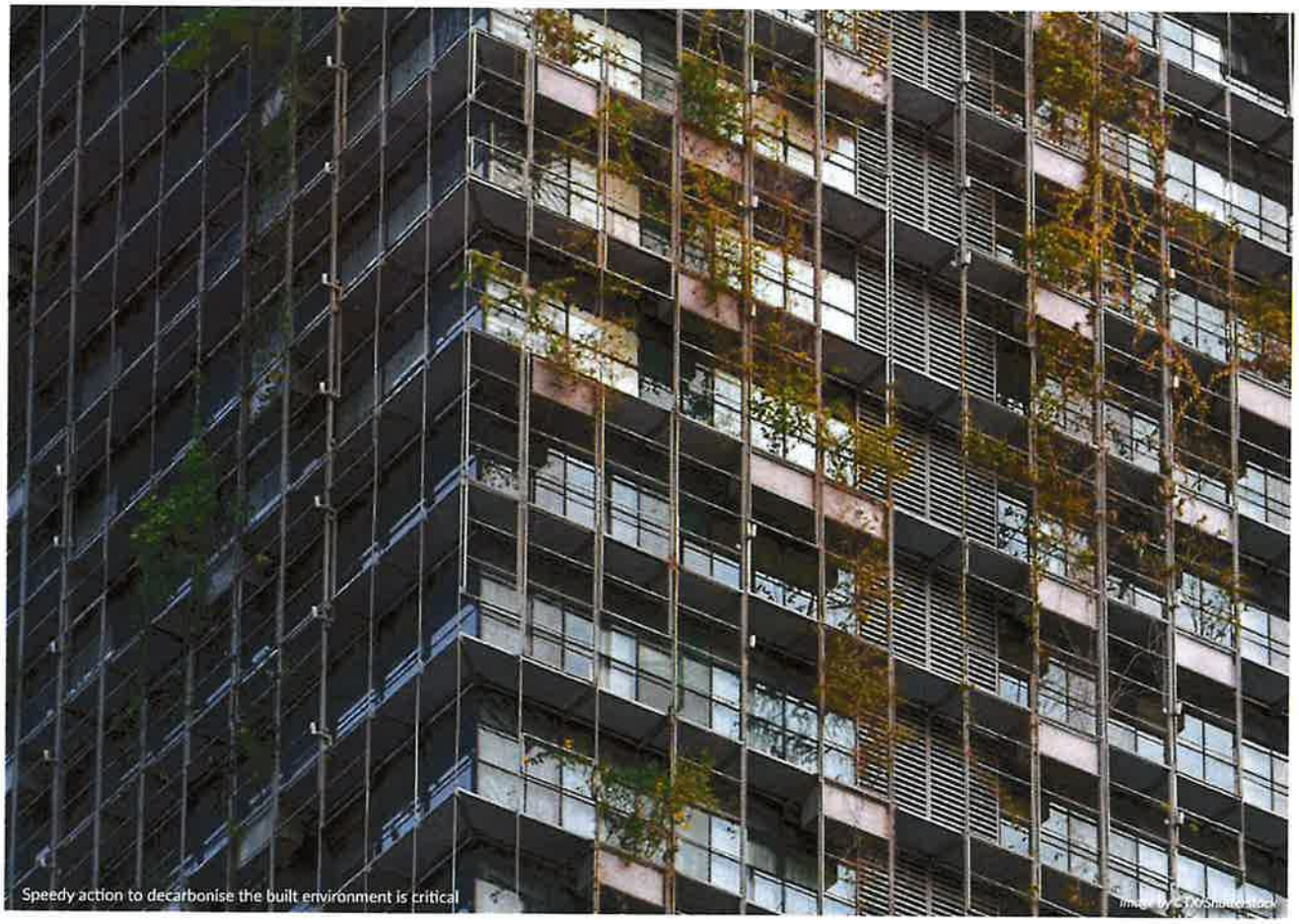

Speedy action to decarbonise the built environment is critical

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ALIGNING DIGITAL TECHNOLOGIES TO DECARBONISE THE BUILT ENVIRONMENT

By Dr TamilSalvi Mari & Dr Tan Sie Ting

The 2021 Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report indicates that even with a significant reduction in global carbon emissions over the next two decades, it is improbable for us to limit global warming to 1.5°C. The report reveals some promising suggestions: large-scale net-zero buildings can be built by 2050, but only if policymakers enforce policies and remove barriers to decarbonisation. This net-zero transition entails a grand scale of economic transformation and the complexity of balancing the significant short-term risks of poorly planned action with the longer-term risks of inadequate measures. These reasons explain why the industry is doubtful about how net-zero carbon can be achieved by 2050. What would it take to achieve this aspiration?

The construction sector is responsible for almost 40 per cent of global carbon emissions. Thus, imperative and speedy action to decarbonise the built environment is critical. At the global level, the Advancing Net-Zero programme of the World Green Building Council (WGBC) calls for halving the building and construction emissions by 2030 and decarbonising the sector by 2050. This framework outlines the basic principles to reduce carbon emissions through energy consumption reduction and energy efficiency—to make sure buildings are performing as efficiently as possible without wasting energy as well as preventing and avoiding embodied carbon from the start by looking for other ways to get the job done (for example, renovation of existing buildings rather than new development).

