SOLAR 2004 CONFERENCE: GIS TOOLS FOR COMMUNITY DEVELOPMENT APPLICATIONS

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ABSTRACT

This paper describes efforts of the Marin Solar Program to canvass the potential for development of solar resources in Marin County.

By integrating Geographic Information Systems (GIS) analysis tools, such as Solar Analyst, with readily available data sources such as orthographic aerial photos and parcel information, our team created a map that contains corridors of high and low solar access, location of buildings within those corridors and information on building type. This map enables identification and cataloguing of structures that are located in optimal solar corridors throughout Marin County.

The applications of the map include assessment of solar potential, outreach to niche markets, and aid in technical assistance as well as policy development and implementation. The project has resulted in a successful pilot outreach effort to commercial businesses. Most importantly, simply by integrating resources that were easily accessible to the County's planning department, it was accomplished with overall expenditures totaling less than $5,000.

1. INTRODUCTION

The County of Marin Community Development Agency (CDA) created the Marin Solar Program in August 2002. The charge of the program is to foster solar installations through outreach and education. To this end, the program's associates provide free services to Marin's residents and businesses including workshops, site surveys as well as advice on financing options, selecting contractors and comparing bids.

It is difficult to successfully develop and operate a solar program without first understanding what resources are available. Knowing the potential in a community for solar applications is an important first step in this process. The solar potential map (SPM) is the result of efforts to determine the build-out potential for photovoltaics (PV) and other solar technologies in Marin.

2. SOLAR POTENTIAL MAP

The solar potential map (SPM) involves the integration of three data layers and the creation of a fourth to generate a graphical representation of solar resources in Marin. The four layers are: 1) solar insolation, 2) orthographic aerial photographs, 3) County parcel information and 4) a database containing identified candidate sites.

Within the GIS environment, orthographic images constitute the bottom-most layer of the map. Next, a solar insolation map was added as a transparent layer over the orthographic images. Parcel data act as the third layer and visually demonstrate property lines. When viewed together, these first three layers provide new, useful information, which is then incorporated as the map's fourth layer.

2.1 Layer One: Orthographic Information

The first component of the SPM is digital orthographic images of Marin. Aerial photographs are useful for land cover and land use analyses. In the solar potential map, aerial photos allow for the identification of buildings and structures in Marin that have large, unobstructed spaces. The aerial photographs were orthorectified with a 6-inch per pixel resolution.

Fig. 1: Orthographic image of rooftops in Marin.

2.1.1 Limitations to Orthographic Information

An inherent limitation of orthographic images in the solar potential map is that they capture the landscape at a particular point in time. Changes in vegetation, as well as changes and additions to a structure's envelope can lead to inaccuracies in the SPM. Frequently taken satellite images that are GIS-importable are one way to mitigate this concern.

2.2 Layer Two: Solar Insolation

The next component of Marin's SPM is a map illustrating where the sun shines and where it does not. Marin County is comprised of a wide variety of topography, from the tidal flats of the bay region to narrow valleys to hilly slopes that rise 2,600 feet (240 meters) above sea level. As a result, solar insolation in Marin can vary significantly over relatively small geographical areas.

To address the issue of topography, Solar Analyst software was employed. Solar Analyst requires ArcView 3.2, a common GIS operating platform, and the Spatial Analyst extension to run. Solar Analyst is now available in the public domain for free[1]. The key input for the software was a digital elevation model (DEM) of the region, which uses latitude, longitude and height for its x, y and z coordinates. Marin County's GIS and Mapping Division generated the DEM for this project.

As shown in Figure 2, areas of high solar potential (approximately 1,400 kwh/m^2-year) are indicated by light/yellow shading while areas of low solar potential (approximately 250 kwh/m^2-year) are indicated in dark/purple shading.

