A study on the driving and hindering factors for renewable energy development

By

JEONG, Jungi

CAPSTONE PROJECT

Submitted to

KDI School of Public Policy and Management

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ABSTRACT

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We are currently living in an era of climate change crisis. The most significant portion contributing to greenhouse gas emissions, identified as the cause of climate change, lies within the energy sector. Much of humanity's energy consumption has relied on fossil fuels. Transitioning from fossil fuels to renewable energy is a direction the world must undoubtedly take. As part of these efforts, installations of renewable energy, primarily solar energy, have steadily increased. However, the recent conditions for renewable energy supply are unfavorable. While the installed capacity of renewable energy in Korea has been steadily increasing, its proportion in the overall power mix remains low. Particularly, the annual supply of solar energy has decreased over the past three years.

Various conditions must be addressed for the proactive development of renewable energy. Achieving this goal requires meeting all review factors, including resident acceptance issues, power grid concerns, licensing issues, profitability concerns such as generation capacity and revenue, and others.

In this study, necessary review elements for the expansion of renewable energy were categorized into four areas and detailed, while licensing matters and project implementation procedures were analyzed. Based on this, realistic challenges faced in the field were summarized through in-depth interviews with practitioners involved in renewable energy projects. Consequently, procedural improvements necessary to facilitate project execution and methods for community involvement were presented. Various measures to promote the supply of renewable energy will contribute to addressing the climate change crisis.

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1. Introduction

Solving the problem of the climate crisis is essential for humanity's sustainable survival. International efforts to overcome climate change are continuing, and efforts to reduce greenhouse gases are at the heart of it. To solve this problem, the Paris Agreement was signed in 2015 as part of the United Nations Framework Convention on Climate Change(UNFCCC). The increase in global average temperature compared to pre-industrial times will be maintained below 2℃ per year, and we will pursue as much as possible not to exceed 1.5℃.

To implement this concretely, we are establishing a national greenhouse gas reduction goal, the NDC(Nationally Determined Contribution), and establishing a plan to achieve it.

The biggest problem in reducing greenhouse gas emissions is energy consumption. The energy sector primarily deals with electricity production, and the development and distribution of new and renewable energy is recognized as the most efficient solution. The RE100 campaign, which is spreading worldwide, is a representative effort to supply renewable energy. RE100 calls for a rapid and economical transition to renewable energy.

As part of these efforts, by 2022, the global renewable energy installation capacity was 3,372 gigawatts (GW). This is an increase of 295 GW, or 9.6%, compared to the previous year and an increase of 84.36% over 10 years compared to 2014. (IRENA , GCC 2023)

In order to promote harmony between nuclear and renewable energy, the government revamped its renewable energy policy by announcing “Measures to improve renewable energy policy according to changes in the energy environment.” (Ministry of Trade, Industry and Energy, 2022) Problems such as the power system and complaints from residents were pointed out in the development of renewable energy. A reasonable and feasible strategy for promoting new and renewable energy was proposed to contribute to the domestic industry and cooperate with residents. Nonetheless, renewable energy is the main means of implementing RE100 and NDC, and the continuous development of renewable energy is an inevitable challenge in the

future.

Despite the seemingly rapid expansion of renewable energy, the development and expansion of renewable energy has recently been slowing down. Renewable energy supply has continued to decline over the past three years. New and renewable energy installed capacity recorded 2.1GW in 2017, 3.4GW in 2018, 4.5GW in 2019, 5.3GW in 2020, 4.3GW in 21, and 3.7GW in 2222. (Korea Energy Agency, 2023)

The share of renewable energy in the overall energy mix is also very low. As of 2019, the share of renewable energy in Korea's final energy is only 3.36%. This is one-seventh of the average (23.4%) of member countries of the Organization for Economic Co-operation and Development (OECD), which ranks last. (Statistics Korea, 2023)

K-water is also actively working to supply new and renewable energy. K-water's entire energy portfolio consists of new and renewable energy, starting with the Soyang River Hydroelectric Power Plant in 1973, and ranks first in the country in the power generation business sector. Most of it is hydroelectric power generation, but it also operates a tidal power plant with the world's largest capacity of 254 MW, and has recently been actively pursuing the development of solar power generation, focusing on floating solar power. Following the installation of 3MW Chungju Dam floating solar power in December 2017, 41MW Hapcheon Dam floating solar power was installed in November 2021, 2.6MW Chungju No. 3 floating solar power in 2023, and 8.8MW Soyang River Dam floating solar power plant. However, it is true that K-water also does not have a floating solar power plant scheduled to be completed in 2024, making it difficult to develop renewable energy.

External and policy changes in the business environment for the development of renewable energy include the 'realization of social values' policy, one of the government's national tasks. As a result, the issue of resolving resident acceptance is having a significant impact on the project, such as demanding the return of profits and increasing income through

resident participation and recommending that local governments convert the project method into resident participation projects to provide opportunities for community development and resident income generation. Also, technically, there is a problem with the power system. Renewable energy development is often impossible due to the lack of track connecting renewable energy production to energy consumers.

In addition, in order to examine the reasons for the slow development of renewable energy in detail, it is necessary to find out the procedure for the completion of the renewable energy project and various factors to consider in each procedure. The challenges facing the supply of new and renewable energy can be largely divided into technology, finance, laws, systems, and water solubility. (rebel group, 2009)

It is necessary to redefine the challenges faced, define the various complex factors, and present a model for schematizing causality among the factors considered. This model will be of great help to related personnel because it allows them to comprehensively understand the renewable energy development process and procedures at a glance.

The business progress procedures and causal relationship map of various factors make it easy to understand what is needed. In-depth interviews with relevant experts helped to derive what is needed to promote renewable energy from causal maps and procedures. The main contents of the interview are as follows. First, the main matters necessary for the development of renewable energy based on expert experience. Second, it is to supplement the causal map for driving and hindering factors for renewable energy. Finally, improvements in business procedures and methods are derived.

Renewable energy development is able to be revitalized through analysis of driving and hindering factors for renewable energy and improvement measures.

2. Methods

In this study, interviews were conducted with experts in charge of planning and developing renewable energy projects or managing projects at the site where renewable energy facilities are installed. Interview refers to a research technique in which a researcher meets an interviewee in person, talks, and collects data.

In-depth interviews are a process of enhancing understanding of research participants and finding answers to questions through long one-on-one conversations between researchers with specific research problems and subjects. It is suitable for listening to various professional opinions related to insider specific experiences or research topics and drawing new insights. (Choi et al.,2018)

When promoting a renewable energy project, resolving the difficulties surrounding the renewable energy installation site is more important than theoretical discourse. In order to conduct research on this, I conducted interviews at the level of project managers who are in charge of actual projects and are active in the field to collect various stories that occur in the field.

A total of five experts were interviewed for this study. Two renewable energy project managers working at public power generation-related institutions, two business managers from EPC-related companies, and one K-water's renewable energy construction staff presented their opinions.

In order to conduct an interview, the various elements necessary to promote renewable energy were first summarized in a causal map. In addition, we prepared materials and questions necessary to conduct interviews, such as renewable energy promotion procedures, and visited experts in person from January to February 2023 to have a conversation in a free atmosphere.

3. Review of theories and practices

3.1 Review of theories: Academic literature

Renewable energy development is inevitable in order to solve various problems with existing fossil energy as the climate change problem emerges. There are various technology development and legal and institutional measures to support this. In addition, research on renewable energy has been continuously conducted.

(1) Early studies on renewable energy

The Alternative Energy Development Promotion Act was first enacted in 1988 to establish a legal basis for renewable energy development. At that time, along with the definition of alternative energy, there was only institutional support for the creation of project costs for technology development and implementation of technology development. In the 2000s, it was revised to the Act On The Promotion Of The Development, Use And Diffusion Of New And Renewable Energy. Through this, the development of renewable energy began in earnest with the establishment of the RPS (Renewable Energy Portfolio Standard).

Initially, research on invigorating renewable energy was aimed at regulatory reform, technological development, or institutional arrangements. In fact, because energy technology is a key response to climate change reduction and at the same time has a great influence on the country's energy security, it is essential for the government to provide long-term support for renewable energy-related technologies and establish a policy and market system that can give investors confidence. (IEA, 2015)

In order to revitalize the development of hydroelectric power generation as a renewable energy source, multifaceted efforts are needed, such as changing public awareness, developing technologies such as local production, fostering related industries, and simplifying business permits (Lee et al., 2010). Providing procedural convenience for the development of renewable energy and energy technology is regulatory reform for sustainable energy development (Ha.,

2012).

(2) Studies on resident acceptability perspective

On the other hand, most of the recent research on revitalizing renewable energy development focuses on ways to improve resident acceptance. Although there are many obstacles to the development of renewable energy, the issue of resident acceptance is recognized as the most important issue to be resolved.

