

**Preliminary Report:**  
**Renewable Energy Feasibility Study**  
**for**  
**Bridgeport Indian Colony**

**By: Community Assessment of**  
**Renewable Energy and Sustainability**  
**&**  
**The Renewable and Appropriate**  
**Energy Laboratory**

# Contents

- i. About CARES
- ii. About RAEL
- iii. Executive Summary
- 1. Wind Resource Assessment
- 2. Geothermal Resource Assessment
- 3. Cost Estimates for Power Plant Infrastructure
- 4. Recommendations and Future Work
- 5. References

## **i. About CARES**

The Community Assessment of Renewable Energy and Sustainability (CARES) is a sustainability consulting and engineering organization founded in 2007 that is composed of engineering and architectural graduate and undergraduate students at the University of California, Berkeley. The purpose of CARES is to enable consumers to make informed decisions about sustainability and renewable energy technologies by co-design and implement information technology tools that can be used to (1) design culturally appropriate, sustainable buildings, (2) improve indoor air quality, (3) improve energy and water conservation, and (4) design renewable energy infrastructures for communities. CARES conducts custom user needs innovation workshops, consults with consumers on sustainability and renewable energy technologies and best practices implementation plans, and creates white papers and presentations on sustainability and renewable energy.

## **ii. About RAEL**

The Renewable and Appropriate Energy Laboratory (RAEL) is a unique new research, development, project implementation, and community outreach facility based at the University of California, Berkeley in the Energy and Resources Group and the Department of Nuclear Engineering. RAEL focuses on designing, testing, and disseminating renewable and appropriate energy systems. The laboratory's mission is to help these technologies realize their full potential to contribute to environmentally sustainable development in both industrialized and developing nations while also addressing the cultural context and range of potential social impacts of any new technology or resource management system.

### iii. Executive Summary

The Bridgeport Indian Colony (BIC) is federally recognized, sovereign National American nation located on Bridgeport, CA. It is dedicated to the “preservation, protection, conservation, assistance in health, education, welfare, and tradition for the members of Bridgeport Indian Colony”

This report aims to present and analyze information on the potential of renewable energy in near Bridgeport Indian Colony to provide an environmentally-friendly, cost-effective energy options for commercial development

For each renewable energy option we examine, wind and geothermal in this case, we compiled cost information for construction, estimates of energy capacity, and data on electricity exports rates.

#### Key Findings

1. Mammoth Lakes is recommended for wind farm development given its average levelized cost of energy: \$97.92/MWh. The lowest levelized cost of energy at Mammoth Lakes is \$84.55/MWh. The highest levelized cost of energy at Mammoth Lakes is \$113.85/MWh.
2. There are 4 wind farm sites near Mammoth Lakes. The average capacity of these wind farm sites is 150 MW. The highest capacity of these wind farm sites is 270 MW. The lowest capacity of these wind farm sites is 30 MW. The wind speeds at these sites range from 7.0 m/s to 9.0 m/s at 80 m
3. The wind farm sites surrounding Walker Lake near Hawthorne, NV had the highest average levelized cost of energy: \$139.68/MWh. The lowest levelized cost of energy near Hawthorne, NV is \$125.17/MWh. The highest levelized cost of energy near Hawthorne, NV is \$171.67/MWh.

4. There are 8 wind farm sites surrounding Walker Lake near Hawthorne, NV. The average capacity of these wind farm sites is 146 MW. The highest capacity of these wind farm sites is 450 MW. The lowest capacity of these wind farm sites is 60 MW.
5. The wind speed near the Sweetwater Mountain Range's Wheeler Peak range from 7.0 m/s to 9.0 m/s at 80 m and should be considered by the BIC for wind energy development
6. Wind farms were found to cost \$1.87 per watt installed, with an annual fixed O&M of \$0.0578 / MW and no variable O&M.
7. Mammoth Lakes also has strong potential geothermal thermal energy and should be considered for development if the tribe pursues wind farms at this location as well.
8. Geothermal generators were found to cost \$3.78/W installed, with an annual fixed O&M of \$0.2613 / MW and no variable O&M.
9. The average levelized cost of energy for geothermal sites near Mammoth Lakes: \$68.29/MWh
10. The average cost in the US in 2007 to connect generators without large transmission lines to the grid was \$91,289/MW.
11. Of this \$91,289/MW, the cost of substation and grid upgrades was \$65,639/MW and constructing a small transmission line to the existing grid accounts for \$25,650 per MW of this cost.
12. The cost to build a new transmission line is \$1,000/MW/km which is an average cost and doesn't reflect the added cost of traversing mountainous terrain.

13. As of December 2010, BLM rental fee for wind energy projects is \$4,150/MW and \$1/acre; this is currently being revised and is expected to follow BLM's megawatt (MW) capacity solar rental fee but with a far lower encumbrance value.
14. The average Power Purchase Agreement (PPA) contract price for exporting electricity from wind in CA is \$52.55/MWh. This is based on publicly available PPA data from the CPUC.
15. The average Power Purchase Agreement (PPA) contract price for exporting electricity from geothermal in CA is \$35.65/MWh. This is based on publicly available PPA data from the CPUC.

