Smart Grid: A Digital Brain for Power Infrastructure

Sustainable & Resilient Future

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Korea Electrotechnology Research Institute (KERI)

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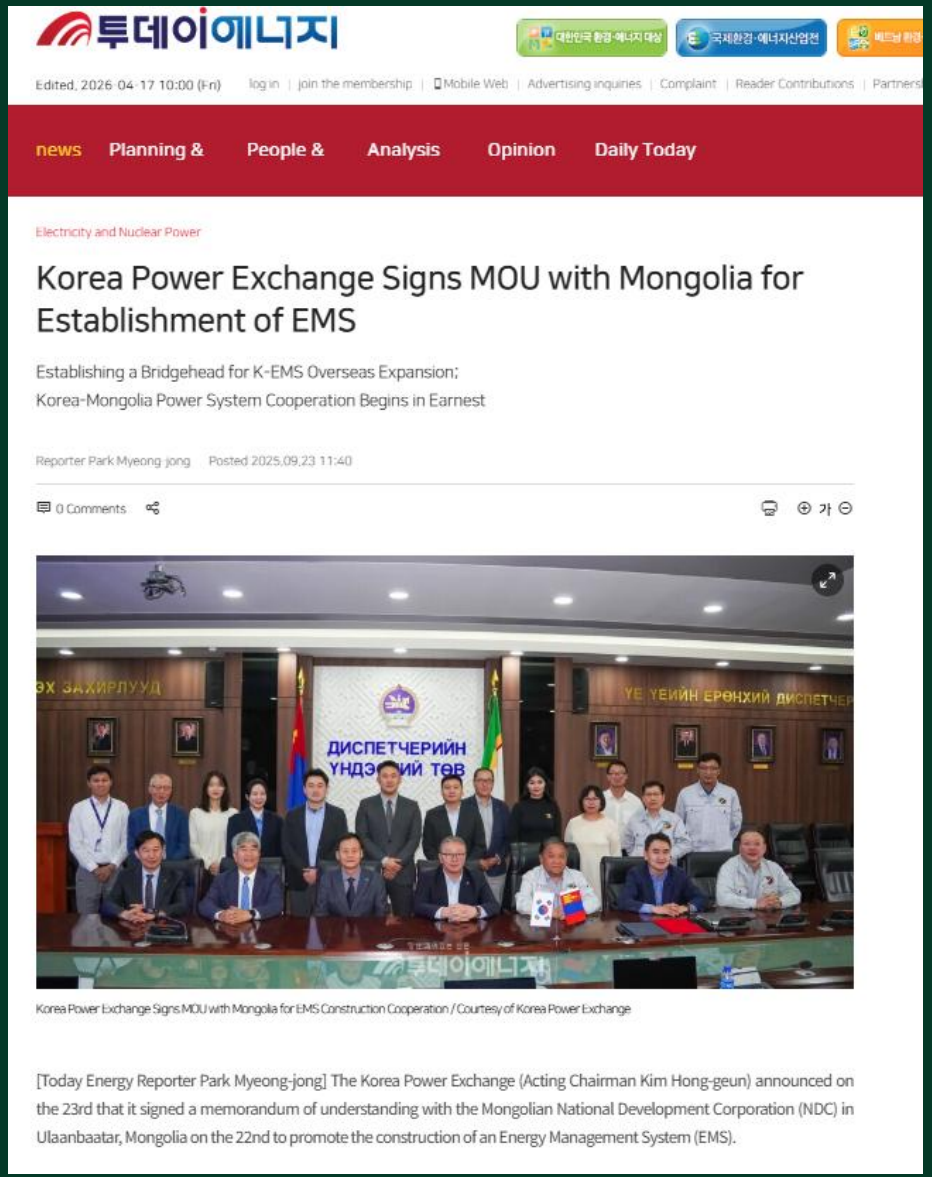

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Electricity and Nuclear Power

Korea Power Exchange Signs MOU with Mongolia for Establishment of EMS

Establishing a Bridgehead for K-EMS Overseas Expansion;
Korea-Mongolia Power System Cooperation Begins in Earnest

