APPENDICES

Appendix 1

HKUST Net-Zero Building Standards

These standards form part of all Consultants' briefs, and the benchmarks shall be included in all contracts and subcontracts.

Application

These standards set benchmarks for the minimum performance for new capital projects and major existing building alterations and additions 5,000 m^2 or above. They shall be included in all Requests for Proposals issued and form an integral part of contracts for design consultants and contractors. The benchmarks shall be included in all contracts and sub-contracts where applicable.

First Created: 2015 (formerly known as HKUST Design Principles and High Performance Building Standards), January 2024 (HKUST Net-Zero Building Standards)

Last Reviewed: Mar 2025

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1 HKUST Sustainability Objectives

1.1 Mission and Vision

The Hong Kong University of Science and Technology (HKUST) strives to be a leader in sustainability, as articulated by the following sustainability mission statement:

HKUST will become a global leader in sustainability education by transforming the Clear Water Bay campus into a carbon-neutral, zero waste, and net-positive environmental impact living lab for experiential learning, demonstrating cutting-edge research and sustainable operations within a vibrant and engaged community.

To work towards this vision, HKUST embraces the concept of becoming a "Smart and Sustainable Campus," where our buildings and surroundings are complements to the learning environment, and where cutting-edge technologies, data, and building system information form a bridge between campus operations and learning priorities. HKUST's Smart and Sustainable Campus principles are:

1. Emphasize flexibility in spaces
2. Anticipate future energy needs and opportunities
3. Maximize potential for metering, monitoring, and sensors
4. Embrace the benefits of the surroundings
5. Design for social interaction
6. Integrate potential for student experimentation, research, and exploration

1.2 Net-Zero Carbon Timeline

Recognizing HKUST's net-zero commitment (see HKUST Net-Zero Carbon Action Plan) and support of the 2015 Paris Agreement and Hong Kong's Climate Action Plan, HKUST has made a commitment to:

- Reach a level of net-zero carbon emissions by 2045 by adopting decarbonization strategies that prioritize aggressive energy reductions, development of campus renewable energy installations, and elimination of climate-warming tracer gases and refrigerants.
- Maximize the generation of renewable energy on campus by looking to extend existing renewable energy methods and by piloting, with an aim to deploy, new types of renewable energy resources.
- Identify carbon capture and sequestration solutions to pilot with an aim towards deployment on campus.
- Use the platform, visibility, and research capacity of HKUST to support efforts of the greater Hong Kong community to reach this goal.
- Utilize our unique Sustainable Smart Campus as a Living Lab (SSC) framework for supporting University researchers, faculty, and staff to test innovative ideas and decarbonization measures on site for developing proof-of-concept climate solutions.

Each of these commitments are relevant to the design approaches to new construction on the HKUST campus. These HKUST Net-Zero Building Standards are intended to help design teams and contractors understand how to operationalize HKUST's Net-Zero commitments.

1.3 Net-Zero New Construction

Recognizing the need to support campus growth while maintaining an achievable path to net-zero, HKUST Net-Zero Carbon by 2045 Action Plan requires all new buildings to be net-zero carbon from construction stages through the end of the operational life of the building. Design consultants are expected to achieve net-zero carbon through the following four strategies:

1. Designers are required to **provide embodied carbon assessments** for new construction. While initial embodied carbon calculations may focus on the superstructure structural elements, these requirements will be refreshed and tightened over time to reduce embodied carbon in new construction.
2. Design consultants and construction contractors must account for **carbon emissions created during the construction process** so they can also be included in the overall embodied carbon footprint.
3. All **embodied carbon emissions must be offset** by purchasing an equal number of carbon removal credits. The purchase of offsets must come from the capital budget.
4. New buildings must reduce energy consumption to the greatest extent possible while simultaneously maximizing renewable energy potential on-site. The **building will reach net-zero emissions** when (1) the renewable generation replaces as much grid-powered electricity as possible, and (2) the revenue generated from the on-site renewables is sufficient to pay for the costs of carbon removal offsets for the remaining emissions.

2 Scope of Application

These standards apply to all new construction and major renovations that impact a space of 5,000 m^2 or above. For smaller renovations or fit outs, please refer to the HKUST Building Renewal Standards. This document represents the requirements of the University and expects all contractors, designers, and consultants to abide by the provisions herein.

These standards identify a minimum level of design and requirement, should be included in all Requests for Proposals issued for new projects, and referenced in contracts for design consultants and construction managers.

These standards will be periodically updated and revised.

3 Reference to Other HKUST Policy Documents

This document shall be read in conjunction with other HKUST policy documents as per Table 1 below.

Table 1: Applicability of HKUST Policy Documents for Different Building Related Procurement

HKUST Policy Documents to be Referenced	Type 1: New Building Construction	Type 2: Existing Building Major Renovations ≥ 5,000 m^2	Type 3: Minor Renovations 500 to < 5,000 m^2	Normal Departmental Purchases inside Buildings
HKUST Net-Zero Building Standards (this document)	Yes	Yes	-	-
HKUST Building Renewal Standards	-	-	Yes	-
HKUST Sustainable Purchasing Requirements for Suppliers and Contractors [1]	Yes	Yes	-	-
HKUST Sustainable Office Standards & Guidelines [2]	-	-	Yes (for offices)	Yes (for offices)
HKUST Operation Guidelines on Sustainable Purchasing for Departments [3]	-	-	-	Yes

4 Net-Zero Building Requirements

4.1 Elements

This section outlines the performance-based requirements relating to embodied and operational carbon, renewable energy as well as water consumption. The Net-Zero building requirement comprises two elements (refer to Figure 1):

Figure 1: Key Elements of Net-Zero Building Requirements

1. **Performance-Based Targets**, including embodied carbon in the construction process, and operational targets for energy and water post-occupancy.
2. **Comply-or-Explain Requirements** containing sustainability design strategies that shall be evaluated for each project. Non-compliance will require justification in the form of a technical feasibility study containing calculations, drawings, etc.

4.2 Performance-Based Requirements for Embodied Carbon

4.2.1 Approach for Embodied Carbon

HKUST's strategy is to invest in the reduction of greenhouse gas (GHG) emissions in all capital projects so that both embodied carbon and emissions from future operations are brought to zero, or as close as possible.

Embodied Carbon Performance Target (for new buildings only):

The maximum amount of embodied carbon shall be 500 kg CO_2e/m^2 of Construction Floor Area for the superstructure portion (stages A1 to A3) as well as the construction process (stages A4 to A5). This is aligned with the latest new construction at HKUST. By 2031, this maximum amount shall include building services equipment and selected finishes, and by 2035 this will be expanded to include all interior finishes as well.

Embodied Carbon Disclosure Requirement (for new buildings and major existing building alterations and additions):

Recognizing limitations of available data, the materials required for inclusion in embodied carbon calculations will increase over time, reflecting the anticipation that Life Cycle Assessment (LCA) databases will become more robust and complete.

2023-2030	Core building and shell (superstructure including glazing, cladding, external doors, and internal walls)
2031-2035	Core building and shell (superstructure), plus building services equipment, and selected finishes
2035 onward	All building elements, including interior and exterior furnishing

4.2.2 Life Cycle Analysis for Embodied Carbon

HKUST has adopted a life cycle approach to analyze the long-term costs and benefits of capital project decision-making. Assessing the embodied carbon relies on life cycle analysis to determine the overall climate impacts of building materials.

- **Software:** HKUST uses One Click LCA and the Hong Kong Construction Industry Council Carbon Assessment Tool. Although our performance requirements only relate to stages A1 to A3 (raw material extraction and supply, transport to manufacturing plant, and manufacturing and fabrication), data for stages A4 to A5 (transport to project site, and construction and installation process) shall be tracked and disclosed.
- **Area:** The definition of "area" shall refer to construction floor area and "superstructure" shall include frame, upper floors, roofs, stairs and ramps, external walls (façade), windows, external doors, internal walls (structural and non-structural), partitions and internal doors. Refer to Royal Institution of Chartered Surveyors (RICS) whole life carbon assessment for the built environment for further breakdown of building elements to be included.
- **Quantities:** Material quantities shall follow the project cost plan / bill of quantities, the building information modeling (BIM) model, be estimated from drawings, or delivery receipts.
- **Carbon emission factors:** Carbon emission factors shall refer to database from these sources in order of priority - (1) actual product data such as from Environmental Product Declarations or CIC Green Product Certification from suppliers where available, or other local generic data from (2) CIC Carbon Assessment Tool, or (3) One Click LCA (use local generic data where available or next closest overseas generic data).
- **Submission schedule**: At the end of each design stage, calculations for embodied carbon stages A1 to A3 shall be submitted. During the construction stage, calculations for stages A1 to A5 shall be submitted every three months. A final as-built embodied carbon report for stages A1 to A5 shall be submitted after Occupation Permit stage.

4.3 Performance-Based Targets for Operational Carbon

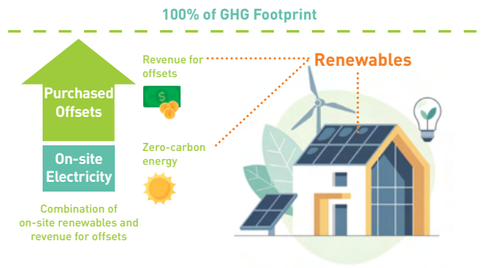
4.3.1 Approach for Operational Carbon

With new buildings and major building upgrades expected to last for many decades past our 2045 net-zero target, all new buildings and major upgrades must be designed to the highest efficiency level possible to reduce the carbon burden on the larger campus footprint. Since each building is unique, the performance target is simple:

Operational Performance Target:

GHG emissions from energy consumption must be offset by the revenue / avoided costs from building integrated zero carbon renewable energy production.

Figure 2: Making New Buildings / Major Upgrades Net-Zero Carbon



All GHG emissions from the operations of the building over time must be offset through either the purchase of high-quality carbon offsets (in alignment with The Oxford Principles for Net-Zero Aligned Carbon Offsetting) or by contributing an equal amount into an HKUST carbon reduction fund. To limit carbon offset costs, designers should maximize the amount of on-site renewables while simultaneously employing aggressive energy reduction strategies.

When the revenue from renewables equals the costs of buying offsets, HKUST considers the building to be net-zero carbon.

- **Types of carbon offsets:** Renewable energy shall be creatively placed to maximize the outputs using means such as solar panels on paving / roof trellis / car park roofs, and / or micro-turbines harvesting wind / kinetic / wave energy. Carbon sequestration such as biochar, algae, and / or carbon scrubber shall also be explored. Submetering shall be in place to track the renewable energy generated and carbon dioxide sequestered.
- **Costing assumptions:** Shadow cost of carbon offsets, earnings from renewable generation, efficiency gains, derating of equipment, feed-in-tariff rate and building life span shall be based on the latest HKUST operational and embodied carbon and life cycle cost calculators.

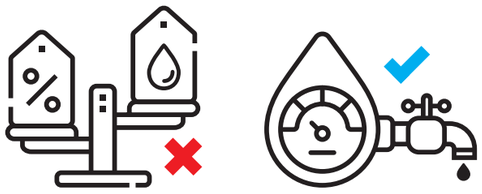
4.3.2 Energy Modeling for Operational Carbon

- **Software:** To estimate the operational carbon, energy modeling using an ASHRAE recognized software shall be used.
- **Occupancy rate:** Occupancy rates shall be based on operating hours of the space type, reduced occupancy during school holidays, and diversity based on typical usage.
- **Weather file:** Weather file (e.g. EPW) used shall be based on a moderate future climate change scenario for Representative Concentration Pathway (RCP) 4.5 (2.7°C). This shall include temperature, humidity and solar irradiation.
- **System:** The entire building services system shall be modelled using equipment efficiency from tender and as-built stages.
- **Submission schedule:** At the end of each design stage, calculations for operational carbon shall be submitted. A final as-built operational carbon report based on as-built equipment shall be submitted after Occupation Permit stage.

4.4 Performance-Based Targets for Potable Water

The performance goal for potable water consumption shall be measured against an overall target of net-zero potable water for the building measured on an annual basis (instead of a comparison to a base building).

Figure 3: Focus on Actual Water Consumption



% water saved compared to base building

Total potable water consumed

Designers should consider how alternative sources of water (such as grey water, rainwater, A/C condensation water, filtration-reject water, and water from other reuse strategies) can be used within the building as well as outside of the building (using the campus) so that potable water consumption is offset.

Net-zero water is achieved when the total amount of alternative water produced from the building, and used on campus, offsets the amount of potable water consumed by the building.

4.5 Life Cycle Cost Analysis

To achieve the best value for money from a net-zero aligned perspective and recognizing the vital importance of procurement in influencing key purchasing decisions, HKUST has adopted a life cycle cost analysis (LCCA) approach to evaluating costs and benefits over time. This means:

- All energy-consuming and water-consuming purchases and investments must use **life-cycle cost analysis (LCCA)** to ensure all associated costs of ownership, operation, and end-of-life costs are included in cost-benefit analyses.
- Utilizing an **internal carbon pricing (ICP)** to assign a cost to each metric ton of carbon emissions, allowing carbon considerations more central to University decision making, de-risking against the future carbon prices, and encouraging the adoption of low-carbon innovations. (See the internal price of carbon table in Annex 2).
- Utilizing **HKUST LCCA and spreadsheets and calculators [4]** for decision-making.

HKUST has developed a series of training resources for practitioners in the building sector to help build skills and awareness of using LCA software, life cycle costing calculators, and other relevant materials. These resources, developed by HKUST's Life Cycle Lab [5], are available for free, and all contractors are strongly encouraged to become familiar with them so that they can provide the life cycle information as expected by HKUST for capital projects.

4.6 Independently Verified Green Building Standards (BEAM Plus)

BEAM Plus Platinum: The Platinum Standard of performance for BEAM Plus shall apply. BEAM Plus [6] is Hong Kong's green building tools developed by Hong Kong Green Building Council. The tool covers sustainability performance criteria relating to planning, design, construction, commissioning, fitting out, management, operation and maintenance of a building, and is aligned with local regulations, standards, and codes of practice. All BEAM Plus pre-requisite credit requirements must be complied with. This includes the requirement for the project to demonstrate performance improvement or at least compliance based on the latest edition of Building Energy Code. [7]

4.7 Comply-or-explain Requirements

4.7.1 Approach for Comply-or-Explain Requirements

Based on the pain points faced by the users of our existing buildings, these requirements encapsulate our challenges beyond carbon. These are specific built elements that go beyond standard building specifications and will become the best practice standards tailored to HKUST's needs and operational policies. They shall be evaluated for each project. Non-compliance will require justification in the form of a technical feasibility study containing calculations, drawings, etc.

To align with BEAM Plus Platinum requirement and based on University priorities, the following sections reference specific BEAM Plus credits that must be met, **plus additional criteria to address HKUST's specific needs.**

4.7.2 Integrated Design and Construction Management (IDCM)

a) IDCM 3 Integrated Design Process

- **(a), (b), (c) Early consideration of integrated building design, buildability / constructability, operation, and maintenance:** Achieve 4 BEAM Plus credits for integrated design process, multi-disciplinary design charrette, early-stage consideration of buildability / constructability and design consideration for operation and maintenance.

Comply with additional criteria below:

- **Integrated design charrettes:** At least three integrated design charrettes are required, the first of which should happen at the time of project kickoff and prior to the end of Schematic Design. Charrettes should include tracking of project goals and analyzing the life cycle cost impacts of potential design options. Charrettes should include representation of major stakeholders including occupants and operations staff. Project stage review reporting should include sustainability components to ensure that issues can be addressed early in the design process. It should provide an update on all elements of the standards and focus on how sustainability aspirations will be addressed through next stage review.

b) IDCM 4 Life Cycle Costing

- **Life cycle costing:** Achieve 1 BEAM Plus credit for conducting life cycle costing for active systems.

Comply with additional criteria below:

- **Energy and water consuming systems:** Include all energy-consuming and water-consuming products and systems. Calculator resources and templates will be available on the HKUST Life Cycle Lab [8] website.

c) IDCM 5 Commissioning

- **(a), (b), (c), (d) Commissioning authority, reviewing report(s):** Plus credits through appointing independent commissioning authority (independent from design consultant or contractor), providing commissioning plan and commissioning review report(s).

