Rearch on the Development Strategy of Qinghai Clean Energy Demonstration Province

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Abstract: With the new round of power system reform and the in-depth advancement of "Internet +" smart energy, the Qinghai Provincial Government has issued a series of related policies and studies on the major requirements of General Secretary Xi Jinping to "make Qinghai an important national new energy industry base". The development strategy of Qinghai Province's clean energy demonstration province has become a top priority. This article combines China's new energy consumption kinetic energy, new models and new forms of energy industry development, summarizes the five bottlenecks in the development of Qinghai’s energy sector based on the actual situation in Qinghai Province, and explores the new energy consumption mechanism of Qinghai Province from four aspects combined with examples. It also puts forward five suggestions on energy policies that promote the development of new energy consumption models and new business forms in Qinghai.

1. Introduction

In the face of new changes in the energy supply and demand pattern and new trends in international energy development, China released the "Energy Production and Consumption Revolution" (2016-2030) in 2015 to ensure national energy security, promote the energy revolution, and realize China's energy development transition. In the context of the continuous advancement of the energy revolution in China, China's energy consumption will generate new driving forces and release new kinetic energy. Under the "multiple drivers" of policy, environment, technology and demand, the development of China's energy sector will release new momentum. On the energy consumption side, there are multiple new energy consumption models; on the energy supply side, it is the development of multiple energy industries.

Researchers at home and abroad have achieved certain results in the research of new energy consumption models and new business forms, mainly focusing on virtual power plants [1] and shared energy storage. Literature [2] studied the virtual power plant demonstration projects in developed countries in Europe and China, and concluded that the technical route of European virtual power plants is more suitable for domestic reference, and made reasonable suggestions on the key technologies and development directions of domestic virtual power plants that need attention in the next step. Literature [3] constructed a virtual power plant "wholesale-retail" two-level market
transaction system, and established the coordination and optimization mechanism of virtual power plants through the three dimensions of aggregation, economy, and operation, and measured the economics of the virtual power plant business model. Literature [4] proposed a shared energy storage business operation model for renewable energy consumption, and discussed the application prospects of blockchain technology in shared energy storage transactions under the background of the energy Internet. Literature [5] aimed at minimizing the purchase cost of electricity sales companies, and proposed a method of energy storage optimization and investment benefit analysis methods for electricity sales companies based on the theory of full life cycle under the market mechanism.

In January 2019, the General Office of the People's Government of Qinghai Province issued a notice on the "Work Plan for Qinghai Province to Build a National Clean Energy Demonstration Province (2018-2020)". The overall idea is to "make Qinghai an important national new energy industry base". Focusing on the large-scale development of new energy, aiming at 100% clean energy use, supported by scientific and technological innovation, and secured by the construction of smart grids, we will create a model province for the construction, use and output of clean energy.

The main purpose of this article is to study the development strategy of Qinghai Province's clean energy demonstration province. Combining China's new energy consumption kinetic energy, new models, and new business forms of energy industry development to study the bottleneck of Qinghai's energy sector development based on the actual situation of Qinghai Province. Then explore the new energy consumption mechanism of Qinghai Province, and put forward suggestions on energy policies that promote the development of new energy consumption models and new business forms in Qinghai.

2. New kinetic energy, new models, and new business forms of China's energy consumption development

In the face of new changes in the energy supply and demand pattern and new trends in international energy development, China released the "Energy Production and Consumption Revolution" (2016-2030) in 2015 to ensure national energy security, promote the energy revolution, and realize China's energy development transition. In the context of the continuous advancement of the energy revolution in China, China's energy consumption will generate new driving forces and release new kinetic energy. These include policy driving forces: a new round of power system reform and "Internet +" smart energy; environmental driving forces: green, low-carbon and clean energy consumption; technology driving forces; intelligent energy consumption; demand driving forces and diversification and comfort of energy consumption.

With the profound changes in the global and China's energy supply and demand pattern, and the rapid development of energy technology innovation, energy consumers are no longer satisfied with the basic energy supply under the traditional model, and diversified and differentiated energy demand will be derived. Therefore, new models of energy consumption continue to emerge and develop. The new energy consumption model is an energy consumption model that has been driven by new kinetic energy in the past five years, has developed rapidly in market scale, and is strongly supported by national policies. According to the survey summary, the current new energy consumption models in China mainly include electric energy substitution, new heating, gas-fired cold-heat-electricity trigeneration systems, electric vehicles, microgrids, smart buildings and smart homes, energy Internet (multi-energy complementation), virtual Power plant and many other types.

