Temporary Devider as an innovation tool in reducing operational losses of PT PLN (Persero) UP3 Sidoarjo

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ABSTRACT

Temporary Devider is a new tool that was created in October 2024 by the PT PLN (PERSERO) UP3 SIDOARJO PDKB Team. Temporary Devider was created to help and solve problems with SUTM maintenance work that could not be carried out by the PDKB team due to high risk factors. The results of the study from 5 implementations in the PT PLN (Persero) UP3 Sidoarjo work area, local blackouts by utilizing the Temporary Devider as a new innovation tool with an investment value IDR 4,000,000 can reduce the difference in company losses by 89,376.08 kWh or Rp. 104,263,090 when compared to blacking out one feeder and 16,839.02 kWh or IDR 19,578,227 when compared to per-section outages. The use of Temporary Deviders has been proven to be able to reduce losses due to blackouts which result in Energy Not Supplied.

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1. INTRODUCTION

In this modern era, there are many conveniences for living life by using equipment that utilizes energy sources from electricity. PT PLN (Persero) as an electricity provider continues to face challenges from customers to always maintain the reliability of the electricity network. Customers no longer want the electricity in their homes to frequently go out. Power outages have losses on the customer side and also on the electricity provider side [1]. When the electricity goes out, customers can be harmed because their activities are disrupted and electricity providers will be harmed because electricity that cannot be utilized becomes ENS (Energy Not Supplied) and impacts the company's operational losses. [2].

In an effort to reduce power outages, PT PLN (Persero) has formed a PDKB (Work Under Voltage) Team. With the PDKB Team, maintenance of the 20KV SUTM network can be carried out without having to shut down the network so that continuity of electricity supply to customers can be maintained [3]. The work of the PDKB Team carries high risk, so every work that will be carried out must be well planned by paying attention to the safety of workers, equipment and systems. It is not uncommon for the PDKB Team to encounter obstacles such as large risks of danger, difficult locations, and work for which there is no SOP to carry out using the PDKB Team method. [4]. If problems such as those above are encountered, work will be carried out by making a plan to extinguish one feeder or per section. However, one feeder or per-section blackout is still too extensive because at least the area affected by the blackout is very large and can cause large losses [5]. Therefore, the PT PLN (Persero) UP3 Sidoarjo PDKB Team has created a new innovation tool called Temporary Devider to overcome this problem so that blackouts can be kept to a minimum and company losses can be reduced. It is still unknown how big an impact this Temporary Devider will have in reducing losses, increasing potential income, and improving the company's positive image. The aim of this research is to find out how much energy or rupiah loss can be reduced in blackouts using Temporary Deviders compared to blackouts at one feeder or per section.

2. THE COMPREHENSIVE THEORETICAL BASIS

2.1 Energy Not Supplied calculation formula

Energy not Supplied is energy lost due to outages for maintenance, repair and network expansion work. In a 3-phase 20KV network system, the calculation formula for lost energy is in Kilo Watt hours (kWh) can be calculated using the following formula [8]-[9]:

$$ENS = I(A) \times T(Jam) \times V(KV) \times Cos\ \varphi \times \sqrt{3}$$

ENS : Energy not Supplied (kWh)

I : Average feeder load (Ampere)

T : Processing time (Jam)

V : Voltage (KV)

Cos φ : Power Factor = 0,85

$\sqrt{3}$: 1,732

2.2 Losses in Rupiah calculation Formula

Losses in Rupiah Value is a financial loss, a decrease in lost income due to outages for maintenance, repair and network expansion work. In a 3 phase 20KV network system. To calculate losses in rupiah value, it can be formulated as follows [8]-[9] :

Rplosses = Elosses × (Rp/ kWh)

Rplosses : Losses in Rupiah (Rp)

Elosses : Energy not Supplied (kWh)

(Rp/kWh) : Electricity tarrif price in a kWh

3. METHOD

This Analytical Study uses a quantitative research methodology with a focus on collecting and analyzing existing data as well as formulas that have been studied to determine the impact of using the Temporary Divider as a new innovation tool. The following is an image of the flow diagram for conducting this analytical study

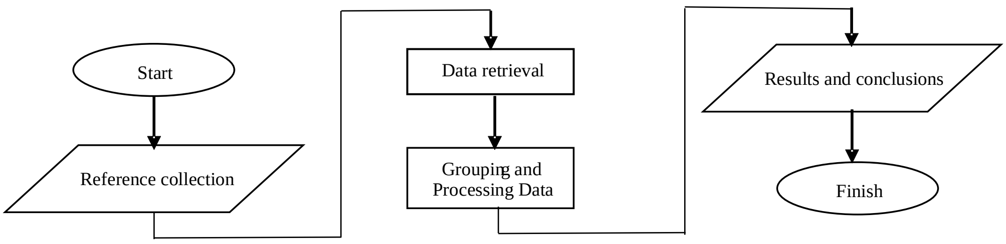

Figure 1. Research flow diagram

From Figure 1 above, it is explained that the first step in this research is collecting references so that you can find out what data is needed. After the data is collected, the data is processed and grouped. Finally, write the research results and explain the conclusions.

