

Commercial Proposal

Solar Powered Drinking Water Treatment Plant RPWT2C-5000 Kochi Kerala India

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Index

Item	Content	Page
Section 1.	Introduction	
Section 1.1.	Project Background	
Section 1.2.	Regen Power's Profile	
Section 2.	Initial Investment	
Section 2.1.	Brief Introduction	
Section 2.2.	Major Components	
Section 2.3.	Civil Work	
Section 2.4.	Cost Composition	
Section 3.	Operational Expenses	
Section 3.1.	Fuel Consumption	
Section 3.2.	Consumables & Periodical Expenses	
Section 4.	Economical Analysis	
Section 4.1.		
Section 4.2.		
Section 4.3.		

1. Introduction

Clean drinking water is a basic human need, and its availability is a critical factor for reducing water borne diseases. Water used for drinking should be treated and disinfected before consumption. Water used for drinking should also be professionally tested for quality as there may be concentrations of naturally occurring elements such as arsenic, uranium, or nitrates, which exceed health criteria.



It is estimated that more than 60% of the population in remote areas is without access, or have inadequate access, to clean drinking water. Water is drunk directly from rivers and streams without being cleaned, or it is collected and boiled. In developing countries, impure water is responsible for 2.5 million deaths per year.



One of the biggest challenges facing about 1.6 billion people living in remote areas living in the world is the lack of sustainable energy supply (energy that is accessible, cleaner, more efficient and affordable) for services such as water pumping and treatment



Regen Power introduces AcquaSmart - a clean sustainable solution to provide clean drinking water to remote areas. AcquaSmart is powered Regen's patented Hybrid Energy system which combines renewable energy sources such as Solar Photovoltaic , Small Wind Turbines , Micro Hydro with our innovative Variable Speed Generator technology. The system results in the lowest cost of production of drinking water meeting WHO standards. The system can be used to provide bottled water in recyclable plastic bottles to remote village households at an affordable price.

Regen is also able to combine power and water supply- in which case most of the water pumping and treatment will occur during the sunshine hours. The battery storage requirement will be minimised in order to cut down on the capital cost.



1.1. Project Background

The Kochi district administration has been actively considering a solar energy based projects to purify water in granite quarries. Professor C. V. Nayar, Chairman and Managing Director of Australian based renewable energy company, Regen Power Pty Ltd visited one of the quarries at Ambalappara near Kakkandalong with the District Collector Mr. P.I. Sheikh Pareeth and the Assistant Collector Mr. G.R. Gokul.



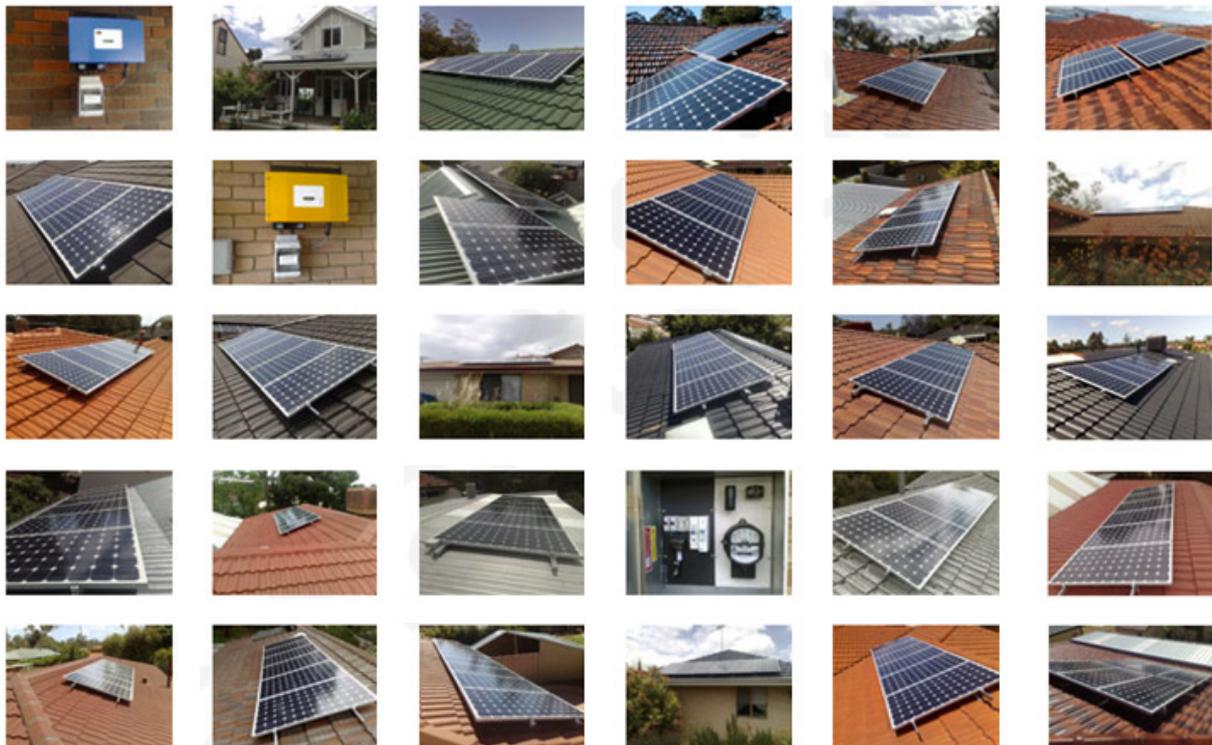
Dr. Nayar was asked to submit a detailed proposal through Regen's Indian partner Transdotto give for a pilot project to treat about 5000 litres of water per hour. Total daily production will be 30, 000 - 50,000 litres depending upon the number of hours of operation.



1.2. Regen Power's Profile

Regen Power was established in 2003 and is renowned for both innovation in the field of renewable energy in Australia. The company has secured its market share in Western Australia, NSW and Queensland under the leadership of founding Managing Director, Professor Chem Nayar, who has over 30 years experience in applied research and commercialisation of alternative energy sources. Regen provides a wide range of products for solar energy systems including solar panels, inverters, charge controllers, and wind turbines for both urban electricity grids and remote area off grid PV market systems at very competitive rates.

To date, Regen has installed and maintains over five thousand residential rooftop Solar PV systems in Australia. Regen has designed, installed and commissioned several commercial rooftop solar photovoltaic installations including a 100kW installation on a warehouse in Sydney. Regen is one of the most experienced companies in the world providing complete solutions to micro-grid systems by combining and integrating different renewable energy technologies and sources such as solar, wind and micro-hydro technologies. Regen installed one of the largest solar hybrid power system in Western Australia using this concept at the "Eco Beach Wilderness Resort" out of Broome, 2200 km north of Perth. Regen was also involved in the design, engineering and installation of three remote islands in the Republic of Maldives which were commissioned in August 2007.



Case Study: Thousands of Residential PV Systems installed by Regen WA, NSW, QLD of Australia

Regen’s expertise in the field of remote area renewable energy electrification has been drawn from various research activities and publications of our director Prof Chem Nayar (over 30 years of vast experience in this field) and Regen Power Intellectual Property (IP), which includes US Patent titled ‘Power conversion system and method of converting power’ (US Patent Number - 7,072,194 granted in 2006), “A Power Management System and Method for optimising fuel consumption, (PCT/AU2011/001068) and “Variable Speed Gas Turbine Generation System and Method” (patent pending). Professor Nayar was awarded the auspicious Ambassador Award 2011 for an ‘outstanding individual that has, through philosophy, attitude, behaviour and action shown commitment and leadership in the areas of sustainable energy, energy efficiency or greenhouse gas abatement / mitigation.’

Regen Power can provide engineering and consulting services in the field of renewable energy and energy efficiency. It strives to meet its customers’ needs by providing tailor-made solutions. We provide total engineering solutions by integrating various technologies for power management with information & communication technology for increased operational reliability and efficient energy management. The services include :Business Energy Audit, Project Consultation, Feasibility Study and Analysis, Engineering and Design, Installation and Commissioning.

Regen Power has close association with educational institutions such as Curtin University, Murdoch University, Regional TAFE (South Australia), Hefei University (China), PNG University of Technology etc.



**Case Study: Veteran Retreat Project
WA, Australia, Off-grid**



**Case Study: Solar Vila Project
WA, Australia, On-grid**



**Case Study: Hybrid Off-Grid System
Three islands, Maldives, Off-grid**

Regen Power has come up with an innovative solution to save fuel in a diesel generator by running the engine at variable speeds in response to the variation electrical load demand. The product available from 8kW to 300kW is marketed under the brand name, Hybrid-Gen, which was awarded the Sustainable Energy Industry Association Product and Technology Award 2011 as the most innovative new renewable energy product introduced to the market.

