NUS National University of Singapore | University Campus Infrastructure

Cool NUS

Zero Waste

Carbon Neutral

Campus in a Tropical Rainforest

HARNESSING DATA & TECHNOLOGY TO DRIVE CHANGE

CAMPUS SUSTAINABILITY ROUNDUP 2022

About NUS Campus Sustainability Roadmap 2030:

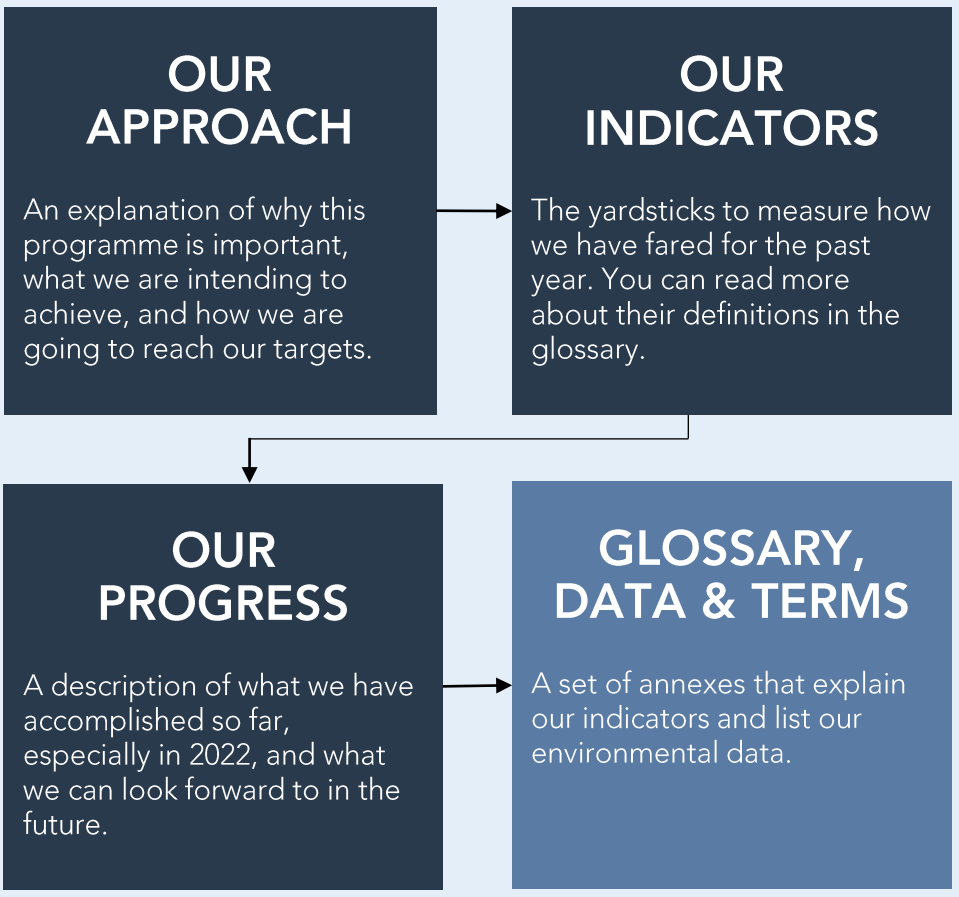
ABOUT THIS DOCUMENT

This document details the NUS campus' sustainability performance in Financial Year (FY[1]) 2022, spanning 1 April 2022 to 31 March 2023 (denoted as "2022" in this publication). Using an operational control approach, our organisational boundary comprises largely of our three main campuses: Kent Ridge, Bukit Timah and Outram[2].

For our emissions and electricity targets, we have set our baseline year to be 2019 – the most recent and representative year before the pandemic, which makes our sustainability endeavours more challenging. Our emissions inventory computation covers Scopes 1, 2 and 3 for all relevant categories in accordance with the GHG Protocol Corporate Accounting and Reporting Standard.

For waste, our baseline year is 2021 as we implemented our smart waste and recycling collection system that provides bin centre-level data in that year. This data is more granular and accurate compared to the aggregated campus level data obtained in previous years.

HOW TO READ THIS DOCUMENT



[1]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*.
[2]NUS' organisational boundary is defined as comprising: Kent Ridge Campus (including University Town, Yale-NUS College), Bukit Timah Campus, Duke-NUS Medical School (Outram), Data Centre at NUS High School and 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 Study, 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).

HIGHLIGHTS

Driving Change Through Data and Technology

In 2021, we developed our Campus Sustainability Roadmap 2030 featuring three unique sustainability programmes with **ambitious targets set with recent base years** – Carbon Neutral NUS, Cool NUS and Zero Waste NUS. Besides pushing sustainability boundaries, the strategies outlined in the Roadmap tackle the **decarbonisation challenge of an expanding campus** to support mission-driven activities, such as new research areas in renewable energy and agri-food technology, and enhancing the quality of student life with rejuvenated student spaces and new high-rise student hostels.

Climate Mitigation

CARBON NEUTRAL NUS

Taking responsibility for our carbon footprint, we aim to achieve carbon neutrality with energy reductions as a first priority before quality offsets.

Climate Adaptation

COOL NUS

Given rising global temperatures, we aim to achieve a climate-resilient and cool campus for our community.

Resource & Behaviour

ZERO WASTE NUS

We will drive a whole-of-university behavioural and cultural change where waste sorting and reusing is a social norm, and aim to close waste loops.

To enable us to tackle the challenge of rising carbon emissions, leveraging data and technology is key. We have been regularly collecting and analysing granular environmental data for programme review. This allows us to monitor and share with others where we are, and where we aim to be in our sustainability journey, enabling change to take place.

Under Carbon Neutral NUS, we doubled our Energy Usage Intensity reduction target and set a new emissions reduction target with more granular data. We broke new ground with the **first building cluster targeting net zero energy** in the College of Design and Engineering precinct. For energy intensive buildings, we developed a **suite of green laboratory measures**, including trialing new energy reduction technologies, following findings of a comprehensive energy audit and load profiling of a top energy consuming laboratory building.

Under Cool NUS, we are setting up a system to collect **high-resolution microclimate data to obtain a year-long baseline** and support an evidence-based approach to develop mitigation measures. The campus-wide sensor coverage will be used to evaluate mitigation measures, such as **testing cool paint on building facades** to reduce heat absorption and **planting about 35,100 trees to date**.

Under Zero Waste NUS, we want to shape good waste sorting and reuse norms. We have installed new **ground-level Resource Sorting Stations** at two residential colleges to encourage residents to mindfully sort and recycle their waste, instead of using the highly contaminated recycling chutes. Students now have access to their own unit-level waste and recycling data to compare with their peers.

We are deeply committed to transform our campus into a low-carbon, climate resilient and a less wasteful one. Together in collaboration with faculty, students and staff, we will shape a sustainable campus together.