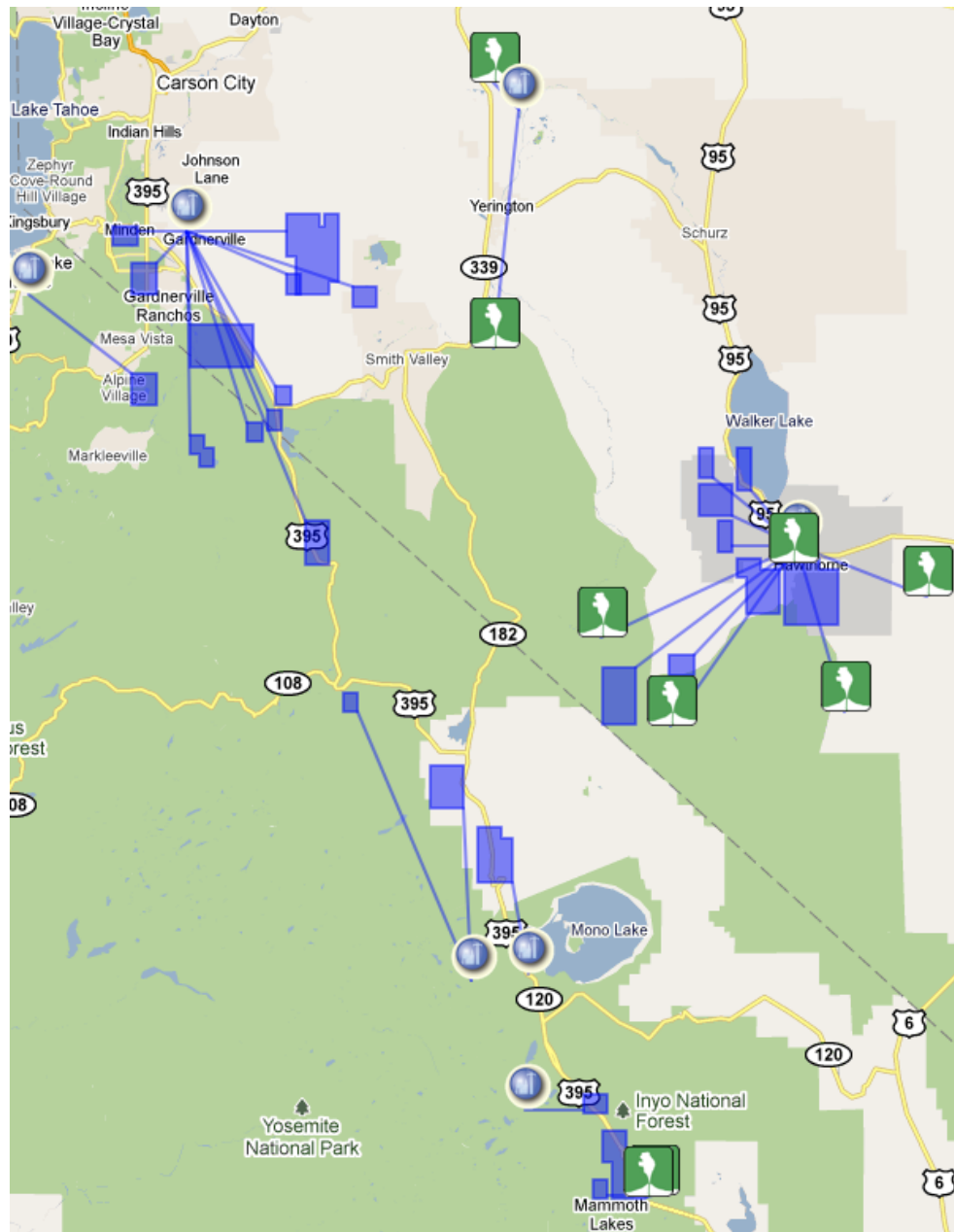
# 1. Wind Resource Assessment

This study is designed to give the members of the Bridgeport Indian Colony information on the wind energy potential available within 60 miles of their main reservation by providing energy capacity information of existing wind farms. These existing wind farms and substations are located near (1) Gardenville, CA, (2) Mammoth Lakes, CA, (3) Bridgeport, CA, and (4) Hawthorne, NV. Figures 1-4 provides an overview of where these sites are located.

New sites for wind farms were compiled from the Western Wind and Solar Integration Study [2]. Each of their sites was a grid cell that could fit 10 Vestas V90 3-MW turbines at a hub height of 100 meters, for an installed capacity of 30 MW per grid cell. The expected wind speed at 100 meter elevation was calculated by using Numerical Weather Prediction models to recreate the historical weather from 2004 to 2006 on a 10-minute basis at a 2 kilometer grid resolution. The expected power output of the turbines was derived from the resultant wind speeds using the turbine power curve with corrections for hysteresis and stochastic elements of observed turbine power output.

We constructed larger wind farms from the WWSIS dataset by merging adjacent grid cells then expanded their boundaries to reflect the inexact nature of the turbine siting. The expected annual power output of wind farms per MW installed was calculated by multiplying the average capacity factor of the individual grid cells by 8760 hours per year, then derated by typical outage rates (1.8%). Some wind sites with typical or below-average power output that were farther from Bridgeport were manually excluded to simplify the map.

Most of the proposed projects are on federal land. The exceptions are the three wind sites to the east of Gardnerville (2021, 2012, 2023), the wind site closest to Bridgeport (2519), and everything that connects to Hawthorne except the wind and two geothermal sites closest to the CA border (2027, 27015, 26968).



*Figure 1: Overview of wind and geothermal sites and substations within 60 miles of Bridgeport Indian Colony*



