Just Map It! Using GIS to Show Diffusion, Leakage and Market Potential

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Abstract

While a proven tool for other fields, Geographic Information Systems (GIS) have not been widely employed in evaluation projects in the energy field. Nonetheless, this software enables spatial visualization of large quantities of data. Data is translated into a map and primarily shown by areas or points which represent densities. This paper discusses four applications of the GIS software using examples from Summit Blue projects. The use of GIS in the Arizona Public Service (APS) CFL buy-down program evaluation estimated a more precise leakage rate[1] for utility conservation and energy efficiency programs. An example from New York State Energy Research and Development Agency (NYSERDA) demonstrates gap analysis and shows areas of high and low program penetration compared to LEED projects. In the Self-Generation Incentive Program (SGIP), GIS enabled precise pinpointing of potential markets. The use of the GIS software in the Flex Your Power Rural (FYPR) campaign evaluation provided outreach opportunities for future program design. GIS is an important tool that can streamline the evaluation process, provide a method to sift through mounds of data efficiently and effectively, and present program effectiveness to regulators and management.

Introduction

A picture is worth a thousand words. A meaningful map may significantly add to the efficacy of program design and evaluation in the energy industry. Geographic Information Systems (GIS) can be exceptionally useful in spatial comprehension of large amounts of data and attributes by mapping the data according to certain specifications. Companies and organizations in other fields use GIS for visualizing resources, understanding market dynamics and decision-making support. In the early 1990s, Luisa Freeman[2] discussed extensively the use of GIS for marketing support. However, evaluation has not historically relied heavily on GIS. This paper provides four examples of the application of GIS mapping in evaluations of clean energy initiatives.

Estimating Leakage Rate

Evaluation of rebate programs can involve onsite verification of the installation of energy efficient equipment and can include an estimation of leakage of energy savings outside the utility's service area. However, this non-participant spillover can be difficult to estimate for manufacturer or retail buy-down programs.

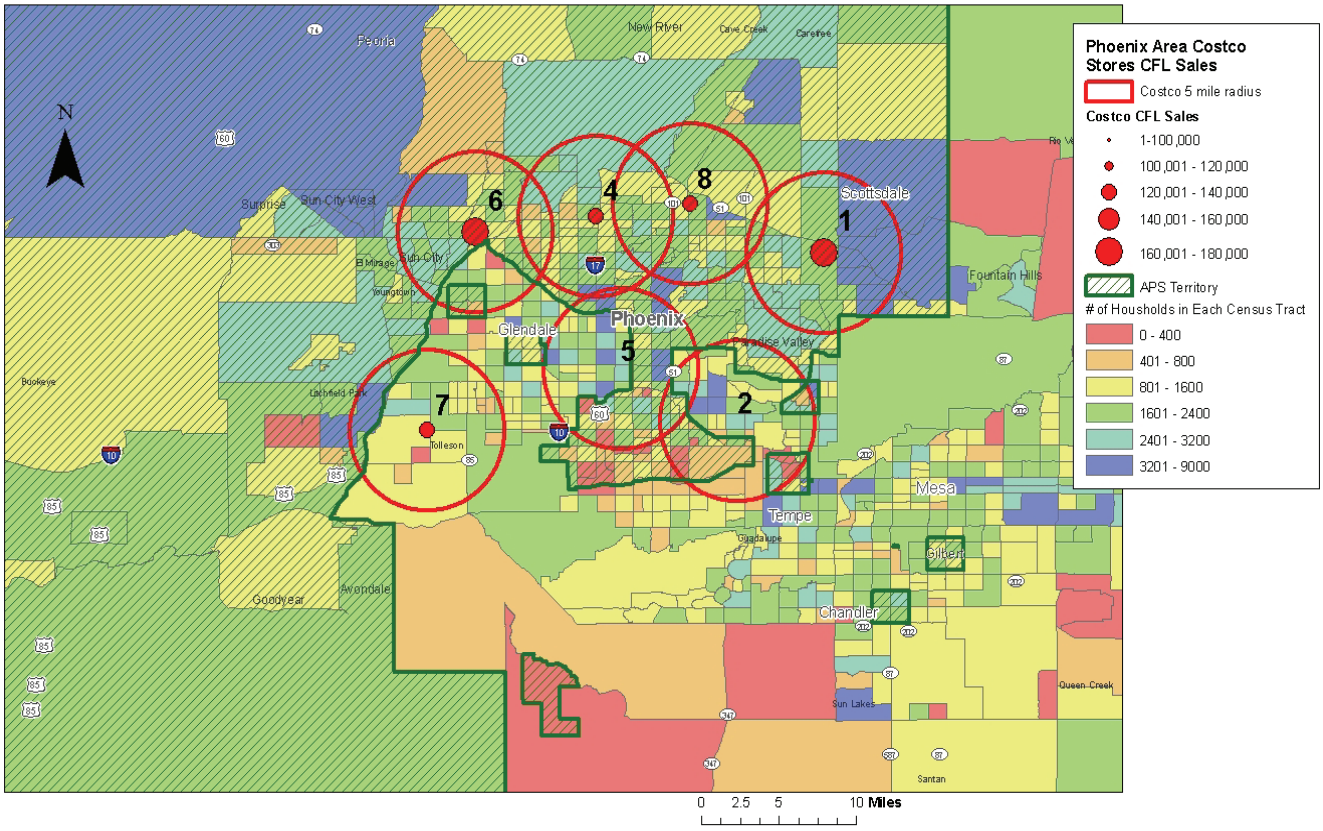
Under a retail buy-down program, retail stores offer a reduced price product to all customers. Therefore, customers of any utility can purchase these products and install them in their homes. The utility company offering the program absorbs the price difference between the true retail rate and the reduced price product. The energy savings arising from these products can be "leaked" outside of the