There are a number of applications for which power demand varies greatly that can benefit from Hybrid-Gen. Examples of such applications are:

- staff accommodation on oil, gas and mineral exploration sites;
- construction sites where electrical demand fluctuates day and night;
- remote villages, islands, houses, cabins, and
- mobile telecom towers.
- Solar Diesel Hybrid water pumping for irrigation
- Solar Diesel Hybrid water treatment plants

Some of the recent projects undertaken by Regen Power using the variable speed generator (Hybridgen) are:

- Telecom BTS projects implemented in India, Sri Lanka, Vietnam and Singapore
- Remote Micro-Grid Facility in PulauUbin Island, Singapore
- 6kW Solar/Diesel Hybrid Power Meentheena Station Veterans Retreat, Western Australia
- Solar Hybrid system for the 60 kilometres of haul road between BC Iron Nullagine Iron Ore project and FMG's Christmas Creek, Western Australia



Case Study: BTS Project
Sri Lanka, Off-grid

Regen Power has several commercial partners in different countries. Our important partners include:



Daily Life Renewable Energy Pvt Ltd. Singapore



Carbon Recycle Energy Co. Ltd. China



High Hope International Group China

2. Initial Investment

In this part we will calculate the initial investment to establish the proposed water purification set at Kochi, Kerala, India.

The initial investment consists of:

- cost of major components
- assembling & pre-wiring charges
- logistics charges
- local service charges
- civil work cost

In general, Regen Power's responsibility is to provide the equipments of PV modules, mounting racks, whole water purification set, and a multi-functional modified container. We will also provide local services of commissioning and testing these equipments, but excluding civil work of building foundation, building shed, and installing the PV modules.

For the goods and services within Regen Power's responsibility, we will provide detailed information and proper calculation. For those out of Regen Power's range, we will give rough but reasonable estimation. For the civil work part in particular, we would describe the basic scope of work but will not give value estimation because such costs differ so greatly from region to region, and from country to country.

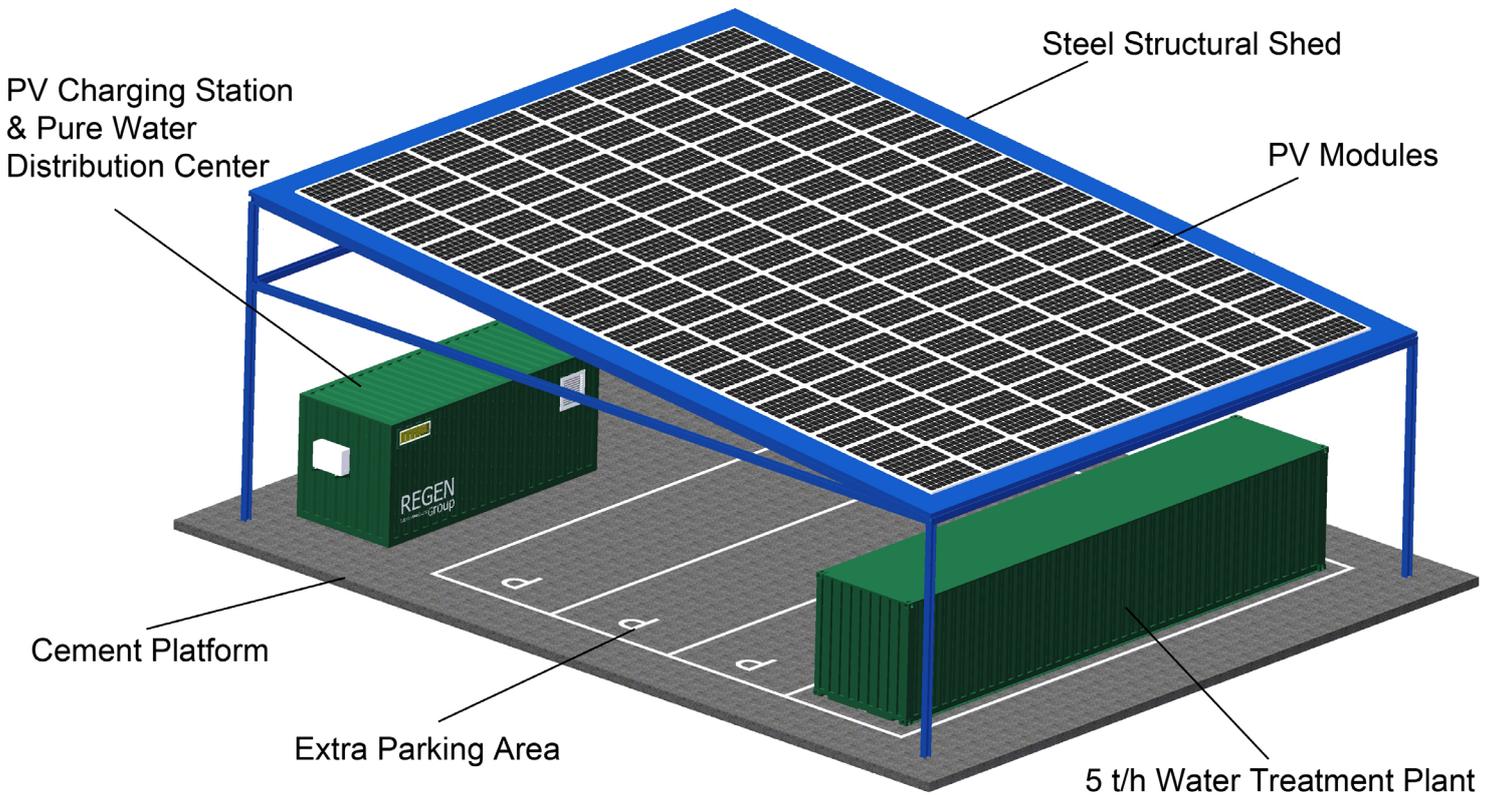
2.1. Brief Introduction

The water purification set we designed and proposed can meet the following technical parameters:

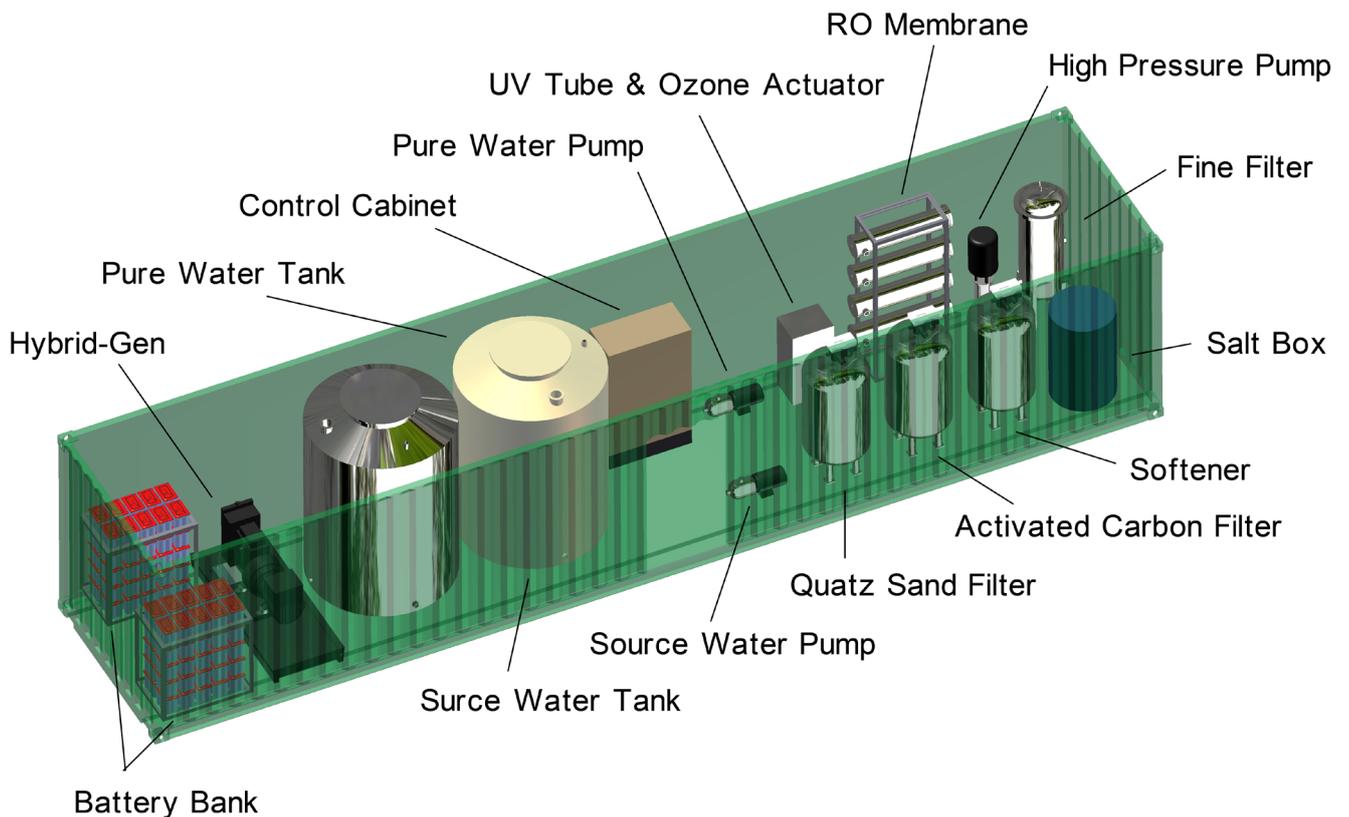
Input Water:	river, pond, stream, canal, lake, and sub-surface water
Output Water:	$\leq 20\mu\text{S}/\text{cm}$, drinkable water as WTO standards
Outflow Rate:	$\geq 5000\text{L}/\text{h}$ (25°C)
Productivity:	$\geq 25\%$
Mounted Size:	11800 * 2300 * 2300 mm
Mounted Weight:	8000 kgs
Operational Mode:	automatic & manual switchable
Power Source:	grid-power or diesel generator

Also we supply an effective and efficient renewable-energy power solution by adopting PV modules as the primary power source, OPzV battery as the energy storage medium, and Regen Power's patented fuel-saving variable-speed generator Hybrid-Gen as back up. Further more we will supply a multi-functional 20-foot container which includes the power control room, pure water warehouse and water distribution room.

