CleanPowerSF feed-in tariff: design recommendations

Prepared for CleanPowerSF/San Francisco Public Utilities Commission

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About the Clean Coalition

The Clean Coalition is a nonprofit organization whose mission is to accelerate the transition to renewable energy and a modern grid through technical, policy, and project development expertise.

The Clean Coalition drives policy innovation to remove barriers to procurement and interconnection of distributed energy resources (DER)—such as local renewables, advanced inverters, demand response, and energy storage—and we establish market mechanisms that realize the full potential of integrating these solutions. The Clean Coalition also collaborates with utilities and municipalities to create near-term deployment opportunities that prove the technical and financial viability of local renewables and other DER.

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Table of Contents

List of acronyms

Below is a list of acronyms used in this document:

CAISO = California Independent System Operator
CCA = Community Choice Aggregation
CCSF = City and County of San Francisco
COD = commercial online date
ITC = investment tax credit
kW = kilowatt
kWh = kilowatt-hour
LADWP = Los Angeles Department of Water and Power
MRP = market responsive pricing
MW = megawatt
NEM = net energy metering
O&M = operations and maintenance
PG&E = Pacific Gas & Electric
PPA = power purchase agreement
PV = photovoltaic
RPS = Renewable Portfolio Standard
SFPUC = San Francisco Public Utilities Commission
UCLA = University of California at Los Angeles
W = watt
X_{ac} = capacity (in alternating current)
X_{dc} = capacity (in direct current)

Executive summary

The document details the Clean Coalition's recommendation for the design of CleanPowerSF's feed-in tariff (FIT) program. Our recommendations are based upon discussions with San Francisco Public Utilities Commission (SFPUC) staff, market analysis, solar insolation for San Francisco, and best practices associated with existing FITs nationwide.

This guide is divided into six sections. The first section, titled *Project eligibility*, details the criteria for projects to participate in the CleanPowerSF FIT. We recommend that any new Renewable Portfolio Standard (RPS)-compliant generating facility, sited within CleanPowerSF territory, and sized up to 1 megawatt (MW) be eligible to participate in the program.

Section two, titled *Program size and timing*, offers recommendations on how to best initiate and then expand the FIT program. Capacity for the FIT program will be limited by available budget, which is tied to the expansion of CleanPowerSF's customer base and revenues. Our recommendations are based off SFPUC projections regarding CleanPowerSF phasing and expansion. In summary, we believe CleanPowerSF should open a 4 MW program in early 2017, with a plan to open new program capacity every 6 months until reaching 40 MW in 2020. To support a diversity of projects, we recommend CleanPowerSF reserve 25% of program capacity for smaller projects sized up to 150 kilowatts (kW).

Section three, titled *Pricing*, provides insights and recommendations for initial program pricing and overall pricing design. We suggest an initial price of 17¢ per kilowatt-hour (kWh) for larger projects and 18¢/kWh for smaller projects. These numbers are based upon recent solar pricing data, solar insolation for San Francisco, nearby FIT program pricing, and relevant site lease costs data. Most FIT projects will be installed on non-owner occupied property, and property owners will be increasingly motivated to make their rooftops available as the site lease payments increase. Yet, income from site leasing is a minor component of the overall property value, and as a result, very substantial increases in leasing rates are required to attract high participation rates from site owners. Interconnection costs, which can vary widely, are also taken into account in our pricing analysis. Expensive grid upgrades can be triggered as the added capacity of a proposed project crosses threshold constraints specific to each circuit or line section, and such upgrades are more likely to be triggered as participation levels in the FIT program increase.

We also recommend the use of market responsive pricing, which is a best practice in FIT program deign. Pricing is critical to successful procurement under the FIT. The optimal fixed price is defined as the price that will attract the desired amount of new local renewable energy capacity within the defined timeframe and at the lowest cost to customers. Prices set too high will ensure rapid development of local renewable energy capacity but will result in *less clean energy produced* for a given budget and cause unnecessary upward impact on electricity rates. Prices set too low will not attract the market to develop desired amount of local renewable energy capacity. Through a market responsive pricing design, the price paid under the FIT will adjust based on market response to ensure CleanPowerSF is paying the optimal price for local renewable energy.

Section four, titled *Program budget*, details the financial requirements to maintain the FIT program. The budget required will depend on the amount of capacity procured, as well as the price paid for power. We recommend expanding the program from 4 MW to 40 MW by 2020, and the timing of the proposed FIT expansion aligns with CleanPowerSF's planned phasing. Ultimately, the ability to finance expansion of the FIT will depend on CleanPowerSF revenues.

Section five, titled *Policies and procedures*, details how CleanPowerSF can manage their FIT program to be efficient and effective. Our recommendations, based upon lessons learn from FIT programs nationwide, offer insight to designing the application process, guiding projects into and through the program, and developing effective contracts for wholesale procurement.

Section six, titled *Anticipated challenges*, details potential hurdles CleanPowerSF may face when implementing a FIT program.

I. Project eligibility

This section contains recommendations for determining project eligibility for participation in CleanPowerSF's FIT program.

New resource

The generating resource should be new, meaning that is has not produced or delivered electric energy prior to the date in which CleanPowerSF receives its application.

Location

The project should be located entirely within the service territory of CleanPowerSF, which is the City of County of San Francisco (CCSF).

Technologies

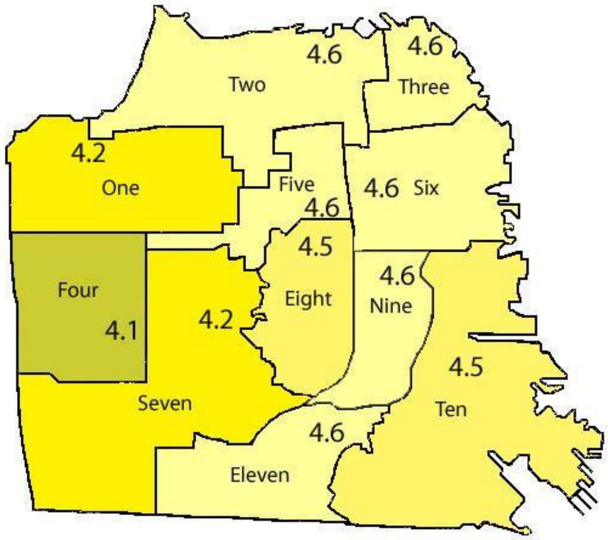
All technologies that are compliant with California's RPS requirements can be eligible to participate in the CleanPowerSF FIT. Eligible fuel sources may include, but are not limited to, the following:

- Solar photovoltaic (PV)
- Wind
- Digester gas
- Landfill gas
- Wind
- Geothermal

The development of local renewable energy projects will be determined by physical limitations and resource opportunities in the FIT region, as well as the pricing requirements of the program.

The Clean Coalition analyzed the potential for renewable electricity generation in San Francisco. We found the primary and most widely applicable local renewable electric generation potential for the area is solar PV. The area is well suited for rooftop installations on warehouses, commercial buildings, and residences, as well as parking lots and other potential dual-use spaces. Siting opportunities are widely available in San Francisco, although large commercial rooftop and parking lot options are concentrated east of Highway 101. Figure 1, below, details San Francisco's solar resource quality by district.

Figure 1. San Francisco solar resource average insolation by district



Location		Insolation	
District	Zip code	kWh/m^2/yr	kWh/m^2/day
1	94121	1,531	4.19
2	94123	1,664	4.56
3	94133	1,679	4.60
4	94116	1,492	4.09
5	94117	1,694	4.64
6	94102	1,669	4.57
7	94116	1,524	4.18
8	94114	1,631	4.47
9	94110	1,689	4.63
10	94124	1,657	4.54
11	94134	1,671	4.58
Average		**1,627**	**4.46**

There is a daily insolation of 4.1-4.2 kWh/m^2/day for the west side of the city and 4.5-4.6 kWh/m^2/day for the east side of San Francisco, with a 12% difference between the highest and lowest districts. Data comes from the SFPUC solar monitoring stations representing San Francisco's 11 supervisorial districts. The kWh numbers in the above map are at the approximate locations of the monitoring stations. Although the colors in the above map follow district lines, solar radiation does not follow these lines exactly. For example, insolation in the western portions of Districts 2 and 11 is most likely lower than the figure from the monitoring stations, which are located in the eastern part of these districts.[1]

Opportunities for other renewable resources, such as wind and biomass, are very limited in San Francisco. There is an existing renewable biogas-fueled cogeneration facility at a

[1] San Francisco Solar Resource Average Insolation by District, available at http://www.sfog.us/solar/sfsolar.htm, last visited March 20, 2016.

wastewater treatment facility in San Francisco, which can generate up to 3.2 MW of electricity.[2] Biogas generation is very site-specific though.

