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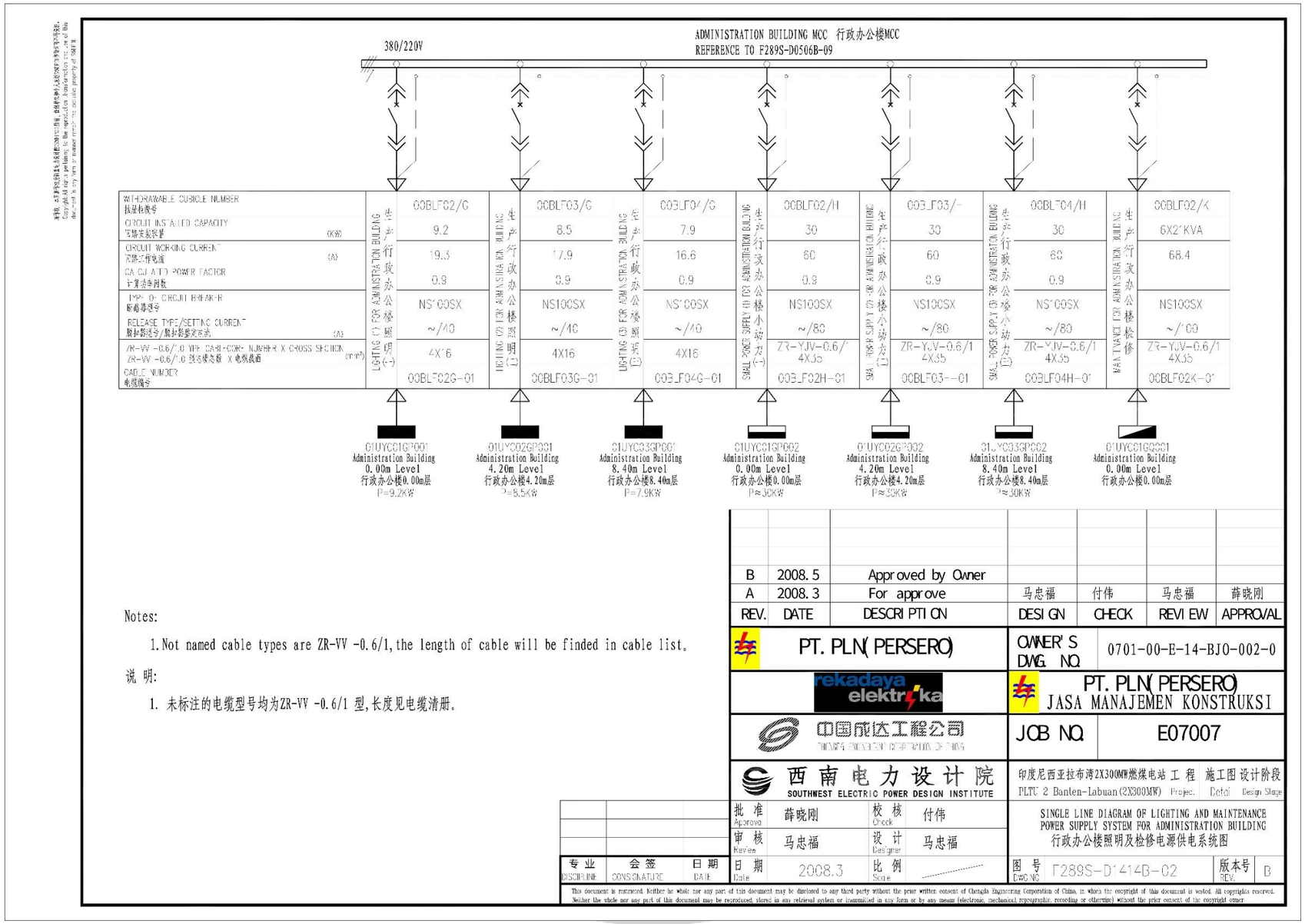
SINGLE LINE DIAGRAM GEDUNG ADMINISTRASI PLTU LABUAN



Notes:

1. Not named cable types are ZR-VV -0.6/1, the length of cable will be finded in cable list.

说 明:

1. 未标注的电缆型号均为ZR-VV -0.6/1 型,长度见电缆清册。

REV.	DATE	DESCRIPTION	DESIGN	CHECK	REVIEW	APPROVAL
B	2008.5	Approved by Owner				
A	2008.3	For approve	马忠福	付伟	马忠福	薛晓刚

PT. PLN(PERSERO)

OWNER'S DWG. NO. 0701-00-E-14-BJO-002-0

rekadaya elektrika

PT. PLN(PERSERO) JASA MANAJEMEN KONSTRUKSI

中国成达工程公司 CHENGDA ENGINEERING CORPORATION OF CHINA

JOB NO. E07007

西南电力设计院 SOUTHWEST ELECTRIC POWER DESIGN INSTITUTE

印度尼西亚拉布湾2X300MW燃煤电站 工 程 施工图 设计阶段
PLTU 2 Banten-Labuan(2X300MW) Projec. Detail Design Stage

批准 Aproval	薛晓刚	校核 Check	付伟
审核 Review	马忠福	设计 Designer	马忠福
日期 Date	2008.3	比例 Scale	

SINGLE LINE DIAGRAM OF LIGHTING AND MAINTENANCE POWER SUPPLY SYSTEM FOR ADMINISTRATION BUILDING
行政办公楼照明及检修电源供电系统图

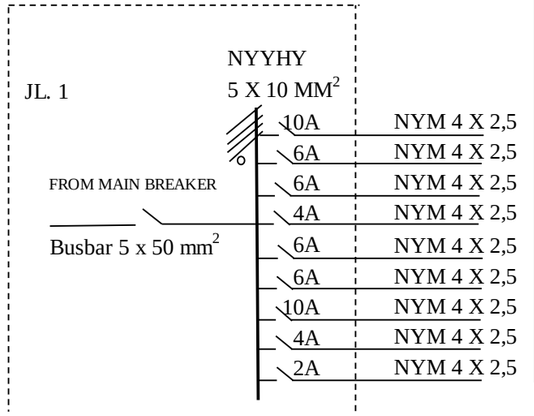
图号 DWG NO. F289S-D1414B-02 版本号 REV. B

专业 DISCIPLINE | 会签 CONSIGNATURE | 日期 DATE

WIRING DIAGRAM PLTS GEDUNG ADMINISTRASI PLTU LABUAN

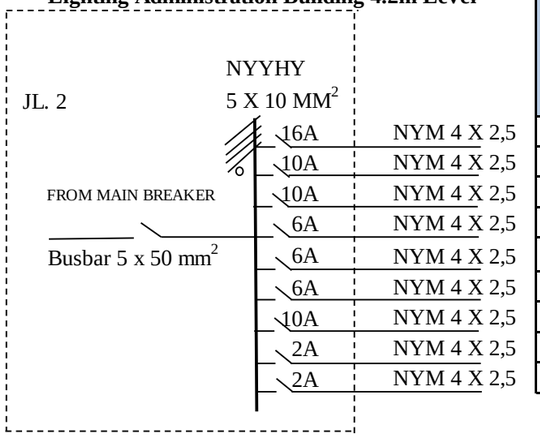
WIRING LIGHTING ADMINISTRATION BUILDING

Lighting Administration Building 00m Level



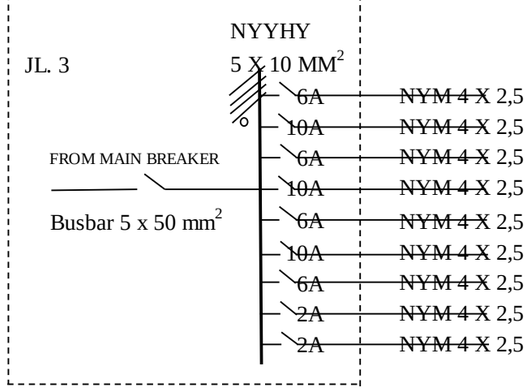
NO.	Grup	Load Point	Ampere (I)	Lighting											Power Total (Watt)	Power (Watt)		
				Flush Mounted Flourescent Fixture 2x36 watt	Flush Mounted Flourescent Fixture 3x18 watt	Flush Mounted Flourescent Fixture 2x40 watt	Flush Mounted Cylindrical Fixture 18 watt	Celling Mounted Fixture 32 watt	Anterior Mirror Lamp 20 watt	Alumunium Alloy Flourescent Fixture 1x36 watt	Alumunium Alloy Flourescent Fixture 2x36 watt	Evacuation Direction Sign Fixture 13 Watt	Exit Sign Signature 20 watt	Damproof Lamp 100 Watt		R	S	T
1	N1	15	6,14	15											1080	360	360	360
2	N2	21	5,41	9			4	6	2						952	386	283	283
3	N3	12	4,91	12											864	288	288	288
4	N4	16	3,97		11		4	1							698	232	233	233
5	N5	12	4,91	12											864	288	288	288
6	N6	10	4,09	10											720	240	240	240
7	N7	15	6,14	15											1080	360	360	360
8	N8	8	2,45							4	4				432	144	144	144
9	N9	3	0,34										3		60	20	20	20
	Σ	112	38,35	73	11	0	8	7	2	4	4	0	3	0	6750	2318	2216	2216

Lighting Administration Building 4.2m Level



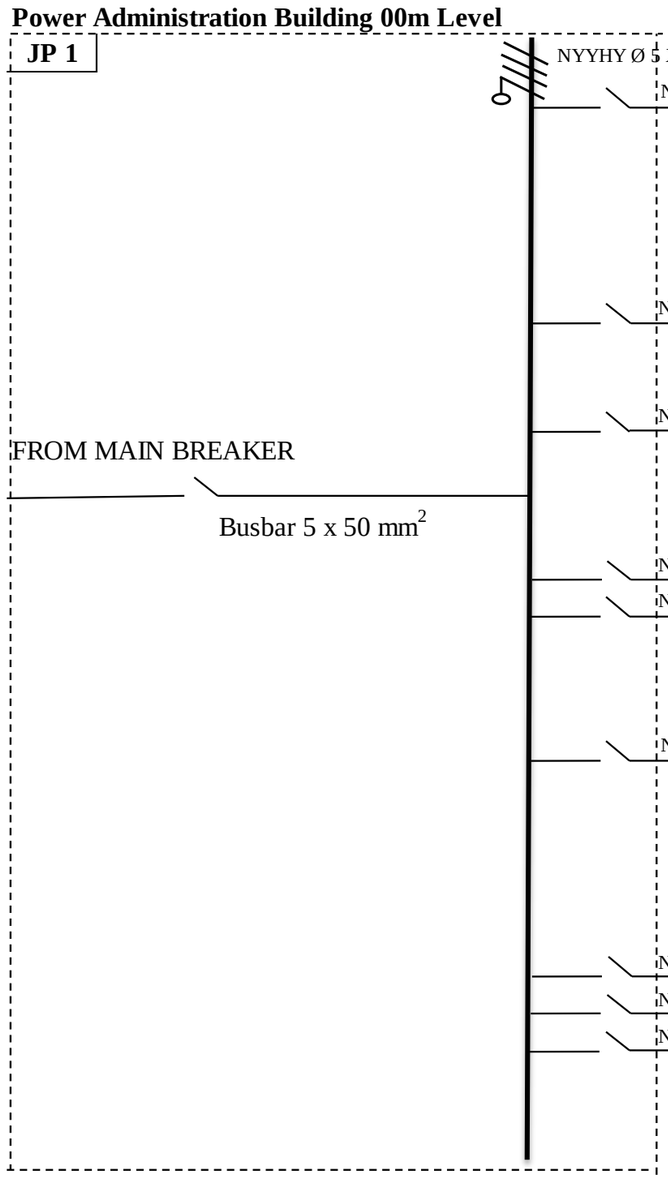
NO.	Grup	Load Point	Ampere (I)	Lighting											Power Total (Watt)	Power (Watt)		
				Flush Mounted Flourescent Fixture 2x36 watt	Flush Mounted Flourescent Fixture 3x18 watt	Flush Mounted Flourescent Fixture 2x40 watt	Flush Mounted Cylindrical Fixture 18 watt	Celling Mounted Fixture 32 watt	Anterior Mirror Lamp 20 watt	Alumunium Alloy Flourescent Fixture 1x36 watt	Alumunium Alloy Flourescent Fixture 2x36 watt	Evacuation Direction Sign Fixture 13 Watt	Exit Sign Signature 20 watt	Damproof Lamp 100 Watt		R	S	T
1	N1	27	10,80	19		6		1	1						1900	634	633	633
2	N2	20	8,18	20											1440	480	480	480
3	N3	24	6,64	12			4	6	2						1168	390	389	389
4	N4	12	4,91	12											864	288	288	288
5	N5	12	5,09	8		4									896	298	300	298
6	N6	10	4,09	10											720	240	240	240
7	N7	15	6,14	15											1080	360	360	360
8	N8	15	1,85				11	4							326	110	108	108
9	N9	142	0,52									7			91	31	30	30
	Σ	277	48,21	96	0	10	15	11	3	0	0	7	0	0	8485	2831	2828	2826

