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Policy Paper

Provision of Clean Energy and Cheap Energy Conservation in Islamic Boarding Schools

Penyediaan Energi Bersih dan Konservasi Energi Murah di Pondok Pesantren

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Clean Energy; Communal Biogas; Electricity; Energy Conversion; Islamic Boarding Schools; New Renewable Energy; Solar Power.

Abstract

This paper describes that Islamic boarding schools in Indonesia in 2024 will reach 36,600 boarding schools, with a total of 3,642,738 students, which is a potential market share as well as a potential target to be developed into a clean energy manufacturing provider as well as an energy conservation area. On the other hand, the Indonesian Government is trying to increase the portion of the renewable energy mix according to the National Energy Policy (KEN) which will reach 23% in 2025. Islamic boarding schools as one of the centers of educated people are the right place to socialize and implement the New Renewable Energy and Energy Conservation program. The purpose of this study is to calculate the technical feasibility of utilizing communal biogas for cooking, generating rooftop solar power to support the energy diversification program and reduce PLN electricity bills, and replacing LED lamps according to SNI 6197:2011 concerning lighting systems in building structures and supporting energy conservation efforts. The methodology used is a survey and direct measurement related to local solar energy potential, the precision of the PLTS location, electricity needs, biogas potential and its designation, and lighting needs. Data processing was carried out using Meteonom, CorelDraw, and Pvsyt software. The results of the study showed that, for example, the Al Ihsan Islamic Boarding School case, is worthy of being recommended as a pilot project for the program. PP Al Ihsan has a potential for solar radiation of 4.91 kWh/m2.day with an average annual temperature of 27.8 oC so it is feasible to build a rooftop PLTS with a capacity of 13,000 Wp to supply the electricity needs of the boarding school which reaches 15,840 VA. The number of students of PP Al Ihsan which reaches 590 students with a *sufficient area makes PP Al Ihsan feasible to build a communal biogas with a scale of 6 m3. In terms of replacing LED lamps, PP Al Ihsan will meet SNI standards by replacing 39 5-watt LED lamps, 89 13-watt LED lamps, and 18 27-watt LED lamps.*

Kata Kunci:
Energi Bersih; Biogas Komunal; Listrik; Konversi Energi; Sekolah Asrama Islam; Energi Terbarukan Baru; Tenaga Surya.

Abstrak

Makalah ini menjelaskan bahwa pesantren di Indonesia pada tahun 2024 akan mencapai 36.600 pesantren, dengan total 3.642.738 siswa, yang merupakan pangsa pasar potensial serta target potensial untuk dikembangkan menjadi penyedia manufaktur energi bersih dan juga area konservasi energi. Di sisi lain, Pemerintah Indonesia berupaya meningkatkan porsi bauran energi terbarukan sesuai dengan Kebijakan Energi Nasional (KEN) yang akan mencapai 23% pada tahun 2025. Pesantren sebagai salah satu pusat pendidikan merupakan tempat yang tepat untuk mensosialisasikan dan mengimplementasikan program Energi Terbarukan Baru dan Konservasi Energi. Tujuan penelitian ini adalah untuk menghitung kelayakan teknis pemanfaatan biogas komunal untuk memasak, menghasilkan tenaga surya atap untuk mendukung program diversifikasi energi dan mengurangi tagihan listrik PLN, serta mengganti lampu LED sesuai dengan SNI 6197:2011 tentang sistem penerangan pada struktur bangunan dan mendukung upaya konservasi energi. Metodologi yang digunakan adalah survei dan pengukuran langsung terkait potensi energi surya lokal, ketepatan lokasi PLTS, kebutuhan listrik, potensi biogas dan penunjukannya, serta kebutuhan penerangan. Pengolahan data dilakukan menggunakan perangkat lunak Meteonom, CorelDraw, dan Pvsyt. Hasil penelitian menunjukkan bahwa, misalnya, kasus Pondok Pesantren Al Ihsan, layak direkomendasikan sebagai proyek percontohan untuk program tersebut. Pondok Pesantren Al Ihsan memiliki potensi radiasi matahari sebesar 4,91 kWh/m2.hari dengan suhu rata-rata tahunan 27,8 oC sehingga memungkinkan untuk membangun PLTS atap dengan kapasitas 13.000 Wp untuk memenuhi kebutuhan listrik pondok pesantren yang mencapai 15.840 VA. Jumlah siswa Pondok Pesantren Al Ihsan yang mencapai 590 siswa dengan luas yang cukup membuat Pondok Pesantren Al Ihsan layak untuk membangun biogas komunal dengan skala 6 m3. Dalam hal penggantian lampu LED, PP Al Ihsan akan memenuhi standar SNI dengan mengganti 39 lampu LED 5 watt, 89 lampu LED 13 watt, dan 18 lampu LED 27 watt.

