



# RECURVE

SHAPE THE FUTURE OF ENERGY

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# Case Study 1:

## PG&E

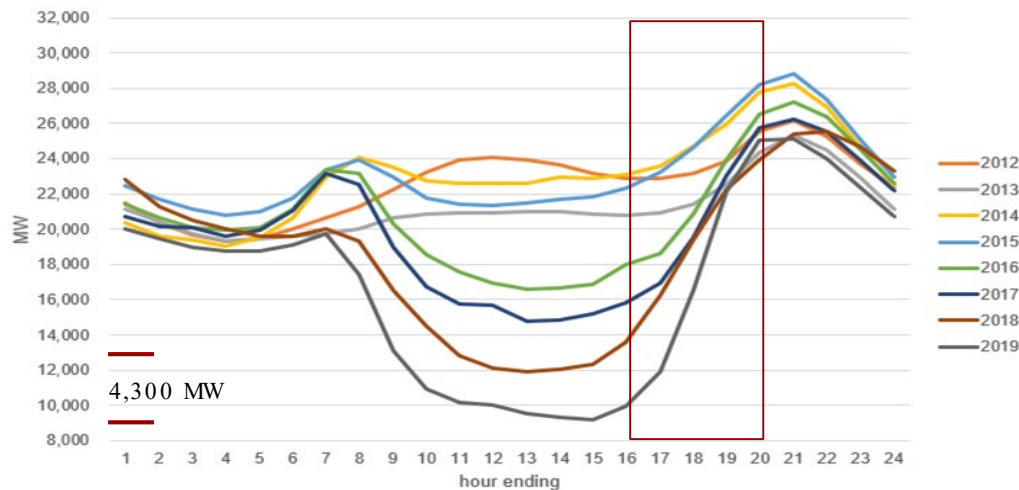
### Residential

### Pay-for-

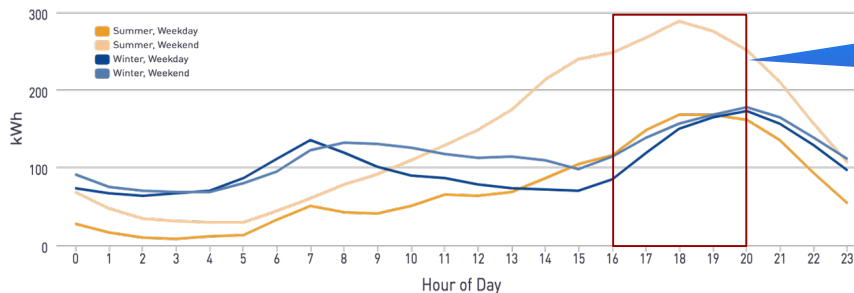
### Performance



### CAISO Net Load - Duck Curve



### Residential HVAC Resource Curve




3x P4P  
Kicker

# Case Study 1:

## Enabling Competitive Markets Drives Innovation



Home Energy Rewards

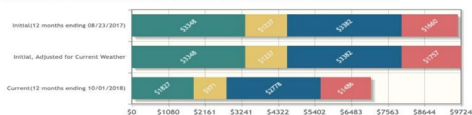
- Launched August, 2018
- As of 11/30/18
- 593 projects enrolled in our pool
- Savings
  - 4627 MMBtu
  - 9% electric, 15% gas

**Household Summary**

Number of Occupants: 2.0	Rent/Own: Own	Owner: 3,200 sqft.	Activation Date: August 23, 2017
Type of Home: Single Family	Size of Home: Fountain, pond, etc.): No	Year Home Was Built: 1970	Has Tubs/Spa: Yes
Pool: No			

**How has my energy cost changed?**

Each of the charts below compare information about your home across two different periods: (1) the Initial 12 month period just before you signed up for this service, and (2) the most recent 12 months. Because both periods cover all seasons, we effectively "normalize" the two periods for variations caused by seasonal energy use. However, we also need to adjust for the different weather conditions (for example a particularly cold winter or one summer that was hotter than the next) so we also normalize the energy use for the initial period to match the weather of the most recent period.



Since registering on 08/23/2017, on an absolute basis, your annual energy cost has gone down \$2,417 (25%). Taking weather differences into account, your annual energy cost has gone down \$2,512 (25%).

**Build it Green – Cool Savers**



Together, Building a Better California

**Cool Savers**

Seal Ducts

Smart T-Stat

High Efficiency AC

Stay cool, save energy

Replacing your heating and cooling system? A new program for Pacific Gas and Electric Company (PG&E) customers makes it more affordable with up to \$1,800 in rebates.

Lower your monthly energy bills and replace your outdated heating and cooling system, thanks to rebates and incentives through the new Cool Savers Program.

<https://www.coolhomesavers.com/>


EGIA

GEO Smart

FINANCING CL EARNINGHOUSE

Advancing Our Clean Economy

**ICF – Home Energy Optimization**



- \$199 for \$2,000 in Products and Services (\$59 for DAC customers)
- Home Energy Report, Home Energy Advisor
- Smart T-Stat plus optimization (all)
- Advanced Power Strips (half)
- LEDs (4 per home)
- AC Tune Up (most)
  - Air Flow Adjustment
  - Refrigerant Charge
  - Condenser Coil Cleaning
  - Evaporator Coil Cleaning
- Comfort Guard for HVAC Equipment Performance Optimization
- SWH Controller for Electric and Gas Water Heaters (all)
- Temperature Control Valves (TCVs) (half)
- Faucet aerators
- Pipe insulation (half)

PG&E

FILTERS (5) ▾

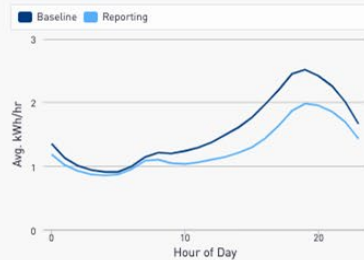
3\_Summer\_Peak\_kWh Top Quartile

5\_Summer\_Shoulder\_Ratio Top Half

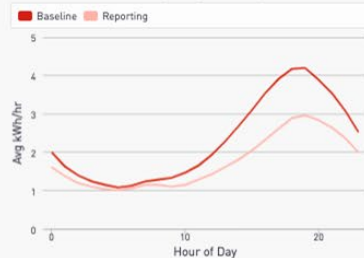
Climate\_Zone 4

Year 2020

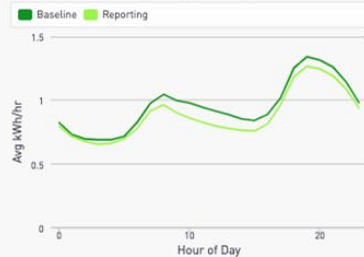
Annual Baseline and Reporting Load Shapes



