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[Smart Grid Solutions]

Digitalization in Power Grid

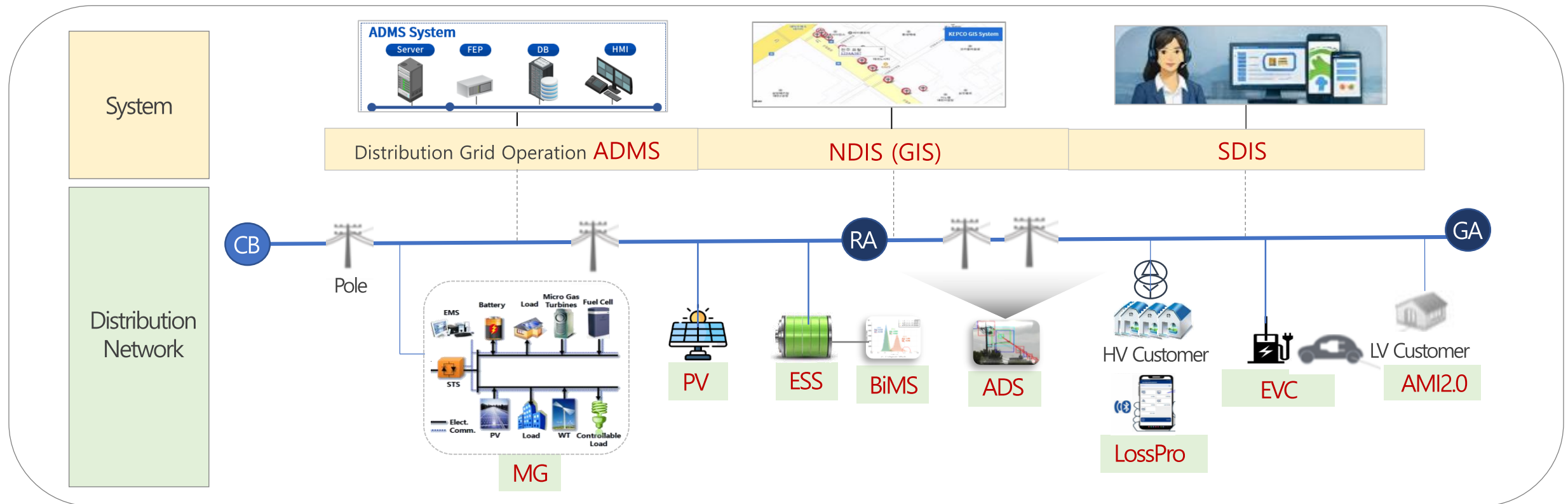


Young-Sung Park
General Manager, Global Business Department
Korea Electric Power Corporation (KEPCO)

Global Energy & Solution Leader

Digitalization in Power Grid

Global Business Department
Energy Solution Team



ADMS	MG	NDIS	BiMS	ADS	LossPro	AMI 2.0	SDIS
- DMS - DERM - OMS - FLISR - SCADA - Protection Coordination	- ESS - PV, Fuel Cell - PCS, EMS - Grid/Off Grid	- Geo-Enabled Grid - Spatial Intelligence Asset Mapping - Design - Construction - O&M	- ESS Battery diagnostics (SoC/SoH) - Degraded Cell Detection - Life Prediction	- AI diagnosis of facilities - Camera & Sensor on Vehicle - GIS	- Non-Technical Loss Reduction [Step1] Metering Error diagnosis using AMI Data analysis [Step 2] Reference Meter	- Standard S/W - Value-added Service - IoT PLC - Enhanced Security	- Tariff Management - Customer Service - Distribution GIS

Contents

- 1 LossPro
- 2 AMI 2.0
- 3 BiMs

- 4 ADMS
- 5 ADS / GIS
- 6 MG

World first, only, safe, fast, effective, economical Loss Reduction

1

LossPro

AI-based smart metering power loss reduction solution



KOREA

Annual power generation : 600 TWh

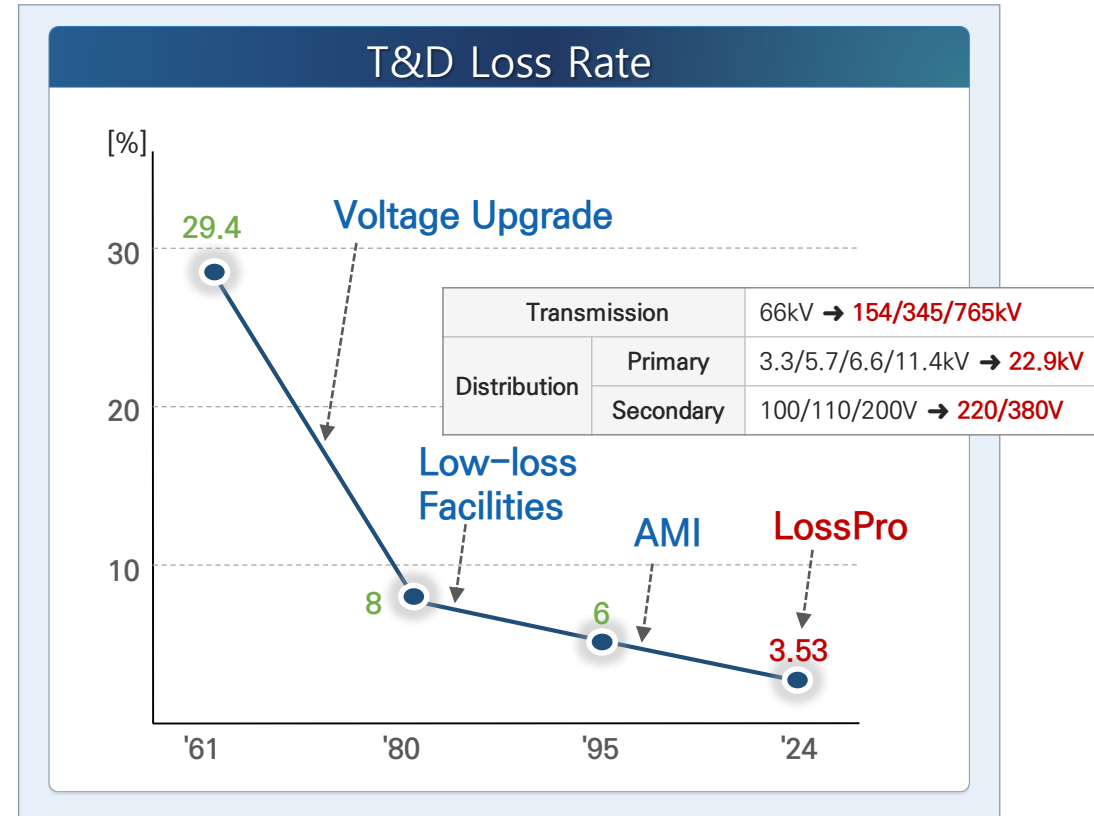
Loss of power during
transmission and distribution : 3.5 %

Generated

Sold

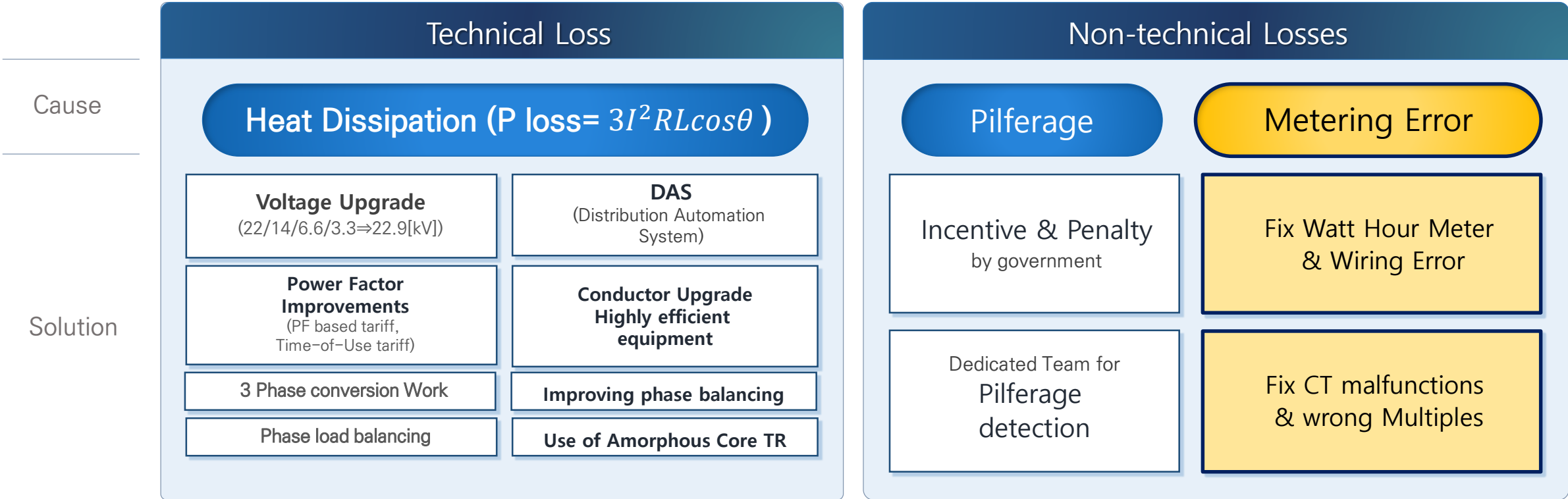
Non-Technical
Loss

Technical Loss



Reducing just **1%p** of annual Power loss(6TWh)