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INTRODUCTION

The development of Islamic boarding schools has grown rapidly from year to year, both in terms of the number of Islamic boarding schools and the number of students. Until

2024, the number of Islamic boarding schools in Indonesia was around 36,600 with 3,642,738 students. As a means of education, with a large number of students, it certainly requires a lot of energy, both for the teaching and learning process and for housing. On the other hand, the Indonesian Government is trying to increase the role of renewable energy (EBT) and energy conservation (KE) in ensuring the fulfillment of national energy needs sustainably. This increase in role is carried out through energy diversification and conservation. And Islamic boarding schools as one of the centers of educated people are the right place to socialize and implement the New Renewable Energy and Energy Conservation program.

By considering technological advances and the ease of implementation of New Renewable Energy and Energy Conservation technology, three types of technology were chosen that would be feasible to implement in the Islamic boarding school community. Utilization of communal biogas and rooftop solar power plants (PLTS) can be applied to support energy diversification programs while replacing or retrofitting LED lights is one of the energy conservation efforts by using more efficient equipment.

Biogas is one of the renewable energies that can be developed to meet the fuel needs of rural communities. Biogas is a biofuel in the form of methane-rich gas that is flammable and produced through a biochemical conversion of biomass waste (including human waste) with a fermentation process without oxygen in an airtight space (anaerobic reactor/digester). Biogas can be used for cooking fuel (utilization of heat energy) and also for the provision of electricity. In addition, the use of biogas also supports environmentally friendly energy activities to reduce greenhouse gas emissions.

Rooftop PLTS is one of the renewable energies that is installed on the roof of a building. Rooftop PLTS with an off-grid system can be used as a substitute or backup source of electricity in the event of damage to the main electricity source. Meanwhile, installation with an on-grid system can be used as a solution to reduce the cost of electricity bills that must be paid as regulated in Ministerial Regulation (Permen) Number 49 of 2018 concerning the use of the Rooftop PLTS system by PLN consumers. The amount of savings in PLN electricity bills in general reaches IDR 1,685,121 per month per 10 kWp of Rooftop PLTS installed. (BLU P3TEK, 2018). The lighting sector in building structures has the potential for national average energy savings of around 10 - 30%. This can be done through efforts to increase energy efficiency, especially related to equipment replacement, efficient equipment operation and implementing energy conservation action programs. However, in its implementation, there are still many obstacles, including the problem of funding energy audit activities to identify problems and their implementation. The middle way is to directly replace or retrofit lamps from incandescent or fluorescent lamps with LED lamps which are more efficient in using energy.

METHOD

The methodology used in providing this cheap clean energy is a survey and direct measurement related to local solar energy potential, the precision of the PLTS location, electricity needs, biogas potential and its use, and lighting needs. Data processing is carried out using Meteonom, CorelDraw, and Pvsyt software. The results of data processing are used to prepare comprehensive planning related to the construction of communal biogas, rooftop PLTS, and LED retrofitting at Islamic boarding schools to increase the implementation of new renewable energy and energy conservation. The reference criteria for selecting Islamic boarding schools include a minimum of 500 students staying overnight (male/female) with an area required for the construction of a communal biogas complex of at least 500 m2; the distance between the communal biogas construction location and the public kitchen is a maximum of 50 m; the availability of a permanent source of clean water; the willingness of the Islamic boarding school management to accept and manage assets; roof construction that allows the construction of a rooftop PLTS, and the absence of potential shading around the area where the rooftop PLTS will be installed; and there are electrical facilities at the Islamic boarding school that can be used for replacing or retrofitting LED lights.

