RENEWABLE ENERGY for LIVELIHOOD and YOUTH

RELY

A Project Funded by the European Union

ASEP


# SOLAR ELECTRIFICATION GUIDE

Lead:

sequa gGmbH
Partner of German Business

Partners:

VIVANT FOUNDATION

PROCESS-Bohol, Inc.

Co-funded by:

german cooperation
DEUTSCHE ZUSAMMENARBEIT

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## List of Abbreviations

| | |
|---|---|
| AC | Alternating Current |
| ASEP | Access to Sustainable Energy Programme |
| BOS | Balance of System |
| DC | Direct Current |
| DepEd | Department of Education |
| DoD | Depth of Discharge |
| EIM | Electrical Installation and Maintenance |
| EU | European Union |
| Imax | Solar Module's Maximum Current |
| kW and kWH | Kilowatts and Kilowatts per Hour |
| MoA | Memorandum of Agreement |
| MSME | Micro, Small and Medium Enterprises |
| NCS | National Certificate |
| OJT | On-the-Job Training |
| PRAG | Procedure and Practical Guide of the European Union |
| PV | Photo Voltaic |
| RE | Renewable Energy |
| SHS | Senior High School |
| SoC | Status of Charge |
| TESDA | Technical Education Skills and Development Authority |
| TVET | Technical Vocational Education and Training |
| VA | Volt Ampere (apparent power) |
| VRLA | Valve-Regulated Lead-Acid (battery technology) |
| Wh | Watt Hour (unit of energy) |
| Wmax | Solar Module's Maximum Power |
| Wp | Watt Peak |

# INTRODUCTION

This Solar Electrification Guide has been developed and distributed under Project Renewable Energy for Livelihood and Youth (RELY), an endeavor funded by the European Union with additional financing from the Federal Government of Germany.

Project RELY aims to promote the use of renewable energy to improve lives and foster climate change mitigation in poor and remote communities in the Central Visayas and Southern Tagalog (MIMAROPA) Regions of the Philippines by energizing their off-grid public schools. The approach combines solar electrification with community development and improved vocational education by collaborating with partner senior high schools.

Project RELY is jointly implemented by international development organization sequa gGmbH, Vivant Foundation, the corporate social responsibility arm of Vivat Corporation, and PROCESS-Bohol, a social development NGO that is responsible for the community development component of the project.

The EU support comes under the Access to Sustainable Energy Programme (ASEP), a joint undertaking of the Department of Energy and the European Union, whose goal is to assist the Philippine Government in expanding sustainable energy generation to meet growing economic needs and provide energy access to the poor and marginalized sectors.

The key activity of RELY is the provision of renewable energy (RE) to remote schools, communities and MSMEs for rural development through the electrification of public schools by a PV system. The electrification of the schools serves as an entry point to the communities and demonstrates an effective approach to rural micro grids. It is accompanied by awareness raising activities on RE and climate change for all stakeholders and by support to the communities in improving their livelihoods.

RELY raises not only the education level of public schools through electrification but also reaches out to related senior high schools (SHS) that offer electrical installation and maintenance (EIM) vocational training courses. The SHS are supported by trainings and additional equipment so that they can include RE technologies in theory and practice in their EIM courses. It cooperates with the respective accreditation authorities to increase the employment opportunities of the EIM graduates.

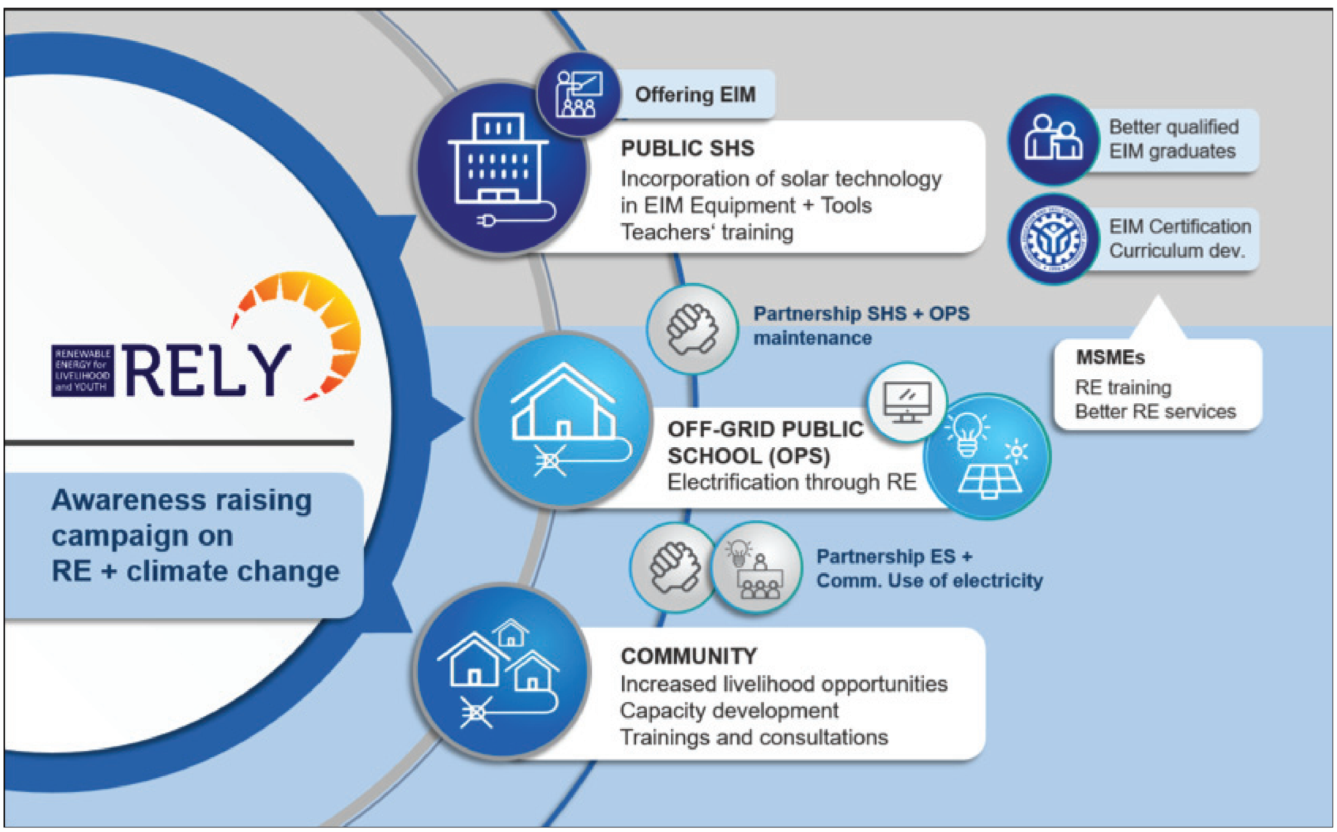



*Figure 1: Project Logic and Main Stakeholders of RELY*

## Rationale

This publication aims to guide private sector organizations or individuals and donor agencies that plan to energize or help energize off-grid schools through solar. It is a summary of the experience the Project RELY team gathered when energizing off-grid public schools.

In the Philippines, there are many public schools that are not energized as they are too remote or are located in an area that is deemed commercially unviable to be served by the distribution utility, or both.

Project RELY worked on the energization of 16 off-grid and remote schools in the Provinces of Cebu, Bohol and Palawan. But there are still many schools in the country that are similarly situated. In these schools, students are unable to work with computers, are struggling to learn in classrooms that get uncomfortably warm during summer, or are getting eye strain from trying to read in rooms that have no lighting. In most off-grid schools, students face all these challenges.

Without electricity, learning is difficult and students either lack the will to continue their studies or, if they do graduate, realize they are not equipped with the knowledge and skills that is needed to get a job.

Energizing off-grid schools is a laudable endeavor. However, the path towards achieving the mission is not straight and paved. The RELY Project Team has a substantial experience in the field to develop a guide that will help individuals and/or organizations who share our vision.

## Scope and Limitations

This Guide covers existing conditions, rules and regulations of the Department of Education as of this writing. It does not cover new rules, regulations and circulars that may arise after the publication of this guide.

The Guide tackles solar energy as the most viable technology to energize off-grid schools during Project RELY's implementation. In choosing solar technology, the RELY Project Team considered, among others, availability of technology and knowledge, affordability, and logistical requirements.

The Guide is based on actual experiences of the RELY Project Team. It does not claim to be the best or most effective approach to the situation of students in remote public schools. Other methods may be developed by other individuals or entities that may just be as effective. However, the approach was chosen after comprehensive evaluation by the European Commission for a grant under the Access to Sustainable Energy Programme.

The Guide has two parts. The first deals with the administrative side of the endeavor and tackles government permits and clearances required before any school energization project can be implemented.

The second part details the technical requirements, including but not limited to, determining the load profile of the school and designing the appropriate solar power system to be installed. The technical information covers only the basic project steps and has been simplified to be understood by laymen. As soon as the project is progressing and the concrete implementation of a solar PV system is planned, consultation with appropriate technical experts is absolutely necessary.

# PART I. ADMINISTRATIVE AND ORGANIZATIONAL REQUIREMENT

Getting through the administrative requirements is the best way to start the process of energizing an off-grid school. Most of the administrative requirements concern the Department of Education (DepEd), which has jurisdiction on all private and public elementary and high schools in the Philippines. DepEd can also provide most of the information needed for evaluating target schools and for designing the solar power system of the recipient school.

When dealing with most national government offices in the Philippines, it is important to be aware of the three main organizational levels of the concerned agency and their respective jurisdiction.

Like other national government agencies, DepEd has the following organizational levels: Central Office, which has overall or national jurisdiction of all regional and/or field offices and makes executive decisions that must be adhered to by everyone in the agency; Regional Offices, oversee all provincial and city schools division or offices to ensure national policies and programs are implemented; and Provincial and City Schools Divisions, which oversee all school districts and schools.

## Step A1 – Data gathering to identify potential beneficiary schools

For organizations and donor agencies that have yet to decide which off-grid school or schools in the country they want to energize, the best initial step should be to ask the DepEd Central Office for a list of schools that have no electricity. With the initial data, one can decide which area to focus on. Once a decision has been made on an area of focus, it is advisable to verify the data from the Central Office with the concerned Regional Office and/or Provincial/City Division Office (see Annex 1).

If one has a specific area in mind, one can cut short the process by directly contacting the Regional Office and/or Provincial/City Division Office to ask for the data.

The initial data to be obtained from DepEd should also include student population (total student population and enrollment figures (enrollment for the current schoolyear and for the recent three to five years). Apart from determining the impact of your assistance, these figures will also give you an idea on how many users of electricity there are/will be in the campus (more on determining the load requirements or energy usage of the school in the **TECHNICAL REQUIREMENTS**).

Depending on the targets of your organization or donors, you may select the top schools according to the size of the student population. The student population figure, however, may not be relevant if your organization or donors are more concerned about the locations of the schools, such as when they have target areas as beneficiaries.

Often, solar energization projects in off-grid areas are not sustained because of the lack of technical persons who can conduct maintenance on the installed system. This is why Project RELY includes a component identifying a partner public senior high school and upgrading its technical-vocational Electrical Installation and Maintenance (EIM) track.

Project RELY, in collaboration with the DepEd and the Technical Education Skills and Development Authority (TESDA), upgraded the EIM curriculum of partner senior high schools so that instructors will be able to competently teach the EIM track with a solar technology component. The aim is to establish a pool of qualified EIM-Solar electricians in the town.

More often than not, the center of the town that has jurisdiction on the off-grid school has a public senior high school. However, not all public senior high schools in the Philippines offer the EIM track. It is best to inquire about this matter with the Provincial or City Schools Division office. Ideally, potential beneficiary schools are clustered geographically and have a partner SHS that offers the EIM track.

The upgraded EIM curriculum, which incorporates solar technology, of partner senior high schools under Project RELY can be replicated by other organizations and donor agencies. Information about EIM-Solar curriculum can be obtained from the DepEd. To find the right contact persons in the Department of Education consult **Annex 1**.

Establishing good relations with DepEd, particularly at the Regional and Provincial/City Divisions level, is vital at all points of the project implementation. Depending on your organization's and/or donors' requirements, the initial data on off-grid schools will only be the first among many administrative requirements that you need to accomplish to complete the project. You also have to consider legal requirements that your organization/donors and DepEd will require, like the Deed of Donation or Deed of Assignment (to be discussed later).

Having face-to-face meetings is one sure way to establishing good relations with DepEd, and similarly, with other agencies and offices in the Philippines.

Discuss the solar electrification project in detail with the concerned Schools Division office head. The meeting—or meetings, as may be necessary—with the concerned Schools Division office will allow you and your organization to gain the trust needed to conduct site assessments and to secure the contact details of principals/head teachers of target off-grid and partner senior high schools. Depending on the advice of the Schools Division head, it may be necessary to also inform the Regional Office about the project.

Separate meetings with principals or head teachers of target off-grid schools and their partner senior high schools are equally necessary before conducting any work at the site.

**Output of Step A1:**

- ➔ *List of potential beneficiary schools, clustered by municipality and with partner SHS with EIM track offerings.*
- ➔ *Approval and endorsement of DepEd*
- ➔ *List of contact persons for potential beneficiary schools*

## Step A2 – Assessment of off-grid school and partner public senior high school

It is necessary for a team to visit the potential beneficiary schools—the off-grid school and the partner senior high school—in order to effectively assess conditions in both campuses. Before visiting any of the these schools, the Project Team must contact the principals or acting heads to obtain permission and set meetings with concerned school officials.

Considering the remoteness of target schools, it is important to set appointments with concerned school officials to maximize the Project Team's visit. One must also take into consideration that in some off-grid communities, mobile phone service is intermittent so appointments have to be set to ensure the school officials that have the information needed will be present during the visit.

During the visit, the team leader will explain the project to the school principals/acting heads and why the school was initially selected. He/she will make it clear that a final decision will be made after the initial assessment and that the school will be informed if they are chosen as part of the project or not. Furthermore, he/she will gather information about the school such as the school profile, performance indicators and other relevant information for the project.

On the technical site, the suitability of the school building for the installation of a PV system will be examined and the existing electrical equipment in the school will be inspected and documented by the team (see also **TECHNICAL REQUIREMENTS, Step T1.1**).

Ideally for the assessment, the project shall send a **TEAM** composed of the following:

**TEAM LEADER** - Preferably an employee of the proponent organization or donor agency. He/she is the point person in all communications between DepEd and his/her organization/agency. He/she will gather and compile all relevant information for the project, including the inputs of team members, and report on the results of the assessment.

**ELECTRICAL ENGINEER** – At off-grid school, he/she must determine current energy source and usage (off-grid schools that have electricity often rely on diesel generator sets so there is a need to secure fuel consumption of the generator set), existing electrical wiring system, and existing lighting and other electronic appliances. The electrical engineer must conduct a room-to-room assessment to determine conditions of the existing wiring system, lights, IT equipment and other electronic devices. Doing so will allow the team to determine the load profile or energy requirement of the school. The electrical engineer must also determine if there are existing PV panels/system in the school and if there is, its generation capacity. The electrical engineer will design the PV system to be installed based on the ideal load profile. His/her design should include scope of work and estimated costs.

At partner senior high school, the electrical engineer must assess existing tools and equipment being used in the EIM track and determine what is needed to effectively teach EIM-Solar in the said school.

**CIVIL ENGINEER** – The civil engineer is needed only for assessing the off-grid school to be energized. He/she will determine the structural integrity of the school building where the solar panels are supposed to be mounted as well as the rooms to be constructed or upgraded, which will contain the inverters, batteries and other electrical equipment. He/she needs to prepare the school lay-out and the orientation of the PV panels, bearing in mind their maximum exposure to the sun.

In RELY's team experience, the assessment of the target schools can be completed in around four hours. Travel time will depend on the location of the target schools and travel conditions.

