

中国数据中心能效现状及相关政策分析

Current Development and related policies of energy efficiency in China's data centres

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Part 01

第一部分

1

数据中心现状分析

Current development of the data centre

数据中心的政策导向 Policy orientation of the data centre



数据中心的经济支撑 Economic underpinning of data centres

企业数量 Number of companies

截至2023年底，登记在册经营主体达1.84亿户，同比增长8.9%。其中，企业5826.8万户。

By the end of 2023, there were 184 million registered business entities, up 8.9 per cent year-on-year. Of these, 58.268 million were companies.

网民数量 Number of Internet users

截至2023年12月，我国网民规模达10.92亿人，较2022年12月新增网民2480万人，互联网普及率达77.5%。

As of December 2023, the number of Internet users in China reached 1.092 billion, with 24.8 million new Internet users compared with December 2022, and the Internet penetration rate reached 77.5%.

网络基础设施数量 Number of network infrastructures

截至2023年12月，累计建成5G基站337.7万个，覆盖所有地级市城区、县城城区。由5G和千兆光网组成的“双千兆”网络，全面带动智能制造、智慧城市、乡村振兴、文化旅游等各个领域创新发展。

By December 2023, a total of 3.377 million 5G base stations have been built, covering all urban areas of prefecture-level cities and county towns. The "Dual-Gigabit" network, combining 5G and gigabit optical networks, has fully driven innovation in smart manufacturing, smart cities, rural revitalization, cultural tourism, and other sectors.

数字经济产值

Value of the digital economy

据初步核算，2023年我国数字经济规模达56.1万亿元，占GDP比重超过44%。
According to preliminary calculations, China's digital economy will reach 56.1 trillion yuan in 2023, accounting for more than 44 per cent of GDP.

新兴产业产值

Output value of emerging industries

数据中心、云计算、大数据、物联网等新兴业务快速发展，2023年共完成业务收入3564亿元，比上年增长19.1%。

Data centres, cloud computing, big data, Internet of Things and other emerging businesses are developing rapidly, with a total business revenue of \$356.4 billion in 2023, an increase of 19.1% over the previous year.

数据中心产值 Data centre output

截至2023年底，三家基础电信企业为公众提供服务的互联网数据中心机架数量达97万个，全年净增15.2万个。

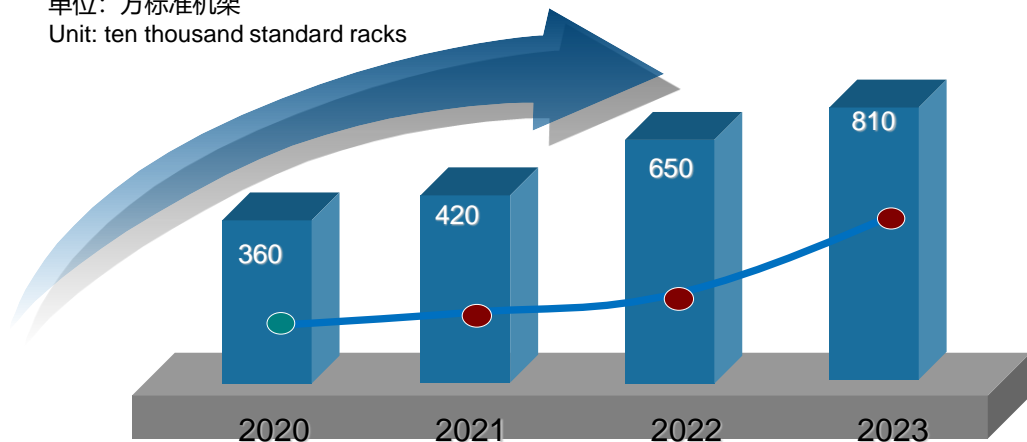
By the end of 2023, the number of Internet data centre racks serving the public by the three basic telecommunications companies reached 970,000, with a net increase of 152,000 for the year.



数据中心的市场发展 Market development of data centres

单位：万标准机架

Unit: ten thousand standard racks



- 中国数据中心每年新增投资规模在1800-2000亿元人民币左右；
- 截止2023年，全国在用数据中心机架总规模超过810万标准机架；
- 数据中心年均增速超过20%。

- The scale of new investment in China's data centres is around RMB 180-200 billion per year;
- By 2023, the total scale of data centre racks in use in China exceeds 8.1 million standard racks;
- Average annual growth rate of data centres exceeding 20%.

