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Shenzhen Launches World's First Large-Scale Park-Level Energy-Use Net Practice for Green and Low-Carbon Energy Transition

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In January 2025, research and development on the key technology of the Energy-Use (EU) Net for smart microgrids, a major new energy storage special project under Shenzhen's 2024 municipal-level key science and technology programs, was officially launched. This initiative is a joint effort by Shenzhen Energy Corporation, Shenzhen Energy Innovation Technology Co. Ltd., Huawei Digital Power, Southeast University Shenzhen Research Institute, and Jiangsu intelligent Energy Use and Low Carbon Technology Research Institute. This project is not only a crucial measure for Shenzhen to build a global pioneer city of digital energy, but also marks the world's first large-scale park-level practice of the EU Net theory,[1] proposed by Professor Xingying Chen from Hohai University in 2016. The project will build a model of a microgrid EU system that incorporates the integration of photovoltaics (PVs), energy storage, electric vehicle (EV) charging, and Vehicle to Grid (V2G) with the mutual support of hybrid AC-DC microgrids, which can provide a feasible and replicable solution for green and low-carbon energy use.

MICROGRID: A KEY APPROACH TO SOLVING ENERGY-USE CHALLENGES IN SHENZHEN'S HIGH-DENSITY PARKS

Shenzhen, as a frontier city with rapid economic development, has witnessed a continuous surge in energy demand. In 2024, the total social electricity consumption in Shenzhen reached 121.49 billion kWh, with a year-on-year growth of 7.7%.[2] In recent years, Shenzhen has planned and built more than 4,000 industrial parks[3] while also actively promoting the integration of distributed PVs, ES systems, and EV charging stations. However, the continuous growth of electricity demand from diverse parks and the whole society poses multiple challenges to the traditional energy supply model. On one hand, the pressure on energy supply and grid hosting capacity is becoming prominent. Shenzhen is deficient in local energy resources and mainly relies on external power supply. Meanwhile, as the penetration rate of EVs rises rapidly, a large number of high-power charging stations lead to intensive electricity draw during peak demand periods. This results in a sudden surge in local electricity load, posing a huge impact on the safe and reliable operation of the power grid. On the other hand, there is an urgent need for energy structure transformation under the "dual carbon" goals. Reducing carbon emissions and improving energy use efficiency have become inevitable requirements for urban development. Therefore, it is imperative to tap into the potential of local distributed renewable energy resources such as solar PVs to optimize the local energy structure and mitigate external dependence.

In this context, the traditional centralized energy supply model can hardly meet the requirements for a stable, clean, and efficient energy supply in high-density parks like Shenzhen Bay Super Headquarters Base. However, microgrids, with their core advantages of distributed location, multi-energy complementarity, and flexible control, have become a key approach to address the aforementioned challenges. Microgrids can accommodate various flexible resources such as PVs, energy storage systems, and supercharging stations.[4] Through localized energy production and control, microgrids reduce reliance on the external power grid, which is in line with the policy orientation of an integrated network for PV-storage-EV charging-V2G proposed in the government work report. Moreover, the AC-DC coordinated architecture can reduce equipment access losses and facilitate the consumption of renewable energy. The flexible islanded operation capability can also improve power supply reliability, meeting Shenzhen's dual needs of energy transition and energy security assurance.

MICROGRID+ENERGY-USE NET: INNOVATIVE INTEGRATION TO BUILD A NEW ECOSYSTEM FOR GREEN AND LOW-CARBON ENERGY USE

The user side is the core source of energy consumption and carbon emissions. Building a microgrid energy-use system based on the EU Net is the key to solving problems on the user side,[5] such as dispersed multi-energy resources, difficult quantification of use value, and a lack of transaction mechanisms. This project deeply integrates the EU Net theory by taking the energy element as the core carrier to accurately quantify the physical attributes and economic value of EU resources and construct fair and free energy rights trading mechanisms centered on users. Based on this, the project converts various flexible multi-energy resources including PVs, energy storage, charging piles, and flexible loads in the microgrid clusters of a park, into standardized units that are measurable, tradable, and controllable, and drives the in-depth participation of these flexible EU resources in energy interaction through value incentives.

The project advances four key research technologies around the integration of microgrids and the EU Net. 1) Develop power electronic equipment for AC-DC microgrids, aiming to make breakthroughs in high-power density conversion and grid-forming equipment technologies with the localization of key components; 2) Innovate the control strategy for park-level microgrid clusters, construct a multi-level coordination mechanism, and solve the