## Step A2.1 – Assessment of off-grid school

The visit to the target off-grid schools has the following purpose:

- Obtain the profile and performance indicators of the school. This is a set of data that includes student population, enrollment figures, and number of teachers, among others.
- Determine existing energy supply. If the school is powered by a diesel generator, obtain fuel consumption or energy usage.
- Document all electrical equipment used in the school to determine the energy consumption of the school. Teaching equipment such as computers, projectors, and printers shall be considered as well as general equipment such as lightbulbs, electric fans and power outlets. The assessment shall includwwe the wattage of each equipment and the estimated number of hours of daily use. Usually the teachers can provide this information.
- Assess the stability of existing school buildings to determine where the PV panels can be mounted. The best option would be on the school roof but floor mounting is also an alternative.
- Determine the existence of rooms that can be designated as the electrical room that will house inverters, batteries and other electrical equipment related to the PV system. There might be a need to construct a room or upgrade an existing room for the purpose.
- Examine the condition of the existing wiring in the building. Often the buildings have undersized wires that are too small in gauge for carrying the current needed in the circuit.
- Ensure substantial photo and/or video documentation of the school and its facilities.

**Output of Step A2.1:**

- ➔ *School profile including performance indicators and photo/video documentation*
- ➔ *Identified area where to place the solar panels and the electrical room*
- ➔ *Quantity of electrical equipment used in the school and existing energy supply*
- ➔ *Number of hours they use their equipment*
- ➔ *Condition of the existing wiring system*

## Step A2.2 – Assessment of partner public senior high school

During the visit to the partner public SHS the team leader will share the same information as he did to the remote off-grid schools but will focus on the vocational education aspect and the advantages for the SHS if they participate in the project.

The purpose of the visit to the target SHS is to:

a. *Secure data: school profile and performance indicators*

b. *Evaluate EIM track offering of said school:*

    i. *Check available teaching tools and equipment*

    ii. *Determine average class size and/or trend in enrollment*

    iii. *Discuss with instructors the standard tools and equipment they need*

c. *Determine number of EIM instructors and evaluate their skills.*

d. *Take photos and/or videos of the school, particularly rooms and equipment related to the EIM track*

**Output of Step A2.2:**

- ➔ *School profile including performance indicators and photo/video documentation*
- ➔ *List of existing training equipment for EIM course*
- ➔ *Summary of the needed training equipment*

The Team Leader will consolidate the findings and recommendations of the electrical engineer and civil engineer, and submit the full report to decision makers of his/her organization or donor agency. Details on the assessment and evaluation of the engineers can be found in **Step T2** of the **TECHNICAL REQUIREMENTS**.

## Step A3 – Final decision and notice to beneficiaries

The team leader will present the full report to decision makers of his/her organization or donor agency for discussion, selection and approval. The report shall also contain budget estimates for each off-wwgrid school and senior high school. Based on the decision made, the final list of beneficiaries will be prepared. The project team shall inform the DepEd Region and/or Division Office concerned that the school/ schools have been selected to benefit from the solar energization and/or EIM tech-voc upgrade.

When implementing projects with the Philippine Government, it is customary to sign or enter into a Memorandum of Agreement (MOA) with the partner government agency. The agreement will institutionalize the cooperation between the parties. It will also provide the roles and functions that each party plays to ensure the success of the project.

When your organization or donor agency decides to implement more than one solar energization project under the jurisdiction of a particular Provincial or City Schools Division, it is ideal to include the Schools Division Superintendent as one of the signatories of the MOA. The principals or heads of beneficiary schools ought to sign as witnesses.

If that is not the case, the co-signatory should be the principal or head of the beneficiary school and the other co-signatory is the head of the Donor Agency/Project Proponent. The Schools Division Superintendent should be present in the MOA signing and sign in conforme. Other officials of the school and/ or DepEd present may sign as witnesses. You can find a sample for a MoA with DepEd in **Annex 2**.

## Step A4 – Bidding and Awarding of Supply Contract

Procurement rules and procedures may vary depending on the donor organization and/or project proponent. It is standard procedure among many organizations and donors that a bidding or a call for tender be made to find a supplier that is able to provide all requirements within budget. One has to follow the applicable procurement rules, depending on the source of funding, the threshold of the budget, and the country where the action takes place.

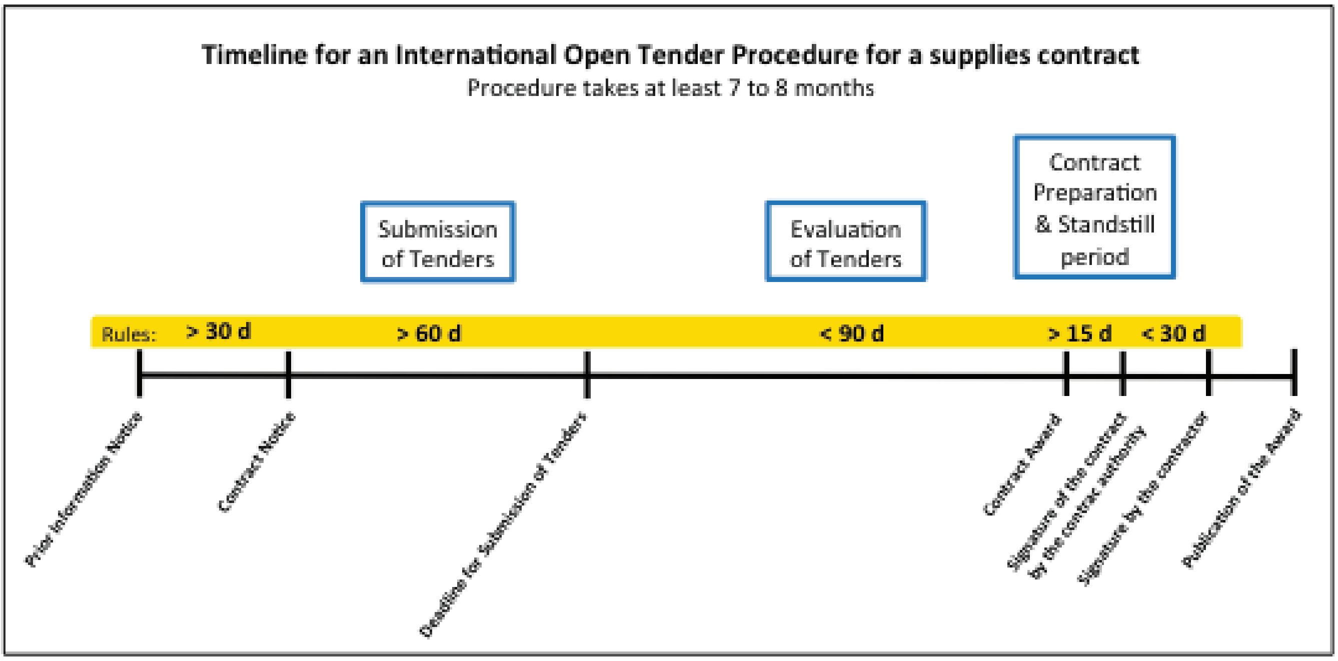



*Figure 2: Timeline for an international open tender procedure for a supplies contract*

It is important to keep in mind that procurement can be quite time consuming and, depending on the rules and regulations, it may include official timelines that have to be observed e.g. in case of an international open tender procedure ( see Figure 2).

Details on the bidding process shall depend on the requirements of the donor agency. The Project Team should become familiar with these requirements and procedures to ensure the success of the bid process.

Since Project RELY was funded by the European Union, the EU's procurement rules had to apply and the team followed the Procedure and Practical Guide of the European Union (PRAG).

As an initial step in the conduct of bidding, the Project Team needs to prepare the scope of work and the terms and conditions for the project, including timelines, PV design and other system specifications. Details on the definition of the PV system can be found in step T3 of the TECHNICAL REQUIREMENTS.

In case of an open tender, these documents shall be made available to the general public by uploading them on the implementing agency and/or donor agency's website. These documents shall serve as guide for interested bidders.

Once the documents are in the public domain, the project shall then publish a notice or invitation to bid in a newspaper of general circulation. The required number of days for the notice may vary per donor agency. Check with the donor agency for this information. If the project has a social media page, the notice or invitation to bid may also be posted there.

In open tender procedures, it is necessary to form a bid evaluation team made up of impartial subject matter experts. In this case, electrical engineers with knowledge on solar technology are needed to be members of the evaluation team.

After a comprehensive evaluation of all qualified bids, the project shall award the supply contract for the solar energization to the winning bidder. The manner of notifying the winning bidder may vary according to the procedures of the donor agency.

Once the supply contract has been awarded to a contractor, the Project Team needs to prepare the down payment required. The amount of down payment and the payment of the balance will vary according to what is agreed in the contract between the project proponent and contractor.

Depending on the rules of procurement of your organization and/or donor agency and the cost, it may not be necessary to conduct a bidding on the purchase of EIM-Solar teaching tools and equipment. In lieu of a bidding, the project will need to contact at least three potential suppliers and ask for their quotations. The best supplier can be selected based on cost, delivery timelines and/or quality of materials.

**Output of Step A4:**

- *Contract with a supplier or suppliers*
- *Deliverables of the PV system supplier as specified in the contract:*
  - *Detailed activity plan (has to be approved by contracting authority)*
  - *Detailed bill of materials per school*
  - *Single line diagram per school (has to be approved by contracting authority)*

## Step A5 – Training for EIM teachers and EIM-Solar donation to partner senior high school

Most, if not all, EIM instructors in the Philippines do not have knowledge/expertise on solar technology. It is therefore advisable that the project includes a training on solar technology for EIM teachers.

The Technical Education and Skills Development Authority (TESDA) in your project area may offer EIM-Solar training with NC II certification. There are also TESDA-accredited training centers that offer EIM-Solar with NC II certification. You can ask TESDA for recommendations.

The training will not only ensure that the teachers have the competence to teach the EIM-Sola track in the partner senior high school, it will also serve as the initial step towards establishing a pool of individuals who are qualified to install and maintain PV systems in the community.

It is practical to schedule the teachers' training in May to ensure the availability of the teachers. When the new school year opens in June, the teachers can use their newly acquired knowledge to their students.

The turnover of the EIM-Solar teaching tools and equipment can be timed shortly after the start of the school year so that the Project Team can observe the students and teachers. You may use the occasion to hold the Deed of Donation signing for the EIM-Solar teaching tools and equipment with the school officials. The same set of signatories in the MOA may be called on for the Deed of Donation signing.

**Output of Step A5:**

- *Deed of Donation and Deed of Acceptance with each SHS*
- *EIM teachers trained on solar technology*
- *NCSII Certificates for each teacher*

## Step A6 – Solar energization and project turnover

In case the wiring condition of the school does not adhere to safety standards and rewiring is considered necessary, it is the responsibility of the team to assure that rewiring work takes place before the installation of the PV systems. Rewiring entails also procurement of materials and most probably the hiring of additional (local) qualified manpower. Close coordination of the work steps with the timeline of the contractor is required.

During the rewiring activities, the students of the partner SHS may be involved as part of their immersion/training (OJT). Often the schools have problems to find enough OJT opportunities for the students and will be happy about the offer and cooperate (see Annex 6 for a Work Immersion Agreement). The students shall be supervised by their teacher-in-charge, certified electricians and by the project's technical coordinator during the whole duration of the rewiring to ensure the quality of work and that the designs are followed accordingly.

The solar energization project in the off-grid school can be turned over shortly after the installation of the PV system is completed. Barring any technical and logistical hitches, the installation of the PV system in the off-grid school may take between two and three weeks, depending on the PV system specifications and the site accessibility.

Task the electrical engineer of the project to conduct regular monitoring of the contractor to ensure that the system being put in place adheres to the design and specifications.

During the turnover, it is customary to hold a ceremony to be attended by concerned DepEd officials (at least the Schools Division), local government officials, and other stakeholders. Your organization and donor agencies might want to invite representatives from the media to cover the event so that the good news can be shared to the public.

With all concerned officials in attendance, the project turnover is the best opportunity for the signing of the Deed of Donation and Deed of Acceptance of the Solar Energization Project. The MOA, the Deed of Donation and Deed of Acceptance shall all be notarized to be deemed legal and binding. Your organization's legal team or consultant should draft these documents and ensure they are notarized. You can find a sample in **Annex 3**.

## Step A7 - Project management and monitoring

The turnovers of the solar energization component and the EIM-Solar donation do not mean the end of the Project Team's responsibilities.

To ensure the sustainability of both project components, the Project Team and the EIM-Solar teaching staff shall establish the process and schedules for EIM-Solar students to conduct maintenance work at the newly energized off-grid school. Normally, this hands-on learning exercise is incorporated into the EIM-Solar students' immersion program during their second semester of the current school year.

A template (or sample) of the maintenance report to be accomplished by the EIM-Solar students can be found in **Annex 7**.

The Project Team and the Donor Agency shall also conduct their own monitoring of both project components. Depending on requirements of the project's organization and/or donor agency, a twice-a-year monitoring is sufficient to determine the impact of the project and determine if goals have been met.

Effective monitoring can also help the Project Team and/or donor agency to determine best practices and areas of improvement that can guide similar projects in the future.

**Output of Step A6 and A7:**

- ➔ *MoA, Deed of Donation and Deed of Acceptance with each beneficiary school*
- ➔ *Monitoring plan with indicators*

# PART II. TECHNICAL REQUIREMENTS

## Step T1 – Introduction to Basic Components of a PV System

The initial planning of the solar electrification of a building/school requires a basic understanding of a PV system and its main components. It is advisable to get to know the main components of a PV system and understand the principle of creating energy. In case of the electrification of remote off-grid schools, the system would be a stand-alone PV system. Therefore, we will only consider this type of system and not elaborate on other options such as grid-connected systems.

### ● How to generate electricity from the sun

The sun is full of energy and solar energy comes from sunlight that reaches earth. The amount of sunlight that reaches the earth varies depending on location, time of day, time of year, and weather conditions. Solar cells turn light from the sun into electricity. Solar cells are also called photovoltaic cells. “Photo” is Latin for light and “voltaic” means electricity. Solar cells are put together to make solar panels that are also called photovoltaic modules.

Photovoltaic modules are usually installed on a building’s roof to collect sunlight and convert it into electricity. The electricity produced is used to charge a bank of batteries. These batteries store the power produced by the solar panels and then one can use the energy from these batteries to power anything in the building that needs electricity.

### ● Photovoltaic modules or Solar Panels

Photovoltaic modules take the solar energy from the sun and generate direct current electricity (DC). A PV module is an assembly of photo-voltaic cells mounted in a framework for installation. It typically consists of an assembly of 6 x 10 photovoltaic cells (also called solar cells).

A collection of PV modules is called a PV Panel, and a system of Panels is an Array. Arrays of a photovoltaic system supply solar electricity to electrical equipment (see Figure 4).

