PRELIMINARY RENEWABLE ENERGY FEASIBILITY STUDY:

CITY OF BRISBANE

ANALYSIS OF THE BAYLANDS RENEWABLE ENERGY ALTERNATIVE

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Project Background

This report provides an assessment of the feasibility of including renewable energy generation in the redevelopment of the Brisbane Baylands Planning Subarea (Baylands). In February 2006, the primary Baylands property owner, Universal Paragon Corporation (UPC), submitted a Specific Plan that would guide the redevelopment of the eastern portion of the site. The City of Brisbane (City) is in the process of identifying and evaluating project alternatives, as required for the Environmental Impact Report (EIR). One of the alternatives being considered is the Renewable Energy Alternative, which is based on a proposal by the Committee for Renewable Energy for the Baylands (CREBL) to develop utility-scale renewable energy generation at the Baylands. CREBL's goal for this alternative was to not only offset the demand of the entire development, but to also produce additional electricity for consumption by Brisbane homes, businesses, and city-owned facilities.

The City worked with the CREBL to develop a preliminary land use plan reflecting the goal as stated above. This preliminary plan defined the approximate acreages and locations for solar photovoltaic (PV) and wind energy facilities. This preliminary plan was diagrammatic in nature to illustrate a potential land use concept, but it was not based on a technical analysis of the site or its potential for renewable energy generation. When the City discussed the potential viability of a renewable energy project on the site with Pacific Gas and Electric Company (PG&E), PG&E indicated it could provide preliminary feedback on a proposal put forth by the City.

It was determined that the preliminary plan would require additional technical analysis and possible refinements to allow for PG&E to undertake a meaningful review of a renewable energy proposal for the site. Subsequently, the City contracted with Energy Solutions (ES) to perform an analysis regarding the technical feasibility and energy generation potential of PV and wind energy on the site. This analysis led to a refinement of the preliminary plan as originally conceived in order to optimize energy generation potential in a cost effective manner as discussed further in Section 1 of this report. The City will utilize findings from this analysis, which are presented in this report, as the basis for a request to PG&E to assess the feasibility of onsite energy generation as shown in the Renewable Energy Alternative. This analysis and PG&E evaluation will in turn serve as the basis to further refine a renewable energy strategy for the Baylands, and possibly the City as a whole.

Report Layout

Section 1 of the report presents technical and design considerations, which renewable energy developers may find useful when considering the feasibility of installing PV or wind systems at the Baylands site. It includes the estimated annual generation potential of PV and wind systems as presented in the Refined Renewable Energy Alternative. Section 1 concludes with a recommendation that the Renewable Energy Alternative include a utility-scale PV project and a smaller wind project that focuses on community-scale generation or wind technology research and development. Section 2, which is intended for a City and community audience, focuses on considerations for implementing a utility-scale PV project and may help inform the next step in moving the Renewable Energy Alternative forward.

Section 1: Renewable Energy Feasibility Analysis – Renewable Energy Alternative

Introduction

As indicated in the background section of this report, this section presents findings from an analysis of the electricity generation potential of the solar photovoltaic (PV) and wind systems associated with the Refined Renewable Energy Alternative. The alternative was based upon the concept proposed by CREBL, which was further refined to optimize energy generation in a cost-effective manner. This was intended to be consistent with CREBL's concept and objective that PV and wind systems at the Baylands site produce enough electricity to offset all of the demand at the Baylands redevelopment and to produce sufficient additional electricity for consumption by Brisbane homes, businesses, and city-owned facilities.

CREBL's preliminary concept included a larger area for wind development than the refined proposal, which is presented below. The technical analysis of a more wind-intensive preliminary concept, including the estimated electricity generation potential is included in the Appendix as background information. The Appendix also includes a discussion of the reasoning behind the decision to expand the area allocated for PV and de-emphasizing wind generation, thereby creating the Refined Renewable Energy Alternative.

The total estimated generation capacity for the Refined Renewable Energy Alternative is presented below. This is followed by a more detailed description of design considerations for the PV and wind systems. This analysis provides only an estimate of the size and cost of potential PV and wind systems located at the Baylands site and is intended to help PG&E or qualified energy developer complete the project design, permitting, installation, and financing. If the City or UPC intends to pursue this option further, it will be necessary to select a developer to finalize the renewable energy project design before installing the systems. Note that renewable energy developers will likely propose their own designs and equipment, and their results may vary from those presented in this report.

Refined Renewable Energy Alternative

SITE PLAN

Figure 1 presents the site plan for the refined alternative. The wind zone parallels the south side of Geneva Avenue. The area on the north side of Geneva Avenue has been allocated for solar PV or a waste-to-energy project. This analysis assumes the area will be occupied by a waste-to-energy facility, not additional PV. Additional PV on this site would increase the overall power generation associated with the project.

