SoLAr

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"In 30 years Solar Will Be Ubiquitous"

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Glossary Of Term

PV- Photovoltaic cell

MW- Mega-Watt

GW- Giga-watt

DG- Distributed generation

RPS- Renewable portfolio standard

LADWP- Los Angeles Department of Water and Power

FiT- Feed-in Tariff

IREC- Interstate Renewable Enery Council

DSIRE- Database of State Incentives for Renewable Energy

CSI- California Solar Initiative

PPA- Power Purchasing Agreements

SOPPA- Standard Offer Power Purchasing Agreement

Kilo-watt-hour- unit of energy equal to 1000-watt hours

LABC- Los Angeles Business Council

ITC- Investment Tax Credit

Research Question:

In 2008, Los Angeles passed Solar LA, a plan that defined the city's solar strategies through 2020. How has Solar LA been implemented and transformed over the past five years? What is the future of solar power in Los Angeles?

Sub question:

What are local and statewide initiatives to support solar growth?

What forms of solar policy can be implemented to continue the growth of this energy sector?

Executive Summary

Solar energy in California has changed in many ways since the creation of Mayor Antonio Villiagosa's Solar LA plan in 2008. The plan was in response to the first renewable portfolio standard goal of 20% by 2017 set by the LADWP that was later extended to 33% by 2020 through Senate Bill 2. Solar LA has been able to produce a considerable amount of solar in Los Angeles through its various programs. One of the more prominent ones is the new Feed-in Tariff system (FiT). This along with large-scale utility owned solar projects being constructed in the desert has led Los Angeles towards a more solar future.

The Solar LA plan has three components, the Customer Solar Program, Utility-owned Solar Program, and the Large-scale Solar Program. By 2020 Solar LA is projected to produce 1.3 gigawatts of solar distributed across the Los Angeles basin and in surrounding areas. The plan has been on track with LADWP achieving a 20% renewable portfolio standard goal in 2010. As the programs outlined in the plan have

had time to mature it is clear where the city is allocating its resources. Both utility owned solar projects and the FiT program have been highly publicized in the past few years. The emphasis placed on these types of projects has left other programs like the SunShares to be neglected.

There are several future events that will shape the way solar is able to grow in the United States. The first is the expiration of the investment tax credit that will diminish the 30% credit solar customers received on their installed systems. The reduction of the tax credit to 10% of the installed system will deter solar growth due to the dramatic increase in project cost. The second will be the augmentation of local solar incentives as money for renewable energy investment becomes scarcer. The third is the current financial difficulties of Chinese solar producers are currently. Finally the structure of solar financing is rapidly changing. Companies like Sunrun are leasing solar systems to residents for a flat fee. In turn the residents are able to offset a certain percentage of their power usage from the solar system. All of these will factor into the how the solar market grows in the future.

The reason that solar has not been fully utilized in the Los Angeles area is due to the price. Solar on average is twice as expensive as most non-renewable resources forcing it to be a tertiary investment option for power providers. The primary goal of power utilities like LADWP is to provide reliable power to their customers at a competitive rate. This goal along with the continued integration of more renewable energy sources has created tension. On one hand LADWP is pressured internally and by policy makers to shift to more green sources but the department has an obligation

to maintain customer satisfaction. This balancing act has forced solar growth to be inhibited.

The solar market is one that has experienced a period of hyper growth over the past five years in several specific markets.[1] This has been possible through consumer demand, good public policy and the abundance of sunlight in certain regions of the United States. As the market continues to mature over time it will be important for policy makers to be able to adapt. This will be in the form of new and inventive policies that will continue to drive the demand forward.

Introduction:

As of 2010 the city of Los Angeles's energy mix includes 39% from coal plants, 3% from large hydroelectric stations, 22% from natural gas, 11% from nuclear, 20% from eligible renewable and 5% from unspecified sources of power. Of this 20% from eligible renewable, 4% comes from biomass and waste, 1% from geothermal, 7% from small hydroelectric, 8% from wind, and 0% from solar.[2] In a state that is known as the sunshine state, and in a city that averages 276 full sun and partial sun days per year it is unimaginable that 0% of the cities power comes from solar energy production. The measuring tools used by LADWP are unable to capture the total amount of solar power that is produced by the variety of sources.[3]

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[1] Woods Mathew, Mathew Woods Interview, Phone, March 7, 2013.
[2] "Los Angeles Department of Water and Power," December 10, 2012, https://www.ladwp.com/ladwp/faces/ladwp/aboutus/a-power/a-p-factandfigures?_adf.ctrl-state=mwxeyabmf_26&_afrLoop=196989872003000.
[3] *The Los Angeles Solar Energy Plan* (Los Angeles: The City Of Los Angeles, November 24, 2008), 1, Solar LA, accessed February 10, 2013.

Mayor Villaraigosa's 2008 Solar LA plan looks to raise this percentage from 0% to nearly 10% of all electricity bought by LADWP from solar sources by 2020. This is an aggressive plan that has been successful in improving Los Angeles's solar profile. The city has been able to accomplish this through an effective feed-in tariff program paired with investment in several large-scale utility owned solar projects that are being constructed in the various regions surrounding Los Angeles. The residential solar market has also been able to develop more through innovative funding programs. A whole new market of potential solar customers has been targeted through crowd funding programs or through agreements between the solar customer and the utility company in which the utility sets a fixed price that they purchase the electricity generated, known as Standard Offer Power Purchasing Agreements.

The growth California's solar industry has achieved over the past five years has been tremendous but future growth could be threatened with future policy and incentives changes. The expiration of the investment tax credit in 2016 and changes to local rebate incentives in Los Angeles will alter the way solar projects are funded in the future. The investment tax credit began in 2009 with the introduction of The American Recovery Reinvestment Act of 2009. This provides a 30% tax credit on all solar projects built in the United States. The tax credit is set to expire and will be reduced to 10% due to financial pressures placed on the government. Also the financial turmoil Chinese solar manufacturers are facing could also play a significant role in future

markets.[4] These three factors combined will shape the solar landscape in the United States in the near future.

Throughout this research project, I have aimed to gain a comprehensive understanding of the solar market in Los Angeles, the policy mechanisms that frame the market, and how it has grown over the past five years.

Benefits of Solar Energy

There are many benefits to solar energy that are often overlooked by the general public. Besides the generation of clean energy, energy created without fossil fuel emissions, solar energy has many other factors that make it an attractive energy source for the coming future. The production of solar energy especially in residential communities creates a distributed generation system. The second benefit is that solar panels are able to produce the most when the demand for energy is the greatest. This is at peak sun hours during the middle of the day. Solar energy is also an investment opportunity for commercial building and homeowners alike. It also helps to fortify the emerging green jobs market. Finally, as energy prices continue to climb while the price of producing a solar system is declining more people will have access to the product as time continues.

Distributed generation is one of the major benefits policy makers and utility companies are looking for in terms of solar energy. Although distributed generation can be defined many ways, the Swedish Royal Institute of Technology describes it as

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[4] Joe McDonald, "Chinese Solar Producer Suntech Declares Bankruptcy," *Yahoo! Finance*, March 20, 2013, http://finance.yahoo.com/news/chinese-solar-producer-suntech-declares-bankruptcy-130337430--finance.html.

"an electric power source connected directly to the distribution network or on the customer side of the meter."[5] There are many advantages to having an energy grid that contains a high volume of distributed generating stations. One of the primary benefits is that solar panels produce energy nearest to where it is demanded. This form of generation not only reduces the loss of energy due to travel on transmission lines but also reduces the overall wear on the utility equipment.[6]

Distributed solar power also is able to provide a level of security that fossil fuel energy generation has not been able to.[7] In John Farrell's article he writes that, "just 500 MW of distributed solar could have prevented the massive 2003 Northeast blackout." [8] Along with these benefits distributed solar generation helps hedge against finite supplies of fossil fuels while reducing air pollution.[9]

Solar energy production during a day follows the shape of a bell curve with the y-axis being energy production and the x-axis being time. Why this is a pro argument for solar is due to the graph that shows the total amount of energy consumption over the period of a day. The two curves are nearly mirror images of each other as seen in the diagram below. Photovoltaic cells are operating at their maximum potential during the middle part of the day when the sun is at its highest peak. This is also the time when cities are demanding the most amount of electricity from their utility. Therefore

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[5] California Public Utilities Commission Energy Division Staff, *Impacts of Distributed Generation* (Itron Inc, January 2010).
[6] "Distributed Solar Power Worth Far More Than Electrons," *Institute for Local Self-Reliance*, accessed March 27, 2013, http://www.ilsr.org/distributed-solar-power-worth-far-more-electrons/.
[7] Varun Sivaram, "Distributed Solar in LA," March 1, 2013; Varun Sivaram, Varun Sivaram Interview, In Person, March 20, 2013.
[8] "Distributed Solar Power Worth Far More Than Electrons."
[9] Ibid.

solar is a great energy source to meet the growing peak demand of cities like Los Angeles that enjoy a wealth of sun year round. This is represented graphically in Appendix 1.

One of the first arguments for solar is for the environmental benefits it provides. Solar energy is generated without producing any carbon emissions. This is advantageous in comparison to other more conventional fossil fuels that have large amounts of carbon emissions tied to the electricity generation process. These negative externalities caused by fossil fuel power plants are felt locally in the form of air pollution. Unlike energy produced from fossil fuel sources, solar energy production has no negative externalities produced during the production of electricity. These negative externalities associated with coal and natural gas manifest themselves as air pollution. This negative externality has detrimental effects on the general health of the public. Furthermore externalities like air pollution are not easily quantifiable. Therefore they are not taken into account when analyzing the price of generating electricity from a coal source against a solar or wind source. As Mr. Pascual said in his interview, "It is just not what folks are thinking about yet in terms of how they price it."[10]

Solar energy also has many economic advantages as well. Residents are able to offset the cost of their installed solar panels in only a few years. This figure depends on the resident's electric bill and system size. This is due to the number of rebates and tax credits residents are able to take advantage of. In Los Angeles there are rebate programs offered through LADWP as well as Southern California Edison. There are

[10] Romel Pascual and Navarro Alexa-Rae, Romel Pascual Interview, In Person, January 18, 2013.

also state rebates that could be applicable along with the investment tax credit that is worth 30% of the PV system.[11] Also with the rising price of electricity from a utility and the declining cost of solar system over the past five years has made solar more available to people who want to reduce or eliminate their electricity bill.[12] Finally the price of solar is decreasing yearly. The reduction in cost of a solar system can be seen graphically in Appendix 2 declining by nearly three dollars per completed system.

The decrease in cost of producing a solar system can also by shown by how far the costs have gone down to produce solar energy. Varun Sivaram, a senior advisor in the mayor's office quotes the price of utility scale solar projects to be roughly around 11 cents per kilowatt-hour.[13] Both residential and commercial solar projects are even more expensive than this due to the small size of these types of projects. The price of solar estimated in 2007 by Jack Pare using the 2005 United States Department of Energy data was 18.12 cents per kilowatt-hour.[14] This is a 40% decline in cost per kilowatt-hour in just five years. At this rate solar will become accessible to everyday person who is looking reduce his or her electricity bill.

This change in price point of solar will alter the way it is purchased in the future. Mathew Woods of Sunrun believes that purchasing solar will be a similar experience to purchasing a Direct TV package or any other mainstream service.[15] The

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[11] McMenamin Michael, Michael McMenamin, Michael.McMenamin@water.ladwp.com, March 20, 2013.
[12] Ibid.
[13] Varun Sivaram, Varun Sivaram Interview March 20 2013.
[14] Jack Pare, "Energy Source Cost Comparison," February 23, 2007, http://des.nh.gov/organization/divisions/water/wmb/coastal/ocean_policy/documents/te_workshop_cost_compare.pdf. No need to put the link to the pdf in the footnote. You can put it in your bibliography
[15] Woods Mathew, Mathew Woods Interview.

acquisition of a solar system is a process that often takes many months to get through. Along with the time it takes to get approved there are many permitting issues and confusion regarding rebates that a potential solar customer can run into deterring them from completing the process. With a more expedited procedure solar companies will be able to market their product making a better buying experience for the customer.

