香港科技大學
THE HONG KONG UNIVERSITY OF
SCIENCE AND TECHNOLOGY

HKUST Design Principles and High Performance Building Standards

GUIDELINES FOR IMPROVING CAMPUS SUSTAINABILITY PERFORMANCE IN THE BUILT ENVIRONMENT

HKUST Sustainability

Developed by the Sustainable Operations Executive Committee

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HKUST High Performance Building Standards

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 is embracing 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:

- Emphasize flexibility in spaces
- Anticipate future energy needs and opportunities
- Maximize potential for metering, monitoring, and sensors
- Embrace the benefits of the surroundings
- Design for social interaction
- Integrate potential for student experimentation, research and exploration

These standards identify a minimum level of design and requirements for *all capital projects over $20 million* and should be included in all Requests for Proposals issued for new projects and referenced in contracts for design consultants and construction Managers. In addition, these standards should be used as core principles for renovation projects less than $20 million.

These Standards will be periodically updated and revised.

Contents

Design principles

Emphasis on Smart, Sustainable, and Flexible design

Flexibility in spaces

1. Design for flexibility of public space uses. Consider ways in which needs might change over time. Include the availability of utilities and drains in ways that can be shifted or removed.
2. 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.
3. Ensure that heating and cooling systems are not constrained or limited by mechanical systems; emphasis should remain on ability to allow fresh air into the buildings when appropriate without creating an imbalance in the HVAC systems.
4. Avoid any single-use spaces (dressing rooms, group study rooms, cooking areas) in favor of spaces that can fulfill more than one function depending on intended use. For example, kitchens that can serve as a café-style lounge and meeting space; TV rooms that can be used for entertainment and group study.
5. Emphasize flexibility of spaces both inside and outside of the buildings; the immediate outdoor environment can be equally appealing for work, study, and socializing.

Anticipating future energy opportunities

1. 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.
2. Consider how to isolate certain systems (e.g., lighting) so that they can be served by DC current as renewables are added to the building.
3. Identify and protect spaces for energy storage – thermal and electrical – to ensure flexibility in energy flows and ability to better manage intermittent renewable energy resources. Provide for the ability to connect air-side controls (smart thermostats) and lighting sensors to BMS dashboard programs.

Metering and monitoring

1. Integrate an open source data collection and visibility dashboard software system with the building management system (BMS) so that information collected from the operations of the building can be seen, downloaded, and analyzed by all interested users (students, faculty, and FMO staff).

2. Allow for maximum potential for sensors and metering. Even if metering is limited in the original design, assume additional metering will be installed over time. Allow space in utility rooms for energy, water, and gas meters at the circuit level.
3. Design wiring diagrams that allow for the ability to isolate lighting, plug loads, and heating/cooling consumption at the individual room level.
4. 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.

Maximize benefits of surroundings

1. Investigate areas of planting and landscaping for productive uses. Certain plants are useful for absorbing 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.
2. Consider the value of trees at the end of their lifespan and create a maintenance program to protect benefits (value for lumber, woodworking, or incense).

Interaction and "Active Design"

1. Pay attention to pedestrian flows to ensure that students have multiple opportunities for socializing and interacting.
2. Consider designs that make active lifestyles more appealing and desirable (e.g., make stairs prominent and attractive while placing elevators in less prominent locations). Avoid traditional sedentary-style workspaces.

Student experimentation

1. As a school of science and technology – and with a growing priority for giving students hands-on experiential learning opportunities – the designs should provide spaces for hands-on workshops that include flexible "maker" spaces with appropriate tools and equipment.

Sustainable Building Guidelines

Emphasis on high performing buildings over time

BEAM Platinum Plus Standard as Foundation

HKUST has adopted the ***Platinum Standard of performance under the HK-BEAM Plus (Building Environmental Assessment Method) system*** as the minimum level to be achieved for all new buildings and renovations over 1,000m^2 or $25 million in capital costs.

