California Energy Commission

CONSULTANT REPORT

DER Program Implementation Plan

For the City of Richmond Advanced Energy Community EPC-15-076

Subtask 3.4 Develop DER Community Program

Prepared for: **California Energy Commission**
Prepared by: **Olivine, Inc.**

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ABSTRACT

The Richmond DER Community Program is designed to create an aggregation of diverse customers from several sectors within the City of Richmond, including commercial & industrial, municipal, and residential, with specific options targeted to low-income households. The aggregated electrical loads from these diverse customers will be used to provide services to the grid to ease local grid congestion and thereby increase transmission and distribution system resilience and lower the cost of local electric supply. Participants in the DER Community Program would periodically be called upon to curtail or shift electric load during event periods when congestion on the grid causes wholesale prices to spike. In exchange, participants generate bill savings and earn additional revenue from providing valuable grid services that increase reliability and enable higher penetrations of clean renewable energy.

Keywords: DER Community Program, Richmond, aggregation, grid, demand response, distributed energy resources

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CHAPTER 1: Introduction

This document is a deliverable for the development of a Community Distributed Energy Resources (DER) Program for the City of Richmond, under the Richmond Advanced Energy Community (AEC) project, led by the ZNE Alliance and funded by the CEC EPIC program (GFO-15-312). Olivine, Inc. is leading the development of the Community DER Program under subtask 3.4 of this project. The objective of the DER Program Implementation Plan is to document requirements for a sustainable and scalable DER Community Program (Pilot DER Community Program) that creates value for the City of Richmond, for Richmond residents and businesses, and for MCE Clean Energy (MCE). The DER Program Implementation Plan and the accompanying deliverable, the *Richmond DER Program Enrollment and Participation Manual*,[1] also provide a framework for implementing similar programs in other cities.

The Richmond DER Community Program is designed to create an aggregation of diverse customers from several sectors within the City of Richmond, including commercial & industrial (C&I), municipal, and residential, with specific options targeted to low-income households. The aggregated loads from these diverse customers will provide both economic and emergency services to the grid through implementation of demand response (DR) and DER strategies. Participants in the DER Community Program will periodically be called upon to curtail or shift electric load during event periods when congestion on the grid causes wholesale prices to spike. In exchange, participants generate bill savings and earn additional revenue from providing services and capabilities that increase reliability and enable higher penetrations of clean renewable energy.

The services targeted for the implementation of the DER Community help to ease local electric grid congestion and thereby increase system resilience and lower the cost of local electrical supply. The Pilot DER Community Program is designed to use DR strategies to mitigate the impact of price spikes during the *evening ramp*, a time period when net energy demand on the distribution grid increases sharply due to the drop off in solar production coincident with increased demand as many people return home in the evening. California's day-ahead (DA) and real-time (RT) wholesale electricity prices during the evening ramp have increased dramatically in recent years, reflecting a growing premium for flexible energy resources, including resources from DER programs.

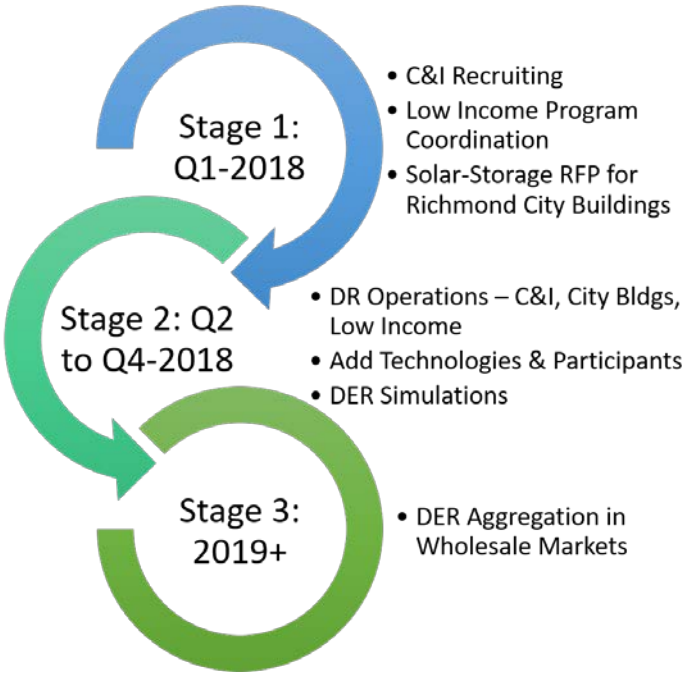
1 Reid, Beth, Valerie Nibler, AJ Howard (Olivine, Inc.). 2017. *Richmond DER Program Enrollment and Participation Manual.* California Energy Commission. CEC-EPC-15-076.

By reducing load during the evening ramp period, the DER Community Program offers the possibility of creating multiple value streams including:

- The local load serving entity (LSE), MCE Clean Energy (MCE), would benefit by avoiding the need to purchase more expensive and non-renewable energy in the DA and RT wholesale energy markets to cover procurement shortfalls during the evening ramp.
- Program participants would benefit from utility bill savings (from reduced energy and demand charges) and greater control over energy costs.
- Grid operators would benefit from access to an energy resource with ramping flexibility that can improve grid resilience and penetration of renewables.
- The local community would also benefit from increased grid resilience and the many environmental and societal benefits associated with higher penetration of renewables.

As Figure 1 shows, the DER Community Program is proposed to be rolled out in three stages, with the focus in the first quarter of 2018 on enrolling C&I buildings located within the City of Richmond. The staging will allow the program administrators to more quickly build program scale by focusing first on customers with larger loads. The eventual goal of the Richmond DER Community Program, however, is to create an aggregation of customers from multiple sectors that reflect the diversity of Richmond's community.

Figure 1: Richmond DER Community Program Staging



Activities in the first stage will position the DER Community Program for expansion in the second stage by identifying points of coordination with existing residential low-income programs and by releasing a request for proposal (RFP) to install solar and storage in Richmond's municipal buildings. During the second stage, which is anticipated to run from April to December 2018, the DER Community will be scaled to include low-income residential customers, municipal buildings, and additional DR and DER enabling technologies.

In the second stage of the program, program participants will be called upon to participate in DR events with the objective of shifting load from the evening peak. Reports will be provided based on these events to educate participants and to improve program design. In addition to putting DR into operations, program administrators will also simulate aggregations that include customer-sited generation resources, such as solar and storage, that can supply net energy to the grid. Simulation will show the capabilities of a DER aggregation (DERA) to provide grid services beyond load curtailment.

Limitations on multi-use applications currently pose a policy barrier to including energy storage in a DERA for wholesale market participation, but program administrators anticipate some resolution to these limitations by 2019. If so, the results of the DERA simulations will position the Richmond DER Community to be one of the first DERAs to participate in CAISO markets going into 2019 (identified as stage three in Figure 1).

