LAMPIRAN

Lampiran 1. Data Penelitian

1. Kamis, 20 Maret 2025

No	Waktu	*Monocrystalline*			*Polycrystalline*			Intensitas Cahaya (Lux)	Intensitas Cahaya (W/m^2)	Sudut Kemiringan (Derajat)
		Tegangan (Volt)	Arus (Ampere)	Temperature (Celsius)	Tegangan (Volt)	Arus (Ampere)	Temperature (Celsius)			
1	11.06	13.64	3.26	38.1	15.26	2.7	33.5	111500	921.4876033	10
2	11.11	13.71	3.21	39.4	14.97	2.46	32.7	110700	914.8760331	10
3	11.16	13.76	3.11	38.7	14.59	2.31	32	106000	876.0330579	10
4	11.21	13.41	1.49	35.4	14.84	2.96	36.2	51500	425.6198347	10
5	11.26	13.99	3.38	36.7	14.11	2.6	35.8	121000	1000	10
6	11.31	13.81	2.49	37.3	13.09	1.43	37.4	87200	720.661157	10
7	11.36	13.32	1.14	36.6	13.76	2.3	37.8	40400	333.8842975	10
8	11.41	14.31	3.37	36.4	14.33	3.23	35.4	115200	952.0661157	10
9	11.46	13.61	3.18	38.6	14.2	3.1	33.1	104000	859.5041322	10
10	11.51	14.2	2.67	39.1	13.53	2.07	34.3	91000	752.0661157	10
11	11.56	14.3	3.31	37.8	13.83	2.62	34.3	114500	946.2809917	10
12	12.01	13.67	1.26	35.3	13.97	2.99	36.1	47800	395.0413223	10
13	12.06	13.43	0.84	34.8	13.55	2.18	37.1	30400	251.2396694	10
14	12.11	13.5	0.87	38.7	13.58	2.19	37	31600	261.1570248	10
15	12.16	14.06	1.54	38.8	13.69	2.43	37.3	55200	456.1983471	10
16	12.21	13.85	1.24	36.8	13.27	1.5	39.1	44000	363.6363636	10
17	12.26	13.62	1.09	39.8	13.2	1.29	39.1	38000	314.0495868	10
18	12.31	13.67	0.78	34	14.22	3.29	38.9	29400	242.9752066	10
19	12.36	14.36	2.46	37.2	14.26	3.32	35.5	85000	702.4793388	10
20	12.41	16.13	2.15	40.4	14.27	3.24	36.3	57700	476.8595041	10
21	12.46	15.1	3.31	39.6	13.86	1.89	36.6	111500	921.4876033	10
22	12.51	15.16	2.93	38.6	14.43	3.12	36.5	103400	854.5454545	10

23	12.56	14.95	2.63	38.9	13.28	0.87	36.3	90000	743.8016529	10
24	13.01	15.97	2.93	36	13.14	0.6	38.9	101200	836.3636364	10

