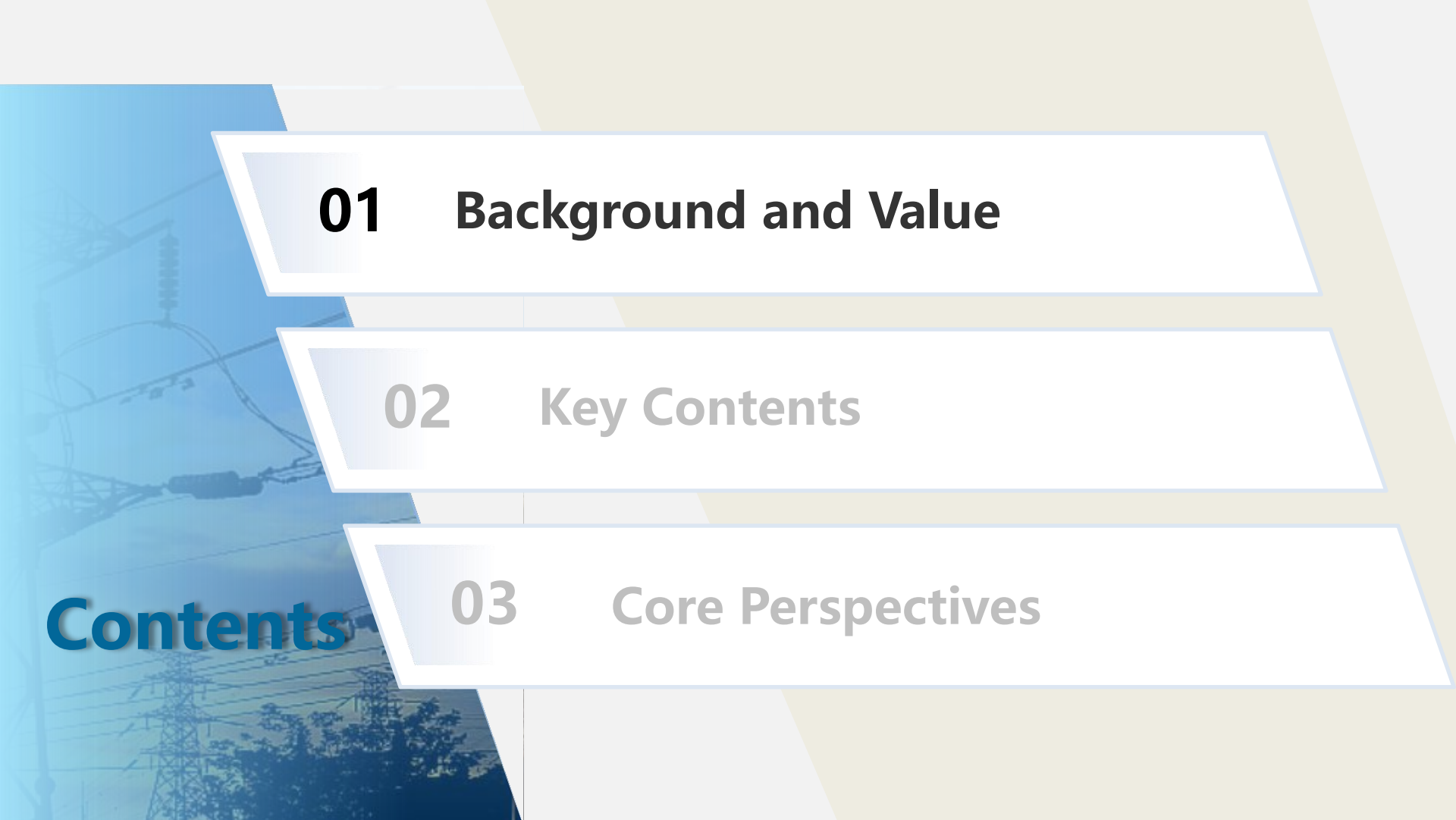




Digital-intelligent Resilient Power Grids

**Global Energy Interconnection Development and
Cooperation Organization**

August 2025



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1.1 Background



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Development and Cooperation Organization
全球能源互联网发展合作组织

