



# Frequently Asked Questions On Solar Powered Irrigation Pumps



# Table of contents

## 1. Technology Overview



## 2. Installation

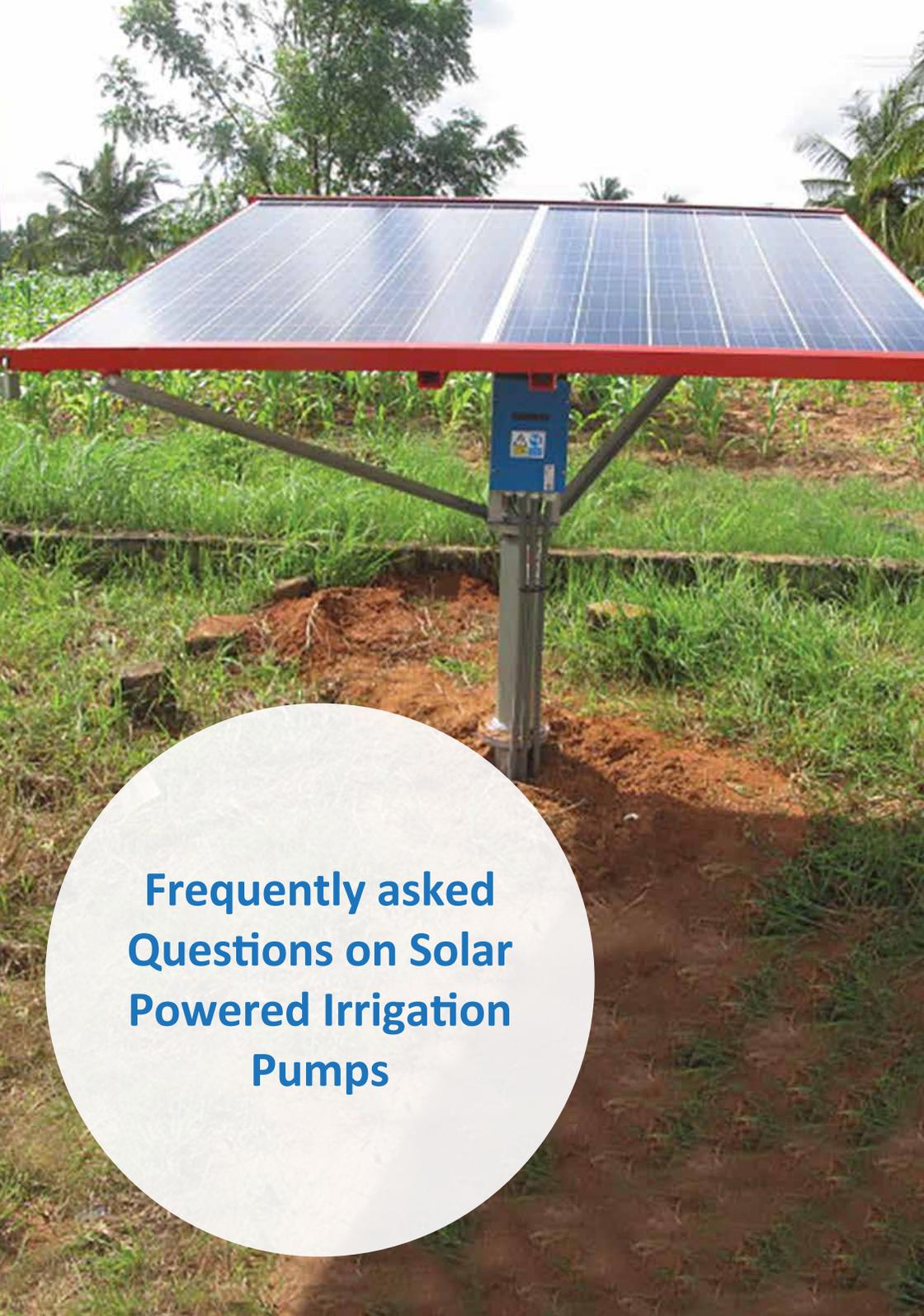


## 3. Operation and Maintenance



## 4. Safety And Security





**Frequently asked  
Questions on Solar  
Powered Irrigation  
Pumps**

## Why have we prepared the frequently asked questions (FAQs)?

The use of solar for pumping is increasing due to lack of electricity in remote places coupled with unstable supply of electricity. In Ghana, the market of solar powered pumps is presently being driven by subsidies from donor agencies. More so, the prices of photovoltaic modules are becoming more affordable and energy efficient causing a reduction of the cost of the system. This should result in high market demand of the technology in the next few years.

