Olivine, Inc.

# The Olivine Community Energy Initiative: A Study of Home Energy Use in Disadvantaged Communities

February 28, 2019

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## About Olivine

Olivine provides infrastructure and services that enable distributed and aggregated resources—such as solar, demand response, electric vehicles and battery storage—to effectively and efficiently offer grid services. Designing first-of-a-kind, proof-of- concept projects, Olivine has developed unique approaches, especially relating to behind-the-meter challenges, and is the first third-party to integrate battery storage and other demand-side technologies into California's wholesale markets.

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# Executive Summary

From July to December of 2018, Olivine performed a first-of-its-kind study of disadvantaged communities (DAC) known as the Olivine Community Energy Initiative (OCEI) in Richmond and Oakland, California. The purpose of this study was to specifically study households' use of energy in disadvantaged communities and their ability and interest in participating in demand response programs. Secondary goals of this study were to also test outreach, marketing, and facility with technology among these households. The intention was to gain a greater understanding of how to directly address the needs and specific requirements of disadvantaged communities in order to increase their participation in, and benefit from, demand response programs.

Participation in the OCEI was extremely positive. The majority of enrolled households completed surveys and participated fully in the demand response program, earning full incentives available. They also expressed high interest in understanding their home energy use, participating in future demand response opportunities, and contributing to the study's findings. Almost all households expressed air quality and emissions as a 'very high concern'. All of these findings held constant regardless of income, type of residence, level of education, number of children in the home, and whether or not the household was located in a DAC. DAC households generally consumed slightly less energy than non-DAC households, reduced less energy during demand response events, and had lower overall participation than non-DAC households, however, their participation levels were still high.

The findings of the OCEI, while promising, point to the need for larger studies of home energy use and demand response participation by DAC households as well as the use of a control group in any such studies.

# Introduction

Disadvantaged Communities (DAC) have become an increasingly important policy focus in California in recent years.[1] From an environmental efficacy and environmental justice standpoint, the state has determined the necessity of directly incorporating DACs into its carbon emissions goals. A DAC designation reflects a community's disproportionate exposure to pollution and the resulting health effects of that exposure. As these communities are on the front lines of exposure to pollution generated by both public and private activity, development and implementation of clean energy programs, technologies, and jobs must of necessity be prioritized in these communities. To date, billions of dollars in public funds have been spent on programs encouraging Californians to purchase electric vehicles, acquire solar panels, and upgrade home appliances. These pursuits, though important and admirable, are not targeted towards DACs or necessarily accessible by the residents of DACs due to a variety of causes.

In response, the California Public Utilities Commission (CPUC) has issued several rulings and decisions in recent years to increase focus on and investment in DACs – such as the Green Tariff Renewables Program, Single Family Affordable Solar Homes (SASH), and Solar on Multifamily Affordable Housing Roofs (SOMAH), to name a few. In December of 2018, the CPUC issued a decision requiring the Investor Owed Utilities (IOUs) to prepare and develop a demand response pilot providing direct economic benefit in DACs within each of their territories[2]. This pilot seeks to alleviate demand on high polluting nearby gas peaker plants[3] and provide economic and environmental benefits directly to residents of DACs by implementing demand response programs that reduce load on these nearby plants during peak demand hours.

In order to design programs that are both beneficial to residents of DACs and efficient to taxpayers and ratepayers, more needs to be learned about these communities. In anticipation of the demand response pilot, Olivine conducted a self-funded study with the purpose of learning more about the use of energy in DAC households and the feasibility of demand response programs. This study, known as the Olivine Community Energy Initiative, is the subject of this paper and the findings and learnings from this study, which ran from July to December of 2018, are presented herein.

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[1] Disadvantaged Communities are those census tracts defined by the California Environmental Protection Agency (Cal EPA) as meeting or exceeding a 75% threshold based on factors developed by the Cal EPA and published in their tool, Cal Enviroscreen 3.0, plus an additional 22 census tracts that score in the highest five percent of CalEnviroScreen's pollution burden but do not have an overall CalEnviroScreen score because of unreliable socioeconomic or health data.

[2] D. 18-11-029, December 10, 2018.

3 These gas peaker plants are generally located near or in DACs.

Approximately one in four Californians live in a DAC[4], so alleviating their pollution burden and creating clean energy communities and economies is no small task. However, it is Olivine's strong belief that all members of a community should benefit from energy solutions and is committed to bringing energy services to all Californians. It is in this spirit that the OCEI was conceived and implemented.

# Overview

## Purpose

The purpose of the Olivine Community Energy Initiative (OCEI) is to learn about how households in DACs use energy in their homes, the feasibility of demand response programs, and what types of services and programs would be of greatest benefit to DAC households. More specifically we were interested to learn about their capacities, technological capabilities, and motivations for participating in demand response events.[5] A sample of some of the questions we hoped the study would answer are:

- How and when do individuals use energy in their homes?
- Can a household reduce energy when requested?
- Will households participate in demand response programs?
- Are there observed differences between households in DACs and those not in DACs but proximate to DACs?
- What are important concerns of households for their communities?
- Do carbon emissions fit into those concerns and to what extent?
- What methods and approaches to outreach are most successful?
- How much facility do households have with technology?

The OCEI was further envisioned as a follow on to the work performed by Olivine on a California Energy Commission (CEC) funded Richmond Advanced Energy Community Project in Richmond, California. Work on phase I was completed in 2018. The mission of the Richmond Advanced Energy Community (AEC) Project was to accelerate the decarbonization of buildings, energy, and transportation systems—and enhance community resilience, public health, home ownership, and prosperity for the residents of California's Disadvantaged Communities. As Richmond contains a number of DAC census tracts, it was envisioned that programs specifically aimed at DAC households would be instituted as part of the larger scope of work.[6]

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4 Cal Enviroscreen, 3.0.

[5] A demand response event as defined for the OCEI study is when a participant is asked to reduce home energy use when requested.

[6] For more information on the AEC Richmond project and Olivine's work: Chipman Jane, Richard Schorske. ZNE Alliance, 2017. Richmond Advanced Energy Community. California Energy Commission. Publication Number: CEC-500-2018- 03.

## Parameters

Due to the short time frame available for implementation, as well as the limited budget, the study's population was kept intentionally small, with a goal to enroll fifty households. Data was collected at multiple points: from surveys, meter data, and participation in a demand response program. An incentive structure was built into each component of the study so that households were paid for each action they took. None of these actions were mandatory. Participants were given the option to pick whichever actions they felt most comfortable with. The purpose was to maximize participation and not have potential enrollees feeling that they were committed to actions they were unsure of.

- The study was kept intentionally small, with a goal to enroll 50 households.
- Two main locations were chosen - Richmond and East Oakland.
- Zip codes were used to determine eligibility for enrollment. The selected zip codes largely encompassed DACs, though the coverage ratio was not 100%.
- Multiple data collection points were gathered from surveys and meter data.
- An incentive structure was built into each component of the study: Households were paid for each level of participation.

### Locations

The choice of Richmond as one of the locations of the study was influenced by the learning, experience, and connections gained through the work performed there during the CEC grant. East Oakland was added as a second location to provide expanded opportunities for additional data and learnings.

Zip codes were used to determine eligibility for enrollment in the OCEI, as census tract designation was challenging for an individual to self-identify. The list of eligible zip codes is found in Figure 1.

Figure 1. List of zip codes.

| Zip Code | Location | Number of enrolled households |
|---|---|---|
| 94801 | Greater Richmond Area | 7 |
| 94803 | | 0 |
| 94804 | | 9 |
| 94805 | | 1 |
| 94806 | | 3 |
| 94601 | East Oakland | 1 |
| 94603 | | 1 |
| 94621 | | 0 |

As the greater Richmond area is comprised of several DAC census tracts, zip codes generally overlay on top of DAC tracts fairly well. However, zip codes cross city lines in many cases, so a subset of households in El Sobrante, Pinole, and El Cerrito were also eligible for enrollment as long as they resided within the study zip codes. We included a zip code that does not technically cover any DAC communities, but does contain AB 1550 designated low income communities (zip code 94803). Selected zip codes cover many different types of census tracts: disadvantaged communities, low-income communities within a ½ mile of a disadvantaged community, low-income communities, and communities that are both low-income and disadvantaged communities. These different types of census tracts and the study zip codes are illustrated in Figure 2. Figure 3 displays a map overlay of zip codes on census tracts.

Figure 2. Map of zip codes in Richmond, Ca.

