DOI 10.15302/J-SSCAE-2021.01.007

Promoting the Construction of Xiongan New Area Through Energy Revolution: General Idea and Implementation Route

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Abstract: An analysis model framework was established for determining the energy revolution requirements during the planning and construction of the Xiongan New Area. This framework was based on the strategic background, positioning, and objectives of the planning and construction of this area. It was found that the energy revolution can support the construction of the Xiongan New Area. Specifically, the energy technological revolution is able to support the Xiongan New Area as a global energy innovation center. The energy operation mode of this area may be reformed through innovations in the energy system, while the planning and construction requirements of the Xiongan New Area may be addressed with the energy consumption revolution. Ultimately, a safe and efficient energy supply system may be secured through energy supply revolution. An energy revolution will create an urban energy supply system that is green, safe, efficient, smart-friendly, and innovative in the Xiongan New Area. This revolution may be implemented by carrying out projects pertaining to integrated energy operation systems, energy internet, green and smart transportation systems, ultra-low-energy buildings, energy saving, and emissions reduction.
Keywords: energy revolution; demand analysis; Xiongan New Area; planning and construction

1 Introduction

The Fifth Plenary Session of the 19th Central Committee proposed the construction of the Xiongan New Area in line with recent scientific and technological innovations centered around an energy revolution. The construction of the Xiongan New Area must meet national and international standards, as this proposal is considered a historic component of the millennium plan for China. The Xiongan New Area is intended to function as a national model for energy revolution, being characterized by high-quality development, a modern economy, a new green and smart city, high-tech industries, high-quality public services, and a rapid and efficient transportation network. It also is a place for showcasing system and mechanism reforms, while opening up to the global society. The strategic positioning and functional goals of the planning and construction of the Xiongan New Area are related to the direction, key projects, and related policies underpinning the new global energy revolution.

The Xiongan New Area Energy Development Planning research team have created a physical demonstration and virtual environment in terms of the infrastructure and institutional environment of this area [1]; this can help explore the construction of a zero-carbon, smart, and green energy system [2]. The findings of this research are reflected in the *Master Plan of Hebei Xiongan New Area (2018–2035)*. Other researchers have also provided insights into the use of green buildings [3] and public energy supply systems [4]. The Xiongan New Area has also been evaluated as a case study; studies have proposed measures for the optimization of the energy system [5] and discussed the expansion of Xiongan as a first step toward the low-carbon coordinated development of the Beijing–Tianjin–Hebei region [6]. The *Hebei Xiongan New Area Planning Outline* proposes the creation of a modern energy system utilizing green, low-carbon, safe, efficient, and smart processes, which support the

Received date: November 08, 2020; **Revised date:** December 23, 2020
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Funding program: CAE Advisory Project "Promoting the Revolution of Energy Production and Consumption (2035)—Energy Revolution Promotes Economic and Social Development and Ecological Environment Protection" (2018-ZD-11)

Chinese version: Strategic Study of CAE 2021, 23(1): 032–041

Cited item: Ma Lianxiang et al. Promoting the Construction of Xiongan New Area Through Energy Revolution: General Idea and Implementation Route. *Strategic Study of CAE*, https://doi.org/10.15302/J-SSCAE-2021.01.007

implementation of the national energy revolution strategy. This article analyzes the strategic demand for an energy revolution during the planning and construction of the Xiongan New Area. It proposes pathways and key projects to promote the energy revolution and realize the positive role of the National Energy Think Tank.

2 Theoretical analysis and research design

The need for an energy revolution is driven by two key requirements: (1) to improve the level of energy supply services while overcoming various supply constraints; and (2) to change the overall approach to implement energy planning. The first requirement is related to the achievement of functional goals and strategic objectives within restrictive conditions. The second requirement is associated with circumventing the shortcomings of a passive approach for energy planning. This is driven by demand-related constraints and fails to reflect the leading role of energy revolution in economic and social innovations. Therefore, it is necessary to change the role of energy revolution from a passive protection function to a more proactive initiative that drives innovation.

Promoting the energy revolution during the construction of Xiongan New Area begins with selecting pathways and projects, followed by strategic positioning and collaborative innovation. Based on an analysis of the urban energy system and modern urban functions, this research considers the strategic background, positioning, and target tasks of the Xiongan New Area; particularly in terms of functional, non-functional, and restrictive requirements. The strategic demand for an energy revolution in the Xiongan New Area was analyzed by applying the KANO model and the Five Whys analysis method.

