EAST BAY community energy

The Power to Choose

**Notes regarding submitting comments on this Draft Work Product:**

**Comments are Due November 30th, 2017.**

**Comments shall be no longer than 5 pages.**

**Comments should be submitted to LDBPcomments@ebce.org**

# Grid Scale Wind Energy Siting Survey

*for*

# East Bay Community Energy

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## SUMMARY

This section describes the approach to and results of a high level assessment of the grid scale wind potential in Alameda County.

To find suitable wind development sites, our team overlaid wind speed maps with parcel information to find large, unoccupied, publicly owned land in high wind speed regions. Once these target sites were established, our team used standard wind turbine layout geometry to determine the capacity of each site and an excel based performance model to determine the energy yield of each turbine.

Our survey showed the potential for 110 MW of wind capacity, primarily on public land though including some adjacent agricultural parcels. The wind turbine placement is focused on the two areas of the County with the highest average wind speed: the narrow stretch between I-880 and the bay and in the northeast corner near Mountain House.

## METHODOLOGY

*Step 1: Property Search*

The LDBP team focused our efforts on large publicly owned properties in Alameda County. To aid this search, the County provided property data for over 400,000 parcels in the County. This list was filtered to focus on publicly owned land over 50 acres in size. Using publicly owned land eliminates the need for leasing costs which can be significant; site rental costs were estimated at 20% of revenue for our team's solar resource assessment.

Once the large public parcels were identified, our team used satellite imagery to eliminate those properties that had existing development or seemed otherwise unsuitable due to site topography.

*Step 2: Assess Wind Potential of Property*

Assess average wind speed and hosting potential of these sites. 80 m speed. power proportional to cube of wind speed?

Wind data was primarily sourced from AWS Truepower, a UL company that provides high quality location specific wind data. Though several data points were collected, including elevation and air density, the most critical is the average annual wind speed. Wind power is proportional to the cube of wind speed, making this parameter the most critical.

The highest wind speeds in Alameda County are concentrated in the northeast corner just west of Mountain House. The lower speed areas (in pink below) are where hillshade is experienced on the windward side of hills.

