

CleanPowerSF

At Long Last

June 2015



City and County of San Francisco
Civil Grand Jury, 2014-2015

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Philip Reed, Foreperson Pro Tem

Anne M. Turner, Recording Secretary

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Leonard Brawn

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Matthew Cohen

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For each finding the response must:

- 1) agree with the finding, or
- 2) disagree with it, wholly or partially, and explain why.

As to each recommendation the responding party must report that:

- 1) the recommendation has been implemented, with a summary explanation; or
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- 3) the recommendation requires further analysis. The officer or agency head must define what additional study is needed. The Grand Jury expects a progress report within six months; or
- 4) the recommendation will not be implemented because it is not warranted or reasonable, with an explanation.

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Summary

San Francisco has spent more than a decade trying to implement a Community Choice Aggregation (CCA) program known locally as “CleanPowerSF” that would sell renewable or “green” power to residents and businesses. Implementation, however, has moved forward at a glacial pace.

The Civil Grand Jury has studied the challenges that led to the delay and finds that they are primarily political. Stakeholders disagreed over how to define “green” power and where to acquire it, whether it could be provided at rates that all could afford, and the extent to which the program would provide jobs in the local community.

While we are glad to report that rollout of CleanPowerSF is scheduled to occur within the next twelve months, some of those disagreements still exist and could cause further delay. In this report we identify these challenges and suggest ways to overcome them.

We first compare CleanPowerSF with CCAs in two neighboring counties, and find that CleanPowerSF will be a much smaller program than those others at rollout, which will reduce its risk and provide much potential for growth. By the same token CleanPowerSF will need to grow quickly to keep pace with the City’s ambitious goals for reduction of greenhouse gas emissions, which have been established by law.

As a cost-cutting measure both neighboring CCAs use an accounting mechanism known as “unbundled” Renewable Energy Credits (RECs) to provide some of their green power. Critics oppose this on the ground that such power is not really “green.” We look at this controversy, and conclude that there is no compelling reason why CleanPowerSF should not use unbundled RECs, if necessary, to support the growth of its enterprise.

With regard to job creation, we find that this was not a core element of the program as originally constituted, and while it is a laudable goal, CleanPowerSF will have a relatively small impact on local employment for reasons both legal and practical. By law, a CCA takes no part in distributing the power that it sells, which is the most labor-intensive part of the business. That task is retained by the preexisting electric utility – in this case, Pacific Gas and Electric Company. And as a practical matter, based on the City’s geography, most of its energy needs must be satisfied from out-of-town sources. While green sources are plentiful and their numbers are growing, most are located far outside the City limits, and so, therefore, will be most of the jobs that they create.

That is not to say that CleanPowerSF cannot create local jobs. It can, particularly those associated with installing and maintaining rooftop solar generation systems. For that reason, we consider another City program known as GoSolarSF, which provides financial assistance to property owners who install such systems, and find

that CleanPowerSF and GoSolarSF are complementary in nature and can help each other.

Finally, we make several recommendations – most notably, that CleanPowerSF be designed, first and foremost, to be financially viable and to grow quickly without undue risk; that its other policy goals be subordinated to those needs; and that local officials, including the Mayor, put the full weight of their offices behind the success of the program.

Background

Community Choice Aggregation (CCA) is an idea adopted by a number of states that allows local governments to aggregate (i.e. gather) the buying power of local customers to secure alternative energy supply contracts and/or a better price for power. In power-industry parlance, “aggregation” means combining the “loads” (i.e. demand for electric power) of multiple customers.

California first adopted the CCA system in 2002, under a law popularly known as AB 117.¹ In 2004 the Board of Supervisors passed an ordinance establishing such a program in San Francisco.² For the next three years various city agencies and outside advocacy groups debated the program design. In June 2007 the Board of Supervisors adopted a draft implementation plan and assigned SFPUC to manage the program.³ More than two years later, in November 2009 SFPUC issued its first Request for Proposals (RFP) seeking an outside contractor to provide power and other services for the system.⁴ A potential contractor was selected and negotiations ensued, but were unsuccessful.

In August 2010 SFPUC issued a second RFP, again seeking an electricity supplier for the program. No bidders met the minimum qualifications and further delays ensued. After two more years a draft contract was negotiated with Shell Energy North America (SENA), and in September 2012, the Board of Supervisors authorized the General Manager of SFPUC to sign it provided certain conditions were met.⁵ In August 2013 SFPUC declined to approve a rate structure for the program, which effectively nullified the contract and sent the CCA process “back to the drawing board.”⁶ Mayor Edwin M. Lee concurred in this decision.

Another two years of work ensued both at SFPUC and the Local Agency Formation Commission (LAFCO). Consultants were hired and reports issued, and in early 2015 – nearly 11 years after a CCA was first authorized – yet another type of program was suggested. At a joint meeting of SFPUC and LAFCO on January 30, 2015, SFPUC instructed its staff to design a new program along the lines suggested by the consultant. Mayor Lee supported this action, provided the new design met certain criteria that he set out. On February 24, 2015, SFPUC approved a timeline to complete the design and implement the new program, which is projected to begin serving customers in 2016.

Methodology

Members of the Jury conducted legal research using materials from the Government Information Center of the San Francisco Public Library and the online compilation of local ordinances provided by the Board of Supervisors. We also relied on reports and other materials provided online by various sources including the San Francisco Public Utilities Commission (SFPUC), the San Francisco Department of the Environment (DOE), San Francisco's Local Agency Formation Commission (LAFCO), Marin Clean Energy (MCE), Sonoma Clean Power (SCP), International Brotherhood of Electrical Workers (IBEW) Local 1245, and Pacific Gas and Electric Company (PG&E). We interviewed members and staff of these same entities, others with expertise in the power industry, and past and current City officers and employees. We also attended SFPUC and LAFCO public meetings. Additionally, we reviewed the documents and statistics provided to us by those entities and interviewees.

Discussion

The Civil Grand Jury decided to investigate San Francisco's CleanPowerSF for two reasons:

- because we wondered why the program has taken an extremely long time to develop, and
- because even though by February 2015 CleanPowerSF seemed to be on its way to rollout, we questioned whether some of the issues that had caused delay might reassert themselves and further delay implementation.