Reporter Park Myeong-jong Posted 2025.09.23 11:40

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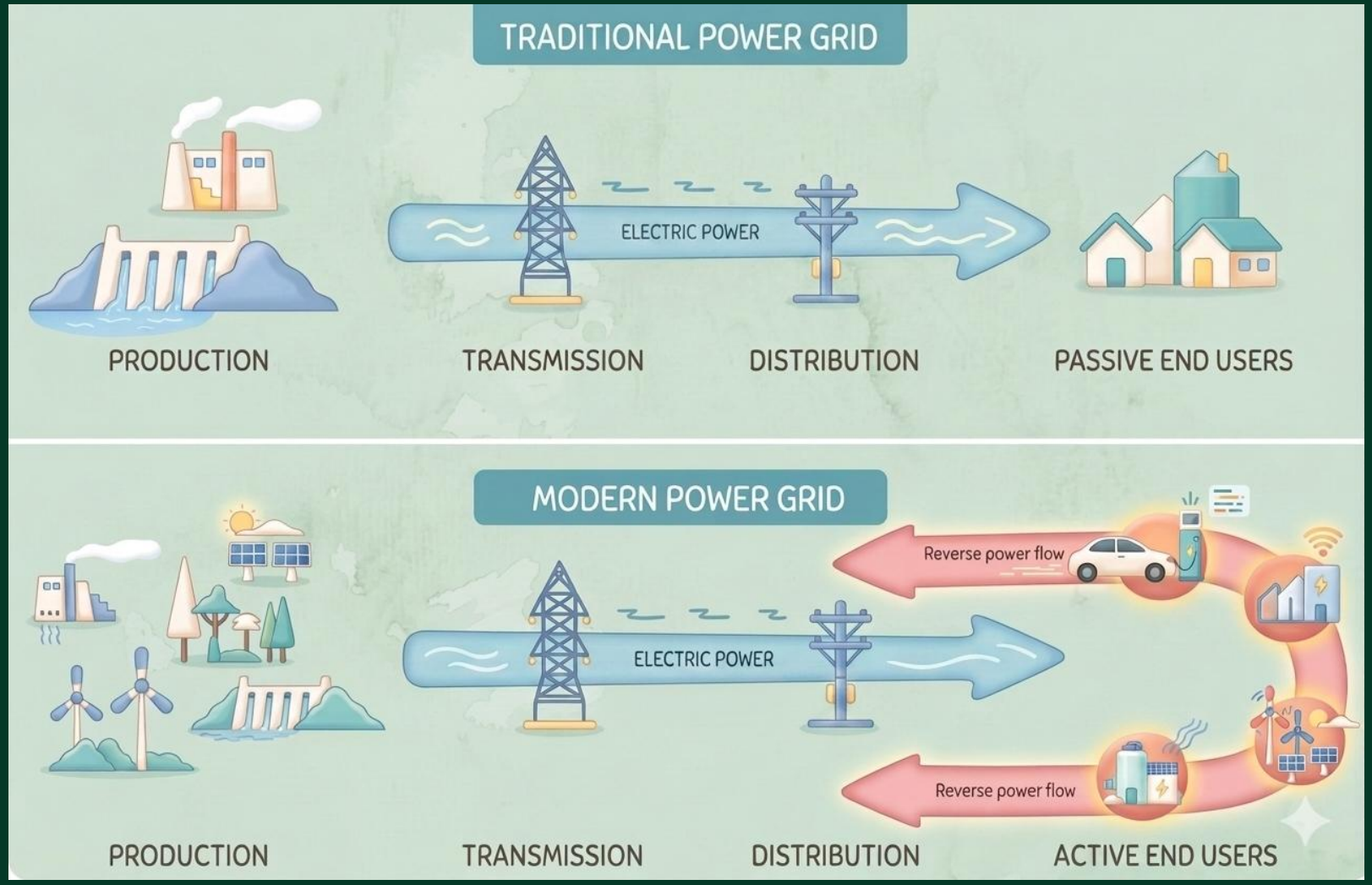
Korea Power Exchange Signs MOU with Mongolia for EMS Construction Cooperation / Courtesy of Korea Power Exchange

[Today Energy Reporter Park Myeong-jong] The Korea Power Exchange (Acting Chairman Kim Hong-geun) announced on the 23rd that it signed a memorandum of understanding with the Mongolian National Development Corporation (NDC) in Ulaanbaatar, Mongolia on the 22nd to promote the construction of an Energy Management System (EMS).

