Updates and revisions

Masterplans
Estimated
155 MW

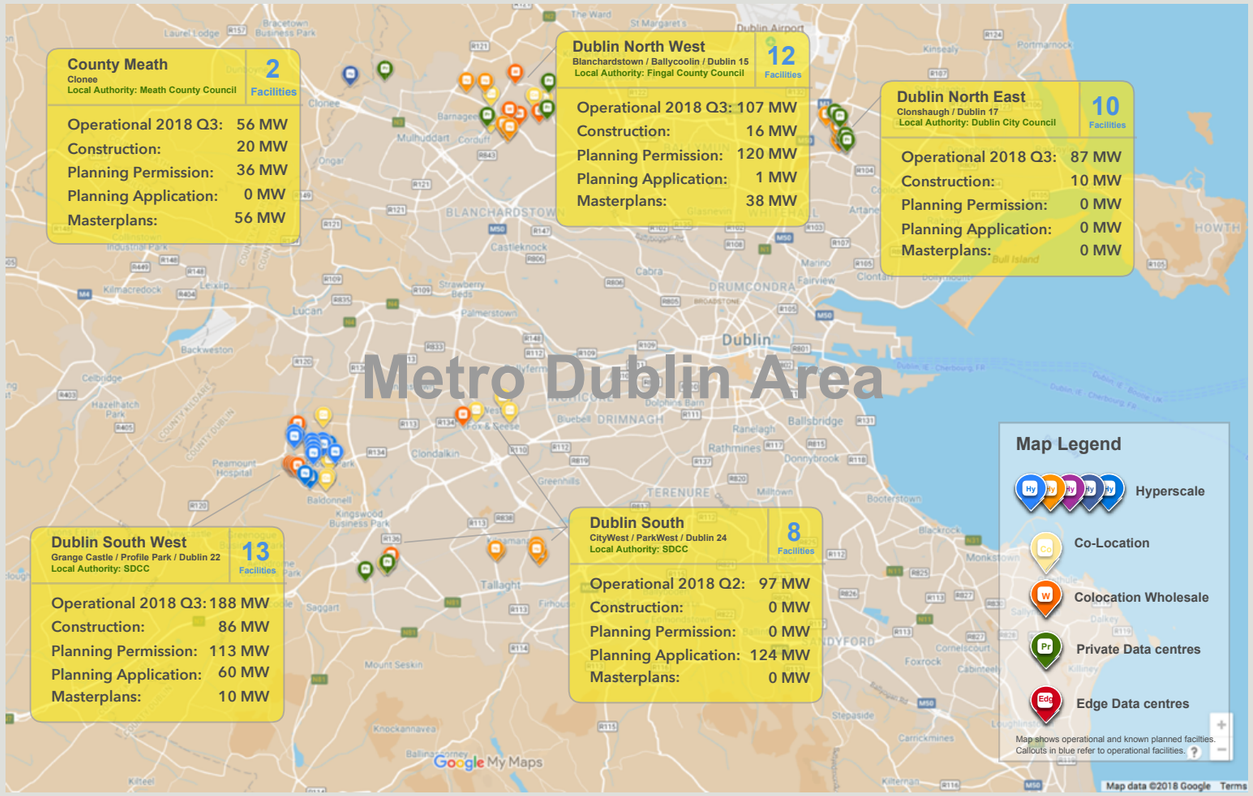
Planning Applications
Currently in the Planning Process
165 MW

Planning Permission
Approved
279 MW

Construction
Projects currently in Development
123 MW

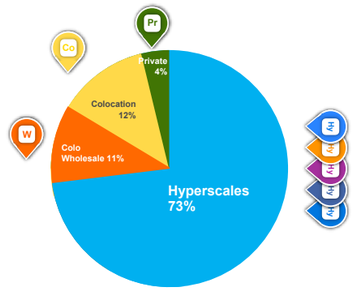
Data Centre Capacity
Operatonal in 2018 Q3
540 MW
Includes 20 MW Private