[1] Leakage is here defined as spillover outside the utility service area.
[2] Freeman (1990)

subsidizing utility's service area. For manufacturer or retail buy-down programs, GIS can be used to estimate this leakage—the amount of energy saved outside of a utility's service territory by equipment or upgrades promoted or financed by the utility's program through retailers.

Under the Arizona Public Service's CFL buy-down program, the utility reduces the price of CFLs for participating retailers. Specific store locations that largely serve the customers of the utility are selected to participate. However, some stores are located on the border of the service territory, and thus there is large potential for leakage. The leakage rate is the number of bulbs sold through participating retailers that were estimated to be installed outside of APS' territory. GIS software and analysis was used in the past two years to estimate leakage for this program (Figure 1). First, census tract data was obtained, identifying the number of households in each census tract.[3] The household map was overlaid by store locations that had sold a large volume of reduced priced bulbs, regardless of whether the store was a program participant or non-participant. Then, a boundary of two and a half miles was drawn around general, retail, grocery, drug stores, and a five mile boundary was drawn around participant stores. These distances were based upon the evaluators' judgment of how far people are willing to travel to shop at these locations. A variety of store types were sampled in 2008, thereby reducing the potential for sampling bias. Finally, the utility service territory boundary was overlaid on the map. Census tracts that lay within a store boundary were divided into two groups: those within and those outside of the service territory. The ratio between the numbers of tracts in these two groups was then applied to the number of bulbs sold in a particular store. The one caveat is that store boundaries do not align perfectly with census tract shapes. However, the overestimation in one case is evened out by the underestimation in other cases.

[3] Definition of census tracts according to the census website: "Census tracts are small, relatively permanent statistical subdivisions of a county. Census tracts are delineated by local participants as part of the Census Bureau's Participant Statistical Areas Program. Census tracts usually have between 1,500 and 8,000 persons and, when first delineated, are designed to be homogeneous with respect to population characteristics, economic status, and living conditions. Census tracts do not cross county boundaries. The spatial size of census tracts varies widely depending on the density of settlement. Census tract boundaries are delineated with the intention of being maintained over a long time so that statistical comparisons can be made from census to census. However, physical changes in street patterns caused by highway construction, new development, etc., may require occasional revisions; census tracts occasionally are split due to large population growth, or combined as a result of substantial population decline."