数据中心
面临快速
发展
Data Centres
Facing Rapid
development

Part 02

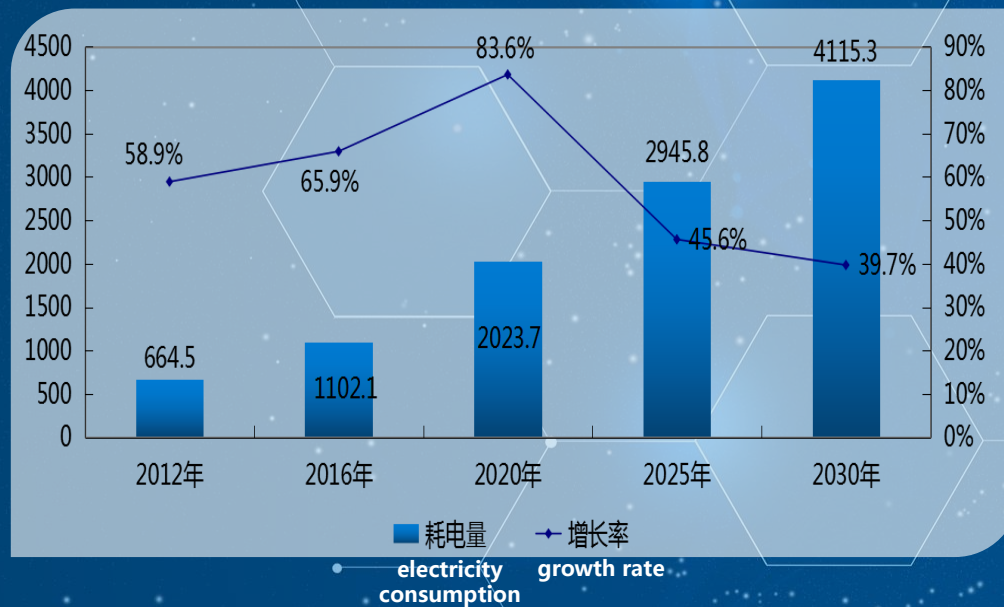
第二部分

能效现状分析

2 Analysis of the current state of energy efficiency

数据中心的能耗紧迫 Urgent energy consumption in data centres

- 《绿色数据中心白皮书》显示，2017年，中国数据中心耗电量为1221.5亿千瓦时，超过当年三峡大坝全年年发电量。
- 《中国“新基建”发展研究报告》称，从全球来看，到2025年，数据中心将占全球能耗的最大份额，高达33%。
- 从国内看，根据ICTresearch咨询调研显示，全国数据中心的耗电量已连续八年以超过12%的速度增长。
- According to the *Green Data Centre White Paper*, China's data centres consumed 122.15 billion kilowatt-hours of electricity in 2017, more than the annual power generation of the Three Gorges Dam.
- Globally, data centres will account for the largest share of global energy consumption, up to 33%, by 2025, according to *China's 'New Infrastructure' Development Research Report*.
- Domestically, according to ICTresearch, the national data centre power consumption has been growing at over 12% for eight consecutive years.



数据中心能效提升存在的问题

Problems with data centre energy efficiency improvements

产业结构和区域布局

Industrial structure and regional layout

- IDC发展迅速，云计算逐渐形成寡头垄断
- 区域主要集中在京津冀、长三角、珠三角三个主要区域
- IDC development is rapid, cloud computing gradually formed oligopoly.
- The region is mainly concentrated in three major regions: Beijing-Tianjin-Hebei, Yangtze River Delta and Pearl River Delta.

节能低碳多样化

Energy-saving and low-carbon diversification

- 能效专项提升
- 新能源、余热回收、储能
- 绿色节能成本增高
- Specialised Energy Efficiency Improvement
- Renewables, waste heat recovery, energy storage
- Increased cost of green energy efficiency



当前能源效率

Current energy efficiency

- 当前只注重基础设施的电能使用效率，比较片面
- 用电最大的IT设备缺少能效标准和参考指标
- Currently focusing only on the efficiency of electricity use in infrastructure
- Lack of energy efficiency standards and references for IT equipment, which uses the most electricity

低碳化能源结构

Low-carbon energy structure

- 当前还是以火电为主
- 屋顶光伏和余热利用基本属于空白
- Currently, thermal power is still the main source of energy
- Rooftop PV and waste heat utilisation are basically blank

