



国家电网公司
STATE GRID
CORPORATION OF CHINA

国网客服中心南北园区 局域能源互联网项目

Local Energy Internet of Northern
and Southern Park of State Grid
Customer Service Center

国家电网有限公司客户服务中心 李树泉

二〇一八年九月



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一、项目背景/Background

能源利用现状/Status of Energy Utilization

1、过度依赖化石能源，导致资源紧张、环境污染、气候变化等问题日益突出；

The over-reliance on fossil energy has led to increasing problems such as resource crisis, pollution, and climate change.

2、不同能源供应系统彼此独立，缺乏统一规划，导致基础设施建设投资大，设施利用率和能效低；

The lack of interconnection and unified planning results in a high investment in infrastructure construction and the low utilization ratio of facilities.

3、能源供应智能化水平不足，冷、热、电供应缺乏协调和有效控制，不能很好的满足用户的多样化需求。

the intelligent level of energy supply system is inadequate and coordinated control is lacked among the cooling, heat, and electricity supply system, the diverse energy demand of users cannot always be met.

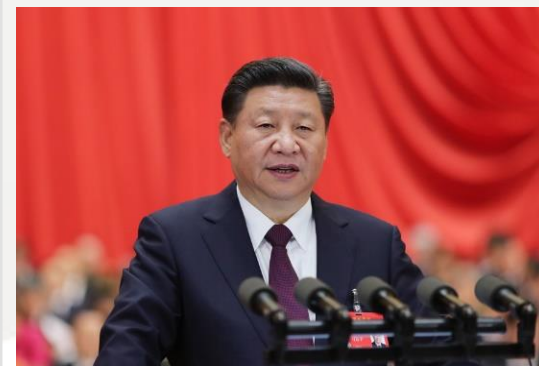


一、项目背景/Background

国家倡议/National Initiative

2015年9月26日，中国国家主席习近平在联合国可持续发展首脑会议上首次提出“**中国倡议探讨构建全球能源互联网，推动以清洁和绿色方式满足全球电力需求**”。

On September 26, 2015, Chinese President Xi Jinping first proposed that “**China is proposing to explore the construction of global Energy Internet to meet the global power demand in a clean and green way**” .



全球能源互联网发展布局
Development Layout of Global Energy Internet

一、项目背景/Background

国网战略/Strategy of State Grid Corporation of China

国家电网有限公司积极探索构建能源互联网，以清洁和绿色方式满足电力需求，助推公司由传统电能供应商向综合能源服务商转型，着力打造具有卓越竞争力的世界一流能源互联网企业。

State Grid Corporation of China is actively exploring the construction of Energy Internet to meet the power demand in a clean and green way. SGCC is promoting a transition from a traditional power supplier to an integrated energy service supplier, and is striving to build a top class Energy Internet company with excellent competitiveness.





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二、南北园区示范工程/Pilot Project

建设定位/Project Orientation

2012年，国家电网有限公司规划建设国网客服中心南北园区，打造“国家电网能源技术与服务创新园区”，成为**节能的先导、生态的示范、服务的典范**。

In 2012, SGCC planned the construction of Northern and Southern Customer Service Center, which supposes to be "Innovation park of energy technology and service of State Grid", as a pilot project for **energy saving, ecologic and service**.

一大目标：建设国家电网能源技术与服务创新园区



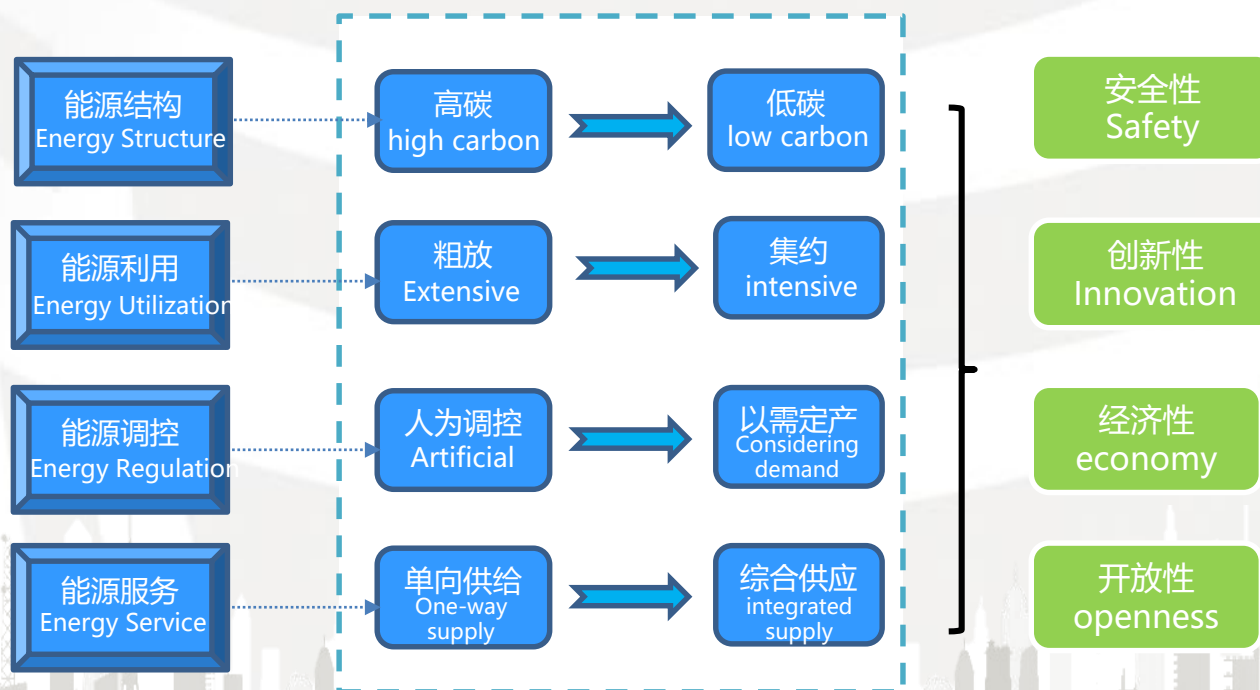


二、南北园区示范工程/Pilot Project

设计思路/Design Concept

国网客服中心 and 天津大学一道，从园区能源结构、能源利用、能源调控、能源服务四方面进行深入研究、体系设计。

Together with Tianjin University, Customer Service Center conducts the research and system designing from four aspects including energy structure, energy utilization, energy regulation and energy service.

