

ENGR290: Renewable Energy

Quiz 5: Energy storage and deferred loads

Nov 21, 2013.

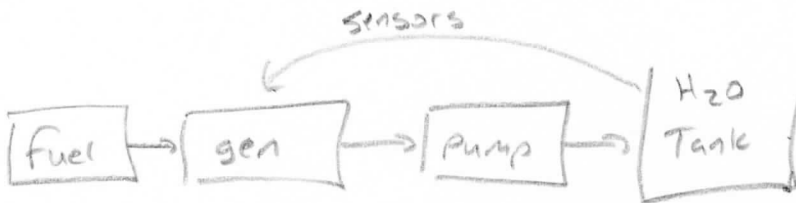
Problem 1

Mr. West owns a ranch out in Nowhere, New Mexico which 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 600l of water each day. The well pump burns 1200W at 120VAC and pumps 50l/min to the tank. The water tank holds 4000l. The sun is similar to Albuquerque's climate ($6.4 \frac{kWh}{m^2 day}$).

$$\frac{600 \text{ l}}{\text{day}} \frac{\text{min}}{50 \text{ l}} \frac{\text{hr}}{60 \text{ min}} = 0.2 \text{ hr/day}$$

1. On average, how much does the pump need to run each day? (hr/day) 0.2 hr/day
2. On average, how much power does the pump consume each day? (kWh/day) 0.24 kWh
3. (a) Draw a block diagram of a diesel generator based system.

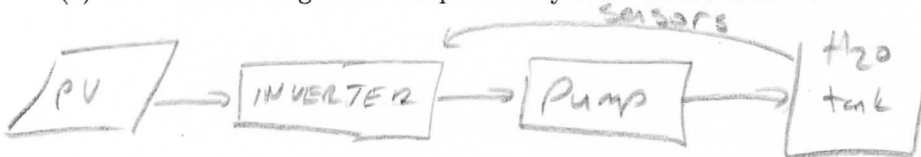
$$0.2 \frac{\text{hr}}{\text{day}} \cdot 1.2 \text{ kW} = 0.24 \text{ kWh}$$



- (b) On what schedule should the generator be run to maximize its efficiency.

Turn on when tank is almost empty
Turn off when tank is full.

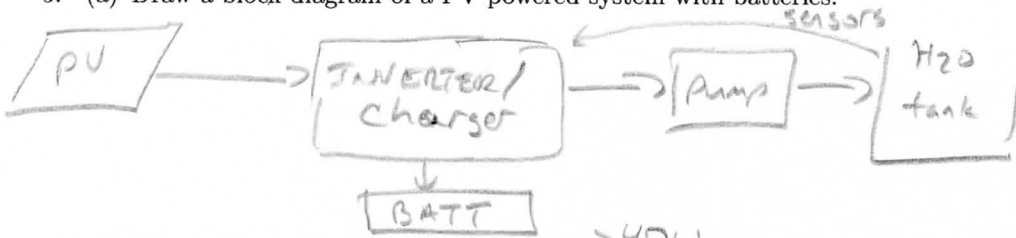
- (a) Draw a block diagram of PV powered system without batteries.



- (b) How big must the PV array be? (kW) >1200W
- (c) On what schedule should the pump run to maximize its efficiency.

On whenever PV power is present and tank is not full

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



- (b) How big must the PV array be? (kW) > 40W
 (c) What battery capacity would be appropriate? (kWh) > 0.24kWh
 (d) On what schedule should the pump run to maximize its efficiency.

run pump whenever battery is charged and tank is not full.

Need 0.24kWh/day, get 6.4h/day of sun

So to meet req we need $\frac{0.24\text{kWh}}{\text{day}} \frac{\text{day}}{6.4\text{h}} = 0.038\text{kW}$

So a 40W panel would do.

Battery needs to store enough to run the pump a reasonable amount of time so somewhere around 0.24kWh is reasonable, and fairly small.