

Article

Distributed Power Sources to Improve the Decent Living Standard (DLS) in the Ethnic Minority Areas of Myanmar

Masako Numata ^{1,*} , Masahiro Sugiyama ¹  and Gento Mogi ²

¹ Institute for Future Initiatives, The University of Tokyo, Tokyo 113-0033, Japan; masahiro_sugiyama@alum.mit.edu

² Department of Technology Management for Innovation (TMI), School of Engineering, The University of Tokyo, Tokyo 113-8656, Japan; mogi@tmi.t.u-tokyo.ac.jp

* Correspondence: m.matsuo-numata@05.alumni.u-tokyo.ac.jp

Abstract: Myanmar has been suffering from ethnic conflicts for approximately 70 years. The instability remains ongoing, and villagers in ceasefire areas are vulnerable. To ensure that no one is left behind, sustainable development in these areas should consider local needs. The objective of this study was to identify the living conditions required by local villagers such that they do not exacerbate conflicts. We interviewed stakeholders related to the peace process and rural electrification in Myanmar to identify the needs in conflict-affected areas. Needs were identified using the decent living standard (DLS) as the main analytical framework and energy justice as a complementary framework. The results show a strong local need for mobile phones and the importance of access to information provided by mobile phones and other dimensions of DLS, such as education and health care. For electrification options, off-grid solar products were found to be less likely to exacerbate conflicts compared to large-scale power plants. Historically, the latter has caused many issues related to energy justice.

Keywords: distributed power source; decent living standard; energy justice; interview survey; Myanmar



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1. Introduction

Myanmar has a 70-year history of ethnic conflict which remains unresolved. The seeds of this conflict date back to the British colonial period prior to World War II. Conflicts are becoming more complex and protracted due to the high ethnic diversity of the country (there are 135 ethnic groups in Myanmar) [1,2], the historical context, and the intentions of neighboring countries. (Rohingya are not included in the list of 135 ethnic groups recognized by the government. The discussion of the Rohingya is extensive and complex and will not be dealt with in this paper). The uneven distribution of rich natural resources, such as teak, jade, and hydropower, to areas inhabited by ethnic minorities has further contributed to the conflict. The number of battles has not decreased despite the signing of the Nationwide Ceasefire Agreement (NCA) with 10 ethnic armed organizations (EAOs). This represents approximately half of the total EAOs as of 2018 [3]. Regardless of these initiatives, the socio-political situation continues to be very volatile.

The central pledge of the 2030 Agenda for Sustainable Development is “no-one left behind” [4]. This statement underlines that it is important not to leave a conflict-affected area unsupported in terms of development. In terms of international development indicators, Myanmar is rated 0.584 in the Human Development Index (HDI). This means it is ranked 145th in the world, and in the Association of Southeast Asian Nations (ASEAN) it ranks second lowest after Cambodia [5]. In Myanmar, there is a large disparity between urban and rural areas, where poverty is more acute in the latter. The number of people below the national poverty line is 11% in urban areas and as high as 30% in rural areas [6]. On average, conflict-affected areas are more underdeveloped. As many as 330 townships have been affected by the conflict; this constitutes approximately one-third of the total

number of townships in Myanmar [7]. According to the Township Development Index (TDI), on average, areas experiencing conflict have a lower score than non-conflict areas across various dimensions, including health, education, lighting, and living standards [7]. Conflict-affected areas do not suffer from a shortage in only one dimension. However, these areas are less developed than non-conflict areas in many dimensions, as the TDI has shown from various data. Because it is impossible to provide adequate support across all community needs, appropriate support should be provided to the dimensions required by locals.

Additionally, aid projects must be conflict-sensitive. Burke et al. [7] explained the importance of this sensitivity and concluded that interventions improving the living standards of local villagers were particularly useful and smaller community-driven projects were less controversial. However, the Myanmar Government is attempting to implement with large-scale projects, stating that economic development through large-scale development may lead to peace [8]. It is very difficult to simultaneously pursue economic growth and peace. Studies have highlighted that large-scale development projects may exacerbate conflicts. The worst example of this is large-scale dams [7]. The impact of economic development on conflict may be positive or negative [9]. This study discusses the specific areas of projects that may contribute to the development of the region without exacerbating conflict.

This study primarily focuses on the Kayin State in southeast Myanmar. The part of Kayin state is mainly controlled by the Karen National Union (KNU), the most influential organization among signatory EAOs. Southeast Myanmar had many internally displaced persons (IDPs) at the center of the battle [7] in the mid 2000s. However, the center of the battle moved to the north in the 2010s and in recent years it has shifted to the west [10]. Sporadic battles continue to occur in Kayin State [11,12], despite signing of the NCA. As such, it is difficult to consider Kayin State as a post-conflict area [13]. Currently, foreigners are allowed to stay in the state capital, Hpa-an, in a government-controlled area without receiving prior permission. However, villagers in conflict-affected areas remain extremely vulnerable.

In this context, we consider Kayin State to be a suitable case study to address the objective of this study. Previous research has identified several needs in health, education, livelihood, and food in the area [14]. These dimensions have attracted attention as the focus of aid projects and research topics in conflict-affected areas [2,13]. Although these needs are clearly important, other dimensions should be considered depending on the local needs. Using the decent living standard (DLS) [15] as a framework for analysis, we conducted open and semi-structured interviews with 43 stakeholders to clarify the dimensions considered important for regional development, the advantages, and the issues experienced by existing projects. Based on these interviews, 17 semi-structured interviews were coded and analyzed. These interviews highlighted a considerable local need for mobile phones as a means of information and communication, along with improved health care and education. The use of mobile phones requires telecom infrastructure and electricity.