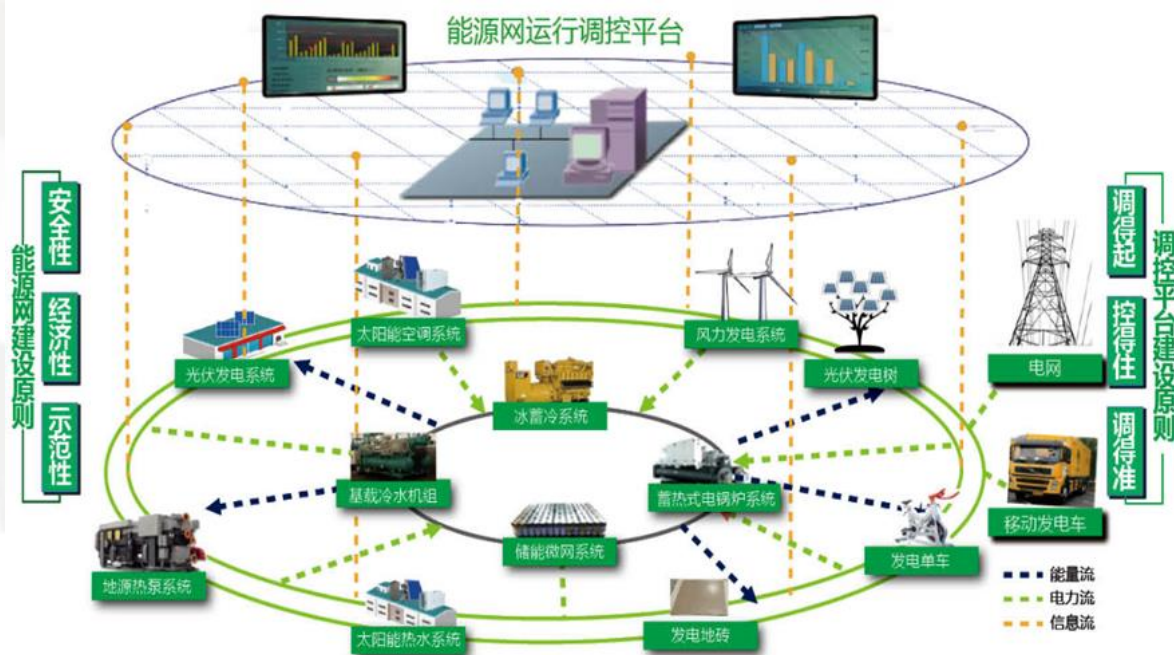


二、南北园区示范工程/Pilot Project

建设规划/Construction Plan

以电能为中心，灵活接纳多种可再生能源，广泛集成能量流和信息流，实现能源生产和能源消费的协调控制、优化运行，形成分布接入、需求感知、泛在物联、网络共享的局域能源互联网。

Taking electricity as the core of integrating multi energy flow and information flow, the energy internet could realize the coordinated control and optimized operation of energy production and energy consumption. Thus a local Energy Internet is formed with distributed access, demand perception, ubiquitous connectivity, and network sharing.





二、南北园区示范工程/Pilot Project

建设内容/Construction Content

局域能源互联网建设内容包括：**八大系统+一个平台+新能源发电设备。**

The construction of local Energy Internet include: **8 Energy Production Systems + Management Platform + Renewable Energy Generators.** Energy production systems including ground source heat pump system, ice thermal storage system, water-cooled chiller system, regenerative electric boiler system, solar water heating system, photovoltaic power generation system, energy storage system, and solar air conditioning system in northern park and wind power generation system in southern park.





二、南北园区示范工程/Pilot Project



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ice thermal storage system

ground source heat pump

solar water heating system



太阳能热水系统



冰蓄冷系统



地源热泵系统

photovoltaic power generation system



光伏发电系统

wind power generation system



风力发电系统



智控中心

Intelligent control center



蓄热式电锅炉系统

regenerative electric boiler system

water-cooled chiller system



机载冷水系统



太阳能空调系统

solar air conditioning system



铅酸储能系统

energy storage system



二、南北园区示范工程/Pilot Project



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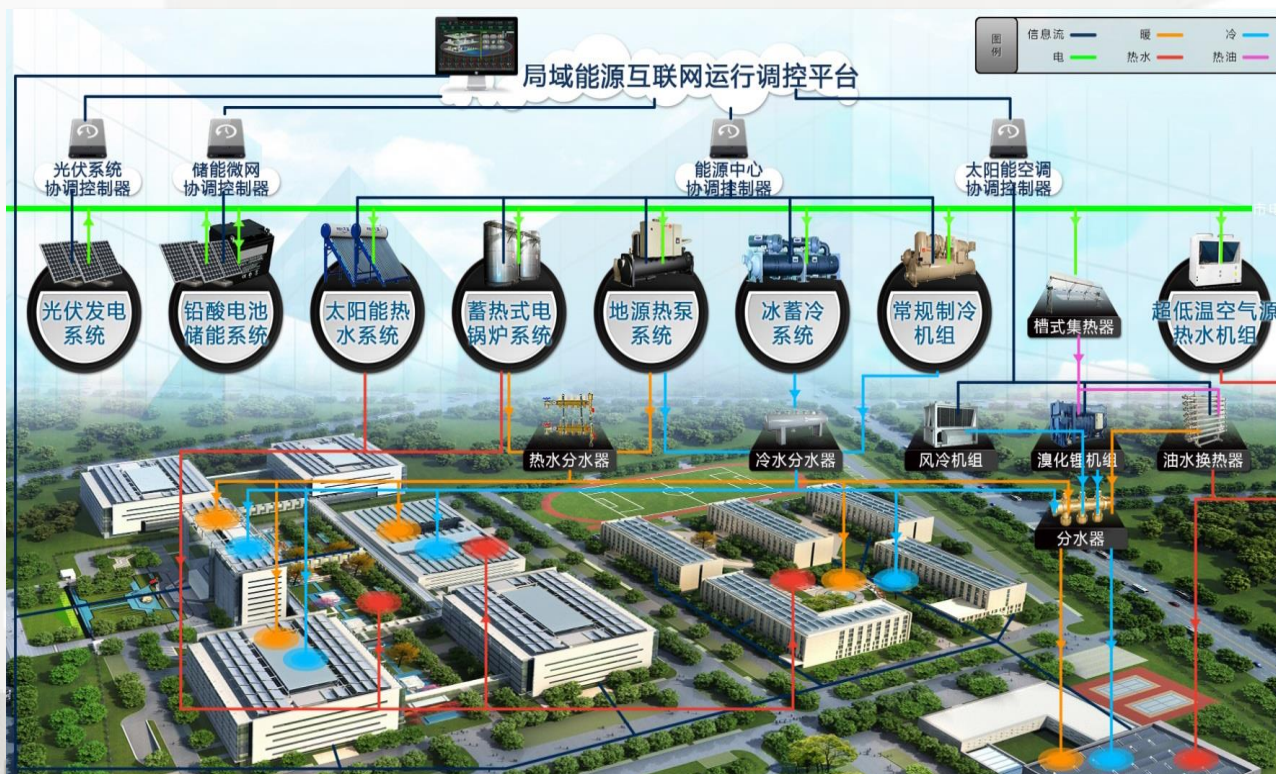


