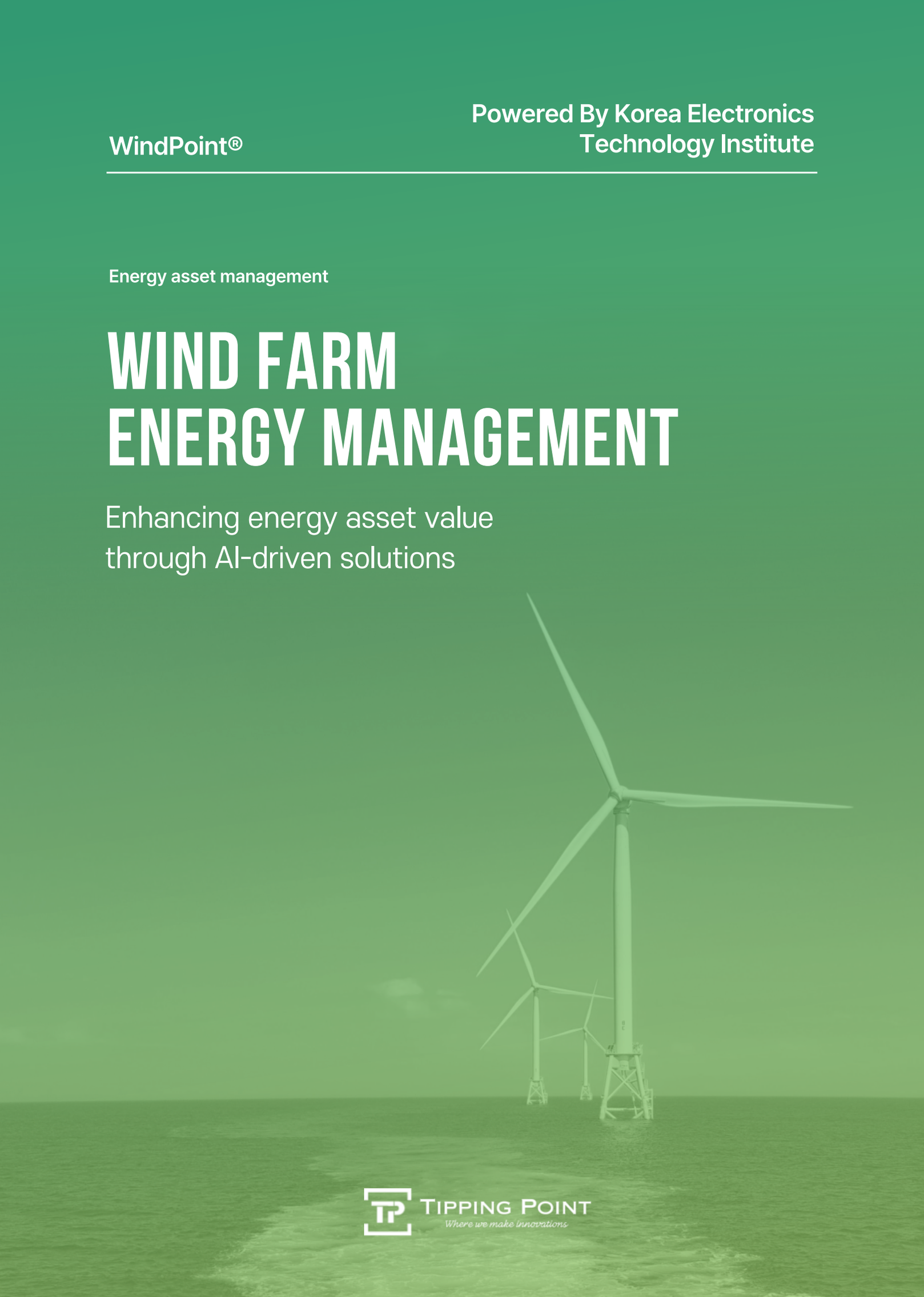
WindPoint®

Powered By Korea Electronics Technology Institute

Energy asset management

WIND FARM ENERGY MANAGEMENT

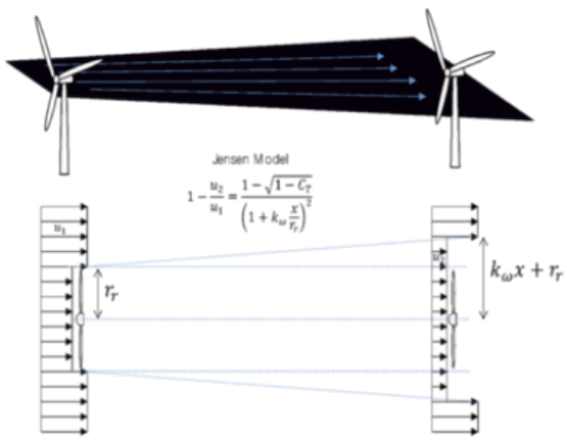
Enhancing energy asset value through AI-driven solutions



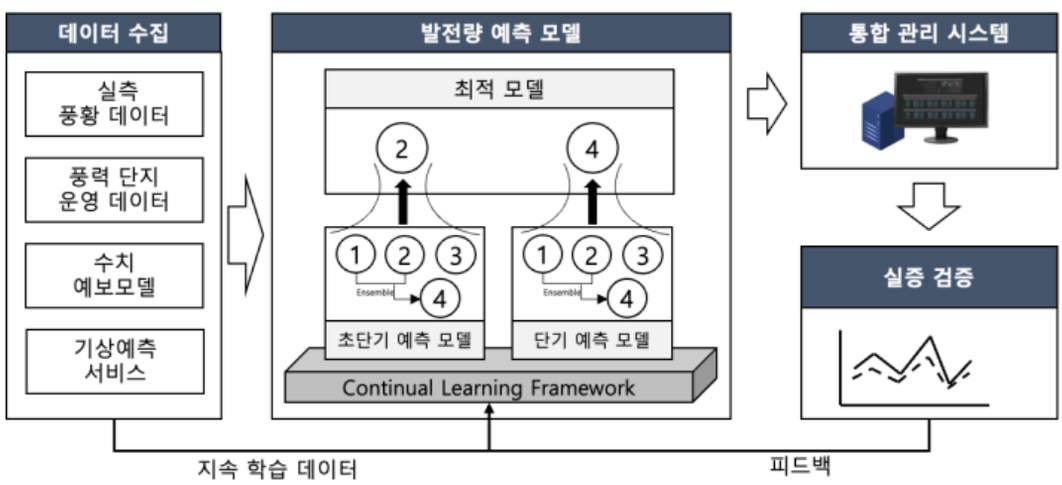
TIPPING POINT
Where we make innovations

WindPoint®

Wind Power Generation Forecasting



WindPoint® utilizes **real-time wind condition data and estimated wind input** which varies according to the dynamics of a wind turbine to enhance wind power forecasting.



By integrating various forecasting models and dynamically selecting the best-performing model, WindPoint® has implemented a **Continual Learning Framework** for optimal forecasting accuracy.

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Wind Power Generation Forecasting

The uncertainty of wind power generation poses a significant threat to Grid stability. So Grid system operators must accurately predict wind power generation to establish reliable power generation plans. This forecasting is an obligation of power generation company, and failing to meet the contracted amount of generation on each time can result in financial losses. Therefore, accurate wind power forecasting is a crucial energy asset management technology that maximizes the utilization rate of wind power facilities.

