

Study of Energy Saving Potential through ISO 50002:2014 Energy Audit at Fuel Oil Storage Terminal in East Kutai, East Kalimantan

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Abstract - Energy conversion is important for the development of technology and modern life and has a significant impact on improving energy performance in equipment or systems that use very large amounts of energy. This study was conducted using the ISO 50002:2014 method, which is a standard for defining minimum requirements that lead to identifying opportunities to improve energy performance such as determining EnPI (Energy Performance Indicator), determining SEU (Significant Energy Use), and measuring energy performance in equipment that uses energy. In the Company's activities, the energy consumed is electrical energy of 93.88% and solar power of 6.12% with Significant Energy Uses (SEU) being the HVAC-1 system (22.92%) and HVAC-2 (19.52%). And the other largest electrical loads are non-UPS and lighting (17.81% and 14.64%). The EnPI value for activities ranges from 0.0031-0.0049 GJ/kL with an average energy cost of Rp. 49,368,512,-/month and productivity cost intensity of Rp. 1,176.99,-/kL. For office activities, the average is Rp. 8,496,860,-/month with energy cost intensity of Rp. 24,207.58,-/m²/month. To improve optimal energy performance, the Company can target the EnPI value in the range of 0.0022 GJ/kL with a B30 distribution value of 47,000-53,000 kL/month. This performance improvement can be done by improving the quality of electrical voltage, replacing lamps in the work space, and managing energy in the air conditioning system.

Key Words: Energy Conservation, EnPI, SEU, ISO 50002:2014, HVAC

1. INTRODUCTION

As environmental awareness increases, energy conservation has become a frequently discussed topic. Energy conservation is not only an effort to reduce energy use, but also an inseparable part of the world's efforts to avoid the negative impacts of global warming and climate change. The Indonesian government through Government Regulation Number 33 of 2023 concerning Energy Conservation has regulated the implementation of energy conservation. Referring to Government Regulation of the Republic of Indonesia No. 33 of 2023, energy conservation is a systematic, planned, and integrated effort to conserve state resources and increase the efficiency of their use. Energy conservation can be achieved through efficient use of energy, including by implementing energy-saving behavior. Energy conservation is very important because the impacts of global warming and climate change are increasingly visible.

Moreover, the increase in global warming is caused by high energy consumption.

The analysis that will be conducted in this study is able to manage and utilize energy at the Fuel Oil Terminal so that a picture of the performance of energy user units is obtained so that the potential for increasing energy performance can be known. In addition, this study also provides efficiency values on SEU (Significant Energy Used) equipment so that an EnPI (Energy Performance Indicator) picture is obtained which can be used as a reference for optimizing performance in productivity activities^[10].

2. METHODOLOGY

This study uses quantitative methods^[11]. Quantitative approaches are used to analyze a phenomenon systematically based on secondary and primary data. In this study, for historical data on energy use and production, researchers use statistical techniques. For the analysis of Specific Energy Consumption (SEC) & Energy Performance Indicators (EnPI), energy consumption data will be collected then plotted in a table in MS Excel and then analyzed for correlation using the linear regression method. Secondary data collection is based on historical data on energy use and production at the BBM Terminal for the last 3 (three) years and data on equipment specifications that use significant energy. While primary data collection is carried out by measuring electrical and thermal parameters and light intensity to obtain actual data on conditions in the field so that accurate and real information is obtained.

3. RESULTS AND DISCUSSIONS

When viewed from the energy distribution side, the use of electrical energy is intended for all electrical activities and equipment, while the use of solar energy is intended for the operation of all diesel engines. Based on the results of the search for the use of energy sources, the following is a description of the energy reference system.

