To: Cheryl Taylor

SFPUC CC: Harlan Kelly, Jr., Barbara Hale, Shaibya Dalal

From: Local Power Inc.

Date: March 31, 2013

RE: CS-920R-B, Task 3, Subtask E, First Draft Briefing Paper and Program Design Analysis

---

Table of Contents

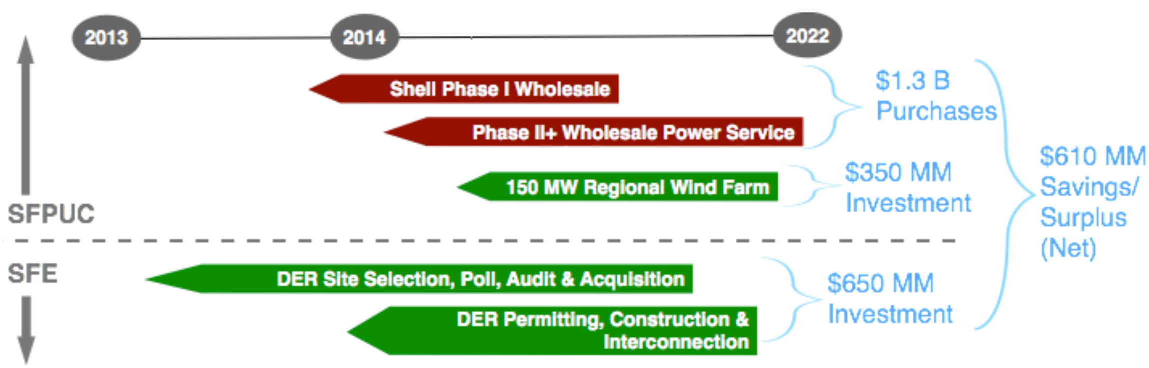
Summary

CleanPowerSF will facilitate the targeting, financing, construction, and operation of local in-City and regional renewable, distributed generation, and demand-side management technologies and practices sufficient to supply a minimum of 28% of the program's electricity requirements by 2017, with a goal of reaching 51%+ as soon as possible. The San Francisco Public Utilities Commission (SFPUC) will oversee wholesale contracting and operations, as well as the construction of a 150 MW wind farm in the region; the in-City deployment will be implemented by private sector firms under the management of the San Francisco Department of the Environment (SFE), under supervision of the SFPUC.

These resources will be funded primarily by the issuance of revenue bonds by the SFPUC, and integrated into power procurement and operations at the SFPUC. To do so, CleanPowerSF will establish a Virtual Power Plant (VPP): a system that aggregates, automatically optimizes and, for certain technologies, dispatches distributed energy resources (DER, or distributed generation, renewables, advanced energy storage including electric vehicles, and demand-side resources) through a secure communications platform.

The simplified graphic below delineates agency roles for these processes, as well as the level of financing or expense associated with each component, and the draft projected program net surplus and customer savings (as compared to PG&E) from the deployment by 2022.

CleanPowerSF: Timeline, Preliminary Finances & Agency Roles



The purpose of this draft Briefing Paper and Program Design Analysis is to advise the SFPUC on program design and operations to ensure the integration of the DER deployment with wholesale power procurement activities, including customer phasing and comprehensive portfolio planning. These actions will enhance CleanPowerSF's portfolio economics and mitigate the risk of revenue conflicts between power procurement and other revenue-funded commitments.

Introduction

As a Community Choice Aggregation (CCA), CleanPowerSF will provide retail electric generation services within the City and County of San Francisco to all customers on basic service who choose to not actively opt-out of the program. New or relocated customers within this geographic boundary will be automatically enrolled in the program, and customers that are already served by 3rd party suppliers under Direct Access will also be allowed to join (but must elect to do so). In addition, the program may elect to offer natural gas commodity services to its customers on an opt-in basis in the future, in order to increase the percentage of natural gas supplied by biogas and/or to lower the cost of natural gas for participating customers.

CleanPowerSF will be distinguished from any other existing program or retail provider in the country by its strong commitment to delivering 'Energy as a Service' through the development of local in-City and regional distributed generation, renewable, and efficiency resources. Instead of only delivering electricity from remote resources, CleanPowerSF will offer customers a qualitatively different value proposition over the 'status quo' by financing and facilitating the installation of targeted distributed generation, storage, demand response, new appliances for homes and businesses, and comprehensive building retrofits. These distributed energy resources (DER) will be integrated into resource planning to ensure the cost-competitiveness of the program. Program goals adopted by Ordinance mandate that the program supply 51% of its electricity requirements from renewable sources or through efficiency by 2017, while meeting or beating the incumbent utility's (PG&E) basic service rates.

Preliminary financial projections indicate that the program may supply ~28% of its electricity requirements from local and regional sources by 2017, and by doing so, the program will save $610 million by 2022 as compared to the incumbent utility rates. These results are to be considered preliminary and conservative, and were intended to be updated in mid-2013 with an expanded financial analysis after a Siting Analysis is conducted by LPI to determine the customer premises best suited for energy efficiency retrofits and to host distributed generation. The preliminary financial results indicate that, over a ten year period, approximately $650 million will be required to finance solar photovoltaics at ~600 sites (100 MW), combined heat and power (CHP) at ~300 sites (60 MW), district heating and cooling supplied by CHP at a single site (15 MW), and energy efficiency retrofits at ~12,000 sites. In addition, ~$350 million will be required to construct a 150 MW wind farm in the region.

The purpose of this deliverable is to advise the SFPUC on actions necessary for the integration of these DER, financially and operationally, into the program and power procurement.

General Planning Principles

CleanPowerSF policy objectives have been established by several Ordinances and voter mandates.[1] The principles detailed here are a summary of key objectives, which will guide the implementation of CleanPowerSF:

- Accelerated, scaled deployment of regional and distributed energy resources (distributed generation, renewables, energy efficiency, advanced energy storage, electric vehicles, and automated demand response), including a 150 MW wind farm in the region;
- Reducing costs and maximizing the availability of financing for ownership of distributed energy resources by residents and businesses using voter-approved H Bond financing;
- Cost control and competitive rates as compared to PG&E;
- Reduction of greenhouse gas emissions and local pollution;
- Local investment and job creation;
- Full enrollment of all eligible customers in San Francisco (both residential and nonresidential).

