녹색에너지연구원
Green Energy Institute

Green Energy Institute's Technology Solutions 2025

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Foreword

I am pleased to publish Green Energy Institute's Technology Solutions. This publication compiles the Green Energy Institute's (GEI) major technology demonstrations and international cooperation cases. As a Network Member of the UN Climate Technology Centre and Network (CTCN), we hope these case studies will be helpful in contributing to the shared global journey toward climate-crisis response and carbon neutrality.

Today, the world faces the great challenge of climate change and the transition to sustainable energy. In this era of transformation, GEI has devoted itself to developing and disseminating sustainable energy technologies that enable local innovations to be scaled up and used on a national and global level.

In particular, the projects presented in this volume—Energy-Independent Islands, Suncheon's Energy-Independent Village, and the community-based energy ecosystem initiative—represent field-driven solutions for achieving a carbon-neutral society and inclusive energy-transition models jointly created by local governments and citizens.

Jeollanam-do Province, located in the south-western part of the Republic of Korea, possesses one of the highest levels of renewable-energy potential in the country. Building on its abundant offshore wind and solar resources, the province is promoting the establishment of a comprehensive industrial ecosystem for green hydrogen, encompassing production, storage, transportation, and utilization. To this end, the Green Energy Institute is strengthening its efforts in technology development, policy recommendations, and international cooperation, evolving into a sustainable partnership platform that connects regional initiatives with global progress.

We hope this publication offers practical inspiration for developing countries striving toward carbon neutrality and green growth, inspired by GEI's experiences. The Green Energy Institute will continue to lead regional energy transition through innovative technologies and collaboration, and will remain committed to sharing its technological innovation experiences with partners around the world.

Gyou Cheol Hwang, President of the Green Energy Institute, Republic of Korea.

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Introduction

Green Energy Institute is a local government-affiliated research institute specializing in new and renewable energy. Established in 2009 through a joint initiative between the Jeollanam-do Provincial Government and the Ministry of Climate, Energy and Environment, Republic of Korea, GEI plays a central role in fostering regional industries by promoting research, development, and commercialization of renewable energy technologies.

GEI has implemented a range of domestic and international demonstration projects. In Korea, these include agrivoltaics testbeds and Medium Voltage Direct Current (MVDC) demonstration sites in Naju, an Energy-Independent Island in Haenam, and an Energy-Independent Village in Suncheon. Internationally, GEI has established microgrid infrastructure in Dong Nai Province, Viet Nam, supporting industrial energy self-sufficiency and sustainable power distribution.

GEI was officially admitted as a Network Member of the UN Climate Technology Centre and Network (CTCN) on May 12, 2022. Since then, GEI has collaborated with the CTCN and international partners on a range of initiatives, including co-hosting the Capacity-Building Workshop on Green Hydrogen for Asia and the Pacific and co-publishing the 2023 CTCN report Green Hydrogen Technologies for Systems Transformation featuring 10 Korean case studies. Building on this, GEI continues to strengthen regional capabilities and accelerate the transition to sustainable energy solutions through innovation, technology integration, and international cooperation.

