Food and Agriculture Organization
of the United Nations

SOLAR POWERED WATER LIFTING FOR IRRIGATION

TOOLS AND METHODOLOGY IN ACTION FOR SPIS

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ITALIAN AGENCY FOR DEVELOPMENT COOPERATION

MEASURES OF SOLAR ENERGY USE IN IRRIGATION

Al Ghadeer Al Abyad project
Source: FAO, 2018, Al-Mafraq Governorate, Jordan

Al-Afir project – Solar powered irrigation system in the Nile Delta I
Source: FAO, 2017, El- Behiera Governorate, Egypt

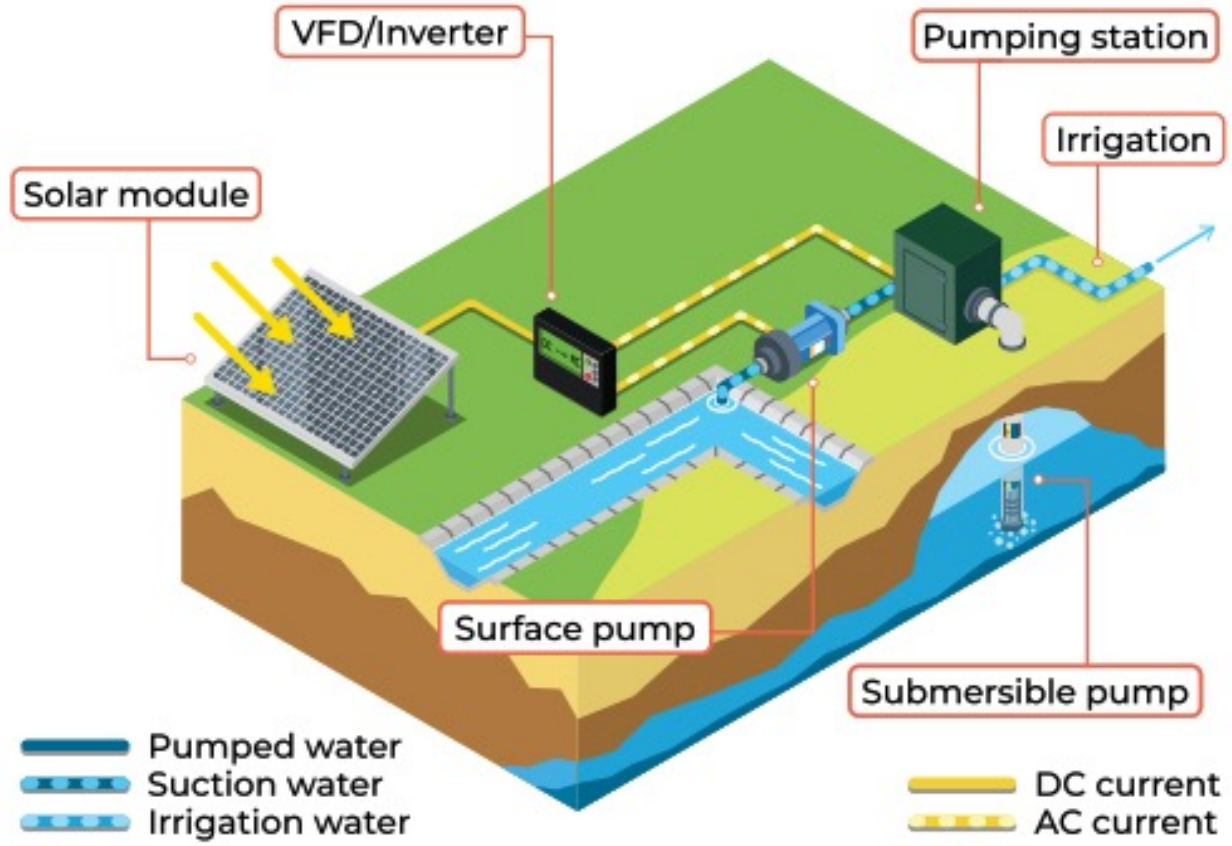
There are many applications for solar water pumping, each requiring a different type of pump and a special design to perfectly meet the water pumping requirements. It is important that only the right amount of water is applied to the fields at any point of time according to daily water requirements and irrigation period per day according to the crop type which synchronize with peak sun hours

Agriculture irrigation systems require constant water supply with daily operation times of up to 16 hr/day where solar operation hours lies 6-8 hr. In order to compensate for this divergence, solar pumps are integrated in a solar irrigation system designed to specific local needs. The challenge for both designers and operators of solar irrigation systems is to harmonize the non-constant solar energy and the constant irrigation requirements.

