System Dynamics Approach and Causal Mapping Analysis for the Invigoration of Renewable Energy Business

By

HONG, Jungmin

CAPSTONE PROJECT

Submitted to

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ABSTRACT

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The renewable energy business is receiving worldwide attention due to climate change, however the supply status is still insufficient. This study aims to prepare a plan to invigorate the renewable energy business through a system dynamics approach and causal mapping analysis. Through careful review of previous studies and cases, mediate variables (acceptability of residents, resident participation, shared growth) for invigoration of the renewable energy business were discovered. A causal mapping was created through the analysis of the causal relationship between the dependent variables closely related to the mediate variables. And through this, a policy plan for invigoration of the renewable energy business was prepared. The policy plan was derived by applying the Galbraith's Star Model. (***Structure***: Establish an advanced cooperative system, ***Strategy***: Establish a continuous government support system, ***Rewards***: Develop a systematic profit sharing system, ***Process***: Establish a strategy for each sector for shared growth, ***People***: Strengthen governance among stakeholders). In order for these policy plans to be successful, the residents and the government must cooperate with each other in a horizontal relationship to find solutions to the problems.

Keywords: *Climate change, Causal mapping, Acceptability of residents, Resident participation, Shared growth, Galbraith's Star Model, Cooperatives, Mutual cooperation*

TABLE OF CONTENTS

LIST OF FIGURES

I. Introduction

Concerns about the impact of climate change on the environment as well as society and the economy have increased worldwide, leading to continued international discussions on reducing greenhouse gas emissions. However, the fundamental measure is to try to reduce or avoid human activities that cause climate change. This means efforts should be made to reduce or eliminate greenhouse gas emissions from fossil fuel combustion. In other words, it will eventually be converted into energy supply through renewable energy that does not emit greenhouse gases.

The International Energy Agency (2017) predicts that renewable energy will be the biggest source of power after 2020 and will rise to 40% by 2040. Along with these forecasts, each country has set a high target for renewable energy and focuses on renewable energy. Most major advanced countries, including Germany, Japan and the United States, are focusing their national capabilities on building sustainable and environment-friendly energy systems by expanding renewable energy while creating economic growth effects based on them.

Korea is also continuing its efforts to expand the supply of renewable energy. Moon Jae-in president (2017) announced a plan to increase by 20% renewable energy by 2030. It also announced the Korean version of the Green New Deal, which aims to create 1.9 million jobs by investing 160 trillion won over five years in 2020. Among them, it can be seen that the government will focus on renewable energy projects through the green energy policy, which will invest 11 trillion won by 2025 to expand the supply of solar and wind power.

Why is it difficult to supply renewable energy even when focusing on national capacity to achieve this goal? The obstacles to expanding the supply of renewable energy can be largely classified into skill, finance, the legal system and acceptability. The acceptability can be classified into the acceptability of the general public and the acceptability of residents in the surrounding areas of the plant, and the problem is the acceptability of residents. (Jung, 2017)

In other words, the reality of Korea is that the acceptability of the general public of renewable energy is high, while that of the residents in the area where the actual power plant is located is significantly low.

Despite the fact that renewable energy has a higher social support rate than nuclear power plants and coal power plants in most countries, the frequent occurrence of large and small conflicts and friction in the process of location of specific power generation facilities proves the previous proposition. However, despite the inevitable social acceptability in order to achieve and spread higher supply targets, study on renewable energy policies has been conducted mainly in terms of supply.

For this reason, study on the acceptability of residents is important. It is difficult to expand the supply of renewable energy without improving the acceptability of residents. So what are ways to increase the acceptability of residents? Many policies are being proposed to increase the acceptability of residents, among which the resident-participating renewable energy project is most suitable. The resident-participating renewable energy project is a project that enhances the acceptability of residents and contributes to the promotion of residents' income by introducing a BSM[1] for renewable energy projects. (Lee & Kim, 2015) Major foreign countries such as Denmark and Germany are encouraging the expansion of renewable energy supply while enhancing social acceptability through resident-participating renewable energy business models.

In the case of Denmark, the representative country of the wind power generation, it is operated by more than 80% of local residents by introducing the resident-participating renewable energy project. Germany's Yoonde Village is a resident-led renewable energy town that produces electricity on its own and generates profits from the sale of surplus energy. (Song, 2016) Also, Seoul, Goesan and Suncheon are engaged in renewable energy projects for

[1]. BSM: Benefit Sharing Mechanism

residents. But so far, no significant results have been made in Korea. To improve this, many studies have been conducted to improve the acceptability of renewable energy suitable for domestic conditions.

Lee (2014) estimated the amount due for payment for renewable energy using the CVM[2]. Based on this, measures were proposed to enhance social acceptability. Jung and Lee (2018) insisted on overcoming the limitations of the current resident participation incentive system, which focuses solely on economic profit-sharing perspectives, and introducing more diverse forms of profit-sharing incentives. Unlike previous studies, two studies are significant in that they dealt with not only economic benefits but also social perspectives. However, there is a limit to not being able to escape from the residents-centered study.

The study also seeks to apply the concept of shared growth with SMEs[3] promoted by public corporation to invigorate renewable energy businesses. Korea's economic growth has been declining every year since 2017. (3.2% in 2017, 2.7% in 2018 and 2.0% in 2019) Also, SMEs are suffering a lot from the recession caused by Covid-19. Therefore, it is to proceed with study on invigoration of local economy caused by technology exchange and recruitment of local residents through collaboration with SMEs.

After all, the main purpose of this study is to present a plan to expand the supply of renewable energy businesses that have not been invigorated despite the global interest in renewable energy due to climate change and the full support of the government. Previous studies on invigoration of renewable energy businesses have been limited to individual factors rather than comprehensive correlations. Therefore, in this study, based on the mediate variables such as acceptability of resident, resident participation, and shared growth, the purpose of solving problems is to derive solutions through a comprehensive relationship of interests.

[2]. CVM: Contingent Valuation Method
[3]. SMEs: Small and Medium-sized Enterprises

Against this background, this study aims to establish a causal mapping model that analyzes the invigoration of renewable energy businesses according to the mediate variables of acceptability of resident, resident participation, and shared growth through a system dynamics approach. Through this, this study establishes a causal mapping to identify the factors for invigoration of the renewable energy business and the relationship between these factors. In the future, it is expected to provide basic data for suggesting policy directions for invigorating the renewable energy business through more detailed quantitative analysis.

