ENERGY AND GENDER NEEDS ASSESSMENT REPORT

FOR THE

MELEANGI TABAI SECONDARY SCHOOL

March 2017

SOLAR PV HYBRID SYSTEMS IN BOARDING SCHOOLS

EU-GIZ ADAPTING TO CLIMATE CHANGE AND SUSTAINABLE ENERGY (ACSE) PROJECT

TABUAERAN ISLAND - KIRIBATI

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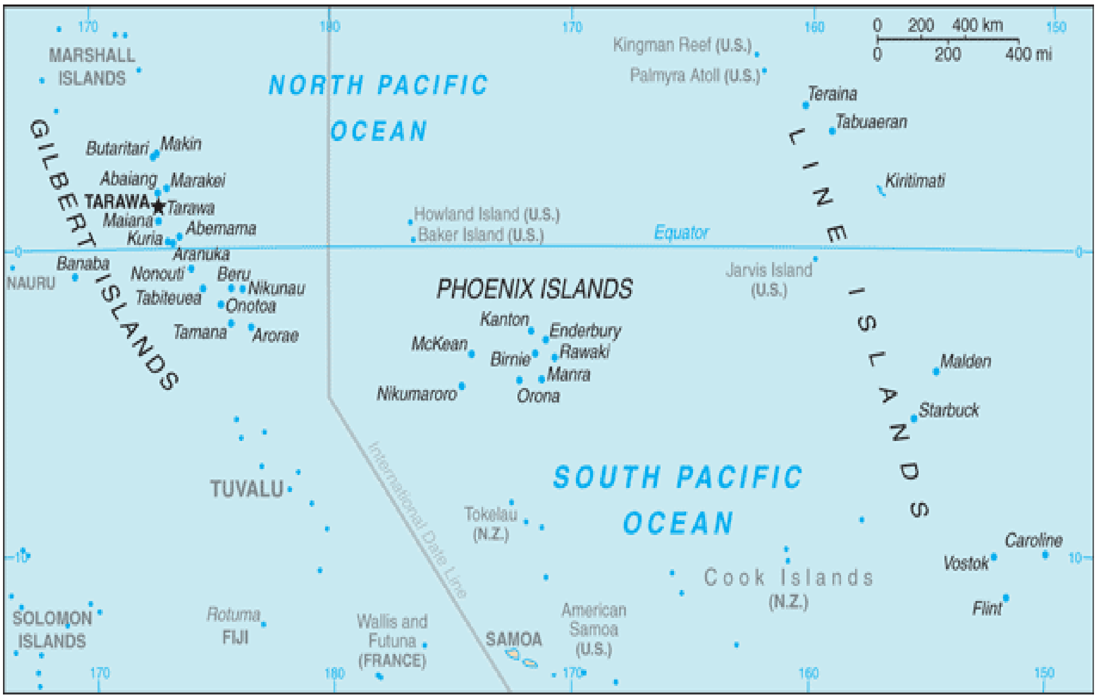
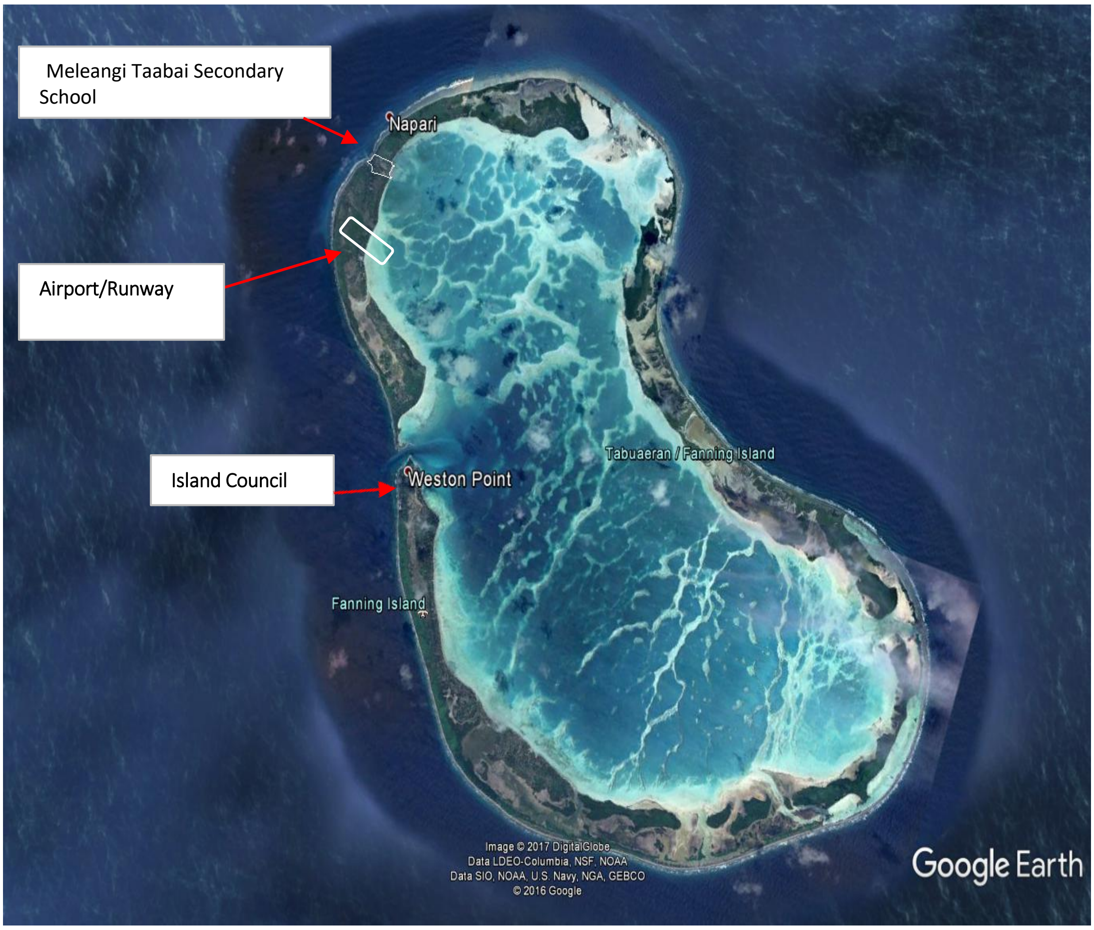


Map of Kiribati



Map of Tabuaeran (Fanning) Island and the location of the MTSS project site

Acknowledgement

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The team members of the Joint Scoping Mission were Craig Bohm, GIZ Technical Adviser and the ACSE Kiribati In-Country Coordinator (ICC), Tarakabu Tofinga, and Toomi Tarangkoa, Kiritimati Islands Assistant Energy Officer. There contributions are much appreciated for their contribution and inputs to this report.

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Abbreviations

ACSE	Adapting to Climate and Sustainable Energy
AUD	Australian dollars
EPU	Energy Planning Unit
CFL	Chlorofluoroscent
ft.	Foot
GIZ	German International Cooperation
GWG	Governance Working Group
ICCC	In-Country Coordinator
Kw	Kilo Watts
kWh	Kilo-watts hour
KUC	Kiribati Uniting Church
MTSS	Meleangi Tabai Secondary School
MOE	Ministry of Education
PV	Photovoltaic

Executive Summary

Meleangi Tabai Secondary School (MTSS) is one of the three government-run secondary schools managed and administered by the Ministry of Education (MOE). MTSS was established to cater for students from the Line and Phoenix Group of Islands, Kiritimati, (Christmas Island, Tabuaeran (Fanning Island), Teraina (Washington Island). The other government secondary schools are the King George Elaine Bernachi School (KGV & EBS) on South Tarawa and Teabike Secondary School at Tabiteuea South, which caters for the students from the Southern Islands.

Providing a reliable and affordable sources of electricity in rural boarding schools is the outcome of the EU-GIZ ACSE project which aligns to the Government of Kiribati Renewable energy target of 100% use in rural boarding schools. In 2014 seven boarding schools were recipients of an EDF 10 funded project that enabled the installation of solar PV grid systems.

