AN ANALYSIS OF CHINESE INVESTMENT OPPORTUNITIES IN RENEWABLE ENERGY POWER INDUSTRY IN THAILAND

LIQIN WU

ID 5817190055

AN INDEPENDENT STUDY SUBMITTED IN THE PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE DEGREE OF MASTERS IN BUSINESS ADMINISTRATION

INTERNATIONAL PROGRAM, GRADUATE SCHOOL OF BUSINESS,

SIAM UNIVERSITY, BANGKOK, THAILAND

2019

Title: An Analysis of Chinese Investment Opportunities of Renewable Energy Power Industry in Thailand

Author: **LIQIN WU**

ID No: **5817190055**

Major: **International Business Management**

Degree: **Master of Business Administration (International Program)**

Academic: **2019**

This Independent Study has been approved to be partial fulfillment of requirement for the degree of Master of Business Administration in International Business Management

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(Assistant Professor Dr. Om Huvanandana)
Advisor

Date: ...../...../.....

.....

Dean: .....

(Associate Professor Dr. Jomphong Mongkhonvanit)

Date: 10/June/2020.

Abstract

Title: An analysis of Chinese investment opportunities of the renewable energy industry in Thailand

Researcher: Ms. Liqin Wu

Degree: Master of Business Administration (International Program)

Major: International Business Management

Advisor: .....

(Assistant Professor Dr. Om Huvanandana)

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Thailand and China are friendly neighbors, relations between the two countries are stable, political mutual trust is strengthened, and trade cooperation is increasing. In 2011, China and Thailand signed cooperation projects in four major areas, one of which is new energy cooperation. In 2013, China proposed the "Belt and Road initiative" and the "go global" strategy. With the encouragement and support of the Chinese government, more and more Chinese companies are investing overseas.

With the development of the economy, the demand of Thailand is expanding, especially for the power energy. In 2016, Thailand proposed the "Industry 4.0" strategy, including "Energy 4.0", and launched a series of preferential policies to attract foreign investment. In addition, Thailand is located in the tropics, with developed agriculture and abundant natural resources, which has brought enormous potential for Thailand to develop renewable energy.

This paper uses literature analysis and qualitative analysis to analyze the Chinese investment opportunities in the renewable energy industry of Thailand. First, through the analysis of relevant research literatures, there are few papers to study renewable energy of Thailand. By analyzing the status of renewable energy industry of Thailand, it is found that Thailand's demand for energy is very large. By analyzing the status of renewable energy cooperation between China and Thailand, a small number of companies have cooperated in solar energy, wind energy, biomass energy, and waste incineration. Finally, by analyzing the Chinese investment opportunities in the renewable energy industry of Thailand, it is found that: 1. Both the Chinese and Thai governments attach great importance to the development of renewable energy sources, each with policies to support the development of energy companies; 2. Thailand has abundant natural resources and has great potential for developing renewable energy. 3. China and Thailand engage in renewable energy cooperation to achieve complementary industries; 4. Thailand's on-grid tariff policy is beneficial to SME investment, in addition, Thailand began to develop renewable energy vehicle industry; 5. Compared with other countries, the prices of Chinese products are relatively cheap.

In short, China and Thailand have broad prospects for cooperation in the renewable energy industry.

Key words: Investment opportunities; renewable energy; Solar, Wind, Biomass

Approved

Acknowledgement

Firstly, I would like to thank my supervisor, Professor Dr. Ohm Huavanand for his expert advice and good suggestions whenever he thought it would be useful for this project. Anytime I faced any problems, clear and sharp possible solutions have been answered.

Secondly, I would like to express my gratitude to all professors at the department of MBA, who has instructed and helped me to get a lot of knowledge and analysis skill about business in the last two years.

Thirdly, I want to extend my profound gratitude to my family and people I have mentioned above, who always support and encourage me throughout my year of study and through the process of researching and writing thesis would not have been able without them. Thank you.

Liqin Wu

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Chapter I Introduction

1.1 Research background

In 2010, China and the ASEAN Free Trade Area were opened, and Chinese enterprises entered ASEAN to enjoy zero tariffs. In 2011, China and Thailand signed cooperation projects in four major areas, one of which is clean energy cooperation. In 2013, China proposed the “Belt and Road Initiative” to strengthen the interconnection and cooperation of energy infrastructure between China and the countries along the “Belt and Road”.

Thailand is China's friendly neighbor. Since the two countries formally established diplomatic relations in 1973, bilateral relations have been stable, political mutual trust has been increasingly strengthened, and the trade cooperation has become increasingly close. In 2016, Thailand proposed the “Industry 4.0” strategy, planning six key development areas, and targeting the top ten industries such as industrial robots, aviation and logistics, bio-energy and bio-chemicals, and digital economy as the new engines for Thailand's economic development. In order to promote the “Industry 4.0”, Thailand has built infrastructure, developed the eastern economic corridor (EEC), and successively introduced a number of preferential policies, which is very attractive to Chinese companies to invest in Thailand. In addition, Thailand is an important member of ASEAN and located in the core area of ASEAN. It has become the first choice for Chinese enterprises to explore the ASEAN market.

With the economic development, Thailand's energy demand is expanding, especially for electric energy. Sufficient power reserves can effectively promote the

long-term development of the country. However, Thailand is a country with poor petrochemical resources. Most of its energy is imported and its power facilities are lagging behind. The Thai government expects that the petrochemical resources of Thailand will be exhausted after 2030, and the development of alternative energy sources is an urgent issue. In order to attract foreign investors to invest in alternative energy sources, Thailand's BOI has introduced a tax-free eight-year unlimited policy.

Thailand is located in the tropics and developed in agriculture. The abundant natural conditions have brought great potential to Thailand's development of alternative energy sources, and China's energy industry accounts for 70% of the global related industries. At present, China is the fastest growing energy industry in the world. In this context, the cooperation between China and Thailand on energy is very promising. Thailand can use the new technologies and equipment of China's energy industry to upgrade its energy production capacity, improve domestic demand for energy, and promote the sustainable development of the Thai economy.

1.2 Research content

This paper mainly analyzes Chinese investment opportunities of new energy industry in Thailand, and is divided into six parts:

First: introduction, mainly introduces the research background, research content and research significance of this paper.

Second: literature review, mainly includes the definition of new energy concepts, the definition of new energy power, and related research on new energy power.

Third: the development status of new energy power industry in Thailand,

mainly analyzes from two aspects. The first is to analyze the current situation of the Thai electricity market, including Thailand's power system, power structure, consumption structure, power demand and so on. The second is to analyze the status of Thailand's new energy power industry, including power structure and installed energy, power consumption, and the impact of grid level on new energy power.

Fourth: the status of Chinese investment of new energy power industry in Thailand. It mainly summarizes Chinese investment status and investment trends of new energy and power industry in Thailand, and analyzes the problems and causes of Chinese investment in Thailand.

Fifth: analysis Chinese investment opportunities of new energy power industry in Thailand, mainly using Porter's diamond theory model, from the government, production factors, demand situation, related and supporting industries, corporate strategy and horizontal competition to analysis Chinese investment opportunities of new energy power industryin Thailand.