The selection of solar-powered irrigation systems is dependent on several factors to ensure effective operation and reliability. There are no relevant communication materials to promote solar powered pumps. This publication seeks to provide answers to “Frequently Asked Questions” (FAQs) which will be a valuable tool for all stakeholders especially farmers. The present FAQs are an effort to increase the level of awareness about the technology among the farmers and are the result of stakeholder discussions.



Source: EnDev

## Who are the potential users of the (FAQs)?

Farmers who are engaged in manual irrigation and those presently using diesel /petrol pumps but want to switch to solar pump are the target of the FAQs. The objective is to provide them with an overview and to raise their awareness on solar powered irrigation pumps. It is also intended to provide the relevant knowledge to Agricultural Extension Officers and District Agricultural Officers in order for them to disseminate information on the technology to farmers. The FAQs can also be used by private sector companies involved in the marketing, sales and promotion of solar powered irrigation pumps. In sum, the FAQs provide a basic overview of the technology, instructions for setting up the system, questions on improved operation and maintenance, as well as the safety and security of the technology.

## How are the FAQs structured?

The FAQs are divided into four sections. The first section is the overview of the technology, the second provides information on the ways and means of setting up the system, the third highlights issues on operation and maintenance, and the last section looks at safety and security of solar powered pumping systems.



# 1. Technology Overview

## What is a solar powered pump?

A solar powered pump is a pump powered by solar energy. A solar powered pump consists of one or more solar panels (also known as solar modules or solar plates), a pump (mostly a centrifugal pump), electronic controls or a controller device to operate the pump, the required hardware and in some cases other items like inverters, batteries, etc. On a simpler note, solar powered pumps are like traditional electric pump with the only exception that it uses solar energy instead of fossil fuel or electricity.

A solar powered pump can be cost-effective, environment-friendly and low-maintenance solution for meeting water requirements for irrigation, community water supply, livestock and other purposes.

## What are the potentials for use of a solar powered pump?

Solar pumps are more suitable for remote areas with no or unreliable grid or as an alternative to diesel pumps. Some of the most popular applications are:

- ❖ Drinking water supply for communities
- ❖ Irrigation for agricultural purposes
- ❖ Horticulture farms, orchards, vineyards, gardens and nurseries
- ❖ Agro forestry and plantations
- ❖ Dairy, poultry and sheep rearing,
- ❖ Aqua culture, fish farming



## What are the advantages of solar powered pump?

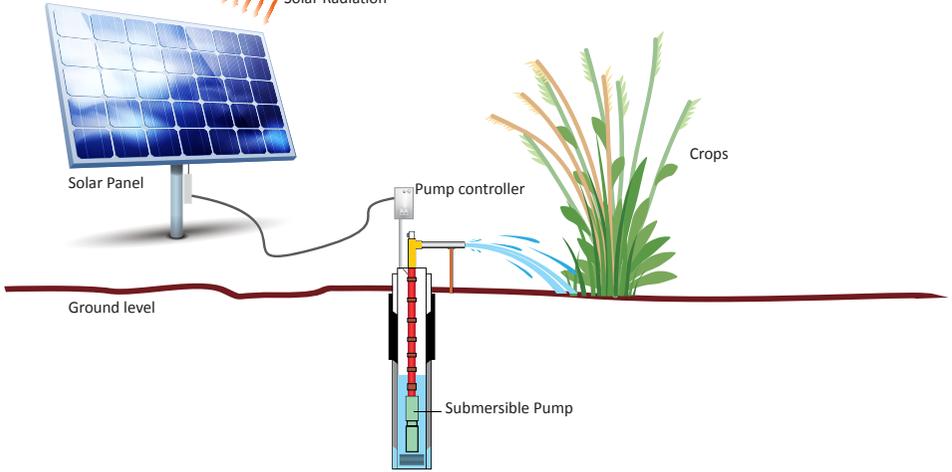
- ❖ There is little or no loss in energy transmission with the solar powered pumping system.
- ❖ Can be installed to the required load of pumps up to 30kw or more
- ❖ Solar powered pumping systems need only minimum maintenance and
- ❖ In most cases no battery is required.
- ❖ Clean energy without emissions.