This deliverable serves to advise the SFPUC on the program and procurement structures that will allow the program to achieve the above policy goals, in the context of customer enrollment and resource needs.

Wholesale Procurement and Scheduling Coordination

CleanPowerSF will initiate service under a full requirements contract with Shell Energy North America, under which all scheduling coordinator services, energy, capacity, and renewable energy requirements will be provided. This contract will supply approximately 9% of the program's requirements (as expressed as a percentage of full enrollment), for a period of five years. During the first year of the program, CleanPowerSF will expand its existing in-house capacity for power procurement to manage the procurement and operations, so that the remaining 81% of the program's requirements may be contracted for and managed 'in-house'. In general, a wholesale electricity and capacity is procured by one of two means: through bilateral contracts with individual power plants (PPAs, or power purchase agreements), or on competitive markets regulated by the California Independent System Operator (CAISO).

---

[1] See Ordinances 147-07, Ordinance 86-04, Ordinance 348-12, and Ordinance 200-12.

Recommendations for Phase II+ Wholesale Power Contracts and Services

As the remaining ~90 percent of customer load is phased in over subsequent years, the CleanPowerSF program will be free to contract with other suppliers to supply this load. The SFPUC should issue an RFP for Phase II wholesale procurement in the near-term, to ensure it receives competitive price quotes for wholesale power. The impacts on customer load from the deployment should be closely integrated into wholesale procurement activities as early as 2014.

Modifications to Current Wholesale Contract Needed

The current contract with SENA may not be used for subsequent phases without precluding the local deployment, for three reasons:

1. The ability to finance the deployment using revenue bonds issued by the SFPUC must not violate the agency's Debt Service Capacity Ratio (DSCR); net revenues must equal at least 125% of annual debt service payments (capital and interest payments).[2] The contract with Shell contains a 'lockbox' provision, which gives Shell first rights to the program revenues. As such, program revenues do not count towards the calculation of net revenues for the SFPUC. This provision must not be incorporated into future wholesale procurement contracts, and Shell supply must not be used for additional power supply or services under the original contract; otherwise, the ability to issue revenue bonds to finance the deployment will be constrained or eliminated.
2. The CleanPowerSF deployment will require the intelligent monitoring and control of distributed generation and demand-side assets, coordinated in real-time and integrated with scheduling activities to lower the overall cost of service. These operations will be vital to the performance of the program overall. While the contract with SENA allows for the integration of resources specified by the City, SFPUC staff should be aware that the Scheduling Coordinator software that SENA has elected to use (supplied by Czarnecki-Yester) does not have the functional capability to aggregate distributed energy resources nor integrate these resources into procurement operations.

Integration of the Deployment with Procurement

The SFPUC's current contract structure with SENA allows for the substitution of City Assets into wholesale procurement, provided that the City makes SENA whole for any costs incurred through the resale of the displaced wholesale power. Conversely, if wholesale power prices are lower than the price for the contracted power, the City receives the benefit of the energy sold, after making SENA whole for any transactional costs.

The volume of power to be displaced by year 10 of the deployment is currently projected to account for 28% of the City's electricity requirements. If the wholesale power for CleanPowerSF

---

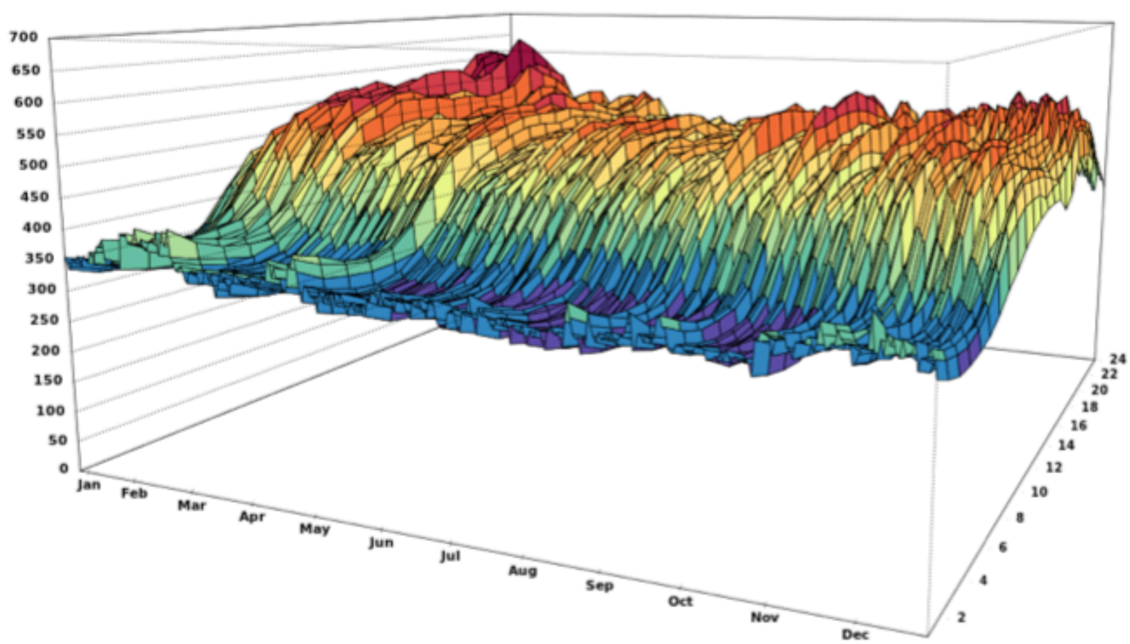
[2] [2] SFPUC Debt Management Policies and Procedures, Section VII

is procured through medium- or long-term contracts without taking into consideration the impacts of the deployed assets, this substitution clause exposes CleanPowerSF deployment projects to significant market price volatility risk.

