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Characteristics of Energy Consumption in Apartment during The COVID-19 Pandemic in Indonesia

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ABSTRACT: The COVID-19 pandemic has been going on for more than 2 years. The policy of restricting public movement issued by the government of the Republic of Indonesia changed its term during the COVID-19 pandemic. Several national and international researchers have examined the effect of electrical energy consumption during the implementation of restrictions/lockdowns. The method used includes the measurement of monthly electricity usage and others. In this study, researchers measured electrical energy consumption to monitor the effectiveness of the implementation of Level-3 Community Movement Restrictions implemented by the Government of Indonesia. The research location will be conducted in an apartment building in Jakarta. The measurement of the apartment's electrical load is not effective enough to monitor the effectiveness of the COVID-19 policy in Jakarta. The occupants who are supposed to carry out the WFH program and live in apartments, in fact, return to their respective homes because the apartment is a temporary shelter. Our data shows that 43% of building occupants are rental units and not property rights. During the COVID-19 pandemic and the implementation of WFH, the electricity load on weekdays with holidays is greater on weekdays. The maximum load imbalance in this building reaches 29.51%.

KEYWORDS: COVID-19, ERCA Level-3, Energy, Electricity, Unbalance load.

I. INTRODUCTION

COVID-19, better known as Novel Corona Virus, is associated with respiratory disorders in humans and was declared a global epidemic and pandemic in the first quarter of 2020 by the World Health Organization [1]. The COVID-19 virus infects people of all ages. However, evidence to date suggests that two groups of people are at higher risk of developing severe COVID-19 illness [2]. This is an older person; and those with underlying medical conditions.

Transmission of COVID-19 can occur through direct, indirect, or close contact with an infected person through infected secretions such as saliva and respiratory secretions or their respiratory droplets, which are released when an infected person coughs, sneezes, talks, or sings [3]. Respiratory droplets less than 5-10 μm in diameter while droplets more than 5 μm in diameter are referred to as droplet nuclei or aerosols [4]. Airborne transmission is defined as the spread of infectious agents caused by the spread of droplet particles (aerosols) that remain infectious when suspended in the air over long distances and time [4]. Allegedly airborne transmission of SARS-CoV-2 can occur even in medical procedures that produce aerosols [2][5]. The vapor from the exhaled breath and its flow led to the hypothesis that the possible mechanism for the spread of SARS-CoV-2 was through this aerosol [6].

In the early stages of the findings of the COVID-19 pandemic, several countries implemented lockdown policies. However, the policy received a pro and contra response. Not all countries implement lockdowns for various reasons. For example, in Indonesia, the government did not issue a lockdown policy. The regulations issued are in the form of Large-Scale Social Restrictions or LSSR. With this LSSR policy, there has been a decline in population mobility [7].

Over time, the coronavirus undergoes gene mutations [8]. Gene mutation is a spontaneous gene change and is hereditary from the parent virus particle to its daughter virus particles. The SARS-CoV-2 variant of concern has the characteristics of a higher spread, increases disease severity, and has the potential to reduce vaccine efficacy and effectiveness when compared to the wild variant. WHO reports that the variants of COVID-19 of concern are Alpha (B.1.1.7), Beta (B.1.351), Gamma (P.1), and Delta (B.1.617.2) [8], [9].

Towards the end of 2021, the world was again surprised by the presence of the latest variant of COVID-19 called omicron. The World Health Organization (WHO) has designated this variant that originated in South Africa as worrying. This is because the number of spike protein mutations is higher than other variants [10]. To measure the effectiveness of the policies taken by the government it is necessary to take a benchmark. One of the methods used is to monitor energy consumption [11], [12],[13],[14]–[16]. The increase in bills is due to changes in the behavior of people

who use electricity during the Covid-19 pandemic. Quantitative research method with random sampling technique. The results were 137 people who experienced an increase in their bills (90.5%) with 67.9% of respondents being prepaid customers, and the increase in electricity bills was caused by activities that consume more electricity, namely being in front of a computer/laptop and connected more often. to the internet as much as 28.5%, watching TV/Film as much as 11.7%, and opening multimedia online platforms as much as 9.5% [13].

