THE HIGHEST VALUED GRID TIED PHOTOVOLTAICS

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ABSTRACT

Photovoltaics (PV) is highly valued in outer space and for off-grid applications like telecommunications. Recently on-grid has been the fastest growing market sector for PV. There are places on-grid where PV makes the most sense for its distributed generation qualities. This paper investigates methodologies to determine where PV has the highest value, and where it can actually be inappropriate, for grid tied applications. Strategic Value Analysis is used to determine power flow hot spots in need of distributed generation. Demographics of the locations are used to determine social and economic values. Grid issues and values are combined to determine the best locations to target grid-tied PV installations. This paper explores methodologies used for determining the most advantageous places in California for sighting distributed generation from building integrated photovoltaics (BIPV).

1. INTRODUCTION

BIPV installed on new residential and new commercial roofs has the highest value for distributed generation (DG).

In the past, utility planners have focused on the best time to generate electricity. Some renewables, like wind and solar have intermittent qualities which reduce their marketability. However, solar's uniquely qualified for reliable coincidence with peaking grid needs. Richard Perez of the State University of New York in Albany has shown that electricity from PV has a high correlation with when building loads are highest.

Up until recently, the grid has been assumed to be a reservoir that can handle less than 1 MW solar effectively, thus location of solar has not been a predominant requirement. Distribution level analysis proposed in this paper can highlight grid issues that can be addressed by DG technologies like PV.

First, solar resources will be evaluated, then methodologies for these grid issues investigated, and then growth patterns will be combined to locate the highest value locations for these DG PV solutions.

2. SOLAR RESOURCE MAPS

Using recent un-validated data from the National Renewable Energy Laboratory (NREL) we have illustrated the geography for solar resources in California. While the state is excellent overall, some spots are potentially very well suited for flat plate installations. On these high-resolution resource assessments, each small square represents

10 kilometers by 10 kilometers (kM) of area, or 100 square kilometers (kM^2).

Flat plate resource maps are used for solar thermal or PV. For this paper's purposes, it refers to PV. Flat plate radiation data is the energy expected to hit a fixed surface that is tilted at an angle equal to the latitude of the location, pointing directly south. Fig. 1 shows a gradient of solar performance for flat plate, yellow being higher average radiation, blue not as high. Fig. 2 through 4 reflects more valuable quantification, where the bright yellow indicates cells that meet or exceed the performance of the map title. The "kW" in kWh / kW is AC kilowatts for grid-connected systems. This is used to eliminate questions of system performance inherent in DC ratings. Similarly, "kWh" is in AC kWh.

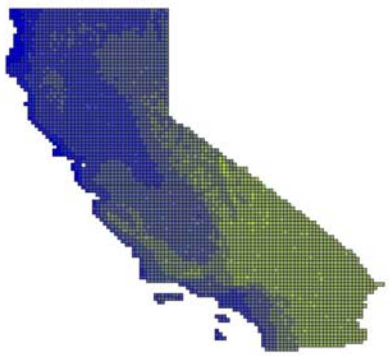

Fig. 1: Gradient of Flat Plate resources.

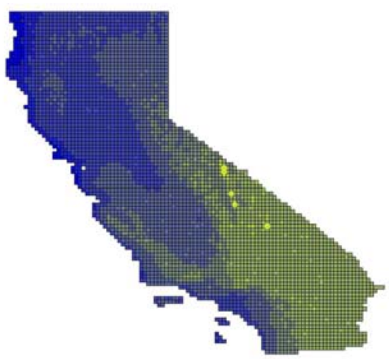

Fig. 2: Flat Plate map for places with greater than 7 kWh / day average, or 2,555 kWh / kW installed capacity per year.

As seen in Fig. 2, five of the 100 square kM blocks show a large resource for flat plate solar systems.

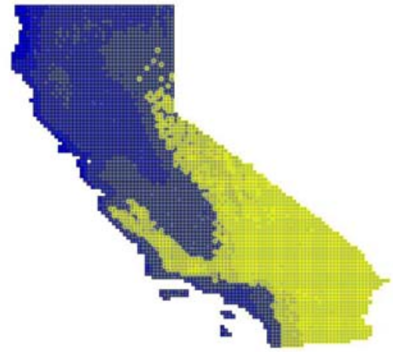

Fig. 3: Flat Plate map for places with greater than 6 kWh / day average, or 2,190 kWh / kW installed capacity per year.

