

“One Code One-Line Grid-Connected Independent ESS Integrated Solution”

“A Plug-in method that uses complex electrical wiring without construction by simply plugging in directly into the grid and immediately operating — Plug-in One-Line ESS.”

“Through the single line Plug-in method, solar, wind, and other renewable energies are connected directly to the grid without complex construction, and during emergencies switch to independent power mode. This innovative solution enables microgrid formation and distributed power network expansion, simultaneously achieving energy self-sufficiency and carbon reduction.”



🌱 [[Problem Definition & Market Opportunity]]



🌱 Market Opportunity and Necessity

Global electricity consumption is increasing annually, and along with the expansion of carbon neutrality and RE100 policies, the demand for distributed power and ESS is exploding.

Domestic electricity rates have risen by an average of 27% over the past five years, and the costs due to transmission losses amount to hundreds of billions of won annually.

As a result, the need for cost-effective and easy-to-maintain Plug-in ESS solutions has sharply increased, especially due to the necessity for self-generation and energy storage in homes, commercial, and industrial facilities.

✓ Market Data

- Global ESS Market: \$5 billion in 2022 → \$10.7 billion by 2030
- Domestic Market: approx. \$1.64 billion in 2022 (2.3 trillion KRW) → approx. \$3.57 billion by 2026 (5 trillion KRW)
- Industrial and Commercial ESS CAGR 22% growth
- Over 500 domestic companies participating in RE100, with numbers increasing

✓ 1) Why is this market necessary?

Sharp increases in electricity rates
Transmission loss issues
Pressure for carbon neutrality and RE100 compliance

✓ 2) Market Growth Data

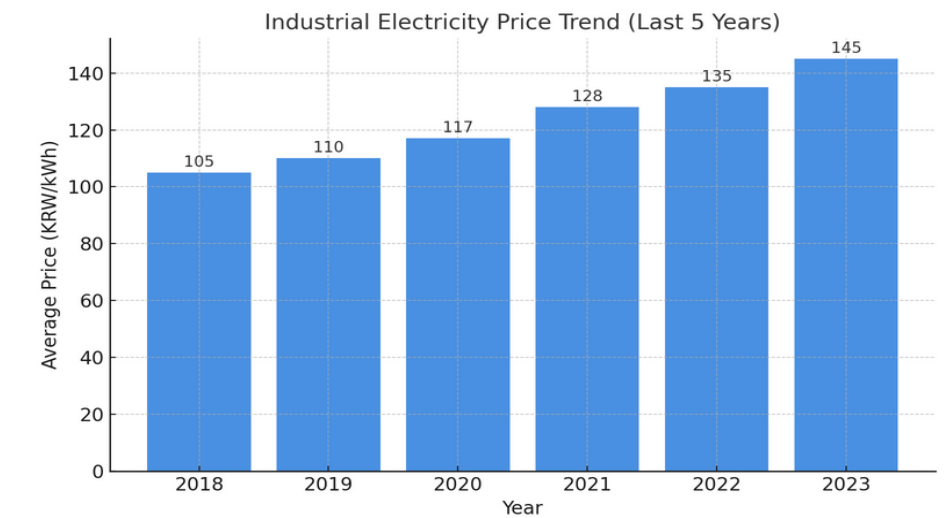
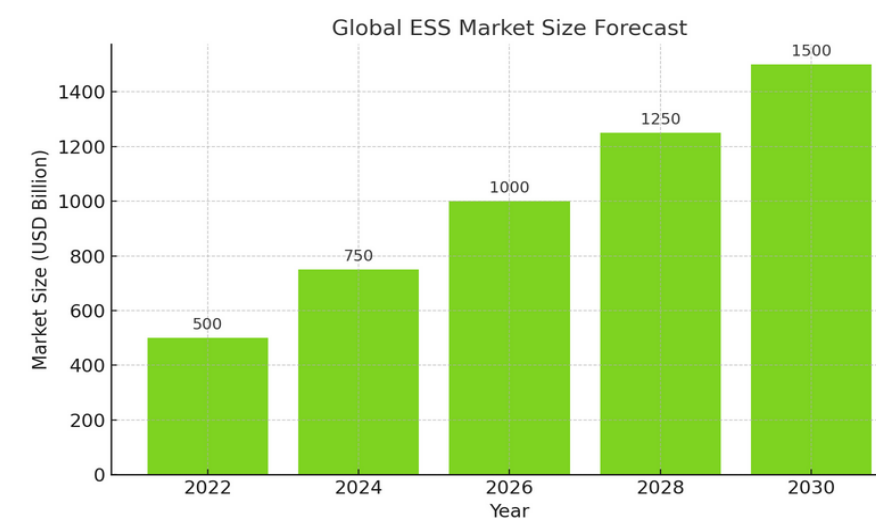
- Domestic and global ESS market size
- Average annual growth rate
- Policy trends (Mandatory installation of distributed power systems)

🌟 1. Industrial Electricity Rate Trends (Last 5 Years)

This graph shows the steady rise in domestic industrial electricity rates over the past five years. From an average of 105 KRW/kWh in 2018, rates increased approximately 38% to 145 KRW/kWh in 2023.

This trend, along with factors such as fuel costs, supply risks, and carbon neutrality policies, continues to drive electricity rates upward.