Although social support and political acceptance of renewable energy development are improving, a contradictory situation is being observed around the world in which social resistance at the local level, that is, opposition from local residents, is not decreasing. As a way to improve resident acceptance of renewable energy power generation facilities, we proposed a community power plant method that would realize distributive justice and allow local residents to own and operate renewable energy power plants (Lee & Yoon, 2015).

Lee & Lee (2018) conducted a study on establishing a profit sharing system to improve the acceptance of renewable energy projects. Residents in areas where new renewable energy has been built or is scheduled to be built generally had low satisfaction with renewable energy projects. To overcome this, the limitations of the current resident participation incentive system, which focuses only on economic benefit sharing, must be overcome and more diverse forms of benefit sharing incentive systems must be introduced. The implementation of this must be carried out smoothly through governance establishment and financial support measures between the central government and local governments (Jeong & Lee, 2018).

Even in Europe, where renewable energy spread before us, there were many difficulties in accepting residents. Factors that cause social acceptance, especially opposition at the local level, can be divided into three categories: environment, NIMBY, and opportunism (Rebel Group, 2009). Environmental factors are threats to plants and animals, health impacts, etc., and the NIMBY phenomenon is the opposite of personal types, such as economic compensation.

Opportunistic opposition is usually motivated by the desire to achieve maximum personal gain and is the type of opposition that does not want the project to fail.

The European Union established a communication manual to improve resident acceptance in 2008. It was created through 27 cases of renewable energy projects such as solar and wind power in Europe. The communication process was divided into six stages and tasks to be done for each stage were determined. (EU, ESTEEM, 2008) Steps 1 and 2 are to identify the context of the project, stakeholders, and confirm mutual expectations, and steps 3 to 4 are to identify expected conflicts and issues and seek solutions. In the final steps 5 and 6, a common agreement and future action plan are drawn. In this process, the opinions and points of disagreement of each stakeholder in the project are identified and tabulated, issues are ranked according to importance and urgency, and improvement measures are found. We look for things that can be modified in the project itself or within the context of the project and come up with a joint improvement plan. Kim & Kim(2021) argue that it is necessary to develop programs like ESTEEM that fit the Korean situation.

(3) Studies from other perspectives

In order to promote renewable energy development, the introduction and supplementation of a planned location system is proposed (Kim & Yoon, 2022).

It is necessary to reduce the burden of companies' implementation of RE100 and prepare, distribute, and provide financial support for incentive measures to expand participation. Through the introduction of the K-RE100 industrial complex and certification (labeling) system, the burden of corporate RE100 promotion should be linked to corporate profit creation, and it should be used as a key indicator for various business selection and ESG evaluation (Seo, 2022).

Kim (2023) said that the flexibility of the power system should be improved as a way to improve renewable energy policy. It was said that there is an urgent need to improve the

accuracy of power generation forecasts, and to break away from dependence on natural conditions, expansion of ESS, expansion of sector coupling to absorb surplus power, and power grid connection between Northeast Asian countries should also be reviewed (Kim, 2023).

As there are many restrictions on the location of renewable energy under the current law, it is necessary to switch to flexible land regulations so that land functions can be used more efficiently in each region. The solution to the land location problem is through technology development such as floating wind, solar power, and building-integrated BIPV and national R&D investment (Lee, 2023).

Despite the declaration to expand renewable energy centered on solar and wind power generation in accordance with the Renewable Energy 3020 Implementation Plan announced in 2017, it is currently at 80% level compared to the average country with the highest technology in the renewable energy sector five years later. The gap between the direction of the national renewable energy policy and actual R&D investment and performance is widening. It is time to present a balanced R&D budget portfolio strategy to increase the overall technological competitiveness of renewable energy (Ha et al., 2022).

3.2 Review of practices: Renewable energy development procedure

(1) Administrative procedures for renewable energy project approval

There are three main administrative licensing procedures for renewable energy projects : power generation business permit, environmental impact assessment, and development activity permit. A power generation business license is applied to the Ministry of Trade, Industry and Energy when the power generation facility capacity exceeds 3,000 kW in accordance with Article 4 of the Enforcement Rules of the Electricity Business Act. If the power generation capacity is less than 3,000kW, apply to the local government (province, city, county).

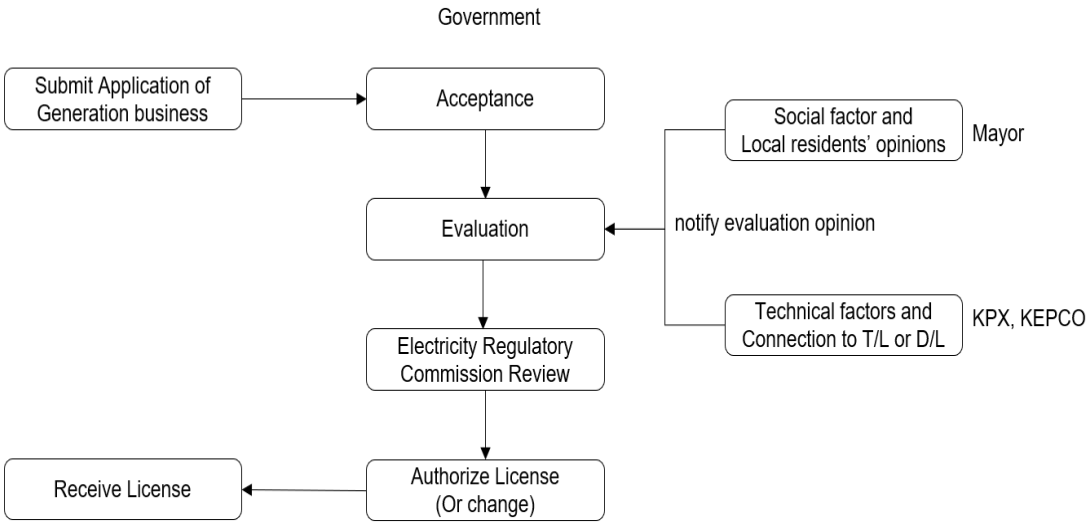

Figure 1. Generation Business Licensing Procedures

Renewable energy of 100 MW or less is subject to small-scale environmental impact assessment, and in accordance with Article 43 of the Environmental Impact Assessment Act and Annex 4 of the Enforcement Decree of the same Act, the local government (Permission for development activities or Electric Utility Licenses) or the Ministry of Trade, Industry and Energy (Electric Utility Licenses), which is the approval agency for the project, requests consultation with the local environmental office for approval of the environmental impact assessment. Afterwards, the business operator submits an environmental impact assessment to the local environmental office and receives approval.

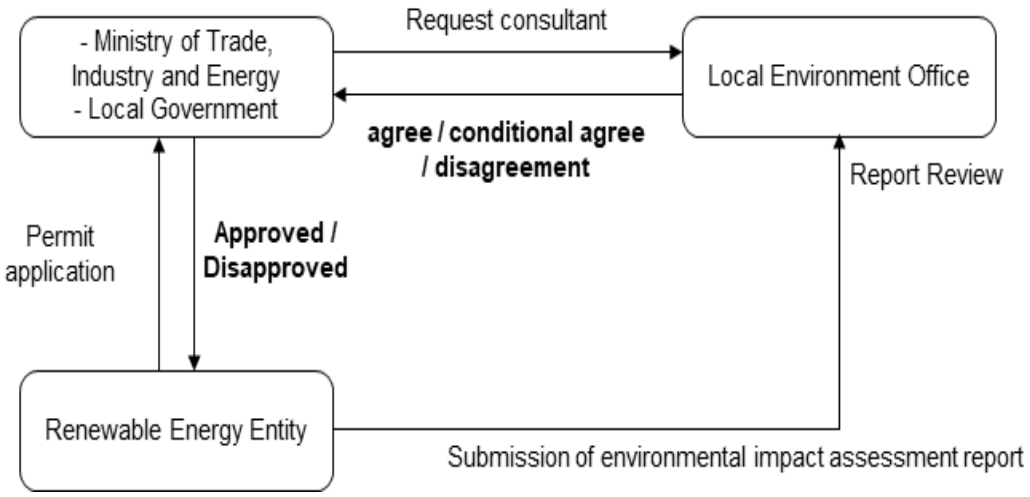

Figure 2. Environmental Impact Assessment Procedures

Permission for development activities is the authority of the local government in the area where renewable energy is installed. In accordance with Article 56 of the Enforcement Decree of the National Land Planning and Utilization Act, business entity apply for a permit to the local government listens to the opinions of relevant departments and local residents to decide whether to grant permission.

