International Journal of Trends in Mathematics Education Research
Vol. 5, No. 3 (2022), pp. 281~290
ISSN 2621-8488 (online)
DOI: https://doi.org/10.33122/ijtmer.v5i3.127

Research Article

Electrical distribution system efficiency and effectiveness with simple mathematics at the Indonesian aviation Polytechnic of Curug

Yenni Arnas✉, Zulina Kurniawati, KGS. M. Ismail

Politeknik Penerbangan Indonesia Curug, Tangerang, Banten, Indonesia, 15810
✉Corresponding Author: yenni.arnas@ppicurug.ac.id

Received: 14 June 2022 *Revised: 21 August 2022* *Accepted: 26 September 2022* *Available online: 30 September 2022*

ABSTRACT

Indonesian Aviation Polytechnic of Curug (PPI Curug) uses power from PLN of 3 Mega Watts. Since the beginning implementation of the electrical system at the PPI Curug Campus, adjustments have never been made. The additions of a new distribution system did not go through careful planning, this can be shown by the data that until now there are still buildings at PPI Curug which are supplied with a voltage of 110 V per phase. Upgrading the electrical system in several buildings that are supplied with a voltage of 110 V per phase has been carried out slowly through the adjustment mechanism of the electrical installation in these buildings, and has not yet touched on the distribution system. The large number of power transformers turned out to be not proportional to the power supply borne by each transformer, and overall none of the transformers was burdened more than 40% of the nominal load. On the other hand, the number of electricity subscription bills paid by PPI Curug has increased from year to year. This study aims to determine whether the electricity distribution system used at PPI Curug is currently effective and efficient and to determine an effective and efficient electricity distribution system based on the characteristics of the area and type of load at PPI Curug. The research method used is an evaluative qualitative method which will describe the condition of the distribution system and installation at PPI Curug, then evaluate it based on existing standards. The differences that exist between the real conditions in the field and the existing standards will be used as conclusions and suggestions for improvements. The results showed that the percentage value of the efficiency of all transformers showed a value of 95% so that the efficiency of the transformer at PPI Curug was categorized as good, but the condition that there was still a large amount of unused power needed to anticipate the use of electrical power beyond the requirement.

Keywords: bill; distribution; power; transformer

1. INTRODUCTION

The Indonesian Aviation Polytechnic curug (PPI Curug) has an area of 85 ha and subscribes to electricity service power from the State Electricity Company (PLN) of 3 Mega Watts (MW) which is divided into 5 incomings. Each incoming line from PLN is divided into 6 substations and distributed through 10 power tranformators which then supply electrical power to the loads spread on the buildings on the PPI Curug Campus. Since the beginning of the electricity system at the PPI Curug Campus, adjustments have not been made. The addition of a new load or building is always followed by creating a new distribution line separate from the existing power distribution line. This process adds to the long list of transformers and generator sets/generator sets designed as back-up systems in the event of a failure of the electrical power supply from PLN. The number of electricity subscription bills paid by PPI Curug from year to year has increased. From the primary distribution line the distribution substations take the voltage to lower their voltage with the distribution transformer into a low voltage system, which is 220/380 Volts. Furthermore, through secondary distribution channels it is channeled to consumer customers. In a long-distance power distribution system, it is mandatory to use the maximum possible voltage, using a step-up transformer.

The large number of power transformers is not proportional to the power supply borne by each transformer. (Irwan, Kartika dan Saputro, 2020) said that the electrical power consumption in each distribution transformer at PPI Curug is still very far from its nominal capacity, even overall there is no transformer that is burdened with more than 40% of the nominal load. (Agung et al., 2018) mentioned that measurements have been taken to determine the efficiency and shrinkage values of the distribution transformer by comparing two transformers that have a load below 10% and above 10%. From the calculation results, it was found that distribution transformers with a load below 10% tend to have a lower efficiency value compared to distribution transformers with loads above 10% and relatively higher distribution transformer shrinkage values in distribution transformers with loads below 10%.