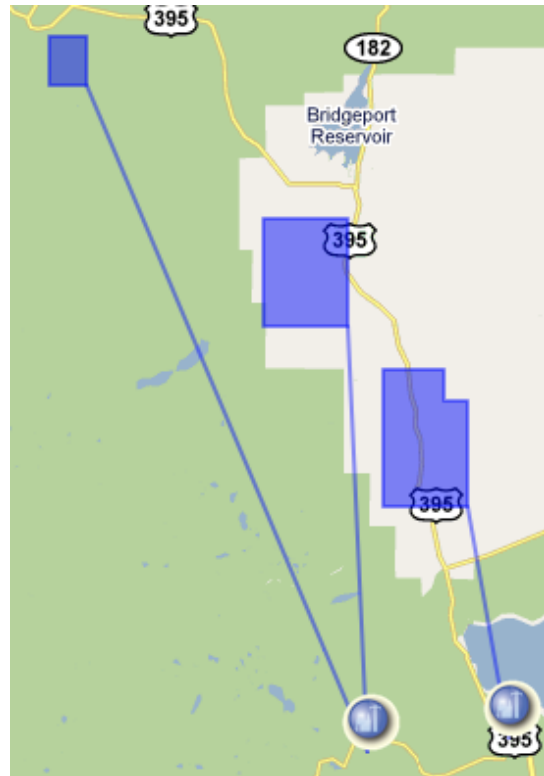


Figure 2: Wind Farms near Bridgeport and Mono Lake substation

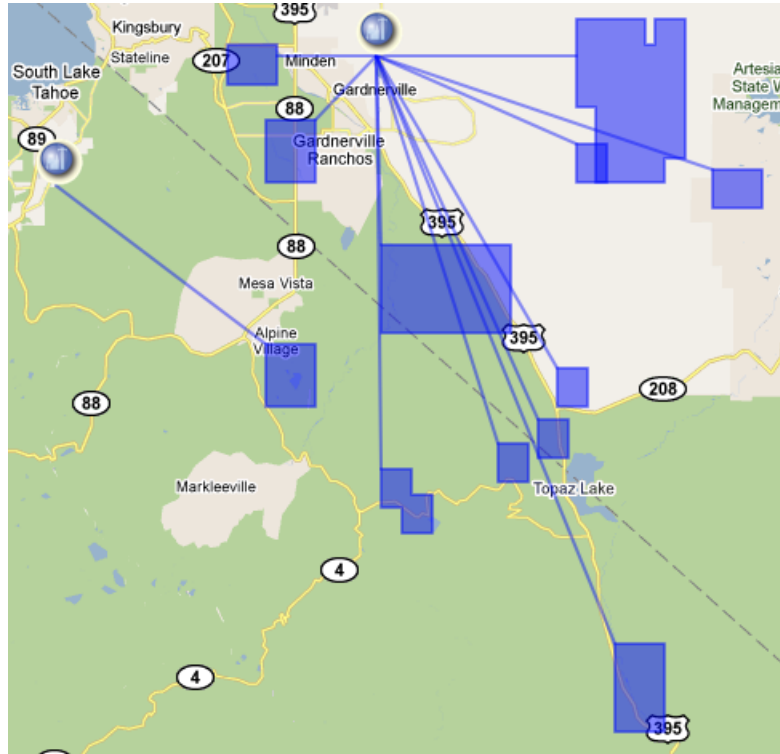


Figure 3: Wind Farms near Gardnerville substation

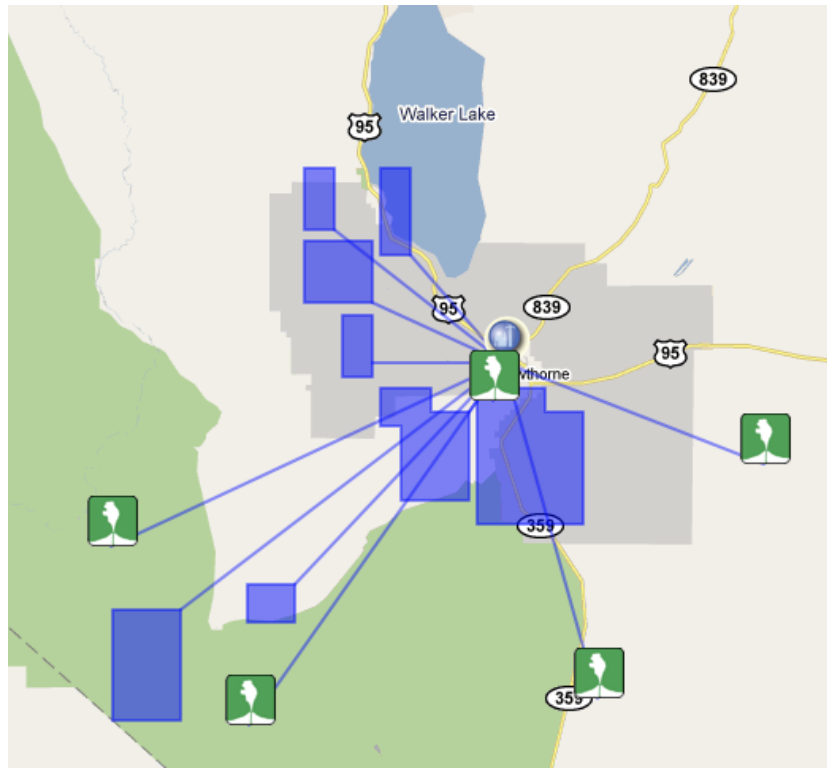


Figure 4: Wind Farms near Walker Lake and Hawthorne substation

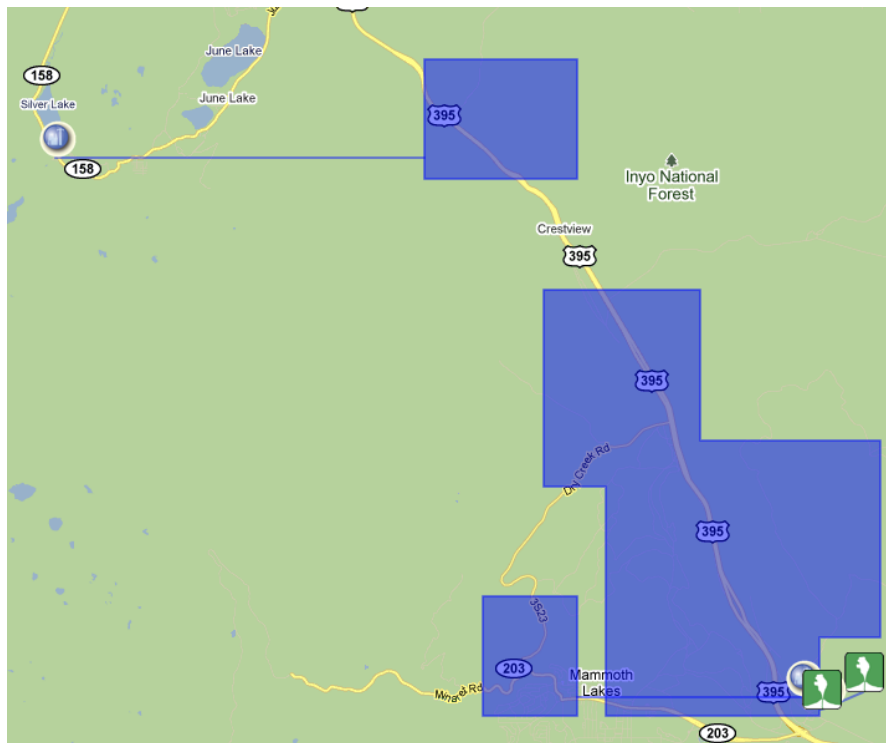
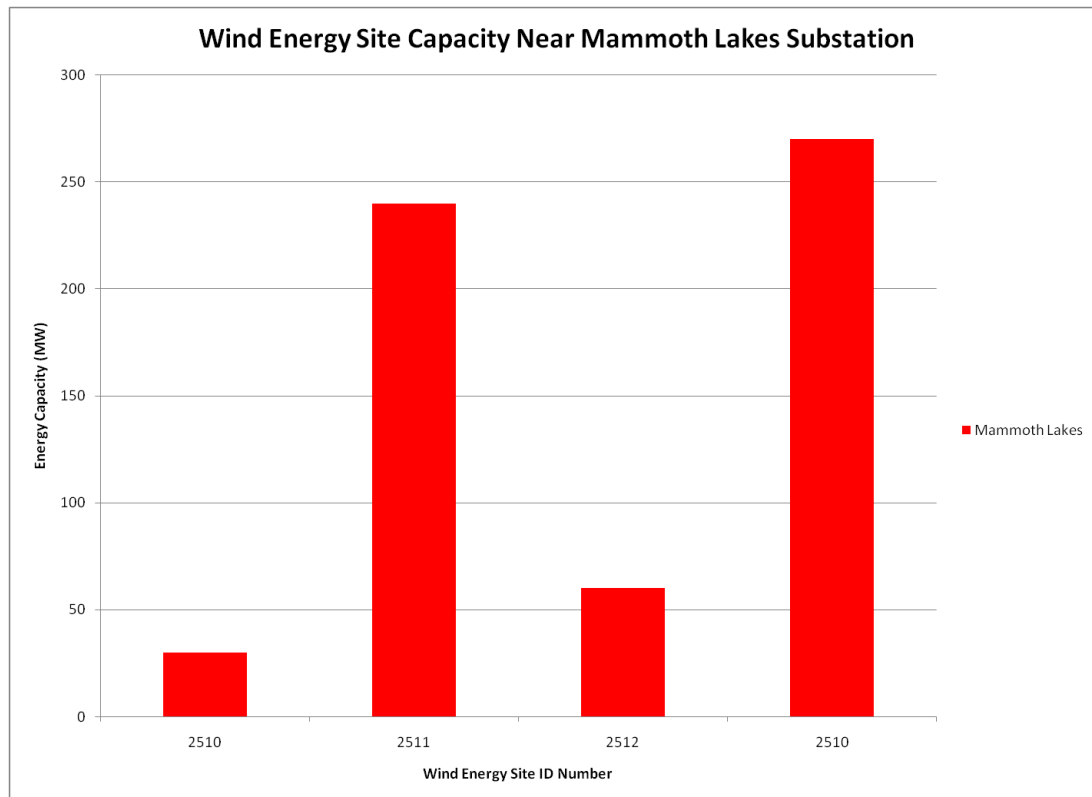


