Significant energy use analysis and energy conservation on Diponegoro University

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Abstract. In the current era of technology and information advancements, consumer growth and electrical energy are certainly getting more significant over time. Therefore, Energy Conservation can be carried out to find detailed information on energy usage. How much should be paid in using that energy, Biggest potential user, and ultimately this Conservation energy will show recommendation on Operational Equipment, even the processes. According to the Regulation No. 13 of 2012, concerning an infrastructure that requires large-scale energy use, conservation energy needs to be done as the will for maintaining the balance of energy using further on maintaining Eco saving energy for further generation come as well as Psychology Faculty Universitas Diponegoro from 2016 to 2019 have a specific large number of Energy consumer as education infrastructure that included from 13 Faculty and 5 unit operation. From that faculty, there is spread more inside each faculty called Unit. Overall, In this case from 13 Faculty and 5 Unit, we analyze the detailed recommendation for the Psychology Faculty of Diponegoro University as the newest building infrastructure and Non-Exact type Educational Departement such as Potential energy user of Equipment and Lightning.

1. Introduction

Energy is the crucial things that could help our life activities more accessible, but in overcome using energy that over from regular using will connect with ISO 5001 is un-efficient, Energy Conservation on Diponegoro University which contain 13 Faculty and 5 unit field survey proofing that over from Secondary data year 2016 to 2019 until now 2020, For instance, RSND is the highest payment bill to PLN from 2016 to 2019 by the secondary data [1,2]. In this case, according to *Peraturan Menteri ESDM No. 14, 2012 Article 10* periodically, conservation energy on any infrastructure in each environment or organization infrastructure should be done[3-6]. From 13 Faculty and 5 unit Audit, we take a study case at Psychology Faculty. Hedaya Wafid already did previous research with the title *Analysis of electrical energy users in UNDIP Tembalang campus using WEB-based software* [7]. This research purpose is not using energy-saving and recommendations from energy conservation that have been analyzed based on secondary data [8]. According to our research, we analyze further the recommendation and energy

saving management. Also, there is previous research by *A T Yunanto* with the title *Study on the efficiency of PT's electrical energy consumption opportunities. SAI APPAREL Semarang.* This paper is an energy conservation industrial while our research takes place in Diponegoro University's educational infrastructure. Overall previous research by *A T Yunanto* has the same idea where conservation energy object has recommendation and energy-saving planning.

Figure 1. Faculty of Psychology at Diponegoro University Semarang.

Besides Psychology Faculty is the newest one among 13 faculty and 5 unit. According to the field survey database and secondary data audit, this building has potential energy use that can be maintained for energy saving.

In order of classification SEU (Significant Energy User), we focused on a resource that we have for analysis energy-saving potential and high load that has significant potential for energy saving. By *SNI 6196:2011* audit energy for high potential energy users on the Faculty of Psychology and field survey on 16th July 2020. Identification of equipment and process should be the solution for an energy-saving recommendation for that infrastructure use.

2. Methodology

2.1. Energy Conservation and Audit Energy

According to *SNI 6196:2011*, an energy audit is a process of evaluating energy use and identifying energy-saving opportunities and recommendations for increasing efficiency in energy use and users of energy sources in the context of energy conservation. Moreover, by the *Peraturan Menteri ESDM No. 14 article 1 number 4 and 5* about audit energy is the implementation result of evaluation from efficiency energy project by system, facility, and process. From *SNI 6196:2011* and *Peraturan Menteri ESDM No* 14, both are in the same mean that can be sorted as Verification, Monitoring, Analysis [9].

Implementation of Audit energy is divided into three steps by international standards of ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) as follows:

- ASHRAE Level 1: Preliminary Audit
- ASHRAE Level 2: Energy and Survey Analysis
- ASHRAE Level 3: Detailed analysis of capital intensive modification

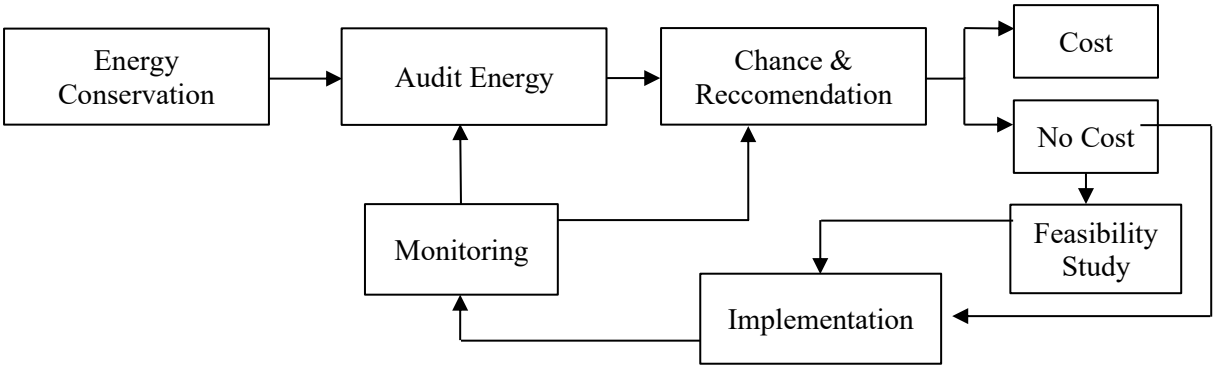

Figure 2. Energy conservation step.

