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SG GREEN

SINGAPORE GREEN BUILDING COUNCIL

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ACCELERATING BUILT ENVIRONMENT DECARBONISATION

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ACCELERATING BUILT ENVIRONMENT DECARBONISATION

The Intergovernmental Panel on Climate Change (IPCC), a body created by the United Nations to provide policymakers worldwide with regular scientific assessments on climate change, its implications and potential future risks, released on 9 August 2021 the Sixth Assessment Report. While the extensive, 1800-page report addresses the most up-to-date physical understanding of the climate system and climate change, combining multiple lines of evidence from a variety of disciplines, one outcome is clear: there is an urgent need to ramp up sustainable development.

The report highlights the direct influence human activity is having on extreme weather phenomena and deep reductions in carbon emissions must be made in the coming years. While there is a small window of opportunity to stabilise global temperatures below 2 degrees by implementing stringent emissions cuts this decade to result in net-zero emissions by 2050, the urgency is on as this window will become smaller and smaller for each year without concrete climate action.

Stakeholders across the built environment value chain will also become more sensitive to carbon emissions, especially embodied carbon emissions which are associated with the full supply chain of all materials and systems put into any built environment project and cannot be improved over the lifetime of a building, unlike operational carbon emissions. Industry-fronted initiatives such as the Singapore Built Environment Embodied Carbon Pledge launched on 5 August 2021 will help to unify and amplify industry action towards carbon emission reductions.

This issue of SG Green draws a bead on built environment decarbonisation, with a collection of articles that cover a variety of carbon-centric topics. From looking at how reducing embodied carbon emissions will be important to built environment projects to understanding the role of carbon credits and making use of technology to drive decarbonisation goals, the magazine will give you plenty of food for thought and hopefully help to kickstart your own carbon-based initiatives.

The term "new normal" has been used a lot in recent times, but the new normal we should all be gunning for is a greener, healthier and low-carbon built environment for this generation and beyond.

Yours Sincerely,
SG Green Editorial Team


OUE

ACCELERATING THE DECARBONISATION OF THE BUILT ENVIRONMENT

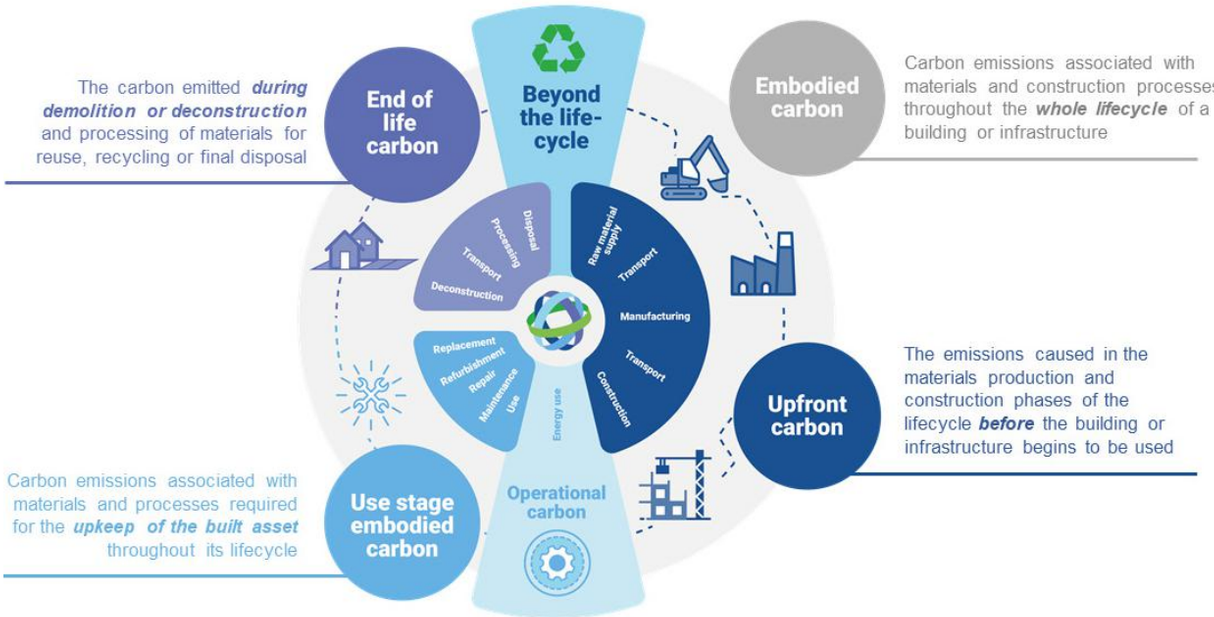
The built environment is in a prime position to mitigate the effects of climate change while providing healthy and equitable places and spaces for the growing world population. To meet global climate aspirations, built environment decarbonisation efforts will need to be ramped up to meet global climate aspirations.

BRINGING EMBODIED CARBON UPFRONT TO UNIFY AND AMPLIFY INDUSTRY ACTION

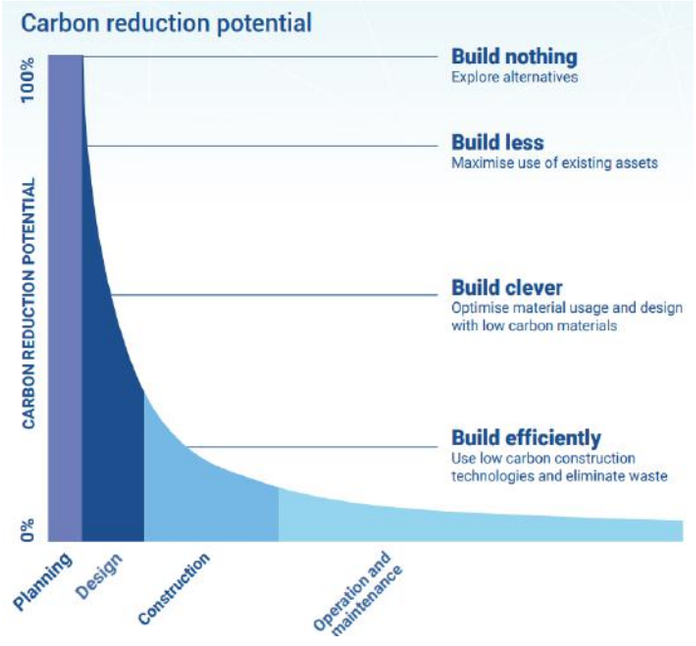
Driven by major changes in fertility rates, increasing urbanisation and accelerating migration, the global population is expected to increase by 2 billion people within the next three decades - from the current 7.7 billion to 9.7 billion in 2050. As such, demand for more buildings to live, work, play, heal and learn is set to grow. Additionally, shifting global trends – such as the impact of the pandemic and ageing populations – will shape the buildings for the years to come.

As the world continues to witness firsthand the effects of rising global temperatures, cognizance of climate change is at an all-time high. With multiple reports, papers and statistical studies highlighting the direness of the climate emergency, the built environment is in a prime position to help address the challenges brought on by climate change. Buildings only occupy three percent of the world's total land mass, yet are responsible for more than half of the planet's annual energy consumption and 40 percent of carbon emissions. Decarbonisation of the built environment therefore presents an opportunity on a greater scale to not only save resources and reduce carbon emissions but also to educate, create jobs, strengthen communities as well as improve human health and wellbeing.

BRINGING EMBODIED CARBON UPFRONT



According to the World Green Building Council (WorldGBC), the built environment is responsible for 40 percent of global carbon emissions, with embodied carbon emissions being especially critical. The carbon dioxide equivalent of emissions associated with the full supply chain of all materials and systems put into any built environment project, embodied carbon is different from operational carbon in that the latter can be improved over the lifetime of a building. If embodied carbon emissions are not addressed before the building project moves past the design stage, there is no way for building owners to reclaim lost carbon savings once the building is constructed and subsequently used. The breakdown of carbon emissions for buildings is typically 30 percent embodied carbon emissions versus 70 percent for carbon emissions due to building operations. In Singapore, where the lifespans of buildings tend to be shorter due to urban renewal, the embodied carbon emissions of buildings can constitute up to 40 percent of the total carbon emissions over the lifespan of the building.

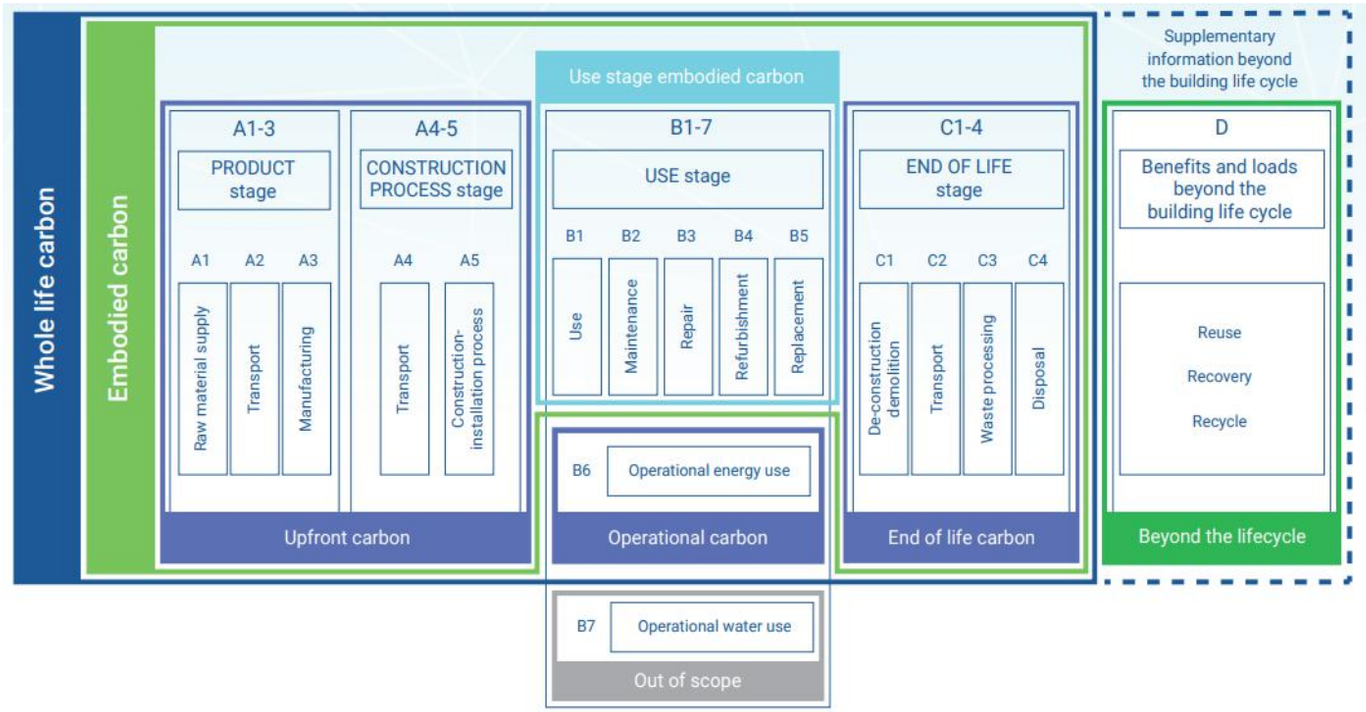


The upfront emissions from materials and products used to construct buildings and infrastructure, and those installed later during maintenance and renovation, usually represent a significantly greater source of embodied carbon than all other stages in the lifecycle. Globally, cement and steel are two of the most important sources of material-related emissions in construction. Cement manufacture is responsible for around 7 percent of global carbon emissions, with steel also contributing 7-9 percent of the global total, of which around half can be attributed to buildings and construction. At the asset level, embodied carbon emissions released before the building or infrastructure begins to be used, will be responsible for half of the entire carbon footprint of new construction between now and 2050, threatening to consume a large part of the world's remaining carbon budget. As operational carbon is reduced, embodied carbon will continue to grow in importance as a proportion of total emissions.

There are many sources of embodied carbon emissions across the lifecycle of a building or infrastructure project. The full impact from each source and the impact on lifecycle stages varies depending on local and project conditions but commonly are (cross referenced against EN 15978):

TYPE AND VOLUME OF STRUCTURE INSTALLED

Elements such as foundations, frames and other forms of superstructure often represent the biggest contribution to embodied carbon, sometimes up to 80 percent, can be emitted during product manufacturing (A1-A3) and construction (A5) alone. The substantial contribution is due to:



- The large volume of materials used (e.g., footings of a building, concrete slabs)
- Types of materials used with desirable load bearing properties being carbon intensive (e.g., concrete, steel, masonry)

Additionally, site selection can play a large role in how much embodied carbon the structure will contribute to a project. Sites that have soil conditions that require stabilisation or deep foundations will have a larger volume and therefore a higher embodied carbon contribution.

ASSOCIATED CARBON INTENSITY FROM MANUFACTURING PROCESSES

The upfront carbon from materials and products (A1 – A5) are a significant source of embodied carbon to consider. Both cement and steel are carbon intensive as they require very high temperatures during production (which is energy intensive and often supplied by fossil fuels) and also release carbon dioxide emissions as a chemical reaction during the manufacturing process. Similarly, glass and aluminium (generally) also require high temperatures for production and are therefore carbon intensive.