These changes demonstrate that ESS adoption is not a choice but a necessity for energy self-sufficiency and cost reduction.



🌟 2. Global ESS Market Size Forecast

This graph shows the forecasted growth of the global Energy Storage System (ESS) market from 2022 to 2030.

The market size is expected to more than double from \$5 billion in 2022 to about \$10.7 billion in 2030.

This growth, driven by renewable energy expansion, electricity rate stabilization, and increased power demand, presents a major opportunity.

The Plug-in One-Line ESS solution is positioned to capitalize on this growth in both domestic and global markets as a core technology.

“Technology Overview and Key Differentiators”

1. Why can't existing products be used?

- Complexity of existing ESS inverters
- Need for wiring construction
- Slow switching time

2. How is our solution different?

- Plug-in One-Line
- Grid-connected, independent, and UPS integrated
- Zero switching time of 25ms

3. Core Technology Elements

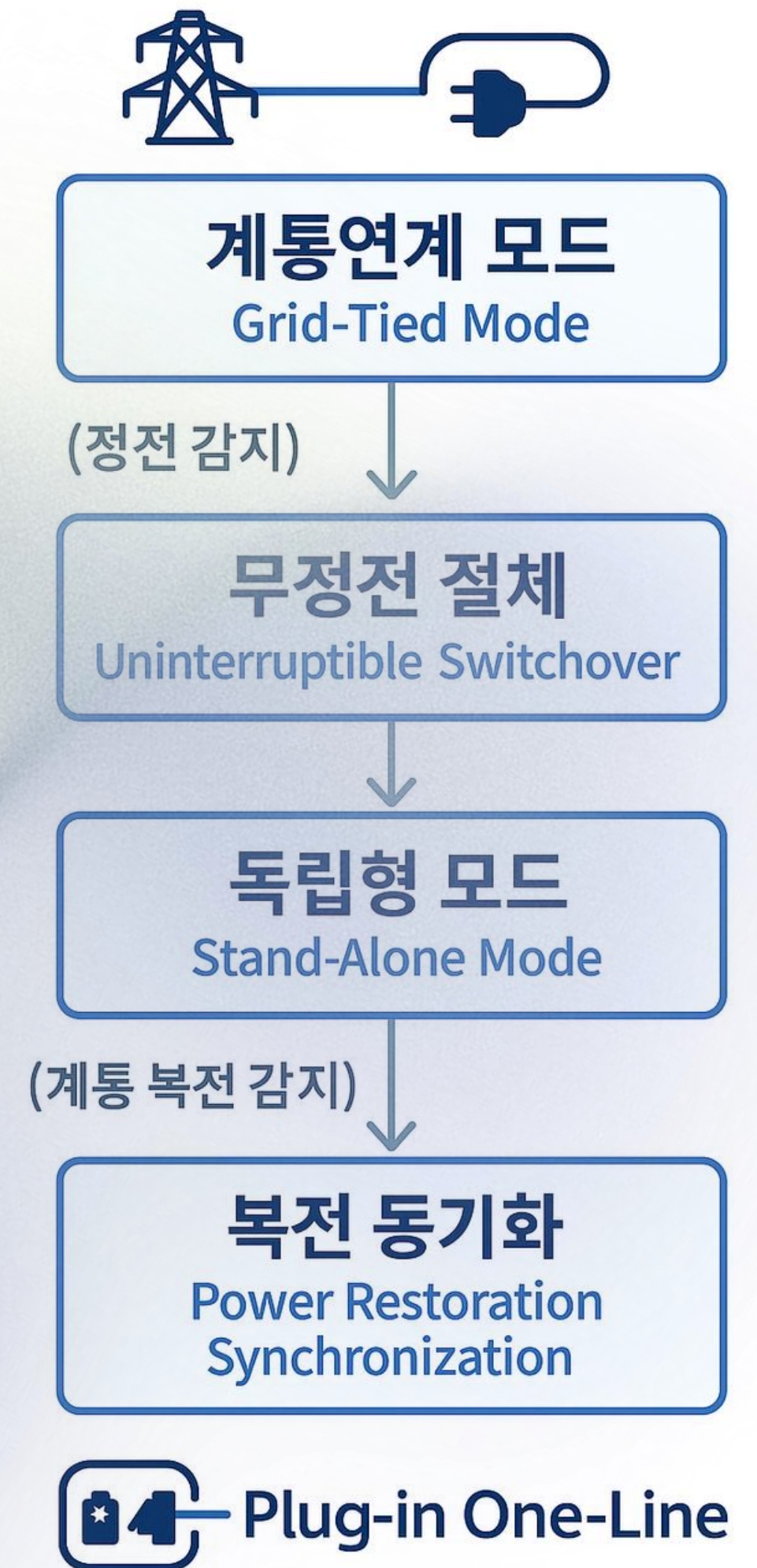
- Independent/grid-connected hybrid DC/AC inverter
- Zero-Cross abnormal synchronization algorithm
- Multi-layer protection for overcurrent/overvoltage
- Internal BMS and real-time power management