At the national level, a recent initiative worth mentioning is the launch of the malaysiaGBC Carbon Score (MCS) in 2021 by Malaysia Green Building Council (malaysiaGBC). This assessment tool is developed to comprehensively measure the carbon footprint of both new and existing Malaysian buildings. It aims to accelerate the decarbonisation of the local built environment in five key subcategories: Energy, Materials, Transport, Waste and Emissions Offsets. The MCS is developed according to national standards for carbon reporting and management, and also the guidelines from the Greenhouse Gas Protocol (GHG) accounting standards.

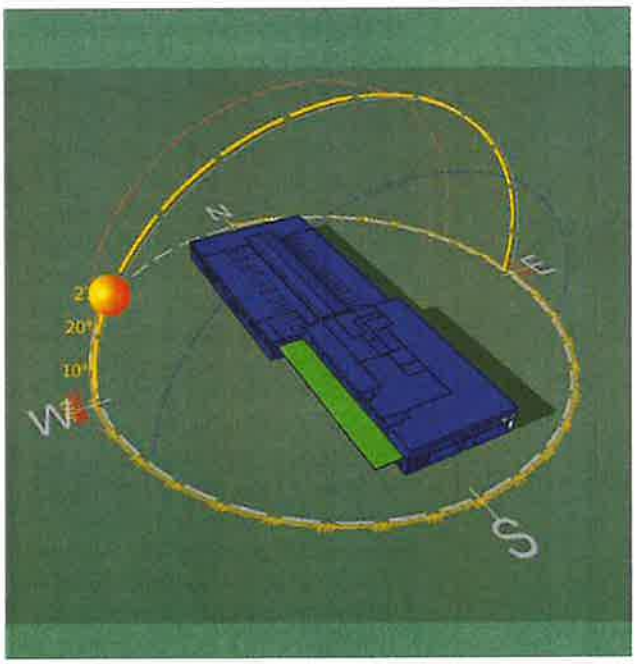
Besides, the Government launched the National Low Carbon Cities Masterplan in 2021, which aims to address climate change and a sustainable urbanisation roadmap. It provides guidance to state governments and local authorities in developing low-carbon cities. The masterplan also emphasises a '3M' approach to lead the low-carbon initiative: Measurement of GHG emissions from various sectors; Management of planning cum strategy; and Mitigation of GHG gasses through design and implementation of projects.

To assist the transition, the Budget 2020 extends the Green Investment Tax Allowance to purchase Green technology assets and the Green Income Tax Exemption for Green technology services until 2023. These programs encourage investments in Green equipment production, Green technology adoption by service/system providers and corporate Green asset acquisition.

