

## Emerging practices from Agricultural Water Management in Africa and the Near East

### Thematic Workshop



### Theme 7

# Solar Powered Water Lifting For Irrigation

**Ahmed Abdelfattah**

International consultant / solar energy

Land and Water Division ( CBL )

30 August 2017



Theme 7:

# Solar Powered Water Lifting For Irrigation

## PRESENTATION OUTLINE



1. Introduction
2. Solar Powered irrigation solution
  - 2.1 Solar Pump Concepts
  - 2.2 Measures Of Solar Energy Uses In Irrigation.
    - A. Stand Alone system for Direct Irrigation
    - B. Stand Alone system for Direct Irrigation with Batteries.
    - C. Stand Alone system with high level water storage.
    - D. Solar/Diesel Hybrid solution.
    - E. Solar combined with power from the electricity grid
3. What information needed to take to SWP design?
4. Benefits of Solar Pumping Solutions for Farmers and Governments.
5. Next Steps



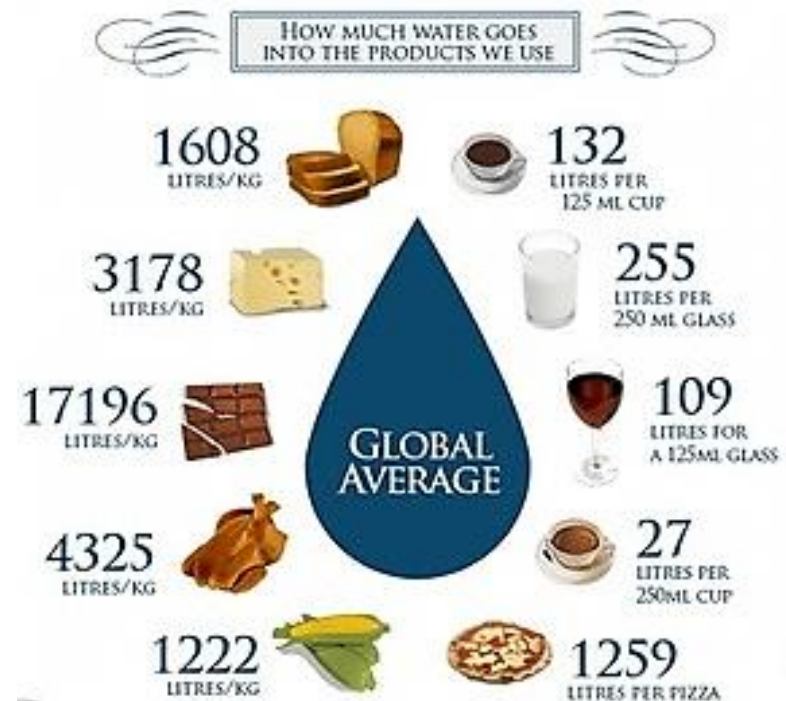
Theme 7:

# Solar Powered Water Lifting For Irrigation

## 1. INTRODUCTION AND DEFINITION

By definition solar energy is “ the conversion of sunlight into usable energy forms”. The main solar technologies are photovoltaics (PV), solar thermal electricity and solar heating and cooling. For agricultural production and processing, solar energy is an important energy source, in particular for irrigation.

Irrigation is very important to the productive agriculture, accounting for 20% of all farmland and 40% of all production worldwide.





Theme 7:

# Solar Powered Water Lifting For Irrigation

## 1. INTRODUCTION AND DEFINITION

Solar Powered Irrigation system is a complete system which provides fresh water from a well and reservoir for use in livestock, domestic use and industrial or agriculture.



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.