We discovered that political pressures were interfering with SFPUC's ability to stick to its first priority—development of a financially viable program serving as many San Franciscans as possible with affordable clean power. Members of the Board of Supervisors and the Mayor publicly expressed disapproval of contracting with SENA, a large fossil fuel company, to provide green energy. Mayor Lee also criticized the program for lacking specific job creation plans, and questioned whether it would be an economic burden on lower-income San Franciscans. The International Brotherhood of Electrical Workers (IBEW) Local 1245, which represents many PG&E workers, shared the worry about job creation. Environmentalists such as the Sierra Club, the San Francisco Green Party, 350.org and others were outspoken in their support for CleanPowerSF, but many saw the program as simply a stepping-stone to an eventual takeover of PG&E's electric utility in San Francisco by a municipally owned utility. There was also controversy about the definition of "green" energy, where it would be obtained, and how much of it CleanPowerSF could afford to provide to its customers and still offer competitive rates.

The purpose of our report is to examine these controversies and suggest a resolution for each one.

Will CleanPowerSF Be Financially Viable?

CCAs represent a legislative innovation. They balance the desire of cities for local independence from investor-owned utilities (IOUs), hoping to find cheaper power for their residents, with the IOUs' desire to continue to make money. The local CCA agency is only allowed to *purchase* power. *Distribution* of that power must remain in the hands of the local IOU if there is one. So it is that San Francisco's CCA program will buy power on the open market, and the local IOU, PG&E, will continue to distribute it. CleanPowerSF is basically an energy procurement program, not a distribution one.

One key feature of CCAs, as implemented in California, is that when a CCA is launched all electric customers within its service area automatically become customers of the CCA unless they "opt out" of the program. If a customer opts out, that customer has the right to continue to be served by the existing IOU.⁷ This feature virtually guarantees the CCA a substantial customer base at launch, which contributes greatly to the program's financial stability. However it also provides an incentive for the CCA to keep its rates competitive with those of the existing IOU, to avoid "opt outs."

San Francisco has established ambitious goals for reducing its greenhouse gas emissionsⁱ that cannot be met unless local residents and businesses shift from using power generated by conventional sources to so-called "clean" power.⁸ Accordingly, the purpose of CleanPowerSF is not only to sell power cheaply, but also to sell power that is "cleaner" or "greener" than the power provided by PG&E.⁹

"Clean power," "green power," or "renewable power" (the terms are interchangeable in this report) means electricity that is generated in a way that does not pollute the atmosphere or increase the emission of greenhouse gases. Clean power is renewable: the sources, such as the sun, wind, or water, are constantly replenished and for all practical purposes, will never run out. Energy generated by fossil fuels pollutes, contributes to climate change, and is non-renewable: oil pumped up from underground or coal dug from a mine, are finite. Their sources will eventually expire. See the Appendix to this report, and the documents cited therein, for a fuller description of renewable energy sources.

San Francisco will be buying clean power on the open market for its CCA program. The sellers can be producers, such as a water district that has more power than it

ⁱ Pursuant to the San Francisco Environment Code, Chapter 9 ("Greenhouse Gas Goals and Departmental Climate Action Plans") the City is committed to reducing greenhouse gas emissions: 20% below 1990 levels by the end of 2012, 25% below 1990 levels by the end of 2017, 40% below 1990 levels by the end of 2025, and 80% below 1990 levels by the end of 2050.

needs, and therefore elects to sell the excess. There are also nonprofit and profit-oriented vendors, who have jumped into the renewable energy market to meet growing demand and are hoping to make money doing so.

At present, clean power from these sources costs more than conventional power. While a CCA enjoys various tax and other financial advantages that make it somewhat cheaper to run than an IOU,¹⁰ CleanPowerSF still faces a challenge, in that it seeks to provide an inherently costlier product – green energy – at rates that are competitive with those charged by PG&E for a less “green” product.ⁱⁱ

As recently as 2013, CleanPowerSF planned to provide 100% renewable energy to all San Franciscans. Due to the cost differential just noted, this would have required CleanPowerSF to charge its customers more than the rates charged by PG&E. This led to an outcry. Mayor Lee and others expressed concern that under the “opt out” provision of CCA law some low-income customers would be automatically enrolled in the program, inadvertently fail to “opt out”, and find themselves paying more for electricity than they had been paying to PG&E.

For that reason and others, SFPUC rejected the 2013 program design and has since adopted an approach modeled on successful CCA programs in Marin and Sonoma Counties, that provides a mix of renewables and conventional power at rates that are expected to be lower than, or equal to those charged by PG&E for comparable products. These programs will be discussed below, comparing and contrasting them with the current plan for CleanPowerSF.

First, however, we must address a threshold issue. Also in 2013, CleanPowerSF proposed to use an accounting mechanism known as “unbundled” renewable energy credits (“RECs”) to reduce its cost of acquiring green energy. Mayor Lee, the City’s Commission on the Environment and members of the labor movement objected that unbundled RECs are not green energy, and using them in this way was misleading. Insofar as unbundled RECs figure in the program designs discussed below, we will begin by addressing this question.

Is an Unbundled REC Really Green?

Electricity is the same whatever its source. Whether created by wind, sun, fossil fuel or nuclear fission, the product is the same: a flow of electrons. The only way that a user of electricity can be sure of its origin is to connect directly to the source.

ⁱⁱ PG&E is required by law to include some green power in its product mix. Under California’s Renewables Portfolio Standard (“RPS”) program, all IOUs, electric service providers, and CCAs must increase procurement from eligible renewable energy resources to 33% of total procurement by 2020. For 2015, PG&E’s RPS target is 23.3% of retail sales. See <http://www.cpuc.ca.gov/PUC/energy/Renewables/hot/33RPSProcurementRules.htm>

Few have this luxury. Most of us receive our electricity through the “grid” — that is, a shared transmission system that gathers electrons from many sources, mixes and transmits them over major trunk lines, then distributes this mixture to individual users. There is no way to know that electrons transmitted in this way come from any particular source. When power enters the grid from a green source it mixes with power derived from all other sources, many of which are not green. What reaches the user is this mixture. Thus, until all sources are green, there is no way to receive power over the grid that is identifiable as coming from a green source.

Yet some customers need to do just that. California requires electrical utilities to provide their customers with a certain percentage of power from green sources.¹¹ If utilities cannot connect directly to a green source, then they must buy green power that is transmitted over the grid. To allow these transactions to occur, government and the power industry have devised an accounting process that tracks green power at the point of production.

