Promoting Renewable Energy Consumption

The Cases of Kitakyushu and Seoul

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ICLEI Local Governments for Sustainability EAST ASIA

Background

Increasing the share of renewable energy in the global energy mix is imperative for addressing climate change. While much attention has been given to the supply side of renewable energy expansion, including the establishment of solar and wind farms, the equally critical aspect of encouraging consumers to utilize more energy generated from renewable sources should not be overlooked. This case study sheds light on the measures implemented by Kitakyushu and Seoul to promote the consumption of renewable energy.

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Kitakyushu: 100% Renewable Energy Model

Background

Kitakyushu has pledged its commitment to contributing to global climate change mitigation efforts, setting a target to achieve net-zero greenhouse gas (GHG) emissions by 2050. As outlined in its net-zero roadmap, the city aims for a substantial reduction of at least 47% in GHG emissions by 2030.

A prominent facet of Kitakyushu's decarbonization strategy centres on the expansion of renewable energy sources. To expedite the adoption of renewable energy and stimulate innovation in related technologies, Kitakyushu introduced the Kitakyushu Model for 100% Renewable Energy in February 2021 and 100% Renewable Energy Certification System in December 2021.

The two initiatives are tailored to drive the transition to renewable energy in two key sectors: public facilities and private companies. Concerning public facilities, Kitakyushu plans to shift the power sources of all municipal establishments–comprising around 2,000 facilities–to a 100% renewable energy framework by 2025. The effort encompasses facilities for which the City Government is responsible for electricity bills. For the private sector, the city is dedicated to accelerating the integration of power generated from renewable sources. Beyond the core decarbonization objective, the initiatives encompass broader aspirations, including the realisation of an "advanced battery system city" and contributing to achieving Sustainable Development Goals (SDGs).

Actions

Public sector

From 2021 onward, the Kitakyushu Model for 100% Renewable Energy is designed with a three-step framework to facilitate the transition towards renewable energy utilisation at public facilities (Kitakyushu City Government, 2021a).

- Step 1: Integration with existing renewable power sources. Public facilities are connected to readily available renewable energy sources, including wind farms and biomass energy. The city is strategically expanding its utilisation of biomass power (waste-to-energy) at public facilities, with projections for connections to reach 200, 600, and 1,200 facilities in 2021, 2022-2023, and 2024-2025, respectively.
- Step 2: Implementation of solar panels and battery systems at public facilities. Third-party entities are entrusted with the installation of solar panels and battery systems at public facilities. The electricity generated from solar panels is managed by Kitakyushu Power Company. Moreover, surplus energy generated by solar panels and local renewable sources is stored within batteries. The stored energy is optimally utilised during peak hours characterised by high electricity cost, thereby contributing to reducing electricity costs.

- Step 3: Installation of energy-efficient equipment. In scenarios involving construction or facility renovation, energy efficient equipment is installed. This approach enhances overall energy efficiency and curtails the total power consumption.

In the execution of this project, Kitakyushu has embraced the “Usage Rather Than Ownership” business model (Kitakyushu City Government, 2021a). This approach eliminates the initial costs of renewable energy equipment. Under this business model, solar panels, batteries, and other energy efficient equipment are owned by third parties. The government needs to pay a fixed usage fee for equipment and electricity bills, bypassing the need for upfront costs. For a comprehensive overview of the pivotal stakeholders and their respective roles, refer to Figure 1.