Solar Disadvantages

The production of energy through PV does also has some drawbacks in comparison to other energy sources. The first issue that has deterred much solar growth is the price of solar energy. Although the costs of parts and labor of a full solar system have gone down considerably, solar is still twice as expensive to produce as natural gas. Natural gas produces electricity at around $0.055 per kilowatt-hour whereas solar energy costs upwards of $0.11 per kilowatt-hour including transmission costs.[16] The comparison to coal is even worse due to the very low price of coal. Solar is also more expensive than any other renewable energy outside of tidal power making it a less attractive option for large renewable energy projects.

The price of a solar can also be inflated from other factors. One cost that is overlooked is the positioning of the system. If a resident is interested in installing a solar system on his or her roof they would need to get the roof inspected to decide whether or not it is strong enough to support the system. If a roof is deemed too weak renovating it could double the cost of the solar project. This issue was experienced by

[16] Varun Sivaram, Varun Sivaram Interview March 20 2013.

Occidental College when trying to plan their solar project.[17] Also the acquisition of land to install a larger commercial sized system would also cost money attributing to a higher installation cost per kilowatt.

The look of solar panels has also arisen as a downside. This is due to the bulky nature of PV panels when installed on roof space. Residents are apprehensive to install solar on their home due to the look of the system.

One of the core issues with solar energy generation is that it is only possible during sunny days. Conventional power sources like natural gas and coal are able to produce power all day and all night regardless of weather conditions. Only being able to produce half of the day makes solar energy difficult to invest in over other renewables such as wind and geothermal that have the potential of producing at all times of the day. Also rain and clouds will inhibit the system from producing energy. The remedy for the issue of production is the implementation of batteries along with solar systems. Installing a battery that will charge during the day and discharge at night when the system is not producing will create a smooth power demand graph instead of one in Appendix 1. This unfortunately is expensive to do since there is no local rebate program for batteries.[18] Also battery technology for PV systems has lagged due to lack of demand resulting in higher prices and less efficient products.[19]

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[17] Snowden-Ifft Daniel, Daniel Snowden-Ifft Interview, In Person, February 19, 2013.
[18] Varun Sivaram, Varun Sivaram Interview March 20 2013.
[19] Ibid.

Literature Review

National Policy Trends

Energy policies have been implemented at every level of government and are constantly changing from year to year. The Database of State Incentives for Renewables & Efficiency (DSIRE) in union with the Interstate Renewable Energy Council (IREC) have tracked and studied these policy changes annually for the past thirty years. This is the nonprofit solar research arm of the North Carolina Solar Center at North Carolina State University. The most recent report found California to be the most prominent solar market in America.[20] The solar market nationwide has grown since 2010 as well. The report states that "the total installed capacity of utility and nonresidential systems increased by 145% and 132% respectively compared to 2010.[21] The average size of photovoltaic projects also increased b 54% in 2011 to 29 kilowatts.[22] In 2010 the average size of a PV project was 18 kilowatts.[23] The total number of PV system installations grew to over 64,000, a 30% increase in comparison to 2010.[24] As shown above it is safe to say the United States' solar market has been rapidly expanding since the Global Financial Crisis.

2008 Global Economic Crisis & Renewable Energy Investment

The bankruptcy announcement of Lehman Brothers on the 15th of September 2008 sent shockwaves through the financial sector. This announcement caused investor confidence to become shaky in terms of clean energy investment. A report in

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[20] *2012 Annual Updates & Trends* (Orlando, FL: Interstate Renewable Energy Council, September 12, 2012), 11.
[21] Ibid., 17.
[22] Ibid.
[23] Ibid.
[24] Ibid.

April of 2009 by Sebastian Friz-Morgenthal and four other authors analyzed the impact of the crisis on clean energy investments throughout the world. The results that they published are very interesting and tell a great deal about the nature of clean energy investment worldwide.

From 2007 to 2008 investment in clean energy firms fell by 51% from $23.4 billion to $11.4 billion.[25] The quantity of clean energy deals reached a two year low in the final quarter of 2008 totaling 207. Even though the solar industry took a hit on total investments, the future for PV markets looks bright. This is due to the constantly changing factors that shape the PV market. One that is explicitly cited is the technological advancement firms have achieved. The study predicts that by the end of 2009 PV module prices will reduce by 40% from $4/W to $2.40/W.[26] This fall in prices is expected to increase demand due to increased profit margins on many solar projects. The one main problem that will inhibit solar growth in America is the restricted credit lending practices banks have adopted since the crisis.

In the United States, 66% of the solar projects constructed in 2011 are owned by a third party utility.[27] These types of projects are larger than normal residential rooftop solar projects and require a larger initial investment. Considering the strains on the banking system many third party solar developers may find it difficult to secure the proper level of capital for projects resulting in a slowdown in solar development.

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[25] Sebastian Fritz-Morgenthal et al., *The Global Financial Crisis and Its Impact on Renewable Energy Finance* (UNEP Division of Technology, Industry and Economics, April 2009), 10.
[26] Ibid., 14.
[27] *2012 Annual Updates & Trends*, 19.

For the U.S. PV market to realize its true potential lenders will need to begin providing capital to developers again.

Chinese PV Manufacturing Sector

The solar market has recently taken a hit by the bankruptcies of one of the largest photovoltaic cell producers in China. The company Suntech filed for bankruptcy on March 20th 2013 due to a large accumulation of debt paired with a missed payment to bondholders.[28] With more than $2 billion in debt Suntech defaulted on a payment that was worth $541 million.[29] This has become an epidemic amongst Chinese solar manufacturers. Solar producers including Yingli Green Energy Lt., Trina Solar ltd., Sharp Crop., and LDK Solar Co. have all reported losses this quarter.[30]

The communist leaders of the Chinese government have viewed renewable energy as a way to attract higher skilled jobs to China while hedging against the reliance on oil and the price volatility that accompanies it.[31] The poor financial performances by solar manufacturers have been directed at the Chinese government because of the subsidies it has provided.[32] These aggressive incentives led to a supply glut and over production of Chinese solar panels effectively driving their price down of the units sold. Although these bankruptcies are from Chinese based companies, many

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[28] Joe McDonald, "Chinese Solar Producer Suntech Declares Bankruptcy."
[29] Ehren Goossens and Justin Doom, "Biggest Solar Collapse in China Imperils $1.28 Billion," *Bloomberg*, accessed March 21, 2013, http://www.bloomberg.com/news/2013-03-20/biggest-solar-collapse-in-china-imperils-1-28-billion-energy.html?cmpid=yhoo; Joe McDonald, "Chinese Solar Producer Suntech Declares Bankruptcy."
[30] Joe McDonald, "Chinese Solar Producer Suntech Declares Bankruptcy."
[31] Ibid.
[32] Ibid.

of them were able to fuel their debt from ambitious Wall Street investors.[33] This has exposed US investors to considerable risk considering many of the shareholders feel they will not legally be able to stake a claim during the bankruptcy process on a Chinese asset governed by the Bank of China.[34] In two stock offerings in 2005 and 2009, Suntech was able to raise $1.28 billion dollars. This money could be lost that is owed to shareholders could already be gone.[35]

Suntech is not the only solar manufacturer that is or has been in trouble financially. This has led investor confidence in Chinese solar companies to fall considering if the company goes underwater investors are unable to claim their principle investment. Although it is unclear now how these failing Chinese solar panel producers will affect the solar energy market in the United States, if China continues to allow these companies to accumulate such large amounts of debt the Chinese solar manufacturing market could be in jeopardy. Since a large portion of total solar panels used in the United States come from Chinese producers the solar market domestically will be hurt. Experts predict that solar companies in China will be forced form partnerships or merge by the government in order to stay competitive.[36] This again is due to both excess number of producers and quantity of panels produced.

Los Angeles Solar Policy

In 2006 California Senate Bill 1, the Eligibility Criteria and Conditions for Solar Energy System Incentives, was passed. This bill passed into law Governor

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[33] Goossens and Doom, "Biggest Solar Collapse in China Imperils $1.28 Billion."
[34] Ibid.
[35] Ibid.
[36] Joe McDonald, "Chinese Solar Producer Suntech Declares Bankruptcy."

Schwarzenegger's Million Solar Roofs Initiative. The bill expanded the California Solar Initiative (CSI) and the Energy Commission's New Solar Homes Partnership program (NSHP). The California Solar Initiative is a program that offers cash rebates on solar installations on homes or businesses. The rebates only apply for California residents who purchase their electricity from Pacific Gas and Electric, Southern California Edison, or San Diego Gas & Electric.[37] This is due to the partnership that these utility companies have with the state of California. This program is primarily for residents with existing solar units while the New Solar Homes Partnership offers similar rebates for new solar projects. The expansion of the CSI and NSHP programs along with the enactment of the Million Solar Roofs Initiative provided much of the groundwork that Los Angeles's Mayor, Antonio Villaraigosa, needed to move forward with his green initiatives.

In May of 2007 Mayor Antonio Villaraigosa, and his office released a new energy plan called Green LA. This plan outlined future target goals for the city of Los Angeles to help combat climate change and ease the demand on non-renewable energy sources. In the study it states that in June of 2005 the City Council approved LADWP's Renewable Portfolio Standard policy (RPS) that requires 20% of LADWP energy sales to come from renewable sources by 2017.[38] The plan also states that by 2030 35% of the electricity bought by LADWP will have to come from eligible renewable sources. The interim goal was set at 13% in 2010. LADWP later accelerated their efforts and

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[37] See http://www.gosolarcalifornia.ca.gov/csi/index.php

[38] *Green LA An Action Plan to Lead the Nation In Fighting Global Warming* (Los Angeles: The City Of Los Angeles, May 2007).

made the interim goal 20% instead of 13%.[39] The city met the interim RPS goal of 20% by 2010.[40]

The plan also states that by 2030, 35% of the electricity bought by LADWP will have to come from eligible renewable sources.[41] The Green LA plan as a whole is a comprehensive look at all aspects of environmental change in Los Angeles. This includes energy reform, transportation policy, land use issues, waste, and the port to name a few. The follow up Solar LA Plan released by the mayor's office in 2008 specifically shows the breakdown of how the city and LADWP plan on meeting the 35% RPS goals established by the Green LA plan.

Solar LA

Solar LA Plan was released on November 24th, 2008 and was the most ambitious solar plan undertaken by any single city in the world at the time.[42] The Los Angeles Department of Water and Power is the largest municipal utility in North America.[43] The end goal of this plan is to have built and installed 1.3 gigawatts of solar by 2020.[44] In order to do this the mayor's office along with LADWP outlined three target markets in which they plan to use to achieve this goal.

