A Study on Enhance of Social acceptance for Floating Solar Power using Shared Water Surface : Focusing on in-depth interviews of Floating Solar Power development managers

By

KOH, Ji Hun

CAPSTONE PROJECT

Submitted to

KDI School of Public Policy and Management

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For the Degree of

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Committee in charge:

Professor Lee, Junesoo, Supervisor — Junesoo Lee

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ABSTRACT

Korea is a country that emits large amounts of greenhouse gases, so Korea plans to drastically expand the supply of renewable energy to supply and demand eco-friendly energy while keeping pace with the changes in global energy policy stances caused by climate change. Especially, it plans to supply most of renewable energy with solar and wind power. In order to meet the government's recent renewable energy policy, Korea Water Resources Corporation (K-water) and Korea Rural Community Corporation are expanding large-scale floating solar power projects using water surface.

In promoting floating solar power projects, issues of 'environmental' related to water pollution, water ecological disturbance, heavy metal extraction, electromagnetic wave-related environmental hazards, and damage to the landscape are raised. And there are problems with delayed or terminated projects due to public opposition to development caused by damage to residents in the development area.

Experts think that 'environmental' and 'resident acceptance' are the biggest problems in large-scale floating solar power development. In order to solve the environmental problem, it is necessary to comprehensively study the impact on water quality and aquatic ecosystems and environmental risks from a mid- to long-term perspective through continuous monitoring. And by sharing objective facts with the residents, we will be able to resolve doubts about the environmental problem. And resident acceptance can be enhanced when it is shared with the residents as a real benefit by forming a trust relationship through continuous communication with local residents, and by sharing the profits generated through the project with the business operator and local residents. From the initial planning stage to the construction and operation of the project, the business can be smoothly promoted only by considering the major issues, response plans, decisions, and expected effects response plans.

In this study, an in-depth interview was conducted on the floating solar power development of Chungju Dam and Hapcheon Dam to experts participating in the development of floating solar power projects. Opinions were collected and analyzed to improve the social acceptability of floating solar power generation. It is meaningful that it presents effective strategic implications.

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Korea is a country that emits large amounts of greenhouse gases, which are the main cause of global warming. The total amount of greenhouse gas emissions in 2017 was 709.1 million tons CO_2eq., an increase of 142.7% compared to 1990 and 2.4% (16.6 million tons CO_2eq.) compared to the previous year. Among the 36 Organization for Economic Cooperation and Development (OECD) member countries, it is estimated to be the fifth place after the United States, Japan, Germany and Canada.

Table 1. Greenhouse gas emissions by year

(Unit : million tons CO_2eq.)

Classification	1990	2000	2010	2015	2016	2017	Increase/decrease rate compared to 1990 (%)	Increase/decrease rate compared to 2016 (%)
Energy	240.4	411.8	566.1	600.8	602.7	615.8 (86.8%)	156.2	2.2
Industrial process	20.4	51.3	54.7	54.4	52.8	56 (7.9%)	174.1	6.0
Agriculture	21	21.2	21.7	20.8	20.5	20.4 (2.9%)	-2.6	-0.3
LULUCF*	-37.7	-58.3	-53.8	-42.4	-43.9	-41.6	10.1	-5.3
waste	10.4	18.8	15	16.3	16.5	16.8 (2.4%)	62.2	2.0
Total emissions (except LULUCF)	292.2	503.1	657.6	692.3	692.6	709.1 (100%)	142.7	2.4
Net emissions (include LULUCF)	254.4	444.8	603.8	649.9	648.7	667.6 (94.1%)	162.4	2.9

* LULUCF: Land Use, Land Use Change and Forest

[Source: Ministry of Environment, Greenhouse Gas Inventory & Research Center of Korea. (2019). National Greenhouse Gas Inventory Report of KOREA]

Table 2. Total greenhouse gas emissions by country

(Unit : million tons CO_2eq.)

Classification		1990	2000	2016	2017 (As of 2019.9)	Increase/decrease rate 1990-2016 (%)	Increase/decrease rate 2015-2016(%)	source [1]
1	China	-	-	12,205[2]	-	-	-0.5	UNFCCC, IEA
2	USA [3]	6,371	7,232	6,492	6,457	1.9	-2	UNFCCC
3	India	-	1,524	2,687[2]	-	-	2.5	UNFCCC, IEA
4	Russia	3,187	1,901	2,097	2,155	-34.2	0.2	UNFCCC
5	Japan[3]	1,270	1,375	1,306	1,290	2.8	-1.2	UNFCCC
6	Brazil	551	728	956[2]	-	73.6	-7.7	UNFCCC, IEA
7	Germany [3]	1,251	1,045	911	907	-27.2	0.4	UNFCCC
8	Indonesia	267	520	822	-	208.2	2.4	UNFCCC
9	Iran	251	443	742[2]	-	196.3	1.8	WRI, IEA
10	Canada[3]	602	731	708	716	17.5	-2	UNFCCC
11	**Korea [3]**	**292**	**503**	**693**	**709**	**137**	**0.03**	**-**
12	Mexico [3]	445	536	688[2]	-	54.6	0.7	UNFCCC, IEA
13	Saudi Arabia	188	278	607[2]	-	223.7	-0.8	WRI, IEA
14	Australia [3]	420	485	547	554	30.1	2.2	UNFCCC
15	South africa	347	439	546[2]	-	57.3	1	UNFCCC, IEA