Part 1

The Imperative of Smart Grid: Global Context and Framework

WHY WE NEED A SMART GRID?



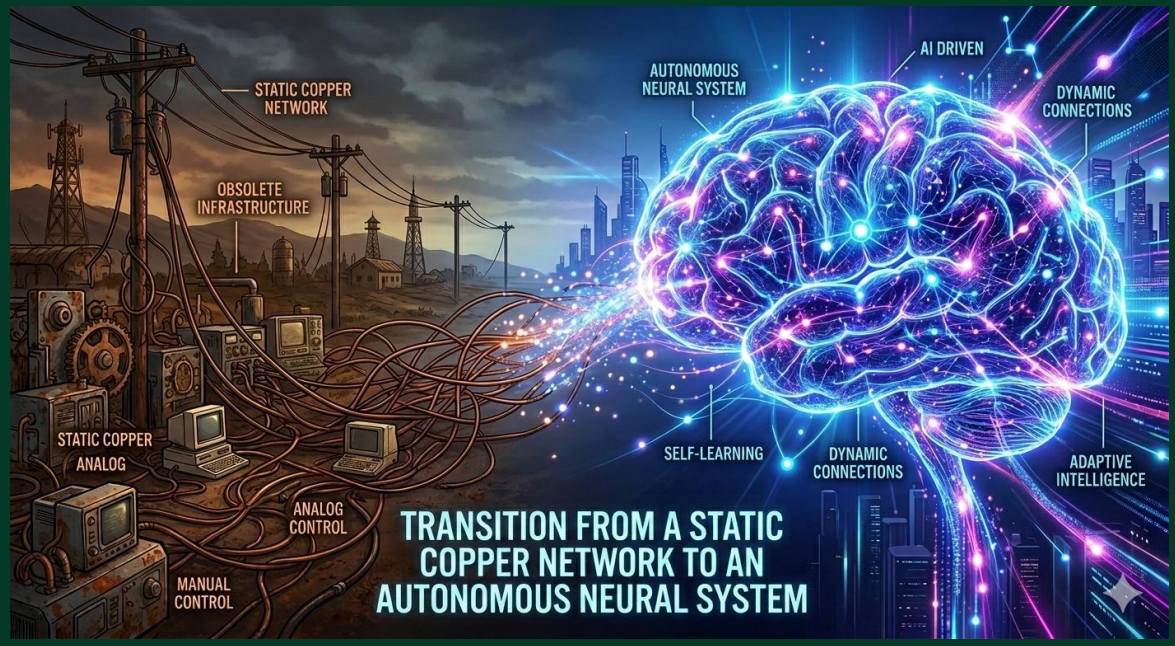
Source : www.enel.com/learning-hub/grids/smart-grid

EVOLUTION OF POWER SYSTEMS

The Great Paradigm Shift

- Past 100 years: Passive "Copper Network"
- Last 20 years: Rapid digital revolution
- Today: Transition to **Digital Intelligence**

"Transition from a **Static Copper Network** to an **Autonomous Neural System.**"



WHY SMART GRID? (BACKGROUND 1)

VRE Integration

Variable Renewable Energy (Solar/Wind) is **Intermittent**.

- Challenges: Frequency & Voltage fluctuations.
- Solution: Smart Grid provides the **Flexibility** to balance intermittent resources.

WHY SMART GRID? (BACKGROUND 2)

Aging Infrastructure & Reliability

- Global grid assets are 40~50+ years old.
- Legacy systems threaten **National Security**.
- Digitalization extends equipment life and operational efficiency.

SMART GRID DEFINITION: USA

US Department of Energy (DOE)

> *"A digital technology to save energy, reduce cost, and increase reliability and transparency."*

- Focus on **Two-way Communication**.
- Leveraging massive computing power for grid stability.