二、南北园区示范工程/Pilot Project

整体架构/Overall Structure

以电能为唯一外部能源，其他八大能源生产系统通过局域能源互联网运行调控平台的统一监测、调度、控制下协调运行，保障园区能源供需平衡，**实现园区能源自给自足**。

Using **electric as the only external energy source**, the energy production systems are coordinated under the operation and control platform to realize the **energy self-sufficiency** of the park.

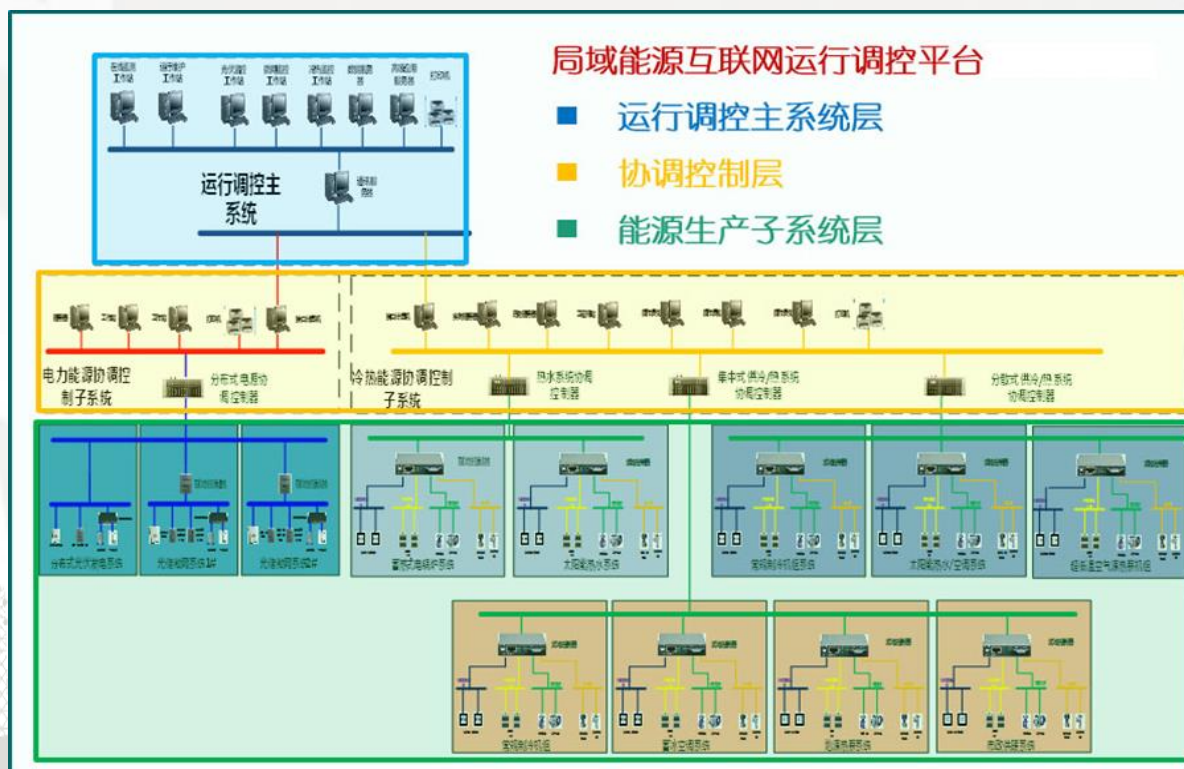


二、南北园区示范工程/Pilot Project

物理架构/Physical Structure

通过调峰调蓄、优化调度、协调控制等运行策略，实现了园区多种能源的联合优化运行及柔性负荷响应，冷、热、电、热水的统一调度、综合分析。

The unified optimization and flexible demand response of the involved energies is realized through peak load shifting, optimal scheduling, and coordinated control.



