Rosefinch Research | 2022 Series # 3

The Three Drivers Towards China's '3060' Goal

In the 3rd part of our Rosefinch 2022 Series, we take a deeper look at the three drivers of China's '3060' strategy. Below is the strategic outlook presented by Advanced Manufacturing Team 1's head Mr. HU Xiaojun 胡小俊 during the annual Rosefinch Strategy Review in late December. Here are some highlights:

- **China's strategic '3060' theme may create even bigger photovoltaic demand than our previous aggressive forecasts.**
- **The photovoltaic industry has rallied for three years since 2018. We believe the industry will see more differentiation ahead.**
- **Historically in emerging industries, major bull stocks will appear alongside key industry supply chain bottlenecks.**
- **We expect new photovoltaic technology will surpass current PERC prices within next 1-2 years. The corresponding new equipment or material providers will see a boom year in 2022.**
- **We see next 1-2 years as the kick-off years for energy storage, especially electrochemical energy storage industry.**

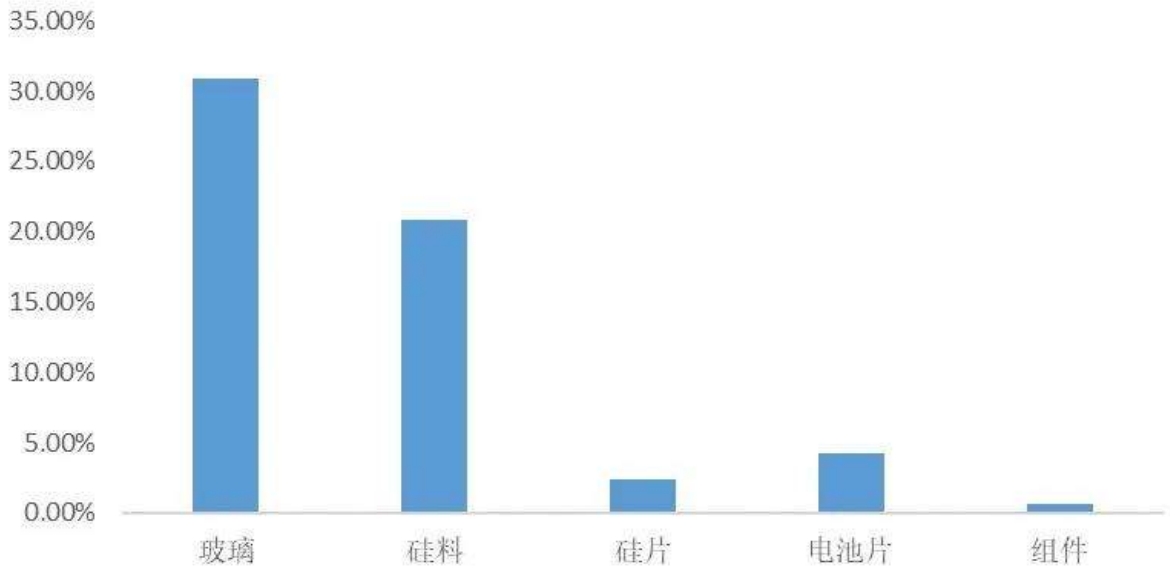
Please see Mr. Hu's detailed comments below:

The three industries that benefit directly from '3060' theme are photovoltaic solar energy, energy storage, and hydrogen energy. **We will first look at the photovoltaic solar energy industry.**

When it comes to carbon-emission, over 40% are energy related. Photovoltaic energy is used both directly for electricity generation and for potential collaboration in the remaining 60%. For example, in the construction sector which is unrelate to energy production, the combination of photovoltaic panels and construction will accelerate the development of the 'Building-Integrated PhotoVoltaic' or BIPV market. Once photovoltaic energy integrates with industry production, it will grow the green-hydrogen market. And when photovoltaic energy integrates with transportation sector, it will create new infrastructure like integrated power stations with photovoltaic energy storage capacities. Therefore, 3060 theme leads to bigger demands for photovoltaic energy than our previous aggressive forecasts. Of course, the market has pushed photovoltaic sector up in the last 3 years, where will be the opportunities in 2022?

