

Solar Pumping system – 0.5HP 120Vac – Test Report

This report quantitatively documents the tested performance of a solar water pumping system consisting of a specific AC pump powered by solar PV panels in conjunction with a PicoCell controller. Solar PV panels are the DC input for the PicoCell controller and the single or three phase AC pump is connected to the PicoCell’s output, as shown in Figure 1 below. Solar PV panels are connected in series in order to provide the required DC solar power to the PicoCell controller that is generating the appropriate AC output for a specific AC pump.

The PicoCell controller can be used for running any AC pump from solar independent of phase, voltage and frequency. For a given pump specification, PicoCell is capable of generating a true sinewave with a variable frequency range of 30-60Hz. By varying the frequency, PicoCell controls the pumps speed in the range between 50 and 100% of rated speed, depending on the power availability from the solar panels (PV input). It also provides soft start functionality, which can dramatically extend the life of the motor and pump.

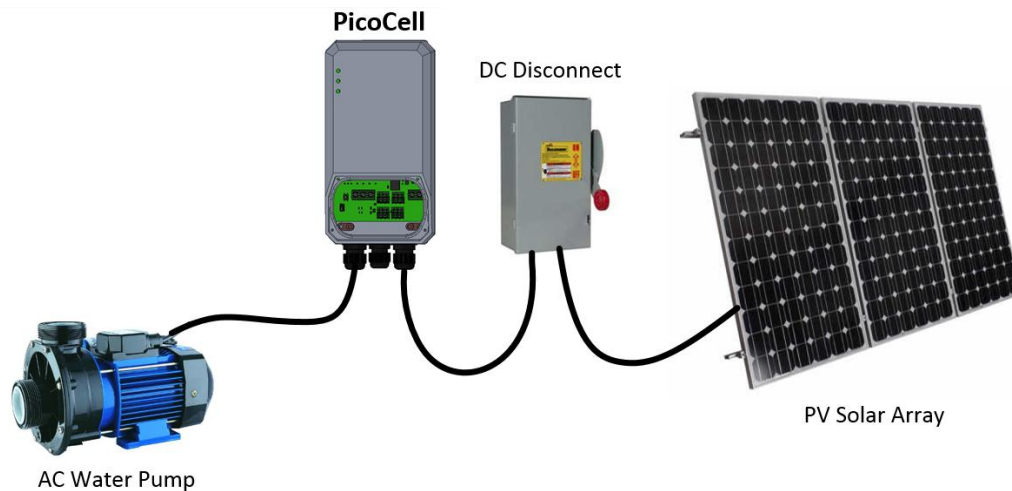


Figure 1: Solar AC pumping system diagram

In this particular setup, a 0.5HP, 120Vac, 60Hz, single-phase (2-wire) pump was tested with the PicoCell controller powered by 4 standard (60cells, 250-270W) PV panels wired in series. The technical specification of the AC pump is provided in the table 1.

Table 1: Technical specification of tested AC pump:

<i>Submersible centrifugal pump: 100QJD3-25/4-0.37</i>			
<i>Power: 0.5HP</i>	<i>Voltage: 110V</i>	<i>Current: 7A</i>	<i>Frequency: 60Hz</i>
<i>Rated head: 25m</i>	<i>Max flow: 3m³/hr</i>	<i>Speed: 3400rpm</i>	<i>MFG# DSJ20160602SS</i>

Interpreting the load curve:

The AC pump was tested for 4 different pressures (heads) versus flow versus solar PV power as shown in Figure 2. For a 23ft head the pump starts at 200W input power only, and provides around 4gpm, but at this head the rated flow is 20.5gpm, at which point the system needs to be powered by 750W solar PV.

For a head of 46ft, the maximum flow is 18.5gpm for the same input solar PV power of 750W, while for a head of 70ft, max flow is 14.5gpm at the same input power of 750W. As a final example, for a 93ft head the max flow is 10.5gpm and it takes 450W of solar PV power to start the AC pump at this head.

