诗两首

一、工地剪影

高速边坡光伏采用的轻质组件自清洁效果好、对比发电量高，
令日夜抢工的前后方团队精神振奋。

昨夜泥点雨，今晨了无痕。
日上三竿后，喜煞晚归人。

二、渔舟唱晚

记风光联合发电海洋牧场。

当年秦帝观沧海，枭雄止步碣石山。
古人不见今时月，舟楫为马海作田。
一字长缨束风龙，万片硅宝锁光源。
夕阳美景同君醉，何不斗酒诗百篇。

（一道新能集体创作，2022年5月。）

一道新能N型产品白皮书

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DASOLAR 一道新能

一道阳光 照亮生活

DAON™

一道新能N型产品白皮书

A DASOLAR White Paper of
N Type Crystalline Si Solar Cell and PV Module

DASOLAR 一道新能
一道阳光 照亮生活

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走向成熟的N型TOPCon产业链
N-TOPCon is Maturing

凭借优良的电池结构和衬底，N型TOPCon电池效率有望达到28.7%，接近晶体硅理论极限。2022年以来，在技术迭代驱动和平价上网拉动双重作用下，N型TOPCon电池片和组件产能逐步扩大、成本逐步降低，产业链正在走向成熟。

Based on the excellent cell structure and substrate，the efficiency of N-TOPCon solar cell is expected to reach 28.7%. With rapid production expansion and cost down since 2022, the N-TOPCon industrial chain is maturing.

TOPCon电池结构堪称完美

PERC、HJT、IBC等电池结构均源自上世纪80-90年代，而TOPCon是2013年由德国Fraunhofer太阳能研究院首次提出的，是一种非常新的电池技术。这种电池结构基于全面积钝化接触原理，通过选择能带结构匹配型功能材料，在Si界面直接形成对空穴较高的势垒和对电子较小的势垒，形成最佳的载流子选择性传输；同时电极不直接与Si衬底接触，降低了金属/Si的接触损失。堪称是目前为止硅电池最完美的电池结构。计算表明，TOPCon电池效率极限28.7%，最接近晶体硅太阳能电池理论极限效率29.43%。

Perfect Structure of TOPCon Cell

The PERC/HJT/IBC was invented in 80-90s last century, while the TOPCon was a younger technology raised by Fraunhofer ISE in 2013. Based on full area passivation contact, the TOPCon cell has higher potential barrier against hole while lower against electron, ensuring a best performance of the carrier selective transportation. The electrode-substrate indirect contact reduces the contact loss. Calculation shows that the maximum efficiency is up to 28.7%, which is closed to the Si-PV theoretical limit, 29.43%.

2022是N型TOPCon电池的产业化元年

The Starting Year of N-TOPCon Industrialization

1 - More than 15GW N-TOPCon cells shipment.
2 - Production line of TOPCon is compatible to PERC. 3 - Key equipments and processes are mature.
4 - ROI is higher than that of other N type Cells.
5 - Higher potential of efficiency increase.

N型衬底具备先天优势

相对于PERC电池所使用的P型硅片，TOPCon选用的N型衬底具有相同金属杂质浓度下光电转换效率高、对铜铁等金属杂质的容忍度高、少子寿命高、没有硼氧复合体带来的光衰等优势。
两种技术的拉晶工艺没有本质的区别，都是非常成熟的半导体工艺。随着N型单晶硅片生产规模的扩大和技术进步，两者之间的生产成本将会越来越接近。

其它优势

N型电池组件双面率达到80%以上，比P型高15%；
TOPCon工艺无需背面激光开槽，比BiPERC电池的应力小、抗隐裂能力更强；N型TOPCon电池的高开路电压，因此温度系数更低、发电量更高。

Natural Advantages of n Type Wafer

Compare with P type wafer used by PERC cell, the TOPCon takes N type wafer with advantages in terms of the higher efficiency and tolerance to metal impurity, longer lifetime of minority carrier, lower or even non-light-induced-degradation due to non-boron oxygen complex formed, phosphorus doping instead.

The crystalline Si growth processes of these two technologies are mature with no essential differences. The cost gap will be narrowed as long as n type wafer production expansion and technical further improvements in near future.