~~Lighting Administration Building~~ 8.4m Level



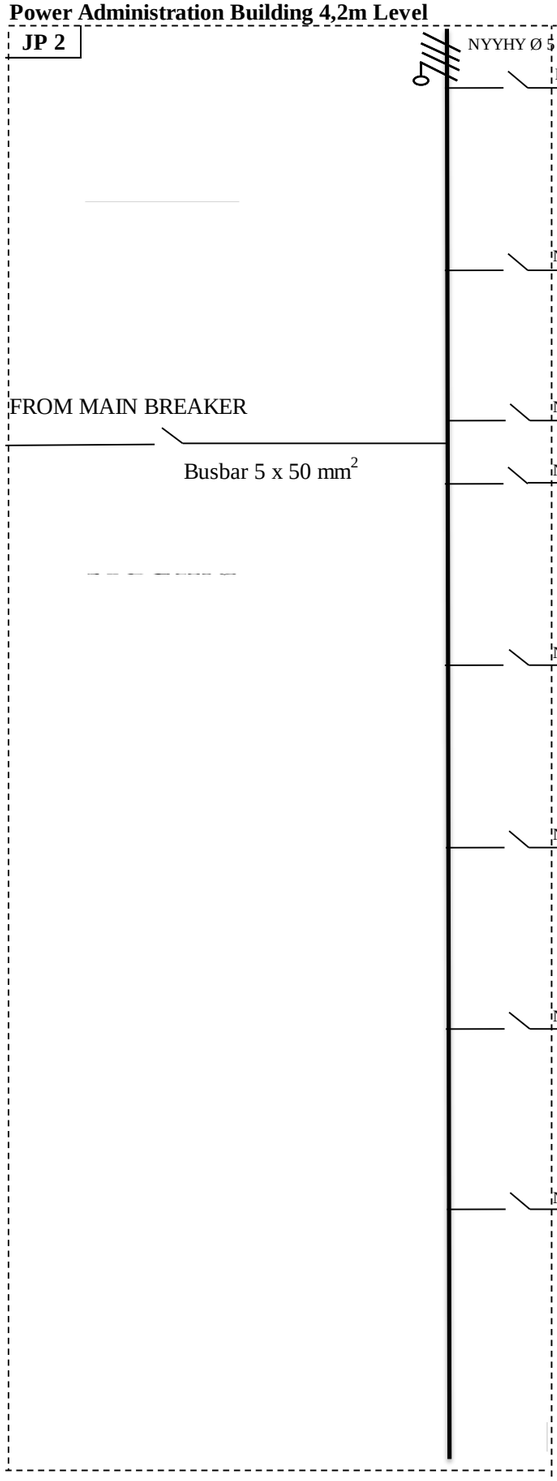
NO.	Grup	Load Point	Ampere (I)	Lighting											Power Total (Watt)	Power (Watt)		
				Flush Mounted Flourescent Fixture 2x36 watt	Flush Mounted Flourescent Fixture 3x18 watt	Flush Mounted Flourescent Fixture 2x40 watt	Flush Mounted Cylindrical Fixture 18 watt	Celling Mounted Fixture 32 watt	Anterior Mirror Lamp 20 watt	Alumunium Alloy Flourescent Fixture 1x36 watt	Alumunium Alloy Flourescent Fixture 2x36 watt	Evacuation Direction Sign Fixture 13 Watt	Exit Sign Signature 20 watt	Damproof Lamp 100 Watt		R	S	T
1	N1	12	4,91	12											864	288	288	288
2	N2	16	6,55	16											1152	384	384	384
3	N3	12	4,91	12											864	288	288	288
4	N4	16	6,55	16											1152	384	384	384
5	N5	12	4,91	12											864	288	288	288
6	N6	16	6,55	16											1152	384	384	384
7	N7	15	4,10		11			4							722	242	240	240
8	N8	7	0,52									7			91	31	30	30
9	N9	2	1,14											2	200	68	66	66
	Σ	108	40,12	84	11	0	0	4	0	0	0	7	0	2	7061	2357	2352	2352

WIRING POWER ADMINISTRATION BUILDING



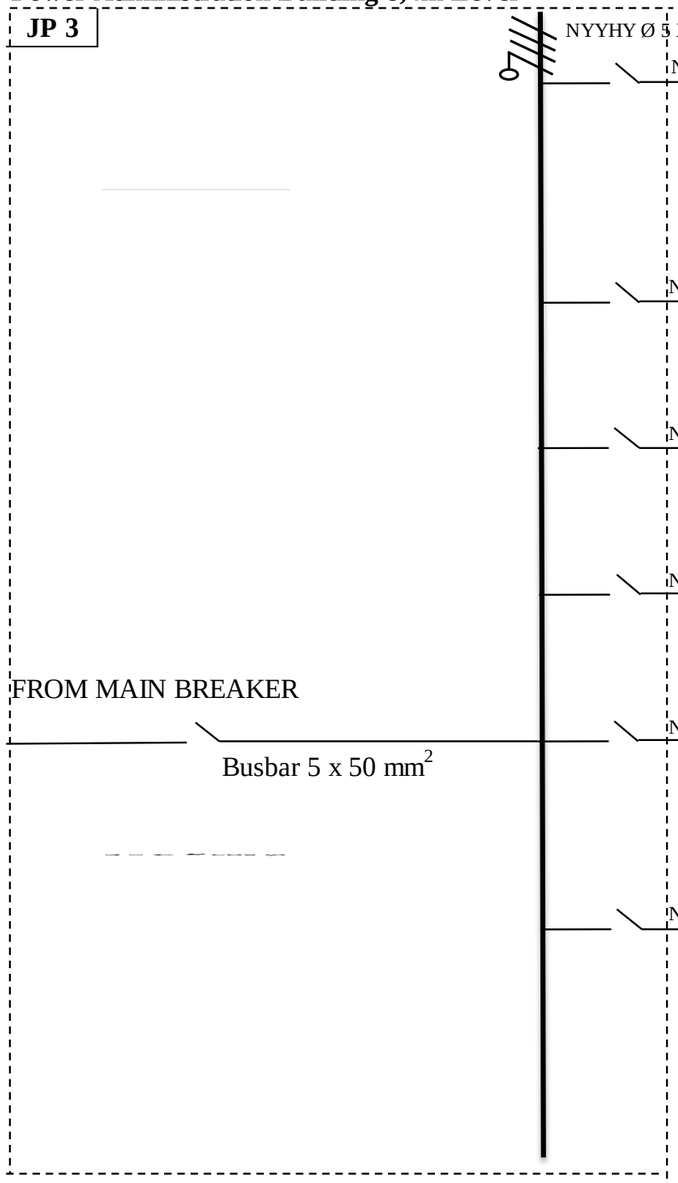
No.	Grup	Equipments	Power Total (Watt)	Ampere (I)	Total Ampere (I) Tiap Grup
1	N1	- AC central 5 PK (380 V, 3 Φ, 50 Hz) @ 1 Pcs	3730	6,667	56
2	N1	- AC split R. Engineering 2 PK (220 V, 1 Φ, 50 Hz) @ 4 Pcs	5968	31,914	
3	N1	- Laptop 65 watt (220 V, 1 Φ, 50 Hz) @ 25 Pcs	1625	8,690	
4	N1	- Printer 50 watt (220 V, 1 Φ, 50 Hz) @ 4 Pcs	200	1,070	
5	N1	- Dispenser 350 watt (220 V, 1 Φ, 50 Hz) @ 2 Pcs	700	3,743	
6	N1	- Kulkas 2 Pintu 1000 watt (220 V, 1 Φ, 50 Hz) @ 2 Pcs	700	3,743	
7	N2	- AC split R. Engineering 2 PK (220 V, 1 Φ, 50 Hz) @ 1 Pcs	1492	7,979	17
8	N2	- Dispenser 350 watt (220 V, 1 Φ, 50 Hz) @ 2 Pcs	700	3,743	
9	N2	- Water Heater 1500 watt (220 V, 1 Φ, 50 Hz) @ 1 Pcs	1000	5,348	
10	N3	- AC split R. Keuangan 1 PK (220 V, 1 Φ, 50 Hz) @ 1Pcs	746	3,989	10
11	N3	- Laptop 65 watt (220 V, 1 Φ, 50 Hz) @ 10 Pcs	650	3,476	
12	N3	- Printer 50 watt (220 V, 1 Φ, 50 Hz) @ 2 Pcs	100	0,535	
13	N3	- Dispenser 350 watt (220 V, 1 Φ, 50 Hz) @ 1 Pcs	350	1,872	
14	N4	- AC split R. Tamu 1 PK (220 V, 1 Φ, 50 Hz) @ 1Pcs	746	3,989	4
15	N5	- AC Standing Floor R. Rapat Lt.1 No. 1 2 PK (220 V, 1 Φ, 50 Hz) @ 1 Pcs	1492	7,979	21
16	N5	- AC Standing Floor R. Rapat Lt.1 No. 2 3 PK (220 V, 1 Φ, 50 Hz) @ 1 Pcs	2238	11,968	
17	N5	- Laptop 65 watt (220 V, 1 Φ, 50 Hz) @ 2 Pcs	130	0,695	
18	N5	- Proyektor LED 150watt (220 V, 1 Φ, 50 Hz) @ 1 Pcs	130	0,695	
19	N6	- AC Standing Floor R. Admin Lt.1 3 PK (220 V, 1 Φ, 50 Hz) @ 1 Pcs	2238	11,968	36
20	N6	- AC split R. Admin Lt. 1 2 PK (220 V, 1 Φ, 50 Hz) @ 1 Pcs	1492	7,979	
21	N6	- AC split R. Admin Lt. 1 2 PK (220 V, 1 Φ, 50 Hz) @ 1 Pcs	1492	7,979	
22	N6	- Laptop 65 watt (220 V, 1 Φ, 50 Hz) @ 15 Pcs	975	5,214	
23	N6	- Printer 50 watt (220 V, 1 Φ, 50 Hz) @ 4 Pcs	200	1,070	
24	N6	- Dispenser 350 watt (220 V, 1 Φ, 50 Hz) @ 1 Pcs	350	1,872	
25	N7	- AC MCC Lantai 1 3 PK (220 V, 1 Φ, 50 Hz)	2238	11,968	12
26	N8	- Monitor LED TV 150 watt (220 V, 1 Φ, 50 Hz) @ 3 Pcs	195	1,043	1
27	N9	- Axial Fan 370 watt (380 V, 1 Φ, 50 Hz) @ 1 Pcs	370	1,146	1
Total			**32247**	**158**	

