

An Analysis of Chinese Enterprises Opportunities to Invest in Myanmar Electric Power Industry

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Abstract—Under “one belt one road” initiatives and the smooth progress of reform in Myanmar political, more and more Chinese enterprises “going out” to invest in the electric power sector in Myanmar. This paper analyzed the first-hand field research data and investment opportunities. Domestic support policies together with the better political situation in Myanmar provide Chinese enterprises an excellent encourage platform. In the field of power generation and grid construction field-funded enterprises have significant opportunities. In different power structure of power plant field, Chinese enterprises should be tailored to discover suitable investment opportunities.

Keywords—myanmar; electric power sector; investment opportunities

I. DEVELOPMENT SITUATION OF ELECTRIC POWER INDUSTRY IN MYANMAR

A. Electric power’s construction development situation in Myanmar

The electric power system which is the electricity production and consumption system consisting of power generation, transmission, substation, distribution and use. The electric power system transforms natural energy into electricity by power plant, and through the transmission and substation systems and power distribution systems, electricity will be supplied to the users.

Myanmar does not have the technical ability to afford the construction of electric power production independently. At the same time, the Myanmar government does not have enough money to invest the electric power system. The early development is very slow, but in the past twenty years, Myanmar government attract business vigorously [1].

According to the Electricity Ministry of Myanmar, the number of power stations which have been put into operation is 43, the national installed capacity has reached 5089 MW till the end of 2015. From 2009 to 2014, the annual generating capacity of Myanmar power plant has increased from 6829863 MW to 13674558 MW and with an annual growth rate of 13%. In the aspect of electricity power coverage, only 1/3 of the country’s population get electricity supply in Myanmar, rural areas are lack of electricity seriously, among country’s 60000 villages and towns, only about 15000 villages and towns have access to the national grid. Per capita electricity consumption of Myanmar is 222 KWH, Myanmar is only higher

than Cambodian in Southeast Asia [1-8]. Per capita electricity consumption can reflect the power of a country or region’s economic development level and people’s life level in a certain extent. The world per capital consumption grade is shown in table I, table shows that Myanmar’s per capita consumption is of the lowest grade level in the world [9].

TABLE I. WORLD PER CAPITA ELECTRICITY CONSUMPTION GRADE

The first grade	The second grade	The third grade	The fourth grade
Over 10000 KWH	5000-10000 KWH	2000-5000 KWH	Less than 2000 KWH
Developed countries such as north America, north Europe and Australia	Most developed countries	BRIC countries and other emerging countries	Some developing countries and less developed countries

Source : the world bank website

According to the Myanmar Ministry of statistics, till the end of 2015, Myanmar’s electric power is supplied by hydroelectric power, natural gas, coal, hydroelectric power accounts for 67%, natural gas accounts for 28%, coal accounts for 3%, wind power, solar power and biomass power accounts for 2%.

TABLE II. INSTALLED CAPACITY OF MYANMAR HYDRO POWER STATION

Sequence number	Power station	Province / state	Installed capacity (MW) of Myanmar Hydro power Station	Design output (MWh)	Production time
1	Baluchaung (1)	Kayar State	28	672	1992
2	Baluchaung (2)		168	4032	1960
3	Baluchaung (3)		52	1248	2014
4	Kinda	Mandala y Division	56	1344	1985
5	Sedawgyi		25	600	1989
6	Paunglaung		280	6720	2005
7	Yeywa		790	18960	2010
8	Namcho		40	960	2014
9	Upper Paunglaung		140	3360	2014
10	Zawgyi(1)	Shan	18	432	1995

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11	Zawgyi(2)	State	12	288	2000
12	Shweli(1)		600	14400	2009
13	Kengtaung		54	1296	2009
14	Zaungtu	Bago Division	20	480	2000
15	Yenwe		25	600	2007
16	Kapaung		30	720	2008
17	Kun		60	1440	2012
18	Shwegyin		75	1800	2012
19	Thaukyekhat (2)		120	2880	2013
20	Phyuchaung		40	960	2014
21	Thaphanseik		Sagaing Division	30	720
22	Mone	Magwe Division	75	1800	2004
23	Kee ohm Kee Wa		74	1776	2012
24	Tarpain(1)	Kachin State	240	5760	2011
25	Chibwe		99	2376	2013
	Total		3151	75624	

Source : The Ministry of electric power of Myanmar

It is shown in Table II that hydroelectric power stations in Myanmar that have all been put into operation are 25, those stations are located in 4 provinces and 3 states. The scale of installed capacity of hydroelectric power stations in Myanmar is divided into table III.

