Here's the Key to Net-Zero Buildings

B1M Webinar Q&A

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Introduction

Q: Will the recording be available after the webinar?

A: A recording of the *Here's the Key to Net-Zero Buildings* webinar is available to view here.

University of Glasgow Project

Q: Can the public access the Glasgow University dashboard?

A: Yes, there will be a publicly available dashboard in early 2022. This will be anonymised for the campus but will allow visitors to see what the University are doing on their smart campus.

Q: Is this a case study on IES website?

A: Yes, you can ready the University of Glasgow case study **here**.

Q: With regards to Glasgow University, how did you manage to accumulate the building fabric data, knowing the inaccuracy and lack of data held in O&M manuals. Knowing metering data is important but this must be supported by accurate building envelopes/fabric data for existing buildings of varying ages?

A: First, we would do an energy audit of any building to identify how the building is being used, what unregulated loads there are and an assessment of the fabric and age of the building. If no data is available for the fabric, the option is to carry out a detailed assessment drilling small bore holes to identify what the make-up of the fabric is, or alternatively assessing the age of the building and what the likely make up would be based on the regulations at the time. The other option is to carry out a dynamic U-Value test on the building to achieve a high accuracy of the U-Value of the envelope. All methods can be used depending on the level of accuracy you wish to achieve.

However, we also now have an optimised calibration tool, where all 'known' parameters can be set and then any 'unknown' parameters are optimised against the given standard you are calibrating too, e.g. IPMVP or ASHRAE 14.0. This will then set a value for the unknown parameter, which could be the U-value of the envelope and then an assessment would be made by the engineer as to whether this is reasonable for the type and age of the building.

As with anything, it is not an exact science, the goal is to have a Digital Twin that as closely represents the building as it can be, given the limitations you might have with respect to data of the building.

University of Glasgow Project

Q: Does the university allow any of its students access to the hard data from the Digital Twin? The students could then see, where they could make changes to the buildings on campus to reduce the emissions from those buildings and also gain educational knowledge in the process?

A: The academics on the campus are using the IES technology with their undergraduate and postgraduate courses with many students creating Digital Twins of the buildings themselves. As such, the answer is yes that the students are engaging with the software and gaining education on how to reduce campus emissions as a result.

Q: What do you think are the barriers to adopting this kind of Digital Twin at other Universities? Do you think it is related to cost or lack of knowledge about the benefits?

A: Like all advancements in technology, adoption requires upskilling. For universities, not only do academics need to learn the tools, they need to be competent enough to teach it to their students.

The living laboratory approach also relies on collaboration between the estates departments and academics – two parties who traditionally seldom interact.

There are also barriers with respect to accessing the data from BMS or other systems and upskilling in particular the IT departments to help to do this. There is also education needed in the early design stage of projects to ensure the correct type of equipment is specified to enable the creation of a performance Digital Twin, including sensing technology and items such as servers to enable access of building related data.

Whilst the creation of a Digital Twin requires some initial expenditure, savings tend to pay for the Digital Twin within the first year, depending on the age and condition of the built asset.

Q: In the University Project what % of the campus would you say is currently being monitored as a Digital Twin?

A: Currently approximately 10%.

What's required to create a Digital Twin?

(i.e. DT tools, training, building info/data, what goes into the model)

Q: What sort of data goes into these models? Meter readings? Live sensor data e.g. temperature/humidity?

A: Any time-series data from BMS/BEMS, automatic meter readings (AMR), sub-meters and IoT sensors can be brought into our cloud-based data analytics platform, as well as historic data (CSV, JSON, SQL, XML).

Data from utilities, sub-metering of electricity, natural gas and heat, temperature, humidity etc. can all be used, ideally hourly recordings over a 12-month period as a minimum to account for season fluctuations.

Q: How difficult / easy is it to train people to use Digital Twins? Does it take much educating?

A: IES offers basic and advanced levels of training to support users in learning to use our Digital Twin technologies, however, users are expected to have a good understanding of energy performance in the built environment and any previous experience in energy modelling, particularly with the IES Virtual Environment, will accelerate the learning process. Find out more about our training options **here**.

Q: Do we need an existing building with lots of previous data to be inputted, in order to build a reliable Digital Twin for the building or maybe new buildings can also have their Digital Twins which would perform at least closely similar to the real buildings?

A: Digital Twins can be used for both existing and new buildings. The Digital Twin can also be used to support the construction and commissioning process to help close the performance gap.

Q: How does a Digital Twin software provider, e.g. IES, interact with controls vendor or BMS to gain access to data to calibrate building simulation models?

