NUS Campus Sustainability
ROUNDUP 2021

RESOURCE SORTING STATION

#NUS

Ventus

University Campus Infrastructure
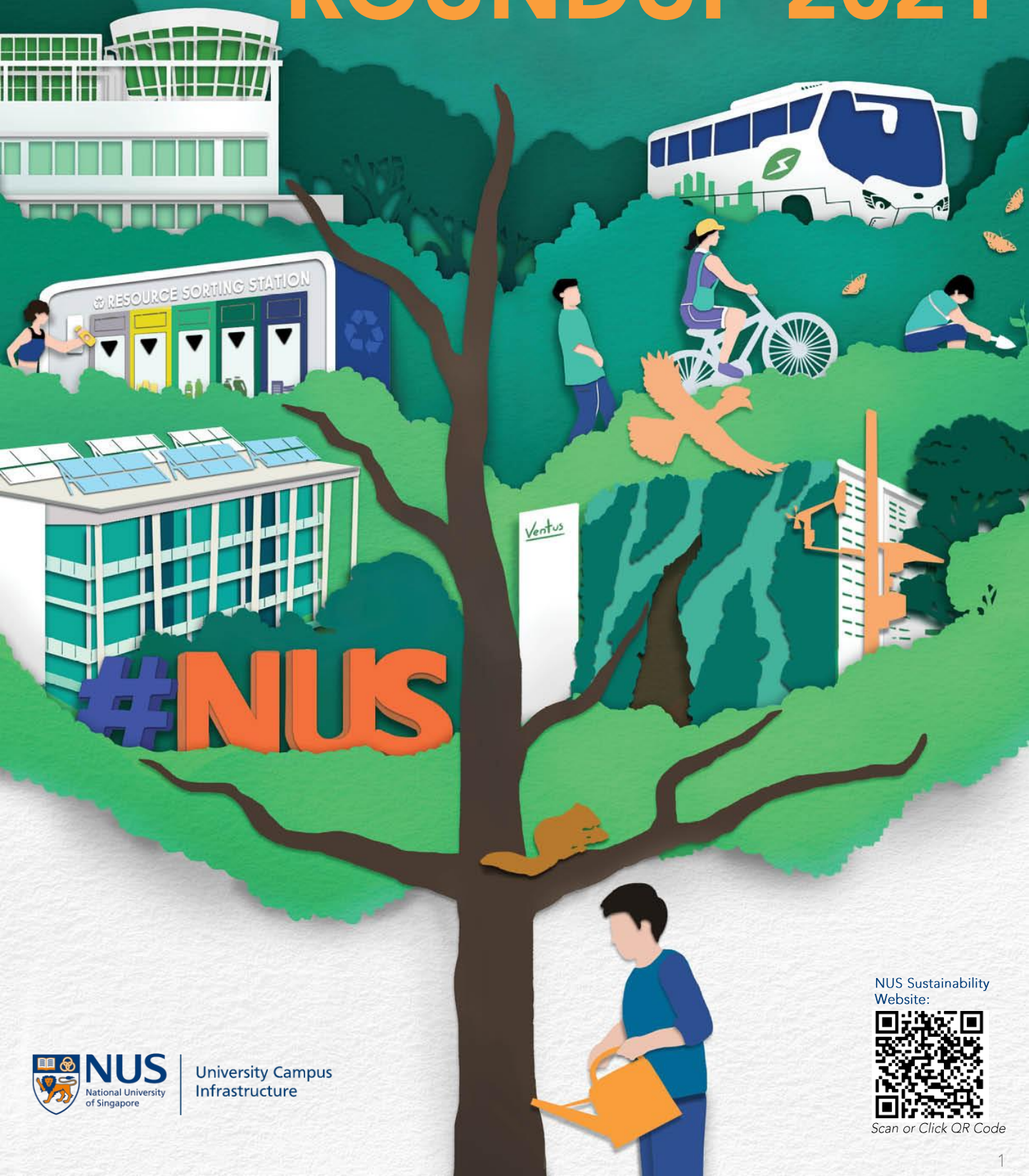
NUS Sustainability Website:

YEAR IN REVIEW: ROADMAP TO 2030 DEVELOPED

Sustainability and climate action have gained impetus nationally with the launch of the inter-ministry Singapore Green Plan 2030. Our past 2017-2020 Sustainability Strategic Plan has positioned us well to contribute to national efforts, like a seedling growing into a tree. Building on our past efforts, we have developed our Campus Sustainability Roadmap 2030 with three main anchor programmes – Carbon Neutral NUS 2030, Cool NUS Living Lab and Zero Waste NUS 2030.

