



Food and Agriculture Organization  
of the United Nations

# SOLAR POWERED WATER LIFTING FOR IRRIGATION

FUNDAMENTALS AND ESSENTIALS OF SOLAR ENERGY

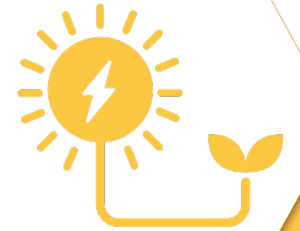
**Ahmed Abdelfattah**

Land and Water Division (NSL), FAO

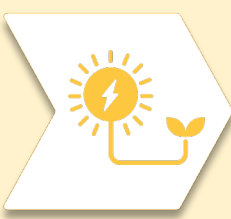
Tunis, 14 December 2022

Regional gathering

Tunis, 12 – 16 December 2022



ITALIAN AGENCY  
FOR DEVELOPMENT  
COOPERATION



# SOLAR ENERGY CHARACTERISTICS

Using solar energy for irrigation makes a lot of sense. Firstly, irrigation is often implemented in rural areas with poor access to reliable electricity or fossil fuel supplies. Secondly, solar radiation is an abundant resource in many developing countries where irrigation is essential to food security and international trade.



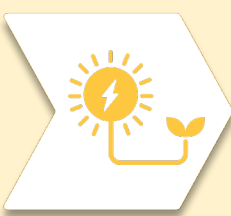
## USING SOLAR ENERGY FOR irrigation purposes

The implementation of solar powered irrigation helps overcoming the risk from fluctuations in both fuel and supply prices, and instead guarantees stable and reliable on farm energy supply. Therewith, crop losses that result from insufficient irrigation are avoided.

It is important to note that a solar-powered irrigation system (SPIS) is more than just a solar pump used for irrigation. Panels, pumps and irrigation systems are designed on the basis of water availability and local crop water requirements. SPIS is a system where the different components, from pump to plant, are integrated and harmonized.

Decreasing carbon and water footprints is essential for farmers, and will become more and more important in the future for these reasons:

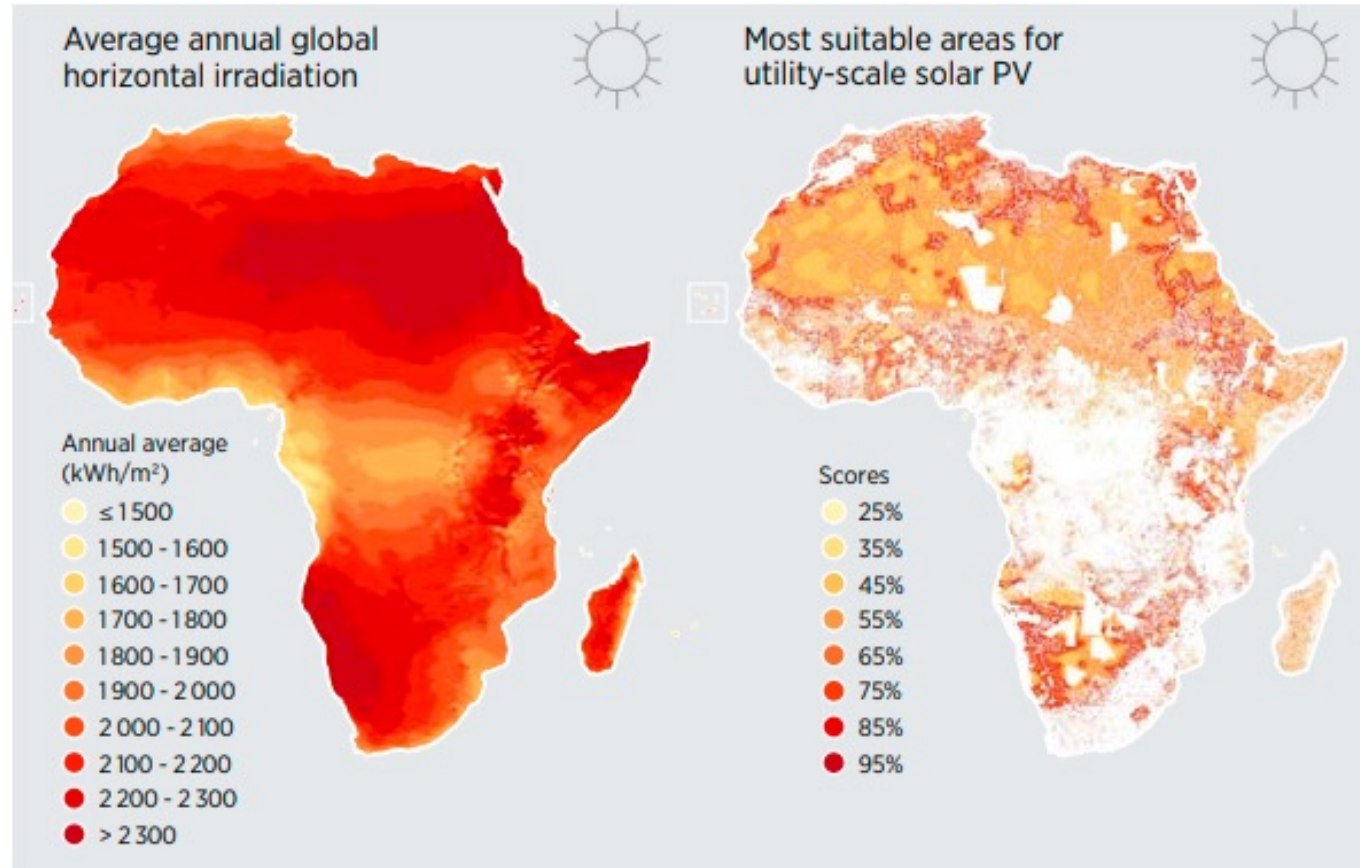
- Water availability.
- Energy cost rising.
- Energy availability.
- Consumers' pressure.



