A CASE STUDY ON DEVELOPMENT STRATEGIES FOR THE RENEWABLE ENERGY INDUSTRY IN KOREA FOCUSING ON CREATION OF INDUSTRIAL CLUSTER WITH CONSIDERING LOCAL COMMUNITY

By

KIM, Ah Reum

THESIS

Submitted to

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ABSTRACT

A CASE STUDY ON DEVELOPMENT STRATEGIES FOR THE RENEWABLE ENERGY INDUSTRY IN KOREA FOCUSING ON CREATION OF INDUSTRIAL CLUSTER WITH CONSIDERING LOCAL COMMUNITY

By

Ah Reum Kim

Due to the increased energy use, depletion of fossil fuels and other issues such as climate change and greenhouse gas emissions, the world has focused on the development of renewable energy technology and the renewable energy industry as a solution to obtaining substantial energy resources. In this sense, there is a growing momentum towards formulating clusters as a fundamental method for the sustainable development of the renewable energy industry. When compared to other successful cases abroad, South Korea is still struggling for development of renewable energy because of various reasons such as lack of technology, domestic manufacturers, policy as well as the generally low social acceptance when renewable energy becomes in its construction step for power generation**.**

Therefore, this paper focuses on how other well-established countries such as Germany and Denmark have implemented appropriate approach to foster renewable energy by using cluster in consideration of local community. To do this, this paper firstly analyzes and describes what barriers and weaknesses South Korea has by showing three domestic cases. Based upon this result, the study finalizes important elements South Korea should consider when it wants to create~~s~~ cluster model with local community.

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INTRODUCTION

1.1 Statement of the Problem

Unlike the past, many countries around the world cannot maintain industrialization and economic development without taking into account/consideration the environment and sustainability of resources. More specifically, nowadays, we should be concerned about depletion of fossil fuels, climate change and greenhouse gas emissions. However, we should also consider how we can continue to expand our industrialization and economic development. In order to do this, growth of the power sector and reliable and affordable provision of electricity are crucial for almost every country in the world, in terms of promoting continuous industrialization and economic development for upcoming decades. Because of those various reasons, the world has been focusing on the development of renewable energy technology and its industry as a solution to obtaining substantial energy resources to keep their economic development on the rise.

Jeremy Rifkin, one of the world's most well-known economists, published in the book called "The Third Industrial Revolution"(2012), arguing that it is essential to have energy transition from conventional to renewable energy sources especially for sustainable economic development. He introduced the five concepts, which are coming from renewables, and next phase of industrialization will be able to create new businesses and jobs. In addition, "…the creation of a renewable energy regime, loaded with construction of buildings, distributed via a green electricity Internet, and connected to zero-emission transport system, opens the door to a Third Industrial Revolution".[1] In this sense, the entire system is interactive, integrated, and seamless. Thus, the synergies among these variables will create a new economic paradigm that can transform the world.

[1] http://www.thethirdindustrialrevolution.com

Moreover, regarding climate change and reducing greenhouse gas emissions, it is undoubtable that the renewable energy is the key and fundamental solution for future sustainable industrialization and economic development. So many countries, both developing and developed, have been focusing on promoting the development of renewable energy sector and its action plan has been more specific since Paris Agreement in 2015.

Thus, it is obvious that there has been rising consensus regarding the needs of development of renewable energy. In real world, however, the way of developing renewable energy industry is not simple. Most of renewable energy sources are still not cost-effective, and depend on weak technology compared to fossil fuels. Because of this, most countries continuously implement various types of energy policies as a basis to foster their renewable energy industries, such as the Renewable Portfolio Standard (RPS), Feed-In-Tariff (FIT), and Renewable Fuel Standard (RFS) (Bürer, &Wüstenhagen, 2009). RPS and FIT are generally the most widely implemented policies (Kim, 2011; Cory, Couture, &Kreycik, 2009). Basically, RPS is a quota obligation focusing on increasing the amount of non-fossil fuel usage, which ~~it~~ forces electric utilities to supply a certain portion of their output by renewable energy sources. On the other hand, FIT is a price control to accelerate investment in renewable energy by providing tariffs above the retail rate of electricity based on the cost of generation of each technology (Kitzinga, Mitchellb, &Morthorsta, 2012). In the case of South Korea, the government implemented RPS instead of FIT to increase power generation by renewable energy in 2012 (Park, & Lee, 2013), the proportion of renewable energy usage is still very low at 4.92%, one of the lowest in the OECD (Statistics Korea, 2015). This result shows the following scenarios regarding RPS: 1) it has not been implemented correctly; 2) it has fewer advantages for power producers compared to other policies; and 3) it presents causes other than policy-related reasons.

In South Korea, research in this area has mainly focused on energy policy effectiveness, between RPS, FIT, and additional existing promotion policies. Lee and Park (2008) argued that RPS is less effective than FIT as an instrument based on FIT's success in Japan. Of course, policy is also a very important factor to nurture such industry. However, as Klessmanna, Heldb, Rathmannc, and Ragwitzb(2011) maintained, empirical evidence shows that it is possible for countries, even if they adopt the same energy policy, to have mixed results depending on various reasons such as economic growth, industrial structure and other relevant factors. Moreover, Burtis, Epstein, and Hwang (2004) suggested that according to public policy, creating green clusters and financial support are the key factors in private equity investment decisions based on the California Cleantech Cluster case. Other European countries such as Sweden, Austria, France and Norway have been developing clusters with a supportive policy as a standard framework. This standard is being utilized in various ways to stimulate long-term development in the renewable industry (Johansson, 2007).

Why are such countries focusing on creating clusters as core role of development of renewable energy industry? The answer is due to strengths of cluster itself. Basically, cluster plays the role of catalysts to boost industrial growth and competitiveness. Since Michael Porter firstly developed this concept in 1990s, clusters have had the potential to affect competition by increasing the productivity of the companies in the cluster, driving innovation in the field and stimulating new businesses. In other words, region or nation which formulated a cluster, can have agglomeration economies from this cluster and this is mainly due to the complementary relation between factors that such areas have; if capital investments move in, jobs will be created, which will induce labor to move in, which in turn will farm land and decrease wage and increase skill, again, capital moves in[2]. Furthermore, capital is very important in attracting investments as it reflects the presence of a high quality

[2] Revised phrase from 2015 Urbanization and Economic Development Lecture note, Prof. Choi, Songsu, in KDI School

and healthy workforce. Moreover, the advantages that some regions have are low cost of labor and skills, infrastructure, institutions, good governance, IP protection, tax rate etc. Therefore, there is a-big interest in increasing the investment in such region. Besides jobs, labor and land, there are more factors that seem to influence the formation of industrial clusters. Thus, by using industrial clusters, the country would promote a certain type of industry and its value chain, and this is the partially why such countries have developed clusters for renewable energy industry as well.

So far, the South Korean government has been concentrating on policy to increase renewable energy usage and the development of the renewable energy industry to achieve high usage of clean energy. However, it has not yet implemented an appropriate framework for green clusters incorporated within its policy, as it is still in the beginning stage. More importantly, the big difference between South Korea and other successful countries, such as Denmark and Germany which have already achieved high proportion of renewable energy usage, is that those countries have been deeply engaged and communicated with local community for renewable energy development from the beginning while many renewable energy projects have failed to generate electricity due to low acceptance from local communities in South Korea.

Moreover, research that focused on identifying a suitable framework that includes green clusters with considering local community to increase social acceptance, which is in fact basis of renewable energy development for South Korea, is yet to be done. Therefore, this study will fill the gap in the research by comparing various successful cases and solutions that have been implemented in well-established countries in order to achieve sustainable renewable energy industry promotion using clusters while considering a local community. The results of these case comparisons will be used to formulate basic strategy as a standard for the development of the renewable energy industry in South Korea.

1.2 Research questions

1. Which sustainable renewable energy framework, including green clusters considering social acceptance, has been implemented in the renewable energy industry development and growth in countries such as Germany and Denmark?
2. What are the lessons learned from those cases and how can these results be properly applied in South Korea in order to achieve a sustainable renewable energy industry?

PREVIOUS RESEARCH OF RENEWABLE ENERGY

2.1 Introduction

The low proportion of renewable energy usage in South Korea is a rising issue, since the South Korean government aims to increase renewable energy usage to 11% by 2035; meanwhile, other European countries already achieved it in the early 2000s. This problem is due to a lack of strong and well-designed frameworks to develop the renewable energy industry. As it was mentioned earlier, this study aims to propose a basic strategy as a standard framework for the development of the renewable energy industry through mainly clusters including options to achieve high expectation of social acceptance by providing recommendations based on best practices.

Before directly going into the recent research overview of renewable energy clusters, it is necessary to discover how research has been developed and verified about energy polices itself so that this paper can be sufficiently supported logically from the very beginning to reach the result of the reason why this paper should focus on creasing on cluster based on local community's acceptance for sustainable development of renewable energy industry. Regarding energy polices itself, several reports/research publications identify the disadvantages of the existing supportive policy for the development of the renewable energy industry in South Korea. Lee and Park (2008) argued that RPS is less effective than FIT as an instrument based on FIT's success in Japan. This is supported by No (2010), and Lee and Ahn (2010) who maintained that RPS is only partially helpful for renewable energy sources which have economically high feasibility. However, there is still controversy between proponents of

RPS and those who favor other supportive policies such as FIT, Renewable Energy Certificate (REC)[3], and Renewable Fuel Standard (RFS)[4].

2.2 Renewable Energy Industry Supportive Policy Comparison: RPS vs. FIT

In South Korea, research in this area has especially focused on the effectiveness of RPS and FIT in growing and expanding the RES industry. Joo (2014) examined the performance results of the mandatory supply of solar photovoltaic energy assigned to providers and the present state after the implementation of RPS. As a result, new investment has almost tripled in comparison to the previous period in which FIT had been adopted. It can be argued that RPS does not equally and positively influence the development of every renewable energy source. As established by Lee (2012), new investment in Refuse Derived Fuel (RDF)[5] has decreased by half after the implementation of RPS. These results indicate that both RPS and FIT have positive and negative impacts due to each policy's characteristics.

At the same time, however, the policy performance results from previous studies are evaluated only for a maximum of 3 years; this is not sufficient to adequately and reliably show the long-term effects of the policies on the development of the renewable energy industry. Yoo and Oh (2013), by showing empirical evidence argue that FIT, in the long term, affects the development of the RES industry more than RPS does. In addition, this research maintains that the long-term effect of both RPS and FIT on the RES industry seems to be larger

[3]Renewable Energy Certificates (RECs) is tradable, non-tangible energy commodities that represent proof that certain amount of electricity was generated from an eligible renewable energy resource. Retrieved from: https://en.wikipedia.org/wiki/Renewable_Energy_Certificate_(United_States)

[4]The Renewable Fuel Standard (RFS) is a program that requires transportation fuel sold to contain a minimum volume of renewable fuels. Retrieved from: https://en.wikipedia.org/wiki/Renewable_Fuel_Standard

[5]Refuse-derived fuel (RDF) or solid recovered fuel/ specified recovered fuel (SRF) is a fuel produced by shredding and dehydrating solid waste. Retrieved from: https://en.wikipedia.org/wiki/Refuse-derived_fuel

than the short-term effect. Moreover, FIT and RPS are appropriate methods in accelerating the development of the RES industry based on the panel data of 40 countries.

Since both RPS and FIT have certain limitations and strengths, it can be assumed that both policies can be mutually complementary. Park (2011) claimed that combination or concurrency management of the two policies, rather than unilaterally abolishing the FIT, is reasonable to accelerate the development of the RES industry by maximizing the benefits from both policies. As established by Kwon (2014), for most of the European countries, using a combination of FIT, RPS and other policies can improve the efficiency of policy operation and performance results.

However, even though the South Korean government implemented RPS, FIT and other supportive polices to enhance the RES industry as other countries did, why is the RES usage in South Korea still low at 4.92%? This leads to other possible reasons that influence the development of the renewable energy industry.

2.3 Other Reasons Having an Impact on the Renewable Energy Industry

A number of studies have succeeded in finding strong evidence which shows that it is possible for countries, even if adopting the same supportive policy, to have mixed results depending on various reasons. In this regard, Klessmanna, Heldb, Rathmannc, and Ragwitzb (2011) provided that empirical evidence showing various reasons for generating mixed results, such as economic growth, industrial structure, and other relevant factors. Given that every country has different levels of economic growth, technology and consensus about the renewable energy industry, it is definitely obvious that the result after policy implementation will differ from country to country. Therefore, as Choi, Hwang, and Moon (2013) claimed, the renewable energy supportive policy should be established after comprehensive consideration of a number of variables related to economic, social, environmental, and international aspects. Moreover, as Lee and Yoon (2011) showed, the success or failure of the renewable energy industry depends on an individual country's supportive institutional framework.

Since the economic feasibility is still very low for renewable energy in comparison to fossil fuels and other resources, many countries are implementing energy policies with special types of frameworks such as industrial clusters, which help to increase investment in the renewable energy industry.

2.4 Creation of Clusters with Proper Policy Implementation

Several studies have indicated successful performance results using industrial clusters. For example, Ahn (2014) outlined that the bio-technology cluster in Muenchen is one of the key success factors in the development of the German renewable energy industry owing to the larger amount of private investment after industrial clusters were introduced in the early 1990s. This is supported by Han (2009), whose study suggested that the cluster itself is the main engine to enhance investment in certain industries by using localization economy which attracts related industries, education, infrastructure, and institutions; this would more than double the resulting performance.

Because of the strengths of clusters as discussed above, industrial clusters can possibly be used in the renewable energy industry as well. According to a KOTRA report, the German government has developed the 'Germanwind' to increase the competitiveness of wind power technology. The cluster is a useful strategy to maintain the development of an industry and technological growth. Many European countries have adopted green clusters in the renewable energy industry. Lee (2011) reported several examples and the growth of the renewable energy industry as a result of green clusters established in France, Denmark, Spain and Germany. The renewable energy industry has contributed to regional economic development by becoming the major industry in its location. This result is part of the reason why most European countries have comparatively high renewable energy usages in the world.

Even though clusters are one of the key elements in the development of the renewable energy industry, there is still a need to implement appropriate supportive policies. The implementation of such policy is actually a main player which is equivalent to government support in a form of development strategy in the renewable energy industry. Burtis, Epstein, and Hwang (2004) suggested that the combination of public policy, green clusters/technology and financial support are the key factors in private equity investment decisions based on the California Cleantech Cluster case. Germany has also built the standard design for the development of the renewable energy industry by using policy as the main driver and clusters as complementary methods (Kim, Joo, and Oh, 2011). Other European countries such as Sweden, Austria, France and Norway have been developing green clusters with a supportive policy as a standard framework. This standard is being utilized in various ways to stimulate long term development in the renewable energy industry (Johansson, 2007). Based on the reviewed cases, it seems the combination of policy and clusters is a more supportive and creative method as it has demonstrated a significant positive impact on the renewable energy industry.

However, even previous research has recognized the role of clusters, there has been not much research to consider local residents as a member of cluster to promote renewable energy industry. Even if the investment and technical capabilities and institutions are backed in order to develop the renewable energy industry and achieve sustainable growth, the verification and diagnostics, through the construction of actual demonstration technology complex (actual renewable energy power generation plant as demonstration) should be established as the main basis to have actual capability of renewable energy technology itself and industry. If the improvement of technical capabilities is carried out based on the verification and diagnostics from the complex, then, these technologies can be helpful to the national economic development as well as within the region by exporting technologies abroad.

Nonetheless, in the case of South Korea, it is not easy to ensure the full acceptance of local residents at the time of promotion and construction of renewable energy power generation complex in the area.

2.5 Importance of Social Acceptance

In case of South Korea, the majority of renewable energy power generation complexes are for solar and wind sector due to the amount of potential energy that Korea has. In particular, in the case of wind sector, as Kim (2006) argued from early period, by the resistance of the local residents, construction projects have been delayed occasionally. He also suggested solutions such as, 1) the central and local government should reflect public opinions from an early stage of project, 2) design of benefit-sharing program for local residents would be another way to reduce opposition. Also, Lee and Yoon (2015) proposed that it is necessary to promote community participation-type of wind power business by using energy cooperative as a method for benefit sharing. Besides benefit-sharing scheme, Lee (2015) additionally insisted that R&D expansion regarding environmental impact assessment which is one of reason why public oppose can be another solution to have social acceptance.