Climate Mitigation

CARBON NEUTRAL NUS

Taking responsibility for our carbon footprint, we aim to achieve carbon neutrality with a strong priority in achieving energy reductions.

Climate Adaptation

COOL NUS

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

Sustainability & 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.

In our 10-year Roadmap, we have set more ambitious targets, such as ramping up our decarbonisation efforts with a strong priority on energy reductions, cooling our campus to improve outdoor thermal comfort and closing waste loops. These goals are very challenging amid a growing campus with new research needs, especially since our campus is mature and densely built-up.

As a leading research university, we are collaborating with our research community to use our campus as a living lab to testbed initiatives to address these challenges. Our efforts will bear fruit when we harness our collective intellectual and operational resources to innovate. For example, we are tapping on the College of Design and Engineering's expertise in urban heat island to set up a high resolution sensor network to establish the Kent Ridge campus baseline micro-climate conditions. With this baseline, we will be able to simulate and implement measures to improve our outdoor thermal comfort.

As an educational institution, we have a role in public service to nurture the hearts and minds of our students and staff to be change catalysts and leaders of sustainability. In the next few years, we will shift the needle towards nurturing a sustainable culture, such as creating a culture of careful waste sorting and reuse towards an operational Zero Waste campus and involving our community in our 100,000 tree planting efforts.

Sustainability remains at the root of what we do at University Campus Infrastructure (UCI). We will continue to integrate our various programmes and develop infrastructure to shape sustainable behaviours. In turn, we hope that our efforts will bear fruit as our students shape the change for future generations.
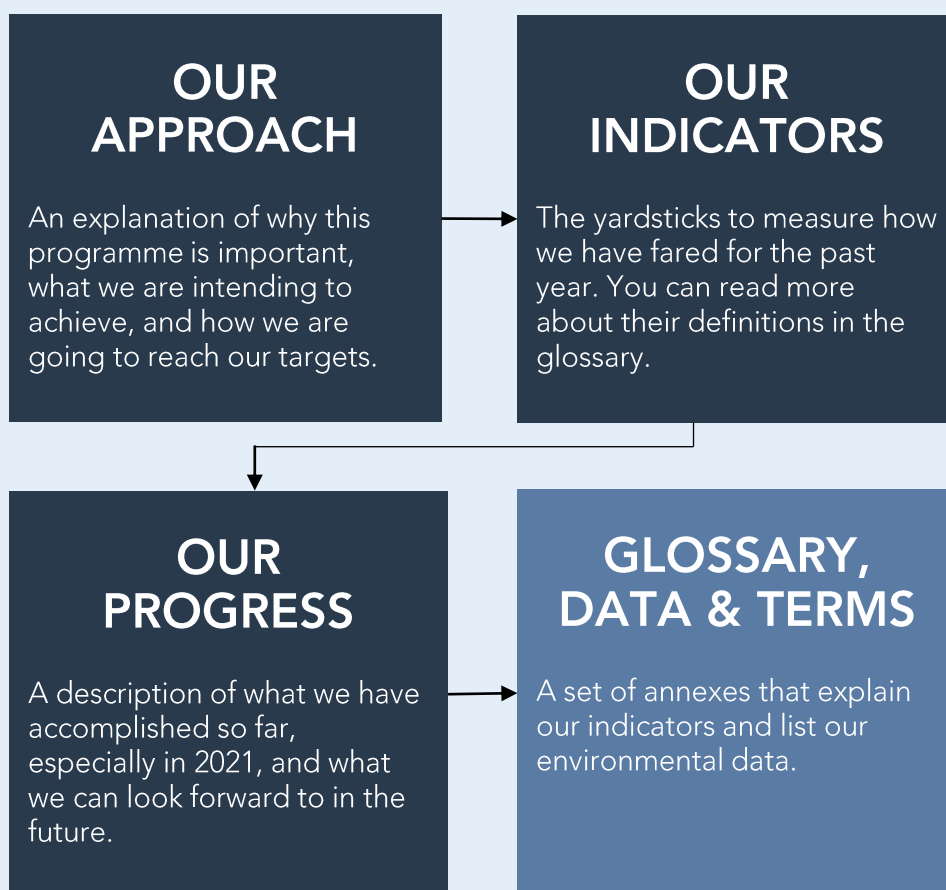
Mr Koh Yan Leng
Vice President (Campus Infrastructure)
National University of Singapore