STAND ALONE SYSTEM FOR DIRECT IRRIGATION

Stand-alone systems for direct irrigation are the simplest way to set up a SWP system. The pump is directly connected to a solar pump inverter and starts operating in the morning when the solar output is higher than the minimum power required to start the pump.

The solar system keeps the pump running as long as sufficient irradiation is available. The pump stops before sunset, when the solar output less than the minimum input power required for the pump. During the day, the flow-rate of water changes with the solar irradiation. The daily water volume changes with the daily and seasonal profile of solar irradiation.

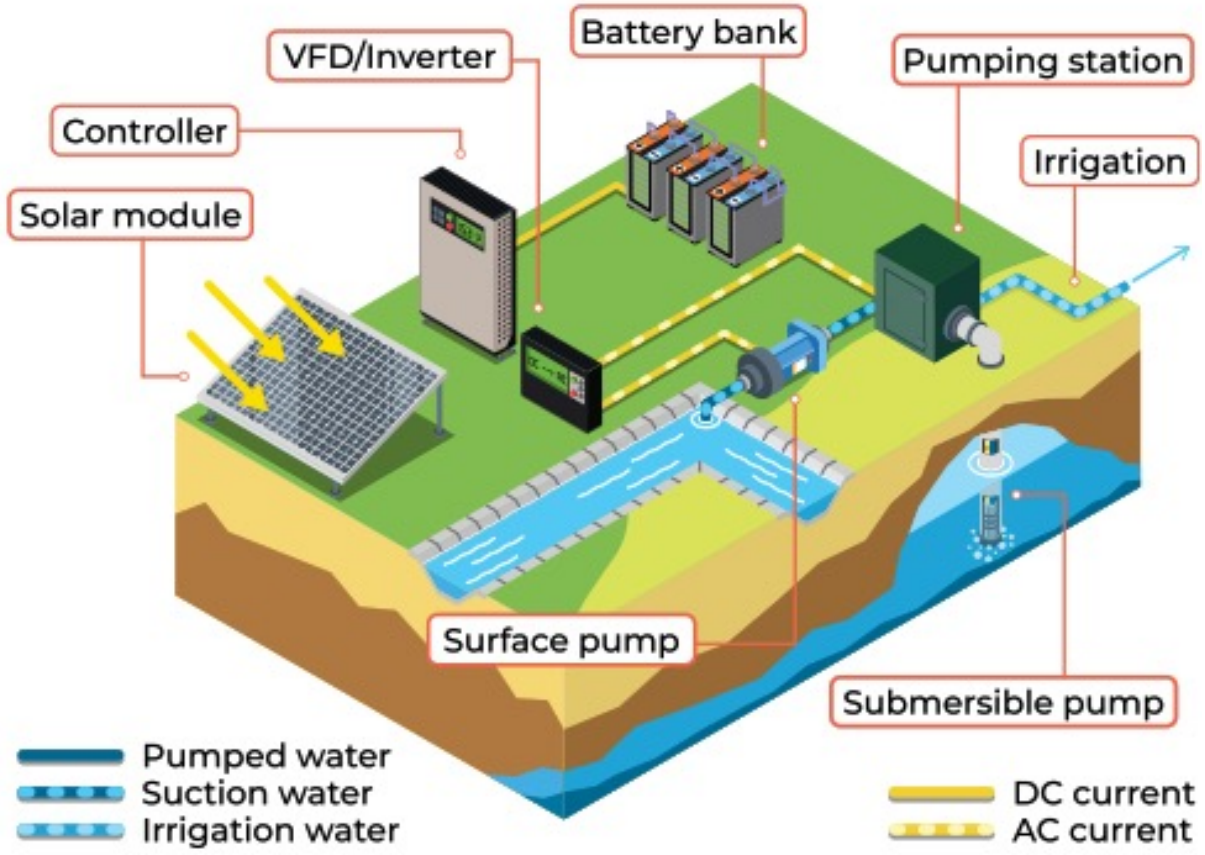


Stand Alone system for Direct Irrigation . Source: FAO

STAND ALONE SYSTEM FOR DIRECT IRRIGATION WITH BATTERIES

This type of system is effective when the time of peak irrigation demand cannot be synchronized with the peak sunshine hours due to operational reasons. The system uses solar panel modules combined with lead-acid batteries to store the generated electrical energy during peak sunshine hours.

