

Implementation of the ASEAN Power Grid Interconnection West Kalimantan and Sarawak to Fulfill Electrical Energy Needs in Khatulistiwa

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Abstract

West Kalimantan is a province in Indonesia that is directly adjacent to Sarawak, Malaysia. Electrical energy in West Kalimantan is not fulfilled because the source of electricity in West Kalimantan still relies on diesel which is expensive and cannot last all day, depending on the supply of fuel. Meanwhile, Sarawak has quite a large supply of energy coming from hydropower plants. To overcome the gap in those regions, ASEAN has made the West Kalimantan and Sarawak as one of the ASEAN Power Grid projects which connects certain areas in two different countries to share electricity supply. The purpose of this study is to determine the effectiveness of the cooperation between West Kalimantan and Sarawak electricity interconnection in meeting the electricity demand in the West Kalimantan region. In this research, the authors used qualitative methods by reviewing the literature. As the results of this study, the cross-border electricity interconnection cooperation between West Kalimantan and Sarawak is quite effective. By importing electricity from Sarawak the demand for electrical energy-especially in the main cities of West Kalimantan, can be fulfilled. So those two areas have the advantage where West Kalimantan is able to meet the electricity needs and Sarawak gets a profit margin by selling its electricity.

Keywords: *Power Interconnection, ASEAN Power Grid, West Kalimantan, Sarawak, Electrical Energy.*

INTRODUCTION

The rapid growth in various sectors has led to an increasing demand for energy. The availability of energy supply is now a concern for many countries, especially in meeting their electricity needs. Furthermore, energy crisis-related issues have always been a threat to both developed and developing nations. To date, energy demand in each country has risen while reserves are decreasing. Additionally, countries reliant on energy sources from other nations are becoming uneasy due to unstable conditions within those countries or regions, as well as their governments. Environmental issues related to non-renewable energy sources are also a concern.

According to Pratiwi (2012), energy sources can be classified into two categories: primary and secondary. Primary energy is derived from nature and can be either non-fossil or fossil-based. Coal, natural gas, and oil are examples of fossil-based energy sources. These sources are non-renewable and can lead to environmental pollution. Various regions in Indonesia, particularly in the use of coal as the dominant fuel for Steam Power Plants (PLTU), are still heavily dependent on these energy sources. Additionally, the use of oil as fuel is dominant in remote and inaccessible areas (3T) that are not connected to the national grid.

Given the challenges in various Southeast Asian countries, ASEAN intends to leverage, manage, and develop energy resources and infrastructure to meet energy needs and availability in the region. Interest in the development of regional-scale electrical grids is expected to create benefits for the countries in the surrounding region.

In Indonesia, one of the regions still heavily reliant on fossil-based energy sources for electricity generation is West Kalimantan. West Kalimantan primarily uses oil as a fossil energy source for power generation, which has negative environmental consequences. Additionally, oil is the most expensive fuel source for electricity generation compared to other energy sources.

The use of fossil-based energy sources has made West Kalimantan one of the regions in Indonesia with the highest electricity production costs.

In line with these challenges, West Kalimantan has agreed to collaborate on cross-border electricity exchange to reduce electricity production costs and meet the region's electricity needs. Therefore, PT PLN Persero, which is Indonesia's sole electricity company, intends to purchase electricity from the Sarawak region to meet West Kalimantan's electricity needs at a relatively low cost. This project is funded by the Asian Development Bank (ADB), involving the construction of a transmission line from Bengkayang, West Kalimantan, which is close to the Malaysian border in Sarawak. Malaysia has also extended the transmission line to the West Kalimantan border in Mambong (Hasnie, 2017).

Sarawak, serving as an electricity exporter, uses renewable energy sources, particularly hydropower, which is considered cost-effective and highly potential. This is in contrast to West Kalimantan, which still relies on diesel for electricity generation. Furthermore, Sarawak has claimed that its electricity generation can meet the electricity demand in the Borneo region.

The interconnection collaboration between West Kalimantan and Sarawak is one of the priority projects of the Trans-Borneo Power Grid, an electricity interconnection project that will connect sub-national entities on the island of Borneo. The ASEAN Power Grid (APG) is a cooperative effort aimed at meeting the electricity demand in regions with insufficient supply by enabling cross-border transmission interconnections, thus facilitating sub-state cooperation (ASEAN, 2010:16). This electricity interconnection project is a result of the ASEAN Power Grid, supported by the fact that bilateral and multilateral cooperation in electricity interconnection and cross-border electricity trade is a realization of the ASEAN Power Grid project (Pitakdumrongkit & Robles, 2014:1).