TABLE III. THE SCALE DIVISION OF HYDROELECTRIC POWER STATIONS IN MYANMAR

Scale	Large hydroelectric power stations	Medium-sized hydroelectric power stations	Small hydroelectric power stations
Division standard	installed capacity over 250MW	installed capacity 50MW-250MW	installed capacity less than 25MW
Number	3	17	5

Source : The existing design standards of water resources and hydroelectric power projects in China

Through the comprehensive analysis of able II and table III, it is concluded that water resources in Myanmar is abundant, but there are few large hydroelectric power stations and small power stations were developed in 90s. In recent years, The scale of hydroelectric power stations which are investment by foreign businessman in Myanmar increases gradually, but the medium scale is the main aspect [10]. 31% of Myanmar's power structure is natural gas and coal power. Table IV shows the data of installed capacity of natural gas and coal power stations in Myanmar.

Myanmar people have been opposed to coal power generation. Dickie Tikyit coal power plant is Myanmar's first coal power station, it was contracted by the China Heavy Machinery Corporation, and it was put into operation in 2004 [11]. Foreign investment countries are China, Thailand, the United states. Ywama natural gas power plant of Yangon and Ahlone natural gas power plant are invested by Thailand electric power company (EGAT) and Thailand Toyo-Thai project company [12].

TABLE IV. INSTALLED CAPACITY OF NATURAL GAS AND COAL POWER STATIONS IN MYANMAR

Sequence number	Power station	Province / state	Installed capacity (MW) of Hydro power Station	Design output (MWh)	Production time
1	Tikyit (coal)	Shan State	120	600	2004
2	Kyunchaung (GE)	Magwe Division	54.3	300	1974
3	Mann		36.9	238	1980
4	Shwetaung (GE)	Bago Division	55.4	300	1984
5	Mawlamying	Mon State	12	60	1980
6	Thaton		51.0	300	1985
7	Mawlamying (ML)		43.5		2001
8	Kyaukse (GE)	Mandalay Division	100.3		
9	Hlagwa	Yangon Division	154.2	640	1996
			350	1999	
10	Ywama		70.3	238	1980
					2004
					2004
11	Ahlone		154.2	640	1995
			350	1999	
12	Thaketa	92.0	368	1990	
		200	1997		
13	Hlawga (MCP)	26.7			
14	Ywama (EGAT)	240			
15	Ywama (UPP)	52			
16	Ahlone (Toyo-Thai)	94			
17	Thaketa (MAX)	53.6			
18	Myanung	Ayeyarwady Division	34.7	200	1984
					1975
	Total		1445		

Source : The Ministry of electric power of Myanmar

The 18 natural gas and coal power plants in run are distributed in 5 provinces and 2 states. From the perspective from natural endowment, there are abundant oil and gas resources in central and coastal areas of Myanmar, while Myanmar’s natural gas power plants are mainly distributed in the central and coastal areas. To sum up, Myanmar’s power generation is not enough, the geographical distribution is unbalanced, the electric power is extremely scarce. Power grid of Myanmar is composed by the national power grid and isolated power grid in remote areas [13]. The main grid surround the two big load center of Yangon and Mandalay and extend around, covering the central population of 6 provinces and 5 states. 94% of the national electricity demand is supplied by national grid, another 6% is supplied by independent small power stations beyond the power grid, namely isolated power grid [14]. The grid structure is weak and it need to be built and upgraded urgently.

land area of Myanmar is 677 thousand square kilometers, the population is 51 million and 400 thousand people, city population density is the second in Southeast Asia, the fact is that there is only 43 power stations in Myanmar, power grid distribution is scattered, power grid concentrates on the central Myanmar province state with better economic development.