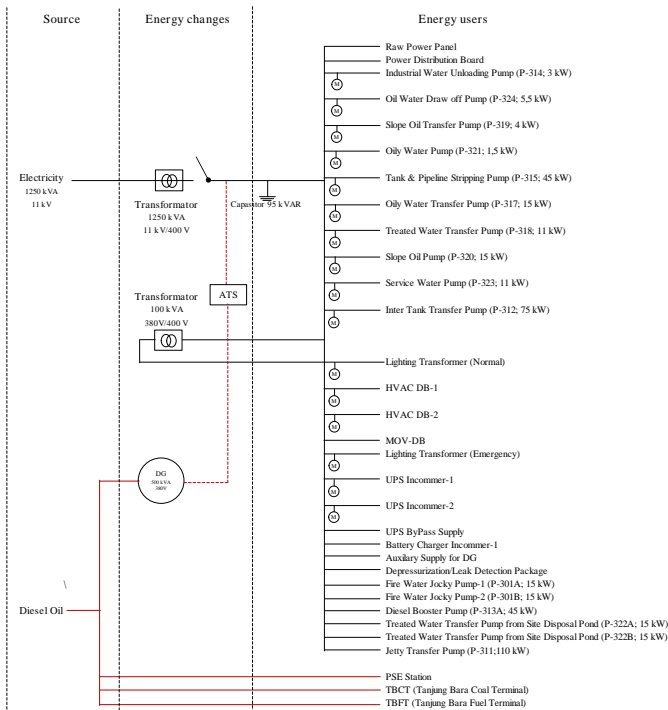


Fig -1: Energy reference system

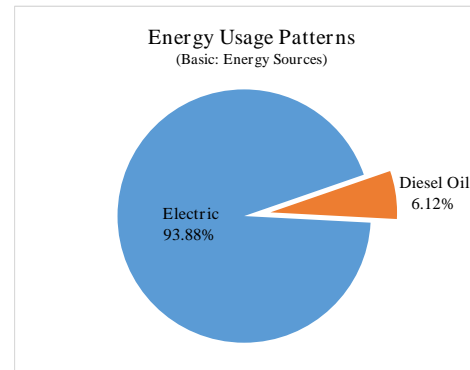


Fig -2: Energy usage patterns

From the description of energy usage patterns, it can be seen that most of the energy usage is using electrical energy, which is around 93.88%, while the use of diesel is only 6.12% of the total energy usage.

From the energy usage data, the average electrical energy consumed is 40,617.84 kWh/month, while the average diesel consumption is 26.80 liters/month.

From the description of the energy reference system, certain energy usage patterns can be identified. The description of energy usage patterns can be identified from historical data or from monitoring data. Based on energy usage data, the description of energy usage profiles is as follows.

Based on the electricity usage data for each load path, it is obtained that the overall electricity load is mostly borne by the HVAC system where the load is the air conditioning system for the substation and office. From the electricity usage data for the total electricity load, the following is a description of the use of electrical energy.

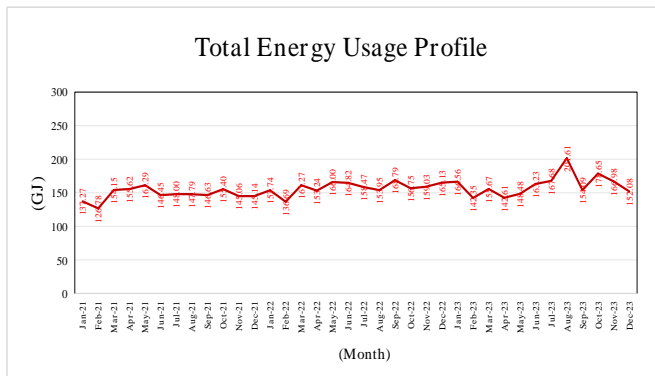


Chart -1: Total energy usage profile

Based on the total energy usage data, it can be seen that the largest total energy usage occurred in August 2023, which was 201.61 GJ, while the lowest energy usage occurred in February 2021, which was 126.78 GJ. This value is based on the conversion of each energy unit into GJ so that the energy value can be equated to find out the comparison of the amount of energy consumption from each energy source consumed.