In overall, recent literature has provided a wealth of information about the basic concepts related to the renewable energy industry such as supportive policies, other key factors, and abroad cases. Although the South Korean government has established various policies and incentive programs to promote the development of the renewable energy industry, and as a result previous research has been focusing on policy implications and introducing other countries' successful cases. In addition, many studies have agreed that enhancing the social acceptance for renewable energy business is very crucial factor, so they have explored a variety of solutions for this problem based on benefit-sharing scheme. However, in real world, especially in South Korea, it is still on-going issues to interrupt continuous growth of renewable energy business and industry. Moreover, developers and government still hardly provide active role for local residents for their business, it is still in infancy. Furthermore, studies so far has generally not considered the implications of modifying or applying those successful strategies regarding clusters especially more considering with local residents as well to the South Korean case. With this circumstance, there is a need to ensure improved sustainable renewable energy industry development plans and supportive actions in South Korea to reach the target level of the renewable energy usage, 11%, by 2035. Yet, now, Korea is facing fossil fuel depletion, energy security and climate change issues including cutting its greenhouse gas emission to 37%, below business as usual, by 2030 and should discover the momentum for sustainable economic development at the same time. In addition, the government should design its own method that takes into consideration the South Korean renewable energy industry environment in long run and other related factors that would enhance or slow down the development of the renewable energy industry. This would aim to help in promoting development strategies for a sustainable renewable energy industry in South Korea.

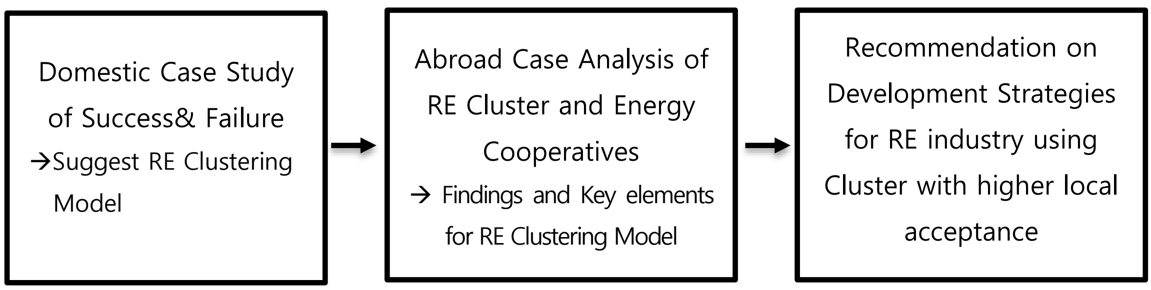
It is, therefore, particularly essential for subsequent researches to explore the formulation of a basic strategy as a standard, especially focusing on creation of industrial cluster with considering local community that has positive impacts on expanding and enhancing the sustainable renewable energy industry for South Korea.

RESEARCH METHODOLOGY

3.1 Research Method

A qualitative methodology will be used to review sources such as government statements, reports, and previous research papers to explore the effective strategies as a standard framework to nurture the renewable energy industry in selected countries. Additionally, this study tried to reflect the results of interviews from people who were involved in each projects. Finally, based on the previous exploration, this study will analyze what the South Korean government can learn from those countries with a view to designing a basic structure in terms of sustainably developing the renewable energy industry.

3.2 Analytical Framework



RESULTS and DISCUSSION

4.1 The Renewable Energy Status in South Korea

4.1.1 Major Reasons Why Korea Should Develop Renewable Energy

As it was mentioned above, Korea is facing various issues regarding energy. Therefore, before we move into the renewable status in Korea, it is necessary to understand more in detail what kind of problems Korea should concern from now on. **Table 1** shows the major problems that Korea should solve for the next decades, in terms of energy sector as basis to promote the next phase of industrialization and sustainable economic development.

Table 1 Major Problems in Energy Sector

Problem	Explanation
Centralized Power Generation System	Rising conflict due to centralized power plant in certain areas(Regarding facility construction of transmission, distribution)→ Need to develop de-centralized power generation complex such as micro-grid system using renewable energy source
Lack of Environmental Friendly Power Generation (Climate Change Issue)	Rising issues on greenhouse gas emission but conventional coal-fired plant is not environmental friendly way since it emits most of CO2s→ Need to take actions to reduce greenhouse gas emission by adopt renewable energy power generation
Energy Security	Korea relies on imports for more than 90% of the essential energy of the national economy→ Need to develop non-importable energy source
Limited Energy Sources	Rising concerns about less energy source diversity→Need to figure out the way we can use natural sources efficiently and sufficiently
Rising Concerns of Nuclear Power Plant	Rising concerns about the stability of nuclear power plant after Fukushima accident in Japan→ Need to develop more stable & less harmful power generation

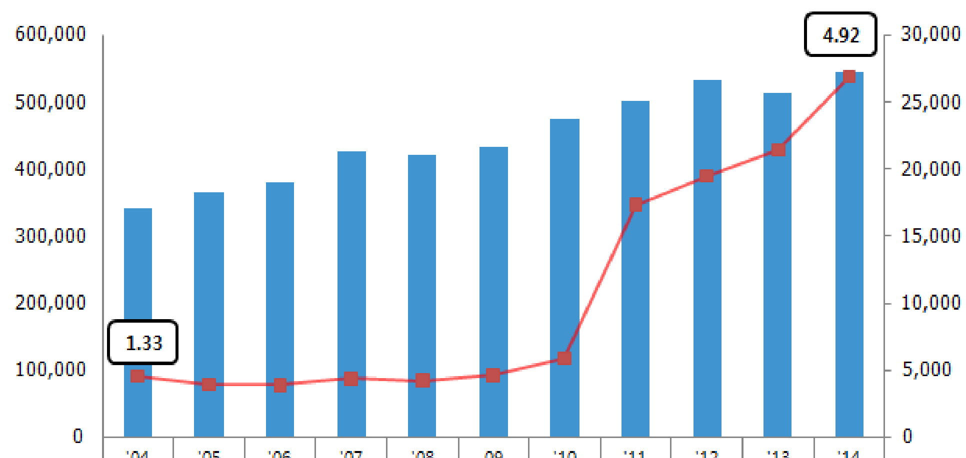
Source: 2013 Global Challenge program in KEPCO, 'Micro-grid System Using Renewable Energy Sources' final report

As the table shows, the solution for most of problems results into adopting renewable energy. Especially, if we consider the climate change issue, it is obvious that we should take actions to reduce CO_2 emissions by changing energy sources since the major source emitting the greenhouse gas is the energy sector with a share of 87% (Statistics Korea, 2015).

4.1.2 Current Status of Renewable Energy in South Korea

Renewable Energy is the solution for those problems an aforementioned; renewable energy's proportion out of total power generation is very low as of 4.92% based on Picture 1. Although the South Korean government implemented RPS instead of FIT to increase power generation by RES in 2012(Park, & Lee, 2013), this does not have enough impact on increasing the power generation by renewable energy sources as we expected. RPS and FIT are generally the most widely implemented policies (Kim, 2011; Cory, Couture, & Kreycik, 2009). Basically, RPS is a quota obligation focusing on increasing the amount of non-fossil fuel usage, so it forces electric utilities to supply a certain portion of their output by renewable energy. On the other hand, FIT is a price control to accelerate investment in renewable energy by providing tariffs above the retail rate of electricity based on the cost of generation of each technology (Kitzinga, Mitchellb, &Morthorsta, 2012).

Picture 1 Trend on Renewable Energy Power Generation of Total Power Generation

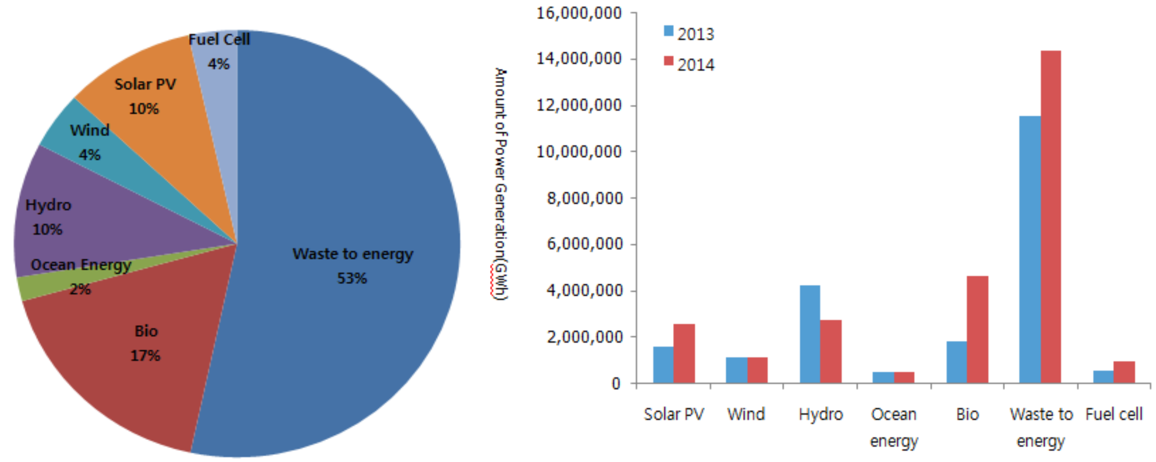


	'04	'05	'06	'07	'08	09	'10	'11	'12	'13	'14
Total Power Generation (GWh)	342,148	364,639	381,181	426,647	422,355	433,604	474,660	501,527	532,191	513,098	546,249
Amount of RE(GWh)	4,534	3,950	3,899	4,395	4,227	4,618	5,890	17,346	19,498	21,438	26,882

Source: 2014 New and Renewable Energy Supply Statistics, Korea Energy Agency, Ministry of Trade, Industry, Energy

In **Picture 1**, the peak point in 2011, which is the last year of having FIT advantages, renewable energy power generation was sharply increased. Thereafter, since 2012, driven by the need to produce a part of the power generation from renewable energy source due to RPS introduction, renewable energy use for power generation has slowly expanded, but, still not enough as to achieve 11% of renewable energy power generation which is target by 2035. Some people argue that the current figure, 4.92% is enough to achieve 11% by 2015. However, as **Picture 2**shows, this 4.92% includes hydro power generation, 10%, and other renewable energy sources such as wind, solar are still very small portion for power generation.

Picture 2 Proportion of Each Sources, Amount of Power Generation between 13'~14'



Source: 2014 New and Renewable Energy Supply Statistics, Korea Energy Agency, Ministry of Trade, Industry, Energy

In addition, this solar, wind power generation has actually large potential for development. Since this report will closely look into for solar clusters from other countries, the following part will focus on the solar potential in Korea as reference.

- **The Potential of Renewable Energy in Korea**

Each country has different definitions and calculations, in terms of potential and research, to improve the accuracy and precision which are still under progress. Currently, there is a detailed analysis of the regional distribution characteristics of renewable energy sources, using Geographical Information System (GIS), for calculation of a more realistic amount of existing renewable energy sources in each area. Renewable energy resources projects typically begin with a theoretical assessment of the market potential. In this sense to calculate the potential more accurately, it is needed to accumulate historical data over a long period of time with standardized technical factors such as geographical conditions, energy efficiency, utilization, etc. In case of Korea, the Korea Energy Technology Research Institute defined four renewable energy potential as **Table 2**.

Table 2 Definition of Renewable Energy Potential

Category	Definition
Theoretical Potential	The total natural energy existed in the region that can be determined as per the environmental conditions of the area of interest
Geographical Potential	Can be calculated from the theoretical potential excluding the energy from the limited areas such as shipping channel, military zone, natural preserve area, fishing zone, port facility, too shallow and too deep area, etc.
Technical Potential	The energy extracted in the area available for the device installation of the region. The energy extraction can be different from the assumptions of device type, its performance, system efficiency, interaction, power rate, etc.
Market Potential	The practical energy assessment that can be realized with the financially feasibility considering the SMP (System Marginal Price[6]) of electricity and any compensation rate given from the government based on policies such as Feed in Tariff or Renewable Portfolio Standard.

Source: 2014 New and Renewable Energy Outlook, Korea Energy Agency, Ministry of Trade, Industry, Energy

Table 3 shows the total renewable energy potential in Korea. Similarly, it shows that the technical potential is an actual energy resource that Korea can develop from current level of technology, which is approximately 10% of geographical potential. Thus, it can be easily assumed that there is still a long way to go forward for renewable energy development as to use existing resources efficiently. However, the solar energy has the largest technical potential among the various renewable sources and the ratio of technical

[6] The variable cost of the most expensive generation plant within the price setting schedule

potential/geographical potential is the largest, which means that its contribution to power generation could be increased if Korea is able to develop sufficiently.

Table 3 Total Renewable Energy Potential in Korea

Category		Theoretical	Geographical	Technical
Solar		11,370,987	3,767,130	1,161,080
Wind	Onshore	76,562	24,186	7,713
	Offshore	95,628	47,750	16,711
Bio		367,094	16,590	11,481
Waste to Energy		14,091	13,386	10,360
Geothermal		5,253,414	2,115,869	12,528
Hydro		43,427	22,698	7,250
Ocean Energy	Tidal Current	591,873	196,999	31,344
	Tidal Power	7,878	3,033	1,893
	Wave	17,597,206	3,519,441	106,468
	OTEC	6,006	5,410	4,847
Total		35,424,166	9,732,492	1,371,675

Source: 2014 New and Renewable Energy Outlook, Korea Energy Agency, Ministry of Trade, Industry, Energy

Additionally, if Korea develops the renewable energy industry more efficiently based on geographical potential, it can be easily assumed that it will be beneficial for economic development, in terms of increasing full time employment, profits, the amount of exports, etc. Until 2014, the renewable energy industry has been contributing to economic development as shown in **Table 4**. In this regard, only 4.92% of the total proportion contributed this amount of economic contribution and its industrialization, hence, if we achieve 11% by 2035, we can forecast more contribution from renewable energy sector.

Table 4 Economic Contribution from Renewable Energy Industry

# of Enterprises	Full-Time Employment	Profit (.1 billion)	Export (.1 billion)	Investment(.1 billion)
485	15,707	101,282	32,218	8,738

Source: 2014 New and Renewable Energy Industry Statistics, Korea Energy Agency, Ministry of Trade, Industry, Energy

If we breakdown this into each renewable energy sources, again, solar pv sector has the largest proportion in every categories including the amount of exports, profits, and investments, as shown in **Table 5**. Thus, it is definite that it is valuable to focus on solar sector and the way in which Korean government can promote its industry more wisely, since it has huge potential among various types of energy sources.

Table 5 Breakdown table of each renewable energy sources' contribution

Category	# of Enterprises	%	Full-Time Employment	%	Profit (.1 billion)	%	Export (.1 billion)	%	Investment (.1 billion)	%
Solar PV	135	28	8,239	52	63,358	63	25,462	79	4,889	56
Solar heat	28	6	283	2	321	0	5	0	4	0
Wind	37	8	2,424	15	12,866	13	5,625	17	742	8
Fuel Cell	11	2	562	4	2,284	2	2	0	868	10
Geothermal	26	5	504	3	1,083	1	-	-	126	1
Hydro	4	1	81	1	145	0	21	0	10	0
Bio	110	23	1,441	9	11,055	11	1,020	3	492	6
Waste-to Energy	129	27	2,011	13	7,940	8	82	0	1,573	18
Hydrogen	5	1	162	1	2,228	2	-	-	34	0
Total	485	100	15,707	100	101,282	100	32,218	100	8,738	100

Source: 2014 New and Renewable Energy Industry Statistics, Korea Energy Agency, Ministry of Trade, Industry, Energy

4.2 Previous Renewable Energy Power Projects

As the previous tables and graphs have shown so far, South Korea has continuously invested in the renewable energy sector—solar, wind, fuel cell, geothermal and so on. However, the growth rate of the renewable energy sector does not appear to be satisfactory since 2012. At this point, it is necessary to reflect on the successes and failures of the previous renewable energy power projects. The following subsections will describe projects showing the advantages and disadvantages of renewable energy in South Korea.

4.2.1 Gasa Island, the First Energy Self-Sufficient Village in South Korea

Gasa island, located in Jindo County, South Jeolla province, became the first energy independent island in South Korea. Energy independent island or energy self-sufficient island means the generation of sufficient electricity using resources such as wind, solar, geothermal or other renewable energy and energy storage systems, instead of the existing diesel power plants. This project was initiated in 2012, as a research and development (R&D) project for technological demonstration by the Ministry of Trade, Industry and Energy, Jeollanam Provincial Government, Jindo County, Korea Electric Power Corporation (KEPCO) and the Research Institute of KEPCO. The isolated type of Micro-grid System based on Energy Management System (EMS) was first applied in Gasa island, which is now efficiently generating eco-friendly energy by itself, based on the amount of energy usage and demand. (Korea Electric Association, 2015)

Table 6 Gasa Island Project Overview

Category	Detail
Project Period/Funding	2016.10–2015.09/28.8 billion Won
Location/Size	Gasa Island/6.4 km^2 (168 houses; 286 residents)
Existing Power Sources	Diesel Power Plant (100 kW x 3, installed in 1993) -approximately 1,000 Won/kWh
Power Load	Average 96 kW (Peak: 173 Min: 61)

Project Target	Design, installation, operation and management of renewable energy with the EMS system to demonstrate the energy self-sufficiency of the island Reducing power fuel cost min 50%
Renewable Energy Sources	Wind 400 kW, Solar 314 kW, Floating Solar 48 kW, Battery 3 MWh
Achieved Benefits	Cost reduction app. 0.396 billion Won/year - Fuel: 0.248 billion Won/year - Maintenance Cost of Diesel: 0.086 billion Won/year - REC: 0.062 billion Won/year Reduction of CO2 emissions: 607 tones/year Using Gasa island as a tour destination

Source: Gasa Energy Self-Sufficient Island Status Report, 2016.06, KEPCO Research Institute

As shown in **Table 6**, by using the newly installed wind and solar power plants, the fuel cost of the existing diesel power plant has been reduced up to 80%. Currently this eco-friendly power system generates 80% of the island's total electricity requirement, while the remaining 20% continues to be supplied from a diesel power plant, to ensure that bad weather does not affect to the power supply to the residents.