Findings (Sya'roni dan Rijanto, 2019) that uneven loads at the consumer level cause load imbalances on transformers. The load imbalance on the transformer causes the neutral current to increase in size, resulting in power losses also increasing in size (Lamtiar et al., 2020) . For this reason, the solution to the load imbalance is to move the load so that the loading between phases can be evenly distributed. (Hidayat, Legino dan Mulyanti, 2018) in their research stated that the load imbalance between phases will affect transformer performance, overheating in the load phase (Arnas et al., 2021; Sihono, Fatkhulloh, et al., 2021; Sihono, Fatkulloh, et al., 2021), current flowing on the neutral wire, drop the end voltage on the overload phasa network. However, the efforts made in the context of load balancing will not meet ideal conditions due to different load characteristics. According to (Tharo, Tarigan dan Pulungan, 2018) Unbalanced loading on a 20 kV distribution transformer causes current to flow at neutral current. This current is a loss that must be borne by PT PLN because along the neutral delivery there is resistance. Load equalization carried out by rewiring the customer's home connection from the heavy phase to the lightly loaded phase on the 20 kV Transformer distribution line can reduce losses at neutral delivery of 65.68 kW (LWBP condition).

Based on several studies that have been carried out, this research will focus on whether the electricity distribution system used in PPI Curug is currently effective and efficient and find out an effective and efficient electricity distribution system based on regional characteristics and types of loads in PPI Curug seen from several factors including transformer loading, load imbalance and several other factors. Efforts are made by re-collecting installed electrical power along with load calcification, measuring power consumption in each distribution transformer, and recalculating the factors that affect the determination of the capacity of the protection system and or distribution transformer. The energy loss (losses) that occur in distribution transformers are caused by a load effect generally of less than 5%, however, the loading factor on distribution transformers usually has a greater impact on power losses than the diversity of daily loads, (APEC, 2018). Power losses on the transformer can be caused by technical factors in the transformer itself, but nevertheless, an average of 70% of the power loss on the transformer is due to unburdened losses. Transformer efficiency is critical in efforts to improve electrical energy efficiency, (B. Elizabeth, 2013).

High loading affects the quality and lifetime of the transformer. Similarly, the magnitude of the load imbalance also affects the amount of neutral current flowing on the transformer and soil conductor. The small efficiency of the transformer affects the quality and decreases the reliability of the electrical energy distribution system and causes damage and the lifetime of the tool concerned, (Antonov, 2017). Loading affects the heat that appears in the transformer. Excessive heat in the transformer coils can damage the insulation and raise the temperature in the transformer oil. Excessive temperature in transformer oil can damage the viscosity of the oil itself, ultimately affecting the shrinkage of transformer age/age, (Maruf dan Primadiyono, 2021).

The efficiency of the power transformer, which is used in many places, from the production stage to the phase of transmission and distribution of electrical energy, affects energy efficiency significantly. When different periodic time periods are considered, for different enterprises and institutions, it can be seen that when transformers operate at a small power ratio, the loss ratio increases significantly, (Kaya, İmal dan Gökhasan, 2018). One of the disturbances that occurs in the distribution transformer is an overblast in the transformer caused by uncontrolled load growth on the path borne by the transformer (Ta et al., 2017). The development and addition of loads on the electricity distribution line, especially in the downstream, usually has poor instrumentation so that it is difficult to control it and becomes an obstacle in the efficiency of electrical energy. Optimization of electrical power can be carried out by making operational arrangements on the load installed in the system, so that there is no oversupply, (Mieftah, 2018). Power losses can be due to the distance of the load centers away from the center of the electrical energy source, and the imbalance of the load of the distribution transformer. One way to do efficiency is to balance the load borne by the distribution transformer. The cost of procuring a distribution transformer takes up about 10% of the cost for the procurement of an electric power distribution, so when replacing the distribution transformer, you should pay attention to the load served by the old distribution transformer, the capacity of the transformer and the load so far, and the general condition of the existing distribution system, (Chaerul Arifin, Bambang Satriyo P, 2017).

This study is expected not only to contribute scientifically, but is also expected to be able to describe, analyze, and evaluate the condition of the installation and distribution system at the Indonesian Aviation Polytechnic Curug so that it is expected to provide a more complete picture of its advantages and disadvantages to be able to make improvements in order to efficiency without reducing the effectiveness of the installation system and distribution of electrical power itself.

