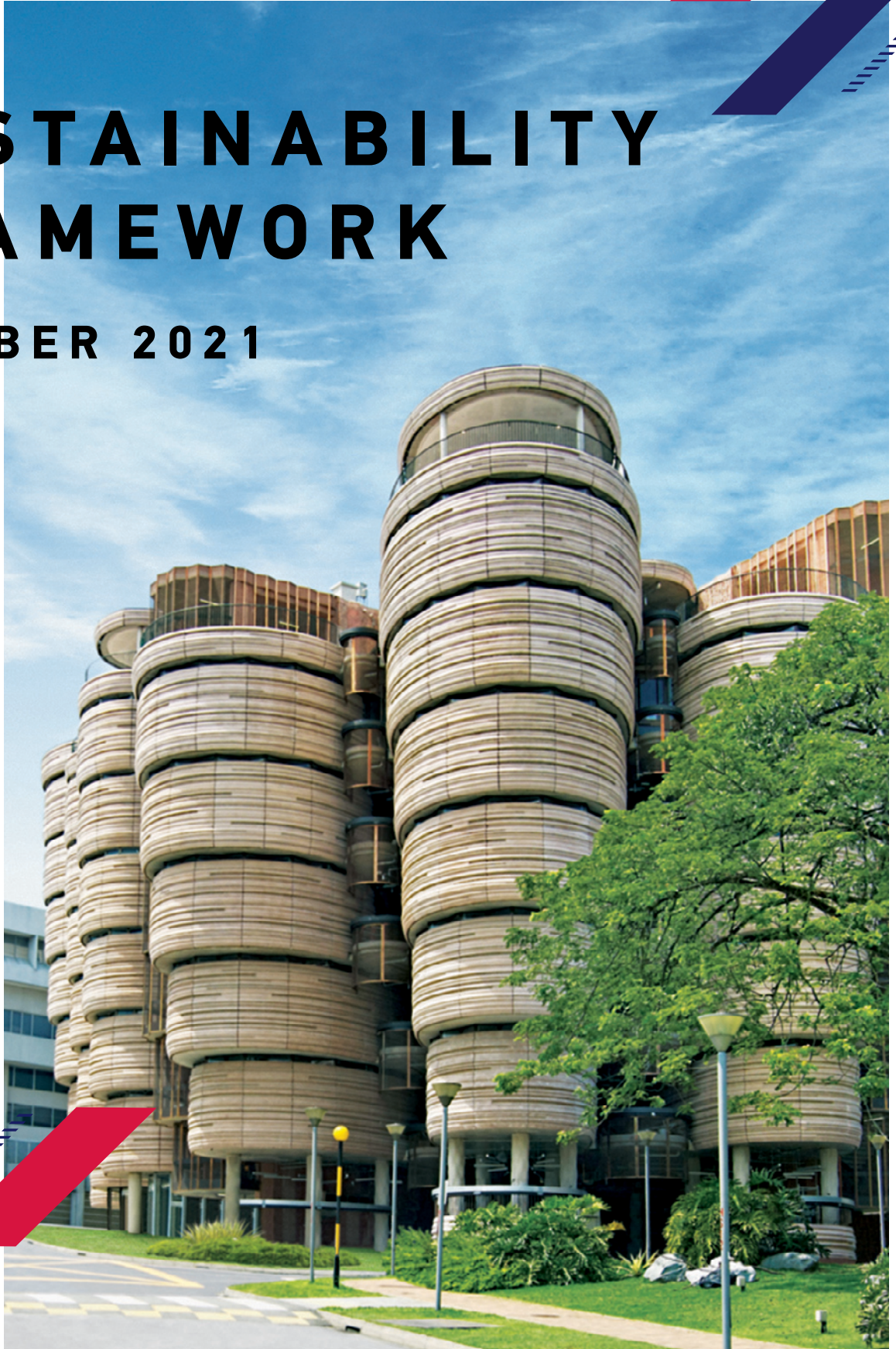




**NANYANG
TECHNOLOGICAL
UNIVERSITY**
SINGAPORE

SUSTAINABILITY FRAMEWORK

OCTOBER 2021



NTU 2025

Universities have long played a pivotal role in creating new knowledge, advancing the frontiers of human intellect, fostering innovation to produce economic value, and addressing societal needs and challenges. With a vision to become a great global university founded on science and technology, nurturing leaders, and creating societal impact through interdisciplinary education and research, NTU's current momentum and agility positions the University well to set an ambitious agenda for the next stage of significant growth and impact through our five-year strategic plan, NTU 2025.