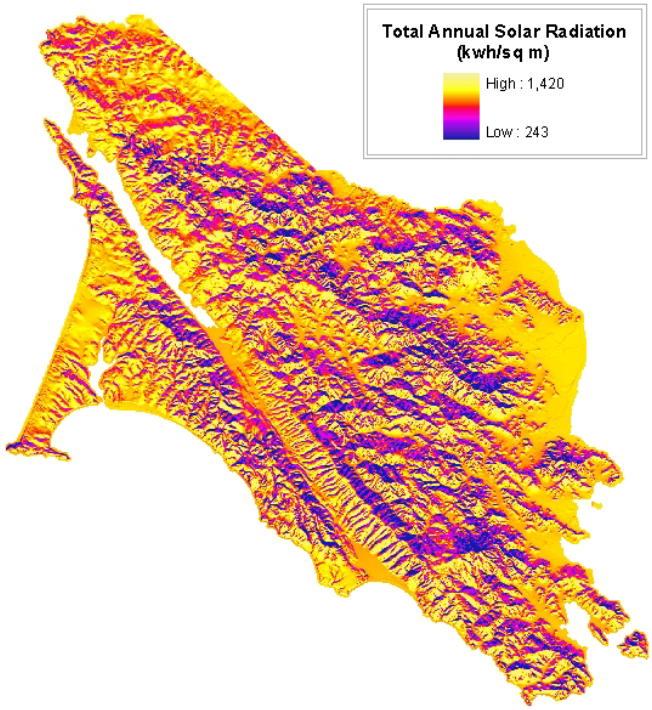

Fig. 2: Solar insolation map of Marin County.

2.2.1 Limitations to Generated Solar Insolation Map

The map does not take into account variations in solar insolation due to microclimates or shading from local physical obstacles, such as adjacent buildings.

2.3 Layer Three: Parcel Information

The third layer of the database is the parcel data file. Parcel data provides information on property and its legal attributes, including tax assessor use codes (Table 1) and ownership information. By utilizing the parcel information (demonstrated by the white lines in Figure 3) in combination with the orthographic images in the GIS environment, we have a reference for location and ownership of any site in the County.

TABLE 1: TAX ASSESSOR USE CODES

Code No.	Land Use Description
11	Single Family
21	Multi-family residential
41/51	Industrial/Commercial
80	Non-taxable

2.4 Layer Four: Database of Identified Candidate Sites

The overlay of the first three data layers gives rise to the creation of a fourth layer: a shapefile (e.g. graphic representation of a database) with a catalogue of suitable structures located within optimal zones, as defined by the solar insolation map layer. Buildings and structures were visually selected based on the following criteria: 1) location in high solar insolation corridors, indicated by light/yellow zones, and 2) exclusion of structures with non-uniform roof shapes or obvious obstructions such as large HVAC units.

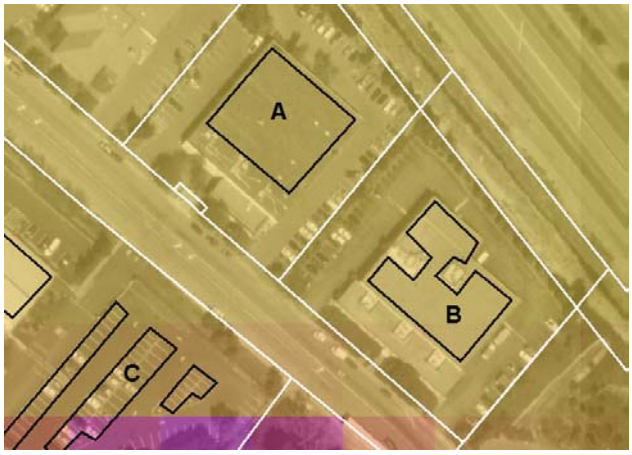

Fig. 3: Integrated layers with digitized structures.