4. Unlike all other products worldwide that use two wires, our solution uses only one wire.

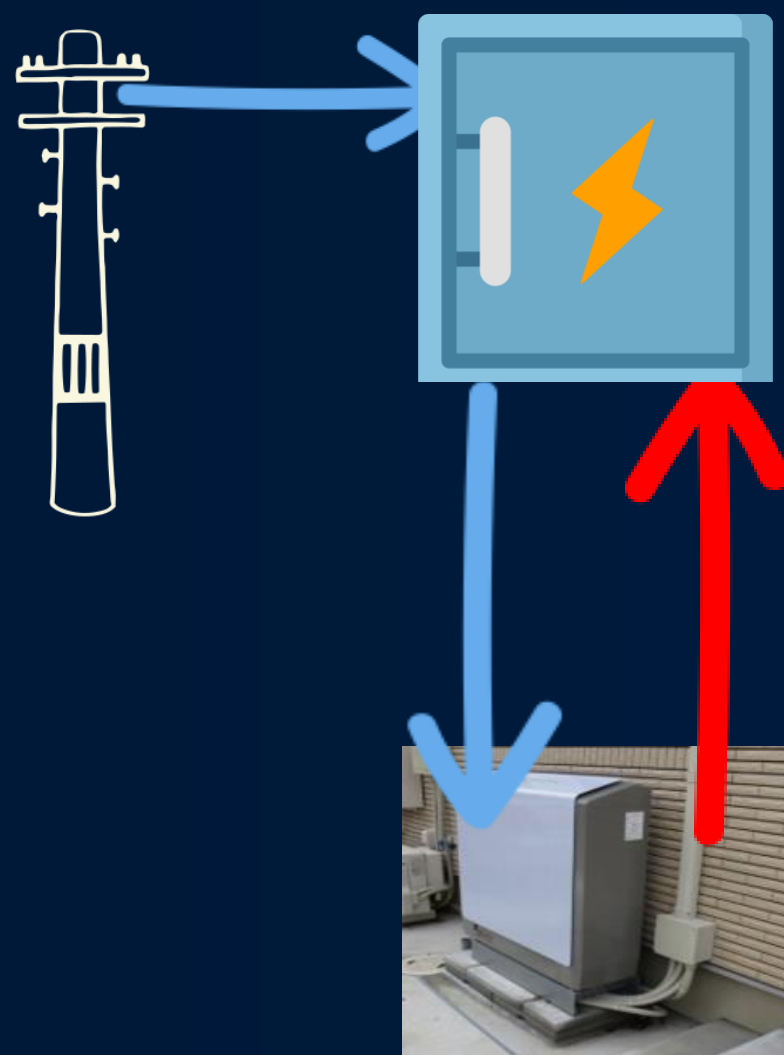
While some single-wire products stop operating during power outages, ours seamlessly integrates grid connection and independent operation without interruption, ensuring continuous power supply even during outages.

Technology Overview and Differentiators

- This product was developed to solve the complexity of installation structure, slow switching time, and wiring construction issues in conventional grid-connected ESS inverters.
- Using the Plug-in One-Line method, the system automatically switches modes between grid-connected, independent, and UPS modes through a single line connection.
- Key technologies include:
 - Grid-connected/independent hybrid DC/AC inverter
 - Conventional independent/grid-connected hybrid inverter integration in a single circuit to reduce space and component count
 - Zero-Cross abnormal synchronization algorithm
 - Grid-connected mode with zero switching time (less than 25ms)
 - Instant switching to UPS mode on power failure for uninterrupted power supply
 - Multi-layer protection circuits
 - Protection against overcurrent, overvoltage, and overtemperature, including automatic restart logic
 - Real-time BMS and power management
 - Internal battery status monitoring and output control for integrated management

