KEMENTERIAN RISET, TEKNOLOGI, DAN PENDIDIKAN TINGGI
UNIVERSITAS SAM RATULANGI
LEMBAGA PENELITIAN DAN PENGABDIAN KEPADA MASYARAKAT
Alamat : Kampus UNSRAT Manado
Telp. (0431) 827560, Fax. (0431) 827560
Email: lppm@unsrat.ac.id Laman: http://lppm.unsrat.ac.id

Hal: Undangan Manado, 23 November 2020

Kepada Yth:
Bpk. Kunaifi, S.T.,M.Sc.
Dosen Teknik Elektro Fakultas Sains dan Teknologi
UIN Sultan Syarif Kasim Riau
di tempat

Dengan Hormat,

Dalam rangka pelaksanaan Seminar Nasional secara daring yang dilaksanakan oleh Pusat Energi Baru Terbarukan Lembaga Penelitian dan Pengabdian Kepada Masyarakat Universitas Sam Ratulangi, maka dengan ini kami mengundang Bapak untuk dapat menjadi pembicara dalam acara seminar yang akan diselenggarakan pada:

Hari: Senin, 30 November 2020

Jam: 13:00 Wita (jadwal acara terlampir)

Demikianlah undangan ini kami buat, dan atas kesediannya disampaikan terima kasih.

Koordinator Pusat Energi Baru Terbarukan
Universitas Sam Ratulangi

Glanny M.C. Mangindaan,ST.,MT.,Ph.D
NIP197403272002121002

Pusat Energi
Baru Terbarukan
LPPM-UNSRAT

Himpunan Kimia Indonesia
Sulawesi Utara

perhimpunan biologi indonesia
Sulawesi Utara

Sertifikat

Diberikan kepada

Kunaifi, S.T.,M.Sc.

sebagai

Pembicara

Dalam kegiatan Webinar Nasional

"Pemanfaatan Sumberdaya Alam untuk Energi Terbarukan di Indonesia"

kerja sama antara Pusat Energi Baru Terbarukan LPPM Universitas Sam Ratulangi, Himpunan Kimia Indonesia Cabang Sulawesi Utara, dan Perhimpunan Biologi Indonesia Cabang Sulawesi Utara, yang diselenggarakan secara daring pada:

Senin, 30 November 2020

Ketua LPPM Universitas Sam Ratulangi

Prof. Dr. Charles L. Kaunang, MS
NIP. 195910181986031002

Koordinator Pusat Studi Energi Terbarukan

Glanny Mangindaan, ST, MT, Ph.D.
NIP. 197403272002121002

KINERJA PLTS DI INDONESIA

KUNAIFI
Seminar Nasional Universitas Sam Ratulangi Manado
30 November 2020

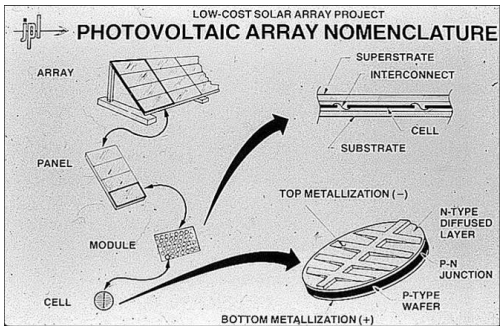
OUTLINE

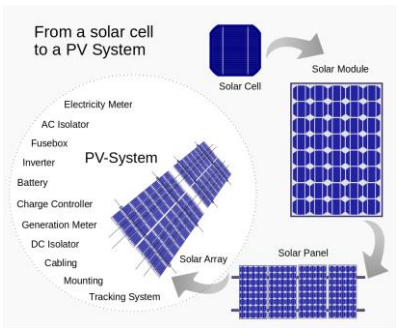
- Bio
- Nomenklatur
- Monitoring Sistem PLTS
- Kinerja PLTS
- Pesan untuk dibawa pulang
- Diskusi

BIO

NOMENKLATUR

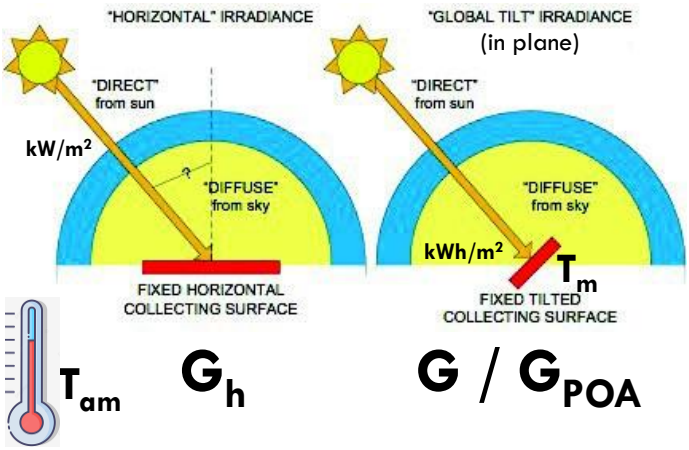
NOMENKLATUR





Jaringan distribusi (grid)

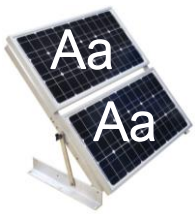
NOMENKLATUR



T_{am} G_h G / G_{POA}

STC:
standar pengujian modul surya di pabrik.

- Suhu sel: 25°C
- Radiasi: 1000 W/m² → G_{ref}
- Massa udara: 1.5.