BEAM embraces a range of good practices in planning, design, construction, management, operation and maintenance of buildings, and is aligned with local regulations, standards and codes of practice. It also provides designers with a high level of flexibility to meet energy and environmental performance goals. However, based on university priorities, the following credits are required:

MA-11 – Construction Waste Reduction: Achieve 60% reduction level.

EU-1 or EU-1 Option 2 – Annual Energy Use: Achieve level that is consistent with meeting a minimum 30% reduction below ASHRAE 90.1-2010.

EU-6 – Renewable Energy Systems: Achieve minimum of 2.5% of total energy load from renewable energy.

EU-10 – Independent Commissioning Agent: Achieve bonus point for engaging an independent commissioning authority for testing and verification.

EU-12 – Metering and Monitoring: achieve requirements for metering and measurement.

Integrated Design Process

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.

BIM - All new buildings must utilize BIM or other equivalent 3-D platforms to model proposed building designs, assist with life cycle costing, estimate greenhouse gas (GHG) emissions, and facilitate future measurement and verification.

Passive Design

Passive design – Incorporate reduction on energy use in all building projects. Design teams must show that passive design options have been evaluated and adopted, or reasons for rejecting. Conservation of resources (land, water, energy and materials) is fundamental aspect of sustainable design. Passive design will make significant contribution and hence attention to air-tightness, natural ventilation, air cooling, shades, day lighting and solar energy are important aspects of any approach.

New building siting - Look at building as a system and review orientation and landscape elements. Incorporate bio-climatic approach to sun and shelter to save energy. The orientation, massing and landscaping aspects of buildings can contribute significantly to the overall energy budget of a building through conservation, heating and cooling. To ensure right balance between solar gain and minimize overheating, there are different modeling that that architects can provide with a range of responses for analysis.

Life-cycle Cost Accounting and Total cost of Ownership Analysis

It is crucial to assist project teams to assess the total cost of ownership impacts for decisions throughout the course of design, we will adopt Life Cycle Cost (LCC) analysis for projects depending on their scope of work. It is best practice to include building operations staff in all LCC and value engineering review.

Life Cycle Costing will be performed to quantify the 20 year impacts on GHG, energy costs, maintenance costs, etc. The scope of LCC will vary depending on project, but will typically include envelope, HVAC, electrical, and many other building systems.

As we build increasingly energy efficient buildings that use less energy to run, the proportion of the building's lifecycle carbon that comes from the embodied carbon becomes more significant. Design teams should measure and reduce embodied carbon on the project with life cycle assessment.

Active Commissioning by HKUST-appointed Agent

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. This agent will perform the role of "owner's representative" on behalf of the university for all aspects of the design that impact energy, greenhouse gas emissions, and water.

Learning Laboratory with involvement by Students and Faculty

To fully embrace the vision that the campus as a learning laboratory, the campus itself is increasingly becoming a place where it is utilized as a means of instruction. This may include a continuous commissioning process and easy to verify performance "dashboards" accessible to occupants or stakeholders. 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. All building design should incorporate the elements for achieving this strategy and vision of goals.

Campus Standards for Lighting, Windows, Equipment and Other Systems

Windows - Maximize the use of double glazed window or low-emissive (Low-E) glass for the building envelope. This requirement can be waived on northern facades if budget requires further review.

Insulation – Use ASHRAE 90.1-2016 as the standard for insulation of the building envelope and rooftop spaces, hot water pipes (especially from rooftop solar DHW), and around hot water tanks or heating equipment.

Ventilation & Air Conditioning Equipment - Effort should be taken in design and controls to eliminate systems that allow simultaneous cooling and reheating. Employ less energy intensive ways of dehumidification. Design team should include modeling and option appraisal of ventilation strategies to ensure optimized and well-controlled low energy ventilation strategies on a room by room basis.