3.1 References collection

3.1.1 Sistem Distribusi Tenaga Listrik

The electric power distribution system within PT PLN (Persero) includes all 20 KV Medium Voltage Networks (JTM) and all 380/220 Volt Low Voltage Networks (JTR) down to customer meters. Distribution of electrical power from the substation to the load centers is carried out by pulling distribution wires through conductors. This distribution system is useful for distributing electrical power from large electrical resources (Bulk Power Source) to consumers. So the function of electric power distribution is dividing or distributing electric power to several places (customers) [8].

3.1.2 PDKB (Pekerjaan Dalam Keadaan Bertegangan)

PDKB is a special squad or team formed by PT PLN (Persero) to carry out maintenance of the Electric Power System Network while the voltage remains on (hot lines maintenance) [7]. The PDKB team has been provided with special training supported by highly insulated equipment in carrying out their duties so that their lives are maintained. The PDKB team in the PT PLN (Persero) area is divided into 3 methods, namely;

a. Distance Method
PDKB works using insulated poles where PDKB personnel must maintain a minimum distance of 60cm from live networks. PDKB Distance Method works in the distribution system with a voltage of 20KV-24KV.

b. *Contack Method*
PDKB works using highly insulated mobile cranes where PDKB personnel must use rubber sleeves on body parts that have the potential to touch live tissue. PDKB Direct Touch Method works in the distribution system with a voltage of 20KV-24KV.

c. *Potencial Method*
PDKB works by equalizing the potential between PDKB personnel and network voltage when carrying out maintenance. So that there is no potential difference, PDKB personnel use special PPE and conductive clothing. PDKB Potential Method works in the scope of 70KV-500KV transmission systems.

3.1.3 Energy not Supplied

The energy produced from generation must be able to be distributed to customers and generate income for the company. However, the energy that has been produced and distributed cannot be distributed due to several factors, so this is usually called Energy Not Supplied, which results in losses for the company. The calculation of Energy Not Supplied can be calculated by knowing the difference between the energy distributed and the income from utilizing that energy. One of the factors that causes Energy Not Supplied is outages due to disruption and maintenance [2]. The company always strives to reduce the value of Energy Not Supplied so that the percentage of income from the use of distributed energy is large and increases profits for the company.

3.1.4 Innovation tool Temporary Devider

Temporary Devider is a new tool that was created in October 2024 by the PT PLN (PERSERO) UP3 SIDOARJO PDKB Team. Temporary Devider was created to help and solve problems with SUTM maintenance work that could not be carried out by the PDKB team due to high risk factors. Temporary Dividers are used as temporary supports for live and non-live conductors. Temporary Devider is made from high insulating material, namely polymer and aluminum strength as a conductor clamp holder. The Temporary Divider has been simulated with good insulation resistance and mechanical strength results so it is ready to be implemented. Temporary Divider is applied to SUTM 20KV with a conductor cross-sectional area of 70mm² - 240mm². The investment value that has been spent on making this Temporary Divider innovation tool is IDR 4,000,000.

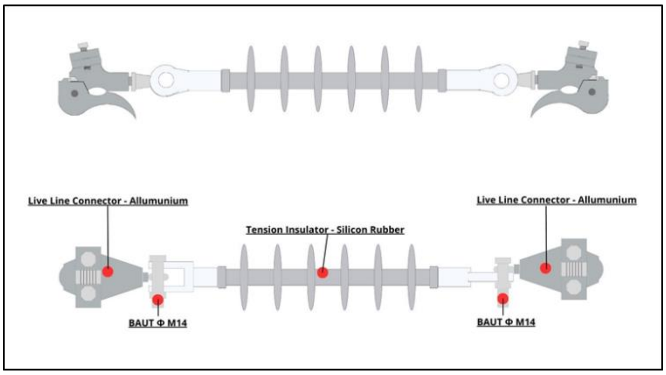

Figure 2. Innovation tool Temporary Devider

Figure 2 explains the shape and parts of the Temporary Divider innovation tool. In the middle there is a Tension Insulator made of Silicon Rubber. On the right and left sides there are parts to hold the conductor, namely the Live Line Connector which is made of aluminum.