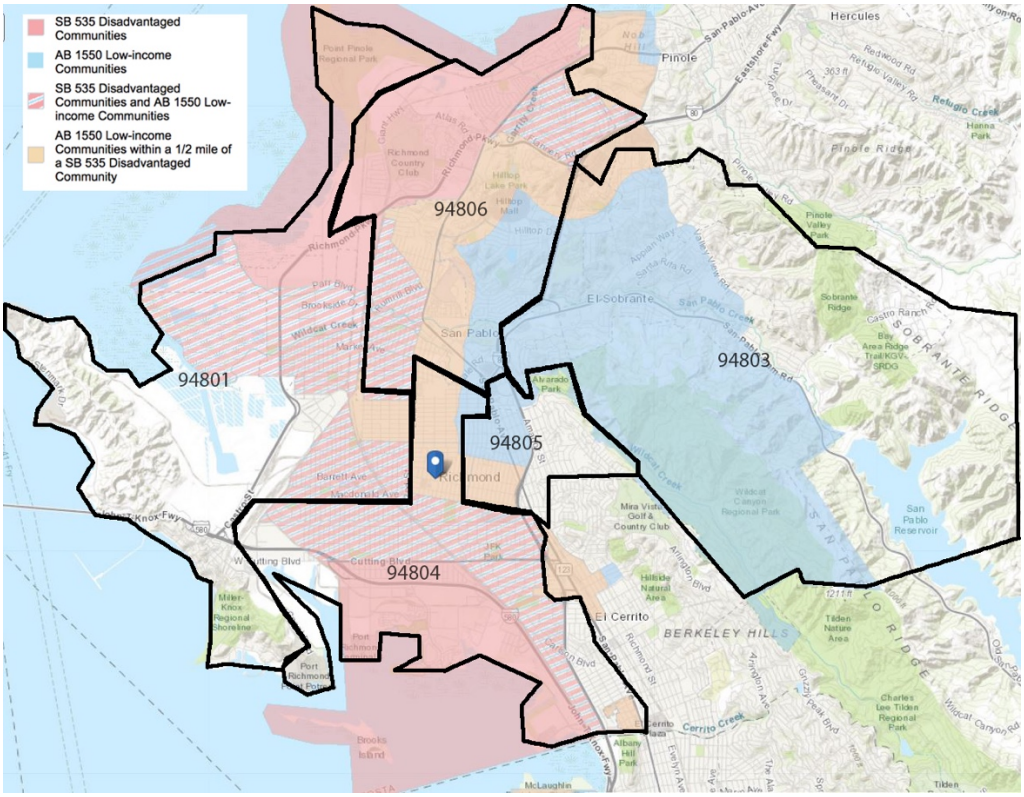


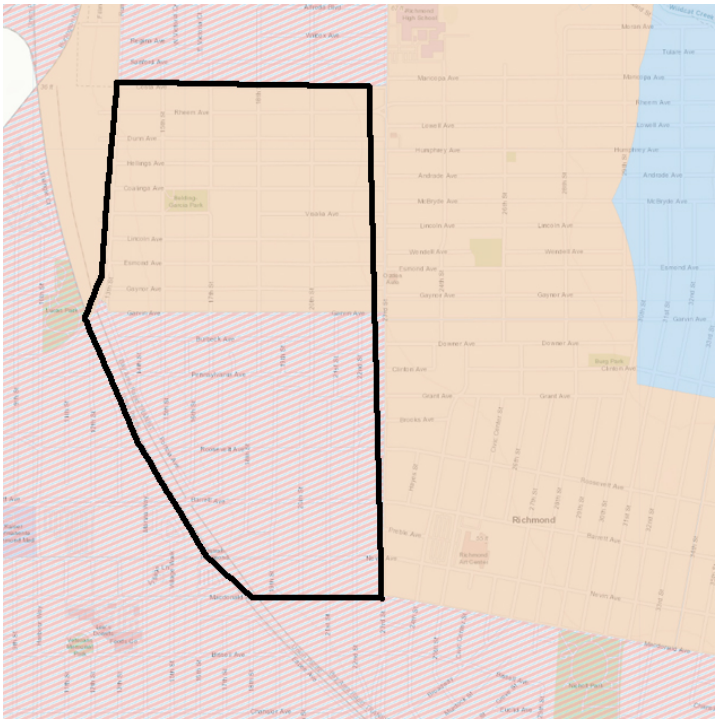

Figure 3. Community Category of OCEI Households

| Category of Community | Number of Households | Legend |
|---|---|---|
| SB 535 Disadvantaged Communities | 1 | |
| AB 1550 Low-Income Communities | 0 | |
| SB 535 Disadvantaged Communities and AB 1550 Low-Income Communities | 10 | |

| | | |
|---|---|---|
| AB 1550 Low-Income Communities within ½ mile of a SB 535 Disadvantaged Community | 3 | |
| None of the above | 8 | |

The map illustrates the challenges of defining a community by DAC vs non-DAC status for study and program purposes, as census tracts cross city and neighborhood boundaries, splitting and grouping households among multiple different categories. For example, the Belding Woods neighborhood, which encompasses a relatively small area, is split into two census tracts, one a disadvantaged community, and one a low-income community, as can be seen in Figure 4.

Figure 4. Map of the Belding Woods neighborhood, Richmond, Ca.




Within the OCEI households were split among these various categories is illustrated in Figure 3.

In East Oakland, zip codes and DAC boundaries overlapped more evenly than in Richmond, although zip codes also encompassed different categories of community as well. People were asked for their zip code when signing up on the Olivine Community app. Once GBC data was available, a verification check was run to ensure that the individual's home meter was located within one of the eligible zip codes. This home meter address was used to determine DAC status of an enrolled household.

## Incentive structure

To motivate the highest level of participation, we provided monetary incentives for each action performed. The use of monetary incentives also provided us with the ability to understand motivations for participation in different components of the study. Furthermore, we allowed for high flexibility – participants could perform as many or as few actions as desired. The maximum a participant could earn was $225, not including a referral bonus. The different incentives available are listed below in Figure 3.

Figure 5. Incentives in the OCEI.

| Incentive | Amount | Timing | Action |
|---|---|---|---|
| Enrollment Survey | $75 | Upon enrollment | Complete 26 question survey |
| Home Energy Study | $100 | September – December | Reduce home energy use on 5 occasions when requested |
| Home Energy Study Survey | $50 | Upon completion of 2 successful events | Complete 23 question survey |
| Referral Bonus | $20 | At any time | Refer an eligible household into study |

## Review of Existing Studies

Prior to designing the OCEI, we reviewed existing studies focusing on DACs. No studies to date have been performed to specifically study DACs – the OCEI is the first - but one study recently conducted on the DAC level provided useful information and guidance. In 2016, UCLA was given an Electric Program Investment Charge (EPIC) grant to design a program providing 'locally generated GHG-free electricity from community solar and storage to offset electricity consumption of participants who "opt in" to the AEC through an enrollment system.'[7] The project, AEC Avocado Heights/Bassett, took place in a suburb of Los Angeles County over the course of a year and employed a grassroots community organization to conduct the outreach. The program report[8] outlines the methodologies, outreach strategies, survey designs, and incentives as well as challenges and limitations of the program.

As the AEC Avocado Heights/Bassett project and the OCEI had different purposes and goals, the relevant sections of this report were on performing outreach at the community level. Multiple in-person events were held – both tabling at various community events, presentations at the local schools which provided free dinner, and a multifamily apartment outreach. The project also employed social media outreach, the use of surveys, and focus groups. Central to their outreach strategy was identification of and

[7] https://www.ioes.ucla.edu/project/the-epic-challenge-accelerating-the-deployment-of-advanced-energy-communities/

[8] Ibid.

collaboration with identified neighborhood leaders. We adapted several of these methodologies, particularly the use of a multipronged approach (employing different forms and types of outreach) and the identification of and plan to collaborate with community-based organizations (CBOs). The report indicated challenges to performing outreach in DACs. This was anticipated to be the most challenging part of our study, which proved to be the case.

# Study Components

## Surveys

Surveys were employed to learn about population characteristics of OCEI members[9] and their experiences with demand response. General characteristics help us to understand how different populations are enabled for demand response, and as such can help tailor and design programs for maximum benefit. An initial survey was emailed to participants upon enrollment in the study. The enrollment survey asks 26 questions on demographic, socio-economic, household composition, and building and appliance characteristics. The purpose of the enrollment survey was to answer such questions as:

- What kind of electric rate schedules are participants enrolled in?
- What is the education level of participants? Are different messaging or additional education on home energy use and demand response indicated depending on education levels?
- What is their employment status and income levels? How able might they be to acquiring internet ready devices and appliances?
- What types of residences do they live in? How are these residences heated and cooled? How energy efficient are their appliances?
- Are they renters or owners? Have owners invested in newer appliances or received energy efficiency rebates?
- Are participants already participating in demand response programs? Do they try to reduce energy in their homes? If so, what actions do they perform to reduce energy?
- What were the motivations to enroll in the study? Were incentives purely incentive driven or was messaging also important?

A second survey was emailed to those participants who participated in our Home Energy Study which was the demand response portion of the initiative. The goal of the Home Energy Study Survey was to learn about participants' experiences with using our app and participating in demand response events. Generally, we hoped to learn how well participants were able to interact with an app for demand response purposes and what measures they took to reduce home energy use. A further goal was to understand the effectiveness of an app for communicating with participants and providing information on home energy use. The results of both these surveys will presented in some detail in the Findings section of this paper.

[9] The terms 'participants' and 'members' are used interchangeably to refer to individuals enrolled in the Olivine Community Energy Initiative. 'Respondent' refers to those members who completed a survey.

## Demand Response Simulation: The Home Energy Study

In order to test out the interest and ability of households to participate in demand response programs, we designed a simulation, known as the Home Energy Study, in which households would be paid for participation, rather than directly for load shifting or reductions. The Home Energy Study attempts to primarily address the following questions:

- Will households participate in a demand response program?
- How and when do households use energy?

Of secondary interest were the following questions, though we were uncertain the data would be meaningful enough to observe any real patterns or draw conclusions:

- How much energy do they use?
- How much energy can they reduce?
- Are there differences in patterns, use, and participation between DAC and non-DAC households?

The Home Energy Study ran from September to December of 2018. Two to three requests to reduce home energy use were issued per month for a total of 10 requests. Seven requests were one hour long with the other three being two hours long. Requests were scheduled in the evenings, between the hours of 5 pm and 9 pm. However, as incentives were tied to participation, only one request was scheduled with a start time of 5 pm in order to allow for as much participation as possible. Participation in requests was voluntary. An opt-out function built into the app was enabled during the 30 minutes prior to each request so that participants could effectively signal a lack of participation rather than a lack of performance.