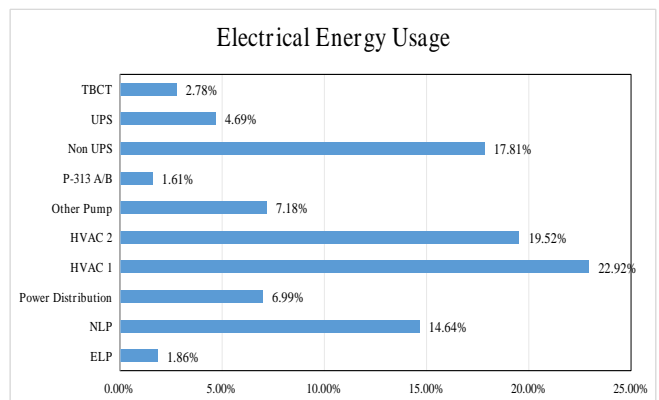
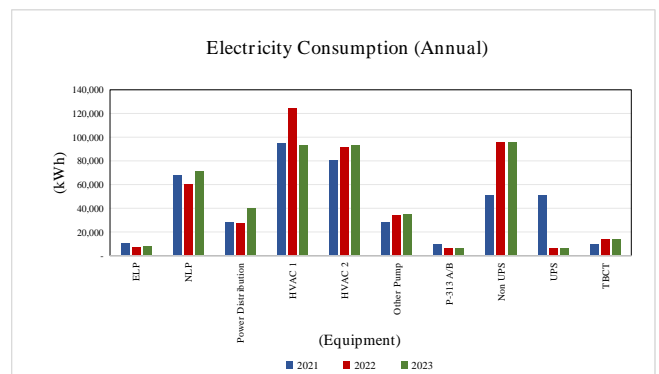


Chart -2: Electrical energy consumption

From the description of the use of electrical energy, it can be seen that the largest electrical load or commonly called Significant Energy Uses (SEU) is borne by the HVAC-1 and HVAC-2 systems. The HVAC-1 system is an air conditioning system for the main substation building and the HVAC-2 system is an air conditioning system for office buildings. And other large electrical loads are non-UPS and lighting.

Diesel fuel is an energy source used for generators, official vehicles and other diesel engines. Based on diesel usage data, it can be seen that the largest usage is charged to the PSE Terminal, which is 45.49% and the rest is used in the rare TBCT area of 31.30% and the TBFT area of 23.21%. When viewed from the diesel usage area, for the PSE Terminal area the largest diesel usage is charged to the 500 kVA generator equipment, which is 78.44%. In the TBCT area, the largest diesel usage is charged to the fire pump equipment (P-303) which is 87.28% and for the TBFT area the largest diesel usage is charged to the 60 kVA generator equipment, which is 97.07%.

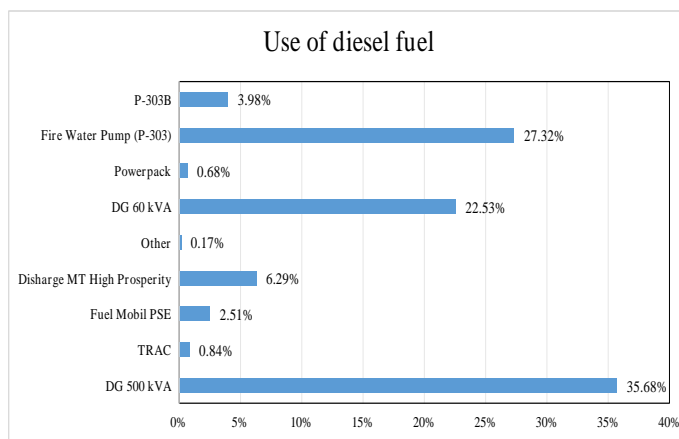


Chart -3: Fuel consumption

From the total diesel fuel usage load, it can be seen that the largest diesel fuel usage is borne by the 500 kVA generator at 35.68%, the fire water pump (P-303) at 27.32%, and the 60 kVA generator at 22.53%. The large amount of diesel fuel usage for the 500 kVA generator provides an illustration that the electricity conditions in the Company often experience power outages. The use of the fire water pump is operated for fire extinguishing simulations which are routinely carried out every month.