3 Analysis of the strategic demand for energy revolution during the construction of the Xiongan New Area

3.1 Strategic objectives of the Xiongan New Area

The Central Committee of the Communist Party of China and the State Council stipulated the strategic objectives of the Xiongan New Area in response to the *Hebei Xiongan New Area Planning Outline* (April 14, 2018) and the *Master Plan of Hebei Xiongan New Area (2018–2035)* (December 25, 2018)). These objectives include: (1) planning a reasonable and scientific spatial layout; (2) creating a new era of urban style; (3) constructing a beautiful natural environment; (4) developing high-tech industries; (5) providing high-quality shared public services; (6) building a rapid and efficient transportation network (7) constructing a green and smart new city; and (8) building a modern city security system to ensure orderly and effective plan implementation (Fig. 1).

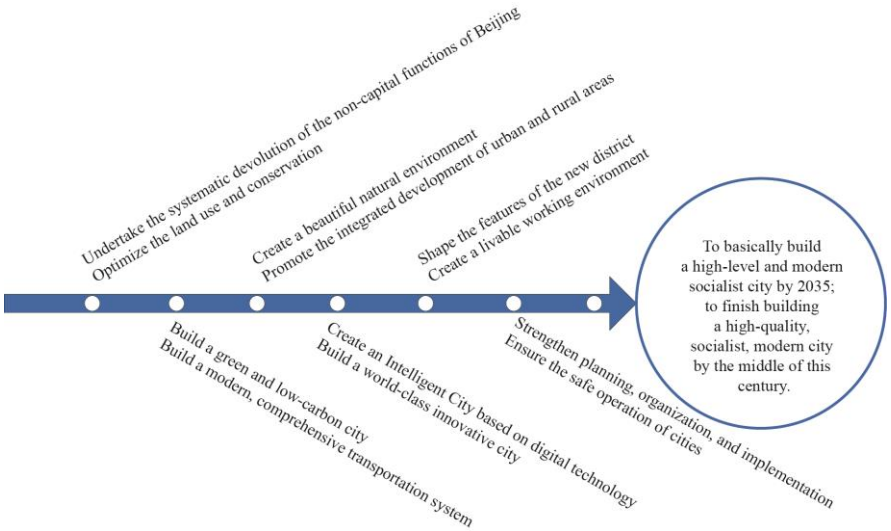

Fig. 1. Strategic objectives of the Xiongan New Area.

3.2 Framework to analyze the demand for an energy revolution during the construction of Xiongan New Area

Tables 1 and 2 present the logical relationship between the construction of the Xiongan New Area and the demand for an energy revolution. Fig. 2 illustrates the demand for an energy revolution in relation to Maslow's hierarchy of needs.

The demand for an energy revolution during the construction of the Xiongan New Area involves various aspects such as economy, society, and the natural environment. The construction of the Xiongan New Area aims to provide a modern energy system that is green, low-carbon emitting, smart, efficient, safe, and reliable in line with advances in energy supply. Fig. 3

DOI 10.15302/J-SSCAE-2021.01.007

identifies the key areas and implementation paths that are based on aligning the construction of the Xiongan New Area with the needs of an energy revolution.

Table 1. Framework for the demand of an energy revolution in the Xiongan New Area.

National strategic mission	Innovation side cluster	Energy innovation system construction	Actively lead	Scientific and technological revolution
Functional level	Basic needs	Energy revolution content	Energy revolution path	Energy revolution mission
Regional development goals	Management change	Energy operating model reform	Active revolution	Management system revolution
Natural constraints	Demand-side constraints	Energy use pattern changes	Active adaptation	Energy consumption revolution
Basic function guarantee	Supply-side guarantee	High-quality energy supply	Active guarantee	Energy supply revolution

Table 2. Analysis of the relationship between the four actives and an energy revolution.

Four actives	Production revolution	Consumer revolution	Technological revolution	Institutional revolution	Global cooperation
Active guidance	◎	◎	●	○	●
Active revolution	◎	◎	○	●	○
Active adaptation	◎	●	◎	○	○
Active guarantee	●	◎	◎	○	○

Note: ○Weak association ◎Medium association ●Strong association

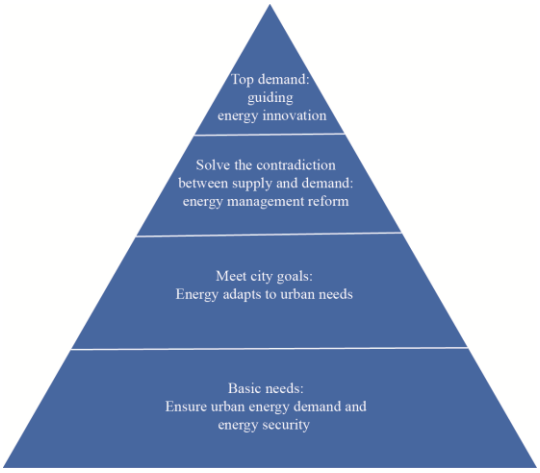

Fig. 2. Hierarchical structure of urban functions for energy demand.