1) UNFCCC: Greenhouse gas statistics submitted to the United Nations Convention on Climate Change(Annex I countries emissions 1990-2017, Non-Annex I Country is the latest national report), WRI: Total GHG emissions by country calculated by the World Resources Institute by UNFCCC, International Energy Agency (IEA), US Environmental Protection Agency (EPA), Energy Information Administration (EIA), and Food and Agriculture Organization (FAO) data (1990-2014), IEA: CO2 emissions from fuel combustion published by the International Energy Agency (1990-2016)
2) Estimate calculated by applying the proportion of fuel-fired CO2 in the IEA to total greenhouse gas emissions provided in the latest national report. However, Saudi Arabia and Iran, which do not have national reports that provide statistics since 2014, are estimated to apply IEA fuel combustion CO2 weight to WRI total emissions (1990-2014).
3) OECD Members
[Source: Ministry of Environment, Greenhouse Gas Inventory & Research Center of Korea. (2019). National Greenhouse Gas Inventory Report of KOREA]

Therefore, in December 2017, the Korean government established the Renewable Energy 3020 Implementation Plan (Ministry of Trade, Industry and Energy 2017.12) to keep pace with changes in global energy policy stances caused by climate change. In the 8th power supply and demand plan, which is the core content of the renewable energy 3020 implementation plan, the target demand for 2030 is 57.9TWh, and it is planning to supply 115.9TWh, 20%, as renewable energy. Of these, more than 85% of the new facilities are planned to be supplied with solar and wind power, and the target for the capacity of onshore and floating solar power generation facilities is 36.5GW.

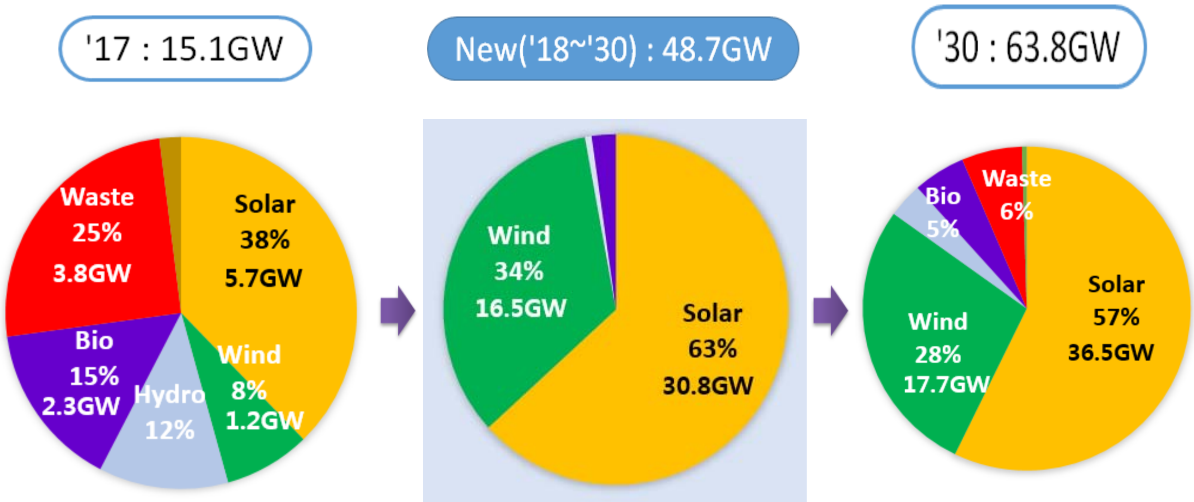


Figure 1. Mid- to long-term goal of renewable energy generation ratio (Ministry of Trade, Industry and Energy, 2017)

In 2018, renewable energy output of Korea was 17,838,000toe, up 8.45% from 2017, and the ratio of supply to primary energy was 5.83%.

Table 3. Renewable energy production performance in 2018

Classification		2017		2018		Increase or decrease from the previous year		
		Production capacity	Weight (%)	Production capacity	Weight (%)	Production capacity	Increase/Decrease rate(%)	Contribution degree(%)
Primary energy (thousand toe)		302,065	100	306,123	100	4,058	1.34	-
Renewable Energy		16,448,386	5.45	17,837,507	5.83	1,389,127	8.45	100
	Renewable E	15,861,222	5.25	17,098,676	5.59	1,237,460	7.8	89.1
	New E	587,164	0.19	738,831	0.24	151,667	25.83	10.9
Re new abe	Solar Heat	28,121	0.2	27,395	0.2	△725	△2.6	△0.1
	Solar Power	**1,516,343**	**9.2**	**1,977,148**	**11.1**	**460,805**	**30.4**	**33.2**
	Wind	**462,162**	**2.8**	**525,188**	**2.9**	**63,026**	**13.6**	**4.5**
	Hydro	600,690	3.7	718,787	4	118,097	19.7	8.5
	Ocean	104,256	0.6	103,380	0.6	△876	△0.8	△0.1
	Geothermal heat	183,922	1.1	205,464	1.2	21,542	11.7	1.6
	Water heat	7,941	0	14,725	0.1	6,784	85.4	0.5
	Bio	3,598,782	21.9	4,442,376	24.9	843,594	23.4	60.7
	Waste	9,358,998	56.9	9,084,212	50.9	△274,786	△2.9	△19.8
New	fuel cell	313,303	1.9	376,304	2.1	63,001	20.1	4.5
	IGCC	273,861	1.7	362,527	2	88,666	32.4	6.4

[Source: KOREA ENERGY AGENCY Renewable Energy Center, (2019). New & Renewable Energy Statistics 2018]

In the Renewable Energy 3020 implementation plan, more than 85% of the new facilities will be supplied with solar and wind power, and the target for the capacity of onshore and onshore solar power generation facilities is 36.5GW, 0.3GW for private house, 10.0GW for farm households, and 20.5GW for large scale project promotion. In order to meet the government's recent new and renewable energy policy, demand for large-scale floating solar power generation using the water surface is expected to increase.