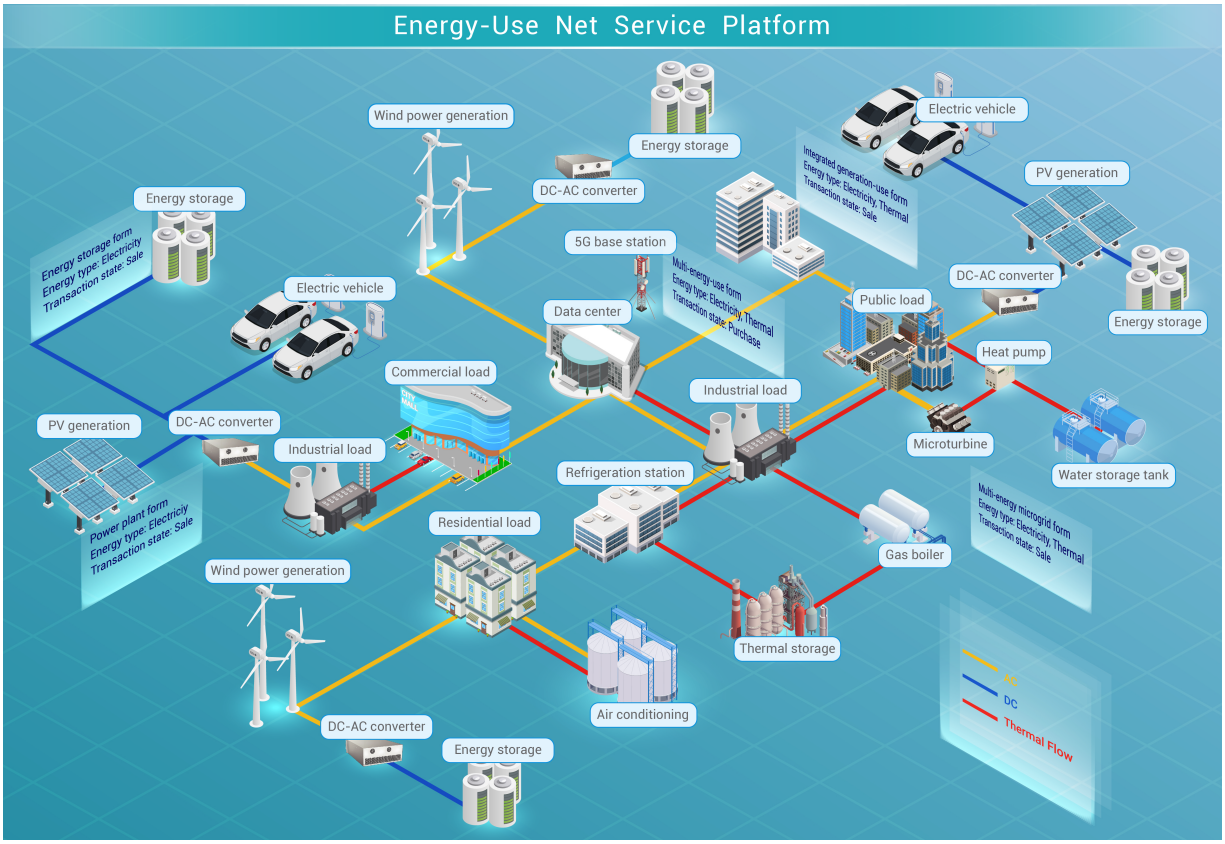

Figure 1. Energy-Use (EU) Net for smart microgrids.

problems of power mutual supply and fault ride-through; 3) Build a EU Net-based cloud-edge-end energy management architecture to achieve the regulation of flexible resources and their aggregation in microgrids under multiple operation scenarios; 4) Explore the EU right trading mode and mechanism for multi-park scenarios and its connection with external markets such as electricity and carbon markets. Through these research and development, a unified benchmark quantitative evaluation method for heterogeneous energy, such as electricity, cooling and gas, will be constructed with the energy element as the core, enabling the value assessment of heterogeneous EU resources as well as cross-energy transactions. On this basis, the friendly interaction of EU resources within parks, between different parks, and between parks and the external power grid will be promoted. Supported by this mechanism, park-level energy use will evolve from mere physical interconnection to value circulation, creating the world's first large-scale park-level practice of the EU Net.

From theory to practice, the project will establish a comprehensive implementation system and standards for the EU Net in the park level, providing theoretical references and practical models for energy transition in the Guangdong-Hong Kong-Macao Greater Bay Area and even global cities. The green and low-carbon EU goals targeted by this system and standards are highly aligned with Shenzhen's development orientation. As a city committed to being a global leader in digital energy, Shenzhen has persistently pursued green and low-carbon EU pathways aligned with EU system and standards. This progress benefits from Shenzhen's favorable innovation ecosystem, open cooperation mechanisms, and internationalized development environment, which provide solid conditions for the implementation of technological research and development as well as model innovation. In 2024, under the guidance of the Central Committee of the Revolutionary Committee of the Chinese Kuomintang, the China Electricity Council and others, various parties jointly organized and hosted two principal events in Shenzhen: The Energy Green Development Conference and The International Digital Energy Expo. The first focused on the frontier of green digital energy, and discussed low-carbon technology breakthroughs and development as well as energy digital transformation, gathering nine distinguished academicians and numerous representatives from the government, research institutes and enterprises. By contrast, with the theme of Digital Intelligence, Innovation, Green, and Sharing, the second set up seven exhibition areas covering energy storage, new power systems, renewable energy, core components of energy storage, digital empowerment, integrated energy services, and international enterprises. The exhibition highlighted global cutting-edge technologies and practice achievements in digital energy. In the future, these two events will continue to be held in Shenzhen, gradually becoming a prominent symbol and city brand in Shenzhen's energy field. They will help Shenzhen consolidate its position as a global pioneer city of digital energy and lead the global trend of energy transition.

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DECLARATION OF INTERESTS

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