The benefit of the DER Community Program is that the DER resources can be aggregated to provide more potential value streams than otherwise would be available to individual facilities. One of the services offered in the Richmond DER Community Program will be to apply Olivine's DER valuation model to aggregated usage data from the facilities in order to identify the stacked value streams, to provide expert advice on available market opportunities, and to devise and test operational strategies to maximize value for MCE, the City of Richmond, and for DER Community Program participants.

CHAPTER 2:
Program Description, Objectives and Theory

Program Description and Theory

The Pilot DER Community Program is designed to create an aggregation of diverse customers from several sectors within the City of Richmond, including C&I, municipal, and low-income residential. DER Aggregations provide the capability of coordinated response across energy resources, and by diversifying enrollment across sectors, the program can attract more participants with more diverse load characteristics, increasing the possible value to be derived from the program.

The value that can be created will depend on the aggregation's overall capacity and response capabilities, and that will depend partly on the DER technologies enrolled. DERs are grid-connected assets that are located on the lower-voltage distribution system – in contrast to typical large-scale transmission-connected generators and storage. Examples of DERs include generation sources like photovoltaic (PV) solar cells, controllable loads such as building-level demand response, electric vehicles (EVs) and EV chargers, and stationary energy storage technologies.

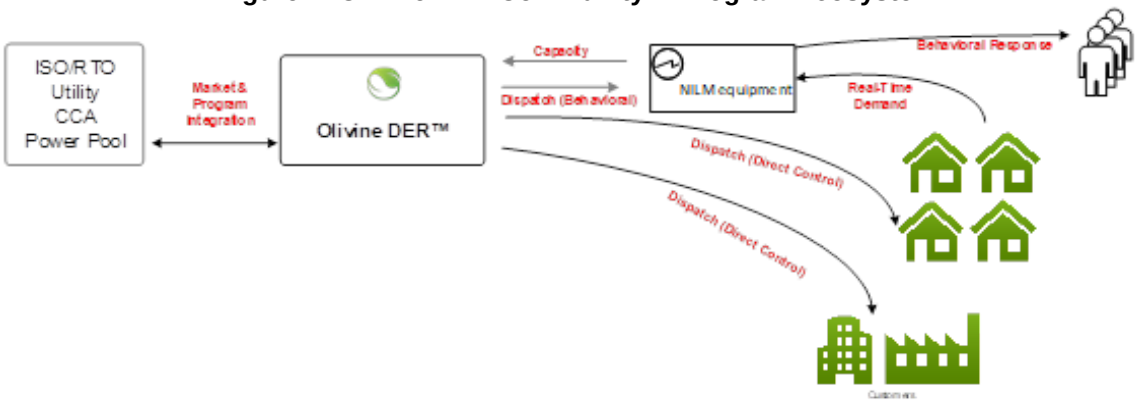
The Pilot DER Community Program will initially focus on DR control strategies. DR is the curtailment or increase of electric load in response to a price signal or incentive. DR can involve a combination of simple load curtailment (e.g., adjusting the thermostat to reduce load if given a dispatch signal) and load shifting (e.g., use of air conditioning for pre-cooling before a dispatch interval). Examples of DR include temporarily reducing lighting or heating, ventilation and air conditioning (HVAC) loads or delaying activities such as laundry or EV charging. In the C&I setting, additional end uses could be available for DR control such as refrigerated warehouses or pumping loads.

Recruitment and enrollments in the Pilot DER Community will be staged to focus first on C&I customers and municipal buildings, followed by low-income households. The staging will allow the program administrators to more quickly build program scale by focusing on customers with larger loads. Initial targeting will be within a cluster of food production and distribution warehouses that have recently established themselves within Richmond. The value streams possible will depend on the unique load characteristics of each facility and the ability to respond during DR events.

During the recruitment and enrollment process, the program administrator will assess the DR opportunities and work with appropriate contacts at each facility to explain the program participation requirements, including actions to be taken during events. Depending on the equipment in the facility, the enrollment process may also include configuration of equipment for automated response to dispatch signals.

Olivine, Inc., as program administrators and as a CAISO-registered Demand Response Provider (DRP), would use existing infrastructure and capabilities of Olivine's DER Community™ platform to manage the program, to dispatch program events (see Figure 2), and to measure response to program events. Part of the enrollment process will include dispatch of test events to ensure that the program is operating as designed and that participants know how to respond to events.

Figure 2: Olivine DER Community™ Program Ecosystem



In the second stage of the Pilot DER Community Program, enrollment will open up to residential households, with recruitment targeted at bringing 50 low- income households with electric air conditioning (AC) and/or electric heating loads into the DER aggregation. The presence of electric space conditioning suggests the possibility of high bills as well as potential for load curtailment or shifting (e.g., from pre-cooling or pre-heating) indicating greater benefits of DR to these participants. To lower residential customer recruitment costs, program targeting, outreach and enrollment processes will leverage existing low-income energy efficiency programs offered by the City of Richmond and MCE.

The Pilot DER Community Program will provide participating low-income households with a smart thermostat. In addition to smart thermostats, a non-intrusive load monitoring (NILM) device will be installed in order to capture appliance usage patterns. This approach will provide an understanding of which end uses contribute to changes in whole-house consumption during DR events. NILM devices provide information on end-use energy consumption at lower cost than sub-metering and can be used to enable measurement and verification (M&V) for demand response programs.[2] The data from these devices will provide insights into how low-income households use energy and the potential of these households to deliver grid services in a scaled DER Community Program.

2 Baechler, MC, H Hao (May 2016). *Business Case for Nonintrusive Load Monitoring.* PNNL-25425.

In the second stage of the program, program participants will be called upon to participate in DR events with the objective of shifting load from the evening peak. Reports will be provided based on these events to educate participants and to improve program design.

During the second stage of the DER Community Program, program administrators anticipate increased scale due to increased enrollment from all sectors and from added DER technologies. In particular, the City of Richmond is releasing an RFP to install solar and storage in Richmond's municipal buildings early in 2018 and some of those projects are expected to come online in late 2018. The enrollment of customer-sited PV and storage in the DER Community Program opens up additional possibilities for wholesale market participation as a DER aggregation (DERA). During stage two program operations, program administrators will also simulate aggregations that include customer-sited generation resources that can supply net energy to the grid. Simulation will show the capabilities of a DERA to provide grid services beyond load curtailment.

Limitations on multi-use applications currently pose a policy barrier to including energy storage in a DERA for wholesale market participation, but program administrators anticipate some resolution to these limitations by 2019. If so, the results of the DERA simulations will position the Richmond DER Community to be one of the first DERAs to participate in CAISO markets going into 2019.