Aa: active area (m2)

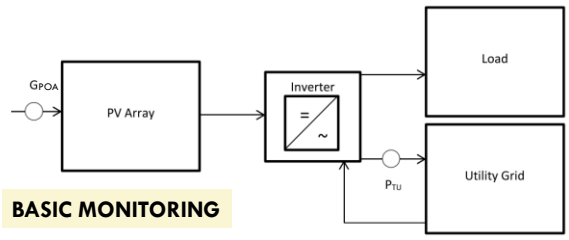
- Irradiance (radiasi): W/m²
- Irradiation (iradiasi) atau insolation: Wh/m² per hari

MONITORING SISTEM PLTS

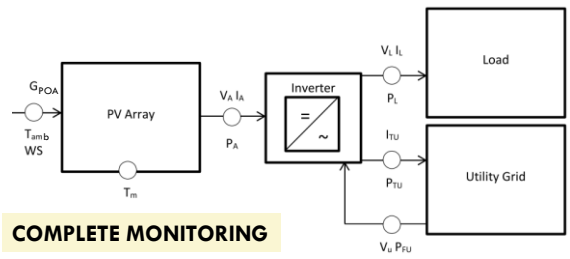
MENGAPA MONITORING?

- Tujuan sistem pemantauan/monitoring PLTS:
  - informasi potensi produksi energi,
  - energi dibangkitkan,
  - suhu operasi,
  - gangguan dan kehilangan energi terkait.
  - kinerja
  - degradasi

PARAMETER YANG DIMONITOR (IEC 61724)



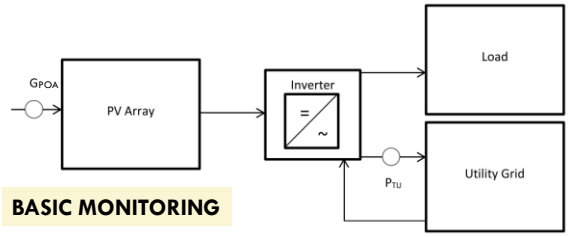
BASIC MONITORING



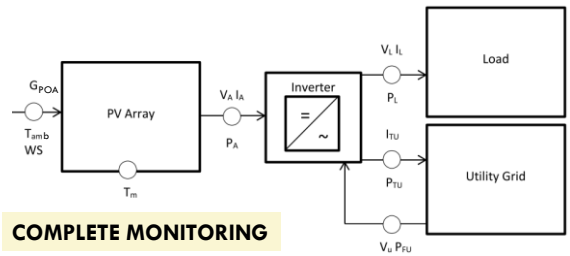
COMPLETE MONITORING

Parameter	Simbol	Satuan	Akurasi Sensor Minimal Disarankan
In-plane irradiance (radiasi pada bidang miring)	G_{POA}	W/m2	5%
Ambient air temperature (suhu udara sekitar)	T_{amb}	°C	1°C
Wind speed (kecepatan angin)	WS	m/s	0.5 m/s untuk WS < 5m/s ±10% untuk WS > 5m/s
Array voltage (tegangan array)	V_A	V	1%
Array current (arus array)	I_A	A	1%
Array power (daya array)	P_A	kW	2%
Module temperature (suhu modul)	T_m	°C	1%

PARAMETER YANG DIMONITOR (IEC 61724)



BASIC MONITORING



COMPLETE MONITORING

Parameter	Simbol	Satuan	Akurasi Sensor Minimal Disarankan
Load voltage (tegangan beban)	V_L	V	1%
Load current (arus beban)	I_L	A	1%
Load power (daya beban)	P_L	kW	2%
Utility voltage (tegangan grid)	V_U	V	1%
Current to utility grid (arus ke arah grid)	I_{TU}	A	1%
Power to utility grid (daya ke arah grid)	P_{TU}	kW	2%
Power from utility grid (daya dari grid)	P_{FU}	kW	2%

PARAMETER TURUNAN

Parameter	Simbol	Satuan
Meteorologi		
- Iradiasi global, pada bidang miring	H_i	kWh/m^2
Kuantitas Energi Listrik		
- Energi dari Array	E_{dc}	kWh
- Energi output ke grid atau beban	E_{ac}	kWh
Index Kinerja Sistem		
- Hasil energi array d.c.	Y_A	kWh/kWp
- Hasil energi sistem a.c.	Y_f	kWh/kWp
- Reference solar yield	Y_r	kWh/kWp
- Array capture losses	L_C	h/d
- Performance ratio	PR	
- Efisiensi energi array d.c.	η_{dc}	
- Efisiensi energi sistem a.c.	η_{PV}	

ANALISIS KINERJA PLTS

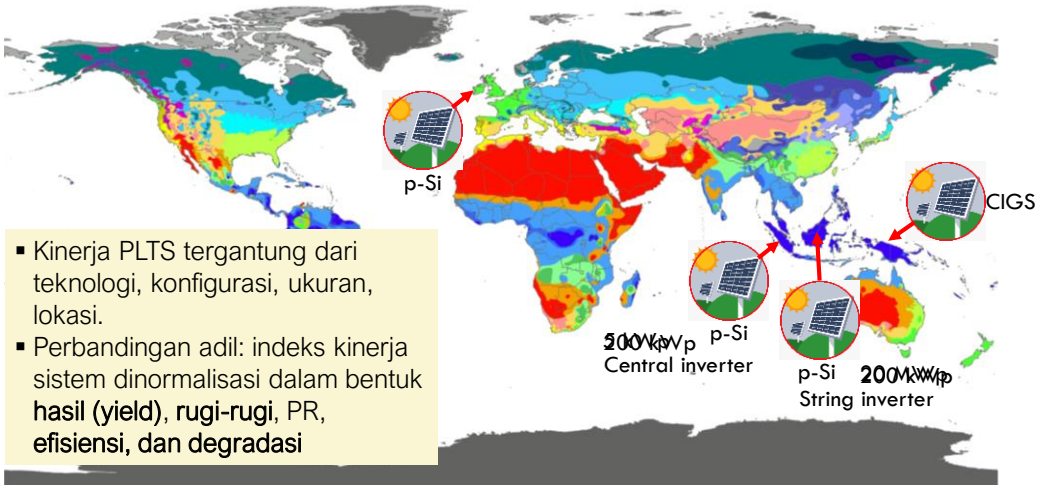
TAHAPAN

- Memeriksa kualitas data
- Indeks kinerja PLTS
- Hasil/yield:
  - Normalised losses
  - PR
  - Efisiensi sistem
- PLR (*performance loss rate*)
- Identifikasi masalah kinerja:
  - Analisis grafis