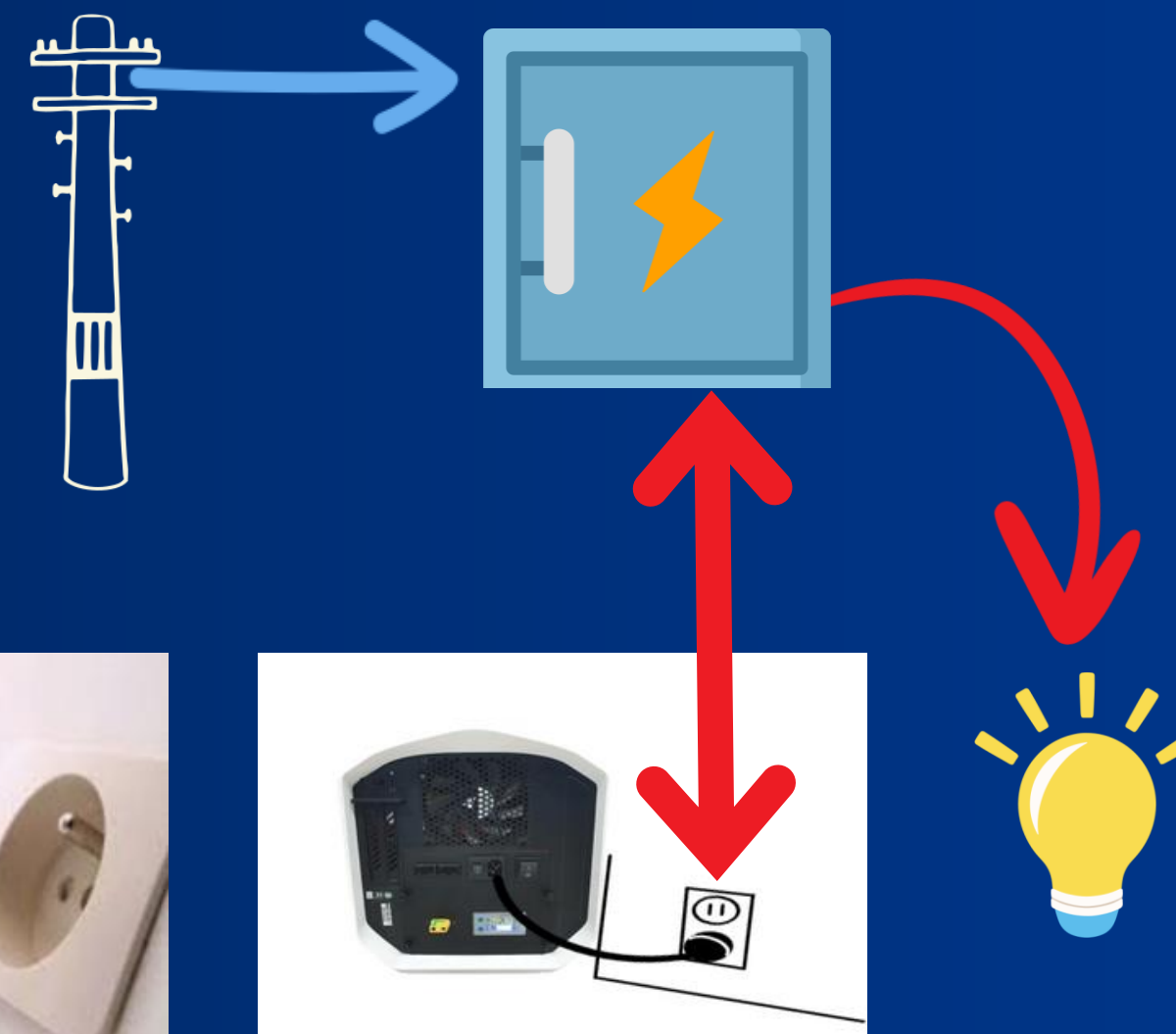


❁ Technology Overview & Key Differentiators Explanation



✓ Key Differentiator Summary

- Conventional Method: Separate input/output wiring, requires electrical construction
- One Code Method: Single line (One Line) connection, Plug-in installation



Conventional ESS Installation Method

- Conventional ESS systems always require accompanying electrical construction.
- The main grid power is divided by the main breaker into separate circuits for distribution.
- During ESS installation, input and output must be wired separately by cutting the main breaker and distribution breaker.
- This process inevitably causes additional wiring, breaker increases, and breaker modification work, which consumes time and cost.

Right Side: One Code Inverter Installation Method

- The One Code Inverter applies the Plug-in One-Line method, cutting or modifying the internal distribution wiring is unnecessary.
- Grid power remains supplied to the load via the existing distribution wiring as is.
- ESS is connected as a branch circuit via a single code (conduit), handling input and output on a single line.
- It can be simply installed without separate electrical work, significantly reducing installation cost and time.



Innovative Portable Hybrid PCS – Experimental Results



Data Provided by Kookmin University

1. Outdoor Mode & Grid-OFF Mode

Status:

- Operating in independent mode without grid power.

Waveform:

- Blue: Output voltage (sinusoidal waveform)
- Green: Output current
- Yellow: DC input or load condition

Meaning:

- Normal independent operation supplying power from the battery.
- Output voltage and current remain stable.

3. NORMAL MODE → UPS MODE

Status:

- Detects power outage during grid operation and switches to UPS mode.

Waveform:

- Slight waveform distortion occurs at the switching moment.
- Immediately switches to independent sinusoidal waveform.

Meaning:

- Uninterrupted power supply function activates, switching to independent supply within 25ms after grid failure.
- No output interruption occurs during this transition.

2. ESS Mode

Status:

- ESS mode connected to the grid.
- Compensates peak loads or supplies power to the grid.

Waveform:

- Blue: Grid-synchronized output voltage
- Green: Output current
- Yellow: Power input

Meaning:

- Grid voltage is accurately synchronized with output.
- Voltage and frequency stability are confirmed.

4. Grid OFF Mode → NORMAL MODE

Status:

- Switches to grid-connected mode when grid power is restored from independent mode.

Waveform:

- Minor changes in output waveform during switching moment.
- Smoothly reconnects using Zero-Cross synchronization algorithm.

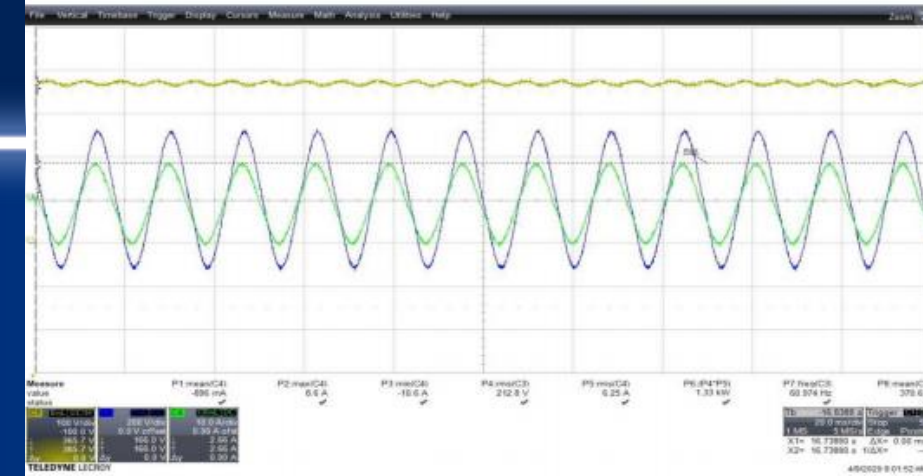
Meaning:

- Automatic synchronized grid reconnection occurs without power surge or interruption.