At the same time, the development of new business forms of the energy industry is a new form that breaks industry barriers and deeply integrates energy production, transmission, storage, consumption and market links with other industries. With the advancement of China's energy production and consumption revolution, new forms of energy industry development continue to emerge and flourish, driving profound changes in energy supply and demand patterns and commercial forms. The development of new business forms of the energy industry is a situation in the energy industry that has been strongly supported by national policies driven by energy consumption in the past five years. According to the research summary, the current development of new business forms of China's energy industry mainly includes integrated energy services, PPP energy investment and financing models,
energy industry investment fund models, third-party cloud service models based on the Internet and energy big data, "energy +" sharing economy system and many other types.

3. The development bottleneck in the energy sector in Qinghai Province

This article analyzes the bottleneck in the development of the energy sector in Qinghai Province from five aspects [6-7].

First, the energy consumption structure is unreasonable. Although Qinghai’s clean energy such as wind and solar has developed rapidly, the installed capacity of wind power has doubled for five consecutive years, and solar power has entered the stage of large-scale development. However, high-quality fossil energy such as oil and natural gas is relatively insufficient, and the proportion of oil and gas and clean energy is low, as shown in Figure 1. Energy consumption is controlled by coal supply. Once coal supply is affected, energy supply will face problems, which is not conducive to the adjustment of energy consumption structure.

![Figure 1. Energy production structure of Qinghai Province in 2018.](image)

Second, the temporal and spatial distribution of energy supply and demand does not match. Qinghai Province has a relatively high proportion of new energy power generation such as wind power and photovoltaics. The power generation is large at the peak of wind and solar energy supply. In order to reduce the load of the large grid, energy has to be abandoned. When the energy supply is low, the power generation is insufficient and it is difficult to meet the electricity demand. At the same time, resources such as wind and solar energy in Qinghai Province are concentrated, but the demand for electricity is small, far away from the load center, and the market has limited absorption capacity, making it difficult to absorb clean energy locally.

Third, various energy systems are not integrated, and industry/regional barriers are severe. It is mainly reflected in the lack of integration of various energy systems, difficulties in implementing multi-energy complementarity, and serious barriers between energy provinces. Qinghai Province is rich in energy resources and still continues the development inertia of large-scale development and more delivery. While demand growth in major energy-consuming regions has slowed down and market space has shrunk, more attention has been paid to the economic and controllability of energy acquisition, and the enthusiasm for receiving energy from outside the region has generally been reduced.

Fourth, the flexibility of new energy regulation is low. Peak shaving capacity is the most fundamental factor that restricts the power system from adopting renewable energy generation, and severely restricts the consumption of new energy. Qinghai Province is a major gathering area for new energy, with a high proportion of heat supply units and lack of power sources with flexible adjustment capabilities. For a long time, the power grid has been difficult to adjust peak loads and cannot
effectively smooth the impact of new energy generation fluctuations on the grid. Especially in winter, when the heating period of coal power units, the dry period of hydropower units, and the period of heavy wind power generation overlap each other, the consumption of new energy is severely restricted.

Fifth, the cost of new energy technologies is high, and there is no reasonable return on investment model. The construction of new energy power generation projects requires a lot of funds. Compared with traditional coal-fired thermal power units, the inherent high cost of new energy power generation such as wind and light still restricts its utilization and development. As shown in Figure 2, taking the mainstream 1.5MW model of a traditional wind turbine as an example, the market price per kilowatt is about 4,000 yuan (excluding the tower). In general, the market price of new energy generator sets is still at a relatively low profit level, and corporate profits still rely on the overall benefits brought by large-scale production.

![Figure 2. 2012-2018 final accounting unit cost of power generation projects.](image)

In September 2016, the National Energy Administration issued the "Notice on the Construction of Solar Thermal Power Demonstration Projects" (Guoneng Xinneng [2016] No. 223). Since then, Qinghai Province has built four demonstration projects. They are China Guangdong Nuclear Power Delingha trough solar thermal power generation project, Supcon Delingha solar thermal power generation project, China Power Construction Gonghe Tower solar thermal power generation project, Yellow River Company Delingha solar thermal power generation project. The total installed capacity is 285,000 kilowatts, with 3 towers and 1 trough. Looking at the four solar thermal power generation demonstration projects in Qinghai Province, there are still some problems after the project construction and expected production and operation. The main manifestations are slow construction progress of some projects and inadequate supporting policies during the construction period.