2. Kamis, 10 April 2025

No	Waktu	*Monocrystalline*			*Polycrystalline*			Intensitas Cahaya (Lux)	Intensitas Cahaya (W/m^2)	Sudut Kemiringan (Derajat)
		Tegangan (Volt)	Arus (Ampere)	Temperature (Celsius)	Tegangan (Volt)	Arus (Ampere)	Temperature (Celsius)			
1	11.06	17.84	2.65	37.7	15.26	2.7	39	117200	968.5950413	10
2	11.11	17.14	2.73	38.2	14.97	2.46	38.3	99400	821.4876033	10
3	11.16	17.58	2.73	37	14.59	2.31	39.8	109500	904.9586777	10
4	11.21	13.23	3.52	39.7	14.84	2.96	35.8	120500	995.8677686	10
5	11.26	14.1	3.33	38.3	14.11	2.6	37	102000	842.9752066	10
6	11.31	14.23	2.12	33.9	13.09	1.43	42	60200	497.5206612	10
7	11.36	15.33	3.14	36.1	13.76	2.3	40.5	96700	799.1735537	10
8	11.41	14.31	3.2	37.8	14.33	3.23	41.6	127200	1051.239669	10
9	11.46	14.03	3.06	37.4	14.2	3.1	41.2	128000	1057.85124	10
10	11.51	14.75	2.84	35.9	13.53	2.07	41.5	86700	716.5289256	10
11	11.56	14.45	3.31	38.3	13.83	2.62	37.1	104600	864.4628099	10
12	12.01	13.91	3.54	39.1	13.97	2.99	36.6	118900	982.6446281	10
13	12.06	14.96	2.98	37	13.55	2.18	36.3	90000	743.8016529	10
14	12.11	15	2.99	38.4	13.58	2.19	38	90300	746.2809917	10
15	12.16	13.3	3.24	37.4	13.69	2.43	39.9	97400	804.9586777	10
16	12.21	14.37	2.26	37.1	13.27	1.5	41.4	66700	551.2396694	10
17	12.26	14.09	1.92	36.4	13.2	1.29	42.5	56200	464.4628099	10
18	12.31	13.46	3.21	37.7	14.22	3.29	38.7	122700	1014.049587	10
19	12.36	13.46	3.23	38.5	14.26	3.32	36.5	129300	1068.595041	10

20	12.41	13.4	3.15	39.5	14.27	3.24	39.5	131400	1085.950413	10
21	12.46	13.41	3.17	40.7	13.86	1.89	38.1	102500	847.107438	10
22	12.51	13.4	3.01	39.1	14.43	3.12	38.2	124400	1028.099174	10
23	12.56	13.86	1.41	34.4	13.28	0.87	41.4	38400	317.3553719	10
24	13.01	13.31	0.95	35.3	13.14	0.6	41.6	28000	231.4049587	10

3. Jumat, 11 April 2025

No	Waktu	*Monocrystalline*			*Polycrystalline*			Intensitas Cahaya (Lux)	Intensitas Cahaya (W/m^2)	Sudut Kemiringan (Derajat)
		Tegangan (Volt)	Arus (Ampere)	Temperature (Celsius)	Tegangan (Volt)	Arus (Ampere)	Temperature (Celsius)			
1	11.06	15.08	2.47	37.8	15.23	2.17	34.9	117200	968.5950413	10
2	11.11	16.87	2.49	38.7	15.63	2.28	31.9	99400	821.4876033	10
3	11.16	16.81	2.51	39.1	15.58	2.21	32.8	109500	904.9586777	10
4	11.21	15.29	2.75	40.6	16.07	2.39	33	120500	995.8677686	10
5	11.26	14.42	2.53	44.7	15.39	2.17	46.5	102000	842.9752066	10
6	11.31	14.6	2.19	37.5	15.35	1.09	36.7	60200	497.5206612	10
7	11.36	15.02	2.21	41.9	15.7	2.33	34.7	96700	799.1735537	10
8	11.41	15.99	2.87	38.7	15.96	2.41	35.8	127200	1051.239669	10
9	11.46	15.38	2.91	40.1	15.74	2.5	37.5	128000	1057.85124	10
10	11.51	14.88	3.11	43.1	16.05	2.46	43.7	86700	716.5289256	10
11	11.56	14.97	2.7	39.5	15.75	2.23	39.7	104600	864.4628099	10
12	12.01	13.07	3.31	40.2	15.96	2.62	38.2	118900	982.6446281	10
13	12.06	13.79	3.22	40	16.21	2.65	38.8	90000	743.8016529	10
14	12.11	12.97	3.26	39.1	16.51	2.55	38.9	90300	746.2809917	10
15	12.16	15.24	1.24	36.4	14.49	1.15	42.8	97400	804.9586777	10
16	12.21	14.26	1.12	34.8	14.31	0.98	32.8	66700	551.2396694	10
17	12.26	13.9	1.34	34.7	14.01	1.24	33.3	56200	464.4628099	10