ABOUT THIS DOCUMENT

This document details the NUS campus' sustainability performance in Financial Year (FY[1]) 2021, spanning 1 April 2021 to 31 March 2022 (denoted as "2021" in this publication).

Following the conclusion of our 2017-2020 Sustainability Strategic Plan, we have revised and set more ambitious targets. Our organisational boundary comprises largely of our three main campuses, Kent Ridge, Bukit Timah and Outram[2]. We have updated buildings within these boundaries mainly due to new buildings being added. For our emissions and electricity targets, we have established a new baseline year of 2019 – the most recent year before the pandemic. We have updated our emissions inventory computation methodology, to cover Scopes 1, 2 and 3 for all relevant categories in accordance with the GHG Protocol Corporate Accounting and Reporting Standard. For waste, we have enhanced the granularity and accuracy of our data with the implementation of the smart waste and recycling collection system in 2021 that provides bin centre-level data. With this, we have established 2021 as the new baseline year for our waste targets.

HOW TO READ THIS DOCUMENT

OUR APPROACH

An explanation of why this programme is important, what we are intending to achieve, and how we are going to reach our targets.

OUR INDICATORS

The yardsticks to measure how we have fared for the past year. You can read more about their definitions in the glossary.

OUR PROGRESS

A description of what we have accomplished so far, especially in 2021, and what we can look forward to in the future.

GLOSSARY, DATA & TERMS

A set of annexes that explain our indicators and list our environmental data.

[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).

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

STRATEGIES TO REDUCE GREENHOUSE GAS EMISSIONS

Redesign

We will set stretched design targets for new buildings and retrofits to avoid energy consumption on the onset and ensure that these standards are upheld in operation.

Reduce

We will increase energy efficiency through campus-wide optimisation and upgrade of remaining chiller plants and change lights to LED, and reducing electricity consumption by building type.

Replace

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

Restore

As a last resort, for emissions that we cannot abate, we will procure quality carbon offsets.

Highest Priority

We will also embark on a sustainable procurement framework to reduce our Scope 3 emissions.

4

In 2021, our emissions and electricity usage have increased but we will persevere to mitigate the rise, against a growing campus with new research needs and an increasing population.

The increase in emissions and electricity usage was due to the addition of new research buildings such as E7 and S9. For the last decade, we have mitigated emissions growth despite a growing campus. We have done it before and are committed to mitigating our Business-As-Usual (BAU) emissions.

OUR INDICATORS

115 $ktCO_2e$ (+ 1%)

SCOPE 1 & 2 ABSOLUTE EMISSIONS
Scope 1: 2.6 $ktCO_2e$ Scope 2: 112 $ktCO_2e$
[Scope 3: 199 $ktCO_2e$]

FY30 Target: 79 $ktCO_2e$
(FY30 BAU: 133 $ktCO_2e$)
FY19 Baseline: 113 $ktCO_2e$
Scope 1: 2.8 $ktCO_2e$ Scope 2: 110 $ktCO_2e$
[Scope 3: 240 $ktCO_2e$]

276 million kWh (+ 2%)