NTU 2025 builds on the University's unique intellectual assets while articulating our bold ambitions and goals for significantly enhancing and deploying these strengths. As NTU implements this plan, we will strive to play a key role in addressing four of humanity's grand challenges:

1. Mitigating our impact on the environment
2. Harnessing the science, art, and technology of learning
3. Addressing technology's impact on humanity
4. Responding to the needs and challenges of healthy living and ageing

To this end, specific initiatives, pathways, and goals have been established to strengthen NTU's four core pillars:

1. **Education:** To nurture leaders with character, competence, and cognitive agility
2. **Research:** To strengthen deep disciplinary discoveries and high-impact interdisciplinary research
3. **Innovation:** To translate knowledge into enterprise that benefits industry and society through partnerships
4. **Community:** To foster a diverse, inclusive, and cohesive community

These activities will be supported through enablers that enhance excellence to achieve NTU 2025 goals:

- **Talent:** A mission-led and high-performing organisation
- **Financials:** Diversified revenue streams and efficiency across the University
- **Technology:** Enabling technologies to power innovation and growth

The 2025 plan also includes the 'NTU Smart Campus initiative' which reflects our commitment to environmental sustainability by deploying our beautiful Smart Campus as a living test bed to translate our intellectual strengths into actionable pathways. It will encompass targeted efforts to promote sustainability and the use of the NTU campus as a test bed to demonstrate how innovative digital and tech-enabled solutions can support better learning and living experiences for members of our community. The initiatives include:

- Support efforts for on-campus test-bedding projects in areas including innovative green energy, lower carbon footprint and waste management technologies
- Undertake clean energy and autonomous vehicle development and pilot projects both on and off campus
- Set an ambitious target of halving our net energy utilisation, water usage, and waste generation each by March 2026, compared to the levels of 2011
- Encourage the use of digital technologies to improve working, learning, and living experiences on campus

As a leading research-intensive university, NTU acknowledges the need and responsibility to respond to environmental, social, and economic challenges. Our commitment to developing innovative solutions to global sustainability challenges runs deep. We have dedicated research centres focussing in the areas of sustainability such as the Energy Research Institute @ NTU (ERI@N), Nanyang Environment & Water Research Institute (NEWRI), Singapore Centre for Environmental Life Science and Engineering (SCELSE) and the Earth observatory of Singapore (EOS). These institutes have developed numerous industry and government partnerships and are well positioned for breakthroughs in sustainability. We have several projects and partnerships that propel us towards this goal. A few examples are highlighted below. We would like to build on this momentum to do our part for the environment and be one of the global leaders in sustainability.

- **Green, Zero Energy and Super Low Energy Buildings:** As of January 2021, the University has a total of 62 Platinum Green Mark Awards: 60 for building projects, one for the rejuvenated Yunnan Garden and a District Award for the campus. Notably, 100% of all buildings in NTU larger than 2,000 m² are Green Mark Platinum certified. NTU has eight Zero Energy Buildings and two Super Low Energy Buildings.
- **Beyond green buildings:** NTU was also named the first winner of BCA's highest Green Mark Platinum Star Champion award in 2016 for having 51 Green Mark Platinum awards.
- **Sustainable Water Management:** NTU has received ABC Waters Certification for two projects – the ponds at Crescent/Pioneer Halls and Yunnan Garden.
- **Circular Economy:** NTU has partnered France's Alternative Energies and Atomic Energy Commission (CEA) to set up the NTU Singapore-CEA Alliance for Research in the Circular Economy (SCARCE) to focus on innovative electronic waste (e-waste) recycling research, including the toxic plastics found on e-waste.
- **Ending Plastic Waste:** The NTU Institute for Science and Technology for Society (NISTH) interdisciplinary approach brings experts from the STEM and non-STEM disciplines together and spurs research to tackle important societal challenges such as the eradication of plastic waste. Assoc Prof Sierin Lim (School of Chemical and Biomedical Engineering) and her team comprising Prof Lam Yeng Ming (School of Materials Science and Engineering), Dr Farid Ghadessy (A*STAR) and Assoc Prof Yew Wen Sha (NUS) secured more than \$6.1M of external funding from the NRF in 2020 for their programme to reduce Poly Ethylene Terephthalate (PET) waste (7.4% of the world's plastic demand) by engineering enzymes and microbes that convert PET into compounds of industrial value (up-cycling). In collaboration with researchers from Imperial College and the University of Nottingham, this programme will therefore be the first to provide a carbon-neutral bio-upcycling solution for plastic waste management by converting PET into a range of value-added molecules. This will be accomplished by engineering both enzymes and microbial hosts for improved PET degradation into feedstock and conversion to value-added molecules.
- NTU has recently partnered with Alliance to End Plastic Waste (AEPW) and together have committed to S\$1.2 million to fund innovative solutions for the global plastic waste problem, and will look to expanding its partnership with industry, government, research institutes and academia.
- **Future Ready Food Safety Hub (FRESH)** was officially launched by Ms Grace Fu, Minister for Sustainability, and the Environment, on 27 April 2021. FRESH is a tripartite collaboration programme between NTU, A*STAR and Singapore Food Agency (SFA), with NTU being the Host Organisation. FRESH is set up to drive food safety research for 'Food Safety Science & Innovation' under the Singapore Food Story (SFS) R&D Programme. It will also build local food safety science capabilities in support of Singapore's growing food innovation ecosystem.
- **Sustainable Agriculture** SCELSE's microbiome and biofilm approach is enabling sustainable solutions for intensive and low-impact food production through a circular economy and high protein stock feed; root-associated soil microbiomes for enhanced crop plant growth and health; and safe/sustainable poultry farming in South and Southeast Asia.
- **Agriculture Technology:** NTU Centre for Optical & Laser Engineering (COLE) partners with Panasonic to research and develop real-time crop health monitoring and nutrient analysis system for waste reduction and productivity improvement in hydroponic cultivation. The project has received S\$1.4M of support from A*STAR and Singapore Food Agency under the Singapore Food Story R&D Programme. The project aims to optimize crop protection and production by providing a solution for automated crop health monitoring and nutrient supply by leveraging the latest Hyperspectral Imaging (HIS) and Laser Induced Breakdown Spectroscopy (LIBS) technologies.