Others

The bi-facial rate of N type cell is about 80%, 15% higher than that of P type cell; There is no laser slotting process on the backside of the TOPCon cell, ensuring lower stress as well as higher micro-rack resistance; With higher open circuit voltage, the lower temperature coefficient leads higher gain.

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晶硅电池技术发展趋势

Si-PV Technical Trends

各种电池技术的市场占比变化趋势（来源：中国光伏行业协会）

近年来，头部光伏企业间P型产品竞争力及市场份额差距不断减小，PERC电池的量产平均转换效率已接近其理论极限值，进一步提升PERC电池效率的难度和成本挑战明显增加。随着P型PERC电池时代红利逐渐褪去，以N型、特别是TOPCon为代表的电池技术，有望接力P型PERC电池，成为下一代主流技术，推动光伏行业技术发展再上新台阶。

2022年上半年，N型TOPCon电池效率不断取得突破，量产效率与实验室效率齐头并进，光伏企业TOPCon电池量产最高效率达24.5%，实验室最高效率超25%，相比28.7%电池效率的理论极限，TOPCon效率提升空间较大，更能契合未来快速增长的光伏市场需求。

根据TrendForce集邦咨询分析，在业界头部光伏企业积极布局下，2022年N型电池片产能有望达到58GW，TOPCon技术占N型电池片产能比重将超过60%。此外，在光伏行业近300GW的PERC产线中，超过100GW产能具备升级为TOPCon产线的能力。

随着N型技术开启规模化量产时代、相关工艺进一步成熟，驱动成本逐步下降，2022年有望成为PERC升级到TOPCon电池技术量产的关键年。

Recently, the gap among tier 1 PV suppliers in terms of product competitiveness and marketing share from P type module is narrowing. The efficiency of PERC is reaching it theoretical limit. Meanwhile, N-TOPCon is expected to be the next mainstream technology to drive the PV industry into a new stage.

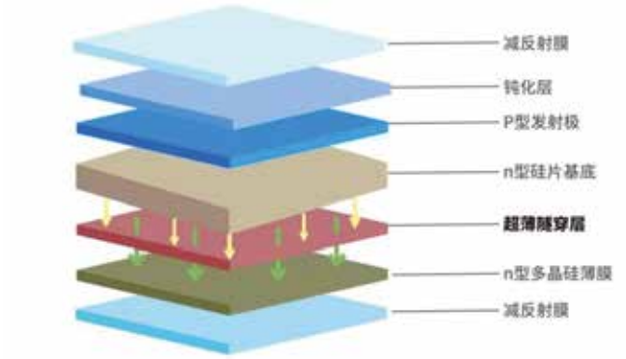
The first half year of 2022, the efficiency of N-TOPCon, the efficiency of N-TOPCon cell has been increasing continuously and reaches to 24.5% in mas production and 25% in laboratory. Compare with the theoretical limit of 28.7%, the potential of market share is promising.

According to TrendForce, the production capacity of N cell is expected to reach 58GW in 2022, driven by the tier 1 PV suppliers, i n which the share of the TOPCon technology will be more than 60%. Besides, about 100GW out of total 300GW PERC production lines could be upgraded to TOPCon.

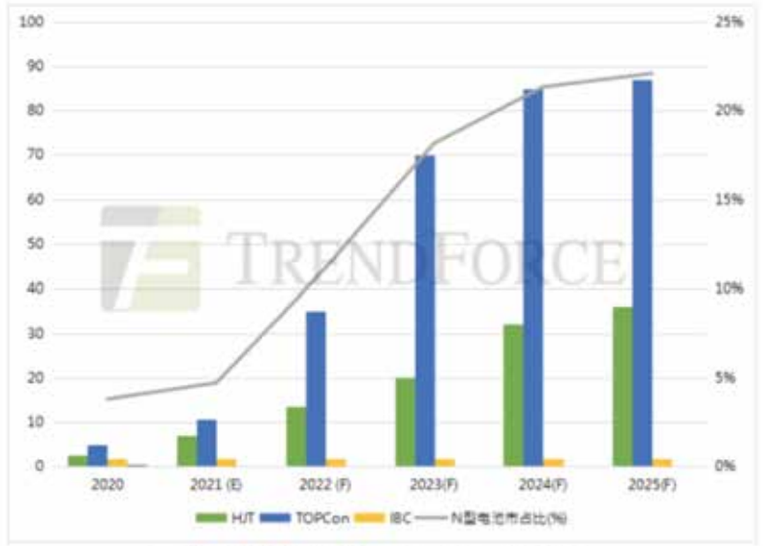
Mass production and mature technology introduction is driving the cost of N type product in 2022. Therefore this year could be the key point of the PERC upgrade into TOPCon.