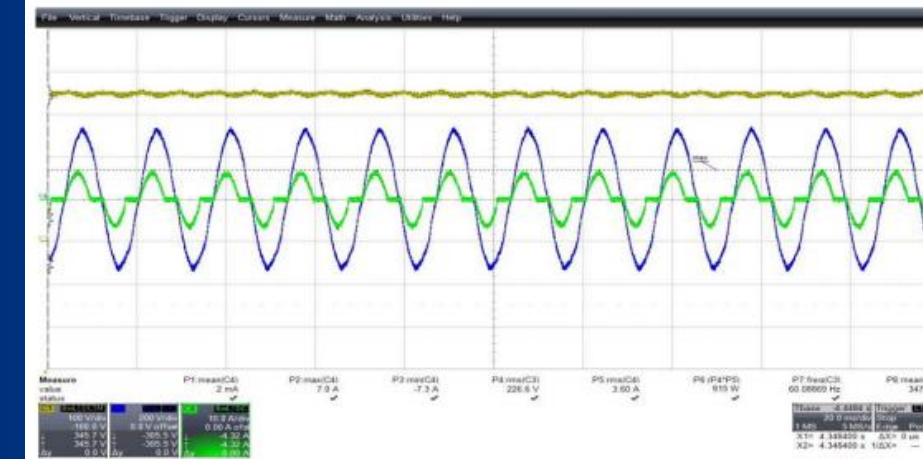
✓ Key Summary

- [Grid and Perfect Synchronization]
- [Uninterrupted Power Supply during Power Outage]
- [Automatic Synchronization during Grid Reconnection]

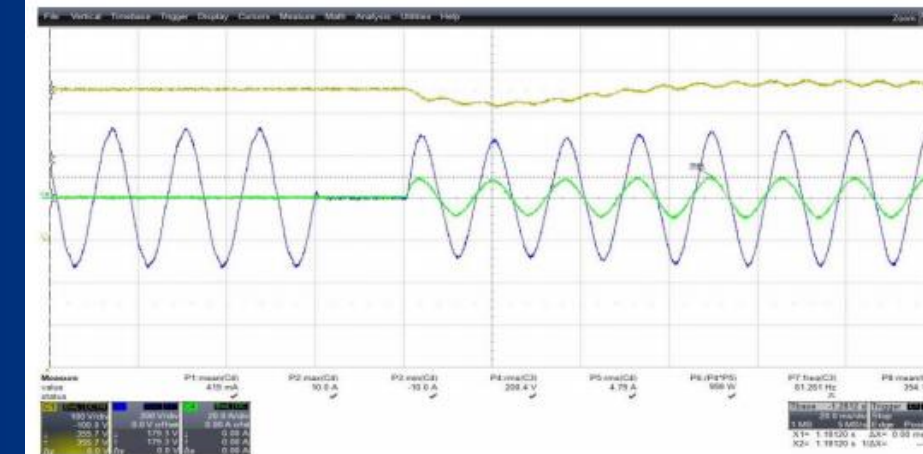
1) Outdoor Mode % Grid-OFF MODE



2) ESS Mode



3) NOMAL MODE → UPS MODE



4) Grid OFF Mode → NOMAL MODE



Kookmin University Joint Development History

- Joint research and development results with Kookmin University Industry-Academia Cooperation Foundation
- This product was developed through close collaboration with the Kookmin University Department of Electronic Engineering's Power Electronics Research Team over 7 years since 2018.
- The lead researcher is Professor No Jong-Wook from Kookmin University Department of Electronic Engineering, and the research team consists of 6 members including Jung Koo-Young, Lee Yong-Hee, Kang Yoon-Soo, Park Chang-Woo, Oh Se-Jae, etc.
- The team proactively contributed to circuit design, firmware development, power quality verification and testing of grid-connected, independent, UPS-integrated ESS inverters.
- Based on accumulated data and know-how during this process, the world's first Plug-in One-Line ESS technology was commercialized and further developed to the prototype stage.

