

光热储能新模式，发展指日可待 (New model of solar-thermal energy storage. Development is around the corner)

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◆双碳目标下，新能源风光发电的装机量和发电量快速发展。2021年风光装机量（6.4亿千瓦）占总装机量（23.8亿千瓦）为26.7%，我们预计2025年风光装机量（11.1亿千瓦）占总装机（30.5亿千瓦）36.3%。预计2020-2025年风光装机量CAGR增速分别为14.3%和17.1%。2021年风光总电量占比总发电量11.8%，我们预计2025年发电量占比为16.5%。

◆储能助力新能源消纳，提供辅助服务。风光不稳定性和波动性催生调峰调频需求，储能将大幅受益。此外，2021年我国风电和光伏利用率分别为96.9%和98%，处于较高水平。但是未来随着风光发电量增大，消纳难度增大，储能是解决问题的优秀方案。

◆光热储能重回视野，度电成本有竞争力。现如今，光热由于其储能特性、经济性和政府政策的支持，增长势头十分强劲。假设100MW的光热发电项目投资成本为16.5亿元，据我们测算，度电成本在0.66元/kWh。

◆光热储能市场空间广阔。根据假设和测算，未来西北光伏大基地项目，75%左右大基地将配置光热，配置比例11%。则十四五光热新增市场容量约为987亿元。

◆投资建议：随着光热储能的发展，我们建议关注已有相关布局的产业链公司，建议关注首航高科。

◆风险提示：光热储能发展不及预期，项目中标进度不及预期，新能源发展不及预期。

1. 储能助力新能源消纳，新型储能高速发展
2. 光热储能为什么重回视野？
3. 光热储能市场空间广阔，招投标加速落地
4. 上市公司梳理
5. 风险提示

1.为什么需要储能？减少弃风弃光+提供辅助服务

◆双碳目标下，新能源风光发电的装机量和发电量快速发展。**2021年风光装机量（6.4亿千瓦）占总装机量（23.8亿千瓦）为26.7%，我们预计2025年风光装机量（11.1亿千瓦）占总装机（30.5亿千瓦）36.3%。预计2020-2025年风光装机量CAGR增速分别为14.3%和17.1%。2021年风光总电量占比总发电量11.8%，根据国家能源局预计，2025年发电量占比为16.5%。**

我们预计，**2020-2025年风光装机量CAGR增速分别为14.3%和17.1%，快速增长**

“十四五”分电源装机容量预测（万千瓦）

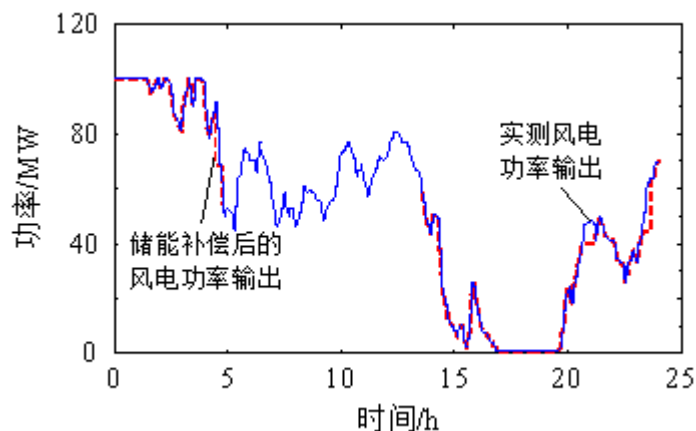
	煤电	气电	常规水电	抽水蓄能	核电	风电	光伏	其他	总计	增速
2019	104463	9022	32611	3029	4874	21005	20468	5894	201366	5.80%
2020	107992	9802	33867	3149	4989	28153	25343	6764	220059	9.30%
2021	110901	10859	35453	3639	5326	32848	30656	8010	237692	8.00%
2022E	113119	11402	36517	4003	5559	38348	36956	8411	254315	7.00%
2023E	115381	12542	37612	4403	5677	43848	43256	8831	271550	6.80%
2024E	116535	13796	38364	5284	5961	49348	49556	9273	288117	6.10%
2025E	117701	15176	39132	6341	6557	54848	55856	9736	305347	6.00%
5年CAGR	1.70%	9.10%	2.90%	15.00%	5.60%	14.30%	17.10%	7.60%	6.80%	

1.为什么需要储能？减少弃风弃光+提供辅助服务

◆风光不稳定性和波动性催生调峰调频需求，储能将大幅受益。新能源发电波动性强，不可预测性强。当新能源大量并入电网时，会增加电网的波动，电网安全性或将受到冲击。我们认为，解决方式为：对火电进行灵活性改造、发展调峰气电或开发储能（包括抽水蓄能和新型储能）。

◆根据国家能源局统计结果，**2019H1**，在电力辅助服务市场中只有火电从辅助服务市场收取的补偿费用高于分摊费用。对于风电、光伏而言，其分摊费用都高于补偿费用，特别是风电。