The overall composition of this study is as follows. First, in Chapter 2, variables for each factor will be derived and defined through investigation and analysis of previous studies and cases related to this study. In Chapter 3, which is the core of the study, after creating a model for the study, a causal mapping for each factor will be constructed and analyzed. Through this, it would like to propose a policy plan for invigorating the renewable energy business. In the last chapter 4, the implications based on the study results are discussed, the limitations of the study and suggestions for follow-up study are made, and the study is concluded.

II. Literature Review

Based on previous studies, this study discovered and classified several common factors that are indispensable for invigoration of the renewable energy business. Based on the results of analysis of various previous studies, it was identified that acceptability of resident, resident participation, and shared growth were the mediate variables influencing the invigoration of the renewable energy business.

1. Acceptability of resident

One out of three solar and wind power projects that were rejected or suspended nationwide in 2016 was estimated to have been caused by resistance from residents. As such, the acceptability of residents in Korea's renewable energy business is quite low.

Jung & Lee (2018) conducted a survey to establish a profit system for improving the acceptability of renewable energy business. As a result, residents in areas where renewable energy is currently built or scheduled to be built were less satisfied with the renewable energy business. Therefore, the government should overcome the limitations of the current resident participation incentive system, which focuses solely on the view of economic profit sharing, and introduce more diverse forms of benefit sharing incentive system. This should be implemented smoothly through the establishment of governance and financial support measures between central and local governments.

Jung (2017) said that the incentive system for resident-participatory renewable energy business, which is being implemented as a way to improve the low availability of residents, should meet the limit acceptability of resident in the area around the renewable energy plant. Accordingly, as a result of analyzing the effect of increasing the rate of return when applying REC 20%, it was found that it exceeded the expected rate of return of local residents and satisfies acceptability of resident. In order to increase the acceptability of residents, local governments, businesses, and residents should establish an appropriate level of compensation system through communication with each other from the beginning of the project.

It can be seen that in the leading countries of renewable energy, where the willingness to pay for renewable energy is high, great efforts have been made to enhance social acceptance. Accordingly, Lee (2017) used the CVM methodology to estimate the willingness to pay for renewable energy. As a result, Korea's willingness to pay for renewable energy is only 20% in Japan, 30% in the US and UK, and 50% in Italy, so it can be confirmed that a lot of effort is needed to improve the acceptability of renewable energy. In order to increase acceptability of resident, it is necessary to actively conduct promotional education for renewable energy.

Ham & Kang (2017) said that when local residents participate in a renewable energy business, the subject that leads the business is most important. Therefore, it seems important

to establish a system that allows local governments to actively participate in renewable energy business and organize governance that local governments can lead as an effective way to increase acceptability of resident. In addition, local residents were more interested in distributional justice, such as distribution of profits, rather than procedural justice, such as participation in decision-making. Therefore, when planning a renewable energy business, the expected return and investment safety must be considered at the same time.

2. Resident participation

In order to invigorate the renewable energy business, improving acceptability of resident is considered the most urgent prerequisite. Therefore, in major overseas countries, efforts are being made to enhance acceptability of resident through resident participatory renewable energy business models. Resident participatory renewable energy business means that the community shares its profits through community participation, ownership, and control in energy production and use, and energy cooperatives are a representative type of resident participatory renewable energy business. In the case of Europe, energy cooperatives are playing an important role in energy conversion, and its potential can be seen.

As a result of analyzing the factors that influence the motivation and spread of energy participation in the community for members of the Korean citizens' sunlight power generation cooperative, it was found that energy cooperative participants mainly join energy cooperatives according to social norms and sense of belonging with neighbors. In addition, compared to overseas cases, normative motives rather than economic interests played a relatively important role, which shows that both policy approaches to strengthen community energy and education promotion strategies should be considered (Koh & Kim, 2019).

In Denmark, in order to meet the goals of energy security and environmental protection, it had to increase the proportion of renewable energy among available energy sources. Accordingly, the renewable energy business was invigorated through a policy direction in

which residents in nearby areas where power generation equipment is located can have a certain share, or through a system that allows the regional coalition of the power plant to reflect opinions without being excluded from important decision-making. Also, in the case of Samso Island's renewable energy project, it was promoted based on the voluntary participation of Samso Island residents and wide support through citizen groups of the island residents, rather than the government's support or development plan. (Choi, 2018)

Lee & Kim (2015) proposed an improvement plan for the Korean renewable energy resident power plant model in order to build a renewable energy resident power plant model suitable for Korea. The most important part of the Korean renewable energy resident power plant model is that it should benefit all market participants (residents, developers, financial sectors, generator suppliers, O&M companies, power generation companies, government, etc.). In addition, the resident participation rate should meet at least 20%, and financial incentives are given to reduce the burden of project participation.

Song (2016) proposed the introduction of a system for sharing local residents with profitability in the renewable energy business. It is differentiated from the existing large-scale power generation projects, and it is possible to secure regional competitiveness by creating profits and minimizing civil complaints by residents participating in village units. It is possible to contribute to improvement of performance and welfare of residents. To this end, it is necessary to establish a cooperative at the village level, and introduce a performance feedback system in which a specialized institution performs operation and maintenance to promote investment and profit distribution.

3. Examples of domestic and foreign residents' participation

The first launch of the Danish wind farm was a partnership-type wind turbine cooperative in which participants, including Copenhagen residents, local power plants and Danish citizens, had legal and shared responsibility. When the wind farm was first built, participants were

limited to local residents, and 10,000 residents were given priority stock purchase rights. As a result, 8,552 out of 10,000 residents, were able to achieve a high participation rate, including enrolling in the union.

In Germany, Yunde Village is operating an energy-independent village using animal manure, food waste, and forest by-products. This is a world-famous form, a biomass town led by residents, where electricity and heat are produced and consumed, and the sale of surplus energy not only generates profits, but also maximizes the use of energy by utilizing by-products for agriculture.