In 2011, the Power Exchange Agreement (PEA) was signed by the first parties, PT PLN Persero Indonesia as the importer of electricity and SESCO, a private electricity company in Malaysia, as the exporter of electricity between Sarawak and West Kalimantan. In this project, Indonesia's estimated financing is approximately US\$120 million, and Malaysia's estimated financing is around US\$41 million (Sarawak Interconnection, 2011:1). For the first time in January 2016, the interconnection cooperation between West Kalimantan and Sarawak delivered its initial power supply of 50MW.

RESEARCH METHODS

The research method employed is qualitative research. According to Creswell (2014:32), qualitative research can be defined as research that involves several individuals or groups related to the research topic. In broad terms, qualitative research prioritizes the process over the final results. After obtaining data through specific processes, researchers will interpret it in accordance with the data collected. This qualitative approach is used to explain the implementation of electrical interconnection between West Kalimantan and Sarawak as part of the ASEAN Power Grid regional project. Specific factors, such as the policies of both countries in carrying out the cooperation between Sarawak and West Kalimantan, are described descriptively.

Furthermore, the research falls into the category of a case study. As stated by Basuki (2010:113), a case study is a specific research that cannot be generalized. A case study is an in-depth examination of a particular event, situation, or environment that allows for exploration and understanding. The implementation of electrical interconnection cooperation to meet the electricity needs in West Kalimantan is the case study examined in this research.

RESULT AND DISCUSSION

ASEAN recognizes the role of efficient, resilient, and reliable electrical infrastructure in stimulating regional development and economic growth. As the demand for electricity continues to rise, investments are needed to build and manage power generation. The setting of electrical interconnection regulations under the ASEAN Vision 2020 was adopted during the second informal ASEAN Summit in Kuala Lumpur in mid-December 1997. As a result, the ASEAN Power Grid Memorandum of Understanding (MoU) was agreed upon on August 23, 2007, laying the foundation for this cooperation.

The ASEAN Power Grid project in Indonesia that has been implemented to date is the interconnection between West Kalimantan and Sarawak. This cooperation is part of the Trans Borneo Power Grid, which is a component of the ASEAN Power Grid on the island of Kalimantan. One of the reasons for establishing this interconnection is that West Kalimantan still relies on oil-based power generation. The use of kerosene lighting is often found in households that still lack access to electricity. Consequently, in October 2010, ASEAN launched the Master Plan on ASEAN Connectivity, prioritizing West Kalimantan as one of the regions to focus on.

Furthermore, the prioritized interconnection between West Kalimantan and Sarawak represents a bilateral cooperation between the two countries with the goal of building an international boundary between the two regions using transmission asset investments to optimize the cost-effective power system. This cooperation can be carried out because West Kalimantan and Sarawak are located along the border, making electricity transmission between regions relatively straightforward. This cooperation is also aimed at avoiding conflicts in border areas due to significant disparities in accessing electrical energy needs. This is supported by the statement of Bangun (2014:32) that disparities in border areas can lead to various issues that could disrupt national stability.

Cooperation between the two countries is crucial because one country cannot meet its energy needs independently. In this case, PLN (Perusahaan Listrik Negara) is unable to meet the electricity demand in West Kalimantan due to limitations in power generation and available resources in the region. Therefore, the neighboring and bordering regions have agreed to carry out this cooperation. The Indonesian government, along with PT PLN Persero in West Kalimantan, and the Malaysian government through the private electric company SESCO Sarawak, have agreed to exchange electrical energy at the border of the two countries with a cross-border interconnected transmission system. This cooperation has materialized with the connection of electrical transmission between West Kalimantan and Sarawak. This interconnection refers to the Power Exchange Agreement (PEA) in which PT PLN Persero and SESCO have agreed to the export-import of electrical energy for a duration of 20 years.

The interconnected system that links the West Kalimantan region with Sarawak has a transmission distance of 128.2 km, with a 275 kV capacity. West Kalimantan is situated 82.6 km from the border, towards the north, in Bengkayang, in the northern part of the West Kalimantan Province, passing through several districts. On the other side, Sarawak, with the same 275 kV transmission lines, is located 45.6 km from the Main Substation to the Serikin border, passing through the Bau and Kuching districts.