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



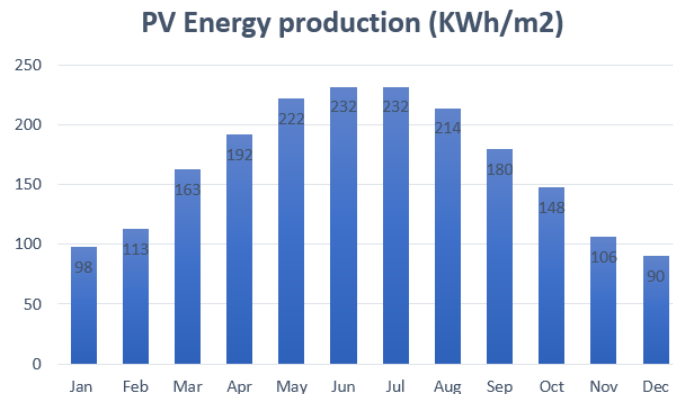


## Theme 7:

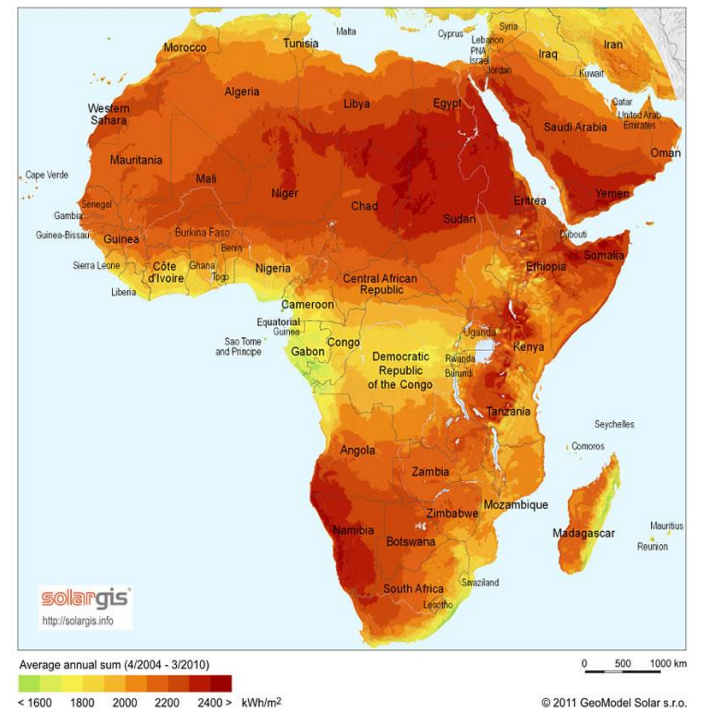
# Solar Powered Water Lifting For Irrigation

## 1. INTRODUCTION AND DEFINITION

North African countries is one of richest countries in the world with regard to solar energy potential . on average, there are 330 - 340 sunny day per year this result in yearly irradiation energy around **1 990 KWh/m<sup>2</sup>** which is the energy equivalent to **200** liters of diesel per/m<sup>2</sup>



Global horizontal irradiation Africa and Middle East









Theme 7:

# Solar powered water lifting for irrigation

## 2. SOLAR POWERD IRRIGATION SOLUTION

### 2.2 Measures Of Solar Energy Use In Irrigation

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.**





## Theme 7:

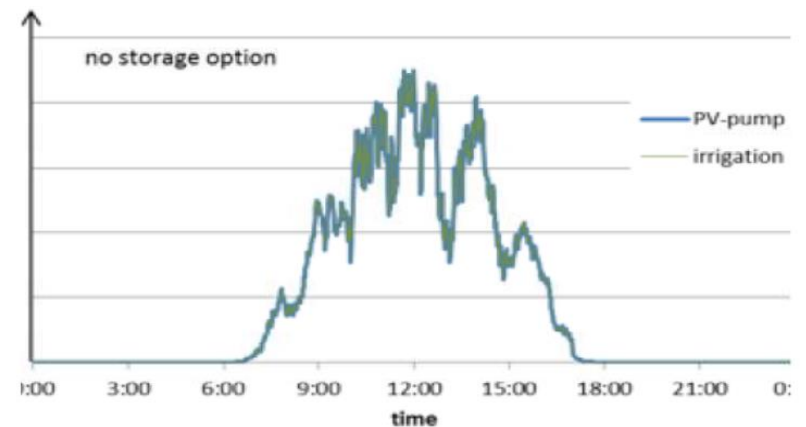
# Solar Powered Water Lifting For Irrigation

## 2.2 Measures Of Solar Energy Use In Irrigation

### A. Stand Alone system for Direct Irrigation

Stand-alone system for direct irrigation is the simplest way to set up a SWP system. The pump directly connected to a solar pump inverter and starts operate 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 change with the solar irradiation. the daily water volume changes with the daily and seasonal profile of solar irradiation.





