TECHNICAL SPECIFICATIONS

Design and Build

Construction of a biomass cogeneration plant based on biomass gasification technology

at

AMRU Rice Noodle Enterprise Cambodia

CONTENTS

ABBREVIATIONS

BOT	Build-Operate-Transfer scheme
CO2	Carbon dioxide
CHP	Combined heat and power plant
CPI	Consumer Price Index
FAC	Final Acceptance
kWe	Kilowatt, electrical
kWf	Kilowatt, fuel
kWt	Kilowatt, thermal
LHV	lower heating value
MWe	Megawatt, electrical
MWf	Megawatt fuel
MWh	Megawatt hours
MWt	Megawatt, thermal
NOx	Nitrogen oxide
PAC	Provisional Acceptance
SO2	Sulphur dioxide
TOC	Test on Completion
ToR	Terms of reference
VAT	Value added tax

DEFINITIONS

INVESTOR	AMRU Rice Noodle Enterprise Cambodia
CONTRACTOR	Is the company, which is performing the installation of the plant and the work within the defined scope.

The International System of Units (SI) shall be used except for temperature and pressure that shall be given in °Celsius and bar.
Decimal fractions shall be used. Prefixes may be used for designation of multiple and fractional SI units (m, k, M, G, T).

1 INTRODUCTION

The INVESTOR is producing rice noodles and his intention is to install a biomass gasifier with an electrical net output of around 50 kWe to reduce the demand of electricity from the Cambodian grid operator EDC www.edc.com.kh. The produced heat should be used to warm up the treated water produced for the existing steam boiler.

The gasifier generator set should be pre-assembled in a container including intermediate storage, gasifier, cooler, engine, exhaust gas system including outside chimney, electro and control system incl. frequency control system. The gasifier generator set should be designed for an island operation.
The foundation will be prepared by the INVESTOR based on the size and load information of the CONTRACTOR. The container will be installed inside the building.The existing building below the roof will be demolished and the foundation for the container will be prepared by the INVESTOR.

Figure 1: Defined location of the biomass gasifiercontainer

The existing steam boiler is currently handfired by cutted wood logs. Wood logs are purchased from farmers. Because of the high price, the INVESTOR's intention is to switch the feedstock after an operation period with wood chips to other biomass fuels. Other kinds of biomass are e.g. by-products from own cashew production. This will help to reduce the demand on wood and protect the Cambodian forest from intensive harvesting fire wood usage only.
The CONTRACTOR has to provide a list of biomass fuel, which can be used instead of wood chips with the same offered gasifier.

2 PROJECT SCOPE

The project objective is to appoint the CONTRACTOR to provide all works, including but not limited to planning, design, engineering, manufacture, procurement, construction, erection, installation, commissioning, testing and completion on a turn-key base of a wood based gasifier generator set at AMRU Rice Noodle Enterprise Cambodia as well as the training of O&M staff to enable the INVESTOR to operate the plant after PAC.

This technical specification provides a Concept design, which takes into account the INVESTOR's objectives and functional specifications for the construction and operation of the Works and the new Plant including basic technical specifications, key performance parameters and drawings reasonably required for the submission of the tender.

The scope of the project includes the following works but is not limited to:

- Engineering services, support of the INVESTOR for the preparation of the foundation with load and size information, preparing of all relevant documents and maps, supply and installation of the equipment and materials.
- Connecting the plant to the heating network, to the internal electrical panels, water and sewage system (if applicable), etc.
- Tests on completion of the new plant and connection to the heating network;
- Training INVESTOR staff for the operation and maintenance of the plant;
- Supporting in operation of the plant during the Defect Liability Period (DLP);
- Providing complete documentation to operate and maintain the plant;
- Supply of recommended spare parts and consumables;

The main components of the plant are:

- Biomass gasifier generator set with approx. 50 kW electrical gross output completely pre-fabricated in a container consisting of an intermediate biomass storage, fuel conveyer, gasifier, cooler, engine, exhaust gas system including the stack, control&instrumentation and monitoring system; small scale electricity driven wood chipper for the chips amount to be used in the gasifier
- **Option package 1** to be offered: Testing program and gasifier adjustment for the fuel switch from wood chips to rice husk (briquettes or pellets)
- **Option package 2** to be offered: Connection from the container to the internal water system (distance see ANNEX 4) to use the heat including approx. 70 kW heat plate heat exchanger PN16, insulated pipes, circulation pumps, pressure holding system, armatures, expansion vessel; the existing water treatment facility (RO-system) can be used to refill the cycle.
- **Option package 3** to be offered: connection from the container to the internal electrical panel, cabeling (distance see ANNEX 4), cable reels, etc.

The INVESTOR has the right to take out each of the options packages 2-3 from the scope and contract a local party directly.

3 PROJECT INTERFACES

(See therefore also ANNEX 4).

3.1 Heating system (option package 2)

Connection to the pipe system after INVESTOR's existing water treatment plant. In Figure 1 the location of the approx. 70 kW plate heat exchanger can be seen, the hydraulic connection has to be with the blue coloured pipes.

Figure 2: Interface connection after water treatment facility

3.2 Raw water

no connection necessary

3.3 Waste water

no connection necessary

3.4 Electricity (Option package 3)

The cable from the container should be fixed on the outside of the walls in a cable tray, which is also in the scope in a high below the roof.

Figure 3: location of container

At the location of the existing emergency engine, the cable (lines in “yellow”) should cross the gangway on a height of approx. 3m and enter the room behind where the internal electro panel is located.

Figure 4: cable from container to the internal electrical panel (Option package 3)

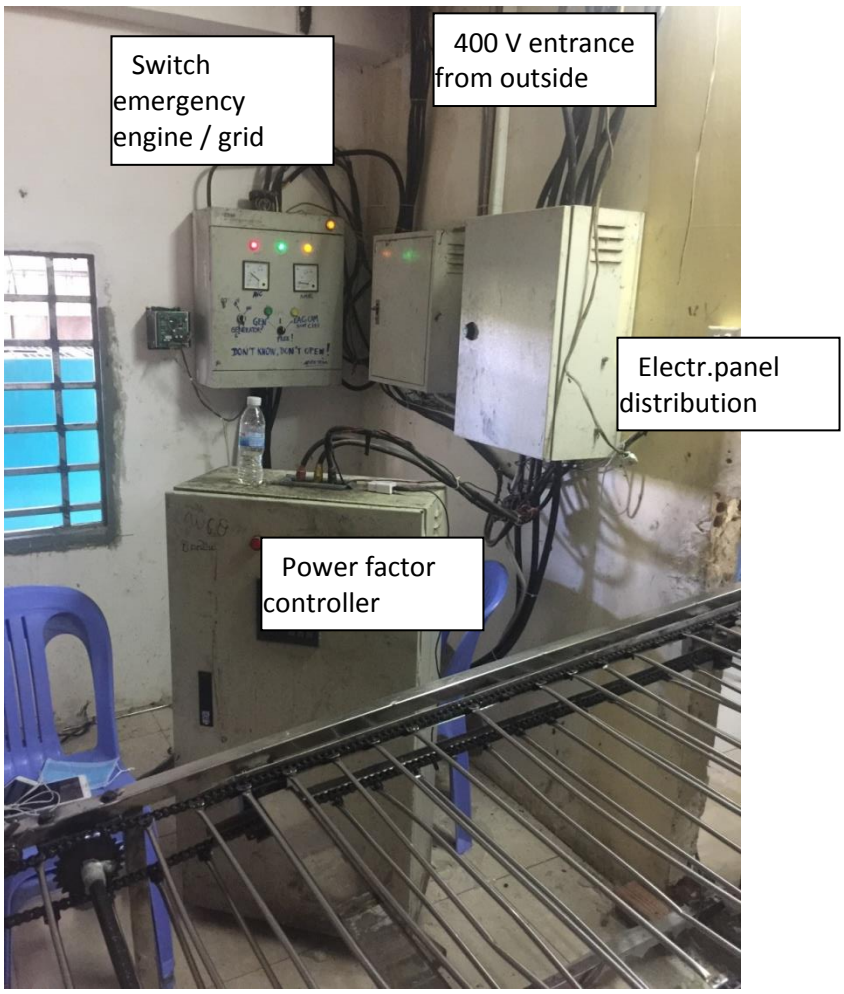

Figure 5: electro room with panels

3.5 Civil works

Upper edge of the foundations for container, plate heat exchanger and circulation pump Sizes have to be provided by the CONTRACTOR.