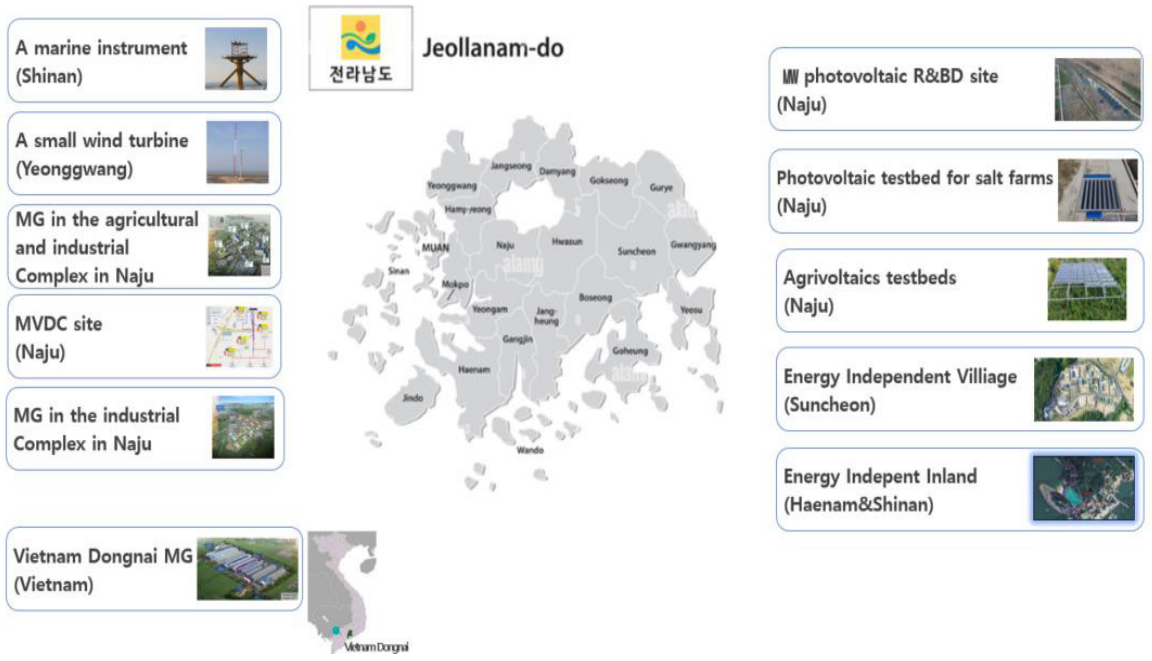

Figure 1. GEI's project sites, located in Republic of Korea

Jeollanamdo Green Hydrogen Policies

Jeollanam-do, as part of its Carbon Neutrality and Green Growth Master Plan (2024–2033), focuses on fostering renewable and clean energy–based industries as a core objective to drive new regional economic growth.
The province is advancing the development of large-scale offshore wind power systems and promoting RE100[1] implementation to expand the adoption of renewable energy.
At the same time, it is positioning clean hydrogen as a key future industry and accelerating the creation of related industrial ecosystems.

Case Project 1 - Energy Independent Island

Project Title: Samma Island Energy Independent System (Haenam, Jeollanam-do, Republic of Korea)

Budget and Duration: 2013 - 2014 (13 months) / KRW 3.34 billion (approximately USD 2,300,000)

Key Strategy: Samma Island, located 110 km off the coast of Haenam, was historically entirely dependent on diesel generators, as it had no connection to the mainland grid. Supported by Jeollanam-do Province and supervised by GEI, the project established a hybrid renewable microgrid, combining solar Photovoltaics (PV), wind, and Energy Storage Systems (ESS) to secure a stable electricity supply and reduce reliance on fossil fuels.

This initiative became a pioneering case for the Korea's off-grid island electrification.

Key Technologies Implemented:

- Solar PV systems with total capacity of 120 kW
- Ten small-scale wind turbines (3 kW × 10 units, total 30 kW)
- ESS of 1,200 kWh capacity for stable supply
- Hybrid Energy Management System (EMS) for optimal diesel-renewable balance
- Remote monitoring and control integrated via GEI's operation center

Energy Efficiency and Community Impacts:

The project strengthened local energy security, improved power reliability, and retrained diesel operators as renewable-energy technicians, supporting sustainable local employment. Now, approximately 45% of total power demand is covered by renewable energy sources, reducing the use of diesel and greenhouse gas emissions.

1) RE100 stands for Renewable Energy 100%. It is a global corporate leadership initiative that brings together hundreds of the world's most influential businesses committed to sourcing 100% of their electricity consumption from renewable sources

The original goal was 60% energy independence on the island. However, post-project electricity use increased due to improved living conditions, leaving a room for improvement in transforming the area with renewable sources by 100%.

Return on Investment / Business Model:

The project combined public funding with private expertise to create a sustainable hybrid-island business model. It was implemented through a collaboration among the Jeollanam-do Province, GEI, and the local companies Wonkang Electric, Woojin Industrial Systems, Hanwha Q Cells Korea, and SELTEC..

Key Outcomes:

- Replaced nearly half of diesel power generation with renewables (≈ 45% energy independence)
- Improved living conditions for 250 residents (85 households)
- Established Jeollanam-do's first renewable energy hybrid microgrid for off-grid islands
- Built local O&M capacity through GEI-led training and monitoring
- Provided a replicable model for future zero emission island initiatives
- Currently under a modernization plan to increase energy independence beyond 60% by optimizing diesel-renewable integration and expanding ESS capacity.

Figure 2. Samma Island Hybrid Renewable Microgrid System (PV + Wind + ESS)

Case Project 2 - Energy Independent Village based on Passive House

Project Title: Suncheon Energy Independent Village (Certified by the Passivhaus Institut, Germany)
Budget and Duration: 2017-2018 / KRW 1.3 billion (approximately USD 890,000)

Key Strategy: This project aimed to establish Korea's first energy self-sufficient residential community, embodying Suncheon City's vision of becoming an Eco-City, demonstrating a resident-participatory and sustainable housing model in practice.

The village was built under the design and construction standards of the Passivhaus Institut (PHI) in Germany. Thus, at the community level, the project integrated high-efficiency building technologies with renewable energy systems to achieve a near zero-energy and environmentally friendly living environment.