## How does a solar powered pump work?

A solar PV water pumping system consists of a number of solar PV modules connected in series or parallel combination to generate sufficient power to operate a motor pump. The solar PV modules are mounted on a metal frame in a manner that the mounting frame can be turned / tilted to ensure that the modules keep facing the sun throughout the day. The system does not have any storage battery since power generated is used directly then and there. The solar PV array converts the solar energy into electricity which is used for running the motor pump set. The water is pumped into a tank that is mounted at a higher level. In this way there is adequate pressure on the taps and there is water available if the sun is not shining. The function of the water tank is comparable to the function of a battery. To obtain a good match between solar panels and the pump, the pump controller is connected in between. The controller converts the direct current from the solar panels into alternating current with a frequency that depends to the irradiation. At low irradiation, e.g. in the morning at sunrise, the pump will be driven by a slowly rotating engine. The speed of rotation will increase when the sun rises in the course of the day. A simple float switch will switch off the pump if the water level is high enough. If the water level drops and the sun shines, the pump will be switched on again. If the float switch does not function well, the solar pump system can be used as a shower. The pumping system can draw water from the open well / bored well or stream / pond or canal.



Sunrays fall on the solar photovoltaic (PV) modules (a combination of multiple photovoltaic cells) and produce direct current (DC). If the pump requires alternating current (AC), the DC current produced by solar PV panels is converted to AC through an inverter before being fed to the motor of the pump.



Source: EnDev

An installed solar pumping system on a farm

## How is a solar powered pump different from conventional pumps that run on diesel or electricity?

①

A solar powered pump is different from conventional pumps because it does not require any fuel (diesel, kerosene, etc.) or electricity supply to operate.

②

A solar powered pump, once installed, does not have the recurring costs of electricity or fuel; and is not affected by power cuts, low voltage, single phase problems or the motor burning due to power coming on the neutral line. Generally, solar powered pumps are installed without a battery since the time for water requirement and the availability of sunshine generally coincides with each other.

③

A solar powered pump can be installed even in remote areas where electricity is not available and diesel is difficult and/or very expensive to procure.

④

A solar powered pump does not require any external electricity supply and rather generates electricity for its own consumption. Thus, it is not dependent on any power company related factors like electricity bill, time of power supply, power cuts, etc.

⑤

A solar powered pump has fewer moving parts as compared to a diesel powered pump; hence, there is less wear and tear leading to low maintenance costs, except for mobile systems.

⑦

A solar powered pump does not require any special skill to operate. Solar powered irrigation pump is relatively easier to operate than a diesel pump.

⑧

Operating a solar powered pump does not require handling liquid fuel like diesel, kerosene, etc. and/or lubricants. Hence, chances of soil/water contamination by these oils are also eliminated with use of solar powered pump.

# What is submersible and surface classification in solar powered pumps?



Source: grundfos

*Submersible Pump*

Submersible pumps are recommended where water table is available at higher depth (more than 14 m). It is highly efficient and rugged multistage pump. Pumps can be conveniently placed under water so as to lift water from up to 50 m depth.



Source: Lorentz

*Surface Mounted Pump*

Centrifugal pumps are suitable for areas where water is available at shallow depths such as open wells / stream / ponds / canals etc. They are driven by a DC motor. The total head is 14 m and maximum suction head is 7m. Better performance in the form of higher water output can be achieved when the suction head is kept at the minimum.

## How do i select between a submersible and a surface pump? Is there a rule of thumb to help with the selection?

### Advantages

#### Submersible Pumps

- ◆ No need of priming since the pump it itself is located deep inside water.

#### Surface Pumps

- ◆ Easy to set-up, installation and maintenance.
- ◆ Low upfront cost compared to a submersible pump.

### Disadvantages

#### Submersible Pumps

- ◆ Needs to drill a borehole which increases the installation as well as repair and maintenance costs.
- ◆ Gets damaged by presence of mud which often happens with lowering of the water table and is not visible from surface.