In Myanmar, 13.5% of households do not have access to electricity. The proportion rises to 30% when including those who have electricity access, yet cannot charge their mobile phone [16]. In Kayin State, 20% of households source their lighting from kerosene and candles; this is much higher than the national average of 9.3% for rural areas. Their 16% candle rate is the largest of all states or regions, and is very high compared to the national average of 7% [17].

For these households, consideration should be given to lower-tier electrification with off-grid solar products. Within the Myanmar Government, grid extension is the responsibility of the Ministry of Electricity and Energy. However, off-grid electrification programs of the National Electrification Plan funded by the World Bank are implemented by the Department of Rural Development (DRD) of the Ministry of Agriculture, Livestock, and Irrigation [18]. The subsidized off-grid electrification projects by DRD target areas where the national grid will not be extended within the next 10 years [19]. There is no

consideration as to whether an area is conflict-affected or not. Few projects have supported energy access in conflict-affected areas, particularly EAO-controlled areas. Additionally, only one project to install solar home systems (SHSs) (a set of solar panel and batteries) has been funded by the international Non-Governmental Organization (NGO) [20].

Distributed power sources have recently attracted considerable attention for accelerating the achievement of the Sustainable Development Goals (SDGs) centered around Goal 7: “ensure access to affordable, reliable, sustainable and modern energy for all” [21]. In addition to the effect of distributed power sources on energy access, previous studies have discussed the co-benefits of distributed power. Case studies in rural Thailand have shown that the benefits of community-scale energy transition extended to citizen empowerment [22]. In the case of rural Kenya, a study analyzed different types of electricity access showing that people preferred solar and decentralized supply to help empower women [23].

However, previous analysis of off-grid distributed power sources in the energy sector in Myanmar has been dominated by technical or economic cost evaluations. As such, the focus has been on costs and there has been a lack of social analysis, as identified in other countries [24], particularly from the perspective of impact on conflict. There have also been analyses of the injustice caused by large hydropower dams. However, the benefits of electricity have barely received a mention, and the distributed power sources have been out of scope. A previous study [25] stated that the provision of energy to rural communities enables services such as health care, education, clean water, and sanitation that overlap with the dimensions in DLS. This study demonstrates that distributed power sources may improve DLS dimensions without exacerbating tensions and injustice in conflict-affected areas. In addition to the DLS scale, which was used in the first half of the analysis, the framework of energy justice [26] was used as a complementary framework.

In the following, the analytical framework is explained in Section 2, which includes the DLS and energy justice frameworks. Section 3 presents the coding of the interview data. This is followed by Section 4, which presents the analysis results from the interview data to illustrate the needs of ethnic minority communities. The results also compare the power sources for electrification contributing to information access. Information access is a less supported aspect among the dimensions that are in urgent need. Furthermore, the positive and negative aspects of the on and off-grid power sources are described. Finally, Section 5 presents the conclusions of the study.

2. Analytical Framework

2.1. Decent Living Standard (DLS)

DLS was used as the theoretical framework for our analysis; this standard defines a universal and essential material requirement [15]. The DLS is consistent with various streams of developmental indicators, such as the Human Development Index [5] and Multidimensional Poverty Index [27]. These indicators seek to define the standard of living conditions beyond the traditional dimensions of poverty such as nutrition, health care, and education. While these indicators focus on measuring outcomes as opposed to identifying the requirements for human well-being, DLS is an indicator of material requirements. Some dimensions are related to SDGs such as SDG 11: “sustainable cities and communities” [28], and the safe shelter of DLS. Moreover, DLS categorizes each dimension into household, community, and society [15,29,30], as shown in Table 1.

Table 1. DLS material requirements.

DLS Dimensions	DLS Scale		
	Household	Community	Society
Nutrition	Food Cold storage		
Safe shelter	Durable housing		
Space	Minimum floor space		
Thermal comfort	Fan		Electricity infrastructure
Lighting	Light		
Hygiene	Toilets Drinking water Sanitation		Water and sanitation infrastructure
Air quality	Clean cooking stove/fuels		
Clothing	Clothing materials	Washing machine	
Health care		Health care facilities	Minimum health expenditure per capita
Education		Primary and secondary schooling	Education expenditure
Information/Communication	Phone Access to media		ICT infrastructure
Mobility	Vehicle	Motorized transport	Road infrastructure Public transport infrastructure

Note: Prepared by the authors based on the literature [15,29,30].

Additionally, DLS aims to shape the energy and resource requirements for poverty eradication [15]. It has been used to estimate the minimum energy requirement to satisfy basic human needs in India, Brazil, and South Africa [30]. Energy is tied to many dimensions as a source [30], and electricity itself contributes to multiple dimensions, including lighting, thermal comfort, information, communication, health care, and nutrition (e.g., cold storage).

DLS is appropriate in the discussion of the development of conflict-affected areas, as it encompasses the different dimensions mentioned in interviews. DLS is also more relevant to the context of developing countries, as it narrowly focuses on the minimum material requirements.

2.2. Energy Justice

Electricity can contribute to many dimensions of the DLS. As DLS focuses only on material requirements, there has been no previous discussion on the supply of energy or electricity. However, ethical perspectives are essential when discussing ethnic minority areas in Myanmar. As such, this study used energy justice from an ethical perspective to complement the DLS analysis framework.

Energy justice is a widely used framework to study inequities in the energy sector [26,31]. Its core tenets are distributive justice, justice, and procedural justice. Distributive justice focuses on the perspective of whether benefits and burdens are distributed fairly; for example, whether resources and pollution are distributed fairly. Justice as recognition focuses on who is being excluded from the decision-making process. Procedural justice focuses on how decisions are made, the process for participating in the decision-making, and whether appropriate information and compensation is provided to the community. The energy justice framework may be summarized as availability, affordability, due process, transparency and accountability, sustainability, intra-generational equity, intergenerational equity, responsibility, resistance, and intersectionality [32].

