

# Analysis and Investment Recommendations of the Photovoltaic Industry in China

Zerui Hao\*

The High School Affiliated to Renmin University of China, Beijing, China

\*Corresponding author: 631512345678@mails.cqjtu.edu.cn

**Abstract.** This paper provides a comprehensive analysis and recommendations for investment in China's photovoltaic industry. Through policy analysis and supply and demand model analysis, the investment value and prospect of China's PV industry segments were analyzed and the conclusion that the distributed PV industry is supported by policies and the market was found; under the calculation of the corporates' Beta Assets, the business risks of representative companies were showed and compared. The main findings of the paper are that the distributed PV industry in China has the highest business risk, Jinko Power Technology Co. The industry has high investment value and development prospects, and CHINT Electronic and Impower Technology Limited are good investment targets in the industry.

**Keywords:** Photovoltaic; Distributed photovoltaic power generation; Photovoltaic power plant.

## 1. Introduction

### 1.1 Background

On September 22, 2020, General Secretary Jinping Xi made a solemn commitment at the 75th General Debate of the United Nations General Assembly that China will increase its autonomous national contribution to addressing climate change, adopt more vigorous policies and measures, strive to peak CO<sub>2</sub> emissions by 2030, and strive to achieve carbon neutrality by 2060. By 2030, the proportion of non-fossil energy in primary energy consumption will reach about 25%, forest stock will increase by 6 billion cubic meters compared to 2005, and the total installed capacity of wind and solar power will reach more than 1.2 billion kilowatts. As a major new energy industry, the Photovoltaic industry is bound to be supported by the policy environment. After statistics, the PV industry in 2020 annual investment of more than 450-billion-yuan, 2021 investment of nearly 750 billion yuan, and in the first half of 2022 PV industry expansion investment exceeded 600 billion. Over the past two years, China's PV industry grew rapidly. Only in the first half of 2022, domestic PV installations increased by 30.88GW, up 119% year-on-year. However, a large amount of capital inflow also led to capital saturation of the current Chinese photovoltaic industry, which causes the investment value to reduce significantly. Fortunately, due to the huge size of China's PV industry, there are still some segments within the industry that have great investment value.

### 1.2 Related research

Wang et al. conducted an in-depth analysis and research on the situation of China's PV industry in 2021 and the forecast and outlook for the industry to 2022. As for the development of the PV industry in 2021, through the analysis of industrial scale, technology development, and representative companies, the authors found that the core technology of the PV industry in 2021 is significantly developed, the manufacturing end, the advantages of head enterprises are obvious, supply chain prices rise, and investment costs are significantly higher. Through policy analysis and market research, the authors predict that in 2022, the PV powering market will continue to expand and the core technology of PV powering will continue to develop. However, there will be many obstacles in infrastructure construction and supply chain coordination [1]. China Business Information Network provided a systematic analysis of the upstream, midstream, and downstream of the supply chain of the Chinese photovoltaic industry in 2022. The authors listed the specific sub-industries in the upstream, midstream, and downstream. The upstream includes the production of industrial silicon, silicon,

wafers, silver paste, and other industrial raw materials; the midstream industry includes the manufacture of core components like PV generators, solar panels (including cells and PV modules), intelligent controllers, and PV inverters; the downstream industry includes the construction of specific facilities such as centralized PV power plants, distributed PV power plants, and PV products. For each industry segment, the author introduced three aspects: production volume changes, representative companies, and the competitive landscape [2].

