Proposal on solutions for increasing social acceptance of the floating solar power business

By

LEE, Jae Heung

CAPSTONE PROJECT

Submitted to

KDI School of Public Policy and Management

In Partial Fulfillment of the Requirements

For the Degree of

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1. Introduction

1.1 Problem Statement & Reseach Question

As the urgency for eco-friendliness becomes more pronounced due to the abnormal weather conditions stemming from ongoing global warming, interest in harnessing renewable energy from natural sources is rapidly increasing. Consequently, the global proportion of solar and wind energy is seeing significant growth, positioning renewable energy as a key player in the energy landscape. With the inception of a new climate regime under the Paris Agreement in December 2015, the renewable energy sector continues its global expansion, with Korea actively scaling up its renewable energy industry with the aim of providing 20% of its electricity from renewable sources by 2030 (equivalent to 21.6% based on renewable energy). Internationally, Germany is set to phase out nuclear power plants by 2022 and aims to derive 60% of its energy from renewables by 2050, Japan targets 22-24% renewable energy by 2030, and France aims for 32% renewable energy by the same year. Therefore, Korea should strive to expand its renewable energy sector by effectively implementing the Renewable Energy 3020 implementation plan in alignment with these global trends.

Expanding the penetration of renewable energy presents challenges at both national and local levels, particularly concerning the expansion of solar power generation. Historically, solar energy expansion has predominantly relied on land-based installations, such as rooftops, buildings, and open land, including forests. However, land-based solar power faces increasing limitations due to constraints on available land, environmental damage concerns, and opposition from NIMBYs. In response to these challenges, floating solar technology has emerged as a viable alternative, utilizing idle water surfaces like reservoirs, dams, lakes, and seawalls. Mounting solar panels in mountainous regions requires significant land area, with approximately 1,000 square meters needed to produce 100kW of energy, ironically leading to deforestation in the pursuit of renewable energy. According to the Korea Forest Service, over

2.327 million trees were felled across the country between 2017 and 2020 to make way for on-site solar power installations, prompting government intervention to curb further expansion since 2018. Additionally, installing solar panels on fields or agricultural land raises concerns about land repurposing and speculation. Conversely, floating solar systems can harness substantial power by leveraging expansive water surfaces efficiently. For instance, the floating solar installation at Hapcheon Dam occupies merely 1.8% of the reservoir's total area. While conventional wisdom suggests that more sunlight translates to increased power generation, solar module efficiency decreases as temperatures rise above 25 degrees Celsius, particularly evident during Korean summers. Consequently, separate cooling mechanisms are necessary on land-based installations, whereas floating solar systems benefit from natural water cooling. Experiments have shown that installing modules on water surfaces can boost power generation efficiency by approximately 5% compared to land-based solar PV systems, as water helps mitigate temperature increases caused by solar radiation. Thus, this project aims to analyze the domestic and international policy landscapes, as well as the current status and challenges facing the expansion of floating solar technology within the renewable energy sector, utilizing K-water's water resources. The goal is to devise strategies to activate and harness the potential of floating solar to create future value and address evolving environmental concerns.

1.2 Global Status

The world's focus has shifted to climate change as a critical post-COVID-19 crisis. According to the 2020 World Economic Forum (WEF) International Risk Report, climate change was identified as the foremost global threat, while the UN underscored its severity by stating that climate change surpasses COVID-19 as an emergency. Consequently, a more robust climate regime, exemplified by the Paris Agreement, has been in effect since 2021, succeeding the Kyoto Protocol, which expired in 2020. Under the Paris Agreement, global climate change responses will be reviewed and promoted every five years, starting in 2023. Both developed and developing nations are subject to voluntary greenhouse gas (GHG) emission reduction commitments, aimed at limiting the global average temperature increase to well below 2°C above pre-industrial levels. Given that the energy sector contributes to over two-thirds of GHG emissions, addressing climate change within energy policy becomes increasingly imperative. However, current reduction targets submitted by countries have been deemed insufficient to meet the goal of limiting temperature rise to below 2°C, signaling the need for intensified pressure on future reduction efforts.

Major countries are pursuing diverse strategies to meet their greenhouse gas reduction targets and are implementing a range of policies to expand renewable energy usage. Germany, for instance, is advancing an energy transition policy that prioritizes phasing out nuclear power and coal while promoting renewable energy sources. It aims to reduce energy consumption by 50% by 2020, with plans to shutter all nuclear power plants by April 2020. Additionally, the Coal Commission has recommended the complete closure of coal-fired power plants by 2020. Following the Fukushima nuclear disaster in 2011, Japan halted the construction of new nuclear power plants, restarted nine out of its 41 existing plants, and decommissioned nine prematurely. France, under the Energy Transition Act of 2015, is reducing its reliance on nuclear power generation to 50% by 2020, down from 73% in 2017. Concurrently, France pursues policy objectives aimed at ensuring energy supply stability, reducing import dependency, maintaining price competitiveness, and curbing energy expenditure.