In the German village of Dardesheim, a part of the renewable energy generation facility was sold to residents to participate in the project first, and the government gave residents an incentive by obligating the price of the difference in solar power generation to be maintained for 20 years. Also, it is successfully carrying out the renewable energy business by creating an environment that encourages residents to actively participate in the renewable energy business.

The Woljeong-ri area in Jeju Island was the first offshore wind farm in Korea, and in this area, a consortium of village associations and local companies invested a stake to build a wind power plant. In addition, Woljeong Wind Power, a special purpose company, commissioned the operation and maintenance company to proceed. At the time, a financial institution, a major conglomerate, raised funds through project financing, and local companies participated in engineering procurement construction in charge of installation and completion, equipment supply, and performance guarantee.

The Sunshine and Wind Power Generation Cooperative in Nowon-gu, Seoul, was established with 1,120 members including 600 civil servants in Nowon-gu Office. Nowon-gu Office rents a site to build a power plant in the parking lot in the Ward Office and receives a rental fee for it. However, since it is a resident business, the ordinance to lower the rental rate from 5% to 1% was amended to add tax benefits.

4. Shared growth

The polarization of the Korean economy has widened the gap between large companies and SMEs due to economic policies centered on large companies that began in the 1960s. However, compared to the importance of shared growth in our society, there is still a lack of awareness and level of activity.

Jung (2016) argued that German order liberalism is more appropriate than neoliberalism as an ideological paradigm due to the economic characteristics of Korean society. And he said that it may be desirable to base the importance of the role of the state in order to establish this order. The Korean economy, based on neoliberalism, is putting a brake on sustainable growth due to the polarization of wealth and the increase of non-regular workers. Therefore, rather than a competition policy that only pursues efficiency, a competition policy drafted from the perspective of society as a whole is needed. In the end, in order for economic actors to maintain freedom, it is important to recognize that individual interests are important, but social interests are also important, and that all economic actors value the interests of society is a shortcut for the shared growth atmosphere to take root in our society.

The New York State Climate Community Protection Act requires most public projects, including renewable energy system development projects, to comply with the prevailing wage standards set by The Public Service Law. In addition, New York State's renewable energy-oriented economy is leading to the transition to a clean economy by creating clean energy jobs, and is pursuing an Energy Affordability Policy to provide free solar power to 10,000 low-income residents of New York State. (Cho, 2018)

Ha & Park & Kim & Yeo (2012) argues that large companies should play a role as a subject of shared growth, and promote shared growth through positioning of management strategies, cooperation programs, and implementation infrastructure. It is said that SMEs should establish a partnership model for win-win management to improve their capabilities,

innovate management, and expand to secondary and tertiary companies. In addition, the mutual cooperation between large companies and SMEs, the management philosophy of the companies, and the characteristics of the industry must be fully considered.

As a result of empirically verifying the impact of shared growth activities on management performance by Shin & Lee (2018) using multiple management performance measures, the company's shared growth activities have a negative impact on management performance as it brings costs. Therefore, according to these results, the incentives for shared growth of companies are inevitably low, and it is determined that policy support and consideration from the governmental authorities is necessary to inspire and promote the activities of shared growth of companies.

Previous studies related to acceptability of resident, resident participation, and shared growth, which are essential factors for invigoration of renewable energy businesses, have been analyzed so far. Variables for each factor that can be derived through this can be summarized as follows.

Prior study	Dependent Variables	Mediate Variables
Jung (2017), Lee (2017) Ham & Kang (2017) Jung & Lee (2018)	Citizen funds, Environmental pollution, Regulation, Job creation, Governance, Financial support, Community consciousness, Cooperatives, Compensation system, Education & public relations, Profit sharing, Distribution conflict, Profit creation	Acceptability of resident
Lee & Kim (2015) Song (2016), Choi (2018) Koh & Kim (2019)	Energy independence, Energy security, Sense of belonging, Relationship network, Institutional support, Shares in power generation projects, Difficulty of development, Low-interest loans	Resident participation
Ha & Park & Kim & Yeo (2012), Jung (2016) Shin & Lee (2018) Cho (2018)	Polarization, Government intervention, Social interest, Step-by-step strategy, Competency development, Value development, Local employment, Management performance, Policy support, Free supply, Priority wage	Shared growth

Table 1. Major variables by prior study

III. Causal Mapping Analysis

1. Study model

The reasons for this study to build a causal mapping model for invigorating the renewable energy business using the system dynamics approach are as follows. It focuses on what are the mediate variables necessary for invigoration of the renewable energy business, and how to deal with the renewable energy business through a causal relationship between them by extracting dependent variables related to the mediate variables. In other words, the purpose is to identify the management tasks of the policy flow for invigoration of the renewable energy business.

Based on this, the conceptual diagram of the study model to achieve the purpose of the study was constructed as follows in Figure 1. Basically, it is assumed that renewable energy business will be invigorated through positive and negative effects through mediate variables such as acceptability of resident, resident participation, and shared growth. The main key variables generated by the mediate variables were economic effects, community consciousness, energy independence, planned development, and environmental preservation, and causal mapping were prepared through mutual causality.

