Los Angeles Business Council

UCLA Luskin Center
School of Public Affairs

BRINGING SOLAR ENERGY TO LOS ANGELES:

An Assessment of the Feasibility and Impacts of an In-basin Solar Feed-in Tariff Program

Los Angeles Business Council Study
in partnership with the
UCLA Luskin Center for Innovation
School of Public Affairs

LABC/ UCLA
Solar Working Group
Members

Allen Matkins
AECOM
Arden Realty Inc.
Bank of America
CB Richard Ellis
Cedars-Sinai
Energy Choice Inc.
G&C Equipment Corporation
Global Green USA
Holland & Knight
Jones Lang LaSalle
JP Morgan
Kahn Solar
KYOCERA Solar Inc.
Los Angeles County
LACCD
Los Angeles World Airports
Latham & Watkins
LAUSD
Macerich
Parsons Brinckerhoff
Psomas
Siemens
Sierra Club
SolarWorld
SunCal Companies
Trammell Crow Company
Turner Construction
UCLA School of Law
UCLA School of Public Affairs
Union Roofing Contractors Association
Watt Companies
Westfield

July 08, 2010

Fellow Angelenos,

Today marks the release of *Bringing Solar Energy into Los Angeles: An Assessment of the Feasibility and Impacts of an In-Basin Solar Feed-in Tariff Program*, completing more than a year of collaborative research between a working group of businesses, nonprofits and environmental organizations led by the UCLA Luskin Center for Innovation and the Los Angeles Business Council (LABC). Together we have examined the potential for bringing a solar Feed-in Tariff (FiT) policy to our region.

FiT is a mechanism that would allow private sector dollars to be invested to meet Los Angles' renewable energy goals and create local jobs by enabling residents and business to install solar panels on their property and sell the power generated back to the electrical grid.

There has been much public debate over the past year about the best way to green our local energy sources, particularly at the Los Angeles Department of Water and Power (LADWP), the largest municipal utility in the nation. The body of research initiated by the LABC/UCLA solar working group makes clear why a FiT should be an important part of any plan to meet our renewable energy goals, drawing on an in-depth survey of major local energy users, advanced mapping analysis of potential solar resources and comprehensive economic modeling.

<u>The rigorous analysis presented in today's study provides concrete evidence that a FiT would be a cost-effective program for ratepayers over the long-term, while meeting the job-creation and clean-energy goals set out by LADWP and city policymakers.</u>

Within 10 years, a well-designed FiT would create a minimum of 600 megawatts of solar projects – which would produce about three percent of our city's energy needs. According to our research, this program could eventually succeed on a far greater scale – potentially generating as much as three gigawatts – though we have chosen to focus our analysis on a smart, tailored 600 megawatt capacity program.

A FiT with a 600 megawatt capacity would create more than 11,000 green jobs in the Los Angeles basin—nearly triple the number of jobs that LADWP has created in the region through green programs to date. Furthermore, a meaningful FiT would serve as an important engine in our emerging green economy by providing incentives for clean-tech manufacturers to relocate to the region.

<u>Perhaps most importantly, the analysis in this study illustrates how a FiT would not only produce energy less expensively than other renewable sources, but also become more cost-effective than LADWP's next best alternative for power generation over the life of a 10-year program.</u>

As FiT programs around the world have demonstrated, the key to successfully employing this unique market mechanism is to design it in a way that spurs participation, creates jobs and produces energy most cost-effectively. Informed by the success of other FiT programs, our research spells out clear guidelines for creating an effective local program that takes into account Los Angeles' unique resources.

<u>With the release of today's study, we have renewed our call to city policymakers to create a FiT program that includes:</u>

- Ambitious energy-generation targets, with the goal of bringing on at least 60 megawatts of new solar capacity every year to create a 600 megawatt program over ten years
- 20-year FiT contracts with a fixed price, which would allow participants to recoup their upfront capital costs plus a 5-7 percent return on their investment over the life of an agreement
- Differentiated tariff contracts that provide varied reimbursement rates for businesses, residents, government institutions and non-profits to spur wide participation and generate the most cost-effective solar energy
- A guaranteed connection to the grid for anyone that seeks to participate in the program
- A simple application procedure and contract
- A built-in program assessment that re-evaluates the FiT contract annually to protect ratepayers

The LABC has built a wide and growing coalition in support of this FiT proposal, including environmental, business, and labor groups, as well as a host of private businesses. A list of coalition members, along with video testimonials in support of the program, is available at www.solarfit4la.com.

Our coalition has called on policymakers to provide adequate funding for an ambitious FiT program in the 2010-2011 LADWP budget, which is being developed this summer and will be agreed upon in October by the LADWP commission. At an annual net cost of $25 million to $35 million, a FiT could be paid for within the $4 billion LADWP budget, which has allocated $800 million for renewable programs.

In mapping out a long-term vision for LADWP, city policymakers must offer bold leadership and look for smart, cost-effective solutions – like a meaningful FiT— to create new jobs and build a sustainable future for our city. We urge fellow Angelenos to join with us in calling for the adoption of a FiT program as policymakers make important decisions about the future of

LADWP. To join our coalition and learn about the many benefits of a FiT in Los Angeles, please visit www.solarfit4la.com.

Sincerely,

Mary Leslie
President, Los Angeles Business Council

Brad Cox,
Chairman, Los Angeles Business Council

Report Commissioners
Brad Cox, Chairman, Los Angeles Business Council
Mary Leslie, President, Los Angeles Business Council

Authors
J.R. DeShazo, Ph.D., Faculty Director, Luskin Center for Innovation
Ryan Matulka, Lead Author & Research Project Manager, Luskin Center for Innovation

Acknowledgments
The authors would like to thank the following individuals for their contributions to this project. Michelle Garakian and the LABC team provided generous support during the entire course of this project including providing access to the Solar Working Group and other subject matter experts. Mark Greninger and Howard Choy at the County of Los Angeles Chief Information Office provided the Los Angeles County Solar Map data used in this study. Norman Wong of the UCLA Lewis Center for Regional Policy Studies created the maps and provided GIS and database support. Eric Zheng developed the code to automate the modeling processes. Evelyn Lee, Juan Matute, and Colleen Callahan provided a helpful review of the content. Paul Gipe, Founder of Wind-Works, Adam Browning, Executive Director of the Vote Solar Initiative, and Claire Kreycik, Energy Analyst at the National Renewable Energy Laboratory provided valuable insights into the issues and analysis presented in this paper. Any errors, omissions or inaccuracies in this report are the sole responsibility of the primary authors. The Los Angeles Business Council and the Solar Working Group commissioned this study and made this project possible.

Solar Working Group Members

Allen Matkins	JP Morgan	Siemens
AECOM	Kahn Solar	Sierra Club
Arden Realty Inc.	KYOCERA Solar Inc.	SolarWorld
Bank of America	Los Angeles County	SunCal Companies
CB Richard Ellis	LACCD	Trammell Crow Company
Cedars-Sinai	Los Angeles World Airports	Turner Construction
Energy Choice Inc.	Latham & Watkins	UCLA School of Law
G&C Equipment Corporation	LAUSD	UCLA School of Public Affairs
Global Green USA	Macerich	Union Roofing Contractors Association
Holland & Knight	Parsons Brinckerhoff	Watt Companies
Jones Lang LaSalle	Psomas	Westfield

Table of Contents

Appendices

List of Tables

List of Figures

Executive Summary

This report represents the second of two studies that have taken a close look at the rationale for, and viability of, an in-basin solar Feed-in Tariff (FiT) program for the City of Los Angeles. The first report, released in April 2010, focused on the general design guidelines common to successful FiT policies, highlighting examples of programs across the country and around the world. This report delves more deeply into the specifics of Los Angeles. We evaluate the existing solar capacity of the region and determine how it can be harnessed in a cost-effective, sustainable manner. We also examine the expected job-creation and economic development benefits of a well-designed FiT program and take a close look at the economics that drive its success.

Interest in developing an in-basin solar FiT is growing for several reasons. First, Los Angeles enjoys abundant solar resources while the cost of capturing this resource is falling rapidly as the cost of solar module production falls. Second, the on-going recession has heightened civic leaders' interest in the jobs and economic development opportunities that an in-basin solar program would bring. Third, such a program can help move the Los Angeles Department of Water and Power (LADWP) towards its ambitious renewable energy goals and away from its heavy reliance on coal-fired power plants. Finally, the analysis in this report demonstrates that a well-designed program will achieve all of these benefits with relatively modest costs to the City's utility customers.

Physical Rooftop Solar Capacity. How much solar can be installed on the rooftops in Los Angeles? To assess the feasible size of such a program, the available physical solar capacity of rooftops in Los Angeles must be estimated. A single megawatt of rooftop solar can offset the annual energy needs of over 100 typical Los Angeles households. This report shows that the City of Los Angeles has approximately 5,536 megawatts of physical rooftop solar capacity spread over the rooftops of single family homes, multi-family residences, commercial and industrial facilities, and government agencies. Each of these market segments contains different amounts of physical capacity. There are 2,218 megawatts in the commercial and industrial segment, 1,752 megawatts in single family homes, 1,411 megawatts in the multi-family segment, and 156 megawatts on government and non-profit buildings. Because these estimates are based only on rooftop space, they represent the lower-bound of the City's aggregate solar generation potential, omitting the capacity that exists in parking lots and open spaces. Angelenos live and work underneath a massive underutilized energy generation resource.

Economically-available Solar Capacity. How much will it cost to install a meaningful amount of rooftop solar in Los Angeles? Economic potential is a measure that describes how much solar capacity households and businesses would be willing to install based on the price offered per kilowatt-hour. This report shows that a significant amount of solar capacity is potentially available at price levels ranging from $0.16 to $0.34 per kilowatt-hour. The economic potential of solar varies greatly across market segments. Under foreseeable economic conditions, gigawatts of solar capacity can incorporated into the electricity grid at reasonable costs.

Designs for an In-basin Solar Program. How should an in-basin FiT program in Los Angeles be designed and what are its important features? Important design elements include the program's overall size in megawatts, the length of the phase-in period over which the utility adds capacity, the allocation of the capacity across different market segments, and the tariff schedule that would apply to each market segment. How policymakers design these features will determine the program's impact on 1) the amount of renewable energy generated and the related environmental benefits, 2) the number of local jobs created and associated economic development benefits, and 3) the cost paid by ratepayers. This report focuses upon those program designs that minimize ratepayer impacts while offering significant environmental and job creation benefits.

Achieving Cost-Effectiveness. Rooftop solar produces energy during the hours of peak demand, so the costs of solar must be evaluated against other peak generation alternatives. An in-basin FiT program will be cost-effective if ratepayers pay the same amount for the solar electricity as they do for electricity from peak-cycle natural gas turbines. Since distributed solar is among the most expensive of renewable energy sources, designing a cost-effective program requires attention to several features. First, program tariffs must be high enough to induce participation but not so high as to overburden ratepayers. Second, the program should focus on those types of solar projects that can produce solar power most cheaply. Third, the program has to be large enough so that the benefits offset the program's fixed costs. Finally, the phase in period must be long enough so that the cost savings to ratepayers in the second-half of the program's life-span are large relative to peaking natural gas generation.

Effective Program Designs. This report features the smallest and shortest program that meets these criteria for cost-effectiveness while suggesting other designs that could also be effective. An effective program should add at least 60 megawatts each year for at least 10 years for a total program size of 600 megawatts. (Larger and longer programs could be even more cost-effective and yield larger environmental and economic development benefits). To be cost-effective the program must focus on large commercially-owned rooftop projects that can take advantage of federal tax incentives. One allocation of the 600 megawatts that is both inclusive of the most stakeholders and cost-effective is as follows: 50% to commercial, industrial and large multi-family projects over 50 kilowatts, 17% to residential and small-scale commercial projects under 50 kilowatts, and the remaining 33% to small utility-scale ground-mounted projects.

Program Administration. Lower-bound estimates for starting tariffs for each type of project are provided in this report, but the tariffs must be adjusted periodically based on participation or on a "cost-plus reasonable rate of return" model. Importantly, the application and interconnection process must be simple, transparent, and timely to reduce costs for applicants and delays for the utility. To maximize the benefits to the distribution network, LADWP could create incentives that steer additional capacity to geographically-advantageous locations. This report provides a general set of guidelines for a successful FiT. Policy makers must be prepared to make other important decisions with regard to the implementation of a specific program.

Job Creation and Economic Development Benefits. The program described above will create approximately 11,000 new jobs over the life-time of the program. In the short-term these jobs will be created through the assembly and manufacturing of selected system components (excluding solar modules which will likely continue to be imported), professional services, system integration and installation, operation, and maintenance. Over time, this program in conjunction with other clean-tech friendly programs could be used to help attract new manufacturing jobs to Los Angeles.

Renewable Energy and Environmental Benefits. The 600 megawatt program described above will meet 3% of the City's projected power needs. This could be the single largest renewable energy project in LADWP's portfolio. It could also lead to significant reductions in greenhouse gases and the creation of renewable energy credits by producing 16 million megawatt-hours of emission-free energy over the life of the program.

Ratepayer Cost-Effectiveness. In the future, LADWP will need additional peak-period energy. It could supply this additional energy from natural gas turbines or from an in-basin solar program. If peak-period natural gas generation costs rise at 4% or more a year, the solar program described here will be cheaper for ratepayers over the long-term. During the implementation phase, years one through ten, typical household ratepayers will experience an average monthly impact of $0.48, while business will experience an average monthly impact of $9.37. Past year ten, ratepayers will benefit from these earlier investments in fuel and emission-free solar generation, with monthly rate impacts less than that of peak natural gas generation.

Section 1: Introduction

Many jurisdictions around the world are moving towards policies to create incentives for the development of distributed renewable energy generation and capture the associated economic development benefits. As part of a comprehensive solar policy for the Los Angeles basin, a local solar FiT would be an important program contributing to the greater use of clean energy in the City. However, Los Angeles cannot simply import the features and design of a FiT policy from other places. Rather, policy makers must shape a program for the local conditions. Several factors stand out as particularly relevant to the challenges confronting policy makers with regard to FiT design.

First, Los Angeles has a history of cheap, reliable, but dirty energy.[1] As a result, the utility ratepayers, both households and businesses, may be particularly sensitive to changes in energy rates. This fact is demonstrated during every rate review process and compounded by the Los Angeles Department of Water and Power's (LADWP) recent fiscal crisis. Second, for many complex reasons Los Angeles was disproportionately impacted by the recent recession. Unemployment is high and the City is aggressively competing with other municipal regions for industry investments and the jobs they bring. Third, the Los Angeles basin is a dense electrical load center with high peak demand that is strongly correlated with solar energy production. This demand peak not only increases the burden on utility customers but also increases the value of in-basin solar energy. It is hard to import solar power from the productive surrounding desert areas because of congestion in the existing transmission lines and long delays in the construction of planned lines. Finally, to be most efficient, FiT policies must be designed to minimize the overlap with existing solar net metering policies. The implications of these economic, geographic, and political factors suggest that Los Angeles must have a tailor-made policy to properly develop its in-basin solar opportunities.

What would a policy for Los Angeles look like? First, it must make a meaningful contribution to the energy goals of the region. Otherwise, the benefits of the program will not exceed the costs of an incremental and short-term approach to in-basin solar procurement. In this context, the FiT program must capture a significant portion of the dormant, unused potential of the targeted renewable resource. Second, it must create real, high-quality jobs for the people of the City. The voters and ratepayers are unlikely to accept short-term costs in exchange for less tangible, long-term benefits. The employment benefits must be real and evident. Third, it must be inclusive of all of the relevant stakeholders. Homeowners must feel properly compensated for providing a valuable product. Business owners of all types must be rewarded for deploying capital and incurring some additional business risk. Labor interests must benefit from employment and the utility must take ownership of implementation. Finally, the program must be cost-effective relative to the next best peak energy alternative. This means that the total long-term costs of a FiT program should be comparable to generating the same energy through natural gas peaker plants which typically provide energy during hours of high demand. The design of the program should consider the long-term sustainability of the solar industry. Since solar can be an expensive energy generation technology, the cost of the FiT program must be carefully managed. A FiT program for Los Angeles must have these general characteristics to be successful.

A FiT is an important part of a comprehensive suite of energy policies that both maximize the use of local renewable resources and contribute to the economic vitality of the region. FiTs can be designed to harness any renewable resource, but solar is both abundant and accessible in the Los Angeles basin. An in-basin solar FiT cannot meet Los Angeles' ambitious goals by itself.[2] However, it can fill gaps in energy procurement and market development that are not addressed by state programs or other local procurement mechanisms. Net metering policies are designed to offset demand rather than to increase supply. Because of this, net metering policies are not scalable and do not maximize the in-basin solar opportunities. Utility-scale renewable projects have a fundamental role in meeting Los Angeles' goals, but their expected development timelines are mismatched with the urgent RPS requirements. Statewide programs, such as the FiT administered by the California Public Utilities Commission (CPUC), are necessarily limited to the customers of California's Investor-Owned Utilities (IOUs) and cannot directly impact LADWP.[3] A comprehensive and well-designed FiT policy is an essential addition to any realistic plan to achieve the aggressive energy goals of Los Angeles.

The purpose of this report is to measure the potential of rooftop solar for Los Angeles and demonstrate the conditions under which a FiT program can be successful. The policy elements in this report should not be considered a proposal, but rather the minimum design elements and general features that will lead to a successful policy for Los Angeles. To bridge this evaluation with an actual program, administrators must be prepared to make important decisions about the details of implementation. The nature of the program rules will have an impact on the results. These details include but are not limited to project selection criteria in the case of high demand, security deposits to discourage speculation, application methods and timing, and other program rules. This report does not analyze the trade-offs associated with specific rule-making, but many lessons can be learned from the other comprehensive FiT policies in North America. Policy makers, citizens, advocates, and decision makers will find this document to be a useful guide to the design of an appropriate policy for Los Angeles.

The Organization of this Report

This report is the second of two reports intended to be useful guides to solar FiT design for Los Angeles. The first report reviewed six policies in North America and abroad, assessed the progress of California and Los Angeles with respect to FiTs, and proposed design elements common to all of these policies. Whereas the first report focused on general design guidelines, this one provides analyses of the local factors which can help policy makers formulate specific programs that are tailored for the City of Los Angeles. The content in this report builds on that of the first. It will be most useful to those who are already familiar with the basics of solar policies and the ideas expressed in the first report.

Section 2 of this report measures the physical quantity and the distribution of rooftops in both the City and the County of Los Angeles. This analysis provides insight into the richness of the rooftop-based solar resources in the region and the solar generation potential implied by this quantity. It also identifies which types of buildings these rooftops belong to, thereby suggesting the market participation and type of ownership of these distributed solar projects. The political and geographic boundaries in the City and County are complex. This section quantifies how the solar potential is distributed within and between these jurisdictions. Finally, Section 2 demonstrates how urban form and development history determine the number, type, and size of solar projects, thereby suggesting where the most cost-effective solar resources are located.

Section 3 of this report evaluates how willing homeowners or businesses might be to install solar on their rooftops and supply energy at different prices. This is an important question since not all of the rooftops can be accessed at cost-effective prices. This section also describes how the economic solar potential changes as broader macroeconomic conditions evolve. It describes how the economic potential varies across different segments of the solar market based on different installation costs, available tax incentives, and likely investment criteria.

Section 4 of this report proposes the minimum design guidelines for an effective policy for Los Angeles. It also evaluates the results of a policy with these specific design elements with respect to cost-effectiveness, energy contribution, and utility ratepayer impacts. The impacts of alternative policy designs are investigated.

The Appendices to this report provide detailed tables of the results and descriptions of the assumptions used in the analysis. Technically-inclined readers can refer to this section of the report to understand the procedural assumptions used to derive the results.

Section 2: Measuring the Rooftops of Greater Los Angeles

In dense metropolitan areas where economically-productive space is in high demand, space for solar installations can be a constraint. Los Angeles, however, has not developed alternative uses for many of its rooftops and parking lots. These are important resources that can help Los Angeles meet its energy and economic development goals. Solar energy production can be the highest and best use for many rooftops, uncovered parking lots, and open spaces in Los Angeles. The purpose of this section of the report is to measure the physical quantity and describe the distribution of the latent potential for rooftop solar energy generation within greater Los Angeles.

Los Angeles has significant potential for rooftop solar energy production. There are many other types of potential solar projects within the County other than rooftops, specifically parking lots, ground-mounted, building-integrated (BIPV) applications, and those installed within infrastructure rights-of-way. The estimated rooftop potential is a lower bound of the total potential available in the region. This analysis focuses only on rooftop projects, but the total solar potential of these other resources could also be significant.

Key Findings

Los Angeles County has 19,113 megawatts of physical rooftop solar potential distributed over roughly 1.4 million land parcels. This potential exists primarily within the urbanized areas of the County. The City of Los Angeles is the largest municipality and has 5,536 megawatts of physical potential distributed over about 500,000 parcels. The other communities within the region also have significant potential for solar, with the distribution of this potential dependant on the urban form and prevailing land use patterns. This rooftop potential represents a massive, underutilized local resource. Figure 1 is a spatial representation of the density of this resource throughout Los Angeles County. The darker colors indicate concentrations of rooftops which have greater solar potential than the surrounding rooftops.