## Olivine Community App

As part of the Home Energy Study, Olivine partnered with Encored Tech to produce a white label app, the Olivine Community Energy app, available for both iOS and Android mobile devices and downloaded directly from the Apple and Google App Stores. A web app version which syncs with mobile devices is also available for download. The app is available to anyone to download, however app users not enrolled in the OCEI did not participate in the Home Energy Study.

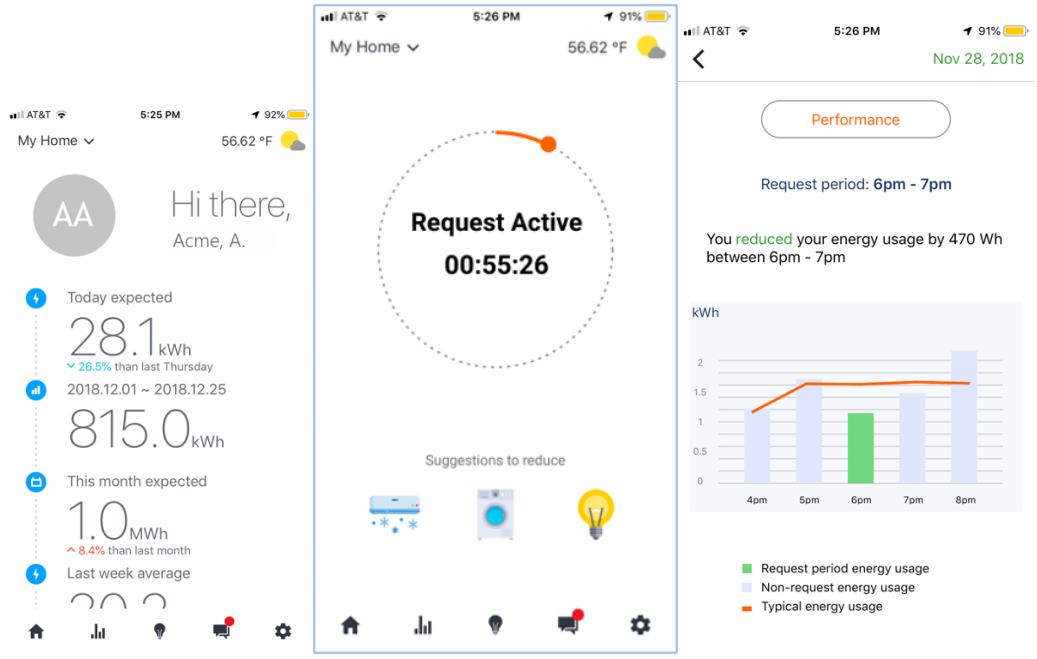
The purpose of the app was to:

- enroll eligible households into the OCEI
- provide general home energy use information (available to all users)
- provide a method for viewing and tracking event performance (OCEI households)
- communicate with OCEI households regarding events.

The app has four main sections:

1. A daily home use graph which displays hourly electricity load data.
2. A request screen which was used for demand response events. On this screen, a user could track request performance and history and find countdown timers for 30 minutes prior to a request and during the duration of the request.
3. A performance screen which contains the performance data for a request date.
4. A message screen for all necessary communications between Olivine and OCEI members. This included request notifications, alerts to results being in, and any necessary app update notices.

Figure 6. Screencaps of the Olivine Community mobile app.




## Understanding Performance: 'Typical Energy Usage' or Baselines

In the Olivine Community app, a participant can see how much energy was consumed during an event compared to the amount of energy consumed on a similar day. This is seen in the third screencap in Figure 4. This 'typical energy use' or baseline, was used to determine performance. Performance is calculated using the difference of a 10-in-10 baseline less the metered load during the request. The 10-in-10 baseline is constructed by building a 'typical load' for the household using similar day-types (weekdays or weekends/holidays) to the request day over a 45-day look-back window. A day-of-

adjustment multiplier is applied to the average profile for all hours of the event to produce the baseline.[10]

## Outreach, marketing, and social media testing

A further goal of the OCEI was to test various methods of outreach, marketing, and the use of social media. Outreach was conducted from July to September and encompassed a number of methods such as flyering, speaking at neighborhood meetings, partnering at community events, tabling, canvassing, and connecting with community-based organizations (CBOs) and houses of worship in Richmond and East Oakland. All materials were provided in English.

### Outreach

Flyers were posted at over 50 businesses, public and governmental offices and agencies, health care centers, retirement centers, non-profits, and youth and family centers. Flyers presented information on study requirements, incentives, and instructions for how to enroll. Photo imagery used for the flyers and all collateral were representative of the populations of Richmond and East Oakland. Flyers were emailed to a list of neighborhood associations and councils in East Oakland and Richmond as well as to a few apartment home owner associations. Events consisted of presentations to neighborhood council meetings in Richmond and community events, such as a Richmond Town Hall meeting on Clean Energy co-hosted by APEN and Communities for a Better Environment (CBE). For tabling we hosted a table at the weekly farmer's market in Richmond. We also connected with CBOs engaged in areas such as community energy, health, social justice, and air quality, such as APEN, Communities for a Better Environment, East Oakland Collective, and East Oakland Building Healthy Communities to name a few. Flyers and other collateral were provided and made available at The Power in our Breath: East Oakland Stories, a community meeting organized at Allen Temple Baptist Church in Oakland by 15 local CBOs working to improve quality of life for East Oakland residents. We reached out to other CBOs operating in Richmond and East Oakland, such as Oakland Collective, Richmond Main Street Initiative, The Unity Council, The Latina Center, Richmond Community Foundation, and many others, providing flyers and press releases and other collateral. Finally, we performed outreach with houses of worship in East Oakland and Richmond, providing flyers and other materials to make available to their congregations. We also canvassed at select locations, such as the Contra Costa College campus, and a DAC neighborhood, both in Richmond. Each method had its own merits and provided feedback on testing outreach methods.

### Customer Support

A customer support phone line and email were set up to field and respond to questions and concerns by anyone interested in enrolling. The customer support phone line was staffed Monday – Friday from 9 am to 5 pm, excluding holidays. We provided live assistance to help walk participants through the enrollment process, answer any questions about the study or incentives. Customer support further

[10] The day-of adjustment is based on the first three of the four hours prior to the event.

handled all incentive payments, survey handling, communications regarding demand response events, and scheduling demand response events. All interactions were held in English.

### Marketing & Social Media

Press releases were crafted and sent out to small local publications, news outlets, and blogs in Richmond and East Oakland, as well as CBOs and public agencies. We further advertised our study using the community advertising site, Craigslist, and the social networking platform, Nextdoor. Both methods yielded responses and enrollments. We maintained a dedicated Facebook page and Twitter account, posting updates, encouraging enrollment and participation, and informing the general public about the OCEI study.

### Education and messaging

Several pieces of marketing collateral were created to inform, educate, and assist the general public. A dedicated website, www.olivinecommunity.org , provided details on the purpose of the study, addressed privacy issues, and assisted with the enrollment process. Other collateral was created, such as:

- a Participation Guide, a quick reference to enrollment steps and incentives; and
- a Users's Guide, with important information on how to use the Olivine Community app and to read the information.

Social media sites, such as a dedicated OCEI Facebook page and Twitter account, were used to inform followers on activities and information in the clean air space, relevant energy related events in Richmond and East Oakland, and further messaging around the design and purpose of the OCEI.

Focused messaging was important to reduce the complexity of the study. We chose to emphasize that participants were enrolling in a 'study' rather than a 'program' to reduce any confusion surrounding enrollment with specific energy providers. The goals and purpose of the study were explained and made clear so that households interested in enrolling understood the larger influence and positive impact of their participation. We emphasized upfront, both through materials and at presentations, that participation would not result in any cost to households whatsoever, and that their information would remain private and not be shared except in aggregated, anonymized form.

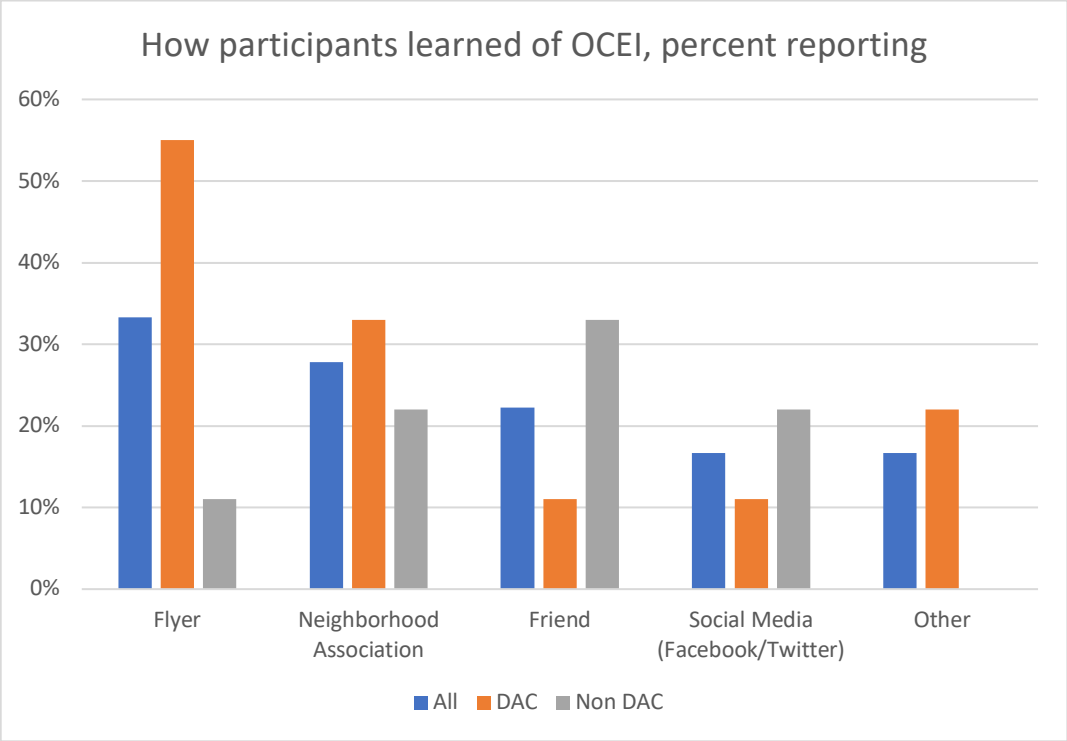
We also simplified the language and the steps as much as possible. We used as little technical language as possible and created simple and accessible icons in our app, with mostly graphic displays of information. For example, the trophy icon was used to indicate a successful demand response event.