In summary, the energy development of Qinghai Province not only faces common problems in the current stage of energy development in China, but also faces individual problems arising from the characteristics of energy development in Qinghai Province. For Qinghai Province, exploring the new mechanism of the energy consumption system is a top priority.

### 4. Research on New Mechanism of Energy Consumption System in Qinghai Province

In view of the current problems and bottlenecks in the development and energy consumption of the energy sector in Qinghai Province, this article puts forward four key goals for the future development of the energy sector in Qinghai.

First, adjust the energy supply side structure to increase the high proportion of new energy consumption. Implement structural reforms on the energy supply side, vigorously develop clean energy, promote large-scale and high-proportion new energy consumption and utilization, optimize...
energy supply structure, form a multi-wheel drive, safe and sustainable energy supply system, and achieve green development.

Second, improve comprehensive energy utilization efficiency. Increase the ratio of high-quality energy to alternative energy sources. When formulating energy development plans, highlight the goal of energy structure optimization, reduce coal consumption, to a certain extent, limit coal directly into terminal consumption, and increase the use of clean energy such as electricity. On the energy consumption side, we should vigorously promote advanced energy-saving technologies, improve the end-use energy supervision system, and improve energy efficiency. Vigorously develop smart energy systems on the energy supply side and accelerate the deep integration of the information industry and energy industry.

Third, enhance the flexibility of the energy system. Promote the flexible transformation of cogeneration units and coal-fired generating units for peak shaving, actively carry out energy storage construction, promote the coordinated and optimized operation of energy storage systems, new energy and power systems, improve system peak shaving performance, and enhance energy system flexibility. Fourth, promote a sustainable and replicable energy development model. It needs to provide supporting policies and market environment. At the same time, it is more important to continue to explore and try. All kinds of enterprises need to do their own role positioning and face highly personalized and differentiated industries and customers. Demand for accumulation of market segments.

5. Case study: Shared energy storage trading practice in Qinghai

As one of the regions with the most abundant new energy in China, the development of the new energy industry in Qinghai Province has always been at the forefront of the domestic provinces and cities. As the source of the Three Rivers, Qinghai is known as the "Chinese Water Tower". It has unique resource endowments, abundant sunshine, and abundant solar energy resources. It is the best place to develop photovoltaic-energy storage new energy bases.

From April 21 to 30, 2019, State Grid Qinghai Electric Power Company adopted a market contract method to organize three new energy companies to carry out a pilot transaction of shared energy storage peak shaving auxiliary services for the first time. The market entities participating in the pilot transaction are shown in Table 1.

| Market players                        | Installed scale | Type of battery            |
|---------------------------------------|-----------------|----------------------------|
| Luneng Haixi Multi-energy Complementary Storage Power Station | 50MW/100MW·h   | Lithium iron phosphate battery |
| Longyuan Golmud Photovoltaic Power Station | 50MW           | Lithium iron phosphate battery |
| SDIC Huajing Golmud Photovoltaic Power Station | 50MW           | Double board battery       |

The Luneng Haixi Multi-energy Complementary Energy Storage Power Station is a self-built self-contained power station of the Haixi Prefecture Multi-energy Complementary Demonstration Project. In this shared energy storage transaction, it is included in the power grid peak shaving dispatch as the grid-side energy storage power station for the first time, and is regulated by the grid side. Take the charging and discharging curve of an energy storage power station on April 29, 2019 as an example for analysis, as shown in Figure 3, during the photovoltaic peak period of 10:00-16:00 that day, Longyuan Golmud Photovoltaic Power Station and SDIC Huajing Golmud Photovoltaic Power Station
use the original waste energy to charge the energy storage system, reduce the waste energy, and improve the power system's ability to absorb new energy; during the low photovoltaic period from 19:00 to 21:00 at night, the energy storage power station discharges at a constant power, and the photovoltaic power station and the energy storage power station share the grid-connected power generation revenue of the energy storage power station during this period. During the trial operation of shared energy storage, due to the influence of weather, the output of photovoltaic power plants is limited, and the utilization level of energy storage devices fluctuates widely, as shown in Figure 4. Among them, on the 22nd, the weather in the west of the Taiwan Strait was mainly sunny and cloudy, with good scenery resources, and the charging capacity on that day was as high as 106,400 KW·H; on the 30th, the west of the Straits was mainly cloudy and rainy, with poor scenery resources, and the charging capacity was only 28,000 KW·H

![Figure 3. Real-time charging and discharging curve of energy storage power station.](image)

