Rounding Up 2023

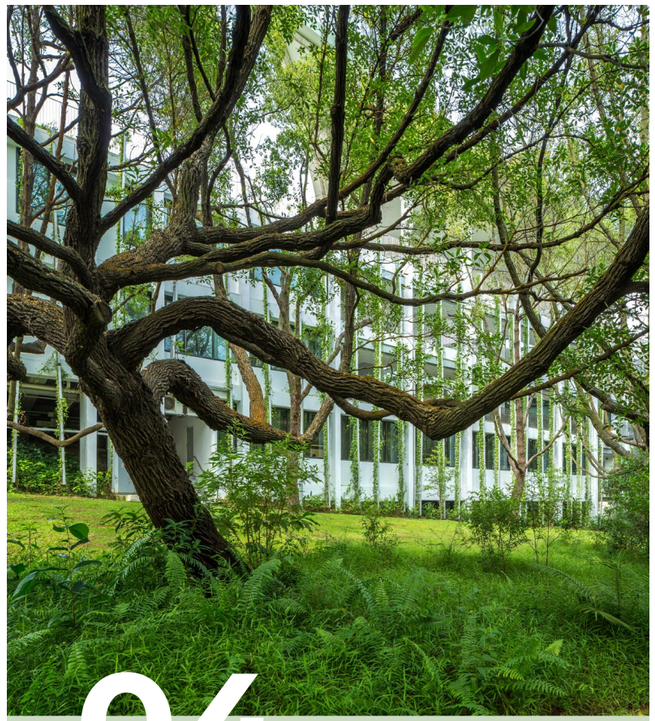
Gearing Up on Campus Sustainability & Climate Action

ENVIRONMENTAL DISCLOSURES

About NUS Campus Sustainability Roadmap 2030

NUS National University of Singapore

Content Page



About

About this document

This document details the NUS campus environmental sustainability performance in Financial Year (FY[^]) 2023, spanning 1 April 2023 to 31 March 2024 (denoted as “2023” in this document). It is meant to complement the NUS Sustainability Report and NUS Impact Report by providing detailed environmental disclosures. It covers NUS' three main campuses - Kent Ridge, Bukit Timah and Outram.

About environmental disclosures

The environmental disclosures are prepared with reference to the Global Reporting Initiative (GRI) Universal Standards 2021. We also align our emissions calculation methodology to the Greenhouse Gas Protocol. It provides details about our progress in campus sustainability and climate action, our targets and plans to achieve them, and next steps. In addition to our top-line indicators, we share the energy performance of our top energy-intensive buildings, details of our campus hotspots and how we manage and close waste loops. All figures in this document have been rounded.

How to navigate this document

We have prepared various segments to cater to general readers, instructors and sustainability professionals:

NUS Explains

For general readers: Explanations of technical terms and how they relate to NUS.

For instructors: Content that can be used to educate students on sustainability (e.g. strategies).

For sustainability professionals: Technical details and data that quantify our plans and progress. For further reading, refer to "Important Details".

[^]Financial Year (FY) for Year N is defined in this document for the period of April in Year N to March in Year N+1. All years in this report are Financial Years unless otherwise stated.

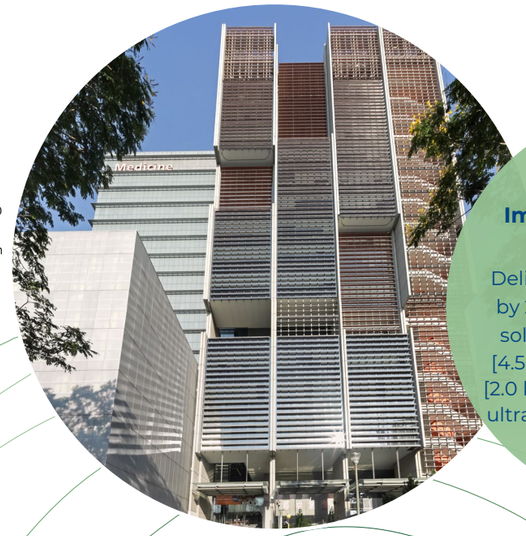
Campus Sustainability at NUS & **2023 Highlights**

Tembusu trees, like the one pictured here, are amongst the first tree species planted on campus in the 1980s.

As a homage to our trees on campus, we use expanding tree rings to symbolise growing possibilities for sustainability, building upon our decades of sustained commitment.

2023 Highlights

Rounding up campus sustainability efforts



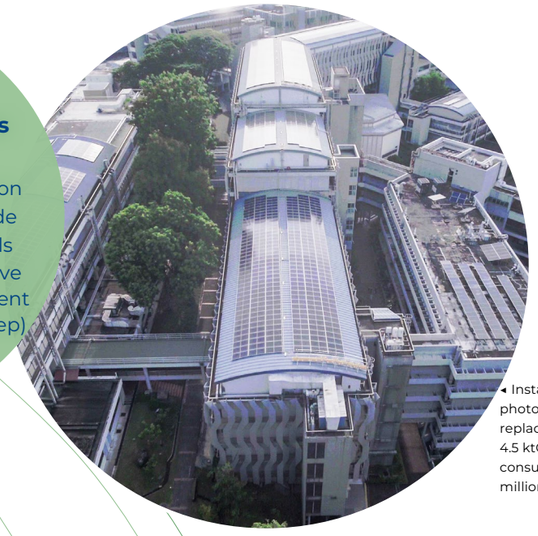
▸ Reduced energy use in MD6 by 10% through adjustments in ventilation and air change rates, saving about 1.9 GWh (0.79 $ktCO_2e$) or around $412,000 in energy costs.

Completing energy audits for top 10 energy-intensive buildings by 2024 and replicating energy optimisation measures to achieve 4.7 GWh (2.0 $ktCO_2e$) annual savings by 2025.

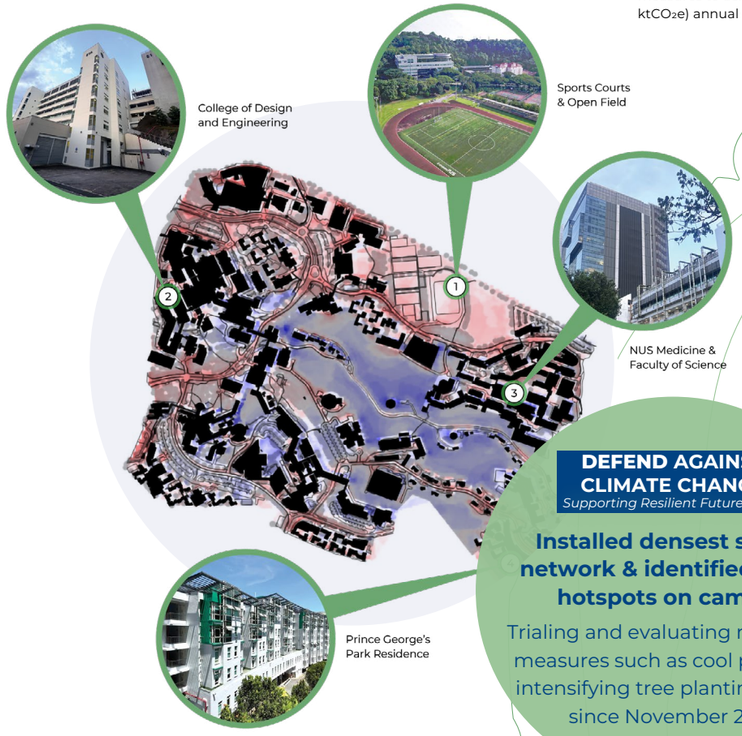
DECARBONISE
Supporting Energy Reset Pillar

Implementing emissions reduction projects

Delivering 7.5 $ktCO_2e$ reduction by 2025 through campus wide solar photovoltaic (PV) panels [4.5 $ktCO_2e$], green lab initiative [2.0 $ktCO_2e$] & change to efficient ultra-low temperature (i.e. deep) freezers [1.0 $ktCO_2e$]



◂ Installing up to 9.2 MWp of solar photovoltaic (PV) capacity by 2024 to replace approximately 4% (11 GWh; 4.5 $ktCO_2e$) of our total electricity consumption, saving about $2.4 million a year.



DEFEND AGAINST CLIMATE CHANGE
Supporting Resilient Future Pillar

Installed densest sensor network & identified major hotspots on campus

Trialing and evaluating mitigation measures such as cool paint and intensifying tree planting efforts since November 2018

DEMATERIALISE
Supporting Sustainable Living Pillar

Launched sustainable procurement & established clean-stream recycling

Implementing ways to close waste loops

NUS SUSTAINABLE PROCUREMENT FRAMEWORK

▴ Introduced 10% quality scoring criteria for sustainability criteria to encourage suppliers to adopt sustainability practices for our value chain.

AWARD

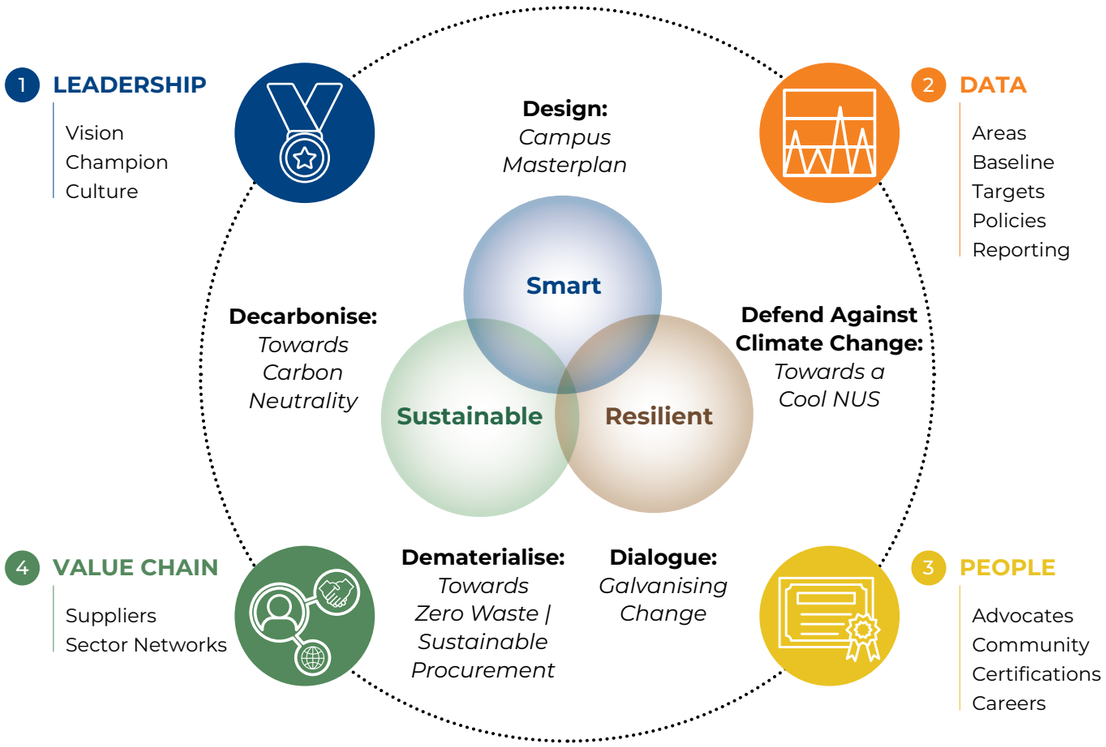
Accorded President's Award for the Environment in 2023, the nation's top accolade for environmental sustainability in recognition of our unwavering commitment towards advancing sustainable development and climate action

Professor Tan Eng Chye
NUS President

"NUS is harnessing the collective expertise of our academia and operating units to grow possibilities and push frontiers on sustainability and climate action using the campus grounds as a real-world testbed. We are committed to contribute to global climate action and support the Singapore Green Plan 2030."

NUS Sustainable Campus Development Framework

Vision: A leader in creating a smart, sustainable & resilient campus



Mr Clarence Ti
Deputy President (Administration)

"We are building practice leadership in campus sustainability – in campus design, decarbonisation, climate defence, dematerialisation and creating change through dialogue."

Embedding Sustainability in Our Work

Envisioning to be a leader in creating a smart, sustainable and resilient campus, our sustainability framework encompasses organisational planning strategies of **Leadership, Data, People and Value Chain**, and environmental strategies under the Campus Sustainability Roadmap 2030 of **Design, Decarbonise, Defend, Dematerialise and Dialogue**.

Organisational planning strategies focus on **leadership** in campus sustainability practices, backed by a **data**-centric approach in setting ambitious targets, monitoring and reporting progress aligned with international standards, enabled by growth in **people** capabilities and expertise in sustainability, and augmenting impact within higher education sector network and influencing its **value chain** to be more sustainable.

The Campus Sustainability Roadmap 2030 outlines our environmental strategies and key sustainability targets:

- **Design** the campus masterplan to incorporate key thrusts of net-zero energy and low carbon precincts, integrate blue-green infrastructure with biophilic design and improve outdoor thermal comfort.
- **Decarbonise:** A carbon mitigation programme with a priority to reduce 30% of its Scope 1 and 2 emissions by 2030 below 2019 baseline before counterbalancing with carbon removals to achieve carbon neutrality as a last resort.
- **Defend against climate change with Cool NUS:** A living lab research collaboration focused on optimising outdoor thermal conditions and reducing hotspots across the campus to adapt to rising temperatures.
- **Dematerialise with Zero Waste Campus:** A programme to implement Zero Waste hierarchy (rethink, reduce, reuse, repurpose, recycle and recovery) to reduce waste disposed per capita by 30% across procurement, administration and operation functions and achieve a high recycling rate of 50%.
- **Dialogue** with an inform-consult-partner approach to foster buy-in, involvement and rally behavioural change needed to achieve targets.

The projects under the Campus Sustainability Roadmap 2030 are collaboratively driven by University Campus Infrastructure (UCI), key departments such as NUS Information Technology (NUS IT), Central Procurement Office (CPO) and Agility Office (AO), faculty stakeholders such as NUS Medicine, College of Design and Engineering (CDE), as well as student groups.

Decarbonise

Towards Carbon Neutrality – Reductions First

Mr Koh Yan Leng
Vice President, University Campus Infrastructure

"We will use all available measures to decarbonise our campus infrastructure and operations, prioritising energy reductions tailored to different building types."

▲ SDE 1 & 3, part of the first building cluster targeting net zero energy, retained most of its building elements (e.g. walls, columns, floors) and refurbished specific ones for better energy performance (e.g. shading fins above). (Photo by Finbarr Fallon)

Emissions are Projected to Grow with New Buildings

Our campus is continuously expanding with new buildings to support growth in research, enhanced student life and computing power required for generative artificial intelligence. Without proactive action, our Scope 1 and 2 emissions are expected to rise to 142 $ktCO_2e$ by 2030 (Scope 1: 2 $ktCO_2e$; Scope 2: 140 $ktCO_2e$) due to the new energy demands from these buildings. To cut energy use, we are designing and operating these new buildings to be energy efficient, optimising energy consumption in our laboratories and deploying solar renewables.