Based on our assessment of renewable energy resource potential in San Francisco, we expect solar PV to be the dominant, and perhaps only, generation technology to come online through the FIT. However, it is unnecessary to prohibit non-solar PV projects that are able to produce clean local energy at the program price. Therefore, we recommend a FIT program that is open to all RPS compliant technologies and allows the market to deliver local renewable electricity generation at the offered price. CleanPowerSF may wish to limit eligibility of local sources to zero emission or net emission reduction facilities however.

Project sizing

The maximum allowable project size should be 1 MW, which is in line with nearby Community Choice Aggregation (CCA) FIT programs. Capping projects at 1 MW will strike a balance between the benefits of economies of scale and a diversity of local renewable energy projects.

Siting opportunities for projects larger than 1 MW are extremely limited, and current California Independent System Operator (CAISO) metering and scheduling requirements limit the cost effectiveness of larger projects unless they are substantially larger.[3] These rare projects may be more appropriately procured through individual negotiations at rates below those offered through the FIT, in line with the size differentiated pricing.

While a smaller maximum project size would ensure a greater number of projects come online through the FIT, it would also require higher pricing to make projects economically viable. Required pricing based on project size is discussed in detail in section *V. Pricing*.

II. Program size and timing

This section contains recommendations for the initial size of the CleanPowerSF FIT program, as well as an expansion plan that aligns with the projected future growth of CleanPowerSF.

Initial program

2 *Biogas*, SF Environment, available at http://sfenvironment.org/article/biomass-amp-biofuels/biogas, last visited March 16, 2016.

3 Pacific Gas & Electric, Rule 21 Tariff, Advice Letter # 4565-E, Filed January 20, 2015, Decision No. 14-12-035, pg. 183, available at http://www.pge.com/tariffs/tm2/pdf/ELEC_RULES_21.pdf, last visited April 17, 2016.

The Clean Coalition recommends that CleanPowerSF initiate a FIT program starting in January 2017 with an initial capacity of 4 MW. Assuming a 20% capacity factor of FIT resources, which is line with local solar PV performance, 4 MW would provide just over 1% of CleanPowerSF's total retail sales. As the CCA expands its customer base and revenues, we recommend CleanPowerSF aim for FIT projects to provide roughly 2% of total retail sales.

This initial 4 MW allocation is a manageable size that strikes a balance between bringing meaningful capacity online, while enabling CleanPowerSF to 'pilot' its program—ensuring its internal FIT procedures are working smoothly before releasing additional capacity.

Program expansion

After the January 2017 allocation, we recommend that CleanPowerSF allocate new program capacity roughly every six months. Figure 2, below, offers a FIT program expansion that scales alongside CleanPowerSF's planned expansion and revenue growth. It is worth noting that through offering capacity in predictable, semi-annual allocations, CleanPowerSF will drive a sustainable and increasingly efficient renewable energy market in San Francisco, as well as learning from market response to reduce FIT pricing over time. This is discussed in detail in section *V. Pricing*.

Figure 2. CleanPowerSF FIT program expansion and timing

Allocation date	Capacity allocation (MW)	Total FIT program size (MW)	Estimated commercial online date (COD)[4]	Approximate annual energy deliveries through FIT (kWh)	Percent of total CleanPowerSF estimated retail sales[5]
January 2017	4 MW	4 MW	July 2018	6,132,000 kWh	1.2%
July 2017	4 MW	8 MW	January 2019	12,264,000 kWh	0.7%
January 2018	4 MW	12 MW	July 2019	18,396,000 kWh	1.1%
July 2018	4 MW	16 MW	January 2020	24,528,000 kWh	1.5%
January 2019	8 MW	24 MW	July 2020	36,792,000 kWh	2.3%
July 2019	8 MW	32 MW	January 2021	49,056,000 kWh	1.9%
January 2020	8 MW	40 MW	July 2021	61,320,000 kWh	2.3%

Timing of contracted capacity

Importantly, there will be a time lag between when CleanPowerSF offers FIT program capacity and when projects come online and begin delivering energy to CleanPowerSF. We would expect, and recommend requiring, a commercial online date (COD) 12-18 months after the PPA is signed with CleanPowerSF. For reference, the Los Angeles Department of

4 Assuming a total lag time of 18 months—6 months for the application process and PPA execution, then 12 months to bring the project online.

5 Using the commercial online date of FIT projects—not the capacity allocation date.

Water & Power (LADWP) is now requires 12 months to COD, with a possible six-month extension, in its FIT program. However, it can take a project 6 months or longer to complete the application review process and have a signed PPA after the application is submitted. And applications will not start to come in until after the capacity is released to the market. Therefore, we assume a total lag time of 18 months—6 months for the application process and PPA execution, and then 12 months to bring the project online.

Taking the COD date into consideration is essential to align FIT capacity with the planned phasing of CleanPowerSF. Given that CleanPowerSF expects its large growth in customers, revenue, and load beginning in 2019, CleanPowerSF will benefit from contracting for FIT projects beginning in 2017. Furthermore, this FIT expansion plan also aligns with CleanPowerSF's projected growth in 2021. By contracting for significant capacity in advance of 2021, CleanPowerSF will be positioned to purchase local capacity around the same time that FIT projects are ready to begin delivering energy. Lastly, the above expansion plan aligns with the planned step down of the federal investment tax credit (ITC). All projects will be brought online in time to make use of at least a 22% tax credit, which drops significantly to 10% starting in 2022. More details about the ITC are provided in section *V. Pricing*.

Capacity management

If any capacity remains unclaimed within 30 days of the next upcoming allocation, then that excess capacity should be rolled into the next allocation. For example, if a 4 MW allocation in January 2017 receives only 2 MW worth of applications, then the July 2017 allocation should total 6 MW—the originally planned 4 MW plus the 2 MW of unclaimed capacity. This will ensure that the program remains on track to deliver the desired capacity in line with the program timeline. Ultimately, budgetary constraints will cap the release of new FIT program capacity however. If a higher price must be paid to procure local renewable energy, then the amount of capacity procured will decrease. As SFPUC makes this financial determination, it is key to remember to that CleanPowerSF will begin paying for power not when FIT capacity is released, but when the projects actually come online—around 18 months later.

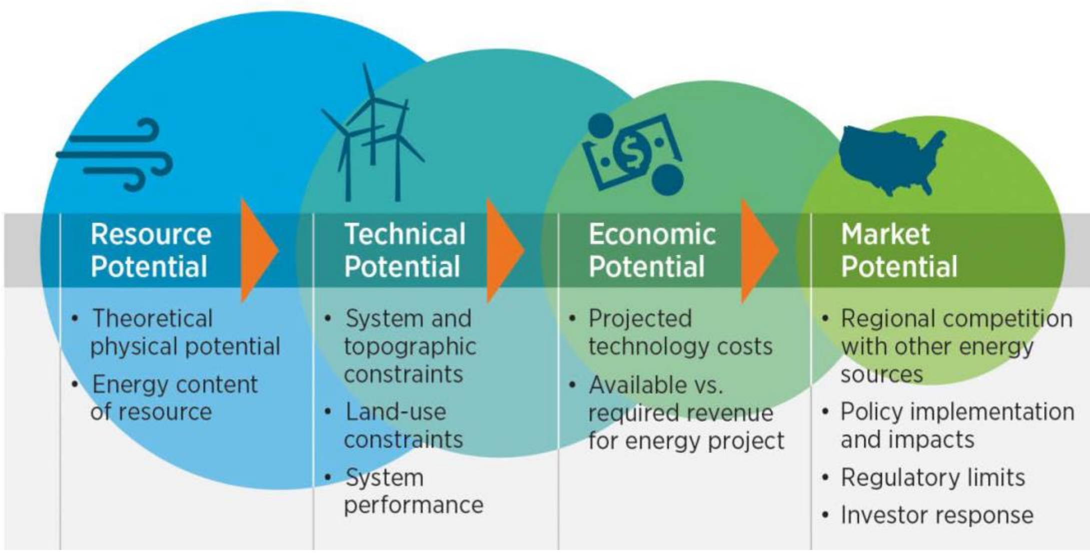
Lastly, through a transparent and continual offering of new program capacity, as shown above in Figure 2, CleanPowerSF can effectively utilize market responsive pricing in its FIT. A market response pricing approach will ensure that CleanPowerSF is offering to pay neither more nor less than is necessary to procure local renewable energy. More details on market responsive pricing are provided in the following section on pricing.