18	12.31	13.99	0.78	34	14.02	0.73	32.1	122700	1014.049587	10
19	12.36	13.09	3.62	49.3	13.39	2.78	41.1	129300	1068.595041	10
20	12.41	15.28	3.22	50.2	13.18	2.42	50.8	131400	1085.950413	10
21	12.46	13.36	3.26	46.7	16.4	2.78	41.5	102500	847.107438	10
22	12.51	13.46	3.49	47.6	13.32	2.7	41.9	124400	1028.099174	10
23	12.56	13.29	3.04	44.5	13.35	2.76	45.5	38400	317.3553719	10
24	13.01	13.3	3.18	44.2	13.35	2.69	42.3	28000	231.4049587	10

Lampiran 2. Rata-rata daya *Input* dan *Output*

Waktu	*Monocrystalline*		*Polycrystalline*		Sudut (Derajat)
	Daya *Input* (Watt)	Daya *Output* (Watt)	Daya *Input* (Watt)	Daya *Output* (Watt)	
11.06	310.5252893	42.99666667	228.7376309	38.09616667	10
11.11	297.367438	44.2692	294.9919559	37.381	10
11.16	301.168595	44.3267	345.2253444	35.56276667	10
11.21	266.8607163	36.19933333	249.9266116	33.48976667	10
11.26	302.2407163	43.57393333	361.1429201	36.76746667	10
11.31	215.6912948	32.17616667	291.9944904	21.6294	10
11.36	219.1025895	32.17173333	335.6127824	27.14783333	10
11.41	340.5446832	46.636	329.3077686	42.57323333	10
11.46	325.5349862	43.6558	319.385124	40.5846	10
11.51	278.1667218	42.02693333	324.553168	33.8779	10
11.56	306.0418733	45.19383333	232.3552617	37.65023333	10
12.01	275.3402204	36.57576667	242.587989	32.7949	10
12.06	228.7516804	33.42193333	145.6354821	27.3945	10
12.11	235.6717355	32.95906667	205.6881543	27.32436667	10
12.16	193.9564738	27.88066667	332.9253994	23.0278	10
12.21	144.5414325	21.8738	245.3787328	16.4576	10

12.26	137.3289807	20.17486667	242.1745455	15.7893	10
12.31	174.5608264	21.5938	345.4320661	22.59713333	10
12.36	316.4706887	42.0624	283.0020937	38.4558	10
12.41	275.3402204	42.03036667	291.9944904	35.0633	10
12.46	313.936584	45.3481	320.5220937	38.51083333	10
12.51	325.7299174	43.9094	315.3540496	39.60126667	10
12.56	231.3832507	33.08756667	153.2841873	27.2512	10
13.01	228.3618182	33.9102	185.1193388	26.84326667	10

Lampiran 3. Rata-rata temperartur

Waktu	*Monocrystalline* (Celsius)	*Polycrystalline* (Celsius)
11.06	37.86666667	35.8
11.11	38.76666667	34.3
11.16	38.26666667	34.86666667
11.21	38.56666667	35
11.26	39.9	39.76666667
11.31	36.23333333	38.7
11.36	38.2	37.66666667
11.41	37.63333333	37.6
11.46	38.7	37.26666667
11.51	39.36666667	39.83333333
11.56	38.53333333	37.03333333
12.01	38.2	36.96666667
12.06	37.26666667	37.4
12.11	38.73333333	37.96666667
12.16	37.53333333	40
12.21	36.23333333	37.76666667
12.26	36.96666667	38.3
12.31	35.23333333	36.56666667
12.36	41.66666667	37.7
12.41	43.36666667	42.2
12.46	42.33333333	38.73333333
12.51	41.76666667	38.86666667
12.56	39.26666667	41.06666667
13.01	38.5	40.93333333