# Findings

## Outreach Findings

As detailed earlier, multiple methods were tested for outreach. The most successful methods for recruiting participants were flyers, neighborhood presentations, and personal referral.

Figure 7. How participants learned of the OCEI.




Why were flyers so successful? Flyers were not just posted but packets handed out and time spent explaining the program and incentives to staff at these locations. Thus, flyers incorporated a fair amount of in-person interaction and explanation, which likely facilitated enrollment.

### Personal interaction

In-person events, such as presentations to neighborhood groups and at the Richmond Town Hall community event, were highly successful forms of outreach. Presentations allowed for answering questions and concerns and tailoring messages for the specific audience. Audiences had many questions and concerns about various aspects of the study that were more effectively answered in person. Furthermore, a persuasive case could more easily be built through in-person communication. Although there was only time for presentations to 3 neighborhood council meetings, at least 28% of OCEI members were recruited from these meetings. All of these members came from the Richmond area. Although East Oakland has a few neighborhood organizations, they held fewer meetings, so presentations to these groups was not possible.

### Differences by Location

Outreach in Richmond yielded more participants than in East Oakland, as fewer opportunities existed in East Oakland. Richmond is a highly organized community, with many community events, councils, public spaces, and active organizations. East Oakland, conversely, has far fewer possibilities for outreach.

Public spaces for community gathering and sharing of information are fewer in East Oakland and are more distant from one another, unlike Richmond which has a strong and active town center. As such, we identified churches and houses of worship as excellent candidates for outreach, but unfortunately time constraints did not allow us to make repeated visits to these locations. Mailings and phone calls were generally not responded to, in-person visits would have been more successful. However, these would have needed to happen before or after worship services, as staff are generally more likely to be on the premises at these times, and likely needed several visits.

### Challenges & Lessons

Early on, we set the goal of identifying potential partners at the community level and reaching out to inform them of our study and enlist aid in spreading information. While we were able to make a few connections, we were unable to make as many connections as we would have liked. Our major challenge to recruiting partners were 1) the lack of time available for outreach, and 2) the time of year in which outreach took place. Outreach took place between late July and mid-September, a period of approximately 2 months. Much more time is needed to cultivate connection and attend relevant neighborhood events. Furthermore, summer is a difficult time to perform outreach, as many people are on vacation, fewer community events and public meetings are held, and neighborhood councils often go on break. If it had been possible, performing outreach in the spring would have been preferable.

## Survey: Characteristics of OCEI members

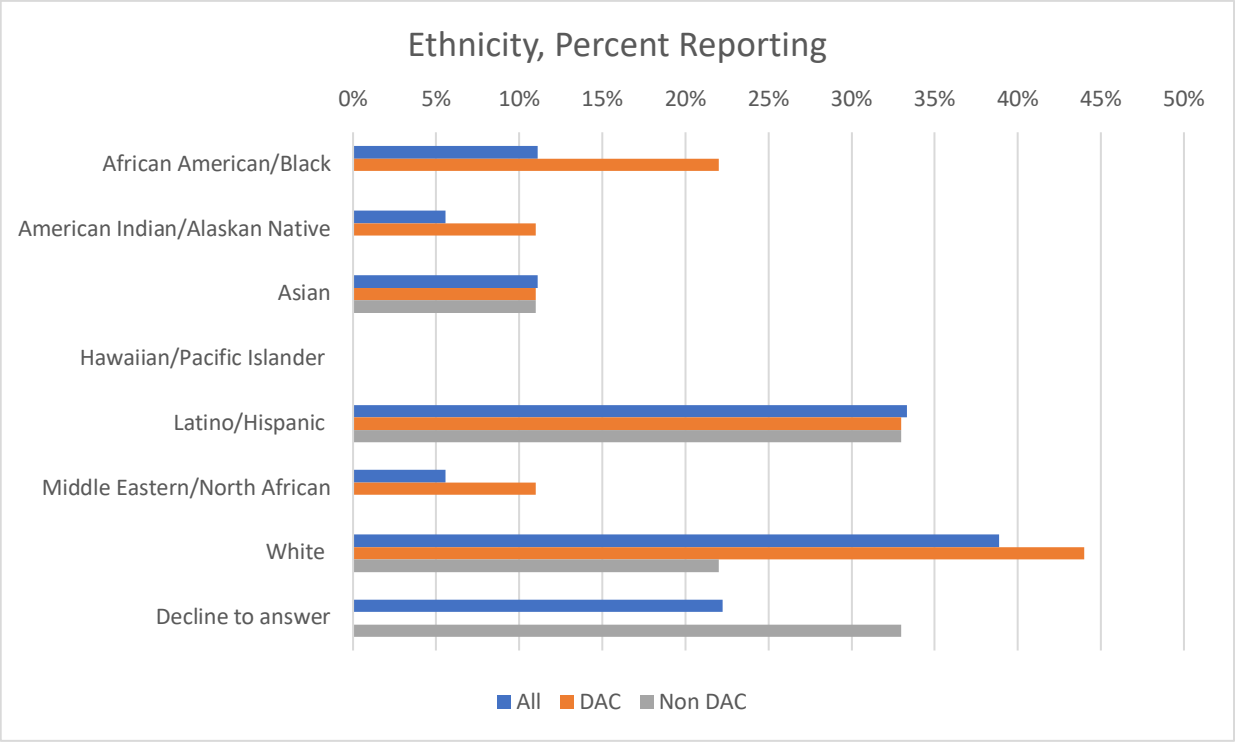
From our surveys, we were able to build a general characteristics profile of the participants in the study. As our study was quite small, data presented are anecdotal in nature. The OCEI was evenly divided between DAC and non-DAC households, and so data is broken out by DAC status where possible.

Findings are presented below by category. For reference, seventy-eight percent of all members completed the initial survey. In general, survey data indicates a population that is ethnically diverse, highly educated, and concerned about both energy bills and air quality in their local community. Due to the small study population, findings are not generalizable to larger populations. Rather the OCEI serves as more of a case study approach – developing learnings and testing methods that can then be used to study larger populations where statistically valid conclusions can then be drawn. Data is presented by DAC household status when possible.

### Demographic: Ethnically diverse, small households

OCEI members are fairly ethnically diverse. While a majority of participants are white or Latino/Hispanic, 22% are of Asian or African American ancestry. Not much difference exists in the ethnic makeup of DAC households vs. non-DAC households.  Nearly a quarter of respondents declined to answer this question, highlighting the question's sensitive nature.

Figure 8. Ethnicity of OCEI members.




All OCEI members report using English as their primary language, which is consistent with the fact that all materials in the study were only available in English.

The median household size of respondents is 3.11 persons, slightly higher than the statewide average household size of 2.9 persons[11]. This number is identical for DAC and non-DAC households even though households are composed differently in these areas. Sixty-one percent report children under 17 living in the home, which is higher than the statewide average of 35.5% [12]. DAC households have more children living at home than non-DAC households.

[11] 2010 U.S. Census.

[12] 2014 American Community Survey, U.S. Census.

Figure 9. Household sizes.

| | DAC | Non-DAC |
|---|---|---|
| Average number of people in home | 3.11 | 3.11 |
| Average number of children (<17 years of age) | 1.44 | 1 |

The majority of respondents (72%) are between the ages of 30 and 59, which is consistent with high work participation rates (see Socio Economic section below).

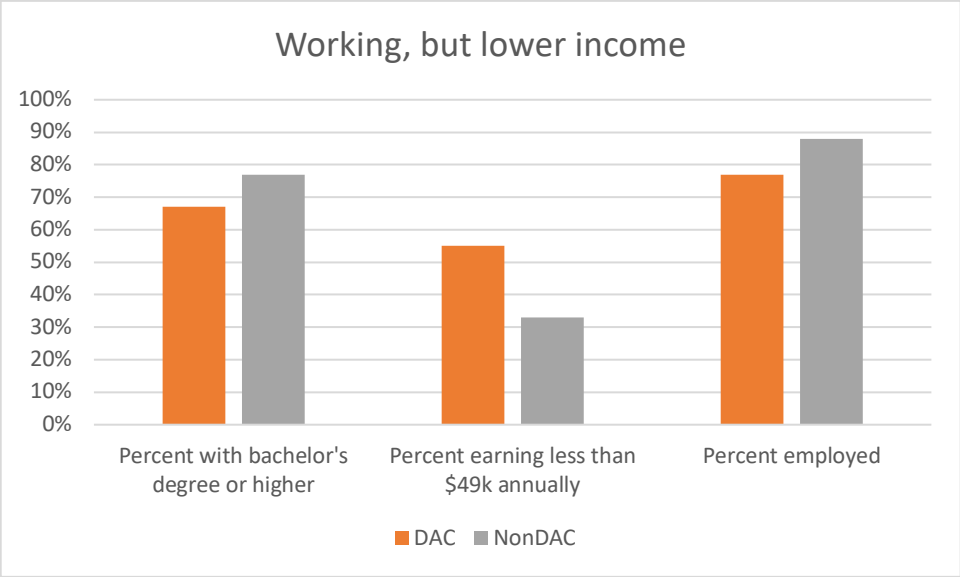
### Socio-economic: Highly Educated, Working, but Lower Income

OCEI participants are highly educated, with 70% reporting having earned a bachelor's degree or higher, far higher than the state average of 9.8% (2017 ACS). Individuals with higher education levels may have more comfort, or greater facility for, participating in an energy study. Enrollment and participation demanded a level of sophistication and understanding of energy use, program requirements, and familiarity with somewhat technical information.

