Water Storage Tanks in Solar Pumping Schemes

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Water Storage Tanks vs. Batteries

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Water Storage Tanks vs. Batteries

- Tanks store potential energy as pressure when elevated
- Widely available
- Relatively inexpensive
- Simple to operate and maintain

- Batteries store electrical energy
- Increase system complexity
- Expensive
- Maintenance-intensive

Water Storage Tanks…

…allow for periods of instantaneous **demand** throughout the day that exceed the instantaneous **supply**.

…provide **emergency** water storage.

…when elevated, tanks provide **head pressure** to the distribution system downstream.

…provide **contact time** and **mixing volume** for chemicals used to disinfect the water (typically chlorine).

Water Storage Tank Sizing

- Ultimately, water storage tank sizing is a function of how much **risk** is tolerable to the end users.
- More storage volume = less risk but higher initial capital cost
- Less storage volume = more risk but lower initial capital cost

Water Storage Tank Sizing

Ten States Standards, 2018

"The minimum storage capacity (or equivalent capacity) for systems not providing fire protection ***shall be equal to the average daily consumption.*** *This requirement may be reduced when the source and treatment facilities have sufficient capacity with standby power to supplement peak demands of the system…Storage structures should be designed to* ***ensure water age does not exceed five days****."*

Water Storage Tank Sizing

Field Guide to Environmental Engineering for Development Workers, Mihelcic, 2009 (Table 14-2)

Ratio of Minimum Daily Supply to Maximum Daily Demand	Minimum Storage Volume Required
< 1	Source is likely not feasible
1 – 2	50% of maximum daily demand
2 – 3	25% of maximum daily demand
3 – 4	12.5 % of maximum daily demand

Water Storage Tank Sizing

Kenya MWI Practice Manual for Water Supply Services, 2005

*"Generally the tank for the balancing of the daily peak demands will have a capacity of **50% of the daily water demand** of the area served by the tank...Where water is pumped for less than 24h a day, the capacity of the receiving tank will have to be calculated by means of a **mass diagram**."*

