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Review of community renewable energy projects: the driving factors and their continuation in the upscaling process

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Abstract. Community energy has recently drawn many interests as a project that pursues a more localized, sustainable energy approach. Many locations across nations have implemented the approach and achieved a degree of success. The project success is established by a combination of driving factors, which created a favourable environment for projects to proceed well in the deployment phase. The success is expected to continue towards upscaling phase. This article aims to summarise the driving factors both during the initial stage and upscaling among small-scale community energy in different contexts. Drawing on content analysis from published materials, we categorize information, classify patterns and label the types from nine case studies from seven countries; Japan, Denmark, Italy, Germany, Thailand, India, and Indonesia. The result shows that, first, there are five driving factors commonly found in the projects, which serve as the background reason for project development, people's motivation and social capital from community side, support from external factors, and the project outcomes experienced by the locals. Each factor comprises types and descriptions reflected in the case study. Second, challenges, dilemmas, and tensions exist along with project development. Third, the success factor shows continuity up until the upscaling projects. We argue that the extension of networks, supports, and the partnership has enabled the projects in upscaling and running in the longer term.

1. Introduction

The local low-carbon initiative has been promoted as an action to tackle many issues, such as carbon emission reduction, energy security, and regional revitalization. The locals who share the same problems initiate the action to achieve their desired goals. One approach of this initiative is through a community-driven renewable energy (RE) project. A rural area has an abundant amount of untapped natural resources that can generate RE. The bottom-up initiatives reveal many benefits, among others, are supporting sustainable energy programs, decreasing energy expenses, enhancing networking, increasing local employment, and reducing carbon emission [1]. These movements often referred to as local low-carbon energy initiatives [2], grassroots innovation [3], local RE organizations [4], and low-carbon communities [5]. The definitions are similar around the idea that actors from civil society, citizen, or community carry out the action, rather than a centralized, private-oriented company. The actions are diverse, such as locally owned RE generation, green building practices, district heat networks, combining a biogas power plant to a solar houseboat, solar home system installations, and so on.

Community RE, or later mentioned as community energy, according to Walker and Devine-Wright [6] stresses two points: process; referring to who takes part in the development, and outcome; referring to who receives the outcomes of the projects. The community energy approach has been implemented in many projects across nations with different contexts. During the process of project development, inputs from the community and the surrounding environment (such as external actors, policies) contribute to the completion of the project. This input is defined as factors that drive the project to succeed. These factors are composed of a few things: components, or any knowledge, traits, values, or characteristics which are necessary and create a favourable enabling environment for projects to proceed well [7]. Previous literature has explored the success factors of community energy initiative [8][9][10]; however it remains unclear on how very diverse factors contribute to the deployment phase towards the upscaling. This question remains important because the project success should continue beyond the initial stage towards a broader scale.

In this paper, we provide a summary of the driving factors in several case studies of community energy, then investigate how the factors continue in the upscaling process. The overall research questions are: What are the driving factors of community energy projects, and how does it continue in the upscaling process? This study uses content analysis from nine community energy projects, then categorizes the information from each case into a group of typologies of driving factors. This paper has significant contributions in terms of providing a new framework of driving factors as part of goals aiming at scaling up.

2. Methods

The method of research is a content analysis from published materials, such as academic journals, non-government organization reports, and news articles. The overall steps [10] are classification of information, identification of patterns and connections within and between categories, and finally, interpretation of data. First, we coded the stages of project sections: the initial, deployment, and scaling up stages. Then, we identified who are the actors in the project building, and what are their role, contribution, or internal characteristics that enable the project to proceed. We observed that some of the cases share certain aspects, then we started to form and label our categories. Based on these observations, we were able to summarize the abstract attributed to each typology. As a result, five typologies of driving factors were formed with their respective abstracts.

The research explored nine case studies from seven countries; Japan, Denmark, Italy, Germany, Thailand, India, and Indonesia. Table 1 shows a summary of all nine case studies. Data population and power capacity illustrate the different scale of each project. Some projects have a large capacity and diverse RE technologies, in example Samso, Denmark, and Iida City, Japan, which are considered a pioneer in each respective country. Some projects are in small capacity and village level, for example, Pa Deng, Thailand, and Cinta Mekar, Indonesia. Case selections were based on the following criteria:

- The project initiator should be the community or a group of local people
- The project has been completed, in terms of the sequences from planning to implementation
- The project has achieved a degree of success, in term of meeting the objectives and enhancing the socio-economic conditions of the locals
- The countries represent different regions and economic groups
- The literature is available in a comprehensive manner, that is the process of project development until the impact of the project on local people.