These secondary schools were Immaculate Heart College in Taborio (North Tarawa), St Joseph Secondary School on Abaiang, Stephen Whitmy High School at Morikao on Abaiang, Kauma High School in Abemama, Teabike Secondary College in Tabiteuea South, Hiram Bingham High School on Beru and George Eastman High School in Nonouti. In 2016, installation for the Chevalier Secondary School was completed by the Energy Planning Unit (EPU) at Abemama supported by the Italian Government. The two remaining boarding schools are the Alfred Sadd Memorial College and the MTSS in Tabuaeran which are the targeted schools in this project.

Between 14th and 29th of March 2017, a Joint Scoping Mission between SPC, the implementing partner in this project and GIZ, who administer this EU project and the EU-GIZ ACSE In-Country Coordinator (ICC) was carried out to Kiritimati Island and to Fanning Island with the purpose to collect data and information to:

(i) ascertain the energy needs of the school and the community;

ii) Confirm the proper site and preparatory work prior to the installation of the solar PV hybrid system;

(iii) Assess the power production and distribution, maintenance and operational plan;

(iv) Establish the Governance Working Group as a decision making body during and after the project implementation;

(v) Conduct a gender analysis of the school and the community; and,

(vi) Create awareness on the project, renewable energy uses and energy efficiency and conservation.

This energy and gender survey showed the current daily energy demand of the school administration is 8.6kWh while the school households (staff quarters) is at 19.61kWh. The staff energy use is further segregated to lighting and other uses; for lighting, the daily energy demand is 11.54kWh and for other uses that include as laptop use, electric kettle, washing machine, fan, PlayStation the daily energy use is estimated at 9.80kWh.

Some houses have freezers and kettles but are not used due to low current that may damage the electrical appliances so these are now left alone to await the availability of good quality power. However it was noted that houses connected directly to the power house – house no. 3 (Senior Mistress House) and 22 (Catholic Chaplain House) are able to use kettle, rice cookers and iron when the power is turned on as the houses are connected direct to the diesel generator set (genset).

However, electricity access is limited to 2.5 hours a day from 7pm to 9:30 pm. Only on Tuesdays and Thursdays the power is turned on during the day time from 10am to 2pm (4 hours) for office work (photocopying and internet). According to the Principal, fuel use is 20 litres for 3 days when the power is turned on only in the evening. And 20 litres a day if the gen-set is turned on in the day and night time. Therefore an average quantity of fuel use is 80 litres per week as this depends on the hours that the gen-set used.

A gender analysis was conducted to look at the current and future energy needs of the school administration and households. The project energy demand increased to 53.25 kWh for the school administration and 21.95kWh for the school households, a total of 74.20kWh, compared to a baseline of 28.21kwh.Using an excel calculation with daily electric load – fudge factor of 1.2 and 3 days estimated sunlight hours, the calculated PV array size for both the school and the community is 30kW (21.30 for the school and 8.78kW for the community). However there are options that the report provides as there maybe limitations on the budget and therefore there will be a prioritisation process on which options to pick. These options are summarised in the discussions and conclusion of this report.

Introduction

The MTSS was established in 1992 as a government school and 2017 is a jubilee (25) years of its establishment. There were four principals[1] that have hold the office since 1992 to 2010. The current principal Taona started in 2012 after the school was closed for two years due to lack of maintenance and support.

Since MTSS re-opened in 2013, the number of students enrolled have increased steadily by 6% in 2016. However in 2017, the number of students increased dramatically by 25%. The school can take around 180 students a year based on the capacity of the dormitories, classrooms and the staff houses. The MTSS currently enrols xxx students in Form 4 to 6 students mostly from Kiritimati and Washington (Teraina) and Fanning (Tabuaeran).

There are 12 staff including supporting staff (cooker, warden, matron and power technician). The staff are on contract basis for 3 years which can be renewed if teachers do not opt to move to other schools.

A site survey done on 5th August 2015 by EPU, provided some information on the energy service and load. The school has a Denyo 15 kW 60Hz Whisperwatt genset single phase generator. The load assessment was conducted using the PE103 recording in Kw during the night from 8:41pm to 10:15 pm when the genset was switch off and showed the load range around 4.5Kw to 5.4Kw for that day.

The gender assessment noted that the baseline energy demand based on the electrical appliances was xxx. A list of electrical appliances was also collated during this mission and this is annexed as Annex 1.

Survey Tools and Approaches

The energy and gender survey was conducted using a self-guided questionnaire administered by the surveyor, Koin Etuati.

The households survey results was tabulated into an excel sheet and analysed accordingly:

- baseline energy uses for school and households
- types of electrical appliances and their power usages (watts) at the school and at households' level.

A gender analysis approach was used to gather information on households and schools practical, productive and strategic needs and interests and to project the future energy demands. Using the same worksheet with related variables, the data was tabulated to project the solar PV array sizing including battery size and related costs. This information is to be used to carry out a technical design for the solar hybrid system.

An energy audit of the school buildings was conducted to collect information on all electrical equipment in all the buildings including the classrooms, administration office, girl's dormitories, boy's dormitories, maneaba, and kitchen and dining hall. Information on the number of power points, number of lights and light switches. The Energy Project Officer based on Christmas Island accompanied the team and collected information on the illumination of lights for households and school administration.

An assessment of the electricity distribution network was also done to determine its suitability and efficiency when connected to the solar PV hybrid system.

Findings

This report presents the findings on the gender and energy households survey conducted at the MTSS from 21st to 28th March 2017.

The result is presented according to the following topics:

- Social economic
- School Governance system
- Infrastructure
- Energy Needs

[1] First principal was Tebouaki, then Tiribo, Maria Teretia, Raine and Taona (current)

- Gender Analysis
- Water Needs

Social Economic Background

At the time of the survey, there were 101 people (56 males and 45 females) residing at the MTSS school compound, comprised of staff and their families. The number of students was 170 (48 boys and 122 girls). There were 21 staff houses with all houses occupied except one which needs to be repaired. There are 6 support staff working at the kitchen, one power man and one watchman, a warden and a matron. In terms of the qualifications of teachers (respondent) or which level of school attained, 7 teachers had tertiary qualification, while the remaining has attained secondary schools.

Out of the 101 people, there were 21 male and female with ages between 16 – 45 years of age, 7 males and 6 females are above 45 years of age, 6 males and 5 females are between ages of 10 to 16 and 20 males and 15 females are below 10 years of age. The households' population is made up of quite a young generation. The kid attends primary school on the same side of the island, while a Junior Secondary School was based at Baerau, where the island council is situated. JSS students are transported by truck and then by a boat. The MTSS school provides education to Form 4, 5 and 6 and student ages ranges from16 to 18 years of age.

School Governance System

The school has management team made up of senior staff –Principal, Vice Principal, Senior Master and Senior Mistress. They convened a meeting every week where each senior staff reports on matters which are priory for the school and staff.

An organising committee is functional and organises events/activities for school guests or government officials that come and visit the school. However all school matters are relayed to the Ministry of Education through the Principal. Another organised group is the students' church groups which are overlooked by the different church chaplain. Students are also organised into teams according to the houses they occupy. There are two houses or teams for girls and two for boys. Every social and sport activities are arranged through the teams. Figure 2 provides governance structure for the MTSS