III. Pricing

Given that solar PV is expected to be the dominant, and perhaps only, technology utilized in the FIT, this pricing analysis evaluates the market pricing required to spur development of wholesale local solar PV installations in CleanPowerSF's territory.

Pricing is critical to successful procurement under the FIT. The optimal fixed price is defined as the price that will attract the desired amount of new local renewable energy capacity within the defined timeframe and at the lowest cost to customers. Prices set too high will ensure rapid development of local renewable energy capacity but will result in *less clean energy produced* for a given budget and cause unnecessary upward impact on electricity rates. Prices set too low will not attract the market to develop desired amount of local renewable energy capacity. It is worth noting that a FIT contract price high enough to trigger a strong market response can drive down renewable energy prices more rapidly over time. This is because as more system installers participate in the local market, increased experience, competition, and economies of scale will support lower FIT prices after the program's initial targets have been reached. However, price declines will be offset to the degree that prime solar siting opportunities are limited in the FIT area, as the best sites will likely be developed early on.

In developing pricing recommendations, the energy resource potential for San Francisco is first modeled against standard system performance to establish the technical potential of installations in the city. Full development and operational costs are then modeled for system owners—based on survey data and cost trends to determine the revenue required for the modeled project to be financially viable. Market potential is estimated based on observed market penetration distribution in regional markets in comparison to San Francisco cost factors and relative siting potential, as illustrated in the following diagram.



Initial 20-year fixed pricing

Based on our analysis, the Clean Coalition recommends that CleanPowerSF utilize a fixed, non-escalating FIT power purchase agreement (PPA) price initially set between 16-17¢/kWh for a term of at least 20 years. Time of Delivery (TOD) adjustments or scheduled price escalations throughout the contract term may be offered but do not change the total payments and complicate a provider's ability to determine whether the offered price is viable and attractive—potentially discouraging participation especially from smaller parties. Shorter contract terms are possible, but amortizing the project's capital costs over a shorter period requires higher annual project revenues and proportionately higher pricing.

As Figure 3 below illustrates, the Clean Coalition expects that a price of at least 16.1¢/kWh will be necessary to meet project costs and spur market development of solar PV projects around 1 MW within CleanPowerSF's service territory. Projects closer to 500 kW will require a price around 17.1¢/kWh. This analysis is based on insolation values for the eastern half of the city, which result in production of 1,533 kWh_{ac}/kW_{dc} per year per kW, where commercial project development is more likely to occur.

Figure 3. Required FIT pricing by project solar PV project size in San Francisco, CA

Size of roof-mounted solar PV system	Installed cost ($/$W_{dc}$)	20-year fixed PPA price (¢/kWh)
>1 MW	$2.03	16.1¢
500 kW	$2.24	17.1¢
100 kW	$2.50	18.2¢
50 kW	$2.68	19.0¢

Taking the 500 kW mid-sized commercial rooftop project as a standard for the CleanPowerSF FIT, Figure 4 (below) illustrates how costs are expected to change with respect to the year of installation and the role of site lease rates in determining a financially viable FIT price. Wholesale projects are typically installed on rooftops or other sites leased from site owners with negotiated lease rates trending toward $50/kW, although some site owners may elect to own the PV themselves—eliminating the site lease cost component.

Figure 4. 500 kW rooftop PV system costs & solar prices for a FIT in San Francisco[6]

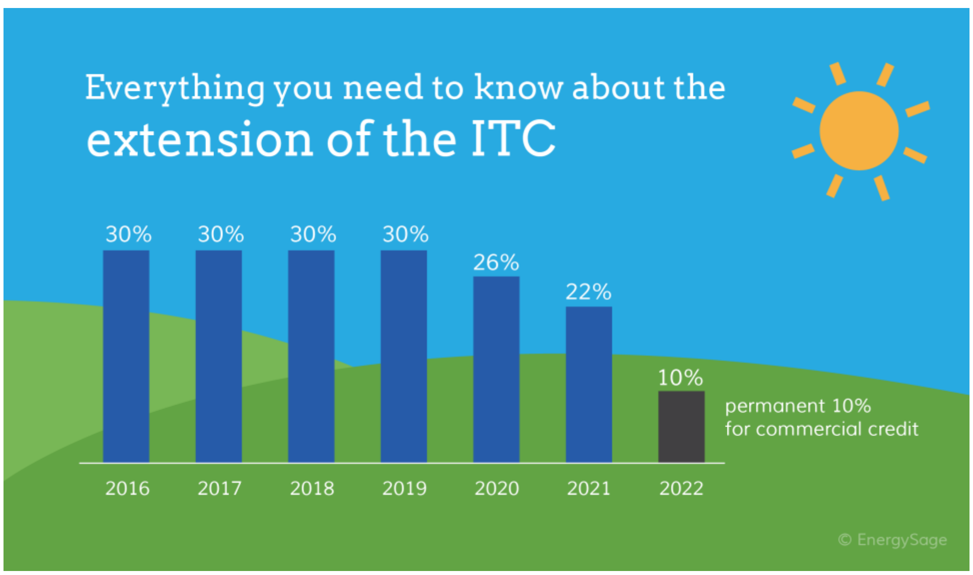
Solar PV system details			Necessary 20-year PPA pricing (¢/kWh)		
Commercial online date (year)	Applicable investment tax credit (ITC) rate	Installed PV system cost at 8% decline annually ($/$W_{dc}$)	With no site lease costs	With site lease cost at $30/kW	With site lease costs at $50/kW
2016	30%	$2.24	13.6¢	15.7¢	**17.1¢**
2017	30%	$2.06	12.8¢	14.8¢	**16.2¢**
2018	30%	$1.90	12.8¢	14.1¢	**15.5¢**
2019	30%	$1.75	11.4¢	13.5¢	**14.9¢**
2020	26%	$1.61	11.2¢	13.2¢	**14.6¢**

6 2014 base year installed cost of $2.65/$W_{dc}$ prior to credits ($2.90/$W_{ac}$) with applicable federal tax incentives and accelerated depreciation. With respect to site lease rates, we assume no cost if solar PV owned by property owner. For third party PV ownership, the average annual reported lease costs in urban regions of California are $30/kW for parking lots, and $50/kW for commercial rooftop. Individual costs will vary subject to normal distribution curves.

We based solar PV systems details in Figure 4 on historical[7] and projected installed cost trends[8] and component prices.[9] Total installed cost for 2014—the most recent year for which complete data is available—is \$2.65 per watt$_{dc}$ (equivalent to \$2.90/W$_{ac}$), which reflects average costs for PV rooftop systems in the 500-999 kW range in California. This base cost is adjusted to reflect pricing trends for subsequent years, calibrated to comparable metropolitan rooftop PV developments and site lease rates and adjusted for differences in solar irradiance and sales tax in San Francisco.

Projected installed cost and component price trends have exhibited annual reductions of approximately 12% in recent years, but there is strong indication of slower cost decreases through the remainder of the decade. Therefore, the lower value of 8% annual cost decline is reflected in the modeled cost and PPA pricing projection results.

As the PV market further matures, price declines will continue to flatten—resulting in lower decreases in installed costs. This will be further compounded by the fact that site lease prices are expected to continue climbing, and the ITC will also decrease in the coming years, as shown below.



Source: Energy Sage, April 2016

Therefore, we do not expect cost reductions in the installed cost of solar PV systems to outpace the planned step-down of the ITC. Given this, there is benefit for CleanPowerSF to bring as much capacity online, as possible given budgetary constraints, before the ITC benefit erodes significantly at yearend 2021.

7 Tracking the Sun Report VII: An Historical Summary of the Installed Price of Photovoltaics in the United States from 1998 to 2013 (September 2014).