图：补偿后风力发电可与需求匹配



图：2019H1电力辅助服务市场补偿和分摊费用



资料来源：中国电力网援引国家能源局，《中国电机工程学报》，《风电场储能容量优化的频谱分析方法》——李滨，陈姝，韦化，海通证券研究所

1.为什么需要储能？减少弃风弃光+提供辅助服务

◆储能有利于新能源消纳，减少弃风弃光。2021年我国风电和光伏利用率分别为**96.9%**和**98%**，处于较高水平。但是未来随着风光发电量增大，消纳难度增大。2021年西藏弃光率达到**19.8%**。青海的弃风率和弃光率为**10.7%**和**13.8%**。弃风弃光问题源于“三北”地区的系统调峰能力、跨省区外送能力无法支撑本地区新能源的大规模开发。我们认为，解决弃风弃光的途径为：（1）储能、（2）电跨区域传输（特高压等）、（3）转变能量形态以达到跨区域传输（氢储能）、（4）在中东部地区等电需求量大的地方发展新能源（存在资源禀赋的桎梏，原因是国内光伏资源较好的地区为“三北”地区）和（5）产业转移，将高耗能行业转移到风光资源好的地方。

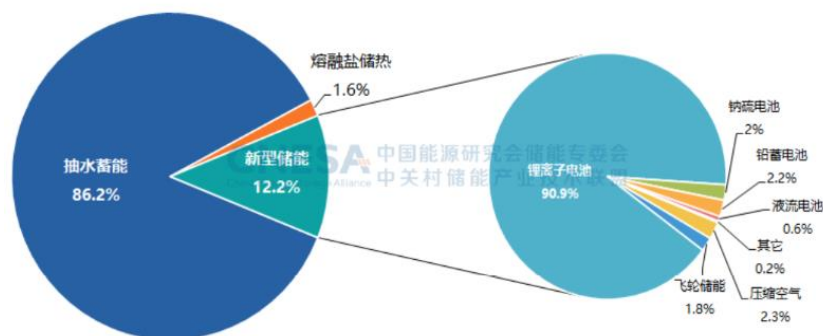
表：2021年风电和光伏利用率（部分城市）

地区	风电利用率		光伏利用率	
	12月	1-12月	12月	1-12月
全国	96.90%	96.90%	98.20%	98.00%
北京	100%	100%	100%	100%
蒙西	87.40%	91.10%	90.50%	96.50%
上海	100%	100%	100%	100%
江苏	100%	100%	100%	100%
浙江	100%	100%	100%	100%
青海	94.20%	89.30%	94.20%	86.20%
西藏	100%	100%	70.70%	80.20%
广东	100%	100%	100%	100%

1.2 世界储能市场发展如何？

- ◆截至2021年底，全球已投运电力储能项目累计装机规模**209.4GW**，同比增长**9%**。
- ◆储能目前主要有：抽水蓄能、新能储能（锂离子电池、钠硫电池、铅蓄电池、液流电池、压缩空气、飞轮储能和氢储能等）和熔融盐储热，2021年全球占比分别为**86.2%**、**12.2%**和**1.6%**。
- ◆储能技术中抽水蓄能占比最高，但是2021年首次跌破**90%**的占比（下降**4pct**）。
- ◆新型储能高速发展（**+67.7%**）。新型储能的累计装机规模第二，为**25.4GW**，同比增长**67.7%**。
- ◆2021年新增投运储能装机规模**18.3GW**，同比增长**185%**。美国、中国、欧洲、日韩和澳大利亚分别占新增投运储能装机规模的**34%**、**24%**、**22%**、**7%**和**6%**。