Researchers have adopted an energy justice framework to analyze issues related to large-scale hydropower dams. This includes the decision-making processes associated with the construction of large dams in Cambodia, Malaysia, Ghana, and Nigeria [33], and IDPs caused by the construction of dams that violate procedural justice [34]. Myanmar possesses abundant hydropower resources [35], and relies on hydropower for 56% of its power generation [36]. Although not within the framework of energy justice, there has been some research on Chinese-led dams located in Myanmar, Laos, and Cambodia from a social justice perspective [37]. There has also been an analysis of dams in the global South, including Myanmar, from an environmental justice perspective where there is mention of the fact that dam construction may exacerbate tensions [34].

In Myanmar, 12 of 26 existing dams and 42 of 50 planned dams are located in an ethnic minority area [7]. Until recently, the villagers residing near the dam were not provided with electricity. In the history of the sub-national conflict in Myanmar, these dams symbolized the exploitation of resources from ethnic minority areas to urban areas, and became an example of the detriments of large-scale development [7]. These studies have discussed how large-scale hydropower may exacerbate tensions. However, small-scale power sources have been out of their scope. In addition, energy justice in Myanmar is detailed in the review of Sovacool (2013) [38] from an energy poverty perspective and an aspect of distributive justice. The challenges listed included poverty, lack of commitment to priorities, lack of funding, and policy fragmentation. Very few studies have considered ethnic minority issues in their analysis of energy poverty in Myanmar. The review by Sovacool [38] barely mentions this issue.

In terms of energy provision in ethnic minority areas, while the issue of dam development is at the fore, it is necessary to use an energy justice framework to address the issues and consider the opportunities from other power sources.

3. Methods

3.1. Interview Survey

We conducted an interview to identify the dimensions that are urgently required by local villagers without exacerbating the conflict. However, it was difficult to directly interview the villagers. Access to villagers requires prior permission from the Myanmar Government and the EAOs. There is no certainty as to how long it takes to obtain the necessary permissions, and ultimately these permissions may not be granted. Due to limited time available to conduct the survey, we collected a wide range of opinions from stakeholders on aspects considered important in the development of conflict-affected area. We also sought opinions on electrification and its means of supply (e.g., national grids, mini-grids, and SHSs), and examples of existing aid projects and the related problems. Stakeholders included NGOs that support Karen (Kayin) people as well as NGOs that collaborate with the Myanmar Government on the peace process. We interviewed village committee members in other ethnic minority villages that no longer experience conflicts with the government to understand their thoughts on peace and development in their area following conflict.

Interviews were conducted from September 2018 to March 2019, with stakeholders related to the peace process and rural electrification, in Yangon, Nay Pyi Taw, Kayin State, Kayah State, Shan State, Tokyo, and via Skype. Interviews were conducted in either English, Japanese, or Burmese, with a Burmese-Japanese translator. We primarily conducted semi-structured interviews; although this had to be modified due to the sensitive nature of interview content, as it included questions related to the peace process. As such, open interviews were conducted when it was considered more appropriate. Table 2 shows the number of interviews and the people met by the authors. The structured interview data used in the analysis were coded according to the attributes of the interviewees. This includes Myanmar government officials (GM-), Myanmar nationals belonging to an NGO (NGM-), foreign nationals belonging to an NGO (NGF-), international organizations (IO-), and researchers (AC-), as shown in Table 3.

Table 2. Interview details.

	Number of Interviews		Number of People Met
	Semi-Structured Interview	Open Interview	
Myanmar government officials	1	1	3
Foreign government officials		2	3
NGO (Myanmar nationals)	10	1	11
NGO (Foreign nationals)	3	9	18
International organization	1		1
Researcher	2		2
Village committee member		1	6
Total	17	13	43

Note: only semi-structure interviews were thematically coded.

Table 3. Interview ID of semi-structured interviews.

	Interview ID
Myanmar government officials	GM-1
NGO (Myanmar nationals)	NGM-1~10
NGO (Foreign nationals)	NGF-1~3
International organization	IO-1
Researcher	AC-1,2

GM-: Myanmar government officials, NGM-: Myanmar nationals belonging to an NGO, NGF-: foreign nationals belonging to an NGO, IO-: international organizations, AC-: researchers.

3.2. Coding Procedure

We constructed the coding framework in Table 4 by iteratively reading the interview transcripts.

First, to identify the dimensions required in conflict-affected areas, the transcript content was categorized based on each dimension and scale of the DLS. This was coded based on the way in which interviewees described their perspective.

Any dimension associated with the categories, “it is important,” “needed,” “useful,” “appreciated by the villagers” or “troubled by the lack of,” were coded as “positive and necessary”. If a dimension mentioned in reference to “negative,” or “many issues caused by”, then it was coded as “negative.” Attitudes such as “I’ve heard of it” or “there is a project” were coded as “other.” The codes were set up deductively based on a literature review, and then added inductively through an iterative process of reading transcripts. In counting the codes of the attitudes of respondents, “positive and necessary” or “negative”, were not mutually exclusive. Rather, they were included in both if the same interviewee mentioned both positive and negative aspects. However, “other” was only counted if there were no corresponding sentences in the same interview that was neither “positive and necessary” nor “negative.”

Second, scripts for the type of power source were coded. A power source was divided into either societal, community, or household scales based on its type. The national grid and large-scale power plants were considered at the society scale, the mini-grid was at the community scale, and off-grid solar products (e.g., solar lanterns and SHSs), were at the household scale. Then, depending on the content of the narrative and attitudes, perspectives on power sources were coded as “positive,” “negative”, or “other.” We simplified to “positive” as electricity is necessary as a starting point, and the primary focus is how to supply electricity. Negative views on energy justice were further coded. A qualitative

analysis of the script data obtained from the semi-structured interviews was conducted using the RQDA package in R.

