

IMPLEMENTATION OF MEDIUM VOLTAGE AUTOMATIC CHANGE OVER (ACO-MV) DEVICE AS POWER OUTAGE REDUCTION FOR PREMIUM CUSTOMERS AT PT PLN (PERSERO) UP3 KRAMAT JATI

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ABSTRACT

This qualitative research analyzes the implementation of the ACO-MV (Automatic Change Over-Medium Voltage) device in reducing power outages. The study aims to understand the experiences, perspectives, and impacts of the ACO-MV device on stakeholders, including premium customers, businesses, and industries. Using a qualitative approach, in-depth interviews are conducted with key stakeholders, such as PT PLN (PERSERO) UP3 Kramat Jati representatives, premium customers, and business owners. These interviews provide insights into their experiences and perspectives regarding the ACO-MV device. Observational studies and document analysis supplement the interview data, providing a comprehensive understanding of outage incidents, device operation, and maintenance procedures. Thematic analysis is employed to identify recurring themes, patterns, and insights related to the effectiveness of the ACO-MV device in reducing power outages and its impact on stakeholders. The research findings contribute to a deeper understanding of the qualitative aspects of the ACO-MV device's implementation, informing decision-making and potential improvements in its design, operation, and maintenance. The framework and dataset utilized in this study offer a robust foundation for analyzing stakeholder perspectives and experiences. This research helps advance the understanding of the ACO-MV device's impact on power outage reduction and supports informed decision-making processes.

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INTRODUCTION

At present, uninterrupted and sustainable electricity supply for 24 hours has become a top priority in various activities. However, electric power distribution often faces disruptions due to natural factors, electrical equipment failures, power generation issues, transmission line problems, and distribution network issues [7]. These disruptions result in inadequate power supply, impacting critical sectors such as government, industry, shopping centers, and other essential institutions, leading to power outages [3]. Therefore, there is a need to enhance the reliability of the electricity distribution system to prevent supply disruptions for premium customers [12].

The referenced study in this paper aims to address this issue by installing Automatic Change Over (ACO) cubicles for premium customers [4]. It is expected that in the event of

a disruption on one line, the ACO cubicles will automatically switch to the backup line within seconds [5]. Although ACO cubicles are typically used as load breakers, their configuration allows them to function as backup power sources during network disruptions [9]. ACO cubicles have two different energy sources, with one source serving as a backup during distribution system disturbances. By leveraging this ACO system, customers can reduce the duration of power outages by receiving electricity supply from the power company (PLN) [1].

Furthermore, statistical data indicates the average duration of power outages in the PLN network across various regions. For instance, in Jakarta, there is an average of 25 hours of power outages per year, with a monthly average duration of 2 hours and a daily average duration of 5 minutes. Similarly, in Surabaya, the annual average duration of power outages is 20 hours,

with a monthly average of 1.5 hours and a daily average of 4 minutes. Meanwhile, in Medan, the annual average duration of power outages is 30 hours, with a monthly average of 2.5 hours and a daily average of 6 minutes [6].

By implementing the ACO system and considering these statistical figures, customers can significantly reduce the impact of power outages and ensure a more reliable power supply [14]. The ability of ACO cubicles to automatically switch to the backup line within seconds contributes to minimizing power disruption durations, providing uninterrupted power supply to premium customers [13]. The Automatic Change Over (ACO) system is designed to prioritize the main power source when it is available and stable [15]. However, in case of failure or instability in the main source, the Automatic Changeover detects the issue and initiates the process of switching to the backup source within milliseconds [8]. Once the main power source returns to normal conditions, the Automatic Changeover restores the load to the main source, ensuring a reliable and continuous power supply [2].

The utilization of the Automatic Changeover system offers numerous benefits. It provides protection against power disturbances, minimizes downtime, and safeguards sensitive equipment from potential damage [11]. Additionally, it eliminates the need for manual intervention during power transfers, thus reducing the risk of human errors and ensuring a swift response to power outages [10]. Overall, the Automatic Changeover (ACO) system is an essential component in the electricity distribution system, ensuring uninterrupted power supply and smooth transitions between power sources [16]. Their reliability and ability to sustain critical operations make them indispensable in various industries where continuous power supply is crucial [17].