1.2 The status of floating solar power

Due to the high density of nuclear power plants and the risk of large-scale disasters, the development and application of new energy such as fuel cells and hydrogen and renewable energy such as solar, wind, hydro, tidal, geothermal and biomass have been more active recently. Among these various new and renewable energy sources, solar power generation, which is environmentally friendly and has high industrial and employment-inducing effects, has grown rapidly worldwide in recent years, with the global cumulative capacity exceeding 227 GW in 2016 and expected to grow to 429 GW in 2020 (Ministry of Trade, Industry and Energy, 2016). In Korea, the solar energy market is the seventh largest in the world with an installation capacity of 1GW in 2015, and the cumulative installation capacity has grown rapidly in a short period of time (Ministry of Trade, Industry and Energy, 2016).

Existing solar power facilities have been mainly installed on land, such as rooftops, buildings, and land forests, but it is increasingly limited due to the risk of disasters such as forest/farm destruction, damage to the ecosystem, and landslides. Recently, floating solar power installed on the water surface such as lakes and rivers has become an alternative. Since the first installation in the United States in 2007, floating solar power has been mainly applied in the UK, Spain, Australia, India, China, Japan and Korea, and it produces electricity by utilizing underutilized dams, reservoirs, freshwater lakes and idle water inside the seawall as an agricultural production infrastructure. It is reported that these floating solar power generation facilities are free from forest damage, have the advantage of providing favorable environment for fish forms through surface lighting and reducing the spread of algae, and have a power generation efficiency of about 11% or more than that of land-based photovoltaic power generation due to cooling effects (Choi, 2014). According to the Ministry of Trade, Industry and Energy's press release (2017/12), the government has set a target of 20% renewable energy generation by 2030 and aims to achieve a 57% or 36.5 GW of solar energy, so floating solar power is a very important means to achieve the goal of solar power distribution.

As of 2018, Korea Rural Community Corporation, K-water, Korea Hydro & Nuclear Power Co., and Korea East-West Power Co. are the organizations that install and operate floating solar power facilities in Korea. The Korea Rural Community Corporation has installed and operated a total of 22 floating solar power generation facilities (2,754 kW) in agricultural reservoirs as of 2018 through its own investment and water surface rental by private investment. Although it set a development target of 4,280MW by 2022, it recently reduced the size of additional projects by one-tenth (422MW) to reflect external points such as the National Assembly and civil petitions.

Table 4. Rural Community Corporation's floating photovoltaic operation status in 2018

Self-investment			**Water surface rental**		
Name of reservoir	**Capacity (kW)**	**Completion of construction**	**Name of reservoir**	**Capacity (kW)**	**Completion of construction**
Buan Chungho	30	‘12	Anseong Geumgwang	465	‘14
Miryang Deokgok	200	‘13	Yeongdong Chupungryeong	2,000	‘14
Jangseong Dalseong	210	‘13	Cheongju Ochang	495	‘15
Najoo Daedo	500	‘15	Hampyeong Daedong	3,000	‘15
Changnyeong Jangcheok	500	‘15	Sangju Otae	3,000	‘15
Chungju Yongdang	500	‘15	Sangju Jipyeong	3,000	‘15

Changnyeong Bongsan	499	‘16	Anseong Deoksan	465	‘15
Anseong Janggye	499	‘17	Gyeongcheon Gyeongji	700	‘16
Boryeong Cheongcheon	2,000	‘17.08	Hwasun Geumcheon	2,000	‘17
Goseong Hai	2,500	‘17.11	Mungyeong Ubon	691	‘17.05
Gangneung Dongmak	500	‘18.01	Uiseong Gaecheon	2,000	‘18.01

K-water has installed and managed 3 site of floating photovoltaic power generation facilities (5,500kW) targeting the Hapcheon Dam, Boryeong Dam, and Chungju Dam multi-purpose dams (Korea Water Resources Corporation, 2018)., Korea Hydro & Nuclear Power Co., Ltd. Korea East-West Power is operating each 1 site floating photovoltaic power generation facility (Korea Rural Community Corporation, 2018).

Table 5. K-water floating photovoltaic operation status in 2018

Classification	**Capacity (kW)**	**Total project cost (hundred million won)**	**Business model**	**Completion of construction**
Hapcheon dam	500	24.5	Own business	‘12.09
Boryeong dam	2,000	64	Own business	’16.03
Chungju dam	3,000	90	Own business	’17.12

1.3 Problems and resident acceptance

Various issues related to water pollution, aquatic disturbances, heavy metal elution, electromagnetic wave-related environmental hazards, and damage to the landscape that can be caused by the installation of floating solar power on the water surface have been raised socially. However, the research on the environmental impact of the installation of floating solar power generation facilities are only in its early stages, and comprehensive research on water quality and water ecology is needed through long-term continuous monitoring, and K-water continuously conducts environmental impact assessment and monitors the impact of floating solar power generation facilities on the surrounding environment.

And in order to achieve the government's goal of supplying new and renewable energy, the improvement of low acceptance is considered the most urgent prerequisite. The obstacles to the expansion of new and renewable energy can be largely classified into technology, finance, legal system, and acceptance (Lee, Yoon, 2015).

