



MEASURING ENERGY EFFICIENCY SAVINGS IN REAL-TIME ENHANCES PROGRAM PERFORMANCE

MODERATOR:

COMMISSIONER KIMBERLY O'GUINN, ARKANSAS

PANELISTS:

CARMEN BEST, DIRECTOR OF POLICY & EMERGING MARKETS, RECURVE

BEN BROWN, EXPERT PROGRAM MANAGER, PACIFIC GAS & ELECTRIC

MARK WYMAN, SENIOR PROGRAM MANAGER, ENERGY TRUST OF OREGON

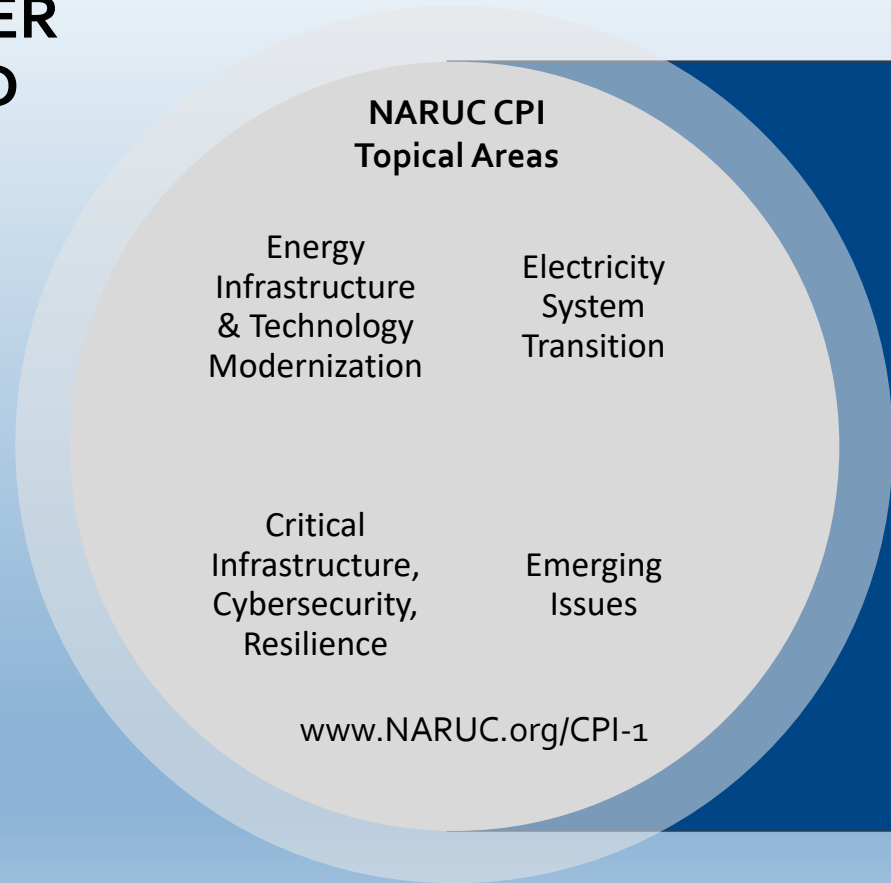
WHAT IS NARUC

- The National Association of Regulatory Utility Commissioners (NARUC) is a non-profit organization founded in 1889.
- Our Members are the state regulatory Commissioners in all 50 states & the territories. FERC & FCC Commissioners are also members. NARUC has Associate Members in over 20 other countries.
- NARUC member agencies regulate electricity, natural gas, telecommunications, and water utilities.



WHAT IS NARUC'S CENTER FOR PARTNERSHIPS AND INNOVATION?

- Grant-funded team dedicated to providing technical assistance to members.
- CPI identified emerging challenges and connects state commissions with expertise and strategies.
- CPI builds relationships, develops resources, and delivers trainings.



WEBINAR LOGISTICS

- We're recording the webinar. It will be posted on the CPI webpage
- Because of the large number of participants, everyone is in *listen* mode only.
- **Please use the questions box to send us your questions** and comments any time during the webinar. You may want to **direct your question to a specific panelist**.
- The panelists will respond to questions typed in the chat box during moderated Q&A, following each presentation and at the end.