Digital Hosting Q3 2018 Update



Data Centre Types

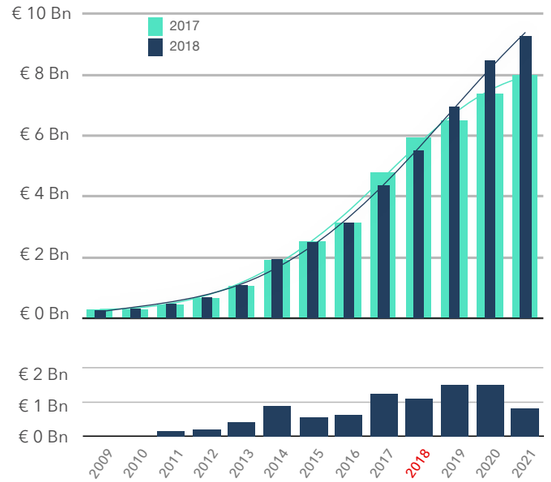
Operator business model



There are forty-eight data centre facilities in operation in Ireland in 2018. Hyperscales continue to dominate in terms of scale, with 73% of the MW capacity. Colocation wholesale trend continues.

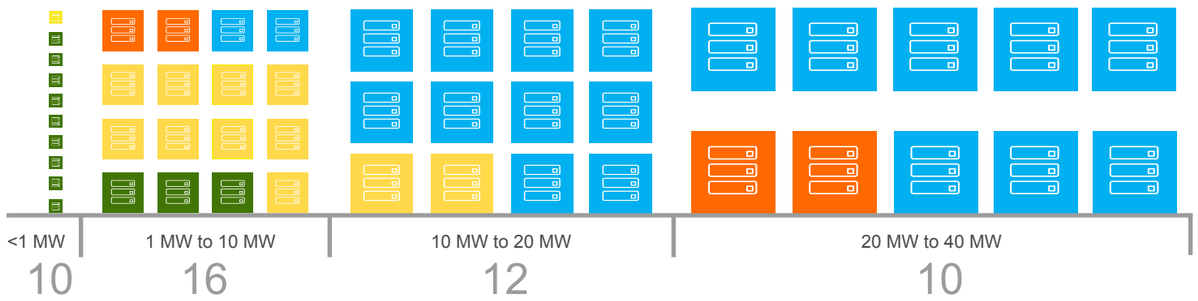
Construction Investment 2009 - 2021

Cumulative and Annual investments in data centre facilities



Ireland Hosts Commercial Data Centres of all Sizes

Forty-eight operational data centres in Ireland in Q3 2018



Highlights in the Q3 2018 update

New Activity

57 MW
Newly Opened Data Facilities
New Hyperscale and Build to suit facilities completed and live

70%
Renewable Ambition
Push by renewable energy industry groups to set high 2030 target

Efficient Design
Special
Feature on energy efficiency and design methodologies

520 MW
Cloud & Managed Services
Colocation, Wholesale, and Hyperscales

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Powering the Data Industry Sustainably

In 2017, 29% of Ireland's grid electricity was generated from renewable sources, 51% from natural gas, and 20% for other non-renewable sources, as shown in Figure 2.

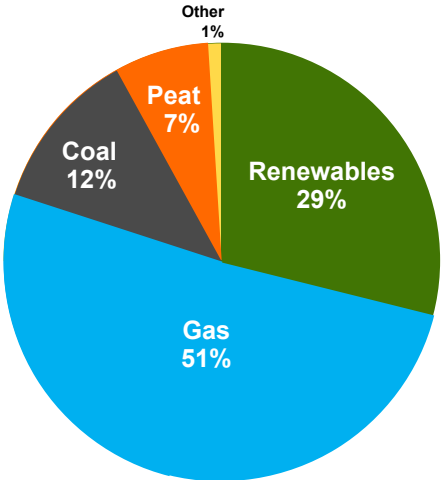


Figure 2 - Ireland's electricity sources in 2017. Source - EirGrid.

The target of 40% renewable electricity by 2020 is likely to be achieved. The new target for 2030 is under discussion with an open consultation by the department of Energy (DCCAE) open until early November[iv]. The baseline scenario for the proposed target indicates a possible target of 55% renewable electricity by 2030 -see Figure 3. Renewable energy industry associations such as the Irish Wind Energy Association have identified that an ambitions target of **70%** renewable electricity by 2030 is technically and economically feasible with appropriate policy measures[v].