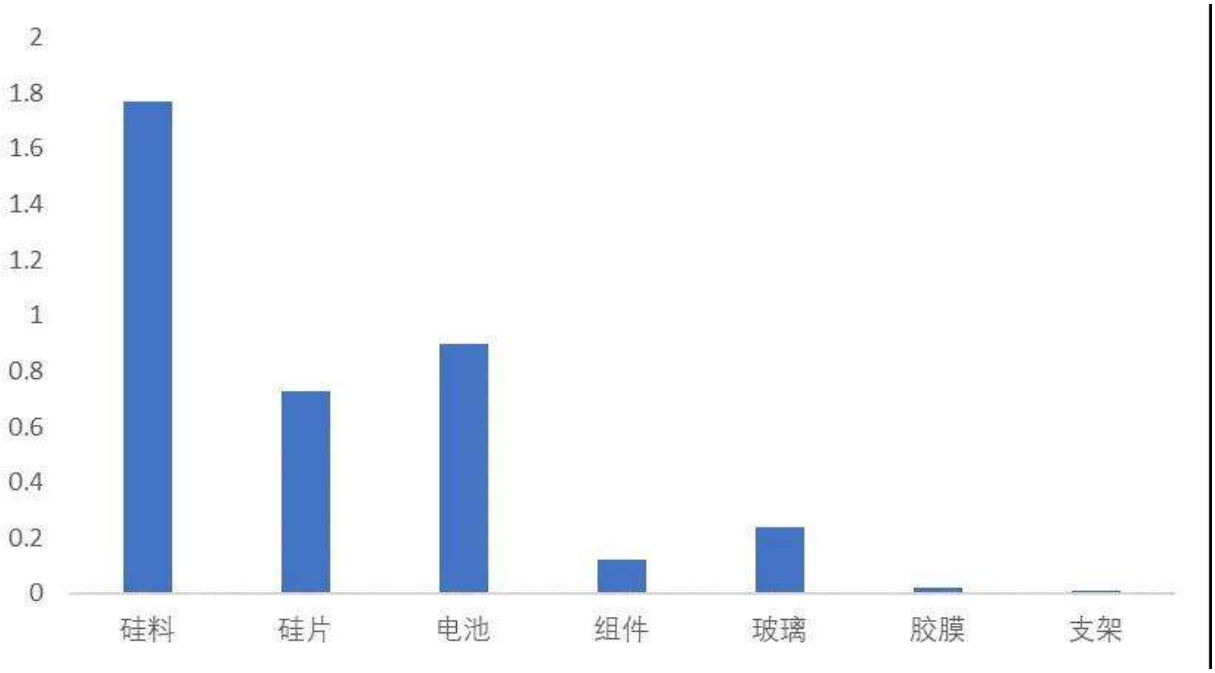
We believe photovoltaic industry will see further differentiation in 2022. **There are five investable themes within the photovoltaic industry. First, we looked the sub-industries with strong potentials, with the first being supply chain chokepoints.** Historically in emerging industries, major bull stocks will appear alongside industry supply chain bottlenecks. We saw such bottleneck rallies back in 2016 in Lithium, 2020 in glass, and 2021 in EVA (Ethylene and Vinyl Acetate copolymer). In these cases, the short-term supply chain bottleneck cut down supply, induced large price rallies, and saw multi-fold increases in stock prices for the controlling companies. We expect strong photovoltaic demand in 2022, which can easily lead to bottleneck situations if supply chain breaks down. When we analyzed the whole supply chain, those links that require long lead-time for capacity expansion or high energy consumption may see bottlenecks forming. Some examples of such links are silicon or photovoltaic glass panel.

Component Cost as % of Total Cost of Photovoltaic Solar Panel



Source: Rosefinch. Items from left: glass, silicon, silicon wafer, battery cell, assembly.

Electricity Consumption for 1Gw Power Station Components



Source: Rosefinch. From left: Silicon material, Silicon Wafer, Battery, Assembly, Glass, Film, Bracket