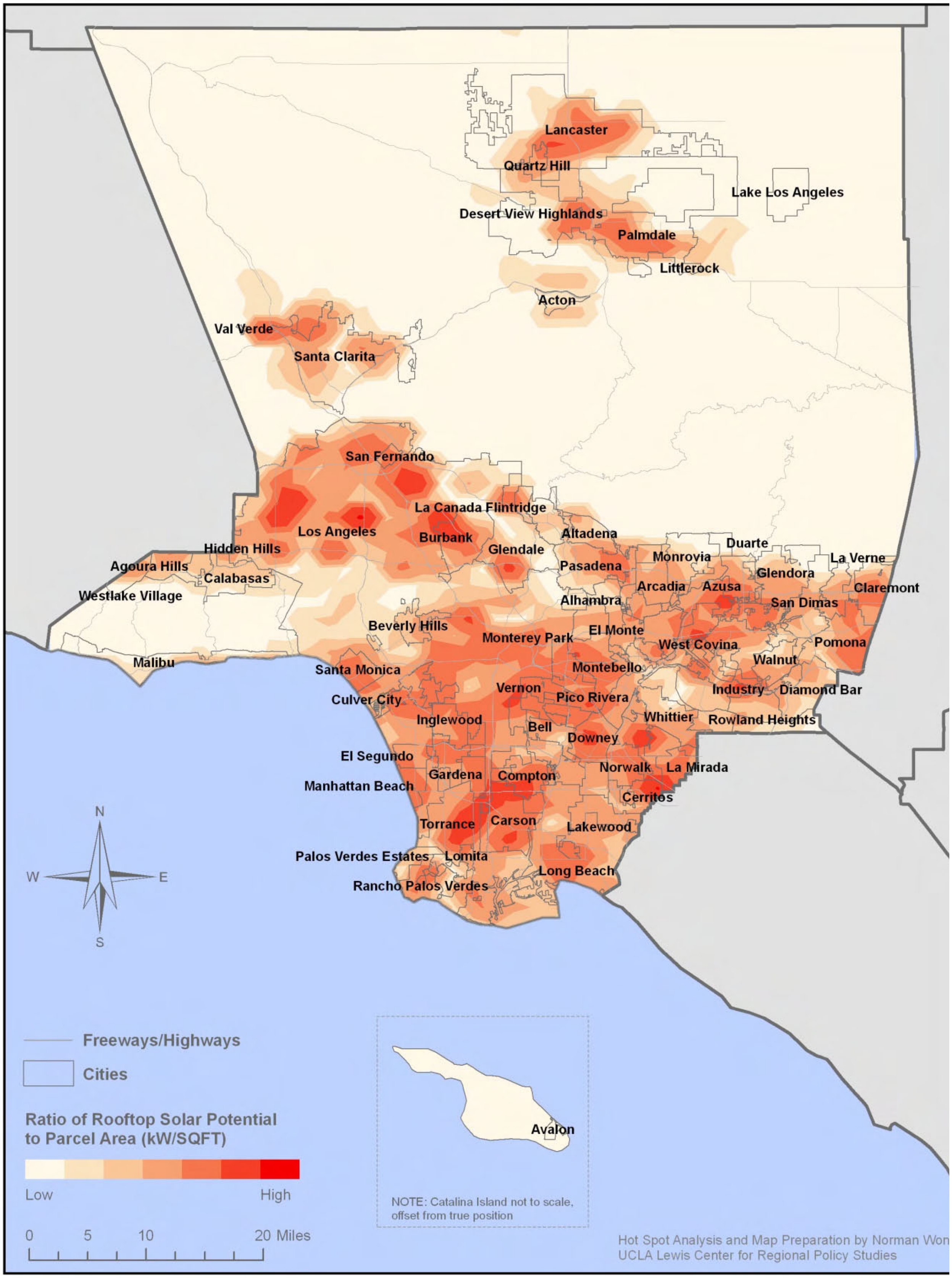
Table 1: Megawatts of Physical Rooftop Potential by Geography and Market

Market Segment	Gov & Non-Profit	Multi-Family	Single Family	Comm & Industrial	Total
Los Angeles County	450	3,336	6,741	8,586	19,113
City of Los Angeles	156	1,411	1,752	2,218	5,536

What is "Physical Rooftop Solar Potential?"

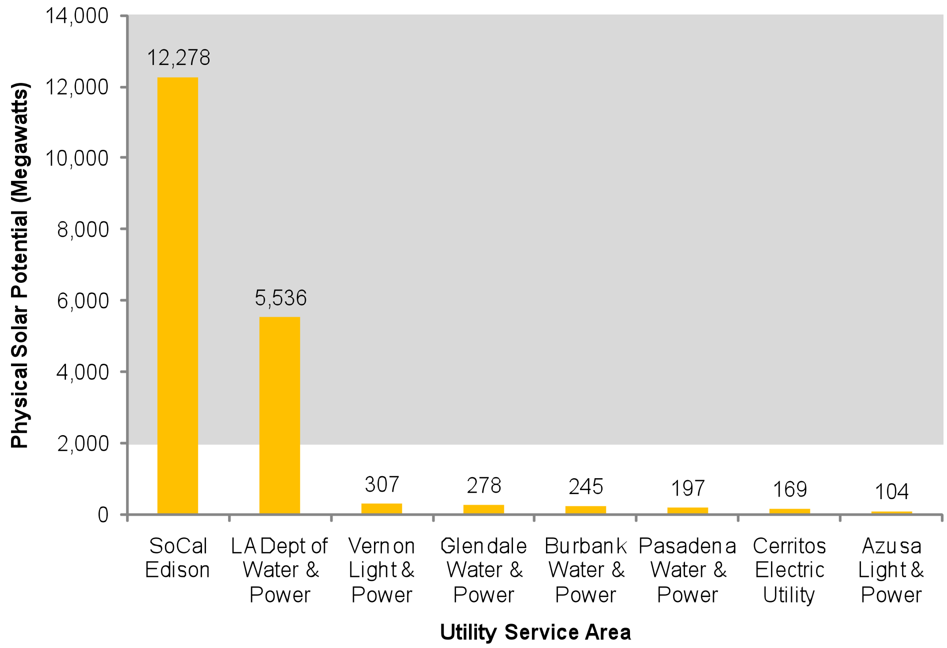
"Physical potential" is the total solar capacity present on the rooftops in the Los Angeles region. It is defined as the maximum solar capacity that could be achieved if solar panels were installed on all available rooftop space which receives direct sunlight from 9 a.m. to 4 p.m. every day of the year. For efficient economic performance, it is critical that a rooftop solar system be positioned to eliminate the impact of shading during these hours of the day.[4] Some owners might prefer to install a larger system on a partially shaded roof rather than to maximize system efficiency. However, the industry best practice is to completely avoid shadows during the hours of peak production. Evaluating physical potential for solar FiT policy analysis must be based on this industry standard.

Figure 1: Map of the Rooftop Solar Potential of Los Angeles County



Physical potential can be expressed for an individual rooftop or for a geographic area. Physical potential is fixed over the short-term. Physical potential may increase over the long-term as more buildings and structures are developed. Technology improvements and innovative applications of solar, such as concentrating photovoltaic technology, can also increase the physical potential of a geographic area. These gains will only be realized incrementally over the long-term.

Figure 2: County of Los Angeles: Megawatts of Physical Rooftop Solar Potential by Utility



The Los Angeles County Solar Map

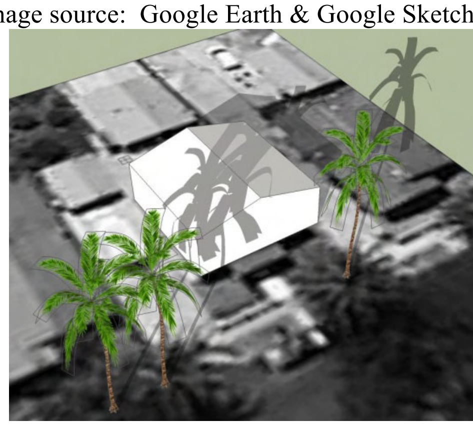
The Los Angeles County Chief Information Office provided the physical solar potential data used in this study. The data was created for use with the Los Angeles County Solar Map.[5] The Solar Map is a high-quality, web-based tool that can be used to investigate the potential of specific rooftops within the County. However, the tool cannot be used to evaluate the potential of parking lots or other applications of solar. The database is a very powerful tool for aggregate analysis of rooftop solar potential within the County.

To generate these data, the County measured the physical potential of the rooftops within the jurisdiction through aerial imagery analysis and advanced GIS modeling. These estimates of physical potential are based on a calculated area, measured in square feet, for the optimal placement of a rooftop solar array (given surrounding building structures, HVAC roof systems, vegetation, and other large obstacles blocking direct sunlight) for each of 2.1 million tax assessor parcels. This is the "optimal area" for rooftop solar. The final database produced by the County contains a maximum value for physical solar potential for the rooftops in each tax assessor parcel within the County. We used this database to estimate the solar potential described in this report.

Adapting the Los Angeles County Solar Map Database

The database consists of physical potential data fields joined with the descriptive fields of the tax assessor parcels. The County intended the physical potential data to be used with the Solar Map website. This interactive tool is designed to help individual users investigate single sites. Furthermore, the descriptive fields of the parcels were intended to be used for property tax assessment. Because of these differences in the intended uses of the original data, we modified the database to align it with the assumptions necessary for a regional evaluation of solar potential. We modified the database in several ways to ensure it was appropriate for a comprehensive regional analysis. See Appendix 1 for a detailed description of the assumptions that underlie the measurement of physical potential.

Figure 3: Validating the Solar Database through Shadow Analysis on a Sample Parcel
(Image source: Google Earth & Google SketchUp)



Our final product was a database that can be analyzed for aggregate physical and economic solar potential. Based on the assumptions described in Appendix 1, there are 19,113 megawatts of rooftop physical potential in Los Angeles County and 5,536 megawatts within the City of Los Angeles. The graphs in Figures 4 and 5 describe the distribution of this potential by market segment within the City and the County. While single family homes are numerous, their total physical potential is constrained by the small individual potential of each building. Multi-family residences are common in the region and many have rooftops that would be attractive for solar. Although fewer in number, non-residential buildings in the commercial and industrial (C&I) segment are the largest available resource in the region. C&I buildings of all sizes are available, but the largest of C&I rooftops can essentially become small power plants, providing both clean energy and economic benefits to greater Los Angeles.

All Shapes and Sizes: The Relative Scale of a Megawatt

The size range of potential solar projects is great. The smallest solar projects on residential homes (1 to 10 kilowatts) can produce enough energy to offset a portion of one home's consumption. They occupy just a few hundred square feet of installation space and can be installed with a low-profile. Mid-scale projects (10 to 1,000 kilowatts), such as those on multi-family residences or small C&I buildings can occupy thousands of square feet of rooftop space and can generate valuable surplus electricity. The largest rooftop projects require hundreds of thousands of square feet and can range from about one to three megawatts (1,000 to 3,000 kilowatts). If properly installed, these projects are low-visibility and do not interfere with the

Figure 4: County of Los Angeles: Megawatts of Physical Rooftop Solar Potential by Market Segment

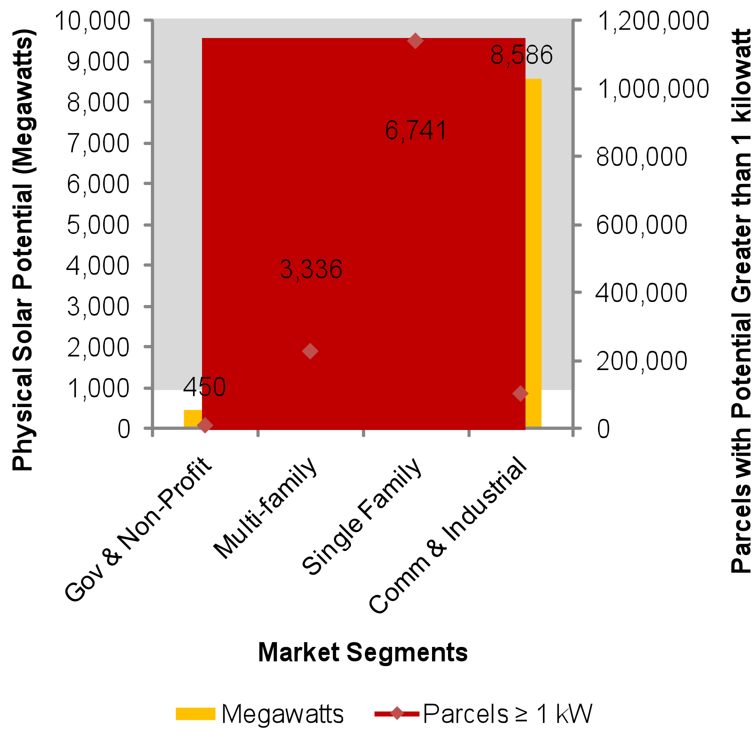
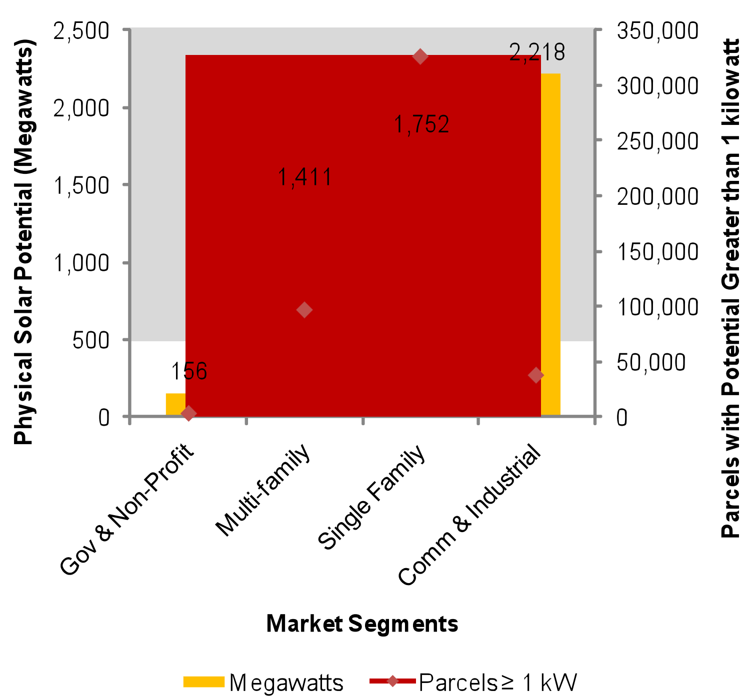
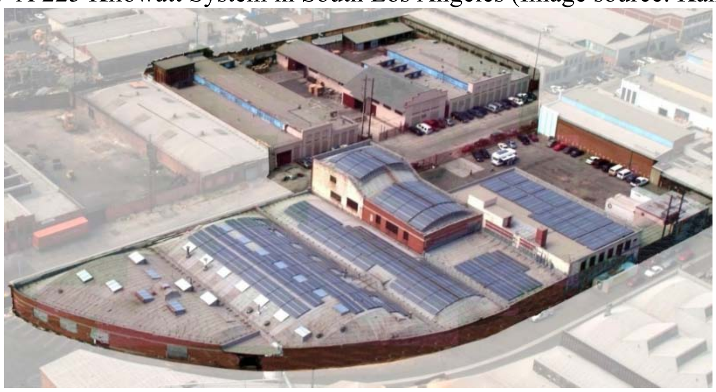


Figure 5: City of Los Angeles: Megawatts of Physical Rooftop Solar Potential by Market Segment



existing operations of the building. Rooftop projects of this scale are only feasible on large, low-rise buildings, typically warehouses and distribution facilities. Some parcels can include several rooftops of this scale. One megawatt of rooftop solar produces every year the same quantity of energy that is consumed by over 100 typical Los Angeles households.

Figure 6: A 225 Kilowatt System in South Los Angeles (Image source: Kahn Solar)



It is important to understand the distribution of project sizes because scale is closely related to cost. As projects get bigger, they generally become more cost-effective per unit of energy generated. The largest and most cost-effective solar resource in Los Angeles is C&I projects over 50 kilowatts. The City has 15,153 parcels with over 50 kilowatts of potential and 118 parcels with over 1,200 kilowatts of potential. See Appendix 4 for a description of the 25 parcels with the largest potential in the City of Los Angeles.

Figure 7: County of Los Angeles: Megawatts of Physical Rooftop Solar Potential by Project Size

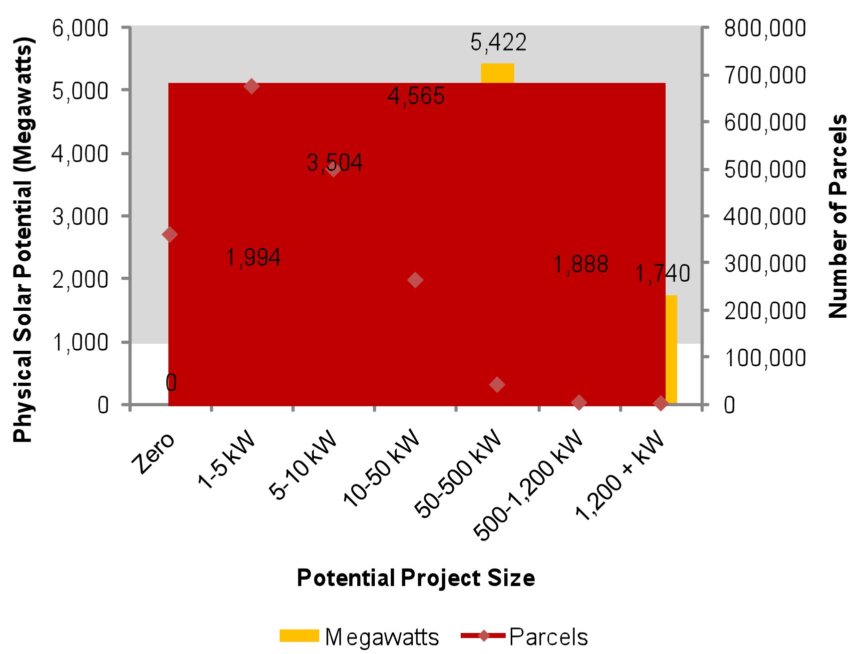
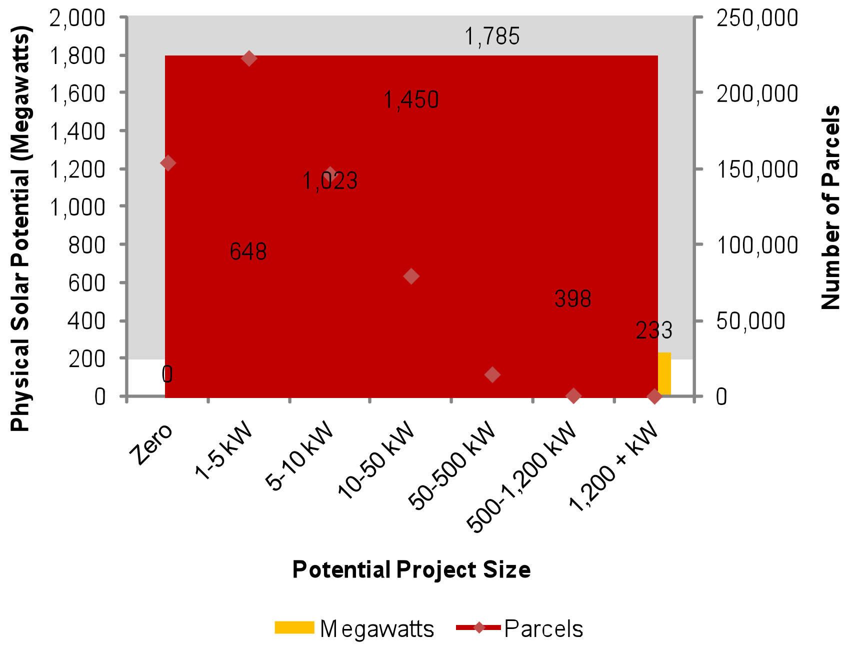


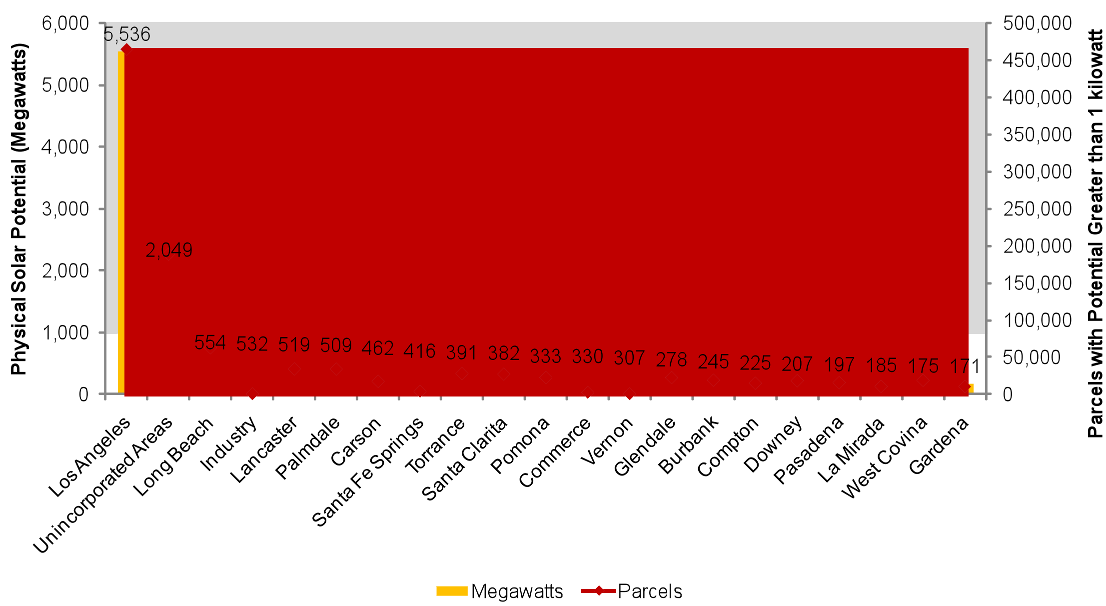
Figure 8: City of Los Angeles: Megawatts of Physical Rooftop Solar Potential by Project Size



The Geography of Urban Solar Potential

The primary determinant of physical solar potential is urban form. Los Angeles County is a diverse collection of communities. Each of the County's 88 cities is distinct with regard to development history, socio-economic profile, and land use patterns. These factors interact to determine the physical solar potential of each city. See Figure 1 for a map of solar potential within the County.