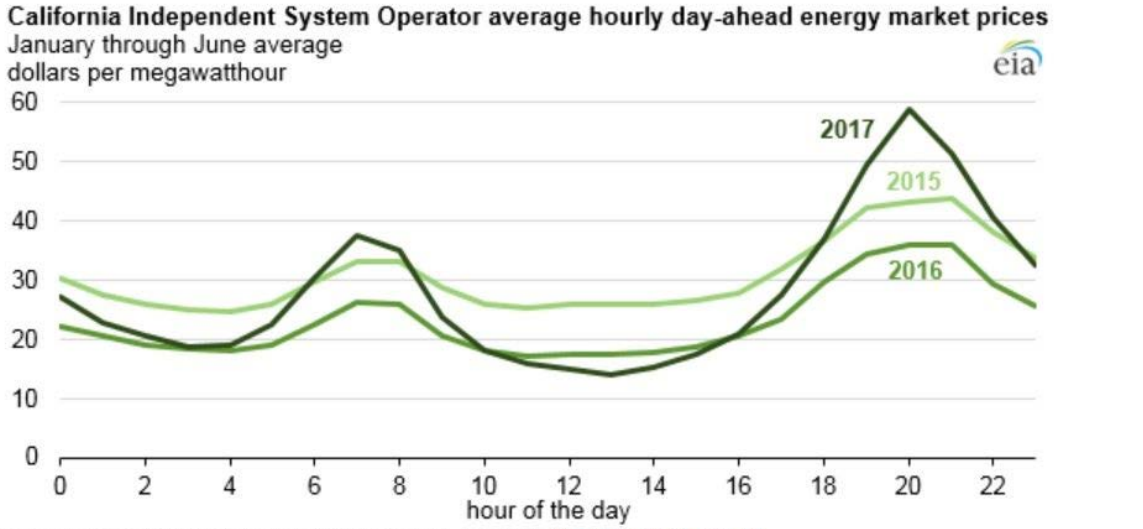
Program Energy and Demand Objectives

The Pilot DER Community Program is designed to use DER technologies, including DR, to mitigate the impact of price spikes during the *evening ramp*, a time period when net energy demand on the distribution grid increases sharply due to the drop off in solar production coincident with increased demand as many people return home in the evening.

According to a July 2017 report from the U.S. Energy Information Administration, the evening ramp has intensified in recent years with corresponding increases in average hourly day-ahead energy market prices.[3] Figure 3 shows that average hourly day-ahead energy market prices during the evening ramp have increased to nearly $60 per megawatt-hour in the first half of 2017 compared with $35 per megawatt-hour in the same period in 2016. These price increases suggest a growing premium for flexible energy resources, including resources from DR programs.

3 Cabral, L., Booth, B., & Peterson, C. (July 24, 2017). California wholesale electricity prices are higher at the beginning and end of the day. *Today in Energy.* Retrieved from https://www.eia.gov/todayinenergy/detail.php?id=32172

Figure 3: CAISO Average Hourly Day-Ahead Energy Market Prices (January to June)



Source: U.S. Energy Information Administration, based on ABB Energy Velocity
Note: Prices are simple averages of CAISO trading hubs ZP26, NP15, and SP15 from January 1 through June 30 of each year.

MCE has identified that they are short on energy supply during these evening ramp periods, which can lead to purchases of high-priced energy in the DA and/or RT markets on the PG&E Default Load Aggregation Point (DLAP). An initial assessment using data from the PG&E DLAP for the period of October 2016 through September 2017 identified over 130 hours per year where both the DA and RT hourly prices were above $70/MWh during the ramp hours of 5:00 PM through 8:00 PM. The $70/MWh price level was selected for this initial assessment as it is above MCE's contracted hedge price for hourly forecasted load volumes, and it is also a likely cost-effective price threshold for triggering DR events. See the Appendix for additional details on this analysis.

As described in the *Richmond DER Program Challenges and Opportunities Report*,[4] community-based DERs can be aggregated and used to reduce the cost of energy procurement even if they are not directly integrated into the wholesale market. Community-based DERs can be incorporated into a program to provide MCE with the ability to offset purchases in the wholesale market. This can involve reducing direct energy costs by shifting load from high cost to cheaper time periods, including taking advantage of the increased prevalence of negative pricing. MCE can also schedule usage of DERs to reduce necessary resource adequacy capacity required. This type of usage is called *load-modifying DER* as opposed to *supply-side resources*, which are resources that participate in the wholesale market.

4 Reid, Beth, AJ Howard (Olivine, Inc.). 2017. *Richmond DER Program Challenges and Opportunities Report.* California Energy Commission. CEC-EPC-15-076.

Program Non-Energy Objectives

The benefit of the DER Community Program is that the DER resources can be aggregated to provide more and differing potential value streams and participation opportunities than otherwise would be available to individual facilities or households. One of the services offered in the Richmond DER Community Program will be to apply Olivine's DER valuation model to participants' aggregated usage data in order to identify the stacked value streams, to provide expert advice on available market opportunities, and to devise and test operational strategies to maximize value for MCE, the City of Richmond, and for DER Community Program participants.

Offering a DR program targeted to low-income households is novel. The program theory is based on the concept that by diversifying enrollment across sectors, the program can attract more participants with more diverse load characteristics, increasing the possible value to be derived from the program. The installation of NILM devices in 50 households will provide insights into low-income residential energy consumption patterns. That data will have value not only for future DR program design but also for energy efficiency program design.

