Data Centres 2021

Power and Influence

Data Centre Industry Thought and Opinion

RENEWABLES SUSTAINABILITY INVESTMENT

ECHELON

DATA CENTRES

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Data Centres - Power and Influence

NIALL MOLLOY
CEO, ECHELON DATA CENTRES

Introduction

At the beginning of 2019, Echelon Data Centres announced an investment of €1bn in two data centre developments in Ireland. The two facilities combined would have a capacity of at least 184MW, planning permission was in place and firm power agreements had been secured.

At that time, this amount of capacity represented 15% of the total capacity that was operational, in construction or in planning on the island of Ireland.

It was also sizeable capacity for the sites – at that time, even large-scale, own-build data centres were rarely more than 25-50MW, and the advent of sites with capacity of 100MW or more was (and is) a game-changer.

It was our stated intention (at the time of our launch) to have 500MW of capacity in 5 countries by 2025. Already, at the end of 2020, our plans provide us with a possible capacity of 410MW on our sites in Ireland and the UK, and we have further European sites in the pipeline.

We are proud to be an international data centre infrastructure developer providing large-scale assets to support the growing global demand for data and computing resource - sustainably, responsibly and with due regard for the environment.

The inexorable rise of artificial intelligence (AI), the continuing roll-out of, and increasing reliance on, the Internet of Things (IoT), the rapid adoption of virtual reality (VR) as a business collaboration tool, and the established use of augmented reality (AR) in marketing communication all means the dataverse is expanding exponentially.

All that new data needs somewhere to go, somewhere to be processed, managed and stored, and it needs to happen ever-more quickly and securely. In 2018, predictions were confidently made about 175 zettabytes of data annually by 2025. Given the dramatic pace of technological change, and changes in usage patterns, that we've seen in the last 12 months alone, these predictions almost certainly understate current and future consumer demand.

As long as people want to use their smartphones; as long as people want to take advantage of the latest technology, to benefit from automation and the safety, security and peace of mind that it brings, and move forward into a new age of machine-assisted living – as long as such as demand exists, there will be a need for data centre facilities.

The need for data centres is irrefutable, but in order for such facilities to co-exist in co-operation with communities, regions, nations and their governing bodies, they need a permission to operate. This takes the form of agreement amongst all parties that there are societal, as well as economic, benefits to establishing more and bigger infrastructure projects, and that the owners and operators themselves are taking their responsibilities seriously.

The focus for the data centre sector needs to be on three things – sustainability, innovation and efficiency – and the progress that's being made against these imperatives needs to be widely communicated. At this stage in the development of the data centre sector, it is not enough to generalise, nor is it enough to pursue the easiest solutions.

We need to acknowledge the issues, be realistic that progress is achievable in the medium to long-term, and commit to working with other industries and tech specialists to deliver the solutions that we know can change the way we run our operations. In the short term, we need to look at the available solutions – the things that we, as an industry, can do now to help us down the road to achieving our sustainability goals.

Through this collection of articles and reports, kindly provided by those involved in the areas of power, innovation, sustainability, investment and infrastructure, Data Centres 2021: Power and Influence examines some of the pressing issues of the day, the progress being made towards solutions, the sustainable energy investment case and – of course – how Irish data centre expertise is blazing a leadership trail in Europe.

Enabling Renewables

The symbiosis between data centres and green energy

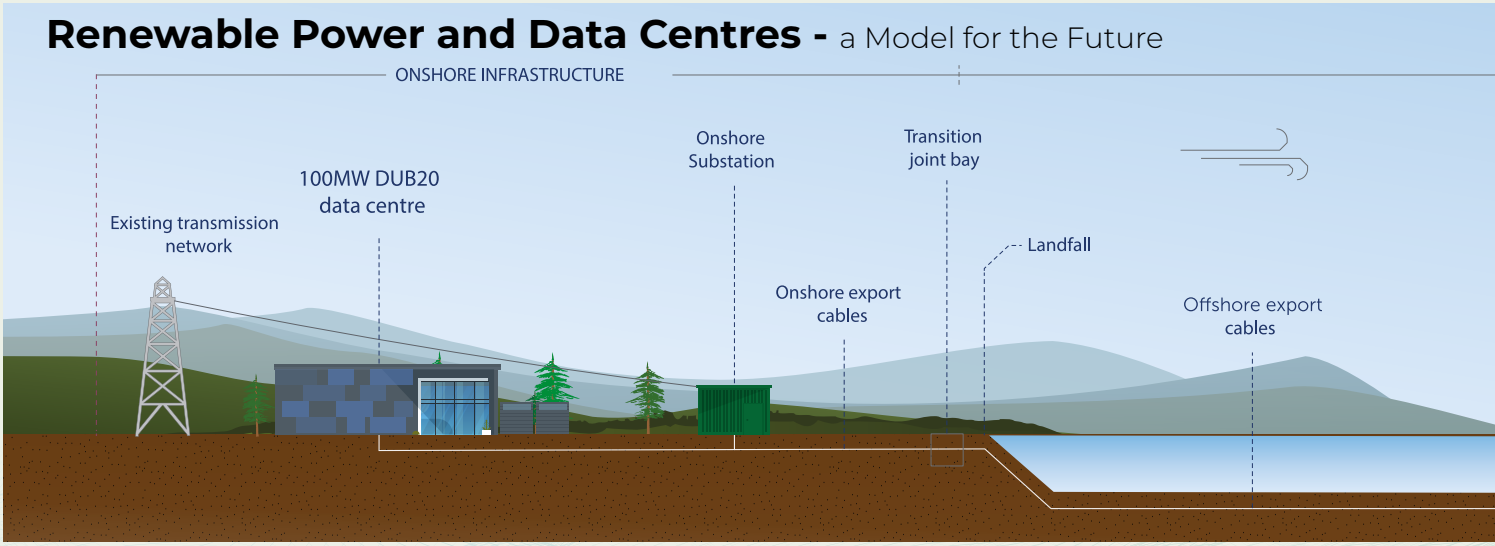
BARRY KILCLINE

DIRECTOR OF OFFSHORE WIND DEVELOPMENT FOR IRELAND, SSE RENEWABLES

At SSE we are driven by our purpose: to provide energy needed today while building a better world of energy for tomorrow. To achieve this, our strategy is to create value for shareholders and society from developing, owning and operating low carbon energy infrastructure – in a sustainable way – to support the zero-carbon transition.

Responding to the challenge of climate change is core to SSE's business strategy. That's why we have set four fundamental goals that are directly linked to the United Nations Sustainable Development Goals, the blueprint for addressing global challenges including climate change.

SSE Renewables is the clean power delivery arm of the SSE plc group and plays a crucial role in helping meet SSE's commitment to achieve the UN's Clean Energy Sustainable Development Goal – to develop and build by 2030 more renewable energy to contribute renewable output of 30TWh a year.



As the UK and Ireland's leading developer, generator and operator of renewable electricity, we recognise we have a major role to play in pushing the boundaries of what can be achieved to ensure a sustainable energy generation mix and a truly sustainable economy.

We're already pushing forward to progress the 3.6GW Dogger Bank Wind Farm in the North Sea, a globally-important offshore wind energy project that is setting revolutionary new standards in renewable energy.

And in Ireland we're driving the delivery of a new offshore wind energy revolution that will transform the way we power homes and businesses on our island in the future.

Powering Ireland's energy revolution

At the forefront of our offshore development ambitions is the delivery of Ireland's first large-scale offshore wind farm, Arklow Bank Wind Park Phase 2, located between six and 13km off Ireland's Co. Wicklow coastline to the east of Arklow.

This 520MW offshore wind farm project has the potential to generate enough energy from one offshore wind site to power around half a million homes and five new 50MW data centres. Crucially it can reduce Ireland's annual carbon emissions by around 1%, offsetting almost half a million kilograms of harmful CO2^, and delivering a key Irish Climate Action target of installing 1GW of offshore wind by 2025.

We believe the delivery of new low carbon energy infrastructure plays a critical, symbiotic role in supporting the sustainable development of Ireland's economy, and that the harnessing of offshore wind power is central to the energy mix required to power Ireland's homes and businesses into the future.

In particular, we believe there is a mutually-beneficial relationship between offshore wind energy – the potential for which is enormous for Ireland given the incredible wind resource off our entire coastline – and the continued development of Ireland's data centre industry, a sector which is delivering vital economic opportunity and operational jobs to Ireland.

That symbiosis is enshrined in Ireland's Climate Action Plan, the backbone of Irish Government climate change policy. Published in 2019, it set the sharing of grid infrastructure and locating data centres closer to renewable sources of generation as a key decarbonisation goal to facilitate regionally-located data centres and minimise grid reinforcement objectives.

"I would like to pay tribute to SSE Renewables and Echelon – having identified an opportunity to share infrastructure to promote sustainability, they worked collaboratively to ensure their vision became a reality."

Taoiseach Micheál Martin

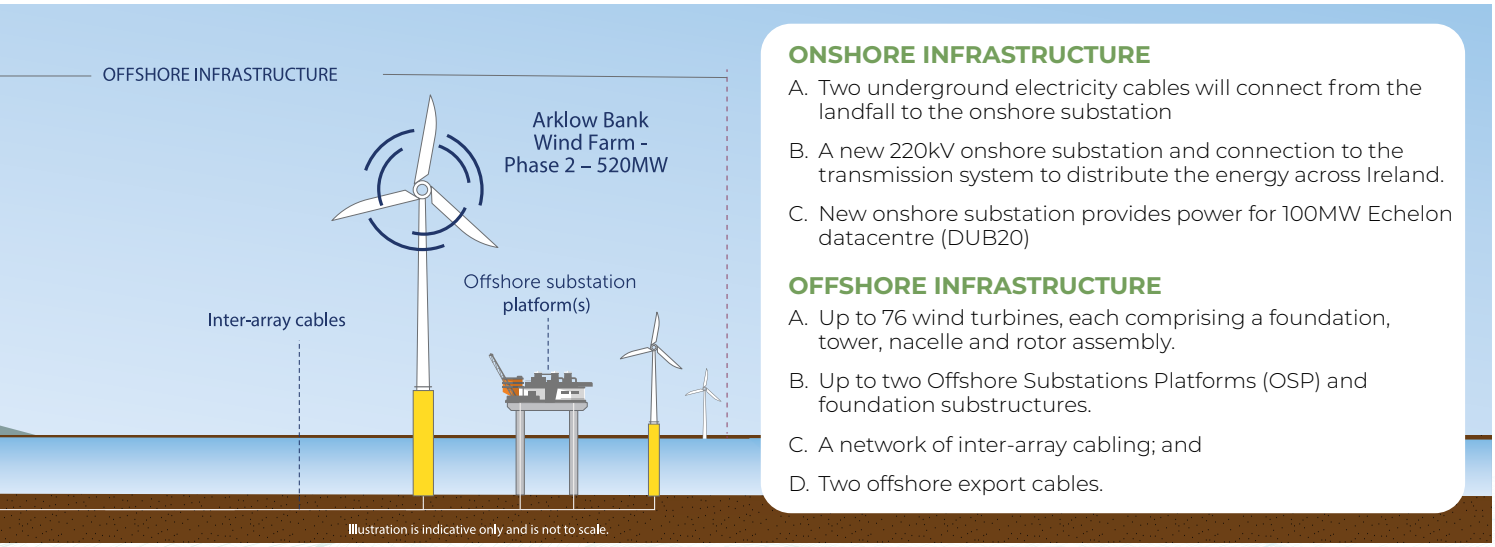
That Climate Action goal has inspired a truly innovative and ground-breaking partnership between SSE Renewables and Echelon Data Centres who together in November 2020 announced an agreement to develop a joint 220kV substation at Echelon's Data Centres' DUB20 site (Avoca River Business Park, Arklow, Ireland). The new shared infrastructure will facilitate both the development of Echelon's DUB20 100MW data centre and the nearby Arklow Bank Wind Park Phase 2.