Lampiran 4. Efisiensi

Waktu	*Monocrystalline* (%)	*Polycrystalline* (%)
11.06	13.84642995	16.65496251
11.11	14.88703682	12.67187096
11.16	14.71823448	10.30131978
11.21	13.56487903	13.39984024
11.26	14.41696336	10.1808632
11.31	14.91769369	7.407468536
11.36	14.68341082	8.089034375
11.41	13.69453182	12.92809869
11.46	13.4104787	12.70710404
11.51	15.10854105	10.43832054
11.56	14.76720582	16.20373606
12.01	13.28384448	13.51876494
12.06	14.61057391	18.81031985
12.11	13.98515889	13.28436573
12.16	14.3747028	6.916804797
12.21	15.1332387	6.707019721
12.26	14.6909025	6.519801646
12.31	12.37035848	6.541701119
12.36	13.29108872	13.58852138
12.41	15.26488452	12.00820603
12.46	14.4449874	12.01503238
12.51	13.48030919	12.55771623
12.56	14.29989706	17.77821997
13.01	14.84933001	14.50051995

Lampiran 5. Uji Statistik *Monocrystalline*

1. Uji Normalitas data

Nilai Residual Data

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	13.6695	15.1501	14.3278	.39471	72
Residual	-2.79655	5.65059	.00000	1.66435	72
Std. Predicted Value	-1.668	2.083	.000	1.000	72
Std. Residual	-1.656	3.347	.000	.986	72

a. Dependent Variable: EFESIENSI

Uji Normalitas Kolmogorov-Smirnov

One-Sample Kolmogorov-Smirnov Test

		Unstandardized Residual
N		72
Normal Parameters[a,b]	Mean	.0000000
	Std. Deviation	1.66435382
Most Extreme Differences	Absolute	.078
	Positive	.078
	Negative	-.046
Test Statistic		.078
Asymp. Sig. (2-tailed)		.200[c,d]

a. Test distribution is Normal.

b. Calculated from data.

c. Lilliefors Significance Correction.

d. This is a lower bound of the true significance.

2. Uji Linieritas

Uji linieritas intensitas radiasi dengan efisiensi

ANOVA Table

			Sum of Squares	df	Mean Square	F	Sig.
EFESIENSI * RADIASI	Between Groups	(Combined)	204.035	68	3.001	2.432	.255
		Linearity	7.285	1	7.285	5.905	.093
		Deviation from Linearity	196.750	67	2.937	2.380	.261
	Within Groups		3.701	3	1.234		
	Total		207.737	71			

Uji linieritas temperatur permukaan dengan efisiensi

ANOVA Table

			Sum of Squares	df	Mean Square	F	Sig.
EFESIENSI * TEMPERATUR	Between Groups	(Combined)	161.577	51	3.168	1.373	.221
		Linearity	.363	1	.363	.157	.696
		Deviation from Linearity	161.215	50	3.224	1.397	.209
	Within Groups		46.159	20	2.308		
	Total		207.737	71			

3. Uji Autokorelasi

Uji Autokorelasi Durbin-Watson

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.231[a]	.053	.026	1.68830	1.339

a. Predictors: (Constant), TEMPERATUR, RADIASI

b. Dependent Variable: EFESIENSI

4. Uji Heterogenesitas

Uji Glejser

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	2.546	1.439		1.768	.081
	RADIASI	-.003	.002	-.225	-1.740	.086
	TEMPERATUR	-.015	.040	-.047	-.362	.719

a. Dependent Variable: ABS_RESS

5. Uji Multokolinearitas

Uji VIF

Coefficients[a]