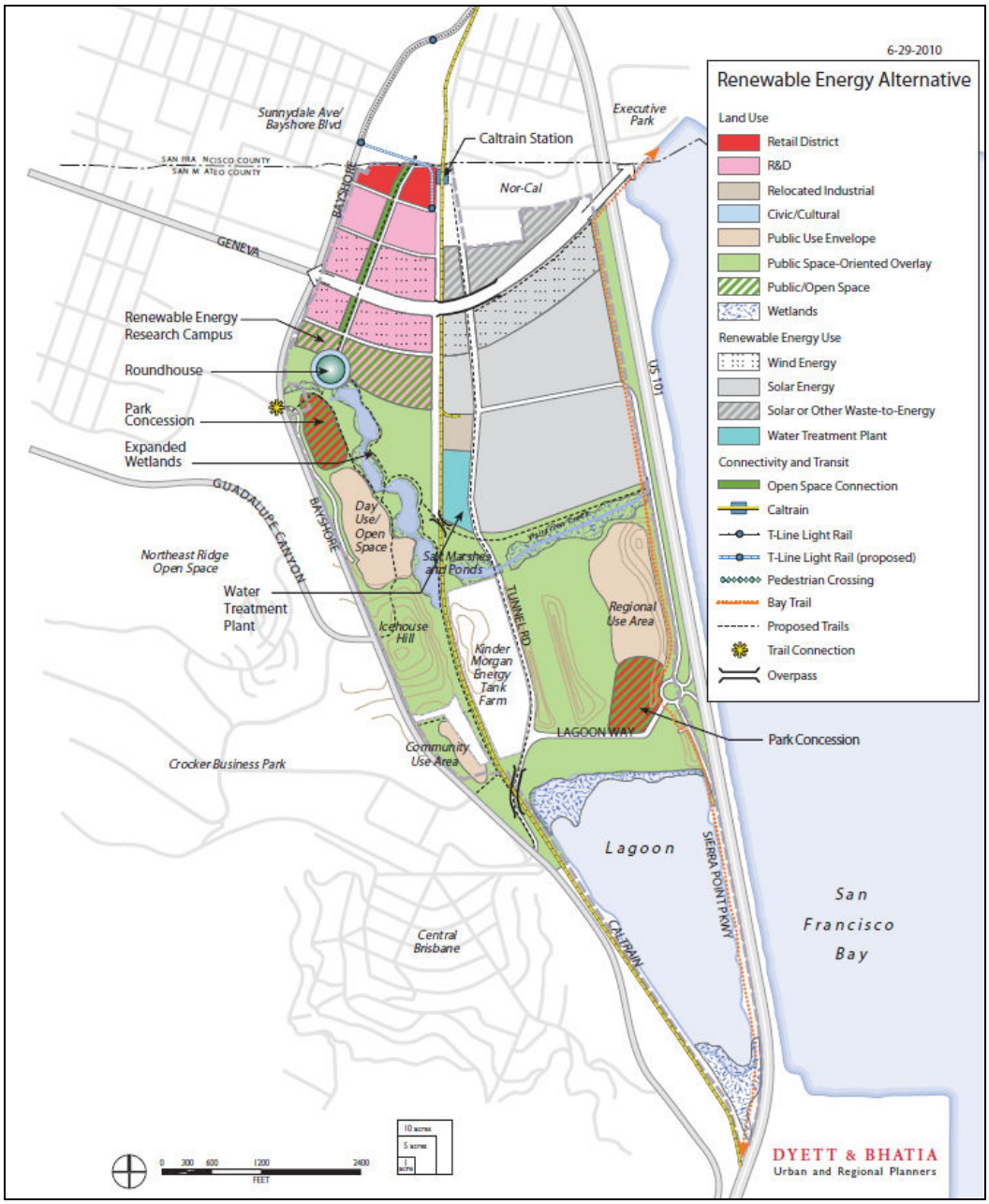

Figure 1: Site Plan of Refined Renewable Energy Alternative

ESTIMATED ELECTRICITY GENERATION

The estimated annual electricity generation from PV and wind systems as proposed in the Refined Renewable Energy Alternative layout is presented in Table 1. Electricity generation from the two PV options is not additive: the site could have wind turbines and either a fixed-axis PV system or a tracking-PV system. Electricity generation from turbines at the R&D site was not included in the analysis because it was assumed that these turbines would not be running on a continuous basis.

The conjunctive use of renewable energy generation with development, such as PV systems on the roofs of new buildings, is an important component of the larger development. It was outside of the scope of this analysis to analyze renewable energy generation potential from conjunctive applications; therefore no projections are included in this report as to the amount of energy that might be produced within the development.

Table 1: Electricity Generation from PV at Baylands Site

	Photovoltaic Systems		**Wind System [a]**
	Fixed Axis PV System	Single-Axis Tracking PV System	100 kW Turbines
Area	104 acres	104 acres	37 acres
Capacity[b]	31.7 MW	15.7 MW	0.6 MW
Annual electricity generation	45,660 MWh	29,780 MWh	2,100 MWh
Generation / capacity	1,440kWh/kW	1,890 kWh/kW	3,500 kWh/kW
Annual GHG emissions savings[c]	12,960 $MTCO_2e$	8,450 $MTCO_2e$	610 $MTCO_2e$
Number of single-family homes powered[d]	1,570 homes	1,030 homes	70 homes
Equivalent number of passenger vehicles removed from road[e]	2,480 passenger vehicles	1,616 passenger vehicles	120 passenger vehicles

a. Electricity generation potential calculated assuming a capacity factor of 0.4, which is about two times higher than the anemometer data indicates is viable for the site. The higher capacity factor was used to demonstrate potential if wind resource is better than data suggests.

b. The capacities from PV system are not additive; the site would either have 1) a fixed-axis tracking PV system or 2) a single-axis tracking PV system. The PV and wind systems can be installed, so PV and wind capacities are additive.

c. Assumes 0.288 metric tons carbon dioxide equivalents ($MTCO_2e$) per MWh of generated power. Source: California Climate Action Registry. *PG&E's 2008 Annual Entity Emissions: Electric Power Generation/Electric Utility Sector. (Actual 2007 emissions)*.

d. Assumes average single-family home in U.S. consumes 12,733 kWh per year. Source: EIA (2008). 2005 Residential Energy Consumption Survey. Table US-3, Total Consumption by Fuels Used, 2005, Physical Units.

e. Assumes average passenger car emits 5.23 MTCO2e/yr. Source: EPA. *Greenhouse Gas Equivalencies Calculator.* Updated March 2010.

PV Project Feasibility

DESIGN CONSIDERATIONS

Either a fixed-axis system or single-axis tracking system, or a combination of the two, could be located at the Baylands site.[1] Fixed-axis systems are stationary, whereas single-axis tracking systems rotate around one axis and follow the sun from east to west as the day progresses (Figure 2). In general, fixed-axis systems are preferable if the project's goal is to maximize electricity generation per square foot of land (kWh/SF), whereas tracking systems are preferable if the project's goal is to maximize electricity generation per dollar invested (kWh/$ invested). It is uncertain which type of system will be most attractive to PG&E or other PV developers. Therefore, this analysis presents the estimated electricity production from both types of systems.



Figure 2: Fixed Axis and Tracking Systems

Image Source: National Renewable Energy Laboratory. *Photographic Image Exchange*. Image 13739.

Annual electricity generation was estimated using PV generation simulation software that accounts for a number of factors, including array orientation, array tilt, type of mounting (tracking vs. stationary), insolation and weather at a particular geographic location, module type, inverter type, shading, and length of DC wiring. Key assumptions used in this Baylands analysis are presented in Table 2.

[1] Another option is a dual-axis tracking system, which not only tracks the sun from east to west, but also tracks the sun as it moves higher and lower in the sky throughout the course of the year. Dual-axis tracking systems produce more electricity per module than single-axis trackers but are also more expensive.