The solar cells’ efficiency and wattage output can vary depending on the type and quality of solar cells used. A solar module can range in energy production from

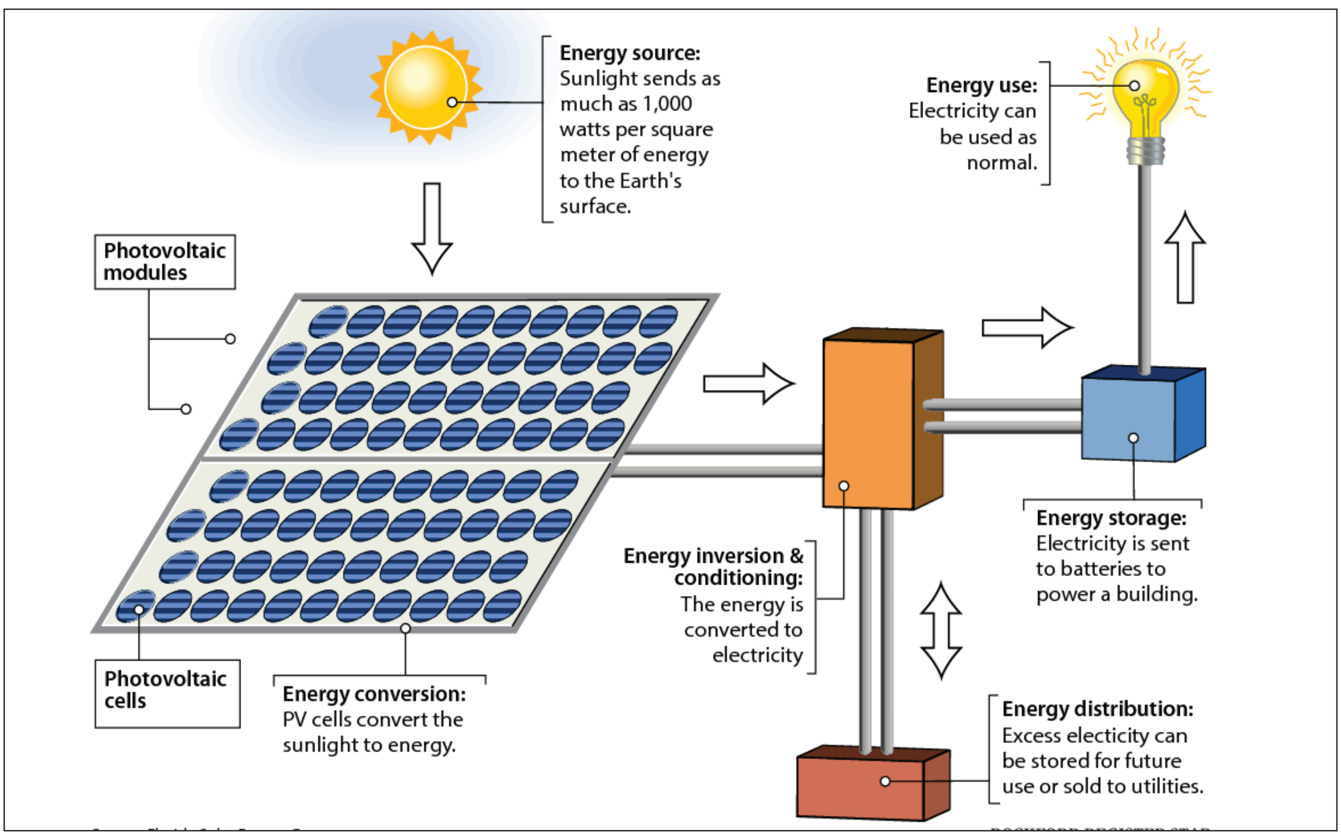



*Figure 3: How Photovoltaic Solar Panels Work*

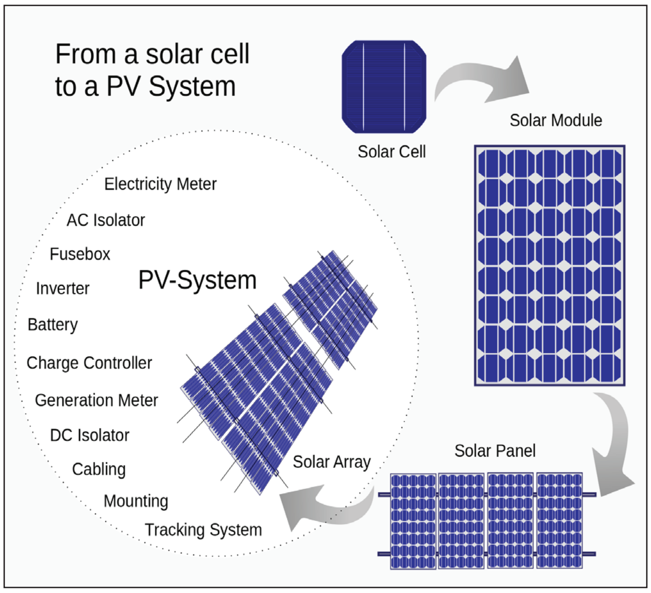



*Figure 4: From a Solar Cell to a PV System*

100-365 Watts of DC electricity. The higher the wattage output, the more energy production per solar module.

Most commonly available panels today are either monocrystalline solar panels (mono) and polycrystalline solar panels (poly). Both are made from silicon, which is used for solar panels because it is an abundant and very durable element.

The main advantages of monocrystalline panels are higher efficiencies and sleeker aesthetics. Polycrystalline solar panels generally have lower efficiencies than monocrystalline options, but their advantage is a lower price point.

| Comparison of monocrystalline solar panels vs. polycrystalline solar panels | | |
|---|---|---|
| | Monocrystalline | Polycrystalline |
| Upfront Cost | More expensive | Less expensive |
| Efficiency | More efficient | Less efficient |
| Lifespan | 25+ years | 25+ years |
| Aesthetics | Solar cells are a black hue | Solar cells have a blue-ish hue |

## ● Array mounting racks

Array mounting racks are used to safely fix solar panels to various surfaces such as roofs, building facades, or the ground. The system is designed to easily be retrofitted to existing rooftops and structures.

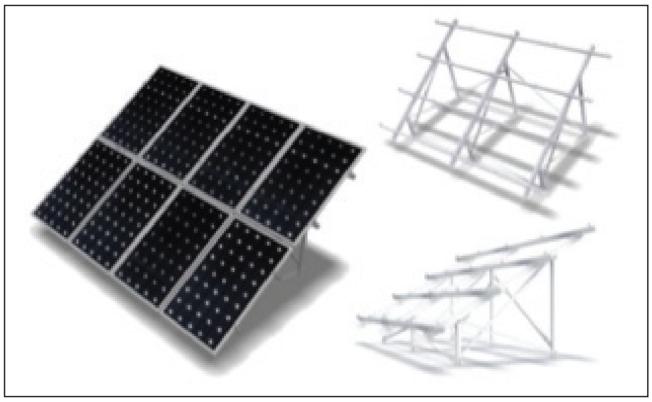


*Figure 5: Mounting Racks for PV Array*

*Figure 6 (right side): Combiner Box*

## ● Grounding equipment

Grounding equipment provides a well-defined, low-resistance path from your system to the ground to protect your system from current surges caused by lightning strikes or equipment malfunctions. This path is expected to carry fault current if system malfunctions occur so the ground wire must be as large as the largest conductor in the system. Two types of grounding are needed in PV systems.

## ● Combiner box


Wires from individual PV modules or strings are run to the combiner box, typically located on the roof. These wires may be single conductor pigtails with connectors that are pre-wired onto the PV modules. The output of the combiner box is one larger two-wire conductor in conduit. A combiner box typically includes a safety fuse or breaker for each string and may include a surge protector.

## ● Surge protection

Surge protectors help to protect your system from power surges that may occur if the PV system or nearby power lines are struck by lightning. A power surge is an increase in voltage significantly above the design voltage. They are often part of the combiner box.

*Figure 7: Surge protector*

## ● Inverter

A solar inverter or PV inverter is a critical balance of system (BOS)–component in a photovoltaic system, allowing the use of ordinary AC-powered equipment. Solar power inverters have special functions adapted for use with photovoltaic arrays, including maximum power point tracking. Inverters take care of these basic tasks of power conditioning:

- Converting the variable direct current (DC) output coming from the PV modules or battery bank into a utility frequency alternating current (AC) that can be used by a local, off-grid electrical network.
- Ensuring that the frequency of the AC cycles is 60 cycles per second
- Reducing voltage fluctuations

## ● Disconnects

Automatic and manual safety disconnects protect the wiring and components from power surges and other equipment malfunctions. They also ensure the system can be safely shut down and system components can be removed for maintenance and repair. In general, a disconnect is needed for each source of power or energy storage device in the system.

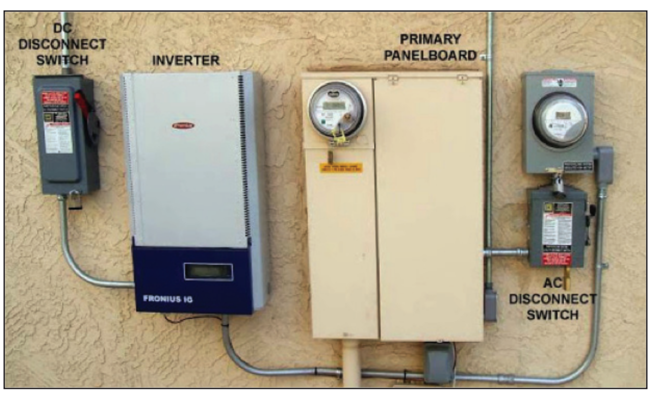



*Figure 8: AC and DC Disconnect Switches in Use*

## ● Batteries

Batteries store direct current electrical energy for later use. In stand-alone PV systems, battery storage is necessary.

The most important specifications to use during your evaluation on which battery to use are the battery's capacity and power ratings, depth of discharge (DoD), round-trip efficiency, and warranty.

**Capacity** is the total amount of electricity that a solar battery can store, measured in kilowatt-hours (kWh).

Power rating is the amount of electricity that a battery can deliver at one time. It is measured in kilowatts (kW). A battery with a high capacity and a low power rating would deliver a low amount of electricity (enough to run a few crucial appliances) for a long time. A battery with low capacity and a high power rating could run all appliances, but only for a few hours.


*Figure 9: Battery*

**Depth of discharge (DoD)** of a battery refers to the amount of a battery's capacity that has been used. Most manufacturers will specify a maximum DoD for optimal performance. For example, if a 10 kWh battery has a DoD of 90 percent, you shouldn't use more than 9 kWh of the battery before recharging it. Generally speaking, a higher DoD means you will be able to utilize more of your battery's capacity.

**Battery's round-trip efficiency** represents the amount of energy that can be used as a percentage of the amount of energy that it took to store it. For example, if you feed five kWh of electricity into your battery and can only get four kWh of useful electricity back, the battery has 80 percent round-trip efficiency (4 kWh / 5 kWh = 80%). Generally speaking, a higher round-trip efficiency means you will get more economic value out of your battery.

A solar battery will have a **warranty** that guarantees a certain number of cycles and/or years of useful life. Because battery performance naturally degrades over time, most manufacturers will also guarantee that the battery keeps a certain amount of its capacity over the course of the warranty.

## Types of batteries

*Two of th*e most common battery chemistry types to be used in PV systems are lithium-ion and lead acid. As their names imply, lithium-ion batteries are made with the metal lithium, while lead-acid batteries are made with lead.

With these differences in chemistry come differences in performance and cost. While both lithium-ion and lead acid battery options can be effective storage solutions, here are some important key comparison points to consider when deciding o*n a battery type:*

| Lithium-ion vs. lead acid batteries | | |
|---|---|---|
| | Lithium-ion | Sealed lead acid |
| Upfront Cost | more | less |
| Capacity | higher | lower |
| Depth of Discharge (DoD) | higher | lower |
| Efficiency | higher | lower |
| Typical Lifespan | 10 years | 5 years |
| | | |
| Weight | lighter | heavier |
| Regular Maintenance | none | none |

### – Lead-acid batteries

Lead acid batteries are a tested technology that has been used in off-grid energy systems for decades. While they have a relatively short life and lower DoD than other battery types, they are also one of the least expensive options currently on the market. Take out the flooded. There are two main types of lead-acid batteries:

- Flooded (Liquid vented)
- Sealed (Valve-Regulated Lead Acid - VRLA)

Flooded lead acid batteries are usually the least expensive but require adding distilled water at least monthly to replenish water lost during the normal charging process. Sealed batteries are spill-proof and do not require periodic maintenance, therefore, they are the better option for lead-acid batteries.

Lead acid batteries are generally installed indoors because they have a preferred charging and discharging temperate range of 50°F (10 degrees Celsius) – 80°F (26.67 Celsius). While you can operate lead acid batteries outside of this temperature range, it will reduce the system's lifespan and efficiency. Manufacturers' guidelines will give additional specific details on operating temperature requirements for specific lead acid systems.

Lead acid batteries are less energy dense than lithium ion systems. This means they will take up more space per installed kW or kWh unit. A single lead acid battery takes up about as much space as a shoebox. Multiple batteries are strung together to make a system large enough to power multiple loads in your home. It is best to mount lead acid systems off of the ground to minimize the potential for water damage.

Lead acid batteries must also be connected to a separate inverter, which must be wall-mounted. Sealed lead acid batteries are more common than their unsealed (or flooded) cousins because they do not require maintenance. If you use a flooded lead acid system, it is important to make sure to vent the space properly and maintain the system monthly. Maintenance includes cleaning the battery terminals and adding distilled water to the batteries.

### – Lithium-ion batteries

Lithium ion batteries are lighter and more compact than lead acid batteries. They also have a higher DoD and longer lifespan when compared to lead acid batteries. However, lithium ion batteries are more expensive than their lead acid counterparts.

Lithium ion batteries have a much wider preferred temperature operating range, typically between 32°F to 100°F. Additionally, lithium ion systems are more energy dense than lead acid batteries and are typically contained in one singular unit. Depending on the manufacturer, Lithium-ion batteries may or may not contain an integrated inverter. This further reduces the space required for these types of systems.

With lithium ion's wider temperature range and smaller footprint, some manufacturers have designed systems that can be installed outdoors, typically mounted on the side of the building near the electric meter or solar connection. This option is only feasible if one does not live in a climate with extreme seasonal temperature swings.

Like sealed lead acid batteries, the lithium-ion technology requires no maintenance. Ongoing operations – cycling the battery on and off – will be controlled by a battery management system in the inverter component of the device. One will not be responsible for manually switching the battery on or off.

## ● Battery bank with cabling and housing structure

As for the housing structure, it is important to consider where the system will be located. Different types of batteries have different temperature requirements, space constraints, and sitting conditions.

## ● Charge controller

A charge controller, sometimes referred to as a photovoltaic controller or battery charger, is only necessary in systems with battery back-up.


*Figure 10: Charge Controller*

It regulates the flow of electricity from the PV modules to the battery and the load. The primary function of a charge controller is to prevent overcharging of the batteries. Most also include a low voltage disconnect that prevents over-discharging batteries.

When the load is drawing power, the controller allows charge to flow from the modules into the battery, the load, or both. When the controller senses that the battery is fully charged, it stops the flow of charge from the modules. Many controllers will also sense when loads have taken too much electricity from batteries and will stop the flow until sufficient charge is restored to the batteries.

In addition, charge controllers prevent charge from draining back to solar modules at night. Some modern charge controllers incorporate maximum power point tracking, which optimizes the PV array's output, increasing the energy it produces.

