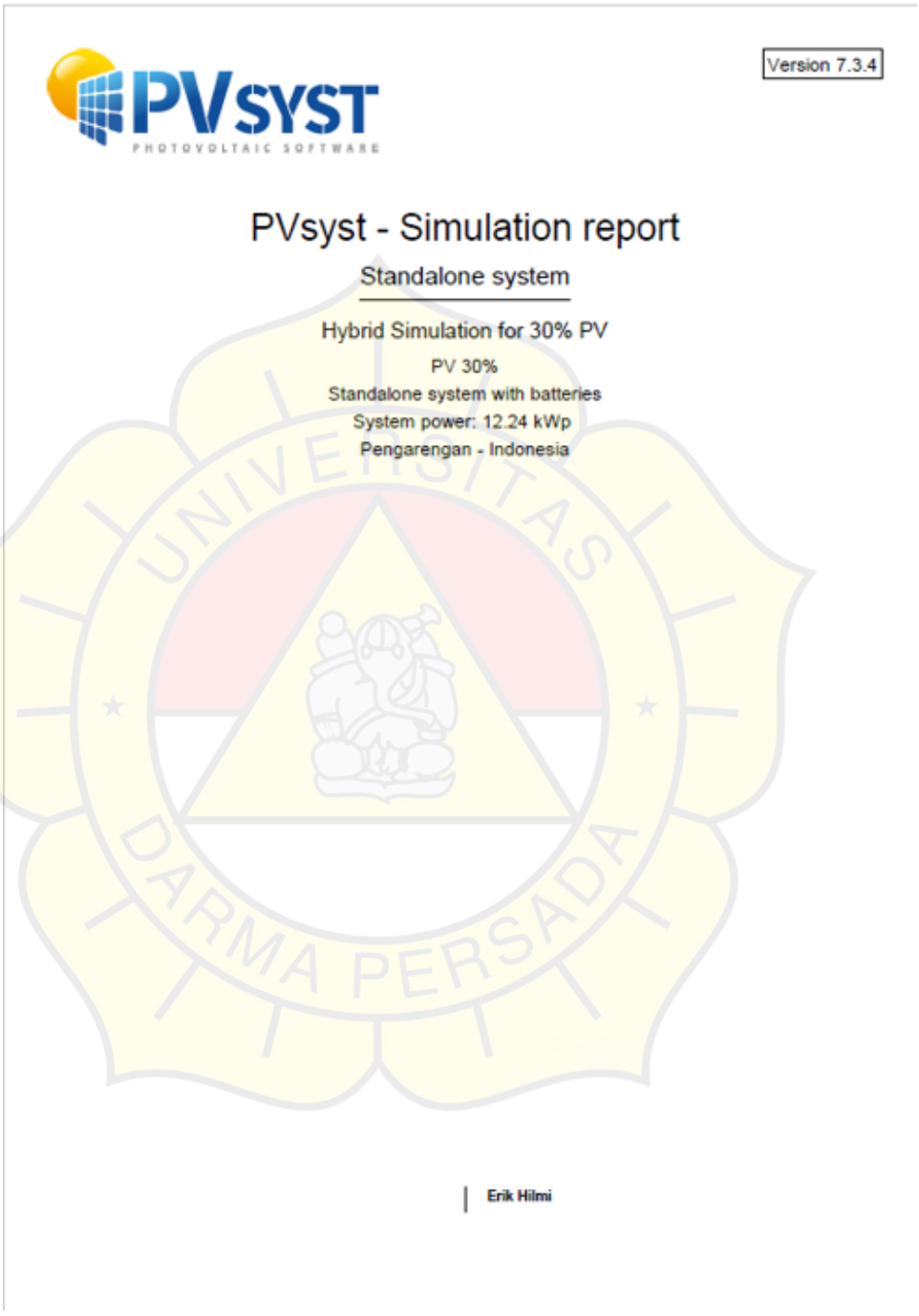
LAMPIRAN

Lampiran 1. Data PVSys



Version 7.3.4

PVSYST
PHOTOVOLTAIC SOFTWARE

PVsyst - Simulation report

Standalone system

Hybrid Simulation for 30% PV

PV 30%

Standalone system with batteries

System power: 12.24 kWp

Pengarengan - Indonesia

Erik Hilmi

Project: Hybrid Simulation On-Grid

Variant: PV 20%

PVsyst V7.3.4
VC1, Simulation date:
10/17/24 10:09
with v7.3.4

Project summary

Geographical Site
Pengarengan
Indonesia

Situation

Latitude	-6.19 °S
Longitude	106.93 °E
Altitude	8 m
Time zone	UTC+7

Project settings

Albedo	0.20

Meteo data
Pengarengan
Meteonorm 8.1 (2016-2021), Sat=100% - Synthetic

System summary

Standalone system

Standalone system with batteries

PV Field Orientation
Fixed plane
Tilt/Azimuth 25 / 0 °

User's needs
Daily household consumers
Constant over the year
Average 33.5 kWh/Day

System information

PV Array

Nb. of modules	48 units
Pnom total	12.24 kWp

Battery pack

Technology	Lead-acid, sealed, Gel
Nb. of units	24 units
Voltage	24 V
Capacity	1816 Ah

Results summary

Useful energy from solar	1738.89 kWh/year	Specific production	959 kWh/kWp/year	Perf. Ratio PR	54.75 %
Missing Energy	481.31 kWh/year	Available solar energy	17099.00 kWh/year	Solar Fraction SF	96.06 %
Excess (unused)	4726.96 kWh/year				

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General parameters