Most members are working, though earnings are fairly low. Fifty percent of respondents report total household income of less than $49,000/year, which qualifies as low-income (at or below 80% of state median income)[13]. Only 27% of respondents report annual earnings of $80,000 or greater. Education, earnings, and employment are all lower for DAC households.

[13] AB 1550.

Figure 10. Socio-economic characteristics.




## Energy bills, rate plans, and energy savings

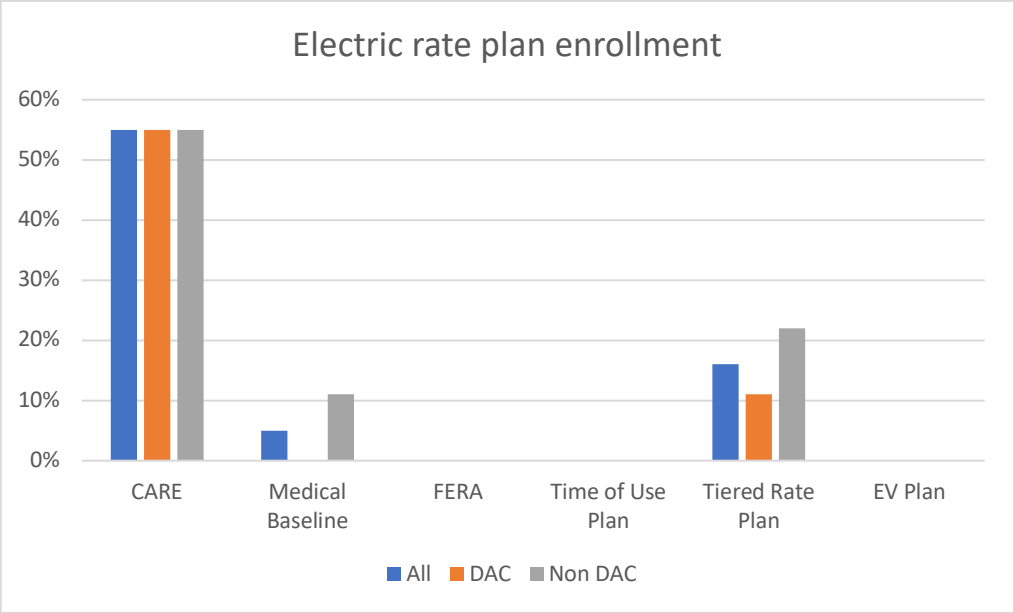
OCEI members reported an average electricity bill of $53 per month, with DAC households spending more on energy bills than non-DAC households. Members were asked to report the previous month's bill amount for consistency. Amounts would have been drawn from bills during the autumn months (September through November), a time when home energy demands are at their lowest during the year given longer days combined with cool weather. Regardless, 100% of respondents reported desiring to lower their energy bills.

Figure 11. Bill amounts.

| | All | DAC | Non-DAC |
|---|---|---|---|
| Electricity bill, previous month | $53.74 | $69.38 | $38.11 |

Consistent with the lower income levels reported on surveys, more than 50% of OCEI members are enrolled in California Alternate Rates for Energy Program (CARE), a program which provides discounted electric rates to low-income households.

Figure 12. Electric rate plan enrollment.

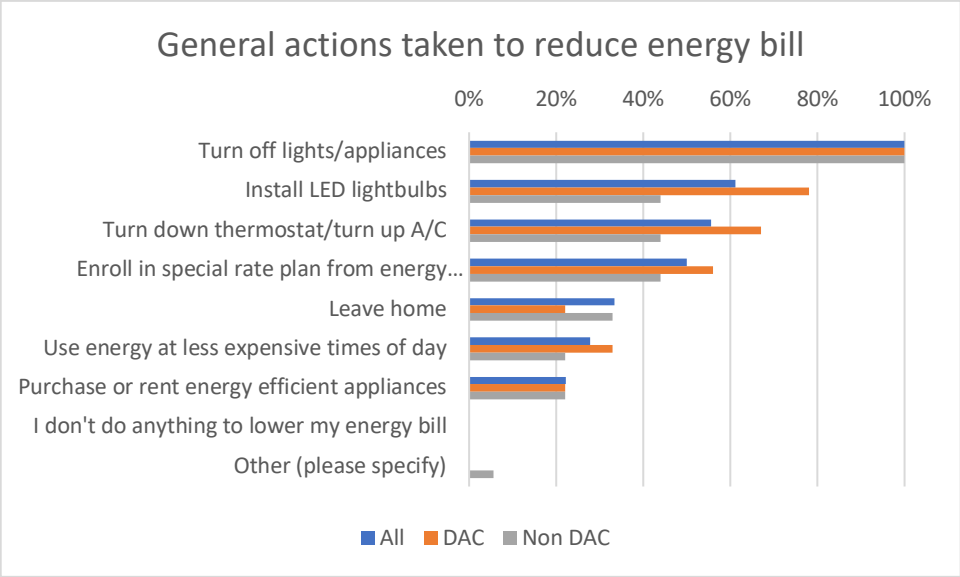



After CARE, most OCEI members are not enrolled on a special rate plan; only two members were enrolled in a tiered rate plan and one member was enrolled in Medical Baseline.[14] Furthermore, most members do not report participating in any demand response or load shifting program; only one member reported doing so, through a program offered by Marin Clean Energy. Thus, no members were enrolled in any programs in which load shifting could possibly result in higher energy bills.

However, all but one member reported taking action to lower their energy bills. The majority reported frequently turning off lights or installing LED lightbulbs to reduce their bills.

[14] Medical baseline rates are discounted energy rates; tiered rate plans tack on a surcharge for consumption above baseline amounts.

Figure 13. Actions taken to reduce energy bill.




## Building and Appliance Characteristics

Slightly more than half of members are renters, the majority living in single family houses. DAC households have a higher rate of home ownership than non-DAC households.

Figure 14. Rate of home ownership.