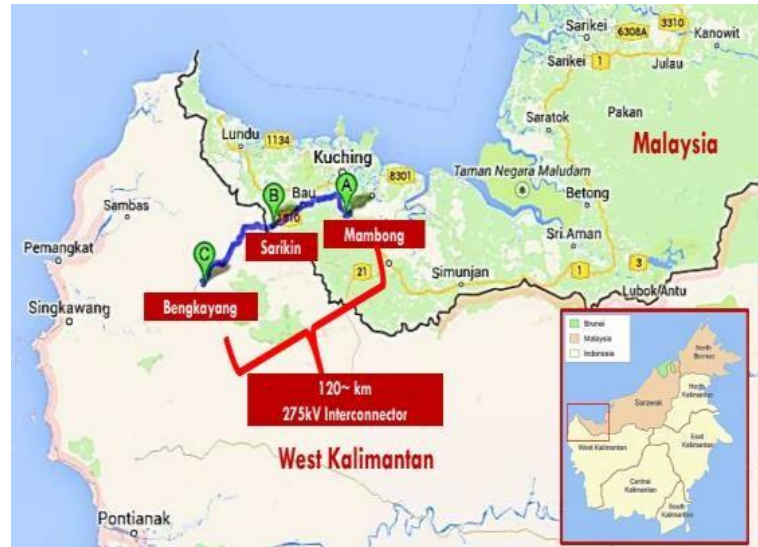


Figure1. Sabah Sarawak Interconnection
Source: Sarawak Energy (2017)

West Kalimantan

The Indonesian government, through PT PLN Persero, with funding provided by the Asian Development Bank (ADB) and the Agence Française de Développement (AFD), each in the amount of US\$ 49.5 million, is implementing the gradual development of electrical resources. This includes the establishment of a 150 kV transmission line in Kalimantan Barat to strengthen the region's electricity infrastructure, aimed at enhancing cross-border electrical reliability through a 275 kV transmission from Mambong (Sarawak) to Bengkayang (West Kalimantan), and specifically, to increase electrification rates in West Kalimantan. Additionally, transmission lines connecting various areas within West Kalimantan have been constructed to facilitate electricity distribution to regions still experiencing power deficits.

The project scope in West Kalimantan includes the following parts:

Bengkayang - Jagoibang

- Package 1: 275 kV Transmission Line between the Bengkayang substation to the Sarawak East Malaysia border (80.26 km) (Completed).
- Package 2: 275/150 kV Substation in Bengkayang (Completed).

Bengkayang - Ngabang - Tayan

- Package 3: 150 kV Transmission Line from the new Bengkayang substation to the Ngabang 150 kV substation (93.3 km). From there to the Tayan substation (46.6 km) (Under Construction).
- Package 4: 150/20 kV Substation in Ngabang and an extension of the substation in Tayan (Completed).

Tayan - Sanggau – Sekadau

Due to the remaining loan funds provided by ADB, it was decided to add three more work packages:

- Package 5: 150/20 kV Substation in Sanggau and Sekadau, with an expansion of the substation in Tayan (Pre-construction).
- Package 6: 150/20 kV Transmission Line spanning 72 km between the Tayan and Sanggau substations (Pre-construction).
- Package 7: 150/20 kV Transmission Line spanning 48 km between Sanggau and Sekadau (Pre-construction).

Sarawak

The 275 kV transmission line built by Sarawak has a transmission length of 45.6 km and consists of 144 transmission towers, passing through several districts such as Kuching and Bau.

Operation of the Electrical Interconnection between West Kalimantan and Sarawak PT PLN Persero in the West Kalimantan region purchases electricity from Malaysia through SESCO via a 275 kV transmission network with a length of 128.2 km, connecting the Bengkayang substation owned by West Kalimantan with the Mambong substation owned by Sarawak. Malaysia possesses 144 transmission towers from Mambong to the border, while Indonesia has 201 transmission towers through Bengkayang to the border.

PLN, as the power provider in West Kalimantan, purchases electricity from Sarawak, Malaysia, specifically from SESCO, with a purchasing contract of up to 230 MW. Import plans are made to anticipate uncertainties in the availability of baseload generators in the West Kalimantan transmission system. Additionally, imports are made during peak loads of up to 230 MW to replace the use of oil during peak demand. In the future, to reduce dependence on electrical energy from Sarawak, PT PLN Persero plans to build a power plant with a capacity of 100 MW. The import-export of electrical energy will be carried out over a period of 20 years:

The first five years (Phase 1) with a take-and-pay scheme, where West Kalimantan will import 50 MW of electricity from Sarawak and gradually increase it up to a maximum import capacity of 230 MW.