Once a site was selected, be it a rooftop or a parking lot (as indicated in Figure 3 as structure A and C, respectively), the outline of its available area was then digitized as a new feature within the shapefile. After being digitized, the square-footage of the site was calculated and added to the database as an attribute of that site. With this square-footage, a theoretical photovoltaic system size could be estimated for the site. Information from the parcel file was then spatially joined to each digitized site as additional attributes. Together these attributes constitute the database layer of the map.

The final database (Table 2) contains the following attributes: owner name(s), address, tax assessor code, building orientation, square-footage of digitized area and system size in Kilowatts (KW). We estimated system size by assuming an average peak PV capacity of 10 watts per square-foot (107 watts per m^2) and a loss of available area due to spacing of 25%.

TABLE 2: DATABASE EXAMPLE

Tax Code	Owner	Address	Area – sf (m^2)	Orient-ation	System Size (KW)
11	Joe Smith	123 Main St	500 (35)	SSW	5
51	ABC, Inc.	234 Main St	20,0000 (1,400)	SSE	150

The database itself can be sorted using tax code information to identify niche markets such as commercial rooftops, municipal buildings, schools, multi-family dwellings, agricultural, residential units, etc. With the database divided by niche markets, supplemental pieces of information can be included as additional attributes. Examples of this include sector-specific tax incentives, rebates and financing options.

3. COMMUNITY APPLICATIONS

The map can be employed to serve a number of purposes and new uses are continually being discovered. The main categories of applications for the map are assessment, outreach and technical assistance.

3.1 Assessment

Assessment of solar resources is an important process that aids in the development of a robust solar energy program. It involves setting expectations for a solar program or policy explicit, setting appropriate criteria and standards for meeting those expectations, and determining how well performance matches those expectations and standards.

Assessment helps to focus attention on the development and implementation of appropriate programs and policies that best foster the utilization of solar energy.

3.1.1 Regional Planning

Community Planning Division: Assessment of resources is very useful from a community planning perspective. The County of Marin CDA is in the process of updating the Countywide Plan[2], which is Marin's long-range guide for use of land and protection of natural resources. The Plan sets forth policies and programs to be used by the public, planning staff, and decision makers when reviewing and analyzing proposed development projects.

The Countywide Plan includes directives for employing local renewable resources as well as shifting imported energy to renewable sources. In the section of the Plan that deals with energy in the built environment, there are specific programs mandating for the assessment of renewable resources (Program EN – 2.a). Proper assessment will support efforts to achieve Marin's renewable energy policy objectives (Policies EN 2.1 – EN 2.4).

Current Planning Division: The solar insolation layer of the SPM is now available on the computer server used by Marin County current planners. When a homeowner approaches a planner for a building permit, the solar potential of the site can be evaluated in addition to the other standard environmental elements considered during the review phase. The planners may notify customers when their site is located in an area of high solar potential and provide the customer with a referral to the free services offered by the Marin Solar Program.

3.1.2. Solar Installation Goals

Indicators and non-binding targets will be institutionalized through the Countywide Plan in order to create a context with which to measure progress toward or away from set goals. The indicators of interest here include the number and size of photovoltaic systems installed countywide and by County government. The non-binding targets for these indicators are 5 Megawatts (MW) by 2010 and 10 MW by 2015 for countywide installations. For County government installations the goal is 400 Kilowatts (KW) by 2010 and 600 KW by 2015.

3.1.3 Results of Assessment

The following results are for structures identified within good solar zones in the Marin solar potential map, as of March 2004:

Commercial Sector: 745 buildings have been identified. The sum of the available area is greater than 7.7 million square-feet (540,000 m^2). This is equivalent to 58 MW. Of these buildings, 615 have enough area to install large-scale PV systems, defined here as ≥ 3,000 square-feet (280 m^2).

Institutional Facilities: 338 buildings have been identified. The sum of the available area is greater than 1.8 million square-feet (126,800 m^2). This is equivalent to 13 MW. Included in this category are city and county buildings, fire and police stations, water and wastewater treatment plants and schools.