This research aims to delve into the understanding of the ACO device, comprehend its functioning, explain its configuration, analyze the types of premium customers to be equipped with ACO, and outline its maintenance procedures. Therefore, this study is expected to provide a comprehensive understanding of ACO and its contribution to enhancing the reliability of power supply for premium customers. Furthermore, this research will offer valuable insights for planning and implementing effective ACO systems in the electricity distribution network to mitigate the impacts of prolonged power outages.

RESEARCH METHOD

Research Methods

In this study, the researchers employed a descriptive qualitative method to investigate the implementation of ACO, ACO network configuration, the generated outputs, and the analysis of these outputs by comparing the electrical reliability before and after the use of automatic changeover. The study also examined the maintenance and inspection procedures for the ACO equipment. The research was conducted through observations conducted at one of the PLN offices in UP3 Kramat Jati, specifically in the network department.

Framework

Definition and Characteristics of ACO-MV Device The implementation of the ACO-MV (Automatic Change Over - Medium Voltage) device has emerged as a solution to address power outages and ensure a stable electricity supply. This framework aims to provide a comprehensive understanding of the ACO-MV device by examining its definition, characteristics, operation, configuration, types of premium customers, and maintenance requirements. By exploring these aspects, this framework seeks to shed light on the working principles and effectiveness of the ACO-MV device in reducing power outages and meeting the critical electricity needs of premium customers:

Definition of ACO-MV Device:

The ACO MV Device (Automatic Change Over - Medium Voltage Device) is designed to address power outages by automatically switching from the main power source to a backup power source when an outage occurs. This device utilizes medium voltage as a backup power supply to ensure a stable electricity provision.

Operation of ACO-MV Device:

During a power outage, the ACO-MV Device detects the outage and promptly switches the power supply from the main source to the backup source. This process involves the operation of automatic switches and voltage control to ensure a smooth power transfer. Once the outage is over, the ACO-MV Device restores the power supply to the main source and returns to standby mode.

Configuration of ACO-MV Device:

The ACO-MV Device is connected to the electrical network through connectors and medium-voltage cables. It is installed in strategic locations such as substations or distribution points. The configuration includes the installation

and adjustment of technical parameters such as voltage, current, and timing for disconnection and power transfer.

Types of Premium Customers:

Premium customers commonly utilize the ACO-MV Device, including industries, large businesses, and public facilities that require a stable and reliable power supply. These premium customers have critical electricity needs and are sensitive to power outages.

Maintenance of ACO-MV Device:

The maintenance of the ACO-MV Device involves regular inspections, servicing, and functional testing. Inspections include physical checks of the device, examination of connectors and cables, and assessment of operational conditions. Servicing includes cleaning, lubrication, and replacement of faulty components. Functional testing is performed to ensure that the ACO-MV Device operates effectively and is ready for use when needed.

RESULTS AND DISCUSSION

Discussion of Research Findings

After describing the previous research, the researcher will provide a concrete discussion of the research findings. The research findings indicate that the implementation of ACO in power distribution systems can improve the reliability of power supply, especially for premium customers such as government institutions, industries, shopping centers, and other important establishments. In this research, the researcher applied the tested and discussed ACO configurations from previous research. The researcher conducted testing and evaluation of ACO performance in simulation conditions and in the field. The results showed that ACO can automatically detect disturbances quickly and switch the load to backup sources with a fast response, minimizing the recovery time and ensuring a stable and continuous power supply. Comparing the researcher's findings with previous research confirms that the implementation of ACO is an effective solution to improve the reliability of power distribution systems. The researcher's findings align with previous research that has identified the needs of premium customers and the importance of maintaining ACO performance through proper maintenance. Thus, the researcher's research findings make a significant contribution to expanding the understanding of ACO usage in power distribution systems and reaffirm its effectiveness in ensuring the reliability of power supply for premium customers.

Definition of Automatic Change Over Medium Voltage Device

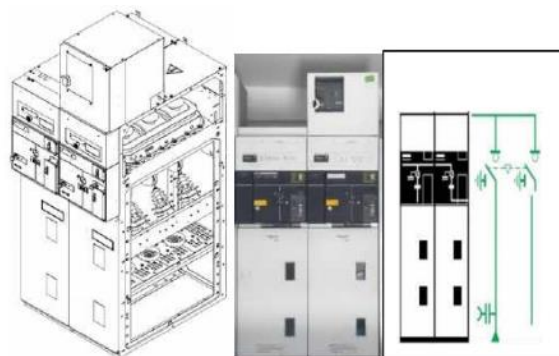


Figure 1. ACO SM6-24 KV Type NSM Switchgear

Automatic Change Over (ACO) is a device designed to improve the continuity of electricity supply to customers, particularly in terms of consumer consumption. In principle, ACO is a switch that operates by transferring the load from the priority power supply to the backup source automatically, ensuring a seamless transition to the backup source.