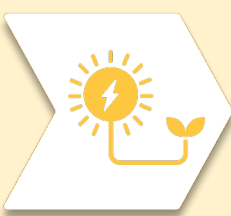
# QUANTIFYING THE AVAILABLE SOLAR ENERGY



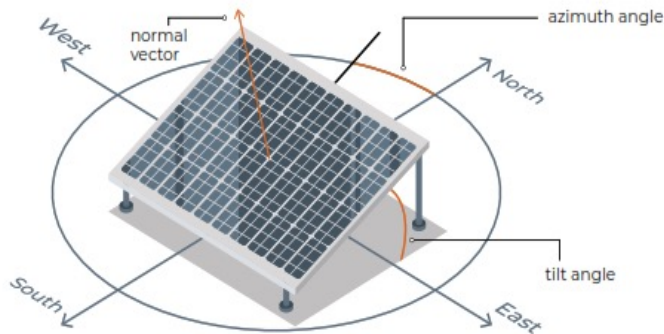
one of the highest solar radiation in the world , average solar radiation of 1800-2,470 kWh/m<sup>2</sup>/day , The huge potential for renewable energy in Libya , Niger and Mali



Source: (a) Global Solar Atlas (ESMAP, 2019b); (b) IRENA Global Atlas for Renewable Energy (IRENA, 2021d).  
Note: kWh/m<sup>2</sup> = kilowatt hours per square metre; PV = photovoltaic.

