Digital Tech for Sustainability – In Building Management

INFOCOMM MEDIA DEVELOPMENT AUTHORITY

eden strategy institute

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Contents

Introduction

THE DRIVE TOWARDS SUSTAINABILITY

Climate change is now recognised as one of the world's **most pressing global challenges**. In 2021, the Intergovernmental Panel on Climate Change (IPCC) released a report declaring that climate change is widespread, rapid, and intensifying. The effects of climate change are also being felt more frequently and intensely around the world, with extreme and unprecedented weather events causing floods, deaths, and massive biodiversity loss. Many of these changes could result in **long-lasting and irreversible damage** to our ecosystem and natural environment.

In response, consumers are **demanding more action** around sustainability; investors are increasingly **shifting their capital** towards responsible and sustainable businesses; and governments are **imposing more regulations** to curb carbon emissions. Singapore's Green Plan 2030 highlights our nation's commitment to setting concrete targets over the next decade to achieve long-term net zero ambitions. Rapid and sustained actions need to be taken across all sectors to limit global warming and mitigate its consequences, as well as protect livelihoods and the resilience of businesses and the economy.

Sources: BCA & SGBC (2021), IPCC (2021), WBCSD (n.d.)

> A sustainable built environment is **circular, designed for longevity, flexibility, adaptability, reuse and recoverability, and considers future climate risks**. It uses low-carbon, low-impact, non-toxic materials and it recovers used resources (materials and products on-site or from other sites).
>
> *– Adapted from the World Business Council for Sustainable Development*

CLIMATE IMPACTS FROM THE BUILT ENVIRONMENT SECTOR

The Built Environment (BE) sector is a key pillar of Singapore's economy, accounting for almost 10% of Singapore GDP and 30% of total workforce employment. With **increasing urbanisation and population growth**, the demand for water and energy to operate Singapore's commercial buildings – such as retail malls, offices, and mixed-use developments – will continue to grow, resulting in a greater strain on our resources and higher operating costs for businesses maintaining their day-to-day operations.

WHY SHOULD SMEs CARE ABOUT SUSTAINABILITY?

Meet increasing demand for green services. Large companies in the Built Environment sector, such as major property developers, are already making efforts to infuse sustainability within their business operations, setting net-zero targets and goals, tracking and reporting their emissions and resource use, and investing in technologies to reduce their environmental impact. Consequently, small- and medium-sized enterprises (SMEs) that provide facilities management services to these large properties will face increasing demand from their customers to provide green products and services to meet their sustainability targets.

Comply with stricter regulations. The increasing environmental regulations around building performance, driven by the Singapore Green Building Masterplan and stricter criteria under the Green Mark 2021, signal a growing regulatory trend towards raising the sustainability performance of buildings. This is an expectation that facilities managers will soon have to comply with.

TOOLS

WHAT IS SINGAPORE'S PLAN FOR SUSTAINABILITY?

READ THE SINGAPORE GREEN PLAN 2030

PLAYBOOK OBJECTIVES

IMDA is therefore **encouraging SMEs to adopt digital technologies in their services** and **track performance metrics to improve their sustainability outcomes**, particularly in the areas of energy, water, and waste. Doing so should help them mitigate their environmental impact while strengthening their business competitiveness and resilience through the benefits of digitalization. These include direct cost savings, competitive differentiation, higher margins, talent attraction, improved reputation, and regulatory compliance.

This playbook has been designed as a starting point to:

Introduce SMEs to the concept of environmental sustainability

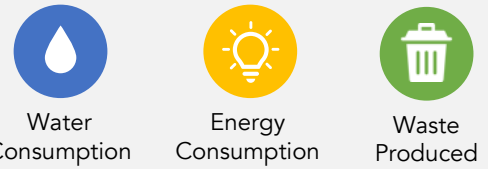
Expose SMEs to the range and capabilities of digital sustainability technologies that have proven to achieve productivity benefits

Inspire SMEs to kickstart their sustainability journey, by sharing the sustainability journeys of other SMEs and building managers

TOOLS

WHY TRACK YOUR BUSINESS' ENVIRONMENTAL FOOTPRINT?

Tracking the environmental footprint of your business regularly – with meters, IoT sensors, or through utilities bills – allows you to identify resource-intensive areas of your operations to improve, which can help to cut business costs. As a next step to reading this playbook, SMEs can use a toolkit designed by Eden Strategy Institute and IMDA to track the sustainability metrics below and calculate their baseline environmental footprint.



ACCESS THE TOOLKIT

SCOPE OF TECHNOLOGIES FEATURED

As part of IMDA's efforts to promote the adoption of digital technologies in Singapore, the technologies featured in this playbook are those that effectively leverage digital and 'smart' elements such as **automation, Artificial Intelligence (AI), Internet-of-Things (IoT), and data analytics** to gather real-time data and automate processes to optimise resources, reduce inefficiencies, improve transparency, and save costs.

There are several types of services within the building management and operations space. These activities can largely be categorised into five distinct groups – general maintenance, integrated building management, and mechanical and engineering (M&E) works, administration, and security.

This playbook **focuses on digital solutions for commercial buildings** for three of these groups – general maintenance, integrated building management, and M&E works. Building administration and security activities are not included in the scope of this playbook. While their environmental impact may not be negligible, they are likely to have a less direct and significant footprint in energy consumption, emissions, water use, and waste production.

SERVICE TYPES REPRESENTED

1. General Maintenance

Cleaning | Landscaping | Waste disposal

2. Integrated Building Management

Building management systems

3. Mechanical & Engineering Works

Electrical systems services | HVAC services | Lift & escalator operations | Plumbing, pump & chiller works

CHAPTER 1:
BUILDING MANAGEMENT AND OPERATIONS LANDSCAPE IN SINGAPORE

Find out which activities in managing and operating a building are the most environmentally impactful, and learn about the changing relationships between key stakeholders in the facilities management sector

The built environment sector contributes to over one-fifth of Singapore's total carbon emissions

ENERGY CONSUMPTION FROM BUILDING OPERATIONS

The management and operation of buildings is a **highly carbon-intensive** activity. The BE sector accounts for more than one-fifth of Singapore's total carbon emissions, of which a majority come from building operations.

DID YOU KNOW?

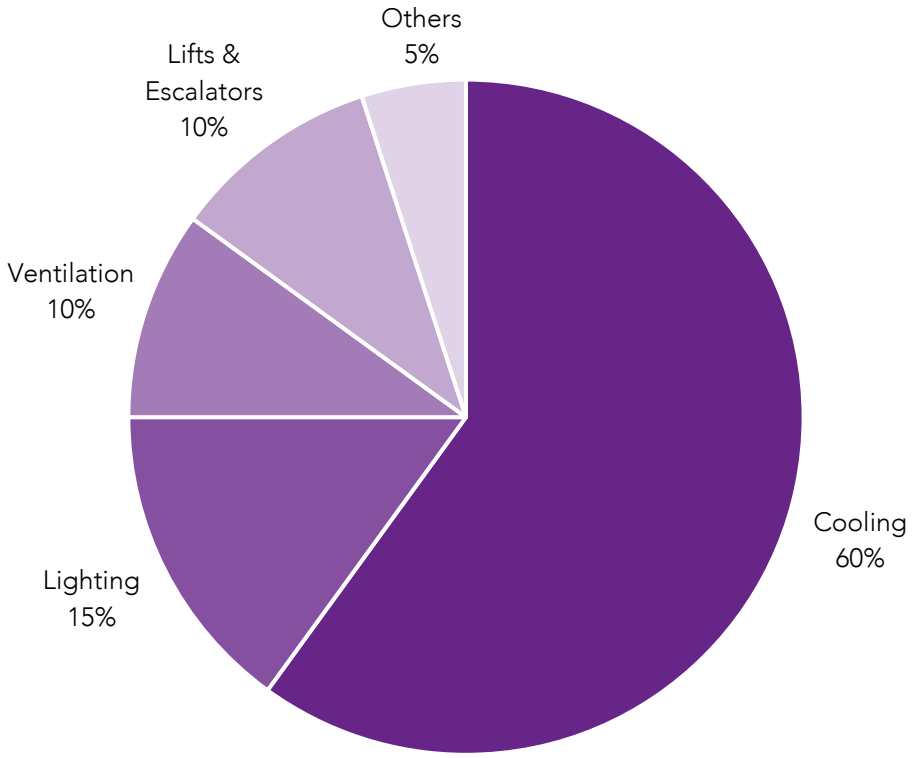
30%

Proportion of building emissions that come from the construction of the building and the manufacturing of steel, concrete, and other building materials (also known as "embodied carbon")

70%

Proportion of building emissions that come from building operations (refer to Figure 1 for breakdown)

Figure 1: Breakdown of energy used to operate commercial buildings

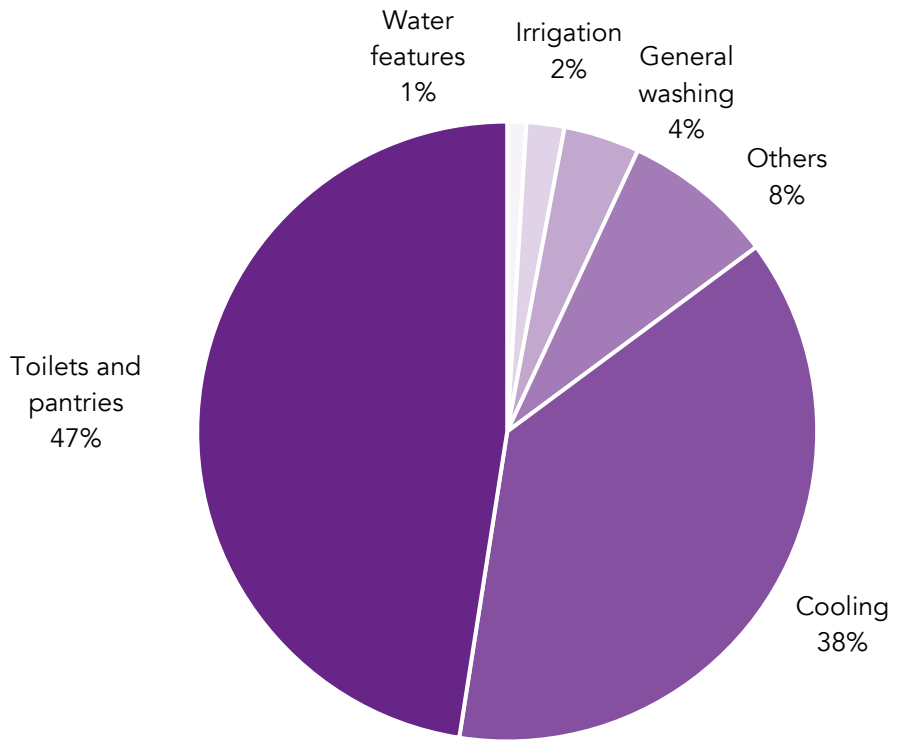


Source: BCA (2018)

Sources: BCA (2018), NCSS (2018), BCA (2021), The Straits Times (2021)

The non-domestic sector, including commercial buildings, accounts for 55% of Singapore's total water use

Figure 2: Breakdown of water used to operate commercial buildings



Source: PUB (2020)

Sources: Gov.sg (2020), PUB (2020)

WATER CONSUMPTION FROM BUILDING OPERATIONS

Singapore uses 1.6 billion litres of water each day, and this number could double by 2060. The non-domestic sector, including office, hotel, and retail buildings, accounts for 55% of Singapore's total water use, or the equivalent of **782 Olympic-sized pools daily**.

