Solar Irrigation

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Our initiative is to design a project which could provide healthy drinking and municipal water for schools in rural communities of sub-Saharan Africa by using solar power.

Providing access to healthy drinking for the youth 3-18 years old can greatly improve the health of a community.

By doing this in conjunction with the schools it can greatly impact the number of children going to and staying in school, and decrease the percentage of illiteracy in a community.

Sudan

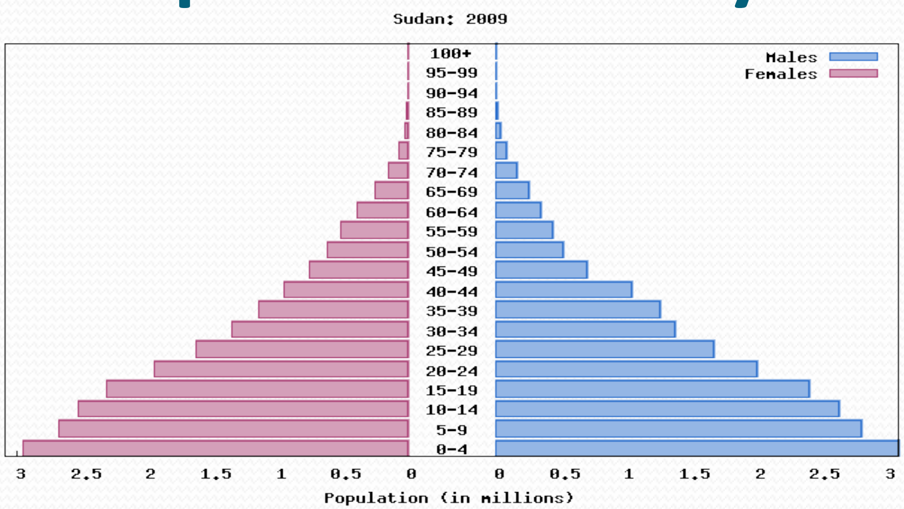
47% of Sudanese do not have access to improved drinking water sources (UNICEF)

Population: 45 million
Area: 2.5 million sq km

Literacy rate for women is about 51% (CIA world fact book @ cia.gov)

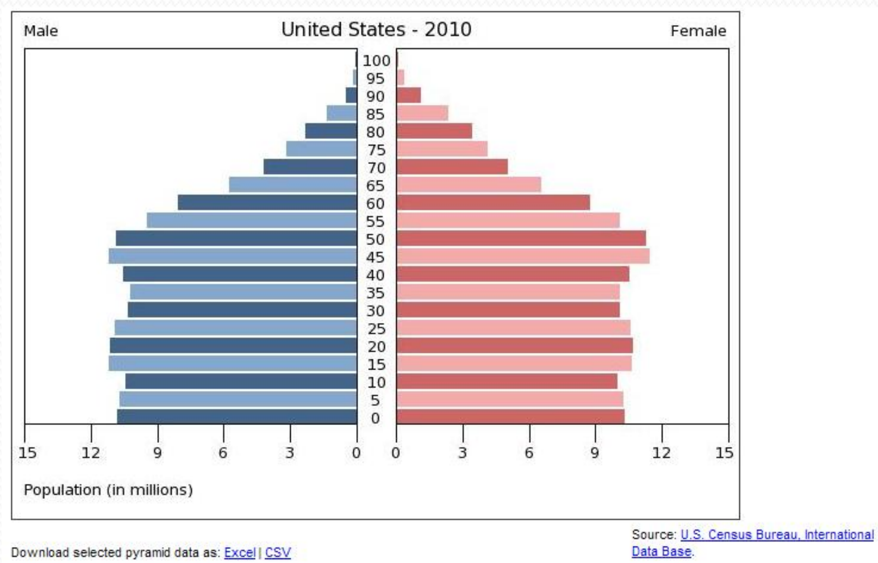
42% of Sudan's population is under 14 years of age (CIA world fact book @ cia.gov)

Population Pyramid for Sudan



This shows a majority youth population in Sudan with 42% under the age of 14

Compare this to the USA which has about 20% of its population under the age of 14



Basic Calculations

These estimations are for rural communities of 1000 people or less. Because these communities are small they are often far from most utilities, like electricity and water. So these communities are in the most need of basic sustainable development.

- 300 Students @ 20l/day = 6000 l per day
- Average Peak Solar Hours (PSH) = 5
- 6000 l / 5 (PSH) = 1200 l/h =.33 l/s

Total Dynamic Head

By looking at much of the terrain of Sudan the average water table depth is estimated at 100 meters. To ensure the well can produce 6000 liters a day we need to drill it at least 25 meters below the water table. I calculate about 15 meters of maximum draw down pumping at this rate.