LIFECYCLE PROCESSES

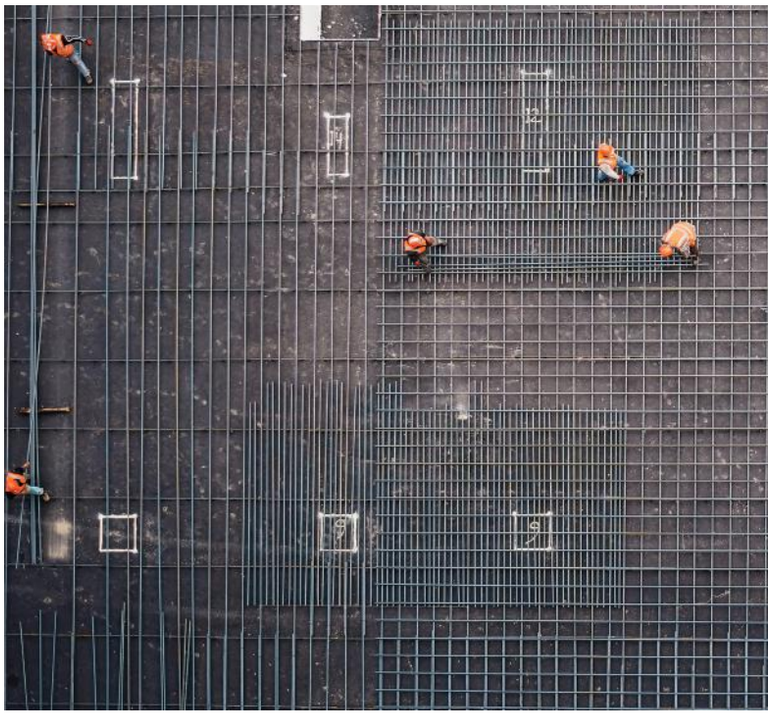
The application of a material across its lifecycle (A1-5, B1-5, C1-4) will have an important impact on the amount of embodied carbon that is emitted at the upfront, use stage and end of life carbon stages. For example, timber and other biomaterials like bamboo sequester carbon during growth meaning they absorb rather than emit carbon. The amount depends on the rapidness of growth and how it is replaced, with biomass retention or increase being of prime importance for the forest. When sustainably grown and harvested, timber and other biogenic material are an inherently low carbon material. However, if appropriate treatment of timber at end-of-life to mitigate any methane emissions associated with its decomposition or disposal is not followed then this may not be the case, demonstrating that understanding the whole lifecycle impact over time is a critical aspect of decision making.

TRANSPORTATION MODES AND DISTANCES

While not being as significant a source of embodied carbon, the mode and distance that a material is transported can add additional emissions especially during upfront (A4) and end of life carbon stages (C2).

ASSOCIATED EMISSIONS FROM CONSTRUCTION PROCESSES AND EQUIPMENT USED ON-SITE

Equipment used during construction (A5), such as excavators and cranes all require a form of energy to operate. When this equipment is powered by fossil fuel sources such as petrol or diesel, they are a source of embodied carbon for the developer. The method of construction can also impact how much embodied carbon a project has. Prefabrication requires less machinery and equipment on-site with lower construction times thereby reducing the upfront carbon of the project. Embracing disruptive technologies in construction like additive manufacturing (e.g., 3D printing) could result in energy savings of up to 21 percent in the sector by 2050, as well as reduce waste and reliance on traditional transportation methods.



THE OPPORTUNITY FOR ASIA PACIFIC

With a lack of awareness within industry and limited data available to determine the embodied carbon of buildings and infrastructure, the business case for action has been hard to clarify. There is increasing interest from industry and green building councils (GBCs) in making this clearer. In 2018, 14 out of 23 green building certification systems in the region addressed embodied carbon. All of these certifications at a minimum ask for reporting of embodied carbon calculations, but most are yet to incentivise performance through benchmarks and targets, due to uncertainty of data accuracy, scope, boundaries for inclusion and standardisation of methodologies. As databases become more populated, benchmarks established, and project targets set this will increase market competitiveness and create incentives that can be leveraged. With predicted increases in supportive regulation, flows of green investment and supply chain pressures, embodied carbon and a whole lifecycle approach will become critical for any new development to address to meet client and investor expectations.

Working towards reducing embodied carbon can yield great results at little additional cost when undertaken from the outset of a project. By intervening at early-stage design, embodied carbon can be reduced to the greatest effect and in some cases at no incremental cost. This will help Asia Pacific companies to become recognised as global leaders and in line with global climate goals.

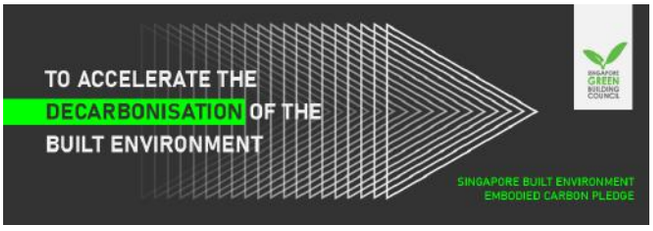
SINGAPORE BUILT ENVIRONMENT EMBODIED CARBON PLEDGE

To bring attention to this important issue and the built environment sector's influence on embodied carbon emissions, the Singapore Green Building Council (SGBC) launched the Singapore Built Environment Embodied Carbon Pledge on 5 August 2021 to help unify and amplify industry action on embodied carbon. With the Pledge as a guiding point, organisations with ambitions, intentions and solutions to address built environment embodied carbon emissions will take concrete actions anchored on the Pledge's 3 key principles:

1. Opting for building materials with lower embodied carbon
2. Minimising materials usage and wastage through collaborative design and optimization
3. Transforming construction site processes to utilise electricity and renewable sources of energy

"The global pandemic has shown us what we can overcome when we work together towards a common goal. Climate change is an even greater threat to humanity and we need to urgently bring together like-minded partners to accelerate decarbonisation of the built environment," said Ar. Tang Kok Thye, President of SGBC. "The Council – with the strong support from fellow industry associations such as the Real Estate Developers Association of Singapore (REDAS) – is ready to support the built environment's transition to one that is greener and low-carbon."

"With fast evolving work-live-play patterns and consumer behaviour, and changing business models and operations, it is necessary for the built environment industry to prioritise sustainability in real estate and take concerted action to push building adaptability and resilience in our urban systems and operations," said Mr. Chia Ngiang Hong, President of REDAS. "We look forward to more members and associates coming on board the Singapore Built Environment Embodied Carbon Pledge. Let us all continue to collaborate and work closely together as we embark on the ongoing journey to building Singapore as a Little Green Dot through Sustainability."



The signatories of the Pledge include the Ministry of National Development, four government agencies, building developers and owners, consultants and specifiers, builders and contractors as well as manufacturers and solution providers. Based on their organisation type, pledge signatories will take specific actions intended to build capability, capacity and demand, enabled by SGBC's framework of knowledge, expertise and resources.

As the world adapts to yet another new normal, the built environment is in a prime position to at once improve the quality of our places and spaces while also accelerating decarbonisation efforts to mitigate the impact of the climate emergency.

Content adapted from World Green Building Council and Singapore Green Building Council.

SINGAPORE GREEN BUILDING COUNCIL

SUPPORTING THE ACCELERATIO
BUILT ENVIRONMENT DECARBO

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Singapore Built Environment Embodied Carbon Pledge

UNDERSTANDING CARBON CREDITS

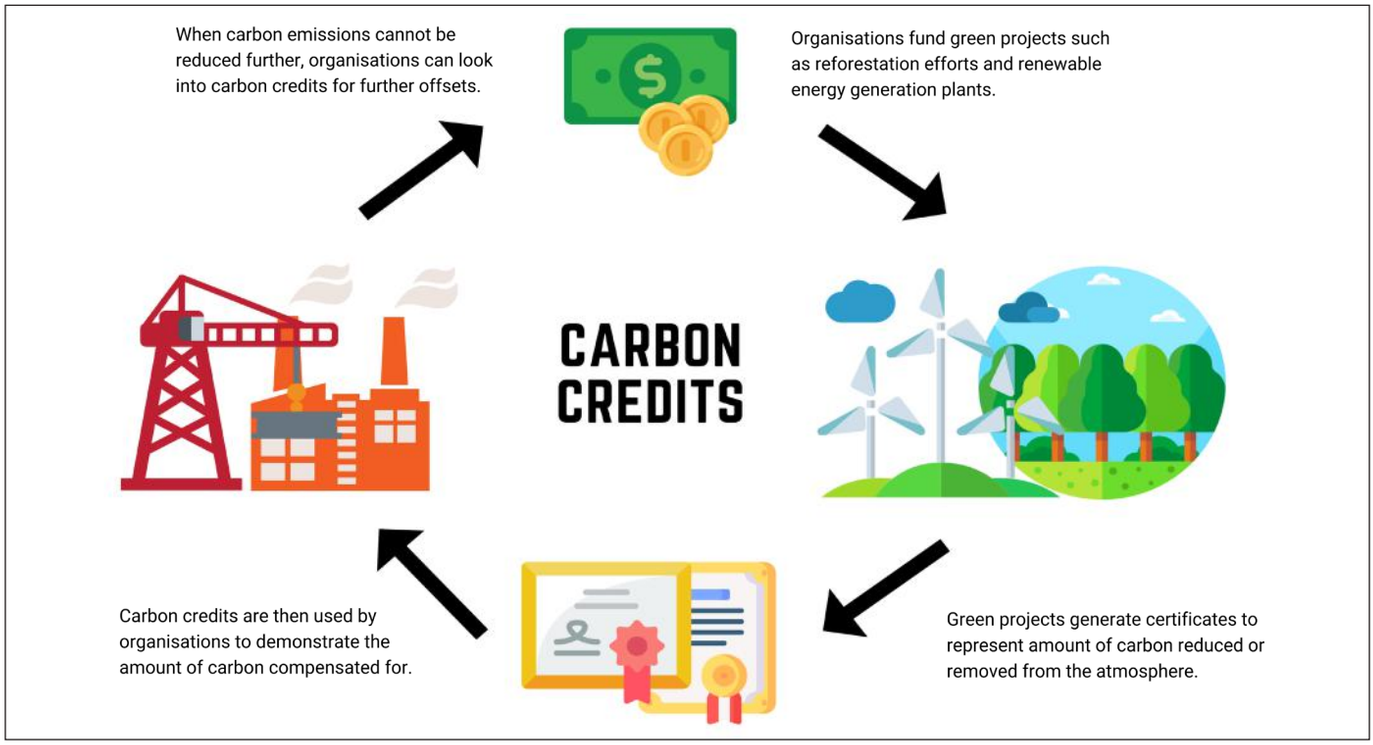
With strong interest in how carbon credits and offsets factor into corporate decarbonisation efforts, understanding the role of carbon credits will help organisations come to more informed decisions and better guide sustainability efforts. This article series will shed more light on how carbon credits can be leveraged to accelerate decarbonisation efforts, with the first part explaining the myriad definitions and terminology.

With more countries and organisations becoming increasingly interested and invested in adopting more aggressive carbon reduction efforts to address both corporate goals and climate ambitions, carbon credits and offsets have gained immense popularity in global decarbonisation and climate mitigation efforts. This can be seen from how voluntary carbon credits representing a sizeable 104 million tonnes of carbon dioxide equivalent (MtCO2e) with a cumulative market value of US$320 million was traded in 2019. As the world accelerates decarbonisation efforts, demand for carbon services and trading looks set to rise, alongside the significant expansion of voluntary carbon markets by about 15 times, with an estimated market value of between US$5-50 billion by 2030. By 2050, the international carbon offset market could hit US$200 billion, where demand is estimated to reach 7 to 13 gigatons of carbon emissions annually.

The Singapore government and local companies have also made active steps to promote and engage in carbon credits, offsets and trading. For example, recommendations made by the Emerging Stronger Taskforce focused on how Singapore should establish itself as a carbon trading and services hub, while fulfilling its own carbon reduction targets and contributing to global efforts to combat climate change. The Singapore Green Plan 2030 launched early this year also highlighted the goals of promoting Singapore as a leading carbon trading and services hub with green finance, sustainability consultancy, verification, credits trading and risk management, as well as encouraging homegrown innovation like decarbonisation technologies under the Research, Innovation & Enterprise Plan 2025. Finally, government agencies such as the Economic Development Board (EDB) and Enterprise Singapore (ESG) have engaged carbon companies to establish a local presence, with services like low-carbon project development, consulting, verification services for Clean Development Mechanism (CDM) projects, carbon footprinting, as well as project financing and legal services for carbon projects. Given Singapore's expertise in being a major financial hub, its proximity to large supplies of carbon credits in Southeast Asia, India, China, as well as being home to many energy traders who form the majority of demand for carbon services, Singapore is in an ideal position to become Asia's top carbon trading and services hub.

However, the concept of being involved with carbon credits and offsets might be intimidating and even off-putting for some organisations, especially given the complexity of the markets and systems, as well as lack of knowledge surrounding the role of carbon credits and offsets in the corporate sustainability journey. This article series will provide an overview of the terminology, types of markets and projects, as well as the role of carbon credits and offsets in helping organisations achieve their carbon reduction and climate mitigation targets.

TERMINOLOGY & DEFINITIONS



Many terms and concepts are utilised when discussing carbon credits, offsets and trading. However, there has not been much universal consensus on the exact meanings behind these definitions, which makes it difficult to even understand the various components. The following is an overview of the common terms used in the market.

CARBON CREDITS & CARBON OFFSETS

There are various definitions of what a carbon credit is or refers to. In general, a carbon credit is equal to one ton of carbon dioxide or greenhouse gas emissions. However, what the carbon credit specifically refers to differs based on whether the credit is based on a cap-and-trade programme or a voluntary carbon market.

A carbon credit is 'a certificate representing one metric ton of carbon dioxide equivalent (MtCO2e) that is either prevented from being emitted into the atmosphere (emissions avoidance/reduction) or removed from the atmosphere'. Given that carbon credits can be tracked and traded like commodities and can be commercialised, prices and costs are therefore associated with carbon and greenhouse gas emissions, which incentivises (or penalises) companies who emit them to reduce their emissions. Similarly, a carbon offset is a reduction in carbon emissions made elsewhere to compensate for emissions caused. Each tonne of emissions reduced by a carbon offset project creates one carbon credits, which leads to the carbon offsets term being used interchangeably with carbon credits in the voluntary carbon market.

There are a few fundamental criteria that projects have to meet in order to generate carbon credits that can be verified and certified by international registries and standards. They need to 'demonstrate that the achieved emissions reductions or carbon dioxide removals are real, measurable, permanent, additional, independently verified, and unique'. One key criterion is that the reduction or removal of carbon emissions after executing the project have to be greater than a baseline scenario. Financial additionality also factors in, where the project and its generated carbon credits 'would not have happened if it were not for the offset finance' or the funds from the sale of carbon credits. Moreover, uniqueness means an organisation can claim the impact of carbon credits and count them towards their climate commitment only if the credit is retired from a registry and can no longer be traded on the market.

