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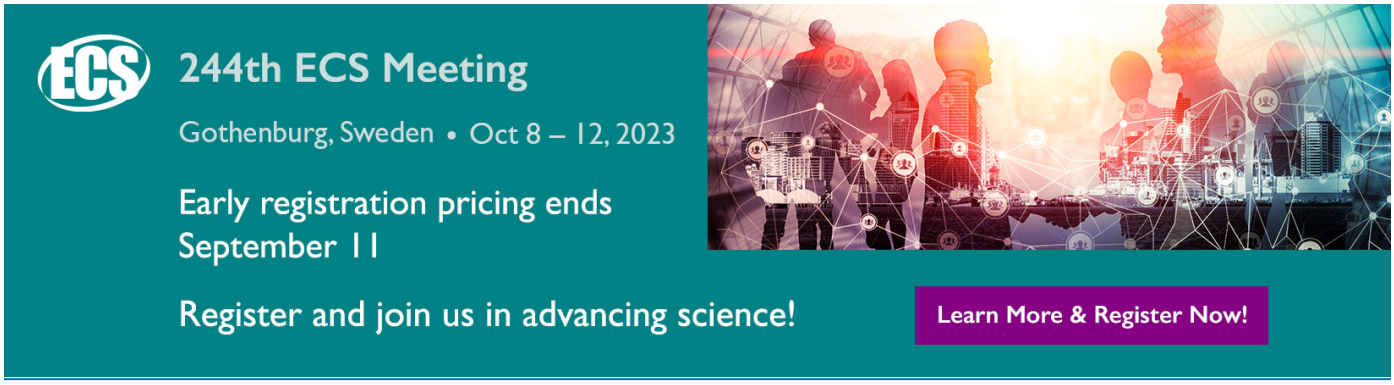

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Utilization of solar and wind energy to improve the quality of life for rural communities in Blora Regency – Indonesia: from triple helix to quadruple helix

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Abstract. Studies of triple helix field indicated that involvement of academician, business, government (ABG) were leading players in bringing up invention to be innovation. In the current decade, society actor served as the new actor added in the ABG-S frame concerning to the sustainability issue of innovation. This study aimed to present the role of the concerned actors in proposing an innovative product of a combined solar and wind energy generator installed in rural areas of Blora Regency. Blora was one of the regions in the Central Java Province that utilized electrical energy sourced from non-fossil. A Qualitative research method was utilized in this study to disclose the involvement of each actor in Blora's case. The study reported that ABG-S actors' involvement in implementing a combined solar and wind energy generator to the villages.

1. Introduction

Renewable energy (RE) becomes one of the most popular issues related to Sustainable Development Goals (SDGs) that has become buzzy words among many countries around the world, including Indonesia. RE has contributed to increasing the quality of life for local communities in ASEAN countries [1]. Through the state-owned electricity enterprise (PLN), the government of Indonesia optimizes RE sources such as solar, wind, geothermal, hydro, mini-hydro, biomass, bioenergy, sea tide, and wave. Even solar and wind energy are categorized as intermittent energy attracting attention for further distribution to numerous areas in Indonesia [2, 3, 4].

Commonly, each RE source in Indonesia is operated by one electricity system, rarely combining the two RE sources in one RE single-operated system of electricity. A combination of two RE sources in a single-operated system of electricity is navigated in villages located in Blora Regency, Central Java Province, Indonesia. Innovation is not all new things globally, but it will be considered an innovative thing in a new place though in previous place it has existed [5] or development of existing invention [6, 7, 8]. A combined solar and wind energy generator operated as a single system is a newness in Blora Regency, specifically. The existence of that electricity generator is not separated from the low electrification ratio in Blora Regency and limited access to electricity from PLN. Blora's electrification ratio in 2016 is 86,9 and the 5 lowest areas of 35 local governments in Central Java Province in the

electrification ratio rank [9]. Regarding this, involving the villages in Blora Regency lags behind compared to villages in other regions of Central Java Province.