Power Administration Building 4,2m Level

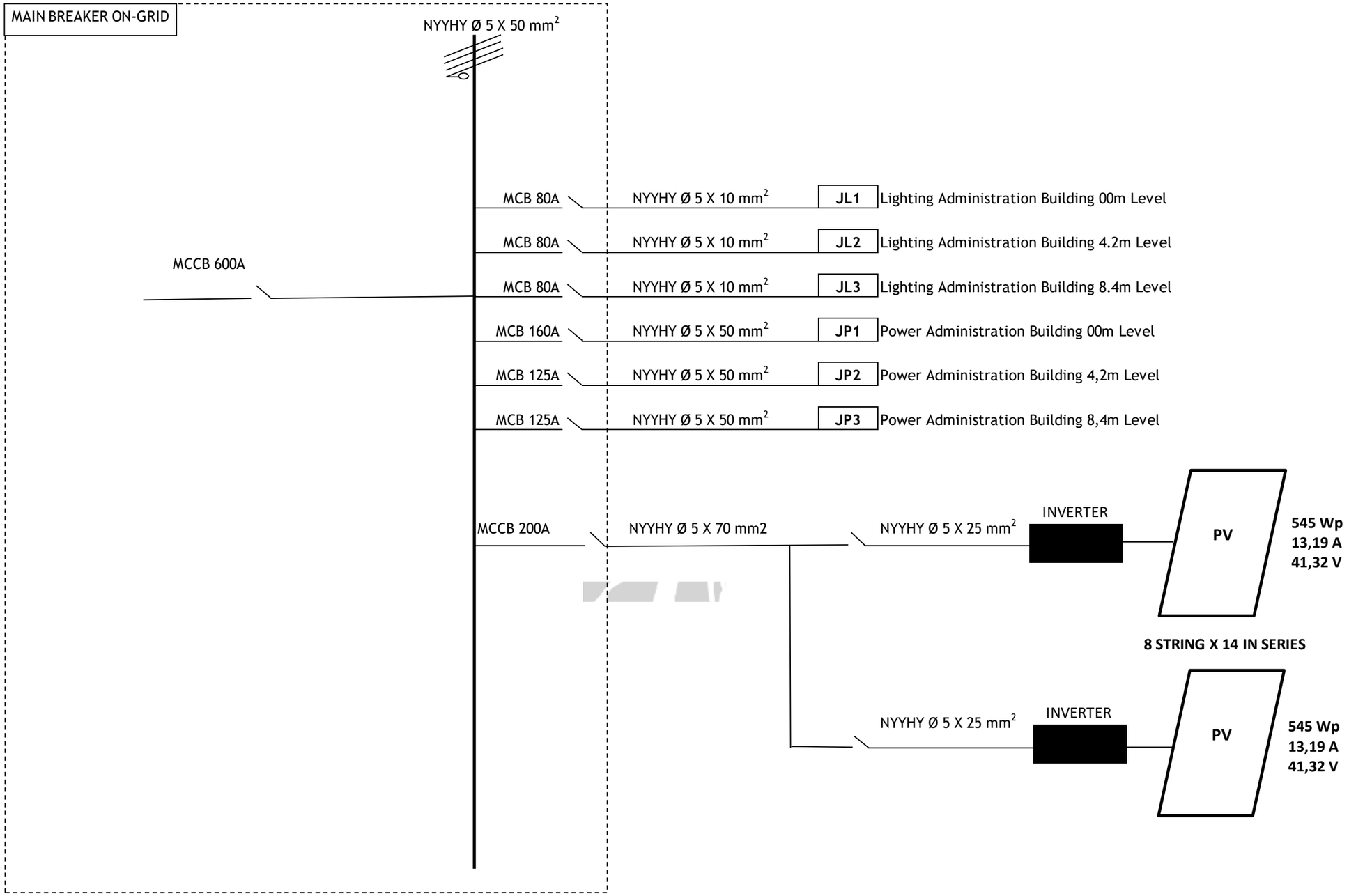


No.	Grup	Equipments	Power Total (Watt)	Ampere (I)	Total Ampere (I) Tiap Grup
1	N1	- AC central 5 PK (380 V, 3 Φ, 50 Hz) @ 1 Pcs	3730	6,667	26
2	N1	- AC Split R. General Manager (GM) 1 PK (220 V, 1 Φ, 50 Hz) @ 1 pcs	746	3,989	
3	N1	- AC Standing Floor R. GM 3 PK (220 V, 1 Φ, 50 Hz) @ 1 pcs	2238	11,968	
4	N1	- Laptop 65 watt (220 V, 1 Φ, 50 Hz) @ 4 Pcs	260	1,390	
5	N1	- Printer 50 watt (220 V, 1 Φ, 50 Hz) @ 1 Pcs	50	0,267	
6	N1	- Kulkas 2 Pintu 1000 watt (220 V, 1 Φ, 50 Hz) @ 1 Pcs	350	1,872	
7	N2	- Proyektor LED 150watt (220 V, 1 Φ, 50 Hz) @ 1 Pcs	130	0,695	7
8	N2	- Dispenser 350 watt (220 V, 1 Φ, 50 Hz) @ 1 Pcs	350	1,872	
9	N2	- AC split R. Sekretaris GM 1 PK (220 V, 1 Φ, 50 Hz) @ 1 pcs	746	3,989	
10	N2	- Laptop 65 watt (220 V, 1 Φ, 50 Hz) @ 1 Pcs	65	0,348	
11	N2	- Printer 50 watt (220 V, 1 Φ, 50 Hz) @ 1 Pcs	50	0,267	
12	N3	- AC Standing Floor R. Rendal 3 PK (220 V, 1 Φ, 50 Hz) @ 1 Pcs	2238	11,968	18
13	N3	- AC Split R. Rendal 1,5 PK (220 V, 1 Φ, 50 Hz) @ 1 Pcs	1119	5,984	
14	N4	- Laptop 65 watt (220 V, 1 Φ, 50 Hz) @ 4 Pcs	260	1,390	10
15	N4	- Printer 50 watt (220 V, 1 Φ, 50 Hz) @ 1 Pcs	50	0,267	
16	N4	- Kulkas 2 Pintu 1000 watt (220 V, 1 Φ, 50 Hz) @ 1 Pcs	350	1,872	
17	N4	- Proyektor LED 150watt (220 V, 1 Φ, 50 Hz) @ 1 Pcs	130	0,695	
18	N4	- Dispenser 350 watt (220 V, 1 Φ, 50 Hz) @ 1 Pcs	350	1,872	
19	N4	- AC split R. ATKP 1 PK (220 V, 1 Φ, 50 Hz) @ 1 Pcs	746	3,989	
20	N5	- Laptop 65 watt (220 V, 1 Φ, 50 Hz) @ 4 Pcs	260	1,390	10
21	N5	- Printer 50 watt (220 V, 1 Φ, 50 Hz) @ 1 Pcs	50	0,267	
22	N5	- Kulkas 2 Pintu 1000 watt (220 V, 1 Φ, 50 Hz) @ 1 Pcs	350	1,872	
23	N5	- Dispenser 350 watt (220 V, 1 Φ, 50 Hz) @ 1 Pcs	350	1,872	
24	N5	- Proyektor LED 150watt (220 V, 1 Φ, 50 Hz) @ 1 Pcs	130	0,695	
25	N5	- AC split R. Manager Pemeliharaan 1 PK (220 V, 1 Φ, 50 Hz) @ 1 Pcs	746	3,989	
26	N6	- Laptop 65 watt (220 V, 1 Φ, 50 Hz) @ 4 Pcs	260	1,390	10
27	N6	- Printer 50 watt (220 V, 1 Φ, 50 Hz) @ 1 Pcs	50	0,267	
28	N6	- Kulkas 2 Pintu 1000 watt (220 V, 1 Φ, 50 Hz) @ 1 Pcs	350	1,872	
29	N6	- Dispenser 350 watt (220 V, 1 Φ, 50 Hz) @ 1 Pcs	350	1,872	
30	N6	- Proyektor LED 150watt (220 V, 1 Φ, 50 Hz) @ 1 Pcs	130	0,695	
31	N6	- AC split R. Manager Energi Primer 1 PK (220 V, 1 Φ, 50 Hz) @ 1 Pcs	746	3,989	
32	N7	- Laptop 65 watt (220 V, 1 Φ, 50 Hz) @ 4 Pcs	650	3,476	14
33	N7	- Proyektor LED 150 watt (220 V, 1 Φ, 50 Hz) @ 1 Pcs	130	0,695	
34	N7	- Printer 50 watt (220 V, 1 Φ, 50 Hz) @ 1 Pcs	50	0,267	
35	N7	- Kulkas 2 Pintu 1000 watt (220 V, 1 Φ, 50 Hz) @ 1 Pcs	350	1,872	
36	N7	- Dispenser 350 watt (220 V, 1 Φ, 50 Hz) @ 1 Pcs	350	1,872	
37	N7	- Water Heater 1500 watt (220 V, 1 Φ, 50 Hz) @ 1 Pcs	1000	5,348	
38	N8	- AC split R. Manager Enginering 1 PK (220 V, 1 Φ, 50 Hz) @ 1 Pcs	746	3,989	20
39	N8	- AC split R. Laktasi 1 PK (220 V, 1 Φ, 50 Hz) @ 1 Pcs	746	3,989	
40	N8	- AC split R. Manager Operasi 2 PK (220 V, 1 Φ, 50 Hz) @ 1 Pcs	746	3,989	
41	N8	- Laptop 65 watt (220 V, 1 Φ, 50 Hz) @ 10 Pcs	650	3,476	
42	N8	- Proyektor LED 150 watt (220 V, 1 Φ, 50 Hz) @ 2 Pcs	130	0,695	
43	N8	- Printer 50 watt (220 V, 1 Φ, 50 Hz) @ 2 Pcs	50	0,267	
44	N8	- Kulkas 2 Pintu 1000 watt (220 V, 1 Φ, 50 Hz) @ 3 Pcs	350	1,872	
45	N8	- Dispenser 350 watt (220 V, 1 Φ, 50 Hz) @ 3 Pcs	350	1,872	
Total			**24028**	**115**	

Power Administration Building 8,4m Level



No.	Grup	Equipments	Power Total (Watt)	Ampere (I)	Total Ampere (I) Tiap Grup
1	N1	- AC central 5 PK (380 V, 3 Φ, 50 Hz) @ 1 Pcs	3730	6,667	39
2	N1	- AC Standing Floor R. PBJ 3 PK (220 V, 1 Φ, 50 Hz) @ 1 Pcs	2238	11,968	
3	N1	- AC Split Floor R. PBJ 2 PK (220 V, 1 Φ, 50 Hz) @ 1 Pcs	1492	7,979	
4	N1	- AC split R. GYM 2 PK (220 V, 1 Φ, 50 Hz) @ 1 Pcs	1492	7,979	
5	N1	- Laptop 65 watt (220 V, 1 Φ, 50 Hz) @ 10 Pcs	650	3,476	
6	N1	- Printer 50 watt (220 V, 1 Φ, 50 Hz) @ 4 Pcs	200	1,070	
7	N2	- Kulkas 2 Pintu 1000 watt (220 V, 1 Φ, 50 Hz) @ 1 Pcs	350	1,872	12
8	N2	- Proyektor LED 150watt (220 V, 1 Φ, 50 Hz) @ 1 Pcs	130	0,695	
9	N2	- Dispenser 350 watt (220 V, 1 Φ, 50 Hz) @ 1 Pcs	350	1,872	
10	N2	- AC split R.rapat (ex Mushola Lt 3) 2 PK (220 V, 1 Φ, 50 Hz) @ 1 Pcs	1492	7,979	
11	N3	- AC split R. rapat Popole 1 PK (220 V, 1 Φ, 50 Hz) @ 1 Pcs	746	3,989	10
12	N3	- Laptop 65 watt (220 V, 1 Φ, 50 Hz) @ 4 Pcs	650	3,476	
13	N3	- Proyektor LED 150watt (220 V, 1 Φ, 50 Hz) @ 1 Pcs	130	0,695	
14	N3	- Dispenser 350 watt (220 V, 1 Φ, 50 Hz) @ 1 Pcs	350	1,872	
15	N4	- AC split R. EX Energi Primer 1 PK (220 V, 1 Φ, 50 Hz) @ 1 Pcs	746	3,989	10
16	N4	- Laptop 65 watt (220 V, 1 Φ, 50 Hz) @ 4 Pcs	650	3,476	
17	N4	- Proyektor LED 150watt (220 V, 1 Φ, 50 Hz) @ 1 Pcs	130	0,695	
18	N4	- Dispenser 350 watt (220 V, 1 Φ, 50 Hz) @ 1 Pcs	350	1,872	
19	N5	- AC Standing Floor R.Rapat Carita Anyer 3 PK (220 V, 1 Φ, 50 Hz) @ 1 Pcs	2238	11,968	26
20	N5	- AC Split R. Rapat carita Anyer 2 PK (220 V, 1 Φ, 50 Hz) @ 1 Pcs	1492	7,979	
21	N5	- Laptop 65 watt (220 V, 1 Φ, 50 Hz) @ 4 Pcs	650	3,476	
22	N5	- Proyektor LED 150watt (220 V, 1 Φ, 50 Hz) @ 1 Pcs	130	0,695	
23	N5	- Dispenser 350 watt (220 V, 1 Φ, 50 Hz) @ 1 Pcs	350	1,872	
24	N6	- AC split R. PIKK (Ex Auditor) 1 PK (220 V, 1 Φ, 50 Hz) @ 1 Pcs	746	3,989	25
25	N6	- AC split R. rapat Popole 1 PK (220 V, 1 Φ, 50 Hz) @ 1 Pcs	746	3,989	
26	N6	- AC R. Aanwijzing / R. Panimbang 2 PK (220 V, 1 Φ, 50 Hz) @ 1 Pcs	1492	7,979	
27	N6	- Laptop 65 watt (220 V, 1 Φ, 50 Hz) @ 4 Pcs	650	3,476	
28	N6	- Proyektor LED 150watt (220 V, 1 Φ, 50 Hz) @ 1 Pcs	130	0,695	
29	N6	- Water Heater 1500 watt (220 V, 1 Φ, 50 Hz) @ 1 Pcs	1000	5,348	
Total			**21770**	**116**	


MAIN BREAKER ON-GRID
NYYHY Ø 5 X 50 mm2
MCCB 600A
MCB 80A
NYYHY Ø 5 X 10 mm2
JL1
Lighting Administration Building 00m Level
MCB 80A
NYYHY Ø 5 X 10 mm2
JL2
Lighting Administration Building 4.2m Level
MCB 80A
NYYHY Ø 5 X 10 mm2
JL3
Lighting Administration Building 8.4m Level
MCB 160A
NYYHY Ø 5 X 50 mm2
JP1
Power Administration Building 00m Level
MCB 125A
NYYHY Ø 5 X 50 mm2
JP2
Power Administration Building 4,2m Level
MCB 125A
NYYHY Ø 5 X 50 mm2
JP3
Power Administration Building 8,4m Level
MCCB 200A
NYYHY Ø 5 X 70 mm2
NYYHY Ø 5 X 25 mm2
INVERTER
PV
545 Wp
13,19 A
41,32 V
8 STRING X 14 IN SERIES
NYYHY Ø 5 X 25 mm2
INVERTER
PV
545 Wp
13,19 A
41,32 V

SPESIFIKASI PLTS JINKOSOLAR JKM545M-72HL4-BDVP

www.jinkosolar.com

Jinko Solar
Building Your Trust in Solar

Tiger Pro 72HC-BDVP

525-545 Watt

BIFACIAL MODULE WITH DUAL GLASS

P-Type

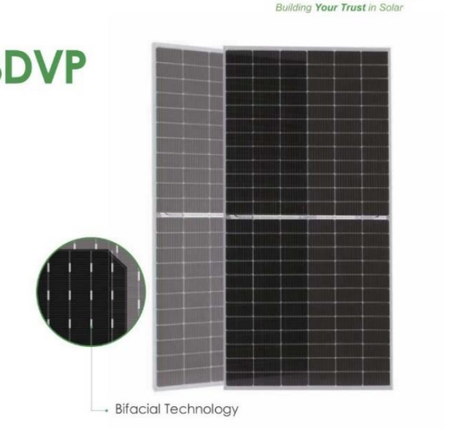
Positive power tolerance of 0~+3%

IEC61215(2016), IEC61730(2016)

ISO9001:2015: Quality Management System

ISO14001:2015: Environment Management System

ISO45001:2018
Occupational health and safety management systems



Key Features

Multi Busbar Technology
Better light trapping and current collection to improve module power output and reliability.

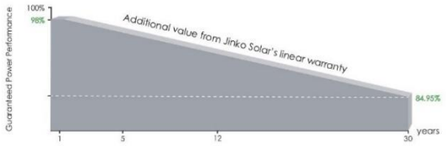
Longer Life-time Power Yield
0.45% annual power degradation and 30 year linear power warranty.

PID Resistance
Excellent Anti-PID performance guarantee via optimized mass-production process and materials control.

Enhanced Mechanical Load
Certified to withstand: wind load (2400 Pascal) and snow load (5400 Pascal).