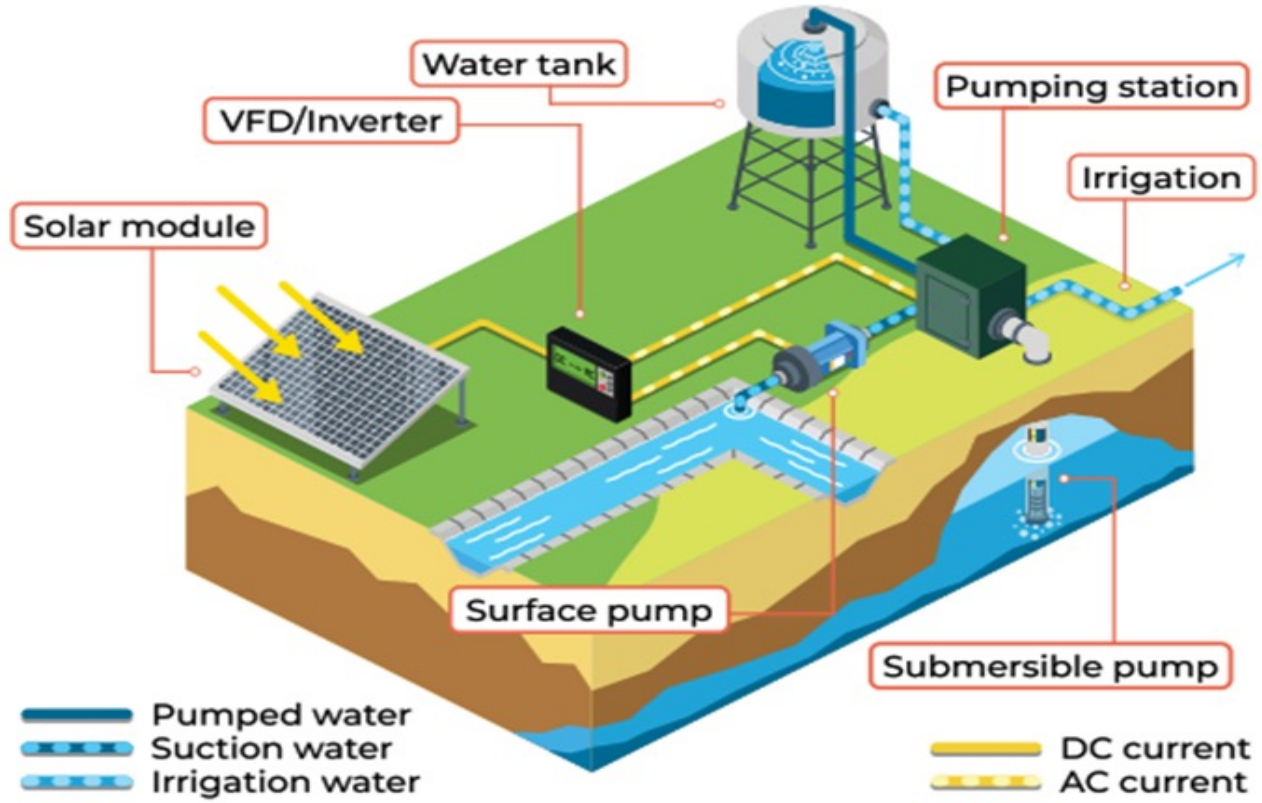
To maximize independence of fuel price fluctuation, there is a system called Battery Based Hybrid System, which uses batteries in order to store any excess energy, making it a good option for full- day operations. However, the batteries and their mandatory replacement over time make this system also very cost intensive



