xiSmart campus: Unleash low-carbon potential through digital technology

SIEMES

Summary

Climate change is a common challenge faced by human society and is increasingly threatening human survival and development. China's economy has maintained rapid growth in the past few decades and addressing climate change has become an inherent need for China's sustainable development. In 2020, the Chinese government clearly put forward the strategic goal of reaching a carbon peak in 2030 and carbon neutrality in 2060; at the same time, China also faces a series of major practical challenges such as fossil fuel dominated energy structure and high energy consumption per unit of GDP, which make the realization of the “dual carbon” goal urgent and daunting.

In China, various industrial campuses are key elements of China's economy and the concentrated consumers of various energy sources. How to achieve low carbon and zero carbon in these campuses will become one of the core issues of China's "dual carbon" strategy.

In 2012, the 18th National Congress of the Communist Party of China put forward the target of intelligent campus construction for the first time, marking a new stage of transformation and upgrading of China's industrial campuses from the traditional type to the intelligent type. Since then, various relevant departments and local governments have issued a series of policies and guidelines to create a good policy environment and development guidelines for the transformation of campuses towards low-carbon and digitalization.

The construction goal of zero-carbon smart campus is to systematically integrate the concept of "carbon neutral" in the planning, construction, and management of the campus, to make comprehensive use of energy saving, emission reduction, carbon sink, carbon capture and utilization, carbon trading etc. Among them, the low-carbon energy system is the core of the zero-carbon campus construction. Meanwhile, digitalization will become a key enabling tool for the intelligent management and zero-carbon transformation of the campus.

The digital solution of zero-carbon smart campus can be built by digitalizing the three main stages of the energy flow: energy supply,

transmission, and consumption. The focuses should be setting up an integrated energy system at the energy supply side, realizing the automation and digitalization of the campus infrastructure at the transmission side, and making loads in campus consume less energy.

There are several best practices done by Siemens and our partners:

The University of Birmingham (UOB) and Siemens have worked together to create an integrated energy system for the campus that can adapt to changing needs and help UOB to reduce its carbon emissions in a sustainable and dynamic way, using measures such as applying digital technology, artificial intelligence, distributed renewable power production and energy storage, changing customer behavior patterns etc.

Changshu High-tech Zone MOBO Innovation Industrial Park Project. In this project, digital technology enables effective management of the people, logistics and vehicles in the campus to optimize resource allocation. The digital technology also allows operators to analyze the energy consumption of the campus. Moreover, the digital platform integrates various applications such as carbon verification, carbon footprint, carbon trading, etc. The large amount of data collected in return helps the operator to improve the energy efficiency and to gradually meet the goal of a decarbonized smart campus.

Shanghai Pudong Lianmin Village Project: Siemens provided an integrated solution from planning, consulting to the core energy management platform. The energy management platform integrates artificial intelligence and other technologies to intelligently manage multiple sources such as PV, wind power, geothermal, energy storage etc. With the comprehensive solution, the total energy consumption of Lianmin Village is expected to be reduced by 10% and carbon emission is expected to be reduced by 50%.

China has formulated and issued many policy documents and supporting incentives to promote the construction of zero-carbon campuses, however, most campuses around the country are still on the road of transformation from traditional campuses to low-carbon smart campuses, and a series of developments and iterations are still needed to achieve the goal of zero-carbon smart campuses, for which we have the following suggestions.

- **Guide the top-level design of zero-carbon smart campuses and improve relevant regulations and technical roadmaps.**
- **Promote the pilot operation of zero-carbon smart campuses and accelerate the implementation of projects in demonstration zones.**

- **Promote distributed energy technology innovation and development, build a new energy system with renewable energy as its core.**
- **Encourage digital technology innovation and development for zero-carbon smart campuses.**

In order to achieve the long-term goal of sustainable development, from global cooperation to China's "dual carbon" policy goal, all industries may be reshaped by "carbon neutrality". As the hosting space for many industries, the campus will play an important role in balancing economic development and decarbonization. Integrating relevant policies and market needs with the main business will be a compulsory course for most campuses and companies in the future. With digital innovation and cross-sectoral industry insight, Siemens will work together with partners in China to create a green ecology, enabling the creation of an end-to-end low-carbon industry chain and helps empowering China to achieve its "dual carbon" goal.