2030 Snapshot of Business-as-Usual Scope 2 Emissions (140 $ktCO_2e$) from Buildings

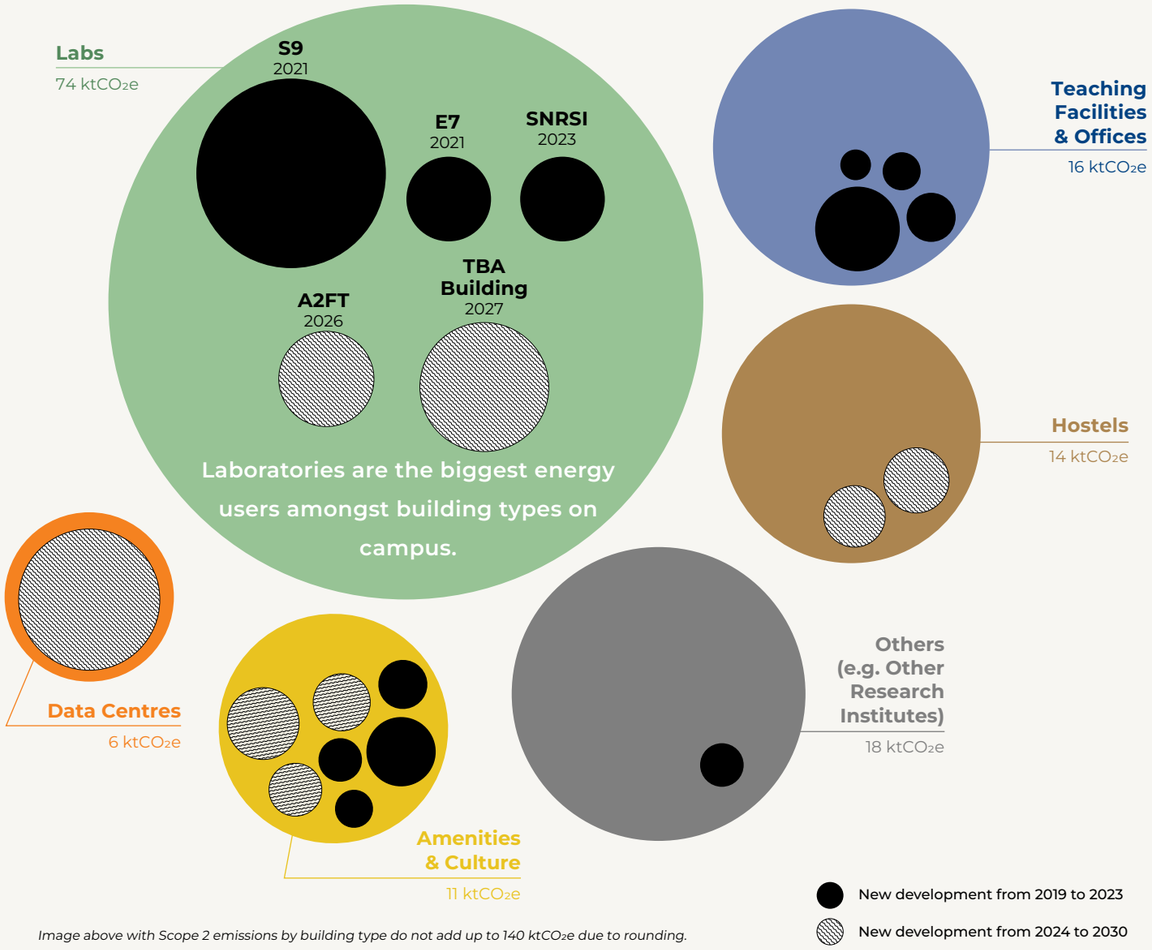


Image above with Scope 2 emissions by building type do not add up to 140 $ktCO_2e$ due to rounding.

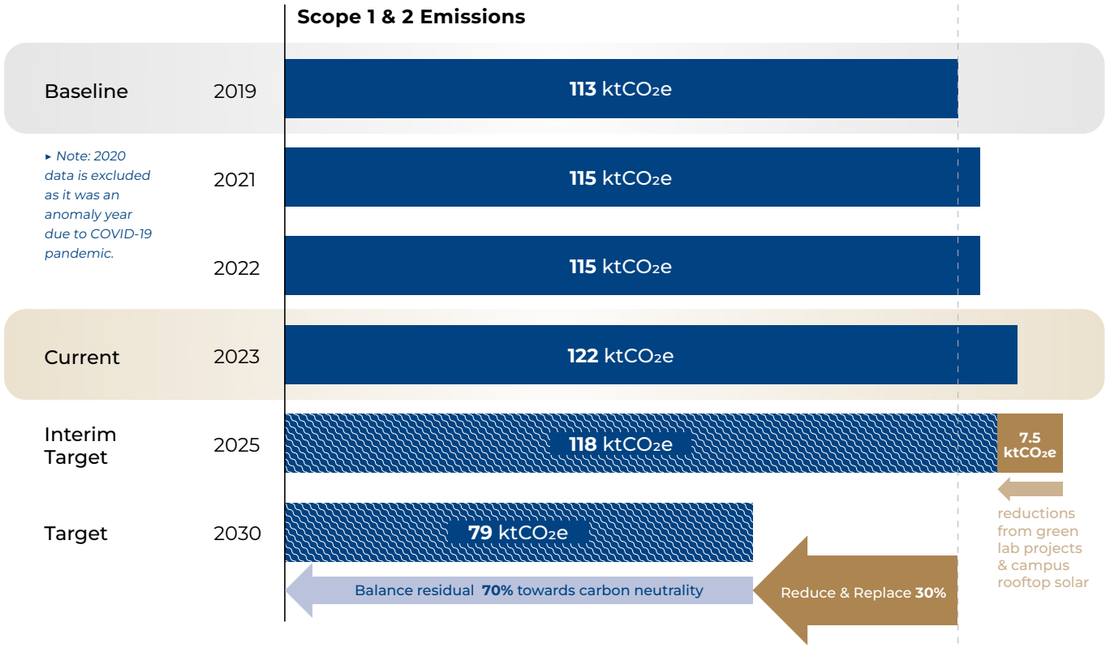
2023 Performance

Delivering Energy Reduction Projects to Decarbonise Campus Growth

We aim to reduce Scope 1 and 2 emissions by prioritising 30% reductions by 2030 from our 2019 baseline before counterbalancing the residual emissions with carbon removals towards neutrality as a last resort.

In 2023, our Scope 1 and 2 emissions rose from 115 $ktCO_2e$ in 2022 to 122 $ktCO_2e$. This can be attributed to three main reasons: (1) additional electricity load from three new buildings in 2023 (Medicine Science Library, Singapore Nuclear Research and Safety Initiative, COM4), (2) increase in electricity usage in hostels, and (3) the rise in Singapore's average grid emission factor – the average emissions emitted per unit of electricity generation.

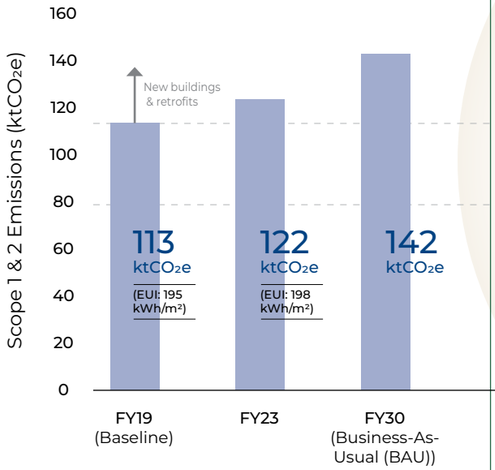
Our interim target is to lower emissions to 118 $ktCO_2e$ by 2025. We expect our emissions to increase to 125 $ktCO_2e$ with increased electricity load from three new buildings in 2024 and 2025. We are implementing 7.5 $ktCO_2e$ of reductions by focusing on energy optimisations in our top consuming laboratory buildings (2.0 $ktCO_2e$), switching to energy efficient deep freezers (1.0 $ktCO_2e$) and commissioning campus rooftop solar panels (4.5 $ktCO_2e$).



Our Strategy

Avoid, Reduce, Replace First

To reduce Scope 1 and 2 emissions by 30% from our 2019 baseline, we have a four-pronged decarbonisation strategy – Avoid, Reduce, Replace, and Neutralise. Our priority is on avoiding and reducing energy consumption and maximizing our campus solar rooftop PV capacity.



▲ *EUI: Energy Usage Intensity - energy consumption divided by gross floor area*
▲ *BAU: A scenario where we do not take proactive action*

▶ AVOID

Strive for best-in-class and optimal energy performance for new buildings and retrofits in design and operations

11 ktCO₂e

- Design stretched targets for new buildings & retrofits
- Ensuring energy performance

- Launched three new buildings, achieving Green Mark Platinum Super Low Energy for Medicine Science Library (funded by Green Bond), Singapore Nuclear Research and Safety Initiative and Green Mark Platinum for COM4
- Ongoing post-commissioning building checks to ensure energy performance

▶ REDUCE

Increase campus-wide efficiency and reduce energy consumption across building types

20 ktCO₂e

- Chiller plant optimisation, upgrading & consolidation
- LED replacement
- Green labs
- Green teaching facilities & offices
- Green hostels
- Green data centres

- Switching to energy efficient deep freezers campus-wide by 2024-2025 (2.4 GWh; 1.0 ktCO₂e)
- Progressive optimisations in top 10 energy-intensive buildings by 2024-2025 (4.7 GWh; 2.0 ktCO₂e)
- Carrying out building energy load profiling for top 9 energy-intensive buildings to develop proposals for targeted interventions by 2024-2025
- Piloting dynamic control of air-conditioning for lecture theatres in 2024

▶ REPLACE

Maximise campus rooftop solar PV capacity and procure overseas renewable energy

32 ktCO₂e

- Campus rooftop solar PV
- Overseas renewable energy

- Installed 9.2 MWp of solar photovoltaic capacity on campus rooftops, pending approval from Energy Market Authority for progressive commissioning in 2024 (11 GWh; 4.5 ktCO₂e)

▶ NEUTRALISE

As a last resort, procure carbon removals to balance residual emissions

↓30%
Scope 1 & 2 emissions through Avoid, Reduce & Replace

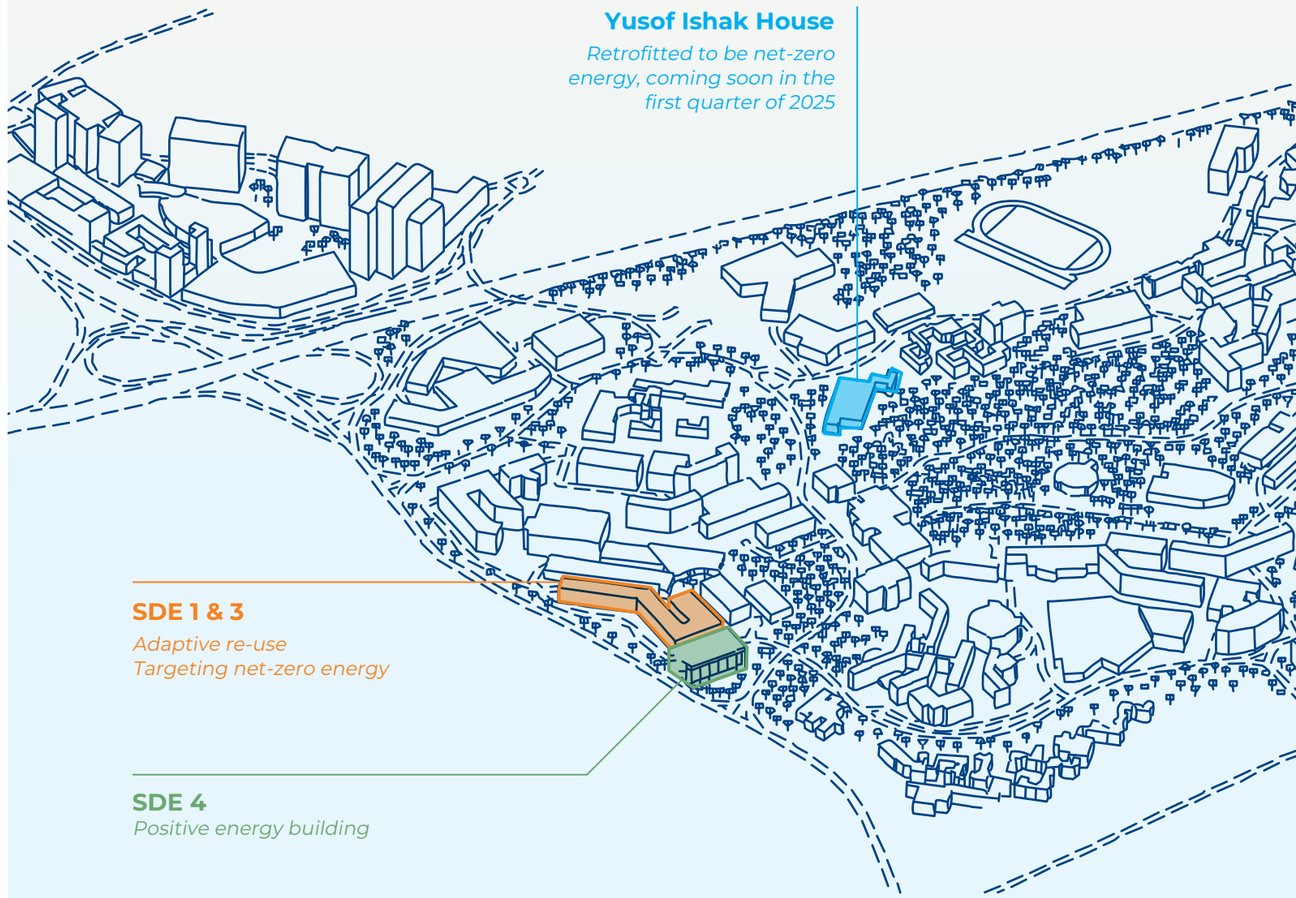
79 ktCO₂e
(EUI: 156 kWh/m²)

Balance residual emissions

FY30 Target

NUS Explains

We are the Pioneer in Net-Zero Energy Buildings in Singapore



NUS is home to the first building cluster that will achieve net-zero energy by 2025, comprising three buildings with very high energy performance: (1) SDE4 (Green Mark (GM) 2021 in Operation Platinum Positive Energy), (2) SDE1 (GM Platinum Zero Energy), and (3) SDE3 (GM Platinum Super Low Energy). SDE3 will achieve net-zero energy once the high efficiency solar PV is installed on its roof by 2025. Our next building designed to be net-zero energy will be Yusof Ishak House.

In general, a net-zero energy building means the amount of renewable energy supplied to the building is equivalent to how much it consumes. However, we take the most stringent definition of “net-zero energy” to mean that all renewable energy has to be produced on-site within the building footprint to meet its needs.

▶ AVOID

Ensuring High Energy Performance in New Buildings

We designed our new buildings to be energy efficient, and are also ensuring high energy performance when in use. We conduct checks on energy hardware (e.g. meters) and systems to make sure they are correctly set up for energy management.

We continuously monitor the buildings' energy usage and make tweaks to improve it, such as gradually adjusting temperature setpoints up to 24-25°C while ensuring thermal comfort, and partnering building occupants to manage electricity consumption from their activities (e.g. rightsizing the number of hours for operations). As of 2023, we have reduced 0.4 GWh (0.15 ktCO₂e).

0.4 GWh
0.15 ktCO₂e

◂ We use the building management system to monitor the performance of the energy hardware and ensure overall building energy performance.

▾ Techno Edge, a Green Mark Platinum Super Low Energy building as of 2023, was one of the newer buildings. (Photo: Forum Architects)

▴ SDE4 is one of the small handful of buildings to receive the Green Mark in Operation Platinum (Positive Energy) award. As of 2023, it has generated a total of 131% of its building consumption.

Financing Our New Buildings with Green Bonds

We launched the Green Finance Framework in April 2020, becoming one of the first universities in Asia to do so. Between 2020 and 2023, we raised a total of $940 million from the issuance of three green bonds. The proceeds from the green bonds are fully allocated and used to fund or re-finance green buildings and the campus rooftop solar PV system that support our decarbonisation efforts.

Mr Tan Kian Woo
Senior Vice President and Chief Financial Officer

"Our fully subscribed green bond issuances underscore NUS' commitment to green building development. Through practice, we aim to lead green and sustainable financing amongst Asian universities and build access to a supply of funds by investors that want green credentials for their portfolio requirements ."