SMART GRID DEFINITION: KOREA

Intelligent Power Grid Act

> *"Next-generation power system integrating IT to optimize energy efficiency through two-way exchange."*

- Emphasis on **ICT Convergence**.
- Optimizing interaction between supplier and consumer.

Part 2

South Korea’s Smart Grid Journey:

Policy, Cases, and Future Outlook

KOREA'S SG ROADMAP (2010–2030)

Phase 1

Testbed & Tech Development (Jeju)

Phase 2

Consumer Intelligence & AMI Expansion

Phase 3

National Grid Intelligence (2030)

CARBON-FREE ISLAND 2030 JEJU

JEJU: BUSINESS MODEL SUCCESS

- Verified **9 Major Business Models**.
- Standardized AMI-based consumer services.
- Established national EV charging protocols.
- Proved feasibility of **Carbon-Free Island (CFI)**.

100% Renewable Energy Goal

Total transition to EVs and replacement of internal combustion vehicles.

Targeting 67% renewable share by 2025.

3RD Smart Grid BASIC PLAN (2023–2027)

Strategic Focus: Flexibility

- Expanding distributed energy share to **18.6%**.
- Launching full-scale VPP (Virtual Power Plant) market participation.

VIRTUAL POWER PLANT (VPP)

Aggregating thousands of small Solar, Wind, and ESS units into one controllable **"Virtual" Plant**.

Status in Korea

- 3.4 GW capacity secured (2022).
- AI-driven prediction improves revenue by 12%.
- Managed via centralized software.

- 6.5 GW capacity secured (2026).
- Full participation in direct energy market.

"VPPs are now a major pillar of grid stability, replacing legacy peak-plants."