Sixth: Conclusions and prospects

1.3 Research methods

This paper mainly uses literature analysis method and qualitative analysis method.

(1) Literature analysis method: It is mainly used in the literature review section to define the concept of new energy and new energy power, and analyze the related research of new energy.

(2) Qualitative analysis method: It is mainly used in the analysis of current

situation and investment opportunity, summarizes relevant information, and puts forward corresponding suggestions.

1.4 Research significance

(1) Theoretical significance: Through the analysis of relevant research literature, it is found that there are few research articles on energy issues in Thailand, and there is almost no research on the new energy power industry in Thailand. This paper uses Porter's theory to analyze Chinese investment opportunities of new energy power industry in Thailand and make recommendations, which has certain theoretical significance for China's investment in Thailand.

(2) Realistic significance: This paper analyzes and makes recommendations on Chinese investment in Thailand. For China, it is beneficial for Chinese companies to take less detours and improve their international competitiveness in the process of “going out”. For Thailand, it will help Thailand adjust its energy structure and enhance Thailand's international competitiveness. Therefore, the analysis of this paper has important practical significance.

Chapter II Literature Review

2.1 Definition of new energy

New energy refers to unconventional energy, which is the energy developed and utilized by new technologies, including solar energy, wind energy, geothermal energy, tidal energy, and bioenergy. Generally speaking, it refers to energy that does not emit pollutants or is less polluting to the environment. Most of the new energy is natural and renewable. Chinese scholar Li Ping (2014) believes that new energy is based on new materials and technologies, gradually replace fossil energy with serious environmental pollution and limited stock, including nuclear energy, wind energy, solar energy and so on have been developed and utilized.

New energy is broadly divided two categories. One is renewable energy, which can be replenished after consumption and does not produce or produce very little pollutants. Such as solar energy, wind energy, water energy, bio-energy, biogas, tidal, etc., with great resource potential, low environmental pollution, and sustainable use, it is an important energy source for the harmonious development of man and nature. The second is non-renewable energy, which aims to minimize pollution to the ecological environment during production and consumption, including the use of low-pollution fossil energy (such as natural gas), fossil energy treated with clean energy technologies (Such as clean coal, clean oil, nuclear energy), and including the recycling of solid waste. (summarized from Wikipedia)

In practice, new energy has become the general term for all unconventional energy sources, including conventional renewable and non-renewable energy sources, as well as unconventional energy sources such as methanol, ethanol, and

shale gas. It also includes new energy utilization models such as distributed energy and new energy vehicles.

2.2 Definition of new energy power

At present, global new energy power generation is mainly based on wind power, solar power, nuclear power generation and ocean power generation. In 2017, global new energy power generation reached 2,179 GW (International Renewable Energy Agency website, 2018). At present, the countries with good new energy generation in the world are still dominated by developed countries. The main reason is that the promotion time is early, the technology is relatively mature, and the new energy technology can be effectively applied under various conditions and environments. This has promoted the modernization and popularization of new energy technologies.

Wind power generation system mainly uses wind power to drive mechanical equipment, thereby generating mechanical kinetic energy, generating heat source under the action of high frequency operation of mechanical equipment, and finally converting thermal energy into electric power through the processing of equipment conduction system to form a complete wind power generation system.

Solar power generation systems mainly use the advantages of light and heat conduction to obtain heat sources to form an effective power output system.

Biomass power generation refers to the use of biological resources for power generation. The sources of biological resources are mainly agricultural and forestry waste and municipal solid waste.

(Information is mainly summarized from the International Renewable Energy Agency

website)

2.3 Research on new energy power

Most of the research on new energy in academia is based on energy security and energy conservation. Little research has been done on investment and development of new energy, especially in the field of power.

Chinese scholars' research on new energy power industry: Mu Xianzhong and Liu Bingyi (2009) studied the status of new energy and renewable energy, and looked forward to the industrialization direction of Chinese new energy and renewable energy from the perspective of the future. Wu Guangzheng (2017) studies the new energy generation technologies such as solar energy, wind energy and nuclear energy in the context of the rapid development of the national economy and the increasingly serious environmental pollution problems. The grid-connected technical problems, voltage stability problems and power control in the process of new energy power generation Analyze the problem and propose rationalization. Fang Guochang (2013) applied the non-linear energy-saving and emission reduction dynamic evolution system to new energy sources, and through research, the development of new energy and the utilization of new energy power generation can change the current energy consumption structure of most countries and truly achieve energy conservation and emission reduction. As long as renewable natural resources are rich enough, they have enormous potential for development. He Lingyun (2017) used the regulation effect model to measure the effects of total renewable energy investment and structure on carbon emissions and compare the differences. And analyzed the guiding effect of renewable energy investment policies on carbon emission reduction. It is found that existing policies have guiding conclusions on

the carbon emission reduction effects of renewable energy investments.

Foreign scholars research on new energy power industry: Paul Komor (2004) researched and compared the investment policies of renewable energy in the world, and analyzed the reasons for the success and failure of investing in the new energy power industry through case studies. KarlMallon (2006) studies the regional differences in the relationship between energy structure and carbon emissions, proposes to reduce the proportion of coal in energy consumption, and vigorously develop solar photovoltaic power generation, wind power generation, biomass power generation and so on, to optimize energy structure.

Chapter III Development Status of Thailand's New Energy Power Industry

3.1 Status of Thailand's electricity market

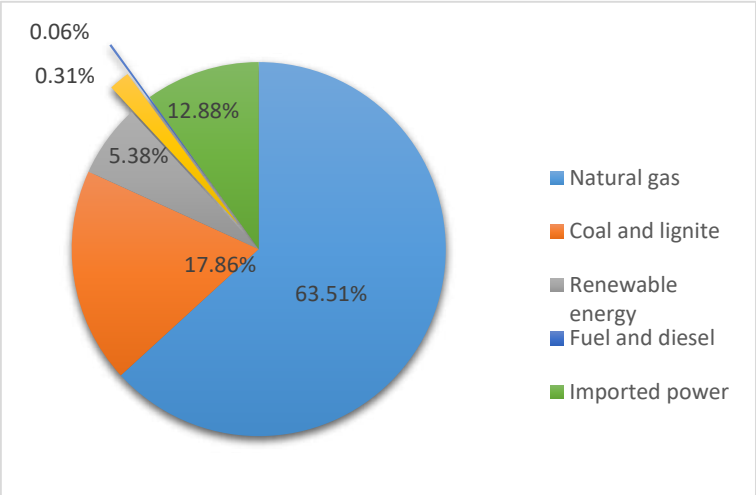
The power infrastructure of Thailand has three systems, including power generation systems, transmission systems and distribution systems. The power generation system can be divided into five parts: Thailand Power Generation Authority(EGAT), Independent Power Producer (IPP), Small Power Producer(SPP), Very Small Power Producer(VSPP), and purchasing electricity from abroad (Imported). Among them, EGAT is a state-owned power generation institution in Thailand, which is affiliated to the Ministry of Energy of Thailand and is mainly responsible for power generation and power transportation. At present, the total installed capacity is 15,000 MW, and there are 39 power plant projects are operated in Thailand, including 8 sustainable energy power plants. In addition, EGAT is also responsible for purchasing large-capacity electricity from private power plants and

is responsible for trading in electricity with neighboring countries. The electricity generated by EGAT will be sold by PEA and MEA. (Information is summarized from the website of the Ministry of Energy)