Renewable energy technology is developing rapidly, and the area achieving grid parity is gradually expanding due to the drop in prices. Financial procurement is gradually becoming easier as economic feasibility is secured, and there are many areas that can be improved in the short term, depending on the government's policy will. However, acceptability is a problem related to the universal perception of many people and is difficult to improve easily in a short period of time. Acceptability can be classified into general “public acceptance” and “resident acceptance” in the vicinity of the power plant, and the problem is “resident acceptance”. Whether a person supports new and renewable energy and whether it can accommodate large-scale renewable facilities such as wind and solar power in the surrounding area of one's life is an entirely different matter. In most countries, although new and renewable energy has higher social support than nuclear or coal power plants, the phenomenon of frequent large and small conflicts and frictions in the process of locating specific power plants well proves the preceding proposition. Therefore, the task of accurately analyzing the acceptability of residents for renewable energy generation facilities and reflecting them in policymaking is a very important factor in expanding the supply of new and renewable energy effectively in the future.

In Korea, it is known that residents' acceptance of new and renewable energy is very low, so that one out of three solar power generation projects (37.5%) whose permits were rejected or withheld in 2016 due to resistance from residents (Asia Times, Increasing the proportion of new and renewable energy, communication with residents comes first, 2017). The reasons why residents oppose the establishment of new and renewable energy facilities in the surrounding areas are generally cited for noise, low frequency and damage to the landscape, although there are some differences in each renewable energy. However, it is analyzed that the more fundamental reason why residents oppose the installation of renewable energy generation facilities is that the renewable energy generation project does not help local residents much, and the profits are taken by external operators. As a result, discussions have been continuously raised in recent years on the introduction of the so-called "resident-participating" renewable energy business model, which improves the acceptability problem through direct income promotion of local residents. In advanced countries of renewable energy such as Germany, the United States, and Denmark, the new and renewable energy resident power plant model has already been activated in the form of local ownership, village fund, and compensation. In response, the government discussed ways to introduce incentive systems for residents' participatory renewable energy generation projects through public hearings at the end of last year, and has been implementing an incentive system since January 2017 to give additional REC weights of 10 to 20 percent depending on the weights of residents' participation only in solar and wind power plants.

Therefore, in this proposal, through interviews with experts in the construction of a floating solar power plant, we would like to look at a case in which conflicts with local residents that occur at each stage of planning, construction, and operation of a floating solar power plant have been resolved and the acceptability has been improved.

2. Literature Review

2.1 Literature review

The environmental factors that should be considered in the context of the installation of the floating solar power generation facilities are the possibility of releasing harmful substances from the structure of the water solar power plant, the physical environmental changes of appeals, and the water quality and water ecosystem. Directly, a long-term review of the impact of heavy metals on major equipment such as buoyant bodies, underwater cables, and conduits is needed. Indirectly, changes in water temperature, pH, DO organic matter, nutritional leaf heavy metals, etc. due to the installation of floating solar power generation facilities, and changes in the structure and function of aquatic organisms and aquatic ecosystems such as animal and plant plankton, fish, and low-flying animals are the main focus of the review. In addition, additional safety reviews are required for the breakdown of floating solar power generation facilities, problems with facilities and disasters from corrosion of facilities caused by bird excrement, torrential rains or typhoons.

Based on the review of the existing literature, the main focus is on research related to the power generation efficiency and small number of surveys of floating solar power generation facilities (Joo In-ho, 2014; Choi Young-kwan, 2014; Lee Jae-hyung et al, 2015; Yeo Kook-hyun, 2016), Research related to the environmental impact of floating solar power generation facilities, especially long-term monitoring of water quality and aquatic ecosystems, is very insufficient.

In some preceding studies, consideration is being made at the basic short-term research level such as the possibility of reducing light and green algae due to floating solar power generation facilities (No Tae-ho et al., 2014); the possibility of securing water resources due to reduced evaporation in lakes (Melvin, 2015); the possibility of ecological change due to water temperature change and chemical elution (Theocharis et al., 2005). The environmental impact assessment is being conducted mainly in countries that are expanding the floating photovoltaic power generation business such as Japan, Italy, France, and Spain. In addition to on-site monitoring in Korea, research on the impact of water quality, aquatic ecosystems and sediments on fixed floating solar power generation facilities in multi-purpose reservoirs (Hapcheon Dam) was conducted (Noh Tae-ho et al. 2014), and research on water and aquatic ecosystems in rotating floating solar power generation facilities in agricultural reservoirs (Geumgwang Reservoir) was conducted (Lee In-ju et al., 2017). Recently, there has been a long-term study of the effects of floating solar power generation facilities on water quality, aquatic ecosystems and sediments on agricultural reservoirs (Otae Reservoir and Jipyeong Reservoir), which have relatively large power generation (3MW) (Korea Rural Community Corporation, 2017 and 2018).

Based on the results of the literature survey, it was found that the possibility of releasing harmful substances from the installation of the floating solar power generation facilities and its negative effects on the water and water ecosystem were not observed based on the water quality, water ecosystem monitoring and elution data of the appeals after the installation of the floating solar power generation facilities. However, since most of the findings were conducted in a short period of time (within two years), for more scientific and empirical verification, long-term and continuous water quality and ecological monitoring of changes in the environment in the appeal (reducing solar radiation, changing water temperature, inhibiting water circulation, etc.) and chemical (reducing dissolved oxygen, releasing harmful substances, etc.) and biological (reducing basic production, changing colonies, etc.). It is also deemed necessary to scientifically verify the positive effects of floating solar power installation such as green algae reduction and fish habitat provision, and to study ways to establish participatory governance among stakeholders for the efficient operation of floating solar power generation facilities and increase the acceptability of local residents.