#### Surface Pumps

- ◆ Dry running can severely damage the pump.
- ◆ Priming is required every time particularly in case of a high difference in water level and pump location.
- ◆ Not appropriate for deep water table.

## What are direct current (DC) and alternate current (AC) pumps?

### DC Pump

A DC pump has a motor which operates on direct current (DC). Solar panels, generate DC current, which is then passed on to the DC pump motor through a controller. Since the current from solar panels or batteries is directly used, and no conversion to AC is required, there is little/no loss of power between generation and consumption. However, it should be noted that the current should not have to travel a long distance before being fed to the pump in order to minimize the losses. DC versions are available both as submersible and as surface pumps.

### AC Pump

An AC pump has a motor which operates on alternating current (AC). DC, generated by solar panels or batteries, is converted to AC by an inverter-cum-controller, and is then passed on to the AC pump motor. The conversion from DC to AC leads to small losses in power between the points of generation and consumption. AC versions are available both as submersible and as surface pumps.



Source: spolegrundfos

*An AC pump*

### Advantages

#### DC Pumps

- ◆ Approximately 10% higher water discharge as compared to an AC pump.
- ◆ No need of inverter between the solar PV panels and the pump.

#### AC Pumps

- ◆ Low upfront cost compared to a DC pump.
- ◆ Easy to set-up, installation and availability of maintenance and repair services.

### Disadvantages

#### DC Pumps

- ◆ High upfront cost.
- ◆ Lack of repair and maintenance services in rural and remote locations.

#### AC Pump

- ◆ Low efficiency and water output compared with a DC pump.
- ◆ Additional inverter is required .

## **Why is a DC pump more expensive than an AC pump?**

DC solar powered pumps are more expensive than AC solar powered pumps because of the application of DC motors, which have a higher upfront cost than AC motors. However, DC pumps do not require any inverter which is costly and needs replacement after 6 - 8 years.

## **Why does a submersible pump cost more than a surface pump despite the fact that surface pumps provide a higher water out-flow?**

A very important thing to note is that submersible and surface pumps have different applications depending on the water source from where water is to be pumped (borehole or open-well). Hence, a direct comparison of the cost of submersible and surface pump on the basis of water outflow should not be made.

In order to serve their peculiar application, submersible pumps have higher complexities in manufacturing and use superior grades of manufacturing materials to ensure seamless under-water operation. Also, submersible pumps have additional safety features like a sleeve (to protect pump from overheating and resultant damage). These factors eventually increase the cost of submersible pumps.

## **Why are solar pumps so expensive?**

The high cost of the solar panels is the key reason for the high price of the solar powered pumps. A large share of up to 60 per cent of the total cost goes towards solar panels however it is worthwhile to mention that the prices of solar panels have been reduced drastically over the last couple of years. Various calculations to estimate the cost-effectiveness of a 1 HP solar powered pump suggest a 3-4 year payback period for replacing a diesel pump with a solar powered pump. The cost-effectiveness of solar powered pumps vis-à-vis electrical pumps running on grid electricity is not so attractive, though it will depend greatly upon prevalent electricity tariffs in the country.

It must be noted that the break-even for replacement of a diesel pump with a solar powered pump is dependent on a number of parameters like pump size, loan repayment period, rate of interest, etc. Solar powered pumps are the most cost effective when run for maximum hours every year, i.e., for irrigation of maximum land area, having cash crops or high value vegetables every year, etc.

## How do i select the solar powered pump most suitable for me? Is there any rule of thumb to help with this selection?

Solar powered pumps should be selected on the basis of suitability depending on various factors, such as

- Farm size to be irrigated (or command area)
- Water discharge requirement
- Type of Irrigation system to be employed on the field
- Availability of shade free area for Solar Panel
- Availability of maintenance and repair services



Source : EnDev

Concerning a rule of thumb, there is no certain method to decide on pump size; however, daily water requirements and the ground water level can give indications. Although it is often mentioned that a 2 HP pump can cater to about two acres of land, and a 7.5 HP is said to cater to 10 acres of land, this data is not universally applicable since the output of pumps changes depending on the groundwater level, and the type of irrigation required for a particular crop, e.g., flood irrigation for paddy cultivation.