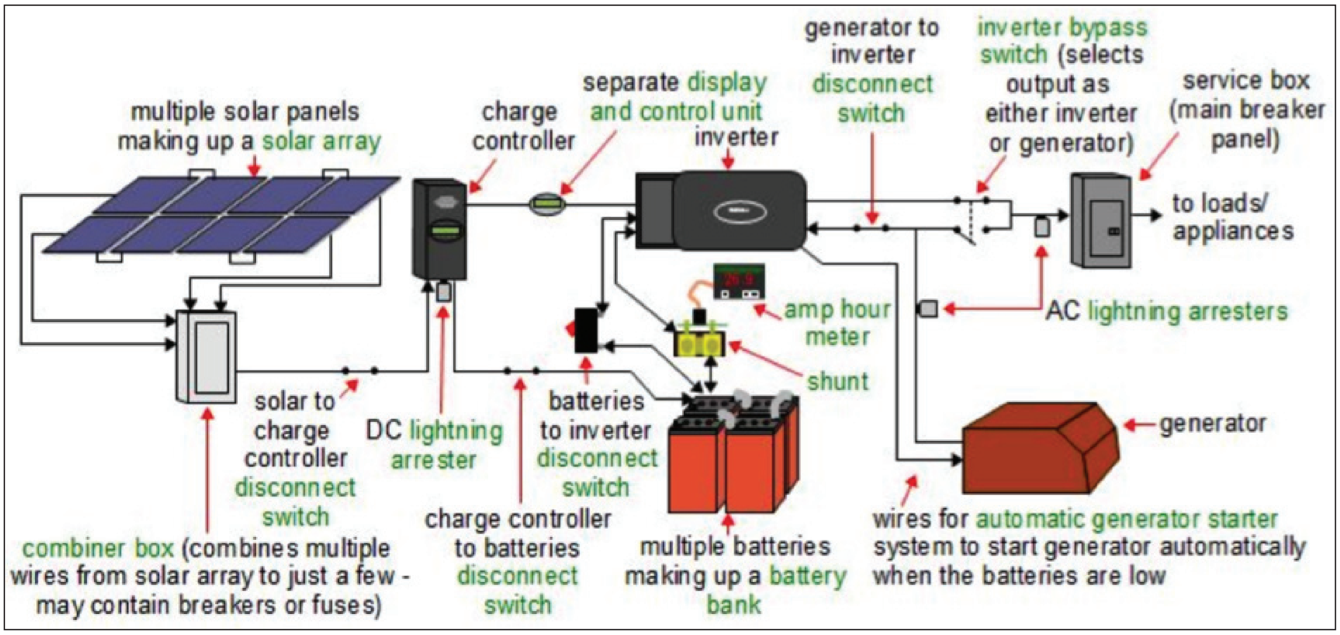



*Figure 11: Diagram of an PV Off-grid System*

## Step T2 – Technical details for the Assessment of off-grid school

### Suitable installation site for solar panels

In planning a stand-alone PV System, the following points shall be considered carefully during the location assessment and surveying for a suitable site:

- Selection of site /location either on the roof or on the ground with minimum (or no) shade
- Orientation and direction of the selected site/ location
- In case of roof, the type, structure, and sturdiness of the roof while keeping in mind the space and weight requirement of the estimated system size
- Total available land/surface area of the selected location/site for alternative floor mounting
- Possible route for cables, battery and inverter from the selected location/site

### Compute the load requirement (energy consumption per day) of the school

The load requirement of each school will be determined based on the existing equipment and will take into account future equipment. To determine a realistic energy consumption, which will be the basis for the definition of the required PV system, one has to consider three main factors:

- The actual situation (equipment, actual hours of use)
- The desired situation (additional equipment anticipated, desired hours of use)
- The available budget of the donor

When asking the beneficiary school representative what they would need in the future they will usually come up with a lot of additional equipment that they plan to purchase or expect from DepEd and they will also increase/maximize the hours of use of the existing equipment.

The desired situation is quite often very ambitious and realization may not be possible within the budget range of the donor. A compromise has to be found together with the beneficiaries that takes everything into consideration and leads to a solution that improves the learning conditions of the pupils but is also realistic and according to budget.

Initially, one will make the computation of the energy consumption of the school with the existing equipment and a realistic assumption for the hours of use (actual situation).

Example table format for the energy consumption per day assessment:

| Appliance | Wattage | Quantity | Operating hrs./day | Energy consumption per day (kWh) |
|---|---|---|---|---|
| Electric fan | 18 | 2 | 6 | 216 |
| Laptop | 60 | 2 | 6 | 720 |
| Etc. | Etc. | Etc. | Etc. | Etc. |
| | | | **TOTAL** | **936** |

To get the energy consumption per day for each appliance (e.g. 2 electric fans), check the wattage of the appliances (look for the sticker or data plate with technical specifications usually found at the back or bottom of the appliance) and multiply the figure by quantity and by normal operating hours (see also Figure 12).


*Figure 12: Example for the energy consumption per day*

When you sum up everything, you get the total energy consumption of the system in a day (total load requirement) during the actual situation.

Once you have the actual total energy consumption (or actual total load requirement), you can discuss with the responsible school official any additional equipment that the school would need and compute the corresponding load requirement based on several scenarios. This exercise is necessary to determine the best and most realistic solution that also takes into account the budget for the project. The outcome of this exercise is what we call the negotiated future scenario and will be the basis for defining and designing the PV system for the school.

To compute the total load requirement of the negotiated future scenario one has to add the additional equipment with its wattage and the assumed daily operating hours. If the school foresees longer usage (additional operating hours) for existing equipment or appliance, a corresponding adjustment should be included in computing the negotiated future scenario.

**Output of Step T2:**

- ➔ *Total energy consumption of the system in a day for the actual situation*
- ➔ *Definition of the negotiated future scenario – what equipment will be added and what are the daily operating hours for each.*
- ➔ *Total energy consumption of the system in a day (total load requirement) for the negotiated future scenario*

## Step T3 – Definition of PV system for the procurement (related to A4)

The definition of the PV system is a necessary step in preparing for the procurement process. The electrical engineer must define the size of the PV system that can support the previously identified load requirement for the negotiated future scenario, factoring in the computation at least one rainy day, and come up with a rough cost estimate.

The input data for the PV system sizing shall be the following:

- load requirement (energy consumption) for the negotiated future scenario
- hourly distribution of energy consumption (morning, midday, and afternoon solar radiation)
- hourly distribution of battery discharge
- energy consumption nighttime (all energy from battery)
- meteorological data (solar radiation power)
- maximum battery discharge - battery health and life span
- maximum battery charging current, ability of battery to absorb maximum current
- momentary peak power consumption (for Inverter power sizing)

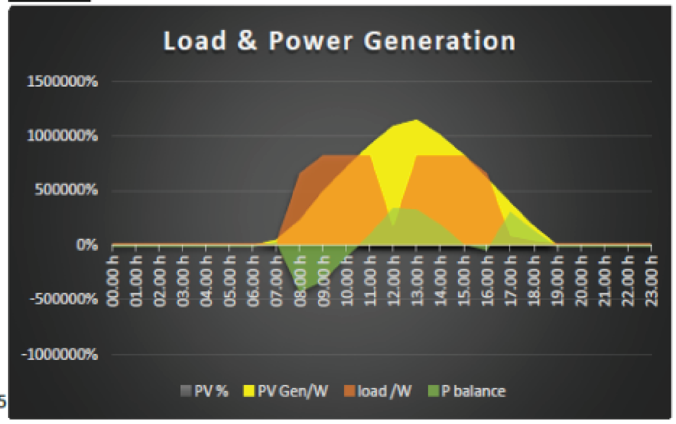
The electrical engineer needs to compute the size of the PV system according to different technical scenarios and compare the performance and the estimated costs of each.

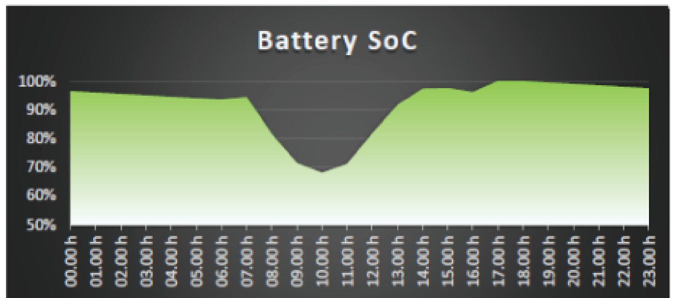
On the next page you can find an example for PV system sizing with two different technical scenarios. Please take note that the cost estimates are not included (Figure 13).

The ideal size of the PV system shall be chosen after evaluating the different options.

10.89%

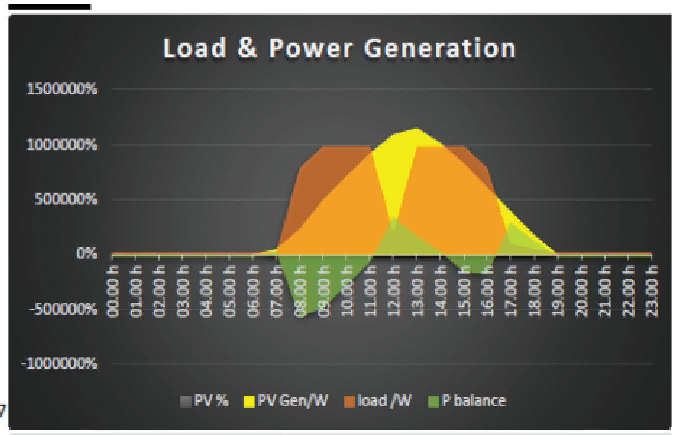
| PV: | av. | 16416 Wp | | 8208 | Batt 48V/ | 684 | Ah | |
|---|---|---|---|---|---|---|---|---|
| time | PV % | PV Gen/W | load | load /W | P balance | Batt Wh | SoC | |
| 00.00 h | 0% | 0 | 2% | 164 | -164 | 31683 | 97% | 0 |
| 01.00 h | 0% | 0 | 2% | 164 | -164 | 31519 | 96% | 0 |
| 02.00 h | 0% | 0 | 2% | 164 | -164 | 31355 | 96% | 0 |
| 03.00 h | 0% | 0 | 2% | 164 | -164 | 31190 | 95% | 0 |
| 04.00 h | 0% | 0 | 2% | 164 | -164 | 31026 | 95% | 0 |
| 05.00 h | 0% | 0 | 2% | 164 | -164 | 30862 | 94% | 0 |
| 06.00 h | 0% | 0 | 2% | 164 | -164 | 30698 | 94% | 0 |
| 07.00 h | 4% | 460 | 2% | 164 | 295 | 30993 | 94% | 0 |
| 08.00 h | 20% | 2298 | 80% | 6566 | -4268 | 26725 | 81% | 0 |
| 09.00 h | 43% | 4941 | 100% | 8208 | -3267 | 23458 | 71% | 0 |
| 10.00 h | 62% | 7125 | 100% | 8208 | -1083 | 22375 | 68% | 0 |
| 11.00 h | 80% | 9193 | 100% | 8208 | 985 | 23360 | 71% | 0 |
| 12.00 h | 95% | 10917 | 20% | 1642 | 3420 | 26780 | 82% | 5855 |
| 13.00 h | 100% | 11491 | 100% | 8208 | 3283 | 30063 | 92% | 0 |
| 14.00 h | 88% | 10112 | 100% | 8208 | 1904 | 31967 | 97% | 0 |
| 15.00 h | 72% | 8274 | 100% | 8208 | 66 | 32033 | 98% | 0 |
| 16.00 h | 53% | 6090 | 80% | 6566 | -476 | 31557 | 96% | 0 |
| 17.00 h | 34% | 3907 | 10% | 821 | 3086 | 32832 | 100% | 0 |
| 18.00 h | 15% | 1724 | 5% | 410 | 1313 | 32832 | 100% | 0 |
| 19.00 h | 0% | 0 | 2% | 164 | -164 | 32668 | 100% | 0 |
| 20.00 h | 0% | 0 | 2% | 164 | -164 | 32504 | 99% | 0 |
| 21.00 h | 0% | 0 | 2% | 164 | -164 | 32340 | 99% | 0 |
| 22.00 h | 0% | 0 | 2% | 164 | -164 | 32175 | 98% | 0 |
| 23.00 h | 0% | 0 | 2% | 164 | -164 | 32011 | 98% | 0 |
| Energy: | | 76531 | | 67388 | 3289 | 725007 | Wh/d | |
| | | PV gener. | | Consum. | waste: | 7.65% | waste: 5855 Wh | |

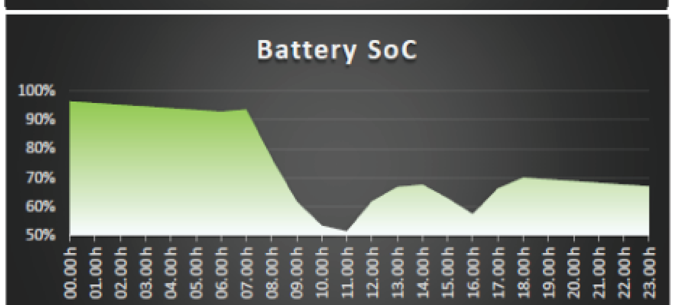



92% average SoC

| PV: | av. | 16416 Wp | | 9850 | Batt 48V/ | 684 Ah | | |
|---|---|---|---|---|---|---|---|---|
| time | PV % | PV Gen/W | load | load /W | P balance | Batt Wh | SoC | |
| 00.00 h | 0% | 0 | 2% | 197 | -197 | 31650 | 96% | 0 |
| 01.00 h | 0% | 0 | 2% | 197 | -197 | 31453 | 96% | 0 |
| 02.00 h | 0% | 0 | 2% | 197 | -197 | 31256 | 95% | 0 |
| 03.00 h | 0% | 0 | 2% | 197 | -197 | 31059 | 95% | 0 |
| 04.00 h | 0% | 0 | 2% | 197 | -197 | 30862 | 94% | 0 |
| 05.00 h | 0% | 0 | 2% | 197 | -197 | 30665 | 93% | 0 |
| 06.00 h | 0% | 0 | 2% | 197 | -197 | 30468 | 93% | 0 |
| 07.00 h | 4% | 460 | 2% | 197 | 263 | 30731 | 94% | 0 |
| 08.00 h | 20% | 2298 | 80% | 7880 | -5581 | 25149 | 77% | 0 |
| 09.00 h | 43% | 4941 | 100% | 9850 | -4908 | 20241 | 62% | 0 |
| 10.00 h | 62% | 7125 | 100% | 9850 | -2725 | 17516 | 53% | 0 |
| 11.00 h | 80% | 9193 | 100% | 9850 | -657 | 16859 | 51% | 0 |
| 12.00 h | 95% | 10917 | 20% | 1970 | 3420 | 20279 | 62% | 5527 |
| 13.00 h | 100% | 11491 | 100% | 9850 | 1642 | 21921 | 67% | 0 |
| 14.00 h | 88% | 10112 | 100% | 9850 | 263 | 22183 | 68% | 0 |
| 15.00 h | 72% | 8274 | 100% | 9850 | -1576 | 20608 | 63% | 0 |
| 16.00 h | 53% | 6090 | 80% | 7880 | -1789 | 18818 | 57% | 0 |
| 17.00 h | 34% | 3907 | 10% | 985 | 2922 | 21740 | 66% | 0 |
| 18.00 h | 15% | 1724 | 5% | 492 | 1231 | 22971 | 70% | 0 |
| 19.00 h | 0% | 0 | 2% | 197 | -197 | 22774 | 69% | 0 |
| 20.00 h | 0% | 0 | 2% | 197 | -197 | 22577 | 69% | 0 |
| 21.00 h | 0% | 0 | 2% | 197 | -197 | 22380 | 68% | 0 |
| 22.00 h | 0% | 0 | 2% | 197 | -197 | 22183 | 68% | 0 |
| 23.00 h | 0% | 0 | 2% | 197 | -197 | 21986 | 67% | 0 |
| Energy: | | 76531 | | 80865 | -9861 | 588333 | Wh/d | |
| | | PV gener. | | Consum. | waste: | 7.22% | waste: 5527 Wh | |




75% average SoC

*Figure 13: Example for PV system sizing with two different technical scenarios (cost estimates not included)*

| Lot 1 (Bohol) | | | | |
|---|---|---|---|---|
| School | PV generator (Wp) | Inverter AC Power (VA) | Battery Capacity (Wh) | max AC load (W) |
| **Bilangbilangan Daku Elementary School** | 20000 | 12000 | 38400 | 10000 |
| **Malingin Elementary School** | 18000 | 11000 | 36000 | 9000 |
| **Hingotanan Elementary School** | 35000 | 21000 | 67200 | 17500 |
| **Hingotanan National High School** | 42000 | 25000 | 86400 | 20500 |
| **Guindacpan Elelmentary School (Campus 1 + 2)** | 26000 | 16000 | 48000 | 13000 |
| **Cataban Integrated School** | 36000 | 22000 | 72000 | 18000 |

*Figure 14: Example for size and performance of PV systems for a geographical cluster as shown in the tender dossier*

The next step is to define the technical specifications of the main elements of the PV system to make sure the bidders will offer the required quality and safety standards. Define specifications and critical points for:

- *solar array*
- *charging system*
- *inverter*
- *wiring and circuit protection*
- *earthing system*
- *electrical room*
- *documentation*
- *end-user training*
- *workplan*

An example for the technical specifications as part of the tender dossier can be found in Annex 4.

