NUS SUSTAINABILITY REPORT 2023

Contents

Cover | Built in the 1970s, SDE1 and SDE3 at the NUS College of Design and Engineering are two adaptive reuse projects. They were redesigned to meet new use requirements while preserving the buildings' embodied carbon and reducing their energy consumption by two-thirds from pre-renovation levels. They are compelling case studies showcasing the application of adaptive reuse interventions to optimise existing structures and improve energy efficiency, which NUS faculty and students can teach and learn from.They also represent the next benchmark for built environment renovation and sustainability on campus and beyond.

This is an interactive report. Use the navigation bar and the page titles on the contents page to jump to specific sections. Clicking on in-text links will direct you to more information outside of the report.

Our approach to sustainability

Sustainability is deeply embedded in everything that is done at the National University of Singapore (NUS), from education to research and campus operations.

The university recognises the interdisciplinary nature of sustainability and climate change education and research. By leveraging intellectual resources across academic disciplines, it aspires to provide students with a broad understanding of sustainability issues to face an increasingly complex future. This will in turn build a strong culture and consciousness of sustainability in the next generation.

On the research front, NUS has deepened its research capabilities and enhanced collaborations and synergies – within and beyond the campus – to generate solutions for greater environmental and societal impact. Its expansive university grounds operate as a living laboratory to testbed technologies and create innovative learning experiences for students.

NUS also endeavours to be responsible stewards of the physical environment, by applying sustainability principles to the master-planning, design and construction, renovation, operation, and maintenance of its buildings and campuses. It strives to reduce its carbon footprint by minimising resources used; reducing waste and carbon emissions; and protecting, preserving, and enhancing the natural environment.

Lastly, through its students and alumni, the university spearheads sustainability within and outside of campus, be it through ground-up initiatives or as leaders of organisations and companies.

As a sign of its commitment, the University Sustainability and Climate Action Council was formed in 2021 to build on its involvement and momentum in spearheading sustainability. Chaired by the NUS President and composed of faculty and staff, the council guides and shapes policies and programmes that will transform how the university generates new knowledge, equips graduates with future-ready skills, and develops a climate-resilient campus.

Report scope

As NUS' first comprehensive sustainability report, this publication tracks the university's contributions to environmental and climate-related sustainability up to December 2023. Sustainability is embedded in all aspects of the university and this report does not claim to be a complete retelling of all that has been done. Rather, the initiatives featured within were carefully selected to showcase the depth and breadth of its efforts.

Many of its sustainability programmes and initiatives support the United Nations Sustainable Development Goals (SDGs) – a global framework designed to accelerate sustainability and climate action by 2030. Broadly, its efforts contribute to the following SDGs:

While Environmental, Social, and Governance (ESG) reporting frameworks and definitions of sustainability cover a broad spectrum of environmental, financial, and social sustainability themes, including gender equality and health and well-being, this report centres on environmental sustainability. It allows for a more focused documentation of its contributions to the environment.

Depending on the type of data, three different reporting time frames were used:

- AY: Academic Year – A one-year study period, comprising two semesters and a special term (every August to July of the following year)
- FY: Financial Year – A one-year fiscal year, typically used for financial accounting and budgeting (every April to March of the following year)
- CY: Calendar Year – A one-year period from January to December

Data highlighted in this report is both quantitative and qualitative, and all data sources are from NUS, unless otherwise stated.

President's foreword

NUS stands at the forefront of scientific research and technological innovation, with our campus serving as a living laboratory for experimentation and discoveries, producing research and knowledge which translate into real-world applications.

Pushing the boundaries of science, we invest in research into sustainable energy solutions such as hydrogen. Our Centre for Hydrogen Innovations aims to make hydrogen commercially viable as a green energy source through new technologies and enable a hydrogen economy – one that relies on hydrogen as one of the major commercial fuels to power Singapore's energy needs.

The Carbon Integrity project by our Centre for Nature-based Climate Solutions monitors natural habitats to map nature-based projects across Southeast Asia – home to many natural and diverse ecosystems including rainforests, peat swamps, and mangroves. They can be developed as potential sources of high-quality carbon credits representing real and additional emissions reduction for investment opportunities.

In advancing energy efficiency and cooling technology, the Sustainable Tropical Data Centre Testbed at NUS is the first in the world to discover innovative and sustainable cooling solutions for power-intensive data centre operations, tailored for the hot and humid climate, such as that in Singapore.

We have also made significant strides in advancing sustainability, across education, the built environment on campus, and leadership.

Our undergraduate, postgraduate, and lifelong learning curriculum stays abreast of new and evolving sustainability trends, ensuring our graduates are imbued with interdisciplinary skills to succeed in the green economy. Our Master of Science in Sustainable and Green Finance, for example, is the first of its kind to equip students with the knowledge to address sustainability challenges through financial solutions.

Sustainability goes beyond the labs to the campus with Singapore's first building cluster targeting net-zero energy,

comprising two rejuvenated buildings at our College of Design and Engineering – SDE1 and SDE3, which come with innovative features to improve energy efficiency; and SDE4, Singapore's first purpose-built net-zero energy building. NUS also received the President's Award for the Environment 2023, Singapore's highest accolade for environmental sustainability, for our commitment to sustainable development and climate action.

As we make meaningful progress in our sustainability journey, we believe it is the right time to publish our inaugural NUS Sustainability Report. This report aims to not just present a holistic view of what we as a university have accomplished, but also ensure we stay on track in meeting our goals and aspirations.

Building a more sustainable future requires consistent and collective effort. At NUS, we are committed to be cognisant of the world's changing needs, and strive to be a global leader in sustainability.

Professor Tan Eng Chye
President
National University of Singapore

2023 Impact at a glance

Data as at December 2023 unless otherwise indicated.

Leadership

11%

of senior NUS leaders

engaged in advisory roles, consultation work, or held non-executive directorships in sustainability-related companies

Education

>800

sustainability-centric courses

offered across the undergraduate, postgraduate, and continuing education curriculum

47%

of undergraduates

found jobs in sustainability-related industries

171

alumni

founded sustainability-related companies (An increase of 44% from Dec 2019)

26%*

of undergraduates

have taken at least one sustainability-related course (AY2023)

*Figure restated due to double counting.

Research

16%

of all research and academic papers published

are sustainability-related (CY2022)

S$178M

in competitive funding

for sustainability research (FY2022)

90

ongoing research collaborations

with external partners on sustainability-related research projects

24

sustainability-related spin-off companies

set up based on NUS Technology

Campus

Launch of the university's first net-zero energy building cluster

comprising SDE1 and SDE3, two adaptive reuse projects, and SDE4, Singapore's first purpose-built net-zero energy building

35%

of target met

to plant 100,000 trees by 2030 (As at March 2023)

32%

recycling rate

(An increase of five percentage points from FY2022)

First Singapore university to receive the President's Award for the Environment

for advancing sustainable development and significantly greening the built environment on campus

Education

MOULDING MINDS

Sustainability is infused into the undergraduate and postgraduate curriculum at NUS, to equip students with the green skills needed to succeed in a low-carbon future.

Imparting sustainability knowledge and skills to learners of all ages

Today's graduates form the backbone of tomorrow's organisations. As the world strives towards a more sustainable future, universities play a vital role in equipping students with the knowledge and skills to be active contributors to the movement.

To prepare its students, NUS has infused sustainability into the undergraduate and postgraduate curricula, either in the form of new programmes or upgrades to existing ones. Through these efforts, it introduces green skills at four levels of specialisation – general awareness and understanding of sustainability; skills that are applicable across sectors and functions; sector-specific capabilities; and lastly, competencies targeted at frontier industries.

At the same time, universities are trusted disseminators of knowledge and have a strong hand in reshaping perspectives. NUS' Faculties and Schools keep a close watch on the evolving sustainability needs of Singapore and beyond, and create programmes that help graduate students and adult learners meet them.

NUS offers a range of environment-related master's programmes, such as in the fields of environmental management, sustainable and green finance, and climate change and sustainability. They are offered in response to a growing need for expertise in these fields.

The university also offers Continuing Education and Training Programmes in emerging areas to help adult learners upskill and reskill. In designing these programmes, it collaborates with government agencies, the industry, and corporate partners to ensure that they meet the specific needs of the workforce.

As the sustainability landscape is ever-changing, NUS' curricula are reviewed regularly to ensure that they are up to date and set its graduates up for success. Here are some of the ways it is bolstering knowledge and expertise in sustainability.

Highlights in numbers

Undergraduate Education
(AY2023)

7
sustainability-themed majors

12
sustainability-themed minors

29
sustainability-themed specialisations

Postgraduate Education
(AY2023)

11
sustainability-related master's programmes

Graduate Employment

47%
of undergraduates found jobs in sustainability-related industries
(CY2023)

Innovation and Enterprise

171 alumni

founded sustainability-related companies as at Dec 2023
(An increase of 44% from Dec 2019)

114 sustainability-related startups

founded by alumni as at Dec 2023
(An increase of 36% from Dec 2019)

Informal Education

>20 environmental student groups
(As at Dec 2023)

Professional and Executive Education
(CY2023)

3
Graduate Certificates

31
Short Courses*

7
Executive Education Programmes

**Short courses may be stacked towards Professional Certificates*

Enrolment in Sustainability-Themed Programmes

2,036
students taking undergraduate majors, minors, and specialisations
(AY2023)

977
students taking master's programmes
(AY2023)

890
training places in Professional and Executive Education
(CY2023)

Ready to excel in a green future

NUS graduates are prepared for a green economy, even if they did not pursue a sustainability-themed degree programme.

Undergraduates can pick between seven majors and 12 minors to take up outside their main course of study to supplement their learning and acquire green skills.

This is especially crucial since a report by LinkedIn revealed that someone who possesses at least one green skill has a 29 per cent higher likelihood of getting hired compared to those who do not.

The minors offered by NUS are not just bite-sized versions of different majors either. Unique programmes, such as the Minor in Botany and Minor in Meteorology and Climate Science, are the first of their kind at the undergraduate level in Singapore. The latter introduces students to the complex field of weather and climate.

Jointly developed by NUS and the National Parks Board, the Minor in Botany aims to increase the number of flora experts in Singapore by providing students with a systematic and critical perspective of learning about the plant and fungal sciences.

Various degree programmes – such as those in Architecture and Building, Humanities, Science, Engineering, Law, Business, and Medicine – also explore key principles and concepts of sustainability in their respective fields.

No matter their major, NUS provides all of its students with the tools needed for a successful future.

Students taking the Minor in Botany attending an outdoor Tropical Horticulture class.

Nurturing the green finance experts of tomorrow

The workforce is turning green and education needs to keep up. To pave the way for other leading Asian universities, NUS launched the Master of Science in Sustainable and Green Finance – the first of its kind.

Launched in 2022, it spans 12 months for full-time students – or 21 months for part-time students – equipping them with the knowledge and skills to combat environmental and sustainability challenges through financial solutions and services.