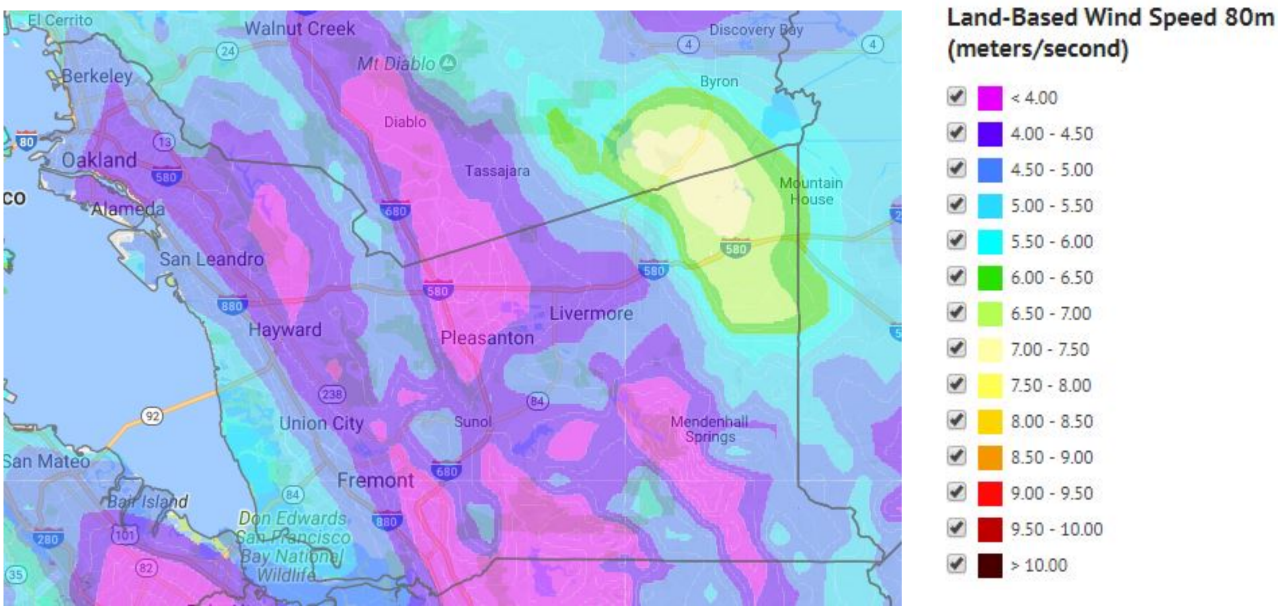


*Figure 1 - Alameda County wind speed map*

Terrain was also considered, though to a limited extent given the remote nature of this assessment. Google earth satellite imagery and Google street view were used to obtain an idea of a parcel's shape, topography, and ground cover. Though any property being developed will require some site work (including clearing and leveling for turbine pads, paving access roads, and installing utility lines) our team attempted to focus on properties that would not require too much additional site preparation to accommodate wind turbines. We avoided areas with forest cover, major topographic unevenness, or features such as streams that would impede turbine installation efforts.

*Step 3: Look for Opportunity on Adjoining Properties*

When available, our team looked to expand the development zone to include adjacent parcels that appeared unused and suitable for development. Due to the expense of building out utility interconnection infrastructure and mobilizing construction crews for installation, it is advantageous to install as much capacity as possible at any given location. None of the parcels we found were able to accommodate more than a few large wind turbines, so we looked to expand to neighboring properties when possible.

Our team used the interactive Alameda County parcel map to determine the property lines and ownership structure of adjoining parcels, and satellite imagery to determine whether the parcel was actively managed or farmed. When suitable properties were available, our team expanded the wind turbine layout accordingly.

*Step 4: Determine Wind Capacity of Site*

Once the suitable properties were identified, our team placed turbines in a realistic layout to determine the site's hosting capacity. Unlike solar, which has a relatively constant power capacity per square foot, for wind energy the power density or 'ground cover ratio' can vary greatly depending on the parcel shape, terrain, prevailing wind direction, and turbine size.

Our team chose 2 MW turbines for our modeling. This is a popular size choice for modern turbines and finds a middle ground between going larger (which allows greater efficiencies and energy capture) staying small enough to keep the turbine size manageable. The typical dimensions for a 2 MW turbine would be a 260 foot hub height and a 300 foot rotor diameter.

To determine the physical location of the turbines on the property, our team followed the rules of thumb below. At right is a wind rose diagram for a typical County property which also informed our layout decisions (this diagram visualized the prevailing wind direction).

- 4D spacing perpendicular to prevailing wind
- 6D spacing parallel to prevailing wind
- 2D setback from property lines
- *D = turbine diameter = 300 feet*

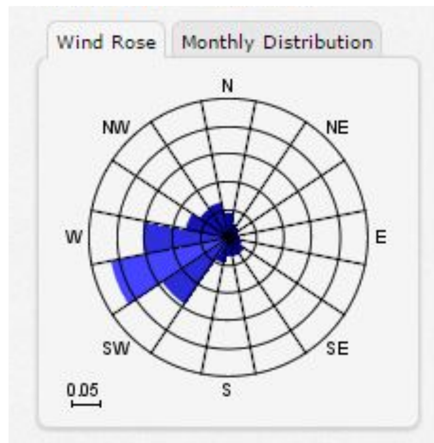

*Figure 2 - Typical wind rose*

A Google Earth file was created describing the physical locations of all turbines.

Limitations of approach: Properties were assessed by our team remotely, primarily using satellite imagery; detailed information for each property was not obtained. There may be parcels within our survey that are earmarked for other uses or otherwise unavailable.

*Step 5: Determine Energy Yield of Site*

Once the quantity and placement of turbines had been considered, our team looked to identify the energy production. The equation for wind power is:

Power = (1/2)*(air density)*(turbine blade swept area)*(wind speed)^3

Each of these components was modeled using an excel-based turbine performance tool. Air density is similar across the County, though changes in elevation (higher elevations have less density and thus slightly lower power yields) were factored in to our calculations. Turbine blade swept area was modeled using specifications from commercially popular turbines.