In commercial buildings such as retail malls, almost 90% of water used is to cool towers, for toilet flushing and washing, and to operate pantries.

The **treatment and production of clean water is energy-intensive**, and water is a scarce resource in Singapore. Businesses may need to anticipate hikes in water prices in the long run as the demand for water increases.

The use of water-efficient technologies – which can help to monitor water usage, identify leakages, optimise water use, and recycle greywater – is thus critical in helping businesses minimise their environmental impact and reduce business costs.

There is an increasing demand for green products and services in facilities management

SHIFTING CONSUMER DEMAND

Consumers are increasingly looking to patronise and invest in sustainable businesses

+

REGULATORY PRESSURE

The Government is stepping up efforts to improve energy, water, and waste management in commercial buildings

BUILDING OWNERS LOOK TO GREEN THEIR BUILDINGS

As a result, building owners are increasingly looking for environmentally-sustainable services and engaging vendors with sustainability solutions to help them reduce building operating costs, lower their environmental impact, and achieve sustainability targets and ratings

FM COMPANIES PROVIDE MORE SUSTAINABLE PRODUCTS AND SERVICES

FM service providers will increasingly invest in digital sustainability solutions and pass on cost savings to building owners to provide cheaper, more efficient, and less resource-intensive services, thus becoming more competitive in the market

Digital technologies can play a key role in collecting and tracking data to support targeted action

Why collect data?

- To meet **regulatory requirements** and check eligibility for green building certifications
- To meet **investor and consumer demand** for transparency around business practices
- To identify operating needs and **cost-saving opportunities** within building operations
- To formulate **targeted action** based on data-driven insights to improve building operations

What types of data should I track?

- The above metrics can be tracked on an annual basis per building, or on a project basis for FM service providers
- This information can be collected and aggregated from on-site sensors, meters, or utilities bills
- Access **this toolkit** to track these metrics and calculate your baseline environmental footprint

What can digital technology do to track data?

- **Monitor and track data remotely** within buildings using digital technologies such as IoT sensors and AI
- **Analyse large amounts of information** using data analytics with Machine Learning (ML) and AI to optimise processes and predict maintenance needs of facilities
- **Collate data across different scenarios** using digital twin technology, which can model various operating states via a virtual replica of the building in real time

CHAPTER 2:
THE CASE FOR SUSTAINABILITY

Why should your business care about sustainability? Learn about the latest industry trends and national policies that are pushing businesses to become more sustainable and creating more opportunities for green businesses to thrive

Industry trends are driving sustainable practices as an attractive business strategy

Rise of smart buildings

Facilities management has evolved to become smarter and more resource-efficient in recent years to drive down operational costs, meet growing demand for sustainable products and services, and comply with the green building regulations in Singapore.

Newer buildings are leveraging the rise of data analytics and Internet-of-Things (IoT) technology to enable predictive maintenance and optimise resource use, while older buildings are undergoing retrofitting to **future-proof** themselves to comply with regulations.

Adoption of digital technology

Key digital technologies for buildings are maturing, helping to create a more sustainable built environment industry.

For example, **IoT sensors** collect data to track relevant environmental indicators, and work in tandem with **data analytics** to optimise resource use. **Automation** in building systems helps to adjust lighting, temperature, and other building functions in real-time to more energy-efficient settings.

Boom in green finance

Green finance refers to the flow of investments and loans into sustainable developments, including the products and services of businesses. There has been a surge in green finance activity in Singapore recently, such as MAS's rolling out of a new Green and Sustainability-Linked Loan Grant Scheme (GSLS) in 2021.

Green finance schemes help companies **finance sustainability projects** and **defray costs** required to validate the sustainability credentials of the project. Eco-friendly buildings such as DUO Tower have been funded through green loans. SMEs such as Env Tech Pte. Ltd. have also received green loans for green projects, such as for wastewater treatment solutions.

Sources: BCA (2021), MAS (2021), OCBC (2021), World Business Council for Sustainable Environment (n.d.)

The regulatory landscape is also accelerating the need to adopt sustainable practices

POLICY PUSH FOR SUSTAINABILITY

Over the years, Singapore has launched a variety of policies, programmes, and initiatives to advance the sustainability efforts of the Built Environment across multiple government agencies and stakeholders.

Click on each header below to access the official website for more information

Green Mark Scheme

- Spearheaded by BCA since 2005
- Green building rating system designed to evaluate a building's environmental impact and performance

- **Objective:** Encourage building owners and managers to adopt greener practices in construction and building operations

Singapore Green Building Masterplan (80-80-80 policy)

- Key targets:
  i. Green 80% of buildings in Singapore by 2030
  ii. Ensure that 80% of new developments by Gross Floor Area are classified as Super Low Energy from 2030
  iii. Ensure that best-in-class buildings achieve more than 80% energy efficiency by 2030

- **Objective:** Shape the future of sustainable construction and building maintenance

Energy Efficiency National Partnership (EENP) Programme

- Spearheaded by the National Environmental Agency (NEA); includes learning network activities, energy efficiency-related resources, as well as incentives and recognition

- **Objective:** Support companies that wish to become more energy efficient to reduce their carbon footprint and be more competitive

Sources: BCA (2021), Energy Efficient Singapore (2020)

SMEs should consider the implications of these policies on their business activities

WHAT ARE THE IMPLICATIONS OF THESE POLICIES FOR SMEs?

- SME property owners must stay abreast with such policies in order to **assess their business implications.** For example, the 80-80-80 policy under the SGBMP signifies potential business costs involved in retrofitting new and existing buildings to meet the new energy requirements.

- In order to **ensure compliance**, SMEs should also stay up-to-date with current policies. The Green Mark Scheme for instance was recently updated in September 2021 to reflect tighter requirements, focusing more on embodied carbon, in order to be certified green.

- For facilities management service providers, customers – building owners – will also start to **demand greener services** to meet policy requirements. These regulatory updates present an opportunity for SMEs in the facilities management sector to enhance their technology offerings to meet these standards.

- Failure to stay informed and compliant with such policies will result in **loss of contracts** for facilities management companies for properties that are keen on securing certification. Building owners and managers will also **lose out on cost savings** from better resource efficiency and be **less competitive** in the market.

Businesses can enjoy real cost savings with the help of digital sustainability technologies

Deploying green technologies may require businesses and building owners to front the initial cost (even if these may be offset against green loans and grants), but these technologies often pay for themselves over time in the form of reduced energy, water, material, and manpower costs.

Financial Benefits

Significant cost reductions: Using less energy and water can greatly lower the utility bills for buildings. For example, CapitaLand avoided SGD 270 million in utilities costs since 2009 by reducing its overall energy and water intensities.

Manpower efficiency: These technologies allow SMEs to improve manpower allocation through data-backed decision making. For example, with smart bins, waste management companies can use sensor alerts to reduce the number of collections and reallocate their personnel to other activities.

Increase in real estate value: Based on a study by UOB in 2020, commercial buildings in Singapore that have recently undergone retrofitting increased in value by 1.7%. With the recent real estate market expansion in Singapore in 2021, this value is likely higher.

Non-Financial Benefits

Tenant traction: Tenants prefer working with building owners that are forward-thinking, progressive, and investing in improving building efficiency, which could also translate into lower rental costs.

Preferred service provider: For FM companies, the ability to reduce a building's environmental footprint through energy, waste, and water management can make it a preferred vendor as it helps these buildings meet their sustainability KPIs.

Avoid fines: Stakeholders in the built environment sector that closely monitor and abide by the policies set in place avoid penalties and fines. For example, NEA imposes strict fines of up to SGD 20,000 for failure to abide by proper waste disposal guidelines.

Sources: NEA (2020), UOB (2020), Bigbelly (2021), CapitaLand (2021)

CHAPTER 3:
GREEN TECHNOLOGIES

This chapter showcases proven digital solutions that leverage IoT, data analytics, and automation to reduce the environmental impact of building management and operation activities, while also delivering cost and time savings for businesses

Explore a range of technologies to kickstart your sustainability journey

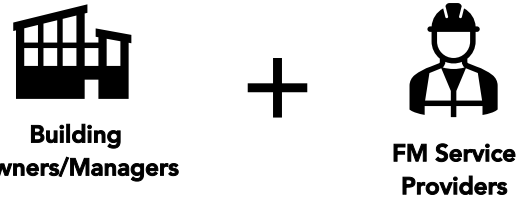
WHY THESE TECHNOLOGIES?

The technologies featured in this section were chosen because they:

1. Can be adopted across common building activities that **significantly impact** energy, water, and waste;
2. Have a proven **business case**; and
3. Are relatively **simple** to access and implement for SMEs.

SMEs can look towards these range of technologies as a starting point to explore on their sustainability journey. These technologies may be installed within buildings by building owners/managers or supplied to buildings by third-party facilities management service providers.

WHO ARE THESE TECHNOLOGIES FOR?



These technologies are meant to support SMEs – facilities management service providers as well as building owners/managers – that are starting out on their sustainability journey.

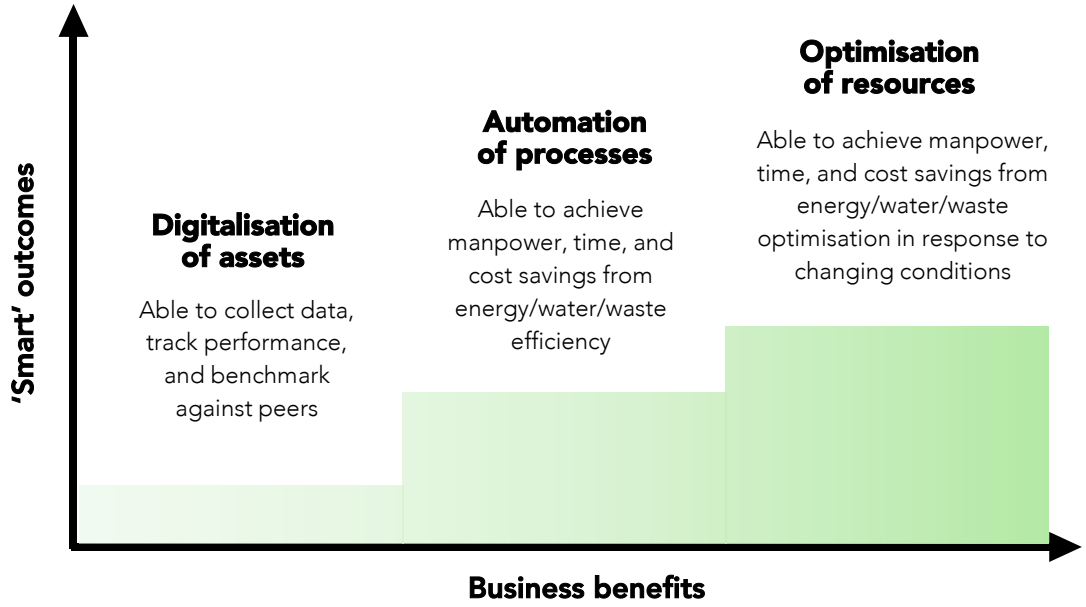
FM service providers that offer these technologies to building managers will be able to market their services more competitively, while building managers that adopt these technologies will be able to drive down operational costs for their buildings and meet their sustainability targets more quickly.

Invest in proven sustainability technologies to increase business competitiveness

REAPING THE BENEFITS OF SMART TECHNOLOGIES

The integration of multiple digital technologies within a building allows facilities management service providers and building owners/managers to easily collect data and track building performance with **IoT sensors**, **automate** manual processes for manpower efficiency, and optimise resources and manpower deployment using **AI and data analytics** to save on manpower, material, and utilities costs.