Application How Automatic Change Over works.

The Automatic Change Over (ACO) operates based on non-priority, and we have two reliable 20 kV power supply sources. When cubicle A is closed and cubicle B is open, if a disturbance occurs in cubicle A, cubicle A will automatically open, and cubicle B will automatically close. The same applies vice versa without any prioritization. We use this system for our VIP, VVIP, and Premium customer substations. Currently, the majority of our installations utilize ACO instead of SACO because SACO requires manual switching at the substation, while ACO allows for automatic switching.

ACO can also be configured as SACO with priority settings. For example, if cubicle A is set as the priority and cubicle B as the backup, when a disturbance occurs in cubicle A, the system will automatically switch to cubicle B. Once cubicle A is back to normal, the system will switch back to cubicle A. This type of configuration results in two switching events. Currently, we have only set a few systems with this priority configuration. The dominant brand for ACO cubicles is Schneider NSM.

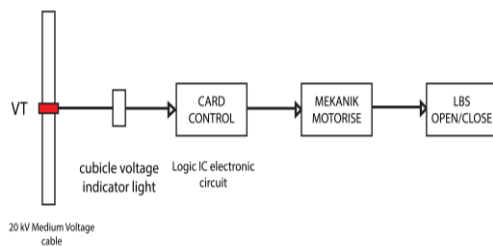


Figure 2. Automatic Changeover System

The cubicle that has two different power sources and can automatically switch to the backup power source when a disruption or voltage loss occurs in one of the sources is called an Automatic Change Over (ACO) cubicle. The working system of an ACO cubicle can be divided into two parts: (1) Priority System: In the priority system, one of the power sources is given priority. If the primary source experiences a disturbance or voltage loss, the backup source immediately takes over. Once the primary source returns to normal, it will automatically resume its role as the primary source, restoring the system to its original condition. (2) Non-priority System: In the non-priority system, no power source is considered as a priority. The ACO operates in an alternating manner. If there is a disturbance or fault in Load Break Switch 1 (LBS1), Load Break Switch 2 (LBS2) will immediately take over as the backup source. Similarly, if there is a fault in LBS2, LBS1 will automatically serve as the backup source. This alternating backup arrangement ensures continuity of power supply without any specific source being prioritized.

The working principle of an ACO can be understood based on the diagram below:

1. Main source to backup source switching: If a voltage drop of less than 40% is detected, the switching device (SW) 1 opens with a transition time (t_1) of 0.1 to 0.5 seconds, transferring the load from the main source to the backup source (SW 2).

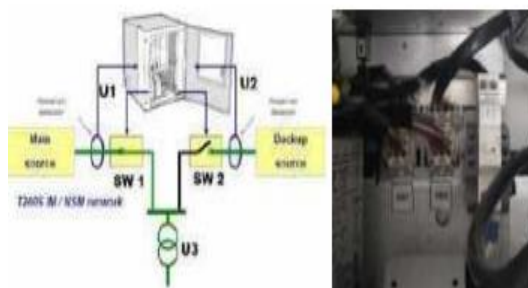


Figure 3. Operation Principle of ACO.

2. By detecting the return of normal voltage, exceeding 40%, the switching device (SW2) will open within a time period of $t_2 = 5 - 120$ seconds. Subsequently, the switching device (SW1) will close within a time range of $t_1 = 70 - 80$ milliseconds. This process allows for the restoration of the main source while ensuring a smooth transition and continuity of power supply. As a result of implementing ACO, which is expected to significantly reduce the frequency and duration of outages, the quality of electricity supply received by PLN's premium customers is projected to improve significantly.

After implementing ACO, it is estimated that the number of outages per year for premium customers will be reduced to 5 times, with an average duration of outages of only 0.5 hours. This significant improvement will enhance the quality of electricity supply received by premium customers of PLN.

Automatic Change Over machine working system configuration.