Higher Power Output
Module power increases 5-25% generally, bringing significantly lower LCOE and higher IRR.

LINEAR PERFORMANCE WARRANTY

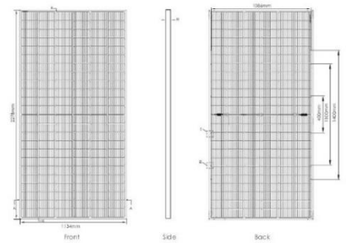


12 Year Product Warranty

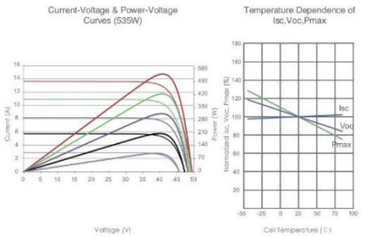
30 Year Linear Power Warranty

0.45% Annual Degradation Over 30 years

Engineering Drawings



Electrical Performance & Temperature Dependence



Packaging Configuration

(Two pallets = One stack)

35pcs/pallets, 70pcs/stack, 700pcs/ 40'HQ Container

Mechanical Characteristics

Cell Type	P type Mono-crystalline
No. of cells	144 (6×24)
Dimensions	2278×1134×30mm (89.69×44.65×1.18 inch)
Weight	32 kg (70.55 lbs)
Front Glass	2.0mm, Anti-Reflection Coating
Back Glass	2.0mm, Heat Strengthened Glass
Frame	Anodized Aluminium Alloy
Junction Box	IP68 Rated
Output Cables	TUV 1×4.0mm (+): 400mm , (-): 200mm or Customized Length

SPECIFICATIONS

Module Type	JKM525M-72HL4-BDVP		JKM530M-72HL4-BDVP		JKM535M-72HL4-BDVP		JKM540M-72HL4-BDVP		JKM545M-72HL4-BDVP	
	STC	NOCT	STC	NOCT	STC	NOCT	STC	NOCT	STC	NOCT
Maximum Power (Pmax)	525Wp	391Wp	530Wp	394Wp	535Wp	398Wp	540Wp	402Wp	545Wp	405Wp
Maximum Power Voltage (Vmp)	40.80V	37.81V	40.87V	37.88V	40.94V	37.94V	41.13V	38.08V	41.32V	38.25V
Maximum Power Current (Imp)	12.87A	10.33A	12.97A	10.41A	13.07A	10.49A	13.13A	10.55A	13.19A	10.60A
Open-circuit Voltage (Voc)	49.42V	46.65V	49.48V	46.70V	49.54V	46.76V	49.73V	46.94V	49.92V	47.12V
Short-circuit Current (Isc)	13.63A	11.01A	13.73A	11.09A	13.83A	11.17A	13.89A	11.22A	13.95A	11.27A
Module Efficiency STC (%)	20.32%		20.52%		20.71%		20.90%		21.10%	
Operating Temperature(°C)	-40°C~+85°C									
Maximum system voltage	1500VDC (IEC)									
Maximum series fuse rating	30A									
Power tolerance	0~+3%									
Temperature coefficients of Pmax	-0.35%/°C									
Temperature coefficients of Voc	-0.28%/°C									
Temperature coefficients of Isc	0.048%/°C									
Nominal operating cell temperature (NOCT)	45±2°C									
Refer. Bifacial Factor	70±5%									

BIFACIAL OUTPUT-REARSIDE POWER GAIN

5%	Maximum Power (Pmax)	551Wp	557Wp	562Wp	567Wp	572Wp
	Module Efficiency STC (%)	21.33%	21.56%	21.76%	21.95%	22.14%
15%	Maximum Power (Pmax)	604Wp	610Wp	615Wp	621Wp	623Wp
	Module Efficiency STC (%)	23.38%	23.61%	23.81%	24.04%	24.27%
25%	Maximum Power (Pmax)	656Wp	663Wp	669Wp	675Wp	681Wp
	Module Efficiency STC (%)	25.39%	25.67%	25.90%	26.13%	26.36%

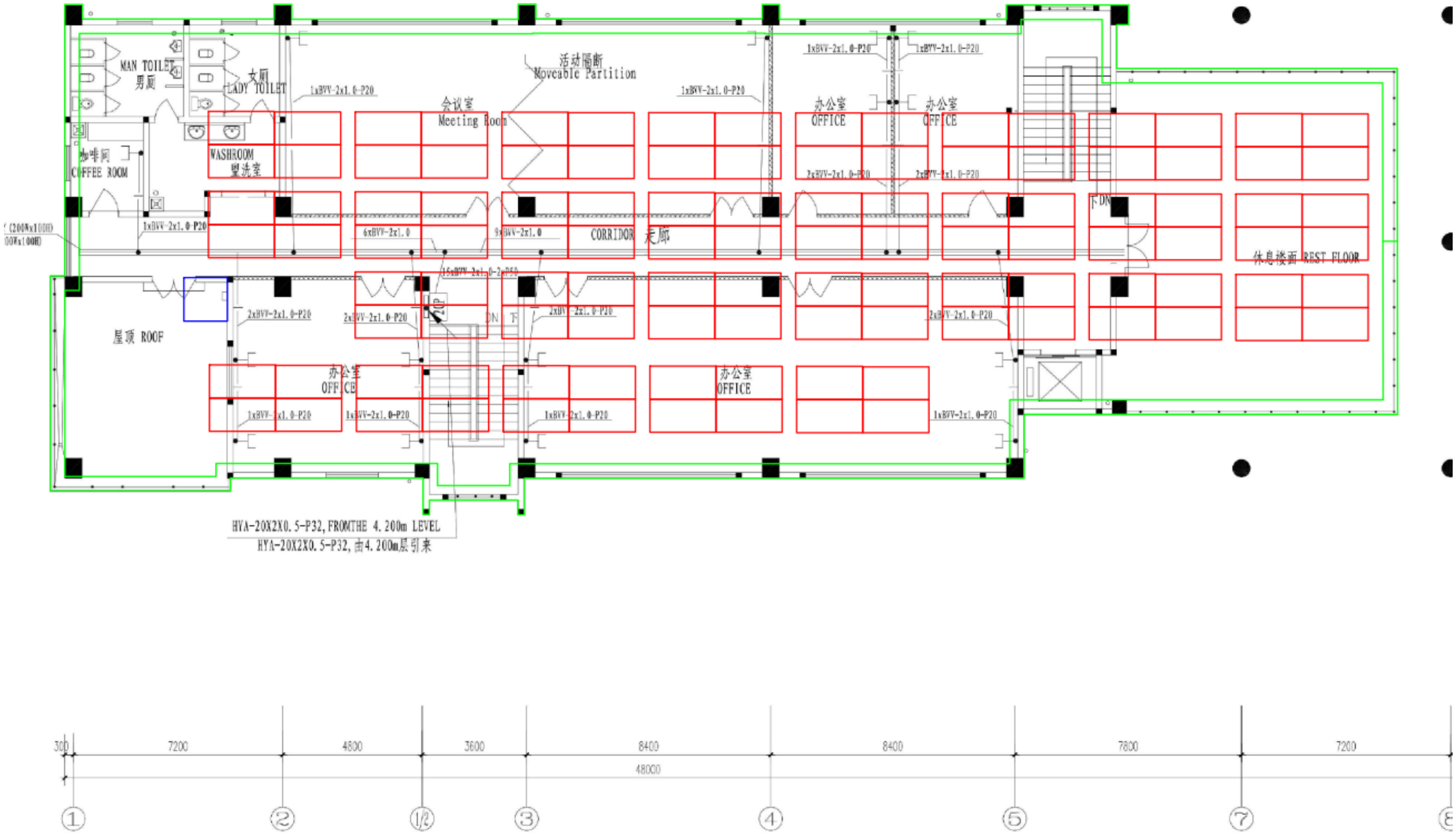
*STC: Irradiance 1000W/m² Cell Temperature 25°C AM=1.5