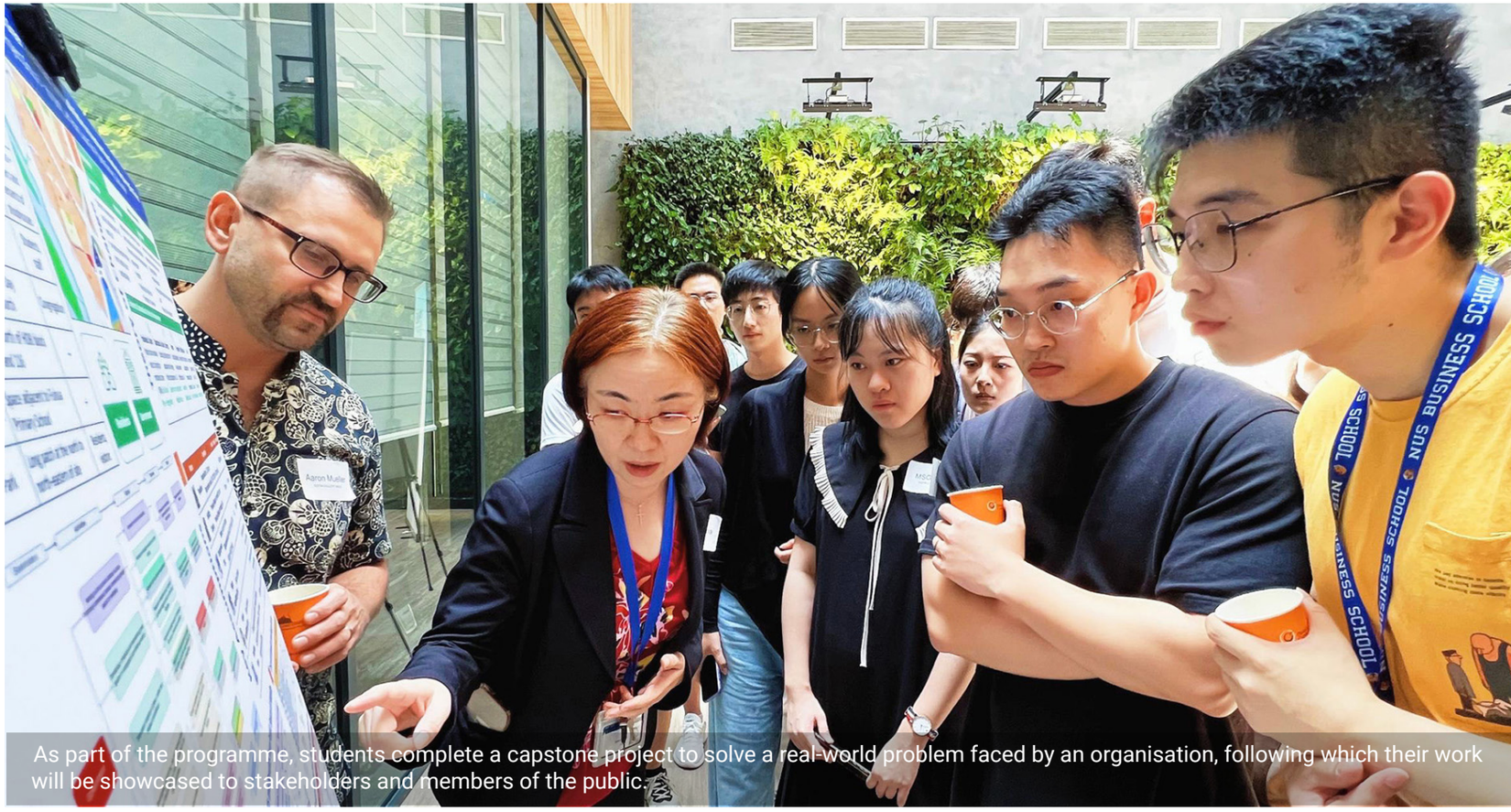
Through different modules – such as Economics of Sustainability, Sustainability Risk Management, and Impact Assessment and Impact Investing – the programme incorporates social and environmental considerations to conventional finance models, preparing students to contribute to a more sustainable world after graduation.

The programme was set up by the Sustainable and Green Finance Institute (SGFIN) in collaboration with NUS Business School, with support from the Monetary Authority of Singapore.

Since the programme was opened for admission in 2022, SGFIN has been facilitating Singapore's transition into a hub for sustainable and green finance by nurturing young talents, providing training to businesses, and fostering impactful research.

"We need people with the right capabilities and skill sets – not just skill sets in finance and financial expertise, but also other inter-disciplinary skills like environmental science and climate risk," said then-Deputy Prime Minister and Minister for Finance Mr Lawrence Wong at the launch of SGFIN.

With a comprehensive overview of green finance and the necessary skill sets, graduates will be set for roles in a variety of places, including the corporate or financial sector, government agencies, and non-governmental organisations.



As part of the programme, students complete a capstone project to solve a real-world problem faced by an organisation, following which their work will be showcased to stakeholders and members of the public.

A modern approach to a flagship programme

It may be two decades old, but it is still scaling new heights. The Master of Science in Environmental Management (MEM) recently underwent a revamp to stay abreast with the increased global focus on sustainability.

Jointly offered by six Faculties and Schools at NUS, it is now multidisciplinary and interdisciplinary. Throughout their course of study, students would have the opportunity to learn from a wide range of professors – each a specialist in their respective fields – as well as industry experts from local and international environmental agencies and organisations.

Through interactive lectures, field trips, workshops, seminars, and both local and overseas project work, students gain insights into policymaking, data analysis, and other areas. Completing this internationally recognised master's degree will also open doors to key managerial roles in the private and public sectors, even outside of Singapore.

Ms Juat Ying Ng, an alumnus from the class of 2021, currently serves as the Assistant Director of the Sustainability Office at Gardens by the Bay.

She said: "With a background in science, I found the interdisciplinary nature of the course the most beneficial as it broadened my horizons on different dimensions of environmental protection, from business to law and economics."

Similarly, Mr Samuel Tan Weicheng, another alumnus from the same graduating class, credited the MEM programme for helping him "connect the dots across diverse domains".

The Vice President of Environment, Social and Governance Solutions at Sector Solutions Group, United Overseas Bank added: "The knowledge and skills acquired through the MEM programme – ranging from greenhouse gas accounting and environmental impact assessments to environmental valuation and climate science – now form the core of my skills as a sustainability practitioner, enabling me to execute my responsibilities more holistically."

Students attend seminars delivered by prominent practitioners and researchers from Singapore and abroad, exposing them to a wide range of perspectives and enabling them to develop a well-rounded understanding of environmental management.

Keeping up with the green transformation

With the changing landscape of the workforce demanding more green skills, NUS supports adult learners wanting to upskill and reskill with its sustainability-themed Continuing Education and Training (CET) programmes.

In collaboration with the National Climate Change Secretariat and NUS School of Continuing and Lifelong Education, the Sustainability 101 Course for Policy Officers was launched in November 2023 by the NUS Centre for Nature-based Climate Solutions.

The four-day programme covers topics such as international climate negotiations and domestic environmental policies, which will help learners develop well-balanced and science-based policies in their fields.

For technical officers involved in urban planning, engineering, building design, or facilities management, they can strive to attain NUS' Professional Certificate in Sustainability for the Built Environment, developed jointly by NUS and the Ministry of National Development.

To do so, they will have to complete four short courses – Sustainability Landscape and the Built Environment, Embodied Carbon and Life Cycle Assessment, Operational Carbon and Smart Facilities Management, and Green Finance for the Built Environment – within 18 months.

These courses collectively explain the fundamentals of sustainability specific to the built environment sector and guide learners through incorporating such considerations in their work.

Adult learners interested in a geospatial career can also find out more about the cutting-edge technologies in the field and gain skills required through the Professional Certificate in Applied Geographic Information Systems – a partnership between NUS and the Singapore Land Authority that is targeted to be launched in late 2024.

By partnering with experts in varying fields, NUS' CET programmes remain industry-relevant, and help adult learners stay competitive amidst the green revolution.

The Sustainability 101 Course for Policy Officers enables public officers to gain insights from experts from academia, the government, and the industry.

Knowledge is power, but it is how you put it to work that really matters. For budding entrepreneurs wanting to use what they have studied to turn ideas into impact, the university helps them gain the know-how and skill sets needed by placing them in the thick of start-up action.

The NUS Overseas Colleges (NOC) programme, established in 2002, gives undergraduates the opportunity to live, work, and study in over 20 key entrepreneurial hubs worldwide. Through internships, they get to experience the inner workings of a successful start-up first-hand, picking up nuggets of wisdom that will help lay the foundation for their own future ventures.

As of December 2023, over 1,000 start-ups have been founded by NOC alumni, raising more than S$3.5 billion in equity funding.

The start-up's Spent Grain Granola is sold by Japanese retailer Muji.

Brewing innovation:

How NUS alumni made baked goods from spent grain

What can you do with unwanted cooked rice? Three graduates from NUS – Mr Kong Qi Herng, Mr Lim Jia Wei, and Mr Varden Toh – produced other edibles from it. The trio, who met during their time on the NOC Programme, share the same mission: to reduce food waste and find creative ways to upcycle it.

They first worked on using rice to brew beer as part of their undergraduate capstone project. But as they experimented, they found that the grains used to produce beer were not completely utilised. Byproducts, known as spent grains, as heavy as 20 per cent of the weight of the beer itself were left behind. While rich in protein and fibre, spent grains are not usually consumed due to their fibrous texture.

With the amount of food wastage in Singapore growing by about 20 per cent in the last decade, the team was committed to achieving a zero-waste production cycle and persisted in their research. They later found a way to modify the texture and taste of the spent grain so that they could be used to create baked goods.