二、南北园区示范工程/Pilot Project

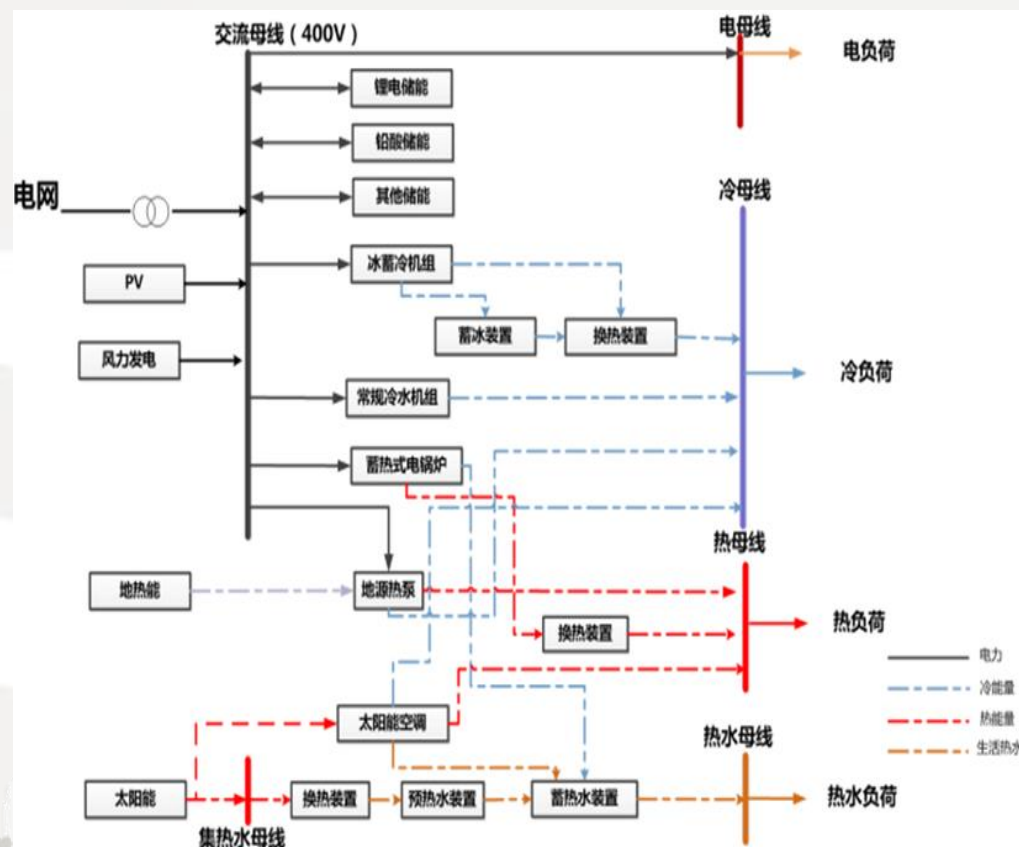
理论创新/Theory Innovation

1、局域能源互联网建模方法（能源母线法）

Modeling method for Local Energy Internet (Energy Bus Method)

将电力系统母线概念加以扩充，根据传输介质和电/冷/热/热水需求特征，构建**能源母线**结构模型，便于各母线节点功率平衡关系的描述。

Expanding the bus model in power system, **energy bus** is constructed according to the type of the carried energy sources. The energy bus model can clearly express the connection relationship of multi-energy sources and clearly describe the energy balance equations



综合能源系统能源母线结构图

Energy bus structure of integrated energy system

二、南北园区示范工程/Pilot Project

理论创新/Theory Innovation

2、多能源、多目标、多变量能源协调优化模型

Coordinated optimization model considering multi-energy, multi-objective and multi-variable.

根据冷、热、电负荷预测及风电、光伏等生产预测结果，结合能源系统运行状态与运行环境等具体情况，设计了三种优化配比准则，即经济效益最优准则、绿色节能最优准则、综合效益最优准则。

According to the conditions of the operating state and environment of energy system, three optimization objectives are designed, best economy principle, best environment principle and comprehensive principle.



二、南北园区示范工程/Pilot Project

理论创新/Theory Innovation

3、综合评价指标体系/Evaluation indexes



提出了由局域、子系统、设备、环境四大类**148**项指标构成的局域能源互联网综合评价指标体系和评价方法，实现了对局域能源互联网的客观评价。

148 indexes are proposed to realize the comprehensive evaluate of Local Energy Internet.

- 能源互联率
- 可再生能源占比
- 能源自给率
- 峰谷系数
- 电能替代率
-
- 光伏系统发电量
- 光伏系统上网电量
- 太阳能空调集热效率
-



- 光伏逆变器有功功率
- 光伏逆变器功率因数
- 光伏逆变器三项电压
- 地源热泵冷却塔运行状态
-
- 辐照度
- 环境温度
- 湿度
- 节能减排
-

局域能源互联网指标体系图

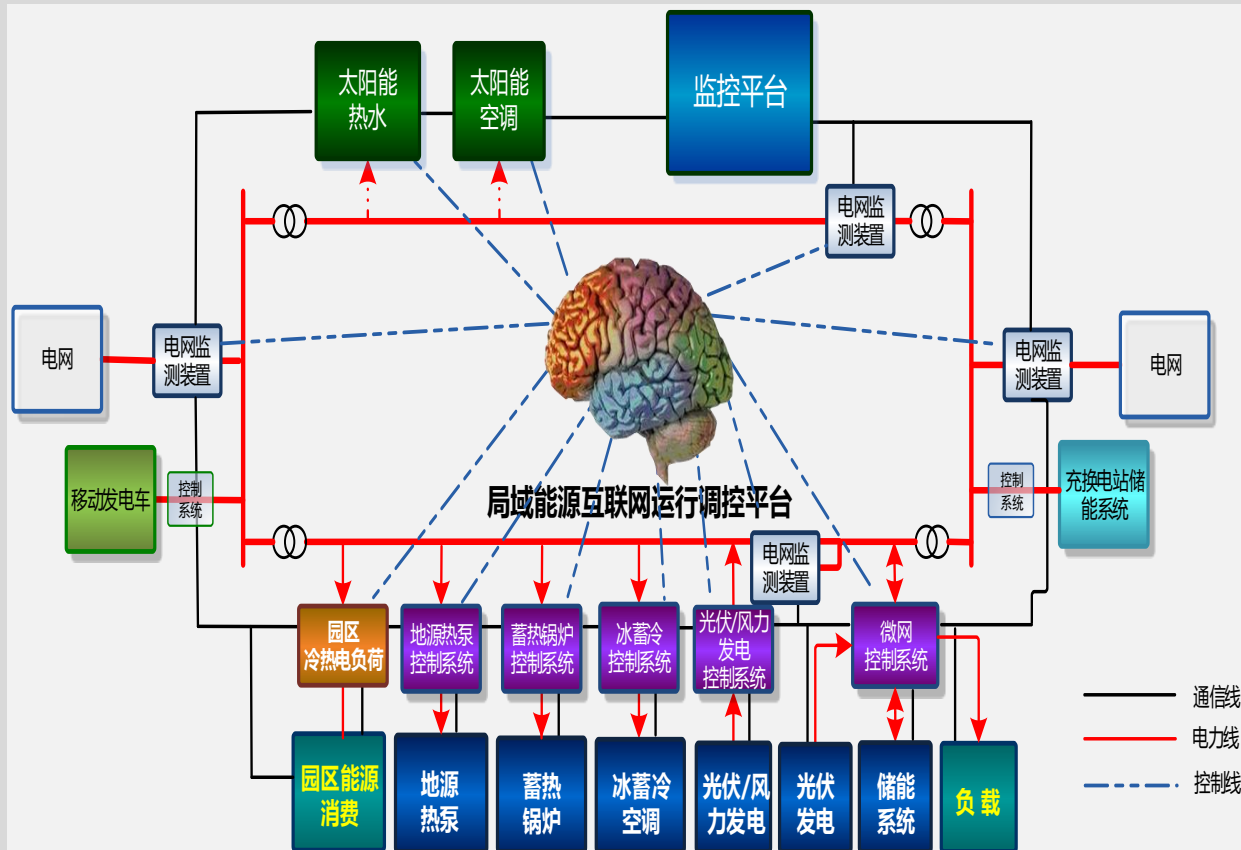
二、南北园区示范工程/Pilot Project

技术创新/technology Innovation

1、局域能源互联网典型架构/Typical Structure of Local Energy Internet

以全面实现“两个替代”为目标，规模化高效应用可再生能源，建立以电能为中心、多种能源互补协同的局域能源互联网架构模型，全面集成风、光、储等分布式能源生产系统，构建“泛在物联、多能协调、网络共享”的局域能源互联网。

Taking electricity as the core of integrating multi-energy, renewable sources and information, the comprehensive structure of local Energy Internet is formed with distributed access, demand perception, ubiquitous connectivity, and network sharing.