Table 4. Coding framework.

Needs identified in conflict-affected area for development	DLS dimensions	Education Health care Information and communication Mobility Nutrition Safe shelter Hygiene and water Lighting Thermal comfort Air quality
	DLS scale	Household/Community/Society
	Viewpoint	Positive and necessary/Negative/Other
	Energy justice	Distributional justice/Procedural justice
Source of electricity	Scale	Household: off-grid solar products (solar lanterns, SHSs) Community: mini-grids Societal: national grid, large scale power plants
	Viewpoint	Positive/Negative/Other

4. Results

4.1. Needs Related to Each Dimension for Conflict-Affected Area

Aid projects tend to primarily focus on health care, education, and living standards that are identified by the Multidimensional Poverty Index (MPI) [14]. However, the interview results highlighted importance of access to information under the social aspect of the DLS. Figure 1 shows the proportion of interviewees who mentioned each dimension; if all interviewees mentioned the dimension, the ratio was 100%. A higher value represented a greater number of interviewees that had mentioned the dimension. Education information and communication, health care, and mobility dimensions had a high percentage of concern.

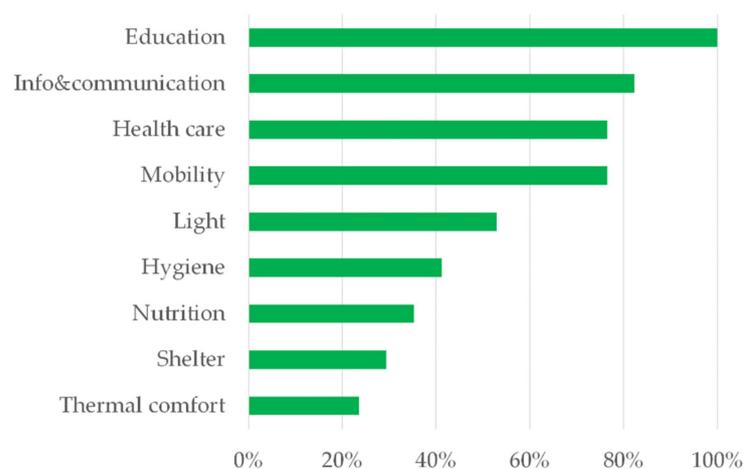


Figure 1. Level of attention associated with each dimension.

Figure 2 presents the views of each interviewee on each dimension classified by scale, and Table 5 presents a representative citation for each code. Education was often cited as important in the development of conflict-affected areas (e.g., AC-1, NGM-1, and NGF-2).

However, as one participant stated, “education can sometimes become more political” (IO-1), so there are many issues to be resolved, including curriculum and institutional aspects at the societal scale.

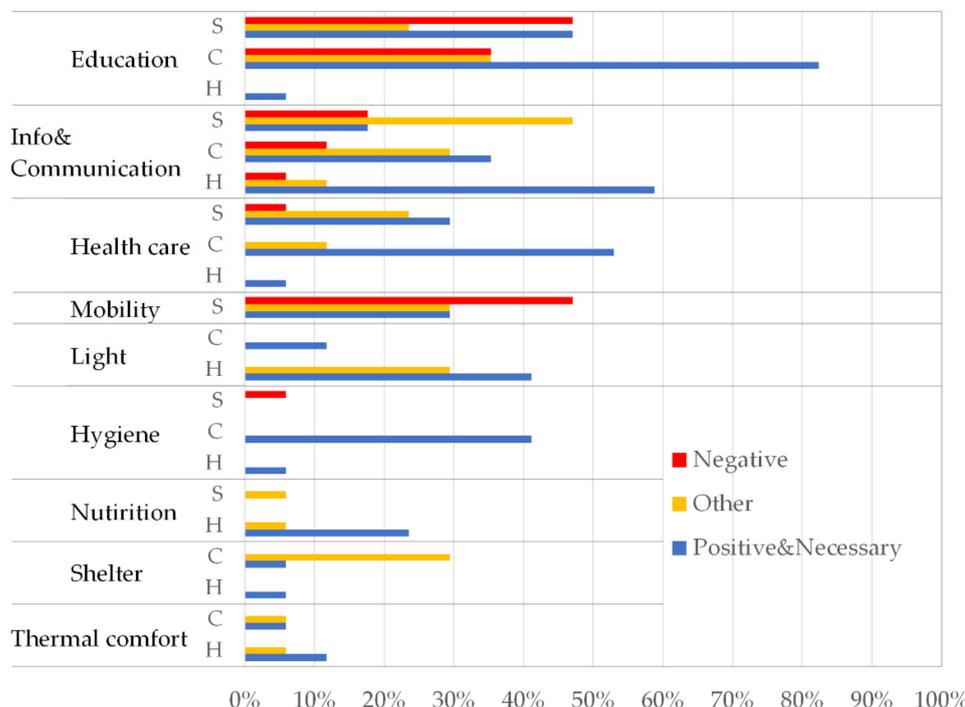


Figure 2. Viewpoints on each dimension at each scale. S: Societal scale; C: Community scale; H: Household scale.

Although primary education in the native minority language was legally recognized in 2015 [39], the level of native language education to be allowed in higher education is still being discussed. In addition, some EAOs have already established their own education systems that differ from those of the government. The connection between the two systems has not been coordinated and problems continue to accumulate (NGF-1). Given the different perceptions of history among ethnic groups, it is clear that there are many difficulties in designing history education curricula (IO-1). As such, it will take a considerable amount of time for the government system to reflect the realities of ethnic minorities (AC-1). Although Myanmar is an agricultural country, there is only one agricultural university in the entire country that is located near the capital. There are only agricultural colleges in ethnic minority areas (AC-2), and these institutions are unable to adequately reflect the circumstances in ethnic minority areas.