3.2 Data retrieval

In this analytical study the data required is:

a. The output voltage from the Transmission Substation is used as data as the voltage value on a feeder. Data collection can be done using SCADA monitoring from the main substation for distribution operators in real time.

Table 1. Analysis Voltage data

	Date	Output GI	Name of Feeder	Voltage
Analysis 1	04/11/24	GI Buduran	Selogiri	20,8 KV
Analysis 2	05/11/24	GI Sidoarjo	Gempolsari	21 KV
Analysis 3	11/11/24	GI Sidoarjo	Jiken	20,9 KV
Analysis 4	18/12/24	GI Sidoarjo	Gempolsari	21 KV
Analysis 5	24/12/24	GI Buduran	Sidokepung	20,8 KV

b. The load of one feeder is taken from the current value monitored from the measuring instrument installed at the output of the main substation. Load data is taken directly when the analysis is carried out

Table 2. Analysis Load data

	Date	Output GI	Name of Feeder	Load
Analysis 1	04/11/24	GI Buduran	Selogiri	63 A
Analysis 2	05/11/24	GI Sidoarjo	Gempolsari	168 A
Analysis 3	11/11/24	GI Sidoarjo	Jiken	217 A
Analysis 4	18/12/24	GI Sidoarjo	Gempolsari	168 A
Analysis 5	24/12/24	GI Buduran	Sidokepung	212 A

c. Section load is taken by providing an estimate of the percentage load of a section in the feeder to the total load of the feeder.

Table 3. Analysis section load data

	Date	Name of Feeder	Section	Load Percentage x Total Load	Load Section

Analysis 1	04/11/24	Selogiri	3	24% x 63 A	15 A
Analysis 2	05/11/24	Gempolsari	4	34% x 168 A	57 A
Analysis 3	11/11/24	Jiken	7	22% x 217 A	47 A
Analysis 4	18/12/24	Gempolsari	3	12% x 168 A	20 A
Analysis 5	24/12/24	Sidokepung	3	21% x 212 A	45 A

d. Local blackout load is calculated by taking an estimate of the sum of the loads from the distribution transformers affected by the blackout.

Table 4. Analysis local blackout load data

	Date	**Location**	**Load blackout**
Analysis 1	04/11/24	Teritory PT Avian	8 A
Analysis 2	05/11/24	Jl KH Ahmad Dahlan - Kalitengah	12 A
Analysis 3	11/11/24	Desa Bulang - Kates	4 A
Analysis 4	18/12/24	Desa Penatar sewu	8 A
Analysis 5	24/12/24	D'Gardenia city	6 A

e. Duration of the blackout is calculated in hours from the time the work starts until the work is finished

Table 5. Analysis duration job data

	Date	**Job**	**Duration**
Analysis 1	04/11/24	Uprating cable SUTM	6 Jam
Analysis 2	05/11/24	Construction fox TM10-TM5	4 Jam
Analysis 3	11/11/24	Construction fox for PBPD	4 Jam
Analysis 4	18/12/24	Maintenance Network of SUTM	3 Jam
Analysis 5	24/12/24	Adding new Transformator	3 Jam

f. Rupiah value in a kWh is obtained by taking sales rupiah acquisition data compared to the number of kWh sold in a month period in one Customer Service Unit

Table 6. Analysis average Rupiah value data

	Date	**Costumer Service Unit**	**Period**	**Average Rupiah Value**
Analysis 1	04/11/24	ULP KOTA	NOVEMBER	Rp 1.222,-
Analysis 2	05/11/24	ULP PORONG	NOVEMBER	Rp 1.138,-
Analysis 3	11/11/24	ULP PORONG	NOVEMBER	Rp 1.138,-
Analysis 4	18/12/24	ULP PORONG	DECEMBER	Rp 1.147,-
Analysis 5	24/12/24	ULP KOTA	DECEMBER	Rp 1.221,-

4. RESULT AND DISCUSSION

4.1 Comparison of energy losses (kWh)

To calculate energy losses or Energy not Supplied during a blackout, you can take Load Current data in Amperes, Feeder Voltage in Volts, and duration of the blackout in Hours. With the formula that has been learned,

$$\boldsymbol{E}\textbf{losses} = \boldsymbol{I}(\boldsymbol{A}) \times \boldsymbol{T}(\textbf{Hour}) \times \textbf{V}(\boldsymbol{KV}) \times \boldsymbol{Cos\ \varphi} \times \sqrt{3}$$
$$\boldsymbol{E} = \boldsymbol{I} \times \boldsymbol{T} \times \textbf{V} \times \boldsymbol{Cos\ \varphi} \times \sqrt{3}$$

To find out the comparison of energy losses. The data that has been obtained can be entered in the following table column

In table 7 below, it is explained that there are 3 conditions in each analysis to comparison of energy losses. the difference between these 3 conditions is the offloading load, namely; outage one feeder, outage one section, and outage a local area by utilizing the Temporary Devider innovation tool.

