# Electrification Status of Alue Keujrun Village and Kluet River Hydrokinetic Energy Potential: A Survey Report

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***Abstract***

*This paper provides survey results of an electricity system that has been carried out from isolated village of Alue Keujrun, South Aceh, Indonesia. The village has a central photovoltaic power plant and a micro hydro power plant. Various problems in the field such as operation errors, lack of maintenance of the electric power system, low voltage and frequency have been found. Power plant operators have also never received any formal training from any institution. The village is located next to the Kluet river which has a very large potential to become a hydrokinetic power plant energy source. Therefore the Kluet river flow velocity was also measured during the survey and described within this paper. Based on the interviews results with local operators, the village power plant does not have an operating permit. Thus, we consider that it is important to review the types of permits required to establish a power plant in Indonesia, including small-scale power plants.*

***Keywords****: renewable energy, hydrokinetic energy, isolated grid, maintenance, power plant permit.*

***Abstrak***

Artikel ini memaparkan hasil survey sistem ketenagalistrikan desa terisolasi yang telah dilakukan pada desa Alue Keujrun, Aceh Selatan, Indonesia. Desa ini memiliki pembangkit listrik tenaga surya sentral dan pembangkit listrik tenaga mikrohidro. Berbagai temuan di lapangan seperti kesalahan operasi, kurangnya perawatan sistem tenaga listrik, rendahnya tegangan dan frekuensi listrik telah ditemukan. Operator sistem kelistrikan juga tidak pernah mendapat pelatihan formal dari lembaga manapun. Desa ini juga sangat berpotensi untuk memiliki pembangkit listrik tenaga hidrokinetik, oleh karena itu hasil pengukuran kecepatan aliran sungai Kluet turut dipaparkan. Berdasarkan hasil wawancara terhadap operator pebangkit listrik, pembangkit listrik desa tidak memiliki izin operasi. Maka dari itu didalam artikel ini penulis merasa perlu untuk meninjau ulang jenis perizinan yang diperlukan untuk mendirikan pembangkit listrik termasuk pembangkit listrik berskala kecil.

***Kata kunci****: energi terbarukan, energy hidrokinetik, jaringan terisolasi, perawatan, izin pembangkit listrik.*

## Introduction

The development of power plants with hydro energy sources has become a concern of various groups, including academician, practitioners, community, and the government. Indonesia with its innumerous natural water resources has the potential to be used as a power plant (Syahputra and Soesanti, 2021). One of the challenges in the utilization of hydro energy is the availability of energy which is fluctuate and highly dependent on the ecosystem conditions (Petinrin and Shaaban, 2012). However, with the rapid development of supporting technology (Li et al., 2020) and good planning (Sangpetch, 2014), the disadvantages in the utilization of hydro energy can


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be compensated so that reliable and efficient power plants can establish. It is necessary to first conduct a survey to know the availability of the hydro energy, as well as to find out the electricity load needs in the local community area (Ikhsan et al., 2013). After completion of the power plant planning, various types of permits must be obtained (Razan et al., 2012). The purpose of this permit is to ensure that the planned power plant is not dangerous to the community, does not disturb the environment, established in an area that is not affected by other government-owned projects, and meets the electrical safety standard.

First part of this paper briefly inform the survey result which has been done in July 2020 at Alue Keujrun Village, one of a prospective site to install the hydrokinetic turbine power plant in Indonesia. The survey results not only informed the current electricity status of the village but also the stream velocity of the river. That is including types and number of load used by the villager and social facilities, status of existing photovoltaic and hydro power plant power plant system, and local river stream velocity and depth. Additionally, the wishes of the community aimed to various parties also included.

The second part of the paper explains procedure and requirement in order to obtain permit for the new power plant from government. The permits are, business permit of electricity supply for public use (IUPTL), Integrated IUPTL, business region determination (PWU) permit, operations permit (IO, only for > 200 kVA only), and certificate of business entity (SBU)..

## Methodology

The survey was conducted in Alue Keujrun Village, South Aceh District, Aceh Province. This village can only be reached by Sampan (small Robin boat) and takes 2-3 hours of traveling time. The location of the village is at coordinates 3 ° 20'51.3 "N 97 ° 17'30.3" E. The survey was carried out only in 800 m long of river area and a village settlement area as shown in Figure 1. The survey was carried out for 3 days from 18.07.2020 to 20.07.2020 which conduct by two universities in Aceh Province namely Ar-Raniry State Islamic University in Banda Aceh and Polytechnic of South Aceh in Tapaktuan. The survey output is divided into two major parts, namely related to electrical energy needs and the availability of hydrokinetic energy sources.