Table 2: Assumptions for PV analysis

Factor	Assumption
Orientation	Fixed-axis system: south Tracking system: generally south tracking east and west
Tilt	Fixed-axis system: 30 degrees Tracking system: 50 degrees
Weather Data	San Francisco weather data, which is collected at the San Francisco airport located about 5 miles south of the Baylands site, was used as an approximation of the local weather patterns.
Shading	No shading; 100% access to sun
Length of DC wiring	10 meters
Representative PV Modules	Evergreen ES-A210 modules were the representative module for this analysis.[2] These 3'3" x 5'5" modules have a rating of 180.7 watts under the California Energy Commission's (CEC) photovoltaic module PVUSA Test Conditions (PTC).[3] This module has an efficiency rating of 13.4%, which is comparable to other equivalently-sized polycrystalline modules from different manufacturers. Module cost and availability at the time of installation will be the main considerations for the final module selection.
Representative Inverters	SatCon

ENVIRONMENTAL CONSTRAINTS

GLARE

U.S. Hwy. 101, a popular commuter route, is located just east of the Baylands site. Therefore, it is probable that concerns will be expressed regarding glare from the PV panels during any future project development process. However, concerns about glare rarely derail a PV project.[4] PV panels are designed to absorb as much visible light as possible. Many panels have an anti-reflective coating to help maximize light absorption. If the Renewable Energy Alternative moves forward, the PV system should be designed to minimize glare.

WILDLIFE

The PV system may disrupt burrowing animals' habitat. This concern may require investigation before the system is installed.

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2 Evergreen Solar PV modules have a high module efficiency and lower silicon content relative to comparable PV modules. The lower silicon content results in a smaller environmental impact from manufacturing. Product data available from Evergreen website: http://www.evergreensolar.com/app/en/products/item/739

3 CEC PTC: PV system rating measured under PVUSA Test Conditions – panel temperature of 113°F, irradiance of 1,000 watts/meter2 and wind speed of 1 watt/meter. The PTC rating is used to describe individual PV module performance. http://www.gosolarcalifornia.org/equipment/pvmodule.html

4 For example, after expressing concerns about glare from a proposed PV system on an 81,000 square foot roof at the Oakland airport, the Federal Aviation Authority determined glare was not a large enough concern to stop the project from proceeding.

Wind Project Feasibility

WIND RESOURCE AT BAYLANDS SITE

With an average annual wind speed of about 10 mph at 50 meters above the ground surface and about 9 mph at 10 meters above the ground surface, the Baylands site is located in a Wind Power Class 1 area. Utility-scale wind farms that use large turbines to generate electricity are generally located in Class 4 (15.7 mph– 16.8 mph at 50 m) or higher area.[5] In general, average wind speeds of at least 11 mph are required for grid-connected applications, however wind speeds as low as 7 to 9 mph could be adequate for turbines designed for low wind speeds. Despite having marginal to poor wind resources for either utility scale or small-scale applications, it is still feasible for the Baylands to include wind turbines in the Renewable Energy Alternative. The Refined Renewable Energy Alternative assumes a small-scale wind project will be installed. However, the site may be particularly well-suited for an emerging technology demonstration project or a field-testing location for research and development.

CREBL has expressed concern that the anemometer tower may not reflect the best case wind resources at the Baylands site. The tower is located on the downwind side of San Bruno Mountain, and CREBL has suggested that data collected from the tower may not be representative of the wind resource along the Geenva Avenue corridor of the Baylands site. To address this concern, this analysis assumes a 40 percent capacity factor – significantly higher than what the 2008 – 2009 anemometer data suggests is viable for the site.[6] While there is no data to back up the assumed 40 percent capacity factor, by determining the generation potential using a higher capacity factor, it is possible to evaluate whether the wind project would be viable if the wind resource is indeed better than the anemometer data suggests.

DESIGN CONSIDERATIONS

SMALL-SCALE WIND

The market for small-scale wind turbines, which have capacities of 100 kW or less, is growing quickly. Despite the economic recession, global sales of small turbines increased 10 percent between 2008 and 2009. Just as the United States is leading market for utility-scale wind installations, the United States is a clear leader in both manufacturing and installation of small wind turbines. About two-thirds of the systems sold in 2008 were manufactured in the United States, and about 48 percent of the 42.5 MW of the global installed capacity in 2008 was installed in the United States. Further, the largest manufacturers are predicting exponential growth in U.S. sales over the next five years with projected capacity reaching 1,000 MW by 2015, up from 100 MW in the beginning of 2009.

Although there are indications that the market for small wind is taking hold, the small wind industry is relatively immature. A vast majority of the 250 companies that sell small turbines or plan to sell small turbines are in start-up phase. Many of the manufacturers are still perfecting their technologies and will likely be looking for locations to demonstrate the efficacy of their products. While the wind resource at the Baylands site is not ideal for

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[5] U.S. Department of Energy. *Wind Powering America: California 50 Meter Resource Map.* Available online at: http://www.windpoweringamerica.gov/maps_template.asp?stateab=ca.

[6] The consultant that evaluated the anemometer data (V-bar LLC) suggests using an annual capacity factor of 20.25 percent for the Baylands site. This analysis assumes a 40 percent capacity factor. According to the American Wind Energy Association, the typical capacity factor of a wind site is 30 – 40 percent.

optimizing electricity generation from wind turbines, there could be an opportunity to collaborate with manufacturers to demonstrate viable applications for small wind, which could help the United States remain competitive in the global small wind market. Products that could be tested or demonstrated at the Baylands site include:

- **Vertical-axis turbines** – These turbines are generally quieter and present a smaller risk to birds and bats than horizontal-axis turbines. Three types of small-scale vertical axis turbines are shown in Figure 4.
- **Building mounted turbines** – Currently, it is rare to see turbines mounted on buildings, though rooftop turbines are a viable alternative to PV in windy areas. In 2009, at least 17 companies were manufacturing or planning to manufacture building-mounted turbines. Many of these turbines have a vertical axis.
- **Low wind-speed turbines** – Many wind turbines require average wind speeds of at least 11 mph to generate electricity. Low wind-speed turbines can produce electricity with wind speeds as low as 2 mph.
- **High turbulence optimization** – Turbines optimized for high turbulence wind are well-suited for urban settings where buildings and trees disrupt the wind flow, creating turbulence.



