A Case Study of the Supply Chain Structural Innovation of China Gold Wind Science&Technology Co. Ltd.

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Abstract: with the initiation of parity on-grid projects, gold wind which is a new-energy company with high-growth and high-tech, implements innovative “dumbbell strategy” to attach importance to manufacturing and design on one side, and service and marketing on the other side, in order to minimize the operating risks and maximize resource efficiency through diversification strategy. This report focuses at analyzing the inspirations as well as potential threats of gold wind supply chain strategies to come to the suggestions at the end.

1. Introduction

Excessive consumption of oil, natural gas and coal, the three most conventional non-renewable resources, have aggravated the global energy crisis during these years. Global warming, environment deterioration, together with energy depletion prove to be a catalyst for rapidly expanding of clean energy, among which wind power is a kind of perpetual renewable resources with stable cost, proven technology, widespread distribution, but without any fuel or pollution. The gold wind science & technology co. Ltd (gold wind) , funded in 1998, is one of the earliest enterprises that have been engaging in wind-turbine r & d and manufacturing. It has three major businesses: wind turbine manufacturing, wind power services, and wind farm investment & development, in other word, gold wind not only provides customers with high-quality wind turbines,but develops integrated solutions including wind power services and wind farm investment to optimize its value chain. Gold wind gained 28.6 billion rmb revenue, ranked a second place worldwide in 2018 and the first in china’s wind power industry for eight consecutive years. Its global wind power installed capacity reaches more than 50 gw, covering 24 countries, and possesses almost 70 billion rbm market value in the shen zhen and hong kong stock exchange.

2. Twist in Policy

The national development and reform commission implemented an annual bidding system in 2003 for wind power concessionary projects, aiming at reducing the barriers to entry for investors as it required the state to undertake the preliminary work of wind power development, guarantee the full purchase of wind power, and provide fiscal subsidies for the winning bidders. The promulgation and implementation of the china “ renewable energy law” in 2010 provided policy guarantee and preference for wind power industry, which was listed in the seven national strategic new industries in this year. The state council unveiled the “made in china 2025” plan at may 19th, 2015, known as chinese “industry 4.0”, which takes advantage of cyber physical system (cps) by data-oriented and intelligence-oriented information integration of the supply-side, manufacturing-side and sale-side, achieving personalized product/service supply in a more effectively and efficiently way. Three policy directions were proposed: structural adjustment of manufacturing industry, developing service-oriented manufacturing industry and producer-oriented service industry. Encouraged by national policies, china’s wind power companies were skyrocketing after the new millennium and accumulated installed capacity increased to 44733 mw in 2010, ranking first in the world according to the global wind 1996-2010 report. However, the u.s. Trade representative ron kirk announced that

“the u.s. Government has requested wto to investigate into the issue of china’s subsidies of up to hundreds of millions of dollars”. April, 2019, “work plan on promoting the construction of wind power and photovoltaic power generation without subsidy and parity on-grid projects” and other two relating government documents are promulgated, heralding an industry revolution.

3. Manufacturing Pattern and Supply Chain of Gold Wind

The manufacturing pattern which is the core of the production model determines the characteristics of the supply chain, and it refers to the form of manufacturing enterprises in terms of production operation, management system, organizational structure, and technical systems. It continuously evolves with the development of social production, and there is no fixed standard [2].

3.1 Manufacturing Pattern - Focused on Lean System

The concept of “Advanced Manufacturing” was first proposed by American scholars in the late 1980s, after which a series of valuable advanced manufacturing models had been refined during production and scientific research. According to their essential characteristics and achieved results in practice, those models can be summarized into four types: Flexible Manufacturing Systems (FMSs), Lean system, Agile manufacturing and LAF (Lean, Agile, Flexible).

FMSs refer to the application of highly intelligent equipment to achieve small batch production of multiple varieties [8]. Lean system is applied to eliminate seven types of wastes as well as to create and improve customer value during the eliminating process on the basis of mass production. Das (2018) concluded that “Lean has been proven to be effective in improving resource stewardship by eliminating potential reasons for obsolescence, implementing Just-in-time-based minimum inventory systems, total quality control, group technologies, flexible operation numbers, in order to minimize usage wastes for inputs and in process materials, and substitution by alternative process” [4]. The concept of Agile manufacturing was raised by Iaccoca Institute of Lehigh University in 1991, the essence of which is to utilize highly developed information technology to make swift respond, in a maximum degree, to meet the diversified demands of users. The agility of a company indicates its comprehensive performance of survivability, leadership and resilience under constantly changing and unpredictable operating environment [9]. LAF system that was first put forward by Chinese scholars Deng and Zhang (2008), was not a simple addition of the three, but an integration at a higher level, comprehensively absorbing the advantages of lean, agile and flexible production [5].

