

Alternative Power Source To Draw Underground Water

November 5, 2012

Team 01

Beau Drumright, Patrick Schimmelbauer, Grant Masters, Emerson Jones, Nathan Heckathorne

**College of Engineering, Forestry, and Natural Sciences.
Northern Arizona University**

Overview

Problem Statement

Pump Requirements

Natural Resources

Wind Analysis

Solar Analysis

Backup System Analysis

Gantt Chart

Conclusion

References

Problem Statement

- The Client requests a solution that will draw water from 520 meters while maintaining the current flow rate of $0.3 \text{ m}^3/\text{min}$ while reducing overall cost.



Wind Power Classification


Wind Power Class	Resource Potential	Wind Power Density at 50m W/m ²	Wind Speed ^a at 50 m m/s	Wind Speed ^a at 50 m mph
1	Poor	0 - 200	0.0 - 5.6	0.0 - 12.5
2	Marginal	200 - 300	5.6 - 6.4	12.5 - 14.3
3	Fair	300 - 400	6.4 - 7.0	14.3 - 15.7
4	Good	400 - 500	7.0 - 7.5	15.7 - 16.8
5	Excellent	500 - 600	7.5 - 8.0	16.8 - 17.9
6	Outstanding	600 - 800	8.0 - 8.8	17.9 - 19.7
7	Superb	> 800	> 8.8	> 19.7

^a Wind speeds are based on a Weibull k value of 2.0

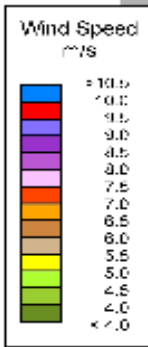
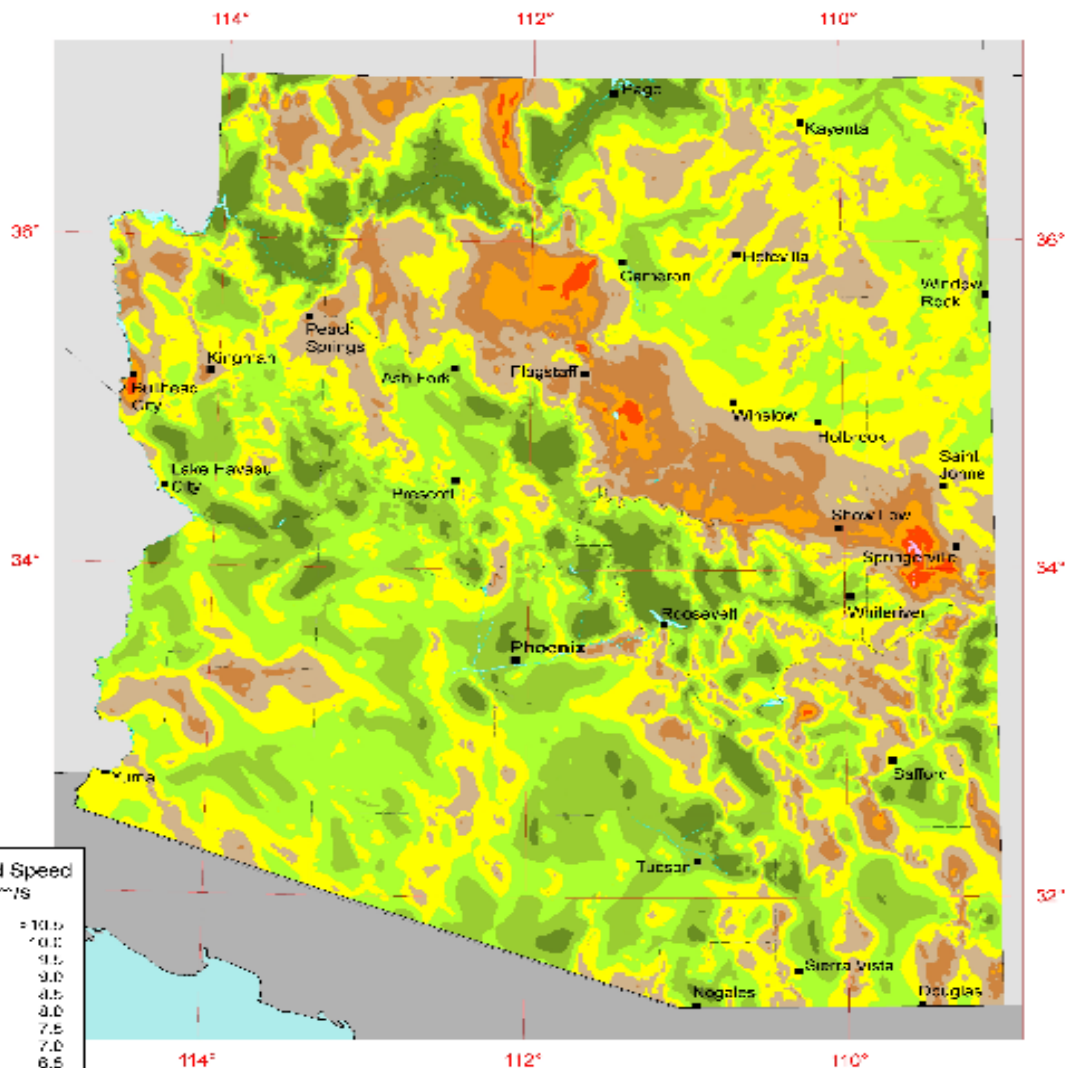
The wind power resource data for this map was produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by the National Renewable Energy Laboratory and wind energy meteorological consultants.