The global energy system is evolving towards **cleanliness, electrification, networking, universal access, digitization and intellectualization.**

Along with regional & global energy interconnection Goals, **accelerating the grid construction has become an imperative strategic choice for energy and power development in the world.**

REGIONAL & GLOBAL ENERGY INTERCONNECTION



Objective

Accelerate the regional electricity grid and power market integration in order to maximise the use of cost-efficient clean energy sources available at the country level and regionally. Facilitate the development of sustainable, secure, and affordable regional electricity systems while contributing to economic growth, climate change mitigation, and decarbonisation of energy systems.

Goals

- Facilitate the transition of energy systems to more interconnected, and electrified modern energy systems, and maximise the use of renewable energy. Facilitate policy discussions on the regulatory and market frameworks for electricity system integration.
- Support the development of sustainable, secure and affordable regional electricity systems to contribute to climate change mitigation and decarbonisation of energy systems.
- Increase the understanding of policy and regulatory issues regarding regional electricity interconnection. Address concerns on the security and reliability of large-scale interconnection.

Cleanliness

Electrification

Networking

Digintelligence

Universal access

1.2 Challenges and Demands



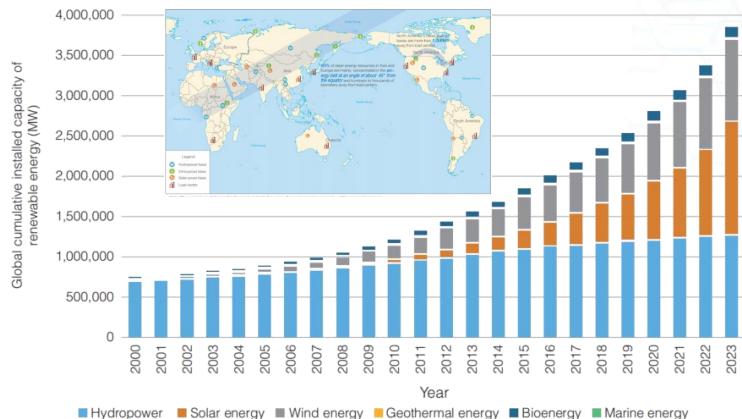
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Large-scale development of clean energy brings challenges in **supply capability, security and stability**, and **cost-effectiveness** of the interconnected power grids. The electricity **market operation** and the **transparency and fairness** require improvements.

There are critical demands for digital-intelligent transformation of the grids in **climate and meteorological analysis**, **massive component integration**, **efficient data sharing**, and **comprehensive development support**.



Large-scale development of clean energy and resource distribution



Critical demands for digital-intelligent transition

> Climate and meteorological analysis

The impact of complex and uncontrollable external factors such as climate and meteorology on system operation is deepening.