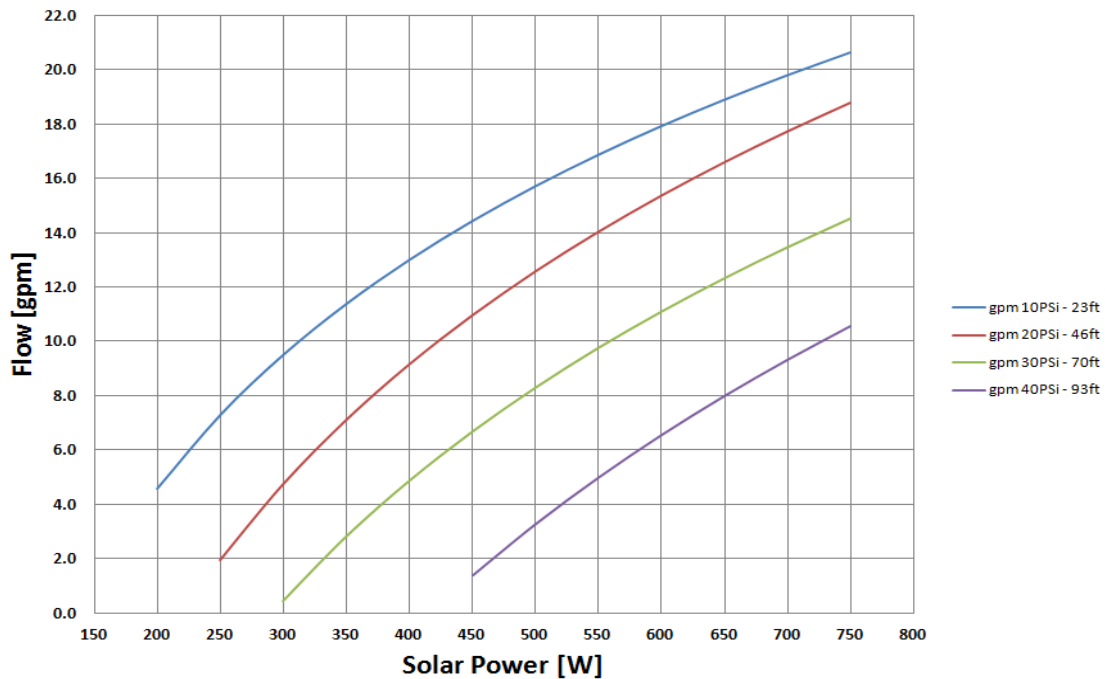


Figure 2: 0.5HP, 120Vac Solar Pump specification – flow vs. solar power for different heads

Depending on the location where this solar system is installed, it will require more or less total PV capacity to achieve these results. There are 6 solar zones that are shown in Figure 3. Zone 6 has the most solar insolation (6-7 kWh/m²/day), while zone 1 has the least amount of sun (1-2 kWh/m²/day).

Figures 4-8 show the cumulative daily water flow for different solar PV installed power, for different world insolation zones. For a given zone, it’s possible to figure out the total solar PV power capacity for the given head and targeted cumulative daily water desired.

For example, from figure 4 (zone 6), if solar PV installed capacity is 1000W the pump will produce 9000 gallons of water for a day for 23ft head, but looking at the figure 6 (zone 4), same 1000W of solar panels will produce 8000 gallons of water. If however same 9000 gallons is required at location in zone 2, then 1600W solar PV system has to be installed.