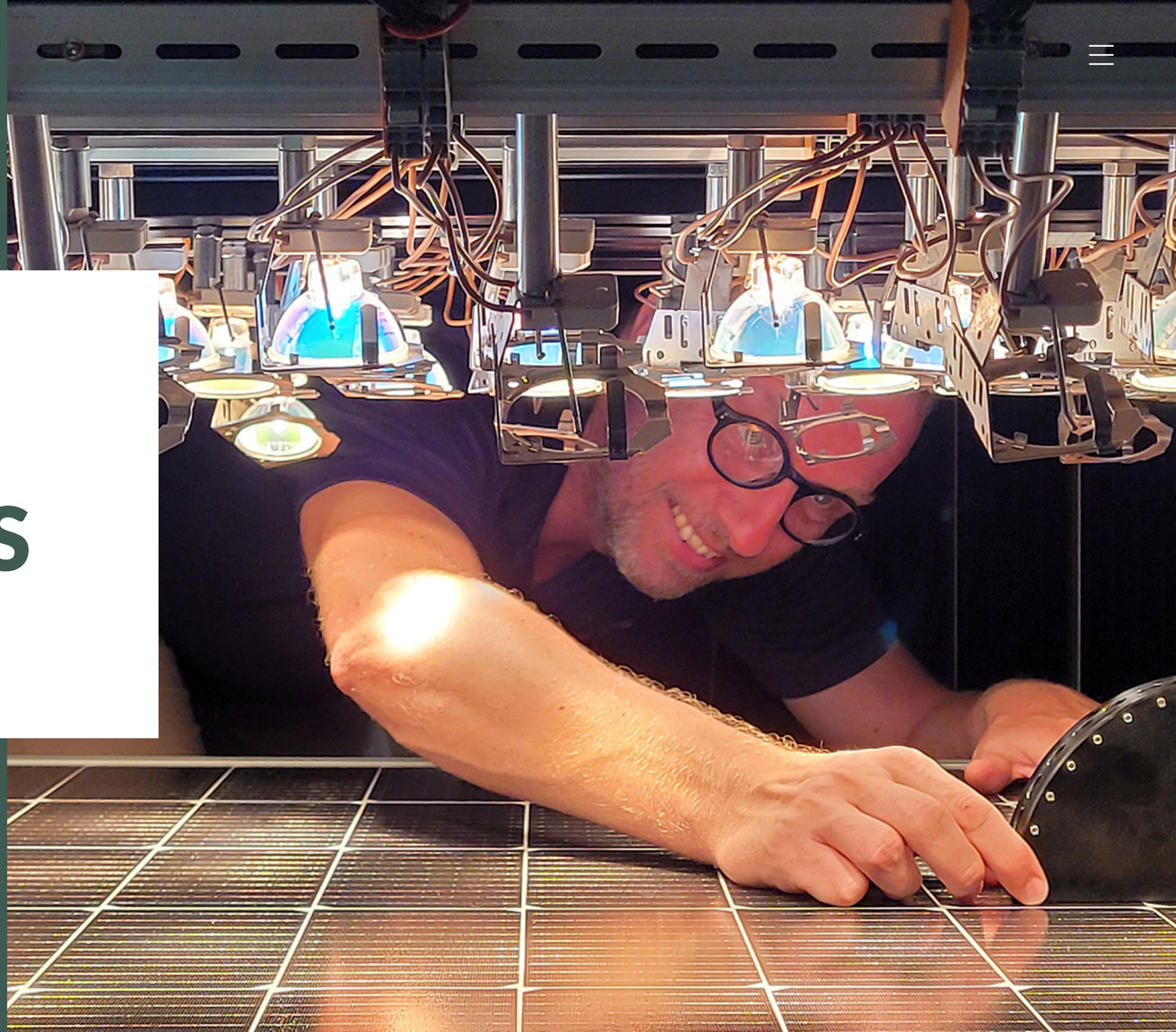
Their project became one of five winners at the inaugural DBS Foundation X NEA Hungry for Change Challenge in 2023, which drew 60 submissions. The team – now known as the food tech start-up the moonbeam co. – was awarded up to S$25,000 from the DBS Foundation to run a six-month pilot programme, which they used to scale up production.

Today, their flagship product Spent Grain Granola is sold by Japanese retailer Muji.


(From Left) Co-founders of the moonbeam co. Mr Kong Qi Herng, Mr Lim Jia Wei, and Mr Varden Toh.

Research

BREAKING BOUNDARIES



An NUS researcher inspecting a solar panel at the Solar Energy Research Institute of Singapore (SERIS). SERIS plays a key role in Singapore's efforts towards reducing its greenhouse gas emissions and carbon intensity.

Pushing the limits of science and engineering to build a more sustainable future

Sustainability issues are typically wide-ranging, and cannot be tackled by experts of any one field independently.

Take climate change for instance. Climate scientists are needed to understand what is causing the phenomenon and how it is expected to change. Engineers develop technologies that can reduce carbon emissions, while behavioural scientists know how to nudge people to live more sustainably. It requires a multidisciplinary and interdisciplinary effort.

This is precisely why universities are well-placed to make a difference to sustainability through research. Not only are they at the forefront of scientific and technological advances, they also have a whole range of experts across various domains. The key is to get them to work together – something that NUS has been promoting vigorously.

In recent years, NUS has been making a concerted effort to organise workshops to bring together researchers from different fields and disciplines, from STEM (science, technology, engineering, and mathematics) to non-STEM institutions.

These workshops facilitate interactions and discussion, especially between researchers who are unacquainted, giving them the opportunity to identify gaps that they would be able to fill in each other's research.

To ensure that research conducted is applicable to the real world, the university has also been working closely with industry players as well as local and international agencies and research institutes. It launched the Campus as A Living Lab at NUS (CALL@NUS) initiative, under which it collaborates with industry partners to testbed new technologies on campus.

Sustainability research across the university currently prioritises nine key areas:

- Green energy and energy efficiency
- Sustainable manufacturing
- Nature-based climate solutions
- Coastal engineering and flood protection
- Water treatment and purification
- Agriculture-food technology
- Sustainable urban systems
- Sustainable medicine and public health
- Governance and policy

Further information on the university's sustainability research is available at NUS Research.

Key research domains

Green energy and energy efficiency

Problem: To keep global warming below 1.5 deg C compared to pre-industrial levels, the world needs to transition away from fossil fuels. But clean energy solutions that are cost-effective and scalable are not always readily available.

Solution: Advance research in emerging clean technologies under the Green Energy Programme. This includes the production of green hydrogen fuel through electrolysis, and the conversion of carbon dioxide from flue gas and ambient air into environmentally-friendly fuels. NUS launched the Sustainable Tropical Data Centre Testbed in 2023, which brings academia and industry partners together to develop cooling solutions that will help data centres operate more sustainably in the tropics.

More about NUS' key programmes:
Sustainable Tropical Data Centre Testbed
Centre for Hydrogen Innovations
Solar Energy Research Institute of Singapore
Energy Studies Institute
REC@NUS Corp Lab
Singapore Energy Centre
Keppel-NUS Low Carbon Living Lab
Singapore Nuclear Research and Safety Initiative

Sustainable manufacturing

Problem: As the global population rises, so will the demand for goods. This results in more carbon emissions and waste generated.

Solution: Develop innovative manufacturing solutions such as bio-based materials and more energy-efficient processes. NUS' know-how is attracting industries seeking expertise in sustainable production methods, and helps to establish Singapore as a hub for responsible industrial practices.

More about NUS' key programmes:
National Centre for Engineering Biology
Wil@NUS Corp Lab
Institute for Functional Intelligent Materials

Nature-based climate solutions

Problem: Combating climate change involves the reduction or elimination of greenhouse gases. But developing technologies to do so can be costly.

Solution: Nature-based climate solutions – a cost-effective alternative that harnesses natural processes. This includes the conservation, restoration, and protection of natural ecosystems, such as forests and wetlands. In 2020, NUS established the Centre for Nature-based Climate Solutions, comprising researchers across different disciplines, departments, and faculties, to produce policy-relevant science that will help better manage natural ecosystems.

More about NUS' key programmes:
Centre for Nature-based Climate Solutions
Tropical Marine Science Institute
RWS-NUS Living Lab

Coastal engineering and flood prevention

Problem: Global sea levels are expected to rise by 0.2 to 0.4 metres over the next 50 years, which poses an existential threat to a low-lying island like Singapore.

Solution: Track climate change through remote sensing, data analytics, physics-based modelling, and data assimilation. The use of modelling tools customised to Singapore's coastal geology aids in flood prevention and decision-making, especially in the adaptation of coastal protection techniques from around the world. The modelling system will also be used to evaluate and guide future coastal protection via both engineering and nature-based solutions.

More about NUS' key programmes:
Coastal Protection and Flood Resilience Institute Singapore
Technology Centre for Offshore and Marine, Singapore

Water treatment and purification

Problem: Singapore is among the world's most water-stressed countries, with water demand estimated to double by 2060. This is exacerbated by unpredictable drought and extreme rainfall events, emerging water pollutants from domestic and industrial activities, and rising temperatures.

Solution: The NUS Environmental Research Institute was set up to develop integrated sustainability solutions for water management, from source to tap. Its expertise includes catchment management, water monitoring and sensing, treatment of drinking water, reclamation of domestic and industrial used water, seawater desalination, and energy and resource recovery. In addition, the Lee Kuan Yew School of Public Policy produces policy-relevant research that helps shape the discourse on water policy in Asia.

More about NUS' key programmes:
NUS Environmental Research Institute
Centre for Water Policy, Institute for Environment & Sustainability

Agriculture-food technology

Problem: Singapore imports more than 90 per cent of its food, making it highly vulnerable to global and regional disruptions to the food chain.

Solution: Strengthen Singapore's agri-food security through research in three key areas: advanced urban agriculture and aquaculture solutions; artificial intelligence and Internet of Things (IoT); and microbes and enzymes. This includes developing superior seeds and soil supplements that enhance the growth and survivability of plants, as well as techniques that enhance the shelf life of food. Researchers also leverage automation, data analytics, machine learning, and IoT sensors to monitor plant physiology to optimise crop yield. In 2021, the NUS Agritech Centre was established to strengthen collaboration in the agri-food industry and provide support for start-ups.

More about NUS' key programmes:
NUS Research Centre on Sustainable Urban Farming
NUS Agritech Centre
AquaPolis Programme

Sustainable urban systems

Problem: Urbanisation has led to the extensive construction of heat retentive surfaces, in turn intensifying the Urban Heat Island (UHI) effect where ambient temperatures rise and remain higher than surrounding areas. Coupled with global warming and climate change, UHI effect will exacerbate the rise in local temperatures and increase the frequency and intensity of extreme heatwave events in urban areas. As a densely populated city-state in the tropics, Singapore is highly susceptible to its adverse effects.

Solution: Address the environmental, social, and economic challenges posed by rapid urbanisation through the development of sustainable urban systems. These systems prioritise the integration of sustainable practices in urban planning, infrastructure development, and resource management to create cities that are resilient, livable, and environmentally friendly.

More about NUS' key programmes:
NUS Cities
Heat Resilience & Performance Centre
Cool NUS

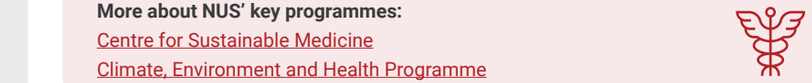
Sustainable medicine and public health

Problem: Extreme weather events such as intense heat, droughts, rising sea levels, and air pollution are known to cause diseases in humans, including those that afflict the cardiovascular and respiratory systems. The medical sector is also highly energy-intensive, generating more than five million tonnes of waste each year and contributing more greenhouse gas emissions than both the aviation and shipping sectors combined.

Solution: NUS' Yong Loo Lin School of Medicine has set up the Centre for Sustainable Medicine – the first of its kind in Asia and the largest globally. The centre aims to transform medical education; pioneer research for high-quality, low-carbon care; and support health policymakers and hospital administrators worldwide in transitioning to net-zero healthcare.

The NUS Saw Swee Hock School of Public Health has also launched the Climate, Environment and Health Programme, dedicated to fostering interdisciplinary research on climate change and health, and collaborating with environmental science groups within Singapore and beyond.

More about NUS' key programmes:
Centre for Sustainable Medicine
Climate, Environment and Health Programme



Governance and policy

Problem: Technological advances can only go so far without the proper frameworks, regulations, and mechanisms that guide their application to the real world.