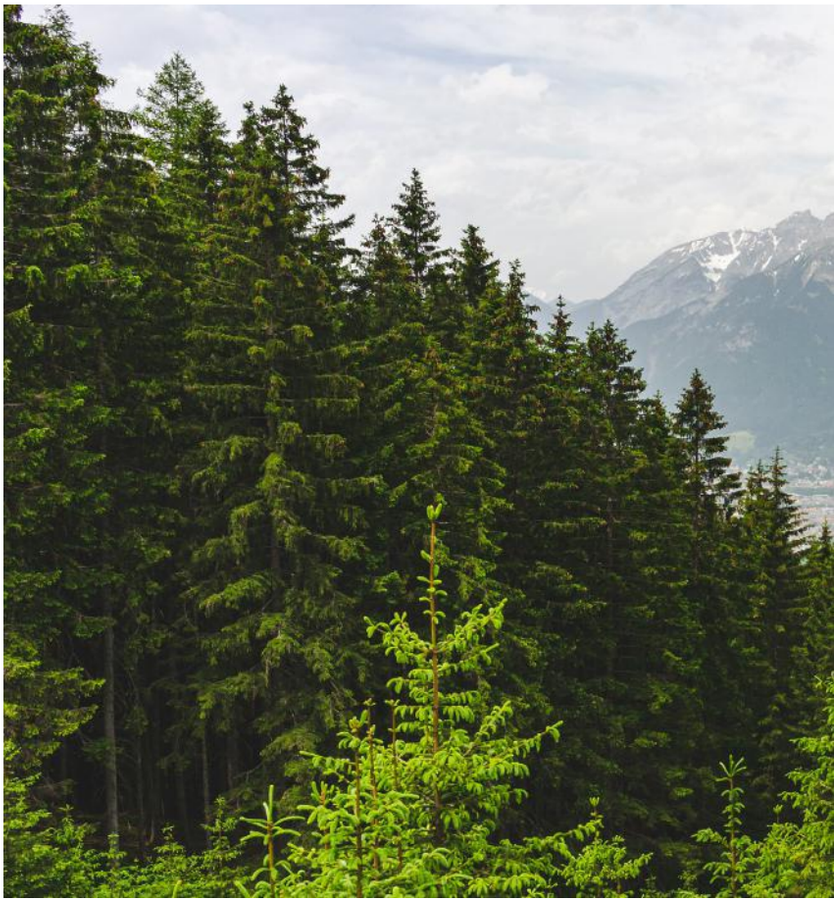
Carbon credits can be broadly sorted into two categories: avoidance/reduction credits, and removal/ sequestration credits. Credits that reduce emissions from current sources and avoid practices that increases emissions include natural climate solutions (NCS), which limit the loss of nature-like forests and peatlands that store and sequester carbon, as well as technology-based avoidance/ reduction with newer technologies like green hydrogen, sustainable fuels and green cement. On the other hand, removal and sequestration credits remove and store CO2 from the atmosphere through nature-based sequestration like reforestation, and technology-based removal projects such as the utilisation of carbon capture, utilisation and storage (CCUS) technology.

CAP-AND-TRADE PROGRAMMES

In a cap-and-trade scheme, also known as the compliance system, the government sets out specific targets of greenhouse gas and carbon emissions that are allowed to be emitted by a certain industry, which are lowered periodically to ensure that companies reduce their emissions over time. A finite number of emissions allowances, which are tradable permits that allow a fixed quantity of emissions to be emitted by companies, will be allocated to the industry, which can then be traded by firms. A carbon credit under a Cap-and-Trade programme thus essentially refers to "a permit that allows the company that holds it to emit a certain amount of carbon dioxide or other greenhouse gases". The scheme works on the principle that firms who have emitted excess carbon would have to purchase pollution permits or carbon credits from companies who have spare allowances, which would increase the costs for heavy emitters and incentivise corporations to reduce their emissions.

VOLUNTARY CARBON MARKETS

The voluntary carbon market 'allows individuals or organisations to buy carbon credits issued by privately organised certification schemes to voluntarily offset their carbon footprint'. Voluntary carbon credits are thus voluntary commitments, which are 'in contrast to compliance carbon markets that are based on obligations created by regulation'. These types of carbon credits are thus generated by carbon offsetting/reduction projects



for the voluntary market, and have been verified or registered by one of the various registries and standards internationally.

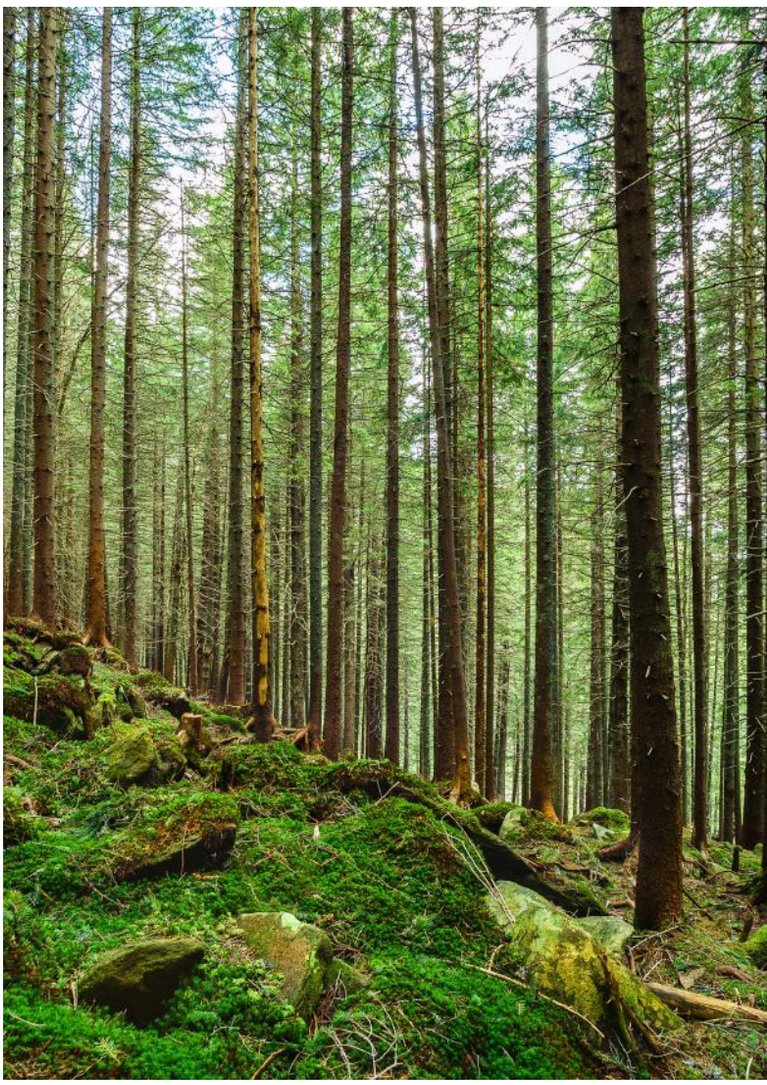
FORESTRY-BASED OFFSETS

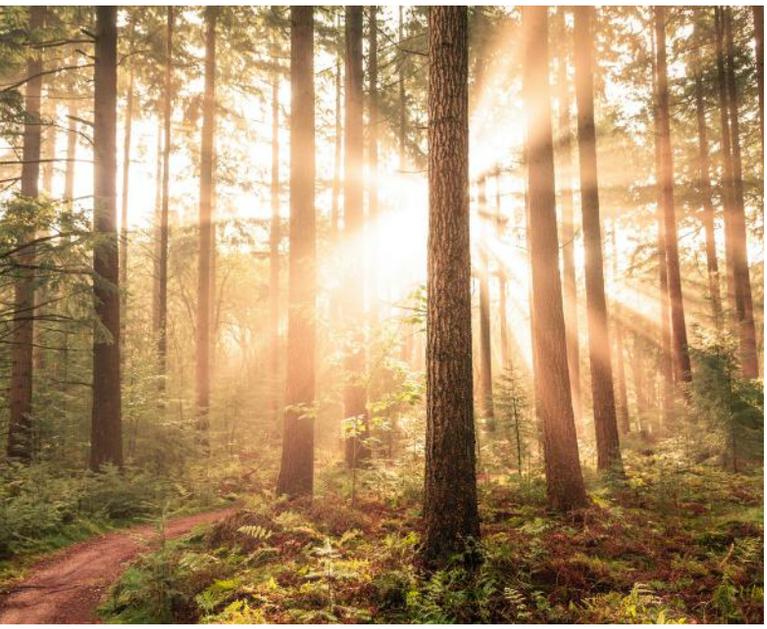
Forests and nature play important roles in mitigating climate change through their ability to absorb approximately 12 percent of annual carbon emissions globally. There are three types of forestry-based carbon offsets and credits:

1. Credits from projects focusing on afforestation or reforestation that promote the sequestration of carbon through the creation of new carbon sinks
2. Prevention of emissions caused by deforestation and forest degradation, also known as Reducing Emissions from Deforestation and Forest Degradation (REDD) projects
3. Improved forest management (IFM) to increase the amount of carbon sequestered in trees

REDD projects generate credits by predicting deforestation that would take place if the REDD project was not in force, with areas referenced to estimate potential deforestation. Forestry-based carbon credits and offsets therefore play an important role in safeguarding existing high-density carbon sinks as natural forests are more resilient and do a better job at sequestering carbon as compared to young plantation forests. Demand for such credits is also driven by the increased attractiveness and appeal of forest projects, as they offer outstanding and prominent socio-economic and/or environmental benefits while achieving effective carbon reductions. Additional benefits of REDD projects include protecting the biodiversity of natural forests and supporting sustainable and alternative livelihoods for local communities.

On the supply side, a recent study by the National University of Singapore's Centre for Nature-based Climate Solutions found that if 1.55 billion hectares of tropical forests which are currently at risk of deforestation are protected through the sale of carbon credits, the annual returns generated would be more than S$61 billion. The study also examined the three tropical forest regions globally, and found that Asia-Pacific holds the greatest number of profitable forest carbon sites. There will thus be growing interest and popularity surrounding such forestry-based carbon credits, especially as seen from how the new Singapore-based platform Climate Impact X and its Project Marketplace is set to focus on such natural climate solutions.





and could in fact release even more carbon than otherwise.

Overall, the potential of nature-based solutions must be recognised as their benefits to biodiversity and positive impact on ecosystem services are worth more than their carbon pricing, even if such projects have questionable carbon returns due to a weak measurement and verification. These projects will, therefore, play a significant and important role in climate mitigation and protection.

In the next part of the article series to be published in the March 2022 issue of SG Green, find out more about local and overseas carbon markets and how carbon credits factor into the corporate sustainability movement.

However, there are also a few problems and risks associated with forestry-based carbon credits, specifically REDD credits. Forestry projects often have 'a reversibly risk' as they are susceptible to ailments such as fire, logging and disease, which would affect the permanence of the credits generated from such projects. Moreover, there is a risk of leakage, which 'occurs when a carbon-reduction project displaces emission-causing activities and produces higher emissions outside the project boundary', such as when projects that protect certain forested areas result in a relocation of deforestation and logging activities to other unprotected locations. These factors thus make it difficult to reliably quantify the amount of carbon offset, which results in much uncertainty surrounding the estimated mitigation and carbon impact achieved by such projects. This results in a divergence from the expected certainty and realistic removal/ avoidance of carbon credits generated from such projects, which calls into question the credibility of these credits and their claims of offsetting emissions.

Moreover, given that the number of credits can be influenced with the selection of the baseline scenario, the carbon reduction/avoidance impact of the project can be inflated to generate more credits and gain more revenue. Doing so results in projects executed on inaccurate predictions of the threat of deforestation, leading to negligible climate impact

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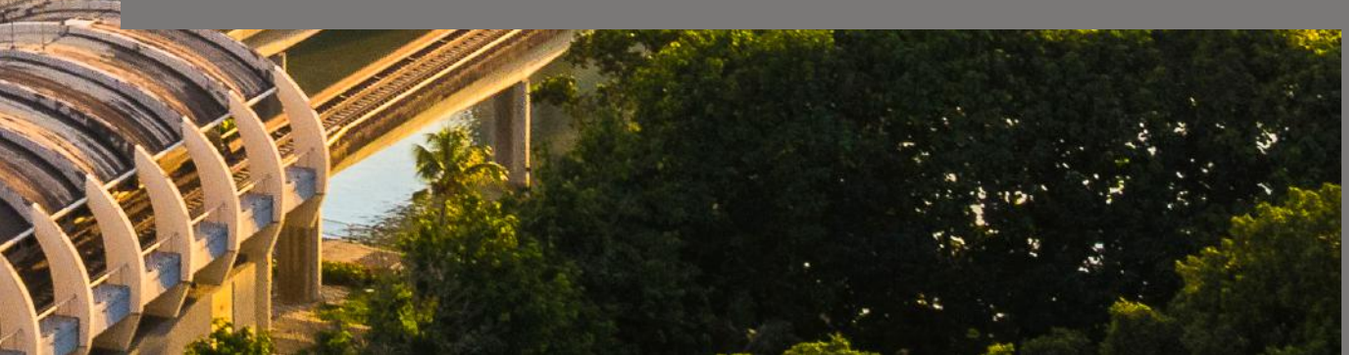
GET SUSTAINABILITY GOING WITH GREEN ENERGY TECH