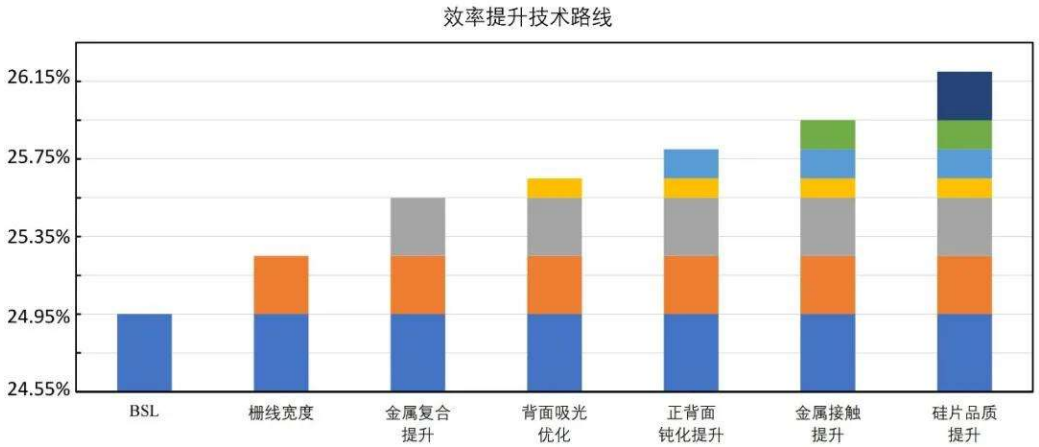
The second investable theme in photovoltaic sector in new technological innovation. Looking back at the development history of photovoltaic industry, it went through major technological innovation every

3 to 5 years. The current technology is the PERC or Passively Emitter and Rear Cells technology. The PERC technology was industrialized in 2017, and will enter its 5th year in 2022. We have noted some new technology like HJT or Hetero-JuncTion solar cells, and Topcon or Tunnel Oxide Passivated CONtact solar cells. These technologies' price to efficiency ratio is improving rapidly as material costs reduce while generation efficiencies improve. We forecast these new technology power generation efficiencies may exceed 25% in the next two years, which is a noticeable improvement to PERC solar cells' 22%-23%. In the world of solar cells, a 2-3% increase in overall efficiency is considered huge!

HJT Efficiency Improvement Routes

Source: Rosefinch. Different areas of potential improvement to increase efficiency.

Topcon Efficiency Improvement Routes



Source: Rosefinch. Different areas of potential improvement to increase efficiency.

Therefore, we expect new photovoltaic technology will surpass current PERC prices within next 1-2 years. The corresponding new equipment or material providers will see a boom year in 2022.

The third investable theme is the new applications for photovoltaic solar cells. There are many potential collaborations between photovoltaic cells and other industries, with the biggest potential in construction sector. This integration is more than simply installing solar panels on rooftops – the future trend is the full integration between solar panel and construction material. The photovoltaic assembly may be a construction material itself, so that the entire building's top and sides can be used for solar power generation. The advantage of such integrated approach is quite obvious, especially for industrial users. They have huge pressure to achieve carbon-neutrality in future. Once they have such integrated building material, it will both support their carbon-neutrality initiative and to reduce energy consumption needs off the electricity grid.