2. RESEARCH METHOD

The research method used in this study is an evaluative method with a qualitative approach that will describe the condition of the distribution and installation system at the Indonesian Aviation Polytechnic Curug, then evaluate based on existing standards, (Sugiyono, 2018). The research was carried out at PPI Curug, by re-recording the installed electrical power along with the load classification, measuring power consumption in each distribution transformer, recalculating the factors that affect the determination of the capacity of the protection system and or distribution transformer, as well as the use of safety standards and the quality of electricity distribution. This research activity will be carried out for 3 months from July to September 2021.

The data collection and processing techniques are as follows: 1) Collecting detailed data from all loads that require electricity supply at PPI Curug; 2) Record and record the measurement of the power consumption of all distribution transformers used as samples; 3) The data will be processed in the laboratory/class to be analyzed and calculated the minimum value, average value and maximum value of each transformer statistically; 4) The statistical results data are analyzed using existing formulas to see how the efficiency of the transformer is; 5) Analyze the impact of distribution transformer efficiency on the cost of PPI Curug electricity bills; 6) Analyze the causes of power transformer inefficiency as a mitigation to the plan to improve the electricity distribution system at PPI Curug

3. RESULTS AND DISCUSSION

3.1 Data Collections

Data collection was carried out for two months, namely June and July of 2021. During the month of June, researchers carried out load data collection in each PPI Curug building. During july, researchers took measurements at each substation during the week. For data retrieval using a power quality analyzer and ampere pliers. The data collection carried out is the number of installed loads along with the size of each load. The data measured is the data of the value of the secondary current in the transformer and the voltage data in the transformer. Here are some examples of load data attached to those in PPI Curug:

3.1.1 The Auditorium Building gets electricity supply from substation 1A Transformer B

Table 1. Average Electrical Power Consumption of Distribution Transformers in PPI Curug

Charges/ Load	Total (Ampere)
TL 58 W Lamp	34.8
Ordinary Lamps	8.51
AC 1/2 PK	3.35
AC 1 PK	117.09
AC 3 PK	40.15
AC 5 PK	133.82
AC 12 PK	120.44
AC 20 PK	669.09
AC 3700 W	16.82
Exhaust fan	0.38
Dispenser	1.14
Projector	1.23
Speakers	17.72
Total	1164.54

3.1.2 The Main Building gets electricity supply from Substation 2

Table 2. Installed Load Data in the main Building

Charges/ Load	Total (Ampere)
TL 18 W Lamp	2.37
Lamp TL 36 W	14.56
Ordinary Lamps	12.98
LED Lights	0.38
AC 1/2 PK	28.44
AC 1 PK	3.35
AC 2 PK	40.12
Exhaust fan	0.27
PC (Computer)	45.68
TELEVISION	3.18
Refrigerator	5.8
Dispenser	11.36
Printer	99.23
Magic com	5.45
Shredder (145 W)	1.98
Projector	1.23
Microwave	2.27
Speakers	1.36
Scanner	6.73
Aquarium Pump	20.4
Electric Stove	20
Heater	4.54
Total	331.68

3.1.3 The Main Building gets electricity supply from Substation 2

Table 3. Load Data Installed in Hangars 3 and 4

Charges/ Load	Total (Ampere)
Lamp TL 36 W	1.96
Ordinary Lamps	0.11
Halogen Lamp	54.55
AC 2 PK	80.24
Compressor 20A	40
Total	176.86

3.1.4 Health Unit of Substation 5 Transformer B

Table 4. Installed Load Data in Health Unit Buildings

Charges/ Load	Total (Ampere)
Ordinary Lamps	2.89
TL 18 W	0.57
TL 36 W	20.95
AC 1/2 PK	5.02
AC 1 PK	53.53
TELEVISION	0.45
1 LAB Tool Set	25
Computer	4.09
Dispenser	15.91
Printer	6.73
Fan	2
Refrigerator	1.02
Blower	0.05
Washing machine	2.27
50 W Floodlights	0.23
400 W Pump	1.82
Total	142.53