N型TOPCon简介

N-TOPCon Introduction



TOPCon电池结构（来源：一道新能）



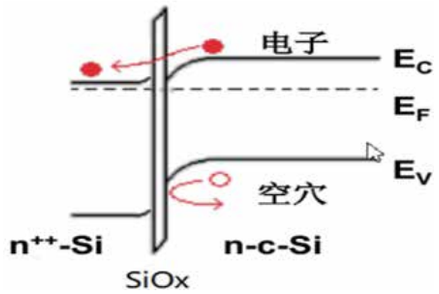
N型电池片产能占比趋势，GW（来源：集邦咨询）

DASOLAR 一道新能
一道阳光 照亮生活

钝化接触技术 Passivation Contacts

钝化接触技术可以使电池表面获得良好的钝化效果，以阻挡少子通过，降低金属接触复合电流，提升电池的开路电压、短路电流和填充因子，从而大幅提升电池光电转换效率。目前，一道新能的量产平均电池效率超过了24.6%。

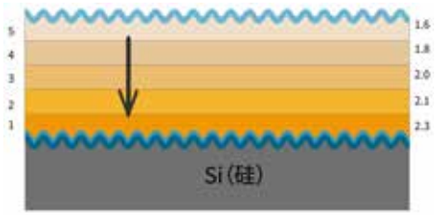
The passivation contacts technology allows the surface of the cell to prevent minority carrier from passing through and reducing the metal contact recombination current, increasing the open circuit voltage, short circuit current and fill factor. Therefore the efficiency could be increased greatly. The efficiency in DAON cell mass production has been exceed 24.6% today.



渐变膜技术 Gradient Refractive Index Film

电池片正面采用渐变介质膜技术，实现钝化、减反射、消光等效果，并实现了抗PID功能。此外，该技术还可以防止电池层压后颜色发生改变，以保持电池片颜色一致、组件外观均匀美观。

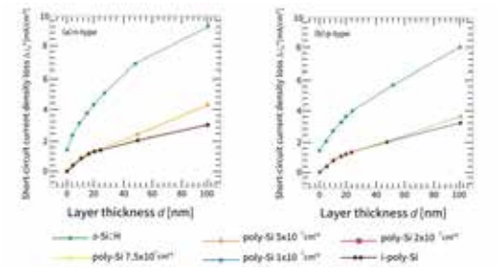
The application of gradient refractive index film technology in the surface helps the cell to be passivated, with the effects of anti-reflection and anti-PID. Besides, the technology avoids the color change after laminating and keeps the uniformity in the module.



超薄多晶硅技术 Ultra-Thin Poly-Si Film

采用超薄多晶硅技术，以减少多晶硅对光的寄生吸收，提升电流密度。背面采用台阶型立体形貌，提升内反射，改善背面金属接触性能，提升电池效率和双面率。

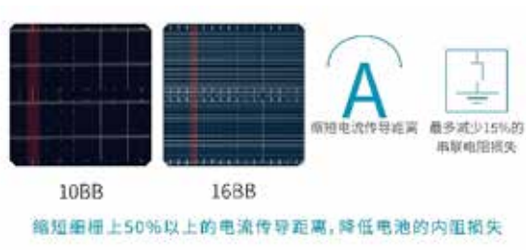
The ultra-thin poly-Si film technology reduces the parasitic absorption by poly-Si, increases the current density. The stepped shape backside design increases the internal reflectance, improves the contact performance, efficiency and bi-facial rate.