In 2017, Thailand's electricity generation capacity was 42,433.25 MW. Among them, EGAT's power generation is 16,071.13 MW, accounting for 37.87% of the total power generation. IPP's power generation is 14,948.50 MW, accounting for 35.23% of total power generation, SPP's power generation is 7,536.02 MW, accounting for 17.76%, and others accounting for 9.14%. (Source: 2018 Thailand Energy Annual Report)

In terms of power supply structure (figure 1), Thailand's electricity production relies mainly on fossil fuels. In 2017, electricity generated from natural gas accounted for 63.51%, coal accounted for 17.86%, purchased from abroad accounted for 12.88%, fuel oil, palm oil and diesel accounted for 0.31%, and others accounted for 0.06%, while renewable energy power plants (Hydraulic, wind, solar, and geothermal) accounted for only 5.38%. Therefore, it is extremely urgent to increase the development of new energy power. (Source: 2018 Thailand Energy Annual Report)

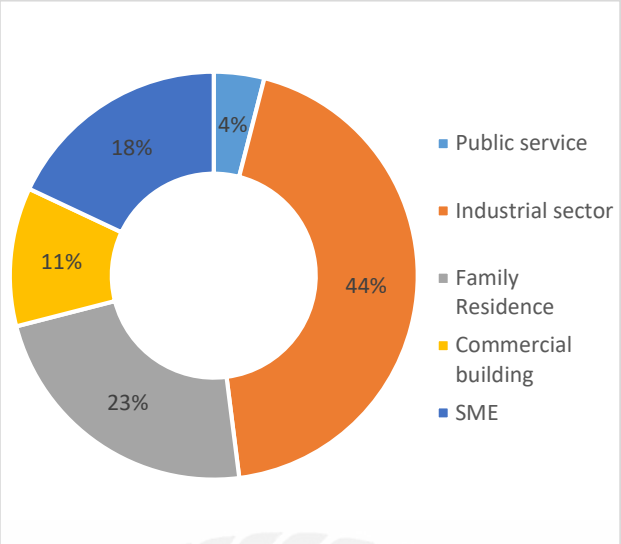
Figure 1 Thailand power supply structure and proportion



Source: Ministry of Energy, Thailand

In terms of power consumption. Thailand is the second largest economy in Southeast Asia, and as economic growth and population increase, energy demand will also increase. In Thailand, energy consumption can be divided into five parts. Among them, the industrial sector accounted for 44%, family housing accounted for 23%, commercial buildings accounted for 18%, small and medium-sized enterprises accounted for 11%, and public service accounted for 4%. It can be found that industrial, commercial buildings and residential demand for energy is high, and the combined energy demand of these industries accounts for 85% of Thailand's total energy demand.

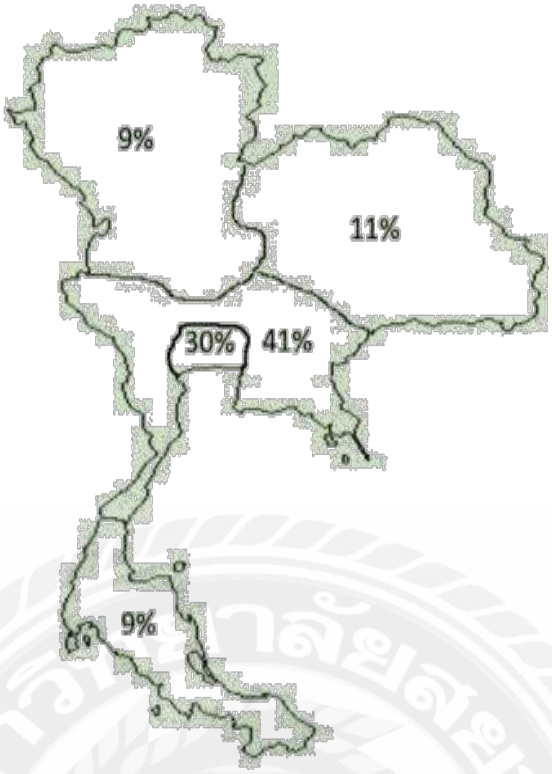
Figure 2 The proportion of power consumption in various industry sectors



Source: Electricity Generation Authority of Thailand

The demand for electricity in various regions. Thailand can be roughly divided into four parts, the southern region, the central region, the northern region and the northeast. The region with the highest energy demand is the central region, accounting for 71% of national energy demand (EGAT, 2017). Energy demand in the capital city of Bangkok alone accounts for 30%, which is almost equal to the total energy use in the south, northeast and north regions. For the central region, the high energy demand is due to the fact that most factories and other heavy industries are located in the region, while in other regions, such as the northeast and south, mainly engaged in agriculture and tourism.

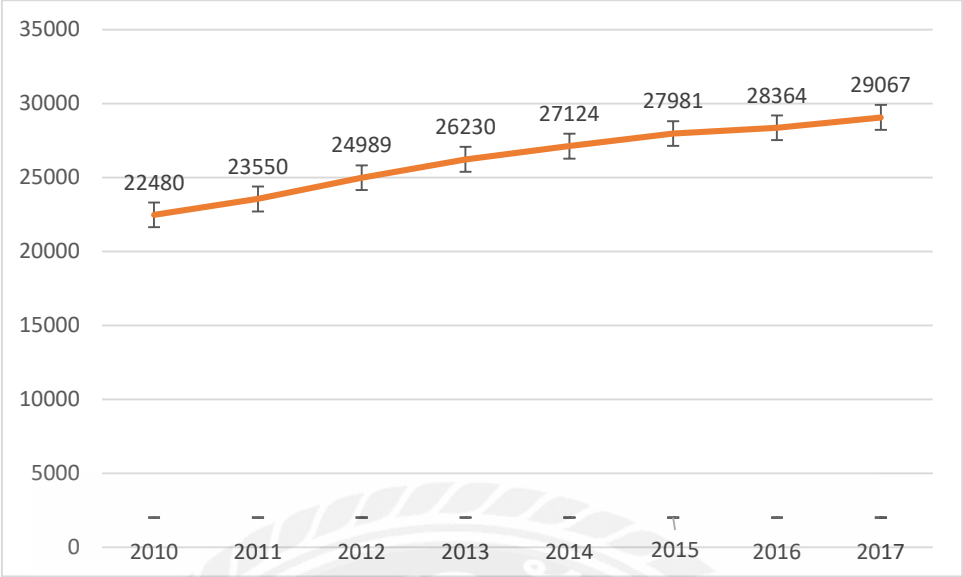
Figure 3 Regional Power Consumption



Source: Electricity Generating Authority of Thailand (EGAT)

High peak demand for electricity. Thailand's electricity demand has a fairly predictable seasonal and daily cycle. The annual peak demand is usually the highest temperature from March to May, and the lowest load is usually in December and January. In May 2016, the summer heat reached a record high of 29,619 MW. In 2016, electricity usage once again reached a new record for peak power generation. In 2014, peak power generation was 27,981 megawatts, and in 2015 it reached 28,364 megawatts. High peak demand has always been a concern for the Thai government, as the government will have to increase its reserve power during peak times. Table 1 shows the growth of peak power generation demand over an eight-year period.