Mr Koh Yan Leng
Vice President (Campus Infrastructure)
National University of Singapore

SUMMARY HIGHLIGHTS

Climate Mitigation

CARBON NEUTRAL NUS

Climate Adaptation

COOL NUS

Resource & Behaviour

ZERO WASTE NUS

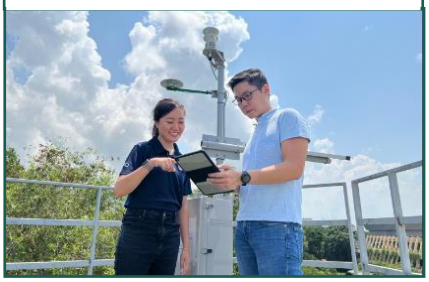
2022 PROGRESS HIGHLIGHTS

✓ Doubled EUI reduction target from 10% to 20% reduction by deep diving and quantifying target areas to push for energy reductions

✓ Launched SDE 1 & 3, the first building cluster in Singapore targeting net zero energy and built through adaptive reuse, saving 80% embodied carbon

✓ Completed a comprehensive energy audit for a high energy consuming lab building, with a ↓20% energy reduction target

✓ Extensive sensor network installation commenced, supporting an evidence-based approach to mitigation implementation



✓ Cool paint trial developed to kickstart assessment of mitigation measures at College of Design & Engineering

✓ Planted 35,100 trees on campus since November 2018

✓ Launched Resource Sorting Stations to promote mindful waste sorting in student residences to increase recycling rate

✓ Waste composition studies conducted to obtain data for programme planning

> Our focus is to decouple campus growth and rising carbon emissions as we scale new peaks of excellence in research and education, while enhancing the vibrancy of student life.
>
> **Mr Koh Yan Leng**
> Vice President (Campus Infrastructure)

SUMMARY HIGHLIGHTS

Climate Mitigation
CARBON NEUTRAL NUS

Climate Adaptation
COOL NUS

Resource & Behaviour
ZERO WASTE NUS

OUR INDICATORS – 2022 PERFORMANCE

Our Gross Floor Area has increased to 1.43 million m^2, a 3% increase compared to FY19 Baseline.

+2% ($115\ ktCO_2e$) **Increase** in **Scope 1 & 2 Emissions**

FY30 Target: **30% reduction** in Scope 1 & 2 emissions from FY19 baseline, before offsetting

FY19 Baseline: $113\ ktCO_2e$
FY22 BAU: $120\ ktCO_2e$

+<1% ($195\ kWh/m^2$) Maintained **Energy Usage Intensity (EUI)**

2030 Target: **20% reduction** in Energy Usage Intensity (EUI) from FY19 baseline

FY19 Baseline: $195\ kWh/m^2$
FY22 BAU: $202\ kWh/m^2$

OTCI In process of establishing campus baseline **Outdoor Thermal Comfort Index (OTCI)** by FY24

Target: Achieve an **acceptable level** of **outdoor thermal comfort**

32% Recycling Rate

FY30 Target: **50% Recycling Rate**

FY21 Baseline: 27%

14% (0.16 kg/day/capita) Increase in **Daily Waste Disposed per Capita**

FY30 Target: **30% reduction** in Daily Waste Disposed per Capita from FY21 baseline

FY21 Baseline:
0.14 kg/day/capita

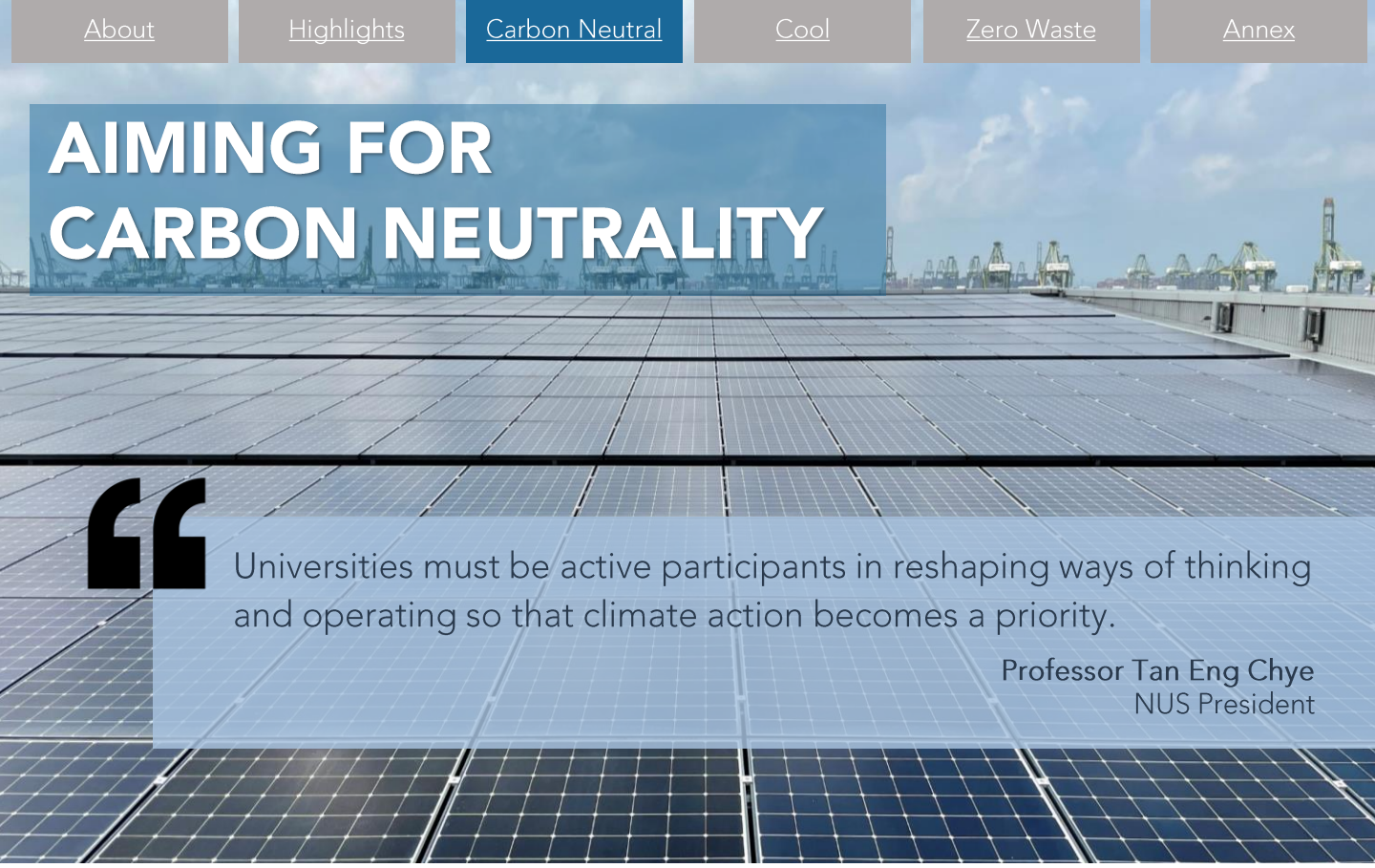
Close Waste Loops for difficult to recycle waste streams, e.g. plastic

On Track: We are on track towards reaching our target.

Monitoring: We need to do more to achieve our target.

Preparing: Baselining or other preparation works being done.

AIMING FOR CARBON NEUTRALITY



> Universities must be active participants in reshaping ways of thinking and operating so that climate action becomes a priority.
>
> **Professor Tan Eng Chye**
> NUS President

OUR APPROACH

DECARBONISING CAMPUS GROWTH

Redesign

We are setting stretched design targets for new buildings and retrofits to avoid energy consumption on the onset and ensure that these standards are upheld throughout the buildings' operations.

Reduce

We are increasing energy efficiency through campus-wide optimisation of our chiller plants, upgrading of our lights to LEDs and significantly reducing energy use by building types (labs, offices & teaching facilities, residences) guided by energy audits and quantity surveying studies.