Maximizing Wind Power Utilization

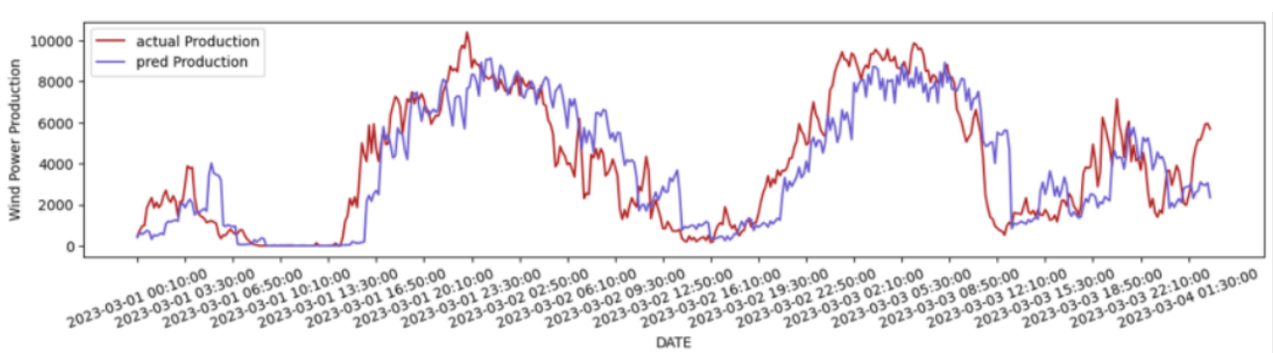
The electricity market will require increasingly precise operations in the future. If wind power generation forecasts are inaccurate, discrepancies in committed production volumes can lead to penalties in electricity trading and additional risks requiring supplementary facilities. Conversely, highly accurate wind power forecasts enable power generation company to supply the promised power to the market, support efficient decision-making, and optimize the cost-effective operation of auxiliary facilities such as energy storage system (ESS), ultimately maximizing profitability.

Wind Power Forecasting Considering Turbine Characteristics

The current accuracy of wind power forecasting often falls short of industry expectations. Traditional black-box estimation models treat wind farms as a single generator, relying solely on meteorological forecast data to estimate the output. In contrast, WindPoint® factors in the dynamics of individual wind turbines within a wind farm, using AI to calculate site-specific wind characteristics. This approach improves forecasting accuracy to meet the precision required in power markets.

A Core Technology for Energy Asset Management

WindPoint® leverages its wind power forecasting technology as a fundamental tool for energy asset management. It provides ultra-short-term forecasts for ESS charging and discharging control and establishes reference values for wind power output control. As forecast accuracy improves, energy asset utilization efficiency increases accordingly.

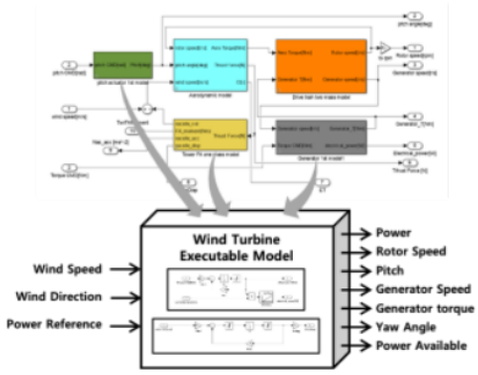


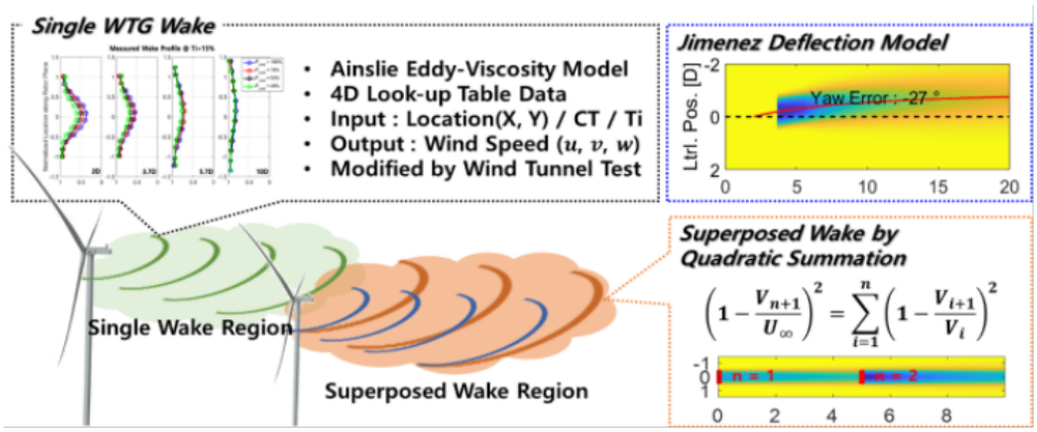
WindPoint®

Individual Wind Turbine Control

WindPoint® creates a virtual wind farm model that approximates and validates actual wind turbine operations, allowing for high-speed computation and simulation.