SMBB金属化技术 SMBB Metalization

SMBB是MBB技术的升级版，采用更细的栅线，以实现更少的遮挡和更短的传导距离。这种技术有效降低了串联电阻，并提高了电池隐裂、断栅、破裂的容忍度，从而提高了可靠性。

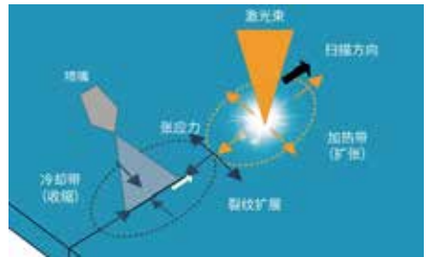
The SMBB is upgraded from MBB. The thinner fingers are introduced to reduce the shadow and the conduct distance. The technology reduces the series resistance, and allows more micro-crack and/or off-grid to ensure a high reliability.



边缘钝化技术 Edge Passivation

电池切割后，边缘将直接暴露在外界环境下。电池钝化水平越高，其切割前后的效率损失越大。DAON产品采用特殊的边缘钝化技术，在分片后立即利用特殊的场效应钝化材料对电池侧面进行处理，修补裂片后的钝化层缺失和侧面缺陷，从而减小电池裂片效率损失。

The cell edge will be exposed to the environment after cutting. More passivation level will cause greater efficiency loss. There is a special edge passivation technology applied in DAON process. In this process, the edge will be protected by special field effect passivation material to repair defects and reduce the efficiency loss.



无损切割技术 Nondestructive Cutting

采用电池无损切割技术，实现无机械损伤、高效率、污染少等效果，并可兼容166/182/210mm大尺寸电池片。

The application of nondestructive cutting technology helps the cell cutting process to avoid mechanical damages, increase the production efficiency and reduce the pollution. The compatibility of large size cell such as 166/182/210mm is guaranteed.

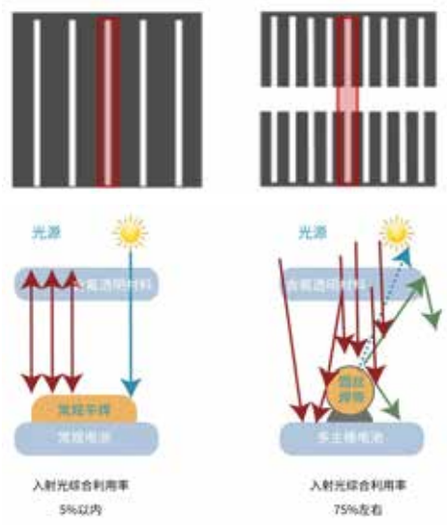
先进封装技术 Advanced Packaging

采用半片技术，使电流减半、电阻降低；增大电池片间距，使反射均匀。采用半片电池技术的光伏组件，其光学增益比采用整片电池技术的组件高30%左右，工作温度低0.5-1°C。在相同遮挡条件下，半片电池组件的热斑温度比整片电池组件低20°C。

The half-cell technology reduces the current and resistance, increases the cell spaces for uniform reflection. The optical gain of half-cells PV module is 30% higher than that of full-cells PV module, and 0.5-1°C lower in terms of the temperature. Under the same shadowing condition, the hot-spot temperature of half-cell PV module is 20°C lower than that of full-cell PV module.

SMBB技术搭配圆丝焊带，可以提高入射光利用率70%，从而获得1-1.5%的功率提升。

The SMBB with round wire welding strip will increase the incident light utilization, therefore 1-1.5% power gain is achieved.



高可靠性光伏组件
Reliable PV Module

钢边框 Steel Frame

钢边框原材料是具有锌铝镁镀层的高强度钢板，防腐能力接近不锈钢，并具有剪切断面的自愈合能力，避免了机加工切口、漏镀点、镀层破损等潜在缺陷导致的腐蚀风险。

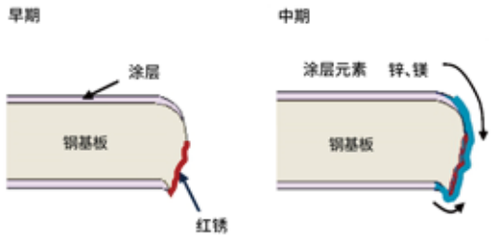
The row material of steel frame is high strength steel strip with Zinc Aluminum Magnesium coating. The capability of corrosion resistance is closed to stainless steel. With the function of self repair, the cutting edges could be covered by its coating material. This avoids the risk of corrosion during a long time operation.