Replace

We are maximising our campus rooftop solar PV capacity and will procure overseas renewable energy through Virtual Power Purchase Agreements.

Restore

As a last resort, after exhausting all our efforts, we will procure quality carbon offsets for remaining unabated emissions.

Most Preferred → Least Preferred

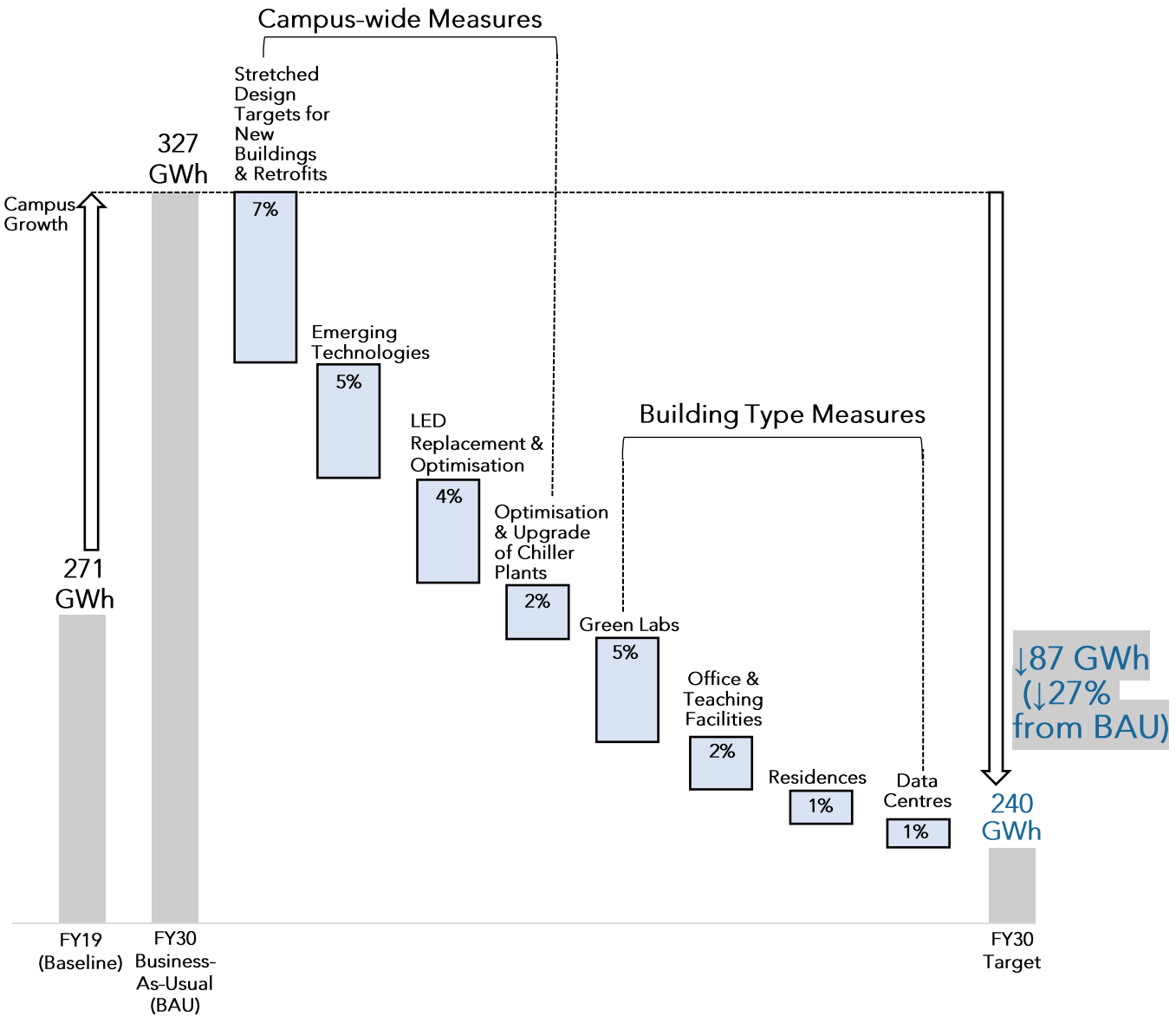
We are developing a sustainable procurement framework and strategy to reduce our Scope 3 emissions and integrate sustainability considerations into major procurement activities.

ENERGY REDUCTIONS AS A FIRST PRIORITY

Our campus will continue expanding to support the mission-driven activities of the University. In a business-as-usual (BAU) scenario, we project that our electricity consumption will increase to 327 GWh in FY30, a 21% increase compared to the recent baseline of 271 GWh in FY19.

We are committed to mitigate and flatten this rise through energy reductions as a first priority. Through a suite of campus-wide and building type measures, we aim to reduce 87 GWh (27%) from BAU by FY30.

