Frequently Asked Questions on Solar PV Installations

This document was developed in close collaboration with UNDP, Office of Information Systems & Tecnology, Global ICT Advisory Unit, and aims to provide answers to common questions about Solar PV installations. It is directed primarily at Country Office staff that want to learn more about solar installations and its potential at their location.

1. What does PV mean?

PV stands for photovoltaic systems, which are ground- and/or building mounted panels that transform the radiant energy from the sun directly into electrical power, using semiconducting materials such as silicon. Added to the silicon are the elements phosphorous and boron, which create conductivity within the cell and activate the movement of electrons. The electrons move across the cell when activated by the sunlight's energy into the electrical circuit hooked up to the solar panel.

2. Can a solar PV installation make sense where I am?

The feasibility of solar PV installations depends on various factors:

- **Solar irradiance** – determines the power of the sun that can be harvested in a given location.
- **Space constraints** – determines the size of a solar installation because one solar panel requires approximately 1.6 square metres and typical installations have hundred(s) of panels.
- **Immobility** – a solar solution is a long-term investment that is difficult to move; building ownership can therefore be a big obstacle to a solar PV installation.
- **Financial Feasibility** – installing a solar PV has to make sense from a financial perspective.

2.1.Irradiance

The power density of the sunlight (in W/m^2) is called the **solar irradiance**[1]**.** Irradiance on the Earth's surface is not constant and varies with atmospheric effects such as clouds, pollution, etc, latitude of the location (in general a country closer to the equator has higher irradiance), season of the year and time of day.

The potential of a solar installation can be estimated with free tools on the internet that can be found here. Especially PV-GIS is recommended, however it is unfortunately not available for the Americas. In general these tools will give an estimate of how many kWh a solar system with a defined capacity (kWp) can produce at a given location per day/month/year.

2.2.Space

The amount of solar panels that can be installed is often limited by the space available. The easiest place to install solar panels are roofs or parking shades – sunlight can reach the panels easily, the panels do not take up space and access to them is restricted. Of course ground-mounted solar panels are also an alternative, provided there is ample space. They are not an option where space is limited and land expensive, e.g. in the middle of a city.

When evaluating locations and space, you should consider the following factors:

- **Southern Exposure** – solar panels should be facing the south to maximize the effectiveness of energy collection.
- **Open Space** – the surrounding buildings and/or trees should not put the panels in the shade at any time of day; additionally, the panels should be free from debris dropping from trees. Shading photovoltaic panels dramatically reduces their effectiveness.

Commented [LD1]: But if the CO is located in the Southern hemisphere, should the solarpanel face true North?

Commented [MH2]: Second this.

Commented [LD3R2]: UNDER DEVELOPMENT - UNDP GIA to provide inputs

[1] Strictly speaking, irradiance is the power density of sunlight prior to passing through the atmosphere. **Insolation** is the term used when referring to the energy density at the Earth's surface. However, many sources use irradiance whenever referring to the power density of sunlight on a surface, and so does this document.

- **Roof Pitch** – most roofs, from flat surfaces to those with 60-degree tilt, can accommodate photovoltaic panels.[2]

2.3.Immobility

Solar PV installations have a life span of roughly 25 years. It is therefore important that the Country Office owns or manages the premises during the whole life span, or that provisions for the sale of the solar installation should be made. Where country offices are housed in host government facilities, all permits should be granted before the PV project is set in motion.

2.4.Financial Feasibility

Country Office budgets are usually tight and investments have to be justified well. While solar PV installations can produce savings in a wide variety of settings, it would help your business case if you can show where your break-even point is; i.e. at what point in time you will have recovered the initial capital investment through savings on your electricity bill.

Other factors that help the feasibility of installing solar panels:

- High electricity prices
- Unstable power grids with frequent disruptions in office operations
- Diesel generators provide back-up power solutions, but are costly in terms of fuel and maintenance, and are noisy and polluting.

3. Can I power my whole office with solar?

The only restrictions on how much energy you can produce through solar PV installations are: a) the funds available for the initial investment; b) space constraints; c) limitations to solar irradiance, and d) the supply of energy from the sun.

The office can even be powered by solar energy during the night, if the PV system includes batteries that store electricity generated during the day. Since the time of the day, weather and seasonal conditions make solar energy a power source that is difficult to predict, you will need to have either the additional storage capacity, or at least an alternative backup power source.

4. Should I get a PV system with or without batteries?

Batteries offer storage options that make your CO more resilient against grid outages and provide for electricity during night hours, but also make your PV installation more complex.

Batteries require a storage room that is air-conditioned and even in best conditions do not reach the same life time as solar panels, meaning that you will have to plan (and budget) for replacing the batteries during the life span of your solar PV solution.

Batteries are costly and delicate, in that if they are discharged in an uneven pattern, their life span will reduce even further. For this reason most COs in areas with a stable grid opt for a PV installation without batteries. That said, batteries make sense where there is no reliable grid available and generators cause constant noise and pollution. Batteries are a viable option as long as one keeps in mind the shortcomings.