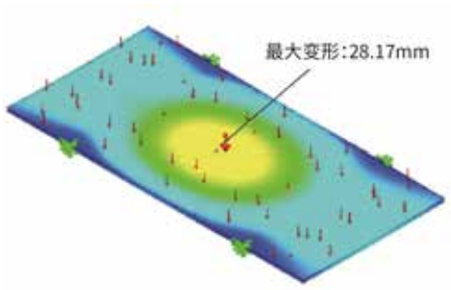
钢边框的良好刚性可以为层压件提供更好的支撑，在同样机械载荷条件下，具有更好的抗隐裂能力。

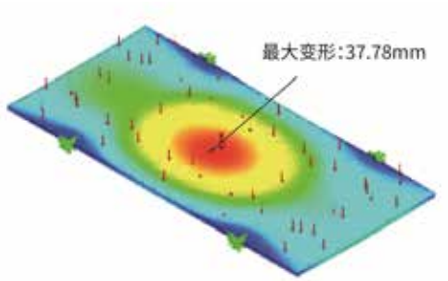
The steel frame gives a better support to the laminate sheet by its higher stiffness. Under the same mechanical load condition, the PV module with steel frame shows better capability of crack resistance.

采用钢边框代替铝边框，可以改善边框膨胀系数与玻璃匹配性，减少密封胶失效风险。

Compare with Al frame, the steel frame has closed coefficient of expansion to the glass used in the PV module. This helps to reduce the risk of sealant failure.







高可靠性接线盒 Reliable Junction Box

对接线盒进行了专门设计开发。采用PPO等环保材料作为盒体，选择优质芯片和散热性能更好的二极管。专用接线盒可以降低1%的功率损失，使光伏组件首年衰减小于1%。

The junction box is design with special considerations. Material such as PPO is designed as box body, the chip is well optimized with better heat dissipation diode. The power loss is less than 1% by the special junction box, while the power degradation in the first year is less than 1%.

绿色光伏组件
Green PV Module

无铅焊带 Lead-free Ribbon

将高标准无铅焊带引入组件产线，实现封装技术无铅化，以满足RoHS各项要求。无铅焊带熔点低、耗锡量少，可以降低焊接温度，从而降低组件隐裂风险；层压件热膨胀系数更低，组件整体抗拉强度更高，有利于提高可靠性。

The introduction of high standard lead-free ribbon into the production line ensures the PV module comply with RoHS standards. The advantages such as the lower melting point and fewer tin consumption ensure the lower welding temperature which reduces the risk of micro-crack. Also, the new ribbon and its welding process helps the laminated sheet keep lower coefficient of thermal expansion, which is helpful for the reliability.

脱醇硅胶 Dealcoholized Silica Gel

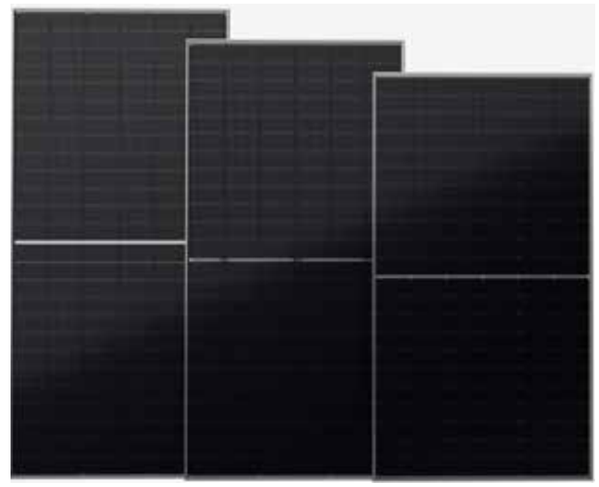
采用脱醇型硅胶作为封装材料，无挥发性气味，对各种表面都具有杰出的粘接性能，具有优秀的热稳定性和机械性能，有利于延长组件寿命、降低运维成本。

With the advantages of no volatile odor, excellent adhesive properties, good thermal stability and mechanical properties, the application of dealcoholized silica gel for module packaging will extend the PV module lifetime and reduce the maintenance fee.