RESULTS AND DISCUSSION

Provision of Communal Biogas from Human Waste at Islamic Boarding Schools

The initial process of human waste decomposition in the digester reactor is the hydrolysis process of organic materials that are easily dissolved and decomposed into simple compounds. The next stage is continued in the acidification process where the dissolved and simplified parts form organic acids and alcohols. The final stage of methane gas formation (CH4) through acid and alcohol decomposition forms methane gas. The accumulation of methane gas is collected in the gas furnace (holding gas) and distributed through distribution pipes using control valves to gas user areas or public kitchens.

Energy Provision through Rooftop Solar Power Plants

PLTS in power generation is converting solar energy into electrical energy using photovoltaic (PV) cells. The process that occurs in photovoltaic cells is based on the photoelectric effect where electrons surrounding metal atoms will be released when exposed to light. This happens because the light that hits the electrons will provide energy to the electrons. These electrons are excited and released from the atoms to an excited state because the energy of the electrons exceeds the bond energy that binds the electrons to the atoms. In simple terms, the process of providing energy through Rooftop PLTS can be seen in Figure 1.

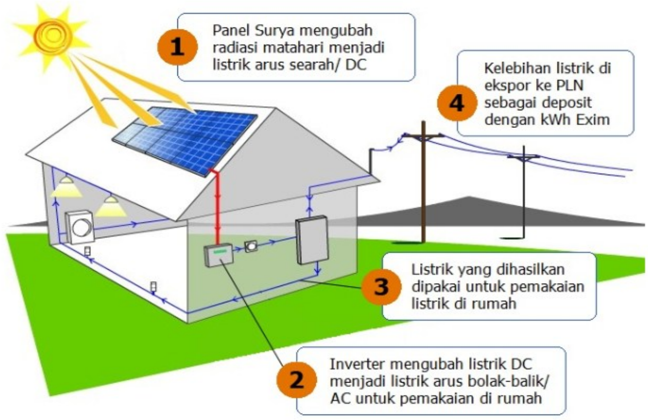


Figure 1. Energy Supply Process Through Rooftop PLTS

There are currently two types of PV module technology, namely crystalline silicon and thin film technology. The PV modules that are widely available on the market today are based on crystalline silicon solar cells and are the type of solar cells with the highest efficiency. This type is very fragile and therefore must be mounted on a strong frame or support. Thin film solar cells were developed to reduce the price of silicon-based solar cells. This type uses deposition technology to produce thin film materials that can behave as solar cells. Some types of thin film PV modules that are already commercial include a-Si, CdTe, and CIGS solar cells.

Energy Conservation Through LED Lamp Retrofitting

Retrofitting LED lights is one of the implementations of the energy conservation program mandated in Law Number 3 of 2007 concerning Energy and Government Regulation Number 70 of 2009 concerning Energy Conservation, especially in building lighting systems. Energy conservation standards for lighting systems in buildings themselves are regulated in the Indonesian National Standard (SNI) 6197:2011. This standard contains provisions for lighting guidelines in building structures to obtain a lighting system with the optimal operation so that energy use is more efficient without having to reduce and/or change the function of the building, comfort, and productivity of occupants, and consider environmental and cost aspects. According to SNI 6197:2011, natural lighting must meet the provisions of the procedures for designing natural lighting systems in buildings. In its utilization, radiation caused by direct sunlight in the building must be minimized to avoid an increase in temperature in the interior of the building. Natural light during the day must be utilized optimally as an alternative to additional light to reduce the use of electrical energy in buildings by considering aspects of the related system. The recommended minimum lighting level must not be less than the standard lighting level. Table 1 presents the average lighting levels, rendering, and color temperature recommended in educational institutions including Islamic boarding schools. The maximum electrical power per square meter should not exceed the values as listed in Table 2.

Table 1. Average Lighting Levels, Rendering, and Color Temperature Recommended in Educational Institutions

Room Function	Lighting Level (Lux)	Color Rendering Group	Color Temperature		
			Warm <3300 Kelvin	Warm White	Cool Daylight
Classroom	350	1 or 2		◆	◆
Library	300	1 or 2		◆	◆
Laboratory	500	1		◆	◆
Computer practice room	500	1 or 2		◆	◆
Language laboratory	300	1 or 2		◆	◆
Teacher's room	300	1 or 2		◆	◆
Sports room	300	2 or 3		◆	◆
Drawing room	750	1		◆	◆
Canteen	200	1	◆	◆	
Mosque	200	1 or 2		◆	

Table 2. Maximum Electrical Power for Lighting Educational Institutions

Room Function	Maximum Lighting Power (W/m2) (including ballast losses)
Classroom	15
Library	11
Laboratory	13
Computer practice room	12
Language laboratory	13
Teacher's room	12
Sports room	12

The energy efficiency of lighting systems can be improved by using lamps with higher efficacy, selecting high-efficiency electronic ballasts, and selecting efficient luminaires.