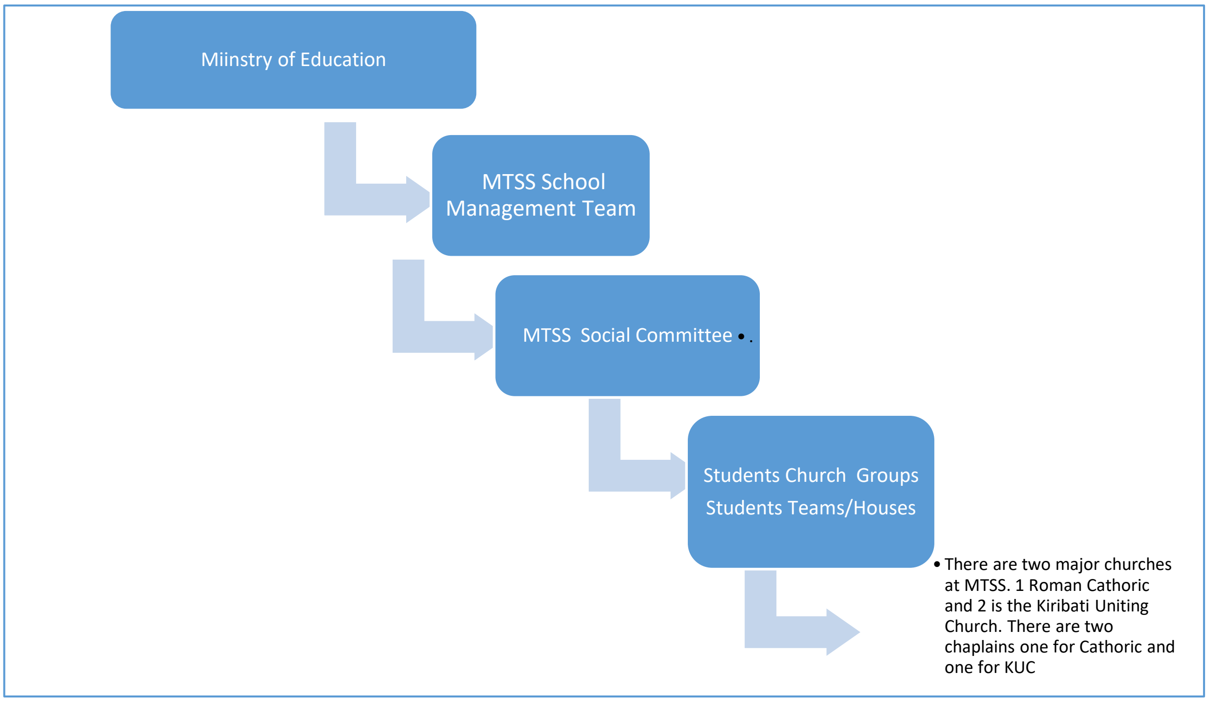

Figure 1. MTSS Governance Structure

Infrastructure

The findings in this section provides information on the current school infrastructure including the assessments on the energy gen set and the distribution line as well as the water infrastructure.

School Buildings

The school was established at its current location owing to the existence of houses/buildings that were built in the for the cable relay station built by the British in 1902. Some of these old building are still standing good and are currently used as kitchen and dining hall, staff houses (4), boys dormitory, school administration office, clinic and class room block (11 rooms). Each of these building has a built in water cistern while there is a big water cistern built between the main classroom and the administration block. The Ministry of Education has built some houses for staff, maneaba, the girl's dormitories and power house.

Figure 2. MTSS school orientation with infrastructure

Figure 3. Staff administration building

Figure 4. Classroom block, 11 rooms at the top. The bottom area is mainly used for storage and a carpenter room.

Figure 5. Boys' dormitory with two blocks for two teams

Figure 6. Girls' dormitories – 2 blocks and 1 maneaba shared by two houses

Figure 7. Staff houses built by Ministry of Education

Figure 8. Students in classrooms

Figure 9: MTSS staff 2017

Energy Infrastructure

The current electricity distribution line is not up to the standard required for integrating into a sola PV hybrid system or to any standards. There is quite a lot of work and resources (financially and technical) to improve the current power distribution network.

Some of these technical issues on the current electrical wiring and distribution lines are:

- Electrical wiring is oversized;
- No distribution boxes in place;
- Distribution line connected from generator to two adjacent houses and then connect to the next houses,
- limited access to good quality electricity, only the two houses connected direct to the generator set, uses high energy consumption appliances, including rice cooker, washing machine and iron;
- No meter boxes at houses;
- Not enough lights and switches in students dormitories; and
- Not enough lights and switches in main maneaba.

The following designs and schematic drawings of a proper electricity distribution lines and underground lines were provided by the team which needs to be complete prior to the installation of solar PV hybrid system:

1. Proper phase lines will need to be laid out throughout the school compound. A Schematic diagram of the phase lines lay out is provided as Figure 10. Phase 2 will be installed to connect to the school buildings;
2. A new distribution line network is also proposed with proper wiring standards to connect the generator to all the staff houses including the school buildings. A schematic diagram is attached as Figure 11;
3. A proposed electrical layout including solar PV integration is presented in Figure 12;
4. With the proper channel, distribution boxes with junction boxes are to be installed. A table showing the location of each distribution box and how it is to be installed is provided in table;
5. There is distribution losses and low voltage experiences along the network and the flow in the current gets lower as its flows further away from the power source. There were cases of electrical appliances not getting enough power that people tend not to use them. A proper underground channel is also proposed with Schematic layout presented in Figure 13; and
6. A discussion on the junction boxes and the ratings to be installed is also provided in table 8.