Solution: By providing comprehensive guidelines, regulations, and legal frameworks, NUS informs policy development. This in turn fosters a conducive environment for encouraging and enforcing compliance with sustainability regulations among businesses, organisations, and individuals. Through research, NUS also helps institutions make well-informed investment decisions and develop management strategies to address risks associated with climate change-related economic, governance, and social issues.

More about NUS' key programmes:
Sustainable and Green Finance Institute
Centre for Governance and Sustainability
Asia-Pacific Centre for Environmental Law
Centre for International Law
Institute for Environment and Sustainability

Highlights in numbers

Research and Academic Publications

16%
(or 2,097)
of research and academic papers published are sustainability-related
(CY2022)

85%
of sustainability-related publications involve collaboration with other institutes
(CY2022)

6%
of sustainability-related publications involve corporate collaboration
(CY2022)

104
collaborating countries/ regions for NUS' sustainability-related publications
(CY2022)

2.06
Field-Weighted Citation Impact for sustainability-related publications*
(CY2022)

*Measures how well-cited a publication is compared to similar publications

Research Collaborations

90
ongoing research collaborations with external partners on sustainability-related research projects

50
with companies and industry associations

30
with research institutes and institutes of higher learning

10
with government agencies

Technology Transfer and Innovation

24
sustainability-related spin-off companies set up based on NUS technology
(As at Dec 2023)

Grants

S$178M
in competitive funding for sustainability research
(FY2022)

Harnessing the power of nature to fight climate change

The general global response to climate change has been to work towards net-zero carbon emissions, and one potentially effective approach is with nature-based climate solutions.

They involve protecting, restoring, and sustainably managing natural habitats, such as forests and mangroves, that help remove greenhouse gases from the atmosphere through photosynthesis.

Spearheading these efforts is the Centre for Nature-based Climate Solutions (CNCS) at NUS.

CNCS has been leading research to improve confidence in the monitoring, reporting, and verification of nature-based carbon projects. Emitters can buy carbon credits from these projects, which protect or restore forests, to offset their emissions. Called Carbon Integrity, this research initiative aims to address one of the biggest obstacles in nature conservation – a lack of capital.

By developing models specific to the region's context, Carbon Integrity will provide more accurate carbon storage estimates for forests in Southeast Asia. This in turn emboldens companies to invest more capital in carbon markets.

In the same vein, CNCS hopes to promote nature-based solutions through a new scenario-modelling facility launched on NUS' Kent Ridge campus in 2023. It houses a state-of-the-art interactive platform which users from Southeast Asia's 11 countries can use in person or remotely to model outcomes of different market and policy scenarios.

Regional stakeholders can perform on-the-fly calculations of the economic potential and co-benefits of establishing a carbon project at a specific site, fostering collaboration, and accelerating the region's climate mitigation efforts by removing uncertainty tied to projects.

Nature-based climate solutions are key in averting a climate catastrophe, and NUS is committed to pioneering their implementation in the region and beyond.

Professor Koh Lian Pin, NUS Associate Vice President and Chief Sustainability Scientist, and Director of CNCS, launched the new scenario-modelling facility during a fireside chat at the COP28 summit.

An indoor farming research facility at the NUS Research Centre on Sustainable Urban Farming.

Bolstering Singapore's food security

Food security is a challenge for Singapore. Importing more than 90 per cent of its food, it is vulnerable to supply chain disruptions caused by issues like climate change and pandemics.

To bolster food resilience, the country has set a "30 by 30" goal aiming to generate 30 per cent of its nutritional needs locally by 2030, and NUS is actively engaged in research efforts to help hit this target.

Land scarcity means Singapore has to rely on vertical farming, which comes with its own set of challenges. These include the need to develop suitable crop varieties, optimise crop growth conditions and energy usage, and implement automation to improve profitability and sustainability.

Addressing these issues requires a diverse range of expertise as solutions often encompass many factors and disciplines. However, experts often specialise in only one field.

To boost collaboration, NUS established the Research Centre for Sustainable Urban Farming at the Faculty of Science in 2022, which brings together a diverse team of experts from Science, Engineering, and Computing.

Together, they have worked on different projects in urban agriculture. For example, biologists and engineers have developed an all-organic, transparent plant e-skin sensor for the non-invasive measurement of strain and temperature of plants.

The new technology will assist with plant growth optimisation and enhance the overall sustainability of indoor farming.

Strengthening Singapore's water resilience

Singapore is one of the world's most water-stressed countries due to its lack of natural water resources. However, it has overcome such constraints by developing a sustainable water supply through membrane technology, with the help of researchers from various institutions including NUS.

This technological advancement, which enables used water filtration, now meets 40 per cent of Singapore's water needs, a figure expected to rise to 55 per cent by 2060.

Despite the breakthrough, water is still a source of concern – especially with climate change. Pollution leads to deteriorating quality of water sources, causing membrane blocking, or fouling. As a result, more energy is required to frequently clean filtration membranes to produce clean water, which adds to Singapore's carbon emissions.

This issue is currently being studied by various NUS researchers. Together with the French Centre for Scientific Research, the NUS Environmental Research Institute (NERI) researchers comprising Professor Prakash Kumar and his team have chemically synthesised artificial water channels, or foldamers, which enable highly selective filtration with low energy consumption.

Another NUS team led by Assistant Professor Zhang Sui is also revolutionising brackish desalination by conducting research into membrane molecular structures and engineering technologies for efficient separation and minimal fouling – to produce cheaper and cleaner water.

Amid the fluctuating quality of seawater supply, NERI has also pioneered low-chemical energy pre-treatment processes to ensure consistent water quality. For instance, Associate Professor Olivier Lefebvre and Assistant Professor Bae Sung Woo are focusing on seawater pre-treatment using electrocoagulation and ceramic ultrafiltration membranes to pre-treat seawater for cost-effective desalination.

These ongoing projects are being done in collaboration with industry partners, with the aim of applying NUS' advancements in water production commercially. This will ultimately strengthen Singapore's water resilience.

Four-inch hollow fibre membrane module for brackish water desalination.

Advancing energy efficiency and cooling technology

It is a balance that Singapore has to strike – maintaining its status as a competitive commercial and manufacturing hub while transitioning to sustainable energy sources.

With its extensive research capabilities, NUS plays a pivotal role in the nation's journey towards energy resilience and sustainability.

For instance, a collaboration between the university, industry partners, and the government – led by Associate Professor Ernest Chua – yielded a breakthrough in District Cooling Systems. By using phase-change materials for thermal energy storage, there is the potential to significantly reduce the energy needed to cool buildings by 10 per cent compared to conventional cooling methods.

The new technology is able to store and release cold energy as it changes between liquid and solid states, mitigating cooling peak loads in commercial buildings.

Research by Professor Seeram Ramakrishna and Associate Professor Lee Poh Seng also helped advance the technology used in data centres, which account for seven per cent of the nation's power demand – a number that is expected to grow to 12 per cent by 2030.

Together with Nanyang Technological University, they are leading the research in developing the world's first tropical data centre testbed – called the Sustainable Tropical Data Centre Testbed (STDCT) – for an indirect evaporative cooling system with desiccant-coated heat exchangers.

With it, they expect to reduce energy consumption by over 30 per cent. This innovation is poised to move STDCT closer to achieving its ambitious Power Usage Effectiveness (PUE) target of less than 1.2 by mid-2024, below Singapore's PUE requirement of 1.3 and the global average of 1.5.

Associate Professor Lee's research on unibody heat sink design for direct chip liquid and immersion cooling will also help eliminate leakage risks and significantly reduce server downtime.

Combining academic and industrial expertise, this pioneering collaborative initiative – which utilises NUS facilities – will fast-track the adoption of innovative and sustainable cooling solutions for data centres in tropical climates.

Associate Professor Lee Poh Seng (right) checking on the direct-chip liquid-cooled servers at the STDCT facility at NUS.

At the heart of research is the translation of laboratory discoveries and inventions into practical solutions that solve real-world problems. Strengthening this technology transfer at NUS is a robust system of support that provides researchers with mentorship, funding, industry link-ups, and other necessary aid to get their solutions market-ready.

The Technology Transfer and Innovation Programme, for instance, offers researchers a range of services from advice on intellectual property to the funding of research translation, geared towards helping them to get their solutions licensed to the industry or spun off into start-ups.

Meanwhile the NUS Graduate Research Innovation Programme (GRIP) provides step-by-step guidance to researchers and postgraduate students wanting to transform research into deep technology start-ups. Teams that are part of the programme also get access to Master Engineers and NUS resources, including labs and prototyping support, as well as investments of up to S$100,000.

Since its launch in 2018, GRIP has supported 110 start-ups, securing S$55 million in external funding and grants as at December 2023.

When opportunity blooms:

Growing climate-resilient strawberries in the tropics

As a child, Dr Bao Shengjie spent many hours in his mother's garden tending to a variety of flowering plants, herbs, and vegetables. Growing up in Zhejiang, China, which experiences four seasons, he could also savour fruits that grow in colder temperatures such as strawberries – one of his favourites.

Since moving to Singapore a decade ago, he has found the strawberries here disappointing. Their taste and appearance paled in comparison with those in his hometown. But instead of settling for less, the scientist in him saw an opportunity. Armed with a PhD in molecular biology from NUS, he set out to create a new breed of strawberries that could thrive in the tropics.

After three years and six generations of crossbreeding and selection, he created the Crystal strawberry – the world's first climate-resilient strawberry variety. It grows in temperatures of around 20 to 28 deg C, unlike regular strawberries which need cooler temperatures of 5 to 15 deg C to survive.

Building on his success, he set up Singrow in 2019, through which he develops indoor vertical farming technologies as well as novel crops and cultivation methods. The agri-tech start-up's goal is to produce more temperate and exotic crops within tropical Southeast Asia.

Singrow's Crystal strawberry – the world's first climate-resilient strawberry variety.

Dr Bao is grateful for the support of NUS Enterprise and GRIP, which helped him polish his business skills, make industry link-ups, and access funding. Singrow was part of the second cohort of GRIP with incubation at NUS Enterprise@Singapore Science Park.

Singrow has seen steady growth. In April 2023, it signed agreements with two farms – TreeGrow in Malaysia and PREINO in Thailand – as part of its global expansion plans that also include China. The firm provides outdoor farms with its crop varieties, starting with strawberries, and works with them to improve their farming techniques for existing crops.

It also sells their newest generation of climate-resilient strawberries; Rouge (Red), Winterbelle (White), and Blush (Pink) strawberry on its e-commerce platform Blooom.

But Singrow's breakthrough technology – dubbed the Fast Cultivation Method – which sees shorter harvesting cycles and better climate resilience for a range of crops has much wider implications beyond urban farming. It could also boost food security.

"It can be applied to many other crops in the future. We are already experimenting with crops like rice, corn, sustainable palm oil, and other staple vegetables, and seeing how these can be grown in new regions to strengthen food security," said Dr Bao.

Minister of State for Trade and Industry Mr Alvin Tan (in blue jacket) visiting Singrow's indoor farm at Science Park to learn about its innovative cultivation methods.

