Rosefinch Research | 2024 Series # 1

The Search for the Photovoltaic Star

In human history, there have been two major energy transitions. The first was the transition from firewood to coal, and the second was the dominance of oil. Now we are experiencing the third transition, which is the transition from fossil fuels to renewable energy.

Behind energy transition is not only the global consensus on carbon neutrality, but also the core interest of national energy security. As in most historical times, transition is not accomplished overnight, but full of trials and tribulations.

Over the past decade and a half, the power output of China's photovoltaic assembly has increased 2.5 times, while the price has dropped by more than 90% where the cost of PV electricity generation is on par with or even lower than coal-fired power. In 2022, photovoltaics accounted for 65% of the global newly installed capacity of electricity, but photovoltaic power generation accounts for only 4.5% of total global power generation, leaving huge room for further replacement of existing capacity.

Meanwhile, the cyclical pattern of "expansion investment → overcapacity → cost reduction and efficiency improvement → demand growth" has always dominated the participant behaviors, bringing cyclical fluctuations to the industry.

After a round of competitive expansion, overcapacity in photovoltaics in 2024 is very likely to materialize. How will the competition between TOPCon, HJT, BC and other battery technology drive changes in the industrial chain? The following is a recap and outlook for the photovoltaic industry organized by Rosefinch research team based on their strategy meeting this year, compiled into an article for sharing with investors.

1. What concerns does market have about Photovoltaic industry?

So far this year, the wind photovoltaic index has underperformed the broader equity market. Concerns about the photovoltaic industry can be summarized in one word: overcapacity. Will industry enter a downswing cycle in profits?

This worry can be divided into two aspects:

First, in terms of quantity, since 2019 when the photovoltaic industry entered a new cycle of parity pricing, the year-on-year growth rate of demand has continued to accelerate each year. As of now and the outlook for the fourth quarter, the year-on-year growth rate of demand for the photovoltaic industry in 2023 may set another new historic high in recent years, reaching an amazing 50%. Looking further, can this growth rate be sustained?

Second, in terms of profits, historically speaking, the peak of capital expenditures in the photovoltaic industry often coincides with the high point of the profit cycle, but the time difference in forming actual effective capacity is usually about one year.

In summary, given the sustained boom over the past two years, the market worries that in 2024, the industry's demand growth rate may slow while supply is accelerating. If there are no external constraints, overcapacity may indeed occur in the photovoltaic industry in 2024, and market concerns are reasonable.

At this time point, how should we view the photovoltaic sector?

2. The ongoing supply-side development in Photovoltaic industry

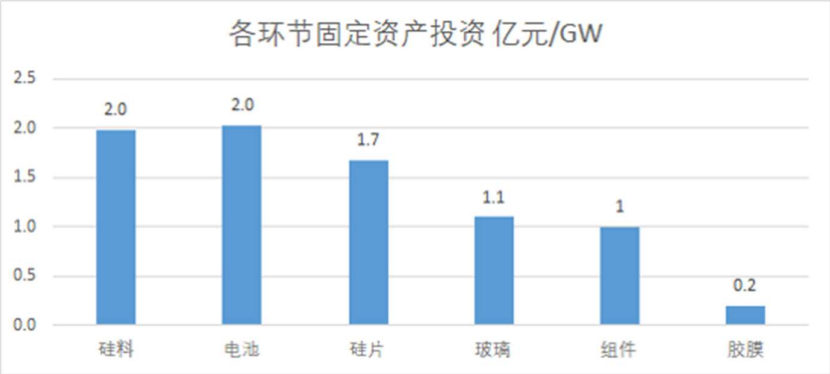
We believe that excessive pessimism is not necessary at the present time, for mainly three reasons:

First, the price to earnings ratio of the Wind's Photovoltaic Index has already reached near historical low in the past 9 years. Because this data series only has a history of about 9 years. This means that most of the concerns about the photovoltaic supply and demand contradiction in the market have already been reflected in the current stock price trend.