However, in the early stages of this project, there were several issues and concerns regarding 1) the first and newly applied technology combining microgrid and renewable energy, 2) opposition from local residents due to uncertainty over renewable energy, 3) noise problems related to wind power generator and so on. To resolve these problems, the following measures were considered and implemented[7]. 1) KEPCO research institute developed the optimal technology in collaboration with 20 companies, to satisfy the requirements of Gasa island from the very beginning; 2) Supportive actions (regulation, approval, etc.) from the MOTIE-Jeollanam Provincial Government-Jindo County; 3) Establishment of a stable investment and funding from Jeollanam Provincial Government and KEPCO; 4) In order to eliminate the anxiety of the local residents and enhance the understanding of the entire project, the project proponents organized meetings and presentations to local residents from the beginning; 5) Lastly, design modification was

[7] Through an interview with Senior Researcher in KEPRI, who was involved in the Gasa Project

carried out to reduce the noise problem of wind power generator. All five efforts led to an increase in the social acceptance of the project.

4.2.2 Seoul Citizen's Solar Power Coop, the First Energy Cooperative in South Korea

Seoul Citizen's Solar Power Coop, the first energy cooperative in South Korea, was established to build a solar power plant in 2013[8]. Its target was to rejuvenate local community and economy through renewable energy by the construction of a solar power plant, with the collaboration of local residents, cooperatives, private and public enterprises. In this kind of energy cooperative, the work is carried out by the initiative of local residents, with local acceptance being the top priority of the project. As shown in **Picture 3**, Seoul City provided the site, such as land or location (roof of the building) and a loan at a low interest rate, while the Coop selects and manages the contractors and proceeds from the small project (xx kW size), allocating profits from the project to the shareholders.[9]

Picture 3 Role of Stakeholders in Citizen's Solar Power Coop

Source: Seoul Citizen's Solar Power Coop

8 http://www.coop.go.kr/COOP/state/guildEstablish.do

9 http://solarcoop.kr/solarcoop_plan/

In 2014, 80 people completed the civil work for the solar plants (37 kW) on the roof of Seoul Sangwon elementary school, with the amount invested by the Seoul Citizen's Solar Power Coop. Currently, dividends of 5% per year are reinvested into the school and the local community as donations (Lee & Kim, 2015). At present, the establishment of these cooperatives is gradually increasing, with citizens actively participating in power generation projects using renewable energy. This kind of enthusiasm from citizens with a positive understanding of renewable energy can lead other people to switch to renewable energy too, so that eventually, people will voluntarily participate in the energy production process (Lee, 2015). Such an environment can actually be a success factor as a project initiated by the cooperative is less likely to face opposition from residents than traditional renewable energy power plant projects that are initiated by project developers. Currently, there are 58 energy cooperatives in South Korea (Korea Cooperatives, 2016[10]), with a gradually growing movement to establish a concrete profit-making business model with initiative from local residents. (Yoon, & Sim, 2015)

However, in South Korea, 1) The market size and the impact of a cooperative are very limited compared to the other traditional power producers, due to a lack of supportive policies; 2) it is also not easy to ensure a project's profit due to various reasons, such as the small capacity of the project, the decreasing price of SMP, fewer advantages for small power producers in REC bidding market and so on.[11] All these issues stem from a lack of governmental policies that are oriented towards traditional power producers, not energy cooperatives, so that many cooperatives make less-than-expected profit or even negative revenue.

[10] http://www.coop.go.kr

[11] http://www.redian.org/archive/78668

Due to this, Seoul city, which has 16 energy cooperatives, 1) reintroduced FIT, which was abolished in 2013, to subsidize solar power plants with less than 50 kW capacity; and 2) lowered the burden of lump-sum investment that the Coop was required to make, by providing low interest loans from Seoul City Climate Change Fund (Yoon & Sim, 2015). However, it is not enough to provide initial economic support to the Coop. In addition, the central government should consider establishing proper and various schemes for energy cooperatives since they can act as an important player in promoting the renewable energy industry by ensuring higher local acceptance. The latter part of this paper will discuss and propose more specific actions based on German and Danish cases.

4.2.3 Southwest Offshore Wind Power Project of 2.5 GW capacity in South Korea

The 2.5 GW Southwest Offshore Wind Power Project, the biggest wind power project in South Korea, was initiated by the government (MOTIE) to promote the offshore wind power industry as a new growth engine by developing its technology, capability and market size, so that domestic enterprises can lead the global market based on the results of this project. In 2011, the government announced the 2.5 GW Southwest Offshore Wind Power Project, with a detailed action plan based on 2 years of feasibility study on wind potential, water depth, distance from land, etc. The project roadmap announced by the government indicated that the project will be carried out through three stages during 9 years, including stage 1(Test Bed with 100 MW), stage 2 (Building operation skills and verification) and stage 3 (Development of a large scale offshore wind farm; MOTIE, 2010)

Table 7 Southwest Offshore Wind Power Project Overview

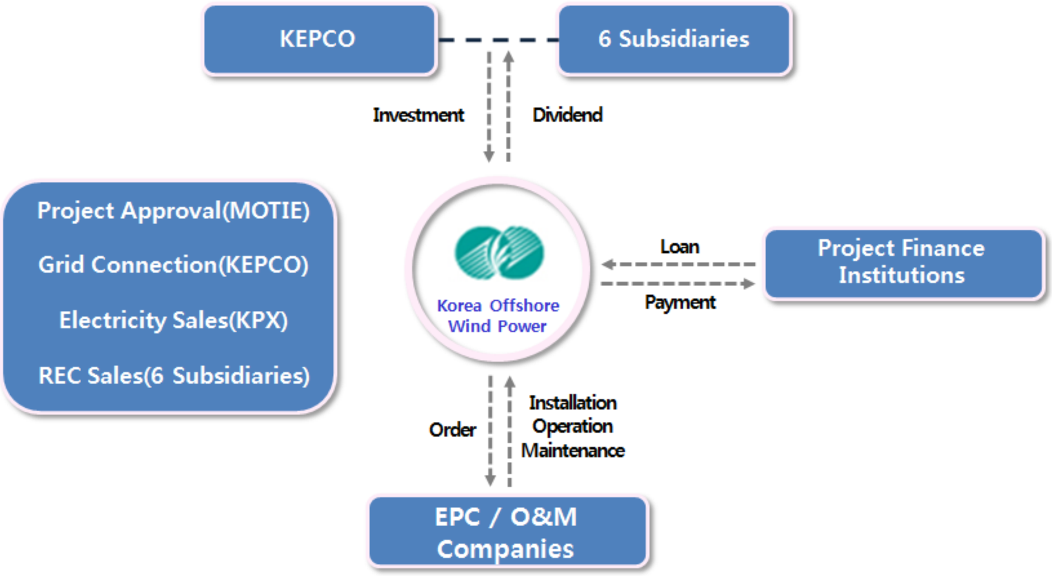
Category	Stage 1		Stage 2		Stage 3	
Purpose	Develop a test bed		Achieve Track Records		Develop Large OWF	
Capacity	100 MW	**80 MW**[12]	400 MW	**400 MW**	2,000 MW	**2,000 MW**
Period	2011–2013	**2016–2018**	2014–2016	**2018–2020**	2017–2019	**After 2020**
Investment (million USD)	590.4	**382.6**	2700	**1400**	5000	**7300**
Developer	KEPCO and 6 subsidiaries Private Companies		KEPCO and 6 subsidiaries Private Companies		Private Companies	
	Korea Offshore Wind Power				**Private Companies KEPCO and subsidiaries**	

Source: Study on the Present Status and Future Direction of Korean Offshore Wind Power, 2013, Southwest Offshore Wind Power Project brochure, Korea Offshore Wind Power, 2016

Based on the initial roadmap, stages 1 and 2 were supposed to be finished by now, with the collaboration of the players mentioned in **Picture 4** below. Since this project has needed a large investment with high uncertainty, the government and SOEs were major players in initiating the project.

[12] Bold characters indicate the recently revised numbers, reflecting the reality.

Picture 4 Role of Stakeholders



Source: Korea Offshore Wind Power, 2013

1) MKE (currently MOTIE): responsible for overall project implementation/administration/policy support for the entire period of the project, including design, manufacture, construction, operation, certification and supply chain.

2) Jeollabuk Provincial Government: approval and permission for using land and grid connection, discussion with local residents.

3) KEPCO and the 6 Subsidiaries: responsible for driving the project, including signing the contract with wind power manufacturers and suppliers by establishing a SPC.

4) Participants: 8 private companies, including Doosan Heavy Industry, DMSE, Samsung Heavy Industry, Unison, Hyundai Heavy Industry, Hyosung Industry, DMS and STX, were responsible for the installation of 2–3 Offshore Wind Power Generators each (3–7 MW), for stage 1 of the project, bringing the total to 100 MW.

5) Korea Institute of Energy Technology Evaluation and Planning: responsible for research and development part of the project.

6) Korea Energy Agency: infrastructure development, such as a performance testing agency.

Since the objective of the project was to promote the offshore wind power industry based on the creation of a sustainable domestic market, the government expected the project to lead to competition among the domestic manufacturers through the initial market deployment and financial aid by the government, including the following possible economic benefits, such as 1) Creation of 80,000 new jobs/year in the offshore wind power industry; 2) Mitigation of GHG emissions by using renewable energy; 3) Contribution to the local economy by the establishment of an energy park, an offshore education center, an Operation and Maintenance factory, etc. and 4) The possibility of offshore wind farms being regional tourist spots after stage 3[13] of the project.

However, because of various reasons[14], which include, 1) huge local opposition with concerns regarding the negative impact on marine ecosystem and fish resources[15]; 2) complex regulation and approval issues; 3) lower-than-expected level of domestic wind power technology; 4) lack of experiences and human resources in the wind power sector in SPC; 5) lack of drive to work towards achieving the target of the project; 6) lack of overall capability of the domestic renewable energy sector and 7) continuing uncertainty regarding economic benefits. With all these reasons, the previous project plan was modified as shown in Table 7. Moreover, 6 private participants (excluding Hyosung and Doosan) recently withdrew from

[13] English brochure from Korea Offshore Wind Power

[14] Reflected based on the interview with Principal Researcher in KEPRI, who was involved in the Offshore Project.

[15] http://www.electimes.com/article.php?aid=1467261211135340005

this project since they were not willing to be involved in the wind power industry anymore due to the financial burden, restructuring and so on.

Since the Southwest Offshore Wind Power Project was initiated from the central government, the project followed a top-down approach, which has often been efficient in developing certain industries rapidly, like the selection of an industry (heavy industry etc.) by the government in the 80s in South Korea, to ensure its rapid development. However, in case of renewable energy, there are different types of barriers, such as several stakeholders (private enterprises, SOEs, local community and so on), lack of economic feasibility and related concerns, complex regulation system, low level of local acceptance and the need for continuous technical support even after project completion. Therefore, it is necessary to prepare carefully and hear opinions from various levels of partners to reduce project uncertainty.

4.2.4 The Important Factors in Promoting Renewable Energy Industry

There were some important factors that had an influence on the three cases accordingly, as shown in **Table 8.** Unlike other industries, one of the key factors that has an impact on the success of a renewable energy project is local acceptance, as mentioned before.

Table 8 Table comparing the three cases

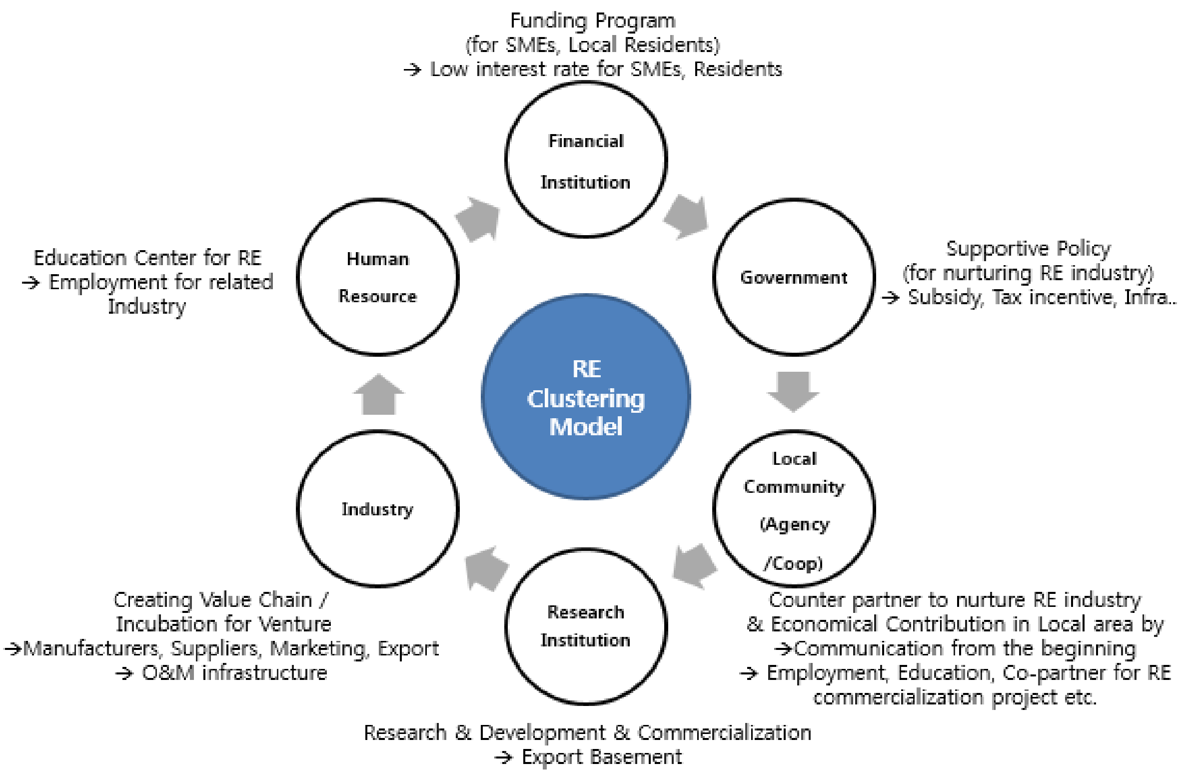
	Gasa Island Energy Self-Sufficiency	Seoul Citizen's Solar Power Coop	Southwest Offshore Wind Power 2.5 GW
Type	Top-down - R&D project (Test Bed)	Bottom-up	Top-down - Test Bed - Track Record - Large Wind Farm
Funding	KEPCO + Jeollanam Provincial Government	Energy Cooperatives (Local Community)	KEPCO + 6 Subsidiaries
Source	Wind, Solar	Solar	Offshore Wind
R&D	KEPRI*	-	KEPRI, KETEP**
Policy Support	MOTIE Jeollanam Provincial Government - Regulation, Approval, Administration, etc.	Seoul City Government - Loan (low interest rate) - Providing land/location	MOTIE Jeollanam/buk Provincial Government - Regulation, Approval, Administration, etc.
Local Acceptance	High	High	Medium High
Important Elements	Optimized Technology and its application Supportive Policy Investment Local Acceptance Sufficient RE resource	Supportive Policy Profitability Investment Loan Program People's Participation	Local Acceptance Supportive Policy Level of Technology Human Resources Profitability Overall Industry Sufficient RE resource

* KEPCO Research Institute
** Korea Energy Technology Evaluation and Planning

Since the Gasa Island project was actually an R&D project, the local opposition was not very strong (the interviewee mentioned that getting local people to invest in a renewable energy project is an efficient way to gain higher social acceptance. However, due to a lack of budget, people normally cannot make such an investment). Similarly, Seoul Citizen's Solar Power project did not face much opposition either, as it was initiated by the local community. However, in the case of the Southwest Offshore Wind Power project, it took several years to negotiate and persuade with the local community to understand the project properly. At present, the people who are involved in this project are seriously considering inviting the local community to invest in this project during the 2^{nd} and 3^{rd} stages, so that local residents can benefit financially from the project, as well as increasing local acceptance of the project itself.