Figure 1. Survey at Alue Keujrun resident area (permukiman) and river area (sungai)

Questionnaires distributed by surveyors to villagers which has aims to knowing the existing conditions of the electric load of each house and public facilities in residential areas, and to knowing the needs of telecommunications system by residential communities. The surveyors also

investigate the existing conditions of the local power generation system, as well as measuring voltage and frequency of the power system.

A hydrokinetic power plant is planned to establish on the site, therefore it is required to measure the stream velocity of the river. Float method (Ahn et al., 2019) is used to calculate the river surface velocity in the river survey area. Then a measuring stick is used to measure the depth of the river. Surveyors also interviewed local villager regarding the river condition and depth during flood or extreme conditions on the past.

## Result and Discussion

### a. Load Demand

The energy demand survey was conducted on 49 of the total 68 households as well as 6 social infrastructures. Not all houses could be investigated because the occupants leave the house to work in their rice farm or plantations. The electric load belongs to the villager and social infrastructure in Alue Keujrun Village can be seen in Figure 3a. It is found that the need for lighting is still dominant, followed by kitchen utensils in second place and television as an entertainment media in third position

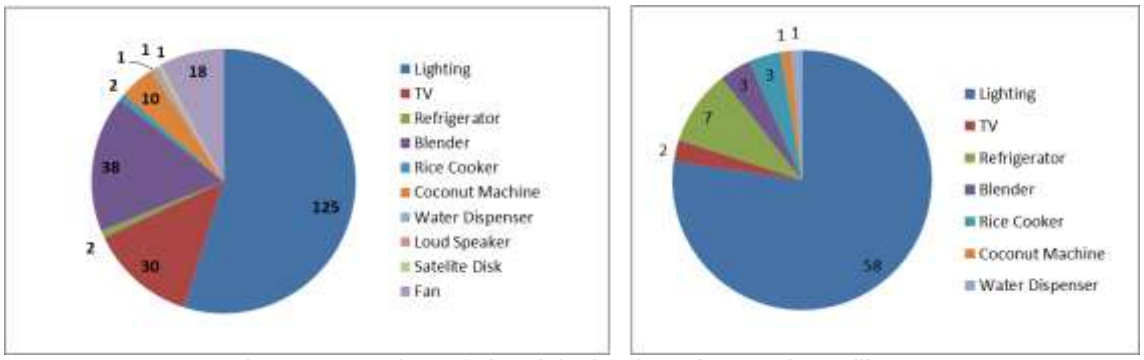


Figure 3. Number of electricity load at Alue Keujrun village
(a)existing load (b)additional-planned load

Even though the village of Alue Keujrun already has a source of electrical power, the community still complains about its poor quality. They blame the electricity quality which caused the electrical equipment easily to become malfunction. In spite of poor electrical quality, the community still has a desire to have additional electrical equipment to support daily activities. If the village has better electricity quality, the future additional electricity load can be seen in Figure 3b. Figure 4 shows the survey activities that are being carried out in community homes. Each building is equipped with a miniature circuit breaker (MCB) that varies from 1 to 10 amperes and villagers pay a monthly flat-rate electricity fee of 1.5 - 2 USD. The number and limit of the MCBs can be seen based on Figure 5.


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Figure 4. Survey of electricity load at Alue Keujrun village

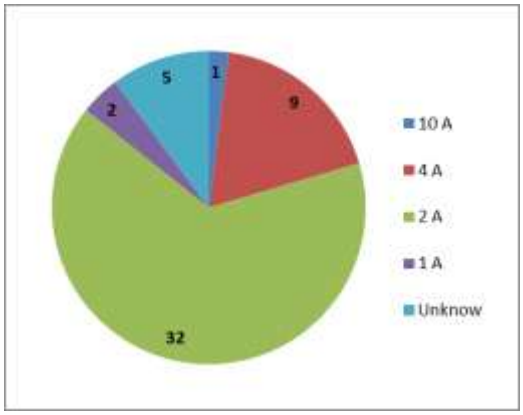


Figure 5. Number and limit of the MCB at Alue Keujrun Village

**b. Existing Solar and Hydro Power Plant**

It was found that the quality of electricity in Alue Keujrun village did not meet the criteria for SPLN No.1-1978 (equivalent to IEC standard) with a voltage ranging about 140 VAC and a frequency only 39 Hz, this could damage residential electrical equipment. The village has two sources of electrical energy, namely a solar power plant (coordinate: 3.349268, 97.291163) with a rating of 20kWp built in 2015 and a micro-hydro power plant (coordinate: 3.351407,97.293020) with a rating of 20 kW built in 2010. Solar power system in Alue Keujrun village was damaged so the electricity supply to the residential area has stopped. The solar power system is also poorly maintained, this is evidenced by the discovery of thick dust on the surface of the solar cell. Figure 5 and Figure 6 show the observation activities on solar power system and hydro power system belong to Alue Keujrun Village.