Wind power equipment manufacturing is an emerging high-tech intensive industry with considerable technology innovation and integration. The production of large-scale grid-connected wind power equipment involves many disciplines such as machinery, electricity, computers, new materials, etc., and requires coordination and cooperation of multiple disciplines and technologies. From the perspective of output, the use of large-scale wind power equipment is very professional, and the scope of application is highly single which is no other demand than meeting the needs of wind farm construction. Meanwhile, differentiated technical solutions are essential to the construction of wind farms due to the various natural environment and wind resource features of different sites, making the production of wind power equipment have to be optimized in line with different situations. Gold wind is currently focused on the lean system to respond quickly on customer demand to integrate innovative resources and address information asymmetry.

3.2 Manufacturing Supply Chain (Msc)

In a connected network chain of the wind power industry, the supply relationship is quite complicated, combining not only material and energy supply, but also the supply of services, both tangible elements and the intangible ones. Different from other industries, the following two product supply relationships (as shown in Figure 1 below) are the core of the wind power supply chain. Firstly, in the upstream of the supply chain, the supply of wind power equipment which is the core of the chain, mostly refers to the relationship between the wind whole turbine manufacturers (Gold Wind) and component manufacturers. The main line of upstream is the production and sales

of wind power equipment. The second is the supply of power products in the downstream, during which wind power generation equipment is used by wind farm to produce power products, and then outputs to gird companies and customers.

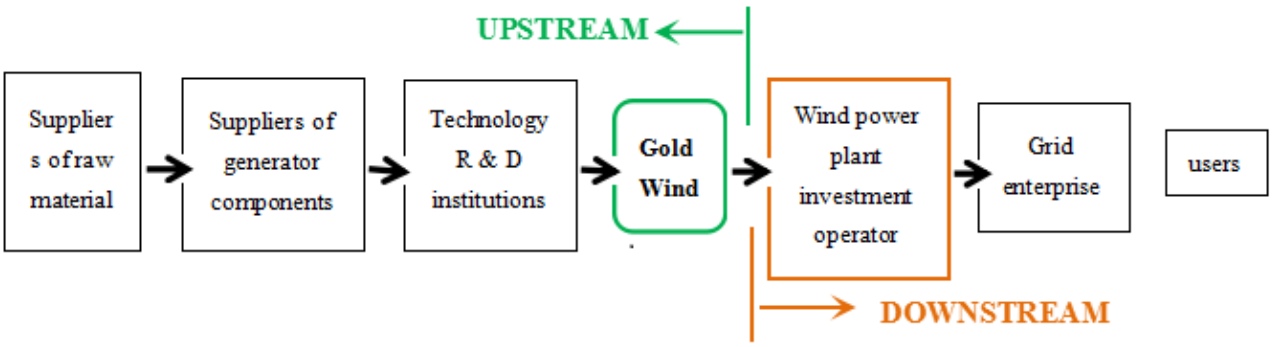

Fig.1: Manufacturing Supply Chain of Gold Wind

Types of components required for wind power generation system are fully complicated and in large varieties mainly including blades (main suppliers: SANY, Sinoma), wheels, spindles (main suppliers: SKF Group, Baota Industrial Co. Ltd.), gear boxes (main suppliers: NGC, Heavy Gear), stators, coils, yaw motors, controllers, boxes, towers (Tianshun Wind Energy), cables, etc., whereas each large variety embedded in different models and technical characteristics. Besides, different large variety requires more smaller components and raw materials producers (China Giant Stone Co. Ltd.). The internal and external scientific and technological resources have been integrated. From external level, Gold wind has major R & D partners such as National Institute of Energy Technology and Economy, UL laboratory, Tsinghua University and many other top universities, as well as major strategic partners such as Exxon Mobil China, Changsheng Solar Technology Co. Ltd., China Datang Corporation, etc., to integrate and complement the advantageous energy and technology of both sides. From internal level, Gold Wind has established seven R & D centers around the world, with a team of more than 2,000 R & D engineers and service engineers. In 2008, Gold wind acquired 70% of German VENSYS Energy by 41.2 million euro and became the first domestic wind turbine manufacturer with complete independent R & D design capabilities and complete independent intellectual property rights. With regard to Gold Wind turbine products, the company' unit adopts Direct Drive Permanent Magnet (DDPM) technology and has 2.XMW, 2.5MV, 3.0MW, and 6.XMW series units, which can be applied to different operating environments such as high temperature, low temperature, high altitude, low wind speed, and coastal. According to the investment situation, equipment will be transported to the wind farm for grid-connected power generation and then to final users. Wind farm investment operators concentrate at China's five major power groups: Guodian Corporation, Huaneng Group, Datang Group, Huadian Corporation and China Power Investment Corporation., who possess quite strong bargaining power.