Potential for BIPV in Europe

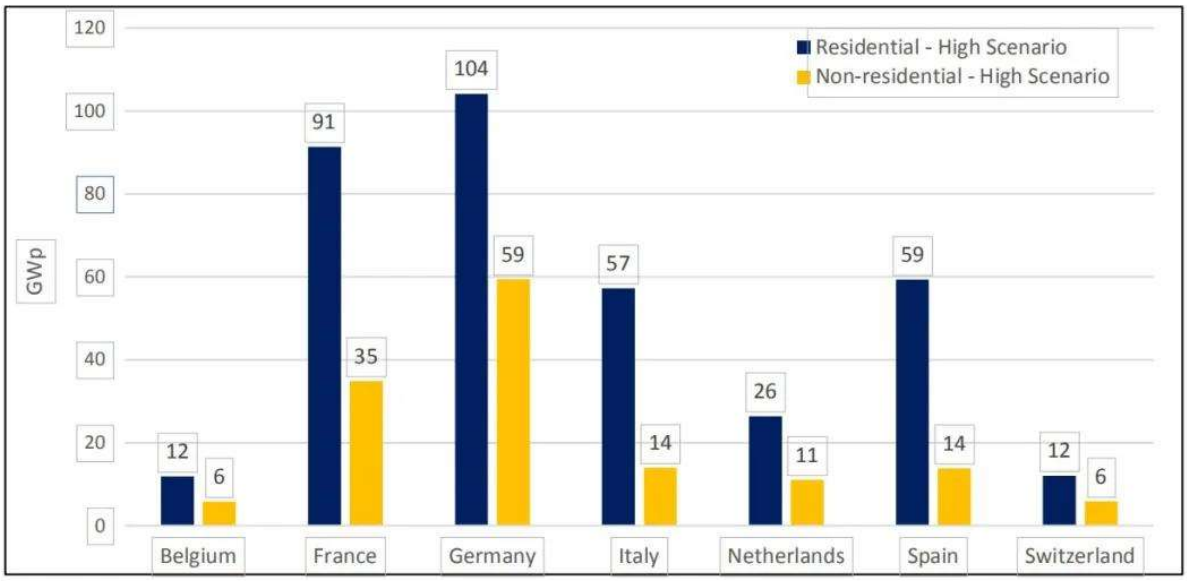
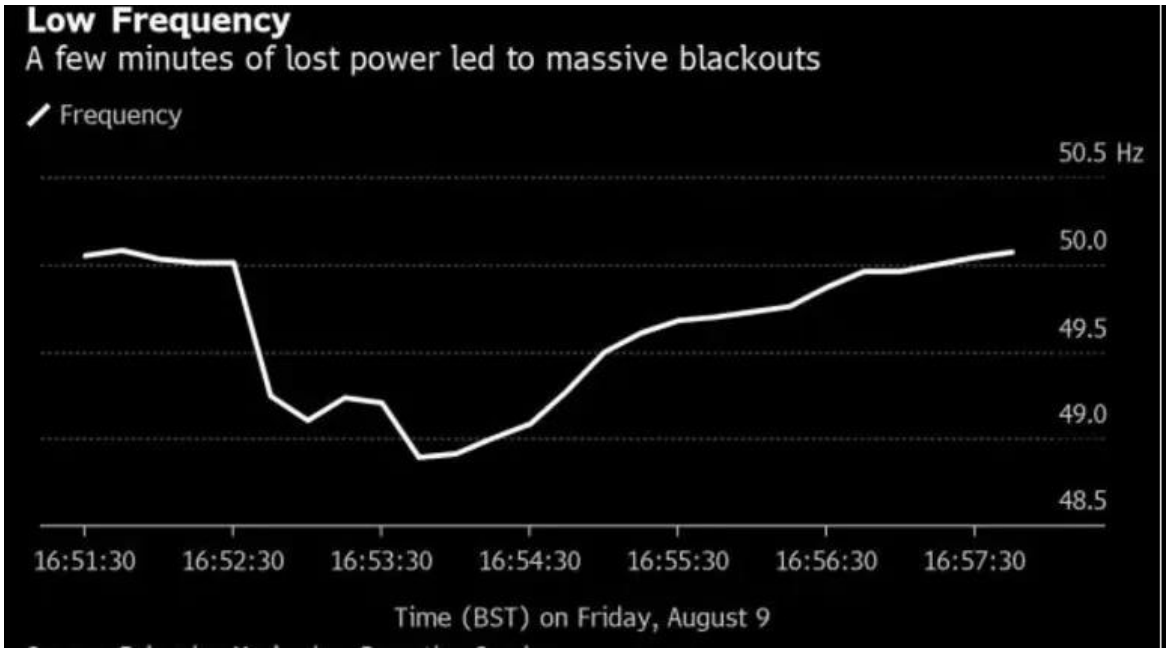


Figure 3.15 Potential of BIPV capacity in target European markets in the high scenario (Elaboration: Becquerel Institute)

In 2021, China saw a lot of power outages across industrial regions which had a large drag in industrial activities. In future, through combination of photovoltaic construction material and energy storage, this will effectively lessen the potential negative shocks from power outage. When we estimate the overall size of the photovoltaic construction material market, the potential is huge: if we assume 10% take-up in the market, this translates to roughly 500GW of annual installed capacity, which is 10 times the 2021 installed amount. There is therefore huge potential for companies supporting new applications of photovoltaic solar cells.

The fourth investable theme in photovoltaic industry is energy stability. Renewable energy is an intermittent energy source, causing stress to existing electricity grid. In August 2019, London had a 90-minute blackout incident that was the most severe since 2003.

2019 British Blackout Incident



Source: Bloomberg.

The cause of this incident was due to mechanical failures in an oceanic wind power station that led to fluctuation in the electricity frequency. Once the frequency becomes volatile, it had a knock-on effect on many connected photovoltaic solar cells which put them offline. Such loss of power further lowered grid frequency and turned into an avalanche that blew past the safety level in the system and triggered the shutdown. This accident clearly illustrated the potential shocks renewable energy sources can have to the stability of the electricity grid. It is therefore imperative for the existing grids to be upgraded to ensure delivery of stable voltage and frequency. Smart grid is increasingly becoming a necessary factor to stability of the entire system as more and more renewable energy resources are integrated.