The move represented major innovation in the integration of renewables and data centres into Ireland's national grid. The joint initiative has marked the first time in Ireland – and possibly in the world – that an offshore wind farm and a data centre have agreed to develop grid infrastructure.

Upon completion, the proposed offshore wind farm and data centre will both directly connect to the Irish national grid via the new shared substation.

A step forward for renewables and data centres

The landmark deal is an innovative step forward for the renewable energy and data centre sectors and was welcomed by the Irish Taoiseach (Prime Minister) Micheál Martin, who acknowledged that the collaboration between renewable energy and tech will ensure that key decarbonisation targets contained in the Climate Action Plan are met.



ONSHORE INFRASTRUCTURE

A. Two underground electricity cables will connect from the landfall to the onshore substation

B. A new 220kV onshore substation and connection to the transmission system to distribute the energy across Ireland.

C. New onshore substation provides power for 100MW Echelon datacentre (DUB20)

OFFSHORE INFRASTRUCTURE

A. Up to 76 wind turbines, each comprising a foundation, tower, nacelle and rotor assembly.

B. Up to two Offshore Substations Platforms (OSP) and foundation substructures.

C. A network of inter-array cabling; and

D. Two offshore export cables.

He also viewed it as a model which could be rolled out in other communities across the country, paying tribute to SSE Renewables and Echelon for having the foresight to work together.

Taoiseach Micheál Martin said: "I would like to pay tribute to SSE Renewables and Echelon – having identified an opportunity to share infrastructure to promote sustainability, they worked collaboratively to ensure their vision became a reality."

The initiative was clearly significant – enabling a large-scale offshore windfarm, contributing to the country's targets of delivering 1GW of offshore renewable energy by 2025, moving large-scale data centre infrastructure close to a direct source of green energy and facilitating the creation of 250 jobs locally.

More importantly, perhaps, it is also a model for the future, where data centre facilities provide constant demand for the nearby renewable power and work with the providers to facilitate the development of the necessary infrastructure. It represents meaningful progress on the road to cleanly and sustainably powered hyperscale data centres.

Promoting symbiosis

The model that we have pioneered with Echelon Data Centres on the east coast of Ireland – working together, co-locating infrastructure, facilitating the development of renewable energy resource and potentially paving the way for direct-line supply – is one that could be easily replicated.

The island of Ireland has more than 3,000 miles of coastline and the potential to generate 9.2GW of renewable energy by 2035 – far more than can be consumed by the Irish population. It could be exported, but it could also – to the benefit of the Irish economy as a whole – be used to power green data.

> The global pandemic has expedited our reliance on videoconferencing, virtual reality and general electronic communication. The move toward the fourth industrial revolution of machine learning and the internet of things that enables it is relentless

As we know, the dataverse (the amount of data created each year globally) is rapidly increasing in size. Predictions made in 2018 said that it would expand to 175 zettabytes by 2025 from some 30 zettabytes at the time.

These predictions have to be seen as conservative – the global pandemic has expedited our reliance on videoconferencing, virtual reality and general electronic communication. The move toward the fourth industrial revolution of machine learning and the internet of things that enables it is relentless.

So data centres are a given – that's an accepted fact – and the dataverse will increase. But moves need to be made towards greening the data. It's not enough to pay lip service to sustainability – the data centre industry needs to be focused on its impacts on the environment, on overburdened grid infrastructure and on the communities in which it operates.

A crucial partnership

That's why partnership and innovation between the data centre and renewables sectors is so vital, and why the low-carbon technology innovation that SSE Renewables and Echelon Data Centres have committed to at Arklow is so progressive and forward-looking.

Through our partnership we've shown what can be achieved, but what we've achieved is just the tip of the iceberg.

> Siting a data centre next to source of green energy means minimal requirement for grid investment

The relationship between data centres and renewable energy providers can be truly symbiotic, with the potential for both parties to reap benefits that would not necessarily be there were it not for the other. For the data centre sector, being close to a source of wind energy presents real possibilities in terms of being directly powered by wind energy – providing a source of truly green data.

For the renewable provider, a large-scale data centre – like the 100MW Echelon facility that is routing our power to the grid in Arklow – provides a constant, level demand. Whenever we're generating, we know we have a customer. Between the two of us, we can fund infrastructure to transfer our renewable power to the grid – to the benefit of the country as a whole – while providing a link from the grid to the data centre.

And siting a data centre next to a sizeable source of green wind energy means minimal requirement for investment by the grid in its own infrastructure, reducing burden on the network.

Viewed in this way, partnerships between Big Data and innovative and forward-thinking providers of green energy are inevitable. These are the symbiotic partnerships that will positively respond to the challenge of climate change and that will help achieve the sustainable delivery of clean energy goals.

Working together, we will not only enable the fourth industrial revolution that will power our shared green recovery but we will also have a significant and game-changing effect on people's energy usage and on the planet's environment.

Barry Kilcline is Director of Offshore Wind Development at SSE Renewables, part of the FTSE-listed SSE plc.

Funding the Fuel of the Future

Demand for sustainable energy provides ample opportunity for investors

RUPERT SHAW

FOUNDING PARTNER,
PIONEER POINT PARTNERS

Pioneer gets its name from the way it approaches investment opportunity – it wants to be first into a market sector, ahead of the pack, leading the way and – because of the nature of the organisation – availing of the returns.

Sustainable energy infrastructure is one of those sectors, requiring specific investment expertise and understanding – an ability to 'speak the language', if you like. Pioneer Point Partners has been at this for more than a decade, and it's always been the strategy. However, it should be clear from the outset that sustainable is not necessarily the same as 'green'.

That being said, Pioneer is dedicated to the sustainable energy space - and sees the market opportunity. However, there is real pride in what we do. Much of it stems from the fact that we're building infrastructure, not buying it, our operations are sustainable and they contribute to the changes in energy production that will be necessary to achieve climate change goals.

Pioneer invests in infrastructure that produces – or facilitates the production of – renewable energy and infrastructure that provides the bridge from reliance on fossil fuels to adoption of renewable, emission-free energy. Sometimes this means that the infrastructure is not powered, in itself, by renewables, but is part of a much wider worldview that takes in the production of renewables as a desirable goal.

It is true to say that, currently, the world cannot produce the power it needs wholly from renewable sources – this is some way off.

In the meantime, if society is to enjoy the benefits of broadband, 5G, AI, VR and the IoT, then it has to deal with the energy needs of – say - data centres in the short term, while being firmly committed to the goal of wholly sustainable solutions in the medium to long term.

The circular economy

While Pioneer does invest in projects that are directly linked to renewable energy generation – a million solar panels installed in the UK in the three-year period between 2013 and 2016 – this is a sector that has become extremely crowded.

A better example of a current Pioneer Point project is sited in Denmark and is Europe's largest producer of renewable, green gas. The project embraces the concept of the circular economy, where everything is used and nothing goes to waste - in this case, it's animal waste from Denmark's agricultural industry,

which is used as raw material for the production of green gas.

This solves the problem of disposing of the waste by other means – no easy task when the quantity is in the order of 5 million tonnes – and, at the end of the gas generation process, gives something back to Denmark's farmers in the form of fertiliser. The end product – the green gas – is a renewable resource, however, its sustainability is in the potential for feeding the European gas grid.

The gas grid exists, clearly, and is the subject of major investment, management and co-ordination, supplying gas to tens of millions of homes and businesses. As the global economy weans itself off fossil fuels, for some time to come natural gas needs to be replaced by an alternative green gas solution, which facilities like the ones in Denmark are producing.

From an investment point of view, in the short to medium term the opportunity is massive – the value of the European gas grid, which is yet to be renewablised, is in the order of €700bn. At the moment, gas is the solution. In the medium to long term, however, it's accepted that gas – natural or bio or green – is a transitional fuel and we're using it while we have to.

Powering communities

Another of our projects is a waste-to-energy facility in Scotland. Waste that would otherwise go to landfill is delivered to our site and converted into heat, steam and then power. Again, the solution we've delivered is sustainable – taking waste that would otherwise require costly and difficult disposal solutions and returning it to the community as power.

Again, this is a medium-term solution and comes with its own environmental impact. However, the energy generated is cleaner than that produced by fossil fuels and, in generating it, a social issue (waste to landfill) is addressed as a by-product.

The point is that investors such as Pioneer don't tend to focus on the traditional – in this case windfarms and solar – they tend to look outside of what is immediately obvious and are prepared to be flexible to meet their investment goals.

$30tn

Globally, sustainable investing assets in the five major markets, representing a

34% increase in two years

But to meet the goal of limiting the global temperature to 1.5 °C (2.7 °C), about

$90tn of investment is needed by 2030

This is what drew Pioneer to our partnership with Echelon Data Centres. Data centre facilities are getting larger and larger – there are plans for a 1.5GW capacity site in Norway – and there is a pressing need for their energy requirements to be met sustainably.

The hyperscalers – such as Google, Microsoft, Apple and Facebook - are making massive promises in terms of how they will power their data centres (and not just their data centres, but their entire operations) and they cannot afford to be seen to renege on those promises.

Pioneer is not investing in data centres themselves – this is not our area of operation, not our field of expertise. What we're doing is seeing and seizing the opportunity to partner with an industry that needs the type of sustainable energy infrastructure that Pioneer invests in and builds – and also has the space to accommodate it.

The data centre owners and operators talk our language – the language of power sustainability, connection agreements and substation installations – and it's an environment where we have the expertise that others don't.

> The aim is to reduce reliance on fossil fuels and move towards increasing quantities of renewable energy... to the point where energy produced by sources of atmospheric pollution will become a thing of the past

As part of our data centre-focused investments, we're looking at substations and we're looking at energy centres. The substation that Pioneer is investing in at Echelon's data centre facility in Wicklow, south of Dublin, is a connection point to the national grid, allowing power to flow into the data centre campus on which it is sited. Additionally – in this case – the unit will allow up to 1GW of wind-generated power to flow out and into the grid.

This power will be generated by phase two of the Arklow Bank windfarm, in construction off the coast of Arklow. Not only does this project facilitate the

Action areas to scale up and shift public and private investments to sustainable infrastructure

Tackle fundamental price distortions

Strengthen investment policy frameworks and capacity

Transform the financial system to deliver the scale and quality of investment needed

Boost investments in clean technology R&D and deployment

The Sustainable Infrastructure Imperative: Financing For Better Growth and Development' a 2016 report by The Global Commission on the Economy and Climate

greening of the grid, it also represents the first time that a hyper-scale sized data centre (up to 200 MW of capacity) will have the capability of being directly and wholly powered by renewable energy. It is possibly the first indication of the beginning of the end for corporate power purchase agreements (PPAs).

Energy centres, such as the ones Pioneer is constructing, again alongside our partner's planned data centre facilities, approach sustainability from a different angle. As already stated, an overarching aim for all is to reduce reliance on fossil fuels and move towards increasing quantities of renewable energy in the system, to the point where energy produced by sources of atmospheric pollution will become a thing of the past.

That may be the goal. As of today, however, it's still very necessary to produce some power from sources of carbon emissions, but these in themselves should still have sustainability credentials – which might be as an enabler for the wider adoption of, and investment in, renewable power.

How does it work? As a rule of thumb – for every 10MW of renewable power in the system, you need a spare MW to smooth the flow. Renewable energy generation – wind and solar – has pronounced peaks and troughs i.e. the time when the sun's not shining and when the wind isn't turning the windmills.

Energy centres – like Pioneer's first project in the UK, PeakGen – while gas-fired, produce the power that smooths the energy flows in the grid. They have limited run-times, limiting their emissions, however, they are key to an uninterrupted transition from where we are now to the future of a grid delivering 100% renewable energy.

Serendipitously, the data centre campuses upon which the energy centres are being sited serve a similar role in facilitating investment in – and the generation of – renewable energy with their energy demand profile.

Because it is constant – 24 hours a day, 365 days a year – whenever a wind farm or solar array is operational, whatever time of the day, there is a customer for the power generated. The renewable generators are no longer reliant on the fluctuating demands of business and domestic users.