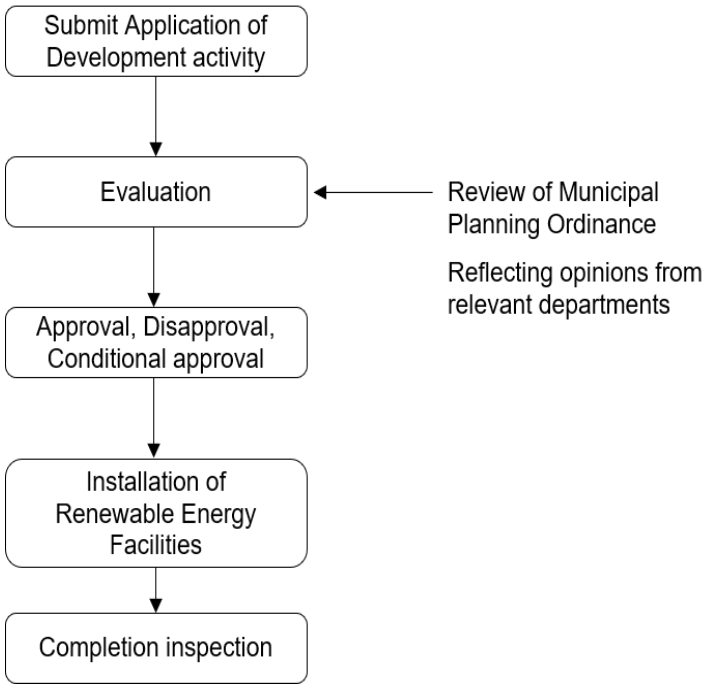

Figure 3. Development Activities Procedures

(2) Review internal procedures of K-water

In the case of K-water, as a renewable energy developer, K-water is promoting the solar energy business internally in the following procedure.

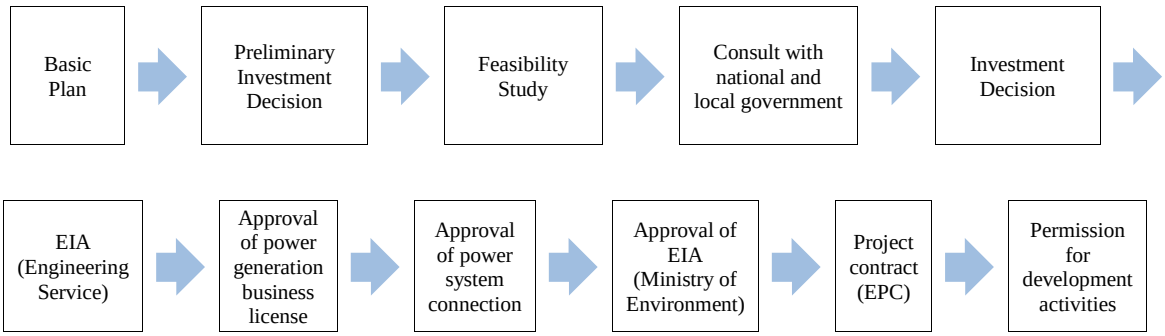

Figure 4. K-water's renewable energy business promotion process

Each process, such as planning, business consultation, and licensing, is being carried out in a step-by-step manner, and after the previous stage is over, the follow-up stage is being carried out. The power generation business license is applied after reflecting the results of the feasibility study service, and the procedure is carried out after the feasibility study and the main investment decision. The environmental impact assessment will proceed with the request for consultation with the local environmental agency at the same time as the application for a river occupancy permit after the investment decision and environmental impact assessment service.

3.3 Factors for renewable energy development

Through this review of prior research, procedures for promoting renewable energy, and projects through personal experience, factors to be considered in renewable energy development were comprehensively reviewed.

There are four main areas to consider in the renewable energy development process. The four main areas are divided as follows. These are social factors such as resident acceptance, economic factors such as B/C analysist, institutional factors such as supporting renewable business environment, and technical factors such as power system or capacity of renewable plant.

The importance of presenting this model is that it can identify all the elements that need to be reviewed until the project is completed. This casual map model was used to interview experts because it can provide inspiration for areas needing improvement.

(1) Social factors

In the development of renewable energy, social factors refer to environmental factors that directly or indirectly affect the development of renewable energy. It refers to various factors that influence the decision to install renewable energy, such as residents near renewable

energy development areas, civic groups such as environmental organizations, and opinions on the development of renewable energy by related companies and research institutes.

Acceptability refers to the tendency of citizens or local residents to accept the introduction of renewable energy, and the most important of these is the acceptance of local residents. If nearby residents have high positive thoughts about renewable energy development, their acceptance will be good, and if they have high negative thoughts, the opposite is true. Strong civil complaints from nearby residents are a cause of blocking renewable energy. All licensing matters include whether or not residents' opinions were received. It is necessary to understand various factors that affect resident acceptance.

Misinformation about renewable energy influenced residents' negative public opinion. Whether solar modules are heavy metals and whether light is reflected or not influenced residents' opinions.

Renewable energy business operators are securing acceptance by returning a portion of the profits earned through energy production to nearby residents. Some residents who have a negative perception believe that outsider’s businesses from other region make money, and the residents are harmed as a result. To eliminate this, it is important to provide direct and indirect benefits from renewable energy and obtain consent from residents. This will have a direct impact on business licensing matters.

In an effort to increase resident acceptance, the resident investment model is receiving attention in many renewable energy projects. Income is created for residents by participating in part in renewable energy project costs and sharing profits from power generation profits. Hapcheon Dam floating solar business (41.5MW) is a representative example of this type of resident investment. Residents near the Hapcheon Dam invest in floating solar power and receive return on investment in the form of interest with a fixed interest rate (about 10% including taxes and fees).

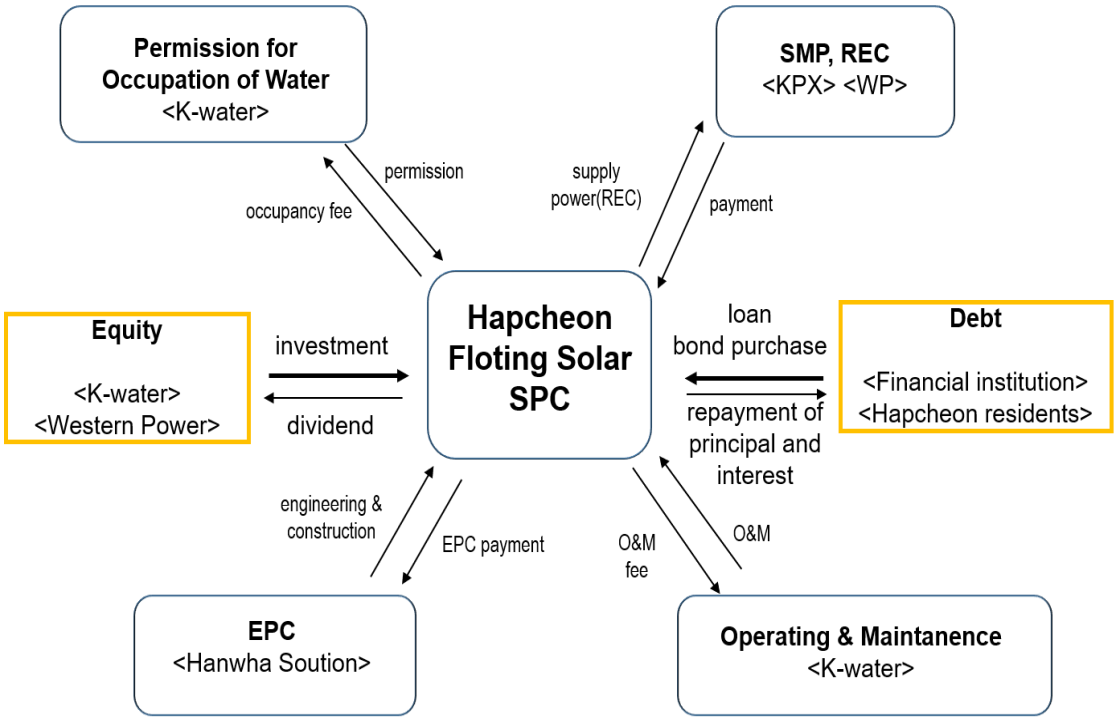

Figure 5. Hapcheon Floating PV Business Model

It is argued that floating solar power plants installed on the water surface or wind power plants installed at sea have a negative impact on the fishing activities of fishermen in the area. It is said that vessel routes are restricted and renewable energy facilities reduce the catch. They present strong opposing opinions because they perceive it as restricting their economic activities and property rights.

The decision-making of the local government in the area is very important in resolving the acceptability of local residents. Local governments show a willingness to actively intervene only when they determine that the local image or economy can benefit from renewable energy projects. Therefore, it is essential for project managers to communicate with local government officials, and through them, conversations with residents can become smoother.

If there is a conflict with other development plans in a renewable energy development area, there is a high probability that renewable energy will be considered as a secondary priority. In the case of a certain dam, even though it was a suitable site for floating solar power, there

were cases where consultation was impossible due to the local government's tourism plan using water buses.