= 1 Thermal plant's Generation = **USD 70mil** saved per year



Costly & long-term

Practically Impossible
And needs national-level
Economic growth

 **LossPro**

The most cost-effective
Tackling the metering error is
the most effective solution



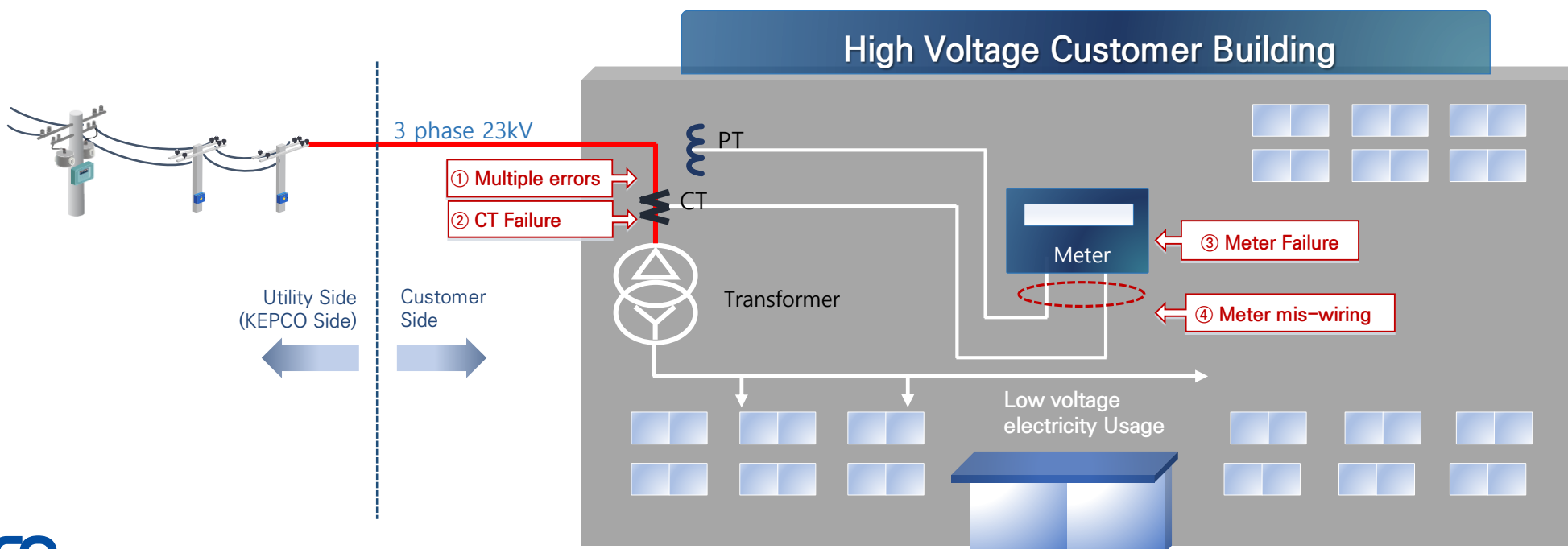


➤ Why Metering Error Management Matters Most

- ✓ In Korea, only 1% of customers (240,000 high-voltage customers) consume approximately 70% of total electricity
 - ☞ Therefore, managing metering errors of high-voltage customers delivers the fastest and most cost-effective loss reduction

Common Metering Error Types

CT Fault, PT Fault, Meter Accuracy, CT Ratio, PT Ratio, 3 Phase Mis-wiring



Step
1

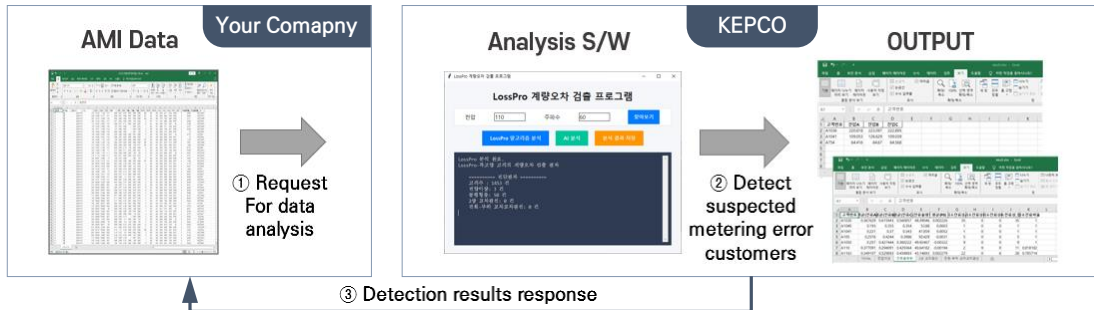
AI Engine Analysis (Algorithm Analysis)

Solution 1 AMI Data Analysis (AI & Algorithm Analysis)

- Analyze AMI data to identify suspected metering error customers(less than 1%)

Detectable Issues

- ① CT Fault ② PT Fault ③ 3Phase Meter Mis-wiring
- ④ Phase loss ⑤ Abnormal voltage

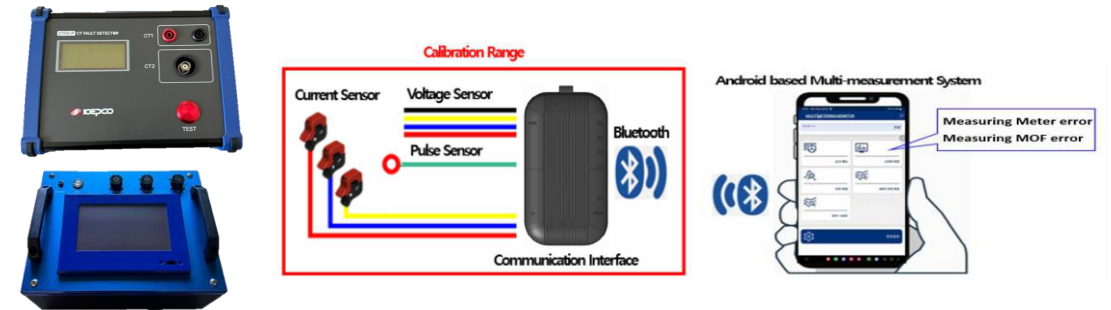


Step
2

Reference Meter

Solution 2

- Testing CT/PT under live conditions is possible without the need for power outage
- Can be applied to all customers even in the absence of AMI data from Solution1



Overseas Field Cases (July 29, 2025)

Method

On-site inspection of suspicious customers and diagnosis

- Utility provided **1,770 AMI** data samples
- 23 suspicious customers** identified by AI engine
- 3 customers** selected for priority on-site diagnosis
- 100% meter faults detected**

Results

100% Meter Faults Detected (Proven with High Accuracy)

Miswiring



Abnormal Voltage

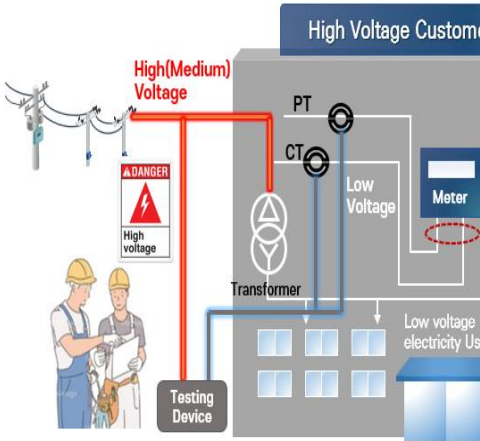
	R상	S상	T상
전압	58.34184	58.59898	64.40066
전류	3.0078	3.15074	3.1067
전압/전류 위상각	25.96289	26.22656	36.08789

CT Defect



As-Is (Current Method)

- High-risk diagnosis using high/medium voltage lines
- Long installation and testing time (30 minutes)
- Diagnosis possible only when load is above 30%
- Low accuracy due to time-delay relay method