Given this, how can the other important factors, such as technology, industry, investment, loan program and human resources be managed? As mentioned in the very beginning of this paper, it can be done by creating clusters. Based on the important elements from the previous cases, more specific factors can be determined by creating renewable energy clusters, which would have an impact on the overall development of the renewable energy industry.

Picture 5 Renewable Clustering Model including Local Acceptance

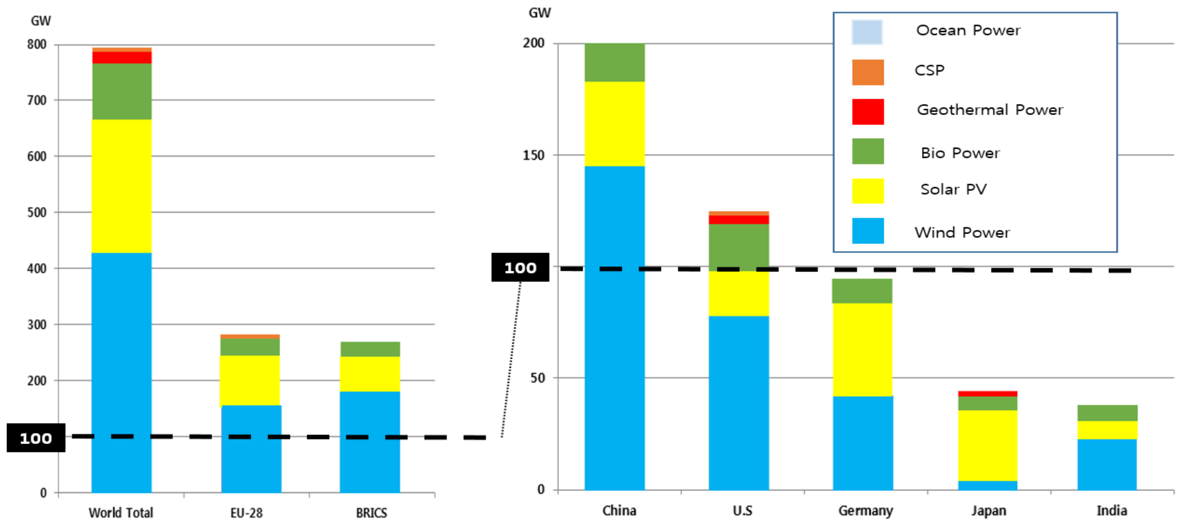


So far, this paper has discussed the current status of the renewable energy industry using three cases in South Korea. The following sections will focus on its global status. Since every country is trying to expand its renewable energy portion at present, it is necessary to check where the world is heading with regard to the development of renewable energy. This paper will explore some cases from other developed countries, like Germany and Denmark, from the renewable energy sector. Subsequently, this paper will suggest the modified clustering model, which will include key elements based on the comparison with those countries, for the renewable energy industry in South Korea.

4.3 The Renewable Energy Situation in the World

4.3.1 Overview

Picture 6 Total Renewable Energy Capacity as of 2015

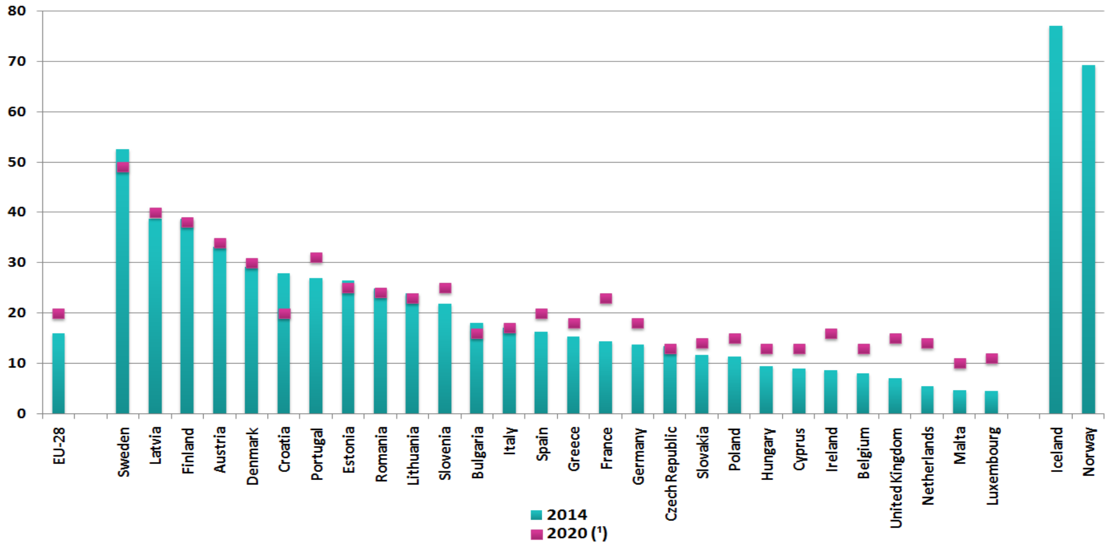


Source: Renewable 2016 Global Status Report, REN21, 2016,

The share of renewable energy is now increasing in the global energy mix. This can be clearly seen in the countries and regions that are promoting a strong dissemination policy in the power sector. Supported by this trend, renewable energy accounted for 19.2% of the global final energy consumption in 2014. It continued to increase its share in global final energy consumption in 2014. By the end of 2015, China, the United States, Germany, Japan and India were the top five countries in the world in terms of installed capacity. If we look at the installed capacity, excluding hydropower, China was the leader, closely followed by the United States, Germany, Spain, Italy and India, according to **Picture 6**. The EU countries are the dominant group, with their combined share being over 40%. According to Europa 2015 Statistics, EU-28 countries are targeting to achieve 20% of the share of renewables in the gross final energy consumption, while already having achieved 16% in 2016.

4.3.2 Status of Germany and Demark in Renewable Energy

Picture 7 Share of renewable energy in gross final energy consumption



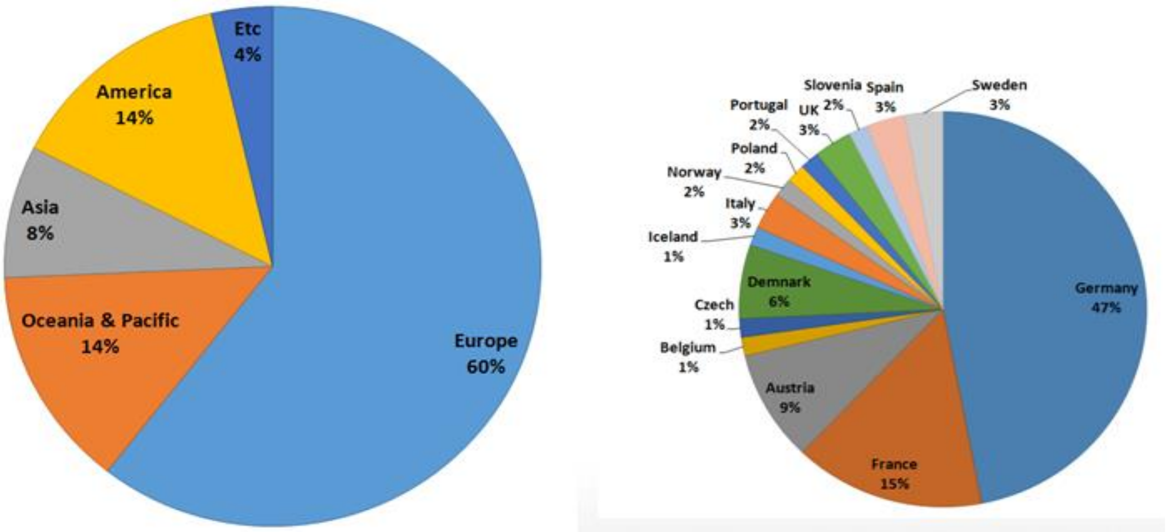
Source: Europa, 2015 Statistics * Legally binding targets for 2020. Iceland and Norway: not applicable.

Among the 28 EU countries, Sweden's share of renewable energy in the gross final energy consumption is the highest, at over 50%, which has already surpassed the 2020 target, as of 2014. Therefore, taking a close look at the Swedish cases might be a good way to understand how Sweden achieved the high proportion of renewable energy. However, the main purpose of this paper is to find out how other countries have successfully promoted sustainable renewable energy industry using clusters with the involvement of local community. With the two-fold criteria of cluster and local community, the following sections will focus on German and Danish cases. (The two assumptions, which were made are: 1) The country that has a high local acceptance, with possibly several 100% renewable energy towns (self-sufficient energy towns). Therefore, based on the cases of 100% renewable energy projects in the world[16], **Picture 8** was analyzed, which indicated that Germany is the dominant country with respect to 100% renewable energy projects in the world, while France, Austria and Denmark followed closely. 2) The renewable energy clusters can also be

[16]http://www.go100re.net

interpreted as the growth of the renewable energy industry. With this regard, indicators which can potentially be used to determine the growth of the renewable energy industry are i) share of renewable energy (Denmark in Top 5), ii) installed capacity of renewable energy (MW/million head of population;[17] Denmark and Germany are ranked as the first and second), iii) employment [18](overall, the employment distribution is the best in Germany, while Denmark is in the 7th position), and iv) 100% renewable energy projects.

Picture 8 World Status of 100% Renewable Energy Projects



Source: 100% Renewables, 2016

4.3.2.1 Hamburg Renewable Energy Cluster in Germany[19]

In Germany, the city of Hamburg has been playing a key role in expanding the renewable energy industry, with its location at the center of the northern part of Germany offering benefits, such as 1) being close to the North Sea and the Baltic Sea, where there is

[17]https://tallbloke.wordpress.com/2014/12/19/ed-hoskins-capital-cost-and-production-effectiveness-of-renewable-energy-in-europe-the-data/

[18]The state of renewable energies in Europe edition 2015 (15thEurobserv'er report)

[19]This section's contents mostly came from official site of Hamburg cluster(http://www.erneuerbare-energien-hamburg.de/en), and publically released presentation files made by cluster managing director, Mr. Jan Rispens. Moreover, KOTRA Hamburg branch helped to understand the status of German wind power sector

ample wind resource, and 2) being the third largest port in Europe (Status-quo report Hamburg, 2013). With these regional strengths, there are approximately 24,700 people working in the renewable energy industry, especially actively engaged in wind, PV and bioenergy in Hamburg city, which provides $1.4 worth of employment in the metro region of Hamburg, as of 2012. Moreover, the growth of employment in the renewable industry was 56% between 2008 and 2012[20].

Picture 9 Existing Strengths that the Cluster provides

Source: Renewable Energy Hamburg, A Leading Industry Cluster by Jan Rispens

Moreover, this region has become a more attractive place to invest in, which resulted in a global investment of 257 billion US dollars. The "Renewable Energy Hamburg" was founded in January 2011 to promote cooperation in the renewable energy sector, due to which this cluster acts as a fundamental platform for skills and knowledge sharing, pooling renewable energy related activities among companies, R&D institutions and other sectors, which can influence the development of the renewable energy industry in terms of logistics, manufacturers and so on. Currently, there are 187 member companies and institutions networking in the cluster. For the wind power sector in particular, these companies have

[20]Renewable Energy Hamburg: A Leading Industry Cluster, 12. 2013 by Jan Rispens

contributed to the production of an overall wind power capacity of 30 GW in Germany in mid-2012[21].

Table 9 Cluster Overview

Category	Detail
Foundation	January, 2011 - By the Free and Hanseatic City of Hamburg and Association for the development of the Renewable Energy Cluster in Hamburg
Ownership	51% for Hamburg city, Department of Economy, Traffic and Innovation / 49% for the Association
Cluster Agency	EEHH GmbH
# of members	Over 187 member companies and institutions.
Renewable Energy Sector	Wind, Solar, Biomass
Economic Contribution	257 billion USD global investment 24,700 employed - 59% in Hamburg - 1.4% of the total employment in the Metropolitan Region 56% growth in renewable energy employment (2008-2012)

Source: http://www.erneuerbare-energien-hamburg.de/en/

What caused this renewable energy cluster to grow so fast then? As mentioned previously, 1) its location (between the North and Baltic Sea) and 2) its wind resource, were important elements. However, there are other elements, like 3) international wind sector manufacturers, such as Siemens, Nordex and other companies' headquarters or technology R&D centers moving to the cluster. Not only large companies, but also SMEs are located in the cluster. This helped Hamburg to host the International Wind Energy Trade Fair (with 33,000 visitors and more than 1,000 exhibitors in 2014), resulting in a huge foreign investment so far. 4) Moreover, within the cluster there are renewable energy project developers such as E-ON, Dong energy, RWE and VATTENFALL, leading to more than 65% of all German offshore wind projects being managed and developed in Hamburg. In addition, with utilities like E-ON and RWE, it is important that they are very active in all fields of

[21]http://www.erneuerbare-energien-hamburg.de/en/

renewable energy, grid and storage projects. 5) Besides, the cluster consists of financing institutions, installation and maintenance firms, universities and legal supporting agencies to nurture the industry and to support members in the cluster. **Table 10** shows the services that the cluster provides. As **Table 10** indicates, Hamburg cluster has a portfolio based on technological know-how with manufacturers, project developers, utilities and other sub-core businesses, such as technology certification, renewable energy legal support, logistics and finance.

Table 10 Services that the Cluster Provides

Category	Major Company
Energy Provider (7)	E-ON, Hamburg Energie, Stromnetz Hamburg, etc.
Financing Companies (11)	Commerz Bank, Capital Stage, DKB, etc.
Certification Provider (7)	Hanseatic Power Cert, aj GmbH etc.
Producer (13)	Adwen[22], NORDEX, Siemens, moventas, etc.
University/Research Institute (13)	Fraunhofer, HafenCity University, Leuphana University, etc.
Engineering Office (14)	Emutec GmbH, Fichtner Group, etc.
IT Provider (4)	Schneider Electric, Wind Sourcing, etc.
Logistics (2)	Bilfinger Marin & Offshore Systems GmbH, Eurogate GmbH & Co., KGAA, KG
Personnel Consultancy (7)	STEERER, Proaccession GmbH, etc.
PR/Media Agency (4)	Bizz energy, Job Media GmbH, etc.
Project Developers (26)	Vattenfall, GDF SUEZ, Dong energy, etc.
Training Providers (8)	IBB, Offshore Safety Training Center, etc.
Law Firms (23)	Andersen Partners, Bird & Bird, etc.
Insurance Companies (3)	ATS, MARSH, NW Assekuranz
Consultancy (17)	Enercity contracting, Buckstay, ensibo, etc.
Association/Chamber/Public institutions/Administration (13)	German Wind Energy Association, Cuxhaven, Offshore Basis, etc.
Maintenance/Service (6)	A2SEA, Airwinwindfarmer, etc.
Others (12)	DS Management, ENSTOR, etc.

Source: http://www.erneuerbare-energien-hamburg.de/en/

[22] Adwen: a 50-50 joint-venture of AREVA and Gamesa, specializing in offshore wind sector—design, manufacturing, installation, commissioning and services.

6) Moreover, the renewable energy cluster has a synergy impact from other existing clusters in Hamburg such as maritime, harbor & logistics, aviation, media and IT, so that they have shared subjects with potential in the following sector; optimizing the logistic chain and interfaces, maritime research, materials for renewable energy, composites, lightweight construction, quality management, process control and simulation and so on. 7) The renewable energy cluster, as well as the other existing clusters have an impact on the regional economic development by providing jobs, education and nurturing the local economy. However, all the above-mentioned factors would not have been very effective for the renewable energy industry in Hamburg unless there were supportive policies at both the central level and the local government level. 8) In particular, Hamburg city has aligned with the federal objective of 35% renewable energy target in the electricity sector by 2020, due to which it has focused on actions regarding climate change and environmental targets. Moreover, the "Green Capital 2011" award that Hamburg received acted as an incentive for the future development of the renewable energy industry in Hamburg. Moreover, the industrial policy of Hamburg is based on sustainable growth, which means the local government focused cluster development in innovative industry sectors, especially in the renewable energy sector, which has a long-term potential with growing international competition in recent years. 9) Eventually, the central government policy measures, as well as the efforts of Hamburg city has been fundamental to the success of renewable energy cluster in Hamburg.

Up to this point, this section has discussed how the successes of the renewable energy cluster in Hamburg, as well as the factors that have influenced its growth. However, the cluster case discussed above does not explain how those companies in the cluster have contributed to the production of an overall wind power capacity of 30 GW in Germany. Of course, all elements were found to have some impact on their contribution. However, for a power project to succeed, local acceptance is also a very important factor. In the case of Germany, this factor was mobilized by the renewable energy policy and governmental support. Studying the cases of energy self-sufficient villages in Germany will show how it has achieved high renewable energy usage in power projects with the involvement of local citizens.