The fuel of the future

What's the future? It's likely that green gas will increasingly replace natural gas, which is a significant step forward in terms of harmful atmospheric emissions – but it's not emission free. Hydrogen is, and would, therefore, be the first choice as the fuel of the future.

The problem is that being able to produce sufficient quantities of hydrogen is a long way off and it is currently unsustainable – by dint of it being uneconomic. All that being said, given the push for solutions and the rapidly increasing pace of change, within 20 years, it's likely that gas will have been phased out, replaced by hydrogen and batteries.

Batteries are the answer to a range of different issues – smoothing grid flows and providing back-up energy for data centres being two of them. The challenge is that there are very limited routes to economically building battery projects in Europe at the moment but it should only be a matter of time before a breakthrough is made.

In the meantime, Pioneer will continue to work with its partners on the sustainable energy infrastructure projects that will transition business and society to a truly sustainable future, reliant on new power sources and new technologies.

Substations and energy centres on data centre campuses will sit alongside biomass gas generators, roof-mounted solar arrays and wind-powered energy generation.

While sustainable energy infrastructure may not be the most high-profile investment play out there, it is rapidly gaining in importance and there are increasing amounts of new projects and new solutions being tabled.

What's required is the specific investment expertise.

How Green is my Data Centre?

Why true sustainability can be best achieved through direct collaboration with renewable power providers

DAMIEN GAYNOR
CMO, ECHELON DATA CENTRES

So far, metaphorically speaking, not a single little boy has stood up, pointed his finger, and said 'look, the Emperor's big green robe is no more than a fig leaf over his privates!' Do away with the metaphor – no-one, as yet, is mounting a robust challenge to the sweeping green claims and the much-vaunted sustainability credentials of the data centre industry.

Questions are being asked, of course. In January 2020, an Irish radio journalist took the data centre sector to task[1]. He claimed the real environmental cost of Irish facilities would be in the order of 1.5 million tons of CO2 per annum and that the financial cost to bill payers would be €9bn by 2027.

Walking the walk, talking the talk

The statistics were broad brush and not terribly specific, no 'right of reply' was given, and there was no real commentary on whether, or not, our industry is rising to the challenge. It was, however, a timely warning that unless we show ourselves to be walking the walk, as well as talking the talk, trust in our sector – in what we say and what we do – will be quick to decay.

In 2017, an article on datacenterfrontier.com[2] addressed the complex issue of Renewable Energy Certificates (RECs), which are a way of buying the right to say your energy is green, when, in fact, the energy you consume is not actually directly from renewable sources.

With RECs, your power comes from the grid, which is great for security of supply but means that, in reality, your power is from a mix of both renewable and non-renewable sources.

The same 2017 article then asked why data centres couldn't simply generate power on-site, and provided the logical answer that it takes a huge amount of extremely costly windmills and solar arrays to power a modern hyperscale data centre.

In 2018, another article on greenbiz.com[3] reported that one data centre operator had a "long-term commitment to 100 percent renewable energy" and had launched a series of wind and solar farm projects able to deliver around 40 percent of its energy. This, of course, has since become the norm, with Amazon Web Services (AWS) recently announcing the operational status of a 23MW wind farm in Co Cork, in Ireland.

Which is exactly how it should be. Massive global organisations, leaders in their fields, investing sizeable amounts in renewable energy generation is laudable and the right thing to do, even if it doesn't equate – yet – to green data centres.

Ultimately, and while it isn't what people want to hear, a lot of it comes down to cost and to risk. Cost in terms

Massive global organisations, leaders in their fields, investing sizeable amounts in renewable energy generation is laudable and the right thing to do, even if it doesn't equate – yet – to green data centres

of the renewable energy itself, which is improving (and would improve even more if there was a more consistent demand profile – such as that created by data centre infrastructure). Cost in terms of replacing diesel generators with batteries, and the cost of installing wind turbines and solar arrays onsite.

What might help mitigate the cost issue is giving serious consideration to locating data centre facilities nearer to existing sources of renewable power. This model is being pioneered at our DUB20 site, in an infrastructure-sharing partnership with SSE Renewables.

Relying on renewable energy sources – except in specific cases, such as Iceland, mentioned below – can, however, bring additional risk to data centre delivery.

Can operators really risk reputations and rewards on anything that has a higher risk of failure or outage, particularly at a time when operational, reliable and efficient data centres are key to the planet's ability to function? The answer is 'no', but the solution, in the short to medium term, is on-site energy centres – only used when necessary to smooth peaks and troughs, and gas-fired, therefore less harmful to the environment.

In March 2020, a piece in Ireland's Business Post[4] gave the industry a right of reply against the small, but current and popular anti-data centre swell of opinion – which, let us remind ourselves, is particularly focused on a perceived lack of real economic benefit and understated climate impact.

In it, one Irish energy company says that it is involved in the development of a 300MW site in the US "that is going to be completely powered by hydroelectricity. Likewise, we have a project in Sweden that is similarly powered by all hydro power". If so, these will be in the vanguard of data centres around the world that are wholly powered by renewable energy of whatever flavour.

In Iceland, a data centre in Reykjavik announced in February 2020 a deal with the Icelandic national energy company, Landsvirkjun, to guarantee it 100% renewable geo-thermal and hydroelectric energy.

This is extremely impressive – although unsurprising, as all energy supplied through the Icelandic grid by Landsvirkjun is geothermal and hydro-electric. Simply hooking up to the country's national grid makes a data centre wholly renewable.

Direct supply of power

More impressive perhaps is a direct line established between the source of the renewable energy and the user, in this case, a data centre. On a limited scale, this is already being achieved around the world – particularly where hyperscalers have invested in their own on-site wind and solar farms.

However, given the energy needs of the facilities and the limited generative capacity, the centres are not being powered wholly by renewables and this is where a country like Ireland presents a natural advantage for the developers of truly green data centres. With its relatively small size, more than 3,000 miles of coastline and a cool temperate climate, Ireland is suited to the development of renewable energy generation, powering nearby facilities directly.

Echelon DUB20

The potential levels of power generated by an off-shore windfarm would easily meet the needs of a hyperscale data centre – with a surplus that could be fed directly into the grid

The potential levels of power generated by an off-shore windfarm would easily meet the needs of a hyperscale data centre – with a surplus that could be fed directly into the grid. The 24/7 demand profile of data centres has long been seen as a strong economic argument for investment in renewable energy generation.

That demand could now be directly linked to the output of the generating infrastructure, in a symbiotic relationship that not only benefits both parties, but also brings benefits to the environment, economy and society within which they operate.

1) https://www.rte.ie/news/business/2020/0109/1105273-what-impact-do-data-centres-have-on-climate/
2) https://datacenterfrontier.com/buyer-beware-buying-renewable-energy/
3) https://www.greenbiz.com/article/data-green-data-centers-still-pretty-cloudy
4) https://www.businesspost.ie/connected/consumer-culture-drives-growth-of-data-centres-9bbb1bb0

Full Charge Ahead

Battery tech will perform a key role in powering green data centres

NICHOLAS HUGHES

SENIOR BUSINESS DEVELOPMENT MANAGER, EDF RENEWABLES IRELAND

Like it or not, the demand for data centre infrastructure is going to continue to grow, and at an increasing rate.

The development and deployment of AI and the IoT, the move toward smart dwellings, smart buildings, smart cities, the predicted increases in the numbers of internet-enabled devices will see the dataverse increase to an estimated 175 zettabytes by 2025.

All of this data has to be handled, processed and stored, and that requires dedicated resource. What is key, therefore, is that the necessary infrastructure is sustainable and has a limited environmental impact and does not stand in the way of climate change action plans.

Renewable energy powering data centres is a given – however, beyond that, consideration must be given to the storage of power to fill gaps in supply (wind and solar) and to supplant traditional methods of back-up power generation, such as gas or diesel generators.

Balancing the grid

EDF has been investigating and deploying battery storage projects for the last 10 to 15 years, starting with research and development projects. The early projects were small in size (ca. 1MW) and mainly for demonstration purposes; however, as our expertise and knowledge of batteries increased, this was mirrored in the scale of our ambition.

The development and deployment of AI and the IoT, the move toward smart dwellings, smart buildings, smart cities, the predicted increases in the numbers of internet-enabled devices will see the dataverse increase to an estimated 175 zettabytes by 2025

In early 2018, EDF delivered a 49MW project at West Burton (Nottinghamshire, UK), developed as part of a UK-wide 200MW frequency response system to balance the grid. This battery has 30 minutes (generation) duration and is currently performing balancing services to the UK's National Grid.

At the time, the project was considered one of Europe's largest in terms of its power capacity, As part of its 'Plan Stockage' (or Plan Storage in English) ambition released in March 2018, EDF is developing a large portfolio of battery storage projects, primarily of lithium ion technology, covering several geographies such as the UK & Europe and the USA.

The industry has seen rapid progress over the last few years with the main focus of R&D being on developing cells that are denser and more efficient, thus driving further cost reduction and higher performance.

Advances in battery storage come primarily from the electrical vehicle sector, with two key factors being economies of scale and the huge scale of R&D funding spent by the leading cell manufacturers

As an example, EDF's West Burton 49MW (30mins) project could now be built on the same footprint, and with a similar capacity, but charge/discharge its energy over a one-hour period – effectively double the usable energy in the same physical area.

The advances in battery storage come primarily from the electrical vehicle sector with two key factors being economies of scale and the huge scale of R&D funding spent by the leading cells manufacturers. Since 2015, there have been several advances made in terms of improved efficiency and density.

Lithium ion battery projects were designed to be of 30-minute duration for most projects throughout 2016-18 in the UK, which moved to one-hour duration in 2019, enabling them to capture several revenue streams. This trend is increasing worldwide, with projects in the USA, coupled with large solar farms, having deployment duration of between four and six hours (and a similar time taken to charge).

It is expected that more services will be covered by battery storage, or other storage technologies – including those of backup power provision to the data centre sector

Batteries replacing generators

Battery storage is already displacing traditional assets for grid services (e.g. frequency services) and it is expected that more services will be covered by battery storage, or other storage technologies – including those of backup power provision to the data centre sector.

EDF Renewables has presence in all global markets and has start-up, innovation companies that are looking at UPS solutions – these are in the very early stages and a lot more work is needed, but the direction of travel for this technology gives us confidence that the application of battery solutions could be back up supply for data centres to displace carbon intensive diesel sources.

With the improvement in efficiencies that the industry has seen in the last five years and the scale of investment in the R&D of batteries, it is entirely plausible that emerging battery technology could change the way back up generation and peaking generation is utilised in many industries.

Diverse energy mix

In summary, EDF as a leading low-carbon generator believes a diverse energy mix, including energy storage, will have a key role to play in a sustainable future, whether in supporting the grid, accelerating the penetration of renewables or enabling a more sustainable offering in industry sectors, such as the provision of data centre infrastructure.

Over the next five to 10 years the scale of change of battery technology will herald an incredibly interesting time, particularly if we see the same improvements in efficiency and cost as we have seen in the past decade. Working with partners to exploit new uses for batteries is a natural next step for EDF to facilitate the delivery of exciting new solutions.

Waste Not, Want Not

How biogas can provide reliable, eco-friendly power generation for data centres

DECLAN MURRAY

MANAGING DIRECTOR,
BIOCORE ENVIRONMENTAL LTD

The data centre sector consumes a significant proportion of the developed world's energy – yet without data centre infrastructure, we would not enjoy the current benefits of modern technology (mobile devices, the Internet of Things, machine learning) or be able to embrace the future (smart cities, driverless cars, virtual reality).

As the world comes to terms with the reality of climate change, the drive to replace fossil fuels with sustainable alternatives and the need to stop generating waste are now imperatives. Reduce, reuse, recycle – it's a mantra that we're all familiar with.

The race is on to see data centres powered cleanly and sustainably, with back-up power systems that are also driven by renewable power. What, however, if unused waste – such as food waste and farm slurry – could be harnessed to provide a constant source of power, as well as a variety of useful by-products?