The first is through consumer based solar programs. The city describes three different programs to aid solar energy growth for private residents. The first is to expand the Residential Program with help from the $313 million funding set aside to

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[39] Ibid., 18.
[40] "Los Angeles Department of Water and Power."
[41] *Green LA An Action Plan to Lead the Nation In Fighting Global Warming*.
[42] *The Los Angeles Solar Energy Plan*, 1.
[43] Romel Pascual and Navarro Alexa-Rae, Romel Pascual Interview. January 18 2013.
[44] *The Los Angeles Solar Energy Plan*. 1.

support California's SB1 solar energy program.[45] The plan states that LADWP will also look to expand its incentive programs in order to help low-income communities afford solar panels. The end goal of expanding the residential programs is to have installed 130 megawatts (MW) of customer owned solar energy systems by 2020.[46]

The second component of the consumer-based approach is implementing a Feed-in Tariff system (FiT). The Los Angeles Business Council describes a feed in tariff policy, "that requires a utility to buy solar power that residents, businesses and public organizations produce by installing solar on their roof-tops, parking lots and vacant land."[47] The implementation of this program will help streamline the process of installing solar energy systems for private residents or business owners. The improvement in efficiency is done by allowing consumers to sell back the energy produced by their solar energy systems directly to LADWP. This type of transaction was not allowed before due to a "long standing prohibition against non-LADWP entities selling electricity to other customers."[48] The city did this because throughout their history they have been reluctant to let anyone stand between them and their customers. The new FiT program's goal is to have installed 150 MW of solar energy systems by 2016. [49]

The last piece is the creation of a new program called the SunShares Program. This program allows residents interested in investing in solar energy to do so even if

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[45] Ibid. 2.
[46] Ibid. 2.
[47] J.R. DeShazo and Ryan Matulka, *Designing an Effective Feed-In Tariff For Greater Los Angeles* (Los Angeles: Los Angeles Business Council & University of California Los Angeles Luskin Center, September 2009).
[48] *The Los Angeles Solar Energy Plan*. 10.
[49] Ibid. 2.

they do not fully have the means. The program allows a group of individuals to pool their money to help LADWP fund commercial sized solar energy projects outside of the city. The people who pay into the program own shares of the project. The customer receives a solar energy credit from the shares they own that is realized on their bi-monthly bill. The SunShares program plans to install 100 MW of solar energy systems by 2020.[50]

The second approach outlined by the plan to increase the city's energy profile is through LADWP owned Solar Projects in Los Angeles. This program looks to use pre-existing city-owned buildings and properties to install solar systems. Rooftops, reservoirs, and parking lots are three spaces proposed to implement this program. This program plans to install 400 MW by 2014.[51]

The final approach is to build large-scale solar projects. The city plans to use the Mojave Desert as the location for many of these large-scale solar sites due to its abundant supply of both land and sun. The city plans on working with private third party solar developers to build these projects through power purchase agreements that would allow LADWP the option to buy the solar energy plant after about eight years. The installation of these large-scale projects is expected to produce 500 MW of power by 2020.[52]

Feed-in Tariff Policy

The mayor's office and LADWP included a 150 MW FiT program in their joint 2008 Solar LA plan. The Los Angeles Business Council (LABC) in conjunction with the

[50] Ibid. 2.
[51] Ibid. 3.
[52] Ibid. 3.

UCLA Luskin Center for Innovation embarked on a project in September of 2009 to design an effective FiT policy program to meet these goals. A Feed-in Tariff policy can be applied to all types of renewable energy production. The policy allows private energy producers to directly sell the energy produced at a negotiated price as specified by a non-negotiable contract or a form of a Standard Offer Power Purchasing Agreement (SOPPA). The council also did extensive research on other FiT programs worldwide and how they were implemented in these regions.

FiT Case Studies

Feed-in Tariff policies have been implemented in cities around the world. The Los Angeles Business Council examined two efforts to establish a local FiT system. The worldwide implementation of this program is one of the main reasons it has been gaining so much attention in the solar industry. One of the oldest and most efficient FiT policies is currently in place in Germany. German power utilities are operated solely at the national level streamlining much of the FiT process.[53] The FiT law was known as Stromeinspeisungsgesetz (StrEG) was established in 1990.[54] This progressive law forced utility providers to purchase energy generated from solar and wind at 90% of the price of electricity. This law came in response to the growing demand by the rural population that had access to small hydroelectric generation sources.[55] What separates this law from other FiT programs at the time was that the

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[53] DeShazo and Matulka, *Designing an Effective Feed-In Tariff For Greater Los Angeles*, 18.
[54] Ibid.
[55] Paul Gipe, "Evolution of Feed-in Tariffs," October 6, 2010, http://www.wind-works.org/cms/index.php?id=39&tx_ttnews%5Btt_news%5D=1240&cHash=361f5c6f56c3170a9ebe8e16d3b6936c.

percentage was based on retail rates of electricity and not wholesale rates. This made the investment opportunity much more attractive because customers were able to charge a higher price for their generated electricity. The conservative German political parties, CDU and CDS, were able to justify this higher price due to the environmental advantages the country would receive by offsetting their reliance on coal-generated electricity.[56] Due to the fluctuation of electricity prices Germans found it hard to obtain financing at a reasonable interest rate for projects. If there was a proven steady revenue stream this would not be an issue but due to the fluctuation banks found these investments often too risky.

Ten years later there were several changes made to the original law. One of the changes that led to much of its success was the differentiation of pricing depending on the solar market. The price breakdown is based on the solar market the investor wishes to participate in. The government's rational was that different markets require different costs therefore the tariff should reflect that difference. For example the differences between the urban and the rural market are great. The urban market faces the difficulties when trying to find space for projects forcing these projects to be smaller in size. The benefit of producing solar in an urban market is that the market is able to reap the benefits of distributed generation. On the other hand, residents in rural markets have much more space to build on allowing them to build larger systems and to take advantage of economies of scale. This change increased enrollment in the program since investors were able to recover losses on their initial investment more quickly while being able to make a reasonable return in the future. This FiT law has

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[56] Ibid.

continued to this day making Germany the best Photovoltaic (PV) market in the world.[57]

The next solar market the Los Angeles Business Council analyzed was that of Gainesville, Florida. The Gainesville Regional Utilities (GRU) adopted the first cost-based FiT solar policy in America.[58] This program offered investors a fixed tariff over a 20-year period of time. The city estimated that the tariff system would be able to offer investors a 4-5% profit. Gainesville's FiT policy was a huge success producing the maximum 4 MW the city allowed annually in the first week.[59] Since its start in 2009, Gainesville's FiT policy has produced over 7 MW of solar beating both France and Japan in Solar Power Per Capita with 36 (Kilowatts per Thousand People).[60]

FiT Price Models

There are three types of pricing models for solar energy outlined by the National Renewable Energy Laboratory. The first is the fixed price model. As the name states, this is a fixed tariff that is agreed upon by the utility and the project owner. The most attractive aspect of this model is that it offers a predetermined payment that is shielded from market shocks. This price model is what most countries choose due to its efficiency and stability.

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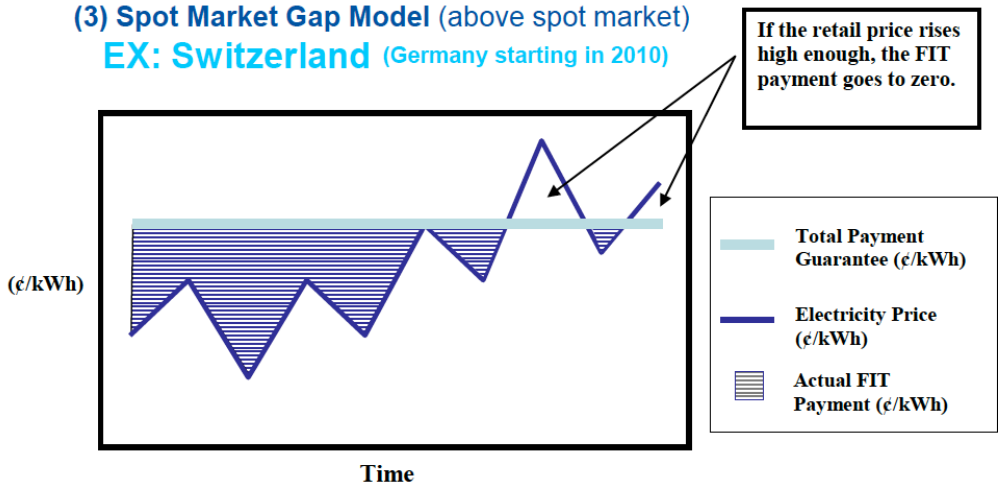
[57] *2011 Updates And Trends* (Dallas, TX: Interstate Renewable Energy Council, October 17, 2011), 17.
[58] DeShazo and Matulka, *Designing an Effective Feed-In Tariff For Greater Los Angeles*, 21.
[59] Ibid., 22.
[60] Andrew Price, "Gainesville, Florida: An Unlikely World Capital Of Solar Power," *Co.Exist*, accessed December 10, 2012, http://www.fastcoexist.com/1678949/gainesville-florida-an-unlikely-world-capital-of-solar-power.

The next price structure offers a premium on top of the market price for electricity. As explained in the study this policy can be variable (price mirrors market price of electricity) or non-variable (fixed-tariff model). Although this model is subject to more risk than a fixed tariff system, investor confidence is helped by the presence of the premium. Spain is one of the more prominent countries that has adopted a variable premium-tariff FiT model.[61] The country has also implemented a price cap and a price floor to further induce confidence.

The third and final FiT model is known as "The Netherlands" model. Karlynn Cory and two other researchers at the National Renewable Energy Laboratory describe the policy as,

> a hybrid approach between the fixed-price and the premium-price models… the government guarantees that projects will receive a predetermined, minimum total payment… instead of paying projects the total amount through a FiT payment, the project receives this payment through two separate revenue streams. The first is the prevailing spot-market price of electricity. The second is a variable FiT payment that covers the real-time difference between a minimum total payment guarantee and the spot-market price.[62]



[61] Karlynn Cory, Toby Courture, and Claire Kreycik, *Feed-in Tariff Policy: Design, Implementation and RPS Policy Interactions* (National Renewable Energy Laboratory, March 2009), 5.
[62] Ibid., 6.

The Los Angeles Business Council along with Luskin Center at UCLA produced a second study that offers detailed guidelines as to how the Los Angeles Department of Water and Power should structure their policy. The report suggests several minimum design guidelines in order for the Los Angeles FiT policy to be successful. The LABC defines success as; " being both cost effective and inclusive, contributing in a meaningful way to the City's energy and economic development goals".[63] The first suggestion is that the new FiT law has a ten year 600 MW goal for in-basin solar production.[64] This figure was calculated based on the total amount of solar capacity that is economically available in the Los Angeles basin. The LABC calculated that to be over 3,300 MW in total so a 600 MW goal is feasible due to the capacity levels. See Appendix 1 for more detailed tables regarding the 3,300 MW calculation. The council proposed the ten-year time frame in order to minimize the total cost of these proposed solar projects. This type of FiT policy would increase the monthly energy charge per household by $.048 and by $9.37 for businesses.[65] The study states that after the price increase would return to a normalized steady state after a twelve-year period as the photovoltaic market adjusts to the policy.

AB1969: Feed In Tariff Initiative

The Solar LA plan was an exciting piece of legislation that put California and especially Los Angeles on the map in terms of solar production. After the plan's

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[63] J.R. DeShazo and Ryan Matulka, *Bringing Solar Energy to Los Angeles: An Assessment of the Feasibility and Impacts of an In-basin Solar Feed-in Tariff Program* (Los Angeles: Los Angeles Business Council & University of California Los Angeles Luskin Center, July 8, 2010), 27.
[64] Ibid.
[65] Ibid.

inception Los Angeles policy makers and renewable energy advocates identified one specific aspect of the plan that could be expanded. This was the Feed-In-Tariff policy piece in the Customer Solar Programs section.

The passage of SB1 in 2006 was accompanied by the passage of the Feed-In Tariff initiative AB 1969 in the same year.[66] This assembly bill authorized public utilities to purchase eligible renewable energy produced by water and wastewater facilities less than 1.5 megawatts.[67] This bill was followed by Decision 07-07-027 on July 26th, 2007 that made it possible for public utilities to purchase energy from customers other than the public water and wastewater customers mandated by AB 1969. These two pieces of legislation allowed not only the FiT policy program outlined in the Solar LA plan to begin being structured and implemented as a 10 MW pilot program in April of 2012.