4.3.2.2 Mauenheim and Dardesheim in Germany

As seen in **Picture 8**, Germany is the dominant country with regard to the number of 100% renewable energy villages or cities. Since there are many existing cases in Germany, this paper will focus on two cases—Mauenheim (which is the first bioenergy village, located in Baden-Wuerttemburg of Southern Germany and was the idea of two farmers in 2003) and Dardesheim (whose goal is to obtain 100% renewable energy from the initiatives of the local citizens, along with constant cooperation between the local government and the citizens). To have a deep understanding of the process of the projects, resources and opinions were gathered through email-interviews[23] with experts from the Solar Complex in the case of Mauenheim and from the World Future Council [24] in the case of Dardesheim. **(APPENDIX B, C)**

Firstly, Mauenheim is located in Baden-Wuerttemberg, in the southwestern part of Germany. It has about 430 local residents in about 100 households. Originally, two farmers decided in 2003 to build a biogas power plant of 250 kW capacity. As they did not want to waste the heat produced in that process, they jointly approached "Solar Complex" as "Clean

[23]The interview on Mauenheim was done in 13.10.8 at Mauenheim, as part of the Global Challenge Program, "Case analysis of Microgrid System with Renewable Energy" in KEPCO, by Lee, Hyo-Jin, Pyo, Eun-Ji, Lee, Jeong-Hee, Heo, Seong-Woon and Kim, Ah-Reum.

[24] World Future Council: head office located in Hamburg, research/identify/spread the best and most sustainable policy solutions.

Energy", in order to realize a joint project. This became the first village to use bioenergy in Baden-Wuerttemburg. The electricity from all three facilities was connected to the grid in Mauenheim. The amount of electricity generated surpasses the demand by a factor of 8. The biogas system produces about 4,000 MWh/year of electricity and 3,500 MWh/year of surplus heat, which is the approximate heat demand of Mauenheim. The woodchip plant (which only operates in the cold months and supplements the heat requirement for the combined heat and power unit), has a capacity of 1 MW, which supplies heat and hot water to the grid in the area.

Table 11 Project Overview

Category	Detail
Location	Baden-Wuerttemberg
Number of inhabitants	Approx. 430, with 100 households
Renewable Energy Resources	Wastes from farm yard and forests, 180 ha
Facility	Biogas plant, woodchip plant and solar panel
Ownership	Local Residents + Operating Company - KCH Biogas GmbH (Two Farmers + private investor) - Solar Complex (Energy Coop with 700 citizens)
Investment	Biogas System 2.1 million euros (KCH Biogas GmbH) District Heat Supply Facility (with woodchip heat plant, the local hot water supply grid, 66 kW of solar panel, the heat transfer system in each building) 1.6 million euros - Local Government Funding (10%) - Financial Institution (60%) - Funding from local residents (30%)
GHG Saving	3,720 tCO2e/year

Source: Implementation plan, Description of best examples by Intelligent Energy Europe

The second one, Dardesheim, is located in the State of Saxony-Anhalt, in the southeastern part of Germany. It has approximately 1,000 residents, similar to Mauenheim. All the energy they consume is regionally generated using wind, biomass, solar and hydro power. The project was started in 1993 by establishing "EnerCon", which is a wind power company started with local residential participation[25]. Due to the wind resource in that area, many people were interested in investing in renewable energy and as of 2012, there are wind

[25]http://www.juminjachi.or.kr/mspp/index.php?document_srl=126527

power facilities of about 62 MW (135,000 MWh) capacity and solar plants of 250 MWh capacity. This amount is much higher than the local electricity consumption of Dardesheim (about 40 times). It also surpassed the total energy demand of Dardesheim by a factor of 15. Therefore, the total electricity produced from this town also provides for villages nearby, which includes about 80,000 residents.

Table 12 Project Overview

Category	Detail
Location	Saxony-Anhalt
Number of inhabitants	Approx. 1,000
Renewable Energy Resources	Wind, Solar, Biomass/Biofuels/Electricity Cars
Facility	Wind Power Plants, Solar Photovoltaic, Biomass Plant
Ownership	Local Residents (EnerCon)
Investment	Local Government Funding (20%) Financial Institution (60%) Funding from local residents—EnerCon (20%)

Source: 100% Renewables 2016

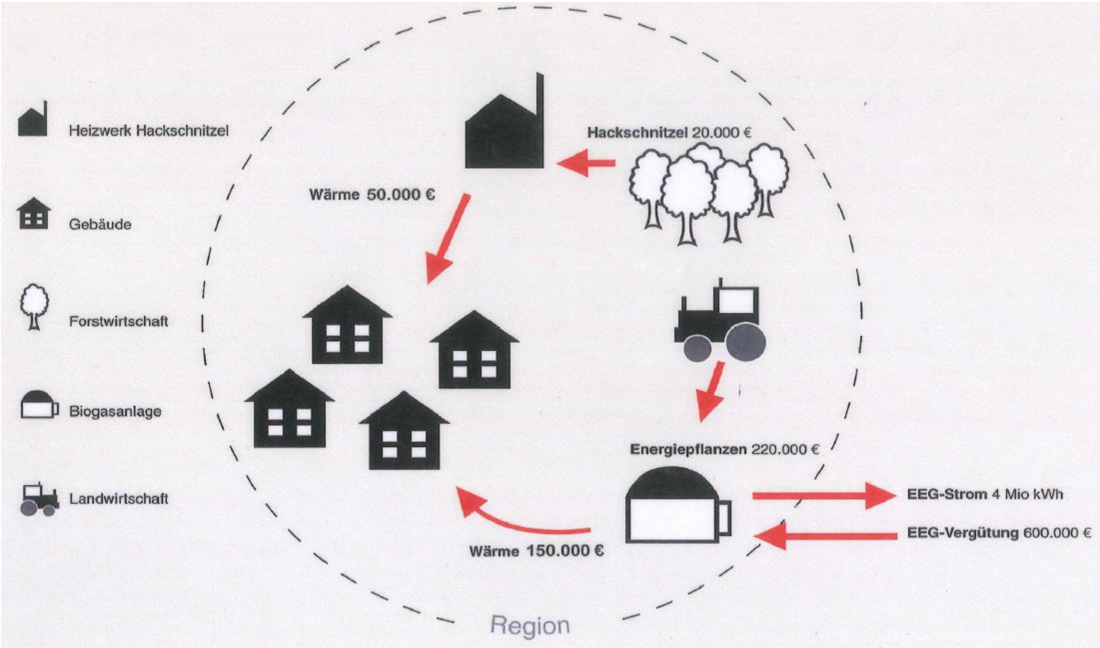
Since both, Mauenheim and Dardesheim, generate electricity by themselves using renewable energy sources, the main benefit is that all the investment they make in that village goes back to the community. Moreover, fuel from all the facilities is supplied locally, with the local residents being contacted and offered a deal where they could receive heat for a very competitive price. In the case of Mauenheim, a profit of €600,000 is generated per year from electricity sales to Utilities. In case of Dardesheim, local residents who invested were guaranteed an 8% rate of return (Lee, & Kim, 2015). Moreover, EnerCon established the "Druiberg Renewable Energy Information Center", where 75 local residents are working for sharing their success story with visitors.[26]

In both the cases, there are common success factors: 1) Community initiative, 2) Collaboration with local government or municipality and 3) Economically viability due to sufficient profit. Beginning with the third factor, it can be interpreted into a proper supportive

[26]http://www.juminjachi.or.kr/mspp/index.php?document_srl=126527

scheme to guarantee a minimum compensation to project participants, so that investors would be willing to make an investment. Not surprisingly, this has been made possible due to the Erneuerbare-Energien-Geseta (EEG, meaning German Renewable Energy Sources Act), which was enacted in 2000.

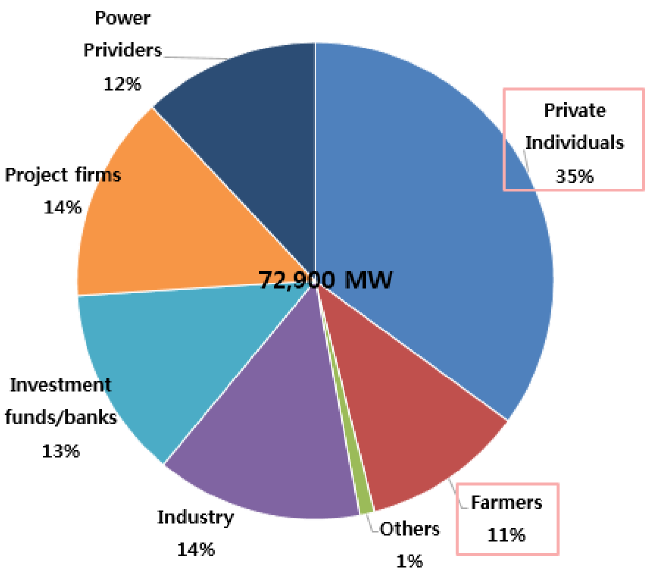
Picture 10 Current Status of Mauenheim



Source: Solar Complex 2013

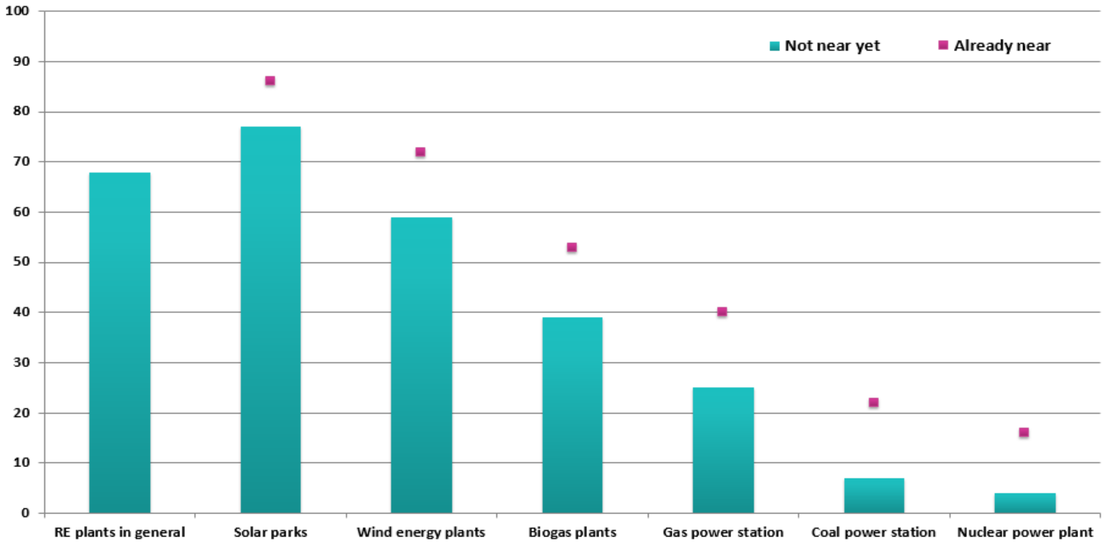
Basically, EEG is like the FIT scheme, which provides subsidies like fixed price, to renewable energy power producers, so that they could have a stable profit for a certain period. The grid operators are required to purchase electricity from renewable energy sources at a fixed tariff. Correspondingly, in principle, everyone, including homeowners, citizens, cities, counties and cooperative associations, are allowed to engage in renewable energy projects actively. This kind of legislative power started the energy transformation, encouraging investment in renewable energy at all levels in Germany. Furthermore, it was very helpful to have a local government that supported the idea of becoming a 100% renewable energy city, county or region. Accordingly, such policy support from both, central and local government, was the basis to attract private individuals, energy coop and farmers to join together for generating electricity projects using renewable energy. Eventually, this led to high social acceptance for and local participation in renewable energy projects in Germany. As **Pictures 11 and 12** show, in Germany, regular people are the biggest renewable energy project developers, with their proportion being higher than formal power providers or project firms. Individuals participate in renewable energy projects actively in Germany, with a higher acceptance for renewable energy sources than conventional power plants or nuclear power plants.

Picture 11 Ownership Distribution of Installed RE Capacity for Power Production in 2012



Source: Renewable Energies Agency (www.unendlich-viel-energie.de), 2016

Picture 12 High Approval for Renewable Energy Plants being near One's Own Home



Source: Renewable Energies Agency, August 2015 (www.unendlich-viel-energie.de)

In this regard, according to the research from Wuppertal Institute for Climate, Environment and Energy in 2014, there were 942 energy cooperatives as of 2013. The author provides empirical evidences showing that these energy cooperatives have been very helpful in encouraging local community to foster renewable energy, since a majority of energy cooperatives in Germany actively participate in the provision of renewable energy. It is obvious that civil society initiatives in the renewable energy sector in Germany are common. It is also an important factor in energy transition, which is why the local government and municipalities are trying to ensure the involvement and constant cooperation of citizens.

4.3.2.3 Copenhagen Cleantech Cluster in Denmark[27]

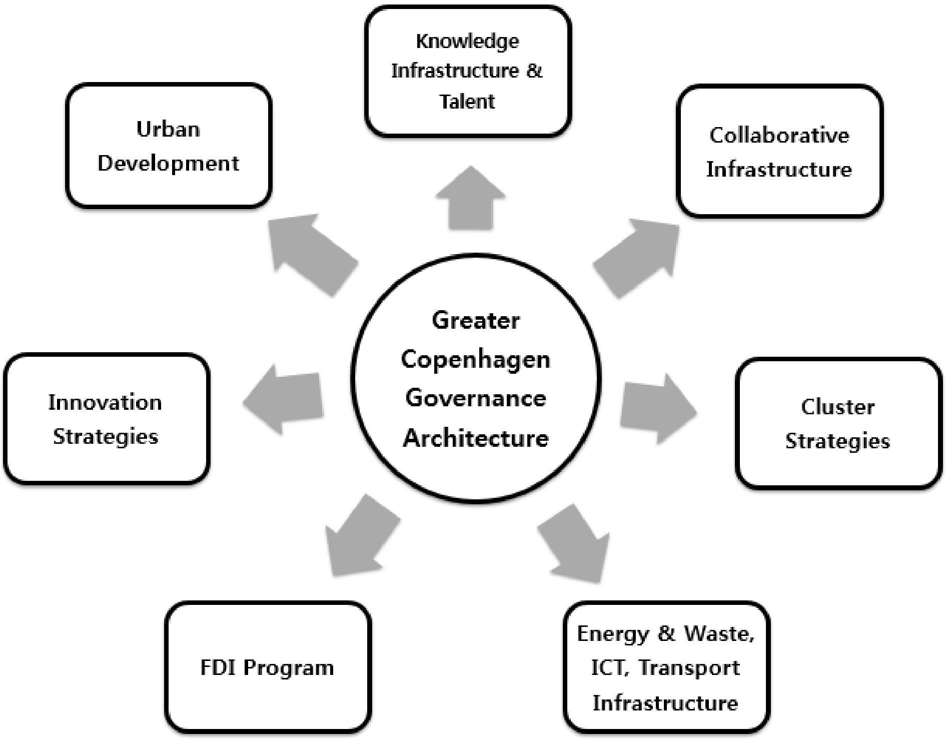
Copenhagen, the city where the Copenhagen Cleantech Cluster is located, is well known as the European Green Capital since 2014. Before that, according to the OECD report in 2012, after Copenhagen had hosted COP 15, it had become more serious about creating a center for climate change adaptation and mitigation, as well as developing green technology. At present, Copenhagen is known the winner of “Green Capital”, “Sustainability Award”, and “Green Building Award” and so on. The underlying factor empowering Copenhagen to achieve its goal is participatory governance, which means involving all the stakeholders, such as local community, enterprises, government, universities and research institutions. This kind of collaborative approach (**Picture 13**) towards green technology has contributed to the competitiveness of Copenhagen in the clean energy sector in the world. Copenhagen is trying to become a Carbon-free city by 2025, based on its collaborative approach with various partners, not only from the government, but also from private enterprises and other energy developers.