图：2021年全球储能市场比例



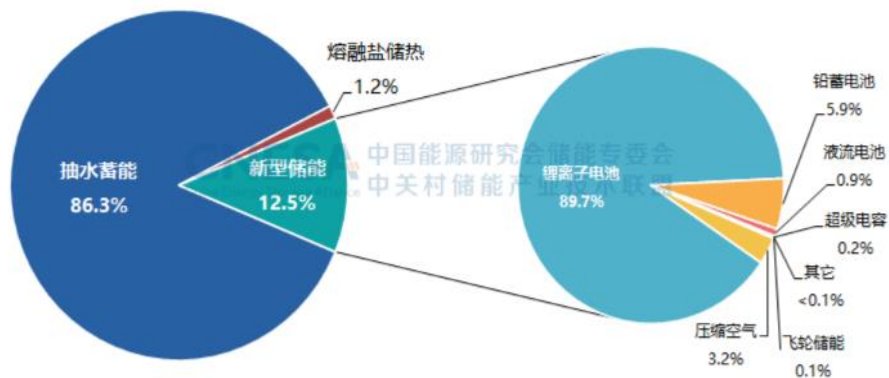
图：2011-2021年全球新型储能规模（MW）&增速



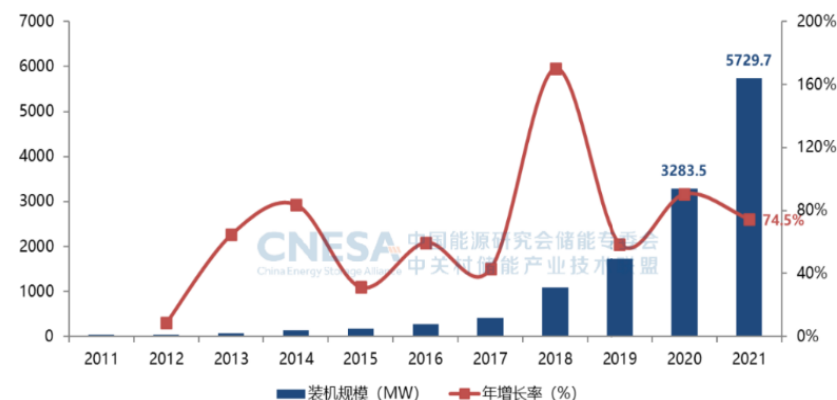
1.3 中国储能市场发展如何？抽蓄为主，新型储能快速发展

- ◆中国储能增速高全球约21pct。2021年底，中国储能项目累计装机规模46.1GW，同比增长30%。
- ◆抽水蓄能装机规模最大，为39.8GW，同比增长25%，所占比重与下降了3个百分点；
- ◆2021年底，新型储能累计装机规模达到5729.7MW，同比增长75%。
- ◆新型储能中关注锂离子电池和压缩空气。2021年两者均有百兆瓦级项目并网运行。2021年实压缩空气新增投运规模170MW，接近2020年底累计装机规模的15倍。

图：2021年中国储能市场装机容量比例



图：2011-2021年中国新型储能规模（MW）&增速



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2. 光热原理、适用场景

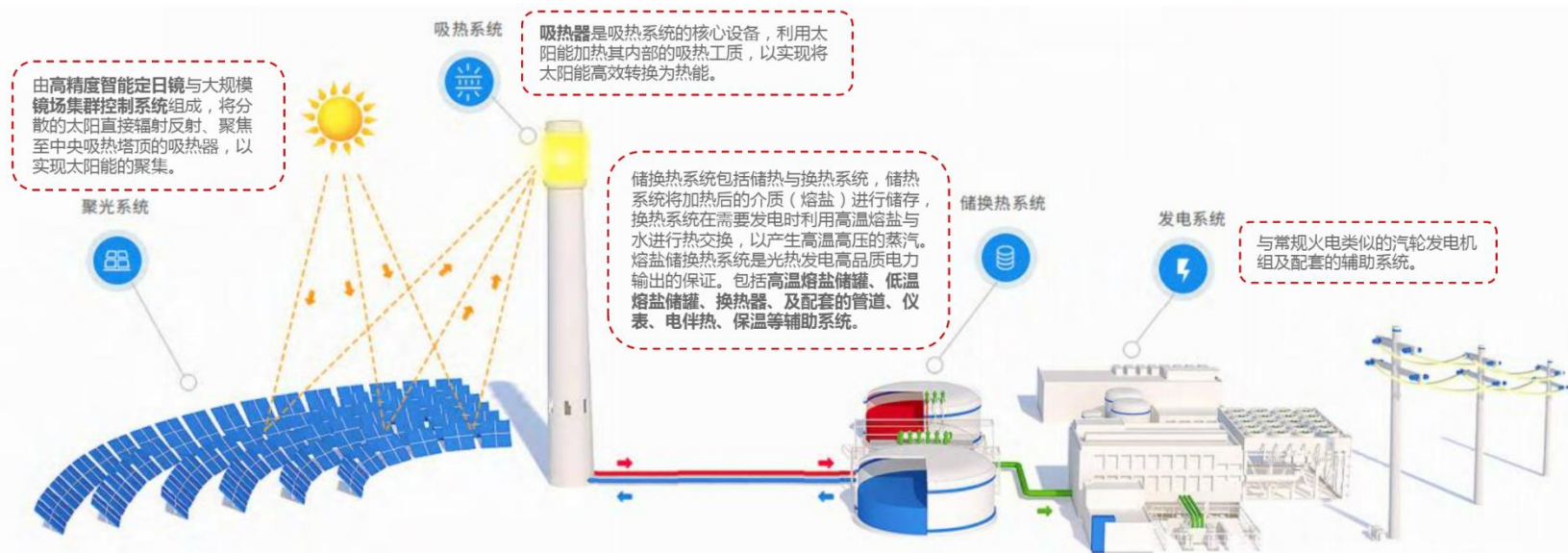
光热电站发电原理：

- 光热发电是一种利用太阳的直接辐射能聚集在吸热器上，加热吸热器中的传热介质；然后产生高温高压蒸汽，驱动汽轮发电机组做功，输出电能。

光热系统的三大核心单元：

- 镜场：就是镜子，主要的作用就是聚焦太阳光收集太阳能热，分为点聚焦和线聚焦。
- 储热岛：光热电站区别于其他新能源的核心，可以实现大容量储能。
- 汽机岛：与燃煤机组的汽机厂房类似，对调节性能要求更高，要求可以进行启停调峰。