These major countries are actively implementing a spectrum of policies to achieve their renewable energy objectives, with considerations to potentially elevate their targets.

It's now common knowledge that clean energy investments, including renewables, have surpassed investments in fossil fuels. According to the International Energy Agency's (IEA) recently released World Energy Investment 2022 report, clean energy investment is rebounding as the impact of COVID-19 diminishes, projected to reach $1.4 trillion in 2022, comprising nearly three-quarters of total energy investment. In 2021, China led clean energy investment with $380 billion, followed by the European Union ($260 billion) and the United States ($216 billion). Globally, the main driver behind renewable energy investment is "grid parity" where the cost of generating electricity from renewables becomes cheaper than that from fossil fuels. The IEA report notes that as of 2022, solar and onshore wind energy are notably cheaper than coal and gas across Europe, the US, China, India, and other key countries. This trend is expected to persist as increasingly stringent climate change regulations and escalating wholesale electricity prices due to the Russia-Ukraine conflict could further elevate the relative cost of fossil fuels. Previously, renewable energy was perceived as environmentally superior to traditional power sources like fossil fuels but was seen as inferior in terms of security of supply and affordability. However, the current trajectory demonstrates that renewable energy excels in all three aspects: security, affordability, and environmental performance, surpassing traditional power generation sources.

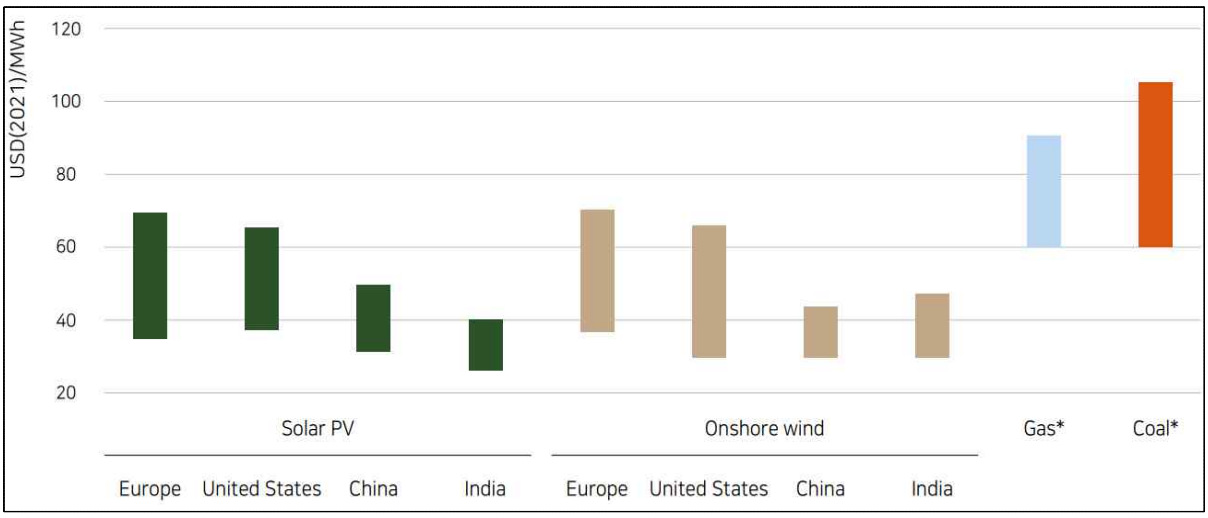

Figure 1. Global Renewable vs. Fossil Fuel Generation Costs

(IEA - World Energy Investment. 2022.06)

1.3 Domestic Status

Korea is actively pursuing the expansion of renewable energy in alignment with global trends, with strong government leadership driving the initiative. However, challenges such as low public acceptance of renewable energy and conflicts between local communities and power producers during site selection hinder its progress. Improving public acceptance is crucial for the smooth implementation of government renewable energy policies. The expansion of renewable energy is widely recognized as the most efficient method for transitioning towards cleaner energy and decoupling economic growth from fossil fuel demand by promoting energy efficiency (Yang et al., 2018). Nonetheless, this general perception of renewable energy contrasts with the views of residents in areas where renewable energy projects are being implemented. Conflicts between local communities, the government, and power producers during site selection have become significant barriers to project advancement. In fact, in 2017, 37.5% of approved solar and wind power projects faced delays or cancellations due to local opposition (Park, Doo-woong, 2018). More recently, despite the government's plan to invest KRW 7 trillion in a floating solar power project, local opposition led to a substantial downsizing of the project, prompting exploration of alternative options (Kim Woo-bo, 2019).