Ropatec Vertical Energy **Windspire** **Quietrevolution**

Figure 3: Examples of Small (<10 kW) Vertical-axis Turbines

LOCATION OF WIND TURBINES

Figure 4 shows the possible turbine locations for 100 kW turbines, the assumed turbine size that was used for the electricity generation estimations for the Refined Renewable Energy Alternative. While the 100 kW turbines were used to estimate generation potential, a larger number of turbines with smaller could also be installed.[7]

Assuming 3 x 10 turbine spacing,[8] six 100 kW turbines could be located along the southern side of Geneva Avenue. The turbines would be set back 150 feet from the property line. There would be about 210 feet between each turbine within a row and about 670 feet between rows. A 100 kW turbine is typically about 120 feet tall from the ground to the top of the rotor, with a rotor diameter of about 70 feet.

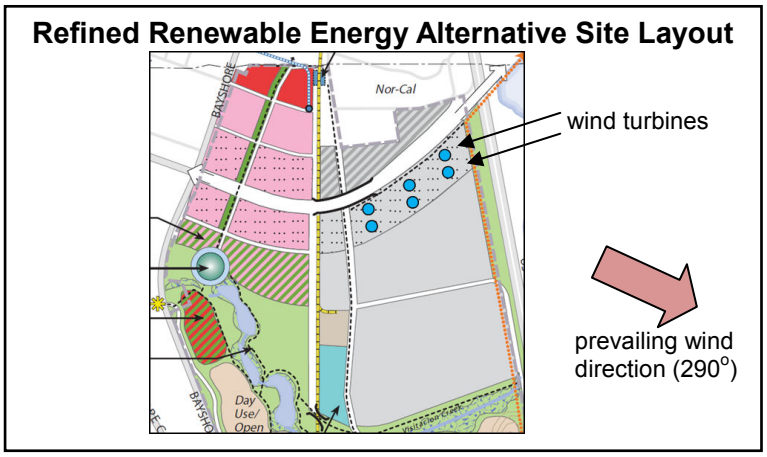

Figure 4: Potential location of wind turbines in refined site layout

ENVIRONMENTAL CONSTRAINTS

NOISE

Vibration noise associated with wind turbines has dramatically decreased in recent years due to technological advances such as taller turbines, more aerodynamic turbine blades, and slower rotor speeds. Both utility scale and small-scale turbines produce audible noise. Noise is a common concern for people living or working near wind turbines, though sound is becoming less of a barrier to adoption. To put sound levels into context, from a distance of 1,000 feet, a utility-scale turbine typically sounds as loud as a library. Similarly, from a distance of 100 feet, a small 10 kW turbine typically sounds as loud as the inside of a home.[9, 10]

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7 Locations for turbines smaller than 100kW were not identified, though there is space to site hundreds of small turbines.

8 In 3 by 10 spacing, rows of turbines are spaced apart by 3 rotor diameters within rows, and rows are separated by 10 rotor diameters.

9 American Wind Energy Association and Canadian Wind Energy Association. Wind Turbine Sound and Health Effects: An Expert Panel Review. December 2009. Available online at: http://www.awea.org/newsroom/releases/AWEA_CanWEA_SoundWhitePaper_12-11-09.pdf

10 American Wind Energy Association. Small Wind Fact Sheet: How Much Noise Does a Small Wind System Make?. Available online at: http://www.awea.org/smallwind/toolbox2/factsheet_how_much_noise.html

VISUAL

Community members are often opposed to the visual impact of wind turbines. The community rejection to the visual impact of the wind farm could dramatically slow down and possibly prevent the completion of a proposed wind project. Utility-scale projects that use tall turbines typically have a larger visual impact than small-scale projects that use shorter turbines.

WILDLIFE

The impact the wind farm would have on wildlife is a concern. The lagoons south of the wind site and the shoreline coast to the east of the wind site are attractive habitats for birds and other animals. Completing a bird and bat study may be a required step in wind farm permitting. It is also recommended that the wind farm be designed according to the California Energy Commission's "California Guidelines for Reducing Impacts to Birds and Bats for Wind Energy Development."[11]

Additional Design Considerations

The following additional design considerations are relevant for both prospective PV and wind projects.

GEOTECHNICAL

The area proposed for the wind and solar farms is on top of a municipal waste landfill that received garbage from San Francisco between 1933 and 1967. Although most of the putrescible material should have decomposed by now, the landfill may continue to settle over time. Differential settlement issues would need to be addressed in the design for pads or foundations required for both PV panels and small wind turbines. This may involve the construction of piers into underlying bedrock.

ENVIRONMENTAL

No specific environmental investigations were performed as part of this study. However, note that the landfill below the proposed renewable energy site was used primarily for household waste, and testing performed to date provides no indication that industrial chemicals or other hazardous waste are present at levels requiring remedial action. Subsequent re-use of the site for renewable energy generation or any other permanent use will require full closure of the site pursuant to California Code of Regulations Title 27, subject to regulatory oversight by the Regional Water Quality Control Board and San Mateo County Environmental Health Department, the designated lead Enforcement Agency (LEA) Methane from the landfill is collected through wells and piping. San Mateo County and the Water Quality Control Board regulate the site. Wells monitor groundwater (leachate) quality, and storm water quality is monitored at eight locations.

[11] California Energy Commission. California Guidelines for Reducing Impacts to Birds and Bats From Wind Energy Development - Final Commission Report. (October 2007). Available online at: http://www.energy.ca.gov/windguidelines/index.html.

ELECTRICAL INTERCONNECTION

The Baylands site is located about one-half a mile from the Martin substation (Figure 4). This substation is an obvious location to connect a utility-scale renewable power project, although a future developer would need to confirm that the substation could accommodate the load.



Figure 5: Location of Martin Substation and Proposed Renewable Energy Site

Image Source: Google Earth

Discussion

Key factors to consider when deciding to pursue a renewable energy project include the quality of renewable energy (solar or wind) resources, ease of permitting (including environmental review), land availability and cost of land, ease of electrical interconnection, and electricity transmission constraints. Marginal wind resources at the Baylands relative to resources available elsewhere in the state makes the Baylands a less favorable candidate location for a utility-scale wind project. However, the Baylands site is a suitable location for small wind and wind R&D projects. The solar resource at the Baylands is favorable for a sizable PV array, though resource in eastern part of the state is better than resource on the coast. Taking the available PV and wind resources into consideration, the Refined Renewable Energy Alternative layout includes a relatively large PV zone and a smaller area for smaller scale wind generation and wind research, development, and demonstration projects. The wind R&D site could play an important role in helping to advance the market for small wind.