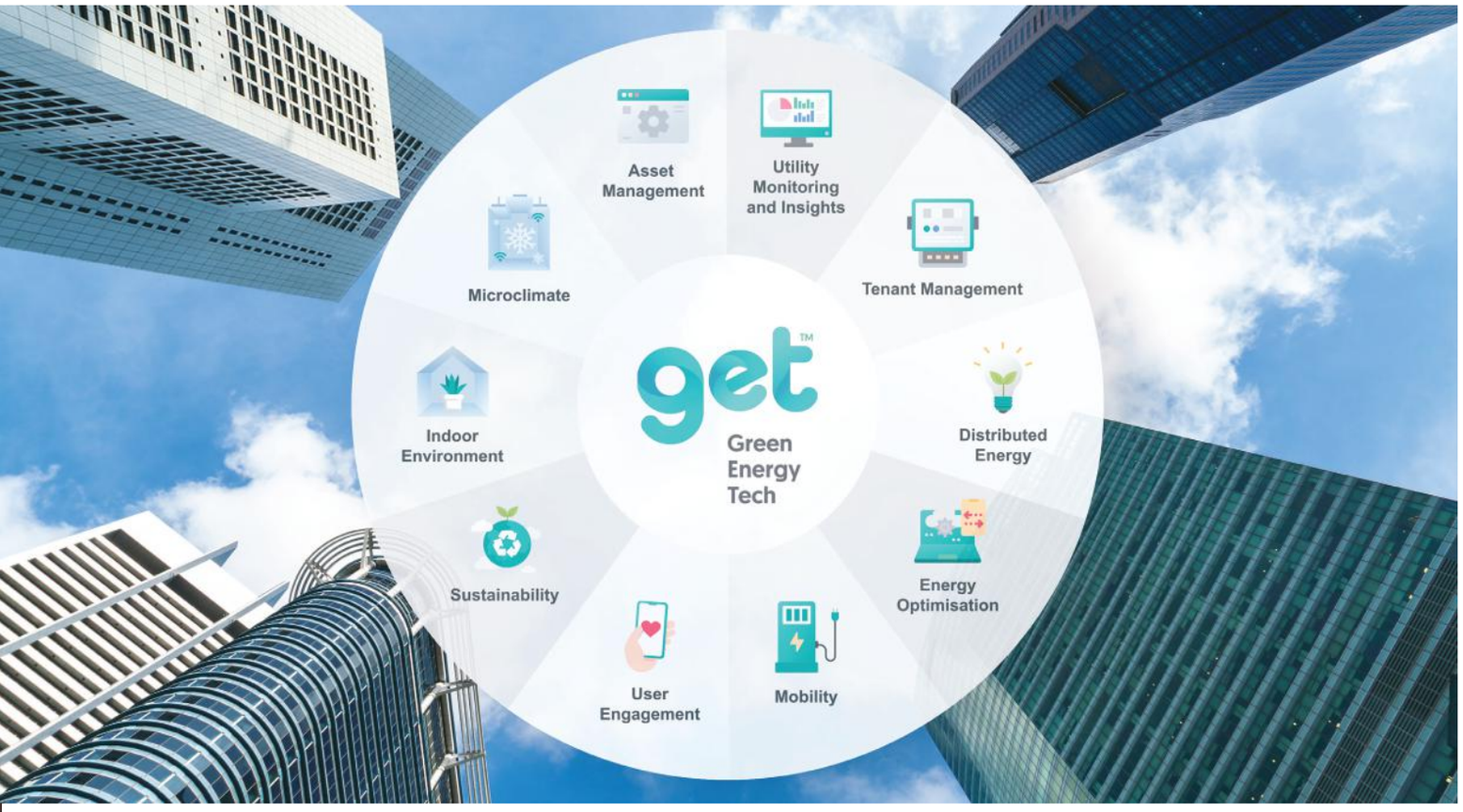
As the world accelerates sustainability ambitions in order to meet the increasingly urgent targets of the Paris Agreement, green energy technology can facilitate the transition to a greener, more efficient future.



Get Sustainability Going With Green Energy Tech

It is no exaggeration to say that the world has changed. The impact of the global pandemic has brought massive upheavals to long-established routines and conventions, forcing many around the world to rethink, reinvent and reimagine the status quo. The pandemic has also shown us what can be achieved when we work together towards a common goal, and this is especially pertinent, as the issue of climate change is an even greater existential threat facing all of mankind.

Building-based prevention and control measures have become one of the most important methods of fighting against disease and epidemic. These measures include self-isolation, community management, elevator disinfection, environmental cleaning, open windows for natural ventilation, and other features that help the building owners maintain a safe and healthy indoor environment for occupants. More intense, pandemic-fuelled digitalisation over the past year has also hastened the development of smart building technology, accelerating the paradigm shift towards greener and healthier buildings powered by sustainability-centric technology.



GET GOING WITH ENERGY TECH

In order to achieve Singapore's sustainability targets outlined through the Singapore Green Plan 2030 and the Singapore Green Building Masterplan, there is a greater need for the country to become more digitally connected, data-driven and low carbon. As the digital transformation arm of national utilities firm SP Group, SP Digital is empowering the future of energy with Green Energy Tech solutions.

SP Digital is no newcomer to the energy technology scene, having developed the SP Utilities mobile application which has over 1.2 million app downloads, to help homeowners track and manage their household utilities while also encouraging them to reduce their carbon footprints through in-app features.

Backed by stellar track records and a clear vision to deliver innovative Green Energy Tech solutions, SP Digital is gearing up to power sustainability for the built environment. Globally, buildings are responsible for 40 percent of global carbon emissions. With the urgent need to mitigate climate change, sustainability is now a central pillar of any organisational strategy, and SP Digital's latest solution will help organisations GET going.

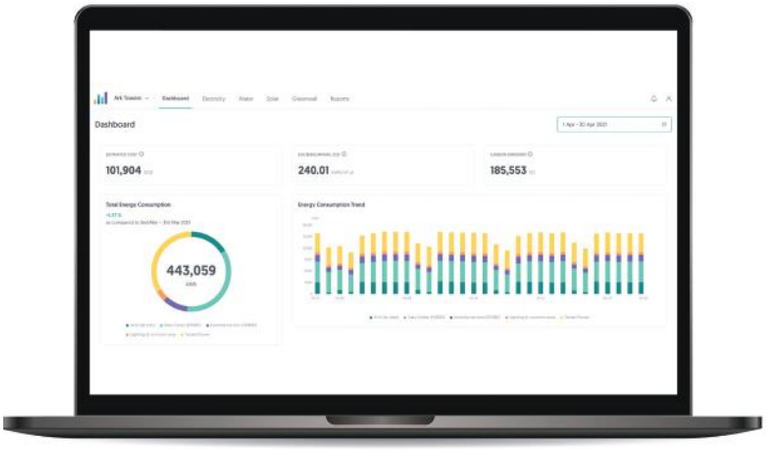
The SP Digital GET™ (Green Energy Tech) suite of solutions harnesses the power of AI and IoT to enable a low carbon, smart energy future, integrating different building systems and diverse data sources for a seamless utilities management experience. GET solutions ease building owners and operators into sustainability objectives, effectively helping to visualise sustainability and building efficiency, along with bringing tenants into the equation to have them more involved with the building's performance.

SMARTER BUILDING MANAGEMENT

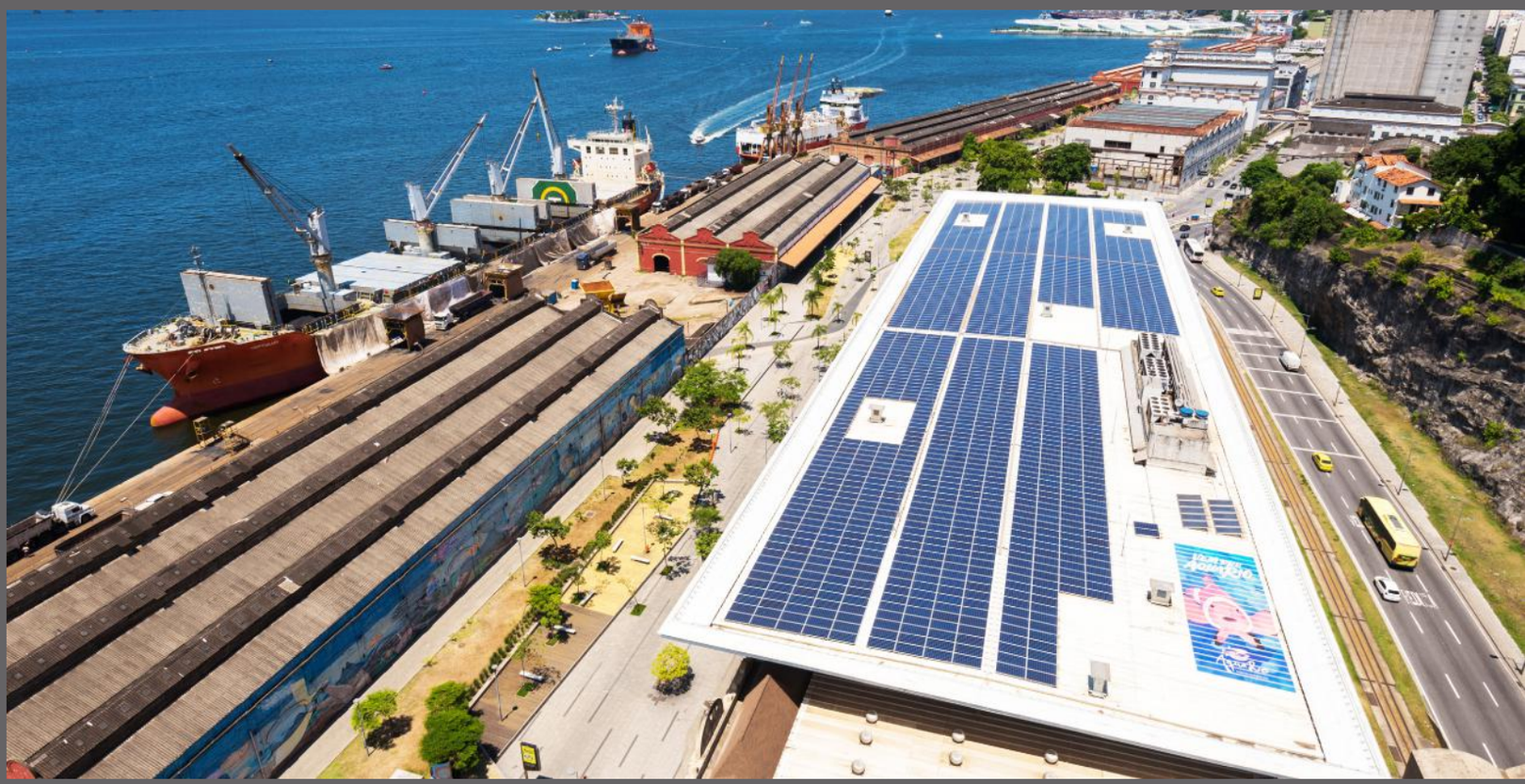
The GET suite of solutions is suitable for deployment in all types of buildings. While GET is able to help alleviate the usual building owner pain points such as electricity or water meter readings, generating reports, benchmarking of Energy Use Intensity (EUI) or detection of energy wastage, it is able to do so much more.

GET Insights helps building owners to form an integrated view of all utilities consumption within a building, premise or across the organisations' portfolio in a single place, relying on a number of data sources including existing meters, energy management systems or by installing extra sensors to better understand activities in their premises.

When used together with other modules within the GET suite, organisations are empowered to manage, monitor, report, analyse and optimise utilities usage to identify wastage, cost savings, drive greener operations and achieve sustainability targets.



GET Insights dashboard



SMOOTH SAILING FOR ENERGY MANAGEMENT IN THE MARINE SECTOR

The Insights, Distributed Energy and Energy Optimisation modules were deployed at a large industrial facility in the marine sector in Singapore, to effectively fulfill their peak operations without exceeding their contracted capacity, as well as meet carbon reduction targets. IoT sensors, advanced metering infrastructure and energy management system were implemented to monitor and manage their on-premise solar photovoltaic (PV) system, Energy Storage System (ESS) and electrical loads. Leveraging AI to forecast the load and automatically schedule the ESS to charge and discharge, the building owner was able to reduce peak consumption from the grid and save on uncontracted capacity charges. Facility managers also saw improved operational efficiency through the digitalisation and automation of the utilities management processes.

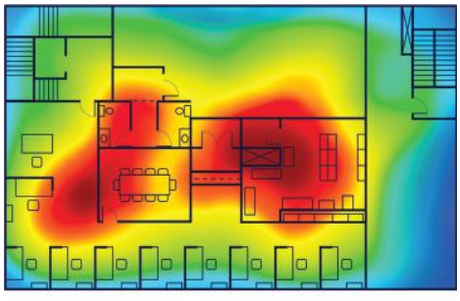
LOOKING FORWARD TO THE NEXT PHASE

The site's sustainability credentials are being further enhanced with a second phase implementation, whereby more solar PV will be deployed across their site and optimised via GET Insights to provide intelligent and reliable energy management to realise significant energy savings.

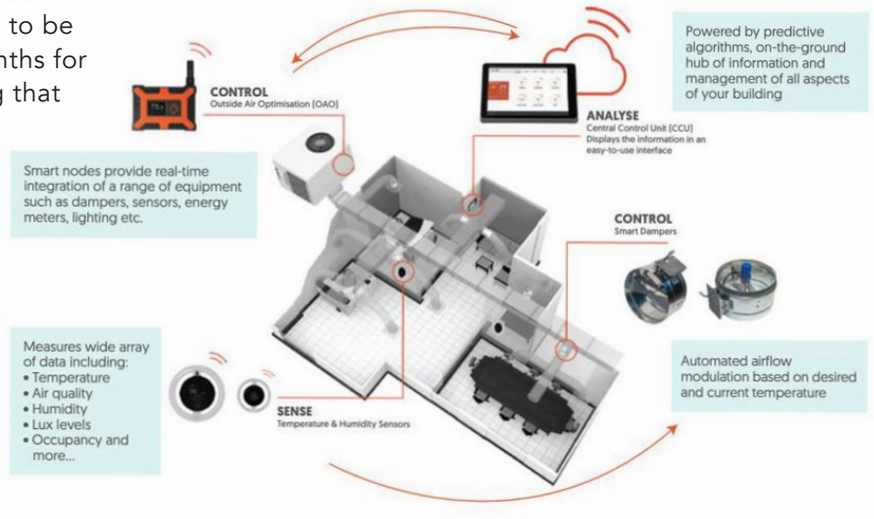
The system optimises the site's energy consumption for greener operations, resulting in significant utilities savings. The integrated energy solution is expected to effectively provide close to 60 percent of electricity consumed by the steel fabrication facility at peak load and avoid annual carbon emissions by more than 4,200 tonnes, equivalent to taking approximately 1,300 cars off the road.