局域能源互联网典型架构图

二、南北园区示范工程/Pilot Project

技术创新/technology Innovation

2、运行调控平台研发/Development of Control and Energy Management Platform

开发了局域能源互联网运行调控平台，实现电、冷、热、热水等多种能源在线监测、优化调度，系统全生命周期运行维护。

The control and energy management platform is developed to realize the online monitoring, optimal scheduling and system operation.



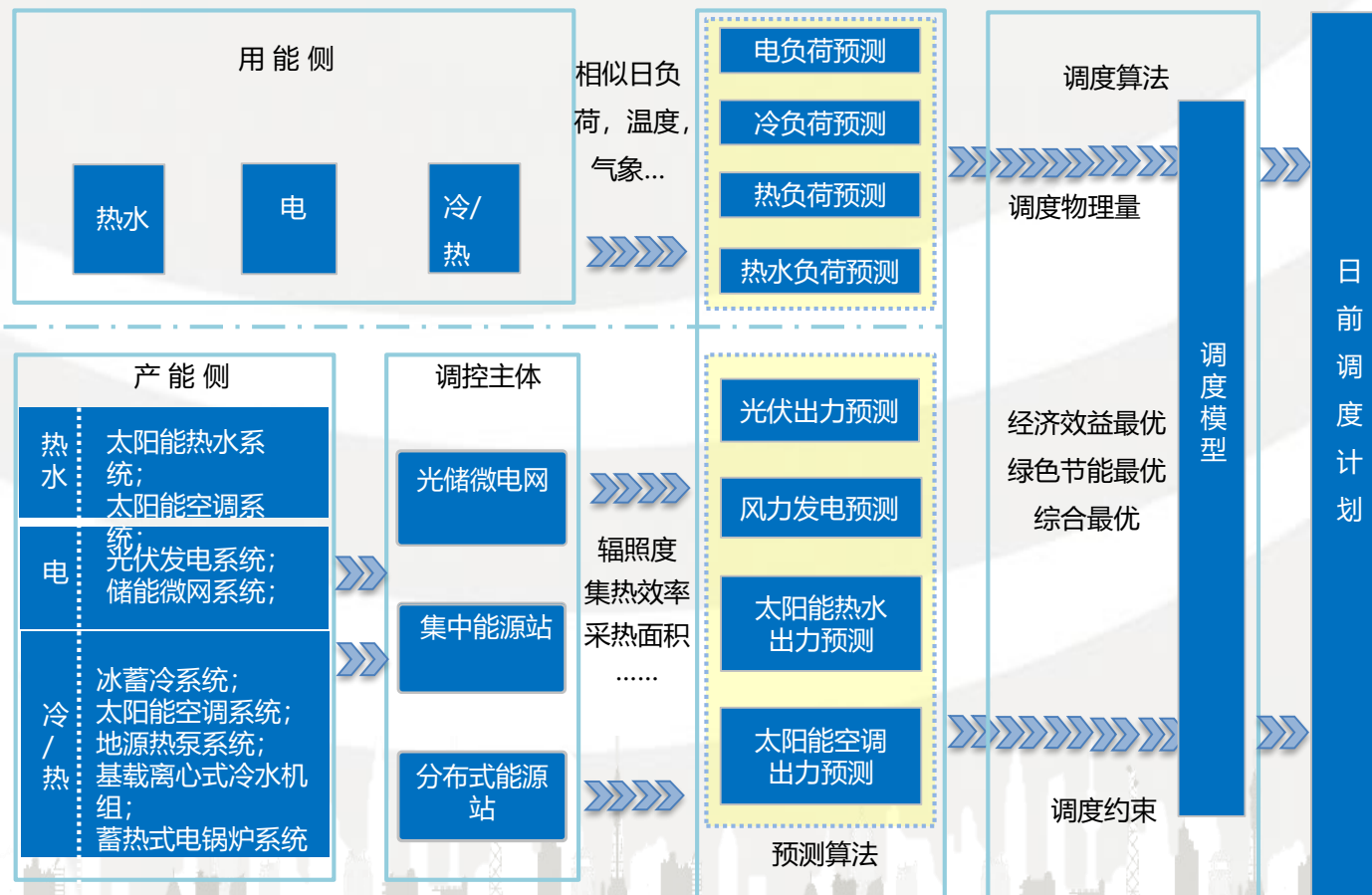
二、南北园区示范工程/Pilot Project

技术创新/technology Innovation

2.1 日前调度计划/Day-ahead operation plan

根据负荷预测、产能预测、天气情况、历史数据等，按照不同配比准则，形成24小时日前调度计划，每天23点由系统自动下发。

According to load and production forecasting, capacity forecasting and historical data, a 24-hour day-ahead operation plan is formed, which is automatically dispatched by the system at 23 o'clock every day.