Moreover, wind power projects are encountering challenges stemming from resident opposition. Despite developers revising the project scale downward and reapplying for a license, resident opposition persisted, resulting in the voluntary withdrawal of the license (Kim Sang-mok, 2019). Concerning biomass, numerous plans to utilize organic waste as a raw material have been either canceled or stalled due to prolonged resident opposition, driven by apprehensions about groundwater and river pollution (Kim Jung-hye, 2018; Kim Nam-hyun, 2019). Recognizing the importance of enhancing resident acceptance for the seamless proliferation and expansion of renewable energy, the government, through the "Renewable Energy 3020 Implementation Plan," aims to bolster resident acceptance by implementing various policies. These policies include addressing the side effects of solar and wind power expansion, minimizing environmental damage, preventing safety incidents, and navigating challenging development processes (Ministry of Trade, Industry, and Energy, 2017).

Although the economic feasibility, social support, and political acceptance of renewable energy have improved due to technological advancements and enhanced policies and institutions, conflicts arising from local opposition are escalating (Lee, Sang-Hoon, & Yoon, Sung-Kwon, 2015; Lee, Chul-Yong, 2014). As disputes between operators and local residents incur significant social costs for renewable energy expansion projects, finding solutions and achieving consensus becomes imperative. Approaching social acceptance requires tailored strategies based on the recipients. While the anticipated benefits of renewable energy expansion may be advantageous for society overall, they may be perceived as disruptive by local residents, leading to issues such as landscape alteration, disruption of local ecosystems, and noise pollution. The challenge of social acceptance of renewable energy stems from the misconception of public acceptance equating to social acceptance (Lee, 2014). Therefore, it is crucial to analyze the disparity between public acceptance of renewable energy and the acceptance levels among local residents. This study aims to dissect the issue of local acceptance in each scenario and present viable solutions.

2. Literature Review

Drawing upon the findings of various prior studies, this research endeavors to identify and categorize key factors crucial for enhancing community acceptance and revitalizing renewable energy projects.

Aitken (2010) emphasized the significance of fostering positive relations between project developers and local communities, focusing on residents' perceptions of community benefits stemming from a wind power project in the UK. The study segmented the analysis into the planning, construction, and operational phases of wind farms, highlighting that decisions regarding the extent of local community involvement and the nature of benefits allocated to them were particularly intricate and contentious. Consequently, the authors advocate for the necessity of institutionalized guidelines for similar projects in the future. Such guidelines could bolster transparency, offer early-stage certainty to participants, and mitigate the risk of community benefits being misconstrued as inducements.

Drawing on interviews with key stakeholders in energy policy and industry in the UK, along with case analyses of renewable energy projects, Cass et al. (2010) present an overview of diverse stakeholders' perspectives—including developers, local residents, politicians, environmentalists, and consultants—regarding community benefit sharing from renewable projects. The authors observe significant variations in perceptions across different energy technologies, types of incentives, and levels of engagement, noting particularly high levels of ambivalence among local residents regarding both the benefits received and the underlying motives. While most stakeholders expressed support for the concept of providing benefits to local communities from a normative standpoint, the authors identified significant challenges in the detailed implementation process.

Warren and McFadyen (2010) conducted a case study in Scotland, UK, to investigate the potential influence of community ownership on residents' attitudes towards wind power. The study utilized a survey of 106 individuals to compare perceptions of wind farms under community ownership versus those under developer

ownership, aiming to ascertain whether community ownership correlates with increased public acceptance. The analysis consistently revealed that respondents residing in community-owned areas exhibited more favorable attitudes towards wind power compared to those in developer-owned areas. Although concerns regarding intermittent power generation and visual landscape disruption were prevalent among respondents prior to implementation, the majority expressed relatively positive views regarding the visual impact in both areas. Based on these findings, the authors concluded that transitioning to community ownership could yield a positive shift in public attitudes towards wind farms in Scotland.

Cowell et al. (2011) examined the role of community benefits in wind energy development from both an acceptability and environmental justice standpoint. The authors critique previous studies for predominantly viewing community benefits through an instrumental lens, wherein increased benefits are seen solely as a means to enhance social acceptance and facilitate project approval. Through empirical analysis of the Welsh region in the United Kingdom, the authors contend that the level of community benefit is contingent upon the community's ability to influence the proposed wind farm project. Rather than directly influencing social acceptance of wind farms, they posit that community benefits are perceived as a form of natural compensation for the impacts of wind farm development, thereby promoting environmental justice.