However, there are few issues when considering education on a community scale. In particular, the importance of laying eyes upon actual equipment was noted (NGM-1, NGM-8, and NGF-2), such as off-grid solar products, diesel generators, and engines. These engineering apparatuses may stimulate the intellectual curiosity of people, particularly the youth, and they may encourage people to participate in education such as vocational training. It would be possible to address the shortage of engineers in rural areas if people are connected to educational opportunities (NGM-8 and NGF-2). Therefore, the presence of electricity that is not limited to simply school lighting is expected to have positive effects on education.

The importance of information and communication, particularly mobile phones at the household scale, is rapidly increasing (e.g., NGM1, NGF2, and AC2). At present, there is a stronger need for mobile phones, where the usage is often longer than televisions (NGF-2). In Myanmar, mobile phone ownership was 93.4% in urban areas and 76.6% in rural areas in 2017 [17]. Even among the poor, 64.3% owned at least one mobile phone per

household [6], and in Kayin State, 83% of households own a mobile phone (76% of which were smartphones) [17].

Table 5. Example comments regarding the various DLS dimensions.

Code	Quotes	Source
Light/Household/ Positive and necessary	When I was in Grade 11, I used candles for exam for practicing rewarding and my hands burned	NGM-3
Education/Community/ Positive and necessary Mobility/ Society and community/ Positive and necessary	If there isn't the opportunity to go to school together or work together, people will deepen their prior beliefs about what other ethnicities are like. I think it's important for people to come and go. (original in Japanese) Issho no gakko ni kayou toka, issho ni hataraku toka, sou iu kikai ga naito, yokei ni minzoku kan no omoikomi mitaina, aitsura ha konnna yatsu da mitainano ga, dondon kajo ni narun desu ne. Yappari ikiki ha sugoku daiji dana to omoimasu ne.	NGF-2
Education/Community/ Positive and necessary	"Education," we're only thinking studying a subject. No, I'm not saying that. Educate whatever necessary to the people. Yes, that is education. I'm not saying, going to school—not that one, no. Education to understand those projects and all that—the vision or the objective.	NGM-1
Education/Community/ Positive and necessary	when we go for work at sites, some people there really interested like about solar systems. So, they tell us like, "So how could you do that?" They're very interested because it's new to them. Especially young people, the youth, they like to know what is very new to them but they have never seen.	NGM-4
Information and communication/ Household/ Positive and necessary	What I mean is this is technology. (snip) give awareness or what is the campaign? We don't need that. If you look many corners of the town, there's a lot of hand phone shop and also other small sub shop who repair it. If you look where wholesale market. I'm not talking about the small shops. I'm very surprised. A lot of accessory shops, wholesale, for the cover. This business is growing in line with that policy change. (snip) We have no figures but really a lot of people getting job.	NGM-10

Although some villages in Kayin State have not been included in the service area (NGM-5), it is anticipated that mobile networks will continue to grow in the future. The mobile telecommunications companies of Myanmar have been competing to expand their service areas and the population coverage rate, which is estimated to be approximately 70% [40]. The difference in mobile phone ownership between urban and rural areas was not due to differences in service areas. Rather, it is was due to differences in purchasing power [17]. The need for mobile phones is considered very strong, even among the poor in rural areas.

Electricity is essential for the use of mobile phones and telecommunication infrastructure. In rural areas, where only 22% of households have access to the national grid, 61% of rural households use off-grid power sources [16]. The most basic use of electricity is light, and interviewees also identified the need for light at the household and community scales. In Kayin State, one in five households used candles and kerosene for lighting; this is much higher than the national average of 9% for rural areas [17]. There was also the additional risk of fires caused by the use of candles (Table 5).

As it is not possible to charge a mobile phone with sources such as candles and kerosene, it is difficult to use a mobile phone daily despite mobile phone ownership in the village. Only 56% of respondents in rural Kayin State used their mobile phones within seven days [17]. This may be due to their ability to charge their phone and receive mobile

service. Even a minimum amount of electricity to charge mobile phones, supplied by small power sources, can dramatically improve access to communication.

Health care was often cited as necessary and important to the development of ethnic minority areas (e.g., GM-1 and AC-1). Moreover, it is less likely to be considered problematic as it is practical, less political, and has few factors that exacerbate conflicts. Vaccination programs in collaboration with the Ministry of Health of the Union Government and the Health Department of the EAO were among a few successful examples of collaborative efforts in ethnic minority communities (NGF-1, IO-1). Interview results identified that travel from a village to a clinic was difficult during the monsoon season (NGM-1, NGM-2). According to the results of a previous study, Kayin State, along with Chin, Shan, and Rakhine State, had poor access to public and private medical facilities [41]. This is despite the fact that 88% of the population in the entire country reside in the vicinity of public medical facilities (including facilities that can provide only basic medical services, and lack doctors or beds). However, another survey showed that 92% of residents received health care services from the KNU or the government [13]. Although there were differences in each survey, the results showed the same tendency as that of the existing surveys [41]. Conversely, the health care sector accounts for 16% of aid projects in Myanmar, this is the second largest following the energy sector [7]. In terms of the health care dimension, needs and attention are consistent with each other, and the situation is expected to improve. Currently, some clinics established by aid projects have been equipped with solar power to supply electricity for lighting and refrigerators for vaccine storage (NGF-2). This is one example of how small-scale electricity may also be used in the health care dimension.