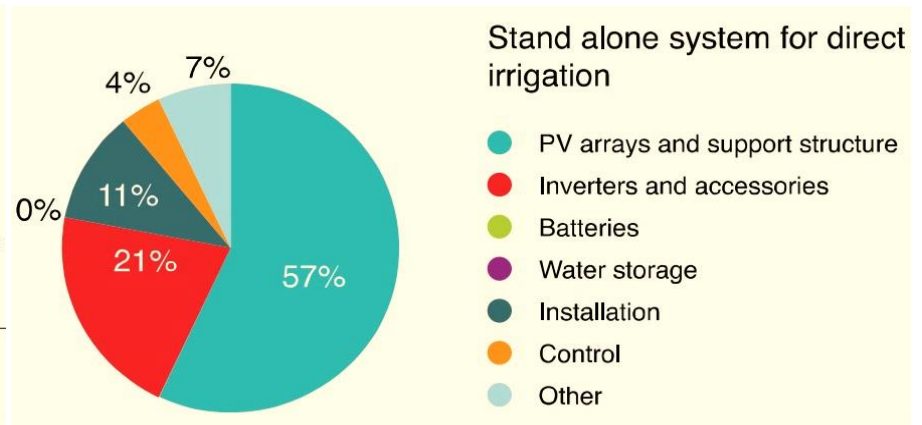
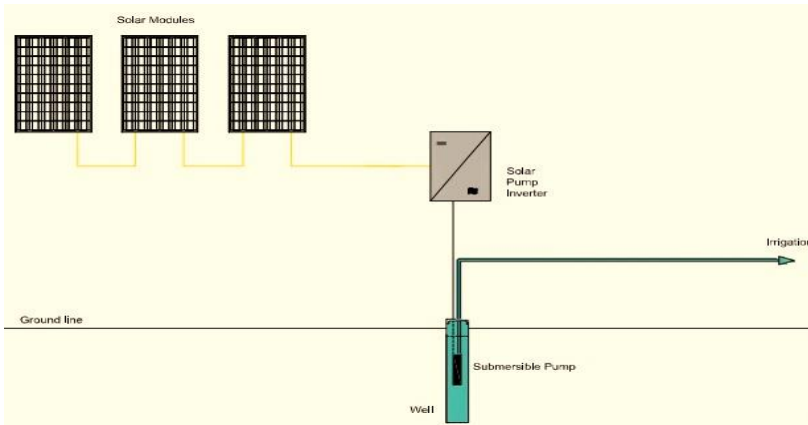


## Theme 7:

# Solar Powered Water Lifting For Irrigation

## 2.2 Measures Of Solar Energy Use In Irrigation

### A. Stand Alone system for Direct Irrigation



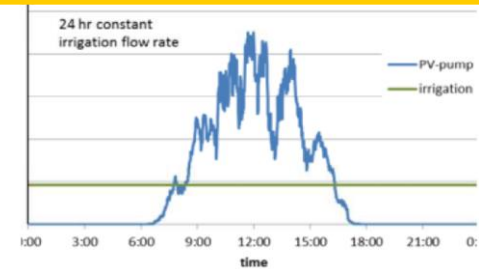


## Theme 7:

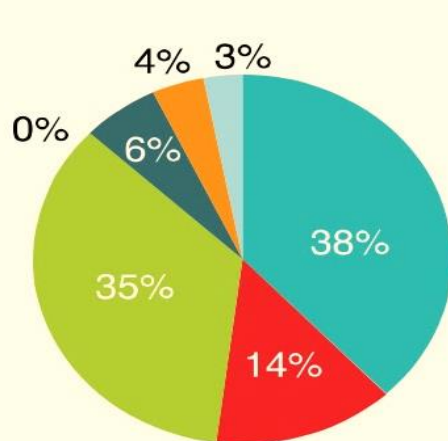
# Solar Powered Water Lifting For Irrigation