Water Storage Tank Sizing

Uganda MWE Water Supply Design Manual, 2013

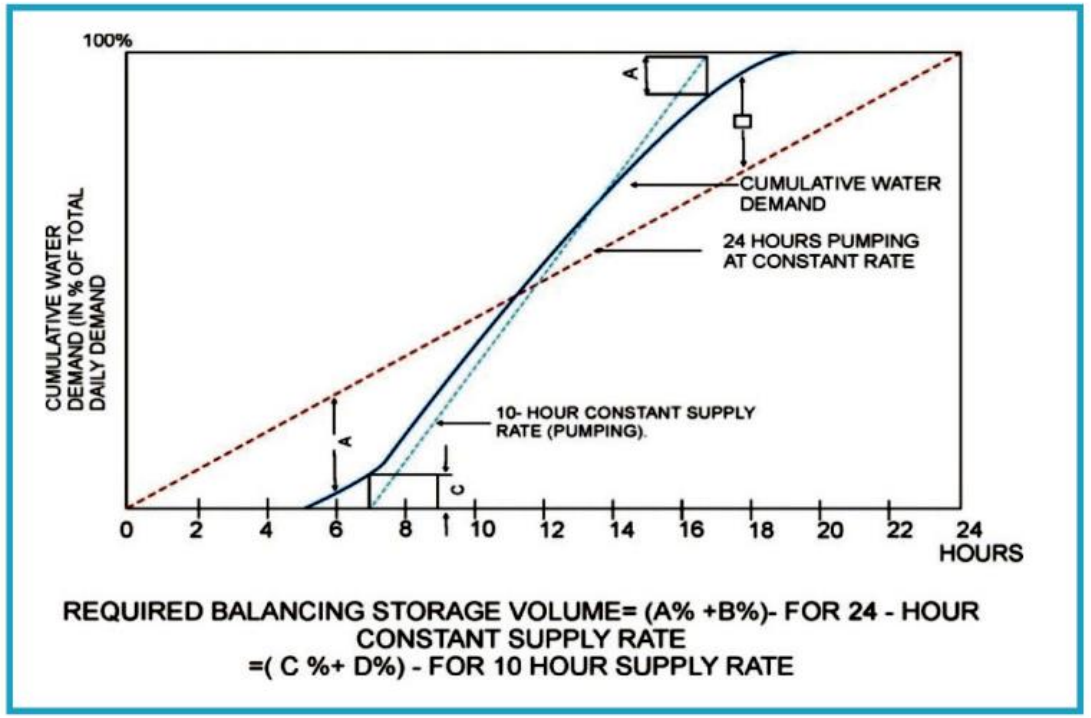


Figure 9-1: Graphical Determination of Required Storage Volumes.