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Table 1. Nine case studies

No	Case study	Project activities	Initiator	Start of operation	Investment (USD)	Selected literatures
1	Ashoro Town, Hokkaido	Woody biomass project and production of pellets for heating	Local community, establish a project group	2005	735,749	[11]
2	Iida City, Nagano	Solar power generation system installation based on citizen funds (joint public investment)	Local people, establish a non-profit organization (NPO)	2004	17,458,150	[12]
3	Bizen City, Okayama	Energy service company (planning, installation, and maintenance), rooftop solar PV project, and biomass heating installation	The municipality, industry association, forestry cooperative, and citizens, establish a council	2005	7,755,000	[13]
4	Samso Island, Denmark	Renewable energy island, covering all energy sectors including electricity, heat, and transport	Local people, establish a local organization	1997	21 billion	[14]
5	South Tyrol, Italy	Biogas cooperatives organizing small-scale and single-farm biogas	Local people, establish an interest group	2001	16 million	[15]
6	Hesse, Germany	Bioenergy villages, a village which has a local heat supply network	Local people, establish a project development group	2007	431,200	[16]
7	Pa Deng, Thailand	Installing a biogas digester for cooking, improving cook stoves, and SHS for lighting and irrigation	Local people, establish a group of interest	2006	1,400	[17][18]
8	Dungapur District, India	Entrepreneurship activities through women empowerment in solar technologies, by assembling, selling, and maintenance of solar lamp business, then establishing a solar panel manufacturing company	A community organization and network of self-help group	2016	37,493	[19]
9	Cinta Mekar, Indonesia	Micro hydropower plant project	An NPO and local people	2004	225,000	[20][21]

3. Result and Discussion
The result and discussion are presented in three parts. First are the driving factors, then tension, dilemma, and conflicts found in the projects, and the last is a summary of the upscaling.

3.1. The driving factors
We identified two crucial players in community energy: the community and external actors who are the government, non-government organization (NGO), or private sectors. On the community side, we identified two driving factors that are motivation and social capital. On the external actor's side, there are different types of supports and supportive policies. Above those factors, there is a background motive, a setting condition that inspires the project initiation. On the far end, the project generates a positive outcome experienced by the community.

3.1.1. Typology of background setting. The background setting refers to the circumstances in respected regions or cases that inspire the community and stakeholders to develop projects. Arguably, these motives are common goals that drive a stakeholder into collective actions. Table 2 shows that the most dominant reason for project development is economic generation and revitalisation by utilising local assets. All case studies are in rural regions facing similar issues of the lack of employment opportunities and the decline of local business. Almost all cases had the motives to generate economic activities from local RE projects, except the case from Thailand (no 7). Pa Deng's Thailand case is particularly interesting because the village is in a national park, restricted to grid extension. The RE project, bio-digesters, and solar homes aimed to supply energy to households self-sufficiently, and did not intend to generate or revitalise the economy. Similarly, the case in India (no 8) and Indonesia (no 9) also aimed to increase the electricity supply in the village and promote community empowerment. The case in Japan (no 1, 2, and 3) had motives to overcome the decline of population in a rural area by circulating local resource for RE and reviving local industries.

Table 2. Typology of background setting

Type	Project	Abstract
Stabilizing the population	1, 2, 3, 4, 6	The situation of decreasing population is alarming the government to take action and mobilise local assets to secure the number in the future.
Economic generation and revitalization by utilizing local assets	1, 2, 3, 4, 5, 6, 8, 9	The stakeholders seek a new opportunity for reinvigorating the local economy by utilising local resources.
Environmental awareness to reduce CO2 emissions	1, 2, 3, 4, 5, 6	The stakeholders have growing environmental awareness and agree to plan a local action supporting sustainable development.
Electrification and community empowerment	7, 8, 9	The region wants to improve access to electricity, cheaper price for cooking and lighting, and empower the local people.

3.1.2. Typology of people's motivation to join the project. People have different points of view and perceptions in responding to a situation which is influenced by the goal they want to achieve. A goal-framing theory is highly relevant to explain people's environmental behaviour. There are three goal frames: the hedonic goal "to feel better right now", the gain goal "to guard and improve one's resources", and the normative goal "to act appropriately" [22][23]. In developing effective strategies, it is essential to understand which goal drives the community to join on board.

Table 3. Typology of people's motivation to join the project

Type	Project	Abstract
Economic benefit	1, 2, 3, 4, 5, 6, 7, 8, 9	Economic benefits; including creating opportunities for job and local business enterprises, and monetary saving on electricity.
Growing awareness in environmental issue	1, 2, 3, 4, 5, 6	The community has consciousness in climate change issues and protecting the local environment. They want to contribute to local action tackling the issues.

Table 3 shows that the gain goal, economic benefit, becomes the most common reason for people to join the local projects. The benefits include job creation, generating local business enterprises, or saving the expense of electricity on the household level. This result indicates that the project should be economically feasible to attract citizens to join in. For example, in the case of Samso Island, Denmark (no 4), a group of people who were afraid of losing out their business needed to be convinced about the new business opportunity coming from the project. The project should involve in the discussion in search of new opportunities.

This result is in line with a report conducted by the Department of Energy and Climate Change [24] among 25 studies on community energy in the UK. Concerning the reasons for engagement, the most frequent answers were economic. This answer includes reduction of community expense, alleviate fuel poverty (for communities in disadvantaged areas), and opportunities for new business (income generation).