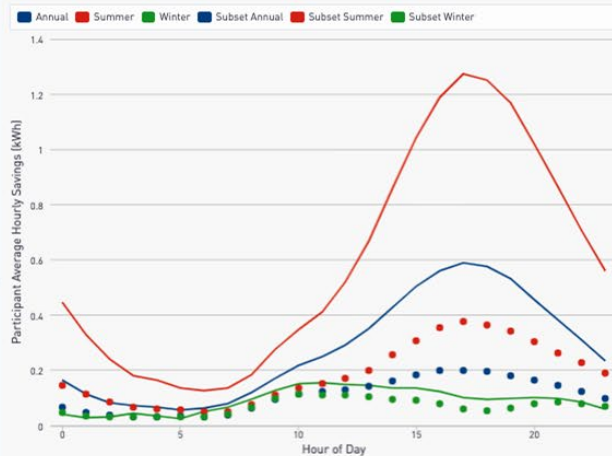
Summer Baseline and Reporting Load Shapes



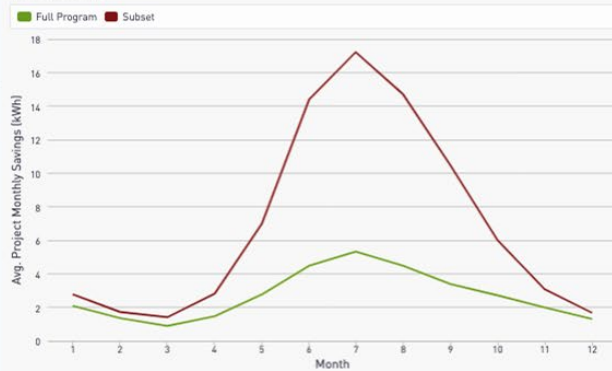
Winter Baseline and Reporting Load Shapes



Resource Curve - Full Program (dots), Cohort (Lines)



Monthly Savings



Program Average

965 kWh

Annual Participant Savings

11 %

Annual kWh Savings

213 kWh

Summer Peak Participant Savings

Subset

2,435 kWh

Annual Participant Savings

18 %

Annual kWh Savings

721 kWh

Summer Peak Participant Savings

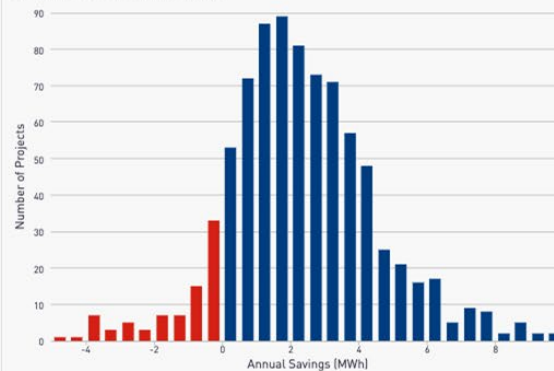
30 %

Summer Peak kWh Savings

9 %

% Negative Savers

Distribution of Annual MWh Savings

2.5x  
Greater  
Savings70%  
Fewer  
Negatives

FILTERS (5) ▾

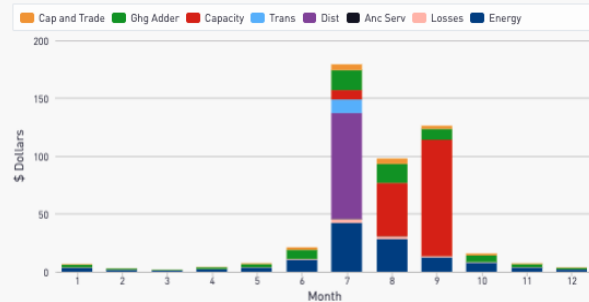
3\_Summer\_Peak\_kWh Top Quartile

5\_Summer\_Shoulder\_Ratio Top Half

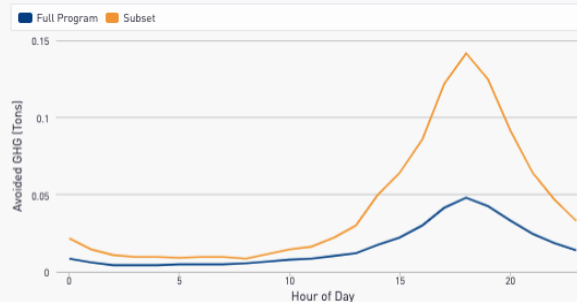
Climate\_Zone 4

Year 2020

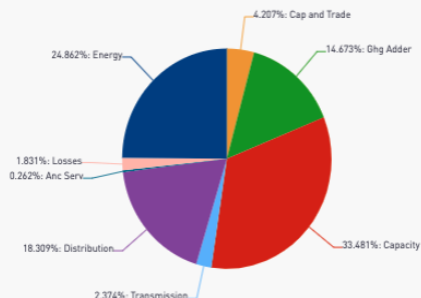
Average Project Electric Utility Avoided Costs



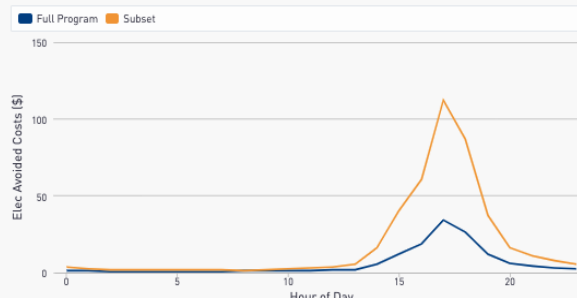
Average Project Marginal GHG Savings



Avoided Cost Profile (Positive Only)



