

The Future of
HVAC is Here:

The Power of *Ai*

AI is bringing energy savings, more comfortable environments, and streamlined maintenance to the HVAC industry. In this white paper, we will delve into the advantages AI is creating for HVAC customers and professionals.



MULTI V i White Paper Contents

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Introduction

From finance and logistics to autonomous driving and healthcare, the focus on Artificial Intelligence (AI) has infiltrated nearly every industry. The application of AI in many facets of our lives is bringing convenience and efficiency we've never experienced before. The HVAC industry is no exception to this trend, as AI enables HVAC systems to save energy, create more comfortable indoor environments, and streamline maintenance processes. Also, let's not forget that energy-saving HVAC systems with AI not only reduce electricity bills but also help the environment. AI is delivering these advantages and transforming the HVAC industry. In this white paper, we will explore the value that AI brings to HVAC.



Energy-Saving



Comfortable Indoor Environment



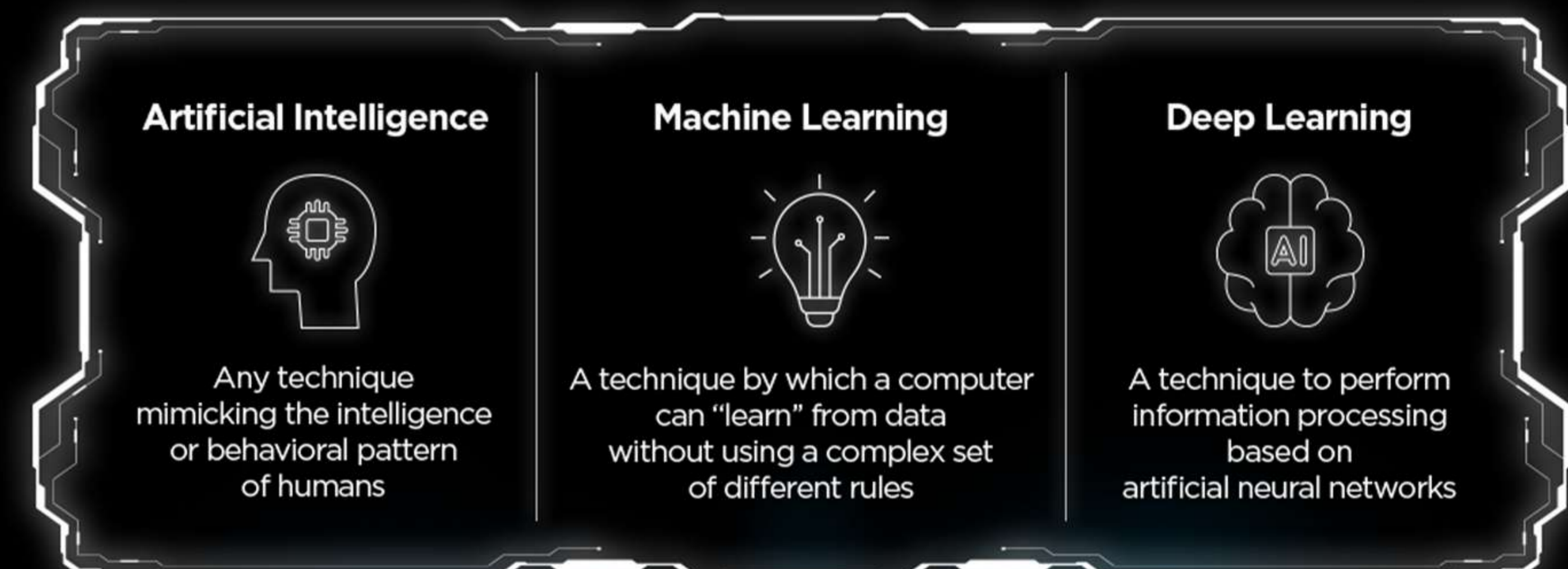
Convenient Maintenance Services

What Does AI Mean for the HVAC Industry?

In short, AI allows HVAC systems to think and learn through human-like intellectual capabilities. The integration of AI, machine learning, and deep learning has revolutionized the traditional HVAC landscape. Machine learning allows systems to learn from data without complex rules, while deep learning processes information using artificial neural networks.

HVAC systems equipped with AI algorithms autonomously learn from data, enabling real-time adaptation and optimization. For example, the MULTI V i Variable Refrigerant Flow (VRF) solution analyzes factors like weather information, occupancy trends, and operation patterns to deliver a personalized HVAC experience. AI-driven HVAC systems also offer personalized comfort, energy savings, proactive fault detection, and predictive maintenance.

In this way, the continuous learning process ensures long-term energy efficiency, reducing operational costs and environmental impact. How does this translate to higher performance and better customer satisfaction? Let's look at each of these advantages provided by AI through the capabilities offered by the MULTI V i.