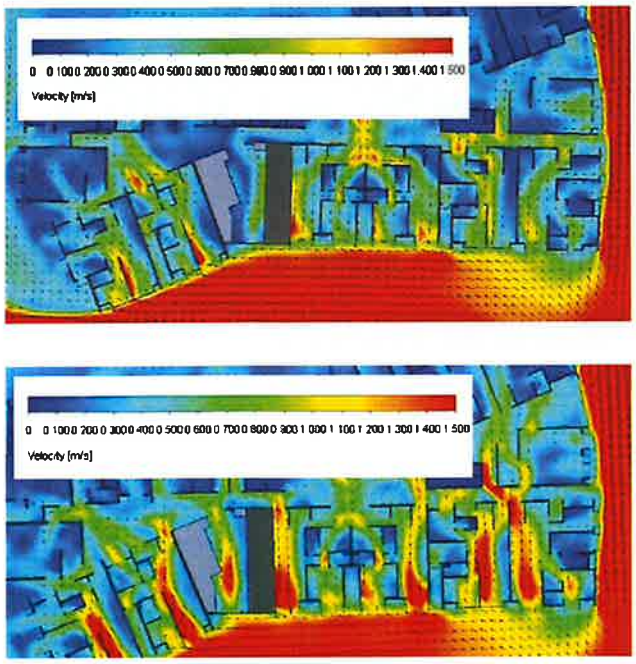
Despite the efforts through policies, initiatives and frameworks, Green technologies in the construction industry are falling behind, particularly the digital technology—the dated methods like Excel sheets, A3 drawings and clipboards are still commonly employed to manage large projects. Skills shortage, lack of training and budget are considered as the primary limiting factors to adopting innovative technologies.

DIGITALISING THE BUILT ENVIRONMENT

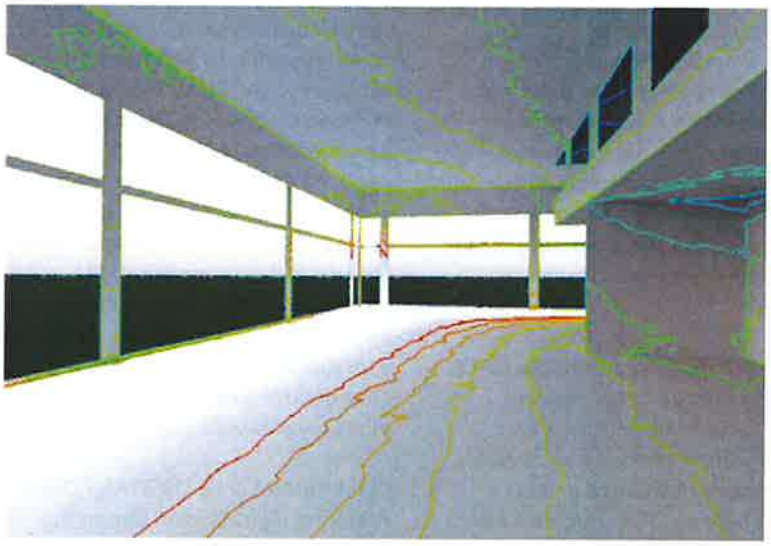
Digitalisation is critical to decarbonising the built environment to achieve net-zero carbon in today's



Simulation of sun path energy



Computation Fluid Dynamic simulation



Daylight simulation through the use of BEM

Daylighting minimises the amount of artificial light

Digitalisation is critical to decarbonising the built environment to achieve net-zero carbon in today's world.

world. It can enhance construction performance; assist in handling complex information; eliminate data silos; improve decision-making; and assure transparency and accountability across the entire life cycle of the built environment. The adoption of digital tools in the industry also allows us to identify wastage in different processes and work to improve construction efficiency.

Digitalisation is a key sustainability driver in the built environment value chain since it enhances the construction sector's performance in all aspects by reducing energy consumption and carbon emissions. The use of data can also help in low-carbon material selection as well as better understanding project-level carbon consequences and net-zero transitions. Sophisticated approaches such as Computer Simulations and Modelling, the Internet of Things (IoT), Digital Twins, Process Digitalisation and Augmented Reality (AR) offer fascinating prospects to create a more sustainable built environment. However, there are various barriers to digital transformation because it necessitates the efforts of a diverse set of players. Successful implementation of digital technologies must prioritise values before cost, and long-term fundamental improvements must take precedence over short-term project objectives.