Service providers especially gain a **competitive advantage** by incorporating these technologies and can tap into **new markets**. Their staff as well have an opportunity to **upskill** themselves as the demand for green jobs increases.



THINK

HOW CAN TECHNOLOGY AFFECT MY BUSINESS MODEL?

The value of sustainability technology goes beyond direct cost savings and extends to the **new operating models** that they enable. Integrated and aggregated FM services can lead to new ways of task integration, job aggregation, deskilling, upskilling, and contracting models.

For example, using AI with CCTVs lets a building's control centre see security gaps and cleaning and maintenance needs. Thus, manpower is dispatched to fix a problem only when the AI-powered system sends an alert, rather than against a scheduled roster. The business model for FM service providers thus changes to an outcome-based contract rather than a manpower-based contract.

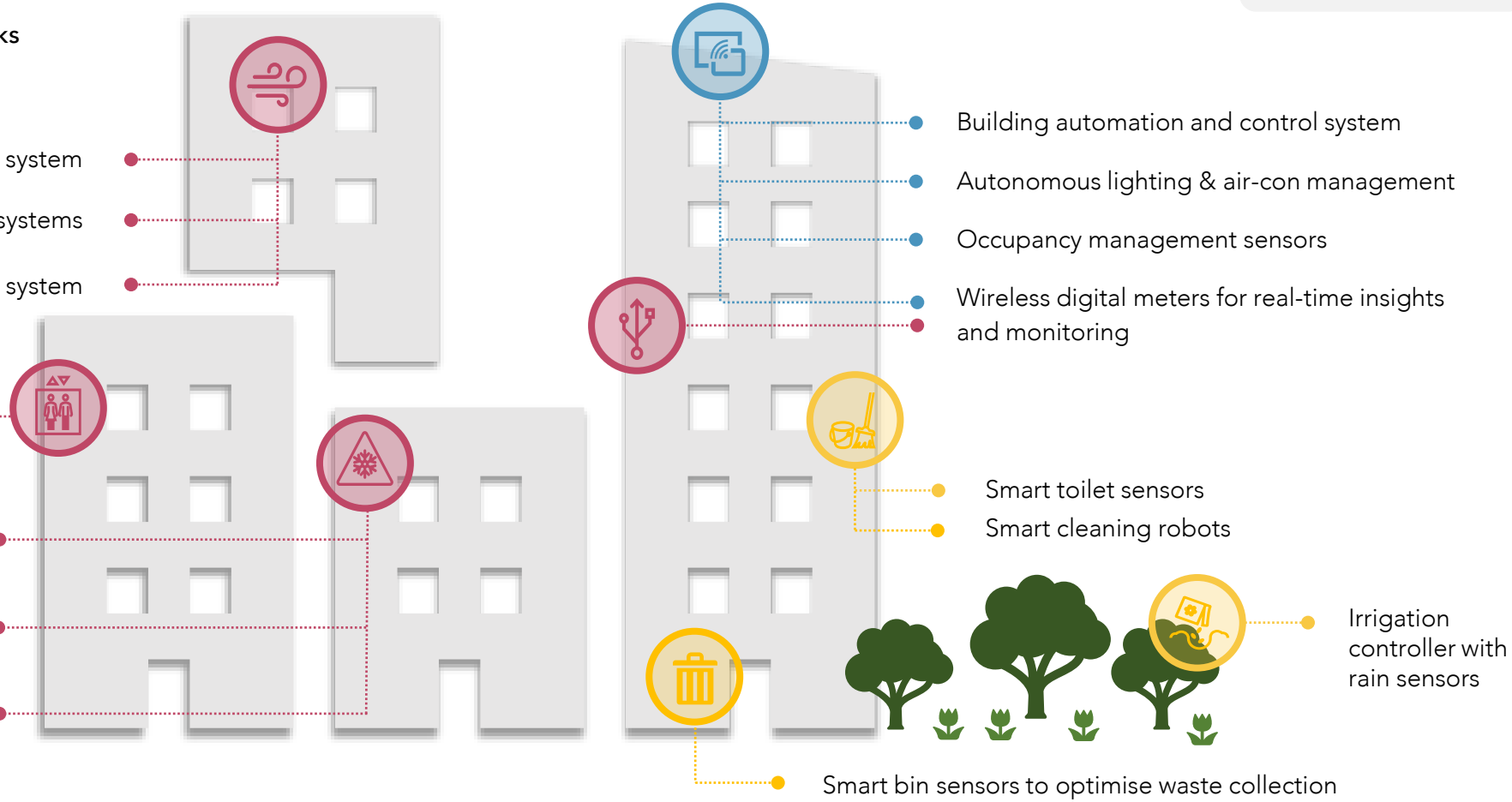
Green technologies can be applied across a variety of building functions

Figure 3: Examples of green technologies for sustainable building management

CLICK

Click on each technology name to view more information

- General Maintenance
- Integrated Building Management
- Mechanical & Engineering Works



Smart toilet sensors for on-demand cleaning

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Use case

To reduce cleaning frequency to save water and manpower

Technology description

There are several types of sensors that can detect when a toilet needs to be cleaned – a people-counting sensor to trigger cleaning after a certain number of people have used the toilet; an ammonia sensor that detects odours in used toilets; and a water detection sensor on floors to detect when floors are wet. These sensors allow cleaners to only be deployed when there is a need, thus reducing water consumption and manpower. Cleaners can be notified via an app when cleaning is required, and the data collected by the sensors can be analysed on a dashboard to enable predictive cleaning.

Relevant building age/size

Any age and size; can be used for both high- and low-traffic toilets

Relevant building function

Cleaning

Positive environmental impact on

Water Consumption

Energy Consumption

Waste Generation

Benefits

- Reduces water consumption from less frequent cleaning
- Reduces cleaning time by up to 75% due to more efficient deployment
- Access to real-time updates on the cleanliness of a toilet, especially those located in more remote areas
- Better data on low-traffic periods of a toilet are so that cleaners can be deployed to clean during low periods

Considerations

- Requires WiFi or router installed to send data from the sensors to a server
- Requires redesigning the jobs of cleaners, who may be deployed to more toilets but require fewer steps to clean them
- **Estimated investment:** From SGD 250/month/toilet for sensors and software-as-a-service

Sources: Green Koncepts (2021), Simpple (2021), SmartClean (2021), Unabiz (n.d.)

Smart cleaning robots

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Use case

To reduce water used to clean buildings compared to manual cleaning

Technology description

Smart cleaning robots automate the task of regular floor scrubbing and optimise cleaning paths in buildings, reducing the amount of water used compared to manual scrubbers. They usually require minimal supervision as they rely on preinstalled cleaning maps and smart sensors to navigate a facility, reducing manpower needed for cleaning as well. Integrated safety features are usually installed to prevent collisions with objects or people.

Relevant building age/size

Any age and size

Relevant building function

Cleaning

Positive environmental impact on

Water Consumption

Energy Consumption

Waste Generation

Benefits

- Reduces water consumption significantly compared to manual scrubbing and mopping
- Reduces manpower required to clean a building, thus reducing manpower costs
- Cleaning can be carried out 24/7
- Allows building managers to track which areas have been cleaned or not to plan and deploy resources as needed

Considerations

- Robots are usually operated in large open spaces with few obstructions such as lobbies
- **Estimated investment:** SGD 20,000–30,000 per robot

Sources: LionsBot (2021), The Straits Times (2021), Avidbots (n.d.)

Irrigation controller with rain sensors

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Relevant building function

Landscaping

Positive environmental impact on

Water Consumption

Energy Consumption

Waste Generation

Use case

To reduce the amount of water used to water grass or plants

Technology description

Irrigation controllers control the output of water for landscaping and limits it to scheduled timings. Rain sensors can be installed together with these controllers to stop water valves from turning on when there is rain or right after rain events. Together, the controller and rain sensor help to reduce the amount of water used to water plants or grass.

Relevant building age/size

Any age and size, though additional costs may be required for buildings with no existing irrigation system for pump, valve, and piping works

Benefits

- Reduces water consumption by 50% during the dry season and up to 100% during the wet season (if there is rain almost every day)
- Cost savings for building owners from reduced water consumption
- Increases productivity of gardeners as less manual watering is required

Considerations

- For buildings with no existing irrigation system, there may be extensive piping and hacking works required if building prefers to conceal the pipes (though surface pipe laying is an alternative)
- Rain sensor needs to work with a controller; it cannot be operated alone
- **Estimated investment:** An irrigation controller with a rain sensor costs SGD 3,000–5,000 to install. For a mid-sized building, one controller and one rain sensor should be sufficient.

Sources: Prince Landscape (2021), LSU AgCenter (n.d.), RF Wireless World (n.d.)

Smart bin sensors to optimise waste collection

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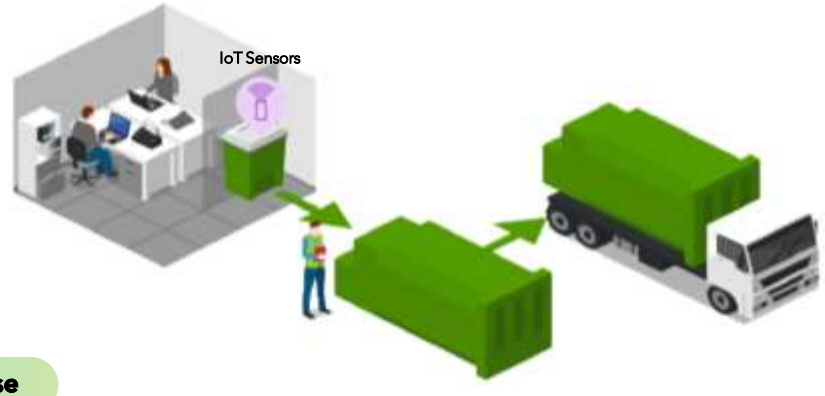

Use case

To alert waste managers only when bins are full

Technology description

Bins are embedded with wireless ultrasonic fill-level sensors which detect how full the bin is. The data gathered through these IoT sensors is sent to a cloud-based monitoring and analytics platform which can also be connected to an application accessible to waste managers. Based on this data, waste collection services can optimise their workflows.

Relevant building age/size

Any age and size

Source: Compactor Management (2021)

Relevant building function

Waste disposal

Positive environmental impact on

- Water Consumption
- Energy Consumption
- Waste Generation

Benefits

- Provides analytics for planning collection routes and bin placement
- Lower labour costs resulting from lower frequency of waste collection
- Affordable options with many variations available at different price points (e.g. can add odour sensor or use load cell/fill level sensor)

Considerations

- Wireless technologies used in the system such as Wi-Fi tend to have a shorter range and lower data speed
- Initial training cost incurred by waste management companies
- **Estimated investment:** Each sensor, which can be attached to one bin, costs upwards of SGD 250. Smart bins with in-built sensors cost upwards of SGD 3,000/bin (for a 190L version)

Building automation and control systems (BACS) incorporated with IoT sensors

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Use case

To improve energy savings and water consumption within the building

Technology description

This technology monitors, controls, and records the functions of building services systems. Buildings with BACS are more resource-efficient, as the BAC can operate systems according to occupancy and energy demand, monitor and correct the performance of systems, and adjust parameters to control the building's environment. Incorporated with IoT sensors, it can connect and control plumbing, chillers, electrical systems, HVAC systems, lighting, lifts, and security systems.