B. Electric power demand analysis of Myanmar

From March 29th to April 10th in 2014, Myanmar holds the census, the census has shown a total population of 51 million and 400 thousand people, including some parts with 1million and 200 thousand population of Rakhine, Kachin and Karen not accepting the census estimates [15]. Myanmar urban population density ranked second in Southeast Asia, thus the demand for electricity is great. But the fact is that Myanmar is the country with the lowest electric power coverage in Southeast Asia. Table IV stands for electric power coverage of Myanmar in recent years.

TABLE V. ELECTRICITY COVERAGE IN MYANMAR IN RECENT YEARS

Time	1998	2005	2009	2013	2015
Electric power coverage	10.6%	11.3%	23.2%	29.0%	33.3%

Source : The Chinese Ministry of commerce

Myanmar is a tropical monsoon climate, the dry season is from October to next year in April, the rainy season is from May to September. Electricity demand peaked at 2468 MW during the dry season and peaked at 2602 MW in 2015. From 2010 to 2015, the electricity demand peak load figure of Myanmar’s dry and rainy season is shown in figure 1.

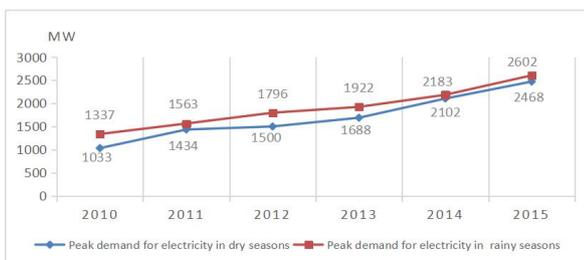


Fig. 1. The peak growth of electricity demand in Myanmar of drought and rainy season in 2010 -2015

Source : The Ministry of electric power of Myanmar

In Myanmar’s current power structure, hydroelectric power accounts for 67%. And it can be inferred that the electricity problem is more severe in drought season of Myanmar.

C. Electric power supply analysis of Myanmar

1) Hydro power Resources

Myanmar’s rivers have great development potential. Main rivers which are suitable for the hydro power development are the Irrawaddy River, Salween River, Chindwin River and Sittang River, the branches are throughout the country. The distribution of major rivers in Myanmar is shown in figure 2.

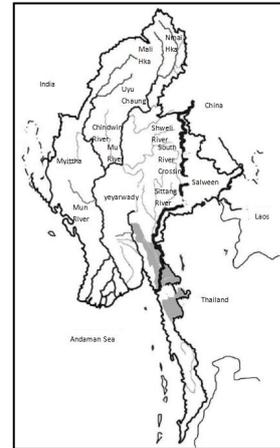


Fig. 2. The distribution of major rivers in Myanmar

Source : Google map

Ayeyarwady River is the first big river in Myanmar, water resources are also very rich, it is suitable for the development of large hydro power station, but few have been developed [16]. At present, the Ayeyarwady River is of no complete hydro power development plan. China’s enterprises Shweli River and Tarpain River participate in the development of hydro power station [17]. Salween River is the longest and second largest river in Myanmar, it is suitable for the construction of small hydro power stations. Sittang River originates from the Myanmar’s Shan Plat, it flows to south about 420 kilometers into the Andaman Sea. According to the data of Myanmar Ministry of Electric Power, including the Banglang and Shangbanglang hydropower stations, including the construction of Yunnan Union Foreign Economic Co., Ltd., The Ministry of Electric Power has built 10 hydropower projects on the Xitang River, which has produced electricity 830 MW [18].

2) Coal resource

The distribution of coal resources in Myanmar is relatively wide, but the resource reserves are not large, it is not suitable for large-scale development of coal-fired power generation, the known reserves of 7.11 tons, basically is lignite and sub bituminous coal. Sub-bituminous coal, between bituminous coal and lignite, is mainly distributed in the northeastern provinces of the province, the central Magu province and Shan State, southern Delingda province, can be used for power generation similarly [19].