日前调度计划流程图

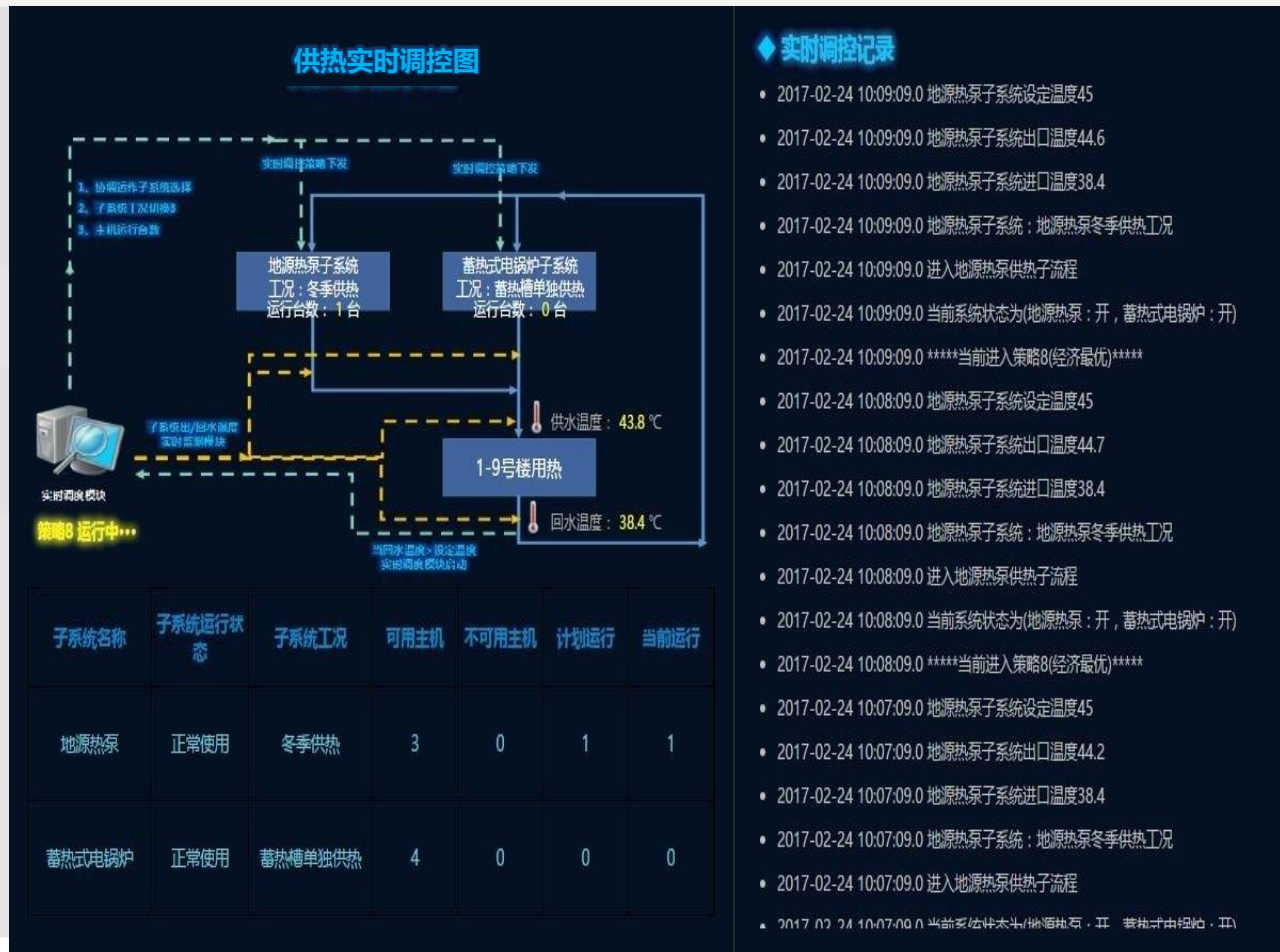
二、南北园区示范工程/Pilot Project

技术创新/technology Innovation

2.2 小时级调控纠偏/Hour-level Control

在24小时日前调度计划基础上，根据实际运行情况，进行小时级自适应调度控制。

On the basis of day-ahead scheduling and the actual operation situation, the hour-level self-adapted control is carried out.

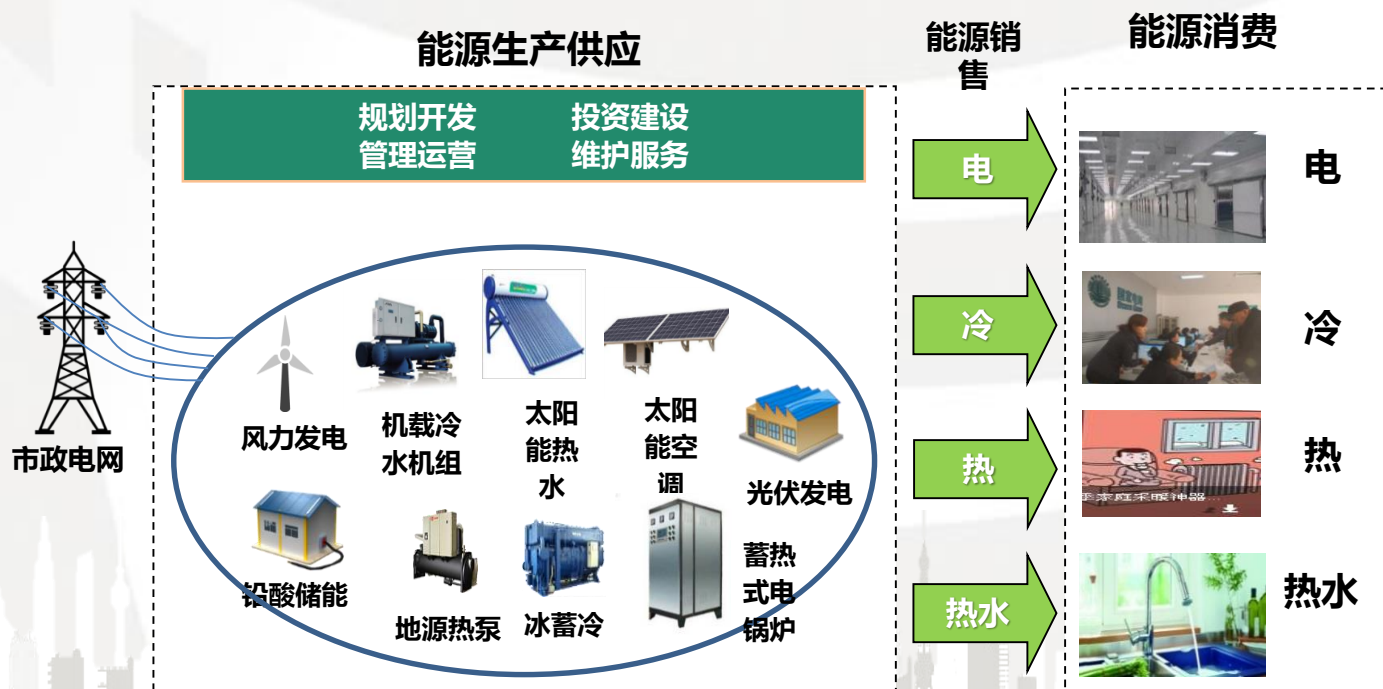


二、南北园区示范工程/Pilot Project

商业模式创新/Bussiness Mode Innovation

综合能源供应服务模式是提出了以电能为中心的局域能源互联网综合能源一站式供应服务模式，是电力营销模式的创新探索。

The electricity-based one-stop **integrated energy supply mode** of Local Energy Internet is proposed, which is an innovative exploration of power marketing mode.