Standalone system — **Standalone system with batteries**

PV Field Orientation
Orientation
Fixed plane
Tilt/Azimuth 25 / 0 °

Sheds configuration
No 3D scene defined

Models used
Transposition Hay
Diffuse Perez, Meteonorm
Circumsolar separate

User's needs
Daily household consumers
Constant over the year
Average 33.5 kWh/Day

PV Array Characteristics

PV module
Manufacturer Topsun
Model TS-S255
(Original PVsyst database)
Unit Nom. Power 255 Wp
Number of PV modules 48 units
Nominal (STC) 12.24 kWp
Modules 48 Strings x 1 In series
At operating cond. (50°C)
Pmpp 10.86 kWp
U mpp 27 V
I mpp 400 A

Battery
Manufacturer Sonnenschein
Model A602 / 1130 Solar
Technology Lead-acid, sealed, Gel
No. of units 2 in parallel x 12 in series
Discharging min. SOC 20.0 %
Stored energy 34.9 kWh
Battery Pack Characteristics
Voltage 24 V
Nominal Capacity 1816 Ah (C10)
Temperature Fixed 20 °C

Controller
Universal controller
Technology MPPT converter
Temp coeff. -5.0 mV/°C/Elem.
Converter
Maxi and EURO efficiencies 97.0 / 95.0 %

Battery Management control
Threshold commands as SOC calculation
Charging SOC = 0.90 / 0.75
approx. 27.7 / 25.1 V
Discharging SOC = 0.20 / 0.45
approx. 23.5 / 24.4 V

Total PV power
Nominal (STC) 12 kWp
Total 48 modules
Module area 77.8 m²
Cell area 68.9 m²

Array losses

Thermal Loss factor
Module temperature according to irradiance
Uc (const) 20.0 W/m²K
Uv (wind) 0.0 W/m²K/m/s