Al Ihsan Islamic Boarding School as a Pilot Project

Al-Ihsan Islamic Boarding School was founded by KH. Abdul Mannan in 1998. PP Al-Ihsan is located in Ringinpitu Hamlet, Kuniran Village, Sine District, Ngawi Regency, East Java Province. The spirit of establishing PP Al-Ihsan is to spread Islamic faith and preaching. In principle, Al-Ihsan Islamic Boarding School is the same as other Islamic boarding schools, where in its daily activities, Al-Ihsan Islamic Boarding School adheres to two schools of thought, namely the Ash'ari school and the Syafi'i school. The Ash'ari school is used as a guideline in the field of faith, while in the field of fiqh, it adheres to the Syafi'i school or what is commonly known as "Ahlus Sunnah Wal Jama'ah."

The Al-Ihsan Islamic Boarding School system is built based on the spirit of the Salaf, where learning activities are more directed at non-formal education patterns. In addition to using a non-formal education system, PP Al-Ihsan also adopts a modern education system. This is a form or effort of PP-Al-Ihsan in facing the challenges of an increasingly complex era and also the development of science and technology.

In 2018, PP Al Ihsan was surveyed by the Research and Development team of the Ministry of Energy and Mineral Resources to be recommended to receive a Communal Biogas, Rooftop PLTS, and LED Lamp Retrofitting grant from the Ministry of Energy and Mineral Resources in 2019. The Al-Ihsan Islamic Boarding School has a land area that is used as a building for the Islamic boarding school of 8,700 M2. Currently, the number of students living in the Al-Ihsan Islamic Boarding School is 590 people (230 boys, 300 girls, and 60 administrators). Figure 2 shows the wastewater treatment installation for communal biogas at PP Al Ihsan.

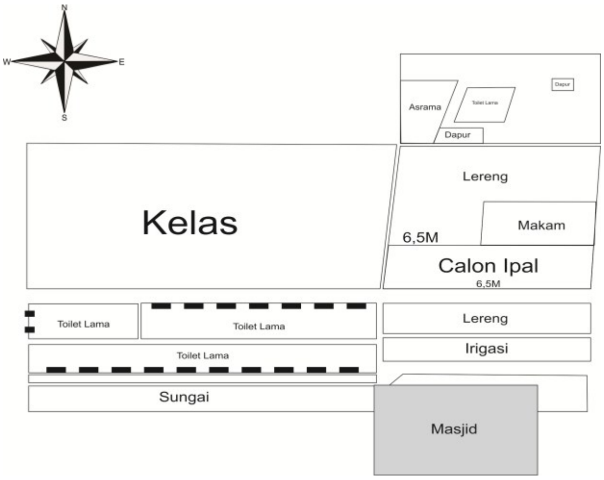
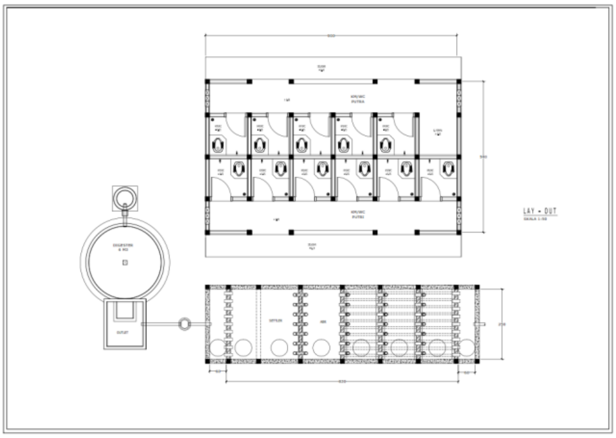


Figure 2. Planning of IPAL for Communal Biogas

Based on the available area the existing condition of the human waste IPAL system and the location of the public kitchen used, Al Ihsan Islamic Boarding School is feasible to build a 6 m3 scale communal biogas as a source of clean biogas energy supply for cooking purposes in the PP Al Ihsan public kitchen. Details of the communal biogas image at Al Ihsan Islamic Boarding School can be seen in Figure 3.