In its purest form the process is rather simple. When one unit of green power is produced, it is assigned one Renewable Energy Credit, or REC. The green producer sells that power and its associated REC to the buyer – we’ll call him “Smith”. The producer places one unit of power on the grid, and Smith withdraws one unit of power from the grid. It is mixed power at that point, because of the transmission system described above. However, Smith may count it as entirely green because he owns the associated REC. In this transaction, the REC is said to be “bundled” because it is sold with the underlying power.¹²

California also recognizes “unbundled” REC transactions, which take place as follows. One unit of green power is produced, and is assigned one REC. However, in this instance Smith buys only the power; Smith does not buy the associated REC. The green producer places one unit of power on the grid, and Smith withdraws one unit of mixed power at the destination, just as before. However, Smith may not count it as green because he doesn’t own the associated REC. Meanwhile, the producer has sold that REC — but no power — to Smith’s neighbor, whom we’ll call “Jones”. Jones may then buy one unit of conventional power from any source; have that unit placed on the grid; withdraw one unit of mixed power at the destination, and she may count that unit as green because she owns one REC.¹³

In both examples, one REC certifies that:

- one unit of power was generated by a green source; and
- someone, somewhere, bought and consumed that power, instead of one unit of power from a conventional source.

When a customer buys a REC — bundled or unbundled — he/she buys the assurance that one such substitution occurred; that one unit of green power replaced one of conventional power. It may be someone else, somewhere else, that

bought that green power, but the system as a whole is one unit greener for each REC.¹⁴

Critics in the environmental movement and organized labor argue that unbundled RECs are deceptive. One writes that they “paper over the fact that the [retail energy provider] is not delivering truly green power... just conventional power they call green by buying the credits.”¹⁵

As explained above, no retailer that uses the transmission grid is “delivering truly green power” to its customers. The power received is a mix from all sources. The question remains: should a retail energy provider be allowed to buy power from conventional sources, and count it as green by buying unbundled RECs? The answer to this question varies according to the goals of the provider.

If the goal is to reduce greenhouse gas in the Earth’s atmosphere as a whole, then unbundled RECs are an appropriate tool. As long as green power is replacing conventional power the system as a whole is greener, even though the power and its associated RECs are bought by different entities. For the same reason, if the goal is to reduce air pollution nationwide, or worldwide, then unbundled RECs are appropriate.

If the provider is in California, and the goal is to reduce *local* air pollution, then the benefits of using unbundled RECs are less clear. This is because at present most unbundled RECs originate outside California. For example, Marin Clean Energy (MCE) buys unbundled RECs from a cooperative of family farms near Mount Hood, Oregon that generates power from a small hydroelectric project and uses it to irrigate their orchards.¹⁶ This replaces conventional power these farms would otherwise buy elsewhere, and since they have no need to count it as green, the cooperative sells the associated RECs to MCE. MCE then buys conventional power and uses these unbundled RECs to count it as green. Green power has replaced conventional power in Oregon, but this does little or nothing to reduce air pollution in Marin County, California — at least in the short term.

In the long term, however, it may do just that. Ultimately air pollution is not a local problem. Pollutants travel long distances and degrade air quality far from their source. Coal-fired power plants in China cause increased ozone levels in California.¹⁷ Contributing to a global solution of this problem will eventually yield local benefits in Marin County and elsewhere.

In short, the use of unbundled RECs results in environmental benefit to the planet as a whole, and also to the local community.

Some of the most strident objections to the use of unbundled RECs have come from labor unions and others concerned about their impact on the local economy, or lack thereof. They argue that if the goal of a clean energy program is to create local jobs, or to stimulate the local economy, then unbundled RECs may be less appropriate than bundled power — again, because unbundled RECs usually represent power

generated at a distance that may not have any economic impact on the area where the retailer is located. Critics also argue that the sale of unbundled RECs does little to stimulate development of new sources of green power, because their price is too low to encourage development of new green sources.¹⁸

Others argue that while all of this is true, it is somewhat shortsighted. Using unbundled RECs to provide green power is indeed much cheaper than using bundled renewables. As Marin Clean Energy has demonstrated, this can help a newly formed CCA keep its rates competitive with those of the incumbent electric utility at the outset, when high start-up costs might otherwise put the CCA at a disadvantage. This, in turn, helps the CCA retain customers who would opt out if its rates were too high.

Unbundled RECs also allow clean power CCAs to begin operation before local sources of green power exist. This creates demand for green power, which acts as an incentive for private investment in new local sources. In some cases the new CCA itself may wish to build or buy these new sources, but will have difficulty borrowing money for this purpose until its customer base and revenue stream are established. Unbundled RECs offer an inexpensive way to deliver some of the environmental advantages of green power, while waiting for this to occur.

In this way, unbundled RECs can serve as a bridge to development of new local sources of green power, and the jobs and other economic benefits that such sources produce.

How Does CleanPowerSF Compare with Other Bay Area CCAs?

While it has spent over eleven years debating a design for CleanPowerSF, San Francisco watched two neighboring communities plan and launch successful CCAs that are now far larger than CleanPowerSF as currently proposed. A comparison of these three programs is instructive.ⁱⁱⁱ

Program Launch, Coverage

Marin Clean Energy (MCE) was the first CCA in California. Founded in 2008, it began serving customers in 2010. At first it served just 8,000 accounts, all in Marin County. By late 2014 it served approximately 125,000 customers, with an additional 25,000 expected from an expansion of its service area that is now underway. It now serves

ⁱⁱⁱ Unless otherwise noted, the statistics and data in this section are taken from three sources: “MCE Integrated Resource Plan Annual Update,” November 2014; “Sonoma Clean Power 2014-2018 Resource Plan, Draft Version VO.4”; and the program design for CleanPowerSF that was presented to SFPUC at its meetings on April 14, 2015 and May 12, 2015.

customers in four different counties including Marin, Napa, Solano and Contra Costa. Its total retail sales for 2015 are projected to be 1,595 gigawatt-hours (GWh).^{iv}

Sonoma Clean Power (SCP) is a relative newcomer. Serious planning got underway in 2011, and in May 2014 it began a phased rollout of its service. By mid-2015 that rollout will be complete, and it will offer service to all electric customers in Sonoma County except those in Healdsburg, which has its own municipal utility. Its average annual sales at that point are projected to be approximately 2,300 GWh.

When CleanPowerSF is launched in early 2016 it plans to serve an average customer load of no more than 30 MW. Over the course of a year, this would result in annual sales of just over 260 GWh. If the program is successful and its governing bodies allow it to expand, that figure will grow. However, at the outset CleanPowerSF will be roughly 1/8 the size of MCE and 1/10 the size of SCP, based on annual sales.