> Efficient data sharing

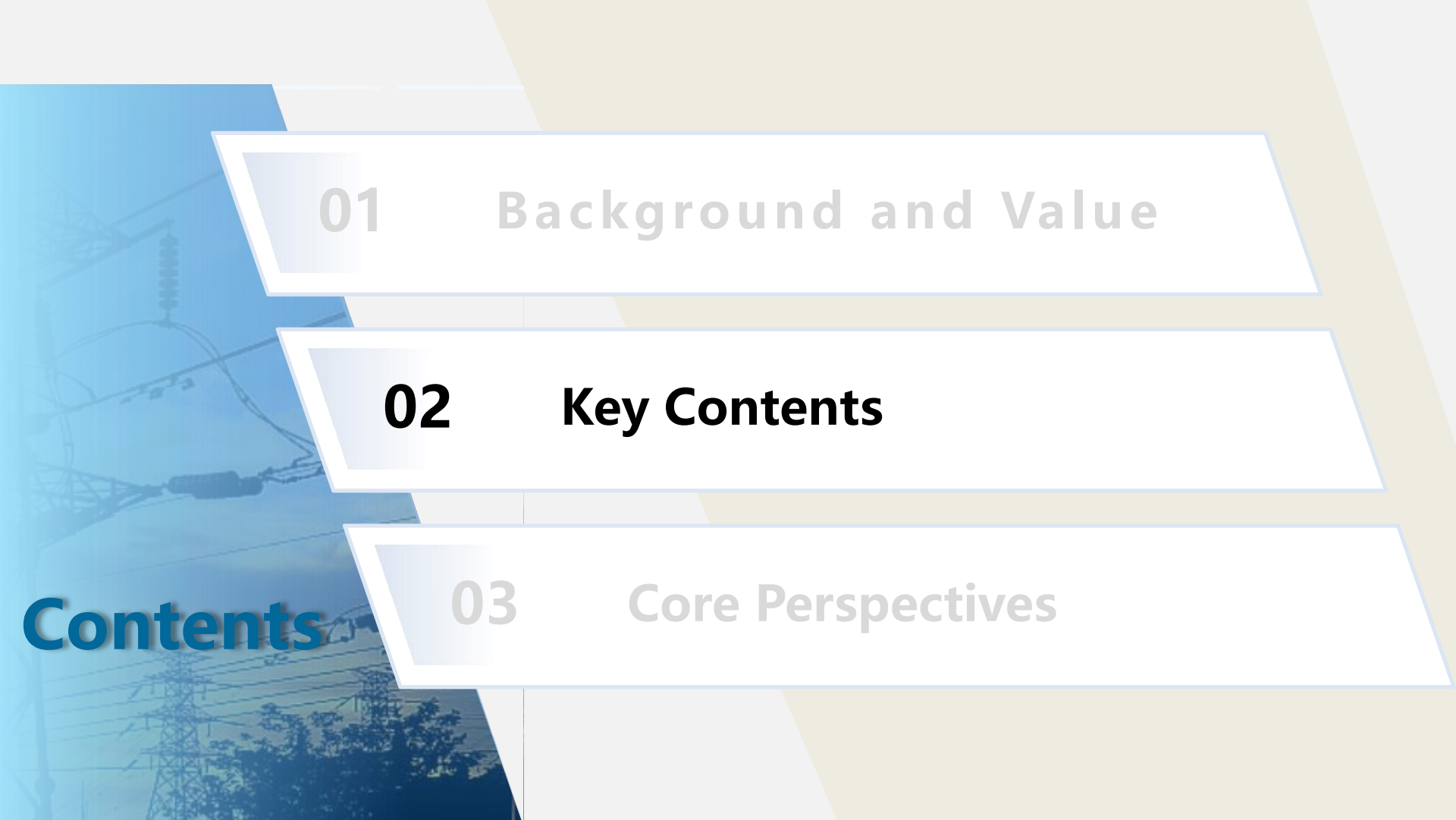
The data of internal equipment, stations, and systems, as well as various time scale data of external users need to be shared.

> Massive component integration

Massive components including various distributed power sources, electric vehicles, and smart appliances integrate.

> Comprehensive development support

Power grids serve as platforms for optimal allocation of clean energy, as well as the key to supporting the industry development and technological innovation.



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2.1 The Key to Breakthrough



Digital-intelligent resilient power grids represent a new generation of power grids which are **built upon UHV/EHV resilient grid infrastructure**, and **driven by the deep integration of power grid technologies and digital-intelligent technologies**. They exhibit distinctive characteristics including climate elasticity, stability resilience, regulatory flexibility, intelligent interactivity, and ecosystem integration.