The urgency of this research will be to see how obedient the citizens of Jakarta are in implementing the Level-3 ERCA policy implemented by the Government. This is related to the COVID-19 pandemic which has lasted for 2 years. This compliance will be monitored through the consumption of electrical energy in apartments in South Jakarta.

Development is one of the parameters for the growth of a region. Jakarta is one of the provinces in Indonesia with a large level of development considering that the need for living facilities for its citizens is constantly increasing in line with population growth [17]. In a metropolitan city like Jakarta, the modern lifestyle is characterized by the establishment of apartments to fulfill a decent place to live. Apartment growth experienced a golden age around 2009 to 2013 when the selling price index and rental price index experienced growth [18].

Energy Consumption Intensity is a measure of the use of electricity in a building [19], [20]. With the implementation of Enforcement of Restrictions on Community Activities (ERCA) Level-3 where 50% of offices are closed and employees or workers carry out work activities from home, electricity consumption will increase.

II. RESEARCH METHODS

Researchers have conducted previous research related to the topic being proposed [21]. The forecast for the growth of COVID-19 cases in Indonesia will continue to experience a significant increase. Researchers have also conducted several studies in the field of electricity. The first is entitled "The Effect of Unbalance Load on Neutral Current and Ground Current on Transformer 1 and Transformer 2 on Momentary Peak Load" and has been published [22].

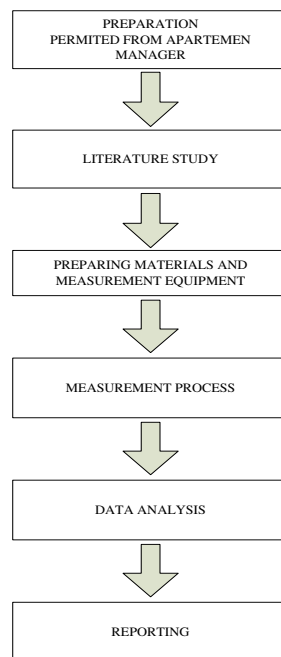


Figure 2.2 Research Block Diagram

From the measurement results, an analysis of the data obtained is carried out to present the right information about the data obtained. The last step is compiling a report.

III. RESULT

Before taking measurements, we took initial data on global electricity use from January to April 2020 when conditions in Indonesia were still in normal condition. Our data is taken based on existing records where every day there are three data collections. Data is taken every 09.00 WIT, 20.00 WIT, and 24.00 WIT (Western Indonesia Times). We also monitor daily electricity usage which we monitor within 24 hours. In Figure 3.1, a daily electric current reading profile



is given on a weekday. And this profile is different from electricity conditions on weekends (working holidays) where the profile is given in Figure 3.2. The details are given in Table 3.1.