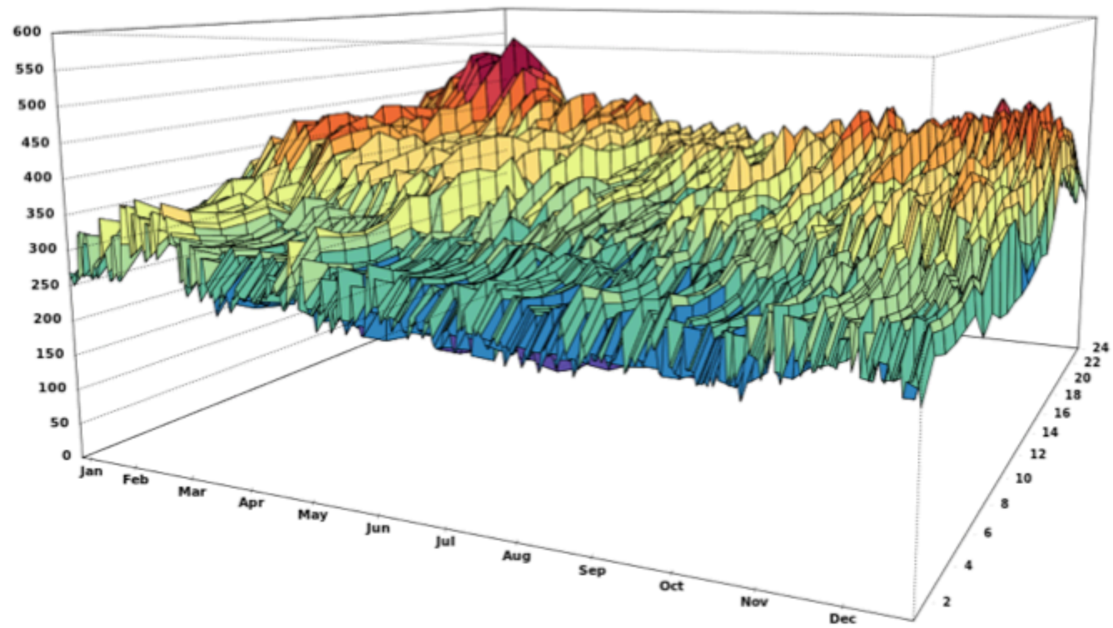
The confirmation agreement to initiate CleanPowerSF Phase I service is anticipated to be a full services agreement to purchase power to serve the residential customer class loadshape. Future confirmation agreements should be executed (with SENA, providing that the current contract is modified to mitigate the clauses detailed under "Modifications to Current Wholesale Contract Needed", or with a new supplier under a contract that does contain these provisions) to supply a more disaggregated mix of power products, including baseload, off-peak, and on-peak wholesale PPAs for a mixture of short, medium, and long terms of supply that plan for the load impact of the deployment. Hedging products for these purchases may be procured through the same confirmation agreement, or through agreements negotiated with alternative suppliers of these products.

As can be seen in the graphics below, the deployment of DER will significantly modify the CleanPowerSF load shape. The more that this transformation is planned for using an integrated approach to procuring wholesale power while predicting the load shape impact of the deployed technologies, the lower the overall cost of service will be.

CleanPowerSF Preliminary Results: Load Shape (2018) Prior to DG & DSM



CleanPowerSF Preliminary Results: Load Shape (2018) After DG & DSM



As the deployment progresses and the program is able to dispatch DER in response to electricity and capacity market price signals, it will be advantageous to plan to procure a portion of the program's requirements through CAISO market. This will allow the dispatch of DER in response to market prices, so as to minimize the overall cost of service for the program. These net short positions should be calculated to take advantage of the capabilities and timelines of the dispatchable DER.

Recommendations for Customer Phase-In

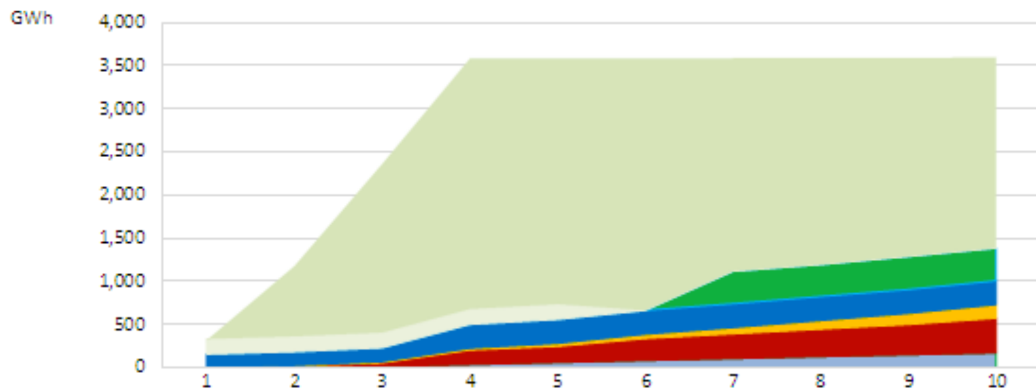
Because of the Debt Sservice Capacity Ratio (detailed in the above section "Modifications to Current Wholesale Contract Needed"), the SFPUC must take care to increase the program's phase-in of customers to increase program revenue in coordination with the annual issuance of revenue bonds. Not increasing revenue to a sufficient degree would limit or preclude the ability of the SFPUC to issue revenue bonds, and would delay the deployment.

Below is a graph and accompanying table from the draft Financial model depicting annual resource mix of CleanPowerSF as all eligible residential and nonresidential customers are phased in over a four year period[3] (assuming a 20% opt out rate) and the deployment is implemented:

---

[3] A four-year phase in is a conservative assumption, based on the experience of MEA and other CCA's around the country. The faster the program enrolls customers would increase upfront revenue for debt repayment.

CleanPowerSF Preliminary Results: Annual Resource Mix



	1	2	3	4	5	6	7	8	9	10
Wholesale Purchases	(15.52)	814	1,951	2,899	2,844	2,916	2,466	2,389	2,299	2,203
Shell Phase I Power	176	176	176	176	176	-	-	-	-	-
Wind Farm	-	-	-	-	-	-	376	372	383	379
Hetch Hetchy Hydroelectric	160	160	160	276	276	276	276	276	276	276
Solar Photovoltaics	-	7	14	22	36	50	71	100	128	157
Combined Heat and Power	-	21	42	167	186	254	286	318	350	402
Energy Efficiency	-	1	18	41	65	87	110	132	154	175

The table below shows the annual financing required by technology and the program overall from the draft Financial model:

CleanPowerSF Preliminary Results: Annual Project Financing

PROJECT FINANCING ($MM)										
Year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Solar Photovoltaics	$-	$ 16	$ 16	$ 16	$ 33	$ 34	$ 51	$ 70	$ 71	$ 72
Wind	$-	$-	$-	$ -	$ -	$ -	$356	$ -	$ 10	$ -
Combined Heat and Power	$-	$ 8	$ 9	$ 9	$ 9	$ 20	$ 14	$ 14	$ 15	$ 24
District Heat and Power	$-	$-	$-	$ 41	$ -	$ -	$ -	$ -	$ -	$ -
Energy Efficiency	$-	$ 1	$ 9	$ 13	$ 14	$ 14	$ 15	$ 16	$ 16	$ 16
Site Acquisition Start-Up	$ 4	$-	$-	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Annual Total	$ 4	$ 25	$ 34	$ 80	$ 56	$ 68	$437	$100	$111	$ 113
Cumulative Total	$ 4	$ 29	$ 62	$142	$198	$266	$703	$803	$914	$1,027

Notes: Color scale indicates lesser (yellow) to greater (green) annual financing by technology.
Sparklines on right indicate trend of each line item

Wholesale Renewable Power Purchases

Renewable Portfolio Standard Requirements

CleanPowerSF plans to meet or exceed the state's Renewable Portfolio Standard (RPS) requirements. The RPS requirements are currently set at 20% and will ramp up to 33% by 2020.

There are three different classifications of supply-side renewable electricity, all sourced from RPS-eligible technologies but varying in product definition, under the California RPS:

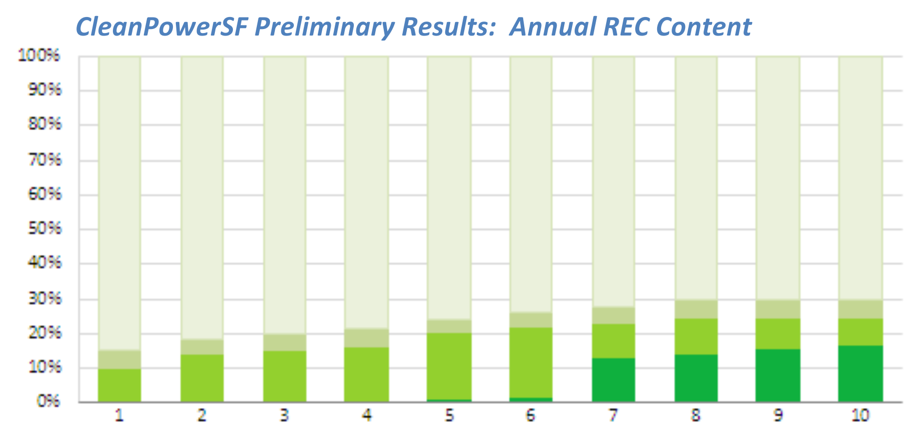
- Category 1: renewable energy from sources located in or deliverable to California;
- Category 2: as above, except that the renewable energy is 'firmed and shaped' with non-renewable energy;
- Category 3: unbundled RECs from qualifying regions (including out of state).

The CPUC has placed restrictions on the percentage of Category 2 and 3 RECs for RPS compliance purposes.

Voluntary Renewable Energy Purchases

In addition to satisfying its California RPS obligations, CleanPowerSF currently intends to procure additional renewable energy to be 100% renewable. This may be accomplished by purchasing the products detailed above, which comply with the California RPS, or may alternatively be met through either 1) purchases of unbundled Green-e Energy certified RECs or 2) other resources that the program deems 'renewable', such as energy efficiency and excess Hetch Hetchy hydroelectric generation. The program is under no obligation by law to purchase California RPS-compliant products to satisfy the portion of its renewable content in excess of its RPS requirements.

Below is a graphic from the draft Financial Model depicting the annual REC content for the CleanPowerSF program:



	1	2	3	4	5	6	7	8	9	10
Bucket 3 (Purchased)	85%	82%	80%	79%	76%	74%	72%	70%	70%	70%
Bucket 2 (Purchased)	5%	4%	5%	5%	4%	4%	5%	5%	5%	5%
Bucket 1 (Purchased)	10%	13%	15%	16%	19%	20%	10%	10%	9%	8%
Bucket 1 (Generated)	0%	1%	1%	1%	1%	2%	13%	14%	16%	17%

Scheduling Coordination and CAISO

Broadly, CleanPowerSF's Scheduling Coordinator will interact with the California Independent System Operator (CAISO) for two general purposes: 1) arranging for the delivery of energy through the electrical grid, and 2) direct participation in ancillary service markets run by the CAISO, by aggregating and dispatching certain DER.

CleanPowerSF Forecasting and Settlement

CleanPowerSF will calculate its own load shapes and estimates of the impact of installed DER internally, and for the purposes of forecasting and settlement, submit to the CAISO estimates of the net load shape to be satisfied through wholesale procurement (either self-scheduled or market purchases). CleanPowerSF will hire staff and/or outside consultants to provide these estimates. The installation of smart meters in San Francisco will simplify this exercise: the City will be able to base a majority of its estimates on hourly or 15-minute interval meter data, instead of extrapolating monthly usage data into hourly usage estimates by rate class and climate zone. Similarly, project impacts may be monitored on an on-going basis using smart meter data.

Please refer to the subsection "Integration of the Deployment with Procurement" above for a discussion and graphical representation of how the DER will impact the programs pattern of energy usage.

It should be noted that preliminary comparisons of residential and nonresidential load shapes provided by PG&E under the CCA-INFO TARIFF to load shapes estimated from customer interval meter data reveal a significant discrepancy in usage patterns. This is likely due to the fact that the load shapes provided by PG&E are statistically-valid representations for customers in the broader Bay Area, and not unique to the City. The City has a number of microclimates, but by and large enjoys milder weather than the Bay Area as a whole, which lessens CleanPowerSF's summer peak in comparison to the other major load centers in this region such as the East Bay and San Jose.