(Diagnosis Method) **Now banned in Korea !!**



① Primary current measurement



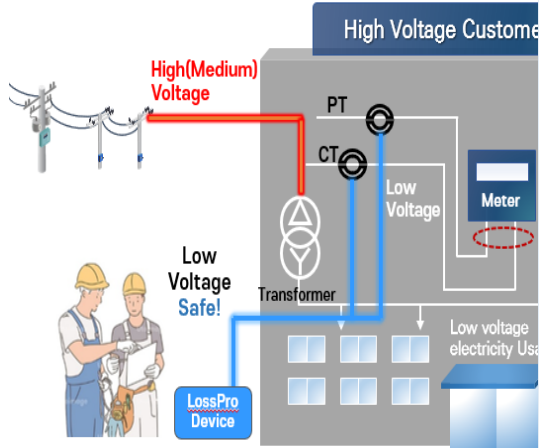
② Secondary current measurement



③ Comparison of primary and secondary

To-Be (LossPro CT Fault Detector)

- Safe diagnosis at low voltage level
- Diagnosis available after clamp installation (within 10 seconds)
- CT abnormality detection possible during live operation or power outage
- Real-time fault detection



(Diagnosis Method) **Safe, Portable, Fast !!**



CTFD(CT Fault detector)



① Connect low-voltage clamp



② Check abnormal status

As-Is (Current Method)

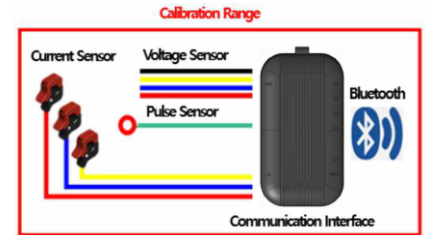
- Active (Reactive) energy measurement
- Meter accuracy test
- Phase angle and harmonic measurement
- CT ratio measurement not supported**
- Size: 210 × 150 × 95 mm**
- Weight: 500 g**
- Output: LCD display**



VS

To-Be (LossPro Multi Reference Meter)

- Active (Reactive) energy measurement
- Meter accuracy test
- Phase angle and harmonic measurement
- CT ratio measurement (fault diagnosis supported)**
- Size: 196 × 98 × 40 mm**
- Weight: 200 g**
- Output: Bluetooth (Android app based)**



Android based Multi-measurement System



Detect all metering errors with a single measurement!!

Existing Functions

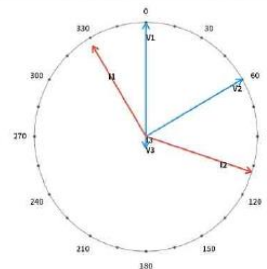
- Active (Reactive) energy measurement
- Meter accuracy test
- Phase angle and harmonic measurement

+



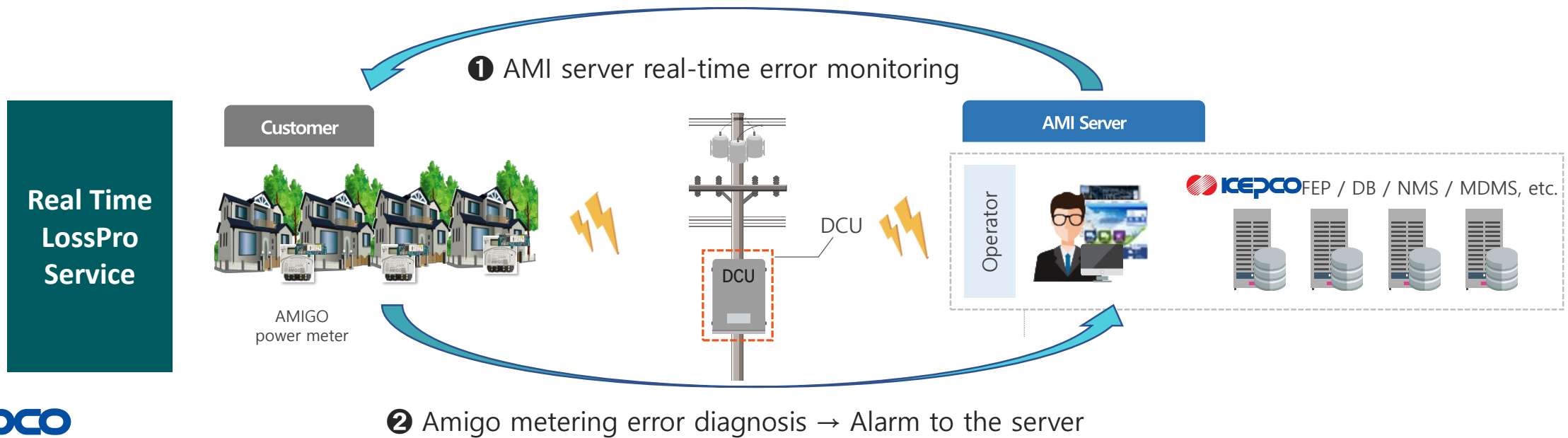
Additional Functions of LossPro RM

- ① Simultaneous measurement of metering data and CT ratio
- ② Phase angle vector diagram generation
- ③ Automatic diagnostic report
- ④ Sensor installation applicable to all meter types



Real Time "LossPro" Service based on AMI 2.0

- ① AMI server : Metering error monitoring in real time
- ② KEPCO Amigo Meter : On-device metering error diagnosis and server alarming



World first manufacturer independent & power utility Driven AMI software

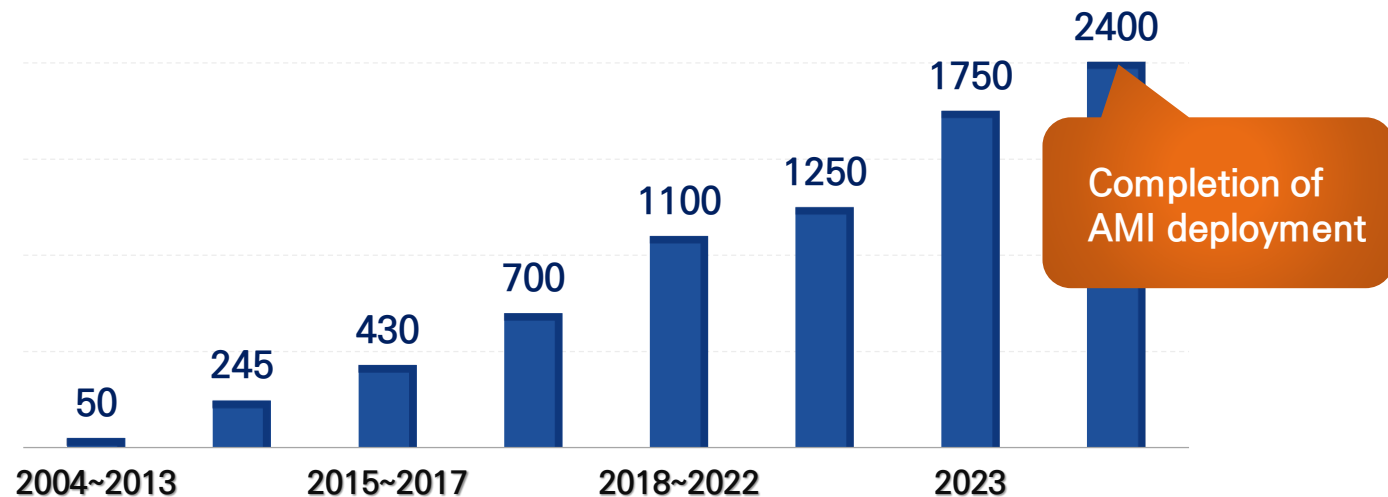
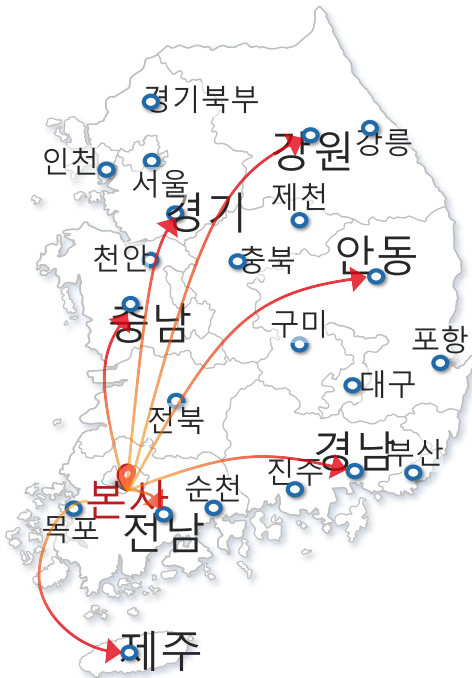
2

AMI 2.0

- **Standard S/W**
- **Value added services**
- **Enhanced security**
- **IoT PLC**

KEPCO's Implementation of AMI2.0

- KEPCO has completed nationwide AMI deployment, covering 24 million customers by 2025
- Proven performance and stability from the meters, to the servers, and to the end users' data access screens over the two decades of development, field application, and experiences



■ Accumulated number of customers on AMI (in 10 thousands)