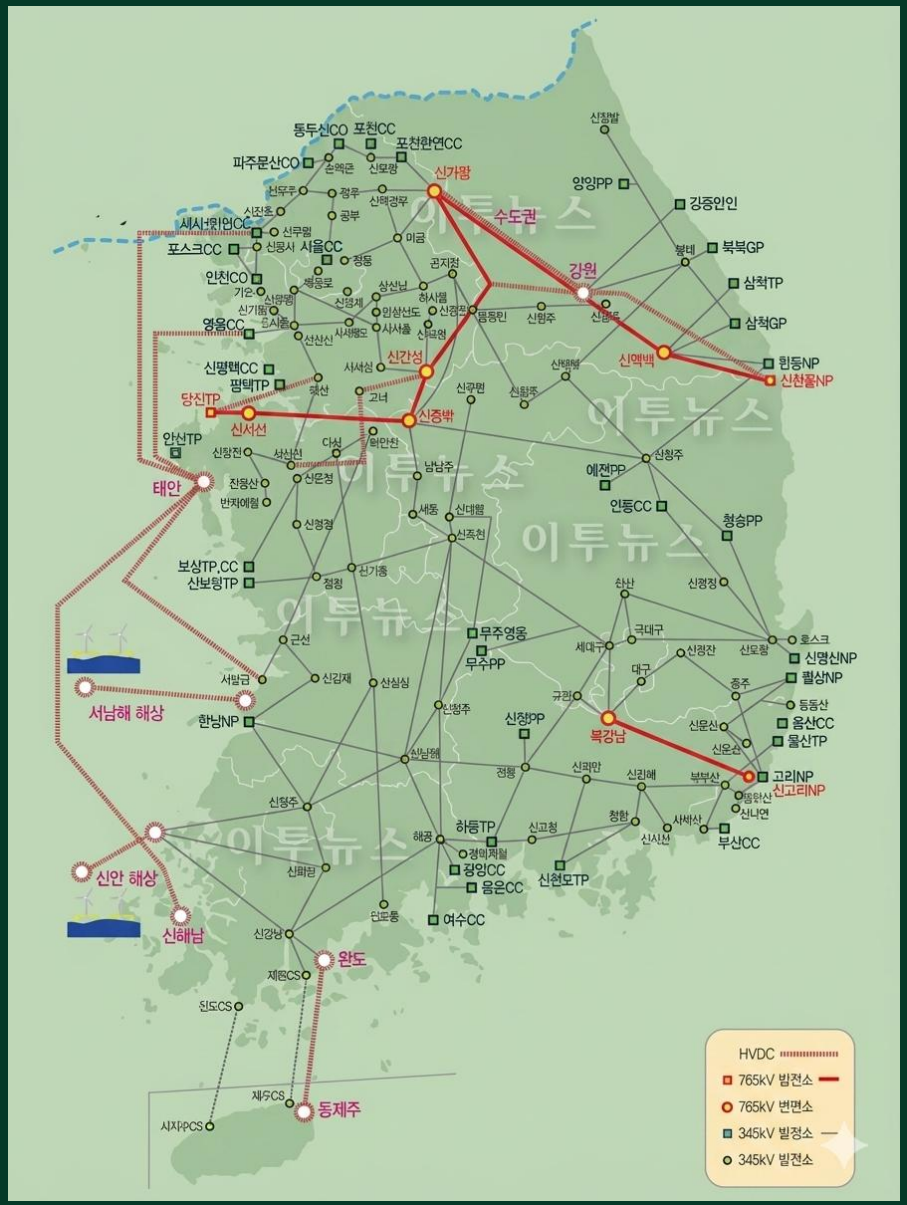
ESS: STRATEGIC GRID ASSETS

Grid-scale BESS

- Frequency regulation.
- Peak shaving.
- VRE buffering (Wind/Solar smoothing).
- Avoiding expensive grid construction.

REGIONAL ELECTRICITY PRICING

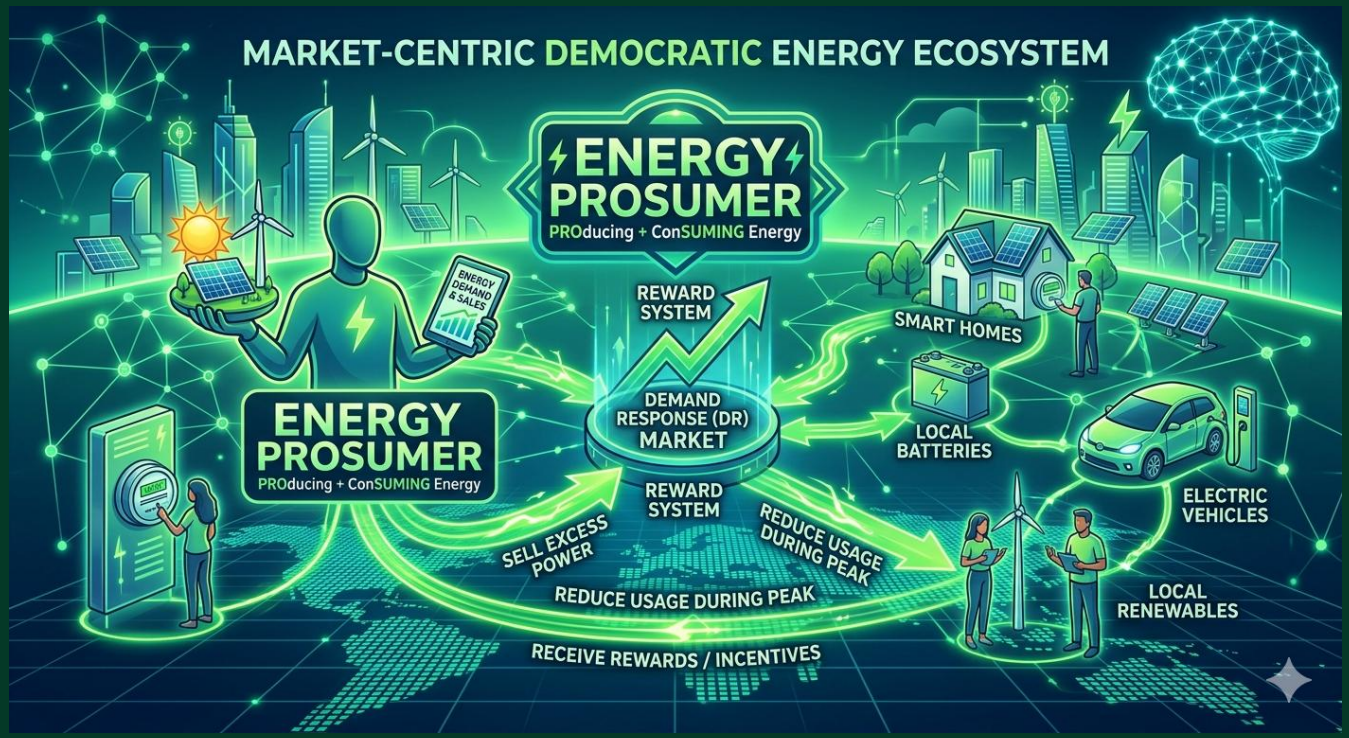
Addressing geographical imbalance between supply (Coastal) and demand (Capital) through **Regional Tariffs** and Time-of-Use (TOU) pricing.