And what if the infrastructure to generate the power could be sited close to data centre campuses, and use waste products (such as heat) from the facilities to assist in their operations?

A virtuous cycle

Biogas – a rough 60/40 split between methane and carbon dioxide with traces of oxygen and other gases – is produced through the process of anaerobic digestion. This process – likened to the workings of a cow's stomach – breaks down organic material (feedstock) to produce the gas, efficiently, constantly and reliably.

A biogas plant – like the Biocore facility in Co Roscommon in Ireland – can be fed from many different sources. Most are waste products such as food waste and farmyard slurry, although, if the price and availability are right, the process can use 'energy crops' such as maize and beets.

The gas produced can be used in two ways. It can be cleaned up – by removing the CO2 content – and then fed into the national gas system, as methane is indistinguishable from natural gas and can be used by all gas appliances without any modification or amendments. It can also be used to power generators, producing electricity to be fed into the national grid.

A by-product of the power generation process is heat. As much as 60% of the biogas fed into a combined heat and power (CHP) generator produces heat. This is used to dry the 'digestate' – what's left of the feedstock after the anaerobic digestion (AD) process – transforming it into a high-quality fertiliser with significant demand from the agricultural sector.

If the biogas is destined for the national gas network, the carbon dioxide that remains after the cleaning process can be liquefied and supplied to the food industry where it is used for carbonating drinks and producing dry ice, amongst other applications.

Biogas generation is a virtuous cycle – starting with waste, the waste is exploited for the gas it can produce, the gas feeds into the nation's grid or gas supply (and its by-products into the industrial food sector), and the spent waste is dried (using excess heat) to become a valuable resource for agriculture. Nothing is left unused.

As, or perhaps more, importantly, is the associated impact on carbon emissions. While unburnt methane is a greenhouse gas, when it is burnt it gives off more

heat and light than its hydrocarbon equivalent and results in lower carbon emissions.

A 2MW biogas facility, processing 50,000 tonnes of feedstock every year, produces enough gas to power 3,000 homes (the equivalent of 6 wind turbines) and biogas production, combined with wind and solar, is contributing to weaning the economy away from fossil fuels.

Under-exploited potential

Ireland has yet to fully embrace the potential of biogas like, for example, Denmark, where the waste from the pig-farming industry feeds large biogas generating operations. There are a handful of smaller operations around the country, but many of them are 'bolted-on' to large farms, providing a method of dealing with animal waste in the months when slurry cannot be spread on the fields.

This situation is changing as companies such as Biocore unroll their plans to capitalise on the opportunity. While the Roscommon facility currently has a capacity of 1MW, the company has plans for bigger plants on the island of Ireland, with capacities ranging between 2 and 2.5MW, within a five-year time frame.

One of the issues, however, is that the state appears slow to appreciate the possibilities presented by biogas, seemingly content to pay fines to the EU for missing renewable energy targets, rather than investing that money in developing new and additional ways of meeting those targets.

Clearly, biogas production – the AD process and projects such as those envisaged by Biocore – is not a silver bullet. The energy provided by these facilities is more expensive than traditionally-generated energy. But it is reliable, it is clean and it is sustainable – and it brings with it a raft of other solutions impacting other industry sectors.

AD is more complex than solar or wind – even if it's not dependent on the vagaries of the weather – and it needs to be carefully managed, all day, every day, to optimise output. The process operates within a very specific operating temperature window of 35-39 degrees Celsius, and thus requires a constant source of heat.

The state appears slow to appreciate the possibilities presented by biogas, seemingly content to pay fines to the EU for missing renewable energy targets, rather than investing that money in developing new and additional ways of meeting those targets

A symbiotic relationship

Heat is, of course, one thing that a data centre produces in abundance and which represents one of the bigger challenges that the data centre sector faces. Aside from the issue of excess energy consumption in cooling processes – and hence the focus on alternative solutions such as liquid cooling – there's also the question of how that heat might be used in a sustainable manner, facilitating ancillary processes and bringing benefit outside of the data centre's primary function.

Much has also been said about making on-site sustainable power generation a part of a data centre's development plans – wind, solar and AD. This is not to power the data centre itself, as the energy demands of the new hyper-capacity facilities are beyond that, but (amongst other, local and community uses) to provide charge to large-scale battery storage to supplant diesel-powered back-up generators.

Thus the idea of co-locating an AD facility on a data centre campus makes a compelling case for itself, particularly where data centres are based in rural locations with greater site availability.

There is a natural symbiosis between the two operations – the data centre supplying heat for the AD process and the resulting gas being used (in part or completely) by CHP generators to provide power to the battery arrays that stand by in the case of power outages to the data centre.

As part of this quasi-circular environment, the heat produced by the generators cycles back to the AD facility to dry the feedstock digestate into fertiliser products for supply to the agriculture sector.

Clearly, as the AD facility is producing a constant flow of biogas, a proportion will be available for cleaning and provision to the gas network – something that would need to factored in to site selection and campus development.

One of the uses of the carbon dioxide that is liberated from the gas purification processes – in addition to the food sector applications – is as a fertiliser, which raises the possibility of siting greenhouses on data centre campuses.

Heated with a by-product of the DC's operation and fertilised with a by-product of the AD process, such facilities might provide a sustainable source of local ingredients for supply to the local HQs of the data centres' customers.

The future holds further possibilities for the working relationship between biogas facilities and the data centres sector – and one of them is the advances being made in fuel cell technologies. Hydrogen is the gas normally mentioned when fuel cells are discussed, but the issue continues to be the cost of hydrogen production.

In 2018, however, a fuel cell was developed in a laboratory that could be powered by methane, rather than hydrogen and that operated at a (relatively) low temperature of around 500 degrees, cooler than the operating temperature of an ICE.

Innovations such as these could see biogas produced by AD powering data centres directly, without the need for generators. They could also see biogas being used as a sustainable fuel for the next generation of electric vehicles and becoming an established fixture in a low-carbon, renewable future.

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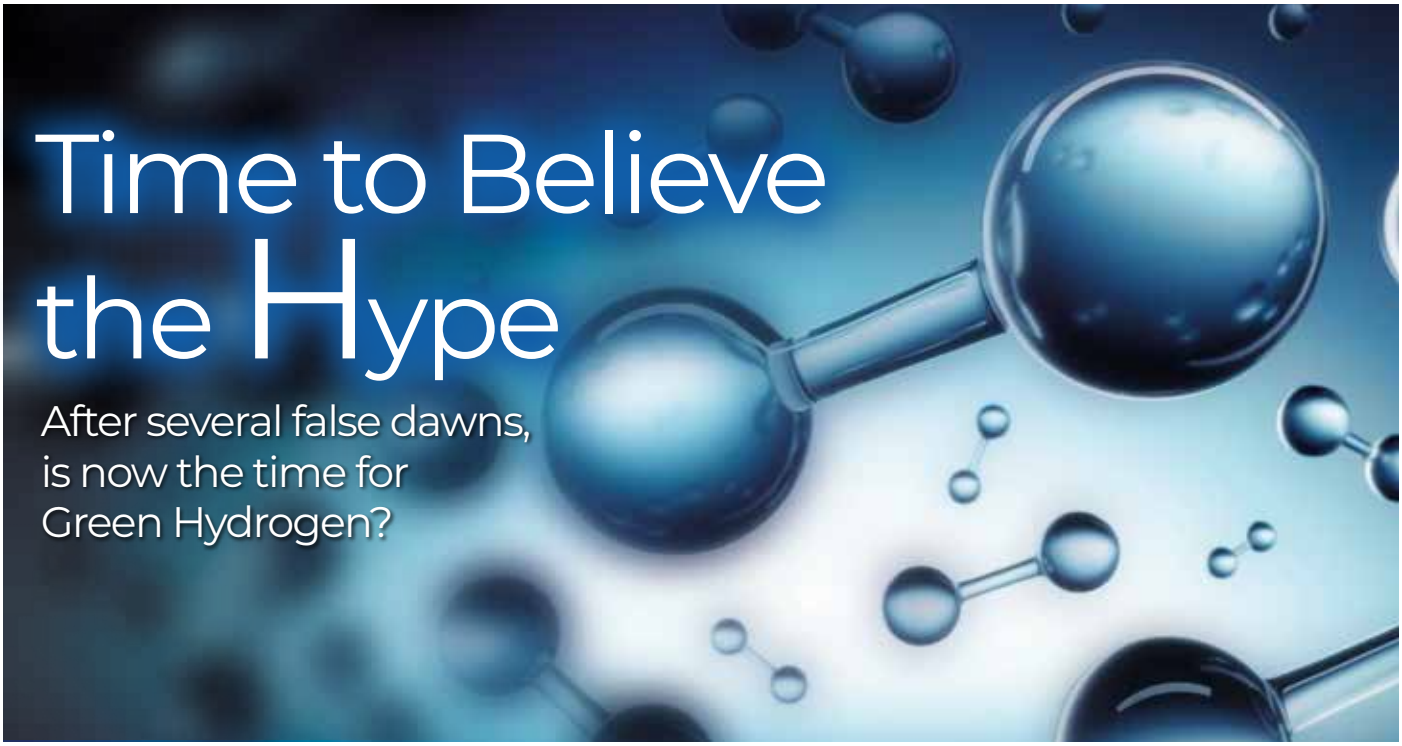
About Biocore

BioCore Environmental Ltd was founded in 2010 and is a leading company in Ireland's organic waste management sector. The Company follows the reduce, reuse, recycle philosophy by actively implementing sustainable management solutions for our client's organic waste streams. Biocore Environmental Ltd currently service a number of public and private clients, including Irish Water, in numerous locations nationwide. Our commitment is to utilise these organic waste streams for renewable energy generation and the implementation of innovative solutions with our partners and customers to provide mutually beneficial long-term solutions which reduce the carbon footprint of our economy. Our operations are conducted under certified ISO Management Systems for ISO 9001 Quality, ISO 14001 Environmental and OHSAS 18001 Health & Safety.



Time to Believe the Hype

After several false dawns, is now the time for Green Hydrogen?

DR RORY MONAGHAN

DIRECTOR OF ENERGY SYSTEMS ENGINEERING, NUI GALWAY

Lost among the headlines of Brexit deals, Covid-19 case numbers, and political upheaval in the United States, a quiet revolution is taking place in the EU's energy and decarbonisation strategies.

At the centre of it is hydrogen, or to be precise, renewable or 'green' hydrogen. Until 18 months ago, I can say with personal experience that hydrogen was the preserve of a fringe within the energy research and policy communities. A technology that has always captured the imaginations and promised so much, yet ultimately failed to deliver at the scale needed to make a difference.

Hydrogen hype has come in waves, the last one crashing in the early 2000s, just as I finished my Masters in hydrogen technology at MIT. I, like many others, segued to related fields of research, but hydrogen always maintained its attraction. And why not? Hydrogen has a lot going for it. It is a clean-burning energy carrier – not a 'fuel' but more on that later – whose only emission is water vapour, it has tremendously high energy density per unit mass, it can be used with very high efficiency to produce power and heat in fuel cells, and it can be made relatively easily by combining water and electricity in an electrolyser. When this electricity is renewable, so is the hydrogen, hence the moniker 'Green Hydrogen'.

Hydrogen is akin to a battery capable of storing renewable electricity, but unlike a battery, it does not need to provide its stored energy as electricity again. Green hydrogen can therefore indirectly feed renewable electricity to end-uses that are very difficult to electrify directly, like heavy duty transport, ships, aircraft, and industrial heating. In a second difference to batteries, green hydrogen is practical for storing large amounts of energy, in the megawatt-hour to gigawatt-hour range, for very long periods of time, from days to potentially months.

So why is green hydrogen not ubiquitous? To start, it is the lightest gas, so therefore difficult and expensive to handle. Converting electricity to hydrogen and back to electricity has much lower efficiency than batteries. The high amount energy of energy needed to make hydrogen is why we use the term 'energy carrier' instead of 'fuel'. But most importantly, when compared to other forms of energy, hydrogen is expensive to make, move and use.