Model		Collinearity Statistics Tolerance	Collinearity Statistics VIF
1	RADIASI	.817	1.224
	TEMPERATUR	.817	1.224

a. Dependent Variable: EFESIENSI

6. Uji Regresi Linier Berganda

Uji Koefesien Derteminasi

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.231[a]	.053	.026	1.68830

a. Predictors: (Constant), TEMPERATUR, RADIASI

b. Dependent Variable: EFESIENSI

Uji F

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	11.062	2	5.531	1.940	.151[b]
	Residual	196.675	69	2.850		
	Total	207.737	71			

a. Dependent Variable: EFESIENSI

b. Predictors: (Constant), TEMPERATUR, RADIASI

Uji T

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	12.615	2.395		5.268	.000		
	RADIASI	-.005	.003	-.251	-1.937	.057	.817	1.224
	TEMPERATUR	.077	.067	.149	1.151	.254	.817	1.224

a. Dependent Variable: EFESIENSI

Lampiran 6. Uji Stastistik *Polycrystalline*

1. Uji Normalitas

Uji Normalitas Kolmogorv-Smirnov

One-Sample Kolmogorov-Smirnov Test

		Unstandardized Residual
N		72
Normal Parameters[a,b]	Mean	.0000000
	Std. Deviation	1.05234226
Most Extreme Differences	Absolute	.119
	Positive	.104
	Negative	-.119
Test Statistic		.119
Asymp. Sig. (2-tailed)		.013[c]

a. Test distribution is Normal.

b. Calculated from data.

c. Lilliefors Significance Correction.

2. Uji Mann Whitney dan Kruskal Wallis

Uji Mann Whitney Radiasi Matahari	**Test Statistics[a]** EFESIENSI Mann-Whitney U: 500.000 Wilcoxon W: 1166.000 Z: -1.667 Asymp. Sig. (2-tailed): .096 a. Grouping Variable: Kategori_intensitas
Uji Mann Whitney Temperatur Pemukaan	**Test Statistics[a]** EFESIENSI Mann-Whitney U: 414.000 Wilcoxon W: 1080.000 Z: -2.635 Asymp. Sig. (2-tailed): .008 a. Grouping Variable: Kategori_Temperatur

3. Uji Spearman

Uji Spearman Radiasi Matahari

Correlations

			RADIASI	TEMPERATUR	EFESIENSI
Spearman's rho	RADIASI	Correlation Coefficient	1.000	.013	.207
		Sig. (2-tailed)	.	.916	.081
		N	72	72	72
	TEMPERATUR	Correlation Coefficient	.013	1.000	-.403**
		Sig. (2-tailed)	.916	.	.000
		N	72	72	72
	EFESIENSI	Correlation Coefficient	.207	-.403**	1.000
		Sig. (2-tailed)	.081	.000	.
		N	72	72	72

**. Correlation is significant at the 0.01 level (2-tailed).

4. Uji Karnel

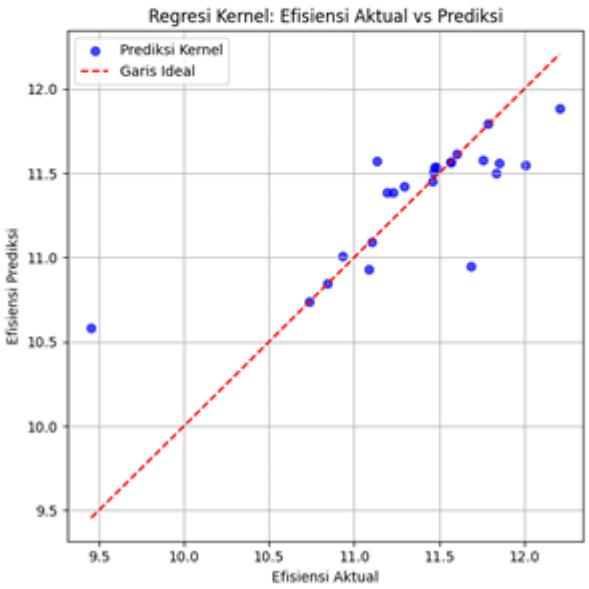
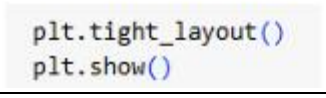
Uji Karnel Kodingan Menghitung Nilai RMSE dan MAE	