These targets will require a large amount of investment. The new Renewable Energy Support Scheme[vi] was announced by government with full details and auctions for supply of the next tranche of renewable generation to begin in 2019. The scheme is somewhat technology agnostic, and will be capable of supporting wind and solar PV and other viable technologies as their cost curves mature. There will also be a requirement to facilitate local community investment in such projects.

The biggest investment potential will come from large corporates, and in particular, data centre operators. The data industry at an international level are keen to buy only renewable energy, as stated in their corporate goals[vii]. Ireland needs to ensure that these targets and policies are compatible with corporate energy procurement requirements.

Ireland's policymakers have recognised that the opportunity will depend on ensuring investor confidence in renewable energy by streamlining the policy arrangements[viii].

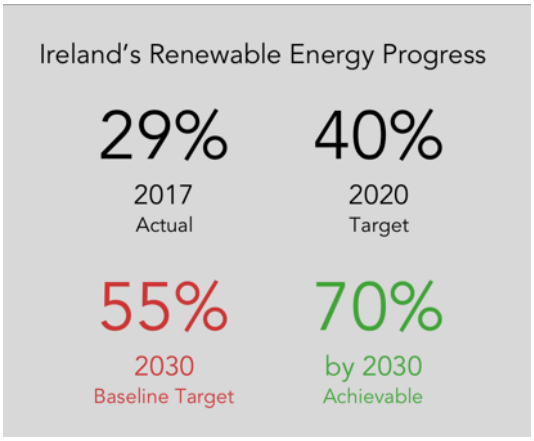


Figure 3 - Renewable energy targets.

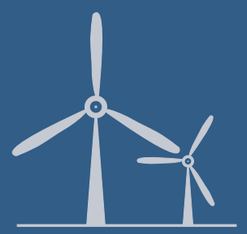
There is also a trend towards non-grid delivered power, typically using the natural gas network. The gas grid operator GNI is targeting 20% renewable gas across the gas system by 2030[ix]. The first biogas injection facility in Ireland is due to open in 2018.

Renewable energy supply forms an important part of the solution to climate change. Efficient use of energy is the other aspect. Clearly both are needed. In the following section we examine the evolution of energy efficiency and look to the future for the next innovation.

How To Build an Efficient Data Centre

Key Energy Aspects

National Electricity System



Wind Generation

Power Station

Transmission System

Electrical Substation

Backup Engines

Energy Supply Options

Natural Gas

Gas Grid

Transmission Level Gas

AGI

AGI

Distribution Level Gas

On-Site / Self Generation

Data Centre

Air Handling

Airflow

Electrical Switchgear

Batteries

White Space

Servers

Hot Aisle

District Heating

Heat Operator

Heat Network

Heat Customers

1 Virtualisation
2 PuE Metric
3 Hot Aisle Containment
4 Enterprise Savings
5 Free Air Cooling
6 Server Efficiency
7 Grid Services
8 On-Site Generation
9 District Heating
10 Solid State Drives
11 Battery Technology
12 Artificial Intelligence
13 Open Compute
14 Liquid Cooling
15 Design Thinking
16 Offshore Pods

The Old Days — *Last Week* — *Today* — *The Future*

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Efficiency trends for Data Hosting

Energy Efficiency

Data centre efficiency has evolved to the point that the vast majority of power input actually gets to the servers and other IT equipment. Compared to a decade ago, this is a significant improvement. Savings can also be attributed to improvements in computer technology, and to changes in how data centres are designed. An economy (or efficiency) of scale is also evident in enterprises moving towards the cloud, rather than building smaller in-house server rooms. Most efficiency improvements are incremental, but some ideas may represent a leap. The key innovations are explored in our new infographic "*How to build an efficient Data Centre*" on the previous page, with the details discussed below.