Based on the data on electricity and diesel oil usage for the Company's activities, the actual EnPI value can be determined. From the actual IKE value, the average EnPI value and the optimal EnPI that must be achieved can also be determined based on the parameters of energy usage for its activities.

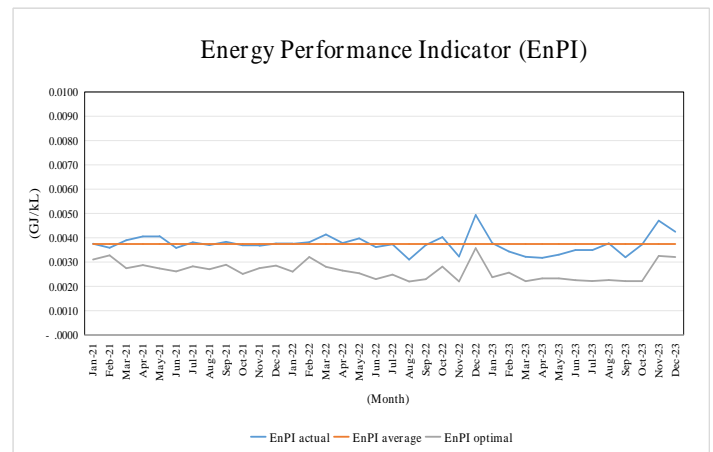


Chart -4: Energy Performance Indicator (EnPI)

From the description of the Energy Consumption Intensity value, it can be seen that the EnPI value tends to fluctuate, which is around 0.0031-0.0049 GJ/kL. If seen from the average EnPI value, it can be seen that the average EnPI value is 0.0037 GJ/kL.

To determine the target EnPI value formula that must be achieved each month, it can be determined using the following equation:

EnPI Target:

$$y = 5.10 \cdot 10^{-12} x^2 - 5.10 \cdot 10^{-7} x + 0.0147$$

Where: x = B30 distribution value [kL]

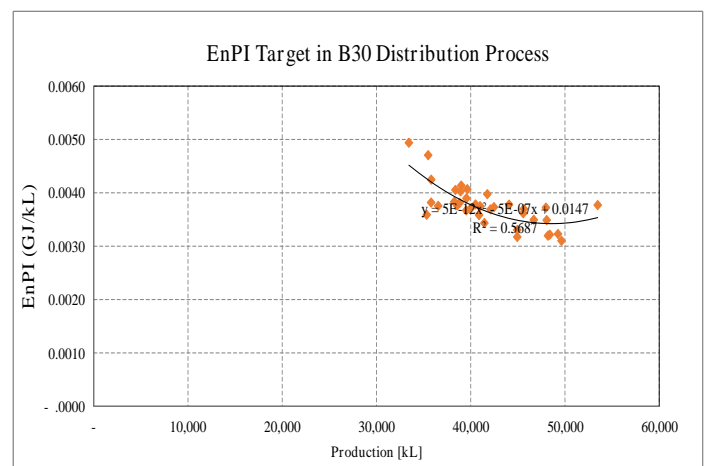


Fig -2: Optimal IKE target value

From this value, can determine the EnPI target based on the productivity value of B30 distribution each month.