The brief introduction of our product is as follows:



Picture 1: Water Treatment Station



Picture 2: Water Purification Set

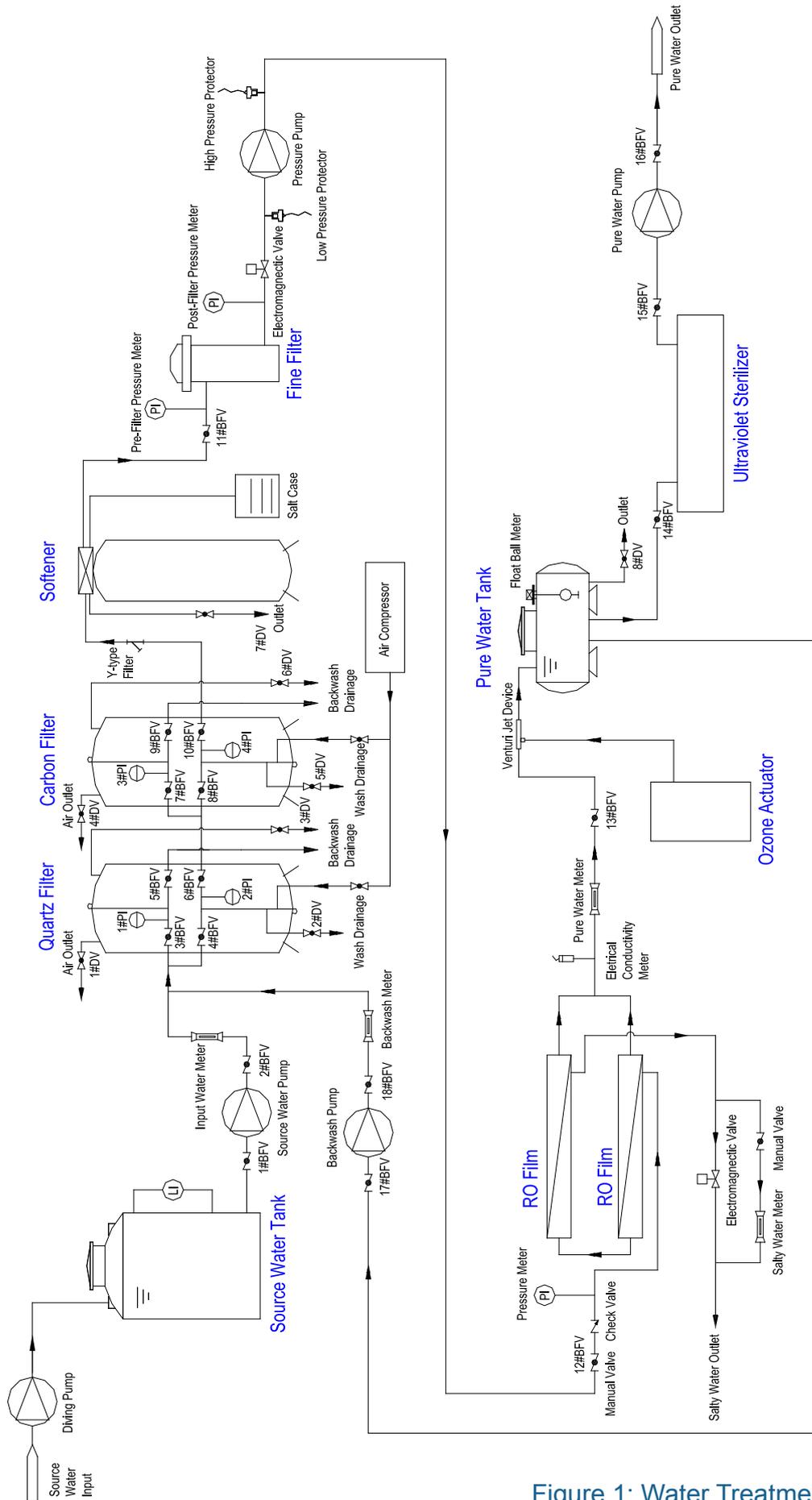


Figure 1: Water Treatment Flow Chart

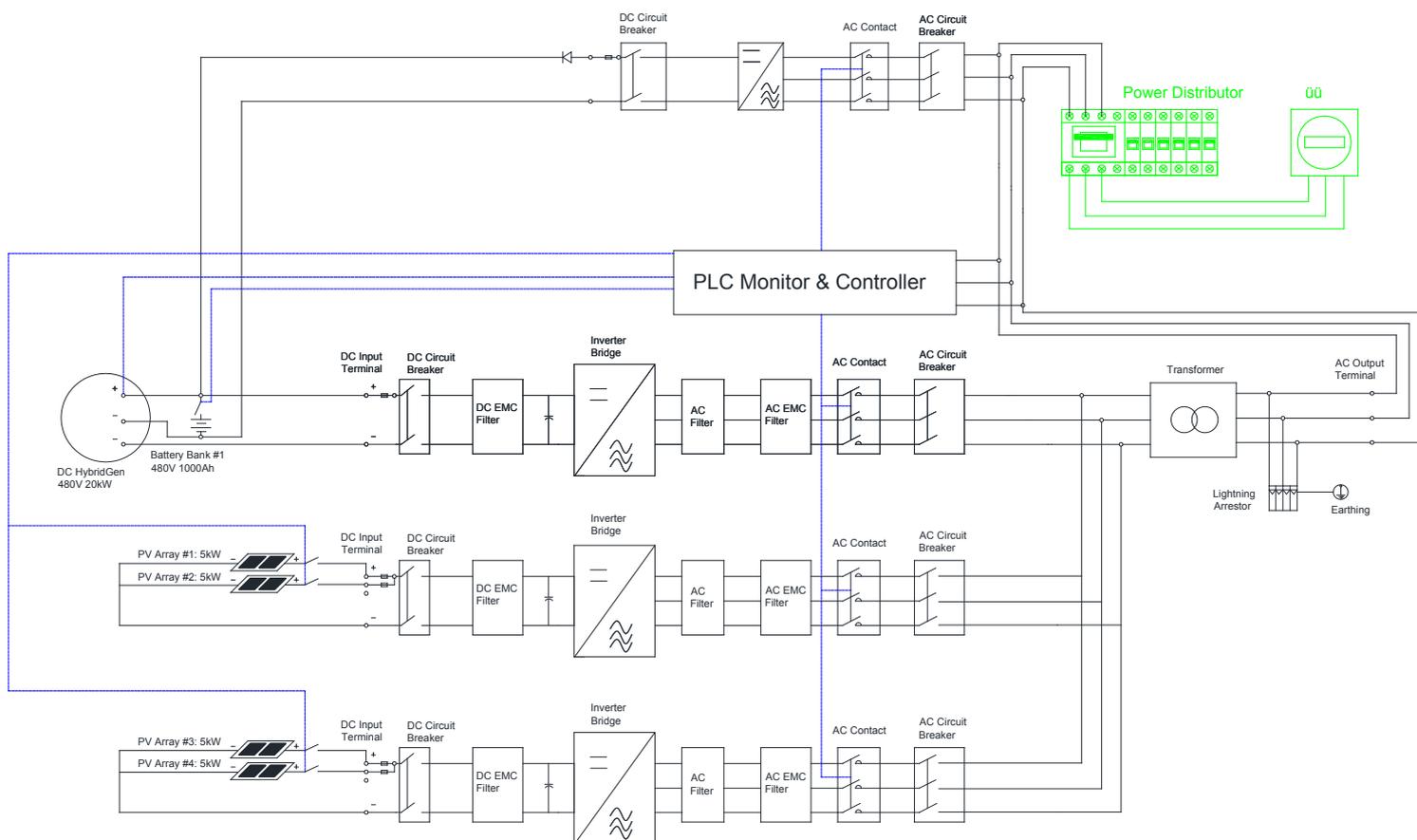


Figure 2: Power System Block Diagram

With reference of Figure 2: Power System Block Diagram, we will understand how the power system works.