Ejdemo and Söderholm (2015) investigated the impacts of wind power investments on local development and job creation, as well as the positive effects of various benefit-sharing mechanisms, such as community funds. Their empirical analysis concentrates on community-based wind power projects in Sweden, employing model-based industry linkage analysis. Consistent with earlier research, the analysis underscores that wind farm construction fosters substantial employment opportunities within local communities. Moreover, the study reveals that the existence of benefit-sharing mechanisms, even at modest levels, significantly enhances employment growth.

Howard (2015) contends that active community backing is indispensable for sustaining the viability of renewable energy industries and advocates for a community engagement approach to empirically analyze wind farm development in Australia. Through two qualitative case studies, the authors discovered that benefit-sharing arrangements bolstered community support for wind farms, with the legal framework playing a role in solidifying residents' engagement in the process.

Building on the premise that small-scale, decentralized, community-owned renewable energy will be pivotal in realizing a low-carbon energy system in the future, Strachan et al. (2015) investigated the challenges faced by the UK in scaling up community-owned renewable businesses and explored potential shifts in this landscape. The authors advocate for joint ownership ventures and community ownership facilitated through community benefits provision as primary pathways for advancing community-based renewable energy projects, although a combination of both approaches can also prove effective.

Applying abductive logic, Hammami et al. (2016) pinpointed factors influencing community acceptance of renewable energy technologies by examining wind energy projects in Tunisia. Amidst an array of macro and micro factors, benefit sharing emerged as a pivotal element in fostering community acceptance. Specifically, the authors delineated three mechanisms through which benefit sharing enhances community acceptance of renewable energy: fostering a heightened sense of community, facilitating increased social interaction, and promoting heightened spatial awareness.

Kerr et al. (2017) highlighted the growing trend of offering financial incentives to local communities, such as benefits payments and compensation schemes, to foster support for renewable energy projects. They conducted a comprehensive examination of the different methods, implications, and dynamics of these incentives, drawing insights from three case studies in the UK. The authors underscored the wide variation in incentive provision levels, institutional arrangements, and negotiation processes across renewable projects, a facet not extensively explored in existing research. By synthesizing the findings from the case studies, the authors contended

that the diversity of incentives is shaped by power dynamics between project developers and local communities, advocating for policy initiatives to prioritize enhancing the relationship between these stakeholders.

Prominent Korean studies concerning renewable energy projects encompass works by Lee Chul-yong (2014) and Lee Sang-hoon et al. (2015). Initially, Lee (2014) advocates for the adoption of a community power plant model, entailing profit-sharing with local residents, to bolster societal acceptance of renewable energy. Specifically, he highlights wind power as a particularly contentious renewable energy source and anticipates that the community power plant model would prove instrumental in advancing wind power projects in Korea. Building on this assessment of the prevailing landscape, the study proposes a novel model for Korean renewable energy community power plants, outlining participation targets, participation rates, and incentivization strategies.

Sang-Hoon Lee et al. (2015) underscored the significance of distributive justice in bolstering resident acceptance of renewable energy. They conceptualized distributive justice as a benefit-sharing mechanism, highlighting community power plants as the most effective and direct approach among various systems. In such plants, residents engage in the ownership and operation of renewable energy generation facilities within their communities. Building on this foundation, the study proposes three avenues to enhance resident acceptance of wind power facilities in Korea. These approaches, informed by literature review, case studies, and stakeholder interviews, include public agency-led initiatives, local association-driven efforts, and crowdfunding initiatives.

A review of both domestic and international studies on community participation in renewable energy projects reveals a predominance of qualitative methodologies, often relying on case analyses, expert surveys, and in-depth interviews. Many of these studies converge on the conclusion that community participation programs, including profit-sharing systems, yield positive outcomes for community acceptance of renewable energy facility construction and associated projects.

3. Case Study

Through the analysis of diverse international cases aimed at enhancing social acceptance of renewable energy, our objective is to identify and categorize common factors crucial for business revitalization. To achieve this goal, we will examine current instances of resident conflicts and resolutions associated with international renewable energy development projects.

3.1 International Dispute Cases and Solutions

Spain serves as an exemplar of a nation where local governments have proactively harnessed renewable energy to propel local industry development, garnering positive reception from residents. In the case of La Muela, the local government introduced a wind farm in an economically disadvantaged area to foster job creation and economic revitalization, channeling wind power profits to enhance the quality of life for locals. Rather than burdening the local populace with the project's adverse effects, profits are reinvested into the community, ensuring that residents benefit. Similarly, in the Navarre region, systematic support from the regional government, wind development initiatives, attraction of related enterprises, and eco-friendly management have collectively rejuvenated the local economy, earning enthusiastic backing from residents (Ministry of Industry and Resources, 2006).