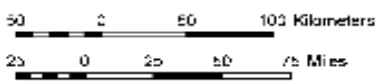
This map was produced by the National Renewable Energy Laboratory for the U.S. Department of Energy September 26, 2007



Arizona - Annual Average Wind Speed at 80 m



Source: Wind resource estimates developed by AWS Truepower, LLC for windNavigator®. Web: <http://www.windnavigator.com> | <http://www.aws.truepower.com>. Spatial resolution of wind resource data: 2.5 km. Projection: UTM Zone 12 WGS84



Wind Analysis

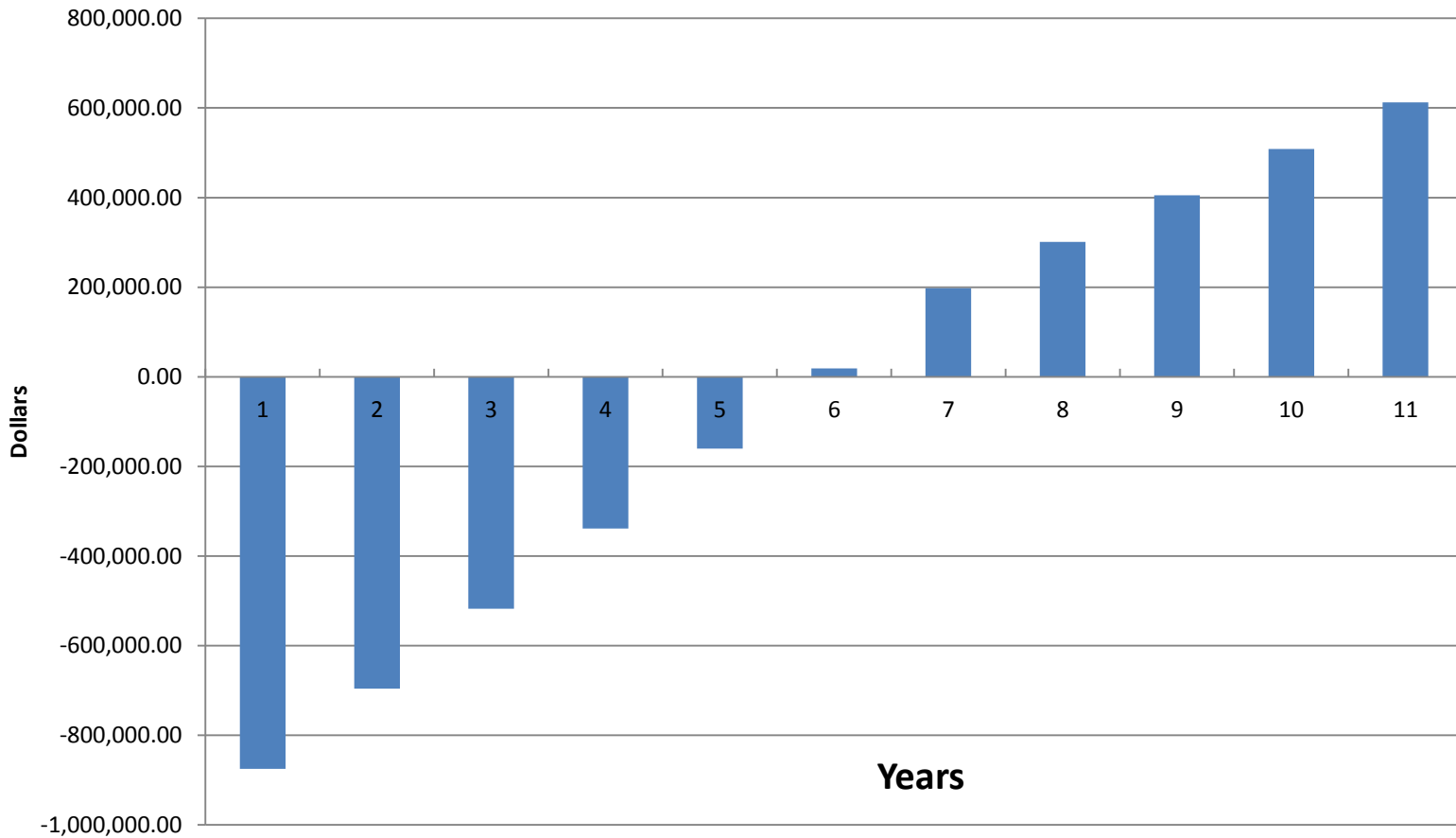
System Specifications		
Power Requirements	50	kW
Hours per year	8760	hr
Energy Usage per year	438000	kW*hr
Average Wind Speed	5.5	m/s
Rotor Diameter	50	m
Height	80	m
Air Density(at 7000 ft elevation)	0.924	kg/m ³
Power (wind)	150.92	kW
Turbine Efficiency (assumed)	0.40	%
Power (Turbine)	60.37	kW
Yearly energy production	528,839.68	kW*hr
Number of Turbines	1	
Total energy prod. Per year	528,839.68	kW*hr