A: The data required to calibrate the Digital Twin must be brought into **iSCAN**, our cloud-based data analytics platform. The BMS within a building can be setup to automatically send data to iSCAN, or data can be imported manually. For additional information, please refer to the following **guide**.

Q: What's the biggest hurdle to take building simulation model, "energy model", to level of "performance" Digital Twin?

A: A performance model must reflect the actual building far more than typical energy models (i.e. compliance models, CIBSE TM54 etc.).

The biggest challenge may be gathering all the as-installed building information/data, therefore sufficient time should be allowed for within the programme for creating the initial Digital Twin.

What's required to create a Digital Twin?

(i.e. DT tools, training, building info/data, what goes into the model)

Q: Does the Digital Twin take into account non-regulated electrical energy in the building?

A: The accuracy of the Digital Twin is dependent on the accuracy and completeness of input data. Therefore, the Digital Twin should always include any non-regulated loads.

Q: With Reference to Digital Twins. As consultants how can we deploy IES software and Tools to help inform and advise clients?

A: As with our Virtual Environment software, licenses and training can be provided to enable consultants to deliver their own Digital Twins to their clients.

IES' in-house consultancy team can also support consultants with the delivery of Digital Twins, with decreasing levels of involvement.

Q: Hello! Is it possible to create digital energy twin in the IES Virtual Environment? And if it is possible, what might be the main steps to do it?

A: To create a Digital Twin of a building, the IES **Virtual Environment** is required, along with **iSCAN**, our cloud-based data analytics platform and our new Calibration Tool which will be launched in early 2022.

There is a specific workflow that should be followed to create a performance Digital Twin. IES can provide training and support on this.

Q: As a structural engineer, where do we really start? Is it a case of sharing the design information of projects to a specific body? Is this something that would be enforced in the future?

A: Design or as-built information will need to be provided to the party who is creating the Digital Twin, this typically includes architectural and MEP information as well as operational information and building data.

The goal is to unite all across the building lifecycle from early concept design to end of life to share data and enable performance Digital Twins, this will require interoperability between tools. It is coming but there is a long way to go and digitalisation of the construction sector needs to become more than just improving build time and reducing build cost or looking at sustainable materials and instead linking to the final end use of the building and ensuring the building performs as expected.

Q: Are the Digital Twins in IES able to be linked to Autodesk Revit models (or equivalent models)? My co-workers aren't receptive to the idea unless I can show them it's easier since there's rarely a budget to learn this new process

A: Revit models can be imported into the IES Virtual Environment to reduce duplication of modelling the building geometry. For more information, please visit our **FAQ**.

What's required to create a Digital Twin?

(i.e. DT tools, training, building info/data, what goes into the model)

Q: I am a Ph.D. student in the power engineering field, and I have a task to make a Digital Twin. For now, it seems overwhelming, because all information I can find is very basic. What are the first steps for building a Digital Twin?

A: The first steps for creating a Digital Twin is to establish what purpose will it serve? If you are planning on creating a Digital Twin of a single building, you will require architectural floor plans, elevations and section drawings along with any documentation on the installed building services. Many buildings have Operation and Maintenance (O&M) Manuals which may include some of this documentation, however, a building survey may also be required.

You will also need to consider what data is available (what is being metered in the building and how frequently the data is being logged).

Finally, you will require access to our Digital Twin technologies and associated training.

Q: When simulated models don't match metered readings, how do you decide what the difference is? missing equipment not modelled vs the actual building running inefficiently vs a Perfect simulation for example? Do you purposely make your model controls worse?

A: Simulated data can be compared against real data within **iSCAN**. Any significant deviations can be investigated and adjusted within the model. The model is also calibrated to international standards such as ASHRAE 14.0 and IPMVP.

Q: Does the Digital Twin work floor by floor, or is it customisable down to the room level? I'm wondering if specific assets are taken into account throughout a building, such as radiators, windows, room volumes, HVAC systems in each room, wall insulation, or if it's more generic?

A: A Digital Twin of a single building can be modelled at room level, factoring all thermal and energy transactions within the room, surrounding spaces and the external environment (i.e. heat losses, internal and solar heat gains, HVAC, building fabric, air exchanges etc.)

Q: How much does Digital Twinning software cost?

Please email **sales@iesve.com** for a detailed quote for your building(s).

What are Digital Twins used for?

(i.e. net zero, close performance gap, identify performance drift etc.)

Q: What's the best strategies for creating Net-Zero Buildings?