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Moderator & Panelists



**Commissioner
Kimberly O'Guinn,**
Arkansas



Carmen Best, Director
of Policy & Emerging
Markets, Recurve



Mark Wyman, Senior
Program Manager,
Energy Trust of Oregon



Ben Brown, Expert
Program Manager
PG&E



RECURVE

SHAPE THE FUTURE OF ENERGY

Meter-Based Efficiency

Building a Grid-Integrated Future

Carmen Best,
Director of Policy & Emerging Markets

NARUC Webinar
June 18, 2020

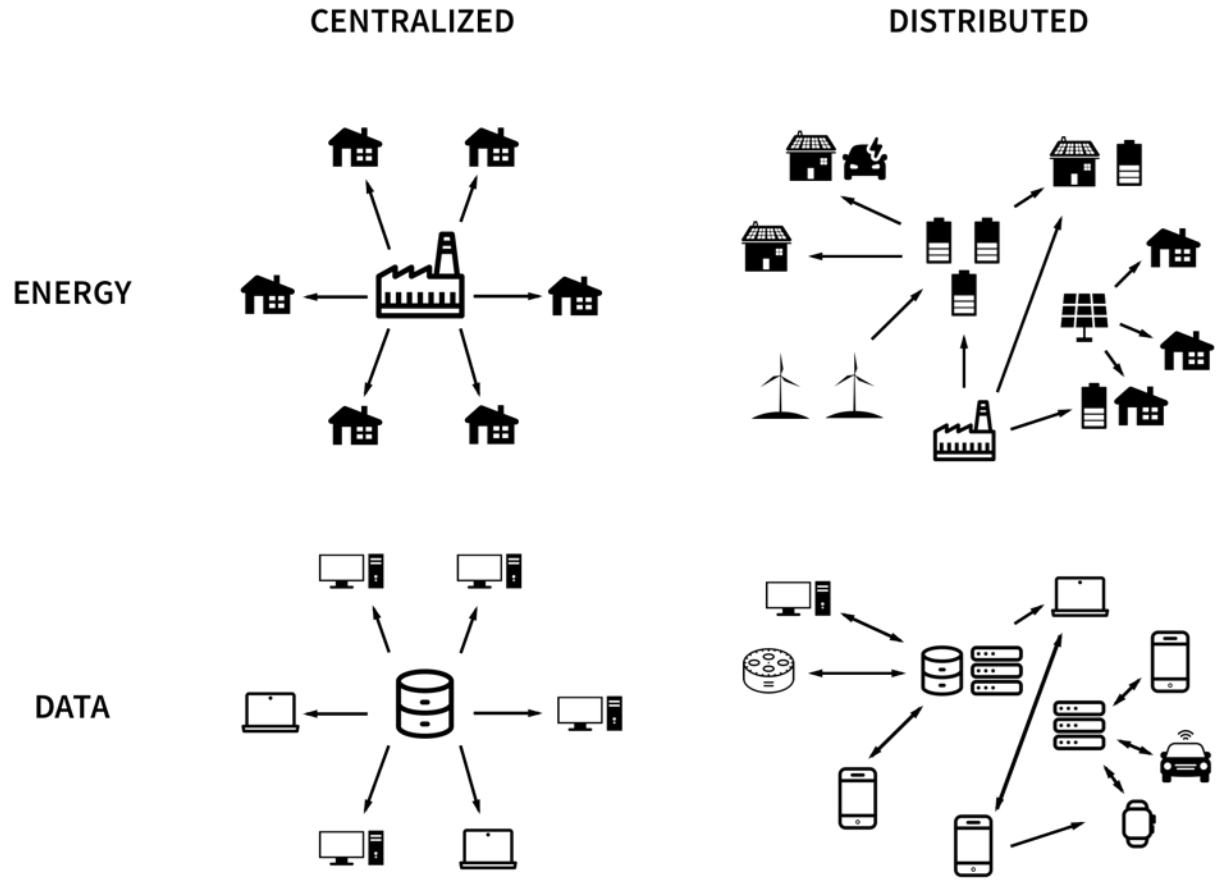
REPORT CARD



The image shows a white report card with a double-line border. The title 'REPORT CARD' is printed in a large, bold, black serif font, slanted diagonally. The card is placed on a wooden surface. A silver pen is visible on the right side, and the spine of a book is on the left.