Comply with additional criteria below:

- **Involvement throughout project:** A HKUST-appointed commissioning agent is required during design, construction and occupancy for all building projects, and must be present from the very beginning of the design process.

d) IDCM 7 Measures to Reduce Site Emissions (SDG 14: Life below Water & SDG 15: Life on Land)

- **(a), (b), (c), (d) Minimization of air / noise / water / light pollution (excluding bonus credits):** Achieve 4 BEAM Plus credits for providing adequate mitigation measures during construction.

Comply with additional criteria below:

- **Low carbon power supply:** Where non-grid power supply is used, adopt low carbon alternatives to reduce on-site emissions and environmental impact.
- **Water pollution mitigation:** All campus construction and maintenance work must follow the University's requirements of minimizing surface runoff and preventing the discharge of dirty water into storm water drains. [9]

e) IDCM 8 Construction and Demolition Waste Recycling (SDG 12: Responsible Consumption and Production; SDG 14: Life below Water & SDG 15: Life on Land)

- **(a), (b), (c), (d) Construction and demolition waste recycling (including bonus credits):** Achieve 1, plus 2 additional bonus BEAM Plus credits for 60% recycling level for construction waste and another 1, plus 2 additional bonus BEAM Plus credits for demolition waste where applicable.

Comply with additional criteria below:

- **Site waste management plan:** Provide a Site Waste Management Plan on how to minimize waste and valuable resources so they are not disposed of in landfills and most waste is sorted at all stages during a construction project.

f) IDCM 9 Construction Indoor Air Quality (IAQ) Management

- **Construction IAQ management plan and activities:** Achieve 1 credit for implementing a Construction IAQ Management Plan, undertaking a building 'flush out', and replacement of all filters prior to occupancy.

g) IDCM 13 Digital Facility Management Interface

- **Digital interface:** Achieve 1 bonus BEAM Plus credit for providing digital interface with energy use breakdown, such as energy use intensity, heating, ventilation and air conditioning (HVAC) equipment, lifts, and escalators.

h) IDCM 14 Occupant Engagement Platform

- **Digital platform:** Achieve 1 bonus BEAM Plus credit for providing a digital platform to engage building occupants.

i) IDCM 16 BIM Integration

- **(a), (b) Coordinated use of BIM within design and construction teams:** Achieve 1 plus one additional bonus BEAM Plus credit for coordinated use of BIM within Design and Construction Teams.

Comply with additional criteria below:

- **Use of BIM for sustainability data:** Use BIM to assist with life cycle costing, embodied carbon calculations, estimate greenhouse gas (GHG) emissions, and facilitate future measurement and verification.

j) IDCM 17 Design for Engagement and Education on Green Buildings

- **Education elements (including bonus credit):** 1 additional Bonus BEAM Plus credit for providing four education elements on strategies and solutions applied to the green buildings.

Comply with additional criteria below:

Access for research: Designers should examine the feasibility of including demonstrations of embedded systems and technologies as educational projects —such as low-level renewables easily visible and accessible for students as learning tools, and available / real-time data for students to conduct analysis and study—and research projects from HKUST scholars, who can also have their projects prominently displayed to explain the theories and applications of their work.

4.7.3 Sustainable Site (SS) (SDG 13: Climate Action)

a) SS 6 Light Pollution Control

- **(a) Control of obtrusive artificial light:** Achieve 1 BEAM Plus credit for demonstrating that the obtrusive artificial light from exterior lighting meets the specified performance for the environmental zone in which the building development is located.
- **(b) Control of external light reflection from building:** Achieve 1 BEAM Plus credit for demonstrating that the sunlight reflection from external surfaces of the buildings is controlled by using materials with acceptable external light reflectance.

b) SS 8 Urban Heat Island Mitigation

- **(a) Shade and high-albedo materials:** Achieve 1 BEAM Plus credit for providing shade on at least 5% of the site area and at least 50% of non-roof impervious surfaces on the site (e.g. parking, walkways, and plazas) using light colored high-albedo materials (albedo of at least 0.4).
- **(b) Tree coverage:** Achieve 2 bonus BEAM Plus credits for at least 10% of the total site area provided with tree coverage.
- **(c) Air ventilation assessment:** Achieve 2 BEAM Plus credits for demonstrating that better or equivalent ventilation performances, compared to the baseline case, under annual and summer wind conditions.
- **(d) Intra-urban heat island study:** Achieve 2 bonus BEAM Plus credits for conducting an intra -urban heat island study demonstrating that a maximum intra-urban heat index in summer is less than 0.8°C.

c) SS 9 Immediate Neighborhood Wind Environment

- **Wind amplification:** Achieve 1 BEAM Plus credit for demonstrating that no pedestrian areas will be subject to excessive wind velocities caused by amplification due to the site layout design and / or building design.

d) SS 10 Outdoor Thermal Comfort

- **(a) Shaded or covered routes:** Achieve 1 BEAM Plus credit for providing at least one shaded or covered route connecting the site with nearby amenities / site main entrance / transport hub.
- **(b) Passive open spaces with thermal comfort:** Achieve 1 BEAM Plus credit where 50% or more of the passive open spaces and pedestrian zones achieve thermal comfort on a typical summer day at 3 pm in Hong Kong.

Comply with additional criteria below:

- **Shelters minimizing direct solar radiation:** Shelters shall minimize direct solar heat gain e.g. using opaque roofing materials. Designs shall prioritize the use of these shelters for solar energy generation.

e) SS 11 Stormwater Management

- **Stormwater management (including bonus credit):** Achieve 2 BEAM Plus credits, plus one additional bonus BEAM Plus credit for demonstrating that adequate stormwater management design measures have been provided to cater the total volume of runoff for one hour corresponding to a design rainfall of at least 40 mm/event for the site in its post-developed conditions.

f) SS 12 Design for Climate Change Adaptation

- **Design for climate change adaptation (including bonus credits):** Achieve 1 bonus BEAM Plus credit for studying the projected variation in temperature / rainfall / water level rise, and storm surge of adjacent water bodies. Due to climate change and its impact on the development, prepare mitigation proposals to improve the climate resilience of the building, reducing impact from typhoons and heavy rain falls. Focus should be on below ground spaces, semi-enclosed spaces, and adjacent spaces to roof terraces / balconies. Achieve 1 additional bonus credit for including quantitative calculation to support the resilience design which is technically eligible and cost effective.

Comply with additional criteria below:

- **Extreme weather events:** Other than temperature / rainfall / water level rise, and storm surge, to include forest fire and typhoons in the study report.
- **Mosquito control:** Provide mosquitoes screens for operable windows. Ensure there is well drained soil / roofs / paved surfaces to prevent water ponding during large rainfalls. If water bodies are provided, ensure no standing water. Plants chosen shall not allow water ponding on its surfaces.
- **Underground facilities:** Ensure that underground facilities are not fully enclosed to reduce risk to occupants and staff.

4.7.4 Materials and Waste (MW) (SDG 12: Responsible Consumption and Production)

a) MW 4 Design for Durability and Resilience

- **(a) Building material selection appraisal:** Achieve 1 BEAM Plus credit for appraisal report to evaluate durability of at least 3 building materials.
- **(b) Protecting vulnerable parts of the building from damage:** Achieve 1 bonus BEAM Plus credit for providing suitable protective measures to prevent damage to vulnerable parts.
- **(c) Protecting exposed parts of the building from material degradation:** Achieve 1 bonus BEAM Plus credit for incorporating appropriate design and specification measures to limit material degradation due to environmental factors.

b) MW 5 Sustainable Forest Products

- **Sustainable timber (including bonus credits):** Achieve 1, plus one additional bonus BEAM Plus credit for 100% timber and composite timber products from sustainable sources / recycled timber.

c) MW 6 Recycled Materials

- **(a) Outside surface works and structures:** 1 BEAM Plus credit where at least 10% of all materials used for site exterior surface works, structures, and features with recycled content.
- **(b) Building façade and structural components (excluding bonus credits):** 1 BEAM Plus credit where at least 10% of all materials used for façade and structural components are materials with recycled content; or the use of Pulverized Fuel Ash (PFA) as a partial cement replacement in concrete that the PFA content is not less than 25%; or the use of Ground Granulated Blast-furnace Slag (GGBS) as a partial cement replacement in concrete that the GGBS content is not less than 40%.
- **(c) Interior non-structural components (excluding bonus credits):** 1 BEAM Plus credit where at least 10% of all materials used for interior non-structural components are materials with recycled content.

d) MW 7 Ozone Depleting Substances

- **(a), (b) Refrigerants and ozone depleting materials:** Achieve 2 BEAM Plus credits through selecting refrigerant with ozone depletion and global warming potentials within threshold, and products in building fabric and services without ozone depleting substances.

Comply with additional criteria below:

- **Refrigerants without hydrofluorocarbons (HFC):** Refrigerants shall not contain HFC.

e) MW 8 Regional Materials

- **Regional materials (including bonus credits):** Achieve 1, plus two additional bonus BEAM Plus credits for using 50% or above of all building materials used in the project.

f) MW 9 Certified Green Products

- **Certified green products (excluding bonus credits):** Achieve 2 BEAM Plus credits for having at least 5% certified green products in two of the listed categories (outside surface works, building façade and structures, interior non-structural components, and building services components).

Comply with additional criteria below:

- **HKUST sustainable purchasing policies:** In compliance with HKUST Sustainable Purchasing Requirements for Suppliers and Contractors [10] and HKUST Operation Guidelines on Sustainable Purchasing. [11]

g) MW 10 Life Cycle Assessment

- **Life cycle assessment:** 1 BEAM Plus credit for demonstrating the embodied energy in the major elements of the building structure of the building has been studied and optimized through a LCA.

Refer to Section 4.2.

h) MW 11 Adaptability and Deconstruction

- **(a), (b) Spatial adaptability and flexible engineering services (excluding bonus credits):** Meet BEAM Plus credit requirements for designs providing both spatial flexibility and flexible design of services that can adapt to changes of layout and use.

Comply with additional criteria below:

- **Daylight and views:** Consider natural sunlight and views in layout of spaces, and ensure that partitions can be shifted and adjusted to maximize the views, sunlight, and natural ventilation.

4.7.5 Energy Use (EU) (SDG 7: Affordable and Clean Energy & SDG 13: Climate Action)

a) EU 1 Low Carbon Passive Design

- **HVAC load reduction, natural ventilation and daylight:** Achieve 4 BEAM Plus credits either using prescriptive or performance path to optimize built form orientation and spatial planning, providing external shading devices, and space layout for daylighting provision.

b) EU 2 Reduction of CO_2 Emissions

Residential Buildings

- **Building envelope:** Achieve 1 BEAM Plus credit for residential buildings which requires Residential Thermal Transfer Value (RTTV) wall to be reduced by at least 10%, Residential Thermal Transfer Value (RTTV) roof to be reduced by at least 50%, Overall Thermal Transfer Value of Residents' Recreational Facilities (OTTV of RRF), lower (if applicable) to be reduced by at least 10%, Overall Thermal Transfer Value of Residents' Recreational Facilities (OTTV of RRF) podium (if applicable) to be reduced by at least 40%.
- **Natural ventilation:** Achieve 2 BEAM Plus credits for at least 40% of normally occupied space (habitable space) to satisfy the ventilation requirements.

Non-Residential Buildings

- **Building envelope:** Achieve 1 BEAM Plus credit for Overall Thermal Transfer Value non-residential towers to be reduced by at least 10%, and Overall Thermal Transfer Value non-residential podiums to be reduced by at least 40%.

Refer to Sections 4.3.

Comply with additional criteria below:

- **Window / door frames:** To provide thermal breaks at window / door frames to mitigate heat gain, and weatherstripping to minimize air infiltration.
- **Roof:** To provide coating with high Solar Reflectance Index and achieve U-value performance to meet ASHRAE 90.1-2016.
- **Glazing:** To achieve U-value performance to meet ASHRAE 90.1-2016.
- **Entryway infiltration control:** At entryways, balconies, lift shafts, and staircases, adopt vestibules, infiltration control, and / or airlocks to prevent humid air entering and cooled air escaping.

- **Building envelope airtightness:** Meet ASHRAE Standard 189.1, or equivalent standard. The measured air leakage rate of the building envelope shall not exceed 3.0 $m^3/h/m^2$ at 50 Pa. Testing shall be conducted in accordance with The Air Tightness Testing & Measurement Association (AATMA) Technical Standard L2, or equivalent standard by an independently accredited third party.

c) EU 3 Peak Electricity Demand Reduction

- **Reduction of peak electricity:** Achieve 3 BEAM Plus credits for at least 15% reduction of peak electricity demand.

Comply with additional criteria below:

- **Reduction of peak electricity demand charge:** Adopt low carbon solutions (e.g. energy storage) to reduce peak electricity demand charge. Consider battery backup power options instead of gensets to allow for more flexibility in utilizing load shifting strategies.

d) EU 4 Metering and Monitoring

- **(a), (b) Fundamental metering and monitoring / metering for tenanted areas (including bonus credits):** Achieve 1 plus 2 bonus BEAM Plus credits for providing energy monitoring system and performance auditing monitoring system for equipment and systems in spaces, allowing monitoring provision of tenants' energy consumption.

Comply with additional criteria below:

- **Fundamental metering and monitoring:** Provide energy monitoring system and performance auditing monitoring system for equipment and systems in spaces, and allowing monitoring provision of energy consumption.
- **Energy consumption monitoring:** Provide power metering system to track power usage for different aspects such as air conditioning, lighting, and equipment. Submeters for major energy consuming equipment e.g. lab fridges and equipment, and renewable systems shall be provided. Electricity and cooling submetering shall allow user charging on a lab / room / zone based on future user allocation.
- **Access for research:** Ensure meters are in place, pipework is accessible, and data and dashboard are open source to facilitate research by researchers and students. Data shall have the ability to be seen and downloaded by all interested users (students, faculty, and Facilities Management Office staff).
- **Usage pattern:** Design for sensors and people counters so that the building can track the flow of people coming and going at different times of the day, and integrate the data into building management, security, and space optimization strategies.

Comply with additional criteria below:

- **Certified electrical appliances and lab equipment:** For all buildings, have 100% of appliances and lab equipment certified Grade 1 under Mandatory and Voluntary Energy Efficiency Labeling Scheme, or most energy efficient rating of an equivalent certification scheme for electrical equipment. Refer to HKUST Sustainable Purchasing Requirements for Suppliers and Contractors [12] and HKUST Operation Guidelines on Sustainable Purchasing. [13]
- **Fume cupboards:** All fume cupboards should be equipped with an auto sash function for energy saving. All new fume cupboards should be equipped with a combination sash which can be open both vertically and horizontally. Both vertical and horizontal sash position should be able to interface with the variable air volume (VAV) system to control the flow rate.

4.7.6 Water Use (WU) (SDG 6: Clean Water and Sanitation)

a) WU 1 Annual Water Use and WU 7 Effluent Discharge to Foul Sewers

- **(a), (b) Potable water reduction: (including bonus credits):** Achieve 3 plus one additional bonus BEAM Plus credit for at least 40% annual water savings.
- **Sewerage volume reduction:** Achieve 1 BEAM Plus credit for reduction in annual sewage volumes by 20% or more.

Comply with additional criteria below:

- **Water efficient sanitary fittings and lab equipment:** All facilities should meet WELS [14] Grade 1 standard for equipment, or US Environmental Protection Agency WaterSense [15] criteria if there is no WELS standard.
- **Water use submetering:** Water consumption submetering for potable and non-potable water uses separately (separate lab and non-lab) shall be provided.

Refer to HKUST Sustainable Purchasing Requirements for Suppliers and Contractors [16] and HKUST Operation Guidelines on Sustainable Purchasing. [17]

b) WU 2 Water Efficient Irrigation

- **No potable water for irrigation (including bonus credit):** Achieve 2 plus one additional bonus BEAM Plus credit for 100% reduction in potable water consumption for irrigation.

Comply with additional criteria below:

- **Water efficient planting:** Native species and / or drought-tolerant plants shall be adopted to minimize water use.
- **Water use monitoring:** Water consumption submetering for irrigation shall be provided.

c) WU 3 Water Efficient Appliances

- **Water efficient appliances:** Achieve 1 BEAM Plus credit for installing water efficient appliances that achieve Grade 1 under the Hong Kong Water Supplies Department (WSD)'s WELS for residential buildings.

Comply with additional criteria below:

- For all buildings, have 100% of appliances certified Grade 1 under WSD's WELS, or most water efficient rating of an equivalent certification scheme for water consuming equipment.
- Refer to HKUST Sustainable Purchasing Requirements for Suppliers and Contractors [18] and HKUST Operation Guidelines on Sustainable Purchasing. [19]
- **Pipe water refilling system:** Install a pipe filtration water refilling system to eliminate the use of bottled water.

d) WU 6 Cooling Tower Water

- **Cooling tower water use:** Achieve 1 BEAM Plus credit for achieving seven or more cycles of concentration with acceptable water quality.