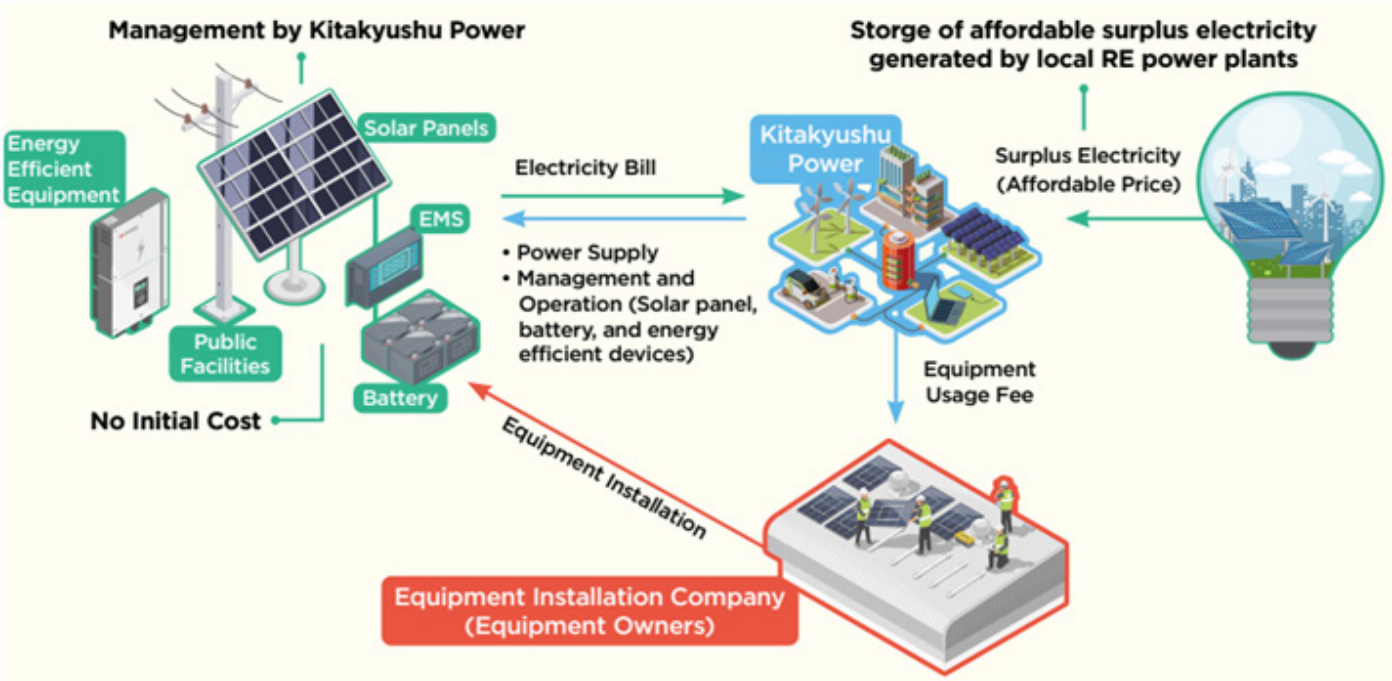


Figure 1: System Structure of Kitakyushu Model for 100% Renewable Energy at public facilities (Translated and adapted from Kitakyushu City Government, 2021a) (EMS: Energy Management System)

Private sector

Following the initiation of efforts to transition public facilities to renewable energy, Kitakyushu introduced 100% Renewable Energy Certification System to accelerate the integration of renewable power within private enterprises. Under this system, companies utilising power sourced exclusively from renewable energy or other decarbonized sources are eligible to seek certification from the government (Kitakyushu City Government, 2021b). The process for application and certification is outlined in Figure 2.