Wind Analysis

Year Of Operation	At Installation	1	2	3	4	5
Gross Installation Cost	-1,250,000.00					
Federal Tax Credit (30% of cost)	375,000.00					
Annual Turbine Maintenance		-18750	-18750	-18750	-18750	-18750
Tax Savings from MACRS Depreciation (5yr)		75000	75000	75000	75000	75000
Deisel Fuel Savings (annual cost of fuel)		122500	122500	122500	122500	122500
Annual Cash Flow	-875,000.00	178750	178750	178750	178750	178750
Cumulative Cash Flow	-875,000.00	-696,250.00	-517,500.00	-338,750.00	-160,000.00	18,750.00

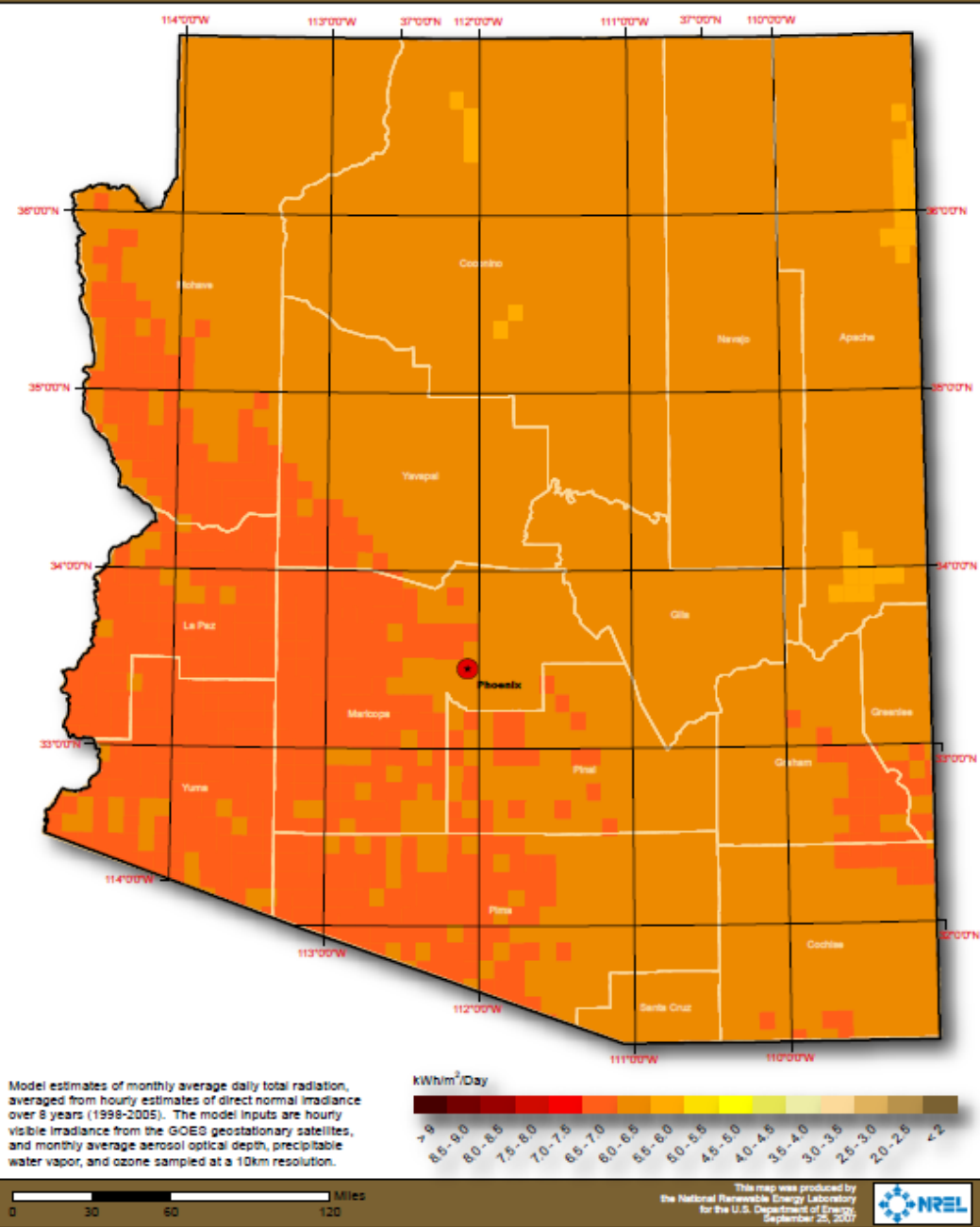
Wind Analysis

Cumulative Cash Flow



Global Solar Radiation at Latitude Tilt - Annual

Arizona



Pump Requirements

System Specifications		
Power Requirements	50	kW
Daily AC Load	1,200	kWh
Days of Autonomous Function	3	days

Batteries

6	Parallel
32	Series
192	Total
6800	\$/Battery

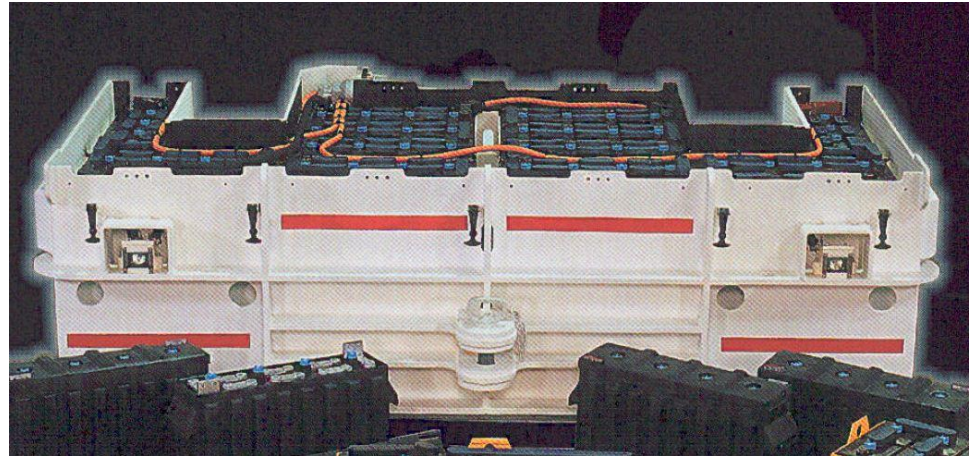


Image Courtesy of: <http://www.solarelectric.com/crinba24vo17.html>

Panel Results

Panels in Parallel	53	panels
Panels in Series	27	
Total Panels	1431	
Cost per Panel	250	\$/panel

