中国车网互动创新实践与标准体系

Innovative Practices and Standards of EV-Grid Integration in China

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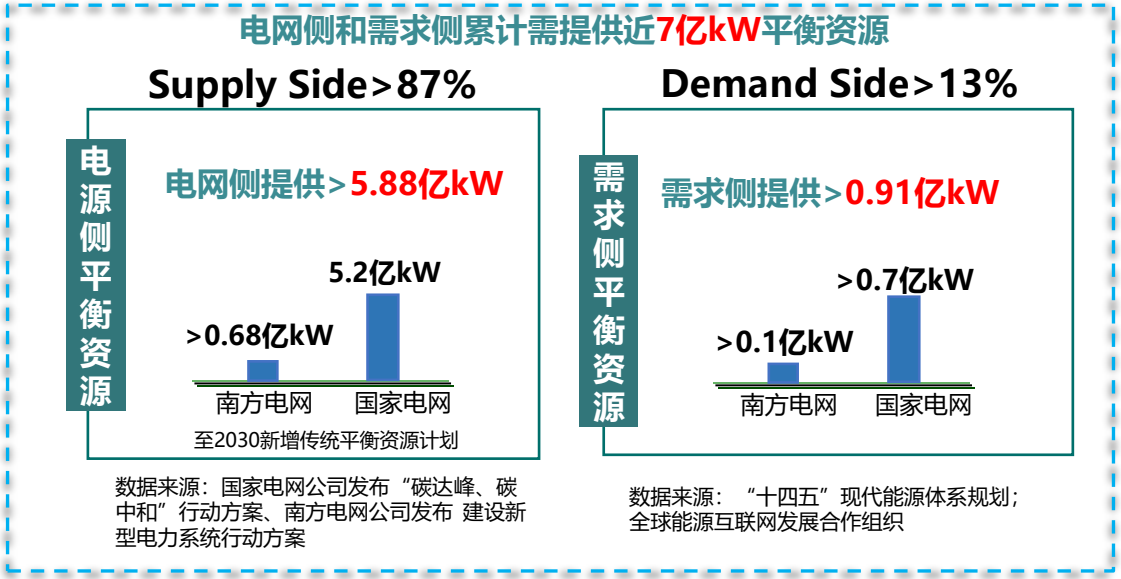
新型电力系统发展趋势 Development trend of new power system

中国向国际社会作出2030年前碳达峰、2060年前碳中和的庄严承诺，**构建新型电力系统是促进能源转型和实现双碳目标的重要支撑**。中国能源电力发展呈现出能源生产加速清洁化、能源消费高度电气化、能源利用效率高效化等新趋势和新特点。 China has made a commitment to the international community to reach peak carbon by 2030 and carbon neutrality by 2060. The construction of a new power system is an important support to promote energy transition and achieve the double carbon goal. China's energy development has shown new trends and characteristics such as accelerated clean energy production, highly electrified energy consumption and efficient energy utilization.

以新能源发电为供给主体的能源结构，将给电力系统的运行控制带来巨大挑战。为消纳2030年装机占比达**25%的12亿kW**风光发电，共规划了近7亿kW的平衡资源，其中需求侧接近1亿kW占13%。 The energy structure with renewable energy generation as the main supply will bring challenges to power system operation. In order to consume 1.2 billion kW of wind&solar power generation, which will account for 25% of the total in 2030, China have planned a total of nearly 700 million kW of balanced resources, within which nearly 100 million kW, or 13%, will be on the demand side.



数据来源：国家电网公司发布“碳达峰、碳中和”行动方案、南方电网公司发布 建设新型电力系统行动方案

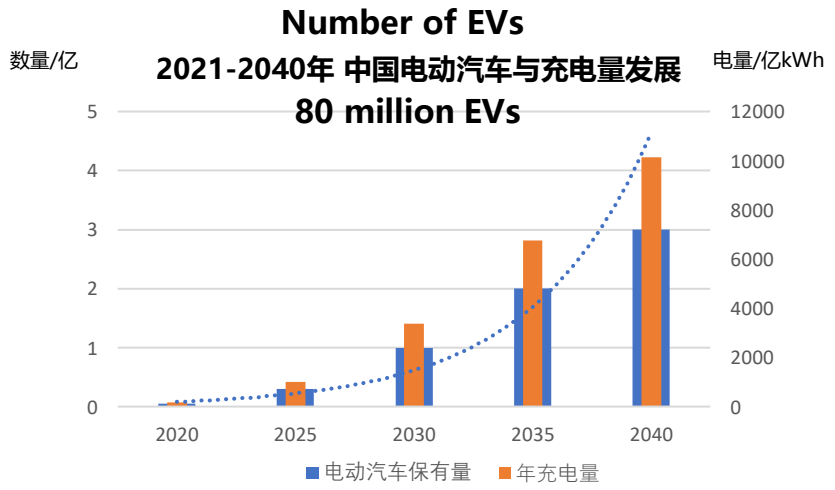
数据来源： “十四五”现代能源体系规划；全球能源互联网发展合作组织

一 电动汽车与充电设施发展趋势 Development trend of EVs and charging facilities

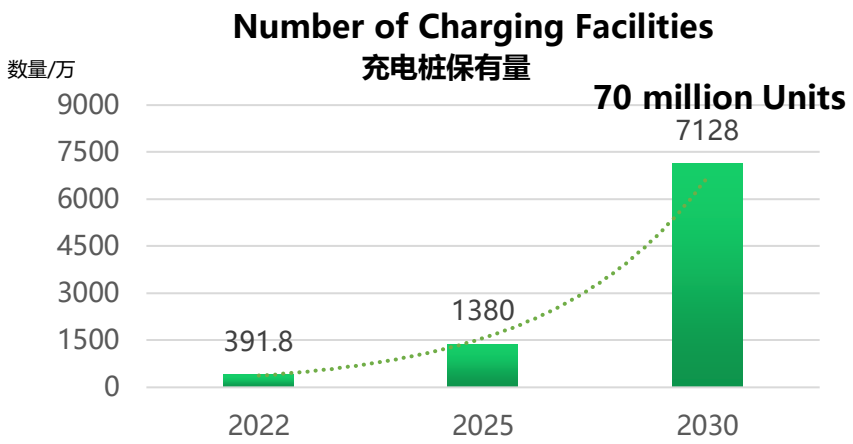
大规模电动汽车是新型电力系统**能源消费侧优质平衡资源的主体**，其数量呈指数级发展，据预测，2030年电动汽车保有量将超过**8000万辆**，若平均配置60kWh，等效储能容量将达到**48亿千瓦时**。 Large-scale electric vehicles are the main demand-side balancing resource of the new power system, and their number is developing exponentially. It is predicted that the number of electric vehicles will reach 80 million in 2030, and if the average capacity for each EV is 60kWh, the equivalent energy storage capacity will reach 4.8 billion kWh.

为满足充电需求，充电桩数量将从当前的390万根激增至超**7000万根**，接入容量超**7亿千瓦**。 To meet the charging demand, the number of charging piles will surge from the current 3.9 million to more than 70 million, with total capacity of 700 million kW.

大规模电动汽车充放电基础设施接入新型电力系统后，可为**系统安全经济运行提供海量可调节资源**。Large-scale electric vehicle charging and discharging infrastructure connected to the new power system can provide a huge amount of adjustable resources for the safe and economic operation of the system.