When it comes to adopting new technologies to promote efficiency and collaboration, the construction industry typically scores towards the bottom compared to other sectors. However, the global COVID-19 pandemic has propelled many construction organisations to utilise technologies to improve energy efficiency, worksite performance, workers' safety and productivity, of which the trend is likely to continue. Consequently, the industry must undergo intense technological transformations to achieve net-zero carbon emissions.

DIGITAL SIMULATIONS IN BUILDING DESIGN FOR DECARBONISING

The construction industry plays a role in anticipating energy consumption, particularly in large-scale buildings, by assessing contributed components for minimising environmental impact and conceiving energy-saving options. As a result, these computational techniques enable users to test new emerging technologies and solutions by determining the dynamics of energy consumption behaviours.

To begin with, the Building Energy Modelling (BEM) is a versatile and multi-functional tool that enhances decision-making at the design and retrofit stages. It helps reduce energy consumption; demonstrate code compliance; achieve Green building certifications; manage real-time building control; and guide policy market to reduce building carbon footprint. BEM is a computer simulation of a building that takes the architectural geometry, building enclosure systems and mechanical & electrical systems into consideration. BEM will provide actionable instructions based on the report results to allow the building to perform alongside energy efficiency and carbon reduction motives.

An office cum showroom project in Ipoh, Malaysia adopting BEM via the IES-VE tool is one of the many good examples. It demonstrated a 61 per cent building energy intensity (BEI) enhancement compared to Malaysia's building energy efficiency standard MS1525 and saved approximately 300 megawatt hours (MWh) per year, equivalent to the annual energy consumption of 80 four-people households. Through BEM, the project optimised the passive building envelope design in terms of glazing selection, daylight factor and lighting improvement. It also strategised the design and installation of sun-shading devices to reduce thermal heat gain inside the building. The arrangement of the air-conditioning and mechanical ventilation (ACMV) system through BEM further enhanced the energy efficiency and thermal comfort. In addition, the BEM demonstrated only a 3 per cent deviation from the actual operational energy consumption of 227 MWh .

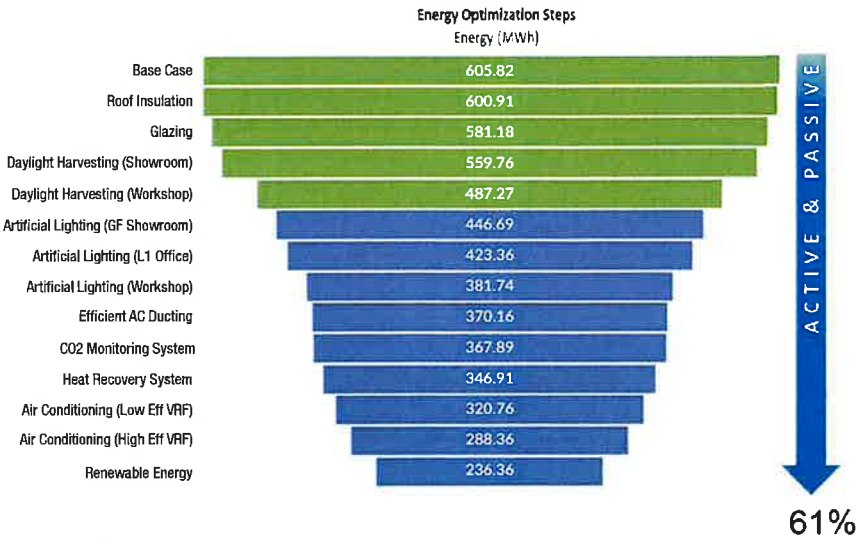
The Computation Fluid Dynamic (CFD) simulation offers another dynamic analysis for building performance in terms of airflow, temperature, pressure and pollutants distributed in and around a building. The structures and the design of buildings should take environmental improvement towards net-zero energy and carbon emission into account, and simultaneously be resilient to the increasingly extreme climatic conditions. There are two main focuses of CFD: the external environment which deals with microclimate; and the internal environment concerning the airflow, ventilation, thermal comfort and air quality for occupants.