DC wiring losses
Global array res. 1.1 mΩ
Loss Fraction 1.5 % at STC

Serie Diode Loss
Voltage drop 0.7 V
Loss Fraction 2.3 % at STC

Module Quality Loss
Loss Fraction -0.8 %

Module mismatch losses
Loss Fraction 0.0 % at MPP

Strings Mismatch loss
Loss Fraction 0.2 %

IAM loss factor
ASHRAE Param.: IAM = 1 - bo (1/cosi -1)
bo Param. 0.05

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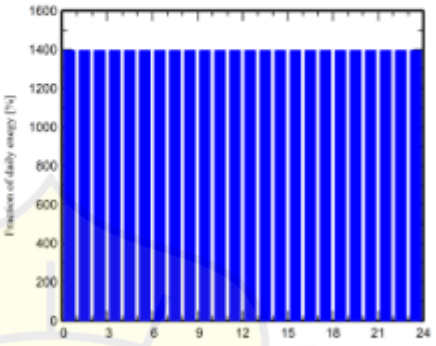
Detailed User's needs

Daily household consumers, Constant over the year, average = 33.5 kWh/day

Annual values

	Nb.	Power	Use	Energy
		W	Hour/day	Wh/day
Beban 30%	1	1395 tot	24.0	33480
Total daily energy				33480

Hourly distribution



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Variant: PV 20%

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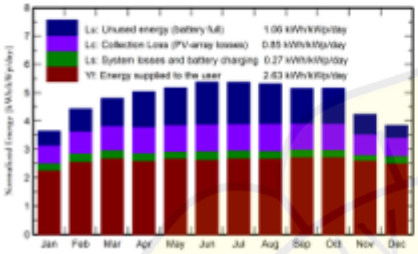
Main results

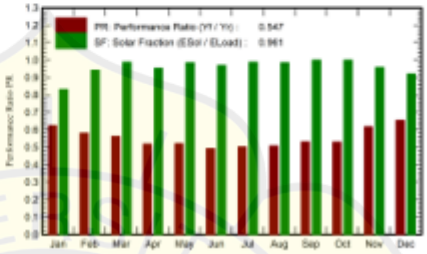
System Production

Useful energy from solar	11738.89 kWh/year	Perf. Ratio PR	54.75 %
Available solar energy	17099.00 kWh/year	Solar Fraction SF	96.06 %
Excess (unused)	4726.96 kWh/year		
Loss of Load		**Battery aging (State of Wear)**	
Time Fraction	3.9 %	Cycles SOW	90.2 %
Missing Energy	481.31 kWh/year	Static SOW	90.0 %

Normalized productions (per installed kWp)



Performance Ratio PR



Balances and main results

	GlobHor kWh/m²	GlobEff kWh/m²	E_Avail kWh	EUnused kWh	E_Miss kWh	E_User kWh	E_Load kWh	SolFrac ratio
January	135.4	108.5	1095	187.2	173.8	864	1038	0.833
February	139.0	119.8	1215	271.0	53.7	884	937	0.943
March	156.1	144.3	1445	363.3	11.6	1026	1038	0.989
April	147.4	147.2	1469	455.2	46.6	958	1004	0.954
May	148.0	156.9	1566	497.1	15.1	1023	1038	0.985
June	143.3	158.1	1581	542.4	30.9	973	1004	0.969
July	150.9	162.9	1639	553.4	11.9	1026	1038	0.989
August	157.6	161.1	1607	530.0	14.1	1024	1038	0.986
September	158.2	150.2	1508	448.6	0.0	1004	1004	1.000
October	174.8	154.9	1564	469.9	0.0	1038	1038	1.000
November	146.1	122.1	1244	251.6	42.0	962	1004	0.958
December	140.5	114.2	1166	157.4	81.8	956	1038	0.921
Year	1797.2	1700.2	17099	4727.0	481.3	11739	12220	0.961

Legends

GlobHor	Global horizontal irradiation	E_User	Energy supplied to the user
GlobEff	Effective Global, corr. for IAM and shadings	E_Load	Energy need of the user (Load)
E_Avail	Available Solar Energy	SolFrac	Solar fraction (EUsed / ELoad)
EUnused	Unused energy (battery full)		
E_Miss	Missing energy		