The relative ease of permitting, comparing the Baylands site to other sites in California, depends largely on local government permitting requirements. All renewable energy developments must comply with federal and state regulations, such as the California Environmental Quality Act, but local permitting processes and fees vary throughout the state. As such, the City of Brisbane has the ability to adjust local permitting requirements to make the development more or less attractive from a permitting perspective.

Plots of land near urban areas, such as the Baylands site, are typically smaller and more expensive than land farther from urban centers. Installing renewable energy at the Baylands

site does present several challenges. The site is situated between two wildlife habitats: a lagoon to the south and the shoreline of the San Francisco Bay to the east. This may present wildlife impact concerns, though any development that occurs at the Baylands will impact wildlife. The cost premium of building on top of a landfill site could present another challenge. Neither the wildlife concerns nor the presence of the landfill precludes the Baylands site from being a good candidate for a renewable energy farm.

Apart from these challenges, there are some are some potential benefits of installing a renewable energy systems close to an urban center. These benefits include minimizing transmission losses, alleviating congestion on transmission lines, and enhancing security of electricity supply. The amount of electricity that is lost between a generating source and a load depends on, among other factors, the distance between the generating source and the load. In 2008, the average transmission losses in California were 6.8 percent, though losses are higher during peak periods when PV systems generate electricity.[12] Locating the generation source closer to a load center will help reduce transmission losses and costs associated with generating electricity that never makes it to the end user.[13] Adding generation close to load will help eliminate the need for, or delay the need for, a costly expansions to the transmission system.

Electricity supply security is another widely quoted benefit of having a larger number of smaller generating sources. Increasing the number of smaller distributed generation sources can help mitigate the risk of blackouts. The PV system at the Baylands, which would generate electricity during peak periods, would also help supply electricity for peak demand within the San Francisco region.

12 United States Energy Information Administration. State Energy Profiles; California. Data year 2008. Released March 2010. Table 10.

13 Transmission lines that are used to transport electricity long distances are high voltage direct current lines, which are more efficient at transmitting electricity than the lower voltage alternating current lines used in the local distribution network. Moving the generation source closer to a load center will eliminate losses associated with long-distance transmission, but losses from the local distribution network will still occur.

Section 2: Implementation Considerations

Introduction

The following section provides an overview of the costs and revenues associated with renewable energy projects; describes some options for partnering with PG&E to develop the project; and concludes with recommendations for next steps in developing the PV project. For guidance on implementing a small-scale wind project, refer to information from the American Wind Energy Association.[14]

Project Costs

Project costs include capital equipment and labor, permitting, operations and maintenance, and taxes on state incentives:

- **Capital costs** – Capital costs include equipment (PV modules, inverters, racking systems, and wiring) and labor, and design costs.
- **Permitting** – PV installations of this proposed size are subject to the permitting requirements of local governments. Although the permitting fees are minimal, significant staff and engineering documentation costs are associated with obtaining permits.
- **Operations and maintenance** – The operation and maintenance cost consists of washing the PV panels twice per year and the replacement of inverter in year 13.
- **Taxes on incentives** – Corporate taxes on incentives will apply to privately owned PV systems. The IRS and the California Franchise Tax Board consider CSI Performance Based Incentive (PBI) payable to private entities as corporate income and is thus subject to Federal and State taxes.

Project Revenues

STATE INCENTIVES

CALIFORNIA SOLAR INITIATIVE (CSI)

Incentives from the CSI are available to solar PV projects ranging in installed capacity (kW CEC-AC) from 1 kW to 5 MW with incentives available for up to 1 MW of installed capacity.[15] Two types of incentives are available: Expected Performance Based Buydown (EPBB) which is based on expected performance and pays on power capacity, and a

[14] American Wind Energy Association. Small Wind. http://www.awea.org/smallwind/.

[15] A project sized to the full technical capacity at the Baylands site would larger than 5 MW. Thus, a project sized to full technical capacity would not qualify for the CSI incentives.

Performance Based Incentive (PBI) which is required for systems over 30 kW AC which is based on the actual performance of the PV system over a 5-year period following installation and pays on kWh produced.

The CSI incentive payment levels decrease over time as the program issues solar PV reservations. As of July 7, 2010, the PBI incentive for government and non-government entities in PG&E service territory is $0.19/kWh and $0.09/kWh for commercial entities.

EMERGING RENEWABLES PROGRAM (ERP)

The ERP program offers cash rebates on eligible grid-connected small wind and fuel cell systems. Qualifying wind turbines have a rated output of 50 kW or less, but the program will only provide incentives for 30 kW of capacity. The incentive level for the first 10 kW is $3.00 per watt through April 6, 2011 and $2.50 per watt beginning April 7, 2011. The incentive for increments between 10 kW and 30 kW is $1.50 per watt.

STATE DEPRECIATION

The California corporate tax code allows for twelve year straight line depreciation on PV equipment costs. Although PV systems have a life expectancy of over 25 years, the entire system can be depreciated in twelve years using the straight line method which allows 8.33 percent of the system cost to be deducted each year for twelve years. Privately owned PV and wind systems can take advantage of this.

FEDERAL INCENTIVES

FEDERAL ACCELERATED DEPRECIATION

The IRS has an accelerated depreciation schedule for PV systems. Although PV systems have a life expectancy of over 25 years, the entire system can be depreciated in 6 years. The accelerated depreciation schedule cannot be claimed for property used mainly outside the United States, used by governmental units and foreign persons and entities, or used by a tax-exempt organization (unless the property is used mainly in an unrelated trade or business).

Businesses with PV installations can also use the Modified Accelerated Cost Recovery System (MACRS). Under MACRS, businesses can recover investments in PV electric equipment through depreciation deductions over 5 years.

FEDERAL INVESTMENT TAX CREDIT (ITC)

The Energy Policy Act of 2005 established a 30 percent federal investment tax credit for the purchase of solar electric and solar water heating property. The tax credit is calculated based on the total installed project cost, including materials, labor, and sales tax but excludes project costs covered by subsidized energy financing or tax-exempt private activity bonds. The ITC expires on December 31, 2016. The American Reinvestment and Recovery Act (ARRA) authorized the direct payments, or grants, in lieu of tax credits, though this program will end on December 31, 2010.