The loads (diving pump, source water pump, high-pressure pump, pure water pump etc) are connected to the power distribution board. The loads will get powered under three modes:

Mode	PV Status	Battery Status	Gen-set Status	Typical Time
Solar Powering	High output	Charging	Off	Noon
Battery Support	Low or None	Discharging	Off	Morning
HybridGen Back-up	Low or None	Charging	On	Evening

PLC monitor & controller will supervise the whole power system and practice the logic as follows:

1. When PV output is higher than loads input, the loads will be totally driven by solar power and extra solar power can charge the battery. Hybrid-Gen is off.
2. When PV output is lower than loads input, all solar power will support loads, while battery is discharging to meet the balance of loads demand. Hybrid-Gen is off.
3. When PV output is lower than loads input and battery voltage is lower than a preset value, HybridGen will start up to satisfy the loads and meanwhile charge battery.

2.2. Major Components

For water purification set:

No.	Item	Specifications	Material	Quantity
1	Diving Pump	Flow: 10m ³ /h, Head: 40m	cast iron	1 piece
2	Source Water Pump	Flow: 10m ³ /h, Head: 40m	stainless steel	1 piece
3	High Pressure Pump	Flow: 10m ³ /h, Head: 80m	stainless steel	1 piece
4	Pure Water Pump	Flow: 5m ³ /h, Head: 20m	stainless steel	1 piece
5	Source Water Tank	5000 L	PE	1 piece
6	Pure Water Tank	5000 L	stainless steel	1 piece
7	Salt Box	2000 L	PE	1 piece
8	Quartz Sand Filter	φ900*1800mm	glass steel	1 piece
9	Activated Carbon Filter	φ900*1800mm	glass steel	1 piece
10	Softener	φ900*1800mm	glass steel	1 piece
11	Fine Filter	φ600*1200mm	stainless steel	1 piece
12	RO Membrane	Output: 5m ³ /h	stainless steel	1 set
13	UV Sterilizer	Flow: 5m ³ /h	stainless steel	1 set
14	Ozone Actuator	Output: 15 g/h	stainless steel	1 set
15	Pipe, Valve, Meter System		stainless steel	1 set
16	Electronic Control System			1 set
17	Hybrid-Gen	DC 480V 20kW	Perkins, Stamford	1 set
18	Battery Bank	480V 200Ah	OPzV	1 set
19	Containerization	Modified 40' container		1 set

For other parts:

No.	Item	Specifications	Material	Quantity
20	PV Module	Poly 250W	poly silicon	80 pieces
21	Mounting Rail	ER-R-4000	Aluminum alloy	24 pairs
22	Mounting Rail Joiner	ER-SP-200	Aluminum alloy	16 pairs
23	Mounting Mid Clamp	ER-IC-ST45	Aluminum alloy	144 sets
24	Mounting End Clamp	ER-EC-ST45	Aluminum alloy	32 sets
25	Tin-Roof Hook	ER-I-05	Aluminum alloy	192 sets
26	On-Grid Inverter	SMA STP10000TL		1 piece
27	Variable-Speed Driver	25kW 380V		1 piece
28	Battery Charger	480V 100A		1 piece
29	PLC Monitor & Controller			1 set
30	Multi-Functional Room	Modified 20' container		1 set



Regen's Patented Innovative Hybrid-Gen Variable-Speed DC Diesel Generator

Major Components		Physical Features	
Engine	Perkins	Max. output power	20 kW
Alternator	Stamford	Rated voltage	480 V
PLC unit	Siemens	Max. output current	55 A
Working Environment		Speed range	1100 ~ 1500 rpm
Ambient temperature	-5 °C ~ +40 °C	Battery selection	480 V 200 ~ 800 Ah
Ambient humidity	10% ~ 90%	Control mode	automatic
Installation slope	< 5 °	Start-up battery	12V 80A
Installation altitude	< 2000 m	Signal transmission	GPRS module
Grounding resistance	< 8Ω	Warranty	12 months



HYBRID GEN
Variable Speed Generator

STAMFORD[®]

Perkins[®]