Since 2019, the solar power system has only been used as a source of street lighting. The damage that occurred was caused by the ignorance of local operators of the electrical system. The person in charge with the electrical system tries to combine two different electrical systems in the hope that both powers can be used by the community simultaneously. However, because the merging of systems was carried out without synchronization, the inverter system owned by the solar power system was suspected to be damaged.

The village hydro power system was not damaged, but the problem that the water intake is not well maintained so that there is a lot of leafs, branches, and debris clogging the water flow, reducing the discharge, as well as the power capacity of the hydro power system.

(a) (b)

(c) (d)

Figure 6. Solar power system of Alue Keujrun village
(a) solar cell after cleaning, (b) power house, (c) panel control inspection (d) battery bank inspection

From interviews with the village's chief, the hydro power plant received regular maintenance performed by the operator, especially the pulley part, cables, and powerhouse. However, the village chief acknowledged that field operators had never received special training from any agency or government. Regarding licensing, he did not know whether solar power and hydro power plants had permits or not. Power plant management has not been carried out professionally, evidenced by the absence of a legal institution, e.g. business entity, appointed to take care the power plant.


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(a) (b) (c)

(d) (e)

Figure 7. Hydro power system of Alue Keujrun village (a) power house, (b) power generator, (c) panstock, (d) forebay cleaning, (e) control panel and dump load

**c. Kluet River Stream Energy**

Apart from the electrical system survey, the Kluet River was also an object to be observed. The stream surface velocity was measured by the buoy method due to the absence of a digital flow meter, the depth of the river was measured using a measuring stick, and the width of the river at the monitoring point was measured using a measuring rope. Kluet river survey activities can be seen in Figure 7. There are three measurement points that predicted to produce a large amount of kinetic energy.

(a) (b)


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(c)

(d)

Figure 7. Survey at Kluet River (a) preparation of river depth measurement (b) stream velocity measurement (c) recording of measurement results by surveyor (d) river depth measurement.

However, based on the measurement results in the field, only point 1 (coordinate: 3.348966, 97.293981) meets the technical criteria for the planned technology. In addition to the river depth, the flow speed at point 1 is higher than the other two points (coordinate: 3.348569, 97.294170 and 3.347613, 97.294377). Point 1 has an average speed of 1.44 m/s with a depth of up to 4 meters, while the other two points have a speed of below 1.2 m/s with a depth of only 1.5 meters. There is an important note that this survey was conducted during the dry season so there is a higher possibility that the Kluet River has greater potential, including at points II and point III which not met the criteria. Based on information gathered from villagers, the river level can increase up to 2 meters when the rainy season arrives. Figure 7 shows the survey activities at Kluet River in Alue Keujrun village.

**d. Telecommunication Infrastructure**

Apart from electricity problems, the community also complained about the absence of a telecommunications system. In general, people have cell phones, but to be able to communicate, they have to travel by boat to a neighborhood village. The villagers of Alue Keujrun hope that the government provides a communication system that can be useful for both personal or business purposes.

**Review of permit and regulation**

To have a license for building and operating a any power plant in Indonesia (renewable energy power plant as well), the project manager needs to establish a business entity. Business entity is an institution that aims to make a profit. There are many type of business entities in Indonesia that can apply for permits, Such as cooperatives (koperasi), state-owned enterprises (BUMN), and privately owned businesses (BUMS) (Kementerian Energi Dan Sumber Daya Mineral Republik Indonesia, 2021).

**a. Cooperative (Koperasi)**

Cooperative is a type of business entity based on family principles. The purpose of the cooperative is to prosper its members who help build a joint economy. Some example of cooperatives in Indonesia is savings and loan cooperatives, village unit cooperatives, multi-


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business cooperatives, school cooperatives etc. Usually Cooperative is used as business entity model for managing small power plant and operate by local community.