Stand Alone system for Direct Irrigation with Batteries. Source: FAO

STAND ALONE SYSTEM WITH HIGH LEVEL WATER STORAGE

The challenge for both designers and operators of solar irrigation systems is to harmonize the non-constant solar energy and the constant irrigation requirements. The solar system keeps the pump running as long as sufficient irradiation is available and during sunny days or little solar system oversizing, the system provides enough water, more than the daily requirements

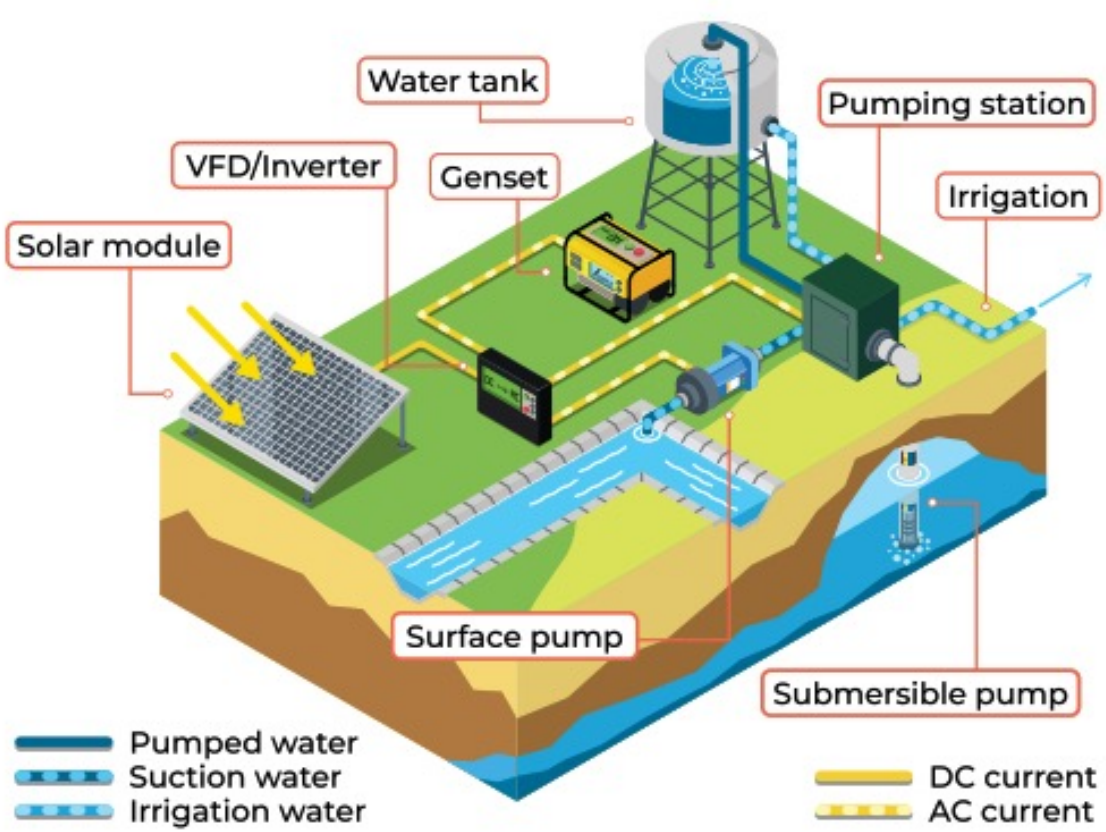


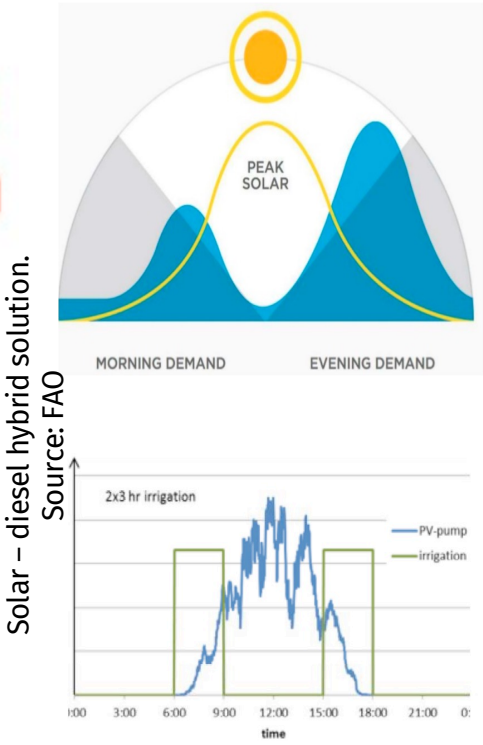
Standalone system with high level water storage. Source: FAO

Storage can be done using elevated water tanks or storage ponds, the most popular system application to use solar water pumping. Water is stored until it is demanded and delivered and released to end-users under constant pressure based on gravity (no booster pump).