数据中心不同领域的贡献

Contributions of different parts

供配电领域贡献
Power supply and distribution

15%

新风制冷领域贡献
Ventilation and cooling

35%

IT设备领域贡献
IT equipment

40%

其他领域贡献
Others

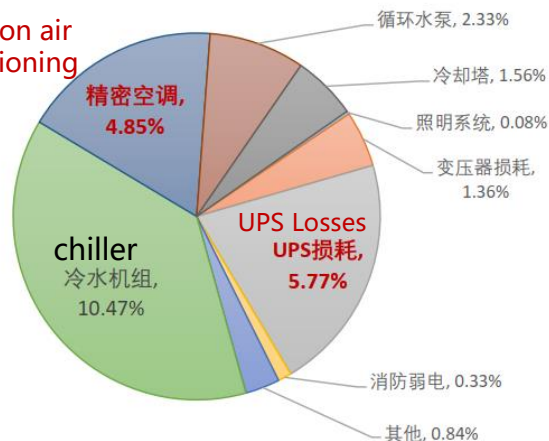
10%



北京市某数据中心节能改造案例-存在问题

Energy-saving Retrofit Case of a Data Centre in Beijing - Existing Problems

Precision air conditioning



3#楼主要设备用能分布图

Energy consumption distribution of main equipment in Building #3

从图中可以看出冷水机组能耗占比较大，3#数据中心冷水机组采

用的是市场上最先进的磁悬浮离心式冷水机组。

除冷水机组外耗能较大的两个数据是精密空调功耗和UPS的损耗。

The chart shows that chiller units have the largest energy consumption. Data Center 3 uses the latest magnetic levitation centrifugal chillers.

Other major energy consumers are precision air conditioning and UPS losses.

Maintenance structure sealing energy saving retrofit

维护结构密封性节能改造

- 3#数据中心数据中心外墙围护保温性能差，门窗及地面孔洞密封性较差，漏风跑冷增加了精密空调的耗能；计划进一步加强3#楼楼体密封改造。

Data Center 3 has poor insulation and sealing, causing air leaks and higher precision air conditioning energy use. Sealing improvements are planned.



- 3#数据中心的UPS已经使用4年，当时安装的UPS设备本身效率较低，UPS损耗相较偏大；计划对3#楼UPS进行更换。

The UPS in Data Center 3 is 4 years old and has low efficiency, leading to significant losses. Plans are in place to replace it.

UPS升级改造 UPS upgrades

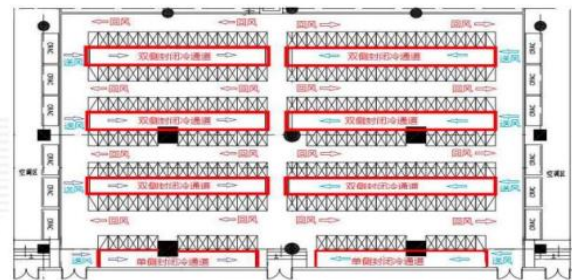


北京市某数据中心节能改造案例-存在问题

Energy-saving Retrofit Case of a Data Centre in Beijing - Existing Problems

Enclosed cold aisle modification 封闭冷通道改造

- 4#数据中心机房IT服务器机柜面对面、背对背形成了冷热通道，但冷热通道未做密封，机房内的气流组织混乱，冷热通道混风现象严重，导致投冷系统耗能高；计划对4#楼冷通道封闭改造。



In Data Center 4, unsealed hot and cold aisles cause airflow disruption and higher cooling energy use. Plans are to seal the cold aisles.

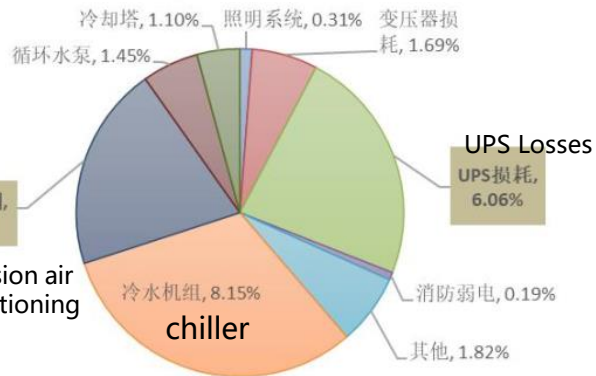
UPS升级改造

UPS upgrades

- 4#数据中心的UPS设备，已经使用4年，当时选型的UPS设备本身效率较低，这也是UPS损耗相对偏大的原因。计划对4#楼UPS进行更换。



The UPS in Data Center 4 is 4 years old and has low efficiency, leading to higher losses. Plans are to replace the UPS.