- Total Vertical Lift (TVL) = 100 m + 15 m (drawdown) + 5m(elevation) = 120m
- Friction head = 7% TVL = 8m
- Total Dynamic Head (TDH) = 128m

Pumps

- We need a pump that can handle a head of 128 meters (425 feet)
- We need a pump that can discharge 20 liters per minute (5 gallons per minute)
- Sunpumps scs 4-550 can pump 4-7 gallons per minute up to a 550 ft head

Panel Sizing

For the panel sizing we used the formula of Total Dynamic Head (TDH) * Liters per second (l/s) * the gravity constant and divided all that by the pump efficiency. Then divided it by the panel efficiency. Then divided it by the wiring efficiency.

$$\frac{128\text{m (TDH)} * .33 \text{ l/s} * 9.81\text{(gravity constant)}}{32\% \text{ pump efficiency}} = 1295 \text{ Wp}$$

- 1295 Wp / 80% panel efficiency = 1619 Wp
- 1619 Wp / 97% wiring efficiency = 1669 Wp
- About 1700 Wp Total

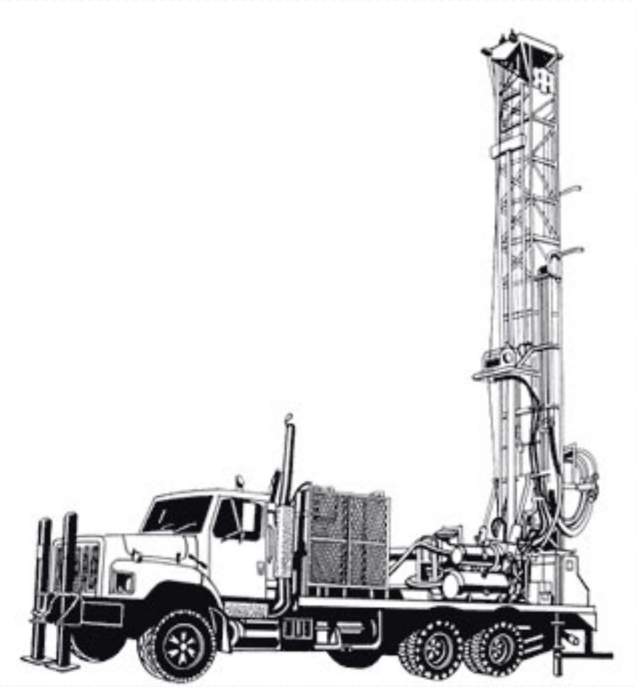
Batteries

It is good to have 3 days worth of power storage incase of cloudy days or solar panel malfunctions. In order to calculate our storage needs we need to convert it to Amp hours (Ah).