Ancillary Services

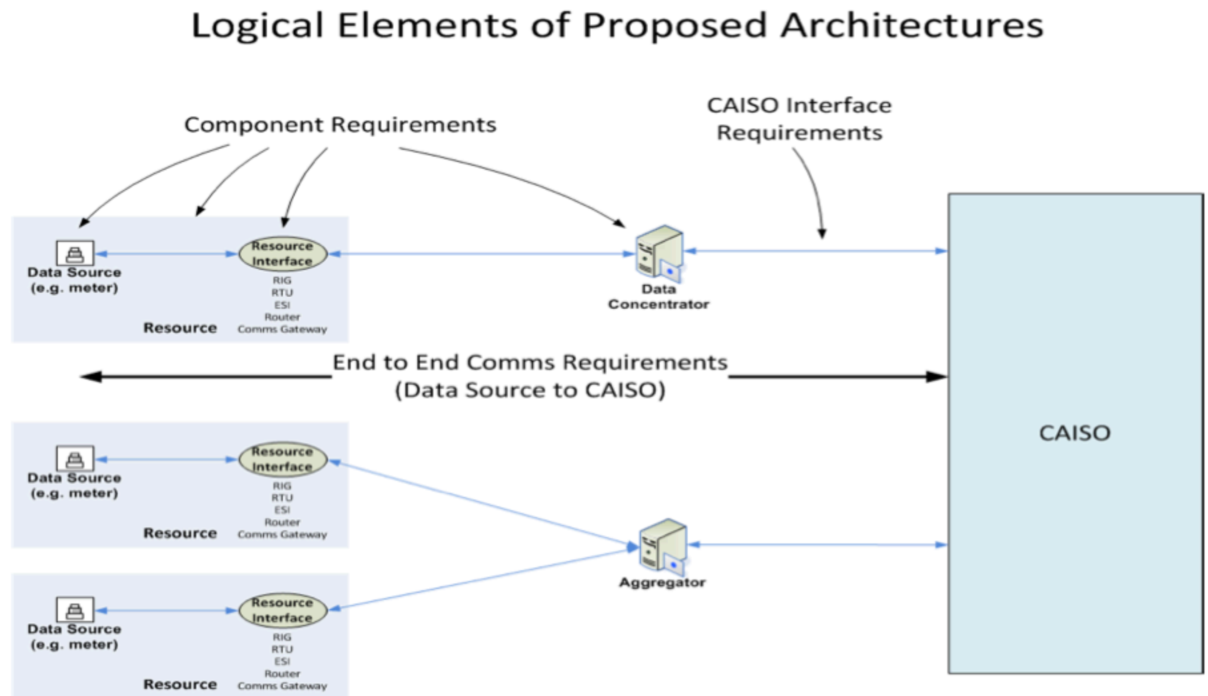
For the purposes of aggregating DER to bid into ancillary service markets, the CAISO must first update its market rules and requirements, which were developed for large power plants. For this purpose, the CAISO has convened a stakeholder group[4] that has met since October 2012; an issues paper will be forthcoming in Q1 2013, summarizing progress made to date regarding the metering and telemetry requirements for DER participation in ancillary service markets. The group has so far reviewed and catalogued 932 requirements from 25 documents. The stakeholder process is projected to conclude by Q2 2014,[5] with certain options for DER participation coming online within that time frame; however, other options will require the

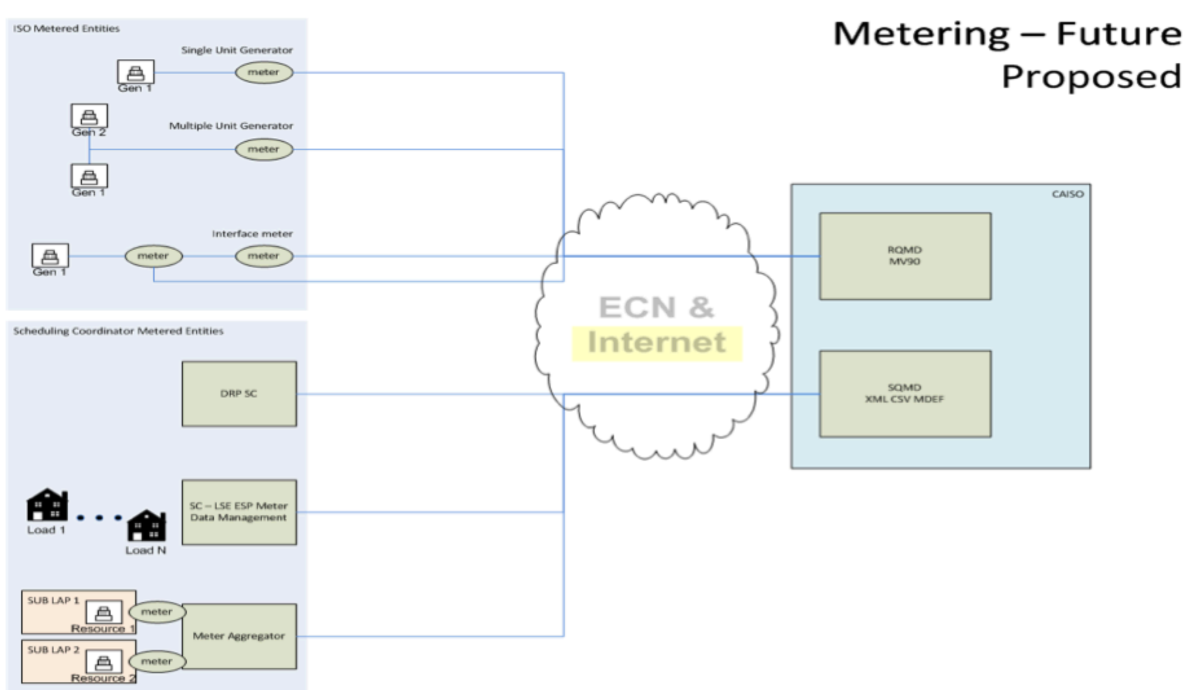
[4] Available: [http://www.caiso.com/informed/Pages/StakeholderProcesses/ExpandingMetering-TelemetryOptions.aspx]