To achieve this, WindPoint® modeled the wake effects of individual turbines based on their operational and atmospheric conditions. It also verified theoretical principles through wind tunnel experiments and refined wake deflection and interaction modeling.





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Individual Wind Turbine Control

By adjusting wind farm output to meet the power grid demands, this approach minimizes mechanical loads on individual turbines, reducing long-term maintenance costs.

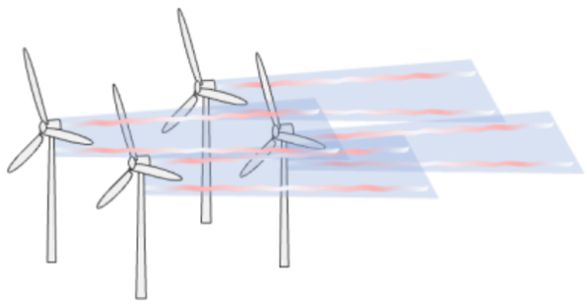
The Need for Individual Wind Turbine Control

Future wind power generation must evolve beyond the current system. Rather than relying solely on wind speed as a variable, it must dynamically adjust the power generation in response to various external environmental changes. When power grid imbalances arise due to fluctuations in supply and demand, wind farms should be able to increase or decrease generation accordingly. Effectively managing and controlling numerous wind turbines under these conditions is a critical task.

The Conventional Approach: Uniform Wind Turbine Control

Under normal grid conditions without specific constraints, individual wind turbines typically operate at maximum output. However, when power production needs to be curtailed, wind farm operators often reduce the output of all turbines proportionally or manually adjust specific turbine outputs. This approach does not account for variations in wind conditions experienced by each turbine, leading to uneven mechanical loads and potential stress concentration on specific turbines.

Minimizing Mechanical Loads Through Turbine-Specific Control



WindPoint® employs a load-balancing control strategy across all turbines within the wind farm. The wind farm controller adjusts the output of front-row turbines while ensuring that mechanical loads are distributed evenly. This control strategy alters the wind conditions applied to the downstream turbines, which are then regulated in the same manner as the upstream turbines. As a result, the wind farm operates in a way that prevents excessive mechanical stress on specific turbines. The wind farm controller, using high-performance computing, continuously predicts changes in wind propagation and turbine dynamics to optimize turbine performance. By regulating farm-wide output while distributing loads evenly, this approach reduces long-term maintenance costs and improves overall wind farm utilization.