Product Offerings

Like CleanPowerSF, MCE and SCP provide a “default” product to all who do not opt-out of the CCA, and a “premium” product to those who wish to “opt up” to a higher percentage of renewables at higher cost. MCE’s default product at first contained 25% renewable energy, and has since increased to 50%. SCP’s default product consists of 33% renewable energy. CleanPowerSF’s default product is targeted to provide from 33% to 50% renewable energy, depending on the cost of these resources, the exact percentage to be determined later this year.

All three systems offer a premium product that is 100% renewable energy. However, in the case of MCE, fewer than 2% of its customers have “opted up” to this product. While it is hoped that this percentage will rise to 5% over the next few years due to increased marketing, the premium product remains a very small part of MCE’s product mix.

Dependence on unbundled RECs varies. In 2010 almost all of MCE’s renewable energy derived from unbundled RECs generated outside California. Today unbundled RECs represent about half of its renewable energy. SCP’s default product uses unbundled RECs for approximately 10% of its renewable energy (3% of total power), while its premium product uses no unbundled RECs. CleanPowerSF plans

^{iv} In this context, the *watt (W)* is a unit of measurement that describes the rate at which power is produced. One kilowatt (kW) means one thousand watts; a megawatt (MW) one million watts; a gigawatt (GW) one billion watts. All are used to describe the capacity of a power source: how much power it can produce in a given instant. A *watt-hour (Wh)* describes the volume of power that is produced over time. One watt-hour (Wh) means the amount of power produced by a one-watt source over a period of one hour. A gigawatt-hour (GWh) means the amount of power produced by a billion-watt source over a period of one hour. All are used to describe the cumulative output of a system: how much power it has produced over time.

to use only bundled renewables produced in California for both its products. It does not plan to use unbundled RECs.

Rates

At launch in 2010, MCE charged rates comparable to those charged by PG&E for its standard product. Since then its rates have sometimes been slightly higher, and sometimes lower than those of PG&E. Today it charges approximately 3% less than PG&E.

SCP's default product is designed to sell below the rate charged by PG&E to similar customers. The premium product sells at a rate that is about 20% more than the default product. As of March 2015, this resulted in total monthly bills for default customers that were 5% to 15% lower than those received by comparable customers of PG&E, while the premium product produced a bill that was 1% to 17% higher than PG&E.¹⁹

Under CleanPowerSF the default product is intended to sell at rates comparable to those charged by PG&E for its basic product. The premium product's price will be equivalent to PG&E's 100% renewable product that is expected to be available in late 2015 through the company's Green Tariff Shared Renewables Program.²⁰

Power Acquisition

At launch MCE obtained its energy exclusively through SENA, the same private concern that CleanPowerSF once contemplated hiring for the same purpose. MCE has since signed contracts with other suppliers, and SENA'S contribution has diminished, although SENA still supplies 69% of MCE energy. Its contract with SENA expires in 2017, and thereafter MCE intends to buy energy directly rather than through an intermediary. Likewise, SCP has contracted with an energy provider known as Constellation Energy Group (a subsidiary of Exelon Corporation) to provide a majority of its energy. It also buys some energy directly from producers.

By contrast, CleanPowerSF plans to forego using an outside provider and buy all of its power directly, either from SFPUC or on the open market. It can do so because SFPUC, which administers the program, has long performed this function as part of its municipal power enterprise, and can do so for CleanPowerSF as well.

Power Sources

Sonoma's default product currently uses approximately 15% geothermal energy, 9% biomass and biowaste energy, and 9% wind energy, for a total of 33% renewable energy. Its premium product uses 100% geothermal energy. Marin's overall product mix currently includes approximately 32% wind, 12% biomass/landfill gas, 5% solar, 3% geothermal and 1% small hydro energy, for a total of 51% renewable energy. Both CCAs obtain renewable energy from a variety

of sources, most of which are located outside their service areas. Even SCP, which buys 15% of its energy from geothermal facilities in Sonoma and Lake Counties, obtains most of its renewable energy from other parts of the state, and a few from outside California.

CleanPowerSF's sources of renewable energy have yet to be determined. Its sales at the default rate are projected to generate almost no surplus over the cost of providing power. Sales of the premium product are projected to produce a surplus, which will be used to fund new local or regional sources of renewable power. These would include public projects built on City-owned and controlled property, and private projects built by CleanPowerSF customers and others, who would receive financial incentives from CleanPowerSF through "net metering," "feed-in tariffs" ^v and GoSolarSF. Also included would be energy efficiency and demand response programs, ^{vi} to be funded by charges collected from ratepayers statewide and administered by the California PUC.

Community Outreach

As MCE expands to include portions of Contra Costa and Napa counties, it has launched CCA service in several large communities with diverse demographics, and a variety of income levels similar to those found in San Francisco. The MCE program has demonstrated that a well-organized and professionally administered community outreach program at all sorts of venues—farmers markets, Kiwanis Clubs, public libraries – makes a positive impact on the community's understanding of Community Choice Aggregation, and helps customers make timely and informed decisions about whether they wish to remain with the program or opt out.²¹ The Sonoma County program used a similar outreach approach, and has experienced the same positive outcome.

Financial Viability: Conclusions

Based on the foregoing comparison, we conclude that when CleanPowerSF rolls out it will be a very modest program that serves a relatively small number of customers.

^v In California a "feed-in-tariff" is a program that promotes investment in small-scale renewable generation projects by offering producers long-term contracts to sell energy to investor-owned utilities. See Cal. Pub. Utilities Code Section 399.20. "Net metering" is a service that allows customers of an electric utility who install a small-scale, renewable generation system on-site to receive a financial credit for power generated by their own system and fed back to the utility. The credit is used to offset the customer's electricity bill. See <http://www.cpuc.ca.gov/PUC/energy/DistGen/netmetering.htm>

^{vi} "Demand response" programs create incentives — usually financial ones — that encourage end-use electric customers to reduce their electricity usage during periods of peak demand. See <http://www.cpuc.ca.gov/PUC/energy/Demand+Response/>

For that reason alone, it appears to be a low-risk enterprise compared with SCP, which has nearly ten times its projected annual sales, and also with MCE, which is intent on growing outside its original service area.

By the same token, CleanPowerSF has a great deal of up-side potential. It is projected that after just one year SCP will sell nearly ten times as much energy in Sonoma County (population 500,000) as CleanPowerSF plans to sell initially in San Francisco (population 850,000).²² This points to the possibility of strong growth for CleanPowerSF.