**b. Partnership Alliance (CV)**

A limited partnership or commanditaire vennootschap (abbreviated CV) is a partnership alliance established by two or more people on the principle of trust.. The main advantage of this structure is that the owner is usually not responsible for the company's debt.

**c. Limited Liability Company (Perseroan Terbatas):**

Limited company or abbreviated as PT is a business entity whose capital is obtained from the sale of shares. PT obtain tax identification numbers, open bank accounts and do business, all in their own name. Every person who holds shares has the right to the company and the benefits of the company.

**d. Foundation**

The foundation is one of the business entities that are not looking for profit. This form of business is only for social activities that have legal entities. The foundation has no members but the goals of the foundation are realized by the foundation's management.

**Type of Permits**

Every business entity that runs an electricity supply business for public purposes is required to have business permit of electricity supply for public use (IUPTL), Integrated IUPTL, business region determination (PWU), operations permit (IO, for > 200 kVA only), and certificate of business entity (SBU). Permits can be proposed online within 5-10 working days.

**a. Business Permit of Electricity Supply for Public Use (IUPTL).**

Requests for granting IUPTLs are submitted to the Minister, Governor, or Mayor in accordance with their authority. However, if the business interest happen in the cross-province, it is obligatory to submit an application for IUPTL to the Minister. After obtaining an IUPTL, the business entity can legally carry out the business of supplying electricity for public purposes.

Basically there are two requirements to obtain the permit, that is

1. Administrative requirement
   The requirement are applicant's identity (ID card or Passport), Proof of establishment of an Indonesian legal entity, tax ID, location permit, and environmental permit
2. Technical requirement
   The requirement are financial feasibility study, operational feasibility study, grid interconnect studies, installation location, single line diagram, type and capacity of business to be carried out, development schedule, operating schedule which prepared by the certified business entity, and power purchase agreement between the applicant and prospective buyers of electricity.


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**b. Integrated Business Permit of Electricity Supply for Public Use (Integrated IUPTL)**

If the business carried out by the company in a certain area consists of generating electricity, transmitting electricity, distributing electricity, and/or sales of electric power then it is required to have Integrated IUPTL. The requirements are same as the IUPTL, with the addition of the Electricity Supply Business Plan (RUPTL) which is planned for at least 10 years of implementation and Establishment of Business Areas (PWU). They are submitted to the Minister or Governor in accordance with their authority.

**c. Establishment of Business Areas (PWU).**

To get a legal business area, several conditions need to be prepared, namely

1. Analysis of supply demand, with explanation of:
   - Introduction
   - Development strategy of electricity supply infrastructure and electricity sales
   - Strategies for utilizing renewable energy sources;
   - Electricity Supply Business conditions, namely;
   - Electricity Generation, Electric Power Transmission, Electricity Distribution and Electricity Sales;
   - Electric Power Generation, Electric Power Transmission, and electricity sales; or
   - Electricity Generation, Electricity Distribution and Electricity Sales.
   - Availability of primary energy sources;
   - Electricity supply plan;
   - Basic cost of electricity generation;
   - Investment and funding; and
   - Risk analysis

2. Recommendations from Governors at Provincial Government, which contains:
   - Boundaries of the Business Area and location map
   - Statement that the IUPTL will be issued after the PWU and RUPTL is provided
   - Statement that the business area has not been reached by the Territory holder or the existing business area holder is unable to provide a reliable electricity

**Conclusion**

The survey has been conducted in the village of Alue Keujrun, South Aceh District, Aceh Province. The power quality in the village is poor, it was found that the electricity received by the houses was only around 140 V with a frequency of 39 Hz. Solar power and hydro power system owned by the village cannot operate optimally due to technical problems caused by the ignorance of the person in charge of the village power plant and high maintenance needs.

The average stream velocity is at 1.44 m/s. Although the river flow rate is relatively low, the Kluet River has great potential to be used as a hydrokinetic power plant, this is because the water level can be increased up to 2 meters during the rainy season. Apart from power quality problems, the community of Alue Keujrun village also complained about the lack of telecommunications facilities. The community hopes that in the future the telecommunication network can enter the village area.

To establish new hydrokinetic power plant on the village, numbers of permit are required, namely business permit of electricity supply for public use (IUPTL), Integrated IUPTL (if


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distribution and selling is included), and business region determination (PWU) permit.). The permits can be proposed online and each of them require at least 5-10 working days until issued. Only legal business entities are able to request permits. Usually, cooperation (koperasi) is chosen to become a business entity to manage small power plants in a remote area**.**

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