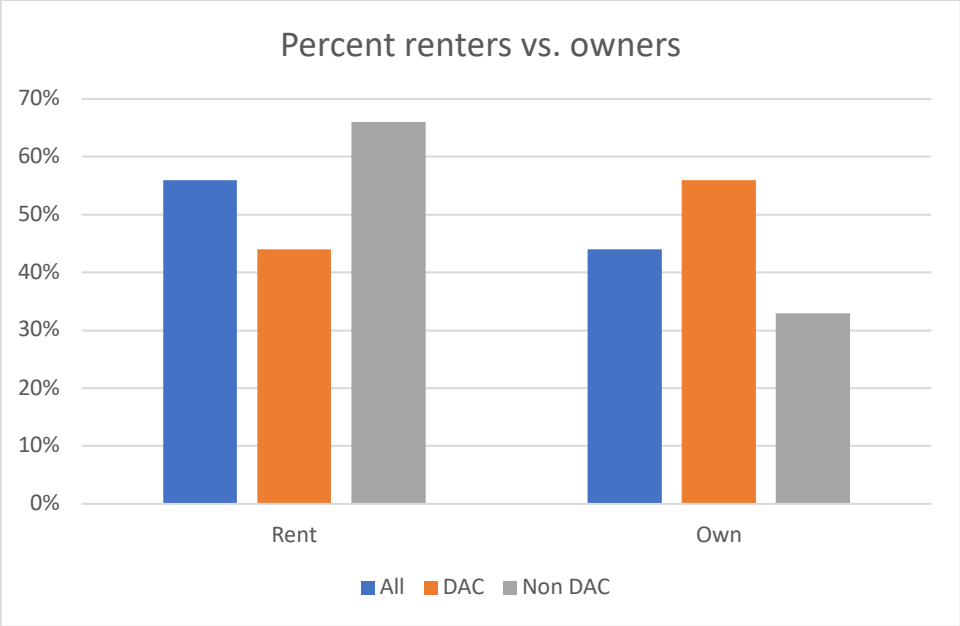
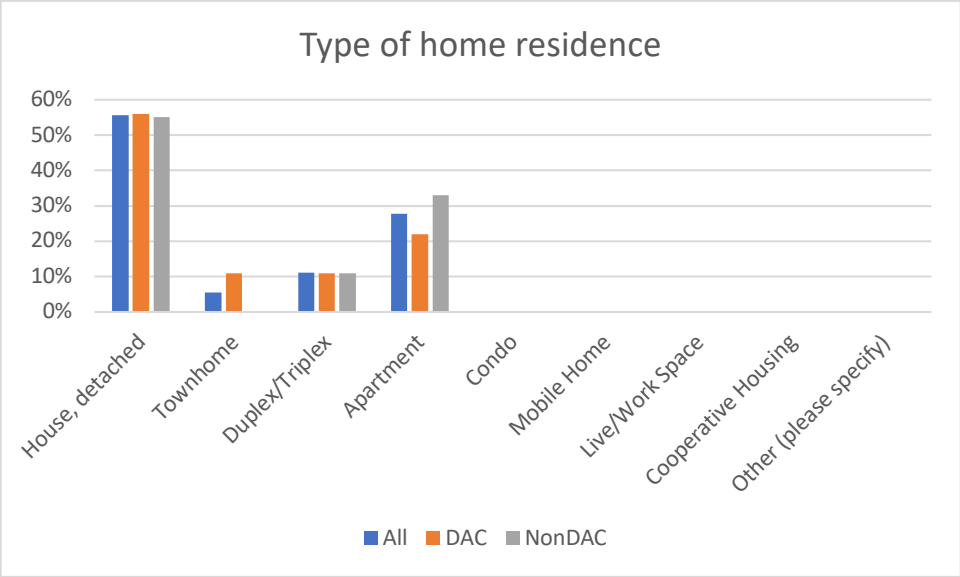
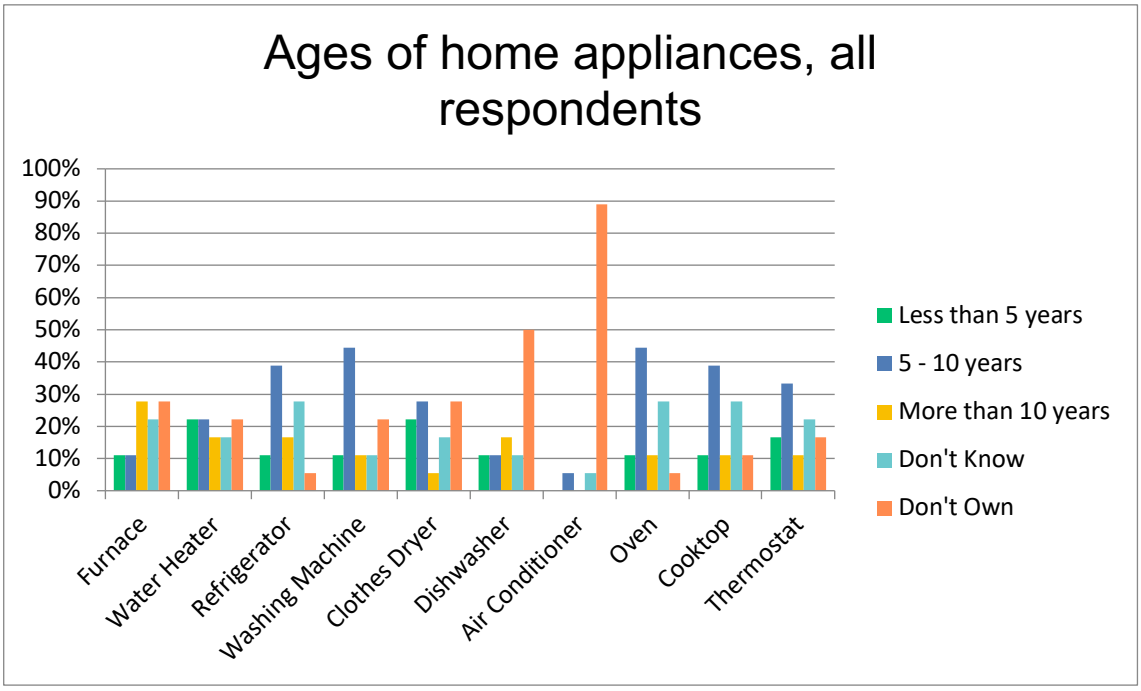


Figure 15. Type of home residence.




Most report fairly recent residency with 75% living in their current home for 5 years or less. This figure is consistent for both DAC and non-DAC households. Interestingly, however, is the finding that few participants (21%) report having received an energy efficiency rebate for an appliance purchase. One might expect some newer appliances given the short length of residency, however, most home appliances are older than five years as can be seen in Figure 14.

Figure 16. Ages of home appliances.



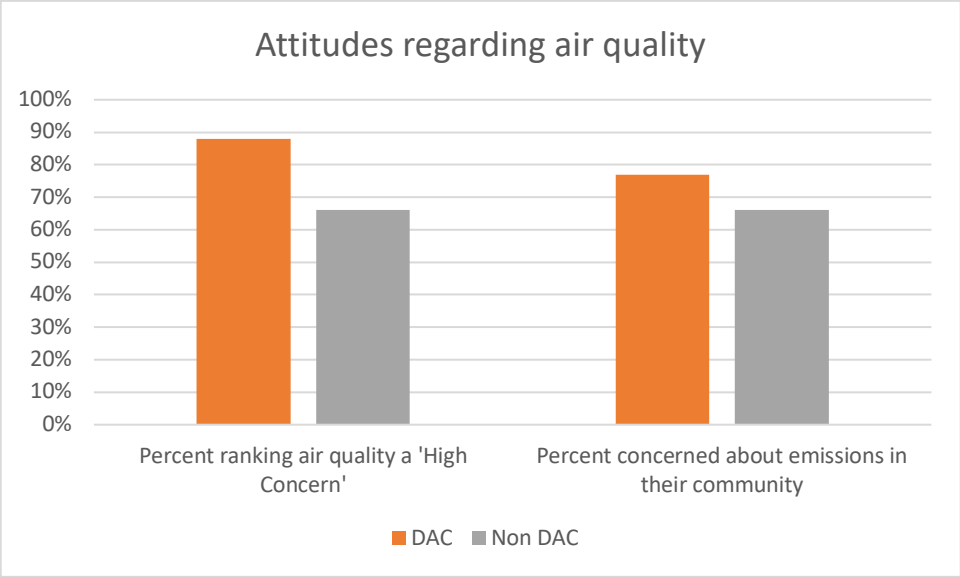

Nearly all respondents report not owning air conditioning, whether central or detached; it is also interesting to note that 50% of respondents report not owning a dishwasher. This has implications for the amount of energy it is possible for a home to reduce. For the majority of members, their large energy consuming appliances (furnace, water heater, clothes dryer) are gas powered.

However, all respondents report having access to Wifi or the internet in their home, so they are enabled for technology though they may not own many electric appliances, or possibly smart devices.

### Attitudinal/Motivational

Seventy-two percent of respondents reported being 'Moderately Concerned' or 'Very Concerned' about local air quality; this finding holds true regardless of level of education. Indeed, air quality scored in the top three concerns of OCEI members which generally reflects the great concern of Richmond residents regarding pollutants released by the Chevron refinery in Richmond. Residents in DACs expressed higher levels of concern about air quality than in non-DACs. However, when the question was framed about emissions in the local community, level of concern seemed to decrease.

Figure 17. Attitudes regarding air quality.



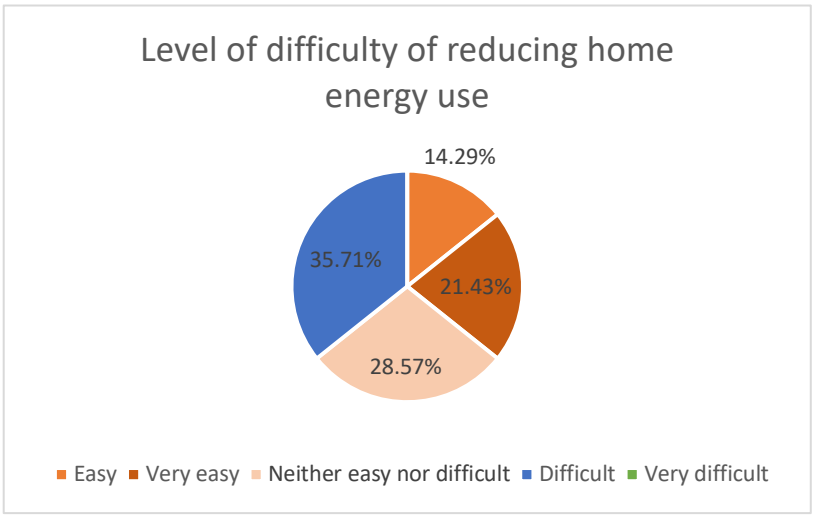

It should be noted that though participants expressed an eagerness to learn more about their energy use and ways to reduce energy bills, incentives were the main motivator for participation. At in person presentations, individuals expressed the desire to take actions to support better air quality but did not want to be financially impacted by any such actions. A commonly held opinion was that state and local governments should be shouldering the financial burden for such programs, and that programs should ensure fairness and not place financial hardship on households, particularly lower income households.

## Survey: Home Energy Study

Findings for the Home Energy Study Survey are presented for all members of the OCEI and are generally not broken out by residency in a DAC census tract. This is due to the smaller number of respondents from DACs for this survey (36% of all members). Fourteen participants, or 60%, completed the Home Energy Study Survey.