Comply with additional criteria below:

- **Water use monitoring:** Water consumption submetering for cooling tower including makeup and blowdown lines shall be provided.
- **Water loss controls:** Measures to eliminate water loss from drift.
- **Water usage controls:** Sensors and automated controls to control water use based on actual requirements.

e) WU 8 Water Harvesting and Recycling

- **(a), (b) Water reuse (including bonus credit):** Achieve 2 BEAM Plus credits, plus one bonus BEAM Plus credit for harvested rainwater and recycled grey water to achieve at least 10% or more potable water reduction.

Comply with additional criteria below:

- **Air conditioning condensate water reuse:** Condensate water from air conditioning systems is not allowed to go into the sewer or wastewater piping. Water derived from air conditioning condensation can be used for irrigation, toilet flushing, or other greywater purposes. Further, since the temperature of the water is generally colder than general potable water, effort should be made to recycle the water into cooling towers or other means for exchanging heat. Submetering shall be in place to track water reuse.
- **Other water reuse:** Rainwater and cooling tower bleed-off reuse shall be maximized wherever possible. Submetering shall be in place to track water reuse.

Refer to Section 4.4.

4.7.7 Health and Well-being (HWB)

a) HWB 1 Healthy and Active Living

- **Healthy and active elements (including bonus credit):** Achieve 1 bonus BEAM Plus credit for at least three items of all applicable design measures for healthy and active living.

Comply with additional criteria below:

Introducing biophilic design and healthy and active elements have been shown to enhance the productivity of the work / study environment, while improving the health of building occupants. During the development of the brief with the building occupants, propose and evaluate the following features:

- **Open layout workstations and flexible and multi-purpose enclosed rooms:** Consider open layout workstations to facilitate communication, while using furniture / plants to define zones. Workstation partitions shall be kept low, while use of glass walls / doors / windows shall be optimized. Enclosed rooms shall be placed in the center to maximize natural daylight and view sightlines for the majority of the users.

- **Inclusions of plants:** For spaces with regular occupants, consider designating areas for indoor plants.
- **Designated active workstations:** Consider using active workstations in selected workspaces e.g. standing desks equipped with walking pads and bicycle-desk hybrid workstation.
- **Choice of colors:** For the colors of the walls, carpet and interior finishing, engage users to select calming color tones preferred by the users and / or aligned with the department's branding.
- **Circadian lighting system:** Use this lighting system in working areas (e.g. rooms without access to daylight) whereby users will benefit from being aligned to the human circadian rhythm by mimicking the color temperature and intensity of natural sunlight throughout the day.

b) HWB 6 Acoustics and Noise

- **(a), (b) Room acoustics, noise isolation and background noise (including bonus credits):** Achieve 4 BEAM Plus credits, plus one bonus BEAM Plus credit for meeting the prescribed acoustic criteria for the prescribed spaces.

c) HWB 7 Indoor Vibration

- **Vibration levels**: Achieve 1 BEAM Plus credit for demonstrating vibration levels not exceeding the prescribed criteria.

d) HWB 8 Indoor Air Quality (IAQ)

- **(a), (b) Indoor air quality in occupied space and car park:** Indoor air quality testing for occupied spaces to meet IAQ Certification Scheme (Good Class) certificate issued by the Hong Kong Environmental Protection Department (EPD). Car park air quality to comply with the pollutant concentration limits specified in ProPECC PN 2/96.

Comply with additional criteria below:

- **Low emitting materials:** Paints, adhesives, furniture, and furnishing shall be in compliance with HKUST Sustainable Purchasing Requirements for Suppliers and Contractors [20] and HKUST Operation Guidelines on Sustainable Purchasing. [21] This shall include built-in furniture and fixture, loose furniture, and carpet.

e) HWB 10 Lighting Quality

- **(a), (b) Artificial lighting in normally occupied spaces and not normally occupied spaces / unoccupied spaces:** Achieve 2 BEAM Plus credits for meeting minimum standards for illuminance, illuminance uniformity, unified glare rating and color rendering index as per the latest CIBSE's Code for Lighting.

4.7.8 Landscaping and Biodiversity (SDG 15: Life on Land)

Trees on the campus landscape of HKUST are some of the most valuable resources of the property, and a key to the attractiveness and beauty to our campus residents and to outsiders. They also have biological and biodiversity value. HKUST places a priority on growing and maintaining campus trees as valuable assets.

- **Prioritization of brownfield site:** HKUST is a relatively young university, with the oldest buildings being only around 30 years old. The land area granted by the Hong Kong government for HKUST campus is a greenfield site surrounded by mostly undeveloped areas. Where future brownfield sites may exist within the allocated land, the project team shall prioritize the evaluation of these sites for constructing future buildings.
- **Site ecology:** Demonstrate how to enhance the ecological value of the site. Adopt measures such as use of surface water, native, and edible planting; avoidance of polluting treatments and materials, and avoid need for irrigation. The design team must show evidence of how plants and trees are used as part of a wider ecological strategy including solar shading and water processing and retention for "sponge city" benefits. There are a range of opportunities to integrate natural environment with overall building ecology providing amenity and environmental benefits.
- **No chemical fertilizer policy:** Use organic fertilizer instead of chemical fertilizer to reduce water pollution and as part of watershed management.

- **Existing plant protection:** For plants on existing sites, identify, monitor and protect plant species listed in the IUCN Red List, Forestry Regulations Cap. 96A [22], and Protection of Endangered Species of Animals and Plants Ordinance Cap. 586 (Schedule 1) [23] to ensure their preservation and promote species recovery, particularly Diospyros vaccinioides.
- **Land conservation and restoration:** Use land sustainably through conservation and restoration. Implement compensatory planting proposal of a ratio not less than 1:1 in terms of number as per the Hong Kong Lands Department mandatory requirements for preparing Tree Preservation and Removal Proposal [24], preferably within the existing site boundary. If constraint by space, compensatory planting shall be in a suitable location within HKUST boundary. Consider the height of compensatory trees in ways that maximize their value on campus, e.g. small trees should be used where we want to preserve sight lines to the coastline, and larger shade trees around pathways and roadways.
- **Native species:** Prioritize native species (more than 50%) in planting and landscaping to maximize the local biodiversity included in planning and development projects through enhancing ecological value of the landscape and providing habitat and food sources for local wildlife.
- **Invasive species:** Control the impact of alien species, especially avoiding invasive ones, to prevent disruptions to ecosystems and maintain the natural balance.
- **Plants with dual purpose**: New plants have more purposes than one. Investigate areas of planting and landscaping for productive uses. Certain plants are useful for absorbing volatile organic compounds (VOCs) and other airborne contaminants, while others are exceptional at releasing oxygen at specific times of the day. Vertical planting on south-facing walls and trees with dense canopies can absorb solar heat during summer months. Bamboo with its high growth rates is good for biochar, carbon sequestration and furniture.
- **Existing saplings:** Where available, existing saplings of native species and exotic species with value shall be transplanted to a suitable site in HKUST.
- **Wood utilization:** Consider the value of trees at the end of their lifespan for lumber use in HKUST projects. Trees felled shall not be in good health and have good amenity value, and shall be cut and sorted for maximum reuse. Tree felling contracts shall meet the below requirements:
  - A crane should be provided to transport 2 m long tree trunks / branches to the road, for ease of delivery off-site to HKUST's designated recycler. This allows maximum reuse into timber furniture and interiors.
  - The tree felling contractor should have some experience with tree felling for purposes of manufacturing timber planks for reuse into timber furniture or interior works.
  - Requirements of size of tree logs:
    - Cut lines shall be as close to the bottom of trunk as possible, around 100 mm from the ground level
    - The form of the tree fork shall be kept
    - Wood logs shall be kept not less than 1.5 m long, preferably over 2 m.
    - Curved parts shall be cut through to keep the wood log straight
    - The length of the wood log should not exceed the container length of the grab lorry / crane lorry
  - All other smaller diameter tree branches (under 200 mm diameter) should be sent to Y-Park for recycling
- **Exposed services:** Pipework shall always be buried to maximize ground area for other usage.

4.7.9 Energy Efficiency, Occupancy Controls, and Thermal Comfort

To achieve net-zero, energy efficiency is of the utmost importance. Equipment selection needs to be the most energy efficient in the local market. Opportunities for further energy savings are presented at HKUST owning to its variability of usage during term time and term break. Flexibility in building services controls also needs to be ensured due to frequent changes in space usage during the lifespan of the building, as well as operation hours. Occupancy controls for ventilation, cooling, and lighting shall have overwrite function for "always on" during occupancy, and facilitating partial use of the space, and reduced occupancy during school holidays.

Cooling & Ventilation Equipment Efficiency

- **Equipment efficiency:** Meet minimum standards for building services equipment as per ASHRAE 90.1-2016 and / or latest version of Building Energy Code, whichever is more stringent.

- **Fan-enhanced ventilation:** For air-conditioned spaces (except protected areas), enhanced ventilation shall be provided to increase temperature set points for energy savings, reduce condensation risk and cater to varying user requirements to enhance thermal comfort satisfaction (e.g. through mechanical or ceilings fans). An example and demonstration of such fan in the HKUST Sustainability Office may be accessed here. [25]
- **Variable equipment:** Equipment shall be variable air volume (VAV) or flow to allow occupancy controls.
- **Energy recovery and demand control equipment:** Equipment shall have heat recovery and demand control ventilation.
- **Mold growth and condensation prevention:** Introduce adequate ventilation for staircases, lobbies, and corridors to prevent mold growth and condensation.

Cooling & Ventilation Controls

- **Room pressure and temperature:** Room temperature is suggested to be kept at a user agreed value when occupied and not exceed 28°C (adjustable) when unoccupied to maintain a minimum flow set point for VAV boxes, unless specified otherwise. No space heating for winter. Relative humidity below 70% unless specified otherwise.
- **Air change:** Provide a user agreed minimum air change rate for occupied periods, and a user agreed reduced amount during unoccupied periods. Recirculation of air is allowed unless otherwise specified.
- **General timer control:** Controls for teaching facilities shall follows classroom schedule as per Academic Registry Office (ARO), and all other areas shall follow Campus Management Office (CMO) schedule. Overwrite function shall be provided with the local zone occupancy controls below.
- **Local occupancy control for specified zones:** When there is no occupancy detected at a certain zone, the zone's VAV box will be adjusted so that the damper position will reduce the airflow rate to an agreed minimum. Once occupancy is detected, the damper will revert back to 100% open. Zoning allocation shall be agreed with building users.
- **Window interlock:** Provide a window contact system that will interface with cooling and ventilation systems. For inner zones, set back temperature to 28ºC. For small rooms, cooling will be switched off and fan speed set to the minimum.

Artificial Lighting Equipment Efficiency

- **Lighting power density:** The total lighting power shall follow the latest edition of Building Energy Code (BEC) or Chartered Institution of Building Services Engineers (CIBSE) standards whichever is more stringent.
- **Task lighting provision:** Task lighting, coupled with occupancy sensor, to be installed in addition to room lighting.
- **Switch and sensor provision:** On / off switch, dimming switch and occupancy / motion sensor should be provided. Daylight dimmers with at least 10 stages of dimming to match daylight levels to be provided for labs, lift lobby, staircase and toilets with glazed windows.

Artificial Lighting Control

- **General timer control:** Controls for teaching facilities shall follow classroom schedule as per ARO, and all other areas shall follow CMO schedule. Overwrite function shall be provided with the local zone occupancy controls below.
- **Task lighting control:** Task lighting (by work area) should be controlled with occupancy sensors (DC connection) or manually by users. Color temperature is around 4,000K. When turned on at 100%, the actual lumens should meet design levels for the space type at 900 mm from floor when combined with room lighting. The time delay for turning off task lighting should be 18 to 360 seconds (adjustable).
- **General lighting control:** Lighting controls should help save energy by limiting either the time lights are on or the power they are drawing, or both. Zoning allocation shall be agreed with building users.

The time delay for turning off lights should be:

- If there is no occupation for a certain zone, zonal lighting can be dimmed smoothly in three stages – from the designed lighting level to 30% to 0% (off).
- Once occupancy is detected, lighting should resume smoothly to the designed lighting level.

4.7.10 Sustainable Smart Campus as a Living Lab (SDG 7: Affordable and Clean Energy)

HKUST's campus as a "Living Lab" helps to facilitate home-grown novel solutions and proofs of concept for net-zero approaches and technologies. The Living Lab approach will transform our campus into a testing ground for ambitious solutions that will support our net-zero goal. The near-term deliverables will be the development of a framework for HKUST researchers, faculty, and staff to test innovative ideas and decarbonization measures focused on energy conservation measures, renewable energy generation, and carbon removal and sequestration.

It is HKUST's expectation that design consultants will, from time to time and when requested, work with HKUST research teams to explore how new research approaches can be integrated into new building designs.

Examples of HKUST research that may be relevant in the design process:

- **Decarbonization research and development:** HKUST has teams working on the development and application of decarbonization through small scale introduction of the following technologies:
  - Carbon storage in materials e.g. biochar blocks, carbon dioxide embedded pavers / blocks / reinforced concrete, bamboo or other timber
  - Carbon dioxide scrubber
  - Carbon sequestration e.g. biochar, algae, bamboo
  - Direct air capture
- **Future renewable provision:** Anticipating that all exterior surfaces (including vertical surfaces, windows, and doors) that have solar exposure will be utilized in the future for energy generation, HKUST researchers are actively exploring new techniques. Design consultants should incorporate in conduit channels and other means for making it easy to access these areas for electrical wiring, and ensure structural loading is sufficient for future solar panel additions.
- **Lower current power systems for renewables:** Considering an emerging area of research looking at how buildings may be converted to be DC powered for greater efficiency, design consultants shall consider how to isolate certain systems (e.g. lighting) so that they can be served by lower current power systems (e.g. direct current) as renewables are added to the building.

5 Deliverables

Checks are in place throughout the building project stages to ensure that the minimum standards can be met. Refer to Table 2 below. This facilitates the building of a database to allow future sustainability performance to be benchmarked and targets to be set.

Table 2: Submission of Sustainability Data Throughout Building Project Stages

Building Project Stages	Submission Deliverables
Request for Fee Proposal (By Consultants)	• Approach and strategy on how performance requirements for operational carbon and renewable energy can be met • Approach and strategy on how performance requirements for stages A1 to A3 embodied carbon can be met • Approach and strategy on how net-zero water use can be met
Schematic Design **Detail Design** **Tender Documentation (By Consultants)**	**At the end of each design stage** • Design calculations with supporting documentation to demonstrate compliance to performance-based requirements—to include operational carbon, stages A1 to A3 embodied carbon, and net-zero water use (at the end of each design stage) • Design checklists to explain how the requirements are incorporated in the design • Life cycle costing for energy-consuming & water-consuming products & systems
Construction Stage (By Main Contractor)	**Monthly** • Electricity consumption and renewable energy per month (kWh per month) • Water consumption and water reused per month (m^3 per month) • Waste generation and waste recycled per month (metric tons or kg per month for each type of waste) **Every quarterly** • Stages A1 and A5 embodied carbon calculations
Occupation Permit (By Main Contractor)	**Within 3 months of obtaining Occupation Permit** • As-built calculations with supporting documentation to demonstrate compliance to performance-based requirements—to include operational carbon, stages A1 to A5 embodied carbon and net-water use • As-built checklists to explain how the requirements are incorporated in the as-built design

Annex 1: Net-Zero Buildings Minimum Standards Checklist

The requirements presented in this document is summarized in the form of a checklist for ease of reference by the consultant and construction teams, as well as for compliance checks by HKUST.

A completed checklist shall be submitted at the end of each design stage and within three months of obtaining Occupation Permit.