NUS Explains

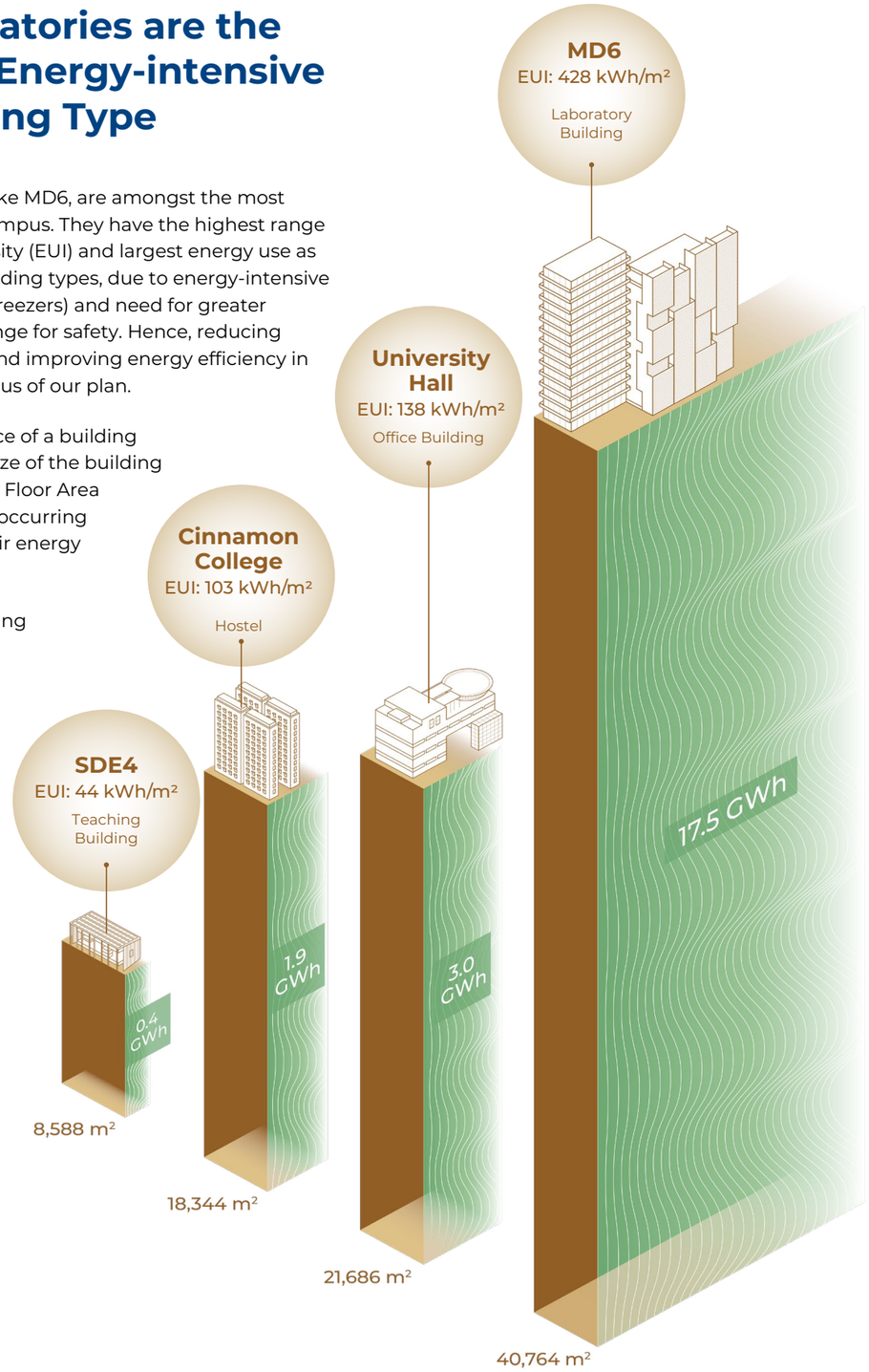
Laboratories are the Most Energy-intensive Building Type

Laboratory buildings, like MD6, are amongst the most energy-intensive on campus. They have the highest range of Energy Usage Intensity (EUI) and largest energy use as compared to other building types, due to energy-intensive equipment (e.g. deep freezers) and need for greater ventilation and air change for safety. Hence, reducing energy consumption and improving energy efficiency in laboratories is a key focus of our plan.

The energy performance of a building depends on both the size of the building measured by the Gross Floor Area (m^2), and the activities occurring in the building and their energy requirements.

EUI, derived from dividing the building's annual energy consumption by its size, is used to compare amongst different buildings. The lower the EUI, the better its energy performance.

1 GWh = 1,000,000 kWh



▶ **REDUCE:** GREEN LABS

Greening Our Laboratories

A third of our total campus energy consumption is from our top 10 energy-intensive buildings^. We intend to green our laboratories by reducing their energy consumption.

We have focused on the top energy-intensive building, MD6, with a target to reduce its energy consumption by 20% by 2026 (15.4 GWh, EUI: 379 kWh/m^2) from 2022 (19.3 GWh, 474 kWh/m^2). After completing a comprehensive energy audit for MD6, we have progressed in reducing energy use by close to 10% in the past year through adjustments in ventilation and air change rates, by about 1.9 GWh (0.78 $ktCO_2e$) to 17.5 GWh (EUI: 428 kWh/m^2), saving around $412,000 in energy costs. In the next two years, we will be optimising the chiller plant, replacing lights to LED and switching to energy efficient deep freezers.

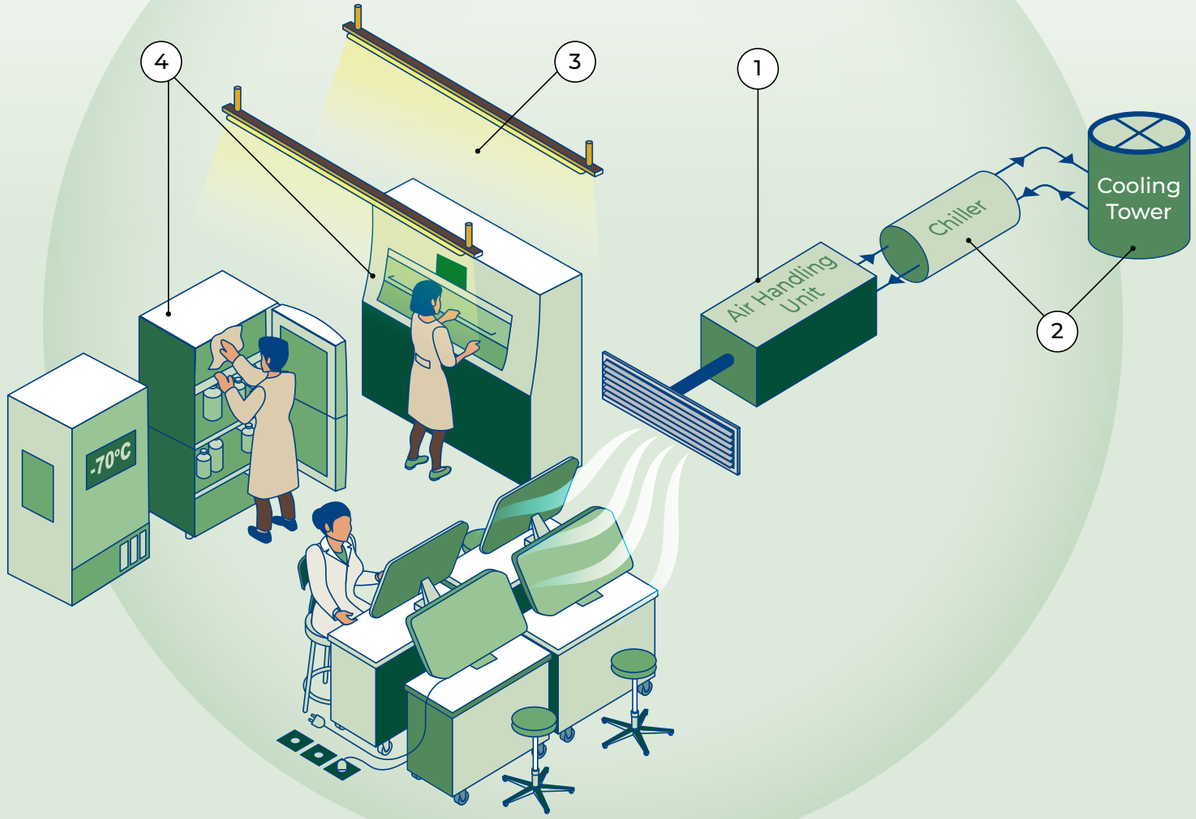
We will replicate successful interventions from MD6 in other energy-intensive laboratory buildings. In 2024, we will be conducting similar adjustments in ventilation and air change rates in the other top energy-intensive laboratory buildings, aiming to achieve 4.7 GWh (2.0 $ktCO_2e$) annual savings by 2025, that contributes to our target 7.5 $ktCO_2e$ reductions by 2025. We are also conducting comprehensive energy audits for the other top 9 energy-intensive lab buildings by 2024-2025 for targeted energy saving interventions.

^These buildings are laboratory buildings from NUS Medicine, Faculty of Science and College of Design and Engineering – MD1, MD2, MD6, CeLS, S1A, S9, E3A, E6, E8, T-Lab.

▲ MD6, NUS' top energy-intensive building in 2022.

▶ **REDUCE:** GREEN LABS

Reducing Energy in Our Laboratories



We are targeting the following areas to reduce energy in our laboratories:

1. **Airside:** Optimising ventilation, air-conditioning and air change rates to a suitable level based on occupancy and air quality, while maintaining safety and without compromising on research activities. In doing so, the Air Handling Unit's energy consumption will be optimised to the space requirement and activities.
2. **Cooling:** Optimising the chiller and cooling tower for better efficiency. This means reducing the amount of electrical energy required to produce the same amount of cooling for a building.
3. **Lighting:** Switching to smart illumination controls with efficient LED lights.
4. **Equipment:** Switching to energy efficient lab equipment for deep freezers and fumehoods.

▶ **REDUCE:** GREEN LABS

Collectively Switching to Energy Efficient Deep Freezers in a Year

We conducted a campus-wide physical stocktake and found that of the 532 deep freezers, 212 or 40% of them are inefficient. We are investing around $2 – 3.5 million to change all 212 freezers to energy efficient ones by 2024-2025, aiming to save about 2.4 GWh (1.0 $ktCO_2e$) and $528,000 in energy costs annually by 2025. This contributes to our target 7.5 $ktCO_2e$ reductions by 2025. The NUS central procurement catalogue was also expanded to include more energy efficient models.

▸ Deep freezers are high-consuming laboratory equipment with a typical temperature setting range of -70°C to -80°C used to store temperature-sensitive chemical or biological samples. Inefficient deep freezers consume more than 18 kWh/day, or 1.5 times the average daily energy consumption of a 4-room HDB unit.

Associate Professor Sanjay Swarup
Director, NUS Environmental Research Institute (NERI)

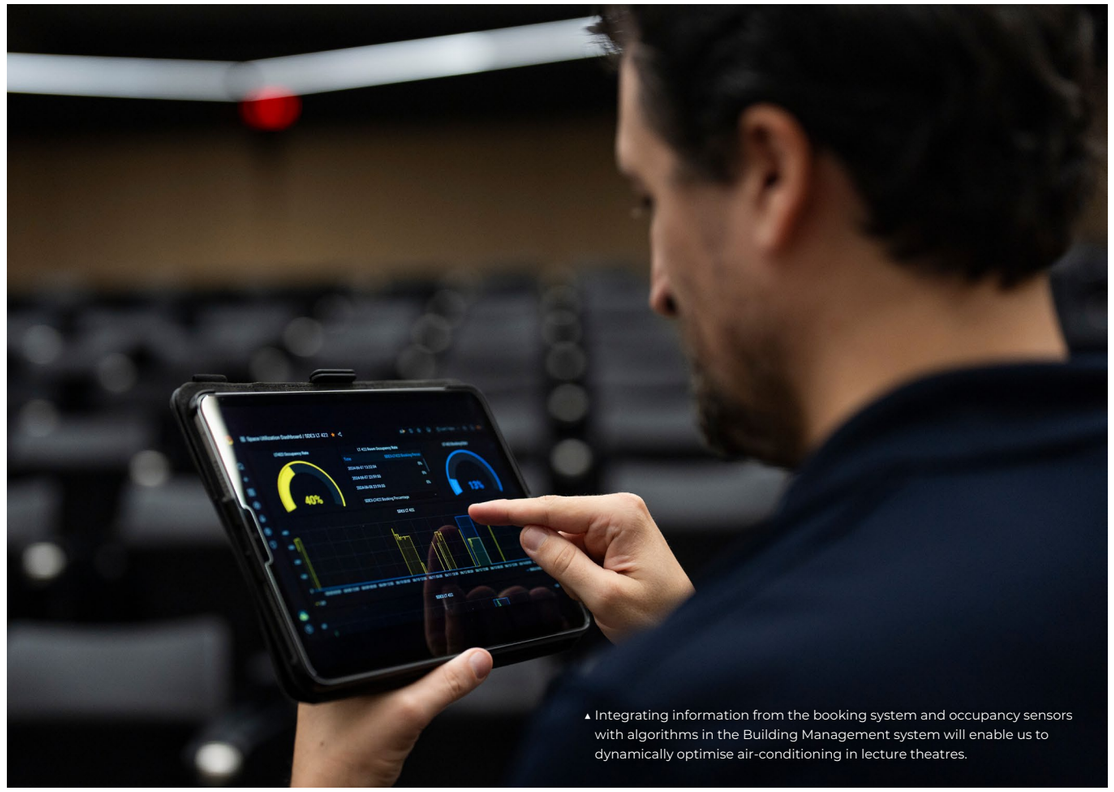
"NERI is committed to doing our part to reduce our energy consumption as one of the first research institutes on campus to switch to energy-efficient deep freezers and adopt green laboratory practices."

Ms Seah Pei Ching
Central Procurement Office

"Sustainable procurement plays an important role upstream to ensure that the equipment that our research community procures are resource efficient and green."

▶ **REDUCE:** GREEN TEACHING FACILITIES & OFFICES

Optimising Air Conditioning in Lecture Theatres



▲ Integrating information from the booking system and occupancy sensors with algorithms in the Building Management system will enable us to dynamically optimise air-conditioning in lecture theatres.

Air-conditioning in lecture theatres in NUS is typically switched on with a fixed schedule between 8am to 10pm but booked at an average of 52% of the time during term period. Even with bookings, lecture theatres may end up unoccupied – actual occupancy is on average 27% for five lecture theatres in College of Design and Engineering during term period.

We are working to optimise the energy used for cooling large lecture theatres by ensuring they are cooled only when occupied. We are trialling a system to dynamically control the air-conditioning in three lecture theatres in the College of Design and Engineering by 2024.

The system will integrate information from the booking system and occupancy sensors with algorithms in the Building Management Systems (BMS) to optimise the air-conditioning. This will allow the system to switch on the air-conditioning of a lecture theatre when booked, and automatically switch it off when no occupancy is detected after a period. It will also change the amount of airflow and temperature setpoint according to the level of occupancy. If the pilot is successful, this will be scaled up to all lecture theatres campus wide, saving about 0.4 GWh (0.17 $ktCO_2e$) annually.

▶ **REPLACE:** CAMPUS ROOFTOP SOLAR PV

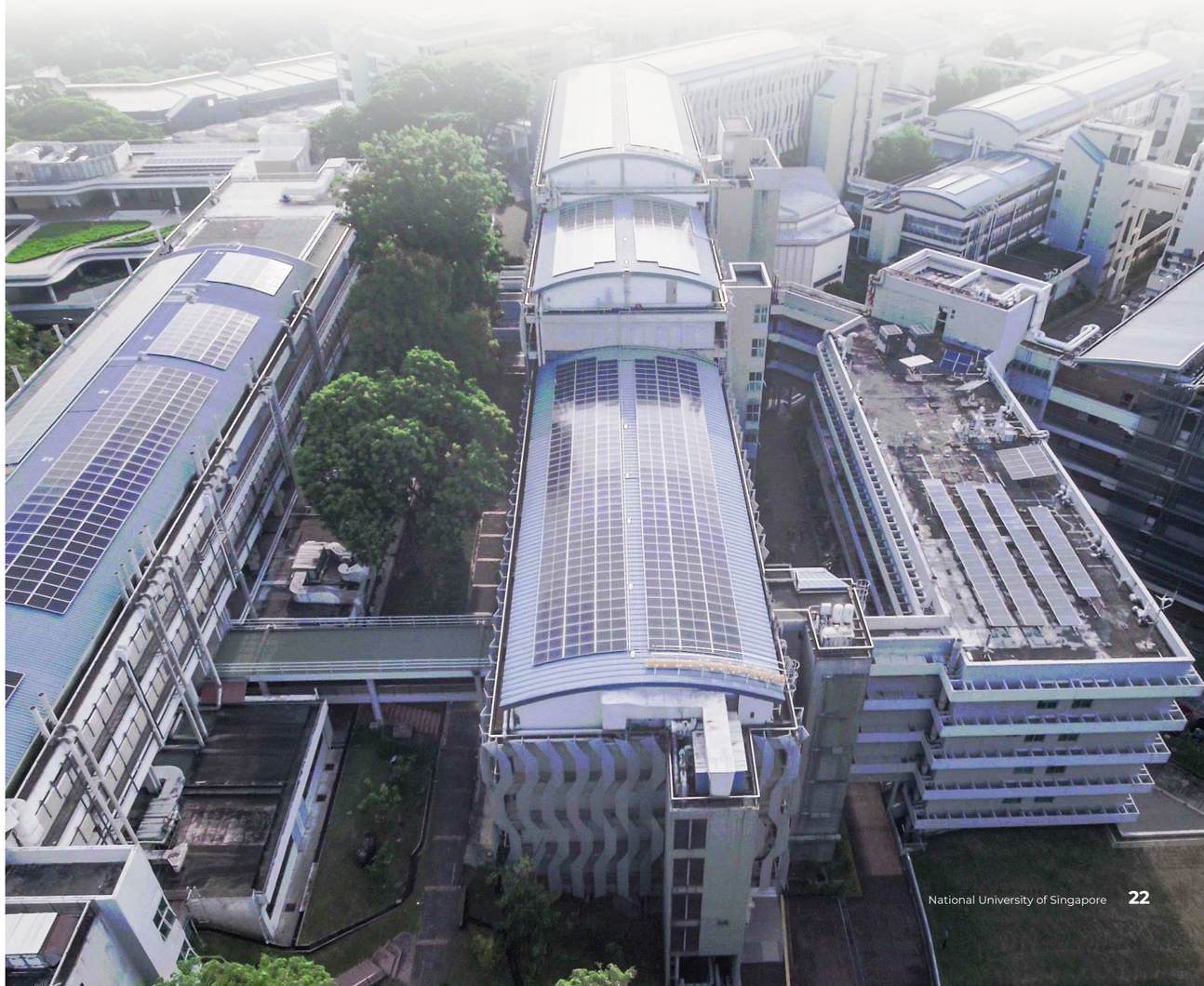
Commissioning 9.2MWp of Solar PV Capacity

We are deploying solar panels on the rooftops of buildings across Kent Ridge campus, supplying on-site renewable energy to replace approximately 4% (11 GWh; 4.5 $ktCO_2e$) of our total electricity consumption, saving about $2.4 million a year. This contributes to our target 7.5 $ktCO_2e$ reductions by 2025. We have invested $16 million in these solar panels, which will be progressively switched on by 2024.