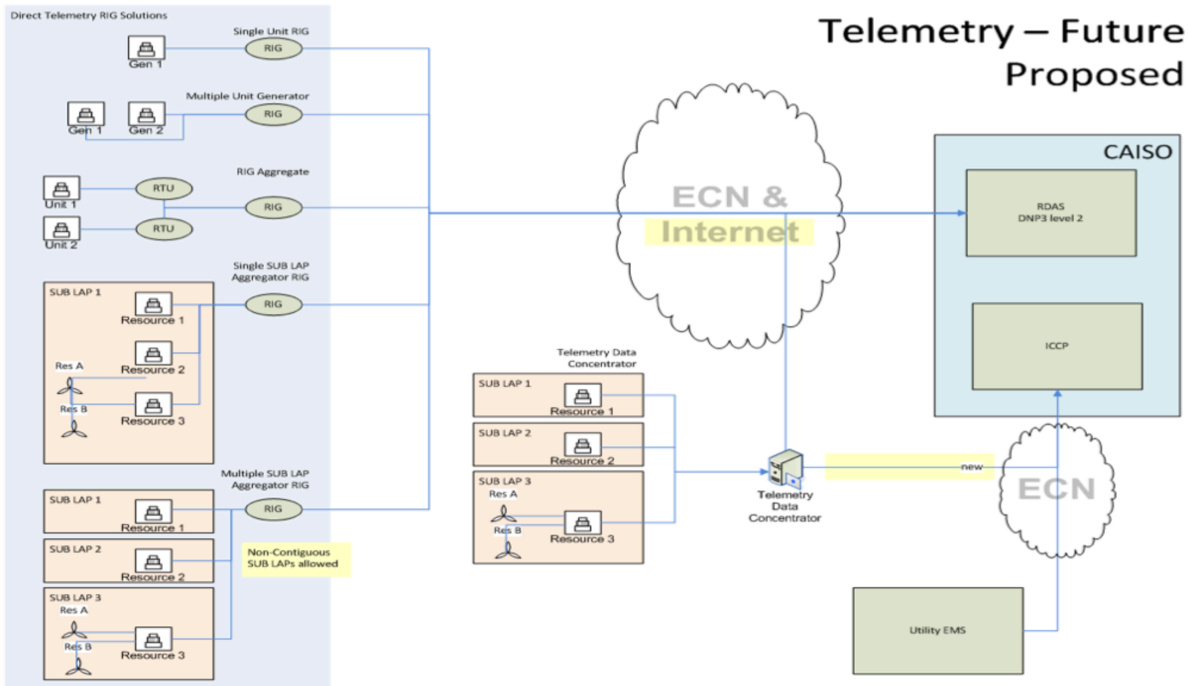
5 Available: [http://www.caiso.com/Documents/Presentation-ExpandingMetering-TelemetryOptionsFeb6_2013.pdf]

revision of CAISO tariffs and FERC Business Process Manual revisions, with a projected (but tentative) online date of Q4 2014.

Current and proposed telemetry and metering architectures for the participation of aggregated DER in CAISO ancillary service markets are shown below:







[6]

Integration Into Grid Modeling

The CAISO has recently initiated information exchanges with the IOUs to track distributed generation installations at a zip code level of geographic granularity, for the purposes of integrating this information into their grid analyses. They will provide CleanPowerSF with forms to use in reporting these installations to the CAISO upon request.

System for Integrating the Deployment with Procurement

Planning Integration

As a high level point of reference, if every project deployed by CleanPowerSF were to suffer a delay of one month, and the program's wholesale supplier unexpectedly forced to procure the power that should have been supplied by the deployed technology on the CAISO day ahead market (DAM), the total cost over the 10 year deployment period would be roughly $4 million. Considering that the net benefit of the deployment is projected at ~$610 million over the same period, the integration of these costs should not be cause for significant concern, given appropriate management and planning.

---

[6] Metering and Telemetry Workshop Agenda, 9 October 2012. Available: [http://www.caiso.com/Documents/Presentation-MeteringTelemetryWorkshop.pdf]

Project Portfolio Management

Monitoring and updating the projected online date and progress of each project must be a priority for the program. Doing so will allow cost-containment on a project-specific basis, as problems are identified in real-time and prioritized for resolution, as well as the effective integration of each project into program power procurement and operations.

A single software platform should be used across all technologies and program areas; this is commonly referred to as project portfolio management (PPM) in project-intensive industries. Any off-the-shelf software will need some amount of customization for CleanPowerSF's purposes, but this will not be a significant expense. All program managers, including staff from the procurement department, and subcontractors will need to use this system; as such, a web-based platform should be selected.

This database will use as inputs the results from the Site Selection analysis, which will identify key target sites and will pre-populate available site information and technology selections.

Document Generation

The PPM database should be customized to generate documents necessary for the negotiation, financing, construction, interconnection, operation and maintenance of each facility. Doing so will significantly drive down the transactional cost associated with document preparation, aid in quality control monitoring and trouble-shooting, and will act as a cost containment and risk mitigation measure.

As noted in our Permitting Report, the Department of Building Inspection (DBI) and the Planning Department are currently transitioning to an electronic Permit and Project Tracking System (PTTS) to unite all city department permitting processes in a single 'one stop shop' platform. The system is expected to be operational November 2013.[7] SFPUC and SFE staff should monitor the implementation of DBI/Planning's electronic Project and Permit Tracking System (PTTS), and the SFPUC Commission and Commission on the Environment should request by resolutions that the platform grant CleanPowerSF programmatic access to the system to monitor all relevant permit pulls and processes to ensure timely processing and immediate identification of any disputes or delays, and to allow streamlining where possible and as appropriate over the life of the program. If possible, the PPM database should be linked to the PTTS to streamline the permitting process for CleanPowerSF projects.

Operational Integration

The operational integration of dispatchable DER requires 1) a Scheduling Coordinator capable of aggregating and controlling DER, or a third-party aggregator of DER that is able to

[7] DBI news release available from: [sfdbi.org/Modules/ShowDocument.aspx?documentid=1412]

communicate with the Scheduling Coordinator and directly with CAISO markets, and 2) appropriate control systems and communications for each technology.

Assets which are not dispatchable (i.e. solar photovoltaics, energy efficiency retrofits, and most CHP technologies) do not have to be integrated into daily procurement operations, but may be monitored for billing and O&M purposes, and the load impacts of each asset must be factored into procurement planning, as should be clear from the discussion and graphics under "Integration of the Deployment with Procurement".

Distributed Energy Resources Aggregator

Capabilities and Services

The DER aggregator will provide a range of services to the program to aggregate and control DER and integrate these assets operationally into schedule coordination and CAISO markets.