CONSUMER PARTICIPATION

The ERA of Prosumers

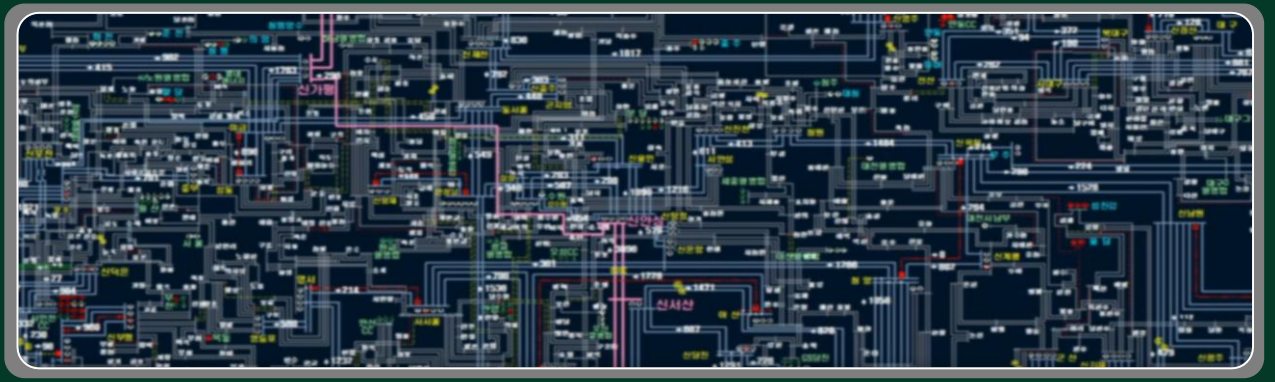
Consumers produce, store, and sell energy. They are no longer passive recipients but **Active Participants**.



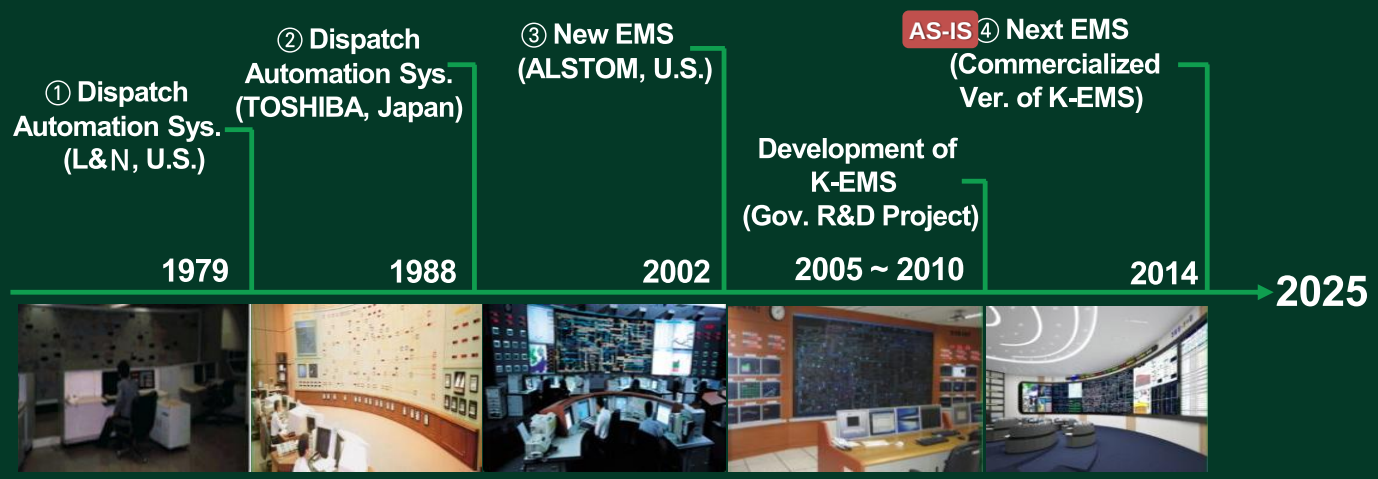
K-EMS for POWER SYSTEM OPERATION

What is EMS?