1 Virtualisation

As enterprise IT moved towards outsourced facilities, technologies emerged to optimise the use of servers for IT workloads. This meant that each new application in a business no longer required a new set of servers and storage. Resources could be shared seamlessly in a virtual way. This has evolved to cover a broad range of resource sharing and was probably the genesis of the colocation data centre business model and the concept of the cloud.

2 PuE Metric

It's a bit clunky, and often misinterpreted, but PuE remains the recognised way to benchmark the energy performance of a data centre. It quantifies the relative power needed to power and cool the IT equipment. The focus on PuE has helped designers and operators to continuously improve the efficiency of their data centres.

Ten years ago, PuE values of 2.8 were common, meaning only 35% of the power feeding the facility was for IT, the remainder being used for power conditioning, UPS, and cooling. In Ireland today, PuE values of 1.15 are more common. Such facilities deliver up to 87% of the total power to the IT equipment. See Figure 4.

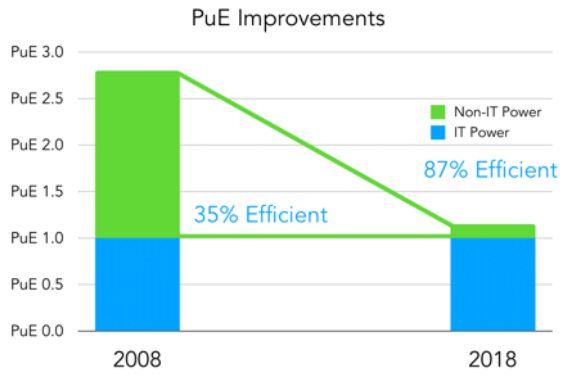


Figure 4 - Improvements in PuE.

3 Hot Aisle Containment

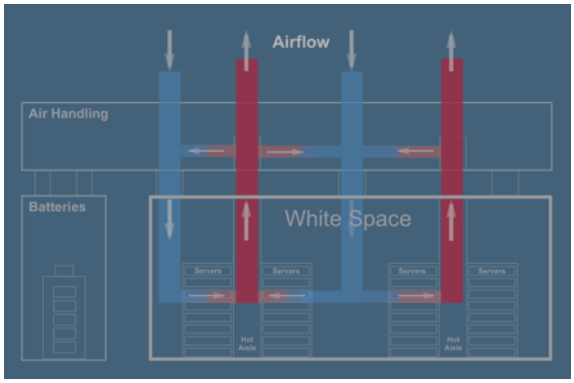


Figure 5 - Hot aisle containment

The principle of preventing the hot air leaving a server to mix with the inlet air seems obvious, but managing the airflow requires careful design and control. Fortunately this is now standard design. Larger data centres no longer use raised floor setups and have simplified the path the air has to take, reducing resistance, and fan power required. Wider operating temperature ranges for IT equipment such as the ASHRAE standards ensure that data centre operators don't need to over-cool their data centres in order for their equipment to remain in warrantee.

4 Enterprise Savings

The trend out of the enterprise and into the cloud / managed service ecosystem continues. Economies of scale and quality service offerings will eventually put all the data into the hands of efficiency-aware operators[x]. According to Gartner & Equinix: "*By 2025, 80% of enterprises will have shut down their traditional data center, versus 10% today*"

5 Free Air Cooling

Why install chillers? Operators began to realise that in some regions, outside air was plenty cool enough to remove heat from servers. Augmented with adiabatic cooling (effectively a water shower to cool the inlet air), this solution has proven itself in Ireland to now be the standard design. This solution works particularly well when the airflow within the white space (IT Space) is carefully managed.

6 Server Efficiency

It's difficult to demonstrate the output of IT systems in terms of energy, but newer servers could process multiple times more per unit of energy input. In 2018, the EU EcoDesign Directive proposed stringent new standards on server efficiency based on power use at a range of utilisation ranges (idle). There has been some discussion amongst industry experts as to the benefits of such an approach. We await the final outcome.