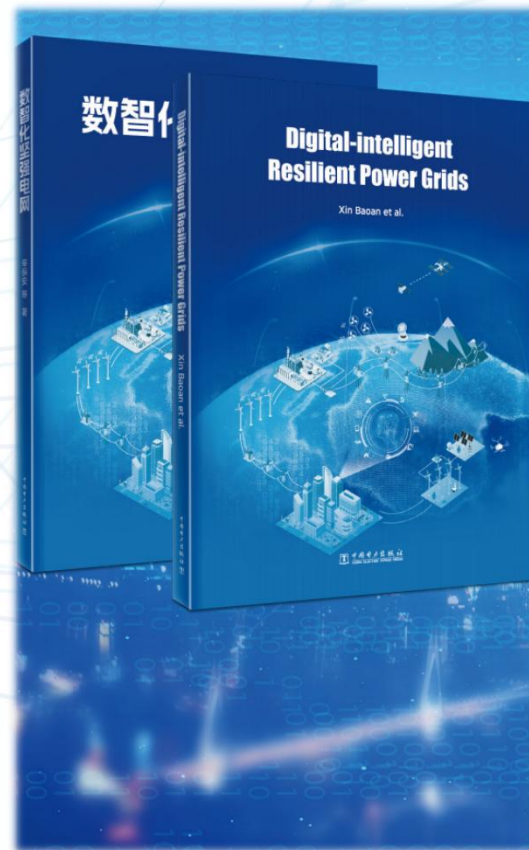
2.1 The Key to Breakthrough



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DIRPG are the latest development of global energy interconnection theory and the **key to breakthrough of achieving the regional & global energy interconnection**, and high-quality development of power grids.

Chairman of the Global Energy Interconnection Development and Cooperation Organization (GEIDCO), Xin Baoan, proposed the development concept of digital-intelligent resilient power grids (DIRPG) and wrote the book which introduces the concept of digital-intelligent resilient power grids, and addresses fundamental issues, including the scientific orientation, strategic transformation, and innovation-driven development of power grids in the new historical period.



The key principles of Digital-intelligent resilient power grids the "44685"

4 Basic Principles:

Security and green; innovation and digintelligent; comprehensive and efficiency; open and shared.

4 Core Essence:

New network form, new digital intelligence momentum, new development hub, new cooperation platform.

Main Features:

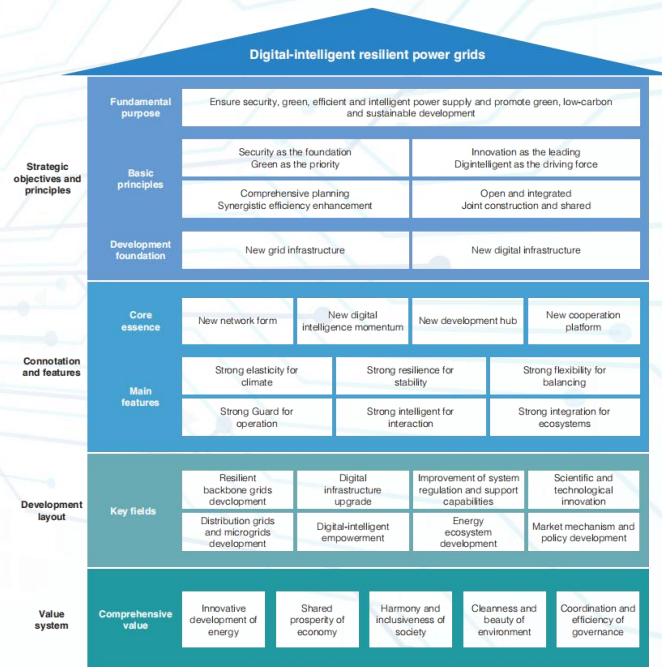
6 Strong elasticity for climate; strong resilience for stability; strong flexibility for balancing; strong guard for emergency; strong intelligence for interaction; strong integration for ecosystem.

Development Focuses:

8 Resilient Backbone Grids Development; Distribution Grids and Microgrids Development; Improvement of System Regulation and Support Capabilities; Digital Infrastructure Upgrade; Digital-Intelligent Empowerment; Energy Ecosystem Development; Scientific and technological innovation and research; Market mechanism and policy development.

Comprehensive Values:

5 Innovative Development of Energy, Shared Prosperity of Economy, Harmony and Inclusiveness of Society, Cleanness and Beauty of Environment, Coordination and Efficiency of Governance.