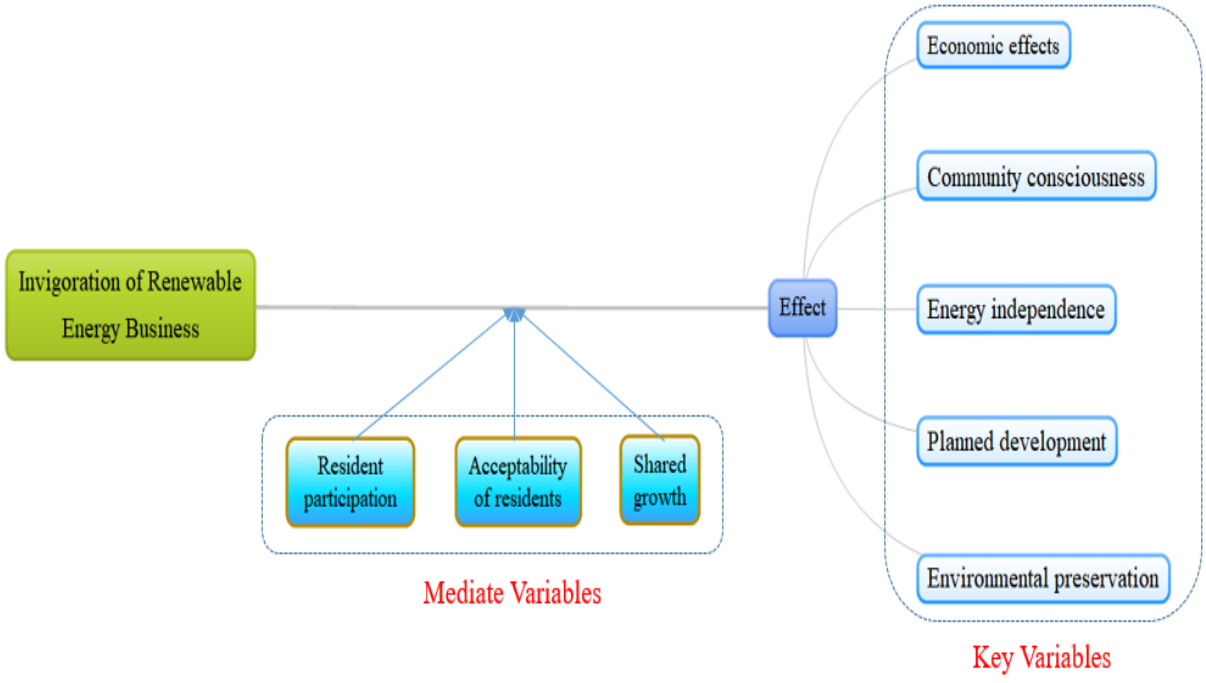

Figure 1. Study model

2. Causal mapping model by factor

In this study, the invigoration of the renewable energy business is investigated through the relationship between the mediate variables (acceptability of resident, resident participation, and shared growth) and dependent variables. To this end, a system dynamics approach was applied and an attempt was made to grasp the dynamics through the analysis of causal mapping for invigoration of the renewable energy business.

1) Causal mapping of acceptability of resident

It is considered that it is possible to explain the dynamic characteristics of acceptability of resident, which is considered the most important factor for the successful promotion of the renewable energy business, through prior study. Major prior studies suggest environmental pollution, community consciousness, and distribution conflict as key variables related to acceptability of resident, and present the basis for theoretical review of this study through causal relations between them.

Residents around the power plant chose environmental pollution because of their dissatisfaction with the construction of a renewable energy power plant. This suggests that the values of environmental pollution may conflict among local residents (Jung & Lee, 2018). In order to solve this problem, it is necessary to establish a compensation system for local residents and establish regulations on environmental pollution. In addition, it is necessary to minimize the problem of environmental pollution by establishing governance through communication between the renewable energy business implementer and local residents.

European countries, including Denmark and Germany, and advanced countries such as the United States and Japan, have high social acceptance of renewable energy. In addition, the model of resident participation through cooperatives is generalized. (Jung, 2017) Community awareness can be raised through information on the benefits provided to local communities when installing renewable energy facilities through public relations and education by

cooperatives. In addition, for the smooth operation of cooperatives, national financial support policies such as citizen funds are required.

Local residents perceived distributive aspects such as participation method and profit distribution more importantly than procedural aspects related to business progress such as participation in decision making. Therefore, increasing acceptance from the planning stage of the business on the premise of a fair distribution of profits will be an important task for the success or failure of the business (Ham & Kang, 2017). Therefore, it is necessary to increase acceptability of resident by minimizing distribution conflicts through fair distribution of incentives and jobs by establishing various profit systems.

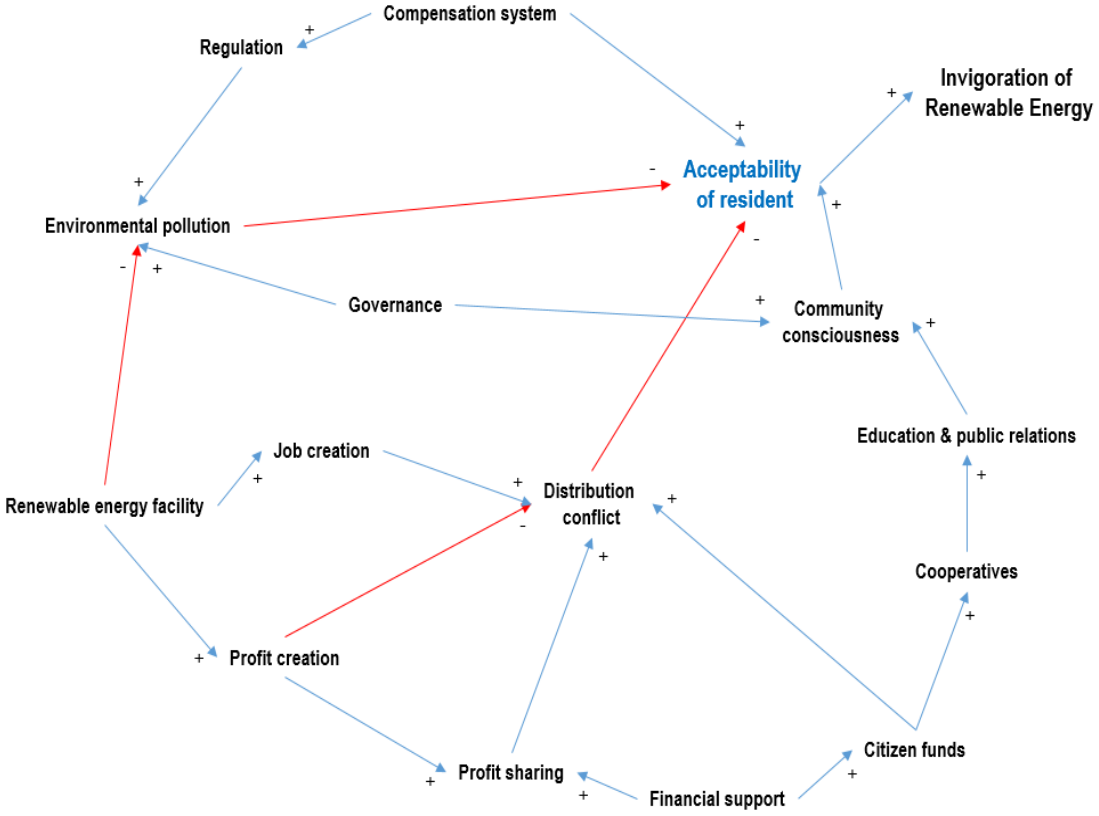

Figure 2. Causal mapping of acceptability of resident

2) Causal mapping of resident participation

Community energy refers to the sharing of the benefits of the community through the community's participation, ownership and control of energy production and use, and energy

cooperatives are a representative type of community energy. As residents' opposition over the installation of renewable energy has recently increased, government support for the production of resident-participating renewable energy, including energy cooperatives, is also increasing as a means to increase the acceptance of renewable energy.