- An intelligent system that monitors and controls the dynamic power system in real-time to ensure economic dispatch and a stable supply of electricity.



EMS Power System Diagram



History of K-EMS

- Developed through 9 years of intensive R&D, K-EMS has reliably managed South Korea's mainland power grid since 2014.

Part 3

Tailoring Innovation for Mongolia:

Strategic Proposals and Implementation

MONGOLIA'S POWER SECTOR: VULNERABILITY

- **91% Coal dependency** – High carbon risk.
- **20% Power import** – Energy Security.
- **12%+ Transmission losses** – Critical waste.
- **10.5% Annual peak demand growth** - Rapidly growing load.

Periodic blackouts are hindering industrial growth.

MONGOLIA : STATE POLICY on ENERGY (2015~2030)

Strategic Targets

- Renewable Capacity Share: 12% (2018) → 20% (2023) → 30% by 2030
- GHG Reduction: Commit to 22.7% cut in emissions by 2030
- Energy independence & Net-Zero by 2050

Modernization & Reform

- **Smart Grid:** Technical modernization for grid stability
- **Auction System:** Shifting from fixed PPAs to competitive bidding

Strategic Priority 01 : GRID DIGITALIZATION

Enhancing grid stability and operational excellence
through a unified digital architecture and real-time intelligence.

Integrated EMS

Establishing the foundational energy management framework for centralized grid control and data visibility.

Homegrown K-EMS

Direct implementation of advanced algorithms to solve Mongolian grid constraints in collaboration with Korean partners

Modern SCADA

Full digital transformation of substations to eliminate data silos and improve response times across the grid.

ADVANCED EMS

MOU signing ceremony between KPX (Korea Power Exchange) and NDC (National Dispatch Center) on Partnership for Development of National EMS in Mongolia (Sep 23, 2025)

Promotion of “Smart Energy”

- Managing high VRE penetration.
- Balancing concentration of power demand.
- Real-time synchronization with regional hubs.

Key Issues: High VRE penetration &

Urban demand concentration

Strategic Priority 02：GRID FLEXIBILITY

Mitigating renewable intermittency and securing grid resilience via strategic storage investments.

Resilience through BESS

Establishing a critical buffer near Ulaanbaatar to manage the variability of solar and wind sources.

- Instantaneous frequency regulation.
- Reducing reliance on Russian power imports.
- Power-to-Heat (P2H) synergy optimization.

GRID-SCALE BESS

Frequency & Voltage Stability

Immediate deployment of **150MW+BESS** units to stabilize grid frequency and absorb renewable volatility.

- **Reducing coal plant cycling costs.**
- **Mitigating carbon emissions through VRE integration.**
- **Strategic buffer for Northeast Asian Super Grid.**

“Stabilizing the Gobi resource integration is the priority.”

Strategic Priority 03 : RENEWABLE INTEGRATION

Fostering energy welfare and a low-carbon economy through distributed and nomadic energy solutions.

Energy Welfare Priorities

Coal-to-Solar

Decarbonizing Ger districts by replacing raw coal heating with PV systems and smart meters.

100,000 Solar Ger

Providing portable solar home systems to nomadic households for universal energy access.

Smart Microgrids

Localized autonomy for remote mining and rural development hubs via VPP integration.

NOMADIC MICROGRIDS

AI-Driven Mobile Systems

- For 140,000 Ger households.
- DRL (Deep Reinforcement Learning).
- 76% Reduction in unmet load.

Addressing energy poverty through tech innovation.

Thank You

Building Mongolia's Digital Brain Together.

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