Key Technologies Implemented:

- A total of 19 detached houses were designed and constructed according to PHI's high-efficiency energy standards.
- High-performance insulation (EPS/XPS 150-200 mm) and triple-glazed windows (Kömmerling, Germany) were applied to minimize heat loss.
- Mechanical ventilation systems with heat recovery (Wolf, Zehnder) were installed to improve indoor air quality and energy efficiency.
- Each house is equipped with rooftop PV systems (3-5 kW per unit) forming a community microgrid.
- Geothermal heating, cooling systems and shading devices were introduced to reduce cooling loads.
- The village also includes a Renewable Energy Promotion Hall, integrating the entire site into a self-sufficient energy ecosystem.

Energy Efficiency and Living Impacts:

From the design stage, rooftops were planned to accommodate solar panels, and all 19 households were equipped with both solar power generation and geothermal systems for heating and cooling.

As a result, heating is supplied by geothermal energy and electricity is generated through solar photo voltaic (PV), enabling almost zero dependence on external energy sources.

Residents' monthly electricity bills, which were around KRW 450,000 on average, have been reduced to about KRW 3,000, demonstrating the tangible benefits of energy self-sufficiency.

The project evolved beyond a technical demonstration into a model of community-level energy welfare and sustainability.

Return on Investment / Business Model:

The project was jointly implemented by Suncheon City, the GEI, and local construction partners, with funding shared by local government, public funds, and residents' contributions.

This partnership established a sustainable operation model and laid the foundation for future public–private Zero-Energy Town initiatives in Korea.

Key Outcomes:

- The energy efficient houses achieved energy performance compliant with PHI standards, maintaining very low heating and cooling needs compared to ordinary homes.
- Energy savings of approximately 70-80% were achieved, according to certified PHI data.
- Recognized as Korea's first PHI-standard energy self-sufficient residential village.
- Enhanced Suncheon's identity as an ecological city and served as a leading example of renewable energy expansion in the region.
- Established a community-based energy management system operated by residents.

Figure 3 Suncheon's Energy Independent Village, Jeollanamdo

Figure 3. Suncheon's Energy Independent Village, Jeollanamdo

Case Project 3 - Energy Ecosystem

Project Title: Suncheon Energy Independent Village (Certified by the Passivhaus Institut, Germany)
Budget and Duration: 2017-2018 / KRW 1.3 billion (approximately USD 890,000)

Project Title: Palma Sports Complex Solar and ESS Integration (Suncheon, Jeollanam-do, Republic of Korea)

Duration: Completed in 2022

Key Strategy: The Palma Sports Complex in Suncheon-si is a major municipal sports facility that includes stadiums, gyms, and outdoor fields. To enhance energy efficiency and reduce electricity demand during peak hours, Suncheon City installed a rooftop solar power system and an Energy Storage System (ESS). The project supports the city's broader initiative to expand renewable energy use in public infrastructure.

Key Technologies Implemented:

- 500 kW solar photovoltaic (PV) system installed on the facility rooftop and parking structures
- 1.8 MWh Energy Storage System (ESS) for energy storage and peak-load reduction
- Energy Management System (EMS) for real-time monitoring and power optimization
- Implemented under Suncheon City's public renewable energy program in cooperation with U Energy Co., Ltd.
- Curving the shape of the PV rooftop for increased durability (i.e. stronger with high wind and snow) and aesthetics

Key Outcomes:

- Reduced dependence on grid electricity and stabilized peak power demand
- Enhanced the energy sustainability of public facilities in Suncheon City
- Provided a replicable model for solar–ESS deployment in other municipal buildings
- Increased the overall utility of public spaces

Figure 4. Suncheon's Palma Sports Complex, Jeollanamdo

Project Title: Suncheon Fruit and Vegetable Wholesale Market Solar Power and Energy Storage System (ESS)

Duration: 2019 - 2020

Key Strategy: The project aimed to enhance energy efficiency and reduce electricity cost in Suncheon's main agricultural wholesale market, a key logistics and commercial hub for regional produce. By integrating solar power and an Energy Storage System (ESS), the facility can store and utilize renewable electricity to stabilize demand and support local grid management.

Key Technologies Implemented:

- Solar power generation system with a capacity of 1 MW installed on rooftop and parking structures.
- Energy Storage System (ESS) with a capacity of 3 MWh for peak-load management and energy shifting.
- Integrated energy monitoring and control system for optimized power operation.
- Implemented under the Regional New Energy Industry Activation Program (Ministry of Trade, Industry and Energy, Republic of Korea) in collaboration with Jeollanam-do Province and Suncheon City.

Key Outcomes:

- Improved energy self-sufficiency and reduced peak-load electricity demand at a major public distribution facility.
- Contributed to Suncheon City's vision as "Korea's Ecological Capital" by reducing fossil fuel use in urban infrastructure.
- Served as a replicable model for renewable energy adoption in public and commercial facilities across Jeollanam-do.

Figure 5. Suncheon's Wholesale Market, Jeollanamdo