The Grid is Transforming from Centralized Power Plants to Distributed Grid Edge Resources

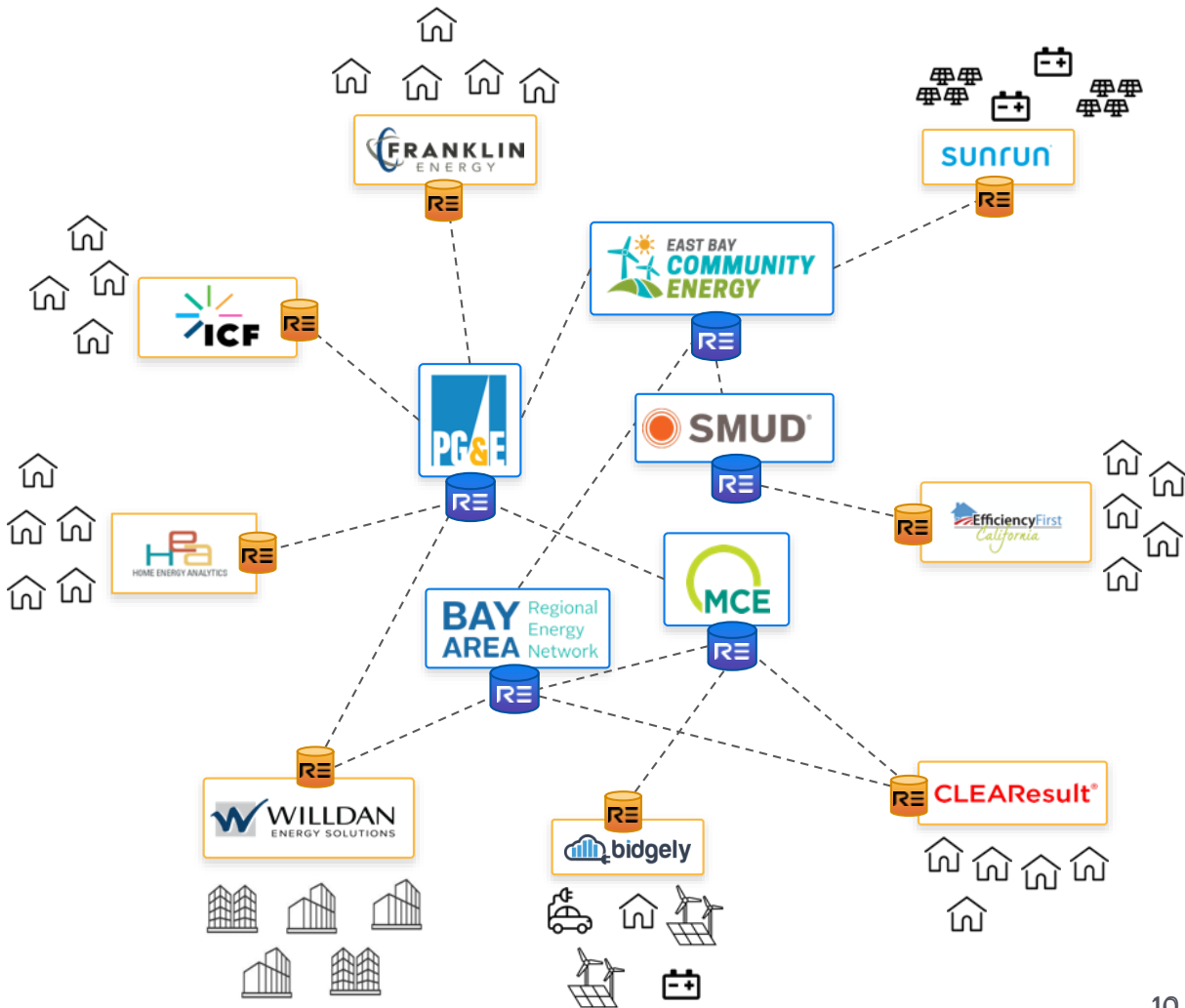
RECURVE



Recurve Platform:

Architected for the
Distributed Grid
Edge

RECURVE





STANDARD WEIGHTS & MEASURES

The Foundation of Market-Based Solutions

RECURVE







- Standard M&V Calculation Methods
- Monthly, Daily, and Hourly
- Public Stakeholders Empirical Process
- www.CalTRACK.org

RECURVE

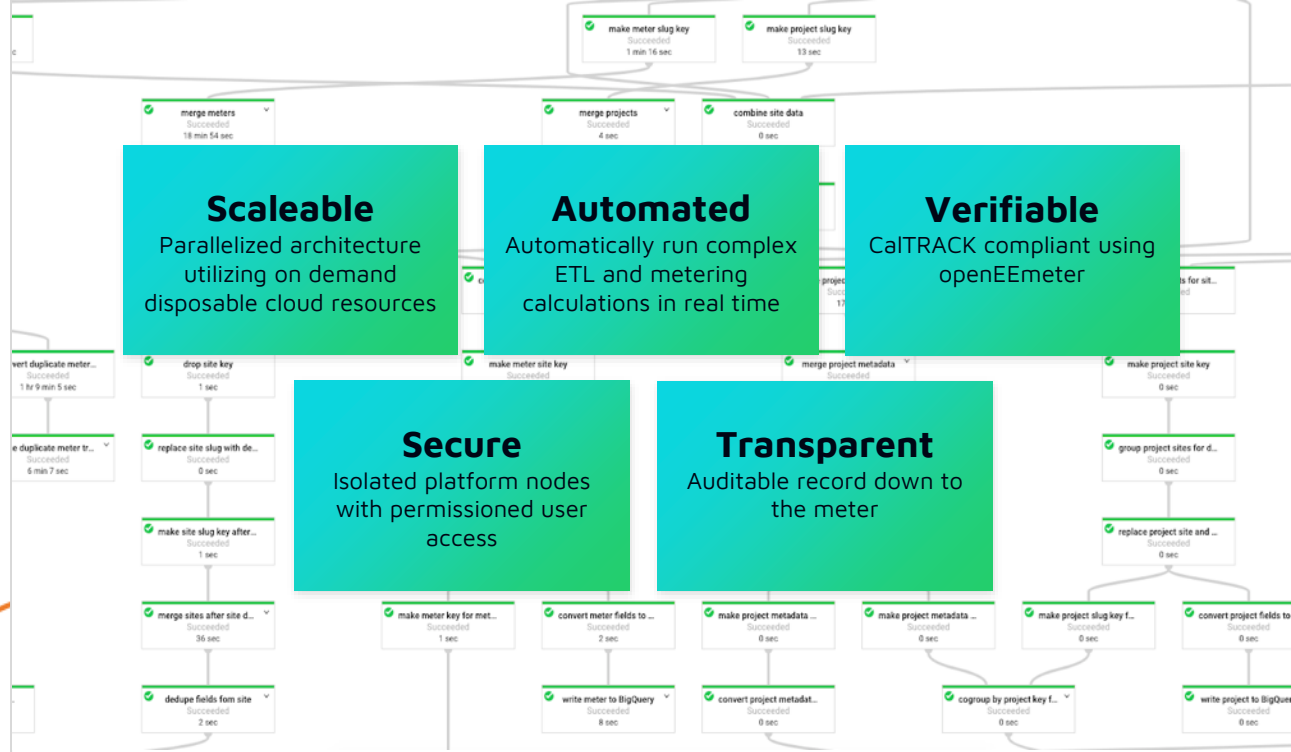


- Python CalTRACK Engine
- Open Source [Apache 2.0](https://www.apache.org/licenses/LICENSE-2.0)
- How It Works:
<https://www.ifenergy.org/projects/openemeter/>
- Code Repo: <https://goo.gl/qFdW4P>

Recurve Platform:

Execution of meter-based calculations at scale

RECURVE



Computing savings once for 1,000,000 meters...