- Needs assessment
    - Assessment of customer base and potential capacity
    - Special conditions due to regulatory, geographic and climatological environment
- Program design services
    - Knowledge of existing programs
        - Program rules
        - Baseline design
        - Financial incentive/penalty rules
    - Ability to design custom programs
    - Metering and telemetry requirements for DER
    - Wholesale bidding strategies
    - Retail engagement and contracting strategies
- Enrollment process management
    - Enrolling customers and registering assets with CAISO (eligibility, meter requirements, approvals, etc.)
- Active management of DER operations
    - Capacity nominations, event dispatch, outage management, etc.
- Retail rate and tariff impact and optimization
- Wholesale market participation
    - Maximize DER investment by bidding resources in applicable markets
        - Day-ahead
        - Real-time energy
        - Non-spinning reserve
        - Regulation products
    - Resource and bid optimization

- Demand Response Provider (DRP) and Scheduling Coordinator (SC) services
    - Resource registration
    - Bidding
    - Award management
    - Dispatch
    - Telemetry
    - Revenue quality meter data
    - Settlement verification
- Performance measurement, validation and settlements
- Integration with other systems (MDMS, etc.)
- Program management reporting ('lessons learned', etc.)

Cybersecurity

The DER aggregator that CleanPowerSF selects should be aware of applicable frameworks and industry practices regarding Critical Infrastructure Protection (CIP) as well as the evolving protocols and standards for various DER technologies, and will implement a Security Information and Event Management (SIEM) system to ensure security across all network levels. SIEM technologies provide real-time alerts and analytics of attacks on networked applications and hardware. While preventing all cyber-attacks is not feasible, these technologies and practices work to identify, sequester, eliminate, and learn from all incoming attacks.

Communications

The communications architecture utilized for communicating with DER in common use in the market today is either via the customer's internet connection (using a virtual private network to encrypt the transmission) or via a 3g or 4g cellular modem connection (with a monthly subscription fee).

The following tables give an overview of the primary and secondary communications by DER technology, as well as a timeline of and overview of the advantages and disadvantages:[8]

[8] KEMA, "Final Report for Assessment of Visibility and Control Options for Distributed Energy Resources", CAISO, 21 June 2012.

DER	Primary Architecture	Secondary Architecture
PV – customer (monitoring)	Public Carrier Wireless	Customer Internet
PV – utility scale (feeder connected)	Utility Private Network	Utility AMI
DR – day ahead / real time	Customer Internet / aggregator VPN	Utility Private Network / broadcast technology
Community (Utility) Storage	Utility Private Network	Public Carrier Wireless
	Customer Internet	Public Carrier Wireless
Consumer storage	Public Carrier wireless	Customer Internet
EV smart charging		
Owner	**Advantages**	**Disadvantages**
Public Carrier Wireless	Efficiency & Coverage.	Security & Reliability without encryption; suitable for monitoring but not desirable for DR control. Performance for very low latency requirements.
Customer Internet	Cost, and coverage to facilities if not end use.	Security & Reliability without encryption and VPN requirements. Performance for very low latency applications.
Utility Private Network	Security & Reliability.	Cost. Ease of access to non-utility facilities and apparatus remote from the distribution feeder itself.

Exhibit 5-4: Primary and Secondary Communications Architecture by DER and by Owner

	Utility				Common Carrier				Third Party		
Network	1	2	3	4	1	2	3	4	1	2	3
Present Status	SCADA[85]	AMI Mesh Network[86]	Broadcast Radio		Cellular GPRS SMS[87]		WiFi	Internet POP/ Ethernet/ WiFi[88]		BAS Networks – larger commerci al[89]	
Emerging Status	Distribution Automation (DA)	AMI Mesh Networks		700 MHz Band		Cellular LTE[90]	WiFi Public Hot Spots		Electric Vehicle (EV) GPRS Wireless		DER maintenance via cellular / internet
Status by 2020	SCADA/ DA on fiber / 700 MHz	AMI Mesh Networks	Migrated to another spectrum?	Adopted for DA and mobile application s	Not Available	Next Generation ?	Next Evolution?	Pervasive	Next Generation EV	BAS is C&I Standard	Next Generation
Network Advantage s	Low Latency levels. NERC CIP compliance	Everywher e. Low Cost Modems	Very Low Cost	Re-allocate spectrum to utility	Everywher e. Low cost.	Everywher e. High Performanc e. In use for PV	Low modem and data cost	Everywher e. Low Modem Cost	Dependent upon auto makers	Open ADR likely.	Low Cost for monitoring
Network Disadvanta ges	Expensive. Proprietary	Utility owned. 3rd party access controlled	No access location. One way communica tions	Utility owned. 3rd party access controlled	Carriers to abandon	High modem costs. High service cost	Security. Not everywhere	Encryption required	Proprietary. Closed Access	Proprieta ry. Closed Access	Proprietary. Closed Access
Applicable DER Profiles	Utility PV & Storage	Residential PV & Storage	Small scale residential	Unknown	Distributed PV & Storage, Air Cond.	Unknown	DER near internet POP	Any C&I and residential	EV Smart Charging	Commerc ial DER, SOC, CHP	Distributed PV & Storage

Exhibit 5-3: Communications Ownership and Technology Timeline

Dispatchable Distributed Energy Resource Technology Overview

Demand Response and Dispatch

Demand response falls into two categories: traditionally, it has meant turning off appliances in response to periods of peak electricity demand (i.e. hot summer afternoons or cold winter nights), and may only be done at certain times, for a limited number of times per year; the more recent definition is referred to as Demand Dispatch or Automated Demand Response, which is the practice of turning assets on or off to mitigate grid instability (for example, from renewable energy intermittency) and instead of relying on combustion turbines burning natural gas. Demand dispatch is an expanded form of demand response, involves the full automation of assets.

Smart Buildings

Smart Buildings are equipped with a communication and control system that allows the monitoring, optimization, and control of end-use appliances and circuits. In the commercial sector, Smart Building systems may have one of several configurations, depending on whether the building has existing controls or not. Many medium and large commercial buildings are already equipped with Building Automation Systems (BAS), which monitor, record, and control end-use appliances and circuits. Depending on the vintage and type, the BAS may use a variety of protocols. A JACE box may be installed to translate these legacy protocols into a universal format, which will communicate with a 'gateway' device that communicates with the aggregator for demand dispatch signals, or with a third party for various purposes (such as data analytics). The gateway device may have additional local control intelligence. Circuits and large appliances may be further monitored with current transformers, to enhance the insight into energy use patterns within the building and to refine operational control strategies.