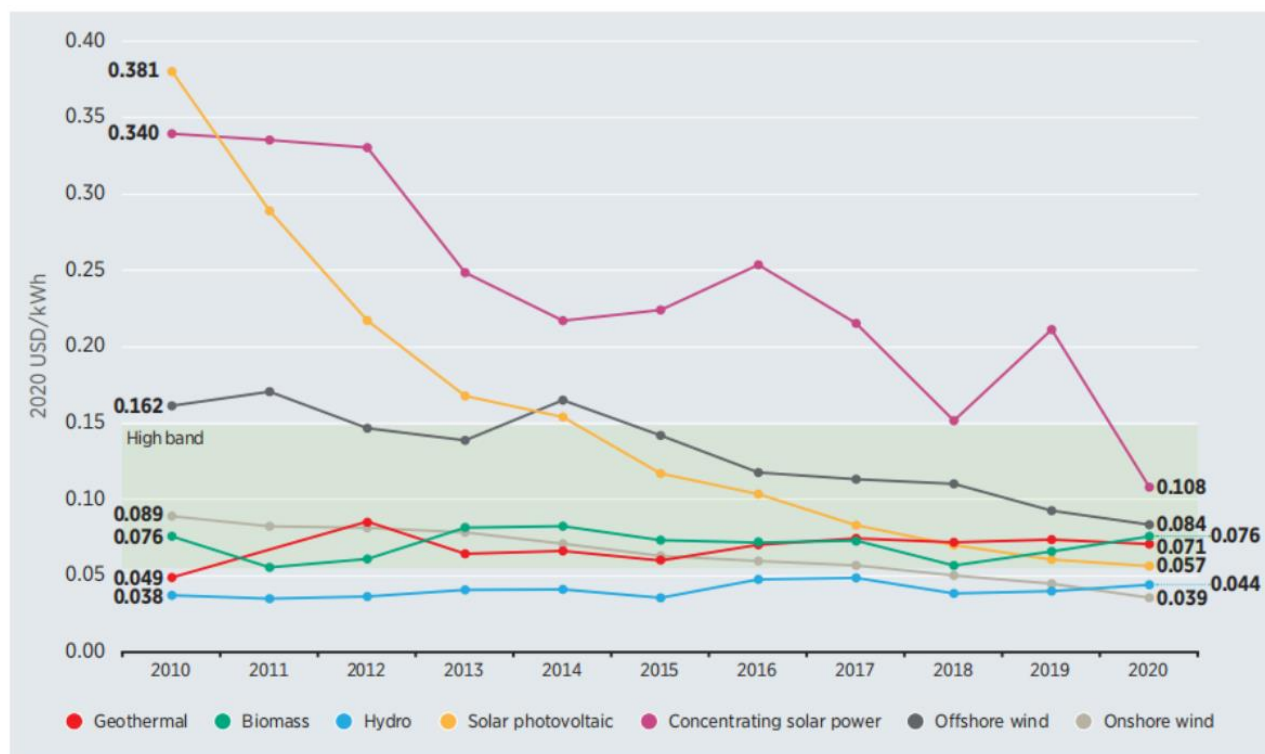
图：光热电站发电原理（塔式光热发电系统）



2. 光热储能为什么重回视野？

曾经，光热作为与光伏正面竞争的发电技术，由于度电成本降幅低于光伏，败下阵来。

图：光热&光伏度电成本



Source: IRENA Renewable Cost Database

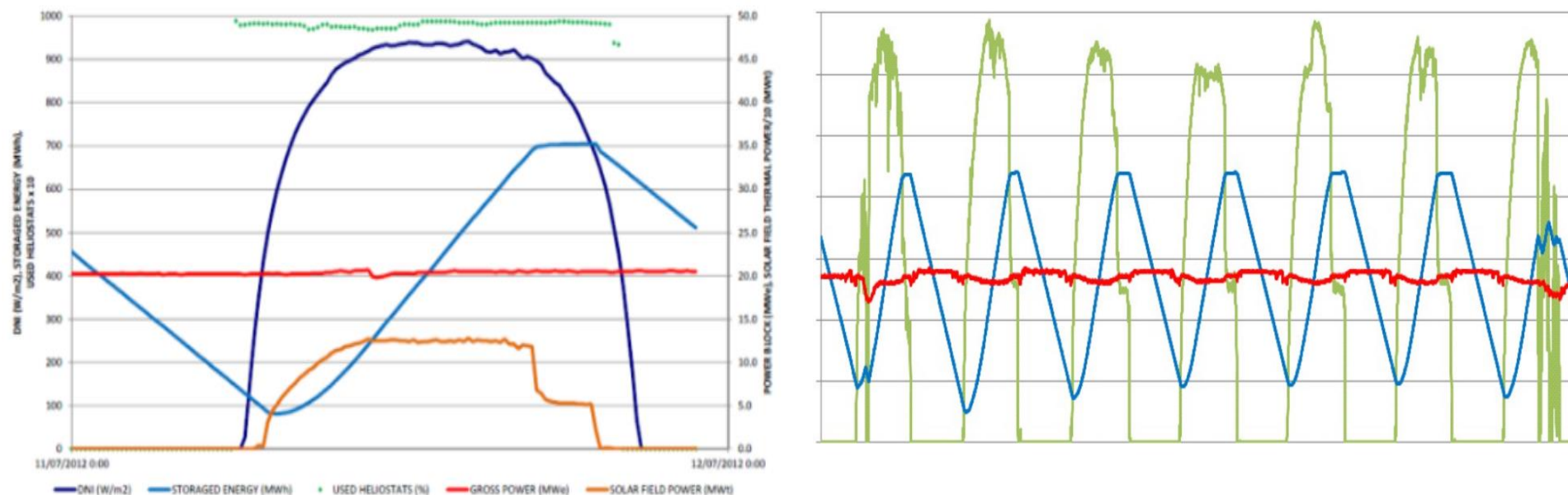
2. 光热储能为什么重回视野？

现如今，光热作为储能技术已不再只以度电成本与光伏竞争，由于其储能的特性、经济性和政府政策的支持，光热的增长势头十分强劲，我们认为足以与各类储能技术竞争，重回市场。

◆长时储能。由于光热发电可以配置储热系统，因此，光热发电机组可以没有光照的条件下稳定发电。如果储热系统的容量足够大，机组可实现24小时连续发电，光热电站可以实现与光伏不同的稳定发电。

◆替代部分火电，作基荷能源。

图：西班牙Gemasolar电厂19.9MW机组(储热15h)一天0:00-23:50(左图)和一周时间(右图)的出力曲线



2. 光热储能为什么重回视野？