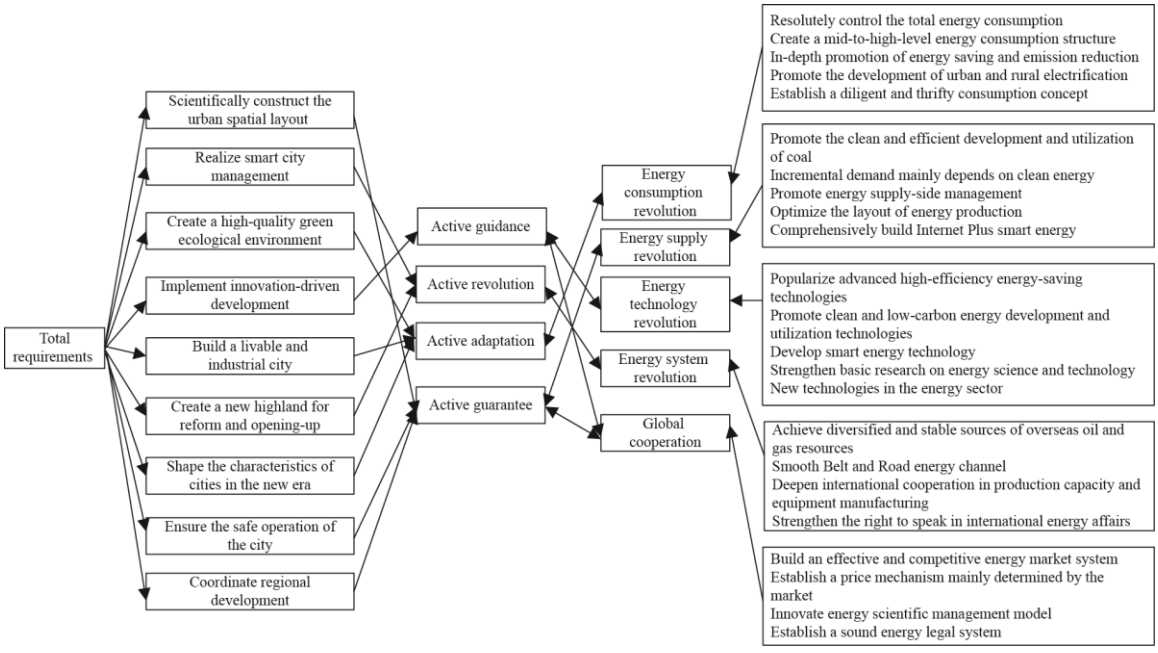

Fig. 3. Key aspects and implementation paths of an energy revolution in the Xiongan New Area.

4 Energy revolution pathways

4.1 Development of a global energy technology innovation center

First, a Xiongan National Science Center is required. In line with the national strategy and relying on the key energy research institutions in Beijing, the construction of major scientific and technological energy infrastructure should be accelerated. Additionally, there is a need to establish large scientific installations for energy Internet, ultra-strong and ultra-short lasers, and national fusion energy devices. An international innovation center should be built that collaborates with energy research institutions in the Chinese Academy of Sciences, central energy enterprises, and universities. The center will focus on frontier physics, the clean and efficient use of traditional fossil fuel energy, the large-scale development and utilization of new energy, the safe use of nuclear energy, energy Internet, equipment for large-scale energy storage, advanced energy equipment, and key materials. This initiative will form a cluster of energy research institutes with an international influence; Fig. 4 shows the model for the Xiongan Global Energy Technology Innovation Center.

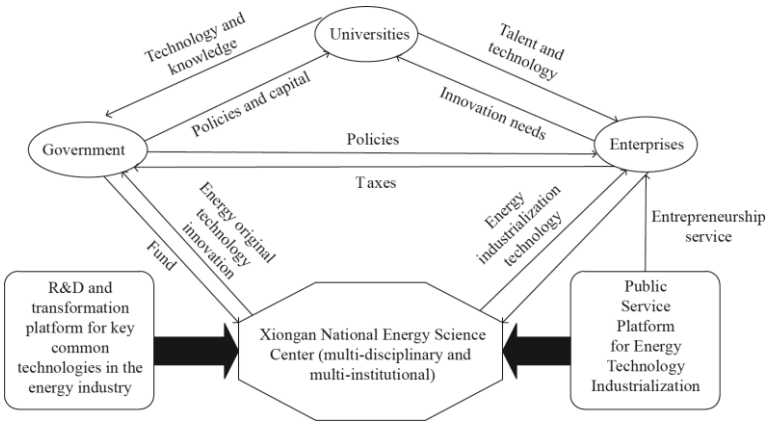

Fig. 4. Model for the Xiongan Global Energy Technology Innovation Center.