## What is the purpose of a solar tracker?

Trackers direct solar panels or modules toward the sun to keep them in the direction of maximum solar irradiation (or maximum intensity of sunlight). The solar panel change their orientation throughout the day to follow the sun's path to maximize energy capture with the assistance of a tracker. Tracking enables the solar panels to provide higher power output (closer to rated output) by higher incidence of solar energy.

## What are the types of solar trackers?

There are two(2) main types of trackers i.e Single-axis solar trackers and Dual-axis trackers. The single-axis solar tracker works based on the rotation of one axis moving back and forth in a single direction. The varying types of single-axis trackers include horizontal, vertical, tilted, and polar aligned, which rotate as the names imply.

Dual-axis trackers persistently face the sun because they can move in two different directions.



Source - Eepublishers

*An installed Solar Panel With Solar Tracker*



## How long does it take to install a solar powered pump (with/without borehole drilling)?

A solar powered pump is rather quick to install and to commission. If an existing diesel pump on an existing bore-well is to be replaced with a solar powered pump, field work of 3-4 days will be required.

Generally, the installation of a solar powered pump will take about 3-4 days depending on the size of the installation. Examples from the field shows successful installation of a 7.5 HP solar powered pump pumping system within two days.

If a borehole is to be drilled, another 5-7 days – depending on the site conditions needs to be envisaged while planning the installation.

## Is there any rule of thumb for selecting solar powered pumps regarding land size?

The following table can be used as an indicative guide for the selection of adequate ratings for solar powered pumps for different farm sizes:

**Approximate time required for solar powered pump with power ratings**

Solar Powered pump Rated Power	Irrigation Per Acre
1HP	14
2HP	7
3HP	5
5HP	3

The above guide is in accordance with two inches of irrigation level and 10 metres of suction head. Generally, farmers have installed 2-3 HP capacity solar powered pumps for irrigating 2-3 acres of land area.

However, other factors like the type of crop to be cultivated, soil type, climatic conditions, water table, etc., also play an important role in determining the adequate capacity of a solar powered pump for any given land size. It is, therefore, highly advisable that you seek the help of an expert from a solar water pumping company to recommend the most suitable pump for you.

## Is there a rule of thumb to determine the capacity of my solar powered pump when replacing a diesel pump?

The criteria of determining the capacity of a solar powered pump to replace the diesel pump is to consider the amount of water needed per day. The daily water requirement needs to be estimated and the level of the water table to be determined. Based on these two criteria, the pump installation team can design an appropriate system for you.

## With what capacity of solar powered pump can i replace my 7.5 HP diesel pump?

Generally a 5 HP capacity solar powered pump works well place of 7.5 HP diesel pump. However, this is only an indicative guideline and should not be solely relied upon for making any pump capacity size choices. You are strongly encouraged to consult a subject matter expert/solar powered pump installer for your specific requirements.

## How many panels are required for a 2HP solar powered pump?

A 2HP pump is ideally powered with 1,800 Wp (peak watt) capacity solar array. The solar array could comprise of eight solar modules with 225 Wp each or 24 solar modules of 75 Wp each or any combination adding up to 1,800 Wp.

## How much land is required for installing a 2HP solar powered pump?

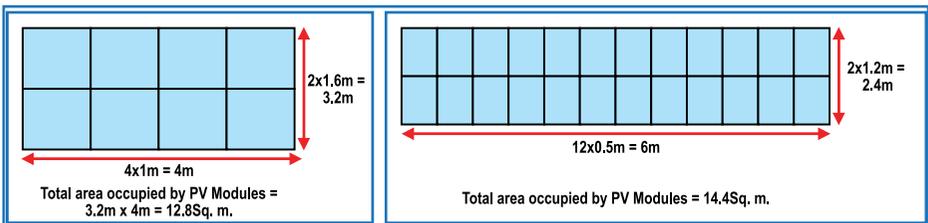
As a general rule of thumb, approximately 10 sqm of land are required for every 1,000 Wp of solar panels installed.

As an example, consider a 2 HP solar powered pump having an 1,800 Wp solar panel installation. The required solar power can be generated using either eight modules of 225 Wp (high wattage rating) or 24 modules of 75 Wp (low wattage rating).