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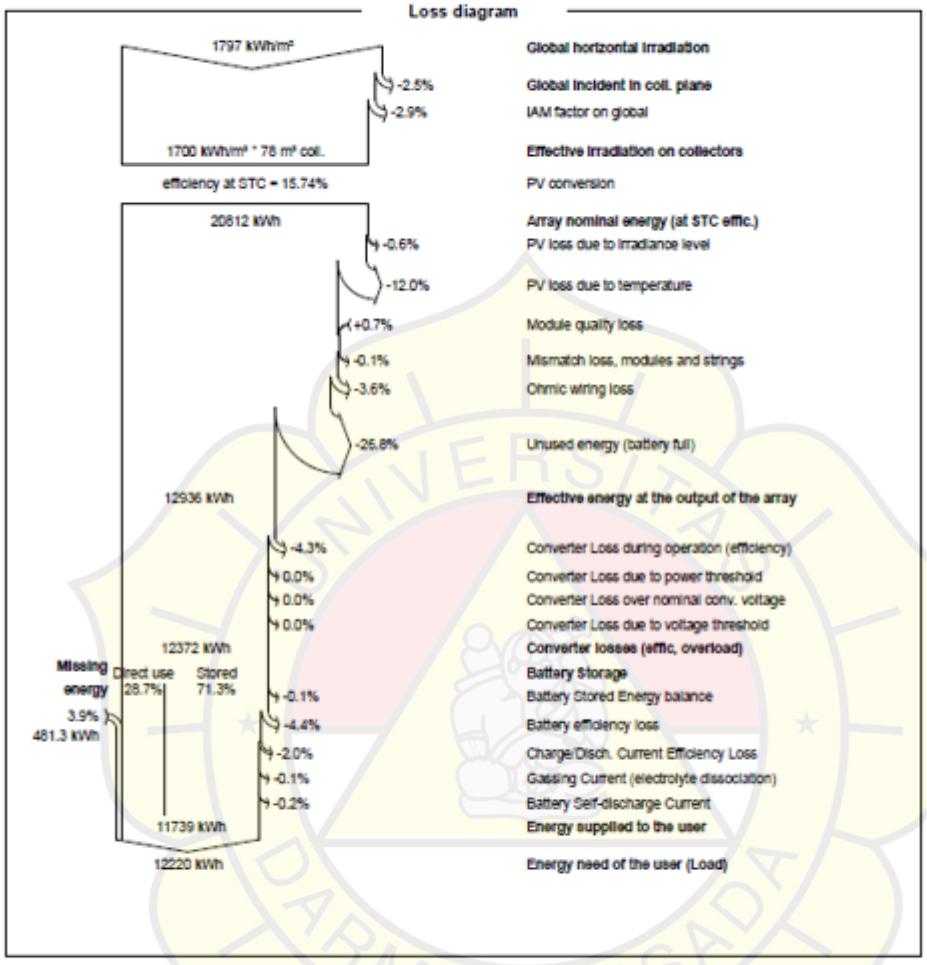
Loss diagram