Second, if we take a longer time perspective, the compound annual growth rate of demand for the industry may still have a high probability of stable growth until 2030, even if the market is worried about whether next year's demand growth rate in the industry will slow down. Compared to other manufacturing industries, this growth rate is quite rare.

Third, there have been positive signals appearing recently on the photovoltaic supply side. The photovoltaic industry belongs to a capital-intensive manufacturing industry. We have statistically analyzed

the four main links in the main industrial chain, and considering only these four links, a minimum of 7 billion yuan in capital expenditure is required for every 1GW of photovoltaic production capacity.

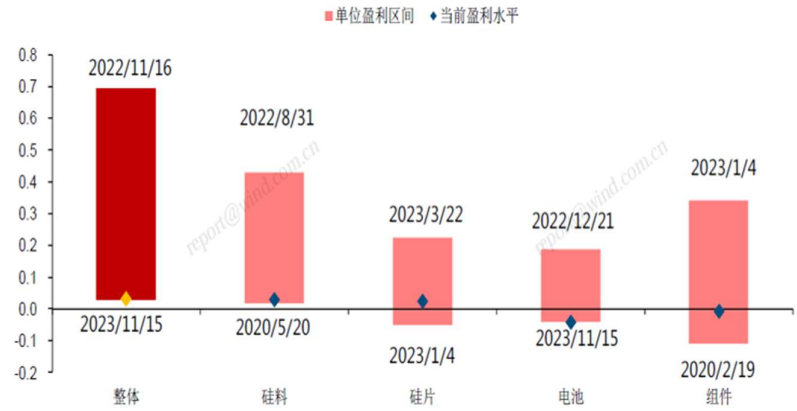


Source: Wind, Infolink, CSC Financial, Rosefinch.

Therefore, most companies' scale expansion depends on the financing environment of that year and the companies' own abilities to self-fund, and recently we have seen some positive changes in financing and profitability.

First, in terms of profits, the photovoltaic industry has shifted from a state of capacity shortages in recent years to an oversupply state. Price adjustments in the photovoltaic industrial chain are very rapid. By the fourth quarter, prices in the photovoltaic industrial chain have hit historical lows, and the profit situation of various links is basically in a break-even state.

The profit margin of various links in the photovoltaic industrial chain is in a relatively low range.



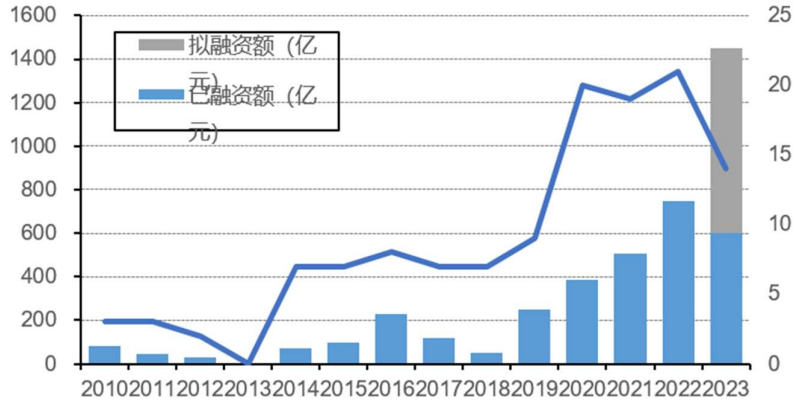
Source: Wind, Infolink, CSC Financial, Rosefinch.

For example, the payback period for 1GW of TOPCon batteries invested last year may have only needed half a year to one year previously, but now it may take 10 years or even longer, which would curb the very enthusiastic cross-sector capital seen last year.

On the other hand, from the perspective of tightening financing. As of the end of the third quarter of 2023, the market value of the photovoltaic industry was over 1.7 trillion yuan, and the amount of financing completed and planned this year exceeds 140 billion yuan. While the market value of A shares is about 80 trillion yuan, the annual financing amount is about 1.5 trillion yuan, which means that with a market value share of only 2%, photovoltaics has realized nearly 10% of financing share.