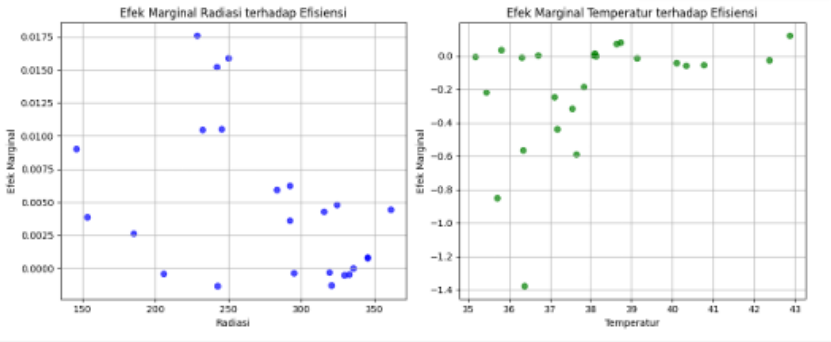
```
[ ] import pandas as pd
    df = pd.read_excel("123.xlsx")
```

```
import pandas as pd
import numpy as np
from statsmodels.nonparametric.kernel_regression import KernelReg
from sklearn.metrics import mean_squared_error, mean_absolute_error
import matplotlib.pyplot as plt

# Unggah file Excel terlebih dahulu melalui sidebar kiri → Files → Upload
df = pd.read_excel("123.xlsx")

X = df[['radiasi', 'temperatur']].to_numpy()
y = df['efesiensi'].to_numpy()

kr = KernelReg(endog=y, exog=X, var_type='cc')
y_pred, marginal_effects = kr.fit(X)

rmse = np.sqrt(mean_squared_error(y, y_pred))
mae = mean_absolute_error(y, y_pred)

print(f"RMSE: {rmse:.3f}")
print(f"MAE: {mae:.3f}")
```

```
rmse = np.sqrt(mean_squared_error(y, y_pred))
mae = mean_absolute_error(y, y_pred)

print(f"RMSE: {rmse:.3f}")
print(f"MAE: {mae:.3f}")
```

```
RMSE: 0.333
MAE: 0.200
```

Uji Karnel Menghitung Sebaran Titik	 
Uji Karnel Kodingan Menghitung Titik Marginal	 

Uji Karnel untuk sebaran titik marginal	

Lampiran 7. Dokumentasi Penelitian

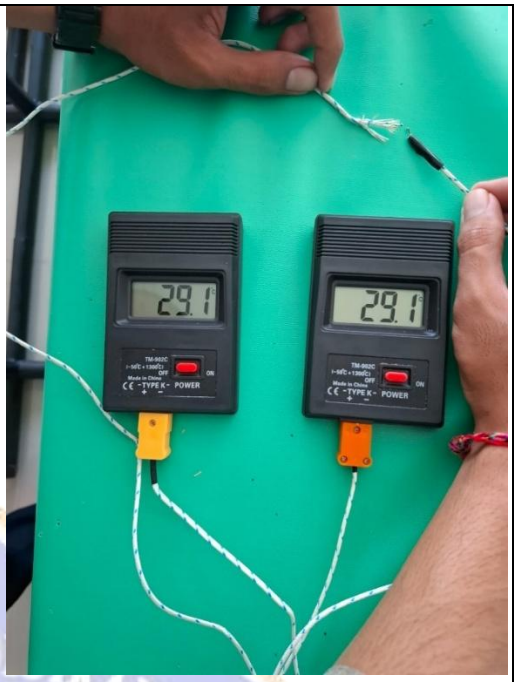
Gambar 1. Kondisi Lingkungan Pengambilan Data

Gambar 2. Kondisi panel Pengambilan data

Gambar 3. Tampilan Lux Meter

Gambar 4. Tampilan Thermokopel Tipe K

Gambar 5. Tampilan Wattmeter



Gambar 6. Kalibrasi thermokopel Tipe K