The operation time of the irrigation system is independent from the pumping operation. The full day demand for irrigation is pumped into high level water reservoir and released under constant pressure based on gravity (no booster pump). The pump operation and daily profile of water flow rate to the tank is similar to stand alone systems for direct irrigation.

SOLAR – DIESEL HYBRID SOLUTION





Solar – diesel hybrid solution. Source: FAO

There are different peaks between irrigation time and peak sun hour. That means the water storage allows an irrigation schedule which differs from the pumping schedule, during the design phase. System designers need to decide on which appropriate hybrid solution should be used according to end user irrigation profile pattern. Hence, they need to fill carefully solar water pumping system checklist to determine all system parameters and operation conditions. These, all are factors that affect the system performance and feasibility of the proposed solution that can be supported with different operation conditions

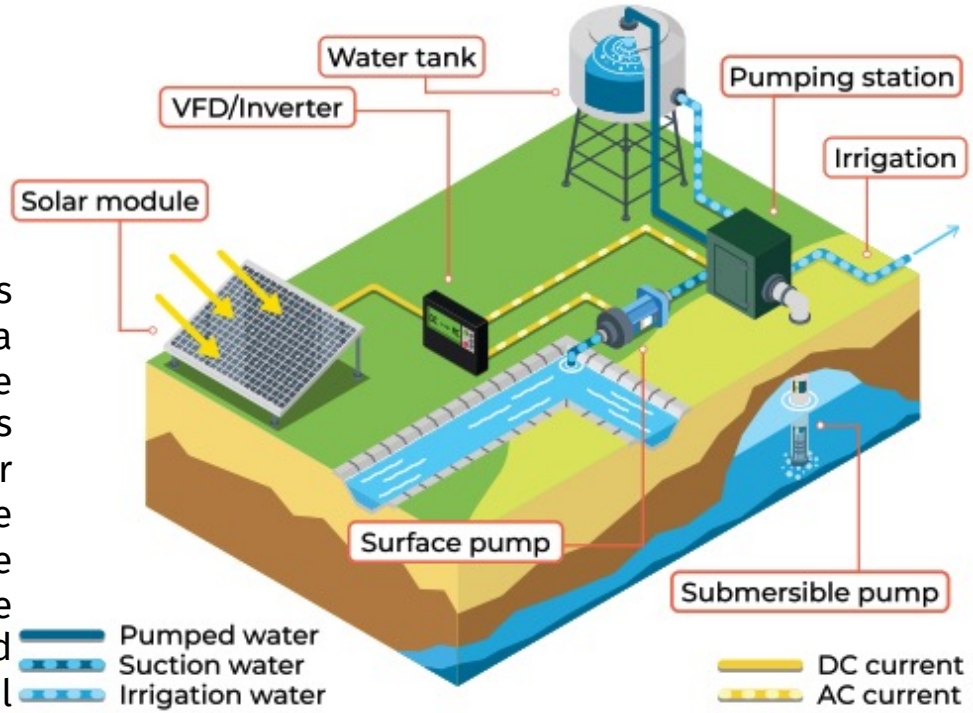
SPIS PLANT CONFIGURATIONS

Depending on the available water resource (well or surface water) and the site-specific conditions, different technical SPIS configurations are possible.

The best suited system configuration should be selected in close cooperation with the farmer, according to the following main aspects:

- Type of water source (well or surface water)
- Motor pump installation (submersible or surface)
- Use of water tanks (irrigation by gravity)
- Fertigation technology
- Direct irrigation.