UTILITY NET METERING CREDITS

Net-metering allows customers to apply on-site generation of electricity towards electricity the consumer consumes. The rule allows customers to receive payment for electricity generated in excess of their consumption, however the program is intended to zero-out electricity bills and excess generation is not encouraged. Net-metering rules in California currently apply to renewable energy systems up to 1 MW in size (or 10MW for up to 3

biogas digesters).[16] Net-metering credits customers for the value of excess energy production based on the time-of-use rates. Thus, if a renewable energy system produces energy during peak periods in excess of the site's usage during peak periods in a given month, the customer is credited for the value of this excess generation at the utility's higher peak rates. Electricity usage charges net of on-site generation during each rate period are billed to the customer according to the rate schedule that applied prior to installing the PV system.

FEED-IN TARIFFS

Feed-in tariffs allow customer to sell the electricity produced by small (3 MW cap) renewable energy systems at time-differentiated market-based prices. Feed-in tariffs are available to customers who enter 10, 15, or 20 year contracts with the utility.

RENEWABLE ENERGY CERTIFICATES / RENEWABLE ENERGY CREDITS (REC)

For the purpose of complying with California's proposed regulations, a REC is defined as a certificate of proof, issued through the Western Renewable Energy Generation Information System (WREGIS), that one megawatt-hour (MWh) of electricity was generated by an RPS-eligible renewable energy resource and was delivered for consumption by California end-use retail customers. A REC includes all renewable and environmental attributes associated with the production of electricity from the eligible renewable energy resource, including any avoided emission of pollutants to the air, soil or water; any avoided emissions of carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, sulfur hexafluoride, or any other greenhouse gases (GHGs) that have been determined by the United Nations Intergovernmental Panel on Climate Change, or otherwise by law, to contribute to the actual or potential threat of global climate change; and the reporting rights to these avoided emissions, such as Green Tag reporting rights.

In 2002, the State of California passed a Senate Bill (SB 1078) that established a Renewable Portfolio Standard (RPS) for the State. The RPS mandated that investor-owned utilities (IOUs) in California had to increase procurement from eligible renewable energy resources by a minimum of 1 percent of their retail sales annually, such that renewable energy comprised at least 20 percent of the utilities' total supply portfolio by this year (2010). Recent executive orders have set a target of 33 percent renewable energy in IOU supply portfolios by 2020.

Currently, the IOUs are not permitted to purchase RECs independently of energy[17] for the purpose of complying with the RPS. Therefore, at this time, IOUs have no motivation to purchase so-called Tradable RECs that are associated with projects in which the power is sold by the project owner directly to the end user. Although Tradable RECs have not yet been authorized by the CPUC, a preliminary framework has been proposed to protect ratepayers from the potential for excessive payments by IOUs seeking to meet their RPS targets. In the early stages of the REC market, the framework suggests a temporary price cap of $50 per REC used for RPS compliance by IOUs. Futures contracts for RECs that meet the Renewable Portfolio Standard (RPS) compliance requirements for the states of New Jersey, Connecticut, and Massachusetts are currently traded on the Chicago Climate Futures Exchange. Massachusetts RECs are reported to be trading at between $23.50 and

[16] A project sized to the full technical capacity possible at the Baylands site would exceed 1 MW. Thus, a project sized to full technical capacity would not qualify for net metering.

[17] RECs unbundled from the actual generated energy are called Tradable RECS, or TRECS.

$25.50 per REC as of February 2010, although the price is significantly lower in other states.[18]

PV Project Partnering and Development

If a utility-scale renewable energy project moves forward, PG&E will be involved in some form. At a minimum, PG&E will play a role in interconnecting the project to the electricity grid – most likely through the Martin substation. However, it is possible that PG&E would take a more substantial role in the project.

On April 22, 2010, the California Public Utilities Commission (CPUC) authorized a program that would lead to the development of small (1 – 20 MW) PV facilities within PG&E territory.[19] The Baylands site could be a viable project to develop under this program, which allows PG&E or third parties to own the PV facilities.[20]

Pursuant to the California RPS Program, PG&E has to increase its total procurement of renewable energy resources by 1 percent of annual retail sales per year. Therefore, PG&E has established a mechanism for procuring renewable energy; every year PG&E solicits offers through a competitive request for proposals (RFP) process. The utility reviews bids through a coordinated process and enters into contracts with winning bidders.

PG&E's draft RFP for 2010's procurement cycle identifies five ways an entity can enter into a renewable energy contract with PG&E. These methods are described below.

- **Power Purchase Agreement (PPA) -** A Power Purchase Agreement (PPA) is an agreement between an electricity generator (provider) and a power purchaser (host). The provider secures financing, designs, builds, operates, and maintains the energy production project. The host purchases power from the provider at a contractual price for the duration of the contract, usually 5 – 25 years. The PPA arrangement has the built-in incentive for the provider to optimize system performance because the provider is paid on the basis of electricity generated.
- **Power Purchase Agreement (PPA) with Option to Own Project** – This is the same as the PPA described above, but at the end of the term, the host has the option to purchase the renewable energy system, or project, for fair market value. The PPA arrangement may also contain a clause to purchase the system after six years, at the end of the accelerated depreciation schedule, for fair market value.
- **Power Purchase and Sale Agreement (PSA)** – Using this model, the contractor would design and build the project and sell it to PG&E when the project becomes operational.
- **Purchase of Site and Development Rights** – The landowner would sell the site and the development rights to PG&E and PG&E would design, build, operate and maintain the facility.

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[18] According to Evolution Markets, Inc. http://new.evomarkets.com/pdf_documents/February%20REC%20Market%20Update.pdf

[19] California Public Utilities Commission. Decision Adopting a Solar Photovoltaic Program for Pacific Gas and Electric Company. April 22, 2010. Item 32a. Available online at: http://docs.cpuc.ca.gov/PUBLISHED/AGENDA_DECISION/116784.htm.

[20] The program is a five-year program; PG&E will install 20 MW per year under direct ownership and 20 MW per year under third party ownership. The total installed capacity will be 500 MW.