A: Building owners can employ lots of renewable energy technologies to displace grid-supplied energy, however, this is not the most efficient or cost-effective method.

To achieve net-zero carbon, the building owner (or designers/contractors acting on their behalf) should always follow the fabric-first approach to minimise the energy demand from the building (considering insulation, air-tightness etc.) before reducing energy consumption through the use of high-performing and efficient building services equipment. Only once the previous two steps have been complete should renewable technologies then be applied. Following this, other solutions that optimise energy use through demand response and flexibility should also be deployed.

As a simple step-by-step guide, the following steps could be used

1. Understand your baseline energy use
2. Identify savings to be achieved using simple low-cost operational measures
3. Investigate different shallow retrofit or renovation strategies typically to be linked with other building renovation activities; these can be linked to both envelope and systems
4. Integrate potential renewable energy sources
5. Investigate potential for demand response and self-sufficiency optimisation

Investigate the possibility to couple with neighbouring buildings and engage with local energy system solutions

Q: Micro climates change around the Digital Twin building... Won't this change affect your Digital Twin technology efficiency? There is a need for agreement on energy use between neighbourhood stakeholders… how can this be?

A: Our **Virtual Environment** software allows external air flow and thermal studies to be performed through the MicroFlo application. We also now have city modelling software called the **iCD** and network analysis software called the **iVN** to allow us to analyse not only the single building but how the building interacts with its community buildings and infrastructure. This enables not only microclimate analysis but also demand response, flexibility, local energy system analysis etc.

What are Digital Twins used for?

(i.e. net zero, close performance gap, identify performance drift etc.)

Q: Presumably the useful aspect of being able to build a Digital Twin is to be used as a planning tool (pre-permission being given) and then monitoring? Could there be a scenario in which new builds have conditions attached to ensure they adhere to their promises?

A: The Digital Twin can be created at any stage of the building lifecycle, from design, construction, commissioning, operation and end-of-life. The ultimate aim is to eliminate the performance gap and ensure that buildings actually operate as per their original Design Intent. Within the **eDigit2Life** project, we are working with the consortium to develop new ways of informing all stages of the building lifecycle to ensure that the building can avail of a performance Digital Twin in operation. This is being fed back through the 'transforming the construction sector' theme within InnovateUK. But that doesn't mean you can't also create the same performance Digital Twin for an existing building, either utilising old compliance models or building a new model of the building from scratch.

Q: Does IES cover the economic value for isolation materials? Does IES contain the suitable insolation materials for optimum energy performance in different climates?

A: Our **Virtual Environment** software allows capital costs for constructions and systems to be assessed through the **CostPlan** application.

The performance of your modelled building can be simulated against any climate, providing **weather data** is available for your chosen location.

What are Digital Twins used for?

(i.e. net zero, close performance gap, identify performance drift etc.)

Q: What is the difference between a Project Digital Twin, a Performance Digital Twin and an Asset Digital Twin?

A: The Project Digital Twin is focussed on combining all the information, data and documents with a 3D model to have a single point of access for all the information belonging to the building across the design, construction and handover phases. It is basically a snapshot in time of the building in its lifecycle, which enables information that are usually siloed to be available to all the project team in a unified data model. BIM is an example of this for buildings. IES is interoperable with Project Digital Twins.

The Asset Digital Twin is now more focussed on the operational phase of the building, providing a bidirectional link to sensors, actuators and data from the real-world counterpart. Specific ontologies and data models like BRICK and Project Haystack help provide the context and relationship across existing sensors, actuators, spaces and equipment, ensuring a universal mapping between the virtual and the real assets. **iSCAN** can be used as a platform for the Asset Digital Twin.

The Performance Digital Twin is totally focussed on the building in operation, unlocking value from the existing asset twin. IES are one of the few companies that have a performance Digital Twin that has physics based principles embedded in it, which combines with the data streams available in the asset Digital Twin to create an exact virtual replica of the building, which behaves like the real-world counterpart at any moment in time. It can be used as an accurate and reliable virtual 3D model to optimise the performance of the building in real time, predict performance degradation and evaluate future 'what-if' scenarios. The IES performance Digital Twin enables a variety of analyses related to energy, health and well-being, comfort, cost savings, decarbonisation and many more.
It can also be used as test bed for evaluating the building technologies ahead of their deployment.

Benefits and Payback of Digital Twin Technology

Q: How do we convince clients / developers to include twins within their budgets initially?

A: Clients and developers should be made aware of the benefits that Digital Twins can offer throughout the entire lifecycle of their development. These conversations should not only include the energy, CO_2 emissions and cost savings that will be realised during operation, but it will also ensure that the building is built and commissioned to the intended design.