Table -1: EnPI value based on B30 distribution value

B30 Distribution (kL)	EnPI (GJ/kL)	B30 Distribution (kL)	EnPI (GJ/kL)	B30 Distribution (kL)	EnPI (GJ/kL)	B30 Distribution (kL)	EnPI (GJ/kL)
10,000	0.0102	31,000	0.0040	52,000	0.0022	73,000	0.0048
11,000	0.0098	32,000	0.0038	53,000	0.0022	74,000	0.0051
12,000	0.0094	33,000	0.0036	54,000	0.0023	75,000	0.0053
13,000	0.0090	34,000	0.0035	55,000	0.0023	76,000	0.0056
14,000	0.0087	35,000	0.0033	56,000	0.0024	77,000	0.0058
15,000	0.0083	36,000	0.0032	57,000	0.0024	78,000	0.0061
16,000	0.0080	37,000	0.0030	58,000	0.0025	79,000	0.0064
17,000	0.0076	38,000	0.0029	59,000	0.0026	80,000	0.0067
18,000	0.0073	39,000	0.0028	60,000	0.0027	81,000	0.0070
19,000	0.0070	40,000	0.0027	61,000	0.0028	82,000	0.0073
20,000	0.0067	41,000	0.0026	62,000	0.0029	83,000	0.0076
21,000	0.0064	42,000	0.0025	63,000	0.0030	84,000	0.0080
22,000	0.0061	43,000	0.0024	64,000	0.0032	85,000	0.0083
23,000	0.0058	44,000	0.0024	65,000	0.0033	86,000	0.0087
24,000	0.0056	45,000	0.0023	66,000	0.0035	87,000	0.0090
25,000	0.0053	46,000	0.0023	67,000	0.0036	88,000	0.0094
26,000	0.0051	47,000	0.0022	68,000	0.0038	89,000	0.0098
27,000	0.0048	48,000	0.0022	69,000	0.0040	90,000	0.0102
28,000	0.0046	49,000	0.0022	70,000	0.0042	91,000	0.0106
29,000	0.0044	50,000	0.0022	71,000	0.0044	92,000	0.0110
30,000	0.0042	51,000	0.0022	72,000	0.0046	93,000	0.0114

Based on the description of the projected value of B30 distribution productivity against the EnPI value, it can be seen that the optimal B30 distribution productivity value is in the range of 47,000-53,000 kL with an EnPI value of 0.0022 GJ/kL.

A. Lighting System

From the measurement results, it is known that the light intensity value in each workspace is that almost all workspaces have low light intensity values, where the lighting level in the room is still below standard, even though when viewed from the lighting intensity, most of the rooms are very spacious. However, the lighting intensity value is still considered lacking if the work lighting level has not been met. In order for the lighting problems that arise to be handled properly, the factors that must be considered are: lighting sources, workers in doing their jobs, the type of work done and the overall work environment.

Table -2: Room lighting flux values in the work space

Room	Actual lumens (Lux)	Total Area of Work Area (m ²)	Flux obtained (Lumen)	Flux required (Lumen)	Flux not yet reached (Lumen)
Meeting Room	243	21.25	5,164	6,375	1,211
Pantry Room	200	20.00	4,007	5,000	993
Corridor	162	55.25	8,951	5,525	(3,426)
GA Room	177	16.00	2,837	5,600	2,763
Terminal Manager Room	226	16.00	3,616	5,600	1,984
M&R Room	276	17.00	4,686	5,950	1,264
M&R Manager and HSE Room	183	17.00	3,105	5,950	2,845
Photo Copy Room	205	12.38	2,533	4,331	1,799
Operation Manager Room	266	12.75	3,392	4,463	1,071
Control Room	279	78.00	21,788	27,300	5,512
Residence Contractor Container	158	29.74	4,709	10,410	5,701
Prayer Room	238	12.00	2,856	4,200	1,344
First Aid Room	219	6.75	1,478	2,363	884
Receptionist	180	11.88	2,134	3,563	1,429
Server Room	178	7.95	1,412	2,783	1,370
Security Room	237	18.12	4,300	2,718	(1,582)
warehouse Office	91	5.00	457	750	293
Substation	217	288.86	62,779	101,101	38,322
Lay Down container	178	14.40	2,568	5,040	2,472

From the results of the evaluation of the lighting level needs of the workspace, it can be seen that almost all workspaces

have not been met. Therefore, to determine the number of lumens needed and the number of light point distributions, it can be determined as follows.