All of these issues can be resolved only when supported by policy decisions from the central government. The Renewable Energy 3020 Implementation Plan established in 2017 became the basis for related projects to be promoted in earnest.

Considering these, technical factors can be listed as follows : Resident acceptance, Property rights restrictions, Resident investment, Fake news, Landscape issues, Nature damage, Local government cooperation, Central government policy and etc.

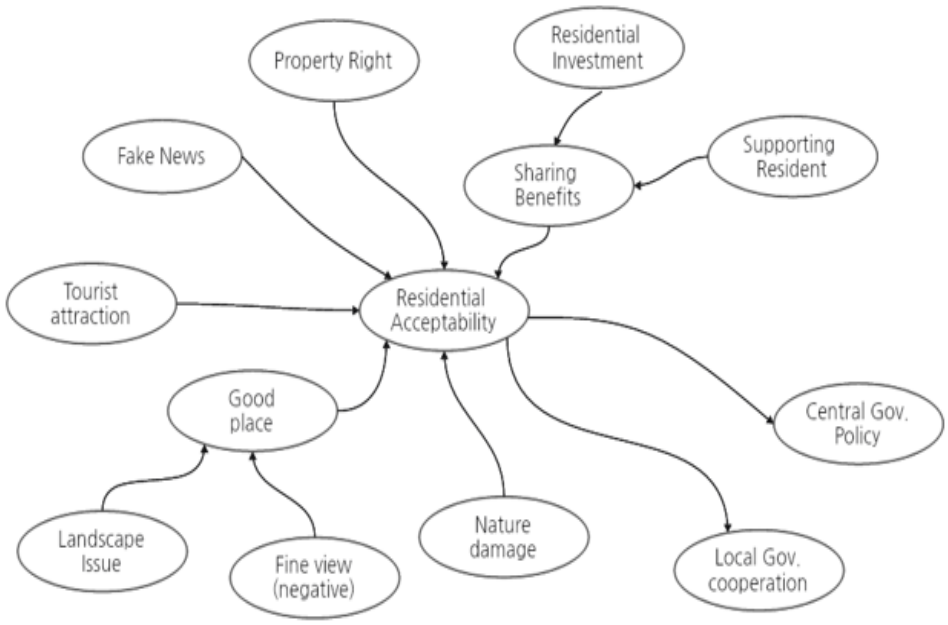

Figure 6. Causal mapping of social factors

(2) Economic factors

Economic factors refer to tangible and intangible factors to be considered at the investment stage for renewable energy construction. First, it is a factor to consider whether it is financially feasible. Investment decisions must be made by judging economic feasibility between the profits earned and the costs incurred.

If there is no financial benefit, you may decide to invest by considering intangible effects.

It can be considered as environmental improvement cost or tourism benefit.

Costs incurred in renewable energy projects include design costs at the business planning stage, various licensing costs such as environmental impact assessments, construction costs, operating costs, and financial costs. Operating costs include labor costs, repair and maintenance costs, and replacement costs directly incurred in operating renewable energy facilities, and indirectly include tax accounting costs, insurance premiums, etc. Financial costs such as principal repayment and interest costs are also incurred during the operation process. The recent rise in interest rates has led to an increase in financial costs, aggravating business difficulties.

The profit earned from electricity sales is made up of the product of the amount of renewable energy generation and the unit price of power generation. The power generation cost of renewable energy consists of SMP(System Marginal Price) and REC(Renewable Energy Certificate). These power generation costs are determined according to government policies and international oil prices. SMP also rose significantly due to the impact of high oil prices caused by the Ukraine War that broke out in 2022. REC considers facility costs, and the weight is determined by government policy. Ultimately, the goal of REC price is zero. Depending on the policy, you can buy and sell through transactions in the spot market, but you can also maintain a stable selling price at a fixed price during the facility operation period.

Considering these, technical factors can be listed as follows : Operating cost, Maintenance plan, Construction cost, Power generation profit, Renewable energy amount, Power generation price (SMP and REC), International oil price, Government policy, Financial cost, Indirect costs such as resolving resident complaints and etc.

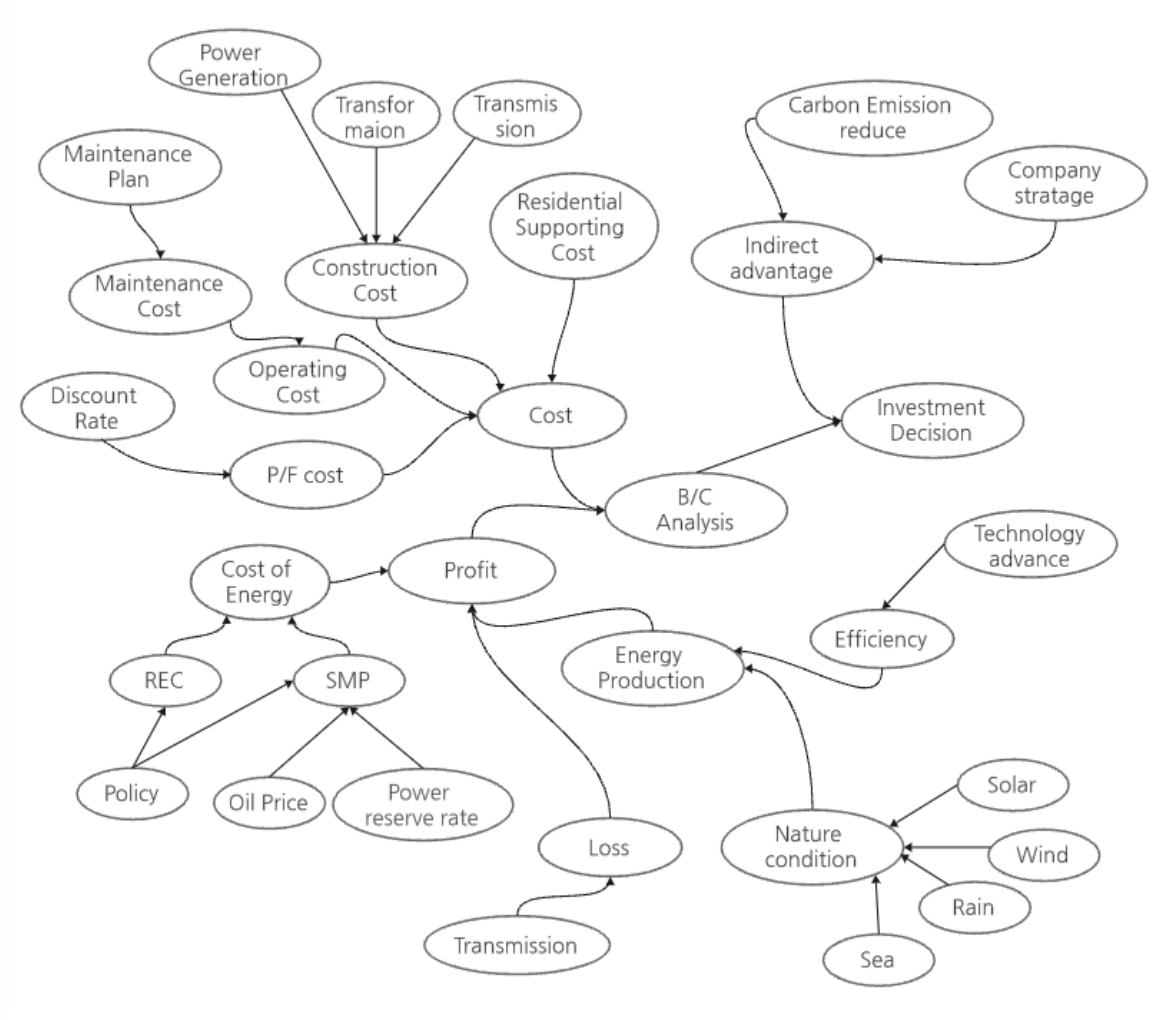

Figure 7. Causal mapping of economic factors

(3) Institutional factors

Institutional factors include legal licensing matters and related laws and regulations to support renewable energy.

Local governments hold the right to permit development activities in accordance with the National Land Planning and Utilization Act. It is a system that promotes efficient use of

land and smooth execution of urban management plans. It prevents urban development by deciding whether to permit development activities in consideration of the adequacy of the plan, availability of infrastructure, and harmony with the surrounding environment. For the purpose of this system, it is mainly reviewed from the perspective of limiting the installation of renewable energy. In addition to the prescribed standards, the opinions of residents are the most important consideration.

Environmental impact assessment according to the Environmental Impact Assessment Act is a system that prevents environmental pollution in advance by predicting and evaluating the degree or scope of the impact of development on the environment and preparing countermeasures. It is recognized as a very difficult procedure because it evaluates the impact on nature, such as plants, animals, and soil, depending on the season.