The second common reason to join the RE project is a concern of environmental issues. Local people in Bizen City, Okayama (no 3) had shown awareness in environmental protection since 1998 by rejecting the construction of an industrial waste incinerator. To enhance the environmental activities, they established a council which consists of the municipality, industry association, forestry cooperative, and citizen. This council's goal is to create economic revitalization by reducing CO2 emissions.

The environmental issue is unlikely to be a reason for people to join in the case of Thailand, India, and Indonesia (no 7, 8, and 9, respectively). We argue that in these three cases where access to energy is still relatively low, the top priority is gaining affordable access instead of environmental consideration.

3.1.3. Typology of community social capital. Characteristics of social capital are influential driving factors for a community energy project. Previous research provided evidence that the quality of social characteristics of the community and interpersonal quality affects the willingness to participate in collective actions [25][26]. Table 4 shows that in the case study, there are four characteristics of social capital: collective values (community spirit), a tradition of cooperation, locality and responsibility, and key individuals.

Table 4. Typology of community social capital

Type	Project	Abstract
Community spirit (collective values)	4, 5, 6, 7, 9	The actors drive the process within their community with a bottom-up approach. The process tried to be inclusive by including all people of the community. The attendance ratio during community gatherings is relatively high.
Tradition of cooperation	4, 5, 7, 9	The culture of cooperation embedded in a community, hence cooperative action becomes an unquestioned view. Historically, the community has had experience in cooperation, i.e. agriculture organization.
Locality and responsibility	1, 2, 3, 4, 5, 6	The local community had a sense of responsibility for better improvement in the environment. The project is tailored to make a better change in the community's local area.
Key individuals	1, 2, 4, 5, 6, 8, 9	Key individuals are members of the community who are able to promote new ideas and good communication with internal and

Type	Project	Abstract
		external actors. This person could be entrepreneurial individuals, formal or informal leaders in the project committee.

Community spirit is a sense of togetherness in a group of people which brings them to collective action. Typically, they have a common interest or are facing the same problem, then will cooperate to solve it together through negotiation, collaboration, and involvement of people. The community in Ashoro Town, Hokkaido (no 1) decided on the project through continuous dialogues in gatherings. Any member of the community can join in, express their ideas, and exchange their interest. Through this interaction, they decided on the project direction and shared responsibilities among the members.

The tradition of cooperation is embedded in the case of Pa Deng's Thailand (no 7). Pa Deng community practices cooperative action by nature as "a way to do things because we are all Thais and we need to help each other". Similarly, in South Tyrol, Italy (no 5) the cooperative culture has roots in agricultural activities which have become a normative "fact" and an unquestioned view. In such a way, they did not consider another alternative.

The characteristics of locality and responsibility strongly appear in Samso Island (no 4). The community holds an intense sense of responsibility for a better chance in their local area. Although they were hesitant about what the projects mean, after a series of clarifications and personal meetings, the committee succeeded in convincing the people. The project was "priming" to tailor to the local community, which improved the local decision ability.

The next factor is key individuals who can advocate the community's interest and promote new ideas. In Samso Island (no 4), the key individuals to lead the projects were chosen from locals who understand local knowledge, instead of someone who understands technical knowledge. The key individuals have the role of a coordinator and mediator of the local community, searching for funding opportunities, and communicate with internal and external stakeholders.

3.1.4. Typology of support from external actor. While the main "drivers" of the community energy projects are local people, a number of external actors may engage in the projects. There are three groups of external actors, namely the government, private sectors, and NGOs. The motivation of involvement of those actors might diverse beyond the scope of this research. This section focuses on the types of support given by the external actors. After reviewing nine case studies, four common supports can be identified: funding, technical, facilitator for capacity building, and supportive regulations, as seen in Table 5.

Table 5. Typology of support from external actor

Type	Project	Abstract
Funding support - Financial support	1, 2, 3, 4, 5, 6, 7, 8, 9	Support from the government, in most cases, including subsidies and grants. In one case, it also appears in the government, allowing the project to use an unused school for a factory. The financial institution, i.e. bank typically provide loan and credit. NGO and donors usually provide funding as grants.
- Citizen investment	2, 3, 4	Citizens invest in the project by providing amounts of money per shares for specific projects. The investors get profit (in some cases from selling the electricity generated to the grid) and dividend or interest.
Technical support	1, 2, 3, 4, 5, 6, 8, 9	Technical support from the government, mostly consultation and discussion on preliminary study, policy, and funding issues. Meanwhile, typically NGO and private sectors assist in making a plan, feasibility study, or even further, such as the construction phase.

Type	Project	Abstract
Facilitator for capacity building	8, 9	External actors, typically an intermediary organization, help the community to build knowledge, skills, and other capacity needed to deliver the projects.
Supportive regulation - Electricity trading (such as Feed-in Tariff/FiT and Power Purchase Agreement/ PPA), et cetera)	2, 3, 5, 6, 9	RE project can sell the electricity generated with a favourable price.
- Non-energy policy	5	Restricted manure output policy in South Tyrol, Italy has encouraged farmers to make biogas cooperative.