KUALITAS DATA

- Kualitas analisis ← akurasi data
- Pemeriksaan kualitas data: konsistensi, gap, anomali.
- Batasan:
  - Radiasi (G_h): 0 s/d 1500 W/m^2
  - Suhu sekitar (T_{amb}): - 40 s/d 60 °C
  - Suhu modul: T_{amb} s/d T_{amb} + 40 ° C (rak terbuka)
    T_{amb} s/d T_{amb} + 60 ° C (atap).
  - Tegangan array: 0 s/d 1,3 x V_{oc} array (STC)
  - Arus array: 0 s/d 1,5 x I_{sc} (STC)

INDEKS KINERJA



- Kinerja PLTS tergantung dari teknologi, konfigurasi, ukuran, lokasi.
- Perbandingan adil: indeks kinerja sistem dinormalisasi dalam bentuk **hasil (yield)**, **rugi-rugi**, PR, **efisiensi, dan degradasi**

INDEKS KINERJA

Tiga level yield

Reference yield

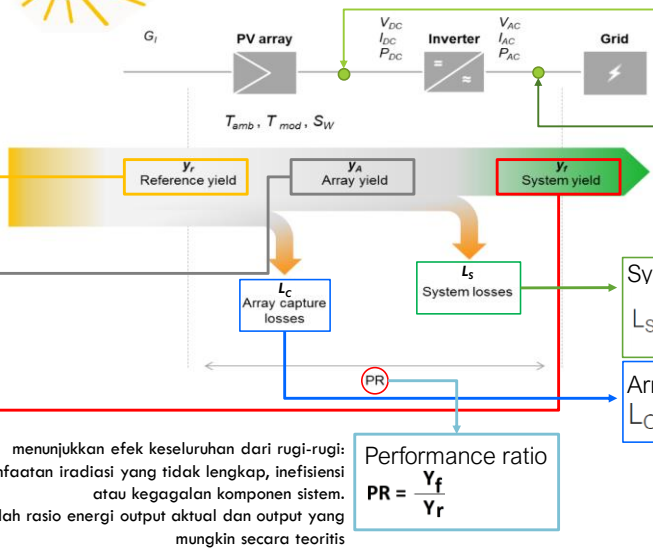
$$Y_r = \frac{H_i}{G_{ref}}$$

Array yield

$$Y_A = \frac{E_{dc}}{P_0}$$

Final/system yield

$$Y_f = \frac{E_{ac}}{P_0}$$



$\eta_{dc} = E_{dc} / (A_a \times H_i)$

$\eta_{PV} = E_{ac} / (A_a \times H_i)$

System losses

$$L_S = Y_A - Y_f = \frac{E_{dc} - E_{ac}}{P_0}$$

Array capture losses

$$L_C = Y_r - Y_A$$

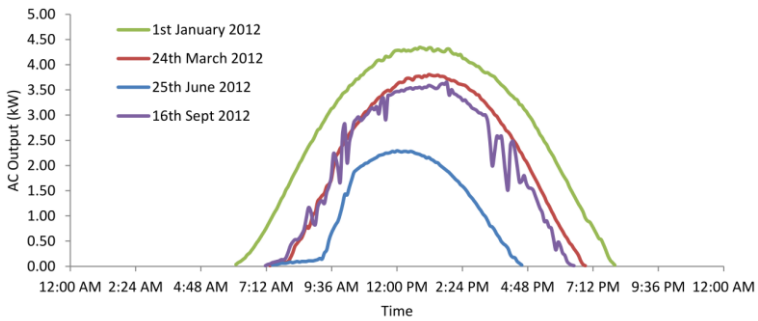
Performance ratio

$$PR = \frac{Y_f}{Y_r}$$

menunjukkan efek keseluruhan dari rugi-rugi: pemanfaatan iradiasi yang tidak lengkap, inefisiensi atau kegagalan komponen sistem. PR adalah rasio energi output aktual dan output yang mungkin secara teoritis

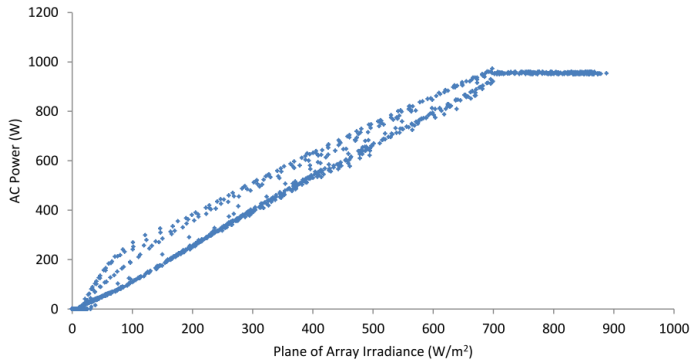
ANALISIS GRAFIS

- Analisis grafis untuk mendiagnosis masalah kinerja sistem ketika nilai PR rendah telah diidentifikasi.
- Disarankan pada level sub-array
  - Clear sky data analysis
    - ❖ Array shading