CHAPTER 3:
Program Implementation Details

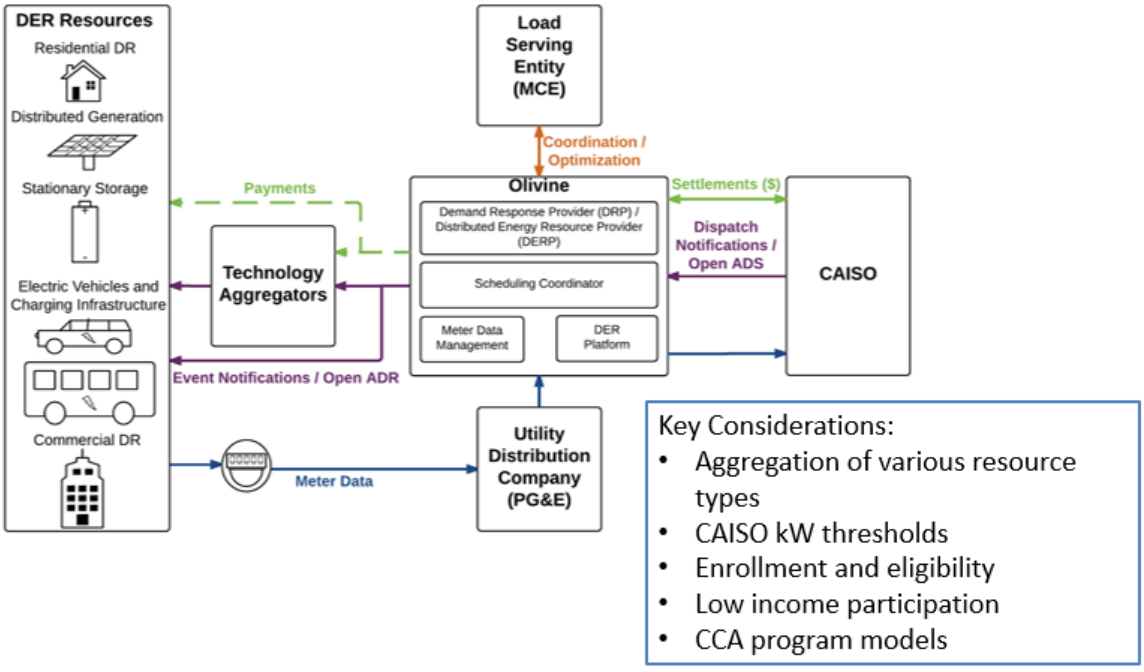
Geographic Scope

The Pilot DER Community Program would be deployed within the City of Richmond, which is served by MCE. The City of Richmond is entirely contained within PG&E's East Bay Sub-LAP (PGEB), while MCE's service territory as a whole includes a total of three Sub-LAPs, including PGEB. The current MCE service area includes 22 municipalities in four counties and three PG&E Sub-LAPs (PGEB, PGFG, and PGNB). This structure can potentially limit participation in wholesale resource aggregations for assets from the wider MCE service territory. However, this limitation does not apply to Richmond-only aggregations, since the city is located within just one Sub-LAP.

Program Administration

The Pilot DER Community Program will be administered by Olivine using existing infrastructure and capabilities. Olivine's DER Community Platform™, illustrated in Figure 4, has been implemented for other Community Choice Aggregators (CCAs) in California, including Sonoma Clean Power. Olivine has developed procedures to administer DER Community™ programs, including: program design & valuation, marketing & outreach, participant qualification, enrollment, event dispatch, and event simulation. Using the platform, Olivine is able to calculate results from events using multiple baselines.

Figure 4: Olivine DER Community™ Platform



Olivine will use these capabilities to provide reporting and expert advice to program participants on opportunities to maximize benefits of DER program participation and opportunities for whole market participation.

As a technology agnostic model, Olivine's DER Community™ provides a flexible approach for aggregating resources from multiple technology aggregators, multiple devices, and multiple sectors. The model allows individual customers to participate in CAISO wholesale markets with multiple technologies (e.g., a smart thermostat and EV), overcoming a barrier that prevents multiple DRPs from registering the same location with the CAISO. The power of this model is the ability to aggregate many small loads into a sizeable resource that is viable in California's wholesale markets. Devices and households, which on their own would not provide enough flexible load capacity to have an impact on the evening peak, are able to provide valuable services to the grid when acting in aggregate.

Program Eligibility Requirements

To be eligible for the Richmond Pilot DER Community Program, participants must:

1. Be located within the City of Richmond
2. Be a MCE customer for retail energy purchases
3. Be located within the PG&E East Bay Sub-LAP (PGEB)
4. Not be enrolled in conflicting DR programs
5. Have an energy usage profile and flexibility that allows participant to curtail load during the evening period (5 pm to 8 pm) or to shift load from that period to different times outside of this period
6. Achieve load shifting from either existing automated building systems (e.g., smart thermostats, building management systems, on-site energy storage) or manual behavioral demand response.

To qualify low-income households for participation in the pilot, Olivine will use participation in existing low-income programs offered by the City of Richmond and MCE to establish eligibility. The *Richmond DER Program Enrollment and Participation Manual*[5] provides additional information on establishing eligibility for program participation.

Program Partners

Olivine, Inc. is leading the development of the Community DER Program under subtask 3.4 of the Richmond AEC project, led by the ZNE Alliance and funded by the CEC EPIC program (GFO-15-312). Partners in the program include ZNE Alliance, Energy Solutions, MCE and the City of Richmond.

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5 Reid, Beth, Valerie Nibler, AJ Howard (Olivine, Inc.). 2017. *Richmond DER Program Enrollment and Participation Manual.* California Energy Commission. CEC-EPC-15-076.

The City of Richmond provided input into the proposed staging for the program, and provided a proposed list of initial program targets within a cluster of food production and distribution warehouses that have recently established themselves in Richmond. The City of Richmond and MCE have provided information pertaining to existing low-income programs operating in Richmond.

City of Richmond programs to be leveraged include the Yellow Brick Road community development program and the Rental Inspection Program. Based on conversations with partners in the City of Richmond, both programs have collected data on low-income households that will enable the DER Community Program to identify homes with electric AC and/or electric heating.

The following MCE programs can also be leveraged to reach qualifying households:

- Multifamily Energy Savings Program: This program provides complimentary walk-through energy assessments and technical assistance to identify energy and water saving opportunities at multifamily properties. In addition, the program provides cash rebates to implement energy upgrades, assists with contractor bid solicitations, educates and trains operations and maintenance staff, and offers a free direct install of energy and water saving equipment.
- Low Income Families and Tenants Pilot Program (LIFT): Multifamily properties with tenants at or below 200% Federal Poverty Guidelines receive a $1,200 per residential unit rebate in addition to rebates provided by the Multifamily Energy Savings Program. It also offers electric heat pumps at no cost.

In addition to the programs above, the EPIC AEC Richmond project activities and deliverables provide avenues for outreach to potential program participants, such as the ZNE Abandoned Homes program. Also as part of the EPIC AEC Richmond project, Energy Solutions conducted a review of existing low-income programs in Richmond[6] that will inform the outreach plan for this program. Olivine will continue to coordinate with program partners, ZNE Alliance, Energy Solutions, MCE and the City of Richmond, to implement the Richmond Pilot DER Community Program.

Measures and Incentive Levels

Table 1 lists the proposed measures to be implemented in each sector as part of the Pilot DER Community Program. For the pilot program, the intent is to provide participating low-income households with a smart thermostat. In addition to smart thermostats, a non-intrusive load monitoring (NILM) device would be installed in participating households in order to capture appliance usage patterns.