The product mix and pricing strategy of all three CCAs are quite similar. All three acquire most of their renewables outside their local service area, mainly from elsewhere in California. Only CleanPowerSF plans to operate entirely without unbundled RECs — a benefit, perhaps, of its diminutive size. By contrast, MCE uses unbundled RECs in large numbers and will continue to do so for the foreseeable future, evidently as a way to control costs during a period of rapid growth. Even SCP, which has been a champion of using bundled resources, continues to use unbundled RECS as part of its mix. All of this suggests that there is no compelling reason why CleanPowerSF should not use unbundled RECs, if necessary, to support the growth of its enterprise.

And growth should be a priority. Like MCE and SCP, CleanPowerSF aims to increase the percentage of renewables in its product mix over time. However, if this impedes the growth of the program, by increasing its rates to a point where they are less competitive, this could have a negative effect on the environment. A 100% renewable program that serves 30 MW peak load is less "green" than a 50% renewable program that serves 200 MW. This is because the former "retires" only 30 MW of conventional generation, whereas the latter retires 100 MW.

<u>% of renewable power</u>	<u>Peak load in MW</u>	<u>Amount of conventional power retired in MW</u>
50%	200	100
<u>100%</u>	<u>30</u>	<u>30</u>
Additional MWs of conventional power retired		70

Moreover, the transition to green power is a key component of the City’s plan to eliminate most of its greenhouse gas emissions by mid-century.²³ A small CleanPowerSF program that grows slowly, or not at all, will do little to achieve this goal.

Finally, the benefits of community outreach are clear. Particularly in light of the “opt out” provision of CCA law, customers deserve a well-designed and well-funded

marketing effort that explains the benefits of CleanPowerSF, and allows each one of them to make an informed choice as to whether to remain in the program.

Is CleanPowerSF A Jobs Program?

As recently as January 2015, Mayor Lee reaffirmed his insistence on local job creation as an essential element in a redesigned CleanPowerSF program, stating, “I call on the SFPUC to develop a program that is affordable for customers, greener for our planet, takes advantage of renewable technology being developed right here in our City and has a real plan for creating jobs for our residents.”²⁴

At a recent joint meeting of SFPUC and LAFCO considerable time was spent discussing this issue. It was noted favorably that, according to a report by the energy consulting firm EnerNex,²⁵ implementation of CleanPowerSF would result in the creation of new jobs. The estimates in the report are debatable and were criticized at the meeting as being too optimistic.²⁶

CleanPowerSF was not originally intended as a jobs program. Job creation was not mentioned in the 2004 ordinance that first authorized a CCA. The program goals at that time were twofold: to provide clean, reasonably priced and reliable electricity to retail customers in San Francisco, and to exercise local control over electricity prices. The emphasis was on developing renewable energy resources, conservation programs and energy efficiency.²⁷

Likewise, job creation was not mentioned in the Draft Implementation Plan for a CCA that was adopted by the Board of Supervisors in 2007.²⁸ The concept first appears in an RFP authorized by the Board in November 2009, which cites job creation as an example of additional benefits that could come from the program but are not required by the program.²⁹

The first mention of job creation as a program goal appears in a revised RFP issued in 2010, which states, “The City seeks to encourage local job creation through CleanPowerSF.”³⁰

By 2013 the labor movement and others were treating job creation as a non-negotiable core element in the CCA. The San Francisco Labor Council adopted a formal resolution stating that it would withhold its support for CleanPowerSF unless SFPUC and the Board of Supervisors formally adopted a set of principals dictated by the Council, designed “to ensure that CleanPowerSF program will create high wage, union jobs with benefits . . .”³¹ Mayor Lee also opposed the program as then proposed, in part because it “doesn’t produce direct local jobs.”³²

Be that as it may, the Civil Grand Jury concludes that “job creation” in relationship to clean power is a red herring, not helped by the EnerNex report. Job creation was not a core element of the program as originally constituted. It is a laudable goal but it does not bear a substantive relationship to the CleanPowerSF program. Why?

Because just as the majority of new clean energy projects are geographically far away from San Francisco, so are the jobs associated with building them. See the section on Green Power Resources below for more on this issue.

More than one interviewee suggested that the real opportunity to create local jobs lies not in generating renewable energy, but rather in energy efficiency: in auditing, assessing, electrical contracting, and accounting. Other interviewees suggested that SFPUC should use the contracting process to ensure that clean energy developers, in and outside the City, comply with basic labor standards in contracting, procurement and hiring used by the City of San Francisco.

A further jobs issue related to CleanPowerSF is whether implementation will result in a substantial *loss* of current jobs. Based on our interviews and other research the Civil Grand Jury has found no evidence that creation of CleanPowerSF would result in substantial job loss. This is because by law PG&E will continue to provide distribution, metering, and billing to CleanPowerSF customers, and virtually all local employees of PG&E's regulated electric utility work in these areas. As a result, none of the many people interviewed nor any of the many documents reviewed have indicated that there would be job loss as a result of the implementation of CleanPowerSF.

Green Power Resources: Are There Enough?

Mayor Lee has stated his desire to see that “San Francisco remains the Greenest City in North America.”³³ One hallmark of a “Green City” is the creation and implementation of new and diverse sources of green power or renewable energy. Where will this energy come from? How much is available?

Geography limits the amount of renewable energy that can be developed in San Francisco proper. Ours is an urban county: We don't have vast tracts of land available for wind farms or large solar arrays within the City limits. Nevertheless, the City has done an admirable job of developing clean energy resources in the City and on property it owns or controls elsewhere. Based on a 2013 study that is still accurate today, hydroelectric generation at powerhouses associated with the Hetch Hetchy system have a capacity of 380.5 MW.^{vii} Small hydroelectric generation projects add 4 MW; solar photovoltaic projects, 7.5 MW; and renewable Biogas energy projects 3.1 MW, for a total installed capacity of 395.1 MW. Another 52 MW is estimated to be available.³⁴

^{vii} Although the Hetch Hetchy system is not considered a renewable power source, for RPS purposes, the power that it generates is effectively exempt from RPS requirements. Under California Public Utilities Code Section 399.30(j), SFPUC is required to procure RPS-eligible electricity resources, including renewable energy credits, to meet only the electricity demands that are not met by Hetch Hetchy, so long as Hetch Hetchy provides more than 67% of its electricity resources.