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A more widely flexible bulk backbone grid.

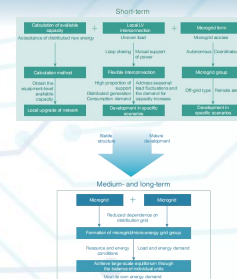
A more resilient and flexible distribution grids. The distribution grid, from the radial to

an active interactive system, with a focus of enhancing structural flexibility and reliability.

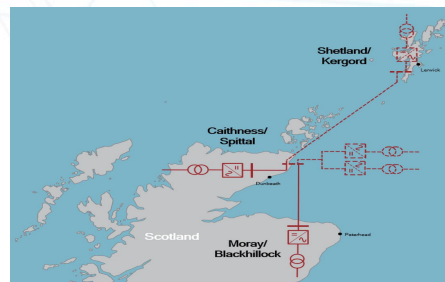
More autonomous and coordinated microgrids. Microgrids evolve towards autonomous management and complementary symbiosis, participating in power regulation, voltage, and frequency support.



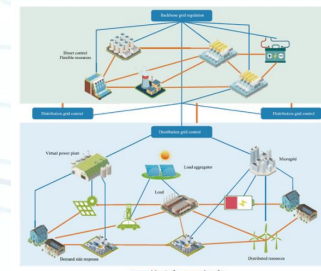
UHV/EHV Grid in Sichuan-Chongqing Region of China



Distribution Grid (Rural) Development



Caithness-Moray-Shetlands Multi Terminal DC



Transmission-Distribution-Microgrids Coordination Architecture

3. Core Perspectives



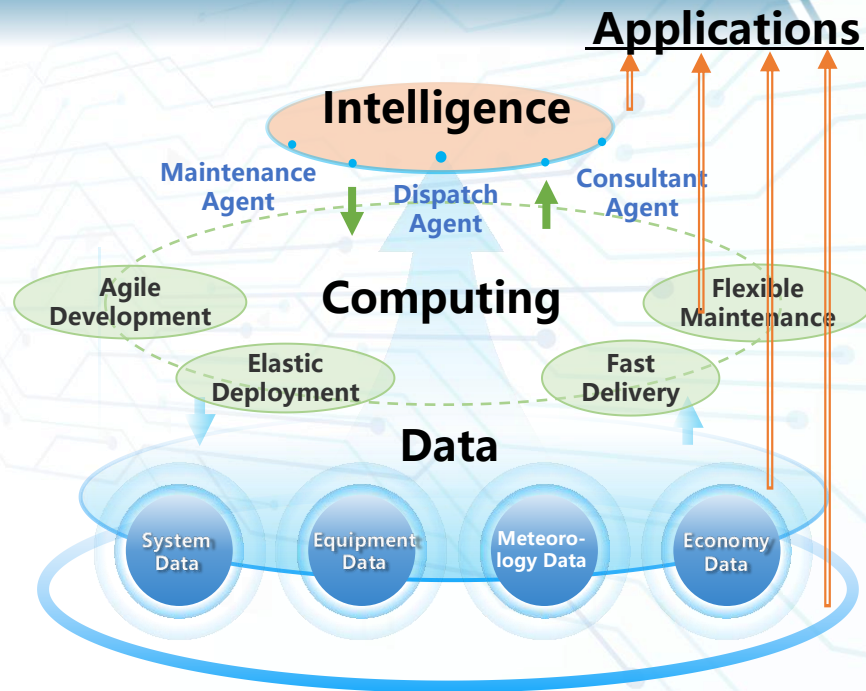
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The cooperation among data, computing and intelligence provides strong digital-intelligent support for power grids.

Data. Enhance comprehensive collection and sharing of internal and external data. Internally, enhance the observability and measurability of all components. Externally, **enhance the cooperation between power system and meteorology**. Break down data barriers to promote data sharing.

Computing. Cooperation and **cloudization of power and computing capability**, provide green and efficient computing.