During the recruitment and enrollment of C&I and municipal buildings, the program administrator will assess the DR opportunities based on existing equipment and facility

6 Riker, Christine, Brett Webster (Energy Solutions). 2017. *Richmond Low-income Program Measure List.* California Energy Commission. Publication Number: CEC- EPC-15-076

energy usage patterns. Depending on the equipment in the facility, the enrollment process may also include configuration of equipment for automated response to dispatch signals.

During the second stage of the DER Community Program, program administrators anticipate increased scale due to increased enrollment from all sectors and from added DER technologies. In particular, the City of Richmond is releasing an RFP to install solar and storage in Richmond's municipal buildings early in 2018 and some of those projects are expected to come online in late 2018. While the DER Community Program will not provide funding for installation of solar or storage at customer locations, where those technologies are available, they could be included in the DER aggregation.

Table 1: Measure List by Target Participant Type

Measures	Residential Low Income	City of Richmond Building(s)	C&I Building(s)
Smart thermostat	Yes	No	No
NILM Device	Yes	No	No
Solar / Battery Storage	No	Yes (Stage 2)	Depending on existing equipment
Behavioral Demand Response (Load shifting)	Yes	Yes	Yes
Direct Load Control (Load shifting and/or shedding)	No	Depending on existing equipment	Depending on existing equipment

Program administrators also anticipate being able to provide ongoing performance-based incentives based on shared savings generated from DR events. The amounts will depend on variable factors such as level of load curtailment and wholesale market prices. More details on the incentive structure will be provided during the first phase of the program based upon C&I recruitment and enrollment outcomes and application of Olivine's DER valuation model.

Program administrators will also provide program participants with reports to educate and inform on response during DR events, general energy use patterns, and opportunities for energy and utility bill savings.

Additional Services

One of the services offered in the Richmond DER Community Program will be to apply Olivine's DER Valuation Model to aggregated usage data from the facilities in order to identify the stacked value streams, to provide expert advice on available market

opportunities, and to devise and test operational strategies to maximize value for MCE, the City of Richmond, and for DER Community Program participants.

Program Specific Marketing and Outreach

Marketing and outreach materials will be produced for the purposes of recruiting participants into the pilot program. One-page program descriptions will be developed for each target participant group. In addition, the program may be promoted through the City of Richmond's website and MCE's website. The program administrators will provide content to support website updates.

As described above, by leveraging existing low-income programs offered by the City of Richmond and MCE, the program administrator expects to be able to target qualified low-income households in order to enroll up to 50 households. Using a database compiled from existing resources supplied by MCE and the City of Richmond, the administrators will send mailers and emails to promote the program and to direct interested households to more information. Those seeking additional information will be able to access information via websites or a customer support telephone number (supported by the administrator). The program administrators will host one community event to promote the program, provide information, confirm eligibility and to schedule installations.

Program Specific Training

Training and protocols will be developed to ensure that the programs activities (outlined in Figure 5 below) produce the desired pilot program outcomes. The program logic model (in Figure 6 below) identifies anticipated program outcomes.

Program Software and/or Additional Tools

The Richmond Pilot DER Community Program would be administered through the Olivine DER Community™ Platform. Additional software and tools are being considered, such as a DER Community App that works with the smart thermostat and NILM device with capabilities to remotely control thermostat settings and to provide real-time energy insights to customers.

Program Quality Assurance Provisions

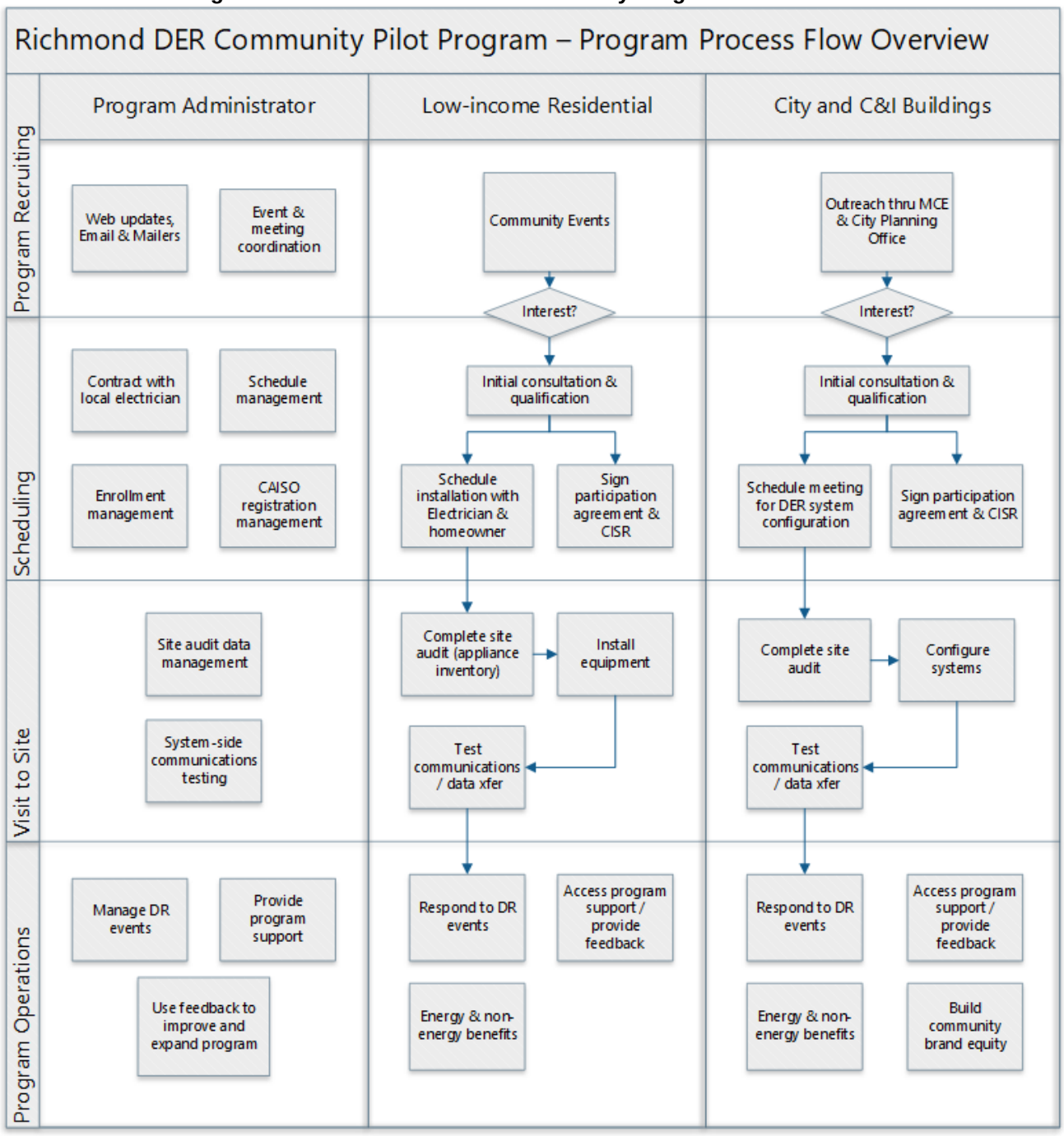
The program will contract with a licensed electrician for installation of NILM devices as well as thermostats, if needed. Training and protocols will be developed to ensure that the programs activities (outlined in Figure 5 below) produce the desired pilot program outcomes.