Water Storage Tank Sizing

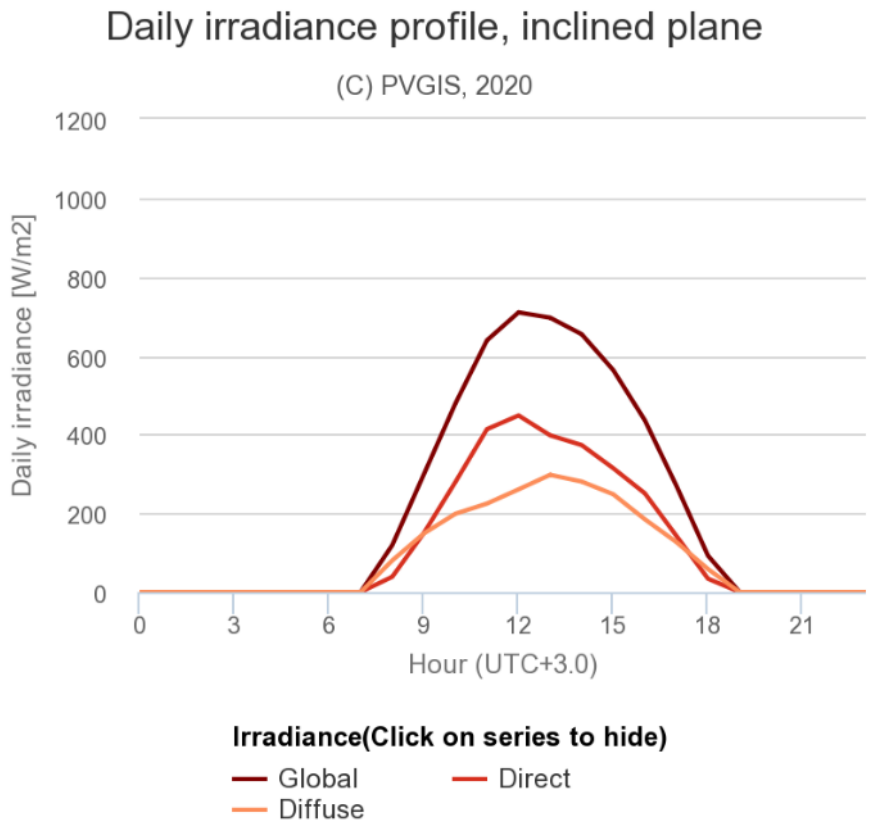
Design Example

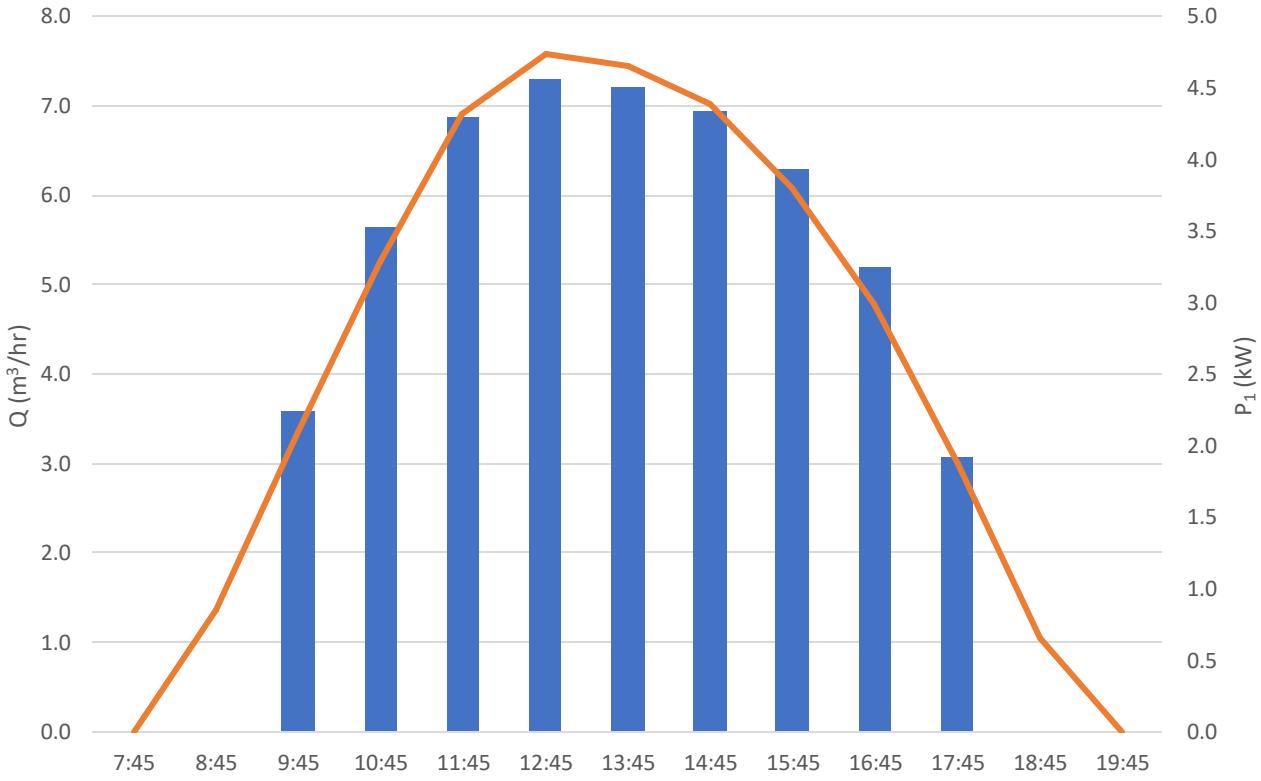
- Population = 2,500
- Average per-capita demand = 20 LPCD
- Average daily demand = 50 m^3/day
- Borehole safe yield = 9 m^3/hr
- Design pumping rate = 9 x 80% = 7.2 m^3/hr
- Head condition = 124 m
- Minimum month irradiation = 4.9 kWh/m^2/day

Water Storage Tank Sizing

Hourly Supply vs. Demand Analysis

- Size solar array given local worst month irradiance and ambient temperature data
- Determine hourly supply in worst month for given array size