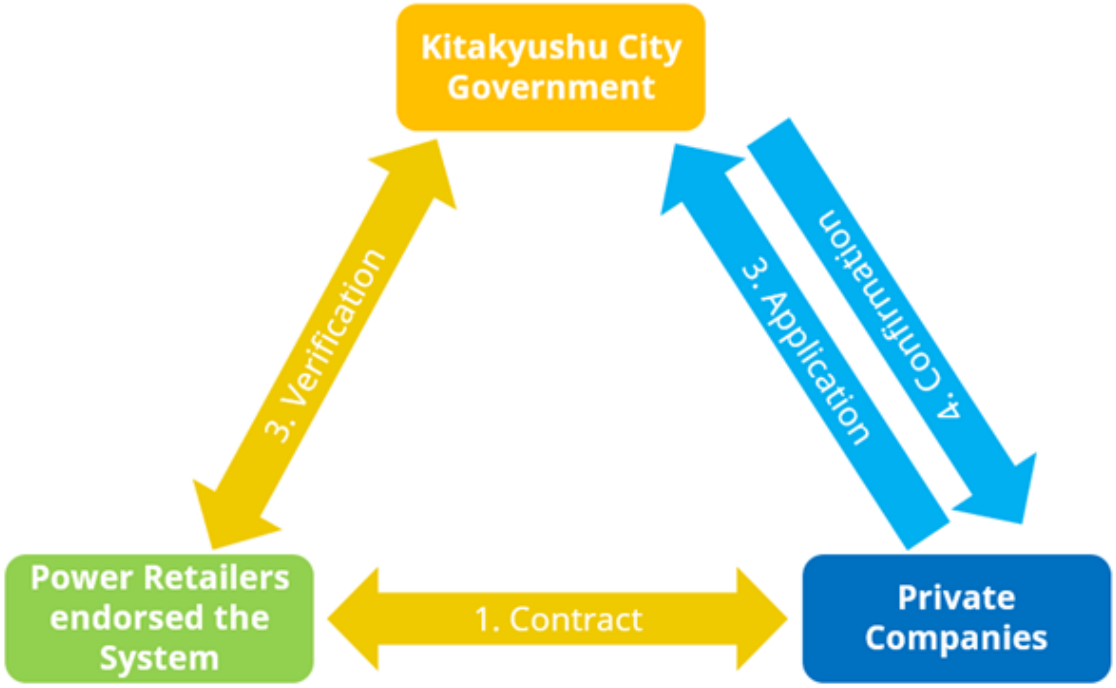


Figure 2: Overview Diagram of Kitakyushu City Decarbonized Electricity Certification System (Translated and adapted from Kitakyushu City Government, 2021b)

To encourage companies to participate in the certification system, the government provides the several benefits for certified entities, including:

- Authorization to utilise the certification sticker and logo on promotional materials and business cards.
- Consideration of additional evaluation points during government subsidy assessments
- Eligibility for low-interest loans while participating in municipal projects
- Publicity on the city's website and social media platforms

Furthermore, the initial 100 certified companies will be recognized as "Decarbonization Pioneering Companies", meriting a special certificate to acknowledge their pioneering role.

To meet the increasing demand from the above renewable energy adoption initiatives, Kitakyushu is focusing on three pillars of renewable energy generation: wind power, energy storage, and hydrogen. Firstly, wind power stands as a foundational energy source for Kitakyushu, fortified by the city's designation as a hub port and the advantageous wind conditions prevalent in the Hibikinada Sea. The city has incorporated wind power, especially offshore wind. Secondly, with the increasing integration of renewable energy, energy storage assumes paramount importance. Kitakyushu's blueprint entails the widespread deployment of storage batteries. Thirdly, Kitakyushu has undertaken demonstration projects within the Kitakyushu Hydrogen Town to foster the advancement of hydrogen technology.

Figure 3: Kitakyushu's 100% renewable energy certification sticker (Source: Kitakyushu City Government, 2021a)

Outcomes

By the end of 2021, 260 public facilities have converted to 100% renewable energy. By February 2023, nine power retailers had endorsed the 100% renewable energy certification system; 36 companies have joined the certification system by June 2023. Kitakyushu's effort on promoting the utilisation of renewable energy in both public facilities and private companies have yielded the following outcomes:

- Through the promotion of renewable energy adoption across public facilities and corporate entities, Kitakyushu has been instrumental in advancing the city's renewable energy deployment. The city's initiatives have fostered advancements in renewable energy-related technologies, particularly in the domains of energy storage and the reduction of battery costs.
- The concerted effort has provided invaluable insights into the societal and economic intricacies entwined with the expansion of renewable energy. This encompasses valuable lessons derived from the innovative "usage other than ownership" business model, which has facilitated the transition to renewable energy sources.
- The incorporation of locally generated renewable energy coupled with the integration of energy storage systems has fortified energy security and resilience.

Challenges

It is prudent to acknowledge that the further adoption of renewable energy in Kitakyushu is not devoid of challenges. Technical and financial hurdles pose significant considerations for sustained progress. Firstly, the proliferation of renewable energy necessitates substantial upgrades to transmission grids. Secondly, while hydrogen holds pivotal status as a renewable energy source in Kitakyushu, cost factors continue to impede its wider-scale integration.

Seoul: Zero Energy Buildings

Background

In 2012, Seoul launched the "One Less Nuclear Power Plant Initiative" to reduce energy consumption and increase renewable energy usage. The city aimed to derive 20% of its total energy supply from renewables by 2020. By 2020, the share of renewable energy reached 13.9%, as a result from challenges, including increased energy usage in commercial buildings, difficulties in finding suitable locations for photovoltaic (PV) power stations, and the economic viability of fuel cells (Seoul Metropolitan Government, 2021).