数据来源：欧阳明高，2021年新能源汽车技术与市场亮点及中长期趋势;中国电动汽车基础设施促进联盟



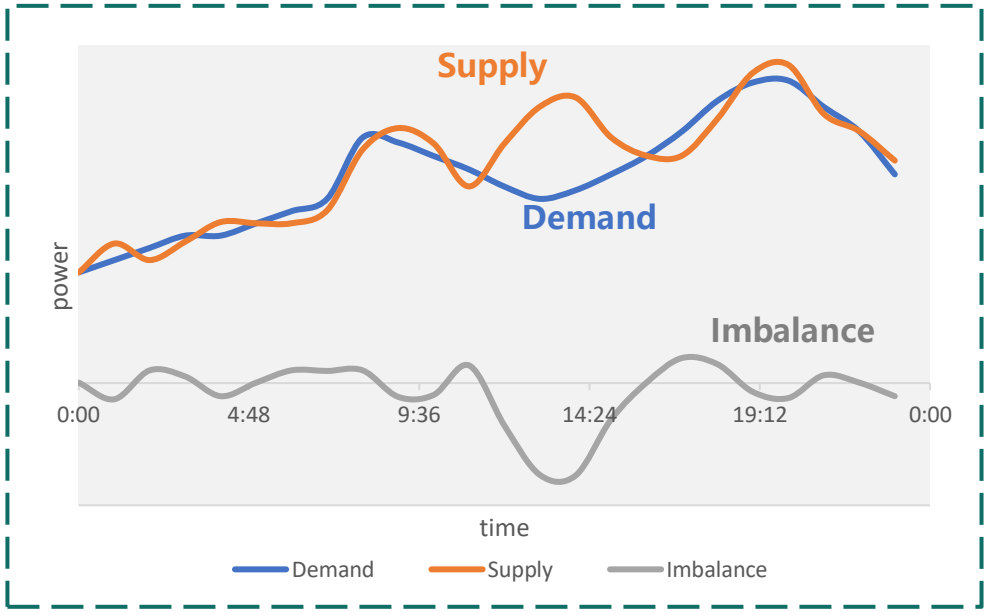
数据来源：新能源汽车国家监测与管理平台
发改委《“十四五”可再生能源发展规划》

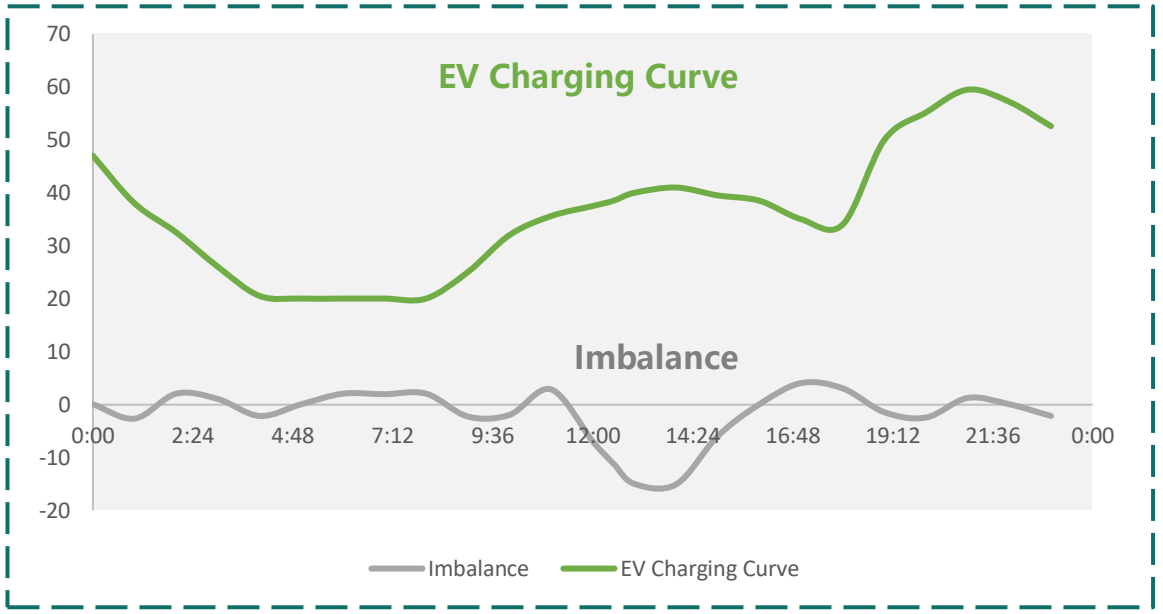
电动汽车与新型电力系统融合发展必要性

Necessity of integrating electric vehicles and new electrical systems

电动汽车充电负荷曲线与**风光发电时段匹配，可实现绿电集中消纳**；同时，通过灵活调控，实现系统供需功率波动的实时平衡，提升系统整体**消纳能力**。EV charging load curve is matched to the PV&Wind generation period to achieve centralized green energy consumption; Meanwhile, EV can provide flexibility to achieve real-time supply and demand balance and improve consumption ability of renewable energy.

在车网融合体系下，充分挖掘用户充电的行为特性，通过智能群体调控，实现可再生能源消纳是必要且可行的，**也是新型电力系统建设的内在要求。** Under EV-Grid integration, it is necessary and feasible to fully explore the behavioral characteristics of users and achieve renewable energy consumption by intelligent control, which is also an inherent requirement for the new power system construction.





国网车网技术企业使命：“两个服务”实现车网互动

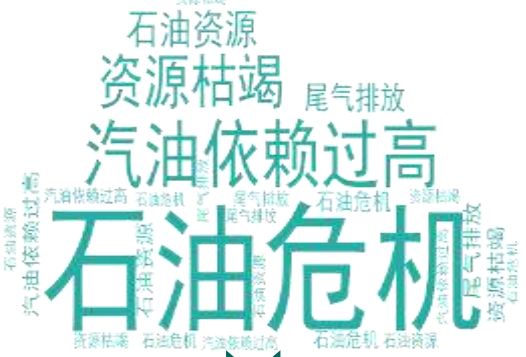
State Grid Smart IoV enterprise mission: "two services" to achieve vehicle network interaction

国网车网技术

State Grid Smart IoV

服务国家新能源汽车战略

To serve the national new energy vehicle strategy

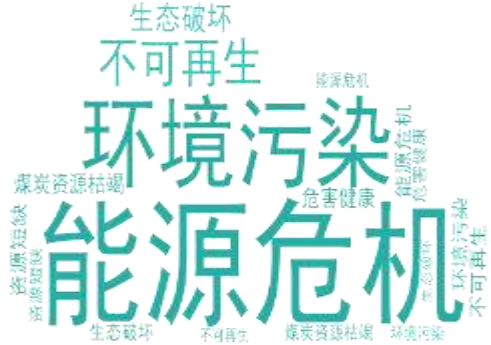


以电代油

Replace oil with electricity

服务国家能源转型战略

To serve the national Energy transformation strategy



清洁替代

Clean alternative

建设能源互联网企业

Build energy Internet enterprises

推动交通电气化

Promote the electrification of transportation

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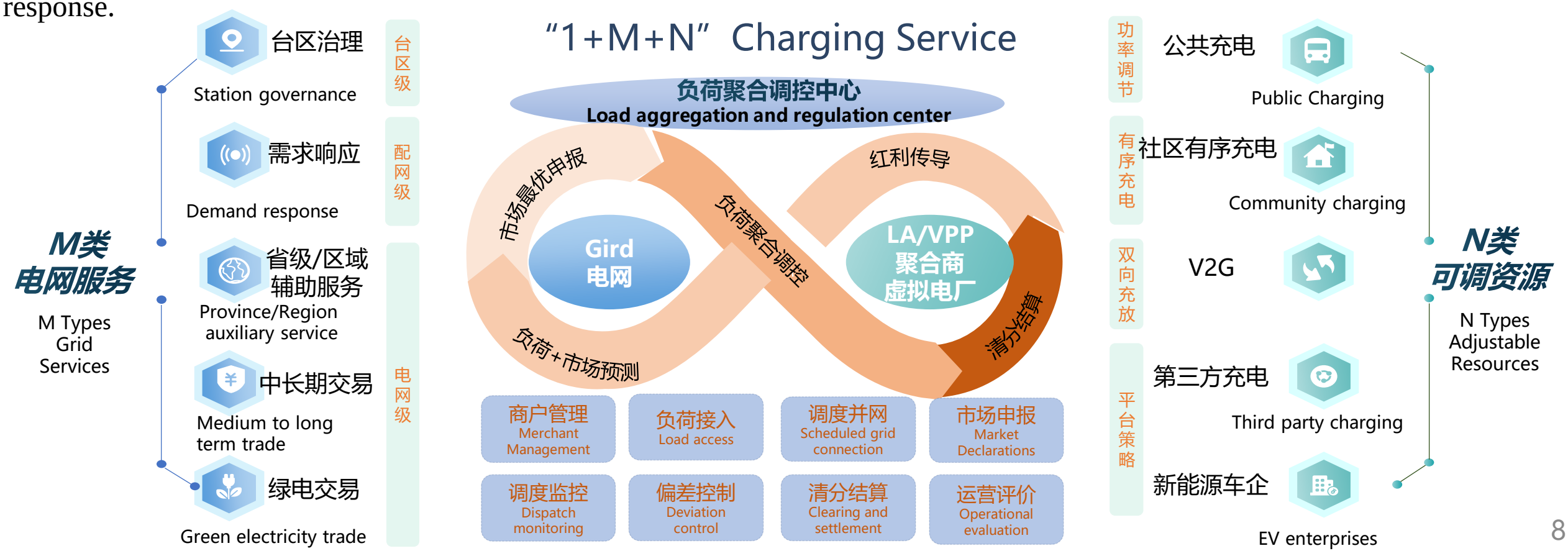
二 车网互动融合发展体系：1+M+N
EV- Grid integration development system

为实现车网融合发展，建立了1+M+N体系。以负荷聚合调控为中心，通过**聚合公共、社区、V2G等N类可调资源**，参与**台区治理、需求响应等M类电网服务**，实现在配电网下的多桩协同，平缓用电峰谷，以及在大电网下的源荷互动，促进可再生能源消纳。1+M+N system is established to achieve EV-new power system integration development. Centered on load aggregation and regulation center, multi-pile synergy control is achieved under the distribution network to smooth peak-to-valley electricity consumption, as well as source-load interaction under regional grid to promote renewable energy consumption by aggregating N kinds of adjustable resources and participating in M kinds of grid services such as auxiliary service and demand response.



车网互动融合发展体系：充换电基础设施

EV- Grid integrated development system: charging infrastructure

国家电网公司 STATE GRID CORPORATION OF CHINA

国网拥有全国覆盖服务半径最大的充电服务能力，国网智慧车联网平台**注册用户1300万**，接入**1700家运营商**，建设和接入充电桩超过**196万**个；覆盖范围北起伊春，南至三亚，东起双鸭山，西至喀什。形成京港澳、京沪等**十纵十横**的高速公路**骨干网络**及县域城市的**毛细血管充电网络**。State Grid has the largest charging service radius in China, with 13 million registered users on State Grid's intelligent vehicle networking platform, access to 1,700 operators, and over 1.96 million charging piles; the coverage area extends from Yichun (north) to Sanya (south), from Shuangyashan (east) to Kashi (west). It forms a ten vertical and ten horizontal highways backbone charging network, such as Beijing-Hong Kong-Macao and Beijing-Shanghai and capillary charging networks in urban & rural.