3.6 Biomass

Entrance in fuel storage of the container.**The CONTRACTOR has to provide a solution how the fuel can be filled into the intermediate storage inside the container.**

3.7 Telephone, communication cables, other cables, empty cables, etc:

no connection necessary

3.8 Ashes/charcoal

Entrance in ash/charcoal container(s), which is in not in the scope of supply; CONTRACTOR has to be submit information about the required size of the containers

4 DESIGN PARAMETERS

The key performance parameters in CHAPTER0 are related to the design base and preconditions. Corrections curves for different conditions during the performance test (ambient air temperature, etc.) have to be provided by the CONTRACTOR before start of the performance test.

4.1 Ambient Conditions

Following ambient conditions are the basis for the Design and for the performance parameters of the Plant inclusive the components:

Parameter	Value	Unit
Altitude (above main sea level) ; approx.	50	m
Temperatures		
Design Ambient Temperature = annual average	30	°C
maximum	42	°C
minimum	20	°C
Ambient Pressure		
Ambient Pressure at site = Design ambient pressure	1006	mbar(a)
Relative air humidity		
annual average	78	%
Maximum (in September)	85	%
Minimum (in March)	70	%
design air humidity	78	%

Table 1: Design ambient conditions

5 DESIGN FUEL

The design fuel is defined as: untreated forestry wood see Figure 6: cutted wood logs from the forest. The fuel mixture will be as homogeneous and as stable as reasonably possible so that any fuel mixture delivered to the boiler has uniform quality.

The solid fuels to be used as design of fuel are fresh wood chips.
The cutted wood logs (diameter 20-25 cm) have to be chipped (see OPTION package 4 or 5), the necessary particle size has to be provided by the CONTRACTOR.

Figure 6: cutted wood logs from the forest

DESCRIPTION Wood	UNIT	FUEL RANGE	MAX. %	Design Fuel
Carbon	% wt. d.b.	48-54	-	50
Hydrogen	% wt. d.b.	5 - 7	-	6
Oxygen	% wt. d.b.	38-44	-	42
Nitrogen	% wt. d.b.		0,35	0,33
Sulphur	% wt. d.b..		0,1	0,07
Chlorine	% wt. d.b..		0,02	0,02
Fluorine + Bromine	% wt. d.b..		0,001	0,0008
Bulk density	kg/m³	250 - 300		300
Size				Will be chipped
Ash	% wt. d.b.	1,0 - 3,0		1,5
Water content	% wt. a.r.	30 - 55		35
LHV	MJ/kg	7,5 - 13		11,1

% wt d.b. means : weight percentage - dry basis
% wt a.r.means : weight percentage - as received

Table 2: Design fuel wood

CONTRACTOR will offer an Option package 1, which includes attesting and adjustment program to substitute step by step wood chips with other kind of biomass e.g by products from cashew production, etc. future target is to substitute wood chips with other biomass fules, which are available as biomass byproducts at AMRU company.

6 KEY PERFORMANCE PARAMETERS

Definitions

Electrical net efficiency η_e:= produced electricity (net) in kWh / fuel input in kWh

Total efficiency η_t:= produced heat in kWh_{th}+produced electricity (net) in kWh / fuel input in kWh

The key performance parameters of the plant are quoted in the
Table 3**:** Performance Indicators of the CHP, which are subject to Liquidated Damages (LDs) are named with "Guaranteed Values".All other technical data in the Technical Specification, apart from the guarantee values specified are not to be understood as guarantee values, they shall only be seen as guide values for information only.

