Advancing Net Zero Ideas Competition
Future Building

1. Preambles

1.1 Local context

Hong Kong has one of the highest population densities in the world, highest real estate values by square meter, buildings are tall and closely packed in a sub-tropical climate where high humidity, long hot summer, light to moderate prevailing wind being the predominate environmental condition, achieving Net Zero Carbon in HK has many challenges.

High investment value and strong demand mean commercial buildings are built fast, cost conscious, high floor area utilization, therefore innovative ideas must contribute to revenue generation, cannot be overtly experimental but bedded on practical sciences using current or near future technologies.

1.2 Local energy source

HK has 2 electrical power providers, but their respective services are segregated geographically and consumers cannot choose. The monopolistic setup discourages competitive services or tariffs for better energy utilization.

1.3 Building typology

The assumed Future Building is a multi-tenant occupied commercial office. Unlike an owner-occupied building where lower energy cost-in-use are incentives, tenants in commercial offices pay service charges based on square meter occupation provide no incentive to save energy.

1.4 Local building codes

HK has one of the most rigid, prescriptive building codes in the world that many building professionals see them as the root cause in stifling creative and innovative designs in HK. Overhauling the statutory control mechanisms is a prerequisite in dealing with ANZ initiatives.

1.5 Social norms & human behavioural threshold

HK populace perception of thermal comfort at 24^0C in indoor spaces is high energy demand.

HVAC design generally aim for uniformity of temperature rather than providing close quarter, human-centric adjustability, hence we often see office workers complain being hot when others in the same space complain being cold.

2. Objectives

2.1 Our ideas are based on 5 simple objectives:

- Minimize energy demand from power grid
- Minimize embodied energy through innovative construction methods and material selection.
- Minimize operational energy through active and passive designs
- Maximize building self-generated energy by harvesting solar and wind power.
- Create added values for both owner and tenants.

2.2 Energy Target

- Based on current OTTV limit, indoor and outdoor design criteria, occupancy density and fresh air requirement, a standard building complied with these parameters would require a peak AC loading of 150 W /m^2
  (An annual energy consumption about 200kWhr /m^2/year)
- By exploring various innovative architectural and engineering measures, our target is to reduce operational energy to 40 W /m^2
  (An annual energy demand about 55kWhr /m^2/year)
- On site renewable energy generation target to provide a maximum of 2,250 kW

3. Embodied Carbon Optimization

3.1 Building Material Selection

Reinforced concrete or steel are poor performer in terms of embodied energy as building material. We would suggest to:

- Use recycled stock for steel, concrete, aluminium, glass, masonry, timber etc.
- Use recyclable products manufactured from sustainable source
- Use structural timber, or Glulam Timber, extensively wherever it can perform the same tasks as steel or R.C.; and
- Adopt “Lightness” as a holistic approach for determining the design concept at an early stage.

3.2 Prefabrication and off-site assembly

To improve built quality and to minimize site generated wastes:

- Design with BIM so that all systems are coordinated at the drawing board to mitigate corrective measures on site.
- Adopt MIC to maximise standardization, facilitate automation, speed construction process and minimize site generated waste.

3.3 Human, Industry and Energy Resources

Working to support local industries is one of the Sustainable Development Goals and “Local” would include the Great Bay Area:

- Create a balanced, sustainable industry network within the GBA to ensure most building components / manufactured products are well within the 800km radius

- Integrate HK with GBA including easing border control to allow “free” movement of goods and people.
- Allow connectivity to China renewable energy power grid.

4. Strategy for Reducing Operational Carbon

Use Stage Carbon reduction can be achieved through rational design, strategic planning, technical specifications and adopting a holistic, total energy approach, such as:

4.1 Planning considerations

- Building Orientation to minimize the elevations with the highest solar exposures that demand high and peak energy loads, while maximizing the elevation with the lowest exposure.
- Optimum Geometric form that maximizes the aspect for views with the lowest energy load orientation while achieving an optimized net to gross efficiency.
- Building Facades with a low window / floor ration for OTTV while optimizing natural light to reduce artificial lighting.

4.2 Active systems

- HVAC accounts for a large proportion of energy spent in an office building. Reductions can be made through adopting energy efficient plant, hybrid cooling systems such as chilled ceilings and underfloor a/c for better air distribution and IAQ.
- Hot water can be provided by solar panels on roofs since hot water usage is not a high demand in offices.
- Artificial Lighting in transient spaces should be switchable automatically, while general offices should be at lower lux level supplemented by task lighting.
- Plug Load should be reduced by using energy efficient appliances.
- Energy Recuperation Lifts can be installed in addition to lift optimization software to manage peak flow demand.

4.2 Passive systems

- Energy Efficient Façade where solar heat within the system can be removed through design, supplemented by external shading and projections.
- PV Panels on roofs as well as spandrel panels of the façades.
- Light Reflectors, Solar Light Tubes provide natural light deep into spaces typically illuminated by artificial lights.
- Wind Turbines provide a much higher energy generation efficiency than solar panels because they work throughout 24 hours.
- Natural Ventilation by heat stack effect provides thermal comfort by convection and excess heat removal.

5. Innovative Technologies to boost further Carbon Reduction

5.1 Microclimate Envelope

Create a microclimate within the building envelope that can assist in managing the building overall energy equation, tempering thermal comfort, and providing accessible, healthy amenities for tenants' well-being.

5.2 Multiple heat stack & wind turbines

Air moved by heat stack effect can be used for driving wind turbines in multiple zones and multiple turbines.

5.3 Heliostat Lighting

Light tubes introduce daylight from outdoor to indoor and to multiple distributed points where natural light is not available.

5.4 Stratified plan zones based on cooling load gradient

By creating a buffer zone for transient activities, which require less cooling than a static activity, along the facades mean the energy curve can be flattened to save energy.

5.5 Increased PV area / window ratio

Introduce PV on both vertical fins and horizontal shelves greatly increases the ratio of PV to window. Our target is to achieve a total PV area equal to 1/3 of the building floor area.

5.6 Earth Cooling

Fresh air, when drawn through below ground cavities, is cooled by ground effect to reduce energy for the PAU and as supply air inside the microclimate envelope.

5.7 Sponge city concept

Create permeable ground surfaces to retain ground water instead of letting rain-water runoff and discharged into sewerage system.

6. Adaptive Commercial Strategy

6.1 Reducing Peak Flow Lift Demand

F&B outlets in the retail mall located at Ground / 1st Level of the building generates the peak flow for lifts. By re-imagining "Food Delivery Service" within the building can substantially reduce total lift journeys during peak time. (See also 7.2)

6.2 Financial Return for Saving Energy by Tenants

An imaginative financial scheme, if feasible, will go a long way to encourage the tenants to save energy in concerted efforts with the owner.

6.3 Recycle furnishing and fit-out for tenants

Owner offers package deal where office furniture and demountable partitions are refurbished and leased to tenants, reducing “End Life-cycle Carbon” substantially.

7. Tenant Wellbeing

7.1 Amenity to Light and Air

Sky gardens, rest areas, food stations are provided at various levels of the building as amenities to satisfy human needs for biophilia, nourishment, natural light and air. These areas are “naturally ventilated” using the Fresh Air within the microclimate of the building.

7.2 Nourishment provisions & accessibility

The building can operate a Hub and Spoke concept for F&B. Pre-ordered foods are prepared by Restaurants or Food Court and served through Food Stations at various levels for customers’ convenience and saving journey time.

7.3 Health and exercise

Sports centre, exercise areas in sky gardens should be planned around the building and in sky gardens to facilitate and to encourage a healthier lifestyle.