Fast forward to 2021, Seoul introduced the "Seoul Climate Action Plan" for 2050, emphasizing cities' pivotal role in addressing climate change. Seoul set clear targets to achieve net-zero GHG emissions by 2050, with a 40% reduction (equivalent to 29 million metric tons of CO2) by 2030 compared to 2005 levels (Seoul Metropolitan Government, 2021).

Concurrently, Seoul plans to significantly expand its solar panel capacity to 5 GW and hydrogen fuel cell capacity to 1 GW by 2050. The city aims to integrate Internet of Things (IoT) technology for optimized energy production and consumption, positioning itself at the forefront of sustainable energy practices and smart urban development (Seoul Metropolitan Government, 2021).

Actions

In 2018, a staggering 91% of Seoul's GHG emissions came from the energy sector, comprising buildings (68.8%) and transportation (19.2%) (Seoul Metropolitan Government, 2021). Therefore, it is imperative for Seoul to increase renewable energy usage in the building sector.

Seoul aims to transform all buildings into low-carbon, zero-energy structures. Seoul's comprehensive strategy includes the initiation of Green Remodeling project for older buildings and the imposition of Zero-Energy Building (ZEB) standards for newly constructed ones. Additionally, the city has implemented GHG emissions caps for public buildings as of 2021 and plans to gradually extend these measures to private buildings (Seoul Metropolitan Government, 2021).

Green Remodeling

Seoul has outlined plans to undertake the Green Remodeling Project for a total of 1,532 aging public buildings (30 years or older) by 2050 (Seoul Metropolitan Government, 2021). Under this initiative, these buildings will be retrofitted to significantly improve their energy efficiency, bringing them up to ZEB standards while enhancing user comfort and functionality. To oversee and manage this project effectively, Seoul has established a "Seoul City Existing Building ZEB Conversion Master Planner." The Planner supervises

old public buildings' remodeling, provides consulting and advisory services, and submits comprehensive reports. The budget for remodeling comes from the Climate Response Fund, with a 2023 budget allocation of 38 billion Korean won ($28 million USD) (Seoul Metropolitan Government, 2023a). As of 2022, the city has remodeled 174 public buildings and plans to convert a total of 544 buildings into ZEBs by 2026 (Seoul Metropolitan Government, 2023b).

Furthermore, to convert old buildings into low-carbon structures, Seoul will implement Building Energy Management Systems (BEMS) in 496 city-owned buildings with a gross floor area equal to or larger than 1,000 square meters by 2026. BEMS is an integrated system for measuring, controlling, managing, and operating, which monitors energy consumption to provide optimized building energy management solutions for a pleasant indoor environment and efficient energy utilization in a building.