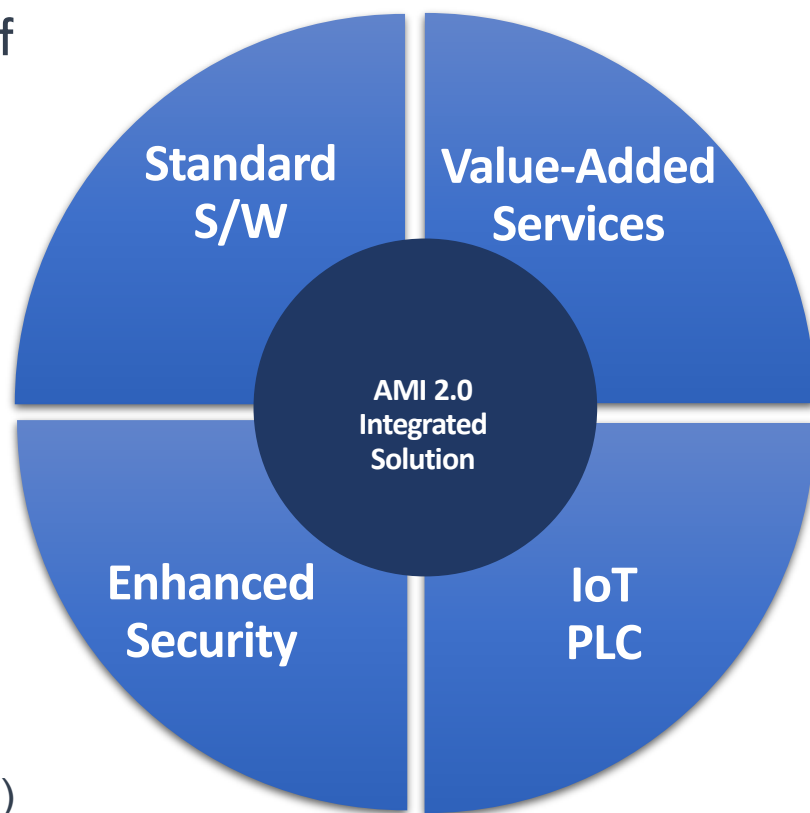
KEPCO AMI is developed by the utility, for the utility, with cost-efficiency in mind

① Efficiency-driven software for power companies, independent of specific manufacturers

- Compatible with all manufacturers and versions
- Simplified upgrade process
- Reduces operational costs

③ End-to End Security application

- Secure communication between Meter ↔ Modem, DCU ↔ Server
- Completed nationwide security application (certification, encryption)



② Development of various services using real-time monitoring data

- Renewable energy monitoring
- Power loss analysis
- Real-time operation management
- Power usage monitoring
- Outage management
- Distribution network monitoring
- LossPro Solution

④ High-performance PLC with world-class reliability

- Enables high-speed, large-volume data transmission(compared to low-speed PLC)
- Simplifies and improves Smart Grid implementation

Background and Necessity

- Various manufacturers and communication types make system compatibility and data integration difficult across local utilities

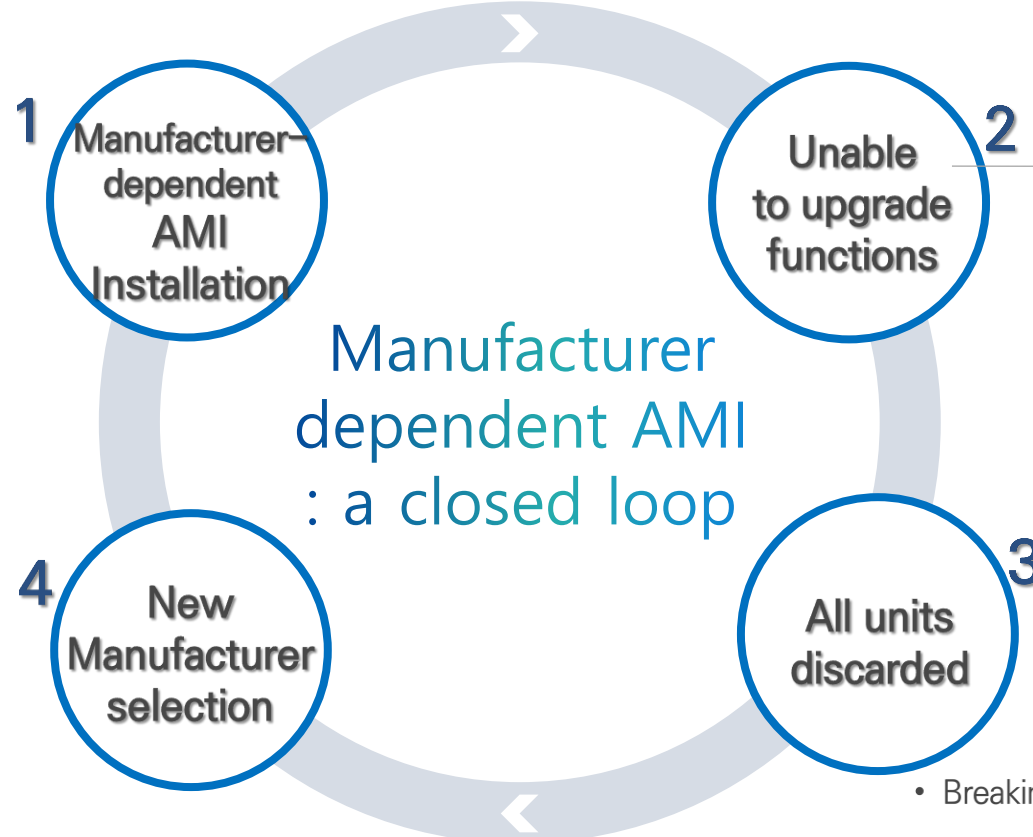
KEPCO's Solution

KEPCO's unified AMI solution connects all regional systems into one platform, enabling seamless data integration and maximizing operational efficiency

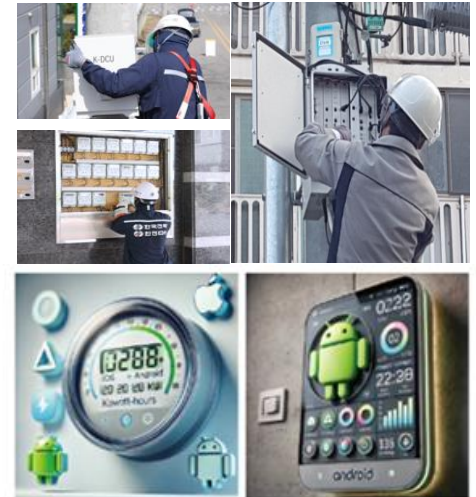
Over 50% of meter device recalls are caused by meter software issues

