Design Brief

Description

This proposal is made according to the carbon net zero project conducted at Oxford House, 979 King's Road, Quarry Bay. This project aims to advance the building towards carbon neutrality and facilitates the design and installation of low/zero carbon technologies. Under the key theme of "Advancing Net Zero", which refers to a highly energy efficient building with all remaining operational energy from on-site / off-site renewable sources, the project seeks to address three sub-themes. They are "Zero Carbon and Ultra-Energy Efficient", "Embodied Carbon" and "Healthy and Sustainable". Through the use of renewable energy, green technology and smart building design, we target to achieve a carbon net zero building.

Solution

Net zero carbon building can be achieved by three green initiatives, which are using renewable energy, adopting smart energy design and installing advanced hydroponics system in the building using recycled pipes.

Renewable Energy by Solar Power and CLP Renewable Energy Certificates

Energy is the most crucial factor in designing a net zero carbon solution. To design an energy system in a building, we must carefully consider the supply of power source and demand from the building users. For the latter, it will be discussed in the smart energy design section.

The energy for the building will be provided by the solar panels installed on site. According to the Department of Energy of US, the average energy consumption in a commercial building is 22.5 kilowatt hours per square foot. As the permitted gross floor area stated in the appendix is 94,144 square meters, the energy consumption for the overall building converts to around 22.8 gigawatt hours annually.

To cater such huge demand of energy, massive amount of solar panels with high efficiency and extensive variety must be installed. Monocrystalline solar panels and flexible solar panels are the suggested types of panels to be used in our project. Monocrystalline solar panels excel in efficiency among all types of solar panels and are readily available in the market. When installed on a flat rooftop, they can steadily convert 20-25% of solar power to electricity. They serve as the main source of electricity in our carbon net zero building.

On top of that, flexible solar panels can be installed at non-flat surfaces, such as building façade and windows. The power generation from this type of panels may not match the monocrystalline panels. However, as flexible solar panels can be attached to a majority of non-flat surface, the power supply could be decent. The flexible panels could be easily replicated by machine printing and therefore could be conveniently replaced if they are out of service.

Should the power generated on site be insufficient for the demand, green electricity could be purchased from CLP through the Renewable Energy Certificate Scheme, thus ensuring the energy supply for the overall building emits zero carbon.

Smart Energy Design in Building

One of the key to optimize energy use is to reduce energy waste and energy loss to the environment. Within a building envelope, improvements can be made on the HVAC system, lighting system, windows shading design and operation system control to further reduce energy use.

For HVAC system, smart HVAC controls can be installed and intelligently adjust the energy use for air cooling in the building by monitoring the key parameters in the area, such as CO2 amount, temperature and humidity. According to a study found by the Pacific Northwest National Laboratory, rooftop units installed with advanced smart HVAC controls save approximately 50% of electricity (Wang et al. 2013). Besides, conducting retrofitting is an effective way to review the building's overall energy performance and suggest ways to further reduce the energy use.

Lighting system constitutes 20% to 30% of the energy use in office buildings, yet this portion are commonly neglected. The most common lighting retrofits are installing LED lights, which could reduce up to 30% of energy. A further approach is to implement advanced lighting control together with LED lighting system, which will reduce an additional 44% of energy. During times when employees leave their office temporarily during breaks or after work, vacancy sensing could be useful to turn off the lights automatically when no presence of workers are detected. It is reported that artificial lighting levels could be reduced by 40-80% through the controls.

In subtropical areas like Hong Kong, sunlight is extremely intense during summer season, thus transmitting huge amount of energy into buildings. In fact, about one-third of commercial HVAC energy use is due to heat gains and losses from windows (Lee et al. 2013). Installing smart shading design and system could help reduce the sunlight penetration effect. Automatically controlled shading system detects the change in outdoor and indoor temperature and adjust the shades on the window. In addition, advanced windows design such as dual reflective, solar control, daylight redirecting films can also be applied to untinted windows to reduce solar heat gain. For Oxford House that uses large extent of windows, such designs are very beneficial to reducing energy use.

In order to achieve net zero carbon in embodied carbon, thorough assessments on material purchase and construction procedures must be carefully conducted to ensure new installations and modifications comply with the principle of zero embodied carbon.

Advanced Hydroponics System

To develop a sustainable environment and promote green living, advanced hydroponics system is also included in the project. The system utilizes scrapped pipelines as a plant carrier, which originally will be disposed to the landfill. By reusing the old pipelines, we constantly strive to achieve a sustainable business operating mode. The hydroponics system can also be attached to the electricity grid and be powered by the solar panels, resulting in a carbon net zero green farm. Moreover, promoting green living in commercial office area can be impactful to employees' working morale and efficiency. By integrating to a greener and more sustainable office environment, building an authentic hydroponics system could therefore enhance the wellbeing of the occupants within the building.

Summary

To summarize, the project building will achieve carbon neutrality through utilizing renewable energy, smart building design and advanced hydroponics system. Three sub-themes will also be fulfilled by implementing the above solutions as well as incorporating future building guidelines to ensure the building will retain its carbon net zero status.

Reference

Wang, W., S. Katipamula, H. Ngo, R. Underhill, D. Taasevigen, and R. Lutes. 2013. Advanced Rooftop Control (ARC) Retrofit: Field-Test Results. Richland, WA: Pacific Northwest National Laboratory. www.pnl.gov/main/publications/external/technical_reports/PNNL-22656.pdf.

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