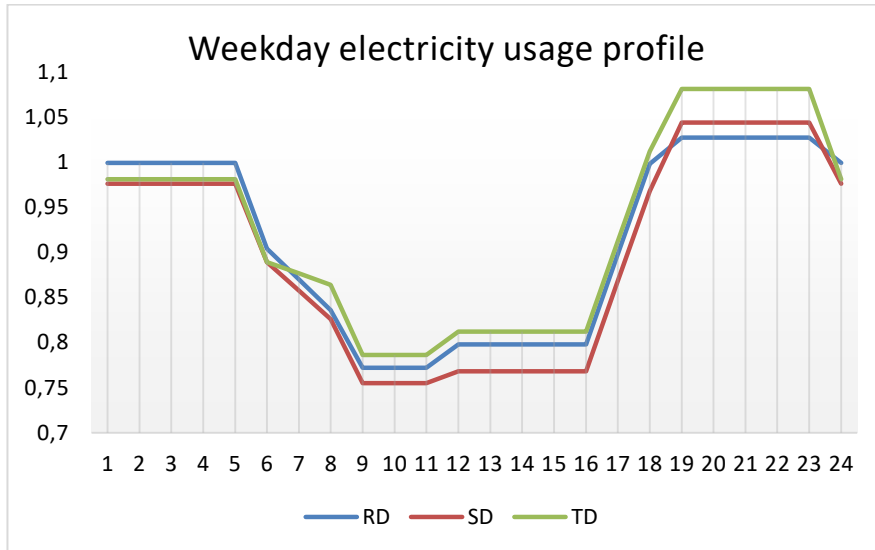


Figure 3.1 Profile of electricity usage on weekdays

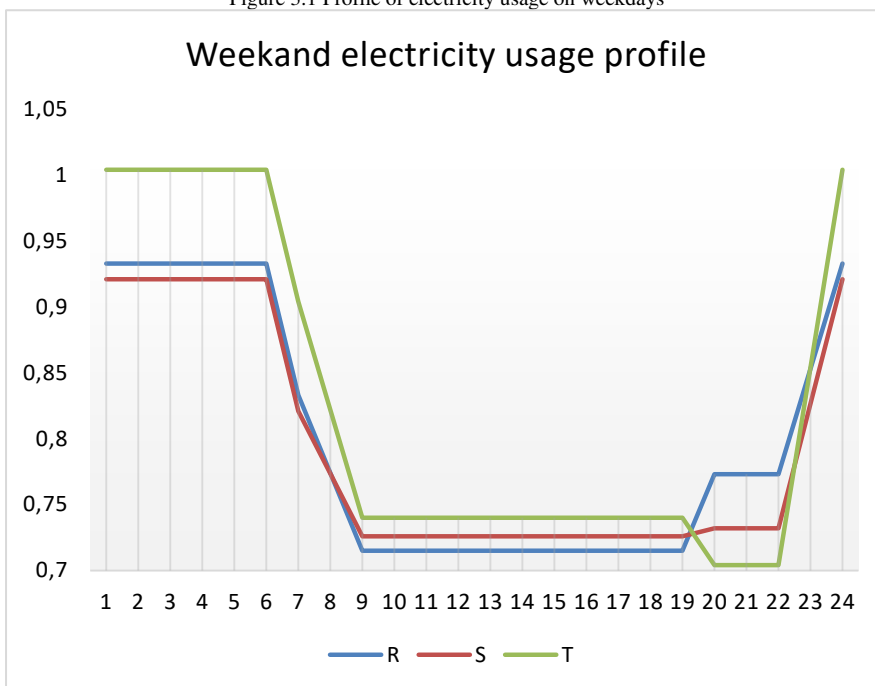


Figure 3.2 Profile of electricity usage on holidays

In Figure 3.3, we measure electricity use during February 2022. We compare the data with the electricity usage profile in April 2020 where that month the Large-Scale Social Restrictions was first implemented in Indonesia, namely on April 10, 2020.

In contrast to the measurement in February 2022, this month Enforcement of Restrictions on Community Activities was implemented which was originally Level 2 and was increased to Level 3 on February 8, 2022.



Table 3.1 Electrical Load Measurement Results

Hour	Weekday			Weekend		
	R	S	T	R	S	T
1	0,999	0,976	0,981	0,933	0,921	1,004
2	0,999	0,976	0,981	0,933	0,921	1,004
3	0,999	0,976	0,981	0,933	0,921	1,004
4	0,999	0,976	0,981	0,933	0,921	1,004
5	0,999	0,976	0,981	0,933	0,921	1,004
6	0,904	0,889	0,889	0,933	0,921	1,004
7	0,87	0,8575	0,8765	0,833	0,821	0,904
8	0,836	0,826	0,864	0,774	0,7735	0,822
9	0,772	0,755	0,786	0,715	0,726	0,74
10	0,772	0,755	0,786	0,715	0,726	0,74
11	0,772	0,755	0,786	0,715	0,726	0,74
12	0,798	0,768	0,812	0,715	0,726	0,74
13	0,798	0,768	0,812	0,715	0,726	0,74
14	0,798	0,768	0,812	0,715	0,726	0,74
15	0,798	0,768	0,812	0,715	0,726	0,74
16	0,798	0,768	0,812	0,715	0,726	0,74
17	0,898	0,868	0,912	0,715	0,726	0,74
18	0,998	0,968	1,012	0,715	0,726	0,74
19	1,027	1,044	1,081	0,715	0,726	0,74
20	1,027	1,044	1,081	0,773	0,732	0,704
21	1,027	1,044	1,081	0,773	0,732	0,704
22	1,027	1,044	1,081	0,773	0,732	0,704
23	1,027	1,044	1,081	0,853	0,8265	0,854
24	0,999	0,976	0,981	0,933	0,921	1,004