- 1 Dimensions of one 225 Wp Module (LxW) = 1.6 m x 1 m
- 2 Dimensions of one 75 Wp Module (LxW) = 1.2 m x 0.5 m

Using modules with greater wattage saves space compared to modules of lesser wattage.

*The graphic below demonstrates this;*





Source: EnDev

### **Since the panels occupy space, i lose some land when i install them. Can i install a smaller array of panels to run the pump?**

A smaller array of solar panels will adversely affect the water output from the pump. It is strongly recommended to install a solar array of adequate capacity with the solar powered pump.

Further, farmers can also grow several varieties of crops, mostly vegetables like lettuce, broccoli, cauliflower, etc., which can be grown in the shade below solar panels. Cultivating such crops will help compensate the reduction in crop due to installation of solar panels

### **How far can the water from a 2HP solar powered pump be transported through plastic pipes?**

A 2 HP solar powered pump can usually carry water over a horizontal distance of 700 metres, though pressure is somewhat reduced at the end of the plastic pipe. However, the flow of the water from the pump would also be influenced by the local regional topography. Hence, the above measures are tentative figures

### **Does a solar powered pump work during cloudy and foggy days? How does one manage with a solar powered pump during such days? Can a hybrid option be provided? Can we run it using batteries?**

The water discharge rate of a solar powered pump is affected by the availability of solar irradiation. However, the limitation can be overcome by use of a hybrid power supply to the pump. The pump can be connected to a suitable connection of the state electricity grid or a diesel generator set while making proper adjustments in the controller. However, this should always be done in consultation with the manufacturer of the solar powered pump. While the pump can also be run

using batteries of adequate capacity, it is normally not advised due to techno-commercial reasons. Suitable features are available in controllers for the selection of power supply from solar panels, state grid or batteries, depending on the requirement. Users should always consult with the pump manufacturer/supplier before attempting any change in power supply to the pump.

### **Are solar powered pumps suitable only for specific crops, eg. vegetables, which require to be watered either early in the morning or late in the evening, or can it be used to irrigate all kinds of crops?**

Solar powered pumps can be used to irrigate all types of crops. For best results, solar powered pumps should be coupled with the most ideal irrigation system for any particular type of crop, for example, drip irrigation system, sprinkler irrigation system, etc.

# 3. Operation and Maintenance

## **What is the maintenance required for a solar powered pump? Can i take care of the maintenance of the pump even though i do not have any knowledge about solar powered pumps?**

A very minimal effort is required to maintain the panels including their regular cleaning. Training is provided for maintenance and cleaning by the company installing the pump. Village personnel can easily be trained to take care of the pump and solar panels. The manufacturer/supplier can be contacted in case of a major breakdown.

## **Is it necessary to clean the solar panels?**

Solar panels must be cleaned, particularly in dry areas or where panel tilt is minimal as, dust and other substances, such as bird droppings, can build up over time and impact the amount of electricity generated by a panel.

Air pollution, dust, fallen leaves and even bird droppings block sunlight falling on the solar panel surface. Grime and bird droppings do not need to cover an entire panel to have an effect. Experience suggests that dirty solar panels, which have not been cleaned for a week, lead to a drop in power generation by as much as 25 - 30 percent. Hence, it is absolutely necessary to clean the solar panels to ensure maximum power output and water discharge rate.

## **how should the solar panels be cleaned?**

Before commencing cleaning, one must always follow the procedure described in the operation manual which is provided by the manufacturer/supplier.

For safety reasons, it is also advisable to clean solar panels from the ground itself, wherever possible. A good quality soft brush and a squeegee with a plastic blade on one side and a cloth covered sponge on the other side, with a long extension is an adequate tool to perform solar panel cleaning from the ground level itself. Solar panels can also be cleaned using a hose with a suitable nozzle to allow a stream of water to reach the panels.



Source: EnDev

*Practical demonstration of the cleaning of a solar panel*

## **Can hail storm and/or lightning lead to damage of the panels?**

Modern day solar panels have adequate safety features in terms of impact resistance and are very unlikely to be damaged by a hail storm.