Wang et al. provide an in-depth analysis of the distributed PV industry in China. The authors propose that as the distributed PV installation industry is supported by policies and current electricity prices are rising and PV is moving towards parity, user demand for distributed PV installations will further increase and the market has more room for development. The authors also introduce the main business and industry scale of six representative companies in this industry [3]. The Qianzhan Industry Research Institute conducted an in-depth analysis of the monocrystalline silicon industry within the 2021 Chinese PV industry from 4 aspects: market size, market share, product structure, and representative corporates. For the industry scale, there is no significant growth in China's monocrystalline silicon production and sales in 2020, and the industry scale growth rate slows down. The authors also mentioned that the share of monocrystalline silicon in China's PV industry is growing rapidly from 2017 to 2020. In terms of product structure, the 2020 China monocrystalline market mainly consists of monocrystalline wafers (P-type and N-type), polycrystalline wafers, and ingot monocrystalline, of which P-type monocrystalline wafers account for the largest share. Finally, for the main enterprises, the authors propose that 2015-2021 monocrystalline silicon enterprises rise year by year but the growth rate slows down, and the largest enterprise in 2021 is LONGi Green Energy Technology Co., Ltd. [4].

The Qianzhan Industry Research Institute analyzed the China silicon materials market in 2022. Silicon materials can be divided into three parts: industrial silicon, monocrystalline silicon, and polysilicon, where monocrystalline silicon and polysilicon are produced by secondary processing of industrial silicon. In terms of market share, China's industrial silicon will account for the largest share (80%) of the silicon materials industry in 2021, followed by polysilicon (15%) and monocrystalline silicon (5%). In terms of production scale, industrial silicon is the largest, reaching 2.61 million tons, polysilicon reaches 500,000 tons, and monocrystalline silicon reaches nearly 150,000 tons [5]. The Qianzhan Industry Research Institute provided an in-depth analysis of China's solar cell industry in 2021 from three aspects: industry composition, industry status, and the competitive landscape. According to the authors' statements, solar cells are mainly divided into crystalline silicon solar cells, thin-film solar cells, and third-generation solar cells, and their industry chain is upstream for raw material processing, midstream for device manufacturing and downstream for the construction of application products. For the current state of the industry, the authors pointed out that the demand and supply of solar cells are growing rapidly; imports, due to the epidemic, declined in large; exports had no significant decline. At present, the vast majority of leading companies in the solar cell market business cover the entire industry chain and occupy most of the market share [6].

Peng provided an in-depth analysis of the photovoltaic inverter industry. The PV inverter mainly contains three types of products: string inverter, centralized inverter, and cluster inverter. The upstream of the industry chain is the production of components (IGBT, PMIC chips); the midstream is the manufacturing of PV inverters, and the downstream is various contractors. Given the current market situation, the author proposed that the production, sales, import, and export of PV inverters in China had increased in 2021; string PV inverters accounted for the largest share (67%) within the market, followed by centralized PV inverters (29%) and decentralized PV inverters (5%) [7]. The Qianzhan Industry Research Institute analyzed the current industry situation and forecast the market outlook for PV inverters for 2022. The authors predicted that PV inverter technology will further develop and the power density is expected to reach 3.5 kW/kg by 2030. technological developments had led to a further decrease in PV inverter unit investment costs and a further increase in demand size, which is expected to reach \$20 billion in 2027. [8]

### 1.3 Objective

This paper will analyze the current investment value of China's photovoltaic industry, identify the segments worth investing in, analyze the investment value and risk of representative companies in the industry, and give investment recommendations.

## 2. Method

$$\beta_A = \frac{\beta_E}{\left[1 + (1 - T) \left(\frac{D}{E}\right)\right]} \quad (1)$$

Where  $\beta_A$  measures the unlevered beta of the corporate,  $\beta_E$  measures the levered beta of the corporate, T measures the corporate's tax rate, D measures the corporate's market value of debt and E measures the corporate's market value of equity.

$$E = \text{Number of Outstanding Shares} \times \text{Share Price} \quad (2)$$

Where E measures the market value of Equity.

$$T = \frac{\text{Income Tax Expenses}}{\text{Total Profit}} \quad (3)$$

Where T measures the corporate's tax rate.

## 3. Overall analysis of the Photovoltaic Industry

### 3.1 Industry Chain Introduction

The industry chain of the photovoltaic industry is mainly divided into upstream, middle, and downstream. The upstream of the photovoltaic industry chain mainly includes the production and processing of industrial raw materials. Among them, silicon and silicon wafers occupy the main position. The midstream is the manufacture of photovoltaic equipment components, mainly including cells, PV modules, inverters, etc. The downstream is the installation and application of PV power plants, which are mainly divided into two categories: centralized PV power generation and distributed PV power generation.