城市就近充电

Charging in the city

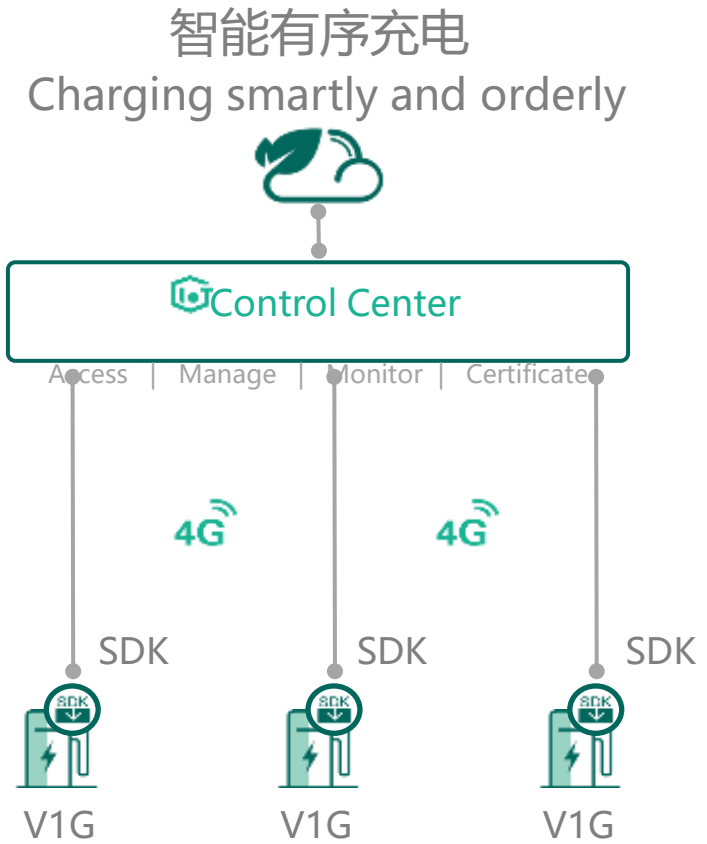
高速公路和城乡公共充电

Highway + urban/ rural public charging

车网互动技术-配网下有序充电

EV- Grid interaction: distribution network interaction-orderly charging

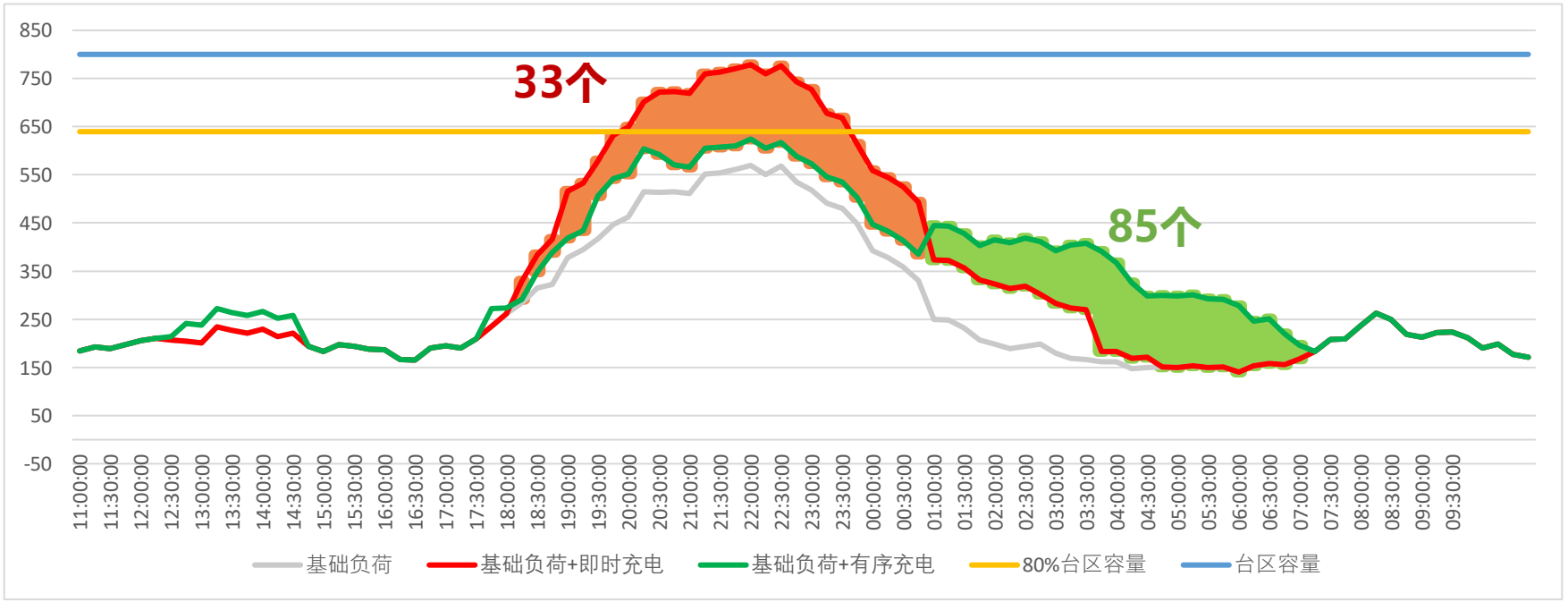
私人乘用车是新能源汽车市场中最活跃、最重要的增量因素。目前已在北京、上海、天津、浙江等**18个省市**建成接入**有序充电桩12万+个**，覆盖**1万+个社区**，服务车主**15万+**名，单月**转移高峰电量432万千瓦时**，推动用户80%在社区充电、80%充低谷电。Passenger car is the most active and incremental factor in EV market. The application of orderly charging technology has been carried out in 18 provinces and cities such as Beijing, Shanghai, Tianjin and Zhejiang. 120000 + orderly charging piles have been built. It covers 10000+ communities, serves 150000+ car owners, and transfers 0.43 million kWh of peak electricity in a single month. Promote 80% owners charging at home and in valley period.



车网互动技术-配网下有序充电

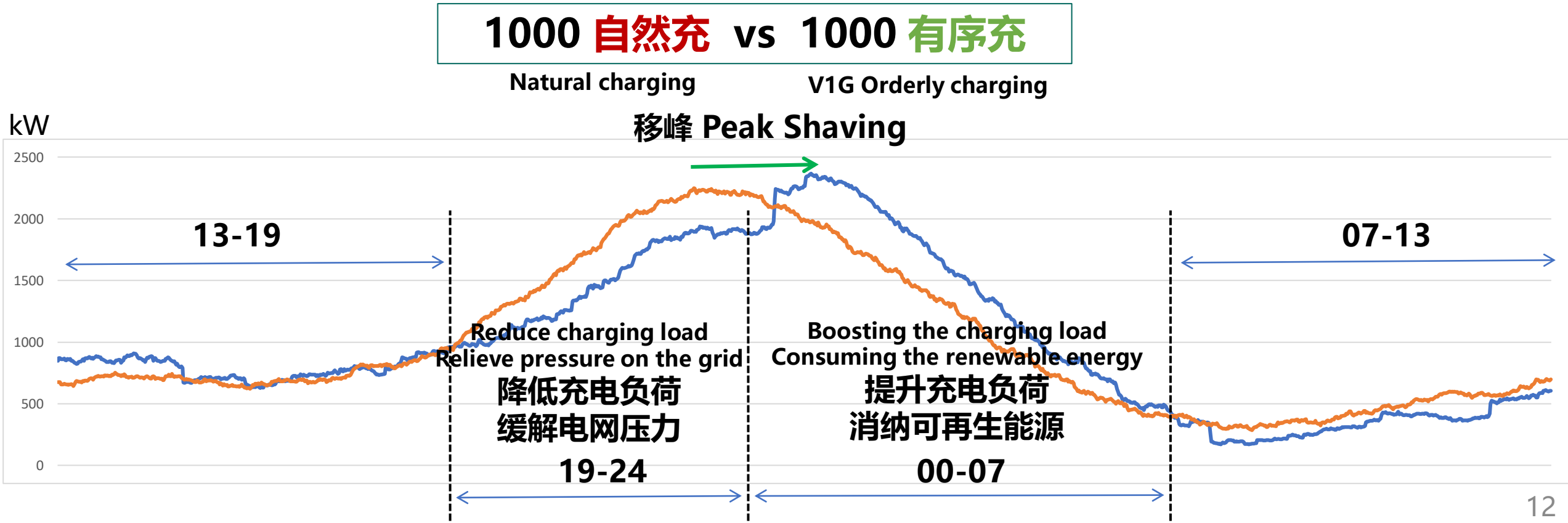
EV- Grid interaction: distribution network interaction-orderly charging

- **场景：**某城市一老旧小区；台变容量：800kVA；Scenario: an old neighbourhood; transformer capacity: 800kVA.
- **社群自然充电负荷：**该区负荷最多可支持**33个无控制能力的**充电桩；Natural charging load of the community: the transformer can support up to 33 V0G charging piles.
- **社群有序充电负荷：**台区负荷峰谷差可降低**30%**；以台区容量80%为上限上线，可支持**85个有序桩。**Community orderly charging load: the peak-to-valley difference can be reduced by 30%; with 80% of station capacity as the upper limit, 85 orderly piles can be supported.



