The 23rd Annual Power Symposium 2025

<u>Grid-Interactive Building:</u>

<u>New Opportunities in the Era of Artificial Intelligence Towards Carbon Neutrality</u>

5 September 2025

Keynote presentation by Ir Raymond POON, JP,

Director of Electrical and Mechanical Services

Opening

Good morning, Ir Henry CHAN, Chairman of the Organising Committee, Prof Steve BU, Mr Francis CHENG, Prof WANG, Ir Dr LO, distinguished guests, ladies and gentlemen. First of all, I would like to express my sincere gradtitude to IET for uniting the global buildings community with this annual symposium. We gather today to talk about grid-interactive building, which is known as one of the key players in transforming the city's electricity network into a smart grid ecosystem.

Challenges of the power grid

In recent years, large-scale power outages caused by asset aging and extreme weather have frequently occurred around the world. The social and finanical impact are substantial. Although the reliability of power supply in Hong Kong is world-leading, we are still facing the challenges of climate change. The increasing use of distributed renewable energy, surging demand from electric vehicles and data centres, high cost of clean energy, and more frequent extreme weather are placing significant pressure on our power grid. As an international city and finance hub, Hong Kong need to accelerate the transformation of our energy system to a smart grid.

The Need for Grid-Interactive Buildings

Smart grid is a dynamic, two-way and interactive energy network of the future. It centered on distributed power generation, energy storage and highly flexible loads, significantly enhancing the reliability and sustaibaility of the entire power system. To facilitate the smart grid development, grid-interactive buildings are essential. A grid-interactive building is a smart structure that dynamically manages its energy use based on grid conditions, renewable energy generation and operational needs. It is no longer as a passive consumer, but keep communicating with the grid to determine the best time of using utility power, when to store energy, when to shed or shift loads, and when to fed power to the grid for the co-benefit of cost effectiveness and resilience. Also, a grid-interactive building should be able to control its demand without considerable impact to comfort or operation. Such as the use of smart sensors to temporarily adjust temperature setpoints, dim lighting and optimize the charging of electric vehicles. The interactions can be realized by smart meters, internet-of-things sensors and energy management system empowered by artificial intelligence.

Mainland China's Photovoltaics, Energy Storage, Direct Current and Flexibility (PEDF, 光储直柔) Strategy

The "Action Plan for Carbon Dioxide Peaking before 2030" of the mainland China clearly requiring the development of buildings integrated with photovoltaics, energy storage, direct current system and power flexibility, in Chinese "光储直柔". This is a representation of grid-interactive building. The integration of the four technologies can achieve energy saving, decarbonisation and resilience of the power grid. Technical specifications of these technologies have been published in several mainland cities and R&Ds are very active. Demonstration projects are in place. One of them is the China Overseas Finance Centre (北京中海金融中心) in Beijing. The building features with photovoltaic system, DC lighting, DC air-conditioning and vehicle to grid system. Here in Hong Kong, I am excited to know that some pilot projects are being planned.

Renewable Energy – Photovoltaics

On site renewable energy is one of the green power sources for grid-interactive buildings. Hong Kong is actively promoting photovoltaics technology. The current use is predominantly at buildings' roof-tops. With limited roof space in Hong Kong, there is potential to make good use of the buildings' façade for solar power generation. The Electrical and Mechanical Services Department is piloting a project in its headquarters to explore the application of building integrated photovoltaics on facades. To assess the feasibility of expanding the application to more buildings, performance data was being analyzed and will be shared. Under the steer of an inter-departmental working group, the Buildings Department had also enhanced the Code of Practice for Fire Safety in Buildings last year, facilitating the wider use of BIPV by updating the combustibilty requirement.

Apart from solar energy, hydrogen as fuel for electricity generation is becoming mature.

The first hydrogen-powered generator has been put into operation at the construction site of the Hong Kong-Shenzhen Innovation and Technology Park. A similar generator will also be used at venue of the golf tournament of the 15th National Games in November this year. With the concerted effort of the industry, I believe the use of green hydrogen to generate electricity at buildings will be piloted in the near future. Green hydrogen will become one of the clean energy sources of grid-interactive buildings, propelling Hong Kong's hydrogen development to a new level.