Widening electrification to reach many areas will increase economic activity in those areas. It means that the quality of life (QoL) of people where they live will also increase due to increasing socio-economic activities [1]. QoL of villagers is influenced by geography aspect that influences on socio-economic activities where they are difficult to access public facilities provided by government and state entities [10,11]. To this study, innovation such as such as combined solar and wind energy generation becomes one of the breakthroughs to increase QoL in Blora's villages. Widely acknowledged that goal of innovation is economic-scaled prosperity [12, 13], and in the current decade, it has enriched the goals of innovation not limited to economic goals but also public goals [14].

As explained above, this notion leads to discussions regarding how the innovation of combined solar and wind energy generators can increase QoL for villagers in the Blora Regency. In a similar vein, innovation is produced by the interaction of many actors, which stemmed from suppliers of research and development (R&D) results and its users. Innovation is the result of close interaction among academicians, businesses, and governments (ABG). In this term, academicians play to supply R&D, business actors are the main users that bring downstream R&D activities to the market, and government agencies are facilitators and catalysts of activities that both actors do [15, 16]. Currently, the involvement of society or communities in innovation activities receives huge attention [14,15] emphasizing that innovation is not merely intended for business goals but also for public goals. Therefore, a broader concept of ABG-S with adding "S" as Society is a popular concept in recent academic debate [15,17,18].

Previous studies related to the RE sources field are relatively new and focused on a single analysis framework either on the triple helix [19,20,21] or quadruple helix [22,23]. In reality, the involvement of actors within one project to other projects is inseparable from previously existing activities and networks. It means that the triple helix and quadruple helix perspective is not a differentiated network model in practice. Currently, it is rarely found a perspective yet related to shifting from triple helix perspective to quadruple helix perspective in a study on the RE field. Scientifically, this study fills the gap concerning how the triple helix can shift to a quadruple helix in establishing, developing, and sustaining RE practice in a region. Literature review

1.1. Renewable energy

Energy demand is increasing incrementally along with population growth. Currently, our energy sources heavily rely on fossil and nuclear fuels, which are limited available [24]. Additionally, those energy sources are producing environmental problems, such as air pollution and the greenhouse gas effect [25]. Therefore, alternative renewable energy (RE) such as wind and solar energy are expected to supplement fossil fuel usage [26]. RE has arisen as the solution to the exhausting energy sources, ensuring sustainable sources and providing safe and clean energy [27]. Additionally, RE produces fewer adverse impacts. However, the diminishing adverse impact of RE application remains challenging. RE is highly assumed to be beneficial for the environment [28]. However, from a social and economic point of view, the RE implementation has made a minor social adverse impact [29].

The isolated and remote communities have often faced energy deficiency, mainly electricity [30]. RE implementation is depending on available sources [31]. There are three types of energy sources commonly available across geographic conditions: PV, hydropower, and wind. Instead of utilizing those energy sources, the local community in several villages or remote areas tends to utilize more accessible energy sources such as biogas that are mainly available in the agricultural village [32]. Implementation of RE combination requires different aspects. It involves technical, socio-economic, and policy aspects [33,34]. Commonly, RE implementation to one or more of those aspects is categorized as an innovation practice in many countries [3,22,35].

1.2. Quality of life in rural communities

There are numerous efforts aimed to improve rural communities. The efforts were however focused on the economic aspect. Then, the discussion is continuing that villagers' quality of life (QoL) is the ultimate goal of rural development 10). QoL research aims to measure how an individual explain their satisfaction toward their lives, evolving from the early concept of QoL in related to mental health, physical health,

social health, and functional health [36,37] to be a complex concept that involves material and immaterial, including aspects of economics, socio, health, environment, education, and others well-being and happiness indicators [38,39,40]. Even QoL measurement is based on personal subjectivity and objectivity [37,38], though perception of individual subjectivity is feasible rather than measurable entity [36,38]. However, there is no clear measurement and definition of QoL [378,3,41]. It can be measured as a personal or all entity of communities [41].

To understand villagers' QoL, scholars established an index that involves myriad aspects. For instance, Diener & Suh's work considers social, economic, and environmental establish the index [42]. Additionally, QoL comprises the geographical aspects. Distance between villagers to public service able to influence villagers' QoL [11]. Currently, there are many rural areas that have not received proper electrification due to various reasons, such as remoteness. Improving rural electrification is significantly contributes to better QoL [1], especially QoL to this study is limited to socio and economic aspects. Based on [36,37,38]. This study focuses on how to measure the QoL increase of rural communities, especially on socio and economic aspects based on villagers' perception (insider objectivity) and outsider objectivity.