如果我们把1000个自然充电的用户和1000个有序充电的用户进行对比，效果更加的显著，可以降低在**午夜前半段缓解电网的压力**，并且在**午夜后半段可以消纳风力发电**。

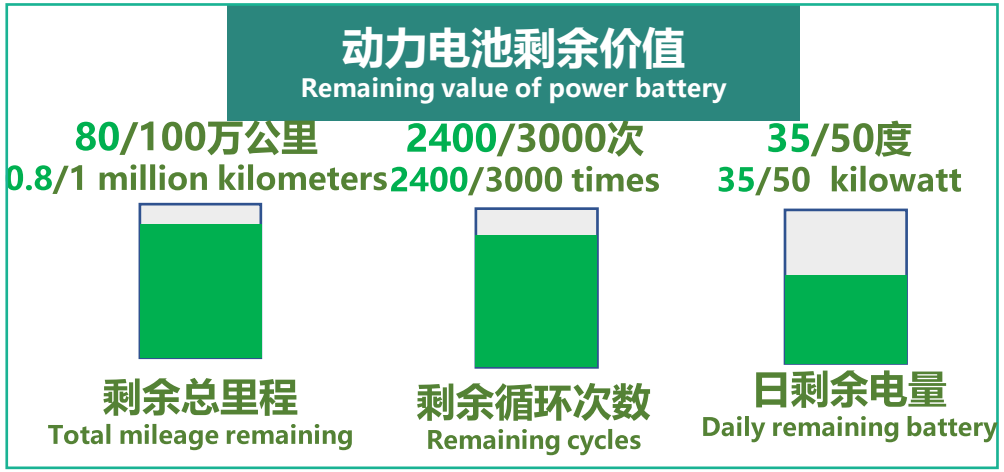
If we compare 1000 natural charging with 1000 orderly charging, the effect will be more significant. It can reduce the pressure on the power grid before midnight and absorb wind power after midnight.



二 车网互动技术-配网下V2G移动储能

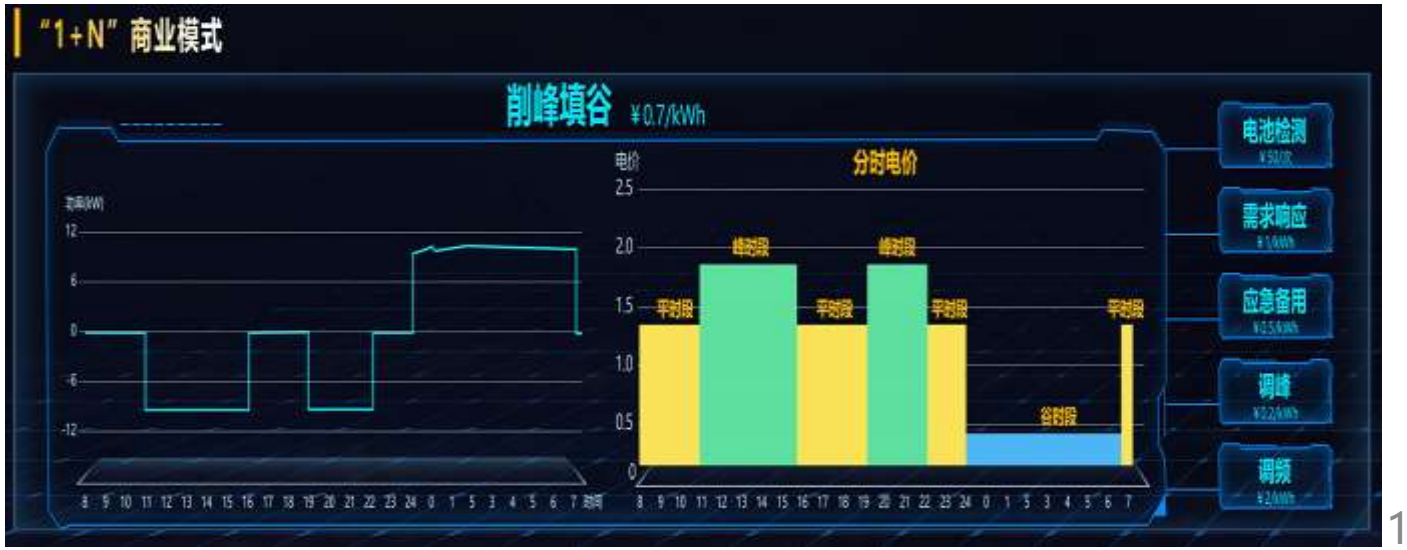
EV- Grid interaction: Distribution network interaction-V2G mobile energy storage

国家电网公司 STATE GRID CORPORATION OF CHINA



基于V2G技术，电动汽车将成为移动储能，**是目前提升电网平衡能力最经济的方式**。目前，电动汽车的**80%闲置储能**价值没有得到充分利用。未来3亿辆车，120亿度储能，400GW的调节能力相当于100个世界最大的抽水蓄能电站，可节省千亿级别的投资。

Based on V2G technology, electric vehicles will become mobile energy storage, which is the most economical way to improve the power grid balance. At present, 80% of the idle energy storage value of electric vehicles is not fully utilized. In the future, 300 million vehicles, 12 billion kWh of energy storage, and 400GW of regulation capacity are equivalent to 100 of the world's largest pumped storage power stations, which can save hundreds of billions of investment.



口 家庭场景1- V2G Family Scene 1

针对某些别墅（含农村别墅），物业或供电公司不给申请报批新能源电表场景，充电桩可安装在入户总表下面，通过V2G可实现峰谷套利，凸出户用应急的功能。

For some villas (including rural villas), if the property or grid company does not approve of meters installation, the charging pile can be installed after the household meter. Peak-valley arbitrage can be achieved through V2G as an emergency power source.

项目	数值
车电池容量battery capacity（kWh）	70
峰谷价差ToU tariff（RMB/kWh）	0.2
放电电量Discharging energy（kWh）	30
每天放电净收益net income（RMB)(考虑18%损耗)	3.6
每年总收益 yearly income(RMB)（300天计算）	1080
若考虑阶梯问题，收益更低，V2G更多体现应急功能	

口 家庭场景2- PV+V2G Family Scene 2

- 储能电池一电两用，同时满足行驶和负载用电需求
- 电动汽车为家务专用、可作为常驻储能设备连接电网
- 光伏发电自用—85%能被消纳，15%余电上网。

Battery used for electrical load and users' driving need
Regarded as BESS device and connected to grid
PV power self consumed --85% consumed on-site and 15% to grid

项目	数值
光伏装机容量PV capacity kWp	8
日平均发电量daily average generation kWh	24
车电池容量 battery capacity（kWh）	70
光伏消纳比例 PV consumption ratio	85%
消纳节省年费用（RMB,按第三阶梯峰时电价计算）	6391
余电上网比例Ratio of surplus power to grid	15%
余电上网年收入yearly income of surplus power to grid(RMB)	514
合计年收益yearly income（RMB）	6905
5年合计收益 5 years' income（RMB）	34525
回收周期 （年）payback years	5

车网互动技术-配网下V2G移动储能

EV- Grid interaction: Distribution network interaction-V2G mobile energy storage

□ 工业场景industrial scene1- V2G(company cars)

- 厂区公车在谷时充电，在单位峰时电价时段放电，获取收益。Charge in the valley time and discharge in the peak.
- 工厂负荷投切可控，通过V2G降低最大功率点，为工厂节省基本电费。minimize the maximum power through V2G to lower electricity cost for the factory .

项目	数值
车电池容量battery capacity（kWh）	70
工厂谷时充电单价elec. Tariff in valley time（RMB/kWh）	0.2589
工厂放电电价discharge elec. Tariff in peak time（RMB/kWh）	1.0347
放电4小时discharge for 4 hours（kWh）	24.4
每天放电节省费用 money saving（RMB，考虑18%损耗）	17.54
每年低充高放节省费用yearly money sacing（RMB，按照350天常年负荷计算）	6139
工厂最大负荷投切时，通过V2G最大功率支撑（kW）	100
每月节省按需基本电费monthly saving money（RMB）	4000
年节省按需基本电费yearly saving basic elec. tariff（RMB）	48000
基本电费折算到20台车*，每车年收益（RMB）	2400
合计每辆车年收益yearly income for each car（RMB）	8539
若遇限电情况，每车年收益将更高	

□ 工业场景industrial scene2-PV+V2G(company cars)

- 厂区公车在谷时充电，在单位峰时电价时段放电，获取收益。Charging in the valley time and discharge in peak time
- 工厂负荷投切可控，通过V2G降低最大功率点，为工厂节省基本电费。Minimize the maximum power through V2G to lower electricity cost for the factory
- 在早上和中午辅助消纳光伏电量，待峰时点价时放电，节省电费。Consume PV power in the morning and at noon and discharge with high tariff.

项目	数值
某工厂光伏装机容量 PV installation capacity kWp	400
日平均发电量 daily generation kWh	1200
早上和中午光伏无法消纳的比例non-consumption ratio of PV	15%
日平均辅助消纳电量 kWh average daily PV consumption	180
日均高峰放电净收益差（RMB，考虑18%损耗）net income	82
高峰放电年净收益（RMB）	29930
每辆车辅助消纳年净收益（RMB，假设20辆车）net income of each car	1497
结合上一页低充高放和变压器需量降费，每辆车收益（RMB）	10036

丽华快餐V2G充放电案例 V2G case

应用场景:

常州市丽华快餐(鸣新分公司)使用工业用电，谷峰电费差异很大，因此安装了**6.6kW**双向直流充电机，EV电动车晚上在家中充电，白天上班到快餐店在峰值时段内放电给店内使用，赚取谷峰电价格差。同时可以起到削峰填谷，支撑电网作用。

Changzhou Lihua Fast Food uses industrial electricity with a great valley peak electricity tariff difference. A 6.6kW two-way DC charger is installed. EV are charged at home at night, and discharged to the fast food restaurant during the peak hours during the day to earn the valley peak electricity price difference.