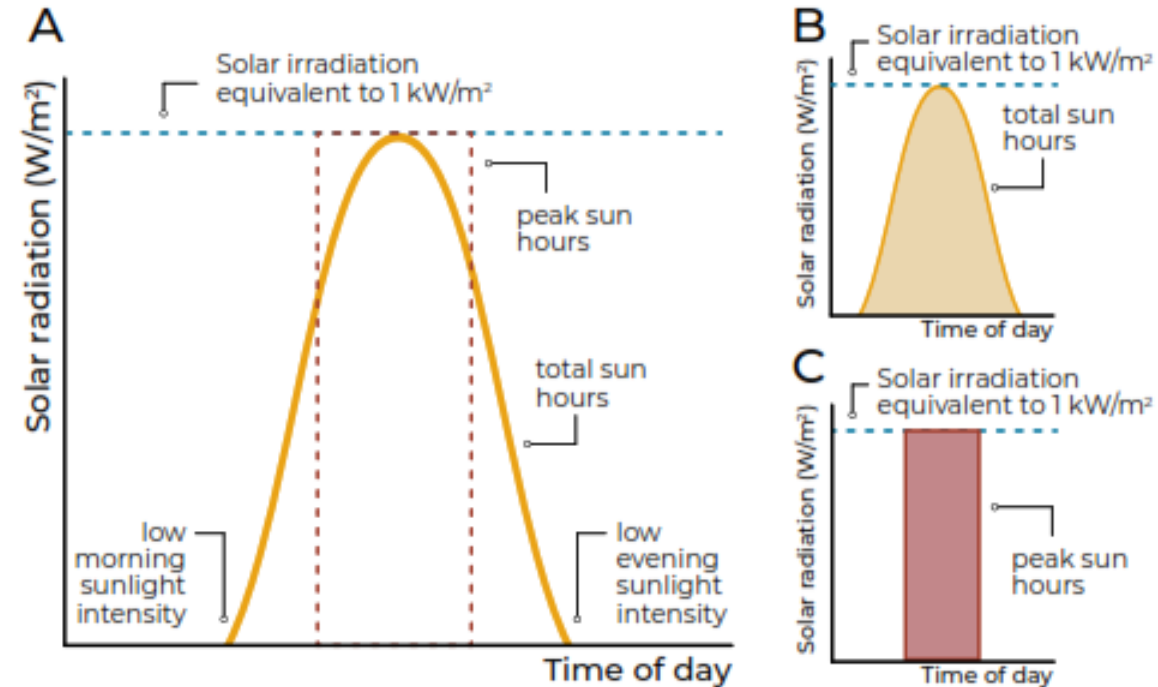


# QUANTIFYING THE AVAILABLE SOLAR ENERGY



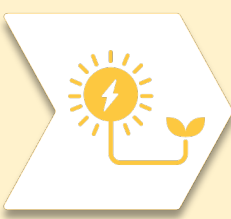
Orientation, positioning and tilt angle of a solar panel.

- Solar irradiance
- Solar radiation
- Solar insolation
- Azimuth and zenith
- Orientation
- Tilt



(A), total sun hours on a horizontal surface (B) and its equivalence as peak sun hours (C).

The colored area under the curve (B) and rectangle (C) are equivalent and represent solar insolation.



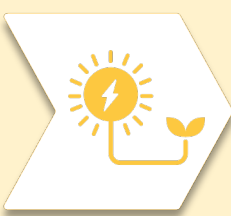