Relevant building age/size

Suitable for new and retrofit of small and large buildings

Relevant building function

Building management systems

Positive environmental impact on

Water Consumption

Energy Consumption

Waste Generation

Benefits

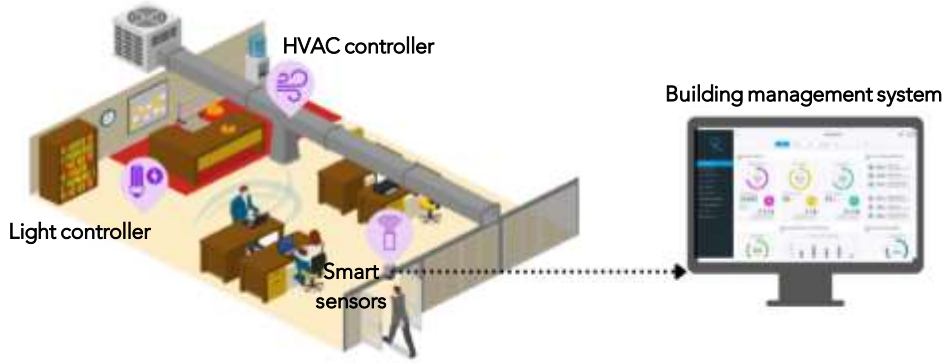
- Reduces maintenance cost and prevents from breakdown
- Reduces energy usage by pointing out energy saving opportunities
- Allows real-time data collection that enables building managers to monitor resource consumption anytime and anywhere

Considerations

- Requires internet connection to send data from sensors to the dashboard
- May need to consider non-proprietary systems to lower down the investment cost for future integrations to BACS
- May not be applicable to old buildings
- Requires training for building managers to understand how to utilise the data dashboard
- **Estimated investment:** From SGD 10,000 per building and SGD 1,000/month for software-as-a-service

Sources: Wattsense (2020), Designing Buildings (2021), Green Koncepts (2021)

Occupancy management sensors



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Use case

To reduce energy use by optimising lighting, heating, and cooling based on occupancy rates

Technology description

This technology optimises the use of underutilised space by determining how many people are occupying an area, zone, or floor based on smart sensors at multiple entry and exit points. Using occupancy usage patterns and data, facilities managers can calibrate lighting and heating, ventilation, and air conditioning (HVAC) services.

Relevant building age/size

Any age and size

Relevant building function

Building management systems

Positive environmental impact on

Water Consumption

Energy Consumption

Waste Generation

Benefits

- Reduced energy consumption while ensuring occupant comfort
- Employees have the flexibility to move freely to less occupied spaces instead of being confined to fixed cubicles for greater productivity
- Building managers /owners can easily compare locations and optimise space planning to reduce capital expenditures across property portfolio

Considerations

- Seek vendor-agnostic solutions for integration with HVAC, Indoor Air Quality solution
- Insight from space planning may lead to redesigning workspace layout, such as allocating space for new usage
- **Estimated investment:** SGD 1,000/month, depending on size of space

Sources: Green Koncepts (2021)

Autonomous lighting and air-con management system

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Relevant building function

Building management systems

Positive environmental impact on

Water Consumption

Energy Consumption

Waste Generation

Use case

To improve energy savings for both lighting and air-conditioning systems

Technology description

This technology uses advanced AI with unique instant error recovery and user pattern correction mechanism, relieving facilities managers' challenge to analyse energy reports and take action to save energy while ensuring occupants' comfort. The technology acts autonomously on data collected and hosted on an open IoT platform accessible to building managers. Some of the tasks it performs include adjusting the room temperature and lighting.

Relevant building age/size

New building and any size

Benefits

- Increases energy savings for both lighting and air-con by up to 45%
- Reduces building manager's work in analysing energy reports and taking action because the system will do it automatically
- Scalable; can be deployed from a room or an office to the entire building

Considerations

- Not applicable to all types of lighting, only works on DC input Dimmable LED Lights
- This system only supports some Multi-Split System, VRV & VRF Air-con, and thermostat types. For central HVAC, the application of this solution is subject to integration with BMS
- **Estimated investment:** From SGD 10,000 per building and SGD 1,000/month for software-as-a-service

Sources: Lumani (2019), Green Koncepts (2021)

Wireless digital meters for real-time insights and monitoring

CLICK
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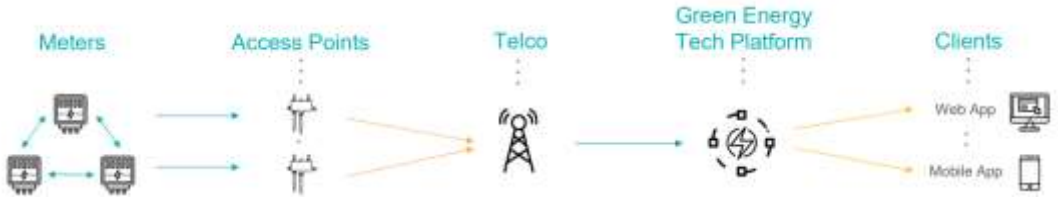

Use case

To provide real-time insights into actual electricity or water consumption within the building using wireless digital meters.

Technology description

This is a system of advanced wireless meters connected to a digital utility monitoring platform that provides real-time and granular level operational insights within the building. It detects potential leakages and spikes in water and energy usage. This helps building managers to identify the problematic areas in the building and make timely decisions to solve the issue.

Relevant building age/size

Any age and size

Relevant building function

- Building management systems
- Electrical systems services

Positive environmental impact on

- Water Consumption
- Energy Consumption
- Waste Generation

Benefits

- Optimise energy and water consumption by providing in-depth and granular operational insights
- Receive real-time alerts and notifications on operational anomalies

Considerations

- Wi-Fi connection required to transmit data to cloud for Machine Learning
- System performance highly depends on the prevailing site and equipment conditions
- **Estimated investment:** SGD 20–50 per meter per month

Sources: SP Digital (2021), Green Koncepts (2021)

HVAC micro-climate control system

CLICK
Return to technology menu

Use case

To eliminate thermal discomfort (hot/cold spots) in buildings by providing targeted cooling in response to actual heat-load in each micro-zone.

Technology description

This is an AI and IoT-based micro-climate control solution that optimises air-conditioning in buildings based on actual occupancy, ambient temperature, and weather conditions. By dividing each floor plan into individual micro-zones according to the occupancy needs of the tenants, the solution works with any existing BMS to enhance thermal comfort while maximising energy and operational efficiency.

Relevant building age/size

Any age and size

Sources: SP Digital (2021)

Relevant building function

HVAC services

Positive environmental impact on

Water Consumption

Energy Consumption

Waste Generation

Benefits

- Reduce energy and water consumption through targeted cooling to individual micro-zones in response to ambient and predicted heat-load instantly delivers air-side chilled water consumption and electrical energy savings
- Improved thermal comfort for building occupants by elimination of hot/cold spots
- Highly flexible and scalable implementation options to suit all site requirements

Considerations

- Wi-Fi connection required to transmit data to cloud for Machine Learning
- System performance highly depends on the site conditions and the existing equipment installed in the building
- **Estimated investment:** SGD 3.50–7.00 per square feet excluding installation costs; installation cost depends on building conditions

IoT-based predictive maintenance for HVAC systems

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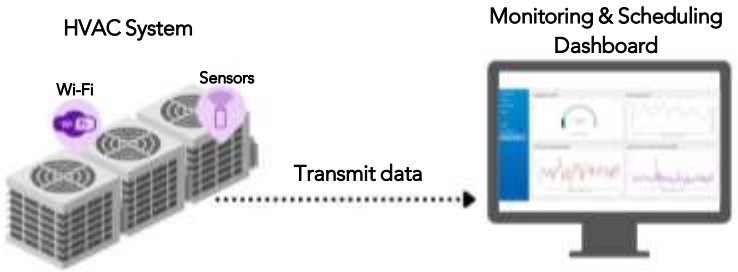

Relevant building function

HVAC services

Positive environmental impact on

Water Consumption
Energy Consumption
Waste Generation

Use case

To detect faults earlier and ensure that the system/machines are in good working condition, which eventually results in better energy efficiency

Technology description

Predictive maintenance technology detects anomalies in the system before system-critical failures. This technology schedule maintenance before the system breaks down and it also increases equipment uptime while reduces maintenance costs in the building. Coupled with the sensors on HVAC system, it can monitor the current, vibration, and airflow in motors, compressors, and fans.

Relevant building age/size

New building and any size

Benefits

- Reduces the overall maintenance cost without having technicians to check often
- Allows early fault detection and maintenance before the system breaks down
- Increase the system/machines uptime with constant condition monitoring

Considerations

- Requires strong Internet connectivity to transmit data from the sensors to the dashboard
- May not be applicable to all existing buildings
- **Estimated investment:** Cost needs to be determined on a case-by-case basis

Sources: Infineon Technologies (n.d.)

Intelligent air distribution system

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Use case

To reduce energy and water consumption by increasing chiller performance

Technology description

An intelligent air distribution system for dynamic control of building ventilation is made up of indoor air quality sensors, controllers, fan, smart dampers, and a direct digital control system. The digital control system receives data from the indoor controllers, smart dampers, and fan to build and update a model for the air duct network. The intelligent adaptive algorithm of the system then computes the required damper positions and fan speed to optimise working conditions to improve indoor environmental quality and minimise energy consumption.

Relevant building age/size

Any age and size

Relevant building function

HVAC services

Positive environmental impact on

Water Consumption

Energy Consumption

Waste Generation

Benefits

- Reduces energy used to treat and distribute air in the building
- Reduces both fan power and energy losses through duct work

Considerations

- Requires adjustments to the system and design control for areas that need heating because the ACMV system operates in cooling mode
- Requires a Wi-Fi or cable connection to transmit data from the sensors to a server
- **Estimated investment:** SGD 300/sqm for installing cost, SGD 10/sqm/year for maintenance and operations

Sources: Cooling India (2018), SLEB Smart Hub (n.d.)

Smart lift monitoring system

Use case

To optimise lift operation and maintenance to minimise energy consumption

Technology description

The IoT and AI-based lift monitoring system helps to better anticipate problems and manage the flow of traffic for lifts based on real-time data. The data allows technicians to pre-empt potential problems and find solutions before they become critical. This system improves energy consumption via intelligent controls while ensuring that the lift operation process is more efficient and transports passengers more quickly to their destination.

Relevant building age/size

Any age and size

Sources: FutureIoT (2019), Bosch (n.d.)

CLICK
Return to technology menu

Relevant building function

Lift & escalator operations

Positive environmental impact on

Water Consumption

Energy Consumption

Waste Generation

Benefits

- Improves energy efficiency via intelligent control
- Captures historical data to provide building managers a clearer view to monitor the lift function and condition
- Reduces operational cost through eliminating costly and time-consuming scheduled maintenance and lift downtime through early fault detection
- Increases tenant satisfaction level from avoided lift breakdowns

Considerations

- Requires a strong internet connection to transmit data from the sensors to the dashboard
- **Estimated investment:** Cost needs to be determined on a case-by-case basis

AHU dynamic chilled water balancing with sensors

CLICK Return to technology menu

Relevant building function

Plumbing, pump & chiller works

Positive environmental impact on

Water Consumption

Energy Consumption

Waste Generation

Use case

To reduce chilled water and electrical energy consumption of AHUs.

Technology description

AHU Dynamic Chilled Water Balancing can be implemented in AHUs quickly with no disruption to existing tenants within a multi-tenanted building. The solution analyses and optimises chilled water and electrical energy consumption of AHU through the direct management of AHU's chilled water Delta-T, delivering both significant savings and maintaining thermal comfort.