Firstly, financial support was a factor in all case studies. The case of Indonesia (no 9) received funding grants mainly from international agencies, UNESCAP (United Nations Economic and Social Commission for Asia and the Pacific). A private company, HIBS, also invested in the project, and in return, owned 50% of project share. Case of Samso Island (no 4) received funding, subsidies, and grants from the government, specifically the Danish Energy Authority, Ministry of Environment and Energy, and Ministry of the Interior. Local public investment was also exercised in Samso, through selling shares of the wind turbine to the inhabitants.

Citizen investments also occurred in Japan's case Bizen City (no 3). The citizens burden relatively low revenue because the facilities' lease schemes have long-term stability, and most of the customers are municipalities. 396 people participated in citizen investment, which in total results to 2,09 million dollars.

Next, technical support typically comes as a consultation of feasibility studies or planning. The County Council supported the Samso project regarding spatial planning issues and environmental permits for wind turbines and district heating systems. An NGO or engineering company usually helps with making a business plan, in the example case of Bizen City and Germany.

Last, support for capacity building appears in cases in which people require to be educated. In India (no 8) and Indonesia (no 9), the intermediary organization took the role to facilitate capacity building in the community. Professional knowledge and experience of this organization are crucial in the community that lack of pre-existing knowledge.

Two supportive policies were commonly found in nine case studies: favourable feed-in tariff and non-energy related policy. Those regulations support the RE project to grow and attract people participation.

First, the feed-in tariff (FiT) in several cases enables stable earning through electricity trading. The FiT obligates electricity companies to buy electricity from RE producers at a fixed from 10 to 20 years. The regulation about FiT varies across countries. Japan's Iida City (no 2) and Bizen City (no 3) have the scheme to sell surplus electricity generated in household consumers' roofs. In Hesse, Germany (no 5), biogas plant operators (farmers) got a higher feed-in tariff if the excess heat is used for heating. We can find more references on different types of economic and financial incentives in mobilizing local citizen investment in the extensive systematic review by Curtin et al. [27].

The second regulation, a non-energy policy, can also influence a RE project. In South Tyrol, Italy (no 5), because South Tyrol has dense livestock units, the government releases regulation about the limitation of manure output per hectare. In response to this policy, farmers tried to look for alternatives instead of reducing the livestock number or increase the storage capacity. This study case provides evidence that non-energy policies are able to influence local stakeholders to consider RE technology as a feasible solution.

3.1.5. Typology of outcome experienced by the local community. The project’s impact experienced by the local community might include social impact, environmental, and economical. Berka and Cramer [27] did an extensive review of community RE and then identified and categorized the local impacts. They listed seven local impacts that were: 1) economic generation, 2) knowledge and skill development,

3) social capital, 4) increased local support for RE, 5) environmentally benign lifestyle, 6) access to affordable clean energy, and 7) empowerment. We used these lists in this research to classify local impacts, as in Table 6.

Table 6. Typology of outcome experienced by the local community

Type	Project	Abstract
Economic generation	1, 2, 3, 4, 5, 6, 7, 8, 9	The project helps increase economic situation and local enterprises, which eventually increases the revenue spent on local improvement. People gain monetary savings.
Knowledge and skill development	1, 2, 3, 4, 5, 6, 7, 8, 9	People involved in the project gain knowledge and skills. For the public, the project increases their awareness of the technology.
Social capital	1, 2, 3, 4, 5, 6, 7, 8, 9	The development process increases community engagement and community networks. Collaborate with other actors, i.e., private sectors and municipalities.
Increased local support for RE	1, 2, 3, 4, 5, 6, 7, 8, 9	The support includes: the community trusts the project, citizen contributes to the fundraising and buying shares, another RE emerges, and the number of cooperatives has doubled in size.
Environmentally benign lifestyle	4	There is a change in behaviour and lifestyle. The project covers all energy sectors and has a relatively high share of RE compared to non-RE.
Access to affordable clean energy	2, 3, 4, 5, 6, 7, 8, 9	The project increases people's access to obtain affordable energy sources. It is cheaper than conventional electricity service.
Empowerment	7, 8, 9	The community gains a sense of empowerment and respect after the project's success.

First, economic generation is an impact experienced by all of the cases. In Japan's Ashoro Town (no 1), and Iida City (no 2), the RE project directly contributes to the local industries. The biomass project in Ashoro Town helps to reinvigorate local forestry and improve the economic situation in town, while in Iida City, the city-based factory manufactured the solar panels. Personal benefit in the economy also appears with Dungarpur, India (no 7). The woman who was involved in entrepreneur activities of solar technologies was able to provide additional household income, purchase household necessities, repay their loans, and repair their houses. Those are pieces of evidence that small-scale community RE projects can contribute positively towards economic situations at the local level and personal individual.