# SOLAR PUMP IRRIGATION SYSTEM \_ SPIS



A water pump is the most well-known hydraulic machine to the farmers. Pumps are used when there is a need to lift the water from a deep source such as groundwater well, low lying water storage, or an excavated canal. In old civilizations, some of the main water-lifting mechanisms were Shaduf, Archimedes' screw, Persian wheel and rope and pulley to lift irrigation water .



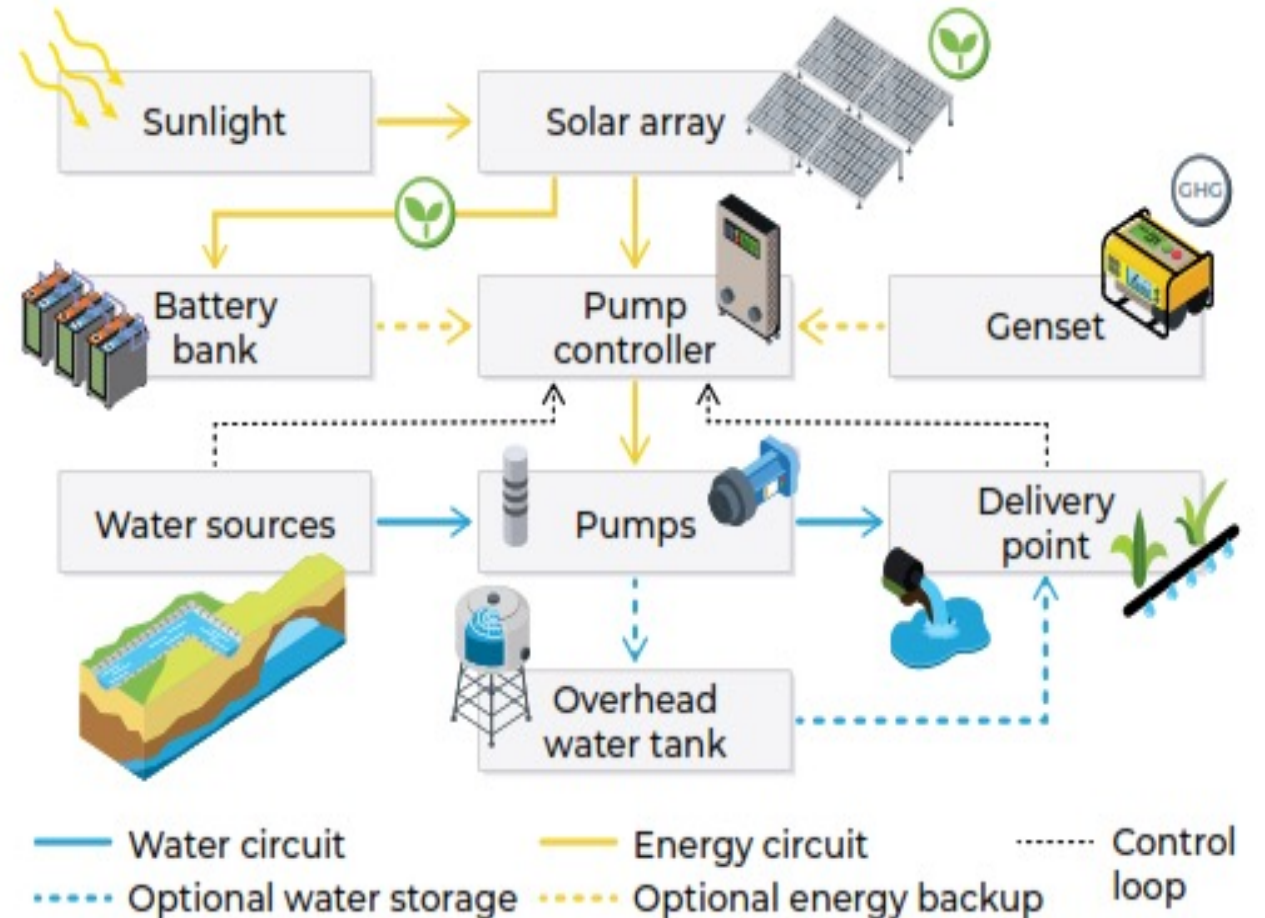
FAO Al-Afir project  
Source: FAO, 2017, El- Behiera Governorate, Egypt