Figure 2 shows the step of energy conservation by the chart table. According to *SNI 6196:2011, energy conservation* is described in 3 words, verification, monitoring, and analysis. The first step is the audit energy. A previous audit that has been done, secondary data is collected from the previous audit and field survey, determines primary data that will generate a recommendation of the audit object. The audit object will have two options between costed recommendation or no cost for implementing the recommendation. Implementation is monitored by a surveyor or technical person for further recommendation energy saving on potential energy users.

2.2. Technical implementation

From a technical point of view, from the start of conducting an energy audit, from forming auditors to field surveys and planning secondary data that must be checked and unchecked, it is concluded that thirteen faculties and five units at Diponegoro University conducted an audit survey based on the highest point of the bill. Payment of more than IDR 100,000,000.00 in a year from 2016 to 2019 also began preparing to license for surveys in thirteen faculties and five units for auditors' access to conduct surveys [10]. Furthermore, after the survey data checklist is carried out, a data survey is carried out. Furthermore, after the data survey checklist is done, data surveys analysis according to secondary data and survey data are combined that make new baseline renewable from secondary data. After the baseline data analysis is completed, the recommendation for potential energy users can be calculated from the base data of equipment and processes such as light, workplace equipment, and process to be identified at least 80% of the process and equipment is analyzed for saving energy recommendation.

3. Results and discussion

3.1 Secondary data

Secondary data audit solves by 13 faculty and five units, including the Faculty of Psychology as the object of study case in this article, is calculated based on secondary data before. These data show a list of bill payments in a year from 2016 to 2019. The field survey started from 20th June 2020 until 1st August 2020; table 1 shown below is the data from the field survey, including lightning and equipment, as the object of significant energy user.

Table1. Faculty of Psychology light and equipment data.

No	Equipment type	Total equipment	Operational hour	Operational day	Power (kwh) opr/1day	Power (kwh) opr/1year	Percentage (%)
1	Peripheral	263	8	240	54.06	12974.4	7.9%
2	Ac	111	8	240	223.7	53688	33%
3	Accessed	7	8	240	140	4200	3%
4	Light	905	8	240	234.16	71282.4	43.5%
5	Non-SEU	20	8	240	90.77	21784.8	13.3%

No	Equipment type	Total equipment	Operational hour	Operational day	Power (kwh) opr/1day	Power (kwh) opr/1year	Percentage (%)
	Total	1306	40		683.04	163929.6	100%
			Total SEU			142144.8	87%
			Total Non-SEU			21784.8	13%
			Total Energy Consumption In 1 Year			163929.6	100%

Table 1 shows the data showed by its still lightning as the potential energy user with 297.01 kWh each 8 hours operational in each day operation. The field data survey of the Faculty of Psychology is using two kinds of light, TL and LED. TL Lamp is the one reason for high potential energy use and placed in the Faculty of Psychology basement floor's parking lot. By percentage of data in light and equipment, we can see a chart from figure 2.

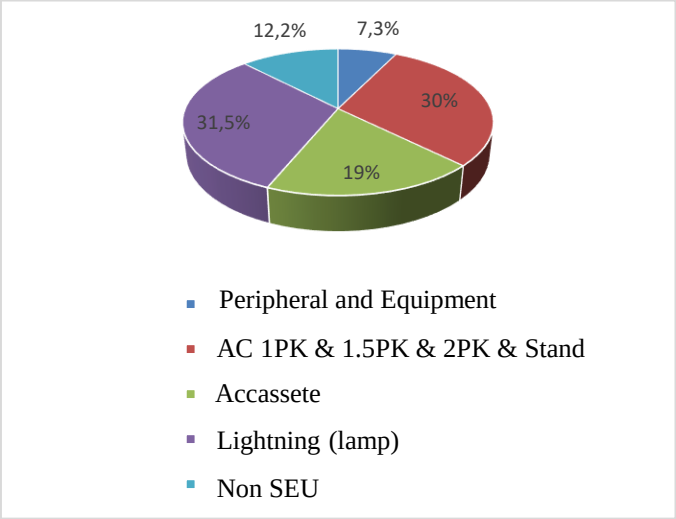

Figure 3. Energy consumption chart Faculty of Psychology.

3.2. Analysis

According to table 1, TL light is the high potential energy user. Changing TL Light, especially in the Parking lot of Psychology Faculty, is extravagant of using energy consumption besides using TL lamp better change to TL LED lamp that saves energy and not overconsume energy. However, changing equipment or peripheral in the structural facility needs to be sure its need investment that has intention this investment will be payback someday, indeed it is taking the time. In this case, table 2 will show how much benefit can get from saving energy TL LED.