Owing to such fundamental support, the Copenhagen Cleantech Cluster was established at the end of 2009, as a pioneer in promoting green growth in Denmark. The target of this cluster was to nurture the green technology industry with joint ventures, research and development activities and providing additional clean business opportunities with SMEs. The origin of this cluster was from a partner-oriented project comprised of more than ten partners including industry, universities and entrepreneurs in the city of Copenhagen. **Picture 14** indicates the governance structure of the cluster. In particular, the Copenhagen Capacity shown in that picture was launched as the official inward investment agency for the

[27]This section’s contents mostly came from official site of Clentech cluster(http://cleancluster.dk/en/), publicly released files such as OECD report 2012, and partially based on interview with a project manager of the cluster **(APPENDIX A)**

cluster for attracting foreign direct investment, which was considered an important factor in developing the cluster and for its future.[28]

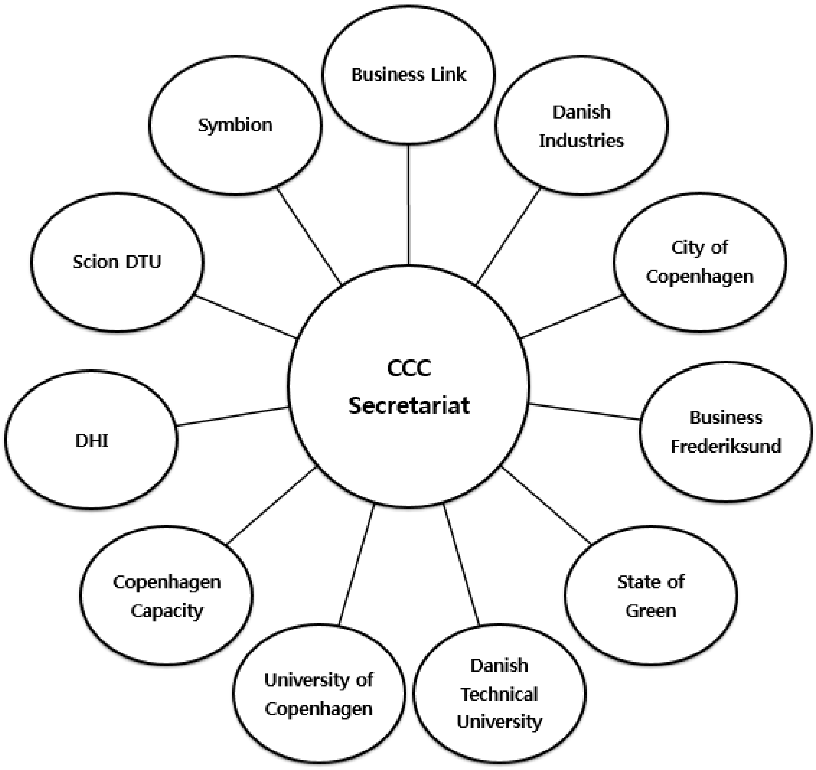
Picture 13 Enablers of the Cluster



Source: OECD, 2012

[28]Publicly released file 'Danish Cleantech–International outreach' by Copenhagen Capacity, Mr. Jakob Elmer.

Picture 14 The Governance Structure of the Copenhagen Cleantech Cluster



Source: OECD, 2012

According to a recent report about the five-year evaluation of the cluster, it has contributed to not only strengthening the green technology in Denmark, but also creating new jobs and supporting new businesses all around the world.

> "The long list of outcomes includes creating 1089 new jobs, 64 new research collaborations, 38 new company partnerships, attracting 12 international companies and supporting 126 entrepreneurial businesses."[29]

However, overall, since the cluster has operated in all 610 related companies, its economic contribution would be enormous (those companies have employed more than 70,000 people and have a turnover of about 30 billion euros, according to the OECD report in 2012).

[29] Copenhagen Cleantech Cluster—proving that clusters matter report, CCC sustainable report 2014

Table 13 Cluster Overview

Category	Detail
Foundation	December, 2009 - Partner driven project comprising of 11 core partners - Initiated through a EU supported project Merged with several smaller clusters in 2014, became CLEAN
Funding	Budget of 20 billion euros - 50% from the EU - 25% from Region Zealand and the Capital Region of Denmark - 25% from the founding partner organization (Apply for grants or have co-funding model)
Cluster Agency	11 core members Copenhagen Capacity for overall co-ordination
# of members	Over 176 members, 120 are companies
Major Activities (Industrial, Research, Commercial)	With four focus areas; Smart Energy, Environment, Smart City, Internationalization Working on - Sustainable Materials, Waste and Recycling, Water and Sewerage Air and Environment, Green/Renewables, Energy Production, Optimization of Energy Consumption, Energy Infrastructure/Distributions, Energy Storage, Smart City
Economic Contribution	1089 new jobs 64 new research collaborations 38 new company partnerships Attracting 12 international companies Supporting 126 entrepreneurial businesses

Source: Information from OECD, 2012; Copenhagen Cleantech Cluster – proving that clusters matter report article[30], CCC sustainable report 2014, email interview from CLEAN

Regarding the success factors of Copenhagen Cleantech Cluster, as already mentioned, 1) the city of Copenhagen planned for an ambitious future as the first carbon-free city in the world, 2) the central government also offered support by changing its policy to embrace clean technology and deal with its growth issues. Thus, both, the central and the local level of policy support, played a fundamental role in creating the cluster as already showed in **Picture 13,** as enablers of green growth in Copenhagen. 3) The collaboration among companies, cities and other core partners was an efficient approach to enhance the impact of the clusters for green and clean industries overall. The cluster was a complex based on the triple helix innovation system among the government-university-industry. This was

[30] http://www.quercus-group.com/#!Copenhagen-Cleantech-Cluster-%E2%80%93-proving-thatclusters-matterr/c7a5/54fd85cd0cf27b8ab24e73d4

vital in aligning and strengthening the relationships among those partners, according to an interview from the cluster recently. Thus, the cluster is trying to be an innovative ecosystem in itself, which is why it has nurtured the acceleration of development of green industry with various stakeholders. 4) There is an official investment agency called Copenhagen Capacity, which is responsible for the overall coordination and facilitation of the cluster project. It was ranked the number 1 regional IPA in the world by the World Bank in 2009. 5) Using the above factors, the cluster has been able to transfer and diffuse new ideas, knowledge and an initiative to provide a complete solution for public and private partners, research institutions and even SMEs, by networking with bigger companies and participating in projects with them, as well as cities. 6) Moreover, the cluster has been focusing on matchmaking by using existing networks, so that members and participants could collaborate with each other to achieve successful results in the green technology area. 7) Another interesting part of the cluster is that, it has been providing an access for testing and demonstration facilities for green technologies. Since full-scale demonstration, assessment and improvement are such an important part of commercializing a technology, this service was important to attract national level companies. Overall, based on the supportive policies by the government, collaborative governance of the cluster is a key element of the Copenhagen Cleantech Cluster. This allows the diffusion of knowledge, improvement of technology, creation of new technology and the attraction of international companies.

While the world was suffering from the oil crisis in the 70s, South Korea and Denmark did not show much difference in the energy sector (high dependency on energy export). However, the Danish government, using the oil crisis as a new opportunity, aggressively invested in the high efficiency and eco-friendly energy sector with a long-term policy plan. The previous cluster case was one of the outcomes of this long-term approach of an eco-friendly plan. At present, the Danish government is targeting to become a 100%

renewable energy country by 2050. In this regard, the next section will discuss the case of Samso Island, which is a 100% energy self-sufficient island, based on the bottom-up approach with high local acceptance, which can be an important factor in being a 100% renewable energy country for Denmark. At the same time, it will provide some lessons for the South Korea too.

4.3.2.4 Samso Island in Denmark

As seen in **Picture 8**, which shows the World Status of 100% Renewable Energy Projects, Denmark is ranked fourth with 16% of its share. Among various cases of energy self-sufficient villages in the world, Samso Island is ideal for this paper to focus on, since it is the world's first island using 100% renewable energy, based on the bottom-up approach[31]. Similar to the previous German cases, for a proper understanding of the process of the projects, the resources and opinions collected through an interview with an expert in the Samso academy[32] (Education center in Samso Island) are reflected in this section. **(APPENDIX D)**

To provide some background, Samso Island is located in Kattegat, which is about 9.3 miles away from the Jutland Peninsula.[33] Under the Samso municipality, there are about 4,000 inhabitants as of 2013. The Energy 21 plan was enacted in 1996, according to which the Danish government would increase the usage of local renewable energy sources for energy supply in that region (Energy Networks and the Law: Innovative Solutions in Changing Markets, 2012). As part of this energy plan, the Ministry of Energy organized a competition, titled "Denmark's Renewable Energy Island", to select the local community that can present the most realistic plan for 100% self-sufficiency through renewable energy in that area within 10 years. Eventually, Samso Island won this contest among four other islands, but the government did not provide any benefits such as funding, tax subsidy or assistance. Of course, some of the primary investments were funded by the Danish Ministry of Energy, the Samso local government and the municipality to the tune of approximately 4 million EUR.

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[31] http://www.ecowatch.com/samso-worlds-first-100-renewable-energy-powered-island-is-a-beacon-for-1881905310.html

[32] The interview(APPENDIX D) on Samso Island was carried out on 13.10.14 at Samso Island, as part of the Global Challenge Program, "Case analysis of Microgrid System with Renewable Energy" in KEPCO, by Lee, Hyo-Jin, Pyo, Eun-Ji, Lee, Jeong-Hee, Heo, Seong-Woon, and Kim, Ah-Reum.

[33] https://en.wikipedia.org/wiki/Sams%C3%B8

However, most of the budget, which was more than 45 million EUR, came from the local community in Samso (NCRC, 2009). Due to this, as well as the challenge of transitioning from conventional power sources to renewables within 10 years, the role of local community was very important. Fortunately, local residents in Samso were actively engaged in the project and they eventually achieved 100% renewable electricity in less than 10 years, in 2005. Currently, there are 21 wind turbines for generating electricity (11 onshore turbines, 10 offshore wind turbines). The 11 onshore wind turbines are installed in three regions (Tanderup: 7600 MWh—3 turbines, Permelille: 7600 MWh—3 turbines, Brundby: 12700 MWh—5 turbines) in Samso, which are connected to the grid on the mainland, Jutland, so that whenever the amount of electricity exceeds the total energy consumption of the island, it is sent to the grid on the mainland. The other 10 offshore wind turbines are used for the transportation sector, with a production of about 77500 MWh. In addition, there are district heating plants located in four regions for generating heat for local areas using wood chip/straw-fired boilers and solar panels.

Table 14 Project Overview

Category	Detail
Location	Between Jutland and Zealand
Number of inhabitants	Approx. 4,000
Renewable Energy Resources	Straw and wood from the local area
Facility	Off/Onshore Wind, Woodchip Plant and Solar panel
Ownership	Local Residents, Energy Cooperatives, Municipality - Local farmers and residents - Energy Cooperatives such as Difko I/S, Paludan Flak I/S - Samso municipality
Partners	Danish Energy Agency, Aarhus Regional Authority, Samso Municipality, Samso Business Forum, Samso Farmer's Association, Samso Energy Supply Company, Samso Energy Academy
Investment	Public Subsidy from the Government: 7.5% of total (4 million EUR) Rest of the budget from local community
Electricity Consumption	100% wind power from 11 on-land wind turbines
District Heating	1/3 heating from biomass and sun, 1/3 oil burners and 1/3 private heating with renewable energy (Pellet, wood, solar collectors, heat pumps, etc.)
Transport	Fossil fuel consumption is compensated by off shore wind turbines.

Source:http://www.musecenergy.eu/web/practices/denmark/02_Renewable_energy_island.pdf, Final Report of Global Challenge Program, "Case analysis of Microgrid System with Renewable Energy" in KEPCO, 2013, by Lee, Hyo-Jin, Pyo, Eun-Ji, Lee, Jeong-Hee, Heo, Seong-Woon, and Kim, Ah-Reum.

Similar to the previous German cases, Samso island generates electricity by itself using renewable energy sources. The main benefit is that all the money they invested in the island was returned to the community. In particular, the fuel for the district heating that all facilities have is used locally, with the local residents being contacted and offered a deal where they could be paid for selling the electricity from the wind turbines. Through the FIT scheme, for local residents who invested in wind turbines, return was guaranteed at 10 cents/kWh for the initial 5 years, after which, 7.1 cents/kWh was offered for the next 10 years. This was actually an efficient way to invite local residents to invest in the project. In addition, there were several other economic benefits from the project, such as additional employment in the renewable energy sector, increase in tourism income, decrease in fuel consumption (about 10,000 DKK per capita), investment returns (400 EUR per household from 2000–4000 EUR as an initial investment for the wind turbine; Samso Academy, 2007).

Table 15 Development in Samso's Energy Consumption from 1997–2009

Energy form	1997 (TJ)	2009 (TJ)
Electricity export	0	283
Electricity import	99	0
Fossil fuels	333	315
Biomass	59	127
Solar thermal collectors	0.1	10
Wind power	5.6	391

Source: Interview with energy advisor at the Samso Academy, 2013

How did Samso island achieve 100% renewable energy self-sufficiency in less than 10 years? Following are the success factors and the lessons learnt from the Samso Island case. 1) As mentioned earlier, this project considered the importance of local involvement and participation from the beginning, even during the competition initiated from the Danish government. Therefore, after Samso won the competition, creating a 'Bottom-up Energy Democracy' was the first step to starting the project. As per this 'Bottom-up Energy Democracy' approach, the project initiator from the government actively participated in local meetings and introduced the project. Moreover, many among the local residents who were interested in the project were invited to the project working groups for the initial planning and development of the project, starting from the selection of the renewable energy sources. This seemingly small starting point eventually led local residents to invest in the project so that they could have financial ownership of facilities for the project. Eventually, most of the local residents in Samso were involved in some capacity. An energy advisor from the Samso Academy described how local residents participated in the project, as follows;

> "We used "energy democracy" and held a lot of open meetings, for the people on Samso. Samso's wind turbines are organized in several different kinds of ownership. Five of the 10 off-shore wind turbines are owned by the island municipal government, the Municipality of Samso. The proceeds from the windmills will be reinvested in future energy projects as Danish law does not allow local municipalities to earn money by generating energy. Three of the off-shore turbines are privately owned, for the most part by local farmers who have pooled resources to buy an off-shore wind turbine. The last two are sold on a cooperative basis to many small shareholders. One of these cooperatives is organized as Paludan Flak I/S, a locally based initiative. The other is a professional investment foundation, Difko I/S. The 11 1 MW wind turbines established on the island as one of the energy island's first projects are also owned in different ways. Nine are owned privately by local formers or small groups of farmers. Two are owned by locally based cooperatives with many small local shareholders. There are about 450 different shareholders, who are all connected to Samso. We held open meetings which highlighted the different problems and the budget as well, and in the end it showed it would be a very good business, and talked about the pro and cons and the impact the project would have on the local geographical area."

Basically, this kind of bottom-up method was successfully in bringing both, local people's involvement and local ownership for the project, so that the local community was naturally integrated and deeply engaged in this project. 2) Based on this, economic benefits such as job creation, more tourism and investment were smoothly generated. 3) Even though the financial support from the government and local municipality was not sufficient to cover all the necessary budget, without their initiative and administrative work, Samso project would not be succeeded. For example, Samso Energy Academy was built in 2007 to support research, education as well as provide service to visitors who wanted to benchmark the project. 4) In addition, as mentioned above in the case of Germany, Denmark has also adopted the FIT/Premium tariffs scheme, so that all who invested in the project received some compensation. In fact, Denmark has been focusing on avoiding the use of conventional fuel resources since 1970s. Right after the oil crisis, its long-term policy has been contributing to the energy transition in Denmark.

One of the biggest characteristics in the wind sector in Denmark are the energy cooperatives that still have ownership of the wind turbines which were erected in the 1980s. Moreover, after the new renewable energy law was enacted in 2009, all new wind energy projects should offer a minimum of 20 percent of project ownership to local residents, including energy cooperatives based on local people[34]. Due to the abundance of wind resources and its top technology, the share of Danish electricity consumption from wind power was 42% as of 2015 (GWEC). It is undeniable that encouraging local ownership and civil society initiatives have played an important role in developing wind energy in Denmark.

[34] http://www.dkvind.dk/html/eng/cooperatives.html

4.4 Comparative Analysis (South Korea vs. Germany and Denmark)

4.4.1 Lessons from South Korea, Germany and Denmark

Up to this point, this paper has focused on the cases from both, South Korea and other well-developed countries, like Germany and Denmark, in renewable energy sector in the world. Firstly, based on three Korean cases, there are many elements that South Korea should consider and develop for sustainable renewable energy industry and its promotion in future. **Table 16** indicates the elements which had a negative or positive impact on each case.