Second, a platform for the research and development (R&D), and the transformation of key common technologies in the energy sector needs to be established. To promote the use of green energy and create a low carbon economy, several open innovation platforms will be established in renewable energy, hydrogen energy, nuclear fusion, and smart energy fields [7]. The platform will also aim to overcome obstacles to the development of key common technologies, and support strategic emerging industries to achieve leapfrog development [8]. Technology transfer institutions such as the International Technology Transfer Center, International Technology Import and Export Promotion Center, and Intellectual Property Protection Center will be developed to promote energy technology standards that will be competitive in the international energy market.

Third, an energy technology innovation and entrepreneurship system is also necessary; this consists of a public service platform for energy technology industrialization to improve the innovation service system. Specifically, beginning with the construction of an open and convenient makerspace, incubator carriers will be created based on the makerspace–incubator–accelerator process. The carriers would include innovative elements, distinctive industrial characteristics, prominent service functions, and a strong radiation role [9]; the incubation outputs will be transferred to surrounding industrial parks.

4.2 Innovations in the energy operation mode of the Xiongan New Area

To establish a national model for high-quality development, the Xiongan New Area should implement new development concepts and innovation demonstration zones. This would focus on innovating urban energy management systems, thereby promoting changes in energy operation models and providing high-quality energy supply [10].

4.2.1 Building a decentralized, multi-center, and networked energy supply model

The Xiongan New Area requires a modern energy system that promotes the use of renewable energy in the mainstream power sector, and facilitates decentralized supply. This can stimulate the active role of microgrids in the overall power grid and realize digitization, informatization, and intelligence in various energy subsystems. The energy supply mode must transform from a traditional, large-scale, centralized fossil fuel energy supply to a decentralized, diversified, clean, and green energy supply. The Xiongan New Area can benefit from clean energy (e.g., geothermal energy), and as such, a diversified clean and green energy supply system can be established [11]. This system would import clean power and allow for local and decentralized renewable power generation using sources such as geothermal energy or urban waste heat. Furthermore, the

DOI 10.15302/J-SSCAE-2021.01.007

Xiongan New Area should combine the long-distance and large-scale transmission of electric energy with the on-site balance of distributed energy and load. This means that the energy and load on-site balance dominates the energy configuration of the area. Finally, the Xiongan New Area allows for a decentralized, multi-center, and networked energy system architecture that is composed of multiple levels such as point, station, and source. An information network is used for efficient integration, and coordinated and optimized deployment, and to establish a collaborative and efficient "1+*N*" energy supply network in the Xiongan New Area.

4.2.2 Creating an integrated and complementary source–network–load–storage smart energy Internet operation mode

An integrated and complementary source–network–load–storage smart energy operation mode is required, where horizontal multi-energy complementation, and vertical coordinated optimization of the source–network–load–storage is realized. In terms of function, this would allow multi-energy coordination, source-network-load-storage coordination, centralized and distributed coordination, and the integration of flows in energy (i.e., electricity, gas, heat, and water), traffic, information, and capital. Based on the needs of end-users, various types of renewable and fossil fuel energies in the region may be converted into different types and grades of power supply. This would lead to a clean energy cycle and an orderly configuration of multiple energy sources, and aims to realize multi-energy system integration and optimization, dynamic and balanced control of energy supply and demand, and integrated management of multi-user group information. In doing this, the Xiongan New Area can accomplish networked and dynamic management of multiple user groups, multiple energy systems, and multiple dimensions for distributed energies.

4.2.3 Building a smart energy comprehensive service system based on energy big data

By integrating energy suppliers, optimal energy system solutions to satisfy the diverse needs of users can be provided in the Xiongan New Area. Through integrated management, overall scheduling, and the optimization of the energy system, end-users are provided with a trading platform to participate in the energy market for balancing supply and demand. Users make independent decisions related to energy consumption (including energy saving), production, storage, and transactions. These decisions are based on the spatio-temporal distribution of energy production and consumption to achieve a dynamic balance of energy supply and demand.

4.3 Adapting to the planning and construction targets of the Xiongan New Area

Aligning with the national model target for high-quality development and the establishment of a green, livable, and coordinated development demonstration zone, the Xiongan New Area should actively adapt to the natural and geographic characteristics of its natural environment. This would create a global energy sustainability model that is green and low-carbon [12], and build a livable city that exists in harmony with its surrounding natural environment.

4.3.1 Building a green and low-carbon model city

The industrial structure evolves in relation to the energy consumption structure. A range of industries should be vigorously developed in the Xiongan New Area including modern life sciences and biotechnology, new material, information technology, high-end modern service industries, and green agriculture [13]. It is necessary to implement green standards, sustainable natural resource management, and environmentally friendly and intelligent manufacturing to establish a green and low-carbon energy consumption mechanism.