Roads and public transportation were mentioned in the DLS as material requirements for mobility [15]. In the rural areas of Myanmar, roads are a practical means of transportation as public transportation such as railways are underdeveloped. Roads were not coded by scale as it was difficult to differentiate between the societal and community scales in the narrative. Roads were essential to access to schools, medical facilities, and economic activities, and the movement of people was undoubtedly important to the development of the region. Myanmar experiences a monsoon season; as such, some roads are only accessible to vehicles during the dry season, and only motorcycles are able to use these roads during monsoons. Some villages also become isolated due to flooded roads (NGM-3). As such, road construction is important to achieve a minimum standard of living. Unfortunately, road construction is an area that the EAO has been very wary of in the past. The extension of the Asian Highway between Thailand and Myanmar in 2015 led to fighting between EAOs and the Tatmadaw (the armed force of the government), causing as many as 1000 IDPs [11,12,42]. Fights erupted in 2018 due to the government road renovation project, which received opposition by the EAO [42]. Many interviewees pointed out that the construction of the road exacerbated the conflict, resulting in an increase in concern.

An example of a successful aid project is the provision of wells. In Myanmar, which experiences monsoon and dry seasons, water security is a very important and practical issue; as such, the percentage of interviewees who considered it negative was low. In the villages that were visited for fieldwork, water from wells in the village was transported to each house via water pipes. This means that wells in rural areas were defined at the community scale. Water wells have greatly improved under the United Nations Development Program (e.g., Community Development for Remote Township project [43]), and other projects (NGF-2, AC-2). AAs such, no interviewees identified water shortage as a pressing issue. This result is consistent with other research findings [17], which indicate that access to water has improved from 2015.

The interview data revealed that among the DLS dimensions, education, information and communication, health care, and mobility were the dimensions that received a prominent level of attention. Mobility was mentioned as necessary, although the construction of roads was likely to exacerbate conflicts. Mobile phones, the most important form of information access, has increased in popularity since market liberalization in 2013 [17]. Although importance of mobile phone access has increased, the need for assistance has not

been recognized. Whilst telecom infrastructure has been expanding according to market principles, electricity is essential for mobile phone use as a telecom infrastructure. The importance of electrification assistance may be reaffirmed in terms of universal access to information. In addition, even small-scale electricity can contribute to education and health care.

4.2. Comparison of the Means of Electrification

The possible means of promoting electrification in ethnic minority communities include the extension of the national grid, and the establishment of mini-grids and SHS. In conflict-affected areas, it is particularly important to avoid exacerbating existing conflicts. In the analysis of the interview data, the means of electrification were coded according to scale: solar lantern and SHS at the household scale, mini-grids at the community scale, and large power plants and the national grid at the societal scale. The percentage of codes mentioned by the interviewees is shown in Figure 3. A higher value signifies that the code was mentioned by a greater number of interviewees, and if all interviewees mentioned the code, the result was 100%.

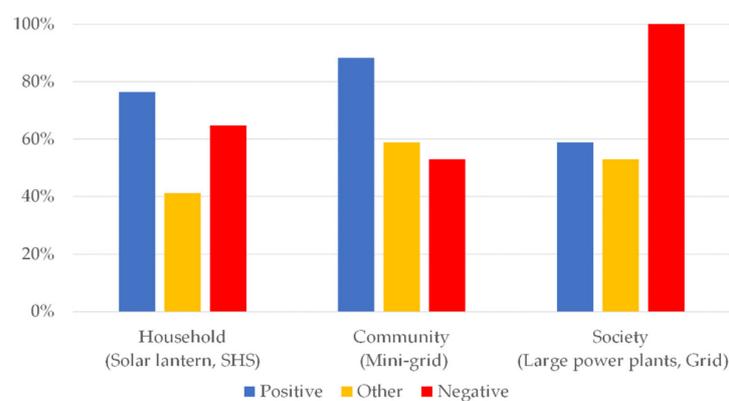


Figure 3. Interviewee perspectives of each power source.

Compared to the societal scale, distributed power sources of household and community scale were viewed positively and were considered less likely to exacerbate conflicts (AC-1, NGF-1, IO-1). With regard to the societal scale, the size of the available capacity and the low tariff of electricity were mentioned as positive (NGM-3, NGF-2).

The problems associated with each source of power supply are shown in Figure 4.

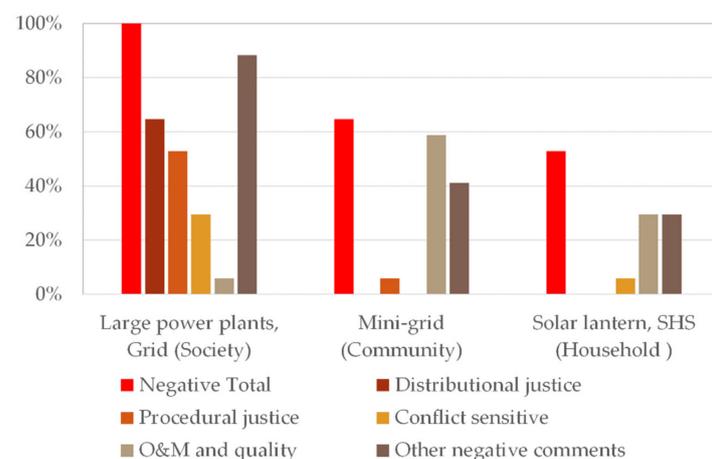


Figure 4. Breakdown of the negative viewpoints.

4.2.1. Energy Injustice at the Societal Scale of Electricity

In terms of the national grid and large-scale power plants at the societal scale, several issues were identified. This was despite large-scale power grids used for industrial purposes being considered necessary for development (NGM-2, NGM-3, NGM-7).