11 GWh
4.5 $ktCO_2e$
$2.4 million

We are striving to maximise our solar photovoltaic capacity to 14 MWp by 2030 through higher efficiency solar panel technology and increased solar panel rooftop coverage.

▾ Solar panels on rooftops of buildings in the College of Design and Engineering



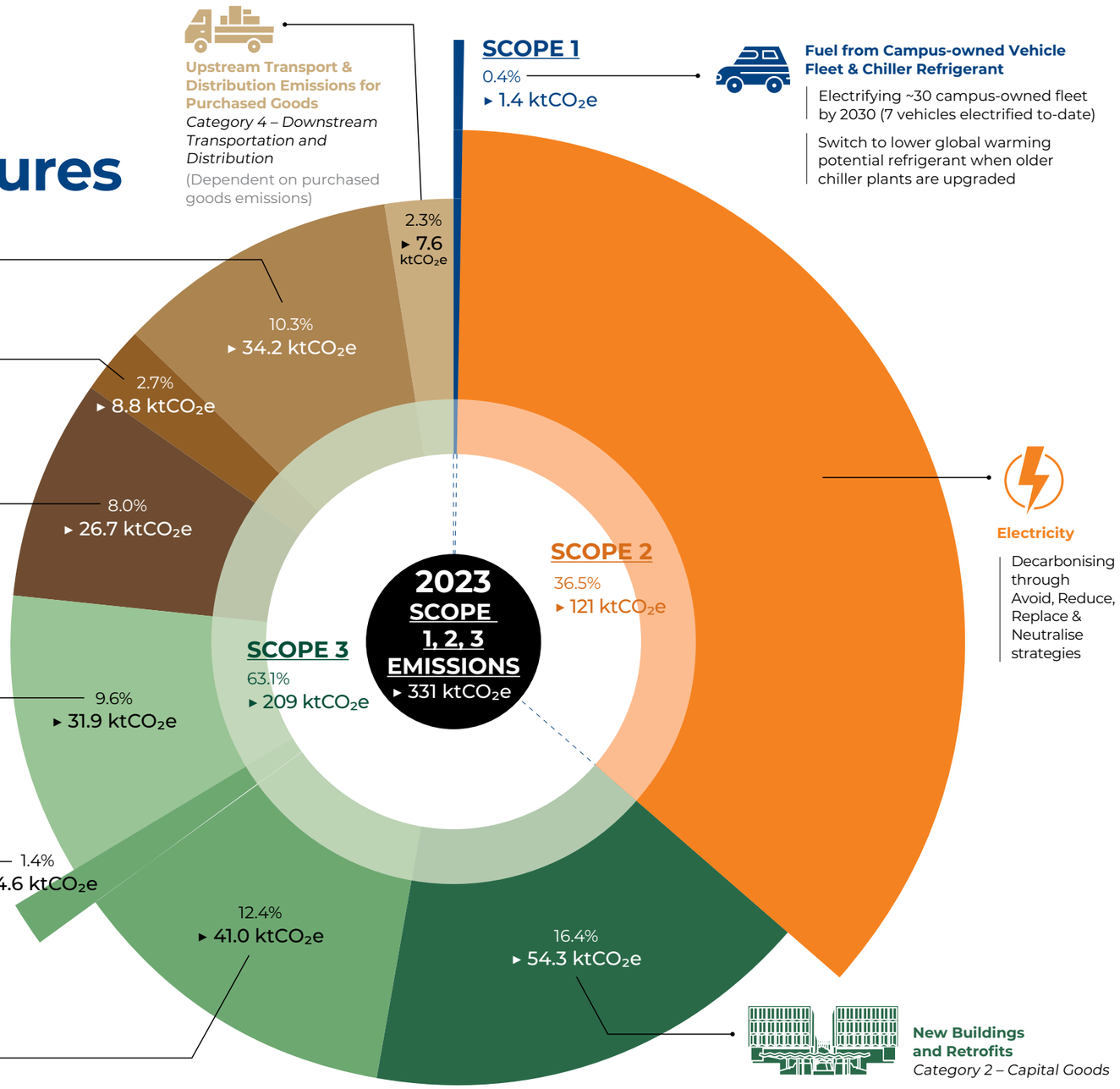
List of GHG Emissions Reduction Projects

This summarises the estimated reductions that we have planned towards achieving our goal to achieve our 30% reduction in Scope 1 and 2 emissions by 2030, and current planned projects to-date to achieve them.

Approach	Measures	Project Description	Estimated Annual $ktCO_2e$ & GWh Savings
Avoid	Setting Stretched Design Targets for New Buildings & Retrofits	Setting high energy performance targets, e.g. Yusof Ishak House to be our next Net Zero Energy Building in 2024	11 $ktCO_2e$ (27 GWh)
	Post-Commissioning Building Checks	Ongoing checks and energy optimisations of buildings after being commissioned to maintain energy performance	
Reduce (campus-wide)	Chiller Plant Optimisation, Upgrading & Consolidation	▸ Ongoing optimisations of existing chiller plants ▸ Upgrade chiller plant at University Cultural Centre by 2025 ▸ Upgrade chiller plants at COM2 and I3 by 2027 ▸ Upgrade chiller plant at University Town by 2030	3 $ktCO_2e$ (7 GWh)
	Campus Wide LED Replacement	▸ Invested $4.4 million for the first batch of buildings, i.e. MD6, University Hall and Sport Facilities by 2025 ▸ Developing a replacement plan for the rest of the campus	6 $ktCO_2e$ (14 GWh)
Reduce (building type)	Green Labs *Reducing from airside (e.g. air change rates), cooling and equipment & lighting.*	▸ Ongoing manual optimisations of setpoints and air changes rates in MD6 and MD1; to expand to the other energy-intensive buildings ▸ Embarking on detailed diagnosis of MD6 cooling tower to develop a suitable intervention to increase efficiency ▸ Carrying out campus-wide replacement of deep freezers by 2025, investing around $2 – 3.5 million ▸ Conducting a feasibility study to dynamically modulate air change rates in MD6 by 2025, before scaling up to more lab buildings ▸ Other initiatives being considered at MD6 in the next 3 years: dessicant technology trial for dehumidification, study of other key lab equipment like fumehoods, and vertical wind turbine trial for energy recovery	6 $ktCO_2e$ (15 GWh)
	Green Teaching Facilities & Offices *Reducing from ventilation, lighting and BMS optimisations, dynamic control of lecture theatres*	▸ Ongoing manual optimisations of setpoints and lighting ▸ Conducting a pilot on dynamic control of air-conditioning for lecture theatres by 2024, before scaling up to lecture theatres campus wide and conducting a similar pilot for seminar rooms	3 $ktCO_2e$ (7 GWh)
	Green Hostels *Reducing from air-conditioning (e.g. operating hours) and lighting; behaviour change*	▸ Developing Green Hostels guidelines, that will include setting the norm of energy saving behaviours	2 $ktCO_2e$ (5 GWh)
	Green Data Centres	▸ Launched the world's first tropical climate data centre testbed in 2023, Sustainable Tropical Data Centre Testbed ▸ Developing a target Power Usage Effectiveness (PUE) by 2024, and concurrently improving it by replacing and upgrading infrastructure like in-row cooling systems and uninterruptible power supplies	1 $ktCO_2e$ (2 GWh)
Replace	Campus Rooftop Solar PV	▸ Invested $16 million for 9.2 MWp of solar PV capacity, to be switched on by 2024 ▸ Embarking on studies for the next phase to maximise total capacity to 14 MWp by 2030	7 $ktCO_2e$ (18 GWh generated)
	Overseas Renewable Energy and Other Renewable Technologies	▸ Explore Virtual Power Purchase Agreements from 2025 onwards ▸ Exploring feasibility of emerging renewable technologies, such as hydrogen	24 $ktCO_2e$ (59 GWh generated/procured)
		TOTAL SAVINGS BY 2030	**63 $ktCO_2e$ (153 GWh*),** reducing emissions to 79 $ktCO_2e$ from BAU of 142 $ktCO_2e$ in 2030

* *Numbers do not add up to 153 due to rounding*

2023 Value Chain Emissions & Intervention Measures



Upstream Transport & Distribution Emissions for Purchased Goods
Category 4 – Downstream Transportation and Distribution
(Dependent on purchased goods emissions)

Upstream Fuel & Energy Emissions
Category 3 – Fuel- and Energy-Related Activities
(Dependent on Scope 1 fuel and Scope 2 electricity emissions)

Commuting
Category 7 – Employee Commuting

- Electrified campus shuttle buses in 2022

Tenants' Electricity Consumption
Category 13 – Downstream Leased Assets

- Introduce green lease for food & beverage tenants by setting energy and waste reduction targets

Air Travel
Category 6 – Business Travel

- Encourage switch from business / first class to economy class for staff travel

Waste
Category 5 – Waste in Operations

- Reducing material wastage in our value chain towards closing waste loops

Purchased Goods & Services
Category 1

- Launched Sustainable Procurement Framework

Fuel from Campus-owned Vehicle Fleet & Chiller Refrigerant

- Electrifying ~30 campus-owned fleet by 2030 (7 vehicles electrified to-date)
- Switch to lower global warming potential refrigerant when older chiller plants are upgraded

Electricity

- Decarbonising through Avoid, Reduce, Replace & Neutralise strategies

New Buildings and Retrofits
Category 2 – Capital Goods

- Reduce embodied carbon through upfront material optimisation in the design phase, and adaptive reuse by retaining existing building elements such as walls, columns and beams during retrofits (e.g. SDE1 and SDE3)

Note: Percentage numbers under the different categories of Scope 3 may not add up due to rounding.

2023
Scope 1 – 3 emissions:
▸ 331 ktCO₂e

Scope 3 emissions represent indirect emissions incurred as part of value chain activities, measuring our impact beyond NUS. In 2023, our Scope 1 and 2 emissions contributed about 37% while Scope 3 emissions contributed 63%. The diagram reflects our emissions for 2023 and summarises our measures to address them.

In 2024, we will assess the potential reduction interventions across our Scope 1, 2 and 3 emissions by calculating their abatement potential and costs. With this, we will develop a plan to address our value chain emissions.

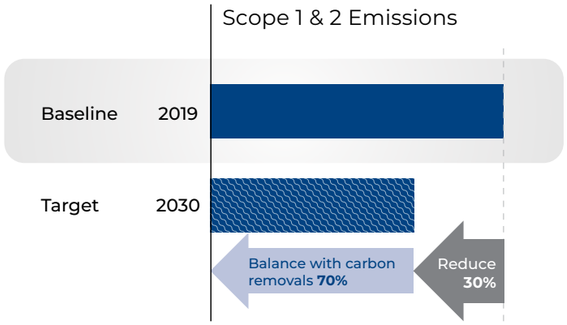
In 2023, we launched a Sustainable Procurement Framework where key guiding principles include avoiding unnecessary purchases, considering total cost of ownership, sourcing sustainable products and incorporating 10% quality scoring on ESG criteria, for procurement evaluation. We have identified five procurement categories that have the highest emissions as our focus areas: (1) laboratory consumables and equipment, (2) building construction & maintenance, (3) software & computer equipment, (4) management, business & administrative services, and (5) food catering.

Carbon Neutrality *versus* Net Zero

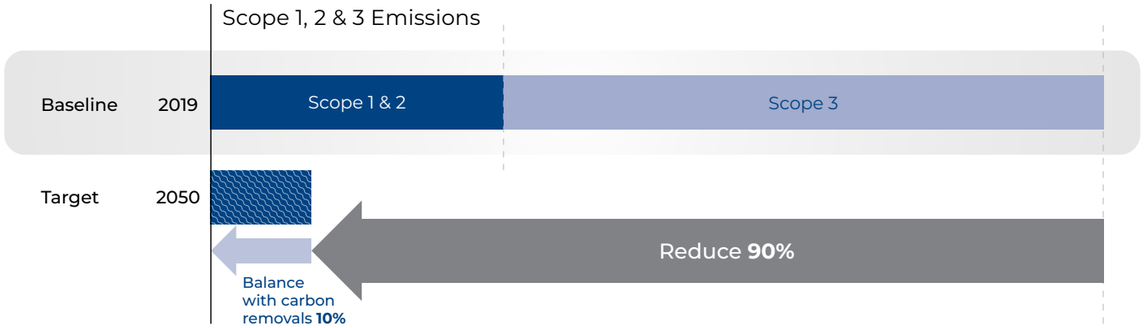
Carbon neutrality means to reduce Scope 1 and 2 emissions and counterbalance the residual emissions by procuring carbon credits. There is no requirement on the minimum to reduce first. For us, we place reductions as a priority and procuring carbon removals as a last resort.

Guided by an established target-setting methodology, setting and achieving a net-zero target is more stringent – it includes Scope 3 emissions and specifies reduction targets. It requires reducing Scope 1, 2 and 3 emissions by more than 90% first, and counterbalancing the remaining 10% through carbon removals. Achieving net zero requires significant investment and accelerating the commercial viability of other renewable energy sources like hydrogen, decarbonising our local grid and decarbonising our value chain such as making low carbon building construction and adaptative reuse a norm.

▼ **Illustration of Carbon Neutrality (e.g. NUS)**



▼ **Illustration of Net Zero**



Professor Tan Eng Chye
NUS President

"Building climate resilience is equally important as the imperative to decarbonise. We are harnessing our faculty expertise to develop evidence-based insights to support our master planning process, infrastructure development and operations to improve the outdoor thermal comfort of our campus."

Defend Against Climate Change

Towards a Cool NUS

Professor Wong Nyuk Hien

Principal Investigator of Cool NUS - BEAM project, College of Design and Engineering

"With our campus-wide network of sensors, the Cool NUS-BEAM project demonstrates how we take an evidence-based approach for microclimate assessment and mitigation to improve outdoor thermal comfort."

▲ University Campus Infrastructure staff and College of Design and Engineering researcher studying data from a weather station located on Innovation 4.0 building rooftop (above), one of the 49 sensors that collect environmental weather data.

Establishing Our Baseline Condition

Our Microclimate Sensor Network

▾ A virtual model of NUS Kent Ridge campus showing part of the sensor network consisting of 40 weather stations, 6 infrared cameras and 3 meteorological towers.

Weather Station
Measures microclimate data at 1-minute intervals

Infrared Camera
Measures surface temperature changes due to solar exposure or surrounding heat emissions

Meteorological Tower
Measures microclimate data across vertical heights of up to 12 meters tall

To adapt to rising temperatures because of climate change, we use an evidence-based approach to ensure outdoor areas remain thermally comfortable.

In partnership with researchers from the College of Design & Engineering, we completed the installation of 49 high-resolution sensors around the Kent Ridge campus in 2023, marking the densest deployment of a sensor network—and the first for any campus—in Singapore.

These sensors measure our Kent Ridge campus' microclimatic conditions across various urban environments and heights. The microclimate data (e.g. temperature, wind speed and direction, solar radiation, humidity) will allow us to establish and update our 2019 baseline outdoor thermal comfort conditions with more granular environmental data by 2024, and subsequently assess the effectiveness of mitigation measures for wider implementation. The insights will also enable us to better plan and design our campus infrastructure development to be more resilient against rising temperatures.

Our Strategy

Minimise, Reduce & Cope

Minimise At Campus-Level And Beyond

In the long term, we will review the masterplanning of our campus (e.g. location of buildings and their orientation) to facilitate natural wind flows for ventilation and minimise man-made heat sources.