Average Project Electric Utility Avoided Costs



## Program Average

.397 Tons

Project Annual GHG Savings  
From Electricity.41  
Tons/MWh

Avoided GHG per MWh Savings

\$146.97

Project Annual Electric Utility  
Avoided Costs

\$.152/kWh

\$ Avoided Cost per kWh Savings

## Subset

1.057 Tons

Project Annual GHG Savings  
From Electricity.43  
Tons/MWh

Avoided GHG per MWh Savings

\$446.73

Project Annual Electric Utility  
Avoided Costs

\$.183/kWh

\$ Avoided Cost per kWh Savings

2.7x  
Avoided  
GhGs3x  
Avoided  
Cost

Cap and Trade Ghg Adder Capacity Transmission Distribution Ancillary Services Losses Energy

# Case Study 2:

## New York

## Pay-for-

## Performance

## Programs

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Aug-19	Con Edison RFP launched
Sep-19	National Grid stakeholder meeting
Oct-19	Con Edison Portfolio Manager awards made
Nov-19	National Grid RFP launch
Jan-20	Con Edison Portfolio Managers in market
Jan-20	National Grid Portfolio Manager awards made
Q1 2020	PSEG LI RFP launch
Q2 2020	National Grid Portfolio Managers in market



End-Use Customers	Portfolio Managers	Utilities
<ul style="list-style-type: none"> <li>Increased confidence in savings</li> <li>Access to a broader set of solutions and services, including finance solutions with little or no upfront contributions</li> <li>Longer and more comprehensive relationships with solution providers</li> </ul>	<ul style="list-style-type: none"> <li>Flexibility to design services around what customers want</li> <li>Minimized transaction costs and administrative burden</li> <li>Multi-year cash flows that can support finance solutions and add-on services</li> <li>Portfolio level performance to manage risk and achieve scale</li> </ul>	<ul style="list-style-type: none"> <li>Elevate EE as a utility resource, with potential temporal and locational impacts</li> <li>Align incentive structure to engage solution providers in the management of performance risk</li> <li>Longer term visibility into system impacts of EE</li> <li>Resource viewed as portfolios, not projects</li> </ul>



# Case Study 3:

ConEd

EnergyFit

Low Income P4P

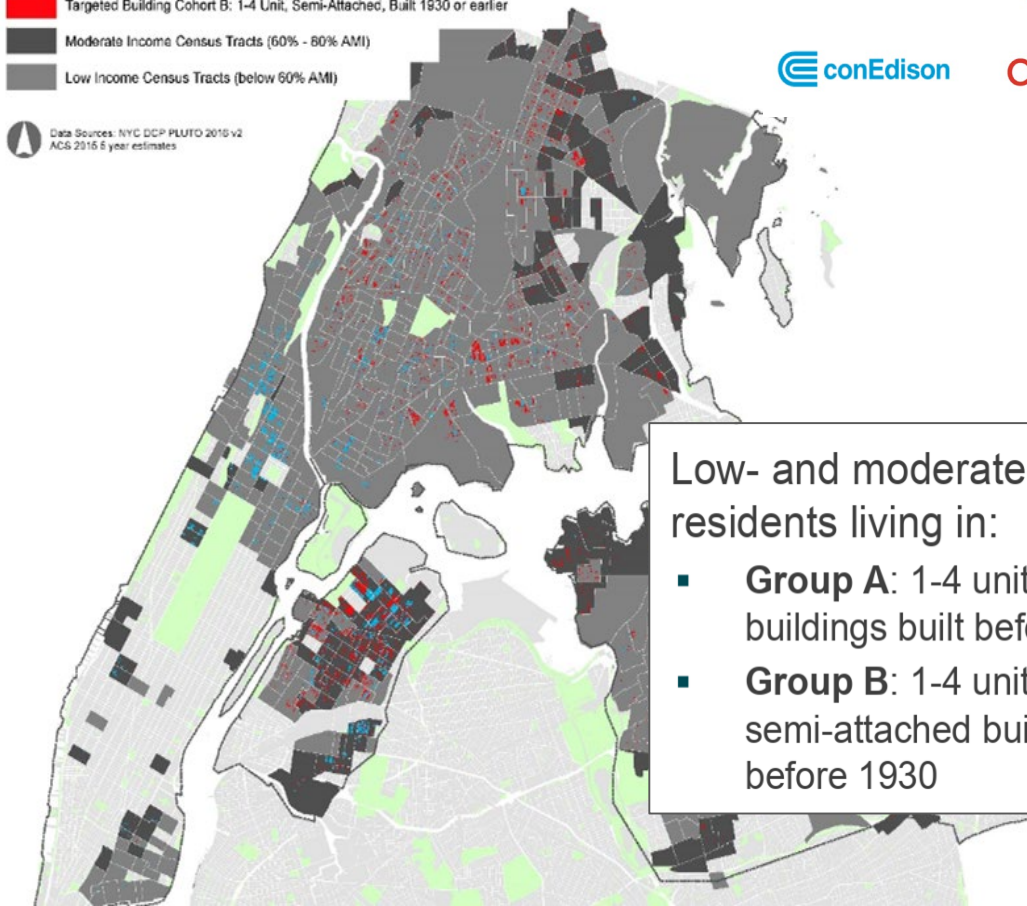
NY Rev Demo

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## EnergyFit NYC Demonstration: Targeted Building Cohorts NYC ConEdison Gas Territory

- ConEdison Gas Territory
- Targeted Building Cohort A: 1-4 Unit, Attached, Built 1930 or earlier
- Targeted Building Cohort B: 1-4 Unit, Semi-Attached, Built 1930 or earlier
- Moderate Income Census Tracts (60% - 80% AMI)
- Low Income Census Tracts (below 60% AMI)