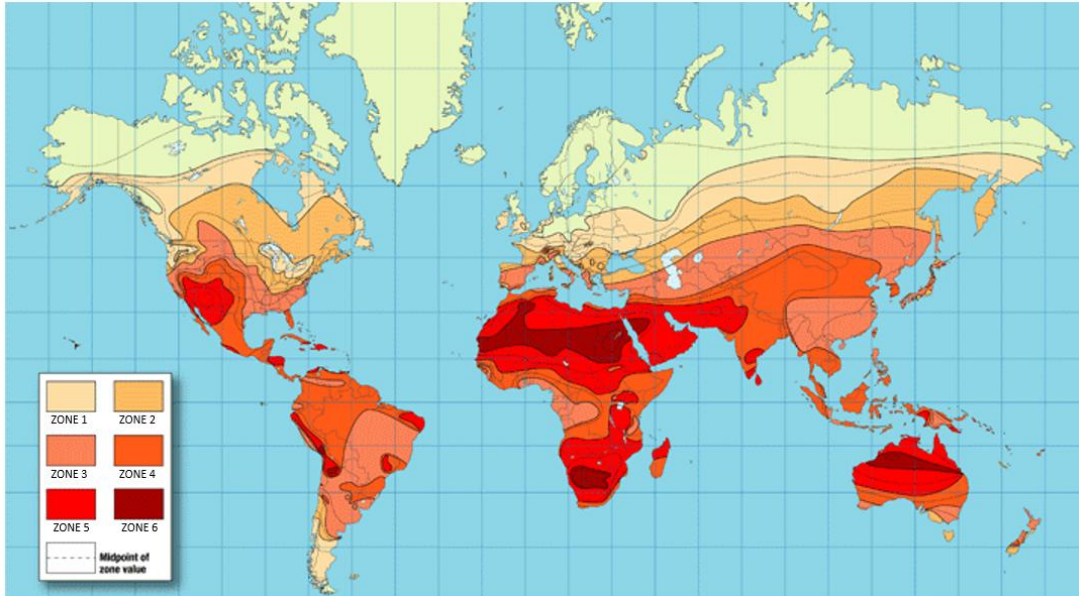


Figure 3: Solar insolation zones in the World

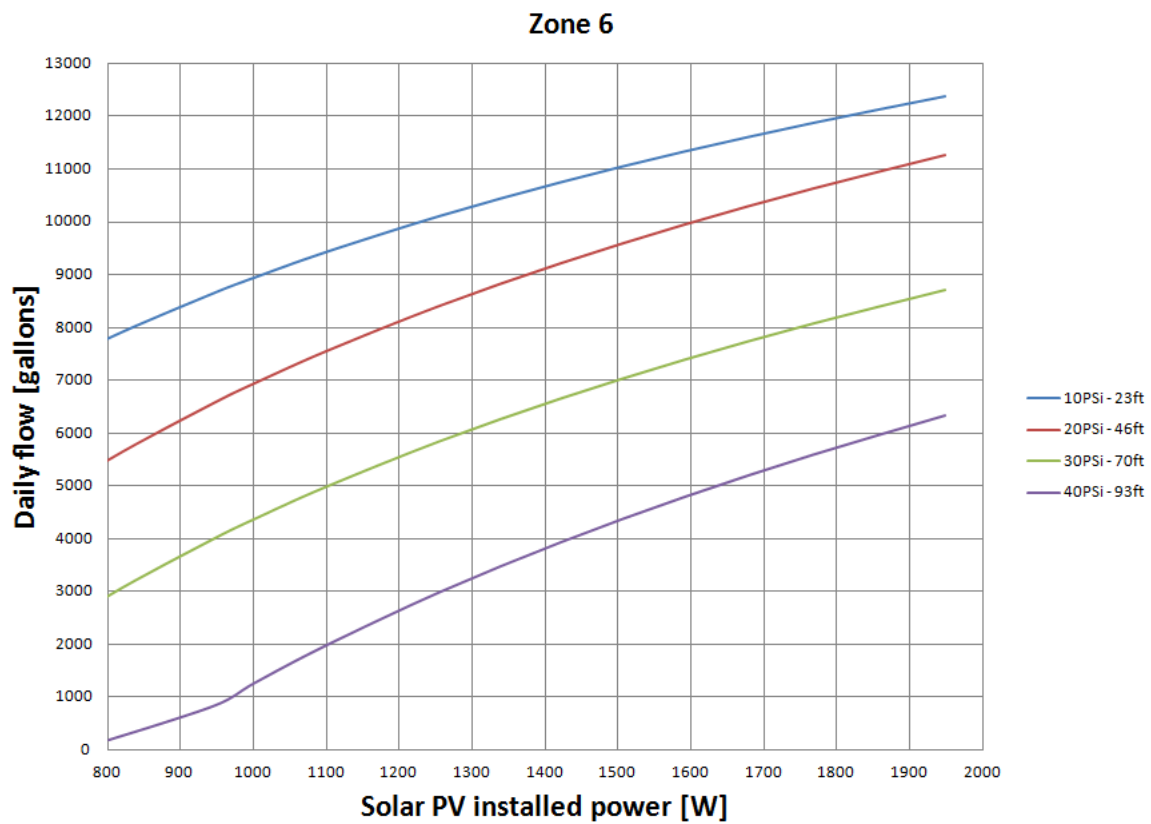


Figure 4: Cumulative daily flow versus solar PV installed power for zone 6

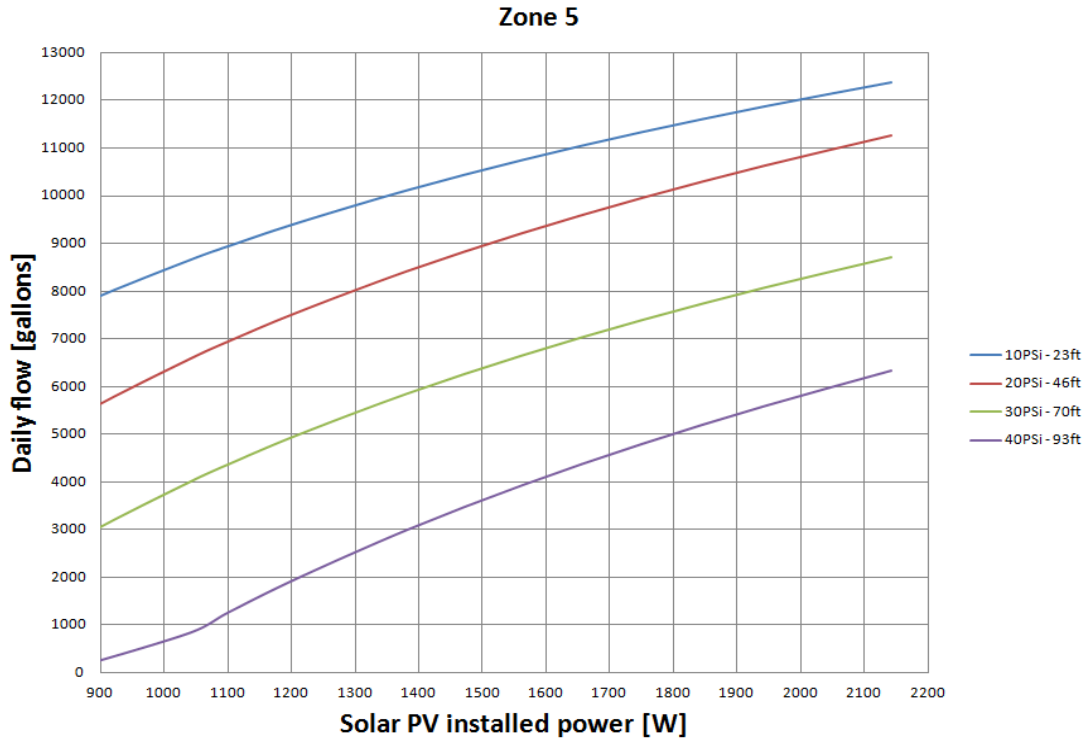