To determine the social acceptability level of renewable energy in Korea, a study using the Contingent Value Measurement Method (1,000 households) estimated the amount of additional payments made to use renewable energy and proposed measures to increase social acceptability to spread the spread of renewable energy (Lee Chul-yong, Korea Institute of Energy Economics, 2015.2) proposed renewable 3,456 won/month, 4,554won/month, de-nuclearization power, 4.005won/month de-thermal power generation. Since the causes of social acceptability vary depending on the stage of implementation, it was suggested that different measures to enhance acceptability are needed, policies to induce residents' participation, education to promote renewable energy to the public, and power price decisions should be made in consideration of social external costs.

In addition, a survey was conducted to analyze the economic effect of the REC weight preferential treatment of the resident-participating new and renewable energy power generation project incentive system, and to analyze the effective effect of the policy by comparing it with the willingness of residents in the area around the power plant (Sungsam Jeong et al., Korea Energy Economics Institute, Oct. 2017). Analysis and conditional value assessment (CVM) were used to quantify the willingness to accept (expected rate of return) for participation in renewable energy power generation projects. And this was compared with the expected rate of return after applying the REC weight preferential treatment, it suggested urgent to prepare a compensation policy in a form that can be easily and clearly understood by the general public, and to prepare a reasonable level of compensation support standards for local residents.

2.2 Conflict cases of solar power plant construction

Due to the conflict that occurred between the business owner and the local residents as no clear regulations for the construction of solar power generation facilities have been established, the relevant local governments and other related organizations have begun to prepare regulations to adjust and mitigate the conflict. Nevertheless, conflicts arising from the construction of solar power generation facilities continue to occur.

In the case of conflict integration of solar power plants (Im Da-hee, 2017), it was confirmed that the differences in the conflict patterns developed by each conflict over the construction of solar power plants in Jeollabuk-do, Gochang and Jecheon(Chungju Dam) areas. In the case of Jeollabuk-do, there was no change of conflict, but due to the preparation of mediation plans by local governments, the conflict between operators and local residents (citizens' organizations) was alleviated. In the case of Gochang, the occurrence and continuation of initial conflicts occurred between business owners and local residents (civil organizations) who opposed the construction of solar power facilities. However, in the process of obtaining permission for the project, it was an example of a conflict between the employer and the related agencies when they delayed the permit without clearly stating their position to the employer in the process of administrative processing of the project. As a result, the employer filed a lawsuit against the central administrative trial for cancellation of the permit, but the conflict was terminated as the result of the administrative trial was rejected. Unlike the previous case, Jeonbuk also ended the conflict, but there were no acts of mediation or guidance to ease the conflict. In other words, the conflict was forced to end. In the case of Jecheon City, it became unclear whether the project would continue as local residents (citizens' organizations) and the Jecheon City Council demanded a review, but K-water, the main body of the project, ended the conflict and completed the construction of the power plant through continuous consultation. In the case of the Hapcheon Dam solar power plant in the Hapcheon area, there was an initial conflict with the local residents, such as concerns about disturbing the landscape. However, this is a case of ending the conflict and promoting the project through efforts such as forming and operating a council and improving the existing four-dimensional shape into a lotus-shaped design in connection with the Hapcheon area.

Table 6. Comparison of conflict development by case

Classification	Jeonbuk	Gochang	Jecheon (Chungju Dam)	Hapcheon (Hapcheon Dam)
Conflict started	○	○	○	○
Conflict persists	○	○	○	○
Conflict transition	×	○	○	○
Conflict relax	○	×	○	○
Conflict closing	△	○	○	○

3. Methodology

3.1 Research method Hapcheon dam

Research on improving the acceptability of residents in floating solar power generation projects has an industrial characteristic that requires expertise with experience in floating solar projects, and it is thought that research by qualitative method will be necessary for more effective research. Therefore, this study aims to utilize in-depth interview methods for experts in the floating solar power field.

Interviews are data collection through verbal interactions between researchers and participants. As a feature, it is the most widely used method of data collection, and it can be viewed as a process of verbal communication between people who have information related to the person seeking information. However, the interview that focuses on the qualitative research method is not a medium of intimacy, but a communication method based on a clear sense of purpose to acquire certain information. It has a kind of form and structure, and is an intentional conversation between the researcher and the participants for the purpose of producing knowledge related to the subject of interest to the researcher.

For in-depth interviews, it is important to deliberately select participants who have in-depth and rich experience in the research subject and subject as the purpose of in-depth understanding of the subject itself.

Choosing an interviewee is the most important step in conducting an in-depth interview because it is not about asking a large number of people, as in a survey, but about a small number of people who are familiar with the area. Questions and answers from those who do not meet the objective of hypothesis verification are more likely to be untrue and have a significant impact on information distortion. Therefore, the selection of the interviewees should follow the criteria below.

1) Are you familiar with the content?

2) Can you give me that information?

3) Didn't you omit someone who must be included?

It is also necessary to seek advice from someone who is familiar with the field and who should be interviewed. Therefore, the subjects for in-depth interviews are experts in planning, design, construction, and operation of floating solar power as shown in Table 7.

Table 7. In-depth interview target

Part	Position	Specialized field			
		Planning	Design	Construction	Operation
Headquarters	Senior manager A	○	○	-	-
Headquarters	Senior manager B	○	○	-	-
Branch	Senior manager C	-	-	○	○

3.2 Research model and survey design

In this study, we would like to conduct an unstructured individual in-depth interview, and instead of a pre-planned questionnaire or question, we would like to collect data by inducing the interviewees to respond to the research woodwork in the course of natural communication with only the least necessary questions. In the interview of this study, the main theme starts from the pros and cons of the development of the floating solar system and approaches the big research problem of the important strategic factors and obstacles for the development of the floating solar system. Specific research issues to be used in the in-depth interview of this study are as follows.