◆度电成本降。第一批光热示范项目多种技术路线 LCOE在1.05~1.10元/kWh之间。首航高科2022年中标了三峡能源青海格尔木100MW光热项目，金额为16.48亿。我们假设100MW的光热发电项目投资成本为16.5亿元，假设利用小时为2000小时（原因为：根据北极星太阳能光伏网，德令哈50MW光热电站利用小时数为2920h），在不考虑资本的时间价值和所得税的情况下，估算得出度电成本为0.66元/kWh。

◆寿命假设：根据搜狐网援引索比光伏网，美国SEGS I&II光热电站运行超30年后正式退役。在测算中，我们保守假设光热储能电站寿命为20年。

◆值得注意的是，此处度电成本无需再加充电成本，而抽蓄和电化学储能现阶段计算的度电成本，还需额外再加充电成本。

表：光热发电度电成本测算

投资额	亿元	16.5
寿命	年	20
大小	MW	100
利用小时	h	2000
资本金比例	%	30%
贷款金额	亿元	11.55
利率	%	4.30%
每年利息（粗略计算）	万元	4966.5
度电成本	元/kWh	0.66

资料来源：北极星火力发电网援引国家发改委，《首航高科：关于签订重大合同的公告》，北极星太阳能光伏网援引西北院、CSPPLAZA光热发电平台、搜狐网、Solarbe 索比光伏网搜狐号、太阳能光热联盟搜狐号、中国银行官网，