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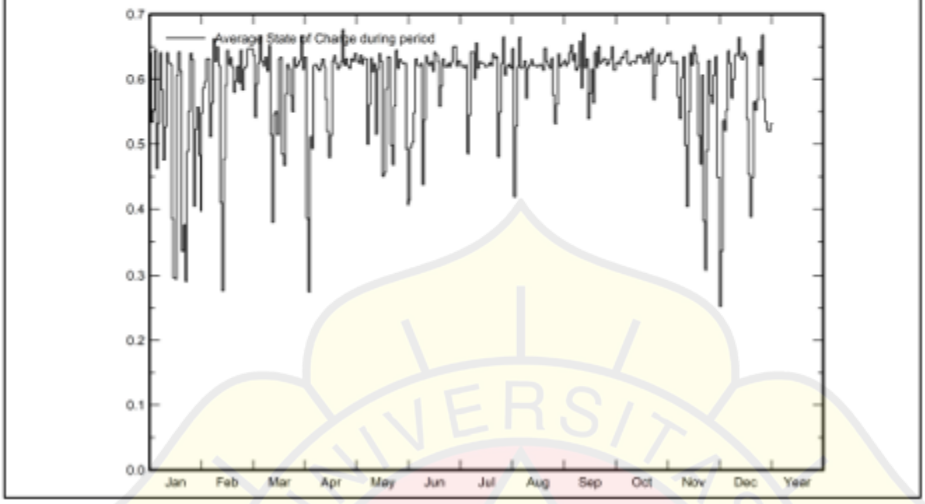
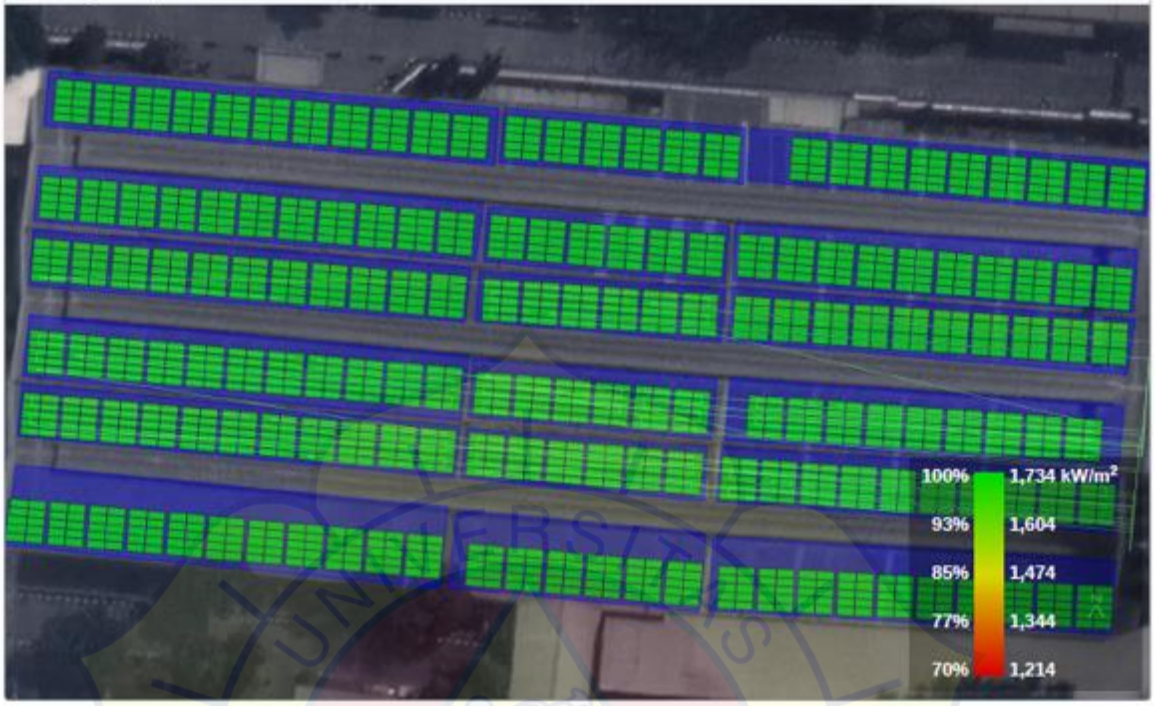
Predef. graphs