4#楼主要设备用能分布图

Energy consumption distribution of main equipment in Building #4

从图中可以看出冷水机组占比最大，4#数据中心冷水机组采用的是市场上最先进的磁悬浮离心式冷水机组。

除冷水机组外耗能较大的是精密空调功耗和UPS功耗。

The chart shows that the chiller units consume the most energy in Data Center 4, which uses advanced magnetic levitation centrifugal chillers. Other major energy consumers are precision air conditioning and UPS.

北京市某数据中心节能改造案例-预期效果

Energy-saving Retrofit Case of a Data Centre in Beijing-Expected results

It can provide 52.79MW of heat, supporting 893,300 m² of residential and 284,300 m² of non-residential buildings. After renovation, the cooling tower stops operating, saving about 130,000 tonnes of water per heating season, based on a 0.5% water loss rate.

waste heat recovery 余热回收

可提供热量52.79MW，余热可以满足居民建筑面积89.33万平方米，非居民建筑面积28.43万平方米。改造后，冷却塔停止运行，按照冷却塔失水率0.5%计算，每采暖季可节约失水量约13万吨。

photovoltaic power generation 光伏发电

增加绿电使用比例,降低企业用电成本，通过绿证、碳排放配额等直接方式，实现碳抵消，园区预估可装机容量2.6MW，项目首年发电量为343.76万kWh，25年累计总发电量为 8301.42万kWh。

Increasing green electricity use reduces electricity costs for businesses. Carbon offsetting is achieved through green certificates and carbon quotas. The park's estimated installed capacity is 2.6MW, with a first-year power generation of 3,437,600 kWh and a total of 8,301,429,000 kWh over 25 years.



更换UPS Replacement of UPS

对3#、4#数据中心的低效率UPS设备进行整体更换，提高供电使用效率，改造后预期效率提升2.11%，年节约总电量343.4万kWh。

围护结构 Enclosure Structure

对3#数据中心围护结构密闭、保温措施改造后，可有效减少机房内、外冷热能量的传递，有利于机房内部温度保持进而降低精密空调制冷能耗，预计PUE降低2%。

封闭冷通道 Closed cold aisle

4#数据中心设计安装封闭冷通道，降低机房冷热通道混风，避免高温点和过冷区域，实现冷量精确传输，减少精密空调负载可使冷量充分利用，提升机房空调利用率及制冷效率，降低数据机房PUE 3%。

The 4# data centre is equipped with closed cold aisles to prevent hot and cold aisle mixing, avoid temperature extremes, and ensure precise cold air delivery. This reduces the load on precision air conditioners, improves cooling efficiency, and is expected to lower the PUE of the server room by 3%.

Replacing inefficient UPS equipment in data centres 3# and 4# will improve power supply efficiency by 2.11%, resulting in annual power savings of 3.434 million kWh.

After renovating the enclosure structure and improving sealing and insulation at the 3# data centre, hot and cold energy transfer between the equipment room and external environment will be reduced. This helps maintain the room's internal temperature and lowers the refrigeration energy consumption of precision air-conditioning, with an expected 2% reduction in PUE.

某运营商福州新建数据中心节能技术案例

A case of energy-saving technology for a new data centre of an operator in Fuzhou



- 某运营商（福建福州）数据中心位于东南大数据产业园内，总占地面积185亩，基础投资约30亿元，规划机架数3万架，可容纳24万台服务器，出口带宽达10T以上。
- 该数据中心广泛选用能效等级较低的节能技术产品，引进先进的智能化管控技术，从根源上降低碳排放，同时不断坚持技术创新，为节能降碳作出有益探索。
- 该数据中心入选“2022年国家新型数据中心典型案例名单”，是福建的重点项目和当地数据中心的标杆。
- The data centre of an operator (Fuzhou, Fujian) is located in the Southeast Big Data Industrial Park, covering a total area of 185 mu. The basic investment is about 3 billion yuan, with a planned number of 30,000 racks, which can accommodate 240,000 servers, and an export bandwidth of more than 10T.
- The data centre widely uses energy-saving technology products, introduces advanced intelligent control technology, and reduces carbon emissions at the source. At the same time, it constantly adheres to technological innovation and makes useful explorations for energy conservation and carbon reduction.
- The data centre was selected as one of the ‘2022 National Typical Cases of New Data Centres’ and is a key project in Fujian and a benchmark for local data centres.