Figure 9: County of Los Angeles: Megawatts of Physical Rooftop Solar Potential by Municipality



Land Use and Solar Potential

The prevailing land use patterns determine the number and size of rooftops. Land uses vary over the urban landscape. Zoning regulations are an important factor in how land use patterns develop. C&I land uses generally create areas with higher solar potential.

C&I buildings tend to be larger than residential buildings and are less likely to have obstructed rooftops. Not only do they have more installation space available, but they also benefit from the economies of scale of larger projects and tend to be more cost-effective. Areas zoned for C&I uses can be dense concentrations of large projects, able to deliver significant amounts of energy to the grid while capturing the benefits of investment in a local resource. Because of their size and relative efficiency, these projects tend to be cheaper to install and operate on a per kilowatt-hour basis.

These buildings are likely to have large, flat rooftops, consistent adjacent building height, and fewer surrounding trees to shade the rooftop. Another factor that creates differences in potential is the time period when the area was developed. Historical development periods favoring symmetrical designs produced in high volume created areas with higher potential than older developments where each building was comprised of unique profiles. These conditions create opportunities for larger, contiguous panel installations. In Los Angeles County, C&I land uses are associated with higher physical solar potential. On average within the County, 37% of the square feet of C&I rooftops is available for solar, while only 18% of single family home rooftops is available for solar installations. The following comparison illustrates this important distinction.

Comparing Vernon and Pasadena

Land use in the City of Vernon, located a few miles south of Downtown Los Angeles, is dominated by C&I buildings. It has only 89 permanent residents within five square miles.[6] Vernon has 307 megawatts of physical potential distributed over 1,089 parcels, almost exclusively C&I. The average rooftop area available for solar in Vernon is 50%. The median potential for these parcels is 147 kilowatts, while the top ten parcels in Vernon each have over 2.2 megawatts of physical potential. Vernon is an example of an area where the urban form is very conducive to large-scale rooftop solar. Based on its urban form, much of Vernon's potential solar capacity could be accessed very efficiently and cost-effectively. The beneficiaries of such a program would be owners of these solar systems. These owners could be the businesses in Vernon, or possibly third party solar service companies located in or outside the region.

Pasadena, northeast of Downtown Los Angeles, has a mixed land use pattern. The population of 133,936 is spread over 23 square miles.[7] The classification of its 28,342 parcels is 77% single family, 14% multi-family, 8% commercial, and 1% government or non-profit owned. Despite a much bigger footprint and many more parcels than Vernon, Pasadena has less physical solar potential, about 197 megawatts. The distribution of this solar potential is 34% single family, 16% multi-family, 41% commercial, and 9% government and non-profit. The average rooftop area available for solar on parcels in Pasadena is 11%. The median potential for all parcels in Pasadena is 2 kilowatts, while the ten largest are each over 800 kilowatts. Pasadena's urban

Figure 10: City of Vernon: Megawatts of Physical Rooftop Solar Potential by Project Size

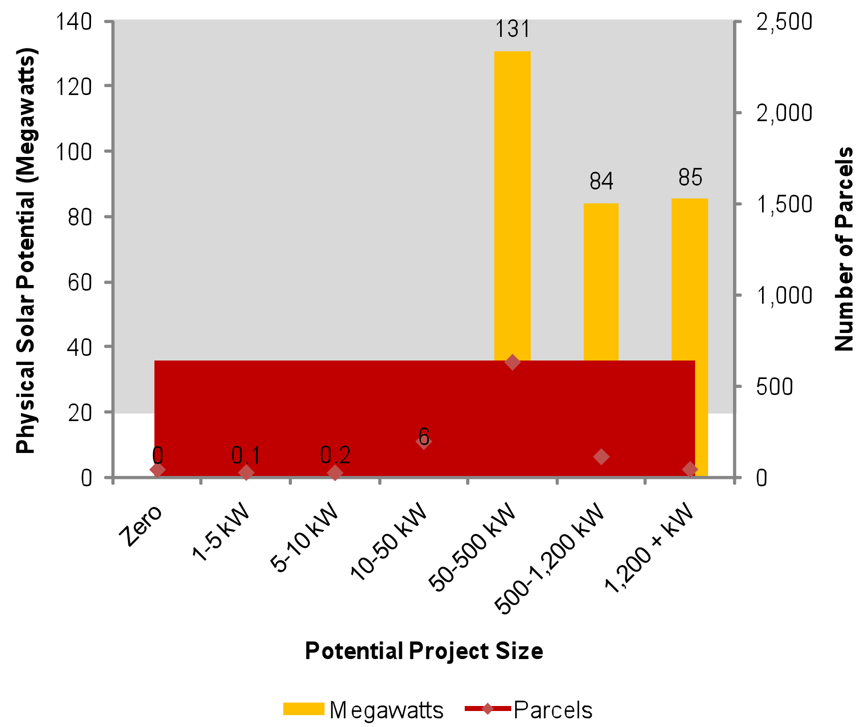
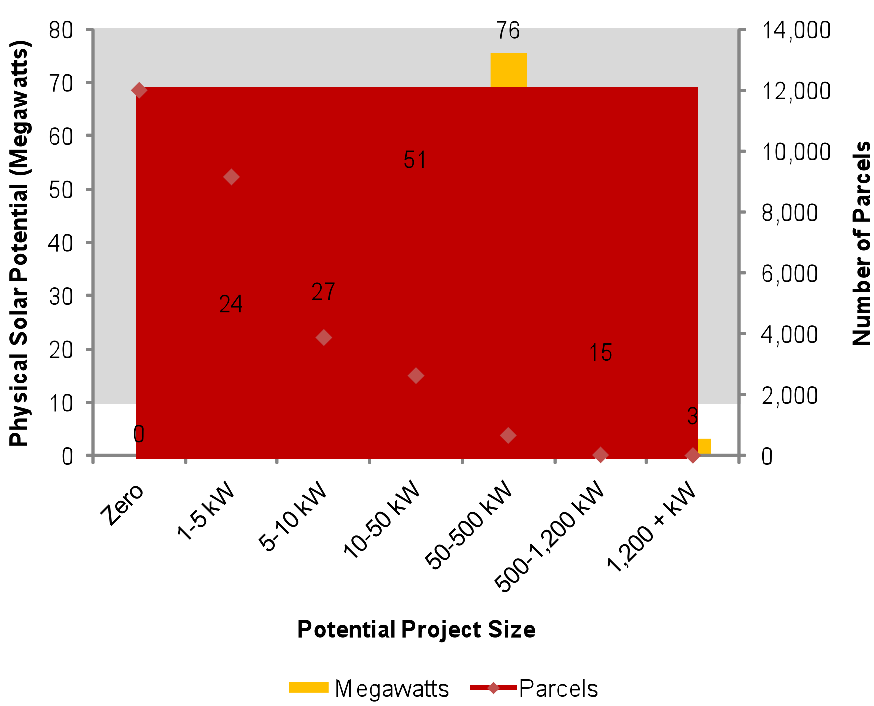


Figure 11: City of Pasadena: Megawatts of Physical Rooftop Solar Potential by Project Size



form creates opportunities for both community ownership of solar and local job creation. The beneficiaries of a FiT program in this jurisdiction could be the local homeowners, businesses, and site owners receiving the energy sales revenue and the local labor force employed to install the numerous small projects.

Pasadena and Vernon are two examples of how the prevailing urban form impacts solar potential. If each of these cities' utilities were to design a FiT program to access the solar potential of the jurisdiction, the programs would necessarily be designed differently. While some communities in the County may have characteristics similar to these two cities, there are many others that are completely distinct from these two examples. Because of the diversity of the communities within Los Angeles County, any FiT program must be well-designed to harness the local solar resources, meet the expectations of the relevant stakeholders, and achieve the jurisdiction's unique energy and economic development goals.

Solar Potential by Political District

Every district within the City and County has solar potential. The solar potential of City Council districts ranges from 186 to 670 megawatts. In the County, the solar potential of Supervisorial districts ranges from 3,173 to 4,782 megawatts. The size, urban form, and land use patterns of each district determine the potential. Every district can benefit from a well-designed solar FiT policy.

Figure 12: City of Los Angeles: Megawatts of Physical Rooftop Solar Potential by City Council District

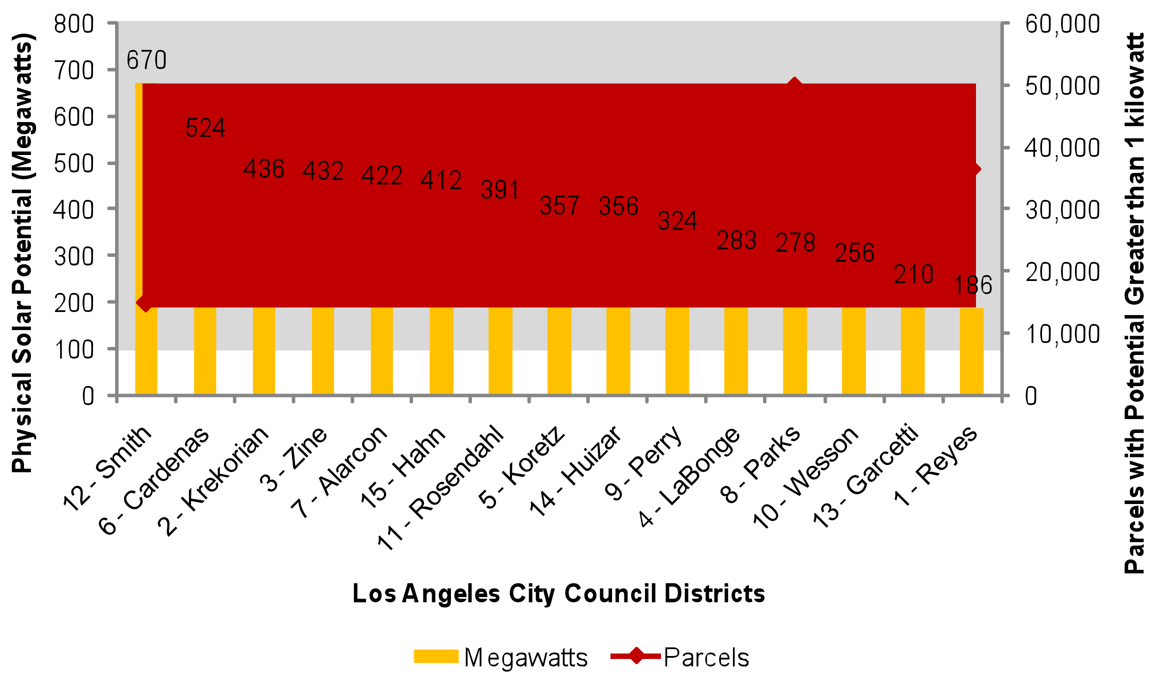
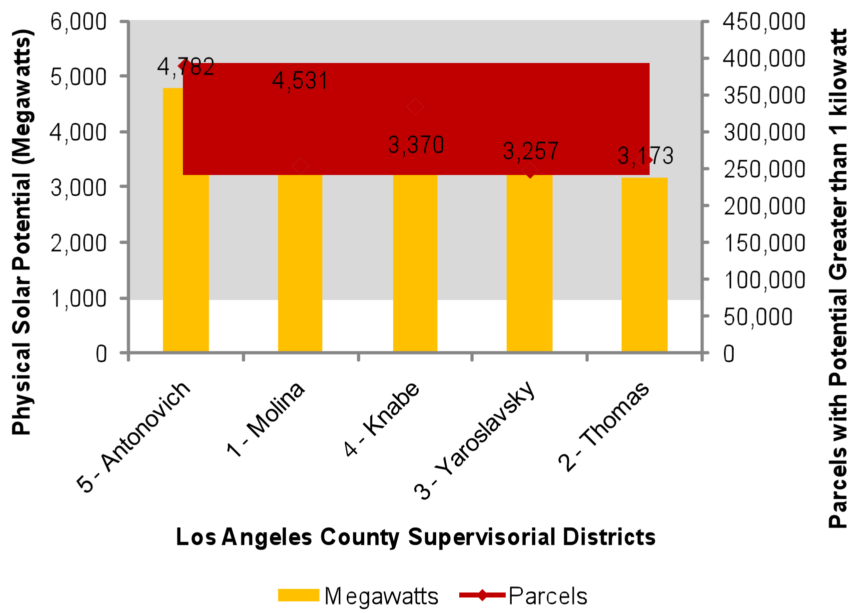


Figure 13: County of Los Angeles: Megawatts of Physical Rooftop Solar Potential by Supervisorial District



Conclusions

Greater Los Angeles has significant physical potential for rooftop solar. About 19,113 megawatts of physical potential exists on the rooftops within the County and 5,536 megawatts of physical potential are present within the City of Los Angeles. Rooftop solar can be among the highest and best uses for these idle assets.

Every community in the County has accessible solar potential. Its quantity and distribution has been determined by the geographic area, urban form, development history, and land use patterns of each community. The physical potential is distributed throughout each district and city within the urbanized areas. Some communities have dense concentrations of solar potential in C&I areas while others have more dispersed potential located on residential homes and small businesses. While these differences will lead to different types of solar projects, each has a role to play in an effective policy. All of the communities in the City and the County can be the beneficiaries of well-designed solar FiT policies.

Section 3: Evaluating the Economic Solar Supply Potential of Greater Los Angeles

Under the traditional utility paradigm, homeowners and businesses are the customers, demanding energy from the utilities, which supply energy at prices allowing capital cost recovery plus a regulated rate of return on investment. Under a FiT policy, a utility must purchase solar energy from any homeowners or businesses willing to supply energy under the terms of a non-negotiable contract. A FiT program reverses the traditional relationship between customers and utilities, transforming the customers into "suppliers" and the utility into the single "customer." An effective FiT program would incentivize some of these "suppliers" to generate solar energy by offering a tariff that covers the cost of installation and provides a reasonable, targeted rate of return.

Suppliers will participate in the program only when their perceived benefits exceed their perceived costs. In order to induce participation cost-effectively, policy makers must understand the suppliers' costs and benefits and how they can vary between suppliers and between sites. Because of this natural variability, not all suppliers are willing or able to supply energy to the utility at equal price points. This natural distribution is expressed in the economic solar potential of an area.

The purpose of this section of the report is to evaluate the cost-effectiveness of the available physical potential from a regional perspective. This knowledge can help determine the feasibility of a large program and can focus policy makers on the geographic regions, the types of projects, and the market segments that will best contribute to an effective FiT program.

Key Findings

Only a small portion of the 19,113 megawatts of physical solar capacity needs to be harnessed in order to make a meaningful and cost-effective contribution to the region's energy and economic development goals. Los Angeles County is a large and diverse place, covering 4,061 square miles and housing 10 million residents.[8] The owners of the rooftops that these residents live and work under could supply about 12,500 megawatts of solar capacity at tariff levels comparable to those offered in other jurisdictions within North America. In the City of Los Angeles, about 3,300 megawatts is available at these tariffs.

Table 2: County of Los Angeles: Megawatts of Economic Rooftop Solar Potential at $0.30 per kWh by Market Segment

Market Segment	Gov & Non-Profit	Multi-Family	Single Family	Comm & Industrial	Total
Los Angeles County	104	1,576	5,106	5,775	12,561
City of Los Angeles	28	648	1,282	1,384	3,342

This is a massive, underutilized resource that belongs exclusively to Greater Los Angeles. While the integration of this much distributed solar into the electricity grid in the short-term could be a considerable challenge, Los Angeles can still feasibly incorporate gigawatts of this latent rooftop solar capacity more cost-effectively than virtually any other place in North America.

Evaluating Economic Solar Potential

"Economic potential" is an evaluation of how economically the solar resources of the Los Angeles region can be harnessed. It is the quantity of physical potential within a geographic region that rooftop owners would be willing to supply at a given "price." Economic potential is a subset of the total physical potential since, from the utility ratepayer's perspective, only a portion of this physical potential can be supplied cost-effectively. The most expensive projects that participated in the California Solar Initiative (CSI) have reached over $100 per installed watt.[9] It is reasonable to expect that a small portion of the potential sites within the County would also reach a similarly high cost. If so, under a FiT regime, owners of these less cost-effective sites would generally not be willing to supply energy at reasonable tariffs.

The economic solar potential of a region under a FiT policy can be expressed in terms of price and quantity, a traditional economic supply function. Expressed in this way, price becomes the tariff offered by the utility, the independent variable. Conforming to the conventional display of supply and demand curves, the independent variable is plotted on the vertical axis of a graph. We measured the tariff in terms of average cents per kilowatt-hour paid to the FiT participant by the utility (e.g. $0.30 per kWh). Quantity becomes the solar capacity within the jurisdiction that participants are willing to install in order to feed energy into the grid. This quantity is measured in megawatts throughout this analysis. Solar capacity is the dependent variable. Graphically, a solar supply function for a large jurisdiction manifests as an upward sloping curve which asymptotes at zero and at the physical potential of the jurisdiction. Other authors have conducted similar analysis to determine the supply potential for rooftop solar.[10]

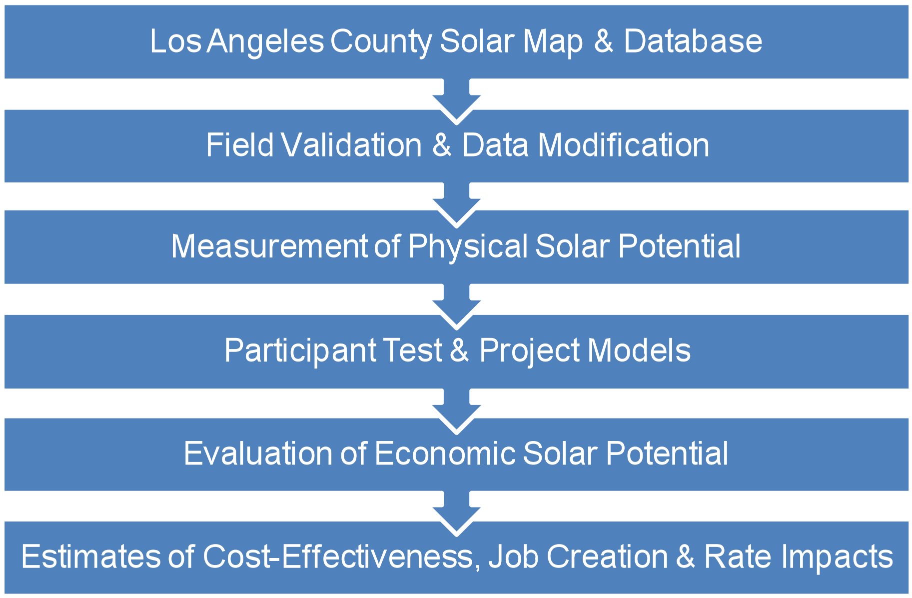
Demand is created by the utility's FiT program. If utilities are willing (or required) to buy a fixed amount of in-basin solar energy under non-negotiable FiT contracts, they create demand for solar energy within the jurisdiction. Utility demand is represented by the total program cap and the tariff offered. The graphical representation of these two FiT program design elements on a demand curve is two lines. A horizontal line at the indicated tariff level, drawn from zero to the program capacity cap, connected with a vertical line extended downward to the horizontal axis represents the utility's demand function. The intersection of these supply and demand functions suggests how much physical capacity is available at the given tariff level.

Physical potential for a geographic area is fixed in the short-term, but economic potential is dynamic, both in the short-term and the long-term. In the short-term, generally considered to be less than one year, economic potential will change as the total benefits available to a solar supplier change. For example, the utility could adjust the tariff offered for new contracts, changing the cost-effective quantity of solar capacity available as the new rules took effect. The fundamental drivers of cost-effectiveness are continuously evolving. Over the long-term these factors can dramatically influence the economic potential of a jurisdiction.

Analytical Methods

The Participant Test outlined in the California Standard Practice Manual is a useful method to estimate the benefits of participation from an owner's perspective.[11] Applying this test or a equivalent variation with a custom made, spreadsheet-based project model or a publiclyavailable software program, the administrators can determine what a specified tariff level, given market conditions, and tax incentives means to a participant in terms of annualized returns.[12] For a more detailed list of the important factors, see Appendix 3 of the first report. Based on this, it is possible to estimate the benefits realized by different segments of participants at different tariff levels.

Figure 14: Flowchart of Methodology and Research Activities



We created an automated computer simulation model to aggregate the Participant Test over the entire set of eligible participants within a geographic area. This model estimates the amount of solar capacity that would participate at any given tariff level. It references the database of physical solar potential for each parcel as described in Section 2. Then, the model calculates the benefits for every potential site within a specified geographic boundary by simulating site-specific variables according to statistical distributions and measuring the incremental participation as the available tariff increases. We used this approach to evaluate economic potential. Appendix 7 provides more detail on the parameters used to simulate variables and evaluate the total supply potential.

The Economic Factors of Solar Potential

Many economic factors determine the supply function of rooftop solar. The most important factors that have an effect on a potential owner's willingness to supply solar energy to the grid are the total installed costs and the owner's required rate of return. Also, the availability of state or federal tax-based incentives will impact the economics of solar projects and change the economic potential of a region. Finally, ongoing operational expenses, expected inflation, access to capital, and the owner's investment alternatives will impact the economic potential. Nearly all of these factors are out of the control of the program administrator, but they directly influence the project economics and the overall economic solar potential of a jurisdiction. For these reasons, program administrators must periodically review these economic factors and adjust the tariff to ensure that the total return provided by a new contract remains as close as possible to the program target rate of return.