Performance indicatorsfor CHP	Minimum requirements	Guaranteed Values
Guaranteed heat output at exit of container to a forward design temperature of 95°C	60 kWt	……
Guaranteed net electrical power output at design base at 100% nominal load (heat cooled with air cooler); the 50 kWe is the net output also including the average self demand of the electrical chipper	50 kWe	…….
Total electrical net efficiency at nominal load	22%	……
Total overall net efficiency at nominal load	80%	……

Table 3**:** Performance Indicators of the CHP

6.1 Verification of the guarantee values subject to Liquidated Damages (LDs)

- The performance test shall be carried out during plant operation under normal steady state conditions.
- Performance guarantees will be considered as average values over the performance test period.
- The fuel weight and the water content of the feedstock will be measured during the performance test.
- Measurement tolerances will be defined according to EN 12952 Standard. Verification will be done with the instruments and measuring equipment used for intended operation.
- The duration of the test is defined with 8 hours, which includes 4 hours with electricity production only (heat will be cooled with the air coolers) and 4 hours with heat production to the external plate heat exchanger. If during the agreed performance test the heat delivery to the heat exchanger is not possible then the performance test for heat will be obsolete.
- The CONTRACTOR shall provide ONE WEEK before starting with the test run CORRECTION CURVES concerning deviation from the DESIGN CONDITIONS.

6.1.1 Guaranteed Electrical Power Output (net)

Verification will be done by measurement at the control panel of the gasifier genset.

6.1.2 Guaranteed Heat Output

Verification will be done by measurement at the heat meters located at the exit of the container. Measuring the heat will be done according DIN EN 1434 or equivalent norms.

6.1.3 Guaranteed Electrical Efficiency (net)

The electrical efficiency of the plant is defined as the ratio of total electricity (net) produced by the plant and the fuel heat input as given in the design load case during the performance test.
The guarantee value for the Electrical Efficiency (η_{el}) in % at nominal load (100%) is defined as:
η_{el} [%] = Electrical net power output [kWh] / (design fuel quantity [kg]* LHV [kJ/kg]) x100 during the performance period of 4 h.
The net electric efficiency is measured and calculated with the fuel input in kWh and the produced electricity indicated by the measurement instruments at the control panel during the performance test period. The fuel, which will be used for the performance test will be weighted before also the water content of the material. The CONTRATOR has to provide a test facility for water content, which remains in his ownership.

6.1.4 Guarantees Total Efficiency (net)

The total efficiency of the plant is defined as the ratio of (produced heat in MWh_{th} +produced electricity (net) in MWh) / fuel input in MWh
The gross electric efficiency is measured and calculated with the fuel input in MWh and the produced electricity indicated by the measurement instruments at the control panel and the heat measured at the heat meter during the performance test period.

6.1.5 Guaranteed plant availability

Over the first year of operation after PAC is guaranteed based on following availability definition. A reasonable scope of spare and wear parts, which should be available at side should therefore be offered by the CONTRACTOR. The spare and wear part package is limited to 5% of the contract value. If an unforeseen substantial break done of the equipment happens then the availability test can be relaunched one time.

The CONTRACTOR guarantees therefore an average time availability ZF(b) of

..%.

To ensure clarification or interpretation provisions the time availability is referred to in the following formula, taking into account the below clarifications, conditions, and exclusions.
Definition:
ZF(b) time = availability based on full load power ZF(b)=(T2J-TNV(b)) / T2J
T2J = 8760 h (first year after PAC)
TNV(b) = Non-availability relative to full-load power
TNV(b)=TNVP(b) + TNVA(b)
TNVP(b) the plan proportion of NV time TNVP is the amount of time in the system because of long-term planned measures out of service like a revision or general plant standstill because the factory is not in operation.
TNVA(b) the non-plan portion of the NV time TNVA is the period of time in which a plant is not in operation due to errors, damages or other measures.