MULTI-PRONGED ENERGY REDUCTION MEASURES

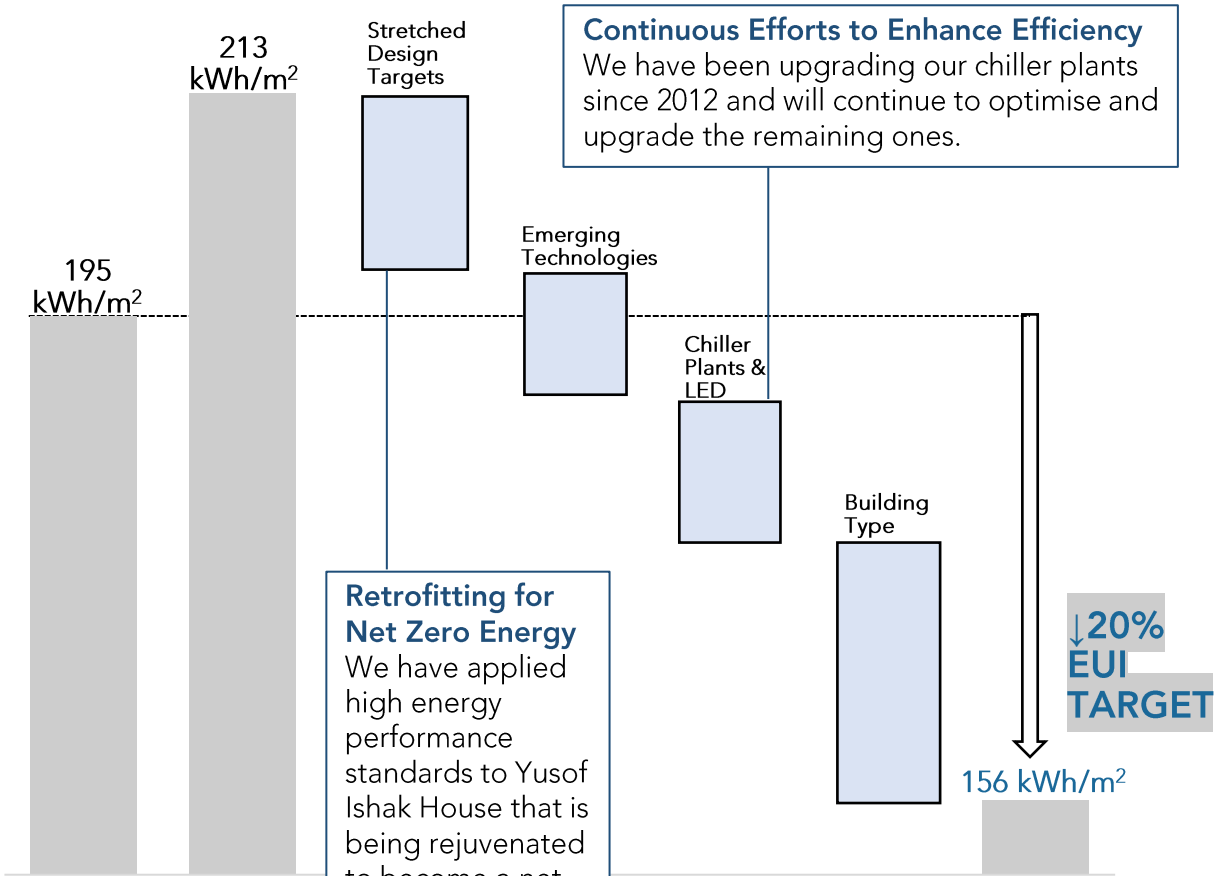


DOUBLED EUI TARGET, NEW EMISSIONS TARGET

Through the suite of energy reduction measures, we doubled our Energy Usage Intensity (EUI) reduction target to ↓20% by FY30 (vs ↓10%) – double what we achieved in 2019 vs 2012.

In parallel, we have set a new target of ↓30% in Scope 1 & 2 absolute emissions. After reducing our energy consumption as much as possible, we will look towards replacing our energy sources with renewables ones. We have installed 9.2 MWp of campus rooftop solar capacity that provides about 4% of our total consumption. We aim to stretch this to 14 MWp by 2030, and will look to procure overseas renewable energy.

ROADMAP TO ACHIEVE 20% ENERGY USAGE INTENSITY REDUCTION TARGET



Retrofitting for Net Zero Energy
We have applied high energy performance standards to Yusof Ishak House that is being rejuvenated to become a net zero energy building in 2024.

OUR INDICATORS

In 2022, we have mitigated the rise in emissions and EUI from new buildings – COM 3, SDE 1 & 3. We are committed to continue mitigating this rise with energy reductions as the first priority, especially in energy intensive lab buildings, and achieving higher energy and carbon performance for our new buildings.

115 $ktCO_2e$

SCOPE 1 & 2 ABSOLUTE EMISSIONS

Scope 1: 2.2 $ktCO_2e$ Scope 2: 113 $ktCO_2e$ *[Scope 3: 219 $ktCO_2e$]*

+2% from FY19 Baseline (113 $ktCO_2e$);
4% lower than FY22 Business-As-Usual scenario (120 $ktCO_2e$)

FY30 Target: 79 $ktCO_2e$
FY19 Baseline: 113 $ktCO_2e$
Scope 1: 2.8 $ktCO_2e$ Scope 2: 110 $ktCO_2e$ *[Scope 3: 240 $ktCO_2e$]*

280 GWh

ELECTRICITY CONSUMPTION

+3% from FY19 Baseline (271 GWh);
4% lower than FY22 Business-As-Usual scenario (290 GWh)

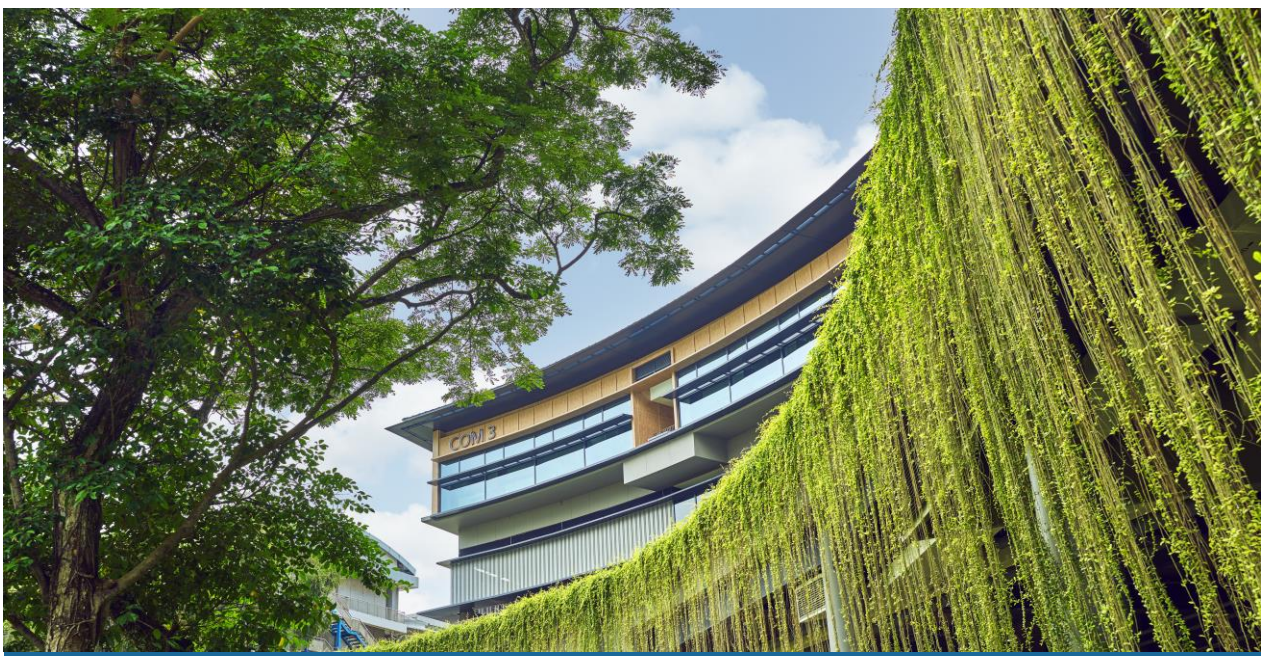
FY30 Target: 240 GWh
FY19 Baseline: 271 GWh

195 kWh/m^2

ENERGY USAGE INTENSITY (EUI)

+<1% from FY19 Baseline (195 kWh/m^2);
4% lower than FY22 Business-As-Usual scenario (202 kWh/m^2)

FY30 Target: 156 kWh/m^2
FY19 Baseline: 195 kWh/m^2



COM 3, a new School of Computing teaching facility, is a Green Mark (GM) Platinum Super Low Energy certified building. It was designed to as a bridge with porosity, serving as a connection to neighbouring buildings while allowing daylight and fresh air to be drawn in.

OUR PROGRESS

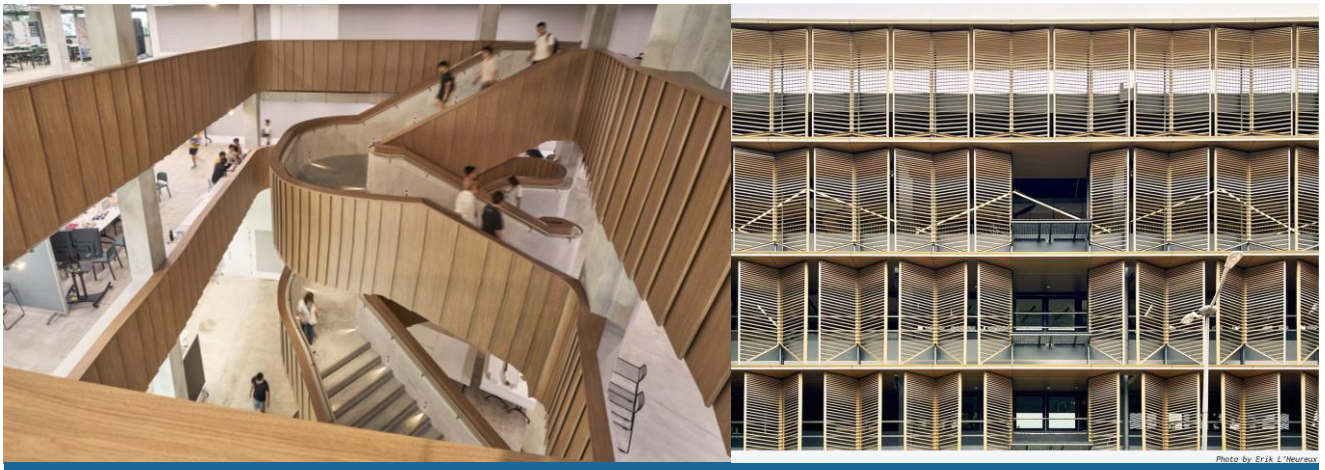
1st BUILDING CLUSTER TARGETING NET ZERO ENERGY

We launched our first building cluster targeting net zero energy comprising SDE 4 and newly completed adaptive reuse buildings, SDE 1 and SDE 3, achieving best-in-class energy performance.