Relevant building age/size

Any age and size

Benefits

- Saves up to 30% on cooling energy
- Little or no disruption to existing tenants in multi-tenanted buildings with quick implementation on site
- Proven and cost-effective AI solution that instantly delivers AHU-level chilled water consumption and electrical energy savings

Considerations

- Wi-Fi connection required to transmit data to cloud for Machine Learning
- System performance depends on the prevailing site and equipment conditions
- **Estimated investment:** Cost needs to be determined on a case-by-case basis

Sources: SP Digital (2021)

Smart control and automation for chiller plants

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Relevant building function

Plumbing, pump & chiller works

Positive environmental impact on

Water Consumption

Energy Consumption

Waste Generation

Use case

To reduce energy consumption from the chiller plant

Technology description

This technology is used to optimise chiller plant configurations for both greenfield and retrofitted projects through advanced control algorithms that manage chillers and system components. It is equipped with advanced optimisation features such as dynamic condensing water setpoint, smart sequencing, and staging to optimise the chiller's performance. The chiller's energy consumption is reduced as system efficiency improves, and building managers or BMS operators can monitor the chiller plant performance on-site through dashboards with in-built data analytics.

Relevant building age/size

Any age and size

Benefits

- Reduces chiller plant's energy consumption by improving the system efficiency through automation and smart control
- Allows building managers or operators to monitor the chiller plant performance and control remotely without visiting the site physically

Considerations

- Requires internet connection to transmit data from the sensors to the dashboard
- Requires training for building managers to understand how to utilise the data dashboard
- **Estimated investment:** Upwards of SGD 10,000; cost needs to be determined on a case-by-case basis

Sources: DG Energy (n.d.), Daikin (n.d.)

Smart-retrofit chillers with variable speed drive

CLICK
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Use case

To reduce energy consumption and refrigerant waste for chillers

Technology description

Smart-retrofit technology for chillers enables the existing chiller to achieve higher efficiency by upgrading the driveline with a more efficient electric motor and compressor and installing a variable speed drive (VSD) which leads to more efficiency at part loads and when the chiller operates a lower lift than designed. This technology also leads to less maintenance as the compressor and motor will run at lower speed.

Relevant building age/size

Existing building and any size

Relevant building function

Plumbing, pump & chiller works

Positive environmental impact on

- Water Consumption
- Energy Consumption
- Waste Generation

Benefits

- High ratio of efficiency gain to cost investment
- No disruption to building operations as there is no need to replace the chiller
- Reduces waste as there is no need to dispose the existing refrigerant
- Reduces energy consumption and system maintenance

Considerations

- This technology is only applicable to centrifugal chillers
- **Estimated investment:** Cost needs to be determined on a case-by-case basis

Sources: Johnson Controls (n.d.)

CHAPTER 4:
LEARNING FROM PEERS

In this chapter, facilities management service providers and building owners/managers who have successfully deployed sustainability technologies share their insights from their sustainability journey, including the technologies adopted, investments made, challenges faced, and the eventual business benefits enjoyed

Explore how these companies have benefited from digital technologies for sustainability

GENERAL MAINTENANCE

CTM

Smart cleaning services help buildings reduce water consumption and cut manpower costs

FM Service Provider (SME)

CBM

Smart cleaning robots and monitoring system to reduce water consumption and enhance manpower efficiency

FM Service Provider (MNC)

CBRE

Robotic cleaning solutions to reduce water consumption

FM Service Provider & Building Manager (LLC)

INTEGRATED BUILDING MANAGEMENT

DAIKIN

Incorporating building management systems to enhance energy efficiency

Technology Vendor (MNC)

QUANTUM AUTOMATION

Smart building control systems boost energy efficiency and enhance predictive maintenance

FM Service Provider (LLC)

sptel
Reliability with an Edge

IoT-as-a-Service enables IoT solution providers and end users to jumpstart IoT deployment for energy savings

Technology Vendor (SME)

MECHANICAL & ENGINEERING WORKS

Hongkong Land

Building automation system further enhances chiller's energy efficiency

Property Developer (MNC)

COMFORT MANAGEMENT

Uncovering energy savings opportunities in HVAC systems with automation

FM Service Provider (SME)

Keppel Land

Blending innovative technologies to achieve Singapore's first commercial net-zero building

Property Developer (MNC)

Click on each company to view a detailed case study

Smart cleaning services help buildings reduce water consumption and cut manpower costs

CHYE THIAM MAINTENANCE
CTM

BACKGROUND

Chye Thiam Maintenance (CTM) is a local SME specialising in cleaning services and waste management for commercial buildings, airports, healthcare facilities, and outdoor public spaces. To remain competitive, especially in a labour-intensive industry, and meet the growing demand for sustainability solutions from building managers, CTM has invested in green technologies and products to cut manpower and material costs, be more efficient, and reduce their environmental impact.

SMART CLEANING TECHNOLOGY

One of the examples of smart cleaning technology that CTM uses is a smart toilet system to assist its manpower in cleaning buildings. With the system, cleaning is carried out on-demand based on sensors that detect smell or spillage coupled with feedback from end users.

This reduces the need for cleaners to come in multiple times per day and allows cleaners to engage in predictive cleaning and promptly respond to any sudden issues. This system has been deployed for government and public sector clients in the aviation, judiciary, finance, retail, and other industries.

CHALLENGES FACED IN DEPLOYING TECHNOLOGY

- Needed to convince building owners to adopt the solution, especially since deploying the tech may result in disruptions to day-to-day processes of the building manager
- High start-up cost for the hardware and software (can range from SGD 8,000 to SGD 80,000)

BUSINESS BENEFITS FROM INVESTING IN SUSTAINABILITY

- **Cost savings** of 15-20% for their clients from manpower reduction per deployment of the smart cleaning technology
- **Competitive advantage** when bidding for projects as CTM has sustainability solutions and know-how
- **Creation of new, higher-value jobs** in sustainability roles (e.g. in green procurement policy and end-of-life recycling) that attract a more talented and diverse workforce

> *"We are willing to invest in the smart cleaning technology because it allows us to be cost-competitive, due to the significant manpower cost savings, and helps us secure more projects. We need to formalise sustainability practices in our business to remain competitive."*
>
> *– Mr. Muhamad Sharul, Assistant Director (QEHS, Innovation & Training)*

Smart cleaning robots and monitoring system to reduce water consumption and enhance manpower efficiency

BACKGROUND

CBM is a company that offers integrated FM services (IFM), such as security, parking, cleaning, and maintenance services, as a packaged offering to provide cost-effective and sustainable solutions.

CLEANING ROBOTS

Cleaning robots are smart cleaning solutions requiring minimal supervision. They are used to clean properties with open spaces such as lobbies, saving up to 70% of the water that is typically used when using a traditional mop.

TOILET MONITORING SYSTEM

In order to reduce water usage during cleaning and to allocate manpower more efficiently, CBM implemented the toilet monitoring system for some of its clients' commercial buildings.

"For SMEs that are yet to embark on their sustainability journeys, strive to be a game changer and not a late-adopter."

– Ms. Saidha Gotboudine, Manager Corporate Marketing & Communications
– Ms. Jemma Lee, Sustainability Consultant

The system comprises an ammonia sensor to detect odours; people-counting data to keep track of footfall in the stall; a toilet feedback panel which indicates the cleanliness level; and toilet amenities sensors/counters which aids to detect components such as the toilet paper level.

Based on the information gathered from these features, a cleaner is alerted on when to clean a toilet thus ensuring that manpower is allocated more efficiently. This also reduces unnecessary water consumption used for cleaning which occurs when a schedule-based system is used.

CHALLENGES FACED IN DEPLOYING TECHNOLOGY

- Cleaning staff must be trained to use both devices before they can operate them
- Clients can be apprehensive to accept these digital solutions as they are more accustomed to non-digital technologies

BUSINESS BENEFITS FROM INVESTING IN SUSTAINABILITY

- **Time savings:** To clean 5,000 sqm daily for one-month, a manual scrubber needs 130 hours operation (man-hours required) and 15 hours upkeep; cleaning robots only need 130 hours operation (no man-hours required) and 2 hours upkeep
- **Enhanced water efficiency:** Significant reduction in water used for cleaning with both solutions resulting from the water saving features

Robotic cleaning solutions to reduce water consumption

BACKGROUND

CBRE offers a variety of services for the real estate sector including property management, facilities management, and real estate consultancy. As the national push towards implementing more sustainable solutions in building management and operation grows, CBRE continues to advise its clients on the different digital technologies that it can implement in order to achieve sustainability targets.

ROBOT CLEANER

As a property manager, CBRE represents its landlord's interests when engaging vendors such as facility management companies. Cleaning robots have been one such technology that its clients have been willing to implement in order to reduce their water usage and ability to work autonomously (for e.g., they can take the lift independently to access different floors).

CHALLENGES FACED IN DEPLOYING TECHNOLOGY

- Cleaning robots can only be used in large open spaces and are therefore less suitable for clients with small office spaces
- High initial investment cost for the client as they have to purchase the robot at approximately SGD 80,000, although business can apply for grants such as the Productivity Solutions Grant

BUSINESS BENEFITS FROM INVESTING IN SUSTAINABILITY

- **Enhanced water efficiency**: Clients who have adopted the robots have reported a reduction in water bills
- **Cost savings** of SGD 60,000 per year from being able to reduce its cleaner workforce by three
- **Improved business relationship** between property managers and their clients as property managers are able to support their sustainability goals and targets by connecting them with vendors offering such solutions

> *"SMEs can feel overwhelmed by the variety of offerings in the market. By selecting tried and tested technologies however, they can easily kickstart their own efforts."*
>
> *– Mr. Mark Yeo, Chief Operating Officer, Property Management*

Incorporating building management systems to enhance energy efficiency

BACKGROUND

Daikin is a manufacturer and provider of air conditioning solutions for residential, commercial, and industrial buildings. The company is driven by its desire to ensure that the quality of people's lives is improved by the quality of air they breathe.

BUILDING MANAGEMENT AND ADVANCED CONTROLS SYSTEM

As the demand for digital technologies that promote sustainability efforts increased, Daikin saw the need to offer a wider set of solutions to enhance the entire scope of building management. In 2019, the company acquired another company as part of their goal to work with building owners to maximise energy efficiency in buildings. This acquisition enabled them to develop a building management and advance controls solution that allows integration of HVAC, smart devices, lightings, and facilities equipment seamlessly.

"It is important to have a clear angle and strong strategy for implementing digital technologies to enhance sustainability efforts. Achieving this will require having a sustainability champion in your organisation."

– Ms. Swen Tan, Head of Sustainability Committee

By utilising AI and IoT to optimise and regulate HVAC performance and enhance indoor environmental quality in buildings, this BMS system enhances thermal comfort and occupant well-being whilst maximising energy and operational efficiency. Building managers can also easily gather data, monitor, control the performance of the building assets to enjoy cost saving through lower energy consumption and predictive maintenance through the operating life of the system.

CHALLENGES FACED IN DEPLOYING TECHNOLOGY

- To gain expertise in building management solutions, Daikin had to invest to acquire a company with relevant expertise at a significant cost of upwards of SGD 10 mn
- The next challenge was how to make this solution available down to their business partners to expand the sales. They invested extensively in time and resources to upskill their staff to deploy the technologies.