**Output of Step T3:**

→ *Determination of PV system size and performance*

→ *Rough cost estimate of the determined PV system*

→ *Technical specifications of the main elements of the PV system*

## Step T4 – Rewiring of school (related to A6)

While doing the assessment of the electrical equipment, the electrical engineer will also examine the condition of the existing wiring in the school building. The existing electrical school networks are often rudimentary and partly not according to the required safety standards. Often the buildings have undersized wires that are too small in gauge for carrying the current needed in the circuit. Undersized wires are dangerous since they can result in overheating which can cause fire, explosion, or injury. The condition of the wiring of each room must be documented and the assessment shall include a list of rooms that need full or partial rewiring.

One needs to consider the following factors for choosing the right size of wire:

- Area where the wire will be placed
- Ampacity that it would carry
- Distance from source to the load

The reference for the wire size shall be the **Philippine Electrical Code and National Electrical Code**. It is downloadable from the official organization of electrical engineers in the Philippines: https://iiee.org.ph:89/uploads/files/1021.pdf

The materials that are needed for the rewiring of the school building to be connected to the new PV system have to be determined/documented for the procurement. Make sure to follow the required procurement rules.

Once procurement proceedings have been completed, the rewiring can be scheduled and implemented, either by a contractor or by the donor. In the case of Project RELY, the rewiring was conducted by EIM students of the partner senior high school as part of their OJT under the supervision of an electrician or their instructor.

**Output of Step T4:**

- *List of materials for the rewiring*
- *List of tools needed*
- *Estimate of working time/ manpower needed*
- *Electrical layout (single line diagram and per room layout)*

*Pilot project for solar electrification of schools - Hilotongan Integrated School in the municipality of Bantayan*

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Figure 1: RELY project document, design Chuck Orillaneda

Figure 2: RELY project document, based on EU guidelines for international open tender procedure

Figure 3: http://www.fsec.ucf.edu/en/consumer/solar_electricity/basics/how_pv_system_works.htm

Figure 4: https://upload.wikimedia.org/wikipedia/commons/a/a0/From_a_solar_cell_to_a_PV_system.svg

Figure 5: https://www.teknosolar.com/componentes-fotovoltaicos/estructuras/page/2/

Figure 6: https://www.chinasuntree.com/combiner-box/shlx-ac4-1-ac-pv-combiner-box.htm

Figure 7: http://www.kejia.com/?product=pv-solar-panel-spd-kdy-40-d900

Figure 8: https://www.cansia.ca/uploads/7/2/5/1/72513707/solar_electricity_safety_handbook_for_firefighters_.pdf

Figure 9: https://www.indiamart.com/proddetail/deep-cycle-solar-battery-13157466973.html

Figure 10: https://cleanenergyprojectnv.org/how-to-select-solar-charge-controller/

Figure 11: https://talenta.usu.ac.id/koridor/article/download/1353/1145/

Figure 12: RELY project document

Figure 13: RELY project document

Figure 14: RELY project document

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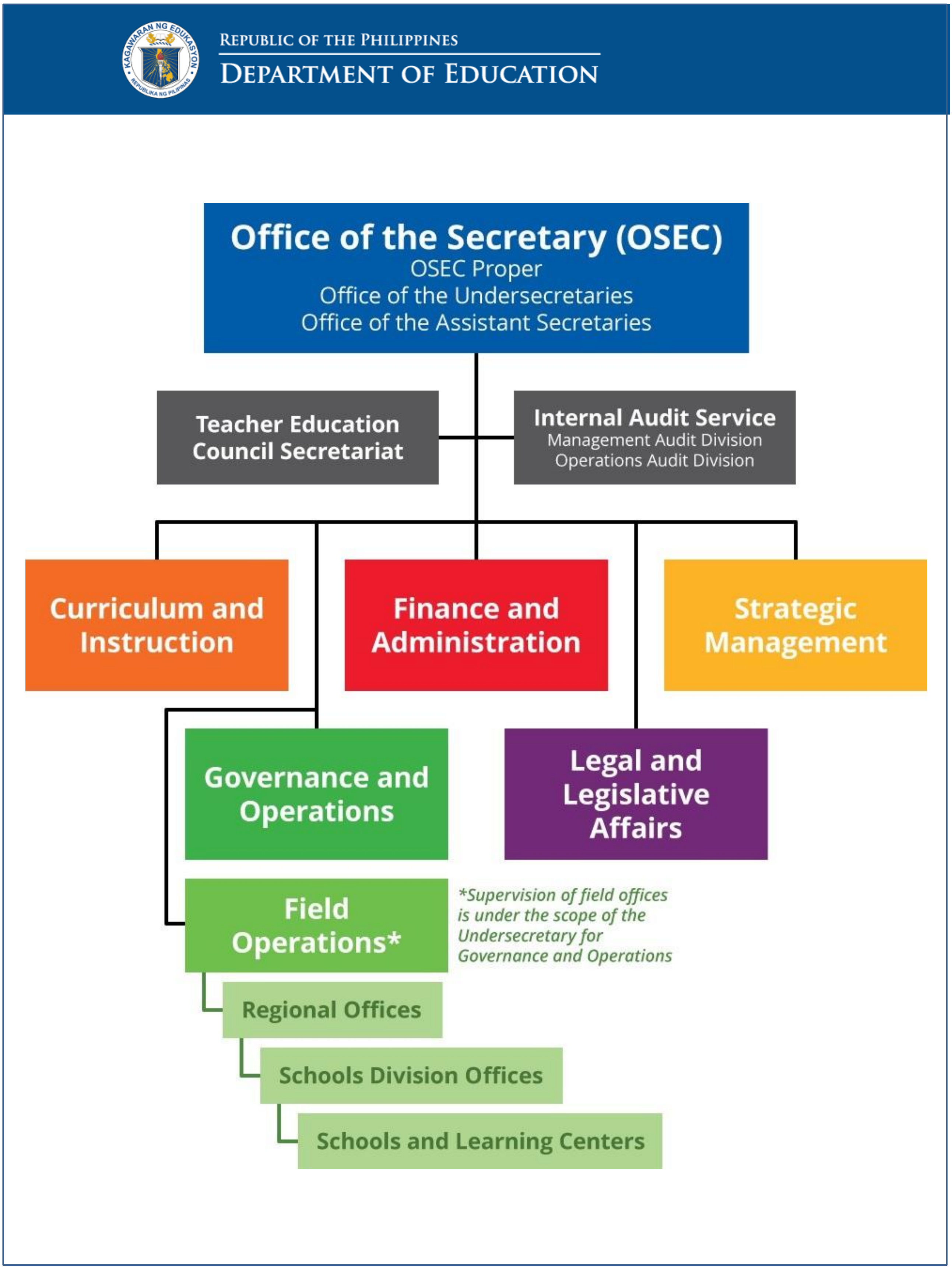
# ANNEX 1

## Overview of the organizational structure of the DepEd's Central Office



# ANNEX 2

## Sample – Memorandum of Agreement with DepEd

**MEMORANDUM OF AGREEMENT**

KNOW ALL MEN BY THESE PRESENTS:

This Memorandum of Agreement (the "Agreement") is made and entered into this _____ day of ________________, in _____________________ by and between:

**DEPARTMENT OF EDUCATION - DIVISION OF _____ PROVINCE AND {NAME OF SPECIFIC SCHOOL OR SCHOOLS TO BE ENERGIZED},** an/a {general description of islet or off-grid islet public schools, funded and operated by the government under the Department of Education of the Republic of the Philippines, located at {province, in Region}, Philippines, and herein represented by its {position, NAME OF REPRESENTATIVE} herein referred to as the "*DepEd*;

- and -

**{DONOR},** a duly organized non-stock, non-profit organization, existing under the laws of the Republic of the Philippines, with principal office address at {address of donor}, represented herein by its {position, NAME OF REPRESENTATIVE}**,** herein after referred to as **"PROJECT MANAGER".**

**WITNESSETH THAT**

**WHEREAS**, the Department of Education of the Philippines, is the primary government instrumentality mandated to formulate, implement, and coordinate policies, plans, programs and projects in the areas of formal and non-formal basic education; supervise all elementary and secondary education institutions, including alternative learning systems, both public and private; and provide for the establishment and maintenance of a complete, adequate, and integrated system of basic education relevant to the goals of national development;

**WHEREAS,** the *DepEd* has the responsibility of securing resources to make public schools competitive and is encouraging the private sector to serve as a major partner in the nation's development and in the improvement of the public education system;

**WHEREAS**, the *DepEd* believes that one way of addressing the shortage of power in some public schools is by providing Solar PV Off Grid System.

**WHEREAS**, the PROJECT MANAGER, together with the {mention partners if there are any}, jointly implement {name of project and brief description} .

**WHEREAS**, the PROJECT MANAGER thru {name of project}, has the responsibility to assist the public school system and provide the resource gaps that the government may not immediately provide;

**WHEREAS**, the PROJECT MANAGER, will donate a Solar PV Off Grid Systems at different capacity levels to {number of schools to be energized}, {Optional annex: (See ANNEX __)} in {address of school or schools}.

**WHEREAS,** in recognition of the parties' common goals and in support of the government's thrusts towards its noble goal of educating all the Filipinos, the **PROJECT MANAGER** thru {name of project}**,** is committed to support the Department of Education.

**NOW THEREFORE,** for and in consideration of the foregoing premises and the terms and conditions herein set forth, the parties agree as follows:

**Section 1.** *Description of the Sponsorship or Package*

The Project is known as **"{Project Name}"** (the "Project")

**Section 2.** *Obligations of DepEd*

*DepEd* shall have the following obligations:

1. Provide policy guidance and directions to ensure the proper implementation of the Project;
2. Coordinate with the PROJECT MANAGER in the implementation of Project and accept the package of assistance and execute the corresponding Deed of Acceptance through the Schools Division Superintendent;
3. Assist in the evaluation of the implementation program;
4. Provide proper management, maintenance and care for the improvement received by the beneficiary schools, through the Schools Division Superintendent, in close coordination with the PROJECT MANAGER.
5. Assign classroom to be used as electrical room;
6. Allocate funds to cover the cost for repair, spare parts and battery once due for replacement;
7. Allow and accommodate the Electrical Installation and Maintenance students of {name of senior high school} to conduct the preventive maintenance schedule of the Solar PV Off Grid Systems.
8. Conduct scheduled computer classes on weekends and or during summer to Out-of-School Youths and other interested individuals/parties in the community.
9. Allow community members the use of computers on weekends and/or during summer on a scheduled basis.
10. Assure regular access for all community members to the charging station dedicated to the community.
11. Secure an approval from the PROJECT MANAGER if electricity is to be used outside the school premises.

**Section 3.** *Rights and Obligations of the Project Manager*

PROJECT MANAGER shall have the following rights and obligations:

1. Fund the Project.
2. Administer the efficient and effective implementation of the Project and closely coordinate with DepEd in the conduct of its activities;
3. Pay the actual cost to the Suppliers of the Project;
4. Execute a Deed of Donation in favor of DepEd for the completed Project.

**Section 4.** *Project Beneficiary*

The Project beneficiaries shall be the following off grid schools:

- {Off-grid school to be energized}
- {Off-grid school to be energized}
- {Off-grid school to be energized}

**Section 5.** *Program Cost / Breakdown*

The estimated cost of {TOTAL PROJECT COST in words (PHP___} consisting of the following:

| ITEM | QUANTITY (for all schools in the Lot) | SPECIFICATIONS OFFE-RED | UNIT COSTS | TOTAL |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| Total | | | | PHP |

**Section 6.** *Project Period*

The Project shall commence from School Year {duration of project}, unless otherwise terminated or extended by the Parties in writing.

Upon signing hereof, the parties through their authorized representatives, shall immediately draw up the implementing guidelines which shall form an integral part of this Agreement.

**Section 7.** *Pre-termination*

Either Party may terminate this Agreement by giving the other party at least thirty (30) days written notice prior to the proposed date of termination. However, such pre-termination shall not prejudice ongoing trainings and activities, and the parties shall continue to discharge their respective responsibilities provided herein but only with respect to all ongoing activities until the same are complete.

**Section 8.** *Capacity and Authorization*

The parties herein warrant that they have the capacity, power and requisite authorization to enter into this Agreement.

**Section 9.** *Separability Clause*

Should any part of this Agreement be judicially declared null and void, such nullity shall not affect the validity of the remaining provisions hereof.

**Section 10.** *Execution in Counterparts*

*This Agreement may be executed in any number of counterparts, each of which when executed and delivered shall constitute a duplicate original, but all counterparts together shall constitute a single agreement.*

**IN WITNESS WHEREOF** the Parties hereto, have signed this Agreement on ____ day of ______________ in __________________,

**DEPARTMENT OF EDUCATION - DIVISION OF {NAME} PROVINCE**

By:

**{NAME OF REPRESENTATIVE OF DEPED}**
*{Position}*

**{DONOR AGENCY}**

By:

**{REPRESENTATIVE OF DONOR AGENCY}**
*{Position}*

Witnessed by:

_____________________________
School Head / Representative
_______National High School

_____________________________
School Head / Representative
_______ Elementary School

_____________________________
School Head / Representative
________ Elementary School

_____________________________
School Head / Representative
__________Elementary School

{NAME OF PROJECT MANAGER}
Manager

# ANNEX 3

## Sample – Deed of Donation, Deed of Acceptance with beneficiary school

**DEED OF DONATION**

KNOW ALL MEN BY THESE PRESENTS:

**DEPARTMENT OF EDUCATION-DIVISION OF ________________________________ AND ________________________________________________,** a public national high school, funded and operated by the government under the Department of Education of the Republic of the Philippines, with address at ___________________________________, Philippines, and herein represented by its School Head, ______________________________ herein referred to as the "**DONEE**";

-and-

**{DONOR AGENCY}**, a duly organized {general description of donor agency and full address}, represented herein by its {designation of representative}, **{NAME OF REPRESENTATIVE},** herein after referred to as **"DONOR".**

WITNESSETH

That for and in consideration of a desire to contribute a share for the cause of the education of Filipino learners through the Adopt-a-School Program of the Department of Education, the DONORS has freely and voluntarily given, transferred and conveyed by way of donation to the DONEE, its successors and assigns free and clear of any and all liens and encumbrances whatsoever all its rights, interests on below described donation.

**Details of the donation:**

The actual total cost is __________________________________________________ with the following breakdown:

| NO. | QTY. | UNIT | ITEM | PER UNIT | AMOUNT |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| TOTAL | | | | | |

**IN WITNESS WHEREOF** the DONORS and DONEE hereto, have signed this on ____ day of _____________ in _______________, Philippines.

_________________________ **{NAME OF REPRESENTATIVE}**
*{NAME OF DONOR AGENCY}*
*(DONOR)*

________________________ **{SCHOOL OR DEPED REPRESENTATIVE}**
*{POSITION/RANK}*
*(DONEE)*

**DEED OF ACCEPTANCE**

The DONEE, for and in behalf of **DEPARTMENT OF EDUCATION-__________________________ ________________________________________**, hereby accepts and acknowledges the donation from the DONORS, and expresses her deepest gratitude for their benevolence and generosity for the donation above-mentioned.