Redesign

SDE 1 & 3 – First Adaptive Reuse Buildings with Ultra-Low Embodied Carbon

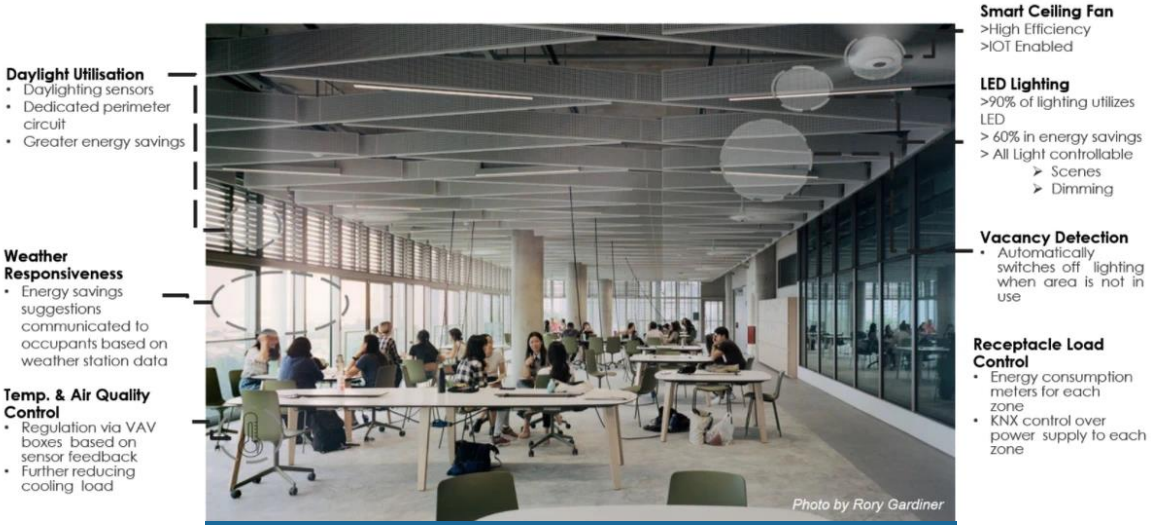
Built in 1970s, SDE 1 and SDE 3 have been rejuvenated through adaptive reuse instead of being fully rebuilt from scratch, achieving high energy performance standards targeting net zero energy. These buildings have achieved ultra-low embodied carbon performance of 200 kgCO2e/m^2, 80% lower than BCA's reference value for non-residential buildings (1,000 kgCO2e/m^2), by retaining most of its building elements.



SDE 1 & 3 retained most of its building elements (e.g. walls, columns, floors; left picture) and refurbished specific ones for better energy performance (e.g. shading fins; right picture), achieving ultra-low embodied carbon performance of 200 kgCO_2e/m^2.

SDE 4 – New-Built Achieving Best-in-Class Positive Energy Performance

Originally constructed as a purpose-built net zero energy building, SDE 4 is the first university building to achieve Green Mark (GM) 2021 in Operation Platinum Positive Energy, achieving an Energy Usage Intensity (EUI) of 44 kWh/m^2 in FY22 through passive and active design features and energy management, and generating 140% of its energy consumption from 1,200 rooftop solar PV panels.



SDE 4 has various energy saving features that help to manage energy consumption in operation, such as vacancy detection that works with other sensors (e.g. carbon dioxide, temperature) to automatically switch off lights when the room is not in use.

OUR PROGRESS (CONT'D)

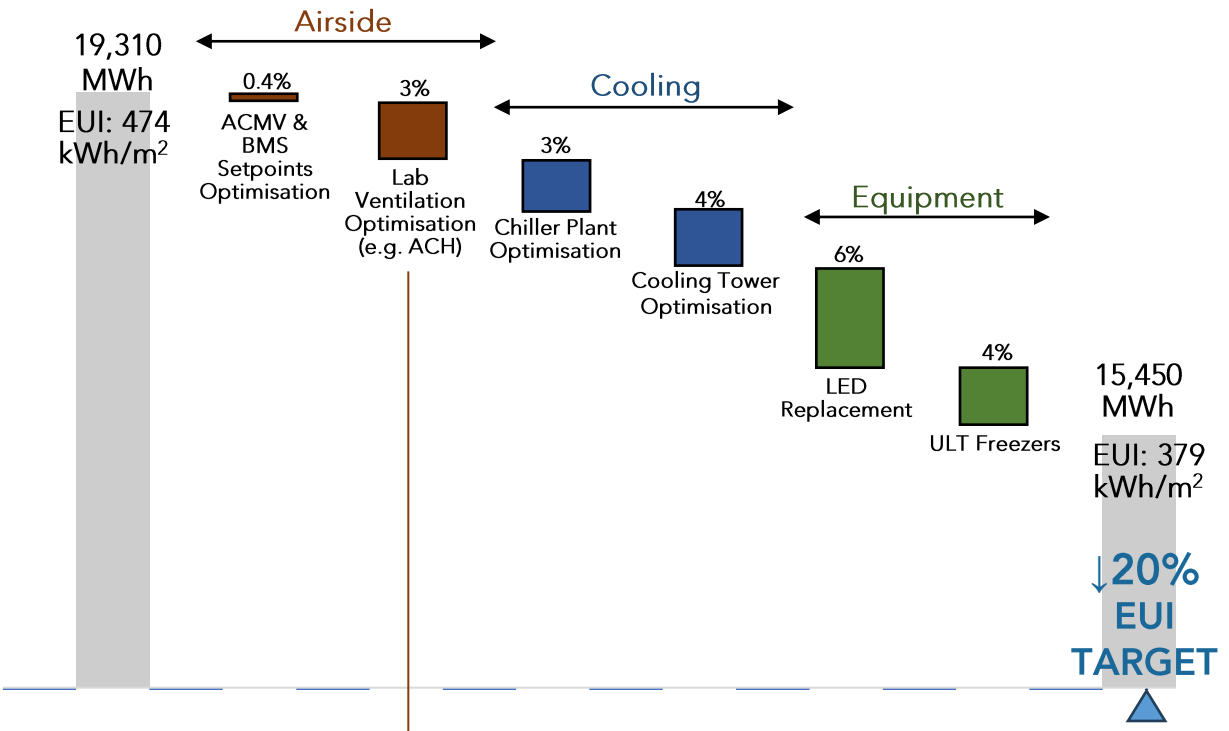
DEVELOPING GREEN LAB MEASURES

Reduce

We have completed a comprehensive Level 3 energy audit at a top energy consuming lab building, MD 6, and developed energy reduction interventions with an aim to achieve 20% reduction in energy use. These interventions target key areas such as airside (e.g. adjusting air change rates (ACH) safely), cooling, and equipment (e.g. procuring energy-efficient Ultra-Low Temperature (ULT) freezers).