### 3.2 Upstream Segment Analysis

In the first half of 2022, China installed 30.88 GW of photovoltaic power generation, up 137.4% year-on-year. Polysilicon production of about 365,000 tons, up 53.4% year-on-year; wafer production of about 152.8 GW, up 45.5% year-on-year. Comparing the two data, the increment of upstream raw material production is smaller than the increment of installed capacity, which shows that the current market demand for silicon wafers and silicon materials is larger than the supply, resulting in a sharp increase in prices and rising profits for enterprises.

However, in the long run, higher raw material prices will inevitably lead to more projects coming on stream. The increase in supply due to the increase in the number of suppliers will cause the prices of upstream industrial raw materials to start falling. It is clear that the best time to invest has been missed.

### 3.3 Midstream Segment Analysis

As of August 2022, the price range of monocrystalline reinjection material in China is 300-312,000 yuan/ton; the price range of monocrystalline dense material is 298-310,000 yuan/ton; the price range of monocrystalline cauliflower material is 295-308,000 yuan/ton. Compared to the price in August 2021, the price had risen by 100,000 yuan. The rise in raw material prices makes the production cost of midstream photovoltaic power generation components higher, lower profit margins, and does not have short-term investment value.

In the long term, PV modules are in a period of accelerated technological iteration to N-type modules with higher conversion efficiency and higher power generation than P-type PERC. Therefore, technology iteration caused by product obsolescence will make a significant risk for midstream companies in the PV industry chain. It is worth mentioning that many central enterprises such as CGN New Energy, China Huadian Corporation Ltd., and State Power Investment Corporation have already started bidding for N-type modules, and these companies will have better development prospects.

### 3.4 Downstream Segment Analysis

The construction of photovoltaic power plants downstream of the industry chain mainly includes two forms: centralized photovoltaic power plants and distributed photovoltaic power plants. In 2021, 29.28GW of new distributed PV installations were installed in China, accounting for 53.35% of new PV installations, the first time in recent years that the scale of distributed PV installations exceeded that of centralized PV installations, and the trend continued in 2022 Q1, with 8.87GW of new distributed installations, accounting for 67.15% of new PV installations. It can be seen that distributed PV installation is in the stage of rapid development, while the centralized PV installation market has tended to saturate, distributed PV installation has more investment value regardless of the short term.

Policy, June 20, 2021, the National Energy Board issued "on the submission of the whole county (city, district) roof distributed photovoltaic development pilot program notice", proposed in a relatively rich roof resources of the county (city, district) large-scale development of roof distributed photovoltaic, and put forward the party and government organs can be installed on the roof of the total area of photovoltaic power generation ratio of not less than 50%; schools, hospitals, village committees, and other public buildings The proportion of photovoltaic power generation that can be installed on the total roof of public buildings such as schools, hospitals, and village committees is not less than 40%; the proportion of photovoltaic power generation that can be installed on the total roof of industrial and commercial plants is not less than 30%, and the proportion of photovoltaic power generation that can be installed on the total roof of rural residents is not less than 20%. The policy support makes distributed PV installation more promising in the future, with long-term investment value.

## 4. Distributed Photovoltaic Power Generation Corporate Analysis

### 4.1 Introduction to Distributed Photovoltaic Power Generation Industry

Distributed photovoltaic power generation refers to photovoltaic power generation facilities that are built near the customer's site and operate on the customer's side for self-consumption, with excess power supplied to the grid. At present, the application site of distributed photovoltaic power generation is mostly commercial buildings, plants, and other public buildings on the roof. This new type of energy utilization can not only reduce the consumption of fossil energy in the region but also effectively increase the power generation capacity of PV power plants of the same scale, while effectively solving the problem of power loss in voltage boosting and long-distance transportation. The representative companies of China's Distributed photovoltaic power plants Industry are Impower Technology Limited, Jinko Power Technology Co., Ltd., and CHINT Electronic.