LADWP's Board of Water and Power Commissioners approved the FiT program on April 17th, 2012.[68] This was a 10 MW pilot plan that was enacted in order to help LADWP reach its 33% RPS goal by 2020 mandated by the state through SB2.[69] The passage of this program allowed Los Angeles homeowners or business owners to become their own utility company by selling the power produced by their solar units directly to LADWP. This pilot program lasted through August and produced favorable results. By the final application period, July 29th 2012, LADWP had received 26

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[66] *AB 1969 Electrical Corporations: Water Agencies*, *Public Utilities*, 2006.
[67] Ibid.
[68] "Los Angeles Department of Water and Power."
[69] *Energy: Renewable Energy Resources*, *Fish and Game*, 2011, 97.

applications for a total of 7 MW of proposed solar projects.[70] The volume of responses was viewed by LADWP officials as grounds to proceed with the full 150 MW program.[71] This will put the city of Los Angeles on track to surpass the 75 MW requirement energy utilities must have by 2016.

Los Angeles FiT Program

The Los Angeles Department of Water and Power (DWP) began its full FiT program in February of 2013. The initial 100 MW program has been divided up into separate tiers. Eligible projects range from 30 KW up to 3 MW and are limited to one project per parcel. This program has a cap limit of 100 MW and will go until there are enough acceptable applications to fill the level of capacity.

The program is divided up into 5 separate tiers defined by the total MW capacity reserved. Each tier has a total capacity of 20 MW, 4 MWs are reserved for small projects that range in size from 30 kW to 150 kW. The price per kilowatt-hour (kWh) decreases as the program fills up over time. Initially, the first tier offers a price of $0.17 per kWh. After the first 20 MWs of the program are filled the program moves to the second tier level that offers $0.16 per kWh. The price continues declining by one cent as each tier's MW capacity is filled. Each tier is planned on being unveiled every six months until the programs completion in 2016.

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[70] *Feed-in Tariff Demonstration Program Update* (Los Angeles: Los Angeles Department of Water and Power, April 17, 2012).
[71] Jessica Robbins, "Feed-in Tariff Success in Los Angeles Results in Full 150 MW Program in 2013," *Renewable Energy World*, 1, accessed November 26, 2012, http://www.renewableenergyworld.com/rea/blog/post/2012/08/feed-in-tariff-success-in-los-angeles-results-in-full-150-mw-program-beginning-2013.

The structure of LADWP's FiT program helps to do two things. The first is to guard against oversubscription. Solar FiT and other solar incentivizing programs that have been cap-less have run into issues of oversubscription and were forced to shut down due to financial constraints on the program.[72] The second key aspect of the program is the fixed price model. This type of pricing allows applicants to quickly calculate their project returns without knowing the current price of electricity. The price of $0.17 per kWh has proven to be very attractive due to the overwhelming enthusiasm for the program. Within the first month the LADWP has received 98 applications that amount to over 107 MWs of capacity.[73] 105 MWs are spread over 76 projects ranging from 151 kW to 3MW while the remaining 2 MW's are spread over 22 small solar projects ranging from 30-150 kW.[74] The positive public response to the new program will continue to drive it until 2016.

The Feed-in Tariff program Los Angeles has enacted is a great step towards meeting the state's renewable portfolio standards goal. If the program progresses on its current path without fault it will produce 110 MWs of solar capacity by 2016. The Solar LA plan in 2008 outlined the FiT program to produce 150 by 2016. The current program falls 40 MWs short of the plan's goal. Although in 2008 it would be difficult to accurately predict how much capacity a future FiT program will produce eight years down the line, it is still important for the city and LADWP to make up these 40 MWs due to the pressures of the 33% RPS goal by 2020.

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[72] Varun Sivaram, Varun Sivaram Interview. March 20 2013.
[73] "100 MW Feed-In Tariff Set Pricing Program," January 31, 2013, www.ladwp/fit.
[74] Ibid.

Solar Energy Policy & Programs

One of the largest debates occurring in energy policy today is the effectiveness of renewable portfolio standards (RPS) versus feed-in tariff policy. In order to compare the two policy tools one should understand what the policies do. As stated in the 2009 report done by the National Renewable Energy Laboratory, "RPS mandates prescribe *how much customer demand must be met with renewables,* while properly structured FiT policies attempt to support *new supply development* by providing investor certainty".[75] California along with thirty-two other states have implemented an RPS policy.[76] Although it is difficult to exclusively measure the effects of RPS policy on the solar market, it is estimated that half of the total 8,900 MW of non-hydro renewable capacity was created in states that had already enacted RPS policies.[77] It is unclear whether FiT policies or RPS policies are better divergent of each other but since over half of states already have RPS policies it is more effective and cost efficient to design FiT laws based around RPS goals where both policies work together.

A renewable portfolio standard mandates that a certain percentage of the total power supply demanded by customers that a utility provides be met by eligible renewable sources. Often these state level RPS mandates do not provide any guide as to how that percentage goal should be met. These types of decisions are often left up to the individual utilities and the local government. That is where feed-in tariff policy

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[75] Cory, Courture, and Kreycik, *Feed-in Tariff Policy: Design, Implementation and RPS Policy Interactions*, 8.
[76] Ibid.
[77] Ibid.

can fill in some of the gaps. The report outlines six separate policy interactions to focus on in order to have FiT and RPS policies work in harmony. This study will only highlight the most pertinent of the six.

The first is in regards to project financing. As mentioned before, RPS policy often does not offer guidelines as to how to achieve the goal therefore much of the financing is done at the local level. Karylnn Cory, a researcher at the National Renewable Energy Laboratory, states that such conventional solar projects find it difficult to secure long-term financing without support. Support in the form of a long-term contract that a FiT policy offers will help ensure projects get the necessary financing to get off the ground.[78] A second problem renewable energy projects often face is delays and cancellations. Cory suggests streamlining the application as a way to ensure more projects are approved by the city. She and her co-authors advocate for an eligibility criteria along with a strictly structured FiT payment level. Projects that meet these criteria and accept these payment levels will obtain a standardized utility supply contract. This will help expand the total number of approved projects along with improving the completion percentage of these proposed projects. The increase in both of these aspects of the renewable energy project process will lead utilities closer to their RPS mandates.

The study concludes that both FiT policy and RPS mandates work both to increase the renewable energy portfolios' of local utilities nationwide. At odds these two policies can get in the way, but in conjunction they can work to complement each other. Each renewable energy market is different; therefore each FiT policy should be

[78] Ibid., 10.

tailored to that specific market in order to maximize renewable energy production. Some of the main variables a utility can augment to form a policy are; price structure, project application criteria, capacity cap level, and other levels rebates/ incentives. With the correct mixture of all of these variables a region will be able to improve its renewable energy profile cost effectively.

Green Economy

The proposed 600 MW FiT cap proposed by the LABC is estimated to produce roughly 11,000 new jobs in and out of the basin[79]. The LABC arrived at this number through extensive research of other studies done on other solar markets. They note that these estimates for Los Angeles are based off of studies that were not published in any peer-reviewed journal. The analysis of these studies yielded information that shows significant differences between the effects of the solar project size on the number of jobs created.

Small-scale PV projects have been found to be much more labor intensive at all levels of the supply chain.[80] This is due to the higher demand for labor during the installation process. On the other hand larger solar projects have been found to be less labor intensive.[81] The flip side of this is that larger projects are always more cost-efficient than smaller ones. The study done by the LABC estimates that Los Angeles will be able to create employment opportunities at a rate of 31 full-time jobs per MW

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[79] DeShazo and Matulka, *Bringing Solar Energy to Los Angeles: An Assessment of the Feasibility and Impacts of an In-basin Solar Feed-in Tariff Program*, 33.
[80] Ibid.
[81] Ibid.

installed for small-scale projects.[82] Large-scale solar projects will produce about 19 full-time jobs per MW installed.[83] Although these numbers are only estimates, it is easy to see the new employment potential growth that the emerging solar market can offer.

Methodology

Methods conducted for this project included semi-structured interviews, document analysis of the Solar LA plan, and an in-depth case study of the solar array built on the campus of Occidental College. The total count was four interviews in person, two over the phone, and one through email correspondence. The interviewees were specifically chosen based on their field of work in the solar market. These included city officials, Los Angeles Department of Water and Power employees, private solar developers, and Occidental faculty. This was done in order to gain an understanding of the solar market from the eyes of the people involved. Many of the interviews attained were through snowball sampling. Interviews conducted in person and on the phone were recorded only after the interview subject gave consent.

Interview subject's professions were carefully selected in order to try and capture the full spectrum of solar energy market and associated policies. In the mayor's office I interviewed Romel Pascual the Deputy Mayor of Environment for Los Angeles and Varun Sivaram a director advisor. To inform my case study of the Occidental Solar Array, I interviewed the lead project manager Professor Daniel Snowden-Ifft and an employee that works in the facilities department to gain data

[82] Ibid.
[83] Ibid.

about the project details and how the steps for this successful project can be replicated in institutions nationwide.

Two interviews were conducted with employees of the Los Angeles Department of Water and Power. These interviews were critical for in the execution of this project due to the fact that LADWP provides all of the electricity to the Los Angeles basin. These interviews helped present the perspective of professionals who interact with solar energy on a day-to-day basis from a utility's point of view. The two interviewees were Moira Moe an Account Manager that helped supervise the Occidental Solar Array project and Michael McMenamin a Civil Engineering Associate who works in the Solar Incentive Group. The final interview was with the Vice President of Chanel Sales and Partner Management at Sunrun Inc, Mathew Woods. Sunrun is the largest provider of solar alternatives for residential homeowners in the United States.[84] This interview was vital in the effort to understand how the consumer side of the solar energy market is faring and the projections for its growth into the future. The data collected from these interviews was vital in trying to answer the research question and sub questions.

The next research method used was document analysis. The Solar LA plan was released by the Los Angeles's Mayor Villaraigosa in 2008 and has been the focal point of this project. Assembly Bill 1969 and Senate Bills 1 and 2 that lay out the California Solar Initiative and California's RPS goal were also analyzed. Senate Bill 1 authorized the California Solar Initiative in 2006. It provided more than $3 billion worth of incentives with a goal of producing 3,000 MW of solar energy by the year 2016. This incentive applies to not only customers of the state's investor owned utilities but also

[84] Woods Mathew, Mathew Woods Interview, March 7, 2013.

customers that are within municipal utility territories as well.[85] Senate Bill 2 authorized the states renewable portfolio standard. The bill set target goals of 20% of retail sales by December 31 2013, 25% by December 31, 2016, and 33% by 2020.[86]

This method was used to help understand the policy frame work in which the solar market operates. The combination of interviews with professionals that interact with solar on a day-to-day basis at varying capacities and document analysis I have been able to achieve an attempt at answering the research questions.

Occidental Solar Array

The Occidental Solar Array is a model for other institutions of this size or larger to achieve their very own system at some capacity. Private institutions have an obligation to be at the forefront of energy security and environmental issues that affect people daily. The Occidental array located above the school's campus on the south facing side of a hill hovering over the campus and is a great lead for schools of similar size or larger to do.

The idea was born from Professor Daniel Snowden Ifft a physics professor at Occidental College. In 2008 upon reading an article in a physics journal article that called for physics professionals to use their knowledge of electricity to promote more green uses. He began an Oxy solar committee that helped in getting the initial idea for the array started. The first plans of the solar array were for a 2 MW system but that was reduced in half due to the limit of power that the substation nearby could handle.

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[85] "SB 1," February 28, 2013, http://dsireusa.org/incentives/incentive.cfm?Incentive_Code=CA134F.
[86] "California Renewables Portfolio Standard" (DSIRE, October 5, 2012), http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=CA25R.

They choose a 2 MW system because this was the largest solar system that one could build and still qualify for the LADWP rebates.[87] The station has been located just off the northern side of campus for forty years and without warranty for the past ten. When contacted about the possibility of improving the substation's capacity Occidental quoted that it would take $750,000 in order to make the necessary improvements.[88] Occidental would have to pay out of pocket for this expense making a 2 MW system economically impossible.

The next step in the process was to figure out how to fund the project. The initial idea was to see if there was a group of wealthy alumni that would be interested in funding part of the project. After this plan was unsuccessful Professor Snowden-Ifft and the CFO of Occidental at the time Mike Groener began looking at the college's endowment as a possible capital source. By this time Professor Snowden-Ifft had already made a presentation to the board of trustees who were apprehensive about the original plan. After some tweaking and a few more presentations the board was on Snowden-Ifft's side.