**IN WITNESS WHEREOF** the DONEE hereto, have signed this on ____ day of _____________ in ________________, Philippines.

________________________________________

___________________________

*School Head*

(DONEE)

SIGNED IN THE PRESENCE OF:

____________________________ ________________________________

# ANNEX 4

## Sample – Technical Specifications

### Scope of work:

Install a complete Solar PV power supply system, including but not limited to following components:

- PV array
- Battery charging system
- Inverter(s) to provide AC power
- wiring of the solar generation side up to ac output (no wiring of ac loads)
- Earthing system
- Establishing an appropriate electrical room by separating a section of an existing room (e.g. class-room)
- Technical documentation
- User manual (Including basic maintenance and troubleshooting)
- User training

The location for the systems are 16 schools in Cebu, Bohol and Palawan.

| LOT 1 (Bohol) | | | |
|---|---|---|---|
| | School | Municipality | Google Maps Coordinates |
| 1 | Bilangbilangan Daku Elementary School | Bien Unido | 10.248628, 124.451321 |
| 2 | Malingin Elementary School | Bien Unido | 10.160485, 124.441427 |
| 3 | Hingotanan Elementary School | Bien Unido | 10.240899, 124.487113 |
| 4 | Hingotanan National High School | Bien Unido | 10.240148, 124.486688 |
| 5 | Guindacpan Elementary School (Campus 1 +2) | Talibon | 10.227034, 124.282968 |
| 6 | Cataban Integrated School | Talibon | 10.230505, 124.383544 |

| LOT 2 (Cebu) | | | |
|---|---|---|---|
| | School | Municipality | Google Maps Coordinates |
| 7 | Carnaza Elementary School | Daanbantayan | 11.508335, 124.097893 |
| 8 | Carnaza National High School | Daanbantayan | 11.513830, 124.099900 |
| 9 | Moamboc Elementary School | Bantayan | 11.129341, 123.691975 |
| 10 | Mambacayao Elementary School | Bantayan | 11.032850, 123.589255 |

| LOT 3 (Palawan) | | | |
|---|---|---|---|
| | School | Municipality | Google Maps Coordinates |
| 11 | New Pangganan Elementary School | Puerto Princesa City | 10.272688, 118.962388 |
| 12 | Marufinas Elementary School | Puerto Princesa City | 10.240864, 118.956699 |
| 13 | Old Caruray Elememtary school | San Vincente | 10.315425, 119.010941 |
| 14 | Caruray National High School | San Vincente | 10.316512, 119.010513 |
| 15 | New Canipo National High School | San Vincente | 10.716126, 119.350560 |
| 16 | New Canipo Elememtary school | San Vincente | 10.715769, 119.345714 |

Details of the school locations can be found in the separate Annex II+III (b)

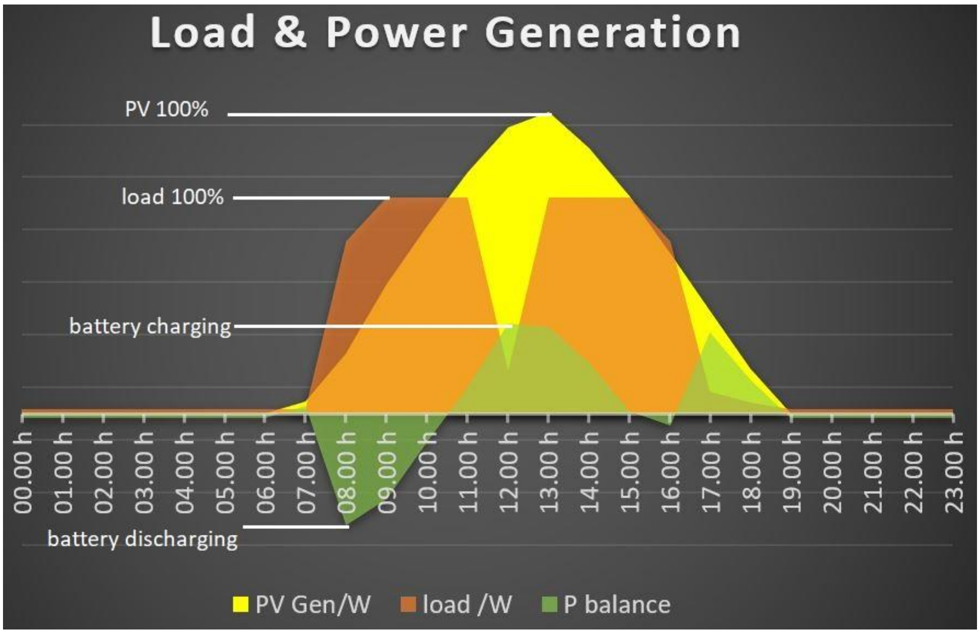
The DC power output for the PV system (Wp), the AC power output of the 230V single phase inverter (VA) and the energy storage of the battery bank (Wh) for each school is as listed below (List of Schools). All components must be adapted to the typical Philippines weather conditions (heat, humidity, salty air).

| Lot 1 (Bohol) | | | | | |
|---|---|---|---|---|---|
| | **School** | **PV generator (Wp)** | **Inverter AC Power (VA)** | **Battery Capacity (Wh)** | **max AC load (W)** |
| 1 | Bilangbilangan Daku Elementary School | 20000 | 12000 | 38400 | 10000 |
| 2 | Malingin Elementary School | 18000 | 11000 | 36000 | 9000 |
| 3 | Hingotanan Elementary School | 35000 | 21000 | 67200 | 17500 |
| 4 | Hingotanan National High School | 42000 | 25000 | 86400 | 20500 |
| 5 | Guindacpan Elelmentary School (Campus 1 +2) | 26000 | 16000 | 48000 | 13000 |
| 6 | Cataban Integrated School | 36000 | 22000 | 72000 | 18000 |

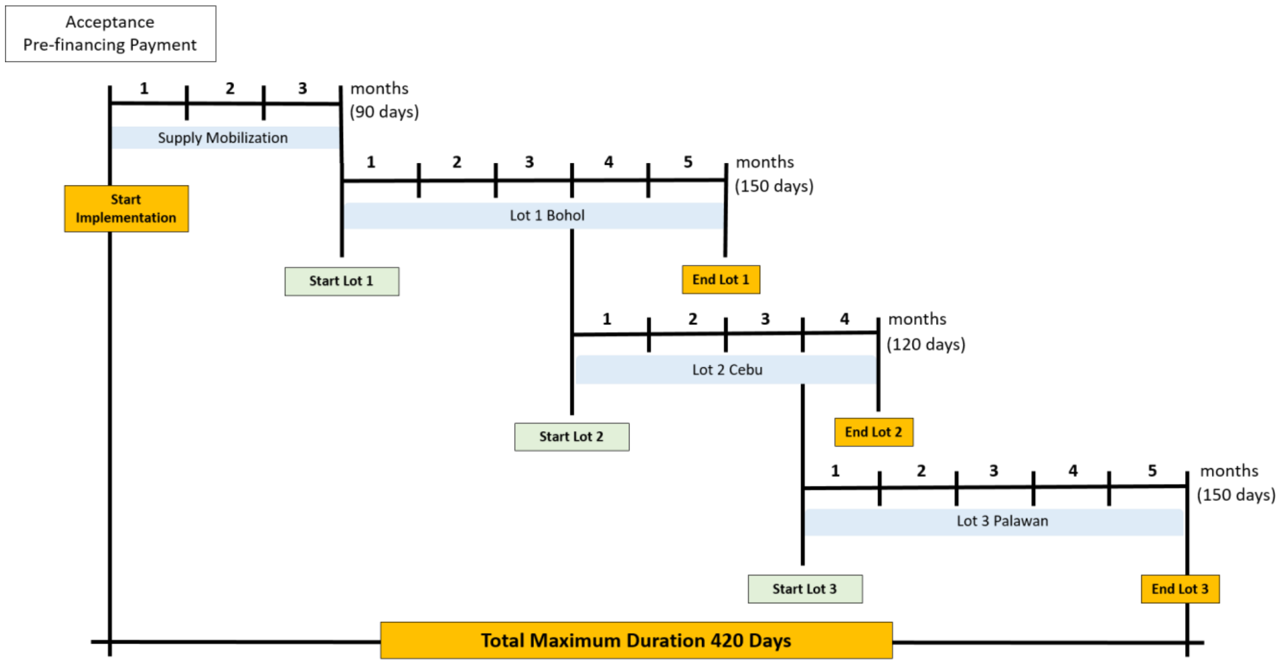
| Lot 2 (Cebu) | | | | | |
|---|---|---|---|---|---|
| | **School** | **PV generator (Wp)** | **Inverter AC Power (VA)** | **Battery Capacity (Wh)** | **max AC load (W)** |
| 7 | Carnaza Elementary School | 23000 | 14000 | 48000 | 11500 |
| 8 | Carnaza National High School | 23000 | 14000 | 48000 | 11500 |
| 9 | Moamboc Elementary School | 20500 | 12000 | 38400 | 10000 |
| 10 | Mambacayao Elementary School | 23000 | 14000 | 48000 | 11500 |

| Lot 3 (Palawan) | | | | | |
|---|---|---|---|---|---|
| | **School** | **PV generator (Wp)** | **Inverter AC Power (VA)** | **Battery Capacity (Wh)** | **max AC load (W)** |
| 11 | New Pangganan Elementary School | 16000 | 10000 | 28800 | 8000 |
| 12 | Marufinas Elementary School | 16500 | 10000 | 33600 | 8500 |
| 13 | Old Caruray Elementary School | 24000 | 15000 | 48000 | 12000 |
| 14 | Caruray National Highschool | 48000 | 30000 | 96000 | 24000 |
| 15 | New Canipo National Highschool | 37500 | 23000 | 76800 | 19000 |
| 16 | New Canipo Elementary School | 20500 | 12000 | 38400 | 10500 |

The load profile (AC loads running hours) **for ALL schools** is according to below graph, the maximum AC load for each school is as table "list of schools".



## Implementation Timeline:




## Detailed specifications of system components and work

The offer must be clear enough to allow the evaluators to make an easy comparison between the requested specifications and the offered specifications.

| Item Number | Specification Required |
|---|---|
| **1** | **Specifications PV array:**<br>1. DC Power output for (Wp) each system according to table "list of schools"<br>2. All PV modules mono or polycrystalline<br>3. The PV modules must be equipped with bypass diodes<br>4. PV modules shall be provided with solar PV connectors (MC4)<br>5. Documentation for PV modules: Name of the manufacturer, date of manufacture, Country of origin (separately for solar cells and module). I-V curve for the module, Wp, Imax, and Vmax for the module, Date and year of obtaining IEC PV module qualification certificate<br>6. Each module must be labelled with a Unique Serial No and Model No.<br>7. All array fasteners shall be stainless steel, galvanized steel or other corrosion resistant material that provides the required mechanical strength to securely fix modules to the support structure in a way that they can withstand the maximum wind-loads which are typical in the region of installation. ((documentation/description/ product sheets of used system required)<br>8. The array must have a minimum clearance of 10 cm between the PV array and the roofing material to allow ventilation and reduce exposure to heat reflection from the roof sheets.<br>9. Anchoring of array fasteners must be to the building substructure and not to the roofing material.<br>10. Any holes drilled in the roof have to be sealed to prevent intrusion of rainwater. The contractor shall explain and give illustrations of the mounting frame to be used in the technical bid. |

| Item Number | Specification Required |
|---|---|
| | 11. The array should be installed with a 10° to 15° angle of tilt, enabling the maximum solar energy yield which is possible on the respective roof. The contractor shall determine the best angle when on site.<br>12. The solar modules should not protrude over the roof edges.<br>13. The solar modules must be installed in a way that they allow access for cleaning (e.g. spaces between modules on the roof to allow walking on roof)<br>14. The array must have efficient protection against energy losses due to partial shading (e.g. by provisions in the connected inverter or charging system - (documentation/description/ product sheets required)<br>15. minimum Warranty on PV modules: 25 years on 80% rated power output (documentation/description/ product sheets required)<br>16. PV modules must comply with IEC 61215 "Design Qualification and Type Approval for Crystalline Silicon PV Modules" and with IEC 61730- "Module Safety Qualification"<br>17. All systems must be installed in accordance with IEC 62548- "Installation and Safety Requirements for Photovoltaic systems" |
| 2 | **Specifications Battery Bank:**<br>1. The energy storage (Wh) for each system according to table "list of schools"<br>2. Only maintenance free batteries shall be provided (lithium or VRLA technology)<br>3. The contractor chooses the best option for the system voltage under consideration of charging system (see specs charging system), inverter and other connected components as well as keeping the total number of battery cells as small as possible<br>4. The contractor should submit in the technical bid documentation, cycle life analysis which should be more than 800 cycles at 50% DOD.<br>5. Batteries shall be interconnected by appropriate battery wires and connectors (documentation/description/ product sheets required)<br>6. Batteries shall be protected by appropriate battery fuse (documentation/description/ product sheets required)<br>7. Batteries must be installed on an appropriate battery rack, painted with acid resitant paint, which uses the space in the most efficient way (documentation , sketch or picture required)<br>8. Batteries must have undergone the initial (low current) charging process before being delivered to the site<br>9. Documentation for battery bank: Name of the manufacturer, date of battery production, Country of origin, data sheet, maintenance instructions<br>10. Battery bank must comply with IEC 62093 – "Balance-of-system components for photovoltaic systems Design qualification natural environments" |
| 3 | **Specifications Battery Charging System:**<br>1. The charging system must provide optimal charging of the battery using the full capacity of the PV array (documentation required) under considering the load-generation profile (see chart above) and without getting overloaded at any condition<br>2. The charging system must have maximum power point tracking (MPPT)<br>3. The charging rate and profile must match the battery type<br>4. The charging system must have as a System Status Indication a self-explaining graphical display, including information on the battery's state of charge (SOC), power of the PV array, daily and total energy logging.<br>5. The charging system must provide battery maintenance features according to battery type (e.g. auto-equalization for lead acid batteries)<br>6. Documentation for charging system components: Name of the manufacturer, Country of origin, Model No., data sheet, user manual, troubleshooting guide |

| Item Number | Specification Required |
|---|---|
| | 7. The contractor is responsible for the correct setup of the charge controller system according to battery type and charging characteristics of the system<br>8. Battery charging system must comply with IEC 62093 - ”Balance-of-system components for photovoltaic systems Design qualification natural environments” |
| 4 | **Specifications of the AC Inverter(s):**<br>1. The inverter(s) must provide the required AC power (VA) for each system according to table “list of schools”, under the specific site conditions (temperature, etc). A single inverter or multiple inverters can be used<br>2. The Inverter(s) must provide 230V/60Hz, single phase, pure sine wave<br>3. The inverter AC output must be connected to an existing AC distribution board<br>4. Efficiency not less than 93%.<br>5. Provide at least 200% of rated power for at least two (2) seconds<br>6. The inverter must be overload and short circuit protected<br>7. The inverter must have a (preferable programmable) battery deep discharge protection which disconnects the inverter from the batteries at 80% depth of discharge<br>8. The inverter must have a status indicator in form of LED or LCD display<br>9. Documentation for inverter system components: Name of the manufacturer, Country of origin, Model No., data sheet, user manual, troubleshooting guide<br>10. The contractor is responsible for the correct setup of the inverter system according to battery type and other system components<br>11. AC inverter(s) must comply with IEC 62093 – ”Balance-of-system components for photovoltaic systems Design qualification natural environments” |
| 5 | **Specifications for Wiring and Circuit Protection**<br>1. Only flexible UV resistant insulated copper wires or cables must be used. All wiring should be suitable for its intended use. (documentation/description/ product sheets required)<br>2. The cross sectional area must be chosen that the voltage drop from PV array to the battery is not more than 3% (documentation/calculation required)<br>3. All connections must be done by appropriate connectors, lugs etc. and secured against causing electrical hazards (documentation/description/ product sheets required)<br>4. An appropriate DC disconnect must be provided for the PV array (documentation/product sheet required)<br>5. All AC circuits must be protected by appropriate AC circuit protection (documentation/description/ product sheets required)<br>6. Surge protection class II must be provided for: inverter AC output, inverter DC input, charge controller DC input. The surge protection can be integrated in the component or as an external installed appropriate SPD (documentation/description/ product sheets required)<br>7. A wiring diagram which indicates all system components must be provided (must include earthing system, too)<br>8. Installation of wires and cables must be according to Phillipines electrical code and to IEC 62548 – “Installation and Safety Requirements for Photovoltaic systems” |
| 6 | **Specifications Earthing System**<br>1. An earthing system with a combined maximum earth resistance of not more than 5 ohms must be installed. All buried earthing components must be copper.<br>2. The frames of the PV modules must be connected with a minimum 25 $mm^2$ wire, passing on the outside of the building to the earthing system<br>3. All metallic system components (inverter housing, charge controller housing etc.) and all SPD must be connected with a minimum 6 $mm^2$ wire to the earthing system |

