WFP
World Food Programme
SAVING LIVES
CHANGING LIVES

# Solar water irrigation
## Energy access for sustainable agriculture

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## WHY IRRIGATION MATTERS

Climate change is altering weather patterns and reducing rainfall predictability, negatively impacting on rainfed agriculture's productivity, especially in semi-arid areas, which, experience climatic instability, frequent droughts and desertification.

**WFP works with smallholder farmers to ensure inclusive agricultural growth and the sustainable dissemination of energy equipment and services. This boosts agricultural market development, which strengthens local food value chains and builds resilience and livelihoods.**

Using irrigation to strengthen rainfed agriculture can play a significant role in stabilizing or increasing food production. In areas where seasonal rainfall is adequate but poorly distributed during the year and varying from year to year, water can be accessed during dry spells from shallow and moderately deep (50-60m) groundwater sources. In combination with adequate soil management, irrigation can help not only to widen the range of crop types and raise yields of specific crops but also prolonging the crop-growing period or permitting multiple cropping (two or more crops per year). It also enhances the efficiency of other yield-improving inputs such as organic fertilisers and compost. This ultimately increases dietary diversity and nutritional intake, as well as resilience and adaptation to variable climatic conditions.

Manual irrigation is however time consuming. Alternatives such as treadle pumps are only marginally better, making mechanised irrigation the only viable option to free up time dedicated to water fetching trips. The time gained is precious, but it does represent an additional cost. As well as the initial capital investment, diesel-powered pumps, are expensive to operate due to the high cost of fuel and maintenance.

## SOLAR POWER

In recent years, solar powered pumps have become a standard option for water supply especially in off-grid locations. Improvement in solar pumping technologies has allowed the sector to overcome a series of technical and cost barriers resulting in reliable cost-effective products that have a robust and versatile design, increased efficiency, minimal operational costs, longer lifetime and lower maintenance requirements.

Solar water pumps preferable to diesel powered ones in many contexts, including irrigation agriculture due to, the unlimited availability of solar radiation in most underserved remote areas, the drop in prices of photovoltaic systems, the scalability of the technology, the expansion of the solar private sector in new markets and their lower environmental impact.

Water pumps allow for irrigation but also oxygenation of fishponds, and water distribution and lifting for hydroponic applications.

A typical solar water pumping system comprises of a PV generator, an electronic controller, an electric pump plus a storage tank if necessary. Solar power generation can be integrated with a back-up diesel generator. Solar pump suppliers design the specifications of the system based upon the site conditions (solar irradiation, water

source, weather and topography), technology choice (with battery storage, hybrid etc), and user specific factors such as water demand, social aspects, contextual and economic status. Quality certified products, balance higher costs by avoiding additional unforeseen expenses for maintenance, reduced productivity, or early failures.

Solar water pumping is considered a suitable investment where there is potential for improving farm productivity and income. In places where a diesel generator is already in place, for example, its replacement will result in a net positive financial and environmental outcome. Solar water pumping should be discouraged in places with low solar radiation and in the absence of an enabling environment around the technology that ensures access to spare parts, correct operation and maintenance of the systems. While solar water pumps present several advantages compared to equivalent diesel solutions, the upfront investment cost is usually higher, which is a key barrier to adoption.

## DESIGNING SUSTAINABLE SOLAR WATER IRRIGATION INTERVENTIONS

**Maintenance and operation**. Evidence shows that in-kind distributions of equipment rarely result in medium to long term impact.  Lack of sense of ownership means that equipment is not taken care of properly, cleaned or protected from theft, and the smallest maintenance issue leads to disrepair and abandon. Common issues, that are linked to the lack of private sector engagement, range from incorrect sizing, which causes inadequate service (little water, little pressure), to failure to maintain and repair damages of electronic parts like inverters and controllers, due to the absence of technicians, spare parts and willingness to pay for the service. Further problems are caused by poor market assessments that fail to inform design and to address end users' needs.

In-kind distributions also fail to create a relationship between supplier and end user, which is essential to maintenance but also to substitution of the product at the end of its lifespan. Delivery of solar water pumps through local retailers and distribution networks may require more initial resources but contributes to building the local economy and consequently to development.