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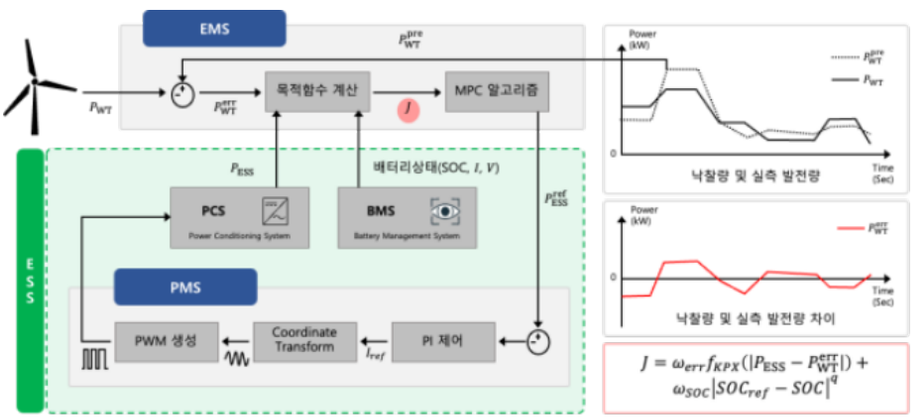
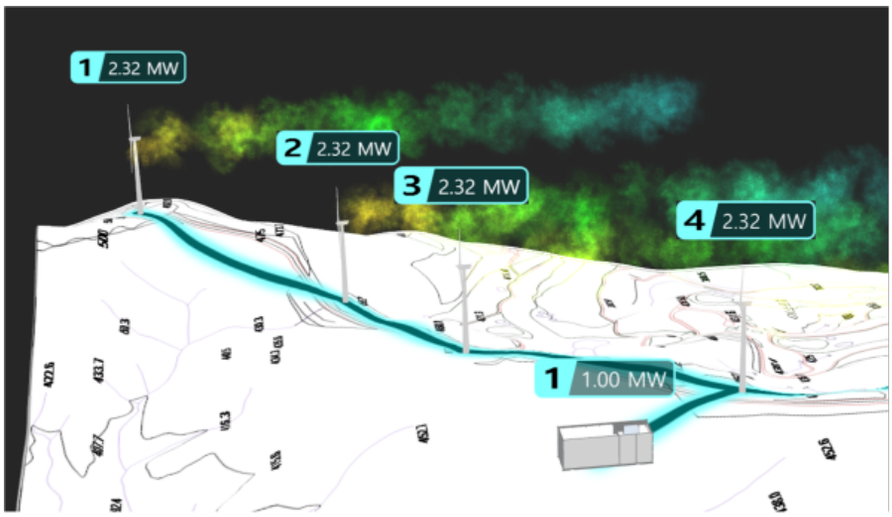
Energy Storage System (ESS) Control



WindPoint® manages ESS charging and discharging **based on the contracted and actual generation output**, ensuring that storage capacity remains optimized.



By rapidly predicting deviations between planned and actual generation, WindPoint® **dynamically adjusts ESS charge levels in real time** to align with wind power conditions.

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Energy Storage System (ESS) Control

Since wind power relies on natural energy, it inherently has variability in power generation. But to sell the generated electricity, only the pre-committed amount must be supplied through the power market. Achieving this requires both accurate forecasting and an efficient ESS strategy to compensate for inevitable forecasting errors. While larger ESS capacity is preferable, it is crucial to efficiently operate ESS of an appropriate capacity for economic feasibility. With WindPoint®, ESS operation can be managed efficiently and cost-effectively.

The Role of ESS in Wind Power Generation

The variability of renewable energy sources poses a significant challenge to the stable operation of the power grid. Since the power system stability depends on maintaining a precise balance between supply and demand, renewable energy operators must commit to their expected production in advance. However, these forecasts inherently contain errors, resulting in gaps between the predicted and actual amount of generation. That is why the role of ESS in mitigating these discrepancies is just as crucial as improving forecast accuracy. Although operating a large-capacity ESS may seem ideal, it is essential to efficiently manage the given ESS capacity in terms of financial sustainability.

AI-Driven Optimization for Cost-Effective ESS Operation

In wind power generation, backup operation using an ESS to compensate for output variability is gaining attention. This means that ESS is charged when power generation exceeds the planned amount and is discharged when generation falls short of the plan. However, determining the appropriate energy level is a challenge beyond human capability. To address this, WindPoint® utilizes wind power forecasting technology and state estimation technology to monitor the ESS status in real time. By continuously determining the required state of charge (SOC) before controlling charging or discharging, it ensures optimal conditions for the next phase. This approach maximizes ESS utilization, contributing to improved profitability.

Pre-Planned ESS Operations

The ESS installed in wind farms operates under the Renewable Portfolio Standard (RPS) and is required to charge and discharge at designated times to qualify for Renewable Energy Certificates (REC). Similarly, when operating ESS for power trade, charging and discharging mostly follow predefined rules and schedules.

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Tipping Point Co., Ltd. is an energy ICT specialized research spin-off
established with investment from the Korea Electronics Technology Institute (KETI).

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