Intelligence. Based on sufficient data and computing capability, an intelligent foundation integrating diverse algorithms, models, and agents has been created.



Accelerate the applications based on LLM and embodied intelligence, achieving intelligent upgrade of resilient power grids.

Develop autonomous and intelligent maintenance. Widely use Unmanned equipment to accelerate replacement of manual operations.

Improve quality and efficiency of development and construction.



UAV Inspection for Power Lines

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DIRPG constitute a critical part of modern infrastructure, driving the integration and value enhancement of multiple flows.

Digital-intelligent resilient power grids are modern infrastructure. It represents systematic, efficient, intelligent, green, safe, and reliable modern infrastructure, across energy, information, and other domains.

Promote “green integration” of energy. Break down energy silos on the consumption side, integrating electricity, hydrogen, heat (cooling), and gas for synergistic complementarity.

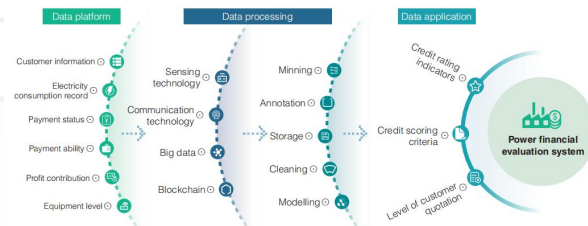
Lead infrastructure convergence. Advance the synergy of energy flow, information flow, business flow, and capital flow, to deliver higher-value services for society and provide support for the Digital China and Digital Earth.



Comprehensive Energy Development of Xiong'an New Area, China



Environmental Monitoring System



Corporate Financial Credit Power Index

3. Core Perspectives



DIRPG serve as critical platforms for fostering new quality productive forces in energy.

Accelerate R&D, pilot, and application of new technologies and equipment. Key focus areas include transmission, distribution, utilization, zero-carbon generation, energy storage, digital-intelligent technology.

Lead the innovation-driven development across the entire industrial chain. It drives technological innovation and product upgrade in upstream equipment manufacturing. It also fuels the growth of downstream strategic emerging industries and future-oriented sectors.

Drive cross-industry innovation. By leveraging energy supply, data connectivity, and value-chain synergy, it achieves deep integration with systems. This approach catalyzes novel industrial models like "Electric-Water-Soil-Forest Convergence" and "Electric-Mining-Metallurgy-Industry-Trade" .

Technical innovation framework

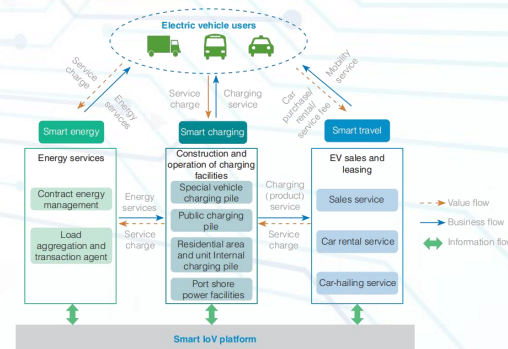
- UHVAC
- UHVDC
- Submarine cable
- Intelligent distribution grid equipment
- Operation control of intelligent distribution grid
- Microgrid

- Electric heating (cooling)
- Electrified transportation
- Data and communication power consumption
- Power to X and raw material

- **Climate dependence:** wind power, PV
- **Zero-carbon controllable power generation:** solar thermal power generation and hydrogen power generation
- **Active support:** broadband oscillation suppression and short-circuit capacity support

- **Traditional energy storage:** pumped storage
- **New short/ultra-short duration:** lithium ion battery, flywheel energy storage
- **New long duration:** compressed air energy storage, redox flow battery and gravity energy storage

- Sensor and measurement
- Communication and control
- Big data and cloud computing
- Blockchain
- System modeling and simulation
- Artificial intelligence



Intelligent vehicle-to-everything (V2X) architecture

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DIRPG contribute both universal and localized schemes for global and regional power grid development.