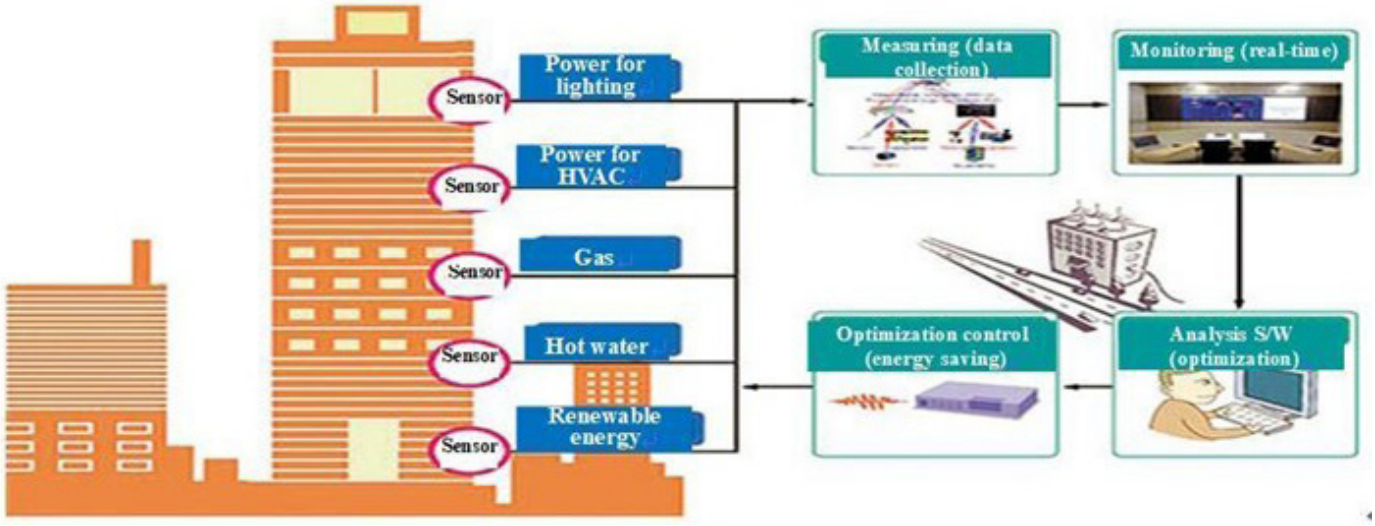


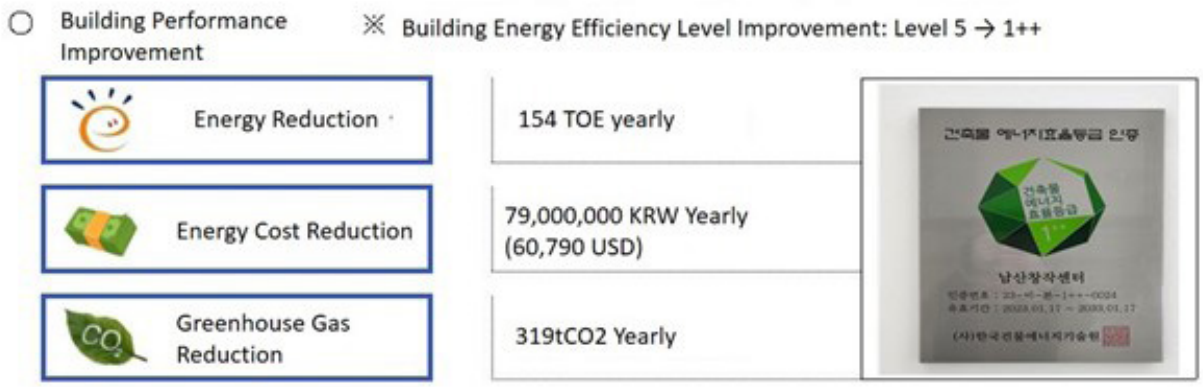
Figure 4: Diagram of BEMS (translated and adopted from Seoul Metropolitan Government, 2023b)

Namsan Creative Center represents a good example of the Green Remodeling project. In the latter half of 2020, the Seoul municipal government initiated the "Namsan Creative Center ZEB Conversion and Remodeling Project". This project aimed to catalyze the adoption of zero-energy principles in public buildings and foster ZEBs in the private sector. The city allocated 4.4 billion Korean Won ($3.3 million USD) to support this initiative.

BEFORE

AFTER

▲ The frontal view of Namsan Creative Center (source: before - Artist's Journal, 2021, after- Eco-Friendly Building Division, 2023)



▲ Energy efficiency achievements and certification of Namsan Creative Studio (translated and adopted from Eco-Friendly Building Division, 2023)

Figure 5: Achievements of Namsan Creative Studio Remodelling

The center was originally built as a gym in 1995 and later transformed into a performing arts center. However, the remodeling efforts were limited, resulting in inefficient space utilization. Post-COVID-19, virtual performances and video production gained prominence. Seoul sought to transform the center into a video content production studio for the public while promoting zero-energy buildings in response to climate change (YZ Architecture, n.d.).

Within this project's framework, the city implemented a series of enhancements, including non-combustible insulation materials, high-efficiency windows, state-of-the-art heating and cooling units, innovative heat recovery ventilation systems, and energy-efficient lighting. These measures collectively achieved a remarkable 77% reduction in the building's primary energy consumption compared to previous benchmarks. To crown these efforts, a 30KW solar power generation system was installed on the building's rooftop, resulting in an impressive energy self-sufficiency rate of 33.45% (Eco-friendly Building Division, 2023).