- **Joint Development and/or Joint Ownership Models** – This option covers any number of models where PG&E would play a role in developing the project and/or owning the project. Under this model, PG&E would have, at least, partial ownership over the proposed project.
- **Renewable Energy Certificates (REC) Procurement** – In this scenario, PG&E would not be involved in the development or ownership of the project, nor would the utility purchase power from the provider. PG&E would, however, purchase RECs from a renewable energy project.[21]

Next Steps

The City and PG&E should evaluate the utility's interest in supporting the development of a PV power plant at the Baylands site. The City may also evaluate the interest-level among private PV and wind developers.

[21] Currently, California does not allow IOUs to purchase Tradable RECs to comply with California's RPS standard. IOUs do not have motivation to purchase RECs until they are an approved mechanism to comply with the RPS.

Appendix A: Preliminary Renewable Energy Alternative

PRELIMINARY SITE PLAN

Figure 1 presents the preliminary renewable energy alternative site plan, which had a strong focus on wind power generation. The wind zone parallels Geneva Avenue on the north and south side and extends south along the eastern property line.

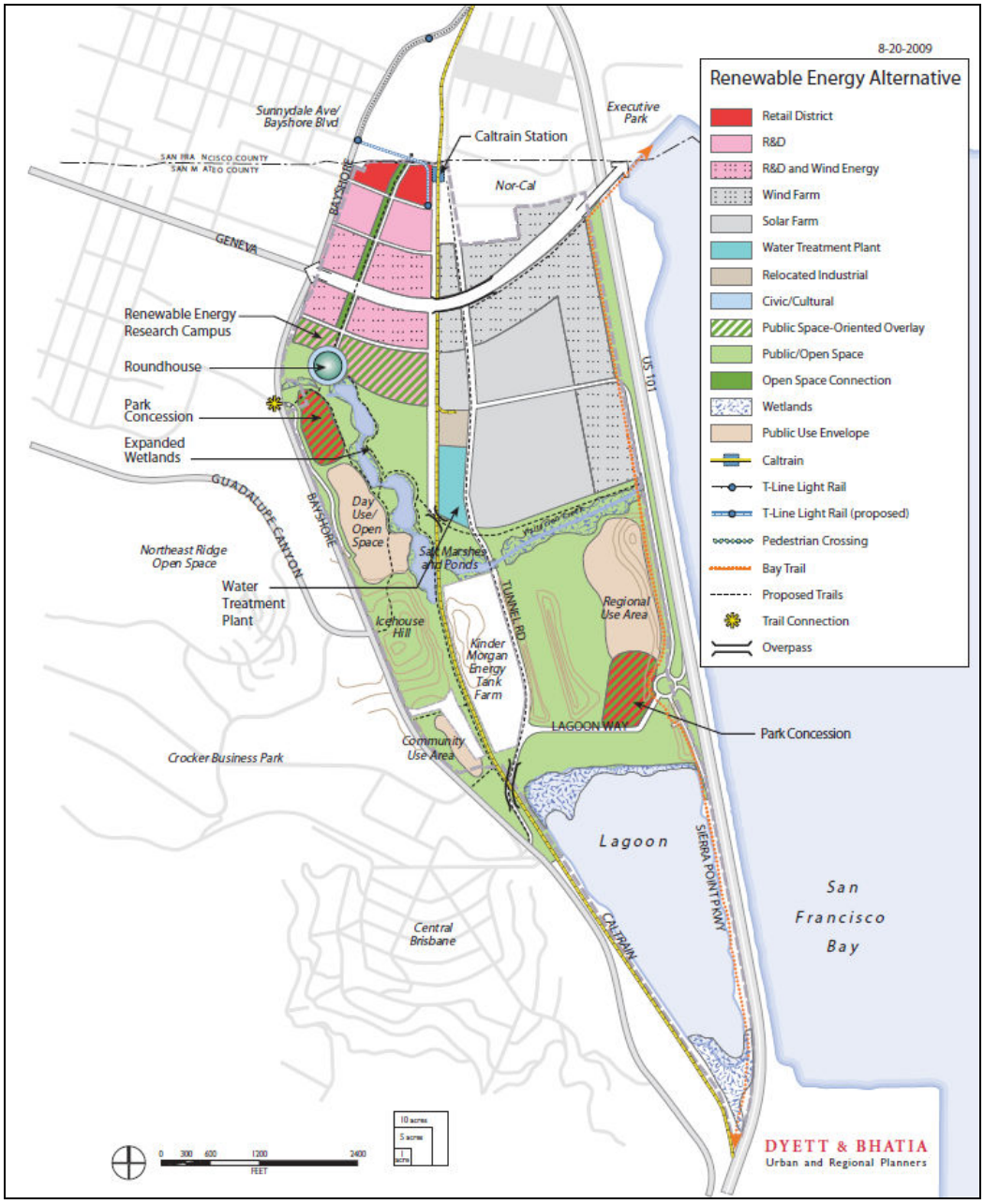

Figure 1: Site Plan of Preliminary Energy Alternative

ESTIMATED ELECTRICITY GENERATION

The estimated annual electricity generation from PV and wind as proposed in the Preliminary Renewable Energy Alternative: is presented in the Table below. Note that the electricity generation estimates are not additive. The analysis assumes that the site would either have: 1) a fixed axis PV system, 2) a single-axis PV system, 3) large wind turbines, or 4) smaller wind turbines.[22]

Installing a PV system in conjunction with wind turbines located west of the PV zone, parallel to U.S. Hwy 101, is not recommended. If the wind turbines are installed, the tall turbines will cast shadows on the PV zone to the west of the turbines. Shading PV modules and arrays can cause disproportional reductions in power output: in extreme cases, 10 percent shading can reduce power output by as much as 90 percent. Installing wind turbines on the north side of the PV zone, or along Geneva Avenue, is feasible because shadows from the turbines would not fall on the PV zone.

While turbines in the wind research and development (R&D) zone will produce electricity, the generation potential was not included in total wind generation potential. It was assumed that generation from turbines at the R&D site may be inconsistent as manufacturers and researchers experiment with turbine efficacy and refine designs.

[22] A renewable energy developer may propose using a combination of PV or wind technologies, though the combined scenario was not modeled.