The indoor ventilation of a residential high-rise building in Malaysia has been obviously improved by applying CFD simulation. The residential units were initially designed with partially operable windows and fixed panel windows in the living rooms and bedrooms. However, there were a lack of operable windows in the opposite direction and so only 46 per cent of overall natural ventilation could be achieved in the units. With the use of CFD simulation, the natural ventilation was increased to 70 per cent by installing more operable windows and hence a considerable amount of time and money was saved.

COLLABORATIVE DIGITAL TOOLS

Adopting digitalisation during the design and building stages allows effective collaboration across design and construction teams. In the construction business, this is accomplished by using Building Information Modelling (BIM). BIM has become an industry standard which transforms the use of blueprints to digital representations of building projects in 3D form.

Aside from designing and modelling, BIM can track project performance and environmental implications for design flexibility, allowing engineers, project managers and architects to collaborate. Digitising construction



Energy optimisation steps demonstrate a 61 per cent BEI enhancement

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practices from pre-design to post-construction will also accelerate decarbonisation. For example, one of the leading housing developers, Gamuda, has adopted a BIM Level 2 at the forefront of this groundbreaking technology. The organisation also uses BIMAR, an in-house AR platform that allows the overlay of virtual design and construction elements with real-time worksite images, capable to identifying and rectifying any issues in advance and efficiently.

Another technology that is revolutionising the industry is Digital Twin. Big Data, the IoT and BIM dramatically improve how buildings are designed, built, operated and maintained. However, at the moment, these technologies are used in isolation. The data generated and gathered from various sources can be fed into the Digital Twin model to establish an interconnected network for analysis to transform data into meaningful insights. Collaboration and information management within an organisation will also be encouraged, offering flexibility and agility to meet the challenging needs of net-zero emission assets.

A case study of an office building shows how the client collated and assessed the actual measured data from the building's various sub-metres and Building Management System (BMS). The data has in turn been used by the specialist consultants to add reality to the air-conditioning and mechanical ventilation model. Through a process known as 'calibration,' they were able to achieve a close match between the model and how the building operates, including more realistic usage patterns and occupancy profiles. The client used this Digital Twin model to assess updates of their lighting design and validate the savings which are positive as anticipated.

MOVING FORWARD: DIGITISE THE INDUSTRY

There are numerous digital technologies available for decarbonising the built environment. These technologies also continue to open up new opportunities for stakeholders and investors. Regrettably, most construction organisations, including bigger corporations that develop Green projects, have yet to adopt BEM, CFD simulation, BIM or Digital Twin as these technologies require upfront investment despite the huge long-term benefits. The construction industry in Malaysia is moving forward at a slow pace to embrace digital technologies.

The COVID-19 pandemic has expedited the implementation of digitalisation but, fortunately, we are currently in the transitional phase. The speed with which the industry will transform to meet the net-zero carbon target is determined by the commitment of stakeholders include the Government, construction leaders and organisations; the availability of green financing; and the business model. Nevertheless, it is necessary to accelerate and scale up these digital innovations to the standard to realise the world's envisioned net-zero carbon future.

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Salvi is currently a Senior Lecturer School of Architecture, Building, and Design (SABD), Taylor's University. She trained in the construction industry before becoming an educator. Her teaching portfolio contributions and achievements include teaching, academic leadership, programme development, research, and supervision. Her commitment to sustainability extends beyond her profession as an academic and certified Green Building Index facilitator (GBIF) to her volunteering as a council member for MGBC from 2020 to 2023. Salvi co-chairs MGBC's Sustainable Development Goals subcommittee, which conducts SDG awareness and reporting training for industry-related businesses.

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