无氟背板 Fluorine Free Backsheet

无氟背板可以支持光伏组件绿色回收。此外，无氟背板与胶膜的粘结力强，具备抗老化能力和优异的耐紫外性，并且具有低水汽透过率，尤其是PO膜和PET具有双层阻隔水汽功能，可满足25年使用要求。

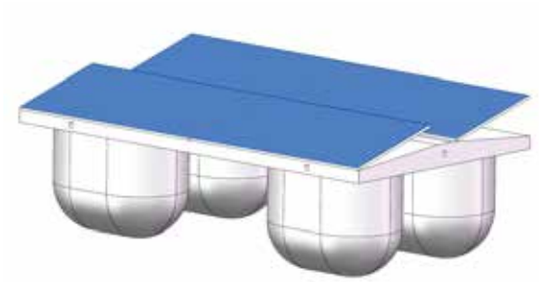
The PV module with Fluorine free backsheet supports the green recycling. Besides, the adhesive force between the Fluorine free backsheet and adhesive film is high. PV module with Fluorine free backsheet has excellent performance in terms of anti aging and UV resistance. The dual-layer vapor isolation of PO and PET films will help the PV module to meet the 25 years lifetime.



系统集成
System Integration

柔性支架光伏系统 Flexible Support PV System

水陆两栖光伏系统 Amphibious PV System



漂浮式光伏系统 Floating PV System

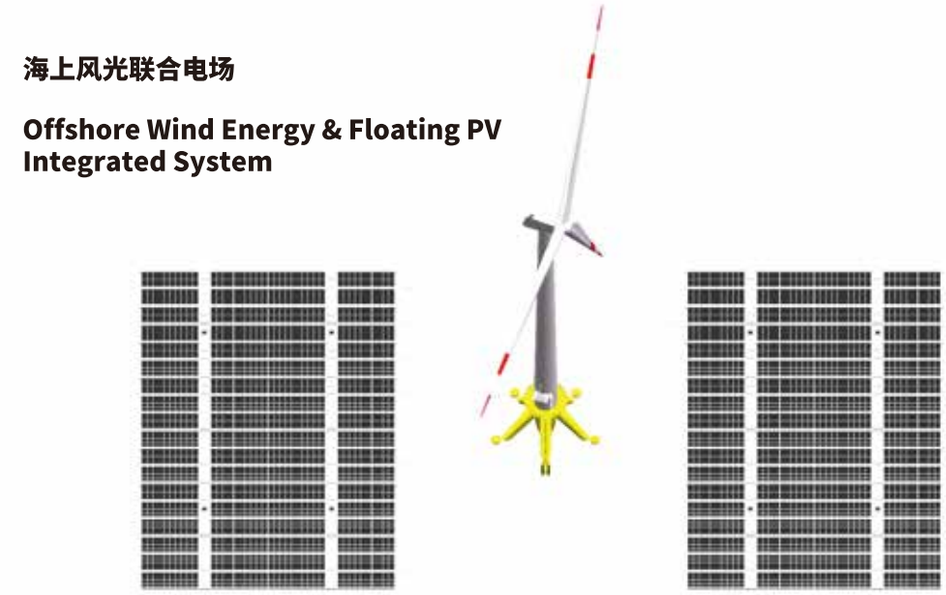
光伏储能充电一体化停车场 PV-Energy Storage-Charging Integrated Parking