Figure 2. Wind farm in La Muela, Navarre

Denmark stands out as a country that has actively sought to understand and address barriers to the social acceptance of wind energy by aligning its national policy with comprehensive strategies. Over several years, the Danish Energy Agency (DEA) has supported research on Low Frequency Noise from Wind Turbines (Delta 2010), demonstrating a commitment to addressing concerns related to wind energy. The Renewable Energy Act, implemented in January 2009, identified four key factors integral to fostering social acceptance of wind energy, emphasizing the nation's deliberate efforts to promote a harmonious relationship between wind energy projects and the community (IEA, 2013).

• Compensation for Property Value Loss:

- The "Property Loss Compensation Scheme" provides clear guidelines for compensating property owners if their values decrease due to the construction of new wind turbines.

• Local Residents' Ownership Rights:

- Ensuring the participation of local residents, those within a 4.5-kilometer radius of the turbine, by guaranteeing their right to purchase a minimum of 20 percent of the turbine's ownership interest.

• Green Plans for Scenic Enhancement:

- The Renewable Energy Act mandates the Minister of Climate and Energy to formulate a "green plan" that enhances the scenic and recreational value of areas.

- Subsidies are provided for projects in municipalities that offer landscaping, recreational opportunities, cultural activities, and information programs. The funding is tied to the number of wind installations in the municipality.

• Funding Guarantees for Preliminary Studies:

- Provision of funding guarantees to assist in raising funds for preliminary studies.

- Local wind turbine owner associations can establish funds to support early business development activities, including wind resource assessments, environmental assessments, turbine purchase negotiations, and regional meetings (DEA, 2009).

France has instituted a support system for areas surrounding tidal power plants. Here, local governments and electric power companies collaborate to devise and execute plans aimed at revitalizing the local economy. If the local government secures necessary financial resources from a national bank, the electric power company either arranges loans or partially covers the costs. This support framework for areas surrounding power plants encompasses a comprehensive localization system, with key components including: prioritizing maintenance of essential infrastructure to facilitate a social life for employees comparable to that in urban areas; conducting facility maintenance geared towards human resource development to maximize local employment opportunities; and fostering holistic regional development. Furthermore, the French government seeks to bolster local tax revenues and stimulate the local economy by introducing power generation facilities to counterbalance opposition to various power generation projects. Under this framework, local governments are mandated to collect a portion of taxes paid by power generators at a fixed rate, while power generators bear the costs of reliability inspections for power generation facilities and contribute to the preservation of water resources in terms of both quantity and quality (Ministry of Knowledge Economy, 2009). Moreover, the cost of constructing a bridge in the area was redirected towards building a seawall for the tidal power plant, enhancing local financial efficiency. Additionally, a two-lane road was established from Saint-Malo to Dinard along the crest of the seawall dam, reducing the distance from 45 kilometers to 15 kilometers. This route is now utilized by 26,000 motorists daily.

Figure 3. Rance Tidal Power Plant in France

Germany has allocated funds for research and development aimed at assessing and mitigating the environmental impact of offshore wind farms. Since 2002, the German Ministry for the Environment has supported the construction and operation of three research platforms in the North Sea and Baltic Sea, situated near Germany's initial offshore wind farms. These platforms serve to scientifically investigate the potential impacts of offshore wind turbines on marine mammals, seabirds, bird migration, seabed fauna, and fish populations (IEA, 2011). Additionally, 70% of tax revenues generated from wind farms are designated for the region where the project is situated, with the remaining 30% allocated to the region where the operator is registered. This allocation ensures that wind farms yield immediate benefits for the local community and provide direct compensation for associated issues such as noise and landscape disruption (IEA, 2013).

In February 2009, the Ontario government introduced the Green Energy Act, aimed at fostering new green jobs, nurturing an environmentally sustainable economy, and expanding the renewable energy sector to safeguard the environment and combat climate change for future generations. To enhance social acceptance of renewable energy, the Green Energy Act incorporates measures to create new green jobs in Ontario, particularly crucial given the region's economic challenges stemming from the decline of manufacturing. Additionally, the Act seeks to bolster the economy of Indigenous communities by facilitating the development and implementation of

renewable energy projects in collaboration with Indigenous groups. Furthermore, the Act established a Participant Funding Program (PFP), designed to offer financial support to various stakeholders—including NGOs, businesses, and residents—who may disagree with project proponents regarding transparency and information dissemination. The PFP empowers stakeholders to actively engage in investigations pertaining to environmentally sensitive or large-scale national projects. This framework not only facilitates the participation of residents with an interest in the project but also allocates funds for investigations conducted by nearby residents, private organizations, and local groups with vested interests in the project.