State of charge daily distribution



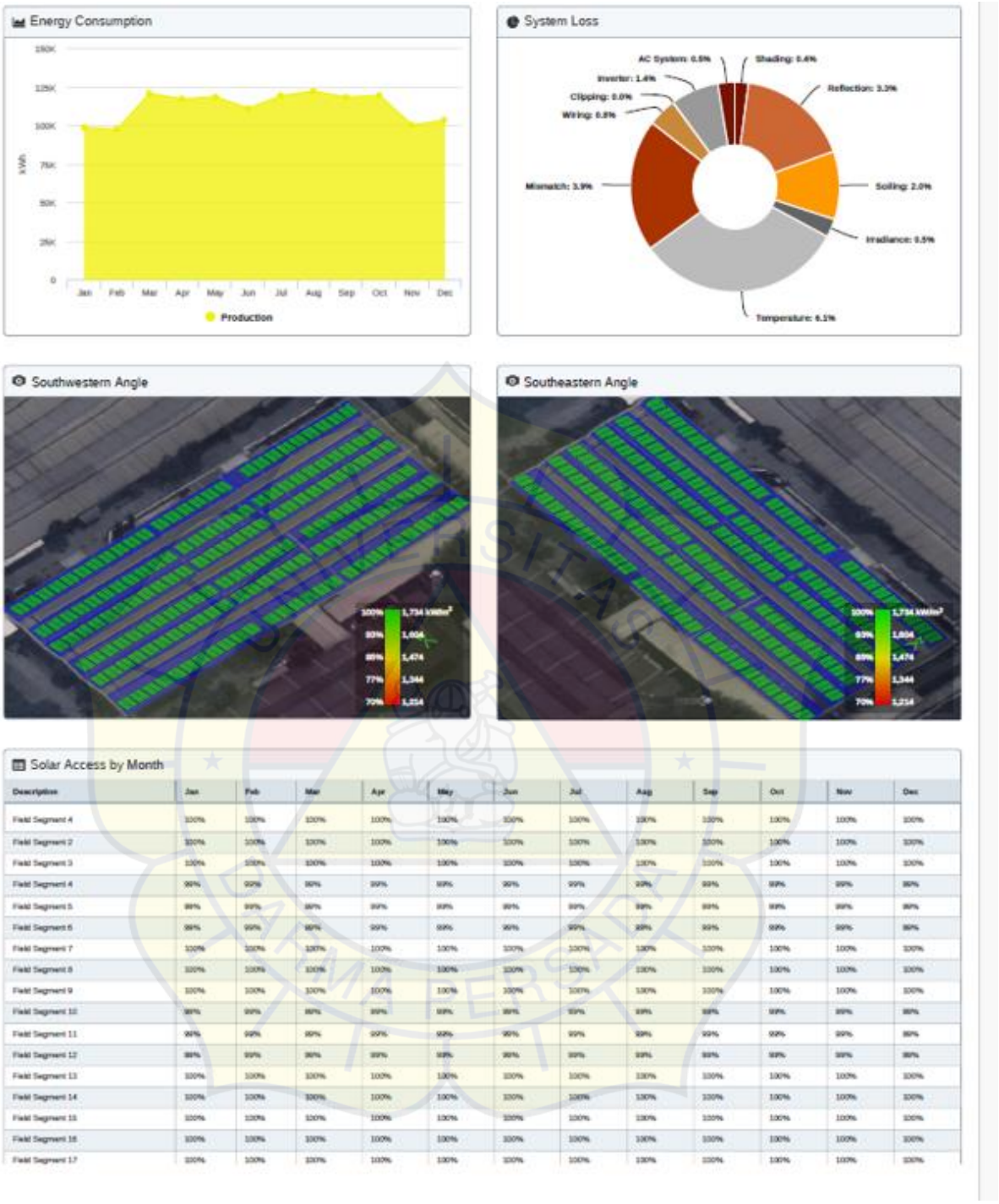
Lampiran 2. Data Helioscope

Shading Heatmap

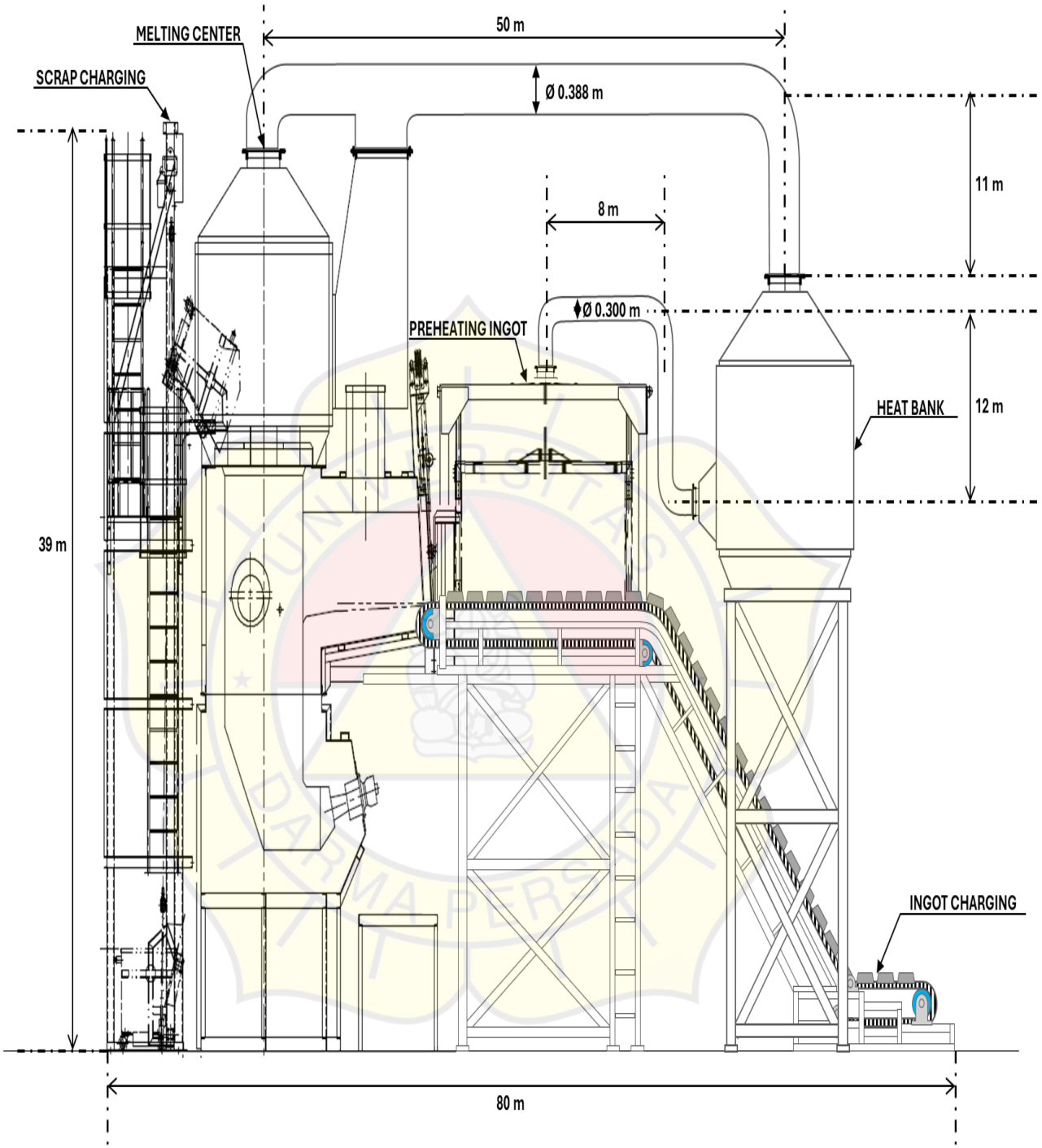


Shading by Field Segment

Description	Tilt	Azimuth	Modules	Nameplate	Shaded Irradiance	AC Energy	TOF[2]	Solar Access	Min TSRF[2]	Avg TSRF[2]
Field Segment 2	Module: 10°	Module: 5°	60	35.40 kWp	1,730.2 kWh/m²	60.07 MWh	100.0%	99.8%	99.4%	99.8%
Field Segment 3	Module: 10°	Module: 5°	110	64.90 kWp	1,730.0 kWh/m²	92.87 MWh	100.0%	99.8%	99.4%	99.8%
Field Segment 4	Module: 9°	Module: 3°	100	59.00 kWp	1,729.6 kWh/m²	84.69 MWh	100.0%	99.8%	99.3%	99.8%
Field Segment 4	Module: 10°	Module: 4°	100	59.00 kWp	1,722.2 kWh/m²	83.41 MWh	100.0%	99.2%	98.2%	99.2%
Field Segment 5	Module: 10°	Module: 5°	60	35.40 kWp	1,718.2 kWh/m²	60.64 MWh	100.0%	99.1%	97.7%	99.1%
Field Segment 6	Module: 10°	Module: 5°	110	64.90 kWp	1,719.4 kWh/m²	92.28 MWh	100.0%	99.2%	97.7%	99.2%