First, what is the purpose of floating solar development and what are the pros and cons of floating solar development? (Big research problem)

Second, what are the obstacles to the promotion of the floating solar project? (Small research problems)

Third, what are the ways to resolve conflicts at each stage when it is possible to be divided into stages of project planning, construction and operation, and demolition by the end of the project during the development of the floating solar project (small research problem)?

4. In-depth Interview Results

4.1 Chungju dam floating solar power development case

Chungju Dam floating solar power plant was installed and operated in 2017 with 3,000kW and project cost of 9 billion won, and the interview with experts for this project is as follows.

1) What was the biggest problem in promoting the business?

'Resident acceptability' and 'environmental' are the most important problems. It uses water-specific solar energy eco-friendly modules such as Pb free, super acid exclusion, etc. Through the implementation of equipment and materials discharge tests and continuous environmental impact assessment that conforms to the sanitary safety standards of the Water Act, 30 water quality items, 10 sediments, and 44 equipment and materials discharge tests and no rise in water temperature and positive effects of providing fish habitats were investigated. The environmental nature was verified and the opposition was persuaded.

2) How can we increase the acceptability of residents?

Efforts should be made to minimize conflicts with stakeholders. The development of floating solar energy can be largely divided into three stages by business planning, construction and operation, and efforts to resolve conflicts through communication with stakeholders are needed at each stage.

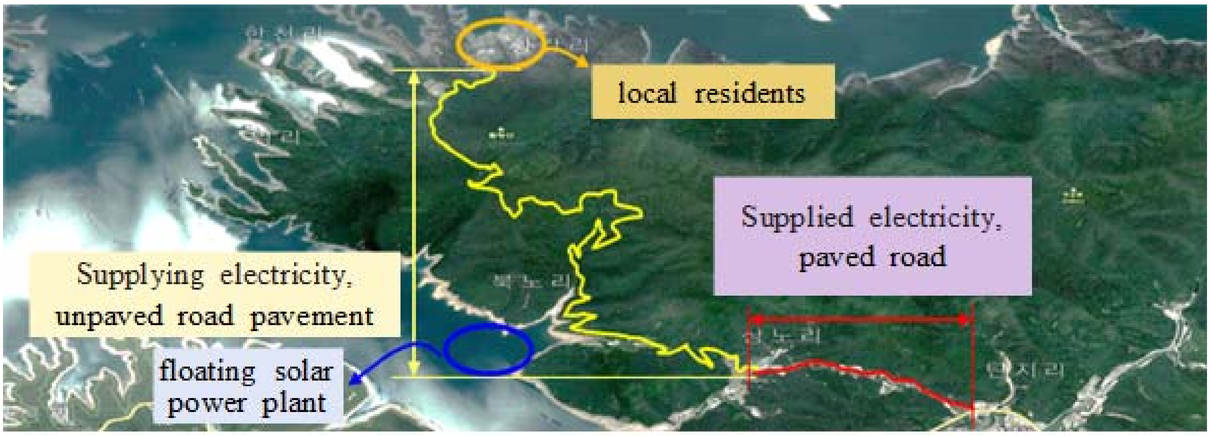


Figure 2. Supplying electricity to remote areas and improved accessibility by paving the road

First of all, in the planning stage, a project should be planned to address the needs of the underprivileged in areas where most of the floating solar project sites are underdeveloped. In the case of Chungju floating solar power project, the power system linkage area for supplying electricity to households without electricity in the Chungju Dam remote area was considered first. In cooperation with local governments, the government promoted the unpaved forest pavement for the convenience of residents near the planned site of the floating solar power.

Through such a plan, it was possible to solve the residents' longing for business and establish a trust relationship with local residents through the signing of an agreement with related organizations(Chungbuk·Jecheon, K-water, KEPCO) for mutual cooperation.

Table 8. Cooperation with related organizations for Chungju floating solar power project

Classification		Chungbuk, Jecheon	K-water	KEPCO
Floating Solar Power		Administrative support	Project execution	Power system connection
Resident needs	Electrical supply (560 million won)	Business application	Contribution support	Business implementation
	Forest road pavement (320 million won)	Business implementation	-	-

Figure 3. Investment agreement, ’16.7

In addition, a business was planned through communication with stakeholders who share water surface. In order to communicate and understand the facts of floating solar power to stakeholders on the water surface of the Chungju Dam projected site for floating solar power development, efforts were made to share the operation results of existing facilities and conduct field tours through resident information sessions.

In order to communicate and understand the facts of floating solar power to stakeholders on the water surface of the Chungju Dam floating solar power development site, efforts were made, such as sharing the operation results of existing facilities and conducting field tours through resident information sessions.

Figure 4. Resident briefing session, Field trip Boryeong Dam Floating Solar Power

In the construction stage, by using nearby fishermen's ships during fishing breaks and participating as construction personnel, it contributed to the increase of the income of the vulnerable. It contributed to vitalization of the local economy by using local restaurants and accommodation facilities by construction workers.

Figure 5. Local Fishermen's Participation in Ship Use and Construction

In addition, local project commitments for regional co-prosperity were thoroughly fulfilled when the project was planned. We have completed the supply of electricity to energy welfare disadvantaged areas. Unpaved access roads in villages were paved to improve reception was improved. In addition, the government made efforts to provide practical benefits to local residents by constructing a fishery product collection center, a long-cherished project for fishermen.