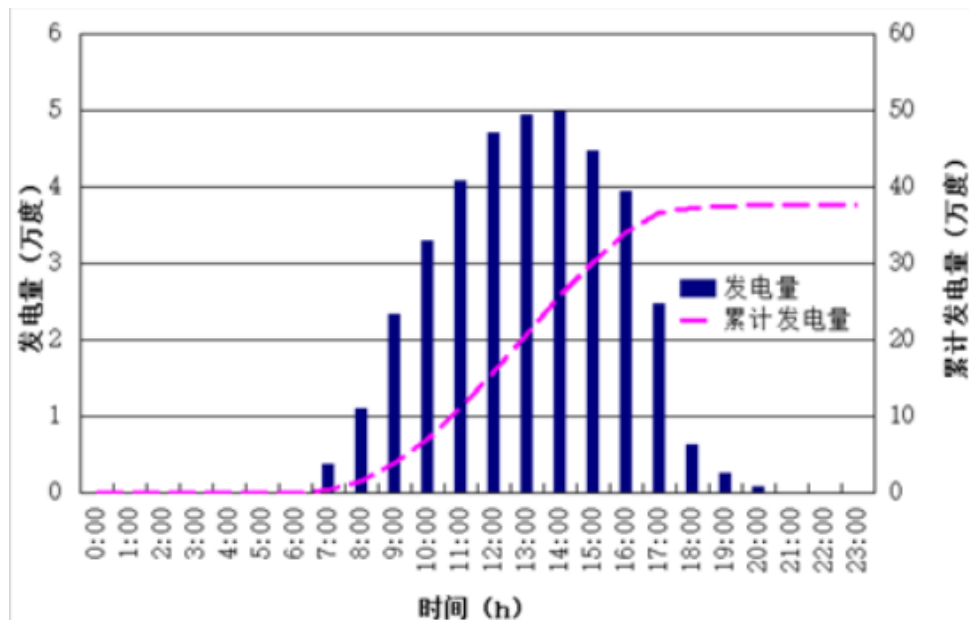
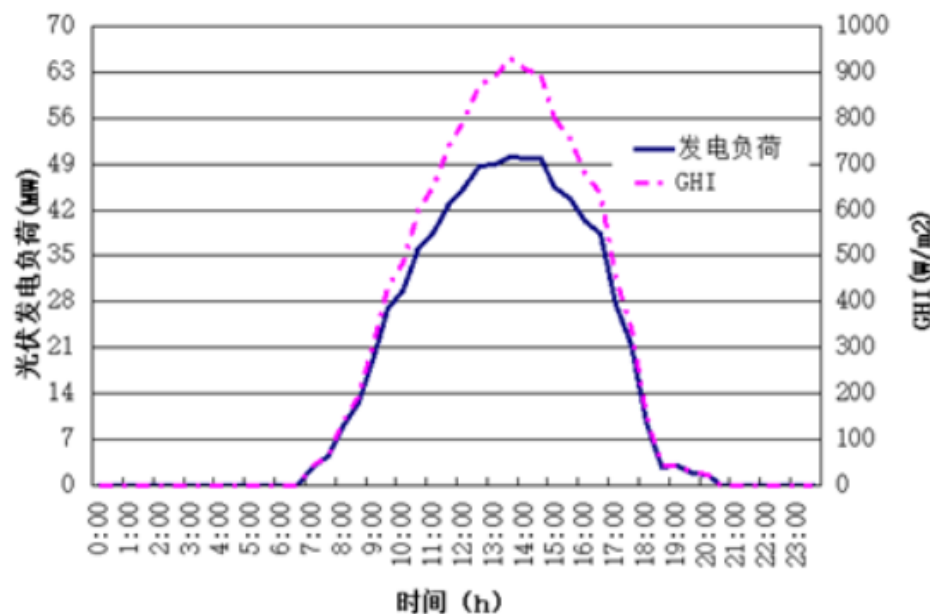
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2. 光热储能为什么重回视野？

- ◆未来或为辅助服务市场的优等生。光热可以提供调峰和转动惯量的服务。对比于抽蓄和电化学储能的优点是，无需再额外增加充电成本，在电价高的时候，使用起来或更经济。
- ◆安全性高。相较于电化学储能而言，光热储能安全性高。

图：光热电站配合光伏出力特征的“调峰”



2. 光热储能为什么重回视野？

现如今，光热作为储能技术已不再只以度电成本与光伏竞争，由于其储能的特性、经济性和政府政策的支持，光热的增长势头十分强劲，我们认为足以与各类储能技术竞争，重回市场。

◆政策支持：在新疆，同规模的光热对比4小时储能，可以配置更多的光伏。根据新疆发改委《服务推进自治区大型风电光伏基地建设操作指引（1.0版）》，配置新能源规模=4小时以上时长储能规模×4，如：建设10万千瓦/40万千瓦时（4小时时长）储能规模，可配置新能源规模=10×4=40万千瓦；建设10万千瓦光热发电项目，可配置90万千瓦光伏项目。

◆但光热也有其弊端，需在光照条件好的地方，同时占地面积大，我们认为，未来主要是在集中式光伏电站旁边建光热储能电站，例如大基地项目。

图：新疆喀什地区莎车县光伏产业园



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3. 市场空间

核心假设，基于新疆第二批市场化新能源装机的统计分析：

- 风电：根据北极星风力发电网统计，风电装机**13.49GW**，主要配置电化学储能。
- 光伏：根据北极星风力发电网统计，光伏装机**27.39GW**，其中装机**≥90万千瓦**的项目有**16**个，合计装机**1615万千瓦**，占**58.9%**（我们假设大基地项目的光伏装机**≥90万千瓦**）。**16**个项目中，**13**个配置光热，合计装机**1215万千瓦**，占比**75%**。根据新疆发改委《服务推进自治区大型风电光伏基地建设操作指引（1.0版）》，建设**10万千瓦**光热发电项目，可配置**90万千瓦**光伏项目。计算得配置比例为**11%** ($10/90 \approx 11\%$)。
- 我们假设，未来西北光伏大基地项目，**75%左右大基地将配置光热，配置比例11%。**

测算结果：

- 十四五上述各省合计新增**24607万千瓦**，假设一半为光伏项目，其中**58.9%**为大基地，**75%**的大基地配置**11%**的光热，即 **$24607 \times 0.5 \times 58.9\% \times 75\% \times 11\% \approx 597.86$** （万千瓦）。
- 以**10万塔式EPC**报价**16.5亿**估算，光热新增市场容量约为**987亿元**。