What is different this time?

Three key drivers have pushed green hydrogen to the centre of the EU's energy agenda. First, technology improvements and manufacturing at scale have drastically reduced equipment costs in the last decade. Secondly, the current focus on deep decarbonisation across all energy use sectors (not just electricity, but in the transport and heating sectors mentioned above) and eventually to net zero, has brought hydrogen into focus for very different reasons than previous hydrogen bubbles.

However, the most important factor driving interest in green hydrogen is the exponential growth in cheap renewable electricity, especially wind and solar, which accounts for 70-80% of the cost of producing hydrogen. These drivers have led the EU to develop an Energy System Integration Strategy, with green hydrogen at its core, and a separate Hydrogen Strategy for a Climate Neutral Europe, which envisages 10 million tonnes or 300 TWh of annual green hydrogen production by 2030.

National hydrogen strategies were released in 2020 by Spain, Portugal, France, Germany, Norway, and the Netherlands, with more to follow this year. By the end of this decade, green hydrogen will be powering trucks,

buses, trains and ships, heating homes and factories, fuelling the production of green steel, and storing wind and solar power across Europe.

An opportunity for data centres

Unlike many of the countries that have announced hydrogen strategies, Ireland does not have many heavy industry users of energy, but it is home to a growing data centre sector which could account for up to one-third of electricity demand in 2030. The recently announced requirement that new data centres planned around Dublin will be granted a grid connection only if they install their own on-site generating capacity potentially presents a hydrogen opportunity to operators. Electricity from these on-site generators, many of which are fuelled by natural gas, is more CO2-intensive than grid power. But what if the gas supplied to these generators could be replaced by green hydrogen?

The major bottleneck in hydrogen rollout is likely to be on the demand side. Without a steady demand for hydrogen, investments in electrolyser and hydrogen supply chains will not materialise. However, as with other renewables, demand from data centres can provide the business case for investment in the production of green hydrogen.

Current on-site gas engine and gas turbine technologies are currently limited to 5% hydrogen content in their fuel, but 100% hydrogen models are due to be launched by the major OEMs from this year on. This would mean data centres could provide their own zero-carbon on-site energy during periods of grid congestion or even during periods of high grid-power prices.

The clusters of data centres in and around Dublin also offer the prospect of ‘hydrogen hubs’, in which a number of hydrogen producers and/or users pool their resources for cost-efficient on-site electrolysis and localised distribution

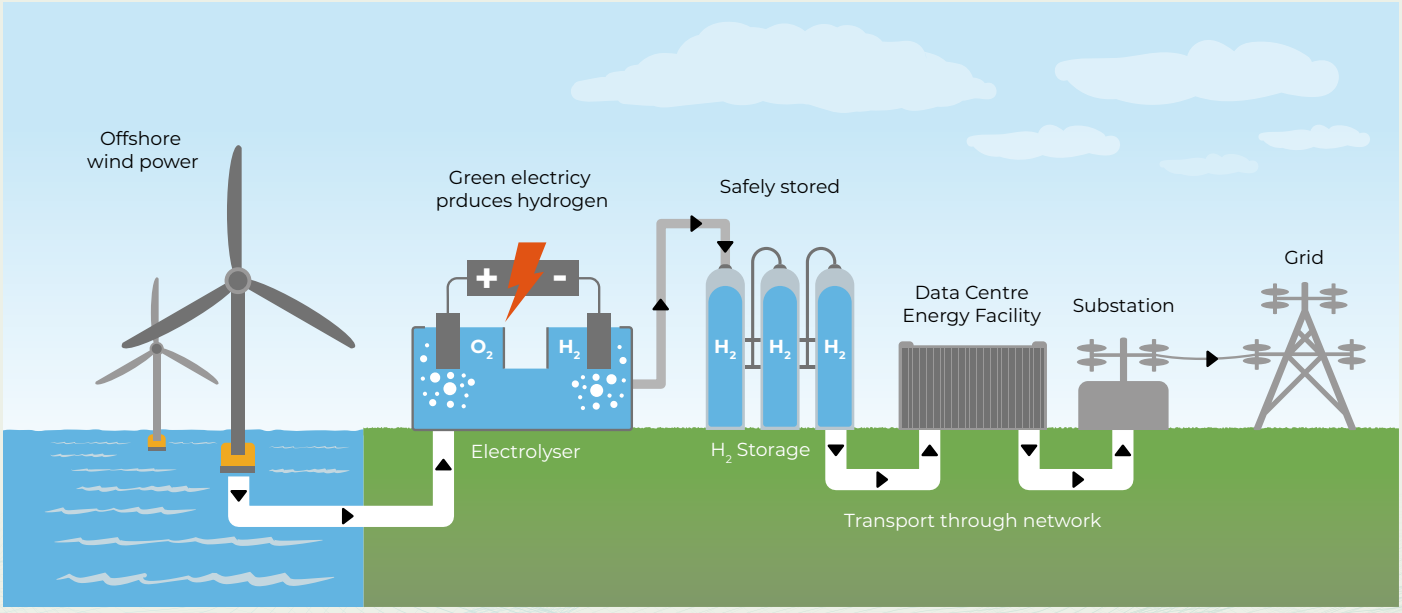
Initial supply chains of green hydrogen to data centres would likely take the form of high-pressure tanker truck deliveries, but large-scale adoption could quickly change that. The Irish natural gas grid is one of the most modern in Europe, and the plastic construction of the low-pressure distribution network means that very high concentrations of hydrogen could be delivered to gas customers, including data centres with on-site generators.

The clusters of data centres in and around Dublin also offer the prospect of ‘hydrogen hubs’, in which a number of hydrogen producers and/or users pool their resources for cost-efficient on-site electrolysis and localised distribution (via truck or pipeline). The addition of, for example, hydrogen filling stations for local truck and bus fleets would further improve the commercial viability and reduce the risk of green hydrogen. Given that many data centres are now powered by corporate PPAs with renewable generators, this hydrogen produced onsite could be certified as renewable. While there currently exists no Europe-wide green hydrogen certification scheme, a number, including the EU-funded CertifHy project, are close to realisation.

Looking further to the future, a number of developments may transform how data centres are powered. Fuel cells are electrolysers in reverse that can produce electricity from hydrogen 50-100% more efficiently than engines or turbines. Fuel cells, which are widely used for powering data centres in California, have seen their costs tumble in the last decade. Microsoft is investigating their use to provide 100% renewable backup power at its data centres.

But hydrogen and fuel cells could also play a role beyond backup and peak-shaving applications. High-efficiency fuel cells coupled with heat-driven air-conditioning technologies, such as absorption and adsorption chillers, offer the prospect of vastly more energy efficient data centres supplied exclusively by renewable hydrogen, while at the same time enabling more renewables through electrolysers and data centres providing grid balancing and demand side management.

Given the current debate on energy consumption and emissions in the data centres, the time is right for the industry to take a close look at green hydrogen.



The Liquid Cooling Principle

Making sustainable innovation a reality

AIDEN CALLALY

REGIONAL DIRECTOR
UK & IRELAND,
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If you ever had the pleasure of visiting a Greek island, you probably have some unforgettable memories: mythological landscapes, small villages kissed by the Aegean sun, and dozens of Orthodox churches scattered everywhere on dry hills populated by thorny bushes and the occasional goat.

The buildings on Greek islands look identical, with white walls and blue roofs. This architecture is not only for aesthetic purposes (although it is much appreciated by tourists) – the main reason has much more practical implications: summers in Greece can be very hot.

But even on the hottest afternoon, under a scorching sun, you'd be amazed at how cool the white walls feel, both inside and out. These buildings are built according to a 'cooling' principle. When I was in Greece a couple of summers ago, I found myself thinking about data centres... The 'Data Centres and The Environment' annual report by Supermicro depicts a harsh reality, to say the least. According to a survey of more than 5,000 IT experts, 88% of data centres are not eco-friendly.

These figures only show the tip of the iceberg, pun not intended. The really worrying part is that according to the report, most of the big players in the data centre industry tend to not consider the environmental impact with the same level of priority or importance, in comparison to data centre costs, infrastructure expansion, performance efficiency, etc.

Put simply, money comes first – and while you cannot blame companies for wanting to achieve maximum profit, what is less justifiable is the tendency to remain stubbornly attached to an old, obsolete way of doing business that blithely ignores the impact it is having on the environment.

An irrefutable necessity

There is considerable debate around themes such as decarbonisation and sustainability in many industries, including aviation, automotive, and agriculture – to name just a few. These are also considered the industries with the highest levels of pollution. Some companies

are setting, perhaps too enthusiastically, plans of achieving net-zero carbon emissions in the next 20-30 years. Where do data centres fit into this debate? How necessary are they? Could the world survive without data centres?

Put simply, no. Society is now so reliant on data centres to carry out simple tasks, that their sudden disappearance would have a drastic impact on life as we know it. Not to mention the effects on communications, transportation, work, health system, economy, etc. All vital components of the life we have grown accustomed to.

Data centres are currently responsible for 5-10% of total electricity consumption (along with the IT sector) and approximately 0.3% of global carbon emissions. Perhaps not yet a cause for concern, yet according to recent predictions, by 2025, data centre energy consumption

will account for 3.2% of worldwide carbon emissions, and by 2040, the industry will be responsible for 14% of global emissions.

We live in a deeply connected world that is fast becoming hyper-connected. This transition is inevitable and cannot be executed without data centres.

Given the digital growth rate projections for areas of the world where the internet has only just become widely adopted, it is likely that society will become increasingly reliant on data centres. For this reason, the sector must find alternative solutions to promote sustainable innovation – investing in renewable energies and open source solutions, creating a circular economy, and utilizing efficient software and smart hardware design. The industry must also avoid uncontrolled growth.

Global hyperscalers such as Apple, Facebook, Amazon, Google and Microsoft, have promised, or have already begun to adopt policies to dramatically reduce their carbon footprint or become carbon negative. This is a good first step but there's a long road ahead.

A three-pillar strategy

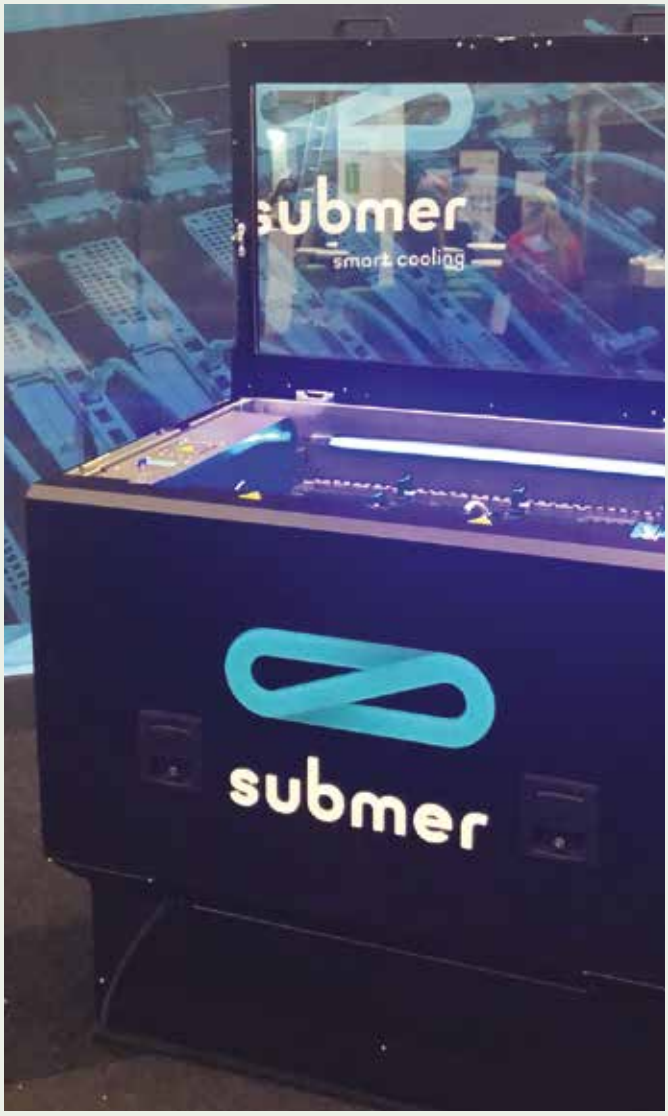
Economic, Environmental and Social needs are the three pillars around which the (r)evolution of the IT sector will be built. Too often, Total Cost of Ownership (TCO) and return on investment (ROI) are the primary metrics that data centre managers use to determine their success.