From biowaste to biofuels:

A circular economy approach to creating sustainable marine fuels

They were three individuals with a shared vision – to reduce carbon emissions and divert biomass from landfills and incineration.

Putting their heads together, NUS alumni Dr Hanson Lee, Mr Low Wang Chang, and Ms Sng Yee Ching came up with a novel solution that could do both – by creating biofuel from biowaste.

The technology originated as Dr Lee's PhD research project in 2019, before it was further developed into a commercially-viable solution with the support of GRIP in 2021.

Green COP's patented technology includes a pre-treatment formulation that requires less energy and operates 50 per cent faster than existing industry methods. It also features a uniquely aerobic fermentation process using bubble-induced agitation, which eliminates the need for the removal of oxygen.

This allows for the production of cost-efficient drop-in fuels – sustainable fuels that can be blended with fossil fuels and seamlessly integrated into existing infrastructure.

(From Left) Green COP's co-founders Ms Sng Yee Ching, Dr Hanson Lee, and Mr Low Wang Chang.

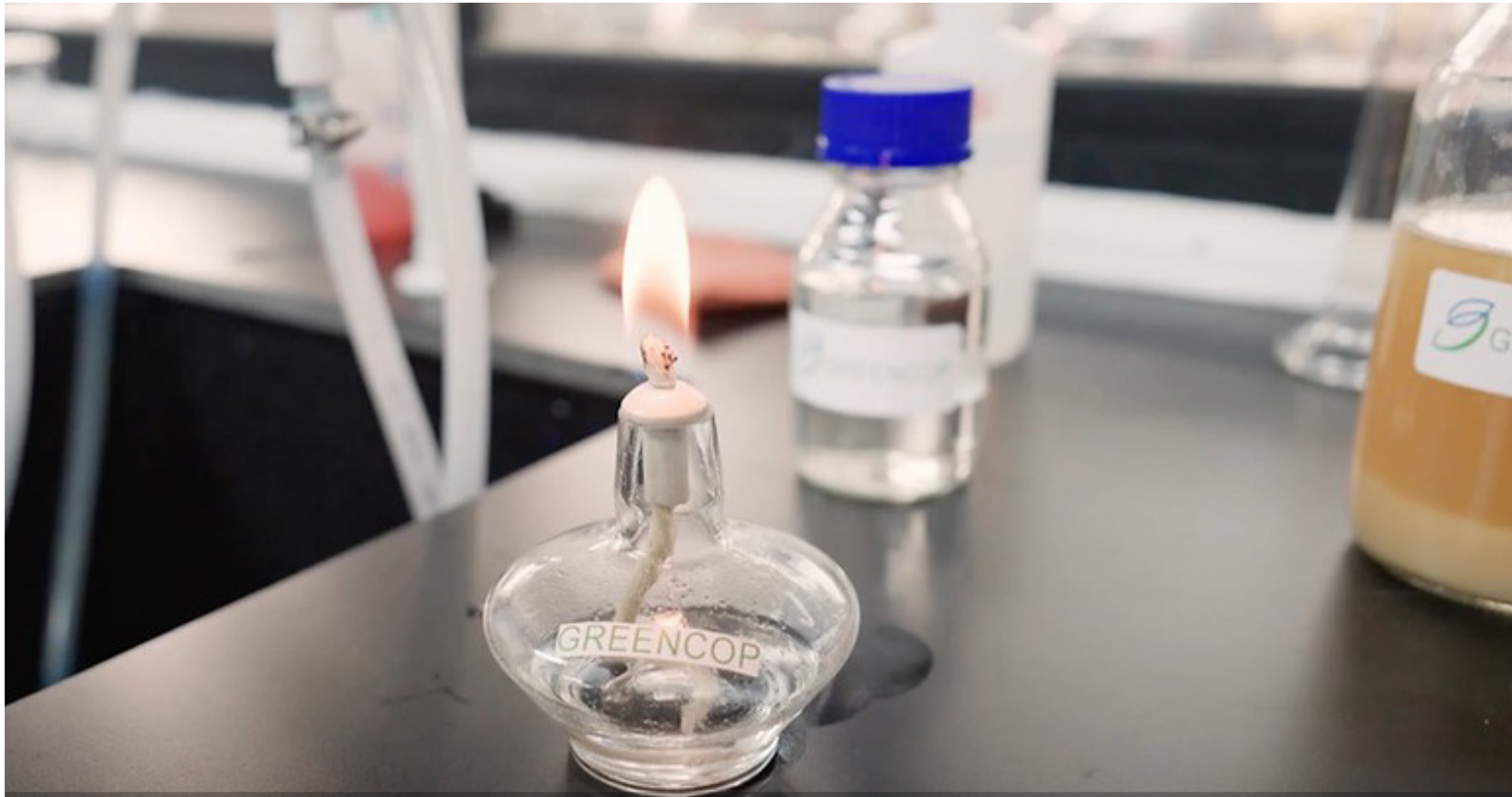
Green COP's biofuels have a shelf life of more than 24 months and reduce nitrogen oxide emissions by 30 per cent, which makes them ideal options in the transition to sustainable marine fuels, said the team.

The team placed second in the Smart Port Challenge 2022 organised by PIER71™ – a joint initiative between the Maritime and Port Authority of Singapore and NUS Enterprise to accelerate innovation in the maritime industry.

This award opened doors for Green COP. In February 2024, the company secured substantial funding from a curated group of angel investors, including local green energy solutions firm Ken Energy. With Ken Energy's support, the company is able to enhance the use of their biofuels in maritime operations.

Green COP has also collaborated with IOI Corporation Berhad, a leading global integrated palm oil player, and are setting up a pre-commercial plant capable of processing one ton of biomass daily to produce sustainable biofuels.

"With our recent fundraising and partnerships with like-minded organisations, we are on schedule to establish a pre-commercial production plant. We anticipate producing our first tonne of biofuels in the third quarter of 2024," said Dr Lee.



Green COP's colourless alcohol-based biofuels offer a cleaner, eco-friendly alternative to traditional fuels, paving the way for sustainable marine fuels.

Campus

DECARBONISING BY DESIGN

SDE1 and SDE3 were retrofitted with innovative features that improved energy efficiency and comfort, and extended the buildings' lifespans.

Shaping sustainable practices and testbedding novel solutions for a greener campus

Given that most campuses function as microcosms of society, they can easily become a testbed for exploring sustainability solutions. By using its facilities and community as a miniature model of this planet, NUS can learn things that will make campuses – and the world – better. Implementing sustainable campus practices also allows it to lead by example and influence university members and the wider community.

To contribute towards the Singapore Green Plan 2030, the university has developed the Campus Sustainability Roadmap 2030, which outlines its goals to achieve a carbon neutral, cool, and zero waste NUS.

Its strategy is to decarbonise its building infrastructure and operations, from laboratories and data centres to teaching spaces and offices, while ensuring its outdoor campus environment remains comfortable with rising global temperatures. NUS plans to achieve campus decarbonisation by increasing energy efficiency, prioritising energy reductions across different building types, maximising its campus rooftop solar photovoltaic (PV) capacity, and purchasing overseas renewable energy.

Beyond infrastructure, it has introduced green initiatives into its community, such as sustainable procurement to reduce waste and Resource Sorting Stations to cut down on contamination in recycling.

In 2022, NUS' gross floor area increased to 1.43 million m², an increase of three per cent from FY2019. This resulted in a slight uptick in its emissions, energy usage, and waste produced.

But there were some bright spots, such as an improvement in the university's recycling rate. The NUS Sustainable Procurement Framework was also implemented with the aim of reducing the university's Scope 3 carbon emissions by guiding the procurement process towards low-carbon and sustainable options, focusing on carbon hotspots identified within its operations.

Nonetheless, its longstanding commitment to sustainability has been recognised. NUS is the first university in Singapore to clinch the prestigious President's Award for the Environment 2023. It also bagged the Building Construction Authority (BCA) Green Mark Platinum Champion award for achieving 50 Green Mark Gold and above certifications for developments across its campus. This is BCA's top accolade.

In the coming years, the university will be doubling down on its efforts as it strives to meet its 2030 targets.

It will also explore the feasibility of implementing technologies that remove carbon dioxide from the air by leveraging the university's research expertise and those of external partners as part of its carbon neutrality drive.

Further information on the university's environmental performance is available in its annual Campus Sustainability Roundups.

Targets and performance

Carbon Neutral NUS

2030 Targets

NUS will reduce energy consumption across all building types to achieve best-in-class energy performance. The university also aims to maximise its solar PV capacity and procure renewable energy from overseas.

30% reduction in Scope 1 (direct) & Scope 2 (indirect) emissions from 113 $ktCO_2e$ in FY2019 to 79 $ktCO_2e$ in FY2030

20% reduction in Energy Usage Intensity (EUI) from 195 kWh/m^2 in FY2019 to 156 kWh/m^2 in FY2030

Performance to date

NUS' **emissions rose slightly** from 113 $ktCO_2e$ to **115 $ktCO_2e$** in FY2022 due to **new buildings** constructed to support research activities and student life. While this upward trend is expected to continue as its campus grows, it is committed to bending the curve.

But the university has managed to **maintain its EUI** at **195 kWh/m^2.**

Cool NUS

2030 Targets

NUS takes an evidence-based approach to achieve a climate-resilient and cool campus for its community.

Establish a campus Outdoor Thermal Comfort Index by FY2024

Plant 100,000 trees

Performance to date

NUS is in the midst of installing an extensive network of close to 50 sensors to establish its **baseline Outdoor Thermal Comfort Index** and monitor the effectiveness of mitigation measures.

To date, it has also planted **35,100** trees.

Zero Waste NUS

2030 Targets

NUS will create zero waste precincts where waste sorting and reusing is a social norm. It also aims to close waste loops.

50% recycling rate

30% reduction in daily waste disposed per capita from FY2021 levels

Close the waste loops for materials such as plastic

Performance to date

NUS' **recycling rate increased to 32%** in CY2022 through **careful waste sorting.** However, the amount of **waste disposed per capita increased** as **more members of the NUS community returned** to campus post-pandemic.

Beyond recycling, the university is working on reducing the waste disposed by cultivating a **zero waste culture**.

Decarbonising the built environment with first net-zero energy building cluster

They may be 50 years old, but the School of Design and Environment (SDE) blocks 1 and 3, also known as SDE1 and SDE3, are now spearheading NUS' net-zero energy drive in the built environment.

Rather than rebuilding from scratch, the two blocks were refurbished with innovative features that improved energy efficiency and comfort, and extended the buildings' lifespans, while preserving their stored carbon content. Their green enhancements include rooftop solar photovoltaic panels, a large network of air quality sensors, a highly-efficient hybrid cooling system, and a "butterfly"-inspired facade that provides sun shading while allowing daylight to enter the buildings.

The total energy consumption of SDE1 and SDE3 is projected to be lower than a third of pre-renovation levels, and the embodied carbon footprint is estimated to be 200 kgCO2e/m², a fifth of the government's reference value for non-residential buildings – making them ideal examples on how to revamp older buildings.