Data Sources: NYC DCP PLUTO 2016 v2  
ACS 2016 5 year estimates



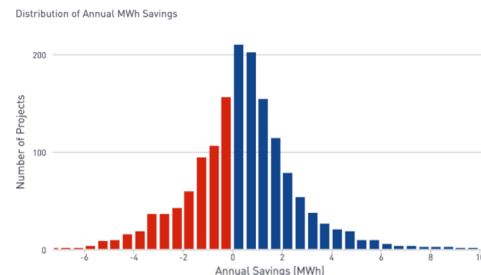
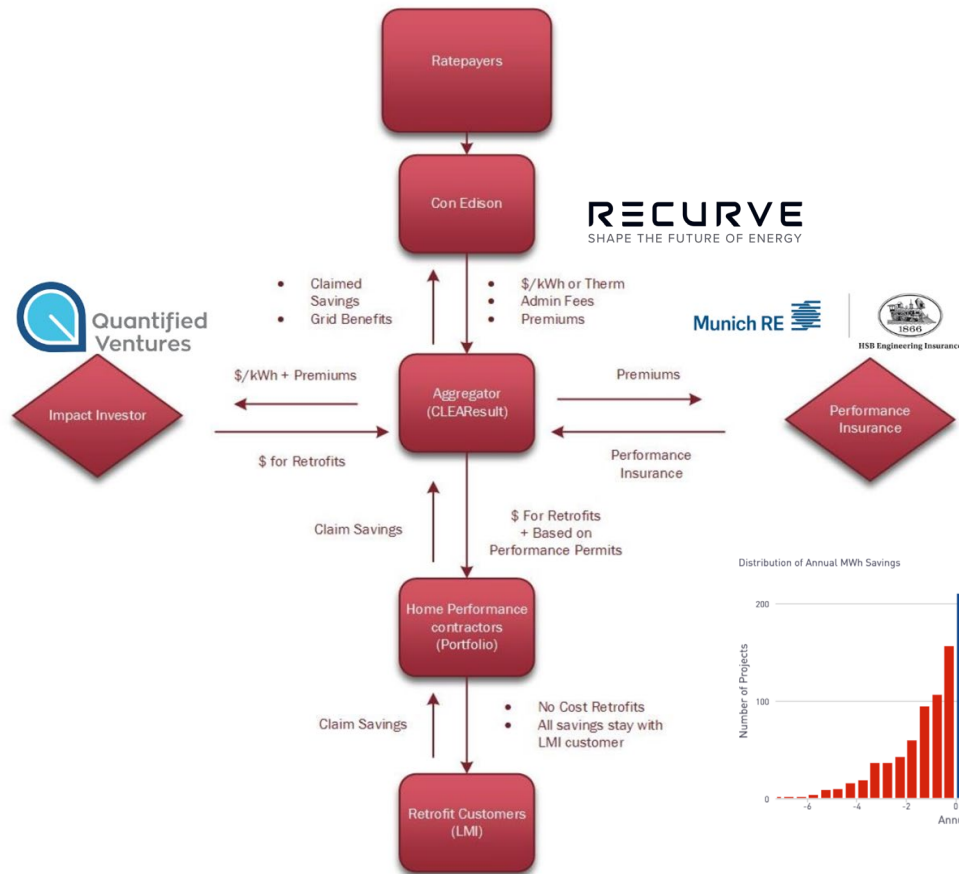
Low- and moderate-income residents living in:

- Group A:** 1-4 unit, attached buildings built before 1930
- Group B:** 1-4 unit, semi-attached buildings built before 1930

# Case Study 3:

## Using Private Capital to Provide Low Income Energy Efficiency

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**Project Finance:** The long-term financing of projects based upon projected cash flows rather than the balance sheets of its sponsors.



# Case Study 4:

## EBCE / Joint CCA

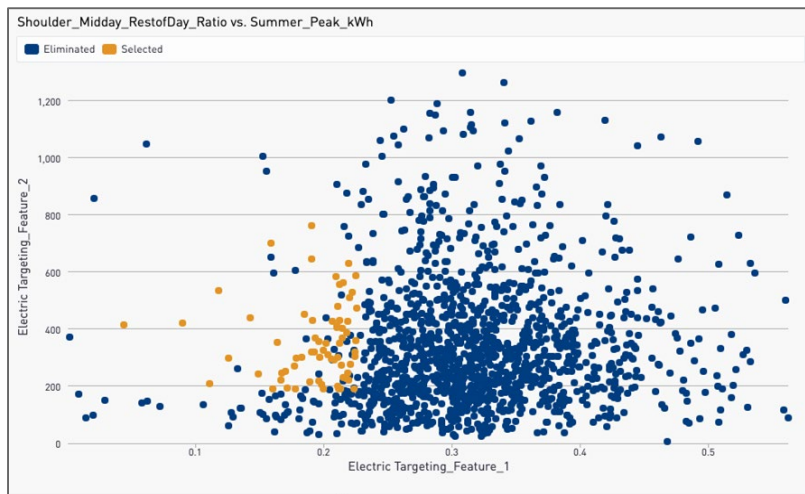
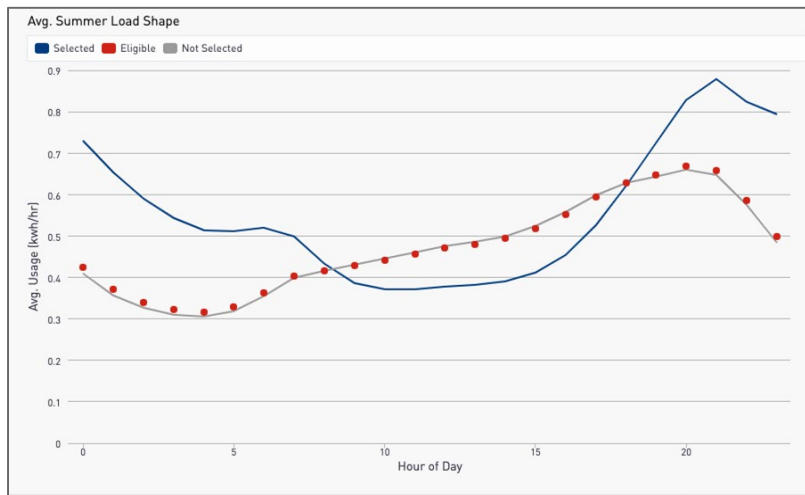
### Solar+Storage