There is also a small amount of hardened coal in the central region of Myanmar. Anthracite is the largest coal quality coal,

mainly used in chemical fertilizers and metallurgical industry, can be used to generate electricity in principle, but the cost is higher, and it is quite a waste of resources.

3) *Oil, solar and other power generation resources*

Oil and natural gas resources are mainly distributed in the central and coastal areas of Myanmar. According to the data of Ministry of Myanmar Energy in 2015, oil proved reserves is 160 million, proven reserves of natural gas is about 637.2 billion cubic meters, from the current exploration situation, no proven reserves have great potential [20-23].

With sufficient sunshine, the 36% of the total area of Myanmar's regional solar radiation is 18-19 trillion per square meter, and solar storage capacity is expected to continue to grow from 0.7 megawatts in 2013 to 50 megawatts in 2016. Myanmar wind power theoretical power generation capacity of 365,100 cubic meters, the potential available wind energy will increase from 120 MW in 2013 to 1209 MW in 2021 [24].

II. ANALYSIS ON INVESTMENT OPPORTUNITY OF POWER SEGMENT MARKET DIVIDED BY INDUSTRY CHAIN

A. *Investment opportunity analysis of Myanmar power station construction*

Electricity production and electricity supply are collectively referred to the power sector. As the country's strategic resource, electricity is a government-regulated industry, subject to geographical constraints and the non-renewable nature of resources. The industry has a highly concentration, generally by several large state-owned power companies occupy most of the market. According to the statistics of Myanmar Electricity Ministry, Myanmar's annual electricity consumption increased by about 13%, need to maintain 30% of the electricity reserves and plans to build new power projects [25]. As a result, the next 15 years Myanmar electricity consumption and the required power installed capacity shown in Figure 3. The figure can be analyzed, by 2030, Myanmar's installed capacity target than the current increase of nearly 4 times.

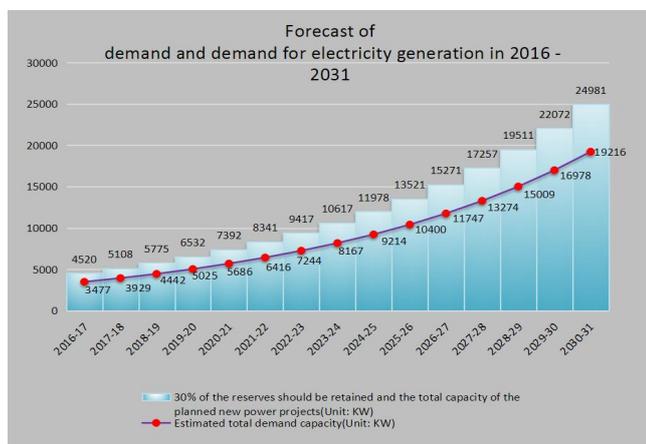


Fig. 3. 2016-2031 Demand and required supply capacity forecast in Myanmar

Source : According to the data of Myanmar Electricity Ministry

B. *Opportunity analysis of power grid construction investment in Myanmar*

All kinds of substation voltage in the power system and the overall composition of the transmission line are known as the grid. It contains substation, transmission and distribution. Power grid and power generation both belong to the very important part of power system, the construction of Myanmar power stations, especially hydropower stations in stark contrast to the "re-issued light" phenomenon is slowly emerging, power grid construction and upgrading. Myanmar government has been ignoring the construction and upgrading of power grids. There is little planning investment in the overall project contracting. However, many investors ignore the fact that compared to the construction of power stations, power grid projects have the advantages of low investment, low risk, short construction period and quick return on earnings [26]. With the vigorous construction of power facilities in Myanmar in recent years, the Myanmar government has gradually realized that the old power grid power loss caused by the shortcomings, began to liberalize the investment in the field of investment. Besides, Myanmar's existing grid lines are not long enough to support the entire country's power system. Most rural areas do not have power supply. The old power grid in the distribution and transmission loss power greatly, the loss rate is nearly 30%. Myanmar's grid status brings the most direct investment opportunities for Chinese-funded enterprises.