The two blocks, together with the newer SDE4, make up NUS' first building cluster targeting net-zero energy, meaning that together, they consume as much electricity as they generate. Launched in 2019, SDE4 is Singapore's first ever net-zero energy building that is constructed from scratch, and the first in Southeast Asia to receive the Zero Energy Certification from the International Living Future Institute in 2020.

It has since performed beyond its net-zero design intent, and is the first positive energy building in a university with at least 115 per cent of its energy consumption supplied from renewable solar energy and a best-in-class EUI of 44 kWh/m² in 2022. The building boasts green features such as an overhanging roof with over 1,200 solar photovoltaic panels that also provides shade to the building, as well as a hybrid cooling system that circulates fresh pre-cooled air, keeping indoor temperatures at a comfortable range of 26 to 28 deg C.

With these successes under its belt, NUS plans to retrofit more old buildings on campus, such as the Yusof Ishak House, which is slated to be completed in 2024. By pushing boundaries in the built environment through innovative designs, the university aims to drive down energy consumption from the onset.

SDE4 is a positive energy building that boasts green features such as an overhanging roof with over 1,200 photovoltaic panels that also provides shade to the building, and a hybrid cooling system that circulates fresh pre-cooled air, keeping indoor temperatures at a comfortable 26 to 28 deg C.

Following energy audits of top energy-consuming laboratory buildings, a suite of measures have been implemented to reduce their carbon footprint.

Greening labs to enhance energy performance

As a research-focused university, NUS dedicates a third of its floor space to laboratories that advance science in areas ranging from medicine to renewable technologies. But a sizable amount of energy is required to power such activities, accounting for about half of the total energy consumed on campus.

To reduce such power consumption, the university is conducting energy audits of top energy-consuming laboratory buildings, identifying a suite of measures to cut down their carbon footprint.

These measures target equipment and processes with high energy needs, including ventilation, humidity control, and laboratory equipment such as ultra-low temperature freezers. They are currently being trialled before being scaled up to more laboratory buildings.

For example, efforts to reduce energy consumption in MD6, the university's most energy-demanding building, are showing promising results, with over 900 megawatt-hours (MWh) saved in the first year. The aim is to achieve savings of 4,000 MWh, about 20 per cent of its annual energy demand and an EUI of 379 kWh/m² for MD6.

First local university to tackle campus outdoor thermal comfort

As a tropical country, Singapore will always be hot and humid. But climate change is causing temperatures to rise even higher.

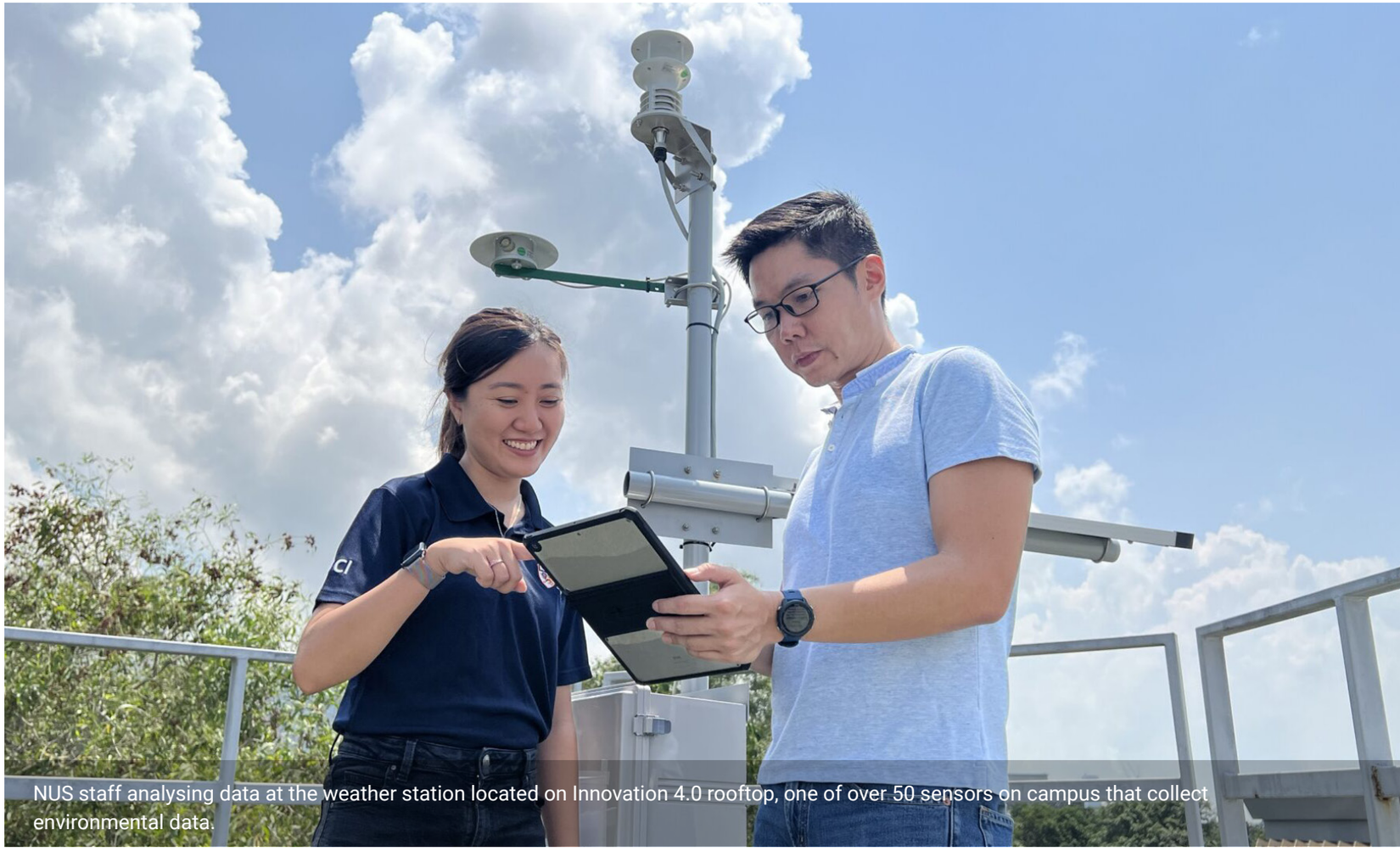
According to Singapore's Third National Climate Change Study, the daily maximum temperatures here could exceed 35 deg C for up to 351 days a year by 2100. To combat this, NUS has adopted an evidence-based approach to ensure outdoor areas on campus remain thermally comfortable.

The first university in Singapore to address climate resilience, it has combined research expertise and campus operations experience. Using the BEAM approach – which involves Baselining, Evaluating, Action, and Monitoring – NUS is measuring the ambient temperature, solar radiation, and wind to establish a comprehensive baseline of the micro-climate conditions in its Kent Ridge campus.

With close to 50 sensors installed across campus, including weather stations, infrared cameras, and meteorological towers, its on-campus sensor network is the densest in the country. The information collected from the sensor network is being evaluated alongside historical data to identify hot and cool spots across the university through simulation modelling tools.

In addition, NUS is testbedding various mitigation measures at identified hotspots such as by applying cool paint on building surfaces and intensifying its tree planting efforts.

The aim is to plant 100,000 trees by 2030, contributing 10 per cent to Singapore's OneMillionTrees movement. The shading and evapotranspiration – the process by which water moves from the earth to the air through evaporation and transpiration – provided by these trees are also being assessed for their mitigation potential.



NUS staff analysing data at the weather station located on Innovation 4.0 rooftop, one of over 50 sensors on campus that collect environmental data.

By using the campus as a testbed to pioneer cooling initiatives, NUS is well-placed to build a climate resilient campus to protect against rising temperatures.

Cultivating a zero-waste culture

At NUS, a whole-of-life approach is taken to reduce waste, from the point a product is purchased to the time it is discarded.

To cut down waste at the source, the university introduced a Sustainable Procurement Framework which guides the NUS community to factor sustainability into their purchase considerations. This includes avoiding the use of single-use items and reusing items to extend their lifespans.

With Singapore's only landfill expected to hit full capacity by 2035, the university also strives to minimise the amount of trash sent for incineration by maximising recycling on campus.

For instance, to deter people from dumping non-recyclable items into recycling bins, NUS has developed a bin that features a clear display with real non-recyclables as examples of what should not be thrown there, and a slidable opening lid that adds friction to reduce mindless throwing of non-recyclables. A transparent bin body also showcases the accumulated clean recyclables. Aptly called the Recycle Right Bins, they have been deployed across campus.

Another initiative is the Resource Sorting Stations that have been placed at Tembusu College and UTown Residences in 2023 to replace heavily contaminated recycling chutes. Residents need to log in to the stations using their room numbers to deposit their recyclables, which enforces more intentional sorting. This has greatly reduced the recycling contamination rate.

Beyond recycling, NUS is also testbedding new systems to close waste loops for low-value waste streams such as plastic and food. It is working with a home-grown deep tech start-up to convert hard-to-recycle plastic waste from campus into a material called NEWBitumen, which will be used to pave roads on campus.