Initial Cost of Installation

The installation costs of solar are variable. Similar projects can have different installation costs based primarily on site-specific characteristics. Some sites are more challenging to install, and therefore more costly, based on rooftop accessibility, electrical configuration, structural integrity of the building, solar system mounting design, and compatibility with existing building operations.[13] This variance makes it difficult to accurately predict the installation costs of a specific site without an estimate from a qualified installer. During 2009 this variance was increasing for small commercial and residential projects and decreasing for large commercial projects.[14] While the costs associated with a single potential site are difficult to predict without a qualified inspection, the central tendencies of a large population of projects display clear patterns and trends.

Size is an important determinant of average installation costs. Larger projects tend to be cheaper per watt because they benefit from the efficiencies achieved by professional developers, discounted long-term contracts for equipment, and economies of scale in planning, design, and installation. On average, their cost of installation is significantly lower than smaller projects. This cost differentiation by size is more drastic for projects over 50 kilowatts. The median cost of a small commercial project (5 kilowatts) during 2009 was $8.38 per watt while the median cost of a large commercial project (over 500 kilowatts) was $5.08 per watt.[15] The differentiation between median costs is primarily due to the economies of scale implied by the project size.

These costs are continuously evolving as global market conditions change. Not only do these costs vary by project size, but they also change over time. From late 2008 to present, installation costs have fallen significantly. The median installation cost of a residential project (4 to 5 kilowatts) participating in California's rebate program dropped from $7.94 to $7.06 per watt during this time.[16] Over time, the economic potential of a jurisdiction changes as the installed costs change. If other factors remain constant and installed costs continue their downward trend, the amount of physical potential that is cost-effective at a given price will increase. The fact that costs have fallen recently, does not prohibit the possibility of increases in the future. Program administrators must pay close attention to solar industry supply and demand projections.

Data taken from the California Solar Initiative online archive in February of 2010 describe the installation costs for each project registered in that program. While the data are for CSI projects in the IOU territories within California (some of which may not even be rooftop projects) they provide the best available descriptive dataset. Because solar costs are dynamic, we developed four scenarios based on this data which represent solar costs if they continue to fall. See Appendix 7 for a detailed description of these scenarios and installed cost assumptions.

Alternative Investment Opportunities

The supplier's required rate of return represents the minimum annualized return on investment an owner must expect to receive before they will enter the market. This threshold is a function of the broader economy. Potential suppliers must choose between a solar investment and their alternative investment opportunities. For a business, alternative opportunities may be to expand an existing business operation, hire more employees, pay off debt, etc. Additionally, the initial costs of installation are likely to be financed through debt or equity mechanisms, each of which has a distinct cost. If the benefits from the solar investment do not cover these costs, owners will not adopt solar on a widespread basis. Even residential owners have alternative opportunities to "invest" (e.g. save for retirement, provide for their children's education, upgrade their home, etc.). The benefits from a solar investment must meet or exceed those offered by other opportunities. The equivalent annual yields from an owner's alternative investments change with both the macro economy and local conditions. The cycles of interest rates fluctuations, equity returns, access to capital, and overall economic growth influence the willingness of owners to supply solar energy under a FiT program. The continual evolution of these alternative opportunities will impact economic solar potential of a geographic area.

For a specific business, the required rate of return can be estimated by observing interest rates and market equity returns for the financing of comparable business operations. This rate changes by industry, firm size, capital source and location. From a regional perspective, it is necessary to make assumptions about the threshold requirements to induce participation.

For the purpose of estimating potential, we assumed a mean of 6% for the required rate of return for the owners of commercial systems. Systems on multi-family buildings would be most likely owned by the building owner or a third-party owner. This implies a commercial ownership structure and a rate of return consistent with other commercial projects, 6% in this case. The behavior of residential owners suggests a lower investment threshold based on a simple "payback" standard.[17] We assumed that 3% would meet the threshold for this segment. Because of their tax status, government and non-profit owned entities have access to cheaper capital than businesses so we assumed a mean of 4%. For each mean, we assumed a normal distribution and a standard deviation of 2%.[18] Our assumptions represent a distribution of values rather than the application of these means to every potential owner. In the real market there is a high degree of variation in alternative opportunities. Some owners have low investment thresholds while others require annual returns as high as 12%. The model simulations account for this wide variance.

Availability of Tax-based Incentives

Tax-based incentives are another major driver of the economic potential of solar projects. Modified Accelerated Cost-Recovery System (MACRS) will for the foreseeable future provide for the recovery of up to 20% of the value of the initial capital investment.[19] The Federal Business Energy Investment Tax Credit (ITC) is authorized until the end of 2016.[20] The ITC effectively reduces the initial capital investment of solar projects by 30%. If construction begins by the end of 2010, commercial projects can receive this benefit in the form of a cash grant from Treasury. However, after 2010, owners must have federal tax liability in order to take advantage of the ITC. The reliance on tax equity investors can partially mitigate this problem, but if tax-based incentives become more challenging for owners to monetize, the overall economic potential of a jurisdiction will be reduced. FiT program administrators must understand how the tax-based incentives influence economic potential.

Other Factors

Economic potential is influenced by the ongoing cost to maintain a system. If it becomes more expensive to operate a solar system, the overall rate of return to the owner will be reduced. The important operational expenses that influence economic potential are annual maintenance, inverter service costs, insurance, and property taxes (solar equipment is not assessed for property taxes in many counties). Because these important variables cannot be known for each of the 1.8 million potential sites in the County, it was necessary to simulate them. We assumed reasonable means and distributions based on the expectations of experienced solar market participants.[21]

Each of these economic factors is outside the control of FiT program administrators. Instead, they are determined by the broader global economy. They will fluctuate with interest rates, industry-wide supply and demand positions, and other drivers. The tariff offered per kilowatt-hour is the primary way to influence participation. The tariff can be adjusted to provide a stable, targeted rate of return necessary to induce enough solar to meet the procurement goals.

The Technical Factors of Solar Potential

Higher quality solar resources make solar systems more productive. More productive systems are more economical and increase the owner's willingness to supply solar energy. If two identical 3 kilowatt (DC) solar systems were placed on identical homes, one in Palmdale, and one near LAX, the system in the Palmdale microclimate would produce about 4,798 kilowatt-hours per year while the system in the LAX microclimate would produce about 3,961 kilowatt-hours per year.[22] Assuming equal costs, the Palmdale system would be more productive and cost-effective so the owner would be more willing to enter the market.

On average, solar systems located in high-resource areas are more cost-effective. In this way, the quality of the solar resource influences how economical the available physical potential is. Los Angeles County has very good solar resources throughout, but the northern areas of the County are excellent. The quality of these resources is unlikely to change significantly over the long-term. See Appendix 8 for the specific solar production factors used in this analysis.

These production factors were calculated for systems designed with optimal tilt and orientation. Systems oriented to true south and tilted to degrees latitude are the most efficient.[23] Specialized applications that cannot be optimally-oriented can reduce efficiency and therefore increase cost. For example, BIPV systems integrated into vertical building surfaces can be more costly per watt and half as efficient as traditional rooftop systems. In the regional model, the tilt and orientation of each rooftop was simulated according to an observed distribution based on the inspection of 60 sample parcels within the County. Based on our observations of sample parcels, the average performance derate factor for tilt and orientation was 93% for single family homes and 91% for other non-residential buildings.

Technical factors are important considerations. These factors are less dynamic than the economic factors, but they can change incrementally over the long-term as technology improves, infrastructure develops, or microclimates change. These factors can be accounted for in the

Figure 15: County of Los Angeles: Megawatts of Economic Rooftop Solar Potential by Market Segment

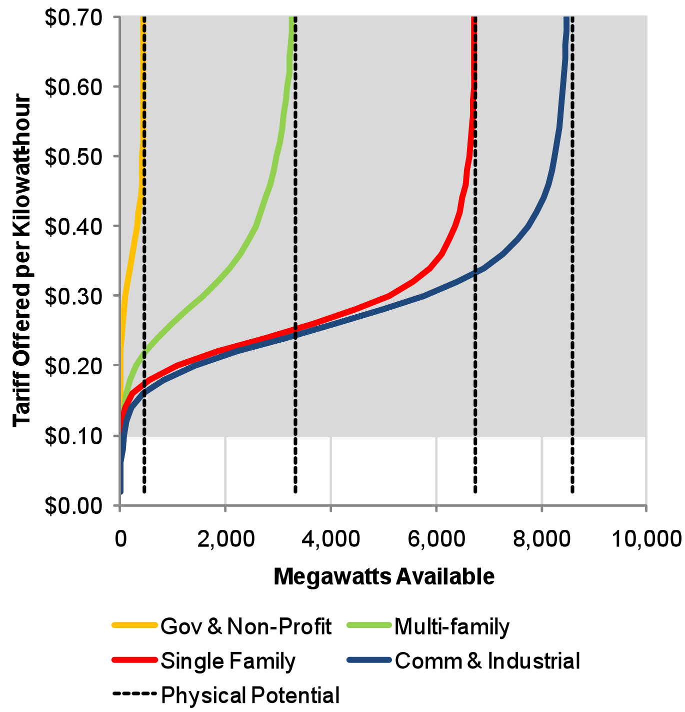
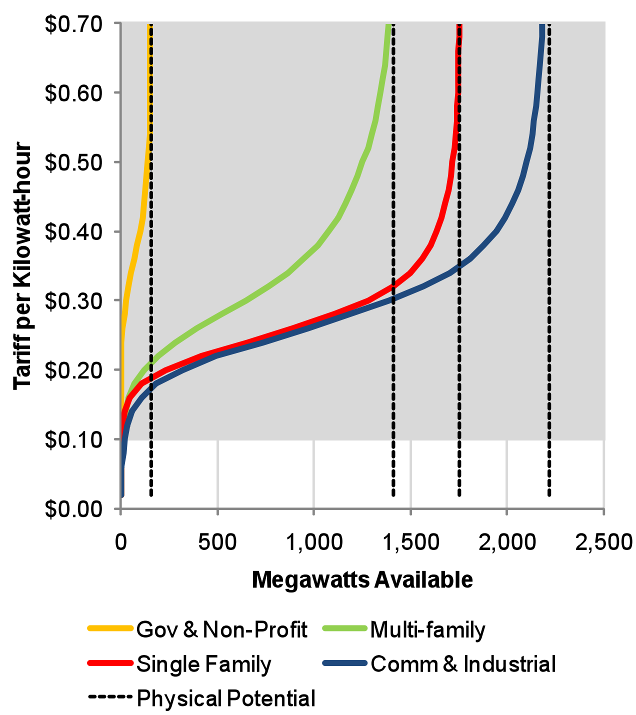


Figure 16: City of Los Angeles: Megawatts of Economic Rooftop Solar Potential by Market Segment



planning and design of the program to incentivize the most efficient and productive sites. The sponsoring utility could incentivize projects in advantageous locations that optimize the reliability of the distribution grid. Technical factors add another important dimension to the evaluation of economic potential that must be considered when designing a FiT program.

The Economic Solar Potential of Greater Los Angeles

Physical solar potential is abundant in Los Angeles, but only a portion of it can be accessed at any given price. There are about 12,500 megawatts of economic potential in the County and 3,300 megawatts of economic potential in the City at $0.30 per kilowatt-hour, a tariff roughly comparable to what is paid for rooftop solar in other places in North America. More detailed tables are available in Appendices 5 and 6. As with physical potential, economic potential is distributed throughout the market segments. The supply functions represented in Figures 15 and 16 are based on the assumptions described in Appendix 7 and are the "reference case" of the evaluation of economic potential.

Sensitivity Analysis

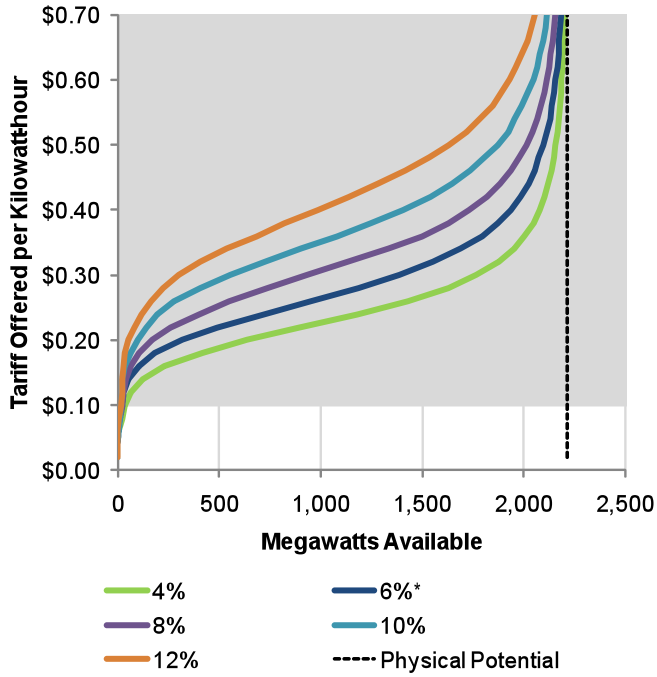
The economic factors, and therefore the economic solar potential of a region, are dynamic. They evolved during the course of this study and will continue to evolve as FiT programs are designed, implemented, and administered. It is necessary to explore how the economic potential changes as these factors change.

We conducted the sensitivity analysis on the C&I properties within the City of Los Angeles. We changed one economic factor at a time to demonstrate how each can influence overall economic potential. We investigated the impact of increasing required returns, falling installation costs, and federal ITC availability. Each change had clear impacts on the overall results. For brevity, we have focused the sensitivity analysis on C&I properties in the City, but similar results can be observed for the other market segments and in other geographies. The tables in Appendix 8 provide more details on the impacts of these scenarios.

Impact of Alternative Investment Opportunities

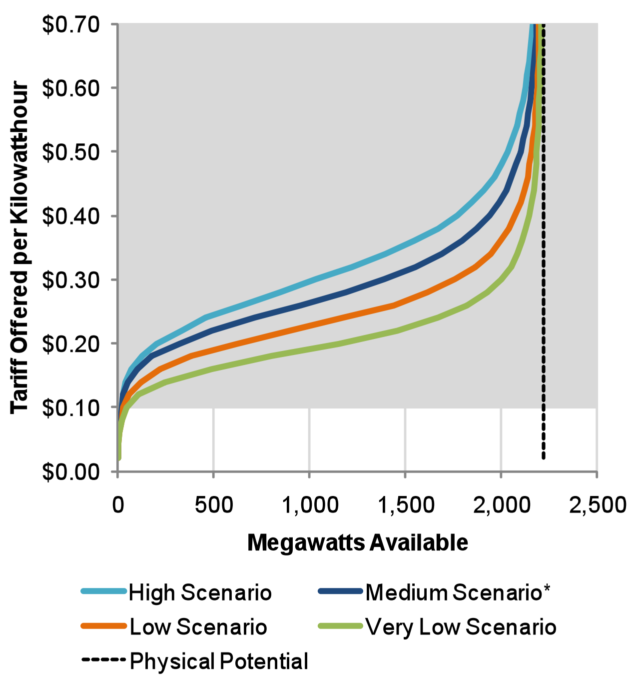
For C&I properties in Los Angeles the owners' average required rate of return is a critical assumption about how much solar potential is available. The reference case assumption of 6% was based on the assessment of opportunity costs of a small business or commercial entity within a low interest rate environment. The range of average values analyzed in the sensitivity analysis was from 4% to 12%. Figure 17 demonstrates the impacts of these extreme values and how this would change the economics of solar within the region. Even if the average business required a 12% rate of return on their investments, there still would be a few hundred megawatts of economic potential in this market segment given a $0.30 tariff.

Figure 17: City of Los Angeles C&I Parcels: Impact of Changes in Mean Required Return on Megawatts of Economic Rooftop Solar Potential



*Indicates the original assumption used in the reference case for Los Angeles C&I properties.

Figure 18: City of Los Angeles C&I Parcels: Impact of Changes in Installed Cost on Megawatts of Economic Rooftop Solar Potential



*Indicates the original assumption used in the reference case for Los Angeles C&I properties.

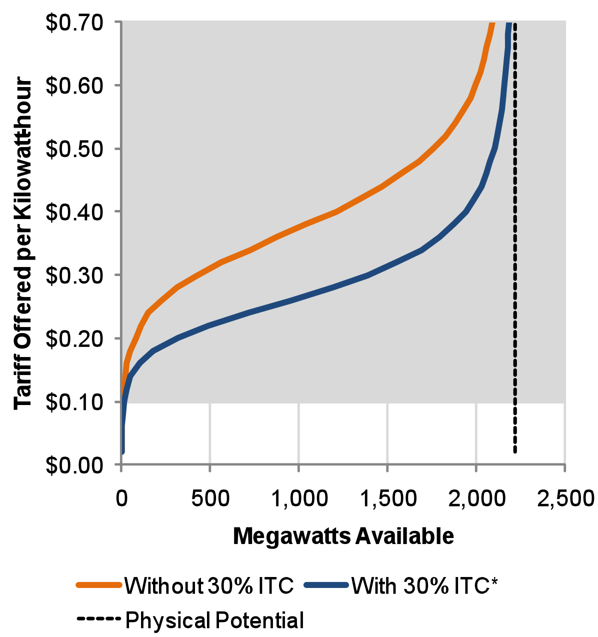
Impact of Installation Costs

The installation costs are a critical driver of solar economics. Data maintained by the California Solar Initiative demonstrate that the installed cost of solar has fallen since 2009. This trend could continue or reverse, changing the economic supply potential. There is over 500 megawatts available in all scenarios analyzed here, given $0.30 per kilowatt-hour. Figure 18 illustrates the impact of these scenarios. At the time this report was released, the installed costs of solar were roughly consistent with the "medium" scenario in Appendix 7.

Impact of the Availability of Federal Tax Incentives

The incentives offered by the federal government in the form of tax credits are important to the economics of solar projects. The Treasury grant option expires at the end of 2010. Beyond this a business must have tax liability to take advantage of this incentive. The 30% ITC is set to expire in 2016. If this program is not reauthorized, it will decrease the overall capacity available and the economic potential. Figure 20 shows two scenarios. First, it shows the economic potential with the 30% ITC available to all suppliers. Second, it shows the potential without any ITC available. The most likely scenario is somewhere in between the two extremes. During 2011 and beyond, some suppliers may have the tax liability to monetize some or all of the ITC while many suppliers may not be able to monetize any of this benefit.

Figure 19: City of Los Angeles C&I Properties: Impact of Federal ITC Availability on Megawatts of Economic Rooftop Solar Potential



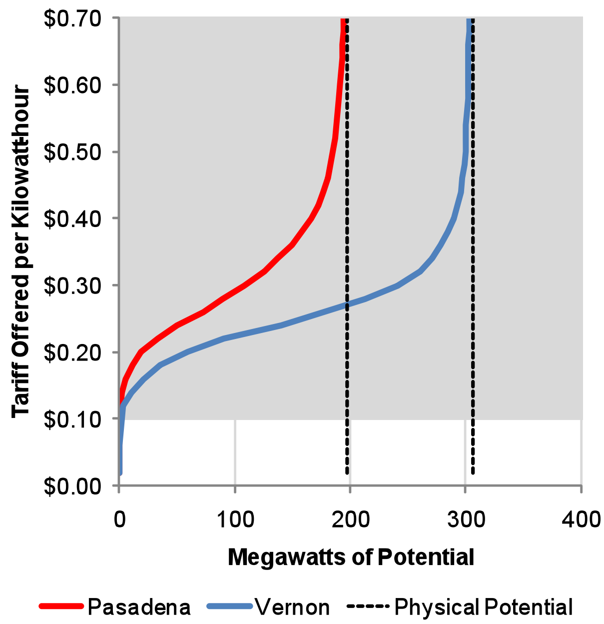
*Indicates the original assumption used in the reference case for Los Angeles C&I properties.

Impact of Urban Geography

As described in Section 2, urban form determines not only physical potential, but it also has an important influence on economic potential. Because of its prevailing land use patterns, Vernon has more physical solar potential than Pasadena. And due to the predominance of large parcels in Vernon, solar cost will be lower on average. Thus, a greater portion of its overall physical potential can be accessed at a lower net cost to the ratepayers.

For example, at $0.30 per kilowatt-hour, about 55% (108 of 197 megawatts) of Pasadena's solar potential might be willing to supply. In Vernon, at this same tariff, 79% (241 of 307 megawatts) of the solar capacity might be willing to supply. The rooftops in Vernon could provide an equal amount of solar as Pasadena at a significantly lower tariff. To induce 108 megawatts of participation in Vernon would require a tariff of about $0.23 per kilowatt-hour, much lower than the required $0.30 in Pasadena. The two case studies are a clear demonstration of how a community's urban form and development history determine the number, type, and size of the potential projects, which in turn influence the cost-effectiveness and economic potential of solar.

Figure 20: Vernon and Pasadena: Impact of Urban Form on Economic Rooftop Solar Potential



Conclusions

Given tariffs comparable to those offered by existing FiT programs, there are about 3,300 megawatts of economic rooftop solar potential within the City of Los Angeles and about 12,500 megawatts within Los Angeles County. As with physical potential, this resource is distributed throughout the different segments of the market. Rooftops on all types of buildings can provide energy and job opportunities, but large C&I rooftops can supply energy most cost-effectively. These types of buildings are plentiful in the region. Based on the evaluation of economic solar potential of greater Los Angeles, gigawatts of rooftop solar capacity can be incorporated into the energy mix more cost-effectively than in virtually any other region in North America.

The economic solar potential of the region is dynamic. It is a function of many constantly-evolving economic factors. These solar supply functions are instantaneous snapshots of solar potential based on static assumptions about dynamic economic factors. These supply functions are not market forecasts. Rather, they measure the potential of a latent resource under a set of given assumptions. There is clearly a massive resource at hand, but there is also some uncertainty in the economic drivers of these resources. Based on this fact, policy makers must approach FiT policy design with a long-term commitment to flexibility, economic efficiency, and effectiveness.