3.1.5 Building Simulator of Substation Simulator

Table 5. Installed Load Data in Simulator Building

Charges/ Load	Total (Ampere)
Lamp TL 36 W	60.87
Ordinary Lamps	7.04
AC 1 PK	10.04
AC 2 PK	193.9
AC 3 PK	40.15
PC (Computer)	28.64
TELEVISION	0.45
Refrigerator	1.02
Dispenser	1.14
Printer	10.09
Projector	2.45
UPS 10KVA	9.09
Heater	2.27
Microwave	2.27
Halogen 100 W	1.36
AC 30PK	301.09
Motion (Drive Simulator) 70A	70
Pump 7.5 KW	34.09
Pump 37 KW	168.18
Pump 10.8 A	18.8
400 W Pump	1.82
Total	964.76

3.1.6 Aircraft Engineering Hangar of the TPU Substation

Table 6. Load Data Installed in Aircraft Engineering Hangars

Charges/ Load	Total (Ampere)
Lamp TL 36 W	150.54
Ordinary Lamps	12.54
AC 1 PK	3.34
AC 2 PK	434.61
PC (Computer)	84.54

Refrigerator	0.68
Dispenser	4.54
Printer	11.77
Wind Tunel (3.7 Kw)	21.022
Projector	1.227
Helicopter Lab Module (10 A)	60
Hydraulic Module (16 A)	160
Hydraulic Pump 3.5 KW	119.318
Pump 3.7 KW	42.04
Pump 2.10 KW	59.65
Pump 1.5 KW	17.04
GWS Module (32 A)	64
Blower	60
Sheet Metal Module (6A)	6
CNC Module (26A)	104
Welding Module (33 A)	99
Total	1515.857

3.2 Load Measurement Results

The measurement of each transformer is taken using a power quality analyzer tool once a week, namely on transformer A at substation 1A, transformer B at substation 1A, transformer A at substation 2 (direction GSG), transformer A at substation 2 (barracks direction), transformer A at Substation Hangar TPU, and transformer A Substation Simulator. Meanwhile, the measurements on transformer A and transformer B at Substation 5 use ampere pliers. After measurements are taken on the Power Quality Analyzer, data will be recorded using the Microsoft Excel application to make it easier to calculate the load.

3.3 Data Processing

3.3.1 Percentage of installed load and power subscription

The following are the load sharing results of each transformer:

Table 7. Load Sharing of Each Transformer

No.	Load Sharing	Total (Ampere)
1	Substation 1 A Transformer B	3089,01
2	Substation 2	2104.91
3	Substation 5 Transformer A	176.85
4	Substation 5 Transformer B	142.53
5	Substation Simulator	1466.07
6	TPU Substation	3860.54
	Total	10829.91

While the table below is the subscription power of PPI Curug August 2019:

Table 8. PPI Curug Subscription Power August 2019

No.	User ID	Name of KWhmeter	Daya (Power)
1	546100475086	Stpi Curug Tangerang	1040000
2	546202092615	Rast Pendidikan Pusbang	105000
3	546700462084	Stpi Curug	1040000
4	546202395520	Simulator Pesawat Stpi	630000
5	546202801848	Gd Asrama Reguler Stpi	197000
6	546202092698	Asrama Rast Pusbang Sdm	147000
7	546700414673	Rumdin Alpha Pusdiklat	41500
		Total	3.200.500 VA

The amount of electricity subscribed to PPI Curug is 3,200,500 VA

$$I = \frac{P}{V} = \frac{3200500}{400 \times \sqrt{3}} = 4619{,}254\ A$$

I Load Sharing of Each Transformer = 10829,91 A

I Subscription Powe = 4619,254 A

Percentage of installed load

$$= \frac{\text{Iinstalled load}}{\text{Iload available}} \text{ x } 100\%$$

$$= \frac{10829{,}91\text{ A}}{4619{,}254\text{ A}} \text{ x } 100\%$$

= 2,34 x 100%

= 234%

Based on the calculation obtained from the percentage of installed load with subscription electrical power in PPI Curug that the installed load has crossed the threshold and even passed from the PPI Curug power subscription.

