Alternative Power Source to Draw Underground Water

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Team 01

Progress Report

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Contents

1. Fall 2012 CEMEX Project Summary

1.1 Introduction

Figure 1 is an aerial view of the CEMEX mining site located on Babbitt Ranches' land. With the large amount of machines and operations using water, there is a very high demand for water on the site. There is one generator, rated at 60 kilowatts (80 horsepower) that supplies power to the pump. The generator rating is more than adequate to meet the pump's power rating of 45 kilowatts (60 horsepower). This pump supplies water from a depth of 520 meters (1700 feet) below the surface at a flow rate of 0.2838 m^3/min (75 gallons per minute). On average, CEMEX is pumping 30,000 gallons of water per day. Because of the high amount of water being pumped, there is a resulting high usage of diesel fuel. The large amount of diesel fuel being purchased by CEMEX, allows for a lower than average price of $3.50 per gallon of fuel.

FIGURE 1: CEMEX SITE [COURTESY: NASA]

1.2 Needs Identification

On October 11, 2012 the team met with the client Billy Cardasco, President of Babbitt Ranches. Mr. Cardasco identified the combined need of CEMEX and Babbitt Ranches for a new means of providing energy to draw water from wells with depths beyond 800 feet at various well sites throughout Babbitt Ranches' land. The first priority for both Babbitt Ranches and CEMEX is to lower the operating costs of their water pumping systems. In addition, they have also expressed interest in mitigating their carbon emissions. Considering all wells on Babbitt Ranches' property, the well that is utilized by CEMEX is the most demanding design challenge and has the highest diesel fuel usage. Therefore, Mr. Cardasco would like a solution to be found for the CEMEX dedicated well, which then can be applied to other wells that are found throughout the ranch property.

Need Statement: The client is unsatisfied with the cost of fuel as well as the emission penalties required to draw 75 gallons of water per minute from 1700 feet below the surface.

Problem Statement: The client requests a solution that will draw water from 520 meters while maintaining the current flow rate of 0.3 m^3/min and reducing overall cost.

1.3 Constraints

The following is a list of constraints for the project:

1. The pump is required to pump water from 1700 feet.
2. The pump must operate at a flow rate of 75 gallons per minute.
3. The energy system must supply 50 kW of power to the pump.

1.4 Wind Energy

When considering wind turbines as an application for power generation, the average wind speed at a certain site is extremely important for determining the energy potential. This importance lies in the cubic relationship between wind speed and potential power. Figure 2 is a topographic map of the CO Bar Ranchlands where the CEMEX site is located. The boundaries of the CO Bar lie within the regions that contain the colored dots, which indicate watering holes. The map shows the average wind velocity (m/s) profiles that are present in the area. The CEMEX site is specified by the large yellow arrow. It can be seen from the map that the average wind velocity for the CEMEX location is 5.5 m/s, which is insufficient in terms of the standard for ideal power potential for wind turbine placement.

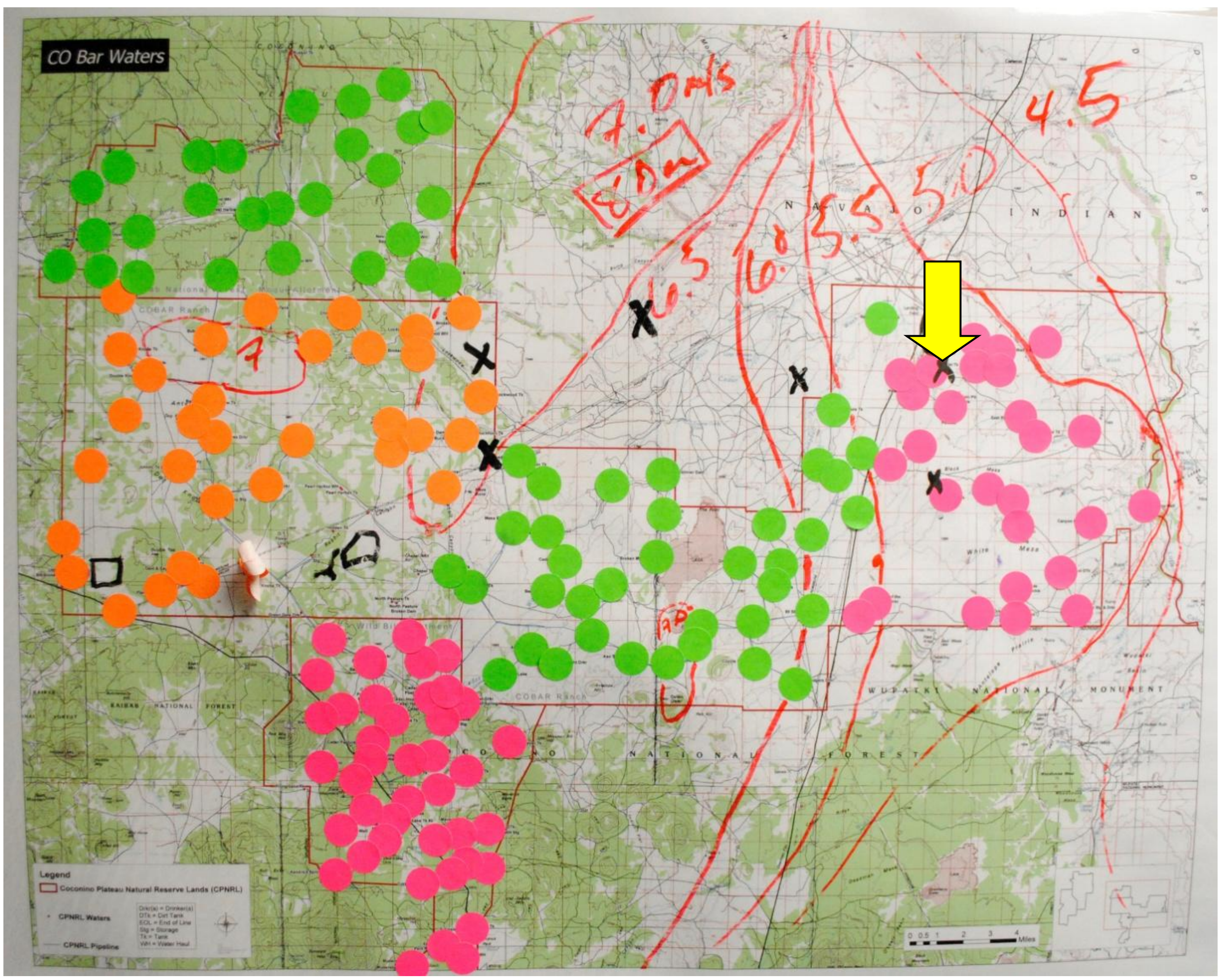

FIGURE 2: TOPOGRAPHICAL MAP OF CO BAR RANCHLANDS [COURTESY: DAVID WILLY]

The average wind speed of 5.5 m/s is helpful for determining a wind turbine(s) that would be required to be able to fully operate the water pump. However, wind turbines are not able to run on minimal amounts of wind speeds. For example, the wind turbine being considered in subsequent analysis to meet the energy requirements is only able to operate on wind speeds greater than 4.5 m/s. Thus, a MATLAB code was written to plot a Raleigh distribution based on an average wind speed of 5.5 m/s. Figure 3 is one result of that code. It displays how the frequency of wind speeds may vary throughout a typical day with an average of 5.5 m/s. Figure 3 illustrates that there would be a large percentage of wind velocities that are less than 4.5m/s, which would be unusable for this operation.