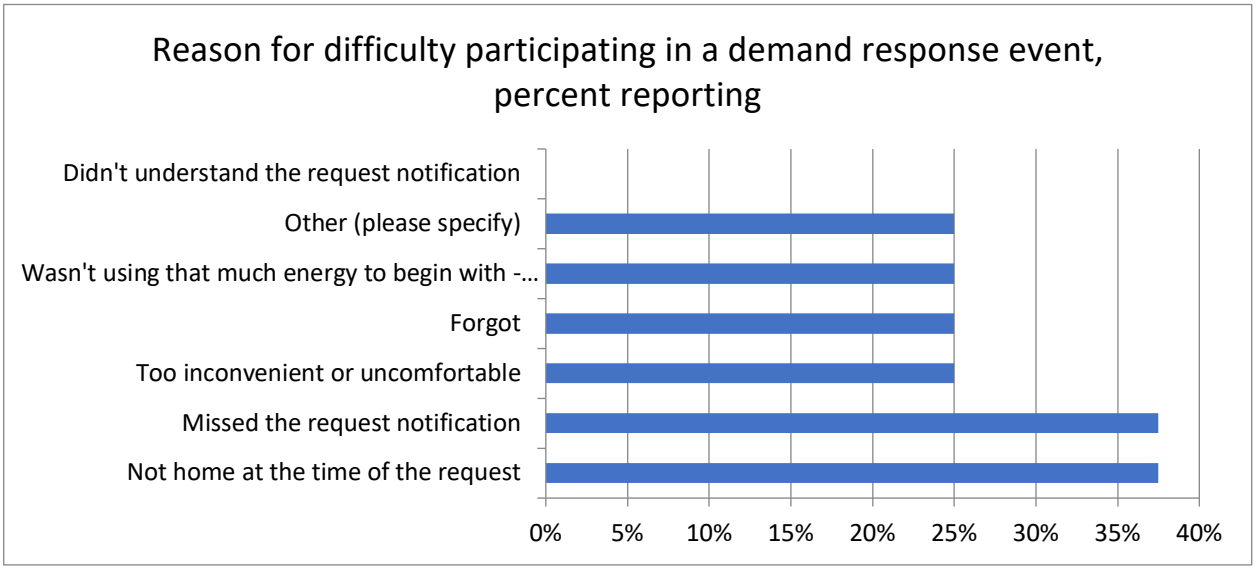
The purpose of the Home Energy Study Survey was to capture participants' experiences with the demand response portion of the study. Given that 100% of OCEI households participated by reducing home energy use when requested on at least two occasions, the overall program was highly successful. Overall, survey respondents report a positive experience, both with requests to reduce energy and the Olivine Community app. When asked how easy or difficult they found it to reduce energy when requested, sixty-five percent of respondents reported it being either easy, very easy, or neutral.

Figure 18. Level of difficulty of reducing home energy use.




For those who found the experience difficult, most reported either not being home during the request or missing the request notification. When asked about the frequency of requests to reduce energy, most respondents reported that 2 requests per month were either the right amount or too few.

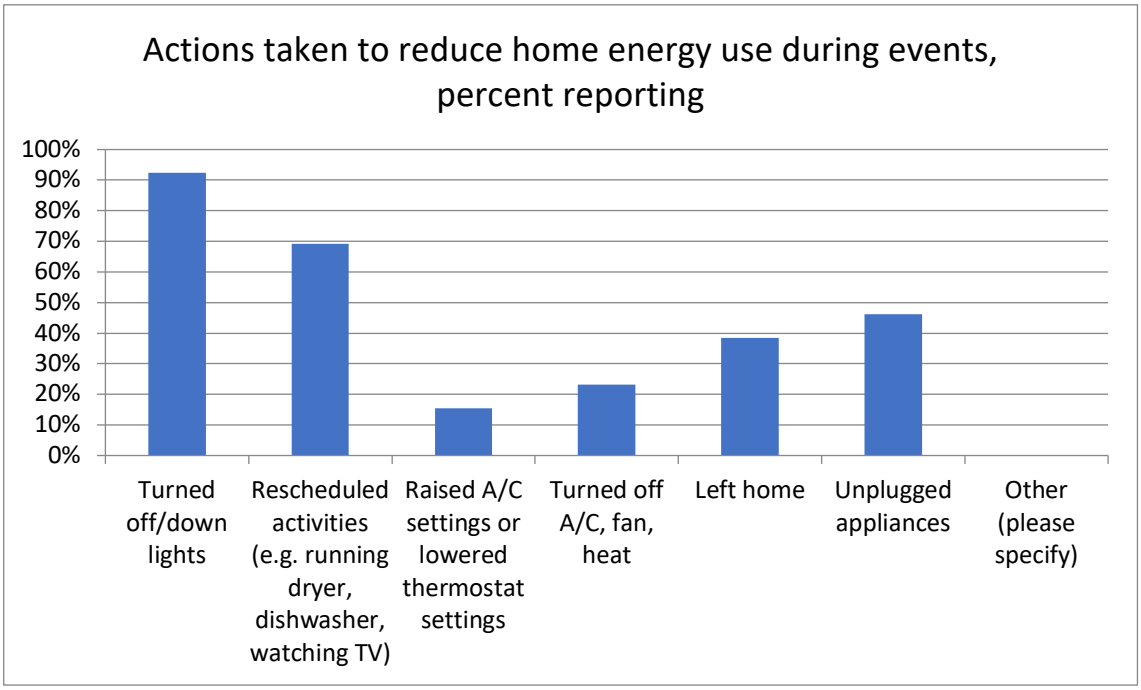
Figure 19. Reasons for difficulty participating in demand response events.




Several respondents reported not being able to reduce energy as their households consumed little energy to start with. This made participating in the demand response requests difficult or impossible.

To reduce home energy use for events, participants reported taking actions similar to regular behavior, as seen in Figure 18.

Figure 20. Actions taken to reduce home energy use during events.




Respondents reported ease with following instructions using the app to reduce energy. Generally, the app was easy to use and instructions to reduce home energy use clear. People expressed the desire to better understand their daily energy use patterns as displayed in the app and what to do with this information.

The median number of successful events was six per household, one more than the number required to earn the incentive.

## Demand Response and Energy Usage

The main goal of the demand response portion of the OCEI, the Home Energy Study, was to find out how much households could participate, whether they wanted to participate, and what actions they took when they participated. Furthermore, we wanted to see if there were any differences between DAC households and non-DAC households on any of these points.

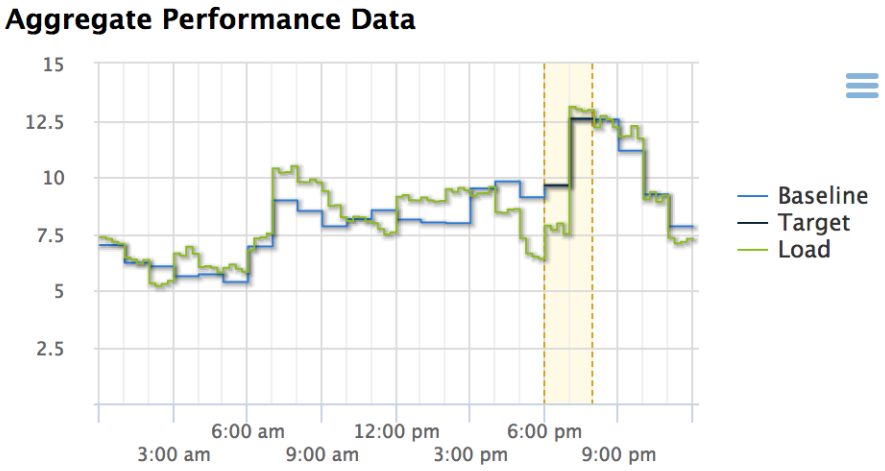
### Energy use pattern

The pattern of home energy use by OCEI members on event days generally correspond to the duck curve with spikes in load during the morning hours of between 6 am to around 10 am, then dropping off

midday to spike again at higher levels for the evening hours, lasting from 5 pm to 10 pm. This pattern is illustrated by Figure 19, which displays the load and baseline[15] in kWh over a 24-hour period on an event day by all OCEI households. Both the green line, the household electric load, and the blue line, the baseline, or 'typical day energy use', fall in with the duck curve pattern of greater energy use during the evening hours. In this image, the event was successful, i.e. overall home energy use was reduced during the event, which took place from 6pm to 8pm. In the area shaded in yellow, the green line, the household electric load, is mostly below the blue line, or the baseline/'Typical day use'.

This pattern correlates with high participation in OCEI demand response events, as participants were generally home consuming energy in the evenings. We found no difference between DAC and non-DAC households in this pattern. In other words, both types of households generally consumed more energy during the evening hours.

Figure 21. A successful demand response event, October 15th, 2018, 6pm to 8pm.

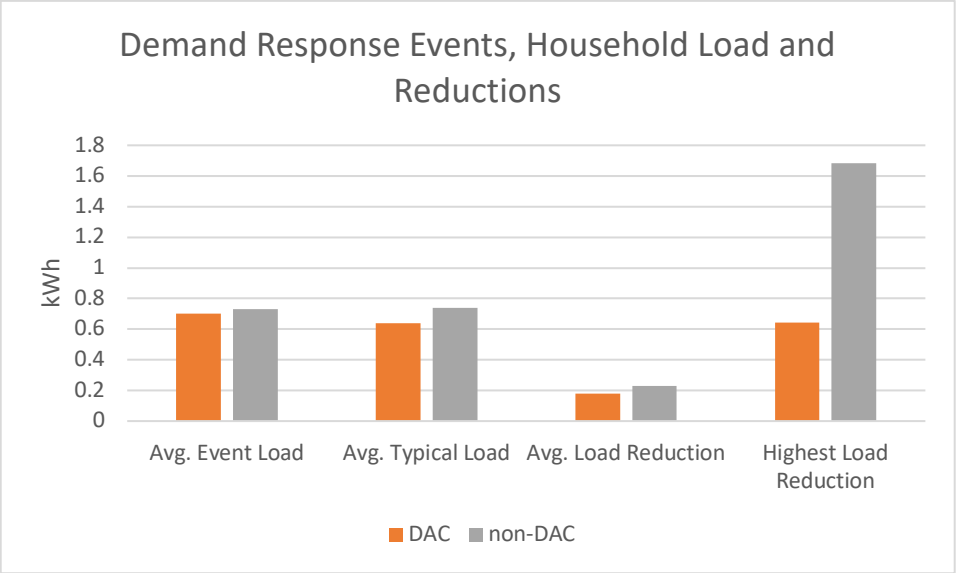



## General energy use and energy reduction

Little variance in energy load existed between DAC households and non-DAC households during events, as can be seen in Figure 20. Generally, DAC households consumed less energy and were able to reduce less energy for an event, than a non-DAC household, though the differences are quite small.