Instead, we should perhaps start considering data centres as a sort of orchestra, where all the elements strive to work together in harmony and each one contributes to the success of the collective execution. That is to say, there are a number of factors and changes - such as adopting energy efficiency solutions, software and hardware design, liquid cooling solutions, smart buildings, the circular economy – that are needed in order to achieve substantial savings on power usage and water consumption.

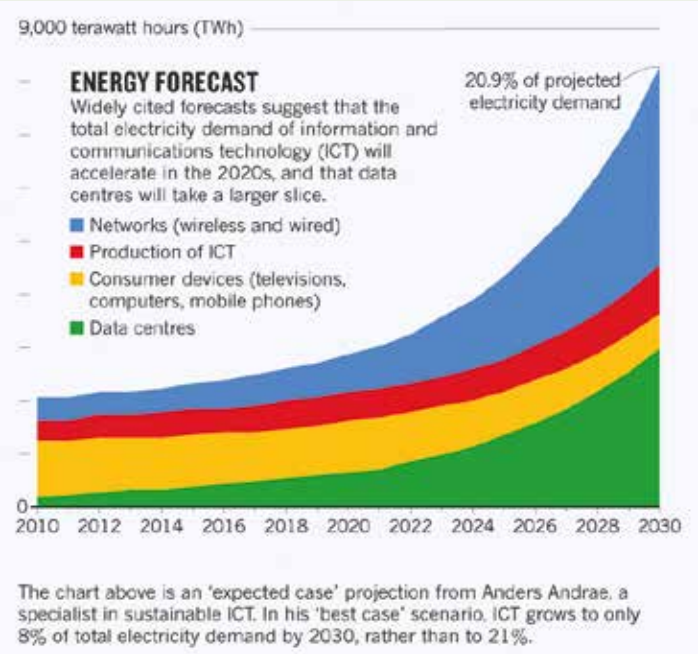
Be smart, stay cool

These savings could then be used to invest in more IT equipment, which would translate into more IT hardware density and, consequently, improved performance. Be smart, stay cool, much like the evolutionary process which led to buildings with thick, white-washed walls and blue roofs providing efficient and effective shelter from the Greek sun, technology is also advancing to meet the needs of the data centre sector.

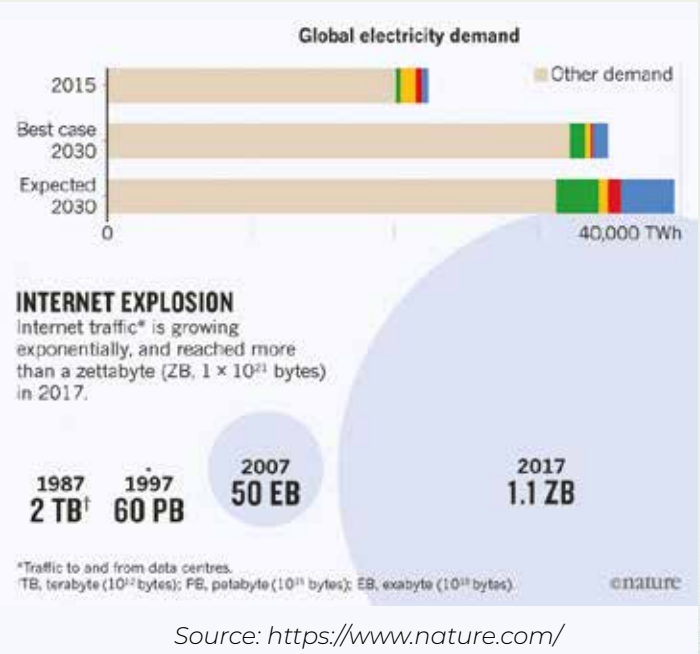
In a conventional data centre, about 40% of the electricity is used by the cooling system. Therefore, it is



not surprising that this a key focus area for innovation and solutions to help manage energy efficiency in the next-generation of data centres – innovations such as liquid-cooled servers. These can allow HPC, hyperscalers, data centre, edge, AI, deep learning and blockchain applications to increase efficiency by significantly lowering cooling and space costs while achieving unrivalled compute densities.



The chart above is an 'expected case' projection from Anders Andrae, a specialist in sustainable ICT. In his 'best case' scenario, ICT grows to only 8% of total electricity demand by 2030, rather than to 21%.



Source: https://www.nature.com/

Submer's SmartPodX Advanced Immersion Cooling units are a great example of how this can be accomplished. Instead of spacing servers out on vertical racks, the SmartPodX can store even the most advanced servers in special, horizontal tanks filled with SmartCoolant, a proprietary dielectric fluid.

The SmartCoolant has a high heat transfer coefficient and a specific heat greater than air. This can allow data centre operators to achieve:

- Up to **95%** savings on cooling costs (corresponding to about **50%** of the electricity consumption)
- Up to **85%** savings on physical space (along with a completely silent machine hall due to the absence of fans)
- Up to **50%** OPEX savings and **25%-40%** CAPEX savings
- A **60%** reduction in IT hardware failure rate because the coolant removes heat away from the cores and protects the servers from dust abrupt changes of temperature and moisture
- A **30%** increase in IT Hardware life-span

According to a 2019 survey, for the first time in the last 12 years, the energy efficiency of data centres slightly declined, from an average Power Usage Efficiency (PUE) of 1.58 in 2018 to 1.67 in 20192.

This is not a result we want to see. What kind of impact does a liquid or immersion cooling system offer? Submer Immersion Cooling systems, for example, can guarantee a certified PUE score of 1.03 – without having to move your data centre to cold-climate regions.

In a conventional data centre, about 40% of the electricity is used for the cooling system, so it is little surprise that this is an area where technology innovators are providing solutions for next generation data centres

The power and cost benefits of liquid-cooled servers are clear – and the environmental benefits follow these. Coolants are biodegradable and heat can be captured and reused to heat the data centre building itself or a nearby urban or industrial area.

The circular economy has economic, environmental, and social benefits. Sustainable innovation rather than uncontrolled growth. Data centre operators must change their way of operating and take accountability and responsibility towards energy consumption and sustainability. Now that would be really cool!

About Submer

Submer makes operating and constructing data centres more sustainable and efficient. We enable next-generation cooling and automation for data and energy-intense environments

by integrating our pristine, highly-efficient and sustainable technologies. Solving the challenges of today and powering the use cases of the future.

1) The number of data centres worldwide has grown from 500,000 in 2012 to more than 8 million today, according to IDC.
2) Source: https://journal.uptimeinstitute.com/is-pue-actually-going-up/

Power and Responsibility

Mitigating energy demand through innovation and efficiency is the true test of data centre sustainability

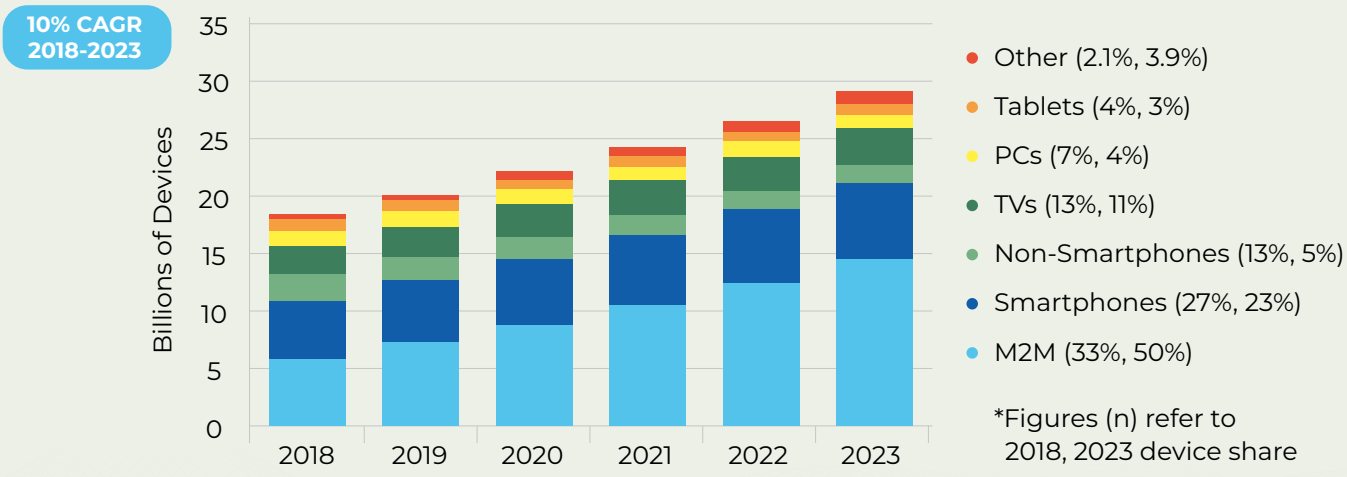
DAVID MCAULEY

FOUNDER AND CEO,
BITPOWER ENERGY SOLUTIONS

Our global appetite for digital has grown to an average of three devices for every human on the planet. This trend is set to continue, with CISCO identifying M2M (machine to machine) applications as leading the charge into the future.[1] The majority of these devices will rely on cloud communications, built upon platforms that comprise sophisticated software and hardware systems networked between and across regions.

Technology companies utilise data centres linked by international fibre cables to provide the backbone for all the internet and cloud services we rely upon in the modern world. These services have been consolidated by a small number of key players into scalable platforms made available to businesses wishing to grow in the cloud. These centres house all kinds of businesses ranging from video streaming to email, and from e-commerce to social media. Sustainability is more relevant than ever, with the realisation of climate change now acknowledged by corporates. Due to the global pandemic, the cloud has become more important than ever in ensuring our world can continue to function.

Data centres tend to cluster where the subsea fibre connections land. They also require proximity to each other in order to facilitate the rapid transfer of data between services. This leads to concentrations of capacity in various regions. In Europe – Frankfurt, London, Amsterdam, and Paris grew data capacity due to their financial centres. But now other regions such as Dublin and Stockholm are host to clusters of new hyperscale datacentres providing cloud services for the



Source: Cisco Annual internet Report, 2018-2023

Figure 1 - Growth in Connected devices by 2023 - Source: Cisco Annual Internet Report, 2018-2023.

European region. Odense, Oslo, Lulea, Warsaw, Hamina, Madrid, Munich, Milan, Vienna, Zurich and Bilbao are all part of this growing landscape.

These concentrations of large data centres pose challenges for grid operators in delivering power capacity. Coupled with this is the change in the electricity supply system to accommodate variable renewable energy technologies, such as wind and solar. The energy system is rapidly evolving away from a hierarchical system of large generators to a distributed system of engaged participants tied together by smart technologies and policy incentives.

Data centres are highly engineered nodes in the power system. They use sophisticated systems to ensure stability and resilience. These systems have the capability to support the changes required to make the power systems more sustainable. In a changing energy system, data centres will be one of the key players.

Digitalisation enables significant improvements in how we develop sustainable solutions, including e-mobility, smart heating control, industrial automation and optimised inventory management. The list of affected sectors is endless. Data analysis (Big-Data) is a critical tool in tackling the global challenges of sustainability, resource management, and – most importantly – health.