## 4.2 Business Risks Analysis

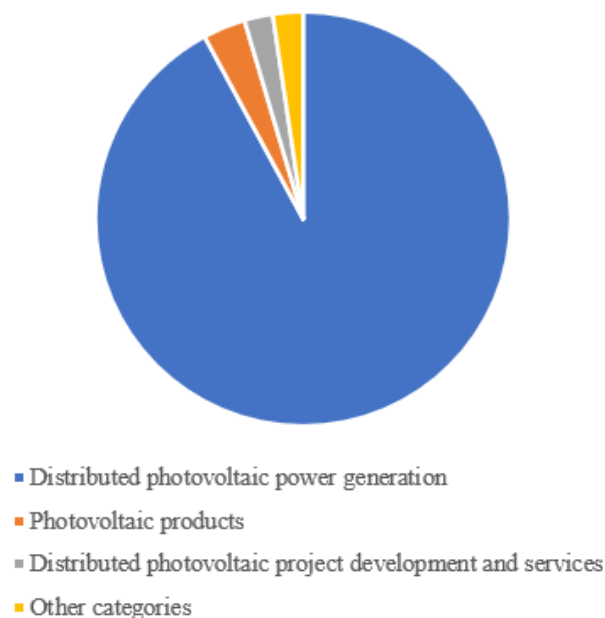
### 4.2.1 Data Comparison

**Table 1.** Data Comparison of the three corporates.

| Data Type (2021)       | Impower Technology Limited | Jinko Power Technology Co., Ltd. | CHINT Electronic |
|------------------------|----------------------------|----------------------------------|------------------|
| $\beta E$              | 1.06                       | 1.00                             | 1.08             |
| Tax Rate               | 0.140                      | 0.194                            | 0.165            |
| Market Value of Equity | 8,310,000,000              | 17,409,700,000                   | 115,864,000,000  |
| Market Value of Debt   | 1,531,000,000              | 17,681,000,000                   | 50,982,000,000   |
| Leverage (D/V)         | 0.156                      | 0.504                            | 0.306            |
| Leverage (D/E)         | 0.185                      | 1.016                            | 0.440            |
| $\beta A$              | 0.915                      | 0.550                            | 0.790            |

### 4.2.2 Business Categories Analysis

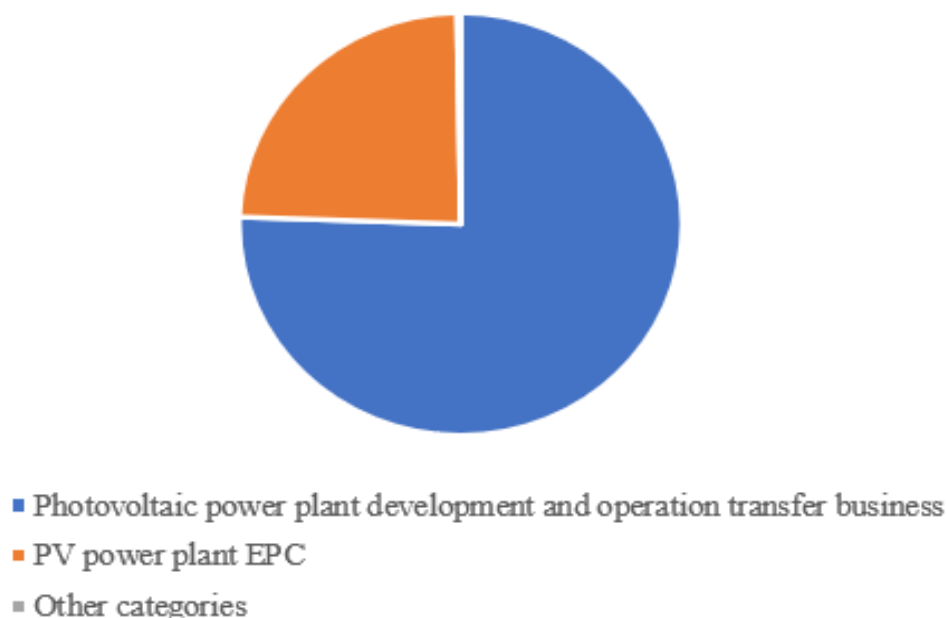
The homogeneity of business categories is one of the main reasons for the highest  $\beta A$  of Impower. Impower Technology Limited's main business is Distributed photovoltaic power generation, photovoltaic product manufacturing, and distributed photovoltaic project development and services from 2017 to 2021, the Company's photovoltaic product manufacturing and photovoltaic project development businesses account for a shrinking share each year. As of 2021, Impower's Distributed photovoltaic power generation business operating income was 408 million, accounting for 91.56%, while the PV product manufacturing and distributed PV project development and service business revenue accounted for only 3.29% and 2.21%. The monolithic nature of the business makes Impower's business risk the highest.