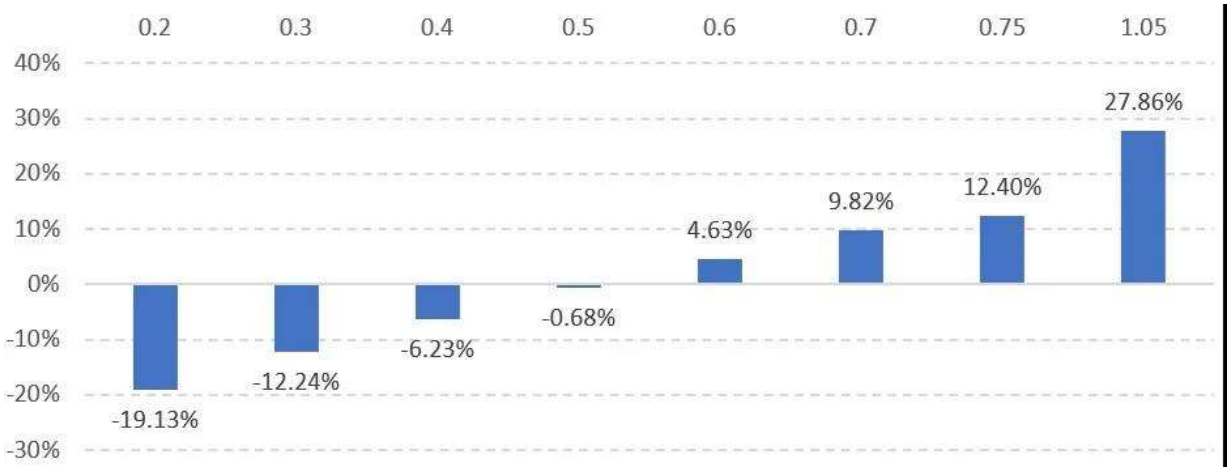
The fifth investable theme is electricity distribution. The traditional energy distribution model uses direct distribution, which has two major drawbacks. The first drawback is that the traditional energy distribution is unidirectional with numerous diode components, which makes it unsuitable for the bidirectional flows in the future energy networks. The second drawback is that the whole distribution network will consume energy, but the renewable energy resource also needs supplementary energy from the network. So the traditional energy distribution is not suitable for large-scale increase in renewable energy integration. The future direction is one of flexible direct current system, which will address the two drawbacks mentioned here. The suppliers that can provide relevant components for such system will have excellent prospects.

The second industry that we'll look at is energy storage. From the electricity grid's perspective, energy storage is an important link to maintain the stability of electric currents. In addition to power

plants, energy storage will also be relevant to consumers. When consumer integrate renewable energy locally, they can use energy storage to supply electricity during peak price periods. This not only addresses the current issue of wasted energy in local generation sites, but also mitigate at least partially the electricity blackouts that we saw in late 2021.

For the second industry of energy storage, we expect 2022-2023 to be the kick-off years. We see future growth potential of up to 10 times current levels by 2025, with annualized growth of over +50%. This is a very fast-growing industry. We see the potential because the price-value ratio is improving rapidly. We did two scenario analyses. First, we look at the differentials in electricity prices across different periods. Our calculation showed that if the peak-to-trough price difference is greater than 60 cents, then energy storage is a feasible option. The current difference averages to be about 59 cents, so we're already quite close to the threshold.

Peak-to-Trough Price Difference with 0.6 RMB/kwh as the Threshold



Source: Rosefinch.

In July 2021, the government announced the policy to differentiate electricity price by various periods, with expected widening of prices in subsequent adjustments. We estimate that to achieve the stated policy goals, the gap may widen to 73 or 74 cents, which gives total return of over 10% for energy storage. That should be sufficient to kick-off the consumer side energy storage initiation.

The second analysis we did was on the power plant side. The three tables below illustrate the sensitivity analysis we did on the system cost, generating hours, and energy storage cycles. We use 6% IRR as the benchmark for achieving sufficient price-value ratio. We put the threshold value in red & bold, while the current status is highlighted in red.