Table 1　Electricity peak demand (MW)



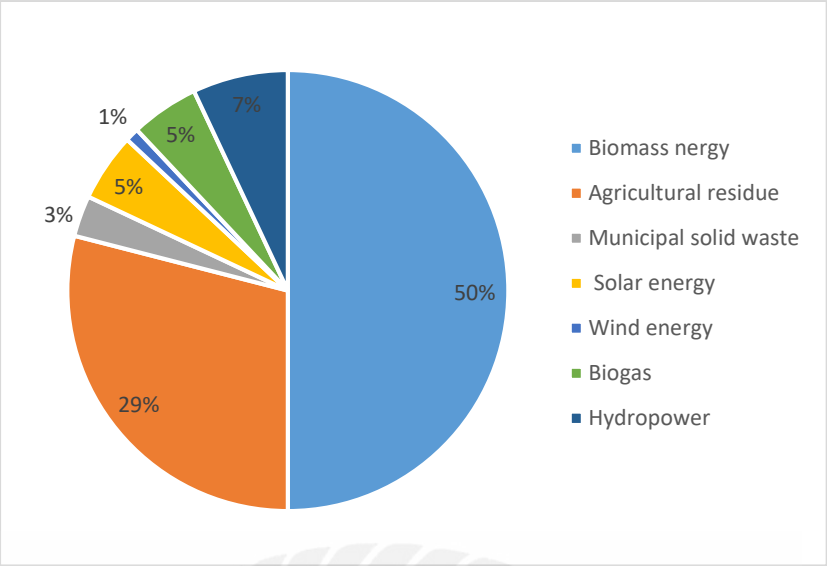
Source: Energy Policy and Planning Office (EPPO) of Thailand

3.2 Development Status of New Energy Power Industry in Thailand

3.2.1 New energy structure and installed capacity

From the above, in terms of power supply structure, Thailand's power production relies heavily on fossil fuels. Renewable energy accounts for less than 10%. As can be seen from Figure 4, Thailand's main new energy sources are biomass and agricultural waste，and the two add up to almost 80%.

Figure 4. The structure of new energy power



Source: Electricity Generating Authority of Thailand (EGAT)

As can be seen from Table 2, bioenergy accounts for the largest share of Thailand's new energy energy portfolio and is the main source of renewable energy generation. In 2013, the share of solar photovoltaic and wind energy quickly caught up, with an average annual growth rate of 30% because the government promoted these two technologies. By 2017, Thailand's wind power generation capacity has doubled. In addition, Thailand's small hydropower is growing at a moderate rate; relatively speaking, biomass power generation capacity is the most Strong, in 2014 reached a high growth rate of more than 70%.

Table 2 Total installed capacity of new energy in Thailand

Unit:Megawatt (MW)

Year / Energy type	2011	2012	2013	2014	2015	2016	2017
Solar energy	48.6	78.7	376.7	823.5	1298.5	1419.6	2446.1
Wind energy	5.6	7.3	111.7	222.7	224.5	233.9	507.0
Hydropower	58.6	95.7	101.8	108.8	142.0	172.1	182.1
Biomass energy	1650.2	1790.2	1959.9	2320.8	2451.8	2726.6	2814.7
Biogas	103.4	159.2	193.4	265.7	311.5	372.5	434.9
Municipal solid waste	13.1	25.5	42.7	47.5	65.7	131.7	145.3
Total	1879.8	2156.6	2786.2	3789	4494	5056.4	6530.1

Source: Development of Alternative Energy Development Efficiency (DEDE)

3.2.2 New energy power consumption

The consumption of alternative energy in Thailand is increasing year by year. Especially for the energy that Thailand has the ability to produce, including solar energy, wind energy, small hydropower, garbage, biogas and biomass, and biofuels (ethanol and biodiesel). The Thai Ministry of Energy hopes to stimulate alternative energy output by increasing energy consumption, thereby reducing fossil energy consumption and energy imports.

Table 3 Consumption of alternative energy sources

Unit: ktoe

Years	2013	2014	2015	2016	2017
Consumption	1138	1341	1467	1556	2122
Growth rate	15.2%	17.8%	9.4%	6.1%	36.4%

Source: Development of Alternative Energy Development Efficiency (DEDE)

As can be seen from Table 3, the consumption of new energy has experienced a trend of growth and decline from 2013 to 2016. This is because the Ministry of Energy proposed the Alternative Energy Development Plan (2012-2021) in 2012, so During this period, the power consumption of alternative energy sources has increased. However, due to the lack of government incentives, relevant new energy companies have certain obstacles and bottlenecks in technology development, and the traditional natural gas power generation system is perfect, so most enterprises pay less attention to new energy. Based on this situation, the government introduced a new alternative energy development plan (2015-2036) in 2015, attaches great importance to the development of alternative energy sources, increased investment and the foreign investment, Introducing advanced technology, so the consumption of alternative energy and power surged in 2016, attracting the attention of Chinese investors.

Summary of this section: Through the analysis of the status of the new energy industry in Thailand, it is found that the existing electricity market in Thailand is generally stable. Since the state has attached importance to renewable energy generation in recent years, it has set certain targets for the power generation capacity

and consumption of renewable energy generation in the future, but Thailand currently has The power grid is not in line with the development of new energy, so the upgrade of the power grid is imminent, which brings considerable investment opportunities for Chinese enterprises in grid design technology.

Chapter IV Chinese Investment Status of New Energy Industry in Thailand

4.1 Overall status of Chinese investment of new energy industry in Thailand

The Ministry of Energy of Thailand developed a new power development plan in 2015, and the environmental impact of energy development is further taken into consideration. According to the “Alternative Energy Development Plan”, the amount of renewable energy generated will increase further. To achieve its goal, Thailand is particularly important to develop a smart grid because it can enhance the entire power management system. As a result, Chinese companies are increasingly investing in new energy power plants in Thailand. It not only attracted the investment eyes of large Chinese companies such as Huawei and China Southern Power Grid, but also attracted a large number of private Chinese enterprises to invest the solar industry in Thailand, such as Sharp.

In terms of wind energy, Xinjiang Goldwind Technology Co., Ltd. (Goldwind Technology) and the subsidiary of EGAT reached a cooperation agreement to provide low-speed series direct-drive permanent magnet units and wind farm central monitoring system to their wind power projects in Thailand.

In terms of biomass energy, Datang Group Technology Engineering Co., Ltd.,

a power company from China, has contracted the biomass power generation project of DOUBLE • A Group, the largest paper company in Thailand. The biomass generator set of this project is currently a single machine in the world. One of the largest biomass generator sets, the annual generating capacity of a single unit is 950 million kWh, which can save about 500,000 tons of coal.

(Information summarized from the China Council for the Promotion of International Trade)

4.2 Investment development trend

(1) Invest in high-tech projects. At present, Chinese related technologies in renewable energy such as wind power and solar photovoltaics are at the forefront of international standards, and the high-tech level of Chinese companies participating in Thai power projects is also increasing.

