Project Proposal

Topic: Solar Drip Irrigation

Solar (photovoltaic) powered pump systems (PVP) use lifted water for low-pressure irrigation systems like drip irrigation.

Introduction

Modern irrigation systems use pressure to lift and distribute water in pipes or hoses directly to the roots of crops or plants by dripping or to planted areas by sprinkling or spraying. Supplement irrigation supports the natural rainfall and therefore reduces the risk of crop loss and improves yield and quality. Traditional irrigation aliments crops with water in the dry season or in arid regions and is a main factor for the success of agriculture production.

The combination of PV pumps with micro (e.g. drip) irrigation systems is especially suitable in remote areas without connection to the electricity grid. The water is distributed directly from the pump or by gravity from a water tank. If you choose to operate a solar-direct system, use a solar tracker for more steady pressure und volume. Optionally a second pump can be applied for boosting water from a lower reservoir. Any low pressure (drip) irrigation system can be used with PV pumps with proper pump layout and effectuate the most efficient crop production.

Solar drip irrigation systems are simple and straight forward. Once introduced and setup properly, they can be extended easily.

Drip Irrigation

Water is distributed at low pressure (app. 1 bar/15 psi) through pipes, hoses and tapes to the water outlets, so called emission points, and leaves the conveyer by dripping. The results are circular wet areas that surround the rootstock in concentric patterns, similar to onion rings, with different humidity levels. If the emission points are closely distributed, a wetted strip is created, normally used for row crops. One to four emission points

should be used for one plant as big as a fruit tree or grape-vine. At minimum 50% of the individual root zone should be wetted. Please use standard publications on pump design for more information.

Drip irrigation systems achieve the highest water efficiency of up to 90%, reducing water losses by conveying or evaporation. If the drip pipes or tapes are placed below mulch or into the topsoil, evaporation (Eo) losses are close to zero. Subsoil drip irrigation inflicts higher cost for installation, usually by machine, and maintenance, hence application is usually limited to hot spots in industrialized countries.

Another effective, though not essential, application is night irrigation, when evaporation (Eo) is reduced due to lower ambient temperature.

Drip irrigation systems can also be used to distribute fluid fertilizer etc. directly to the roots and hereby increase the efficiency of fertilizer deployment and reduce fertilizer expenses.

Filtering

Since the internal diameters of the drip system piping are very small and tend to clog easily, drip systems needs a water filter and periodical flushing by opening the end closure in order to wash out particles. Water passage can also be clogged or narrowed by particles created in waterborne chemical reactions. The filter system should be dimensioned sufficiently generous to reduce friction losses. Please use disk-filter systems.

Pressure

The design pressure is 1 bar/14.5 psi (equivalent to 10 m hydrostatic head). This is usually measured at a point at one third of the length of the drip line, not at the entrance of the pipe systems and laterals. In practice, the variation is between 0.5 and 2.5 bar, depending on the terrain and surface, e.g. in rolling landscape. The variation in the field should be ±10% as a design standard in relation to pressure or water volume per outlet.

Dripper and emission points have their design flow rate at 1 bar. Normally the average flow rate is between 1-5 l/h. Details are indicated in the manufacturer information.

Depending on water demand of the plants and the Eva-Transpiration losses (ETo), irrigation is only needed during certain hours of the day or week. The total irrigation area, the field or plantation, will be subdivided into sub-units and managed by manual or automatic valves. The sub-units should have approximately the same size and the same water pressure at each inlet (valve). With solar pumps (PVP), the system should only be managed on volume basis, because the pump capacity varies during daytime and due to changing weather conditions.

Time-dependent management is possible, but requires precaution. Nonetheless it is more common due to utilization of standard pump applications.

To manage this system automatically, a water meter and latching valves are used. Latching valves (12 VDC) consume energy only while acting on/off. The water pressure effectuates the actual movement. Solar-powered irrigation controllers are available in the international market. LORENTZ can give support to find an appropriate solar irrigation controller. A battery system will be needed to power the controller and electric valves.