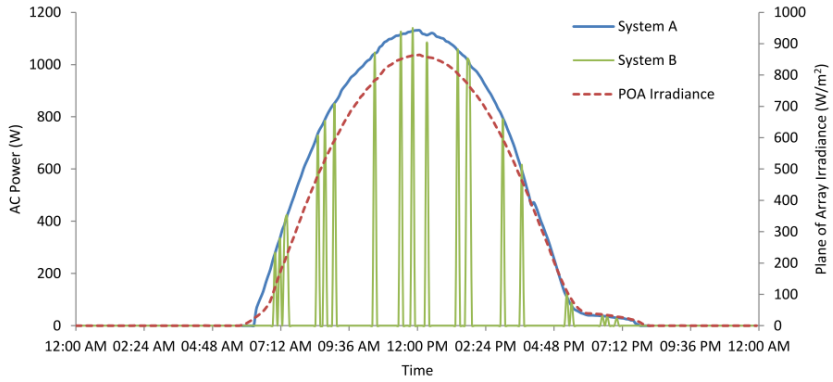
ANALISIS GRAFIS

- Pembatasan inverter



ANALISIS GRAFIS

- Putusnya inverter



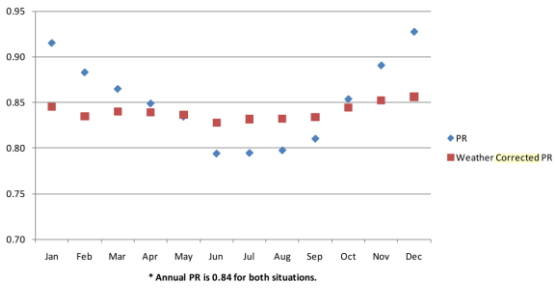
PR

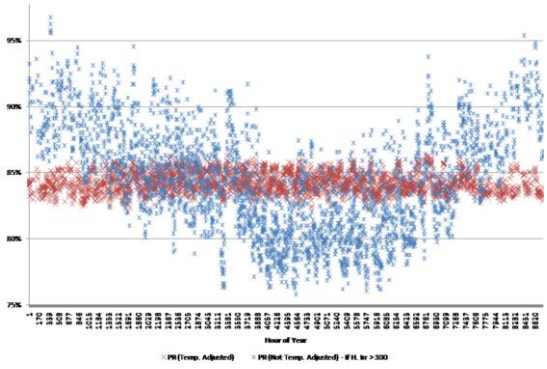
- Tiga jenis PR:
  - PR,
  - PR tekoreksi suhu STC, PR_{stc},
  - PR terkoreksi suhu rata-rata tahunan, PR_{ann}.
  - Untuk perhitungan PR_{stc}. dan PR_{ann}.., koefisien suhu daya maksimum (γ_{Pmp}) adalah komponen penting

Nominal Power(W)	60W
Tolerance(%)	+10/-5%
Efficiency of Module(not Cell)(%)	6.3%
Kind of Cell	a-Si
Cells per Module	108
Shape of Cell	integrated thin film stripe on glass
Voltage MPP(V)	67V
Current MPP(A)	0.90A
Voltage open circuit(V)	92V
Current short circuit(A)	1.19A
Voltage oc at -10 degree C(V)	102V
Voltage MPP at +70 degree C(V)	1.23A
Coeff. of Voltage per degree C (%)	-0.305%/degree C
Coeff. of Current per degree C (%)	0.0752%/degree C
Coeff. of Power per degree C (%)	-0.23%/degree C
Max. System Voltage(V)	530V
Hight(mm)	960mm
Width(mm)	990mm
Thickness(without box)(mm)	40mm
Kind of Frame	Aluminum
Kind of Connection	MC Connector
Weight(kg)	13.7kg
Certificates	IEC 61646 / CE mark

PR

PR dan PR terkoreksi suhu





PLR

- Kinerja sistem PLTS dapat berubah selama pengoperasiannya.
- Penilaian time-series dari data monitoring berguna.
- Daya sistem PLTS biasanya mengikuti tren negatif dari waktu ke waktu.
- Memahami PLR penting untuk meminimalkan risiko investasi.
- PLR digunakan untuk menghitung laju perubahan, di mana nilai PLR negatif menunjukkan penurunan kinerja.

PLR

- Langkah-langkah menghitung PLR:
  - Data preprocessing
  - Memilih metriks kinerja: dipiih PR
  - Memilih metode statistik:
    - YoY dari PR
    - Seasonal and Trend decomposition using Locally weighted scatterplot smoothing (STL decomposition) dari PR
  - Menerapkan metode statistik.

PLR
DATA PREPROCESSING

- Data pengukuran sering mengandung kesalahan.
- Kesalahan data mempengaruhi kesiapan data untuk analisis, kualitas time series, dan, selanjutnya, kualitas analisis.
- Contoh pemrosesan data:
  - Data difilter menurut standar IEC61724-1: 2017:
    - Gh: 200 W/m^2 s/d 1500 W/m2.
    - T_{amb}: -40 s/d 60 °C.
    - T_m: T_{amb} s/d T_{amb} + 30 °C
    - WS: 0 s/d 30 m/s

PLR
DATA PREPROCESSING

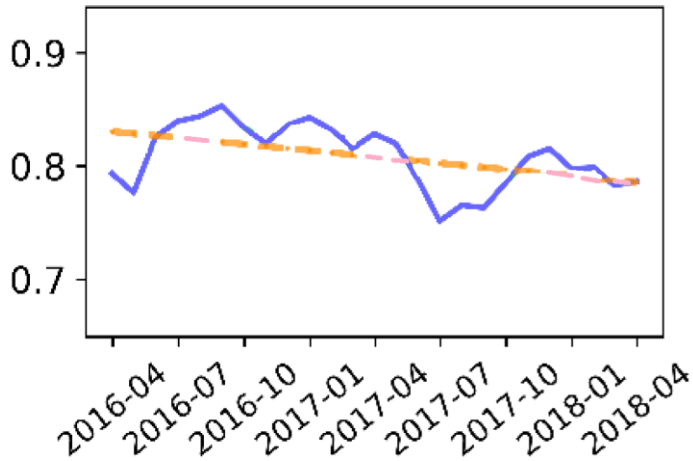
  - Pemeriksaan konsistensi data dan identifikasi gap.
  - Menghapus data duplikat.
  - Menghapus outlier dengan kriteria:

$$|X - \mu| > 2\sigma$$

- Nilai abnormal dihapus.
- Pilih data dengan monitoring fraction (MF) tinggi, missal minimum 85%.