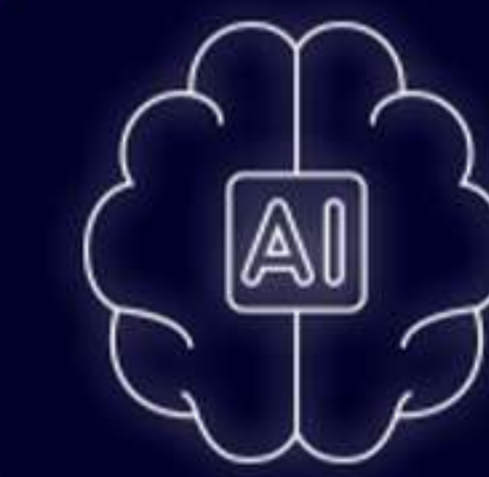


How Do AI-Powered Energy Savings Benefit You?

Each building has unique and complex requirements for its HVAC system. To maximize and maintain optimal operation and energy efficiency, an HVAC system must be able to detect and adapt to its environment. How is it possible for an HVAC system to understand its surroundings and react accordingly? This is how AI makes all the difference.



The AI engine automatically controls the system for optimal operation



Data collected by AI algorithms help reduce energy consumption



AI gathers power usage data to establish a comprehensive database

Optimized for Power-Saving Operation

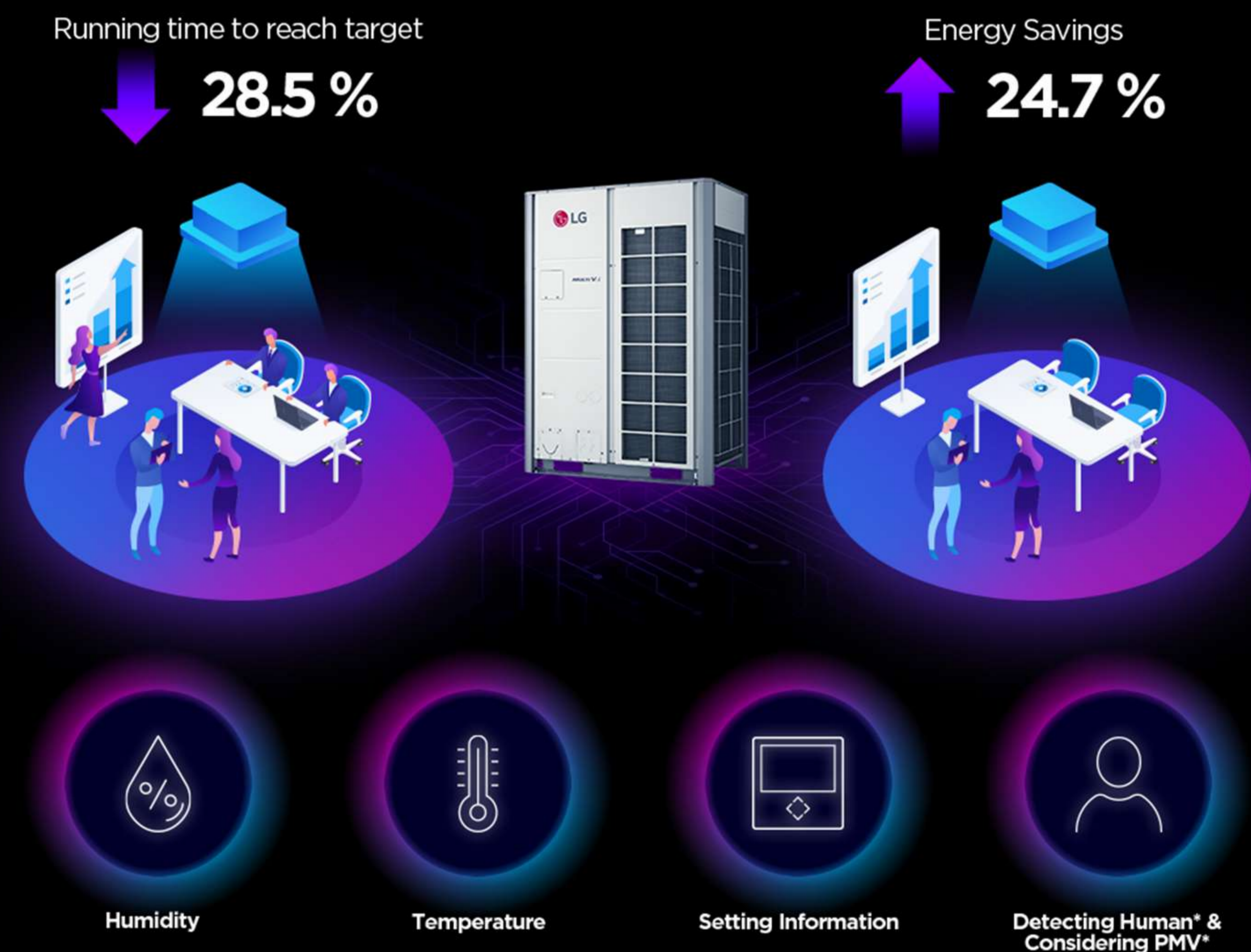
The AI engine of the MULTI V i system uses something known as unsupervised learning to gather and store data on indoor temperature, indoor humidity, and set temperature from each indoor unit. Unsupervised learning is the process of a system identifying hidden patterns in data sets and learning on its own without specified label data. In this way, unsupervised learning allows the system to learn similarly to the human brain. AI Smart Care uses advanced unsupervised learning with K-means clustering to assign a specific 'clustering level' to each unit. Based on this level, the AI engine automatically controls the optimal operation mode, airflow, and other settings.