某运营商福州新建数据中心节能技术案例

A case of energy-saving technology for a new data centre of an operator in Fuzhou



- 该数据中心采用的大型水冷中央空调系统，对比传统风冷精密空调，具备高效节能、集中制冷等特点，并引入利用室外自然冷源制冷的板式热交换器、主机变频技术、热管冷却技术、列间空调等新型绿色产品；
- 运用智能AI群控系统对数据进行分析诊断，结合制冷需求给出最优控制算法，使制冷系统综合能效达到最高。同时，机房内利用气流仿真与冷通道封闭技术，能够实现对冷热气流的有效阻隔。
- The data centre uses a large-scale water-cooled central air conditioning system, which is more energy-efficient and provides centralized cooling compared to traditional air-cooled precision ACs. It integrates green technologies such as outdoor air-source heat exchangers, variable frequency drives, heat pipe cooling, and aisle cooling.
- Additionally, an AI-based group control system analyzes data and adjusts cooling strategies to optimize energy efficiency. The facility also employs airflow simulation and cold aisle containment to effectively separate hot and cold air.

某运营商福州新建数据中心节能技术案例

A case of energy-saving technology for a new data centre of an operator in Fuzhou

- 在供电系统方面，通过使用一级能效变压器以及调整电源系统工作模块负载率等举措，有效降低线路与能源转化损耗；引入UPS智能动态在线技术，供电效率高达98%，可节约3%以上的基础电能。
- 该数据中心还广泛采用智能照明系统，选用节能型电气照明灯具和光源，采取分区、定时、感应、控制等智能控制措施，可有效降低照明能耗50%以上。
- 此外，该数据中心还具备内涝防治设计，优化水循环基础设施，采用节水设备，实现雨污分流；园区设计有太阳能热水器、新能源车辆停车位与充电桩等新型节能设施。
- 通过提升能源效率、优化用能结构、深化绿色赋能等多项举措，数据中心实现园区综合节电率40%以上，为碳达峰、碳中和作出了一定贡献。
- The data centre reduces power distribution losses by using class 1 energy-efficient transformers and optimizing system load rates. UPS intelligent dynamic technology boosts supply efficiency to 98%, saving over 3% in base energy. It also employs an intelligent lighting system with energy-efficient fixtures and smart controls, cutting lighting energy use by 50%.
- Additionally, the centre features flood prevention, optimized water infrastructure, water-saving devices, and rainwater-sewage separation. New energy-saving facilities include solar water heaters and EV charging stations.
- These measures help the data centre achieve a 40% overall energy saving rate, supporting carbon peak and carbon neutrality goals.



某液冷数据中心节能技术案例

An example of energy-saving technology in a liquid-cooled data centre



High heat dissipation efficiency and energy saving

散热效率高、节能

- 液体的比热容大、导热系数高
 - 液冷部分年均 PUE < 1.1
 - 与传统风冷相比，年平均节省电费 40-50%
-
- The specific heat capacity of liquid is large and its thermal conductivity is high
 - The annual average PUE of the liquid cooling part is < 1.1
 - Compared with traditional air cooling, the annual average electricity savings is 40-50%



High performance and low noise

高性能、低噪音

- 满载运行CPU/GPU比风冷低20-30°C
 - 采用并联式冷板，GPU性能更加均衡
 - 普遍满载运行噪音 < 60dB
-
- Full load operation CPU/GPU 20-30°C cooler than air-cooled
 - Parallel cooling plate, more balanced GPU performance
 - < 60dB general full load operation noise



Low power consumption, high reward

耗电低、高回报

- 空调系统能耗降低 80%
 - 风冷部分风扇功耗可降低 70%
 - 通过节电2年可收回增加成本
-
- Energy consumption of AC-system reduced by 80%
 - Energy consumption of fan can be reduced by 70%
 - The increased cost can be recovered through power saving in 2 years