Home Area Networks

Home Area Networks (HAN) refers to smart-grid enabled products and services at a residential customer's home. For dispatchable assets, the HAN enables demand dispatch by receiving electricity price and/or grid reliability signals from the service provider through a local 'gateway' device, which then communicates with radio controlled appliances within the home to turn them on or off in response to the signals. The point at which the signals are translated into appliance specific actions may be hosted remotely (i.e. on a cloud server), locally (in the gateway device), at the appliance itself, or across all three locations. HAN are still under development, with several promising test pilots and nationwide action across all parts of the value chain to deliver these products, standards, and services in the medium-term.

In March of 2013, the Electric Power Research Institute (EPRI), USNAP Alliance, and CEA implemented a testing and certification program for the ANSI/CEA-2045 Modular Communication Interface (MCI) Standard from the Consumer Electronics Association. This standard addresses a significant gap in enabling residential appliances to be used for smart grid purposes. The essential problem has been that manufacturers have not been able to produce smart-grid enabled appliances cost-effectively on a widespread basis, because of a lack of agreement between utilities regarding which communication protocol to use for the purposes of monitoring and dispatching price and grid reliability signals to the appliances over the HAN. The standard allows manufacturers to produce appliances with the communication interface, into which a range of different communication radios may be inserted at a later date, depending on which utility territory the appliances ends up being installed.

This development should accelerate the availability and affordability of residential smart grid enabled appliances. The SFPUC and SFE should monitor appliances on the market for integration into CleanPowerSF deployment programs and scheduling coordinator activities.

Electric Vehicle Managed Charging

Electric Vehicle (EV) managed charging refers to the practice of turning the EV charger on or off in response to price or grid stability signals. The customer specifies what the desired level of charge is for a certain time in the future, and it is left up to the aggregator to ensure that the vehicle arrives at the desired state of charge at the right time, while optimizing the charge pattern to take advantage of the lowest prices for electricity. EV managed charging aggregators must also take into account the impact on the additional load from charging the vehicles on the customer's retail bill, such that the charge schedule does not increase the demand charges for the customer unduly.

Electric Vehicle to Building

Electric Vehicle to Building refers to the practice of using the vehicle's battery to supply onsite power to the customer by discharging the battery. The chargers which enable this are available on the market today, but due to the uncertain impact of this practice on the life of the vehicle battery and the related warranty concerns that manufacturers have, there are no vehicles on the market in the USA today that offer this capability. However, there are two manufacturers that produce and market vehicles with this capability outside of the country, and the SFPUC should monitor the development of this market while ensuring that any chargers deployed by CleanPowerSF have this capability.

Advanced Energy Storage

Distributed Advanced Energy Storage (AES) is a rapidly evolving technology space, not only in the battery technologies at the core of the technology, but also in the hardware and software that controls the battery for both onsite and offsite uses, and the business models to deploy the technology. The versatility AES of is such that the California Energy Storage Alliance (CESA), as part of the CPUC's workshop to implement AB2514, has commenced modeling the energy and financial impacts of energy storage under fourteen different use cases. The modeling for the first use case, ancillary services, was recently released, showing that energy storage has a payback of 2 to 3 years when used to supply ancillary services. Many of these potential revenue streams for distributed storage applications are not available currently, but are in development at the CPUC and CAISO. The SFPUC should monitor the distributed AES market, and take into account the CESA's use case modeling during the DER aggregator program design process.

Combined Heat and Power Peak Boosting

Combined heat and power (CHP) is typically run to satisfy onsite thermal usage and is not dispatchable. However, it is worth noting that at least one CHP technology (Tecogen) is capable of boosting its power output by ~25% for a limited number (~300) of hours per year. As many installations do not produce all the onsite electrical requirements, the DER aggregator may be able to dispatch the peak boosting capability of these units without even back-feeding electricity into the distribution grid.

Standards

CleanPowerSF should in general seek to deploy technologies that adhere to open standards protocols, as a measure of 'future proofing' program deployments against early or unplanned obsolescence.

Open Automated Demand Response (OpenADR) is an open protocol operational in approximately 300 facilities in California, and has been adopted by over 60 commercial vendors. The second iteration of OpenADR was released in August 2012, and encompasses the residential sector as well. It is currently being incorporated into national Smart Grid standards.[9] OpenADR has primarily been used for demand response, but is being explored for demand-dispatch.[10] It may be used to dispatch signals to a variety of different technologies (not just appliances).

In addition to managing seasonal peaks at the portfolio level, and daily and monthly peaks at the site level, loads controlled by OpenADR have a fast enough response time to assist CAISO in areas with a higher penetration of variable resources by smoothing ramps associated with swings in renewable output. OpenADR resources have demonstrated sufficiently rapid response time to deliver non-spinning ancillary services that the CAISO procures to balance the electrical grid. The ability of OpenADR to provide regulation up and down services is currently being explored.

Aggregated OpenADR portfolios have similar grid-balancing characteristics to those of grid-scale battery systems, and at a fraction of the cost and environmental impact. In addition, it is a

---

[9] National Institute for Standards and Technology (NIST) Smart Grid Interoperability Panel (SGIP) Priority Action Plan (PAP) 09. NIST will then pass OpenADR 2.0 to FERC for consideration for a national Smart Grid DR communication standard (as mandated by EISA 2007). Available from: [http://collaborate.nist.gov/twiki-sggrid/bin/view/SmartGrid/PAP09DRDER]

[10] See Lawrence Berkeley National Laboratory's Demand Response Research Center publications, available from[http://drrc.lbl.gov/publications/integrating-renewable-resources-california-and-role-automated-demand-response], and the Integrating Renewable Resources (IRR) pilot.

highly distributed resource and may be used to relieve temporary system constraints across the grid topology, or to smooth out pockets of load or generation. This will become increasingly important and correspondingly valuable as the penetration of electric vehicles and distributed generation increases. The CAISO may eventually dispatch OpenADR resources in a manner analogous to previous contracts for Reliability-Must-Run (RMR) generation, as a location-specific grid balancing resource.

The integration of these protocols and equipment specifications CleanPowerSF DER deployment represent a valuable opportunity to deploy the maximum amount of cost-effective demand-response and demand-dispatch resources within the city. This will require the use of an OpenADR server deployed by the SFPUC.