The system takes the stored data such as occupancy, temperature, and humidity into consideration to determine how the operation can be managed most efficiently and adjusts automatically. By operating based on this data, the system is able to reduce the time it takes to reach the target temperature by 28.5% while also reducing energy consumption by 24.7%.*

* This is the result from an internal test that follows KS Test Standards (24HP model of MULTI V i / KS B ISO 15042 : 2006).

* Results may vary depending on the applied model, local temperature, and environment.

During the initial 10 minutes of operation, the AI engine focuses on optimizing cooling or heating performance to enhance indoor comfort. Afterward, while maintaining a pleasant environment, it switches to power-saving mode to prevent unnecessary energy consumption. This ensures both comfort and energy efficiency throughout the operation of the MULTI V i system.



* The Human Detection Sensor is an optional accessory (PTVSA0) and it can be applied only to the CST Panel (PT-A*GW0).

* Predicted Mean Vote (PMV) is a scale to indicate cold and warm feelings felt by humans.

Understanding Energy Consumption Clearly

The AI Engine of the MULTI V i system efficiently captures and stores energy usage data from both outdoor and indoor units. This data is obtained during regular operation as well as AI Smart Care operation, utilizing the embedded 'Smart Plug logic' in the outdoor units.

Leveraging the collected data, sophisticated AI algorithms generate an Energy Consumption Estimation Model. With the help of eight hours' worth of operational data, the AI Smart Metering feature can estimate total energy savings over various timeframes, such as daily, weekly, monthly, and annually. Users can easily access this valuable information on the controller screen, gaining a comprehensive understanding of the MULTI V i system's energy efficiency performance.