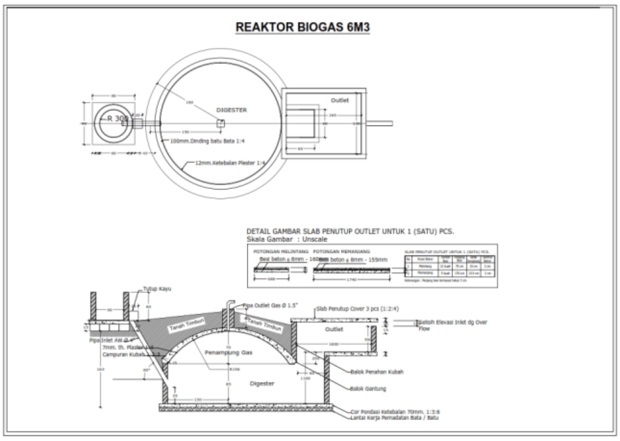
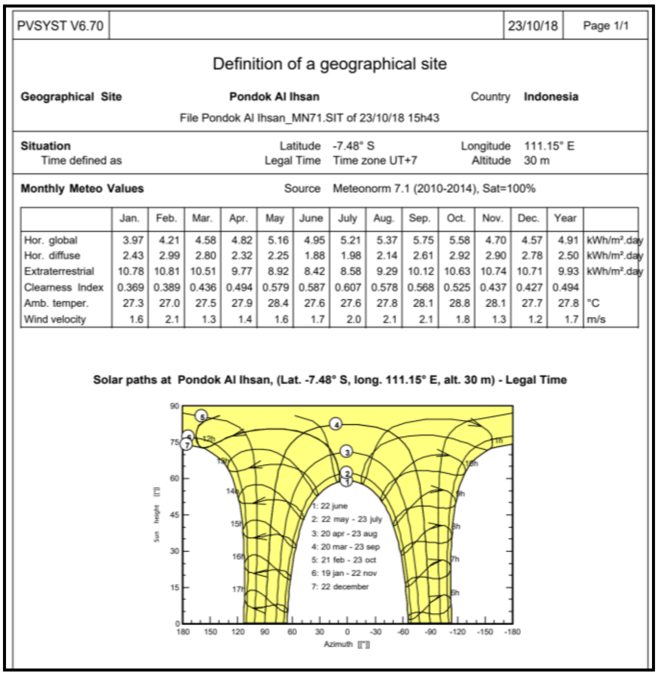


Figure 3. Detailed Engineering Design of Communal Biogas PP Al Ihsan

Before the decision to build a Rooftop PLTS is made at PP Al Ihsan, the coordinate location of PP Al Ihsan must be determined first to determine the meteorological conditions of the location and the potential for radiation or sunlight intensity as shown in Figure 4.


PVSYST V6.70 | 23/10/18 | Page 1/1

Definition of a geographical site

Geographical Site: Pondok Al Ihsan — Country: Indonesia
File Pondok Al Ihsan_MN71.SIT of 23/10/18 15h43

Situation — Latitude -7.48° S — Longitude 111.15° E
Time defined as — Legal Time — Time zone UT+7 — Altitude 30 m

Monthly Meteo Values — Source: Meteonorm 7.1 (2010-2014), Sat=100%

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year	
Hor. global	3.97	4.21	4.58	4.82	5.16	4.95	5.21	5.37	5.75	5.58	4.70	4.57	4.91	kWh/m².day
Hor. diffuse	2.43	2.99	2.80	2.32	2.25	1.88	1.98	2.14	2.61	2.92	2.90	2.78	2.50	kWh/m².day
Extraterrestrial	10.78	10.81	10.51	9.77	8.92	8.42	8.58	9.29	10.12	10.63	10.74	10.71	9.93	kWh/m².day
Clearness Index	0.369	0.389	0.436	0.494	0.579	0.587	0.607	0.578	0.568	0.525	0.437	0.427	0.494	
Amb. temper.	27.3	27.0	27.5	27.9	28.4	27.6	27.6	27.8	28.1	28.8	28.1	27.7	27.8	°C
Wind velocity	1.6	2.1	1.3	1.4	1.6	1.7	2.0	2.1	2.1	1.8	1.3	1.2	1.7	m/s

Solar paths at Pondok Al Ihsan, (Lat. -7.48° S, long. 111.15° E, alt. 30 m) - Legal Time

Figure 4. Meteorological Conditions and Sunlight Intensity

Based on the meteorological conditions and sunlight intensity at PP Al Ihsan as seen in the image above, it can be concluded that Pondok Pesantren Al Ihsan has an average potential for the sunlight of 4.91 kWh/m2.day with an average annual temperature of 27.8 oC and the greatest distribution of sunlight from May to October. In other words, PP Al Ihsan allows for the construction of a Rooftop PLTS.