# SYSTEM ESSENTIALS AND COMPONENTS OF SPIS

A solar water pumping system essentially consists of the following main components:

- solar modules
- pump controller
- pump
- battery bank
- delivery point
- water source



Components of the solar water pumping system and their interconnections.

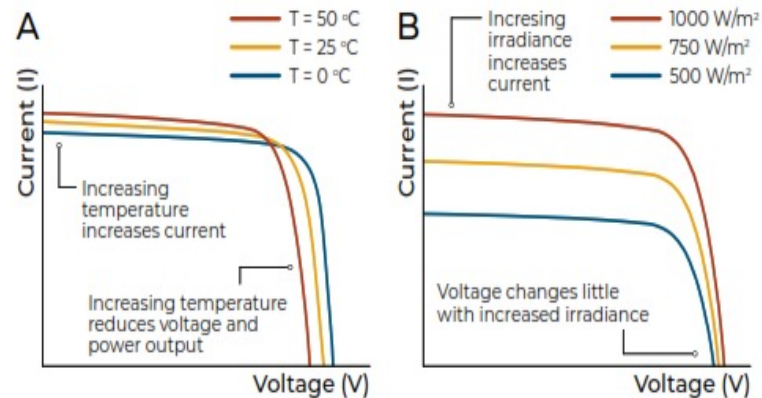


# SOLAR PV MODULES

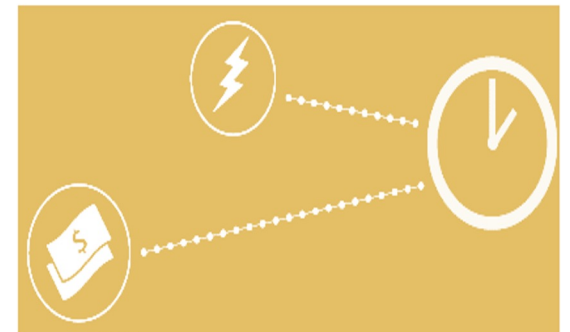


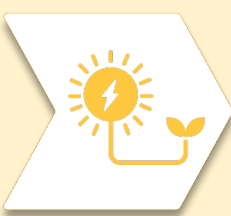
Al-Afir project – Solar powered irrigation system in the Nile Delta, Source: FAO, 2017, El- Behiera Governorate, Egypt