→ No recall needed when KEPCO's standard software is installed

→ Utilities can upgrade the software directly

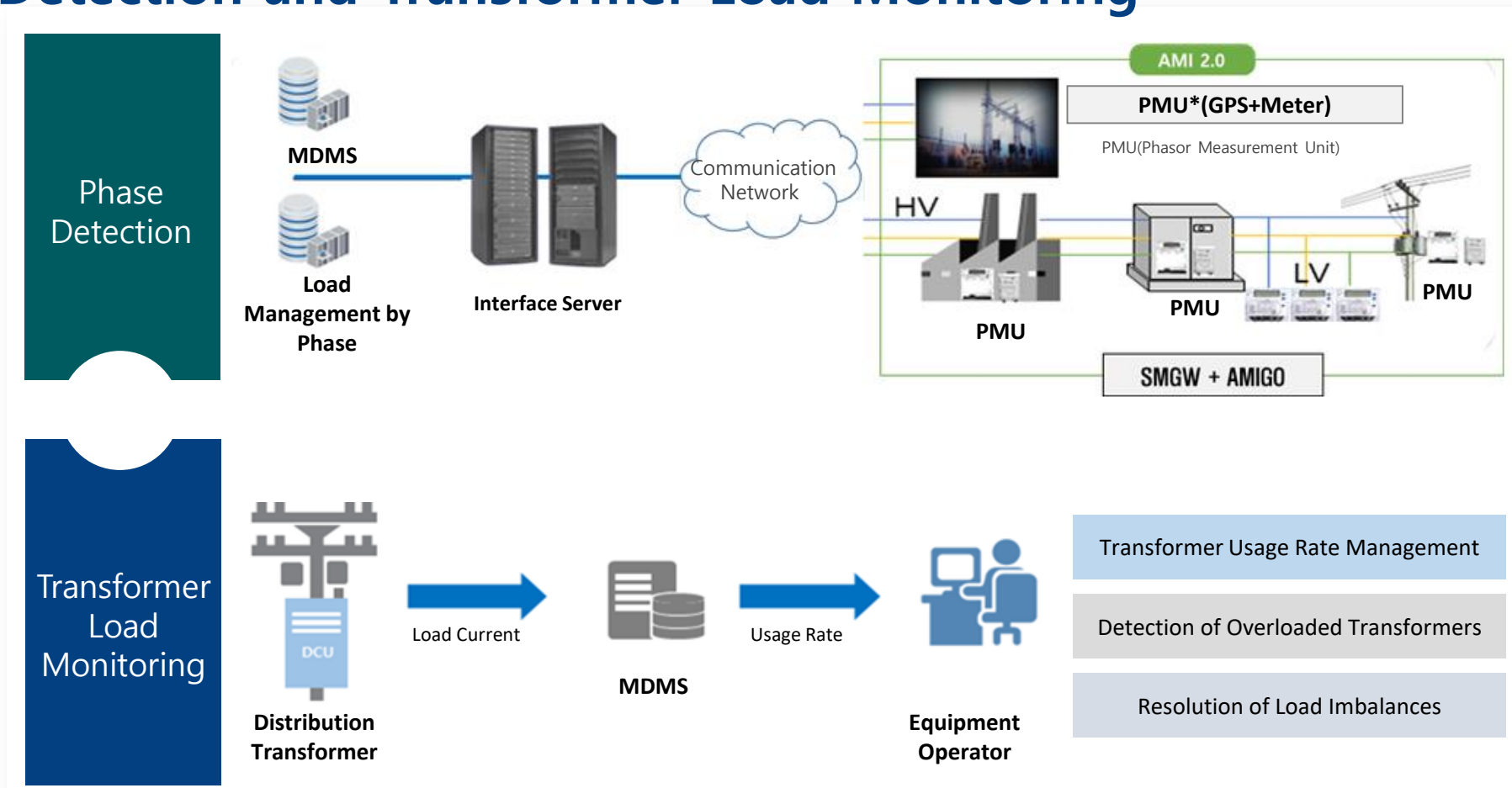


- Required functions (DER, LossPro, outage management)
 - Upgrade is not possible

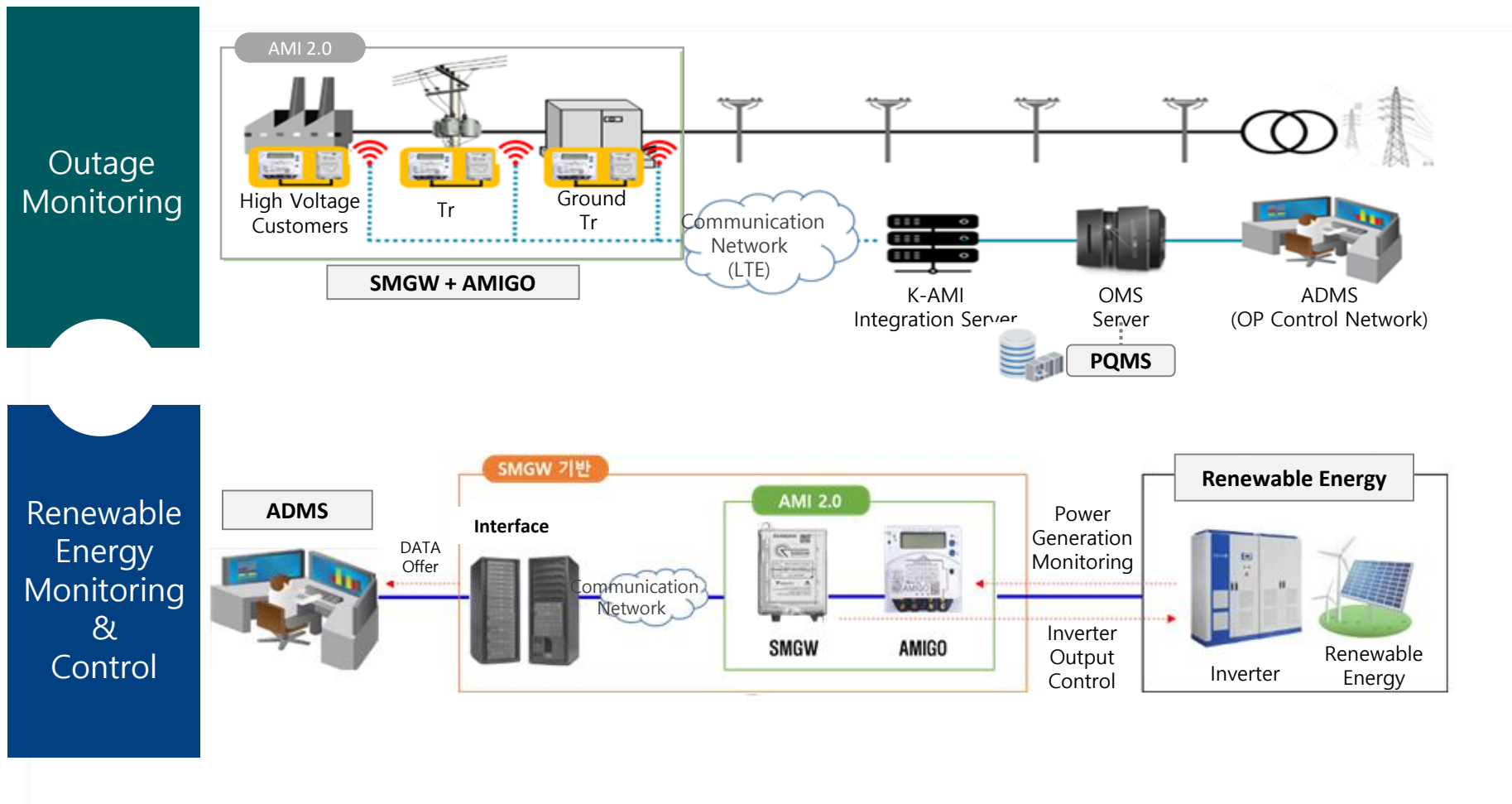


- Breaking Free from Manufacturer Dependency

② Various Services : Detection and Transformer Load Monitoring

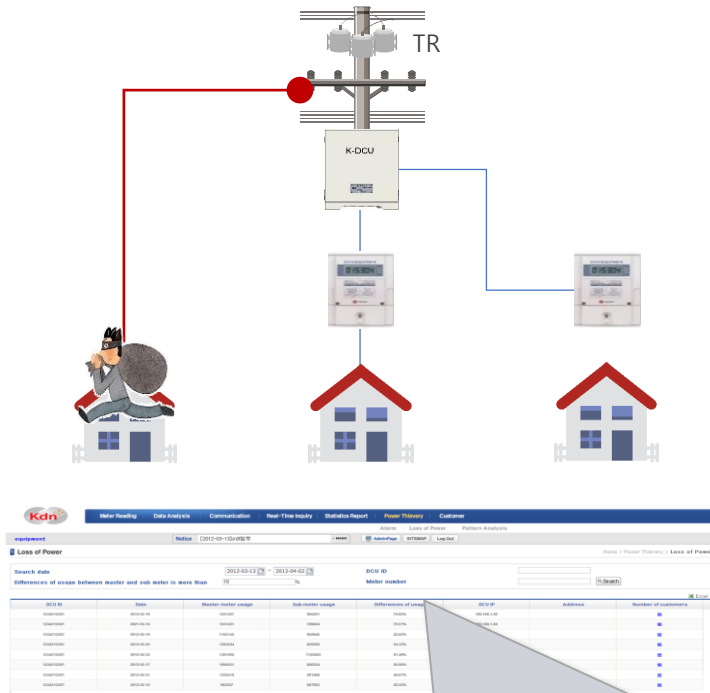


② Various Services : Outage Monitoring and Renewable Energy Monitoring & Control



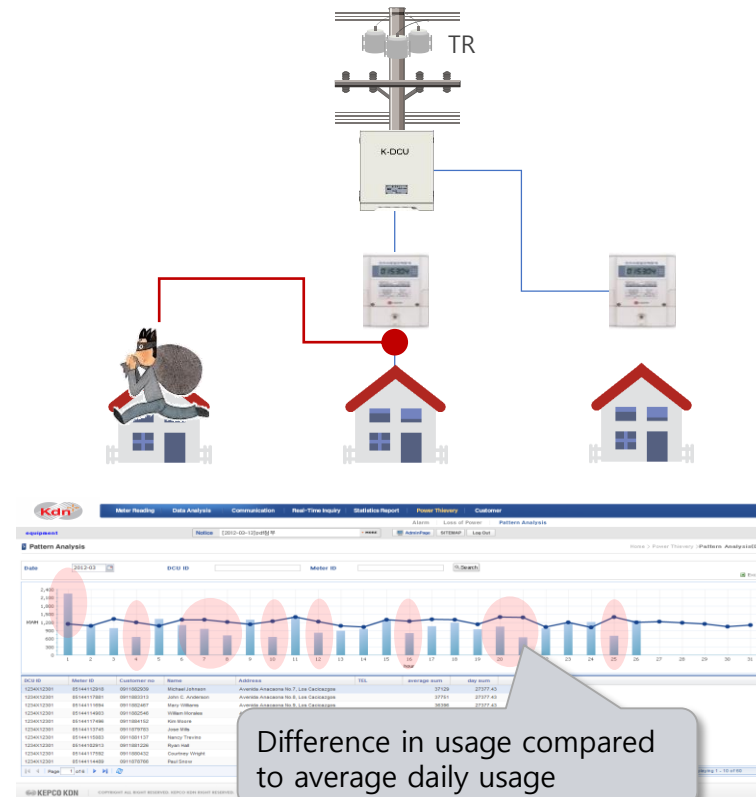
② Various Services : Unauthorized Usage Monitoring via Line Status Detection