[15] For more on baseline calculations see section xx.

Figure 22. Household electric loads and reductions.




Average event load is the average of load for all households across all events. Average typical load is the average of the all households' baseline calculations during events using the 10-in-10 baseline calculation detailed earlier. Average load reduction is the average of all households' reductions for events, but only for those households that reduced energy use when requested (those households that did not reduce energy were not included in this calculation). Highest load reduction was the single highest amount of load reduced by a household for an event.

As can be seen by figure 20, average event load is higher for DAC households than their average typical load. Thus, DAC households increased their energy usage over their baselines for the duration of the study. Indeed, the overall load performance for all households in the Home Energy Study was an increase in energy use over baseline calculations. However, given that households were not incentivized on a per event basis, performance, and load reductions may have been impacted as a result. This is corroborated by the finding that the average number of successful events per household was the same as the number to earn the participation incentive.

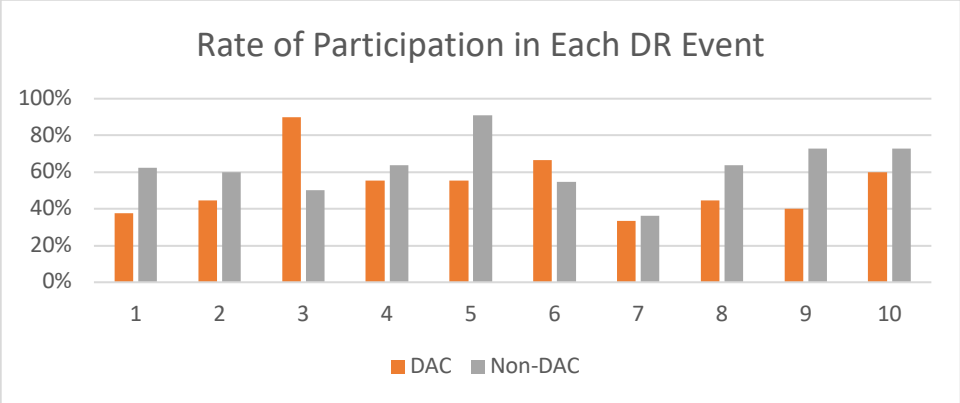
It is important to note here that due to the small group size and the preliminary/tenuous/ nature of the baselines, conclusions drawn from the data should be restricted to the OCEI only and are not generalizable to other populations or locations.

### Participation and Incentives

Participation rates in the Home Energy Study, the demand response portion of the OCEI, were highly promising: the average participation rate across all requests was 57%. DAC households had slightly lower participation rates: the average participation rate was 47% for DAC households vs. 64% for non-

DAC households across the entire study. Figure 21 illustrates rate of participation by DAC household status for each of the 10 events.

Figure 23. Participation rates in demand response events.




Interestingly, the average participation rate held across residence type, i.e. whether a household resided in a house or an apartment made no difference to its ability to reduce energy when requested. Apartment or duplex based households had very similar rates of participation and demand response performance as households based in single family houses.

Although there was a net increase in energy use across all events during the study, total energy reduced by participating households was 23.28 kWh, or approximately 12.2 pounds of carbon emissions.[16]

Participation rates in the study were high overall. Figure 22 presents participation rates for each incentive and the amount of the incentive.

Figure 24. Participation in OCEI, by component.

| Program Component | Percent earning incentive | Incentive Amount |
|---|---|---|
| Enrollment Survey | 81.8 | $75 |
| Home Energy Study Survey | 63.3 | $50 |
| Home Energy Study | 76.1 | $100 |

The average incentive earned by OCEI members was $166.81 and the highest incentive amount earned by a household was $245.

[16] https://www.pge.com/includes/docs/pdfs/about/environment/calculator/assumptions.pdf

## A final comment about observed differences between DAC and non-DAC households

In the OCEI, DAC households exhibited the following characteristics compared with non-DAC households:

- Higher reported energy bills
- Lower home energy use on demand response event days
- Lower education
- Lower income levels
- Lower participation rates in demand response
- More children living in the home
- Greater ethnic diversity

However, an important caveat should be made to these observations. Of all the DAC households in the OCEI, only one household was not also located in an AB 1550 Low-Income Community. Conversely, the majority of our non-DAC households were not located in a Low-Income Community. Therefore, the question to be asked of our findings is "How much of the observed differences between DAC households and non-DAC households are due to DAC designation, Low-Income Community designation, or a combination of the two?" This question cannot be answered by the OCEI due to the small populations of the different community category types. Ideally, a larger study could address this issue by recruiting and studying households within the different community category types.

## Lessons Learned

DACs are not 'communities' in the traditional sense.

It is important to understand that targeting benefits and programs to DACs comes with challenges. Neighbors across the street from one another may have different eligibility status for programs, which can cause headaches for outreach. This adds another level of complexity to program design.

The energy landscape can be overly complex to the general public.

Due to the changing and complex nature of the energy landscape in California, there was typically some confusion from potential participants about the nature of such a study and the need for PG&E meter data.

The emergence of Community Choice Aggregators (CCAs) has been a point of confusion for participants with many unsure of who their energy provider is, what the difference is between their CCA and the utility, whether PG&E would be able to provide data if they have a CCA, and whether or not giving access to their PG&E data will result in a change of provider or other problems to their account.

Proper incentives are critical.

Participants were highly incentive driven, thereby relying on environmental messaging alone, while a positive endeavor, may not provide as successful an outcome. Testing other forms of incentives, not just monetary, would provide interesting results for future studies.

Emissions concerns are real, as is skepticism about solutions.

Resistance and skepticism were encountered in communities with culture of high activism. Richmond has a very well organized and activist community, particularly around environmental issues largely due to the proximity of the Chevron refinery and coal transportation through the city.

A great concern for, and interest in, clean air and environmental impacts from energy production exist, however, people do not want to be unduly financially burdened as a result. Serious concerns exist about unintended consequences of proposed solutions and programs. Many individuals voiced a desire for change and for community concerns to be considered by local programs and businesses.

Outreach is challenging and requires time and creativity.

Outreach and messaging were challenging. Face to face communication was most effective in order to answer questions and convey complex information. Additionally, messaging needed to be modified appropriate to the technological sophistication of the audience. Outreach is time consuming and requires multiple strategies. Often multiple exposures are required.

Collaborate and connect with local organizations.

It is important to coordinate and collaborate with other community-based organizations working within communities on energy and environmental justice issues. They have connections, knowledge and community buy-in that take years to build and convey legitimacy to a project. However, they are often under-staffed and don't have the ability to take on more projects. Furthermore, by partnering with local CBOs we were able to learn about the central issues and concerns of the community as well as active projects which could assist with outreach and implementation.

Provide educational materials.

Participants expressed the desire to better understand their information and know what to do with it. This includes not just helping them to interpret their information and data, but also informing them of actions that can be taken to affect their situation.

## Conclusion

What emerges from our study's findings are that households in the OCEI have the capability, interest, and capacity to participate in demand response programs. Given the right incentives, households will take actions to shift or reduce energy usage in their homes. This finding holds across categories such as DAC status, residence type, level of education, number of children in the home, and income. Barriers to participation included not being home when necessary, missing notifications, and not using enough

energy to reduce. Regardless, every household participated in at least two demand response events, regardless of inconvenience, energy usage, or event time. Thus, participation is possible even for those households that found it difficult on occasion. The point here was not to induce hardship on households, but rather to test their willingness to participate in demand response events. The success of the OCEI demonstrates that participation is not only possible, but highly likely if incentivized correctly.

Furthermore, households were willing to share data as long as privacy was respected and with the understanding that their data were to be used in the pursuit of an important goal, such as the OCEI's purpose of helping to design programs benefitting communities and improving air quality. Wariness around predatory practices by businesses and experiences with being upsold on services are very real. Those concerns need to be addressed and fears allayed to gain trust and encourage participation.

The OCEI was a small, though important, first step towards studying disadvantaged communities. Further work needs to be done on a larger scale and among highly differentiated populations to gain a more comprehensive and generalizable understanding of best approaches to designing demand response programs benefitting households in disadvantaged communities. Some recommendations for subsequent studies based on experiences from the OCEI are:

- conducting outreach and providing materials in other languages
- providing education around demand response and the connection to air quality, as well as education on how to understand home energy data
- incorporating geographic and climate diversity in the study population, so studying populations in different climate zones and urban/rural environments
- incorporating similar households in DAC and non-DAC areas to understand if differences exist solely based on DAC status, or if other characteristics, such as income, play a stronger role

Last but not least, it is Olivine's hope that further studies incorporate qualitative data and analysis supplied by direct engagement and conversations with community members, leaders, and residents. Hard data does not generally capture the whole picture of a community. Feedback and input from those individuals living in a community are an important element of any attempt to understand and analyze behaviors, patterns, and outcomes.