【fishery product collection center】 【live fish carrying vehicle】

Figure 6. Constructing a fishery product collection center and provide fish carrying vehicle

At the operational stage, it contributed to increasing the income of the local people. By using it as a public relations facility for negative public opinion and business consensus through proper information delivery of floating solar power, it is continuously visiting various fields such as government, institution, media, society, and industry. Visitors' use of nearby restaurants, accommodations and tourist facilities contributes to increasing local people's income and revitalizing the local economy. In addition, continuous support is provided to local residents through the project to support the area surrounding the plant.

Table 9. Status of support in areas around the power plant

Classification	**Support business**	**Implementer**	**Support fund and period**
Basic Support	▪Income growth and welfare for residents ▪Public, social welfare, etc.	Jecheon City Chungju City	▪20 million won/year (minimum limit) ▪ Construction and operation period (Payment has been made since 2019)
	▪Electricity fee subsidy, etc.	K-water	
Special support	▪Same as above	Jecheon City Chungju City	▪99 million won (paid in 2019) ▪First time (1.5% of construction cost)

Chungju Dam floating photovoltaic development project is an exemplary case for regional win-win through the installation of eco-friendly renewable energy through public-private cooperation, and I think it will be an excellent model for coexisting with local residents in the entire project planning, construction, and operation process.

4.2 Hapcheon dam floating solar power development case

Hapcheon Floating Solar Power Construction Project started a basic survey in September 2015 and was approved for power generation in October 2019. The project is being carried out with the goal of launching the project in 2020 with 40MW of development capacity and total project cost of 92.4 billion won. The interview details of this project promotion expert are as follows.

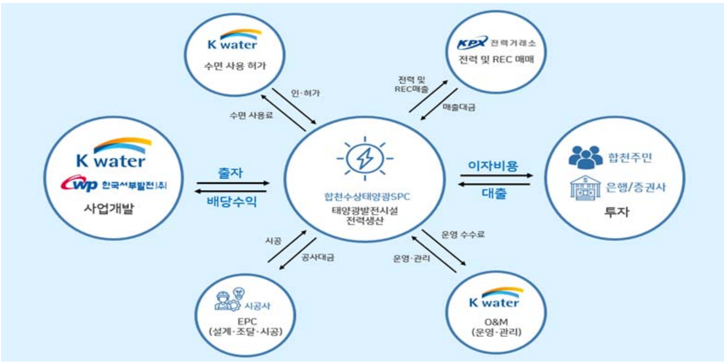
1) What was the biggest problem in promoting the business?

Due to the trend of the local community regarding this project, Hapcheon-gun is in a favorable position toward the project to use it as the development momentum of Bongsan-myeon, a representative underdeveloped area in the county. The project area, Bongsan-myeon, 900 households, 1,400 residents, most of the residents agree, but there is a backlash from 15 households and 25 residents of some local residents in Bonggye-ri, where the water can be seen.

2) How can we increase the acceptability of residents?

Hapcheon Floating Solar Power is a win-win business model that jointly invests and shares profits with local residents to minimize conflict. It is promoting new and renewable energy projects with local residents and local governments around the dam.

First, the project was introduced as a business model to improve the income of residents in areas around the dam. Local residents participated in the project as a loan investor and provided stable financial income for 20 years to enhance their acceptance of the project by increasing household income. In addition, K-water is a major shareholder of SPC and serves as a stable business developer considering public nature and SPC profitability, such as dam operation management. Through joint business development with power generation public enterprises, SMP&REC sales were fixed for 20 years to reduce risks through effective role-sharing, such as minimizing sales volatility.



◦ Local residents participate in the project through loan investment in SPC established by K-water

◦ Distribution of fixed interest income between 4% and 10% over 20 years according to the participation ratio

Figure 7. Hapcheon Floating Solar Power SPC Business Structure

In order to increase acceptance, a consultative body has been formed and operated to promote win-win development, such as attracting successful projects, preparing plans to revitalize local economies, and solving business constraints.

【Organization of the council】 【business briefing session】 【on-site briefing session】

Figure 8. Organization of the council, business briefing session, on-site briefing session

We promoted the development of tourism resources in connection with the local tourism infrastructure by improving the design considering the local culture and surrounding landscape in the existing square format. And design improvement, night lighting and experience programs were prepared.

【Square format type】 【lotus shape type】

Figure 9. Change the shape to improve the landscape

For community revitalization and feedback, part of the subcontracting contract involved local construction. For those who want to work in the region during the construction period, we hire them as on-site construction workers. Local residents were proposed to participate in the operation of the plant as facility inspection personnel.

5. Conclusion

5.1 Research result

The government plans to drastically expand the supply of renewable energy in line with changes in global energy policy due to climate change and supply and demand of eco-friendly energy. In particular, the government plans to supply most of the renewable energy with solar and wind power, which is expected to increase demand for large-scale floating solar power installations using water surface to meet the government's recent policy on renewable energy. There are two challenges to solve in the development of large floating solar power project.

The first is the 'environmental' issue of floating solar power on the environment. Since there are only short-term studies on the environmental impact of floating solar power, comprehensive studies such as its impact on water quality and aquatic ecology and environmental hazards are needed through long-term continuous monitoring. It will also be able to resolve doubts about the environment by sharing its impact on the environment and water quality with residents as objective data.

The second is the problem of resident acceptance. Acceptance builds a trust relationship through continuous communication through the formation of a consultative body with local residents, by sharing the profits generated through the project with the business operator and the local residents, it was possible to increase acceptance when it was distributed to the residents as practical benefits.

Through the development and operation of the floating solar power in Chungju Dam and Hapcheon Dam, it is possible to confirm measures to improve environmental performance and residents' acceptance from the project plan to the construction implementation and operation stages. The results are summarized in Table 10.