NOCT: Irradiance 800W/m² Ambient Temperature 20°C AM=1.5 Wind Speed 1m/s

JKM525-545M-72HL4-BDVP-F3-EN

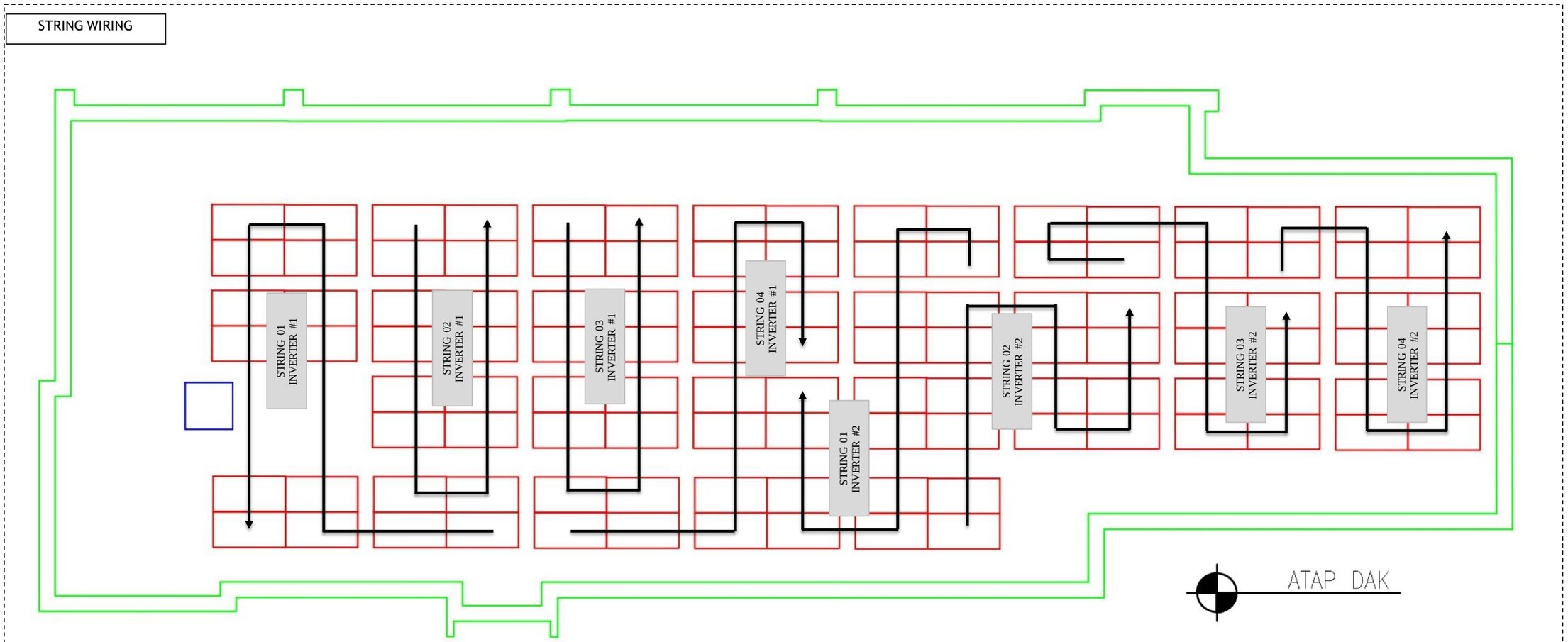
LAMPIRAN 4

DENAH PELETAKAN PLTS



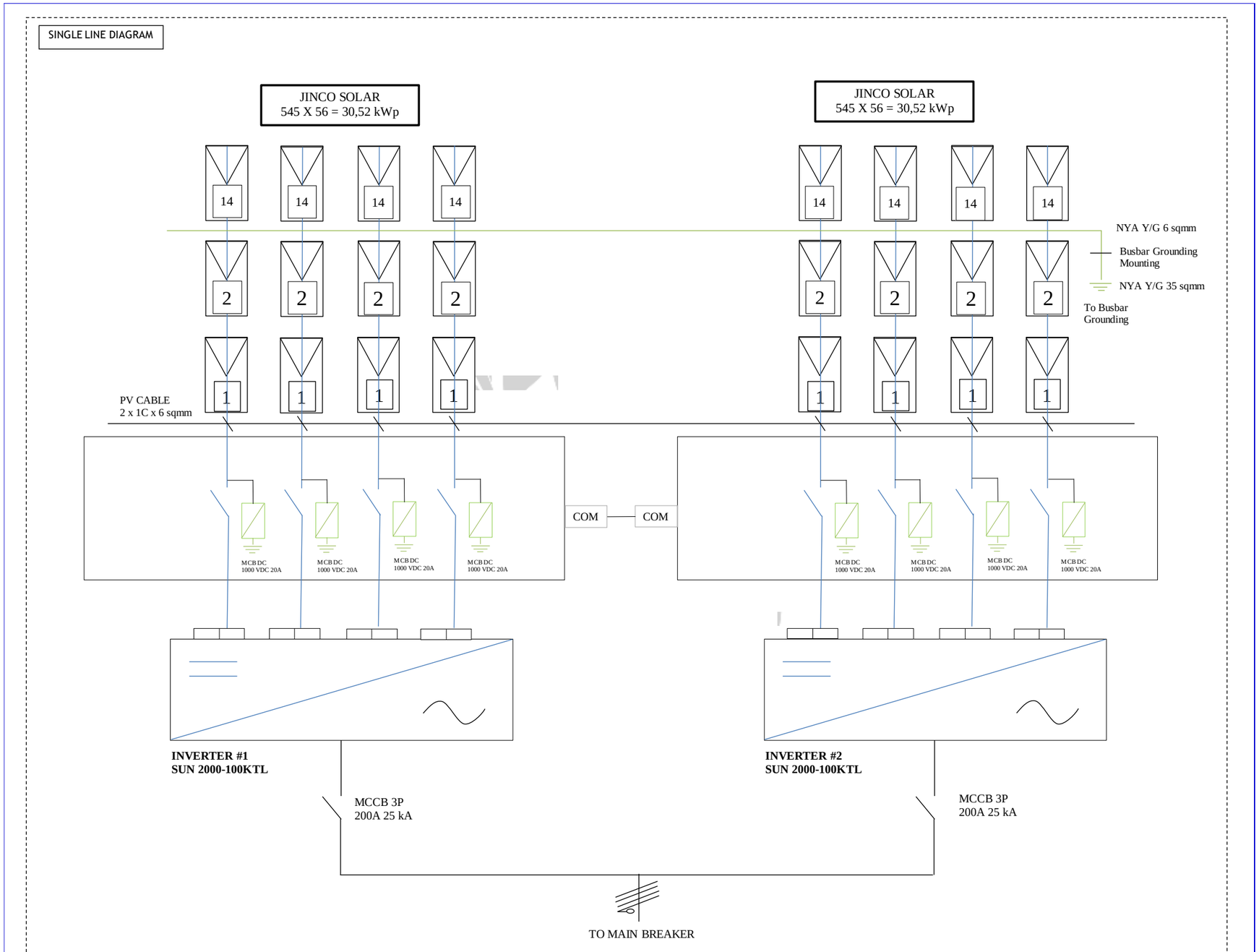
LAMPIRAN 5

STRING WIRING



112 Panel
8 string x 14 In series
2 Invereter

SINGLE LINE DIAGRAM PLTS



LAMPIRAN 7

DATA IRIDIASI AREA PLTU LABUAN

Average hourly profiles

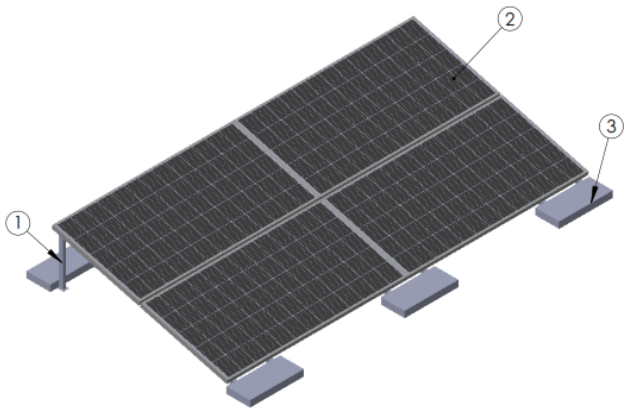
Total photovoltaic power output [Wh]

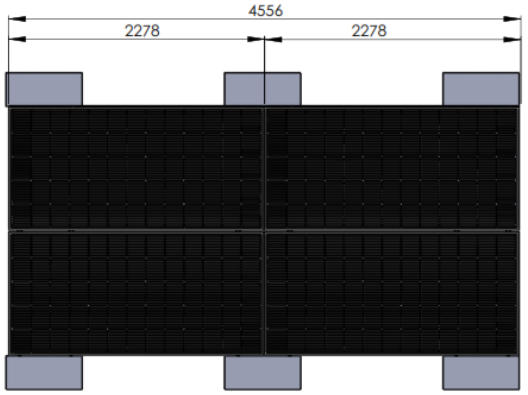
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0 - 1												
1 - 2												
2 - 3												
3 - 4												
4 - 5												
5 - 6											2	
6 - 7	26	16	22	30	30	23	19	23	34	70	70	45
7 - 8	119	117	142	169	174	160	151	178	219	223	197	148
8 - 9	230	237	280	321	327	311	311	352	388	372	330	261
9 - 10	325	345	403	442	452	437	445	495	522	486	425	347
10 - 11	402	432	488	517	523	512	527	573	586	524	460	408
11 - 12	446	470	515	536	537	528	548	576	582	518	455	435
12 - 13	452	472	510	518	508	506	530	549	560	486	430	424
13 - 14	413	427	450	448	438	441	475	491	496	408	350	361
14 - 15	329	336	341	320	318	328	366	373	367	265	241	270
15 - 16	223	226	217	191	180	203	233	238	225	148	140	173
16 - 17	119	122	112	87	71	89	107	113	103	68	65	89
17 - 18	35	39	29	16	6	9	16	17	14	9	11	22
18 - 19												
19 - 20												
20 - 21												
21 - 22												
22 - 23												
23 - 24												
Sum	3,120	3,237	3,509	3,595	3,565	3,546	3,726	3,980	4,096	3,577	3,176	2,982

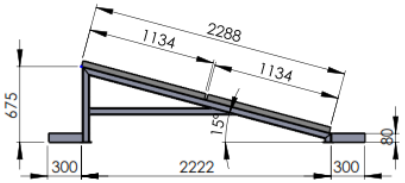
LAMPIRAN 8

SISTEM MOUNTING PLTS ATAP GEDUNG ADMINISTRASI PLTU LABUAN

ITEM NO.	PART NUMBER	QTY.
1	FRAME	1
2	SOLAR PANEL	4
3	BALLAST SYSTEM	6







	PLTS				
ITEM	PART NAME	MATERIAL	DIMENSION	QTY	REMARK

	NAME	DATE	SIGNATURE
DRAWN			
CHECKED			
APPROVED			

A4

SCALE:1:50 SHEET 1 OF 1

LAMPIRAN 9

PERHITUNGAN MANUAL POTENSI ENERGI MATAHARI DI PLTU LABUAN

Faktor koefisien temperatur (TCF) dapat di hitung

TCF = 1 + (*Temperature Coefficient* × *Temperature Difference*)

Koefisien temperatur daya panel: -0.4%/°C

Suhu operasi aktual panel di PLTU Labuan : 33°C

TCF = 1 + (-0.004 × 8)

TCF = 1 - 0.032 TCF

= 0,968

= 0,968%

faktor koefisien temperatur (*TCF*) sebesar 0,968%, sedangkan efisiensi panel surya (*nPV*) yang didapat dari perhitungan daya maksimal panel dibagi luas permukaan panel

$\eta PV = \frac{P_{max}}{A \,.G} \times 100\%$

Dimana:

- Pmax = Daya maksimum (watt) dari panel surya ntuk panel Jinko Solar JKM-545M-72HL4-BDVP, daya maksimalnya adalah 545 Wp (Watt Peak)
- A = Luas permukaan panel (m^2) Ukuran panel bisa dihitung dari dimensinya (panjang dan lebar). Ukuran panel yang dipilih 2,27 m x 1,13 m = 2,56 m^2
- G = Intensitas radiasi matahari (W/m^2), biasanya sekitar 1000 W/m^2 di kondisi standar tes (STC).

$\eta PV = \frac{P_{max}}{A \,.G} \times 100\%$

$\eta PV = \frac{245\ W}{2{,}56\ m^2\ x\ 1000\ W/m^2} \times 100\%$

$\eta PV = 21{,}42\%$

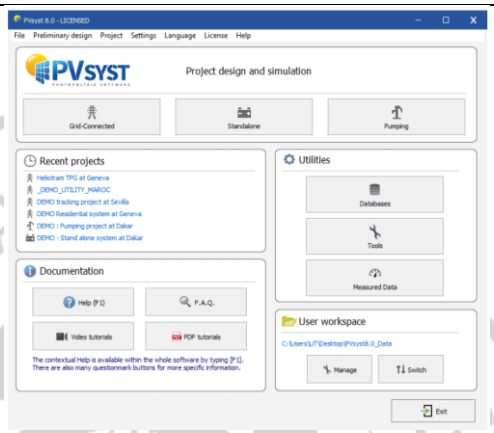
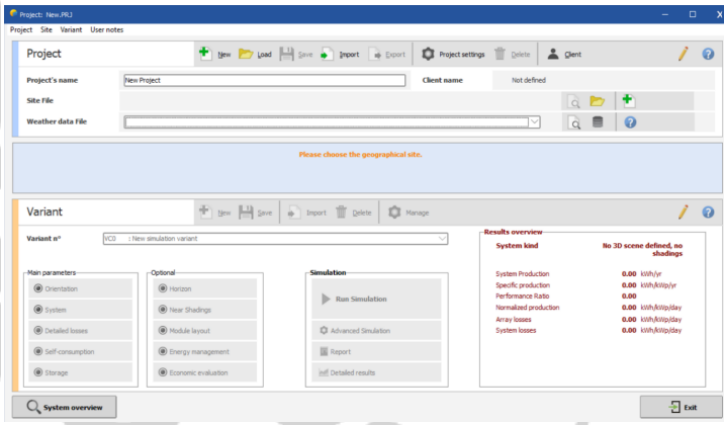
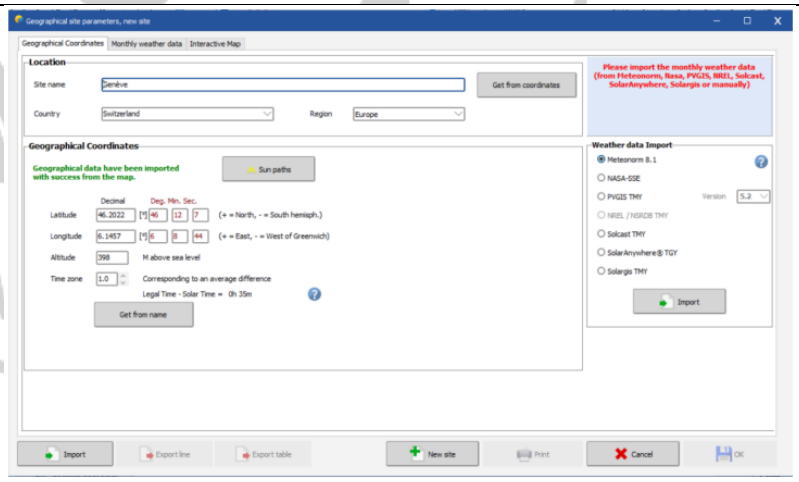
E = $\eta PV \times A \times G$

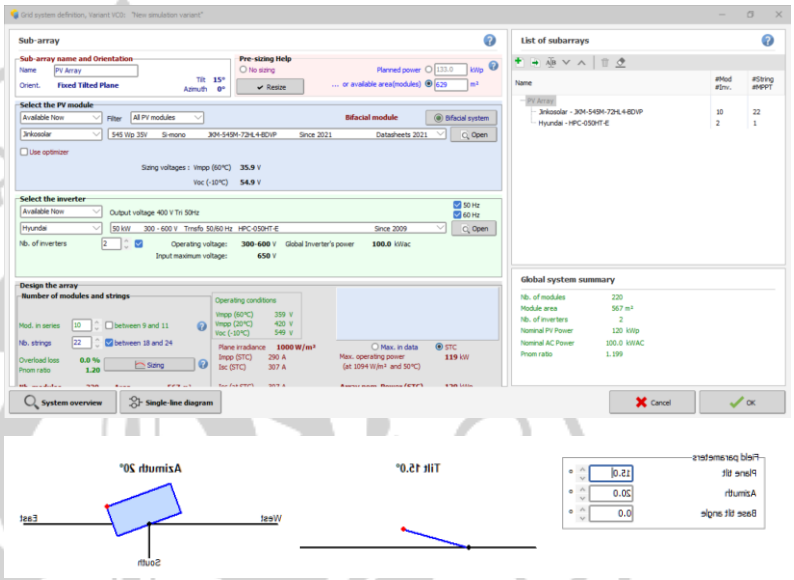
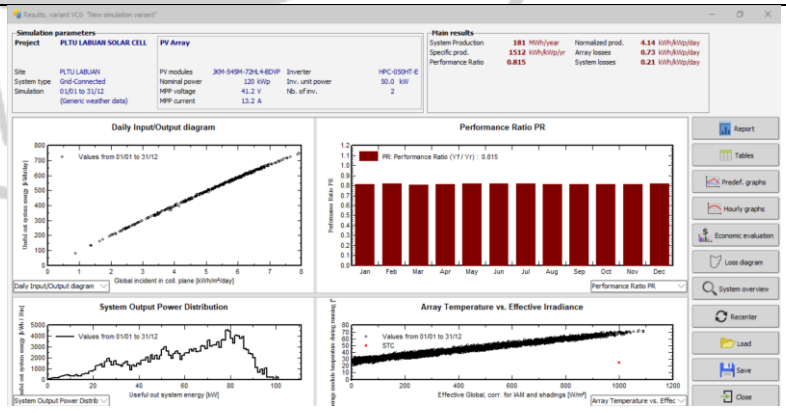
E = 21.24% × 628 m^2 × 2,606 kWh/m^2/hari

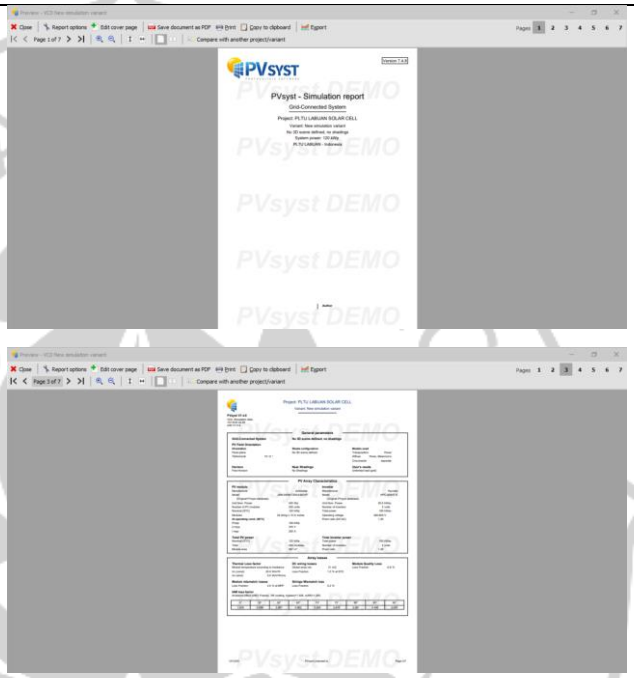
E = 34.760,70 kWh/hari

LAMPIRAN 10

TUTORIAL SIMULASI PVSYST

No	Keterangan	Gambar
1	**Instalasi PVsyst** Unduh dan pasang software PVsyst dari situs resmi pvsyst.com. Setelah instalasi, buka program untuk memulai simulasi.	
2	**Membuat Proyek Baru** • Setelah membuka PVsyst, pilih **"New Project"** untuk membuat proyek baru. • Masukkan nama proyek, lokasi geografis (misalnya Labuan, Banten), dan detail lainnya seperti kapasitas sistem yang akan dipasang.	
3	**Pemilihan Lokasi dan Iklim** • Pilih "Location" yang sesuai dengan lokasi sistem PLTS. Anda bisa menggunakan data dari database PVsyst atau memasukkan data lokasi secara manual. • Pilih latitude dan longitude untuk lokasi yang tepat. Misalnya, untuk Labuan, Banten, nilai-nilai tersebut adalah 6°15' LS dan 105°40' BT.	

