Growatt Monitor

1. Plant Performance Technical Report

Growatt Devices Monitoring System Documentation

May 03, 2025

Version 1.0

2. Plant Performance Technical Report

2.1 Overview

This technical document analyzes the performance metrics of the solar photovoltaic (PV) plant, providing key indicators to evaluate operational efficiency and energy production.

2.2 Theory and Calculation Formulas

2.2.1 Solar Energy Fundamentals

Solar PV systems convert solar irradiance into electrical energy. The theoretical maximum energy production depends on:

- Solar irradiance (kWh/m²)
- Panel efficiency (%)
- Total panel area (m²)
- System losses

2.3 Performance Metrics

2.3.1 Capacity Factor

Current Value: 25.4%

The capacity factor represents the ratio of actual energy output over a period to the maximum possible output if the plant operated at full nameplate capacity continuously.

Formula:

```
Capacity Factor = (Energy Generated (kWh) / (Nameplate Capacity (kW) × Time Period
```

The current value of 25.4% is within the typical range for solar PV installations, which generally fall between 15-30% depending on location and technology.

2.3.2 Performance Ratio (PR)

Current Value: 0.98

The Performance Ratio quantifies the relationship between actual energy output and the theoretical output calculated based on irradiance measured at the plant location.

Formula:

```
PR = Actual Energy Output (kWh) / (Solar Irradiance (kWh/m²) × Panel Area (m²) × P
```

Interpretation:

- Current PR (0.98) indicates near-optimal system performance
- Typical expected range: 0.8-0.9 per PVsyst standards
- Values approaching 1.0 represent systems with minimal losses

2.3.3 Energy Generation

Metric	Value
Daily Generation	18.7 kWh
Monthly Average	499 kWh
Peak Power	5 kW

Daily Energy Calculation:

```
Daily Energy (kWh) = ∫ Power(t) dt
```

Where Power(t) is the instantaneous power output at time t.

2.3.4 Environmental Impact

CO_2 Emissions Avoided: 12.4 kg/day

This represents the equivalent carbon dioxide emissions that would have been produced if the same amount of electricity were generated using conventional fossil fuel sources.

Formula:

```
CO₂ Avoided (kg) = Energy Generated (kWh) × Grid Emission Factor (kg CO₂/kWh)
```

Typical grid emission factors range from 0.4 to 0.9 kg CO_2/kWh depending on the region's energy mix.

2.4 Conclusion

The plant is performing exceptionally well with a Performance Ratio of 0.98, exceeding typical industry expectations. The capacity factor of 25.4% is solid for a solar installation, and the system is making a positive environmental impact by avoiding 12.4 kg of CO_2 emissions daily.

2.5 Recommendations

1. Continue monitoring PR to ensure sustained performance
2. Consider seasonal adjustments for optimization
3. Use this high-performing system as a benchmark for future installations

Report generated on [Current Date]