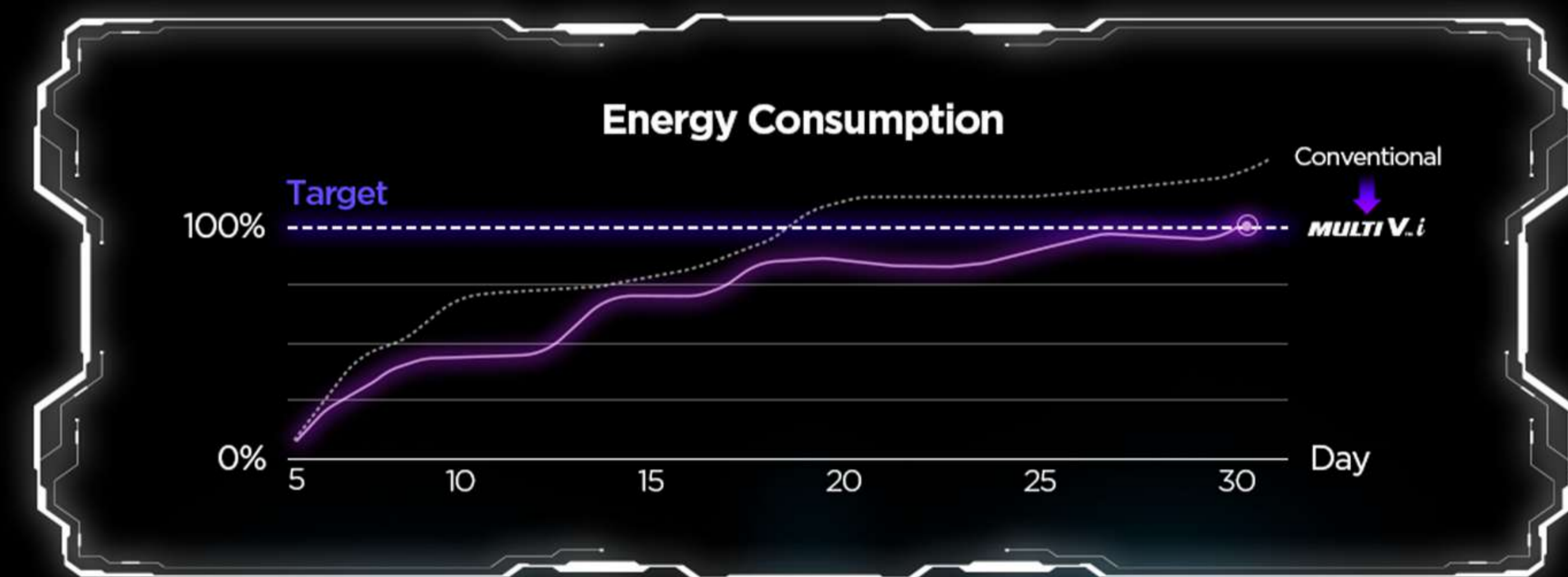
Collecting product operation data



Managing Energy More Efficiently

The AI Energy Management functionality of the MULTI V i system gathers power usage data during operation, establishes a comprehensive database, and generates an Energy Pattern Model for predicting, monitoring, and managing operation rates. Each of the smart features provided by this solution can also be conveniently managed via LG's wired remote controllers. This allows energy management to be done in small and medium-sized buildings even without an energy management system.

Leveraging the power of supervised learning KNN algorithms, it effectively controls the operation of the outdoor unit based on predefined monthly energy usage targets. This intelligent feature allows for optimized energy management and helps achieve energy efficiency goals for the MULTI V i system.



* The above image is a graph intended to help in better understanding the material.

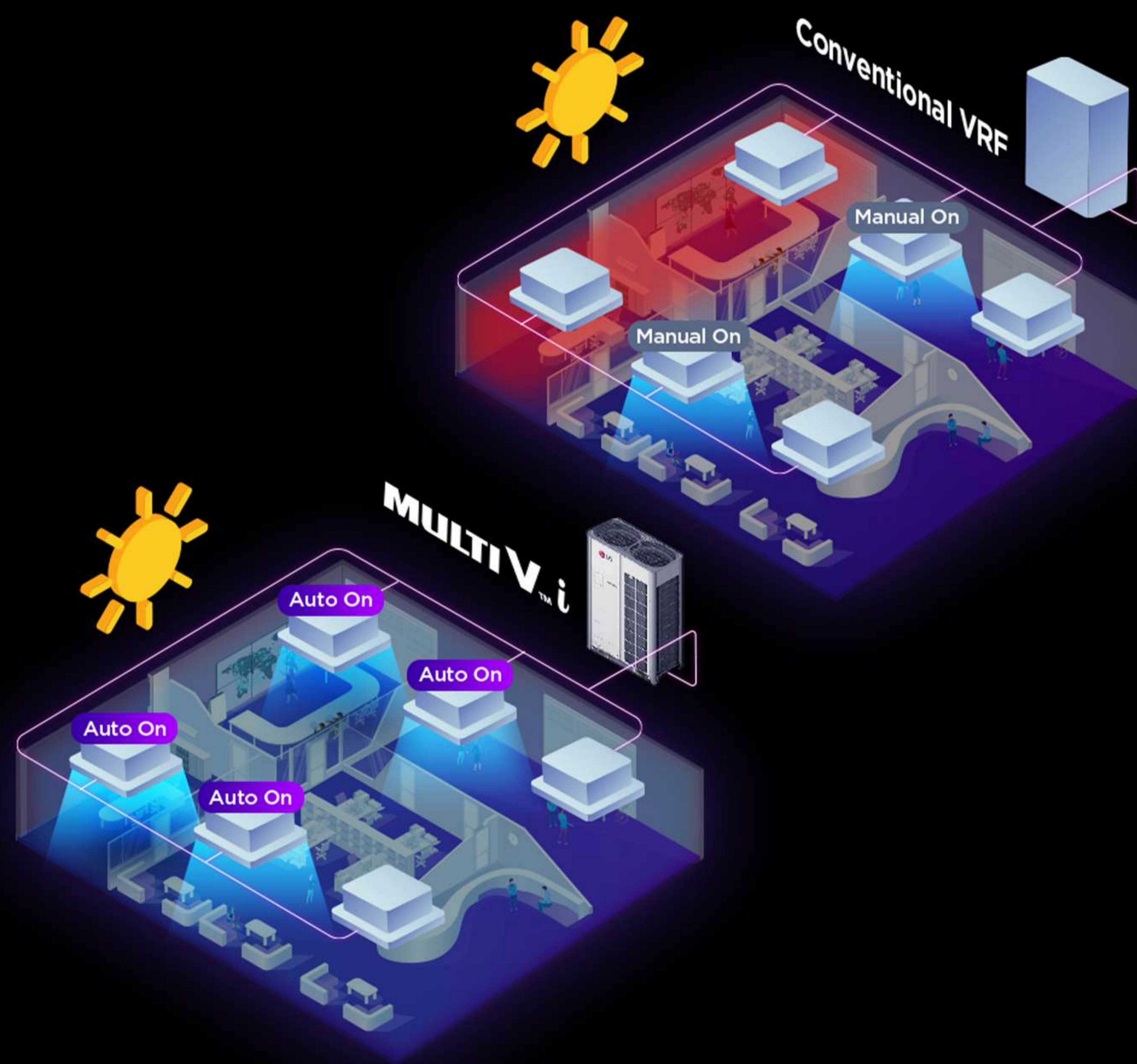
* This function is available when indoor units operate in cooling or heating mode.