Second, a green and smart transportation system should be planned and developed. In the Xiongan New Area, data process integration is essential to adapt to the needs of various application scenarios. At the same time, the transportation system should be supported by related technologies such as Internet of Things (IoT) sensing, artificial intelligence, and mobile Internet. This will create a new intelligent transportation system with instantaneous perception, real-time response, and intelligent decision-making. With the integration of the transportation, information, and energy networks, new types of transportation tools (e.g., smart cars) can allow the intelligent coordination of vehicles and roads and realize an integrated intelligent transportation system for the Xiongan New Area.

Third, a low-carbon, high-quality energy infrastructure is required; currently, energy management and control centers are used in the Xiongan New Area to promote the utilization of ground-source heat pumps, distributed photovoltaic power generation, and solar heating. During operation, the intelligent collection of energy consumption data should be encouraged, and household energy management systems or software should be promoted to accelerate the construction of household energy information systems.

Finally, a simple, moderate, green, and low-carbon lifestyle is advocated. There should be a transition from the traditional high-carbon to a low-carbon lifestyle in relation to clothing, food, housing, transportation, and energy use. This may be achieved by advocating for green low-carbon travel, improving the convenience of walking to community facilities, and encouraging

residents to adopt low-carbon travel options such as walking, cycling, carpooling, ride-sharing, and public transportation.

4.3.2 Building a green and low-carbon society

Clean energy substitution projects need to be implemented; this includes the implementation of alternative green power supply projects in the Xiongan New Area. Specifically, using the existing ultra-high voltage (UHV) grid in central and southern Hebei, the regional grid system may be improved to fully integrate the wind power and photovoltaic energy generated in northern Hebei, Inner Mongolia, and other northern regions. In this way, a cross-regional, long-distance, large-capacity power transmission system may be built along with a power supply method that imports clean energy to support local and decentralized renewable energy generation. Multi-source, multi-level, and diverse urban and rural gas supply systems may be established in the Xiongan New Area; these systems should rely on the main national gas source channels and gas source points. Local geothermal, urban waste heat, and surrounding heat sources may be utilized in the area during the short-term, while implementing hydrogen energy replacement projects in the medium and long terms [14].

A near-zero emission demonstration zone is also required in the Xiongan New area; this would include the utilization of various low-carbon technologies in construction, transportation, energy, and industry to achieve carbon neutrality, thereby increasing forest carbon sinks and carbon trading [15]. A monitoring and management system for carbon emissions should be established in the Xiongan New Area to demonstrate how regional carbon emissions can approach zero [1].

A circular economy should be incorporated through the establishment of a circular and renewable urban development model, a 100% renewable energy plan, and the elimination of barriers to establish a green circular city [16].

4.4 Energy supply revolution guarantees the energy lifeline of the Xiongan New Area

In line with the mission of achieving smart city management in Xiongan New Area, it is necessary to build an urban safety and emergency disaster prevention system, and to improve the energy security level. As such, a green, low-carbon, efficient, safe, friendly, and intelligent modern urban energy supply system should be established to actively ensure the sustainable, stable, and safe operation of the urban energy system.

4.4.1 Building a demonstration model for future urban energy system operation

A comprehensive energy supply system is required in the Xiongan New Area. This can integrate information infrastructure related to urban energy systems, such as power supply, gas supply, heating, cooling, hydrogen supply, and transportation [17]. Multi-energy flow hybrid modeling can be used to incorporate multi-energy system planning, energy conversion technology, intelligent regulation, coordinated control, comprehensive evaluation [18], system information security and communication, energy trading, and business service operation models. An analysis of the Xiongan energy guarantee is shown in Fig. 5.