GREEN LAB ENERGY REDUCTION MEASURES

To trial at MD 6 and scale to other lab buildings if effective



Adjusting ACH Safely

Striking a balance between safety of lab users and energy consumption, we have reduced the ACH in MD 6 where possible by 25%, from 8 to 6. This is estimated to save 300 MWh yearly. To obtain more energy savings, we are installing sensors to adjust the ACH dynamically and will trial this in 2024.

OUR PROGRESS (CONT'D)

OPERATIONAL OPTIMISATION FOR OFFICES & TEACHING FACILITIES

Reduce

In office buildings – University Hall (home to the University's administration) and Ventus (home to University Campus Infrastructure), we have achieved 13% and 17% monthly energy reductions respectively by (1) reducing air-conditioning operating hours by around 22 and 10 hours respectively per week; and (2) encouraging users to maintain temperature setpoints of 25°C, where comfort allows.

In a teaching facility – SDE 2, we have achieved 21% monthly energy reductions by the above air-conditioning interventions and reducing overlit corridors through sensors.

We are monitoring these buildings to ensure the reductions are sustained, and are applying the measures across other offices and teaching facilities.

Ventus achieved 14 MWh savings and an EUI of 60 kWh/m² (↓10% than last year).

SDE 2 achieved 42 MWh savings and an EUI of 88 kWh/m² (↓8% than last year).

Reminders to the NUS community to save energy by reporting instances of energy wastage and maintaining temperature setpoints of 25°C.

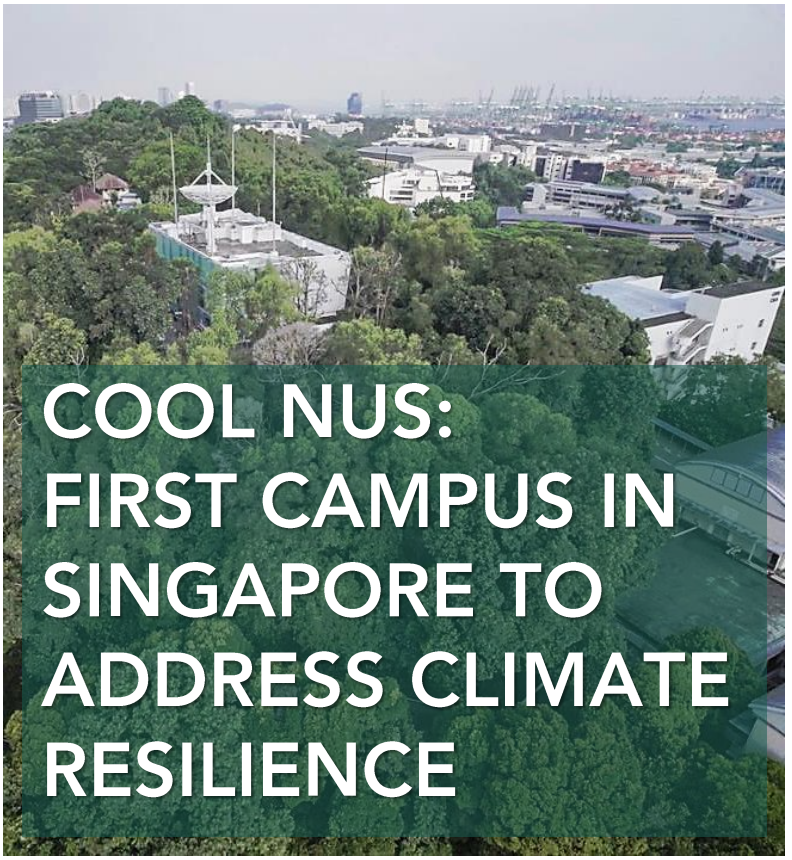
ELECTRIFIED 17% OF CAMPUS FLEET

Replace

From 3 vehicles (11%) in 2021, we have now changed a total of 5 vehicles (17%) to electric ones and are working towards electrifying 100% of our 30 campus-owned vehicles by FY30.

NUS has deployed electric Hyundai Ioniq sedans for campus patrolling purposes.

Beyond campus-owned fleet, we have also electrified our entire shuttle bus fleet.



COOL NUS: FIRST CAMPUS IN SINGAPORE TO ADDRESS CLIMATE RESILIENCE

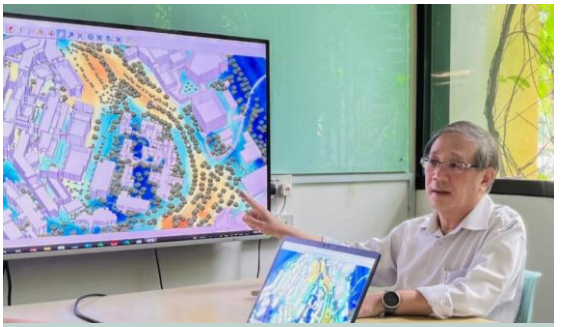
We will testbed tailored mitigation measures on campus to adapt to rising temperatures and ensure an acceptable level of thermal comfort outdoors for our community.

Through baseline measurements developed with high-resolution microclimate data and simulations, we will develop, testbed and monitor the effectiveness of the mitigation measures. These measures may support the national Cooling Singapore initiative.

OUR APPROACH

Our Kent Ridge campus has a variety of urban morphologies and building uses. This makes it an ideal living laboratory to testbed urban heat island mitigation strategies. With the challenge of rising global temperatures, we aim to ensure that our campus achieves an acceptable level of thermal comfort outdoors.

In partnership with researchers from the College of Design & Engineering (CDE), we are installing an extensive, high-resolution network of over 50 microclimate sensors across our Kent Ridge campus. Data from these sensors will determine the campus baseline Outdoor Thermal Comfort Index (OTCI) and contribute to the implementation of mitigation measures.



Prof Wong Nyuk Hien, an Urban Heat Island expert in the Department of the Built Environment, is leading the Cool NUS project.

The weather station located on Innovation 4.0 building rooftop is one of the over 50 sensors that collect environmental data.

OUR INDICATORS

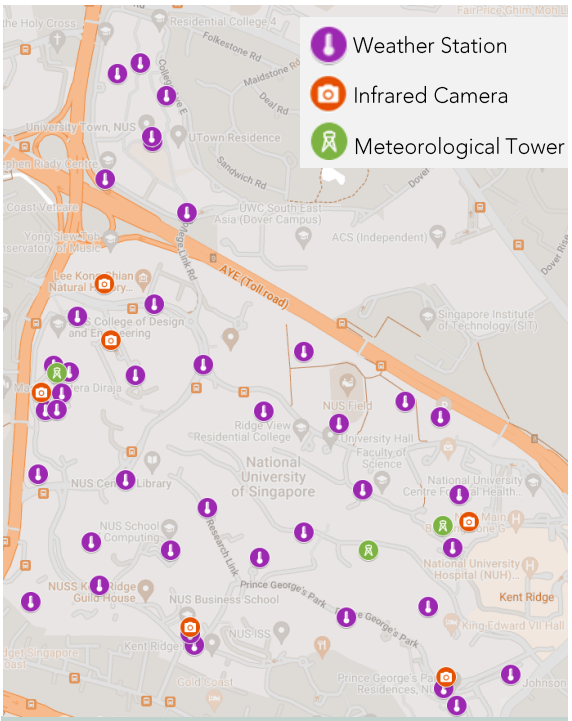
OUTDOOR THERMAL COMFORT INDEX (OTCI)

Our main indicator to establish the level of thermal comfort outdoors on campus is the OTCI. We will establish our baseline by FY24.