1.3. Triple helix and quadruple Helix

Innovation is commonly defined as a newness yielded from research and development (R&D) activities conducted by R&D institutions or universities [13,43], a new development from existing invention to be an innovation [6,7], and the result of diffusion on new products from one place to another place [5] by involving a variety of actors with their specific interests [8,44,45]. The triple helix refers to a concept that involves three inter-connected actors to realize an innovation or support practice of a knowledge-based economy. Higher education, enterprise, and the state represent academician (A), business (B), and government (G) respectively [15,16,46,47]. The university's involvement as an academician plays a role as a science producer, business plays a role as science users, and government plays the role as an initiator and a facilitator and is interconnected with each other by an institutional arrangement [16]. The triple helix pays attention to close relation among ABG as key actors leading to support economic-based knowledge as an innovation driver [15].

The theory evolution of triple helix to be quadruple helix is marked by adding public actors such as media, local communities, and civil society as the main part of the triple helix's actors (ABG). The quadruple helix requires public knowledge such as including society and democracy knowledge. In that sense, innovation in this concept is driven by the knowledge economy and knowledge society simultaneously [15,47]. The positioning of three actors of ABG and society (S) is not a partial scheme. In this regard, the quadruple helix comprises three triple helices in the frame of public-based, media-based, and/or culture-based consideration (ABG-S). Knowledge and innovation conducted by ABG actors are also supported by communication strategies (actors-S), for instance, by mass media or local community values [47].

The knowledge society is essential to make sustainable development of the knowledge economy, in this case for producing innovation from universities or R&D units [15]. Collaboration of social actors will contribute to many goals, such as establishing the determined standard among actors and creating and developing an innovation system [48]. The involvement of social actors or communities is required in the current era. The increasingly dynamic environment and complex political process have provided a larger opportunity to be involved in the decision-making process, not only by state [49,50]. The involvement of local communities in managing renewable energy sources is the critical factor. Therefore, the quadruple helix is feasible to this study to portray sustainable-renewable energy development that adds the role of society or local community in supporting programs of academician, business, and government.

2. Research method

This research is regarded as a qualitative study with the case study aimed to portray a whole phenomenon currently in discussion progress suffering from dynamic issue shifting. Collected data were arranged into a sequence story. Additionally, a triangulation process was employed by interpreting the data and its pattern to navigate the reason behind those findings, along with answering the research questions.

The research variables cover the innovation process, actors of innovation, linkages among actors, and impacts.

Table 1. Research Framework: Identifying Role of Actors in Triple Helix and Quadruple Helix

Actor	Agencies/Affiliation	Role
Academician (A)	R&D Institutes/ universities/ high or vocational schools	Supplier of science & technology (S&T) through research and development (R&D) activities and/or development of the current invention
Business (B)	Firms/manufacturers/enterprises, services business units	Developer and users of R&D results and/or development of existing invention; the taker a risk of doing innovation activities
Government (G)	Central government (ministries & non-ministry agencies) and local government (province & municipality/regency)	Deregulator, facilitator, catalyst, disseminator, donor, an innovation climate creation protector
Society (S)	Social Media, Local Communities, & non-government organizations	Users of R&D results and/or existing invention; mutual partners in innovation diffusion; proponents of doing innovation activities
Triple helix: A, B and G. Quadruple helix: A, B, G and S		

The research was conducted in the three villages of Blora Regency – Central Java Province, including: Tutup, Kedungringin, and Sukorejo Village as pilot villages for green villages in Blora Regency. This research was conducted in a field survey on August 2020. Primary data collection was conducted in two ways, namely depth interview and documentation. The interview was conducted with 11 key informants ranging from academicians, entrepreneurs, local government, and villagers. Most of the interview activities are recorded and transcripted, and part of the rest is noted on the brief field note containing the date and time duration of the interview, name of informants, place where the interview was conducted, and substance of interview with informants.