The issue, however, is whether sufficient clean energy is available statewide to meet San Francisco's needs and those of other communities. In light of the state's 2020 deadline for reducing carbon emissions to 1990 levels, and 40% below that by 2030,³⁵ it is reasonable to ask whether increased demand will cause the cost of clean energy to skyrocket, and the resources to be significantly diminished or tapped dry.

The California Energy Commission estimates that the state's total annual consumption of electricity will approach 290,000 GWH in 2015, and 300,000 GWH or more in 2020. Its peak demand is forecast to be approximately 64,000 MW in 2016, and as high as 69,000 MW in 2020.³⁶ Under current law, California utilities are required to serve 33 percent of retail electricity sales with renewable resources by 2020.³⁷ Based on the forecasts just cited, this means that by 2020 something like 100,000 GWH of total consumption, and 23,000 MW of peak demand will need to be served by renewable sources of energy statewide. See the Appendix to this report for information on where that energy might come from.

It is important to remember that renewable energy is exactly that: it can be renewed almost indefinitely, because it does not run out. So the concern is not whether there is enough, but rather how fast we can develop what we need.

SFPUC has three green energy programs: Municipal solar, which installs solar panels on schools and other city facilities, Energy Efficiency, which undertakes projects that help reduce energy consumption, and GoSolarSF (GSSF), which funds the installation of solar panels at private residences. Unfortunately, their funding has been cut in recent years due to the significant capital needs of replacing the aging infrastructure of the Hetch Hetchy Power System. Cuts to GSSF have been much smaller, among other reasons because the GSSF program has been so successful. See the Appendix to this report, and documents cited therein, for more information.

GSSF is a program that benefits private property owners but is funded by public money. It has been the subject of debate between policymakers and SFPUC staff regarding the appropriateness and legality of this funding arrangement.

A possible solution would be to integrate GSSF into the proposed CleanPowerSF program. CleanPowerSF could fund a portion, or all, of GSSF, as part of its overall local resource build-out plan. In this way CleanPowerSF could market GSSF to its own customers, help those that wish to install rooftop solar, and then purchase their excess power as a local clean energy source.³⁸ This complementary relationship would enhance both programs.

As to the question of whether the City government and the staff of SFPUC have the necessary competence and expertise to operate efficiently in the clean power market, the Jury finds good reason to believe that they do. SFPUC staff has purchased electricity for years to meet the needs of San Francisco civic facilities,

which are not always satisfied by Hetch Hetchy production. They will be able to use this experience in buying clean power for the rest of the city on behalf of CleanPowerSF.

Findings

Based on the foregoing discussion, we make the following findings:

- F1 CleanPowerSF will be a relatively small, low-risk program at startup, but must grow quickly to meet the City's timeline for reducing greenhouse gas emissions.
- F2 CleanPowerSF's rates will be lower and more affordable to all San Franciscans, if it is free to use unbundled RECs as needed, and to provide less than 100% green power.
- F3 Local job creation, while desirable, is not the chief purpose of CleanPowerSF, and should not cause further delay in implementing the program.
- F4 There are ample affordable resources of renewable power to support CleanPowerSF, including local rooftop solar installations such as those funded through the GoSolarSF program.
- F5 Political discord has at times delayed implementation of CleanPowerSF.

Recommendations

Based on the foregoing findings, we make the following recommendations:

- R1 That CleanPowerSF be designed, first and foremost, to be financially viable and to grow quickly without undue risk.
- R2 That CleanPowerSF be free to use unbundled RECs, and to provide less than 100% green power, as needed to meet its goals of financial viability and early expansion.
- R3 That CleanPowerSF be designed to provide as many local jobs as it can, without compromising its financial viability and potential for early expansion.
- R4 That SFPUC integrate the GoSolarSF program into CleanPowerSF to take advantage of their complementary relationship.
- R5 That local officials, including the Mayor, put the full weight of their offices behind the success of the CleanPowerSF program.

Request for Responses

Pursuant to Penal Code Sections 933(c) and 933.05, the civil grand jury requests responses to all of the above findings and recommendations from each of the following:

Honorable Edwin M. Lee, Mayor

San Francisco Board of Supervisors

San Francisco Public Utilities Commission

Response Matrix

<i>Findings</i>	<i>Recommendations</i>	<i>Responses Required</i>
F1 CleanPowerSF will be a relatively small, low-risk program at startup, but must grow quickly to meet the City’s timeline for reducing greenhouse gas emissions.	R1 That CleanPowerSF be designed, first and foremost, to be financially viable and to grow quickly without undue risk.	SF Public Utilities Commission, Board of Supervisors, Mayor
F2 CleanPowerSF’s rates will be lower and more affordable to all San Franciscans, if it is free to use unbundled RECs as needed, and to provide less than 100% green power.	R2 That CleanPowerSF be free to use unbundled RECs, and to provide less than 100% green power, as needed to meet its goals of financial viability and early expansion.	SF Public Utilities Commission, Board of Supervisors, Mayor
F3 Local job creation, while desirable, is not the chief purpose of CleanPowerSF, and should not cause further delay in implementing the program.	R3 That CleanPowerSF be designed to provide as many local jobs as it can, without compromising its financial viability and potential for early expansion.	SF Public Utilities Commission, Board of Supervisors, Mayor
F4 There are ample affordable resources of renewable power to support CleanPowerSF, including local rooftop solar installations such as those funded through the GoSolarSF program.	R4 That SFPUC integrate the GoSolarSF program into CleanPowerSF to take advantage of their complementary relationship.	SF Public Utilities Commission, Board of Supervisors, Mayor
F5 Political discord has at times delayed implementation of CleanPowerSF.	R5 That local officials, including the Mayor, put the full weight of their offices behind the success of the CleanPowerSF program.	SF Public Utilities Commission, Board of Supervisors, Mayor

Glossary of Abbreviations and Definitions

ABBREVIATIONS

CCA:	Community Choice Aggregation
CPSF:	CleanPowerSF
GSSF:	GoSolarSF
GW:	Gigawatts of power. A gigawatt is equivalent to 1,000 megawatts.
IBEW:	International Brotherhood of Electrical Workers
IOU:	Investor-owned utility, e.g. Pacific Gas & Electric Company
IP	Implementation Plan
KW:	Kilowatts of power. A kilowatt is equivalent to 1,000 watts.
LAFCO:	Local Agency Formation Commission
MCE:	Marin Clean Energy
MW:	Megawatts of power. A megawatt is equivalent to 1,000 kilowatts.
PG&E:	Pacific Gas and Electric Company
PV:	Photovoltaic, as solar PV
REC:	Renewable Energy Credit. A certificate of proof showing that one megawatt-hour of electricity was generated by a green source. When one megawatt-hour of green power is produced it is assigned one REC. The power and the REC can be sold separately or together. If the REC and the power are sold together, the REC is called a “bundled REC.” If a customer buys only the power and not the REC, and the REC is sold elsewhere, it is called an “unbundled REC.”
RFI:	Request for Information: a formal query from a government agency requesting vendors to suggest how they might implement a program idea, estimating details such as staffing and costs.
RFP:	Request for Proposals: a formal query from a government agency requesting vendors to propose how they would implement a program, including methodologies and costs.