Source: Summit Blue Consulting (2009)

Figure 1. Example of Leakage Rate for Phoenix Area Costco Stores

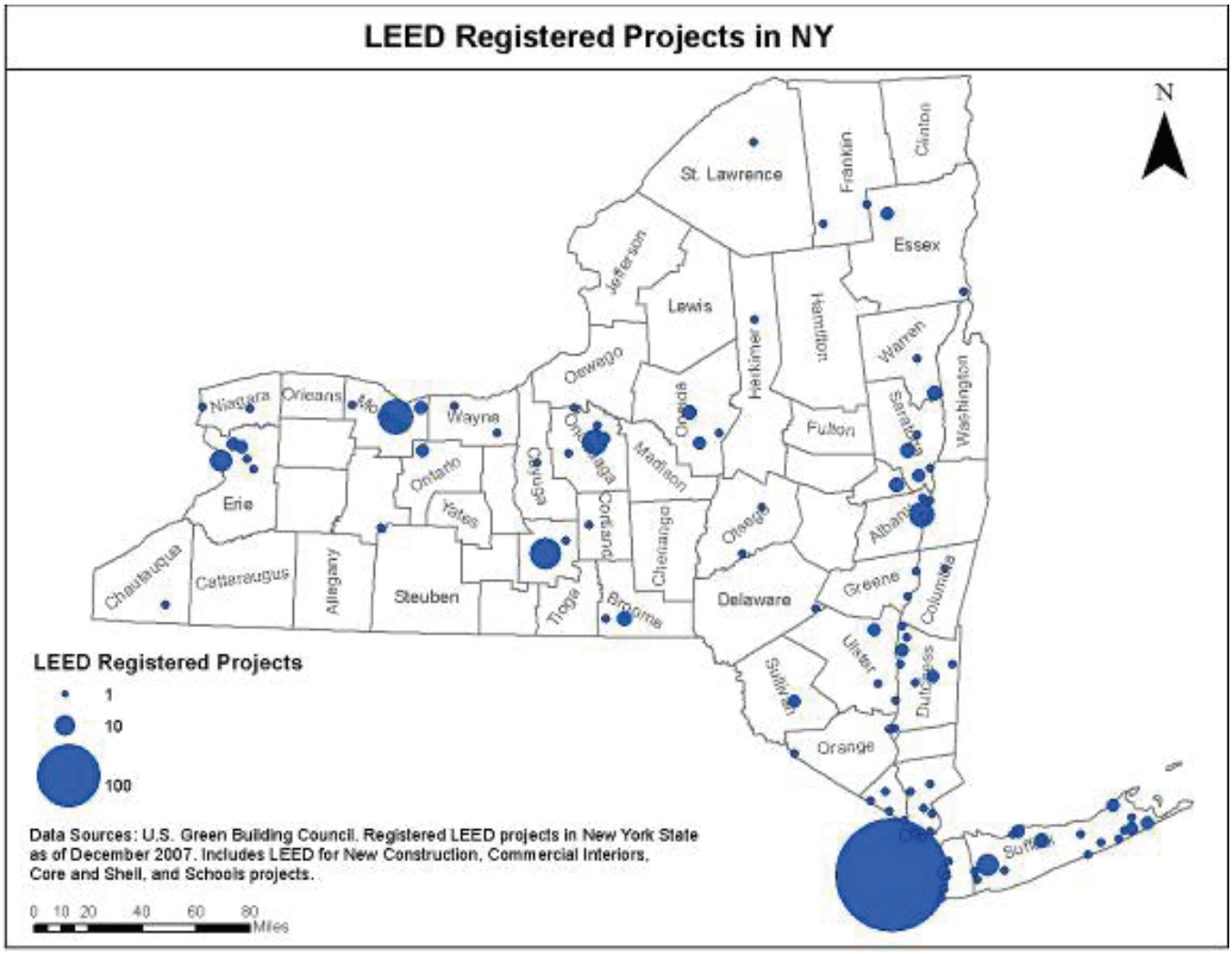
One issue during the 2008 evaluation effort was the fact that some stores are located close to the utility service area and to the Mexican border. Recently published literautre documents that cross-border shopping (from Mexico to the U.S.) is one of the primary reasons for crossing the border. (Anderson, Gerber & Foster 2008). Therefore, it is conceivable that residents of Mexico might travel across the border, purchase discounted bulbs and install them in Mexico. This kind of leakage is more difficult to identify because finding census data for foreign countries is problematic. Such data may not exist, may be unreliable, or may use units other than the census tract system that has been adopted in the U.S. While it might be possible to track down population for the towns on the two sides of the border and use this method to estimate leakage, there are a number of uncertainties that remain unanswered. Can most of the town's residents come across the border? What percent of the people who can cross the border to shop in the US, actually shop at the store in question? What percent who shop at the participant store actually purchase CFL bulbs at the discounted price? What about the availability of electricity in Mexican towns? If only 80 or 90% of the cross-border shopping population has electricity in their homes, should this be considered as the base population? Because all of these questions remain unanswered, during this round of evaluation, the team decided not to attribute any bulbs and energy savings to Mexico.