OUR PROGRESS

INSTALLING SENSORS CAMPUS-WIDE

To collect high-resolution environmental data, we have studied and mapped out optimal locations for over 50 sensors. When fully installed in Q1 2024, this will be the densest sensor network for a campus in Singapore.



Over 50 campus-wide sensors to be installed include weather stations, infrared cameras and meteorological towers.

TESTING COOL PAINT FOR MITIGATION

We are testing the effectiveness of cool paint as a mitigation measure. This will be applied to E1A building façade and selected pavements, which are key sources of anthropogenic heat. The results will be evaluated by end 2024 and scaled up campus-wide if shown to be effective.

Cool paint will be tested on the façade of E1A (shaded in blue), a west-facing building which receives direct sunlight in the afternoon and evening.

PLANTED 35,100 TREES

Under our Campus in a Tropical Rainforest programme, we have planted 35,100 trees on campus since November 2018 (up from 22,087 in 2021). We have pledged to plant 100,000 trees by FY30, contributing 10% to Singapore's OneMillionTrees movement.

We are evaluating its benefits to improve outdoor thermal comfort, such as cooling through shading and evapo-transpiration from trees.

Before (left) and after (right) images of the green space next to the multi-purpose courts in Kent Ridge campus, where 200 trees were planted in March 2023.

CREATING A ZERO WASTE CAMPUS

OUR APPROACH

As a University, we have a role in public service to shape the hearts and minds of our community to become professionals and champions in sustainability.

We will drive a whole-of-university behavioural and cultural change to make careful waste sorting for recycling and reusing for takeaways a social norm, like how it is in Japan and Korea. To reduce waste, we will establish a viable container reuse system and establish a Sustainable Procurement Framework to reduce unnecessary purchases. We will also strive to close waste loops for difficult to recycle streams, such as plastic, within campus.

Student conducting a waste composition study conducted for Tembusu RC waste chutes to derive the waste profile and measure the proportion of recyclables thrown away into the general waste stream.

> I am hopeful that our NUS community can enact a noticeable, positive cultural change through a more conscious use of our resources for the environment.
>
> **Ms Amanda Koh**
> Student, Environmental Studies (Class of 2022)

As more members of our community returned to campus post-pandemic period, our daily waste disposed per capita has increased.

At the same time, the recycling rate has increased with closer engagement with our operations staff, especially for our horticulture and food waste recycling streams.

OUR INDICATORS

32 % (+5%)

RECYCLING RATE

FY21 Baseline: 27%
FY30 Target: 50%

0.16 kg/day/capita (+14%)

DAILY WASTE DISPOSED PER CAPITA

FY21 Baseline: 0.14 kg/day/capita
FY30 Target: 0.10 kg/day/capita

The Resource Sorting Station at Tembusu Residential College has segregated streams with transparent bins to inspire confidence and controlled login access to encourage responsible use.

OUR PROGRESS

Tembusu Residential College residents trialing the Station and learning about recycling contamination issues. The Station is supported by the SG Eco Fund.

DATA-ENABLED RESOURCE SORTING STATION

We installed the Resource Sorting Station at Tembusu Residential College in January 2023 to encourage careful waste sorting for recycling. Replacing heavily contaminated recycling chutes, residents need to login with their room number to deposit their recyclables at the Station. With more deliberate sorting infrastructure, the recycling contamination rate significantly dropped from 50% to near zero. We will be extending the station to UTown Residences in 2H 2023 and work towards rolling them out to other UTown colleges in subsequent years.

Ridge View Residential College carrying out waste composition studies as part of experiential learning.

WASTE COMPOSITION STUDIES FOR PROGRAMME PLANNING

We conducted composition studies of the general waste stream to understand the waste profile of various building types. Overall, over 50% of the waste stream comprised food waste, recyclables and key takeaway disposables – items that could be diverted from general waste through reductions and recycling. This insight emphasises the importance of creating a campus waste sorting norm for recycling, reducing food waste and creating a viable alternative to takeaway disposables.

SHARING BEST PRACTICES BEYOND THE UNIVERSITY

Cross-Sharing Ideas through Sustainability Exchanges

We have hosted exchanges with interested local and international organisations to share best practices.

Campus Sustainability Roadmap

Sharing with local tertiary institutions (e.g. Republic Polytechnic, Singapore Institute of Technology) and overseas ones like Bandung Institute of Technology (above) as they develop their own roadmaps.

Sharing with Minister for Sustainability and the Environment, Ms Grace Fu (left), on our Campus Sustainability Roadmap at Green Action for Communities workshop.

Green Building Technologies

We have had the privilege of sharing our approach to achieve positive energy in SDE 4 with others, in their journey to develop buildings achieving high energy performance.

Sharing with Abu Dhabi Department of Energy, led by Undersecretary of the Abu Dhabi Department of Energy, H.E. Eng. Ahmed Mohammed Al Rumaithi (2nd from left) and Singapore's UAE Ambassador, H.E. Jamal Abdulla Al Suwaidi (1st from left). They were hosted by Prof Heng Chye Kiang, Deputy Dean of Research & Innovation (1st from right) and Mr Koh Yan Leng, Vice President of Campus Infrastructure (2nd from right).

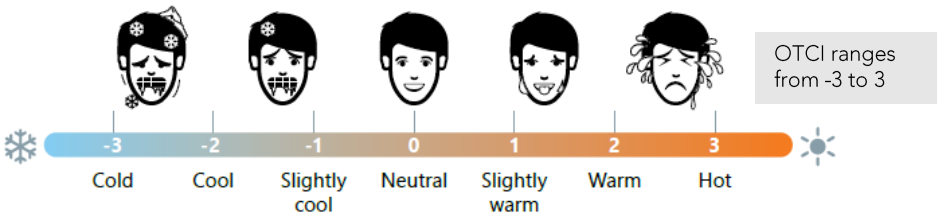
Sharing Ministry of Defence (MINDEF) and their partners, led by Mr Teo Eng Dih, Deputy Secretary (Policy) of MINDEF (1st row, 4th from right). They were hosted by Prof Heng Chye Kiang, Deputy Dean of Research & Innovation (1st row, 3rd from right) and Mr Lincoln Teo, Director of Campus Asset Management (1st row, 2nd from left).

GLOSSARY OF OUR INDICATORS

CARBON NEUTRAL NUS 2030

SCOPE 1 & 2 ABSOLUTE EMISSIONS	Greenhouse Gas (GHG) emissions 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	Total amount of electricity that we use from the grid and renewables.
ENERGY USAGE INTENSITY (EUI)	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.

COOL NUS LIVING LAB

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.

ZERO WASTE NUS 2030

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.