Figure 10. MTSS generator

Figure 11. Phase line positions

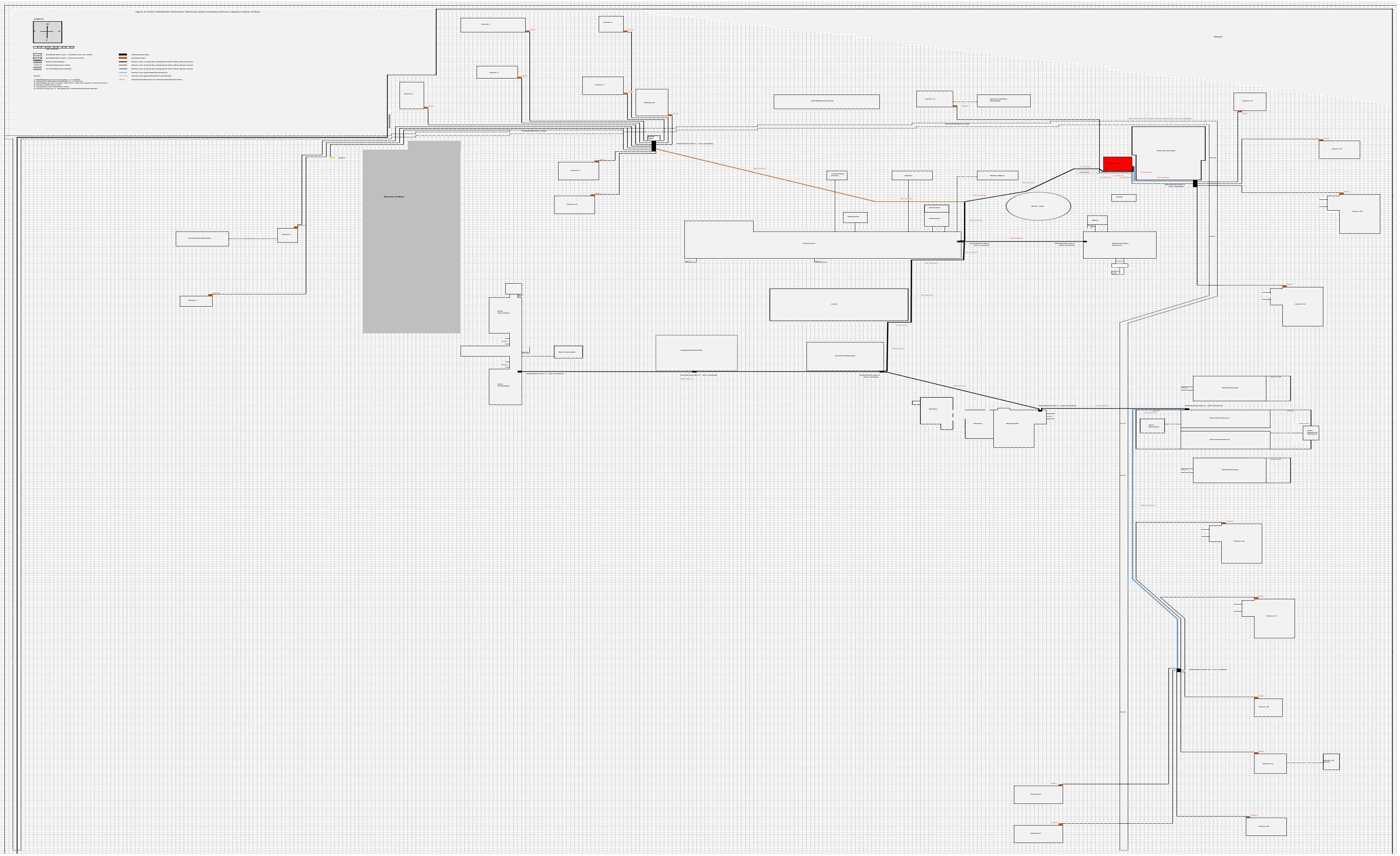

Figure 12. Electricity Distribution Schematic

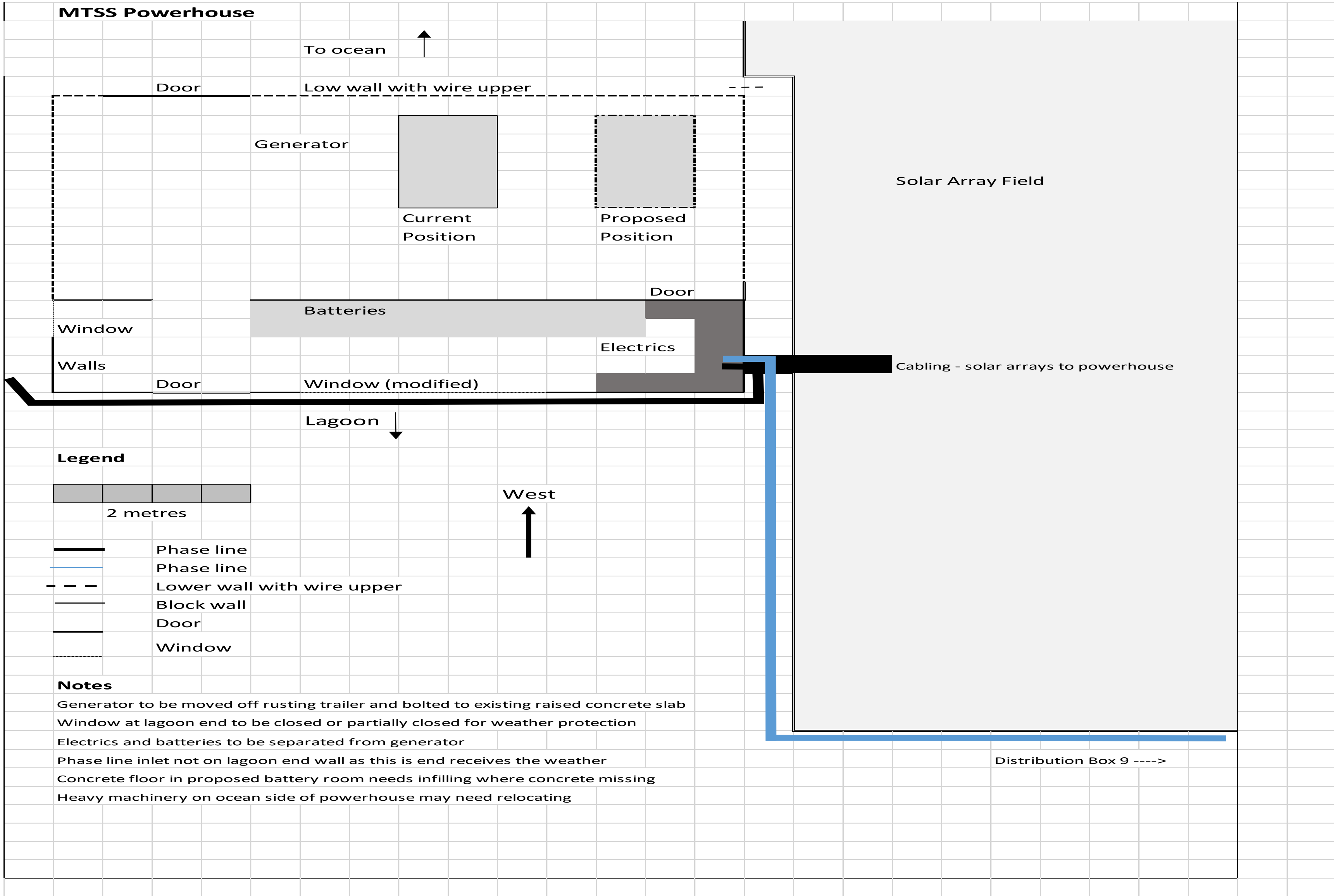

Figure 13. MTSS Powerhouse Schematic diagram including proposed solar pave array field

Table 1. Distribution boxes installation sites

Distribution Box	Name	Distribution (phase) Line	Distribution Box type	Location (see also related diagram)	Installation Notes	Related Junction Boxes	Services	Estimated Max. Load	Circuit Breaker	Other components in DB
DB1	MTSS Sign TB	1	Free standing, fround-mounted, concrete with steel door, padlock and weather protection	North side of MTSS entrance sign.	* Entrance must face west and be protected from eastern rain * Keep separate to, but close to MTSS sign foundations	DB1 - DB11	10 households 1 Protestant maeneba 1 Roman Catholic maeneba	11 houses * 4 amp cap = 0.96kW/hh * 11 = 10.56kW	C4 (4 amp) MCB * 11 units (9 - staff H/H, 1 - KUC chaplancy (including maeneba), 1 - RCC chaplancy (including maeneba) - in case the later relocates to this area	1 unit Master circuit breaker
DB2	Classroom TB	2	Wall mounted	North side of Classroom Building, ground level, on wall next to steps	* Conduit and fittings needed to run phase line from underground channel to wall	None	X classrooms (top floor) Workshop (ground floor) Science lab (top floor) Library (adjacent to classroom block) Maths Office (adjacent to classroom block) Counselling Centre (adjacent to classroom block)	Lights - 43 * 45 watts = 1.935kW Powerpoints - unknown load but add circuit breaker to allow for 3 classrooms (1 * home economics + 2 * science labs) = 3 * 500w = 1.5kW		
DB3	Admin TB	2	Wall mounted	South side of Administration Building, on wall directly opposite to TB2		None	Administration offices (top floor) Satellite dish Storeroom (Ground floor)	Lights - 15 * 45 watts = 0.675kW Powerpoints - 20 * laptops, 1 printer, 3 * monitors, 3 * CPU tower, 1 satellite dish/modum = 3.1kW		
DB4	**Boys Dorm TB**	2	Wall mounted	Mounted on the northern wall of Boys Dormatory in a line direct to TB5 and TB6		None	Lighting in dormatory rooms Lighting in small boys maeneba Powerpoints in dorm + maeneba	Lights - 12 * 45w = 0.54 Powerpoints - 9 laptops (boys using mneba - @75watts/laptop) = 0.675kW		
DB5	**Planned Mneba TB**	2	Free standing, fround-mounted, concrete with steel door, padlock and weather protection	In line with TB4 and TB6 and placed at the north east corner of the planned mneba site		None	Lighting Powerpoint/s	Lights - 6 * 45watt + Safety light - 1 * 45 watts = 0.315kW		
DB6	**General Mneba TB**	2	Free standing, fround-mounted, concrete with steel door, padlock and weather protection	In line with TB4 and TB5 and placed at the north east corner of the general mneba		None	Lighting Powerpoints Path light between maeneba and Dining Hall	Lights - 6 * 45watt + Safety light - 1 * 45 watts = 0.315kW		
DB7	**Kitchen & Dining TB**	2	Wall mounted	Mounted on the western wall of the dining hall, north of the door to the water chamber		None	Lighting in dining hall Lighting in kitchen Powerpoint/s in kitchen	Lights - 7 * 45 watts = 0.315 Powerpoints - 2 freezers @ 240w + 0/48kW		
DB8	**Girls Dorm TB**	2	Wall mounted	Mounted on the western wall of the Girls Dormatory, in the south west corner		None	Lighting in domatory A Lighting in dormatory B Lighting in toliet/bathroom block	Lights - 15 * 45 watts = 0.675kW		
DB9	**Western (Ocean) nHousholds TB**	3	Free standing, fround-mounted, concrete with steel door, padlock and weather protection	Northern side of solar array field, outside of solar array perimeter fence, but at safe distance from the road.			5 households 1 Roman Catholic maeneba	3 houses * 4 amp cap = 0.96kW/hh * 3 = 2.88kW 2 houses * 6 amp cap = 1.44kW/hh * 2 = 2.88kW	C4 (4 amp) MCB * 3 units (1 - Roman Catholic chaplancy (including maeneba), 1 - Matron HH, 1 - Language Teacher /H) C6 (6 amp) MCB * 2 units (1 - Principal HH, 1- Deputy Principal HH)	1 unit Master circuit breaker
DB10	**Eastern (Lagoon) Households TB**	3	Free standing, fround-mounted, concrete with steel door, padlock and weather protection	On the northern side of the road, between Masters house and the next house to towards the lagoon and several metres away from the road - see map for details				5 houses * 4 amp cap = 0.96kW/hh * 5 = 4.8kW 2 houses * 6 amp cap = 1.44kW/hh * 2 = 2.88kW	C4 (4 amp) MCB * 5 units (1 - Account Clerk HH, 1 - Librarian HH, - 1 - English Teacher HH, 1- Cook HH, 1 - Kitchen Hand HH) C6 (6 amp) MCB * 2 units (1 - Mistress HH, 1 - Master HH)	1 unit Master circuit breaker