3.3 Service Supply Chain (Ssc) of Gold Wind

The characteristics and structure of service supply chain have been understood by variety of ways in the theoretical circle for a long time, which can be roughly divided into the following three categories. The first type considers the SSC as the links and activities associated with the service in the manufacturing supply chain, based on which it tries to find a way to achieve the best service and the lowest cost at the same time. The second type regards the SSC as the supply chain of the service industry (or sector) corresponding to that of the manufacturing industry (or sector), to discover an optimal management method by comparing the similarities and differences between the two aspects. Akkermans and Vos (2003) compared the amplification effect in SSC with the bullwhip effect in manufacturing supply chain [1]. Whereas, this report prefers the third interpretation that consider SSC as a service-led integrated supply chain which an immediate respond will be given when a customer submits a service request to a service integrator. Afterwards, system integration services will be provided to the customer and the customer service requests will be broken down to parts when necessary or part of the service activities may be outsourced to other service providers. In this

way, starting from the customer's service request, the service providers in different service positions decompose the customer's request step by step and cooperate with each other to form a supply relationship, among which the service integrator undertakes the integration and full-process management, and that is called Service Supply Chain (SSC). Based on its flexible whole industry manufacturing chain, abundant scientific research and wind farm operation experience for the past three decades, Gold wind is transiting from manufacturing to service chain supplier, combing basic service with high value-added innovative service, expanding the content of wind power service and providing customers with tailor-made integrated solutions (as shown in Figure 2 below).

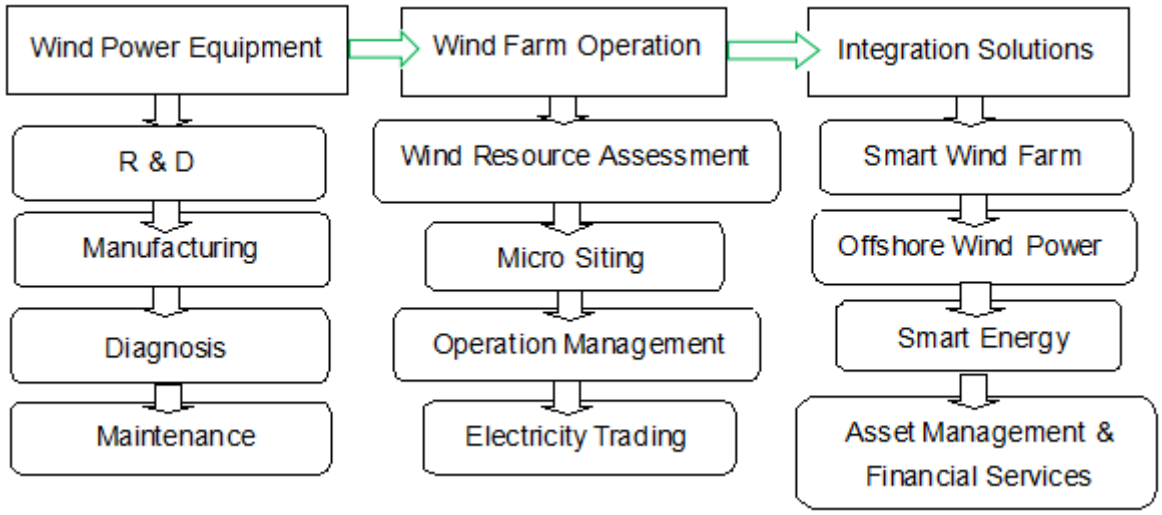

Fig.2 : Service Supply Chain of Gold Wind

Gold wind provides services such as wind resource assessment, micro-site selection, wind farm operation management, wind farm equipment diagnosis, external training, and wind power project management consulting. At the same time, it is developing an online detection system, SCADA monitoring system and improved SVC. Besides, by integrating the global wind power industry's research and development, information and human resources, combined with localized manufacturing experience and service networks, Gold wind is capable to provide customers with various types of wind power generation system solutions. Take “Intelligence Energy Solution” for example, it is characterized with “distributed energy supply (wind, light, gas, storage) , power transaction, demand-side management, intelligent energy efficiency, and digital cloud platforms” [6]. Intelligence Micro-net can accurately plan, configure and allocate various types of energy according to the load analysis result and local clean energy resources situation to achieve the optimal diversified energy allocation. Then relying on Smart Energy Efficiency Management Platform, the firm realizes visual management and dynamic monitoring of various energy sources through industrial big data analysis technology. Furthermore, the self-developed Energy Trading Cloud Platform provides convenient and efficient power trading solutions of wholesale-, retail transactions, green certificate transactions, carbon emissions trading, etc. for power users, electricity sales companies, power generation companies and other market entities, as well as specialized value-added services such as contract energy management, comprehensive energy saving and electricity consulting.