In rural areas, manual management systems are predominant, just using a timer or water meter to determine the delivered amount of water.

Night-time Irrigation

Night-time irrigation by PVP implicates the problem that solar-powered pumps, lacking solar irradiation, cannot operate at night if not amended by costly battery systems. There are the following economical solutions:

Reservoir (tank)

The tank capacity should equal the minimum daily requirement as security stock. The height of the tank installation should be chosen to ensure the minimum pressure in the system. Without filter and short distances, a height of 5 m should be sufficient. In this case the drip line length should not exceed 50 m.

Generator use by night

By night LORENTZ Solar Pump Systems can be used with additional LORENTZ converter and a GenSet to lift additional water. This allows daytime use for direct consumption and filling the reservoir and use at night-time for supplementary irrigation. If needed, an additional booster pump can be deployed.

Water Requirements and Reservoir Sizing

For drip irrigation of an area of 1 hectare (ha) approximately 25-50 m^3/day are needed in a typical irrigation region. The common assumption is that approximately 70% of the area is wetted and 30% remains dry, including walk ways. Variation depends on the plant development and soil type.

Therefore the tank or reservoir should be at least 25-50 m^3 for 1 ha.

For tank height, 5 m is recommended. Some systems work with 3.5 m only, when distances to and within the irrigation area are very short.

Drip line length should be max. 50 m

Filtration should be done, by the incoming water pushed by the well pump.

Outlet: By gravitation with a bigger water meter and bigger pipe diameter to reduce friction losses. Any valve can be used, also electrical ones, if human labour is too expensive.

Examples for a LORENTZ PV Pump System for Drip Irrigation

Like all other pumps, LORENTZ solar pumps are also defined by the vertical lift [H, measured in metres] that must be coped with and the water volume pumped up [Q, measured in m^3/day]. The following examples show standard demands and pumping solutions in drip irrigation (micro irrigation)

Example A

Model:

PS 1200 HR-07 with a 660 W(p) solar generator, 72-96 V DC

(fixed mount, no tracker)

Output:

Volume [Q] = 8.5 m^3/day at a lift [H] = 60 m

With 8,500 l per day you can provide water for the following drip irrigation area:

Eva-Transpiration (ETo)	Drip line spacing	Irrigation area
5.5 mm/day	0.5 m	app. 1,000 – 1,200 m^2 2 greenhouses, each 500 m^2
7.0 mm/day	1.0 m	app. 2,000 – 2,500 m^2

Note: Calculation is based on assumption of 90% efficiency and 30 cm dripper spacing (outlets). Crop water requirements depend on plant development and crop density, as well soil texture. Please use black plastic film (mulch) to reduce evaporation (Eo).

Example B

Model:

PS 1800C SJ5-12 with a 2,100 W(p) solar generator

(fixed mount, no tracker)

Output:

Volume [Q] = 30 m^3/day at a lift [H] = 60 m

With 30,000 l per day you can provide water for the following drip irrigation area:

Eva-Transpiration (ETo)	Drip line spacing (m)	Irrigation area (m^2)
5.5 mm/day	0.5 m	app. 4,000 – 5,000 m^2 8 greenhouses, each 500 m^2
7.0 mm/day	1.0 m	app. 8,000 – 10,000 m^2

Note: Calculation is based on assumption of 90% efficiency and 30 cm dripper spacing (outlets). Crop water requirements depend on plant development and crop density as well soil texture. Please use black plastic film (mulch) to reduce evaporation (Eo).

About LORENTZ

Since more than a decade, LORENTZ successfully produces solar pump systems and solar tracking systems. In R&D, LORENTZ pays special attention to the maintenance-free long-term service of its products. The success of this concept is proven by the daily performance of LORENTZ pumps and trackers in more than 100 countries all over the globe.

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