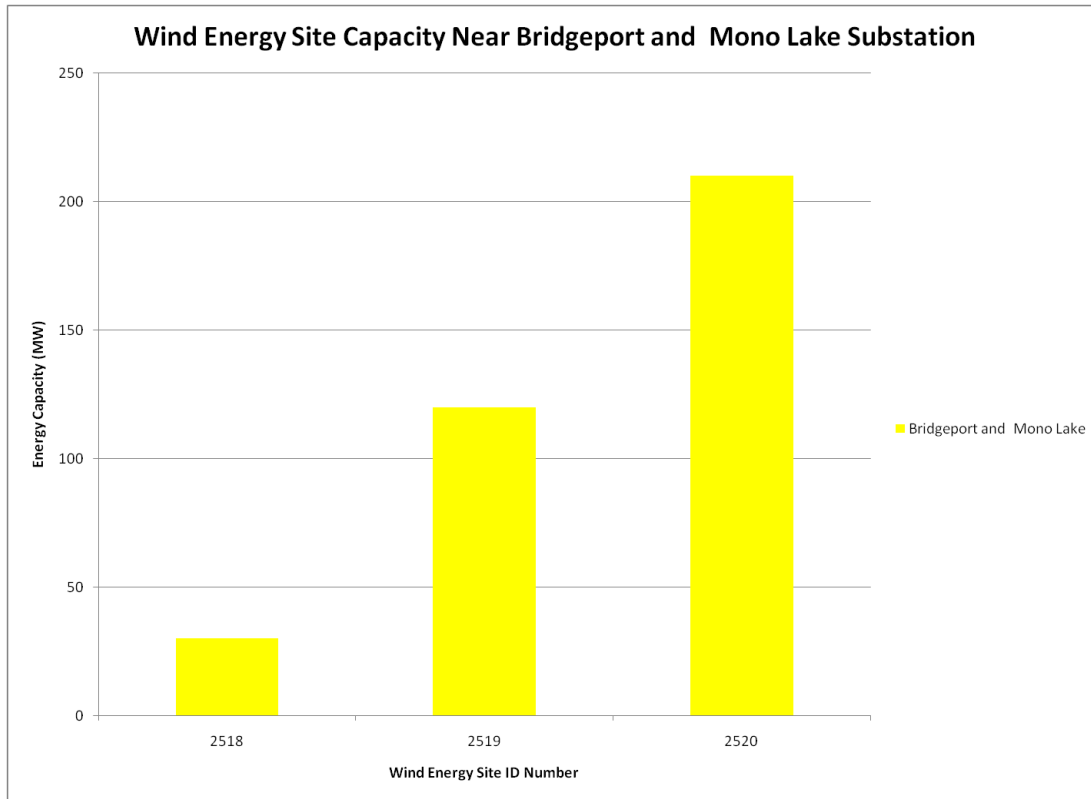
Figure 5: Wind Farms near Mammoth Lakes substation

There are 4 wind farm sites near Mammoth Lakes. The average capacity of these wind farm sites is 150 MW. The highest capacity of these wind farm sites is 270 MW. The lowest capacity of these wind farm sites is 30 MW. The wind speeds at these sites range from 7.0 m/s to 9.0 m/s at 80 m. Figure 6 provides the actual capacity of each site near Mammoth Lakes.



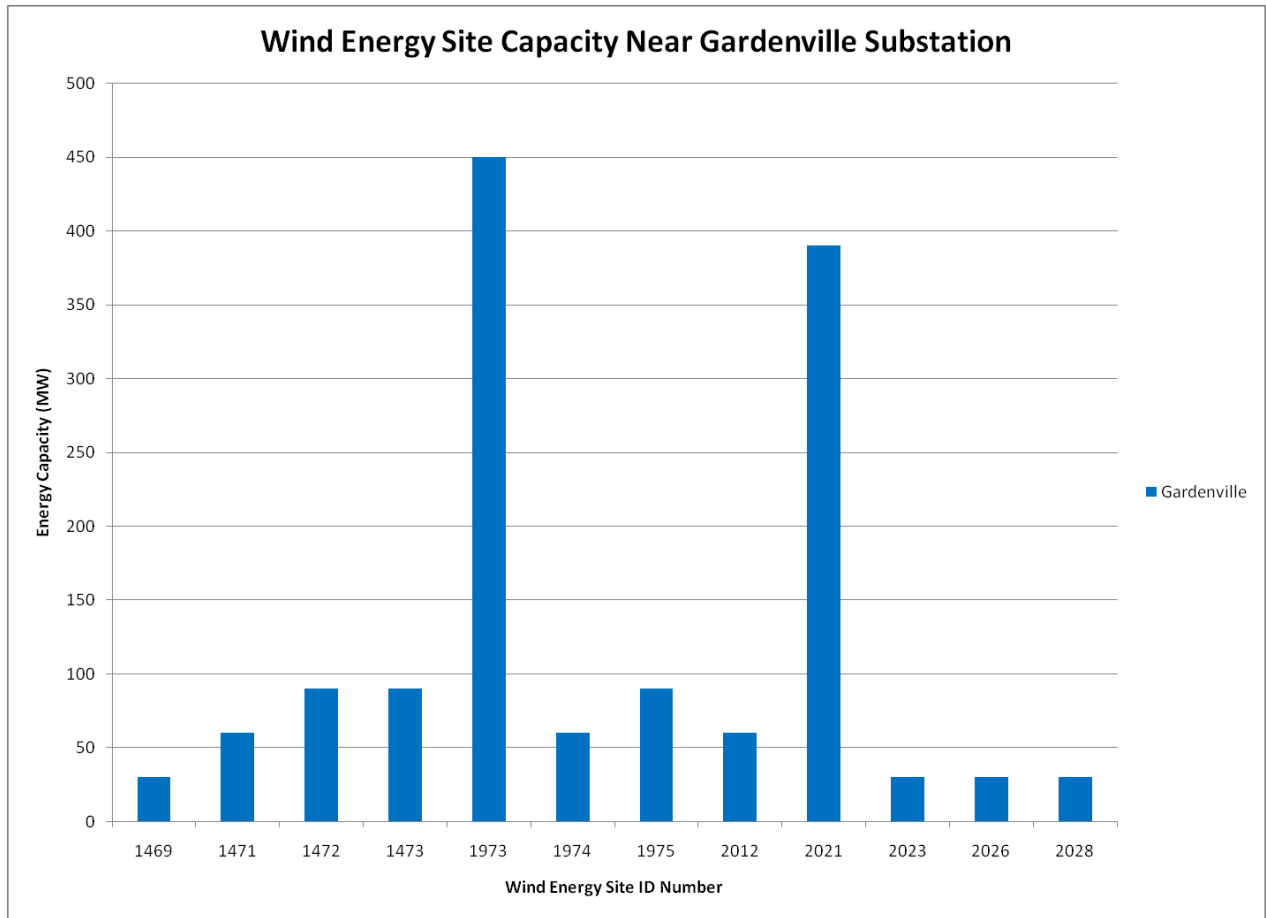
*Figure 6: Energy Capacity of Wind Farm Sites near Mammoth Lakes substation*