Permission for power generation business under the Electricity Business Act is processed according to the technical details of renewable energy facilities. In particular, power system connection plans are mainly addressed. Whether or not connection is possible is determined depending on the capacity of the distribution or transmission line. Previously, local governments and residents' opinions were not addressed, but as resident acceptance became more important, local governments and residents' opinions were included in the application. Only for projects for which a power generation business license has been completed, it is possible to apply for the use of transmission and distribution facilities for grid connection to KEPCO.

Local government ordinances include approval review items related to renewable energy. In particular, the ordinance included a clause requiring a distance of solar power from the road, causing many difficulties in the development of renewable energy.

Based on the Act on Promotion of New Energy and Renewable Energy Development, Utilization and Distribution, which was prepared to promote the development of renewable

energy, guidelines for the creation and support of renewable energy integration complexes, which have been in effect since 2022, have been established to support the promotion of large-scale renewable energy. . The Imha Dam floating solar power project promoted by K-water was adopted as the first project after the guidelines were enacted and is currently being promoted.

Considering these, technical factors can be listed as follows : Electric Utility Act, New and Renewable Energy Act, Environmental Impact Assessment Act, National Land Planning and Utilization Act, Power generation business permit, Environmental impact assessment, Development activity permit, Occupancy permit, Local government ordinance, transmission and distribution facility use regulations and etc.

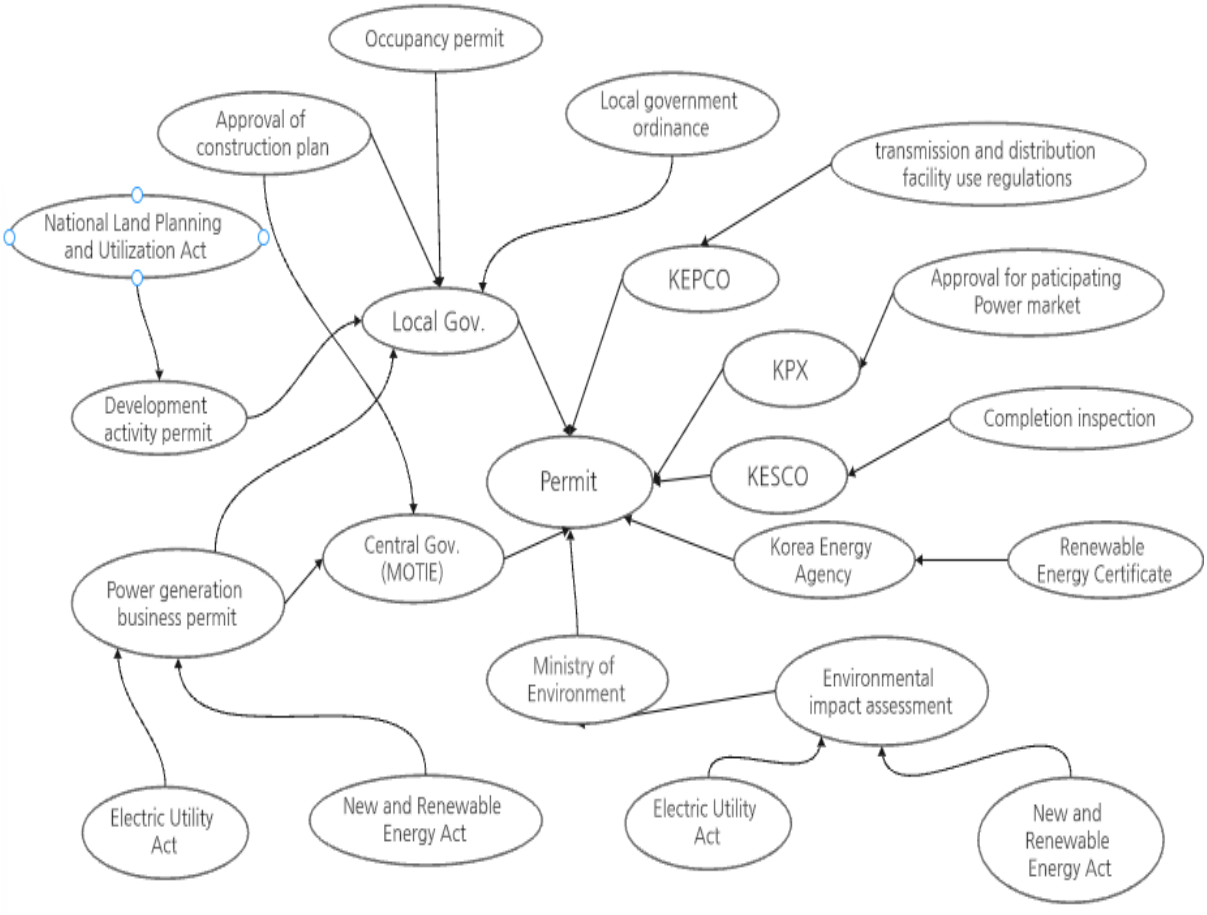

Figure 8. Causal mapping of institutional factors

(4) Technical factors

The power system refers to the link between energy production and energy consumption. Korea's power system is divided into a distribution system (22.9 kV or less) and a transmission grid (154 kV or more ultra-high pressure). Large-scale power plants can also be connected to transmission systems, but most plants that produce renewable energy are connected to distribution networks. KEPCO's distribution line can be connected up to 10MW, and the substation where the distribution line is gathered consists of four 50MW transformers.

Substations are concentrated in the metropolitan area, where more than half of the population lives, but in rural areas, where most renewable energy is actually installed, it is difficult to install new and renewable energy due to saturation of substations and power grids. The available capacity for connecting renewable energy is limited, and it is time for groundbreaking improvements to the power grid.

Natural phenomena absolutely determine the amount of power generation. Renewable energy generation is expressed in terms of facility capacity and utilization rate. The utilization rate is calculated by dividing the annual power generation by the power generation capacity (renewable facility capacity*24*365). In general, Korea's solar power utilization rate is expected to be 15% per year (average of 3.5 hours per day) and power generation is calculated. Power generation is the production of renewable energy, but from a business investment perspective, it is a profit from power generation, so it is important to maximize the amount of power generation by utilizing the same area or facility capacity.

Renewable energy is significant as a distributed power source. Unlike large-scale concentrated power sources such as thermal power or nuclear power, it refers to small-scale power generation facilities that use renewable energy resources to simplify the distribution facilities of the transmission network and increase efficiency. Renewable energy connected to distribution lines is consumed directly by nearby electricity consumers, but in dedicated lines

or transmission networks with long line distances, power loss occurs on the lines. This has the same effect as a decrease in power generation.

The installed capacity of renewable energy is proportional to the installation space and area. Although energy production efficiency has increased due to continuous technological development, a large area brings a lot of energy. An increase in the area receiving sunlight or an increase in the area receiving a large amount of wind is naturally associated with an increase in the ability to generate renewable energy, that is, an increase in installed capacity. However, it may be limited in area because it is difficult to utilize in places where there are obstacles blocking sunlight or wind.

Natural conditions absolutely affect renewable energy, such as wind, solar radiation, and precipitation. Ocean energy, such as tidal power, is a nearly predictable resource. Other natural conditions cannot be predicted accurately, but using historical weather data, we can predict the production of renewable energy. As technology advances, conditions for installing renewable energy have improved, including improved energy efficiency, durability, reliability, and safety. For example, a 240-Wp solar module with an efficiency of about 15% was produced 10 years ago, but technological progress has recently been made to the level of a 600-Wp module with an efficiency of 22%.

Considering these, technical factors can be listed as follows : Power system, Power generation, Area, Installation capacity, Natural conditions, Efficiency, Technological progress, and etc.

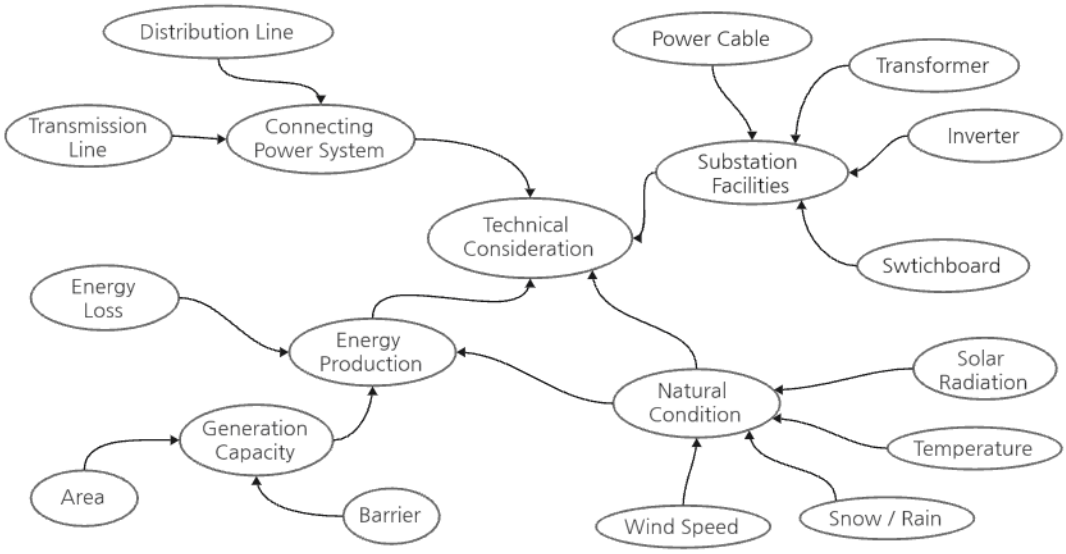

Figure 9. Causal mapping of technical factors

4. Findings from interviews

4.1 Revisiting the factors for renewable energy development

For the interview, four experts were shown a causal map of renewable energy consideration factors and data summarizing K-water's internal procedures, and exchanged opinions in a free atmosphere about ways to revitalize renewable energy. In this process, the main opinions were summarized as findings from interview.