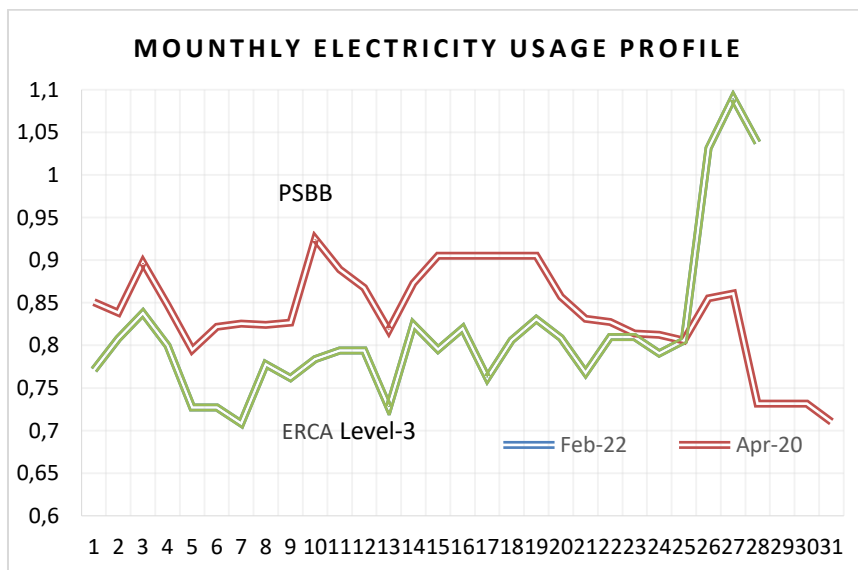


Figure 3.3 Profile of electrical load every day in April 2020 and February 2022, data is taken every day at 09.00 WIT

IV. DISCUSSION

As previously noted, on February 8, the Central government implemented ERCA Level-3. This is due to the increasing number of victims of COVID-19 patients recorded in Indonesia. ERCA Level-3 limits the number of people working in the office in other words 50% of them work from home.

Based on Figure 3.2 and Figure 3.3, the profile of electricity usage has decreased on working holidays. This is an anomaly where the condition must be reversed, namely during working hours the electricity will decrease because residents will go to work. While on holidays residents will live in apartments so that electricity consumption will increase.

4.1 Load Unbalance

Based on the results from the management data, it was found that 43% of the residents in the apartment were not unit owners. They only rent and on work holidays return to their respective homes around Jakarta. This has an impact on decreasing energy consumption in the building. It is noted that electricity consumption has increased starting at 17.00 and continues to rise until 23.00 WIB.

In this study, the value of the load imbalance [22], [23] will be sought. We also follow the IEEE reference with the specified standard [24]. To calculate the load unbalance, we use Equation 1.

$$UB\% = \frac{|I_{max} - I_{av}|}{I_{av}} * 100\% \tag{1}$$

where:

$UB\%$: percentage of unbalance load

I_{max} : Maximum Current

I_{av} : Average Current

To find the I_{av} value, Equation 2 is used:

$$I_{av} = \frac{|I_R| + |I_S| + |I_T|}{3} \tag{2}$$

where:

I_R : Current R phase

I_S : Current S phase

I_T : Current T phase

Using these equations, we calculate the unbalance load. Figure 4.1 is a daily building load imbalance profile, whether it's a working day or during a working day off (Saturday/Sunday).

