1. Tzaneen Technical Performance

The following tables and figures describe the technical performance of the plant compared with the forecast. We have evaluated irradiation, availability, performance ratio and production.

* 1. System Design

The system is a 689.6kWp project with 535Wp JA Solar PV modules connected to six Huawei 100 kW inverters and one Huawei 50 kW inverter with key details noted in Table 9‑1. The inverters installed by Mediclinic are grid tied with anti-islanding protection as explained in Chapter 5.

|  |  |
| --- | --- |
| Project Overview | |
| Design Capacity DC/AC (kW) | 697.1 / 650 |
| Achieved Capacity DC/AC (kW) | 689.6 / 650 |
| Technology | Solar |
| Project Company: | Moshesh Solar PV 1 (Pty) Ltd |
| Address: | Tzaneen, Main Road Somerset West South Africa |
| Commercial Operation Date | 28 Oct 2022 |

*Table 9‑1: Tzaneen Project Overview*

* 1. Irradiation Vs Forecast

Table 9 2 shows the Project irradiance for Q1 2023 compared to the pre-construction Helioscope P50 prediction. Harmattan notes that the irradiance data is satellite-based.

|  |  |  |  |
| --- | --- | --- | --- |
| **Irradiation (kWh/m2)** | | | |
| **Month** | **Actual** | **Forecast** | **Delta (%)** |
| {%tr for item in TZAItable\_contents%} | | | |
| {{item.Date}} | {{ item. TZAIA}} | {{ item. TZAIF}} | {{item. TZAIV}} |
| {%tr endfor %} | | | |
| **Total** | **{{“{:,.0f}".format (TZAIATOT)}}** | **{{“{:,.0f}".format (TZAIFTOT)}}** | **{{“{:,.0f}".format (TZAIVTOT)}}** |

*Table 9‑2: Tzaneen Irradiation and forecast.*

The actual irradiation was {{“{:,.0f}".format (TZAIATOT)}} kWh/m2, {{“{:,.0f}".format (TZAIVTOT)}}% lower than the forecasted irradiation of {{“{:,.0f}".format (TZAIFTOT)}} kWh/m2. The below forecast irradiation in Q1 is due to poor irradiation experienced in March.

* 1. Availability Vs Forecast

The Operator has stated a minimum guaranteed availability of 99 % in their monthly reports. Harmattan has used this guaranteed availability to compare with the actual availability from the SCADA.

|  |  |  |  |
| --- | --- | --- | --- |
| **Availability (%)** | | | |
| **Month** | **Actual** | **Forecast** | **Delta (%)** |
| {%tr for item in TZAAtable\_contents%} | | | |
| {{item.Date}} | {{ item. TZAAA}} | {{ item. TZAAF}} | {{item. TZAAV}} |
| {%tr endfor %} | | | |
| **Total** | **{{“{:,.0f}".format (TZAAAAVR)}}** | **{{“{:,.0f}".format (TZAAFAVR)}}** | **{{“{:,.0f}".format (TZAAVAVR)}}** |

*Table 9‑3:* *Tzaneen Availability and Guaranteed*

Achieved availability was {{“{:,.0f}".format (TZAAAAVR)}}%, while the Guaranteed availability was {{“{:,.0f}".format (TZAAFAVR)}}%, resulting in a variance of {{“{:,.0f}".format (TZAAVAVR)}}%.

Availability is reduced by risks for which the Operator is not responsible. As an example, equipment failures affect availability, but Project switch offs due to force majeure would not. The full calculation methodology can be found in Appendix A1.

Possible factors that could have contributed to the low availability include unexpected downtime such as the high levels of load shedding, experienced by the Project. grid maintenance works, and normal faults. Load shedding is employer risk, but the Operator SCADA cannot distinguish between normal system loss, grid maintenance loss and loadshedding losses, the risk is on the Operator as they must prove that the system was down due to loadshedding. The availability does not reconcile load shedding and thus the Operator must manually record loadshedding. Furthermore, the Operator has stated that sometimes the power only goes off a little bit later and other times it's like clockwork. Additionally, the inverters take some time to start up, which also needs to be accounted for.