Secondary data are also utilized in this study to reinforce primary data findings from several journals, proceedings, books, governmental documents such as Blora's report, and electricity planning related to renewable energy, sustainable development goals (SDGs), rural or local communities, triple helix, quadruple helix, and information regarding Blora Regency. The analysis technique of this research is a case study through reducing field results and then providing the data finding [51] into a period of sequential stories by which innovation emergence can be traced by historical events [52]. Finally, the data accuracy is triangulated through an online interview with Mr. N (an entrepreneur of the Omset-Pintar as well as a teacher at SMKN 1 Blora) and an office staff at Bappeda-Blora. Again, tracing literature review is conducted as a part of another triangulation method. Triangulation is important to minimize analysis misinterpretation of qualitative researchers. The role of each actor represents their affiliations or agencies. Therefore, each agency has an interest that must be accommodated and facilitated in that mutual interlinkage of various actors ranging from academician (A), business (B), government (G), and society (S). This study uses the identifying role of A, B, G, & S actors as a research framework adopted from the general conceptual framework of triple helix and quadruple helix.

3. Result and discussion

3.1. General description of a combined solar and wind energy generator

The idea of the combined solar and wind energy generator is coined by Mr. N, a teacher in the automotive field at the state-owned vocational high School of 1 Blora (SMKN 1 Blora). This energy generator consists of solar and wind energy integrated with a one-single operation system of electricity. There are three main components on this generator, in the top position, in the middle position, and in the below position. In the top position is the wind energy generator, three are propellers functioning to get electrical energy source from the movement of wind around the area where this generator is installed. In the middle position is the solar energy generator, there are 10-20 solar panels functioning to get electrical energy source from sunlight around the area where this generator is installed. In the below position, there are batteries and an electrical panel functioning to save energy from wind propellers and solar panels. Three parts are mutually complemented to yield electricity energy from two sources, the rotation of wind and sun light around its area. Both energy sources get electricity on the noon optimally, then saves it to batteries, and uses it on the night. Especially wind generators, it will be working along day (noon and night) depended on availability of wind speed and its direction. Importantly, all

components and technologies are easily found in the market, affordable cost for end users, and simply used. The total electricity capacity of the generator is 2400-3600 watts/hour at maximum, depending on the strength of wind and level of sun exposure every day. Due to the small wind whirling in the Blora Regency area, wind energy generators produce 70 to 60% less energy than solar energy generators. For maintaining them, the generators will be checked on batteries and other components as well as added machine oil every month. They automatically operate every day without assistance of the people.

3.2. Role of actors in creating and developing a combined solar and wind energy generator

In 2018, the prototype was proposed to the central government agency through the special program of mentoring for a start-up company (named as PPBT) funded by the Ministry of Research and Technology (Kemenristek). They successfully got Kemenristek's funding assistance for two years sequentially (2018-2019) to develop their prototype to be a marketable product (2018 year for ten products and 2019 year for 16 products), to protect the intellectual property rights (license, patents, product register) and to establish a start-up business unit. The activity of mentoring on start-up business unit also involves academicians of the PGRI University-Semarang located in Semarang City, the capital city of Central Java Province. Through Kemenristek's funding, academicians of the University of PGRI-Semarang in collaboration with Mr. N and his students (the initiator team) by establishing a mini-manufacturing workshop firstly in the Mr. N residence back yard. Beginning from this workshop, the start-up business unit called as Omah-Setrum-Pintar (Omset-Pintar), owned and managed by Mr. N, has been firstly established and operated since semester-I 2018 until now.

The Omset-Pintar and the initiator team purchase the main components and existing simple technology from Semarang City, further manufacturing them to combine RE generators. The assistance from the university is less related to R&D activities and more to start-up business management. The first project of the Omset-Pintar was located in Kedungringin village at the end of 2018 (Semester II-2018), and then it was also installed in Sukorejo village and Tutup village in the early-middle 2019 (Semester I-2019). In this phase, role of Blora's local government agencies (represented by the Bappeda-Blora, the society empowerment agency of Blora, and village government) is to disseminate the combined solar and wind energy generators produced by the Omset-Pintar. Although the funding support of the local government of Blora is relatively limited to be disseminated, the enthusiasm of local villagers supported by a head of village government is very good to receive this energy generator. For example, in Kedungringin village, the head of the village asked the owner of Omset-Pintar to build the second energy generator in 2019 to lighten main village roads that have not got the electricity supply of PLN, after the first project was successfully received by villagers in 2018. The funding source to buy those generators and their maintenance is allocated from the village budget and dues of local communities of this village. Even as end-users of this energy generator, they are not reluctant to spend their money to buy new lamps, machinery oil, cable, and other expenses related to maintaining those generators (individual and crowded funding).