收益计算:

项目	数值
车电池容量 battery capacity（kWh）	70
夜间家里充电单价elec. Tariff at home （RMB/kWh）	0.3783
白天丽华快餐店放电电价 discharge elec. tariff（RMB/kWh）	1.509
白天丽华快餐店放电电量 discharge energy（kWh）	40
每天放电净收益daily net income（RMB，考虑18%损耗）	37
每年总收益yearly income（RMB，按照260个工作日计算）	9620
5年收益 5 years’ income（RMB）	48100

场景配置:

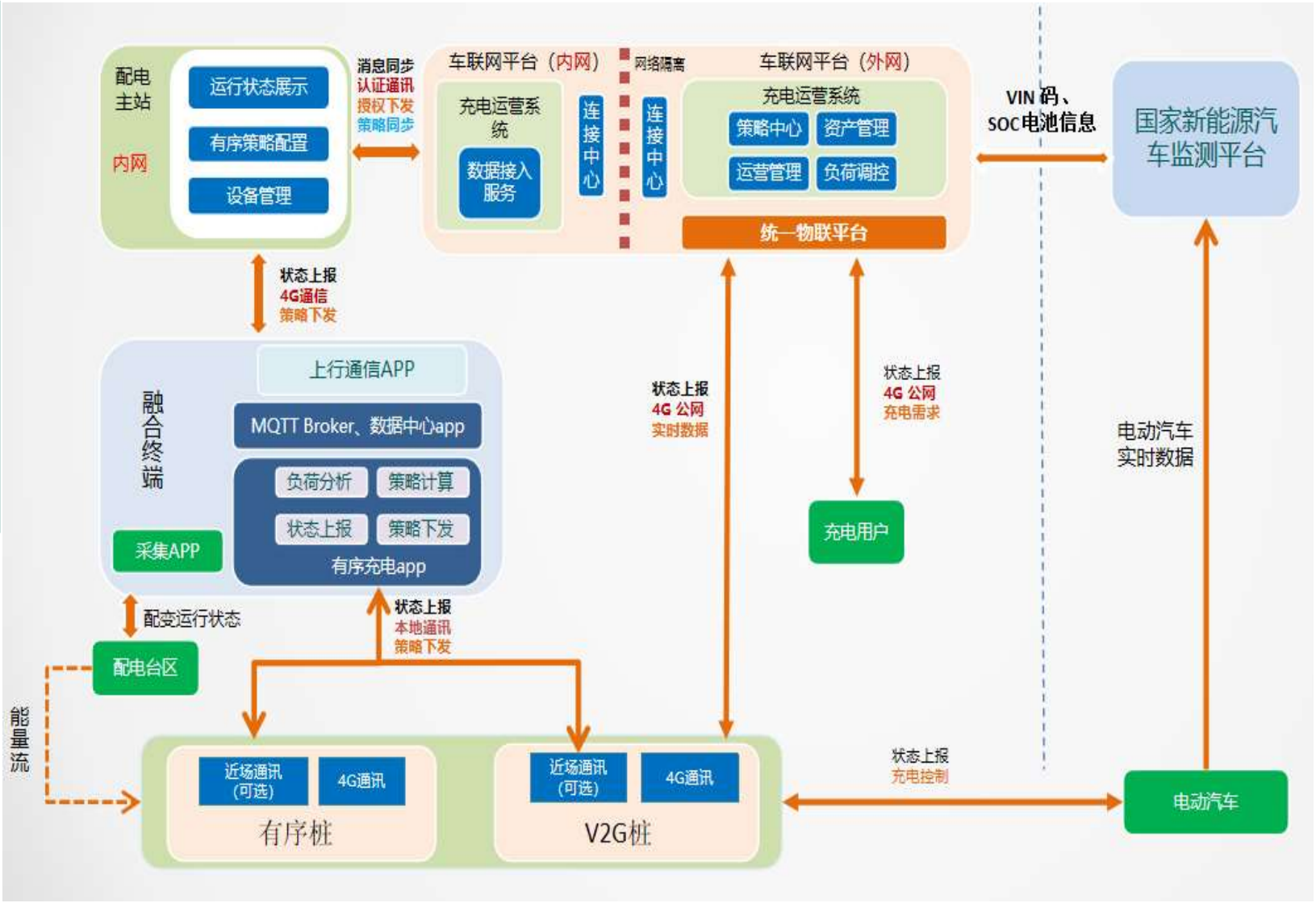
6.6kW墙盒双向直流充电机+双向电表+EV电动车（支持放电）

6.6kW wall box bidirectional DC charger+bidirectional meter+EV (supporting discharge)

二 配网下V2G移动储能-充放电平台技术架构

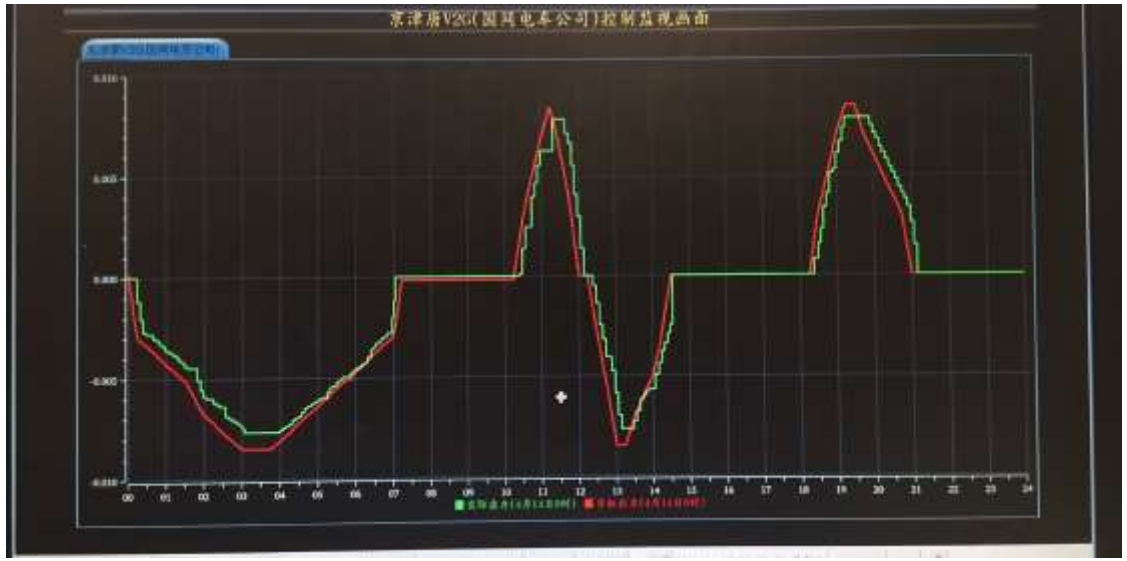
Distribution network interaction-V2G mobile energy storage-Platform Scheme

结合智能融合终端推广应用，通过台区级车桩网智能交互，实现低压配网侧对充电桩的**全景感知及以改善台区电能质量**为目标的电动汽车充放电负荷精准实时调控，解决台区**重过载**等运行问题。 Accurate real-time EV ch/discharging regulation to improve the power quality and overloaded in the station area were achieved based on the application of intelligent terminal and smart EV-pile-grid interaction.



具体的应用成效，实现了对不同时段、不同需求下的V2G充放电功率智能调控。用电晚高峰时，邀约V2G车协同试点内储能设备为台区提供功率支撑；还可以接受调度的**AGC指令**，进行功率指令分钟级跟随，下一步我们可以做到秒级的快速响应。

The specific application has realized the intelligent regulation of V2G charging and discharging power in different periods and different demands. In the evening peak of power consumption, invite V2G vehicle to cooperate with the energy storage equipment in the pilot station to provide power back to the grid; It can also accept the scheduled AGC command and follow the command in minutes. In the next step, we can achieve rapid response in seconds.



二 车网互动技术-聚合参与京津唐调峰辅助服务

EV- Grid interaction : Beijing-Tianjin-Tangshan peak shaving auxiliary service

国家电网公司 STATE GRID CORPORATION OF CHINA

负荷聚合运营平台累计接入充换电站、V2G电站、储能站等近3.3万座，零散设施超过6万台，累计调节能力**835MW**，实时响应调节功率**130MW**。2019和2020年在**华北调峰市场**，累计消纳风光电量达**37GWh**，是全球规模最大的电动汽车参与电网调峰。The load aggregation operation platform has been connected to nearly 33000 charging and power swap stations, V2G power stations, energy storage stations, and more than 60000 scattered facilities. The accumulated regulating capacity is 835MW, and the real-time response regulating power is 130MW. In the peak shaving market in North China, the accumulated wind and solar power consumption reached 37GWh, which scale is world largest.