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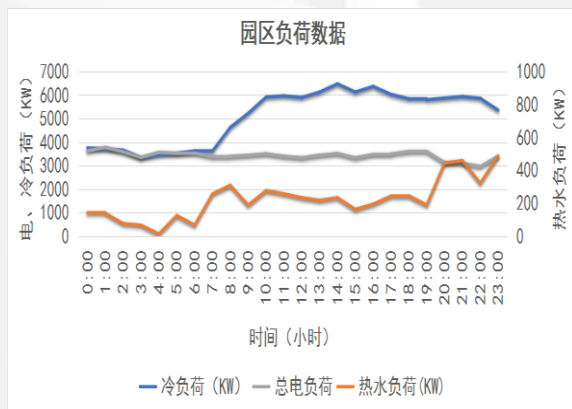
未来发展展望
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三、项目成果/Achievements

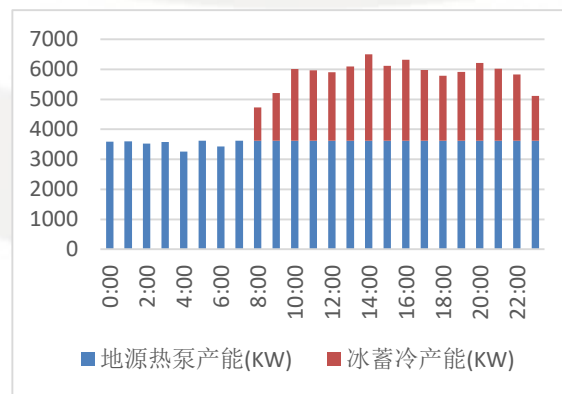
运行数据/Operation Data

园区平台对所有能源系统的生产运行情况、各楼宇用能情况等监测并收集相应数据，其中包括：园区用能负荷数据、设备产热数据等。以2017年7月26日为例，实际运行数据如下图所示：

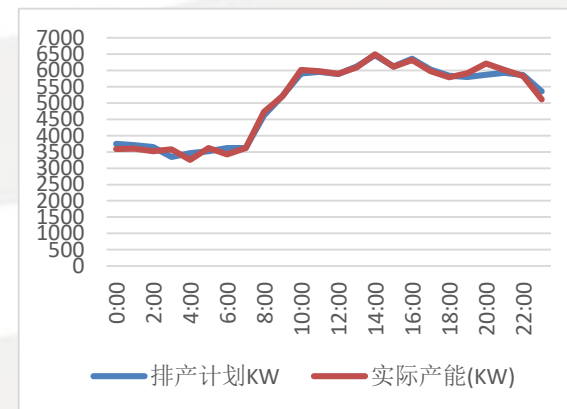
The control and energy management platform can monitor and collect essential data of the whole system, including climate data, production and operation state of energy subsystems, energy consumption of all buildings, etc. Taking Jul. 26 2017 as an example, the measured data is shown as follows:



园区负荷数据
Load Data



园区设备产冷数据
Cooling Production Data



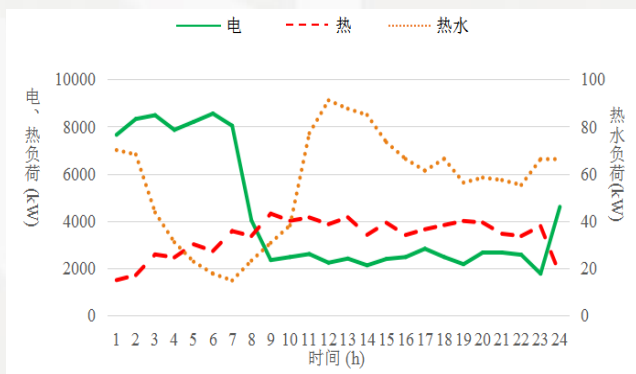
排产计划与实际产能对比
Comparison of real production and planned production

三、项目成果/Achievements

运行数据/Operation Data

园区平台对所有能源系统的生产运行情况、各楼宇用能情况等进行了监测并收集相应数据，其中包括：园区用能负荷数据、设备产热数据等。以2016年11月6日为例，实际运行数据如下图所示：

Taking Nov. 6 2016 as an example, the measured data is shown as follows:



园区负荷数据
Load Data



园区用电量
Power Consumption



园区设备产热数据
Heat Production Data

三、项目成果/Achievements

关键指标/Key Indexes

Ratio of electric power alternative

电能替代率



100%实现污染物零排放

100%, achieving zero pollutants

关键运行指标

所建成的实际工程在**电能替代率、可再生能源占比、能源自给率和峰谷电系数**等方面在国内处于领先水平。

Ratio of self-sufficiency



能源自给率

运行值最高达**56.38%**

Operating value up to **56.38%**

Penetration of renewable energy

可再生能源占比



年均值大于**36%**

运行值最高达**64.17%**

Average higher than **36%**,

Operating value up to **64.17%**

Ratio of peak-valley difference



峰谷电系数

维持在**1.01**左右
削峰填谷效果良好

1.01, which means a great effect in peak shifting

三、项目成果/Achievements

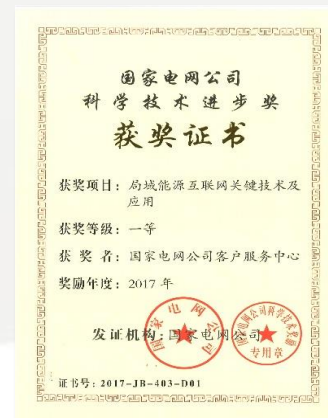


荣誉/Awards



2017年度中国电力创新奖一等奖

First Prize of 2017 China Power Innovation Award



2017年国家电网公司科学技术进步奖一等奖

First Prize of 2017 State Grid Corporation Science and Technology Progress Award



北方园区三星级绿色建筑标识证书

Three-star green building identification certificate of Northern Park



南方园区三星级绿色建筑标识证书

Three-star green building identification certificate of Southern Park



三、项目成果/Achievements

相关政策标准/Policies and Standards



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局域能源网项目建设和运行的成功经验，推动我国政府出台了相关政策；同时，有关技术已经形成中国国家标准的企业标准以及国家行业标准。

The successful experience of construction and operation of the project promote the Chinese government to introduce many policies. Moreover, relevant technologies have been referenced by formulating Industrial Standards of China and enterprise standards of SGCC.