The next fifteen years (Phase 2) with a take-or-pay scheme, enabling both parties to engage in electricity transactions with agreed-upon capacities.

The power supply exported by SESCO is not equipped with Automatic Generation Control (AGC) and is still manually controlled. The power magnitude will be adjusted by West Kalimantan, namely PT PLN Persero, within a range of approximately $\pm 10\%$. Payment calculations for import and export are made at the end of the month at 00:00 Sarawak Malaysia time, based on the results from kWh meters at the Mambong substation. Both parties have three kWh meters, each consisting of a check meter, main meter, and comparator.

Obstacles to the Kalimantan Barat and Sarawak Power Interconnection

The electrical interconnection system between West Kalimantan and Sarawak has experienced several system failures due to lightning strikes. One such incident occurred at the end of November 2016 at 5:50 PM local time, causing a two-hour disruption in the electricity supply. This disruption affected areas including Bengkayang Regency, Singkawang City, Pontianak, Mempawah, Kubu Raya, and Sambas in West Kalimantan, as well as areas in Sarawak. The root cause of these system failures was lightning strikes on the cross-border 275 kV interconnection network.

The disruptions resulting from lightning strikes serve as a lesson on the reliability of cross-border electrical systems. PT PLN Persero has made efforts to enhance the electrical system's reliability in West Kalimantan by improving power generation, distribution, and supply to customers. However, unpredictable and sometimes extreme weather conditions, such as lightning strikes, pose challenges that are difficult to predict.

One preventive measure taken by PLN to address these challenges is the unbalanced insulator work on the High-Voltage Air Transmission Line (SUTT) between Bengkayang and Singkawang. This work involves adding 150 kV insulator units. Unbalanced insulators ensure that if a fault, such as a lightning strike, occurs, only one line experiences a system failure while the other line can continue delivering power from Sarawak to West Kalimantan. These insulator pieces serve as insulators between high-voltage conductors and are also used as insulator holders on the tower structures. The installation location for this work is in the Samalantan area, which is part of the SUTT route between Bengkayang and Singkawang.

The transmission challenges in West Kalimantan extend beyond lightning strikes. Frequent power outages in the region result from various factors, including power generation deficits and disruptions in the grid and transformers. Other contributing factors include falling trees, kites, illegal streetlight installations, collapsed power poles, and transmission line failures. Additionally, maintenance of the grid and transformers leads to scheduled power outages for repairs and the addition of new infrastructure. While there is no solution currently in place to address these power outages, infrastructure maintenance in West Kalimantan will continue.

Perceptions of Energy Self-Sufficiency

Reaching a regulatory agreement among ASEAN countries is not an easy task, as differing opinions on the importance of such regulations have arisen. Heads of ASEAN Power Utilities/Authorities (HAPUA) have emphasized ASEAN countries' commitment to developing utilities and capabilities through knowledge sharing and personal exchanges, particularly concerning cross-border interconnection cooperation.

During the development of the electrical interconnection between West Kalimantan and Sarawak, various perceptions emerged. One of these was related to energy self-sufficiency. At the time, a sense of nationalism and energy self-sufficiency posed obstacles to the interconnection's development. The Ministry of Energy and Mineral Resources (ESDM) argued that electricity imports at the Kalimantan-Malaysia border to meet the demand in West Kalimantan would not threaten national energy sovereignty. They proposed that Indonesia's maximum electricity import would be 30% of West Kalimantan's total consumption. The plan was to increase Indonesia's electricity reserves to 30% of demand. Even if Sarawak stopped supplying electricity to Kalimantan Barat for any reason, West Kalimantan would not be left without power. The imported electricity from Sarawak could cover any supply gaps.

However, some parties expressed concerns about this dependence. They believed that Kalimantan Barat should not need to import electricity from Sarawak because West Kalimantan has abundant natural resources. While it's true that West Kalimantan has considerable natural resources, managing these resources is challenging due to the region's extensive forested areas. In reality, West Kalimantan does not have the same vast potential as other Indonesian provinces.

Some stakeholders involved in the cooperation disagreed with these concerns. They argued that the electrical interconnection between West Kalimantan and Sarawak would not be detrimental to Indonesia. By purchasing electricity from Sarawak, which uses hydroelectric power generation, Indonesia could reduce the costs of diesel consumption, which had been the primary source of power in West Kalimantan. This shift to hydroelectric power would decrease greenhouse gas emissions and lower operational costs for PLN. This perspective was supported by an APGCC (ASEAN Power Grid Consultative Committee) informant, who pointed out that the interconnection was also intended to reduce substantial subsidies in Kalimantan Barat, where a significant portion of power generation relied on diesel.