Table -3: Increasing lighting levels in the workspace

Room	Room Size (m ²)	Present condition		Load (Watt)	Replacement of lamp type											
		Types of Lamps	Amount (Unit)		Types of Lamps	Flux (Lumen)	Lighting Standards (Lux)	Total Area of Work Area (m ²)	Utility Coefficient (CU)	Wall Reflection Standard (LRF)	Coefficient (Room Height)	Number of Lights Per Point (Unit)	Number of Light Points (Unit)	Roundoff (Unit)	Electrical Load (Watt)	Total Flux (Lumen)
Meeting Room	21.25	TL 36	6	216	LED type-TL 18	1,500	300	21.25	0.5	0.7	4.5	1	2.7	3	54	4,500
Pantry Room	20.00	TL 36	6	216	LED type-TL 18	1,500	250	20.00	0.5	0.7	4.5	1	2.1	2	36	3,000
Corridor	55.25	TL 36	12	432	LED type-TL 18	1,500	400	55.25	0.5	0.7	4.5	1	2.3	2	36	3,000
GA Room	16.00	TL 36	4	144	LED type-TL 18	1,500	350	16.00	0.5	0.7	4.5	1	2.4	2	36	3,000
Terminal Manager Room	16.00	TL 36	4	144	LED type-TL 18	1,500	350	16.00	0.5	0.7	4.5	1	2.4	2	36	3,000
M&R Room	17.00	TL 36	4	144	LED type-TL 18	1,500	350	17.00	0.5	0.7	4.5	1	2.5	3	54	4,500
M&R Manager and HSE Room	17.00	TL 36	4	144	LED type-TL 18	1,500	350	17.00	0.5	0.7	4.5	1	2.5	3	54	4,500
Photo Copy Room	12.38	TL 36	2	72	LED type-TL 18	1,500	350	12.38	0.5	0.7	4.5	1	1.8	2	36	3,000
Operation Manager Room	12.75	TL 36	4	144	LED type-TL 18	1,500	350	12.75	0.5	0.7	4.5	1	1.9	2	36	3,000
Control Room	78.00	TL 36	28	1,008	LED type-TL 18	1,500	350	78.00	0.5	0.7	4.5	1	11.6	12	216	18,000
Residence Contractor Container	29.74	TL 36	8	288	LED type-TL 18	1,500	350	29.74	0.5	0.7	4.5	1	4.4	4	72	6,000
Prayer Room	12.00	TL 36	4	144	LED type-TL 18	1,500	350	12.00	0.5	0.7	4.5	1	1.8	2	36	3,000
First Aid Room	6.75	TL 36	2	72	LED type-TL 18	1,500	350	6.75	0.5	0.7	4.5	1	1.0	1	18	1,500
Receptionist	11.88	TL 36	4	144	LED type-TL 18	1,500	300	11.88	0.5	0.7	4.5	1	1.5	2	36	3,000
Server Room	7.95	TL 36	2	72	LED type-TL 18	1,500	350	7.95	0.5	0.7	4.5	1	1.2	1	18	1,500
Security Room	18.12	TL 36	4	144	LED type-TL 18	1,500	350	18.12	0.5	0.7	4.5	1	1.2	1	18	1,500
warehouse Office	5.00	TL 36	2	72	LED type-TL 18	1,500	350	5.00	0.5	0.7	4.5	1	0.3	1	18	1,500
Substation	288.86	TL 36	40	1,440	LED type-TL 18	1,500	350	288.86	0.5	0.7	4.5	1	43.8	43	774	64,800
Lay Down container	14.40	TL 36	4	144	LED type-TL 18	1,500	350	14.40	0.5	0.7	4.5	1	2.1	2	36	3,000

If the lighting system of the workspace is replaced with the type of lamp to LED lamps, then the electrical load for the lighting system will automatically be reduced by about 940.90 kWh/month or about 69% of the electrical load of the existing lamps. In addition, the level of lighting in the workspace can be maintained so that comfort can be met.