Figure 5: Cumulative daily flow versus solar PV installed power for zone 5

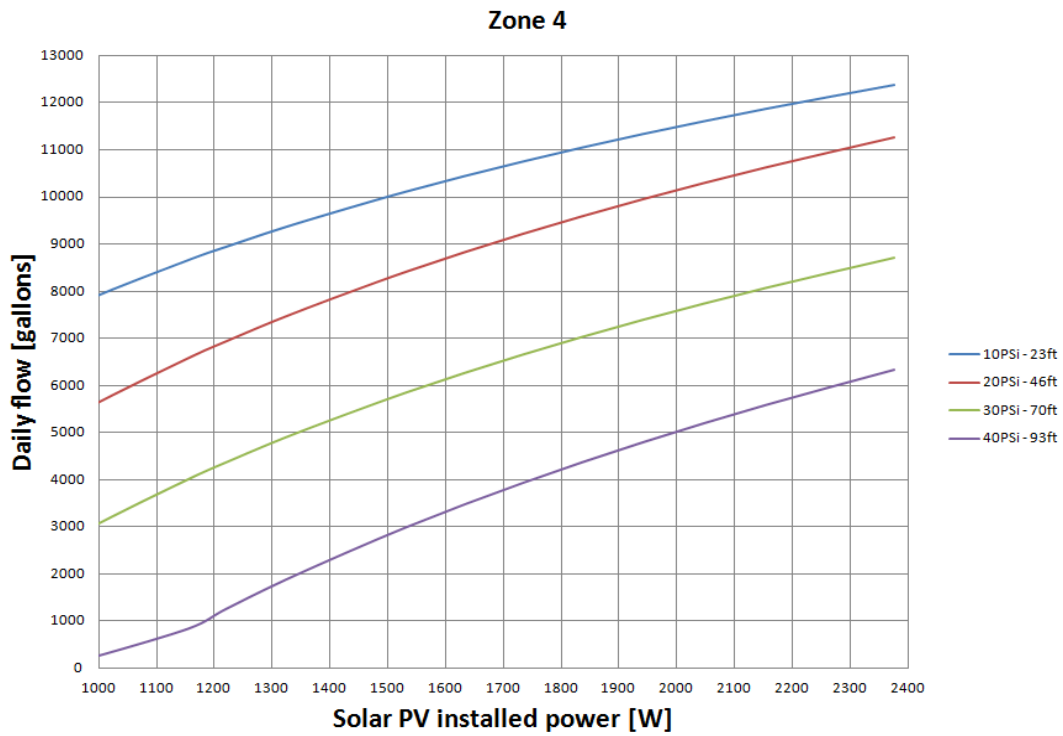


Figure 6: Cumulative daily flow versus solar PV installed power for zone 4

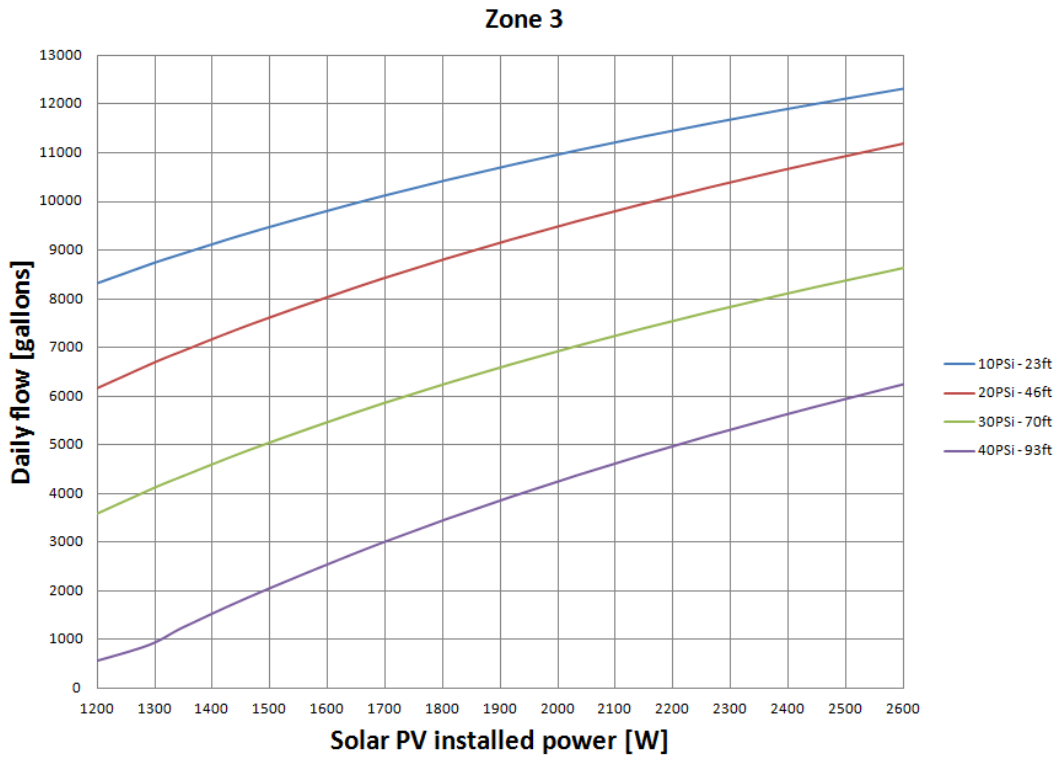


