

# SOLUTION

## ENGR290: Renewable Energy

$$500l \frac{min}{30l}$$

### Quiz 6: Energy storage and deferred loads (again)

Dec 3, 2013.

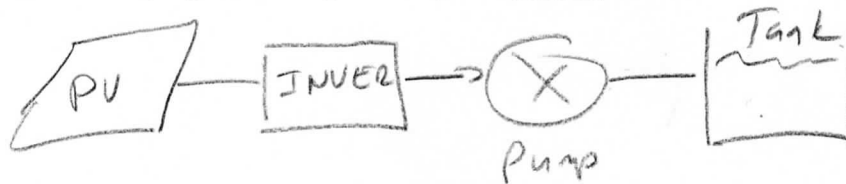
#### Problem 1

Unfortunately, Mr. West relied upon his ENGR290 student's Quiz 5 designs to water his cows and his herd all died painful deaths by dehydration.

Mr. West bought a new herd from the money he was going to use to throw graduation parties for his students, but since they did so badly on Quiz 5, they won't be graduating anyway.

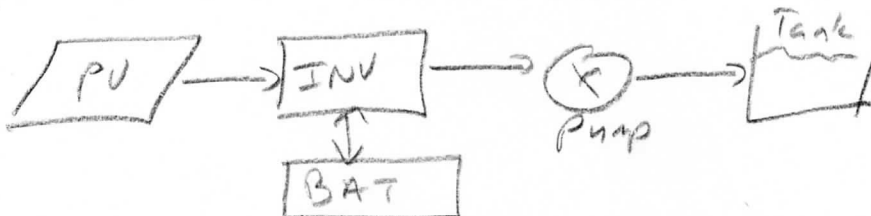
So Mr. West's ranch in Nowhere, New Mexico still has a water well in a remote area that is inaccessible to utility power. To keep his cows from dying of thirst, he needs to keep water in their watering tank at all times. The cows drink 500l of water each day. The well pump burns 900W at 120VAC and pumps 30l/min to the tank. The water tank holds 5000l. The sun is similar to Albuquerque's climate ( $6.4 \frac{kWh}{m^2 day}$ ).

1. On average, how many hours does the pump need to run each day? (hr/day) 0.28 hr/day
2. On average, how much energy does the pump consume each day? (kWh/day) 0.252 kWh/day
3. (a) Draw a block diagram of PV powered system without batteries.



- (b) What is the minimum size for the PV array? (kW) 0.900 kW

4. (a) Draw a block diagram of a PV powered system with batteries.



- (b) What battery capacity would be appropriate to store enough to pump water for 2 days without sun? (kWh) 0.5 kWh
- (c) How big must the PV array be? (kW) 0.040 kW

$$\frac{0.252 \text{ kWh}}{\text{day}} \times \text{day} = 40 \text{ W}$$

$$64 \text{ hr}$$