Table 3: Electricity Generation from PV and Wind at Baylands Site – Preliminary Plan

	Photovoltaic Systems		Wind Systems [a]	
	Fixed Axis	Single-Axis	660 kW Turbines	100 kW Turbines
Area	73 acres	73 acres	68 acres	68 acres
Capacity[b]	22.3 MW	11.0 MW	3.3 MW	1.8 MW
Annual electricity generation	32,050 MWh	20,900 MWh	11,560 MWh	6,310 MWh
Generation / capacity	1,440 kWh/kW	1,890 kWh/kW	3,500 kWh/kW	3,500 kWh/kW
Annual GHG emissions savings[c]	9,100 $MTCO_2e$	5,950 $MTCO_2e$	3,300 $MTCO_2e$	1,820 $MTCO_2e$
Number of single-family homes powered[d]	1,100 homes	720 homes	400 homes	220 homes
Equivalent number of passenger vehicles removed from road[e]	1,740 passenger vehicles	1,140 passenger vehicles	630 passenger vehicles	348 passenger vehicles

a. Electricity generation potential calculated assuming a capacity factor of 0.4, which is about two times higher than the anemometer data indicates is viable for the site. The higher capacity factor was used to demonstrate potential if wind resource is better than data suggests.

b. The capacities are not additive; the site would either have 1) a fixed-axis tracking PV system, 2) a single-axis tracking PV system, 3) large wind turbines, or 4) smaller wind turbines.

c. Assumes 0.288 metric tons carbon dioxide equivalents ($MTCO_2e$) per MWh of generated power. Source: California Climate Action Registry. *PG&E's 2008 Annual Entity Emissions: Electric Power Generation/Electric Utility Sector. (Actual 2007 emissions).*

d. Assumes average single-family home in U.S. consumes 12,733 kWh per year. Source: EIA (2008). 2005 Residential Energy Consumption Survey. Table US-3, Total Consumption by Fuels Used, 2005, Physical Units.

e. Assumes average passenger car emits 5.23 MTCO2e/yr. Source: EPA. *Greenhouse Gas Equivalencies Calculator.* Updated March 2010.

DESIGN CONSIDERATIONS

UTILITY-SCALE WIND

A utility-scale wind project was evaluated for the Preliminary Plan (see Figure 1). Considering the marginal wind resource and the geotechnical challenge of mounting turbines on 180-foot pilings, it is unlikely that the economics of a utility-scale wind farm would be attractive to a prospective wind developer. Even assuming a higher capacity factor than the anemometer data suggests is present, the generation potential from the wind site is less than a hundredth the potential of competing wind projects that are being developed, and which benefit from economies of scale. The generation potential of the utility-scale wind project was included in this analysis as a point of reference.

LOCATION OF WIND TURBINES

The figure below shows the possible turbine location of 660 kW turbines and 100 kW turbines on the preliminary site plan. The 660 kW turbines represent the smallest turbines that might be used in a utility-scale project, and the 100 kW turbines represent smaller turbines that could be used to generate electricity for a community-scale project.[23]

Assuming 3 x 10 turbine spacing,[24] five turbines 660 kW could be located along the eastern edge of the Baylands site parallel to U.S. Hwy 101. The turbines would be set back 150 feet from the property line, and there would be about 465 feet between each turbine. It may be possible to site another one or two turbines along Geneva Avenue, though it probably would not make economic sense to run another 1500 – 3000 feet of wiring to connect one or two turbines. A 660 kW turbine is typically about 288 feet tall from the ground to the top of the rotor, with a rotor diameter of about 155 feet.

Also assuming 3 x 10 spacing, fourteen 100 kW could be located along the eastern edge of the Baylands site parallel to U.S. Hwy 101, and an additional four turbines could be located along Geneva Ave. Again, the turbines would be set back 150 feet from the eastern property line. There would be about 210 feet between each turbine within a row and about 670 feet between rows. A 100 kW turbine is typically about 120 feet tall from the ground to the top of the rotor, with a rotor diameter of about 70 feet.

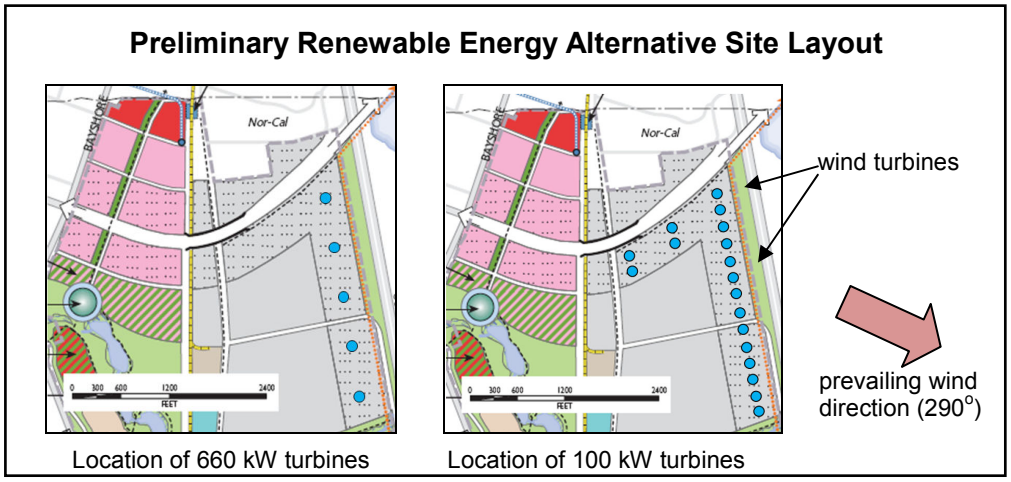

Figure 1: Potential location of wind turbines in refined site layout

REASONS FOR REFINING RENEWABLE ENERGY DESIGN

Based on the preliminary assessment of PV and wind generation capacity of the Preliminary Renewable Energy Alternative, it was Energy Solutions' determination that the Baylands site could generate more electricity if the PV zone were expanded to the eastern property line. The refined layout includes an expanded PV zone and does not include a wind zone to the west of the PV zone. The expanded PV zone increases the PV capacity, which could help the project be more competitive with other PV projects in the region.

[23] Locations for turbines smaller than 100kW were identified, though there is space to site hundreds of small turbines.

[24] In 3 by 10 spacing, rows of turbines are spaced apart by 3 rotor diameters within rows, and rows are separated by 10 rotor diameters.

Considering the marginal wind resource at the site, the incremental costs of installing wind on turbines on a capped landfill, and the fact that Baylands site is significantly smaller than most other wind development sites, a utility-scale wind project does not appear to be practical. It is unlikely that the Baylands wind project would be competitive with other proposed wind projects.