IMPROVING THE INDOOR ENVIRONMENT

A key question that pops up in any smart building discussion is that of sensors: does the solution need its own set of sensors for it to work as intended? The GET suite of solutions is generally brand agnostic when it comes to obtaining environmental data for analysis - for example, in energy monitoring, the platform currently supports various sensors and gateways, and SP Digital is in the midst of supporting more sensors in the months ahead. There are also plans to further integrate with industry-standard sensors from 75F (in GET Control) and other products in the market to provide an even more comprehensive digital solution with actionable insights that can manage the entire indoor environment holistically. Deployment of the solution will be seamless and agile. If the building already has its own sensor network with readily available data on existing systems, GET solutions can be up and running within a day. If sensors need to be installed, it will take no more than three months for the solution to be live, all the while ensuring that safety and accuracy are well safeguarded.



Before implementation:
Hot and cold spots in office space



Dynamic airflow balancing - proactive zone control system that monitors and controls conditions in individual spaces remotely for optimised comfort and efficiency.

After implementation:
Office space is evenly cooled

GET Control, another key feature of the GET suite, is a self-learning building intelligence system. It utilises AI and IoT to optimise and regulate air-conditioning in the building predictively and proactively. Machine Learning algorithms include a live weather stream and forecast data to predict optimal control strategies for the indoor environment. The innovative system enhances occupant well-being and thermal comfort, while maximising energy and operational efficiency. It can also be cost effectively deployed in a minimally invasive and scalable manner.

GENERATING SAVINGS FOR A FINANCIAL INSTITUTION

In one of the major financial institutions in Singapore, building owners were faced with frequent occupant complaints and dissatisfaction due to discomfort from hot and cold spots in the office, manual adjustments that were time consuming and ineffective and poor cooling efficiency resulting in high energy use and carbon emissions. When GET Control was deployed, the site saw more than 30 percent air-side cooling energy savings, enhanced thermal comfort and indoor air quality for employees, and improved operations and productivity.

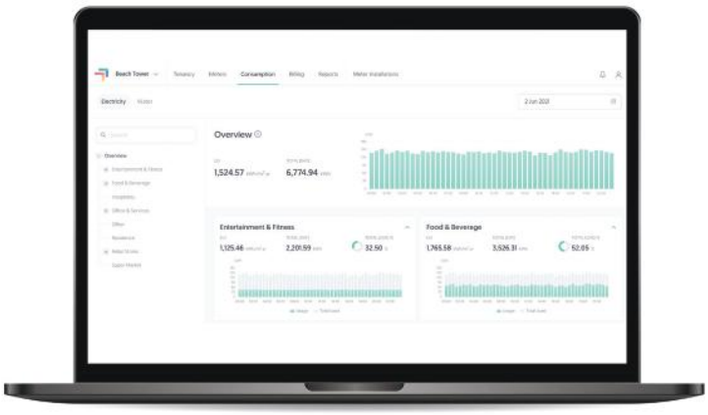
Indoor health and well-being have risen in prominence in the wake of the pandemic. Proper operations and maintenance of air-conditioning and mechanical ventilation (ACMV) systems to enhance ventilation and air quality in indoor spaces are important in minimising the risk of viral transmission in air-conditioned spaces.

GET Control also comes with an interesting feature: Epidemic Mode. A sequence of operations designed to maximise ventilation and outside air to maintain safe and healthy air-conditioned spaces in the event of a pandemic, Epidemic Mode consists of two application profiles, Smart Enhanced Ventilation™ and Smart Purge™, which incorporates recommended guidelines like increasing outside air ventilation and flushing indoor air before and after occupancy hours. The application automatically updates via the cloud as and when the latest guidelines change. Energy consumption is still optimised while improving indoor air circulation, and indoor humidity is maintained at acceptable levels according to SS 554 standards, despite increase in outdoor air with enhanced purging sequences. This mode can be remotely monitored, managed and controlled without physical presence in the building.

SMARTER TENANT ENGAGEMENT

A key driver for the development of the GET suite of solutions is the understanding that any type of data should be used to address multiple problems in order to avoid costs of duplication of sensors. Therefore, as part of the GET suite, a solution will also be launched to engage building occupants into the sustainability journey by letting them provide feedback on how they experience their environment in terms of temperature, indoor air quality and noise levels. Thanks to its experience with the SP Utilities app, SP Digital is able to create an engaging, interactive platform for tenants as well.

GET TenantCare is a smart and automated tenant submetering solution designed to help landlords and property owners efficiently manage tenant utilities consumption. Backed by robust advanced metering infrastructure, GET TenantCare simplifies operational challenges involved in utilities management, enhances tenant engagement, and frees up valuable time for building owners to focus on their core business. The module addresses some of the common challenges faced by building owners and operators, including:



GET TenantCare dashboard

- Non-AMI, Non-standard, multi-brand electricity meters
- Staggered & manual monthly data collection
- Resource & operations intensive process; intrusive, safety & security concerns; productivity loss
- Erroneous data, inaccurate utilities bill, revenue loss
- Inconsistent service & decrease in tenant satisfaction
- Non-standard & transient tenant management services

According to a recent BCA Building Energy Benchmarking report, the average split for electricity consumption between tenanted and common areas is almost equal for commercial buildings. This means that in order to enhance the building's energy efficiency, both areas must be focused on.

SIMPLICITY AND SUSTAINABILITY IN A MULTI-TENANTED PROPERTY

GET TenantCare was deployed for a Major Transport and Retail Hub with multiple tenants in Singapore. Through the deployment of smart electricity and water meters for their tenants, aggregated meter data could be collected through a secure and robust wireless mesh network that connected all the meters together, becoming one of the first integrations of smart electricity and water meters in a single wireless network within a building. Using a combination of smart meters and advanced operational analytics, the building owner was able to detect anomalies which could have resulted in underbilling and revenue losses, improve operational efficiency through digitalisation of meter reading and verification processes, and advance sustainability by recycling old meters and reducing electronic waste.

EMPOWERING THE FUTURE

As we move into a new normal, next-generation green buildings powered by energy technology are likely here to stay. SP Digital will be focusing efforts on advancing next-gen buildings, as well as developing and implementing technologies and digital solutions to enhance buildings' energy efficiency standards.

SP Digital is here to help the industry GET going with sustainability.

SPdigital

GET the key piece in your sustainability efforts

SP Digital GET™ (Green Energy Tech) is a suite of solutions that integrates different building systems and diverse data sources to create a seamless, sustainable utilities management experience. Our solutions enable you to:

Optimise energy efficiencies and drive greater savings

Improve indoor air quality and boost occupant well-being

Gain utility insights and proactively reduce carbon footprint

Enhance tenant satisfaction and add value to your business

Encourage a green mindset and advance sustainability goals

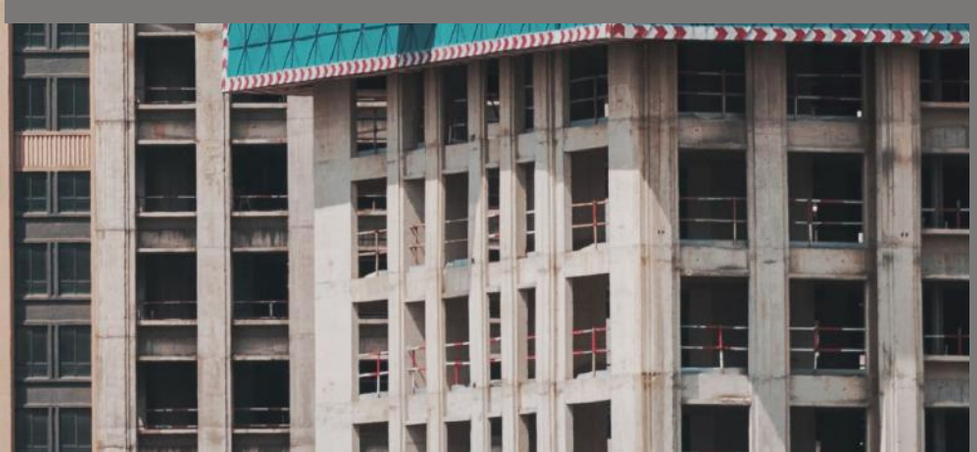
Scan the QR code and share with us your business priorities, and stand a chance to receive $10 NTUC vouchers.
(For the first 100 by 30 Nov 2021)

Connect with our team of experts to learn more now

spd@spgroup.com.sg www.spdigital.sg

POWERING LOW-EMISSIONS CONSTRUCTION SITES

The building and construction sector accounts for almost 40 percent of global carbon emissions with 23 percent directly attributable to the construction of buildings. While the materials used in construction get the lion's share of the blame, the operational activities of construction sites account for around half a billion tonnes of carbon emission per year – largely attributed to the burning of fossil fuels at sites by machinery and equipment. In addition to the carbon emissions generated by such machines, the noise and air pollution from this machinery also harm the local community and is therefore deserving of much more attention as countries and cities around the world strengthen their environmental policies.



NOW IS THE TIME

These three trends make this focus even more vital now:

1. The world is urbanising at an incredible rate. According to the International Energy Agency (IEA), a city the size of Paris will be built every week for the next 40 years to support the urbanisation of humanity. Seeing as this construction will be taking place in areas where people live and work, it is even more important that this is done in a way that minimises the impact on the environment and our health.

2. While the pace of innovation in construction has historically lagged behind other industries, this is quickly changing. Construction firms around the world are using an increasing number of sensors, robots, electric vehicles, drones and other electrical equipment. The growing electricity demand which inevitably stems from this - if powered by fossil-fuels - will have an even greater impact on our planet.

3. Urban environments around the world are clamping down on vehicles with conventional internal combustion engines due to the adverse health impact the resultant fumes have on humans – London's congestion zone is getting increasingly strict; Paris is banning fossil fuel vehicles by 2030; Singapore is banning all diesel cars by 2025 and only allowing clean vehicles from 2040. With these goals, diesel construction equipment must also be phased out. In fact, Europe is already planning to require all non-road mobile machinery (NRMM) to comply with strict Euro Stage V standards (for now, Singapore only requires such equipment to comply with Euro Stage II standards).

With these trends on the horizon, the necessity of transitioning away from fossil-fuels on construction sites is clear.

With its urban nature and dynamic property developers, Singapore's construction sector offers much room for improvement to support the Singapore government's decarbonisation goals. Construction site operations account for an estimated 800,000 tonnes of carbon emissions per year. While these emissions come from multiple different types of equipment, diesel generators appear on almost all sites and are a logical place to start emissions reductions.

DIESEL GENERATORS

Diesel generators are used extensively on construction sites to provide electricity to various types of construction equipment such as cranes, lifts, welders and site offices. Generator technology has changed little in many years, still relying on noisy, polluting and dangerous diesel engines, and in the process, causing significant environmental concerns.

There are an estimated 2,800 generators in Singapore used for construction purposes. Given a typical diesel generator used on a construction site produces around 100 tonnes of carbon emissions a year, diesel generators on construction sites alone produce 280,000 tonnes of carbon a year.

From an air quality point of view, each generator – if Euro Stage III compliant – produces the same emissions as around 200 fossil fuel cars. Imagine having 200 cars constantly circling your neighbourhood at all times. All the generators in Singapore could produce more air pollutants than all of the private vehicles in Singapore.

Finally, we all know that construction is noisy. Generators produce particularly aggravating constant noise and lead to numerous complaints from residents. Given the above, there is a strong case for fossil-fuel free power systems for construction, enabled by clean energy technologies.

ELECTRIFYING CONSTRUCTION

Advances in technology and the reduction in cost of lithium-ion batteries has spurred a shift towards electric vehicles (EVs) and battery storage. Harnessing these wider changes, new-energy alternatives to fossil-fuel-powered construction equipment are emerging. These new technologies have the potential to reduce emissions from construction sites dramatically, while also offering several other benefits. Construction technology company Ampd Energy provides one such technology.

Ampd Energy is focused on creating an emissions-free future for construction. The company produces and distributes an energy storage system called the Enertainer which powers construction sites without the need for diesel.

An Enertainer used to provide power to a construction site can result in up to 85 percent reduction in carbon footprint compared to a traditional diesel generator; even accounting for the carbon emissions of electricity generation used to charge the Enertainer. Furthermore, the Enertainer emits zero air pollutants at the point of use and, as a result, has zero impact on local air quality. Compared to the typical noise level of a diesel generator, the Enertainer is virtually silent. Other benefits include ridding construction sites of the dangers of handling and refilling diesel and providing important data to construction through its online platform for data-driven decision making.

Ampd Energy now has over 70 Enertainer units deployed in Hong Kong which have, till date, reduced carbon emissions by over 7,000 tonnes compared with the diesel generators they replaced.

BEYOND GENERATORS

Generators are just the start. Construction sites use excavators, air compressors, bulldozers and many other diesel-powered pieces of equipment during the construction process. The good news is that electric versions of these types of equipment are quickly coming to market. As they appear on construction sites, batteries will play a vital role in providing fast charging facilities to ensure construction equipment can operate continuously throughout the day. Technology companies such as Ampd Energy will continue to be a key part of the electrification of construction.

Article contributed by Ampd Energy Singapore Pte Ltd

BANKING ON MATERIALS

Exploring the Possible Use of a Material Passport in Singapore's Building and Construction Industry

INTRODUCTION

The 'Material Passport' approach in construction is being refined by various companies in many European countries. There is an urgency to land the right approach because quick access to accurate information on building materials enables active recovery and reuse of units, products or materials in buildings. The construction industry needs to encourage the reuse of building materials particularly when we understand that raw materials are becoming scarce and deficient and that the heavy use of raw resources will destroy the environment. The concept of reusing building components has not been adopted yet on a large scale because of several reasons. One of the key reasons is poor building information management, thus the goal of Buildings as Materials Bank (BAMB) is to let people shift to a circular building sector, which means, reusing the components and products which are in useable condition.