(2) The scope of investment. At present, Chinese new energy power companies investment in the Thai market is diversified, involving gas, wind power, solar photovoltaic power generation, transmission and distribution, and a small amount of nuclear power.

(3) The investment models. At present, the investment models of Chinese new energy power companies include greenfield investment, equity investment, BOT, BOO, BOOT, BOO, PPP, etc., of which equity investment is the main investment type.

(Information summarized from China Renewable Energy Industry Association)

Chapter V Analysis of Chinese Investment Opportunities of New Energy Power Industry in Thailand

This chapter mainly uses Porter's diamond theory model to analyze the Chinese investment opportunities of new energy power industry in Thailand with five aspects: government, production factors, demand status, related and supporting industries, corporate strategy and horizontal competition.

5.1 Government

In the “One Belt, One Road” initiative of China, the environmental protection industry sector is the focus of investment cooperation. The Chinese government also encourages Chinese companies to actively invest overseas, integrate localization operations, and actively undertake more social responsibilities such as protecting the environment, increasing employment, improving people's livelihood, and maintaining ecology.

The Ministry of Energy of Thailand promotes green cities with a focus on solar (photovoltaic), wind energy (wind turbines), hydropower, biomass, biogas and solid waste. Thai entrepreneurs are encouraged to build Thailand into a hub for the export of biofuels and alternative energy technologies in the ASEAN region. In addition, the Investment Promotion Board of Thailand (BOI) offers a range of attractive tax and non-tax benefits for new energy investments. The summary is as follows:

Table 4 Thailand BOI Preferential Projects

Preferential type	Exempt corporate income tax		Exemption from import duties	Non-tax incentive**
		Machine	Raw materials For export products	
A1	8 years (no upper limit)	√	√	√
A2	8 years (upper limit)*			
A3	5 years (upper limit)			

Note:

* In addition to land cost and working capital, the upper limit of corporate income tax exemption is the initial investment amount.

** Includes allowing the introduction of foreign experts and workers to work, owning land, and carrying or repatriating foreign currency abroad; in addition to deducting normal depreciation, the cost of infrastructure installation or construction is not more than 25% of the project.

Table 5 Specific items and corresponding preferential categories

	Iterm	Preferential type
Solar energy	Solar cells and required raw materials	A2
	Solar power generation equipment	A2
	Solar power equipment spare parts	A3
Wind energy	Wind power generating equipment	A2
Small hydropower	hydroelectric equipment	A2
Waste energy	Waste energy power generation equipment	A1
	Agricultural waste fuel equipment	A2
Biomass energy	Biomass power generation equipment	A2
	Biomass coal and pellet production equipment	A3
Biogas	Biogas power generation equipment	A2
	Wastewater biogas conversion equipment	A2

Source: The Board of Investment of Thailand (BOI)

Recognizing the importance of alternative energy to the country, BOI has listed alternative energy production projects as a priority concession: including the use of alternative energy sources such as agricultural materials, biogas and wind energy to produce electricity or steam power; and the manufacture of alcohol or fuel from agricultural products such as agricultural waste, garbage; using the energy-saving machinery, manufacturing fuel cell and so on.

5.2 Production factors

(1) Areas with solar power potential

Thailand is located in the tropical area and, therefore, contains abundant solar power source from solar heat gain. Solar is one of clean natural energy sources that can be transformed into heat and electricity. The deep red region in Figure 5 is the

region with the highest radiation level. In these regions, peak density of direct radiation in Thailand is approximately 1,350-1,400 kWh/m2-yr, Density of direct radiation in Thailand usually escalates from January and reaches the peak in April before descending to the bottom in December. According to the aforementioned data, some areas in Thailand have solar power potential that can be used to generate heat and electricity, including southern and northern parts of the Northeastern region at Udonthani province and certain area in the Central region. (Information summarized from Department of Alternative Energy Development and Efficiency)

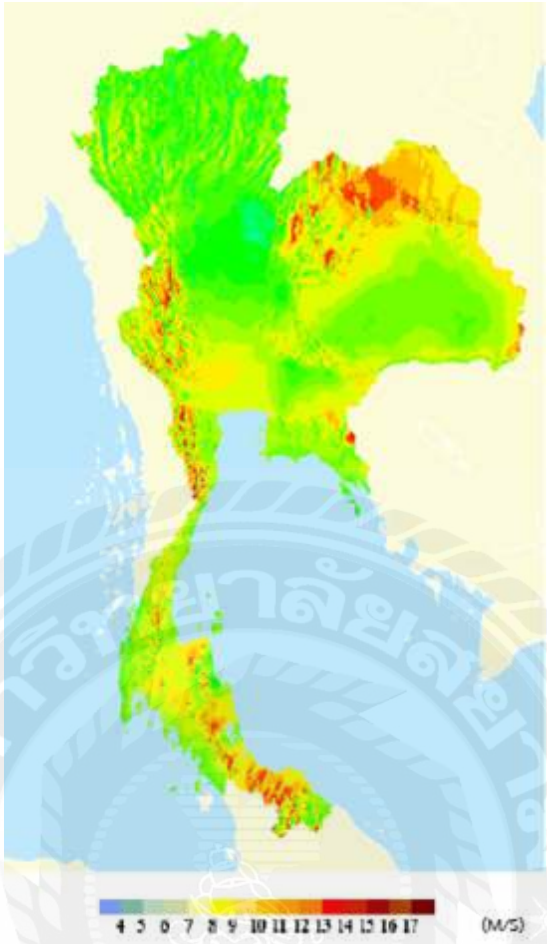
Figure 5 Areas with solar power potential

(Source: Department of Alternative Energy Development and Efficiency)

(2) Wind power and its potential in Thailand

Wind power is one of clean and renewable natural sources of energy. In order to use wind power, we need wind turbines to convert kinetic energy from the wind into mechanical energy and consequently use that energy in pumping water or generate electricity. The crimson area in Figure 5 shows area with highest wind power potential. According the survey of DEDE found that potential wind power sources located in the Gulf of Thailand--from Nakornsritammarat, Songkla, to Pattany-- as well as some area in Petchburi and Doi Intanon, with an average wind speed of 6.4 meters per second at 50-meter height. (Information summarized from Department of Alternative Energy Development and Efficiency)

Figure 6 Wind power and its potential in Thailand



(Source: Department of Alternative Energy Development and Efficiency)

(3) Hydraulic. Hydraulic power is a kind of renewable energy with great potential and relatively low production cost. In Thailand, hydroelectric power can be used anywhere there is water flow. As can be seen from the figure 6, the main rivers in Thailand include the Mekong River, the Chao Phraya River and the Menghe River.Thailand is rich in seasonal rainfall and reservoirs, providing a suitable location for hydroelectric power generation. Because the western part of Thailand is a mountainous area and the northeast is a plateau, there is a certain gap in the river, and there are relatively many hydropower stations in the northeast. (Information summarized from Department of Alternative Energy Development and Efficiency)

Figure 6 River map of Thailand

(Source: Department of Alternative Energy Development and Efficiency)