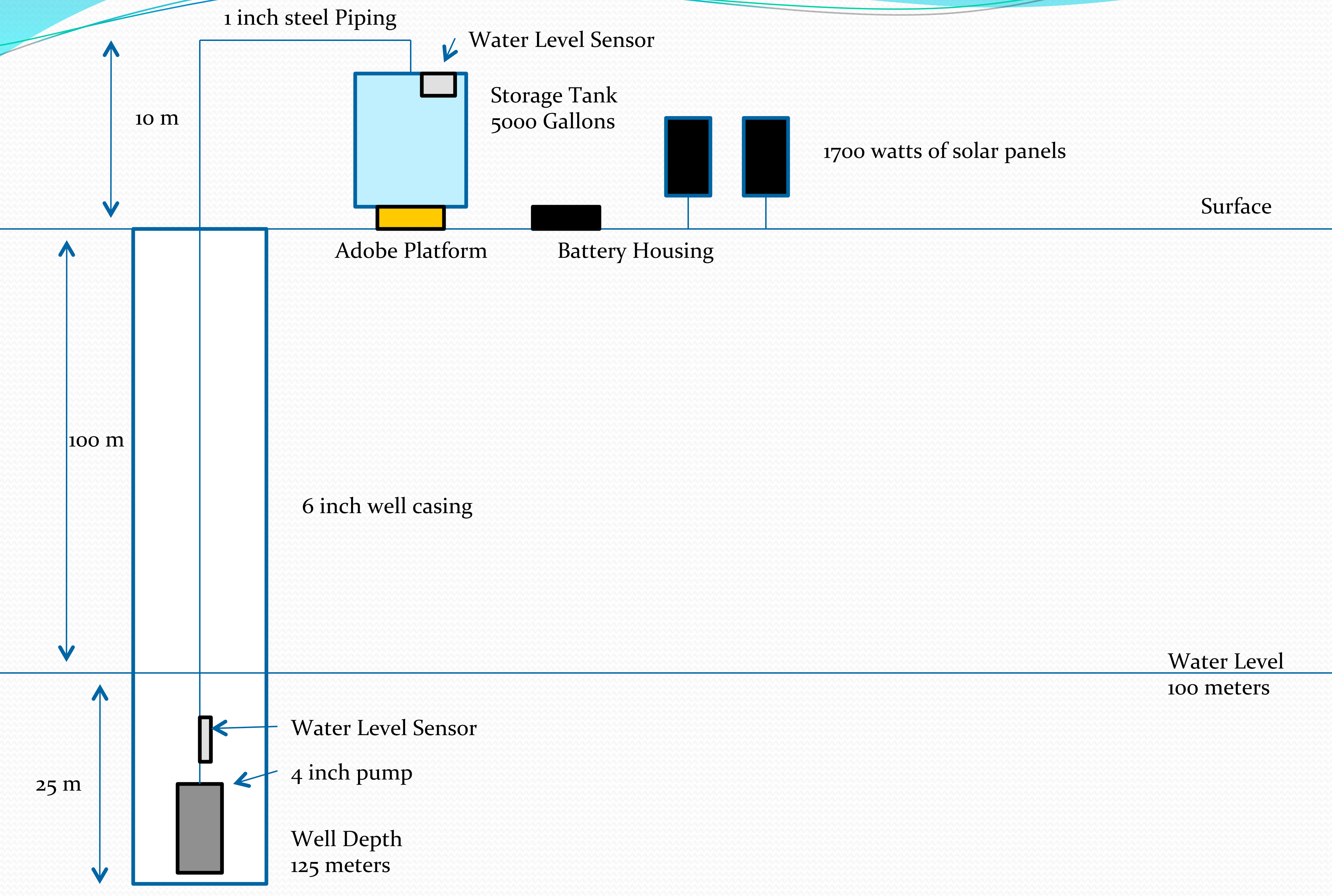
- Battery Capacity (Wp) = 1700Wp (daily load)* 3 days autonomy / 50% depth of discharge = 10200 W
- 10200 W / 12V = 850 Amp Hours (Ah)
- Five 200 Ah batteries gives us 1000 Ah of storage, which should be enough for 3 days of storage.

Well Installation

- 6 inch steel well casing $60 per meter
- Drilling costs $40 per meter (depending on soil type)
- Average cost is about $100 per meter
- Total cost @ 125 meters = $12500



Basic Model


1 inch steel Piping
Water Level Sensor
10 m
Storage Tank
5000 Gallons
1700 watts of solar panels
Surface
Adobe Platform
Battery Housing
100 m
6 inch well casing
Water Level
100 meters
Water Level Sensor
4 inch pump
25 m
Well Depth
125 meters

Material Costs

- SunPumps SCS4-550 (550 ft head, 3-7 GPM, 1440 W) = $2,500
- Sunpumps PCB-180 Controller (2500W) = $1000
- Solar Panels 1700 W @ avg $3/W = $5100
- Mounts for the Solar Panels = $500
- PVC Insulated Pump Wire @ $1/ft (500 ft) = $500
- Water Storage Tank 5000 gal @ $.50/gal = $2500
- Five 200Ah deep cycle batteries @ $400/ea = $2000
- Blue Sky Solar Boost 3048L Controller(1600W) = $500
- Two Blowout Fuse Boxes $50/ea = $100
- Water Well Installation for 125 m @ $100/m for 6 in well = $12500
- One inch steal piping 500 ft @ $4/ft = $2000
- Additional and Miscellaneous Materials = $3000

Total Cost = $32200

Additional Costs

- Labor
- Importing Fees
- Transportation

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These factors can be hard to calculate. We don't know where the nearest drill rig may be. We don't know if there will be local access to all the needed materials. And what it will cost to import everything. That is why this serves as a good pilot project that could be used all over the country. If this project was done in 100 different villages then costs would go down, and it would be more economical to import supplies on a large scale. By working with organizations like the U.N. or charities like charitywater.org this project could be implemented on a mass scale.

Conclusion

- For an estimated $30000-$40000 we could supply a safe and sustainable source of drinking water for schools
- By doing this in conjunction with schools we can help improve the enrollment at these schools
- By providing clean drinking water for the youth it can greatly reduce health risks for them later down the line
- By getting locals involved in the labor it can bring down costs, educate the locals on how to maintain this system, and get them involved in their

References & Resources:

- www.**sunpumps**.com/
- www.**ecobusinesslinks**.com/solar_panels.htm
- http://www.blueskyenergyinc.com/
- http://www.southwire.com/products/SubmersiblePumpCbl.htm
- http://www.tank-depot.com/
- Well information gathered from SCS Contracting, Ft. Wayne, IN