**Fig 1.** Impower Impower Technology Limited Operating Income Distribution in 2021.

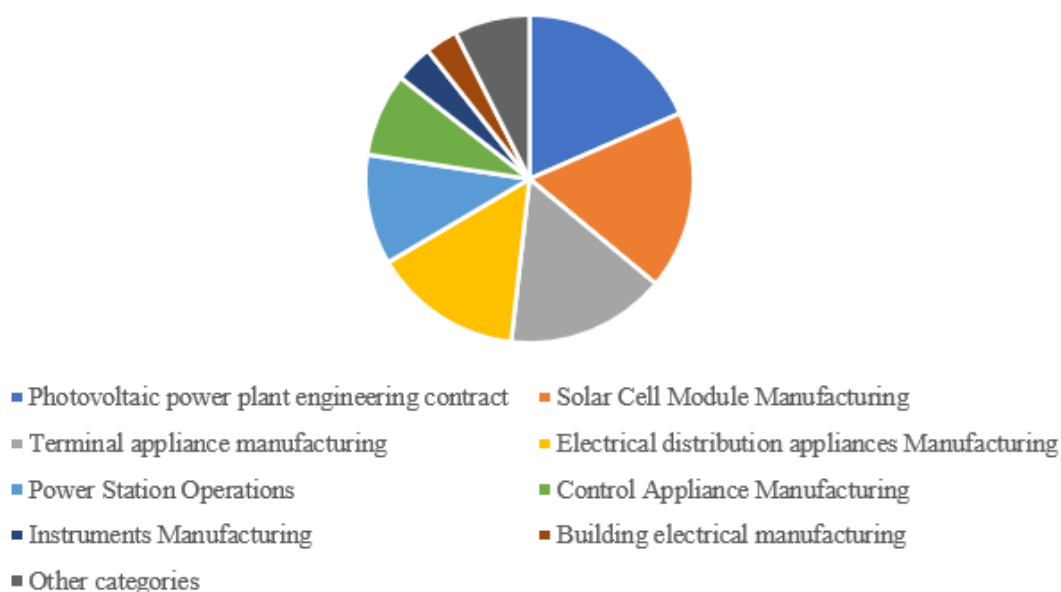
The main business of Jinko Power Technology Co., Ltd. is photovoltaic power generation, photovoltaic power plant EPC business, and photovoltaic power plant voice maintenance and consulting. As of 2021, Jinko's Photovoltaic power plant development and operation transfer business generated revenue of 2.776billion yuan, accounting for 75.53% of revenue, and the PV power plant EPC business generated revenue of 889million yuan, accounting for 24.2%. It is worth mentioning that Jinko's PV power generation industry generated a total of 4.779 billion kWh in the first three

quarters of 2021, of which 2.079 billion kWh was generated by centralized power plants and 2.7 billion kWh by distributed power plants. In summary, although Jinko's revenue is also dominated by the PV power generation industry, the strategy of developing both centralized and distributed power generation models in this field is conducive to adapting to different user needs and catering to the direction of market development, making Jinko more risk-resistant, which is one of the main reasons why Jinko has the lowest  $\beta_A$ .