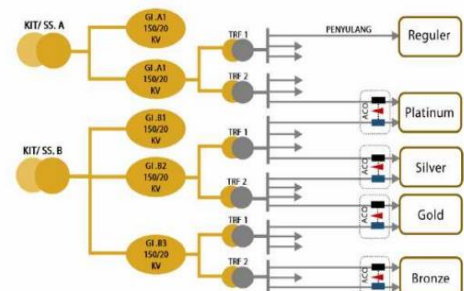


Figure 4. Power Supply Distribution

The distribution process of electricity for premium customers from power generation to ACO involves several stages in PLN's power distribution system. Here is an explanation of the distribution flow:

1. Power Generation: power plants, such as thermal power plants, hydroelectric power plants, wind farms, or solar power plants, generate Electricity. Power plants generate large amounts of electricity to meet the energy demand of various customers, including premium customers.
2. Transmission Network: The generated electricity is transmitted through high-voltage transmission networks (extra high voltage/EHV) to deliver power over long distances. The transmission network consists of high-capacity power lines that connect power plants to distribution centers or substations.

3. **Distribution Substation:** Distribution substations are facilities where high-voltage power from the transmission network is converted into medium voltage. Substations serve as distribution points to divide the electricity into smaller distribution networks.
4. **Primary Distribution Network:** The primary distribution network connects the substations to specific areas or regions. In this stage, power is delivered through the primary distribution network, which then directs the power to the distribution splitting substations.
5. **Distribution Splitting Substation:** The distribution splitting substation is responsible for dividing the power supply to various categories of premium customers, such as regular, bronze, silver, gold, and platinum. These substations are equipped with distribution equipment, including ACO (Automatic Change Over) if needed.
6. **Secondary Distribution Network:** From the distribution splitting substation, power is distributed through the secondary distribution network. This network comprises medium-voltage power lines that connect the splitting substation to the main distribution transformers near the customer's area.
7. **Main Distribution Transformers:** Main distribution transformers are the final distribution points before the power reaches premium customers. They control and distribute power to customer-specific substations connected to the distribution network.
8. **Premium Customer Substations:** Premium customer substations are the final distribution points where the power enters the premises or facilities of premium customers. These substations are equipped with appropriate equipment and facilities to meet the needs of premium customers.
9. **ACO (Automatic Change Over):** ACO is installed at premium customer substations to ensure uninterrupted power supply. If there is a disturbance or outage in the main power source, the ACO will automatically switch to the backup power source to ensure continuous power supply. The ACO operates according to the principles explained earlier, whether in a prioritized or non-prioritized system.

Through this distribution flow, PLN can provide reliable and uninterrupted power supply to premium customers. The distribution process involves various control points and equipment, including ACO, to ensure a stable and high-quality power supply to premium customers. Premium

ACO customers are divided into several categories, including bronze, silver, gold, and platinum types. Each type represents a different level of service or benefits offered to the customers. For bronze-type premium customers, they will receive a 20 kV power supply from two different feeders. However, both feeders originate from the same transformer. Here is an example of a bronze-type premium customer at UP3 PLN Kramat Jati :



Figure 5. ACO-MV device by Schneider brand at substation E258.

As shown in the above diagram, it illustrates the display of an Automatic Change Over (ACO) device, indicating that the power source from the feeder is currently coming from the substation in the direction of main distribution substation from the "Cawang" direction. Meanwhile, the backup power source is derived from a "Miniatur" substation.



Figure 6. Cubicle at Substation E258

Based on its type, this premium customer is classified as bronze and is owned by PT PLN UP3 Kramat Jati. Here is an example of the power supply flow from 2 feeders but originating from 1 transformer.

Table 1. Power Supply Flow from Premium Bronze Customer.

MAIN SUPPLY		
Substation	Transformer	Feeder
Cawang	Trafo 1	Pena
BACKUP SUPPLY		
Substation	Transformer	Feeder
Miniatur	Trafo 1	Global

The above diagram is a display of an Automatic Change Over (ACO) device that explains the power source configuration. The power source from the feeder is coming from the same direction, namely Cawang substation. However, there is a difference in the source of the transformers. The main power source is from transformer 3 of the Antasena feeder, while the backup power source is from transformer 1 of the Yudistira feeder.

Based on its type, this premium customer is classified as Silver, owned by the National Narcotics Agency (BNN). Here's an example of the power supply flow for this customer, involving two different feeders and two separate transformers within the same main distribution substation.

Table 2. Power supply flow from premium silver customer.