For community energy participation and diffusion, the community to which individuals belong rather than individual characteristics play an important role. The stronger the community, the higher the trust, and this trust is important for expanding the energy of the community. (Koh & Kim, 2019) In addition, the role of local governments is important in that energy cooperatives are community-based. It is necessary to make continuous investments to strengthen community along with institutional support such as enacting ordinances for community energy support.

In the 1990s, in many countries, the need for renewable energy has emerged in terms of energy security such as climate change mitigation and stable energy supply. In Denmark, efforts to improve energy self-sufficiency in consideration of eco-friendly policies were linked with policies to use renewable energy. Through legislation such as the “Renewable Energy Promotion Act”, the right to purchase shares in the renewable energy industry was given first, leading to a direction conducive to the economic activities of the local residents where the facility is located. It has a characteristic that it has silenced the voices of opposition from the region that may arise through this (Choi, 2018).

In Korea, conflicts with local residents are caused due to the difficulty of development of many solar energy companies, and it is difficult to invigorate the renewable energy business. In order to solve this problem, if a resident-participating renewable energy business that considers acceptability of resident within the range that does not have a significant impact on the local environment is expected to contribute not only to local energy independence, but also to increase residents' welfare (Song, 2016). In addition, it is necessary to facilitate local

residents' acquisition of shares in renewable energy projects through financial support such as low-interest loans.

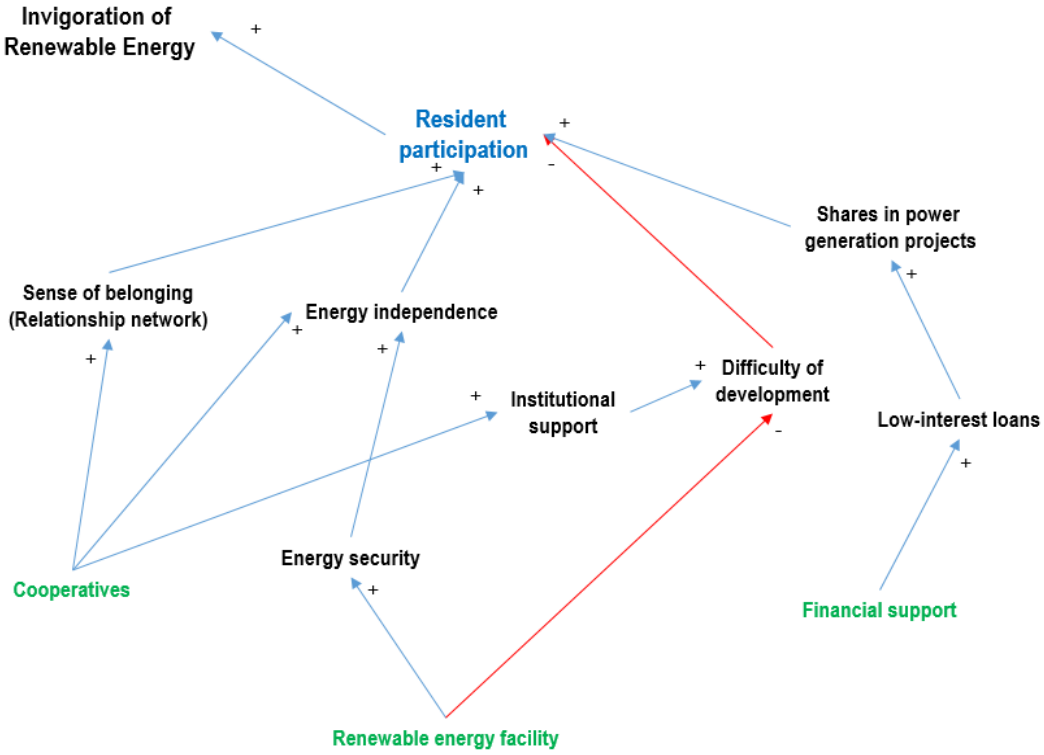

Figure 3. Causal mapping of resident participation

3) Causal mapping of shared growth

In Korea, as the polarization intensifies in many ways, it is not creating an atmosphere of social integration. This is because income polarization is intensifying due to the polarization of regular and non-regular workers and the polarization between large companies and SMEs, and a social imbalance is spreading. As a part of resolving polarization, the need for shared growth between large companies and SMEs is emerging from all walks of life in society.

To solve this problem, policy support is first required. Like the state of New York, renewable energy businesses must comply with priority wage standards. In addition, local employment should be increased by creating jobs in renewable energy businesses, and energy supply policies should be promoted to provide free solar power to low-income residents.

On the other hand, since shared growth activities bring costs, the level of shared growth

activities increases, which negatively affects the business performance of a company. Therefore, policy support through active government intervention is indispensable for corporate shared growth activities to invigorate the renewable energy business.