**Fig 2.** Jinko Power Technology Co., Ltd. Operating Income Distribution in 2021.

CHINT has a wide range of businesses, including the contracting of photovoltaic power plants, the manufacture of solar modules, the manufacture of terminal appliances and distribution appliances, and the operation of power plants. CHINT has no obvious business focus, and the revenue generated by each business is relatively even. Although such a business distribution pattern has improved the company's adaptability and weakened the impact of market changes on the company, it greatly increased the company's operating costs, especially in the case of CHINT's products are mostly customized. This makes CHINT a relatively high business risk for its owners.



**Fig 3.** CHINT Electronic Operating Income Distribution in 2021.

#### 4.2.3 Business Categories Analysis

Impower's core profiting method is to own and operate distributed photovoltaic power plants, from which it earns power generation income by selling the power generated by the plants. The company signs an energy management contract with the owner of the rooftop resource, after the power plant is completed and operated, the power generated will be given to the owner of the rooftop resource for priority use, and the owner of the rooftop resource will be given a certain discount on the electricity price or paid a certain lease fee. If there is any surplus power after the power plant is used by the rooftop resource owner, the surplus power will be sold to the grid. Under this profiting model, the business risk is high due to two reasons: first, settlement of electricity bills for electricity used by rooftop owners is susceptible to fluctuations in electricity prices, so revenue is relatively elastic; moreover, the construction of the power plant requires high-quality rooftop resources and is difficult and costly to develop.

Jinko's revenue is also derived from the sale of electricity from power plants and from contracting for power plant construction work. The difference is that Jinko sells all of its power generations directly to the grid, so the income is stable and less risky. The power plant contracting business is more tied to customers, so it is not easy to lose customers in the short term and the revenue is relatively stable. Therefore, Jinko's business risk is low.

CHINT is mainly engaged in two industries, low voltage electrical and photovoltaic. The low-voltage electrical industry has a wide range of brands and high demand, but the competition is relatively fierce. CHINT occupies a leading position in this industry and does not lack core technology, which makes it face less risk in this industry. For the photovoltaic industry, CHINT's market share is in the second tier, and its market competitiveness is not strong. 2021, CHINT has cooperated with state-owned enterprises and local industries to develop many new projects, which has opened up new profit space but also greatly increased its investment in the short term, making it face much higher commercial risks.

In summary, Impower Technology Limited has the highest business risk, Jinko Power Technology Co., Ltd. has the second, and CHINT Electronic has the lowest.

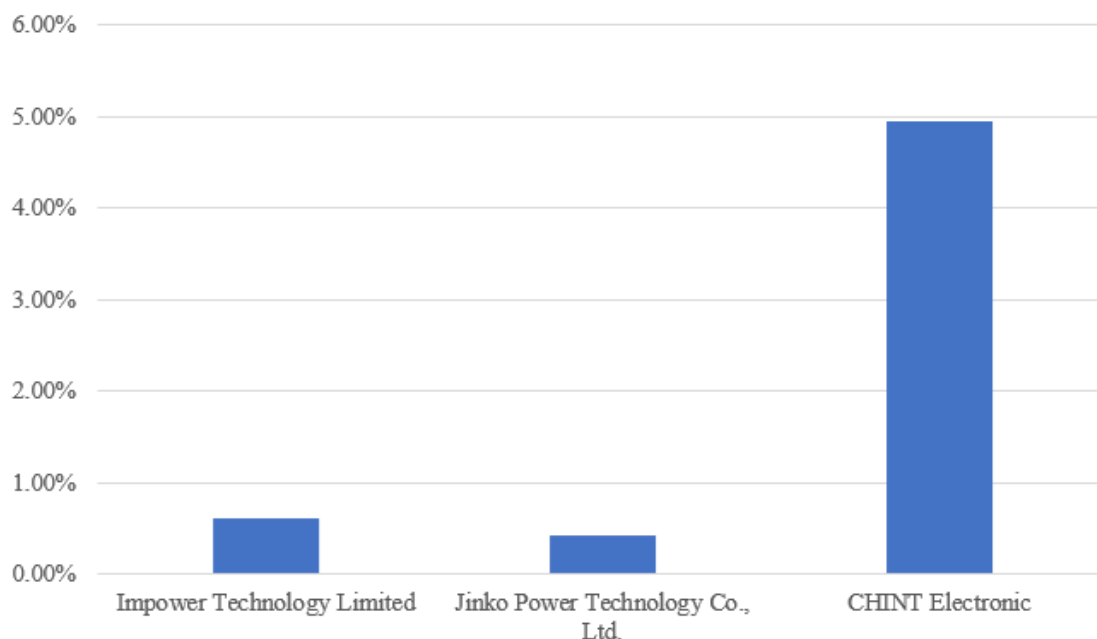
#### 4.3 Predicted Market Share Analysis