No.	Requirement	Ref. Section in Document	Adopted (Y/N/NA)	Remarks
Building Performance Disclosure *Comply with the requirements listed below*				
1	(a) Max. embodied carbon 500 kg CO_2e/m^2 of CFA for superstructure (stages A1 to A3) (for new buildings) (b) Embodied carbon disclosure requirement (for new buildings and major existing building alterations and additions)	4.2		
2	≥ 7.5% renewable energy to generate revenue to offset cost of carbon	4.3		
3	Annual alterative water source offsets annual potable water consumption	4.4		
4	Life cycle cost analysis	4.5		
5	BEAM Plus Platinum standard	4.6		
Comply-or-Explain Requirements *Comply with the requirements listed below* *If not adopted, justification shall be given using technical feasibility study containing life cycle calculations, drawings, etc.*				
Integrated Design and Construction Management				
6	BEAM Plus credit IDCM 3 (a), (b), (c), plus additional criteria for integrated design charrettes	4.7.2 (a)		
7	BEAM Plus credit IDCM 4, plus additional criteria for energy and water consuming systems	4.7.2 (b)		
8	BEAM Plus credit IDCM 5 (a), (b), (c), (d), plus additional criteria for commissioning agent involved throughout project	4.7.2 (c)		
9	BEAM Plus credit IDCM 7 (a), (b), (c), (d) (excluding bonus credits), plus additional criteria for low carbon power supply and waste pollution mitigation	4.7.2 (d)		
10	BEAM Plus credit IDCM 8 (a), (b), (c), (d) (including bonus credits), plus additional criteria for site waste management plan	4.7.2 (e)		
11	BEAM Plus credit IDCM 9	4.7.2 (f)		
12	BEAM Plus credit IDCM 13	4.7.2 (g)		
13	BEAM Plus credit IDCM 14	4.7.2 (h)		
14	BEAM Plus credit IDCM 16 (a), (b), plus additional criteria for use of building information management for sustainability data	4.7.2 (i)		
15	BEAM Plus credit IDCM 17 (including bonus credit), plus additional criteria for access for research	4.7.2 (j)		

No.	Requirement	Ref. Section in Document	Adopted (Y/N/NA)	Remarks
Sustainable Sites (SS)				
16	BEAM Plus credit SS 6 (a), (b)	4.7.3 (a)		
17	BEAM Plus credit SS 8 (a), (b), (c), (d) (including bonus credits)	4.7.3 (b)		
18	BEAM Plus credit SS 9	4.7.3 (c)		
19	BEAM Plus credit SS 10 (a), (b), plus additional criteria for shelters minimizing direct solar radiation	4.7.3 (d)		
20	BEAM Plus credit SS 11 (including bonus credit)	4.7.3 (e)		
21	BEAM Plus credit SS 12 (including bonus credits), plus additional criteria to extreme weather events, mosquito control, and underground facilities	4.7.3 (f)		
Materials & Waste (MW)				
22	BEAM Plus credit MW 4 (a), (b), (c) (including bonus credits)	4.7.4 (a)		
23	BEAM Plus credit MW 5 (including bonus credit)	4.7.4 (b)		
24	BEAM Plus credit MW 6 (a), (b), (c) (excluding bonus credits)	4.7.4 (c)		
25	BEAM Plus credit MW 7 (a), (b), plus additional criteria for refrigerants without HFC	4.7.4 (d)		
26	BEAM Plus credit MW 8 (including bonus credits)	4.7.4 (e)		
27	BEAM Plus credit MW 9 (excluding bonus credits), plus additional criteria for HKUST sustainable purchasing policies	4.7.4 (f)		
28	BEAM Plus credit MW 10	4.7.4 (g)		
29	BEAM Plus credit MW 11 (a), (b) (excluding bonus credits), plus additional criteria for daylight and views	4.7.4 (h)		
Energy Use (EU)				
30	BEAM Plus credit EU 1 (heating, ventilation, and air conditioning (HVAC) load reduction, natural ventilation, and daylight)	4.7.5 (a)		
31	BEAM Plus credit EU 2 (building envelope for residential and non-residential buildings, and natural ventilation for residential building only), plus additional criteria for window / door frames, roof, glazing, entryway infiltration control, and building envelop airtightness	4.7.5 (b)		
32	BEAM Plus credit EU 3, plus additional criteria for reduction of peak electricity demand charge	4.7.5 (c)		
33	BEAM Plus credit EU 4 (a), (b) (including bonus credits), plus additional criteria for energy consumption monitoring, function and location, access for research, and usage pattern	4.7.5 (d)		
34	BEAM Plus credit EU 8 (2 credits), plus additional criteria for 100% of appliances to be certified Grade 1, and fume cupboards	4.7.5 (e)		

No.	Requirement	Ref. Section in Document	Adopted (Y/N/NA)	Remarks
Water Use (WU)				
35	BEAM Plus credit WU 1, WU 3, WU 7 (including bonus credit), plus additional criteria for toilets and water use monitoring	4.7.6 (a)		
36	BEAM Plus credit WU 2 (including bonus credit), plus additional criteria for water-efficient planting and water use submetering	4.7.6 (b)		
37	BEAM Plus credit WU 3, plus additional criteria for 100% of appliances to be certified Grade 1 and pipe water refilling system	4.7.6 (c)		
38	BEAM Plus credit WU 6, plus additional criteria for water use monitoring, water loss, and water use controls	4.7.6 (d)		
39	BEAM Plus credit WU 8 (a), (b), (including bonus credit), plus additional criteria for air-conditioning condensate water reuse, and other water reuse	4.7.6 (e)		
Health and Well-being (HWB)				
40	BEAM Plus credit HWB 1 (including bonus credit)	4.7.7 (a)		
41	BEAM Plus credit HWB 6 (a), (b), (c) (including bonus credit)	4.7.7 (b)		
42	BEAM Plus credit HWB 7	4.7.7 (c)		
43	BEAM Plus credit HWB 8 (a), (b), plus additional criteria for low emitting-materials	4.7.7 (d)		
44	BEAM Plus credit HWB 10 (a), (b)	4.7.7 (e)		
Landscaping and Biodiversity				
45	Prioritization of brownfield site	4.7.8		
46	Site ecology			
47	No chemical fertilizer policy			
48	Existing plant protection			
49	Land conservation and restoration			
50	Native species			
51	Invasive species			
52	Plants with dual purpose			
53	Existing saplings			
54	Wood utilization			
55	Exposed services			

No.	Requirement	Ref. Section in Document	Adopted (Y/N/NA)	Remarks
Energy Efficiency, Occupancy Control, and Thermal Comfort				
56	Cooling & ventilation equipment: Equipment efficiency	4.7.9		
57	Cooling & ventilation equipment: Fan-enhanced ventilation			
58	Cooling & ventilation equipment: Variable equipment			
59	Cooling & ventilation equipment: Energy recovery and demand control equipment			
60	Cooling & ventilation equipment: Mold growth and condensation prevention			
61	Cooling & ventilation controls: Room pressure and temperature			
62	Cooling & ventilation controls: Air change			
63	Cooling & ventilation controls: General timer control			
64	Cooling & ventilation controls: Local occupancy control for specified zones			
65	Cooling & ventilation controls: Window interlock			
66	Artificial lighting equipment: Lighting power density			
67	Artificial lighting equipment: Task lighting provision			
68	Artificial lighting equipment: Switch and sensor provision			
69	Artificial lighting control: General timer control			
70	Artificial lighting control: Task lighting control			
71	Artificial lighting control: General lighting control			
Sustainable Smart Campus as a Living Lab				
72	Decarbonization research and development	4.7.10		
73	Future renewables provision			
74	Lower current power systems for renewables			

Annex 2: Internal Price of Carbon 2020-2050

The Internal Price of Carbon (IPC) is an important tool for determining the collection and reallocation of funding based on greenhouse gas emissions due to operations. The IPC should also be used by contractors and design teams to establish costs for comparison in decision-making. Pricing references the net-zero by 2050 scenario in IEA's Global Energy and Climate (GEC) Model. Pricing is specifically for emerging market and developing economies with net-zero emissions pledges, which includes China, India, Indonesia, Brazil, and South Africa.

Internal Price of Carbon for HKUST

Academic Year	IEA Carbon Price (US$/Metric Ton)	Carbon Price (HK$/Metric Ton)
2020	$30	$ 235
2021		$ 255
2022		$ 280
2023		$ 300
2024		$ 325
2025		$ 350
2026		$ 420
2027		$ 490
2028		$ 560
2029		$ 630
2030	$90	$ 700
2031		$ 755
2032		$ 810
2033		$ 865
2034		$ 920
2035		$ 975
2036		$1,030
2037		$1,085
2038		$1,140
2039		$1,195
2040	$160	$1,250
2041		$1,281
2042		$1,312
2043		$1,343
2044		$1,374
2045		$1,405
2046		$1,436
2047		$1,467
2048		$1,498
2049		$1,529
2050	$200	$1,560

References:

1. HKUST Sustainable Purchasing Requirements. For Suppliers and Contractors, https://sust.hkust.edu.hk/files/HKUST%20Sustainable%20Purchasing%20Contractor%20Requirements_Aug2024.pdf
2. HKUST Sustainable Office Standards & Guidelines, https://sust.hkust.edu.hk/files/HKUSTSustainabilityGuidelinesv1.6.pdf
3. HKUST Operational Guidelines on Sustainable Purchasing, https://sust.hkust.edu.hk/files/SustainablePurchasingOct23.pdf
4. HKUST Life Cycle Cost Calculators, https://sust.hkust.edu.hk/life-cycle-lab/contractors-and-suppliers/net-zero-online-training-module
5. Net-Zero Online Training Module, HKUST Life Cycle Lab, https://sust.hkust.edu.hk/life-cycle-lab/contractors-and-suppliers/net-zero-online-training-module
6. Hong Kong Green Building Council, BEAM Plus, https://www.hkgbc.org.hk/eng/beam-plus/introduction/index.jsp
7. EMSD, Codes & Technical Guidelines, https://www.emsd.gov.hk/beeo/en/mibec_beeo_codtechguidelines.html
8. HKUST Sustainability, Life Cycle Lab, https://sust.hkust.edu.hk/life-cycle-lab
9. Chapter 16: Disposal of Hazardous Materials and Items under Regulatory Control, https://hseo.hkust.edu.hk/sm_16 and Chapter 19: Liquid Effluent and Protection of Watershed and Aquatic Environment, https://hseo.hkust.edu.hk/sm_19
10. HKUST Sustainable Purchasing Requirements. For Suppliers and Contractors, (see Appendix 1, footnote 1)
11. HKUST Operational Guidelines on Sustainable Purchasing, (see Appendix 1, footnote 3)
12. HKUST Sustainable Purchasing Requirements. For Suppliers and Contractors, (see Appendix 1, footnote 1)
13. HKUST Operational Guidelines on Sustainable Purchasing, (see Appendix 1, footnote 3)
14. Water Supplies Department, Water Efficiency Labeling Scheme (WELS), https://www.wsd.gov.hk/en/plumbing-engineering/water-efficiency-labelling-scheme/index.html
15. EPA, The WaterSense Label, https://www.epa.gov/watersense/watersense-label
16. HKUST Sustainable Purchasing Requirements. For Suppliers and Contractors,(see Appendix 1, footnote 1)
17. HKUST Operational Guidelines on Sustainable Purchasing, (see Appendix 1, footnote 3)
18. HKUST Sustainable Purchasing Requirements. For Suppliers and Contractors, (see Appendix 1, footnote 1)
19. HKUST Operational Guidelines on Sustainable Purchasing, (see Appendix 1, footnote 3)
20. HKUST Sustainable Purchasing Requirements. For Suppliers and Contractors, (see Appendix 1, footnote 1) HKUST Operational Guidelines on Sustainable Purchasing, (see Appendix 1, footnote 3)
21. Forestry Regulations (Cap. 96, section 3), GovHK, https://www.elegislation.gov.hk/hk/cap96A
22. Cap. 586 Protection of Endangered Species of Animals and Plants Ordinance, https://www.elegislation.gov.hk/hk/cap586?xpid=ID_1438403490651_001
23. Lands Department, Guidance Notes on Tree Preservation and Removal Proposal for Building Development in Private Projects – Compliance with Tree Preservation Clause under Lease, https://www.landsd.gov.hk/doc/en/practice-note/lpn/PN%206_2023%20Guidance.pdf
24. HKUST Sustainability / Net-Zero Office, Sustainability Office Features, Green Technology, Energy-Saving Bladeless Fans to Reduce Need for Air-Conditioning, https://sust.hkust.edu.hk/greentechnology

Appendix 2

HKUST Building Renewal Standards

These standards form part of all consultants' briefs, and the benchmarks shall be included in all contracts and subcontracts.

Application

These standards set benchmarks for the minimum performance for renovations that impact a space of ≥ 500 m^2 and less than 5,000 m^2. They shall be included in all Requests for Proposals issued and form an integral part of contracts for design consultants and contractors. The benchmarks shall be included in all contracts and sub-contracts where applicable.

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1 HKUST Sustainability Objectives

1.1 Mission and Vision

The Hong Kong University of Science and Technology (HKUST) strives to be a leader in sustainability, as articulated by the following sustainability mission statement:

HKUST will become a global leader in sustainability education by transforming the Clear Water Bay campus into a carbon-neutral, zero waste, and net-positive environmental impact living laboratory for experiential learning, demonstrating cutting-edge research and sustainable operations within a vibrant and engaged community.

To work towards this vision, HKUST embraces the concept of becoming a "Smart and Sustainable Campus," where our buildings and surroundings are complements to the learning environment, and where cutting-edge technologies, data, and building system information form a bridge between campus operations and learning priorities. HKUST's Smart and Sustainable Campus principles are:

1. Emphasize flexibility in spaces
2. Anticipate future energy needs and opportunities
3. Maximize potential for metering, monitoring, and sensors
4. Embrace the benefits of the surroundings
5. Design for social interaction
6. Integrate potential for student experimentation, research, and exploration

1.2 Net-Zero Carbon Timeline

Recognizing HKUST's net-zero commitment (see HKUST Net-Zero Carbon Action Plan) and support of the 2015 Paris Agreement and Hong Kong's Climate Action Plan, HKUST has made a commitment to:

- Reach a level of net-zero carbon emissions by 2045 by adopting decarbonization strategies that prioritize aggressive energy reductions, development of campus renewable energy installations, and elimination of climate-warming tracer gases and refrigerants.
- Maximize the generation of renewable energy on campus by looking to extend existing renewable energy methods and by piloting, with an aim to deploy, new types of renewable energy resources.
- Identify carbon capture and sequestration solutions to pilot with an aim towards deployment on campus.
- Use the platform, visibility, and research capacity of HKUST to support efforts of the greater Hong Kong community to reach the same goal.
- Utilize our unique Sustainable Smart Campus as a Living Lab (SSC) framework for supporting University researchers, faculty, and staff to test innovative ideas and decarbonization measures on site for developing proof-of-concept climate solutions.

Each of these commitments are relevant to the design approaches to renewal projects on the HKUST campus. These HKUST Building Renewal Standards are intended to help design teams and contractors understand how to operationalize HKUST's Net-Zero commitments.

1.3. "Everything Touched" Standard for Renovation

The Campus Renewal Plan (CRP) is a comprehensive assessment of the current conditions of the campus built-environment with an action plan for systematically upgrading selected buildings in sequence through 2035.

The CRP adopts an "everything touched" approach meaning that when we have an opportunity to upgrade a space, we must take advantage of the opportunity to implement all feasible decarbonization measures at that time. This recognizes that major upgrades do not happen frequently so we must be opportunistic when the chances arise. It also recognizes that with a limited timeframe for reaching our net-zero target, we will not have a second chance to return to these buildings before 2045.

The CRP focuses primarily on the oldest labs, student residence halls, and staff quarters and includes a reasonable implementation schedule to complete the work by 2035. Most importantly, the CRP creates a set of standards for renovations that are compulsory, along with a secondary set of options that may be considered with available budget and time.

The overarching strategy for the existing campus is to:

- Invest aggressively in energy conservation, renewables, and decarbonization.
- Continue to invest in the "smart" infrastructure backbone of meters, sensors, monitors, and other data collection and visualization measures.
- Explore new decarbonization opportunities on the campus.

2 Scope of Application

These standards apply to all renovations that impact a space of ≥ 500 m^2 and less than 5,000 m^2. For major renovations 5,000 m^2 or above, please refer to the HKUST Net-Zero Building Standards. This document represents the requirements of the University and expects all contractors, designers, and consultants to abide by the provisions herein.

These standards identify a minimum level of design and requirements and should be included in all Requests for Proposals issued for renewal projects and referenced in contracts for design consultants and construction managers.

These standards will be periodically updated and revised.

3 Reference to Other HKUST Policy Documents

This document shall be read in conjunction with other HKUST policy documents as per Table 1 below.