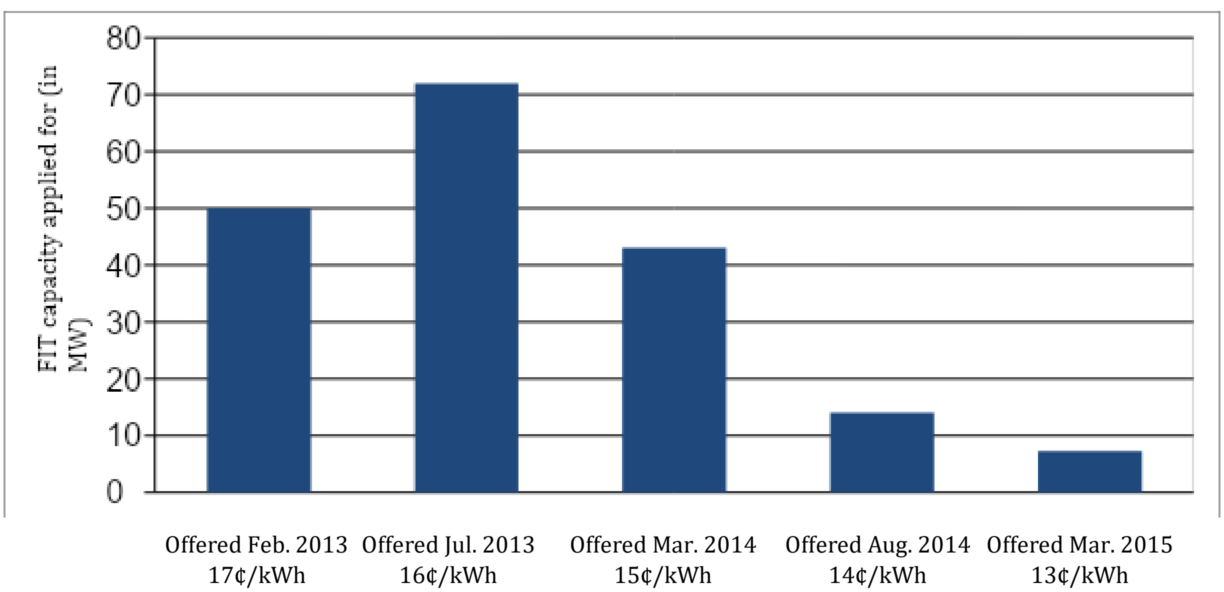
8 Deconstructing Solar Photovoltaic Pricing: The Role of Market Structure, Technology, and Policy. (December 2014).

9 U.S. Solar Market Insight, Q3 2014, GTM Research and the Solar Energy Industries Association www.greentechmedia.com/research/ussmi, last visited April 19, 2016.

FIT pricing of 16-17¢/kWh, outlined above in Figure 4, is consistent with nearby FIT program experience. City of Palo Alto Utilities recently attracted successful solar PV project development in the 500 kW size range with a FIT price of 16.5¢/kWh. It is worth noting that setting a longer contract term, such as 25 years, can reduce the fixed PPA price necessary to spur market activity. The City of Palo Alto Utilities amended its FIT program to offer two contract lengths: 20 and 25 years. In the case of Palo Alto however, the utility offered the same fixed-price for both the 20 and 25-year contracts. As expected, developers have only utilized the 25-year contract length. There is only value in offering two contract lengths if there is a slightly reduced per kWh price offered for the longer-term option.

LADWP utilized comparable pricing for the initial allocation of its FIT program capacity in 2013. LADWP decreased the offered PPA rate on a pre-established schedule in subsequent FIT allocations, as shown below in Figure 5

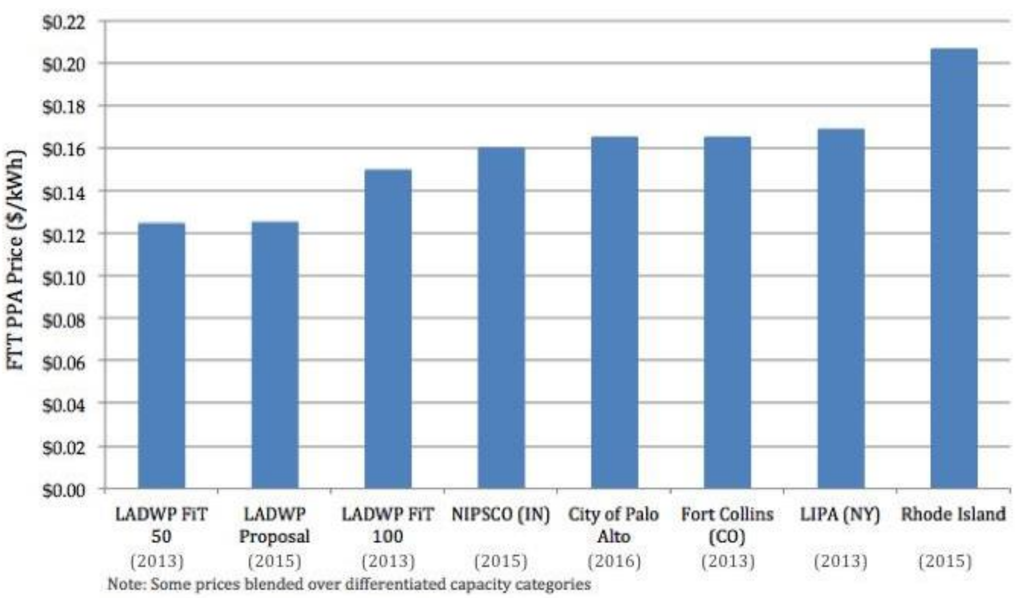
Figure 5. Solar market response to declining FIT pricing in Los Angeles



LAWDP received positive response from the solar market for its initial 20 MW offerings, but sharply lower participation as the FIT price declined. The kW size of the first seven projects completed through LADWP's FIT range from 84 kW to 1,200 kW—with a mean size of 513 kW.[10] A map of locations and sizes for applications in LADWP's third tranche are available online.[11] For this third tranche, there were 25 applications ranging from 37 kW to 3,000 kW, with 5 targeting capacity reserved for smaller projects (sized between 30 kW – 150 kW). It should be noted that San Francisco has lower solar insolation rates than Los Angeles though, which will require a higher initial price in the 16-17¢/kWh range after accounting for cost reductions in subsequent years.

A variety of FIT programs are in place outside of California too. Figure 6, below, offers a snapshot of pricing for several active FIT programs nationwide.

Figure 6. PPA pricing for active FIT programs across the U.S.



10 CLEAN L.A. Solar, *Solar Installations*, available at http://cleanlasolar.com/solar-installations, last visited April 14, 2016.

11 LADWP FIT Projects – 3rd tranche, Run on Sun, available at http://batchgeo.com/map/047927475180e2832ea0af69b4dd01fd, last visited April 28, 2016.

Market sensitivity

As higher FIT participation rates are sought, overall costs increase. However, the sensitivity of cost components is not consistent across all categories.

Module and inverter costs, typically comprising 25% of the total installed project cost, reflect global and national markets and are not generally affected by local conditions. Balance of system costs—such as installation, engineering, and even permitting— comprise roughly 20% of the total project costs and can increase for rooftops with special constraints. The range of variability within BOS costs is unlikely to exceed 50% (10% of the total project cost) though.

Within San Francisco, costs for interconnecting local renewables projects to Pacific Gas & Electric's (PG&E) grid can vary widely and expensive grid upgrades can be triggered as the added capacity of a proposed project crosses threshold constraints specific to each circuit or line section. Upgrades are more likely to be triggered as participation levels increase. Avoiding the most expensive 10% of interconnections, which represent non-viable proposals, both the mean and median interconnection cost has been approximately $150,000 per MW in the PG&E service area, with a standard deviation of $70,000. While significant, even a three-fold increase in interconnection costs will contribute less than 15% of the total 20-year costs to the system owner that must be recouped through energy sales, as reflected in the PPA price. It is worth noting that substantial commercial scale PV could be developed without exceeding 15% of peak load on any circuit, thereby indicating that interconnection costs should be minimized to between $50,000 and $100,000 per MW. Our preliminary analysis indicates that much higher penetration levels of local solar PV will not trigger significant costs on many circuits associated with commercial facilities, and these siting opportunities are available in San Francisco.