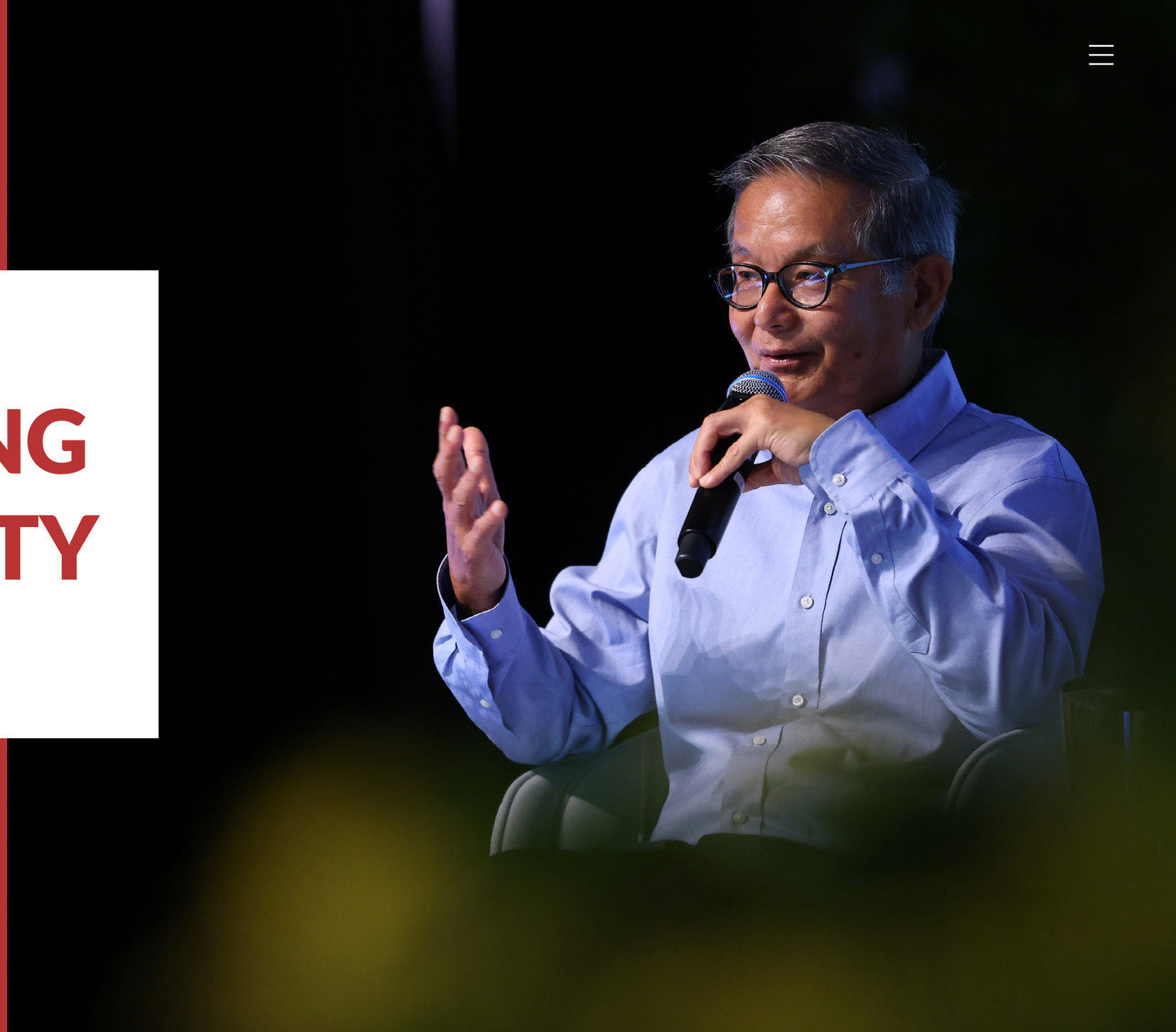
On the food waste front, aerobic digestors are being used to convert discarded food into compost for landscaping, while an emerging food waste valorisation system from LifeLab is being piloted with an aim to convert food waste into high-value aqua feed.

By inculcating a zero-waste culture, NUS aims to forge a more sustainable campus.

Resource Sorting Stations were placed at Tembusu College and UTown Residences in 2023 to replace heavily contaminated recycling chutes.

Leadership

SPEARHEADING SUSTAINABILITY



Professor Khoo Teng Chye, Director of NUS Cities, speaking at the NUS Cities Symposium. The inaugural symposium was held as part of NUS Sustainability CONNECT.

Driving change on national and global stages

Universities are where knowledge is created, disseminated, and challenged. By sharing knowledge about sustainable development extensively with the wider community, they can aid people, businesses, and governments in making better decisions for the environment.

NUS regularly engages with people and organisations outside of the university on sustainability through community partnerships, dialogue with industry and the government, and by spearheading sustainability initiatives. And it does so at both the local and international levels.

For instance, it organised the inaugural NUS Sustainability CONNECT festival in 2023. It is the university's first large-scale sustainability festival that exposes students to out-of-classroom learning, and creates opportunities for academia and industry to come together and spark conversations and ideas about sustainability.

NUS has also been accredited by the United Nations Framework Convention on Climate Change (UNFCCC) as an observer organisation since 2014, and members of the NUS community have attended its annual Conference of the Parties (COP) summits since COP20 as official observers.

At COP28, a delegation of 10 students, along with staff and researchers, witnessed climate negotiations as well as organised panel discussions at the Singapore pavilion.

Ground-up initiatives by students and alumni who have become sustainability leaders are also testaments to NUS' ardent commitment to sustainability and how its importance has been inculcated in its students.

Read on for highlights on how NUS is leading the charge on the sustainability front beyond university walls.

NUS students meeting with NUS President Professor Tan Eng Chye (second from right) at the sidelines of COP28.

Shining the spotlight on climate issues on the world stage

When almost 200 countries made a global pact to transition away from fossil fuels at COP28, NUS students were there to witness the momentous milestone.

NUS is one of 23 universities in Asia, and the only one in Singapore, which is accredited by the UNFCCC to attend its annual climate change conference, or COP.

It is also represented on the steering committee of the Research and Independent Non-Governmental Organisations constituency of the UNFCCC, which conducts research and develops strategies to combat climate change.

To mark its 10th year of accreditation in 2023, a larger-than-usual delegation of 10 students, along with staff and researchers, attended COP28 held in Dubai, United Arab Emirates. Led by NUS President Professor Tan Eng Chye, the team observed negotiations and engaged Singapore leaders such as Ms Grace Fu, Minister for Sustainability and the Environment.

At the conference, NUS was at the forefront of the designated Singapore Pavilion, and organised and participated in more than 20 panel sessions. Various NUS centres were represented, including the Centre for Nature-based Climate Solutions and the Centre for International Law.

Each session showcased NUS' research to the world while forging collaborations between academia, governments, and the private sector.

Furthermore, several significant initiatives were launched, including a new S$1 million scenario-modelling facility that helps users in Southeast Asia to navigate the complex landscape of nature-based carbon projects by allowing them to model outcomes of different market and policy scenarios.

On the medicine front, the Yong Loo Lin School of Medicine launched the Centre for Sustainable Medicine, which targets to pioneer research for high-quality and low-carbon care, among other goals. Meanwhile the Saw Swee Hock School of Public Health launched the Climate, Environment and Health Programme to develop interdisciplinary research on climate change and health with environmental science groups within Singapore and beyond.

NUS also held a networking event which brought together some 150 guests, including researchers, policy makers, businesses, civil society leaders, as well as other stakeholders. It gave them the opportunity to explore potential collaborations with Singapore, which aims to become a carbon services hub.

Six pre-COP events, including the Outlook on Climate and Nature in Asia Symposium organised in partnership with the Singapore government, and NUS' very own COP28 podcast series titled "Voices from Asia", were also held. The events were tailored to different audiences to help the wider community understand the significance and importance of COP meetings and outcomes.

Returning home with the wealth of knowledge gained at COP28, NUS continued to facilitate climate discussions locally with its "COP28 Insights: Elevating Singapore's Business Transition and Transparency" event. Attendees from academia and the private sector gathered to discuss key takeaways from COP28 and their implications on Singapore's business community.

With a climate crisis looming over the world, NUS is committed to doing its part on the global stage to fight for a greener future, especially through its involvement in COPs.

NUS led a panel at the Singapore Pavilion on 'Uncovering Southeast Asia's Seas: Nurturing Marine Ecosystems for Livelihoods and Resilience'.

CONNECTing over sustainability

From exclusive behind-the-scenes laboratory tours and a guided trek through Pulau Ubin, to panel discussions helmed by distinguished speakers, the NUS community, government agencies, and industry partners participated in an array of over 20 activities over five weeks centred on one topic – sustainability.

Called NUS Sustainability CONNECT, it was the first large-scale festival organised by NUS that covered a diverse spectrum of topics such as sustainable cities, solar energy research, and green finance.

Held from 25 August to 29 September 2023, the festival demonstrated the university's commitment to advancing sustainable development, while exposing students to out-of-classroom learning. Some of the highlights included the inaugural NUS Cities Symposium, the Singapore Food Agency-NUS Science Day, and the launch of the Coastal Protection and Flood Resilience Institute Singapore.

Participants were also given tours of national research labs hosted on campus like the Solar Energy Research Institute of Singapore, where they witnessed how mechanical stress tests were conducted on solar panels, and the Technology Centre for Offshore and Marine, Singapore (TCOMS), a national R&D centre dedicated to the marine and offshore and maritime sectors.

Not only did the festival achieve its aim of enabling the NUS community and its stakeholders to connect, it also provided the opportunity for participants to support national and global climate goals.

One example is the launch of the NUS Cities Symposium by Ms Indranee Rajah, Singapore's Second Minister for Finance and National Development. The event facilitated the exchange of ideas about sustainable and liveable cities among civil servants, business leaders, academics, and students.

NUS Sustainability CONNECT will be held once every three years, with the next edition set to be in 2026. During the intervening years, a smaller scale version of the festival called the NUS Sustainability CONNECT Highlight will be organised. Each CONNECT Highlight will feature events centred on a specific theme which changes each year, as NUS continues to champion sustainability in Singapore and the region.

Visitors touring the TCOMS – a national R&D centre dedicated to the marine and offshore and maritime sectors – during NUS Sustainability CONNECT.

Student volunteers planting seedlings at the rooftop edible garden set up by NUS Zero Waste Taskforce and NUS SAVE.

Students drive environmental change from the ground up

The world needs to act fast to combat climate change and NUS students are making sure they are part of the movement. Many have taken the lead to advance sustainability through ground-up initiatives.

For one, the Bachelor of Environmental Studies Student Committee and NUS Life Sciences Society's Environmental Biology Interest Group organised the inaugural Green Connect in 2023. Industry experts from various fields of sustainability were invited to the sustainability-related career fair to give talks, set up booths, and share about their respective areas of work.

Other initiatives like GreeNUSummit 2023 – a key event in the NUS Sustainability CONNECT – were graced by national leaders. Senior Parliamentary Secretary for Sustainability and the Environment Mr Baey Yam Keng was Guest-of-Honour at the event, where the details of the Singapore Green Plan 2030 were explained to students and urban farming and tree-planting activities were conducted.

Also powering sustainability on campus is the growing number of environmental student groups at NUS – now totalling more than 20 – including 1.5degreeNUS. Established in 2023, 1.5degreeNUS aims to equip students from different disciplines with a foundation in sustainability through workshops and critical field exposure trips, such as one to the ALBA E-Waste Visitor Centre.

Meanwhile, the Students' Association for Visions of the Earth (SAVE) – the university's most active group – has five subdivisions targeting different aspects of environmental action: biodiversity, green audit, green canteens, green materials, and green wardrobes.

Other than its annual green bazaar and nature photography competition, the group arranges regular nature walks and holds terrarium and food composting workshops.

In June 2023, SAVE set up a rooftop edible garden with the NUS Zero Waste Taskforce, supported by the SG Eco Fund. It aims to demonstrate the closing of food waste loops on the university's campus.

For instance, it utilises compost from processed food waste – fruit peels and vegetable scraps collected from University Town food courts – as fertiliser, allowing staff and student groups from nearby residential colleges to grow edible vegetables and herbs from seeds.

To celebrate their harvest, the group plans to host farmers' markets and plant-based cooking workshops for the NUS community.

These are but some of the ways that students have taken charge of their future. At NUS, students are not merely passive learners but changemakers of society.

NUS SAVE conducts regular nature walks for the NUS community.

NUS alumni:

Leaders of sustainability

At NUS, education does not prepare students for just a single pathway. Instead, it equips graduates with versatile skills that will propel them towards driving meaningful, sustainable change in their industry and in society.

NUS alumni are contributing to sustainability in all areas, from industry to government and civil society. A LinkedIn search puts the number of NUS alumni currently in sustainability leadership positions in all sectors at over 250.