*
Distribution boxes contain all circuit breakers
Distribution boxes are locked and managed by the school principal
The doors to the 5 concrete distribution boxes must face WEST

Table 2. Number of junction boxes

	Table 2: Junction Boxes*			To be completed during the final desi	
	Junction Box	**Household***	**Feeds into Distribution Box**	**Related Distribution (phase) Line**	**Junction Box Installation Notes**
	JB1	KUC chaplancy + KUC mneba is connected to the	DB1	1	
	JB2	Warden	DB1	1	
	JB3	Reserved for possible relocation of Roman Catholic chaplancy house and mneba to this site from current location on western side of road	DB1	1	* Leave disconnected * This is an additional line in case the Roman
	JB4	Watchman	DB1	1	
	JB5	Power Technician	DB1	1	
	JB6	Chief Cook (at rear)	DB1	1	
	JB7	Kitchenhand (at rear)	DB1	1	
	JB8	Cook (at front)	DB1	1	
	JB9	Kitchenhand (at front)	DB1	1	
	JB10	Graphical Communications Teacher	DB1	1	
	JB11	Vacant	DB1	1	
	JB12	Roman Church chapancy + mneba connected to chaplancy	DB9	3	* The chaplancy and mneba may be
	JB13	Matron	DB9	3	
	JB14	Teacher	DB9	3	
	JB15	Deputy Principal	DB9	3	
	JB16	Principal	DB9	3	
	JB17	Mistress	DB10	3	
	JB18	Master	DB10	3	
	JB19	Account Clerk	DB10	3	
	JB20	Librarian	DB10	3	
	JB21	English Teacher	DB10	3	
	JB22	Cook	DB10	3	
	JB23	Kitchen Hand	DB10	3	
	*				
	NOTES				
1	Names reflect occupancy at time of mapping				
2	The junction box contains one 6 amp or 4 amp circuit breaker				
3	The locations of the 6 amp circuit breakers are indicated in the table				
4	A second circuit breaker for each house is contained in the nearest Distribution Box.				
5	The project only provides power for the households to the junction box on each household.				
6	The project only provides power to the distribution boxes for the school infrastructure.				

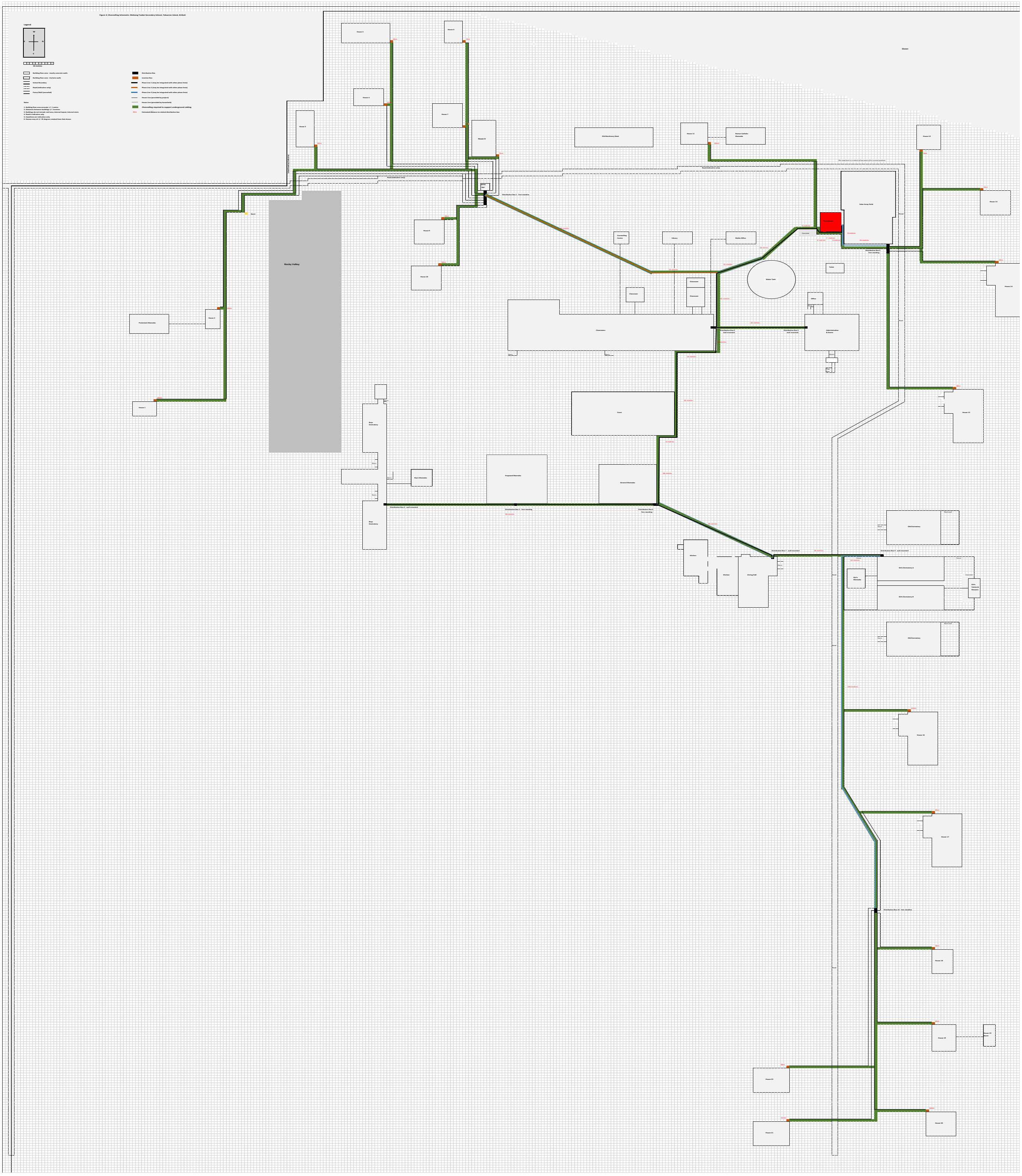

Figure 14. MTSS Channelling schematic

Energy Demand

The energy survey assessed the baseline energy demand including the future demand if the school have access to reliable electricity through solar.

The project main objective is to allow for the school energy system to be more effective in providing electricity access to the main school buildings, classrooms, dormitories and kitchen area and dining hall, while the community demand is second priority as there are other alternatives for households such as solar home systems.

It is expected that the project meets its objectives of providing reliable source of energy for the school needs and that the system will fully utilised sustainability and to its expected lifetime of more than 5 years for battery replacement. The current power is provided by a diesel generator and access to power to limited due to the costs of fuel.

Figure 15. Picture of current generator used

Baseline Energy Demand

The baseline energy data showed an average daily energy use and consumption of 8.7kWh for school and average daily energy use of 23.27kWh for community. Table 3 present a summary of the school the social, economic and energy data.