BUSINESS BENEFITS FROM INVESTING IN SUSTAINABILITY

- **Enhanced branding.** Beyond being an HVAC company, Daikin is now recognised as a "one-stop-shop" for building management, expanding its client pool
- **Enhanced energy efficiency.** Buildings that have integrated Daikin's building management solution have seen increased building performance and energy savings that have enabled them to achieve BCA Green Mark Platinum or SLE certifications

Smart building control systems boost energy efficiency and enhance predictive maintenance

BACKGROUND

Quantum Automation (QA) is a systems integrator for building controls and automation in Singapore. As the demand for more sustainable technologies emerged in the market, QA enhanced its smart building control systems product offerings that would further enhance the building's energy management and consumption. The company works with a variety of stakeholders including hospitals, factories, commercial buildings, and laboratories.

DIRECT DIGITAL CONTROLLERS

QA manufactures Direct Digital Controllers (DDC) with built-in control algorithms to optimise mechanical & electrical equipment in order to enhance energy utilisation thereby enabling building owners to monitor and manage their equipment efficiently.

These DDCs can be programmed with a variety of modules to suit the building's sustainability goals. Such modules can include "data analytic" modules which monitor equipment performance through anomaly and fault detection. The data analytic module uses machine learning to anticipate equipment failure, notifying building managers before issue arises.

Building managers can also define their own rule-based analytics in addition to the normal BMS control logics, which again use to optimise the building's HVAC/ACMV energy systems. The DDC thus enables building managers to enhance their energy efficiency, whilst boosting predictive maintenance.

CHALLENGES FACED IN DEPLOYING TECHNOLOGY

- High start-up and maintenance costs of DDCs (~SGD 102,000/yr). QA has had to hire an R&D team, more than half of whom deal with DDCs exclusively
- Coordination between the manufacturing team that develops the DDCs and project management team that oversees the DDCs building use

BUSINESS BENEFITS FROM INVESTING IN SUSTAINABILITY

- **Access to new market opportunities:** More than 70% of QA's revenue is attributable to implementing the use of DDCs in their clients' premises
- **Brand recognition:** QA has worked with many of its clients to ensure that their sites are certified under BCA's Green Mark scheme

> *"Our ability to remain dynamic and responsive to the demand for sustainability solutions has allowed us to thrive as a company. Companies need to remain adaptable in order to tap into new opportunities."*
>
> *– Mr. Roberto De Jesus, Director*

Building automation system further enhances chiller's energy efficiency

Hongkong Land

BACKGROUND

Hongkong Land is a property conglomerate with a diversified portfolio of property investments and developments across Asia. In Singapore, the company has a total of 165,000 sqm in attributed interests. One Raffles Link is a seven-storey office building, housing financial services businesses and is Hongkong Land's first commercial building development in Singapore. One Raffles Link is also one of the first grade A office building to receive the Green Mark Super Low Energy (SLE). Hongkong Land Singapore invested in sustainability technology to increase energy savings for the buildings.

"We want to do our best in the sustainability domain. Investing in sustainability measures and technology are good for the businesses because it helps reduce a building's cost through energy and water savings."

– Mr. Edward Barrow, Property Manager

ENHANCING CHILLER ENERGY PERFORMANCE

At One Raffles Link, Hongkong Land connected the building automation system to the new chiller system to optimise the building's chiller operations. With the sensors installed in the chilled water system and air handling units (AHUs) integrated with building automation system and JEDI (chiller optimization software), building managers can run the chiller system more efficiently. Overall building electricity consumption has decreased significantly helping Hongkong Land reduce their costs as well as their carbon footprint as part of their sustainability efforts.

CHALLENGES FACED IN DEPLOYING TECHNOLOGY

- Integrating different technologies in the market such as sensors and automation systems can be a challenge as not all of them can complement each other
- Lack of skills and capabilities to track, analyse, and report the data collected from the system

BUSINESS BENEFITS FROM INVESTING IN SUSTAINABILITY

- **Cost savings** of 25-30% from upgrading the chillers and incorporate the chillers with sensors and building automation system

Uncovering energy savings opportunities in HVAC systems with automation

BACKGROUND

Comfort Management is an energy conservation company established in 1992. They specialise in retrofitting HVAC systems and optimising the energy consumption for commercial buildings such as offices, retail malls, hotels, and mixed-use developments.

Comfort Management's knowledge and application of technologies, coupled with experiences in Energy Performance Contracting, has helped many buildings to reap energy savings, with or without capital outlay, while maintaining the same comfort, convenience, and productivity.

RETROFITTING HVAC SYSTEMS WITH IOT SENSORS AND BUILDING AUTOMATION SYSTEM

Comfort Management's Intelligent Energy Management System integrated with various types of field sensors allows the air-conditioning plant to operate at its most optimal performance points and on-demand. As such, energy is consumed efficiently and without wastage.

CHALLENGES FACED IN DEPLOYING TECHNOLOGY

- High upfront cost (ranging from SGD 250,000 and up) for clients to adopt the solutions. Comfort Management provides an option for clients to go green with no upfront capital outlay for the project. This is done through using a portion of the energy cost savings attained from energy conservation measures to pay for the project over a contract period
- Challenging to get the initial buy-in from clients. Comfort Management overcomes this challenge by tailoring the proposals to suit each client's profile. A cost benefit analysis is usually provided to help clients decide the most suitable option for their building

BUSINESS BENEFITS FROM INVESTING IN SUSTAINABILITY

- **Energy cost savings of up to 50%** from re-engineering, system retrofitting or optimisation. The energy efficiency improvement measures are dependent on the type of existing system and the existing system's operating conditions
- **Manpower and time savings** are achieved from the automation and smart controls that operate the ACMV systems

> *"Conserving energy is the way to go in order to save the depleting resources for our future generations. Our mission is to assist buildings in maximising energy savings through our bespoke engineering solutions and to maintain it that way over the equipment lifespan."*
>
> *- Mr. Qiu Xuan, Assistant General Manager (Technical)*

Blending innovative technologies to achieve Singapore's first Green Mark Platinum Zero Energy Commercial Building

BACKGROUND

Keppel Bay Tower is a 394,000 sqft building that was completed in 2002. It is the first commercial building in Singapore to be fully powered by renewable energy and to be certified by BCA as a Green Mark Platinum Zero Energy building, the highest recognition for green buildings under the Green Mark standard. Since 2018, Keppel Land has invested in sustainable technology solutions to significantly reduce the energy and water consumption of Keppel Bay Tower.

"Sustainability is not a choice, but something that all of us must do for the benefit of the planet. While there may be some upfront investment, companies would often find that the life cycle costs are significantly lower. The successful transformation of Keppel Bay Tower is a good example of how Keppel Land can provide sustainability as a service, and contribute to sustainable urbanisation by greening brownfield developments. This will be increasingly important as cities around the world seek to reduce their carbon footprint."

– Mr. Sim Puay Kiak, Head of Sustainable Office of the Future

EMBRACING INNOVATIVE TECHNOLOGIES AND LEVERAGING GRANTS

In 2018, it invested in new and emerging technologies developed both locally by research institutions as well as overseas to find solutions that were cost effective, scalable, and easy to implement. 70% of the total cost of these technologies was funded by a grant from BCA for new and innovative technologies.

CHALLENGES FACED IN DEPLOYING TECHNOLOGIES

- Can be challenging to implement new technologies in an existing building where infrastructure is already in place
- Had to go the extra mile to identify cutting-edge technologies to improve upon its already high baseline sustainability performance
- Extensive research and testing required to test the efficacy and applicability of these emerging technologies

BUSINESS BENEFITS FROM INVESTING IN SUSTAINABILITY

- **Energy-Efficient Air Distribution System**: Air-handling unit fans are 45% more energy-efficient than other best-in-class technologies
- **Air-Conditioning Fresh Air Intake System**: Optimised energy usage for better thermal comfort and indoor environmental quality
- **Cooling Tower Water Management System:** Improved chiller system efficiency, reduced cooling tower water usage and no need for chemical water treatment
- **Cost savings** of SGD 400,000 per year as a result of energy savings of over 2.2 mn kWh from technologies implemented

IoT-as-a-Service enables IoT solution providers and end users to jumpstart IoT deployment for energy savings

Reliability with an Edge

BACKGROUND

As an ST Engineering and SP Group joint venture, we provide unique connectivity and digital services to ensure your business is ready for future opportunities.

REDUCE TOTAL COST OF OWNERSHIP THROUGH IOT DEPLOYMENT

SPTel's IoT-as-a-Service (IoT-a-a-S) comprises of an IoT management platform, Edge Cloud Computing platform, IoT gateways, connectivity and adjacent services such as analytics. This holistic IoT solution supports IoT service providers end-to-end operational requirements from application hosting to bandwidth and data processing. This platform allows businesses to reap IoT benefits without hefty set-up costs and long deployment lead time for a device.

CHALLENGES FACED BY IOT SOLUTION PROVIDERS AND END-USERS IN DEPLOYING TECHNOLOGY FOR BUILT ENVIRONMENT

- Need to deepen the understanding of end-users on how technology can increase their operational efficiency
- Wide range of IoT solutions available in the market makes it difficult for end-users to qualify what suits their requirements
- Need to pair solutions from different IoT providers to meet full requirements, resulting in various providers and dashboards to manage

SPTel's unique advantage lies in their multiprotocol IoT platform. It is application-agnostic so that devices can connect to the platform regardless of their current IoT application protocol. IoT solution providers can also leverage their secure and diverse network that consists of thousands of hubs across the country to perform multi-edge computing. This means that building owners can deploy facilities related IoT such as smart washroom, smart bins, pest control, video analytics, lift monitoring solutions, smart metering, across all their sites, all on one single IoT platform.

BUSINESS BENEFITS FROM INVESTING IN SUSTAINABILITY

- With an IoT-a-a-S platform to monitor the various types of IoT solutions deployed in the building, it can effectively monitor and work towards **overall energy savings of 20%**
- **Cost-effective and saves time**: SPTel helps building owners connect with the right partner solutions to reduce the time needed for solutions sourcing, allowing them to tap onto a ready platform to reduce upfront development cost

> *"We pride ourselves on being a digital services provider of choice. Besides providing diverse and resilient connectivity solutions, we also work together with building owners and facility managers to jumpstart their IoT journey by helping them to test and onboard their solutions on our IoT-a-a-S platform and simplifying the IoT deployment process."*
>
> *– Ms. Susan Loh, VP, Sales, Marketing, Business Development, SPTel*

CHAPTER 5: NEXT STEPS

Keen to get started on your sustainability journey? Access further resources on grants, loans, green schemes, and technology vendors to kickstart your journey

Are you ready to take the next step?