B. Air Conditioning System

Air conditioning system is one of the inseparable needs of a building. This air conditioning system aims to meet the health and comfort of building occupants while still paying attention to energy efficiency. Therefore, buildings must be well designed to accommodate occupants throughout the year comfortably and energy efficiently according to climate conditions. This thermal comfort can be obtained without air conditioning or with air conditioning.

Based on the condition of the currently installed AC equipment, it is known that the AC intensity value is mostly still excessive (over design) above the standard value (35 Watt/m²). From the condition of the equipment with excessive AC intensity value, technically the level of room comfort should be achieved. From the results of the load survey on room conditions, namely temperature and humidity values, several work spaces still have low temperatures except for the server room/control room, this can be seen from the comfort value which is still below the limit.

The concept of COP or Coefficient of Performance is the same as Efficiency which states the comparison between the desired results and expenditure. The COP value is directly proportional to the cooling impact and inversely proportional to the compression work. Based on these data, the AC performance values are as follows.

Table -4: AC system performance

Room	Room Size [m ²]	Merck	AC Performance [Actual]				Remark
			Cooling Effectiveness			COP	
			[kJ/menit]	[TR]	[kWth]		
Meeting Room	21.25	MC Quay	299.71	1.42	5.00	2.91	The AC performance is good
Pantry Room	20.00	MC Quay	272.12	1.29	4.54	2.65	The AC performance is good
Corridor	55.25	MC Quay	308.43	1.46	5.14	3.00	The AC performance is good
GA Room	16.00	MC Quay	149.54	0.71	2.49	3.02	The AC performance is good
Terminal Manager Room	16.00	MC Quay	257.00	1.22	4.28	2.50	The AC performance is good
M&R Room	17.00	MC Quay	236.61	1.12	3.94	2.30	The AC performance is good
M&R Manager and HSE Room	17.00	MC Quay	213.48	1.01	3.56	2.08	The AC performance is good
Photo Copy Room	12.38	MC Quay	246.48	1.17	4.11	2.40	The AC performance is good
Operation Manager Room	12.75	MC Quay	207.03	0.98	3.45	2.01	The AC performance is good
Control Room	78.00	MC Quay	291.47	1.38	4.86	2.00	The AC performance is good
		MC Quay	293.82	1.39	4.90	2.02	The AC performance is good
		MC Quay	291.47	1.38	4.86	2.00	The AC performance is good
		MC Quay	297.30	1.41	4.95	2.04	The AC performance is good
Residence Contractor Container	29.74	MC Quay	258.40	1.22	4.31	2.51	The AC performance is good
		MC Quay	86.13	0.41	1.44	2.99	The AC performance is good
Prayer Room	12.00	MC Quay	235.81	1.12	3.93	2.29	The AC performance is good
First Aid Room	6.75	MC Quay	230.67	1.09	3.84	2.24	The AC performance is good
Receptionist	11.88	MC Quay	266.19	1.26	4.44	2.59	The AC performance is good
Server Room	7.95	MC Quay	133.01	0.63	2.22	2.58	The AC performance is good
		MC Quay	110.41	0.52	1.84	2.14	The AC performance is good
Security Room	18.12	MC Quay	173.49	0.82	2.89	3.36	The AC performance is good
		MC Quay	175.33	0.83	2.92	3.40	The AC performance is good
warehouse Office	5.00	MC Quay	178.38	0.85	2.97	3.46	The AC performance is good
		MC Quay	212.55	1.01	3.54	8.43	The AC performance is good
Substation	288.86	MC Quay	1,360.49	6.45	22.67	2.51	The AC performance is good
		MC Quay	1,724.52	8.17	28.74	3.18	The AC performance is good
Lay Down	14.40	MC Quay	197.82	0.94	3.30	3.05	The AC performance is good