7 REQUIREMENTS CONCERNING EMISSIONS

7.1 Noise emission limits

The noise emission should approach to Good International Industry Practice (GIIP) according ANNEX 1: Environmental, Health, and Safety Guidelines – IFC (Worldbank) defined in ANNEX 2: United Nations Industrial Development Organization (UNIDO); TERMS of REFERENCE (ToR) signed between UNIDO and INVESTOR and should also fulfill ANNEX 3: Cambodian secondary legislation concerning exhaust gas limits and noise emission limits.

7.2 Exhaust gas emission limits

The exhaust gas emission should approach to Good International Industry Practice (GIIP) according ANNEX 1: Environmental, Health, and Safety Guidelines – IFC (Worldbank) defined in ANNEX 2: United Nations Industrial Development Organization (UNIDO); TERMS of REFERENCE (ToR) signed between UNIDO and INVESTOR and should also fulfill ANNEX 3: Cambodian secondary legislation concerning exhaust gas limits and noise emission limits.

8 ENGINEERING SERVICES

The CONTRACTOR is responsible for the preliminary and final design under consideration the conditions defined in ANNEX 2: United Nations Industrial Development Organization (UNIDO); TERMS of REFERENCE (ToR) signed between UNIDO and INVESTOR.
The CONTRACTOR shall present a detailed technological scheme of the proposed solution, specification of equipment to be supplied and a statement that the specification (scope of supply proposed) is complete and guarantees complete delivery of materials for completion of the works.
The final design shall be in accordance with the Good International Industry Practice (GIIP) Standards

9 APPLICABLE NORMS AND STANDARDS

The European directive on machinery (2006/42/EC) has to be applied. Therefor all components of the container have to be marked with the CE label according to the EC directive on machinery. Other applicable EC directives together the EC directive on machinery are inter alia:

- EC directive on pressure equipment 2014/68/EU)
- EC directive on low voltage (2014/35/EU)
- EC directive on electromagnetic compatibility (2014/30/EU)
- All other applicable EC directives

European harmonized standards have to be applied according to the relevant EC directives.

The technical documentation has to be elaborated by the plant supplier and must be in accordance with the EC directive on machinery respectively other relevant EC directives.

10 MAIN COMPONENTS OF THE PLANT TO BE SUPPLIED

The main components have to be descriped by the CONTRACTOR consisting of

10.1 Container(s) incl. interfaces

10.2 **Fuel storage inside the container**: there should be an acoustic/optic alarm if the fuel storage gets empty

10.3 Main conveyor incl dosing chamber

10.4 Gasifier

10.5 Gas cooler

10.6 Engine – Generator Set

10.7 Air cooler

10.8 De-ashing/charcoal incl. expected charcoal quality

10.9 Electrotechnique and control system

10.10 Spare Part package

The CONTRACTOR shall submit together with the technical offer the list of spare parts and consumables for operation and maintenance with unit prices recommended within the DLP (defect liability period) for fulfilment the availability guarantee value. The value of the spare part package should not exceed 5% of the contract value.

The list shall also specify the maximum delivery periods.

The CONTRACTOR shall provide all the special tools and instruments that are required to perform the construction works and installations. The list of special tools shall be included in the technical offer.

11 FRAME CONDITIONS FOR THE OPTION PACKAGES

11.1 Water connection to heat exchanger

- **Pipes:** The basic norm for this system is the EN 13445 – 3 for unfired Pressure Vessels – Part 3. The Pressure Holding systems have to be mounted in the return flow. The pipes should be carefully installed, vertically or horizontally, and positioned parallel when possible. The pipes should be easily removable without causing any degradation of the walls. Each pipe must be installed with a standard small slope in order to empty in one or several points. Each low point should be equipped with a bleed valve.
    - Strainers must be easily accessible. Handles, loops, or a linear expansion compensator will absorb the thermal expansion of the pipes.
    - The insulated pipes should always be installed with enough space to permit the installation of insulation.
    - Pipe must be connected to the ground in order to ensure the electrical equipotential.
    - The sealing of flange assemblies will be done with expanded graphite seal reinforced with high-performance fibres.
    - At each connection steel/copper pipe, neutral connections will be installed in order to avoid electrolysis.
    - The type of fixing collar or other fastener will be adapted to the type and diameter of the pipe and the nature of the space in which it is located, but in all cases, it will include a removable portion to allow removal of the pipe.