≈ 3,472 Days
Using a local computer

≈ 1/2 Hour
Using Recurve Flex Platform
parallel cloud architecture

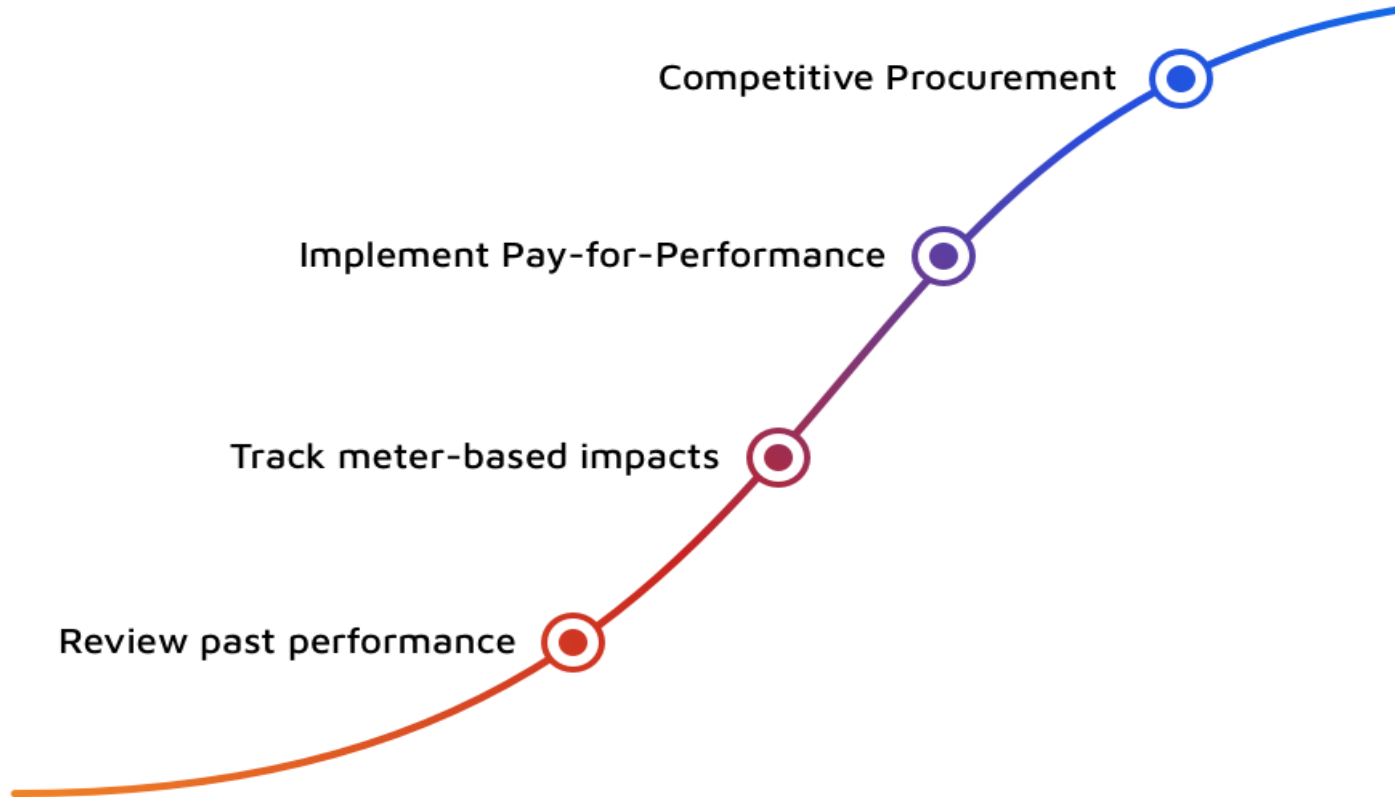


SCALE FOR THE FUTURE

Getting Started on Meter-based Solutions

RECURVE

A Path to Scaling Efficiency



FILTERS (5) ▾

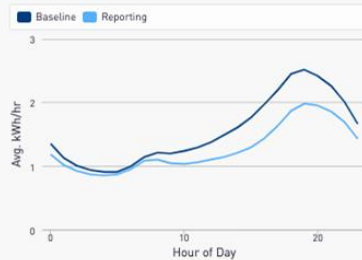
3_Summer_Peak_kWh Top Quartile

5_Summer_Shoulder_Ratio Top Half

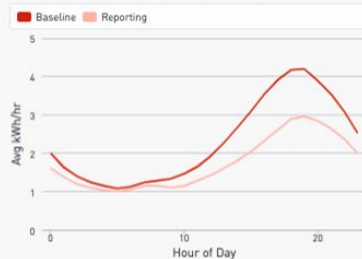
Climate_Zone 4

Year 2020

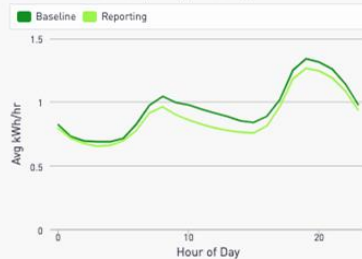
Annual Baseline and Reporting Load Shapes



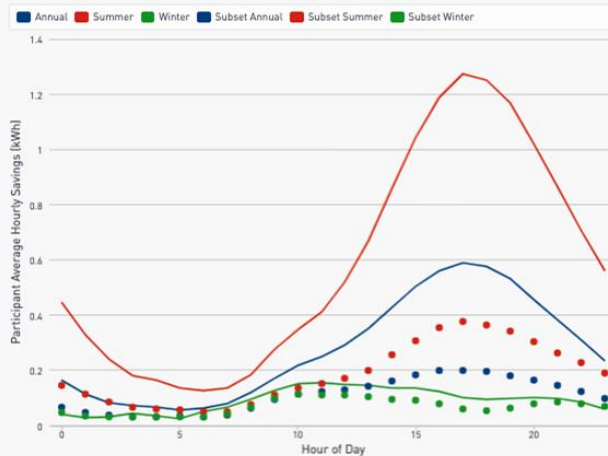
Summer Baseline and Reporting Load Shapes



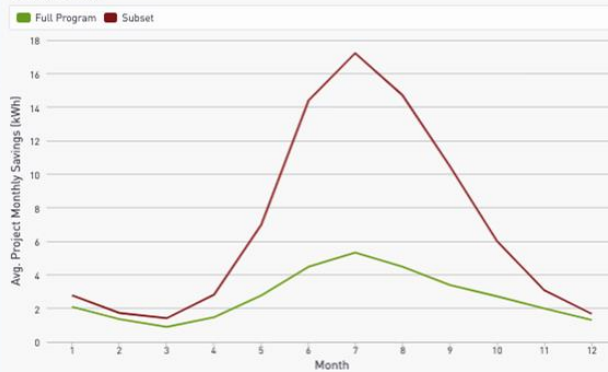
Winter Baseline and Reporting Load Shapes



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

Percent of All Projects