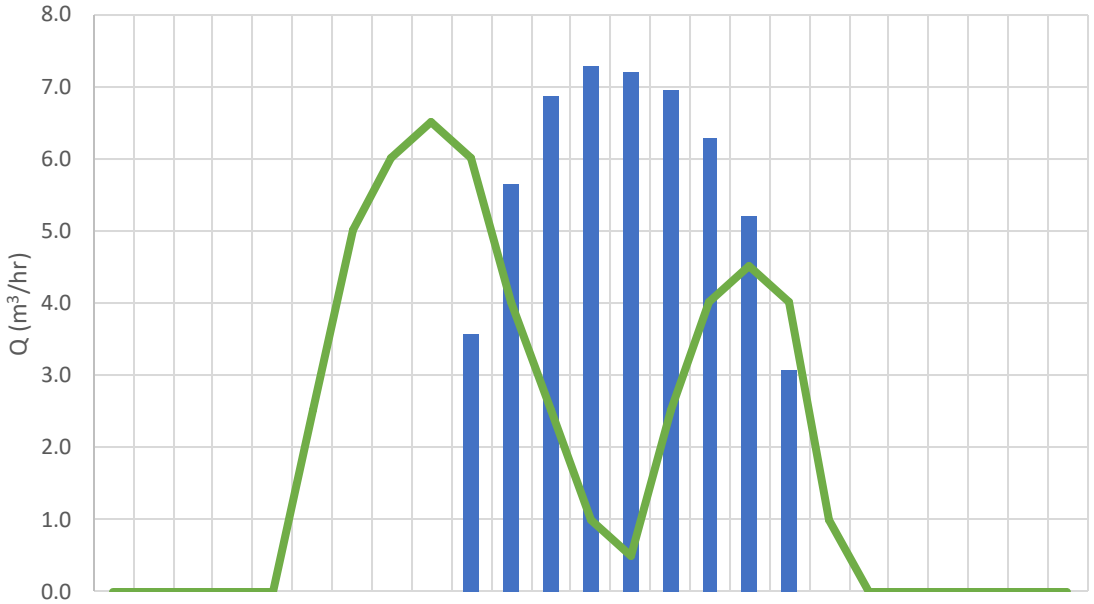


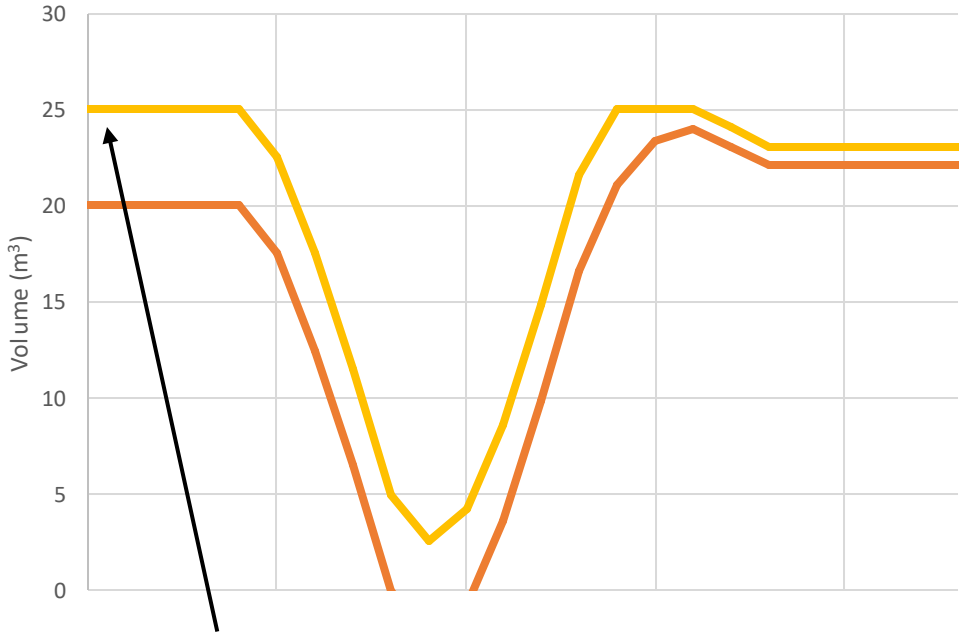


Water Storage Tank Sizing

Hourly Supply vs. Demand Analysis

- Compare hourly supply to hourly demand in worst month
- Determine storage volume required to balance flows
- Determine additional storage volume desired for emergencies, etc.