How Does AI Technology Optimize HVAC Systems for User Comfort?

Thermal comfort refers to the temperature and humidity range that makes people feel comfortable. This range can vary depending on factors like activity levels, clothing, seasons, and personal preferences. Research has shown that when indoor temperatures increase, it can lead to decreased cognitive performance due to reduced physical activity. This highlights the importance of monitoring and maintaining occupant comfort, as it can contribute to better indoor conditions and potentially enhance cognitive function and productivity.

Ensuring Thermal Comfort

Workplace air conditioning and heating issues are common, especially in buildings with outdated HVAC systems, resulting in inconsistent temperatures. Factors like time of day, season, and building structure contribute to temperature variations. To ensure occupant comfort and performance, maintaining constant thermal conditions is crucial. The AI Indoor Space Care feature of the MULTI V i addresses this challenge by supporting balanced temperature maintenance throughout the indoor space. By employing advanced AI algorithms, the AI Indoor Space Care is capable of identifying adjacent indoor units and creating virtual groups based on correlation coefficients that represent their proximity.



Leveraging the power of AI algorithms, such as Q-Learning, the MULTIV i system meticulously analyzes various sets of data to automatically identify adjacent units and create virtual groups. This intelligent grouping enables the system to respond effectively to temperature imbalances within the indoor space.

When an imbalance in indoor temperatures is detected, the MULTIV i system intelligently selects a cooperating indoor unit to operate in coordination, ensuring a harmonized distribution of heating and cooling. As the heating or cooling load decreases, the system further optimizes energy consumption by automatically turning off cooperating units while intensifying the operation of the main units. The AI-driven AI Indoor Space Care delivers optimal thermal comfort throughout every corner of the indoor space, enhancing occupant satisfaction and energy efficiency.

Understanding Outdoor Conditions for Comfort and Convenience

The influence of outdoor weather conditions on indoor comfort poses significant challenges in maintaining consistent temperatures and humidity levels. Addressing these challenges is crucial for occupant well-being and energy conservation. Achieving a balance between comfort and energy efficiency requires an intelligent approach that takes outdoor weather factors into account.

LG MULTI V i, with its advanced features, offers a solution to tackle these challenges, including the innovative Weather Interlocking Control feature, which receives information from the AccuWeather platform. This feature leverages real-time weather data to optimize indoor comfort based on the prevailing outdoor conditions.



In regions experiencing snowy weather, the Weather Interlocking Control feature of the MULTI V i system automatically takes action with Automatic Snow Removal to prevent snow accumulation on the outdoor fan. By efficiently blowing away snow, it ensures uninterrupted operation and safeguards the system's performance. This proactive approach helps maintain optimal indoor conditions regardless of external weather conditions. Additionally, on cold days, the system proactively activates Automatic Pre-heating to ensure immediate comfort upon entering the building, mitigating the discomfort caused by low temperatures.

The Comfort function also detects temperature and humidity outdoors to adjust the operation and maintain a pleasant environment indoors. In addition to temperature and humidity, users are able to access outdoor air quality data on the controller display through the Automatic Air Cleaning Display function while the system uses this information to provide healthier indoor air.

Overall, LG MULTI V i excels in effectively managing the impact of outdoor weather on indoor thermal comfort. By integrating real-time weather data and implementing intelligent control strategies, it maximizes energy efficiency while creating a sustainable indoor environment. This comprehensive solution demonstrates LG's commitment to enhancing occupant comfort, reducing energy consumption, and promoting environmental sustainability.