Easy to maintain, safe and reliable

维护方便、安全可靠

- 热插拔设计，安装维护简单
 - 自封闭无低漏接口，负压防泄漏设计、漏液检测机制
 - 焊接散热器耐压5bar
-
- Hot-swappable design, simple installation and maintenance
 - Self-sealing, no low-leakage connections, negative pressure leak-proof design, liquid leak detection mechanism
 - Welded radiator withstands 5 bar pressure

某液冷数据中心节能技术案例

An example of energy-saving technology in a liquid-cooled data centre



消费级市场培育 cultivation of consumer market

逐渐在PC市场兴起

Gradually emerging in the
PC market

- 发烧友 fans



1980s

1990s-2000s

2010s

一些大型机开始使用 Some
mainframes began to be used

- Cary-2 采用氟化液
- 绰号 “Bubbles”
- Cary-2 uses a fluorinated
solution
- Nicknamed ‘Bubbles’
“高大上”



- 技术成熟
- 成本降低
- 回归企业级和 HPC
市场
- Mature technology
- Lower cost
- Return to the
enterprise and HPC
markets

迅猛发展
Develop rapidly

液冷服务器系统厂商

- manufacturer of liquid-cooled
server systems



液冷套件和方案提供商

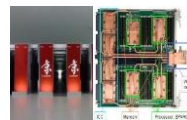
- Liquid cooling kit and
solution provider



液冷用户 Liquid cooling users



德国 Leibniz 超
算中心
SuperMUC
(IBM)



日本 RIKEN
K-Computer
(Fujitsu)



美国 DoE/NREL
Peregrine
(HP)



济南超算中心
神威蓝光
(江南所)

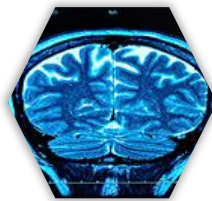
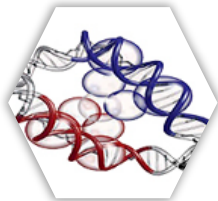
Jinan Supercomputing Centre
Shenwei Blu-ray
(Jiangnan Institute)

某液冷数据中心节能技术案例

An example of energy-saving technology in a liquid-cooled data centre

石油/地震

petroleum / earthquake



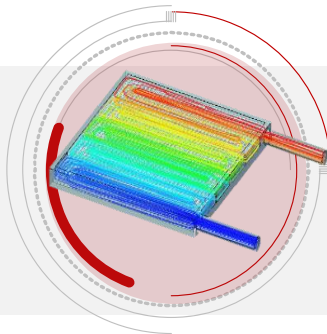
金融行业

financial sector



通用 → 异构

General → Heterogeneous



分散 → 集约

dispersed → concentrated



互联网

Internet



制造行业

manufacturing sector



通信行业

telecommunications sector



在线教育

online education

Part 03

第三部分

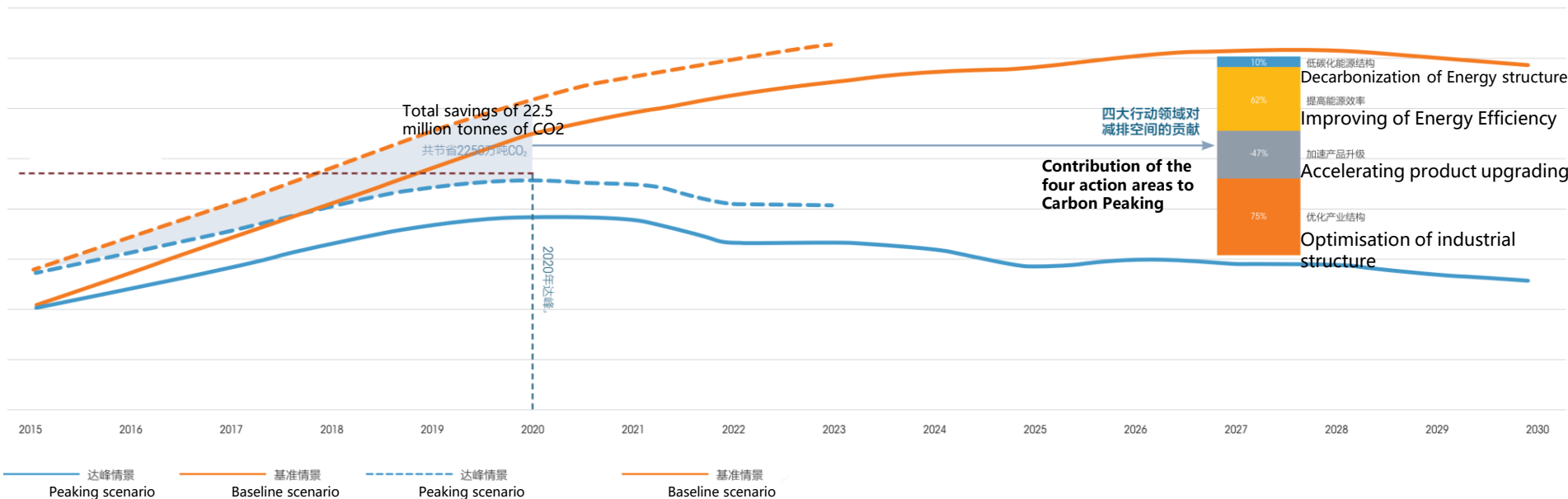
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能效提升建议