Reduce At Building-Level

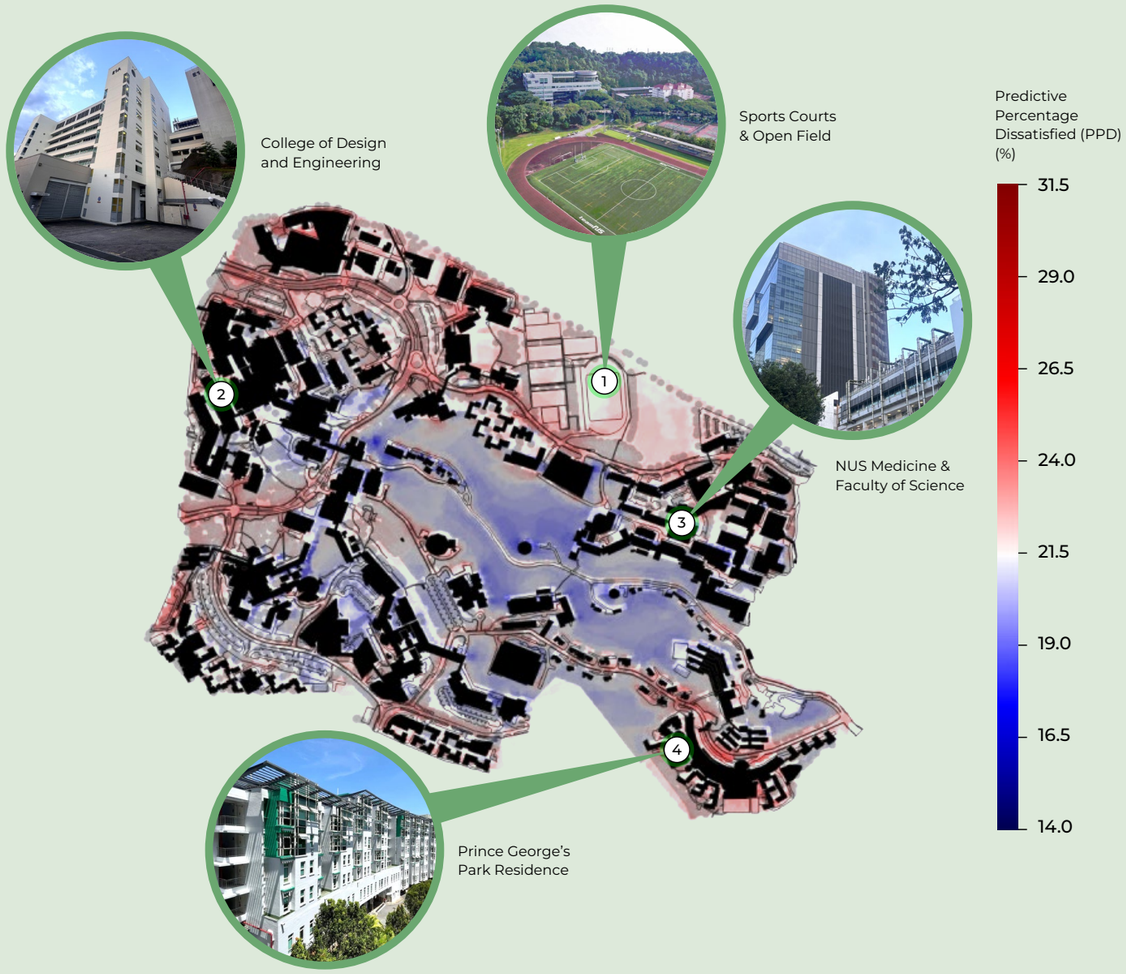
For our existing infrastructure, reduce heat absorption and accumulation by applying cool paint on buildings and road surfaces, and improve shading by expanding campus greenery and other shading infrastructure.

Cope At Individual-Level

Facilitate our community to adapt to the outdoor temperatures. For example, we have a Yellow Ceiling Network that provides seamless sheltered pathways across campus buildings and increased water drinking points. Our staff dress code policy also encourages staff to dress light.

▶ REDUCE

Addressing Our Campus Hotspots



▲ An outdoor thermal comfort map of NUS Kent Ridge Campus showing distribution of Predictive Percentage Dissatisfied (PPD) at midday in July 2019 with four key hotspot areas highlighted. July was one of the warmest months in NUS in 2019 coinciding with the Southwest Monsoon period.

The Predictive Percentage Dissatisfied (PPD) is the percentage of occupants that would feel thermally dissatisfied in an outdoor space. This indicator is computed based on quantitative measurements (e.g. temperature, solar radiation, wind speed) and qualitative measurements based on a local survey where respondents feedback on their level of thermal comfort in an outdoor space.

Our 2019 data showed that there were four key hotspot areas on campus:

Hotspot Areas			
Sports courts & open field	College of Design & Engineering	NUS Medicine & Faculty of Science	Prince George's Park Residence
What Makes It A Hotspot?			
Hard pavement at outdoor sports court; open space with minimal shade	Dense buildings with high heat absorption; high amount of hard pavement		
Planned/ Potential Mitigation Measures			
▸ Implement cool paint on the hard courts by 2025 ▸ Introduce more shade through progressive greenery planting	▸ Implement cool paint to approximately 50% of CDE's building facades by 2024 ▸ Selective implementation of cool paint by 2024	▸ Explore more permeable surfaces (e.g. shrubs, gardens) and greenery shading ▸ Further solar irradiance and wind study to improve outdoor thermal comfort	▸ Planning cool paint on selective building facades with highest solar radiation and existing hard courts ▸ Planning for more permeable surfaces and greenery shading

▶ REDUCE

Assessing How Greenery Impacts Outdoor Thermal Comfort

We have pledged to plant 100,000 trees by 2030, contributing 10% to Singapore's OneMillionTrees movement. Since November 2018, we have planted 47,552 trees.

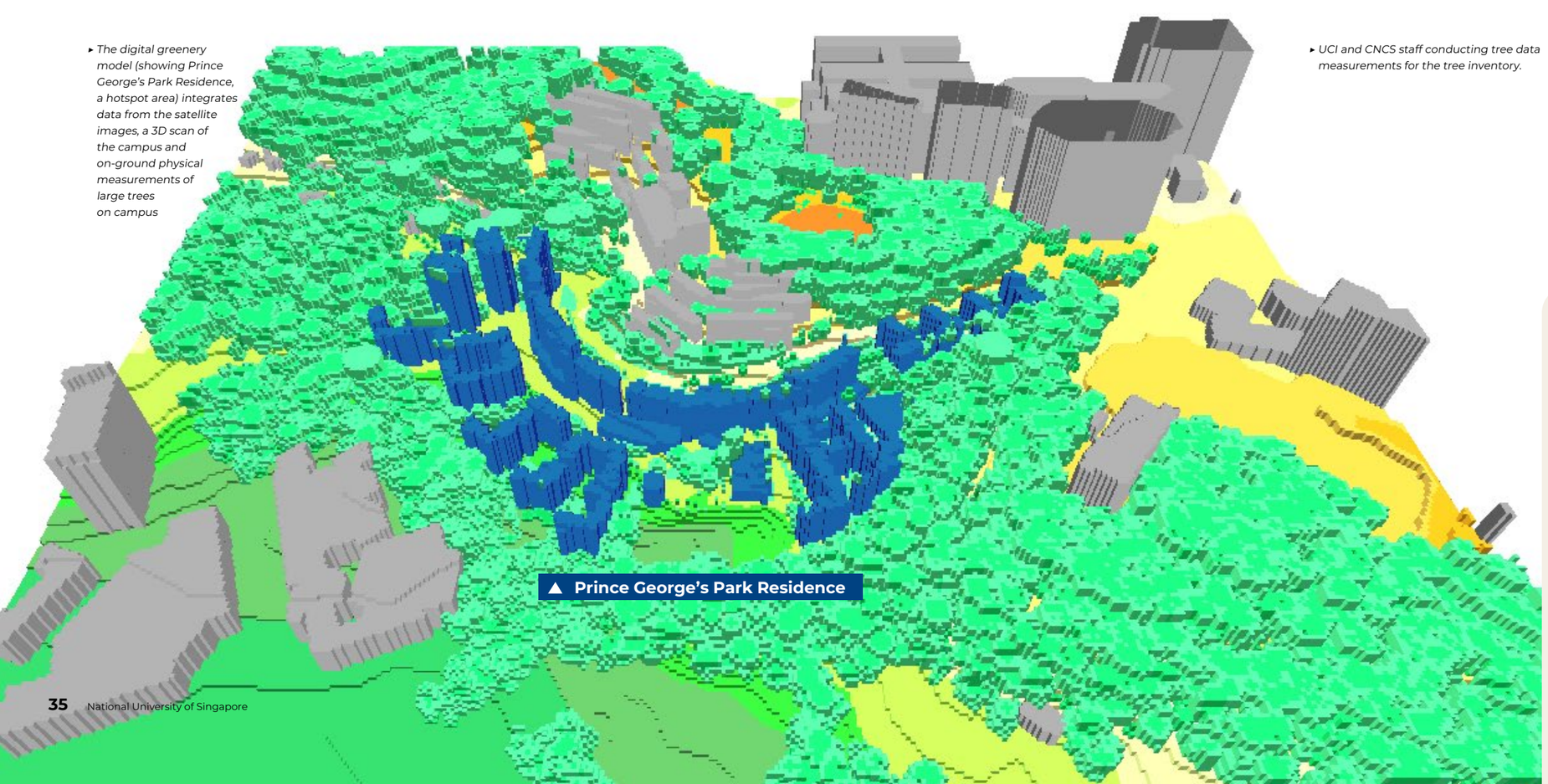
As greenery could improve outdoor thermal comfort, such as cooling through shading and evapotranspiration, we are studying its benefits with a digital greenery model.

This model will analyse how the microclimate and outdoor thermal comfort have changed since the start of our tree planting efforts. At a granular level, we will study how the different plant species and planting approaches influence outdoor thermal comfort to guide our planting efforts.

Digitising Campus Tree Inventory

The Centre for Nature-based Climate Solutions (CNCS) and UCI have created a geospatial inventory of all trees on Kent Ridge campus. This digitised layer will keep a comprehensive record of the type of tree species and its physical parameters (e.g. height, girth), and plot locations of new tree saplings for monitoring. This layer will serve as input to study its impact on outdoor thermal comfort. This project has also quantified the amount of carbon sequestered through trees on the Kent Ridge campus.

▸ *UCI and CNCS staff conducting tree data measurements for the tree inventory.*



▸ *The digital greenery model (showing Prince George's Park Residence, a hotspot area) integrates data from the satellite images, a 3D scan of the campus and on-ground physical measurements of large trees on campus*

▲ **Prince George's Park Residence**

Mr Steve Teo
Centre for Nature-based Climate Solutions

"With NUS' ambition to plant 100,000 trees, digitising the campus' tree inventory will aid in managing it, inform planting approaches to improve greenery coverage and provide an interesting dataset for more collaborations with our research community."

Dematerialise

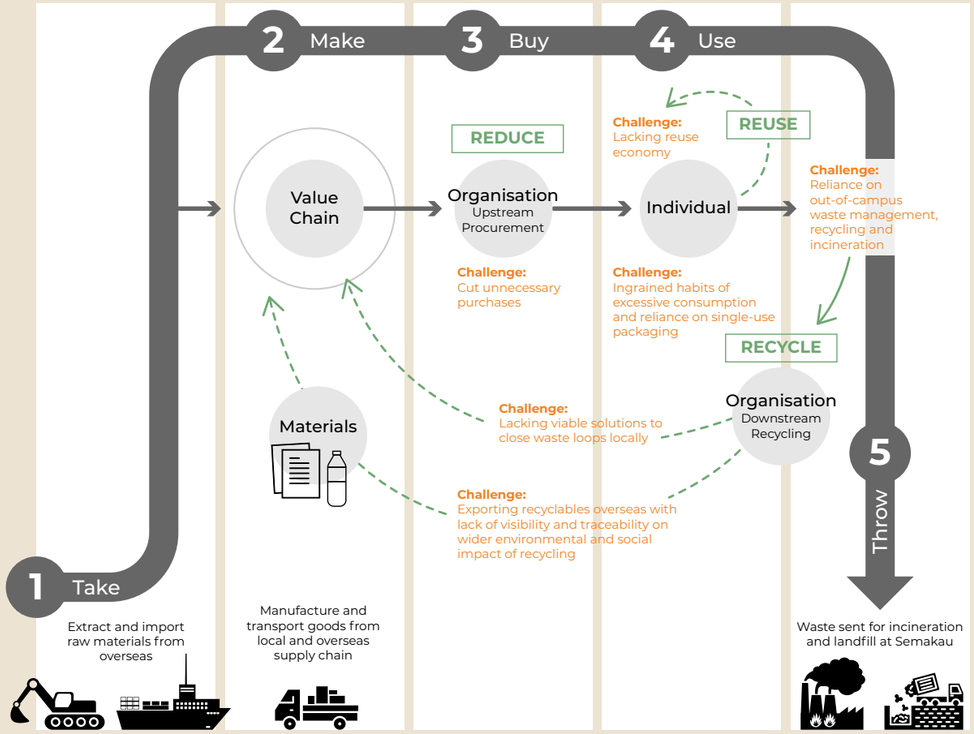
Towards Zero Waste I Sustainable Procurement

Mr Loo Deliang
Head, Sustainability Strategy Unit, University Campus Infrastructure

"Waste does not go away and we cannot recycle everything. Sending our recyclables to responsible recyclers is important but also costly. Even so, there will be downstream environmental and social impact beyond our shores. Reduction should be our priority in the pursuit of Zero Waste."

▲ Faculty of Science students and NUS Zero Waste Taskforce member who developed a prototype using Optical Character Recognition technology to enhance the waste weight data collected from waste trucks.

Doing More with Less: Intractable Challenges of Going Zero Waste



The environmental and social impacts of material extraction, production and consumption are extensive and extends beyond our shores. Like decarbonisation, there is a need for dematerialisation – improvement in material efficiency and reduction in materials demand.

The challenges of going Zero Waste involve systemic value chain, organisational, and individual factors. As a system, we operate within a linear economy (take-make-buy-use-throw) where waste (e.g. food waste, plastics) is not viewed as a resource and is hence disposed of.

Within an organisation, the tendency is to focus on downstream recycling, rather than minimising waste generation at source through upstream sustainable procurement. Recyclables are also exported overseas without adequate consideration whether the value chain processes in the receiving country have negative environmental and social impact.

At the individual level, convenient single-use packaging makes us heavily reliant on disposables for our daily needs.

2023 Performance

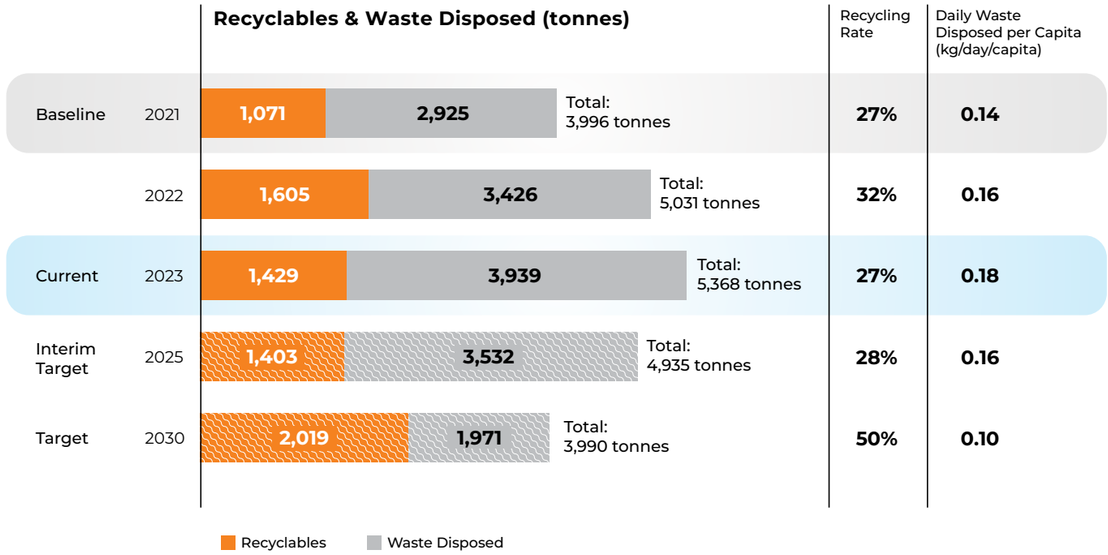
Embarking to Close Waste Loops

Our targets are to establish Zero Waste precincts where we shape positive norms and practices of Reduce, Reuse and Recycle (3Rs), aiming for a 50% recycling rate and 30% reduction in daily waste disposed per capita by 2030. To do so, we will take a holistic upstream and downstream approach to manage waste.