## TERMINOLOGIES OF SOLAR MODULES



## EFFICIENCY





# PUMP CONTROLLER AND INVERTER

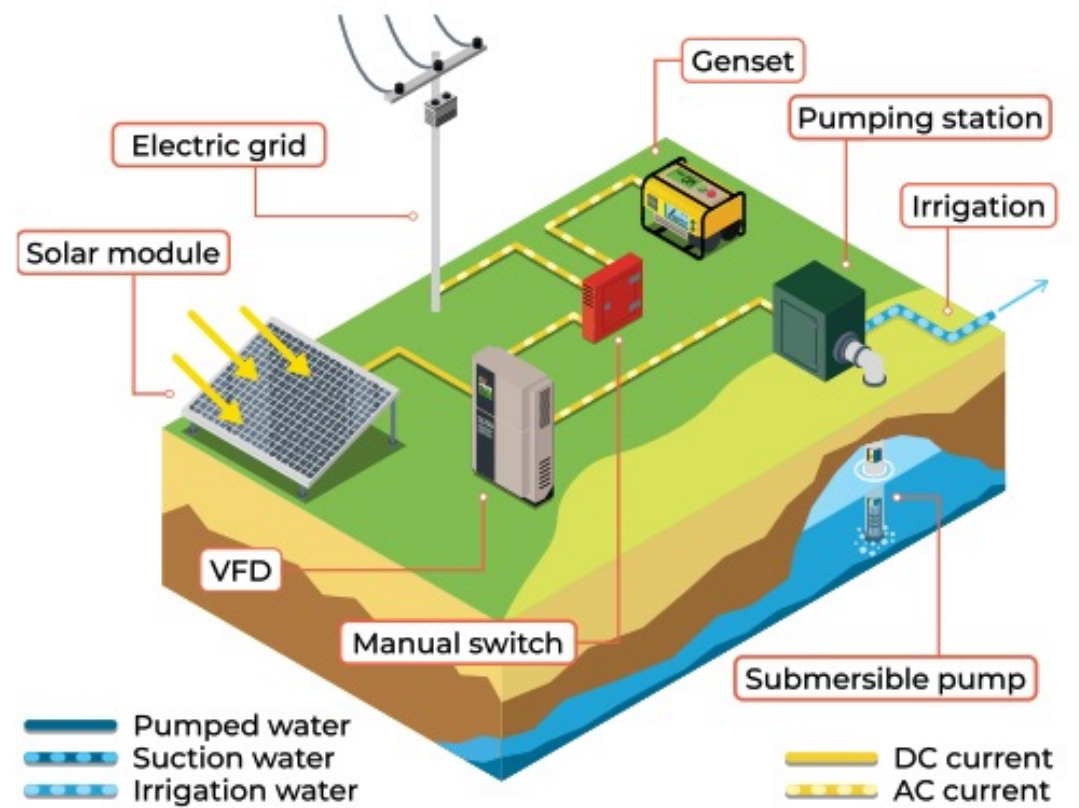


Diagram of solar water pumping with an SJ700 VFD Hitachi controller installed at FAO's Al Ghadeer Al Abyad project in Jordan.



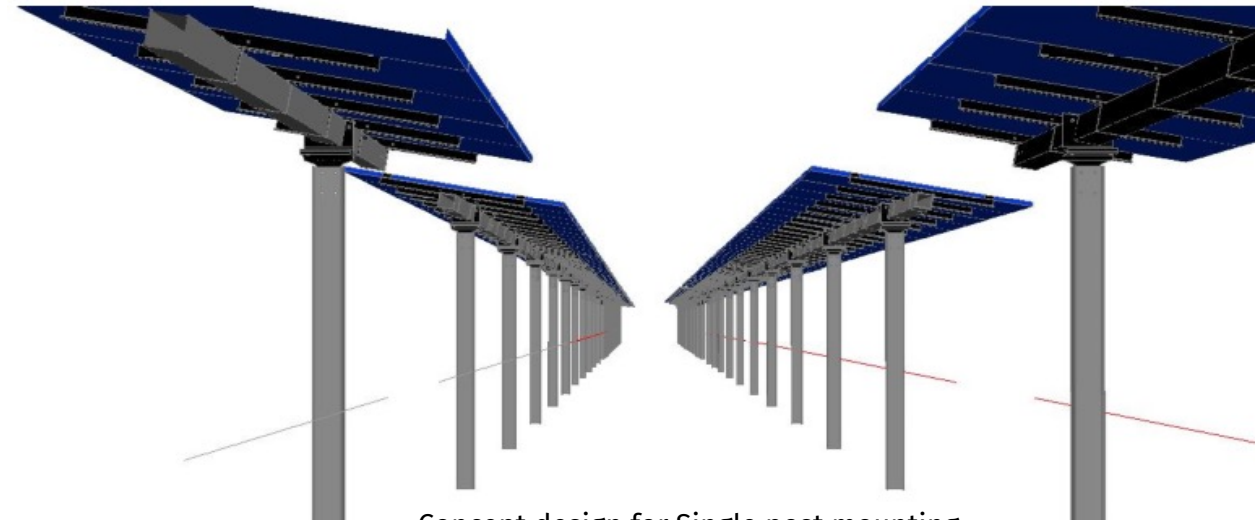


# PV MOUNTING STRUCTURE

- Tracking mounting structure
- Fixed mounting structure



Al-Afir project –  
double post mounting  
structure  
FAO, 2017, El- Behiera  
Governorate, Egypt