Field Segment 7	Module: 10°	Module: 5°	110	64.90 kWp	1,729.2 kWh/m²	92.86 MWh	100.0%	99.7%	99.2%	99.7%
Field Segment 8	Module: 10°	Module: 5°	60	35.40 kWp	1,729.2 kWh/m²	61.01 MWh	100.0%	99.7%	99.2%	99.7%
Field Segment 9	Module: 10°	Module: 4°	90	53.10 kWp	1,729.1 kWh/m²	76.94 MWh	100.0%	99.7%	99.2%	99.7%
Field Segment 10	Module: 10°	Module: 4°	100	59.00 kWp	1,715.6 kWh/m²	83.76 MWh	100.0%	99.0%	96.7%	99.0%
Field Segment 11	Module: 10°	Module: 4°	60	35.40 kWp	1,718.9 kWh/m²	60.30 MWh	100.0%	99.2%	97.6%	99.2%
Field Segment 12	Module: 10°	Module: 5°	110	64.90 kWp	1,720.4 kWh/m²	92.37 MWh	100.0%	99.2%	97.9%	99.2%
Field Segment 13	Module: 10°	Module: 5°	110	64.90 kWp	1,729.4 kWh/m²	93.00 MWh	100.0%	99.8%	99.2%	99.8%
Field Segment 14	Module: 10°	Module: 5°	60	35.40 kWp	1,729.6 kWh/m²	60.74 MWh	100.0%	99.8%	99.2%	99.8%
Field Segment 15	Module: 10°	Module: 5°	100	59.00 kWp	1,729.7 kWh/m²	84.67 MWh	100.0%	99.8%	99.2%	99.8%
Field Segment 16	Module: 10°	Module: 5°	110	64.90 kWp	1,733.6 kWh/m²	92.99 MWh	100.0%	100.0%	100.0%	100.0%
Field Segment 17	Module: 10°	Module: 5°	60	35.40 kWp	1,733.6 kWh/m²	60.84 MWh	100.0%	100.0%	100.0%	100.0%
Field Segment 18	Module: 10°	Module: 5°	90	53.10 kWp	1,733.6 kWh/m²	76.07 MWh	100.0%	100.0%	100.0%	100.0%


Energy Consumption
kWh
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Production
System Loss
AC System: 0.5%
Shading: 0.4%
Inverter: 1.4%
Reflection: 3.3%
Clipping: 0.0%
Wiring: 0.8%
Mismatch: 3.9%
Soiling: 2.0%
Irradiance: 0.5%
Temperature: 6.1%
Southwestern Angle
Southeastern Angle
Solar Access by Month
Description
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Field Segment 4
Field Segment 2
Field Segment 3
Field Segment 4
Field Segment 5
Field Segment 6
Field Segment 7
Field Segment 8
Field Segment 9
Field Segment 10
Field Segment 11
Field Segment 12
Field Segment 13
Field Segment 14
Field Segment 15
Field Segment 16
Field Segment 17

Lampiran 3. Gambar struktur WHR



Lampiran 4. Gambar Struktur Solar Panel