3.3.2 Loading Analysis on the transformer

Based on the measurement results from the field taken, the highest current for one week in each transformer at each substation. The following is an example of calculating the percentage value of loading on one of the transformers, namely on Transformer A substation Hangar 1 TPU:

$$I_{Average} = \frac{172{,}71+ 206{,}81+214}{3}$$

$$I_{Average} = \frac{593{,}52}{3}$$

$$I_{Average} = 197{,}84\ A$$

Maximum load current rated:

$$I_{FL} = \frac{S}{\sqrt{3} \times V}$$

$$I_{FL} = \frac{1.000.000\ VA}{\sqrt{3} \times 400}$$

$$I_{FL} = 1.443{,}37\ A$$

Percentage of transformer loading:

$$\%\ \text{transformer loading} = \frac{\text{I Average}}{I_{FL}} \times 100\%$$

$$= \frac{197{,}84\ \text{A}}{1.443{,}37\ \text{A}} \times 100\%$$

$$= 13{,}7\ \%$$

Based on the calculation results obtained, the percentage of loading shows the value of the percentage of loading on the transformer A of the TPU Hangar Substation of 13.7% of its full load current of 197.74 A.
The following is the percentage value of loading on the transformer at each substation:

Table 9. Percentage value of loading on the transformer at each substation

Transformer Loading Percentage		Total	PLN Distribution Transformer Management (max 80%)
Transformer A TPU Hangar Substation	13,7%	197,74 A	Still worth it
Transformer A Substation Simulator	13,87%	126,124 A	Still worth it
Transformer A Substation 1A	12,41%	112,84 A	Still worth it
Transformer B Substation 1A	12,3%	111,84 A	Still worth it
Transformer A Substation 2 (Barracks)	28,52%	909,32 A	Still worth it
Transformer A substation 2 (GSG)	4,68%	909,32 A	Still worth it
Transformer A Substation 5	4,51%	360,844A	Still worth it
Transformer B Substation 5	8,69%	230,94 A	Still worth it

The highest value is found in the transformer A Substation 2 (Barracks) of 28.52%, then the value of the transformer loading at each substation is still below the maximum limit value determined.

3.3.3 Load imbalance

Transformer A TPU Hangar Substation:

$$a = \frac{I_R}{I_{Average}}$$

$$a = \frac{172{,}71}{197{,}84}$$

$$a = 0{,}873$$

$$a = \frac{I_R}{I_{Average}} \quad b = \frac{I_S}{I_{Average}} \quad c = \frac{I_T}{I_{Average}}$$

$$a = \frac{172,71}{197,84} \quad b = \frac{206,81}{197,84} \quad c = \frac{214}{197,84}$$

$$a = 0,873 \quad b = 1,045 \quad c = 1,081$$

Load Imbalance Percentage:

$$= \{|a-1| + |b-1| + |c-1|\} \times 100\%$$
$$= \{|0,873-1| + |1,045-1| + |1,081-1|\} \times 100\%$$
$$= \{|-0,127| + |0,045| + |0,081|\} \times 100\%$$
$$= \{0,172 + 0,045 + 0,081\} \times 100\%$$
$$= \{0,298\} \times 100\%$$
$$= \{29,8\%\}$$

Table 10. Reference Load Reading and Profiling Percentage of Inter-Phase Current Imbalance

Characteristics	Health Index			
	Good	Enough	Less	Bad
Inter-Phase Current Imbalance	< 10%	10%-< 20%	20%-< 25%	> =25%

Based on the reference Load Reading and Profiling Percentage Of Inter-Phase Current Imbalance This percentage is categorized as a health index, which is bad. This results in a greater load imbalance on the transformer, the greater the neutral current on the conductor, , (PLN (Persero), 2014).