Those providing the tools to enable all this change must have sustainability at the forefront of their strategies. They must balance the growing demand for their services with the active facilitation of the transition to a more sustainable world. In this paper, I would like to talk about energy and data centres.

Efficiency of data centres

According to the International Energy Agency (IEA), the total global data centre energy demand remained steady at about two hundred terawatt-hours (TWh) annually between 2014 and 2020.[2] While this seems at odds with the growth of data centres, it can be explained by the migration out of inefficient server-rooms into purpose-built and optimised cloud and hyperscale data centres (see Figure 2). Businesses moving into the cloud can grow their global IT presence with less power. There is an economy of scale in large data centres.

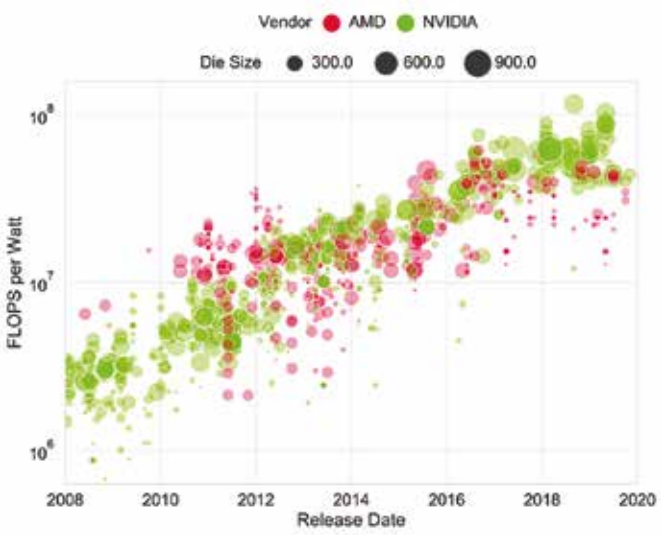


Figure 3 - Exponential performance improvements in GPUs 2008-2020.

The servers and IT systems that deliver the main function of data centres perform lots more operations per unit of energy than previous generations. For example, a 2019 paper published in DeepAI[3] demonstrated that GPU energy efficiency is exponentially increasing, with FLOPS per watt doubling every three to four years (see Figure 3).

Hyperscale data centres were designed at an average power density of 8kW per rack in 2020, with capability for hotspots up to 30kW per rack for localised AI applications. These facilities can typically be cooled using free-air cooling methods with some water (adiabatic cooling) for warmer days. There is a trend towards higher rack densities, with the key barriers being power delivery and heat removal. In these circumstances, direct liquid cooling technologies become viable.

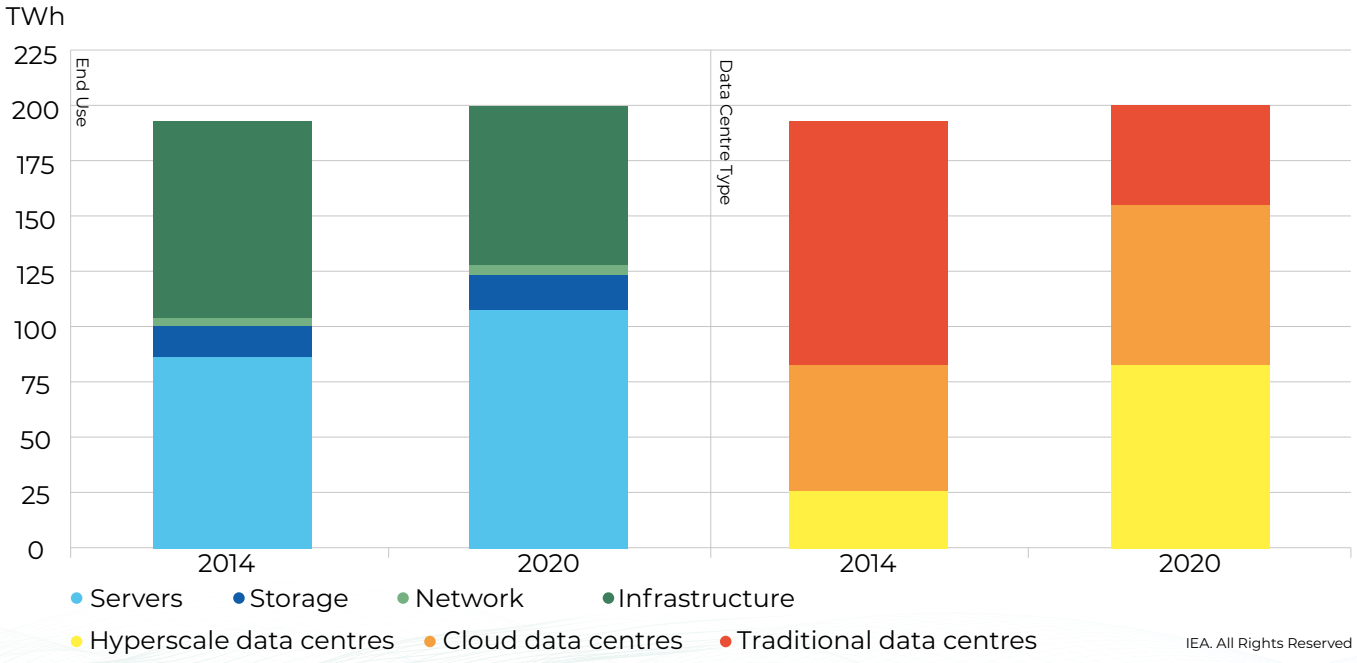


Figure 2 - Total global energy use in datacentres - IEA Digitalisation.

When the air-conditioning and cooling overheads are compared with the IT power requirement, a metric called PuE is often used in the industry. Over the past decade, this overhead has been reduced from equivalent of the IT load (PuE 2.0) to just 15% of the IT load (PuE 1.15) in hyperscale data centres. Almost all of the power feeding a data centre now reaches the IT equipment to deliver the service. Data centre designers over-provision power system capacity for days when the PuE might reach 1.35. In operation, continuous monitoring of PuE is a useful performance metric for a data centre facility.

The improvements in efficiency of data centres included virtualisation (software optimisation and load-sharing), air separation (hot and cold aisles), direct DC, better batteries and UPS systems, OpenCompute[4] standards and free-air cooling. This journey will continue, but data centres now have an opportunity to become carbon negative with a number of strategies.

Renewable energy supply

One way to achieve sustainability is to generate or procure renewable energy. Generating sufficient renewable energy on site is maybe a little impractical, though about 5% of a data centre's annual electricity demand could be delivered through roof-mounted solar PV panels. The challenge will be to fit this in with roof-mounted air systems, but it can work if designed carefully at the outset. Procuring green electrons through the grid is more practical.

Most European grids now include a growing percentage of renewable generation from hydro, solar, and wind. Standard grid electricity continues to improve its green credentials. Ireland, for example, has the highest penetration of onshore wind generation in Europe, with over 32% of grid electricity generated from wind energy in 2019. Other renewable sources bring the total renewable supply to almost 40%, hitting the government's 2020 target. The new target is 70% by 2030, and the most recently announced renewable supports will facilitate the deployment of more wind and solar assets.

To reach 100% renewable supply, most corporates use global or regional procurement strategies. Guarantees of Origin (GoOs) are not as transparent as they could be unfortunately. They can allow a country to consume more renewable power than it generates, which leads to negative PR or to a perception of greenwashing. A more credible option involves entering into direct power purchase agreements with wind or solar farms. Tech companies have globally signed some of the biggest renewable energy deals in recent years. Taking it a step further would be to ensure such PPAs are from unsubsidised projects – i.e. they bring "additionality". The question of local renewables may also be a factor – is the power actually physically able to reach the data centre, at least theoretically? Going beyond this for the absolute gold standard would account hourly for renewable power delivery – i.e. matching the site load to availability of renewable power locally.

Data centre power infrastructure and resilient architecture can be leveraged to help the electricity grid to absorb more renewable power if the right market mechanisms are in place. Simply allowing a UPS system to operate bi-directionally can help grids to achieve the levels of reliability which would otherwise become more difficult to achieve with increasing renewables. Most jurisdictions have multiple grid services schemes that could be lucrative revenue streams for data centres. This is an evolving space, with demand flexibility being much more central to grid infrastructure development than in the past. To date, there is no recognised method to account for the carbon savings enabled by participation in grid services – such a method would be welcome and might help facilitate engagement in grid services schemes.

Most European grids now include a growing percentage of renewable generation from hydro, solar, and wind. Standard grid electricity continues to improve its green credentials

Evolution of data centre power architecture

The data centre power-chain is a tried-and-tested architecture offering resilience and certainty of continuous power to critical services. Uptime is a central part of the data centre offering. Changing any part of the arrangement is risky, at least contractually. The challenges are less technical (proven solutions exist), and more commercial. We can introduce hydrogen fuel cells in place of diesel backup generators, we can operate in tandem with the grid, and we can build more flexible operations. But making these changes will require a stronger effort in terms of trust and commitment by data centre operators, their customers, grid operators, and policymakers.

Sustainability commitments

In Europe and the United States, the data industry is made up of a small number of key players. This should make tracking their sustainability commitments simpler. In the past 12 months, we have seen some of these corporates announce big sustainability commitments. There is a growing sense that these companies are taking climate change seriously and they understand the benefits that can be gained from sustainable business practices. Some of their policies and announcements are detailed below:

- In January 2020, Microsoft announced its plans to become carbon negative for all of its operations by 2030. This includes Scope I, II, and III emissions.[5]
- In July 2020, Apple announced: "Apple commits to be 100 percent carbon neutral for its supply chain and products by 2030".[6]
- Alphabet (Google parent company) – "Alphabet Issues Sustainability Bonds To Support Environmental And Social Initiatives".[7] Google's 24x6 carbon-free project.[8]
- Facebook – "We're committed to reducing our greenhouse gas footprint by 75% and reaching 100% renewable energy in 2020".[9]
- Amazon (AWS) sustainability commitments.[10]
- Equinix Sustainability.[11]
- Echelon Sustainability.[12]

Some of these strategies extend beyond energy and operations into supply chain and product lifecycles. Some are helping to develop solutions for a changing planet. These companies are influential, and their decisions can trigger global impacts, both positive and negative. This space will be interesting to watch over the coming years.

1) Cisco Annual internet report (2018-2023): https://www.cisco.com/c/en/us/solutions/collateral/executive-perspectives/annual-internet-report/white-paper-c11-741490.pdf
2) IEA, Global data centre energy demand by end use and data centre type, 2014-2020, IEA, Paris https://www.iea.org/data-and-statistics/charts/global-data-centre-energy-demand-by-end-use-and-data-centre-type-2014-2020
3) DeepAI Paper: https://deepai.org/publication/summarizing-cpu-and-gpu-design-trends-with-product-data
4) OpenCompute Project: https://www.opencompute.org
5) Microsoft Sustainability: https://news.microsoft.com/climate/
6) Apple Sustainability commitment to 2030: https://www.apple.com/newsroom/2020/07/apple-commits-to-be-100-percent-carbon-neutral-for-its-supply-chain-and-products-by-2030/
7) Alphabet sustainability bonds: https://abc.xyz/investor/news/releases/2020/0803/
8) Google 24x7 Carbon-Free Project: https://sustainability.google/projects/24x7/
9) Facebook Sustainability - https://sustainability.fb.com
10) AWS Sustainability: https://aws.amazon.com/about-aws/sustainability/
11) Equinix Sustainability: https://www.equinix.ie/company/sustainability/
12) Echelon Sustainability - https://techerati.com/features-hub/opinions/echelon-cto-simon-mccormick-data-centre-world-2020-dcw20-dcw/

Data Centre Construction

An international focus for Ireland Inc.

IN CONVERSATION WITH...

DERMOT REIDY, M PHIL. MSC.