- **Insulation of Hot Water Piping:** Every hot circuit must be insulated. The valves, sleeves, manifolds, etc. shall be protected with specific pieces to ensure safety of operators but only for steam pipes.
    - The pipes must be insulated the entire length of line to limit the heat loss. Heat and water hoses must not be isolated within the same sheath.
    - All piping and piping elements and pressure vessels etc. shall be insulated. Exempted from insulation are pumps, strainers, flanges, valves, sleeves, manifolds and the tanks for water treatment and the pressure holding and expansion system. Where flanges are used, the insulation shall allow disconnection of the flanges without damaging the insulation.
    - Pipe insulation shall be fastened with galvanized steel bands or wires.

Pipe size	mm
DN 15-20	40
DN-25-32	50
DN-40-65	60

    - the insulation must have an aluminium finish.

- **Pumps:** Casing - spheroidal graphit iron; Shaft – steel; the pumps are equipped with flexible coupling incl. protection, foundation plate for the pump and the electric motor – (three phase AC current - with squirrel cage rotor) equipped with frequency converter according to EU regulations. The operating or duty point of the pumps shall be at 80 % of the maximum necessary capacity.
- **Heat meters and thermo-sensors**: The norm EN 1434 applies to heat meters and thermo sensors.
- **Manometers**: The manometers to be supplied shall be compliant to the EN 837 standard.
- **Welding**

- Qualification of Welders
  - All welders shall be experienced and qualified in accordance with the requirements of EN 287 (or equivalent).
- Qualification of Welding Procedures
  - The CONTRACTOR shall submit at least 1 month prior to starting with welding works the detailed welding procedure specifications complying with EN 288-3. All dimensions, all combinations of materials to be joined, and all welding processes shall be covered by the specifications.
- Welding Responsibility
  - The CONTRACTOR is responsible for all tests required for qualification of welding procedures and qualification of welders, including, as required, re-qualifying welders.
  - Welding procedures shall together with approval records be presented to the INVESTOR prior to any welding activities.
  - Pipes

11.2 Electrical connection

- **Cable Trays**
  - The cable trays will be used at 70% of its capacity in two-ways:
  - If the laying is in the inside: cable trays must be zinc plated, accessories must be galvanized.
  - If the laying is on the outside: cable trays and accessories must be hot-dip galvanized after machining (thickness of zinc: 55 microns minimum, certificate to be supplied) or in Stainless Steel 316L passivated.
  - Threaded rods are not allowed to support the cable trays.
- **Electrical Requirements**
  - **Potential Equalization** :All steel pipelines will be interlinked with each other, as well as with the earth conductor.
  - **Electrical Protection:** All circuits shall be protected against overload, short circuit, and indirect contacts. They must be protected against overcurrent with omnipolar cut-off switches. Each electrical conductor should be protected in each sector. The protective devices must remain fully effective and must comply with the following rules:
    - The interrupting capacity of the protection device must be equal (or higher) to the assumed maximum short-circuit current at its point of installation
    - The interrupting time for a short circuit occurring at any point in the installation should not exceed the time it takes to raise the temperatures of the conductors at the maximum allowable value
    - All electrical facilities will be dimensioned accordingly so that it can withstand the impact of electromechanical and thermal effects of short-circuit currents. The distribution network will be protected against the failures between phases and against earth fault.
    - It should be ensured that all electrical facilities allow a total selectivity at all voltage levels, including auxiliary voltage.