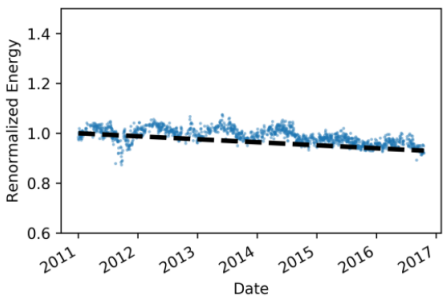
PLR

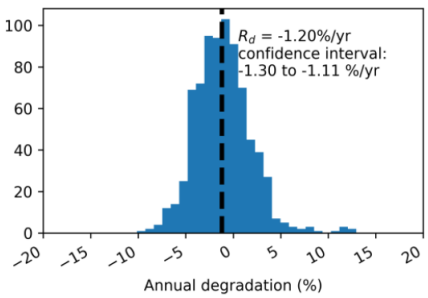
METODE STATISTIK → REGRESI LINIER



PLR

METODE STATISTIK → YOY





Data > 2 tahun

NREL/RdTools → skrip Python.
https://rdtools.readthedocs.io/en/stable

PLR
METODE STATISTIK → YOY

RdTools

Menyediakan informasi penting

```
use_imputed_file = 'NO'    # Yes or NO <-- Do you want to use file that its NaN imputed in Prep_B?

sourcepath= r"C:\Users\kunaifik\Documents\MyPhD\PVData\Cirata_CIS\PV\String\MF\\"
fname     = 'Cir1MWS'
fext      = '_final.txt' # file extension. Imputed
savepath = sourcepath
#savepath = r"C:\Users\kunaifik\Documents\MyPhD\PVData\Bozen_pcSi\\"

# Specify the Metadata
meta = {"latitude"  : -6.673718,        # lintang
        "longitude" : 107.3549,         # bujur
        "timezone"  : 'Asia/Jakarta',# Show all time zones: [line 1]import pytz, [line 2]pytz.all_t
        "tempco"    : -0.0031,      # Module tempco of POWER?? in number (from %/deg.C., divide with
        "azimuth"   : 15,            # Array orientation. Degrees east of north (e.g. North=0, South
        "tilt"      : 10,           # tilted angle
        "pdc"       : 510000,         # rated dc power in Watt
        "temp_model": 'open_rack_glass_polymer'}
        # list of models: https://pvlib-python.readthedocs.io/en/latest/generated/pvlib.pvsystem.sap
```

[2]:

Timestamp	HrActDay	Year	Month	Day	Hour	Minute	poa	Tcell	power	energy	Hi
2016-04-08 07:05:00+07:00	8.666667	2016.0	4.0	8.0	7.0	5.0	228.81	30.92	96359.0	8029.916667	19.067500
2016-04-08 07:10:00+07:00	8.666667	2016.0	4.0	8.0	7.0	10.0	252.13	31.81	116236.0	9686.333333	21.010833

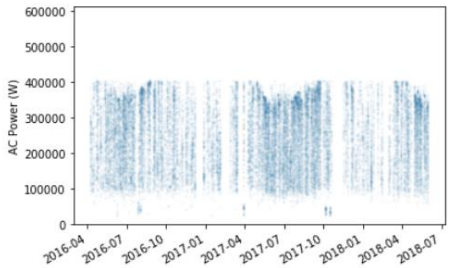
- Lintang
- Bujur
- Zona waktu
- Koefisien suhu modul surya terhadap daya
- Azimuth
- Sudut kemiringan (tilt angel)
- Rated power
- Model rack

PLR
METODE STATISTIK → YOY

RdTools

Plot time series daya a.c.

```
# Sun position
loc = pvlib.location.Location(meta['latitude'], meta['longitude'], tz = meta['timezone'])
sun = loc.get_solarposition(df.index)

# plot the AC power time series
fig, ax = plt.subplots()
ax.plot(df.index, df.power, 'o', alpha = 0.05)
ax.set_ylim(0, (1.2*meta['pdc'])) # depending on the system size
fig.autofmt_xdate()
ax.set_ylabel('AC Power (W)');
```

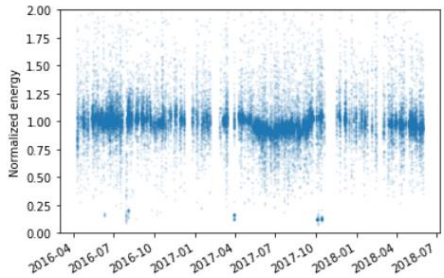


PLR
METODE STATISTIK → YOY

RdTools

Normalisasi

```
pvwatts_kws = {"poa_global" : df.poa,
               "P_ref" : meta['pdc'],
               "T_cell" : df.Tcell,
               "G_ref" : 1000,
               "T_ref": 25,
               "gamma_pdc" : meta['tempco']}

normalized, insolation = rdtools.normalize_with_pvwatts(df.energy, pvwatts_kws)

df['normalized'] = normalized
df['insolation'] = insolation

# Plot the normalized power time series
fig, ax = plt.subplots()
ax.plot(normalized.index, normalized, 'o', alpha = 0.15)
ax.set_ylim(0,2) # set depending on data range
fig.autofmt_xdate()
ax.set_ylabel('Normalized energy');
```