BAMB focuses on reusing building materials that are in good and reusable condition. Reusing construction material leads to less wastage of raw materials, adequate usage of construction material and lower cost of construction. It also saves the environment and on raw materials. The correct information is appropriate for recovery and reuse of materials, products or components in buildings. For storing materials, products and components to be used sometime later in other construction projects, this information is also needed. The electronic Materials Passports developed in BAMB strives to be a one-stop shop for all information pertaining to the building material.

WHAT IS A MATERIAL PASSPORT?

A Material Passport is a document which preserves the details of the materials used during the construction process. This document contains the data which explains the characteristics of materials to be used and focuses on recovery, recycling and reuse. Identity is provided to the material with the help of Material passport.


STOP

Like our personal passport, which gives us identity required for travelling purposes, a material passport gives identity to the so-called used or waste materials. It allows the material to travel to different locations as per the requirement after it has served its purpose in a building. Material is taken from one site to another site or building with the purpose of being reused. The ethos of material passports is that earth's resources should not be wasted and must be saved by reusing the materials because our planet is a closed system and the balance on earth should not be disturbed. The resources which we use as raw material, lose their identity and become rubble after one use, which is the current situation. In this case, the rubble can be put to use in the construction sector by giving the waste materials an identity through a Material Passport.

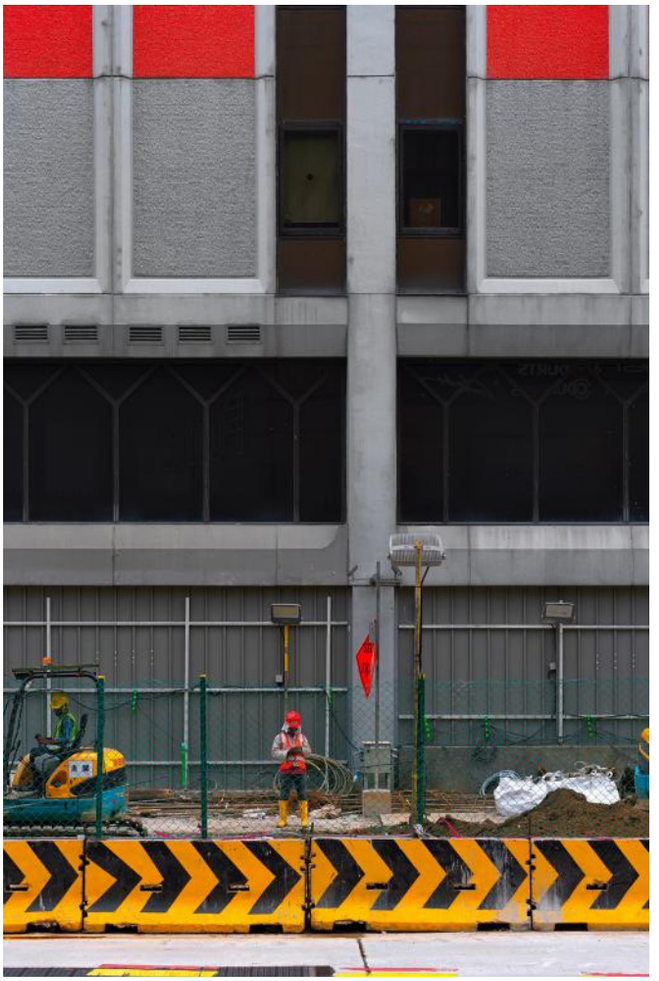
Materials Passports which are developed in BAMB collect detailed data of materials, describing features of materials used in products that give them value for recovery and reuse. In the Material Passport, all the details of the construction material which is used in the construction process is taken into account. This is carried out so that when the building is later demolished, the materials which were used in the initial construction process can be reused if checks and evaluation find them in good and reusable condition. This reduces wastage and ultimately provides both environmental benefits and cost savings.

MATERIAL PASSPORT IMPLEMENTATION CHALLENGES

Currently, buildings are demolished with little consideration to reuse its constituent materials. How much can be retained and what can be recycled is not documented at the onset of design and is also not verified during demolition. This may have adverse effects on the natural environment. In a circular economy, materials which indirectly uphold monetary worth and value of the products and systems is conserved. Currently, only a few countries are following the circular economy pattern and is new to many others.

This practice is not fully developed, especially in Asia, which is why the construction industry is not really aware of the benefits of a circular economy. However, in countries where the Material Passport has started use, those industries are seeing positive response to the adoption of the concept, keeping in view the cost of construction, improved utilisation of resources and preserving the environment.

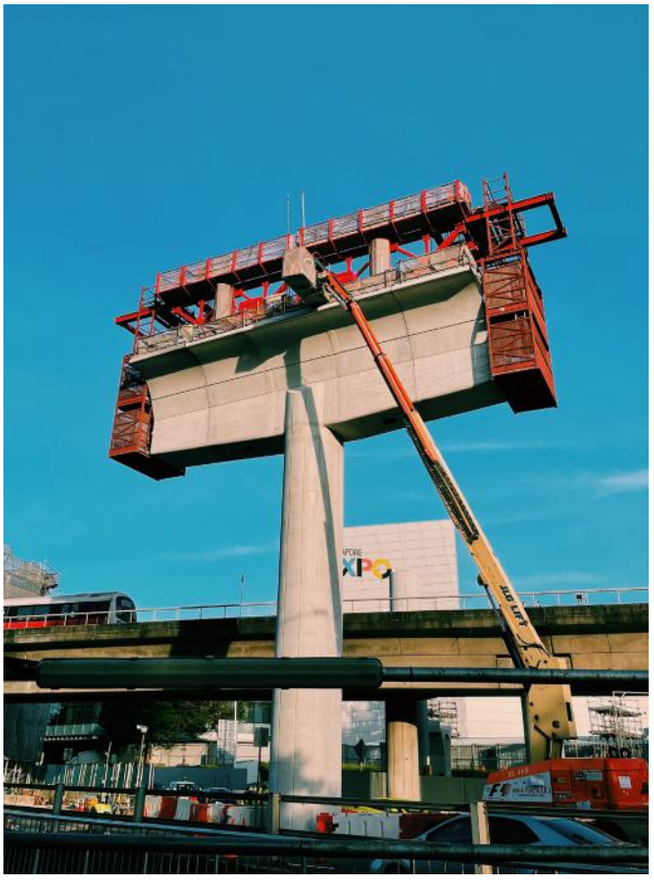
The demand for natural resources will increase in the near future as populations continue to rise. With the increase in demand for construction materials, more waste is expected to be generated. The building sector plays an important role in reducing the waste on our planet because it is the single largest user of resources and the largest producer of waste.



Waste can be reduced if we focus more on recycling. Along with recycling, it is important to have knowledge about the materials which can be reused. Keeping in mind the capability of our Earth and the burgeoning world population, a resource scarcity is expected in the near future. This scarcity of resources will lead to price hikes for building materials and products. In a circular economy, materials are kept in use for as long as possible. The suggestion is to maintain the value of materials, products or components, and materials are considered valuable if they are accessible, functional and attractive. This requires that materials or building products to be removed from a building after their lifetime with minimal effort, contamination and without loss in quality.

The benefits for having a Material Passport in buildings include but are not limited to:

- Improvement in indoor air quality
- Increase in value stability
- Reduction of disposal costs by the avoidance of impurities
- Increased employee satisfaction (e.g. lower absenteeism, health promotion)
- Quality assurance in construction
- Optimisation of resource extraction (sustainable consumption and climate protection)
- Compliance with increasingly stronger regulatory requirements
- Contribution to the achievement of national and international goals and standards (e.g. UN Sustainable Development Goals, Circular Economy Goals)
- Cost-optimised maintenance



CONCLUSION

Adopting a Material Passport can be summarised with the following:

1. With a material passport, we can look into the deconstruction or demolition of properties. We can also look for the highest possible reusability of the materials after the premises have been vacated or demolished.
2. There is an opportunity to recover more reusable parts by selling smaller, separate parts instead of the building as a whole.
3. The Material Passport maintains and even increases the value of materials, products and components even over a period of time.
4. Choosing healthier, more sustainable and circular building materials is easier for the developers, renovators and managers.
5. The Material passport is also considered a one-stop shop to explain the value of the Circular Economy across the building cycle. Its main target is using and reusing the same components and materials. With this, there will be less wastage. The Material Passport platform helps to bridge the gap in the marketplace.

The concept of a Material Passport is excellent for the environment but there would be capital cost that may delay initial adoption. However, considering the impact that a Passport can have on the environment, the initial cost is minuscule as compared to the benefits of extending and improving the lifetime of finite building materials. Material Passports are meaningful and thoughtful tools to bridge this gap, and this idea can improve clarity and access to information on the constituent materials and products used during building construction and renovation.

Singapore's built environment is in a good position to adopt the Material Passport as the foundations of Design for Manufacturing and Assembly (DfMA), Building Information Modelling (BIM) and other initiatives have paved the way for adoption. However, much study on how the Material Passport can be holistically and meaningfully integrated into the BIM design process is still needed. Nonetheless, because of the current national initiatives already in place, such as the Singapore Green Building Masterplan, the local industry is in a good position to adopt the Material Passport and contribute to environmental sustainability.

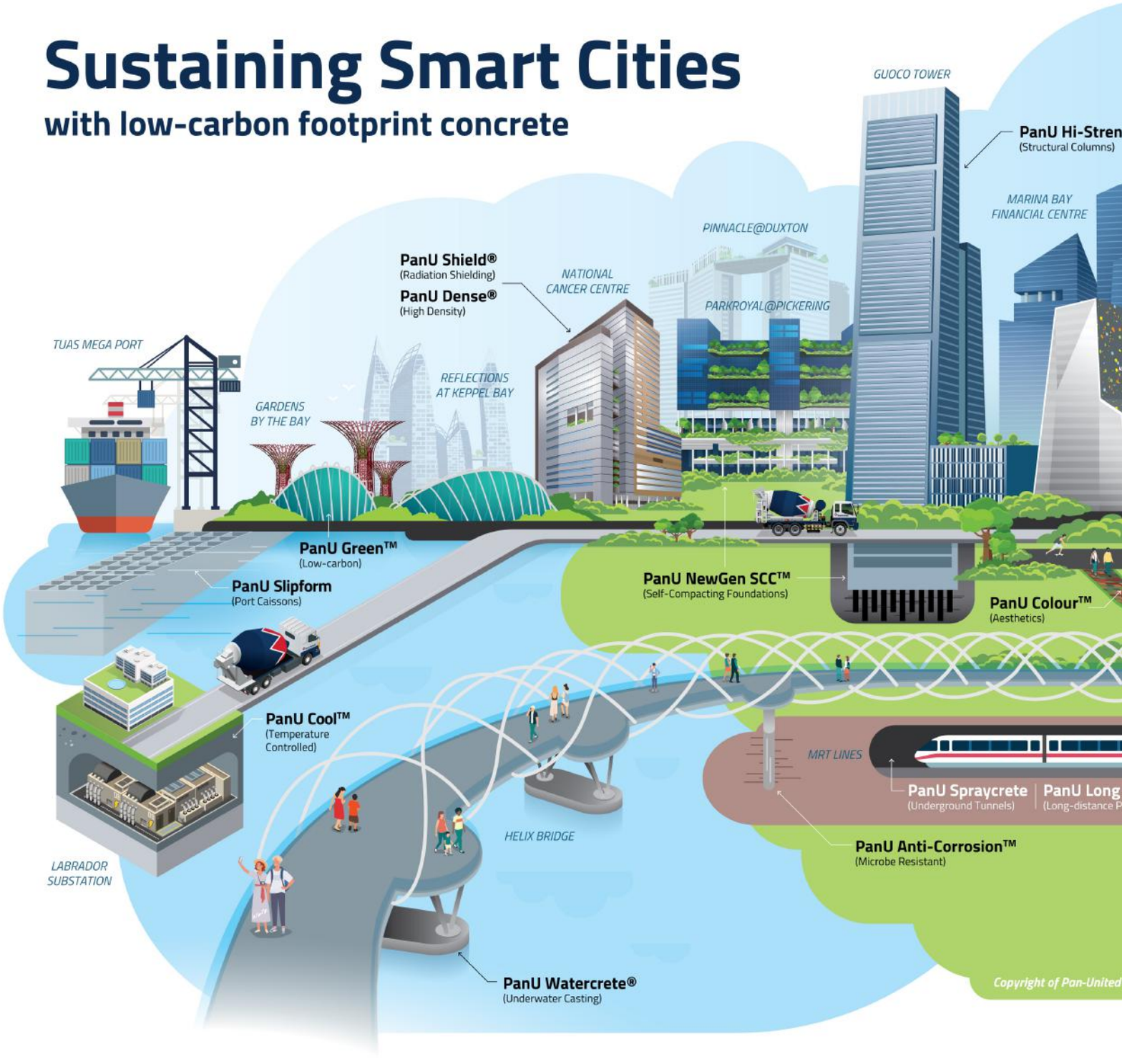
Article Contributed by Mr. Eugene Seah from Surbana Jurong