In the Netherlands, a "nature inclusive design" policy has been established to ensure that plans for wind turbines and nature development proceed concurrently and synergistically as a single project. An exemplary instance of this approach is observed in the Noord-Oost Polder project, where a ramp installed to prevent ship collisions with farms was deliberately designed to double as a bird sanctuary. Spanning a nature reserve designated under the EU's Natura 2000 directive, this project encompasses 86 turbines generating 516 MW of power, exhibiting an overall positive impact on local wildlife and bird (particularly duck) populations. Similarly, in the Delfzijl project situated in the northeastern Netherlands, an additional dam was constructed within the wind farm to serve as a nesting sanctuary for gulls. Remarkably, the gull colonies expanded in size following the establishment of the wind farm, transforming what was initially perceived as a threat into an opportunity and garnering additional support (IEA, 2013).

Table 1. Country-specific policy points

Country	Policy	Main Content
Spain	Giving back to the community	- Utilizing renewable energy as a medium for fostering local industries through local government initiatives
Denmark	Research funding	- Funding research on low-frequency noise from wind turbines
	Renewable Energy Law	- Guarantees of property value lost due to new wind turbines - Option for local residents to purchase a stake in the wind turbine - Green planning to enhance the scenic and recreational value of the area - Funding guarantees to help raise money for preliminary studies
France	Power Plant Neighborhood Assistance Program	- Facility maintenance for the purpose of human resource development to employ local residents near the plant location
Germany	Research support	- Estimating the environmental impact of offshore wind farms and funding research and development to reduce it.
	Profit Sharing	- Benefit local communities through the allocation of tax revenues from wind farms
Canada	Ontario Green Energy Law	- Economic stimulation through the development and establishment of renewable energy projects with indigenous communities
	Participant Funding Program	- Supporting the costs incurred for participation in the environmental assessment process to facilitate public participation in the environmental assessment.
Netherlands	Design for nature	- Operate as a single project with a wind turbine plan and a nature development plan in parallel

By scrutinizing policy cases from abroad aimed at enhancing the social acceptance of renewable energy, we identified common challenges and corresponding solutions proposed in each context. Building upon these proposed solutions, we delved into the disputes arising during domestic renewable energy projects and examined the proposed remedies to address them.

Table 2. Causes of disputes and suggested solutions abroad

Problem		Solutions
1 Environmental concerns		1 Environmental monitoring
2 Local selfishness		2 Landscape improvements
3 Lack of information		3 Local job creation
4 Institutional challenges		4 Policy support
5 Complaints about rewards		5 Profit sharing

3.2 Domestic dispute cases and solutions

Domestic conflicts primarily arise from disputes with local residents stemming from the establishment of solar and wind power projects. Common triggers for these conflicts include environmental concerns such as water and soil contamination, ecosystem degradation around power plants, and disruptions to crops and livestock due to electromagnetic waves and noise. Additionally, residents may experience a decline in property values due to factors like electromagnetic waves, noise, and landscape alterations. Health and safety apprehensions, including potential disease outbreaks linked to pollution and safety hazards associated with facilities, further contribute to tensions. Dissatisfaction with profit distribution methods and profit margins also serves as a significant source of contention.

Table 3. Causes of conflict in renewable energy projects

Renewable Energy	Environmental Pollution	Crop and livestock damage	Landscape damage	Noise	Decreased home and land values	Health and safety	Unsatisfied business methods
Land Solar (Sinan, Jeollanam-do	√	√	√	√		√	√
Onshore wind power (Yeongwol, Gangwon)		√	√	√		√	√
Onshore wind power (Ueryeong, Gyeongnam)	√	√	√	√		√	√
Onshore wind power (Gangwon Gangneung)	√	√	√	√		√	√
Offshore wind power (Namhae, Gyeongnam)	√	√				√	√
Offshore wind power (Buan, Jeonnam)	√	√				√	√
Biomass (Gunsan, Jeonbuk)	√		√		√	√	√

Table 4. Causes of disputes and proposed solutions in Korea

Problem		**Solutions**
1 Environmental concerns 2 Crop, livestock damage 3 Falling house and land prices 4 Health and safety 5 Unsatisfied business methods		1 Environmental monitoring 2 Landscape improvements 3 Local job creation 4 Policy support 5 Profit sharing

In the domestic dispute case, issues were identified based on the unique regional characteristics of Korea, distinct from overseas cases. However, it was noted that the proposed solutions to address these issues were similar. We opted to defer the analysis of this to the next section and instead focused on assessing whether these solutions could be applicable to floating solar projects. Although no complaints were reported regarding crop and livestock damage or reductions in property values, conflicts with local governments responsible for permitting facility installations arose. This was resolved by offering comprehensive solutions to persuade local governments and by raising awareness about floating solar initiatives.