Table -5: Main electrical voltage measurement data

V _R	V _S	V _T	V _{average}	Unbalance (%)
1 Phasa				
218.20	217.41	217.79	217.80	0.18
217.76	217.87	217.64	217.76	0.05
218.20	217.41	217.79	217.80	0.18
3 Phasa				
377.54	377.19	376.88	377.20	0.09
377.54	377.19	376.88	377.20	0.09
377.45	376.58	377.75	377.26	0.13

If viewed from the % unbalance voltage or supply voltage balance value, it looks good, because the average % unbalance voltage value is 0.05-0.18%. This value is still below the required standard value of 3% (IEEC 519 standard). From the description of the electrical voltage value, it can be seen that the electrical voltage value is still low (<380 Volts), therefore to increase the electrical voltage value, a stabilizer can be installed according to the Company's electricity needs. Based on the evaluation results, it is recommended that the installed stabilizer unit have a capacity of 150 kVA.

B. Electric Current

Based on the results of direct measurements of the electrical load, it can be seen that the current or electrical load still has a high unbalance value or can be said to exceed the specified limit of 20%. If traced based on the measurement results, the large current imbalance value comes from the electrical load of the office area where the office electrical equipment is 1 phase electrical equipment. If the distribution of loads between phases (RST) is not balanced, it will cause an unbalanced current value. The following is a description of the electric current profile.

Table -6: Main electric current measurement data

I _R	I _S	I _T	I _{average}	Unbalance (%)
46.84	75.22	75.22	65.76	14.39
44.97	187.22	181.84	138.01	35.66
44.97	187.22	181.84	138.01	35.66

From the unbalanced current value, it can be seen that the unbalanced current value can reach 35.66%. The current imbalance value is still high, which is indicated to come from 1-phase equipment, namely office AC equipment whose load is on the S phase and T phase.

C. Electricity Usage

Based on the electrical load profile, it can be seen that the highest load is 77 kW. When viewed from the installed electrical power (1,250kVA), the electricity absorption value

For central AC units (split duct), design the installed AC equipment according to the cooling load requirements. Installed split duct AC capacity: 29.3 kW or equivalent to 99,971.60 BTU/h

Because there are 2 (two) AC units installed, the total cooling capacity is 199,943.20 BTU/h, so it can be said that the splitduct AC is installed according to its needs.

C. Electrical System

Based on the observation results, it is known that the electrical system at PSE uses an electrical connection from PT KPC with a connected power of 1,250 kVA where the electrical energy is distributed for daily B30 distribution activities and offices such as for Air Conditioning (AC) equipment, lighting (lamps), computer equipment, printers, fax machines, photocopiers, and other office equipment.

A. Electric Voltage

If viewed from the electrical voltage profile, it can be seen that the value of the electrical voltage received is still low, which is <230 Volts per phase or if viewed from the 3 phase load, the average working voltage received is 376 Volts (<400 Volts). The low value of the electrical voltage can cause an increase in the value of the electrical current so that electricity usage becomes greater.

is only 6%. This value illustrates that electricity absorption is not optimal.

Table -7: Total electrical load measurement data

P_R	P_S	P_T	$P_{average}$	Unbalance (%)
9.00	15.00	13.00	12.33	21.62
8.00	35.00	34.00	25.67	36.36
8.00	35.00	34.00	25.67	36.36

4. CONCLUSIONS

The actual value of B30 distribution productivity is 33,438-53,474 kL with an EnPI (Energy Performance Indicator) value of 0.0031-0.0049 GJ/kL. To optimize energy performance in productivity, B30 distribution is optimized at the level of 47,000-53,000 kL with an EnPI value of 0.0022 GJ/kL.

In terms of electricity usage, the current imbalance value is still high (>20%), therefore to optimize energy performance, reinstallation or rewiring can be done on the electrical network for 1-phase loads. To optimize energy performance in the workspace, the workspace lights can be replaced from TL-36 to TL LED-18. Determination of the light point suggests placing the lights right above the work desk and using a frame that uses a reflector with a new design, without light channeling fins. In addition, to improve the quality of the electric voltage, a stabilizer (150 kVA) can be installed according to the Company's electricity needs.

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