ELECTRICITY CONSUMPTION

FY30 Target: 240 million kWh
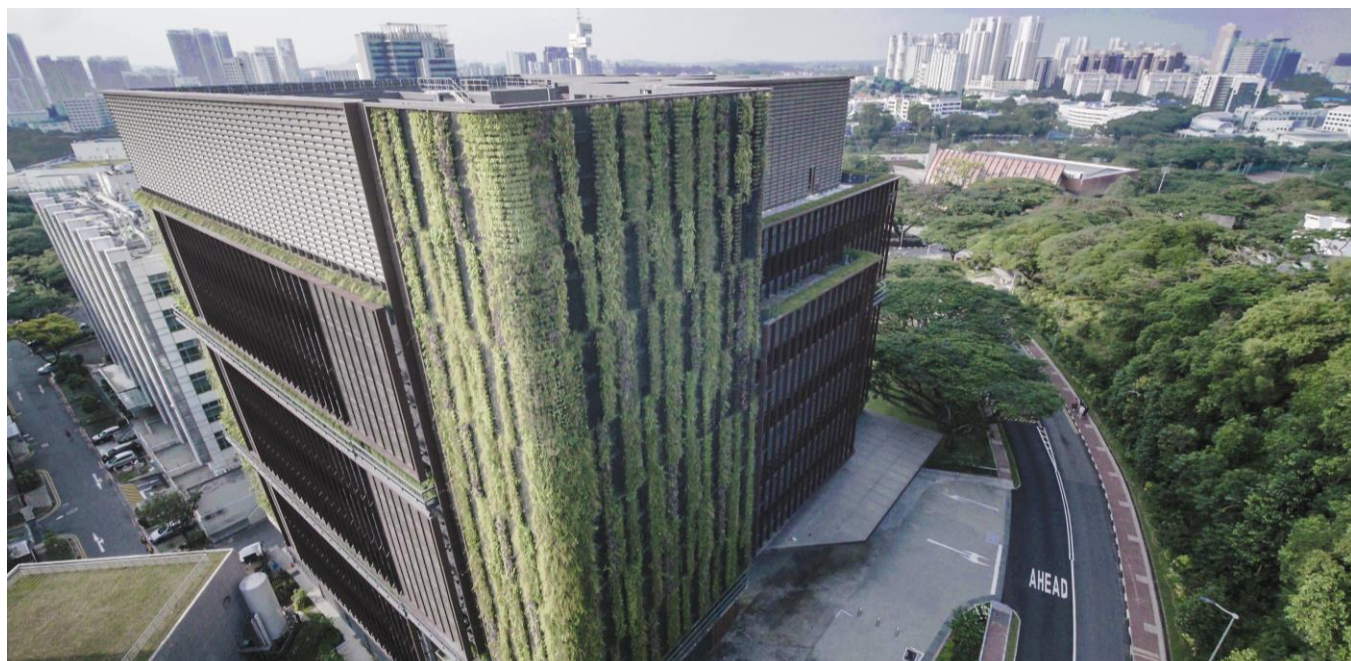(FY30 BAU: 321 million kWh)
FY19 Baseline: 271 million kWh

195 kWh/m^2 (+ <1%)

ENERGY USAGE INTENSITY (EUI)

FY30 Target: 156 kWh/m^2
(FY30 BAU: 209 kWh/m^2)
FY19 Baseline: 195 kWh/m^2

E7, a facility for research on healthcare technology was opened in early 2021. It includes sustainable architecture such as vertical fins around its façade to control the amount of sunlight entering the building and is a Green Mark (GM) Platinum certified building.

TACKLING SCOPE 1 EMISSIONS BY ELECTRIFYING CAMPUS MOBILITY & PLANTING 100K TREES BY 2030

OUR PROGRESS

Measurement

📄
Reporting

Developed GHG Emissions Inventory

We have computed our full Greenhouse Gas (GHG) emissions inventory in accordance with the GHG Protocol Corporate Accounting and Reporting Standard, providing us with a consistent and verifiable baseline.

Please refer to Our Environmental Data for the breakdown covering all categories of our Scope 1, 2 and 3 emissions. This puts us in good standing to embark on developing a green procurement strategy to tackle Scope 3 emissions.

Scope 1

Replace

Electrified 11% of Campus Fleet

We have changed 3 vehicles to electric ones and are working towards electrifying 100% of our 28 campus-owned fleet by FY30.

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

Beyond our campus fleet, we will be electrifying our shuttle bus fleet by the end of 2022.

Planted 22,087 Trees

Restore

Members of the NUS community planting trees next to E7 in December 2021.

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

Mr Koh Yan Leng (Vice President, Campus Infrastructure) [first row, second from right] with UCI team accepting the GM Platinum Champion Award from Mr Jeffery Neng (Deputy Group Director, BCA) [first row, third from right] and BCA team.