Q: Can you please tell us about any examples of successful use (for cost saving/emission reporting and reduction) of data/ analytics offered by performance Digital Twin in FM / building maintenance in education or other sectors?

A: Please visit the following link for examples of where IES' Digital Twin technologies have been successfully implemented on real projects: **IES Case Studies**.

Q: Where payback is unclear or unlikely to be quickly achieved, how can private building owners be incentivised to invest in the process of Digital Twinning and subsequent optimisation?

A: As Digital Twins are a virtual asset that can be used throughout the entire lifecycle of a building, the initial investment will undoubtedly be recuperated (usually within the first 12 months – depending on the age and condition of the building).

Q: What is the impact of digital transformation and design for climate change, and what is the benefit of Digital Twins in reducing CO2 emissions in the AEC industry?

A: Digital Twins have a huge role to play in the AEC sector, enabling built assets to perform at their optimum throughout their entire lifecycle. The Digital Twin also ensures that the building will perform as per its design intent with the aim to eliminate the performance gap completely. Without them, we will have a 'gold rated' built environment on paper but we won't achieve carbon emission reductions in reality.

Q: I think to the vast majority of people, climate change is an immediate issue. My question is, how do we get governments, industrial entities and cities on board to use technologies such as the Digital Twin, IESVE, carbon capture and passivhaus?

A: Education backed up with success stories. Along with a strong track-record in the AEC sector, we have a portfolio of **case studies** where our Digital Twin technologies have been employed.

Benefits and Payback of Digital Twin Technology

Q: With the use of these "twins", can the university or IES, perhaps indicate in monetary terms how much money can be saved in the energy running costs of the university buildings? All new technology which can help reduce carbon footprints, or emissions etc is great and the right way to go but if the financial figures don't add up then it could be a hard sell.

A: With respect to energy payback, there are a number of ways in which the Digital Twin can save energy, e.g. operational measures that don't have any capital cost associated with them to deep energy renovation measures that have high capital cost. All should be considered and evaluated, however there are always other hidden savings that should also be considered. For example, in some cases there might not be any monetary cost saving with respect to your energy bill, however the Digital Twin could help you significantly improve the health and well-being of your building and hence the savings you see are increased productivity and wellness of staff, which in turn means less sick days and ultimately affects the companies output, which can be monetised in other ways.

Predicting cost savings can therefore be difficult, however we have found in general that the cost of creating the initial Digital Twin can usually easily be recuperated within the first year. And once the Digital Twin has been created, it can be used continually to prevent performance drift etc, providing further savings year-on-year as well as better performing buildings with respect to health and well-being.

Q: There's an energy balance to be struck surely if Digital Twin Technology (great application!) used at scale and the energy needed to power the Data Centres needed to execute the data processing required. We're potentially talking many GW per country for example. Is this being considered with regards to energy balance?

A: The aim is that the energy savings offered through the use of Digital Twins far outweigh the energy consumed to run them but we can also create Digital Twins of data centres themselves and we are looking at methods to optimise data centres energy use and exploit distributed energy resources and demand response for data centres so it all comes into the balance of what we are looking at within IES.

Digital Twin Ownership

Q: Who would you recommend to hold the Digital Twin for an asset? The building owner? Should it move with the sale of a building or should they be publicly available?

A: There is no right answer for this, however, ideally, the building owner would hold the Digital Twin of their building as a virtual asset, and perhaps include it in the sale of the building.

If, however, a building owner employs a third party to create and manage the Digital Twin on behalf of them, the agreement should outline the owner of the virtual asset. Building owners should give this careful consideration as they could be tied into a single Digital Twin manager if they do not own it.

Q: Who is best placed to be the custodian of Digital Twins? Does it lie with the asset owners, or is this part of a wider societal effort? I'm just thinking about standardisation - once you get to Digital Twin cities, standard data gathering techniques will surely be important?

A: Please refer to the answer above in relation to Digital Twin ownership.

With regards to standardisation, commonality is key to ensure the successful uptake of Digital Twins in the built environment. Organisations like the Centre for Digital Built Britain (CDBB) are driving standardisation and on the 3rd November 2021 they published ***'Digital Capabilities: a framework for early career professionals across built environment disciplines'***, which sets out six capabilities that are essential for all built environment disciplines:

1. Data Collection and instrumentation
2. Information Management
3. Data interpretation and analysis
4. Data governance
5. Data visualisation
6. Software development