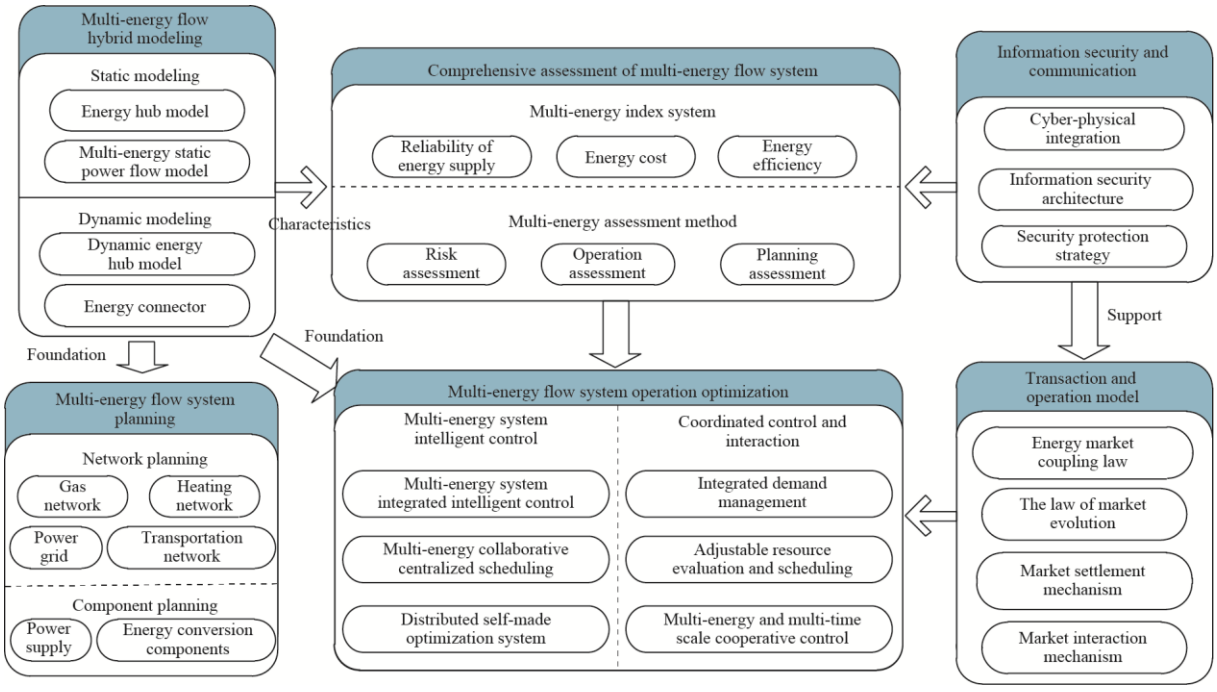

Fig. 5. Analysis of Xiongan energy guarantee.

DOI 10.15302/J-SSCAE-2021.01.007

A complex multi-network flow energy supply management system is also necessary in the Xiongan New Area. This may be established using a complex multi-network flow system formed by the close coupling of natural gas networks, transportation networks, and other systems [19]. Here, the power system functions as the core, other cutting-edge information technology (including the Internet) acts as the basis, and distributed renewable energy is the primary energy source.

Finally, the construction of the energy Internet is accelerated. Through the use of distributed energy storage devices to connect gas, electricity, and heat networks, a smart energy network with a two-way circulation of information and energy, as well as energy exchange and sharing may be realized in the Xiongan New Area. This will give full play to the complementary characteristics of energy, improve the utilization efficiency of terminal energy through energy cascade utilization, and improve the utilization efficiency of energy production and transmission facilities. The latter may be achieved through basic demand-side responses such as big data and wide-area information platforms.

4.4.2 Building a demonstration model for smart energy in future cities

A smart energy system is required in the Xiongan New Area; this system should form a "coupling of low-carbon technology and information technology." This will form a comprehensive solution that relates to all aspects of energy production, distribution, supply, and use.

An intelligent urban energy operation management platform is also required. Based on the existing power grid facilities, the Xiongan New Area may be closely linked with other subsystems to realize the functions of data interchange, energy dispatching, energy trading, application interface, collection, and display. Additionally, the source–network–load–storage may allow the realization of all-round coverage and safe and reliable transmission. Relying on a massive data resource pool, the functions of data sharing and centralized display may be carried out, and subsequently, the optimal scheduling of energy can be achieved according to artificial intelligence and related big data analysis.

4.4.3 Building an intelligent urban energy security operation system

There is a need to establish infrastructure with energy security as its core. To improve the overall resilience level of urban energy and build a green, low-carbon, safe, efficient, and smart energy system with balanced supply and demand, the adaptability of the energy system in the Xiongan New Area needs to be enhanced. The plan proposes a strategy for controlling network fluctuations, randomness, and risk. This also comprehensively considers the clustering, corresponding characteristics, conversion between alternative energy sources, role of energy storage in balancing the spatio-temporal differences of energy sources, and the unified regulation of multiple energy sources.

A sub-platform of municipal public service facilities with interactive management will also be required. The operation of other subsystems in the Xiongan New Area may be supported by the relationship between the energy load characteristics and users. This includes the assistance of abnormal load characteristics for urban disaster prevention systems and emergency systems. Planning should ensure the priority of energy use in urban areas; if a subsystem fails, the energy system may be centrally scheduled to achieve priority protection in the fault area.