The results of the GIS analysis provided a more precise estimate of leakage into other service territories. The use of GIS improved the estimate of leakage rate for the program from 0% to 21%. Some stores were identified as having a leakage rate as high as 90%. This analysis is used by the program implementers for identifying and excluding from the program retail locations that are likely to contribute disproportionately to program leakage.

Understanding the Diffusion of Innovation in Clean Energy Programs

Understanding the diffusion of innovations and the market barriers that keep a program from being successful are important. High resource requirements or target population density may lead to completed projects being located in the same region. Identifying relationships between project applications and completed projects can help the utility to understand the impacts of the program. The GIS software enables the spatial visualization of energy efficiency and renewable energy program applications and completed projects.

Mapping the locations of the NYSERDA High Performance New Buildings (HPNB) program along with LEED registered projects provided an elegant method for a gap analysis and demonstrated the areas with the most successful projects. Figure 2 below shows the locations of LEED-registered projects in New York. HPNB projects were included on the map to make inferences about the market's transformation; however, this information is not shown in Figure 2 because the information is currently not publicly available.



Source: Baker and Thompson (2008). Note that this map is provided as an example only. The original map used in the evaluation is not shown.

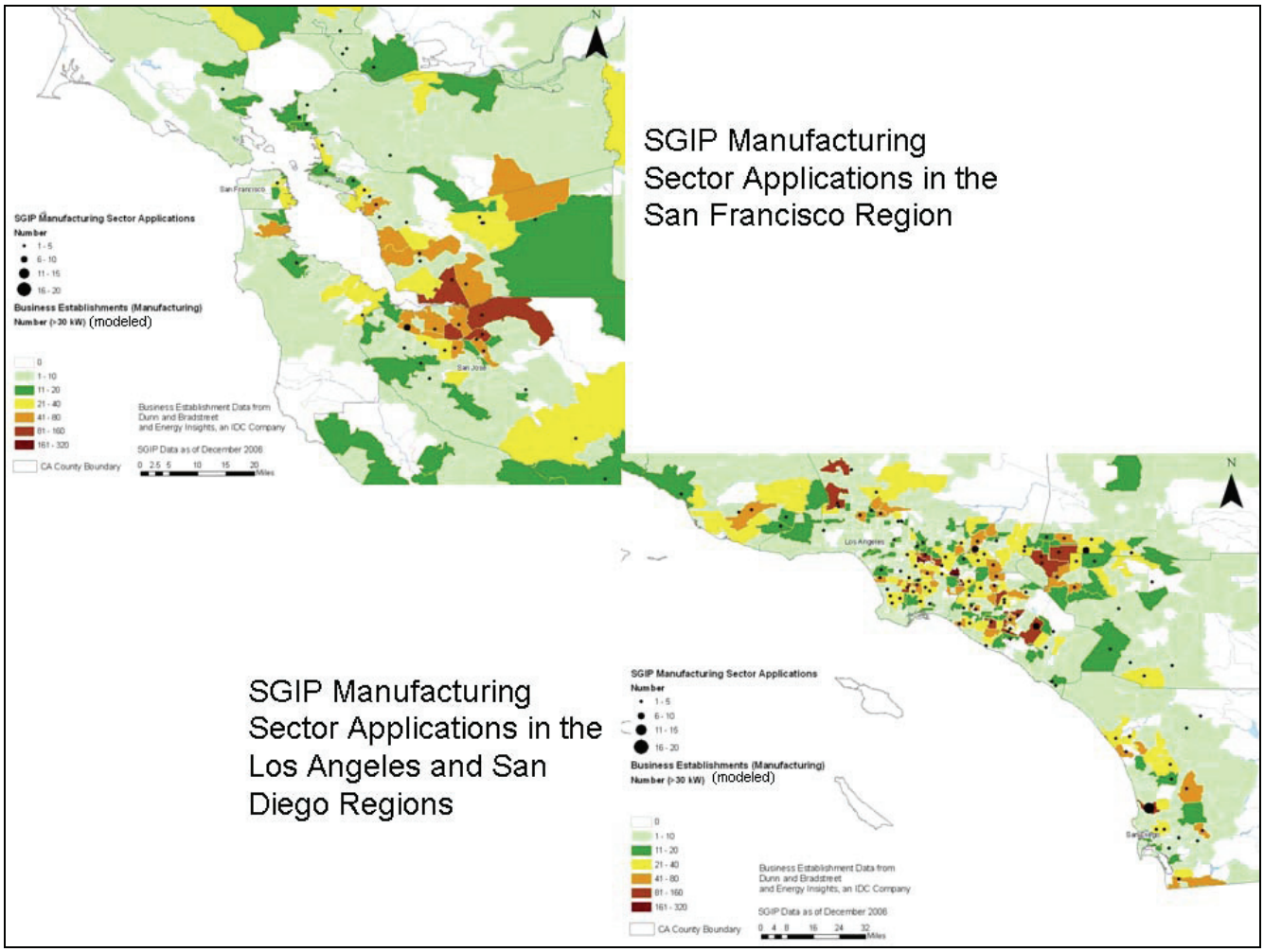
Figure 2. LEED Registered Projects in NY