Table 1: Applicability of HKUST Policy Documents for Different Building Related Procurement

HKUST Policy Documents to be Referenced	Type 1: New Building Construction	Type 2: Existing Building Major Renovations ≥ 5,000 m^2	Type 3: Minor Renovations 500 to < 5,000 m^2	Normal Departmental Purchases Inside Buildings
HKUST Net-Zero Building Standards [1]	Yes	Yes	-	-
HKUST Building Renewal Standards (this document)	-	-	Yes	-
HKUST Sustainable Purchasing Requirements for Suppliers and Contractors [2]	Yes	Yes	-	-
HKUST Sustainable Office Standards & Guidelines [3]	-	-	Yes (for offices)	Yes (for offices)
HKUST Operation Guidelines on Sustainable Purchasing for Departments [4]	-	-	-	Yes

4 Renewal Building Requirements

4.1 Elements

HKUST's strategy is to invest in the reduction of greenhouse gas (GHG) emissions in all renewal projects so that both embodied carbon and emissions from future operations are brought to zero, or as close as possible. With many renewals expected to last past our 2045 net-zero target, all renewal projects must be designed to the highest efficiency level possible to reduce the carbon burden on the larger campus footprint.

The renewal building requirement comprises of two elements (refer to Figure 1):

Figure 1: Key Elements of Net-Zero Building Requirements

1. **Building performance disclosure**, including providing calculations for embodied carbon in the construction process, operational consumption for energy and water and life cycle costing for energy and water consuming technologies.
2. **Comply-or-explain requirements** contain sustainability design strategies that shall be evaluated for each project. Non-compliance will require justification in the form of a technical feasibility study containing life cycle calculations, drawings, etc.

These requirements apply to the extent of the renewal works that are touched in the existing building.

Reference has been made to the recommendations arising from the Campus Renewal Plan, requirements of the HKUST Net-Zero Building Standards [5], and BEAM Plus [6], the independently verified green building standards developed by Hong Kong Green Building Council. The tool covers sustainability performance criteria relating to planning, design, construction, commissioning, fitting out, management, operation and maintenance of a building, and is aligned with local regulations, standards, and codes of practice.

4.2 Building Performance Disclosures

4.2.1 Embodied Carbon of Major Fit-Out Materials

Assessing the embodied carbon relies on life cycle analysis (LCA) to determine the overall climate impacts of building materials. Greater disclosure of embodied carbon for renewals would facilitate internal benchmarking based on space type, complexity, and scale. This helps to better inform decision making process pertaining to material use, and allows the setting of performance targets. Recognizing limitations of available data, the materials required for inclusion in embodied carbon calculations will increase over time, reflecting the anticipation that LCA databases will become more robust and complete. This requirement applies to the extent of the renewal works.

- **Building elements to be included:** Major fit-out materials, including air handling units (AHUs), fan coil units, lighting fixtures, internal walls / partition / ceiling materials, and floor finishes. Include façade, structural, and external elements where applicable. Refer to Royal Institution of Chartered Surveyors (RICS) whole life carbon assessment for the built environment for further breakdown of building elements to be included.
- **Software:** HKUST uses One Click LCA and the Hong Kong Construction Industry Council Carbon Assessment Tool. Although our disclosure requirements only relate to stages A1 to A3 (raw material extraction and supply, transport to manufacturing plant, manufacturing and fabrication), data for stages A4 to A5 (transport to project site, construction and installation process) shall be tracked and disclosed when available.
- **Quantities:** Material quantities shall follow the project cost plan / bill of quantities, the building information management (BIM) model, be estimated from drawings, or delivery receipts.
- **Carbon emission factors:** Carbon emission factors shall refer to database from these sources in order of priority - (1) actual product data such as from Environmental Product Declarations or CIC Green Product Certification from suppliers where available, or other local generic data from (2) CIC Carbon Assessment Tool, or (3) One Click LCA (use local generic data where available or next closest overseas generic data).
- **Submission schedule:** At the end of each design stage, calculations for embodied carbon stages A1 to A3 shall be submitted. During the construction stage, calculations for stages A1 to A5 shall be submitted every three months. A final as-built embodied carbon report for stages A1 to A5 shall be submitted after completion.

4.2.2 Operational Carbon

The campus has evolved greatly over the last 30 years, but our priority to add submetering to understand the energy utilization intensive of each space was started more recently. Today we recognize the necessity of collecting energy data from each space so we can:

1. Achieve our goal of charging each University unit for actual energy consumed
2. Use the data to calculate carbon footprint of space types and activities
3. Set measurable performance targets
4. Respond more quickly when systems are out of calibration

With the renewal of a particular space or entire existing buildings, the resultant operational carbon of the extent of the renewal works needs to be quantified for better decision-making for equipment use, while facilitating future performance targets for each space type and operation mode.

- **Software:** To estimate the operation carbon, energy modeling using an ASHRAE recognized software shall be used.
- **Occupancy rate:** Occupancy rates shall be based on operating hours of the space type, reduced occupancy during school holidays, and diversity based on typical usage.
- **Weather file:** Weather file used shall be based on a moderate future climate change scenario for Representative Concentration Pathway (RCP) 4.5 (2.7°C). This shall include temperature, humidity, and solar irradiation.
- **System:** The entire building services system shall be modelled using equipment efficiency from tender and as-built stages.
- **Submission schedule:** At the end of each design stage, calculations for operational carbon shall be submitted. A final as-built operational carbon report based on as-built equipment shall be submitted after completion.

4.2.3 Water Consumption

Potable water consumption has grown with the campus population and is exacerbated by global warming. Similar challenges are faced with metering water usage for each space type and monitoring deficiencies. For each renewal project, the potable and non-potable water consumption shall be calculated for the equipment replaced in the renewal.

Calculations shall be based on selected equipment flow rates and duration of use as per BEAM Plus references (or LEED where local references are not available).

4.2.4 Life Cycle Cost Analysis

To achieve the best value for money from a net-zero aligned perspective and recognizing the vital importance of procurement in influencing key purchasing decisions, HKUST has adopted a Life Cycle Cost Analysis (LCCA) approach to evaluating costs and benefits over time. This means:

- All energy-consuming and water-consuming purchases and investments must use **LCCA** to ensure all associated costs of ownership, operation, and end-of-life costs are included in cost-benefit analyses.
- Utilizing an **internal carbon pricing (ICP)** to assign a cost to each metric ton of carbon emissions, allowing carbon considerations more central to University decision making, de-risking against the future carbon prices, and encouraging the adoption of low-carbon innovations (see the internal price of carbon table in Annex 2).
- Utilizing **HKUST LCCA and internal carbon pricing spreadsheets and calculators [7]** for decision-making.

HKUST has developed a series of training resources for practitioners in the building sector to help build skills and awareness of using life cycle analysis software, life cycle costing calculators, and other relevant materials. These resources, developed by HKUST's Life Cycle Lab [5], are available for free, and all contractors are strongly encouraged to become familiar with them so that they can provide the life cycle information as expected by HKUST.

4.3 Comply-or-Explain Requirements

4.3.1 Approach for Comply-or-Explain Requirements

Based on the pain points faced by the users of our existing buildings and the outcomes of the comprehensive Campus Renewal Plan study, these requirements encapsulate our challenges beyond carbon. These are specific built elements that go beyond standard building specifications and will become the best practice standards tailored to HKUST's needs and will go hand-in-hand with operational policies. They shall be evaluated for each project. Non-compliance will require justification in the form of a technical feasibility study containing calculations, drawings, etc.

Based on University priorities, some requirements reference BEAM Plus Existing Building standards [8], EMSD's Building Energy Code, ASHRAE standards, **plus additional criteria to address HKUST's specific needs**.

4.3.2 Integrated Design and Construction Management

a) Integrated Design Process

- **Integrated design charrettes:** At least one integrated design charrette is required, preferably at project kickoff or commencement of Schematic Design. Charrettes should include tracking of project goals and analyzing the life cycle cost impacts of potential design options. Charrettes should include representation of major stakeholders including occupants and operations staff. Project stage review reporting should include sustainability components to ensure that issues can be addressed early in the design process. It should provide an update on all elements of the standards and focus on how sustainability aspirations will be addressed through the next stage review. BEAM Plus New Buildings Version 2.0 "IDCM 3 Integrated Design Process" credit provides additional guidance.

b) Commissioning

- **Commissioning:** Provide commissioning for electrical services systems, plumbing and drainage systems, and lift and escalator systems where applicable for the upgraded works. BEAM Plus New Buildings Version 2.0 "IDCM 5 Commissioning" credit provides additional guidance.

c) Measures to Reduce Site Emissions (SDG 14: Life below Water & SDG 15: Life on Land)

- **Site emissions mitigation:** Provide adequate mitigation measures for air and noise pollution control during construction.
- **Low carbon power supply:** Where non-grid power supply is used, adopt low carbon alternatives to reduce on-site emissions and environmental impact.
- **Water pollution mitigation:** All campus construction and maintenance work must follow the University's requirements of minimizing surface runoff and preventing the discharge of dirty water into storm water drains. [9]
- **Site waste management plan:** Provide a Site Waste Management Plan on how to minimize waste and valuable resources so they are not disposed of in landfills and most waste is sorted at all stages during a construction project.

BEAM Plus New Buildings Version 2.0 "IDCM 7 Measures to Reduce Site Emissions" credit provides additional guidance.

d) Construction and Demolition Waste Recycling (SDG 12 Responsible Consumption and Production; SDG 14: Life below Water & SDG 15: Life on Land)

- **Construction and demolition waste recycling:** Achieve 60% recycling level for construction and demolition waste. BEAM Plus New Buildings Version 2.0 "IDCM 8 Construction and Demolition Waste Recycling" credit provides additional guidance.

e) Construction Indoor Air Quality (IAQ) Management

- **Construction IAQ management plan:** Implement a Construction IAQ Management Plan, undertaking a building 'flush out', and replacement of all filters prior to occupancy. BEAM Plus New Buildings Version 2.0 "IDCM 9 Construction IAQ Management" credit provides additional guidance.

f) Digital Facility Management Interface

- **Digital interface:** Provide digital interface with energy use breakdown such as energy use intensity, heating, ventilation, and air conditioning (HVAC) equipment, lifts and escalators. BEAM Plus New Buildings Version 2.0 "IDCM 13 Digital Facility Management Interface" credit provides additional guidance.

g) Design for Engagement and Education on Green Buildings

- **Access for research:** Designers should examine the feasibility of including demonstration of embedded systems and technologies as educational projects —such as low-level renewables easily visible and accessible for students as learning tools, and available / real-time data for students to conduct analysis and study—and research projects from HKUST scholars, who can also have their projects prominently displayed to explain the theories and applications of their work. Refer to Section 4.3.8 Sustainable Smart Campus as a Living Lab.

4.3.3 Sustainable Site (SDG 13: Climate Action)

a) Climate Change Adaptation

- **Design for climate change adaptation:** For below ground spaces, semi-enclosed spaces, adjacent spaces to roof terraces / balconies, prepare mitigation proposal to improve the climate resilience of the building to reduce impact from typhoons and heavy rain falls. BEAM Plus Existing Buildings Beta Version 3.0 "MAN-02-03 Resilience Strategy" and "SS-04-01 Building-scale Climate Adaptation Measures" credits provide additional guidance.
- **Mosquito control:** Provide mosquito nets on openable windows.
- **Underground facilities:** Ensure that underground facilities are not fully enclosed to reduce risk to occupants and staff.

4.3.4 Materials and Waste Aspects (SDG 12: Responsible Consumption and Production)

a) Certified Green Products

- **Sustainable timber:** Ensure 100% timber and composite timber products are procured from sustainable sources / recycled timber.
- **Product certification:** Incorporate green products for paint, ceiling tiles and carpets. Green products are defined to have strategies to minimize environmental impact, and / or environmental labeling / product certification listed under "Strong Preferences" in the HKUST Sustainable Purchasing Requirements for Suppliers and Contractors. [10]
- **HKUST sustainable purchasing policies:** In compliance with HKUST Sustainable Purchasing Requirements for Suppliers and Contractors [11] and HKUST Operation Guidelines on Sustainable Purchasing. [12]

b) Ozone Depleting Substances

- **Refrigerants and ozone depleting materials:** Select refrigerant for all newly purchased and existing equipment with global warming potentials within the stated threshold in BEAM Plus Existing Buildings Beta Version 3.0 "MW-02-03 Ozone Depleting Substances" credit. In addition, refrigerants shall not contain hydrofluorocarbons (HFCs). Avoid the use of materials with ozone depleting substances in their manufacture, composition, or use.

c) Adaptability and Deconstruction

- **Spatial adaptability and flexible engineering services:** Use designs providing both spatial flexibility and flexible design of services that can adapt to changes of layout and use.
- **Daylight and views**: Consider natural sunlight and views in layout of spaces, and ensure that partitions can be shifted and adjusted to maximize the views, sunlight, and natural ventilation.

d) Furniture and Equipment

When possible, existing furniture and equipment from the original office or other locations in the HKUST campus should be used to minimize waste and the cost of renovation. Rethink the need for purchase and ensure that this purchase will serve multi-purpose uses to extend the use phase of the product. Should this be insufficient, the following may be considered:

- **Purchase second-hand furniture:** Usage of second-hand furniture is encouraged. For guidelines relating to the purchase of these objects, please refer to the HKUST Second-Hand Goods Purchasing and Reimbursement Guidelines. [13]
- **Purchase environmentally friendly furniture and equipment:** Furniture and equipment made from low environmental and waste materials and equipment using less energy and / or water should be considered. For example, wooden furniture made from FSC-certified wood (FSC 100%, FSC Recycled, or FSC Mixed), which ensures the wood is sustainably sourced. Consider the lifespan, resources required for manufacturing and transport, ongoing operation and maintenance cost, and end of life disposal. Please refer to the HKUST Sustainable Purchasing Requirements For Suppliers and Contractors [14] and the HKUST Operational Guidelines on Sustainable Purchasing. [15]

4.3.5 Energy Use (SDG 7: Affordable and Clean Energy & SDG 13: Climate Action)

a) Building Envelope

With Building Envelope Replacement

When replaced, façade, roof, and walls that are replaced shall meet the following minimum thermal performance standards.

- **Window / door frames:** To provide thermal breaks at window / door frames to mitigate heat gain, and weatherstripping to minimize air infiltration.
- **Roof:** To provide coating with high Solar Reflectance Index and achieve U-value performance to meet ASHRAE 90.1-2016.
- **Glazing:** To achieve U-value performance to meet ASHRAE 90.1-2016.
- **Entryway infiltration control:** At entryways, balconies, lift shafts, and staircases, adopt vestibules, infiltration control and / or airlocks to prevent humid air entering and cooled air escaping.
- **Building envelope airtightness:** Meet ASHRAE Standard 189.1, or equivalent standard. The measured air leakage rate of the building envelope shall not exceed 3.0 $m^3/h/m^2$ at 50 Pa. Testing shall be conducted in accordance with The Air Tightness Testing & Measurement Association (AATMA) Technical Standard L2, or equivalent standard by an independently accredited third party.

Without Building Envelope Replacement

When existing façade, roofs, and walls are not replaced, adopt the following:

- **Temperature-regulating wall paint:** For walls with high solar heat gain, provide thermal insulating paint on the inner side of external facing office wall surfaces to make it more comfortable for the occupants seated near warm / cold walls during peak summer / winter days. An example and demonstration of such paint in the HKUST Sustainability Office may be accessed here. [16]
- **Solar film:** For windows with higher solar heat gain, adopt solar film to improve thermal comfort of users seated near the windows.

b) Cooling and Ventilation

Opportunities for further energy savings are presented at HKUST owning to its variability of usage during term time and term break. Flexibility in building services controls also needs to be ensured due to frequent changes in space usage during the lifespan of the building, as well as operation hours. Occupancy controls for ventilation, cooling, and lighting shall have overwrite function for always on during occupancy, facilitating partial use of the space, and reduced occupancy during school holidays.

Equipment Efficiency

- **Equipment efficiency:** Meet minimum standards for building services equipment as per ASHRAE 90.1-2016 and / or latest version of Building Energy Code, whichever is more stringent.
- **Fan-enhanced ventilation:** For air-conditioned spaces (except protected areas), enhanced ventilation shall be provided to increase temperature set points for energy savings, reduce condensation risk and cater to varying user requirements to enhance thermal comfort satisfaction (e.g. through mechanical or ceilings fans). An example and demonstration of such fan in the HKUST Sustainability Office may be accessed here. [17]
- **Variable equipment:** Equipment shall be variable air volume (VAV) or flow to allow occupancy controls.
- **Energy recovery and demand control equipment:** Equipment shall have heat recovery and demand control ventilation.
- **Mold growth and condensation prevention:** Introduce adequate ventilation for staircases, lobbies, and corridors to prevent mold growth and condensation.