MAIN SUPPLY		
Substation	Transformer	Feeder
Cawang	Trafo 3	Antasena
BACKUP SUPPLY		
Substation	Transformer	Feeder
Cawang	Trafo 1	Yudistira

For gold-type premium customers, they will receive a 20 kV supply from two different feeders. These two feeders are sourced from different transformers, different main distribution substations, but still within the same power plant. Here's an example of a gold-type premium customer in PLN from the Ministry of Social Affairs of the Republic of Indonesia. Since this substation happens to be a distribution hub or distribution substation (DS), it serves as a branching point to various other feeders and consists of numerous cubicles sourced from different feeders.

Table 3. Power supply flow from premium gold customer.

MAIN SUPPLY		
Substation	Transformer	Feeder
Miniatur	Trafo 2	Nakula
BACKUP SUPPLY		
Substation	Transformer	Feeder
Cawang	Trafo 1	Karton

For the Platinum type, this customer will receive a 20 kV supply from 2 different feeders, which originate from 2 different transformers, 2 different main substations, and 2 different power plants. It can be said that the higher the level of the premium customer type, the more reliable the 20 kV supply system becomes. Here is an example of a Platinum type premium customer at PLN from Halim Perdanakusuma Airport:



Figure 7. ACO-MV device by Talus brand at substation E20B.

Based on its type, this premium customer belongs to the Platinum category, which is owned by Jakarta International Airport (Halim Perdanakusuma). Here is an example of the power supply flow from 2 different feeders, 2 different transformers, 2 different main substations, and 2 different subsystems or power plants :

Table 4. Power supply flow from premium platinum customer.

MAIN SUPPLY		
Substation	Transformator	Feeder
Cipinang	Trafo 1	Muka
BACKUP SUPPLY		
Substation	Transformator	Feeder
Cawang	Trafo 1	Potatos

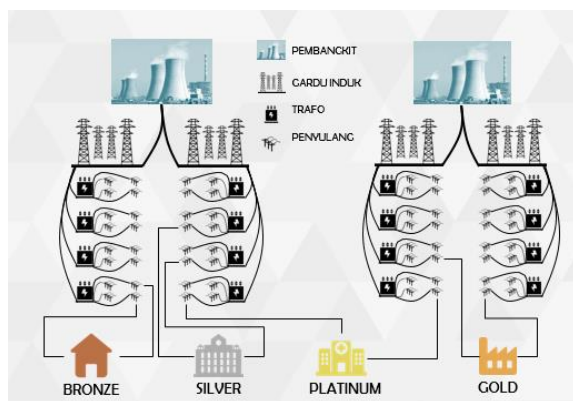


Figure 8. Network Configuration.

In conclusion, the higher the level of PLN premium service, the better the quality of service, reliability, and convenience for premium customers, starting from bronze, silver, gold, and platinum. This is because the backup power supply sources are diverse, ranging from different feeders, transformers, substations, and power plants, ensuring a robust distribution system. As a result, premium customers do not need to worry about power outages.

CONCLUSION.

Based on the findings of this research, the implementation of ACO in the power distribution system provides a configuration that can improve the reliability of power supply for premium customers. In the conducted testing and evaluation, ACO has proven to quickly detect disturbances and responsively switch the load to backup sources, minimizing downtime and ensuring stable and continuous power supply. By using the ACO cubicle, customers receive power supply from two different feeders, creating redundancy that enhances reliability and reduces recovery time during disruptions.

The calculation results show that the implementation of ACO has a significant positive impact on the quality of power supply for premium customers of PT.PLN (PERSERO). The frequency

of outages can be reduced by up to 50%, from 10 times per year to 5 times per year, while the duration of outages can be reduced by up to 75%, from an average of 2 hours to just 0.5 hours. These improvements in outage frequency and duration directly enhance the reliability and stability of the power supply received by premium customers. ACO proves to be an effective solution for minimizing disruptions and improving overall service quality.

Furthermore, it is important to note that the optimal configuration of ACO can vary depending on the characteristics of the distribution network and customer requirements. In this research, the successfully tested and evaluated ACO configuration involved using two feeders as power supply sources. However, in different contexts, a different configuration may be required, such as using more than two feeders or considering other variables like feeder size and capacity.

Suggestions, for customers such as schools, hospitals, government institutions, and others, it is recommended to use premium services to ensure continuous power supply. Based on the data obtained from the use of premium services, customers receive a more reliable power supply compared to regular customers. Therefore, regular customers may consider switching to premium services to obtain uninterrupted power supply.

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