The gap analysis was used by NYSERDA to understand the impact of the program in relation to other programs, to identify successful project areas and to determine market barriers that hinder the program.

Identifying Untapped Market and Outreach Opportunities for Future Program Cycles

GIS enhances the identification of market potential and outreach opportunities that traditional methods may miss. For non-residential programs, business establishment data can be viewed spatially to identify regions with high potential but low participation rates or regions that have not been targeted previously. Furthermore, lessons learned by examining the attributes of successful sectors can be applied to other regions and sectors. New target opportunities can then be presented to utilities through a demonstration with a GIS map.

GIS software was used as part of the measurement and evaluation effort for the Self-Generation Incentive Program (SGIP) in California (Figure 3).



Source: Baker, Thompson, and Cooney (2008)

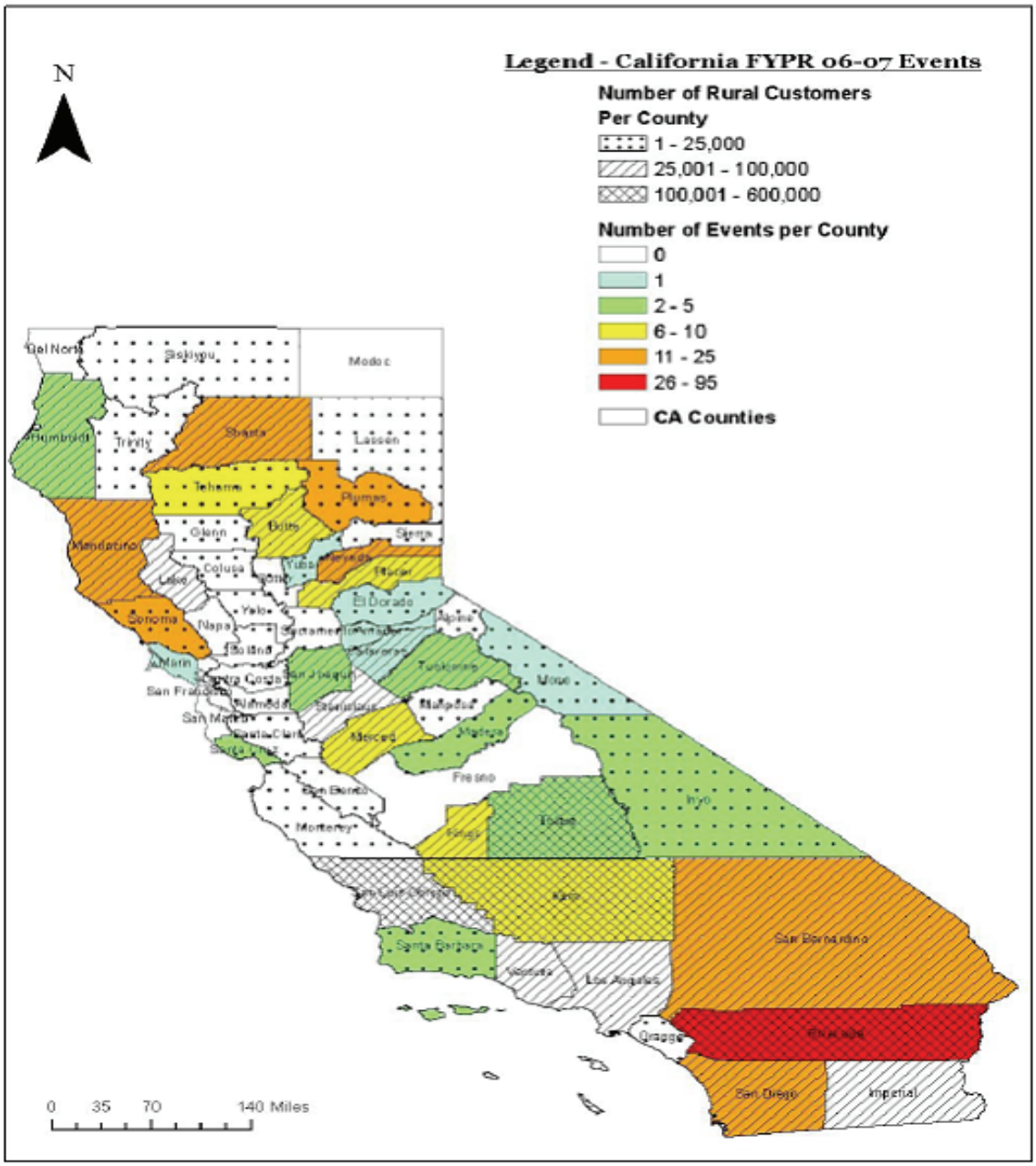
Figure 3. SGIP Manufacturing Sector Applications in Northern and Southern California.

Through this program, commercial, industrial and government entities can apply for incentives to install on-site generation which include solar photovoltaic, cogeneration systems, and small wind systems. The SGIP applications were mapped along with the number of business establishments by sector, thus enabling one to view penetration of applications compared to penetration of business establishments. Based on this insight, inferences were drawn regarding successful sectors, enabling more precise targeting of areas and specific businesses for the future.

Enabling More Precise Program Design

Program design is a prime candidate for GIS analysis. GIS is valuable in revealing whether the program reached the intended target population. In addition, maps can be used to identify what potential populations and regions should be targeted in the next program cycle.