Battery Energy Storage System

To allow flexibility of power dynamics, energy storage is indispensable for grid-interactive buildings. With the growth of distributed electricity generation in Hong Kong, energy storage integrating with digital technology enables "Peak Cut" (削峰填谷) by storing excess energy during low demand and releasing it during peaks, thereby stabilizing the power grid. One of the examples is the battery energy storage system deployed in the Hong Kong International Airport. It stores up electricity generated from routine testing of backup generators for recycling use. Another example is the BESS installed in the CIC's Zero Carbon Park integrated with renewable energy. At grid scale, a BESS is being constructed at the Castle Peak Power Station to help regulate peak demand and facilitate the integration of more clean energy sources onto the grid. While Lithium-ion BESS technology is fundamentally safe when properly designed and managed, the high energy density inherently carries a risk of thermal runaway. The Fire Services Department just issued a circular in June this year to address the safety risk and suppression provision for Lithium-ion battery system. Apart from the minimum safety provision, advanced battery monitoring system which is available in the market, can be a solution for earlier risk mitigation.

Vehicle-to-Grid

As Hong Kong transitions to zero-emission transport, electric vehicles are emerging as "Batteries on Wheels" with potential integration with grid-interactive building. Vehicle-to-grid technology allows EVs to act as mobile energy storage, and supply electricity back to the building or the grid. An energy management system coordinates the two-way energy flow, ensuring the EVs are always charged to the driver's need by their departure time, while optimizing when to buy, store, and sell energy for cost and grid efficiency. In Hong Kong, the percentage of EV among the newly registered private cars had been increased to about 70% in 2024. The collective battery capacity of EVs in the future will be enormous. V2G enabled chargers should be one of the key facilities in grid-interactive buildings.

Low-Voltage Direct Current (LVDC)

While most electricity is transmitted as AC, in reality, we are increasingly living in a DC world. Majority of devices we use in buildings nowadays operate on DC, such as LED lighting and variable speed drive. Power generation has moved to DC with the use of renewable energy such as photovoltaics and hydrogen fuel cell. DC became the most used form of energy storage. The connection of different DC sources to a DC micro-grid enables buildings to be more grid-interactive. And there is no need for AC-DC conversion resulting in energy loss. The problem of harmonic will no longer exist.

The rising use of renewable energy, EVs, energy storage and power electronics has brought the use of DC back to our eye. Integrating DC micro-grid in building can unlock greater efficiency, flexibility and operational cost savings. Without the losses due to skin and proximity effects in power cables, DC also has the advantage of carrying more power than AC. Hong Kong Electric has recently commissioned a LVDC system at Ocean Park. Leveraging the DC technology, the transmission capacity of existing LV cables was increased for 2.5 times the original. While DC system is not a one-size-fits-all solution, its potential and advantage are now prompting the industry to evaluate the integration or hybrid the AC and DC technologies in buildings. Stakeholders in R&D, manufacturing, construction and facility management sectors are encouraged to have a closer look for the development.

Closing

Relying on past technologies won't survive in climate change and achieve carbon neutrality. We require groundbreaking innovation and technology to resolve. Buildings in Hong Kong are the largest electricity consumers. We have the need to develop grid-interactive buildings to facilitate smart grid for long term sustainability and reliability. It represents an opportunity for Hong Kong to address our energy challenges while advancing towards the carbon neutrality goal. EMSD is now supporting China's National Energy Administration for developing international standard for Integrated District Energy System in the ISO platform, thereby promoting the development of grid-interactive buildings. Let this conference be a catalyst for change, sparking innovation and fostering collaboration. Seize this opportunity, let's envision the grid-interactive buildings of the future for enabling a sustainable and reliable smart grid ecosystem. Thank you.

(1 400 words, about 13 mins)