Controls

- **Room pressure and temperature:** Room temperature is suggested to be kept at a user agreed value when occupied and not exceed 28°C (adjustable) when unoccupied to maintain a minimum. flow set point for VAV boxes, unless specified otherwise. No space heating for winter. Relative humidity below 70% unless specified otherwise.
- **Air change:** Provide a user agreed minimum air change rate for occupied periods, and a user agreed reduced amount during unoccupied periods. Recirculation of air is allowed unless otherwise specified.
- **General timer control:** Controls for teaching facilities shall follow classroom schedule as per Academic Registry Office (ARO), and all other areas shall follow Campus Management Office (CMO) schedule. Overwrite function shall be provided with the local zone occupancy controls below.

- **Local occupancy control for specified zones:** When there is no occupancy detected at a certain zone, the zone's VAV box will be adjusted so that the damper position will reduce the airflow rate to an agreed minimum. Once occupancy is detected, the damper will revert back to 100% open. Zoning allocation shall be agreed with building users.
- **Window interlock:** Provide a window contact system that will interface with cooling and ventilation systems. For inner zones, set back temperature to 28°C. For small rooms, cooling will be switched off and fan speed set to the minimum.

c) Artificial Lighting

Equipment Efficiency

- **Lighting power density:** The total lighting power shall follow the latest edition of Building Energy Code (BEC) or CIBSE standards, whichever is more stringent.
- **Task lighting provision:** Task lighting, coupled with occupancy sensor, to be installed in addition to room lighting.
- **Switch and sensor provision:** On / off switch, dimming switch and occupancy / motion sensor should be provided. Daylight dimmers with at least 10 stages of dimming to match daylight levels to be provided for labs, lift lobby, staircase, and toilets with glazed windows.

Control

- **General timer control:** Controls for teaching facilities shall follow classroom schedule as per ARO, and all other areas shall follow CMO schedule. Overwrite function shall be provided with the local zone occupancy controls below.
- **Task lighting control:** Task lighting (by work area) should be controlled with occupancy sensors (DC connection) or manually by users. Color temperature is around 4,000K. When turned on at 100%, the actual lumens should meet design levels for the space type at 900 mm from floor when combined with room lighting. The time delay for turning off task lighting should be 18 to 360 seconds (adjustable).
- **General lighting control:** Lighting controls should help save energy by limiting either the time lights are on or the power they are drawing or both. Zoning allocation shall be agreed with building users.

  The time delay for turning off lights should be:

  - If there is no occupation for a certain zone, zonal lighting can be dimmed smoothly in three stages—from the designed lighting level to 30% to 0% (off).
  - Once occupancy is detected, lighting should resume smoothly to the designed lighting level.

d) Metering and Monitoring

- **Fundamental metering and monitoring:** Provide energy monitoring system and performance auditing monitoring system for equipment and systems in spaces, and allowing monitoring provision of energy consumption.
- **Energy consumption monitoring:** Meet BEAM Plus New Buildings 2.0 "EU 4 Metering and Monitoring" credit requirements. In addition, to provide power metering system to track power usage for different aspects such as air conditioning, lighting, and equipment. Submeters for major energy consuming equipment e.g. lab fridges and equipment, and renewable systems shall be provided. Electricity and cooling submetering shall allow user charging on a lab / room / zone based on future user allocation.
- **Function and location:** Demonstrate meter placement by occupancy and tenancy. Submetering and zone demarcation shall facilitate occupancy controls and user charging schemes in relation to energy and water use and waste generation.
- **Access for research:** Ensure meters are in place, pipeworks are accessible, data and dashboard are open source to facilitate research by researchers and students. Data shall have the ability to be seen and downloaded by all interested users.
- **Usage pattern:** Design for sensors and people counters so that the building can track the flow of people coming and going at different times of the days, and integrate the data into building management, security, and space optimization strategies.

e) Energy Efficient Appliances and Lab Equipment

- **Certified electrical appliances and lab equipment:** Ensure 100% of appliances are certified Grade 1 under Mandatory and Voluntary Energy Efficiency Labeling Scheme, or most energy efficient rating of an equivalent certification scheme for electrical equipment. Refer to HKUST Sustainable Purchasing Requirements for Suppliers and Contractors [17] and HKUST Operation Guidelines on Sustainable Purchasing. [19]
- **Fume cupboards:** All fume cupboards should be equipped with auto sash function for energy saving. All new fume cupboards should be equipped with combination sash which can be open both vertically and horizontally. Both vertical and horizontal sash position should be able to interface with the VAV system to control the flow rate.

4.3.6 Water Use (SDG 6: Clean Water and Sanitation)

a) Annual Water Use, Water Efficient Appliances and Effluent Discharge to Foul Sewers

- **Water efficient appliances, sanitary fittings and lab equipment:** All new sanitary fittings, water consuming appliances, and equipment consuming water should meet Hong Kong Water Efficiency Labeling Scheme [20] (WELS) Grade 1 standard for equipment, or US-EPA WaterSense [21] criteria if there is no WELS standard.
- **Water use submetering:** Water consumption submetering for potable and non-potable water uses separately (separate lab and non-lab) shall be provided. Refer to HKUST Sustainable Purchasing Requirements for Suppliers and Contractors [22] and HKUST Operation Guidelines on Sustainable Purchasing. [23]

b) Water Efficient Irrigation

- **Water efficient planting:** Native species and / or drought-tolerant plants shall be adopted to minimize water use.
- **Water use monitoring:** Water consumption submetering for irrigation shall be provided.

c) Water Efficient Appliances

- **Pipe water refilling system:** Install a pipe filtration water refilling system to eliminate the use of bottled water.
- **Certified appliances:** For new appliances, ensure 100% of appliances are certified Grade 1 under WSD's Water Efficiency Labeling Scheme, or most water efficient rating of an equivalent certification scheme for water consuming equipment.

Refer to HKUST Sustainable Purchasing Requirements for Suppliers and Contractors [24] and HKUST Operation Guidelines on Sustainable Purchasing. [25]

4.3.7 Health and Well-being

a) Healthy and Active Living

Introducing biophilic design and healthy and active elements have been shown to enhance the productivity of the work / study environment, while improving the health of building occupants. During the development of the brief with the building occupants, propose and evaluate the following features:

- **Open layout workstations & flexible and multi-purpose enclosed rooms:** Consider open layout workstations to facilitate communication, while using furniture / plants to define zones. Workstation partitions shall be kept low, while use of glass walls / doors / windows shall be optimized. Enclosed rooms shall be placed in the center to maximize natural daylight and view sightlines for the majority of the users.
- **Inclusions of plants:** For spaces with regular occupants, consider designating areas for indoor plants.
- **Designated active workstations:** Consider using active workstations in selected workspaces e.g. standing desks equipped with walking pads and bicycle-desk hybrid workstation.
- **Choice of colors:** For the colors of the walls, carpet and interior finishing, engage users to select calming color tones preferred by the users and / or aligned with the department's branding.
- **Circadian lighting system:** Use this lighting system in working areas (e.g. rooms without access to daylight) whereby users will benefit from being aligned to the human circadian rhythm by mimicking the color temperature and intensity of natural sunlight throughout the day.

b) Acoustics

- **Provision of acoustic treatment to building services equipment:** Meet BEAM Plus Existing Buildings Beta Version 3.0 "SS-01-01 Noise Control for Building Equipment" credit for providing adequate acoustic treatment to chillers, cooling towers, and ventilation fans with Sound Power Level (SWL) higher than 80 dB(A).
- **Noise isolation:** Meet BEAM Plus Existing Buildings 3.0 Beta Version "HWB-03-01 Indoor Acoustic Environment (c) Noise Isolation" requirements for demonstrating airborne noise isolation between spaces fulfills the prescribed criteria.

c) Indoor Air Quality (IAQ)

- **Fresh air intake:** Meet BEAM Plus Existing Buildings Beta Version 3.0 "HWB-01-01 Ventilation Performance" requirements. Minimum fresh air ventilation rate of latest ASHRAE 62.1 shall be complied with.
- **Indoor air quality in occupied space and car park:** Indoor air quality testing for occupied spaces to meet IAQ Certification Scheme (Good Class) certificate issued by the Hong Kong Environmental Protection Department (EPD). Car park air quality to comply with the pollutant concentration limits specified in ProPECC PN 2/96. BEAM Plus New Buildings "HWB 8 Indoor Air Quality" credit provides more guidance.

- **Low emitting materials:** Paints, adhesives, furniture, and furnishing shall be in compliance with HKUST Sustainable Purchasing Requirements for Suppliers and Contractors [26] and HKUST Operation Guidelines on Sustainable Purchasing. [27] This shall include built-in furniture, and fixture, loose furniture and carpet.

d) Lighting Quality

- **Lighting illuminance and quality:** Meet minimum standards for illuminance, illuminance uniformity, unified glare rating, and color rendering index as per the latest CIBSE's Code for Lighting as per BEAM Plus Existing Buildings Beta Version 3.0 "HWB-04-01 Acceptable Lighting Performance" requirements.

4.3.8 Sustainable Smart Campus as a Living Lab (SDG 7: Affordable and Clean Energy)

HKUST's campus as a "Living Lab" helps to facilitate home-grown novel solutions and proofs of concept for net-zero approaches and technologies. The Living Lab approach will transform our campus into a testing ground for ambitious solutions that will support our net-zero goal. The near-term deliverables will be the development of a framework for HKUST researchers, faculty, and staff to test innovative ideas and decarbonization measures focused on energy conservation measures, renewable energy generation, and carbon removal and sequestration.

It is HKUST's expectation that design consultants will, from time to time and when requested, work with HKUST research teams to explore how new research approaches can be integrated into new building designs.

Examples of HKUST research that may be relevant in the design process:

- **Decarbonization research and development:** To drive HKUST's research and development to take the lead on the development and application of decarbonization through small scale introduction of the following technologies:
  - Carbon storage in materials e.g. biochar blocks, carbon dioxide embedded pavers / blocks / reinforced concrete, bamboo or other timber
  - Carbon dioxide scrubber
  - Carbon sequestration e.g. biochar, algae, bamboo
  - Direct air capture

Within reason, to collaborate with HKUST researchers to integrate research and development into the building.

- **Future renewable provision:** Anticipate that all exterior surfaces (including vertical surfaces, windows, and doors) that have solar exposure will be utilized in the future for energy generation. Design in conduit channels and other means for making it easy to access these areas for electrical wiring. Ensure structural loading is sufficient for future solar panel additions.
- **Lower current power systems for renewables:** Consider how to isolate certain systems (e.g.lighting) so that they can be served by lower current power systems (e.g. direct current) as renewables are added to the building.

5 Deliverables

Checks are in place throughout the building project stages to ensure that the minimum standards can be met. Refer to Table 2 below. This facilitates the building of a database to allow future sustainability performance to be benchmarked and targets to be set.

Table 2: Submission of Sustainability Data Throughout Building Project Stages

Building Project Stages	Submission Deliverables
Request for Fee Proposal (By Consultants)	• Approach and strategy on how performance requirements for operational carbon and renewable energy can be met • Approach and strategy on how performance requirements for stages A1 to A3 embodied carbon can be met • Approach and strategy on how net-zero water use can be met
Schematic Design **Detail Design** **Tender Documentation (By Consultants)**	**At the end of each design stage** • Design calculations with supporting documentation to demonstrate compliance to performance-based requirements—to include operational carbon, stages A1 to A3 embodied carbon, and net-zero water use (at the end of each design stage) • Design checklists to explain how the requirements are incorporated in the design • Life cycle costing for energy-consuming & water-consuming products & systems
Construction Stage (By Main Contractor)	**Monthly** • Electricity consumption and renewable energy per month (kWh per month) • Water consumption and water reused per month (m^3 per month) • Waste generation and waste recycled per month (metric tons or kg per month for each type of waste) **Every quarterly** • Stages A1 and A5 embodied carbon calculations
Occupation Permit (By Main Contractor)	**Within 3 months of obtaining Occupation Permit** • As-built calculations with supporting documentation to demonstrate compliance to performance-based requirements—to include operational carbon, stages A1 to A5 embodied carbon and net-water use • As-built checklists to explain how the requirements are incorporated in the as-built design

Annex 1: Renewal Minimum Standards Checklist

The requirements presented in this document is summarized in the form of a checklist for ease of reference by the consultant and construction teams, as well as for compliance checks by HKUST.

A completed checklist shall be submitted at the end of each design stage and within three months of completion.

No.	Requirement	Ref. Section in Document	Adopted (Y/N/NA)	Remarks
	Building Performance Disclosure *Comply with the requirements listed below*			
1	Embodied carbon of major fit-out materials	4.2.1		
2	Operational carbon	4.2.2		
3	Water consumption	4.2.3		
4	Life cycle cost analysis	4.2.4		
	Comply-or-Explain Requirements *Comply with the requirements listed below* *If not adopted, justification shall be given using technical feasibility study containing life cycle calculations, drawings, etc.*			
	Integrated Design and Construction Management (IDCM)			
5	Integrated design charrettes	4.3.2 (a)		
6	Commissioning	4.3.2 (b)		
7	Measures to reduce site emissions	4.3.2 (c)		
8	Construction and demolition waste recycling	4.3.2 (d)		
9	Construction IAQ management	4.3.2 (e)		
10	Digital facility management interface	4.3.2 (f)		
11	Design for engagement and education on green buildings	4.3.2 (g)		
	Sustainable Site (SS)			
12	Climate change adaptation.	4.3.3 (a)		
	Materials and Waste Aspects (MWA)			
13	Certified green products	4.3.4 (a)		
14	Ozone depleting substances	4.3.4 (b)		
15	Adaptability and deconstruction	4.3.4 (c)		
16	Furniture and equipment	4.3.4 (d)		

No.	Requirement	Ref. Section in Document	Adopted (Y/N/NA)	Remarks
	Energy Use (EU)			
17	Building envelope	4.3.5 (a)		
18	Cooling and ventilation	4.3.5 (b)		
19	Artificial lighting	4.3.5 (c)		
20	Metering and monitoring	4.3.5 (d)		
21	Energy efficient appliances and lab equipment	4.3.5 (e)		
	Health and Well-being (HW)			
25	Healthy and active living	4.3.7 (a)		
26	Acoustics	4.3.7 (b)		
27	Indoor air quality	4.3.7 (c)		
28	Lighting quality	4.3.7 (d)		
	Sustainable Smart Campus as a Living Lab			
29	Decarbonization research and development	4.3.8 (a)		
30	Future renewable provision	4.3.8 (b)		
31	Lower current power systems for renewables	4.3.8 (c)		

Annex 2: Internal Price of Carbon 2020-2050

The Internal Price of Carbon (IPC) is an important tool for determining the collection and reallocation of funding based on greenhouse gas emissions due to operations. The IPC should also be used by contractors and design teams to establish costs for comparison in decision-making. Pricing references the net-zero by 2050 scenario in IEA's Global Energy and Climate (GEC) Model. Pricing is specifically for emerging market and developing economies with net-zero emissions pledges, which includes China, India, Indonesia, Brazil, and South Africa.