Parking Lots: 122 parking lots have been identified. The sum of the available area is greater than 3.4 million square-feet (240,400 m^2). This is equivalent to 25 MW.

TABLE 3: ASSESSMENT RESULTS

Market Sector	No. of structures	Area $10^{\wedge 6}$ SF	(m^2)	Estimated Capacity
Commercial	745	7.7	(540,000)	58 MW
Institutional	338	1.8	(126,800)	13 MW
Parking lots	122	3.4	(240,400)	25 MW

3.2 Outreach

The SPM allows outreach to be conducted on a more targeted basis by first pre-qualifying the physically appropriate candidates in a particular sector. This is especially beneficial for administering a solar program operating with limited staff time and resources.

3.2.1 Pilot Project: Outreach to Commercial Facilities

For the first outreach project using the SPM, commercial businesses were targeted. The focus of the outreach was to introduce them to PV technology in case the business recipient was unfamiliar with it and then offer access to free financial and procurement information. The structure of the outreach was a mailing, which included a reply card and self-addressed stamped envelope to make it straightforward and require minimal effort for the business to respond.

In order to give the business representative a choice as to their desired degree of interaction with the solar program, we provided three no-cost options for response: 1) have an information packet mailed, 2) attend a PG&E-sponsored "photovoltaic basics" course and/or 3) obtain a site visit to the recipient's facility to further assess solar potential and answer additional questions.

3.2.2 Results of Outreach

Two hundred and seventy-five unique buildings were targeted for outreach. For facilities with off-site owners, duplicate letters were sent: one to facility managers and one to the off-site owner. In total 500 letters were mailed. There were thirty-eight responses, each requesting one to three of the options, with the following breakdown:

1) Request information packet: 34
2) Register for free PV class: 25
3) Obtain free site visit: 25

Based on the 38 responses of the 275 businesses contacted, the response rate for the pilot project was 14%. This greatly exceeded our expectation of a 2 – 4% response rate.

3.3 Technical Assistance

The Marin Solar Program offers complimentary assistance to help residents and businesses in deciding whether or not to purchase a photovoltaic system. Energy production analysis is done using PV WATTS Version 2.0[3] and initial cost analysis includes discounts from current tax credits and rebates as well as historical, Marin-specific installation data available through the California Energy Commission[4].

The Program associates' ability to provide assistance has been streamlined and enhanced through use of the map. When a resident or business requests information on their particular site's suitability for solar, the solar insolation map is checked first. If they are located in an area that receives moderate annual insolation, their roof area is digitized. The corresponding system size, energy production and approximate costs are then calculated and sent to the site owner in a report format.

3.4 Future Outreach Projects

Outreach will continue to be done through mailings and workshops for candidates that have been identified in each niche sector. Efforts are already underway to engage Marin's cities on solar energy policies and programs.

3.4.2 Web Access

Staff members from the Marin Solar Program and GIS and Mapping Division are developing an interactive version of the SPM for web. The intention is for a resident or site owner to have the ability to enter their parcel number or street address into the system, zoom to a map of that location and view their solar potential. The map would contain information and links to the Marin Solar Program.

5. CONCLUSION

The solar potential map is relatively inexpensive and simple to generate (Table 3). In addition, it has broad applicability in the areas of resource assessment, outreach and technical assistance. For these reasons, the solar potential map is a beneficial tool for community development and solar education programs.

TABLE 4. PROJECT COSTS TO DATE

	Requirements	Cost
Equipment Requirements	ArcView 3.2	None – pre-owned
	Spatial Analyst for ArcView 3.2	$2,650
	Solar Analyst	$500
Staff Requirements	Running the Solar Analyst model	$175 (5 hours x $35/hr)
	Digitizing structures (to date)	$680 (40 hours x $17/hr)
Total Cost		$4,005

6. ACKNOWLEGEMENTS

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7. REFERENCES

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