

ANNEX 2: M&V PLAN

This Annex sets out the Measurement and Verification (M&V) methodology to be applied under this assignment. It is based on the International Performance Measurement and Verification Protocol (IPMVP), Option C – Whole Facility Measurement and reflects the design-stage assessment summarised at Annex 1. The Consultant shall review, confirm, and, where necessary, refine this plan with CAPRED, the financier and the Facility owner at assignment kick-off.

A2.1 Objective

The objective of the M&V process is to verify whether the Facility achieves its design energy performance following completion, commissioning, and commencement of operation. Verification shall focus on comparing actual operational performance against the design Specific Energy Consumption (SEC) and saving targets set out in Annex 1, and shall support ongoing performance monitoring, operational optimisation, and continuous improvement throughout the monitoring period.

A2.2 M&V Boundary

The M&V boundary encompasses the entire Facility and includes:

- Rice milling process equipment (pre-cleaning, de-husking, paddy separation, whitening, polishing, grading, colour sorting, packaging, and material handling systems)
- The biomass steam boiler and paddy drying system
- The air compressor system
- Auxiliary equipment
- Building services, including lighting and ventilation
- All associated electrical distribution systems serving the Facility

The M&V boundary excludes:

- Office equipment and tenant plug loads not directly associated with the rice milling process
- Temporary construction energy consumption
- Future facility expansions or additional production lines not included in the design energy assessment
- Transportation fuel used for trucks, forklifts, or other mobile equipment
- Domestic water supply and wastewater treatment systems unless directly related to the rice milling process

A2.3 Performance Indicators

The primary performance indicator is the facility's Specific Energy Consumption (SEC), calculated separately for electricity and biomass and combined into a Total Facility SEC, normalised against milled rice production. The following indicators shall be monitored and reported throughout the verification period:

Indicator	Unit	Purpose
Electrical SEC	kWh/ton milled rice	Verify milling efficiency
Thermal SEC	kWh/ton milled rice	Verify drying efficiency



Total SEC	kWh/ton milled rice	Primary performance indicator
Electricity consumption	kWh/year	Utility verification
Biomass (husk) consumption	ton husk/year	Boiler performance
Husk consumption rate	kg/hour	Design reference: 721 kg/hour; to be confirmed in operation
Boiler thermal efficiency	%	Boiler verification (design: 84%)
Dryer moisture reduction	% moisture content	Drying performance (design: 24% to 14%, wet basis)
Milled rice production	ton/year	Output verification (design: 109,980 ton/year)
Paddy drying throughput	ton/year	Input verification

A2.4 Methodology and Stages

The primary performance indicator shall be SEC, expressed as energy consumed per tonne of milled rice. SEC shall be calculated separately for electricity and biomass energy sources and combined to determine the Total Facility SEC. Electricity SEC shall be calculated by dividing measured electricity consumption (kWh) by milled rice production (tonnes); Biomass SEC shall be calculated by converting measured biomass fuel consumption into energy units (kWh equivalent) using the approved fuel heating value and dividing by milled rice production. The M&V process shall be implemented in the following stages:

1. Stage 1 – M&V Planning and Setup

An M&V Plan shall be developed in accordance with IPMVP Option C. The facility boundary, energy systems, metering requirements, and performance indicators set out above shall be reviewed and confirmed. The baseline and design SEC benchmarks in Annex 1 shall be confirmed as the reference for verification. Roles, responsibilities, data collection procedures, reporting requirements, and the overall M&V schedule shall be established at assignment kick-off.

2. Stage 2 – Metering Verification and Data System Readiness

Ahead of practical completion, all metering and monitoring systems shall be inspected and verified to ensure they are capable of supporting the M&V process, including utility electricity meters, biomass fuel measurement systems, production throughput monitoring, and moisture-content measurement equipment. Data acquisition, logging, storage, and reporting systems shall be tested. Any deficiencies shall be corrected before commissioning.

3. Stage 3 – Commissioning Data Verification

Following commissioning and prior to full operation, initial operational data shall be reviewed to verify meter functionality, data quality, and consistency. The baseline and design SEC values shall be confirmed as the performance benchmarks for ongoing monitoring, and production assumptions, operating schedules, and moisture conditions used in the design assessment shall be reviewed and documented. Any metering, data collection, or operational issues shall be resolved before the formal monitoring period begins.

4. Stage 4 – Data Collection and Ongoing M&V

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Following commencement of commercial operation, whole-facility electricity and biomass consumption data, production throughput, operating hours, and moisture-content data shall be collected continuously. Monthly Electricity SEC, Biomass SEC, and Total Facility SEC shall be calculated and normalised for actual production and moisture-removal conditions. During the first full drying season, actual rice husk consumption, boiler thermal efficiency, and moisture reduction shall specifically be verified against design values, and operational adjustments (e.g. airflow or combustion optimisation) recommended where measured performance differs materially. Data quality checks and periodic reviews shall be conducted throughout.

5. Stage 5 – Performance Analysis, Verification, and Reporting

At the end of the monitoring period, collected data shall be analysed to determine actual normalised Electricity SEC, Biomass SEC, and Total Facility SEC. Results shall be compared against both the baseline SEC and the design SEC target in Annex 1 to verify whether the Facility has achieved its intended energy performance and to quantify the actual improvement achieved.

The Final M&V Report shall summarise the monitoring methodology, energy and production data, SEC calculations, normalisation methods, performance results, key findings, and recommendations for operational improvement and continuous energy performance enhancement.

A2.5 Indicative Timeline

The M&V activities shall be implemented progressively across the Facility's construction, commissioning, and operational stages, indicatively as follows (to be confirmed with CAPRED, the financier and the Facility owner at assignment kick-off, and set out in full in the M&V Assessment Plan):

- M&V Planning and Setup – shortly after contract award
- Metering Verification and Data System Readiness – ahead of practical completion of construction
- Commissioning Data Verification – at / around practical completion
- Data Collection and Ongoing M&V – throughout the first 12 months of commercial operation, including the first full drying season
- Performance Analysis, Verification, and Final Reporting – at the end of the 12-month monitoring period