In 2023, our recycling rate dropped to 27% from 32% in 2022 due to the cessation of the National Environment Agency's (NEA) food waste recycling at Ulu Pandan's food waste and sewage co-digestion plant in September 2023 and increase in waste disposed. Our daily waste disposed per capita increased to 0.18 kg/day/capita from 0.16 kg/day/capita in 2022.

The decrease in recycling tonnage from 1,605 tonnes in 2022 to 1,430 tonnes in 2023 was contributed by a 257 tonnes decrease in food waste recycled while the rest of our recycling streams increased by 83 tonnes compared to 2022. This tonnage of food waste recycled is expected to drop to as low as 20 tonnes in 2024 when the decline is registered for the full reporting year. The increase in waste disposed from 3,426 tonnes in 2022 to 3,939 tonnes in 2023 was due to food waste diverted for disposal and more food catering activities on campus.

Our interim target is to achieve a recycling rate of 28% and daily waste disposed per capita of 0.16 kg/day/capita by 2025, by maximising recycling and reducing our total waste generated. We will reduce wastage from food catering, maximise food waste recycled and repurpose other plastic waste streams into road paving material for campus roads.



Closing Downstream Plastic and Food Waste Loops

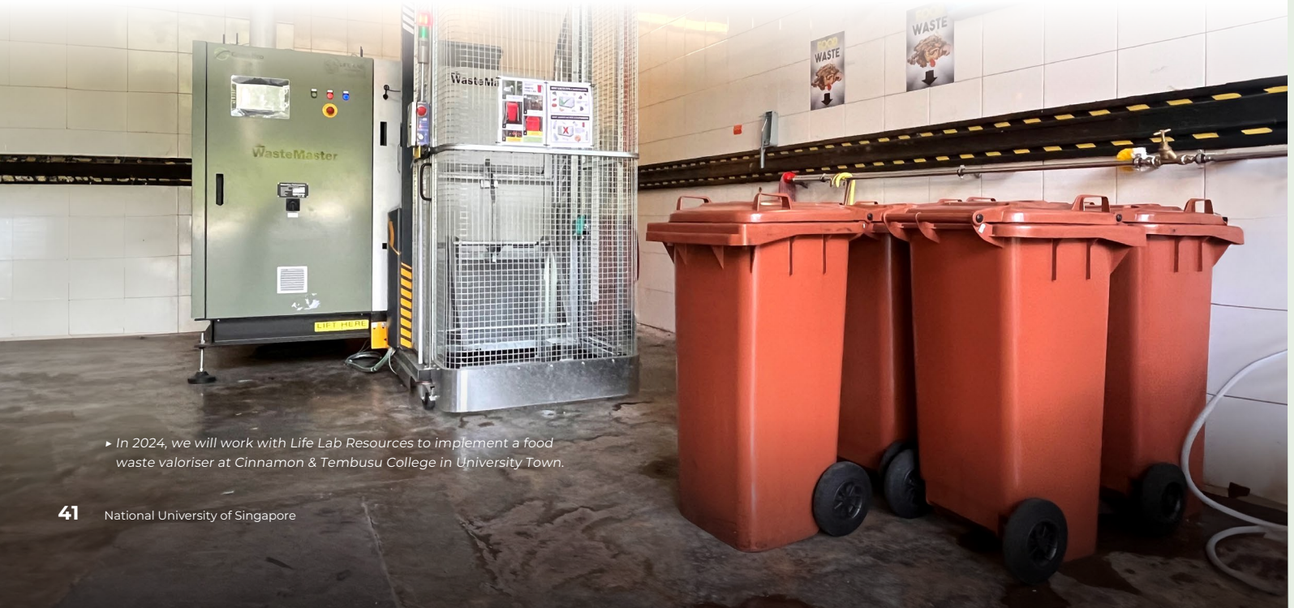
To manage our waste downstream, we are currently recycling all commercially viable waste streams, procuring vendors with track record of responsible end-of-life management of recyclables, and testing ways to close waste loops on campus.

In 2023, student members of our NUS Zero Waste Taskforce placed trackers in plastic recyclables (PET-1 and HDPE-2) on campus. We discovered that our plastic recyclables were sent to Malacca where they were likely processed in facilities with sub-standard environmental controls that negatively affect the local environment, workers and communities.

To ensure that our recyclables are processed responsibly, we are contracting an established vendor to turn our PET-1 bottles into food grade rPET-1 resins to close the plastic waste loop. Considering the immense industrial effort and multi-step processes to properly recycle a PET-1 bottle, the sensible thing to do within our means is to reduce our excessive use.

We are also collaborating with industry and academic partners to test and implement emerging solutions for other plastic streams, namely Low-density Polyethylene (LDPE-4) and Polypropylene (PP-5). We are developing plans to convert them into bitumen for road paving while ensuring its structural integrity, safety and environmental performance. When fully implemented, these additional streams will increase the recycling tonnage by up to 8 tonnes yearly.

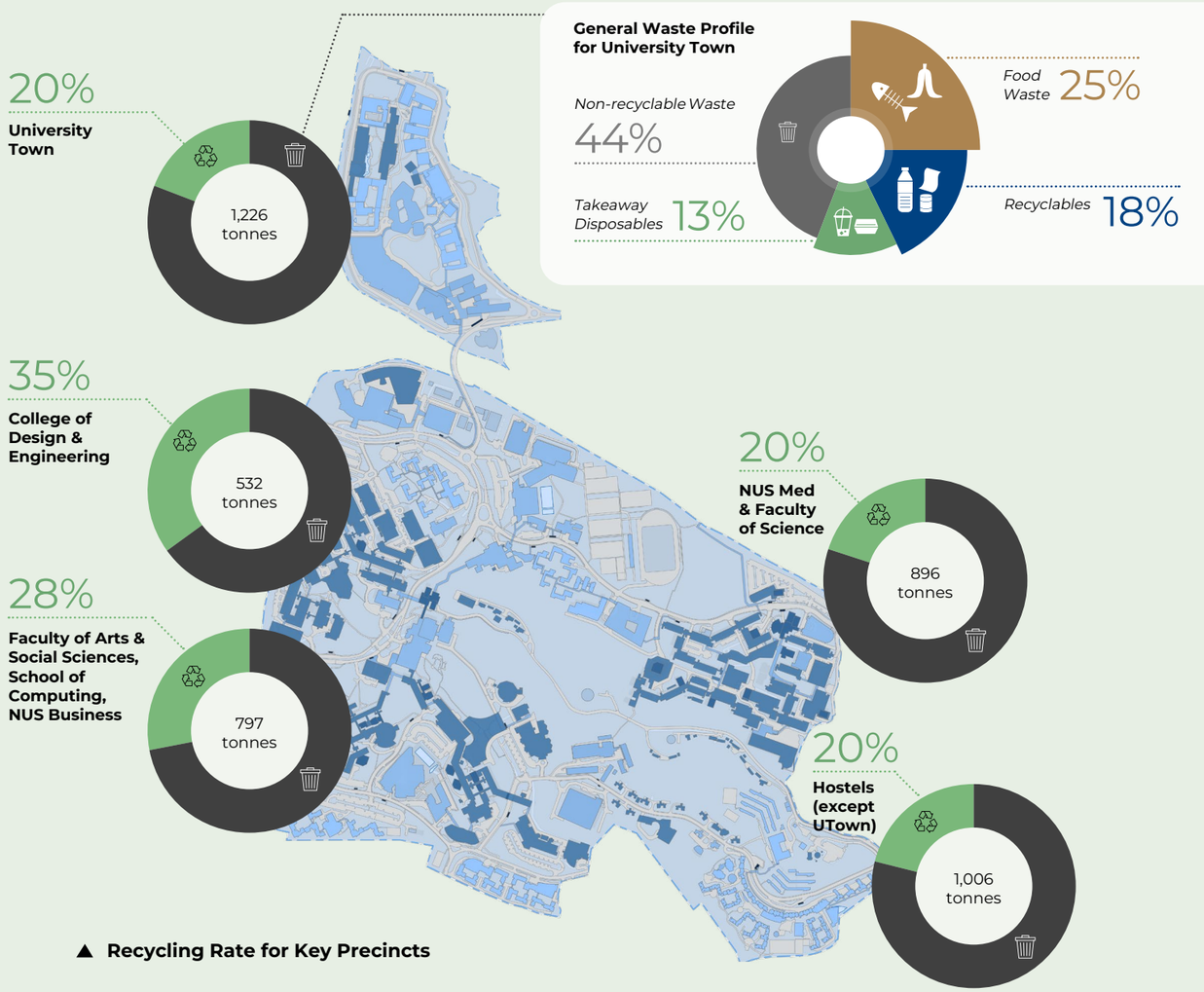
To partially mitigate the drop in food waste recycling, University Campus Infrastructure (UCI) will be maximising onsite food waste processing by implementing a hub-and-spoke model to transport food waste from various canteens across the campus to our three aerobic digestors and one valoriser. Food waste sent to the aerobic digestors will be turned into compost for campus landscaping while those sent to the valoriser will become high protein substrate for aquaculture feed testing. We plan to further increase our food waste recycling efforts through the upcoming Tuas Nexus Integrated Waste Management Facility which is due to open in 2026.



▸ *In 2024, we will work with Life Lab Resources to implement a food waste valoriser at Cinnamon & Tembusu College in University Town.*

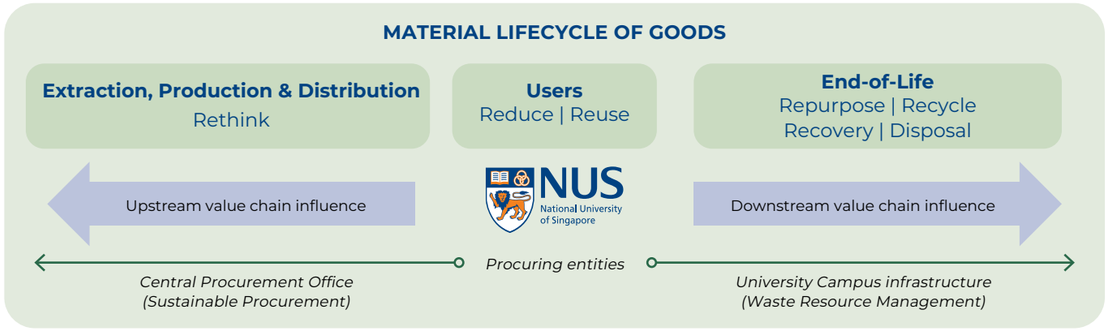
Recycling Rate in Kent Ridge Precincts

Our waste and recyclables are collected from precincts across the campus by NEA-licensed vendors, providing granular, precinct-level data. In 2023, University Town precinct generated the largest amount of waste and recyclables, with a recycling rate of 20%. A waste composition study conducted in University Town in 2022 highlighted opportunities to divert waste from incineration, by reducing food waste (25%), promote sorting behaviour to ensure recyclables are placed in recycling bins (18%) and encourage reuse to reduce takeaway disposables (13%).



▲ **Recycling Rate for Key Precincts**

Reducing Waste Upstream: Managing Material Lifecycle



We are taking a material lifecycle approach to reduce waste across various operating functions, from procurement, administrative services to downstream waste operations. Looking upstream, we will reduce waste upfront by buying only what is necessary and promoting less material wastage in our value chain.

In 2023, we introduced the NUS Sustainable Procurement Framework that integrates environmental, social and economic considerations into our procurement processes. The guiding principles under this framework include reducing unnecessary purchases and considering total cost of ownership.

As a small step, we have phased out the use of packaged water, whether bottled or in a carton, during university meetings and indoor events from October 2023. We have also identified procurement hotspots and will be addressing them in 2024.

Hotspot: Software & Computer Equipment

- Reviewing fixed assets retirement policy to extend the useful life of laptops from 3 years before they are retired.

Hotspot: Catering

- Reviewing ways to reduce over-ordering

Mr Pang Chong Ning
Chief Procurement Officer

"We have woven sustainability requirements into our procurement processes and guidelines to reduce resource and material wastages, influencing sustainable practices across our supply chain."

NUS Explains

Towards Zero Waste

Zero waste is not an end outcome where literally no waste is generated or disposed.

It is an ambition to minimise waste sent for incineration as far as possible. This is achieved by applying a waste hierarchy to reduce consumption, encourage reuse, repurpose for a second life with an objective to close waste loops, and recycle key waste streams responsibly.

WHAT IS ZERO WASTE?

REDUCE — Reduce unnecessary consumption such as takeaway disposables or excess food.

REUSE — Encourage reuse where possible, e.g. Bring-Your-Own containers.

REPURPOSE — For a second life to close waste loops.

RECYCLE — Key waste streams.

INCINERATE & DISPOSE

From Classroom Ideas to Real World Problem Solving

Applying Optical Character Recognition for Data Accuracy

Reliable and verifiable data is important to help us track our progress and for programme planning. While we had worked with our waste collection vendor to deploy an RFID system on waste trucks for granular waste weight, there were occasional errors due to conflicts from RFID tags within the waste stream (e.g. e-commerce packaging).

A group of students from the Faculty of Science developed a prototype in October 2023 to deploy optical character recognition technology for waste truck drivers to take a photo of the waste weight displayed on their dashboard screen, which is then processed and stored in a cloud-based system. The students are now working on a mobile app based on this prototype to be integrated into campus waste collection operations, with plans for deployment in 2025.

▾ Faculty of Science student explaining how optical character recognition technology helps improve data accuracy

Co-creating Projects with Faculty and Students

The Zero Waste Taskforce brings together staff, students, alumni and industry partners and their diverse expertise to contribute towards a Zero Waste campus.

▾ Quarterly meetings with the Taskforce include exchanges with the industry, such as a sharing by Mr Edward Chia, Managing Director of Life Lab Resources (front row in green) on strategies and technologies to manage food waste.

Mr Tommy Cheong

Designer at Design Incubation Centre

Tommy is the designer of Recycle Right bins, and is contributing to a Sustainability Resource Pack (Zero Waste Edition) for schools, comprising teaching materials, recycling bin designs and publicity materials.

Dr Eunice Ng

Fellow and Resident Fellow at Ridge View Residential College (RVRC)

Dr Ng leads a course where students get hands on experience in collecting and using primary waste data to pilot ideas to contribute to Zero Waste within the RVRC community.

Dr Elliot Law

Senior Lecturer at Engineering Design & Innovation Centre

Dr Law supervises student projects on sustainability in the Innovation & Design Programme which is offered as a Second Major or Minor to all students in NUS.

Ms Nadya Heryanto

NUS Accountancy undergraduate and co- President of NUS Students' Association for Visions of the Earth (SAVE)

Nadya is leading the NUS SAVE Sustainability Fund to provide grants to students to implement their green ideas on campus.

Reinforce A Resource Conscious Culture by Activating Touch Points Across UTown

Reuse at hostels: Checkout Drives

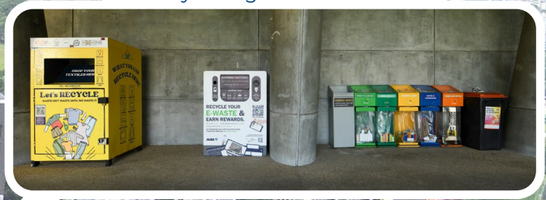
Recycle Right bins

Major F&B outlets where food waste is sorted for recycling

▲ **Food Waste Valoriser**

▲ **Resource Sorting Station**

▼ **Recycling Hub (from L to R):** Textile Bin, E-waste Bin, Recycle Right bins



▲ **Aerobic Digester**

▼ **Marketplace on uNivUS:** uNivUS, a one-stop platform for various NUS services, is introducing Marketplace for students to buy, sell and exchange items securely

▶ **Events:** Reducing over-ordering for food catering

Dialogue:

Galvanising Change

Mr Edric Ong

NUS Alumni (CDE Class of 2024) and NUS Zero Waste Taskforce member

We embarked on an investigative journey to uncover where our recyclables go beyond Singapore, with the intention to raise awareness on the plastic problem and the importance to reduce its consumption and mitigate downstream pollution concerns."

▲ Edric Ong, NUS Zero Waste Taskforce student advocate, giving an introduction at the panel discussion 'Life of a PET Bottle' in September 2023.

Galvanising Change

The journey to tackle climate change and sustainability is a long-drawn marathon over years of collective action. As the proverb goes, “If you want to go fast, go alone. If you want to go far, go together.” To achieve our vision for a smart, sustainable and resilient campus, embedding sustainability goals and action involving all levels of our organisation is key to enable organisational and behavioural change.