The involvement of the local youth community at each village (named as Karang-Taruna) included the weekly checking and monthly report, besides operating and maintaining it. The Omset-Pintar team teaches Karang-Taruna to operate and to maintain the generator(s) before it works automatically. Manual guidance for operating and maintaining this generator is simple, not consuming much time due to appropriate technology in accordance with local needs and resources. This practice is further followed by other villages in Sukorejo and Tutup village as alternative energy to lighten main village roads. Due to affordable cost to maintain those generators, one village in Blora regency uses local communities' dues only, without village budget allocation to buy this generator. In turn, the good support of local communities to this generator invites more attention from other local governments in the Central Java and East Java Province and attracts new buyers from outside areas of Blora.

3.3. Benefits of combined solar and wind energy generator for rural communities living

The quality of life of rural communities is considered as an index comprising sevral aspects such as such as economics, social, and policy that have been surveyed previously. This study focuses on a social and economic aspect to capture the increase of quality of life in rural communities in Blora. Notwithstanding, social aspect will contribute to the economic movement of local people [1,10, 42]. Case of a combined

solar and wind energy generator, with a maximum capacity of 2400-3600 watt/hour of each generator, at this moment, it is only used to turn on 18-20 lamps with the capacity of each lamp 10-15 watts/hour. The most common use of this energy is to lighten main roads connecting from one village to other villages due to there is no electricity grid provided by the PLN. Lamps are installed along the road to ease the movement of local communities at night because people often do activities in the early night, middle night till approaching the down. Thus, this installation provides benefits for those who do activities by walking or cycling either individually or communally in light road conditions.

In the case of the first project in Kedungringin village installed at the end of 2018, villagers feel the benefit in early 2019. Since lamps are installed along those roads, mobilization and activities of local communities have been intense. Education such as teaching, health promotion, socialization of government programs, social and cultural meeting, and economic activities are conducted at day and night. Before lamps are installed, they are afraid and not confident to go out at night. Otherwise, currently, they are confident and not scared to go out every night, both individually or communally. These benefits spread out to neighboring villages such as Tutup and Sukorejo, positively impacting to increase in villager's QoL.

For two examples, in social and cultural meetings, before lamps are installed along the village roads, the meeting is often over in the afternoon due to people are afraid of the dark condition in the road. Otherwise, after lamps are installed, the meeting is often held in the night, starting from 07.00 pm or after Isya' pray time for Muslim communities until middle night. They do not worry regarding walking individually, not only communally such as before lamps are installed. Another example in economic activities is that before lamps are installed around the road, those have a profession as a mobile vegetable seller or as a trader in the market. They start activities ranging 04.30-05.00 am from their houses to the traditional market. After lamps are installed, they start activities ranging 02.00-05.00 am from their houses to the traditional market every day. It means that they have more time to do economic activities in the market and other places

3.4. Sustaining renewable energy generators: Between the triple helix and quadruple helix

Basically, innovation can occur without society, ABG actors are enough prerequisite to creating innovation, but the complex and dynamic social life in this 21st century has led to the importance of society being closely engaged in an innovation process, particularly in a society that are end-users of innovative products. The shift of triple helix to quadruple helix is located on how society is involved in an innovation process, not exclusively on ABG actors. Following the movement of triple helix to quadruple helix, there are two phases proposed in this study. The first phase is the ABG relation, and then to the following phase is the ABG-Society (ABGS) relation. The first one can be classified into five periods of time sequentially, 2015, 2016, 2017, semester-I 2018, and Semester-II 2018. And the second one is divided into three time periods, namely semester I-2019, semester II-2019, and semester-III 2019 up to 2020.