Catalog

1. International and domestic trends

1.1 The Global Framework for Cooperation on Climate Change

With the increase in human activities and the associated use of fossil energy, the possible rise of global temperature caused by a large amount of greenhouse gas emissions may become one of the key factors threatening the human living environment and social development. More than half of the world's countries have set "carbon-neutral" targets to limit the increase in global average temperature to less than 2 degrees Celsius compared to the pre-industrial period and are working to limit it to 1.5 degrees Celsius[1].

1.2 China's "Dual Carbon" Goals and Commitments

The "dual carbon" targets included: By 2030, the overall green transformation of economic and social development will have achieved significant results, and the energy utilization efficiency of key energy-consuming industries will reach the advanced level internationally. Energy consumption per unit of GDP will drop significantly; CO_2 emissions per unit of GDP will drop by more than 65% compared with 2005; the proportion of non-fossil energy consumption will reach about 25%, and the total installed capacity of wind and solar power will reach more than 1.2 billion kilowatts; the forest coverage will reach about 25%, the forest accumulation will reach 19 billion cubic meters, and CO_2 emissions will reach the peak and achieve a steady decline. By 2060, a green low-carbon cycle development of the economic system and a clean, low-carbon, safe and efficient energy system will be fully established, the energy utilization efficiency will reach the international advanced level, the proportion of non-fossil energy consumption will reach more than 80%, the goal of carbon neutrality will be successfully achieved, the construction of ecological civilization will achieve fruitful results, and a new realm of harmonious coexistence between human and nature will be created[2].

1.3 Zero-carbon and smart campuses are important ways to promote China' s "dual carbon" goal

In China, industrial campuses are the core force of the Chinese economy and the central energy consumer. Therefore, how to achieve low carbon and zero carbon in the campus will become one of the core issues of China's "dual carbon" strategy.

In 2019, 48.8% of China' s overall energy consumption occurs in industry, and their main carriers are industrial campuses. For example, the national-level economic

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[1] Siemens Zero Carbon Smart Campus White Paper

[2] Working Guidance for Carbon Dioxide Peaking and Carbon Neutrality in Full and Faithful Implementation of the New Development Philosophy

and technological development zones and national-level high-tech industrial development zones[3].As of July 2022, the number of the two types of national campuses reached a total of 402, with a total GDP of 29 trillion yuan, accounting for 25.3% of the country. The GDP of China' s national-level economic and technological development zones was 13.7 trillion yuan, accounting for 11.9% of GDP; the GDP of national-level high-tech industrial development zones was 15.3 trillion yuan, accounting for 13.4% of GDP. In addition to the national-level industrial campuses, there are many more large numbers of provincial, municipal, and corporate-owned campuses with high energy consumption and GDP output[4].

2. The Development of Smart Campus in China

2.1 Booming industrial campus creates a high demand for carbon reduction

Industrial campuses are the main place for industries and enterprises to gather. Industrial clusters and production scale bring huge energy demand, and a large amount of infrastructure and public services have become the main source of carbon emissions in campuses. China's industrial campuses mainly use electricity as the main energy driver and are limited by the current situation of electricity production in China: 67.8% of the electricity supply of campuses powered by the grid in 2020 still relied on fossil energy; therefore, campuses have become an important carbon emission carrier[5]. Among them, carbon dioxide emissions from industrial campuses alone account for more than 30% of China's total carbon emissions[6].

2.2 China enacts several policies to promote low-carbon and digital transformation of industrial campuses

In 2012, the 18th National Congress of the Communist Party of China put forward the target of intelligent campus construction for the first time, marking a new stage of transformation and upgrading of China' s industrial campus from the traditional type to the intelligent type. Since then, relevant departments and local governments have issued various policies and guidelines to create a favorable policy environment and development guidelines for the transformation of campus to low-carbon and digitalization.