ENHANCING ENERGY EFFICIENCY – AN ONGOING EFFORT

While there was an increase in our Scope 2 (electricity usage) emissions in 2021, we are continuing our efforts to mitigate it, such as through ongoing chiller plant consolidation and energy audits. We see our years of hard work greening our built environment bear fruit, having bagged the GM Platinum Champion Award, BCA's top accolade. We will continue to do more to reduce our electricity consumption.

SDE4, Singapore's first new-build net-zero energy building, on track to becoming positive energy, with more than 1,200 PV panels on its rooftop.

OUR PROGRESS (CONTINUED)

Scope 2

Awarded Green Mark Platinum Champion

Redesign

Clinched Building Construction Authority (BCA)'s top Green Mark (GM) Platinum Champion Award for achieving 50 GM Gold and above certifications for developments across campus, including 40 GM Platinum certifications.

Upgraded BTC Chiller Plant

Reduce

Our efforts in upgrading chiller plants have been ongoing since 2012 with an overall efficiency of around 0.65 - 0.7 kW/RT, with the latest at Bukit Timah Campus achieving an efficiency improvement of 36% (0.90 kW/RT to 0.58 kW/RT). We will continue to upgrade and optimize our remaining plants such as those at University Cultural Centre and I3/COM2.

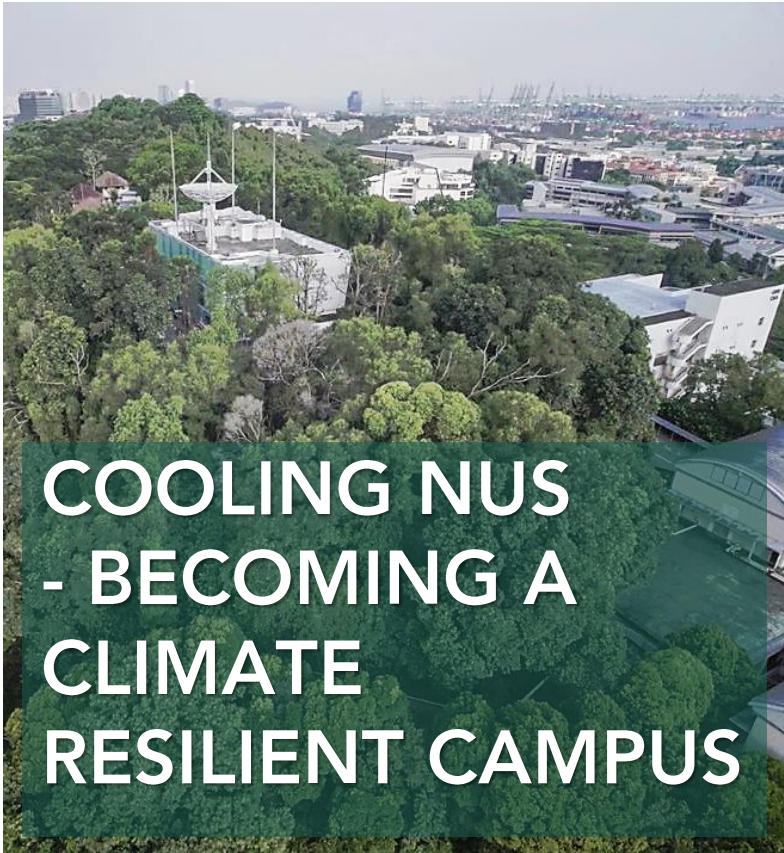### Commencing Energy Audits

Reduce

To further cut electricity consumption at the building level, we will be conducting comprehensive energy audits in various building types, starting with the most energy intensive buildings such as research laboratories. The recommendations arising from our audit findings will help to establish the optimised energy demand of selected buildings.

Campus-wide Solar PV Rollout

Replace

We are installing up to 9.2 MWp of solar photovoltaic (PV) capacity, up from our current 1 MWp. We will complete the installation by 2024. This comprises 4% of our total electricity consumption or equivalent to powering 2,000 four-room HDB flats for a year. We plan to maximise our solar PV capacity by exploring solar PVs with higher energy efficiency for our remaining roof tops., and will also explore procuring overseas renewable energy.