	• Iklim: Pilih data iklim atau gunakan data historis jika tersedia (misalnya, data dari NASA atau METEONORM).	
4	**Desain Sistem** • Panel Surya: Pilih tipe panel surya dari database PVsyst atau masukkan data teknis panel yang akan digunakan (seperti Jinko Solar JKM545M-72HL4-BDVP). • Inverter: Pilih inverter yang akan digunakan dalam sistem, dan masukkan informasi seperti kapasitas inverter dan jumlah unit yang dibutuhkan. • Jumlah dan Penataan Panel: Tentukan jumlah panel yang akan dipasang, serta susunan dalam sistem (seri atau paralel). • Tilt dan Azimuth: Tentukan sudut kemiringan (tilt) dan azimuth sesuai dengan orientasi sistem (misalnya, tilt = 15° dan azimuth = 0° untuk utara).	
5	**Simulasi** • Setelah memasukkan semua parameter, pilih “Simulation” untuk menjalankan simulasi. • PVsyst akan menghitung produksi energi berdasarkan data yang dimasukkan (seperti	

	kapasitas panel, iklim, orientasi, dll). • Simulasi ini juga akan memberikan estimasi produksi listrik tahunan, keandalan sistem, dan efisiensi.	
6	**Analisis Hasil** Lihat hasil simulasi berupa grafik dan laporan yang menunjukkan produksi energi harian, bulanan, dan tahunan. Analisis komponen sistem, termasuk kinerja inverter dan panel surya, serta lifetime performance.	

LAMPIRAN 11

BIAYA INVESTASI PEMASANGAN PANEL SURYA ON GRID

BIAYA INVESTASI PEMASANGAN PANEL SURYA ON GRID

A	**ENGINEERING & DESIGN**								
No	**Item Unit**	**Unit**		**Qty**		**Unit Price**		**Total**	
I	**Biaya Langsung Personil**							**Rp**	**10.887.500**
	Tenaga Ahli Muda man	1	man	0,25	month	Rp	26.550.000	Rp	6.637.500
	Drafter	1	man	0,25	month	Rp	10.000.000	Rp	2.500.000
	Admin Proyek	1	man	0,25	month	Rp	7.000.000	Rp	1.750.000
II	**Biaya Langsung Non Personil**							**Rp**	**3.000.000**
	sewa laptop, komunikasi, internet	1	Ls			Rp	3.000.000	Rp	3.000.000
III	**Trip Survey**	1	Ls			Rp	2.500.000	**Rp**	**2.500.000**
IV	**Software**	1	Ls			Rp	750.000	**Rp**	**750.000**
	Total A							**Rp**	**17.137.500**
B	**PROCUREMENT MATERIAL**								
No	**Item Unit**	**Unit**		**Qty**		**Unit Price**		**Total**	
1	**Panel Surya**								
	Panel Surya Jinko Solar dengan tipe JKM545M-72HL4-BDVP			112	Panel	Rp	6.169.600	Rp	690.995.200
2	**Inverter dan Monitoring System**								
	Inverter Sunzet 25KVA			2	buah	Rp	61.696.000	Rp	123.392.000
	communication device			1	buah	Rp	3.330.000	Rp	3.330.000
3	**Mounting System**								
	Penetrating Mounting System			1	Ls	Rp	18.442.800	Rp	18.442.800
4	**AC Combiner box**			1	set	Rp	8.500.000	Rp	8.500.000
5	**Cabling & Cable Management**								
	PV Solar cable 1x6mm from PV String to Inverter			250	meter	Rp	19.980	Rp	4.995.000
	Connector MC4 20/30A (pairs)			15	pairs	Rp	40.000	Rp	600.000
	NYY 5 X 70 mm^2			50	meter	Rp	547.500	Rp	27.375.000
	NYAF 4mm, module grounding			50	meter	Rp	14.200	Rp	710.000
	NYA 10mm, Inverter grounding			50	meter	Rp	25.400	Rp	1.270.000
	Tray 100 X 50mm, for PV Cable run			50	meter	Rp	226.400	Rp	11.320.000
	communication cable			1	roll	Rp	1.500.000	Rp	1.500.000
6	**Delivery Material**								
	Delivery Material			1	Ls	Rp	19.980.000	Rp	19.980.000
	Total B							**Rp**	**912.410.000**

C	**JASA PEMASANGAN**						
No	**Item Unit**	**Unit**		**Qty**		**Unit Price**	**Total**
1	Installation			1	Ls	Rp 123.204.000	Rp 123.204.000
							Rp 123.204.000
D	**PROJECT MANAGEMENT**						
No	**Item Unit**	**Unit**		**Qty**		**Unit Price**	**Total**
1	Site Supervisor man	1	man	1	month	Rp 13.000.000	Rp 13.000.000
2	Accomodation for Supervisor	1	Ls	3	month	Rp 5.800.000	Rp 17.400.000
3	HSE Officer 1	1	man	3	month	Rp 5.000.000	Rp 15.000.000
4	ITH Personil supervision man	1	man	4	trip	Rp 2.500.000	Rp 10.000.000
Total D							**Rp 55.400.000,00**
TOTAL A+B+C+D							**Rp 1.108.151.500**
PPN 11%							**Rp 110.815.150**
GRAND TOTAL							**Rp 1.218.966.650**

LAMPIRAN 12

BIAYA INVESTASI PEMASANGAN PANEL SURYA OFF GRID

BIAYA INVESTASI PEMASANGAN PANEL SURYA OFF GRID

A	ENGINEERING & DESIGN								
No	**Item Unit**	**Unit**		**Qty**		**Unit Price**		**Total**	
I	**Biaya Langsung Personil**							**Rp**	**10.887.500**
	Tenaga Ahli Muda man	1	man	0,25	month	Rp	26.550.000	Rp	6.637.500
	Drafter	1	man	0,25	month	Rp	10.000.000	Rp	2.500.000
	Admin Proyek	1	man	0,25	month	Rp	7.000.000	Rp	1.750.000
II	**Biaya Langsung Non Personil**							**Rp**	**3.000.000**
	sewa laptop, komunikasi, internet	1	Ls			Rp	3.000.000	Rp	3.000.000
III	**Trip Survey**	1	Ls			Rp	2.500.000	**Rp**	**2.500.000**
IV	**Software**	1	Ls			Rp	750.000	**Rp**	**750.000**
	Total A							**Rp**	**17.137.500**
B	**PROCUREMENT MATERIAL**								
No	**Item Unit**	**Unit**		**Qty**		**Unit Price**		**Total**	
1	**Panel Surya**								
	Panel Surya Jinko Solar dengan tipe JKM545M-72HL4-BDVP			112	Panel	Rp	6.169.600	Rp	690.995.200
2	**Inverter dan Monitoring System**								
	Inverter Sunzet 25KVA			2	buah	Rp	61.696.000	Rp	123.392.000
	communication device			1	buah	Rp	3.330.000	Rp	3.330.000
3	**Battery System**								
	Lithium ion Lithium ion tesla powerwall2			4	Pcs	Rp	80.343.750	Rp	321.375.000
4	**Charger Controller**								
	Schneider Electric Conext MPPT 80-600			3	set	Rp	25.000.000	Rp	75.000.000
5	**Mounting System**								
	Penetrating Mounting System			1	Ls	Rp	18.442.800	Rp	18.442.800
6	**AC Combiner box**			1	set	Rp	8.500.000	Rp	8.500.000
7	**Cabling & Cable Management**								
	PV Solar cable 1x6mm from PV String to Inverter			250	meter	Rp	19.980	Rp	4.995.000
	Connector MC4 20/30A (pairs)			15	pairs	Rp	40.000	Rp	600.000
	NYY 5 X 70 mm²			50	meter	Rp	550.000	Rp	27.500.000
	NYAF 4mm, module grounding			50	meter	Rp	14.200	Rp	710.000
	NYA 10mm, Inverter grounding			50	meter	Rp	25.400	Rp	1.270.000
	Tray 100 X 50mm, for PV Cable run			50	meter	Rp	226.400	Rp	11.320.000

	Kabel PV1-F 2x4mm²			20	meter	Rp	25.000	Rp	500.000
	Kabel Tembaga (Copper Cable)			20	meter	Rp	150.000	Rp	3.000.000
	communication cable			1	roll	Rp	1.500.000	Rp	1.500.000
8	**Delivery Material**								
	Delivery Material			1	Ls	Rp	19.980.000	Rp	19.980.000
Total B								**Rp**	**1.312.410.000**
C	**JASA PEMASANGAN**								
No	**Item Unit**	**Unit**		**Qty**		**Unit Price**		**Total**	
1	Installation			1	Ls	Rp	123.204.000	Rp	123.204.000
								Rp	**123.204.000**
D	**PROJECT MANAGEMENT**								
No	**Item Unit**	**Unit**		**Qty**		**Unit Price**		**Total**	
1	Site Supervisor man	1	man	1	month	Rp	13.000.000	Rp	13.000.000
2	Accomodation for Supervisor	1	Ls	3	month	Rp	5.800.000	Rp	17.400.000
3	HSE Officer 1	1	man	3	month	Rp	5.000.000	Rp	15.000.000
4	ITH Personil supervision man	1	man	4	trip	Rp	2.500.000	Rp	10.000.000
Total D								**Rp**	**55.400.000,00**
TOTAL A+B+C+D+E								**Rp**	**1.508.151.500**
PPN 11%								**Rp**	**150.815.150**
GRAND TOTAL								**Rp**	**1.658.966.650**

LAMPIRAN 13

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Design of Solar Power Plant Capacity for Auxiliary Load at Labuan Steam Power Plant (PLTU) PT. PLN (PERSERO)

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***Abstract* - Solar Power Plants are a form of renewable energy that harness sunlight to generate electricity through solar panels. This research designs a PLTS system for use at the Labuan Steam Power Plant (PLTU) of PT. PLN (Persero), aimed at reducing the plant's own electricity consumption. This study evaluates the design and installation of a PLTS system on a 7200 m² area at the Labuan PLTU and conducts a technical and economic comparison between On-Grid and Off-Grid PLTS systems. The research methods include field surveys, shading potential measurements, and design simulations using PVSyst software. The results show that the On-Grid PLTS installation at the Labuan PLTU Administration Building is technically and economically feasible, with a Benefit-Cost Ratio (BCR) of 1.20 and a Payback Period (PP) of 16.93 years. The implementation of this PLTS system has the potential to reduce carbon emissions by 84,187 tons of CO_2e per year, supporting PT. PLN's program to achieve the 23% renewable energy mix target by 2025.**

Keywords: Renewable Energy, PLTS, PLTU, On-Grid, Off-Grid, Energy Mix.

I. INTRODUCTION

Renewable energy plays a crucial role in meeting current and future energy needs and is essential for mitigating global climate change. By utilizing renewable energy sources, we can reduce dependence on fossil fuels, lower greenhouse gas emissions, and support environmental sustainability. Although renewable energy is increasingly utilized worldwide, the majority of energy still comes from fossil fuels (95%).

Indonesia, with a land area of 1.9 million km² and a population of 267 million, faces growing energy demands due to its stable economic growth. The heavy reliance on limited fossil fuels poses a risk of energy crises. Therefore, energy issues remain a government priority, especially considering the environmental impact of fossil fuel combustion.

According to PT. PLN (Persero)'s Electricity Supply Business Plan (RUPTL) 2021-2030 report, the development of new and renewable energy (EBT) includes the use of Solar Power Plants (PLTS) in various locations, including former mining sites and reservoirs. PLTS can reduce the use of conventional energy and is ready for deployment across different sectors.

PLTU Banten 2 Labuan, managed by PLN Indonesia Power, plans to use rooftop space for PLTS due to the significant solar exposure in Labuan Banten, which receives sunlight for 6 hours a day. With a rooftop area of 7,200 m², PLTS can provide renewable energy.

PLTS is an intermittent power source and requires backup generation to manage fluctuations in solar intensity. By 2020, the operational capacity of PLTS reached 79 MW. PLN aims to increase the share of EBT from 12.4% in 2021 to 23% by 2025, with planned development of PLTS in existing PLN facilities and a potential expansion of 112.5 MW.