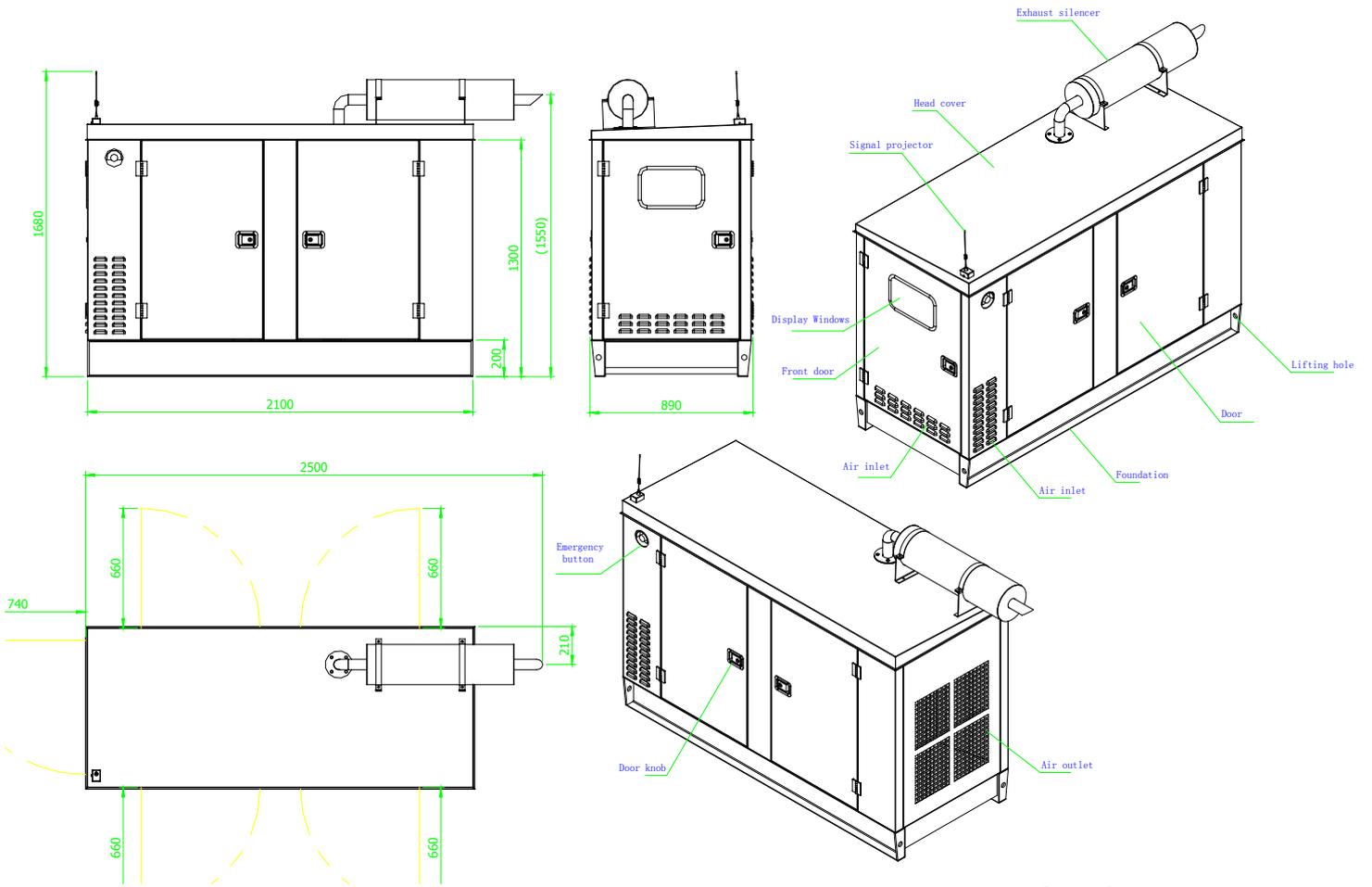


Figure 3: HybridGen Structure

Fuel Consumption L/ hour

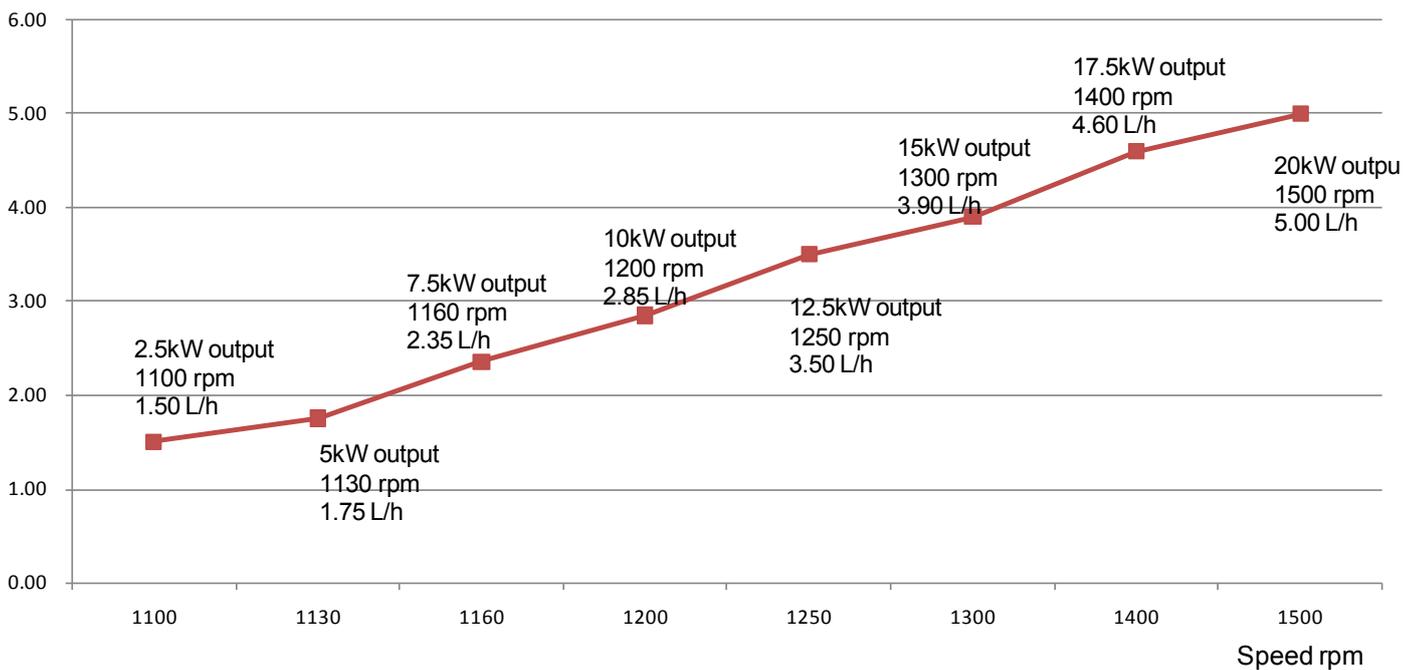
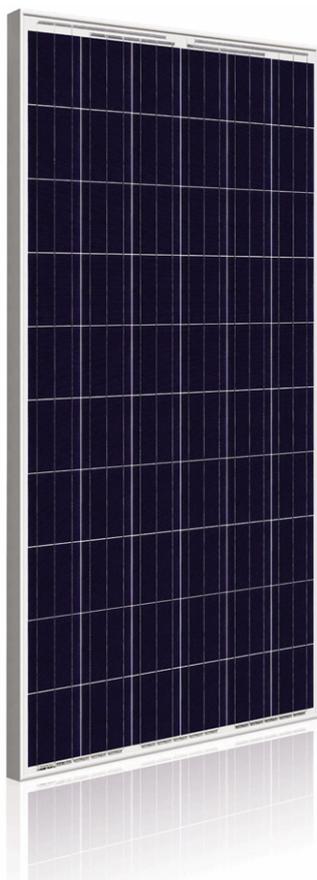


Figure 4: HybridGen Optimal Speed Curve

TYPICAL ELECTRIC PARAMETERS		MATERIALS	
Max. Power (Pm)	250W	Cell Type	156 mm poly-silicon
Tolerance	±3%	Cell Size	156*156 mm
Open circuit voltage (Voc)	37.2V	Cell Array	6*10
Short circuit current (Isc)	8.74A	Front Glass	3.2 mm solar glass
Max. power voltage (Vm)	30.4V	Encapsulation	EVA film
Max. power current (Im)	8.22A	Junction Box	with 3 bypass diodes
Temperature Coefficient of Isc	0.03% / °C	Cable	900 mm
Temperature Coefficient of Voc	-0.41% / °C	Measurement	1652*1000*45 mm
Temperature Coefficient of Pm	-0.55% / °C	Net Weight	22 kgs
Normal Operating Cell Temp.	45°C ± 2°C	Max. Voltage	1000V

WORKING ENVIRONMENT		WARRANTY	
Temperature	-40°C~85°C	IEC, UL, CE certificate	
Snow Pressure	< 2000 Pa	25 years warranty of output power (-20%)	
Wind Pressure	< 3000 Pa	12 years warranty of material & workmanship	



Hanwha Poly 250W PV Module

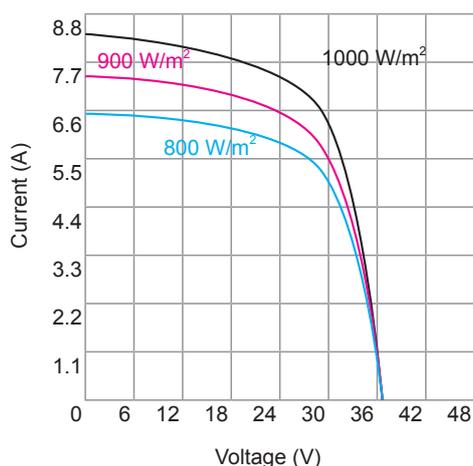
Regen Power is a long-term partner of Hanwha, also its biggest distributor in Australia. Hanwha provides both mono and poly modules at world class.

Considering the shed space in Kerala is limited, Regen engineer selects Poly 250W module which has high efficiency.

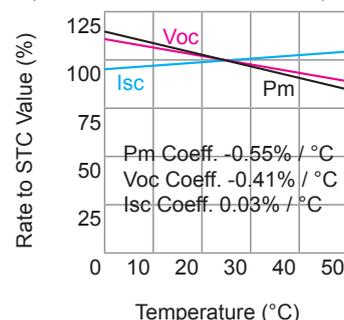
Material and workmanship warranty of Hanwha's module is 12 years, while performance warranty is no less than 25 years.



Electrical Performance at 25°C, AM1.5



Temperature Dependence of Isc, Voc & Pm at 1000 W/m², AM1.5



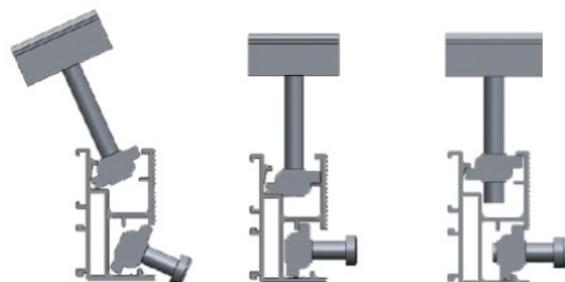
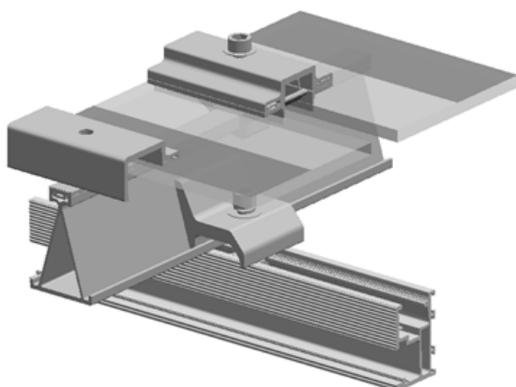
Clenergy Tin-Roof PV Rack

PV mounting structure is also integral part in the system. Considering Kochi is near the sea, and might be exposed to typhoon and corrosive air, we select Clenergy's tin-roof mounting structure. It is made by Aluminum alloy, and can withstand a wind speed of 60 m/s.

The installation of module is also convenient. Preset foundation is not needed. Modules will be mounted only through screws and clamps.