Table 11. Percentage of Load Imbalance on the PPI Curug Transformer

Load Imbalance Percentage		Health Index
Transformer A TPU Hangar Substation	29,8%	Bad
Transformer A Substation Simulator	70,8%	Bad
Transformer A Substation 1A	47,1%	Bad
Transformer B Substation 1A	32,9%	Bad
Transformer A Substation 2 (Barracks)	20,7%	Less
Transformer A substation 2 (GSG)	180,5%	Bad
Transformer A Substation 5	27,7%	Bad
Transformer B Substation 5	182,8%	Bad

The average percentage of load imbalance health index is categorized as under poor conditions according to the reference Load Reading and profiling percentage of inter-phase current imbalance.

3.3.4 Analysis of Power Losses on Neutral Conductors

Based on the results of measurements in the field, the neutral current taken is the highest neutral current during measurements in a week and after an average of 0.36 amperes, the value of power losses at the neutral conductor is obtained as follows (Dimyati dan Alawy, 2018).

$$P_N = {I_N}^2 \times R_N$$
$$P_N = 0,36^2 \times 0,6482$$
$$P_N = 0,13 \times 0,6482$$
$$P_N = 0,09\ Watt$$
$$P_N = 0,09 \times 10^{-3}\ kW$$

Where is the active power of the Transformer (P)

$$P = S \times Cos\ \varphi$$
$$P = 1000 \times 0,85$$
$$P = 850\ kW$$

So that the Percentage of Losses due to the presence of a neutral current in the transformer neutral conductor is (Tanamal et al., 2020):

$$\%P_N = \frac{P_N}{P} \times 100\%$$

$$\%P_N = \frac{0{,}09 \times 10^{-3}\ kW}{850kW} \times 100\%$$

$$\%P_N = 0{,}0105 \times 10^{-6}\,\%$$

Table 12. Calculation of PPI Curug Transformer Power Losses

Transformer	I_N (A)	P_N (Kw)	P_N (%)
Transformer A TPU Hangar Substation	0,36	$0{,}09 \times 10^{-3}$	$0{,}0105 \times 10^{-6}$ %
Transformer A Substation Simulator	0,38	$0{,}09 \times 10^{-3}$	$0{,}0168 \times 10^{-6}$ %
Transformer A Substation 1A	9,74	$6{,}15 \times 10^{-2}$	$0{,}011 \times 10^{-3}$ %
Transformer B Substation 1A	44,60	1,289	$0{,}24 \times 10^{-3}$ %
Transformer A Substation 2 (Barracks)	60,12	2,343	$0{,}437 \times 10^{-3}$ %
Transformer A substation 2 (GSG)	42,57	1,174	$0{,}219 \times 10^{-3}$ %
Transformer A Substation 5	8,60	$4{,}79 \times 10^{-2}$	$0{,}0225 \times 10^{-3}$%
Transformer B Substation 5	12,56	0,102	$0{,}075 \times 10^{-3}$ %

The highest P_N value (%) is in Transformer A Substation 2 (Barracks) of 0.437 ×10^(-3) % with a I_N^ of 60.12 A. Greater the Neutral current flowing in the neutral conductor of the transformer I_N^ the greater the losses in the neutral introduction of the transformer P_N and vice versa.

3.3.5 Efficiency analysis on transformers

The efficiency of a transformer is a comparison between the useful power output and the total power inlet (Sudiartha et al., 2016).

$$P_{out} = (a + b + c) \times V \times I \times Cos\,\varphi$$

$$P_{out} = (0{,}873 + 1{,}045 + 1{,}081) \times 210{,}850 \times 197{,}84 \times 0{,}85$$

$$P_{out} = 106.336{,}68\ watt$$

$$Efficiency = \frac{P_{Out}}{P_{In}} \times 100\%$$

$$Efficiency = \frac{106{,}336}{106{,}336 + 0{,}09 \times 10^{-3}} \times 100\%$$

$$Efficiency = \frac{106{,}336}{106{,}336} \times 100\%$$

$$Efficiency = 100\%$$

Table 13. Transformer Efficiency Percentage

Transformer Efficiency Percentage	Value (%)
Transformer A TPU Hangar Substation	100,0
Transformer A Substation Simulator	100,0
Transformer A Substation 1A	99,8
Transformer B Substation 1A	97,9
Transformer A Substation 2 (Barracks)	98,3
Transformer A substation 2 (GSG)	95,1
Transformer A Substation 5	99,4
Transformer B Substation 5	99,0

3.3.6 After calculations, input power and output power are obtained

Transformers whose magnitude varies according to the size of the load. Judging from the results of the transformer efficiency percentage in table 4.23, the lowest percentage value is found in transformer A Substation 2 (GSG) of 95.1% and the highest percentage value is found in 2 transformers, namely transformer A Substation Hangar TPU and transformer A Substation Simulator by 100%. The percentage value of the efficiency of the entire transformer is more than 95%. This proves that the efficiency of the transformer in PPI Curug is still good.