Solar panel installations also do not increase the probability of lightning strikes. Solar arrays themselves are at no more risk than the inverter or other loads connected to the grid. However, in the rare event of the solar array being hit by a direct lightning strike, the modules are likely to suffer considerable damage. This risk, again however, is mitigated by the integration of an external lightning protection system with the solar array. Good grounding is essential for the proper operation and safety of the solar powered pump system. Users must consult with solar powered pump manufacturers/suppliers on concerns regarding system grounding.

## **What is the life of solar powered pumping system? What happens to performance of solar powered pump over years of use?**

Solar powered pumps have a significantly longer life expectancy compared to diesel pumps. Solar panels continue to produce electricity for the pump for even longer than 25 years. As per MNRE guidelines for the promotion of solar powered pumps, a solar powered pump system, regardless of whether submersible or surface, shall have a warranty for five years provided by the manufacturer. The solar modules must have a warranty for output wattage, which should not be less than 90 per cent after 10 years, and 80 per cent after 25 years

## 4. Safety And Security

### What are the precautionary methods to protect the panels against strong winds?

Solar panels are firmly mounted on structures which are designed to withstand strong winds and storms with a velocity up to 150 km/hr. The direction of the wind needs to be observed and the direction of the panels rotated accordingly so that the minimum area of panels comes under wind pressure.

### How do i protect my solar panels?

Solar panels can be fenced to protect them from theft.

High Supporting structures for the solar panels.

Locking the panels with Padlock to prevent easy removal.

Critical Awareness of the farm manager or operator of the solar pumping System.



Source: EnDev

*A Fenced Solar Panel*

## **Will storms and cyclones damage the panels?**

The panels will only get damaged if the structure on which they are mounted collapses during the storm or cyclone. However, as a precaution, it is suggested that the array is kept horizontally at 180 degrees during storms or cyclones so that minimum resistance is offered to the wind. In areas in which cyclones or strong storms occur, precautions should be taken by building strong foundations in the case of fixed PV systems. Mobile PV systems should be moved to a safe location. Infrastructure works are also necessary if other equipment is prone to be damaged. The solar powered pumps for providing water for domestic use in cyclone-prone areas of Bangladesh, for instance were built with steel-enforced concrete towers.

## **Are there any potential health impacts due to the solar radiation from the solar panels?**

As per our current knowledge, globally, there has been no evidence/occurrence of events causing any negative health impact due to solar radiations from the solar panels. On the contrary, solar powered pumps effectively reduce air pollution and GHG emissions by eliminating fossil fuel for irrigation purposes, which eventually has a positive impact on health and longevity in the long term.



**Published by:**

Deutsche Gesellschaft  
für Internationale Zusammenarbeit (GIZ) GmbH  
Dag-Hammarskjöld-Weg 1-5  
65760 Eschborn, Germany  
E [endeve@giz.de](mailto:endeve@giz.de)  
I [www.endeve.info](http://www.endeve.info)

As of: March 2018



Source: EnDev

**Responsible:**

Samuel Adoboe  
Component Manager  
Energising Development Project

Project Team: Gideon Plange, Ebenezer Koranteng and Kwabena Twumasi

Photo Credits: Gideon Plange and Wolfgang Diederich  
Editing, Layout and Design: Alive Advertising

Acknowledgement : GIZ, Energising Development Project expresses its appreciation to our sister project in India ( Indo-German Energy Programme - Access to Energy in Rural Areas) for their immense contribution to these Frequently Asked Questions(FAQs). The content of this publication was based on the earlier work done by our colleagues in India. The EnDev project will like to thank the contributions of various institutions who supported the preparation of this document. Special thanks goes to Grundfos Ghana Ltd , Lorentz pump and its partners in Ghana, various Farmer Based Organisations in Ghana for their immense support.



Funded by:



Political partner:



Ministry Of Energy

Coordinated and implemented by:



Netherlands Development Organisation

EnDev is currently active in 25 countries in Africa, Asia, and Latin America:

Bangladesh	Ethiopia	Madagascar	Peru
Benin	<b>Ghana</b>	Malawi	Rwanda
Bolivia	Honduras	Mali	Senegal
Burkina Faso	Indonesia	Mozambique	Tanzania
Burundi	Kenya	Nepal	Uganda
Cambodia	Liberia	Nicaragua	Vietnam