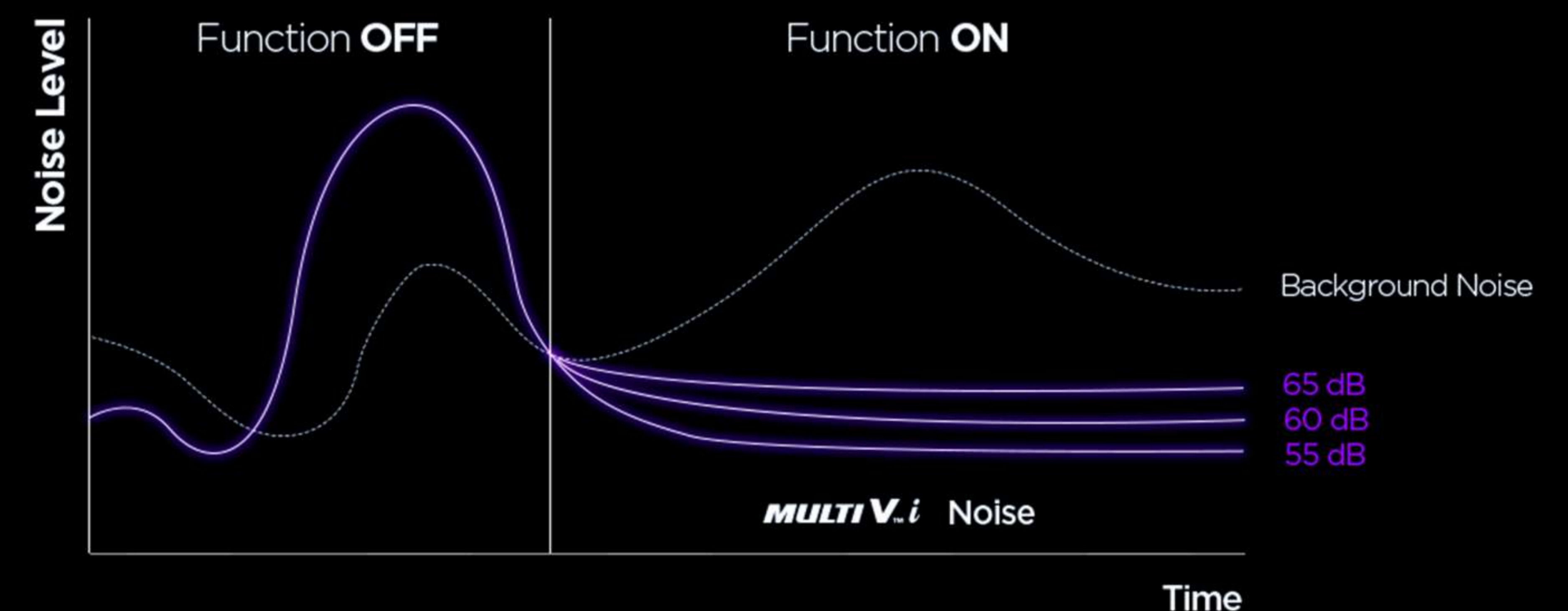


Keeping the Noise Down

Unwanted noise generated by outdoor HVAC units can have a detrimental impact on workplace comfort and productivity. There are also noise emissions regulations in regions like Europe that limit the levels of noise allowed from systems such as HVAC solutions. Recognizing these challenges, LG MULTI V i introduces Noise Target Control as an innovative solution to address this issue effectively.

With Noise Target Control, users have the ability to set operational noise limits for the outdoor unit, ensuring that it operates within specified volume levels.* This feature prioritizes the comfort of occupants in neighboring buildings or houses, minimizing the disturbance caused by excessive noise. By maintaining a quieter environment, the MULTI V i system creates a more pleasant indoor atmosphere, contributing to increased occupant satisfaction and fostering a productive working environment.

* Available setting 50 / 55 / 60 / 65 / 70dB



LG MULTI V i's inclusion of Noise Target Control demonstrates the company's commitment to user satisfaction and ability to comply with local noise regulations where required. By providing users with the means to control and limit operational noise, they gain a superior indoor experience while upholding noise-related guidelines and standards.