C. *Investment opportunities of significant power plant structure*

Power plan of Myanmar: in 2030/2031 fiscal year, Myanmar plans to let the whole country have power, plans power protection structure as: hydropower accounts for 38%, coal-fired power generation accounts for 33%, natural gas generation accounts for 20%, renewable energy power generation accounts for 9% [27]. According to the characteristics of the power station with different power supply structures, put forward the opportunity choice of the Chinese enterprises to invest in power plants with different power supply structure.

1) *Thermal power generation*

The development of natural gas power generation can achieve energy-saving emission reduction and sustainable development of energy supply [28]. Therefore, natural gas power generation is a good choice. Based on the data of Myanmar power supply structure in third chapter, the use of natural gas in Myanmar, 17 natural gas power station has been put into operation, accounting for 28% of the national power structure, showing the Myanmar government policy support for natural gas power generation.

Myanmar possesses rich oil and gas resources and is well suited for the development of natural gas power plants. Six coastal areas along the north to the south of Myanmar are rich in oil and gas resources: Rakhine State, Yiluo Wadi province, Yangon province, Bo solid province, Meng Bang, Delinda province. Especially, Rakhine of the eastern part Myanmar and Meng Bang, Delinda province of the southern state have the largest development potential.

Myanmar plans to build the power security structure in 2030/2031 fiscal year: coal-fired power generation accounted for 33%. And coal power plants in Myanmar has been protested repeatedly by people that they think those will cause serious environmental pollution [29]. Chinese enterprises should strengthen the understanding and integration of Myanmar social culture, to escort the implementation of the project, understand the local culture, religion and customs actively, carry out publicity and social welfare activities, help local communities, people improve the living environment, strengthen interaction with the public and fulfill the social responsibility of the enterprise.

2) *Hydroelectric power generation*

Hydroenergy is an inexhaustible and renewable clean energy, and Myanmar is rich in water resources with great potential, compared to the current stage of development degree is only 10%, it ought to develop hydropower according to local conditions. But in order to use natural water effectively, require construct hydraulic structures that can be used to concentrate the water drop and regulate the flow. So the project has a huge investment and a long period [30]. In the Myanmar environment of political instability and inefficiency of government departments, the risk of investment in hydropower stations seems to be greater. Hydropower stations have a great impact on the lower reaches of the ecological environment, it will cause the local residents of Myanmar migrant to other places, destroy the surrounding ecosystem, also may lead to crisis. For example, the Myitsohe hydropower station has been halted by protests due to there is no good coordination solution to deal with the drawbacks of hydropower projects. In general, the Myanmar government attaches great importance to the development of hydropower stations, encourages all parties to participate in Myanmar's hydropower investment, and plans to 2030 hydropower installed capacity reach 90MW, about three times the existing installed capacity. At present, more than 85% of foreign investment is in the field of hydropower, since the 1990s China has more than 20 years of investment experience in the Myanmar hydropower market, the advantage is more obvious.

3) *Nuclear energy power generation*

Nuclear power generation, the method of generating electricity by the use of a large amount of thermal energy released by the fission of uranium fuel in a nuclear reactor. The heat released by the nuclear reaction is one million times higher than the energy released by the burning of fossil fuels, so the volume of fuel required is small, the transport and storage is also very convenient and does not emit huge amounts of polluting gas as fossil fuel and not pollute environment. However, the safety of nuclear power plants and the cost of nuclear power generation is two important factors restricting the development of nuclear power [31]. On the one hand, in case of a nuclear leakage accident, damage to humans and ecology is immeasurable, such as the Fukushima nuclear leak that shocked the world in 2011. The radioactive material produced by the nuclear fission reaction is very harmful to humans. On the other hand, the capital construction investment of the nuclear power plant is generally one and a half to two times of the same thermal power station. The financial risk of the power company is relatively high. For country such as

Myanmar with a shortage of finance and technology, the nuclear power plant is indeed difficult to run at this stage of development.

The research and development of nuclear power in the less developed countries is likely to cause the world's excessive attention or even intervention. In 2012, the Ministry of Defense of Myanmar said Myanmar lacked funds and technology and had "stopped all nuclear-related activities". To sum up, Asia Pacific countries are actively developing nuclear energy meanwhile, at this stage the feasibility of Chinese enterprises to invest in nuclear power generation in Myanmar is quite little.