In the California Statewide Marketing and Outreach Process Evaluation effort, the Flex Your Power programs were evaluated. Summit Blue completed multiple maps for the evaluation, including maps for the Flex Your Power General and Spanish language outreach programs and the Flex Your Power Rural effort. An example is shown in Figure 4 below. Over a map of California counties, the number of events targeted to rural outreach and the number of rural customers per county were overlaid. Counties with high rural populations and a large number of events were targeted correctly. However, some counties with a large rural population (more than 100,000 people) had no events (for example, San Luis Obispo County). For future program planning, this information is vital in order to capture large sections of the population that have not yet been tapped.



Source: Summit Blue Consulting prepared for *Opinion Dynamic Corporation (2008)*

Figure 4. Number of FYPR Outreach Events by County and by Rural Population

As part of the California Statewide Marketing and Outreach Process Evaluation effort, GIS was employed to spatially portray the location and frequency of outreach events and the density of the target population. Based on this map, the program's success was measured and presented visually. Furthermore, future market opportunities were demarcated.

Conclusion

This paper presented four applications for Geographic Information System analysis. Four examples were discussed to highlight the usefulness of GIS as a tool for program evaluation and to enable better program planning. However, one should not assume that geographic correlation reflects a causal link in mapped attributes without thoroughly investigating the underlying causality and all confounding variables with a high probability. GIS mapping provides a clear, concise, and effective way to estimate leakage to other non-program territories, to understand the diffusion of innovation, measures or equipment, to identify market potential and to enable more precise program design to reach the intended target audience.

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