Program Delivery Method

The program process flow provides in Figure 5 provides additional detail on plans for program delivery, with steps identified for recruiting, scheduling, site visits, and program operations.

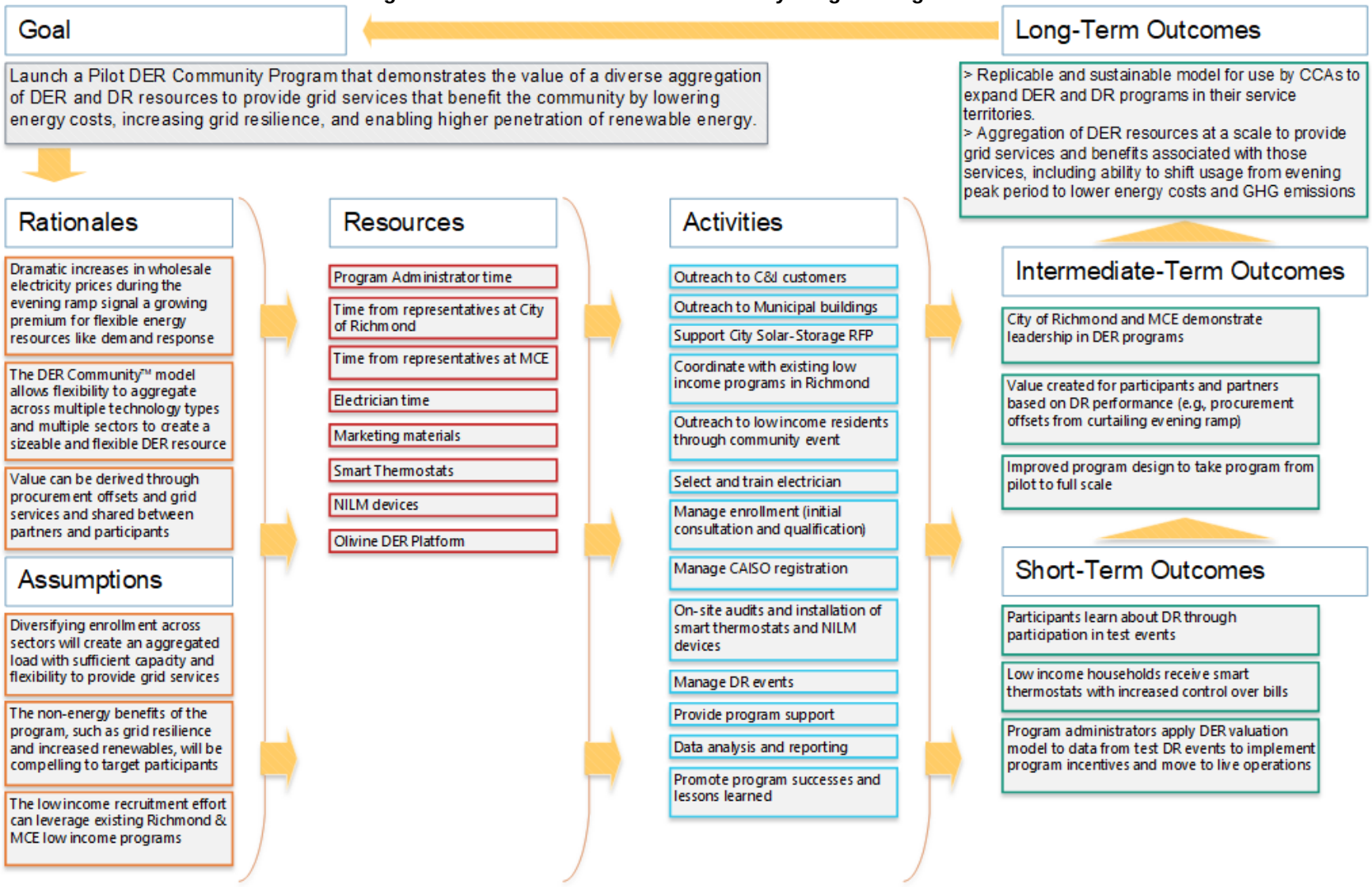
Program Process Flow Chart

Figure 5: Richmond Pilot DER Community Program Process Flow



Program Logic Model

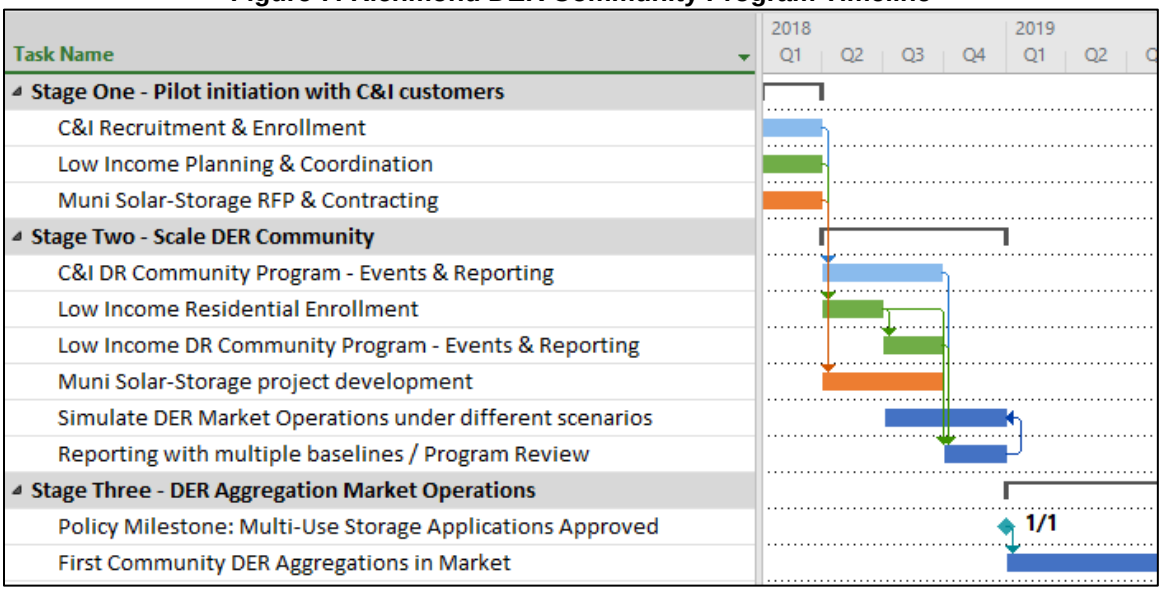
Figure 6: Richmond Pilot DER Community Program Logic Model