Table 3. A summary of demographic and baseline energy data for school and community

Year School Established	1992	Government School to cater for students from the 3 main islands, Kiritimati, Tabuaeran and Teraina
Principal	2012 to 2016	Taon
Total Number of Students	170 (2017)	48 boys, 122 girls
Total number of Teachers and Support Staff and family	22 teaching staff and support staff	Noted the number of local staff for as kitchen staff, a job opportunity for local villagers.
Number of Households	21 (2017)	101 total number of people in households, average number of people per household is 4.8 Male: 56 Female: 45
Current source of electrical power	Genset	
Fuel consumption and cost	400 liters per term (13 weeks)	Cost of $280 per drum Total Annual cost is $1680.00
Main school electrical appliances	Fluorescent tube lights 4 ft. & 2 ft., laptop, printer (HP Tower), CPU, Computer screen monitor, printer (printer), satellite dish for internet use	
Community electrical appliances	Fluorescent tube lights, 4 ft., 2 ft., laptops, TV to watch movies, deck, mobile, radio, iron, electric kettle, electric cooker, electric haircut, washing machine, freezer, fan, electric sealer, PlayStation	
Total daily average load (baseline) for school and households	8.65 kWh (School) 23.27kWh (Households)	

Total daily average load (demand) for school and households	19.83kWh (School) 85.79kWh (Households)	
Combined baseline energy use and demand	28.48 kWh(baseline for school) 109.06 kWh (future demand for households)	

The baseline energy demand for both the school and the community is further summarised in tables 4 and 5 showing the equipment used with the energy usages. The total energy demand for the school and community was estimated to 31.92kWh/day.

Table 4. Summary of current (baseline) energy load for school

Equipment	No. of unit	Rated Wattage	Total Watts	kWh/day
fluoro tube lights 4 ft	46	43	1996.07	5.175
Laptop	7	75	525	1.125
Printer (HP Tower)	1	7	6.9	0.01725
CPU - Tower	3	76	228.9	0.57225
Computer Screen Monitor	3	97	292.2	0.7305
Printer (brother)	2	120	240	0.6
satellite dish - for internet use	1	40	40	0.2
fluoro tube light 2 ft	6	30	182	0.2275
			Kwh/day	**8.6475**

Table 5. Summary of current (baseline) energy daily load for households

Equipment	No. of unit	Rated Wattage	Total Watts	kWh/day
fluoro tube light 4 ft	43	87.95	3782.05	10.91
fluoro tube light 2 ft	3	23	69	0.1725
laptop	12	75	900	2.25
TV to watch movies	3	104	312	0.78
deck	4	60	240	0.6
mobile	1	50	50	0.1
radio	1	65	65	0.1625
iron	3	1800	5400	1.62
electric kettle	3	1500	4500	0.675
electric cooker (rice & pan)	2	650	1300	0.39
electric hair cut	1	100	100	0.03
washing machine	3	1410	4230	4.23
freezer	2	0.00	0.00	0.00
electric sealer	1	300	300	0.6
fan	3	45	135	0.27
playstaton	1	240	240	0.48
			Kwh/day	**23.27**

Future energy demand

The future energy daily demands and needs for both the school and the community is presented in tables 6 and 7 with a total future daily demand of 109.06kWh/day. It is noted that the future energy needs for households is much higher compared to the school and therefore a capping the households is important so the battery lifespan is not jeopardize with high energy wastage. It was agreed with the principal that a circuit breaker of less than or equal to 4amps will be used. There was a concern raised by students mainly girls on the need for path lighting for safety lights as there were issues of intruders into the girl's dormitory areas. Three options were discussed:

1. Path lighting between Girls Dorm and Dining Hall – Mount an energy saver, low wattage (10- 11w) directional light on the North West corner of the Dining Hall facing the path between the Dorm and the Hall. Switch to be mounted inside Dining Hall or Dining Hall entrance;

2. Path lighting between Dinning Hall/Kitchen and General Maneaba – Mount a similar light as above on the South West Corner of the Dining Hall (not kitchen, but hall as it is a solid building) pointing towards the General Maneaba. Switch may be mounted on external wall in water proof housing, or just inside kitchen on Dining Hall wall;

3. Path lighting from General Maneaba to Boys Dorm – not dissimilar to the above, but integrating the lighting into the new maneaba circuitry;

4. Increased number of lights in the classrooms or alternatively to paint classrooms with a lighter colour e.g. white;

5. more power points needed where students study in the maneaba (main), two smaller ones;

6. A washing machine for girls and proper access to water, either from water tanks and cisterns;

7. For proper access to water, to have small water pumps (similar to that used by the Principals house – privately owned) that needs to be installed for access to water cisterns. The energy consumption for the water pump is not yet accessed as it was to be determined whether a standalone solar can be used for water pumps only; and,

8. Have piped water run from the water tanks through pressure pipes so water tanks have to be higher than taps.

Table 6. Summary of future energy daily needs for school

Equipment	No. of unit	Rated Wattage	Total Watts	kWh/day
fluoro tube lights 4 ft	73	45	3285.00	13.7925
Laptop	31	75	2325.00	0.75
printer	4	63	253.80	0.0207
CPU - Tower	3	76	228.90	0.80115
Computer Screen Monitor	2	97	194.80	0.5357
Printer	2	120	240.00	1.2
fluoro tube light 2 ft	6	23	138.00	0.414
street/safety lights	4	10	40.00	0.3
freezers	2	240	480.00	1.92
			Kwh/day	**19.73405**

Table 7. Summary of future energy daily needs for households

Equipment	No. of Unit	Rated Wattage	Total Watts	kWh/day
Fluorescent tube light 4 ft.	45	81.86	3683.86	12.222
laptop	15	75	1125	5.625
tv - watch movies	5	104	520	2.6
deck	5	60	300	1.5
fluorescent tube light 2 ft.	3	23	69	0.207
mobile	1	50	50	0.25
radio	1	65	65	0.325
iron	3	1800	5400	27
electric kettle	3	1500	4500	9
electric cooker (rice and pan)	2	650	1300	2.6
electric hair cut	1	100	100	0.2
washing machine	6	1410	8460	16.92
freezer	4	240.00	960.00	3.46
electric sealer	2	300	600	1.2
fan	5	45	225	1.125
PlayStation	1	240	240	0.48
			Kwh/day	**84.71**

Water Needs

There are two main water source for MTSS community; underground water and rain water harvested from the rooftop buildings. The following water needs are presented for households and school community respectively.

Households

There are a total of 13 rain water tanks, 4 underground cisterns and 22 water wells for staff houses and a total water sources for the 21 households as a summary is presented in table 8. It was noted that houses for support staff share a water well and a water tank. While senior staff houses, have access to water cistern, water tanks and wells.

Table 8. Households with water source

No of Household	Staff Name	Occupation	Rain water tank	Rain water cistern	Underground Well
1	Tatang	Matron	1	0	1
2	Meretiana Erekana	Kiribati Language	1	0	1
3	Anatesi Yee-On	Deputy Principal	1	1	1
4	Taona Ioana	Principal	1	1	1
5	Mwaria Motiina (Iabeta)	Senior Mistress	1	1	1
6	Kinarerei	Senior Master	1	1	1
7	Nei Tika	Account Clerk	1	0	2
8	Ruuti Arinoko	Librarian	1	0	2
9	Aberi Ioata	English	1	0	2
10	Torite Kooti	Cook	0	0	1
11	Bweneti Ioane	kitchenhand	1	0	1
12	Roteti Toorite	Warden	0	0	1
13	Riike Naumata	Chaplain - KUC	0	0	1
14	Vacant				
15	Bureimoa Ieremia	Graphic Communication	1	0	1
16	Viriams	Watchman	vacant		
17	Temataake	Power man	0	0	1
18	Viritati	Cook	0	0	1
19	Kateara	kitchenhand	1	0	1
20	Katikuaa Naan	Cook	0	0	1
21	Mwakin	Chief cook	vacant		
22	Mikaere Banin	Chaplain - Catholic	1	0	1
			13	4	22

Two households located near the power house and near the sea side has water wells contaminated with waste oil that have been kept at the power house site in the past years and may have seeped to the water lens. These wells are also more saline due to sea water intrusion during high tides. There was a discussion of moving these two houses further inland. One staff house have no access to water at all, as they share wells and water tanks. Another staff house has no water tank and relies only on well water. Those houses with issues with well water has to rely on their neighbours. Out of the 22 water wells counted for teachers, 9 wells have quality issues due to salinity, oily, sand and muddy smell.