The second impact is an improvement in knowledge and skills which appear in all of the cases. The Bizen Green Energy, who manages the project of RE in Bizen City, Japan (no 3), obtained specialised knowledge about sustainable energy through implementing solar PV and pellet stoves to the customer. In the case in Dungarpur, India (no 7), a woman who joined the project should take part in a 10-days intensive training program to gain competence in handling solar PV technology.

The third impact of the project is commonly shared increases in social capital. All cases show existing social capital in an earlier phase of project development, for example, bonding, interactions, and connection among individuals. After the project commissioned, the impacts are networking and collaborating with different types of stakeholders. Ashoro Town in Japan (no 1), showed a growing network built through the project, for example, students, government officials, and children joining in. In Cinta Mekar's Indonesia (no 9), a partnership was created between the community's cooperative organisation and a private company who holds partial ownership.

Next, the increase in local support appeared in almost all case studies. Another project using RE technology emerges after the initial project. An example in Pa Deng's Thailand (no 7), the community adopted solar PV technology after successfully installed bio-digester for cooking. In Japan's Iida City (no 2) and Bizen City (no 3), and also Samso's Denmark (no 4), the community participated by providing investments and buying shares of RE installations.

Regarding the impact of environmentally benign lifestyle, only Samso Island in Denmark (no 4) showed a significant increase in RE supply and eventually change lifestyle. Aiming to be a demonstration of "RE Island", the project successfully increased almost 80% of RE share during ten years which covers all energy sectors: electricity, heat, and transportation.

About access to affordable energy, almost all cases provide the service at a lower price than the conventional energy supply. The people in Pa Deng, Thailand (no 7) get the benefit of affordable energy access by implementing bio-digester from cow manure, grass cuttings, and kitchen leftovers. After the project, people significantly reduce the use of expensive kerosene, charcoal, and LPG tanks.

Last, the impact in empowerment is clear with Thailand (no 7), India (no 8), and Indonesia (no 9). The Pa Deng community gained respect after the project success, received visitors who learned about the projects and connected with external actors outside their living boundaries. In Dungarpur, India, a woman entrepreneur who involved in solar PV projects got personal physiological benefits, such as gaining more respect within their family and in the village, breaking stereotypes as a working woman, and increase their self-worth.

3.2. Tension, dilemma, and conflicts through the process of upscaling

The expansion process may involve conflicts, tension, and dilemmas that induce their survival and the possibility of scaling-up. Transformation and growth require creative action, addressing the challenge that can create an opportunity for something new. Conflicts can positively contribute if they are handled productively, thus provide a thoughtful debate and more in-depth consideration. This contribution can be significant for the progress of the project and might lead to upscaling [29].

From our summary in Table 7, our remarks show that the factor we discussed in the previous chapter is still relevant to address these conflicts, notably support from external actors. Problems, mainly technical and financial, require support from external actors, in an example: technical maintenance, replacing the role of the primary organization, high cost of technology, and high risk of project development.

Table 7. Summary and remarks of conflicts

Tension, dilemmas, and conflicts		Project	Remarks
Technical	Raw material	1	Seek other alternative source of materials, however this should not diverge far from the project's initial motivation
	Technology maintenance	7	Assistance from external actors, who have more expertise, is important beyond project implementation
Social and organizational	Gaining trust	2, 4	Key individuals are extremely significant during initial stages. Hold a meeting and a consultation to clarify people's concerns.
	Phase-out role of the primary organization	3	Change of approach might be necessary after the success of the project. It also encourages growth of other local actors.
	Strong inclusivity resulted in equipment's overcapacity	5	Create a more realistic plan of the maximum number of people who can join, or expand the capacity of the power plant if possible.
	Aligning expectation between stakeholders	6	Establish an organization with effective regulation to achieve the same understanding
	Dependency on the role of NGO	9	Create a clear boundary role

Tension, dilemmas, and conflicts		Project	Remarks
Financial	Cut of external funding	4	The project should be able to maintain its initial profit cost, so it can adapt and seek other financial schemes
	The high cost of technology for customer	7, 8	A convenient payment scheme or innovative financial access can help solve this problem. Seek subsidies from the government if possible.
	High risk (cost) of project development	8	Sharing the risk with other institutions, i.e. municipalities or groups of people

3.3. Upscaling
Upscaling means expanding the micro-initiatives to a broader context. Diversity of the driving factors and the dynamic of the expansion process can affect differently in each case, which then creates several patterns of upscaling. Naber et al. [30] distinguished four patterns of upscaling that are growth, replication, accumulation, and transformation. We choose several case studies suitable for each respective pattern of upscaling, present in Table 8. In practice, a project could have two or more different patterns altogether. For example, the case of Iida City in Japan shows growing and replication. Iida City replicated the scheme of citizen investment from the Hokkaido Green Fund, which was implemented in 2001 to install wind power. They also implemented a similar scheme to install PV and energy saving business in 2005. However, the process of replication was not elaborated further in the published literature, compared with the growing process. Therefore, we choose to highlight the growing pattern in Iida.