充换电站

2166.61MW
95.8 %

有序充电桩
Orderly charging pile
33451个
548.2MW

公共充电桩
Public charging pile
15403个
938.23MW

换电站
Swapping station
71个
46.48MW

电采暖
Electric heating

49个
85.43MW
3.8%

储能电站
Energy storage power station

8个
7.6MW
0.3 %

V2G设备
V2G equipment

86个
0.56MW

车网互动技术-聚合参与京津唐调峰辅助服务

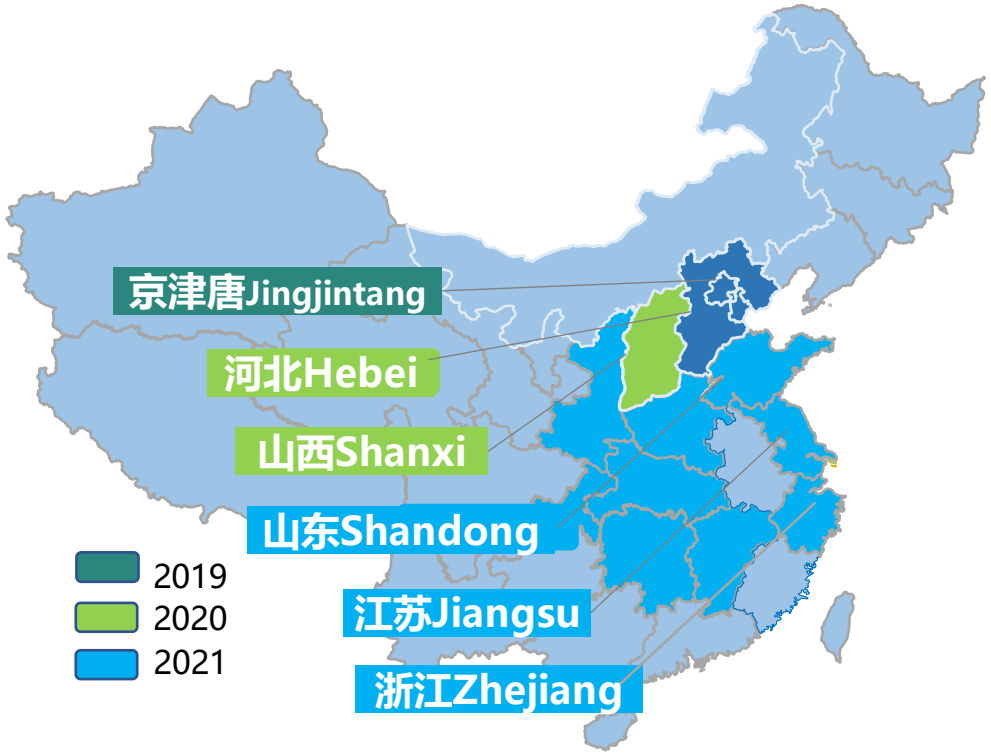
EV- Grid interaction : Beijing-Tianjin-Tangshan peak shaving auxiliary service

夜间 Night

日间 Daytime

以有序和V2G技术为基础，聚合各类电动汽车资源参与大电网的互动，聚合的意义主要还是为了消纳可再生能源，**在白天消纳多余的光伏，在夜间消纳多余的风电**.

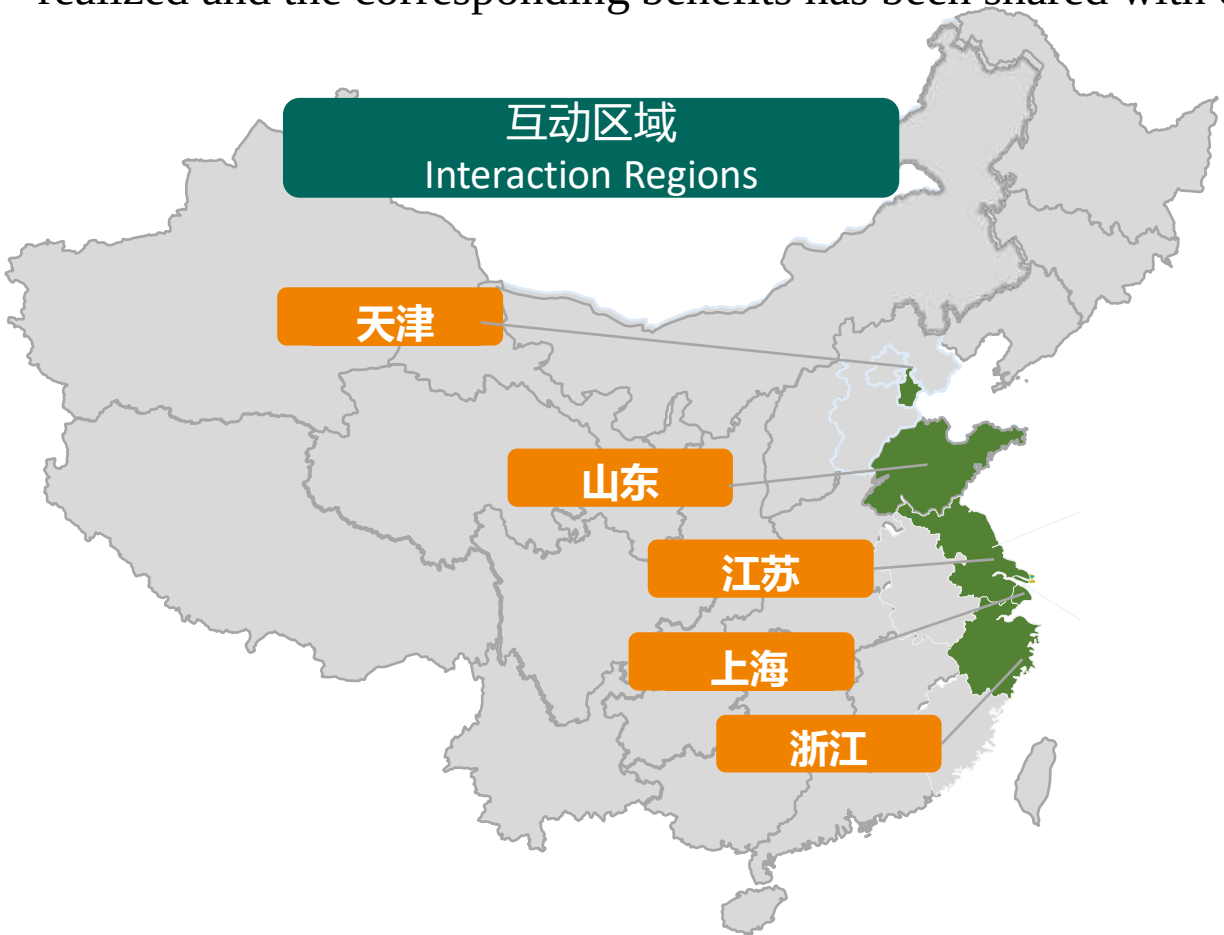
Based on the V1G and V2G technology, we gather all kinds of electric vehicle resources to participate in the interaction with new power grid. The significance of the aggregation is mainly to absorb renewable energy, absorb excess photovoltaic power during the day, and absorb excess wind power at night.

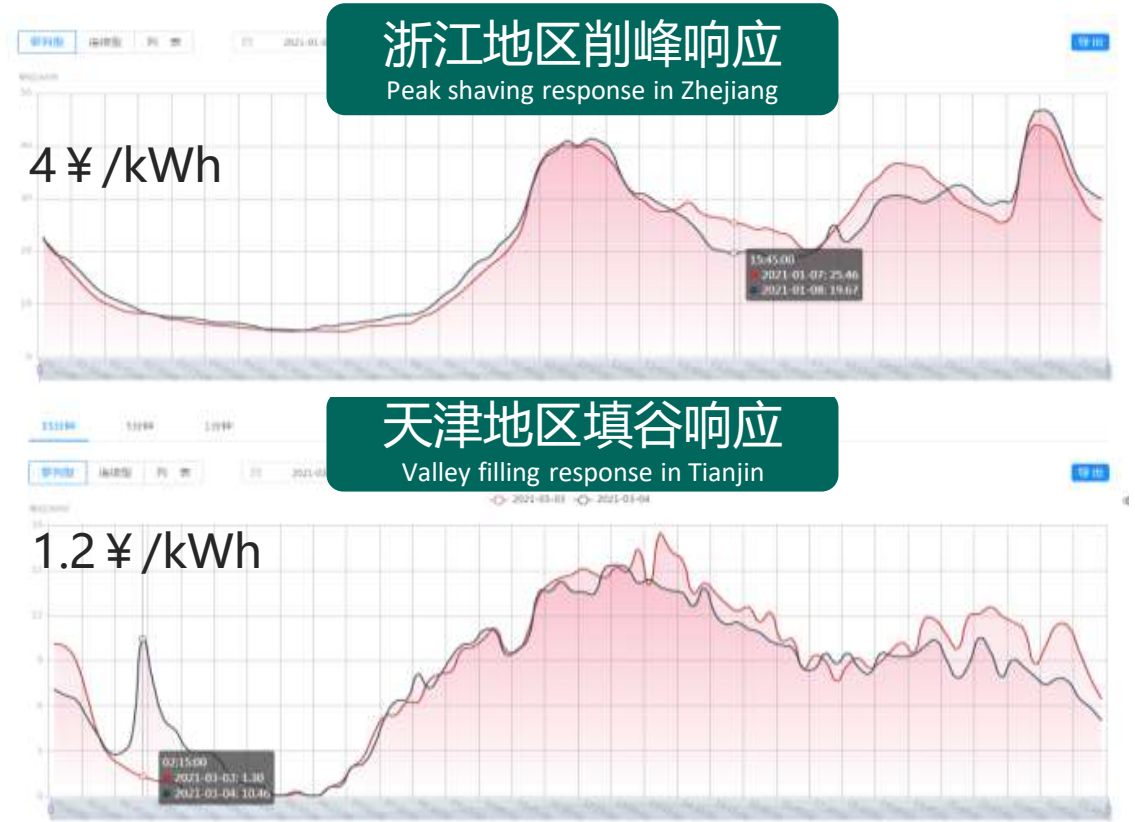


车网互动技术-聚合参与需求响应

EV- Grid interaction: distribution network interaction-orderly charging

天津、山东、上海、浙江、山西、江苏**6个省电网**已开展需求响应；已完成山西、山东、上海、江苏、浙江**5个省需求响应平台与负荷聚合运营系统对接**，实现数据共享，在浙江、天津等地区实现实时响应，并把相应收益传导至终端用户.Demand response market has been carried out in Tianjin, Shandong, Shanghai, Zhejiang, Shanxi and Jiangsu. The demand response platforms of Shanxi, Shandong, Shanghai, Jiangsu and Zhejiang provinces have been connected with the load aggregation operation system to realize data sharing. In Zhejiang, Tianjin and other regions, real-time response has been realized and the corresponding benefits has been shared with end users.