Now that you are aware of the importance of sustainability and the technologies that can help your business be more environmentally sustainable, proceed to do a self-assessment questionnaire on a **Digital Sustainability Readiness Toolkit for Businesses** developed by IMDA and Eden Strategy Institute to find out more about your:

Baseline Environmental Impact

Calculate your company's carbon emissions, water consumption, and waste production annually

Learn more about your company's environmental footprint

Business Risks from Sustainability Gaps

Assess gaps in your current sustainability initiatives and learn about their potential impact in your business

Take action to address the sustainability gaps that impact your business the most

Business Sustainability and Technology Readiness

Identify the financial and non-financial enablers needed to support your organisation's sustainability and technology journey

Build key organisational capabilities in sustainability and technology to succeed in your journey

ACCESS THE SUSTAINABILITY READINESS TOOLKIT

Learn more about Singapore's sustainability plans, policies, and further reading resources

Resource	Description	Target audience
BCA Green Mark 2021	The Green Mark scheme an internationally recognised green building certification scheme that encourages the industry to collaborate and develop green building solutions.	• Building owners
BCA Guide to Smart FM 2019	This guide aims to help building owners and FM service providers begin their Smart FM journey, showcasing technology solutions and case studies of companies that have embarked on a Smart FM journey.	• FM service providers • Building owners
SGBC-BCA Green Facilities Management Firm Accreditation	This accreditation designs to recognise FM companies with strong credentials in operating and showing a good track record of high environmental performance of green buildings during the operational phase. Green FM accreditation helps building owners seek out and appoint Green FM service providers to manage their properties.	• FM service providers
Singapore Green Building Masterplan (SGBMP) 2021	This is a roadmap detailing national ambitions for the sustainability standards of the Built Environment sector. The SGBM is part of the Singapore Green Plan 2030.	• All parties in the Built Environment sector
Singapore Green Plan 2030	This is a roadmap detailing a whole-of-government strategy towards advancing Singapore's commitments to the UN's 2030 Sustainable Development Agenda and Paris Agreement, and to achieve our net-zero emissions target as soon as possible.	• General public

Click on each resource's name for more information

Sources: BCA (2019), BCA (2021), BCA & SGBC (2021), Singapore Green Plan 2030 (2021), SGBC (n.d.)

Finance your sustainability journey through local banks

Programme Name	Loan Amount	Criteria/Requirements	Areas of Funding
HSBC Green Loan for SMEs	At least USD 350,000 (≈ SGD 472,000)	Must have received any award/certifications from: • Singapore Environmental Council: Singapore Green Labelling Scheme • Building and Construction Authority: Green & Gracious Award, and Green Mark Scheme • Singapore Green Building Council: Product & Services certification schemes • Green-e: Renewable Energy Certification	• Creating renewable energy systems • Constructing or renovating green buildings • Purchasing greener equipment and energy-efficient assets • Developing sustainable or recycled products
OCBC SME Sustainable Financing	Up to SGD 20,000,000	• Utilised for green projects with clear environmental benefits (e.g. climate change, natural resources depletion, loss of biodiversity, air, water, and soil pollution) • Must clearly communicate the project's environmental sustainability objectives and disclose any green standards and certifications they are aiming to attain • Funds need to be in a dedicated account and borrowers need to establish an internal protocol to track the usage of funds • Must keep updating the information about the proceeds usage progress until it is fully drawn	• Renewable energy • Energy efficiency • Green buildings • Pollution prevention & control • Water and wastewater management

Sources: HSBC (2020), OCBC Bank (n.d)

Click on each programme's name for more information

Finance your sustainability journey through local banks

Programme Name	Loan Amount	Criteria/Requirements	Areas of Funding
UOB's Sustainable Finance Frameworks	No minimum limits, subject to project/activity evaluation	• Financing for green project/activity or sustainability-linked loans shall meet the eligible criteria under UOB's Sustainable Finance Framework • Borrower to adhere to requirements on use of proceeds, project evaluation and selection, tracking of actual funds usage, and impact reporting ** Other specific criteria or requirements may apply, subject to Areas of Funding*	• Green Building • Renewable Energy (U-Solar) • Energy Efficiency (U-Energy) • Green Transport (U-Drive) • Green Building Construction • Green & Sustainable Trade Finance • E-Waste Management • Plastic Recyclers Ecosystem • Sustainable Water Management and Treatment • Waste Management • Climate Change adaption *If you are keen to find out more or have a project in any of these sectors that requires financing, please contact UOB at sustainable-financing@uobgroup.com*

Click on each programme's name for more information

Sources: UOB (2021)

Finance your sustainability journey through government schemes

Programme Name	Loan/Grant Amount	Criteria/Requirements	Areas of Funding
BCA Building Retrofit Energy Efficiency Financing (BREEF) Schemes	Up to SGD 4,000,000 or 90% of costs, whichever is lower	Applicable to: • Management Corporation constituted under the Land Titles (Strata) Act (Chapter 158) for residential and non-residential buildings • Energy Performance Contracting (EPC) firms accredited by SGBC • Energy Services Companies (ESCO) accredited by the ESCO Accreditation Committee • Special Purpose Vehicles (SPV) set up to deliver, perform or provide energy performance improvements for residential or non-residential buildings	• Energy efficiency retrofits of existing buildings
Enterprise Development Grant (EDG)	Up to 70% of qualifying costs	SMEs can apply EDG if they meet the following criteria: • Registered and operating in Singapore • Have a minimum of 30% local shareholding • Be in a financially viable position to start and complete the project • Enhanced support to cover up to 80% of qualifying costs has been extended until 31 Mar 2022 • Unionised enterprises and Employment and Employability Institute (e2i) partners under the Labour Movement can qualify for an additional 10% funding	Businesses can tap on support for projects in three key areas: • Core capabilities • Innovation and productivity • Internationalisation

Click on each programme's name for more information

Sources: BCA (n.d.), NEA (n.d.)

Finance your sustainability journey through government schemes

Programme Name	Loan/Grant Amount	Criteria/Requirements	Areas of Funding
Energy Efficient Fund (E2F)	Up to 50% of qualifying costs	Criteria and requirements highly depend on the grant components. For more information, please refer to NEA website.	• Resource-efficient design of new facilities or major expansions • Energy assessment of existing facilities • Adoption of energy efficient technologies • Adoption of water-cooled chillers using low-GWP refrigerants • Implementation of an energy management information system
Enterprise Financing Scheme (EFS)	Highly depends on the loan type, refer the website for more information	All applications must reach ESG and be approved by a partner financial institution by 31 Mar 2024.	• New product and technology development • Consultation & certification • Purchase of equipment and machinery related to green initiatives • Finance the fulfilment of overseas and domestics green projects • Finance the growth of innovative enterprises with green initiatives • Finance the mergers and acquisition of green enterprises
IMDA Grant for Advanced Digital Solutions (ADS)	Up to 80% of qualifying cost of the digital solutions For more information, please refer to IMDA website.	Enterprises that meet the following criteria may receive funding support to adopt pre-approved ADS solutions: • Be registered and operating in Singapore; • Have a minimum of 30% local shareholding; and • Be in a financially viable position to start and complete the project	• Advanced digital solutions adoption

Click on each programme's name for more information

Sources: Enterprise Singapore (2021), IMDA (2021), Monetary Authority of Singapore (2021)

Finance your sustainability journey through government schemes

Programme Name	Loan/Grant Amount	Criteria/Requirements	Areas of Funding
MAS Green and Sustainability Linked-Loans Grant Scheme (GSLS)	Up to SGD100,000 per loan over a 3-year period	Companies need to meet the criteria/requirement below: • Companies or financial institutions based onshore or offshore • Loan size of at least SGD 20 mn with minimum loan tenure of 3 years • At least 50% of gross revenue from the loan is attributable to Financial Sector Incentive (FSI) companies • Assessment work of the green or sustainability link aspects of the loan to be performed in Singapore For additional information on the requirements, please refer to MAS website.	• The expenses of engaging independent sustainability advisory and assessment service providers
Productivity Solutions Grant (PSG)	Up to 70% of qualifying cost For more information, please refer to PSG website.	SMEs can apply for PSG if they meet the following criteria: • Registered and operating in Singapore • Purchase/lease/subscription of the IT solutions or equipment must be used in Singapore • Have a minimum of 30% local shareholding; with Company's Group annual sales turnover less than SGD 100 mn, OR less than 200 employees (for selected solutions only • Enhanced support to cover up to 80% of qualifying costs has been extended until 31 Mar 2022	• Sector-specific solutions including the retail, food, logistics, precision engineering, construction, and landscaping industries • Adoption of solutions that cut across industries, such as in areas of customer management, data analytics, financial management, and inventory tracking

Click on each programme's name for more information

Sources: Enterprise Singapore (2021)

Reach out to technology providers and consultants for support in implementing your solutions

Resource	Description	Target audience
Directory of ESCO-Accredited Companies	This document provides a list of Energy Services Companies (ESCO) in Singapore. ESCOs are accredited in the provision of energy auditing services and implementation of energy efficiency as well as conservation projects for buildings and facilities.	• Building owners
SGBC BCA Zero Capital Partnership Scheme (ZCPS)	The ZCPS aims to provide smaller building owners with the expertise of an SGBS accredited energy performance contracting (EPC) firm, which serves as a one-stop solution to help them implement energy-efficient retrofit projects. The EPC firm can provide financing options and facilitate the application of relevant grants or incentive schemes to fund the retrofit works. Through the Scheme, the building owner can work with a proven EPC firm achieve greater energy efficiency with zero capital outlay.	• Small building owners
SGBC Product Directory	The SGBC Product Directory showcases a range of SGBC-certified green building products and suppliers in Singapore and rates them in terms of their effectiveness.	• All parties in the Built Environment sector
SGBC Services Directory	The SGBC Services Directory showcases a range of SGBC-certified green building services providers in Singapore and provides the contact details of these companies.	• All parties in the Built Environment sector
Super Low Energy Buildings (SLEB) Smarthub	The SLEB website is an open database with detailed information on green building technologies. It also hosts an energy performance calculator that buildings can use in preparation for their Green Mark submission.	• All parties in the Built Environment sector

Click on each resource's name for more information

Sources: NEA (2021), SGBC (2021), SLEB (2021)

Glossary of Sustainability Terms

- **Carbon neutrality**

Carbon neutrality is a state of net-zero carbon dioxide emissions, which is achieved by balancing carbon emissions with carbon removal or reduction strategies.

- **ESG**

"ESG" stands for Environmental, Social, and Governance. ESG is generally used as an umbrella term for sustainable and responsible financial considerations.

- **Global Reporting Initiative (GRI) Standards**

GRI Standards are the most widely-used standards for sustainability reporting. They help companies determine which ESG factors to report and describe the metrics for reporting these factors.

- **Green Leases**

A 'green lease' is a lease whereby the owner and occupier agree to specific responsibilities and obligations to ensure the sustainable operation, management, and occupation of a property.

- **Green Loans**

Green loans are types of loans, typically given out by banks or other financial institutions, whose proceeds can only be used to fund green projects or equipment.

- **Greenhouse Gas (GHG) Protocol**

The GHG Protocol is the most widely-used accounting standard globally to calculate greenhouse gas emissions.

- **Sustainability-Linked Loans**

Sustainability-linked loans are loans where there is no restriction on the use of proceeds, but where borrowers are required to commit to sustainability performance targets. Borrowers can enjoy lower interest rates if their sustainability targets are met.

- **Sustainability Report**

A sustainability report provides an overview of a company's economic, environmental, and social impacts arising from its everyday activities. These reports help companies measure, understand, and communicate their sustainability performance and set goals. Since 2016, it is mandatory for all companies listed on SGX to publish ESG reports.