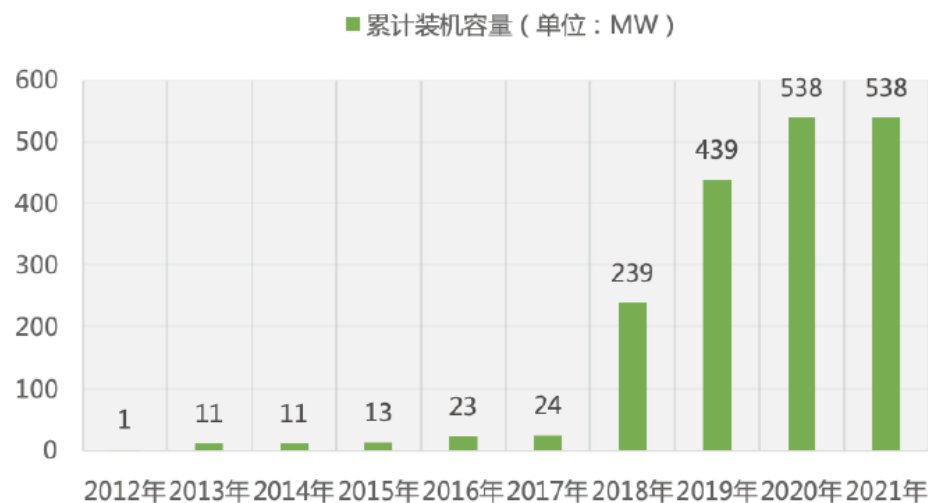
表：“十四五”新能源预计新增装机量（单位：万千瓦）

十四五新能源预计新增装机量（万千瓦）	
新疆	4900
青海	3800
甘肃	5680
内蒙古	8377
宁夏	1850
装机量总计	24607

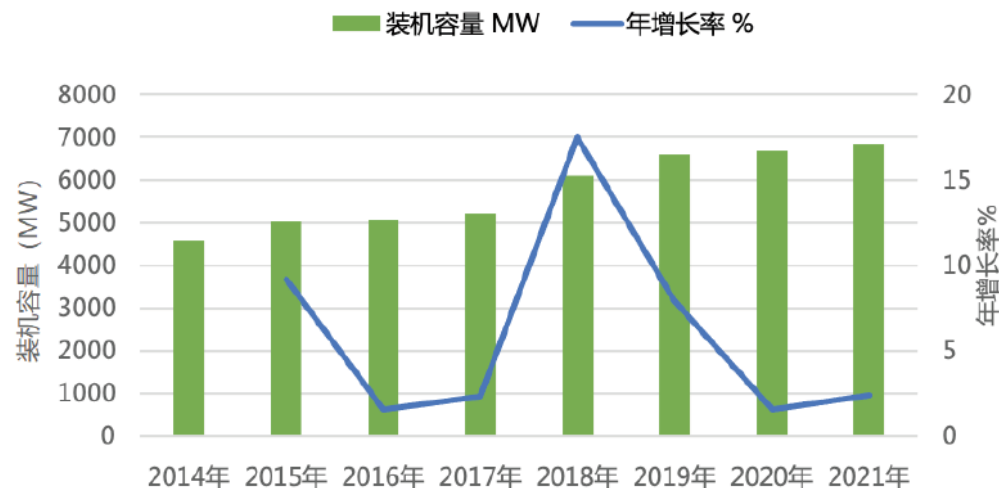
3. 项目进展、竞争格局

- ◆2021年新增光热装机容量较小，2022年开始，光热招投标加速。
- ◆竞争格局上：主要掌握技术的为首航高科和可胜，分庭抗礼。参与EPC的除这两家外，还有中国电建等。

图：我国太阳能热发电累计装机容量



图：全球太阳能热发电累计装机容量



1. 储能助力新能源消纳，新型储能高速发展
2. 光热储能为什么重回视野？
3. 光热储能市场空间广阔，招投标加速落地
4. 上市公司梳理
5. 风险提示

4. 上市公司梳理

表：上市公司各类业务汇总

项目开发/EPC	首航高科		材料	鲁阳节能	保温材料
	中国电建			洛阳玻璃	超白玻璃
设备	中国动力	汽轮机		航天晨光	金属软管
	金通灵	汽轮机		中国重工	熔盐阀门
	宝色股份	蒸汽发生器，换热器		盈丰股份	热镀锌
	宝光股份	集热管		恒立液压	液压
	川润股份	液压驱动		上海机电	减速器
	蓝科高新	换热器，储罐		武进不锈	钢材
	振江股份	支架		川仪股份	熔盐阀门
	哈尔滨电气	汽轮机		久立特材	钢管
	嘉寓股份	集热管		硅宝科技	密封，防腐
	杭州汽轮	汽轮机		久盛电气	电伴热，电缆
	双良股份	空冷，换热器		安彩高科	超白玻璃

4. 首航高科

◆主营业务：光热发电、光热储能+多能互补、氢能利用、电站空冷、余热发电、清洁供暖、海水淡化等领域的研发、设计、制造、设备供应、建设、运维，项目投资及项目总承包等服务。