If structural upgrades or early roof replacement is necessary before a solar PV project can be installed, this can be a substantial additional cost. Such upgrades are more commonly required on older, light-industrial sites where site lease rates are typically lowest. As increasing levels of FIT participation are sought, these costs are more likely to be encountered, and the total cost of a lease combined with these upgrades will be competing with higher lease costs demanded by other building or site owners. Parking lot installations already exemplify this trade-off. Balance of system costs for PV panel supports and labor are higher for parking lots than for PV-ready rooftops, and the lower reported leasing costs for parking lots reflect both the added system owner costs and the site improvement value offered by the shade from a solar PV canopy.

The remaining major cost contributors are the developer margin, overhead, and costs associated with locating and securing rights to a project site, and the cost of leasing that site. These developer costs, which include any associated financing costs, contribute approximately 20% to the typical total project cost. While initial site acquisition requires increased effort as the supply becomes constrained, this is not a major cost contributor, and site availability is not expected to greatly influence significant developer costs and margins. While higher margins will certainly attract greater developer interest, these will remain subject to market competition, and the supply of developers is not likely to become constrained regardless of participation rates in the program.

In contrast, site lease value is highly correlated with participation, defining a classic supply-demand curve. Property owners will be increasingly motivated to make their rooftops available as the site lease payments increase. However, income from site leasing must be recognized as a minor component of the property value, representing 1-2% additional income.[12] As a result, very substantial increases in leasing rates are required to attract high participation rates from site owners. As noted above, sites burdened with necessary structural or interconnection upgrade become economically viable in light of increasing leasing costs associated with higher participation. These cost components are fully substitutable.

As shown in the following table, each $15/kW in annual lease costs contributes 1¢/kWh to the required PPA rate. Installed solar PV requires roughly 200 square feet per kW. For example, a 100,000 square foot rooftop will accommodate approximately 500 kW of solar PV capacity. Therefore, site leasing at $50 per kW will yield $25,000 in annual lease revenues, or $0.25 per square foot.

Figure 7. Projected lease rate relative to market participation & PPA price offered

Participation rate (% of local generation potential realized)[13]	Required PPA rate (¢/kWh)	Average site lease rate ($/kW)	Average site lease rate ($/square foot)[14]	Site lease impact on base PPA rate (¢/kWh)	Site lease cost factor (% of PPA rate)
1%	9¢	*	*	*	*
2%	11¢	*	*	*	*

12 A 100,000 square foot rooftop will accommodate approximately 500 kW of solar PV capacity. Leasing at $50 per kW will yield $25,000 in annual lease revenues, or $0.25 per square foot. This contrasts with a low of $10 per square foot in 2012 for industrial space, $20 for office space, $23 for retail, and higher current rates.

13* The margin of variability in this range exceeds predictive significance. Average observed rooftop lease rates of $30/kW in major California metropolitan areas constitute a 12% contribution to the total wholesale price of energy reflected in the PPA rate. These observed lease rates are seen today in a market in which less than 10% of the potentially available commercial rooftops are participating.[11]
These numbers are derived from a UCLA *Luskin Center* study of Los Angeles solar potential and associated methodology, which assessed the economy potential and price elasticity of a feed-in tariff market response rate. Using the same price elasticity profiles, we applied this to San Francisco solar irradiance and 2016 pricing data. The UCLA report is available at http://innovation.luskin.ucla.edu/content/bringing-solar-energy-los-angeles-assessment-feasibility-and-impacts-basin-solar-feed-tari-0, last visited on April 14, 2016.

14 Installed solar PV requires roughly 200 square feet per kW.

5%	13¢	$0	$0	0¢	0%
11%	15¢	$15	$0.075	1¢	7%
22%	**17¢**	**$45**	**$0.225**	**3¢**	**19%**
36%	19¢	$75	$0.375	5¢	28%
52%	21¢	$105	$0.525	7¢	35%
66%	23¢	$135	$0.675	9¢	41%
75%	25¢	$165	$0.825	11¢	46%
82%	27¢	$195	$0.975	13¢	50%
87%	30¢	*	*	*	>50%
100.0%	Max				

In San Francisco, reported and projected lease rates are substantially higher due to price expectations by site owners and the limited availability of potential commercial sites. Adjusting for this difference, site leasing costs of $50/kW will be expected to constitute 20% of the total PPA pricing required to approach a 25% realization rate of the available technical commercial rooftop potential that may be identified through a solar siting survey.

Additionally, net energy metering (NEM) project development will compete for allocation of the remaining commercial siting opportunities and should be included in the participation rate totals. The LADWP experience with both commercial NEM and the wholesale FIT 100 commercial rooftop programs provides some indication, as 17 MW of commercial NEM projects were added during the 27-month period in which the FIT 100 program has been active. While comparison against wholesale procurement is highly dependent upon the FIT price offered, if we extrapolate the rate of NEM uptake in PG&E territory, we can anticipate the additional NEM participation rate during the 2016-2020 period to be on the order of 2%. This will marginally reduce the number of available siting opportunities and will offer full retail price value for the energy produced; however, NEM is generally only deployed on owner occupied buildings and is limited to the onsite load. Therefore, while NEM will compete for participation, it is not expected to have a major impact on the PPA pricing required to reach participation rates necessary to significantly contribute to CleanPowerSF's desired FIT procurement.

Pricing structure

i. Market responsive pricing

The success of an energy procurement program often hinges upon determining the appropriate fixed price paid for energy. Determining the appropriate fixed price paid for energy is a major challenge in designing fixed-price, long-term contracts. Historically, the most widely used mechanisms to set a price for energy have been auctions or administrative price setting. Both of these mechanisms have been criticized on several fronts however.

The high cost for bid preparation and qualification for parties seeking to sell energy, combined with low certainty of success, discourages participation in auctions, while the development of a request for offers and management of the responses is a substantial burden for the purchasing agency. These factors create disproportionately high transaction costs when seeking to attract development of rooftop scale projects. Additionally, this approach does not send clear and consistent pricing signals to the market that assist developers in determining whether a potential project is financially viable and worth pursuing.

Administratively set fixed-prices are only optimal if the price matches actual market prices. If the price is set too low, there is insufficient participation in the program. If the price is set too high, then a "gold rush" may ensue and the buyer will overpay for energy. Administrative determination of appropriate pricing requires significant effort, and even the best effort cannot perfectly account for all market factors.

Market responsive pricing (MRP) is an effective and easy-to-implement mechanism that allows the price offered to automatically adjust as the market responds to the program. The essential feature of MRP is to adjust the initial FIT prices offered over time based on the market uptake. With high interest in a FIT, the offered price adjusts downward for future PPAs. With low interest in a FIT, the offered price adjusts upward for future PPAs. MRP has emerged as a best practice for accurate price discovery, through ongoing polling of the market, over the duration of an energy procurement program.[15] When purchasing electricity from local renewable generators under a FIT, CleanPowerSF should utilize the MRP approach to adjust the price for successive long-term PPA offers.

There are several advantages of MRP over competing pricing mechanisms and methods. By adjusting the contract price offered to developers as the market responds, CleanPowerSF can efficiently meet its procurement target without administrative recalculation to estimate the correct price. Pricing with MRP is also fully transparent, resulting in market efficiency and a drive towards the lowest viable prices, while also limiting risky speculation through being forced to place bids at prices that are unreasonably low, as happens with auction programs. Competition between sellers for the available contracts maintains the lowest viable pricing while reducing project failure risk when compared to an auction mechanism, as generators are not trying to win a bid, and are far less likely to contract at a price that is too low for the project to be built. Finally, MRP offers visibility and control over program costs. Procurement planning limits the amount of energy/capacity contracted at the offered price, so policymakers are able to control the rate of uptake, the maximum price paid for energy, and total expenditures for purchased energy.

To implement MRP, program designers must first determine tranches for assessing market response, the magnitude of price adjustments (up and down), and the length of the waiting periods to gauge market response before the price is adjusted. For example, a FIT using a

15 *Market Responsive Pricing: Policy Mechanism Brief*, Clean Coalition, May 2013, available at www.clean-coalition.org/site/wp-content/uploads/2013/07/Market-Responsive-Pricing-Brief-14_ssw-7-May-2013.pdf, last visited April 18, 2016.