相关政策 Policies	《关于推进“互联网+”智慧能源发展的指导意见》 Guidance on Promoting the Development of 'Internet Plus' Smart Energy
	《国家能源局关于组织实施“互联网+”智慧能源（能源互联网）示范项目的通知》 Notice on Organizing and Implementing 'Internet Plus' Smart Energy (Energy Internet) Pilot Project
	《关于公布首批多能互补集成优化示范工程的通知》 Notice on the publication of the multi-energy integration optimization demonstration projects
企业标准及 国家行业标 准 Standards	《分布式电源接入电网运行控制规范》 Specification of Operation and Control of Distributed Generator Integrated to Power Grid
	《分布式电源接入电网测试技术规范》 Technical Specification of Test on Distributed Generator Integrated to Power Grid
	《智慧园区建设指南》 Guidance on Construction of Smart Park
	《10kV以下配电网接入分布式电源即插即用装置技术规范》 Technical Specification of Plug and Play Equipment of Distributed Generator Integrated to Distribution System below 10kV Level

三、项目成果/Achievements

推广应用/Application

项目的理念和技术成果可在广大的城镇、产业园区、大型公用设施（机场、车站、医院、学校等）、商务区和海岛地区等新增用能区域进行推广。

The concept and technology of this project has a broad application including new towns, industrial parks, public facilities (airports, railway stations, hospitals, schools, etc.), business districts and islands.

雄安新市民中心

Civic center of Xiongan



陕西富平高新技术产业开发区

High-tech development zone of Shaanxi



天津北辰国家产城融合示范区

Beichen demonstration area



江苏省海安人民医院

People's hospital of Jiangsu





三、项目成果/Achievements

经济效益/Economic benefit

经过实际运行数据分析，局域能源互联网比常规能源供给系统建设投资增加6037.7万元，年运行费用节约1072.32万元，投资回收期5.63年，经济效益显著。

According to real operation data, the construction investment of Local Energy Internet is 60.377 million CNY higher than regular energy system, but the operation cost is 10.72 million CNY lower every year, the payback period is about 5.63 years, which reflects a significant economic benefit.

能源系统	供冷/暖	热水	光伏	配电网	能源网调控平台	合计
局域能源互联网 建设投资 (万元)	地源热泵+蓄热式电锅炉 +冰蓄冷 9100	太阳能热水 720	光伏发电系统 1281.7	配电网 5600	能源网调控平台 2000	18701.7
常规能源供给系统 建设投资 (万元)	市政集中供暖+常规制冷机组 6964	电辅热 100	/	配电网 5600	/	12664
年节约运行费用 (万元)	567.87	152	224.09	0	128.36	1072.32
局域能源互联网比常规能源供给系统建设投资增加 (万元)						6037.7
建设投资增加部分的回收期 (年)						5.63



三、项目成果/Achievements

社会效益/Social benefit

01

践行“两个替代”，推进节能减排，响应国家能源战略。实现了园区内能源的100%电能代替，项目年节约标煤**8248吨**，减排二氧化碳**20558吨**、碳粉尘5609吨、二氧化硫619吨、氮氧化物309吨。

Realizing a 100% electricity alternative, reducing about 8248 tons of carbon, 20558 tons of CO₂, 5,609 tons of carbon dust, 616.74 tons of SO₂ and 308.37 tons of NO_x.

02

项目成果为国家能源局示范工程的规划、建设与运行提供了宝贵的实践经验，对我国能源互联网建设有重要的推动作用。

The project results provide valuable practical experience for the planning, construction and operation and promote the construction of Energy Internet in China.

03

项目集成了各种先进的分布式能源利用技术，实现了各种分布式能源的梯级利用、互补利用，相关技术对于分布式能源利用技术的产业升级具有显著带动作用。

The project integrates advanced distributed energy technologies to realize the cascade utilization of multiple energy sources. The related technologies have a significant driving effect on the upgrading of energy technologies.

04

项目系统性解决了局域能源互联网的重大技术难题，为能源互联网规划建设、运行维护培养了大批专业人才。

The project systematically solved the technical problems of Local Energy Internet, and cultivated a large number of talents for the planning, construction, operation and maintenance of the Energy Internet.

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国家电网公司
STATE GRID
CORPORATION OF CHINA

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四、未来发展展望/Future Developments



与综合能源供应服务商的战略合作

Cooperation with integrated energy service suppliers

建立综合能源供应技术和
管理服务研究平台

Establish a integrated
energy supply service
research platform

完善局域能源互联网数据模型分析体系，通过全运行数据的分析整理，开展精准服务。提高智能化管理水平，实现多能源生产的集中控制和协调优化运行。

Improving the data model analysis system, and carry out accurate services through analysis and collation of data. Improving the level of intelligent management, achieving centralized control and coordinated optimization of multi-energy sources.



与天津大学的战略合作

Cooperation with Tianjin University

深化研究综合能源供应
服务模式

research on
integrated energy
service supply mode

与天津大学成立联合实验室，依托南北园区局域能源互联网示范工程，深入研究综合能源供应服务模式及关键技术，持续提升园区智慧能源系统节能减排能力。

Establishing a laboratory with Tianjin University, carrying out the study of integrated energy supply modes and key technologies relying on Local Energy Internet of the north and south parks, continuously improving the energy-saving and emission reduction capabilities of the park.



四、未来发展展望/Future Developments

01

以电能为中心的综合能源服务将逐步替代单一能源供给服务，分布式可再生能源将高效运行并逐步替代化石能源，实现再电气化与信息化深度融合。

Integrated energy services based in electricity will gradually replace single energy supply services. Distributed renewable energy will operate efficiently and gradually replace fossil energy. And deep integration of electricity and information will be realized.

02

可再生分布式能源利用、智慧能源综合管控、能源信息基础设施网络、多能互补能源供应体系等标准化单元模块逐步完善。

The standardized unit modules such as distributed energy utilization, intelligent energy management, energy information network, and multi-energy supply system are gradually improved.

03

实现“全电、柔性、绿色”用能模式的延伸，为各类园区、社区的新建或改造提供标准化、一站式的全套解决方案。

Realizing the extension of the ‘all-electricity, flexible, green’ energy utilization mode, and providing a standardized, one-stop solution for the construction or renovation of parks and communities.

04

实现基于全球能源互联网的新型智能用电技术引领，不断吸纳新技术和新应用，助推全球能源互联网建设进程。

Leading the new intelligent power technology based on the global Energy Internet, constantly absorbing new technologies and new applications, and promoting the construction of global Energy Internet.

谢 谢

Thank You

国家电网有限公司客户服务中心

二〇一八年九月