SUSTAINING SMART CITIES

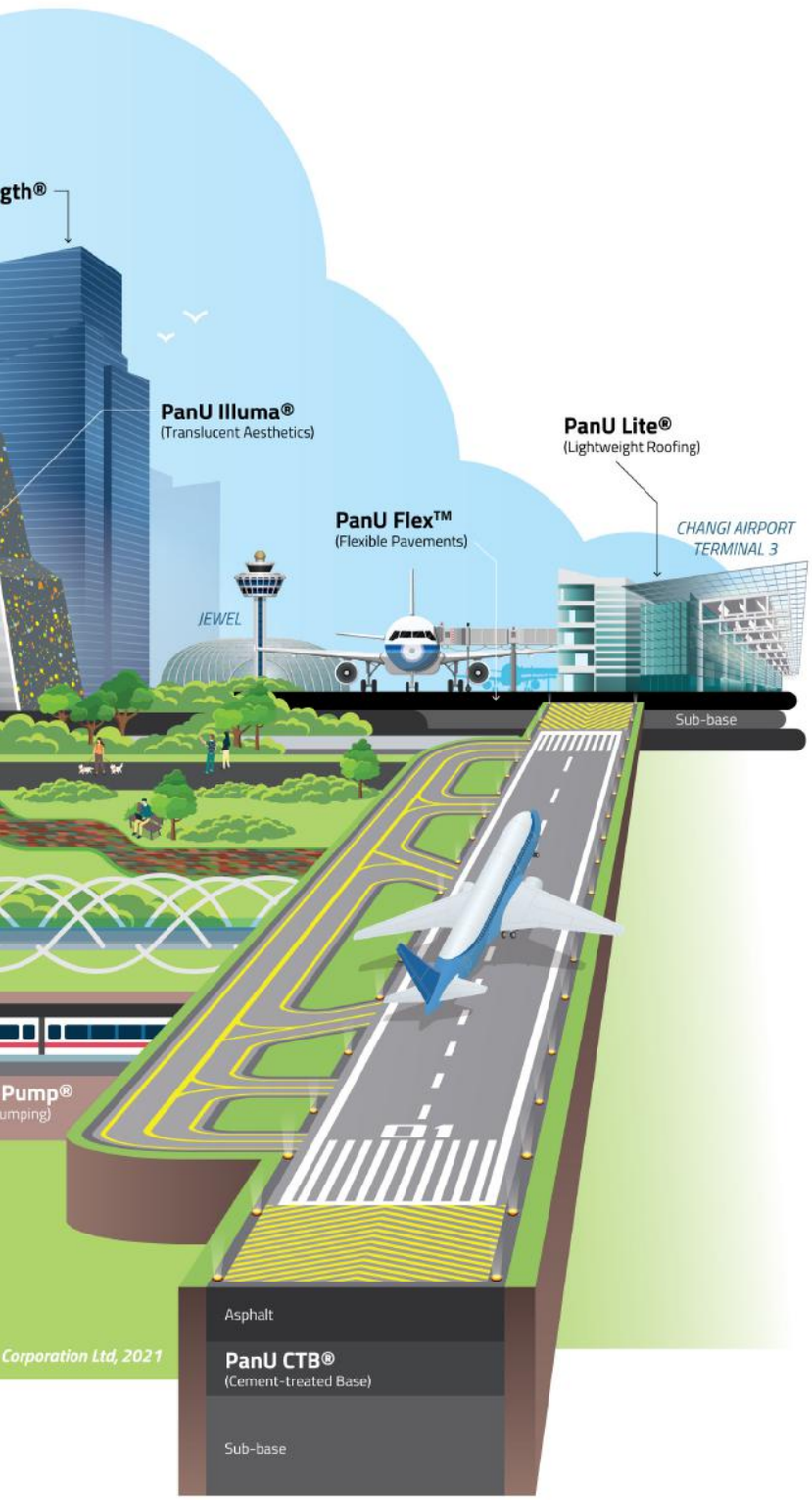
Reducing embodied carbon to build smart cities for tomorrow.

Sustaining Smart Cities

with low-carbon footprint concrete



*Note: *The only fictitious building is the one that has not been built yet using PanU Illuma, our latest specialised concrete that allows light to pass through.*



Swathes of Singapore's built landscape, including many familiar landmarks seen here, have been built using an extensive range of low-carbon footprint concrete.

As the global drive to reduce carbon emissions gains momentum, a rising number of countries and organisations are realising the impact of the built environment on global warming. The World Green Building Council (WGBC) reports that constructing and operating buildings alone make up 40 percent of carbon emissions by the built environment. The need for decarbonisation is greater now than ever in the global building industry.

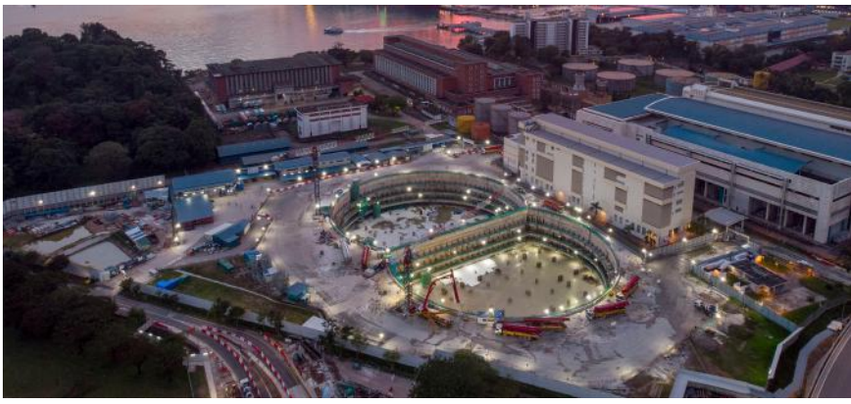
USING LOW-CARBON FOOTPRINT CONCRETE TO DECARBONISE AND REDUCE EMBODIED CARBON

One industry player is spearheading the concept of ready-mix concrete with a low-carbon footprint to reduce embodied carbon, as part of a circular approach to decarbonise its value chain. Low-carbon footprint concrete has low carbon and is produced with the use of more sustainable production processes and technologies.

Singapore-based firm Pan-United Corporation has under its belt over 300 specialised concrete products, over half of which are low-carbon footprint concrete, in a bid to advance sustainability in the concrete industry through continuous concrete innovation.

Pan-United's sustainability journey began over two decades ago when few others gave much priority to its importance. Aware of the impact of its operations on the environment, the concrete producer was constantly looking at ways and means to save or recycle resources. Carbon emissions and climate change were then hardly heard of.

One of Pan-United's first initiatives in the early years was to replace cement with an industrial by-product of steel production, called Ground Granulated Blast Furnace Slag (GGBFS). Since then, it has also extended to use recycled concrete aggregates, washed copper slag and other more sustainable alternatives to replace natural raw materials in producing high-performance low-carbon concrete.



Examples of sustainably produced low-carbon-footprint concrete mixes that use recycled, reused, and upcycled raw materials include:

- **PanU Green™**
  - High-performance structural concrete, with over one-fifth of its contents made from recycled materials or industrial by-products such as demolition waste or washed copper slag, a waste from ship cleaning processes
  - Emits up to almost 50 percent less carbon emissions than conventional concrete, for the same level of strength and higher durability
  - **Used in Gardens by the Bay**
- **PanU Hi-Strength®**
  - Cost-effective concrete that reduces the size of structural elements in construction projects
  - Uses less concrete to efficiently support heavy loads, thus maximising space and reducing construction time
  - **Used in Marina Bay Financial Centre**
- **PanU NewGen SCC™**
  - Self-flowing concrete that reaches hard-to-fill corners without compaction
  - Requires less manpower and minimises physical contact among workers to enhance safe distancing
  - Improves productivity by 75 percent and reduces casting time by 40 percent, resulting in faster construction completion
  - **Used in Tanjong Pagar Centre**
- **PanU Lite®**
  - Lightweight concrete for building upon existing structures without overloading, such as for roof structures
  - Reduces the volume of concrete used
  - **Used in Changi Airport Terminal 3**

FIRST IN ASIA TO USE CO2 MINERALISED CONCRETE TECHNOLOGY

Apart from raw materials, the use of technology also plays an important part in lowering the embodied carbon footprint. In 2018, Pan-United partnered with Canada-based clean technology company, CarbonCure Technologies, to become the first in Asia to use CarbonCure's carbon dioxide (CO2) mineralised concrete technology for concrete production.

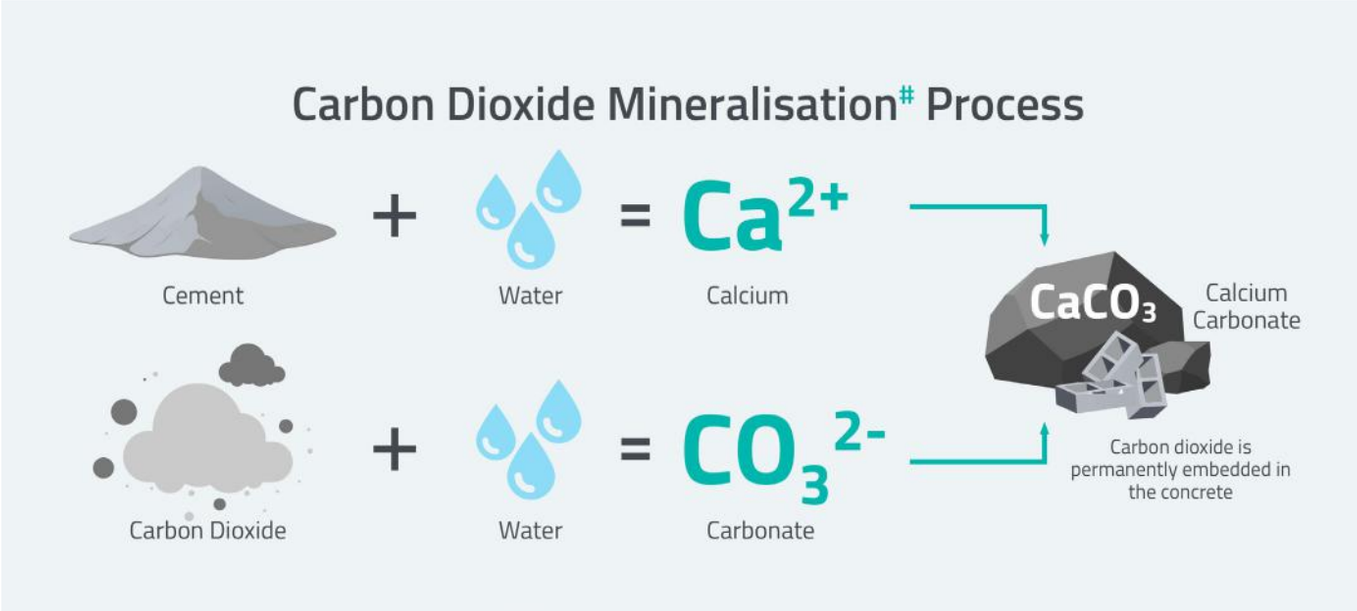
This breakthrough technology is essentially a carbon capture and utilisation (CCU) process that chemically converts industrial CO2 into a nano-sized mineral that becomes permanently embedded and trapped within concrete. The mineralisation reduces embodied carbon emitted during the construction process.

With every one cubic metre of concrete produced, a whopping 17 kilograms of CO2 on average is prevented from entering the atmosphere. Other long-term gains can be accrued after the construction process – an average building with CO2 mineralised concrete saves approximately 680,000 kilograms of embodied carbon, the annual equivalent of carbon absorbed by 360 hectares of forest.

In addition, compressive strength of the resulting concrete design mixes is also enhanced. Past projects have proven that the same workability and desired strength was achieved using five percent less cement – with no change to the workability and setting time of the concrete.

"Our PanU CarbonCure™ concrete has received the seal of approval from industry regulators, developers and customers alike. Our customers have provided feedback that they were able to adapt to using the PanU CarbonCure™ without any complications," said Ms May Ng, CEO of Pan-United.

PanU CarbonCure™ is currently the first and only CO2 mineralised concrete to be inducted into the new product category of Ready-Mix Concrete (Carbon Capture & Utilisation) under the Singapore Green Building Product (SGBP) certification scheme administered by the Singapore Green Building Council (SGBC).



The carbon capture and utilisation (CCU) process when carbon is injected during concrete production.

Developers and customers have given their vote of confidence in using this greener concrete for a wider variety of building and infrastructure projects in Singapore. Two recent examples include:

1 JTC semiconSpace

The JTC semiconSpace is a 32,000 square metre semiconductor facility under construction at the Tampines Wafer Fab Park. Developed by JTC, the facility will be built solely with low-carbon CCU concrete. The first phase of the facility is slated for completion in 2021.

2 Linde's Expansion of Gasification Complex at Jurong Island

Global gas and engineering behemoth Linde is expanding its existing gasification complex at Jurong Island as part of a $1.4 billion investment with ExxonMobil at Jurong Island. Linde's project will include four additional gasifiers, a 1,200-metric-ton-per-day air separation plant, and Linde's proprietary downstream gas processing units and sulphur recovery plants. Pan-United is currently supplying PanU CarbonCure™ for the project, which is slated for completion by 2023.

An artist's impression of the JTC semiconSpace, a semiconductor facility built with PanU CarbonCure™.

SUSTAINABLE CONCRETE FOR FUTURE GENERATIONS

Pan-United is an active industry proponent for the use of environmentally friendly practices and products in the built environment. On this front, it has partnered like-minded industry players and participated in numerous webinars to educate industry stakeholders on the advantages of low-carbon footprint technologies in concrete.

Its mission to become a global leader in concrete sustainability starts with advocating for the reduction of embodied carbon in construction by using low-carbon footprint and low-waste concrete mixes. The concrete innovation company has published a wide range of technical and marketing literature to encourage adoption of these specialised solutions.

"As Singapore's leading producer of green concrete, Pan-United views the expansion of sustainable, viable concrete options as part of our corporate and environmental responsibility to the industry and wider society," remarked Ms Ng. She noted, "While we are heartened to see growing interest in eco-friendly solutions, there is still a long journey ahead before we fully decarbonise the built environment sector."

Ms Ng added, "As an advocator for sustainable concrete solutions, Pan-United encourages our peers and customers to embrace and adopt sustainable concrete for the benefit of future generations and the longevity of our communities."

Article contributed by Pan-United Corporation.