(4) Biomass energy. Thailand is an agricultural country with a developed agricultural economy and a large amount of biomass resources, mainly from agricultural waste or agricultural by-products, including rice husks, sugar cane waste, oil palm waste, cassava waste, rubber, wood waste, corn cobs, and

winemaking. Plant, coconut fiber and shells. In Thailand, agriculture is still important even in the growth of industry and tourism. Thailand's agricultural population accounts for nearly half of the total population, producing about 60 million tons of agricultural waste per year and 20 million tons of electricity for power generation, about 40 million tons. Agricultural residues are not used. In terms of land use, 28% of the land is used to grow crops such as rice, corn and cassava; 7% is used to grow permanent crops such as citrus, coffee and rubber; 65% of them are non-cultivated land or classified as pasture, forest, built-up area, etc. . Geographically, agricultural residues such as rice husks, cassava and bagasse are mainly distributed in the central, northern and northeastern regions, while oil palm residues are mainly distributed in the southern provinces.(Information summarized from Office of Agricultural Economics, Thailand)

Figure7 Major production areas of rice

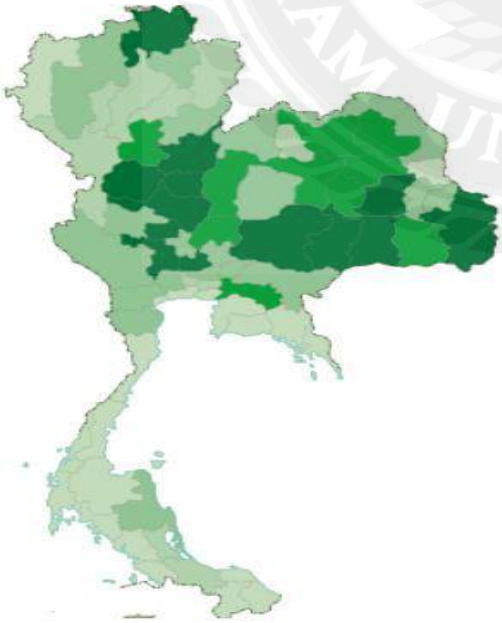


Figure 8 Main production areas of sugar cane

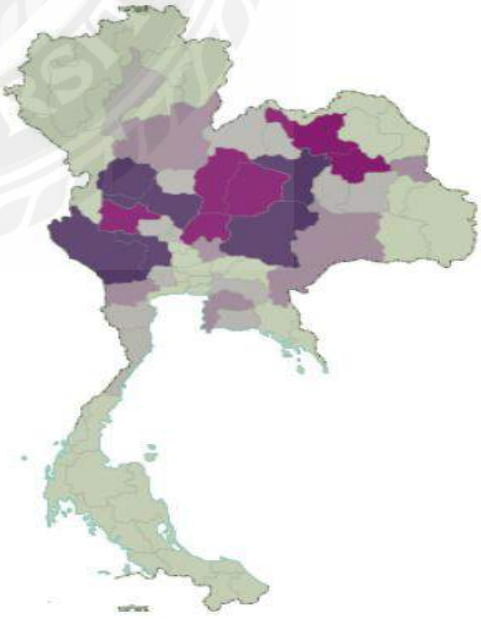


Figure 9 Main production area of cassava

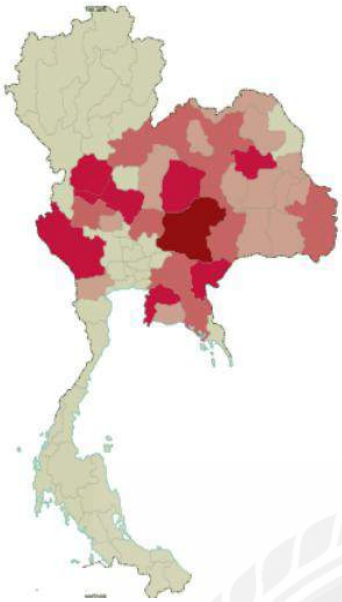


Figure 10 Oil palm (scraping) main production area

Source: Office of Agricultural Economics, Thailand

(5) Biogas and municipal solid waste.

Biogas is a mixed gas mainly composed of methane produced by anaerobic digestion of organic matter and inert carbonic acid gas. The main raw materials for biogas production are industrial waste, farmland waste, wastewater and municipal solid waste. Biogas power generation has great potential in Thailand due to the large supply of industrial waste and livestock manure. Although the scale of biogas power generation is not as good as biomass and solar energy, with the growth of industrial livestock production, the amount of poultry meat waste is expected to increase. This will provide more raw materials for biogas production.(Information summarized from Department of Alternative Energy Development and Efficiency)

Summary of this section: According to Thailand's natural resources, Thailand is located in Southeast Asian countries, and its excellent geographical location has brought abundant natural resources to Thailand. In general, Thailand has abundant

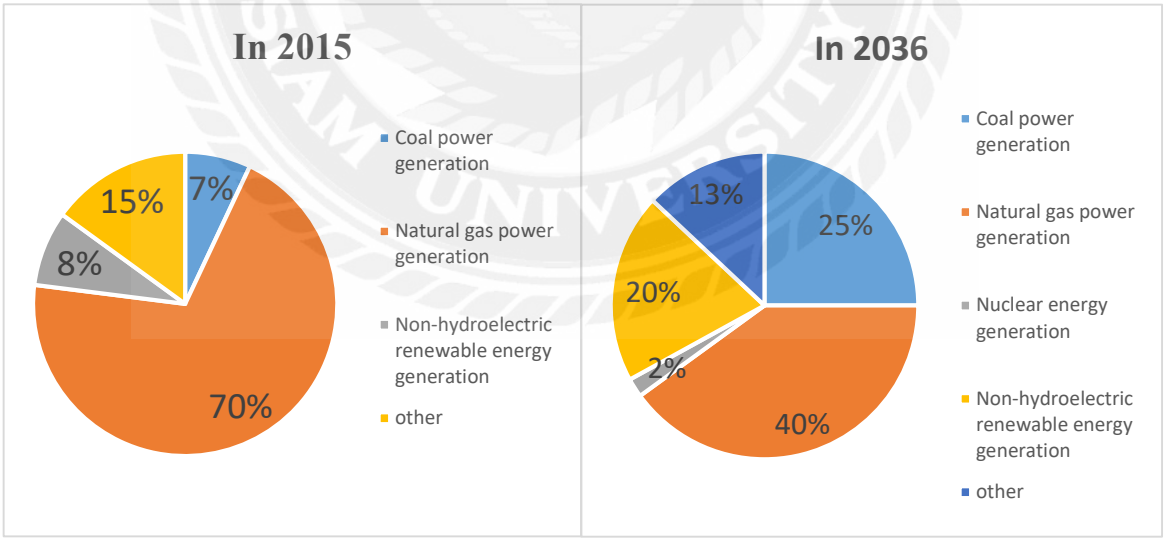
renewable energy resources and great potential. These will be very attractive to foreign investors to invest the new energy industry in Thailand.