◆营业收入：光热发电业务收入逐渐提高，到2022年6月30日提高到38%。

◆光热电站业务：分别投资建设了100MW的塔式熔盐光热发电项目——首航高科敦煌100MW塔式熔盐储能光热发电项目获批为国家第一批光热电站示范项目和三峡能源青海格尔木100MW光热项目

◆三峡能源青海格尔木100MW光热项目中标额：16.48亿。

◆2022年已中标和合作项目：300MW，2个项目（100MW+200MW）。

图：首航高科100MW级塔式光热电站吸热器



1. 储能助力新能源消纳，新型储能高速发展
2. 光热储能为什么重回视野？
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◆光热储能发展不及预期，项目中标进度不及预期，新能源发展不及预期。

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中性，未来12-18个月内预期相对基准指数变化不大，基准定义如下。根据FINRA/NYSE的评级分布规则，我们会将中性评级划入持有这一类别。

弱于大市，未来12-18个月内预期相对基准指数跌幅在10%以上，基准定义如下

各地股票基准指数：日本 – TOPIX, 韩国 – KOSPI, 台湾 – TAIEX, 印度 – Nifty100, 美国 – SP500; 其他所有中国概念股 – MSCI China.

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Analyst Stock Ratings

Outperform: The stock's total return over the next 12-18 months is expected to exceed the return of its relevant broad market benchmark, as indicated below.

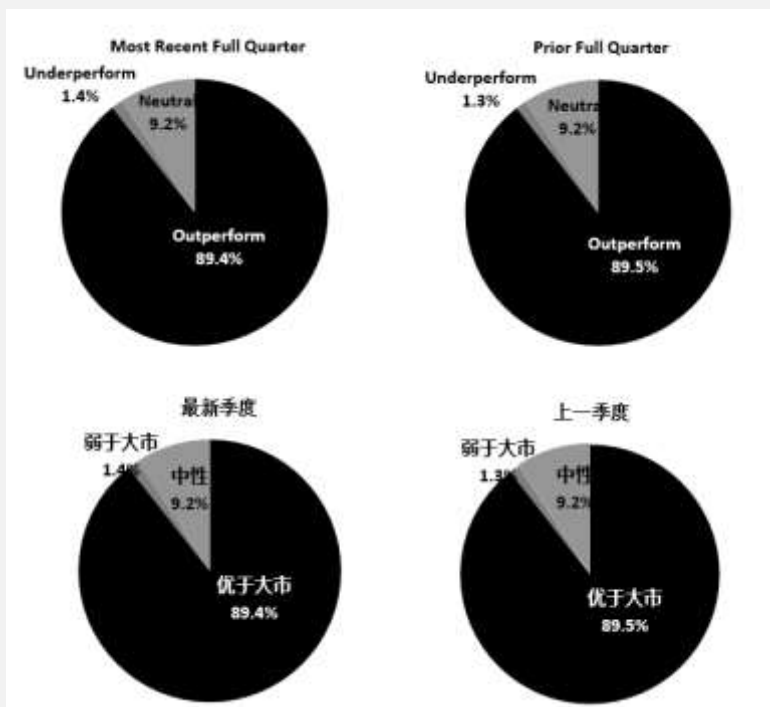
Neutral: The stock's total return over the next 12-18 months is expected to be in line with the return of its relevant broad market benchmark, as indicated below. For purposes only of FINRA/NYSE ratings distribution rules, our Neutral rating falls into a hold rating category.

Underperform: The stock's total return over the next 12-18 months is expected to be below the return of its relevant broad market benchmark, as indicated below.

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评级分布 Rating Distribution



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截至2022年3月31日海通国际股票研究评级分布

	优于大市	中性 (持有)	弱于大市
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海通国际股票研究覆盖率	88.9%	9.5%	1.6%
投资银行客户*	6.8%	5.8%	0.0%

*在每个评级类别里投资银行客户所占的百分比。

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中性，未来12-18个月内预期相对基准指数变化不大，基准定义如下。根据FINRA/NYSE的评级分布规则，我们会将中性评级划入持有这一类别。

卖出，未来12-18个月内预期相对基准指数跌幅在10%以上，基准定义如下

各地股票基准指数：日本 – TOPIX, 韩国 – KOSPI, 台湾 – TAIEX, 印度 – Nifty100; 其他所有中国概念股 – MSCI China.

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	Outperform	Neutral (hold)	Underperform
HTI Equity Research Coverage	88.9%	9.5%	1.6%
IB clients*	6.8%	5.8%	0.0%

*Percentage of investment banking clients in each rating category.

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SELL: The stock's total return over the next 12-18 months is expected to be below the return of its relevant broad market benchmark, as indicated below.

Benchmarks for each stock's listed region are as follows: Japan – TOPIX, Korea – KOSPI, Taiwan – TAIEX, India – Nifty100; for all other China-concept stocks – MSCI China.

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