CHAPTER 6: REFERENCES

References

Introduction:

BCA & SGBC. (2021). Singapore Green Building Masterplan Public Engagement Report. Retrieved from https://www1.bca.gov.sg/docs/default-source/docs-corp-buildsg/sustainability/sgbmp-engagement-report_final_v1-1.pdf?sfvrsn=512c885c_0

Macrovector. (n.d.). https://www.freepik.com/free-vector/isometric-cityscape-composition-with-modern-skyscrapers-green-yards-white-background_3796723.htm#page=1&query=isometric%20nature&position=32&from_view=search

IPCC. (2021). Climate change widespread, rapid, and intensifying – IPCC. Retrieved from https://www.ipcc.ch/2021/08/09/ar6-wg1-20210809-pr/

MTI. (2020). Speech by Second Minister Dr Tan See Leng at SME Day 2020 @ SWITCH. Retrieved from https://www.mti.gov.sg/Newsroom/Speeches/2020/12/Speech-by-Second-Minister-Dr-Tan-See-Leng-at-SME-Day-2020

WBCSD. (n.d.). Blueprint for a sustainable built environment. Retrieved from https://www.wbcsd.org/Programs/Cities-and-Mobility/Sustainable-Cities/Blueprint-for-a-sustainable-built-environment

Chapter 1:

BCA. (2021). Green Building Masterplans. Retrieved from https://www1.bca.gov.sg/buildsg/sustainability/green-building-masterplans

BCA. (2018). Super Low Energy Building Technology Roadmap. Retrieved from https://www.bca.gov.sg/greenmark/others/SLE_Tech_Roadmap.pdf

Gov.sg. (2020). Our 4 National Taps. Retrieved from https://www.gov.sg/features/every-drop-counts

NCSS. (2018). Building Energy Efficiency R&D Roadmap. Retrieved from https://www.nccs.gov.sg/docs/default-source/default-document-library/building-energy-efficiency-r-and-d-roadmap.pdf

The Straits Times. (2021). Green buildings: Why the benefits of retrofitting outweigh the costs. Retrieved from https://www.straitstimes.com/singapore/environment/green-buildings-why-the-benefits-of-retrofitting-outweigh-the-costs

PUB. (2020). Retail Benchmarks. Retrieved from https://www.pub.gov.sg/Documents/WaterEfficiencyBenchmark_Retail.pdf

Chapter 2:

BCA. (2021). Green Building Masterplans. Retrieved from https://www1.bca.gov.sg/buildsg/sustainability/green-building-masterplans

BCA (n.d.). Smart Facilities Management. Retrieved from: https://www1.bca.gov.sg/buildsg/facilities-management-fm/smart-facilities-management-fm

Craig, N. (2021). Battling Climate Change One Building at a Time. Retrieved from https://www.cushmanwakefield.com/en/singapore/insights/blog/battling-climate-change-one-building-at-a-time

Disruptive Technologies (2021). The IoT Sustainability Guide for Facilities Managers. Retrieved from https://www.disruptive-technologies.com/blog/the-iot-sustainability-handbook-for-workplace-facilities-managers

Energy Efficient Singapore. (2020). Energy Efficiency National Partnership (EENP). Retrieved from https://www.e2singapore.gov.sg/programmes-and-grants/programmes/energy-efficiency-national-partnership

References

Environmental Protection and Management (Trade Effluent) Regulations. (n.d.). Retrieved from https://sso.agc.gov.sg/SL/EPMA1999-RG5

Keppel Corporation. (2020). Keppel Bay Tower certified as Singapore's first Green Mark Platinum (Zero Energy) commercial building. Retrieved from https://www.kepcorp.com/en/media/media-releases-sgx-filings/keppel-bay-tower-certified-as-singapores-first-green-mark-platinum-zero-energy-commercial-building/

Lim, K (2021). Financial Benefits For SMEs To Take A Green and Sustainability-Linked Loan. Retrieved from https://dollarsandsense.sg/business/financial-benefits-smes-green-and-sustainability-linked-loan/

Nawathe, S. (2020). How Singapore's 4th edition of Green Building Masterplan Targets Sustainability for the Built Environment Sector? Retrieved from https://www.xempla.io/facilty-management-times/how-singapores-4th-edition-of-green-building-masterplan-targets-sustainability-for-the-built-environment-sector/

Straits Times. (2021). Buildings in S'pore have to meet higher standards to be certified green under refreshed scheme. Retrieved from https://www.straitstimes.com/singapore/buildings-in-spore-have-to-meet-higher-standards-to-be-certified-green-under-refreshed

OCBC. (2021). Setting a green standard for sustainable water and wastewater management. Retrieved from https://www.ocbc.com/business-banking/articles/env-tech

SGBC (n.d.). Advancing Net Zero & Climate Resilience in the Built Environment. Retrieved from https://www.sgbc.sg/images/SGG11_ANZ.pdf

UOB. (2020). Improving buildings' energy efficiency to reduce CO2 emissions. Retrieved from https://www.uobgroup.com/web-resources/industry-insights/pdf/construction-infrastructure/improving-buildings-energy-efficiency.pdf?adobe_mc=MCMID%3D58807668847636526022661862915996130797%7CMCORGID%3D116168F454E6DA2A0A4C98A6%2540AdobeOrg%7CTS%3D1608163200

World Business Council for Sustainable Environment. (n.d.). Retrieved from https://www.wbcsd.org/contentwbc/download/11292/166447/1

Chapter 3:

Avidbots. (n.d.). Deploying Automated Floor Cleaning Robots in Facilities Management. Retrieved from https://www.avidbots.com/wp-content/uploads/2020/12/Avidbots_Deploying-Automated-Floor-Cleaning-Robots-in-Facilities-Management.pdf

Bosch. (n.d.). Get insights into the lifts in your building. Retrieved from https://bosch.io/products/lift-manager/

Compactor Management. (2021). https://www.norcalcompactors.net/technology-innovating-waste-management/

Cooling India. (2018). Air Distribution System. Retrieved from https://www.coolingindia.in/air-distribution-system/

DG Energy. (n.d.). Chiller Plant Optimization. Retrieved from https://dgenergycontrols.com.sg/chiller-plant-optimization/

Daikin. (n.d.). iCM Intelligent Chiller Manager. Retrieved from https://www.daikinapplied.eu/products/icm-intelligent-chiller-manager/

Designing Buildings. (2021). Retrieved from https://www.designingbuildings.co.uk/wiki/Building_Automation_and_Control_System_BACS

FutureIoT. (2019). AI and IoT are the keys to smarter lifts and elevators. Retrieved from https://futureiot.tech/ai-and-iot-are-the-keys-to-smarter-lifts-and-escalators/

Green Koncepts. (2021). Retrieved from https://www.greenkoncepts.com/

Infineon Technologies. (n.d.). Predictive Maintenance: Smart Monitoring. Retrieved from https://www.infineon.com/cms/en/discoveries/predictive-maintenance/

References

Johnson Controls. (n.d.). Chiller Best Practices VSD. Retrieved from https://www.johnsoncontrols.com/en_my/hvac-equipment/chillers/variable-speed-drives/chiller-best-practices-vsd

LionsBot. (2021). Why Lionsbot. Retrieved from https://www.lionsbot.com/why-lionsbot/

LSU AgCenter. (n.d.). Rain sensors for a landscape irrigation system. Retrieved from https://www.lsuagcenter.com/~/media/system/d/e/f/5/def5e032ee5c557e45d9175c6bef501f/pub3365rainsensors.pdf

Lumani. (2019). The Best Control is No Control. Retrieved from http://www.lumazones.com/download/lumazones_introduction_30aug19.pdf

Prince Landscape. (2021). Irrigation system in Singapore. Retrieved from https://www.princelandscape.com/irrigation-system/

RF Wireless World. (n.d.) Advantages of Rain Sensor | Disadvantage of Rain Sensor. Retrieved from https://www.rfwireless-world.com/Terminology/Advantages-and-Disadvantages-of-Rain-Sensor.html

Simpple. (2021). Solutions for Smart Toilets. Retrieved from https://www.simpple.com.sg/smart-toilet

SLEB. (n.d.). Thermosiphon Beam, Intelligent Air Distribution System. Retrieved from https://sleb.sg/Technologies/TechnologiesDetails/286

Smart Clean. (2021). Sensors. Retrieved from https://www.smartclean.io/sensors.html

SP Digital. (2021). SP Digital Smart Metering Hardware and Solution [Brochure]

SP Digital. (2021). SP Digital GET™ Green Tech Control [Brochure]

The Straits Times. (2021). Smart cleaning to keep Singapore spick and span. Retrieved from https://www.straitstimes.com/singapore/environment/smart-cleaning-to-keep-singapore-spick-and-span

Unabiz. (n.d.). Smart Toilet Management. Retrieved from https://www.unabiz.com/use_case/smart-toilet-management/

Wattsense. (2020). Retrieved from https://blog.wattsense.com/building-management/bacs-energy-eu/

Chapter 5:

BCA. (n.d.). Building Retrofit Energy Efficiency Financing (BREEF) Scheme. Retrieved from https://www1.bca.gov.sg/buildsg/sustainability/green-mark-incentive-schemes/building-retrofit-energy-efficiency-financing-breef-scheme

BCA. (n.d.). Built Environment Accelerate to Market Programme. Retrieved from https://www1.bca.gov.sg/buildsg/buildsg-transformation-fund/built-environment-accelerate-to-market-programme

BCA. (2019). Guide to Smart FM. Retrieved from https://www1.bca.gov.sg/docs/default-source/docs-corp-buildsg/guide_to_smart_fm.pdf

BCA. (2021). Green Mark 2021. Retrieved from https://www1.bca.gov.sg/buildsg/sustainability/green-mark-certification-scheme/green-mark-2021

BCA & SGBC. (2021). Singapore Green Building Masterplan Public Engagement Report. Retrieved from https://www1.bca.gov.sg/docs/default-source/docs-corp-buildsg/sustainability/sgbmp-engagement-report_final_v1-1.pdf?sfvrsn=512c885c_0

References

Enterprise Singapore. (2021). EFS Green Overview. Retrieved from https://www.enterprisesg.gov.sg/financial-assistance/loans-and-insurance/loans-and-insurance/enterprise-financing-scheme/green/overview

Enterprise Singapore. (2021). Productivity Solutions Grant (PSG). Retrieved from https://www.enterprisesg.gov.sg/financial-assistance/grants/for-local-companies/productivity-solutions-grant

HSBC. (2020). HSBC launches Singapore's first Green Loan for SMEs. Retrieved from https://www.about.hsbc.com.sg/news-and-media/hsbc-launches-singapores-first-green-loan-for-smes

IMDA. (2021). Advanced Digital Solutions. Retrieved from https://www.imda.gov.sg/advanceddigitalsolutions

Monetary Authority of Singapore. (2021). Green and Sustainability-Linked Loans Grant Scheme. Retrieved from https://www.mas.gov.sg/schemes-and-initiatives/green-and-sustainability-linked-loans-grant

NEA. (n.d.). Energy Efficiency Fund. Retrieved from https://www.nea.gov.sg/programmes-grants/grants-and-awards/energy-efficiency-fund

NEA. (2021). List of Accredited ESCOs. Retrieved from https://www.nea.gov.sg/docs/default-source/our-services/energy-efficiency/list-accredited-escos.pdf

OCBC Bank. (n.d.). SME Sustainable Financing – Green Financing. Retrieved from https://www.ocbc.com/business-banking/smes/loans/sustainable-financing

SGBC. (2021). SGBC-BCA Zero Capital Partnership Scheme. Retrieved from https://www.sgbc.sg/sgbc-certifications/zero-capital-partnership/zero-capital-partnership

SGBC. (n.d.) Green FM. Retrieved from https://www.sgbc.sg/sgbc-certifications/sgbs-certification/green-fm

SGBC. (2021). SGBC Product Directory. Retrieved from https://web.sgbc.online/public/product

SGBC. (2021). SGBC Services Directory. Retrieved from https://web.sgbc.online/public/service

Singapore Green Plan 2030. (2021). Introducing the Green Plan. Retrieved from https://www.greenplan.gov.sg/

SLEB. (2021). SLEB Smart Hub. Retrieved from https://www.sleb.sg/

UOB. (2021). UOB Sustainable Financing. Retrieved from https://www.uobgroup.com/uobgroup/sustainable-financing.page

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