性价比测算1-电价提高+发电小时增加			
2.13%	1100	1300	1600
0.27	-4.28%	-1.77%	1.81%
0.3	-2.73%	-0.03%	3.89%
0.33	-1.23%	1.68%	**5.98%**
0.36	0.23%	3.37%	8.10%
0.39	1.68%	5.07%	10.25%
0.42	3.11%	**6.77%**	12.45%
0.45	4.55%	8.50%	14.72%
0.48	**5.98%**	10.25%	17.05%
0.51	7.43%	12.04%	19.45%
0.54	8.90%	13.86%	21.91%

性价比测算2-成本下降+发电小时增加			
2.13%	1100	1300	1600
4.8	-1.19%	1.73%	**6.05%**
4.6	-0.48%	2.55%	7.06%
4.4	0.28%	3.43%	8.17%
4.2	1.12%	4.41%	9.40%
4.0	2.02%	5.48%	10.78%
3.8	3.03%	**6.67%**	12.32%
3.6	4.14%	8.00%	14.06%
3.4	5.38%	9.51%	16.06%
3.2	**6.79%**	11.24%	18.37%
3.0	8.40%	13.24%	21.06%

性价比测算3-循环次数提升+成本下降					
	5000	6000	7000	8000	9000
4.8	-6.85%	-2.52%	1.73%	2.91%	4.11%
4.6	-5.61%	-1.50%	2.55%	3.66%	4.80%
4.4	-4.28%	-0.40%	3.43%	4.49%	5.56%
4.2	-2.85%	0.80%	4.41%	5.39%	**6.39%**
4.0	-1.29%	2.11%	5.48%	**6.40%**	7.32%
3.8	0.42%	3.56%	6.67%	7.51%	8.35%
3.6	2.30%	5.16%	8.00%	8.77%	9.52%
3.4	4.38%	6.95%	9.51%	10.19%	10.86%
3.2	6.71%	8.98%	11.24%	11.83%	12.40%
3.0	9.33%	11.30%	13.24%	13.74%	14.22%

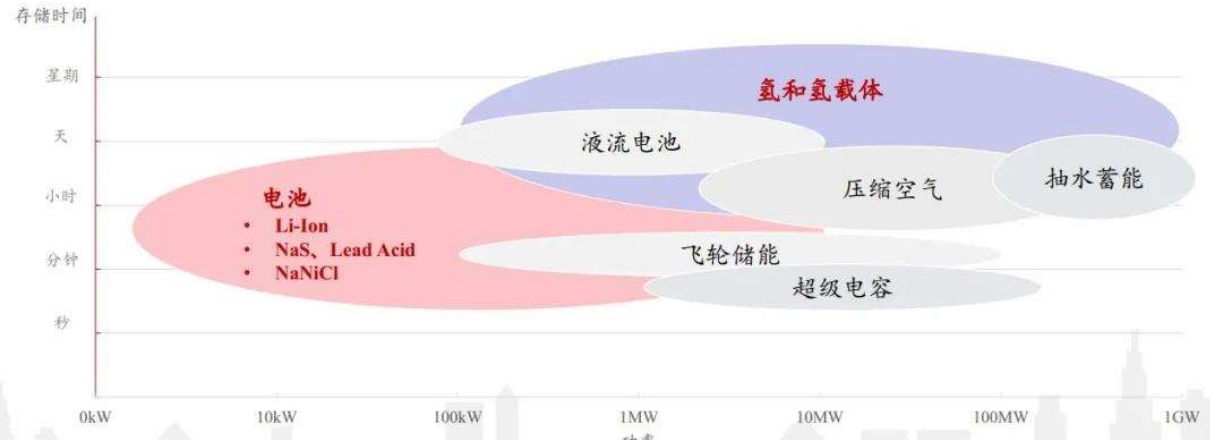
Source: Rosefinch. Threshold value is bold, current value is highlighted in red cells.

What we can see clearly from the tables is that we are currently not through threshold levels yet. There are specific scenarios, such as favorable solar conditions or higher electricity prices, which will make energy storage for solar power plants economical. While there are gaps now, we don't see these as insurmountable. For example, there are some conditions that'll change the dynamic: if future system construction cost drops by 20%, or energy storage usage life increases to 8,000 or 10,000 times, or electricity price increases by 20%. If any one or two conditions are satisfied, most solar plants will implement energy storage. We believe all three conditions will be met in the next 1-2 years, which is why we favor the energy storage industry outlook. Another reason for energy storage is driven by government policy. The main pain point of energy storage industry is the unclear profit prospective and capital source. Previously, it was the power generation companies that invested, while the power distribution companies did not have the need. Another pain point is the safety issue of such energy storage infrastructure. The government is well-aware of these issues and have announced policies to address them directly. These include increasing peak-to-trough price differential to address the profitability issue. There's also clarification on the principle of whoever profits shall pay the construction cost. The energy storage cost may integrate into electricity prices, so the end users will shoulder part of the cost. And to address the safety issue, government increased quality control and accountability, requiring quality certification for each component in the energy storage system.