5. What size of solar PV installation makes sense? Matching demand and output

Every case is different but usually the size is determined by money, space and energy demand. To match the energy demand of a country office with solar panels, the output of the panels has to be estimated:

5.1.How much energy can I produce?

The output of solar panels are measured in kWp (kilowatt-peak). Since conditions for solar power production vary all over the world, the kWp unit corresponds to a level of output that is created using optimal conditions in a laboratory environment. Therefore a solar installation with 1 kWp cannot be expected to produce 1 kWp. Rather, according to PV-GIS, a 1 kWp

[2] http://solarenergy.net/solar-power-resources/solar-power-faq/

installation in, for example, Freetown, Liberia will produce 3.78 kWh per day on average vs. # kWh per day under perfect conditions (e.g. – a laboratory).
What capacity a CO wants to install therefore heavily depends on local conditions, because it is the output that matters. Furthermore the installation can be sized accordingly to the available budget.

5.2. How much energy do I consume?

The size of the country office or rather, its load profile, which is the power demand in any given moment during a typical day, determines the scope of your solar PV installation. This scaling needs to be done properly to avoid waste of excess genergy and/or having costly generators to supply shortages in your energy demand.

Energy demand varies highly between COs and depends on factors such as appliances used, staff, size, technology etc. Therefore there is no general rule of thumb and COs will have to measure their consumption individually. A first indication is the electricity bill, a next step would be the employment of a *Power Consumption and Monitoring Solution* that allows the real-time measurement of power use and the collection of historical data.

6. How much does a solar PV solution cost me?

6.1. Investment

Solar PV installations generally take up 1.6m² for each solar panel rated at 200 Wp or 0.2 kWp. As per a current business case reviewed by the GIA unit estimates the installation cost of 45 kWp on-grid solar panels (i.e. without back-up batteries) in Sao Tome and Principe at US$135,000.

A rule of thumb is that a "smaller" solar installation up to a 100 kWp can cost US$3,000 per kWp; bigger installations may be less expensive through their scale economies of scale at US$2,600. A solar PV installation with batteries will generally increase the price by approximately 25%.

Note: These prices are historical and depend highly on location, type of solution and market situation.

6.2. Running costs

Running costs are generally very low for a PV system without batteries. Operating cost can be broken down into cleaning, maintenance, replacement and batteries. Panels may have to be cleaned sporadically depending on local conditions but running costs can be expected to be minimal. Since the life span of a solar panel amounts to up to 25 years, once the panels are installed they produce energy at virtually no cost.

6.2.1. Maintenance costs for solar PV panels

Solar PV panels do not have any moving parts that need maintenance. The only maintenance necessary involves cleaning the solar panels to ensure that dust or debris does not reduce effectivity of collecting sunlight. Maintenance frequency depends on the region as rainfall also cleans the panel – a simple rinse-off with water is enough in most cases, and can be combined with sponges if necessary.

6.2.2. Replacement of solar PV panels

Solar PV panels have a long life span and would only need replacement in case of damage, for example through weather conditions (lightning) or animals. Restricting access to the PV panels would help reduce damage cause by the latter.

6.2.3. Running costs for batteries

Including battery in yourSolar PV solution increases the running costs significantly as they need a storage room with a constant temperature in order to maximize their lifespan. This often means constant air-conditioning of the room, which adds on to to your recurring cost.

Since batteries have a shorter life span than the solar panels they will also have to be replaced, depending on their type and the pattern of use and the amount of discharge and recharge cycles. The current battery generation has to be replaced about 2 times over the life span of solar panels, assuming controlled conditions of discharge/recharge.

Commented [MH4]: Added this which may make it more clear if we can fill in the number for perfect conditions.

Commented [LD5R4]: UNDER DEVELOPMENT - UNDP GIA to provide further inputs

Commented [LD6]: I do not see how this clarifies anything to a layman. Would suggest to delete

Commented [LD7R6]: UNDER DEVELOPMENT - UNDP GIA to provide inputs

7. Can somebody help me with the PV process?

Yes. GIA has put in place a 7 Steps Process that assesses the viability of solar PV at your location, provides the business case and the procurement tools and helps you along the way. For more information please see the ICT Information Circular (IC) to Country Offices No. 2015/002.

8. Can my PV system survive a hurricane?

Yes, if properly mounted solar PV installations can resist high wind speeds. A bigger danger is damage by objects and debris flying around.[3]

9. Stating the obvious

Solar PV installations go a long way towards complying with UN Millennium Development Goal #7, which formulates the target to ensure environmental sustainability. With the new Sustainable Development Goals, environmental sustainability will continue to be part of the UN mandate.

Solar PV installations relieve burdened power grids in developing countries, green the energy supply of your CO, reduce the carbon footprint of your organization and provide an example for a more sustainable way of generating electricity.

For feedback regarding these FAQs, please contact gia.green.energy@undp.org

[3] https://pureenergies.com/us/yes-solar-panels-can-survive-a-hurricane/