Internal Price of Carbon for HKUST

Academic Year	IEA Carbon Price (US$/Metric Ton)	Carbon Price (HK$/Metric Ton)
2020	$30	$ 235
2021		$ 255
2022		$ 280
2023		$ 300
2024		$ 325
2025		$ 350
2026		$ 420
2027		$ 490
2028		$ 560
2029		$ 630
2030	$90	$ 700
2031		$ 755
2032		$ 810
2033		$ 865
2034		$ 920
2035		$ 975
2036		$1,030
2037		$1,085
2038		$1,140
2039		$1,195
2040	$160	$1,250
2041		$1,281
2042		$1,312
2043		$1,343
2044		$1,374
2045		$1,405
2046		$1,436
2047		$1,467
2048		$1,498
2049		$1,529
2050	$200	$1,560

References:

1. HKUST Sustainability / Net-Zero Office, HKUST Net-Zero Building Standards, https://sust.hkust.edu.hk/files/Net-Zero%20Building%20Standards.pdf
2. HKUST Sustainability / Net-Zero Office, HKUST Sustainable Purchasing Requirements. For Suppliers and Contractors, https://sust.hkust.edu.hk/files/HKUST%20Sustainable%20Purchasing%20Contractor%20Requirements_Aug2024.pdf
3. HKUST Sustainability / Net-Zero Office, HKUST Sustainable Office Standards & Guidelines, https://sust.hkust.edu.hk/files/HKUSTSustainabilityGuidelinesv1.6.pdf
4. HKUST Sustainability / Net-Zero Office, HKUST Operational Guidelines on Sustainable Purchasing, https://sust.hkust.edu.hk/files/SustainablePurchasingOct23.pdf
5. HKUST Sustainability / Net-Zero Office, HKUST Life Cycle Lab, https://sust.hkust.edu.hk/life-cycle-lab
6. Hong Kong Green Building Council, BEAM Plus, https://www.hkgbc.org.hk/eng/beam-plus/introduction/index.jsp
7. HKUST Sustainability / Net-Zero Office, HKUST Life Cycle Cost Calculators, https://sust.hkust.edu.hk/life-cycle-lab/contractors-and-suppliers/net-zero-online-training-module
8. BEAM Society Limited, BEAM Plus Existing Buildings Version 3.0, https://www.beamsociety.org.hk/About-Us/News-and-Updates/News-and-Events/~/link.aspx?_id=B3C257CBD1E6485287773B10C4278010&_z=z
9. Chapter 16: Disposal of Hazardous Materials and Items under Regulatory Control, https://hseo.hkust.edu.hk/sm_16 and Chapter 19: Liquid Effluent and Protection of Watershed and Aquatic Environment, https://hseo.hkust.edu.hk/sm_19
10. HKUST Sustainable Purchasing Requirements. For Suppliers and Contractors, (see Appendix 2, footnote 2)
11. HKUST Sustainable Purchasing Requirements. For Suppliers and Contractors, (see Appendix 2, footnote 2)
12. HKUST Operational Guidelines on Sustainable Purchasing, (see Appendix 2, footnote 4)
13. HKUST Second-Hand Goods Purchasing & Reimbursement Guidelines, https://sust.hkust.edu.hk/files/Second-Hand%20%20Purchase%20Guidelines%20May%202023.pdf
14. HKUST Sustainable Purchasing Requirements. For Suppliers and Contractors, (see Appendix 2, footnote 2)
15. HKUST Operational Guidelines on Sustainable Purchasing, (see Appendix 2, footnote 4)
16. HKUST Sustainability / Net-Zero Office, Sustainability Office Features, Green Technology, Temperature Regulating Wall Paint, https://sust.hkust.edu.hk/greentechnology
17. HKUST Sustainability / Net-Zero Office, Sustainability Office Features, Green Technology, Energy-Saving Bladeless Fans to Reduce Need for Air-Conditioning, https://sust.hkust.edu.hk/greentechnology
18. HKUST Sustainable Purchasing Requirements. For Suppliers and Contractors, (see Appendix 2, footnote 2)
19. HKUST Operational Guidelines on Sustainable Purchasing, (see Appendix 2, footnote 4)
20. Water Supplies Department, Water Efficiency Labelling Scheme (WELS), https://www.wsd.gov.hk/en/plumbing-engineering/water-efficiency-labelling-scheme/index.html

21. EPA, The WaterSense Label, https://www.epa.gov/watersense/watersense-label
22. HKUST Sustainable Purchasing Requirements. For Suppliers and Contractors, (see Appendix 2, footnote 2)
23. HKUST Operational Guidelines on Sustainable Purchasing, (see Appendix 2, footnote 4)
24. HKUST Sustainable Purchasing Requirements. For Suppliers and Contractors, (see Appendix 2, footnote 2)
25. HKUST Operational Guidelines on Sustainable Purchasing, (see Appendix 2, footnote 4)
26. HKUST Sustainable Purchasing Requirements. For Suppliers and Contractors, (see Appendix 2, footnote 2)
27. HKUST Operational Guidelines on Sustainable Purchasing, (see Appendix 2, footnote 4)

Appendix 3

HKUST Sustainable Purchasing Requirements for Suppliers and Contractors

The Hong Kong University of Science and Technology (HKUST) has an ambitious target to achieve net-zero carbon by 2045, reduce waste to the landfill, and promote sustainable and healthy lifestyles within our community. Therefore, we emphasize green procurement practices of goods and services to help achieve these ambitious goals.

First Created: January 2024
Last Reviewed: August 2024

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1 General Considerations

Tenderers should be aware that HKUST has adopted a life cycle thinking approach as standard practice in evaluating procurement, meaning that in addition to lowest costs, we also look for costs (or savings) over time, environmental impacts along the supply chains, green certifications, and end-of-life impacts. For more information on life cycle approaches, please visit the HKUST Life Cycle Lab.

2 Requirements

Life Cycle Costing

If you are supplying / upgrading energy-consuming and water-consuming products and systems, your tender will be reviewed based on cost factors that will be incurred over the life of the product or system. As such, vendors are required to provide (in addition to the purchase cost):

- Purchase / acquisition price
- Usable life span of the product (in years)
- Estimated operations costs, e.g. energy or water consumption (annually)
- Maintenance, e.g. replacement, planned maintenance and management cost (annually)
- End-of-life costs / residual value

Tenderers should also declare whether they will take back the items at the end of their life for recycling or repurposing.

Examples of energy-consuming and water-consuming products and systems include hot water system, interior lighting system, air-conditioning system, sanitary fittings, etc.

Green Product Labeling and Certifications

a) Energy Consuming Appliances / Equipment
All energy-consuming electrical appliances and equipment shall meet the Hong Kong Electrical and Mechanical Services Department (EMSD) Energy Label Grade one rating under EMSD's Mandatory Energy Efficiency Labeling Scheme or other equivalent international schemes such as ENERGY STAR, TCO Certified, Blue Angel, EPEAT and / or ACT-labeled registered products. Devices covered include room air conditioners, refrigerating appliances, compact fluorescent lamps (CFLs), washing machines, dehumidifiers, televisions, storage type electric water heaters and induction cookers.

b) Water Consuming Appliances / Equipment
All water-consuming sanitary fittings and plumbing fixtures shall meet the Hong Kong Water Suppliers Department (WSD) Water Efficiency Labeling Scheme (WELS) Grade one rating or other equivalent international schemes. Devices shall include showers, water taps, washing machines, urinal equipment, flow controllers, and water closets.

c) Timber / Composite Timber Products
All timber and composite timber products shall be from sustainable sources (has certification from Forest Stewardship Council, American Forest and Paper Association or Programme for the Endorsement of Forest Certification, China FSC National Forest Stewardship Standard or equivalent) / recycled timber (reused from other sites).

d) Cleaning and Janitorial Paper Products
All cleaning and janitorial paper products shall meet one or more of the following criteria:

- Hong Kong Green Label Scheme
- US EPA Design for the Environment
- China Environmental Label
- Blue Angel labeled (German Federal Environment Agency)
- Cradle to Cradle Certified
- ECOLOGO certified (UL Environment)
- EU Ecolabel
- Forest Stewardship Council (FSC) certified
- Good Environmental Choice Australia (GECA) certified
- Green Seal certified
- Nordic Swan labeled (Nordic Ecolabeling Board)
- U.S. EPA Safer Choice labeled

Other multi-criteria sustainability standards and ISO Type one ecolabels are acceptable if developed or administered by Global Ecolabeling Network and / or ISEAL Alliance member organizations.

Cleaning products include general purpose bathroom, glass and carpet cleaners; degreasing agents; biologically-active cleaning products (enzymatic and microbial products); floor-care products (e.g. floor finish and floor finish strippers); hand soaps and hand sanitizers, disinfectants, and metal polish, and other specialty cleaning products. Janitorial paper products include toilet tissue, tissue paper, paper towels, hand towels, and napkins.

e) Office Paper Purchase
All office paper products shall have post-consumer recycled, agricultural residue, and / or Forest Stewardship Council (FSC) or Program for the Endorsement of Forest Certification (PEFC) certified content.

f) Electronic Products
All electronic products shall be EPEAT registered, third party certified under a multi-attribute sustainability standard or ISO Type one ecolabel developed / administered by a Global Ecolabeling Network or ISEAL Alliance member organization (e.g . Blue Angel, TCO Certified, UL Ecologo), and / or labeled under a single-attribute standard for electrical equipment (e.g. ENERGY STAR, EU Energy A or higher, or local equivalent). Included are desktop and notebook / laptop computers, displays, thin clients, tablets / slates, televisions, mobile phones, and imaging equipment (copiers, digital duplicators, facsimile machines, mailing machines, multifunction devices, and printers and scanners). Specialized equipment that EPEAT does not register may be excluded.

The products shall comply with Restriction of Hazardous Substances (RoHS) requirements for hazardous substances including lead.

All lighting fixtures must be mercury-free, unless a unique situation calls for a specialty bulb. In such a case, an exception must be made in writing and approved by the Sustainable Operations Executive Committee (OpCo).

g) Paint, Adhesives, Furniture, and Furnishings
Tenderers shall provide declaration that there are no materials, chemicals or elements in their products or systems that are listed in (1) the latest Living Building Challenge (LBC) Red List; or (2) banned items under Hong Kong's ordinances (e.g. asbestos, lead, added formaldehyde, toxic heavy metals, hydrochlorofluorocarbons (HCFCs), chlorofluorocarbons (CFCs), halogenated flame retardants).

All materials may not have volatile organic compounds (VOC) emissions which exceed levels stated in South Coast Air Quality Management District (SCAQMD) for Adhesives and Sealants or the California Air Resources Board (CARB), Suggested Control Measure (SCM) for Architectural Coatings, ANSI/BIFMA e3-2011 Furniture Sustainability Standard or equivalent standards.

3 Strong Preferences

Atmosphere Impact

Global Warming Potential and Ozone Depleting Substances
For materials containing refrigerants, there shall be no use of products that contain HCFCs or CFCs. Preference will be given to suppliers who adopt tracer gases with Global Warming Potential under 5,000 (100 year time horizon). For other materials, there shall not be any use of products that use ozone depleting substances in their manufacture, composition, or use.

Life Cycle Costing

a) Life Cycle Assessment
Preference will be given to suppliers who can provide the Life Cycle Assessment or Environmental Product Declarations that had been verified by a third party. At a minimum, perform Cradle to Site assessment of the products / systems which includes Stages A1 to A5 (ref: ISO 14044), from raw material extraction to construction and installation process.

b) Strategies to Minimize Environmental Impact
Preference will be given to suppliers who adopt the following strategies to minimize their life cycle environmental impact.

- Adopts pre-consumer and / or post-consumer recycled contents and / or store carbon dioxide as part of resource extraction / production
- Adopts renewable energy, energy-efficient, water-efficient, low-waste and / or low-carbon as part of their manufacturing processes
- Has a lower environmental impact compared to its competitors during use phase (e.g. more efficient energy label or water efficiency grade)
- Provides maintenance / repair during use phase
- Provides end of life collection
- Enables product / system (design / installation method / material use) to be recycled at the end of life

Preference will be given to suppliers who can provide at least one or more local or international healthy product labeling / product certification that had been verified by a third party, as part of the tender submission. This shall be relevant to the product / system nature. This may include but not limited to the following:

- Declare Label (by International Living Future Institute)
- Health Product Declaration (HPD) included in HPD database
- Cradle to Cradle Material Health Gold or Platinum Label

c) Environmental Labeling / Product Certification
Preference will be given to suppliers who can provide at least one or more local or international environmental labeling / product certification that had been verified by a third party, as part of the tender submission. This shall be relevant to the product / system nature. This may include but not limited to the following:

- Construction Industry Council (CIC) Green Product Certification
- Carbon Labeling Scheme / HKGBC Green Product Accreditation and Standard (HK G-Pass)

Annex A: Green Procurement Checklist to be included in Tender Submission

No.	Checklist	Yes	No	N/A
Mandatory Items				
M1	**Energy-consuming & Water-consuming Products / Systems** Please confirm that you have provided a product-specific or system-specific Life Cycle Cost Analysis for all energy-consuming and water-consuming products and systems	☐	☐	☐
M2	**Environmental Impact: Global Warming Potential** For materials containing refrigerants, please confirm that no HCFCs and CFCs is used	☐	☐	☐
M3	**Environmental Impact: Global Warming Potential** For other materials, please confirm that no ozone depleting substances is used in their manufacture, composition, or use-phase	☐	☐	☐
M4	**Energy Consuming Appliances / Equipment** Please confirm that your energy-consuming electrical appliances and equipment meets EMSD Energy Label Grade one rating, or other equivalents	☐	☐	☐
M5	**Water Consuming Appliances / Equipment** Please confirm that water-consuming sanitary fittings and plumbing fixtures shall meet Water Suppliers Department (WSD) Water Efficiency Labeling Scheme (WELS) Grade one rating, or other equivalents	☐	☐	☐
M6	**Timber / Composite Timber Products** Please confirm that timber and composite timber products are sustainability sourced (has certification from FSC, PEFC or equivalent) or is recycled	☐	☐	☐
M7	**Cleaning and Janitorial Paper Products** Please confirm that cleaning and janitorial paper products meets the criteria of Hong Kong Green Label Scheme, Green Seal, or equivalent	☐	☐	☐
M8	**Office Paper Purchase** Please confirm office paper products shall have post-consumer recycled, agricultural residue, and / or FSC or PEFC certified content	☐	☐	☐
M9	**Electronic Products** Please confirm that electronic products shall be EPEAT registered, ENERGY STAR, EU Energy A or higher, or equivalent	☐	☐	☐
M10	**Electronic Products** Please confirm that the products shall comply with RoHS requirements for hazardous substances including lead	☐	☐	☐
M11	**Electronic Products** Please confirm that all lighting fixtures must be mercury-free, unless a unique situation calls for a specialty bulb	☐	☐	☐
M12	**Paint, Adhesives, Furniture, and Furnishings** Please confirm that there are no materials, chemicals or elements in your products or systems that are listed in (1) the latest Living Building Challenge (LBC) Red List; or (2) banned items under Hong Kong's ordinances	☐	☐	☐
M13	**Paint, Adhesives, Furniture, and Furnishings** Please confirm that the VOC emissions in your product or systems do not exceed levels stated in SCAQMD, CARB, SCM, or equivalent standards	☐	☐	☐

No.	Checklist	Yes	No	N/A
Preferred Items				
P1	**Environmental Impact: Global Warming Potential** Please confirm that refrigerant with low Global Warming Potential under 5,000 (100 year time horizon) is used	☐	☐	☐
P2	**Life Cycle Assessment** Please confirm that you have provided a Life Cycle Assessment or Environmental Product Declarations that had been verified by a third party	☐	☐	☐
P3	**Strategies to Minimize Environmental Impact** Please confirm that you have adopted pre-consumer and / or post-consumer recycled contents and / or store carbon dioxide as part of resource extraction / production	☐	☐	☐
P4	**Strategies to Minimize Environmental Impact** Please confirm that you have adopted renewable energy, energy-efficient, water-efficient, low-waste and / or low-carbon as part of your manufacturing processes	☐	☐	☐
P5	**Strategies to Minimize Environmental Impact** Please confirm that your product has a lower environmental impact compared to its competitors during use phase (e.g. more efficient energy label or water efficiency grade)	☐	☐	☐
P6	**Strategies to Minimize Environmental Impact** Please confirm that your company or partner service provider can provide maintenance / repair during use phase	☐	☐	☐
P7	**Strategies to Minimize Environmental Impact** Please confirm that your company or partner service provider can provide end of life collection	☐	☐	☐
P8	**Strategies to Minimize Environmental Impact** Please confirm that the design / installation method / material use of the product allows recycling at the end of life	☐	☐	☐
P9	**Paint, Adhesives, Furniture, and Furnishings** Please confirm that you have provided at least one or more local or international healthy product labeling / product certification that had been verified by a third party	☐	☐	☐
P10	**Environmental Labeling / Product Certification** Please confirm that you have provided at least one local or international environmental labeling / product certification that had been verified by a third party e.g. CIC, HK G-Pass	☐	☐	☐

Annex B: Contractor Sustainability Performance

Contractor Sustainability Performance

HKUST is committed to creating a sustainable campus through the reduction of wastes, conservation of natural resources, and the protection of our community be creating a safe and healthy work environment. HKUST is also committed to meeting the Hong Kong government target of net-zero greenhouse gas emissions by 2045.

HKUST will prioritize Contractors based on sustainability performance criteria. The questions below are threshold questions for all contractors. Additional detailed questions may be included in each specific tender.