Analyzing power usage differences



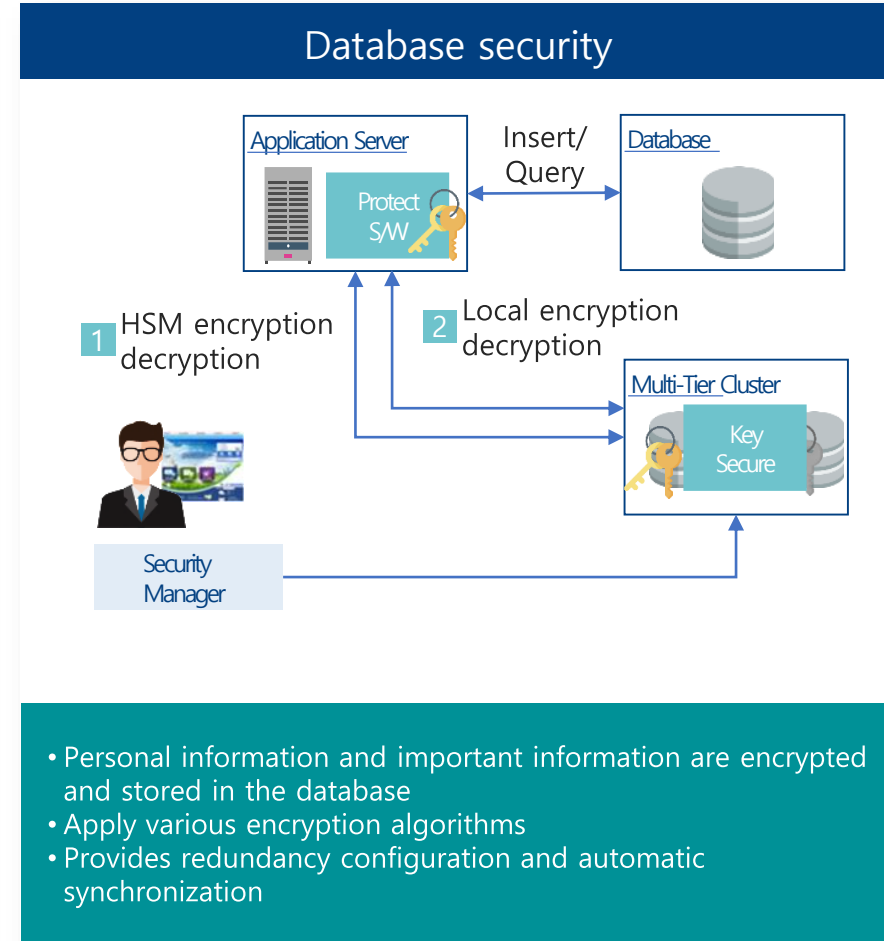
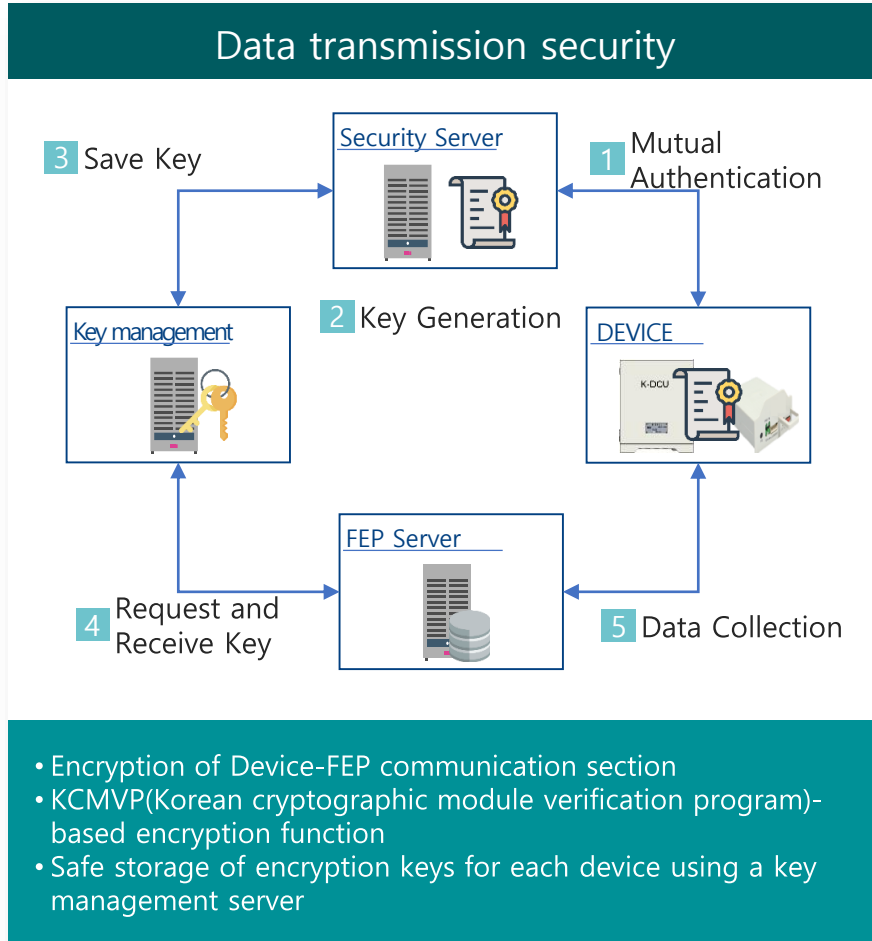
The loss ratio is calculated based on the difference between the usage of the master meter and the sum of usage of the meters belonging to the master meter.