There are two types of water catchments for the older houses (cable company houses); (i) underground water cistern built under the houses and normal water tanks. However 4 of these houses cisterns are not have been maintained and quality of water is not good for consumption. Collected is not of good use. The water tanks are installed in these houses for drinking purposes with well water used for bathing and washing.

Table 9. Households water needs

Households water needs	Average bucket of water per day
Practical needs	
Washing	4- 6
Cooking	1- 2
Drinking	1
Cleaning dishes	1
Bathroom use	5-6
Toilet use	3
Productive Needs	
Bread making	1
Vegetable farming – pumpkin and banana – does not need to water	1

Students water needs

Boys dormitory have two wells, a water cistern and a water tank (1,000 litre) while the girls have access to two wells and two water tanks (1000 litres). The water tanks for the girls are not fixed properly to the cutters with the bottom taps leaks and the height of the tank is also not sufficient to collect water, which is low for a bucket.

Figure 16a, 16b, 16c. Water tanks for girls (left and middle) and for boys (right side).

There were ways of improving access to the ground water with the use of a hand water pump or an overhead tank. During the time of the visit, the hand water pump was not working. The boys are much better off with access to water as the water hand pump works properly and the water quality is not as bad as that noted for the girls.

Figure 17a, 17b. Hand- made pumps for girls and boys.

The students' water needs was estimated during a brief focus group discussion with a group of girls and is presented in table 10. An estimate of water use using a bucket of 5kg (FMF biscuit container) as it is the common container used by students and kitchen staff. A bucket of water would be 5 litres of water. Access to clean water is important for practical needs such as cleaning, washing, and bathroom and also important for health related issues such as skin diseases, dehydration, etc.

Table 10. Students (Girls) Water needs

Girls Water needs	Average bucket of water per day per student.	Litres of water per person per day
Practical needs		
Washing	3-4 (2 days only, Wed and Sat)	15 – 20 litres
Toilet cleaning	10 buckets	55 litres
Toilet use	1 bucket	5 litres
Bathroom use	1- 2 buckets	5- 10 litres

Kitchen Water Needs

Water access to the kitchen is from a well water (shown in Figure 18 a), water tanks and water cistern. The well water is pumped to the kitchen with a small solar pump, see Figure 18b but the quality of water is not very good, and not suitable for cooking and washing dishes. It is used only for cleaning the kitchen and dining hall floor.

Figure 18a, 18b. Well water for kitchen use and a small pump being used

The kitchen staff has to bail water from the water cistern which is kept only for drinking and cooking. The water tanks connected to the dining hall is not fully utilised as it is not piped to the cooking area, thus creating more tasks for the kitchen staff. There is a need to clean up the water cistern situated between the administration building and the classroom as a backup supply for the kitchen and the households. It would also be beneficial to connect it to a water pump so it is connected direct to the kitchen area.

The estimated water needs for the kitchen as presented in table 11 will an average of 305 litres of water per day. In a week and if adding cleaning of dining hall which is done every week, an average of 2185 of litres of water a week. The water resource assessment is outside the scope of the visit, however it was noted that there is a need to upgrade all the water cisterns and maintain the current water tanks and have it piped to the kitchen area so there is enough water also during the dry months.

Table 11. Kitchen water needs

Kitchen	Water use by bucket per day	Water use (in Litres)
Practical Needs		
Cooking – 7 buckets per meal per day (2 for soup and 4- 5 for cooking rice)	21 buckets	105
Drinking – 6 buckets per meal	18 buckets	90
Cleaning dishes- 2 buckets/meal	6 buckets	30
Cleaning pots- 2 buckets/meal	6 buckets	30
Cleaning floors - 5 buckets per 2 days	10 buckets	50
Cleaning dining hall	5- 6 buckets every Saturday	50 (a week)

Access to clean and portable water is still a challenge on MTSS, especially for the girls use for washing and bathing and kitchen as well as some houses. The water tanks provided for the girl's dormitory and the kitchen are not well maintained and cutters to collect water were not fixed properly. There is no piped connected to the main areas of washing and bathing or cleaning and cooking.

It is recommended that it is not suitable to have solar water pump in the school as the water is contaminated from the open pond situated at the lagoon side. It is proposed that the water tanks and cisterns should be well maintained and new ones to be installed.

Gender Analysis

A gender analysis of the school's energy needs was compiled through observations, households' energy and gender survey and a focus group discussion with Form 7 students.

The school is government owned, and therefore income generating activities are not allowed, so there is limited productive activity that could be promoted with the new energy system.

However it was noted that staff pay for internet use during night time, a rate of $2.00 per day, to help pay for diesel fuel use. If the solar PV can provide 24 access to internet, this may increase internet use by students and fees for internet use. The use of internet would improve access to information that would improve information sharing, and strategic interests. It is anticipated that the student's grades would improve with improved electricity use. At the same time, communication with families will improve.

Gender analysis for school and households needs is provided in table 12 and 13, in three different gender interests' needs; practical needs, productive needs and strategic needs. The energy future demands does not includes additional lighting hours for study times in classrooms and in both dormitories for girls and boys but increased the number of lightings so there is better quality lighting. The study program remains the same which is from 1900pm to 2030.

Table 12. Schools Gender and Energy Needs Analysis

Practical Needs	Productive Needs	Strategic Needs
More lighting in classrooms – or needs to paint the inside wall to white	Internet use and access through electricity will also increase income which can be used for recreation/entertainment needs such as prizes, hire of PA system, etc.	Entertainment – use of PA system to continue
More lights in dormitories so better lighting during study time at night. Street lights for safety.	Ice Block Making to sell households needs	Church meetings
Access to water through water pump that can be used to pump rain water to bath rooms or toilet, laundry area for girls Water pump for kitchen use using water cisterns.		
More and proper water tanks for girls use for bath, brush, toilet use and washing. Overhead tanks can be place on top of the old buildings.	Access to internet 24 hours and not to be limited to electricity availability	Access to internet 24 hours and not to be limited to electricity availability
Food processing use for special occasions for students. Cake and. Refrigerator for food storage in kitchen such as fish and chicken	Solar charging – students with solar radios and torches can pay for charging system	All users should learn more on solar uses and to participate in technical training
Lighting uses – for kitchen for better lightings after sunset	Washing of clothes – student to pay use of washing machine	Study time at afternoon and night time. Radio use to listen to news.

Table 13. Other electrical needs for all the buildings

School Buildings	Expectations
Maneaba	The maneaba is used by students to study at night and current lights are not good for studying. Additional lights and power points is needed.
Kitchen	None articulated, main concern was water access, though additional lighting would be beneficial
Classrooms	All needs to have 1 power point each for use of computers or power point projectors. Need to paint classrooms with white paint to give a brighter colour.
General Office	Needs 2 lights x 40 Power points for computers and projectors
Dormitory	Lights x 40 (4 feet's) for boys and girls
Shop	1 power point 1 light inside and outside shop
Dining Room to be build	6 x 2 feet lights (20 watts)
Chapel to be build	1 power point 8 x 2 feet lights (20 watts)

Technical Specification Options

The school is in need of a new electricity distribution line to provide an efficient network compared. A three phase option was recommended and a second trip to the school to conduct a proper solar PV design and laying down of the wire cables was schedule for early 2018. However due to the decision by the Ministry of Education, to close the school the project has opted for another option to replace MTSS.

Table 14 presents the options to be considered depending on the budget availability and the cost benefit study and design report findings. The project is mindful of the mentality of people if having access to 24 hours of electricity will lead to wastage and therefore unnecessary usage of electricity on the solar system. A cap of 4 amps per household was agreed with the school as a way of managing possible wastage energy use.