COOLING NUS - BECOMING A CLIMATE RESILIENT CAMPUS

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 environmental big 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, with its varied urban morphology and building uses, is an ideal living laboratory to testbed urban heat island mitigation strategies. As Singapore gets hotter and more humid due to global warming, ensuring our campus is climate resilient and livable with an acceptable level of thermal comfort outdoors is imperative.

In partnership with researchers from the College of Design & Engineering (CDE), we will be starting a BEAM project (<u>B</u>aselining, <u>E</u>valuating, <u>A</u>ction, <u>M</u>onitoring) to install a comprehensive high resolution sensor network to establish the Outdoor Thermal Comfort Index (OTCI) of the campus, simulate, and testbed heat mitigation interventions such as cool paint, greenery and removing anthropogenic heat sources.

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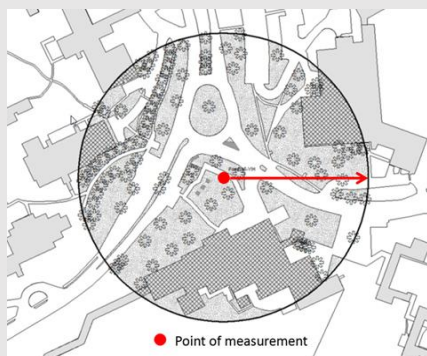

Weather station[2] installed in NUS.

[2]Image source: Cool NUS research team from the CDE.

OUR INDICATORS

BASELINING WITH EXTENSIVE SENSOR NETWORK

We will establish our baseline using two indicators by FY24: OTCI and Predictive Percentage Dissatisfied (PPD). To do so, we will collect large amounts of dense environmental data through an extensive sensor network that covers various location types – from ground-based to entire building facades.

This will be complemented with simulation modelling, such as air temperature modelling and urban ventilation analysis.


Our sensor network density will be the most extensive for campuses in Singapore, with over 50 sensors including weather stations, infrared cameras, meteorological towers and an unmanned aerial vehicle.

STEVE (Screening Tool for Estate Environment Evaluation) tool – the air temperature predictor. It predicts the air temperature within a 50-metre radius around a particular point, using urban morphology predictors such as green plot ratio.[3]
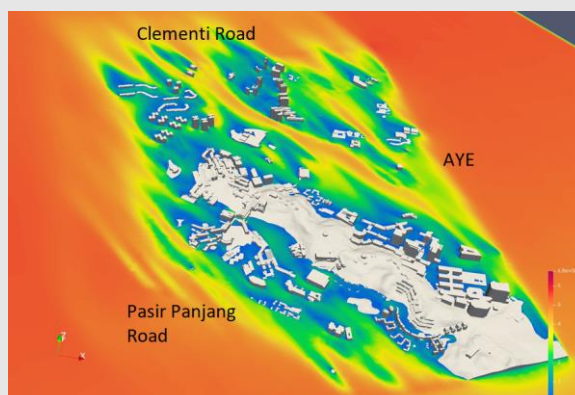
Urban ventilation analysis of NUS using Computational Fluid Dynamics (CFD).[3]

Outdoor Thermal Comfort Map of NUS
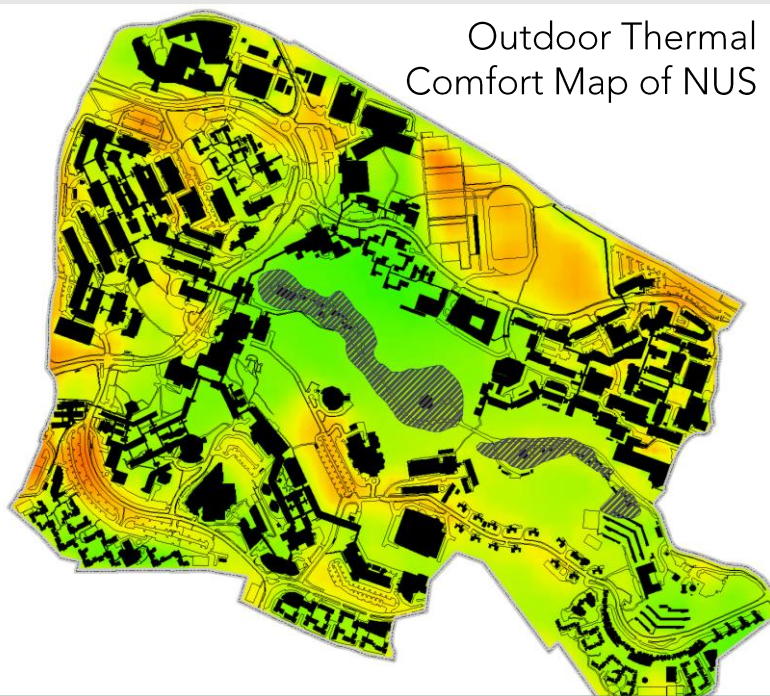
Outdoor Thermal Comfort map of NUS generated using 2019-2020 preliminary data.[3]