Table 16 Key Elements that have an impact on the project

Case	Element	P*	N**
Gasa Island	Stable renewable technology application	○	
	Resistance from the local residents		○
	Noise problem due to wind generator		○
	Supportive administrative actions from local government and municipality	○	
	Co-funding from local government and Power Utility	○	
	Meeting and hearing to discuss the project with local community	○	
	Generator design modification to increase higher social acceptance	○	
	Sufficient RE resource	○	
Seoul Citizen Coop	Small market portion and weak influence on the traditional power producers		○
	Lack of supportive policies for the Coop		○
	Less profitable		○
	Reintroduced FIT to subsidize for small capacity RE (Solar)	○	
	Providing financial program (such as low interest rate)	○	
	Lack of various schemes for supporting energy cooperatives		○
South West Offshore Wind	Low local acceptance		○
	Tight regulation		○
	Lack of RE technology		○
	Lack of Human Resources		○
	Lack of Long-term policy support		○
	Sufficient RE resource	○	
	Less profitable		○

*P: Positive impact on a project
**N: Negative impact on a project

In other words, it is clear that, for the success and development of the renewable energy sector, the following key indicators that were determined as the weak points in the Korean cases, i.e. local acceptance, administrative support and supportive policy including financing, profitability, technology and its proper application, renewable energy resource, are essential.

What about other developed countries, especially with regard to the renewable energy sector? Since the purpose of this study was to compare various successful cases and solutions that have been implemented in well-established countries in order to establish a sustainable renewable energy industry using clusters with the involvement of local community in South Korea, the paper discussed this in two categories, which are cluster and use of 100% RE project in Germany and Denmark to obtain key ideas to implement in South Korea.

Firstly, there were several success factors from the two cluster cases as shown in **Table 17** below.

Table 17 Success Factors from the two Clusters

Case	Element	Remark
Hamburg Cluster	Consideration of location benefit (Close to North Sea and Baltic Sea)	Location
	Existing Infrastructure (the 3rd largest port in Europe)	Infrastructure
	Top wind manufacturers' headquarters and R&D centers were moved	Stakeholders
	International Wind Energy Trade Fair	International Networking
	Wind Energy project developers and Utilities	Stakeholders
	Financing Institutions, Universities, Legal agencies, etc.	Stakeholders
	Synergy impact from other existing clusters such as maritime, harbor and logistics,	Infrastructure
	Clear target of Hamburg city for renewable energy	Long-term Policy
	Both central and local government's fundamental support	Support from Government
	Providing consultancy service for SMEs	Nurturing SMEs (Role of Incubator)
Copenhagen Cluster	Copenhagen plan for carbon-free city	Long-term Policy
	Central and local government's policy support and target for renewable energy	Support from Government

	Various partners including companies, cities, universities	Stakeholders
	Acting as solution provider and knowledge diffuser for SMEs, new innovator for industry	Nurturing SMEs (Role of Incubator)
	Focusing on matchmaking among various partners for better results in green technology	Networking
	Full-scale demonstration and assessment of technology	Test-bed

Both the cluster cases have some success factors in common, like 1) Various stakeholders, including government offices, universities, private enterprises (developers, manufacturers and so on), research institutions, Utilities, etc., 2) Long-term governmental policy and support from both, central and local, governments, and 3) Responsible for providing several services (for SMEs / other administrative work) and networking to expand renewable energy industry. Since each cluster consists of several role players, this kind of partnership-based system is very efficient for developing renewable energy technology and its industry, based on the knowledge diffusion among various partners, because each partner has its own strengths for developing the technology. Moreover, this kind of clusters can also eventually bring the momentum in promoting domestic manufacturers and private enterprises, so that they can compete in the world market in the near future. Thus, it can be assumed that technology enhancement and its innovation can happen through the collaboration of participants in cluster. Moreover, as technology is developed, more people can access it at a lower price. In this regard, successful clusters can bring down the cost of renewable energy technology to influence the overall expansion of renewable energy. During this process, human resource will be automatically and simultaneously accumulated as well as accumulating the knowledge of industrial development. From the German and Danish cases, two factors can be finalized, i.e. the cluster should include all participants in various sectors, and these participants should be actively involved in developing the renewable energy technology based on a well-structured cluster with aggressive governmental actions for the expansion of the renewable energy industry.

Secondly, there were also success factors from the three cases using 100% renewable energy, as shown in **Table 18** below.

Table 18 Success Factors from the three cases

Case	Element
Mauenheim and Dardesheim	Community Initiative
	Collaboration with local government or municipality (Support)
	Economically viable (Profitability due to FIT and other policies)
	Educational center
	Economic benefits such as job creation, tourism
Samso Island	Economic benefits such as job creation, tourism
	Administrative assistance from the central and local government
	Economically viable (Profitability due to FIT and other policies)
	Designed as a bottom-up approach project
	Educational center

It seems obvious that the bottom-up method, as well as the compensation scheme based on various governmental supportive policies, such as FIT or the mandatory clause, which requires the project to involve local community for renewable energy, are key factors in enhancing local acceptance and success of 100% renewable energy projects. Moreover, education centers play an important role in persuading local residents and explaining the pros of renewable energy to them, which can lead to higher local acceptance and the project's success.

In both, clusters and 100% renewable energy projects, governmental supportive policy and its long-term plan are very essential to achieve the project goal. Unlike South Korea, Germany and Denmark have been concentrating on the development of renewable energy, which are bearing results now, albeit with newly found bottlenecks, which should be taken care of, based on decades of experience.

Compared to those countries, South Korea is still in the beginning stage in terms of both, nurturing renewable energy industry as well as obtaining higher social acceptance, as discussed throughout this paper. The southwest offshore wind power project is a combination of wind power project and creating a wind industrial cluster, although this is yet to be developed due to the various reasons previously mentioned. Moreover, the actual improvement in the renewable energy technology level and related industrial development must be preceded by the formation of the renewable energy market, such as the MW capacity of the renewable energy project or 100% renewable energy town, replacing conventional energy in school, homes and towns, etc. In addition, creating markets is dependent on the local community, in terms of its acceptance or perception about renewable energy. However, regarding the involvement of local community, so far, South Korea did not realize the importance of local residents. Instead, it attempted to change their mind within a short time period by offering monetary compensation. However, in recent years, project developers, like Utilities and government offices are gradually recognizing the importance of local community, due to which they are trying to find out ways of inviting the local residents to join the project.

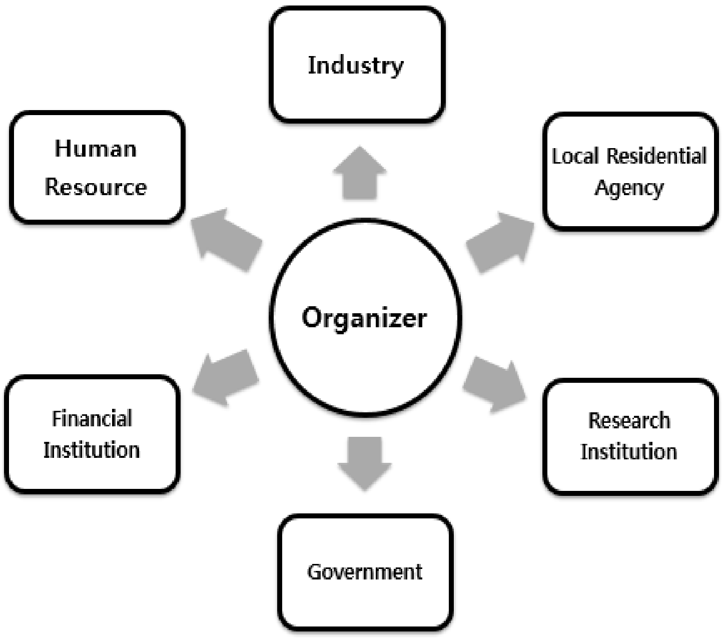
In this regard, MOTIE announced the "2nd Energy Plan" in January 2014, to expand the decentralized energy system and the renewable energy usage. Under the 2nd Energy Plan, the government evaluated the current status of renewable energy and found four major reasons (1. Lack of cost competitive and technology due to low usage, tight regulation and low local acceptance, 2. High import rate[35] for the main facility of each renewable energy, 3. Weak linkage between commercialization and long-term investment, 4. Lack of finance) for the gap existing between actual renewable energy usage and its target. The government now plans to introduce a new scheme to expand decentralized renewable energy by improving the existing financing system, RPS, incentives and investing in R&D program, which is still in its initial stages.

[35] Solar panel: 79%, Wind: 85%, Fuel Cell: 91%

4.4.2 Cluster Model with the Involvement of Local Community

Based on the German and Danish cases, it is essential to build a cluster model with the involvement of the local community for the development of a sustainable renewable energy industry in South Korea.

Picture 15 Renewable Energy Cluster Model with the Involvement of Local Community



Of course, before creating a cluster, at least two factors should be considered with regard to location: 1) Whether the place has existing infrastructure (harbor, highway, universities, companies, etc.) or not, 2) Whether the place has existing renewable energy industry or not. With these two factors, the cluster will be able to create a synergistic effect and achieve its contribution on regional development with less economic cost. Going back to the renewable energy cluster, more detailed roles and responsibilities are described below.

1) Government: Long-term planning and concrete supportive policy with a target

The policies should not be changed due to political issues or conflicts between ministries. The government should have long-term momentum to achieve the target (central government should set renewable energy targets more specifically by sector, such as such as electricity, heating and cooling or transport. More comprehensive targets will be helpful for enhancing the usage and technology level of renewable energy sources). Until the competitiveness of the renewable energy cluster is secured, an aggressive incentive policy of the government is essential. Moreover, it is time to consider re-introducing FIT or a similar monetary support program for the expansion of renewable energy, until it achieves a certain level.

2) Organizer: Manager, planner or council for overall cluster work[36]

The Organizer should be the most powerful, but liberal organization, with member representatives from all six sectors shown in **Picture 15**. Based on concrete support from the government, it is necessary to establish special types of management organization structures, which would be completely responsible for tenant companies, providing various programs such as research and development support, commercialization of core technology, various support programs for shifting to a mature stage of technology, post-management support for small and medium-sized companies, including start-ups, so that these companies can succeed, linkage between large and small companies and international network. In this way, it is possible to have a unified administrative system, so that all tenant companies and institutions would cooperate actively while leading this cluster.

3) Financial Institutions: Designing funding and financial programs

Financial institutions should build at least two types of programs: 1) Low interest rate loan / co-funding program for local residential agencies. In fact, a lot of cities and local governments are in debts or cannot generate enough money to enforce and accelerate the

[36] Partially from term paper (A study on Korea's Renewable Energy Industrialization and the creation of Industrial Clusters – Case studies on Solar Clusters from Germany and France, pp. 10 by Kim, Ah-Reum) of Industrialization and Economic Development course

extension of renewable energy. To solve this problem, programs and initiatives for easier investments and public contributions (like the "Nationale Klimaschutz initiative des BMUB[37]" in Germany) should be undertaken through communication with the central government. 2) Technology commercialization (including demonstration) fund for SMEs, since SMEs usually suffer from a lack of investment, due to which they are not be able to commercialize their technology even though they may have already achieved a certain level.

4) Human Resource: Education for students / Information for local residents

This sector should provide two important benefits, i.e. 1) Education and 2) Information. Firstly, it is essential to train of professionals, with the accumulation of institutions and companies in the cluster. In particular, people should be trained in renewable energy-related technology, which is a multi-technology field. Since it is difficult to achieve success in the absence of a continued education and training program, a relevant technical course must be established in the region to expand the training institutions to allow the training of new personnel. In addition, if necessary, the development of a professional training program through personnel exchanges with domestic and foreign experts should be encouraged for the continuous development of specialized human resources in the cluster.[38] Secondly, it is necessary to provide correct information to local residents on how the cluster and renewable energy projects will be / are planned, managed and executed.

5) Industry: SMEs and Large enterprises (Manufactures, Utilities, etc.)

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[37] Since the beginning of 2008, additional funding from the auction of emission allowances has been available to the BMUB(Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety) for the implementation of the Climate Initiative. The Climate Initiative aims to cost-effectively tap existing potential for emission reductions and advance innovative model projects for climate protection. Retrieved from: http://www.bmub.bund.de/en/topics/climate-energy/climate-initiative/

[38] Partially from term paper (A study on Korea's Renewable Energy Industrialization and the creation of Industrial Clusters – Case studies on Solar Clusters from Germany and France, pp. 10 by Kim, Ah-Reum) of Industrialization and Economic Development course

Their role is very important as a part of the cluster. Based on this sector, the overall value chain will be created in the form of incubation > manufacture > marketing > supply > export > operation and management.

6) Local Residential Agency: Formal partner for cluster and RE project[39]

As discussed several times in this paper, even if the investment and technical capabilities of institutions are supported in order to develop the renewable energy industry and achieve sustainable growth, the verification and diagnostics, through the construction of an actual demonstration technology complex (actual renewable energy power generation plant as a demonstration unit) should be established as the main basis. For this reason, the cluster should involve local residents as members from the very beginning, so that gaining local acceptance is possible through the investment and profit sharing by the time the construction of the actual demonstration unit and the real project commence. In addition, it can be considered to have local branch office of Suhyup (National Federation of Fisheries Cooperative) or Nonghyup (National Agricultural Cooperative Federation) with local customers as the energy coop, so that they can invest in the renewable energy project in their area.

7) Research Institution: Co-R&D program among GRI, Private, and University

Research and development are a very essential since this can be fundamental basis for produce high-level. Since the research capability and strengths of GRI, private institutions and universities are different, R&D collaboration would be able to generate at least double the capacity of technology.

[39] Partially from term paper (A study on Korea's Renewable Energy Industrialization and the creation of Industrial Clusters – Case studies on Solar Clusters from Germany and France, pp. 10 by Kim, Ah-Reum) of Industrialization and Economic Development course

CONCLUSION

This study focused on examining the clusters and 100% RE projects from Germany and Denmark regarding the development of renewable energy industry by the development of clusters with the involvement of local community. Of late, the pursuit of sustainable development has increasingly focused on the importance of the development of environment-friendly energy technology, with the recognition of changes in the energy consumption pattern, such as the tightening of regulations on the environment, which is acting as the new variable in the world economy. Subsequently, while the share of renewable energy is increasing, the proportion of fossil fuels has been gradually decreasing. In case of the US and the EU, a greater focus to commercialize renewable energy technologies has prompted the market to grow incredibly fast. Due to these global trends, the construction of industrial complexes specializing in renewable energy sector has been growing. However, in South Korea's case, this has not been successful. Hence, this paper provides a review of the current situation in South Korea, as well as cases from other countries to offer recommendations.

It appears that South Korea is behind these countries, being in the initial stages. Even so, it is gradually changing the policy direction, based on its trial and error experiences from the past. At present, the government is trying to adopt renewable energy in several islands based on the Gasa case. In addition, the Southwest Offshore Wind Project's plan has recently been modified to reflect the reality and overcome various barriers. If all the lessons learned from these cases are incorporated in future projects, South Korea would be able to achieve sustainable economic growth while also actively responding to climate change, thus creating a new economic paradigm that can transform the world in the near future.

However, since this paper is based on case studies, it would be more informative and objective if more cases were covered from various countries. Moreover, in case of South

Korea, KEPCO and the six subsidiaries control the energy sector. In this regard, additional studies should be conducted in the near future to encourage sustainable development and the creation of a virtuous cycle for the renewable energy industry based on their roles and responsibilities in the cluster together.

APPENDIX

APPENDIX A

Interview contents of Copenhagen Cleantech Cluster

1. What would be the most important element to promote renewable energy cluster? (Priority with following elements)

Supportive policy (Government/Local) 1

Capital 1

Technical level/innovation 1

Human capital 2

Local acceptance and participation 3

Existing industries 1

Main agent (Central gov / local / residents)

Other elements that have impact on the success of renewable energy cluster:

- Collaboration between companies, cities and knowledge institutions. It is vital to align and strengthen the relationships between these three – it is the triple helix innovation system.

2. Basic information about cluster

- Starting year: CLEAN is the result of a merger between several smaller clusters in 2014
- Main focus/area(renewable energy, efficiency, smart grid, ESS, etc):

Internationalization, Smart Cities and Environement are our focus areas. Within these areas of cleantech, we work with the areas of: energy efficiency, intelligent energy systems, green energy production, sustainable materials, waste and resources, air and environment, water and waste water, energy storage. We also have to innovation networks: Smart Energy (Inno-SE) and Environemntal Technology (Inno-MT)

- The number of companies involved in cluster: out of 176 members, 120 are companies.

- Funding source (from the government or private enterprises or others): we write applications to grants and have a co-funding model.

- Services for SMEs: Networking with bigger companies and participating in projects with bigger companies as well as cities. (R&D, consultant, venture capital, training & education, technology transportation, market evaluation, marketing, PPP, export supportive service.. etc)

3. Why did you decide to promote renewable energy cluster especially in Cophenhagen region? (Specific reasons regarding location? – infrastructure, existing industries… etc)

-

4. How did local residents participate on this cluster? (For example, local employment, education.. etc – regarding local economy development(economical effect) from the cluster)

- Employment at CLEAN is not related to geography – we even have an employee who lives in Milan, Italy, and who have x amount of days at the office in Copenhagen. Other than that, we also have offices in Jutland and Funen and thus geographically cover most of the country.