Summary of Professor No Jong-Wook's Career

- Mar 1995: Ph.D. in Electrical and Electronic Engineering, Korea Advanced Institute of Science and Technology (KAIST)
- Mar 2000 – Feb 2004: Lead Researcher, Samsung Electronics VDX Division
- Mar 2004 – Present: Professor, Kookmin University Department of Electronic Engineering
- Sep 2005 – Present: Researcher, Samsung SDI CDS Division (Samsung SDI Natural Energy Research Center: SPEC)
- Mar 2010 – Oct 2012: Researcher, Samsung Electronics Network Business Division (Samsung Network Power Research Center: SNPC)
- Mar 2011 – Feb 2012: Senior Technical Advisor, Samsung Electronics Living Appliance Business Division
- Mar 2012 – Mar 2013: Technical Advisor, Samsung Electronics Living Appliance Business Division
- Sep 2009 – Dec 2014: Center Chief, Energy IT Convergence Research Center (ITRC), Ministry of Science and ICT
- 2017 – Present: Director, Sungil Energy Research Center
- Published over 250 papers and holds more than 120 patents in power electronics
- Recipient of the IEEE IES Best Paper Award and multiple awards from the Power Electronics Society

제 2024 - 028 호

Certificate *Of Industry-University Cooperation*

기업명 : (주)성일에너지
대표자 : 김영실
등급 : Sliver
유효기간 : 2024.04.23 ~ 2025.04.22

귀사는 긴밀한 산학협력을 통한 대학-기업의 공생발전을 도모하기 위하여 국민대학교와 산학협약을 체결한 유료가족회사로 인증합니다.

2024년 04월 23일

국민대학교 LINC 3.0 사업단장



✿ Explanation of Technology Based on PCT International Search Authority Review

This One Code ESS inverter technology was recognized as novel and inventive after the 2021 international patent (PCT/KR2021/010554) examination process.

During this process, the international search authority examiner directly issued an opinion letter confirming the novelty and inventiveness, evaluating it as a unique solution that cannot be easily derived by those skilled in the art.

The examiner reviewed existing prior arts regarding grid-connected, independent automatic transfer, and backup uninterrupted power supply, including technologies from LG Electronics, Samsung SDI, LS Industrial Systems, Sungshin Electric, and Korea Energy Technology Research Institute.

It was confirmed that these existing references do not disclose or suggest this technology.

“No prior art related to energy storage systems has been found anywhere, and this invention cannot be easily derived by skilled technicians”

This opinion is officially recorded in the examination report.

This serves as strong objective evidence that this technology is globally unique and possesses distinctive novelty.

It implies that it is a core technology with competitive advantages in the future RE100, distributed power



Patents and Certifications

- Patent No. 10-2443460: Energy Storage System
- Patent No. 10-2020-0053516: Power Supply Device
- Patent No. 10-2807069: Air Conditioning System with Heat Exchanger and Cooling Unit
- Patent No. 10-2693305: Integrated Exhaust Heat Recovery Air Conditioner
- Patent Application No. 2024-0197904: Road Wind Power Generation System Using Its Name
- Patent Application No. 10-2025-006117: Plug-in Hybrid Power Generation and Power Control System
- Patent Application No. 10-2025-006137: High-Speed Road One Code Parallel-Connected Inverter and Smart Power Transmission System
- Patent Application No. 10-2025-0062350: Vehicle-Mounted Small Wind Power Generation System
- Patent Application No. 10-2025-0069761: Coreless Dual-Rotor Axial Flux Concentration Generator

High-Efficiency Energy Material Certification: Power Storage Device (ESS) No. 93685
Broadcast Communication Equipment Certification KC: PCS [Model] SSE-3KHB-120

국제조사기관의 견해서

국제출원번호
PCT/KR2021/010554

제5기제란

신규성, 진보성 또는 산업상 이용가능성에 관한 견해(PCT규칙 43의2.1(a)(i)), 이를 뒷받침하는 인용문헌 및 설명

1. 견해

신규성 (N)	청구항	1-2	있음
	청구항	없음	없음
진보성 (IS)	청구항	1-2	있음
	청구항	없음	없음
산업상 이용가능성 (IA)	청구항	1-2	있음
	청구항	없음	없음

2. 인용문헌 및 설명:

참고한 인용문헌은 다음과 같습니다.
D1: KR 10-1643705 B1 (정신전기공업(주)) 2016.07.29
D2: KR 10-2017-0046990 A (엘지전자 주식회사) 2017.05.04
D3: KR 10-2020-0089056 A (한국에너지기술연구원) 2020.07.24
D4: KR 10-2011-0084751 A (삼성에스디아이 주식회사) 2011.07.26
D5: KR 10-2017-0127179 A (엘에스산전 주식회사) 2017.11.21

I. 신규성 및 진보성(PCT 제33조(2) 및 (3))

청구항 1의 인덕터(IL)에 흐르는 인덕터전류(IL)와 사용자에 의해 정해지는 복전제한전류(Iref)를 비교하는 전류판단부(50); 및 전류판단부(50)에서 인덕터전류(IL)가 복전제한전류(Iref)보다 작으면 활성화된 스위칭제어신호(SWC)를 출력하여 스위칭부(SW)를 온시키고, 인덕터 전류(IL)가 복전제한전류(Iref)와 동일하면 비활성화된 스위칭제어신호(SWC)를 출력하여 스위칭부(SW)를 오프시키고, 스위칭제어신호(SWC)가 비활성화된 이후 사용자에 의해 정해지는 기준시간(Tref)이 경과되면 스위칭제어신호(SWC)를 활성화시켜 스위칭부(SW)를 온시키는 스위칭제어부(60)를 구비한 것을 특징으로 하는 에너지 저장 시스템은 인용문헌들 어디에도 개시되어 있지 아니하고, 통상의 기술자가 쉽게 도출할 수 없습니다.

청구항 2는 청구항 1의 종속항입니다.

따라서 청구항 1-2는 신규성 및 진보성이 있습니다.