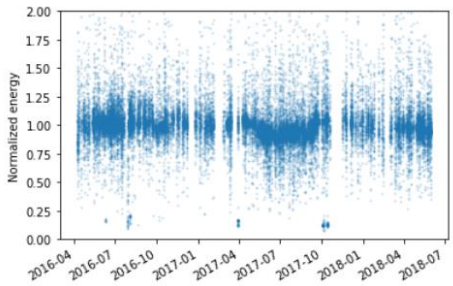


PLR
METODE STATISTIK → YOY

RdTools

Filter

```

# Calculate a collection of boolean masks that can be used
# to filter the time series
nz_mask = (df['normalized'] > 0) # set depending on data range
poa_mask = rdtools.poa_filter(df['poa'])
tcell_mask = rdtools.tcell_filter(df['Tcell'])
clip_mask = rdtools.clip_filter(df['power'])

# filter the time series and keep only the columns needed for the
# remaining steps
filtered = df[nz_mask & poa_mask & tcell_mask & clip_mask]
filtered = filtered[['insolation', 'normalized']]

fig, ax = plt.subplots()
ax.plot(filtered.index, filtered.normalized, 'o', alpha = 0.25)
ax.set_ylim(0,2) # set depending on data range
fig.autofmt_xdate()
ax.set_ylabel('Normalized energy');
```

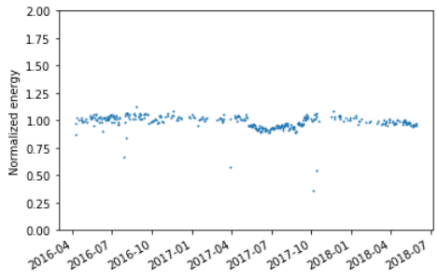


PLR
METODE STATISTIK → YOY

RdTools

Agregasi

```
daily = rdtools.aggregation_insol(filtered.normalized, filtered.insolation, frequency = 'D')

fig, ax = plt.subplots()
ax.plot(daily.index, daily, 'o', alpha = 1)
ax.set_ylim(0,2) # set depending on data range
fig.autofmt_xdate()
ax.set_ylabel('Normalized energy');
```

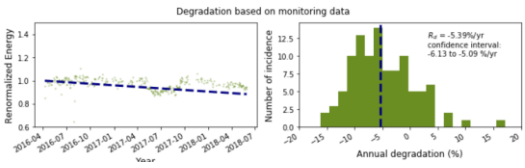


PLR
METODE STATISTIK → YOY

RdTools

Menghitung degradasi tahunan

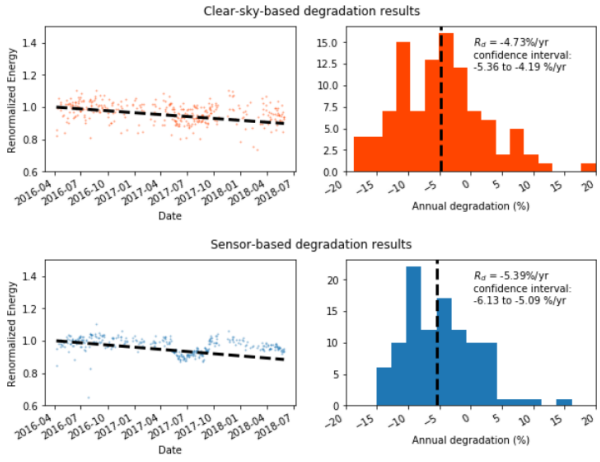
```
yoy_rd, yoy_ci, yoy_info = rdtools.degradation_year_on_year(daily, confidence_level=68.2)

# Visualize the results
start = daily.index[0]
end = daily.index[-1]
years = (end - start).days / 365.0
yoy_values = yoy_info['YoY_values']

x = [start, end]
y = [1, 1 + (yoy_rd * years)/100]

fig, (ax1, ax2) = plt.subplots(1,2, figsize=(10, 3))
ax2.hist(yoy_values, label='YOY', bins=len(yoy_values)//2, color='olivedrab') # //5 set number of bins
ax2.axvline(x=yoy_rd, color='navy', linestyle='dashed', linewidth=3)
ax2.set_xlim(-20,20) # set depending on data range
ax2.annotate( u' $R_{d}$ = %.2f%%/yr \n confidence interval: \n %.2f to %.2f %%/yr'
            %(yoy_rd, yoy_ci[0], yoy_ci[1]),  xy=(0.57, 0.68), xycoords='axes fraction',
            bbox=dict(facecolor='white', edgecolor=None, alpha = 0))
ax2.set_xlabel('Annual degradation (%)', fontsize=12);
ax2.set_ylabel('Number of incidence', fontsize=12)


ax1.plot(daily.index, daily/yoy_info['renormalizing_factor'], 'o', color='olivedrab', alpha = 0.5)
ax1.plot(x, y, 'k--', linewidth=3, color='navy')
ax1.set_xlabel('Year', fontsize=12)
ax1.set_ylabel('Renormalized Energy', fontsize=12)
ax1.set_ylim(0.6, 1.5) # set depending on data range
fig.autofmt_xdate()
plt.tight_layout()
fig.suptitle('Degradation based on monitoring data', fontsize=12, x=0.5, y=1.05);

plt.show()
```



PLR
METODE STATISTIK → YOY

RdTools

Model clear sky



PLR
METODE STATISTIK → STL DECOMPOSITION

- Tahap:
  1. Dekomposisi time series PR bulanan menjadi komponen-komponennya, menggunakan salah satu dari metode berikut:
     - ✓ Simple Linear Regression (SLR)
     - ✓ Moving averages
     - ✓ X11,
     - ✓ SEATS decomposition,
     - ✓ Classical Seasonal Decomposition (CSD),
     - ✓ Holt-Winters exponential smoothing (HW)
     - ✓ X12 ARIMA
     - ✓ **Seasonal and Trend decomposition using Locally weighted scatterplot smoothing (STL decomposition) → paling akurat.**

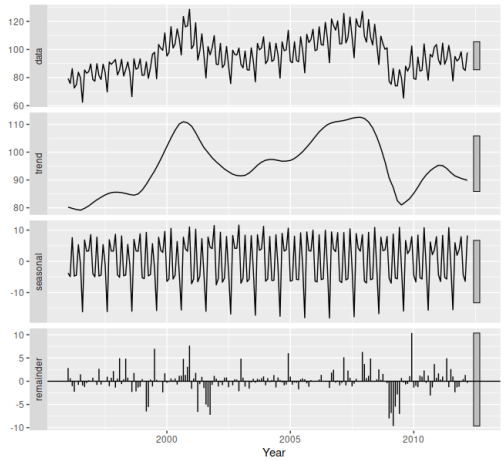
PLR
METODE STATISTIK → STL DECOMPOSITION