## 2.2 Measures Of Solar Energy Use In Irrigation

### B. Stand Alone system for Direct Irrigation with Batteries.

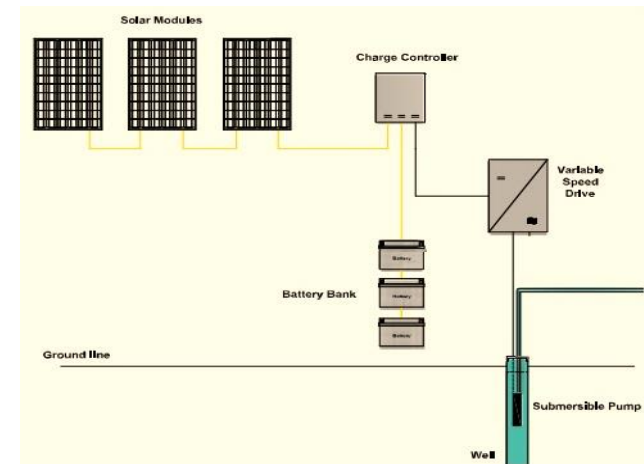


To maximize independence of fuel price fluctuation, there is a System called Battery Based Hybrid System, uses batteries in order to store any excess energy, making it a good option for full- day operations. However, the batteries and their mandatory replacement over time make this system also very cost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



### Stand alone system for direct irrigation with batteries

- PV arrays and support structure
- Inverters and accessories
- Batteries
- Water storage
- Installation
- Control
- Other



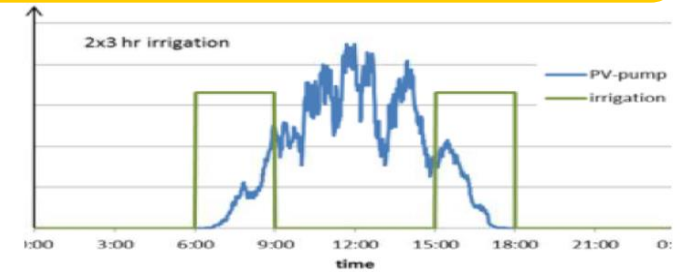


## Theme 7:

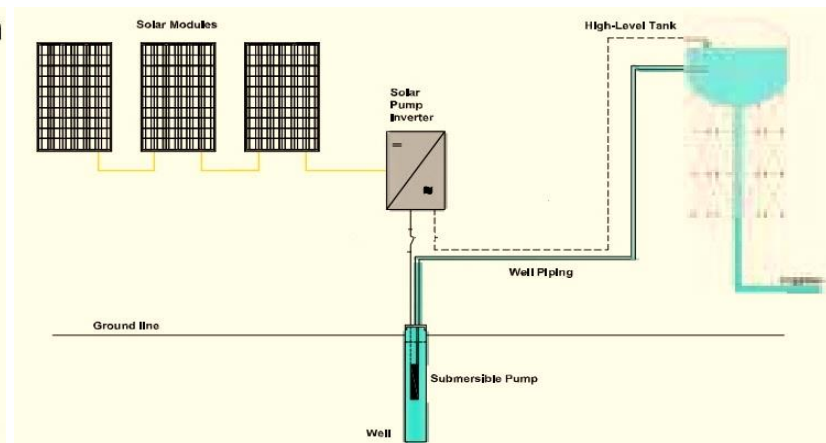
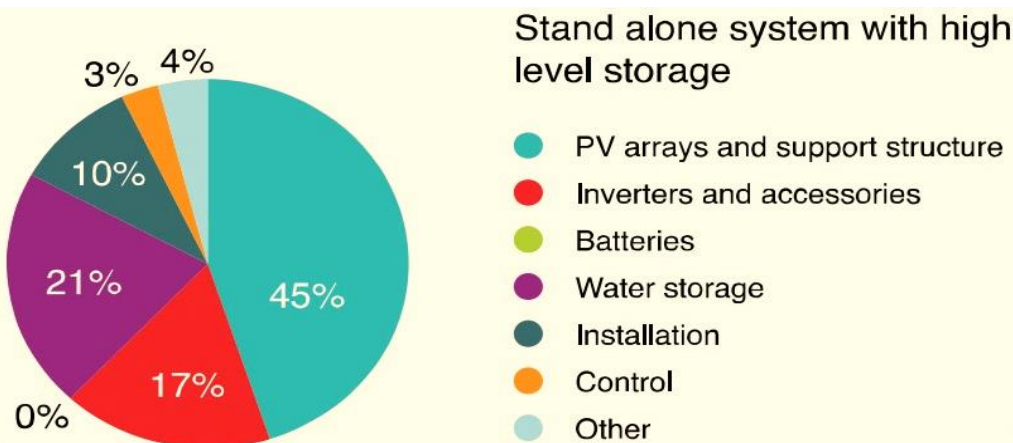
# Solar Powered Water Lifting For Irrigation

## 2.2 Measures Of Solar Energy Use In Irrigation

### C. Stand Alone system with high level water storage.



Stand-alone system with high level storage are the most popular system, 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.