MRP might allow the first 10 MW of capacity to contract at a starting fixed price. If the 10 MW tranche fills quickly with projects, then the price paid for the following 10 MW tranche is reduced by a predetermined adjustment. If, on the other hand, desired capacity is not procured within the planned time frame, then the fixed price adjusts upward by a predetermined increment after a set period of time.

The MRP mechanism continues to apply through the lifetime of the FIT, which means that only the initial fixed price was determined in another manner. The use of MRP limits the risk associated with a starting price that might not be optimal, and deliberations over the starting price can be minimized—further reducing administrative burden.

CleanPowerSF should be aware that a small program will have proportionately fewer participants, which means fewer data points and limited opportunity for market response. A smaller program also needs time to garner market interest and establish a record of successful contracting and development.

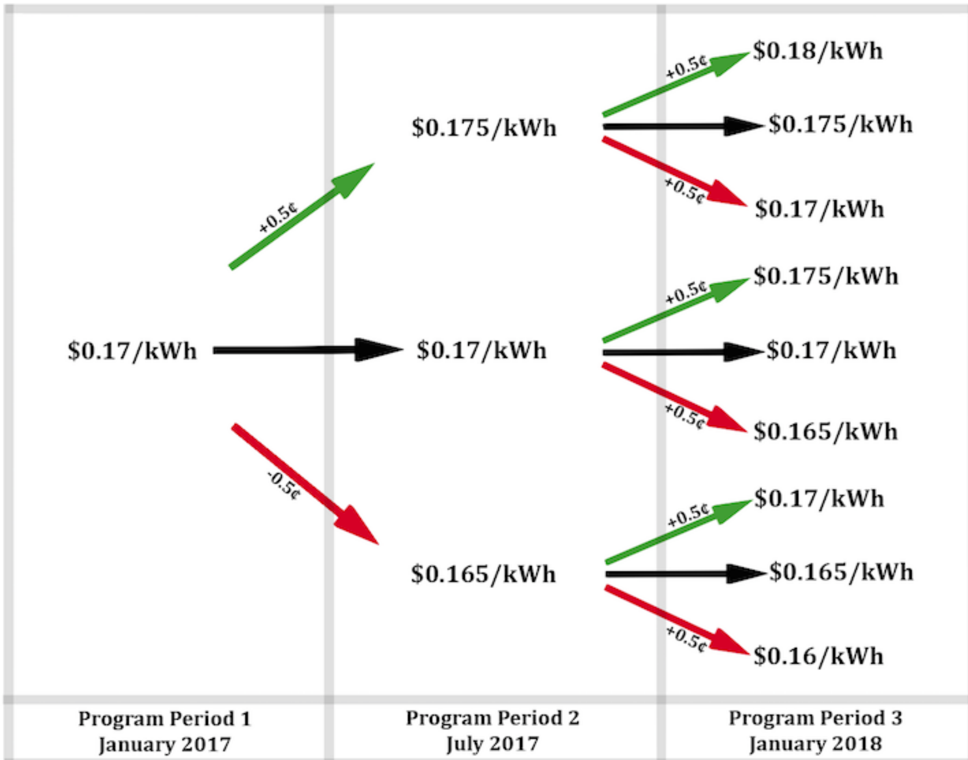
With that in mind, we recommend CleanPowerSF institute a MRP for its FIT, using the following guidelines:

- If valid applications exceeding 100% of desired capacity have been reserved as of 30 days prior to the next scheduled semi-annual procurement, then there is a downward price adjustment of 0.5¢.
- If valid applications exceed 50% of desired capacity, but less than 100%, no price adjustment is made.
- If valid applications constitute less than 50% of desired capacity, then there is an upward price adjustment of 0.5¢.

Pricing adjustments should be made every 6 months when new FIT program capacity is allocated. The adjustments of ±0.5¢ are large enough to ensure program pricing is market responsive, while not so large enough that wild swings in pricing will create an unstable and ineffective program. Furthermore, the ±0.5¢ pricing adjustments create program symmetry—simplifying program administration and participation.

Figure 8, below, illustrates how the MRP pricing structure will work for the few first allocations of the CleanPowerSF FIT, based on market response.

Figure 8. Market responsive pricing (MRP) design for CleanPowerSF's FIT



Note that semi-annual pricing adjustments allow adequate time for potential providers to respond. And our recommended pricing adjustments are proportionate to the level of market response, while providing increments sufficient to change market response in the next allocation.

CleanPowerSF will ultimately determine the level of local procurement based on the budget available to support a local procurement premium, and the associated procurement targets will limit the CCA's total contract cost commitments. As a result, it is not necessary to establish a maximum price cap for the MRP. However, higher PPA prices will reduce the amount of capacity that can be procured within the defined budget, and CleanPowerSF may wish to provide a signal to the market that it will limit maximum MRP and wait for costs to decline in order to meet minimum levels of procurement within a set budget allowance.

ii. Size dependent pricing

MRP will establish the minimum price at which the market will provide the desired quantity of local renewable capacity. Economies of scale favor larger installations, which are more likely to be financially viable at the set price. As a result, if CleanPowerSF wishes to include a substantial number of smaller installations, the CCA can reserve a portion of capacity for smaller projects. However, this reserved capacity may need a higher price to attract a comparable level of interest. Reserving capacity for smaller projects will allow more projects to be developed and will distribute these projects across a wider range of local sites. Therefore, if this is a desirable outcome, we recommend CleanPowerSF reserve 25% of FIT procurement capacity for smaller projects.

As illustrated in Figure 3, smaller installations are typically more costly to install per kW of rated capacity—requiring higher PPA rates. However, other factors also influence costs and the PPA contract rate required for a project to be financially viable, among the most significant of which are site lease costs. As a result, a single price may prove viable for projects representing a significant range of sizes, but smaller installations are less likely to be competitive. Additionally, because CleanPowerSF will limit the total procurement contracted in any proposed semi-annual period, a few large projects are likely to reserve most of the capacity, leaving limited opportunity for additional participants distributed across other segments of the community.

For a 4 MW capacity allocation, a 1 MW carve-out for smaller projects will support 6-12 projects in the 50-150 kW range, which is aligned with small to medium commercial sized installations. The remaining 3 MW of capacity in the larger commercial size will support 3-6 projects in the 200-1000 kW range.

iii. Prevailing wage

As a rule of thumb, a prevailing wage adder is likely to result in a roughly 10% increase in the total installed cost of a project.

For a 250 kW rooftop PV project at an installed cost of $2.50/W, labor costs comprise roughly $0.30/W. A prevailing wage will doubles this to $0.60/W for a total project cost of $2.80/W. Developers have also told us that the cost impact of prevailing wage depends on the specifics of any one project. The two biggest drivers will be labor content of a project, and the labor mix. Labor content is the portion of the total project cost that is labor. Higher labor content means higher impact of prevailing wage. High labor content projects are typically smaller, roof-mounted or carport. Large ground mount projects are lower labor content. Labor mix is the use of skilled labor versus unskilled labor. The labor mix of a project is important, as skilled labor is often already closer to prevailing wages rates than are unskilled labor. Therefore, projects with more unskilled labor will expedience a bigger impact from prevailing wages. Ground mount projects tend to have more low skilled labor, as assembly work does not require experience working at heights.

iv. Local workforce development and training

Pricing for a FIT program can be designed to support local workforce development and training. However, it is worth noting up front that pricing incentives for FIT projects that meet select criteria add complexity, and therefore cost, to FIT program administration.

Nonetheless, Sonoma Clean Power adopted a bonus pricing approach in its ProFIT program. Under the ProFIT tariff, there is an extra 1¢/kWh bonus for 5 years for FIT projects that meet the "Local Business" criteria.

Local Business is defined as follows:

1. The developer and/or prime contractor has a place of business (i.e. possesses a business license) and headquartered in Sonoma County, and

2. At least 75% of the non-management project-specific labor resides in Sonoma County.

Sonoma Clean Power's ProFIT also offers an extra 1¢/kWh bonus for 5 years to projects that meet its "Training" requirements. To fulfill the "Training" requirement:

1. At least 20% of project-specific job hours are staffed by an apprentice who resides in Sonoma County and is participating in a State of California Division of Apprenticeship Standards approved program, and
2. A contractor licensed by the Contractors State License Board as a Class C- 10 electrical contractor for the placement, installation, erection and/or connection of all electrical work, as described in Title 16, California Code of Regulations, Section 832.10, will be part of any work involving an electrical system of 100 volt-amperes or more.