7 Grid Services

The electricity grid evolves towards using more variable renewable energy sources. In 2018, the Irish grid reached renewable energy penetration levels of up to 65% (in a 24-hour period). Data centres can help improve grid efficiency by shifting demand or by running back-up systems for the benefit of the grid (and get paid for it). The data centre business model is based on availability of power at an instant, hence over-provisioning of power capacity is normal. Until the energy and data systems can find a compromise solution, we will continue to have grid challenges. This is not unique to Ireland, and is evident in other fast growing data locations.

8 On-Site Generation

Also called self-generation. In order to relieve pressure on the electrical infrastructure, many operators have begun to invest in on-site power generation facilities using natural gas. This can be a temporary or a long-term strategy. A hybrid of gas and grid electricity presents cost optimisation opportunities (and challenges). It also avoids the 8% national grid transmission losses. If a practical use for the waste heat from generation can be realistically applied, these could become the most efficient data centres. Further into the future, fuel cells powered by gas may be practical, offering efficiencies of 65% compared to the 45% available from gas engines.

9 District Heating

We posed some research challenges for District Heating in our Q2 Update[xi]. In 2018, South Dublin County Council published a tender for the construction of a district heating network. Others will likely follow. For those generating on-site there may finally be a facility to recycle waste heat. Recycling waste heat is recognised by the EU as a renewable energy resource, thus improving the sustainability credentials of generators. Waste heat recovery from servers is not practical due to the low grade nature of the heat, and the cost of upgrading that heat into a useful resource.

10 Solid State Drives

Using very low power and practically zero power in "idle" means these storage devices could drastically improve the efficiency of a data centre. A two tier solution is emerging, which uses SSDs for high-speed requirements and regular hard drives for backup.[xii]

11 Battery Technology

Traditional battery arrangements required battery room cooling. The move from lead-acid batteries to Lithium-Ion and other technologies means more efficiency and less cooling load. Better management of backup power also helps.

12 Artificial Intelligence

The future? – Google and others already utilise AI to help their power management systems to learn and adapt to changes in conditions, thereby optimising power. "*Machine-learning algorithms are now adjusting cooling-plant settings automatically, in real-time, on a continuous basis*".[xiii] Imagine a system that continuously monitors conditions and workloads, and can make and implement decisions that optimise energy use. This is not a static strategy like a traditional building management system, rather it is one that can change as the data centre changes. This overcomes the Achilles heel of building management strategies.

13 Open Compute Project

Rethinking the server and rack arrangements, the open compute project offers more serviceability, improved airflow within racks, optimised power conversion, and in-rack batteries, together yielding significant energy savings. It does this by removing unnecessary server ports such as mouse and keyboard connections, replacing power cables with a simple buzz-bar delivering low voltage power to remove the need for in-server ac/dc conversion, increasing fan size for lower speeds and therefore power, and other changes. OpenCompute has been adopted by Facebook across their Clonee campus[xiv].

14 Liquid Cooling

Air cooling has been the trusted standard for decades. But air isn't the best heat transfer medium. Water can carry 3,000 times the heat energy that air can, so why not use water instead? Obviously water and electricity don't mix, but new non-conductive liquids under development (by 3M, for example) will allow for total submergence of servers in liquids. The could reduce the space and cooling requirements for data cantres by a factor of ten or more.

15 Design Thinking

Design is everything. Every data centre company evolves it's design solutions over time. Consistency and modularity are important for serviceability and saleability. There's now a government-backed scheme (SEAI EXEED[xv]) to help companies adopt a systematic approach to efficient design. This approach directly complements the ISO 50001 energy management standard and forces designers to think about things like operational flexibility when making design decisions. We explore this in detail later.

16 Offshore Pods

Seems crazy – floating pods that house mini data centres located offshore. There are some big advantages – most populations live near the coast, so deployment is simplified. Connectivity today is via subsea cables already. They could be easily powered by offshore renewable energy. Cooling and security conditions offer other advantages. Microsoft have deployed a test pod off the coast of Scotland[xvi].

Excellence in Energy Efficient Design - EXEED

We take a look at the new process being applied to help drive further efficiencies in data centre design. As we have explored, the efficiency of data centres has evolved and improved over the past decade. Most facilities already implement the major innovations in their designs. How can data centre developers identify and evaluate further innovations to ensure continuous improvement?