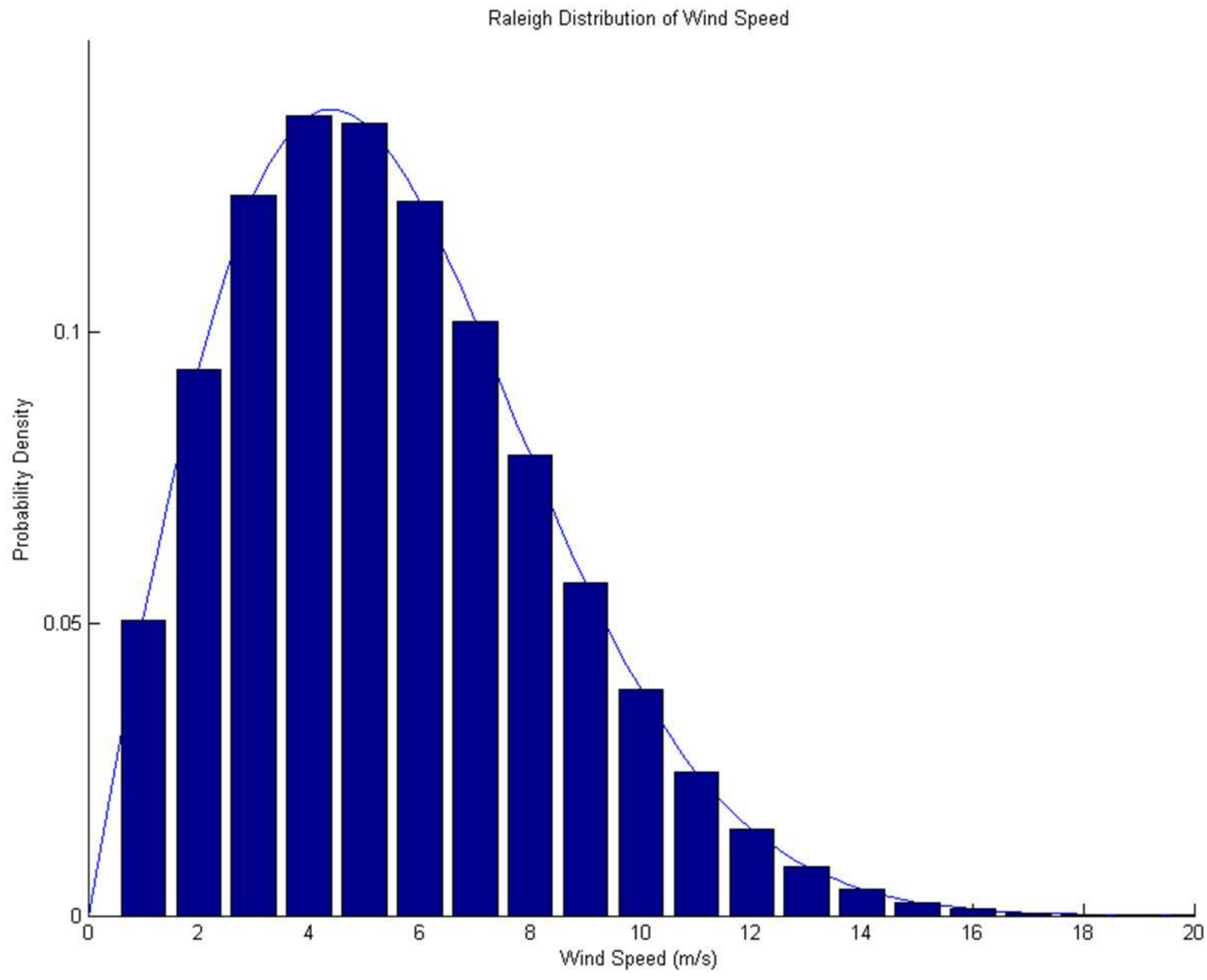

FIGURE 3: RALEIGH DISTRIBUTION BASED ON AVERAGE WIND SPEED

Calculations were then performed to determine the properties of the usable wind that the CEMEX site would experience. These showed that the site would receive usable wind speed (above 4.5 m/s) 64.29% of the time.

A wind turbine's cut in speed is defined as the wind speed that is necessary to provide enough torque to turn the turbine and generate power. For most turbines cut in speed is approximately 4.5 m/s. Additionally, wind turbines do not produce power at their designated power rating until wind speeds reach approximately 14m/s. Figure 4 below shows an idealized power curve for a wind turbine with a 30 m rotor diameter. It shows the amount of power that this particular turbine would output based on the wind speed available. It shows again that the poor average wind speed would provide very low amounts of power comparable to how much power the turbine can actually produce. This would mean that purchasing a turbine would be far overpaying for the turbine's power potential, when only much lower amounts of power are needed.