| Item Number | Specification Required |
|---|---|
| | 4. If metal waterpipes are penetrating the building they have to be connected to the earthing system with a minimum 16 $mm^2$ wire and by appropriate pipe clamps. (equipotential bonding)<br>5. All connections between components must be done by appropriate connectors, also considering galvanic corrosion between components of different materials<br>6. Installation of wires, cables and earthing electrodes must be according to Phillipines Electrical Code 2017 Edition<br>7. A layout sketch and a short description of components for the earthing system must be provided with the bidding documents |
| **7** | **Specifications electrical room:**<br>1. The electrical room shall be adequate in size and layout such that all electrical equipment components such as panel boards, circuit breakers, inverters, batteries and switches can be conveniently accessed for inspection and/or maintenance and can be conveniently removed for repair and replacement<br>2. The room for the batteries shall be separated from the room with all other components in order to avoid unnecessary exposure to heat<br>3. The electrical room shall be lockable such that access is limited to authorized personnel of the school<br>4. The electrical room shall be accessible from an egress corridor and, where appropriate, from the exterior of the school building. Electrical room doors shall be open outward.<br>5. The electrical room shall be provided with sufficient cooling/ventilation (i.e. fans) to prevent overheating of electrical equipment<br>6. The electrical room shall be labelled “Electrical Equipment” and all necessary danger and instructions signs shall be set up<br>7. A layout sketch and a short description of the materials used for the electrical room must be provided with the bidding documents |
| **8** | **End User Training for School’s Technical Representatives**<br>1. Startup of system<br>2. Shutdown of system<br>3. Operating principles of the system in consistence with the user manual<br>4. Role of each of the system components<br>5. Procedures for the proper system operation, including permitted loads and negative effects of overloading the system<br>6. Measures for efficient system operation as well as actions to be taken during periods of bad weather, and/or a low battery disconnect events<br>7. Explanation of system performance data and information displayed during operation (such as battery state of charge, AC loads, warning signals etc).<br>8. Function of control interface, pushbuttons etc.<br>9. Basic troubleshooting procedures<br>10. Routine maintenance as cleaning of the PV modules when necessary, check for shading on modules (growing of plants) cleaning of batteries, battery top and terminals<br>11. Dismantling of PV modules which might be necessary in case of typhoon warnings<br>12. A short description of training topics, material and methodolgy must be provided with the bidding documents |
| **9** | **Workplan**<br>1. A workplan in form of a timeline or gantchart which allows quick overview of timeframe for all necessary steps for realisation of the project must be provided with the bidding documents |

| Item Number | Specification Required |
|---|---|
| **10** | **Required handover documentation at the completion of the work**<br><br>1. System description with working principles<br>2. User manual which describes: startup, normal operation parameters and indicators, warning signals error messages, fault condition procedures<br>3. Maintenance manual for preventive maintenance of all components including maintenance logbook<br>4. Manufacturers manuals and datasheets for all components<br>5. System single line diagram<br>6. Diagram which indicates the location of the system components in the school building<br>7. Document of final testing of each component and the performance of the whole system (test run report)<br>8. Warranty cards for all components<br>**9.** Service number of the contractor for technical support. The service number must be prominently displayed, e.g. a sign on the wall or a sticker on one of the components |

# ANNEX 5

## Sample – Energy consumption for one school

| GENERAL INFORMATION | |
|---|---|
| Educational Institution | Carnaza Elementary School |
| Date Visited | 04. Mrz 19 |
| Number of School Buildings | 6 |
| Number of School Rooms | 12 |
| | |
| **POWER REQUIREMENT** | |
| **Total AC Power Required (kW)** | 21,188 |
| **Total DC Power Required (kW-peak)** | 27,5444 |
| | |

| **LOAD ESTIMATE** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Location** | **Description of Load** | **Wat-tage(W)** | **Quan-tity** | **Demand Factor** | **Total Wattage (W)** | **Usage (Hrs/Day)** | **Energy Con-sumption (kW-H)** |
| **Perime-ter** | Lighting Bulb | 6 | 10 | 1,0 | 60 | 6 | 0,36 |
| **Rm.1** | Lighting Bulb | 5 | 4 | 1,0 | 20 | 6 | 0,12 |
| | Socket - Outlet | 180 | 4 | 0,25 | 180 | 2 | 1,44 |
| | Electric Fan Socket - Outlet | 180 | 2 | 0,80 | 288 | 8 | 2,88 |
| **Rm.2** | Lighting Bulb | 5 | 4 | 1,0 | 20 | 6 | 0,12 |
| | Socket - Outlet | 180 | 4 | 0,25 | 180 | 2 | 1,44 |
| | Electric Fan Socket - Outlet | 180 | 2 | 0,80 | 288 | 8 | 2,88 |
| **Rm.3** | Lighting Bulb | 5 | 4 | 1,0 | 20 | 6 | 0,12 |
| | Socket - Outlet | 180 | 4 | 0,25 | 180 | 2 | 1,44 |
| | Electric Fan Socket - Outlet | 180 | 2 | 0,80 | 288 | 8 | 2,88 |
| **Rm.4** | Lighting Bulb | 5 | 4 | 1,0 | 20 | 6 | 0,12 |
| | Socket - Outlet | 180 | 4 | 0,25 | 180 | 2 | 1,44 |
| | Electric Fan Socket - Outlet | 180 | 2 | 0,80 | 288 | 8 | 2,88 |
| **Rm.5** | Lighting Bulb | 5 | 4 | 1,0 | 20 | 6 | 0,12 |
| | Socket - Outlet | 180 | 4 | 0,25 | 180 | 2 | 1,44 |
| | Electric Fan Socket - Outlet | 180 | 2 | 0,80 | 288 | 8 | 2,88 |
| **Rm.6** | Lighting Bulb | 5 | 4 | 1,0 | 20 | 6 | 0,12 |
| | Socket - Outlet | 180 | 4 | 0,25 | 180 | 2 | 1,44 |
| | Electric Fan Socket - Outlet | 180 | 2 | 0,80 | 288 | 8 | 2,88 |
| | Lighting Bulb (CR) | 3 | 0 | 1,0 | 0 | 2 | 0,00 |
| **Rm.7** | Lighting Bulb | 5 | 4 | 1,0 | 20 | 6 | 0,12 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Socket - Outlet | 180 | 4 | 0,25 | 180 | 2 | 1,44 |
| | Electric Fan Socket - Outlet | 180 | 2 | 0,80 | 288 | 8 | 2,88 |
| | Lighting Bulb (CR) | 3 | 0 | 1,0 | 0 | 2 | 0,00 |
| **Rm.8** | Lighting Bulb | 5 | 4 | 1,0 | 20 | 6 | 0,12 |
| | Socket - Outlet | 180 | 4 | 0,25 | 180 | 2 | 1,44 |
| | Electric Fan Socket - Outlet | 180 | 2 | 0,80 | 288 | 8 | 2,88 |
| | Lighting Bulb (CR) | 3 | 0 | 1,0 | 0 | 2 | 0,00 |
| **Rm.9** | Lighting Bulb | 5 | 4 | 1,0 | 20 | 6 | 0,12 |
| | Socket - Outlet | 180 | 4 | 0,25 | 180 | 2 | 1,44 |
| | Electric Fan Socket - Outlet | 180 | 2 | 0,80 | 288 | 8 | 2,88 |
| | Lighting Bulb (CR) | 3 | 0 | 1,0 | 0 | 2 | 0,00 |
| **Rm.10** | Lighting Bulb | 5 | 4 | 1,0 | 20 | 6 | 0,12 |
| | Socket - Outlet | 180 | 4 | 0,25 | 180 | 2 | 1,44 |
| | Electric Fan Socket - Outlet | 180 | 2 | 0,80 | 288 | 8 | 2,88 |
| | Lighting Bulb (CR) | 3 | 0 | 1,0 | 0 | 2 | 0,00 |
| **Rm.11** | Lighting Bulb | 5 | 4 | 1,0 | 20 | 6 | 0,12 |
| | Socket - Outlet | 180 | 4 | 0,25 | 180 | 2 | 1,44 |
| | Electric Fan Socket - Outlet | 180 | 2 | 0,80 | 288 | 8 | 2,88 |
| | Lighting Bulb (CR) | 3 | 0 | 1,0 | 0 | 2 | 0,00 |
| **Faculty Room** | Lighting Bulb | 5 | 4 | 1,0 | 20 | 5 | 0,10 |
| | Socket - Outlet | 180 | 4 | 0,25 | 180 | 2 | 1,44 |
| | Electric Fan Socket - Outlet | 180 | 2 | 0,80 | 288 | 8 | 2,88 |
| | Projector | 500 | 0 | 1,00 | 0 | 4 | 0,00 |
| | Printer | 46 | 0 | 1,00 | 0 | 2 | 0,00 |
| | 55' Television | 180 | 0 | 1,00 | 0 | 1 | 0,00 |
| | Lighting Bulb (CR) | 3 | 0 | 1,0 | 0 | 2 | 0,00 |
| **Stage** | Lighting Bulb | 5 | 10 | 1,0 | 50 | 0 | 0,00 |
| | Amplifier | 300 | 1 | 0,0 | 0 | 0 | 0,00 |
| | Speaker | 700 | 2 | 0,0 | 0 | 0 | 0,00 |
| | Socket-Outlet | 180 | 4 | 0,75 | 540 | 2 | 1,44 |
| **Comfort Room** | Lighting Bulb | 5 | 1 | 1,0 | 5 | 0 | 0,00 |
| **Electrical Rm.** | Ventilation Fan | 90 | 1 | 0,8 | 72 | 12 | 1,08 |
| | Lighting Bulb | 5 | 2 | 1,0 | 10 | 12 | 0,12 |
| | Battery | 3840 | 3 | 1,0 | 11520 | 0 | 0,00 |
| **Water Pump** | Water Pump Motor | 800 | 0 | 0,75 | 0 | 0 | 0,00 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Outsided Campus** | Charging Station | 500 | 1 | 0,75 | 375 | 6 | 3,00 |
| **Future Load** | Computer Room (12 Monitors, 12 CPU, 4 Outlet, 8 LED Lights) | 2700 | 1 | 1,0 | 2700 | 4 | 10,80 |
| **Total** | | | | **--** | 21188 | **--** | 70,060 |

*****_Note:_

*Load was not considered in estimation as equipment's practical operation is not simultaneous with other devices*

*If the schools has a Generator and opt to have a motorized water pump, the Generator should be used to power it.*

# ANNEX 6

## Sample – OJT Work Immersion Agreement

**WORK IMMERSION AGREEMENT**

Know All Men By These Presents:

This Work Immersion Agreement (the "Agreement") is made and entered into this ____ day of {date} at {location}, Philippines by and between:

[Name of Student], [of legal age, if applicable], Filipino, and a resident of ______________________, and (if a minor) [his/her] [parent/guardian], ______________________ and hereinafter referred to as the "Student";

and

**{NAME OF DONOR AGENCY}**, a duly organized non-stock, non-profit organization, existing under the laws of the Republic of the Philippines, with principal office address at {full address}, represented herein by its {rank or designation of representative}, {NAME}**,** and hereinafter referred to as "{ACRONYM OF DONOR, IF ANY}".

WITNESSETH; THAT:

WHEREAS, pursuant to the K to 12 Basic Education Reform Program, **{NAME OF DONOR AGENCY}**, has entered into a Memorandum of Agreement for Work Immersion Partnership (the "MOA") dated __________, with _____________ (the "School");

WHEREAS, the Student is duly enrolled in Senior High School in the School;

WHEREAS, under the Work Immersion Program (the "Program"), the Student is required to undergo Work Immersion with {Donor} to expose the Student to a work environment, and {Donor} is willing to accommodate the Student's Work Immersion and allow the Student to undergo practical training in its work premises;

NOW, THEREFORE, for and in consideration of the foregoing premises, the parties hereby agree as follows:

1. **Immersion and Immersion Period.** The Student shall undergo Work Immersion with {Donor} for the period of ________ *[weeks]* starting on _________ until _________ (the "Immersion Period"), for a minimum of ____ hours per day; provided, however, that at no instance shall the hours worked shall exceed eight (8) hours per day and five (5) days per week.

2. **Daily Allowance**. {Donor} shall give the Student a daily allowance of {amount in words} **{(amount in figures)}** for every day where an eight-hour workday is spent participating in the Program. For the avoidance of doubt the payment of an allowance is not intended to serve as compensation for any assigned task or performance by the Student for {Donor} during the course of the Work Immersion. {Donor} shall also shoulder the meals for the entire duration of the of the immersion period.

3. **Compliance with {Donor} Rules and Regulations.** The Student shall abide by all the rules and regulations imposed by {Donor} employees during [his/her] Work Immersion with {Donor}, exert his best efforts, and exercise care and diligence in the task assigned to [him/her].

4. **No Employer and Employee Relationship.** Notwithstanding the Student's reporting to work, the payment by {Donor} and the receipt by Student of an allowance, and the compliance with the rules and regulations of {Donor}, no employer-employee relationship shall exists between the Student and {Donor}.

5. **Effectivity; Miscellaneous Provisions.** This Agreement shall be effective from the time of its signing and shall be valid for the whole duration of the Program.

Notwithstanding the above provisions, the terms and conditions under the MOA shall be considered as part of this Agreement.

IN WITNESS WHEREOF, the parties have affixed their signatures on the date and place first above-mentioned.

**{DONOR AGENCY}.**

Represented by:

**[NAME OF STUDENT]**
*Student*

**{NAME OF REPRESENTATIVE}**
*{Designation/Position}*

**[NAME OF PARENT/GUARDIAN]**
*Parent/Guardian*

Signed in the presence of:

__________________________ __________________________

# ANNEX 7

## Sample – Inspection & Maintenance Checklist for PV system

**GENERAL INFORMATION**

| | |
|---|---|
| Customer Name : | Customer Email : |
| Address : | |
| City : | State : |
| | Zip Code : |
| Inspector name : | Inspection date : |

**SAFETY EQUIPMENT TO PERFORM INSPECTION**

- [ ] Yes
- [ ] No
- [ ] N/A

**IS THE SYSTEM POWERED ON?**

- [ ] Yes
- [ ] No
- [ ] N/A

**IS THE INVERTER INDICATING ANY GROUND FAULTS OR OTHER ERROR MESSAGES?**

- [ ] Yes
- [ ] No
- [ ] N/A

**DO NOT PROCEED IF ALL ANSWERS ARE NOT YET COMPLETED**

Comment :

**BUILDING INFORMATION**

**SYSTEM TYPE**

- [ ] Roof mount
- [ ] Pole mount
- [ ] Ground mount
- [ ] other

**ROOF TYPE**

- [ ] Shingle
- [ ] Metal
- [ ] Clay
- [ ] Other

**EXISTING ROOF CONDITION**

- [ ] Excellent
- [ ] Good
- [ ] Average
- [ ] Other

**SOLAR MODULE**

Total capacity Solar Array (kW):

Solar Module size (watt peak per module): Wp

Type of solar module (mono/polycrystalline) :

Brand of solar module :

Model of solar module :

Cracked glass of PV panel

- [ ] Yes
- [ ] No

White or brwon spot,bubble of air,moisture behind the glass

- [ ] Yes
- [ ] No

Broken back sheeting (white EVA), delamination

- [ ] Yes
- [ ] No

Junction boxes at backside loose or without cover?