Analyzing power usage patterns

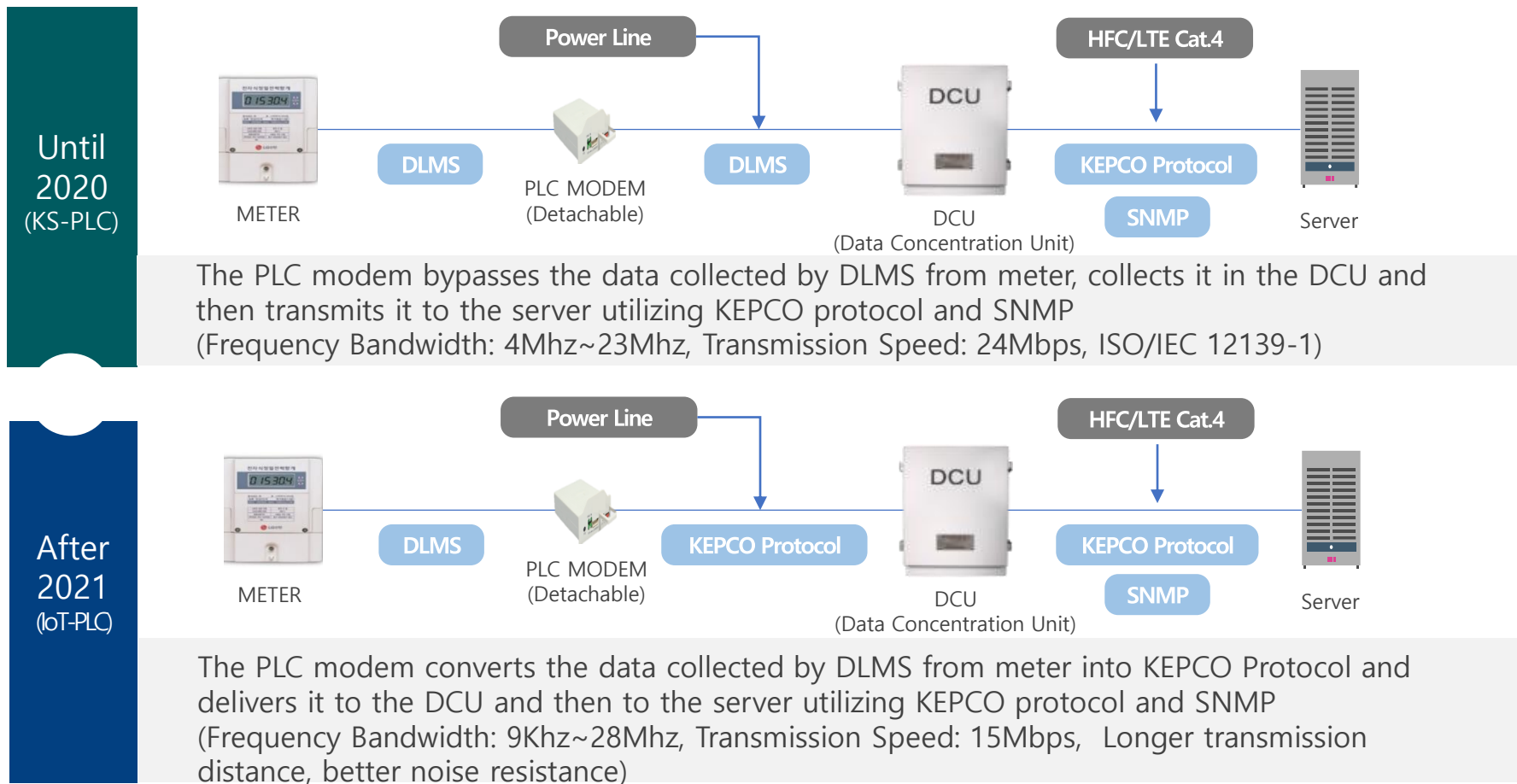


Difference in usage compared to average daily usage

③ Ensuring AMI security



④ The World's Fastest High-Speed IoT-PLC



The background of the slide is a deep blue with intricate, swirling patterns that resemble ripples in water or the flow of data. A bright, glowing sphere is positioned in the center, partially obscured by the swirling lines. The overall effect is a sense of dynamic movement and technological sophistication.

Kyrgyzstan AMI Deployment

108,719

Single-phase Meters

Includes PLC Modem



16,281

Three-phase Meters

Includes PLC Modem



125,000

Meter Protective Enclosure

Single-phase / Three-phase



2,500

Data Concentrator Unit (DCU)

Built-in 4G Router



Other Materials

**Transformer Monitoring Device and
Current Probe Set**

Spare 3G Modems Provided for Areas with Poor
PLC Communication Coverage

50

**Meter Commissioning and Handheld
Terminal for Commissioning**

Supports Mobile CAS Work App



Approved and Validated Solution — Certification Completed



Type Approval

Kyrgyzstan Center for Standardization and
Metrology / 3 types: Single-phase, Three-phase,
and CT
(2024.07.25)



EAC Certification (DCU)

Kyrgyzstan Center for Standardization and
Metrology / DCU
(2024.11.01)



DLMS Certification

DLMS UA / 3 types of meters: Single-phase, Three
phase, and CT
(2024.09.26)

LossPro is

A "smart metering diagnostic process" that packages KEPCO-developed diagnostic technology to improve metering errors related to non-technical power losses of extra-high-voltage customers

- Field demonstration with KEPCO expert support, followed by equipment provision (1 set of 3 devices)

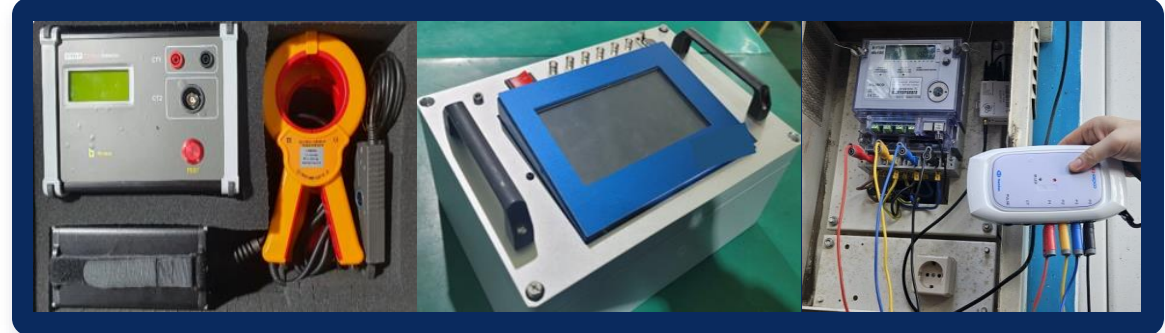


Solution 1 — AI Analysis

KEPCO-developed program analyzes AMI data and automatically identifies customers suspected of metering errors (distinguishing CT failure, PT failure, and miswiring)

As-Is (Conventional Method)

- CT Installed Directly on High-voltage Lines → Very Dangerous
- Inspection Only During Outages → Long-duration Power Outage
- Inspection for All Customers



Solution 2 — On-site Diagnosis

Easy diagnosis of metering errors on the low-voltage side at customer facilities — the world's first and only solution without dangerous extra-high-voltage work

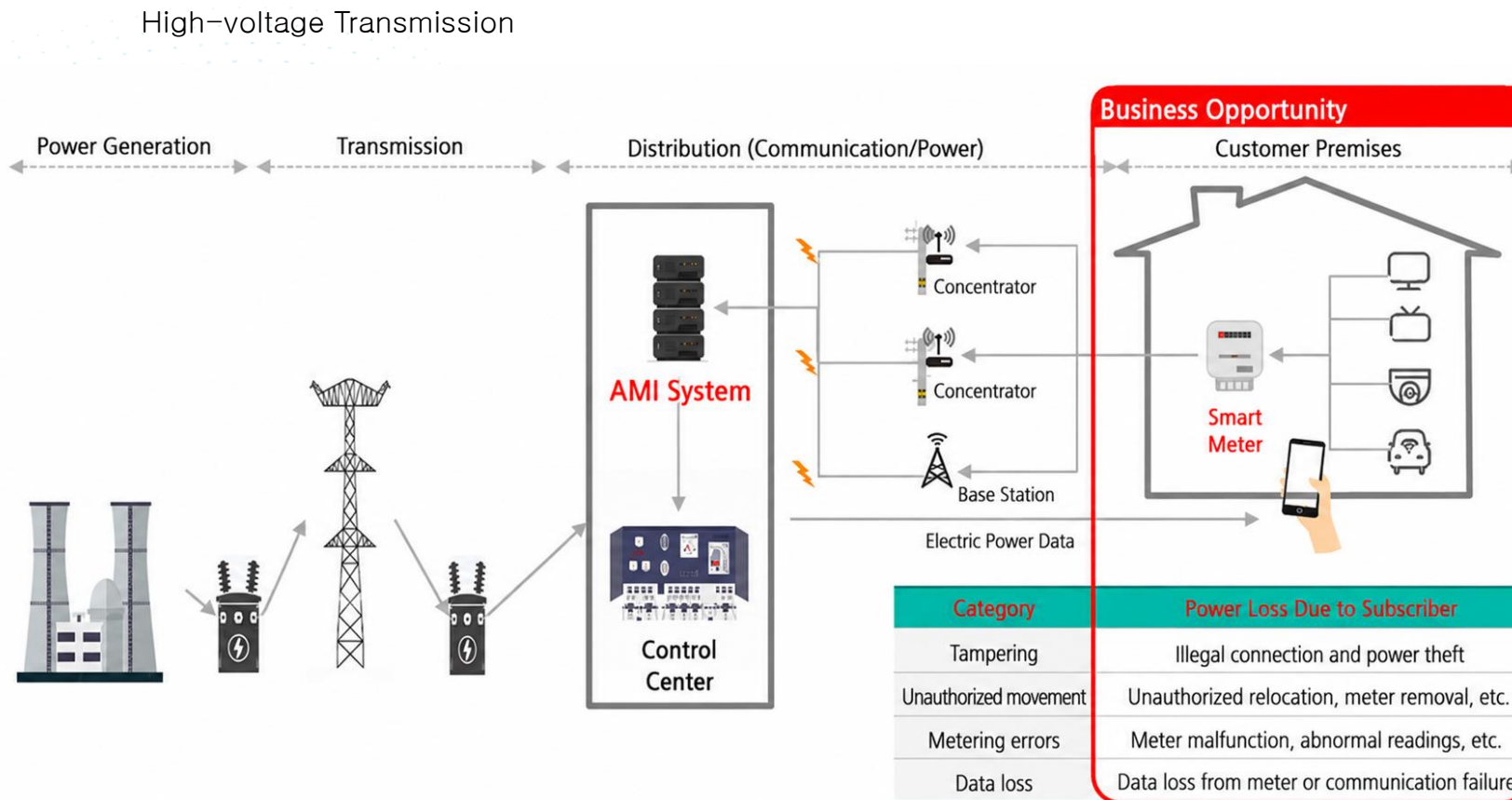
- ✓ **To Be (LossPro)** Low-voltage Side Inspection Under Live-line Conditions (Safety Secured)
- ✓ Diagnosis Completed Within 10 Minutes Using Compact Equipment of About 3 kg
- ✓ Diagnose Only Suspected Customers (About 1% of Total) → Safe
· Portable · Fast

The background of the slide is a deep blue with a complex, abstract pattern of swirling, concentric lines and numerous small, bright blue dots, resembling a stylized galaxy or a digital data field. A faint, glowing globe is visible in the center, partially obscured by the swirling patterns.