The first phase refers to the early period by which a combined solar and wind energy generator was firstly created as newness in Blora Regency (Figure 1). The emergence of this generator as an innovative product was triggered by the initiator team (A) and Toyota corporation (B) as the first-funding assistance (2015). Then, it is accelerated by the local government of Blora (Bappeda-Blora) (G) and the provincial government of Central Java (Bappeda-Jateng) (G) by inviting the initiator team to join in the Krenova competition at both regency and provincial level (2016 & 2017). The initiator team (A) was inter-linked to government agencies because both actors have a mutual interest to be achieved through this program. On the one hand, the initiator team wants to introduce and develop their products to the public and business actors. On the other hand, the local government has the interest to show up and proving of government's performance to the public (responsibility) and to hierarchically higher structure government (accountability). and the successful policy of the local government to implement renewable energy depended on cooperation among stakeholders and actors of business and academician. Though, during two years, there is no business actor that facilitates the initiator team to develop this combined RE generator.

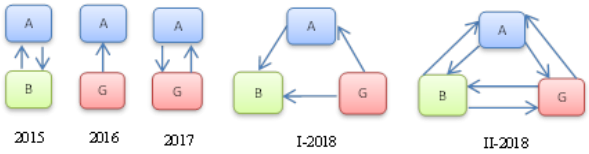

Figure 1. Phase I – From Ideas to Innovation: ABG Actors (Triple Helix)
Source: Author's analysis

In 2018, involvement of government level (G) was appearing because there were a number of acknowledgments to the initiator team (A) in the local competitions previously. This project was granted a large funding assistance from the central government (Kemenristek), including to develop products and to assist for start-up business management (B) involving university (A) as their working partner. In semester-I 2018, Kemenristek fully funded, promoted, and facilitated the initiator team to actualize their products to be used by end-users. Therefore, the emergence of business actors was the key element in this period. The government was aware that the initiator team could not work by themselves without no business unit to bring their works to market. The establishment of a start-up business unit was closely interlinked to the initiator team because they have accumulated knowledge resources, experience, supporting tools/machines, and mini-laboratorium related to the RE system. Thereof the name of this start-up business unit is the Omset-Pintar led by Mr. N, a teacher at SMKN-1 Blora.

In the Semester-II 2018, the Omset-Pintar (B) had been operated to produce combined RE generators at the first time, assisted by the PGRI University -Semarang (A) and the inventor team (A). While the full support and facilitation of Kemenristek (G) were still continuing in this period, the two were mutually interconnected. In addition, feedback was also provided in relation to developing a combined RE generator prototype to be marketable products. As a result of this network formation, there are the 10 RE generator units produced that are ready to be installed in many sites, including in villages around Blora.

In the first phase by which a triple helix network was formed, the inventor team (A) and Toyota corporation (B) were the focal actors playing a role to create a new idea for the prototype (invention) (2015). In the next year, the local government of Blora (G) was the focal actor playing a role to push invention to be massively and legally acknowledged to the public and to the provincial government of Central Java (2016). The inventor team (A) and the provincial government of Central Java (G) were simultaneous actors playing the role to introduce and bringing the invention to national government level (2017). At the central government level, Kemenristek (G) was the focal actor playing the role of developing an invention to be an innovation by establishing the Omset-Pintar (B) and involving PGRI University-Semarang and the initiator team (A) in the same time period (I-2018). And the last, the initiator team and the University of PGRI-Semarang (A), Kemenristek (G), and the Omset Pintar (B) were simultaneous actors playing a role to create innovation (II-2018). In the last network, the combined RE energy generators were ready to be commercialized to market

In the second phase by which a quadruple helix network was formed, the combined RE energy generator was widely disseminated to the public, not only in one place (Figure 2). Referring to Rogers [5], innovation is not only a newness firstly created in the world, but it is a newness in a place/an area though it was not a newness in previous places/areas. Based on this definition, it is hence important to disseminate the existing products to other places as new/innovative products. In this case, the initiator team and the University of PGRI-Semarang (A), the Omset-Pintar (B), and local government agencies of Blora, including village governments in three villages (G), are the simultaneous actors to disseminate this product to villagers as end-users (S) around Blora. ABG actors included the focal actors playing roles actively as disseminators, while the actor of S is the beneficiaries passively (I-2019).