CHAPTER 4:
Program Timeline

As described earlier, recruitment and enrollments in the Pilot DER Community will be staged to focus first on C&I customers and municipal buildings, followed by low-income households. The staging will allow the program administrators to more quickly build program scale by focusing on customers with larger loads. Figure 7 illustrates the proposed timeline for the Richmond DER Community Program, listing activities for each of the three stages. The light blue bars highlight activities that relate to C&I customers, the green bars highlight activities that relate to low-income customers, the orange bars highlight activities related to the Solar & Storage RFP, and the dark blue bars relate to all sectors.

Figure 7: Richmond DER Community Program Timeline



Key: Light blue = C&I Customers; Green = low-income customers; Orange = Solar and Storage projects on City properties; Dark Blue = all sectors.

By focusing stage one efforts on coordinating with existing low-income program offerings in Richmond, program administrators expect to be able to significantly lower the per customer enrollment costs and to begin enrolling residential customers in the DER Community Program by Q2-2018. Activities in the first stage will position the DER Community Program for expansion in the second stage by identifying points of coordination with existing residential low-income programs and by releasing a request for proposal (RFP) to install solar and storage in Richmond's municipal buildings. During the second stage, which is anticipated to run from April 2018 to December 2018, the DER

Community will be scaled to include low-income residential customers, municipal buildings, and additional DR and DER enabling technologies.

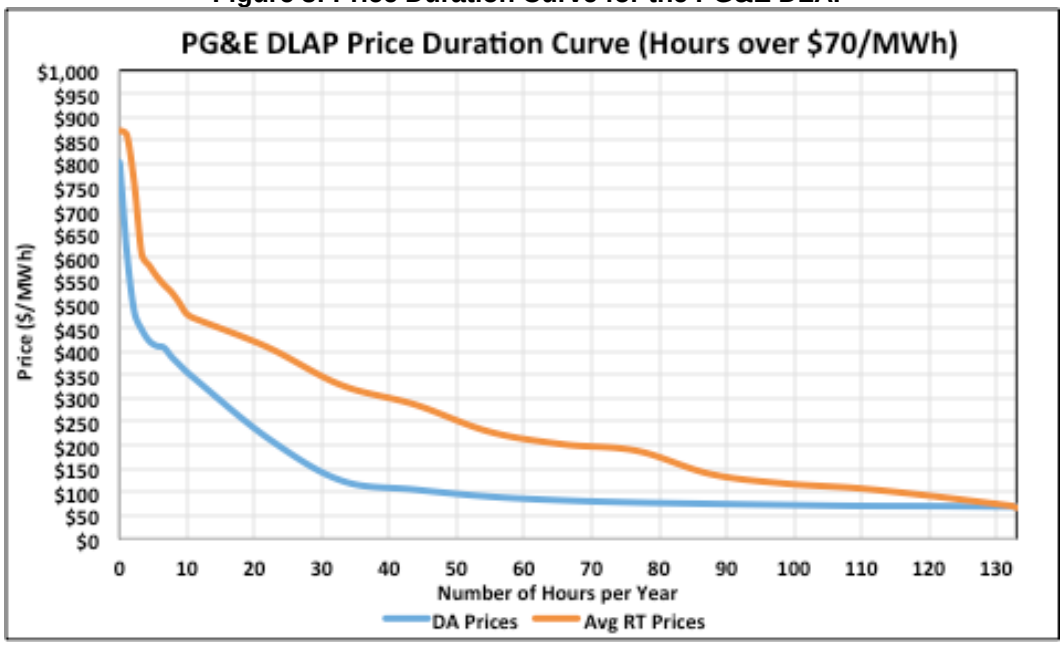
In the second stage of the program, program participants will be called upon to participate in DR events with the objective of shifting load from the evening peak. Reports will be provided based on these events to educate participants and to improve the program design. In addition to putting DR into operations, program administrators will also simulate aggregations that include customer-sited generation resources, such as solar and storage, that can supply net energy to the grid. Simulation will show the capabilities of a DER aggregation (DERA) to provide grid services beyond load curtailment.

Limitations on multi-use applications currently pose a policy barrier to including energy storage in a DERA for wholesale market participation, but program administrators anticipate some resolution to these limitations by 2019. If so, the results of the DERA simulations will position the Richmond DER Community to be one of the first DERAs to participate in CAISO markets going into 2019 (identified as stage three in Figure 7).

APPENDIX:
Economic Impacts of Demand Response Resources for MCE

MCE has indicated that it is short on energy supply during critical pricing periods of the day. These periods correspond to the afternoon "ramp" of wholesale power supplies on the transmission grid. Being short on energy supply during these periods can lead to purchases of high-priced energy in the Day-ahead (DA) and/or Real-time (RT) markets on the PG&E DLAP. An initial assessment of the DA and RT hourly prices on the PG&E DLAP for the period of October 2016 through September 2017 identified over 130 hours per year where both the DA and RT hourly prices were above $70/MWh during the ramp hours of 5 PM through 8 PM. The $70/MWh price level was selected for this initial assessment as it is above MCE's contracted hedge price for hourly forecasted load volumes, and is also a likely cost-effective price threshold for triggering demand response events. Figure 8 below illustrates a Price Duration Curve for the highest price DA and RT hours on the PG&E DLAP within the 5-8 PM ramp period. As seen in Figure 8, there are over 40 hours per year where the DLAP price is over $100/MWh in both the DA and RT markets during the ramp period, with prices over $500/MWh for a small number of hours during the year.