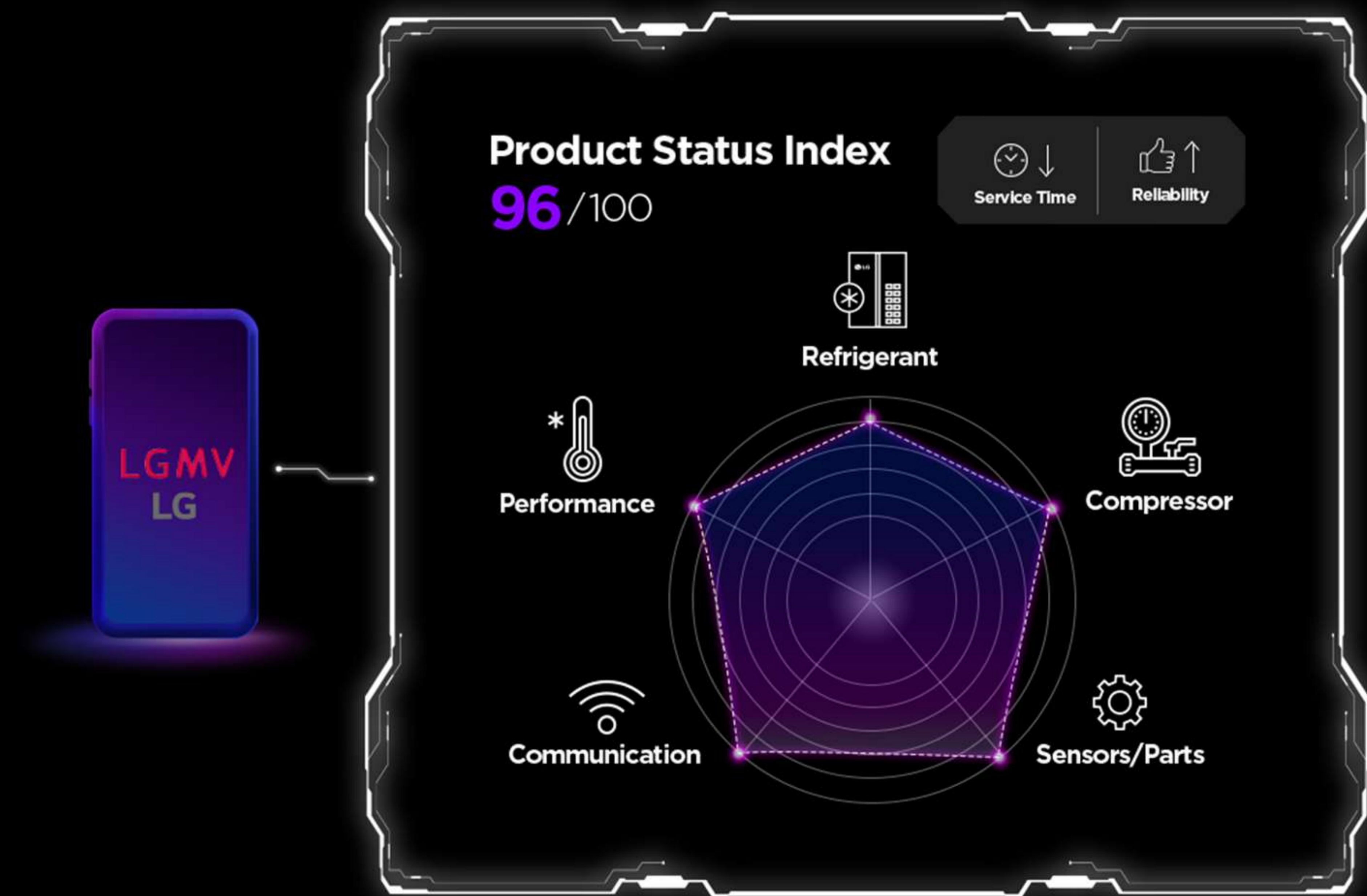
How Does AI Make Maintenance More Convenient?

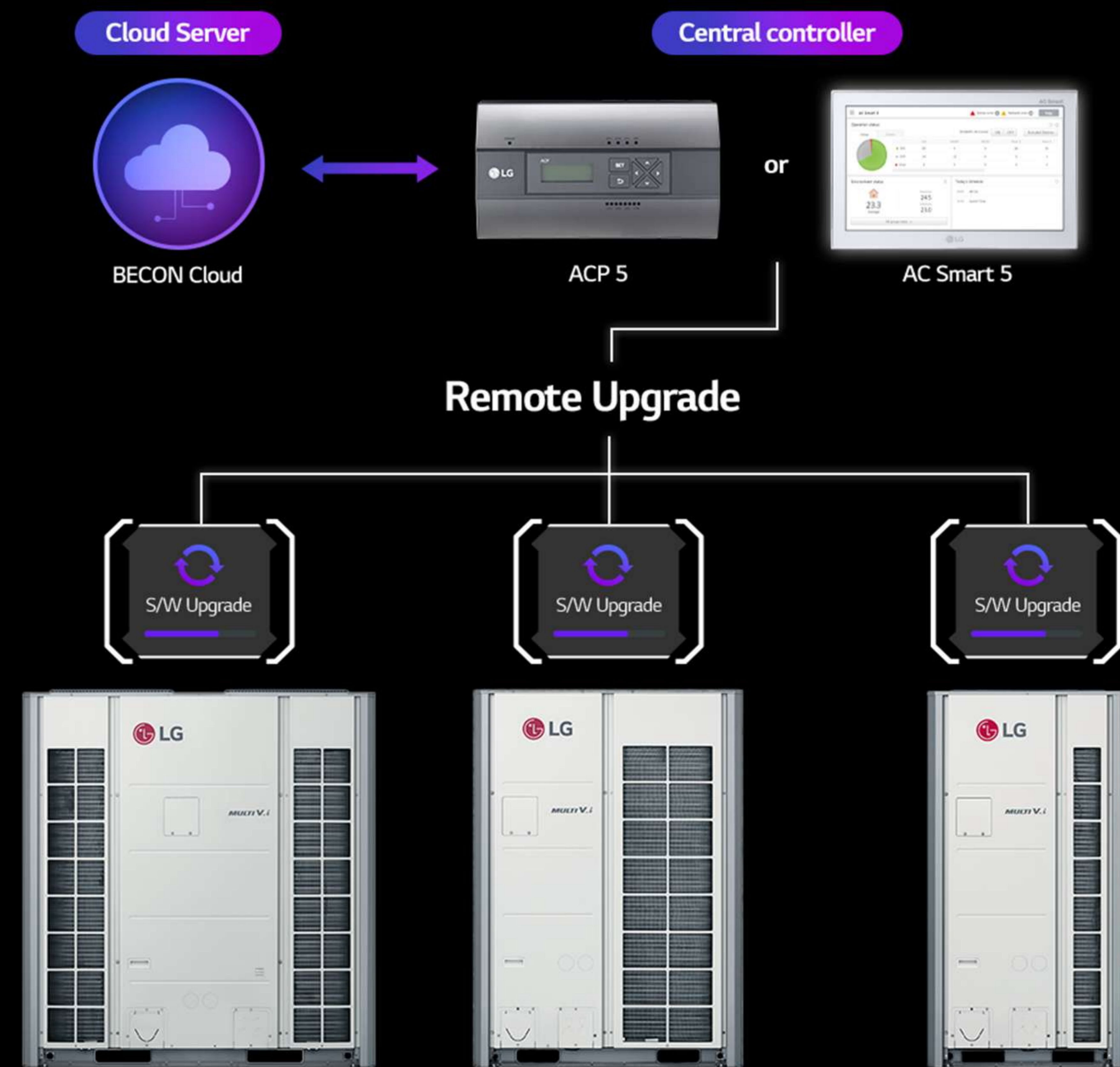
AI in HVAC not only benefits the end user but also makes HVAC engineers' jobs easier as well. Comprehensive system monitoring, data storage and analysis, automated system upgrades, and automated component monitoring all take the guesswork out of the maintenance process. With these tools at their fingertips, HVAC engineers are able to provide faster and more precise service.