By the end of 2021, the cumulative installed capacity of distributed PV in China reached 126.8GW, with 19.95GW newly installed in the first half of 2022, up 156.9% year-on-year. According to this growth rate, by the end of 2023, the cumulative installed capacity of distributed PV in China will reach 206.6GW.

By the end of 2021, Impower's cumulative owned distributed PV plant capacity was about 605MW. by the end of the first half of 2022, the capacity increased by about 57MW to 662GW, and there are about 167MW of owned distributed PV plants under construction, to be built and to be contracted. combined with the above data, Impower's cumulative owned distributed PV plant capacity is expected to be about 830MW by the end of 2023. The cumulative distributed PV power plant capacity of Impower is expected to be 830MW by the end of 2023, plus 400GW of contracted operation capacity, totaling about 1.25GW, accounting for 0.61% of the total installed capacity in China.

By the end of 2021, Jinko's cumulative installed capacity of distributed PV will reach 830MW, an increase of about 10MW compared to the end of H1 2021, and at this growth rate, it is expected that the cumulative installed capacity will reach 870MW by the end of 2023, accounting for 0.42% of the total installed capacity in the country.

At the end of the first quarter of 2021, the total installed capacity of CHINT was 4.20GW, and by the end of 2021, the total installed capacity of CHINT distributed PV plants was 5.70GW, with an increase of 1.5GW in two quarters. according to this growth rate, the cumulative installed capacity is expected to reach 10.2GW by the end of 2023, accounting for 4.94% of the total installed capacity in China.



**Fig 4.** Comparison of the Corporates' Predicted Market Share in China's Distributed PV Power Generation in 2023.

#### 4.4 Investment Recommendations

After comparing the three companies, CHINT has moderate business risk, making it a relatively reliable investment target; in the long term, CHINT will maintain its position as a leading company in the distributed photovoltaic power generation industry, guaranteeing its strong profitability and the ability to maintain long-term growth; in the short term, CHINT has strong ability to capture resources and maintain high growth when the industry is supported by policies and the environment, making the short-term Return on investment guaranteed. So CHINT Electronic is the best corporate to invest. Meanwhile, Impower's capacity growth is also very strong in the short term, keeping pace with the rapid development of the industry and earning substantial revenue, making it a good short-term investment target. However, Impower is not a suitable long-term investment due to its high business risk.

## 5. Conclusion

This paper includes the analysis of the investment value of the upstream, midstream, and downstream segments of China's PV industry; the analysis of the business risks, and the prediction of the future market share of the three representative companies in the distributed PV power generation industry: Impower Technology Limited, Jinko Power Technology Co. Electronic, with investment recommendations were given. The Main Finding of this paper is that the distributed PV industry has the highest investment value in China's PV industry, and one of the representative companies in the industry, CHINT Electronic, is the best investment target, while Impower Technology Limited is a considerable short-term investment target.