Working Environment		Physical Features	
Installation Site	tin roof	Standard	AS/NZS 1170
Roof Sheet	any type	Material	Aluminum alloy
Roof Slope	up to 60°	Supporting Rail	extruded Aluminum
Building Height	up to 20m	Color	natural
Wind Load	60m/s	Recyclability	100% recyclable
Snow Load	1.4kN/m ²	Anti-corrosion	anodic oxidation
PV Module	framed	Warranty	10 years

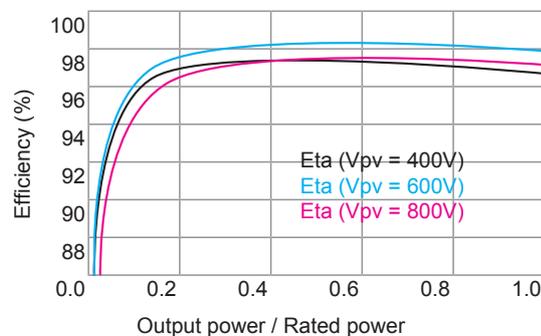




Model	STP 10000TL
Input (DC)	
Max. DC power (@cosφ=1)	10200 W
Max. input voltage	1000 V
MPP voltage range	320 ~ 800 V
Rated input voltage	600 V
Min. input voltage	150 V
Initial input voltage	188 V
Max. input current A / B	22 A / 11 A
Max. input string current A / B	33 A / 12.5 A
Number of string of MPP A	4
Number of string of MPP B	1
Output (AC)	
Rated power (@230V 50Hz)	10000 W
Max. apparent AC power	10000 VA
Nominal AC voltage	3 / N / PE; 220 V / 380 V 3 / N / PE; 230 V / 400 V 3 / N / PE; 240 V / 415 V
Nominal AC voltage range	160 ~ 280 V
AC power frequency range	44 ~ 55 Hz
Rated grid frequency / voltage	50 Hz / 230 V
Max. output current	16 A
Power factor at rated power	1
Adjustable displacement factor	0.8
Phase conductors	3
Efficiency	
Max. efficiency	98.1%
European efficiency	97.7%
Protection	
Input-side disconnection device	yes
Ground fault monitoring	yes
Grid monitoring	yes
DC reverse-polarity protection	yes
AC short-circuit protection	yes
All-pole residual current monitor	yes
General Data	
Dimension (W/H/D)	665/690/265 mm
Weight	64 kgs
Operating temperature range	-25 ~ 60 °C
Noise emission (typical)	51 dB(A)
Self-consumption at night	1 W
Topology	transformerless
Cooling concept	Opticool
Protectin degree	IP65
Climate category	4K4H
Max. relative humidity	100%
Warranty	5 years



Efficiency Curve of SMA STP 10000TL



SMA Grid-Inverter STP 10000TL

3-phase on-grid inverter comes from SMA. The Sunny Tripower series products are ideal to be applied in Kochi. 97% ~ 98% efficiency is the guarantee that PV energy will be utilized at the most.

In the future when electricity demand increases, we simply need to connect more PV module matrix into the mini-grid through another STP product.

Shoto OPzV Storage Battery 480V 200Ah

The battery we use comes from a Top 3 brand in China, Shoto who have already set up a post-service network in Asian area.

We choose GEL instead of AGM battery, since the former's life span is almost twice of the latter.

In the designed hybrid system, almost 50% of load energy uses AC power during day time. The actual DOD of battery will not exceed 25%, so a theoretically 3000 cycle times is expected.

The battery bank voltage should keep 480V. Multiple battery banks can be connected to the bi-inverter.



Reverse Osmosis Membrane Assembling



Reverse osmosis process utilizes a semi-permeable helix membrane to remove substances like dissolved solids, organic matter, colloidal matter and bacteria in the water.

When the raw water is sent to the RO membrane at a certain pressure, the water will permeate the membrane through the tiny pores and then permeated water can be collected, and the impurities in water will be concentrated and removed in the detained liquid.

- This membrane is capable of removing:
- more than 96% dissolved solids
- more than 99% organic substances
- more than 99% colloid
- nearly 100% bacteria

RO has become the first choice for water purification due to its low operation cost, no pollution, easy and reliable operation. Our RO System includes a high-pressure pump to guarantee sufficient flow rate through the RO membrane. The inlet & outlet pipes are made by stainless steel, allowing a flow rate of 5 cubic meters per hour. The plant is equipped with high pressure & low-pressure protectors.



**Case Study: PV + Wind + Genset Powered
200 L/h Mobile Water Treatment Plant
Whyalla, Adelaide, Australia**



Quartz Sand Filter Activated Carbon Filter Fine Filter Softener

The objective of the pre-treatment system is to collect source water and perform preliminary purification of the water before it goes through the Reverse Osmosis plant. In this stage, portion of microscopic or minute organisms such as an amoeba, bacteria, colloids, heavy metal ions, organic matters, and free chlorine will be removed.

The system consists of

- Driving pump to pump surface water into treatment plant
- Source water tank collect water (water level control included)
- Source water pump provide sufficient pressure for pretreatment
- Quartz sand filter remove sand, impurity, suspended matter
- Activated carbon filter remove organic, heavy metal, smell, chlorine
- Softener reduce water hardness to 0.03 mmol/L
- Fine filter to remove all impurities larger than 5 μm



Case Study: Genset powered
2000 L/h Mobile Water Treatment Plant
Africa, UN Mission

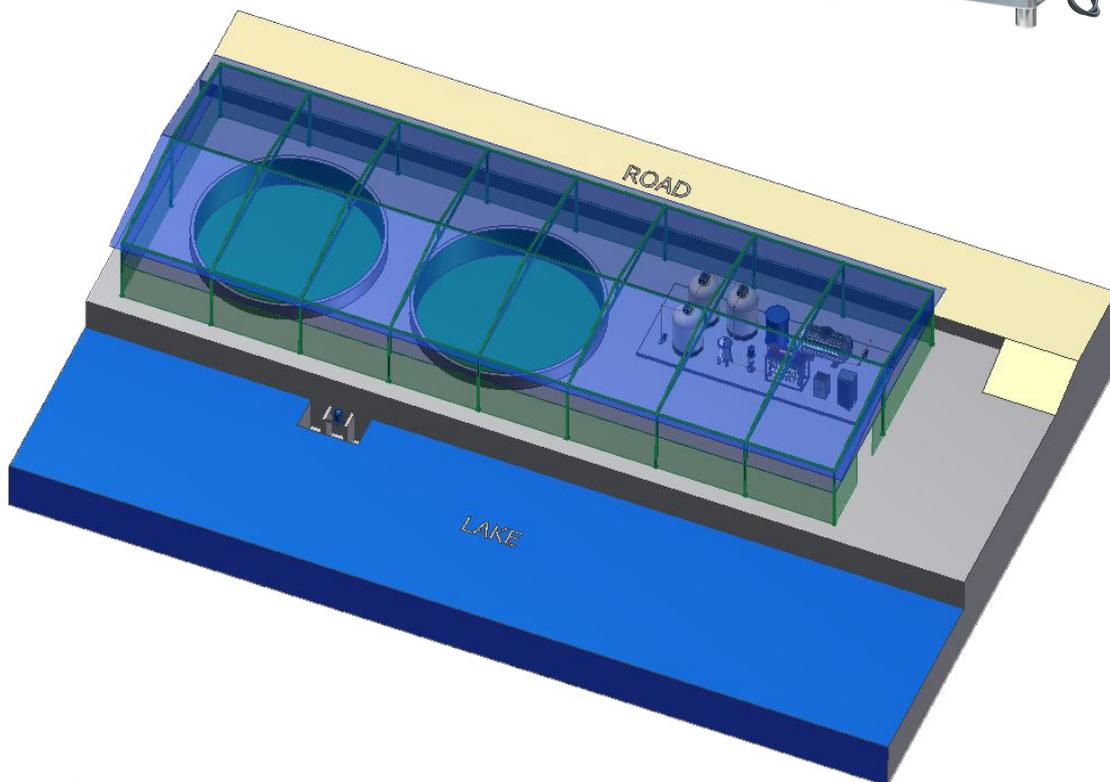
The sterilization system consists of Ozone actuator and a Ultraviolet (UV) tube. UV treatment of water inactivates pathogenic microorganisms that cause E-coli, cholera, typhoid, dysentery and hepatitis.

Ozone treatment is also able to remove organic and inorganic material, iron, manganese and sulphur. This is secondly used for the disinfection of the pipelines between treatment and the delivery nozzle.

Ozone will oxidize and decompose the enzyme which can form the glucose to maintain bacteria. The ozone actuator can ionize air to produce ozone which is further mixed with water through Venturi ejector. By using these sterilization techniques together, we ensure highest water quality.



Ultra-Violet Tube & Ozone Sterilization



Case Study: PV + Grid + Genset powered
10000 L/h Fixed Water Treatment Plant
Thiruvilla, Kerala, India

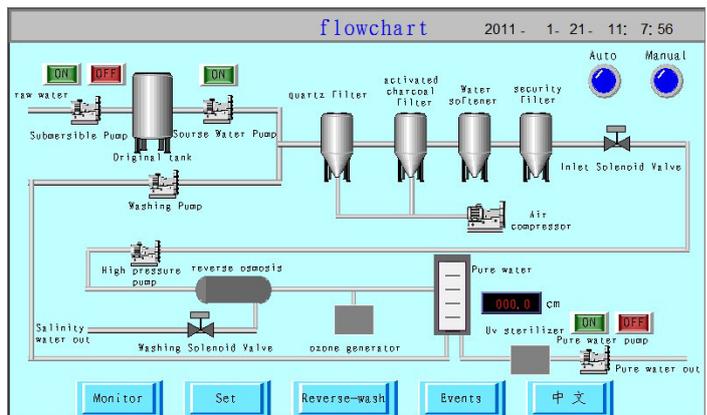


Regen power has developed live monitoring system suitable for several applications such as educational institutions, commercial and government buildings, remote mining camps and resorts , community power and mobile telecommunication tower power supply. The system will enable you to efficiently monitor renewable energy installations remotely and cost effectively with live data.