Since the "dual carbon" target was proposed, a series of top-level documents and key policies have been issued to guide and promote the zero-carbon transformation of campuses. In the "14th Five-Year Plan", the National Development and Reform

[3] IEA, Energy Efficiency 2019

[4] Foresight Industry Research Institute - 2022 China Smart Campus Development White Paper

[5] GLP – 2022 Zero Carbon Campus Practice White Paper

[6] Prospective Industry Research Institute – 2022 China Smart Campus Development White Paper

Commission (NDRC) proposed to promote the development of circular economy, build a green, low-carbon and circular economic system, and encourage campuses to promote the construction of green factories. At the end of 2021, NDRC and the Ministry of Industry and Information Technology (MIIT) issued the "Circular Economy Development Plan for the 14th Five-Year Plan" to promote the development of a circular economy, build a green, low-carbon, and circular economic system, and encourage the campus to promote the construction of green factories[7].

During the same period, MIIT, the Ministry of Housing and Construction, and other authorities guided the campus to further develop towards green and low carbon in terms of green building, energy structure, and energy efficiency in their policies such as the "14th Five-Year Plan for the Development of Building Energy Efficiency and Green Building" and the "14th Five-Year Plan for Industrial Green Development" respectively. The status of zero-carbon transformation of the campus has been deepened[8].

The diversification of business modes and the complexity of functions of the campus have gradually increased the requirements for intelligence in infrastructure and operation. In the context of the rapid development of information technology, the relevant policies in China' s digital transformation stage have also put forward guiding directions for the digital development of the campus. In December 2021, the State Council proposed in the "The 14th Five-Year Plan for the Development of the Digital Economy'' to promote the digital transformation of industrial campuses and industrial clusters, and to actively explore the joint operation mode of platform enterprises and industrial campuses[9]. MIIT's "The 14th Five-Year Plan for the Development of Intelligent Manufacturing" suggests that the campus could build a virtual-reality integrated, knowledge-driven, dynamically optimized, safe and efficient, and green and low-carbon intelligent manufacturing system to promote digital transformation, networked collaboration, and intelligent change, with the process and equipment as the core and data as the basis, relying on manufacturing units, workshops, factories, supply chains, and other carriers[10].

2.3 The construction of a digital low-carbon energy system is the only way to achieve carbon neutrality

The construction goal of a zero-carbon smart campus is to systematically combine the concept of "carbon neutrality" in the planning, construction, and management

[7] Circular Economy Development Plan for the 14th Five-Year Plan

[8] 14th Five-Year Plan for the Development of Building Energy Efficiency and Green Building

[9] The 14th Five-Year Plan for the Development of the Digital Economy

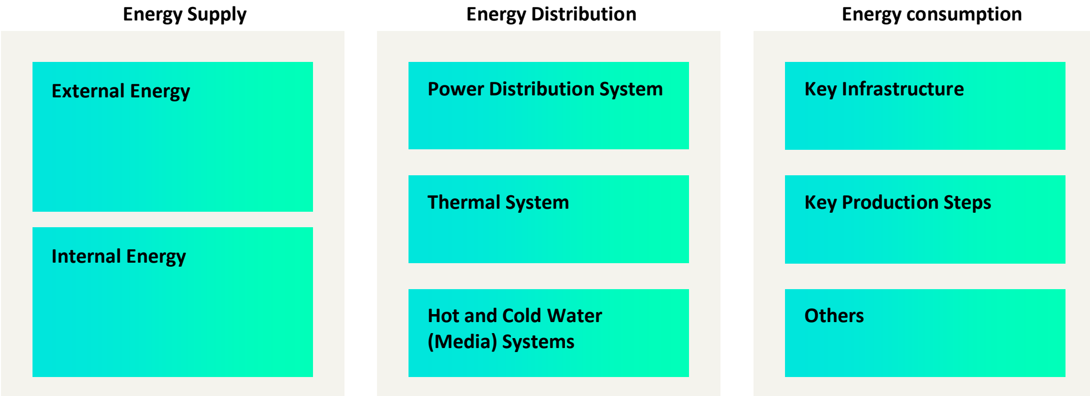
[10] The 14th Five-Year Plan for the Development of Intelligent Manufacturing

of the campus, to make comprehensive use of energy saving, emission reduction, carbon sink, carbon capture and utilization, carbon trading, and other technologies, and to achieve net carbon emissions close to or at zero in the campus through low-carbon and recycling utilization of industries, facilities, and resources. In this way, production, ecology, and life will be deeply integrated[11]. Among them, a low-carbon energy system is the core of the construction of a zero-carbon smart campus. The three ends, generation, grid, and load, should work together; at the same time, digitalization will be the key enabling means for the smart management and zero-carbon transformation of the campus.