SCP: Sonoma Clean Power
SENA: Shell Energy North America
SFPUC: San Francisco Public Utilities Commission

DEFINITIONS

BIOENERGY: Power generated from biomass, or plants

“DARK GREEN” OR “DEEP GREEN”: An electricity product comprised of 100% renewable energy.

GEOHERMAL ENERGY: Power generated from heat energy derived from hot rock, hot water, or steam below the earth’s surface.

GRID (POWER): A system of power lines and associated equipment used to transmit and distribute electricity over a geographic area.

HYDROELECTRIC ENERGY: Power generated by the flow of water. For example, O’Shaughnessy Dam, which creates Hetch Hetchy Reservoir, is a large hydro project. Raising the height of an existing dam is one example of a small hydro project.

“LIGHT GREEN”: An electricity product comprised of less than 100% renewable power.

OPT OUT: To choose not to join a program, e.g., CleanPowerSF

OPT UP: To choose to buy an optional, more expensive electricity product such as MCE’s “Deep Green” product

PHOTOVOLTAICS: A solar power technology that uses solar cells or solar photovoltaic arrays to convert light from the sun directly to electricity.

RENEWABLE ENERGY: Energy for which the sources (sun, wind, water) are constantly replenished and for all practical purposes will never run out. Renewable energy is also called clean or green energy.

SOLAR ENERGY PROJECTS: A field of solar panels meant to provide a stream of power to a group of users is a large solar project. Solar panels on the rooftop of a residence, meant to heat the house’s water, is a small solar project.

TARIFF: (As used in the the electric power industry) The price of electricity.

WATT: A unit of measurement that describes the rate at which power is produced.

WATT-HOUR: A unit of measurement that describes the volume of power produced over time.

Appendix

SOURCES OF RENEWABLE ENERGY

There are at least seven types of renewable energy.³⁹

Solar energy projects can be small (panels installed on a rooftop to heat the water in an individual residence) or large (fields of panels meant to provide a stream of power for a group of users).

Hydroelectric power is energy generated by the flow of water. Large hydroelectric projects, such as O'Shaughnessy Dam at Hetch Hetchy, generate clean power but are not eligible for inclusion in the Renewable Portfolio Standard (RPS) program. A small hydroelectric power project might be raising the height of a dam, or generating power from water running downhill through a pipe. One report shows that, provided there is no negative impact on water delivery, small hydro projects can be a viable renewable generation technology. The report further states that it should be considered along with solar, wind, and geothermal projects. Some preliminary studies indicate that small hydro projects have some of the lowest costs of all renewable sources.⁴⁰

Wind power projects capture the wind in turbines that create energy. Although California's high wind areas are growing more and more limited, there are still opportunities for development available. Wind has the advantage of being a mature technology with requirements that are well understood. The primary challenges are environmental and permitting: the projects are highly visible and thus not necessarily welcome in some communities. Also, it has been difficult to accommodate the needs of birds occupying wind power sites.

The sun causes plants to grow, and the result is a biomass. Biomass can be turned into electricity, which is called bioenergy. Although it does not offer large opportunities for expansion, this form of green power does generate 3.1 MW of power for San Francisco.

Hydrogen gas can be burned to generate power if it is separated from the other elements with which it is usually combined – to form water, for example.

Sonoma County uses geothermal energy for 15% of its overall energy mix. Treated wastewater is pumped into deep cracks in the ground, where hot rocks heat the water, creating steam, which runs turbines.⁴¹ In other areas of the state, extremely hot water is "flashed" into steam within the power plant, and that steam turns the turbine.⁴² New or operating geothermal projects are limited, and they too have challenging siting and permitting issues. Among the difficulties is access to transmission lines.

Ocean energy in various forms—tidal movement, temperature differences based on depth, wave power—can all be used to create power. But this opportunity is too

limited and too expensive to meet a major portion of the renewable requirements of San Francisco.

As of December 31, 2014 the total wholesale renewable energy capacity in the State was 18,800 MW.⁴³ The breakdown of these sources is as follows: ⁴⁴

SOLAR PHOTOVOLTAIC	4,800 MW
SOLAR THERMAL	1,100 MW
SMALL HYDRO	1,700 MW
WIND	7,100 MW
BIOMASS	1,300 MW
GEOTHERMAL	2,800 MW
TOTAL	18,800 MW

The state also has additional 2,200 MW of self-generation capacity (e.g. rooftop solar) for a total operating capacity of 21,000 MW. ⁴⁵

Wind, solar photovoltaic (PV), and geothermal projects are the primary sources for renewable energy available to the SFPUC, ⁴⁶ although geothermal projects present problems as noted above.

Solar thermal and solar PV have shown the most growth. Commercial in-state generation from these sources has increased more than 250% since 2013. ⁴⁷ This trend is expected to continue throughout the State of California. The cost of solar installation is also going down.

New rooftop solar units seem to be the least problematic of the green energy programs.⁴⁸ SFPUC currently funds GoSolarSF (GSSF). The program subsidizes the installation of solar panels on the roofs of private residences, and has been lauded as beneficial for local citizens because it reduces carbon-based fuel use and greenhouse gas emissions.

Data provided to the Jury by SFPUC show that residential and business solar installations are growing as well. SFPUC estimates there is a total achievable solar potential of 60 MW if every available roof were covered. The City has a laudable goal of installing 50 MW by 2020. Currently there are 28 MW of solar installed, so SFPUC is over halfway towards reaching that goal. The breakdown is as follows:

- Owned or under contract by SFPUC – 8 MW
- Projects owned by residents or businesses that received a GSSF incentive – 10 MW
- Projects owned by residents or businesses that did not receive a GSSF incentive – 10 MW (either installed before the program started in 2008 or the owner opted not to receive an incentive and worked with a private company.)