Table 7. Comparison of energy losses

	Condition	Load (A)	Voltage (kV)	Time (Hour)	$Cos\ \varphi$	√3	Losses Energy (kWh)
ANALYSIS 1	Outage one Feeder	63	20,8	6	0,85	1,732	11.575,03
	Outage one section	15	20,8	6	0,85	1,732	2.755,96
	Temporary Devider	8	20,8	6	0,85	1,732	1.469,84
ANALYSIS 2	Outage one Feeder	168	21	4	0,85	1,732	20.775,69
	Outage one section	57	21	4	0,85	1,732	7.048,89
	Temporary Devider	12	21	4	0,85	1,732	1.483,98
ANALYSIS 3	Outage one Feeder	217	20,9	4	0,85	1,732	26.707,47
	Outage one section	47	20,9	4	0,85	1,732	5.784,57
	Temporary Devider	4	20,9	4	0,85	1,732	492,30
ANALYSIS 4	Outage one Feeder	168	21	3	0,85	1,732	15.581,76
	Outage one section	20	21	3	0,85	1,732	1.854,97
	Temporary Devider	8	21	3	0,85	1,732	741,99
ANALYSIS 5	Outage one Feeder	212	20,8	3	0,85	1,732	19.475,44
	Outage one section	45	20,8	3	0,85	1,732	4.133,94
	Temporary Devider	6	20,8	3	0,85	1,732	551,19

4.2 Comparison of Financial losses in IDR

To analyze losses in financial terms during a blackout, you can take losses energy data in kWh and the average value of rupiah per kWh. With the formula that has been learned,

Rplosses = Elosses × (Rp/ kWh)

To find out the comparison of financial losses in IDR, the data that has been obtained can be entered in the following table column.

After knowing the magnitude of energy losses, the comparison of financial losses in IDR units in table 8 below, explains that each analysis has a different value of rupiah per kWh according to the data collected. The result of multiplying the energy loss and the rupiah value per kWh becomes the financial losses in IDR.

Table 8. Comparison of Financial losses in IDR

	Condition	Energy Losses (kWh)	Rupiah value in a kWh (Rp)	Financial Losses (Rp)

ANALYSIS 1	Outage one Feeder	11.575,03	Rp1.222	Rp	14.144.681
	Outage one section	2.755,96	Rp1.222	Rp	3.367.781
	Temporary Devider	1.469,84	Rp1.222	Rp	1.796.150
ANALYSIS 2	Outage one Feeder	20.775,69	Rp1.138	Rp	23.642.731
	Outage one section	7.048,89	Rp1.138	Rp	8.021.641
	Temporary Devider	1.483,98	Rp1.138	Rp	1.688.767
ANALYSIS 3	Outage one Feeder	26.707,47	Rp1.138	Rp	30.393.106
	Outage one section	5.784,57	Rp1.138	Rp	6.582.839
	Temporary Devider	492,30	Rp1.138	Rp	560.242
ANALYSIS 4	Outage one Feeder	15.581,76	Rp1.147	Rp	17.872.284
	Outage one section	1.854,97	Rp1.147	Rp	2.127.653
	Temporary Devider	741,99	Rp1.147	Rp	851.061
ANALYSIS 5	Outage one Feeder	19.475,44	Rp1.221	Rp	23.779.511
	Outage one section	4.133,94	Rp1.221	Rp	5.047.538
	Temporary Devider	551,19	Rp1.221	Rp	673.005

5. CONCLUSION

From the analysis and discussion above, it can be concluded that the use of Temporary Dividers can indeed reduce company losses. The results of the study from 5 implementations in the PT PLN (Persero) UP3 Sidoarjo work area, local blackouts by utilizing the Temporary Devider as a new innovation tool with an investment value of Rp. 4,000,000 in making the tool, can reduce the difference in company losses by 89,376.08 kWh or Rp. 104,263,090 when compared to blacking out one feeder and 16,839.02 kWh or IDR 19,578,227 when compared to outages per section.

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