5.3 Demand status

Power load forecasting is generated to predict future energy demand. This provides a basis for long-term planning and construction of centralized power plants. According to figure 11, Natural gas power generation will be reduced from 70% in 2015 to 40% in 2036, while increasing coal-fired power generation, from 7% in 2015 to 25% in 2036, non-hydro renewable energy generation will be 8% from 2015 Increase to 20% by 2036

Figure 11 Thailand's Power Development Plan (PDP2015-2036)

Unit: Megawatt(MW)



Source: Ministry of Energy, Thailand

According to the table 6, in order to mitigate the risks of excessive dependence on natural gas and maintenance of national energy security, the PDP aims to

diversify power sources by increasing the use of renewable energy, coal, hydropower and nuclear energy. The project predicts that by 2036, natural gas power generation will only account for 30% to 40% of total power generation, renewable energy accounts for 15%-20%, clean coal (including lignite) accounts for 20%-25%, and As you can see, from 2035, Thailand will begin to mine and develop nuclear energy and put it into use, accounting for about 5% of total power generation. As the Thai government encourages micro-generation companies to participate in bidding competition, it is estimated that by 2036, private power producers (including IPP, SPP and VSPP) and new energy companies will have broad development space and generate more than 30%. electricity supply.

Table 6 Thailand's main renewable energy generation target

Unit: Megawatt（MW）

Category	Existing installed capacity (2018)	In 2021 year	In 2036 year
Solar energy	2446	2993	6000
Wind energy	507	1200	3002
Small hydro power	182	259	376
Biomass energy	2815	3630	5570
Biogas	435	484	600
Municipal solid waste	145	160	500
Total	6530	8726	16048

Source: Ministry of Energy,Thailand

According to Table 6, in order to mitigate the risks of excessive dependence on natural gas and maintaining national energy security, the PDP aims to diversify its sources of electricity by increasing the use of renewable energy, coal, hydropower and nuclear energy.The department expects that natural gas power generation will

only account for 30% to 40% of total power generation in 2036, renewable energy accounts for 15%-20%, and clean coal (including lignite) accounts for 20%-25%. And as can be seen from the above figure, starting from 2035, Thailand will begin to excavate and develop nuclear energy and put it into use, accounting for about 5% of total power generation. As the government encourages micro-generation companies to participate in bidding competition, it is estimated that by 2036, private power producers (including IPP, SPP and VSPP) and new energy companies will have broad room for development and can generate and supply power supply above 30%.

Summary of this sections: There is a widespread shortage of electricity supply in Southeast Asian countries. In the peak season of electricity consumption every day and the peak hours of daily electricity use, and especially in remote rural areas, there will be power shortages and even power outages. In addition, according to the requirements and forecasts of Thailand's alternative energy development plan for power production capacity and consumption, Thailand urgently needs to expand the installed capacity and power generation capacity of new energy generators, which also brings Chinese investors. Very good opportunity.

5.4 Related and supporting industries

5.4.1 The Development level of Thai Manufacturing Industry

The use of new energy to generate electricity is inseparable from the development level of upstream related industrial chains. Due to the seasonal limitations of new energy sources, the development difficulty and technical requirements are relatively high. Therefore, the entire industry chain must be

interlocked to make the best use of new energy.

The solar power industry has a long industrial chain. Currently, it is dominated by the poly silicon battery industry chain, including poly silicon enterprises, batteries and their component companies, photo voltaic power generation enterprises and downstream power users. The main process is for poly silicon companies to acquire high-efficiency batteries and battery components by acquiring purified silicon germanium, processing it into silicon rods, and cutting it into silicon wafers for solar cell manufacturers. Photo voltaic power generation companies operate by generating photo voltaic modules and solar power generation equipment.

For the wind power industry chain, all aspects need to have enterprise layout, but the different aspects are different: the downstream wind farm mainly involves the technical security of wind power grid connection, and the midstream wind power machine industry also needs layout; upstream wind power parts and equipment It involves technologies in key manufacturing areas such as blades, gearboxes and main bearings.

For the wind power industry chain, each link of the industrial chain is different: the downstream wind farm mainly involves the technical security of the wind power grid connection, and the midstream wind power machine industry also needs layout; the upstream wind power component equipment such as blade, gearboxes and main bearings, involved the key technologies of manufacturing areas.

5.4.2 The new energy utilization level of the non-power sector

For the non-power sector, renewable energy applications focus on heating and transportation. Since solar energy and biomass are among the most resource-rich

renewable energy sources in Thailand, the use of these two energy sources is also the most abundant.

In terms of heating, many small and large industries in the industrial sector rely on biomass as their main source of energy; large plants producing sugar cane, cassava and palm oil use biomass to produce thermoelectricity and electricity to meet their own needs.

In terms of transportation fuel, the contradiction between supply and demand is increasing with the increasing demand for energy and the reduction of the supply of traditional energy. The Thai government is striving to reduce its dependence on imported fuel oil and promote green by promoting the use of alternative energy sources such as biodiesel and ethanol. technology. To support the use of alternative energy sources, most vehicles in the Bangkok public transport network have been designed to use flexible fuels that allow them to burn biodiesel and biofuels such as ethanol. Therefore, it is expected that the share of biofuels in Thailand's alternative energy portfolio will increase significantly in the future. These goals will in turn promote greater use of Thailand's natural resources and affect Thailand's future agricultural prospects.

In terms of transportation, the government is very supportive of the development of new energy electric vehicles in Thailand, especially pure electric vehicles with zero carbon dioxide emissions. In 2016, the overall planning framework for electric vehicles in Thailand was also released. According to the Energy Policy and Planning Office, the specific support policy for new energy electric vehicles is being prepared. By 2036, the number of electric vehicles in

Thailand will increase to 1.2 million. According to the government's promotion and support for the development of the electric vehicle industry in Thailand, the plan is divided into 4 stages. After 20 years, Thai electric vehicles will completely replace fuel-powered vehicles. With the structural performance of solar electric vehicles becoming more outstanding, the promotion of solar electric vehicles will gradually increase.

Summary of this section: First of all, to meet the development goals of Thailand's new energy power industry, there must be certain requirements for the upstream manufacturing level of solar energy and wind energy. From the perspective of Thailand's overall manufacturing level, although Thailand's manufacturing industry is developing rapidly, Thailand's circuit integration board, semiconductor technology, silicon industry and wind energy gearbox and other industries are not developing at a high level, while China is in solar panels. The development level of high-purity polysilicon and semiconductor industry is at the forefront of the world, bringing good investment opportunities to related companies in China.

In addition, new energy companies can also extend energy to non-electrical areas, such as solar electric vehicles, biomass fuel-powered vehicles and so on. China has also made certain achievements in the development of solar electric vehicles. For example, BYD, Geely Group and BAIC Group have all produced solar electric vehicles. Therefore, based on the development of Thailand's electric vehicle development plan, the development of related fields has also brought great investment opportunities for the development of new energy power.

5.5 corporate strategy and horizontal competition.

5.5.1 Analysis of corporate strategy and influencing factors

From the above overview of Thailand's power system, from power generation to transmission and distribution, the entire value chain is largely controlled by the country. Since 1992, in order to promote competition in the power industry, the Thai government has gradually promoted private power producers to launch power generation businesses with small power producer (SPP), Very small power producer (VSPP) and independent power producer (IPP). The size of the generator of SPP is between 10MW and 90MW, and the electricity generated by these generators is only allowed to be sold to EGAT. While the power generation of VSPP is equal to or less than 10MW, the power of these generators can be sold to the EGAT ,and can also be supplied to the MEA and PEA depending on where the grid is connected. The Electricity Generation Authority purchases electricity from private operators through the Power Purchase Agreement (PPA) to secure the national electricity supply. Private power producers guarantee a fixed time and corresponding financial benefits through corresponding power purchase agreements, so that the investment in renewable energy can be guaranteed.