Professor Snowden Ifft made several very powerful arguments as to why Occidental should move forward with his idea. The first and strongest was seeing the solar array as an economic investment for the school. After running the numbers, the payback time on the original system amounted to 17 years. By the time the array was being built that figure had decreased down to about 12 years.[89] This was helped by the 50% rebate the city provided for the project and ultimately priced came out to about

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[87] Snowden-Ifft Daniel, Daniel Snowden-Ifft Interview. February 19, 2013.
[88] Ibid.
[89] Ibid.

$5.68 per installed watt.[90] The board analyzed the investment opportunity of a solar array and found that it was better than many of the investments the school was already involved with.

The Occidental board of trustees approved the project on April 8th, 2010 on a 39 to 1 vote. This was following the hire of an architect to address aesthetic concerns. From the time of approval till December of 2011 the school was wrapped up in permitting issues with government agencies such as LADWP and the county. This was a long and arduous process. Appendix 3 shows the necessary steps all residential and non-residential solar projects must go through in order to meet the permitting and rebate qualifications. As seen in the flow chart this is an extremely long process especially for projects the size of Occidental's solar array. Not only is the process long and tedious, the school also needed to hire a third party consultant. They hired Bruce Miller, a land-use consultant, and his sole job was to aid Occidental in pushing papers through the city during the permitting period.[91] After all permitting and funding issues were resolved the construction of the array began in December of 2011.

The solar array officially went online on March 6th 2013 after construction was completed a few weeks earlier. The array produces enough energy to offset about 12% of Occidental's electricity expense. This breaks down to an annual savings of about $260,000.[92] The total cost of the project was $6.8 million with half of it coming out of Occidental's pocket and the other half through the LADWP rebate.[93] It is one of

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[90] Ibid.
[91] Anonymous, Occidental Facilities Faculty Interview, February 21.
[92] Ibid.
[93] Snowden-Ifft Daniel, Daniel Snowden-Ifft Interview. February 19, 2013.

the largest solar arrays on a small college institutions campus.[94] Private institutions should follow in Occidental's footsteps with regards to tackling energy and environmental issues. The Occidental Solar Array is a model for what can be achieved on campuses around the world using part of a school's endowment if funding is difficult.

Findings

Los Angeles Solar Policy

Policy regarding solar energy has changed in the past five years in a few ways. The most promising program that has emerged in the past year and a half is LADWP's FiT program. This program has begun its first 100 MW segment in February of 2013 based on the favorable results from the pilot program.

Mayors Office

Through the interviews with Mr. Sivaram and Mr. Pascual I learned a great deal regarding the mayor's position with regards to renewable energies. Since his inauguration into the mayor's office, Antonio Villargiosa has put environmental issues pertaining to renewable energy sources near the top of his agenda. This began in 2007 & 2008 with the Green LA and the Solar LA plan and has been followed through until his final days in office. Most recently the mayor has announced that the coal contracts that end is 2027 will not be renewed.[95] This is a big step towards Los Angeles purchase a larger percentage of its energy mix from renewable energy sources. Coal

[94] "Array We Go," March 6, 2013, http://www.oxy.edu/news/array-we-go.
[95] Romel Pascual and Navarro Alexa-Rae, Romel Pascual Interview. January 18 2013.

makes up 39% of the city's current energy pie. This is the largest percentage out of any energy source. To replace a base power like coal with an intermittent power source like solar is unrealistic.[96] This is because reliability is the first priority for LADWP. On the days where the weather is cloudy solar is unable to produce rendering it useless during that time. Energy demand does not drop off during this time forcing solar to be a power source that is used in support of other sources.

Since the contracts still have over a decade to expire the mayor's office is looking at innovative ways to improve upon the Los Angeles's current renewable energy portfolio. Currently LADWP and the mayor's office are looking to firm up the renewable supply with the increased use of natural gas.[97] This has been due to the declining price and reduced emissions of energy produced by natural gas in comparison to electricity produced from coal sources.

The data collected from the mayor's office also points to an internal power struggle. This struggle is between maintaining low power rates and integrating new renewable power sources. Mr. Pascual said in his interview that, "There is always a tension between getting green power and keeping the rates low." The power rates for LADWP are close to 30% less than the nearest competitor. The cost of increasing the renewable portfolio standard through utility owned large-scale solar projects is passed onto the LADWP customers through their monthly bill. Therefore the department must create a balance in order to slowly increase rates while trying to achieve the RPS goal of 33% by 2020. This is one limitation the mayor's office has run into when attempting to increase the solar profile of the city.

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[96] Ibid.
[97] Ibid.

Solar Project Financing

Solar project financing has shifted in the past several years. Through several creative financing models more and more people are able to achieve their very own solar system on their house. The first model is crowd funding. This type of financing strategy was outlined in the mayor's Solar LA plan through a program named the SunShares program. As written in the plan, "The SunShares program will enable anyone, including low and moderate income customers the prospect of owning a "virtual share" of an LADWP solar power facility."[98] This type of financing is referred to as crowd funding. Unfortunately the program has not been fully developed by either LADWP or the mayor's office.[99]

Another way people have begun financing their solar systems is by purchasing the electricity produced and not the system itself. In an interview with Mathew Woods, a vice president at Sunrun, he said that, "The industry has changed most fundamentally where close to 80% of people no longer are purchasing the solar panels they buy solar energy."[100] Sunrun does this by installing a solar system on a resident's roof for almost no cost. The resident has his or her energy offset by the solar system all while paying Sunrun a predetermined monthly fee. This is done through a form of power purchasing agreement. Although this does not completely offset residential electricity cost due to the monthly payments to Sunrun, it has made offsetting a percentage of electricity costs by a solar system very accessible to lower and middle class households.

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[98] *The Los Angeles Solar Energy Plan*.
[99] Romel Pascual and Navarro Alexa-Rae, Romel Pascual Interview. January 18 2013
[100] Woods Mathew, Mathew Woods Interview March 7, 2013.

Both of these finance models offer great ways to increase accessibility of solar to middle and low income electricity customers. One issue that may force these models to become even more ubiquitous is the end of the investment tax credit at the end of 2016. The expiration of the tax credit worth 30% of a completed solar system will force many potential solar consumers out of the solar market. The expiration of this tax credit will increase the cost of installed solar projects by a substantial amount isolating much of the population from accessing solar. The federal government has announced that when the tax credit will be reduced to 10% for solar projects when the current tax credit expires. If the solar industry is to continue with a reduced form of tax credit, creative funding methods like the SunShares program or the program implemented by Sunrun will need to take center stage.

Future Growth

The future growth of the solar energy market is a contested question. Through my interviews I have identified that depending on what side of the market someone aligns determines where they see the most amount of potential growth. The professionals I interviewed that worked for the city at different levels believed that utility scale solar is going to take off in the next few years.[101] On the other hand solar developer Mathew woods believes that solar can be characterized as a hyper growth industry where solar leasing on residential homes will become the main market.[102] With the solar market evolving all the time both of these growth potentials are possible.

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[101] McMenamin Michael, Michael McMenamin; Romel Pascual and Navarro Alexa-Rae, Romel Pascual Interview. January 18 2013.
[102] Woods Mathew, Mathew Woods Interview, March 7, 2013.

Large-Scale Utility Owned Solar Systems

There are a few reasons why large-scale utility owned solar systems will be the largest growing market in Los Angeles. First, these types of projects make up 400 MWs of the Solar LA plan and are to be completed by 2014. This is an enormous amount of planned solar being produced by the city. Appendix 5 shows all LADWP renewable energy projects that are counting towards the RPS of 33%. There are currently 26 MW worth of photovoltaic projects that are already in use while there is 550.5 MWs of solar currently being built. Large-scale utility owned solar projects normally range between 100-200 MW depending on the facility.[103] When asked about how the city sees utility owned large-scale solar being in the future Mr. Pascual said, "We have to look at large scale solar. We have to begin looking at those large-scale projects because the mayor has made a commitment to get off of coal. Coal is the most reliable, the cheapest but also the dirtiest."[104] Another explanation Michael McMenamin offers as to why large solar projects are the way of the future is due to the finite supply of solar consumers in Los Angeles.[105] He is also concerned that the dwindling number of incentives for rooftop projects will hurt the residential solar market.[106] Finally solar projects of this nature often have high fixed costs that attribute to the overall cost. These fixed costs come in the form of building transmission line infrastructure and the acquisition of a large enough site. The variable cost comes in the form of solar panels. Solar projects

[103] Romel Pascual and Navarro Alexa-Rae, Romel Pascual Interview. January 18 2013.
[104] Ibid.
[105] McMenamin Michael, Michael McMenamin. March 20, 2013.
[106] Ibid.

will be able to take advantage of lower overall projects costs due to the economies of scale.[107]

Residential Solar

Another area that has seen a large amount of growth is in residential solar projects that involved more creative funding. Mathew Woods believes that growth in the residential sector that purchases energy and not necessarily solar systems will lead to the most amount of growth in the coming years. Sunrun offers its customers a $0 down solar system that the company owns. Through an arranged agreement the customer will pay Sunrun a certain amount per kilowatt-hour of solar energy produced while having their normal electricity bill significantly reduced. Varun Sivaram thinks that crowd-funding programs will begin to take off as the incentives begin to dry up both locally and nationally. A well-organized crowd-funding program to fund solar systems will create a level of accessibility to solar many middle and lower income electricity users that has not been reached before.

The growth that will be seen in the solar market over the next five years will be directly influenced by public policy changes in the future especially an emphasis on rebate programs. All of these types of projects or funding models look to hedge against the expiring investment tax credit in 2016 and the possibility of local and state incentives being eliminated by position changes in government. The next five years will be very important for the landscape of solar.

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[107] Ibid.

Recommendations

The recommendations here are proposed based on the research performed from September 2012 to April 2013. These recommendations aim to improve the solar energy market in Los Angeles.

Public Education

The city should look to improve awareness about solar programs that are being offered by the city and state. Programs such as the SunShares program have not been properly advertised by the city. This lack of a marketing strategy has led the service to be underutilized. Sunshares is a type of crowd funding program aimed at middle to low-income households that are interested in purchasing a part of a solar system. If there is not enough outreach to these households' citizens are unable to take full advantage since they do not know about it. This falls on the backs of the city to provide enough support for programs in order for the to be effective.

The solar rebate system is also extremely confusing for a first time user. Luckily the city has taken steps in order to streamline the process of applying for rebates. Through an online application resource called PowerClerk LADWP has been able to increase the number of solar incentives processed by 400% from 2011 to 2012.[108] The program has also been able to reduce application review time by 65% according to Clean Power Research one of the partners helping implement the new program management solution.[109] This has been a great step forward for LADWP to

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[108] Mark Liffmann, "LADWP Doubles Solar Generation Capacity With Streamlined Incentive Processing," *Clean Power*, December 18, 2012, http://www.cleanpower.com/2012/ladwp-doubles-pv-capacity/.
[109] Ibid.

improving the total amount of solar installed in Los Angeles by taking a lot of questions out of the application process. The clarity PowerClerk has brought to solar incentives in Los Angeles has been an enormous step forward in educating Southern California residents of what solar options are out there. This needs to be carried through to other programs such as SunShares to improve education in order to capture the full market of potential solar customers.

Future Research

The solar market and the policies surrounding it are constantly evolving. There are many factors that have leaded us to the solar market in Los Angeles today. The next five years will become very critical for solar energy. The first is the expiration of the federal investment tax credit in 2016. The second is research regarding the rampant growth of the natural gas industry and its affects on renewable energy investment. Finally further monitoring of the financial situation many Chinese solar manufacturers are in will be necessary to provide some stability to solar investors.