A number of negative views focused on the issue of distributive justice regarding hydropower dams. In the past, hydropower dams led to forced labor and displacement, and there continues to be a strong sense of wariness regarding large power plants (NGF-2). The area around the Baluchaung No. 2 hydropower plant in Kayah State was located in a conflict zone, and landmines were laid to protect the power plant and the national grid. The mines harmed villagers and their livestock (Table 6), and compensation for displacement was also very low (NGM-8). Furthermore, even if a power plant was built, it did not necessarily mean that nearby villages would be connected to the grid (NGM-8). It was unclear as to when they would be connected, if ever. For example, in Kayah province, the Baluchaung No. 2 hydropower plant was built as compensation as part of the post-war construction by Japan and began its operations in 1960 [44]. However, nearby residents were not connected to the grid until 2012 (NGM-8).

Table 6. Example of comments regarding power sources.

Code	Quotes	Source
Society/Negative/ Distributive justice	And then, for the national grid security, the government put in the past, land mines under the grid, 12 feet around the grid, and the grid construction is not parallel to the road only. It also goes around the farmland of the villagers. So, during the farming season, planting season, the villagers could not ascertain the landmines because the signboards were only written in Burmese, that don't come near here, there is a landmine. They put a signboard, but the villagers don't read Burmese, because they are Kayah, so they don't know how to read Burmese. So, once there is a landmine accident, they were being sued by the government for destroying the state property, saying that this landmine is state property and they have to pay back the cost of the landmines.	NGM-8
Society/Negative/ Procedural justice	But the problem is how to communicate. It's not about the energy as an issue. It's about communication on energy issues.	GM-1
Household and Community/Positive	They need electricity. They need light at nighttime. They want to watch their TV. They want to run their small motor for their use. That's significant. But they can't afford. They are doing at the measure of their capacity.	NGM-10
Society/Negative/ Distributive justice Community/Positive	I think this small, this mini grid is still useful because for commercial power we still have to wait too many years to like distribute to the villages. They have to wait.	NGM-3
Household/Negative/O&M	When we went to the field it was like, the solar home systems were given, but they were not well maintained. I don't know if people were given the basic knowledge that you have to clean your panels. We went to the homes and sometimes the solar panel is placed in such a way that it doesn't get full sunlight also.	NGF-3
Society/Negative/ Conflict sensitive	the example that comes quickest to mind is the Hatgyi Dam project. They can cause more fighting because as there is development and what is seen as sort of a valuable object, a valuable resource—different armed groups may try to control it either in order to extract financial benefit from it or to extract leverage against others. It doesn't just result in fighting between armed groups. It also results in further displacement of people being caught in the crossfire but it also oftentimes resulting mining, laying down of landmines in these areas, which makes them permanently problematic. Unless of course, they end up under water because there's a dam.	NGM-5
Household and community/Positive	I mean if it's in a relatively small-scale those are probably the sort of projects which could be implemented in areas under the authority of EAOs. If it's in a relatively small-scale, I think maybe more likelihood of these being successfully piloted perhaps as projects which could be done jointly between governments and ethnic armed organizations so that there would be a trust building element there.	AC-1

O&M: Operation and maintenance.

At present, the national grid itself is a source of distributional injustice. While urban residents only have to pay a connection fee for a new connection to the grid, rural residents have to bear the cost of the distribution lines, and the availability of subsidies has to be discussed with the local government office. Villagers will also not be reimbursed even if the distribution lines they paid for were extended to another village (NGM-10). In addition, rural residents need to wait for years until the grid is extended (NGM-8). Off-grid electrification projects subsidized by the government only span areas where the national grid will not be extended within the next 10 years [19]. In other words, villagers in these areas where the grid is planned for extension in the ninth or tenth year will need to wait without support. The feasibility of such plans has also been questioned (NGM-8).

Several procedural justice issues that have been identified in existing studies [34] were also highlighted in the interviews (e.g., GM-1, NGM-8). Local communities were neither informed nor consulted regarding plans for power plants, such as capacity and fuel. This was the case for large hydropower and coal-fired power plants. The importance of information sharing, particularly from technical experts, and the involvement of local people was noted (NGM-1). Other concerns were focused on the environmental impact of large dams on water resources, the collapse of dams that have exceeded conventional safety designs due to recent climate change, and the aging of the national grid (NGM-10). Energy injustice in Myanmar varied from the direct effects of sub-national conflict to indirect effects.

Additionally, there were concerns that additional hydropower dams may be developed in the area if the NCA is signed and the area would become a post-conflict area [42]. Thus, there was a strong sense of distrust in large-scale power plants. The extension of the national grid also required detailed prior coordination with each EAO in each region for implementation. Moreover, several households will not be able to connect to the grid without financial support to afford the distribution cost. There were many more issues to be resolved in the conflict-affected areas than the non-conflict area.

4.2.2. Positive and Negative Aspects of the Distributed Power Source

Distributed power sources at the community and household scales were viewed more positively than societal scale power sources from large power plants and the national grids. These smaller scale power sources were considered to introduce fewer problems that may exacerbate conflicts. There is also a strong need to install lighting in health centers, clinics, and high schools where classes are larger than in primary education (NGM-1, NGM-3). However, there were challenges associated with maintenance and quality.

Many quality issues were noted for off-grid solar devices at the household scale. Many inferior products have entered the market from abroad, and the product life span was very short at approximately one to two years; this is much shorter than expected (NGF-1). As such, quality standards must be established.

At the community scale, there was a lack of maintenance and technical translation to the villagers, regardless of the generation technology (e.g., solar or diesel) (NGF-2, NGF-3). For example, the installation of a power generation system was implemented as a support project, with no follow-up, and villagers were unable to repair the system. The performance of electricity generation was far below the design parameters as even simple maintenance instructions were not provided. Moreover, there were solar panels installed in shaded areas that had been left in the dirt and dust (NGF-3).

5. Conclusions and Discussion

5.1. Implementation Difficulties of Development Projects in Conflict Affected Area

The importance of access to information, or the desire for mobile phones was very strong alongside the traditional aid segments of health care and education.