Figure 1 Architecture of a campus energy system

2.3.1 Energy supply: energy structure optimization

The low-carbon degree of energy supply structure directly determines the effect of carbon management on the whole campus, which is an important part of realizing a zero-carbon smart campus. Therefore, the zero-carbon campus should continuously optimize the energy supply structure and increase the proportion of low-carbon energy in the internal and external energy sources, such as increasing the proportion of purchased clean energy, making full use of local resource endowment, developing renewable energy according to local conditions, and building distributed clean energy systems in the campus, including distributed photovoltaic, biomass, geothermal heat pumps, trigeneration (CHPC), etc., to make the energy structure of the campus clean and reduce carbon emissions from the source.



[11] China Society for Technology Economics, Standardization Association, Guideline for the Construction of Low/Zero Carbon Industrial Campus - T/CSTE 0042-2022

In the process of decarbonizing the energy supply side, the following challenges that may exist need to be actively addressed.

- **Clean energy procurement decisions and supply chain construction.** Be familiar with relevant regulations and policies as well as market operation means, make procurement decisions flexibly and reasonably, and establish matching supply chain systems, such as real-time trading systems and access to the relevant trading platform, etc.
- **Guarantee the power quality on the campus.** Access to a large number of new energy sources (mainly locally built systems) may lead to problems in power quality, which requires the establishment of reactive power compensation systems and various types of energy storage/heat storage/cooling storage systems to increase system toughness and flexibility.
- **Balance low carbon and economy.** The cost of procuring low-carbon power and equipment and building and operating related systems in low-carbon construction needs to reflect an acceptable economy.

2.3.2 Energy Distribution: Integrated Energy Management

The importance of energy distribution systems in the "dual carbon" scenario is often underestimated. As a basic link between the energy supply and consumption sides, the energy distribution system is responsible for the transmission and control of various types of energy, including water, electricity, steam, and heat. In an era when the proportion of electric energy in the campus is gradually increasing, the stability and toughness of the distribution system determine the lower limit of energy security on the campus and is the basic guarantee for production and life on the campus. At the same time, due to the unstable characteristics of major clean energy supply methods such as photovoltaic and wind power, and the emergence of more and more AC/DC hybrid equipment and systems, the distribution system is also tasked with stabilizing supply and ensuring power quality.

Therefore, the decarbonization in the energy distribution end should take into full consideration the energy consumption characteristics of the campus, relevant policies and regulations, commodity market dynamics, and local natural endowments, from the design to the operation stage, to create a strong and flexible integrated energy management system and improve the operational efficiency of the overall energy supply system and reduce carbon emissions.

2.3.3 Energy consumption: energy efficiency improvement and management optimization

Energy consumption in industrial campuses involves consumption in infrastructure, industrial production processes, transportation, and other activities of campus users, etc. To address the complex energy demand side structure in the campus, carbon reduction can be started with energy efficiency improvement and management optimization: increase the proportion of energy-efficient equipment according to the local resource endowment and technical and economic conditions; reduce energy consumption by optimizing the process and management flow; improve the management level of energy consumption and achieve carbon reduction while improving energy efficiency through energy gradient utilization and waste heat and pressure recycling, as well as the use of recycling processes to realize the recycling of various types of energy and materials.

The carbon reduction measures in the energy consumption link should meet the requirements of the high-quality operation of the campus and meet the needs of campus users, taking into account the economy of energy-saving measures and the practicality of energy-energy recycling, and be realized through the long-term refined operation.