Table 10. Floating solar power development case

Development stage	**Classification**	**Main Issue**	**Countermeasures**
Planning	Chungju Dam	Backward region Environmental concerns	Improved square shape to lotus shape Introduction of resident participation projects

	Hapcheon Dam	Increase resident income and local economy activation	Local residents' participation in construction Using local restaurants and accommodations for construction worker
Constructing	Chungju Dam	Increase resident income and local economy activation	Local residents' participation in construction Using local restaurants and accommodations for construction worker
	Hapcheon Dam	Local community activation and feedback	Support business around power plants Increase in tourists by using tourist facility Support for the construction of a fish storage facility and carrying vehicle
Operating	Chungju Dam	Maintain continuous benefits	Support business around power plants Increase in tourists by using tourist facility Support for the construction of a fish storage facility and carrying vehicle
	Hapcheon Dam	Local community activation and feedback	Participate as facility inspection personnel

From the initial plan establishment stage to construction and operation, and demolition, the business can be smoothly promoted only by considering major issues, response plans, decisions, and expected effects in each project development stage.

Table 11. Considerations for each stage of development

Development stage	Main Issue	Countermeasures	Decisions/Expected Effects
Initial planning	Survey of stakeholders involved in the project Interrelationships among stakeholders	Using social survey methodologies such as surveys, meetings, and focus group meetings	Assessment of the acceptability of stakeholders in the planning stage

Medium-term planning	Project impact prediction Designing the process of collecting stakeholders' opinions	Communicate with stakeholders based on accurate information on floating solar power	Prepare additional reduction measures if necessary based on the opinions of stakeholders
End of planning	Establish governance system when operating Preparing a plan for civil petitions and monitoring	Check whether residents have the technology to participate in environmental monitoring and come up with alternatives	Establishing a governance system during construction and operation increases the acceptability of the interested parties to the project.
During construction and operation	Monitoring the participatory environment of residents Prepare behavioral tips based on monitoring results	Check whether residents have the technology to participate in environmental monitoring and come up with alternatives	Securing the acceptability of stakeholders through transparent operation of business sites
End of a business	Establishing measures to prevent environmental impact on demolition Reviewing the continuation of the project through the reorganization	Residents' participation in environmental monitoring and disclosure of demolition results	Prepare additional measures to reduce environmental impact if necessary Business Effect Feedback

5.2 Limitations of research and future research directions

This study attempted individual in-depth interviews to collect natural opinions with experts in order to derive measures to improve the acceptance of the floating solar power generation project. Due to the time and space constraints of each expert, it is necessary to have a more in-depth conversation by conducting 2nd and 3rd interviews on the subject of the interview. On the one hand, it will be possible to draw more effective results by applying a focus group interview method that can easily draw a number of expert opinions and eliminate the effects of interactions that cause stimulation through a group discussion process on a common topic.

Despite these limitations, this study is meaningful in that it provides realistic implications by freely collecting and analyzing opinions from experts who are carrying out the floating solar power generation project.

BIBLIOGRAPHY

Choi, Y. K., (2014). *A Study on Power Generation Analysis of Floating PV System Considering Environmental Impact.* International Journal of Software Engineering and Its Applications, Vol. 8 : No. 1, 75-84.

Joo, I. H., (2014). *Overview and status of floating solar power generation technology.* Electric World, Special Issues 3, 37-41.

Jung, S, S,. Lee, C, Y,. Heo, S, Y,. Woo, J, R,. (2017). *A Study on Improve resident acceptance of new and renewable energy.* Korea Energy Economics Institute.

Korea Economic Daily, (2019). *Korea Rural Community Corporation, Decrease the Floating solar power target by one-tenth.*

https://www.hankyung.com/economy/article/2019062745901

KOREA ENERGY AGENCY Renewable Energy Center, (2019). *New & Renewable Energy Statistics 2018*

Korea Rural Community Corporation, (2018). *Ecological Effects of Water Use in Agricultural Reservoir: Fishing and Floating Photovoltaic Power Plant.*

Lee Chul-yong,. (2015). *Estimation and Social Acceptance of Will to Pay for Renewable Energy*, Korea Energy Economics Institute.

Lim, D, H,. (2017). *Conflict Integration Case of Solar Power Plant.* The Korean Association for Conflict Studies. 37-51.

Lee, J, H,. Won, C, S,. Choi, Y, K,. (2015). *Technology Development and Market Trends for Floating Solar Power System.* Bulletin of the Korea Photovoltaic Society, 35-56.

Lee, S. H., & Yun, S. G., (2015). *Review of measures to enhance local acceptance of renewable energy projects.* Environmental Law and Policy, 133-166.

Melvin, G., *Experimental study of the effect of floating solar panels on reducing evaporation in singapore reservoirs,* MS Thesis, 2015.

Ministry of Environment, Greenhouse Gas Inventory & Research Center of Korea. (2019). *National Greenhouse Gas Inventory Report of KOREA*

Ministry of Trade, Industry and Energy. (2016). *New & Renewable Energy White Paper.*

Ministry of Trade, Industry and Energy. (2017). *Renewable Energy 3020 Implementation Plan*

Roh Tae-ho,. (2014). *Environmental monitoring and environmental safety verification study for floating solar power generation business, K-water*

Theocharis T., Niki F. Vassilis G., *"Environmental impacts from the solar energy technologies, Energy Policy"*, 33(3), pp.289-296. 2005.

Yeo, G. H., (2016). *Technical Trend of Floating Solar Power Generation System.* Konetic Report, 109.