There are 3 wind farm sites near Bridgeport and Mono Lake Substation. The average capacity of these wind farm sites is 120 MW. The highest capacity of these wind farm sites is 210 MW. The lowest capacity of these wind farm sites is 30 MW. The wind speeds at these sites range from 7.0 m/s to 9.0 m/s at 80 m. Figure 7 provides the actual capacity of each site near Bridgeport and Mono Lake Substation.



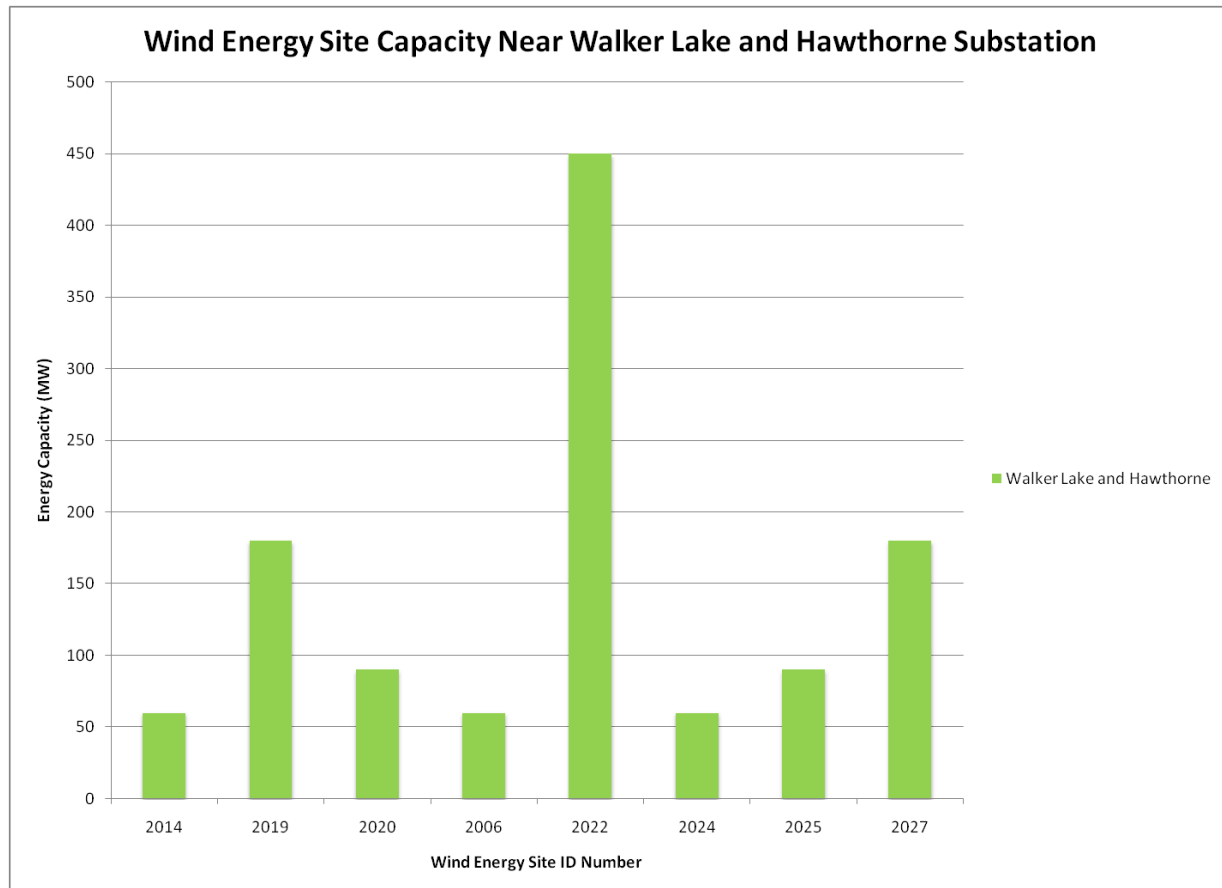
*Figure 7: Energy Capacity of Wind Farm Sites near Bridgeport and Mono Lake substation*

There are 12 wind farm sites near Gardenville Substation. The average capacity of these wind farm sites is 117.50 MW. The highest capacity of these wind farm sites is 450 MW. The lowest capacity of these wind farm sites is 30 MW. The wind speeds at these sites range from 7.0 m/s to 9.0 m/s at 80 m. Figure 8 provides the actual capacity of each site near Gardenville Substation.



*Figure 8: Energy Capacity of Wind Farm Sites near Gardenville substation*

There are 8 wind farm sites surrounding Walker Lake near Hawthorne, NV. The average capacity of these wind farm sites is 146 MW. The highest capacity of these wind farm sites is 450 MW. The lowest capacity of these wind farm sites is 60 MW. The wind speeds at these sites range from 7.0 m/s to 9.0 m/s at 80 m. Figure 9 provides the actual capacity of each site surrounding Walker Lake near Hawthorne, NV.