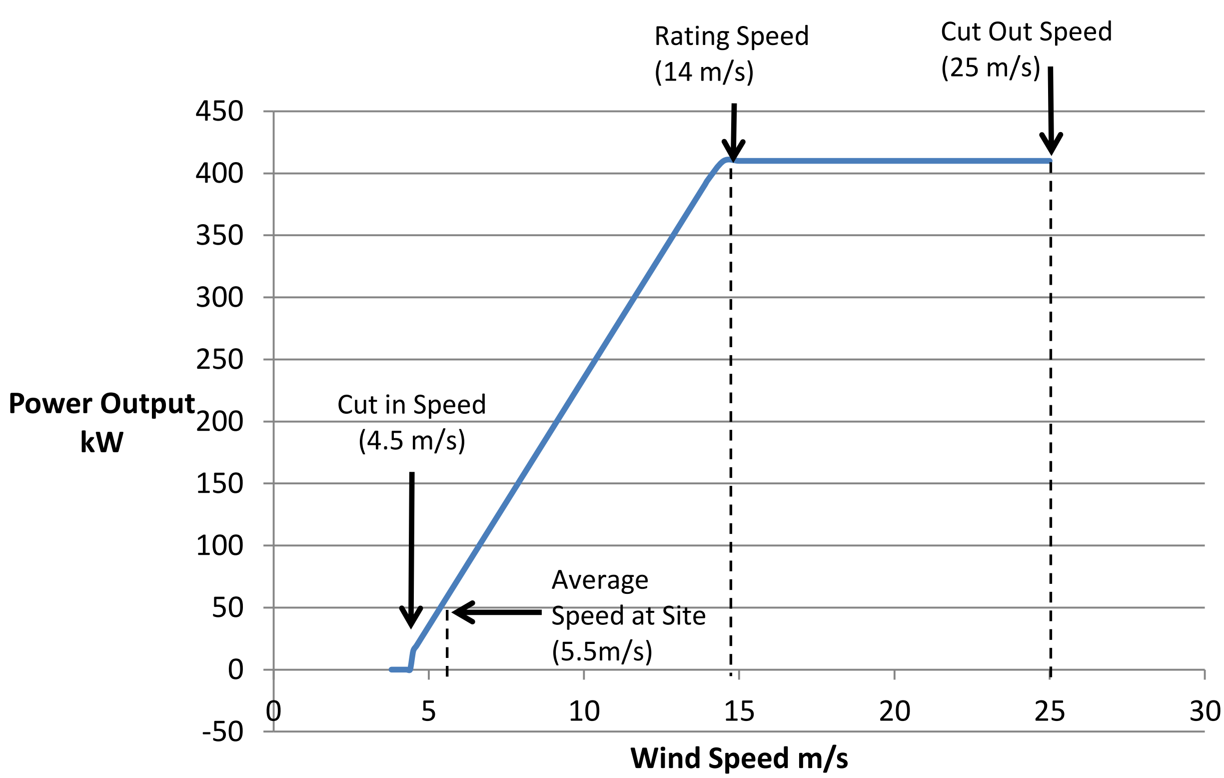

FIGURE 4: IDEALIZED POWER CURVE - 30M ROTOR DIAMETER

1.5 Wind Power Cost

Assuming a turbine of specifications previously discussed and a given average wind speed of 5.5m/s that will meet the energy demands of the client, a cost analysis was performed. The associated cost of a wind turbine of this scale is illustrated in Table 1 which includes a subsidy (30% of installation cost) by the Federal Government for renewable energy projects.

TABLE 1: WIND POWER COST

Estimated Cost	Amount	Units
Average cost of single Turbine	1,250,000.00	$
Installation Cost of Turbine Array	1,250,000.00	$
Federal Tax Credit	375,000.00	$
Net Cost	875,000.00	$

The average wind speed at the location is approximately 5.5 m⁄s. The relatively poor wind speed requires that the wind turbine be oversized to compensate, increasing the cost of installation. Additionally another large problem with a wind turbine would be that a standard diesel generator would have to be fully available, at full cost of fuel and ownership, to meet the power needs of the client if the turbine production was suboptimal. This requirement coupled with the poor average wind speed may prevent the installation of a wind driven power generation system and the associated large capital investment. The team recommends that a wind power resource no longer be considered to meet the needs of the client.

1.6 Solar Energy

Arizona is well known for having an extremely high percentage of days with full sun. Figure 5 shows the average sun resource for Arizona in kWh/m^2/day. The CEMEX site experiences 6.0-6.5 kWh/m^2/day, which is more than adequate for the consideration of solar installation. These values alone indicate that solar may be a highly optimal resource for this application.

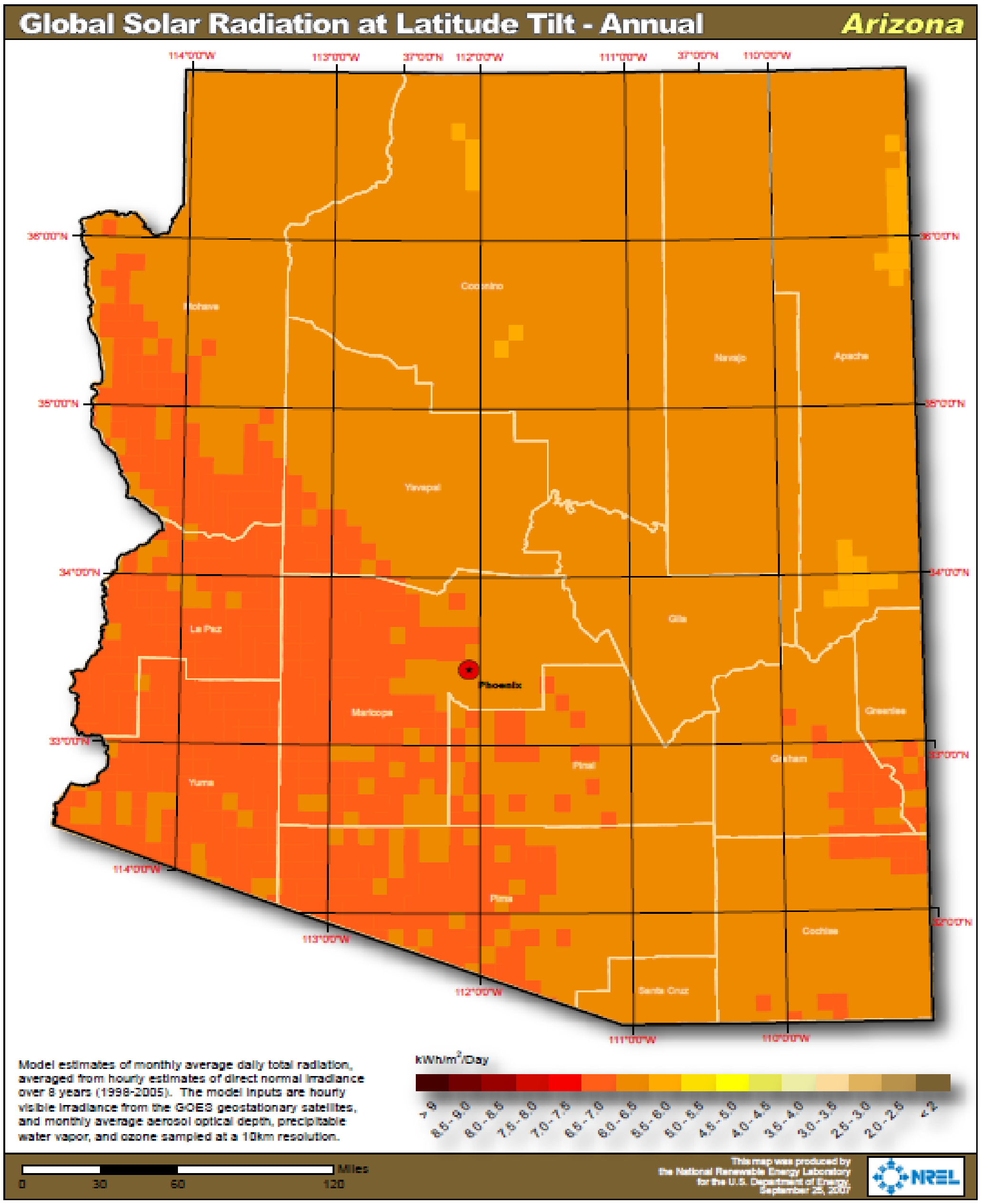

FIGURE 5: SOLAR RESOURCE FOR ARIZONA [COURTESY: NREL]