Recommendations for energy efficiency improvements

数据中心达峰路径比对研究

Pathways for Carbon Peaking in Data Centres



数据中心能效挑战与风险

Challenges of Improving Energy Efficiency in Data Centres



未来驱动因素 Driving factors

- 环境保护理念在国家层面得到认可。
- 能效提升是企业的重中之重。
- The concept of environmental protection is recognised at national level.
- Energy efficiency improvement is a top priority for companies.

关键影响因素分析 Key influencing factors

- 企业是否在碳达峰、碳中和的过程中受益
- 国家的监管和激励政策的颁布
- Whether companies are benefiting from decarbonisation
- National regulation and incentive policies

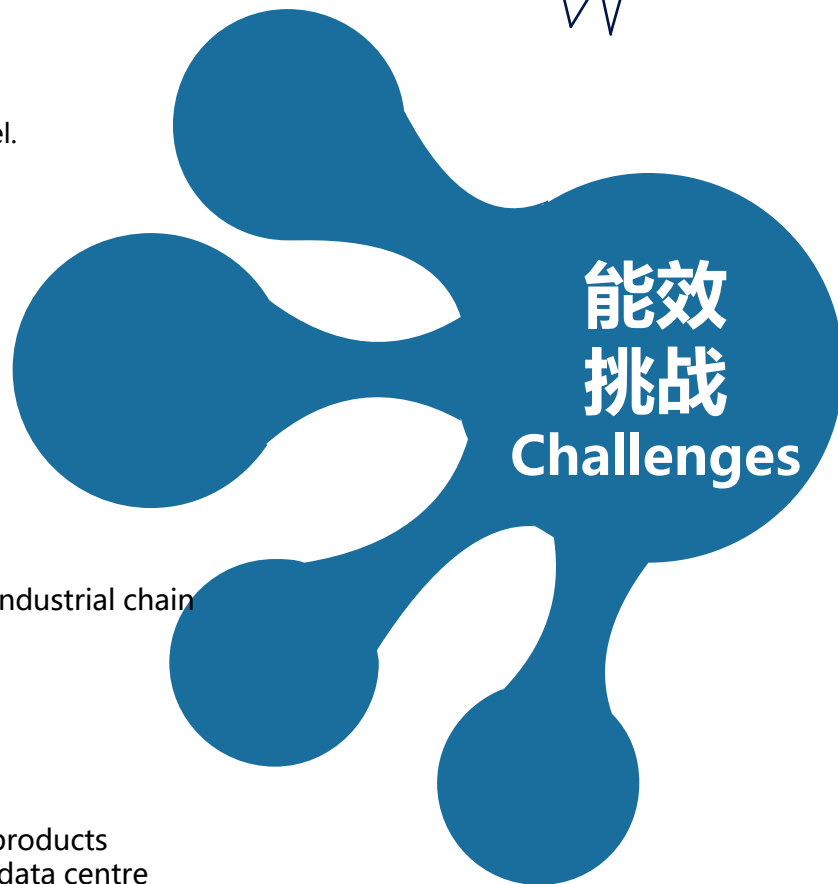
节能减排潜力和投资分析

Energy efficiency potential and investment analysis

- 注重市场引导，好过政策性强制
- 引入节能改造资金和企业，形成产业链条
- Focus on market-led, better than policy-based
- Introducing energy-saving renovation funds and ESCO to form an industrial chain