Asian DIRPG

- Towards challenges of energy transition and regional disparities.
- Build resilient data measurement and ICT infrastructure.
- Promote digital and AI applications in power grids.
- Foster clean energy ecosystems in Asia.

North American DIRPG

- Towards challenge of aging power grids.
- Leverage AI, finance, tech, and talent strengths. Use grid upgrades to drive power industry digital transformation.
- Apply AI and digital devices extensively in power grids.

European DIRPG

- Towards challenges of energy reliability and transition
- Scale up clean energy development and flexible grid interconnection.
- Build a regional energy-electricity cooperation platform. Drive tech and industrial upgrades through electricity-carbon-data innovation.

Central & South American DIRPG

- Build clean, climate-resilient intelligent power grids.
- Increase digital infrastructure investment, enhance digital application to reduce operational losses.
- Support regional reindustrialization with clean energy.

African DIRPG

- Towards challenges of energy poverty and weak infrastructure.
- Strengthen grid infrastructure and smart metering systems.
- Enable digital empowerment for multi-level power grids.
- Accelerate industrialization and socio-economic development by co-development of Electricity-Mining-Metallurgy-Manufacturing-Trade.

Oceanian DIRPG

- Drive regional green development in the Southern Hemisphere.
- Promote submarine power grid interconnection.
- Eliminate electricity shortages.
- Enhance power infrastructure in remote island areas.

3. Core Perspectives

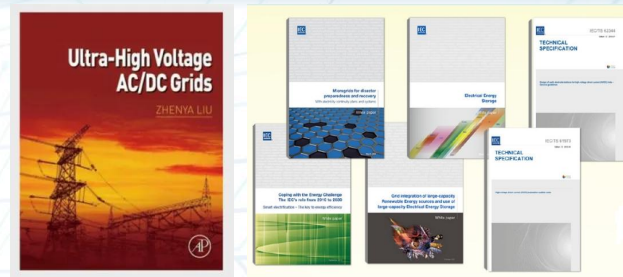


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Global DIRPG provide platforms for international cooperation, promoting connectivity of infrastructure, rules, and hearts.

DIRPG facilitate multinational and multi-type interconnections. Through bilateral, multilateral, and regional grid interconnection, physical grid interconnection and digital-smart sharing are combined to shape a new pattern of international cooperation in **power technology, standards, and trade.**

DIRPG propel all-round, multi-field cooperation among countries. Starting with interconnection, expanding gradually, digital-intelligent resilient power grids facilitate economic policy coordination and institutional alignment, promote orderly free flow of economic factors, efficient resource allocation, and deep market integration, and advance broader and deeper global cooperation.