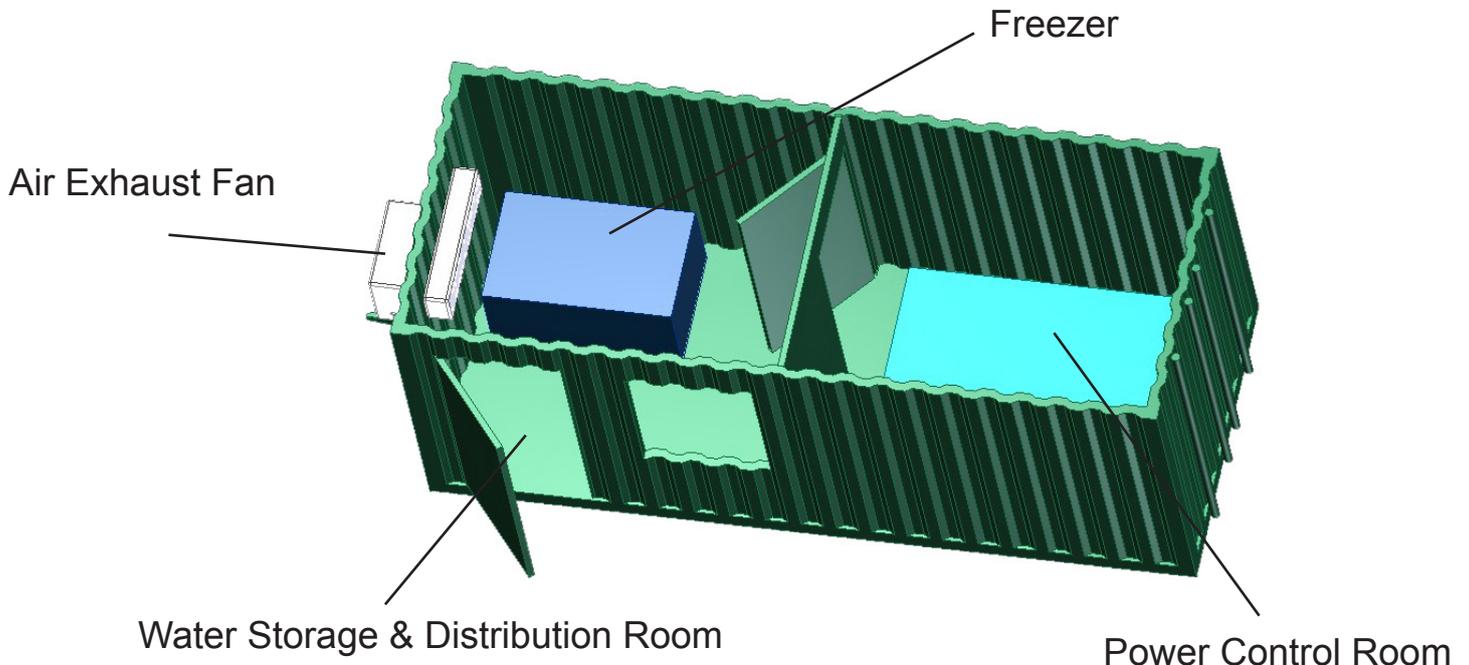
Regen's Monitoring System

The monitored parameters include:

- grid voltage, frequency
- PV output voltage, current
- battery voltage, capacity
- diving pump status
- source water pump status
- high pressure pump status
- pure water pump status
- quartz sand filter status
- activated carbon filter status
- softener status
- fine filter status
- output water pressure
- output water electro-conductivity
- source water tank level
- pure water tank level



Regen's Solution: Pre-wiring & Containerization



Regen power has also developed multi-functional container where all major components like inverter, charge controller, Hybrid-Gen, battery, power distribution board are put inside. Main features of this hybrid container are:

- 1) components pre-wired & almost one-stop product delivered
- 2) sufficient protection in extreme weather
- 3) air-conditioning, ventilation, wooden floor, room partition & heat insulation achieved
- 4) modified from standard 20' & 40' container to make it easy to transport



2.3. Civil Work

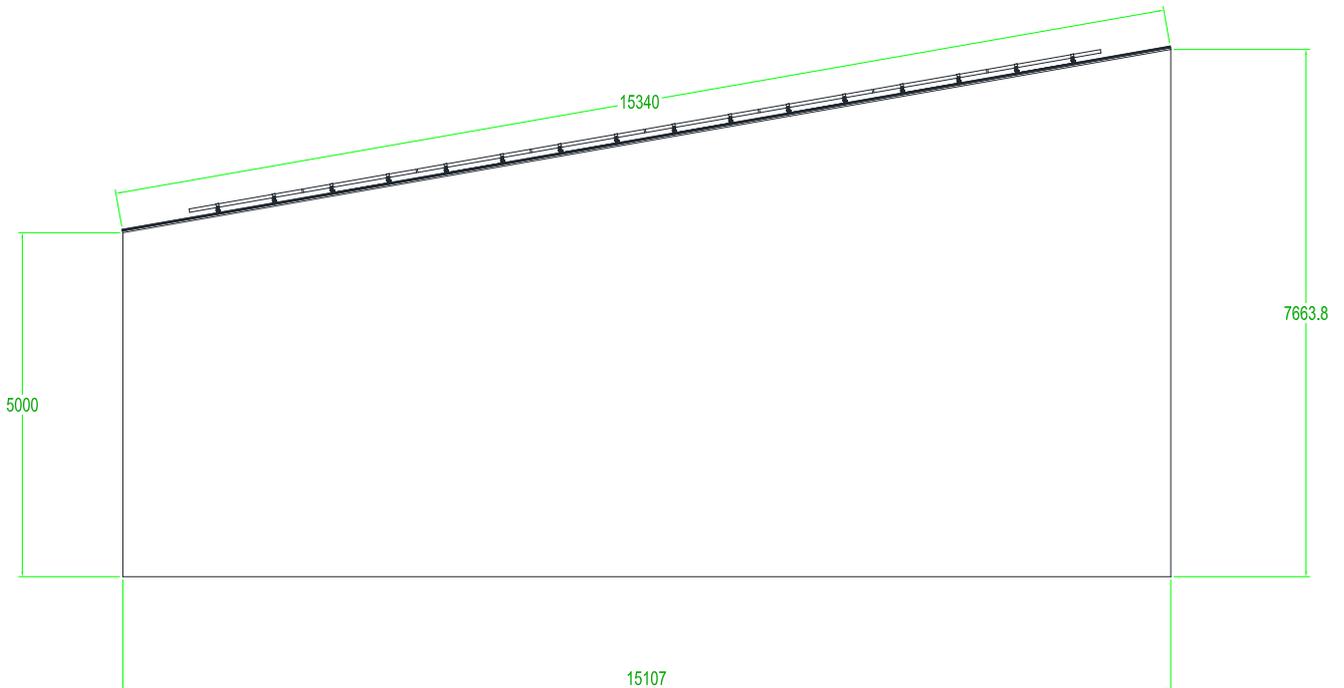


Figure 3: Shed Size

A shed is needed, so all equipments and operating staff are protected from direct sunshine. 20kW PV modules can be mounted on top of the shed. The basic information of shed size is:

- Shed Platform Area: 15107 * 12180 mm
- Shed Roof Area: 15340 * 12180 mm
- Shed Slope: 10 degrees
- Shed Minimum Height: 5000 mm
- Shed Maximum Height: 7664 mm

As for the selection of materials for the foundation, the shed column, and the shed roof tin sheet, please resort to local regulation on public construction. For reference, the total weight of PV modules and mounting racks is approximately 2500 kgs.

At present, the shed will hold 1 * 20 foot container as control and storage room, and 1 * 40 foot container as water treatment plant. As designed, the shed can totally hold 4 * such 40 foot water treatment plants. So this is an expandable solution.