### Targeting and

### Grid Integration



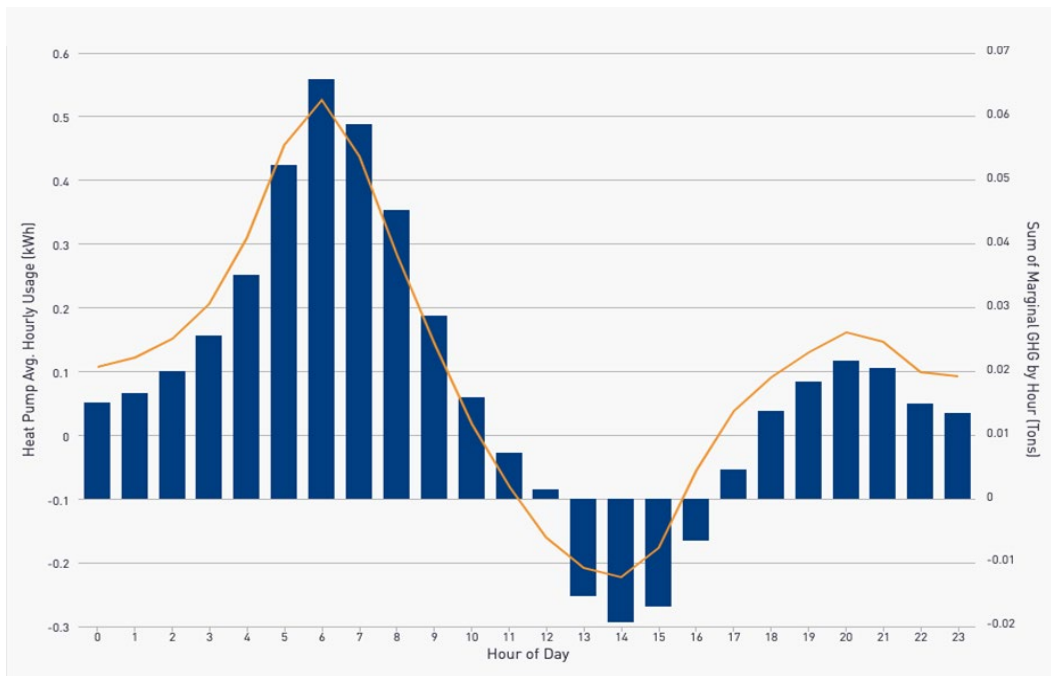
- Storage Customers Targeting
- Integration into EBCE Forecast
- Resource Adequacy for BTM Flexibility



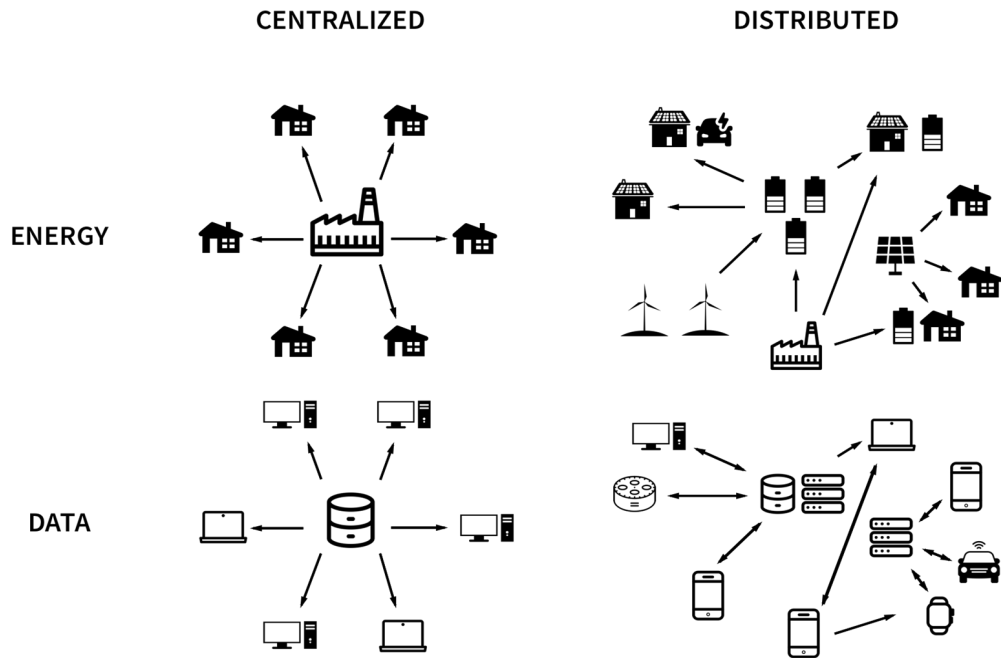
- Storage Candidate
- Ineligible

# Grid Integrated Buildings - Data Tells the Story

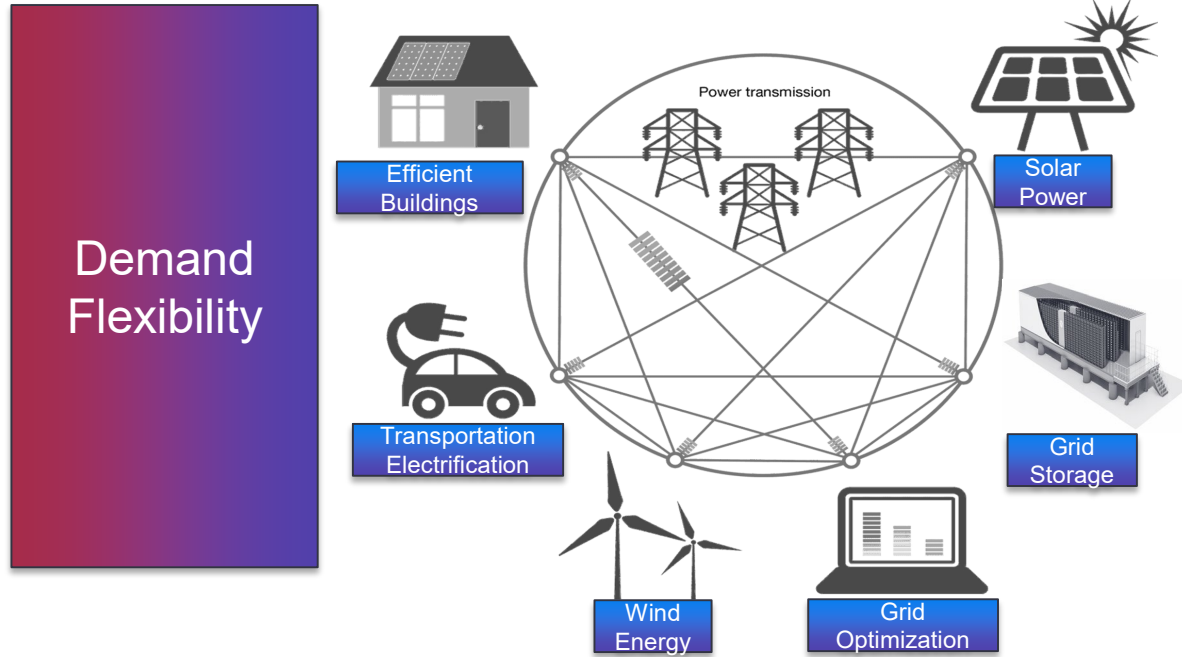
- Load Shifting  
(e.g., Storage, DR)
- Load Shaping  
(e.g., EE, Solar)
- Load Balancing  
(e.g., EVs, Heat Pumps)