Zero Energy Buildings (ZEB)

The definition of ZEB may vary between countries. In Korea, the Green Building Construction Support Act defines a ZEB as "a green building that minimizes energy requirements by reducing the building's energy load and utilizing renewable energy" (Ministry of Land, Infrastructure, and Transport, 2021). In practical terms, a ZEB is a building designed with passive technology to reduce energy consumption, combined with renewable energy sources and active technology components for enhanced energy efficiency and self-sufficiency. This entails the use of passive technologies such as high insulation, air tightness in external walls and windows, along with renewable energy sources like solar power generation, geothermal systems, fuel cells, and high-efficiency heating, cooling systems, and BEMS (Seoul Energy Dream Center, 2020).

ZEB standards include:

- An energy efficiency level of 1++ (the second-highest rating) or above.
- An energy self-sufficiency rate of 20% or higher.
- Installation of BEMS or automated digital watt-hour meters (Zero Energy Buildings, n.d.).

An energy efficiency level above 1++ grade implies that the building consumes less than 90 kWh/m^2 per year for residential buildings or 140 kWh/m^2 per year for non-residential buildings. Energy self-sufficiency is determined by the ratio of energy produced per square meter to energy consumed per square meter.

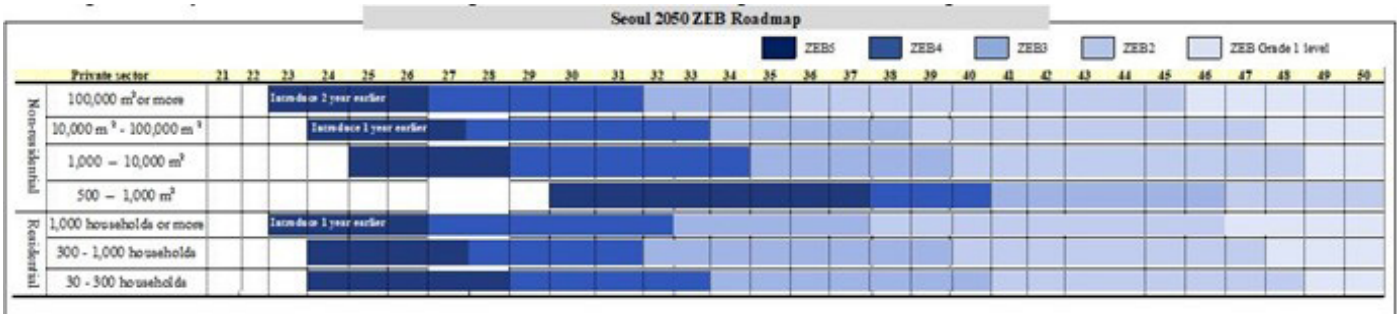


Figure 6: ZEB Roadmap (Translated and adopted from Seoul Metropolitan Government, 2023b)

Since 2021, all newly built public large-scale buildings, defined as those with a total ground area of 500 square meters or more, must adhere to ZEB standards. Seoul extended ZEB mandates to newly built residential buildings with 1,000 apartments or more, as well as non-residential private buildings with a total ground area of 100,000 square meters by 2023. Newly constructed buildings with a total ground area of 10,000 square meters will also be subject to ZEB mandates by 2024, which is 1 to 2 years ahead of the national government's roadmap. Seoul plans to implement higher levels of ZEBs gradually (Seoul Metropolitan Government, 2023b).

As of November 2023, Seoul boasts a total of 332 ZEBs. The Seoul Metropolitan Government actively promotes energy-saving technologies, such as elevator regenerative brakes and zoning control pilot projects, to enhance energy performance in various sectors (Jin, 2022). Both the national government and the Seoul Metropolitan Government offer incentives to encourage the widespread adoption of zero-energy buildings. These incentives include relaxing building standards, providing tax benefits, offering financial support, subsidies for renewable energy system installations, and funding for energy efficiency measures (Seoul Energy Dream Center, 2020). Additionally, the Seoul Metropolitan Government allows higher floor area ratios for ZEBs (Seoul Metropolitan Government, 2023b).

In addition to promoting the adoption of green buildings, separate green building management guidelines are being developed to ensure continuous and systematic management. These plans encompass the entire lifecycle management of buildings, from

green building design, construction, and completion to regular inspections during operation. The focus is on computerizing data to track and manage performance, with input from experts and supervision guidelines for construction (Jin, 2022).