![Figure 4. Daily charge and discharge capacity of Luneng Multi-energy Complementary Energy Storage Power Station.](image)

During the shared energy storage transaction cycle, the Luneng Multi-energy Complementary Energy Storage Power Station has accumulated charging power of 803,600 kW·h and discharging power of 658,000 kW·h, with a comprehensive energy storage conversion efficiency of 81.9%,
creating direct economic benefits of 750,000 yuan. In the whole year, it is estimated that the utilization hours of photovoltaic power stations will increase by 180h, which will increase economic income by 22.5 million yuan. The success of the Qinghai shared energy storage trading pilot has verified the feasibility of the shared energy storage auxiliary service transaction model for the consumption of renewable energy. While helping photovoltaic power plants increase their power generation capacity, they can also increase the power system’s power to wind, light and other renewable energy. The level of consumption and the stability of system operation have enriched the profit model of energy storage power stations and achieved a win-win situation for the source-grid-storage tripartite. Footnotes should be avoided whenever possible. If required they should be used only for brief notes that do not fit conveniently into the text.

6. Suggestions on energy policy to promote the development of new energy consumption models and new business forms in Qinghai

Based on the above analysis, this article puts forward five energy policy recommendations to promote the development of new energy consumption models and new business forms in Qinghai.

First, optimize the industrial structure and expand the proportion of delivery. The Northwest Division of State Grid should promptly communicate with the relevant departments of the company headquarters, actively coordinate with the relevant provincial trading centers, coordinate with multiple parties, implement comprehensive policies and take multiple measures simultaneously, and go all out to increase the delivery of clean energy from Qinghai. Realize the optimized allocation of Northwest clean energy nationwide.

Second, improve the energy price mechanism. Innovating and improving the price mechanism for promoting green development is an important task of price work at present and in the future. All localities must strengthen organization and leadership, clarify work tasks, formulate timetables, roadmaps, responsible persons, and establish accounts one by one. There are strong measures to ensure that various policies take root, and accountability should be strengthened for weak implementation. It is necessary to strengthen reform and innovation, correctly handle the relationship between promoting green development and ensuring the lives of the people, and strengthen publicity and guidance.

Third, improve the market transaction mechanism. Qinghai Province should sum up its experience in power market-oriented transactions, combine actual conditions, and further accelerate the reform of the power system, speed up the development of power utilization plans, speed up the liberalization of power users other than users without bargaining power to participate in transactions, expand the scope of market entities, and build multi-party participation. In the electricity market in China, the scale of market-oriented transaction electricity has been greatly increased, and the expansion of market-oriented transaction scale and the development of power consumption plans should be coordinated.

Fourth, let go of user choice. Give users the right to independently choose energy supply entities, gradually lower the threshold for users to participate in energy market transactions, establish a comprehensive energy competitive retail market, cultivate diversified retail market entities, and promote an interactive mechanism between the wholesale market and the retail market. Promote the coordinated development of centralized energy and distributed energy.

Fifth, improve energy subsidies and incentive mechanisms. The improvement of the new energy subsidy system is a systematic project, which should be carried out in the following aspects: (1) Improve the provisions of the subsidy parties. (2) Clarify the types of new energy subsidies. (3) Expand the scope of new energy subsidies.

7. Conclusion

Clean energy is the direction of energy development and Qinghai's advantage. The future energy consumption pattern and energy development of Qinghai Province will realize the integration of various links within the energy industry, between different energy industries, and between the energy
industry and other industries. Transition from a centralized energy system to a centralized and
distributed energy system, from green energy to a green industry.

Secondly, according to the actual situation in Qinghai Province, the bottlenecks in the development
of Qinghai’s energy sector have been studied. They are the irrational structure of energy consumption,
the time-space mismatch of energy processes, the inconsistency of various energy systems, severe
industry/regional barriers, and low energy regulation flexibility. The cost of new energy technology is
high and there is no reasonable return on investment model. The new energy consumption mechanism
of Qinghai Province was explored from three aspects: structural adjustment on the energy supply side,
high proportion of new energy consumption, improvement of comprehensive energy utilization
efficiency, and enhancement of the flexibility of the energy system. And a case study was carried out
taking Qinghai Province's shared energy storage transaction as an example.

Finally, starting from optimizing the industrial structure, expanding the proportion of outbound
delivery, improving the energy price mechanism, liberalizing user options, improving energy subsidies
and incentive mechanisms, it gave suggestions on energy policies to promote the development of new
energy consumption models and new business forms in Qinghai.

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