Qualifying developers and/or prime contractors must EITHER (a) have a place of business (i.e., possess a business license) and be headquartered in Sonoma County, OR (b) show that at least 75% of the non-management project-specific labor resides in Sonoma County. Documentation supporting this requirement will be required prior to payment for bonus amount will be issued. An apprenticeship program must be active and documented for the duration of the incentive payout. Sonoma Clean Power requires an affidavit in their program application for projects seeking to qualify for the "Local Business" and "Training" bonuses.[16]

IV. Program budget

The budget required for the CleanPowerSF FIT program will depend on two factors: program size and program pricing.

Initial budget requirements

Below is the annual FIT budget requirement for our recommended initial program of 4 MW. The program budget is determined by multiplying the FIT premium per kWh (the amount over the wholesale rate) by the number of expected number of kWh procured annually through the FIT. This budget assumes a wholesale cost of 6¢/kWh and annual production of 1,533 kWh_{ac} per kilowatt of FIT capacity.

Figure 9. Budget required for initial 4 MW FIT program

16 *ProFIT Application*, Sonoma Clean Power, available at http://2tgc4v3kjp5mrjtdo183d8716ao.wpengine.netdna-cdn.com/wp-content/uploads/2015/06/SCP-ProFIT-Application_2.2.pdf, last visited April 14, 2016.

Program size (MW)	Expected annual FIT generation (kWh/year)	PPA price (¢/kWh)	FIT premium (¢/kWh)	Incremental budget required[17]
4 MW	6,132,000 kWh	17¢	11¢	$674,520

If CleanPowerSF wants to create a 25% carve-out for smaller projects, as we recommend, this will have an impact on the overall program budget. Figure 10, below, shows the budget required if there is a 1 MW carve out for smaller projects (up to 150 kW) with pricing of 18¢/kWh for these smaller projects.

Figure 10. Budget required for 4 MW FIT program with carve-out for smaller projects

Project size bucket	Capacity	Expected annual FIT generation (kWh/year)	PPA price (¢/kWh)	FIT premium (¢/kWh)	Incremental budget required
≤150 kW	1 MW	1,533,000 kWh	18¢	12¢	$183,960
151 kW to 1 MW	3 MW	4,599,000 kWh	17¢	11¢	$505,890
Total	**4 MW**	**6,132,000 kWh**			**$689,850**

The additional annual budget required for the 1 MW carve-out for smaller projects, in this instance, is roughly $15,000.

Budget sensitivity

As stated, the FIT budget will vary depending on program size and pricing. Figure 11, below, illustrates the required budget for a suite of program sizes and pricing.

Figure 11. Budget required for initial FIT capacity at various sizes and pricing levels

Program size (MW)	Expected annual FIT generation (kWh/year)	PPA price (¢/kWh)	FIT premium (¢/kWh)	Incremental budget required
2 MW	3,066,000 kWh	16¢	10¢	$306,600
2 MW	3,066,000 kWh	17¢	11¢	$337,260
2 MW	3,066,000 kWh	18¢	12¢	$367,920

Program size (MW)	Expected annual FIT generation (kWh/year)	PPA price (¢/kWh)	FIT Premium (¢/kWh)	Incremental budget required
4 MW	6,132,000 kWh	16¢	10¢	$613,200
4 MW	6,132,000 kWh	17¢	11¢	$674,520

17 This represents the additional, annual budget needed, on top of wholesale procurement at 6¢/kWh, to run the FIT program.

4 MW	6,132,000 kWh	18¢	12¢	$735,840

Program size (MW)	Expected annual FIT generation (kWh/year)	PPA price (¢/kWh)	FIT Premium (¢/kWh)	Incremental budget required
6 MW	9,198,000 kWh	16¢	10¢	$919,800
6 MW	9,198,000 kWh	17¢	11¢	$1,011,780
6 MW	9,198,000 kWh	18¢	12¢	$1,103,760

Program budget over time

As the FIT expands over time, the annual budget required to pay for additional capacity will grow. The exact budget will depend on how much new program capacity is established, as well as the pricing offered for the new capacity, and any potential capacity carve-outs for small projects. Figure 12, below, shows an expansion of program capacity, which aligns with projected CleanPowerSF phasing and make strong use of existing federal tax incentives. Note that the annual program budget requirements lag behind capacity allocation. This is because, as previously discussed, there is a roughly 18 month lag time between a capacity allocation and that capacity coming delivering power to CleanPowerSF.

Figure 12. Estimated budget requirements as FIT program capacity expands

Date	Capacity allocation (MW)	Estimated commercial online date (COD)[18]	Annual incremental budget required for allocation[19]	Total annual incremental program budget
January 2017	4 MW	July 2018	$0	$0
July 2017	4 MW	January 2019	$0	$0
January 2018	4 MW	July 2019	$0	$0
July 2018	4 MW	January 2020	$674,520	$674,520
January 2019	8 MW	July 2020	$674,520	$1,349,040
July 2019	8 MW	January 2021	$674,520	$2,023,560
January 2020	8 MW	July 2021	$674,520	$2,698,080
July 2020	0 MW	n/a	$1,349,040	$4,047,120
January 2021	0 MW	n/a	$1,349,040	$5,396,160
July 2021	0 MW	n/a	$1,349,040	$6,745,200
Total	**40 MW**			**$6,745,200**

18 Assumes a lag time of 18 months—6 months for the application process and PPA execution, then 12 months to bring the project online.

19 This budget assumes a FIT rate of 17¢ and annual production of 1,533 kWh_{ac} per kilowatt of FIT capacity.

Of course, the expansion of the CleanPowerSF's FIT will depend on the rate at which the CCA grows its customer base and has budget available to support local renewable generation.

V. Policies and procedures

This section offers high-level recommendations on FIT program policies and procedures. Lessons learned and pro formas from existing FIT programs are referenced.

Program application

The application process should require enough information to enable CleanPowerSF staff to thoroughly evaluate the viability of a proposed project without being unnecessarily onerous on program participants. Key details include:

- Evidence of emerging site control, which can come in the form of a SFPUC-standardized letter of intent signed by the project developer and property owner
- Proof of the ability to develop, finance, and construct within 24 months[20]
- Technical and engineering aspects
- A history of successful project management and development

The Clean Coalition recommends that CleanPowerSF require a non-refundable application fee and a refundable per kW performance deposit. This will ensure a more efficient program by deterring non-viable bids from clogging the lottery and project queue. Sonoma Clean Power, under its ProFIT program, requires a non-refundable application fee of $500 and a performance deposit, which is fully refundable upon project completion.[21] The Clean Coalition believes that a $500 application fee and performance deposit around $40/kW$_{AC}$ would be effective for the CleanPowerSF FIT application process.

Below are a number of FIT application pro formas:
- Marin Clean Energy
- Sonoma Clean Power
- City of Palo Alto Utilities

Project queuing

CleanPowerSF needs to clearly define, in advance, how applications will be handled. The Clean Coalition believes it is best practice to kick-off the FIT program with a two-week

[20] Marin Clean Energy requires: financial statements for project participants (developer and financier, in particular); a PG&E Generating Facility Interconnection Application and PG&E notice of complete application; copy of application for RPS certification (from the California Energy Commission) and assigned pre-certification number, if available; and, evidence of environmental compliance review/notice of determination receipt.

[21] *Feed-in Tariff*, Sonoma Clean Power, available at http://2tgc4v3kjp5mrjtdo183d8716ao.wpengine.netdna-cdn.com/wp-content/uploads/2014/09/SCP-ProFIT-Tariff-revised-2014-09.pdf, last visited March 16, 2016.

open application period. At the end of the open application period, a lottery system will be used to determine the order in which projects will be listed in the queue. All applications submitted after the open application period should be accepted on a first come-first served basis.

Once CleanPowerSF accepts an application, the project developer should have a set amount of time, ideally between 15-30 days, to officially move the proposed project into the FIT program queue. Once a project moves into the queue, the stated capacity of the project should be officially reserved in the program. The performance deposit, which should be around $40/kWAC, becomes non-refundable if a project in the queue does not meet agreed upon milestones, including its COD.