For the shared growth of large companies and SMEs, the first step should be to develop self-sustainability through competency development of SMEs. In the second stage, large corporations, SMEs, and the government must share values as a single goal. In the third stage, organizations and institutions can implement a shared growth model by establishing a network and organically linking with the division of roles. (Ha & Park & Kim & Yeo, 2012)

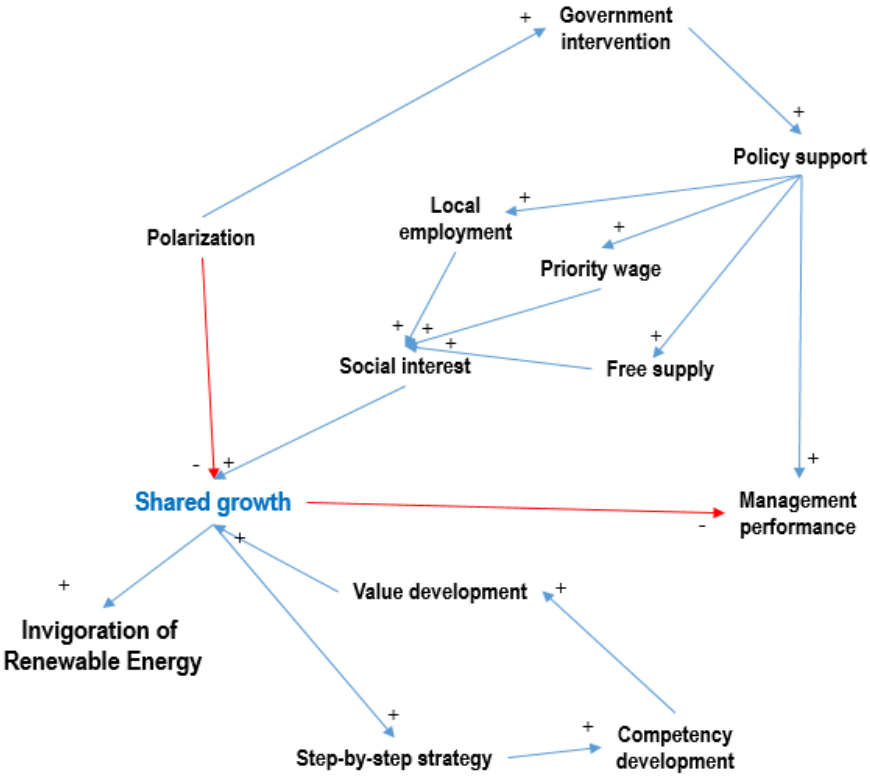

Figure 4. Causal mapping of shared growth

3. Integrated causal mapping model

Based on the discussions so far, by integrating the causal cycle structure between the mediate variables (acceptability of resident, resident participation, and shared growth) and dependent variables for invigorating the renewable energy business, an integrated causal mapping as shown in <Figure 5> can be created.

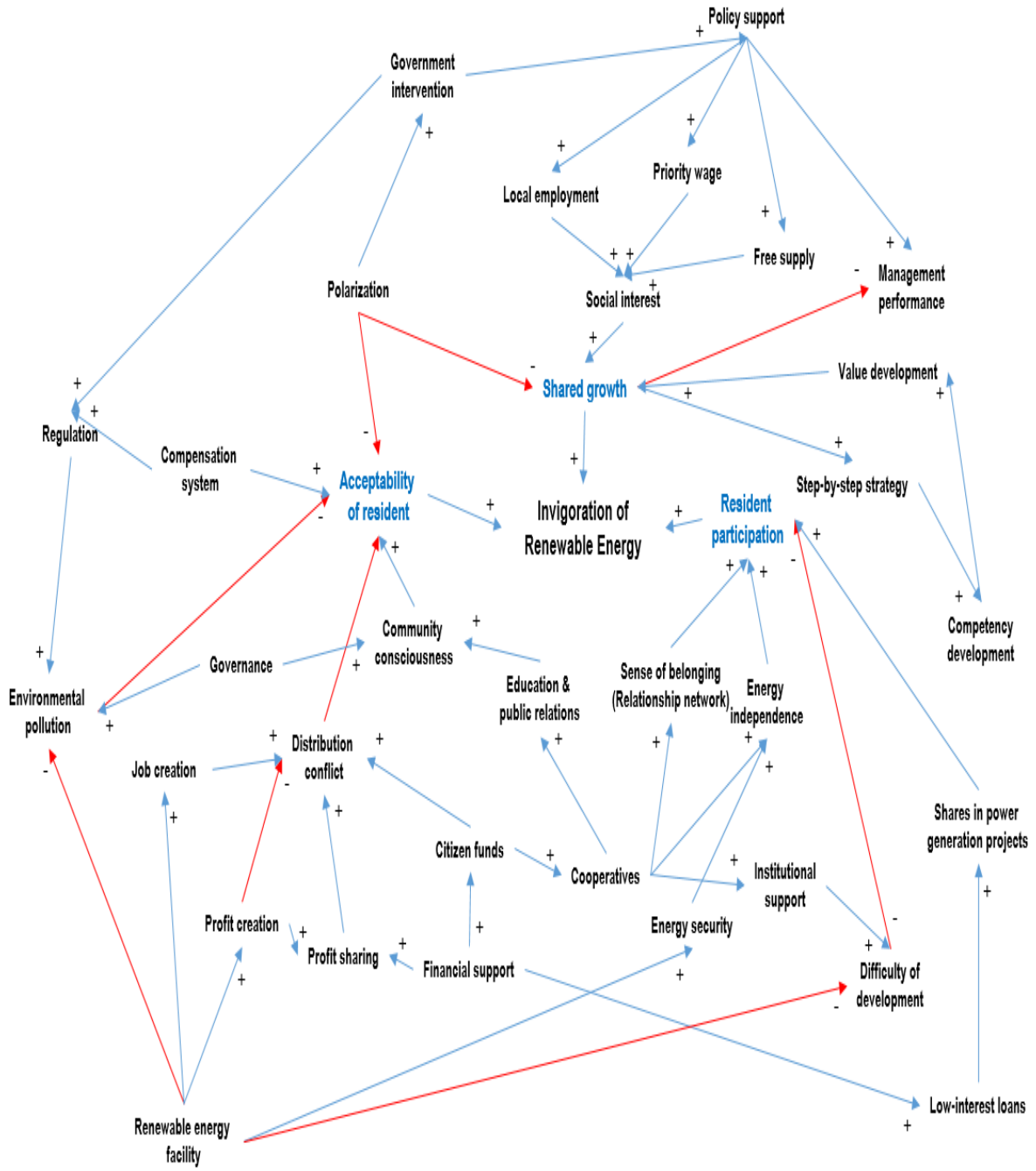

Figure 5. Integrated causal mapping model

In summary, the integrated causal mapping was prepared based on previous studies and cases, and the first variable, acceptability of resident, included citizen funds, environmental pollution, regulation, financial support, community consciousness, job creation, governance, cooperatives, compensation system, education & public relations, profit sharing, distribution conflict, profit creation. The second variable, resident participation, included energy

independence, energy security, sense of belonging, relationship network, institutional support, shares in power generation projects, difficulty of development, low-interest loans. Shared growth, the last variable, included Polarization, government intervention, social interest, step-by-step strategy, competency development, value development, local employment, policy support, management performance, free supply, priority wage.