2.3.4 Digital Technology Empowers Zero Carbon Smart Campus

Digital technology is an essential enabler for the construction of a zero-carbon smart campus, not only in the planning, construction, and operation stages of the campus but also in the supply, distribution, and use of the energy system.

- **Realize the visualization and transparency of zero-carbon smart campus management through digital technology.** The visualization and transparency of energy, resource, and carbon emission data is the basis of low-carbon and intelligent management of the campus. Therefore, a digital energy and carbon management platform based on the Internet of Things and information technology is needed as a carrier for energy and carbon emission data and related information interchange and communication in the campus, to realize all-round and multi-dimensional transparent monitoring of energy consumption and carbon emission data in the campus, and to visually display the effect of energy saving and carbon reduction, as well as to realize carbon footprint, carbon verification, carbon asset management, and scientific carbon target management.

3. Digital Solutions and Related Cases

3.1 Introduction to the digital solution

The digital solution of a zero-carbon smart campus can be built by combining the three main links of energy flow: generation-grid-load, focusing on the construction of the integrated energy system of the campus at the generation end, the automation and digitalization of the campus infrastructure at the grid end, and the implementation of the intelligent and zero-carbon campus buildings at the load end.

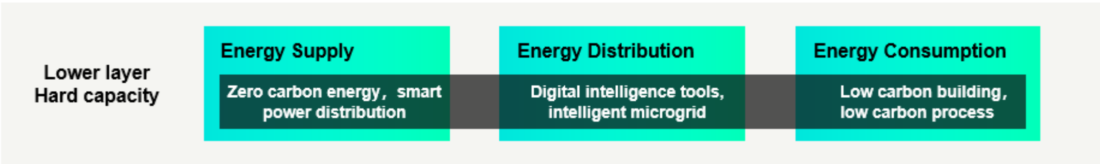


Figure 2 Digital Solution Architecture

3.1.1 Construction of integrated energy systems

- **Energy system planning:** The energy system is the main link of carbon emission reduction on the campus, and the construction planning specifically for the energy system can avoid inefficient input. Using technologies such as "digital twin" and digital simulation, grid planning, distributed equipment selection, and simulation of construction scale and return on investment can be done more accurately.
- **New energy/distributed energy:** The selection and construction of new energy and distributed energy is also an important part of integrated energy management. From wind and solar energy to energy storage, electric vehicles, and hydrogen energy, appropriate equipment and technologies are selected to help the campus further reduce carbon.
- **Micro-grid management platform:** Micro-grid management solution that integrates distributed energy and energy storage can improve local grid flexibility, reliability, and new energy penetration rate, thus reducing the cost of energy use, which is a key technology for energy saving and carbon reduction at a time when energy demand is changing, and the proportion of new energy is gradually expanding.

3.1.2 Decarbonization and digitization of campus infrastructure

- **Low carbon and digitalization of power distribution, heat, and building equipment:** for example, environmentally friendly gas switchgear equipped with intelligent power distribution systems
- **Smart campus platform:** comprehensive digital capability is reflected in the ability of mutual interaction and coupling between multiple types of systems, such as the coupling of electricity and heat and cold, the linkage between subsystems such as security and fire protection, and the automatic adjustment

of systems in the building according to the specific usage of people and space. Account enterprise/campus carbon emissions accurately, build an energy and carbon management platform with good data transparency and granularity and a comprehensive digital platform for the campus.

3.1.3 Intelligent and zero-carbon campus buildings

- **Smart buildings:** Explore the value of data through a one-stop building self-control IoT platform, combined with BIM and AI technologies, learn from changes in the environment and user needs, intelligently adjust the building' s power distribution, HVAC, elevator, lighting, security, and other systems, monitor and manage energy consumption, optimize office and commercial space, meet the three major needs of comfort and security, asset and energy efficiency, space, and user efficiency.
- **Zero-carbon buildings:** Implement low-carbon design concepts in new and renovated buildings, popularizing the use of low-carbon building materials, strengthen the recycling and reuse of construction waste, complement the design of low-carbon intelligent HVAC mechanical and electrical systems, introduce distributed energy, and then achieve the goal of zero-carbon buildings through supplementary procurement of green electricity.