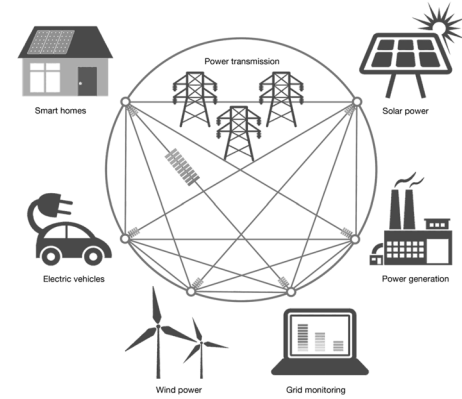
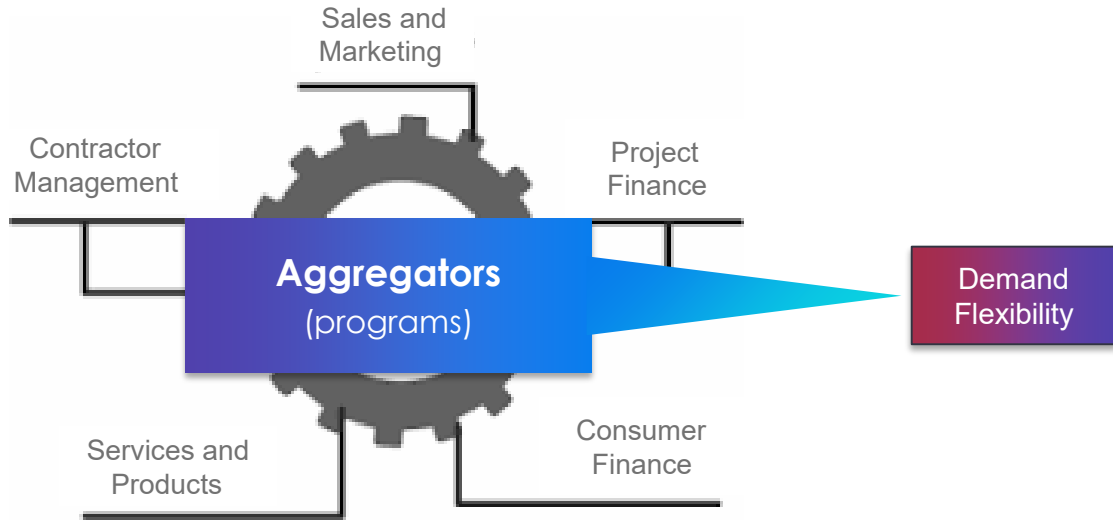
# Distributed Grid = Distributed Data = Distributed Flexibility