The discussion of this study to emphasize by grasping the causal cycle structure of these mediate variables and dependent variables is as follows.

First, when analyzing the integrated causal mapping, it is necessary to pay attention to the role of cooperatives among the key variables for invigorating the renewable energy business. Cooperatives are responsible for joint ownership and sharing of benefits for renewable energy facilities, and for local residents to be interested in how energy is produced and consumed. In addition, it has the effect of minimizing conflicts that may arise from renewable energy business by private company and increasing acceptability of resident. Since we strive to return the benefits of renewable energy development to local residents, incentives to increase the value of local resources can be used to reduce environmental damage, and new jobs are created in the region because they are operated by cooperatives.

Second, the role of cooperatives is important to invigorate the renewable energy business, but it is difficult to succeed without the government's policy support. Many people know that renewable energy is important due to climate change and fossil fuel depletion, but there are still many difficult parts in terms of economics. Therefore, the government should provide policy support in various fields such as manpower, finance, technology, and sales channels. For example, for shared growth between large corporations and SMEs, an active intervention is required, like order liberalism in Germany. In addition, in order to minimize environmental pollution, various regulations should be established to increase acceptability of resident of renewable energy business.

Finally, it shows that the renewable energy business can be invigorated only when the residents and the government seek policy measures to cope with the mediate variables of acceptability of resident, resident participation, and shared growth.

4. Proposal of policy plans for invigoration of renewable energy business

Due to climate change and depletion of fossil fuels, the renewable energy business is attracting worldwide attention. Accordingly, Korea also announced a Korean Green New Deal policy. However, there are still issues to be resolved, and this study analyzed the causal relationship between the mediate variables and dependent variables for invigoration of the renewable energy business. From now on, I would like to propose a policy plan for invigorating the renewable energy business by applying the Galbraith's Star Model.

1) *Structure*: Establish an advanced cooperative system

In developed countries, renewable energy resident power plants are operated with national characteristics such as residents are interested in the environment and actively participate in renewable energy power generation projects or consume generated electricity within the same region. On the other hand, in Korea, they tend to sign contracts with local companies to maximize the profits of local communities and reinvest in energy education with these profits. (Lee & Kim, 2015)

However, as a result of analyzing factors influencing the motivation and spread of community energy participation targeting members of Korean citizens' sunlight power generation cooperatives, normative motivations rather than economic benefits played a relatively important role compared to overseas cases. (Koh & Kim, 2019) This shows that Korea's policy approach to cooperatives has been focusing only on economic support, and that change is needed.

To this end, the government should prepare for strengthening community, forming social

capital in local communities, and providing institutional incentives for community energy activities. And support should be strengthened so that economic motives can be harmonized with normative motives. In addition, it is necessary for cooperatives to expand the energy organization of the community and induce active activities of members by continuously providing feedback on the effectiveness of participation and education promotion tailored to each target, taking into account the motives of their participation.

2) *Strategy*: Establish a continuous government support system

With the expansion of the global renewable energy business, Korea also decided to expand the share of renewable energy generation by 20% by 2030, and announced the Korean version of the Green New Deal policy to create 1.9 million jobs by investing 160 trillion won over five years in 2020. However, due to the nature of the renewable energy business, policies have to be promoted in the long run. Looking at various policies in Korea, when the president changes, the policies of the former regime are often changed.

Since the first Danish energy plan was established in 1976, the Danish government has made the use of renewable energy a focus of its energy policy. Denmark has been working on cost-benefit analysis and quantification over the past 40 years that renewable energy is by no means an expensive energy source and is profitable in the long run. Through these policy outcomes, the Danish government continues to persuade its citizens about renewable energy policies. (Choi, 2018)

Looking at the results of the causal mapping analysis, it can be seen that government support is very important. In order to resolve environmental pollution and polarization, active intervention by the government is required. And policy support from the government is required for shared growth. Therefore, Korea must also establish a system of continuous government support, like the legislation of renewable energy business such as the Danish Renewable Energy Promotion Act and order liberalism in Germany.

3) *Rewards*: Develop a systematic profit sharing system

Korea's resident participation incentive system can be applied only when residents invest more than a certain level, such as equity or bond/fund investment. In addition, since it was designed only from an economic point of view, it is difficult for local residents with insufficient economic capacity to invest. For this reason, in the case of the resident participation incentive system implemented on January 1, 2017, two years have passed since it was implemented, but the actual number of applications is only one. (Jung & Lee, 2018)

In order for such a profit sharing system to be effective, it is necessary to establish a systematic system in which values such as community consciousness and environmental preservation are fused together with economic performance and increase acceptability of resident through resident participation. First, when promoting renewable energy business, a system such as hiring local residents and priority wage should be established to lay the foundation for invigorating the local economy. In addition, the current resident participation incentive system has uncertainty in profits, and it is difficult to calculate the profit rate of local residents. Therefore, the degree of participation of local residents should be increased by improving the system so that local residents can easily understand it.

In addition, the internalization of externalities related to power supply has not been achieved in Korea's power market structure. And since there is no difference in electricity rates by region, local residents have no choice but to avoid the renewable energy supply facility itself. Therefore, it is necessary to introduce a system that provides free or premium electricity bills to local residents with renewable energy facilities by benchmarking the “energy supply policy” to provide free solar power to low-income residents of New York State.

4) *Process*: Establish a strategy for each sector for shared growth

In Korea, in order to find a way to resolve the polarization between large companies and SMEs amid continuous economic growth and advancement, large companies and SMEs are

promoting shared growth through mutual cooperation rather than unilateral support. However, in the case of the renewable energy business, shared growth is not actively progressing than in other fields. Therefore, strategies for each field of shared growth must be established to invigorate the renewable energy business.

First, in order to promote shared growth in the renewable energy business, policy support from the government is required. Like German order liberalism, policies to support SMEs should be actively established in order to minimize the polarization between large companies and SMEs. For example, policies to foster SMEs should be established, such as the "ESCO Project," which provides low-interest policy funds so that SMEs with insufficient funding capacity can carry out energy saving projects.