主要风险点分析 Main risk points

- 隐形数据中心的粗狂式发展
- 节能人才短缺、节能产品缺失标准
- 监管机制不健全，无法对数据中心碳达峰进行评价
- Extensive development of invisible data centres
- Lack of energy-saving personnel and standards for energy-saving products
- Inadequate regulatory mechanisms to evaluate decarbonisation in data centre



数据中心碳达峰建议

Recommendations on Decarbonisation of Data Centres



政策建议 Policy



- 增强政府对行业发展的引导作用
- 推广数据中心绿色节能技术方案
- Enhancing the Government's Guiding Role
- Promoting green and energy efficient technology solutions

技术建议 Technology



- 完善绿色数据中心标准体系的建立和推广
- 产学研合作促进绿色数据中心关键技术发展
- Improving the establishment and promotion of standard system for data centres
- Promoting key technology development through industry-university-research

投资建议 Investment



- 引入节能改造的头部企业, 打造改造链条
- 完善节能改造关键环节, 推出节能改造标准和研究课题
- Introducing ESCOs to create a chain of energy-saving renovation
- Improving key aspects of retrofitting and formulate relevant standards

市场建议 Market



- 重视解决数据中心人才储备不足问题
- 深入开展绿色数据中心测评和认证工作
- Addressing the shortage of talents related to energy efficiency
- Evaluation and certification green data centres

Part 04

第四部分

4

我们都做了些什么
What have we
done?

促进会对产业主要支撑 Main support for industry

企业帮扶业务 Business support



协会每年对数据中心企业进行定点帮扶，帮助企业制定规划，解决企业技术难题和市场难题。
It provides targeted assistance to enterprises to help them formulate plans and solve technical and market problems.

咨询规划业务 Consulting Service



规划、咨询；整体的可行性研究，节能报告、客户的研究，趋势研究。
Planning, consulting; overall feasibility studies, energy efficiency reports, customer research, trend studies.

会展活动业务 Exhibition Services



会议、展览、沙龙、企业公关、新闻、稿件、展会。数据中心市场年会和国际数据中心展。
Conferences, exhibitions, salons, corporate PR, news, press releases, trade shows. Data Centre Marketplace Annual Conference and International Data Centre Exhibition.

核心 支撑 main support

标准制定业务 standardisation



主导和参与数据中心和综合布线的行业标准和国家标准。当前协会主要参与国家标准11部，地市标准5部，团体标准8部。
Leading and participating in industry standards and national standards. The Association is mainly involved in 11 national standards, 5 local and municipal standards and 8 group standards.

培训业务 Training Services



对数据中心和综合布线的设计、建造、运维、检测、改造等全产业链进行培训，培养优秀人才。
Training for the whole industry chain of design, construction, operation and maintenance, testing and renovation of data centres and integrated cabling to cultivate outstanding talents.

课题研究业务 Project Study



每年承接各部委和地市的研究课题，已经完成各类课题8部以上。
It undertakes research projects for ministries and local municipalities, and has completed more than eight works on various topics.

促进会当前现状 Current Development

会员单位

300家+

Membership units
300+

协会涵盖了用户、研究院所、咨询机构、生产企业、运维单位等全产业链会员，是数据中心行业优秀的正规行业组织代表。

The association includes members from the entire industry chain, such as users, research institutes, consulting firms, manufacturers, and operation and maintenance units, and is a leading representative of formal industry organizations in the data center sector.

专家组

120人+

expert groups
120 people+

专家组由设计院、用户专家、政府机构、企业总工组成，其中设计院所占50%以上的份额，用户专家占据30%的份额。

The expert group is composed of design institutes, user experts, government agencies, and chief engineers from enterprises, with design institutes accounting for more than 50% and user experts making up 30%.

活动参与人数

50000人次+

Number of participants
in the event
50,000 people +

协会每年举办的CDCE国际数据中心展、数据中心市场年会、数据中心巡展、数据中心沙龙等，参与总人数已经超过5万人次。

The association hosts events like the CDCE Expo, Data Center Conference, Roadshow, and Salon annually, with over 50,000 participants.

数据中心咨询服务 Consulting Service



数据中心展会服务 Exhibition Services



国际数据中心及云计算产业展览会

International Data Center & Cloud Computing Industry Expo

All-in-One Data Center & Cloud Computing Platform

数据中心及云计算全产业展示



中关村协众创智信息产业促进会

Zhongguancun Digital Intelligence and Innovation Information Industrial Promotion Association



预祝会议圆满成功