1.7 Photovoltaic System with Battery Array Cost Analysis

One main idea of how to utilize the resource of the sun was to use a photovoltaic panel (PV) array with a corresponding battery array. The PV panels would capture energy from the sun and either send it to the pump or store it into the batteries for future use. Research has shown that six days of autonomous function are required for systems that are not grid tied. This means that the battery array would need to provide six full days of power when there is no solar resource available for the PV array, such as during long stormy weather. For this to be possible, 384 batteries would be required to match the demand. A wholesale cost estimate of this is $1,300,000 which is comparable to the cost of the entire PV array itself. Additionally, these batteries have a maximum 11 year maximum life. Cost analysis found that there would be an 18 year time period for the batteries to pay back their cost in diesel fuel savings. This shows that it would payback period is greater than the useful life of the batteries. As a result, the team recommends that a solar array with battery backup no longer be considered to meet the needs of the client.

1.8 Photovoltaic System with Diesel Backup Cost Analysis

Various metrics were calculated to understand the performance of a solar array as compared with the current diesel generator system. The following shows the results of calculating cumulative cash flow at the optimum system size. The system was optimized to provide 100% of the pump's energy requirements given perfect weather conditions. To ensure that the pump could deliver 30000 gallons of water per day, the system was oversized to account for the changing angle of the sun. However, cloud cover may dictate that the system is unable to produce the power the pump requires and thus the pump would have to rely on the diesel generator. Various assumptions were made in calculating the performance of the system (Table 2). One assumption that must be noted is the annual increase in fuel price is 2.5%. The team's research indicates that this is a conservative annual fuel price increase.

TABLE 2: ASSUMPTIONS

Assumptions	
Factor	Assumption
Solar Resources	Assumed solar irradiance value of 900 watts per square meter
Panel Contamination	Cleaned frequently: 98% sunlight transmission
Temperature	System operates at average temperature of 25C
Orientation	South facing array: Tilted at optimal angle for given latitude
Shading	Array can provide power for 80% of available hours per year
Energy Delivered	Various system losses: Delivery is 81%
Fuel Price	Diesel fuel will rise 2.5% annually
Diesel Generator	Generator must be available to ensure power demands are met

The cumulative cash flow for the project can be seen in Figure 6. The project will have a payback period of greater than 20 years. With an annual fuel price increase of 2.5% the fuel savings are not sufficient to offset the project cost.

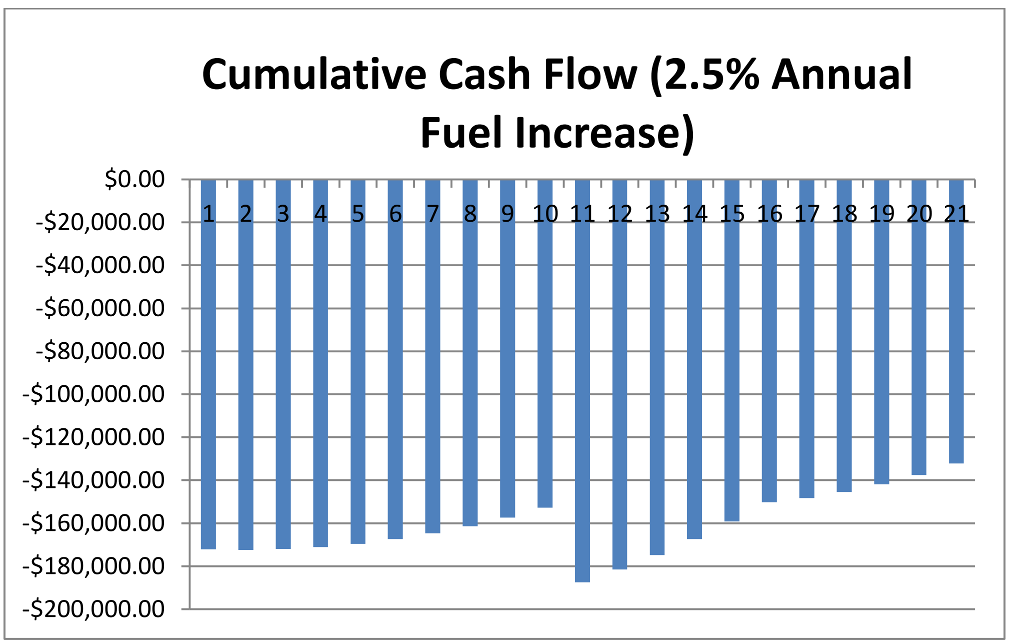

FIGURE 6: CULUMLATIVE CASH FLOW

The payback period for the previous iteration of the project was found to be suboptimal. The team discovered that an annual fuel price increase of 4.5% brought the project payback period into a reasonable timeframe. The team's reevaluation of assumptions is illustrated in Table 3.

TABLE 3: ASSUMPTION REEVALUATION

Assumptions	
Factor	Assumption
Solar Resources	Assumed solar irradiance value of 900 watts per square meter
Panel Contamination	Cleaned frequently: 98% sunlight transmission
Temperature	System operates at average temperature of 25C
Orientation	South facing array: Tilted at optimal angle for given latitude
Shading	Array can provide power for 80% of available hours per year
Energy Delivered	Various system losses: Delivery is 81%
Fuel Price	Diesel fuel will rise 4.5% annually
Diesel Generator	Generator must be available to ensure power demands are met

The associated system configuration necessary to meet the power demands of the pump can be seen in Table 4.

TABLE 4: ESTIMATED SYSTEM SIZE

Estimated System Size	
Solar Rating Northern Arizona (Watts-per-square meter)	900
Panel Efficiency	15%
System Efficiency	81%
Number of Panels	420
Equivalent Area Required (square meters)	504
System Power Delivered (kilowatts AC)	55.34

The team created a MATLAB program which would take these inputs, as well as local weather and sun conditions, to create a plot of the total energy the PV panels are able to output as a function of the hour of the day. This plot is shown below in Figure 7.