The active role of the private sector is essential to ensure both operational and financial sustainability. Professional suppliers, linked by contract terms and warranty to the end users, will ensure the correct sizing, installation and technical reliability of system components as well as after sales service and the availability of spare parts locally.

**Upfront cost barrier.** A barrier to the diffusion of solar irrigation is the relatively high upfront cost of the equipment, that may restrict access to poor populations. The real problem however, is not the cost per se, since the introduction of this solution is meant to lead to increased income, but the availability of the lump sum necessary to purchase.

To overcome the high capital investment, many companies have therefore introduced deferred payment mechanisms for their clients that spread the investment over a suitable period or align it with the moment when the farmer has liquidity—usually the time of harvest. Schemes such as Pay as you go or Lease-to-Own, which allow leasing and payments in instalments are becoming increasingly common. Alternatively, companies might partner with micro-credit institutions or other local financial actors that can provide loans to end users directly. The increased productivity and income, allows smallholder farmers to repay their debt.

In some cases, the need to support the most vulnerable end users remains. Smart subsidies designed in collaboration with the private sector, with a phase out and exiting plan, a differentiated approach linked to the socio-economic status and an accurate communication campaign can play an important role in ensuring inclusion. These can be in the form of conditional cash transfers.

**Financing the supply**. On the supply side, other tools are often used to develop value chains. Companies need funds to invest in their own infrastructure and to offer credit to the end users. Support can come in the form of Results-Based Financing (RBF), where a reward is linked to each sale, and guarantees (e.g. First-Loss Guarantee), where a donor pledges to absorb losses essentially de-risking the companies' investment.

## THE WATER SOURCE

The availability, governance and managing of the water source remain the most important factor to consider when introducing mechanised irrigation. The presence of a reliable and high-quality water source is the first requirement. There must also be sufficient supply for the population to avoid social and environmental issues caused by over extraction. Governments usually have regulations and environmental standards for water abstraction. Any feasibility assessment needs to be undertaken together with local authorities and governmental bodies. Private sector suppliers on the other hand have the experience to estimate the expected water consumption, based on the type and quantity of crop and the most suitable technology and irrigation method (the most common are surface, sprinkler and drip irrigation).

## SOLAR WATER PUMPING IN EGYPT

Almost 90 percent of farmers in Upper Egypt live off the little average annual income of 300 US$ generated from areas of less than 0.4 hectares. Water pumping powered by diesel generators is common, but sharp rises in the cost of fuel and other agricultural inputs, combined to crop loss due to extreme weather events as well as long-term climate change, have impacted farmers' income from agriculture.

In partnership with the Government of Egypt, WFP supports the livelihoods and resilience-building of 280,000 smallholders in 63 villages in Luxor, as well as 4 other governorates in Upper Egypt. In collaboration with local authorities and Community Based Organizations in the area, WFP has established water user associations, promoted the use of improved seeding and enhanced access to markets by establishing digital platforms and reinforcing value chains. In addition, WFP has introduced 10 solar photovoltaic systems powering water pumps with a capacity of 12-60 kW. These provide irrigation services for approximately 33,000 smallholder farmers. The systems consist of solar panels combined with an inverter and other electrical and mechanical hardware. Each installation is backed up by a diesel generator for use in case of cloudy sky if solar radiation alone cannot meet demand.

The amount of water pumped daily by one system in peak season is of approximately 280-500 $m^3/h$. The average production is of 20,000 kg/acre for wheat and 50,000 kg/acre for sorghum. By transitioning from diesel- to solar-powered irrigation systems, farmers have experienced both operational and maintenance cost-savings and reduced crop loss. As a result farmers were able to reduce the use of farming inputs by almost 30% with a positive impact on their economy.

**CLIMATE & DISASTER RISK REDUCTION UNIT**

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**Photo page 1:** WFP/Matteo Cosorich

**Photo page 2: Left:** WFP/Badre Bahaji, **Right:** WFP/Francis Thawani

**Photo page 3:** WFP/Simon Pierre Diouf

**Photo page 4:** WFP/Khaled Chatila