As is evident from the equation, air speed is the most critical component. Wind power is proportional to the cube of wind speed. As such, average wind speed is insufficient for measuring performance; a site in which the wind speed was often much higher and much lower than the average value would not produce the same amount of energy as a site that is often near the average speed. A more detailed hourly distribution profile is needed to get an accurate result. To this end, our team used a typical Bay Area Weibull K factor of 1.997, which defines the distribution of wind speeds around the mean speed. In the absence of actual measured hourly values for wind over an extended period of time, this is the best proxy for estimating the available wind power.

**RESULTS**

All results were cataloged in both spreadsheet form, which contains the detailed property and turbine information for each site, along with a Google Earth file, which contains an interactive map with pins at each turbine location. Our team placed (55) 2 MW turbines within the County for a total of 110 MW of wind capacity.

These turbines were placed on 19 distinct parcels. These 19 parcels are arranged in 11 distinct clusters; many parcels are adjacent as described earlier in this summary. A visual depiction of the parcels is below (parcel outlines are indicated in red):

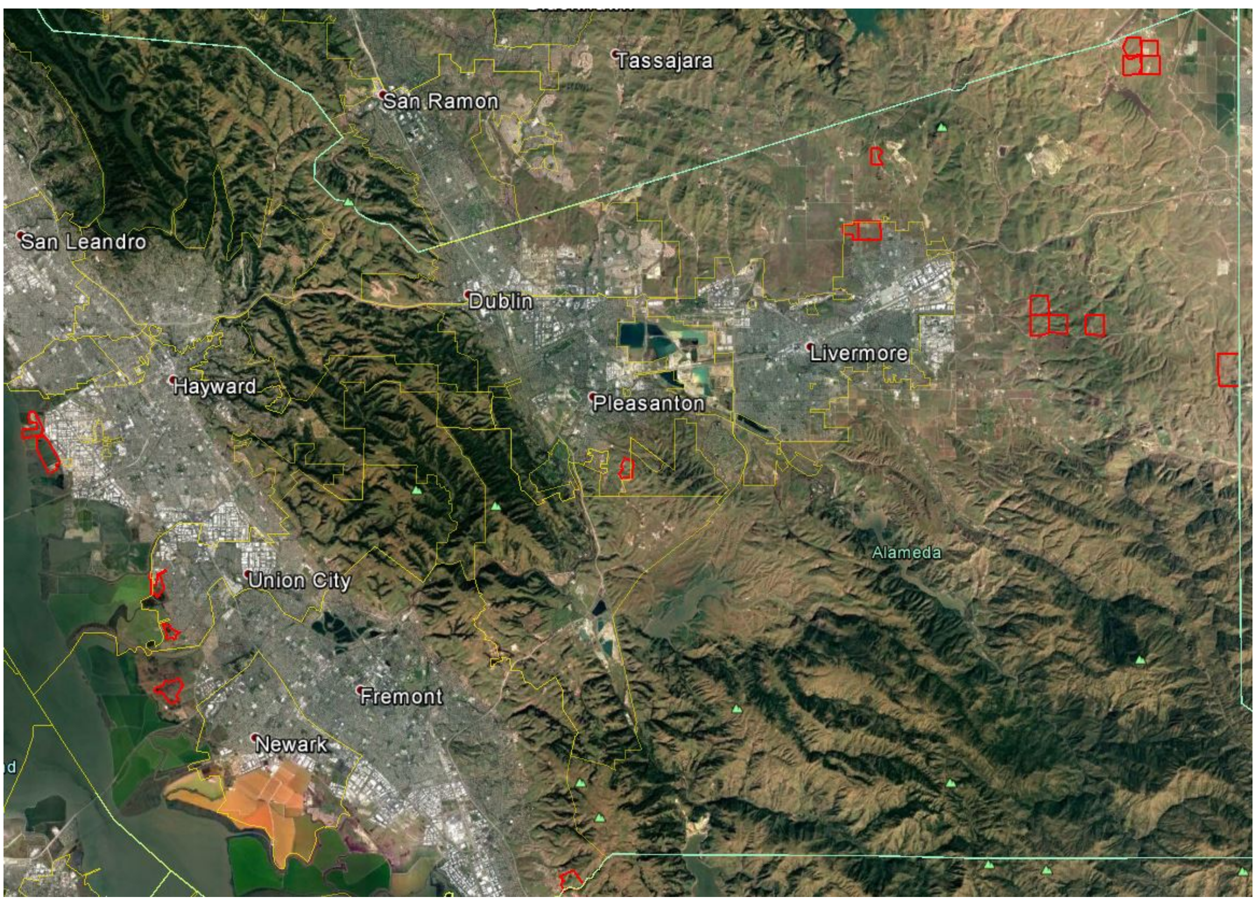


*Figure 3 - Parcels hosting turbines*

As shown on this map, over half the parcels are located north and east of Livermore, in the high wind speed corner of the County. Most of the remaining parcels are located in the next highest wind area, the corridor directly adjacent to the Bay. The geographic breakdown of parcels as is follows:

- (12) parcels in the northeast corner of the County
- (5) parcels along the Bay
- (2) parcels in miscellaneous inland region

Zooming in to the parcel level, individual pins are shown for the wind turbines. The below image is a view of a cluster of 4 parcels in the northeast corner of the County near Mountain House:


Figure 4 - Mountain House turbine placement detail

The turbine placement accommodates the topography of existing sites and the generally spacing rules that are designed to prevent eddies from one turbine affecting another either beside or behind it. A total of (55) turbines were located on the available parcels totaling 110 MW. Most of these turbines are on public land, though some are on adjacent agricultural properties:

- 80 MW on public land of over 50 acres in size
- 30 MW on adjacent agricultural land that does not appear to be actively farmed or is in transition away from agricultural use.

Zooming in to the pin level reveals some high level information for each turbine including parcel address and ownership status, average wind speed, and energy yield of the turbine:


*Figure 5 - Turbine popup info*