The expiration of the investment tax credit on December 31st, 2016 could have severe detrimental effects on the solar market not only in Los Angeles but also across the country. The tax credit provides a 30% credit on installed solar projects greater than 0.5 kW with no maximum credit.[110] The federal government has announced that the investment tax credit on solar projects used to produce energy will decline to 10% of installed project costs.[111] This change will take effect when the current credit expires at the end of 2016. The reduction of this credit will immediately increase the

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[110] "Business Energy Investment Tax Credit," *DSIRE USA*, accessed April 7, 2013, http://dsireusa.org/incentives/incentive.cfm?Incentive_Code=US02F.
[111] Ibid.

overall cost of solar projects isolating many potential solar customers. The increase in price will cause a decline in number of solar projects overall due to the isolation of electricity customers interested in solar energy. This will especially hurt potential solar customers that fall into the middle to low-income brackets due to the high upfront costs associated with solar panels projects. It is unknown how much the reduction of the tax credit will hurt the amount of solar produced this is why further research is needed.

Natural gas has become a leading source for electricity production over the past decade. This has been in part due by the price reduction over the past five years.[112] This low price point has drawn the attention of power providers nationwide as many look to switch from coal as the main source of power. Los Angeles is one of these utilities exploring the option of natural gas to replace coal. This is because mayor Villaraigosa has already announced that LADWP will not be renewing the coal contract that is set to expire in 2027. As the city begins to use more natural gas produced energy sources in the future they must not lose sight of the benefits renewable energy sources provide. This can be overlooked by how much lower natural gas produced energy costs in comparison to renewables like solar. The shift from coal to natural gas must be monitored in order to make sure renewables have a strong position in LADWP's future energy mix.

Finally future monitoring must be done on the financial situation plaguing many Chinese solar manufacturers. Clarity regarding the position of the companies is important not only for US investors but for future solar consumers. This is because

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[112] "5 Year Natural Gas Prices and Price Charts," *InfoMine*, accessed April 7, 2013, http://www.infomine.com/investment/metal-prices/natural-gas/5-year/.

volatility in the solar market heightens the amount of risk felt when investing in such technologies. If a group of Chinese solar companies collapse unexpectedly then the solar PV panel market could be in trouble. In turn this will hurt domestic solar companies that purchase solar panels from Chinese sources. In the future it is important for Los Angeles to not be enticed by the low cost of fossil fuels like natural gas and to stay committed to renewable energy sources.

Solar & Incentive Policy

The state of California needs to continue its progressive stance on solar energy into the future. This can be done by making sure cities are following through on the 33% renewable portfolio standard goal set out by Senate Bill 2. Considering SB 2 is one of the main motivations for power providers to incentivize various types of renewable energy production projects, it is vital to continue to implement the bill. Without the legislation of SB 2 many utility providers will look to cut costs by shifting away from renewables and into natural gas.

The models for incentivizing solar should be changed as the marketplace for solar grows. Currently most solar rebate programs offer a certain percentage of the installed solar project cost back from the electricity provider. This need to change and in place the city needs to create a "smooth energy" incentive. This would be accomplished by providing a rebate structure for smooth power being produced. As seen in Appendix 1 the solar energy generation curve is bell shaped. With the implementation of a battery, solar projects can achieve a smooth power distribution curve. The batteries charging during the day when the solar panels are generating electricity and discharging at night when the panels are unable to produce

accomplishes this type of curve. The city can enter into agreements with solar power producers to purchase smooth energy all day instead of just when the panels are producing. The benefit of incentivizing solar this way is that it includes the implementation of battery technology like the UPG 35 AH Solar Energy Storage Battery that allows the solar producer to be paid for 24 hours of solar power produced instead of only during the time when solar panels are producing.

Another change to the way solar is incentivized is to provide additional rebates to projects that meet a distributed generation qualification. The beneficial effects of distributed generation done by solar can easily be obtained if rewarded through a program. This can be incentive can be applicable to solar projects of all sizes considering the idea to try and decentralize electricity generation. This can be done effectively in Los Angeles where much of the city is spread out over many square miles. A distributed generation incentive for solar energy projects will further help grow the solar market in Los Angeles.

The Feed-in Tariff program that LADWP began in February is a positive step towards a more solar energy production in Los Angeles. This program needs to be continued and expanded upon in order to reach all potential Los Angeles solar customers. LADWP is currently in its third month of its first 100 MW FiT program that runs until 2016. The original Solar LA plan had a 150 MW program that lasted the same amount of time. This 50 MW difference will need to be made up in either large-scale utility solar projects or through another source because of the looming 33% RPS goal in 2020. The city should look to use the FiT program to its largest capacity because it allows the city to invest in more projects with the same amount of money.

This is because instead of giving a certain percentage of the total solar project cost back to the solar customer, LADWP purchases the power through a Standard Offer Power Purchase Agreement. These agreements can last up to 20 years and outline the fixed rate LADWP is going to purchase the electricity generated at. The current FiT program purchases solar generated power at $0.17 per kWh for the first 20 MW of the program. The allows the city to spread more of the money allocated for solar incentives over more projects since all they are paying for is the actual power produced by the system. Feed-in Tariff programs have been tested in cities around the world and have been found to be extremely effective at improving the solar profile of a city.

Altering Residential Roof Building Codes

One issue people run into who are interested in installing solar on their roofs is that they are often too old or weak to hold the weight. Occidental experienced this same problem when attempting to identify roof space in which to utilize for its own solar project. In order to promote rooftop solar installation building codes will need to be altered for residential homes. The change would be to improve the amount of weight residential roofs could handle. This would allow for solar projects of any size to be installed on new homes without fear of them being too heavy. Solar project size and weight are issues all potential solar consumers face. Implementing policy measures to create the most ideal location for solar systems will be important as the solar market continues to grow.

Mayors Office & The Future Mayor

The mayor's office and the next mayor have a unique opportunity to be at the forefront of renewable energies. The office has the ability to strongly influence the direction in which Los Angeles heads in with regards to energy security and environmental issues through initiatives and policy. The current mayor and the incoming mayor should revise the 2008 Solar LA plan. The updated plan would cover total amount of solar produced by the programs outlined in the original document while also accounting for the difficulties of the solar market after the economic collapse around the same time. Most notably changes should be made to the SunShares program and how LADWP and the mayors office plans to move forward with that program.

The SunShares program outlined in the Solar LA plan is one that allows LADWP customers to buy into a share of a solar system and earn a percentage return on the power produced by the system based on their initial investment. This type of program or other crowd-funding models needs to become a more apparent in the solar market. The general public is currently under utilizing the SunShares program due to its lack of outreach. These types of funding models will be necessary in the future as incentives for rooftop solar begin to change. The mayor's office needs to get ahead of the elimination of some incentives by investing in a strong crowd-funding program that is well organized and staffed. The issue with these types of programs is that they often need a lot of structural organization and time to set up. This is a program that the mayor has already promised in his plan and needs to be followed through on. The

creation of this type of program will allow solar to penetrate markets that it would not otherwise be able to operate in leading to more solar production overall.

Programs like the SunShares program or another crowd-funding model are in a certain level of jeopardy when a new mayor administration is elected. This is due to the amount of time and effort needed to organize and maintain this type of program. A new mayor that does not have the same affinity towards solar would likely phase out a program like this due to its high capital costs. The city needs to set up mechanisms in which to guard against the outright elimination of good programs without accurate justification. The can be done by an evaluation metric to gauge program performance in comparison to past performances or other programs with similar goals. From these assessments the mayor or other program director can choose to continue with the program or alter it in a way to make it more beneficial. This was a problem outlined to me during the interview that was conducted with the Deputy Mayor of Environment for Los Angeles Romel Pascual. With mechanisms in place current programs like LADWP's FiT or future crowd-funding programs will be safe from administrative changes like elections.

Private Institutions

Private institutions like universities and colleges have a great opportunity when it comes to participating in the environmental conversation. Institutions such as Occidental and many others have looked to get ahead of the issue by making substantial investments in renewable energy. Not only are these types of investments good for the environment and the image of the school, but for the financial side of these institutions. Solar arrays or other solar projects can be viewed just like stocks or

bonds when analyzing investment strategies for endowments. The trustees of schools should see solar as not only a financially viable opportunity but also one that can improve many aspects of an elite institution.

Conclusion

The solar market is currently enjoying a period of enormous growth especially within California. The renewable portfolio standard goals set out by states have helped drive the demand for renewable energies forward by forcing power providers to integrate them into its power mix. With the goal as the motivation cities like Los Angeles are experimenting with various programs and policies in order to produce the most amount of renewable electricity possible. The Solar LA plan has been the strategy in which Los Angeles follows to help achieve the 33% goal in 2020. Out of this plan the feed-in tariff program has received the greatest level of support. The Los Angeles Department of Water and Power will look to improve upon the program as time progresses.

The information collected during the research process has led to the conclusion that Los Angeles is currently implementing good policy to meet the level of demand. Since the inception of the mayor's plan LADWP has put into place programs to improve the solar profile for Los Angeles. Also the city has taken it upon itself to meet the renewable portfolio standard by investing so heavily in utility owned large-scale solar projects. For example construction of a 200 MW system in Southern Owens Valley

began in 2012 and will be completed in 2015.[113] Projects of this size may need to become more common with the looming expiration of the federal income tax credit in 2016.

Electricity customers who are interested in purchasing a solar system for their house are able to apply for the 30% investment tax credit from the federal government. The government is planning on reducing this to 10% when the tax credit expires December 31st 2016. The solar market nationwide will be hurt because of this policy change. The largest issue is that many rebate structures have relied on this tax credit to help make solar projects economically viable. The feed-in tariff program could be affected most since the program does not cover any of the parts and labor costs. The breakeven points for solar investments will be extended several more years when the tax credit expires leading to less new solar being created.

Chinese solar companies will also play a large role in the future landscape of solar. The bankruptcy of Suntech in March of 2013 and the financial strains expressed by other solar manufacturers has led investor confidence in the Chinese solar panel industry to fall. Although it is early to predict what might happen to many of these struggling corporations, it is safe to say that their outcomes will be felt across the Pacific Ocean in America. This is due to the widespread use of Chinese solar panels in the United States solar market. If many of the companies go out of business and there are only a few remaining this may lead to the price of solar leveling out. On the other hand if the Bank of China bails many of these companies out and they continue

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[113] "LADWP RPS Master Project List," accessed April 9, 2013, https://www.ladwp.com/cs/idcplg?IdcService=GET_FILE&dDocName=AD17DWPWEB9173003320&RevisionSelectionMethod=LatestReleased.