5 Key projects for an energy revolution to promote the construction of the Xiongan New Area

5.1 Energy comprehensive operation system engineering

The integrated energy operation system mainly includes the source, storage, network, sale, use, and cloud business sectors. Specifically, sources include oil, electricity, and natural gas, as well as clean energy sources, such as solar, wind, geothermal, and biomass. Storage refers to energy storage systems, including heat storage, cold storage, and electricity storage systems and facilities. Network mainly refers to the micro-grid, heating, and natural gas networks. Sale mainly refers to providing users with personalized energy service plans and comprehensive energy transactions. Use essentially means the continuous optimization of the energy use experience by improving the service quality of energy storage and distributed energy, and satisfying the individualized energy needs of users. Cloud mainly refers to the construction of a source–storage–network–sale–use–cloud coordinated control system with the help of an integrated management and control platform, such as the Internet and big data.

5.2 Energy Internet project

5.2.1 Multi-energy complementary integration optimization demonstration project

Energy Internet projects can use energy and information technology to efficiently integrate the energy grid, IoT, and Internet, while combining distributed natural gas cogeneration and multiple renewable energy sources to form a modern energy system solution. We applied a multi-energy complementary integrated energy model. A multi-dimensional information model covering real-time operating data, such as distribution networks, multiple distributed energy sources, user energy consumption

characteristics, and energy demand was established. This model may be used to build a comprehensive energy control and service platform for multi-information interaction. The platform comprises complete functional modules, including consulting, monitoring, training, personalized design, diagnosis, and custodial transactions of energy consumption. It can carry out comprehensive transactions for various energy types (e.g., cooling, heating, and electricity) and storages to build a multi-energy complementary energy system market-oriented operation model. This model can consider the win-win cooperation of multiple entities, such as energy suppliers, power distribution companies, multiple users, and park management committees.

Subsequently, a new model of ubiquitous energy microgrid power supply was applied. The energy internet project incorporates all cold, heat, and electricity-related users and effective energy storage facilities in the Xiongan New Area for the unified management of the regional energy network. The energy sources largely include pipeline gas, electricity purchased from large grids, general energy stations, and distributed photovoltaic power supply/heat energy. It is supplemented by energy storage power stations, cold/heat storage systems, and electric vehicles during idle periods.

5.2.2 Smart energy construction demonstration project

Smart heating is an example of a smart energy construction project. In the future, the multi-heat source networked urban pipe network system of the Xiongan New Area may not be able to meet the requirements of source and network optimization by relying on traditional manual adjustment and control. Precise heating and heating on demand would be required, alongside energy saving and the energy consumption reduction for heating systems. This requires the construction of a data information system covering the heat source, primary heating networks, heating stations, secondary heating networks, and heating users. It also requires an intelligent heating optimization system. Smart heating and energy-saving technology, based on data collection and remote monitoring of heating sources, heating pipe networks, heating stations, and heating users, will be the direction of smart heating development in Xiongan New Area.

Smart gas supply is another example of a smart energy construction project. To meet the future energy needs of the Xiongan New Area, a smart gas supply system should be constructed using the cloud, pipe, and end system architecture. The specific plan includes the terminal layer, network layer, cloud platform, and gas application layer, and supports the development and listing of smart gas supply applications with the help of IoT, cloud computing, and big data. Through online monitoring equipment such as data acquisition instruments, pipe pressure, and pipe network dispatching, the system can monitor the operational status of the city gas system in real time. The program can integrate gas management departments and gas facilities to form a city gas IoT.

Smart power supply is the third factor in the smart energy construction project. The smart power supply in Xiongan New Area is based on renewable energy, the integration of scattered energy collection points, and integration and distribution through smart grids. This maximizes the effective use of energy and realizes the reliability, safety, economy, and efficiency of the grid, while maintaining efficient and sustainable economic development.

5.3 Green and smart transportation system construction project

This project involves the development of a safe, convenient, efficient, green, and intelligent transportation system. This system will enable the smooth transfer and seamless connection of various transportation modes, and the execution of intelligent management and integrated services of the Beijing–Tianjin–Hebei transportation network.

5.3.1 Building a convenient and efficient urban transportation system

Based on the networking, intensive, and multi-mode principles, the core and periphery areas will be considered as the primary part in the layout of the rail transit network, and the convenient connection between the starting area and the peripheral town clusters will be established. This rail transit system will be guided by the construction phases, population scale, and transportation needs. Effective control should be increased over planning and space be reserved for urban and regional rail transit corridors. Medium- and low-volume rail transit systems should be designed to connect large-volume rail transit.

There is a need to create a backbone road network in the new area with complete functions. The plan is to transform the original road network into an urban expressway, forming a rapid passage between the point of origin and neighboring cities and counties to create a backbone road network with full coverage and a network layout. In addition, a dedicated bus rapid transit channel is planned to improve the efficiency of the public transportation system and provide intelligent high-quality public transportation and logistics distribution services. This also includes a two-level urban and rural regional public logistics distribution facility composed of allocating centers and community distribution centers, and an intelligent, intensive, and shared logistics system.