Company	Category of business	Name	Career
W	Power Generation company	Lee, O O	Development (3-yr)
N	Power Generation company	Lee, O O	Development (5-yr)
H	EPC company	Cho, O O	EPC Project manager (10-yr)
L	EPC company	Lee, O O	EPC Project manager (6-yr)
K	Power Generation company	Shin, O O	Operating renewable(5-yr)

Figure 10. List of interviewees

(1) Findings from Interview

1) How to secure the power system is the most important factor in establishing a business plan.

Experts in charge of renewable energy projects generally judged problems with the power system to be more important than residents' acceptance. Securing the power system is the most important factor in establishing the initial plan for a renewable energy business and is the driving force for starting the business.

2) In order to secure resident acceptance, key local people must be captured.

In order to secure resident acceptance, an ally is needed who can deliver accurate information about the project to local residents and lead the project in a positive direction. It is possible to create favorable public opinion through the village head, local fishing community leader, or agricultural cooperative leader. To this end, advancing the project through close communication with them from the business planning stage can serve as the core of renewable energy development.

To achieve this, we need to meet with them a lot, listen to a lot of their stories, and convince them that no major damage will occur to the region. Even the benefits to be received must be carefully presented. For example, a village head who had the most opposition in the area acted as a speaker at the front to persuade residents after communication was established with the head of the village, which greatly helped in reducing resident acceptance. Conversely, if the key man was not persuaded, opposition from local residents spread further.

3) Type of resident investment method

The hope is to own shares (stocks) and receive dividends linked to the rate of return of the business, but in reality, residents have little capacity to invest in renewable energy, except for some residents with high income levels. In addition, some residents with high income levels

want to invest directly, but in this case, the problem arises that the benefits from renewable energy are concentrated only on some residents. The problem of the majority of residents being excluded from the benefits may arise.

In the case of the Hapcheon Dam floating solar power plant, which was completed in 2021, there was a high demand to increase the amount of resident investment at the business planning stage, but at the stage of setting up resident investment shares for financing, there was little direct resident investment intention, except for a few. . Resident investment was made through a green fund supported by the government, and therefore no direct financial compensation was paid to individuals in the form of village funds. However, in this form, residents do not invest separate capital, and since it does not require personal effort for investment and is handled by the business operator, it can be a good method of resident investment if the village community agrees. there is.

All of the interviewed experts said that this was the most preferred method of investment for residents.

4) A method of persuading elderly residents is needed.

It is true that most large-scale renewable energy projects are focused on rural areas and small and medium-sized cities rather than urban centers. In rural areas, many people are elderly, so their understanding of business is low. Additionally, because the future life expectancy is low, 20 years, the typical investment period and useful life of renewable energy, may feel like a long time. The benefits that can be received from renewable energy are the key to residents' acceptance, but the elderly may feel that the benefits received are insufficient as they are spread over 20 years. Due to the uncertainty that may arise over a long period of time, there is a strong desire to obtain many short-term benefits at the time of project completion.

As a result, an opinion was suggested that elderly residents should be persuaded through their children or by key men such as village heads, and that profit distribution should be

reviewed through in-kind support at the time of completion.

5) Ideas for KEPCO power system expansion

In order to secure KEPCO's power system, the construction of new transmission lines and substations must be supported. However, it is true that this will take a long time, and it is difficult to proceed due to problems with resident acceptance. This can be seen in the Miryang transmission tower incident, which was finally built through administrative execution in 2014 after suffering a 10-year conflict due to opposition from residents starting in the early 2000s. It is true that renewable energy can only be expanded if it is supported to some extent by the construction of new transmission lines and substations, but there was an expert opinion that in the meantime, consideration should be given to ways to utilize existing power infrastructure.

The transformers in KEPCO's substations are comprised of 3 to 4 banks, but if the site of the existing substation is slightly expanded or 1 to 2 transformers are added by utilizing empty space, the system's spare capacity can be increased. Also, in the case of power lines, it is necessary to expand the capacity of the lines by reinforcing or replacing existing transmission line towers or distribution line poles rather than new ones. This could be presented as a way to significantly reduce the effort required to access renewable energy.

6) Internal decision-making and licensing procedures must proceed quickly.

Although problems and improvement plans were discussed in depth through surveys with related experts, it is true that it is not easy to approach actual solutions to the plans. When reviewing short-term and practical solutions, it was determined that improving the company's internal decision-making process would be helpful. In common, project managers believed that too much time and effort was spent on internal decision-making procedures and licensing procedures. There may also be cases where approval is missed due to delays in internal processes.

By receiving opinions from experts, we came up with ways to improve the process of

decision-making and progress within K-water. The improvement plan will be presented in detail in the improvement plan of this research report.

4.2 Recommendations for promoting renewable energy development

(1) Establishment of business method selection criteria

It is necessary to determine the business method from the beginning, taking into account the scale of development, participation of business partner, etc., to prevent project delays due to changes in the business method. The business method should be determined in advance based on the size of development so that there is no confusion about the business direction. It is necessary to introduce its own business for projects below 3 MW, and a joint business through the establishment of SPC for projects exceeding 3 MW. Considering the indirect costs required to establish an SPC and the low profits compared to large-scale development, it is suggested that projects under 3 MW be promoted on their own. However, it is necessary to select the business method in consideration of the business conditions, and if there are no residents willing to participate in the project, it is necessary to switch to its own business.

In the case of SPC projects, it is possible to secure development momentum, share risks among participating companies, and reflect social trends through resident participation projects. In order to block factors that can change the way the project is carried out, it is necessary to consult with related organizations, decide on residents' participation, and recruit companies that will jointly participate in the project in advance.

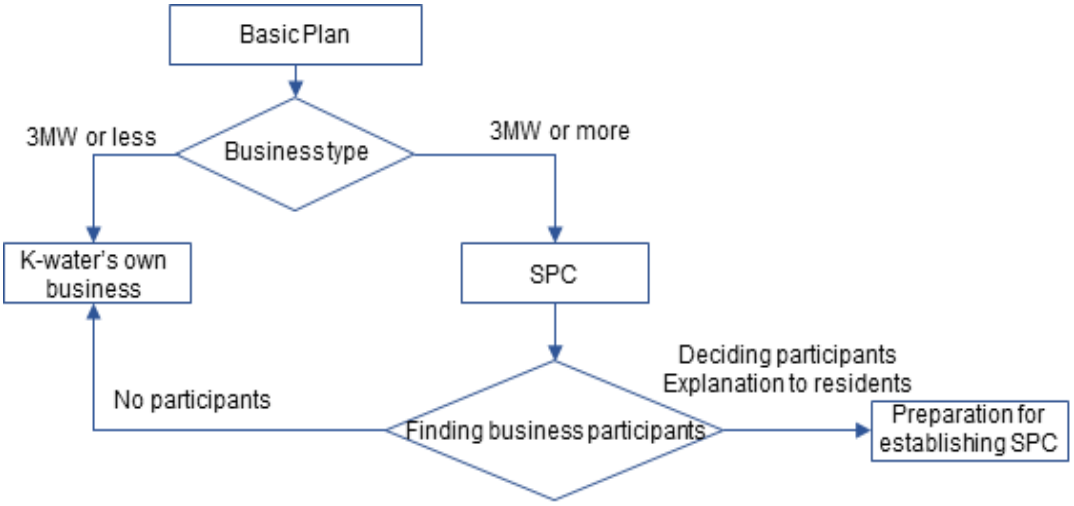

Figure 11. Improvement of business method selection criteria

(2) Reduce risk by changing the timing of the process

Fast progress is required when pursuing a project, and it may be necessary to review the project changes depending on the changes in the surrounding conditions. It may even lead to the cancellation of the project. We would like to suggest ways to improve the company's work process for smooth work process.