Market Change Risks

In the past, electricity markets were often controlled by vertically integrated utilities (state monopolies). However, the emergence of new technologies allowed for competition in electricity generation, supply, and more, while transmission and distribution systems were still generally considered as monopolies (though, in some regions worldwide, even transmission was seen as having competitive potential). As a result, the electricity industry has experienced a radical restructuring through vertical unbundling (separating generation, transmission, distribution, supply, and services) and horizontal unbundling (splitting generation and supply), introducing competition, ownership changes, and new regulatory regimes.

Today, the market structure of the power system can be categorized into four types: Vertically Integrated Utility (VIU) or monopolistic structure, Single-Buyer, Retail Competition, and Wholesale Competition. The vertically integrated utility structure is characterized by a lack

of competition between power companies, with the government usually fully controlling the power supply (typically through state-owned enterprises). In the single-buyer structure, competition is present, but only in the generation segment, allowing one vertically integrated public utility to purchase electricity from generators. Retail competition represents the highest level of competition, where consumers can choose their preferred electricity supplier. Lastly, wholesale competition separates the transmission system, enabling only distribution companies to select energy suppliers through bilateral contracts or power pool energy markets.

Most ASEAN countries still have vertically integrated utilities (except for Singapore and the Philippines), where only one entity is responsible for supplying the country's electricity. Changes in market structure in the future could pose challenges to this interconnection, potentially conflicting with the agreed-upon regulations of Sarawak and West Kalimantan. The introduction of direct transactions between consumers and power companies could lead to unforeseen consequences, potentially interfering with the agreed-upon rules. Unlike the European Union (EU), ASEAN cooperation is voluntary, emphasizing cooperative and collaborative targets rather than absolute mandates.

Economic Impact

The West Kalimantan power network strengthening project aims to not only increase electricity supply to West Kalimantan but also to nearby provinces while enhancing reliability. The construction of a 150 kV transmission line to Ngabang and Tayan will provide electrical access to many households and connect approximately 8,000 new households to the grid, potentially reducing connection costs and waiting times. Reliable electricity will stimulate the local and national economy, contributing to industrial growth and increased trade, especially in the rubber factories that are vital to West Kalimantan. These activities will generate jobs, particularly for low-income groups. Increased access to electricity will improve essential public services such as education, healthcare, and water supply.

For Sarawak, this interconnection represents a long-term plan with numerous benefits. It not only adds to their economic potential but also allows them to channel excess power from various hydroelectric sources optimally. The interconnection project is estimated to cost around \$33 million (ADB, 2017:6). According to the Directorate General of Electricity, the interconnection between Kalimantan Barat and Sarawak has added capacity to the Khatulistiwa system, preventing power deficits. Here are some benefits observed from this interconnection:

Before the interconnection between West Kalimantan and Sarawak was operational, there was a power deficit of 27 MW in the Khatulistiwa system, with available power at 258.4 MW and a peak demand of 285.4 MW.

After the interconnection was operational, the Khatulistiwa system had a power reserve of 17 MW, with available power at 308.4 MW and a peak demand of 291.4 MW.

The interconnection has resulted in a reduction in the Basic Cost of Supplying Electricity (BPP), from nearly Rp 2,000/kWh before operation to approximately Rp 1,650/kWh afterward (Directorate General of Electricity, 2016:15).

The effects of this interconnection align with the bilateral cooperation's goals, particularly in the economic sector. In addition to transmitting significant electrical power, transmission interconnection's economic benefits usually encompass aspects of power system operation that are not easily measurable, such as reducing generator capacity and reserve losses, mitigating operational issues, improving electricity supply stability, and avoiding voltage collapses (ADB, 2014:16).

Social Impact

The project implementation has been carefully planned to minimize the impact of construction and operation on agricultural land, communities, and international borders. Strict environmental mitigation and evaluation measures have been applied to minimize environmental

effects and avoid relocations. Nonetheless, the construction of transmission systems inevitably leads to land and house displacement along the transmission route. However, these affected households receive compensation in the form of cash from PT PLN Persero as compensation for the displacement.