Building a green network that is internally and externally connected is also necessary. To do this, a three-level network of regional, urban, and community greenways, is planned to run through various parks, forming a regional greenway system that integrates urban and rural areas and interlocks regions. To create a comfortable and independent greenway environment, a slow

DOI 10.15302/J-SSCAE-2021.01.007

road system suitable for cycling and walking will be designed. This system is isolated from the motor vehicles to allow for leisure, fitness, and entertainment, and for group, cultural, and sporting activities.

5.3.2 Planning and building an intelligent transportation system

There is a need to improve the level of traffic intelligence across all aspects. This necessitates the simultaneous implementation of hardware, software, terminal, and network construction to promote the interconnection of roads, vehicles, and control systems. It is proposed that to build a customized public transportation system based on demand, we must actively promote new energy vehicles and other transportation tools. We must also explore the creation of intelligent driving and logistics systems [20]. There is a need to establish a data-driven intelligent collaborative management and control system, together with the development of a network that jointly controls intelligent driving vehicles, maintains system operation safety, and improves system operation efficiency.

5.4 Ultra-low energy consumption construction projects

5.4.1 Fully unlocking the energy-saving potential of buildings

To capitalize on the energy-saving potential of buildings requires the implementation of seven key steps: (1) improve the energy-saving standards of buildings in the Xiongan New Area; (2) actively develop green buildings; (3) construct green building evaluation, building materials demonstration, and marking systems; (4) improve building energy-saving standards; (5) promote ultra-low energy consumption buildings; (6) improve the energy efficiency level of new buildings; and (7) increase the proportion of energy-saving buildings.

Additionally, we will accelerate the transformation of energy conservation and heat metering in existing buildings, implement a quota system for energy consumption in public buildings, and implement energy-saving renovations for public buildings in key cities and public welfare buildings (e.g., schools and hospitals). We will also promote the use of green building materials, and vigorously develop pre-fabricated buildings.

5.4.2 Promoting the development and construction of passive housing

To encourage the proliferation of passive housing, energy-saving regulations related to low-energy buildings and passive houses is required. This should go alongside a series of supporting systems, such as the development of auditing systems for building energy consumption, limiting the maximum energy consumption value, calculating the electricity price depending on different levels of consumption, and penalizing waste. The frequency of revising energy-saving standards should be increased and law enforcement should be strengthened. In terms of laws and policies, to enable greater investment in passive houses, planning recommendations may be adapted to provide economic incentives to low-energy buildings that meet specific standards [21]. In terms of equipment parts, the plan proposes increased R&D investment in building energy-saving technologies, products, and related application technologies, while standardizing the building energy-saving market through product energy efficiency evaluation labels and technology and product certification. Regarding the living habits of residents, the plan proposes ventilation and heat recovery circulation systems in residential design. In terms of use and maintenance, special management or lifestyle manuals may be issued to properties and owners. This will elucidate the guiding role of the maintenance and use of passive houses in the future. In terms of energy-saving publicity, the plan proposes to continue to publicize building energy-savings measures and improve the awareness of social responsibility among enterprises dealing with the development, design, construction, and supervision of real estate [22].

5.5 Energy conservation and emission reduction projects

The safety of constructing Xiongan city, a logical space layout, and the efficient use of clean energy will be fully considered, based on prioritizing the planning of underground systems before above ground systems. A three-dimensional spatial big data platform will be established underground in the Xiongan New Area to plan and construct urban aboveground space and underground integrated corridors and complexes, alongside the development of groundwater and clean energy resources. It is necessary to create a digital integrated management service cloud platform for underground exploration and the efficient development and utilization of energy resources.

Promoting energy-saving technologies for green smart home appliances is also planned to advance the development of new thermal insulation materials, reflective wall coatings, high-efficiency energy-saving glass, and green lighting. This will also facilitate the R&D of near-zero energy-consumption buildings and technologies to improve the energy efficiency of existing buildings. The plan also proposes the active promotion of the large-scale application of renewable energy such as solar, geothermal, and air thermal energy in buildings.

To optimize the use of renewable resources, reeds and kitchen waste should be used to produce biomass energy. In Baiyangdian and its surrounding villages and towns, abundant reeds and other plants may be used to produce biomass energy

to meet part of the energy needs of the region. The plan proposes to ensure ecosystem integrity in the new district and stabilize the proportion of blue and green spaces to approximately 70% [23]. The complete use of renewable resources such as garden waste and agricultural straw will effectively address the energy supply problem of some towns. Making full use of related technologies such as high-temperature incineration and water source heat pumps will also allow the achievement of the efficient utilization of resources such as garbage and sewage.

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