To determine the capacity of the Rooftop PLTS built at PP Al Ihsan, the total electricity usage must first be calculated. The total number of lamps in all the boarding schools is 374 lamps with the lowest power of 5 watts and the highest at 45 watts, the brand that is often installed is Visicom. In more detail, the use of electricity at PP Al Ihsan can be seen in Table 3.

Table 3. Existing Condition of PP Al Ihsan Lighting System

DETAIL BANGUNAN PONPES AL-IHSAN (ASRAMA PUTRI)																
Nama Gedung	Lantai Ke-	Nama Ruangan	Fungsi	Ukuran (PxLxT)			Saklar		Lampu							Kapasitas MCB Lampu
				panjang	lebar	tinggi	Jml.	Tipe (Manual/	Tipe (TL/Bulb/	Merk	Jml.	Baris x kolom	Daya (Watt)	Lumen	Lux	
Masjid	1	-	-	8	8	5	6	Manual	Bulb	-	5	-	9-4 45-1	-	30	10
Kmr Mndi	2	-	-	1.6	1.2	-	1	Manual	Bulb	-	12	-	5	-	24	-
Koridor	3	-	-	17.9	6.3	4.2	5	Manual	Bulb	-	5	-	-	-	21	-
R. Kls	3	-	-	5	5	4.1	-	Manual	Bulb	-	1	-	23	-	18.22	-
Kamar	3	-	-	5	5	4.1	-	Manual	Bulb	-	1	-	65	-	35	-
Koridor	3	-	-	24.8	5.9	3.3	-	Manual	Bulb	-	4	-	-	-	24	-
Koridor Asrama Putri	-	-	-	-	-	-	-	Manual	Bulb	-	-	-	-	-	12	-
Asrama Putri	-	-	-	7.8	24	5	2	-	Bulb	-	5	-	23	-	-	-
Kntr Putri	-	-	-	11	5.8	3.5	-	Manual	Bulb	-	3	-	45 / 23	-	34	-
K. Mndi Putri	-	-	-	-	-	-	1	Manual	Bulb	-	11	-	-	-	-	-
Asrama Putra	1 & 2	-	-	9	6	-	1	Manual	Bulb	-	1	-	-	-	-	-
Krdor Asr. Putra	1 & 2	-	-	7.8	4.5	3.5	2	Manual	Bulb	-	6	-	-	-	-	-
Asrama Putri 2	-	-	-	-	-	-	-	Manual	Bulb	-	-	-	-	-	-	-
R. Tamu Putri	3	-	-	6.8	4.4	-	3	Manual	Bulb	Shinyoku	3	-	23	-	24	-
Masjid Utama	4	-	Ibadah	22.5	17.6	6.3	8	Manual	Bulb	-	10	-	45	-	-	-
Kmr Ustadz	2	-	-	2.8	2.9	3		Manual	-	-	1	-	23	-	30	-
Aula	2	-	-	8.8	6.2	2.6	2	Manual	-	-	2	-	23	-	29	-
Masjid	-	-	-	10	7.6	7.8	2	-	-	-	4	-	45	-	82	-
Kmr Bawah	-	-	-	7.4	4	2	-	-	-	-	2	-	5	-	12	-
Asrama Tahfidz	-	-	-	10.6	3.4	3.2	2	-	-	-	2	-	15	-	10	-
Asrama Tahfidz	-	-	-	16	3.4	7.3	2	-	-	-	4	-	5	-	10	-
Masjid Tahfidz	2	-	-	16	11.8	6	8	-	-	-	15	-	23,45,5	-	-	-
Rmh Ustadz		-	-	3.8	7	2.5	3	-	-	-	5	-	-	-	-	-
Rmh Anak Ustadz	-	-	-	-	-	-	-	-	-	-	201	-	-	-	-	-
Dapur	-	-	-	8.8	7.7	3.5	-	-	-	-	6	-	23	-	-	-
Teras Rmh	-	-	-	-	-	-	-	-	-	-	5	-	23	-	-	-

Based on the survey results and referring to the requirements that the PLTS system to be installed has a maximum power of 25 KWp and a maximum of 80% of the total PLN connection power, the proposed maximum PLTS capacity is 80% x 15,840 VA equals 12,672 VA or in other words, the recommended PLTS capacity is 13,000 Wp. The type of solar cell used is Polycrystalline with a unit power of the solar module to be used is 325Wp, with the following specifications.