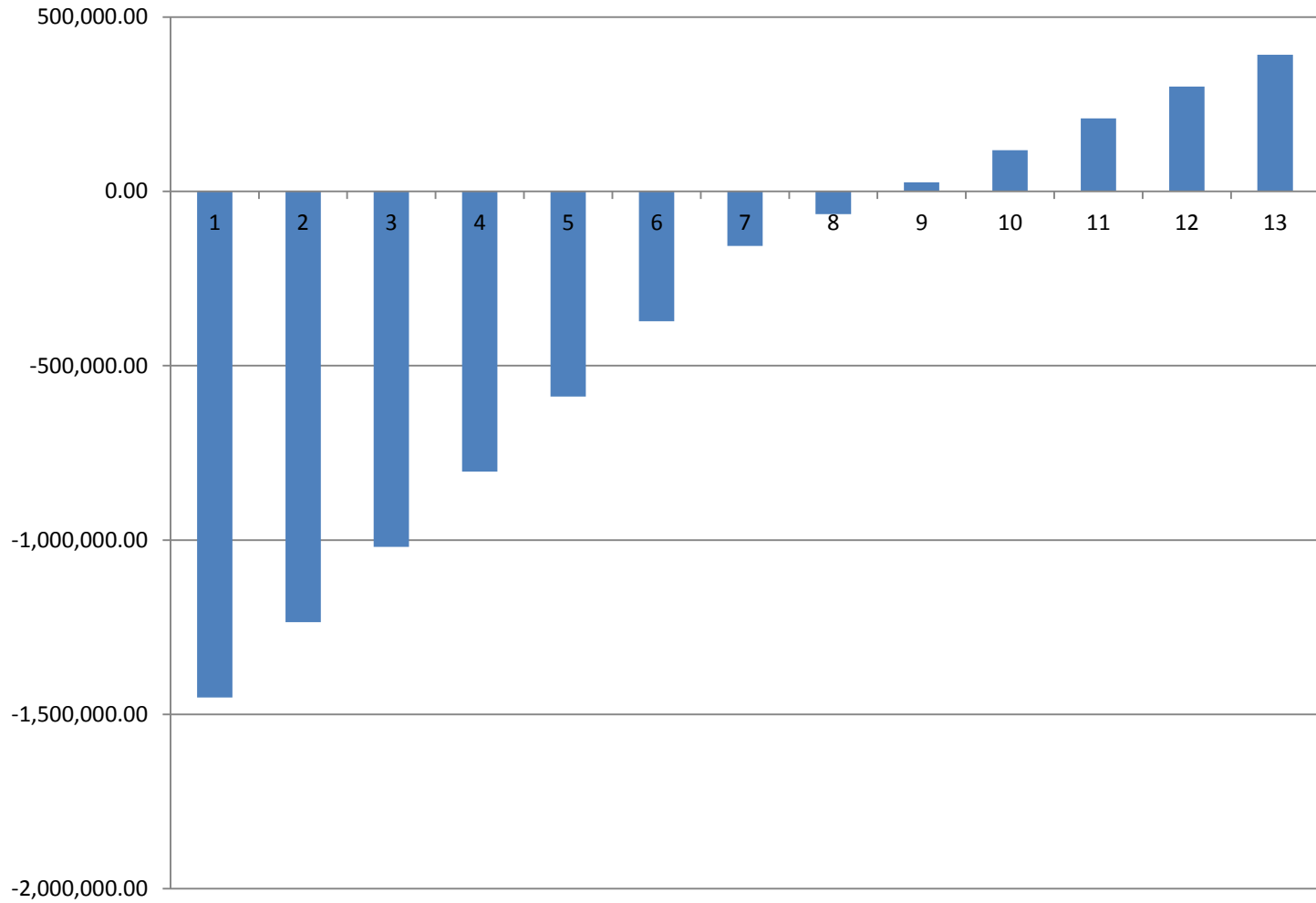


Image Courtesy of: www.solarworld-usa.com

Costs

Panels	\$ 357,750.00
Batteries	\$ 1,305,600.00
Inverter	\$ 250,000.00
Other Materials	\$ 100,000.00
Construction	\$ 60,000.00
Total Cost	\$ 2,073,350.00