II. 산업상 이용가능성(PCT 제33조(4))

청구항 1-2는 산업상 이용가능합니다.

서식 PCT/ISA/237 (제5기제란) (개정 2019년 1월)

Kim Man-ik / Current CTO, Sungil Energy Co., Ltd. – Career and Achievements

Career Summary

- Over 30 years of experience in power generation and energy storage systems (ESS)
- Executed numerous projects in power generator manufacturing, ESS development, and renewable energy convergence systems
- Director of ESS Research Center at Kookmin University Industry-Academia Cooperation Foundation
- Proven track record in national defense, public works, and corporate projects

Year	Position
1990	Deputy Head of Technical Department, General Machinery Division
2010	CEO, AlphaWay Generator
2014	Deputy General Manager, Generator Company
2016	Executive Director, Renewable Energy Sector
2018	Head of Renewable Energy Research Center
2019–2023	Head of ESS Research Center, Kookmin University Industry-Academia Cooperation Foundation
2023	CTO, Sungil Energy Co., Ltd.

Core Technology Development Achievements

- World’s first hybrid generator patent and sample production
- AI-in-One Plug-in ESS development
- Power consumption reduction for air conditioners and PC power supplies technology development
- Microgrid power management technology
- ESS linked to small wind turbines development
- Prototype production of power consumption optimized air conditioners
- ESS grid connection algorithm development

Reference Product Achievements

- Delivered 450 units of 5kW generators to national defense with maintenance and after-sales services
- Manufactured 8 units of military-use trailers
- Supplied ESS products to national defense small-scale goods
- Manufactured solar generators and generator vehicles for public institutions (Siheung City Hall, Gwangmyeong City Hall, Nowon Police Station, etc.)
- Automated Japanese Chiba City garbage trucks
- Manufactured large inspection service generators (Seongnam Medical Center, Noksapyeong Hospital, Neodam Hospital)
- Supplied large-scale public broadcasting generators (MBC, JTBC, Sejong Culture Center)
- Participated in manufacturing heating and cooling generators for the Beijing Olympics

Career Highlights

- 2000–2010: Manufacturing power generators and supplying electricity to hospitals and public facilities
- 2011–2014: Developed military generators and utility trailers, delivered products
- 2014–2018: Developed integrated technology for solar, wind, and ESS
- 2019–2023: Joint development of ESS and PCS grid-connected systems with Kookmin University Industry-Academia Cooperation Foundation

ONE CODE INVERTER PCS 1.5KW BATTERY 2KWh



Portable Plug-in ESS

- Compact and lightweight design optimized for home and mobile use.
- Supports grid-connected, independent, and UPS functions with built-in 2kWh battery, delivering up to 1.5kW output.
- Can be installed easily without separate wiring work using Plug-in method.

ONE CODE INVERTER PCS 3KW BATTERY 3KWh



Residential ESS

- High-performance ESS inverter with built-in 3kWh battery, all-in-one model.
- Suitable for residential and commercial peak load reduction and emergency power supply, supporting uninterrupted power supply functions.

ONE CODE INVERTER PCS 3KW BATTERY 12KWh



Commercial ESS

- Large-capacity ESS solution featuring 6kWh battery modules with two-stage modular structure.
- Supports high-voltage grid connection and independent power supply simultaneously, enabling large power capacity.

ONE CODE INVERTER 산업용 3KW



Industrial ESS

- Industrial ESS solution designed with waterproof and dustproof casing for outdoor installation.
- Supports stable power supply in various environments including outdoor street lamps, distribution, and industrial sites, operating safely even in extreme weather.
- Supports grid-connected, independent, and UPS modes, integrating large-capacity batteries and high-efficiency inverters.
- Can be installed quickly and conveniently using the Plug-in method.

🌿 Market Opportunity and Growth Prospects

✓ Core Background

The global ESS market is growing at an average annual rate of over 20%.
With the expansion of RE100, carbon neutrality, and ESG management, the demand for distributed power and ESS is rapidly increasing.
Due to rising electricity rates and transmission losses, self-generation and energy storage infrastructure are expanding.
Domestic policies are expanding the mandatory installation of distributed power.
The demand for renewable energy + ESS packages continues to grow.



✓ Market Data (Example)

- Global ESS market size: Approximately \$50 billion in 2022, expected to reach \$150 billion by 2030
- Domestic ESS market size: Approximately 2.3 trillion KRW in 2022, expected to reach 5 trillion KRW by 2026
- Distributed power supply target: Over 30% of total power generation by 2030
- Industrial ESS average growth rate: Over 22%

✓ Growth Opportunities

- Peak load reduction ESS demand expansion in smart factories, data centers, and commercial facilities
- Expansion of energy self-sufficiency supply for residential and commercial use
- Increasing demand for power supply for national defense and disaster relief mobile power
- Export expansion to power-deficient regions in Southeast Asia, the Middle East, and Africa

✓ Major Market Trends

- 1.Preference for plug-in installation productsReduced installation cost and construction period
- 2.Demand for grid-connected + independent hybrid ESSEmphasis on stability and reliability
- 3.Smart monitoring and control integrationGrowth of SaaS platform services
- 4.Efficient and modular designCustomized installation environment

Note: This image illustrates the design concept of the commercialized product, and the actual mass-produced model will be optimized and developed according to installation conditions.