The results also indicate the effectiveness of dividing the dimensions into scales. Often, the societal scale is more challenging than the smaller scales across many dimensions. As the scale increases, there is a rise in the number of stakeholders involved and coordina-

tion becomes more difficult. As represented by roads, anything that contributes to the development of the area while also having potential for military use, arouses suspicion and is likely to exacerbate conflicts. It was mentioned that in previous ceasefire periods, the Tatmadaw used the period to strengthen its forces. As such, the EAOs have become more paranoid regarding the ceasefire [45]. It should be recognized that a significant amount of effort is required to build without exacerbating conflict. It is difficult to build an organization-to-organization relationship due to the cultural backdrop of Myanmar. This culture emphasizes that society is highly independent from organizations, and is based on connections between individuals [46]. It is essential to consider the individual circumstances of each area in Myanmar, which is a multi-ethnic society. As such, there is no single solution that is applicable to all regions.

Thus, a bottom-up approach is important, and projects should be community-driven and responsive to local needs. When implemented in a conflict-sensitive manner, community-driven development projects have been considered effective in addressing development needs in active conflict areas. This is based on cases in Ache in Indonesia and Mindanao in the Philippines [47]. However, community-driven development projects have rarely been reported from a multi-dimensional perspective, such as the DLS. Community-driven mini-grids that may serve as good examples exist in ethnic minority areas with small hydro resources, such as Kachin State. This is because the military junta in Myanmar were supported by international organizations prior to the introduction of projects. They have run micro hydropower plants for years without government support by making the capital investment commensurate with their income (NGM-8). These community-driven power plants are unlikely to exacerbate the tensions in conflict-affected areas.

However, there are also challenges for community-driven projects. Often, community-driven projects encounter issues with insufficient technical knowledge. There has been a shortage of technical experts in fields such as the civil, mechanical, and electrical fields. Additionally, there has not been sufficient follow-up on community-driven projects even if the program was funded by an aid agency and the union government. However, there are many positive opinions regarding the willingness to learn by the youth in rural areas, particularly for engineering equipment. It is important to provide educational opportunities for those with a desire to learn and provide a system of engineering training at appropriate levels.

5.2. Distributed Power Sources and Implications for Sustainable Development

The results showed that as mobile phones have become increasingly important, the use of distributed power sources has also increased in value. At present, decentralized power generation has not received much attention from outside the energy sector. Although the SHS installment projects by international NGOs in conflict-affected areas of Kayin State [20] may be considered a reference case, these efforts are not widespread. It is preferable to support conflict-affected areas in rural electrification to improve living standards, or DLS. These initiatives may contribute to modern energy access and peaceful and inclusive societies as per SDG 7 and 16, respectively [21].

The Myanmar Government has set a target of 100% electrification by 2030 [48] and stated that it reached 50% in December, 2019 [49]. However, this is the percentage electrified by the national grid. Based on the method used to calculate this achievement percentage, the government appears to be placing more importance on the national grid.

Regardless of the background of each interviewees, there were many indications that the construction of large dams was associated with procedural injustice, which overshadowed the energy sector in Myanmar. Issues relating to procedural injustice should be recognized and addressed with caution in accordance with due process and with sufficient dialog with the local villagers. From a technical viewpoint, there are limits to the extension of the national grid when the construction of large power plants placed on hold. This is because of the frequent blackout/brownout in urban areas due to a nationwide shortage of generation capacity [50].

Although off-grid power sources receive lower priority, these sources are demonstrating progress.

According to a World Bank study [16], 86.5% of the country is electrified; 39% of this is from the national grid, while 48% is from off-grid power sources. The breakdown of the off-grid power may be divided into four groups: (1) 11% is SHS with a capacity to connect televisions and fans, (2) approximately 20% is solar lanterns for lighting and mobile charging, (3) 9% is for rechargeable batteries, and (4) 8% is for the mini-grid. Although the levels of these off-grid power sources vary, mobile charging itself is very small in terms of electricity demand and can be met by distributed power sources such as solar lanterns and SHSs. Distributed generation has a much shorter deployment period than grid extension. It is less likely to exacerbate conflicts than grid extension, which requires a certain amount of work and coordination to be deployed in conflict-affected areas. Some interviewees identified the limited capacity of off-grid solar products (NGM-3). However, this should be evaluated as a rapid, first step in electrification.

Some challenges for distributed power sources were identified, such as operation and maintenance. Many of these failures occurred because villagers were not properly technically trained, and the systems were broken down and abandoned. A previous survey [16] on issues associated with off-grid solar products showed that 29% of respondents regarded insufficient sunlight as the key issue, followed by 39% who believed there was no issues. The analysis showed that the cause of these responses may be due to the monsoon and low-quality products [16]. However, a lack of basic knowledge, such as installation in unshaded areas, may have been one of the reasons for many to believe insufficient sunlight was a major issue.

Additionally, ownership should be carefully designed in terms of sustainability, particularly if it is granted or constructed as an aid project in the beginning; this will ensure proper and ongoing operation and maintenance. Cooperatives were considered not to be effective in Myanmar (NGM-10, NGF-2, AC-2). It is necessary to take measures to clarify ownership and responsibility after installation, similar to the running of a business by a private company. Alternatively, the village electrification committee may be established as a legal entity that is primarily run by volunteers (NGM-10).

Currently, government-subsidized off-grid electrification programs have been led by the DRD without conflict sensitivity. However, power plants not connected to the national grid with a generation capacity of 30 MW or less may legally be licensed by the state or regional government. If there is a greater transfer to the state or regional governments, it may provide a good example of decentralization from the union government to the state or regional government [36]. If projects are undertaken in a conflict-affected area, it presents an opportunity to work cooperatively between local governments, EAOs, and/or ethnic civil society organizations.

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