Cash Flows



Backup System Analysis



Courtesy: ZBB energy corporation

Storage Batteries

- Up to 2MWh
 - Size: four trailers
 - Price 161 \$/kW

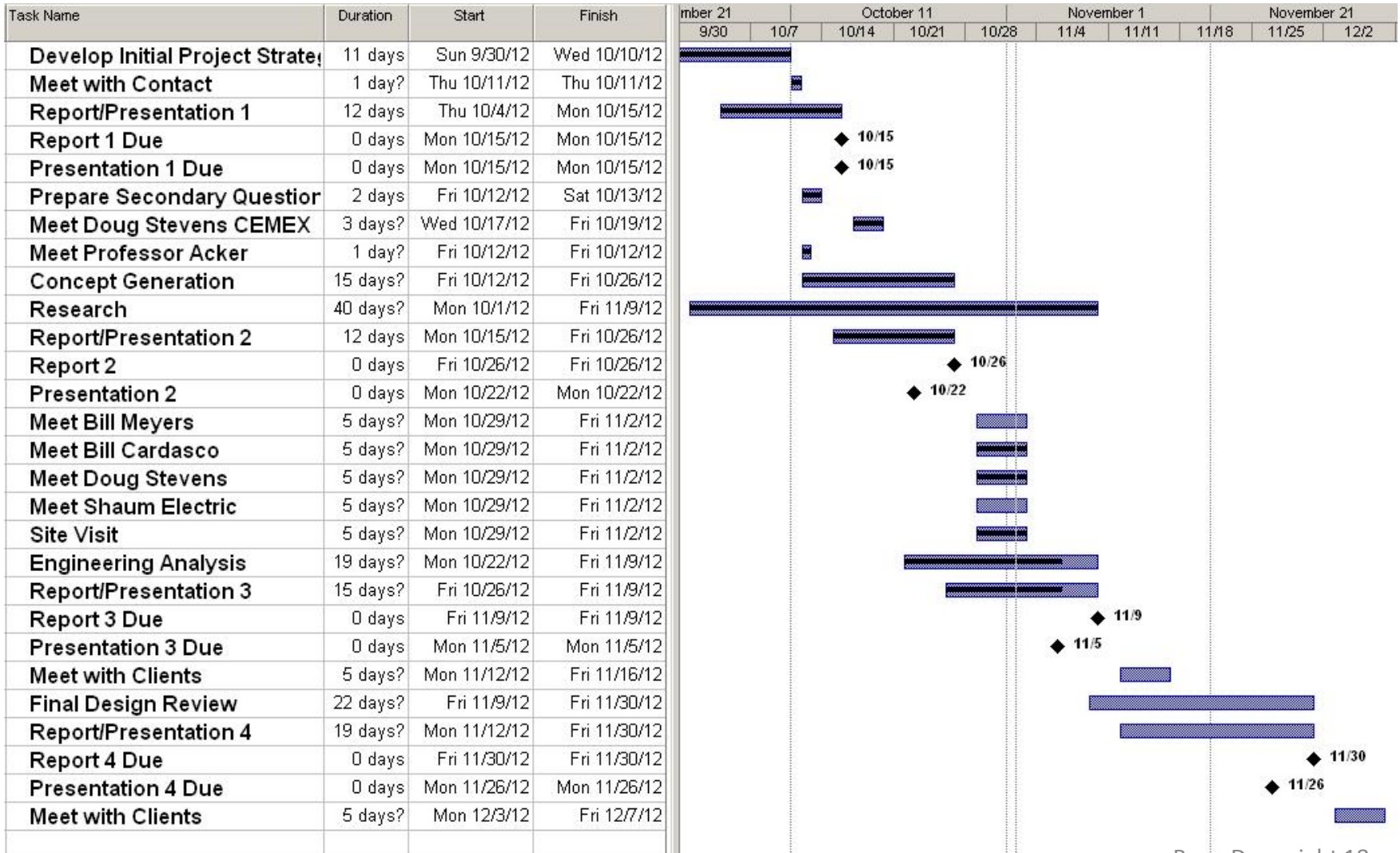


Courtesy: S&C electric company

Storage Tank

- Increase size of current tank (\$0.41 per gallon)
- Install additional 30000 gallon back up tank (\$21042)

Gantt Chart



Conclusion

Technology Comparison			
	Wind Turbine	Solar Array	Unit
Initial Cost	1,250,000.00	2,073,350.00	\$
Payback Period	~5	~9	years

- Alternative energy sources require large capital investment
- Next step-Optimization of both technologies

References

Doug Stevens – Cemex

Bill Cardasco – Babbitt Ranches

www.energy.ca.gov

www.lipower.org

www.usasolarwind.com

<http://www.azgs.az.gov/geothermal>

nau.edu

<http://www.zbbenergy.com/>

<http://www.windindustry.org/>

<http://www.wind-estimate.org>

solarenergy.advanced-energy.com

www.wind-sun.com

www.solarworld-usa.com

Questions?