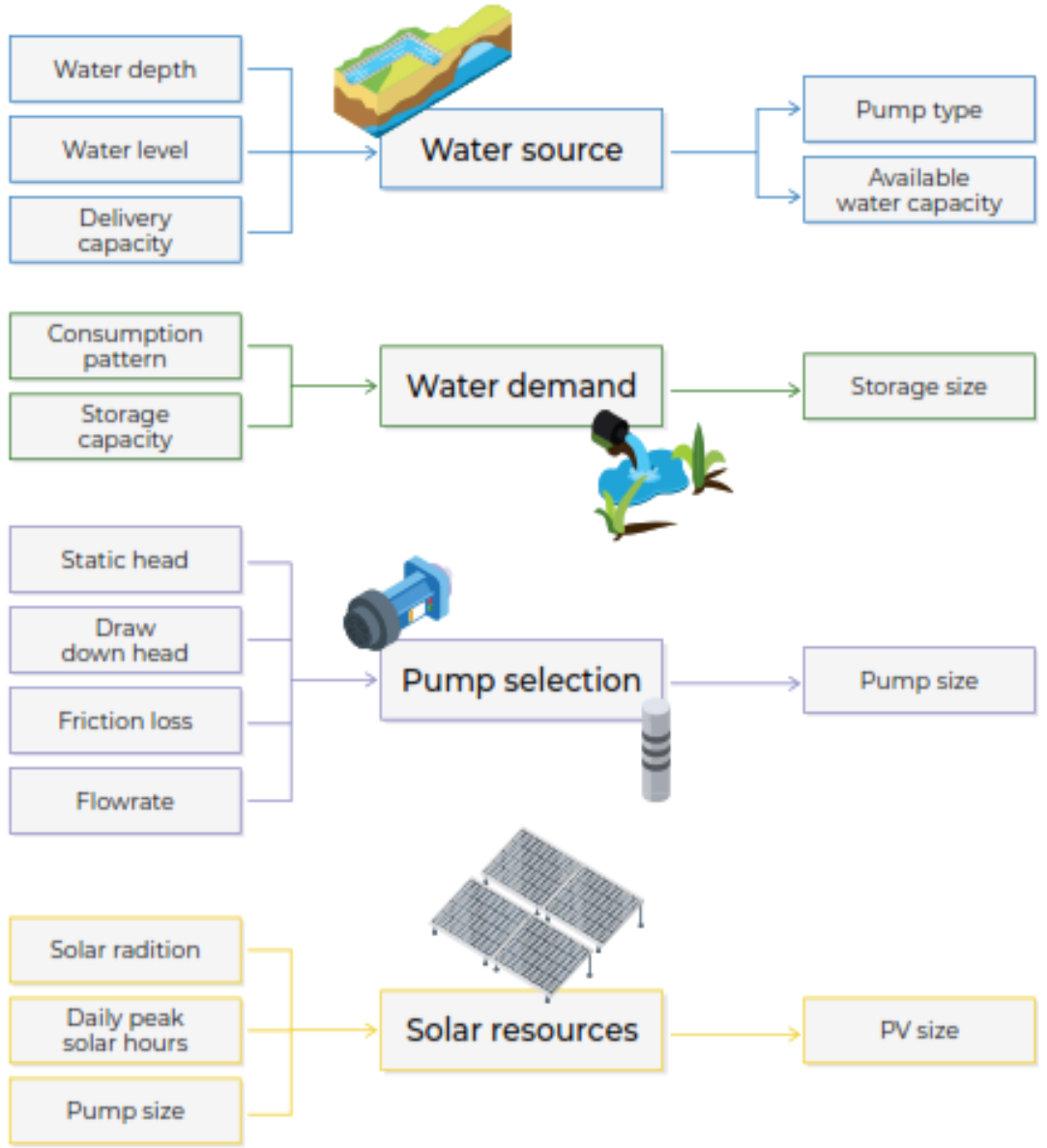
Solar-powered water pumps have to be oversized to a certain extent to meet these peak demands, which means that they are under-utilised for most of the year. Variable water requirements during the year resulting in a low degree of system utilisation would generally favour conventional motor-driven pumps.



scheme of a typical solar pumping system.
Source: FAO

The maximum daily output of a conventional motor-driven pump depends not only on its technical specifications but also on the (freely selectable) daily operating time. This gives a comparatively high level of adaptability to fluctuation in demand and constitutes an advantage over a PV pump

GENERAL APPROACH FOR DESIGNING A SOLAR PV POWERED PUMPING SYSTEM



THANK YOU

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