新型应用场景
New Applications

光伏治沙 PV-Desert Control

海上风光联合电场

Offshore Wind Energy & Floating PV Integrated System



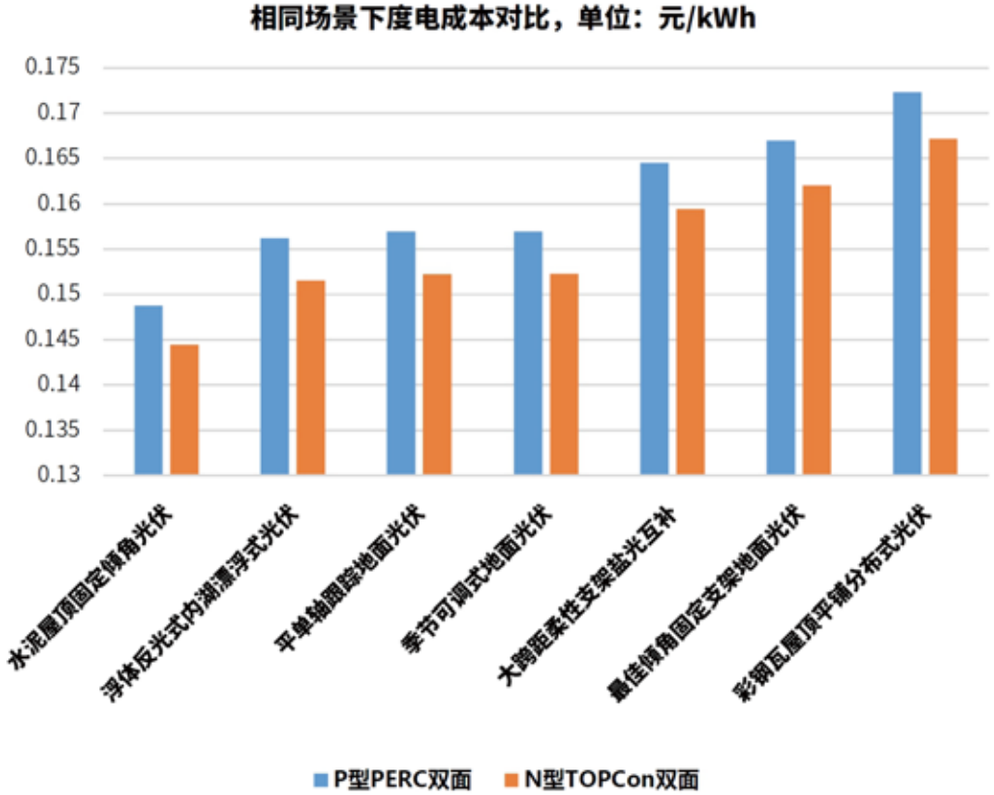
高速公路边坡光伏 Expressway Slope PV System

度电成本对比
LCOE Comparison

建设成本　资产折旧、税收　运维成本　固定资产残值现值

$$LCOE=\frac{P_{dynamic\_cost}-\sum_{n=1}^{T_{O\&M}}\frac{D_{depreciation}R_{tax}}{(1+R_{discount})^{n}}+\sum_{n=1}^{T_{O\&M}}\frac{P_{O\&M}(1-R_{tax})}{(1+R_{discount})^{n}}-\frac{V_{residual\_value}}{(1+R_{discount})^{T_{O\&M}}}}{\sum_{n=1}^{T_{O\&M}}\frac{E_{accrual}}{(1+R_{discount})^{n}}}$$

发电量现值



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一道阳光 照亮生活
Sunshining World & Life

首先，衷心感谢各界同仁对一道新能的关心和支持！

一道新能成立于2018年，是光伏行业的新兵。四年来，我们和光伏同仁共同经历了531新政、平价上网、双碳战略等重要事件，见证了清洁能源大发展的时代洪流。

一道新能的核心成员最早2000年进入光伏行业，人均相关工作经验15年以上。这个阶段，恰逢中国光伏突飞猛进，为个人员的职业生涯留下了浓墨重彩的一笔。

接下来，一道新能将以“碳达峰、碳中和”为使命，以光伏为纽带，将企业与国运紧密相连，秉承“协同、创新”理念，与员工、客户及合作伙伴一道“共创、共赢、共享”，创造一流业绩，书写绿色传奇。

让我们一道迎接每天的阳光，温暖世界、照亮生活！

It is a great honor for me to express my sincere thanks to all of you, for your long term care and support.

DASOLAR is a new member of PV industry. Since 2018, we have been experienced many milestones, such as 531-PV-Policy、PV-Grid-Parity、Targets of Emission Peak and Carbon Neutrality, etc., witnessing that the clean energy being the times mainstream.

Key members of DASOLAR have been working in PV industry for more than 15 years, in which someone started from 2000. During this period, PV industry is developing rapidly for both China and the world. The individual careers are full of achievements。

In the coming years, DASOLAR will take the "Emission Peak and Carbon Neutrality" as our mission, tie in with national strategy, fulfill the ideas of coordination and innovation, together with team members, customers and partners, create first-class achievement, write a green legend.

Let's work together to create a sunshining world, and life.