In terms of influencing factors, the most important factor is the policy of on-grid price of Thailand. Because the power industry is a special industry, it needs to rely on Thailand's on-grid price support plan under the premise of high investment and limited return. For the first time in 2006, the Adder “premium price” program was launched for small and micro-sized power companies. It adds additional surcharges above the normal purchase price. The surcharge rate will vary depending

on the type of renewable energy technology and the size of the plant. The most attractive resources in the Adder program are solar projects and wind energy projects. The solar project has the highest purchase price of 6.50 Baht/kw, and the wind power purchase price is 3.50Baht~4.50Baht/kWh. For biomass energy and biogas, it is only 0.30 Baht~0.5Baht/kWh. In addition, in the three provinces bordering Malaysia on the southern border, due to certain security risks brought about by the independence movement in the region, additional prices have been deliberately added to promote investment.

However, the Adder program has a degree of uncertainty for investors, developers and end users. In 2013, the Ministry of Energy turned to small-scale power generation companies from adder to new energy power feed-in tariff (FIT) project, thereby encouraging more micro-generation enterprises to participate, and to reinforce the confidence of investment companies with more long-term plans.

The FIT price is composed of three parts. FIT (F) is a fixed price and takes effect within the agreed time. FIT(i) is a price that varies flexibly according to factors such as inflation and corporate financial conditions. This category usually targets the generation of biogas, biomass and waste. FIT(T) is a subsidy fee divided into two project types. The first category is support for any project that uses renewable fuels for eight years. The second category is for projects located in the three southern provinces of Thailand, which will be fully supported throughout the project. The Adder project also subsidizes the costs of the three southern provinces, but in the Adder project, due to low electricity prices and short deadlines, this is not enough for investors to bear the security risks in the region. The FIT program increases the attractiveness of investment in the three southern provinces by

providing continuous support for the long duration of the entire project.

(Information is summarized from the website of the Ministry of Energy)

Table 7 Electricity price subsidy for new energy projects of micro power generation enterprises

		FIT（F）(Baht/kwh)	FIT（V2017）(Baht/kwh)	Deadline（Year）	FIT additional subsidy	
					For bioenergy（8Year）	Southern Province (Baht/kwh)
Solar Energy		5.66	-	25	-	-
Wind Energy		6.06	-	20	-	-
Small water energy	≤200kw	4.90	-	20	-	0.5
Biomass	≤1mw	3.13	2.21	20	0.5	0.5
	1mw-3mw	2.61	2.21	20	0.4	0.5
	≥3mw	2.39	1.85	20	0.3	0.5
Biogas		2.79	2.55	20	0.5	0.5
Waste biogas		3.76	-	20	0.5	0.5

Source: Ministry of Energy, Thailand

5.5.2 Industry competition

There are three types of competition in the industry. The first is the competition among the new energy and power companies in Thailand, the second is the competition among foreign power companies investing in Thailand, and the third is the power companies in Thailand and neighboring power companies. Competition between. The reasons for competition, on the one hand, due to the geographical location, resource status, economic development level, and labor price of Southeast Asian countries are mostly similar. China’s investment in Thailand’s new energy and power industry needs to consider factors such as investment level and cost competitiveness. It is necessary to consider producers in other countries to establish solar, wind and other production bases in neighboring countries with good economic development levels such as Malaysia, and there is commercial competition among them. On the other hand, in order to encourage private power generation companies to participate in the competition, the Thai government has simplified the relevant bidding procedures, strongly supported and encouraged Very small producers to participate in the new energy power generation industry. This is a very favorable investment opportunity for China's five major state-owned large-scale power generation enterprises, subordinate wholly-owned or small-scale power generation enterprises, and electric power construction enterprises.

Summary of this section: The corporate strategy of new energy power companies is relatively simple compared to other industries. Due to the particularity of the power industry, all electricity produced is purchased by the state and then distributed and delivered. Therefore, the main factor affecting corporate strategy is the on-grid tariff policy. Different times will adjust the on-grid price for different

status quo, so the change of on-grid price has a lot to do with the amount of subsidies and the length of subsidy. Nowadays, Thailand has implemented a long-term continuous on-grid tariff subsidy and auxiliary value-added program, which is very attractive for enterprises that invest in power generation. Chinese enterprises, especially micro-scale biomass power generation enterprises with a power generation scale of less than 10MW. There is a great investment prospect in Thailand. As for the competition in the same industry, the competitive environment experienced by Chinese companies in the field of new energy and power in Thailand is not only conducive to the development of Thailand in this field, but also a challenge for China to develop.

Chapter VI Conclusions and Prospects

6.1 Conclusion

This paper analyzes the current situation of Thailand's new energy industry, the current situation of Chinese investment in Thailand's new energy industry, and uses Porter's theory to conclude that China has great investment opportunities in Thailand's new energy power market.

First of all, through the analysis of the status of the new energy industry in Thailand, it is found that the existing electricity market in Thailand is generally stable. Since the state has attached importance to renewable energy generation in recent years, it has set certain targets for the power generation capacity and consumption of renewable energy generation in the future. However, the existing power grid in Thailand is not in line with the development of new energy, so the upgrade of the power grid is imminent, which brings considerable investment

opportunities for Chinese enterprises in grid design technology.

Secondly, by analyzing the current investment situation of existing Chinese enterprises in Thailand's new energy industry, understand the current investment environment of Thailand's new energy industry and the trends of Chinese investment in the future.

Then, based on Porter's theory of competitive advantage, China's investment opportunities in Thailand's new energy power industry were analyzed separately. First, the two governments strongly supported. Second, Thailand's rich new energy natural resources complemented China's technology. Third, industry complementarity in related industries; Fourth, Thailand's electricity price plan can be an important factor affecting Chinese corporate strategy.

In general, Thailand's new energy power market has great investment opportunities.

6.2 Prospects

Energy is the material basis of human activities. The traditional energy crisis has led to the exhaustion of energy resources. The issue of energy security and the increasingly serious environmental pollution are gradually threatening the survival and development of human beings. Based on the principle of sustainable development of limited resources and environmental protection, A prelude to a new energy revolution around the world has begun. As the largest user of traditional primary energy, the power industry needs to play a leading role in this wave of new energy revolution, vigorously research and develop new energy conversion technologies, and accelerate the comprehensive utilization of new energy

development.

Because the research scope is too broad, the author's research ability is relatively insufficient, which leads to certain limitations: on the one hand, the analysis of investment opportunities can only be analyzed from the macro aspect based on Porter's national competitive advantage, it is difficult to quantify relevant indicators. On the other hand, due to the extensive scope of the paper and the difficulty of data query, the lack of comparative analysis of the competitive disadvantages of various countries in Thailand's new energy power industry has led to a lack of research depth. Therefore, in the future, it is necessary to continue to strengthen the collection and analysis of relevant data and data to make up for the defects left in this article.

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