3.2 Smart Campus – Siemens and University of Birmingham

The University of Birmingham campus covers 272 hectares and over 200 buildings of various ages for 8,000 staff and 38,000 students. The University aims to achieve net zero carbon by 2050 at the latest and has already reduced its joint campus carbon footprint by 20% through a comprehensive partnership with Siemens, as well as being the first campus in the world to have applied smart IoT technology on a large scale.

Figure 3 University of Birmingham Smart Campus

To accelerate the achievement of the zero-carbon goal, a large number of technologies in the fields of renewable energy, IoT and big data, smart transportation, and smart building technologies are applied to the campus, such as 23,000 IoT sensors, deployment of smart building management systems and energy management software, and installation of thermostatic radiator valves in the UK and Dubai. The whole system can adjust the lighting system, and HVAC system, and balance air conditioning and temperature requirements according to the building occupancy and environmental changes to achieve harmony of comfort, efficiency, resilience, and security. In addition, as all types of real-time data from campus buildings, various infrastructure, transportation, and energy centers are fed into the campus' digital twin system, various new solutions for improving energy efficiency can be developed and quickly tested in a virtual environment, helping the university explore new patterns of space use, adjusting energy demand and energy production.

Siemens and the University of Birmingham have worked together to create an integrated energy system for the campus that can adapt to changing needs and help it reduce carbon emissions sustainably and dynamically, drawing on a range of initiatives including digital technology, artificial intelligence, distributed new energy production and storage, and changing customer behavior patterns. Siemens will also provide a total of 10 years of integrated energy and IoT services to ensure that the university receives the full potential of its technology and industry expertise to help it achieve its carbon neutrality goal.

3.3 Changshu High-tech Zone MOBO Coordinated Innovation Industrial Park

Figure 4 Changshu High-tech Zone MOBO Coordinated Innovation Industrial Park

Changshu High-tech Zone MOBO Coordinated Innovation Industrial Park is a modern industrial campus integrating high-end advanced equipment manufacturing and electronic information business. Siemens and Xilanhua Digital Technology (Suzhou) Co., Ltd. worked together to create a new round of investment heights for the clustering of intelligent manufacturing and information business industries. The campus is the first pilot campus and demonstration base for the transformation of the old industrial area in Changshu High-tech Zone, Suzhou, reflecting “high starting point planning, high standard planning, high-quality construction, and high-level management”. The campus has a construction area of 180,000 square meters, including high-grade comprehensive office buildings, high-quality integrated workshops, high-standard talent apartments, and living facilities.