Table 14. Proposed options for the solar pv hybrid sizing

Options	Details on energy demand	Daily average use/load (kWh)	Installed PV capacity (kW)
Option 1: Baseline Load	No future demand included	School : 8.65 Households: 23.27 **Total: 31.92**	12.77
Option 2 –School and Households Future Demands	Future school and households demand	School: 19.93 Households: 84.71 **Total: 104.64**	41.78
Option 3: School and Households demand capped at 4amps	Include future school and household demand	School: 19.93 Households:69.12 **Total: 89.05**	35.62

Annexes

Annex 1 – SPC/GIZ Joint Scoping Mission Program for EU-GIZ ACSE KI08

KI09 GSD/SPC Meeting & KI08 MTSS Inception Mission Program
09th ~ 29th March 2017

#	Date	Program	Remarks
1	Monday; 13th March 2017	ICC fly in from Tarawa to Suva	
2	Tuesday; 14th March 2017	Finalize and adopt TOR with Work-plan (ICC, Craig & GSD/SPC) and met with SPC Finance Officer Suva to Nadi – at 19:30 flight to connect to Kiritimati Depart Nadi for Kiritimati (midnight)	ICC Airfare/per-diem catered under KI08
3	Wednesday; 15th March 2017	Arrive in Kiritimati (morning) & check in at hotel Meet with Secretary MLPID	Confirm/ticketing Tabuaeran flight for 21/03 & return at 28/03/17
4	Thursday; 16th March 2017	Meet with MOE Education Coordinator responsible for Line Islands Meet with MLPID Water Technician Meet KSEC/MLPID Solar Technician	Craig suggest taking along w/technician to Fanning
5	Friday; 17th March 2017	Meet with EU Project Water Specialist Meet MLPID Project Officer & Logistician (shipment, freight etc…)	
6	Saturday; 18th March 2017	Site visit (existing solar hybrid systems)	
7	Sunday; 19th March 2017	Report Writing & FREE	
8	Monday; 20th March 2017	Visit to Kiribati Port Authority (KPA) & meet with OIC Meet with Shipping Agents (based in Kiritimati)	
9	Tuesday; 21st March 2017	Depart/Arrive at Tabuaeran (morning) Brief meet with Principal for Program	
10	Wednesday; 22nd March 2017	Meet with Principal/School Management including power/water tech. (morning) Visit to key sites at school (afternoon)	
11	Thursday; 23rd March 2017	Gender/Energy Need Assessments Water need assessments	
12	Friday;		

	24th March 2017	Training Workshop (Energy Efficiency & Conservation etc.)	1/2 day workshop to students & staff
13	Saturday; 25th March 2017	Continuation of energy & water need assessments	
14	Sunday; 26th March 2017	Report Writing & FREE	
15	Monday; 27th March 2017	Continuation of energy & water need assessments Wrap-up meeting with Principal	
16	Tuesday; 28th March 2017	Team depart Tabuaeran & arrive at Kiritimati Island	
17	Wednesday; 29th March 2017	Team depart Kiritimati Is & arrive at Nadi	
18	Thursday; 30th March 2017	ICC depart Nadi for Tarawa	ICC Airfare paid under KI08 (return ticket)

Annex 2. Households Energy Demand Needs

Staff Quarters										
Staff Houses - Eastern	House 1- Power Technician (closes to ocean)	Fluorescent (Fluoro) tube light (4 ft.)	2	5	45	0.09	0.45	30.00	13.50
	House 2 - Teacher- Art	Fluoro tube light (4 ft.)	2	5	45	0.09	0.45	30.00	
	House 3 - Cooker	Fluoro tube light (4 ft.)	2	5	45	0.09	0.45	30.00	13.50
	House 4 - Vacant- Repaired	Fluoro tube light (2 ft.)	2	5	23	0.046	0.23	30.00	6.90
	House 5 - Vacant	Fluoro tube light (2 ft.)	2	5	23	0.046	0.23	30.00	6.90
	House 6 - Matron	Fluoro tube light (4 ft.)	2	5	45	0.09	0.45	30.00	13.50
	House 7 - Teacher - Science	Fluoro tube light (4 ft.)	2	5	45	0.09	0.45	30.00	13.50
		Fluoro tube light (2 ft.)	1	5	23	0.023	0.12	30.00	
	House 8 - Vacant	Fluoro tube light (2 ft.)	2	5	23	0.046	0.23	30.00	6.90
	House 9 - Vacant	Fluoro tube light (2 ft.)	2	5	23	0.046	0.23	30.00	6.90
	House 10 - Vacant	Fluoro tube light (4 ft.)	2	5	45	0.09	0.45	30.00	13.50
Staff Houses - Western	House 1- Guest House	Fluoro tube light (4 ft.)	2	5	45	0.09	0.45	30.00	13.50
	House 2 - Principal	Fluoro tube light (4 ft.)	2	5	45	0.09	0.45	30.00	13.50
	House 3 - Kiribati Teacher	Fluoro tube light (4 ft.)	1	5	45	0.045	0.23	30.00	6.75
		Fluoro tube light (2 ft.)	1	5	23	0.023	0.12	30.00	3.45
	House 4 – Librarian	Fluoro tube light (4 ft.)	2	5	45	0.09	0.45	30.00	13.50
	House 5 - Registry Clerk/Warden	Fluoro tube light (4 ft.)	1	5	45	0.045	0.23	30.00	6.75

		Fluoro tube light (2 ft.)	2	5	23	0.046	0.23	30.00	6.90
	House 6 - Art/Geography Teacher	Fluoro tube light (2 ft.)	2	5	23	0.046	0.23	30.00	6.90
	House 7 - Religious Education	Fluoro tube light (4 ft.)	1	5	45	0.045	0.23	30.00	6.75
		Fluoro tube light (2 ft.)	1	5	23	0.023	0.12	30.00	3.45
	House 8 – Carpenter	Fluoro tube light (2 ft.)	2	5	23	0.046	0.23	30.00	6.90
Cooking Huts	18 houses	CFL Light	18	5	7	0.126	0.63	30.00	18.90
Increase in Demand from Teachers	Teachers now access to Power with many hours on their hand - Using 3 Amp restriction gives allowance for 720 Watts	DVD Deck	17	3	60	1.02	3.06	30.00	91.80
		TV Screen - 21 inch	17	3	110	1.87	5.61	30.00	168.30
		phone charger	17	1	5	0.085	0.09	30.00	2.55
		Stereo/radio	17	4	60	1.02	4.08	30.00	122.40
		Laptop	12	2	75	0.9	1.80	30.00	54.00
TOTAL						**6.36**	**21.95**		**202.35**

Annex 3. Solar PV sizing for school

Equipment	No. of unit	Rated Wattage	Total Watts	kWh/day
Fluoro tube light (4 ft.)	57	45	2565	9.52875
Fluoro tube light (2 ft.)	16	29	464.00	1.982
CFL Light	1	7	7	0.07
LED light	2	7	14	0.14
printer	3	100	300	0.9
photocopy	1	1280	1280	3.84
Scanner	1	45	45	0.045
fax machine	1	95	95	0.0475
CPU for computers	1	90	90	0.27
desk top flat screen monitors	4	30	120	0.36
laptops for teachers	12	75	900	4.5
Projector	1	1800	1800	1.8
Speaker x 1	1	700	700	2.8
Speaker x 2	1	700	700	2.8
Amplifier and mike	1	1200	1200	4.8
Freezer - Kitchen	1	800	800	2.88
Freezer - Shop	1	800	800	2.88
Washing machine	1	450	450	2.25
laptops charging for student	10	75	750	2.25
Manabí use for meetings, festive activities, Easter, etc.	11	45	495	1.60875
Computers for classes and internet	20	75	1500	7.5
			Kwh/day	**53.252**

Daily consumption	53.25	kWh	
Daily Electric load - fudge factor	63.90	kWh	Accounting for the system efficiencies, including wiring and interconnection losses, as well as the efficiency of the battery charging and discharging cycles.
Estimated sunlight hours	3.00	hr/day	Peak sunlight hours for Kiribati - Enquire with KSEC
PV array size needed	21.30	kW	
Battery size needed	15975.60	Ah	3 *No. of days- Planned system operation for 3 days with no sun light*