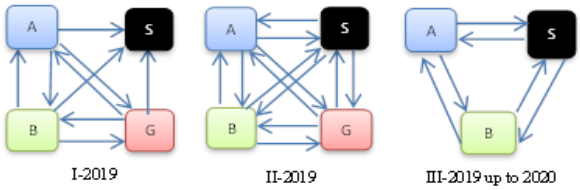

Figure 2. Phase II – From Disseminating to Sustaining an Innovation: ABGS Actors (Quadruple Helix) and ABS actors
Source: Author's analysis

The dissemination process was positively received by villagers (S) as the beneficiaries. This process had led to a new interaction among actors of the initiator team and the University of PGRI-Semarang (A), the Omset-Pintar (B), local government agencies of Blora (G), and the villagers (S). They interacted with each other to get input from each actor and then to respond to it in a revised way to fulfill each actor's needs. In this period, A, B, G, and S are the simultaneous actors actively playing roles in implementing the energy generators to the practice. It means that innovation can occur in the frame of the ABGS concept (quadruple helix) (II-2019).

The interlinkage of quadruple helix in implementing combined RE generators generated the expected result, due to the affordable maintenance cost, simple technology, and appropriate function; thus, the involvement of government actors (G) in this period had been reduced because three actors (A, B, S) could independently operate and maintain those RE generators. The active role of government was absent in this period, but it did not mean that the government did not do anything, but its role appeared as the provider of "land" by which an innovation grew in that area. The active role of the three actors was the proof that an innovative product that had been well disseminated will sustain over time without direct intervention of the government. It is interesting to this study that actors of A, B, S are the simultaneous actors playing an active role to sustain innovation in a particular area (III-2019 up to 2020).

4. Conclusion

The combined solar and wind energy generators in Blora Regency are established and developed by three actors in the frame of the triple helix (academician/A, business/B, and government/G). The first idea of a combined RE generator was coined by the initiator team (A). Though there is support of Toyota corporation's funding, the making of a prototype RE generator was limited. The existence of the Local Government of Blora, the Local Government of Central Java Province, and the Ministry of Research and Technology (G) play the main role in actualizing the prototype products yielded by the initiator team (A) to be the marketable products. The formation of the Omset-Pintar (B) as a start-up business unit facilitated by the Ministry (G), and support of the University of PGRI-Semarang (A) in collaboration with the Omset-Pintar (B) and the initiator team (A) play a key role to bring an invention to innovation. It means that two actors of A&B are embedded in one person. The close geography residence of the single A&B actor has positively impacted to reach of the specific market in Blora Regency.

The benefits received by rural communities from the combined RE generator appear while the first generator installed in Kedungringinn village at the end of 2018 has been successfully provided a better quality change for villagers' daily lives, thereby increasing the demands to buy and install those generators in other villages, including Tutup and Sukorejo, and the second generator in Kedungringin village. Actors involving in sustaining the combined RE generator are in the frame of quadruple helix (academician/A, business/B, government/G, and society/S), particularly in the early dissemination and socialization stage. In the next stage, the A&B actors are able to influence the perception of society (actor-S) to be involved in maintaining those generators. The A&B actor proves to the rural communities that those generators created are affordable cost, simple technology, and easy tool to be used for villagers. As a result, rural communities (S) as the beneficiaries are not reluctant to operate and to maintain the generators. Hence, identifying the interaction among RE actors is essential to spur RE development and to sustain the benefits. Villages in Blora Regency become pilot projects in utilizing combined solar and wind energy generators integrated into a single-operated system of electricity. The

combined RE generators are yielded from creative process of existing invention and its diffusion to other places dominantly conducted by the initiator team, not by universities or R&D institutes or universities. The role of university is as a mentor to develop start-up business management.

This case reveals that the academicians dominate the process of establishing, developing, creating, and disseminating innovative products to the end-users. While, business actor partially contributes to realizing invention to be innovation, as well as to sustain it. However, Government is the key actor to facilitate all processes that academicians and businesses conduct. In other words, ABG actors are in the initial phase by which an innovative product enables to be established and developed. This case also describes that involvement and participation of society (S) as an inseparable part of ABG actors are encouraged by their daily needs on electricity, not by the needs of "cutting-edge technology". Making an appropriate, feasible, and an affordable technology of this combined RE generator has thus provided the answer towards the existence of this proposed generator, despite suspension of governmental funding assistance has been stopped. In sum, within the sustaining phase, actors of "A&B with S" are regarded eligible to maintain the innovative products and to expand the products to new areas.

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