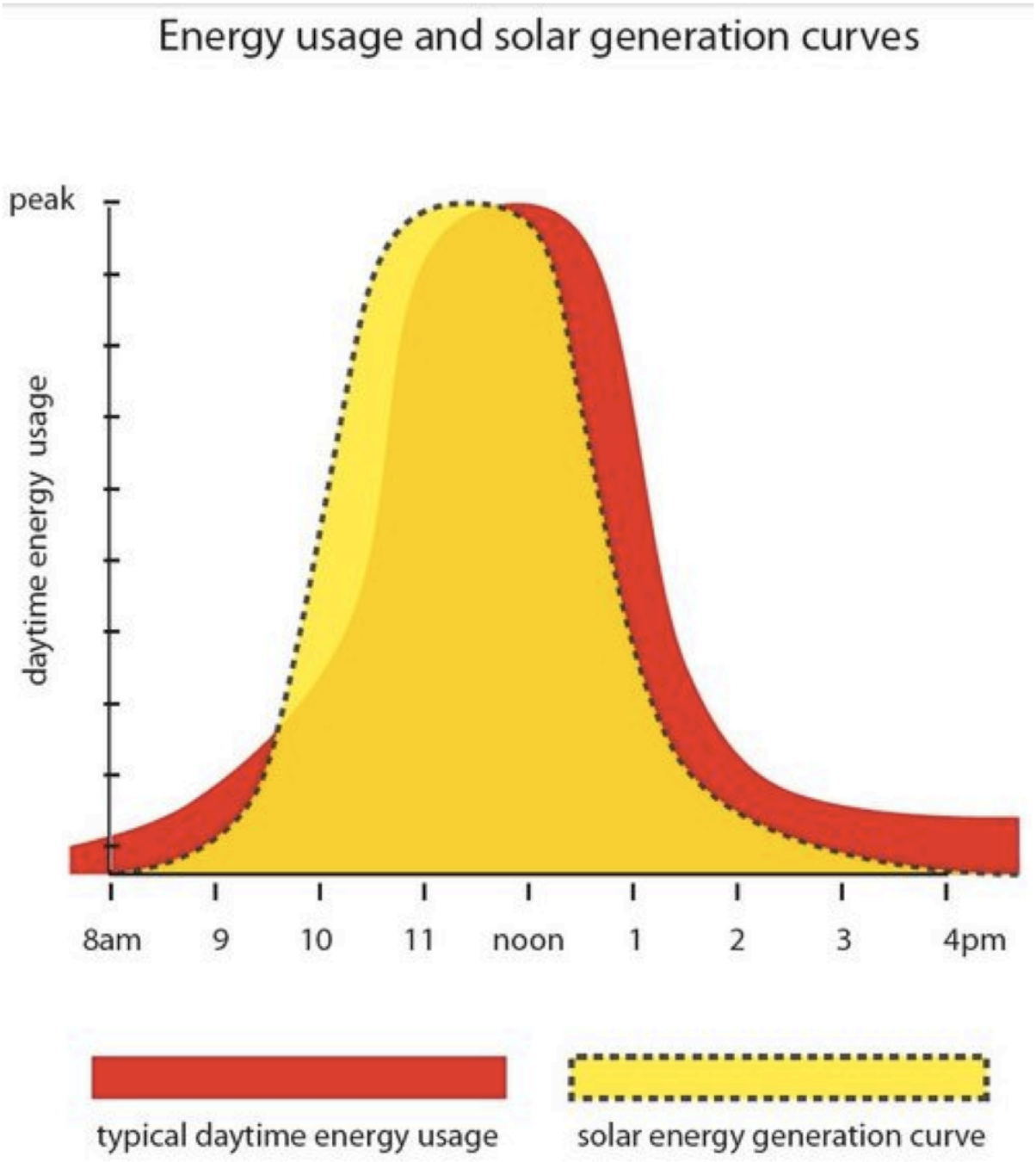
operating as they have this creates its own moral hazard problem resulting in the same outcome years down the road when the company needs funding again. These two options are neither ideal when trying to create a stable market for solar energy.

The situation Chinese solar manufacturers are facing and the reduction in the investment tax credit will play key roles in the future solar market. Natural gas will also play a key role as power providers move away from coal and into natural gas. This is due to the tempting price natural gas is able to offer utility companies. Renewable energy investment could partially be in at risk if these companies see natural gas as a more viable long-term solution. The implementation of both of these technologies will be the best path moving forward as coal use is reduced.

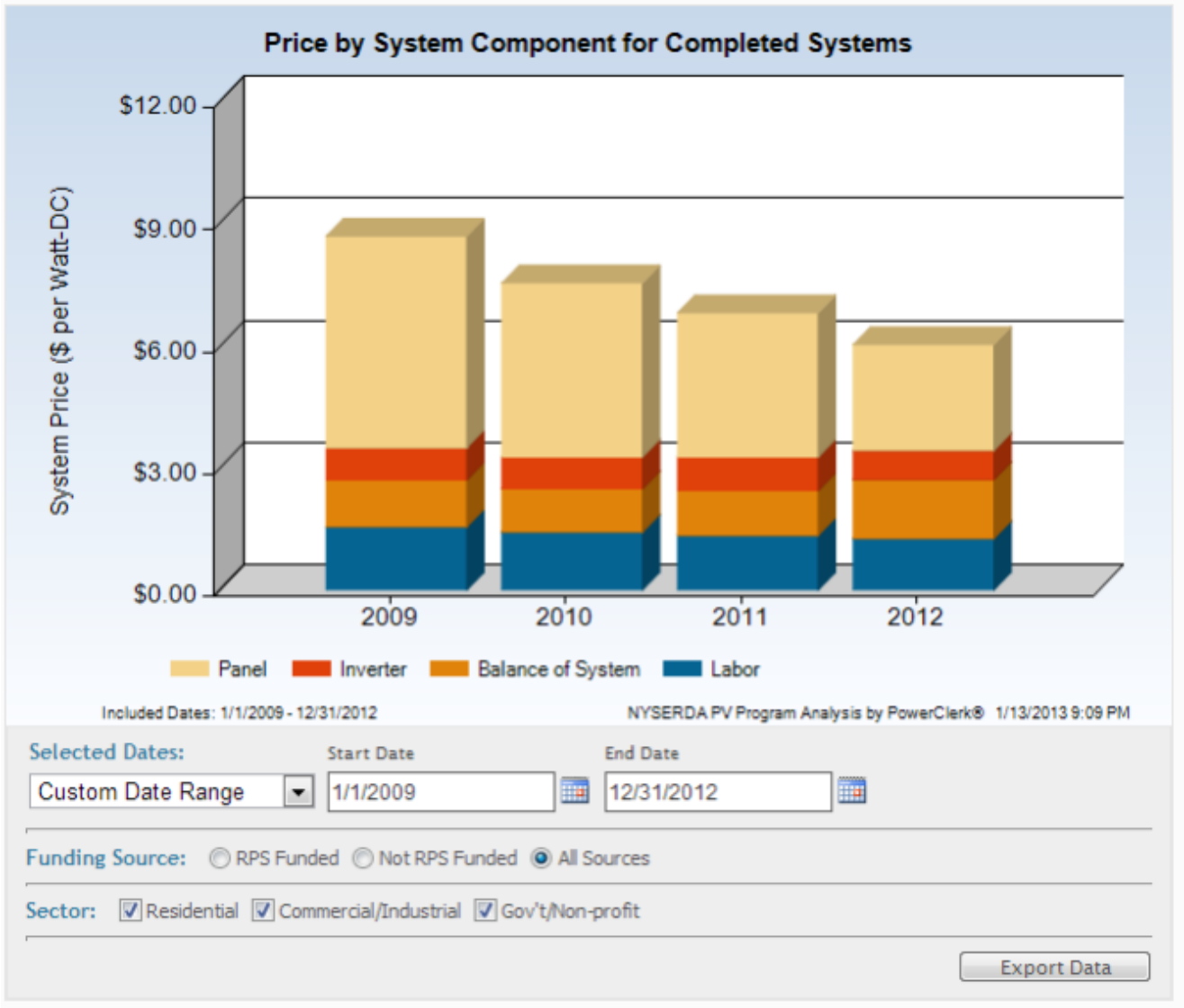
The Solar LA plan created in 2008 was the most ambitious plan ever by a single city at the time. The progression of this plan has gone well with both the mayors office and LADWP adapting to the changing market. I advise the next mayor of Los Angeles to continue following the guide that Mayor Villaraigosa has laid out and to expand on it. Two places to look for expansion are the feed-in tariff program and the SunShares program. The execution of the plan paired with the aid of good local and state policy will allow Los Angeles to achieve the 2020 renewable portfolio standard goal of 33%. The future for solar is bright in Los Angeles but the initial steps must be taken in order to achieve the level of solar energy production the city is capable of producing.