Excellence in Energy Efficient Design

SEAI recently launched a support scheme for efficient design based on an ISO-type standard which is compatible with the ISO50001 energy management standard. The scheme, named the EXEED certified program, includes grant supports[xvii] for implementation in the design process and capital supports for the resulting technology adoption.

The essence of the approach is to define and understand the energy service – *what service does energy deliver?* In the case of a data centre, the service might be defined as "to process data in a secure, reliable and efficient manner". Everything else then builds on that premise. A check-list of questions are applied through the process to help capture all relevant aspects of energy and sustainability. The methodology can be applied to new facilities, those undergoing upgrades, or even be isolated to just a particular asset.

Approach and Benefits

The new process for design includes defined activities such as Design for Energy Performance and Design for Energy Management. See page 13. Not only do these ensure that decision making in the design process is tied to energy efficiency, but also that these decisions can be carried through the tendering and construction stages. Monitoring and verification plans can be established early and consideration is given to improving short-term performance while ramping-up in the first years of operation. This is particularly relevant to data centre facilities where steady state conditions take time to appear in real-world operation.

Energy Model Analysis

Building a model of energy consumption ahead of time (the energy balance study) has benefits in helping the design team to evaluate ideas. It may begin, for example, with the high-level energy flows identified in our "*How to Build an Efficient Datacentre*" infographic shown on page 8 of this report. Working to challenge decisions and analyse potential improvements, design teams can ensure that their efficiency ideas, even if not feasible today, can be documented for resurrection on future projects. It also allows for corporate design guidelines to be applied and even updated if the results show corroborated efficiency gains.

Other aspects, such performance deterioration parameters can be established and communicated to the operation team. If clearly documented, the communication of relevant information through to the operator should make their job much easier – the project summary report facilitates handover of the building with all the supporting assumptions. If things change, the operator knows what to look out for.

Grant Support

Certifications are available through the scheme at different stages (EXEED Designed, Verified, and Managed), allowing the data centre to display its green design credentials. Grant supports are available to help achieve these levels. Other related schemes may in the future require certification for eligibility.

The EXEED process of efficient design, already tested by other industries, looks set to make its mark in the data hosting industry in Ireland in 2019.

The **EXEED** process explained

EXEED Designed | EXEED Verified | EXEED Managed

Planning

DELIVERABLES
- EED Project Execution Plan
- Project organisation structure
- EED Expert and EED Owner

KEY REQUIREMENTS
- Define new roles, responsibilities and authorities
- Understand the project risks and opportunities
- Understand the organisation context, stakeholders and interested parties
- Develop procurement strategies and requirements, including specialist suppliers

NEW PROJECT ORGANISATION

EED Owner
Accountable to Top management for implementing the EXEED requirements within the design project application

EED Expert
Responsible for the day-to-day execution, coordination and management of the EED activities during the project lifecycle

Design for Energy Performance

DELIVERABLES
- Energy Balance Study of baseline design
- Energy Saving Register, master document recording all ideas and opportunities
- Measurement and Verification Plans

KEY REQUIREMENTS
- Determine annual energy consumption and profile of baseline design
- Consider alternative energy sources if relevant
- Challenge baseline design using a required methodology
- Assess co-energy benefits
- Ensure ongoing communication and integration into construction and commissioning plans for implementation
- Continually assess for energy performance during implementation

Design for Energy Management

DELIVERABLES
- Energy Measurement Plan
- Updated Energy Saving Register

KEY REQUIREMENTS
- Conduct energy variables review
- Conduct energy performance deterioration review
- Integrate other metering requirements
- Integrate new findings including: design changes, measurement and verification, performance deterioration measurement, mitigants, new opportunities, commissioning actions, operational control

Project Summary

DELIVERABLES
- Project Summary Report

KEY REQUIREMENTS
- Conclude all financial, energy, co-energy and other benefits for the asset in operation
- Capture all outcomes and information developed by the process
- Include the current revision of the Energy Saving Register
- Include lessons learnt
- Handover of the Energy Saving Register, technical documentation and other knowledge to the operator