FiT policies must be tailored to both the appropriate solar market segments and the available solar resources. Policy makers cannot control the economic or technical factors of solar potential, but they can shape the program by deliberately crafting the program design elements to target specific market segments.

Section 4: Minimum Design Guidelines for a Solar Feed-in Tariff for Los Angeles

There are several examples of successful FiT programs in North America. These programs show a clear pattern to which general design element choices result in widespread adoption of renewable generation technology. They also illustrate that thoughtful program design can shape participation to best meet the intended goals of the sponsoring jurisdiction. These successful programs were tailored not only to adjust to global economic conditions but also to ensure that much of the program benefits stay local. In this context, programs are successful when they channel a global industry to invest in local resources in a way that is beneficial to local constituents.

Los Angeles cannot simply import these other programs and be successful. It is important to design and implement a program that can capitalize on the unique characteristics of the locally-available solar resources to help meet its ambitious goals, but also do it in a way that is both cost-effective and comprehensive.

The purpose of this section of the report is to demonstrate the conditions under which a FiT program for Los Angeles can be successful. For Los Angeles, success means being both cost-effective and inclusive, contributing in a meaningful way to the City's energy and economic development goals. The design choices outlined in this section are the minimum required for an effective policy.

Key Findings

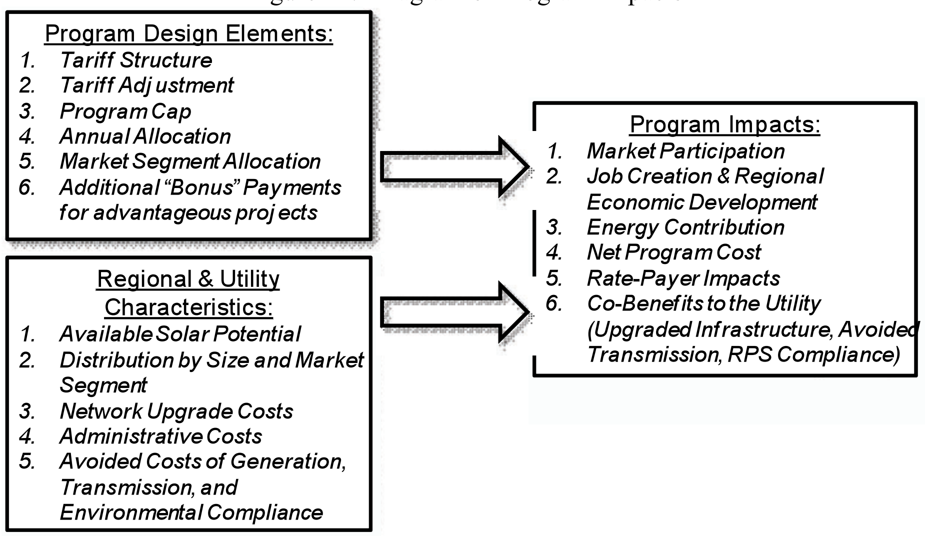
An effective and meaningful FiT program for Los Angeles must be both large and long-term. To capitalize on the abundant solar potential in the City, the program should target a minimum of 600 megawatts of in-basin solar generation implemented over ten years. This target is clearly feasible given the existing solar capacity. Furthermore, it is the point where the benefits of a well-designed program begin to outweigh the costs. By extending the implementation period to ten years, the overall cost of the program can be minimized. If the cost of solar installations continues to fall and the cost of new natural gas generation and high-voltage transmission escalates at even moderate rates, solar will become more attractive relative to its alternatives. This procurement goal is large relative to the other FiT programs implemented in the U.S., but it is a conservative target given the fact that 3,300 megawatts of solar is economically available.

This 600 megawatt in-basin solar FiT program has the potential to create over 11,000 jobs for Los Angeles, contribute 3% of the City's annual energy, and help position Los Angeles as a clean-tech leader. During the first ten years of the program, households would experience an average increase of $0.48 in their monthly energy charges. Business would experience an average impact of $9.37 per month. This impact would peak then eventually fall to zero beyond year 12. Later in the program, the benefits of solar would overcome the initial costs, so the monthly rate impacts would be less than that caused by natural gas peaker plants.

Anticipating and Measuring the Results

The results of FiT programs must be anticipated and evaluated by program administrators. Transparent and thoughtful evaluation is critical to minimizing the impacts and maximizing the benefits. Energy procurement is inherently a complex and uncertain process, but the risks can be reduced through effective planning. The task of evaluating the program requires both organizational capacity and political will. Without a commitment to ensuring that the program performs as intended by policy decision makers, the program is unlikely to be successful. The results are a function of the design choices and the local jurisdiction's characteristics. These two inputs interact to produce measurable impacts.

Figure 21: Diagram of Program Impacts



In the first report, we proposed six general categories of evaluative criteria. They are useful for developing more specific performance criteria that measure progress towards the overall goals. Using these criteria, we describe the specific impacts of the Los Angeles FiT and how any program can be evaluated along these dimensions.

Estimated Participation

The evaluation of economic potential serves as a foundation for anticipating how the market will respond to the FiT program. Interpreting the economic supply function of solar can answer questions about the feasibility and cost-effectiveness of alternative program designs that focus on different geographic areas or segments of the market. It demonstrates the marginal cost of increasing program capacity targets. The evaluation can also suggest whether a program might be in high demand, filling its queue quickly. This could happen if the tariff is attractive to the average participant and the program capacity cap is relatively low. Estimated participation is a central consideration because all of the other impacts follow from participation.

There are important considerations when inferring market participation from economic potential. The actual aggregate economic supply potential is greater than suggested by the supply functions in this report. These calculations are for rooftop projects only. Presumably, the typical project in Los Angeles will be a rooftop. However, there are other applications of solar, specifically, parking lots, and ground-mounted projects. Each application will have a distinct supply function. This potential is additional to rooftops and is not evaluated in this report. Also, commercial entities can own solar projects located on non-commercial parcels. This fact somewhat reduces the otherwise sharp distinction between the market segments assumed by this analysis.

Furthermore, several factors can reduce actual market participation compared to the economic potential. The accessibility of investment capital can influence the number of potential suppliers who can enter the market. A fixed, 20 year contract can improve an owner's chance of debt financing for a solar project, but overall, capital accessibility can inhibit market participation relative to its total potential. Installers and manufacturers have a fixed capacity in the short-term and require time to accelerate their operations to meet increasing market demand for equipment and services. If the FiT program is implemented over the long-term, industrial capacity is less likely to constrain market development. Occasionally, the installation of solar on a non-residential building might interfere with the operations of the building, even if it could otherwise be a suitable site. Lack of awareness, both of the program and of its overall benefits, can impede market participation. Finally, personal preferences and aesthetic concerns can prevent suppliers from participating even if it makes economic sense to do so.

These factors must be considered in any realistic estimate of participation. Economic potential is the fundamental basis for estimating participation. It is an essential analysis to estimate the feasibility of alternative program designs. In Los Angeles, the abundance of solar resources and potential sites demonstrate that a large program is not only feasible but also optimal, especially if it focuses on cost-effective market segments and is implemented over a long time period. Despite these important considerations, Los Angeles is not supply constrained and can expect a strong market response if the program is well-designed.

Energy Contribution

The ability to bring solar capacity online quickly is one of the most commonly cited benefits of FiTs. This contribution must be anticipated, measured, and evaluated. While Los Angeles cannot meet its goals entirely through a FiT, the potential energy contribution from an effective FiT could be an important part of achieving the goals. In Section 3, economic potential was expressed in megawatts, but it also can be effectively measured in megawatt-hours. The analytical capability to estimate energy production from different applications of solar projects must be integrated into the program design process.

Distributional Impacts

FiT programs can redistribute costs and benefits between stakeholders. These stakeholders include system owners, the utility, utility ratepayers, taxpayers, the political administration, and the solar industry itself.

The most evident, and sometimes controversial, distributional impact of FiT programs is the impact on utility ratepayers. The Ratepayer Impact Measure (RIM) outlined in the California Standard Practice Manual outlines a methodology to assess the rate impact of utility programs.[24]

This method is useful for estimating the total cost of the FiT program from the utility ratepayers' perspective. The method incorporates the additional annual costs and benefits associated with the program and allocates the net impact over each kilowatt-hour sold by the utility.

Direct Economic Impacts

FiT programs create jobs within the sponsoring jurisdiction. The tariff payments incentivize additional solar installations above and beyond what would have been installed in the area during the same period without a FiT policy. These new installations create employment opportunities and can stimulate local industrial development.

Additional employment effects can be decomposed into direct, indirect, and induced effects. Direct employment results from the jobs created directly within the solar supply chain. Some analyses also include estimates of indirect jobs that arise from demand for inputs into solar supply chain. Other analyses include induced jobs, which arise when people employed in solar supply chain jobs spend money on food, housing, clothing and other expenditures that require labor inputs.

Different types of projects have different economic impacts. While residential projects can be more expensive than larger C&I projects, they can create more jobs per installed megawatt. Although residential projects do not have economies of scale relative to C&I projects, the additional job creation potential can itself be a valuable benefit. Similarly, different project types are more likely to localize the additional revenue benefits. Residential projects are more likely to be owned by the occupants of the home, while large C&I projects can be owned by corporate entities headquartered in other cities.

Cost-Effectiveness

It is important to evaluate the cost of an in-basin solar program to the next best alternative. Since solar produces energy when it is most valuable, during peak demand periods, it must be compared to the generation sources which would otherwise be used at these times. Natural gas peaker plants are used to provide peak-period energy and are the most appropriate alternative option.

Some solar projects are more cost-effective than others. Solar projects must be evaluated and compared against each other on the whole of the costs and benefits associated with each. Solar projects are not interchangeable commodities. As the administrators design the program, they must compare the net cost with the relative energy contributions from each distinct technology application and each market segment.

It is important to consider the total costs and benefits over the entire time horizon of the program. One way to do this is to calculate the net present value of the program from the perspective of the utility. A public utility is effectively operating with public funds. Without a transparent evaluation of energy procurement alternatives, the best use of public funds cannot be ensured. This type of evaluation can help shape the program's participation to achieve the best mix of both cost-effectiveness and inclusiveness.

Policy Interactions

FiT policies can be designed to complement other in-basin solar incentive policies. Many utilities offer net metering and rebate programs which are popular with utility customers and can also be effective at reducing the peak load on the grid.[25] Both types of customer programs are funded through rate-based measures and both have potential to contribute in different ways to the energy mix. They can be designed to complement each other with respect to program goals, project eligibility, and customer participation. If a FiT program is well-designed it can target customers who cannot otherwise benefit from net metering and rebate programs, thereby increasing the overall penetration of solar projects and increasing solar's overall RPS contribution.

The federal incentives delivered through tax-based mechanisms will eventually expire and may not be reauthorized at their current levels, if at all. If these valuable incentives are not accessible, the tariff provided by the FiT program may no longer induce participation. The interaction between tax-based incentives and FiT payments should be anticipated and pro-actively addressed by program administrators.

A well-designed FiT program would expand the economically available solar capacity by unlocking the full potential of the in-basin solar market. Net metering programs target homes and businesses with high electricity consumption, tiered rate structures, and time-of-use multipliers during peak periods. FiT programs could target solar market segments that do not use large amounts of energy and therefore are not easily accessed by net metering policies. Examples of these segments include multi-family rooftops, warehouses, parking lots, open-space, and infrastructure rights-of-way. This could be accomplished by defining the general eligibility requirements of FiT programs to align with those types of utility customers that cannot benefit from net metering. Alternatively, FiTs and net metering can be hybridized, so the first kilowatt-hours produced would offset on-site consumption, and all remaining surplus generation would be fed into grid and sold to the utility at fair and efficient tariffs.

An Effective Feed-in Tariff for Los Angeles

The policy design choices described here are the minimums required for an effective policy. Based on the market conditions at the time of this report, the tariffs are the lowest required to induce meaningful participation. These minimum design element choices are fiscally responsible, allocating the greatest share of solar capacity to the most abundant and cost-effective in-basin sources. Finally, the program is inclusive, providing opportunities for participation from any homeowner or business willing to supply energy at the given price.

The program should target 600 megawatts allocated according to Table 3. The tariffs for new contracts should be differentiated by project size and decreased by 5% annually or based on market participation triggers, every 60 megawatts in this case. Every new contract must be given a standard, fixed price, 20 year contract with guaranteed grid access. The utility must orchestrate project permitting and interconnection support. The application process must be straightforward with low transactions costs. A small deposit, completely refundable with the commercial operation of the project, would be appropriate to deter speculators and avoid creating a free financial option on public funds.

Table 3: Minimum Design Guidelines for a 600 Megawatt FiT in Los Angeles

Category	Eligible Systems	Typical Participants	Initial Tariff per kWh	Capacity Allocation
Small-scale Rooftops	Less than 50 kW	*Single family homes, small office & retail, apartment buildings*	$0.34	100 MW
Large-scale Rooftops	50 kW and Greater	*Warehouses, distribution facilities, light manufacturing, industrial*	$0.22	300 MW
All Ground Mounted	Ground-mounted systems	*Large ground-mounted, installed for optimal efficiency & cost-effectiveness*	$0.16	200 MW

Under this alternative, Los Angeles could benefit from a 3% RPS contribution and experience over 11,000 additional jobs in the downstream solar value chain. During implementation, household utility customers could expect to pay, on average, $0.48 more per month in energy charges. Perhaps most importantly, a program of this scale would signal a strong commitment from Los Angeles towards clean-tech development, fiscal responsibility, and environmental sustainability.

Analysis of the Impacts

The following impact analyses evaluate how the 600 megawatt FiT in Los Angeles might impact the City. It looks at the employment, overall cost-effectiveness, and rate impacts of the program. Alternative designs are investigated to demonstrate the impacts of design choices.

The Job Creation Potential of Solar

Most of the analysis to assess the feasibility and impacts of an in-basin program utilizes data specific to the local conditions in Los Angeles; however there are no pre-existing studies of the job creation potential of solar in Southern California. Therefore, this report uses the most credible studies conducted in other parts of the country and seeks to calibrate these estimates to the Los Angeles context. Throughout this transfer, conservative assumptions are used to avoid overstating job creation potential.

A wide variety of job creation studies have been conducted by solar stakeholders and trade groups within the last 10 years. Job creation estimates associated with the manufacturing of solar modules range from 10 to 40 jobs per megawatt, with a clear mode of 11 jobs. Professional services, installation, construction, maintenance (and BOS component manufacturing) create between 8 and 31 jobs per megawatt. The total job creation potential of solar ranges from as low as 19 jobs per installed megawatt to up to 51 jobs per installed megawatt.

While some of these studies use replicable methods and sound data, none of these estimates have appeared in peer-reviewed journals. Thus, program administrations must use caution when extending these results to Los Angeles. For the purposes of this report, two factors are especially important for valid transfers to Los Angeles. First, carefully distinguishing the jobs created according to the different "links" to the supply chain is important so that in-basin job creation can be distinguished from out-of-basin job creation. Second, differentiating project by scale is

Table 4: Summary of Existing Studies of Job Creation Potential of Solar

Authors and Year	Total jobs per MW	Manufacturing wafers, cells & modules	Services installation, construction, O&M
Heavner and Churchill, 2001 (REPP, CA)	51	40	11
Cameron and Teske, 2001 (Green Peace)	51	20	31
New Energy Finance, 2009	42	11	25
Singh and Fehrs, 2002 (REPP, National)	36	28	8
Clean Edge, 2003	35	10	15
Navigant , 2008 (Residential)	31	11	20
Navigant, 2008 (Commercial)	19	11	8

important since projects of different scales have unique labor needs. For example, smaller projects use labor more intensely during installation. When these differences are expressed in terms of total jobs created per megawatt installed, smaller projects are more labor intense. For these reasons, the studies that breakdown job creation according to the link in the supply chain and project size are most useful for assuming impacts in Los Angeles. The Navigant (2008) studies offer both of these features. While some of the upstream manufacturing jobs may be created out-of-basin, some may be captured locally with the right incentives. Table 5 presents the results of Navigant's analysis for residential (smaller) projects and commercial (medium or larger) projects.

Table 5: Job Creation Potential by "Link" with the Solar Supply Chain (source: Navigant Consulting, 2008)[26]

Location in the Supply Chain	Residential (< 50KW)	Commercial (>50KW)
Wafer & Cell	8	8
Module	3	3
BOS Components	3	3
System Integration	7.8	2.8
Installation	9.2	2.1
Annual O&M	0.3	0.4
Total Direct Jobs	31.3	19.3

The total employment depends on both the overall program size and the allocation of capacity between smaller and larger projects. The following table shows the differences in job creation potential between small projects and large projects. Small projects, such as those on single family homes, create about 31 full-time jobs per megawatt of installed capacity while larger projects create about 19 per megawatt. The important trade-off lies in the fact that while smaller projects have greater potential to create jobs, they are less cost-effective, entailing a greater overall program cost. These estimates are for the direct employment effects, project sales and installation. The direct infusion of wages into the local economy will create further demand for ancillary products and services, indirectly adding even more jobs.

The 600 megawatt program could create 11,000 jobs for Los Angeles. The job creation potential will scale up with a larger program. If the same amount of energy were procured from out-of-basin energy sources, additional jobs would be created, not necessarily in Los Angeles, but in adjacent regions. A FiT program can be an important first step to create local "green-collar" jobs and help build a local solar industry in Los Angeles.

Table 6: Impact of Program Size and Capacity Allocation on Direct Employment

FiT Program Size (MWs)	Exclusive Single Family Program		Exclusive Comm & Industrial Program	
	Jobs Created	Cost Per Job	Jobs Created	Cost Per Job
100	3,130	$44,438	1,930	$5,656
250	7,825	$40,236	4,825	-$1,158
600	18,780	$38,602	11,580	-$3,808
750	23,475	$38,369	14,475	-$4,186
1,000	31,300	$38,135	19,300	-$4,565

Cost-Effectiveness and Cost Convergence

When designed to exploit the most abundant and least expensive sources of solar energy, a FiT can be cost-effective compared to a peaking natural gas alternative over the time horizon of the program. This assertion is predicated the continuation of current trends, including declining solar costs, increasing solar industry manufacturing capacity, escalating centralized energy generation costs, systemic transmission constraints, fuel price volatility, and impending carbon regulation. These trends are the nexus of an economical future for solar. Under these conditions, a well-designed FiT program is not only environmentally sustainable, but also fiscally prudent.

Table 7: Impact of Program Size and Allocation on Net Cost

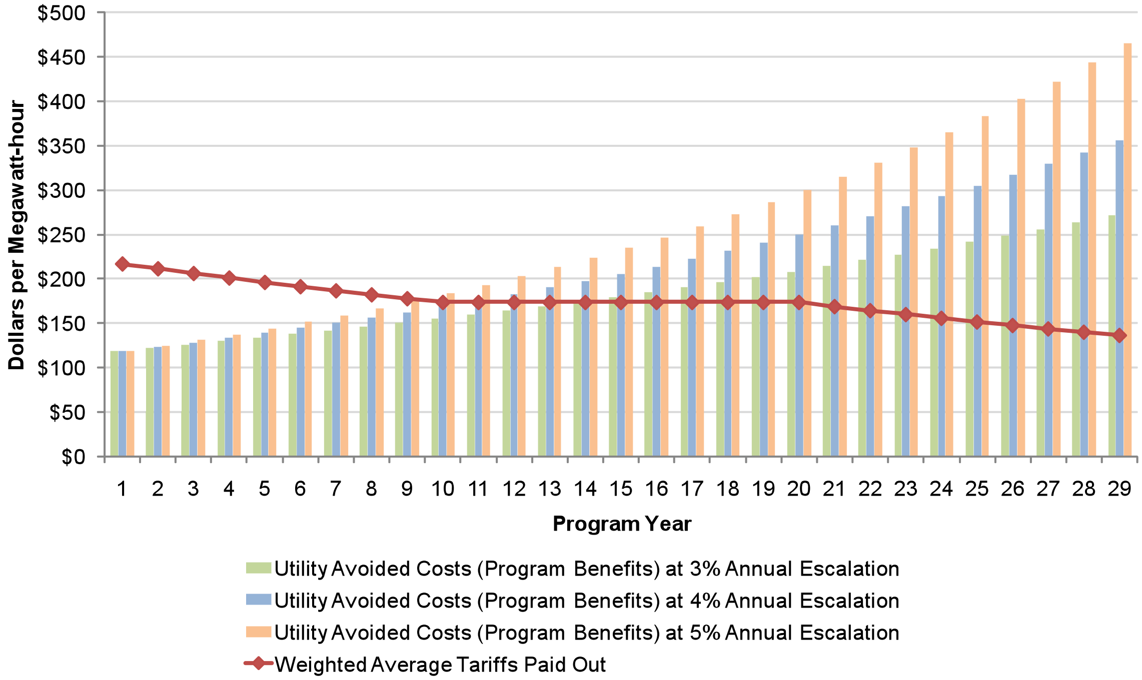
FiT Program Size (MWs)	Exclusive Single Family Program		Exclusive Comm & Industrial Program	
	Year 10 RPS Contribution	Net Cost ($ MM)	Year 10 RPS Contribution	Net Cost ($ MM)
100	0.5%	$139	0.5%	$11
250	1.2%	$315	1.2%	-$6
600	2.9%	$725	2.9%	-$44
750	3.6%	$901	3.6%	-$61
1,000	4.8%	$1,194	4.8%	-$88

"Net cost" is the net present value of all program costs and benefits over the 30 year program (20 year contracts implemented over 10 years). It quantifies the economic value of the program from the perspective of the utility. And since the utility's costs are passed to the ratepayers, net cost is a useful proxy for the social value created by the FiT program. A positive net cost means that the program would be more expensive than a natural gas alternative, while a zero net cost indicates that the program is equal in cost to the natural gas alternative. A negative net cost indicates that measurable, positive economic benefits will accrue over the life of the program. See Appendix 10 for a detailed description of the cost-effectiveness analysis.