Tajikistan AMI Operations Center Establishment F/S

Establishment of a Smart Metering-based Power Data Collection System

AI Based Digitalization
In Power Grid



Scope

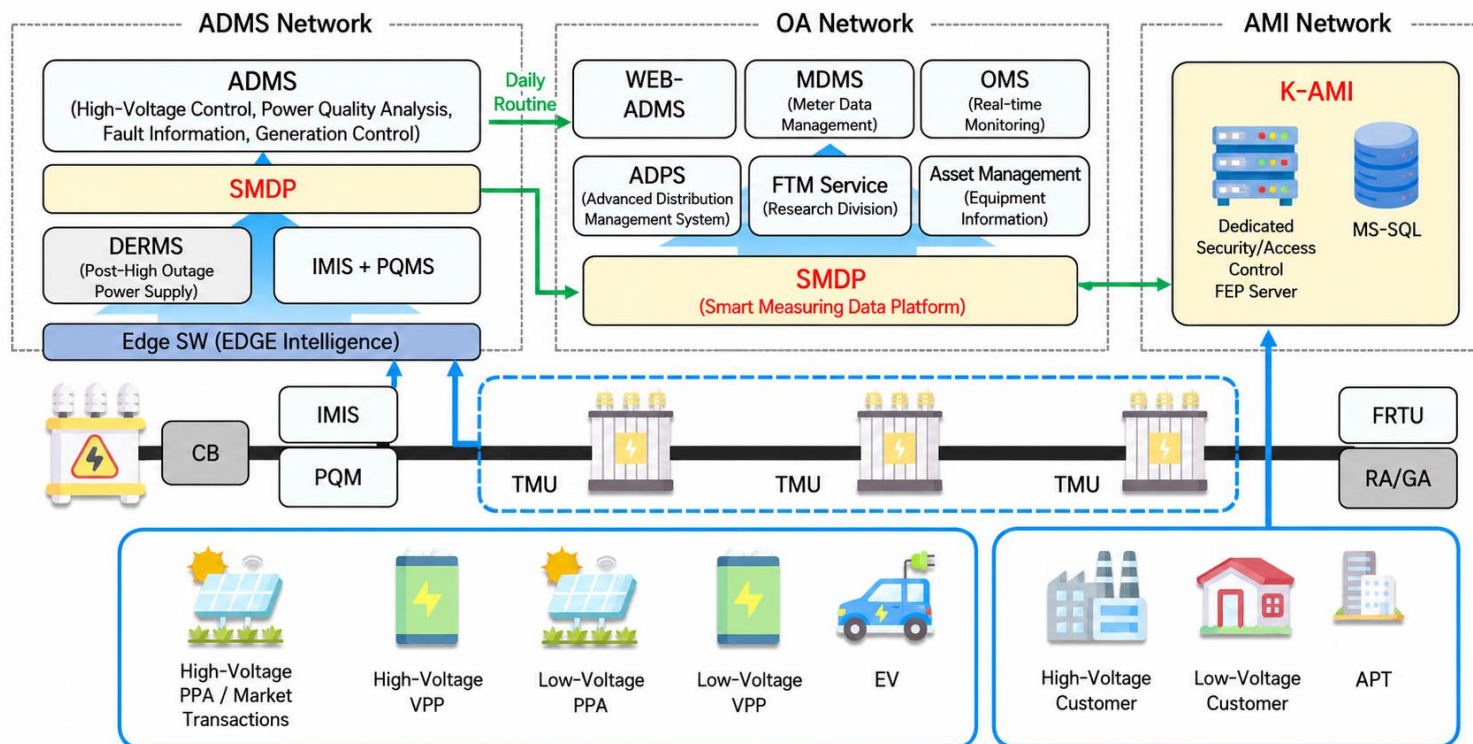
- Approximately 50,000 Households in the Pilot Area
- Smart Meter Installation
- DCU Installation
- Establishment of Remote Meter Reading Infrastructure

Expected Effects

- Verification of Normal Operation of the Smart Metering Platform
- Automatic Collection of Power Consumption Data
- Reduction in Meter Reading Errors and Fraudulent Readings
- Acquisition of Usage Pattern Data
- Establishment of a Basis for Detecting Faults and Abnormal Usage

Establishment of an Integrated AMI System and Central Control Center

AI Based Digitalization
In Power Grid



*SMDP (Smart Measuring Data Platform) : AI-based continuous data platform, TMU (Transformer Monitoring Unit)



Integration Targets

- Existing HES
- Customer Information System
- Billing and Settlement System

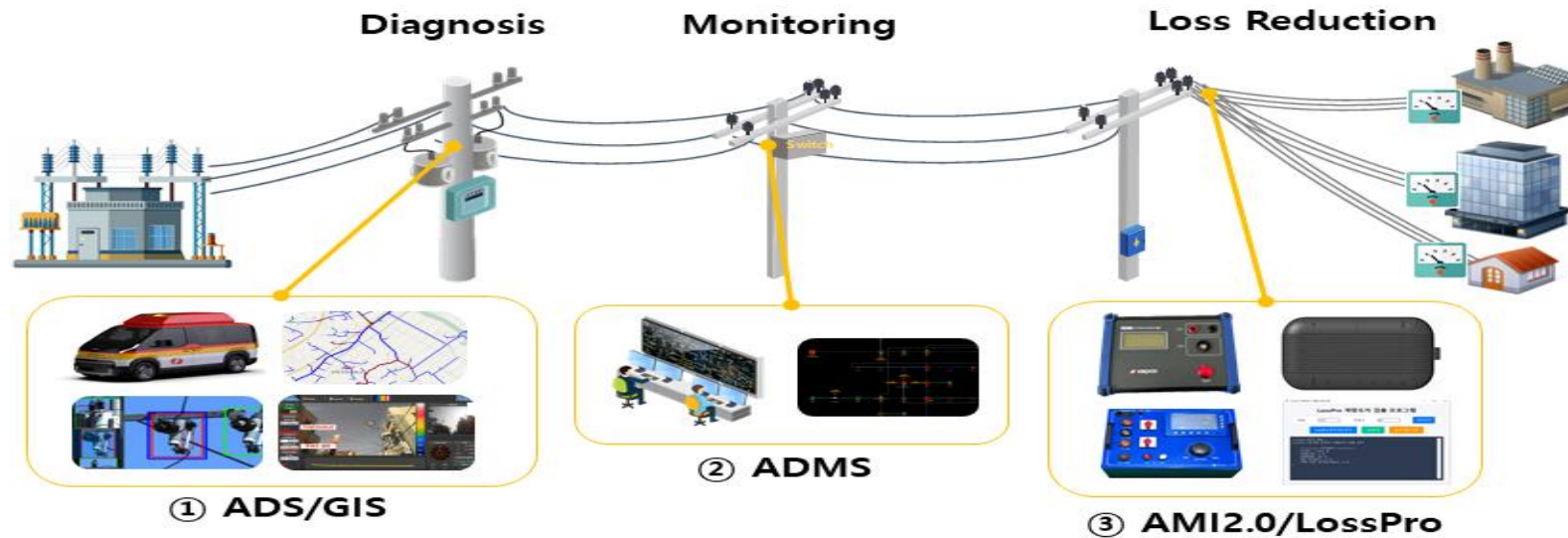
Control Functions

- Real-time Usage Monitoring
- Loss and Abnormal Usage Analysis
- Fault and Communication Status Management
- Data Analysis by Region and Customer
- Capacity for 2 Million Households Nationwide
- Relay Control for Households with Unpaid Bills
- Seasonal Power Limit Control

The background of the slide is a deep blue with a complex, abstract pattern. It features numerous small, glowing white and light blue particles scattered throughout. Overlaid on these are several concentric, glowing blue arcs that resemble orbits or energy fields. In the center of the slide, there is a faint, glowing sphere with a textured surface, possibly representing a planet or a core of energy. The overall effect is one of high-tech, futuristic, or scientific themes.

Uzbekistan KGGTF

Digitalization in Power Grid



No.	Tech	Description	Keyword
1	ADS	AI-based Diagnosis System for facilities during vehicle inspection and collection of pole location data	Automatic Diagnosis
2	GIS	Establishment of Geographic Information System using pole location coordinates	Facility Management
3	ADMS	Distributed energy integrated real-time grid optimization and automatic fault detection	Real-time Monitoring
4	AMI2.0	World's first utility-led AMI S/W model (Distributed to 22.5 million households in Korea)	Remote Metering
5	LossPro	AI-based smart metering power loss reduction solution (S/W and H/W)	Power Loss Reduction