Efficient and Effective System Diagnosis

The AI Smart Diagnosis feature revolutionizes device and system management for HVAC technicians, providing them with intuitive monitoring capabilities that encompass crucial data on refrigerant levels, compressors, sensors, components, communications, and overall performance. By accessing this comprehensive information, technicians can efficiently identify issues, troubleshoot problems, and optimize system performance.

Furthermore, the storage of up to 6 months of operation data via the large-capacity black box not only allows for proactive maintenance and preventive measures but also helps prevent system failures by enabling early detection of potential issues. The convenience of accessing this valuable diagnostic information through the LG MV app empowers technicians to deliver precise and thorough service, leading to improved efficiency and customer satisfaction. LG MV is an application that enables engineers to connect to an LG HVAC system for convenient access to comprehensive and easy-to-comprehend data sets and system monitoring.





Convenient System Upgrades

The Remote Upgrade System powered by AI brings immense benefits to HVAC technicians by enabling automatic remote updates for both the AI engine and the software of outdoor units. This streamlined upgrade process automatically delivers systems that are equipped with the latest advancements, features, and bug fixes.

By connecting to the LG BECON cloud and delivering updates through the central controller, technicians can efficiently and effectively keep the entire system up to date without the need for physical access to each unit. BECON cloud provides real-time access to comprehensive data monitoring through the cloud server for analysis results and reporting. This not only saves time but also enhances system performance, functionality, and compatibility, ultimately reducing both maintenance efforts and system downtime.

Keeping Your System in Tune

The Auto Tuning System offers significant advantages for HVAC technicians, particularly when it comes to component replacements such as compressors or fan motors. This intelligent system recognizes the specific operating parameters required for newly installed or replaced components, eliminating the need for extensive manual adjustments or fine-tuning.

By automating this process, the Auto Tuning System reduces service time and minimizes service costs, allowing technicians to efficiently complete replacements and optimize system performance. This advanced feature not only enhances productivity and efficiency but also ensures accurate and reliable operation, ultimately benefiting both technicians and customers.

Conclusion

In conclusion, the integration of AI technology in HVAC systems, exemplified by smart HVAC solutions such as the MULTI V i, lays a strong foundation for ongoing optimization and effectiveness. As new algorithms, technologies, and data sources are incorporated, HVAC systems become more elaborate and efficient in their operation. With a continuous influx of data, the MULTI V i AI engine can further refine its prediction and control strategies, leading to enhanced performance and improved energy efficiency. Looking ahead, the advancements in AI will empower systems to respond dynamically to changing conditions in real-time, paving the way for a future where MULTI V i sets new standards of excellence in the HVAC industry.

Related Articles

Explore more on MULTI V i with Related Articles from the LG HVAC Blog.

Optimize Your Comfort and Energy Use with AI-based Air Conditioners | LG Global

The New LG MULTI V i Elevates HVAC with AI Technology | LG Global

The Benefits of MULTI V i with AI Engine at Commercial Space | LG Global

Reference

- 1) Artificial Intelligence for Efficient Thermal Comfort Systems: Requirements, Current Applications and Future Directions, Ghahramani, Ali; Galicia, Parson; Lehrer, David; Varghese, Zubin; Wang, Zhe; Pandit, Yogesh, 2022**

<https://escholarship.org/uc/item/75j1m967>

- 2) Environmental Noise Directive, European Commission**

https://environment.ec.europa.eu/topics/noise/environmental-noise-directive_en



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