OUR ENVIRONMENTAL DATA

	FY19	FY20	FY21	FY22
CARBON NEUTRAL NUS (SCOPES 1 AND 2)				
Total Carbon Emissions ($ktCO_2e$)[3]	353	284	324	334
(i) Scope 1	2.8	2.3	2.6	2.2
Fuel Combustion	0.3	0.3	0.3	0.3
Fugitive Emissions from Refrigerants	2.5	2.0	2.3	1.9
(ii) Scope 2	110	101	112[6]	113
(iii) Scope 3[4]	240	181	209	219
Category 1- Purchased goods and services[5]	57	49	52	49
Category 2 – Capital goods[5]	85	69	73	63
Category 3 - Fuel and energy related activities	22	22	32[6]	33
Category 4 - Upstream transportation and distribution[5]	2	2	2	2
Category 5 - Waste generated in operations	5	4	3	4
Category 6 - Business travel	34	1	7	30
Category 7 - Employee commuting	9	10	9	9
Category 13 - Downstream leased assets	25	25	30[6]	29
Scope 2 Gross Carbon Emissions Intensity ($kgCO_2e/m^2$)	79	72	79	79

[3]GHG emissions are derived in accordance with the requirements of the "GHG Protocol Corporate Accounting and Reporting Standard". The equivalent CO_2 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.

[4]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.

[5]Scope 3 Category 1, 2, 4 figures restated from FY19 to FY21 due to the exclusion of additional categories as they do not emit material emissions e.g. licensing/subscription or are already accounted for under other Scopes e.g. the leasing of research facilities that are accounted for under Scope 2. From FY22, there was an update in the emission factors from the U.S. Environmental Protection Agency.

[6]FY21 Scope 2, Scope 3 Category 3 & 13 electricity data are restated due to improvement in data completeness on our tenants' consumption.

OUR ENVIRONMENTAL DATA

	FY19	FY20	FY21	FY22
CARBON NEUTRAL NUS (SCOPES 1 AND 2)				
Total Electricity Consumption (GWh)[7]	271	249	276[6]	280
Energy Usage Intensity (EUI) (kWh/m^2)	195	178	195[6]	195
Total Energy (GWh)	273	250	278	281
Total Energy (GJ)	975,551	895,780	995,132	1,006,605
(i) Electricity (GWh)	270	248	276[6]	279
Electricity (GJ)	973,299	893,700	992,986	1,004,841
(ii) Campus solar energy (GWh)	0.6	0.6	0.6	0.5
Campus solar energy (GJ)	2,230	2,060	2,126	1,744
(iii) Fuel use (GWh)	1.7	1.6	1.6	1.5
Fuel use (GJ)	6,139	5,580	5,637	5,549

[6]Restated for FY21 due to improvement in data completeness on tenant consumption.
[7]Total electricity consumption is the sum of (i) electricity from the grid & (ii) campus solar energy used.

OUR ENVIRONMENTAL DATA

	FY19	FY20	FY21	FY22
COOL NUS				
Outdoor Thermal Comfort Index (OTCI)	Baseline to be established by FY24			
Predictive Percentage Dissatisfied (PPD)	Baseline to be established by FY24			
ZERO WASTE NUS				
Total Waste Generated (tonnes)	5,920	5,077	3,995	5,024
(i) Incinerated / Waste directed to disposal by disposal operation	4,416	3,535	2,925	3,426
(ii) Recycled / Waste diverted from disposal by recycling operation	1,420	1,506	1,070	1,598
Paper, Plastic, Metal, Glass	81	81	109	134
Food	209	165	282	367
Horticulture	1,130	1,260	633	1,043
Electronic Waste (E-waste)	-	-	46	54
Recycling Rate	24%	30%	27%	32%
Daily Waste Disposed per Capita (kg/day/capita)	0.22	0.17	0.14	0.16
OTHER ENVIRONMENTAL DATA				
Gross Floor Area (million m^2)	1.39	1.40	1.41	1.43
Campus Fleet Vehicles Electrified (%)	0%	6.5%	11%	17%
No. of Trees Planted (Cumulative)	5,915	15,154	22,087	35,100
Green Mark-Certified Gross Floor Area (%)	55%	55%	59%	60%
No. of Green Mark Platinum Developments (Cumulative)	27	28	40	44
Water Consumption (million m^3)	2.02	1.68	1.66	1.78
Water Efficiency Index (WEI) (m^3/m^2)	1.41	1.16	1.22[6]	1.24

WASTE COMPOSITION STUDIES

Waste composition studies were conducted between 18 April – 5 May 2022. The methodology comprised sorting and weighing of the general waste contents according to the listed categories for each listed bin centre across three days. The weight listed below reflected the average of the three days.

	Building Category	Recyclables (Packaging & E-Waste)[8] % (kg)	Food Waste % (kg)	Takeaway Disposables[9] % (kg)	Non-Recyclable Waste[10] % (kg)
UTown	-	**18% (53)**	**25% (74)**	**13% (39)**	**44% (131)**
Utown Residence - North	Residential	18% (9)	36% (19)	14% (7)	33% (17)
Utown Residence - South	Residential	17% (9)	29% (15)	13% (7)	41% (21)
Tembusu/Cinnamon College	Residential	16% (9)	22% (12)	11% (6)	51% (27)
RC4 / College of Alice & Peter Tan	Residential	21% (12)	27% (15)	11% (6)	41% (23)
Stephen Riady Centre	Mixed Use	17% (15)	16% (13)	15% (13)	51% (43)
Techno Edge Canteen	Canteen	**13% (7)**	**54% (29)**	**8% (4)**	**25% (13)**
EW1A	Teaching Facility	**26% (14)**	**8% (4)**	**26% (14)**	**40% (21)**

[8]Recyclables (Packaging & E-Waste) refer to glass, plastic (HDPE, PET), metal, paper, e-waste.
[9]Takeaway disposables refer to takeaway food and drinks containers.
[10]Non-recyclable waste refers to non-recyclable packaging (e.g. plastic bags, UBC, candy wrappers, sandwich containers), other wet waste (e.g. tissue paper, disposable utensils, aluminum foil, sanitation pads, masks) and other dry waste (e.g. textile, ceramic/ porcelain, wood, rubber, stationery).

KEY TERMS

Carbon Neutral	Refers to the reduction of Scopes 1 and 2 absolute emissions to as far as possible, followed by the purchase of quality carbon offsets through reputable, credible platforms.
Greenhouse Gas (GHG)	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 (CO_2), methane (CH_4) and nitrous oxide (N_2O).
kgCO_2e	Refers to the unit of measurement that accounts for all GHG emissions. As different GHGs have different global warming potentials (i.e. heat absorbed in the atmosphere), this reflects the number of kilograms of carbon dioxide (CO_2) emissions with the same global warming potential as one kilogram of another GHG. This allows us to evaluate all emissions in a single metric.
kWh	Refers to a unit of measurement for electrical energy. Mathematically, it refers to the amount of power (kilowatts or kW) that appliances consume over a time period (hour or h), where one kilowatt (kW) equals 1,000 watts (W).
Zero Waste	Refers to applying the waste hierarchy with an aim to send as little as possible for incineration (~10-20%). This means to rethink/redesign production and materials, reduce, reuse, recycle, and utilize waste-to-resource technologies (i.e. generating valuable products from waste).

Credits

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- Duke-NUS Medical School
- Office of Finance
- Yale-NUS College

Solar panels on the rooftop of Ventus. Ventus is home to UCI and a GM Platinum certified building with an EUI of 60 kWh/m^2. Built around existing site topography and greenery, it is designed upfront for natural ventilation. For example, it features a wind scoop area which is shaped like a funnel to increase airflow.