From ensuring Singapore's water security to producing sustainable packaging to wildlife conservation, here are three noteworthy NUS alumni who have made an impact in their fields.

Mr Harry Seah, Deputy Chief Executive (Operations) of national water agency PUB.

Ms Susan Chong, founder of sustainable packaging firm Greenpac.

Ms Anbarasi Boopal, Chief Executive Officer of animal welfare organisation ACRES.

Singapore's third tap: Flowing towards water sustainability

Singapore's high-grade reclaimed water, named NEWater, is Mr Harry Seah's pride and joy.

As a small island nation with no natural resources, water security is of utmost priority. But how do you secure a sustainable water supply?

"The conventional approach of water management and international best practices will not be able to deliver sustainable water supply for us," noted Mr Seah, an NUS civil engineering graduate from the class of 1983 who is now Deputy Chief Executive (Operations) at PUB, Singapore's national water agency.

"We must push the boundaries of (research and development) in water sustainability to develop new solutions and technologies based on sound engineering and scientific principles." And that is exactly what Singapore did, with a breakthrough technology that produced NEWater from recycled water.

In 1998, Mr Seah was one of two engineers whom PUB sent to the United States for two weeks to learn about water recycling methods and test the latest technology available.

After they brought home the knowledge, opening the first NEWater plant in 2000 was challenging. Over the first three months, Mr Seah and his team were constantly working overtime to find fixes to never-ending problems.

All the sweat and tears poured into the project were worth it. NEWater was tested extensively beyond drinking water standards and reviewed by a panel of local and international experts. It was found to be a safe and sustainable water source – even for drinking – and was introduced to the public in February 2003.

"Our Water Story is a good story and a never-ending one." Mr Seah said. "It captures the can-do and dare-to-do spirit of our pioneers. This DNA has been passed from one generation of water engineers to the next in PUB."

Mr Seah was one of two engineers sent to the United States by PUB in 1998 to learn about water recycling methods that eventually led to the development of NEWater.

Green packaging without the red bottom lines

The odds were stacked against Ms Susan Chong when she decided to leave her high-profile sales career at pharmaceutical giant Pfizer for the less prestigious and male-dominated packaging industry in 2002.

Even during a time when no one prioritised sustainability, the NUS Executive Master of Business Administration graduate did not let anything deter her from launching sustainable packaging company Greenpac.

The idea for the start-up came while she was helping her husband with his own woodworks packaging company. Having noticed the green trend while abroad in Europe, she realised the industry's high amount of waste generated presented a business opportunity.

"Even in Singapore, people had never taken packaging seriously before. It was always last on their agenda — an afterthought," she said. "I thought it was time to professionalise it and make it something technical."

But with clients' main priority being cost, she had to change the perception that everything green would create financial red lines.

"When I first started and told people about (green and sustainable) packaging, they laughed," Ms Chong recalled. "The first thing they asked was 'How much does it cost?'"

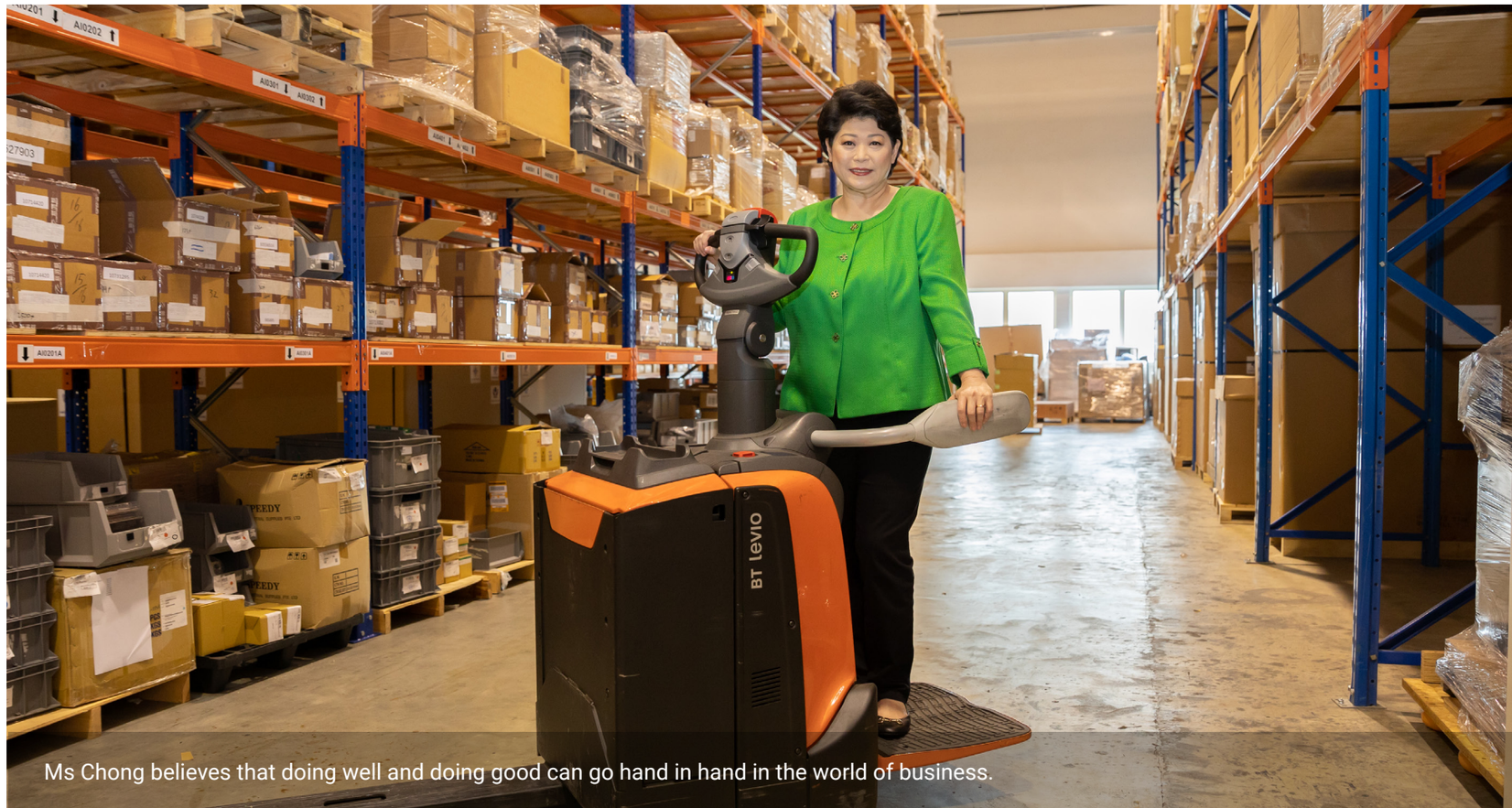
That was how Greenpac's business model was born: innovative and sustainable packaging solutions that deliver cost savings.

"It's not about what you can do. It's about what (clients) want and their needs," she said. "If you are able to come up with a solution and bring it in as a bonus, then you have the formula (for a successful business)."

Today, the startup has grown to become a multi-million-dollar company, serving some of the largest Fortune 500 companies in its clientele.

From multiple Singapore Star Packaging Awards to being named EY Entrepreneur of the Year by Ernst & Young Singapore in 2014, Ms Chong has paved the way for sustainable packaging with Greenpac.

That same year, she also founded Greenphyto, a sustainable urban farming company that uses novel agricultural technology to enhance food security and reduce food waste globally.



Ms Chong believes that doing well and doing good can go hand in hand in the world of business.

A passion for wildlife conservation

Ms Anbarasi Boopal survived on a meagre salary of S$500 every month for four years, but it was a sacrifice she was willing to make to help build Singapore's first wildlife rescue centre. She considered it a privilege to help animals.

Her mother was rightfully worried for her, especially since she graduated from NUS in 2006 with a Master of Science in Environmental Management. Her mother told her: "People go to Singapore to earn money, and you are there working for $500, cutting grass and taking care of snakes. What kind of career is that?"

Recalling that conversation from 2007 when speaking to women's magazine Her World Singapore, Ms Anbarasi – who is an Indian national and Singapore permanent resident – has since come a long way.

While she is an animal lover with experience in wildlife in India, her passion to tackle the illegal wildlife trade was only ignited when she found an Indian star tortoise that was being kept illegally during her graduate days in NUS.

When she called Animal Concerns Research and Education Society (ACRES), she was saddened to learn that Singapore did not have a wildlife rescue centre and that the tortoise would not be returned to India. That was when she decided to be part of the team to build one.

Giving up the opportunity to work at better-paying jobs, she spent hours constructing, gardening, cleaning, and setting up the ACRES Wildlife Rescue Centre (AWRC), which opened its doors in 2009.

When ACRES founder Mr Louis Ng announced that he would be stepping down as Chief Operating Officer in 2021, Ms Anbarasi took over the role with colleague Mr Kalai Vanan Balakrishnan.

"If I could telepathically communicate with over eight billion people on our planet, I'd ask them to make some serious changes to our lifestyles – go plant-based or drastically reduce meat consumption, and buy possessions that you need, not what you want. Technology may solve climate-related problems over time or turn plastic to mushrooms, but you and I have a choice today to not create problems that need solving for our future generations," said Ms Anbarasi.

Ms Anbarasi believes all animals deserve a chance to live a safe life.

Looking ahead

Driving environmental sustainability

NUS has made much headway in advancing environmental sustainability, in the areas of education, research and innovation, campus operations, and leadership, as outlined in this report. The university will continue to build on this strong foundation to advance its commitment to sustainable development and aspirations to be a leader in this field.

It is also the university's intention to use this report to create opportunities for collaboration internally – amongst academic staff, researchers, administrators, and students – as well as with external partners in the government, private sector, and non-profit community.

The report represents NUS' best effort to provide a transparent and engaging account of its sustainability contributions, achievements, and targets thus far, leveraging a framework which will guide future iterations.

NUS will continue to track its progress in the coming years as it spearheads environmental sustainability, in support of national and international sustainability goals.

Building climate resilience

In addition, with the growing impact of climate change – coupled with NUS' breadth and depth of sustainability research – the university aims to broaden its focus to encompass climate resilience, that is, enhance the capacity of institutions, cities, and countries to survive and thrive, in the face of future climate changes. NUS has built up a strong network of internal and external research institutions, with excellent researchers working in emerging areas relevant to climate resilience as well as urban city resilience, including complexity science.

Through collaborations and partnerships, the university aims to expand its resilience thrust to holistically encompass issues beyond climate and the built environment to the economy, society, communities, and individuals, with an emphasis on the interconnectivities between them.

Going forward, NUS will work to bring together expertise from across campus in the fields of science, technology, and the humanities to develop a programme of research and education on resilience.

This is not only strategic to the university but also supports the national agenda, which includes a Resilience Working Group under the Inter-Ministerial Committee on Climate Change that studies Singapore's vulnerability to the effects of climate change and develops long-term plans to address them.

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Editorial & design
The Nutgraf

Published by
Sustainability and Resilience Unit
NUS Office of the President

21 Lower Kent Ridge Road
Singapore 119077

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