The rapid expansion of photovoltaic production capacity in recent years and the tightening of financing policies for photovoltaics will be a very important signal for the deceleration of future photovoltaic production capacity expansion.

Historical Photovoltaics industry financing



Source: CMS, CSC Financial, Wind.

After the tightening of financing policies, some companies have started to terminate IPOs and related capital increases, which may also mean that the production capacity scale originally expected to be put into production in 2024-2025 is likely to be greatly discounted, and the degree of overcapacity in the industry may not be as severe as predicted in early or mid-year.

What are some sub-sectors worth paying attention to in 2024?

3. Watching the industry transformation caused by technological innovations

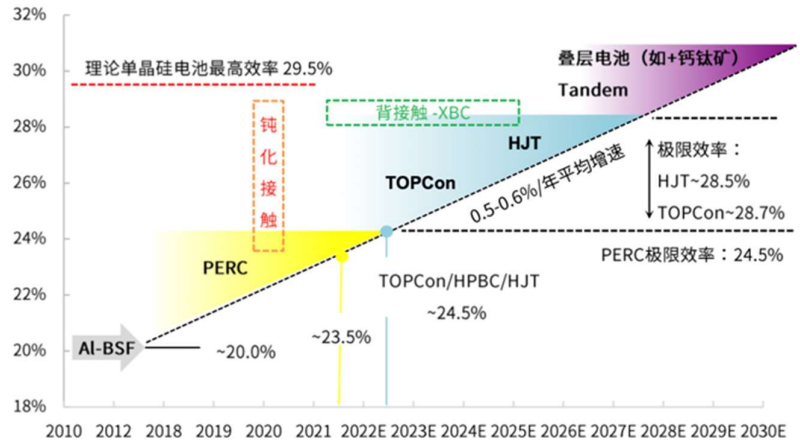
One of the directions that needs to be paid attention to is the transformation of the entire industrial chain brought about by technological innovations in photovoltaic cell technology.

First, the price of silicon materials has seen a significant decline recently, and future cost reduction space may be limited. In the future, the cost reduction of the industrial chain is more likely to focus on new technologies that can improve efficiency, and batteries are one of the links where the newest technical changes are being brewed.

Second, the future development space and potential of new photovoltaic cell technologies is still large. The previous mainstream technology was PERC, with a ceiling conversion efficiency of 23.5% to 24%, Starting in 2022, the industry began large-scale production of TOPCon, with initial conversion efficiencies ranging from 24% to 24.5%, and now after a year, the main efficiencies are between 25% and 25.5%.

According to public reports, if further iteration continues along new technology paths, the conversion efficiency of single crystal silicon cells can continue to increase, and technologies such as perovskite/silicon tandem structures have emerged, with the potential to even exceed 30%. We believe that technological iteration in the photovoltaic industry has just begun, and there is still great potential in the future.

Various Photovoltaic conversion rates and future outlook (as of 22.4)



Specifically in terms of industry and company choices, because there are multiple paths to improve the efficiency of silicon cells, there are still some divergences in technology direction selection among top companies in this round of new technology iteration. Some top companies will continue to upgrade the technology along TOPCon, such as double-sided poly, but at the same time, other companies in the industry choose to further expand production of BC and HJT.

Although it is difficult to determine now which technology path will definitely be the future mainstream, if following the path of efficiency improvement, it will be difficult to avoid development towards the BC structure in the future, but BC structures currently need to solve the cost-benefit issue. BC batteries have inherently higher open voltages and higher fill factors, and this technology is highly likely to attract enterprises to realize mass production.

During the process of rapid technological iteration, we often see it will bring some equipment upgrades and increases in single GW value. Although we cannot determine the technology direction with 100% certainty, some generic platform technologies will benefit from the iteration of these new technologies, including technologies that reduce silver consumption such as electroplating copper and 0bb, as well as

equipment segments such as laser equipment, which will benefit from the development of double-sided poly, BC structures develop.