SFPUC's statistics on solar activity as of December 2014 are impressive:

- SFPUC has completed 3106 solar installations
- These installations generate 10 MW
- 132 jobs were created since 2008 for disadvantaged San Franciscans; 29 are currently employed, 10 in this Fiscal Year alone, and they are paid on average \$17.00 an hour.

The GSSF program was funded at \$5 million in 2014-15; \$5 million is expected to be spent in 2015-2016.

Solar PV is a growth program at SFPUC. Projects are in development and design stage at: Downtown High School, Cesar Chavez and Marina Middle School, and at the SF Police Academy. SFPUC also has plans to install additional solar projects on municipal sites as their 10-year capital plan funding allows.

Endnotes

¹ California Assembly Bill 117 (Migden), Chapter 838, Statutes of 2002 – “An act to amend Sections 218.3, 366, 394, and 394.25 of, and to add Sections 331.1, 366.2, and 381.1 to, the Public Utilities Code, relating to public utilities”

² San Francisco Ordinance (hereafter “Ordinance”) 86-04

³ Ordinances 146-07, 147-07

⁴ Ordinance 232-09

⁵ See San Francisco Board of Supervisors Resolutions (hereafter “Resolutions”) 348-12, 331-13; SFPUC Resolution 11-0194.

⁶ See Resolution 331-13.

⁷ See Cal. Public Utilities Code Section 366.2(a)

⁸ See “San Francisco Climate Action Strategy” (SF Department of the Environment, 2013), Table 2.

⁹ See Ordinances 86-04, 147-07.

¹⁰ See, “The Economics of Community Choice Aggregation” (Bay Area Economic Forum, 2007), at pp. 7-8.

¹¹ See footnote ii at page 9 of the text.

¹² See information provided by the California Public Utilities Commission at <http://www.cpuc.ca.gov/PUC/energy/Renewables/FAQs/05REcertificates.htm>

¹³ Ibid.

¹⁴ Ibid.

¹⁵ Stern, Hunter, “Mixed report on Clean Power in San Francisco”, an opinion piece published in the *San Francisco Chronicle* on December 30, 2014.

¹⁶ See MCE Integrated Resource Plan Annual Update, November 2013, p. 11.

¹⁷ See <http://www.universityofcalifornia.edu/news/ten-percent-san-joaquin-valleys-ozone-pollution-comes-outside-california>

¹⁸ See, e.g., Stern, op. cit.; Press, Daniel, “Opinion: ‘Renewable energy certificates’ are a feel-good scam” (*San Jose Mercury News*, April 9, 2009), at http://www.mercurynews.com/opinion/ci_12049267

¹⁹ “PG&E – SCP Comparison, at http://www.pge.com/includes/docs/pdfs/myhome/customerservice/energychoice/communitychoiceaggregation/scp_rateclasscomparison.pdf

²⁰ See <http://www.pge.com/en/about/environment/pge/greenoption/faq/index.page>

²¹ See MCE Clean Energy, “MCE Benicia Community Outreach Plan”, February 2015.

²² See U.S. Census Bureau, “State & County Quick Facts”, <http://quickfacts.census.gov/qfd/states/06/06075.html>

²³ See San Francisco Environment Code, Chapter 9, Sec. 902.

²⁴ News Release, January 26, 2015, “Mayor Lee & Board President Breed Announce San Francisco Exceeds Greenhouse Gas Emissions Reduction Goal”

²⁵ EnerNex, “Local Build-Out of Energy Resources of the Community Choice Aggregation Program” (LAFCO, 1-30-15) (hereafter “EnerNex Report”)

²⁶ “Minutes, Special Joint Meeting of the San Francisco Public Utilities Commission with the Local Agency Formation Commission, Friday, January 30, 2015” (as approved February 10, 2015)

²⁷ Ordinance 84-04

²⁸ See Ordinance 147-07 and “Community Choice Aggregation Program Description and Revenue Bond Action Plan and Draft Implementation Plan” dated June 2, 2007, attached thereto and adopted therein.

²⁹ Request for Proposals, Agreement No. CS-978R, SF PUC Power Enterprise, November 5, 2009, at p. 32; and see Ordinance 232-09.

³⁰ Revised Request for Proposals, Agreement No. CS-160, “Electricity Supply Services for Community Choice Aggregation Program” (SF PUC Power Enterprise, September 30, 2010), at p.8

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- ³¹ “Resolution Supporting A Labor Friendly Community Choice Aggregation Proposal For San Francisco” adopted by the Delegates of the San Francisco Labor Council on May 13, 2013.
- ³² Mayor’s Appearance before the Board of Supervisors, 9/10/13; see video at sfgovtv.org
- ³³ News Release, May 1, 2014, “Mayor Appoints Deborah Raphael as SF Environment Director”
- ³⁴ SFPUC, “Generating Clean Energy for San Francisco” (July 2013).
- ³⁵ See Executive Order B-30-15, issued by Governor Edmund G. Brown, Jr. on 04/29/2015, at <http://gov.ca.gov/news.php?id=18938>
- ³⁶ California Energy Commission, “California Energy Demand Updated Forecast” (February 2015), pp. 2-4, see <http://www.energy.ca.gov/2014publications/CEC-200-2014-009/CEC-200-2014-009-CMF.pdf>
- ³⁷ Senate Bill X1-2, signed by Governor Edmund G. Brown, Jr., in April 2011; see also <http://www.energy.ca.gov/portfolio/>
- ³⁸ See EnerNex Report, pp. 82, 154-158.
- ³⁹ These definitions are based on material contained in RenewableEnergyWorld.Com, “Types of Renewable Energy”, see <http://www.renewableenergyworld.com/index.html>
- ⁴⁰ EnerNex Report, p. 139; see also Olson, Scott and Jon Pietruskiewicz et al, “Renewable Energy Assessment—Final Report” (Black and Veatch for SFPUC, 2014)
- ⁴¹ See <https://sonomacleanpower.org/about-scp/power-sources/>
- ⁴² See <http://energyalmanac.ca.gov/renewables/geothermal/types.html>
- ⁴³ See http://www.energy.ca.gov/renewables/tracking_progress/documents/renewable.pdf
- ⁴⁴ Ibid., figure 1
- ⁴⁵ Ibid., p. 2
- ⁴⁶ See Olson and Pietruskiewicz, op. cit., p. 1-1.
- ⁴⁷ See http://energyalmanac.ca.gov/electricity/electricity_generation.html
- ⁴⁸ See Olson and Pietruskiewicz, op. cit., pp. 4-4 to 4-28.