Table 8. Example of upscaling pattern in the study case

Pattern of upscaling	Description by Naber [30]	Case study
Growing	The experiment continues and more actors participate, or the scale at which technologies are used increases	Iida, Japan The number of users increased and the type of initiatives were also more diverse.
Replication	The main concept of the experiment is replicated in other locations or contexts	Pa Deng, Thailand Replicated biogas digester from the other village, adjusted the tank using plastic materials.
Accumulation	Experiments are linked to other initiatives	Hesse, Germany On a regional scale, the bioenergy-powered village is linked to a rural development initiative funded by the EU.
Transformation	The experiment shapes broader institutional change in the regime selection environment	Samso Island, Denmark The project covers the entire energy sector in the local area: electricity, heat, and transport. From 1997 to 2013, the RE share has increased to 80%.

3.3.1. Growth: Iida City, Japan. Iida city, Nagano is one of the earliest cities in Japan that has had an environmental plan since 1997 [31]. A group of people established NPO in 2011 to tackle the issue of climate change. Later in 2004, this organization transformed into an energy corporation to carry out social business and energy service [12]. Together with municipalities, national government, and private organizations, this energy company implemented RE projects which include energy-saving, solar PV, solar thermal, biomass. One program is zero initial cost scheme for a solar home system. This strategy enabled many households to install the technology without an expensive upfront cost. Instead, the fixed payments are conducted for nine years, and then in the tenth year, the installations will be owned by the homeowner without additional cost. Another advantage is that the surplus of electricity can be sold back to the grid with a competitive rate. The municipality and local banks collaborated in this program. The initial applicant was 30 households, then increased to 50 in the second year.

Another program was the change of security light from a conventional one to LED, locally produced by business enterprises in Iida City. About 15 companies joint this initiative, together with local government. The national government granted the subsidy. Through the cost-reduction effort, the LED products were 30% cheaper than products in the market. The company has received consultation from other municipalities who were interested in implementing the same program.

We concluded that the attractive financial scheme resulted in an increasing number of customers. Convenience and affordable prices for RE installation are one key to the high adoption of RE technology. The key actors in Iida City continue to seek the possibility for an experiment in an energy-saving program, using LED for security lamps. While the major project in Iida is solar PV installations, expanding the initiatives are necessary to demonstrate that different sectors can contribute to reducing carbon emission. The broad network in Iida City enables resources for new initiatives. A diverse range of actors is crucial for potential innovation and upscaling.

3.3.2. Replication: Pa Deng, Thailand. The Pa Deng community is a self-organised network who have embedded idea of "moderation society": resiliency, community cohesiveness, healthier households, livelihoods, and capacity building. Source of livelihoods are raising cattle and planting crops. These households live inside national parks where grid extension is prohibited. They started their experiment of RE technology by implementing bio-digester. The technology aimed to replace expensive kerosene for lighting and also high-cost LPG, charcoal, and some illegal firewood for cooking. Having identified the need, the community searched for an appropriate solution. They had heard the biogas digester from Burmese neighbour, then implemented the technology based on their context [17]. Instead of using concrete bio-digester, they experimented using plastic materials which are cheaper and locally available. The system has succeeded to run and was since applied to many households in the community network. The members paid for the installation, or community fund provided some financing if the members could not afford (paid in monthly plus low interest). The community received support from external actors that were granted from NGOs, technical support from the local university, and recycled batteries from a private firm. The innovation continued by using solar PV for lighting and irrigation [18]. This technology has also proven to deliver cheaper electricity costs and reduce expenditure on fuel.

The case of Pa Deng showed evidence that adjustment of technology to fit in the local condition is a necessary step, aiming to wider adoption of RE technology. Pa Deng community planned affordable alternatives for RE implementation by using cheap materials and financial schemes in instalment. The community could launch the project independently outside the government intervention. However, there is an external network comprising NGOs, academics, and private sectors, which is a potential network for innovation and upscaling. The interview notes from a local community noted that they recognised the importance of reaching out to build an external network, to seek help, and learn new knowledge [32].

3.3.3. Accumulation: Hesse, Germany. In Germany, the number of bioenergy project has been growing since the first project launched in 2000. The concept of bioenergy village aims to produce electricity and the local heat based on biomass. The electricity produced is fed to the public grid, while the heat is distributed directly to households by a hot water grid [33]. Nationally, in 2018, there are 147 bioenergy villages, and 44 projects are under development [34].

In Marburg-Biedenkopf, Hesse, Germany, the communities seek for mutual benefit in bioenergy cooperation. The farmers who own biogas plant search for alternatives to utilise excess heat from electricity generation. Meanwhile, some villagers interested in promoting environmental issues through RE activities. These two groups developed a feasibility study, mobilise citizens, and found a legal cooperative [16].

In terms of regulation, national frameworks on RE have contributed significantly to this local initiative [35]. The first regulation is the RE Source Act (EEG), which was implemented in 2000, regulates fixed and guaranteed compensation for producers over 20 years per amount of feed-in electricity produced by RE. This regulation encourages development in renewable electricity and biogas plant and becomes an example in other European countries. The regulation was revised in 2004, 2009, and 2012, to accommodate residual energy from electricity generation, and offers a higher feed-in tariff for biogas plant operators if the residual energy is consumed for the heating process.