ELECTRICAL DATA | STC*

CS6U	315P	320P	325P	330P
Nominal Max. Power (Pmax)	315 W	320 W	325 W	330 W
Opt. Operating Voltage (Vmp)	36.6 V	36.8 V	37.0 V	37.2 V
Opt. Operating Current (Imp)	8.61 A	8.69 A	8.78 A	8.88 A
Open Circuit Voltage (Voc)	45.1 V	45.3 V	45.5 V	45.6 V
Short Circuit Current (Isc)	9.18 A	9.26 A	9.34 A	9.45 A
Module Efficiency	16.20%	16.46%	16.72%	16.97%
Operating Temperature	-40°C ~ +85°C			
Max. System Voltage	1500 V (IEC) or 1500 V (UL)			
Module Fire Performance	TYPE 1 (UL 1703) or CLASS C (IEC 61730)			
Max. Series Fuse Rating	15 A			
Application Classification	Class A			
Power Tolerance	0 ~ + 5 W			

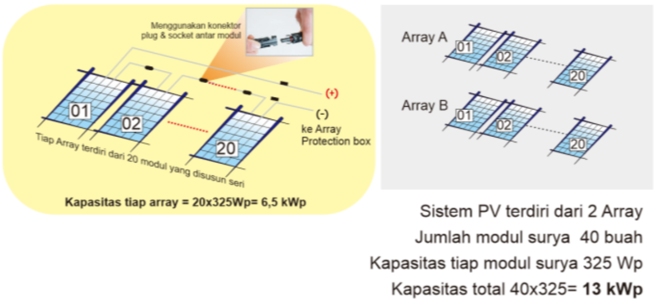
* Under Standard Test Conditions (STC) of irradiance of 1000 W/m², spectrum AM 1.5 and cell temperature of 25°C.

MECHANICAL DATA

Specification	Data
Cell Type	Poly-crystalline, 6 inch
Cell Arrangement	72 (6 × 12)
Dimensions	1960 × 992 × 40 mm (77.2 × 39.1 × 1.57 in)
Weight	22.4 kg (49.4 lbs)
Front Cover	3.2 mm tempered glass
Frame Material	Anodized aluminium alloy
J-Box	IP67, 3 diodes
Cable	PV1500DC-F1 4 mm² (IEC) & 12 AWG 2000 V (UL), 1160 mm (45.7 in)
Connector	T4 series or PV2 series
Per Pallet	26 pieces, 635 kg (1400 lbs)
Per container (40' HQ)	624 pieces

Figure 5. Technical specifications of Rooftop PLTS

Based on the specifications above, the planning of the PLTS configuration at Al Ihsan Islamic Boarding School can be seen in the following image.



Solar Module Configuration 13 kWp
Number of Solar Modules = 40 units
Power Per Solar Module = 325 wp
Total Power = 13 kWp

Figure 6. Rooftop PLTS Configuration PP Al Ihsan

In terms of energy conservation, especially replacing or retrofitting LED lamps, the initial step that must be taken is to record and calculate the number of light points and lamp capacity per m2 per room, which is then determined by the number of LED lamps and capacity so that it is in accordance with the SNI 6197:2011 standard as seen in tables 1 and 2 above. In more detail, the number of light points and lamp capacity per m2 per room PP Al Ihsan can be seen in Table 4.