- **Electromagnetic Compatibility**
  - The electrical facilities should not disturb or be disturbed at EMC level and should be compatible with the Directive EMC 89/36 CEE. This equipment will not cause or suffer from conducted or radiated disturbances.
  - The electrical installation shall be designed, constructed, and fitted in order to take all necessary precautions to limit the risk of conduction of harmonic current or radiation of electromagnetic waves. The concept of equipotential bonding, grounding connection, measuring loops, and cabling rules will be carried out with particular attention.
  - All necessary resources will be employed in order to ensure that the THD rate is below 5% in all parts of the low voltage grid.
- **Electrical Cabinets**
  - The electric switchboards are placed in metal cabinets to prevent equipment damage. All user controls and meter lights are clearly visible and readily discernible in the front of the cabinets.
  - The IP codes of the cabinets and metal boxes should be at least IP 30.
  - The CONTRACTOR must foresee in each cabinet a power reserve of 20% for the adding of extra devices.
  - The main circuit breaker is always placed in the upper range of the equipment.
  - As with any device containing an outside general interrupting system, this one must be equipped with a locking device which allows 3 locks in the open position.
  - If the general interrupting device is a disconnector, it contains the auxiliary contacts needed to interrupt the power. Those auxiliary contacts must open before the main contacts.
  - The electrodynamic strength of the device and the breaking capacity of the protections is sufficient in order to contain any short-circuit current at the connecting point between the switchboard and the alimentation line.
  - The insulation nominal voltage of the electrical panel and the specific voltage of the electrical equipment are at least equal to 400 V (AC).
  - The different levels of electrical distribution are clearly separated in clearly identified areas, protected with a circuit breaker
- **Plans Pocket**
  - The electrical diagrams, as well as intervention sheets for personnel, shall be available inside each electrical cabinet. They are provided with special protection and they are thus weather-proof.

12 SITE WORKS

12.1 Consumables during implementation phase

The costs of consumables of water, electricity, waste water, etc until start of hot commissioning will be covered by the INVESTOR.

12.2 Site Preparation

The INVESTOR shall provide protected storage of all equipment of the CONTRACTOR including, materials, pipes, fittings, etc. during the implementation of the works until the PAC.

13 TRAINING AND SUPPORT IN OPERATION

The CONTRACTOR shall organise a training programme for the staff of the INVESTOR for 5 nominated persons. The draft training programme should be presented in the technical offer. The draft training programme should include at least:

- One week of staff training in operation, including the manual (in English language);
- The training consists of a theoretical and a practical part. The practical part includes the participation of relevant staff during the site tests (pre-commissioning) and commissioning.
- The above-mentioned manuals could be improved by staff and trainer suggestions.
- Processes of interactions of the 3 heat sources and the fuel supply systems;
- Operation modes under different load conditions;
- Procedures for start and operation;
- Major emergency cases and responses to them, awareness for potential major risks and related response plan;
- Safety elements and equipment;
- Monitoring and control systems and their use in troubleshooting;
- Standardised test procedures for different equipment;
- Preventive maintenance procedures
- Maintenance planning and work;
- Instructions for replacement and repair of wearing parts;
- Impact of fuel quality;

The CONTRACTOR shall provide operational support to the INVESTOR during the Defects Liability Period (DLP):

- A remote monitoring should be done via the installed SCADA system. The CONTRACTOR shall describe its function and services in the technical offer and should include it in the financial offer.

14 PROJECT DOCUMENTATION

14.1 Documentation

The CONTRACTOR shall provide comprehensive documentation in accordance with the present section and with the requirements of the General and the Special Conditions of the Contract.

All calculations, drawings, manufacturer's specifications, minutes of meetings, certificates and other documentation specified in the Technical Specification and in Special Conditions shall be included in the final documentation and shall be provided in 5 complete sets in binders. The documentation shall also be provided in electronic form where written text shall be in Microsoft Word, calculations in Excel, and drawings in AutoCad. The electronic form shall be on a CD or flash disk suitable for Microsoft Office software.

Documentation shall be prepared and delivered to the INVESTOR for approval, as a draft version before start of hot commissioning and the final version latest 4 weeks before PAC the as-built documentation in accordance with the Contract Special Conditions. Modifications may be requested in case the INVESTOR finds the documentation not in compliance with the requirements of the Contract.

14.2 Operation and Maintenance Manuals

The CONTRACTOR shall deliver O&M manuals: three (3) sets in English. The manuals shall be both in hard copy and in electronic form and shall include as a minimum:

- Catalogue information about the equipment
- Operation and Maintenance Guidelines and Instruction.