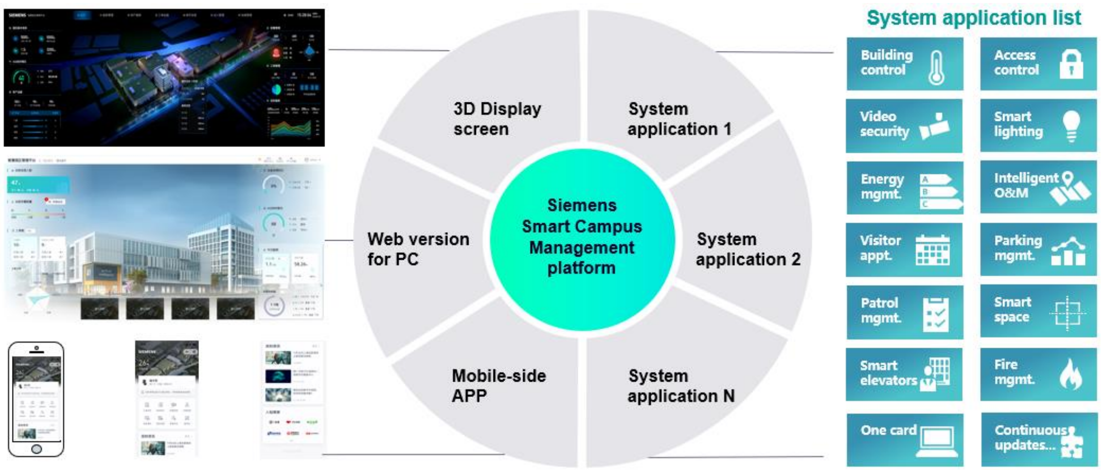


Figure 5 Campus system applications overview

- **Project construction content:** Adopt Siemens building automation, intelligent lighting, room automation of office building sample floors, energy management, dormitory control, security access control, intelligent IoT Enlighted space management demonstration system, and low-carbon intelligent campus digital platform.
- **Solution:** Realize the monitoring and management of the flow of people from the perspective of optimizing the allocation of resources and realize big data analysis to record the campus' energy consumption using digitalized energy supply and distribution infrastructure. Integrate various interfaces such as carbon verification, carbon footprint, carbon trading, etc., the all-powerful data center serves as the central brain of the campus, effectively cope with the massive data brought by the digital infrastructure, and realize the data value through it, realize the big goal of low-carbon smart campus and empower the campus enterprises to upgrade their industries and achieve smart manufacturing and leapfrog development.

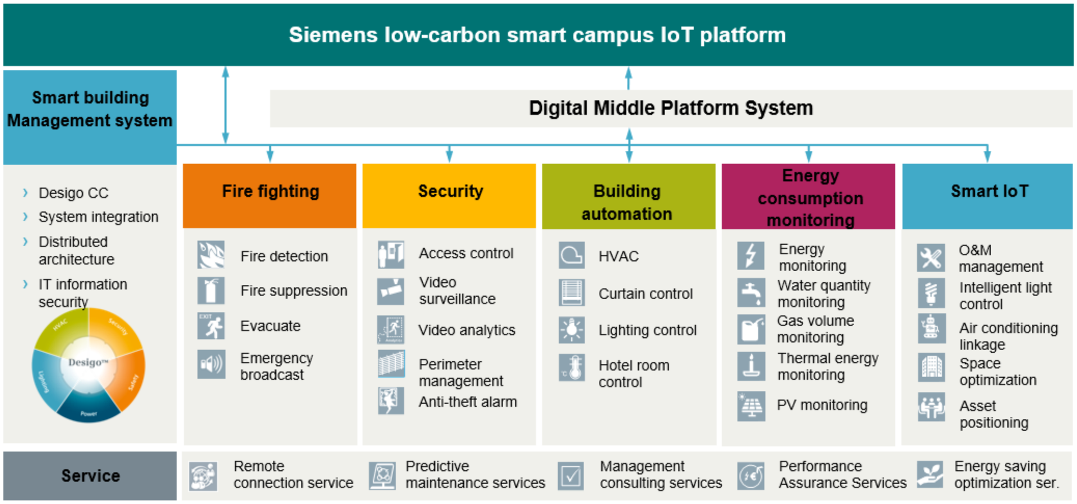


Figure 6 Low-carbon intelligent digital platform architecture of the campus

3.4 Shanghai Pudong Lianmin Village Multi-energy Complementary Project:

Lianmin Village is in Pudong, Shanghai. Siemens has turned Shanghai Lianmin Village into the "first smart energy village" and provided an integrated solution from planning and consulting to the core energy management platform. The energy management platform integrates artificial intelligence and other technologies to intelligently manage photovoltaic, wind power, geothermal, energy storage, and integrated energy supply, coordinate supply and demand, optimize the operation, and achieve maximum benefits. With the comprehensive multi-energy complementary solution, the energy consumption of Lianmin Village is expected to be reduced by 10%, and carbon emission is expected to be reduced by 50%.


Figure 7 Shanghai Pudong Lianmin Village

4. Policy Recommendations

China has formulated many policy documents and supporting incentives to promote the construction of a zero-carbon campus. However, most campuses around the world are still on the road of transformation from traditional campuses to low-carbon smart campuses, and a series of developments and iterations are still needed to achieve the goal of zero-carbon smart campuses, for which we have the following suggestions.