✓ **Key Summary**

Based on hardware sales and installation revenue, sustainable maintenance power sales, and SaaS subscription revenue, a stable and scalable business model is being established.

 Revenue Model and Business Strategy

✓ **Revenue Model Overview**

This business focuses on hardware sales and aims for a multi-layered revenue structure including maintenance, power sales, and SaaS platform services.

Category	Revenue Details
Product Sales	- Sales, installation, and delivery of ESS inverter and battery packages
Maintenance Service	- Annual maintenance contracts and monitoring system management
Energy Sales / REC	- Power sales connected to the grid (SMP) and renewable energy certificate (REC) trading
SaaS Platform	- Cloud-based monitoring subscription revenue - smartphone/web dashboard services
Additional Solutions	- Solar and wind power integration solutions - export packages for national defense and disaster relief

Project Schedule and Roadmap

✓ Major Milestones

- Certification and initial delivery within 6 months
- Commercialization and securing references domestically within 1 year
- Achieving annual sales of over 10 billion KRW within 2 years
- Full-scale overseas export within 3 years

Promotion Goal

This project aims to pioneer the domestic and international distributed power markets and RE100 demand by stepwise technology commercialization, mass production, and export promotion.



Phase	Period	Key Activities
Phase 1	Up to 6 months	Completion of mass-production design, certification, and testing reports secured; production line preparation
Phase 2	6–12 months	Domestic pilot installations (industrial facilities, residential use, military); initial sales contracts; monitoring platform development
Phase 3	1–2 years	Expansion of domestic supply; strengthening industrial and commercial model sales; launch of defense and disaster relief supply
Phase 4	2–3 years	Export contracts to Southeast Asia, Middle East, etc.; acquisition of global certifications; establishment of overseas sales networks

✓ Key Summary

Based on roadmap technology validation and early market expansion, the goal is to establish a leading domestic and international ESS market brand within 3 years.

Vision and Core Competitive Advantages



- 01**
World's first Plug-in One-Line technology
Installation time and cost reduced by over 70% compared to conventional ESS
No separate electrical wiring work required
- 02**
Integrated grid-connected, independent, and UPS modes
Uninterrupted transfer function
Automatic backup synchronization
- 03**
Proven performance and international trust
7 years of joint research with Kookmin University Industry-Academia Cooperation Foundation
PCT patent novelty and inventiveness recognition
- 04**
Versatile models and market adaptability
Portable, Residential, Commercial, Industrial
Targeting both domestic and overseas markets
- 05**
Smart monitoring platform
SaaS subscription service for continuous revenue

Vision

Our company aims to grow beyond simple ESS sales to lead new standards in energy self-sufficiency and distributed generation.

Based on Plug-in One-Line ESS solutions, we provide energy infrastructure that anyone can easily install and operate, advancing the era of carbon neutrality, RE100, and smart grids.

Core Message

Our One Code Plug-in One-Line ESS is a unique global solution integrating grid-connected, independent, and UPS functions into a single circuit, unlike conventional products.

Without complex wiring or construction, it connects with just one plug to the existing conduit, drastically reducing installation time and costs.

It ensures power quality and stability through uninterrupted transfer and automatic backup synchronization during power outages.

From portable to industrial applications, our wide product range and SaaS-based real-time monitoring platform set new standards for energy self-sufficiency and distributed generation.

“We lead the future of the energy industry through technological innovation and customer-centric services.

By contributing to sustainable development and carbon neutrality, and providing user-friendly, reliable solutions,

we will establish a unique position in the global energy market.

We will continue relentless research, development, and collaboration to create positive change for society and the environment.”

Company Vision and Future Strategy



1. Global Market Expansion

Targeting emerging markets with power grid shortages such as Southeast Asia, the Middle East, and Africa

Acquiring international certifications and expanding overseas partnerships



2. Smart Energy Platform

Enhancing SaaS-based real-time monitoring services

Developing big data and AI-based energy management solutions



3. Product Portfolio Expansion

Building a full product lineup from small residential ESS to large-scale commercial ESS

Continuous innovation in high-efficiency modular and eco-friendly designs



4. Sustainable Value Creation

Solutions responding to carbon neutrality (RE100)

Contributing to national industry and residential energy self-sufficiency

✓ Vision Statement

We provide a Plug-in One-Line ESS solution that anyone can easily install and use, setting new standards for energy self-sufficiency and distributed power ecosystems.

✓ Core Message

Seongil Energy is leading energy self-sufficiency and carbon neutrality with the Plug-in One-Line ESS that anyone can easily install.

It supports grid-connected, independent, and UPS modes all integrated into one plug without complex construction.

We have verified technology reliability through 7 years of R&D and international patents.

We will continue to create new standards in the distributed power market with high-efficiency, high-reliability, convenient solutions, and a smart monitoring platform.

Meet Our Team



MANIK KMI

Senior Managing Director

010-4405-5604

kjs8876@naver.com



YEONGSIL KIM

Representative

010-2608-8003

y1588654@naver.com



KWON KI-HYUNG

Executive Director

ri ddo1@hanmail.net

010-3088-5701

Thank You

Get in touch!

 +82.31.984.3301

 kjs8876@naver.com

 143beon-gil 66, Tongjin-dong, Gimpo-si, Gyeonggi-do, 10015, Republic of Korea