时间	发布部门	政策文件	解决痛点
21.7	能源局	《新型储能项目管理规范》	**新型储能无歧视接入电网**
21.7	发改委	《关于进一步完善分时电价机制的通知》	**扩大峰谷价差，解决用户侧储能盈利模式：**上年或当年预计最大系统峰谷差率超过40%的地方，峰谷电价价差原则上不低于4:1；其他地方原则上不低于3:1。尖峰电价在峰段电价基础上上浮比例原则上不低于20%
21.8	发改委、能源局	《关于鼓励可再生能源发电企业自建或购买调峰能力增加并网规模的通知》	**明确责任：**保障性规模内电网承担消纳责任，其余电源企业承担消纳责任
21.8	发改委、能源局	《电化学储能电站安全管理征求意见》	**提升壁垒，改善目前竞争格局鱼龙混杂，**劣币驱逐良币的现象
21.8	能源局	《并网主体并网运行管理规定（征求意见稿）》	**明确了新型储能做为辅助服务主体地位：**国家层面明确储能可以独立参与辅助服务市场并获取收益，相当于发了身份证
21.8	能源局	《电力系统辅助服务管理办法（征求意见稿）》	**解决了辅助服务资金来源：**明确"谁提供，谁获利；谁受益、谁承担"的原则，由原来的发电侧内部分摊变为包括发电企业、电力用户在内的所有并网主体共同分摊，预计电力用户后续的电费会列出辅助服务成本

Source: Rosefinch.

With price-value ratio improving and relevant policies announced, energy storage industry is well-positioned to kick-off in the coming months. There are many options for energy storage. Pumped-storage hydroelectricity now account for 80-90% of total energy storage capacity, though we believe future growth will come from electrochemical storage.



Source: Rosefinch.

As the chart illustrates, different energy storage system is needed for different capacities. The X-axis above is the energy storage capacity, with Y-axis the energy storage time in seconds, minutes, hours, days, or weeks. Since the electrochemical storage (highlighted in red) is most applicable for smaller capacity and shorter time periods, it is well suited for most of the end-user and power plant demands. In comparison, the pumped-storage hydroelectricity, hydrogen storage, or air-compression storage are more suitable for larger capacity requirements. These systems will also see some future applications.

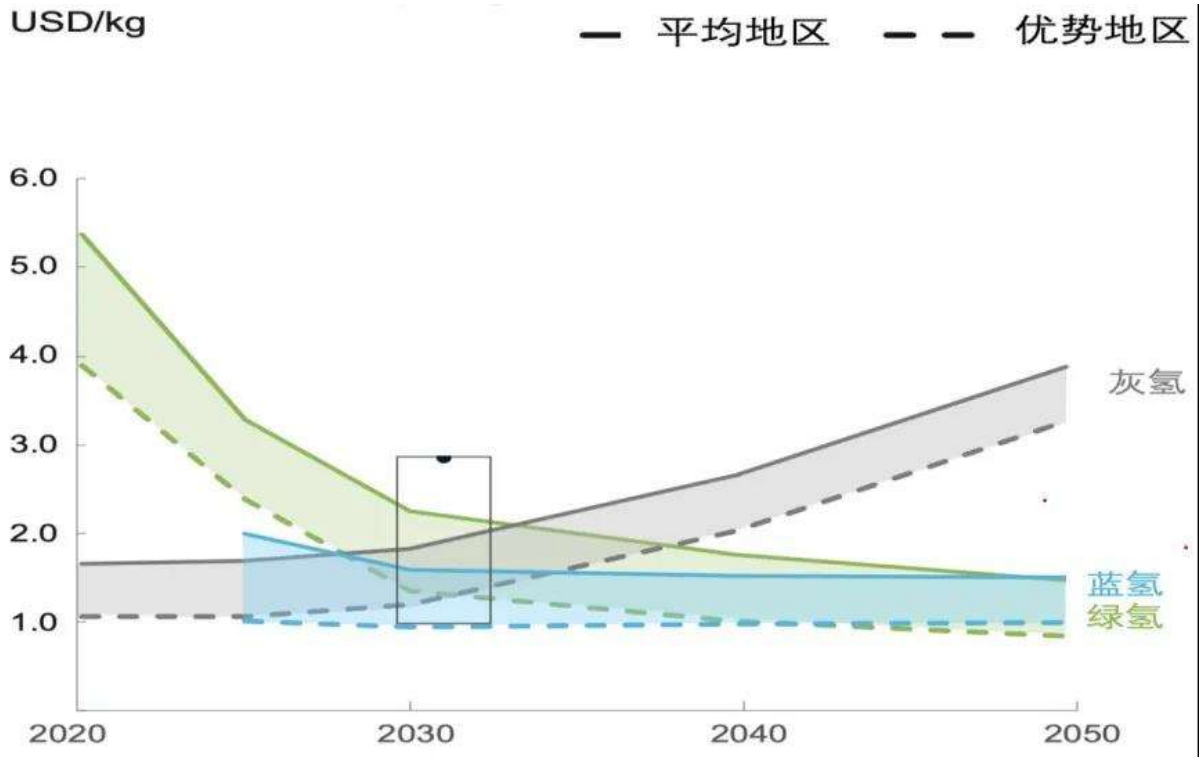
From our investment perspective, the electrochemical storage is the most attractive space. Most of the values of the electrochemical storage come from two parts: battery and Power Conversion System, or PCS. We believe the best investment opportunities will come from these two areas. The current state of the industry is fairly diversified with no major company taking more than 10% of total market share. We'd measure the future opportunities by two metrics: first the cycle life, and second the safety. Cycle life is directly linked to cost, while safety is a crucial factor. In July 2021, there was an explosion in Australia Tesla energy storage plant, which consisted of 256 units. Only a few units were affected, yet it burned for 4 days. In future, whoever can address the safety issue satisfactorily will have the edge to capture larger market share.