Guide the top-level design of the zero-carbon wisdom campus, and improve the relevant regulations and technical realization roadmap. The top-level design of a zero-carbon smart campus determines the height and the boundary of the planning, which can effectively clarify the construction ideas of the campus, support the construction of the campus in terms of systems and standards, improve relevant regulations and the technical realization path, and meet the demand of the campus development ahead of time. From the perspective of decarbonization, it should include energy transformation and multi-energy complementation, energy saving and efficiency enhancement of industrial equipment, clean energy transportation development, green energy-saving building construction, carbon elimination, and carbon offset, etc. From the digitalization perspective, it should consider multiple layers: campus infrastructure, intelligent sensor, supporting platform, smart supplication, and integrated management, etc.[12]. Issue relevant encouragement policies and guide various market participants to enhance digitalization capability and energy use efficiency and build a new ecology of recyclable and sustainable campuses.

[12] Research on the Standardization of Smart Community Construction

Promote the pilot operation of a zero-carbon smart campus and accelerate the implementation of demonstration zone projects. Under the influence of these factors, most domestic zero-carbon smart campus construction is still in the exploration stage due to the large investment, extensive departments involved, long construction and operation cycles, and high resource attribute requirements. The government should take the lead in promoting pilot demonstrations by combining the construction goals of a zero-carbon smart campus and local resource conditions. At present, Shanghai, Shenzhen, Jiangsu, and other provinces and municipalities have been carrying out the construction of near-zero carbon emission campus demonstration projects, and the construction of these demonstration projects can not only play an exemplary leading role but also have a positive effect on the accumulation of practical experience. Therefore, the national and local governments should give strong support to the management system, industrial development, investment attraction, technology support, infrastructure, financial and taxation guarantee, and government services, etc., and at the same time, provide corresponding subsidies or incentives to encourage the demonstration projects to land[13].

Promote distributed energy technology innovation and development, and build a new energy system with renewable energy as the core. The zero-carbon campus should adhere to ecological priority, green development, and diversified guarantee, continuously propel renewable energy substitution actions, and promote the continuous provision of renewable energy supply ratio in the campus. Build a highly resilient energy network with diversified integration, high carrying capacity, high interaction, high self-healing, and high efficiency, enhance the campus' renewable energy consumption capacity, and improve the campus' load elasticity. Actively promote the development of energy generation, distribution, load, and storage, virtual power plant, and other technologies to encourage local development and local consumption of renewable energy. Encourage international market players to participate in the construction of the campus' energy system, and actively use various investment and financing methods including green investment funds and carbon-neutral industrial funds to guarantee the construction of a zero-carbon campus and continuous financial support.

Encourage digital technology innovation and development, and provide support carriers for zero-carbon wisdom campus. Building a smart campus is an important engine to promote the efficient development of the campus in the digital era, and the smartization of the zero-carbon campus is the way to build a green and digital ecology of the campus. According to statistics, the percentage of smart campuses in national high-tech zones is only about 35%, and the smartization

[13] GLP – 2022 Zero Carbon Campus Practice White Paper

penetration rate of industrial campuses has much room for improvement[14]. In terms of regional distribution, the problem is that high-quality campuses are unbalanced across regions. According to the Top 100 Research Report on High-Quality Development of 2022 Campus, based on the division of the four major regions, the eastern region has the largest proportion of high-quality campuses, with more than 50%, taking the absolute leadership position[15]. The campus lacks data governance in terms of digitalization, and there are problems of rough management and passive services; meanwhile, the information on energy resources is scattered, resulting in low utilization efficiency of the campus' energy and resource and affecting low-carbon green development and efficient management. For example, relying on digital technologies such as the Internet of Things technology and artificial intelligence to realize the campus' energy and carbon management platform, which is the basic information service facility for the campus, is a direct manifestation of the campus' s basic services and industrial service applications, an important carrier of energy and carbon emission data and related information interchange and exchange, and key support for carrying out the campus' s zero-carbon transformation and collaborative use of resources and building the campus' s green resource interaction network. We should actively promote the deep integration of digital technology and the real economy in the campus, construct the digital advantage of the campus development, create balanced development of the campus among regions, and support the transfer demand of industries among regions.

[14] Foresight Industry Research Institute - 2022 China Smart Campus Development White Paper

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