There are several drivers of cost-effectiveness for a FiT program in Los Angeles. First, the tariffs paid out are a function of the size of the projects and the types of participants. Decreasing the tariffs offered for new contracts as solar costs fall will increase the program's cost-effectiveness. Utilities will incur both fixed costs associated with administering the program and variable costs as additional solar is interconnected with the grid. Finally, the avoided costs of natural gas peaker plants are an important benefit. The costs and benefits of a well-designed FiT program will converge sometime during the life of the program. Figure 22 is a graphic representation of the trends contributing to this convergence.

An important observation from Table 7 is that net cost increases with program size in the single family segment while net cost decreases with size in the C&I segment. This inverse relationship

Figure 22: Cost Convergence of the 600 Megawatt FiT in Los Angeles



is caused by two factors. First, the difference between tariffs paid out per kilowatt-hour is significant. For this specific program design, the initial C&I tariffs are 65% of the initial single family tariffs. Second, because of this difference, single family projects do not become cost-effective relative to peaking natural gas power plants until far into the life of the program. Single family tariffs do not drop below avoided costs until year 22 of the program, while this convergence occurs in year 12 of a C&I program. The net benefits that accrue after year 22 are discounted more than those which begin after year 12. The inherent characteristics of the market segments tilt the cost-effectiveness equation in favor of C&I projects.

The length of the implementation phase during which the contracts are originated and executed is another important determinant of the program's cost-effectiveness. Table 8 shows how extending the implementation of the program can take advantage of these trends. If a program with the design features described in Table 3 is phased in over three, five, or ten years, the net costs will be lower for the longer implementation period. The program is only cost-effective with a ten year implementation and begins to achieve a meaningful energy contribution at 600 megawatts.

Table 8: Impact of Implementation Period on Net Cost

FiT Program Size (MWs)	Year 10 RPS Contribution	Net Cost ($ MM)		
		3 Year Implementation	5 Year Implementation	10 Year Implementation
100	0.5%	$87	$60	$7
250	1.2%	$185	$117	-$15
600	2.9%	$413	$251	-$67
750	3.6%	$510	$309	-$89
1,000	4.8%	$673	$404	-$127

Ratepayer Impacts

As with solar rebates, the funds that pay for the energy fed into the grid are sourced from utility ratepayers. Since projects on single family homes are more expensive per kilowatt-hour than C&I projects, it follows that 100 megawatts of solar capacity, for example, has a greater impact on monthly energy charges if it is sourced exclusively from single family homes. As with cost-effectiveness, ratepayer impact is smaller and declines faster in a C&I scenario.

Table 9: Monthly Impact of Program Size and Allocation on Utility Customers' Energy Charges

FiT Program Size (MWs)	Exclusive Single Family Program		Exclusive Comm & Industrial Program	
	Year 1	Year 10	Year 1	Year 10
100	$0.10	$0.30	$0.07	$0.07
250	$0.22	$0.71	$0.14	$0.13
600	$0.51	$1.68	$0.31	$0.27
750	$0.63	$2.10	$0.38	$0.33
1,000	$0.83	$2.79	$0.50	$0.43

The ratepayer impacts in Table 9 are the annual costs of the program during the specified year, distributed evenly over each kilowatt-hour of retail energy sales. These impacts are for customers who consume 510 kilowatt-hours each month. This is the average monthly household energy consumption in Los Angeles. See Appendix 10 for a detailed analysis of the expected ratepayer impacts. The impact on a business utility customer will be proportional to its energy use assuming the annual costs are equally distributed over all retail energy sales.

Increases in Avoided Costs

While the cost of a recently installed in-basin solar array is known with relative certainty, the lifecycle cost of a natural gas facility is more uncertain because of long-term fuel price volatility and potential greenhouse gas regulation. For each tables above, we assumed 4% annual escalation of these costs. This critical assumption affects the other results. Table 10 demonstrates the sensitivity of both net cost and ratepayer impact to avoided cost escalation.

Table 10: Impact of Avoided Cost Escalation on Total Cost of a 600 Megawatt Program

Avoided Cost Escalation	Monthly Rate Impact Yr. 1	Monthly Rate Impact Yr. 10	Net Cost ($ MM)
3% Annually	$0.31	$0.45	$123
4% Annually*	$0.31	$0.24	-$67
5% Annually	$0.31	$0.01	-$288

*Indicates the original assumption used in the previous analyses of impacts.

Conclusions

The trade-offs between alternative solar FiT program designs and conventional energy generation must be evaluated to properly inform the conversation between policy makers, ratepayers, and industry stakeholders. Using the six evaluative criteria and the analytical techniques demonstrated in this report, policy makers can develop more specific guiding principles and performance criteria in order to make a policy that best suits all of the stakeholders involved. This evaluative framework is key to developing a FiT that can be successful for Los Angeles.

A comprehensive in-basin solar FiT for Los Angeles is not only feasible, but also is likely to be cost-competitive with fossil fuels given likely future conditions. Sections 2 and 3 of this report demonstrated that those who own the rooftops in the City and the County have the resources to generate copious amounts of solar energy. These rooftops are distributed throughout every community and utility in the County and among all the segments of the market. Not only is solar potential abundant, but much of it can be accessed in an economically prudent way, capturing investment benefits for the community and contributing to the broader environmental objectives. Gigawatts of solar capacity can be incorporated into the grid at reasonable prices. It is an optimal course of action to take advantage of these local resources with an extensive, long-term program.

The optimal design elements of a solar FiT for the City of Los Angeles are at least a 600 megawatt total goal, with at least 60 megawatts procured annually for a decade. Based on current market conditions, tariffs must be at least those suggested in Table 3 to achieve a reasonable market response. A more aggressive goal may require a somewhat higher tariff and a more nuanced approach could offer additional payments to incentivize solar in advantageous locations or from local manufacturing sources. These two alternative approaches may cost slightly more, but also would reap tangible benefits for the region. While all types of projects must be able to participate with low transactions costs, most of the participation can be allocated to large C&I projects to achieve cost-effectiveness.

Given the economic conditions and minimum design elements described in this report, a FiT for Los Angeles can produce at least 11,000 new jobs, generate 3% of the City's energy, and will cost ratepayers less than peak natural gas generation over the long-term. These results are driven by many factors. First, the richness of Los Angeles' rooftop solar potential, measured with relative certainty in this report, suggests that much of it can be efficiently harnessed at moderate cost. Second, solar costs and traditional energy costs will converge in the coming years, reversing the current economic paradigm. While there is uncertainty in the timing and degree of this circumstance, there is also great risk in the status quo. In the future, the cost of an in-basin solar program can be comparable to or even cheaper than our next best fossil fuel alternative. A FiT is a tradeoff between a known program cost and myriad uncertain economic and environmental factors. Any decision to institute a FiT represents a decision to purchase a more certain future for Los Angeles.

Appendix 1: Adapting the Los Angeles County Solar Map Database

This appendix describes the assumptions necessary to adapt the Los Angeles County Solar Map database for use with this study. Our field observations validate the Solar Map and its database as a valuable tool for the analysis of solar potential. To align the database with our assumptions, we made the following modifications to the database provided by Los Angeles County.

First, we removed parcels that, in our best estimation, did not contain buildings. There are many parcels within the County, primarily government-owned land, that are located far from the urbanized areas and do not contain any significant urban development. These parcels could be suitable for ground-mounted solar projects, but they are not relevant to the rooftop analysis. Based on a combination of database fields, (e.g. “zero” values for the site address or building area) we identified these parcels and removed them from our analysis. There were 246,792 parcels that met these criteria.

Shading Impact Assumptions

Second, we assessed the impact of shading on the potential of each parcel. Solar systems must avoid large shadows and receive direct sunlight to produce energy, but their energy performance can be disproportionately impacted by shading from the seemingly innocuous shadows from small objects. There are technological options (e.g. bypass diodes) to partially mitigate the negative effects from shading. However, shading must be avoided for optimal efficiency and system design. The County’s aerial imagery identified and recorded objects with an overhead footprint of at least five feet by five feet. Presumably, the shading impacts of smaller objects were not captured in the “optimal area” field of the database.

Figure 23: Shadow Analysis on a Large Non-Residential Parcel
(Image source: Google Earth & Google SketchUp)

To investigate this suspected impact, we evaluated 60 randomly-sampled parcels throughout the County (See Appendix 2 for a description of these parcels). These parcels were representative of the different property types present within the County. Using on-site sketches, photographs, and web-based aerial images, we identified the location and height of obstacles which could potentially shade the rooftops in each sample parcel. These types of obstacles included trees, streetlights, parapets, rooftop HVAC equipment, utility poles, billboards, and nearby buildings.

Next, we evaluated the physical potential of each sample parcel through a shadow impact area analysis on a property mock-up using publicly-licensed versions of Google Earth and Google SketchUp. We simulated the shadows from easterly, southerly, and westerly obstacles from 9 a.m. to 4 p.m. on December 21, 2010, the day of this year with the longest shadows. The rooftop area that was not impacted by these long shadows was recorded as the observed physical potential.

This observed value for physical potential was used to calculate a percentage factor of the rooftop space available for solar. This was compared to the same factor calculated from the database values. The average difference between the observed potential and the database potential was -4.2% while the standard deviation was 12.2%. Based on this assessment, we discounted the "optimal area" by 4.2% of the measured square feet for each parcel in the database. These results validate the Solar Map and its associated database as an exceptionally valuable tool for solar potential analysis.

Average System Efficiency Assumptions

Third, we modified the physical potential for each parcel to reflect the efficiency of an average solar module rather than the best efficiency available on the market. In order to demonstrate the best case scenario to the Solar Map user, the database field for system size was initially based on 66 square feet of required installation area per kilowatt. However, general industry planning factors are about 100 square feet per kilowatt.[27] We calculated the potential system size using this larger factor. This adjustment represents a more useful assumption for the aggregate analysis of physical potential since not all solar owners will install the most efficient panels. Based on this assumption, the physical potential of each parcel in the database was reduced by one-third.

Figure 24: Overhead View of Single Family Homes with Zero Solar Potential Due to Dense Surrounding Vegetation (Image source: Bing Maps)

Fourth, we zeroed the physical potential values for all parcels in the database with 100 square feet or less of optimal area. Potential values within this range were associated with significant vegetation and structure surrounding the rooftop. In the database, these types of parcels tended to have an optimal area value between 25 and 100 square feet rather than zero. However, based on the uncertainty of the shading effects, we assumed that rooftop solar projects with less than 100 square feet of clear installation space would not be feasible. Simply discounting these by

4.2% would not sufficiently account for fact that parcels with this little space and this much shading impact are unlikely candidates for solar. Overall, 21% of the remaining parcels met this definition, but their impact on total physical potential was not significant, accounting for only 121 megawatts.

Market Segment Assumptions

Finally, we categorized the parcels into market segments. The four market segments are based on the type of ownership that is most likely given the parcel's descriptive fields. Although the ownership status of the parcel is not necessarily correlated with the ownership of a solar system on the parcel, the parcel's description is the only useful indicator of ownership characteristics. In this way, a commercial solar service company could own a system located on a government parcel. For the estimation of potential, we assumed solar ownership to be consistent with parcel ownership. The four market segments are single family homes, multi-family residences, commercial buildings, and government or non-profit owned non-residential buildings. These segments are distinct groups within the solar market which have unique characteristics. The basic differences between them are tax status, size of potential systems, occupancy, cost of installation, and opportunity costs. These differences drive the economics of solar and shape the prospective owner's behavior.

To facilitate both the analysis and policy design, we categorized the parcels into market segments based on their likely ownership status. Government and non-profit parcels are those with a use description suggesting ownership by a government agency or non-profit entity, such as a public agency, school, university, church, hospital, or community center. Multi-family parcels were those with use descriptions of "multi-unit residential." Also, "single residential" parcels with addresses containing "Unit", "No.", or "Apt." were assumed to be condominiums and the building was categorized as one multi-family parcel. Parcels described as "single residential," but with a potential greater than 100 kW and a ratio of unit area to total building area smaller than 10% were assumed to be condominiums and categorized as multi-family parcels. C&I parcels were those non-residential parcels with specific commercial and industrial use descriptions. Single family parcels were those remaining with use descriptions of "single residential."

These market segment definitions facilitate a useful conceptualization of the market. Using segmentation techniques, program administrators can develop a FiT program targeted to specific market segments. There are many other acceptable ways to define the solar market segments. Those involved in program design should choose the scheme that fits best with the stated goals of their program.

Appendix 2: Results of Fieldwork on Sample Parcels

Table 11: Estimation of Rooftop Availability of Sample Parcels

CITY (Location of Sample Parcel)	SITE_ZIP	USE_DESCRIPTION	AREA_OPT (sqft)	ROOF_AV	ROOF_PITCH	NEW_AREA_OPT (sqft)	NEW_ROOF_AV	VAR
Los Angeles	90042	Homes For Aged & Others	475	9.0%	7 to 12	400	7.6%	-1.4%
La Canada Flintridge	91011	Schools (Private)	20,150	19.0%	4 to 12	20,000	18.9%	-0.1%
Glendale	91214	Single	0	0.0%	4 to 12	0	0.0%	0.0%
Unincorporated	91744	Single	775	35.6%	4 to 12	700	32.2%	-3.4%
Los Angeles	90065	Store Combination	400	22.9%	Flat	300	17.1%	-5.7%
Los Angeles	91601	Churches	4,775	21.5%	Flat	3,300	14.8%	-6.6%
Los Angeles	90013	Stores	0	0.0%	Flat	0	0.0%	0.0%
Los Angeles	90744	Stores	875	49.3%	Flat	875	49.3%	0.0%
Los Angeles	90710	Hotel & Motels	3,475	43.6%	Flat	2,800	35.1%	-8.5%
Los Angeles	90011	Three Units (Any Combinat	250	10.0%	7 to 12	0	0.0%	-10.0%
Los Angeles	91331	Single	650	26.8%	4 to 12	600	24.7%	-2.1%
Los Angeles	90731	Single	700	29.5%	4 to 12	300	12.6%	-16.8%
Los Angeles	90065	Single	0	0.0%	4 to 12	0	0.0%	0.0%
Carson	90745	Single	550	41.5%	4 to 12	300	22.6%	-18.9%
Downey	90242	Restaurants, Cocktail Loun	975	21.8%	4 to 12	300	6.7%	-15.1%
Los Angeles	91356	Single	0	0.0%	4 to 12	0	0.0%	0.0%
Glendale	91203	Professional Buildings	325	7.7%	Flat	300	7.1%	-0.6%
Los Angeles	90044	Store Combination	750	25.6%	Flat	700	23.9%	-1.7%
Unincorporated	91745	Single	175	6.5%	7 to 12	0	0.0%	-6.5%
Whittier	90605	Two Units	225	9.7%	4 to 12	200	8.6%	-1.1%
Inglewood	90302	Two Units	625	21.4%	4 to 12	300	10.3%	-11.1%
La Puente	91744	Single	1,325	50.5%	4 to 12	700	26.7%	-23.8%
Los Angeles	90027	Two Units	750	23.3%	7 to 12	700	21.7%	-1.6%
Pasadena	91103	Churches	225	5.3%	12 to 12	200	4.7%	-0.6%
Palos Verdes Estates	90274	Single	1,325	28.5%	4 to 12	2,000	43.0%	14.5%
Los Angeles	90016	Churches	2,325	36.3%	Flat	900	14.1%	-22.3%
Los Angeles	90011	Three Units (Any Combinat	550	14.7%	12 to 12	700	18.7%	4.0%
Los Angeles	90066	Three Units (Any Combinat	475	20.7%	7 to 12	500	21.7%	1.1%
Compton	90221	Churches	2,225	73.6%	Flat	1,000	33.1%	-40.5%
Unincorporated	90606	Single	600	36.4%	Flat	400	24.2%	-12.1%
Carson	90746	Single	350	16.3%	4 to 12	800	37.2%	20.9%
Pasadena	91107	Single	0	0.0%	7 to 12	0	0.0%	0.0%
Long Beach	90808	Single	225	13.6%	7 to 12	700	42.4%	28.8%
Arcadia	91007	Single	175	5.3%	7 to 12	100	3.0%	-2.3%
Los Angeles	91342	Single	1,100	50.0%	2 to 12	1,100	50.0%	0.0%
Unincorporated	91744	Single	650	28.3%	2 to 12	600	26.1%	-2.2%
Los Angeles	90744	Single	475	24.7%	7 to 12	500	26.0%	1.3%
Hermosa Beach	90254	Two Units	600	22.4%	4 to 12	600	22.4%	0.0%
Santa Clarita	91351	Homes For Aged & Others	825	20.6%	Flat	0	0.0%	-20.6%
Pomona	91768	Single	250	7.9%	4 to 12	200	6.3%	-1.6%
San Fernando	91340	Lgt Manf.Sm. EQPT. Manuf	1,925	36.7%	Flat	2,000	38.1%	1.4%
Los Angeles	90717	Single	1,150	45.1%	Flat	0	0.0%	-45.1%
Los Angeles	91342	Single	600	18.9%	4 to 12	0	0.0%	-18.9%
Unincorporated	91745	Single	0	0.0%	7 to 12	0	0.0%	0.0%
Unincorporated	91384	Single	425	24.6%	7 to 12	500	29.0%	4.3%
Los Angeles	90036	Two Units	775	21.4%	Flat	400	11.0%	-10.3%
Lakewood	90713	Single	375	20.3%	7 to 12	300	16.2%	-4.1%
Alhambra	91803	Churches	1,775	8.8%	7 to 12	2,000	9.9%	1.1%
Los Angeles	91042	Churches	3,025	15.2%	Flat	2,000	10.1%	-5.2%
Long Beach	90810	Single	475	20.9%	4 to 12	500	22.0%	1.1%
Los Angeles	90027	Single	425	19.3%	4 to 12	500	22.7%	3.4%
Los Angeles	91367	Single	150	5.2%	7 to 12	0	0.0%	-5.2%
Industry	91745	Hospitals	11,525	12.3%	Flat	15,000	16.0%	3.7%
Redondo Beach	90278	Auto, Recreation EQPT, Co	575	48.9%	Flat	400	34.0%	-14.9%
Huntington Park	90255	Store Combination	400	6.2%	Flat	2,000	30.9%	24.7%
El Monte	91732	Single	0	0.0%	4 to 12	0	0.0%	0.0%
Long Beach	90806	Two Units	350	17.3%	4 to 12	300	14.8%	-2.5%
Pico Rivera	90660	Single	775	35.2%	4 to 12	500	22.7%	-12.5%
Hawthorne	90250	Three Units (Any Combinat	1,175	28.0%	4 to 12	800	19.0%	-8.9%
Gardena	90249	Single	125	6.7%	4 to 12	200	10.7%	4.0%

Appendix 3: County of Los Angeles: Physical Solar Potential

The following tables describe the distribution of physical solar potential as defined in Section 2. "Megawatts" is the potential solar capacity as measured by the Los Angeles County Solar Map and adjusted based on our assumptions. "Parcels" are the number of parcels in each geographic area with over one kilowatt of potential, the number of parcels in a market segment with over one kilowatt of potential, or the number of parcels in a defined range of project sizes. See Appendix 1 for the definitions of each market segment.