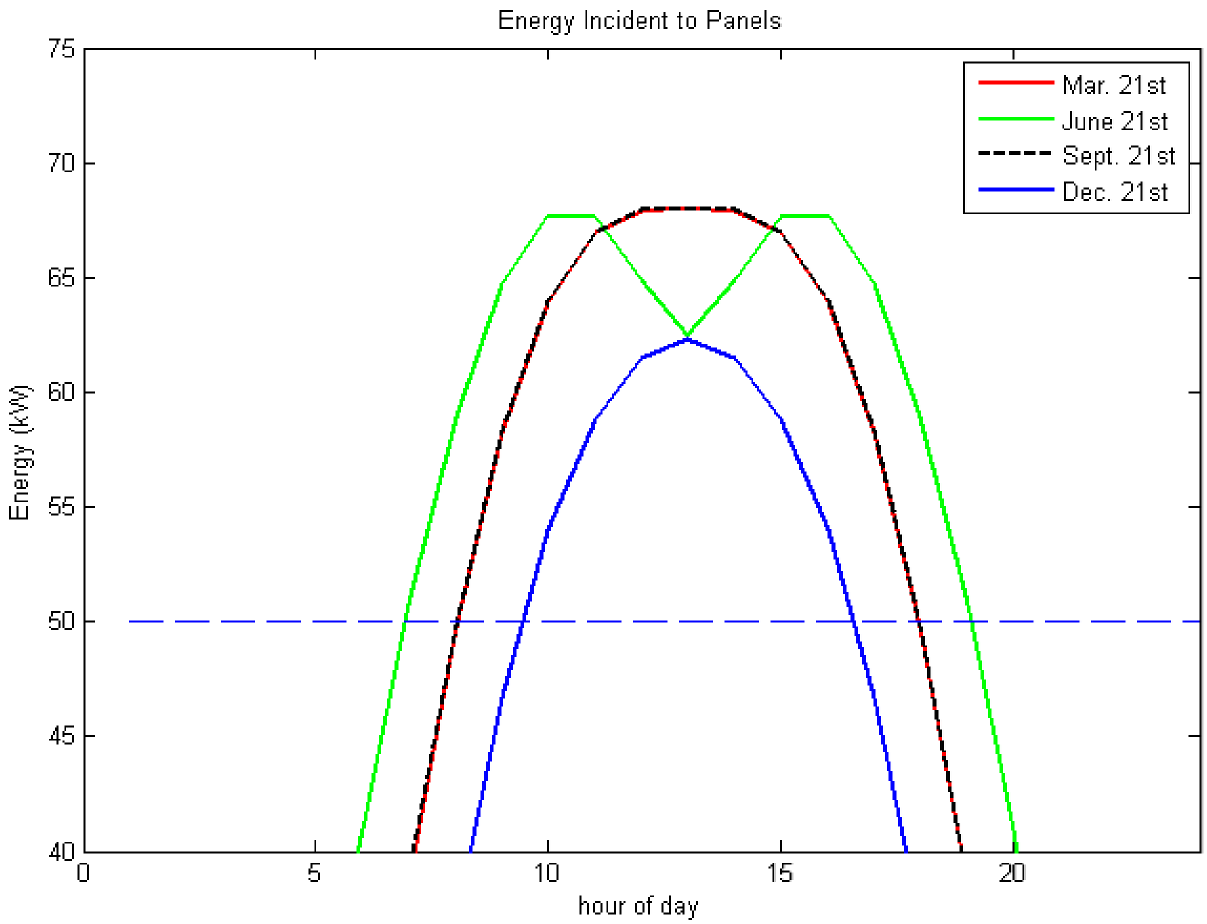

FIGURE 7: ENERGY AVAILABLE TO PV ARRAY VERSUS HOUR OF DAY

The estimated system cost is based upon average system a cost of similar size is shown in Table 5.

TABLE 5: ESTIMATED SYSTEM COST

Estimated System Cost	
Average Cost per Watt (AC):	$7.00
System Installation Gross Cost	$387,368.81

Financial Incentives at the time of installation are shown in Table 6. Refer to Cumulative Cash Flow in Table 8 to see incentives span the life cycle of the array of 20 years. A number of incentives for renewable energy installations exist. The few listed are applicable for an off-grid installation in Arizona of the rated size.

TABLE 6: FINANCIAL INCENTIVES

Financial Incentives	
Federal Tax Credit (30% of cost)	$116,210.64
State Credits corporate (10% of gross cost)	$38,736.88
Utility Credits APS Utility rebate ($1.35 per Watt AC)	$74,706.84
AZ solar energy production tax credit ($0.01 per kilowatt-hr)	$25,566.34
ESTIMATED NET COST	$132,148.10

Figure 8 is the summary of the cumulative cash flow the installation can expect over time. The annual net cash flow is the total cash after all costs are summed with all incentives, fuel savings, and tax effects. Cash Flow breakeven is where the chart crosses the $0 point. The chart illustrates that the project will have a payback period of approximately 19.5 years (column 1 represents cash flows at installation i.e. year zero, therefore column 20 is representative of year 19).

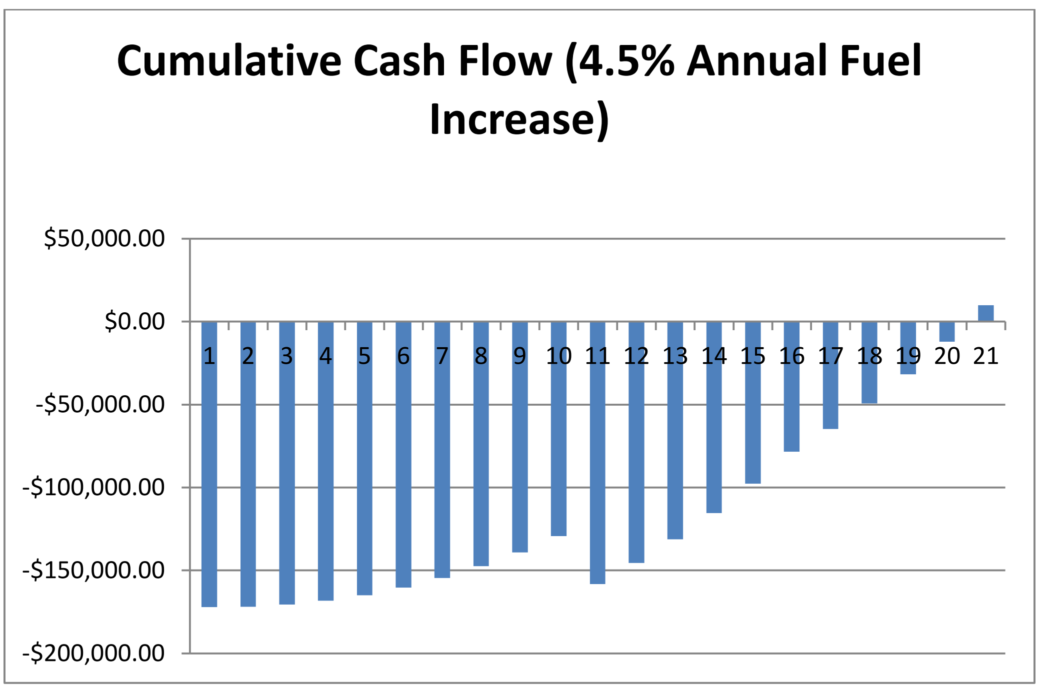

FIGURE 8: CUMULATIVE CASH FLOW

Financial and environmental benefits of the solar array are listed in Table 7.