II. AIM AND OBJECTIVES

This research is conducted at PLTU Banten 2 Labuan, a coal-fired power plant with a gross installed capacity of 300 MW, with the following aims:

1) To assess the potential solar energy capacity at PLTU Banten 2 Labuan as a basis for designing the capacity of a Solar Power Plant (PLTS) for the administrative building at PLTU Banten 2 Labuan.
2) To analyze the impact of PLTS as a self-consumption power supply on the stability and quality of power at PLTU Banten 2 Labuan.
3) To develop recommendations for an appropriate PLTS capacity design for self-consumption at the administrative building of PLTU Banten 2 Labuan.
4) To compare the design of Off-Grid and On-Grid PLTS for the administrative building at PLTU Banten 2 Labuan from both technical and economic perspectives.

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III. STUDY AREA AND METHODOLOGY

Study Area

At this stage, a field survey is conducted to observe and measure the parameters used for designing the rooftop Solar Power Plant, including: location coordinates, roof condition, megascopic observation of shading potential, and installed electrical capacity at the unit. Location coordinates will be collected using GPS to determine precise points for obtaining global irradiation data and calculating the rooftop area through geotagging methods. Simply put, the calculation of rooftop area can be performed using Google Earth software. Observations using Google Earth are also intended to provide a better overview. The images of several sampling locations can be seen, and the measurement of rooftop area is based on the geotagging method using Google Earth software. The rooftop area calculation also takes into account areas that are indicated to be shaded, so these shaded areas will be excluded from the rooftop area calculation. The second stage involves collecting data after the installation of the rooftop Solar Power Plant by measuring the power output of the installed rooftop.

Method

The data collection methods used in this research are:

1) Field Data Collection: Gathering data on power consumption loads at the power plant unit.
2) Computational Simulation: Using Helioscope (non-beta) and PV Syst version 7.2 software for simulation.
3) Data Analysis: Based on the results of the simulations.
4) Economic Analysis: Assessing the economics of investing in PLTS.
5) Supplementary Data Collection: Obtaining additional data related to the research theme from books, literature, articles, and journals.

IV. RESULT AND DISCUSSION

Figure 1: Photo of PLTU Labuan 2 on Google Earth

The Solar Power Plant will be installed on the roof of the Administrative Building at PLTU Labuan, Banten, with coordinates of latitude: -6.3710° S and longitude: 105.8257° E. As shown in Figures 1, the total surface area of the PLTS is 628.57 m². The aim is for the PLTS to reduce the Self-Consumption (PS) load of PLTU Labuan, Banten. Based on the research review obtained from online sources, the solar radiation values at PLTU Labuan are as follows range 1,834 - 3,186 kWh/m²/day

The amount of potential solar energy is obtained from calculation (1). This calculation shows that the PV area is 628.579805 m², with an average solar intensity of 2.60667 kWh/m²/day, as obtained from Table 4. Additionally, the temperature coefficient factor (TCF) can also be calculated:

TCF = 1+(Temperature Coefficient×Temperature Difference)

TCF = 1 + (-0.004 × 8) TCF = 1 - 0.032 TCF = 0,968

= 0,968%

From the energy management report for August 2024, the total auxiliary power consumption for non-generation areas in August was 251,551.06 kWh, or 1.12% of the total auxiliary power at PLTU Labuan. This amount includes the electricity consumption of the Administrative Building, which is 46,344.76 kWh.

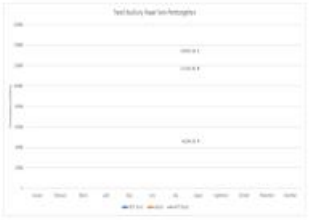

Figure 2: Auxiliary Power Consumption at PLTU Labuan

The selection of solar panel types is based on the products available in the market. The researcher chose Jinko Solar's Tiger Pro 72HL4-BDVP model, which has a power output of 545 watts and is a bifacial module with dual glass. The selected module type is JKM545M-72HL4-BDVP, chosen for its maximum power output of 545 Wp.

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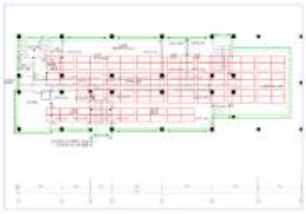

Designing solar panels on the rooftop requires detailed planning to account for structural, aesthetic, and energy efficiency factors. The roofing material used is concrete for the Administrative Building at PLTU Banten 2 Labuan. The number of panels installed is based on the available roof area and accessibility for maintenance and monitoring. The solar panel design includes 112 units

The estimated potential electrical energy that can be generated by the rooftop Solar Power Plant (PLTS) at the Administrative Building of PLTU Labuan, based on the PVsyst simulation performed by the Detail Engineering Design (DED) author, is 92,514 kWh per year, or 7,709 kWh per month, with an average of 256 kWh per day. Considering the electricity tariff for coal-based power plants, the production cost of electricity usually ranges around Rp 1,325 per kWh. If we take an average value, for example, Rp 1,000 per kWh, the calculation for 92,514 kWh would be:

Saving = 92.514 kWh × 1.325 Rp/kWh

= 125.078.928

So, for a solar power plant (PLTS) electricity production of 92,514 kWh, the estimated savings on electricity from a coal-based power plant is approximately Rp 125,078,928.00

To determine the reduction in carbon emissions achieved by the Solar Power Plant (PLTS), the following calculation can be used:

CO_2e Emissions (kg) = Energy Consumption (kWh) × Emission Factor (kg CO_2e/kWh)

CO_2e Emissions (kg) = 92,514 kWh × 0.91 kg CO_2e/kWh

CO_2e Emissions (kg) = 84,187.74 kg CO_2e = 84.187 tons CO_2e

*Coal-based power plants have an emission factor of 0.91 kg CO_2e/kWh.

The installed Solar PV serves as an alternative power source, directly contributing to the reduction of self-consumption power. The initial investment costs for the rooftop PLTS at the Administrative Building of PLTU Labuan include expenses such as: solar module costs, inverter and communication system costs, installation costs, protection and power cable costs, module support frame costs, monitoring system costs, grounding costs, as well as installation, technical, commissioning, and operation feasibility certification costs.

V. CONCLUSION

This research aims to analyze the potential implementation of a Solar Power Plant (PLTS) at PLTU Labuan. The findings are as follows:

1) Solar Energy Potential: The highest solar radiation value in Labuan occurs in August at 3.186 kWh/m²/day, due to the peak dry season. Conversely, the lowest radiation occurs in December at 1.834 kWh/m²/day, due to the rainy season. For the administrative building's rooftop with an area of 628 m² and using panels with 21.24% efficiency, the potential daily electricity generation is about 666 kWh.
2) Self-Consumption Electricity Load: The highest electricity consumption at PLTU Labuan occurred in June at 20,474.97 MWh, while the lowest was in March at 9,131.14 MWh, reflecting fluctuating power usage. The self-consumption electricity need for the Administrative Building is 251,551.06 kWh, or 1.12% of the total auxiliary power at PLTU Labuan, including 46,344.76 kWh for the building itself.
3) Electricity Generation Forecast: The estimated annual electricity generation by the rooftop PLTS at the Administrative Building is 92,514 kWh, or 7,709 kWh per month, averaging 256 kWh per day, based on PVsyst simulation.
4) System Comparison: From a technical perspective, the off-grid system offers better reliability during power outages, while the on-grid system is more economical, saving around 26.55% or Rp 440,000,000.00 due to the absence of battery costs. The NPV for the on-grid system is Rp 238,651,041.00, making it feasible, whereas the off-grid system has an NPV of -Rp 201,348,959.00, making it unfeasible. The Benefit-Cost Ratio (BCR) is 1.20, indicating that the on-grid PLTS investment is feasible. The Payback Period (PP) is 16.93 years, shorter than the project lifespan, supporting the continuation of the on-grid system.
5) Long-Term Investment Feasibility: The PLTS at the Administrative Building will reduce carbon emissions by 84.187 tons CO_2e annually and supports PT. PLN's commitment to achieving a 23% renewable energy mix by 2025, as outlined in the National Energy General Plan (RUEN). The abundant solar potential in Indonesia makes PLTS a key resource for reaching this target.

Conclusion: Implementing rooftop PLTS at PLTU Labuan shows significant potential for generating renewable energy and reducing carbon emissions. The research provides a basis for optimizing solar energy use in conventional power plants, contributing to energy diversification and environmental impact mitigation. Further potential can be explored by installing PLTS on available land at PLTU Labuan.

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PERHITUNGAN EKONOMI PLTS ON GRID

Economical Analysis - NPV, IRR, and PP PLTS On Grid

Project Title PLTU Banten 2 Labuan PLTS On Grid
Kapasitas 1 Panel 256 kWh/hari
7.710 kWh/minggu
92.514 kWh/tahun

General Values
Discount Rate 7% (Permen ESDM No. 2 Tahun 2024)
Project Life Time 30 years
Tax Rates 0% (insentif pajak untuk proyek energi terbarukan)

Project Capital Cost
Investment Rp 1.218.966.650,00 Referensi harga dari vendor dan manufacture

Project Income
Power Generation Save 256 kWh/hari

Power Price 1.444,70 Rp/kWh (golongan B-2/TR)
Inflation Rate 2,5% per-year https://tradingeconomics.com/indonesia/inflation-cpi

O&M Cost
Operation Expense Rp 12.189.666,50 per year

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Capital and Operational Cost															
Investment	Rp 1.218.966.650,00														
Operating & Maintenance Cost	Rp -	Rp 12.189.666,50	Rp 12.806.768,37	Rp 13.126.937,58	Rp 13.455.111,02	Rp 13.791.488,79	Rp 14.136.276,01	Rp 14.489.682,91	Rp 14.851.924,98	Rp 15.223.223,11	Rp 15.603.803,69	Rp 15.993.898,78	Rp 16.393.746,25	Rp 16.803.589,90	Rp 17.223.679,65
Total Cost	-Rp 1.218.966.650,00	-Rp 12.189.666,50	-Rp 12.806.768,37	-Rp 13.126.937,58	-Rp 13.455.111,02	-Rp 13.791.488,79	-Rp 14.136.276,01	-Rp 14.489.682,91	-Rp 14.851.924,98	-Rp 15.223.223,11	-Rp 15.603.803,69	-Rp 15.993.898,78	-Rp 16.393.746,25	-Rp 16.803.589,90	-Rp 17.223.679,65
Revenue															
Power Saving	Rp 134.992.768,00	Rp 134.992.768,00	Rp 134.992.768,00	Rp 134.992.768,00	Rp 134.992.768,00	Rp 134.992.768,00	Rp 134.992.768,00	Rp 134.992.768,00	Rp 134.992.768,00	Rp 134.992.768,00	Rp 134.992.768,00	Rp 134.992.768,00	Rp 134.992.768,00	Rp 134.992.768,00	Rp 134.992.768,00
Shutdown Period		-Rp 1.109.529,60	-Rp 1.109.529,60	-Rp 1.109.529,60	-Rp 1.109.529,60	-Rp 1.109.529,60	-Rp 1.109.529,60	-Rp 1.109.529,60	-Rp 1.109.529,60	-Rp 1.109.529,60	-Rp 1.109.529,60	-Rp 1.109.529,60	-Rp 1.109.529,60	-Rp 1.109.529,60	-Rp 1.109.529,60
Cash Flow Before Tax	-Rp 1.083.973.882,00	Rp 121.693.571,90	Rp 121.076.470,03	Rp 120.756.300,82	Rp 120.428.127,38	Rp 120.091.749,61	Rp 119.746.962,39	Rp 119.393.555,49	Rp 119.031.313,42	Rp 118.660.015,29	Rp 118.279.434,71	Rp 117.889.339,62	Rp 117.489.492,15	Rp 117.079.648,50	Rp 116.659.558,75
Taxes		Rp -	Rp -	Rp -	Rp -	Rp -	Rp -	Rp -	Rp -	Rp -	Rp -	Rp -	Rp -	Rp -	Rp -
Cash flow After Tax	-Rp 1.083.973.882,00	Rp 121.693.571,90	Rp 121.076.470,03	Rp 120.756.300,82	Rp 120.428.127,38	Rp 120.091.749,61	Rp 119.746.962,39	Rp 119.393.555,49	Rp 119.031.313,42	Rp 118.660.015,29	Rp 118.279.434,71	Rp 117.889.339,62	Rp 117.489.492,15	Rp 117.079.648,50	Rp 116.659.558,75
Year	Rp 1,00	Rp 2,00	Rp 3,00	Rp 4,00	Rp 5,00	Rp 6,00	Rp 7,00	Rp 8,00	Rp 9,00	Rp 10,00	Rp 11,00	Rp 12,00	Rp 13,00	Rp 14,00	Rp 15,00
NET CASH FLOW	-Rp 1.083.973.882,00	Rp 121.693.571,90	Rp 121.076.470,03	Rp 120.756.300,82	Rp 120.428.127,38	Rp 120.091.749,61	Rp 119.746.962,39	Rp 119.393.555,49	Rp 119.031.313,42	Rp 118.660.015,29	Rp 118.279.434,71	Rp 117.889.339,62	Rp 117.489.492,15	Rp 117.079.648,50	Rp 116.659.558,75
Discounted Cash Flow	-Rp 1.013.059.702,80	Rp 106.291.878,68	Rp 98.834.465,43	Rp 92.124.403,72	Rp 85.863.590,45	Rp 80.022.203,50	Rp 74.572.389,92	Rp 69.488.136,32	Rp 64.745.147,79	Rp 60.320.734,78	Rp 56.193.707,39	Rp 52.344.276,66	Rp 48.753.962,24	Rp 45.405.506,26	Rp 42.282.792,72