1) Procedure for power system connection

In order to connect to the renewable energy power system, a power generation business permit must be completed. After receiving a power generation business permit, apply to the Korea Electric Power Corporation for a permit to use electricity for transmission. Previously, preliminary procedures were completed and permits were applied for at the time of completion of the feasibility study, but it is necessary to conduct a preliminary investment review before implementation. After finalizing the grid connection plan at the basic planning stage and applying for a power business permit, grid connection capacity is secured by utilizing electricity for transmission. If the application time is changed, it is expected to proceed more than 150 days earlier than the existing application time, so the process for securing system connection capacity will proceed quickly.

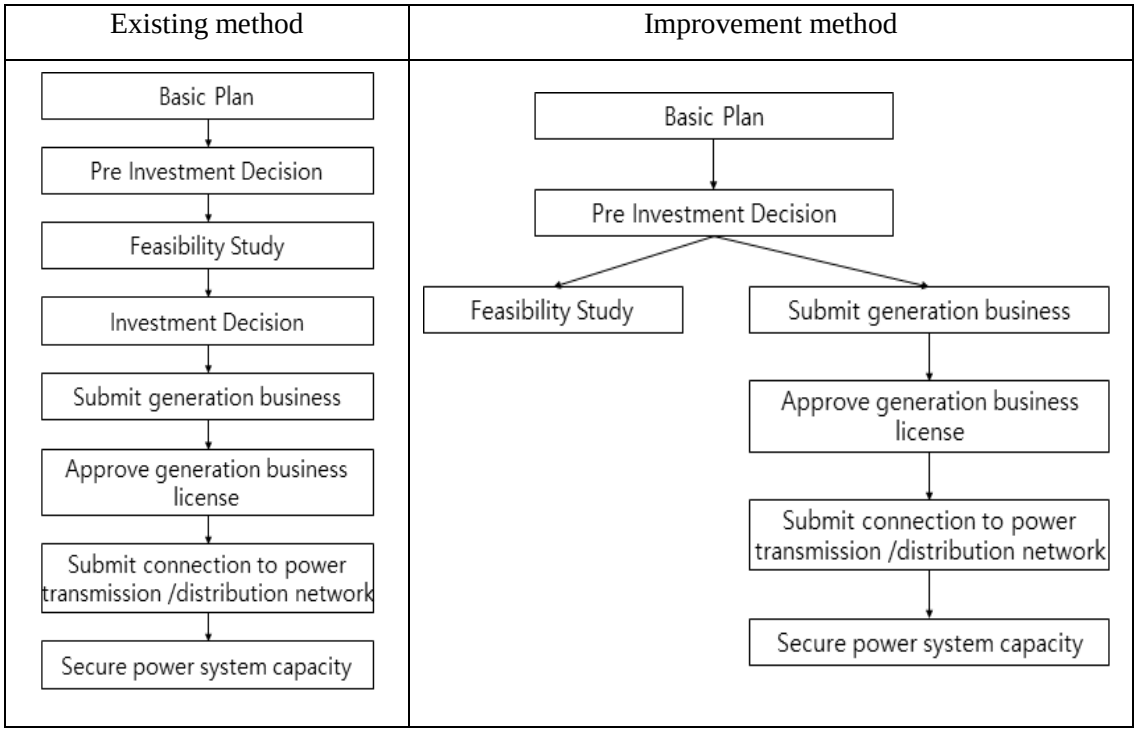

Figure 12. Measures to Improve Procedure (for power system connection)

After notification of permission, changes in development scale and business method, or adjustment of business timing through internal decision-making may occur. In this case, the relevant problem shall be resolved through an application for change of electricity business license pursuant to Article 7 of the Electricity Business Act and Articles 4 and 5 of the Enforcement Regulations of the same Act.

2) Early implementation of EIA

The timing of pre-site consulting and small-scale environmental impact assessment services has been changed to the timing of business basic plan and pre-investment review. Once the basic business plan, such as project location and development scale, is completed through on-site inspection, etc., the relevant environmental agency must conduct prior site consultation and collect opinions from the Ministry of Environment in advance. In order to conduct environmental impact assessment consultations before early project placement, the timing of small-scale environmental impact assessment service will be changed to after the pre-investment review. In addition, by securing a sufficient environmental impact assessment

period from the beginning of the project, there is an effect of preventing additional supplementary requests from the Environmental Protection Agency, which is a consultative body, such as seasonal surveys.

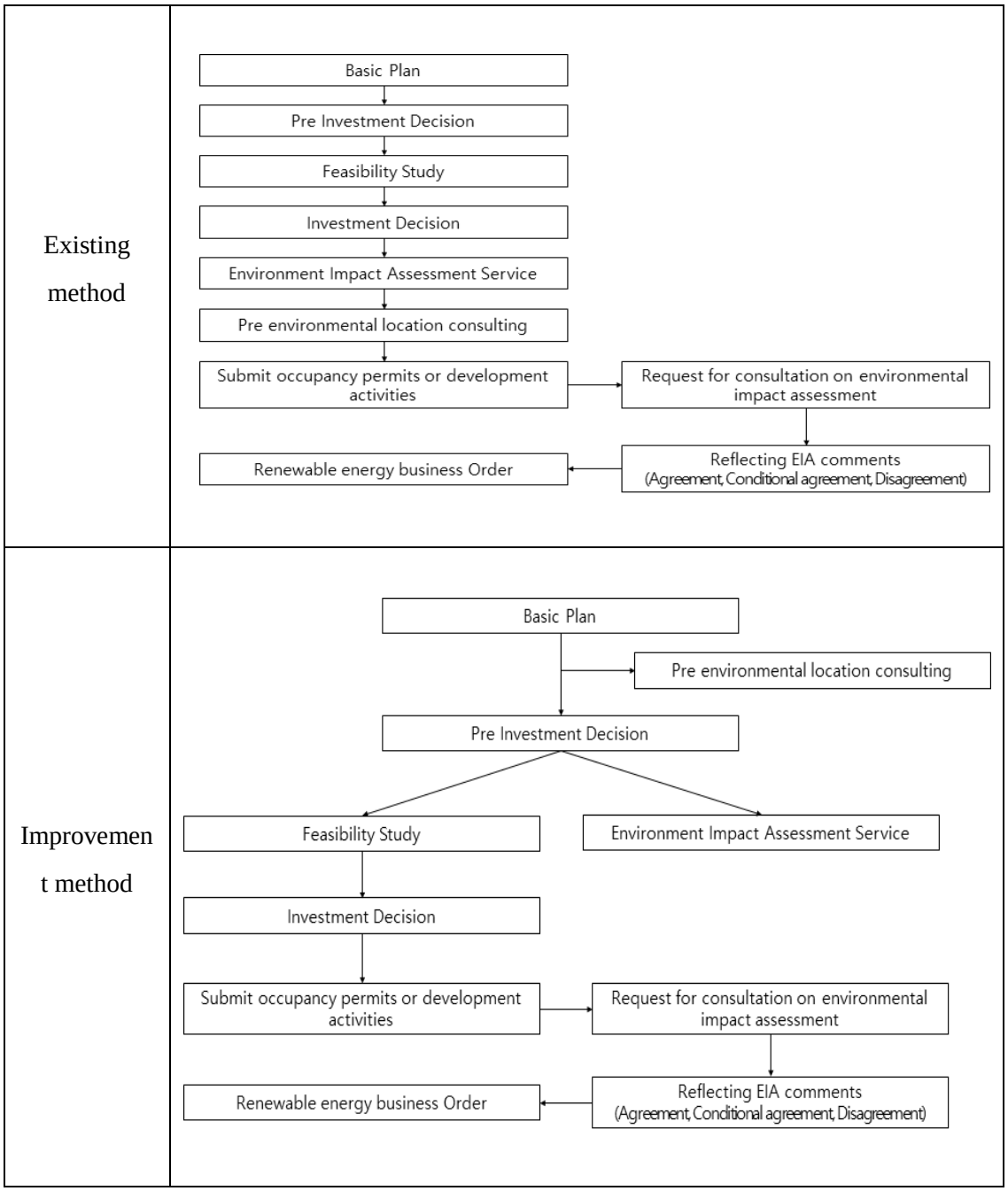

Figure 13. Measures to Improve Procedure (for environmental impact assessment)

In order to quickly proceed with power system connection and environmental impact assessment, all procedures from planning to ordering contracts and constructing renewable

energy plant are presented as follows.