From financial level, Gold wind and partners set up an industrial fund to provide private wind farms with a basket of service solutions containing complete equipment, EPC general contracting, operation and maintenance, and financing. The future cash flow of wind farm investment projects can be predicted through using the creditworthy transaction subjects in the industry chain to pass credit, and hence a very stable “cash cow” asset is constructed. In addition, Tianxin Leasing Corporation and Wind Energy Treasure Platform owned by Gold wind separately offer financial leasing and financial supply chain service.

4. Analysis of Gold Wind Supply Chain Characters

Gold wind's supply chain has the following characteristics. First of all, the center of the supply chain is prominent. Wind power equipment manufacturers and wind power investment operators are separately the upstream and downstream hubs of the supply chain, which control the whole process from material procurement, product design, manufacturing, storage management, sales and distribution transportation in the supply chain to customer service and market demand prediction. Secondly, the hierarchy of the supply chain is complex. Wind turbine equipment production has typical modular integration characteristics, composing not only a wide variety of components (Gold wind has more than 300 suppliers), but the high degree of integration of each component that requires the cooperation of great quantity of suppliers. It is extremely challenging to coordinate every link on both manufacturing and service chain horizontally and vertically. The last is the palpable uncertainty and dynamic variability of the supply chain. The overall effects of technology development, demand and policies, combined with the continuous adjustment of the production, services, operation environment and evolution of the competitive landscape, contribute to the uncertain response of suppliers and partners, which is the inevitable result of multiple levels of the supply chain.

4.1 Inspirations

4.1.1 Manufacturing to Service Supply Chain Transformation

During the transmission from manufacturing to service supply chain, it forms a new profit growth point and maximizing the total value chain while cross-disciplinary collaboration is essential. Holmström & Partanen (2014) believed that the innovative combinations of supply chains will decrease supply chain complexity through simpler and more effective solutions [7]. Meanwhile, it also aggregates relevant industry resources such as suppliers, partners and investors to construct a service sharing platform throughout the entire industrial chain, containing services such as clean energy development, engineering, production, operation, electricity sales, technology and capital operations , with the aim to achieve all-round cost reduction and efficiency improvement, and create a clean energy industry-wide shared ecosystem. The five integrated solutions caters to the energy demand of cost reduction and efficiency enhancement of the end users, aiming at reducing the comprehensive energy cost, improving the proportion of clean energy and reshaping the energy value chain. The new financial thinking of "emphasis on projects and light on entities" that improves the industry's financing ecological environment has established a credit system for wind power assets.

4.1.2 Synergy Effect

From a business structure perspective, the multiplicative effect of technological associations is one of the approaches. It is also known as "concentric polyhedralization", that is, polyangulation with a certain technology as the axis. DDPM technology is the core of Gold wind that enables the firm to obtain huge economic benefits. The synergy effect also can be presented from Gold Wind technology supply: ongoing product innovation enables the enterprise's life to continue; technology development resources are shared among cooperated technology groups, such as R & D personnel, information resources, etc. to reduce costs and improve resource efficiency.

From the angel of resource structure, the production is unable to proceed only with funds, plant, raw materials, energy, equipment, and without technology, knowledge, talent and organizational coordination, vice versa. Hence increasing the supporting level of tangible manufacturing resources to intangible services will optimize operating efficiency, and only intangible resources and services be at the core can achieve sustainable synergy. It is worth noting that human resources assets are generally considered as the most important intangible assets, thereafter, the management of human capital, the source of knowledge and innovation, turns to be the commanding height of operation management [3]. The proportion of technical R & D personnel (with the number of 3132) of total Gold wind workers was 36% in 2018, and R & D investment was 1.58 billion RMB, occupying 5.5 % of total revenue. The firm is emerging collaborative innovation with many local labs, and

those of South wales and Denmark. Consequently, sustainable differentiation competitive advantage is consolidating in the long-run through resource synergy, in particular human resource.

From organizational level, the application of a series of new manufacturing and management models of Gold wind such as: FMS, Lean production, Intelligent Manufacturing System (IMS), SCADA monitoring system, Smart Energy Efficiency Management Platform play an irreplaceable role in improving product quality and productivity, together with Gold wind's market resilience and competitiveness.

5. Conclusion

Through transformation from manufacturing to service supply chain, Gold wind enjoys the superiority of both lean system and synergy effect among its upstream and downstream suppliers with the aim to achieve an optimizing value chain. Meanwhile, many of low wind areas and industrial clusters have not been developed yet, neither has the corresponding quality standard system, which is impeding the strategy sustainability and Gold wind's global alignment.

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