## Theme 7:

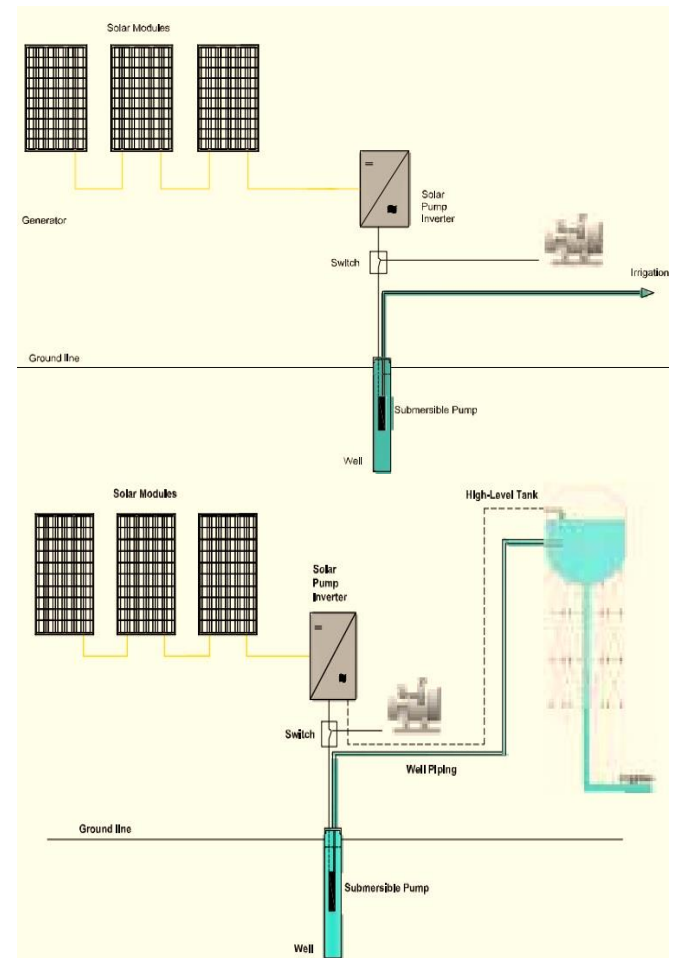
# Solar Powered Water Lifting For Irrigation

## 2.2 Measures Of Solar Energy Use In Irrigation

### D. Solar/Diesel Hybrid solution.

During the solar hours, the solar system runs the pump with the same principle as for stand-alone system. If no solar power available the system switches to the diesel generator operation, the switch can be done manually or automatically depending on diesel generator control options. Savings of fuel and therefore of costs are achieved dependent on the total required irrigation time and the designed operation time of the solar system.

If the system additionally allows to use high level reservoir this is a good solution when the well/dam performance does not allow pumping, the total daily demand during day time or we have different peaks between irrigation time and peak sun hours, that means the water storage allows an irrigation schedule which differs from the pumping schedule.