- Komponen time series;

$$y_t = S_t + T_t + \varepsilon_t$$

  - y_t: data,
  - S_t: seasonal component
  - T_t: trend-cycle component
  - εt: remainder

Hasil dekomposisi



PLR
METODE STATISTIK → STL DECOMPOSITION

- Tahap:
  2. Menghitung nilai regresi kuadrat-terkecil linier dari komponen "tren", T_t, dari PR yang dikoreksi suhu.

$$T_t = ax + b$$

dimana x adalah variabel bebas atau variabel untuk membuat prediksi, a adalah kemiringan garis regresi yang menunjukkan pengaruh x terhadap T_t, dan b adalah perpotongan T_t.

Tahap ini menghasilkan nilai PLR akhir, dalam persentase, adalah laju perubahan, baik positif maupun negatif, dari regresi komponen tren.

PLR
METODE STATISTIK → STL DECOMPOSITION

Membaca time series PR (bulanan)

```
import pandas as pd
import statsmodels.api as sm
import matplotlib.pyplot as plt
%matplotlib inline

# the main library has a small set of functionality
from stldecompose import decompose, forecast
from stldecompose.forecast_funcs import (naive,
                                         drift,
                                         mean,
                                         seasonal_naive)


%load_ext autoreload
%autoreload 2
df = pd.read_csv(sourcepath+fname+fext, usecols=['Timestamp','PR','PRtc,stc','PRtc,ann'])
df['Timestamp'] = pd.to_datetime(df['Timestamp'])
#df.set_index('Timestamp', inplace=True)

df.head()
```

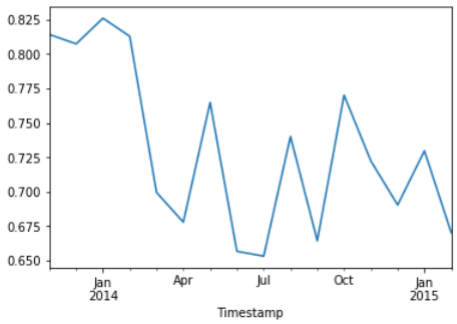
	Timestamp	PR	PRtc,stc	PRtc,ann
0	2013-11-30 00:00:00+07:00	0.811629	0.896261	0.814306
1	2013-12-31 00:00:00+07:00	0.804279	0.888818	0.807487
2	2014-01-31 00:00:00+07:00	0.833241	0.908224	0.826152
3	2014-02-28 00:00:00+07:00	0.808828	0.894973	0.812985
4	2014-03-31 00:00:00+07:00	0.698069	0.769606	0.699336

PLR
METODE STATISTIK → STL DECOMPOSITION

Plot $PR_{tc,ann}$

```
df['PRtc,ann'].plot()
```

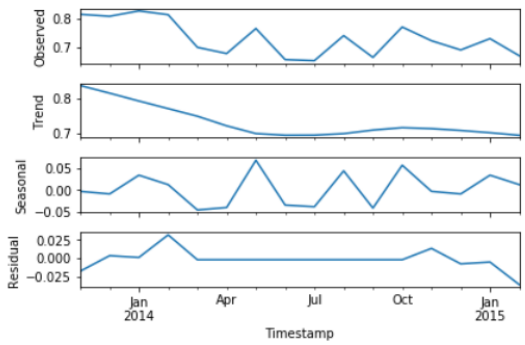
```
<matplotlib.axes._subplots.AxesSubplot at 0x29036a88748>
```

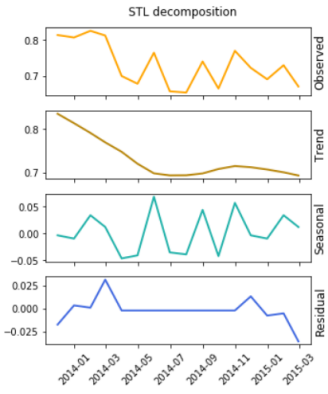


PLR
METODE STATISTIK → STL DECOMPOSITION

Uraikan time series menjadi komponen-komponenya menggunakan STL Decompose

```
decomp = decompose(df, period=12)
decomp.plot();
```



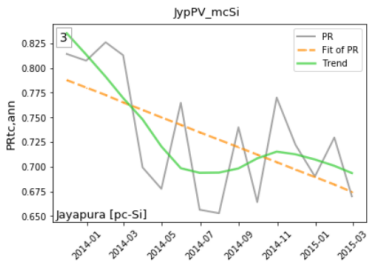


Beautified for publication

PLR
METODE STATISTIK → STL DECOMPOSITION

All in one

```
print('Root mean squared error regression loss (RMSE)       :', '%.6f'% RMSE)
print('Mean squared logarithmic error regression loss (MSLE):', '%.6f'% MSLE)
print('Median absolute error regression loss (MeAE)         :', '%.6f'% MeAE)
print('Coefficient of determination regression (R^2)        :', '%.6f'% R_Sq)

# Save plot
plt.savefig(savepath + fname + "Fit+PR+Tr_v2.png", format='png', dpi=600, bbox_inches="tight")
```



PLR
METODE STATISTIK → STL DECOMPOSITION

Fit of trend

```
from scipy import stats
from scipy.stats import linregress
slope, intercept, r_value, p_value, std_err = stats.linregress(X,y)

#linregress(X,y)
print("                                    Slope ( a ) :", slope)
print("                                Intercept ( b ) :", intercept)
print("                    Correlation coefficient ( r ) :", r_value)
print("          Coefficient of determination ( r-squared ) :", r_value**2)
print("  Two-sided p-value for a hypothesis test whose null\
    \n   hypothesis is that the slope is zero ( p-value ) :", p_value)
print("           Standard error of the estimate ( stderr ) :", std_err)

#kalkulasi slope belum diuji
```