PORTFOLIO MANAGER - CONSTRUCTION SERVICES AT ENTERPRISE IRELAND

In late 2008, as the Irish construction industry lay in ruins, another victim of the global credit crunch, Enterprise Ireland launched a Leadership4Growth programme specifically for construction company clients. The focus was on moving away from the domestic market and into export markets – some 70 chief executives participated. This programme laid the foundations for a remarkable turnaround in the Irish construction sector, where Irish capability and expertise is now building data centre facilities across the globe.

The collapse of the Irish construction sector was precipitous. In 2007/08, construction generally accounted for 36% of Irish GDP but companies were wholly focused on the boom in the domestic market. In some cases, they were closing their overseas/export business to pursue that focus.

Historically, construction activity is divided into four areas – residential, commercial, industrial and infrastructure. Following the global credit crunch and recession of 2008 and beyond, three out of the four collapsed totally. The industrial sector held up for a period, as construction companies provided services to FDI clients still committed to the Irish market, but that sector also declined, although it was slower in its inevitable winding down.

The outcome was a 73% drop in construction production value between 2008 and 2011, falling from €31.7bn to €8.5bn.[1]

Faced with such a challenging environment, Enterprise Ireland – the organisation responsible for the growth of Irish enterprises in world markets – sought to help move companies in construction back into export markets.

However, EI found little or no real experience of reconfiguring business or moving business into other markets within construction companies, so it repurposed its world-class Leadership4Growth (L4G) and International Selling Programme (ISP) training programmes to address the issue.

As construction company CEOs and leadership teams completed the programmes, the outlook started to change. A number of businesses began to consolidate, reconfigure and streamline. They re-balanced their portfolios and focused on stable clients in international markets in order to grow by building on their experience and relationships with FDI companies.

Central to this was re-establishing contact with their previous clientele – rather than the more expensive route of trying to attract new business – particularly in the industrial and hi-tech sectors in foreign markets, where there was an obvious need for expertise and where their capability was proven.

Simply put, it was discovered that while indigenous companies can service the residential and commercial sectors – Irish firms had the edge of demonstrable expertise in bigger and more complex projects. Many of those bigger projects turned out to be the design and construction of large data centre facilities, for hyperscale clients.

In 2008, very few Irish companies in this sector had revenues outside Ireland. Today, at least 50% of revenues, in this client portfolio, are from abroad – and external construction revenues by EI clients in 2019 were €2.5bn.

Adaptable and capable

Clearly, all the skills and expertise needed to succeed in the rapidly changing data centre sector weren't just on the shelf, waiting to be applied. Irish companies have had to learn new skills and adapt to the dynamics of a marketplace that is constantly evolving, sometimes at breakneck speed.

Irish suppliers are used to this changing environment and, internationally, demonstrate a 'can do' attitude which brings in projects on time, budget and to the high standards required. It is not, for example, simply about the construction of data centres. What's often expected is DBOM – design, build, operations and maintenance – and this was an area in which Ireland Inc needed to develop expertise, linking back to the 'Green Jersey' effect and the supply chain community it delivers.

The power of the 'Green Jersey'

Irish businesses tend to promote, and prefer to work with, Irish businesses – which has meant that a symbiotic relationship has grown up amongst companies that provide services to the development of data centre facilities.

Design, engineering, construction tech, project management, professional services and the construction companies themselves – new skills have been learned and new areas of expertise established which have also benefited from the power of the Green Jersey.

As this 'trickle-down' effect focuses and maximises the value of a project's revenues towards the Irish supply chain, there is also a multiplier effect as further Irish supply chains are established and exponential growth takes place. Amongst the Irish companies who have benefited from this process are numbered names such as PM Group, Sisk, Collen, Mercury and Winthrop.

It is estimated that some 40% of Europe's data flows through Ireland and the country is ideally placed in terms of its geographical location, but also in terms of political environment, size, climate, and capacity for the generation of renewable energy

Ireland Inc has – over many years – developed a reputation in the hi-tech, big project construction field and it is really the only 'one nation' group of businesses operating in the field of data centre construction.

There's no doubt that this has a lot to do with the island of Ireland being a 'hub' for data centres. It is estimated that some 40% of Europe's data flows through Ireland and the country is ideally placed in terms of its geographical location, but also in terms of political environment, size, climate, and capacity for the generation of renewable energy. It is a stable, open and adaptable environment, in all respects.

There are other, extremely current, issues that are associated with data centre provision that are taking up immense bandwidth amongst all those operating in the sector.

One of these is the supply and management of power, including delivery of power to the sites from national grids and other sources, and the control of power on the sites themselves.

It's fair to say that Irish companies have developed skills that other countries either don't have or that have been relinquished by the domestic transmission systems. It is also the case that power networks have changed dramatically. They have needed to be reconfigured as a result of changes in nuclear and fossil fuel power generation, the move to renewables and remote locations, and the utilisation of and demands on these same networks.

A range of Irish companies have specialisations in these areas, including (amongst others) H&MV, Gaeltec Utilities, TLI, Kirby Engineering, MTM Engineering, and Suir Engineering. They have delivered projects for some of the most recognisable tech brands and data and information management services companies in the world – including Amazon Web Services (AWS), Microsoft, Facebook, Google, Iron Mountain, Digital Realty, in countries such as Denmark, Sweden, Germany, the Netherlands, and others.

Experienced and compliant

As part of its mentoring services to Irish business, Enterprise Ireland reinforces the importance of compliance with the latest standards and the latest thinking – for example, BIM (Building Information Management) systems, LEED, BREAM and LEAN construction methodologies – which are critical to the companies' journey into foreign markets.

At the risk of stating the obvious, clients (particularly in the data centre space), don't want a learning curve – the nature of the industry is one of immediacy and they want companies that have a proven track record of delivering.

The market doubles every two years (Moore's Law). The dataverse – the amount of data created each year – is estimated to reach 175ZB by 2025, up from 30ZB in 2018, and the need for data centre facilities is pressing. Construction of those facilities is massively time-sensitive – the maintenance of market share in each market is critical – and the data centre owners can only deal with people and businesses who are compliant and capable.

It's not that there is no expertise elsewhere. There are some experienced constructors in this field in the UK, for example, but mostly the expertise in construction of large capacity data centres resides in Ireland. There are capable and experienced companies in the US, but they tend not to travel and those that do are mainly in management and design, and not in construction.

Clients in the data centre space don't want a learning curve – the nature of the industry is one of immediacy and they want companies that have a proven track record of delivering

As an example, there is an Irish element to just about every hyperscale data centre project in the Nordic region – construction management, design, engineering, mechanical and electrical contractors are from Ireland and many of them are winning general contracts as well. Apple, Facebook and Google are in Denmark; Microsoft, Amazon Web Services and Facebook are in Sweden; and Google is in Finland. Irish contractors are working on all of them.

Because the US client companies work with them in Ireland, they know how they work and they know their reputations and they're choosing Irish services providers to build both hyperscale and co-location centres in the Nordics. Team Green Jersey at work – Irish contractors bring suppliers and subcontractors with them but, interestingly, it is a collaborative approach – Irish companies are not just coming in and taking over. They are partnering with local firms which haven't had the experience that Irish companies have on big, complex projects and so are not competing for these larger projects on their own.

Opportunities for growth

Many of these sector experts are already working with both hyper-scalers and co-locators in Ireland and have taken these relationships and run with them into export markets. They have become expert at it – delivering against the challenges presented by type of facility, complexity, size, scheduling and timescale.

A greater volume of large data centre construction is happening in Africa and the Middle East as these markets (especially Africa) have become more saturated with mobile devices and networks, mobile payments, the IoT and the inexorable global rise of AI.

Latency – the time delay in transfering data from one location to another, and so critical for the smooth running of applications such as virtual reality conferencing – often does not allow for the data to be handled effectively in northern Europe anymore.

These projects – because of contacts, capability and compliance – are increasingly being handed to Team Ireland Inc. as clients are recognising the Irish expertise and capacity in this area. Irish construction companies are now working, across the globe, for many of the hyperscalers such as Amazon, Facebook, Microsoft, Google as well as a selection of the co-locators on projects ranging from 10 to >60MW and beyond.

Data centres can cost between $1,000 and $3,000 per square foot to construct – including construction, systems and equipment – and the largest in Europe (currently) is likely to be built in an area of nearly 166 hectares. The data centre construction market is expected to be worth around €13bn annually by 2024, so the size of the opportunity is staggering.

The approach to risk

Ireland Inc. has the capability to meet the challenges that the data centre sector faces now and will face in the future, whether that's the focus and emphasis on generation and supply of renewable energy, or the latest developments in cooling or battery tech. Ireland Inc. has been, and will continue to be, adaptable to its clients' requirements.

In part, this is because Irish companies have a track-record of risk taking and the ability to have their shareholders approve the risk. Big construction projects, like hyperscale data centres, come with a level of risk that is not to everyone's taste.

It's also because Irish companies have learnt to re-organise, re-focus and re-structure, incorporating into their organisations roles and disciplines that might, hitherto, not have been seen as peripheral or core – such as strategic development, environmental and detailed construction planning, BIM, LEAN, LEED and BREAM.

All this has happened in 12 short years – and things will only move faster from here.

Data Centres 2021

Power And Influence: Conclusion

GRAEME MCWILLIAMS

CHIEF OPERATING OFFICER, ECHELON DATA CENTRES

This collection of articles and reports has been 12 months in the production. That's not because it was particularly problematic, or difficult to pull together, or because the design was complex, or because the pictures were difficult to source. It was because – like everyone else around the world – we had to work under the restrictions imposed as a result of the COVID-19 pandemic.

What this meant, simply, was that people had more important things to focus on. What it also meant was that – as we all struggled to come to terms with one new normal after another – we did it online, via videoconferencing and virtual reality. The dataverse grew exponentially, Pandora's Box was opened, and the inevitable knock-on effect is greater demand for data centre infrastructure and capacity.

The data centre sector must now be considered an essential industry. We cannot have the technology to which we have become accustomed without it. And data centres will get bigger – we're already talking about facilities with capacities in excess of 1GW. The only question is: how does the industry address the issue of powering them sustainably and cleanly?

Green data. There is an expectation that data processing, storage and management – the data itself – will be green. It's no coincidence that the hyperscalers are the largest purchasers of green energy, nor that they are the ones making pledges of achieving carbon neutrality/negativity.

Sustainability, innovation, efficiency – these three things are key to data centre operations in the future.

Sustainability through recognition that – in the short to medium term – it may not be possible to power data centres wholly with renewable energy, and therefore we need to look for a half-way house, a mid-point solution, so that our business is sustainable. Doing away with diesel generators for back-up power is a start – running energy centres on natural gas, as required to balance flexible grid supply and feed battery arrays which provide back-up power, has a lesser environmental impact.

Innovation is looking at the road ahead, which is tech such as fuel cells and the co-location and joint funding of grid architecture with the renewable energy generators. It means moving data centres away from major cities and closer to the sources of green power, and utilising space on larger sites for renewable energy generation – whether wind, solar or biogas – and for hydrogen production.

Efficiency takes its lead from innovation – finding new ways of improving PUE, reducing energy consumption overall. As outlined here, liquid cooling is one such innovation, as is the simple expedient of using a nearby body of water as a heat exchange (Echelon's site in London's docklands does just this).

Of all the issues facing the data centre sector, that of power is the biggest and is the one that draws the most public attention to our facilities. All over the world, grids are struggling to keep up with demand, and data centres will increasingly have to be located away from population centres where demand is high in order to be sure of power. Data centres should be part of the solution and enhance grid infrastructure through investment enabling supply of renewables to the system.

Ireland can be a model for this. Much of its thousands of kilometres of coastline is ripe for wind farming, with a reported potential to generate some 15 times more energy than we could ever use. The Irish government's climate action plan encourages the close location of data centre facilities to sources of renewable power, and An Taoiseach Micheál Martin himself has congratulated SSE Renewables and Echelon on making a deal to co-locate grid infrastructure.

We know that Ireland is net exporter of data centre construction expertise – it can now become a global exemplar of best practice in powering the facilities once they're built and being part of a resilient and renewable grid ecosystem.

Data Centres 2021

Power and Influence

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