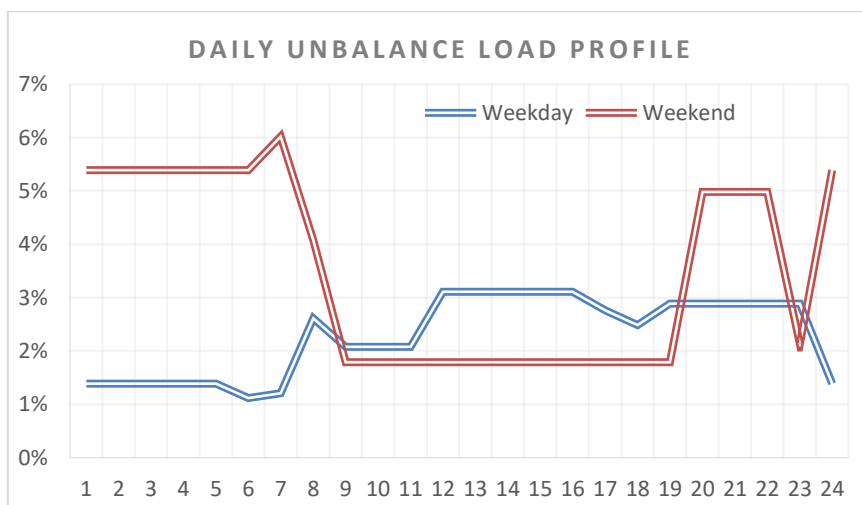


Figure 4.1 Profile of building load imbalance on weekdays and holidays

Furthermore, based on Figure 3.4, in April 2020 when the LSSR began to be implemented in Jakarta, building electricity consumption seemed to increase. However, the increase was only in the early days of the first week of the LSSR being implemented. The use of electricity in the second week onwards tends to decrease. It is possible that there are 2 conditions, namely residents return to their respective homes or start actively working even though the LSSR is

enforced. The results are different from the monitoring in February 2022. On the first day, February 8, the level of electricity consumption increased.

This condition can be seen from Figure 3.4 that on the 8th there was a surge in electricity use in the building under study. However, the increase was not too significant. Figure 3.2 is a graph showing consumption usage at 09.00 WIB. Assuming 50% of workers take part in WFH (work from home) and are in the building, electricity consumption will increase. Using the same method, we carry out load imbalance measurements as given in Figure 4.2.

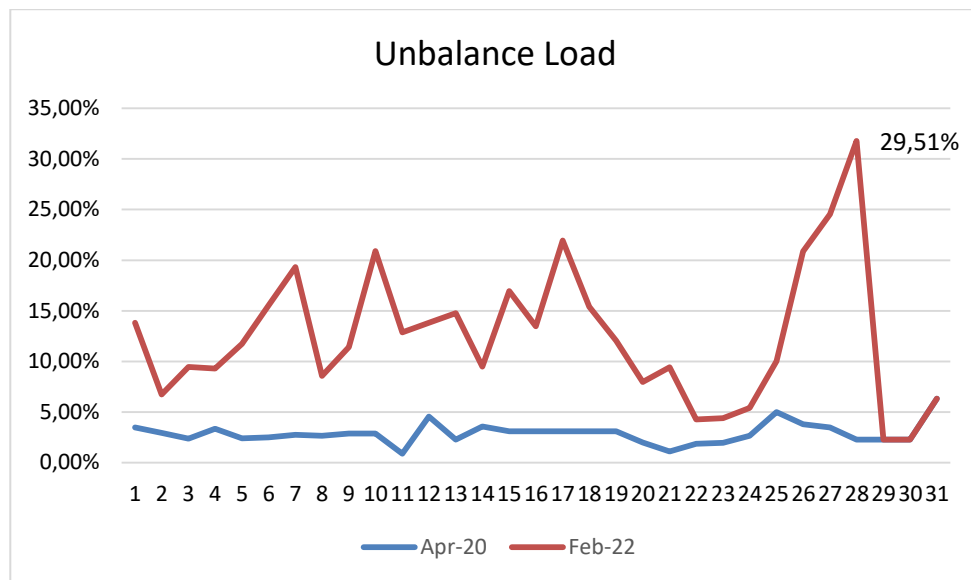


Figure 4.2 Profile of building load imbalance on weekdays and holidays

4.2. Discussion

The cause of this load imbalance is that there is no definite pattern for each occupant. They are independent of time and have no ties. The highest level of imbalance occurs at a value of 29.51%.

The most significant impact is experienced by 3-phase motors such as elevators or pumps. This imbalance lowers the motor's efficiency by causing extra heating in the motor. The heat generated also affects the life of the equipment by increasing the operating temperature, which decomposes the lubricant or oil in the bearings and lowers the rotational speed of the motor.