Table 2. TL to LED investment payback.

Use of Bulb (TL/SL/PLC)	
Total power (kWh/1year)	30,53 kW
Total Lights	905
Operation Long	8 hour for 240 day
Operating Frequency	80%
Energy Consumption	5,6198.4 kWh/year
Electricity Costs	Rp1.467,28/kWh
1 Day Operation Cost	Rp343.57,008
1 Year Cost	Rp82.458.788,00

Replacement with TL LED Lamp	
Total Lights	590 TL Lamp
Savings Per Lamp	22 Watt
Energy Savings TL LED/1Year	20,390.4 kWh/year
Saving Costs 590 TL LED/Year	Rp29.918.426,00
Overall Saving Cost in 1 Year	Rp45.891.823,00
Investment Costs Initial	Rp23.600.000,00
Payback	1.2

From this table 2, analysis its showed if we use TL LED lamp with the first investment of Rp23.600.000,00, there is electricity cost-saving and also energy saving over 20,390.4 kWh/year that will be balanced with payback from the first investment by 1.2 years further.

After all, this effective energy use not only happens at lightning but also for equipment [8-10]. The Air Conditioner inside a workplace is potential energy that could be minimalized. According to *President decree No. 17, 2009*, every equipment used inside the workplace or used for processes should have a logo or labels of efficiency energy levels SKEM (*Standard Kinerja Energi Minimum*) or Minimum Energy Works Standard.

Figure 4. SKEM (*Standar Kinerja Energi Minimum*).

For the analysis of equipment used in the Faculty of Psychology, we use table 3. The air conditioning system is designed to maintain thermal comfort, cleanliness and freshness of the air in the building. Thermal comfort is achieved when the average temperature is between 24º-27º C, with humidity between 55% -65% for the area tropical. Singh said, "*every one-degree increase in the Air-conditioner temperature setting results in saving 6% of electricity consumed"*. By the statement, Our recommendation is by changing the refrigerant to the R32. R32 refrigerant is the best solution used in the global environment and settings management of the temperature. The central temperature AC used in the Faculty of Psychology is R22, with 23º C compared with R32 is 25º C.

Table 3. 23º C to 25º C temperature setting.

Total Energy Data	Energy Total		kWh Difference	Efficiency In Rupiah
	23º C	25º C		
One Day	1,515.13	1,363.62	151.51	Rp157,312.70,00
One Month	45,453.84	40,908.45	4,545.38	Rp4,719,381.11,00
One Year	545,446.06	490,901	54,544.61	Rp56,632,573.35,00

Table 3 shows us if using R32 AC with benchmark DAIKIN FTV35BX is 6% Saving energy than using R22 AC with benchmark PANASONIC 2KS314D3AC01 with R32 daily need 151.51kW, monthly 4,545.38 kW, and in a year, it is 54,544.61 kW. Changing from R22 to R32 freon, energy efficiency over 3221.28 kWh or in rupiah is Rp56,632,573.35 in one year.

Changing of refrigerant R22 to R32 needs compressors specification, a suitable condenser that right type, so this must change completely one packet with the AC itself. Surely need to pay attention to the economic aspect, effective and efficient. BEP (Break-Even Point) will analyze this circumstance in a matter of payback and investment below:

$$\text{BEP} = \frac{\text{DAIKIN FTV35BXV}-\text{Used AC Selling}}{\text{Potential Efficiency in 1 Month}} \quad (1)$$

$$\text{BEP} = \frac{\text{Rp 454.900.000}-\text{Rp100.000.000}}{\text{Rp 4.719.381}} = 75 \text{ Month} \quad (2)$$

In this case, it can be concluded that changing 111 AC in the Faculty of Psychology needs investment over Rp454.900.000,00, assuming that selling used AC is Rp100.000.000,00 until it gets efficiency cost each month. Rp4.719.381,00 then return of investment is in 75 months or six years two months.

4. Conclusion

Audit energy is a step from energy conservation that including preliminary data, analysis and detailed analysis. Audit energy consists of crew forming, planning, field survey, and then in-depth detailed analysis based on surveillance data taken directly in the field survey. By using table 2, the Faculty of Psychology should be saved Rp5.484.956,00 each year from Rp. 74.035.427,00. Overall, over 80% of detailed data collection is implemented from light and equipment, and energy-saving from potential energy users eliminates over 20% of the total power before reaching 3738 kWh each year. Moreover, from equipment analysis changing freon R22 to R32 according to the BEP, it analyzes its recommendation, resulting in 6% energy saving from 23ºC to 25ºC and setting temperature and remotely management, increasing potential energy saving from Air Conditioner. According to *ISO 50001*, *PP No. 70 2009*, and *Peraturan Menteri ESDM No. 14 2012*, energy conservation is taken to minimize potentially high energy users that consume energy more from limit standardization change or even shut down.

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