Figure 7: Cumulative daily flow versus solar PV installed power for zone 3

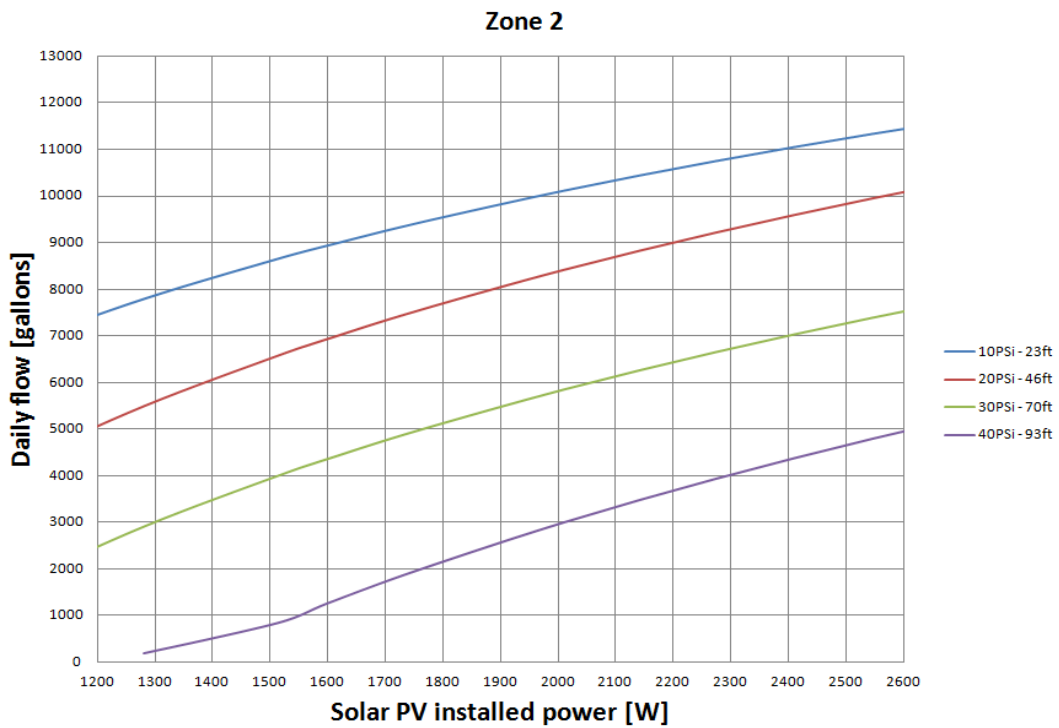


Figure 8: Cumulative daily flow versus solar PV installed power for zone 2

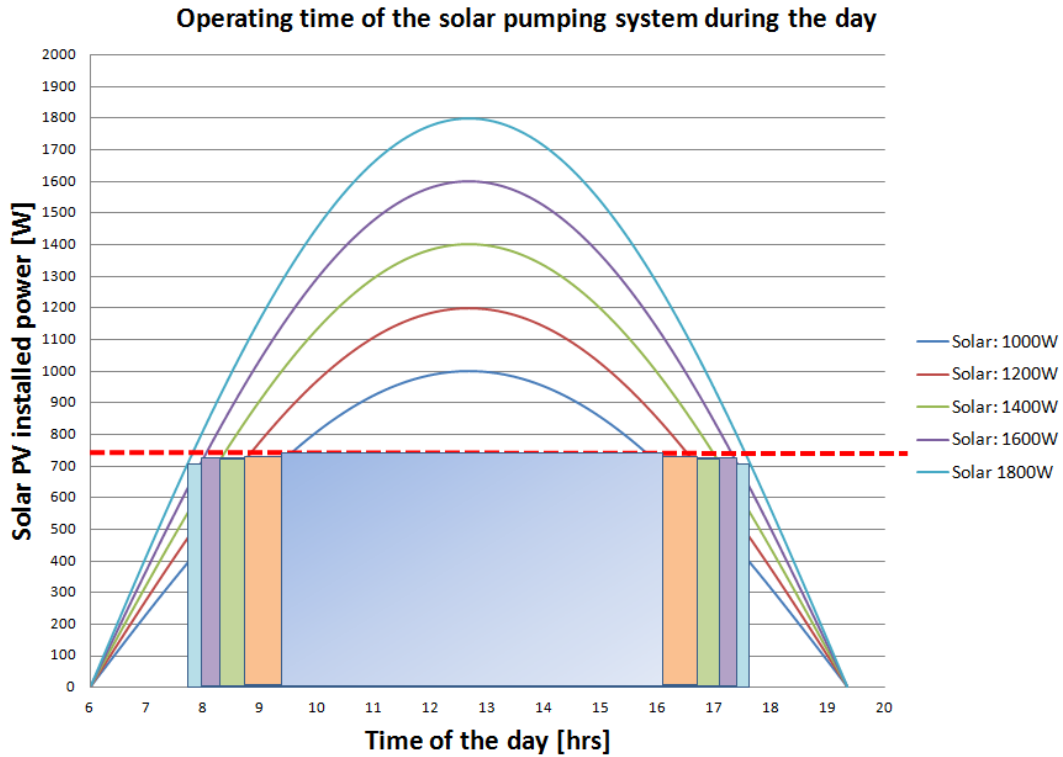


Figure 9: Full operation of the pump during the day for different solar PV installed power

Table 2: Total operation of the solar pumping system for different solar PV installed power

Solar PV installed power [W]	Total operation of the solar pumping system [hrs]
1000	8
1200	9
1400	9.5
1600	10
1800	10.5