Figure 8: Price Duration Curve for the PG&E DLAP

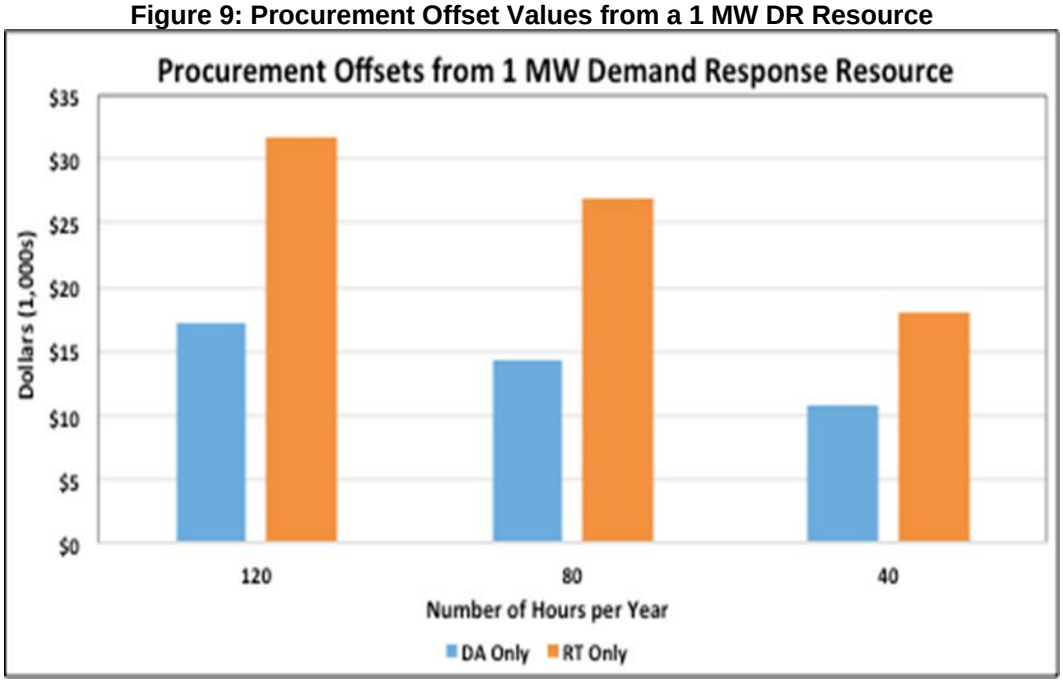


Deploying DERs during hours with high DA and RT prices is a viable strategy for MCE to reduce wholesale power purchase costs, especially when being short on supply during these hours leads to non-economic purchases of energy. The use of behind the meter DR resources can result in an equal to or greater than 1:1 offset of CAISO market purchases, as the procurement offsets also include System Line Loss Factor requirements of 6% above the system load requirements.

While the ability of a DR program to offset procurement of wholesale power supplies will require different types of DR resources for the DA and RT prices, Olivine's estimate of the value of DR events to MCE during these high-priced periods is technology agnostic. The initial program concept is that DR resources would be deployed within the City of Richmond boundaries to demonstrate its value, and then it could be expanded and scaled up throughout the MCE's service area.

To assess value to MCE, a hypothetical 1 MW demand response resource was used to develop estimates of the procurement offset savings values. This simple assessment looked at the top 40, 80, and 120 price hours in the DA and RT markets during the daily ramp period and calculated the dollar savings provided by demand response resources based on DR's ability to reduce MCE system loads and reduce wholesale power purchases. Figure 9 below illustrates the indicative value to MCE of wholesale offsets of DA and RT procurements during the highest 120, 80, and 40 hours of the year within the daily ramp period of 5-8 PM from a 1 MW demand response resource.

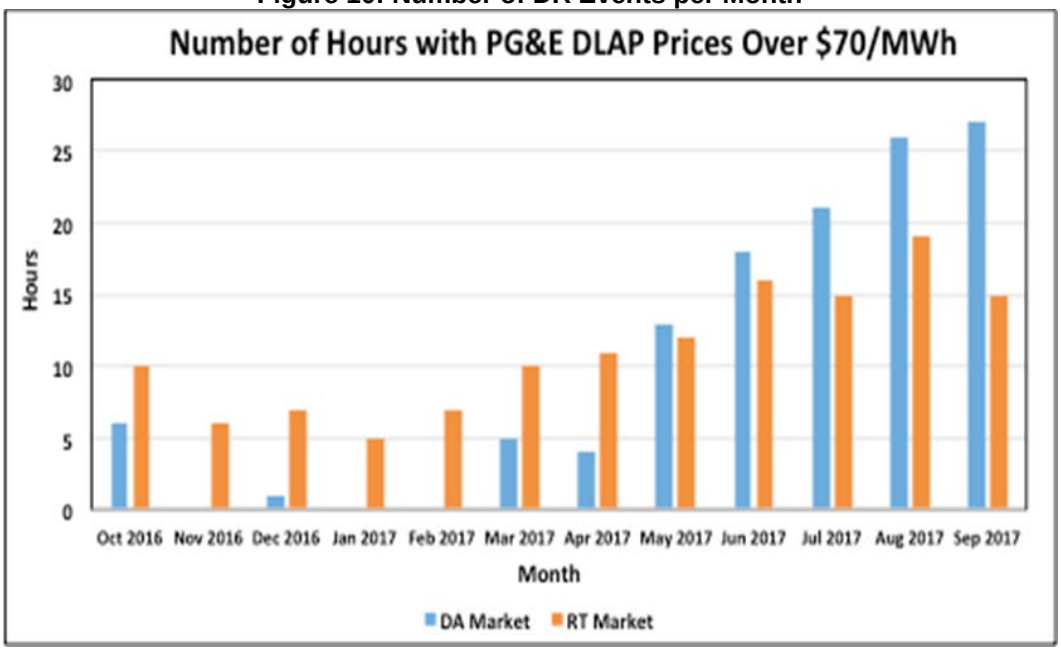
Figure 9: Procurement Offset Values from a 1 MW DR Resource



Based on this initial analysis, demand response resources could provide savings to MCE of between $11,000-$17,000 per MW-year on avoided DA procurements depending on the number of event hours the resource is utilized. Similarly, DR resources could provide between $18,000-$31,000 per MW-year on avoided real-time procurements depending on the frequency and duration of events. This initial analysis does not account for potential snap back or load shifting effects of the DR resource and only looks at the procurement savings during the event hours. However, it also does not include the potential for additional revenues from DR participation in the wholesale supply markets at the CAISO level. Based upon the price triggers used in this analysis, there would be a high correlation of these events also being able to capture revenues from the Capacity Bidding Program at the Sub-LAP.

The final element of this initial analysis for MCE was to determine the potential frequency of DR events on a monthly basis. We approached this by identifying the number of hours per month that the DLAP price exceeded $70/MWh during the ramp hours of 5-8 PM in DA and RT markets. Figure 10 below illustrates the distribution of DR event hours by month.

Figure 10: Number of DR Events per Month



While additional analyses are needed to incorporate additional cost and revenue streams from a DR program demonstration in Richmond, this initial review indicates that the program could provide significant cost savings to MCE in the form of avoided procurement costs during periods that it is short energy and that the market prices are high. These procurement cost savings are likely to increase as the program is scaled up and targeted to customers with the ability to shed or shift load with minimal disruption to the comfort, productivity, or business operations of the customer.