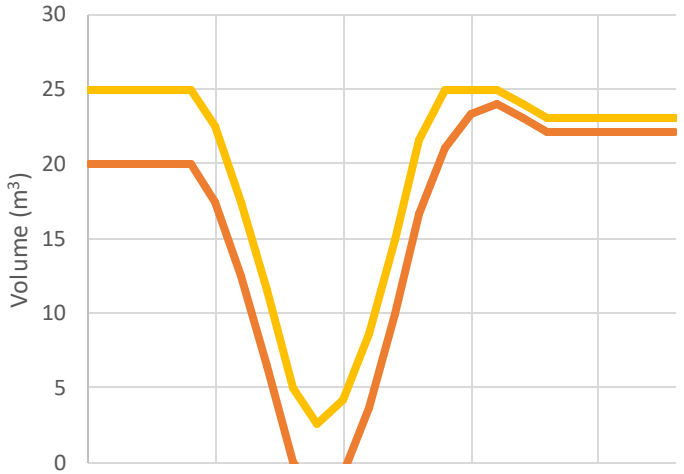
25 m^3 of storage volume ensures that water is available even in the minimum month irradiation condition – recall that this is 50% of the average daily demand in this example.

Water Storage Tank Sizing

- An hourly supply vs. demand analysis is the most precise method of sizing water storage volume requirements for a solar pumping scheme. This method enables the designer to optimize the storage volume for the specific water system. However, this method requires detailed knowledge of the piping system, pump, solar panels, local irradiance and temperature conditions, and hourly diurnal demand.
- A good general rule is to provide a storage volume equal to the daily demand. Where this is not feasible, a minimum storage volume of 50% of the daily demand may be sufficient but should be verified with a detailed hourly analysis.

Water Storage Tank Challenges

- Undersized water storage tanks



- Insufficient storage for peak demand or emergencies

- Oversized water storage tanks

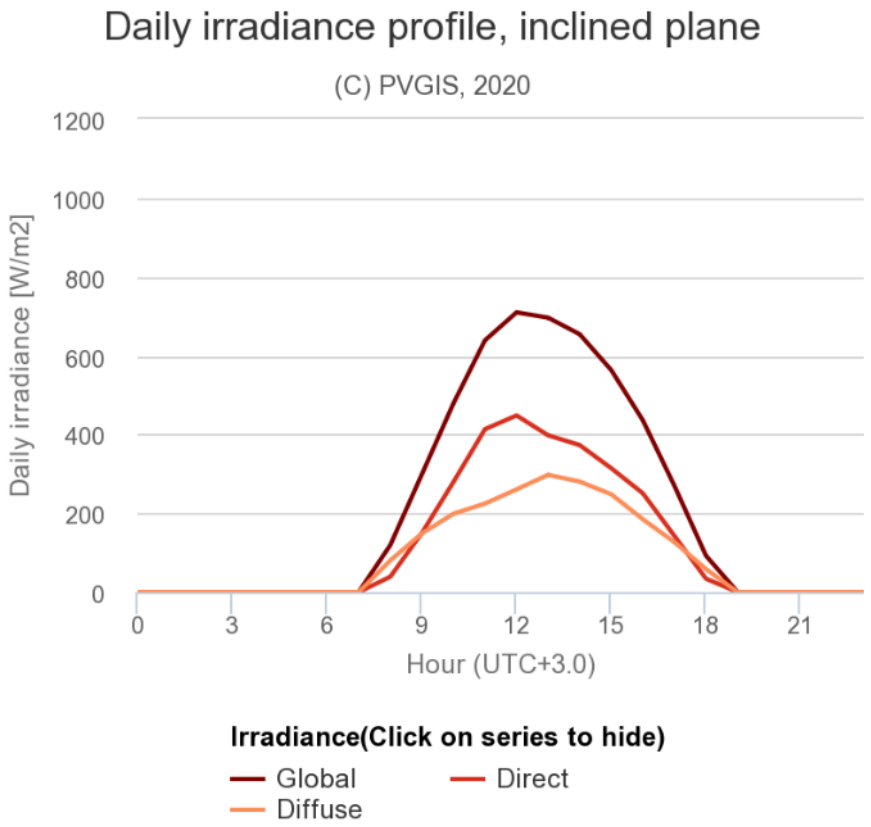
- Significant water age can result in poor water quality