TABLE 7: SAVINGS AND BENEFITS

Savings And Benefits	
Average Monthly Fuel Savings (20 year life)	$3,797.16
Average Annual Fuel Savings (20 year life)	$45,565.94
20 Year Fuel Savings	$911,318.75
Levelized cost of Solar Energy for Installation ($/(kW-hr))	0.49
CO2 Saved over lifetime of array (Tons CO2)	1,628.19

Cash flow and cumulative cash flow by year is illustrated in Table 8. The current year's value of cumulative cash flow is the sum of the previous year's cumulative cash flow and the current year's annual cash flow.

TABLE 8: CUMULATIVE CASH FLOW BY YEAR

Year Of Operation	At Installation	1	2	3	4
Gross Installation Cost	-$387,368.81	$0.00	$0.00	$0.00	$0.00
Federal Tax Credit (30% of cost)	$116,210.64	$0.00	$0.00	$0.00	$0.00
AZ solar energy production tax credit	$25,566.34	$0.00	$0.00	$0.00	$0.00
State Credits corporate	$38,736.88	$0.00	$0.00	$0.00	$0.00
Utility Credits APS Utility rebate	$74,706.84	$0.00	$0.00	$0.00	$0.00
Tax Savings from 15 year straight line	$0.00	$7,747.38	$7,747.38	$7,747.38	$7,747.38
Diesel Fuel Savings per Year	$0.00	$29,049.33	$30,356.55	$31,722.59	$33,150.11
Annual System Maintenance	$0.00	-$30,000.00	-$30,000.00	-$30,000.00	-$30,000.00
Cost for fuel to run generator	$0.00	-$6,550.34	-$6,845.10	-$7,153.13	-$7,475.02
Generator Purchase (10 year life)	-$35,000.00	$0.00	$0.00	$0.00	$0.00
Generator tier 4 maintenance program	-$5,000.00	$0.00	$0.00	$0.00	$0.00
Annual Cash Flow	-$172,148.10	$246.37	$1,258.82	$2,316.84	$3,422.46
Cumulative Cash Flow	-$172,148.10	-$171,901.74	-$170,642.92	-$168,326.08	-$164,903.62

Year Of Operation	5	6	7	8	9
Gross Installation Cost	$0.00	$0.00	$0.00	$0.00	$0.00
Federal Tax Credit (30% of cost)	$0.00	$0.00	$0.00	$0.00	$0.00
AZ solar energy production tax credit	$0.00	$0.00	$0.00	$0.00	$0.00
State Credits corporate	$0.00	$0.00	$0.00	$0.00	$0.00
Utility Credits APS Utility rebate	$0.00	$0.00	$0.00	$0.00	$0.00
Tax Savings from 15 year straight line	$7,747.38	$7,747.38	$7,747.38	$7,747.38	$7,747.38
Diesel Fuel Savings per Year	$34,641.86	$36,200.75	$37,829.78	$39,532.12	$41,311.07
Annual System Maintenance	-$30,000.00	-$30,000.00	-$30,000.00	-$30,000.00	-$30,000.00
Cost for fuel to run generator	-$7,811.40	-$8,162.91	-$8,530.24	-$8,914.11	-$9,315.24
Generator Purchase (10 year life)	$0.00	$0.00	$0.00	$0.00	$0.00
Generator tier 4 maintenance program	$0.00	$0.00	$0.00	$0.00	$0.00
Annual Cash Flow	$4,577.84	$5,785.21	$7,046.91	$8,365.39	$9,743.20
Cumulative Cash Flow	-$160,325.78	-$154,540.57	-$147,493.66	-$139,128.27	-$129,385.06

Year Of Operation	10	11	12	13	14
Gross Installation Cost	$0.00	$0.00	$0.00	$0.00	$0.00
Federal Tax Credit (30% of cost)	$0.00	$0.00	$0.00	$0.00	$0.00
AZ solar energy production tax credit	$0.00	$0.00	$0.00	$0.00	$0.00
State Credits corporate	$0.00	$0.00	$0.00	$0.00	$0.00
Utility Credits APS Utility rebate	$0.00	$0.00	$0.00	$0.00	$0.00
Tax Savings from 15 year straight line	$7,747.38	$7,747.38	$7,747.38	$7,747.38	$7,747.38
Diesel Fuel Savings per Year	$43,170.07	$45,112.72	$47,142.79	$49,264.22	$51,481.11
Annual System Maintenance	-$30,000.00	-$30,000.00	-$30,000.00	-$30,000.00	-$30,000.00
Cost for fuel to run generator	-$9,734.43	-$10,172.48	-$10,630.24	-$11,108.60	-$11,608.48
Generator Purchase (10 year life)	-$35,000.00	$0.00	$0.00	$0.00	$0.00
Generator tier 4 maintenance program	-$5,000.00	$0.00	$0.00	$0.00	$0.00
Annual Cash Flow	-$28,816.99	$12,687.62	$14,259.93	$15,902.99	$17,620.00
Cumulative Cash Flow	-$158,202.05	-$145,514.43	-$131,254.50	-$115,351.51	-$97,731.51

Year Of Operation	15	16	17	18	19	20
Gross Installation Cost	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Federal Tax Credit (30% of cost)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
AZ solar energy production tax credit	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
State Credits corporate	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Utility Credits APS Utility rebate	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Tax Savings from 15 year straight line	$7,747.38	$0.00	$0.00	$0.00	$0.00	$0.00
Diesel Fuel Savings per Year	$53,797.76	$56,218.65	$58,748.49	$61,392.18	$64,154.82	$67,041.79
Annual System Maintenance	-$30,000.00	-$30,000.00	-$30,000.00	-$30,000.00	-$30,000.00	-$30,000.00
Cost for fuel to run generator	-$12,130.87	-$12,676.76	-$13,247.21	-$13,843.33	-$14,466.28	-$15,117.27
Generator Purchase (10 year life)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Generator tier 4 maintenance program	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Annual Cash Flow	$19,414.27	$13,541.90	$15,501.28	$17,548.84	$19,688.54	$21,924.52
Cumulative Cash Flow	-$78,317.24	-$64,775.34	-$49,274.06	-$31,725.22	-$12,036.68	$9,887.85

The previous analysis shows the high sensitivity of the payback period to the percentage rise in fuel price. The volatility of fuel prices makes it difficult to make an accurate forecast of future prices. Given a modest annual fuel price increase of 2.5% the installation payback period is much greater than 20 years. At a 4.5% annual fuel price increase the payback period approaches an appropriate timeframe for a project of this scale.