# Demand Flexibility Anchors the Decarbonized Grid



# Recurve Makes the Market for Demand Flexibility



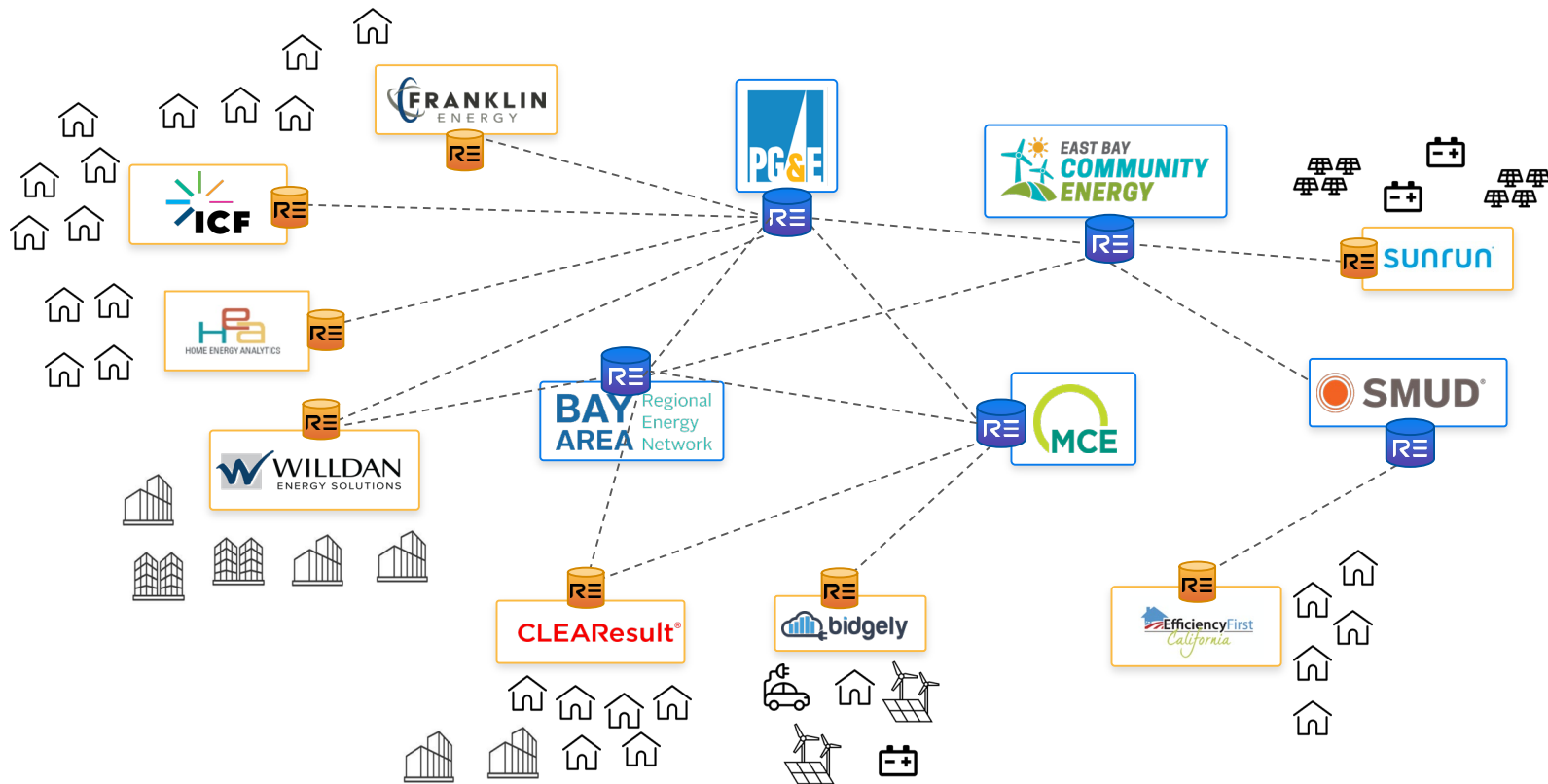
**BUSINESS  
MODELS**



Savings Comfort Health



# Grid Integrated Buildings are Demand Flexibility Assets





# Standard Weights and Measures



**CALTRACK**

- Standard M&V Calculation Methods
- Monthly, Daily, and Hourly
- Public Stakeholders Empirical Process
- [www.CalTRACK.org](http://www.CalTRACK.org)



**OLFENERGY**

**OPENEEMETER**

- Python CalTRACK Engine
- Open Source [Apache 2.0](https://www.apache.org/licenses/LICENSE-2.0)
- Contributed to Linux Foundation
- Code Repo: <https://goo.gl/qFdW4P>

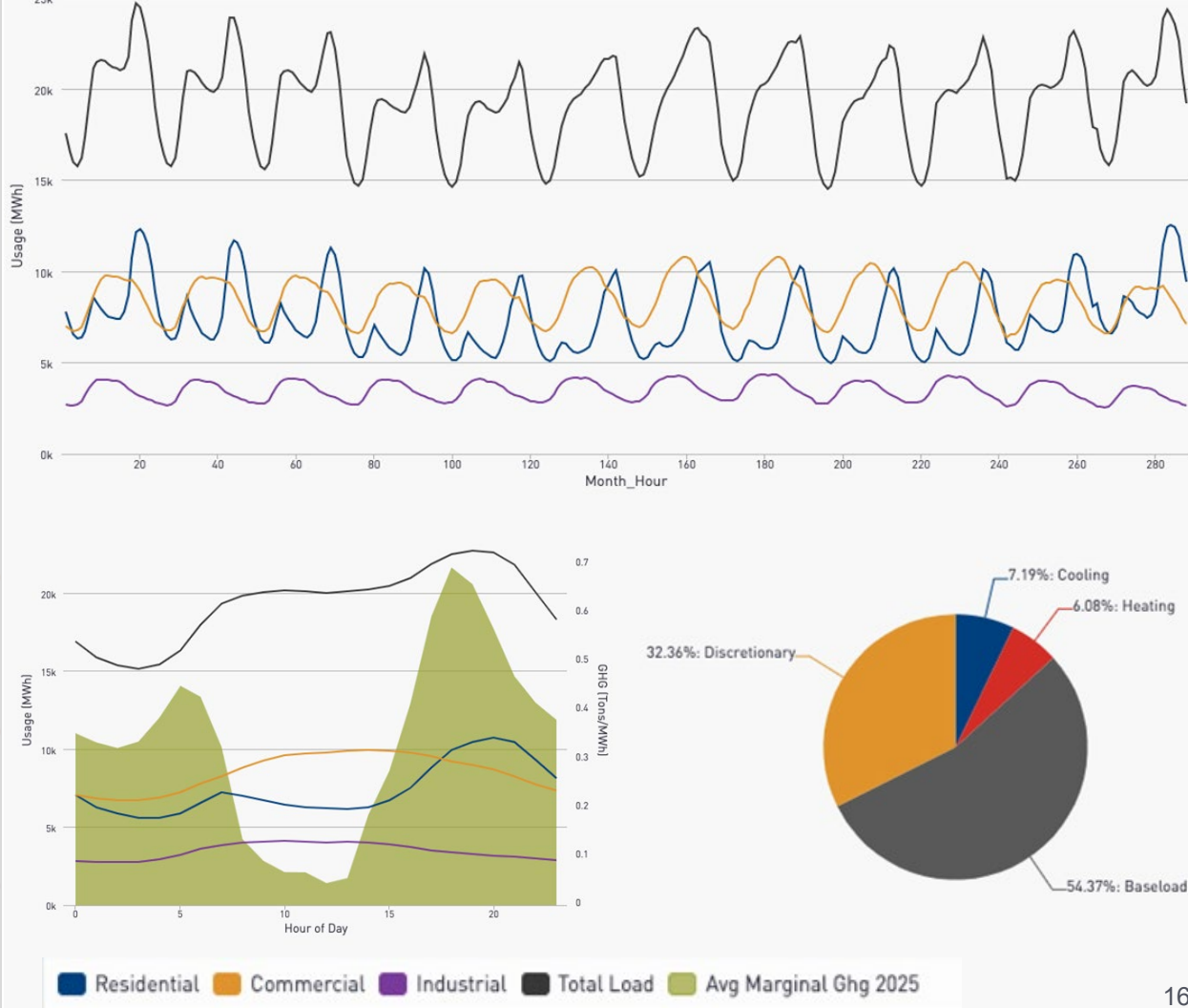
**OLFENERGY**

**RECURVE**

# Resource Planning

Population Grid Analytics to Design, Forecast, and Procure Demand Side Resources

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# Fleet Management

## Tools for Behind the Meter Demand Flexibility

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Combined electricity and gas resource curve by month shown against baseline (MMBTU/Day)