In an induction motor connected to an unbalanced supply, the negative sequence current flows along with the positive sequence current resulting in a decrease in the percentage of productive current and poor motor efficiency. Any imbalance above 3% hinders the efficiency of the motor.

An imbalance of 1% is acceptable as it doesn't affect the cable. But above 1% it will increase linearly and at 4% the device performance will decrease by 20% [25]. This implies that 20% of the current flowing in the wires will be unproductive and thus the copper losses in the cables will increase by 25% at a 4% imbalance.

In addition, the effect on the distribution of the transformer is very significant. Ideally, every distribution transformer provides the best performance at 50% load and every electrical distribution system is designed for that. But in case of imbalance, the loading exceeds 50% because the equipment draws more current. In this study, we did not calculate current losses under unbalance conditions.

V. CONCLUSION

The measurement of the apartment's electrical load is not effective enough to monitor the effectiveness of the COVID-19 policy in Jakarta. This is because when residents who are supposed to carry out the WFH program live in apartments, they instead return to their respective homes. This anomaly occurs because 43% of building occupants are rented units and not property rights. Electricity load on weekdays with holidays is more significant on weekdays. The maximum load imbalance in this building reaches 29.51%. To overcome the impact of load imbalance, technicians always monitor the existing electrical load. When the unbalance value reaches the limit, reduce the use of equipment that uses 3-phase motors. In addition, it is necessary to increase the accuracy of utility meter readings so that the data presented has good accuracy.