Contracts

There should be a standard PPA between CleanPowerSF and a renewable energy facility owner to purchase energy at a predefined, fixed rate for a long duration. The standardized PPA should fulfill the needs of all relevant parties in the simplest fashion possible. The key parties are the utility, the developers, and the project investors (including lenders).

An optimal PPA is simple enough to minimize the review effort by developers and investors, yet substantial enough to avoid potential disputes and provide clear procedures for resolving disputes if there were to occur. The level of complexity of the form will depend on the complexity of the program. For example, the Gainesville Regional Utilities PPA only contains 18 pages, while the Sacramento Municipal Utility District PPA consists of 49 pages.

The standard agreements should be circulated for review by likely project developers and potential investors to ensure that the PPA is straightforward, financeable, and fair to CleanPowerSF, project developers, and project investors.

Key provisions of a FIT PPA are detailed below:

Contract Provision	Overview
Length	This specifies the length of a contract terms between CleanPowerSF and the project owner. Well-designed FIT programs offer terms of at least 20 years, and sometimes longer. Generally, the longer the contract length, the lower the fixed price offered. Contract length is an essential feature of a FIT that makes it possible for developers to secure financing at reasonable rates and gives CCA customers protection against rising conventional energy prices.
Performance excuses	This specifies under what circumstances a FIT project is penalized, or not penalized, for not being able to deliver electricity as expected, as well as the timeline for a project owner to resolve performance issues. Since FIT project owners are only compensated for delivered energy, they are inherently motivated to promptly resolve performance issues. It is also common to define when the purchaser is not responsible for buying electricity from a FIT facility. Without capping exceptions, it is possible that project financing becomes far more difficult.
Environmental attributes	This section details ownership of the environmental or renewable energy attributes of the purchased electricity. This includes: (i) proof that the renewable energy is certified as an eligible resource that meets state and/or local requirements; (ii)

	conveyance of all renewable energy attributes, such as RECs; and (iii) any reporting obligations necessary to meet state and/or local requirements.
Project milestones timeline	This provides deadlines for submitting proof of permit applications, engineering drawings, equipment orders, and commercial operation date. Firm, reasonable deadlines ensure that projects proceed as committed. Projects that are not proceeding in a timely fashion may be removed from the queue. It is common for timelines to reasonably accommodate all good faith applicants and allow for events that are not under the control of the project developer, such as natural disasters.
Assignment	This specifies if a contract can be assigned to any new owner that meets program eligibility criteria. In effect, allowing assignment enables program participation by potential facility owners that may sell the facility and/or the real property where the facility is located during the term of the contract.
Form of lender consent	A standard form for lender consent adds consistency and streamlines a FIT program, as it avoids negotiating individual lender consent agreements for each project. A standard lender consent form if often included as part of the standard contract.

More information on FIT contract provisions is available on the Clean Coalition website.[22] Below are FIT program PPA examples:

- Sacramento Municipal Utility District
- City of Palo Alto Utilities
- Los Angeles Department of Water & Power
- Sonoma Clean Power
- Marin Clean Energy

The Clean Coalition worked closely with the City of Palo Alto and the municipal utility to open City-owned properties up to solar installations. Through this effort, a lease agreement for siting solar on municipal properties was developed and is available to CleanPowerSF for reference.

VI. Anticipated challenges

Based on the experience of other FIT programs nationwide, below are anticipated challenges CleanPowerSF may face.

Interconnection

Interconnection of FIT projects can be a lengthy and expensive process. The timeline, costs, and uncertainly involved in interconnection can be reduced through active support from the local utility, which in this case is PG&E. The Clean Coalition recommends proactive engagement with PG&E staff to streamline interconnection to the extent possible. One key step for CleanPowerSF is to identify feeders and line segments within San Francisco's grid where new local capacity will be quickest and easiest to interconnect. Much of this information is now available due to the Distribution Resources Planning effort

[22] *Local CLEAN Program Guide: Module 6*, Clean Coalition, available at http://www.clean-coalition.org/site/wp-content/uploads/2012/10/Local-CLEAN-Program-Guide-Module-6-Designing-CLEAN-Policies-Procedures-SSW_21-12-June-2012.pdf, last visited April 19, 2016.

spearheaded by the Clean Coalition. For publicly available details regarding PG&E's distribution network, please visit the California Public Utilities Commission's Distribution Resources Planning website.[23]

Property owner participation

There is large potential for the installation of solar PV systems on commercial and industrial properties. However, building owners often have concerns regarding solar installations on their facilities, and these concerns fall into five major areas.

1) Economic considerations: Building owners are concerned about the cost of the system, as well as ongoing operations and maintenance (O&M) costs.

2) Outside core business area: Building owners see solar as a distraction to their core business area.

3) Facility concerns: Building owners see solar installations as a facility liability.

4) Vendor and technology risk: Building owners have expressed concern regarding the reliability of solar developers—with respect to workmanship, project management, and length of time in business.

5) Permitting and approvals: Building owners do not want to navigate the permitting and approval process for a solar installation. Additionally, some building owners need approval from the landowner to make significant modifications.

Appendix – pricing analysis assumptions

Below are our assumptions for the System Advisory Model (SAM) pricing analysis.

System size (example only)	Installed cost $/W(dc)	Initial output kWh(ac)/kW(dc)-yr	20 year fixed PPA price	LCOE @ 2% inflation
1 MW roof	$2.03/W	1,553	16.1¢/kWh	13.6¢/kWh
500 kW roof	$2.24/W	1,553	17.1¢/kWh	14.4¢/kWh
100 kW roof	$2.50 /W	1,553	18.2¢/kWh	15.4¢/kWh
50 kW roof	$2.68/W	1,553	19.0¢/kWh	16.0¢/kWh

Modeling assumptions

- NREL System Advisor Modeling (SAM) performed with PVWatts system design standards

23 Distributions Resources Plan, California Public Utilities Commission, available at http://www.cpuc.ca.gov/general.aspx?id=5071, last visited April 28, 2016.

- Installed cost is turnkey cost per nameplate capacity for completed interconnected system delivering power to the grid, including all permits, fees, taxes, administrative costs, overhead and margin for projects with assumed 50% debt ratio. Installed costs vary with market maturity (date, size, market development).
- Analysis includes no escalator and no residual value after 20-year term of PPA
- Renewable Energy Credits (RECs) are bundled with energy sales
- Internal Rate of Return (IRR): 8%
- DSCR 1.3 (50% debt)
- Interest rate on debt: 6%
- Nominal discount rate: 8% (6% Real + 2% inflation)
- Federal depreciation: MACRS 5-year (without bonus option)
- Federal tax rate: 28%
- Federal Investment Tax Credit (ITC): 30% through yearend 2019, then declining per the ITC schedule
- O&M: $18-20/kW/yr for fixed tilt rooftop
- Inverter replacement reserve: $10/kW/yr
- Interconnection costs: 15¢/W_{dc} including gen-tie and system upgrades (i.e., $150,000 for a 1 MW system), and declining 15% per year
- Insurance costs: 0.5%

Location specific assumptions

- System output based on NREL's TMY, direct normal solar irradiance: 1,553 kWh/m2, (rooftop installation @ 20º fixed tilt)
- Flat Rate: no Time of Delivery (TOD) price adjustment
- Site rental: $50,000/MW/yr ($30,000 for parking lot)
- State corporate income tax rate: 8.84%
- State tax benefits: MACRS schedule (§171.107)
- Sales tax: 8.75%
- Property tax: 0%
- Debt & tax equity financing rates can affect results if they differ from the IRR

Potential adjustments influencing PPA price

For a baseline pricing of 16¢/kWh:

- PPA term 25 years: - 0.8¢/kWh
- Add PPA escalator @ 1%: - 1.3¢/kWh (starting price reduction)
- IRR target +/- 1%: 0.2¢/kWh (subject to debt assumptions)
- Installed cost +/- 25¢/W: 1.1¢/kWh
- Site rental costs +/- $15,000: 1.0¢/kWh
- O&M cost +/- $5/kW-yr: 0.4¢/kWh
- Inflation rate +/- 1%: 0.7¢/kWh
- Interest rate +/- 1%: 0.7¢/kWh
- BOS cost +/- 20%: 0.5¢/kWh
- Grid interconnection +/- 5¢/W: 0.2¢/kWh
- Installer margin and overhead

+/- 20%: 0.7¢/kWh