Baseline Usage Lower Reporting Usage Higher Reporting Usage



9,418 MMBTU  $\pm 11.91\%$

Combined EEmetered Savings

11,080 MMBTU

Combined Predicted Savings

85 %  
Combined Realization Rate

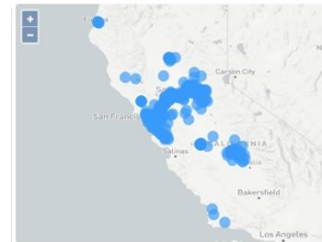
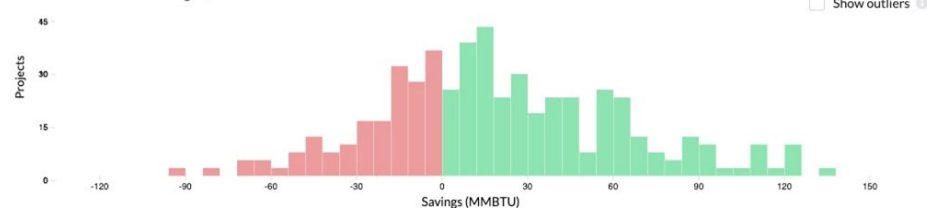
23 %

Combined Savings

40,640 MMBTU

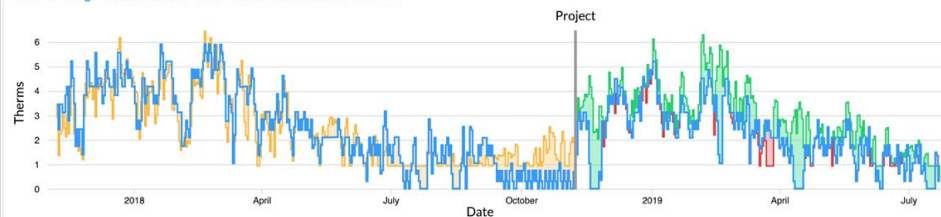
Combined Counterfactual

Portfolio Distribution of Savings



Time series of energy consumption and model values during the baseline and reporting periods (Therms)

Meter readings Meter exceeds model Meter exceeds model Residual



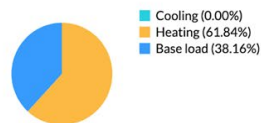
168.5 Therms  $\pm 44.3\%$

EEmetered Savings

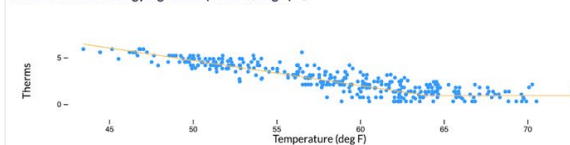
23.52%  
Percent Savings

716.3 Therms  
Counterfactual

Baseline Load Disaggregation



Baseline model energy signature (Therms/deg F)



0.3203

CVRMSE

2,045 HDD

Baseline Heating Demand

0 CDD

Baseline Cooling Demand

12 months  
Baseline Length

887.9 Therms  
Baseline Usage

# Flex Ledger

## System of Record for Revenue Grade Demand Flexibility Transactions

RECURVE

Portfolio Ledger

Account: 841044 January 21st, 2020 [Create New Payment](#)

1,040 Projects	2,033 Meter Assets	\$338,290.59 Base Value	\$0.00 Kicker Value	\$236.90 Assigned Value	\$338,527.49 Total Value	\$171,920.12 Upfront Credit	\$510,447.61 Total Value + Upfront Credit	\$255,223.80 Previous Payments	\$255,223.81 Balance
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2,030 Meter Assets  [Show filters](#) Showing 1 to 10 of 2,030 Meter Assets [Prev](#) [Next](#) [-](#)

METER ID ▾	METER TYPE	PROJECT ID	PROJECT MATURITY ▾	LAST UPDATED	BASE VALUE ▾	KICKER VALUE ▾	ASSIGNED VALUE ▾	TOTAL VALUE ▾	UPFRONT CREDIT ▾	TOTAL V
M77-electricity	electricity	PROJ12377	0 months	12/20/2019	\$266.04	\$0.00		\$266.04	\$133.09	\$399.13
M151-electricity	electricity	PROJ123151	0 months	12/20/2019	\$1,729.98	\$0.00		\$1,729.98	\$865.43	\$2,595.4
M91-gas	gas	PROJ12391	0 months	12/20/2019	\$0.00	\$0.00		\$0.00	\$107.55	\$107.55
M91-electricity	electricity	PROJ12391	0 months	12/20/2019	\$776.13	\$0.00		\$776.13	\$388.26	\$1,164.3
M176-electricity	electricity	PROJ123176	0 months	12/20/2019	\$118,587.04	\$0.00		\$118,587.04	\$59,323.69	\$177,911
M85-electricity	electricity	PROJ12385	0 months	12/20/2019	\$742.65	\$0.00		\$742.65	\$371.51	\$1,114.1
M85-gas	gas	PROJ12385	0 months	12/20/2019	\$0.00	\$0.00		\$0.00	\$107.55	\$107.55
M140-electricity	electricity	PROJ123140	0 months	12/20/2019	\$10,400.31	\$0.00		\$10,400.31	\$5,202.80	\$15,603.
M140-gas	gas	PROJ123140	0 months	12/20/2019	\$0.00	\$0.00		\$0.00	\$107.55	\$107.55
M359-electricity	electricity	PROJ123359	0 months	12/20/2019			\$47.38	\$47.38		\$47.38

1 Payments

PAYMENT ID ▾	DATE ▾	STATUS ▾	# OF PROJECTS ▾	# OF METER ASSETS ▾	PAYMENT ▾	BASE PAYMENT ▾	KICKER PAYMENT ▾	ASSIGNED PAYMENT ▾	TOTAL PAYMENT ▾
1	01/21/2020	CONFIRMED	1,040	2,033	\$221,429.73	\$169,145.29	\$0.00	\$118.45	\$169,263.74

BAY AREA  
Regional Energy Network

SoCalGas

P&E

EnergyTrust  
of Oregon

MCE

nyserda  
Energy. Innovation. Solutions.