NTU'S COMMITMENT TO UNITED NATIONS' SUSTAINABLE DEVELOPMENT GOALS ("UN SDGS")

NTU supports and promotes the principles of the Sustainable Development Goals (SDG). NTU's publications on Sustainability (covering water, energy, environmental science, plants, earth science, marine science, and ecology) constitute approximately 16% of NTU's total research output. The citation impact of these papers is on par with the overall NTU performance. The top categories are Energy (18%), Engineering (16%), Environmental Science (15%) and Earth Science (8%). The papers are published in top journals with 63% in top 10% journals. Based on the UN SDGs, NTU's top 5 SDG goals by publication output are below (i) Affordable and clean energy, (ii) Good health and well-being, (iii) Climate action, (iv) Quality education and (v) Sustainable cities and communities.

Sustainable Development Goals (SDG)

NTU Actions



1. Good health and well-being:
Ensure health and well being

- Respond to the needs and challenges of healthy living and ageing through science, technology research and innovation.
- Strengthen NTU's Lee Kong Chian School of Medicine as one of the key pillars of HealthCity Novena, a new holistic ecosystem that includes health services, research, and education.



2. Quality education:
Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

- Educate and train the next generation of thinkers, innovators, leaders and lifelong learners in varied sustainability related courses, programmes and topics through science and art of learning.
- Encourage the use of digital technologies to improve working, learning, and living experiences on campus.



3. Affordable and clean energy:
Ensure access to affordable, reliable, sustainable and modern energy for all

- Undertake clean energy and autonomous vehicle development and pilot projects both on and off campus.
- Large scale implementation of photo-voltaic cells.
- Convert all NTU buildings to Green Mark Platinum certification.



4. Sustainable Cities and communities:
Make cities and human settlements inclusive, safe, resilient and sustainable

- Support efforts for on-campus test bedding projects in areas including innovative green energy, lower carbon footprint and waste management technologies.
- Future Ready Food Safety Hub (FRESH) Programme: Building local food safety capabilities to support growing innovation in food production and manufacturing and developing new food safety standards.



5. Responsible consumption and production:
Ensure sustainable consumption and production patterns

- Ambitious target of halving our net energy utilisation, water usage, and waste generation each by March 2026, compared to the levels of 2011.



6. Climate Action:
Take urgent action to combat climate change and its impacts

- NTU Earth Observatory of Singapore (EOS) has a newly awarded MOE TIER 3 SEA-level programme (SEA2) & NRF National sea-level programme to provide sea-level rise projections for Southeast Asia.
- NTU EOS has partnered with NASA jet propulsion lab and Caltech's ARIA system to conduct natural hazard monitoring and disaster response. A flagship remote sensing laboratory for emergency response and climate monitoring.



7. Partnerships for the Goals:
Strengthen implementation and revitalise global partnership for sustainable development

- Share NTU's unique strengths in educational research, EdTech, science of learning and pedagogical techniques through strategic collaborations with other institutions, industries, and academia.

**INSPIRING AND
EDUCATING
CURRENT
AND FUTURE
GENERATIONS
ABOUT
SUSTAINABILITY**

**NTU WILL
STRIVE TO
ACHIEVE CARBON
NEUTRALITY,
ALONG WITH
AT LEAST
50 PERCENT
REDUCTION
IN CARBON
EMISSIONS BY
2035**

To produce a new generation of scientists with leading-edge knowledge and skills in Artificial Intelligence (AI) to address critical environmental challenges, the University has launched an interdisciplinary **PhD programme in AI and Sustainability**.

At the undergraduate level, sustainability will constitute a core component of the the common **interdisciplinary core curriculum** introduced in August 2021.