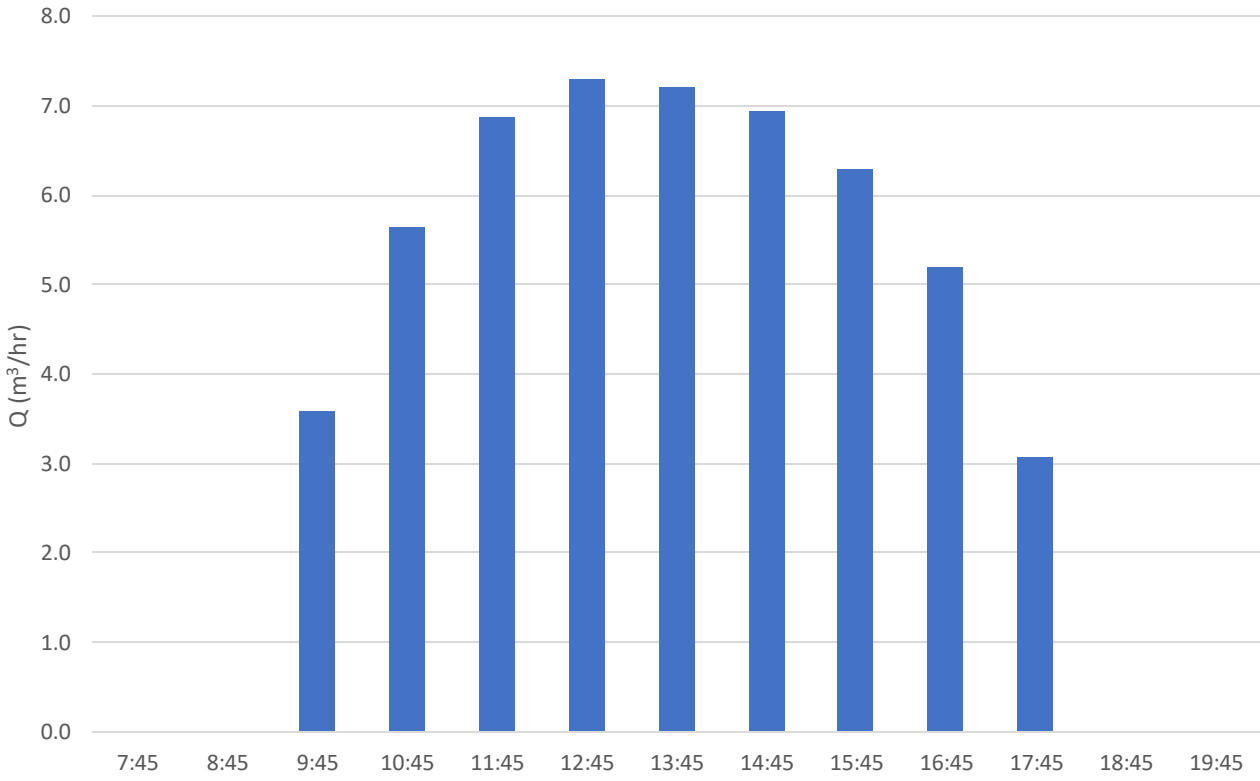
- Water storage tanks not sufficiently elevated

- Insufficient head to the downstream distribution system

Disinfection Challenges

Flow is Variable!





Disinfection Solutions

Tablet Chlorination

Disinfection Solutions

Flow-Activated Chemical Dosing Systems

Disinfection Solutions

Chemical Metering Pumps

Questions?

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