4. CONCLUSION

Based on the results of measurements and data processing that have been carried out, several conclusions were obtained, namely: 1) Judging from the results of the percentage of transformer efficiency in the calculation, the lowest percentage value is found in transformer A Substation 2 (GSG) of 95.1% and the highest percentage value is found in 2 transformers, namely transformer A Substation Hangar TPU and transformer A Substation Simulator of 100%. The value of the percentage efficiency of the entire transformer is more than 95%. This proves that the efficiency of the transformer in PPI Curug is still good. 2) Based on the percentage of power used with available electricity subscription power and the percentage of power used with installed load for August 2021 is still below 10%. This proves that KWHmeter is still effective in its use. 3) That the load consumption of only 14% (2019) of the available power shows that the PPI Curug Electricity power subscription is still very far from efficiency, so it is necessary to combine the load on the nearest transformers and properly schedule/class/lab management between study programs. The advice we have given is that it is better for transformers that have a small value to be combined with other transformers. In addition, it is necessary to conduct further studies on neutral currents so that losses do not occur or minimize existing losses and also conduct studies on transformer performance.

ACKNOWLEDGEMENTS

We would like to express our gratitude to: Director of PPI Curug who has given permission for implementation and also helped with research funding; Center for Research and Community Service (PPM) PPI Curug which has facilitated the implementation of research; and the entire academic community of PPI Curug who have supported until this research can be completed.

AUTHOR'S CONTRIBUTIONS

The authors discussed the results and contributed to from the start to final manuscript.

CONFLICT OF INTEREST

There are no conflicts of interest declared by the authors.

REFERENCES

Agung, M. et al. (2018) "Studi komparasi efisiensi trafo distribusi pada pln unit layanan pelanggan pangkalpinang," hal. 1–4.

Antonov, M. I. S. (2017) "Studi Analisa Kinerja Trafo Pemakaian Sendiri PT. PLN (Persero) Sektor Bukittinggi PLTA Batang Agam dengan Menggunakan ESA."

APEC (2018) "Reducing Losses in Power Distribution through Improved Efficiency of Distribution Transformers," (January).

Arnas, Y. et al. (2021) "Pelatihan perawatan / service AC untuk masyarakat sekitar Politeknik Penerbangan Indonesia Curug," *Penamas: Journal of Community Service*, 1(2), hal. 90–99.

B. Elizabeth, F. H. (2013) "Estimating energy saving potential from transformers and evaluating their impact on the feasibility of renewable energy systems," (March), hal. 1–46.

Chaerul Arifin, Bambang Satriyo P, A. S. (2017) "Studi Analisa Penempatan Transformator Distribusi Berdasarkan Beban Lebih pada PT. PLN (Persero) Area Kediri UPJ Rayon Srengat Blitar," *Journal of Chemical Information and Modeling, 7*(2), hal. 1–15. doi: 10.1017/CBO9781107415324.004.

Dimyati, M. A. dan Alawy, M. T. (2018) "Studi Analisa Evaluasi Beban Terhadap Arus Netral dan Losses Transformator Distribusi Area Crusher Di PT . Semen Indonesia (persero) Tbk .," hal. 12–18.

Hidayat, S., Legino, S. dan Mulyanti, N. F. (2018) "Penyeimbangan Beban Pada Jaringan Tegangan Rendah Gardu Distribusi Cd 33 Penyulang Sawah Di Pt Pln (Persero) Area Bintaro," *Sutet, 8*(1), hal. 21–27.