4. The search for the photovoltaic star through the industry cycle

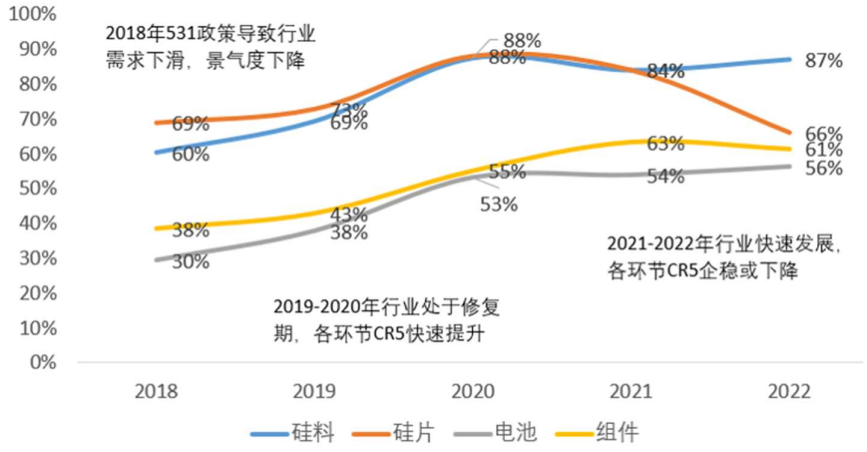
To increase our investment certainty, we search for photovoltaic industry leaders that can transcend cycles. In the next two years, the photovoltaic industry may go through a process of clearing excess capacity, and this round of clearing excess capacity may be tougher than in 2018. During this process, it is possible that a large number of enterprises may face elimination.

During this challenging process, what kind of enterprises really have the ability to transcend cycles? We believe there are several main conditions:

First, it must have stronger technical advantages and cost advantages, so as to ensure its own regeneration ability. Second, it must have stronger new technology iteration capabilities to keep up with this round of battery new technology innovations. Third, the liability side must be very healthy. We have done statistics on various links, and it is very obvious that different enterprises made different preparations in financial reports for this round of industry capacity clearing in the industry. If only indiscriminately expanding production capacity, there will indeed be risks of elimination, while some enterprises have prepared their financial war chest and also have technology and cost advantages.

Looking back at history, the industry bottom in the previous round was in 2018. After 2018, the degree of concentration in various links of the industrial chain has increased significantly. After this round of clearing excess capacity, the competitive landscape of the photovoltaic industry will be optimized more obviously, and barriers to entry will be further elevated with new technology iterations.

The degree of concentration in the industrial chain tended to increase after 2018.



5. The high-certainty growth path of electric equipment sector

From the perspective of the new power system, we believe there are high-certainty growth opportunities around power equipment, because the instability of wind and solar power output will have a certain impact on the power grid. Research from IEA shows that when the proportion of renewable energy reaches 15%, the industry's absorption bottleneck will gradually emerge. This critical value of wind and solar share in China is very likely to reach within the next year or two.

Some European countries have already reached this critical value. That is to say, with the development of the photovoltaic industry, we will see more and more countries facing related challenges. This also requires that regardless of the industry perspective or investment research perspective, new power systems cannot only focus on the power generation side, but also need to be able to see opportunities on the grid side, because the grid side also needs a lot of capital and support to achieve balance and flexibility between power systems.

According to BNEF statistics, the global annual investment in the grid end has reached $277 billion in 2022. So what specific directions should we focus on?

Since power equipment is a very broad concept, in the short term, our focus will be on grid equipment and energy storage. This is also related to the characteristics of our country. The load center is concentrated in Eastern China, but wind and solar power generation are concentrated in Western China. To resolve the differences between East and West, it is necessary to build UHV grids to balance electricity.

Early this year, we identified the development trend and positioned relevant grid hardware companies which had performed well. However, because market now has consensus around absorption opportunities, we believe future opportunities will come from more specialized sub-fields.

Looking at industry trends, on the one hand, the proportion of market-traded electricity in China will continue to increase. On the other hand, under the new power system, the degree of mismatch between the volatile new energy power generation and local charging loads will increase further. Power market trading with source matching, power balancing, and its core will likely be software. Software technology in the power industry will become a key part of future new power system construction.

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