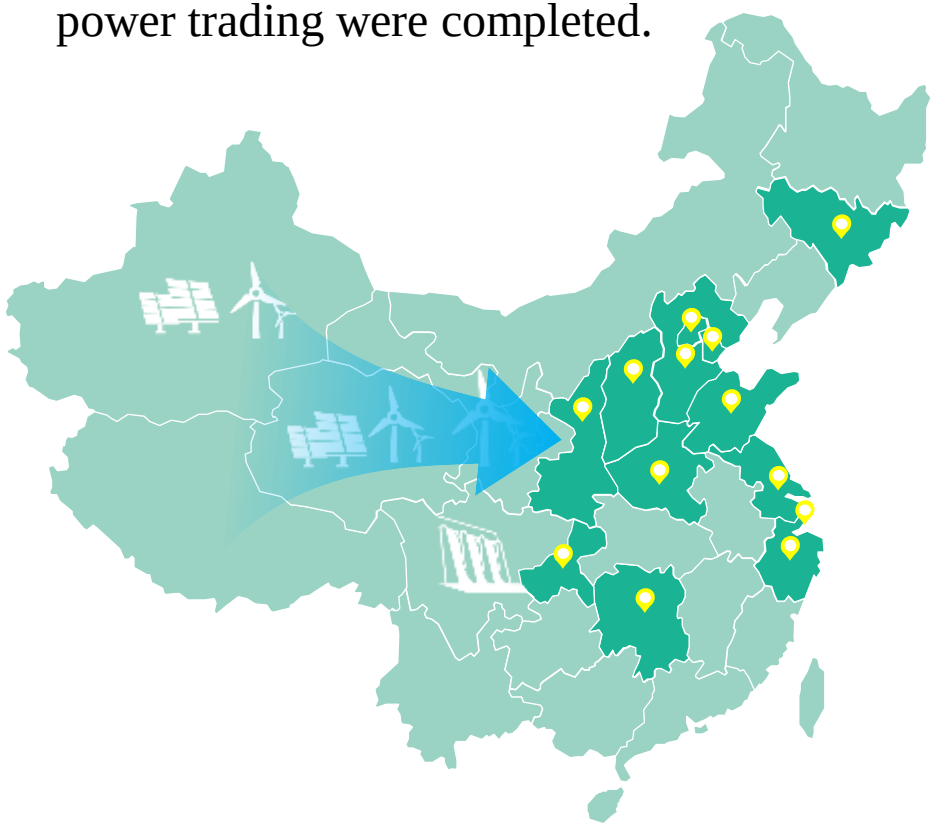




车网互动技术-聚合参与绿电交易
EV- Grid interaction: Green electricity trading effectiveness

组织电动汽车广泛参与到绿电交易中去。推广到了北京、浙江、重庆等全国**10个省市**，聚合社会运营商**149家**，生成绿证532万个,**充电清洁比37.9%**，是全社会用电清洁度的**1.6倍**。全社会完成绿电交易电量约**19亿千瓦时**，真正实现新能源车用新能源电。

Organize electric vehicles to participate in green power trade. It has been promoted to 10 provinces and cities including Beijing, Zhejiang and Chongqing, and 149 social operators have been gathered, generating 5.32 million green certificates. The charging cleanliness ratio is 37.9%, which is 1.6 times the cleanliness of the other regions. About 1.9 billion kWh of green power trading were completed.



- 支撑绿电交易电量19.32亿千瓦时
  Supporting green electricity trading power of 1.932 billion kWh
- **试点地区充电清洁比37.9%是平均水平的1.6倍**
  The charge-to-clean ratio of 37.9% in the pilot area is 1.6 times the average

全国10个省市，聚合社会运营商149个
149 social operators in 10 provinces and cities across the country

联盟链生成绿证532万
Consortium chain generates 5.32 million green certificates

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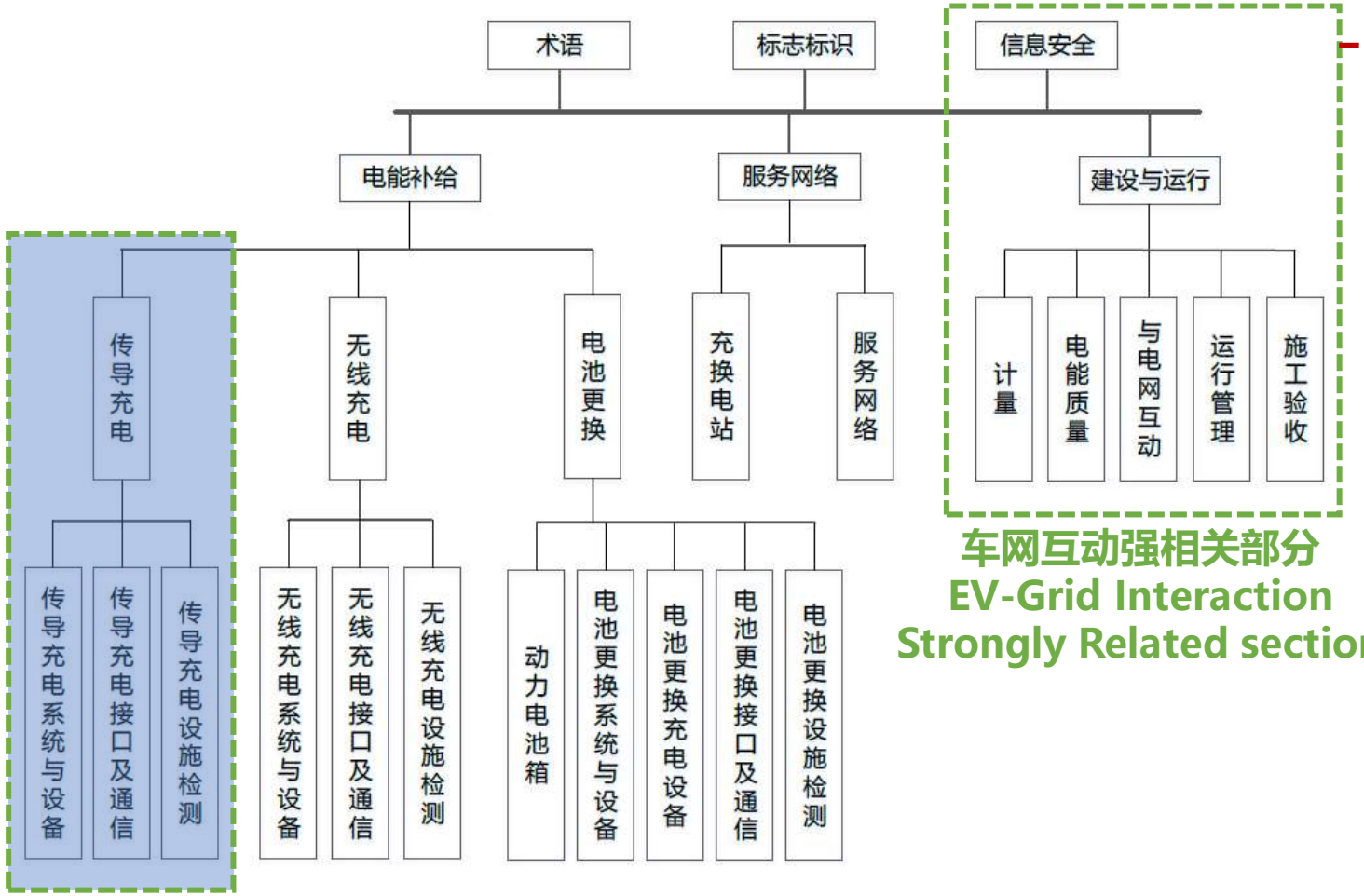
车网互动标准现状-标准体系
Current Status of EV-Grid Integration Standards