Table 12: County of Los Angeles: Megawatts of Physical Rooftop Solar Potential by Utility

Utility	SoCal Edison	LA Dept of Water & Power	Vernon Light & Power	Glendale Water & Power	Burbank Water & Power	Pasadena Water & Power	Cerritos Electric Utility	Azusa Light & Power	Total
Megawatts	12,278	5,536	307	278	245	197	169	104	19,113
Parcels ≥ 1 kW	939,260	464,326	1,044	23,125	19,431	16,341	12,462	5,825	1,481,814

Table 13: County of Los Angeles: Megawatts of Physical Rooftop Solar Potential by Municipality

City	Physical Solar Potential (Megawatts)					Parcels with Potential Greater than 1 kW				
	Gov & Non-Profit	Multi-family	Single Family	Comm & Industrial	Total Physical Potential	Gov & Non-Profit	Multi-family	Single Family	Comm & Industrial	Total Parcels
Los Angeles	156	1,411	1,752	2,218	5,536	3,519	97,011	325,716	38,080	464,326
Unincorporated Areas	34	303	1,116	595	2,049	847	21,380	159,332	7,309	188,868
Long Beach	21	151	181	202	554	417	15,310	43,332	4,253	63,312
Industry	1	0	0	530	532	6	3	14	1,029	1,052
Lancaster	13	53	332	122	519	118	1,044	32,358	1,270	34,790
Palmdale	5	45	373	86	509	69	601	33,199	700	34,569
Carson	2	21	84	355	462	57	626	16,305	1,216	18,204
Santa Fe Springs	1	3	13	399	416	12	108	2,744	1,561	4,425
Torrance	8	58	129	197	391	108	2,199	24,520	1,471	28,298
Santa Clarita	6	62	150	164	382	83	601	26,100	1,045	27,829
Pomona	12	34	105	182	333	161	2,013	19,237	1,743	23,154
Commerce	0	4	6	320	330	8	489	1,443	1,062	3,002
Vernon	0	0	0	306	307	2	1	1	1,040	1,044
Glendale	8	91	84	95	278	174	5,547	15,077	2,327	23,125
Burbank	4	42	71	128	245	92	2,954	14,252	2,133	19,431
Compton	3	15	52	156	225	131	1,926	12,104	1,273	15,434
Downey	6	35	88	77	207	91	2,078	15,903	868	18,940
Pasadena	18	46	52	81	197	277	3,234	11,114	1,716	16,341
La Mirada	4	6	63	113	185	38	133	10,842	305	11,318
West Covina	7	16	112	41	175	64	466	18,571	414	19,515
Gardena	4	29	45	93	171	79	1,811	7,909	1,221	11,020
El Monte	5	36	43	87	170	111	2,715	8,994	1,153	12,973
Cerritos	2	2	47	117	169	23	41	11,981	417	12,462
Inglewood	6	55	45	60	166	124	4,817	9,288	1,323	15,552
Montebello	3	21	45	92	161	60	1,582	7,984	861	10,487
Pico Rivera	2	8	53	93	156	50	433	10,956	523	11,962
Norwalk	4	14	85	52	155	85	517	18,051	588	19,241
Hawthorne	3	50	32	65	149	61	2,963	6,082	842	9,948
South Gate	2	24	35	84	146	70	3,297	8,721	1,133	13,221
Santa Monica	4	61	25	52	142	122	4,146	5,239	1,421	10,928
Alhambra	4	47	39	46	136	93	3,785	8,046	859	12,783
Glendora	5	14	80	32	130	58	449	11,041	496	12,044
Whittier	5	18	56	51	130	84	1,626	11,283	836	13,829
Covina	3	16	52	56	127	55	819	8,075	791	9,740
Baldwin Park	4	16	59	48	127	54	1,010	10,167	637	11,868
Paramount	2	22	16	71	111	34	1,461	3,343	806	5,644
Lakewood	1	9	77	23	111	32	479	18,345	243	19,099
Redondo Beach	2	36	37	35	109	44	2,925	8,061	540	11,570
Monterey Park	2	23	56	26	107	48	1,614	8,862	518	11,042
Bellflower	6	32	40	29	107	90	1,849	7,549	818	10,306
Azusa	4	18	25	56	104	42	789	4,406	588	5,825
Rancho Palos Verdes	3	9	87	3	101	20	65	10,516	45	10,646
South El Monte	1	5	11	83	100	9	413	2,013	1,297	3,732
Arcadia	2	20	45	32	99	49	963	7,659	634	9,305

Table 13 (Continued): County of Los Angeles: Megawatts of Physical Rooftop Solar Potential by Municipality

City	Physical Solar Potential (Megawatts)					Parcels with Potential Greater than 1 kW				
	Gov & Non-Profit	Multi-family	Single Family	Comm & Industrial	Total Physical Potential	Gov & Non-Profit	Multi-family	Single Family	Comm & Industrial	Total Parcels
La Verne	4	10	51	32	97	39	260	6,731	261	7,291
Irwindale	1	0	2	93	96	8	27	251	309	595
Claremont	10	6	63	16	95	68	270	7,044	229	7,611
Diamond Bar	1	4	63	19	87	12	94	11,120	213	11,439
El Segundo	4	8	10	65	87	24	718	2,149	540	3,431
San Dimas	3	5	41	38	86	34	187	7,150	316	7,687
Rosemead	3	20	33	26	82	54	2,062	6,159	536	8,811
Huntington Park	3	20	13	44	79	54	2,276	2,572	921	5,823
Lynwood	3	15	20	40	77	68	1,662	5,070	672	7,472
Culver City	2	15	13	45	76	52	1,231	3,714	951	5,948
Monrovia	2	13	16	43	74	56	1,425	3,766	651	5,898
San Gabriel	3	16	25	23	67	41	1,075	4,949	631	6,696
Beverly Hills	1	14	35	14	64	22	1,038	4,036	516	5,612
San Fernando	2	5	20	35	62	49	474	3,238	505	4,266
Manhattan Beach	1	8	38	14	62	26	1,374	7,701	302	9,403
Walnut	1	1	43	14	59	19	18	7,572	157	7,766
La Puente	1	7	35	15	58	23	229	5,821	272	6,345
Bell	1	14	9	31	54	22	1,552	1,726	358	3,658
Temple City	2	9	32	12	54	37	858	6,068	343	7,306
West Hollywood	1	34	2	15	52	27	1,652	450	609	2,738
Signal Hill	0	7	4	35	46	7	482	874	476	1,839
Calabasas	0	4	30	12	45	5	68	4,560	86	4,719
Duarte	3	4	21	17	45	24	90	4,098	169	4,381
Bell Gardens	2	18	4	20	44	42	2,009	944	450	3,445
Agoura Hills	1	2	22	16	41	11	60	4,413	140	4,624
Malibu	0	8	27	4	39	11	230	3,017	98	3,356
Lawndale	0	18	9	10	38	22	2,200	1,913	373	4,508
La Canada Flintridge	1	1	27	5	34	19	92	4,097	165	4,373
Westlake Village	2	2	9	20	34	9	55	1,795	112	1,971
Lomita	1	11	11	6	30	38	731	2,426	271	3,466
Hermosa Beach	0	10	14	6	30	11	1,295	2,932	273	4,511
Artesia	1	3	15	10	29	30	290	2,814	248	3,382
Cudahy	0	13	2	10	26	12	778	437	143	1,370
Maywood	1	9	6	9	26	22	1,269	1,387	270	2,948
South Pasadena	1	9	7	6	23	18	637	1,683	203	2,541
Palos Verdes Estates	0	0	21	0	22	4	19	2,692	14	2,729
Hawaiian Gardens	1	4	4	7	17	13	448	1,031	131	1,623
Rolling Hills Estates	0	1	11	3	15	7	7	1,683	58	1,755
San Marino	0	0	10	2	13	9	3	2,350	112	2,474
Sierra Madre	1	3	6	2	11	22	224	1,345	105	1,696
La Habra Heights	0	0	10	0	10	6	15	1,176	3	1,200
Rolling Hills	0	1	4	0	4	0	4	338	0	342
Hidden Hills	0	0	3	0	3	1	0	307	0	308
Bradbury	0	0	3	0	3	0	9	244	0	253
Avalon*	0	0	0	0	0	0	0	0	0	0

*The physical solar potential located in the City of Avalon was accounted for in the Unincorporated areas in the Solar Map database.

Table 14: County of Los Angeles: Megawatts of Physical Rooftop Solar Potential by Supervisorial District

District	Megawatts	Parcels ≥ 1 kW
5 - Antonovich	4,782	388,752
1 - Molina	4,531	252,351
4 - Knabe	3,370	333,491
3 - Yaroslavsky	3,257	246,372
2 - Thomas	3,173	260,848

Table 15: County of Los Angeles: Megawatts of Physical Rooftop Solar Potential by Project Size

Project Size	Zero	1-5 kW	5-10 kW	10-50 kW	50-500 kW	500-1,200 kW	1,200 + kW	Total
Megawatts	0	1,994	3,504	4,565	5,422	1,888	1,740	19,113
Parcels	360,080	675,475	498,964	263,256	40,756	2,505	858	1,841,894

Table 16: County of Los Angeles: Megawatts of Physical Rooftop Solar Potential by Market Segment

Market Segments	Gov & Non-Profit	Multi-family	Single Family	Comm & Industrial	Total
Megawatts	450	3,336	6,741	8,586	19,113
Parcels ≥ 1 kW	8,849	227,790	1,142,578	102,597	1,481,814

Appendix 4: City of Los Angeles: Physical Solar Potential

Table 17: City of Los Angeles: Megawatts of Physical Rooftop Solar Potential by City Council District

District	Megawatts	Parcels ≥ 1 kW
12 - Smith	670	14,818
6 - Cardenas	524	34,682
2 - Krekorian	436	38,654
3 - Zine	432	21,618
7 - Alarcon	422	33,155
15 - Hahn	412	30,062
11 - Rosendahl	391	28,008
5 - Koretz	357	40,285
14 - Huizar	356	26,517
9 - Perry	324	26,138
4 - LaBonge	283	39,108
8 - Parks	278	49,870
10 - Wesson	256	17,518
13 - Garcetti	210	27,416
1 - Reyes	186	36,476

Table 18: City of Los Angeles: Megawatts of Physical Rooftop Solar Potential by Project Size

Project Size	Zero	1-5 kW	5-10 kW	10-50 kW	50-500 kW	500-1,200 kW	1,200 + kW	Total
Megawatts	0	648	1,023	1,450	1,785	398	233	5,536
Parcels	154,126	223,166	146,543	79,464	14,502	533	118	618,452

Table 19: City of Los Angeles: Megawatts of Physical Rooftop Solar Potential by Market Segment

Market Segments	Gov & Non-Profit	Multi-family	Single Family	Comm & Industrial	Total
Megawatts	156	1,411	1,752	2,218	5,536
Parcels ≥ 1 kW	3,519	97,011	325,716	38,080	464,326

Table 20: City of Los Angeles: Top 25 Parcels by Solar Potential

Rank	Potential (kW)	Council District	Zip Code	Use Description
1	6,987	15	90731	Warehousing, Distribution, Storage
2	6,296	1	90031	Warehousing, Distribution, Storage
3	4,797	15	90731	Warehousing, Distribution, Storage
4	4,524	12	91311	Lgt Manf.Sm. EQPT. Manuf Sm.Shps Instr.Manuf. Prnt Plnts
5	4,402	9	90058	Warehousing, Distribution, Storage
6	3,771	4	90039	Lgt Manf.Sm. EQPT. Manuf Sm.Shps Instr.Manuf. Prnt Plnts
7	3,629	14	90031	Warehousing, Distribution, Storage
8	3,597	3	91367	Heavy Manufacturing
9	3,596	15	90502	Food Processing Plants
10	3,366	12	91406	Heavy Manufacturing
11	3,351	3	91303	Shopping Centers (Regional)
12	3,313	15	90731	Warehousing, Distribution, Storage
13	3,052	12	91324	Shopping Centers (Regional)
14	2,982	15	90018	Mobile Home Parks
15	2,806	6	91605	Warehousing, Distribution, Storage
16	2,703	14	90023	Heavy Manufacturing
17	2,693	14	90021	Warehousing, Distribution, Storage
18	2,673	12	91311	Lgt Manf.Sm. EQPT. Manuf Sm.Shps Instr.Manuf. Prnt Plnts
19	2,672	7	91342	Lgt Manf.Sm. EQPT. Manuf Sm.Shps Instr.Manuf. Prnt Plnts
20	2,588	11	90066	Government Parcel
21	2,463	11	90045	Colleges, Universities (Private)
22	2,447	12	91304	Mobile Home Parks
23	2,431	11	90045	Heavy Manufacturing
24	2,430	6	91406	Lgt Manf.Sm. EQPT. Manuf Sm.Shps Instr.Manuf. Prnt Plnts
25	2,404	12	91311	Heavy Manufacturing

Appendix 5: County of Los Angeles: Economic Potential Reference Case Results

Table 21: County of Los Angeles: Megawatts of Economic Rooftop Solar Potential by Market Segment

Tariff per kWh	Megawatts of Potential			
	Gov & Non-Profit	Multi-family	Single Family	Comm & Industrial
$0.02	0	0	0	0
$0.04	0	0	0	0
$0.06	0	3	1	12
$0.08	0	16	4	46
$0.10	0	22	10	71
$0.12	0	37	30	108
$0.14	0	66	92	214
$0.16	0	117	241	434
$0.18	1	192	546	817
$0.20	6	309	1,083	1,412
$0.22	11	481	1,859	2,223
$0.24	23	714	2,769	3,143
$0.26	38	992	3,677	4,080
$0.28	73	1,288	4,472	4,987
$0.30	104	1,576	5,106	5,775
$0.32	143	1,841	5,564	6,396
$0.34	185	2,083	5,885	6,902
$0.36	235	2,281	6,104	7,264
$0.38	283	2,446	6,253	7,539
$0.40	319	2,570	6,361	7,759
$0.42	355	2,673	6,442	7,917
$0.44	384	2,768	6,506	8,035
$0.46	403	2,844	6,556	8,131
$0.48	415	2,912	6,597	8,196
$0.50	422	2,973	6,630	8,252
$0.52	428	3,026	6,657	8,299
$0.54	432	3,072	6,678	8,334
$0.56	435	3,112	6,694	8,365
$0.58	438	3,148	6,706	8,393
$0.60	439	3,178	6,715	8,415
$0.62	439	3,204	6,721	8,432
$0.64	440	3,224	6,725	8,447
$0.66	442	3,241	6,728	8,461
$0.68	442	3,255	6,730	8,476
$0.70	443	3,267	6,732	8,486

Appendix 6: City of Los Angeles: Economic Potential Reference Case Results

Table 22: City of Los Angeles: Megawatts of Economic Rooftop Solar Potential by Market Segment

Tariff per kWh	Megawatts of Potential			
	Gov & Non-Profit	Multi-family	Single Family	Comm & Industrial
$0.02	0	0	0	0
$0.04	0	0	0	0
$0.06	0	1	0	4
$0.08	0	5	1	15
$0.10	0	9	2	22
$0.12	0	12	6	32
$0.14	0	25	18	57
$0.16	0	40	46	111
$0.18	0	69	109	185
$0.20	1	119	231	318
$0.22	3	192	421	495
$0.24	5	280	652	733
$0.26	11	395	892	969
$0.28	18	523	1,108	1,186
$0.30	28	648	1,282	1,384
$0.32	41	765	1,409	1,563
$0.34	55	864	1,499	1,704
$0.36	71	947	1,560	1,807
$0.38	85	1,020	1,604	1,880
$0.40	103	1,077	1,636	1,946
$0.42	114	1,126	1,660	1,989
$0.44	121	1,164	1,679	2,027
$0.46	127	1,197	1,695	2,054
$0.48	134	1,227	1,708	2,080
$0.50	141	1,252	1,718	2,101
$0.52	144	1,278	1,726	2,116
$0.54	150	1,297	1,733	2,129
$0.56	151	1,316	1,738	2,139
$0.58	151	1,332	1,741	2,149
$0.60	152	1,345	1,744	2,157
$0.62	152	1,356	1,746	2,165
$0.64	153	1,366	1,748	2,171
$0.66	153	1,373	1,749	2,175
$0.68	153	1,380	1,749	2,179
$0.70	153	1,385	1,750	2,182

Appendix 7: Assumptions for Economic Potential Reference Case

Installed Costs: The following scenarios were used in the simulation of installation costs for with respect to economic potential. First, data from end of February 2010 from the California Solar Initiative were analyzed by project size and type. The original observations produced the observed means and their associated empirical distributions. Second, in order to investigate the effects of the falling cost of solar we adjusted the empirical distributions downward by a percentage for each scenario. Installed costs were simulated in accordance with these empirical distributions. The medium scenario was selected as the assumption for the reference case. Finally, we conducted a sensitivity analysis evaluation for each scenario on the Los Angeles C&I parcels.

Table 23: Distributions of Installed Cost Simulation Scenarios ($ per watt DC)

Scenario	Non-residential Project Size					Single Family Project Size			Adjusted Factor
	1-5 kW	5-10 kW	10-50 kW	50-500 kW	500 + kW	1-5 kW	5-10 kW	10 + kW	
Observed Mean	$9.71	$9.07	$7.88	$6.25	$5.30	$8.95	$7.20	$6.95	100%
High	$8.86	$8.28	$7.19	$5.71	$4.83	$8.17	$6.57	$6.34	91%
Medium	$7.65	$7.14	$6.21	$4.93	$4.17	$7.05	$5.67	$5.47	79%
Low	$6.44	$6.01	$5.22	$4.15	$3.51	$5.93	$4.77	$4.60	66%
Very Low	$5.22	$4.88	$4.24	$3.36	$2.85	$4.81	$3.87	$3.74	54%

Required Rate of Return: We assumed normal distributions, mean values, and standard deviations for the required rates of return for participants within each market segment. The sensitivity analysis explores the impact of changes in the mean required return for Los Angeles C&I parcels from 4% to 12%.

Table 24: Distributions of Simulated Required Rates of Return by Market Segment

Segment	Mean (μ)	Standard Deviation (σ)
Gov & Non-Profit	4.0%	2.0%
Multi-family	6.0%	2.0%
Single Family	3.0%	2.0%
Comm & Industrial	6.0%	2.0%

Availability of Tax Incentives: We assumed the 30% Federal ITC was available in either cash or tax credit form to all residential and commercial participants. MACRS depreciation was available only to commercial owners. Non-profit and government owners do not receive tax incentives. The impact of no 30% Federal ITC was examined in the sensitivity analysis.

Other Factors: These other factors were simulated according to a normal distribution for each parcel. These factors are less significant to the results than installed cost or required return.

Table 25: Distribution of Other Simulated Economic Factors

Factor	Mean (μ)	Standard Deviation (σ)
Inv. Maint. Cost per Watt	$0.30	$0.20
Inverter Svc Year	15	3
Annual O&M per Watt	$0.020	$0.005
Annual Insurance Cost	0.5%	0.2%

Effective Tax Rate: Owners' tax rates were assumed to be discretely distributed across tax brackets. Federal tax applies to commercial and residential participants with the following distributions: Residential {0.167, 0.167, 0.167, 0.167, 0.167, 0.167; 10%, 15%, 25%, 28%, 33%, 35%}, Commercial {0.142, 0.142, 0.142, 0.429, 0.142; 15%, 18%, 22%, 34%, 35%}. California state taxes apply to both commercial and residential as follows: {0.33, 0.33, 0.33; 7%, 8%, 9%}.

Performance Derate Factors: To simulate the installation configuration and building profile's effect on system productivity, we simulated rooftop tilt and orientation for each parcel and derated the system performance accordingly. These distributions were based on the examination of 60 sample parcels within the County: Module tilt on residential rooftops {0.05, 0.70, 0.20, 0.05; Flat, 4 to 12, 7 to 12, 12 to 12}; Module tilt on non-residential rooftops {0.75, 0.15, 0.05, 0.05; Flat, 4 to 12, 7 to 12, 12 to 12}. Primary system orientation {0.20, 0.20, 0.20, 0.20, 0.20; South, SSE-SSW, SE-SW, ESE-WSW, E-W}. The simulations resulted in an average derate factor of 93% for residential and 91% for non-residential parcels.

Appendix 8: Sensitivity Analysis of Economic Potential of Los Angeles C&I Parcels

Table 26: Impact of Mean Required Return on Economic Solar Potential of Los Angeles C&I Parcels

Tariff per kWh	Megawatts of Potential				
	4%	6%*	8%	10%	12%
$0.02	0	0	0	0	0
$0.04	0	0	0	0	0
$0.06	6	4	2	1	0
$0.08	18	15	11	8	4
$0.10	35	22	22	15	15
$0.12	61	32	27	19	20
$0.14	122	57	39	22	21
$0.16	231	111	63	36	24
$0.18	420	185	106	60	32
$0.20	638	318	169	96	52
$0.22	890	495	256	142	82
$0.24	1,177	733	401	192	117
$0.26	1,427	969	547	276	161
$0.28	1,628	1,186	738	404	220
$0.30	1,768	1,384	932	554	297
$0.32	1,875	1,563	1,130	727	405
$0.34	1,953	1,704	1,335	903	534
$0.36	2,004	1,807	1,497	1,080	682
$0.38	2,047	1,880	1,627	1,244	818
$0.40	2,080	1,946	1,731	1,404	985
$0.42	2,101	1,989	1,820	1,538	1,139
$0.44	2,120	2,027	1,882	1,648	1,279
$0.46	2,135	2,054	1,937	1,735	1,415
$0.48	2,147	2,080	1,980	1,804	1,534
$0.50	2,158	2,101	2,012	1,869	1,632
$0.52	2,166	2,116	2,045	1,923	1,715
$0.54	2,172	2,129	2,067	1,956	1,785
$0.56	2,178	2,139	2,085	1,989	1,847
$0.58	2,182	2,149	2,100	2,020	1,890
$0.60	2,186	2,157	2,115	2,047	1,928
$0.62	2,189	2,165	2,126	2,067	1,961
$0.64	2,193	2,171	2,135	2,081	1,992
$0.66	2,196	2,175	2,143	2,095	2,018
$0.68	2,198	2,179	2,152	2,108	2,038
$0.70	2,200	2,182	2,159	2,116	2,056

*Indicates the original assumption used in the reference analysis for Los Angeles C&I properties.

Table 27: Impact of Installed Cost Changes on Rooftop Solar Potential of Los Angeles C&I Properties

Tariff per kWh	Megawatts of Potential			
	Very Low	Low	Medium*	High
$0.02	0	0	0	0
$0.04	0	0	0	0
$0.06	10	6	4	2
$0.08	19	18	15	12
$0.10	43	28	22	19
$0.12	109	58	32	25
$0.14	246	121	57	41
$0.16	487	222	111	72
$0.18	804	382	185	126
$0.20	1,152	620	318	201
$0.22	1,455	897	495	334
$0.24	1,671	1,174	733	459
$0.26	1,819	1,439	969	646
$0.28	1,927	1,614	1,186	847
$0.30	1,999	1,755	1,384	1,032
$0.32	2,049	1,862	1,563	1,220
$0.34	2,084	1,943	1,704	1,394
$0.36	2,109	1,996	1,807	1,542
$0.38	2,128	2,039	1,880	1,668
$0.40	2,143	2,070	1,946	1,767
$0.42	2,156	2,098	1,989	1,842
$0.44	2,167	2,119	2,027	1,904
$0.46	2,174	2,135	2,054	1,960
$0.48	2,180	2,147	2,080	1,999
$0.50	2,185	2,157	2,101	2,029
$0.52	2,187	2,165	2,116	2,055
$0.54	2,191	2,173	2,129	2,079
$0.56	2,193	2,178	2,139	2,097
$0.58	2,196	2,183	2,149	2,111
$0.60	2,198	2,185	2,157	2,124
$0.62	2,200	2,189	2,165	2,134
$0.64	2,202	2,191	2,171	2,143
$0.66	2,204	2,193	2,175	2,152
$0.68	2,205	2,195	2,179	2,159
$0.70	2,207	2,197	2,182	2,164

*Indicates the original assumption used in the reference analysis for Los Angeles C&I properties.