Concept design for Single post mounting  
structure \_Al Ghadeer Al Abyad project  
Source: FAO, 2018, Al-Mafraq Governorate,  
Jordan



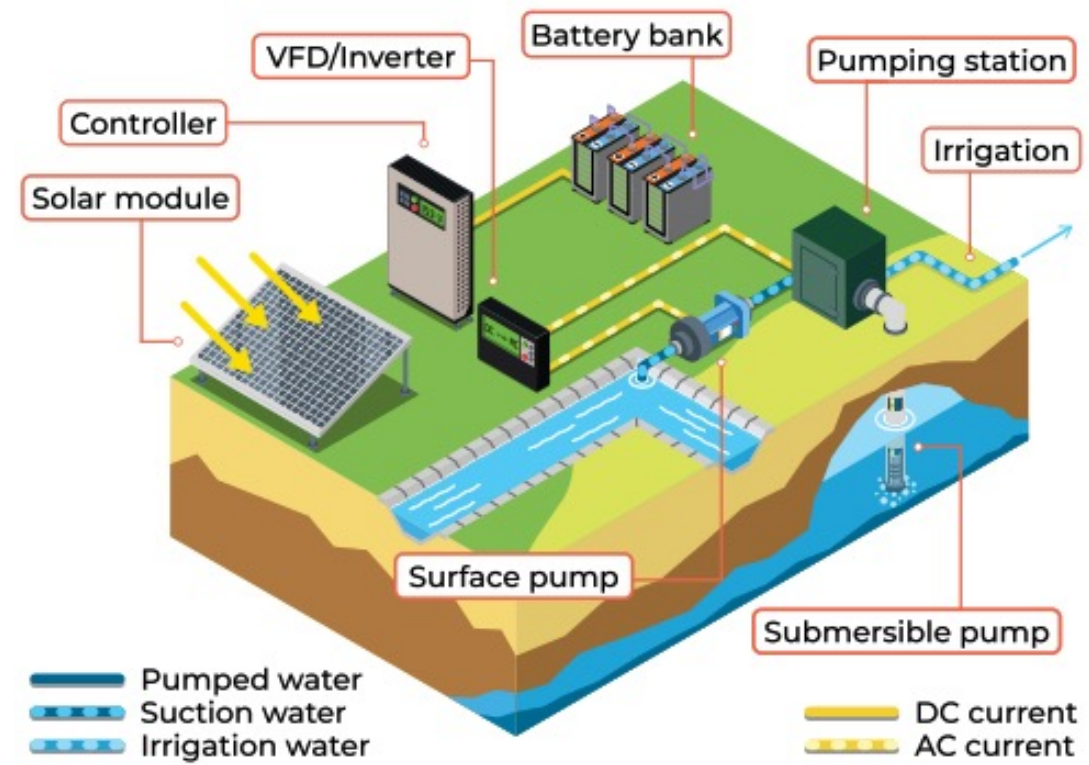
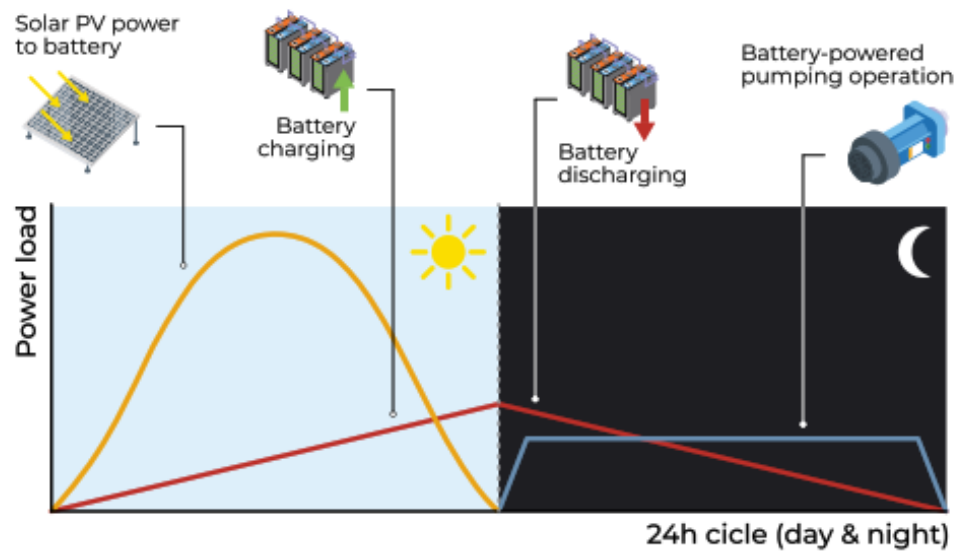
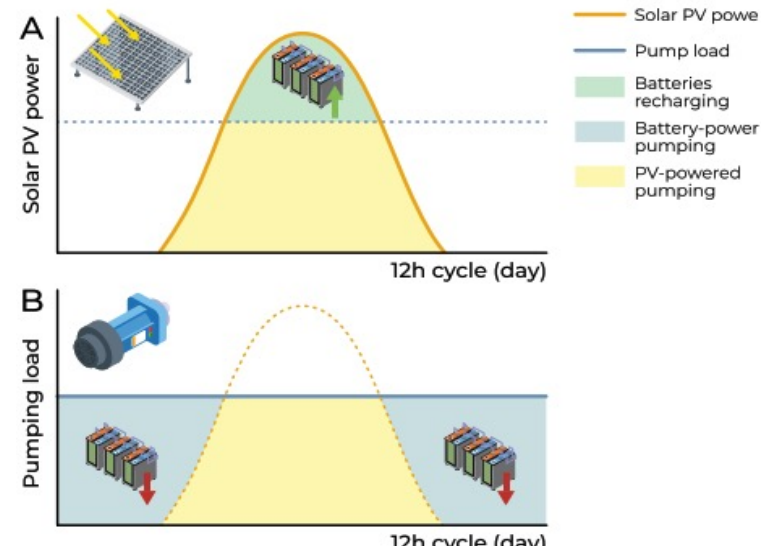
Single post mounting structure \_Al  
Ghadeer Al Abyad project  
Source: FAO, 2018, Al-Mafraq Governorate,  
Jordan