Table 4. Existing Condition of Number of Lamps and Lamp Capacity PP Al Ihsan

Nama Gedung	Lantai	Ruangan	Tipe Lampu	Daya Lampu	Jumlah	Total Daya Lampu	Existing (Rp)	Retrofit		LED (W)	Total daya retrofit
								Type	Intensitas		
Rumah Tahfidz			CFL	10	2	20	128,597	LED	4-5	5	10
Rumah Ustadz	1		CFL	10	5	50	321,492	LED	4-5	5	25
	1		CFL	10	20	200	1,285,968	LED	4-5	5	100
Kamar mandi	1		CFL	5	12	60	385,790	LED	4-5	5	60
Koridor Lantai 3	3		CFL	23	5	115	739,432	LED	9-13	13	65
Ruang kelas	3		CFL	23	6	138	887,318	LED	9-13	13	78
Koridor Asraman Putri	3		CFL	23	4	92	591,545	LED	9-13	13	52
Asrama Putri	3		CFL	23	5	115	739,432	LED	9-13	13	65
Kamar mandi putri	3		CFL	5	11	55	353,641	LED	4-5	13	143
Asrama Putra	1		CFL	23	10	230	1,478,863	LED	9-13	13	130
Koridor Asrama Putra	1		CFL	23	6	138	887,318	LED	9-13	13	78
Ruang Tamu Putri	3		CFL	23	3	69	443,659	LED	9-13	13	39
			CFL	23	10	230	1,478,863	LED	9-13	13	130
Aula	2		CFL	23	3	69	443,659	LED	9-13	13	39
Kamar Ustadz	2		CFL	23	1	23	147,886	LED	9-13	13	13
Kamar bawah	2		CFL	5	2	10	64,298	LED	4-5	13	26
Masjid Tahfidz	2		CFL	23	12	276	1,774,636	LED	9-13	13	156
Dapur	1		CFL	23	6	138	887,318	LED	9-13	13	78
Teras Rumah	1		CFL	23	5	115	739,432	LED	9-13	13	65
Masjid Sunan Kalijogo	1		CFL	45	5	225	1,446,714	LED	25-28	27	135
KANTOR	3		CFL	60	1	60	385,790	LED	25-28	27	27
Kantor Putri	3		CFL	45	3	135	868,028	LED	25-28	27	81
Masjid Utama	4		CFL	45	2	90	578,686	LED	25-28	27	54
			CFL	60	1	60	385,790	LED	25-28	27	27
Masjid Al-Iman	1		CFL	45	5	225	1,446,714	LED	25-28	27	135
			CFL	45	1	45	289,343	LED	25-28	27	27
				689	**146**	2983	**19,180,213**				1838

Based on the data on the number of light points and the capacity of the lights per m2 per room of PP Al Ihsan above, the total number and capacity of the lights that must be replaced can be determined so that they meet the SNI 6197:2011 standard as seen in tables 1 and 2 above with details as seen in table 5.

Table 5. Retrofitting LED Lights at the Al Ihsan Islamic Boarding School

Budget Plan				
Item	Quantity	Unit	Price	Total
LED 5 Watt	39	Unit	30,000	1,170,000.00
LED 13 Watt	89	Unit	55,000	4,895,000.00
LED 27 Watt	18	Unit	81,000	1,458,000.00
Total				**7,523,000.00**

CONCLUSION

In conclusion, the effective management of PPPK personnel, encompassing strategic placement, robust welfare provisions, and well-structured retirement plans, is crucial for optimizing their contribution to public service. Addressing the identified disparities in benefits and ensuring equitable treatment are paramount to fostering a motivated and secure PPPK workforce. By implementing comprehensive policies that prioritize financial security, healthcare access, and opportunities for continued engagement, governmental institutions can significantly enhance the overall well-being of PPPK employees, both during their service and throughout their retirement.

In summary, ensuring a dignified retirement for PPPK employees necessitates the development of clear, consistent, and equitable retirement policies. The provision of standardized pension benefits, comprehensive pre-retirement planning programs, and ongoing post-retirement support are essential for mitigating the uncertainties faced by PPPK members. By prioritizing the long-term financial security and well-being of this vital workforce, governmental institutions can demonstrate their commitment to valuing and supporting their dedicated employees throughout their entire career lifecycle.

Ultimately, the successful integration of PPPK personnel into government institutions hinges on strategic placement and robust welfare provisions. Aligning PPPK competencies with organizational needs, ensuring transparent placement processes, and implementing equitable compensation and benefit structures are critical for maximizing their contributions. By addressing the identified disparities and prioritizing the well-being of PPPK employees, governmental institutions can create a more motivated, productive, and secure workforce, ultimately leading to improved public service delivery.

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