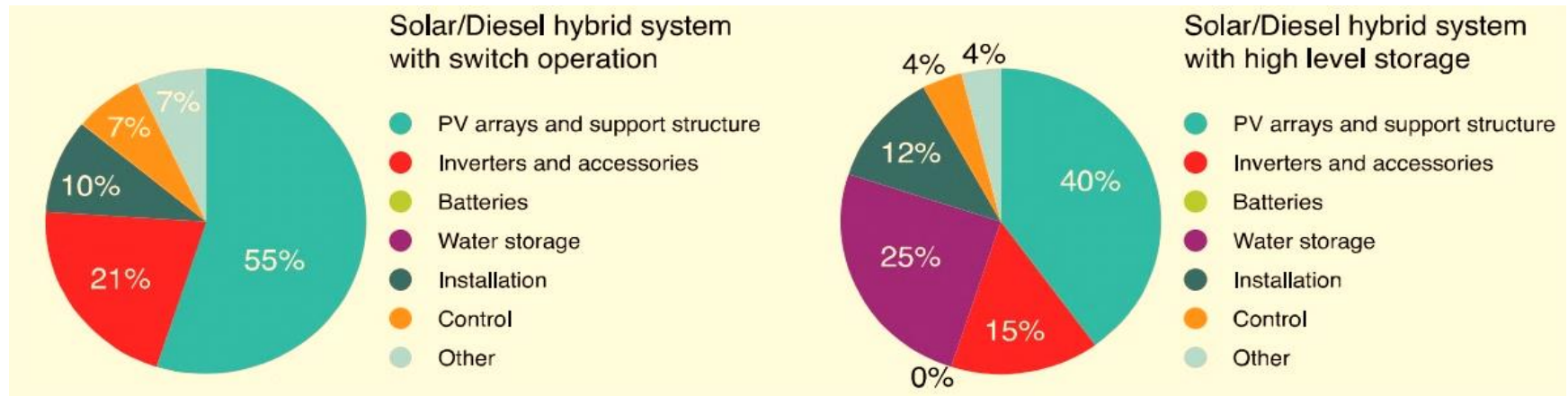


## Theme 7:

# Solar Powered Water Lifting For Irrigation

## 2.2 Measures Of Solar Energy Use In Irrigation

### D. Solar/Diesel Hybrid solution.



### E. Solar combined with power from the electricity grid

The grid provides reliability and enables the pump to be operated in a flexible way to meet changing requirements.





## Theme 7:

# Solar powered water lifting for irrigation

## 4. WHAT INFORMATION WE NEED TO TAKE TO SWP DESIGN

### Water requirements

- The water will be used (for example, livestock, irrigation),
- Your daily water requirements, and
- Monthly/ seasonal variation/water profile of consumption.

### Locations for SWP system

- The proposed location (geographical coordinates) for SWP
- The proposed location of the solar array, and
- Potential sources of shading.

### Water sources

- The type of water source (a bore, dam or river),
- The recovery rate of the proposed water source,
- The depth of the water source, and
- The distance from the top of this water source to the ground.

### Water delivery

- The location to which the water will be pumped to (such as a storage tank or dam, directly to irrigation network),
- The vertical lift between the pump and the water delivery point,
- The length of the route between the pump and the water delivery point



## Theme 7:

# Solar Powered Water Lifting For Irrigation

## 5. Benefits of Solar Pumping Solutions for Farmers and Governments

### Farmers

- Low maintenance costs
- Reduced manual work
- foods with high-value crops
- Protection from rising energy costs
- Enhanced crop resilience and food security
- Improved crop yields and increased incomes
- Reduced bills for mains electricity and diesel
- Supply of energy and improved access to water for irrigation
- Additional benefits for health, education and poverty alleviation



### Governments

- Subsidy savings
- Emissions reductions
- Reduced fuel imports
- Reduction in electricity and fuel use
- Improved reliability of power systems
- Increased agricultural economic output
- Creation of small businesses/employment across the value chain





Theme 7:

# Solar Powered Water Lifting For Irrigation

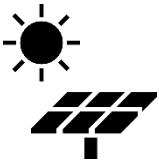
## Next Steps



**1. Value of** the different Solutions and **select the** most suitable SWP model



**2. Conduct a site visit to study** daytime power needs.



**3. Study** feasible financing solutions and choose the optimum one.



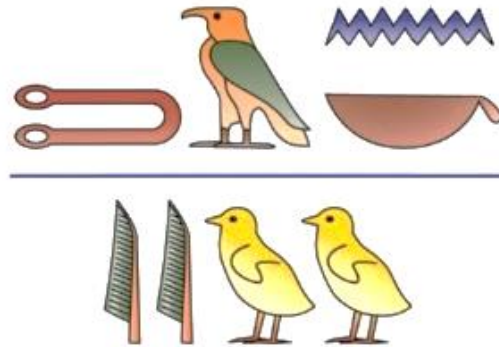
**4. Design & Install** SWP systems



**5. Monitor** impact



**6. Work on** potential projects to be executed for further FAO facilities.



Thank You



**Ahmed Abdelfattah**

International consultant / solar energy  
Land and Water Division ( CBL )  
Climate, Biodiversity, Land and Water Department ( CB )

Food and Agriculture Organization  
of the United Nation