Second, large companies should actively participate in shared growth. Song & Lee (2016) said that Samsung Electronics' shared growth activities positively affect the profitability of SMEs, and that Samsung Electronics' shared growth activities lead to SMEs' technology development and management improvement. Therefore, when bidding for large-scale renewable energy business, it is necessary to increase the participation rate of shared growth with large companies through policies such as giving benefits the higher the stakes of SMEs in the consortium between large companies and SMEs.

Lastly, SMEs must develop their own self-sustainability through competency development. Considering the scale of capital and human resources, the difference in technology between large companies and SMEs is inevitably large. Therefore, SMEs should improve their technological prowess through technology exchanges with large companies, and large companies and SMEs must actively participate in shared growth through value development so that they can establish a partnership model for shared growth management.

5) *People*: Strengthen governance among stakeholders

In the case of renewable energy business, there are many stakeholders (local residents,

local governments, and business implementers) who participate in the business, and most of them have different directions. Therefore, it is quite difficult to coordinate what stakeholders want. In particular, the most important issue related to the renewable energy business is to create a good relationship with the local community, so persuading local residents should be the top priority.

When local residents take part in a renewable energy business, the most important factor is who leads the business, and among them, local governments are highly preferred. From the standpoint of local residents, the preference of local governments as the subject of the business as the initiative of the business is not to be a decision maker for the business, but to expect a role as a mediator and coordinator for the business. (Ham & Kang, 2017)

Therefore, it is necessary to prepare a system for local governments to actively participate in renewable energy business, and to establish governance that local governments can lead. In addition, business implementers should participate in the business with the mindset of contributing to the development of local communities rather than economic benefits. Lastly, in order to enhance the bargaining power of local residents who are unfamiliar with the renewable energy business, they should participate in governance through cooperatives.

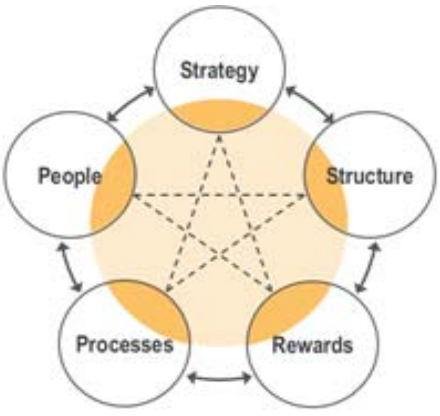

Figure 6. Star-Model

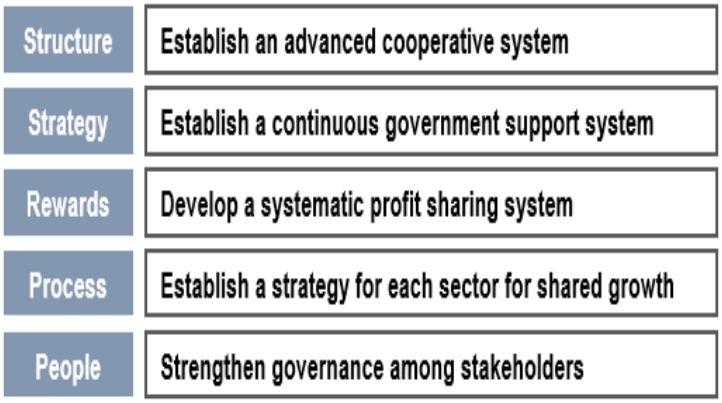

Figure 7. Policy Proposal Item

IV. Conclusion

1. Study contents and implications

To minimize climate change, countries around the world have signed UNFCCC and Paris Climate Agreement. To this end, European countries such as Germany and Denmark are reducing carbon emissions through energy conversion from thermal power to renewable energy. Korea is also implementing the Green New Deal policy to reduce carbon emissions, but unlike in Europe, the period of full-fledged implementation of the renewable energy business was short, so the solution to problems such as opposition from local residents was insufficient.

In this study, the preceding studies and cases of the renewable energy business were extensively examined, and mediate variables (acceptability of residents, resident participation, shared growth) were derived. Based on this, to recognize the invigoration of the renewable energy business from an integrated perspective, a study model was built through a causal cyclical relationship based on system dynamics approach about the relationship between mediate variables and dependent variables. And through causal mapping analysis, a meaningful policy plan was proposed.

Galbraith's Star-model was applied to propose a systematic policy plan, and it was found that smooth interaction between the five policy plans must occur to invigorate the renewable energy business. First, it was proposed to establish an advanced cooperative system in the structure field, and to successfully carry out this, as shown in the integrated causal mapping, a continuous government support system in the strategy field must be established.

Also, government support is indispensable to develop a systematic profit sharing system in the rewards field. To establish a strategy for each sector for shared growth in the process field, mutual communication through reinforcement of governance among stakeholders in the people field must precede. As such, policy plans for each field of Star-model do not exist separately, but can exert a great effect when they work organically with each other.

In the end, to invigorate the renewable energy business, it is necessary to cooperate with each other in a horizontal relationship with local residents, SMEs, and large corporations, unlike past national projects that were conducted only by government policy. In addition, it is judged that if the relationship between the many key variables indicated in the integrated causal mapping is carefully analyzed and resolved step by step, it will be able to become a low-carbon country due to the invigoration of the renewable energy business.

2. Limitations of study and suggestions for follow-up study

This study created a causal mapping through a system dynamics approach based on previous studies. Through this, a policy plan was suggested by qualitatively analyzing the correlation between mediate and dependent variables for invigoration of the renewable energy business. However, quantitative analysis was insufficient because data collection and statistical techniques were not applied through surveys.

In follow-up studies, it will be possible to create a more advanced causal mapping by deriving additional mediate and dependent variables based on the causal mapping presented in this study. In addition, it is expected that more sophisticated analysis results, in-depth policy and strategic implications can be obtained through a quantitative analysis model that was not performed in this study.

In this study, when creating a causal mapping, it focused only on the flow of the overall causal relationship between key variables in order to invigorate the renewable energy business. However, it is expected that more interesting results can be derived if individual and detailed studies on the mediate variables such as acceptability of residents, resident participation and shared growth.

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