The second regulation is the Renewable Energies Heating Act (EEWarmeG) that supports the financial aspects of implementing and operational of a bioenergy village. One crucial part of this regulation is the market incentive program, which includes the provision of financial credit from a German bank. Local municipalities were involved in the financial efforts as a debt guarantee for the bank credit. The payback and interest rate is significantly lower for an authority compared to a new bioenergy cooperative. This risk-taking and risk-sharing actions showed robust support from the municipality and a critical force for bioenergy village.

Bioenergy village in Marburg-Biedenkopf is not only linked with energy-related support but also from the rural development sector. An EU initiative for rural development projects called LEADER provides financial support for the village renewal program. At the regional level, several counties form "a LEADER regions" to receive this funding. Hence, this bioenergy village links with a wider regional and EU scale. Another effort of linking bioenergy villages is through the working group at the county level. The local authority in Marburg-Biedenkopf has tried to accumulate the knowledge and experience in this group. The activities include meetings, sharing experiences, and networking with experts or other members of bioenergy villages.

This case demonstrated the external actors; in this case, the authorities were imperative in the scaling-up process. First, the cooperation between project executor and the government is important to identify potential improvement in the policy. Revision of policy is necessary as the project runs, to attract more key interest groups. Second, linking to cross-sectoral support can provide more resource for the project. In this case, the supportive regulations came from national and regional EU and cross-sector in energy and rural development. The last, the government continues its support after the project completion by setting up a working group for knowledge accumulation.

3.3.4. Transformation: Samso Island, Denmark. In 1997, the Danish Ministry of Energy set up a competition for local areas to submit a plan towards 100% self-sufficient based on RE. It was part of the Danish Action Plan ("Energy 21") which aimed to achieve a 35% share of RE in Denmark by 2030. The plan should include the availability of resources and how they are implemented in organizational and technical [36]—the island-scale project targeted all sectors of energy consumption, including electricity, heating, and transportation. The ministry announced Samso Island as the winner of the competition. Since then, the people, with support from the municipality, national government, and private sectors established the framework, planned the implementation and carried out the transformation process. In 2005, the island succeeded to reach a positive net budget of energy, and today it produces more electricity than it consumes [37][38].

In early 1990, imported fossil fuel was the primary source of energy in Samso and Denmark in general. The island depended on energy supply from the mainland through underwater cable [39]. Implementation of the plan towards 100% of RE were through these technologies: land-based wind turbines, offshore wind turbines, district heating systems, and solar PV panels [40].

The Samso project involved a diverse set of stakeholders. The quality of social capital had enabled high participation: strong community spirit, cooperativeness, sense of locality and responsibility, and entrepreneurial skills [14]. An organization called Samso Energy Company (SEC) was founded to implement the project. This company comprised representatives from the municipality, the farmer association, Samso Energy and Environment Office, and the island's commercial council [40]. The municipality took a role as the main informant who disseminates the information to encourage local participation. There were at least fourteen organizations provided support to this project ranging from national to local, which had tasks varying from consultation to provision of funding.

The financial scheme in the project has significantly affected people's acceptance [39][40]. The potential negative impacts of wind turbines caused tensions about the location and ownership. Ultimately, meetings and consultation with the locals achieved consensus building. It also arranged how the ordinary locals able to get the benefit of wind turbines, not only the "powerful farmers". As a result, ordinary citizens could buy shares of ownership of wind turbines. Nine of the eleven onshore turbines are privately owned by local farmers, while local cooperatives own the other two turbines with many small shareholders.

After the model of RE island project regarded as successful, Samso Island began towards a vision to complete phase-out of fossil fuel by 2030, called "Samso 2.0". The idea includes restructuring of agriculture to support organic farming and biogas production, energy saving, electric vehicles, the establishment of a service system for batteries, and an intelligent power system [36]. A sector that has not achieved desirable results is transportation; hence it needs more decisive action. Some issues were tax barriers for rapeseed oil in the agricultural sector and the hesitation of technical problems in using an electric vehicle [14].

The case of Samso aimed for wide-scale change in terms of scale and sector. It was a massive work, during the period of eight years, from 1997 to 2005, which requires high commitment from the local community and external actors. Upscaling of low-carbon transformation progresses gradually, which takes years of implementation. Samso implemented 23 MW offshore wind turbines in 2002, for about six years after the first initiation took off. Consultation, organizational preparation, and physical installation require years. The time is also considered necessary for the community to adapt to the new dynamics that emerge from the alternative energy system [39].

Samso municipality is one of the key actors who assisted on channelling subsidy from national and provided an institutional framework for the local organization. For the future vision (Samso 2.0), the partnership and collaboration from external stakeholders are expected to continue [36]. The local organization can identify the associated stakeholder for each of their ideas.