Table 28: Impact of ITC Availability on Rooftop Solar Potential of Los Angeles C&I Parcels

Tariff per kWh	Megawatts of Potential	
	With 30% ITC*	Without 30% ITC
$0.02	0	0
$0.04	0	0
$0.06	4	0
$0.08	15	5
$0.10	22	13
$0.12	32	19
$0.14	57	21
$0.16	111	27
$0.18	185	50
$0.20	318	81
$0.22	495	113
$0.24	733	152
$0.26	969	225
$0.28	1,186	310
$0.30	1,384	426
$0.32	1,563	565
$0.34	1,704	724
$0.36	1,807	872
$0.38	1,880	1,040
$0.40	1,946	1,210
$0.42	1,989	1,347
$0.44	2,027	1,467
$0.46	2,054	1,573
$0.48	2,080	1,674
$0.50	2,101	1,755
$0.52	2,116	1,824
$0.54	2,129	1,880
$0.56	2,139	1,925
$0.58	2,149	1,965
$0.60	2,157	1,994
$0.62	2,165	2,020
$0.64	2,171	2,040
$0.66	2,175	2,056
$0.68	2,179	2,072
$0.70	2,182	2,086

*Indicates the original assumption used in the reference analysis for Los Angeles C&I properties.

Table 29: Impact of Land Use on Economic Solar Potential

Tariff per kWh	Megawatts of Potential	
	Vernon	Pasadena
$0.02	0	0
$0.04	0	0
$0.06	0	0
$0.08	2	0
$0.10	3	1
$0.12	3	1
$0.14	11	3
$0.16	21	6
$0.18	36	11
$0.20	59	19
$0.22	91	33
$0.24	140	50
$0.26	177	73
$0.28	213	90
$0.30	241	108
$0.32	261	126
$0.34	271	137
$0.36	279	150
$0.38	285	158
$0.40	289	167
$0.42	293	172
$0.44	296	177
$0.46	298	181
$0.48	299	183
$0.50	300	185
$0.52	300	187
$0.54	301	188
$0.56	301	190
$0.58	302	190
$0.60	303	191
$0.62	303	192
$0.64	303	193
$0.66	303	193
$0.68	303	194
$0.70	303	194

Appendix 9: Solar Productivity by Zip Code in Los Angeles County

This table shows the solar production assumptions for every zip code represented in the Solar Map database. The production factors are annual kWh/kW DC. They are from PVWatts queries. For zip codes representing a single point, adjacent productivity factors were assumed. These data assume true south orientation and latitude tilt.

Table 30: Solar Production Factors for Los Angeles County Zip Codes

Zip Code	Prod Factor	Zip Code	Prod Factor	Zip Code	Prod Factor	Zip Code	Prod Factor	Zip Code	Prod Factor	Zip Code	Prod Factor	Zip Code	Prod Factor	Zip Code	Prod Factor	Zip Code	Prod Factor
90001	1,467	90059	1,467	90242	1,488	90502	1,467	90749	1,467	91105	1,488	91326	1,497	91409	1,497	91740	1,488
90002	1,467	90060	1,488	90245	1,467	90503	1,467	90755	1,467	91106	1,488	91327	1,497	91410	1,497	91741	1,488
90003	1,467	90061	1,467	90247	1,467	90504	1,467	90801	1,467	91107	1,488	91328	1,497	91411	1,497	91744	1,488
90004	1,497	90062	1,467	90248	1,467	90505	1,467	90802	1,467	91108	1,488	91329	1,497	91412	1,537	91745	1,488
90005	1,497	90063	1,488	90249	1,467	90506	1,467	90803	1,467	91109	1,537	91330	1,497	91413	1,497	91746	1,488
90006	1,467	90064	1,497	90250	1,467	90507	1,467	90804	1,467	91110	1,537	91331	1,537	91416	1,497	91747	1,488
90007	1,467	90065	1,537	90251	1,467	90508	1,467	90805	1,467	91114	1,537	91333	1,537	91423	1,497	91748	1,488
90008	1,467	90066	1,497	90254	1,467	90509	1,467	90806	1,467	91115	1,537	91334	1,537	91426	1,497	91749	1,488
90009	1,467	90067	1,497	90255	1,467	90510	1,467	90807	1,467	91116	1,537	91335	1,497	91436	1,497	91750	1,607
90010	1,497	90068	1,537	90260	1,467	90601	1,488	90808	1,467	91117	1,537	91337	1,497	91470	1,497	91754	1,488
90011	1,467	90069	1,497	90261	1,467	90602	1,488	90809	1,467	91118	1,537	91340	1,537	91482	1,497	91755	1,488
90012	1,488	90070	1,467	90262	1,467	90603	1,488	90810	1,467	91121	1,488	91341	1,537	91495	1,497	91756	1,488
90013	1,488	90071	1,488	90263	1,497	90604	1,488	90813	1,467	91123	1,488	91342	1,537	91496	1,497	91759	1,607
90014	1,488	90072	1,488	90264	1,497	90605	1,488	90814	1,467	91124	1,537	91343	1,497	91497	1,497	91765	1,488
90015	1,488	90073	1,497	90265	1,497	90606	1,488	90815	1,467	91125	1,488	91344	1,537	91499	1,497	91766	1,488
90016	1,497	90074	1,488	90266	1,467	90607	1,488	90822	1,467	91126	1,488	91345	1,537	91501	1,537	91767	1,607
90017	1,488	90075	1,488	90267	1,467	90608	1,488	90831	1,467	91129	1,488	91346	1,537	91502	1,537	91768	1,488
90018	1,467	90076	1,488	90270	1,488	90609	1,488	90832	1,467	91131	1,488	91350	1,504	91503	1,537	91769	1,488
90019	1,497	90077	1,497	90272	1,497	90610	1,488	90833	1,467	91182	1,488	91351	1,504	91504	1,537	91770	1,488
90020	1,497	90078	1,488	90274	1,467	90623	1,488	90834	1,467	91184	1,488	91352	1,537	91505	1,537	91771	1,488
90021	1,488	90079	1,488	90275	1,467	90630	1,488	90835	1,467	91185	1,488	91353	1,537	91506	1,537	91772	1,488
90022	1,488	90080	1,488	90277	1,467	90631	1,488	90840	1,467	91188	1,488	91354	1,504	91507	1,537	91773	1,488
90023	1,488	90081	1,488	90278	1,467	90637	1,488	90842	1,467	91189	1,488	91355	1,504	91508	1,537	91775	1,488
90024	1,497	90082	1,488	90280	1,467	90638	1,488	90844	1,467	91191	1,488	91356	1,497	91510	1,537	91776	1,488
90025	1,497	90083	1,488	90290	1,497	90639	1,488	90845	1,467	91201	1,537	91357	1,497	91521	1,537	91778	1,488
90026	1,488	90084	1,497	90291	1,497	90640	1,488	90846	1,467	91202	1,537	91361	1,500	91522	1,537	91780	1,488
90027	1,537	90086	1,488	90292	1,497	90650	1,488	90847	1,467	91203	1,537	91362	1,500	91523	1,537	91788	1,488
90028	1,497	90087	1,488	90293	1,467	90651	1,488	90848	1,467	91204	1,537	91363	1,497	91601	1,537	91789	1,488
90029	1,537	90088	1,488	90294	1,497	90652	1,488	90853	1,467	91205	1,537	91364	1,497	91602	1,537	91790	1,488
90030	1,537	90089	1,467	90295	1,497	90659	1,488	90888	1,467	91206	1,537	91365	1,497	91603	1,537	91791	1,488
90031	1,488	90091	1,488	90296	1,497	90660	1,488	91001	1,537	91207	1,537	91367	1,497	91604	1,497	91792	1,488
90032	1,488	90093	1,488	90301	1,467	90661	1,488	91003	1,537	91208	1,537	91371	1,497	91605	1,537	91793	1,488
90033	1,488	90094	1,467	90302	1,467	90662	1,488	91006	1,488	91209	1,537	91372	1,497	91606	1,537	91795	1,488
90034	1,497	90095	1,497	90303	1,467	90670	1,488	91007	1,488	91210	1,537	91376	1,497	91607	1,497	91801	1,488
90035	1,497	90096	1,488	90304	1,467	90701	1,488	91009	1,488	91214	1,537	91380	1,504	91608	1,537	91802	1,488
90036	1,497	90101	1,488	90305	1,467	90702	1,488	91010	1,488	91221	1,537	91381	1,500	91609	1,537	91803	1,488
90037	1,467	90102	1,488	90306	1,467	90703	1,488	91011	1,537	91222	1,537	91382	1,504	91610	1,537	92397	1,607
90038	1,497	90103	1,488	90307	1,467	90704	1,486	91012	1,537	91224	1,537	91383	1,504	91611	1,537	93243	1,498
90039	1,537	90189	1,488	90308	1,467	90706	1,467	91016	1,488	91225	1,537	91384	1,504	91612	1,537	93510	1,537
90040	1,488	90201	1,488	90309	1,467	90707	1,467	91017	1,488	91226	1,537	91385	1,497	91614	1,537	93523	1,735
90041	1,537	90202	1,488	90310	1,467	90710	1,467	91020	1,537	91301	1,497	91386	1,504	91615	1,537	93532	1,504
90042	1,488	90209	1,497	90311	1,467	90711	1,467	91021	1,537	91302	1,497	91387	1,537	91616	1,537	93534	1,733
90043	1,467	90210	1,497	90312	1,467	90712	1,467	91023	1,537	91303	1,497	91388	1,537	91617	1,537	93535	1,778
90044	1,467	90211	1,497	90313	1,497	90713	1,467	91024	1,488	91304	1,497	91390	1,504	91618	1,537	93536	1,504
90045	1,467	90212	1,497	90397	1,497	90714	1,467	91025	1,488	91305	1,497	91392	1,537	91702	1,488	93539	1,733
90046	1,497	90213	1,497	90398	1,497	90715	1,488	91030	1,488	91306	1,497	91393	1,537	91706	1,488	93543	1,778
90047	1,467	90220	1,467	90401	1,497	90716	1,467	91031	1,488	91307	1,497	91394	1,537	91709	1,479	93544	1,778
90048	1,497	90221	1,467	90402	1,497	90717	1,467	91040	1,537	91308	1,497	91395	1,537	91711	1,607	93550	1,778
90049	1,497	90222	1,467	90403	1,497	90723	1,467	91041	1,537	91309	1,497	91396	1,497	91715	1,488	93551	1,733
90050	1,488	90223	1,467	90404	1,497	90731	1,467	91042	1,537	91310	1,504	91399	1,497	91716	1,488	93552	1,778
90051	1,488	90224	1,467	90405	1,497	90732	1,467	91043	1,537	91311	1,497	91401	1,497	91722	1,488	93553	1,778
90052	1,467	90230	1,467	90406	1,497	90733	1,467	91046	1,537	91312	1,497	91402	1,537	91723	1,488	93560	1,486
90053	1,488	90231	1,467	90407	1,497	90734	1,467	91066	1,488	91313	1,497	91403	1,497	91724	1,488	93563	1,607
90054	1,488	90232	1,497	90408	1,497	90744	1,467	91077	1,488	91316	1,497	91404	1,497	91731	1,488	93584	1,733
90055	1,488	90233	1,497	90409	1,497	90745	1,467	91101	1,488	91321	1,537	91405	1,497	91732	1,488	93586	1,733
90056	1,467	90239	1,488	90410	1,497	90746	1,467	91102	1,537	91322	1,537	91406	1,497	91733	1,488	93590	1,778
90057	1,488	90240	1,488	90411	1,497	90747	1,467	91103	1,537	91324	1,497	91407	1,497	91734	1,488	93591	1,778
90058	1,488	90241	1,488	90501	1,467	90748	1,467	91104	1,488	91325	1,497	91408	1,497	91735	1,488	93599	1,778

Appendix 10: 600 Megawatt Feed-in Tariff: Assumptions & Impacts

This appendix describes the assumptions which drive the cost-effectiveness and ratepayer impact analysis. The table below summarizes the annual program costs and ratepayer impact during the implementation phase of the 30 year program.

Table 31: Summary of Annual Net Program Costs for 600 Megawatt Los Angeles Feed-in Tariff

Program Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Energy & Capacity										
Utility Retail Sales (MWh)	25,000,000	25,250,000	25,502,500	25,757,525	26,015,100	26,275,251	26,538,004	26,803,384	27,071,418	27,342,1
Small-scale Participation (MW)	10	10	10	10	10	10	10	10	10	
Cumulative Small-scale (MW)	10	20	30	40	50	60	70	80	90	1
Large-scale Participation (MW)	30	30	30	30	30	30	30	30	30	
Cumulative Large-scale (MW)	30	60	90	120	150	180	210	240	270	3
Ground-Mounted Participation (MW)	20	20	20	20	20	20	20	20	20	
Cumulative Ground-Mounted (MW)	20	40	60	80	100	120	140	160	180	2
Total Cumulative Participation (MW)	60	120	180	240	300	360	420	480	540	6
Total Energy Generated (MWh)	83,610	166,801	249,577	331,939	413,889	495,429	576,562	657,288	737,612	817,5
Portion of Total Retail Sales	**0.3%**	**0.7%**	**1.0%**	**1.3%**	**1.6%**	**1.9%**	**2.2%**	**2.5%**	**2.7%**	**3.0%**
Costs ($)										
Wtd Avg Tariff for New Contracts	$0.22	$0.21	$0.20	$0.19	$0.18	$0.17	$0.16	$0.15	$0.15	$0
Wtd Avg Tariff Paid Out	$0.22	$0.21	$0.21	$0.20	$0.20	$0.19	$0.19	$0.18	$0.18	$0
Total Tariffs Paid Out	18,138,843	35,280,049	51,473,954	66,768,375	81,208,734	94,838,181	107,697,706	119,826,248	131,260,795	142,036,
Program Admin & Fixed Costs	1,000,000	1,030,000	1,060,900	1,092,727	1,125,509	1,159,274	1,194,052	1,229,874	1,266,770	1,304,
Network Upgrade & Variable Costs	6,000,000	6,180,000	6,365,400	6,556,362	6,753,053	6,955,644	7,164,314	7,379,243	7,600,620	7,828,
Total Annual Costs	25,138,843	42,490,049	58,900,254	74,417,464	89,087,295	102,953,099	116,056,072	128,435,365	140,128,186	151,169,
Benefits ($)										
Utility Avoided Cost ($/MWh)	$119	$124	$129	$134	$139	$145	$150	$156	$163	$1
Total Annual Benefits	9,938,740	20,620,898	32,088,247	44,384,649	57,556,155	71,651,106	86,720,241	102,816,810	119,996,687	138,318,
Annual Net Costs	**$15,200,103**	**$21,869,151**	**$26,812,008**	**$30,032,815**	**$31,531,141**	**$31,301,993**	**$29,335,831**	**$25,618,555**	**$20,131,499**	**$12,851,**
Impact per kWh Sold	$0.00061	$0.00087	$0.00105	$0.00117	$0.00121	$0.00119	$0.00111	$0.00096	$0.00074	$0.00
Monthly Household Rate Impact	**$0.31**	**$0.44**	**$0.54**	**$0.59**	**$0.62**	**$0.61**	**$0.56**	**$0.49**	**$0.38**	**$0.24**
Monthly Business Rate Impact	**$6.08**	**$8.66**	**$10.51**	**$11.66**	**$12.12**	**$11.91**	**$11.05**	**$9.56**	**$7.44**	**$4.70**

Table 32: Tariff Schedule for 600 Megawatt Los Angeles Feed-in Tariff

Category	Tariff per kWh for a New Contract in Program Year									
	1	2	3	4	5	6	7	8	9	10
Small-scale Rooftops	$0.34	$0.32	$0.31	$0.29	$0.28	$0.26	$0.25	$0.24	$0.23	$0.21
Large-scale Rooftops	$0.22	$0.21	$0.20	$0.19	$0.18	$0.17	$0.16	$0.15	$0.15	$0.14
All Ground Mounted	$0.16	$0.15	$0.14	$0.14	$0.13	$0.12	$0.12	$0.11	$0.10	$0.10

Utility Assumptions:
Utility Retail Sales: 25,000,000 MWh per year.[28]
Annual Retail Sales Growth: 1%
Annual Inflation of Costs: 3%
Utility Avoided Costs: 2009 MPR for a 20 year contract beginning in 2010. This original value ($0.09674) was weighted to both solar production and daily, weekly, and seasonal time-of-use (TOU) factors. The weighted average TOU factor was 1.23.
Annual Escalation of Utility Avoided Costs: 4%
Average Customer Energy Consumption: 510 kWh per month for a household.[29] 10,000 kWh per month for a business. Annual net costs distributed uniformly over annual retail energy sales.
Fixed Program Administration Costs: $1,000,000 per year
Variable Program Costs and Network Upgrades: $100,000 per megawatt
Discount Rate: 5.0%

Average Solar System Assumptions:
Production Factor: 1,493 kWh per year per kW DC
Annual Performance Degradation Factor: 0.5%
Rooftop Tilt and Orientation Derate Factor: 90%

Impacts:
Net Cost Relative to Peaking Natural Gas: -$67 million
Year 1 RPS Contribution: 0.3%
Year 10 RPS Contribution: 3.0%
Year 1 Monthly Household Rate Impact: $0.31
Year 10 Monthly Household Rate Impact: $0.24
Average Monthly Household Rate Impact During Implementation: $0.48
Year 1 Monthly Business Rate Impact: $6.08
Year 10 Monthly Business Rate Impact: $4.70
Average Monthly Business Rate Impact During Implementation: $9.37

Endnotes

[1] LADWP generates 43% of its energy from coal power plants. Accessed on June 23, 2010 from http://www.ladwp.com/ladwp/cms/ladwp010027.pdf.

[2] Los Angeles and LADWP maintain ambitious clean energy goals. The utility's RPS goals are 35% by 2020. More detail is available in the 2007 Integrated Resource Plan available at http://www.ladwp.com/ladwp/cms/ladwp005148.jsp. The Mayor of Los Angeles quoted an RPS goal of 40% by 2020 with no coal in the generation mix. Available at the following site http://carbon.energy-business-review.com/news/ladwp_plans_to_eliminate_coalfired_power_generation_to_reduce_gas_emissions_090702/. Accessed on June 23, 2010.

[3] While the CPUC has not made a final ruling on SB32, the amendment to the statewide FiT which compensates developers for the valuable attributes of solar energy, one indicator to its value may be the range of prices published in a recent analysis by the California Solar Energy Industries Association (CalSEIA) that suggests a potential range of $0.18 to $0.24 per kilowatt-hour. The analysis is available at http://calseia.org/feed-in-tariff-for-california.html.

[4] Joel Davidson & Fran Orner, The New Solar Electric Home (Ann Arbor: 2008) 162.

[5] Available at http://solarmap.lacounty.gov/.

[6] Accessed on April 18, 2010 from http://factfinder.census.gov.

[7] Accessed on April 18, 2010 from http://factfinder.census.gov.

[8] Accessed on June 10, 2010 from http://quickfacts.census.gov/qfd/states/06/06037.html.

[9] Accessed on February 28, 2010 from http://www.californiasolarstatistics.ca.gov/data_archive/.

[10] Paul Denholm & Robert Margolis, National Renewable Energy Laboratory, Supply Curves for Rooftop Solar PV-Generated Electricity for the United States (Golden: 2008) 9.

[11] California Public Utilities Commission, Standard Practice Manual (San Francisco: 2001) 8.

[12] Two publically available models are the NREL Solar Advisor Model and Natural Resources Canada's RETScreen.

[13] Framework for solar site evaluative criteria shared by Yamen Nanee, Los Angeles Department of Water and Power.

[14] Based on statistical analysis of data from the CSI archive.

[15] Based on statistical analysis of data from the CSI archive.

[16] Based on statistical analysis of data from the CSI archive.

[17] This assumption was based on interviews with the participants from the Solar Working Group. Homeowners are more willing to purchase a solar system if it simply pays itself back over the life of system. This standard suggests homeowners require a lower rate of return than a business, for example.

[18] These assumptions estimate a potential owner's behavior and investment criteria. They are not recommendations for program design in Los Angeles.

[19] Accessed on June 12, 2010 from http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=US06F&re=1&ee=1.

[20] Accessed on June 12, 2010 from http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=US02F&re=1&ee=1.

[21] These assumptions were developed based on interviews with the Solar Working Group and other industry participants.

[22] Based on queries from PV Watts Version 2 available at http://rredc.nrel.gov/solar/calculators/PVWATTS/version2/. These two examples were derated to 90% to account for tilt and orientation losses.

[23] California Energy Commission, A Guide to Photovoltaic (PV) Design and Installation (Sacramento: 2001) 9.

[24] California Public Utilities Commission, 13.

[25] Net metering programs allow customers to offset their utility energy charges with production from an on-site solar system. However, the eligibility of net metering programs is limited to those who have significant energy usage. This necessarily limits the overall contribution that in-basin solar can provide. See the first report for more details.

[26] Navigant Consulting, Economic Impacts of Extending Solar Tax Credits, September, 15, 2008. Accessed on May 20, 2010 at http://www.seia.org/galleries/pdf/Navigant%20Consulting%20Report%209.15.08.pdf.

[27] Accessed on June 15, 2010 from http://www.solarbuzz.com/Consumer/fastfacts.htm. This planning factor was also used by several members of the Solar Working Group for economic analysis of potential projects.

[28] U.S. Energy Information Administration, Form EIA-861 Final Data File for 2008, Accessed on February 20, 2010 from http://www.eia.doe.gov/cneaf/electricity/page/eia861.html.

[29] Accessed on July 7, 2010 from http://www.ladwp.com/ladwp/cms/ladwp000509.jsp