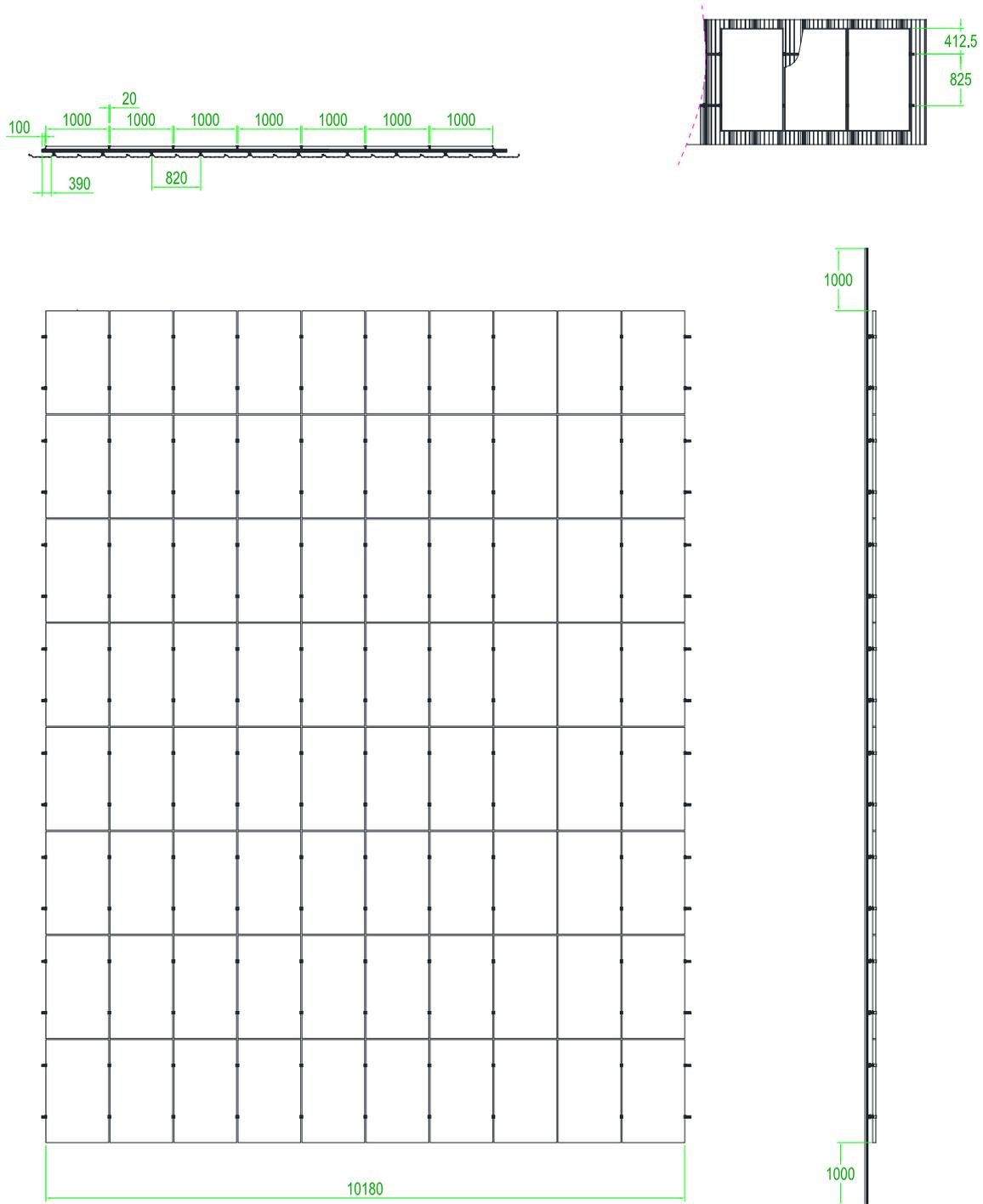


Figure 4: PV Array

The PV module array is 8 * 10 as shown in the drawing above. In between two modules 20mm distance is kept to mount the Z-type middle clamp. End clamps are also used at the side of each module row.

As for detailed module installation work, please resort to professional installing company.

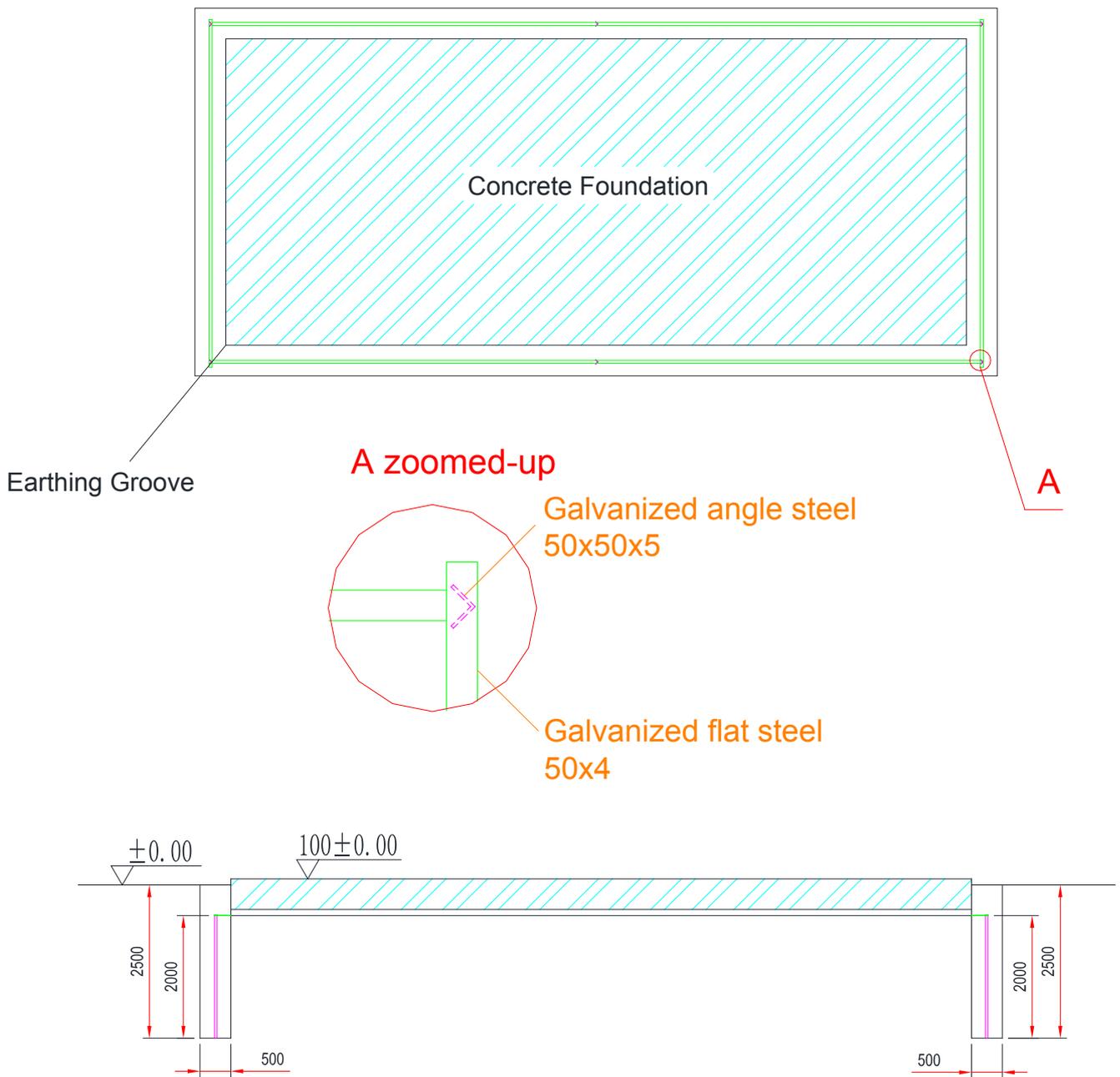


Figure 5: Earthing Groove around Foundation

Instructions on building the earthing groove:

- 1) Dig a rectangle groove around the concrete foundation.
- 2) Insert galvanized angle steel underground at a distance of 5 ~ 7 meters.
- 3) Lay 4 * galvanized flat steel along the groove and connect the flat steels with each angle steel by welding.

2.4. Cost Composition

The cost composition of initial investment will include the following parts:

- cost of water treatment set
- cost of HybridGen
- cost of battery bank
- cost of PV modules
- cost of mounting racks
- cost of inverters
- cost of other control units
- cost of 20 foot multi-function room
- sea transportation charges
- local services charges

Please also notice that our cost composition at this stage does NOT include:

- civil work cost to build the foundation & shed
- PV module installation charges
- other charges incurred by local regulations

The quoted cost is corresponding to commercial terms as follows:

1. Currency is in U. S. Dollars
2. Pricing term is CIF Kochi for equipments
3. Payment term is 50% in advance & 50% before shipment
4. Delivery time is within 45 days after receipt of payment
5. Quality warranty is 12 months after equipments being installed
6. Consumable chemicals & devices are provided for 12 months' usage for free

Cost Composition of Initial Investment

No.	Item	Description	Cost Value
1	Water Treatment Set	5000 L/h, containerized package	\$75,000.00
2	HybridGen	480V 20kW, pre-installed	\$10,000.00
3	Battery Bank	480V 200Ah, pre-installed	\$15,000.00
4	PV Modules	Poly 250W * 80	\$12,000.00
5	Mounting Racks	tin-roof type	\$3,000.00
6	Inverters	SMA STP 10000TL * 2	\$10,000.00
7	Other control units	PLC, VSD etc.	\$15,000.00
8	Multi-Function Room	modified container	\$10,000.00
9	Sea Transportation	by full-containers to Kochi	\$3,000.00
10	Local Services	2 engineers for 5 working days	\$2,000.00
11	CIF Totality		\$155,000.00

So we can conclude that the total initial investment is USD155,000.00 for water and power set.



Figure 6: Project Schedule