Using an Inform-Consult-Partner approach, we are involving all levels of our community in this transition, harnessing expertise of our researchers to drive innovation using the campus as a living laboratory, administrative and professional staff to implement sustainability best practices, faculty staff to shape next generation of change makers, and students to rally behaviour change among their peers.

- **Inform:** Broadcast across a variety of digital, physical and media platforms as well as face-to-face engagements to increase awareness of Campus Sustainability Roadmap 2030, key programmes and campus sustainability targets
- **Consult:** Regular engagements for advisory input from research expertise and leadership guidance on Campus Sustainability Roadmap 2030
- **Partner:** Co-create with diverse network of strategic partners to drive Design, Defense, Decarbonisation, Dematerialisation and Dialogue efforts

Inform

Platforms	Frequency	Stakeholder Groups	Details
Digital Campus Sustainability website	Ongoing	All staff and students, public	Updates on campus sustainability efforts, including Campus Sustainability Roundup annual disclosures since 2021
Digital Campus Sustainability Roundup	Annually	All staff and students	Annual environmental disclosures on campus sustainability progress since 2021
Digital Internal email letters and circulars by Deputy President of Administration	Quarterly	All staff	Sharing on the state of campus sustainability progress and staff engagement efforts, e.g. DPA letter ‘NUS Accorded the President’s Award for the Environment’ (Oct 2023).
Digital University-published reports	Annually	All staff and students, public	University-level sharing on sustainability efforts across Education, Research and Administration clusters (i.e. including NUS Sustainability Report and NUS Impact Report)
Digital NUS Sustainability Feature e-newsletters Live Green@NUS	As and when	All staff and students	To raise visibility on campus sustainability efforts e.g. Campus Sustainability Roadmap 2030 (Apr-May 2023), President Award for Environment 2023 (Oct-Dec 2023), ERC Rooftop Edible Garden managed by NUS SAVE (Mar-Apr 2024)
Media NUS News	As and when	All staff and students, public	News update e.g., President’s Award for Environment 2023 (Oct 2023)
Physical Publicity e.g., large wall displays and internal shuttle bus advertisements	Ongoing	All staff and students, public	Raise awareness on Campus Sustainability Roadmap 2030
Face-to-face Staff orientation briefing	Monthly	New professional and administrative staff across all levels and departments in university	Started in January 2024, sharing on NUS Campus Sustainability Roadmap 2030 monthly as of March 2024
Face-to-Face Meetings	As and when	Global universities and public agencies	Hosted global stakeholders on campus to share NUS Campus Sustainability Roadmap 2030, exchange ideas and learnings, and support capacity-building as a leading university . Institutions hosted this year include Singapore General Hospital (July 2023) and Peking University (Jun 2023).
Face-to-Face NUS Sustainability CONNECT event	Annually	All staff and students, public	Sharing on sustainability-related issues (Panel discussion on “Life of a PET1 Bottle” (Sep 2023)
Face-to-Face Sustainability Officers, Leaders and Representatives (SOLAR) Panel series	Bi-annually	All staff and students	Partnered NUS SAVE student group to host events to improve sustainability literacy, e.g. ‘Grasping the Landscape of Sustainability Reporting’ (April 2024)

Consult

Platforms	Frequency	Stakeholder Groups	Details
University Level University Sustainability and Climate Action Council	Quarterly	NUS President and senior leadership across Education, Research, Campus Operations and Administration and Community Engagement	Update progress of Campus Sustainability Roadmap and identify opportunities for collaboration across clusters
Cluster Level Briefing to Deputy President of Administration (DPA)	Quarterly	DPA and key representatives across management and Admin cluster	Update on cross divisional projects under Campus Sustainability Roadmap 2030
Division Level University Campus Infrastructure (UCI) Sustainability Roundtable	Quarterly	UCI management across divisions and units	Update on cross divisional projects under Campus Sustainability Roadmap 2030
Division Level Meetings with presidential cells of key student groups	Annually	Key student group representatives from National University of Singapore Students’ Union (NUSSU), Graduate Student Society (GSS), NUS Students’ Association for Visions of the Earth (SAVE)	Share campus sustainability priorities and opportunities for student involvement
Unit/Project Level Energy Management Workgroup Meetings	Bi-monthly	University Campus Infrastructure (UCI) divisions and units	Plan, implement and review energy saving projects to support Decarbonisation effort
Unit/Project Level Design Review for New Buildings and Retrofits	As and when	Faculty staff with green building expertise	Stretch the carbon, energy and sustainability targets of new buildings and retrofits (e.g. Site B new hostel housing)
Unit/Project Level Zero Waste Taskforce Meetings	Quarterly	Faculty staff, Campus infrastructure and administrative staff, students and alumni	Update on programme progress supporting Campus Dematerialisation and opportunities for collaboration and knowledge sharing
Unit/Project Level Cool NUS Living Laboratory meetings	Bi-weekly	CDE Researchers and University Campus Infrastructure (UCI) divisions and units	Update on progress on mitigation strategies at key hot spots on campus
Unit/Project Level Expert advisory	As and when	Researchers	Seek advice on emerging issues, technology and solutions

Partner

	Platforms	Frequency	Stakeholder Groups	Details
Decarbonise: Carbon Neutral	Green laboratory initiative	Ongoing	NUS Medicine Dean’s Office and labs	MD6 flagship energy saving project at energy-intensive buildings
	Ultra-low temperature freezer change out project	As and when	Faculty Dean’s Offices, Central Procurement Office (CPO) and Office of Finance (OFN)	Campus-wide switch to energy efficient laboratory equipment
Defend Against Climate: Cool NUS	Living labs collaborations	Ongoing	Researchers, industry partners and UCI divisions	Synergise expertise to testbed projects (e.g. Cool NUS projects such as evaluating cool paint and campus greenery)
	100,000 tree planting project	As and when	RVRC, Toddycats	Reforestation efforts at the Ridge
Dematerialise: Zero Waste	Zero Waste Taskforce	Quarterly	Faculty staff, Campus Administration and UCI staff, student environment groups and alumni	Plan, implement and review projects to achieve Zero Waste goals
	Zero Waste Testbed Initiative	Annually	South West Community Development Council, National Environment Agency (NEA), students	Provide funding and mentorship for students to testbed project ideas on campus
Dialogue: Galvanising Change	Events and activities by key student environmental groups	Ongoing	NUS Students’ Association for Visions of the Earth (SAVE)	Provide mentorship and guidance to the students as staff advisors
	Sustainability education modules	Annually	Lecturers (e.g. Ridge View Residential College) and students	Started in August 2021, co-create education modules with experiential learning on campus including learning journeys, problem statement for projects and case studies (e.g. Module RVN2000, Jan – May 2023)
	National Environment Agency’s YES Leaders’ Programme	Ongoing	National Environment Agency, students	Provide mentorship and training to develop student leaders for sustainability. Nominated 14 student leaders since 2023.

▲ Sharing by Mr Loo Deliang (Head, Sustainability Strategy Unit) of the Campus Sustainability Roadmap 2030 with new NUS staff across departments and faculties at monthly orientation programme.

▲ Students in an afforestation activity at The Ridge as part of the GreeNUSummit 2023, an environmental summit organised by NUS students.

▲ Students from Ridge View Residential College conducting a sample waste composition study, as part of immersive sustainability education.

▲ Since 2023, we have nominated 14 students for the NEA YES Leaders Programme curated for Institutes of Higher Learning (IHL) students.

▲ Publicity on buses and large wall print outs to raise awareness on the Campus Sustainability Roadmap and key programmes.

▼ NUS SAVE, a student environment group, organised a panel discussion on Sustainability Reporting with over 50 staff and student attendees. The panel involved (from left) Ms Goh Tian Ning (Co-President of NUS SAVE) as the moderator, Mr Loo Deliang, (Head of Sustainability Strategy Unit, University Campus Infrastructure, NUS), Mr Sunil Kumar Yadav (Director - KPMG ESG, KPMG Singapore) and Dr Martin Leo (Chief Risk Officer, NUS).

▸ NUS Vice President (Campus Infrastructure) Mr Koh Yan Leng (left) received the President's Award for the Environment 2023 from President Mr Tharman Shanmugaratnam (middle) and Minister for Sustainability and the Environment Ms Grace Fu (right).

▴ At the President's Award for Environment 2023 ceremony, we shared our net zero energy design philosophy with President Mr Tharman Shanmugaratnam, Ms Jane Ittogi, Senior Minister of State for Sustainability and the Environment & Ministry of Transport Dr Amy Khor, Minister for Sustainability and the Environment Ms Grace Fu and Senior Parliamentary Secretary, Ministry of Sustainability and the Environment & Ministry of Transport Mr Baey Yam Keng.

Professor Tan Eng Chye
NUS President

"NUS is honoured to be recognised with the President's Award for the Environment, which affirms our whole-of-University approach in championing sustainability."

Important Details

Annex

Ms Mindy Ong
Sustainability Strategy Unit,
University Campus Infrastructure

"We are in the sustainability journey for the long haul. The data provides an objective measure of our performance and serves as the basis to review and report the progress against our long-term targets, in alignment with international standards."

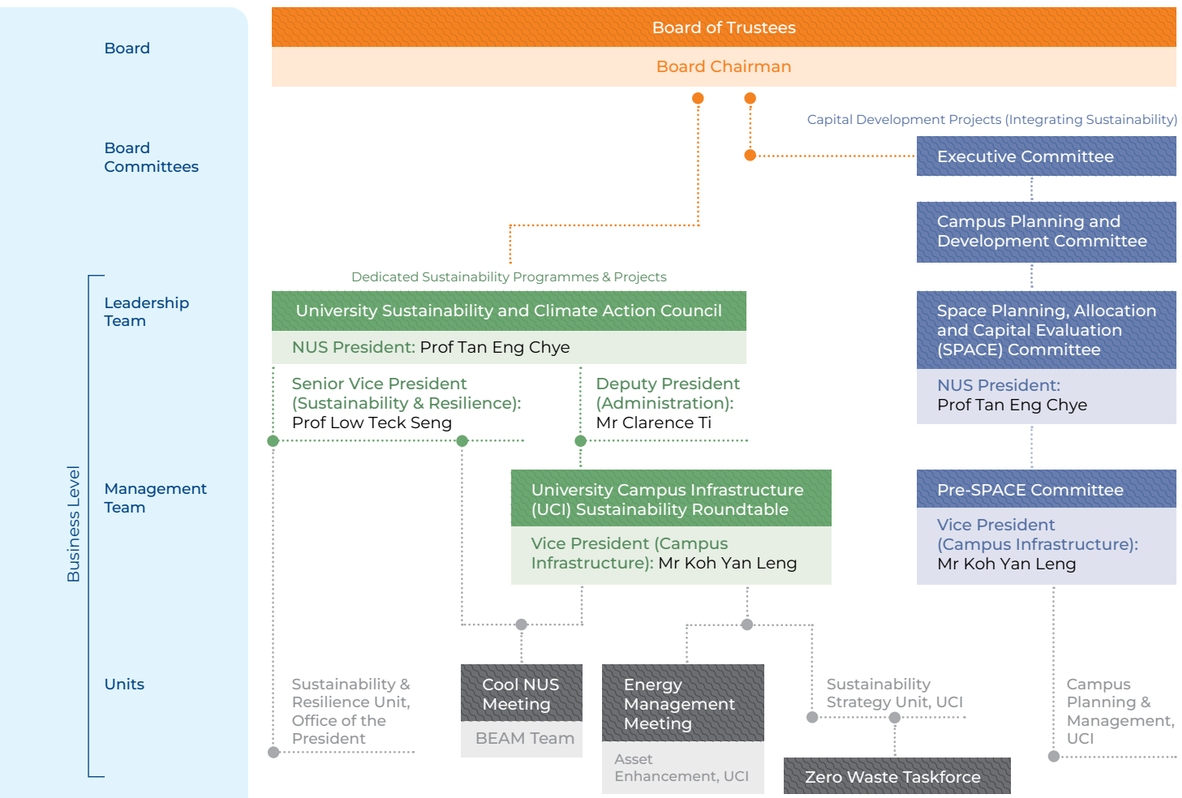
▲ University Campus Infrastructure staff analysing the energy performance of top 10 energy-intensive buildings on campus.

How We Organise Ourselves

The sustainability governance structure at NUS ensures a comprehensive approach to environmental responsibility across its functions. At the apex of this governance is the University Sustainability and Climate Action Council (USCAC), chaired by NUS President Professor Tan Eng Chye. This council, comprising faculty with sustainability expertise and senior leaders, integrates activities across Education, Research, Innovation and Enterprise, Campus Operations and Administration, and Community Engagement. It guides campus sustainability policies and programs. The University has also appointed a Senior Vice President (Sustainability and Resilience) in 2022, Prof Low Teck Seng, a senior civil servant, who collaborates closely with university leadership to oversee and implement sustainability initiatives across all functions.

To achieve its Campus Sustainability Roadmap 2030 objectives, NUS has established reporting platforms chaired by the Deputy President of Administration and Vice President (Campus Infrastructure). For instance, the University Campus Infrastructure (UCI) conducts a quarterly Sustainability Roundtable to monitor campus sustainability performance. Division and unit heads oversee specific sustainability projects through regular meetings such as Energy Management and Zero Waste Taskforce Meetings.

Beyond programs, sustainability considerations are integrated into capital development projects through oversight from two Board committees: the Executive Committee (Exco) and the Campus Planning and Development Committee. These committees oversee strategic planning, development, and implementation procedures. The Space Planning Allocation and Capital Evaluation (SPACE) Committee, chaired by the NUS President, further oversees capital projects and reports to the Board committees, ensuring sustainability is embedded in the university's campus development.



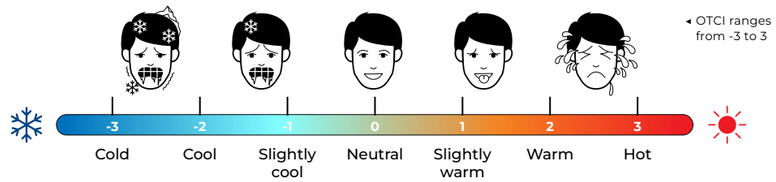
NUS Explains

Glossary of Our Indicators

Decarbonise

SCOPE 1 & 2 ABSOLUTE EMISSIONS ($ktCO_2e$)[1]	Greenhouse Gas (GHG) emissions[2] from activities we have control over - Scope 1 emissions are from our usage of fuel & refrigerants in chiller plants; Scope 2 emissions are from the production of grid electricity that we use.
ELECTRICITY CONSUMPTION (GWh)[3]	Total amount of electricity that we use from the grid and renewables.
ENERGY USAGE INTENSITY (EUI) (kWh/m^2)	Total amount of electricity that we use from the grid and renewables per metre square. Tracking per metre square allows us to monitor our consumption as the campus grows.
SCOPE 3 ABSOLUTE EMISSIONS ($ktCO_2e$)	Indirect GHG emissions from sources not owned or directly controlled by NUS but related to NUS activities including the goods and services we purchase, the waste we generate, how we commute & travel, and the grid electricity that our tenants use.

Defend Against Climate Change

OUTDOOR THERMAL COMFORT INDEX (OTCI)	 Measures the level of thermal comfort (a state of mind whether they feel hot or cold) a person experiences when outdoors. Its computation accounts for both temperature, solar radiation, and wind speed.
PREDICTIVE PERCENTAGE DISSATISFIED (PPD)	The percentage of occupants that would feel dissatisfied in a given outdoor space. It is mathematically converted from OTCI for easier interpretation.

Dematerialise

RECYCLING RATE	Amount of waste sent for recycling, instead of being sent to incineration plants, compared to total amount of waste generated on campus.
DAILY WASTE DISPOSED PER CAPITA	Amount of waste a person throws into the rubbish bin every day on campus that is sent for incineration. Tracking per capita allows us to monitor the waste disposed as our campus population grows.

[1] $ktCO_2e$ refers to the unit of measurement that accounts for all greenhouse gas (GHG) emissions. As different GHGs have different global warming potentials (i.e. heat absorbed in the atmosphere), this reflects the number of kilotons of carbon dioxide (CO2) emissions with the same global warming potential as one kiloton of another GHG, where 1 kiloton (kt) = 1,000,000 kilograms (kg), This allows us to evaluate all emissions in a single metric.

[2] Greenhouse gases (GHG) are gases that trap heat from the sun in the Earth's atmosphere, leading to an overall warming of the Earth. The three key GHGs accounted for in NUS are carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O).

[3] GWh refers to a unit of measurement for electrical energy. Mathematically, it refers to the amount of power (gigawatts or GW) that appliances consume over a time period (hour or h), where one gigawatt (GW) = 1,000,000 kilowatt (kW) = 1,000,000,000 watts (W).