As seen in Fig. 3, the hot, dry central valley and the California desert have many locations that are quite good solar resources for flat plate systems.

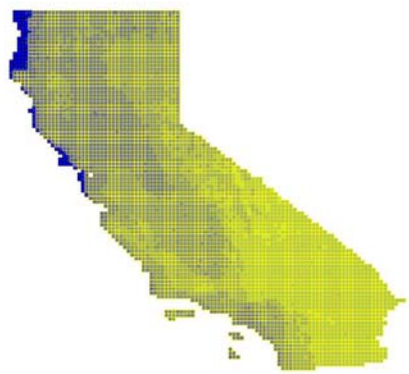

Fig. 4: Flat Plate map for places with greater than 4.930 kWh / day average, or 1,800 kWh / kW installed capacity per year.

As seen in Fig. 4, almost for the entire state, a 1 kW AC system will supply at least 1,800 kWh AC per year.

3. HOT SPOT ANALYSIS

Hot Spot Analysis looks at the electric grid and determines current and future location problems. It represents the best place to site distributed generation, along with places where DG would not be helpful, where it might actually disrupt power flow. Grid problems could be a capacity problem, reflecting a place where DG would possibly be beneficial. Or, the grid problem could be a congestion problem, in which case, injecting more DG could be increasing the congestion problem. The grid needs to be analyzed at various voltage levels, high voltage down to distribution voltages, and looked at for the capacity and congestion issues of today and tomorrow. Fig. 5 visualizes what an analysis might determine, for the year 2007. It is theorized that the red spots would be the best locations to reduce future grid overload potentials. The blue spots would be places where DG would have a negative effect on grid reliability, increasing overload potential.

Fig. 5: Example visualization of hot spot analysis.

4. GRID VALUE

The hot spot analysis is one factor important in sighting DG. PV can have other site-specific values to the utility. These might include capacity value, sub-and bulk-transmission value and voltage support. With impending distributed resource loads, and the unknown effects of two-way power flow on the electric grid, the same size attributes, which result in high cost-effective impacts, can also minimize the operations impact and risk to the utility grid. Site-specific DG, like PV, can have positive community relations by reducing perceived issues of environmental justice.

5. ECONOMICS

High economic potential for solar is accomplished on buildings because of the opportunity for net metered installations. Ground mounted systems require structural, electrical, and real-estate expenses. On buildings, the structural, real estate, and electrical wiring costs for PV are either low, or free. Because of net metering, the building installations accrue the highest "retail value" for the electricity produced.

Photo-1 PowerGuard BIPV installation (Photo courtesy of PowerLight).

Existing Commercial buildings define the most logical place for retrofit commercial PV. With new commercial construction and new residential installations facilitating real building integration of PV (BIPV) in the building design phase. BIPV can have the added energy benefits of shading the buildings, thus reducing HVAC peak loads. BIPV can also have a material credit for the displaced materials which PV modules replace; concrete roof tiles that do not need to be purchased.

New residential construction with PV can capture long term, low mortgage rates; developers benefit from economies of scale, thus capturing the lowest installation cost. Locating new communities with PV roofs in locations that help the grid capacity issues will provide the highest valued grid tied photovoltaics.

Additional economic, social, and energy values that accrue to owners, businesses, and utilities are expanded upon in reference (2).

6. LOCATION, LOCATION, LOCATION

As discussed above, hot spot analysis can determine grid locations needing generation capacity. Census data and building databases can help to estimate the amount of roof space available to address the capacity issues with roof mounted PV. State, county, and city based growth forecasts can help highlight locations with major new construction. With growth comes grid capacity problems, but growth also brings opportunities for DG on building roofs with BIPV.

7. CONCLUSION

Using solar resource maps, grid hot spot analysis, demographic information, and forecasted growth patterns, locations can be determined where BIPV can solve today's and tomorrow's utility grid capacity issues.

8. ACKNOWLEDGMENTS

We would like to acknowledge NREL's work on 10 kM solar radiation database. The graphics used in this paper utilizes data that has yet to be verified. In addition, we would like to acknowledge the California Department of Forestry's work on strategic value analysis for renewable energy generation in California.

9. REFERENCES

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