Measure and Verify

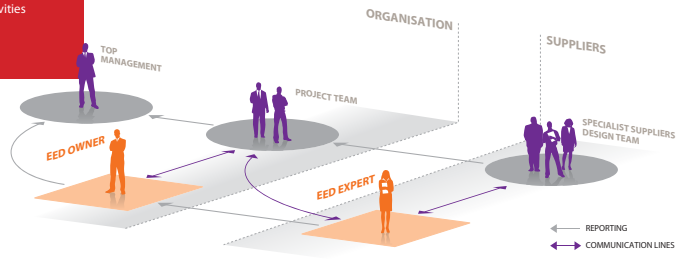
DELIVERABLES
- Measurement and Verification reports
- Updated Energy Saving Register

KEY REQUIREMENTS
- Implement Measurement and Verification plans
- Adhere to competency requirements for measurement and verification
- Verify design assumptions and operational energy performance
- Management and approval by EED Expert and EED Owner

Energy Management

DELIVERABLES
- Asset within scope and boundary of an ISO 50001 Energy Management System

KEY REQUIREMENTS
- Conduct Energy Review using the Energy Balance Study, Energy Saving Register and Measurement and Verification data
- Continual improvement of energy performance



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References & Links

[i] Host in Ireland: http://hostinireland.com

[ii] Bitpower: www.bitpower.ie

[iii] EirGrid's All-Island generation capacity statement 2018-2017: http://www.eirgridgroup.com/site-files/library/EirGrid/Generation_Capacity_Statement_2018.pdf

iv Consultation on energy Ireland's National Energy & Climate Plan 2021-2030: https://www.dccae.gov.ie/en-ie/energy/consultations/Pages/Initial-Consultation-NECP-2021-2030.aspx

[v] Renewable energy groups advocate for 70% renewable energy 2030 targets: https://www.breakingnews.ie/business/groups-urge-govt-to-set-70-target-for-irelands-renewable-energy-by-2030-873281.html

[vi] Renewable Energy Support Scheme: https://www.irishexaminer.com/breakingnews/lifestyle/homeandinteriors/newsview-heres-all-you-need-to-know-about-the-renewable-electricity-support-scheme-859914.html

[vii] See our Host in Ireland/Bitpower discussion on sustainability in the data hosting industry in our 2017 report available here.

[viii] SEAI National Energy Projections to 2030 report - https://www.seai.ie/resources/publications/National-Energy-Projections-to-2030.pdf

[ix] Gas Networks Ireland Renewable Gas developments:https://www.gasnetworks.ie/corporate/company/our-commitment/environment/renewable-gas/

[x] Enterprise migration - the data centre is dead – Gartner & Equinix: https://www.equinix.ie/resources/analyst-reports/gartner-emerging-digital-infrastructures/

[xi] Host in Ireland/Bitpower Q2 2018 update: https://bitpower.ie/images/RDDSTUDY/Bitpower_2018_Q2_Update_V5.pdf

[xii] Solid State Drives: https://www.networkcomputing.com/storage/6-reasons-ssds-will-take-over-data-center/1773773354

[xiii] Artificial Intelligence in Google data centre: https://www.datacenterknowledge.com/google-alphabet/google-switching-self-driving-data-center-management-system

[xiv] Facebook adopt OpenCompute in Clonee: https://www.rte.ie/news/ireland/2018/0914/993768-facebook-data-centre/

[xv] SEAI Excellence in Energy Efficient Design: https://www.seai.ie/energy-in-business/training-and-standards/exeed-certified-program/

[xvi] Microsoft offshore DC Pods - https://news.microsoft.com/features/under-the-sea-microsoft-tests-a-datacenter-thats-quick-to-deploy-could-provide-internet-connectivity-for-years/

[xvii] For more details on the SEAI EXEED grant supports, check out: https://www.seai.ie/energy-in-business/training-and-standards/exeed-certified-program/ or contact SEAI programme manager John Mullaney: John.Mullaney@seai.ie

Contacts:

David McAuley
Bitpower
david@bitpower.ie
www.bitpower.ie

Garry Connolly
Host In Ireland
garry@hostinireland.com
www.hostinireland.com

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