Our Environmental Data

	2019	2020[6]	2021	2022	2023
Decarbonise					
Total GHG Emissions ($ktCO_2e$)[4,5]	**353**	**284**	**324**	**334**	**331**
(i) Scope 1	**2.8**	**2.3**	**2.6**	**2.2**	**1.4**
Fuel Combustion	0.3	0.3	0.3	0.3	0.3
Fugitive Emissions from Refrigerants	2.5	2.0	2.3	1.9	1.1
(ii) Scope 2	**110**	**101**	**112**	**113**	**121**
Scope 2 Gross Carbon Emissions Intensity ($kgCO_2e/m^2$)	79	72	79	79	82
(iii) Scope 3[7]	**240**	**181**	**209**	**219**	**209**
Category 1 – Purchased goods and services	57	49	52	49	41
Category 2 – Capital goods	85	69	73	63	54
Category 3 – Fuel and energy related activities	22	22	32	33	34
Category 4 – Upstream transportation and distribution	2	2	2	2	8
Category 5 – Waste generated in operations	5	4	3	4	5
Category 6 – Business travel	34	1	7	30	32
Category 7 – Employee commuting	9	10	9	9	9
Category 13 – Downstream leased assets	25	25	30	29	27
Total Electricity Consumption (GWh)[3]	**271**	**249**	**276**	**280**	**290**
(i) Grid Electricity (GWh)	270	248	276	279	290
(ii) Campus Solar Energy (GWh)	0.6	0.6	0.6	0.5	0.6
Energy Usage Intensity (EUI) (kWh/m^2)	**195**	**178**	**195**	**195**	**198**
1st Building Cluster Targeting Net Zero Energy – SDE4, SDE1, SDE3					
SDE4 – Awarded Green Mark (GM) 2021 in Operation Platinum Positive Energy in 2022					
Solar Energy Generated (GWh)	0.6	0.6	0.6	0.5	0.4
Electricity Consumption (GWh)	0.5	0.4	0.4	0.4	0.4
EUI (kWh/m^2)	55	44	46	44	44
SDE1 – Awarded Green Mark (GM) 2021 in Operation Platinum Zero Energy in 2022[8]					
Solar Energy Generated (GWh)	–	–	–	–	–
Electricity Consumption (GWh)	–	0.04	0.4	0.4	0.4
EUI (kWh/m^2)	–	4	44	43	47
SDE3 – Awarded Green Mark (GM) 2021 in Operation Platinum Super Low Energy in 2024[9]					
Solar Energy Generated (GWh)	–	–	–	–	–
Electricity Consumption (GWh)	–	–	–	0.08	0.6
EUI (kWh/m^2)	–	–	–	6	38

		2019[10]	2020[10]	2021	2022	2023
Top Energy-Intensive Buildings (Labs)						
MD6	Electricity Consumption (GWh)	18.8	18.4	19.3	19.3	17.5
	EUI (kWh/m^2)	462	453	474	474	428
CeLS[11]	Electricity Consumption (GWh)	–	–	6.7	9.8	8.5
	EUI (kWh/m^2)	–	–	333	487	424
E3A	Electricity Consumption (GWh)	–	–	7.6	8.8	9.3
	EUI (kWh/m^2)	–	–	626	723	769
E6	Electricity Consumption (GWh)	–	–	7.0	6.7	6.9
	EUI (kWh/m^2)	–	–	570	552	565
E8	Electricity Consumption (GWh)	–	–	6.2	6.1	6.1
	EUI (kWh/m^2)	–	–	395	385	388
MD1	Electricity Consumption (GWh)	–	–	9.0	8.7	8.0
	EUI (kWh/m^2)	–	–	250	225	224
MD2	Electricity Consumption (GWh)	–	–	6.5	6.8	7.1
	EUI (kWh/m^2)	–	–	652	936	721
S1A	Electricity Consumption (GWh)	–	–	6.9	5.8	6.6
	EUI (kWh/m^2)	–	–	653	551	631
S9	Electricity Consumption (GWh)	–	–	16.6	16.9	18.1
	EUI (kWh/m^2)	–	–	449	456	488
T-Lab	Electricity Consumption (GWh)	–	–	11.5	11.1	11.1
	EUI (kWh/m^2)	–	–	470	454	454

[4] GHG emissions are derived in accordance with the requirements of the "GHG Protocol Corporate Accounting and Reporting Standard" (GHG Protocol). GHG protocol's 'Operational Control' approach was used to set NUS' organizational boundary. This covers NUS' three main campuses – Kent Ridge (including University Town, Yale-NUS College), Bukit Timah and Outram (Duke-NUS Medical School) and the Data Centre at NUS High School & Tropical Marine Science Institute at St John's Island; and excludes the following: A*STAR and other non-NUS research institutes and centres located on any of the above-mentioned premises (e.g. Brenner Centre for Molecular Medicine, Temasek Life-science Lab, Defence Science Organization, CREATE, Singapore Wind Tunnel Facility, TCOMS, Institute of South Asian Studies, Middle East Institute, Energy Studies Institute), Kent Ridge Guild House, Residential Tenants (Kent Vale Residences, Pandan Valley, College Green); and retail and dining tenants (e.g. canteens). From August 2025, the NUS Faculty of Law will move from its current location at Bukit Timah campus to Kent Ridge campus.

[5] For our emissions and electricity targets, our baseline year is 2019 – the most recent year before the COVID-19 pandemic. The equivalent CO emissions for electricity used are calculated based on the updated average operating margin grid emission factor from the Energy Market Authority for the relevant time period. Scope 1 direct emissions and Scope 3 indirect emissions are calculated using: IPCC (the United Nations Intergovernmental Panel on Climate Change): AR6 Synthesis Report, Guidelines for National Greenhouse Gas Inventories, BEIS (Department for Business, Energy & Industrial Strategy) Greenhouse Gas reporting: conversion factors, EPA (U.S. Environmental Protection Agency): emission factors hub, the National Environment Agency: Greenhouse Gas (GHG) Emissions Measurement and Reporting Guidelines, Waste Statistics and Overall Recycling, the World Bank: Electric power transmission and distribution losses, and Singapore's Fifth Biennial Update Report. Relevant emission factors were sourced from: Linde plc gases and equipment information, Monetary Authority of Singapore exchange rates, US Bureau of Statistics CPI inflation calculator. For spend based category data, Monetary Authority of Singapore, Supply Chain GHG Emission Factors for US Commodities and Industries from the EPA were applied by economic sectors to calculate the Scope 3 indirect emissions.

[6] Due to the COVID-19 pandemic, there were reduced on-campus activities in 2020. Hence, 2020 performance is not considered representative of the NUS' business-as-usual operations.

[7] Scope 3 Categories 8, 9, 10, 11, 12 and 14 are not applicable as NUS does not produce or manufacture any products or operate any franchises. Scope 3 Category 15 is currently not reported due to data unavailability. NUS adopts a responsible investment strategy with a focus on ensuring that its investments generate income to support our activities while closely aligning to principles of environmental sustainability and social responsibility.

[8] SDE1 was opened in Mar 2021 after retrofit through adaptive reuse. Solar PV at SDE1 is expected turn on in Q2 2024.

[9] SDE3 was opened in Feb 2023 after retrofit through adaptive reuse. Solar PV at SDE3 is expected turn on in Q1 2025.

[10] Historical electricity consumption data from 2019 & 2020 for other top consumers (apart from MD6) are not available.

[11] CeLS refers to the Centre for Life Sciences.

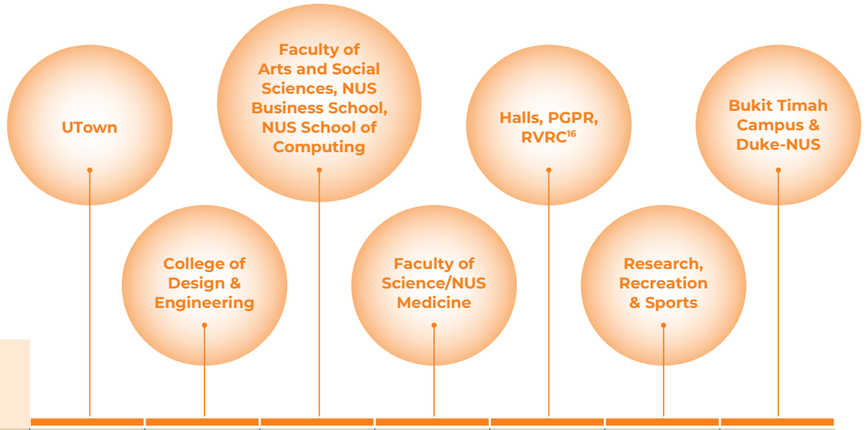
	2019	2020	2021	2022	2023
▸ Defend Against Climate Change					
Outdoor Thermal Comfort Index (OTCI)	Baseline to be established by 2024				
Predictive Percentage Dissatisfied (PPD)	Baseline to be established by 2024				
▸ Dematerialise[12]					
Total Waste Generated (tonnes)	**5,921[13]**	**5,078[13]**	**3,996[14]**	**5,031[14]**	**5,368**
(i) Incinerated / Waste directed to disposal by disposal operation	**4,416**	**3,535**	**2,925**	**3,426**	**3,939**
(ii) Recycled / Waste diverted from disposal by recycling operation	**1,505[13]**	**1,543[13]**	**1,071[14]**	**1,605[14]**	**1,429**
Paper, Plastic, Metal, Glass	81	81	109	135	138
Food	209	165	282	367	110
Horticulture	1,130	1,260	633	1,043	1,105
Electronic Waste (E-waste)	84[13]	36[13]	46	54	65
Textile	-	-	1[14]	6[14]	12
Recycling Rate	**25%[13]**	**30%**	**27%**	**32%**	**27%**
Daily Waste Disposed per Capita (kg/day/capita)	**0.22**	**0.17**	**0.14**	**0.16**	**0.18**

[12] 2021 was selected as the baseline year as we have bin centre-level waste data in 2021, arising from the implementation of the smart waste and recycling collection system. 2019 and 2020 data were previously derived from the following: waste weight estimations based on number of bulk bins, actual waste weight from mobile compactors and campus-level aggregated weight of recyclables collected by the previous vendor. We are continuously enhancing our waste data collection approach to ensure accuracy, such as working towards using optical character recognition technology to read data from photos taken of the load cell readings.

[13] Restated for 2019 & 2020 due to the availability of e-waste recycling data.

[14] Restated for 2021 & 2022 due to the availability of textile recycling data.

▸ Dematerialise



2023 WASTE DATA BY PRECINCT[15]							
Total Waste Generated (tonnes)	**1,226**	**532**	**797**	**896**	**1,006**	**666**	**245**
(i) Incinerated / Waste directed to disposal by disposal operation	**986**	**346**	**575**	**716**	**800**	**333**	**183**
(ii) Recycled / Waste diverted from disposal by recycling operation	**239**	**186**	**223**	**180**	**206**	**333**	**62**
Paper, Plastic, Metal, Glass	38	19	20	34	12	10	4
Food	70	5	9	17	9	-	-
Horticulture	120	148	171	109	181	321	55
Electronic Waste (E-waste)	2	14	23	19	3	1	3
Textile	9	0.4	0.4	0.4	0.4	0.4	-
Recycling Rate	**20%**	**35%**	**28%**	**20%**	**20%**	**50%**	**25%**

[15] 2023 precinct level waste data was obtained by aggregating the bin centre level data within each precinct as obtained through the smart waste and recycling collection system deployed in NUS. This is except for horticulture waste where the total tonnage was divided based on the proportion of green areas within each precinct and textile waste data which was obtained from the Cloop textile recycling bins at Utown and MD4, and manual weighing during the check out drives held at the various hostels on campus.

[16] Halls, PGP, RVRC refers to Eusoff Hall, Kent Ridge Hall, King Edward VII Hall, Raffles Hall, Sheares Hall, Temasek Hall, Prince George's Park Residences (PGP) and Ridge View Residential College (RVRC).

▸ Dematerialise

OUR RECYCLABLES

Recyclable Type	Source of Recyclables and How They Are Currently Recycled
Electronic Waste	IT equipment from faculties and electronic waste contributed via the bins located in Central Library Forum, outside LT27 and UTown are collected by Alba E-Waste Smart Recycling Pte Ltd. These items are transported to Alba's Material Recovery Facility for further sorting and subsequent export to neighbouring countries for recycling.
Food	Food waste generated by stallholders during food preparation and leftovers collected from our community at tray return points are processed in composters located in Techno Edge, Stephen Riady Centre and Terrace, producing compost that is used in campus landscaping works.
Glass	Accumulated glass (e.g. drink bottles) from F&B outlets and residences are collected by P&R Resource Management Pte Ltd and transported to their facility to be crushed and packed in containers for subsequent export to Malaysia for recycling.
Horticulture	Plant matter collected from regular tree pruning works are transported by our landscaping contractor to a biomass waste-to-energy plants by 800 Super Holdings Ltd and Kim Hock Corporation Ltd where it is used to generate steam for energy production. Approximately 10% of our horticulture waste which comes from fallen leaves and minor pruning works are transported to a local nursery to be turned into mulch, which is used for landscaping works back on campus.
Paper	These items are collected from Recycle Right bins across our campus by Asia Recycling Resources Pte Ltd and transported to their material recovery facility, where they are baled and then exported to neighboring countries for recycling.
Plastic (PET1 & HDPE2)	
Metal	
Textiles	Apparel and other textiles like pillows are collected by Cloop who will pack them into bags and export them to Malaysia for further sorting and recirculation.

Other Environmental Data

Gross Floor Area (million m^2)	1.39	1.40	1.41	1.43	1.47
Campus Fleet Vehicles Electrified (%)	0%	6.5%	11%	17%	25%
No. of Trees Planted (Cumulative)	5,915	15,154	22,087	35,100	47,552
Water Consumption (million m^3)	2.02	1.68	1.73[17]	1.78	1.89
Water Efficiency Index (WEI) (m^3/m^2)	1.41	1.16	1.22	1.24	1.29

[17] Restated for 2021 due to update in data source for 2021 water consumption for one building.

▸ GRI Content Index

Statement of use

National University of Singapore (NUS) has reported with reference to the GRI Standards for the period 1 April 2023 to 31 March 2024.

GRI 1 used

GRI 1: Foundation 2021

GRI Standards	Disclosure Number	Disclosure Title	Page
General Disclosures			
GRI 2 (2021): General Disclosures	2-1	Organisational details	Annual Report Page 46
	2-2	Entities included in the organisation's sustainability reporting	3
	2-3	Reporting period, frequency and contact point	3
	2-9	Governance structure and composition	59
	2-29	Approach to stakeholder engagement	51-52
Decarbonise			
GRI 3 (2021): Material Topics	3-3	Management of material topics	11
GRI 305 (2016): Emissions	305-1	Direct (Scope 1) GHG emissions	12-13, 25-26, 60-61
	305-2	Energy indirect (Scope 2) GHG emissions	12-13, 25-26, 60-61
	305-3	Other indirect (Scope 3) GHG emissions	25-26, 60-61
	305-4	GHG emissions intensity	61
	305-5	Reduction of GHG emissions	13, 23-24
GRI 302 (2016): Energy	302-1	Energy consumption within the organisation	15-22, 61-62
	302-3	Energy intensity	15-22, 61-62
	302-4	Reduction of energy consumption	23-24
Defend Against Climate Change			
GRI 3 (2021): Material Topics	3-3	Management of material topics	31-32
Dematerialise			
GRI 3 (2021): Material Topics	3-3	Management of material topics	39
GRI 306 (2020): Waste	306-1	Waste generation and significant waste-related impacts	39
	306-2	Management of significant waste-related impacts	40-44
	306-3	Waste generated	40-42, 63-64
	306-4	Waste directed to disposal	40-42, 63-64
	306-5	Waste directed from disposal	40-42. 63-64
Water Consumption			
GRI 303 (2018): Water	303-5	Water consumption	65

Solar panels on the rooftop of Ventus, home to University Campus Infrastructure and a Green Mark (GM) 2021 in Operation Platinum Super Low Energy certified building.

Produced by:

Sustainability Strategy Unit,
NUS University Campus Infrastructure (UCI)

With thanks to:

Agility Office, Office of the President
Campus Asset Management Division, UCI
Campus Life Division, UCI
Campus Planning & Management Unit, UCI
Central Procurement Office
Centre for Nature-based Climate Solutions
College of Design and Engineering
NUS Environmental Research Institute
NUS Information Technology
NUS Medicine
NUS Students' Association for Visions of the Earth (SAVE)
NUS Zero Waste Taskforce
Office of Finance
Ridge View Residential College