The third industry we'll look at is hydrogen energy. We see hydrogen energy taking a strategic role in the global clean energy strategy. US, Europe, and Japan have all announced hydrogen energy development roadmap, earmarking it as a key component of their national energy strategy. If we assume hydrogen energy will take up 15% of total energy mix, this is equivalent to the percentage oil represents in China today. We expect China to announce hydrogen energy roadmap in the near future. The global market for hydrogen energy will quite large, with market size of roughly 100 million tons by 2030, or

roughly 1 trillion USD market. This is just valuation of the hydrogen itself – once we include related industry chain, then it's an even larger factor in future economic activities.

We believe the demand for hydrogen will be led by industrial activities. Based on current downstream usage, over 80% of hydrogen today are consumed by industrial activities. Most of these industrial hydrogens are classified as "grey hydrogen," i.e. generated through coal or oil. This is of course inconsistent with China's Carbon-Neutral goal. Therefore much of these will be replaced by "green hydrogen," which will be generated via wind or solar energy. One future opportunity is through the substitution of grey-hydrogen by green-hydrogen.

Annual Cost of Green-Hydrogen vs Grey-Hydrogen



Source: Hydrogen Council.

Another area of hydrogen utilization is in transport. We believe hydrogen can be complementary to Lithium Battery. In some long-distance heavy-lifting transport sector such as heavy truck, ocean shipping, airplane, hydrogen may play a bigger role in future.

In terms of hydrogen energy investment opportunities, we favor the mid- or up-stream companies. This is because we currently do not have a well-established infrastructure for green-hydrogen generation, storage, and transportation. These links will the first ones benefiting from increased hydrogen demand. Within the hydrogen production link, there are various routes. We believe the best value is in the Alkaline Electrolysis, or AE. AE approach has been industrialized for decades with and is still improving

its price-value ratio. Recently there was announcement of 25% cost-reduction of hydrogen-production by a major producer, signaling further room for AE technological advancement. Another popular hydrogen production model is via Polymer Electrolyte Membrane, or PEM. This can be more useful when there is limited space, such as ocean wind farms. For storage and transportation, there are also different approaches. We believe the main activities will be short-distance, small to medium sized hydrogen storage or transportation in gas form. (For long-distance transport, liquefied hydrogen will be more applicable.) The main opportunity will be on producers of stationary hydrogen containers, and more specifically the main component of carbon-fiber. The hydrogen containers must withstand high pressure, so carbon-fiber will be used to ensure container's integrity. Currently there are very few qualified hydrogen container carbon-fibers, so this may become a future bottleneck. Our investment ideas for hydrogen energy will therefore center around AE hydrogen production, hydrogen container, and container carbon-fiber.