16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Rp 17.654.271,64	Rp 18.095.628,43	Rp 18.548.019,14	Rp 19.011.719,62	Rp 19.487.012,61	Rp 19.974.187,93	Rp 20.473.542,63	Rp 20.985.381,19	Rp 21.510.015,72	Rp 22.047.766,12	Rp 22.598.960,27	Rp 23.163.934,27	Rp 23.743.032,63	Rp 24.336.608,45	Rp 11.602.300,06
-Rp 17.654.271,64	-Rp 18.095.628,43	-Rp 18.548.019,14	-Rp 19.011.719,62	-Rp 19.487.012,61	-Rp 19.974.187,93	-Rp 20.473.542,63	-Rp 20.985.381,19	-Rp 21.510.015,72	-Rp 22.047.766,12	-Rp 22.598.960,27	-Rp 23.163.934,27	-Rp 23.743.032,63	-Rp 24.336.608,45	-Rp 11.602.300,06
Rp 134.992.768,00	Rp 134.992.768,00	Rp 134.992.768,00	Rp 134.992.768,00	Rp 134.992.768,00	Rp 134.992.768,00	Rp 134.992.768,00	Rp 134.992.768,00	Rp 134.992.768,00	Rp 134.992.768,00	Rp 134.992.768,00	Rp 134.992.768,00	Rp 134.992.768,00	Rp 134.992.768,00	Rp 134.992.768,00
-Rp 1.109.529,60	-Rp 1.109.529,60	-Rp 1.109.529,60	-Rp 1.109.529,60	-Rp 1.109.529,60	-Rp 1.109.529,60	-Rp 1.109.529,60	-Rp 1.109.529,60	-Rp 1.109.529,60	-Rp 1.109.529,60	-Rp 1.109.529,60	-Rp 1.109.529,60	-Rp 1.109.529,60	-Rp 1.109.529,60	-Rp 1.109.529,60
Rp 116.228.966,76	Rp 115.787.609,97	Rp 115.335.219,26	Rp 114.871.518,78	Rp 114.396.225,79	Rp 113.909.050,47	Rp 113.409.695,77	Rp 112.897.857,21	Rp 112.373.222,68	Rp 111.835.472,28	Rp 111.284.278,13	Rp 110.719.304,13	Rp 110.140.205,77	Rp 109.546.629,95	Rp 122.280.938,34
Rp -	Rp -	Rp -	Rp -	Rp -	Rp -	Rp -	Rp -	Rp -	Rp -	Rp -	Rp -	Rp -	Rp -	Rp -
Rp 116.228.966,76	Rp 115.787.609,97	Rp 115.335.219,26	Rp 114.871.518,78	Rp 114.396.225,79	Rp 113.909.050,47	Rp 113.409.695,77	Rp 112.897.857,21	Rp 112.373.222,68	Rp 111.835.472,28	Rp 111.284.278,13	Rp 110.719.304,13	Rp 110.140.205,77	Rp 109.546.629,95	Rp 122.280.938,34
Rp 16,00	Rp 17,00	Rp 18,00	Rp 19,00	Rp 20,00	Rp 21,00	Rp 22,00	Rp 23,00	Rp 24,00	Rp 25,00	Rp 26,00	Rp 27,00	Rp 28,00	Rp 29,00	Rp 30,00
Rp 116.228.966,76	Rp 115.787.609,97	Rp 115.335.219,26	Rp 114.871.518,78	Rp 114.396.225,79	Rp 113.909.050,47	Rp 113.409.695,77	Rp 112.897.857,21	Rp 112.373.222,68	Rp 111.835.472,28	Rp 111.284.278,13	Rp 110.719.304,13	Rp 110.140.205,77	Rp 109.546.629,95	Rp 122.280.938,34
Rp 39.370.772,31	Rp 36.655.392,05	Rp 34.123.529,66	Rp 31.762.932,17	Rp 29.562.158,59	Rp 27.510.526,39	Rp 25.598.061,40	Rp 23.815.451,11	Rp 22.154.001,02	Rp 20.605.593,79	Rp 19.162.651,14	Rp 17.818.098,28	Rp 16.565.330,63	Rp 15.398.182,72	Rp 16.063.694,35

NPV	**Rp 364.174.359,46**	
IRR	**10,301%**	
Payback Period	**11,17**	**years**

Economical Analysis - NPV, IRR, and PP PLTS Off Grid

Project Title	PLTU Banten 2 Labuan PLTS Off Grid		
Kapasitas 1 Panel	256	kWh/hari	
	7.710	kWh/minggu	
	92.514	kWh/tahun	
General Values			
Discount Rate	7%		(Permen ESDM No. 2 Tahun 2024)
Project Life Time	30	years	
Tax Rates	0%		(insentif pajak untuk proyek energi terbarukan)
Project Capital Cost			
Investment	Rp 1.658.966.650,00		Referensi harga dari vendor dan manufacture
Project Income			
Power Generation Save	256	kWh/hari	
Power Price	1.444,70	Rp/kWh	(golongan B-2/TR)
Inflation Rate	2,5%	per-year	https://tradingeconomics.com/indonesia/inflation-cpi
O&M Cost			
Operation Expense	Rp 49.768.999,50	per year	

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Capital and Operational Cost															
Investment	Rp 1.658.966.650,00														
Replace Battery after 15 years															Rp 500.691.778,51
Operating & Maintenance Cost	Rp -	Rp 49.768.999,50	Rp 52.288.555,10	Rp 53.595.768,98	Rp 54.935.663,20	Rp 56.309.054,78	Rp 57.716.781,15	Rp 59.159.700,68	Rp 60.638.693,20	Rp 62.154.660,53	Rp 63.708.527,04	Rp 65.301.240,22	Rp 66.933.771,22	Rp 68.607.115,50	Rp 70.322.293,39
Total Cost	-Rp 1.658.966.650,00	-Rp 49.768.999,50	-Rp 52.288.555,10	-Rp 53.595.768,98	-Rp 54.935.663,20	-Rp 56.309.054,78	-Rp 57.716.781,15	-Rp 59.159.700,68	-Rp 60.638.693,20	-Rp 62.154.660,53	-Rp 63.708.527,04	-Rp 65.301.240,22	-Rp 66.933.771,22	-Rp 68.607.115,50	-Rp 571.014.071,90
Revenue															
Power Saving	Rp 134.992.768,00	Rp 134.992.768,00	Rp 134.992.768,00	Rp 134.992.768,00	Rp 134.992.768,00	Rp 134.992.768,00	Rp 134.992.768,00	Rp 134.992.768,00	Rp 134.992.768,00	Rp 134.992.768,00	Rp 134.992.768,00	Rp 134.992.768,00	Rp 134.992.768,00	Rp 134.992.768,00	Rp 134.992.768,00
Shutdown Period		-Rp 1.109.529,60	-Rp 1.109.529,60	-Rp 1.109.529,60	-Rp 1.109.529,60	-Rp 1.109.529,60	-Rp 1.109.529,60	-Rp 1.109.529,60	-Rp 1.109.529,60	-Rp 1.109.529,60	-Rp 1.109.529,60	-Rp 1.109.529,60	-Rp 1.109.529,60	-Rp 1.109.529,60	-Rp 1.109.529,60
Cash Flow Before Tax	-Rp 1.523.973.882,00	Rp 84.114.238,90	Rp 81.594.683,30	Rp 80.287.469,42	Rp 78.947.575,20	Rp 77.574.183,62	Rp 76.166.457,25	Rp 74.723.537,72	Rp 73.244.545,20	Rp 71.728.577,87	Rp 70.174.711,36	Rp 68.581.998,18	Rp 66.949.467,18	Rp 65.276.122,90	-Rp 437.130.833,50
Taxes		Rp -	Rp -	Rp -	Rp -	Rp -	Rp -	Rp -	Rp -	Rp -	Rp -	Rp -	Rp -	Rp -	Rp -
Cash flow After Tax	-Rp 1.523.973.882,00	Rp 84.114.238,90	Rp 81.594.683,30	Rp 80.287.469,42	Rp 78.947.575,20	Rp 77.574.183,62	Rp 76.166.457,25	Rp 74.723.537,72	Rp 73.244.545,20	Rp 71.728.577,87	Rp 70.174.711,36	Rp 68.581.998,18	Rp 66.949.467,18	Rp 65.276.122,90	-Rp 437.130.833,50
Year	Rp 1,00	Rp 2,00	Rp 3,00	Rp 4,00	Rp 5,00	Rp 6,00	Rp 7,00	Rp 8,00	Rp 9,00	Rp 10,00	Rp 11,00	Rp 12,00	Rp 13,00	Rp 14,00	Rp 15,00
NET CASH FLOW	-Rp 1.523.973.882,00	Rp 84.114.238,90	Rp 81.594.683,30	Rp 80.287.469,42	Rp 78.947.575,20	Rp 77.574.183,62	Rp 76.166.457,25	Rp 74.723.537,72	Rp 73.244.545,20	Rp 71.728.577,87	Rp 70.174.711,36	Rp 68.581.998,18	Rp 66.949.467,18	Rp 65.276.122,90	-Rp 437.130.833,50
Discounted Cash Flow	-Rp 1.424.274.656,07	Rp 73.468.633,85	Rp 66.605.566,74	Rp 61.250.926,01	Rp 56.288.530,02	Rp 51.690.954,02	Rp 47.432.641,59	Rp 43.489.779,28	Rp 39.840.179,60	Rp 36.463.171,79	Rp 33.339.499,86	Rp 30.451.227,38	Rp 27.781.648,68	Rp 25.315.205,89	-Rp 158.436.330,66

16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Rp 72.080.350,72	Rp 73.882.359,49	Rp 75.729.418,48	Rp 77.622.653,94	Rp 79.563.220,29	Rp 81.552.300,80	Rp 83.591.108,32	Rp 85.680.886,03	Rp 87.822.908,18	Rp 90.018.480,88	Rp 92.268.942,90	Rp 94.575.666,47	Rp 96.940.058,14	Rp 99.363.559,59	Rp 47.370.850,21
-Rp 72.080.350,72	-Rp 73.882.359,49	-Rp 75.729.418,48	-Rp 77.622.653,94	-Rp 79.563.220,29	-Rp 81.552.300,80	-Rp 83.591.108,32	-Rp 85.680.886,03	-Rp 87.822.908,18	-Rp 90.018.480,88	-Rp 92.268.942,90	-Rp 94.575.666,47	-Rp 96.940.058,14	-Rp 99.363.559,59	-Rp 47.370.850,21
Rp 134.992.768,00	Rp 134.992.768,00	Rp 134.992.768,00	Rp 134.992.768,00	Rp 134.992.768,00	Rp 134.992.768,00	Rp 134.992.768,00	Rp 134.992.768,00	Rp 134.992.768,00	Rp 134.992.768,00	Rp 134.992.768,00	Rp 134.992.768,00	Rp 134.992.768,00	Rp 134.992.768,00	Rp 134.992.768,00
-Rp 1.109.529,60	-Rp 1.109.529,60	-Rp 1.109.529,60	-Rp 1.109.529,60	-Rp 1.109.529,60	-Rp 1.109.529,60	-Rp 1.109.529,60	-Rp 1.109.529,60	-Rp 1.109.529,60	-Rp 1.109.529,60	-Rp 1.109.529,60	-Rp 1.109.529,60	-Rp 1.109.529,60	-Rp 1.109.529,60	-Rp 1.109.529,60
Rp 61.802.887,68	Rp 60.000.878,91	Rp 58.153.819,92	Rp 56.260.584,46	Rp 54.320.018,11	Rp 52.330.937,60	Rp 50.292.130,08	Rp 48.202.352,37	Rp 46.060.330,22	Rp 43.864.757,52	Rp 41.614.295,50	Rp 39.307.571,93	Rp 36.943.180,26	Rp 34.519.678,81	Rp 86.512.388,19
Rp -	Rp -	Rp -	Rp -	Rp -	Rp -	Rp -	Rp -	Rp -	Rp -	Rp -	Rp -	Rp -	Rp -	Rp -
Rp 61.802.887,68	Rp 60.000.878,91	Rp 58.153.819,92	Rp 56.260.584,46	Rp 54.320.018,11	Rp 52.330.937,60	Rp 50.292.130,08	Rp 48.202.352,37	Rp 46.060.330,22	Rp 43.864.757,52	Rp 41.614.295,50	Rp 39.307.571,93	Rp 36.943.180,26	Rp 34.519.678,81	Rp 86.512.388,19
Rp 16,00	Rp 17,00	Rp 18,00	Rp 19,00	Rp 20,00	Rp 21,00	Rp 22,00	Rp 23,00	Rp 24,00	Rp 25,00	Rp 26,00	Rp 27,00	Rp 28,00	Rp 29,00	Rp 30,00
Rp 61.802.887,68	Rp 60.000.878,91	Rp 58.153.819,92	Rp 56.260.584,46	Rp 54.320.018,11	Rp 52.330.937,60	Rp 50.292.130,08	Rp 48.202.352,37	Rp 46.060.330,22	Rp 43.864.757,52	Rp 41.614.295,50	Rp 39.307.571,93	Rp 36.943.180,26	Rp 34.519.678,81	Rp 86.512.388,19
Rp 20.934.776,30	Rp 18.994.741,67	Rp 17.205.616,91	Rp 15.556.520,42	Rp 14.037.324,91	Rp 12.638.606,27	Rp 11.351.595,86	Rp 10.168.136,00	Rp 9.080.638,42	Rp 8.082.045,50	Rp 7.165.794,13	Rp 6.325.781,99	Rp 5.556.336,05	Rp 4.852.183,24	Rp 11.364.883,03

NPV	**-Rp 873.096.504,22**	
IRR	**-1,140%**	
Payback Period	**22,28**	**years**