OUR PROGRESS

EVALUATING, ACTION & MONITORING MEASURES

We will select mitigation measures for testbedding by simulating their impact at hot spots on campus, guided by the baseline measurement. We will testbed these measures on campus and continue using the sensor network to monitor their effectiveness by FY25.

[3]*Image source: Cool NUS research team from the CDE.*

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, similar to how it is in Japan and Korea. To reduce waste, we will phase out key takeaway disposables in food and beverage establishments. We will explore opportunities to close our waste loops with emerging technologies.

Students from Ridge View Residential College (RVRC) conducting a waste composition study of their own general waste in March 2022. Following the study, RVRC subsequently phased out takeaway disposables in their dining hall as it constituted a major component of their waste stream.

" At the heart of the plan is the drive to instil behavioural change throughout the campus community and see students conscientiously sort and recycle their waste at student residences.

Professor Tan Eng Chye
NUS President

We have progressively established recycling for all major waste streams – paper, metal, plastic, food, electronic and horticulture waste, and significantly improved our recycling rate from 9% in 2012 to 27% in 2021. The next leap for us is to create an operational Zero Waste campus by 2030, including closing waste loops for materials such as plastic.

OUR INDICATORS

27 %

RECYCLING RATE

FY30 Target: 50%

0.14 kg/day/capita

DAILY WASTE DISPOSED PER CAPITA

FY30 Target: 0.10 kg/day/capita

Mr Tommy Cheong (NUS Industrial Design, Class of 2020) [middle], designer of the Recycle Right bins, with Ms Grace Fu (Minister for Sustainability and the Environment) [right] and Ms Low Yen Ling (Mayor of South West District) [left].

CO-CREATING A ZERO WASTE CAMPUS

OUR PROGRESS

ALBA-WH's waste trucks are fitted with load cells that collect waste weight data from RFID-tagged bins at every bin centre.

Measurement
Getting Granular Data

We have worked closely with our collector, ALBA-WH, to deploy a smart waste and recycling collection system that provides granular bin centre-level data, compared to the previous aggregated campus data that is the industry norm. To delve deeper, we have also conducted audits to verify data accuracy and waste composition studies to gain insights on the breakdown of the waste disposed. These exercises will enable us to develop targeted initiatives to engage various stakeholders.

Sorting More, Sorting Right
Recycle Right Bins

We have rolled out *Recycle Right* bins starting from two precincts to the entire campus to get the community into the habit of sorting. These bins were also piloted in shopping malls in collaboration with the National Environment Agency (NEA) and were similarly proven to be effective in reducing recycling contamination rate from 79% to 29%. To further enhance sorting on campus, we have plans to trial resource sorting stations in our Residential Colleges.

RecyClean, a student group, led a publicity campaign partnering with the NUS Zero Waste Taskforce.

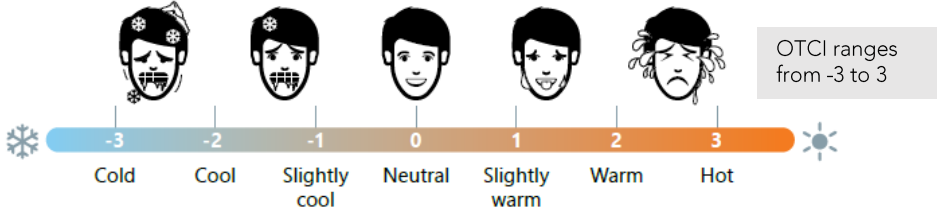### Co-Creating Ideas to Reality
Zero Waste Testbed Initiative

Together with South West Community Development Council (SW CDC) and supported by NEA, we have funded and mentored four pilot projects which were tested on campus, covering the topics of recycling right, waste-to-resource and promoting reuse. One of the projects included an evidence-based publicity campaign that resulted in a 10% decrease in recycling contamination rate in University Town.