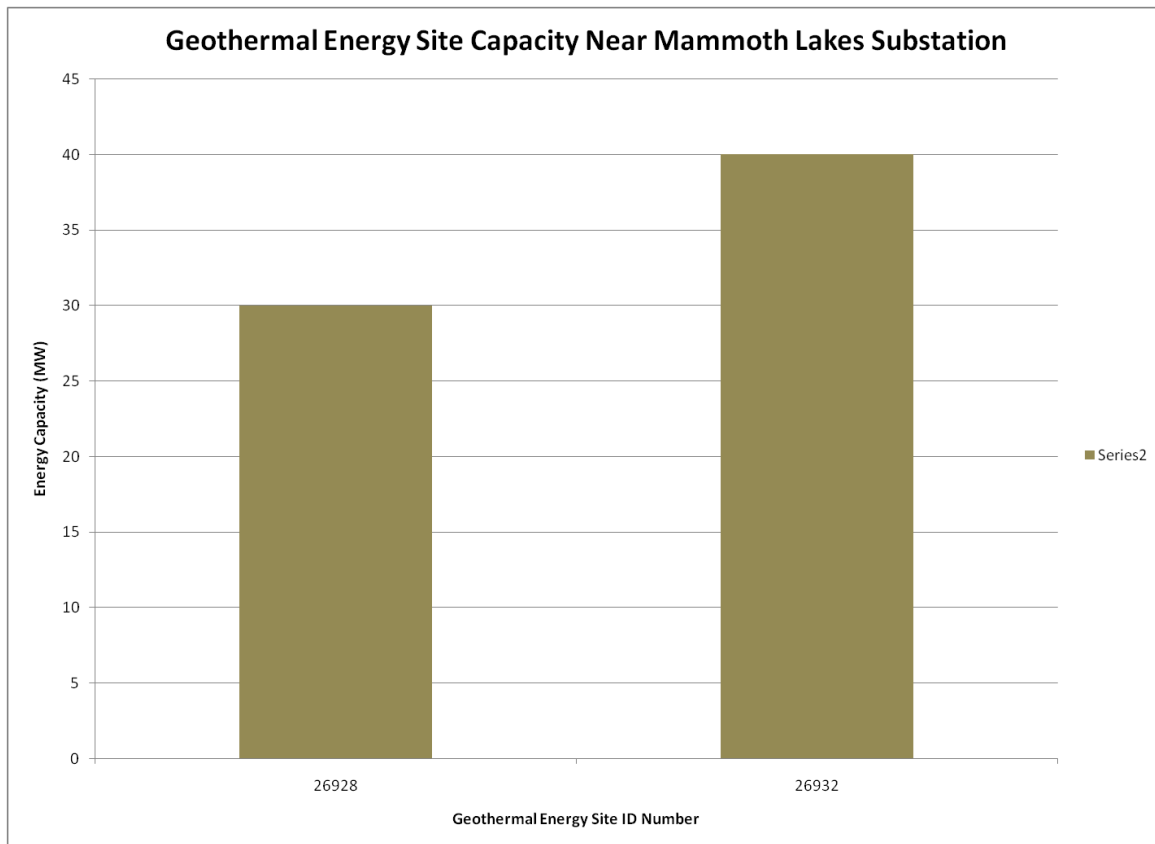


*Figure 9: Energy Capacity of Wind Farm Sites near Walker Lake and Hawthorne substation*

## 2. Geothermal Resource Assessment

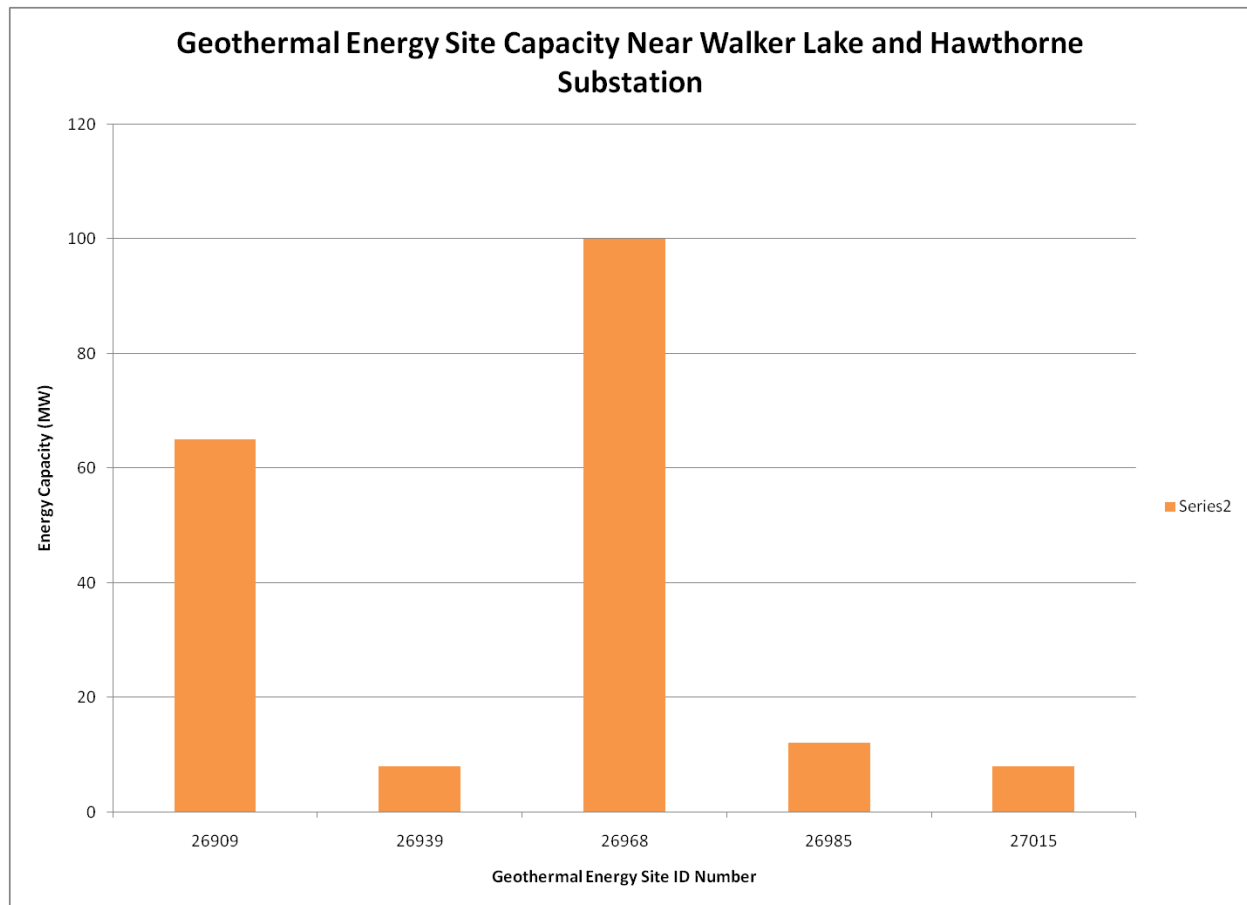
New sites for geothermal steam turbine power projects are compiled from Ventyx EV Energy Map (4) and the Western Renewable Energy Zones GIS portal (3). If a project appeared in both datasets, the larger potential capacity was used. The existing geothermal sites and substations are located near (1) Mammoth Lakes, CA and (2) Hawthorne, NV. The estimated annual power output of geothermal plants per MW installed was calculated by derating the typical baseload capacity factor of 1 by typical outage rates of 3.16% and multiplying that by 8760 hours per year.