Appendix

1. Institute of Climate Studies USA

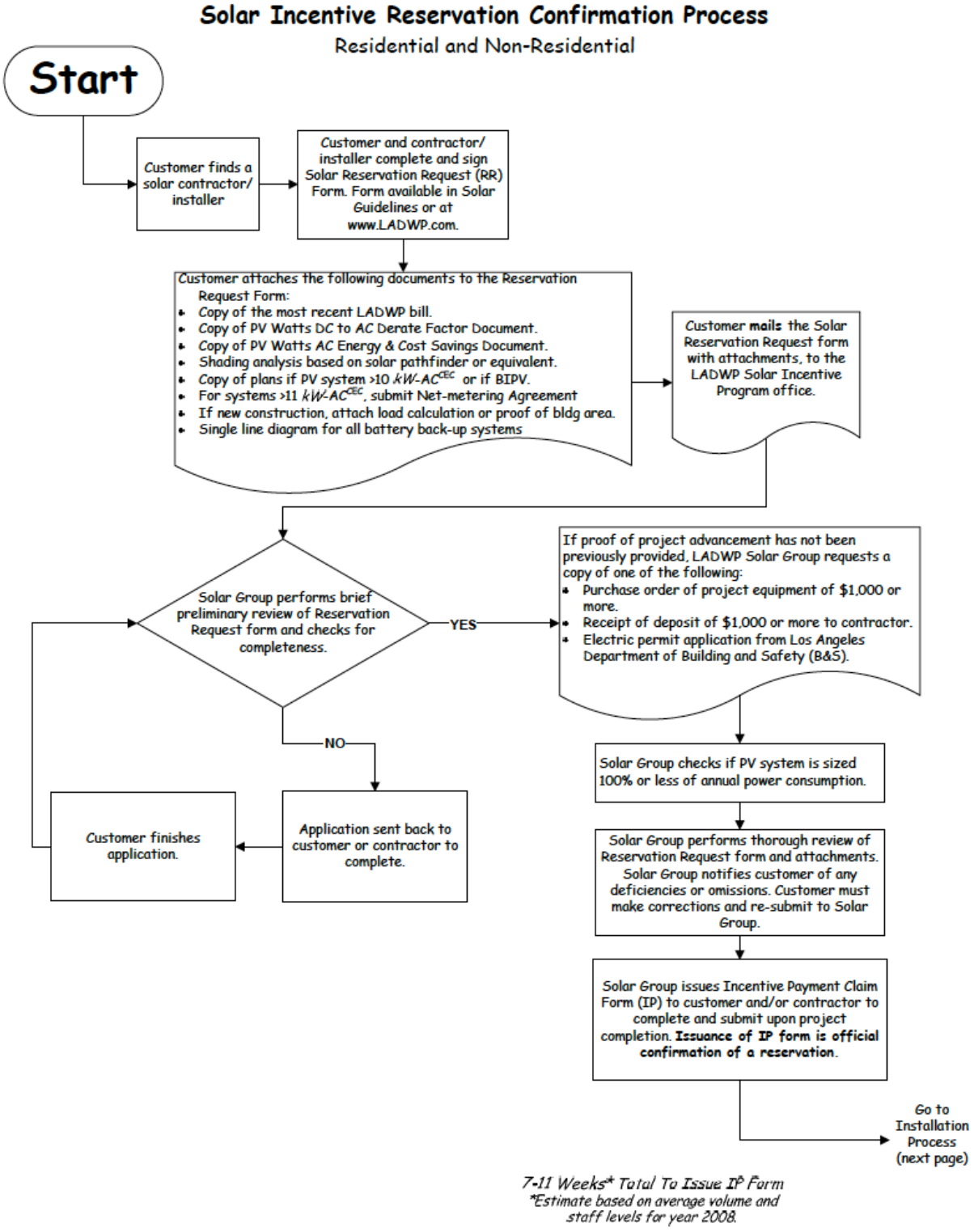


2. CleanPower.com[114]

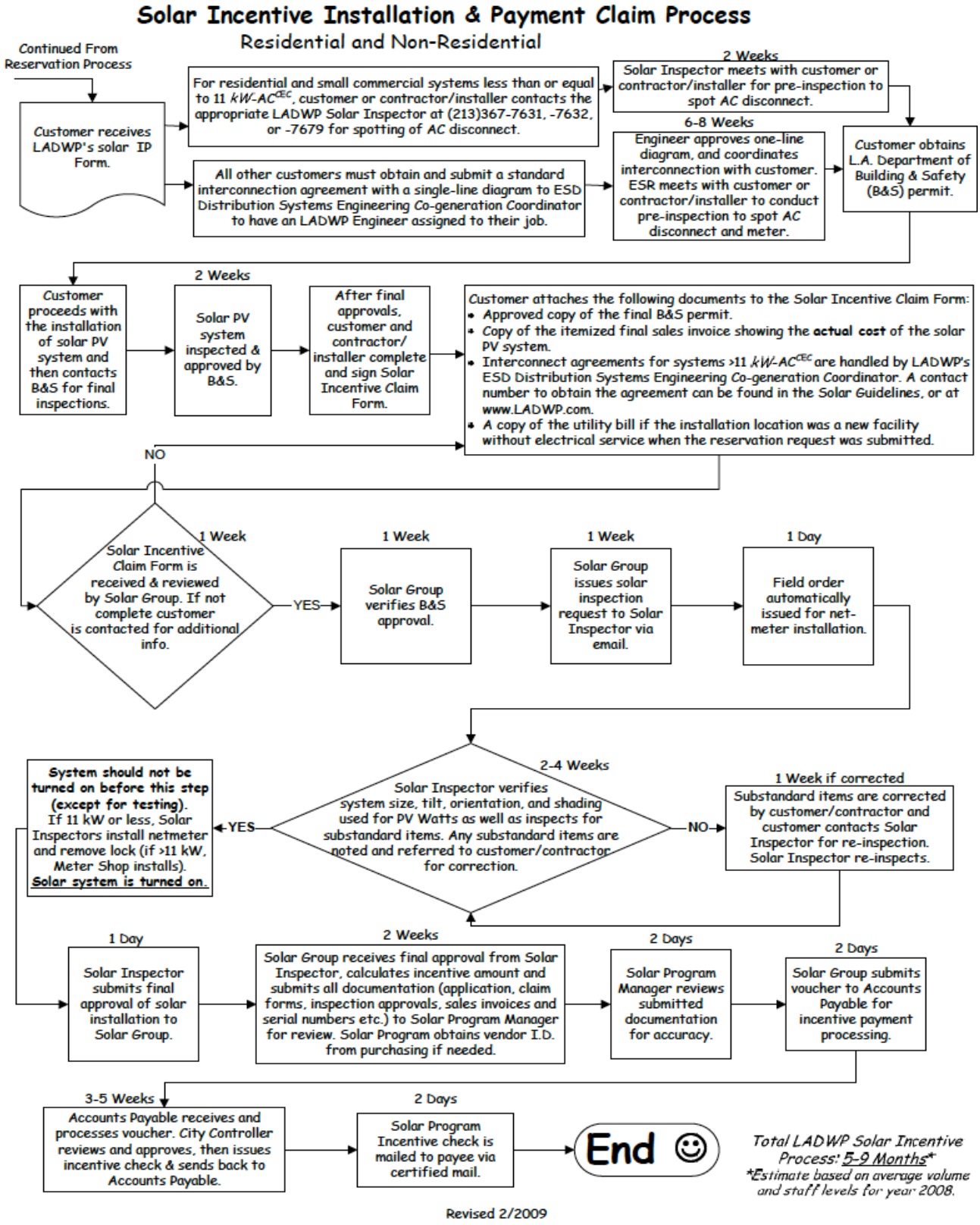


[114] Mark Liffmann, "2013 Trends: PV Soft Cost Reduction," *Clean Power Research*, January 16, 2013, http://www.cleanpower.com/2013/soft-cost-reduction-trend/.

3.


Solar Incentive Reservation Confirmation Process
Residential and Non-Residential
Start
Customer finds a solar contractor/ installer
Customer and contractor/ installer complete and sign Solar Reservation Request (RR) Form. Form available in Solar Guidelines or at www.LADWP.com.
Customer attaches the following documents to the Reservation Request Form:
Copy of the most recent LADWP bill.
Copy of PV Watts DC to AC Derate Factor Document.
Copy of PV Watts AC Energy & Cost Savings Document.
Shading analysis based on solar pathfinder or equivalent.
Copy of plans if PV system >10 kW-AC^CEC or if BIPV.
For systems >11 kW-AC^CEC, submit Net-metering Agreement
If new construction, attach load calculation or proof of bldg area.
Single line diagram for all battery back-up systems
Customer mails the Solar Reservation Request form with attachments, to the LADWP Solar Incentive Program office.
Solar Group performs brief preliminary review of Reservation Request form and checks for completeness.
YES
If proof of project advancement has not been previously provided, LADWP Solar Group requests a copy of one of the following:
Purchase order of project equipment of $1,000 or more.
Receipt of deposit of $1,000 or more to contractor.
Electric permit application from Los Angeles Department of Building and Safety (B&S).
NO
Customer finishes application.
Application sent back to customer or contractor to complete.
Solar Group checks if PV system is sized 100% or less of annual power consumption.
Solar Group performs thorough review of Reservation Request form and attachments. Solar Group notifies customer of any deficiencies or omissions. Customer must make corrections and re-submit to Solar Group.
Solar Group issues Incentive Payment Claim Form (IP) to customer and/or contractor to complete and submit upon project completion. Issuance of IP form is official confirmation of a reservation.
Go to Installation Process (next page)
7-11 Weeks* Total To Issue IP Form
*Estimate based on average volume and staff levels for year 2008.
Revised 2/2009

4.


Solar Incentive Installation & Payment Claim Process
Residential and Non-Residential
Continued From Reservation Process
Customer receives LADWP's solar IP Form.
For residential and small commercial systems less than or equal to 11 kW-AC(CEC), customer or contractor/installer contacts the appropriate LADWP Solar Inspector at (213)367-7631, -7632, or -7679 for spotting of AC disconnect.
All other customers must obtain and submit a standard interconnection agreement with a single-line diagram to ESD Distribution Systems Engineering Co-generation Coordinator to have an LADWP Engineer assigned to their job.
2 Weeks
Solar Inspector meets with customer or contractor/installer for pre-inspection to spot AC disconnect.
6-8 Weeks
Engineer approves one-line diagram, and coordinates interconnection with customer. ESR meets with customer or contractor/installer to conduct pre-inspection to spot AC disconnect and meter.
Customer obtains L.A. Department of Building & Safety (B&S) permit.
Customer proceeds with the installation of solar PV system and then contacts B&S for final inspections.
2 Weeks
Solar PV system inspected & approved by B&S.
After final approvals, customer and contractor/ installer complete and sign Solar Incentive Claim Form.
Customer attaches the following documents to the Solar Incentive Claim Form:
• Approved copy of the final B&S permit.
• Copy of the itemized final sales invoice showing the actual cost of the solar PV system.
• Interconnect agreements for systems >11 kW-AC(CEC) are handled by LADWP's ESD Distribution Systems Engineering Co-generation Coordinator. A contact number to obtain the agreement can be found in the Solar Guidelines, or at www.LADWP.com.
• A copy of the utility bill if the installation location was a new facility without electrical service when the reservation request was submitted.
NO
1 Week
Solar Incentive Claim Form is received & reviewed by Solar Group. If not complete customer is contacted for additional info.
YES
1 Week
Solar Group verifies B&S approval.
1 Week
Solar Group issues solar inspection request to Solar Inspector via email.
1 Day
Field order automatically issued for net-meter installation.
2-4 Weeks
Solar Inspector verifies system size, tilt, orientation, and shading used for PV Watts as well as inspects for substandard items. Any substandard items are noted and referred to customer/contractor for correction.
NO
1 Week if corrected
Substandard items are corrected by customer/contractor and customer contacts Solar Inspector for re-inspection. Solar Inspector re-inspects.
YES
System should not be turned on before this step (except for testing). If 11 kW or less, Solar Inspectors install netmeter and remove lock (if >11 kW, Meter Shop installs). Solar system is turned on.
1 Day
Solar Inspector submits final approval of solar installation to Solar Group.
2 Weeks
Solar Group receives final approval from Solar Inspector, calculates incentive amount and submits all documentation (application, claim forms, inspection approvals, sales invoices and serial numbers etc.) to Solar Program Manager for review. Solar Program obtains vendor I.D. from purchasing if needed.
2 Days
Solar Program Manager reviews submitted documentation for accuracy.
2 Days
Solar Group submits voucher to Accounts Payable for incentive payment processing.
3-5 Weeks
Accounts Payable receives and processes voucher. City Controller reviews and approves, then issues incentive check & sends back to Accounts Payable.
2 Days
Solar Program Incentive check is mailed to payee via certified mail.
End
Total LADWP Solar Incentive Process: 5-9 Months*
*Estimate based on average volume and staff levels for year 2008.
Revised 2/2009

5.

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

6.

LADWP RPS Master Project List

		Technology	PPA/Own	COD	MW	GWh
Short-Term Purchases						
Short-Term Market Purchases (CFE, Wind, Hydro, Pac)		Various Types	PPA	In service	0	723
				Total:	**0**	**723**
Projects In-service						
Small Hydro		Small Hydro	Own	In service	166	538
Hyperion Digester Gas		Biomass Digester	Own	In service	16	147
Lopez Microturbine		Biomass Landfill Gas	Own	In service	1.5	2
WM Bradley		Biomass Landfill Gas	PPA	In service	6.4	36
SCS Penrose		Biomass Landfill Gas	PPA	In service	6.1	45
DWP Built Solar		Solar Photovoltaics	Own	In service	1	1
SB1 Solar Rooftop Program		Solar Photovoltaics	Own (REC's only)	In service	25.0	37
PPM SW Wyoming		Wind	PPA	In service	82.2	233.3
Castaic U3&U5 Upgrade		Hydro	Own	In service	30	15
PPM Pebble Springs		Wind	PPA	In service	68.7	192.6
MWD Sepulveda		Small Hydro	PPA	In service	8.5	42
Willow Creek		Wind	PPA	In service	72	197.3
Powerex - BC Hydro		Small Hydro	PPA	In service	50	430
Pine Tree Wind and Expansion		Wind	Own	In service	135	381.5
Shell Energy Landfill Gas		Landfill Gas	PPA	In service	0	350
Atmos Energy Landfill Gas		Landfill Gas	PPA	In service	0	288
Milford Wind Phase I		Wind	PPA/Own	In service	185	434.3
Windy Point Phase II		Wind	PPA/Own	In service	262.2	693.9
Toyon Power Plant		Biogas or Biomethane	PPA	In service	3.6	11.5
Linden		Wind	Own	In service	50	145.4
North Hollywood PS Power Plant		Small Hydro	Own	In service	1	5.0
				Total:	**1,170**	**4,227**
Projects Under Construction						
DWP Built Solar	1) DWP Built Solar	Solar Photovoltaics	Own	2010-2014	120	194
	2) Southern Owens Valley Solar Ranch (SOVSR) Phase 1	Solar Photovoltaics	Own	1/1/14	100	198
	3) Southern Owens Valley Solar Ranch (SOVSR) Phase 2	Solar Photovoltaics	Own	7/1/15	100	198
	4) DWP Built Solar Owens Lake Demo	Solar Photovoltaics	Own	10/1/12	0.5	1.0
Sunshares		Solar Photovoltaics	Own/Shares	2011-2018	80	130
SB1 Solar Rooftop Goal		Solar Photovoltaics	Own (REC's only)	2008-2017	110.5	164
Feed-In-Tariff		Solar Photovoltaics	PPA	2011-2014	150	236
Water System Hydro		Small Hydro	Own	12/1/13	4	22
Aqueduct PP Improvements		Hydro	Own	4/1/12	4	30
Milford Wind Phase II		Wind	PPA/Own	7/1/11	102	217
				Total:	**669**	**1,173**
Projects Planned						
Pine Canyon Wind Project		Wind	Own	12/31/15	150	394
SS Frink Lands-1,2,3,4		Geothermal	Owned Jt.	10/1/14-12/31/19	100	800
Castaic U1 Upgrade		Hydro		7/10/12	15	7.5
				Total:	**265**	**1,202**
				Grand Total:	**2,104**	**7,325**

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