Table 5. Causes of conflict in Floating solar projects

Region (Capatity)	Environmental Pollution	Crop, livestock, & fishery damage	Landscape damage	Decreased home and land values	Health and safety	Unsatisfied business methods	Conflict with local governments
Hapcheon Dam (40MW)	√		√			√	
Chungju Dam (3MW)	√				√	√	√
Boryeong Dam (2MW)	√				√	√	√
Gunwi Dam (3MW)	√		√		√	√	√

Table 6. Causes of disputes and proposed solutions in Floating solar projects

Problem		Solutions
1 Environmental concerns 2 Crop, livestock, & fishery damage 3 Conflicts with local governments 4 Health and safety 5 Unsatisfied business methods		1 Environmental monitoring 2 Landscape improvements 3 Local job creation 4 Policy support 5 Profit sharing 6 Education to improve awareness

4. Proposal of solutions for invigoration of business

4.1 Establish community support and benefit sharing guidelines

In ongoing renewable energy development endeavors, the project owner assumes all responsibilities pertaining to compensation, support, and consultations with local residents following project licensing. While monetary compensation for local residents is commonly provided in most renewable energy projects, including wind power development, the absence of standards or guidelines has led to significant variations among individual projects, sparking conflicts between regions and residents. Of particular concern is that most local residents become aware of renewable energy development only during the public notification and local opinion collection phase of the environmental impact assessment, which occurs after project licensing. It is at this juncture that opposition from local communities toward renewable energy projects is most pronounced. Consequently, in the current framework for advancing renewable energy projects, the licensee of the power generation project remains detached from social conflicts, such as local opposition, with the burden of any project delays resulting from local opposition resting entirely on the project owner. Local residents' grievances are typically addressed by officials from local environmental agencies, who engage in negotiations on the environmental impact assessment with local governments.

The absence of standardized compensation and support protocols for residents poses challenges for entities engaged in renewable energy development projects, impeding project implementation significantly. To address these issues and foster the expansion of renewable energy, it is imperative to establish and rigorously enforce official standards or guidelines governing compensation, support for residents, and profit-sharing schemes for such projects. This initiative should be spearheaded by the licensee of the renewable energy development project.

Effective resident acceptance relies on the establishment of reasonable compensation support standards. Given that renewable energy power generation projects typically operate for extended periods, often spanning 10 to 20 years or more, government incentive programs are often structured for long-term implementation, commonly set at 20 years. Consequently, it becomes challenging to reduce the initially guaranteed compensation within the implementation period. As the government aims to supply approximately 4 GW of new renewable energy facilities annually by 2030, a policy of expanding the supply of renewable energy facilities that ensures more than adequate compensation may lead to a future increase in the tax burden on citizens, sparking controversy over reverse discrimination. Conversely, a compensation policy that fails to meet residents' expectations will lose its effectiveness. Thus, it is imperative to establish reasonable compensation support standards promptly. The government should maintain a consistent incentive policy and refrain from introducing overly generous compensation policies aimed at achieving short-term gains.

Conversely, a study conducted by the Energy Economics Research Institute in 2017 reveals that while public acceptance of renewable energy generation facilities may be low, overall public acceptance of renewable energy is notably high. Consequently, aside from enhancing local public acceptance, increasing public participation in renewable energy through an incentive system could be a viable approach to bolstering public acceptance in the long term. Presently, only "local residents" residing within a 1km radius of a renewable energy power generation

facility qualify for participation incentives. Hence, incentives should not only target local residents but also extend to ordinary citizens engaging in renewable energy generation projects through cooperatives or crowdfunding. This would facilitate the creation of conditions conducive to establishing a renewable energy business model that involves all citizens. Furthermore, given the challenge of promptly improving resident acceptance, the government should strive to elevate resident acceptance to the level of general public acceptance over the long term. In the interim, both central and local governments should take proactive measures to secure sites for renewable energy projects by introducing a "planned location" system.

4.2 Share and expand the social legitimacy of renewable energy policies

Although early renewable energy policies and facilities have primarily focused on strategies offering economic compensation to mitigate inconveniences and burdens for local residents, relying solely on monetary compensation or benefits for individual residents has its limitations in enhancing acceptance of government policies. In certain instances, despite the assurance of reasonable financial compensation and benefits, local residents and stakeholders persist in opposing renewable energy facilities.

To enhance public acceptance, it's crucial to foster a positive social perception of renewable energy generation facilities while also increasing awareness of their negative aspects. Particularly, rural residents tend to be less receptive to policies compared to their urban counterparts, potentially due to insufficient specific information about renewable energy, given its prevalence in non-urban areas. While opposition to renewable energy often stems from concerns about environmental impacts and democratic processes, there's also significant resistance to profit maximization and monopolization by private companies. Consequently, environmental organizations may oppose certain power projects while advocating for community-led and community-managed alternatives.