PLR
METODE STATISTIK → STL DECOMPOSITION

Hitung annual change dalam %

Equation **y' = ax + b**

```
trend_row, trend_col = trend.shape

relative_change1 = (12*slope)/intercept  # belum diperiksa kebenarannya
relative_change2 = 100*((12*slope)/(trend_row*intercept)) # 12 = number of
                                                          # trend_row= numb
absolute_change = 12*slope               # belum diperiksa kebenarannya
print('Relative change,1 (Ingenhoven 2019) =', relative_change1, '%')
print('Absolute change (Ingenhoven 2019)   =', absolute_change, '%')
# Method 2: Using Logarithmic Transformation in Linear Regression Models
percent_change = np.log(y) - np.log(y.iloc[0]) # this reads the linear fit
print('Meth 2 Percent change (logaritmic)  =', percent_change.mean(), '%')
```

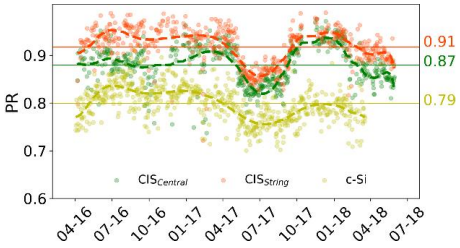
```
Relative change,1 (Ingenhoven 2019) = -1.7811108000431526 %
Absolute change (Ingenhoven 2019)   = -1.4070469564084966 %
Meth 2 Percent change (logaritmic)  = -0.13462949641924496 %
```

KINERJA PLTS DI INDONESIA

Cirata, Jawa Barat, PJB, PR

- 510 kWp (CIS) dengan inverter string, 532.4 kWp (CIS) dengan inverter sentral, dan 5 kWp (p-Si).

- G_{POA} pada bidang miring 10º: 410 W/m^2 (rata-rata) dan 1,250 W/m^2 (max).
- PR CIS central: 87.4%, string: 91.7%,
- PR p-Si: 80%.

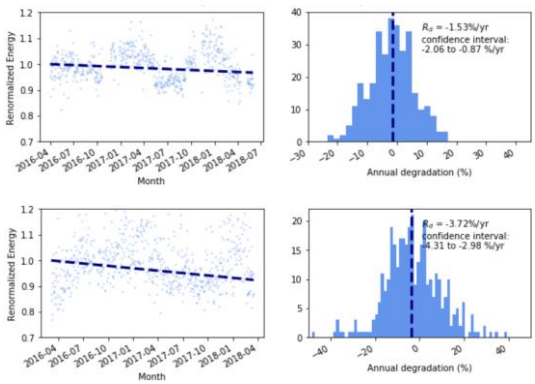


KINERJA PLTS DI INDONESIA

Cirata, Jawa Barat, PJB, Degradasi YoY

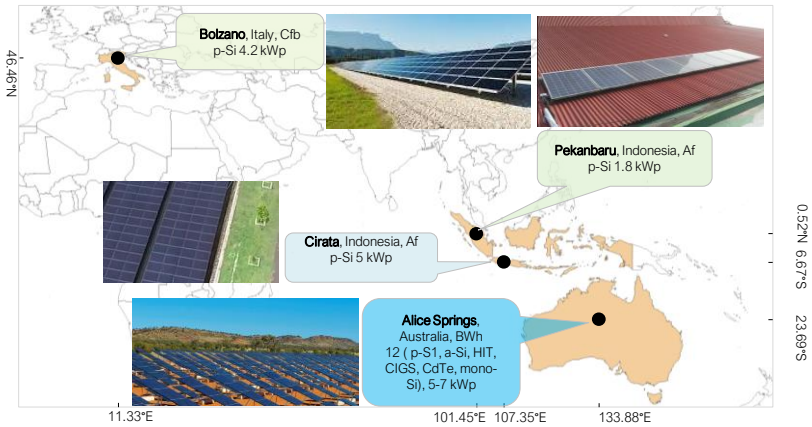
<u>CIS$_C$ system:</u>
-1.53 % per tahun
[confidence interval: 0.87% - 2.06% per tahun]

<u>p-Si:</u>
-3.72 % per tahun
[confidence interval: 2.98% - 4.31% per year]



KINERJA PLTS DI INDONESIA

Tiga Iklim



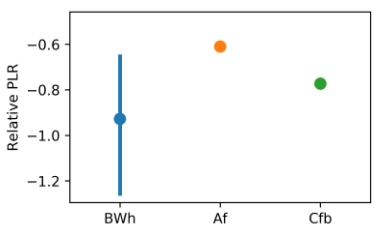
KINERJA PLTS DI INDONESIA

Tiga Iklim

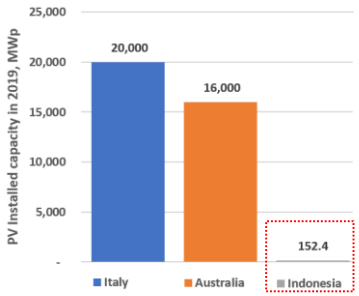
PR

Climate	Country	$PR_{ann.}$
BWh	Australia	0.81 ± 0.02
Af	Indonesia	0.81 ± 0.03
Cfb	Italy	0.84 ± 0.03

PLR



PV installed capacity (2019):



PESAN UNTUK DIBAWA PULANG

CELOTEH ENERGI BERSIH

YouTube

https://www.youtube.com/watch?v=7H0MTdHwaac

Discussion

kunaifi@uin-suska.ac.id
k.kunaifi@utwente.nl
WA: +62823 8132 8424
Telegram: +31682 454 184