There are 2 geothermal sites near Mammoth Lakes, CA. The average capacity of these geothermal sites is 35 MW. The highest capacity of these geothermal sites is 40 MW. The lowest capacity of these geothermal sites is 30 MW. Figure 10 provides the actual capacity of each site near Mammoth Lakes.



*Figure 10: Energy Capacity of Geothermal Sites near Mammoth Lakes substation*

There are 5 geothermal sites near Hawthorne, NV. The average capacity of these geothermal sites is 39 MW. The highest capacity of these geothermal sites is 100 MW. The lowest capacity of these geothermal sites is 8 MW. Figure 11 provides the actual capacity of each site near Mammoth Lakes.



*Figure 11: Energy Capacity of Geothermal Sites near Walker Lake and Hawthorne substation*



### 3. Cost Estimates for Power Plant Infrastructure

The capital costs for each power plant type were derived from Black & Veatch and decrease over time via exponential decay. For this report, wind farms were found to cost \$1.87 per watt installed, with an annual fixed O&M of \$0.0578 / MW and no variable O&M. Geothermal generators were found to cost \$3.78/W installed, with an annual fixed O&M of \$0.2613 / MW and no variable O&M. The capital costs of geothermal plants have historically varied significantly between sites depending on the local geology and resource quality, so the capital costs of geothermal should be treated as a rough estimate only.

The cost to connect new generators to the existing electricity grid is derived from the United States Energy Information Agency's 2007 Annual Electric Generator Report. The cost of connecting a renewable generator to the grid is divided into the cost of building a transmission line to the nearest substation of 115kV or above and the cost of upgrading the substation and surrounding grid. The average cost in the US in 2007 to connect generators without large transmission lines to the grid was \$91,289/MW. Of this \$91,289/MW, the cost of substation and grid upgrades was \$65,639/MW and constructing a small transmission line to the existing grid accounts for \$25,650 per MW of this cost.

The cost to build a new line is \$1,000 per MW per km which is an average cost and doesn't reflect the added cost of traversing mountainous terrain. We estimated the length of the transmission line as a straight-line distance for simplicity. Given that the wind farms sites of interest are located on Bureau of Land Management (BLM) lands, the rental fees of \$4,150/MW and \$1/acre have to be factored in as well. It should be note that the BLM is currently revising these fees and it is expected to follow BLM's megawatt (MW) capacity solar rental fee but with a far lower encumbrance value.

While these figures provide a good estimate of the capital and O&M cost associated with the various power plants, the levelized cost of energy is needed to compare the various renewable energy technologies of unequal life times and capacities.

Mammoth Lakes is recommended for wind farm development given its average levelized cost of energy: \$97.92/MWh. The lowest levelized cost of energy at Mammoth Lakes is \$84.55/MWh. The highest levelized cost of energy at Mammoth Lakes is \$113.85/MWh. For comparison, the wind farm sites surrounding Walker Lake near Hawthorne, NV had the highest average levelized cost of energy: \$139.68/MWh. The lowest levelized cost of energy near Hawthorne, NV is \$125.17/MWh. The highest levelized cost of energy near Hawthorne, NV is \$171.67/MWh.

If the Bridgeport Indian Colony pursues the development of wind energy near Mammoth Lakes, attention should also be given to the development of geothermal energy as well given the site's average levelized cost of energy: \$68.29/MWh.

The authors of this preliminary report also surveyed publicly Power Purchase Agreements (PPA) from the California Public Utilities Commission (CPUC) in order to understand the market prices that these energy options have commanded. The average Power Purchase Agreement (PPA) contract price for exporting electricity from wind in CA: \$52.55/MWh. The highest contract price for exporting electricity from wind in CA: \$58.50/MWh. The lowest contract price for exporting electricity from wind in CA: \$43.00/MWh

The average Power Purchase Agreement (PPA) contract price for exporting electricity from geothermal in CA is \$35.65/MWh. The highest contract price for exporting electricity from geothermal in CA: \$72.75/MWh. The lowest contract price for exporting electricity from geothermal in CA: \$17.12/MWh. Please note that energy site locations are not necessarily in CA, but the utility providers purchasing the power are located in CA. Figures 12 -13 shows the contract price and capacity of wind and geothermal energy sites that are publicly available from the CPUC.