5. Is there any difficulty when the city started this project in the beginning?

-

6. Advice for anyone who consider to promote renewable energy cluster

Be very clear on WHY you want to promote renewable energy. Work with companies and cities who are prioritizing the area, and use the universities to secure the quality of technological development and their collaboration in order to educate the youth in regards to the needs of society in 5-10 years.

7. The most important element to promote renewable energy industry based on the case of Denmark

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APPENDIX B

Interview contents of Mauenheim

1. Why did you decide using renewable energy in Mauenheim?

- Two farmers decided 2003 to build a biogas powerplant with 250 kW. Because they did not want to waste the heat produced in that process, they contacted solarcomplex in order to realize a joint project. This is how the first bio-energy village came into being in Baden-Württemberg, Germany

2. How did local residents participate on this project?

- The local population did not participate actively. The local residents were contacted and offered a deal where they could receive heat for a very competitive price. Subsequently 70 residents/houses signed a contract and were connected to the grid.

3. Is there any difficulty when you started this project in the beginning?

- No. The farmers were well known and because there were information campaigns from the beginning, there was no opposition. The 2 farmers and solarcomplex were well known and trusted, so there were no difficulties at all.

4. Economical effect on local community by using renewable energy

- The main benefit is that all the money spent in this community stays within the community. The fuel is sourced locally, which means that there is no money flow outside. The economical benefit is that the local community does not have to spend € 300.000,- per year on having to buy fuel from the global market, meaning this money stays in the community.

5. Are local residents satisfied after using renewable energy?

- They are very satisfied, because they spend a lot less on heating than villages around them. Instead of having to spend € 4.000,- on oil every year, the only have to spend € 2.000,-/year for their heating. As you can imagine they quite like that.

5. Government/EU policy related to renewable energy and smart grid

- I recommend that you research this on the internet, as this is too broad a topic to discuss briefly.

6. What would be the effect on power production? (Both technical & economical effect)

- Not quite sure what you mean. This was explained during the tour. The biogas plant provides the fuel for the combined heat and power unit, which produces heat and electricity. The heat is consumed locally, the electricity is fed into the grid. The wood chip furnace is only operating in the cold months and supplements the heat requirements for the combined heat and power unit.

7. Consideration when you (Mauenheim) decided to apply the renewable energy sources at the very beginning

- Other renewable energy sources (PV, Wind) only produce electricity. The bio-energy village enables to produce electricity **and** heat. The farmers had the waste from the animals, so this could be utilized as cheap fuel for the biogas plant.

8. Have you done the environmental impact assessment of Mauenheim?

- No, there was no EIA. The related administrative offices did not require an EIA, as the law does not require this. Nothing has changed as the agricultural activities did not change and the emissions from the plant and wood chip furnace are regulated and observed.

9. Advice (Based on the trial and error that the Mauenheim went through)

- Do the same in South Korea! The technology is available everywhere and there is no reason why this could not be implemented in your country. You just have to convince the local population and offer a good service. You have animals, they produce waste. You have access to the same technologies (biogas plants, combined heat and power units, wood chip furnaces). Technically speaking it is very straight forward. Obviously you would have to build a local grid (pipes and pumps) that can transfer hot water from the plants to the houses)

APPENDIX C

Interview contents from World Future Council

1. What would be the most important element to promote 100% renewable energy village/renewable energy industry based on German cases? (Priority with following elements)

Supportive policy (Government/Local)

Capital

Technical level/innovation

Human capital

Local acceptance and participation

Existing industries

Main agent (Central gov / local / residents)

Other elements that have impact on the success of renewable energy cluster

- Primarily, the basis of the transformation towards a sustainable energy system and investing in renewable energies came from the legislative power. The German government passed an act called "Erneuerbare-Energien-Gesetz EEG" (English Version of the act), which gave the opportunity to invest in and running renewable energy sources. Correspondingly, in principle everyone (including homeowners, citizens, cities, county, cooperative associations, etc.) could engage with renewable energies. In the End, actually all of these elements you have mentioned have an impact on the success of the promotion. Anyway, according the cases in Germany the commitment of the locals (the government and the citizens) was a consequence of the national legislative basis (implementing the EEG). Furthermore, it was most helpful to have a local government that stood behind the idea of becoming a 100%-RE-city, county or region. Having a local acceptance and participation of the resident citizens is one of the central issues, as well. Especially in some cases, the goal to achieve 100%-RE came from initiatives of the citizens. You can find them on the map on www.go100re.net/map. Two examples are Dardesheim and Feldheim. Additionally, below the last question there is a list of all German cases (as far as we know) that might be helpful for you.

2. How did local residents participate on 100% renewable energy project in common?

- In Many cases the local citizens are or have been involved in the process or even in the initiation of 100% renewable energy projects in Germany. For example, in Dardesheim there is a constant cooperation between the local government and the citizens and initiatives. Wolfhagen municipality gives another way of involvement. 25% of the local energy service is owned by citizens. Correspondingly, they have an access to decision-makings and to the profit made from the operation of RE plants. Here you can find more information about this. Further, a lot of German municipalities have decided to buy back their electricity grids from energy companies. This development has its basis in a discussion about who should be responsible for providing the national grids. Hamburg's citizens, for example, voted to force the city to buying back the grid – currently owned by E.On and Vattenfall (two power companies). The main reason that came up was the doubt that these companies would rather pay attention on increasing their profit instead of investing in REs and taking care of the demands of the people in terms of energy supply. http://www.power-to-the-people.net/2013/09/hamburg-citizens-vote-to-buy-back-energy-grid/

3. What would be the common difficulties when government started 100% renewable energy project from the beginning? (Such as opposition forced from the local residents etc.) / How did the most project developers resolve previous problems?

- The main task was (and still is) to overcome the local resistance as well as making them being aware of the advantages of REs and disadvantages of fossil fuels. In case of Wolfhagen for example (which was already mentioned in question 2) they decided to let the citizens be part of the ownership of the grid and therefore of the profit on generating REs. Further a lot of people now would agree with REs but they still have to become aware of what it means to them, where the tangential points between everyone's daily life and the REs are and what each of us can do to enforce and accelerate the transformation towards a 100%-RE community. Another point is the fact that a lot of cities and local governments are in debts or in another way cannot generate enough money to enforce and accelerate the extension of REs. To solve this problem, programs and initiatives for easier investments and public contributions like the "Nationale Klimaschutzinitiative des BMUB" have been set up.

4. Economic impact on local community by using renewable energy?

This paper considers the significant investments made in the renewable energy sector from 2010 to 2012, the effects on the GDP are markedly positive, without the energy transition altering the overall growth path significantly. Nevertheless, long-term financing via the EEG surcharge leads to increased electricity prices in subsequent years for all consumer groups, except for the electricity-intensive industries, who are able to slightly benefit from the reduction of wholesale prices. A sensitivity analysis is performed to break down the stimulus and thus clarify the cause-and-effect relationships. Other relevant information can be found in the following links:

- The Economic or Competitive Advantages of the Energiewende for Germany
- Some graphs (see slide 17-21)
- See conclusion in this article
- The German Institute for Economics published this paper last year (see mainly chapter 5)
- The co-benefits of community energy (study which is referred to in this article is unfortunately only in German but this blog gives you a rough idea about the findings)

- Some infographics

Even though it is a bit older (from 2010), maybe helpful: Value Creation for Local Communities through Renewable Energies To find out more about the economic impact on Germany in general, just have a look at this report.

5. How do you think of adaptation of energy cooperative as a solution to promote renewable energy industry and increase higher social acceptance?

- The energy transformation starts in the fundamental way our system is structured. And with it comes a battle, as power and profits shift hands from the few to the many. Decentralizing the energy market and empowering new stakeholders to the market is the only way to achieve the energy transition in the speed and at the scale needed. Energy Cooperatives are here an ideal model to enable this development. In this link you will find the WFC Policy Handbook which deals with the questions about how to achieve 100% REs. We suggest you to have a look on page 48 under #3. This chapter is about maximizing opportunities for citizens' participation and the development of new business models.

6. Advice for anyone who consider to promote 100% renewable energy village or city based on the trial and error that Germany went through

- The aspects from question 1 should be mostly included in the promotion. It is of key importance to convince the (local) government as well as making sure to getting enough support from the industry and businesses and the local population. To achieve this, it is obviously indispensable to show all involved groups of participants the advantages of the REs (especially the advantages for themselves) and the disadvantages of not promoting REs. Using these facts, for example, might be helpful: Facts on 100-Percent-Renewable Energy.

Consequently, other attributes or elements should be added. One of the most important aspect is that transparency should accompany the entire process. Furthermore, setting a main target is essential for reaching a 100%-RE energy mix. To do so, several institutions and governments adopted targets to diversify their energy mix, boost the share of renewable energy sources, and reduce their reliance on imported energy resources. By setting these ambitions the resistance of stakeholders and the (local) residents decreases and gives a clear overview of the prospective role of REs. Consequently, communicating a 100%-RE target is central. In fact, there are completely different 100%-targets, including only one sector, such as electricity, heating and cooling or transport or more comprehensive targets that aim to supply 100% of total energy needs with renewable energy sources. You can find more about setting targets and the transparency work in the Policy Handbook, as well.

Another aspect, which was already mentioned before, is to set up the target and the methods and financial support established in laws. Anyway, in Germany, e.g., primarily the pass of the EEG act initiated the "Energiewende".

Further information/links

If you are interested in some good practice examples, we suggest you to have a look at the following link: click here. Further the website from "100 EE Erneuerbare Energie Region" might be interesting, as well. Unfortunately, it is mostly in German. But anyway you can find some reports (e.g. this one and another link) in English, too.

In general, it can be said that nowadays one of the main challenges in promoting the so called "Energiewende" in Germany is the lack of possibilities to store energy and the need to build a sufficient grid to transport the generated energy (in case of electricity). E.g., in the North of Germany there are plenty of off- and onshore wind parks which produce much energy. Even though sometimes they produce more energy than demanded, there is no adequate grid with high voltage lines to transport the energy, for example, to Southern Germany. You can read more about the challenges here and here: Understanding the German Energiewende (incl. cost-benefit analysis and Germany`s competitiveness in the global market).

Furthermore, below you can find a list of cities, counties, towns, etc. in Germany which have set a 100-%-RE Target. You can also see if you will find the city already on the map at Go100Re, which we are constantly completing. There you will find all the case studies of the German cities including a lot of additional information about how they want to achieve the target, how they implement it and if it was a social initiative or a governmental decision.

Table 19 List of 100% RE cities, counties and towns in Germany

City	Administrative unit	Target	Sectors
Alheim	town	Progress	Electricity
Berchtesgadener Land	region	Progress	Electricity
Hagen	city	Not actively pursued	Electricity
Pellworm	island	Achieved	Electricity
Rietberg	city	Progress	Electricity
Saerbeck	village	Achieved	Electricity
Schleswig-Holstein	region	Achieved	Electricity
Sontra	village	Progress	Electricity
Traunstein	city	Progress	Electricity
Wolfhagen	city	Achieved	Electricity
Bad Hersfeld	city	Progress	Electricity, Heat
Bamberg	city	Progress	Electricity, Heat
Ebersberg	city	Not actively pursued	Electricity, Heat
Feldheim	town	Achieved	Electricity, Heat
Frankfurt am Main	city	Progress	Electricity, Heat
Giessen	city	Progress	Electricity, Heat
Gräfelfing	city	Progress	Electricity, Heat
Lausitz-Spreewald	region	Progress	Electricity, Heat
Morbach	village	Progress	Electricity, Heat
Munich	city	Progress	Electricity, Heat
Odenwald District	region	Achieved	Electricity, Heat
Trier	city	Progress	Electricity, Heat
Wangen im Allgäu	city	Progress	Electricity, Heat
Wilhelmsburg (Hamburg)	city district	Achieved	Electricity, Heat
Lüneburg county	region	Progress	Electricity, Transport
Dardesheim	town	Achieved	Electricity, Transport, Heat
Flecken Steyerberg	village	Achieved	Electricity, Transport, Heat
Freiburg im Breisgau	city	Progress	Electricity, Transport, Heat
Fürstenfeldbruck	region	Progress	Electricity, Transport, Heat

Osnabrück	city	Progress	Electricity, Transport, Heat
Rhein-Hunsrück	region	Progress	Electricity, Transport, Heat
Steinfurt	region	Progress	Electricity, Transport, Heat
Wildpoldsried	village	Achieved	Electricity, Transport, Heat
Ulm	city	Progress	

APPENDIX D

Interview contents from Samso Island

1. Why did you decide using renewable energy in Samsø island?

- This information is available in on page 7 under Preface in the link above.

2. How did local residents participate on this project?

- We used "energy democracy" and held a lot of open meetings, for the people on Samsø. Samsø's wind turbines are organised in several different kinds of ownership. Five of the 10 off-shore wind turbines are owned by the island municipal government, the Municipality of Samsø. The proceeds from the windmills will be reinvested in future energy projects as Danish law does not allow local municipalities to earn money by generating energy. Three of the off-shore turbines are privately owned, for the most part by local farmers who have pooled resources to buy an off-shore wind turbine. The last two are sold on a cooperative basis to many small shareholders. One of these cooperatives is organised as Paludan Flak I/S, a locally based initiative. The other is a professional investment foundation, Difko I/S. The 11 1MW wind turbines established on the island as one of the energy island's first projects are also owned in different ways. Nine are owned privately by local formers or small groups of farmers. Two are owned by locally based cooperatives with many small local shareholders. There are about 450 different shareholders, who all is connected to Samsø.

3. Is there any difficulty when you started this project in the beginning?

- How did you resolve those problems?

- We held open meetings which highlighted the different problems and the budget as well, and in the end it showed it would be a very good business, and talked about the pro and cons and the impact the project would have on the local geographical area.

4. Economical effect on local community by using renewable energy

- When the turbines were erected the feed-in tariff was 0,6 DKK per. kwh, the first 12,000 (full load) hours, there after 0,43 DKK per. kwh. for 10 years. The smallest in Denmark for all offshore wind farms built since. For comparison, for the new at Krieger flak and Horns Rev is the price per kwh 1.03 DKK and 1.05 DKK. Minimum tariff is now on the market conditions and is approx. 0,32 DKK per. kWh for offshore wind turbines.

5. Are local residents satisfied after using renewable energy?

- We have not done any studies on satisfaction level, but a good indicator is that there are no complaints about wind turbines or other projects, and residents still invests in renewable energy projects.

5. Government/EU policy related to renewable energy and smart grid

- I our project we used existing national framework

Main targets EU policy:

The strategy identifies five headline targets the European Union should take to boost growth and employment. These are:

- To raise the employment rate of the population aged 20–64 from the current 69% to at least 75%.
- To achieve the target of investing 3% of GDP in R&D in particular by improving the conditions for R&D investment by the private sector, and develop a new indicator to track innovation.
- To reduce greenhouse gas emissions by at least 20% compared to 1990 levels or by 30% if the conditions are right, increase the share of renewable energy in final energy consumption to 20%, and achieve a 20% increase in energy efficiency.
- To reduce the share of early school leavers to 10% from the current 15% and increase the share of the population aged 30–34 having completed tertiary from 31% to at least 40%.
- To reduce the number of Europeans living below national poverty lines by 25%, lifting 20 million people out of poverty.

6. What would be the effect on power production? (Both technical & economical effect)

- Related industry development etc.

http://energiakademiet.dk/en/vedvarende-energi-o/energikort/

Position the cursor over the object on the map and get access to information and images.

Table 20 Energy consumption from 1997-2009

Energy form	1997 (TJ)	2009 (TJ)
Electricity export	0	283
Electricity import	99	0
Fossile fuels	333	315
Biomass	59	127
Solar thermal collectors	0,1	10
Vindpower	5,6	391

Electricity consumption: 100% wind power from 11 wind on land turbines

Heat 1/3 heating (biomass + sun) 1/3 oil burners and 1/3 private heating with renewable energy (Pellet, wood, solar collectors, heat pumps, etc.)

Transport: Fossil fuel consumption is compensated by off shore wind turbines.

7. Consideration when you (Samsø) decided to apply the renewable energy sources at the very beginning

- We have only used already known and proven technology in our project, so it has been possible to estimate various parameters such as lifetime, economy ect

8. According to report, Samsø island already achieved "Cabon negative goal", Have you done the environmental impact assessment of Samsø island?

- In Denmark, the average carbon footprint per capita is approx. 10 tons, but if you put one the inhabitants on Samsø into this equation the footprint is minus 2 tons, because we sell about 60% of our "green" production of electricity to the mainland.

9. Advice (Based on the trial and error that the Samsø went through)

- There is a need for political support from the municipality, enthusiasts to execute the project as well as providing public backing through energy democracy. It is a long process and it is not easy, but the end result is that you have found the best solution.

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