On the positive side, rural communities in West Kalimantan, particularly those bordering Sarawak, have benefited. Before the interconnection agreement, remote areas did not have adequate access to electricity, while Sarawak's electricity supply was of higher quality. This significant disparity in electrical access between the two bordering regions led PT PLN Persero to purchase electricity on a smaller scale for isolated border systems, including the Badau 800 kVA system, Aruk 340 kVA system, Entikong 1200 kVA system, and Jagoi Babang 800 kVA system. The closer proximity to the border networks in neighboring countries was a more cost-effective solution and allowed for longer electricity access in rural areas.

This situation aligns with the statements of an APGCC informant, who mentioned that PLN attempted to purchase electricity from SESCO to provide power to villages bordering Sarawak. These villages previously had access to electricity for only six to eight hours a day. The power sourced from Sarawak offered lower prices than diesel, 24-hour availability, and better power quality. This demonstrates the significant positive impact of electricity transferred from Sarawak on West Kalimantan's electricity system, especially for the local consumers.

Environmental Impact

Many countries in Asia, especially Southeast Asia, still heavily rely on coal and oil, fossil fuels, as sources for electricity generation. Such overreliance results in vulnerability to price shocks, carbon emissions, and pollution. Using oil-based fuels for electricity generation is not a wise choice due to the high costs and environmental consequences. In line with information obtained from an ASEAN Centre of Energy informant (2018), Kalimantan Barat employed diesel generators, which are both expensive and unreliable for 24-hour operations due to fuel availability. Moreover, diesel usage generates environmentally unfriendly carbon dioxide emissions.

Purchasing electricity from Sarawak, which relies on hydroelectric power generation, is expected to reduce diesel consumption costs. In addition to cost savings, this shift away from diesel can also decrease greenhouse gas emissions. The utilization of Sarawak's power significantly reduces West Kalimantan's reliance on oil-based power generation. While oil-based power generation is still in use, it can be gradually phased out as a result of power transfer from Sarawak. Thus, the carbon footprint of Kalimantan is significantly reduced. This interconnection is expected to help Kalimantan reduce its carbon footprint by avoiding emissions generated by oil-based power generation.

CONCLUSION

West Kalimantan is a province in Indonesia that still heavily relies on fossil energy as the fuel for its power plants. The power generation used in this region is primarily based on oil. Power generation from oil is known to be relatively expensive compared to other forms of power generation and is not capable of operating around the clock, depending on the fuel supply. Moreover, it has adverse environmental effects. On the other hand, Sarawak, which is not far from and shares a border with West Kalimantan, has hydroelectric power plants with significant capacity. In addition to being cost-effective, hydroelectric power plants do not produce emissions harmful to the environment. The urgent need to meet the demand for electricity in West Kalimantan has led to the creation of a cooperative interconnection agreement between the bordering regions of West Kalimantan and Sarawak. Both regions agreed to cooperate by

connecting a 275kV transmission line that spans 128.2 km, linking the two areas. Subsequently, the electricity trading took place over a 20-year period with two schemes, "take-and-pay" for five years and "take-or-pay" for 15 years. The "take and pay" scheme required PT PLN Persero in West Kalimantan to import electricity from SESCO Sarawak, while the "take or pay" scheme allowed the two countries to exchange electricity according to the agreement.

The electricity cooperation between West Kalimantan and Sarawak connects several districts in the respective provinces to ensure the public benefits from this cooperation. After the completion of the transmission network's construction, this cooperation was realized in mid-January 2016, with the initial purchase of 50 MW of electricity by PT PLN Persero from SESCO. After several years of operation, it can be concluded that the bilateral cooperation between West Kalimantan and Sarawak, as a form of implementing the ASEAN Power Grid, has been successful. Both parties have experienced the benefits. West Kalimantan, as an electricity importer, has been able to meet the supply deficit in its region, saving on electricity subsidies due to the relatively expensive power generation. This cooperation has also integrated the regions in West Kalimantan through the newly constructed transmission system. On the other hand, Sarawak has benefited economically by selling electricity to West Kalimantan. Based on this, it is hoped that this cooperation will not only make West Kalimantan an importer but also enable it to become an exporter when power plants are built to meet the electricity demand in its region.

In conclusion, the electrical interconnection between West Kalimantan and Sarawak presents numerous benefits in terms of economic growth, energy self-sufficiency, and environmental impact. It also offers social advantages by increasing access to electricity for rural communities. However, it does bring about potential market changes and coordination challenges that need to be addressed. Overall, the project represents a significant step towards a more reliable, sustainable, and interconnected power system in the region.

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