REFERENCES

- [1] W. World Health Organization, "WHO Director-General's opening remarks at the media briefing on COVID-19 - 11 March 2020," *WHO Dir. Gen. speeches*, no. March, p. 4, 2020, [Online]. Available: <https://www.who.int/dg/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020>.
- [2] World Health Organization (WHO), "Coronavirus disease 2019 Situation Report 51 11th March 2020," *World Heal. Organ.*, vol. 2019, no. March, p. 2633, 2020, doi: 10.1001/jama.2020.2633.
- [3] World Health Organization, "Transmission of SARS-CoV-2: implications for infection prevention precautions. Scientific brief, 09 July 2020," vol. 19, pp. 1–20, 2020.
- [4] World Health Organization (WHO), "Infection prevention and control of epidemic- and pandemic-prone acute respiratory infections in health care," *WHO Guidel.*, pp. 1–156, 2014, [Online]. Available: http://apps.who.int/iris/bitstream/10665/112656/1/9789241507134_eng.pdf?ua=1.
- [5] Organización Mundial de la Salud, "Advice on the use of masks in the context of COVID-19: interim guidance-2," *Guía Interna la OMS*, no. April, pp. 1–5, 2020, doi: 10.1093/jiaa077.
- [6] L. Morawska and J. Cao, "Airborne transmission of SARS-CoV-2: The world should face the reality," *L. Morawska J. Cao Environ. Int.* 139 105730, no. January, 2020.
- [7] COVID-19 Community Mobility Report, "Indonesia Mobility changes," [google.com/covid19/mobility](https://www.google.com/covid19/mobility/), no. July 12, 2020.
- [8] E. Parwanto, "Bermutasi," *J. Biomedika*, vol. 4, no. 2, pp. 47–49, 2021, doi: 10.1101/2020.12.30.20249034.
- [9] W. F. Putra, "Analisis Efikasi dan Efektivitas Vaksin COVID-19 terhadap Varian SARS-CoV-2: Sebuah Tinjauan Literatur Analysis the Efficacy and Effectivity of COVID-19 Vaccines to the SARS-CoV-2 Variants: A Literature Review," vol. 28, no. 1, pp. 107–119.
- [10] N. Mujtaba, W. Fizriyani, I. S. Margareta, and N. Ilahiyati, "ANALISIS TINDAK TUTUR PERLOKUSI PADA BERITA COVID-19 VARIAN OMICRON DI SALURAN YOUTUBE," vol. 2, no. 2, pp. 1–15, 2021.
- [11] E. Buechler *et al.*, "Global changes in electricity consumption during COVID-19," *iScience*, vol. 25, no. 1, p. 103568, 2022, doi: 10.1016/j.isci.2021.103568.
- [12] J. Radtke, "Smart energy systems beyond the age of COVID-19: Towards a new order of monitoring, disciplining and sanctioning energy behavior?," *Energy Res. Soc. Sci.*, vol. 84, no. January 2021, 2022, doi: 10.1016/j.erss.2021.102355.
- [13] R. Ridlo Al Hakim, Ropiudin, A. Muchsin, and F. Satya Lestari, "Analisis Kenaikan Tagihan Listrik Selama Pandemi Covid-19 Berdasarkan Perilaku Konsumtif Energi Listrik Di Indonesia," *J. Cafe.*, vol. 2, no. 1, pp. 25–35, 2021, doi: 10.51742/akuntansi.v2i1.279.
- [14] Y. Soluyanov, A. Fedotov, A. Akhmetshin, and V. Khalturin, "Monitoring of electrical consumption, including self-isolation during the COVID-19 pandemic," *Proc. 2020 Ural Smart Energy Conf. USEC 2020*, no. December, pp. 80–83, 2020, doi: 10.1109/USEC50097.2020.9281179.
- [15] A. Trimanto and A. Rakhmawan, "Strategi Manajemen Sistem Tenaga Listrik Sumatera Saat Pandemi Covid-19," *Transmisi*, vol. 23, no. 1, pp. 21–27, 2021, doi: 10.14710/transmisi.23.1.21-27.
- [16] U. Muhammadiyah and S. Utara, "Monitoring of Electrical Energy during the Covid-19 Pandemic Using SMS on Microcontrollers," vol. 1, no. 2, pp. 54–62, 2020, doi: 10.30596/jcsosite.v1i2.4968.
- [17] J. Suwandi, "Dampak Lalu Lintas Pembangunan Apartemen Di Jakarta Selatan," *Agregat*, vol. 2, no. 2, pp. 123–132, 2017, doi: 10.30651/ag.v2i2.1192.
- [18] Simon. Zainal Zawir, "APARTEMEN DI JABODETABEK Abstrak," *J. Orientasi Bisnis dan Interpreneersh.*, vol. 1, no. 1, pp. 1–13, 2020.
- [19] A. F. Tasya and A. D. Putranto, "Konsep Green Building Pada Bangunan Kantor," *J. Mhs. Jur. Arsit.*, vol. 5, no. 4, pp. 1–8, 2017.
- [20] E. Wanimbo and M. Amiruddin, "Perhitungan nilai intensitas konsumsi energi (ike) ruangan bptik universitas PGRI Semarang," *Sci. Eng. Natl. Semin.* 4, vol. 4, no. 1, pp. 162–166, 2019.
- [21] R. Ruliyanto and E. R. Nugroho, "Forecast of COVID-19 Cases in Indonesia with the Triple Exponential Smoothing Algorithm Perkiraan Kasus COVID-19 di Indonesia dengan Algoritma Triple Exponential Smoothing," *J. Ilm. GIGA Vol. 23 Novemb. 2020*, vol. 23, no. November, pp. 61–68, 2020.
- [22] R. Ruliyanto, "Pengaruh Ketidakseimbangan Beban Terhadap Arus Netral dan Arus Ground pada Trafo 1 dan Trafo 2 pada Beban Puncak Sesaat," *J. Ilm. Giga*, vol. 23, no. 1, p. 27, 2020, doi: 10.47313/jig.v23i1.867.
- [23] J. Sentosa Setiadji, T. Machmudsyah, and Y. Isnanto, "Pengaruh Ketidakseimbangan Beban Terhadap Arus Netral dan Losses pada Trafo Distribusi," *J. Tek. Elektro*, vol. 7, no. 2, pp. 68–73, 2008, doi: 10.9744/jte.7.2.68-73.
- [24] A. E. Emanuel, R. Langella, and A. Testa, "Power definitions for circuits with nonlinear and unbalanced loads the IEEE standard 1459-2010," *IEEE Power Energy Soc. Gen. Meet.*, pp. 1–6, 2012, doi: 10.1109/PESGM.2012.6345330.
- [25] A. Basuki, "THE EFFECTS OF SIGNIFICANT UNBALANCED THREE PHASE LOADS OF 500 kV EHV JAMALI SYSTEM ON ITS GENERATING UNIT," pp. 159–166.



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