1.9 Diesel Generator Analysis

One of the clients' main concerns is the purchase of a new diesel generator to conform to new EPA standards. This factor directly relates to why they are considering alternative energy as means of drawing water before the new emission standards take effect. If an alternative energy system could be designed to draw the water and fulfill the flow requirements of the client, there would be no need to purchase a new generator and potentially, a huge savings on the cost of diesel fuel.

The upcoming Tier 4 Emissions Standards were initiated by the EPA in 2006 for all non-road diesel generator sets. The program introduces a significantly more stringent set of limitations placed on diesel generators to reduce carbon emissions. The program started taking place in 2011 and finalizes in 2015. The time period for conforming to the new Tier 4 standards is indicative of generator size, with larger generator sets required to conform earlier followed by smaller generators to conform by 2015. The following chart illustrates the year in which specific generator sets must comply with the new EPA standards.

EPA Stationary Diesel **Non-Emergency** Genset Emissions Standards

bkW	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
<8gggg	10.5 8.0, 1.0	7.5 8.0, 0.80	7.5 8.0, 0.40		7.5 8.0, 0.60					
8<19	9.5 6.6, 0.80	7.5 6.6, 0.80	7.5 6.6, 0.40							
19<37	9.2	7.5 5.5, 0.60	7.5 5.5, 0.30					4.7 5.5, 0.03		
37< 56 Option 1	9.2	7.5 5.0, 0.40	4.7 5.0, 0.30					4.7 5.0, 0.03		
37< 56 Option 2	9.2	7.5 5.0, 0.40	4.7 5.0, 0.40				4.7 0.5, 0.03			
56<75	9.2	7.5 5.0, 0.40	4.7 5.0, 0.40				3.4, 0.19 5.0, 0.02			0.40, 0.19 5.0, 0.02
75<130	9.2	4.0 5.0, 0.30					3.4, 0.19 5.0, 0.02			0.40, 0.19 5.0, 0.02
130<225	9.2, 1.3 11.4, 0.54	4.0 3.5, 0.20				2.0, 0.19 3.5, 0.02			0.40, 0.19 3.5, 0.02	
225<450	9.2, 1.3 11.4, 0.54	4.0 3.5, 0.20				2.0, 0.19 3.5, 0.02			0.40, 0.19 3.5, 0.02	
450<560	9.2, 1.3 11.4, 0.54	4.0 3.5, 0.20				2.0, 0.19 3.5, 0.02			0.40, 0.19 3.5, 0.02	
560<900	9.2, 1.3 11.4, 0.54	6.4 3.5, 0.20				3.5, 0.40 3.5, 0.10				0.67, 0.19 3.5, 0.03
900<2237	9.2, 1.3 11.4, 0.54	6.4 3.5, 0.20				0.67, 0.40 3.5, 0.10				0.67, 0.19 3.5, 0.03
>2237	9.2, 1.3 11.4, 0.54					0.67, 0.40 3.5, 0.10				0.67, 0.19 3.5, 0.03

FIGURE 9: TIER 4 EMISSIONS STANDARDS-COURTESY WWWW.GENERAC.COM

As can be seen from Figure 19, the 60 kW diesel generator used at the CEMEX site does not need to be replaced until 2015. This being said, it has been difficult to price an exact generator to fulfill the needs of the client because generator manufacturers have released only larger generator sets to conform to the standards that take place in the initial stages of the Tier 4 program.

After contacting generator manufactures, it is assumed, by information given by sales agents, that although no official MSRPs have been released, they cost of a new generator that conforms to the new EPA standards should be comparable to the cost of current generators of equal power, in the range of $35,000-$40,000. Cummings Diesel stated that they offered a Tier 4 maintenance program which guaranteed that if a new generator was purchased that did not currently conform to Tier 4 standards they would overhaul or replace the generator before the standards were set to take effect. The price quoted for this guarantee was $5,000, but it was stated that was only an approximation and not an exact quote.

1.10 Recommendation

Two natural resources were initially considered for a renewable energy system to pump water: wind and solar. The wind resource was found to be insufficient to meet the project requirements. This left solar as the only option. A solar system with battery storage was initially considered so the system could be completely autonomous with no back-up system required. The cost of a battery bank, sized to the project requirements, was found to be cost prohibitive. This left a final option for solar: using an over-sized solar array to power an inverter which would feed electricity directly to the pump during the hours of the day when the solar energy would be high enough to generate the required electricity.

In terms of engineering analysis, this option was found to be the most viable because solar is an abundant resource at the site and it also eliminated the extremely large battery bank. The major shortcoming of this system is that back-up diesel generation would be required.

In the calculations, it was assumed that the solar system would be able to pump 80% of the annual water requirements, thus, only 20% of the water would need to be pumped with a diesel generator.

The solar/diesel system was then financially compared to a diesel-only system. The major costs associated with a solar system are the initial investment and annual maintenance, which consists of cleaning, replacing parts, system monitoring and more. The major costs associated with a diesel only system are the initial purchase, regular maintenance, and fuel.

In comparing the two, it was found that diesel would have increase 4.5% year over year for a solar/diesel system to be cost effective (Figure 8). This means that in twenty years the price of diesel per gallon would be close to $8.44. Under these conditions it would take 20 years to recover the cost of the initial investment.

The analysis is highly subject to a variety of assumptions and beliefs about future costs. With the high energy requirement of the project, solar energy is worth considering as an alternative or supplement to diesel under any of the following conditions:

1) Technological innovation decreases solar system cost
2) Bigger alternative energy incentives are offered
3) Cost of diesel increases by 4.5% or more every year

Although a solar/diesel system currently is not a cost effective option, it is worth noting its potential for future energy generation.

1.11 Proposal

After the team presented the proposal to the client, the client chose not to act upon the option of a solar panel system in conjunction with the diesel generator. The main reason for not using this for the client's problem was the payback period. As stated before the payback period for the whole system would be 19 years. The client mentioned that the overall lifetime of a PV array is not that much longer than those 19 years, therefore only a minimal amount of money would have been saved. As a solution to the problem the client will purchase a new generator that compiles with the newest tier 4 standards. Also the client is only using the area on Babbitt Ranches for another 25 years. The team is not able to guarantee that the whole system will last for that long without replacing panels, which would have caused an increase in the overall cost for the whole project.

2. Spring 2012 Babbitt Ranches Project

2.1 Background Information

Babbitt Ranches currently pumps water at Cedar Ranch Well as its primary head water for many of its stock tanks. It is located northwest of Flagstaff off of Fort Valley road. The well has a 243,000 gallon storage tank in proximity. Currently, the storage tank is not in use because the well has not been pumping at the capacity it was when initially installed. The Slate Mountain Well is a supplemental supply of water to Cedar Ranch Well. Slate Mountain Well is on US Forest Service land and is a contracted supply of water for Babbitt Ranches.

2.2 Goals

Goal Statement: The team will design an alternative energy system that can be utilized to draw water from wells at 120 to 600 feet that can reduce the client's current operating expenses and simulate the system under a variety of conditions.