International power standards



China-Laos 500 kV
Interconnection Project



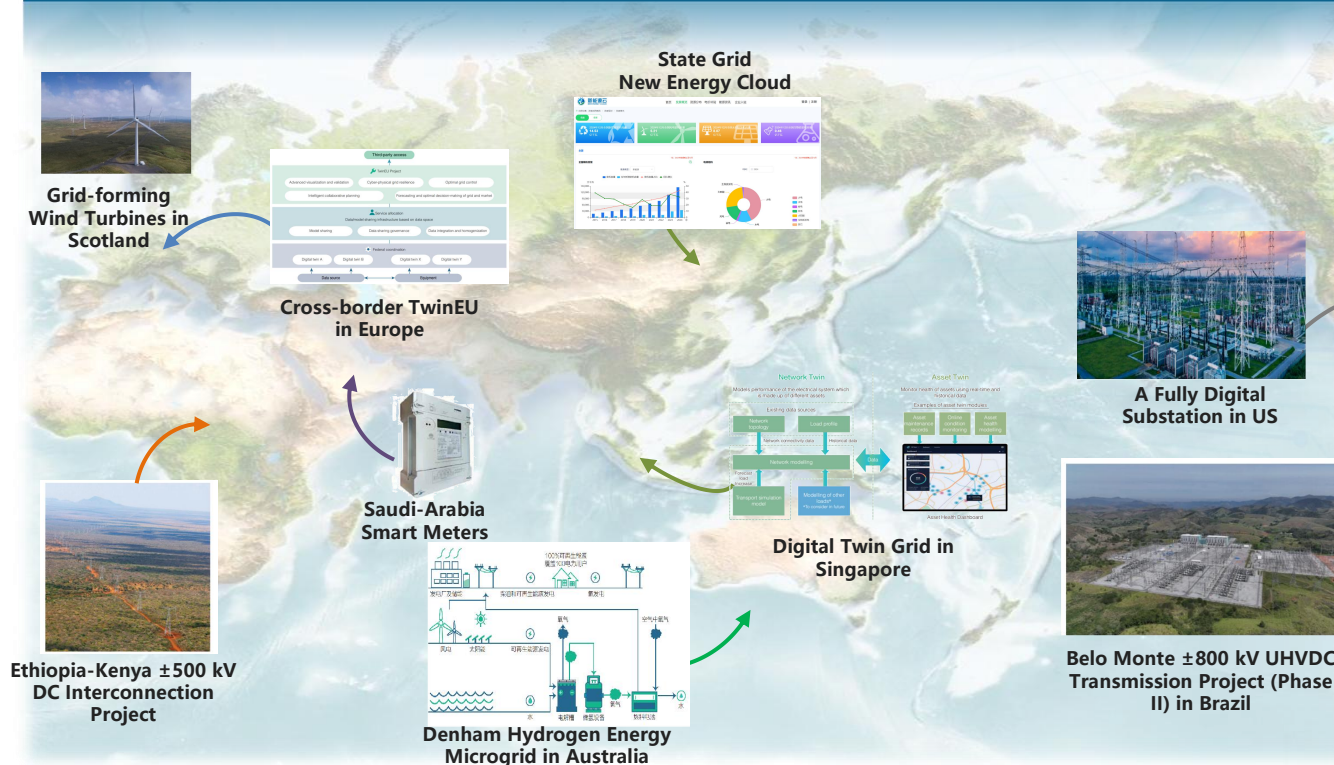
Pakistan Matri-Lahore ±660 kV
HVDC Transmission Project

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Global practices provide a solid foundation for DIRPG construction.



China: World's largest UHV AC/DC hybrid grid. "Guangming" AI LLM with trillion parameters. World's largest "New Energy Cloud" and vehicle-grid platforms.

Saudi Arabia: 5 million smart meters.

Europe: TwinEU for pan-European data sharing.

Australia: Renewable-based hydrogen production.

Brazil: Belo Monte UHV DC Transmission Project.

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DIRPG are in a process of continuous innovation, and will reshape the future energy system.

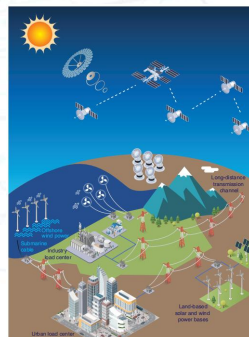
Digital-intelligent resilient power grids are an integrated and openness system of information, physics, and society.

DIRPG will advance with society, technology and energy.

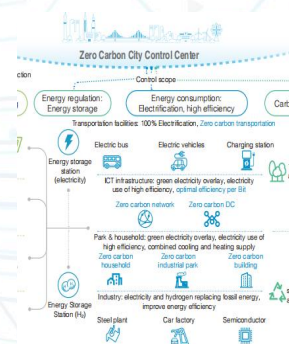
Future energy production



Future energy transmission



Future energy utilization



Future energy ecology



- Integration of air, space, land, and sea, combined with wired and wireless transmission
- New infrastructure equipped with network-integrated IoT featuring intelligent coordination capabilities
- Energy material collaborative production
- Breakthroughs in human' s living space, development paradigms, and modes of coexistence with nature



GEIDCO stands ready to collaborate with all sectors of society to accelerate the development of global digital-intelligent resilient power grids, establish a new paradigm of global cooperation, and write a new chapter for regional & global energy interconnection!