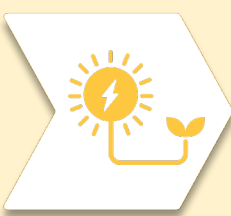
# BATTERY BANK

Simultaneously powering the pumping unit and charging the battery bank; (B) 12 hours pump operation during daytime

Charging of battery bank during the peak sun hours for 12 hours pump operation at night-time



Concept diagram of solar pumping system with battery storage.



# PUMPING SYSTEMS

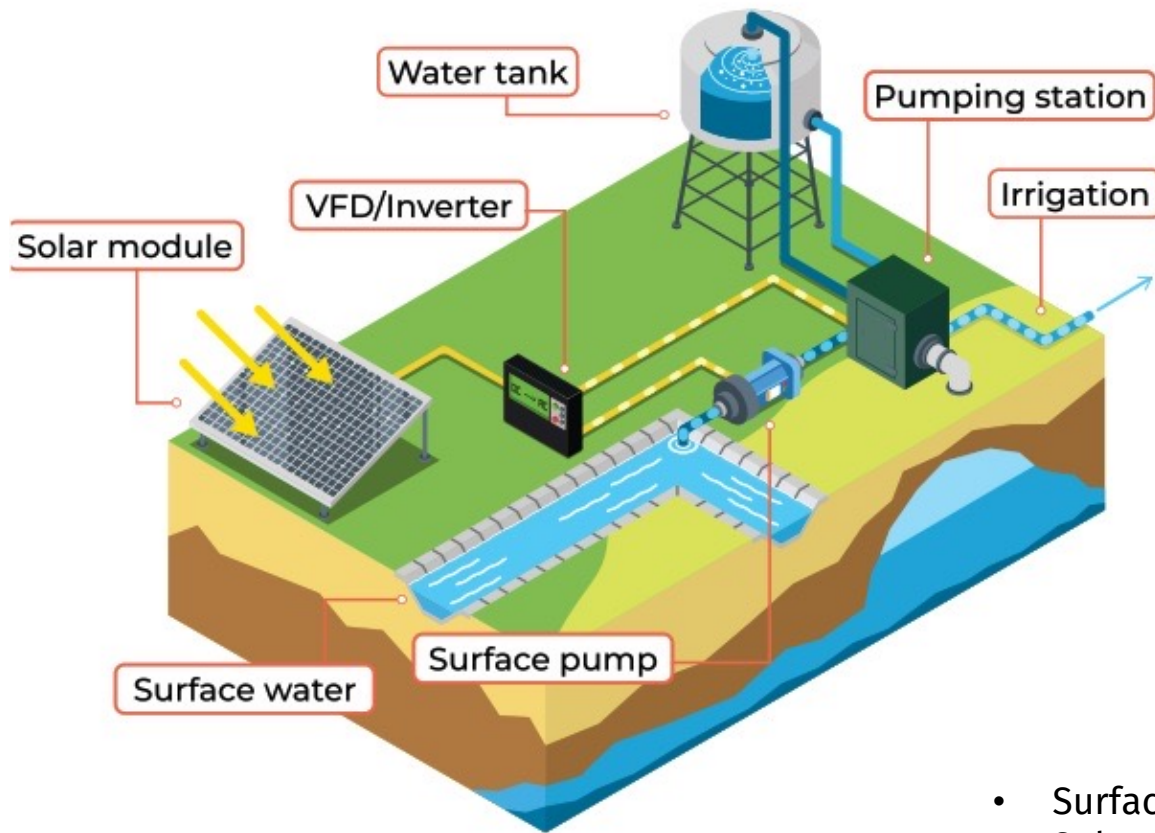


Figure (A)

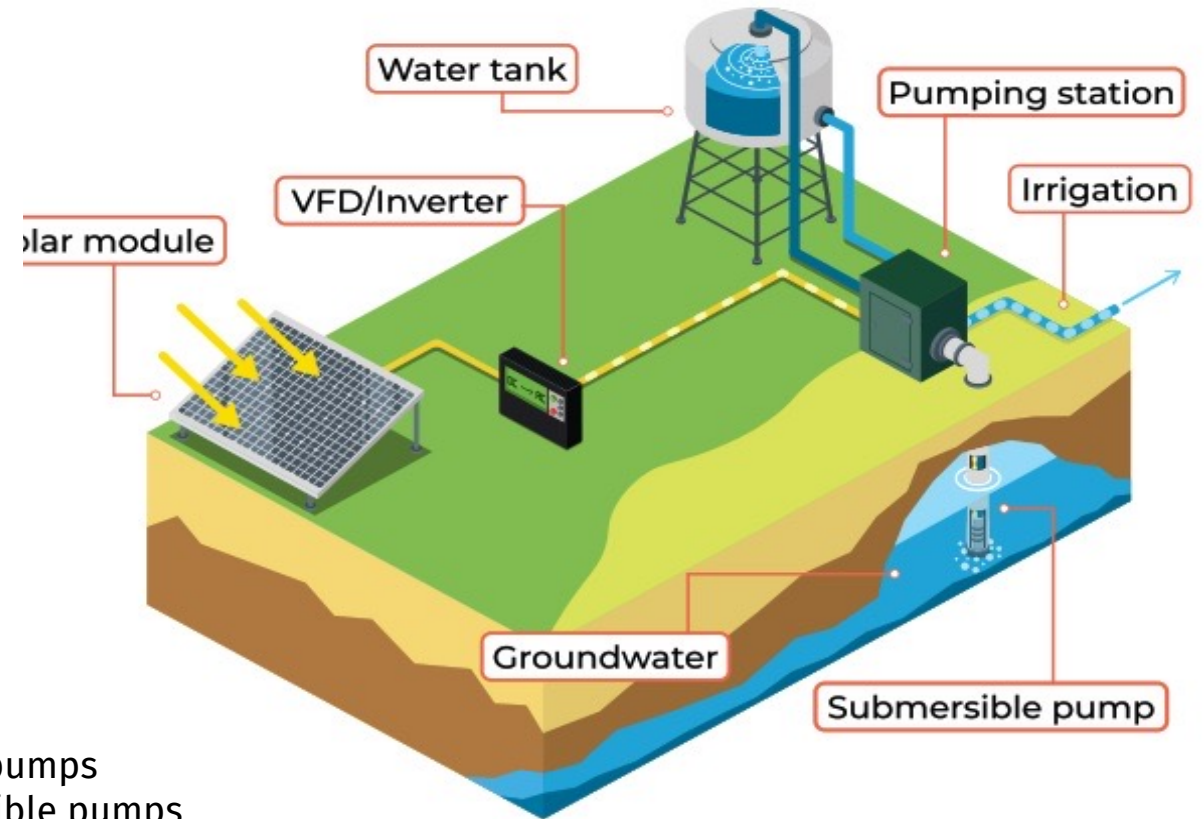
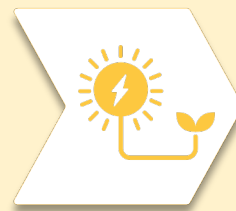


Figure (B)

- Surface pumps
- Submersible pumps



# THANK YOU

---

**Ahmed Abdelfattah**

Land and Water Division (NSL)

Natural Resources and Sustainable Production Stream

Food and Agriculture Organization of the United Nations (FAO)