15 TECHNICAL DATA SHEETS

The Tenderer shall fill in the following technical datasheets for each equipment listed below. Technical datasheets should be part of the technical offer.

15.1 Gasifier container

Performance guarantees at design base and with design fuel:	**Unit**	**prescribed design data (minimum requirment)**	**technical data of TENDERER**	**comments of TENDERER**
Heat output at 100% load	kWt	60		
Electrical net output 100% load	kWe	50		
Total efficiency (interface container) at 100% load	%	80		
Electrical net efficiency at 100% load (heat is 100% air cooled)	%	22%		
Guaranteed time availability ZF(b)	%	90%		

Container No 1	**Unit**	**prescribed design data**	**technical data of TENDERER**	**comments of TENDERER**
Content :				
Lenght	m			
Width	m			
Hight	m			
Weight	kg			
Amount of openings				

Container No 2 (if applicable)	**Unit**	**prescribed design data**	**technical data of TENDERER**	**comments of TENDERER**
Content:				
Lenght	m			
Width	m			
Hight	m			
Weight	kg			
Amount of openings				

Container No 3 (if applicable)	**Unit**	**prescribed design data**	**technical data of TENDERER**	**comments of TENDERER**
Content:				
Lenght	m			
Width	m			
Hight	m			
Weight	kg			
Amount of openings				

Fuel storage and conveyer system		**prescribed design data**	**technical data of TENDERER**	**comments of TENDERER**
Max.fuel mass flow	kg/h			
Storage size	m3			
Diameter of screw to the dosing chamber	cm			
Sie of dosing chamber	m3			
Material of storage				
Material of conveyer				

Gasifier		**prescribed design data**	**technical data of TENDERER**	**comments of TENDERER**
Type				
Max. temperatur in gasifier	°C			
Gas temperatur out	°C			
Ash removal (automatic <….)				
Biomass loading (automatic,…)				
Syngas production	Nm3/h			
Syngas composition based on design fuel				
Syngas composition based on design fuel				
Material of gasifier				

Gas cooler		**prescribed design data**	**technical data of TENDERER**	**comments of TENDERER**
Type				
Gas temperatur IN	°C			
Gas temperatur OUT	°C			
Heat exchanged	kWt			
Material of heat exchanger				

Generator Engine set		**prescribed design data**	**technical data of TENDERER**	**comments of TENDERER**
Type of engine				
Power Rating / Rpm	kWe/Rpm			
Generator	°C			
Type of generator	kWt			
Nominal Power				
Power factor				
Voltage	V			
Frequency		50 Hz		

Wood chipper

Electric Chipper	Unit	prescribed design data	technical data of TENDERER	comments of TENDERER
type				
capacity	t/h	0.2		
Electrical demand per hour full load	kWh			
Connection power	kWe			

15.2 OPTION package No 2 : heat connection

Feed water system	Unit	prescribed design data	technical data of TENDERER	comments of TENDERER
max temperature	°C	95		
Temperature difference	K	35		
Pipe diameter	DN			
Pipe material				
Heat exchanger type		plate		
Heat exchanger capacity	kW	70		
Heat exchanger size lenght, width/hight	m/m/m			
Static pressure	bar	2		
Pump type				
Pressure holding: The basic norm for this system is the EN 13445 – 3 for unfired Pressure Vessels – Part 3. The Pressure Holding systems have to be mounted in the return flow.				
expansion vessels	pcs			
pump	kW			

15.3 OPTION package No 3 : Electrical connection

Electro cabeling	Unit	prescribed design data	technical data of TENDERER	comments of TENDERER
type of cable				
type of cable trays				

Annexes

ANNEX 1: Environmental, Health, and Safety Guidelines – IFC (Worldbank)

ANNEX 2: United Nations Industrial Development Organization (UNIDO); TERMS of REFERENCE (ToR) signed between UNIDO and INVESTOR

ANNEX 3: Cambodian secondary legislation concerning exhaust gas limits and noise emission limits

ANNEX 4: Conceptual positions of the gasifier and connection points