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)	OTCI ranges from -3 to 3. 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
CARBON NEUTRAL NUS 2030 (SCOPES 1 AND 2)			
Total Carbon Emissions (ktCO$_2$e)	342	275	314
(i) Scope 1	2.8	2.3	2.6
Fuel Combustion	0.3	0.3	0.3
Fugitive Emissions from Refrigerants	2.5	2.0	2.3
(ii) Scope 2	110	101	112
(iii) Scope 3[4]	229	172	199
Category 1 & 2 - Purchased goods and services, capital goods	132	110	115
Category 3 - Fuel and energy related activities	22	22	33
Category 4 - Upstream transportation and distribution	2	2	2
Category 5 - Waste generated in operations	5	4	3
Category 6 - Business travel	34	1	7
Category 7 - Employee commuting	9	10	9
Category 13 - Downstream leased assets	25	25	30
Total Energy (million kWh)	271	249	276
(i) Electricity	270	248	276
(ii) Campus solar energy	0.6	0.6	0.6
Energy Usage Intensity (EUI) (kWh/m^2)	195	178	195
Gross Floor Area (million m^2)	1.39	1.40	1.41

[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.

OUR ENVIRONMENTAL DATA

	FY19	FY20	FY21
COOL NUS LIVING LAB			
Outdoor Thermal Comfort Index (OTCI)	Baseline to be established by FY24		
Predictive Percentage Dissatisfied (PPD)	Baseline to be established by FY24		
ZERO WASTE NUS 2030[5]			
Total Waste Generated (tons)	5,920	5,077	3,995
(i) Incinerated	4,416	3,535	2,925
(ii) Recycled	1,420	1,506	1,070
Paper, Plastic, Metal, Glass	81	81	109
Food	209	165	282
Horticulture	1,130	1,260	633[6]
Electronic Waste (E-waste)	-	-	46[7]
Recycling Rate	24%	30%	27%
Daily Waste Disposed per Capita (kg/day/capita)	0.22	0.17	0.14
OTHER ENVIRONMENTAL DATA			
Campus Fleet Vehicles Electrified (%)	0%	6.5%	11%
No. of Trees Planted (Cumulative)[8]	5,915	15,154	22,087
Green Mark-Certified Gross Floor Area (%)	55%	55%	59%
No. of Green Mark Platinum Developments (Cumulative)	27	28	40
Water Consumption (million m^3)	2.02	1.68	1.66
Water Efficiency Index (WEI) (m^3/m^2)	1.41	1.16	1.17

For past data, please refer to: NUS Sustainability Review 2017-2020.

[5] FY21 was selected as the baseline year as we have bin centre-level waste data in FY21, arising from the implementation of the smart waste and recycling collection system. FY19 and FY20 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.

[6] For horticulture waste, in FY19 and FY20, the data was collected by estimations by waste volume. In FY21, the data collection methodology has been updated. From January 2022 onwards, the data is collected by using a weigh bridge and all FY21 data has been rebased using the weigh bridge data obtained.

[7] From FY21, we have added electronic waste into the computation of recycling rate.

[8] Count of trees planted started from the launch of the Planting 10,000 Trees initiative in November 2018. We have since stretched the target to 100,000 trees.

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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 platforms like Climate Impact X.
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$_2$e	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).

Produced by NUS University Campus Infrastructure (UCI), Sustainability Strategy Unit.

With thanks to the following NUS entities for their inputs:
* Campus Planning & Management Unit, UCI
* Central Procurement Office
* Division of Campus Asset Management, UCI
* Division of Campus Life, UCI
* Duke-NUS Medical School
* Office of Finance
* Yale-NUS College

Solar panels on the rooftop of Ventus, home to UCI and a GM Platinum certified building.