4) *Solar electrical energy generation*

Enough sunshine in Myanmar provide a good natural condition for solar power. The energy density of solar energy is low, and it varies from place to place. Solar power generation has the problem of high cost and low conversion efficiency, not suitable for poor countries such as Myanmar, from the actual situation at this stage can only be used as a supplementary support [32]. Considering the geography and climate, Magway Province and Mandalay Province are famous arid areas, known as the "fire area" of Myanmar. The duration of sunshine in the summer is very long, and this happens to be the time when the water power station is unable to operate effectively because of the depletion of water sources. If construct solar power stations in these two provinces, it is able to make up for lack of electricity in summer. When the rainy season comes, due to the reduction of sunshine time, solar power plants may reduce the amount of electricity, but at this time due to the water power plant is sufficient, can run the full power generation.

III. CONCLUSION

Based on the previous research, this paper draws the following conclusions:

Firstly, from Myanmar's political, economic, social, power industry's technology and policy analysis of the five aspects, the investment environment of Myanmar is summed up as follows: the political situation in Myanmar is unstable, economic level is low, highway and railway facilities are not perfect, electric power supply can only meet the needs of 1/3 national, technical level of the electric power industry is backward, health care and education are not developed, the talent market is not perfect, these factors have hindered the Chinese investment and also lead to the severe unbalanced situation of economic development of the whole country. While at the same time, Myanmar is rich in resources and the great potential for economic development, social is stable, the folk is simple and friendly. After the democratic reform of Myanmar in 2011, Myanmar began to open to the outside world, the government of Myanmar has carried out a series of preferential policies for foreign investment to encourage foreign investors to enter Myanmar. In 2015, Aung San Suu Kyi leading the Democratic League won the election, the political situation in Myanmar is expected to improve further. From these points of view, Myanmar's investment environment is gradually improving, challenges and opportunities are both existing.

Secondly, through the first hand data, a thorough and detailed analysis of overall electric power system of Myanmar

electric power industry has been made : the installed capacity and location of power plants, substations, transmission lines. From the national distribution coverage map of Myanmar's power grid, it is concluded that there are only 43 power stations in run of Myanmar, hydroelectric power accounts for 67%, the structure is unbalanced, the scale is not enough; matching grid distribution is lax, loop length is not enough, the lack of long distance transportation of ultrahigh pressure level's transmission line; it is difficult to meet the demand of Myanmar's substation for substation number and installed capacity. To sum up, Myanmar's electricity can only cover 1/3 population of the country, the power system covers the better economic development provinces of the central region in Myanmar. There are no power station, no inter-provincial power lines in the Chin state, Kayah State, Karen state, Tanintharyi Division of remote areas, power system development is very backward. On the other hand, Myanmar has abundant resources, hydropower of huge potential, abundant oil and gas reserves, sufficient sunshine in the dry season, and natural conditions for the construction of related power generation projects. However, coal reserves are generally not suitable for the construction of coal power stations.

Thirdly, after analyzing the current situation, the author studies the current situation of the development of Chinese electric power enterprises in Myanmar. It is found that the majority of Chinese investors entering the Myanmar power industry are large state-owned enterprises, mainly in BOT mode, because Chinese enterprises enter the Myanmar market earlier and have full experience, investment projects in Myanmar showing a good development trend as larger scale, wider field and more mature technology. Through the further analysis of the status emerged in the Myanmar power industry investment opportunities, do the overall policy analysis of the two countries and opportunity analysis of the micro-industry chain, and make a feasibility investment judgment of different power plants. Conclusions are as follows, China will provide strategic and policy support for Chinese enterprises to "go out"; Myanmar will have a big improvement in the overall investment environment after the 2015 election, moreover Myanmar would join Asian Infrastructure Investment Bank actively and have some preferential policies in the investment of electricity field, and plan the systemic power system nationally. For Chinese enterprises, there are huge opportunity in the electricity demand and the new power structure adjustment in the field of power generation and power grid construction.

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