Irwan, K. S., Kartika, R. B. B. dan Saputro, R. (2020) "Analisis Pembebanan Transformator Tenaga Pada Gardu Listrik Di Sekolah Tinggi Penerbangan Indonesia," *Langit Biru: Jurnal Ilmiah Aviasi. Sekolah Tinggi Penerbangan Indonesia, 12*(1), hal. 29–40.

Kaya, Z., İmal, N. dan Gökhasan, O. (2018) "On power transformers energy efficiency based load transfer analysis," *International Journal of Energy Applications and Technologies, 5*(3), hal. 115–118. doi: 10.31593/ijeat.442589.

Lamtiar, S. et al. (2020) "Making Modeling Control System Of The Use of Electrical Energy in a Flight Engineering Department Building Stpi Curug-Tangerang," *International Journal of Progressive Sciences and Technologies (IJPSAT), 23*(2), hal. 523–532.

Maruf, A. dan Primadiyono, Y. (2021) "Analisis Pengaruh Pembebanan Dan Temperatur Terhadap Susut Umur Transformator Tenaga 60 Mva Unit 1 Dan 2 Di Gi 150 Kv Kalisari," Edu Elektrika Journal, 10(1), hal. 1–10.

Mieftah, M. (2018) "Kajian Efisiensi Energi Dengan Pengaturan Suplai Energi Listrik," Jurnal Eltek, 16(1), hal. 98. doi: 10.33795/eltek.v16i1.90.

PLN (Persero) (2014) "Acuan Load Reading and Profiling Presentase Ketidakseimbangan Arus Antar Fasa," No. 0017.0, hal. 8 bagian 6.6.2.6.

Sihono, S., Fatkulloh, A., et al. (2021) "Pemantapan Dan Refreshing Materi Electrical & Electronik Untuk Guru Smk Penerbangan Di Jawa Tengah Dan Sekitarnya," *Jubaedah : Jurnal Pengabdian dan Edukasi Sekolah (Indonesian Journal of Community Services and School Education), 1*(1), hal. 12–19. doi: 10.46306/jub.v1i1.2.

Sihono, S., Fatkhulloh, A., et al. (2021) “Pendalaman Buku Ajar Elektrikal dan Elektronika Pesawat Udara Bagi Guru SMK Penerbangan,” *Jurnal Pengabdian Kepada Masyarakat (JPKM) Langit Biru, 2*(1), hal. 46–54. doi: 10.54147/jpkm.v2i01.462.

Sudiartha, I. W. et al. (2016) “Manajemen Trafo Distribusi 20kv Antar Gardu Bl031 Dan Bl033 Penyulang Liligundi Dengan Menggunakan Simulasi Program Etap,” 16(3), hal. 166–171.

Sugiyono (2018) Metode Peneltian Evaluasi (Pendekatan Kuantitatif, Kualitatif, dan Kombinasi). 1 ed. Diedit oleh Y. Yuniarsih. Bandung: ALfabeta.

Sya’roni, Z. dan Rijanto, T. (2019) “Analisis Ketidakseimbangan Beban Transformator Distribusi 20 kV Dan Solusinya Pada Jaringan Tegangan Rendah,” *Teknik Elektro, 8*(1), hal. 173–180.

Ta, I. K. et al. (2017) “Analisis Persentase Pembebanan Dan Drop Tegangan Jaringan Tegangan Rendah Pada Gardu Distribusi Ga 0032 Penyulang Wibrata,” *Matrix : Jurnal Manajemen Teknologi dan Informatika, 7*(2), hal. 42. doi: 10.31940/matrix.v7i2.526.

Tanamal, H. et al. (2020) “Analisis Pengaruh Beban Tak Seimbang Terhadap Arus Netral Pada Trafo IV GI Sukamerindu Bengkulu,” 9(2), hal. 7–13.

Tharo, Z., Tarigan, A. D. dan Pulungan, R. (2018) “Pengaruh Pemakaian Beban Tidak Seimbang Terhadap Umur Peralatan Listrik,” *RELE (Rekayasa Elektrikal dan Energi) : Jurnal Teknik Elektro, 1*(1), hal. 10–15. doi: 10.30596/rele.v1i1.2256