To establish a sustainable foundation for green building development, Green Building Fund is being created. This fund will support research on new technologies, improve incentive standards, and educate permit holders to raise awareness and enhance the effectiveness of green building regulations (Jin, 2022).

Other renewable energy initiatives within the building sector

The city primarily focuses on expanding the adoption of renewable energy, especially solar power and hydrogen fuel cells. Additionally, Seoul aims to ensure the economic viability of other energy sources like solar thermal and geothermal through ongoing technological advancements. The city acknowledges the need to assess the operational efficiency and economic feasibility of fuel cells, particularly in building-integrated fuel cell applications. Seoul's goal is to create a smart energy city by seamlessly integrating emerging technologies such as information and communication technology and the Internet of Things (IoT) (Seoul Metropolitan Government, 2021).

Recognizing the spatial constraints often associated with traditional solar panels, Seoul actively embraces the concept of Building Integrated Photovoltaics (BIPV). A notable example is the successful implementation of BIPV at the Seoul Silver Light Hospital, supported by a total financial commitment of 3 billion KRW (approximately $2.2 million USD) from the Seoul Metropolitan Government (Seoul Metropolitan Government, 2020).

Figure 7: Before and after BIPV installation of Seoul SilverLight Hospital (translated and adopted from Energy Economy News, 2023)

Outcomes

The Green Remodeling Projects in Seoul have, on average, improved energy efficiency in buildings by 16%. As of September 2022, Seoul has successfully remodeled 118 old public childcare centers and medical facilities, resulting in a reduction of 344 tons of greenhouse gas emissions (Eco-Friendly Building Division, 2022). Additionally, by 2020, Seoul made significant strides in renewable energy deployment, achieving 305 MW of solar power capacity and 142 MW of fuel cell systems (Seoul Metropolitan Government, 2021).

Challenges

While the concept of transitioning to ZEBs is commendable, practical challenges exist within the building industry. As of September 2023, over 61% of ZEB-certified buildings barely meet the lowest Grade 5 certification standards, indicating that more than half have only met the minimum requirements for certification. For residential buildings, where a higher energy self-sufficiency rate is required, 67% of the 81 certified buildings received Grade 5 certification, while only 6 achieved Grade 1 certification (Jung, 2023).

The construction industry expresses concerns about extending mandatory ZEB certification to private buildings. Given the already high construction costs due to increased prices of construction materials, ZEB certification could further escalate building expenses. For non-residential buildings, creating ZEBs can add an additional 30-40% to construction costs, while residential complexes could see an estimated increase of approximately 4-8% compared to the standard construction cost ceiling (Jung, 2023).

Industry insiders point out that energy conservation is not a significant issue, but the challenge lies in the cost efficiency of energy production facilities. Most construction companies possess excellent insulation materials and related technologies for passive systems, providing sufficient technical expertise in energy conservation. However, the introduction of environmentally friendly energy production facilities is considered burdensome due to construction costs and ongoing maintenance expenses. For instance, solar panels may only generate enough energy to power one elevator in a building, making it cost-ineffective (Jung, 2023).

Summary

Kitakyushu and Seoul's journey towards achieving higher renewable energy share offers valuable insights for other regions seeking to pursue sustainable and comprehensive renewable energy initiatives. Key takeaways from Kitakyushu's successful transition to renewable energy include:

- Leadership of Local Governments: Kitakyushu and Seoul have demonstrated the critical role that local governments can play in driving renewable energy adoption. By harnessing their significant purchasing power, governments can exert substantial influence over the marketplace. Both cities have proactively embraced renewable energy in their public facilities, effectively increasing the market share and competitiveness of renewable energy sources.
- Private Sector Engagement: Private sector involvement is essential for accelerating the transition to renewable energy. In Kitakyushu's initiatives, private enterprises have played pivotal roles by owning renewable energy assets, deploying efficient equipment, and actively participating in certification systems. In Seoul, while promoting ZEB, the construction sector has encountered technical challenges and high costs. Addressing these challenges requires close collaboration between the construction industry and policymakers to find innovative solutions.
- Renovation of Older Buildings: Kitakyushu's and Seoul's experiences highlight the importance of addressing older buildings in the transition to renewable energy. Older buildings often emit significantly more GHG emissions compared to newer structures. Both cities have undertaken renovation projects to transform these aging buildings into energy-efficient structures, reducing their environmental impact.

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