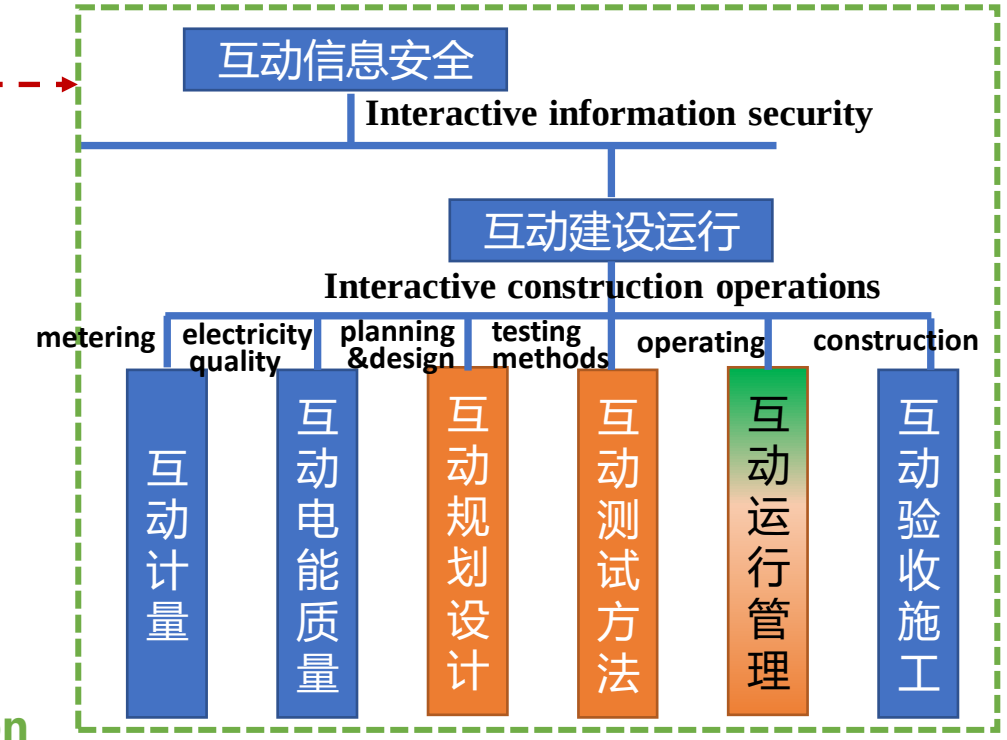
当前电动汽车充电设施标准体系框架
Framework of the current standard system for EV charging devices



车网互动强相关部分
EV-Grid Interaction
Strongly Related section

图 电动汽车充电设施标准体系框架图
EV Charging Devices Standard Scheme Framework Diagram

车网互动标准体系更新需求
The standard update requirement for EV-Grid Interaction



因互动需更新
Update

因互动需新增
Additional Standards

因互动要新增与更新
Update & Addition

三 车网互动标准现状-标准体系
Current Status of EV-Grid Interaction Standard - Standards Scheme

车网互动标准体系包括**电动汽车充放电系统、电网接入、资源运营**等三个分支，重点关注电动汽车充放电/有序充电系统架构、功能和技术要求、系统接口、接入电网的要求、资源聚合和资源运营等。

The EV-grid interaction standard scheme which including three branches of **electric vehicle charging and discharging system, grid access and resource operation**, is focusing on electric vehicle charging and discharging/ordered charging system architecture, functional and technical requirements, system interfaces, requirements for access to the grid, resource aggregation and resource operation, etc.

电动汽车充放电系统
electric vehicle charging and discharging system

主要包括电动汽车充放电/有序充电系统架构、技术要求、系统接口与通信协议等
Mainly includes electric vehicle charging/discharging/ordered charging system architecture, technical requirements, system interfaces and communication protocols, etc.

接入的技术要求与规划
Technical requirements and planning for access

互动的试验与测试
Interactive trials and tests

主要包括电动汽车充放电设施接入配电网的技术要求和试验规范
Mainly includes technical requirements and test specifications for electric vehicle charging and discharging devices connected to the distribution network

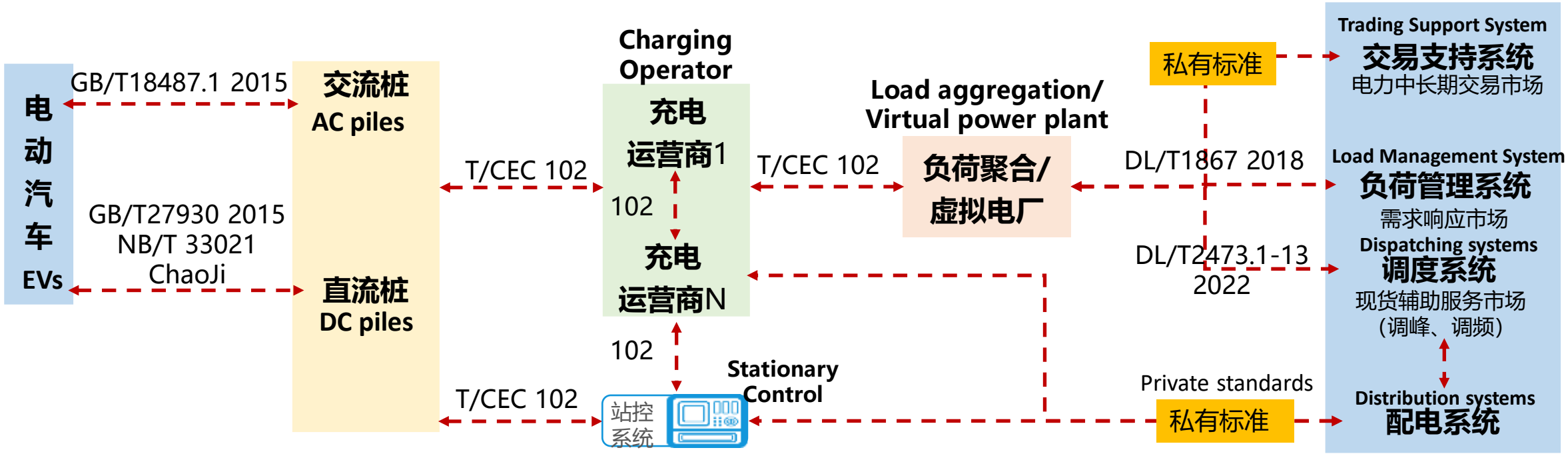
资源运行、运营与管理
Resource Operations & Management

互动信息安全防护
Interactive information security protection

主要包括电动汽车充放电参与电网调度、需求响应和辅助服务要求，电动汽车充放电设备与储能、分布式电源的互动要求等Mainly includes requirements for EV charging and discharging to participate in grid dispatch, demand response and auxiliary services, and requirements for interaction between EV charging and discharging equipment and energy storage and distributed power sources, etc.

三 车网互动标准现状-互动运行中通信标准现状

Current status of EV-grid interaction standards - communication standards in interactive operation



国内协议标准 Domestic protocol standards		标准化度 Standard	普及度 Popularity	标准化难度 Difficulty of standardization	车网协同 interaction	信息传输丰富度 information	网络安全性 Security
车-桩协议 Vehicle-Pile Agreement	GB/T 27930	国家标准 National	高 High	已标准化 Standardization completed	不支持 Not support	有限 Limited	有限 Limited
桩-充电运营商协议 Pile-Charging Operator Agreement	T/CEC 102	团体标准 Group	低 Low	市场化水平高，多方配合难度大 High level of marketability and difficulty of cooperation between multiple parties	不支持 Not support	有限 Limited	有限 Limited
电网-分布式资源协议 Grid-Distributed Resources Agreement	DL/T 2473	行业标准 Industry	中 Medium	处于发展初期、集中化程度高、国企把控，有条件标准化 In the early stages of development, highly concentrated, controlled by nation-owned enterprises, with conditions for standardization	支持 Support	--	高 High
	DL/T 1867	行业标准 Industry	中 Medium		支持 Support	--	高 High

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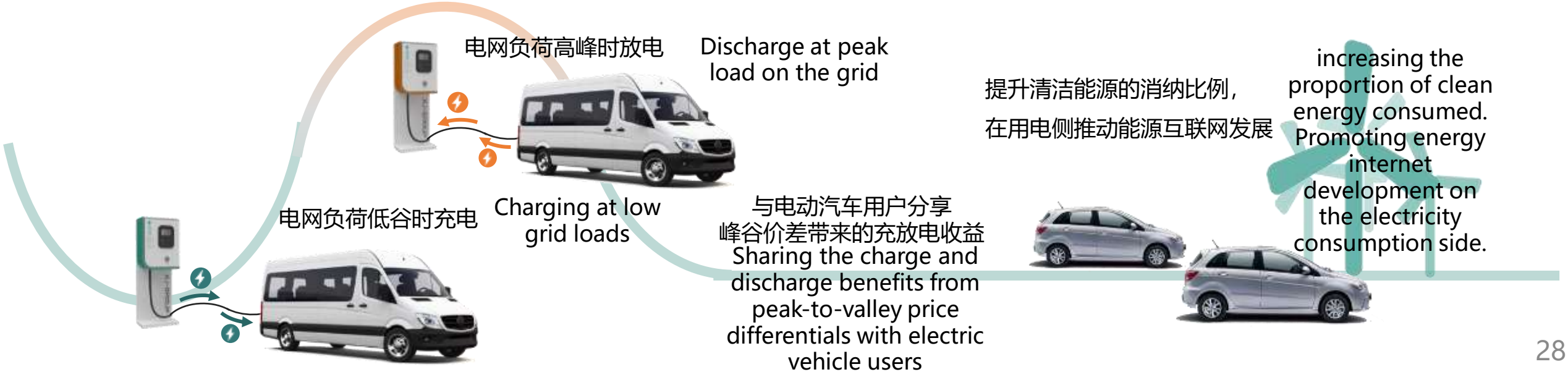
- **交流桩、直流桩实现有序充电的功能（功率、时间），下一步需纳入相关标准修订计划.** AC piles and DC piles can achieve the function of orderly charging (power, time), the next step needs to integrate the relevant standards revision plan
- **参考国际上相对较成熟的运营商平台间和平台与桩的通信标准，制定和更新通信标准。**Develop and update communication standards with reference to the relatively mature international standards for inter-operator platform and platform-to-pile communications.
- **充电身份认证的相关行标，需在车网互动的标准体系中进行考虑。**The relevant industry standards for charging identity authentication need to be considered in the EV-grid interaction standards scheme.



汇报完毕
Thanks