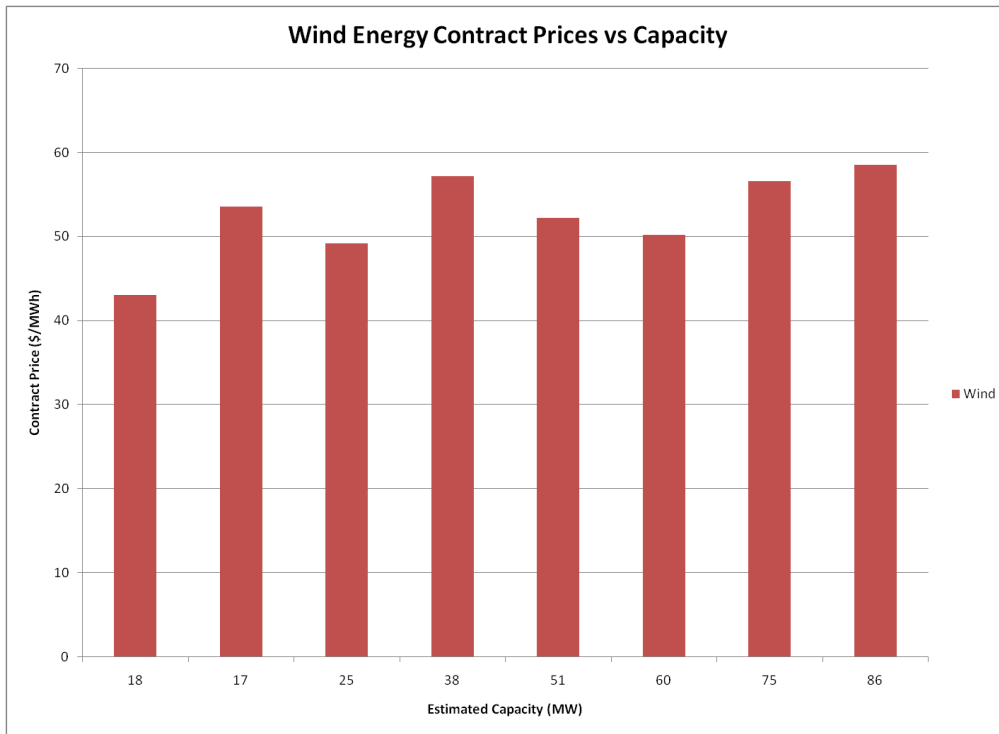


Figure 12: Wind Energy Contract Prices and Capacity based on PPAs from the CPUC

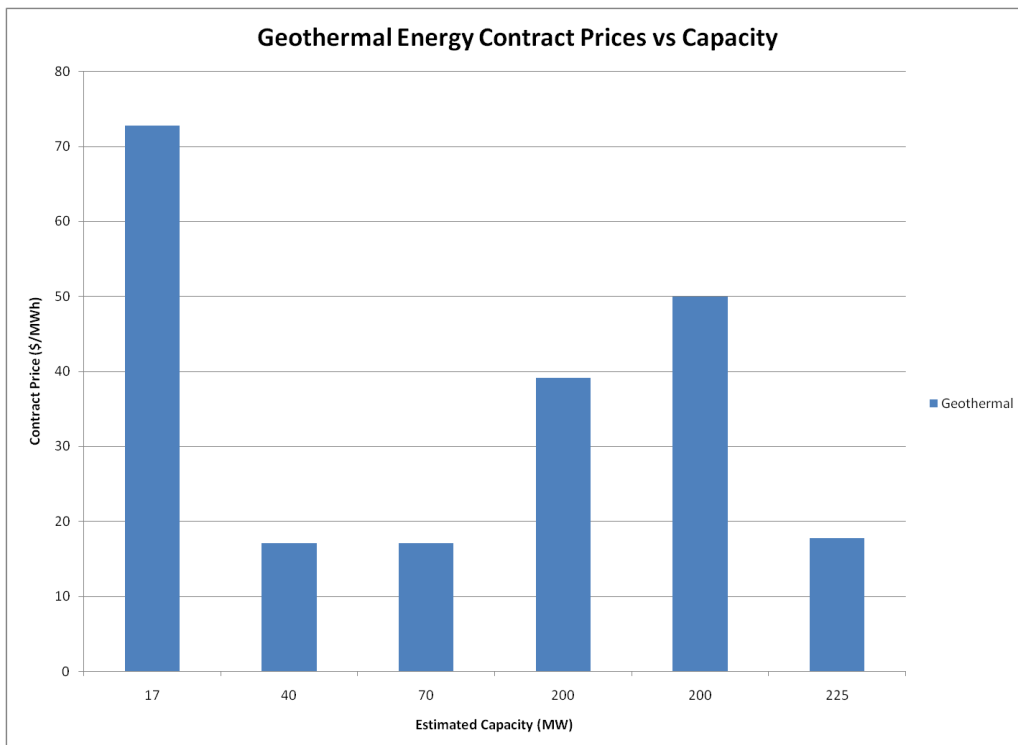


Figure 13: Geothermal Energy Contract Prices and Capacity based on PPAs from the CPUC

## 4. Recommendations and Future Work

The findings in this report are preliminary estimates based on the best available information at this time. The work performed for this report reveals in the following conclusions:

- a) Mammoth Lakes is recommended for wind farm development given its wind resources and average levelized cost of energy: \$97.92/MWh.
- b) Mammoth Lakes is also an attractive option for geothermal energy development as well and the Bridgeport Indian Colony (BIC) should give it serious consideration
- c) The wind speeds near the Sweetwater Mountain Range's Wheeler Peak are comparable to those near Mammoth Lakes. The biggest areas of concern for Wheeler Peak are the availability of the range for development, lack of substation within 40 miles, and cost for transmission lines in mountainous terrain.
- d) In order for the development of either wind or geothermal energy to realized, the BIC should focus on securing access to federal lands managed by the Bureau of Land Management (BLM) and negotiating rental fees
- e) Based on the publicly available electricity contract prices from PPAs, BIC wind farm projects could feasibly command contract prices ranging from \$50/MWh to \$58/MWh while geothermal energy projects could feasibly command contract prices ranging from \$17/MWh to \$40/MWh

Future work is needed on the following areas:

- a) Determination of the availability of BLM lands for wind and geothermal development
- b) Determination of rental fees per MW and acres for wind and geothermal development on BLM lands
- c) Determination of transmission line costs over mountainous terrain
- d) Analyze of the financial options in the United States and the State of California for renewable energy: RPS and Feed-in Tariffs for example

## 5. References

1. Bureau of Land Management, "Solar Energy Interim Rental Policy" <  
[http://www.blm.gov/wo/st/en/info/regulations/Instruction\\_Memos\\_and\\_Bulletins/national\\_instruction/2010/IM\\_2010-141.html](http://www.blm.gov/wo/st/en/info/regulations/Instruction_Memos_and_Bulletins/national_instruction/2010/IM_2010-141.html) >
2. Mendelsohn, Michael, . Bureau of Land Management, "Grazing in the Grass? Making Sense of the New BLM Rate Structure for Solar Projects"
3. The Cost of Transmission for Wind Energy: A Review of Transmission Planning Studies. Mills, A., R. Wiser, and K. Porter. LBNL-1471E. February 2009
4. <http://www.nrel.gov/wind/integrationdatasets/western/methodology.html>
5. "Western renewable energy zones GIS portal" (Western Governors' Association, Washington, DC, United States Department of Energy, Washington, DC, 2009;  
<http://mercator.nrel.gov/wrez/>)
6. "Ventyx EV Energy Map" (Ventyx Corporation, Atlanta, GA;  
<http://www.ventyx.com/velocity/ev-energy-map.asp>).
7. "Form EIA-860 database annual electric generator report," (United States Energy Information Agency, Washington, DC, 2007).
8. "Input assumptions spreadsheet" (Black & Veatch, Overland Park, KS and Renewable Energy Deployment System, National Renewable Energy Laboratory, Boulder, CO, 2010).

