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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Table of Contents

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)