Conversely, it has been noted that residents' opposition to renewable energy deployment in their own areas, despite understanding its importance and supporting it

generally, should not be dismissed as a simple NIMBY (Not In My Backyard) phenomenon. Structural analysis of social disparities indicates that factors such as inadequate democracy, conditional support, and personal interests contribute to the local opposition to renewable energy projects, despite their overall high levels of support. These conflicting behaviors arise when residents perceive inadequate compensation or feel ignored by operators during the installation and operation of renewable energy projects.

To enhance community acceptance, it is essential to provide objective information and ensure a fair process, enabling residents to form a balanced understanding of the project. When processes are perceived as fair, people are more inclined to accept and trust their outcomes. Currently, residents may perceive the consultation process for power projects as solely focused on environmental impact assessments rather than on project acceptance itself. Establishing a transparent and equitable process to gather local opinions throughout project implementation is crucial. Final decisions should be reached through discussion, consultation, and respect for the majority opinion.

In cases of conflict regarding the siting of renewable energy projects, operators have often set short notice periods for public meetings and information sessions, or have even prevented opponents from attending altogether. These approaches have proven counterproductive, as they foster mutual distrust and suspicion, exacerbating the conflict. It's essential for residents to feel respected in their interactions with operators and licensing authorities. The lack of communication between businesses, licensing authorities, and residents undermines mutual trust. As conflicts escalate, residents become suspicious of information provided by operators and municipalities, widening the gap between stakeholders' perspectives. To address this, operators and municipalities must provide accurate information to residents and engage in ongoing dialogue to foster trust.

When examining cases of social conflicts stemming from renewable energy development projects in Korea, a consistent trend emerges: the absence of a long-term

deployment plan for renewable energy and the lack of an organization to coordinate social conflicts, notably local opposition, represent significant hurdles in renewable energy development. Additionally, there is widespread misrepresentation of wind and solar power, the primary forms of renewable energy development, hindering objective discussions on the topic. To address social conflicts arising from renewable energy development, it's imperative for all stakeholders—including the energy development ministry, business owners, and local residents—to recognize the necessity of expanding renewable energy and the challenges posed by social conflicts. Collaborative efforts are needed to find solutions to these issues.

Current social conflicts related to renewable energy stem largely from the Ministry of Trade, Industry and Energy's practice of licensing renewable energy power generation projects without adequately considering the anticipated social and environmental impacts of such development. This approach shifts the responsibility for resolving conflicts arising during the power generation process to operators and other ministries, leading to unresolved issues. To address these inefficiencies, the energy development ministry must take proactive steps to resolve social conflicts surrounding renewable energy development and promote its expansion. While some local residents legitimately require compensation and support due to direct impacts from renewable energy projects, there are instances of excessive compensation demands, especially in areas with minimal environmental impact. Instead of blanket opposition and excessive compensation demands, local residents should engage constructively in renewable energy projects and explore revenue-sharing opportunities. Renewable energy project entities should prioritize coexistence with local communities and minimize environmental impacts. This requires transparent communication with residents from project inception, proposing coexistence measures, and considering alternative locations, scales, and land use plans to mitigate environmental damage and ensure optimal social and environmental outcomes.

5. Conclusion

5.1 Summary

Renewable energy projects play a vital role in sustainable energy provision, but their success hinges on fostering positive relationships with local communities. This entails establishing clear compensation and support standards, fostering transparent communication, and ongoing management of social acceptability. By doing so, renewable energy projects can achieve mutually beneficial outcomes with local communities, ensuring the sustainability of energy provision. A primary driver of conflict between renewable energy projects and local communities is the absence of standardized compensation and support protocols. Currently, these aspects are determined and executed solely by project owners, often resulting in grievances over inadequate compensation or perceived unfairness. Therefore, the establishment of standardized guidelines for fair compensation and support to local residents is imperative. Insufficient information dissemination is another source of conflict. In many instances, residents are not adequately informed or consulted during the planning and implementation phases of renewable energy projects, leading to feelings of neglect and disenfranchisement. To mitigate such tensions, it is crucial to proactively provide residents with comprehensive information and solicit their feedback to explore suitable alternatives. Furthermore, effective conflict resolution necessitates robust communication and collaboration with residents. Actively soliciting and incorporating residents' input into decision-making processes fosters a sense of inclusivity and fairness. Through open dialogue and consultation, mutual understanding and compromise can be achieved, ultimately enhancing social acceptance of renewable energy initiatives.

5.2 Limitations & future reseach

Ultimately, the sustainable advancement of renewable energy projects hinges on the proactive engagement of governments and local authorities. Policy backing for

setting compensation and support benchmarks, as well as fostering dialogue with residents, is paramount. Simultaneously, businesses must collaborate with communities to develop sustainable business frameworks and uphold their social obligations. Through these collective endeavors, renewable energy initiatives can address conflicts with local communities and attain sustainable growth. It's imperative for all stakeholders to collaborate in securing a sustainable energy provision for the future.

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