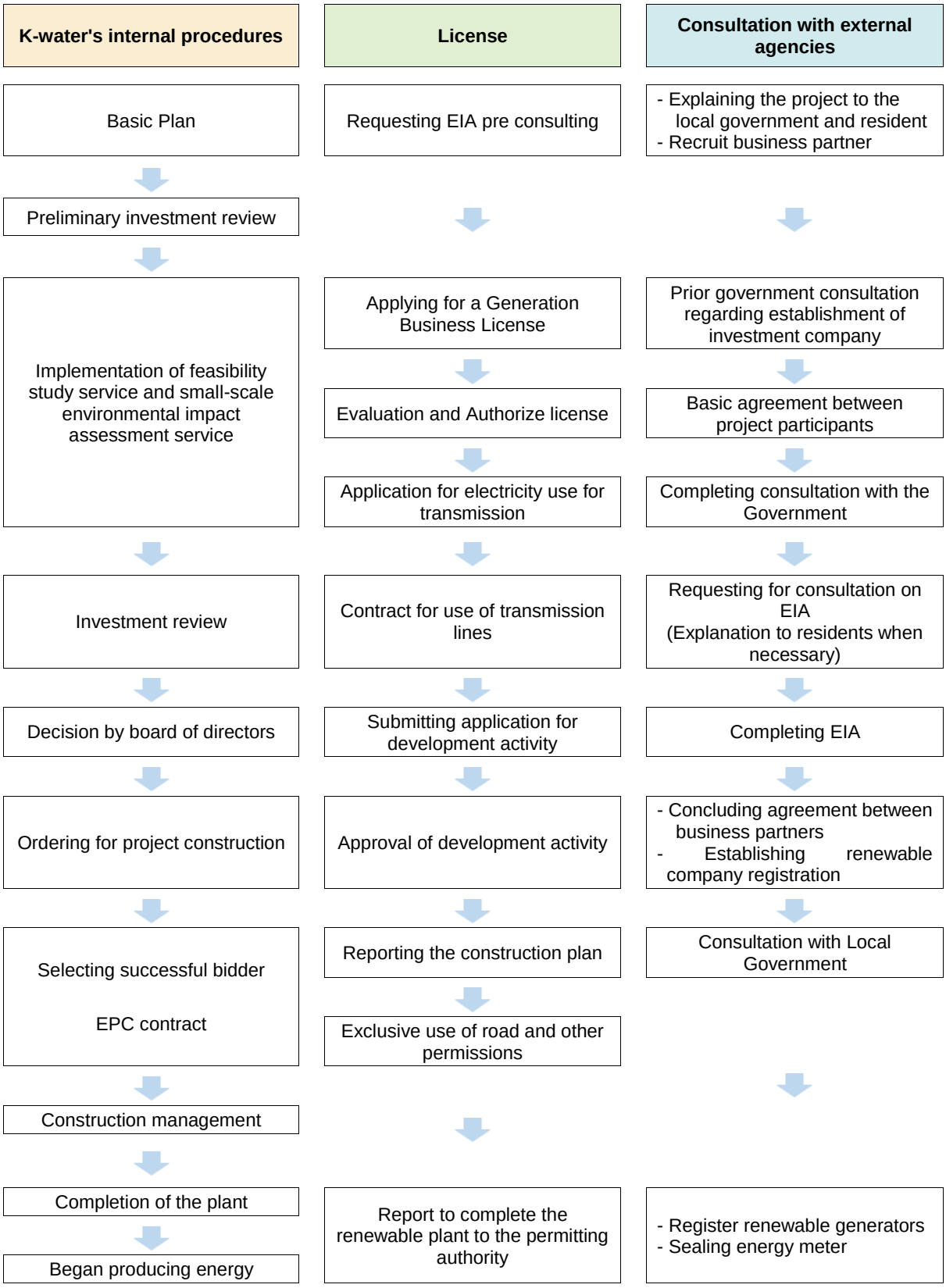

Figure 14. Measures to Improve Business Implementation Procedures

(3) How residents participate in investment

There are two main ways for residents to invest in renewable businesses. These include capital participation and lending through bonds. Participating in capital means directly investing in the relevant renewable energy facilities and owning a certain stake. In this method, dividends are higher when profits are high depending on the amount of renewable energy generation or unit cost of energy. It also means directly participating in facility operation or having a stake in decision-making.

Loans are a form of lending funds for the construction and operation of renewable energy facilities. Interest is charged according to the contract. In general, renewable energy operators pay interest to residents who have invested at a level higher than the commercial bank interest rate.

A maximum of 0.2 REC is additionally issued to projects that apply this resident investment method, and the additional REC profits are returned to residents. Residents who invest based on this support can expect high returns.

As a result of interviews with experts, among the two methods, investment in the form of loans is recommended to residents. When participating in capital, you can expect a large dividend amount if the performance of renewable energy generation is good, but on the contrary, if the performance is poor, the dividend amount may be very small. In addition to this volatility in expected profits, if a problem occurs in the business, such as an equipment accident, a situation may arise where the business owner must be held responsible.

The loan type can expect a certain amount of profit regardless of the amount of renewable energy generation. If a problem occurs in the business, repayment can be guaranteed as a priority. In terms of stability of return of investment funds, it is more advantageous than capital participation.

In addition, it is necessary to adopt a community investment method in the form of a

village enterprise rather than an investment method for individual residents. Residents do not have a lot of spare funds, and most of them are elderly, so they are reluctant to invest in personal expenses. This is a phenomenon that appears in most resident-participatory renewable energy projects being promoted. There is a need to utilize the green innovation finance project (wind power and solar power generation resident participation fund loan support project) implemented by the Ministry of Trade, Industry and Energy. Loans are provided with lump-sum repayment over a 20-year grace period to residents who have been registered as residents in towns, villages, or wards surrounding wind power (3 MW or more) or solar power plants (500 kW or more) for more than one year, or to village businesses (5 or more people) comprised of residents. Renewable energy project implementers consult with local residents and implement administrative procedures on their behalf. Local residents can generate economic benefits for their village without much effort. It is necessary to present specific plans on how to utilize the profits to prevent disputes between village residents within the community.

5. Conclusion and future research

(1) Comprehensive presentation of considerations necessary for business development

Through analysis of obstacle factors, it is possible to check at a glance the comprehensive considerations required for business development. So far, research projects have dealt with only one topic related to renewable energy or a few items for activation. However, the comprehensive map presented in this study is significant in that it provides a glance at all the matters to be considered from the initial planning stage of the project to project completion.

We were able to closely examine the obstacles that business developers directly feel, and we were able to organize some measures that we consider important and think about ways to resolve them.

(2) Directions for solving problems to revitalize renewable energy

Based on the considerations necessary for business development, personal opinions that have been considered so far, and the opinions of experts from public and private companies working in related industries, problems that must be solved in order to revitalize renewable energy were presented. There are many studies and cases on resident participation in order to improve resident acceptance, but since the majority of residents are elderly, it was suggested that residents need benefits that can be provided in a short period of time to help them understand the project. In addition, opinions were presented that community investment, rather than individual investment, and support in the form of village funds would actually help promote the project.

Like ESTEEM in Europe, there is a need to establish national standard guidelines to address renewable energy acceptability.

Regarding the problem of grid connection, the construction of new substations and transmission lines to supplement the power system took a long time, cost a lot of money, and there were many difficulties in persuading residents. Accordingly, it was said that there was a need to solve the problem of connecting renewable energy by additionally expanding transformers in existing substations and increasing the capacity of existing distribution lines.

(3) Improvement of business promotion procedures for smooth progress of business development

We have summarized K-water's business progress procedures, and based on this, we have summarized the direction of improvement in K-water's business progress procedures by considering the opinions of experts working in the related industry as well as personal opinions. Regarding the progress of the renewable energy project, it is thought that not only K-water but also renewable energy business operators and interested people will be able to refer to this and help them proceed and understand the project.

(4) Study limitations and additional suggestions

In this paper, it is true that it largely reflects the situation of the previous government, which had full support and interest from local governments, residents, industries, and related organizations, as well as government policy support for the revitalization of renewable energy.

Recently, the government reset the ratio of renewable energy to lower than the existing policy. Accordingly, experts in related industries believe that interest in renewable energy has decreased significantly compared to the previous government. Revitalizing renewable energy is a global trend that cannot be avoided as a key task for responding to climate change. It is believed that research is needed on the problems and directions for improvement in the direction of renewable energy considering the current government's policy direction.

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Appendix

☐ Interview questionnaire

① What business are you directly or indirectly responsible for or are aware of?

③ What is the progress status of the above project (completed, in progress, discontinued), and what are the factors of success or failure?

③ What was the most difficult aspect while carrying out the business, and how did you overcome it (or if you failed, how did you try to overcome it)?

④ What are the review items, project progress procedures, elements that need to be resolved in advance, and elements that need to be improved for the development of a renewable energy business?

⑤ Is there anything that needs to be modified or supplemented about the causal map diagram?

⑥ Which factors do you think are most important or do you find difficult to solve the problem for revitalizing the renewable energy business?

⑦ Among these, what do you think is the most important or most difficult factor?

⑧ What do you think is the way to overcome this?