## References

- [1] Wang, Q., Sun, D., Zang, H., Ru, J. & Jiang, H. (2022) China PV Industry 2021 Review and 2022 Outlook. *CHINA PHOTOVOLTAIC INDUSTRY ASSOCIATION (CPIA) & CCID Think Tank Integrated Circuit Research Institute*
- [2] China Business Information Network (2022) Upstream, midstream, and downstream market analysis of the industry chain in China's photovoltaic power generation industry in 2022. Available at: [https://www.toutiao.com/article/7143561597632381451/?app=news\\_article&timestamp=1663505194](https://www.toutiao.com/article/7143561597632381451/?app=news_article&timestamp=1663505194)

- &use\_new\_style=1&req\_id=2022091820463301015806601524B38BD7&group\_id=7143561597632381451&wxshare\_count=1&tt\_from=weixin&utm\_source=weixin&utm\_medium=toutiao\_android&utm\_campaign=client\_share&share\_token=334d914f-d00d-408d-8a8a-10bf432e1302&source=m\_redirect [Accessed 19 September 2022]
- [3] Wang, L. & Zheng, H. Zhongtai Securities (2022) Photovoltaic industry features: policy and market drive, focusing on the distributed photovoltaic. Available at: [https://www.toutiao.com/article/7115207961529664014?app=news\\_article&timestamp=1663505194&use\\_new\\_style=1&req\\_id=2022091820463301015806601524B38BD7&group\\_id=7143561597632381451&wxshare\\_count=2&tt\\_from=weixin&utm\\_source=weixin&utm\\_medium=toutiao\\_android&utm\\_campaign=client\\_share&share\\_token=334d914f-d00d-408d-8a8a-10bf432e1302&from\\_gid=7143561597632381451&from\\_page\\_type=article&source=m\\_redirect](https://www.toutiao.com/article/7115207961529664014?app=news_article&timestamp=1663505194&use_new_style=1&req_id=2022091820463301015806601524B38BD7&group_id=7143561597632381451&wxshare_count=2&tt_from=weixin&utm_source=weixin&utm_medium=toutiao_android&utm_campaign=client_share&share_token=334d914f-d00d-408d-8a8a-10bf432e1302&from_gid=7143561597632381451&from_page_type=article&source=m_redirect) [Accessed 19 September 2022]
- [4] Qianzhan Industry Research Institute (2022) Market size and competitive landscape analysis of China's monocrystalline silicon industry in 2021. Available at: <https://bg.qianzhan.com/report/detail/300/211112-9f5fc1ab.html> [Accessed 20 September 2022]
- [5] Qianzhan Industry Research Institute (2022) China Silicon Materials Industry Segmentation Development Status Analysis in 2022. Available at: <https://www.qianzhan.com/analyst/detail/220/220916-b1695052.html> [Accessed 20 September 2022]
- [6] Qianzhan Industry Research Institute (2022) In-depth analysis! A detailed understanding of China's solar cell industry market status, competitive landscape and development trend in 2021, 2022. Available at: <https://bg.qianzhan.com/trends/detail/506/220330-ee66f139.html> [Accessed 20 September 2022]
- [7] Peng, Z. (2022) China PV inverter market status analysis in 2021, 2022. Available at: <https://www.huaon.com/channel/trend/791249.html> [Accessed 20 September 2022]
- [8] Qianzhan Industry Research Institute (2022) China PV Inverter Industry Market Status and Development Prospect Analysis in 2022, 2022. Available at: <https://www.qianzhan.com/analyst/detail/220/220324-455c2766.html> [Accessed 21 September 2022]
- [9] Huatai Securities (2022) CHINT Electronic Research Report: Clear First Mover Advantage in Distributed Photovoltaic, Steady Growth in Low Voltage Appliances, 2022. Available at: <https://www.vzkoo.com/read/20220318fe713eadebd35bf14eb00c31.html> [Accessed 07 October 2022]
- [10] Intelligence Research Group (2022) Analysis of China's installed distributed PV capacity in 2021, 2022. Available at: <https://caifuhao.eastmoney.com/news/20220706091248267031420> [Accessed 07 October 2022]