- [ ] Yes
- [ ] No

Check for physical damage to any PV module

- [ ] Yes
- [ ] No

Check for loose cable terminations between PV modules

- [ ] Yes
- [ ] No

Shading on solar panels removed

- [ ] Yes
- [ ] No

PV modules are properly grounded with lugs on each module

- [ ] Yes
- [ ] No

Check surfaces temperatures with IR camera or if using contactless thermometer

- [ ] Yes
- [ ] No

Rear junction box with IR camera or if using contactless thermometer

- [ ] Yes

**DC COMPONENT ENCLOSURE**

Proper conductor sizes and insulation types

- [ ] Yes
- [ ] No

Proper conductor terminations

- [ ] Yes
- [ ] No

DC ratings on DC components

- [ ] Yes
- [ ] No

Listed equipment

- [ ] Yes
- [ ] No

SINGLE POINT GROUNDING!

- [ ] Yes
- [ ] No

Optional grounding electrode conductor

- [ ] Yes
- [ ] No

**AC COMPONENT ENCLOSURE**

Isolated Neutral busbar

- [ ] Yes
- [ ] No

Listed components

- [ ] Yes
- [ ] No

Labelled disconnects and C/B

- [ ] Yes
- [ ] No

**UTILITY DISCONNECT**

Labelled

- [ ] Yes
- [ ] No

Visible, lockable, accessible, load break, external handle

- [ ] Yes
- [ ] No

**APPROPRIATE SIGNS INSTALLED**

Check for sign identifying PV power source system attributes at D.C. disconnect

- [ ] Yes
- [ ] No

Check for sign identifying A.C. point of connection

- [ ] Yes
- [ ] No

Check for sign identifying switch for alternative power system

- [ ] Yes
- [ ] No

**BUILDING MAIN DISCONNECT**

Labelled

- [ ] Yes
- [ ] No

**INVERTER**

Inverter Manufacturer :

Inverter Model :

Power output (kW / kVA) :

Inverter Model :

Type of Inverter (pure or modified sine wave) :

Brand of Inverter :

Model of Inverter :

Number of inverters :

Open circuit voltage ( Voc ) :

Impp (A) :

Check AC disconnect circuit breakers and its cable connectors temperatuire with IR camera or if using contactless thermometer

- [ ] Yes
- [ ] No

Check DC circuit connectors temperature with IR camera or if using contactless thermometer

- [ ] Yes
- [ ] No

Check DC disconnect circuit breakers and its cable connectors temperature with IR camera

- [ ] No

## ARRAY INSTALLATION AND WIRING

Proper insulation on module wiring
- [ ] Yes
- [ ] No

Proper connectors on array wiring extensions
- [ ] Yes
- [ ] No

Proper grounding of array & array mount
- [ ] Yes
- [ ] No

Grounded conductors installed
- [ ] Yes
- [ ] No

Proper insulation on module wiring
- [ ] Yes
- [ ] No

Array mount properly secured and sealed
- [ ] Yes
- [ ] No

Suitable transition from open wiring to enclosed wiring
- [ ] Yes
- [ ] No

Wrong cable dimension used?
- [ ] Yes
- [ ] No

## STRUCTURAL AND ROOF

Is equipment mounted securely, and level?
- [ ] Yes
- [ ] No
- [ ] N/A

Any sign of damage to modules or wiring?
- [ ] Yes
- [ ] No
- [ ] N/A

Results of module hand lift test?
- [ ] Secure
- [ ] Not secure
- [ ] N/A

Are footings, support structure, and all penetrations suffiiently flashed and waterproofed?
- [ ] Yes
- [ ] No
- [ ] N/A

All conduit penetrations and roof safety anchors properly sealedwith exterior grade sealant?
- [ ] Yes
- [ ] No
- [ ] N/A

All roof mounted junction boxes, combiners are securely installed ?
- [ ] Yes
- [ ] No
- [ ] N/A

Are Conductors loose, touching roof surface or in contact with sharp or abrasive surfaces?
- [ ] Yes
- [ ] No
- [ ] N/A

Conductors follow the mounting rails?with exterior grade sealant?
- [ ] Yes
- [ ] No
- [ ] N/A

Conductor plug-and-receptacle connectors are fully engaged between junction boxes ?
- [ ] Yes
- [ ] No
- [ ] N/A

Are all zip ties and wire ties rated for UV resistance?
- [ ] Yes
- [ ] No
- [ ] N/A

Are conduit supports rated for the installation and properly installed ?
- [ ] Yes
- [ ] No
- [ ] N/A

Are any dissimilar metals being combined?
- [ ] Yes
- [ ] No
- [ ] N/A

Check that all DC wiring from combiner box onward is in dedicated conduit using weather tight fittings and labeled accordingly ?
- [ ] Yes
- [ ] No
- [ ] N/A

From inside the attic, is there any sign of existing water damage?
- [ ] Yes
- [ ] No
- [ ] N/A

From inside attic as viewed from the attic access point, are there exposed lag screws or lag screws that missed rafters? Are there split rafters due to lag screws?
- [ ] Yes
- [ ] No
- [ ] N/A

From inside the attic, is there any sign of existing structural damage?
- [ ] Yes
- [ ] No
- [ ] N/A

Should an additional structural evaluation be conducted based on a limited visual inspection?

or if using contactless thermometer
- [ ] Yes
- [ ] No

Check cable connector fasteners for torque values
- [ ] Yes
- [ ] No

Micro Inverters?
- [ ] Yes
- [ ] No
- [ ] N/A

Is the inverter located in an area which is exposed to direct sun?
- [ ] Yes
- [ ] No
- [ ] N/A

Is the inverter operating?
- [ ] Yes
- [ ] No
- [ ] N/A

Is the inverter mounted to the manufacturer specifiations ?
- [ ] Yes
- [ ] No
- [ ] N/A

Defects founded
- [ ] Yes
- [ ] No
- [ ] N/A

Input and output disconnect labelled
- [ ] Yes
- [ ] No
- [ ] N/A

Proper wire sizes ?
- [ ] Yes
- [ ] No
- [ ] N/A

Grounded ?
- [ ] Yes
- [ ] No
- [ ] N/A

Record accumulated solar energy production since start of operation ?

## MAIN ELECTRICAL DISTRIBUTION PANEL

Primary Service Breaker Size : Amps

Primary Service Main Busbar Rating : Amps

Inverter Fuse / Breaker Rating : Amps

Electrical Concerns or Code Violations
- [ ] Yes
- [ ] No
- [ ] N/A

Check for cable conditions
- [ ] Yes
- [ ] No
- [ ] N/A

Check cable terminals for burnt marks, hot spot or loose connection
- [ ] Yes
- [ ] No
- [ ] N/A

Check for physical damage
- [ ] Yes
- [ ] No
- [ ] N/A

Number of feeder breakers :

System voltage 220 or 230 VAC :

Check voltage from inverter :
- [ ] Yes
- [ ] No

Monitoring Device installed (Volt Meter) :
- [ ] Yes
- [ ] No
- [ ] N/A

Monitoring Device installed (Current/Amp meter) :
- [ ] Yes
- [ ] No
- [ ] N/A

Monitoring Device installed (Frequency Meter) :
- [ ] Yes
- [ ] No
- [ ] N/A

Monitoring Device installed (kWh meter) :
- [ ] Yes
- [ ] No
- [ ] N/A

Check circuit breaker body temperature with IR camera or if using contactless thermometer
- [ ] Yes
- [ ] No

Check incoming cable connection temperature with IR camera or if using contactless thermometer
- [ ] Yes
- [ ] No

Check output cable connection temperature with IR camera or if using contactless thermometer
- [ ] Yes
- [ ] No

Check busbar temperature with IR camera or if using contactless thermometer
- [ ] Yes
- [ ] No

Check cable connector fasteners for torque values

Yes
No
N/A

## DC CONNECTIONS

Source Circuit Combiner Boxes
Yes
No

DC-rated circuit breakers or fuses with adequate voltage rating
Yes
No

Listed equipment
Yes
No

Comment :

## WIRING

Are standard building wire conductors and appropriate wiring methods used?
Yes
No
N/A

Is conduit rated for its location, with supports properly spaced for the size and type of conduit?
Yes
No
N/A

Nonmetallic-sheathed conductors and cables are secured within 12 inches of each box, cabinet, conduit body or other termination?
Yes
No
N/A

The minimum bending radius of the cable or PV Wire is no more than 5x the diameter of the cable. (i.e. for .02 inch diameter, minimum bending radius is 1.0 inches, total bend is 2.0 inches)?
Yes
No
N/A

Do PV Source Circuit free-air conductors have 90 degree C,sunlight, and wet service ratings. Single-conductor cable type and specifially listed and labeled as PV wire is permitted in PV source circuit ?
Yes
No
N/A

Where DC PV source circuits are run inside a building, they are in metal conduit from the point of penetration into the building to the first accessible disconnect.
Yes
No
N/A

Are any conductors exposed to UV?
Yes
No
N/A

Is a strain relief fiting appropriate for the installation at the junction box or the transition into conduit?
Yes
No
N/A

Are splices suitable for the location in which they are made? Wet-location wire nuts shall be used even when installed in a waterproof junction box
Yes
No
N/A

wire nuts shall be used even when installed in a waterproof whyte or gray and equipment grounding conductors (EGC) shall be grren, green/yellow, or bare.
Yes
No
N/A

Is the system properly grounded? Is the equipment-grounding conductor (EGC) continuous to all metal components, and connected to the main grounding electrode conductor (GEC)?
Yes
No
N/A

Are the required Warning Label(s) used at the Junction Box?
Yes
No
N/A

Check all fuses and circuit breakers on combiner box with IR camera temperature or if using contactless thermometer
Yes
No

Check all cable connectors on combiner box with IR camera temperature or if using contactless thermometer
Yes
No

## BATTERY BANK ( BATTERY BACKUP SYSTEMS ONLY )

Terminals protected from shorting
Yes
No
N/A

Cables properly terminated (no set screw lugs on fine stranded wire)
Yes
No

Yes
No

Positioning of Distribution Panel as per safety standard and easy to monitor by the operator?
Yes
No

## BONDING SYSTEM

Bonding of the exposed metallic structure of solar PV system to lightning earth
Yes
No
N/A

Check bonding cable conditions
Yes
No
N/A

Check physical bonding conditions
Yes
No
N/A

Check continuity of the bonding to lightning earth
Yes
No
N/A

## SIGN AND WARNING LABELS

Warning Label(s) installed at the DC Disconnects/ Combiner boxes?
Yes
No
N/A

Warning Label(s) installed at the Inverter?
Yes
No
N/A

Are labels provided at the Production Meter?
Yes
No
N/A

Warning Label(s) installed at the AC Disconnect?
Yes
No
N/A

Warning Label(s) installed at the Sub Panel/Main Service Panel ?
Yes
No
N/A

Warning Label(s) installed at the Main Service Point of Interconnection/PV Breaker?
Yes
No
N/A

Sign Identifying Photovoltaic Power Source, Related Max Power-Point Current, Rated Max Power-Point Voltage, Max System Voltage,Short-Circuit Current, and Max Rated Output at DC disconnect?
Yes
No
N/A

Sign identifying switch for alternative power system?
Yes
No
N/A

## CHARGE CONTROLLERS ( BATTERY BACKUP SYSTEMS ONLY )

Status/Condition
Yes
No
N/A

Input and output disconnects labelled
Yes
No
N/A

Listed charge controllers
Yes
No
N/A

Proper wire sizes
Yes
No
N/A

Grounded
Yes
No
N/A

Record accumulated solar energy production since start of operation :

Comment :

## BATTERY INVERTERS ( OFFGRID SYSTEM OR GRID-TIE WITH BATTERY BACKUP)

Battery Inverter size (kW) :
Type of Grid Inverter (pure or modified sine wave) :
Brand of Battery Inverter :
Model of Battery Inverter :
Battery Inverter voltage ( V ) :
Battery Inverter current ( Amp ) :
Total supplied energy since start of operation :

N/A

Maintenance-free vented for cooling

Yes

No

N/A

Check for battery ambient temperature?

Yes , the temperature degree is = °C

No

Labelled with proper safety procedures

Yes

No

N/A

Brand of battery :

Type of battery :

Nominal capacity (volts per cell) :

Battery capacity/cell (Ah) :

Battery voltage ( individual battery ) : V

Battery voltage ( per bank battery ) : V

Battery current ( per bank battery ) : A

Are there hot battery cells (touch by hand each cell)?:

Yes

No

Proper insulation around battery-to-battery cables?

Yes

No

N/A

Exposed main battery bank combiner terminal?

Yes

No

N/A

Incorrect battery connections?

Yes

No

N/A

Main cables exposed to physical damage?

Yes

No

N/A

Signs of sulfide flakes at terminals?

Yes

No

N/A

Check battery banks with IR camera temperature or if using contactless thermometer

Yes

No

Check fuses banks with IR camera temperature or if using contactless thermometer

Yes

No

Check battery rack and DC distribution box

Yes

No

N/A

Check cable connector fasteners for torque values

Yes

No

N/A

Check AC disconnect circuit breakers and its cable connectors temperatures with IR camera or if using contactless thermometer

Yes

No

Check DC circuit connectors temperatures with IR camera or if using contactless thermometer

Yes

No

Check DC disconnect circuit breakers and its cable connectors temperatures with IR camera or if using contactless thermometer

Yes

No

Check cable connector fasteners for torque values

Yes

No

Check AC disconnect circuit breakers and its cable connectors ?

Yes

No

Check DC circuit connectors ?

Yes

No

Check DC disconnect circuit breakers and its cable connectors ?

Yes

No

Check mounting structure and bracket ?

Yes

No

Check if any damage (e.g. cracks, holes, missing) endangers the operating safety, the battery inverter must be deactivated immediately

have done

Not yet

Cleaning the fan with the aid of a vacuum cleaner (recommended) or a soft paint brush/hand brush if they are covered with loose dust and when they are at a standstill

have done

Not yet

Clean the display with a soft, damp cloth. Never use solvents, abrasives or corrosive materials.Clean the membrane keypad when battery inverter is deactivated and don't press the membrane buttons during cleaning

have done

Not yet

Check the functionality regularly whether error messages are present to ensure optimal operation discover hidden faults in the installation or errors in the configuration ( especially during the first months after commissioning )

have done

Not yet

Inspect, maintain, and observe all of the battery

have done

Not yet

Comment :

## OUTBACK INVERTER ROUTINE-MAINTENANCE

Disconnect all circuit breakers and related electrical connections before doing any cleaning or adjustments

have done

Not yet

Solar modules may produce hazardous voltages when exposed to light; cover them with opaque material before servicing any connected equipment

have done

Not yet

If a remote or automatic generator start system is used, disable the automatic starting circuit and/or disconnect the generator from its starting battery while servicing.

have done

Not yet

Comment :

## SMA INVERTER ROUTINE-MAINTENANCE

Check inverter for DC connection ESS

have done

Not yet

Check inverter for colling (clean the heat sink if applicable)

have done

Not yet

Check inverter for fan test ( clean it if applicable )

have done

Not yet

Create maintenance report :

keep record of yield monthly, sunny portal, compare yields

have done

Not yet

Comment :