Schneider Electric

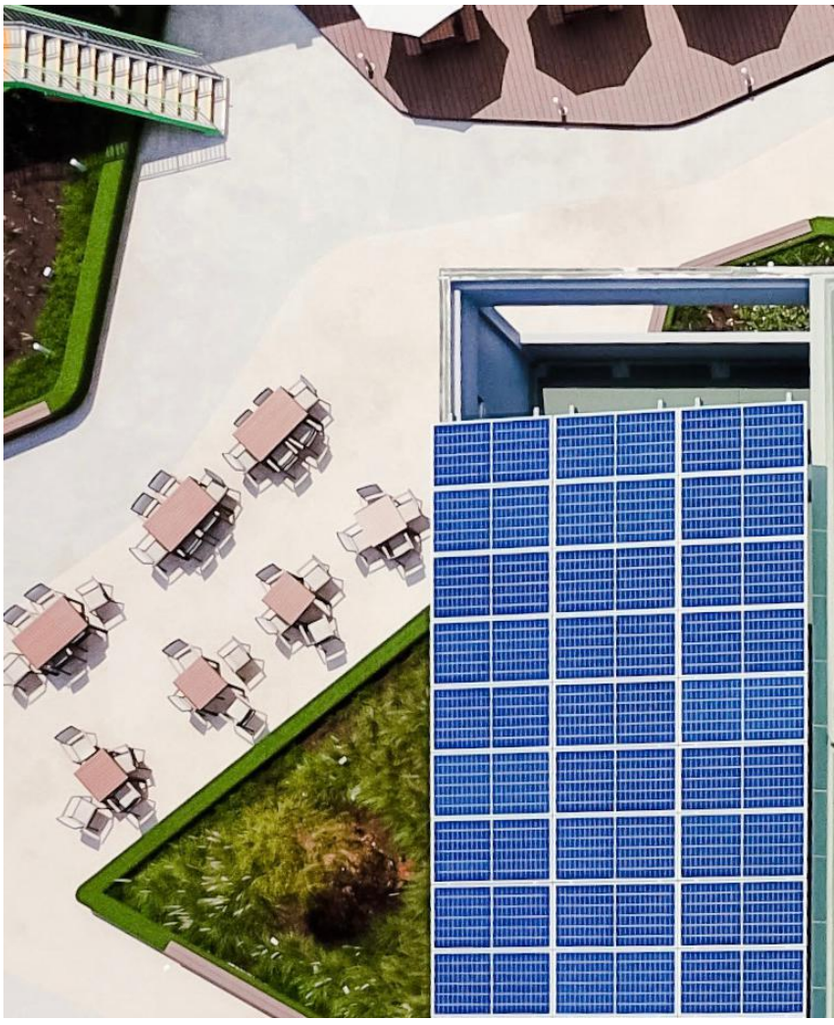
ENVISIONING THE FUTURE OF BUILDINGS – SUSTAINABLE, RESILIENT, HYPER-EFFICIENT AND PEOPLE-CENTRIC

The pandemic has permanently transformed the world of work, forcing us all to rethink our physical infrastructure of buildings. Next-gen buildings will start with an intelligent, fully connected infrastructure that goes beyond the base building network and integrate multiple generations of technologies.

Our buildings leave a huge carbon footprint on the planet – they consume about 30 percent of the world's energy, and account for almost 40 percent of global greenhouse gas emissions. Reducing the emissions of the building lifecycle will be one of the most important areas in our fight against climate change. 28 cities, including London, New York, Tokyo and Sydney, have joined the Net-Zero Carbon Buildings Commitment, pledging to ensure that all buildings will operate at net-zero carbon by 2050. To achieve these sustainability goals, we need to transform the way we design, build and operate our buildings.

Two key trends will drive new innovation in the next generation of green buildings. Firstly, digitisation will enable buildings to leverage the Internet of Things (IoT), big data and artificial intelligence to optimise its systems. Secondly, electrification will effect a shift from fossil fuel use to renewable sources of energy. This all-digital, all-electric future gives us a foundation to reshape the lifecycles of our buildings.

For decades, we have been working with the industry to solve its energy management challenges. Based on what we have learnt, we believe that buildings of the future should be founded on these four key principles: Sustainability, Resiliency, Hyper-efficiency and People-centric.



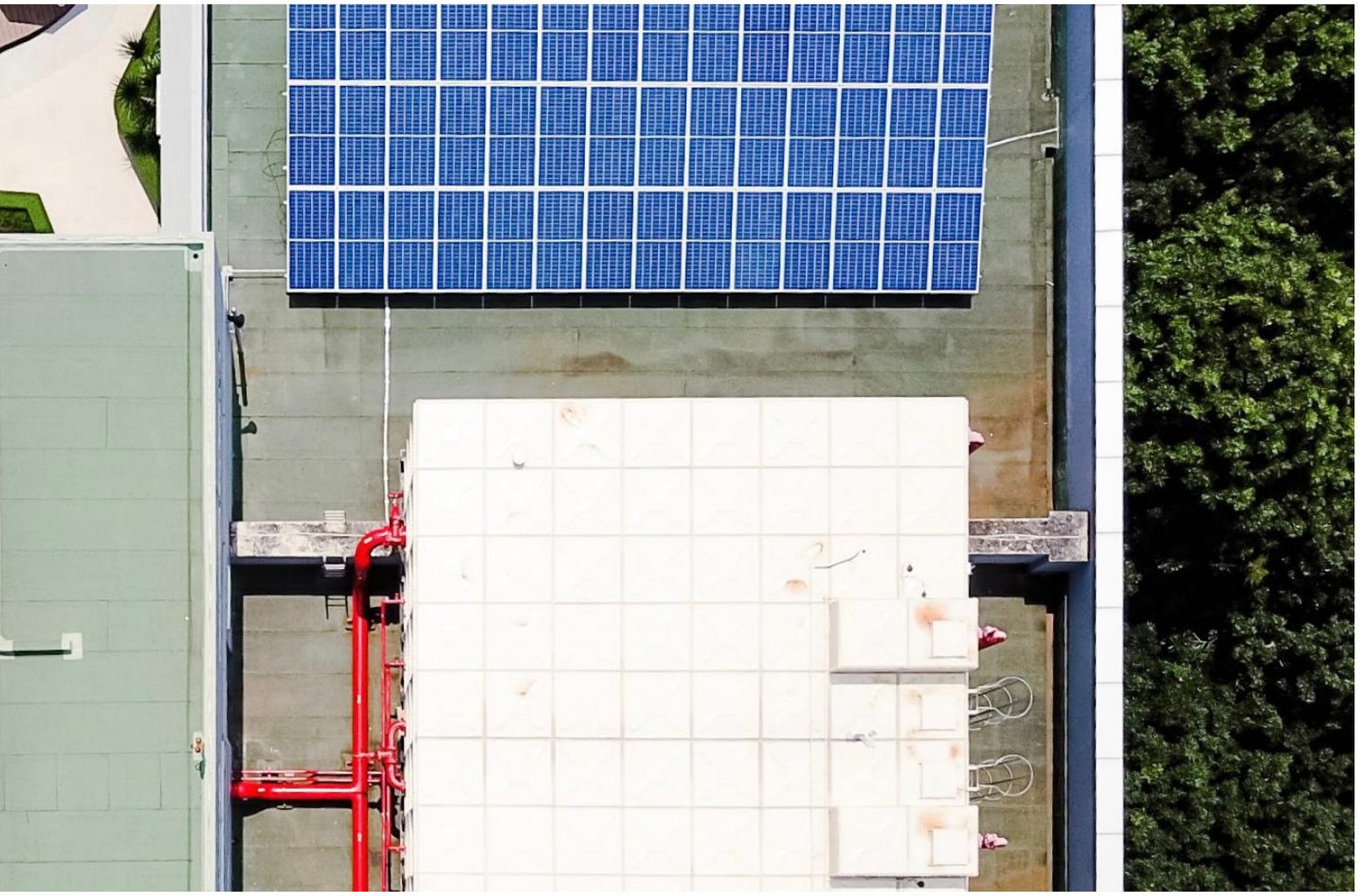
SUSTAINABILITY: TOWARDS ZERO CARBON AND POSITIVE ENERGY BUILDINGS

How can our buildings achieve carbon neutrality by 2050? First, buildings must become fully electric, and the use of fossil fuels should be replaced with more efficient electric systems. To maximise sustainability, a digitised electrical infrastructure is needed to produce, store and distribute power intelligently.

In many organisations today, energy and sustainability strategies lack cohesion, with each department deciding how to buy and use energy, and having its own fragmented silo of data. Building operators must transition to digitised active energy management, so that real-time data can be collected across all departments and integrated onto a single global platform. This will give organisations a holistic view of their energy strategies, bringing together renewable energy generation, predictive analytics, automated control of facilities and microgrids to drive continuous improvement and reduce carbon emissions.

As renewable energy gains greater adoption, we will increasingly see "positive energy" buildings that can generate onsite electricity and store it as an asset. Intelligent microgrids will be needed to manage distributed renewable energy resources, allow buildings to switch between the most cost-efficient sources of energy, and feed excess energy back into the grid. These buildings will become net suppliers of energy to national grids, rather than mere consumers.

Existing buildings can be digitised too – their power networks can be retrofitted with smart sensors and



energy monitoring devices, enabling a more data-driven and sustainable approach to operations and maintenance.

RESILIENCY: BUSINESS-AS-USUAL THROUGH TIMES OF CRISIS

With pandemic outbreaks, natural disasters and cyber-attacks on the rise, buildings of the future need to be more resilient than ever. In times of crisis, our buildings must have the resiliency to keep operations running smoothly amidst unpredictable challenges.

For example, in the pandemic's new normal, services that were formerly provided in-person must now be performed offsite. Using connected platforms, more than 70 percent of a building's operations can be performed remotely. Operators can continue to make data-driven decisions, anticipate potential malfunctions through analytics, and quickly diagnose and resolve facility issues from a distance.

In the buildings of the future, we will see a shift from reactive responses to a proactive prevention approach, with time-based and condition-monitored maintenance schedules. Power availability and reliability can be strengthened with uninterruptible power supplies, harmonics control and mitigation solutions. These measures will reduce the risk of costly unplanned downtimes.

The threat of cyber-attacks against building management systems is a growing concern, hence cyber-security will be a critical component of resiliency. Devices used by the building must be developed with cyber-security in mind, and processes should be designed to limit the chances of cyber vulnerabilities.

HYPER-EFFICIENCY: INTELLIGENT ECOSYSTEMS THAT DELIVER MORE WITH LESS

The principle of hyper-efficiency is the nexus which makes all other principles possible. With IoT and digital technology, we can completely digitise and connect all systems inside a building. Power and energy management, HVACs, building automation and IT systems will be integrated to form a single interconnected ecosystem. Sensors will be embedded in the fabric of the building to collect data, while artificial intelligence can be used to analyse this data in real-time to optimise operations and maintenance schedules.

A smart, hyper-efficient building will understand people's changing needs and quickly adapt to meet these needs, creating personalised environments for occupants. With today's new work-from-home and contactless culture, traditional workplace design will be replaced by dynamic, agile spaces that can flexibly adapt to remote working and safe-distancing requirements. Underutilised offices, desks, meeting rooms and amenities can be identified and reconfigured, and building spaces can be flexibly reconfigured based on real-time data.

PEOPLE-CENTRIC: ADAPTIVE AND PERSONALISED SPACES

The building of the future will be people-centric. It will put the needs of people first, enhancing the experience, health and wellness of its occupants. Companies are increasingly aware of the importance of the workplace in attracting and retaining the best talents. Employees will have greater control to personalise their work environment, tailoring

comfort levels to their preferences using their mobile devices. Sensors can monitor airflow, pressure, temperature and humidity to maintain a healthy environment, and detect areas where cleaning and servicing are needed.

Tomorrow's people-centric buildings will deliver new levels of comfort and personalised experiences, and adapt collaborative workspaces for changing needs. This in turn can boost productivity levels and free up thousands of hours each year for employees.

- At the design phase, digital simulations of the building can be used to engineer better solutions for improved airflow, insulation and energy usage. AI-powered generative design will help designers discover new possibilities in optimizing design layouts.
- In the build phase, the goal is to connect all stakeholders and data via a cloud-based platform for better collaboration, decision making and construction management.
- In the operation phase, a digital twin of the building provides rich data on infrastructure and assets, which can be used to optimise operations and maintenance.

DIGITISING THE LIFECYCLE OF BUILDINGS

These four principles should be applied across the entire life-cycle of a building. Through building information management (BIM) systems and digital twin technology, we can digitise every phase of the building life cycle and further reduce its carbon footprint:

Buildings are where we spend 90 percent of our time, and the need to make buildings more sustainable, resilient, hyper-efficient, and people-centric has never been greater. By leveraging cutting-edge technologies such as IoT, data analytics and artificial intelligence, we can build the foundation for the next generation of intelligent buildings, and pave the way for a greener built environment and a net zero-carbon future.

Article contributed by Schneider Electric.

CASE STUDY: KALLANG PULSE, SINGAPORE

Since its official opening on 29 March 2018, Schneider Electric's Kallang Pulse has been a testament to the organisation's commitment to sustainability. The 18,583m2 building acts as their East Asia and Japan regional headquarters, housing over 1,200 staff within its premises.

This building also acts as a showcase of Schneider Electric's suite of solutions which consists of 3 distinct layers, IoT-enabled Connected Products, Edge Control and Software and Analytics.

At Kallang Pulse, more than 5000 products are connected, ranging from mechanical systems (transport & cooling), electrical systems (fully connected), water meters, to security systems which includes access control systems and surveillance systems. This setup allows the system to interface with edge control on application and analytic levels.

The Edge Control layer allows the building operation team to manage their operations on-premise as well as from the cloud. This includes connected control platforms with remote access, advanced automation and operator override capabilities.

Lastly, the Software and Analytics layer provides the building operation team with insights and constructive advice on how to improve efficiency while and generating regular reports to help assess the health condition of their building systems.

By integrating these solutions into their building, Schneider Electric saved an estimated 122,000 kWh of electricity and 3,700 m^3 of water per year from 2018 to 2020. Moving forward, they also plan to adopt a Digital Twin system that will help them simulate and plan for future improvements.

Below are some of the prominent green features that have been implemented in the building:

- LED lightings are used in the entire building.
- Recycling programmes and specialized waste streams such as E-waste, fluorescent lamps etc.
- Occupancy sensors for common areas and workspace areas.
- Using energy efficient magnetic -bearing chillers.
- PV panels are installed to generate onsite solar power.
- Analytic systems in building BMS to monitor reliability of installed sensors (Power Advisor and Building Advisor).
- Integrated Power Monitoring System for effective power monitoring at granular level.
- IAQ Sensor and Workplace Advisor for zone planning, occupancy, occupant comfort monitoring.
- 5000+ connected products as a backbone to supply real time data to the edge control applications and advisors in the building.
- Priority parking lots for electric vehicles with EV charging points provided.
- Dedicated green committee to drive sustainable education, events, etc.

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