Besides offering 200 electives related to sustainability across its vast curricular programmes, NTU has also introduced an interdisciplinary Minor in such topics as Environmental History, Environmental Sustainability, Environmental Management, Environmental Humanities, and Sustainability for undergraduates.

The unifying theme of the manifesto is NTU's conviction that its efforts in sustainability begin with its own actions on campus. NTU's belief in 'walking the walk' culminates in its distinct approach that tests and puts into scalable practice its teaching and research advances in sustainability on its 200-hectare Smart Campus. It also places a strong emphasis on sharing its best practices and innovations with the world and by working closely with industry and government for the benefit of local and global society.

The University's manifesto draws together a wide range of existing and new activities and aspirations, encompasses the actions of all employees and students, and spans all aspects of the university's mission in education, research, innovation and service to society and humanity.

In addition to striving for carbon neutrality, the University plans to:

- Achieve Green Mark Platinum certification for all eligible NTU buildings at Yunnan Gardens campus;
- Reduce by 50% NTU's net energy utilisation, water usage, and waste generation, by March 2026, compared to the levels of 2011 in each category;
- Incorporate sustainability as a key component of its common interdisciplinary core curriculum for all undergraduate students;
- Launch new undergraduate, postgraduate and continuing education programme options on different aspects of sustainability;
- Promote sustainable food tech solutions for food production and minimize food wastage;
- Create a global network with industry partners, non-governmental agencies and policy makers to develop sustainable solutions
- Establish a new NTU Sustainability Office to coordinate and support all sustainability efforts in education, research, individual and community engagement, and applications to practice in a holistic and integrated way.

Having made much progress since 2011, NTU aims to continue its ambitious sustainability journey by committing to a new target as follows:

KPI - NTU's scope 2 gross carbon emissions intensity (kgCO₂e/m²) from the campus¹	Scope 2 gross carbon emissions from NTU's total electricity consumption divided by the gross floor area ² of the NTU campus.
Sustainability Performance Target	Achieve carbon neutrality for the NTU Yunnan Campus by 2035, while aiming to reduce gross carbon emissions intensity by at least 50% from 2019 baseline
Base Line (2019)	Gross carbon emissions intensity of 56 kilogram of carbon dioxide equivalent / square meter in 2019

NTU is committed to achieve the SPT, and there are mainly 3 levers to achieve it – 1) Reducing energy consumption for the campus, 2) Sourcing renewable energy and 3) Carbon offsets

1. Reducing energy consumption

As part of the NTU 2025 strategy, NTU has planned a series of sustainability initiatives. NTU will support efforts for on-campus test-bedding projects in areas including innovative green energy and carbon footprint lowering technologies. NTU also plans to undertake clean energy vehicle development and pilot projects, both on and off campus. NTU will also encourage the use of digital technologies to improve working, learning, and living experiences on campus. Some of the initiatives NTU has planned to embark on to drive down NTU's energy consumption include:

- Investments in smart technology to regulate temperature on a real-time basis;
- Adopting state-of-the-art materials to improve energy efficiency in its infrastructural buildings; and
- Continuing research in the area of sustainability to bring about reductions in its carbon footprint

Although the University has identified future projects to reduce its energy consumption, NTU will still require considerable efforts and investments to achieve the SPT, including exploring new technologies and innovative solutions to enable further savings.

2. Sourcing renewable energy

NTU will explore sourcing its electricity from renewable sources together with its utility providers.

3. Carbon offsets

¹ Gross carbon emissions shall be calculated for each calendar year, from 1st January to 31st December.

² Gross floor area is defined the total area of the covered floor space measured between the centre line of party walls, including the thickness of external walls but excluding voids

While NTU is fully committed to reducing its gross carbon emissions intensity as much as possible through (1) and (2), in the event that there are residual gross carbon emissions, NTU will purchase carbon offsets from internationally reputable sources, such as The Gold Standard, to achieve carbon neutrality by 2035.

Reporting

NTU will publish a report annually, and in any case for any date/period relevant for assessing the SPT performance leading to a potential adjustment of the SLB's financial and/or structural characteristics.

Information related to NTU's sustainability performance against the set targets will be available in the progress reports to be published on the University's website at www.ntu.edu.sg.

NTU shall consider including the following information in the report:

- Up-to-date information on the performance of the selected KPI, including baselines where relevant.
- Verification assurance report outlining the KPI performance against the SPT.
- Any information which the issuer considers relevant towards enabling investors to monitor progress against SPT as well as analysis of the University's selected KPI and SPT.

Verification

NTU is committed to aligning with best practices and will engage an independent third party with the relevant expertise to verify the University's performance level against each SPT for each KPI on an annual basis. The verification of the performance against the SPTs will also be published on the University's website at www.ntu.edu.sg.



Professor Subra Suresh
NTU President