Scope of the Goal Statement: The team plans to analyze the problems that Babbitt Ranches are experiencing, and through the analysis, create a design that meets the objectives set forth for this project. A simulation will be created that will test such a system under a variety of conditions.

2.3 Constraints

The team's sponsor requested that the Ranch Manager for the Cedar Ridge/Slate Mountain site be contacted for information regarding the redefined project. The data acquired and presented in Table 9 are approximations. Specific values will be acquired during a site visit planned to occur in the following two weeks.

As can be seen in Table 9, the project will include three wells at two locations. These two sites are close in proximity and work in conjunction as the head water for most of the gravity fed pipe system operating on Babbitt Ranches. Comparing the new data with the original project data, it can be seen that the new sites have much shallower wells and substantially slower flow rates. These two factors will be an advantage when attempting to design an alternative energy system to draw the necessary water. The most notable disadvantage is that the current diesel generator system is pumping water continuously. This factor is always a problem for alternative energy systems. The majority of systems engineered to surpass this issue result in higher initial costs, which results in prolonged payoff periods.

TABLE 9: CONSTRAINTS

	Cedar Upper	Cedar Lower	Slate Mtn.	units
Depth	120	300-400	400-600	ft
Flow Rate	18	5	32	gpm
Pump	Submersible 460 3 Phase			
Generator Distance from Well	.5 mile	400 yds.	on site	
Generator Type	Perkins 20kW, 4 cylinder	Perkins 12kW, 3 cylinder	Perkins 12kW, 3 cylinder	
Fuel Usage	0.75 - 1.0			gph
Avg Daily Run Time	24 hours per day			
Time of Year Opp.	All Year		April - November	
Pipe Outlet Dia.	1.25		2	in
Fuel Tank	1800		500	gal
Refueling Time	2 - 3 months		Refueled from Cedar Tank	

2.4 Possible Solutions

The team has discussed several solutions which have been deemed feasible. The new project has lower flow rates, shallower well depths, and the energy resources are greater at the new site. The new site has a much higher wind resource. Thus the team will propose the following tentative solutions:

1. Solar and wind arrays
2. Only wind
3. Only Solar

Relative to the CEMEX project, energy demands are much lower. Thus, diesel back-up has not yet been deemed an absolute necessity. A potential back up for water storage would be the 243,000 gallon tank that is currently unused.

2.5 Next Steps

With a completely new project, the team will collect information on the new wells. Information such as flow rates, maximum pumping capacity, resource availability, reliability, water consumption, well depth will be acquired from the client. Furthermore, the team will design an alternative energy system that meets the needs of the client.

Once such a system has been designed, the team will generate a computer simulation to analyze different scenarios. Variables such as resource, decreased flow rate, increased water demand, storage and others will be built into the simulation.

2.6 Gantt Chart

Task Name	Start	Finish
Redefine Strategy	Mon 1/14/13	Tue 1/29/13
Contact Mr. Cardasco	Wed 1/16/13	Wed 1/16/13
Meet Mr. Cardasco	Thu 1/24/13	Thu 1/24/13
Progress Report Presentat	Tue 1/29/13	Tue 1/29/13
Progress Report	Fri 2/1/13	Fri 2/1/13
Contact Ranch Manager	Tue 1/29/13	Fri 2/1/13
Site Visit	Fri 2/8/13	Fri 2/15/13
Prepare Simulation Tool	Tue 2/5/13	Fri 3/15/13
Sim Tool: Adjust Variables	Mon 3/18/13	Fri 4/26/13
Midpoint Review Pres.	Tue 2/26/13	Tue 2/26/13
Midpoint Review Report	Fri 3/1/13	Fri 3/1/13
Hardware Review 1	Tue 3/12/13	Tue 3/12/13
Meet Ranch Manager	Thu 3/14/13	Fri 3/22/13
Poster Design	Mon 3/4/13	Tue 4/23/13
Hardware Review 2	Tue 4/9/13	Tue 4/9/13
Walk through Presentation	Tue 4/16/13	Tue 4/16/13
Final Report Due	Fri 4/19/13	Fri 4/19/13
Poster Due	Tue 4/23/13	Tue 4/23/13
Final Presentation	Fri 4/26/13	Fri 4/26/13

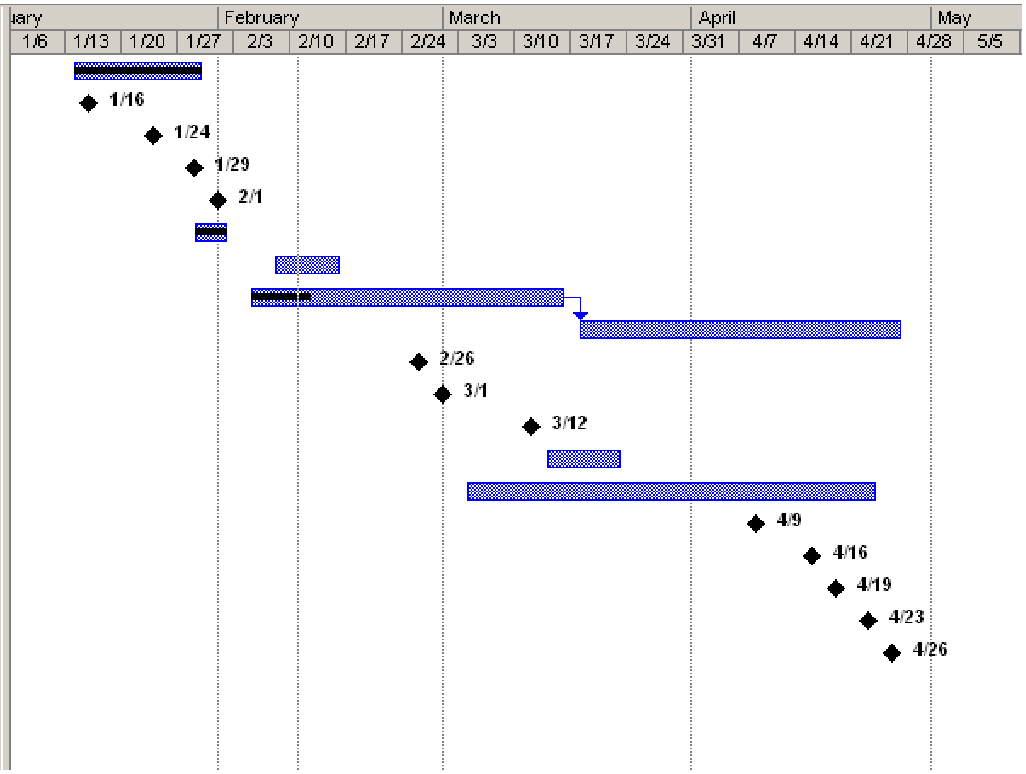

FIGURE 10: GANTT CHART

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