We recommend that the Operator improve data logging on the system as it is not clear from the SCADA when load shedding took place due to the unpredictability of loadshedding.

* 1. Performance Ratio Vs Forecast

Table 9‑4 shows the measured and forecast performance ratio (PR) of the Project.

|  |  |  |  |
| --- | --- | --- | --- |
| **Performance Ratio (%)** | | | |
| **Month** | **Actual** | **Forecast** | **Delta (%)** |
| {%tr for item in TZAPRtable\_contents%} | | | |
| {{item.Date}} | {{ item. TZAPRA}} | {{item. TZAPRF }} | {{item. TZAPRV}} |
| {%tr endfor %} | | | |
| **Total** | **{{“{:,.0f}".format (TZAPRAAVR)}}** | **{{“{:,.0f}".format (TZAPRFAVR)}}** | **{{“{:,.0f}".format (TZAPRVAVR)}}** |

*Table 9‑4: Tzaneen PR and Forecast*

In Q1 2023, the Performance Ratio was {{“{:,.0f}".format (TZAPRAAVR)}}%, {{“{:,.0f}".format (TZAPRVAVR)}}% higher than the forecasted value of {{“{:,.0f}".format (TZAPRFAVR)}}%. PR The higher-than-expected performance ratio is due to the inclusion of December 2023 production into Q1 2023 data. This reconciliation was due to the meter connection error in December 2023.

* 1. Production Vs Forecast

Table 9 5 shows the Q1 2023 actual production and comparisons to the original and weather adjusted forecasts.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Month** | **Production (kWh)** | | | **Actual vs Original Forecast (%)** | **Actual vs Weather Adjusted Forecast (%)** |
|  | **Original Forecast** | **Weather Adjusted Forecast** | **Actual Production** |
| {%tr for item in TZAPtable\_contents%} | | | | | |
| {{item.Date}} | {{“{:,.0f}".format (item.TZAPF)}} | {{“{:,.0f}".format (item.TZAPW)}} | {{“{:,.0f}".format (item.TZAPA)}} | {{item.TZAPV}} | {{item.TZAPWV}} |
| {%tr endfor%} | | | | | |
| **Total** | **{{“{:,.0f}".format (TZAPFTOT)}}** | **{{“{:,.0f}".format (TZAPWTOT)}}** | **{{“{:,.0f}".format (TZAPATOT)}}** | **{{TZAPVTOT}}** | **{{TZAPWVTOT}}** |

*Table 9‑5: Tzaneen Production and Forecast*

Production of {{“{:,.0f}".format (TZAPATOT)}} kWh was {{TZAPVTOT}}% below the original forecast of {{“{:,.0f}".format (TZAPFTOT)}} kWh, and {{TZAPWVTOT}}% below the weather-adjusted forecast. The low production in a period of low irradiance and low availability, likely reflects the curtailment due to load shedding and poor weather conditions.

* Production {{“{:,.0f}".format (TZAPATOT)}} kWh with a variance of {{TZAPVTOT}} % below the P50 forecast.
* Irradiation is {{“{:,.0f}".format (TZAIATOT)}} kWh/m2 with a variance of {{“{:,.2f}".format (TZAIVTOT)}} % below P50 forecast.
* Availability is {{“{:,.0f}".format (TZAAAAVR)}}% with a variance of {{“{:,.2f}".format (TZAAVVR)}}% above the warranted availability.
* PR is {{“{:,.0f}".format (TZAPRAAVR)}}% with a variance of {{“{:,.2f}".format (TZAPRVAVR)}}% below warranted availability.
* Revenue is R{{“{:,.0f}".format(TZAZARLT)}} with a variance of {{TZAZARVLT}} % below forecast.