In regards to energy yield, the average capacity factor across the portfolio is 21%. This figure ranges from a high of 30% in the Mountain House area to a low of 12% on the (2) inland parcels away from the high wind corridors. The breakdown of turbines by energy yield is as follows:

- (15) turbines in low energy yield areas (<1,500 kWh/kW/yr)
- (25) turbines in medium energy yield areas (1,500 to 2,500 kWh/kW/yr)
- (15) turbines in high energy yield areas (>2,500 kWh/kW/yr)

The high yield sites, primarily those in the Mountain House area, are likely to provide the best power prices and should be prioritized. Most of the existing wind capacity in the County is in this area, proving the viability of wind power here.

The medium yield sites could also provide acceptable power prices. An anemometer placed on site for several months can determine the actual wind speed distribution and provide a more accurate picture of the sites viability. Grid integration costs will be the other big variable which will tilt these sites toward or away from development.

Though the turbines in low energy yield areas are less likely to have favorable power purchase agreement rates, it may be worthwhile to keep them in the fold and let the market determine what power prices can be delivered from these properties.

The chart below shows how much wind capacity could be developed at various price levels:

| LCOE ($/kW)[1] | Viable Capacity (MW)[2] |
|---|---|
| $0.10 | 32 |
| $0.12 | 52 |
| $0.16 | 80 |
| $0.24 | 102 |

*Note 1 – LCOE assumptions: 20 year fixed price for energy to break even on investment*

*Note 2 – The viable capacity in each row is cumulative (e.g. 52 MW at $0.12 includes the 32 MW developable for under $0.10)*

# APPENDIX

*References*


1. Wind speed maps, wind rose data, and Weibull parameters from AWS Truepower
2. Parcel data from Alameda County Assessor
3. Energy yield estimates using WindCad Turbine Performance Model by BWC


*About Optony*

Optony Inc. is a global research and consulting services firm focused on enabling government and commercial organizations to bridge the gap between clean energy goals and real-world results. Optony's core services offer a systematic approach to planning, implementing, and managing commercial and utility-grade renewable power systems, while simultaneously navigating the dramatic and rapid changes in the solar industry; from emerging technologies and system designs to government incentives and private/public financing options. Leveraging our independence, domain expertise and unique market position, our clients are empowered to make informed decisions that reduce risk, optimize operations, and deliver the greatest long-term return on their solar investments. Based in Silicon Valley, Optony has offices in Santa Clara, Chicago, and Beijing.

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