Demand-side ventilation – Use only proportional control (VFDs) for all air handling units, fans, pumps, and chillers, and employ strategies where ventilation rates are controlled by occupant need, not schedules or on/off controls (such as the use of CO2 controls or similar strategies). Thermostats should be connected to occupancy or vacancy controls.

Chillers and Cooling Towers: Use only chillers and towers with efficiencies in the top 5% across all load ranges, seasonably and as a system. Evaluate utilizing heat from the condenser water for preheat use and consider closed loop towers that save water and minimize the effect of contaminants and corrosion on heat exchange surfaces. Design for variable flows and temperatures to optimize performance and system efficiencies.

Elevators: Require Energy Star or equivalent energy saving rated units, lights, fan and motor de-energized unless unit is in "call" mode.

Lighting: Provide naturally lit internal spaces where possible with optimized, controlled and well-integrated artificial light to contribute to energy saving. Use only LED lighting. Use fixtures that deliver proper light levels efficiently to the work surface. Do not over illuminate spaces. Move day light to work spaces with enhanced window use and with effective use of light tubes. Provide a detailed sequence of operation and schematic on drawings for easy interpretation of installing contractor. Provide occupancy lighting control and step dimming in office, meeting, classroom and similar spaces.

Energy Performance and Modeling

New buildings must meet a performance level that is a minimum of 30% reduction below ASHRAE 90.1-2010. For new construction, this performance level must be demonstrated through full modeling, where the modeling should reflect how the spaces and systems will operate once occupied. The models – with all the inputs, calculations, and assumptions – shall remain the intellectual property of HKUST.

Energy Use Intensity (EUI) calculation from energy model will be compared to similar space use types, and must meet a level of performance that exceeds a 30% reduction from ASHRAE 90.1 2010.

Building Type	ASHRAE 90.1 2010		HKUST EIU Target
	Kbtu/f2	kWh/m2	kWh/m2
Office	37.1	117	82
Classroom	39.8	123	86
Library	55	174	122
Residence Hall	66.6	210	147
Research Fac. (Other)	125	394	276
Research Fac. (Bio)	148	467	327

Water

Toilets: All facilities should meet Hong Kong WELS Grade 1 standard for equipment, or US-EPA WaterSense criteria if there is no WELS standard.

Landscaping: no potable or well water should be used for landscaping purposes (except within first year to help establish the plantings).

Air conditioning condensate water – Condensate water from air conditioning systems is not allowed to go into the sewer or waste water piping. Water derived from air conditioning condensation can be used for irrigation, toilet flushing, or other grey water 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.

Targeted Specifications

Contractor and design consultants should adhere to the followings:

- Provide sustainable development policy, overview of practices, procedures and approach. Contractor should include project targets, key performance indicators and detail site environmental management tools.
- Provide a Site Waste Management Plan, how they minimize waste and valuable resources are not disposed of in landfills and most waste is sorted at all stages during a construction project.
- Undertake microclimate analysis and consider exposure of public space to wind, sun and rain, creating space for shelter as well as sun. This can ensure the quality and usability of external spaces is in line with best practice and we will optimize space use.
- Demonstrate how they will protect existing ecological features on the site. Measures such as use of surface water, native and edible planting, avoidance of polluting treatments and materials, avoid need for irrigation. Design team to show evidence of how plants and trees are used as part of a wider ecological strategy including solar shading and water processing and retention. There are a range of opportunities to integrate natural environment with overall building ecology providing amenity and environmental benefits.
- Provide robust solutions for management and creative use of rain water. Surface run-off can be used for water landscape and to aid sewage management through dilution. Slow surface run-off of rainwater can maintain cost effectiveness to use it as a resource.
- Demonstrate meter placement by occupancy and tenancy. Data transfer and communications must be addressed. Sub-metering is a vital part of energy monitoring and targeting. It helps determine the specific consumption of different building services enabling facility managers to make informed decisions about performance and energy efficiency.
- Incorporate option appraisal and proactive pursuit of best value options for renewable contribution.

Key contacts and Questions

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