Question	Answer (Yes/No)	Further Comments/Explanation
Does your company produce an annual ESG (Environmental, Social, and Governance) report? **If yes, please show evidence.**		
Does your company track Scope 1 and Scope 2 greenhouse gas emissions? **If yes, please provide information on your most recent inventory.**		
Has your company committed to the Science Based Targets initiative (SBTi) to ensure greenhouse gas reductions in line with the Paris Climate Agreement? **If yes, please show evidence.**		
Are all of your employees paid wages that are considered to be at or above Hong Kong's Living Wage calculations? **If yes, please provide evidence.**		
Does your company track environmental impacts from your supply chain using Life Cycle Analysis (LCA) methods? **If yes, please provide evidence.**		

Appendix 4

Environmental, Social, and Governance Policy for the Long-Term Investment Pool

Effective Date: November 2022
Next Review: November 2026

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1 Introduction

This document sets out the guiding principles of The Hong Kong University of Science and Technology's (HKUST's) environmental, social, and governance (ESG) policy, as applied to its Long-Term Investment Pool.

HKUST is a globally respected university and contributes both locally and internationally to talent development, new knowledge, and societal interests. Being international is an intrinsic element of the HKUST spirit. The University was founded on the principle that education, original scholarship, and the development of society are integrally linked and best pursued together. We believe that humanity's advancement is generated through the fostering of an international community and the nurturing of individuals through holistic education, original research, and knowledge transfer into the wider society. [1] We recognize our role as a responsible steward of our capital, which has two distinct aspects:

1. Firstly, responsible stewardship of our own portfolio requires us to take into account all material determinants of risk and opportunity for the investments we make. These include ESG factors which are in many cases material to the longer-term success and resilience of businesses in which we invest.

2. Secondly, we seek alignment with our values as an educational institution and certainly to avoid misalignment. Our goal is to be a sustainability leader across the region and beyond, and a trusted resource for businesses and government alike. With grand generational challenges to solve in climate change, water scarcity, building a circular economy, transforming food production systems, and building a fair, just, and equitable society, HKUST has a special responsibility to advance technical research, policy solutions, and educational expertise to spotlight a sustainable pathway forward. [2] We therefore are interested in understanding how managers integrate these considerations into their investment decisions.

HKUST's portfolio is invested via third party investment managers, and we will be investing into pooled investment funds with their own fixed policies. Thus, HKUST's ESG policy will be implemented in large part though our choice of investment managers and their own ESG policies.

2 Core Beliefs

We believe it is important to consider what material ESG-related risks and opportunities apply to the assets in which we invest and the managers through who we invest. This may provide insight into future performance as well as facilitate good decision-making and encourage a long-term mindset. Example topics include, but are not limited to, climate change, supply chain and human rights, fair pay, diversity, and global health. These areas, as well as others, may present both risks and opportunities from an investment point of view. Accordingly, we do not see ESG integration in itself as a drag on returns, rather a potential enhancement.

Further, we are keenly aware that investment strategies that do not align with our core beliefs present serious risks to our reputation and our standing within the community. A misalignment can cause skepticism of our true intentions to fulfil our vision for a sustainable campus of the future, and can inhibit our ability to recruit top tier students and globally recognized faculty and researchers. We believe that our core beliefs must be consistent throughout.

To implement an ESG policy through third party managers while delivering attractive returns requires a degree of pragmatism and flexibility. The more that hard limits and targets are imposed, the fewer manager options available and the greater the danger of achieving compliance over quality. HKUST accordingly prefers to invest with managers whose own investment philosophies are already closely aligned with our own ESG policies.

3 ESG Investing Approach

3.1 ESG Integration

HKUST intends to work with investment managers for whom ESG considerations are integral to their investment philosophy and manifested throughout their investment process. We accept that different approaches may be necessary in different asset classes or strategies, according to current market practice, but we will use our voice as an investor to encourage better standards, especially regarding transparency. A well-explained, well-documented, evidenced-based process for how ESG is integrated into the investment decision-making is a priority. We expect to understand the link between a manager's ESG considerations and their investment decisions. To be credible, managers need to evidence clearly and regularly how this is achieved in practice and report adequately.

3.2 Responsible Ownership of Assets

HKUST believes that good stewardship can enhance long-term portfolio performance and we expect our investment managers to recognize their role as responsible stewards of capital. Managers' voting policies and records shall form part of manager selection due diligence and shall be monitored for consistency with HKUST's ESG policy. Effective proxy voting is only the minimum threshold for responsible ownership. However, and we prefer to see managers directly engaging with portfolio companies to encourage improvement in line with ESG considerations and the interests of long-term shareholders. Reporting on the outcomes, both good and bad, from engagement efforts demonstrates the credibility of an engagement program.

4 Net-Zero Policy

4.1 Introduction

HKUST considers climate change, driven by human-induced greenhouse gas (GHG) emissions, to be one of the most critical global issues for at least the next several decades. As a long-term investor, HKUST has decided to incorporate climate change into its investment decision-making process. It supports the goals of the 2015 Paris Agreement to limit global warming by eliminating net emissions of carbon and other GHGs by mid-century as well as Hong Kong's commitment to achieving carbon neutrality by 2050. The goal of this policy is to ensure our investment approach is informed by the scientific consensus on climate change and consistent with the goals of the Paris Agreement, as operationalized by the Science Based Targets initiative (SBTi) initiative [3], or equivalent for the benefit of long-term returns and for all stakeholders.

4.2 Goals

The policy has three broad goals:

- To ensure the risks and opportunities arising from a low carbon transition are reflected in the way investments are chosen for the portfolio.
- To seek out investments whose activities can accelerate or otherwise support the low carbon transition while contributing to our return goals.
- To support and encourage all businesses to adopt business plans and strategies consistent with the goals of the Paris agreement.

Goals 1 and 2 align the portfolio with net-zero, i.e., benefit from a low carbon transition while at the same time protecting against the risks from uncontrolled climate change. Goals 2 and 3 also contribute to net-zero as an economy wide, and global goal not merely transferring GHGs from HKUST's balance sheet to someone else's. This is important given uncontrolled climate change implies vast net costs to the global economy, in extremis posing existential risks to complex societies. Targeting net-zero for the economy as a whole seeks to preserve the economic returns that drive the portfolio and therefore HKUST's ability meet its target return into the long-term future.

5 Net-Zero Implementation & Targets

HKUST acknowledges that there is no one right approach and that methodologies are evolving. Accordingly, it aims to be pragmatic and move forward promptly where the path is clearest. Because the portfolio is invested through third party investment managers, it is through the choice of managers and what HKUST asks of them, that the policy can be implemented.

5.1 Policy Applicability

The availability of emissions data, methodologies for target setting, and the means of control vary widely across asset classes. It is therefore not practical to set a uniform approach for each asset class. For the time being, this policy applies fully to public equities and public fixed income, referred to as 'in-scope' assets. [4] For other asset classes, HKUST will evaluate all investment opportunities according to whether they contribute to or hinder climate goals. Managers whose strategy clearly hinders climate goals—even through indifference only—will be ineligible for the portfolio.

It is accepted that the world has more than sufficient existing reserves of exploitable fossil fuels to meet its energy needs through a Paris Agreement consistent transition. Moreover, investing in such businesses is to some degree conflicted with our goal of low carbon transformation—essentially taking away the market for their principal products. Such business assets may become 'stranded'—unusable and worthless—in the event of successful decarbonization. For these reasons, HKUST pledges to divest from fossil fuels within the Long-Term Investment Pool.

5.2. Strategy

To achieve the long-term goal of net-zero emissions by 2045, HKUST needs a clear and robust strategy to guide its actions and against which success can be measured. Data and methodological gaps limit how specific targets can be today, but the approach will be tightened and refreshed over time. Initially, HKUST is adopting the following strategy:

1. Reduce and target to eliminate investments in fossil fuels.
2. Improve portfolio transparency:
    - Aim for full transparency in public equities and public fixed income, which allows for detailed carbon analysis.
    - Extend to hedge funds and private investments over time.
3. Engage to drive real world change:
    - Invest in managers with aligned policies.
    - Use its influence as an asset owner to request and require managers across all assets and strategies to adopt net-zero aligned processes.
4. Reduce carbon-emissions:
    - Halve emissions for in-scope assets by 2030 from a 2021 baseline calculated on a consistent basis.
    - Ensure in-scope asset class emissions are below relevant benchmark index on an ongoing basis from end 2023.
    - By 2025, 70% of emissions from in-scope assets should be from companies which are aligned with net-zero or with whom HKUST is engaging (directly or indirectly) toward that objective. Increase this target to 100% in 2030.
5. Investment in 'climate solutions' [5] to increase as a percentage of the portfolio by 5% by end 2025.

5.3 Measurement

An annual review will be undertaken covering all investments, with details to vary by asset class depending on information available. This is to include a detailed 'look-through' to the underlying holdings of each manager. Managers should support this by identifying exposure to material ESG issues, be they positive or negative, and explaining how negatives are being managed both by the underlying company and by the manager themselves (e.g. through engagement or position sizing). This annual review will also identify managers who either don't provide holdings transparency or are not explaining the negatives to our satisfaction, and what action is being taken to either engage with them or remove them from our portfolio.

- Portfolio GHG emissions are measured in CO_2 equivalent (CO_2e), with the baseline at portfolio emissions in 2022, and tracked on an annual basis.
- The degree to which portfolio holdings are Paris-aligned with commitments confirmed by SBTi, TPI [6] or equivalent is also tracked on an annual basis via manager reporting.

5.4. Private Investments

Methodologies and data for net-zero are less developed around private investments so it is more challenging to include them in the targets and monitoring framework. Nevertheless, HKUST will lay out its aspirations as well as guideposts to prevent committing now to long-term investments that will impede net-zero goals in future. HKUST's aspiration and expectation from private investment managers follow from the approach to public investments:

- Disclose robust data on emissions from portfolio companies.
- Require and support portfolio companies to adopt Paris-aligned targets.

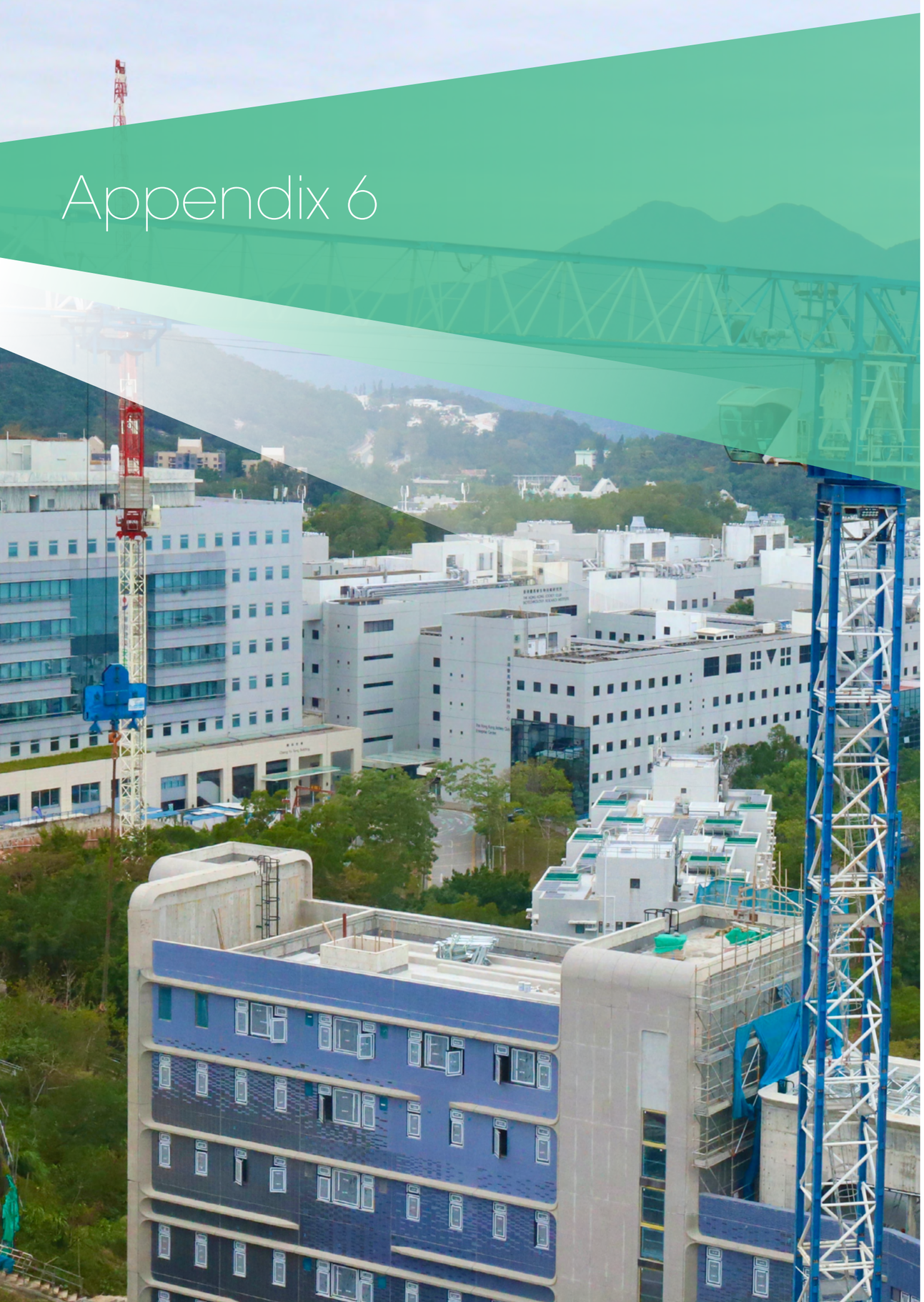
References:

1. From HKUST's Strategic Plan 2021 - 2028
2. From HKUST's Sustainability and Net-Zero carbon commitment
3. From https://sciencebasedtargets.org.
4. This covers 64% of the CCP's Strategic Asset Allocation.
5. Climate Solutions include Cleantech and renewable infrastructure as well as industrial businesses whose products support a low carbon transition.
6. https://www.transitionpathwayinitiative.org/

Appendix 5

Projected New HKUST Construction, 2023-2050

Academic Year	New Building	kWh/Year
2023-24	iVillage Hall	5,100,000
2024-25	Innovation Building	2,200,000
2025-26	Research Building 2	5,300,000
2026-27	Data Center: Phase 1	25,000,000
2027-28	Research Building 3	3,600,000
2028-29	Data Center: Phase 2	23,000,000
2029-30	Teaching & Learning:	3,000,000
2030-31	Data Center: Phase 3	22,000,000
2031-32		
2032-33	New Building (Lab)	3,600,000
2033-34		
2034-35	New Building (T&L)	3,000,000
2035-36		
2036-37	New Residence Building	5,600,000
2037-38		
2038-39	New Building (T&L)	3,000,000
2039-40		
2040-41	Medical Research Bldg	5,500,000
2041-42		
2042-43	New Building (Lab)	3,600,000
2043-44		
2044-45	New Building (Lab)	3,600,000
2045-46		
2046-47	New Residence	5,500,000
2047-48		
2048-49	New Building (Lab)	3,600,000



Appendix 6

Carbon Price, 2020-2050

The Internal Price of Carbon (IPC) is an important tool for determining the collection and reallocation of funding based on greenhouse gas emissions due to operations. The IPC should also be used by contractors and design teams to establish costs for comparison in decision-making. Pricing references the net-zero by 2050 scenario in IEA's Global Energy and Climate (GEC) Model. Pricing is specifically for emerging market and developing economies with net-zero emissions pledges, which includes China, India, Indonesia, Brazil, and South Africa.

Internal Price of Carbon for HKUST

Academic Year	IEA Carbon Price (US$/Metric Ton)	Carbon Price (HK$/Metric Ton)
2020	$30	$ 235
2021		$ 255
2022		$ 280
2023		$ 300
2024		$ 325
2025		$ 350
2026		$ 420
2027		$ 490
2028		$ 560
2029		$ 630
2030	$90	$ 700
2031		$ 755
2032		$ 810
2033		$ 865
2034		$ 920
2035		$ 975
2036		$1,030
2037		$1,085
2038		$1,140
2039		$1,195
2040	$160	$1,250
2041		$1,281
2042		$1,312
2043		$1,343
2044		$1,374
2045		$1,405
2046		$1,436
2047		$1,467
2048		$1,498
2049		$1,529
2050	$200	$1,560