3.4. A summary of the process of community energy projects

We generated Figure 1 to describe our findings of the process of project initiation to upscaling. There are two key actors in the project development, that are the community (as initiator) and external actors (the government, private sectors, NGO, et cetera). Background settings are the reasons for project development, commonly related to national concern or regional situation. In the community, they have the motivation of joining the projects and social capital characteristics that enable the community to collaborate and working together to build a project. From the external actor's side, they provide various types of supports, including financial, technical, facilitator, and supportive regulations. These contribute to project deployment. After the project's run, the community experiences challenges, tensions, and dilemmas that urge them to do actions. The process continues to the upscaling that can vary into growth, replication, accumulation, and transformation. The outcome emerges, then contributes back to the community's driving factors.

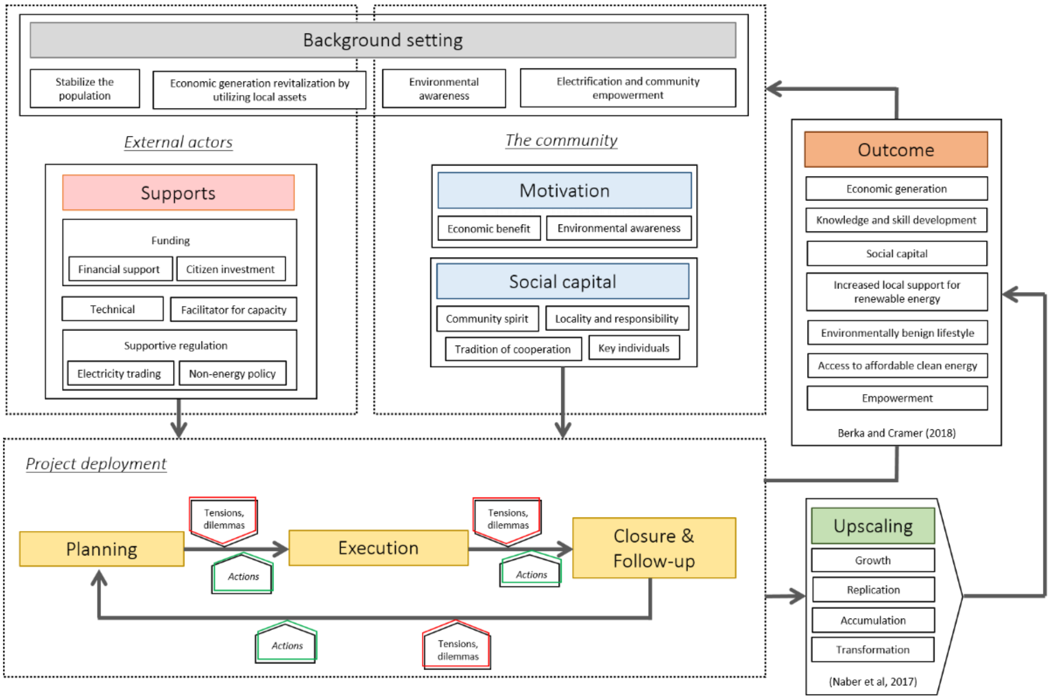

Figure 1. Diagram of the driving factors and the process towards upscaling

4. Conclusion

This research reviewed nine case studies of community energy in seven different countries to identify the driving factors and its continuation in upscaling stage. We found five driving factors of a project to proceed well, which are background settings, a community's motivations, the social capital of the community, support from external stakeholders, and project outcome.

The most dominant reason for project development is economic generation and revitalisation by utilising local assets. All the cases located in rural areas are facing similar issues of lack of employment opportunities and the decline of local businesses. From the community's side, the economic benefit appears to be the most common reason to join the projects. The benefits include job creation, generating local business enterprises, or saving the expense of electricity on the household level. This result indicates that the project should be economically feasible to attract citizens to join. Internal social capital is an imperative factor to create collective actions and drive collaboration. The social characteristics are community spirit, the tradition of cooperation, locality and responsibility, and key individuals. While the main "driver" of the community energy projects are local people, the numbers of external actors may engage in the projects. While the main "driver" of the community energy projects are local people, external actors engage, such as the government, NGO, and private sectors. They provide various types of support, such as financial and technical support, supportive regulation, and facilitation of capacity building. As the project runs, the locals experience the impacts. All cases showed impacts in an economic generation, knowledge development, an increase of community engagement, and support for RE.

Tension and conflicts have existed in different stages of project development. The conflicts, along with the learning process, can lead to the upscaling. Support of external actors is essential to address the issue in technical and financial. In the upscaling process, the success factor shows continuity. We argue that the extension of networks, supports, and the partnership has enabled the projects for upscaling and running in the longer term.

We consider several limitations in our research. First, tensions and actions in table 7 were limited to the selected literature. We are almost certain that in the actual case, the tensions and dilemmas are plenty along with the project development and follow-up phase. Second, a more rigorous review is required to explore the state of upscaling in all cases. The cases which have not yet mentioned upscaling might, in the future, progress to scale up. Third, our research does not delve into the current energy characteristics and detailed energy policy in respected countries. We suggest future research to take both of those into account, to analyse how the positioning and priority of the RE project in each country.

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