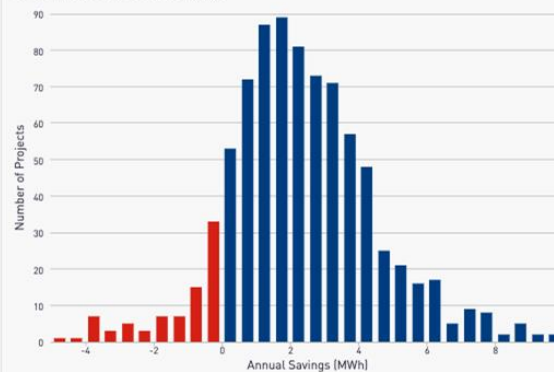
30 %

Summer Peak kWh Savings

9 %

% Negative Savers

Distribution of Annual MWh Savings

2.5X
Greater
Savings70%
Fewer
Negatives

California's Path to Meter-Based Efficiency



2015 **Legislation** sparked change
California Public Utilities Commission's key
regulations support:

- Early pilot pathways
- Consistency and Transparency
- Flexibility for implementation
- Integration with third-party transition
- Performance and accountability

[SB-350 Clean Energy and Pollution Reduction Act of 2015. \(2015-2016\)](#)
[Ruling on High Opportunity Programs and Projects - CPUC 2015](#)



Population-Level NMEC

Program Fit

*Programs must meet the Population-level NMEC **regulatory and filing requirements** described in this document;*

Meter-Based

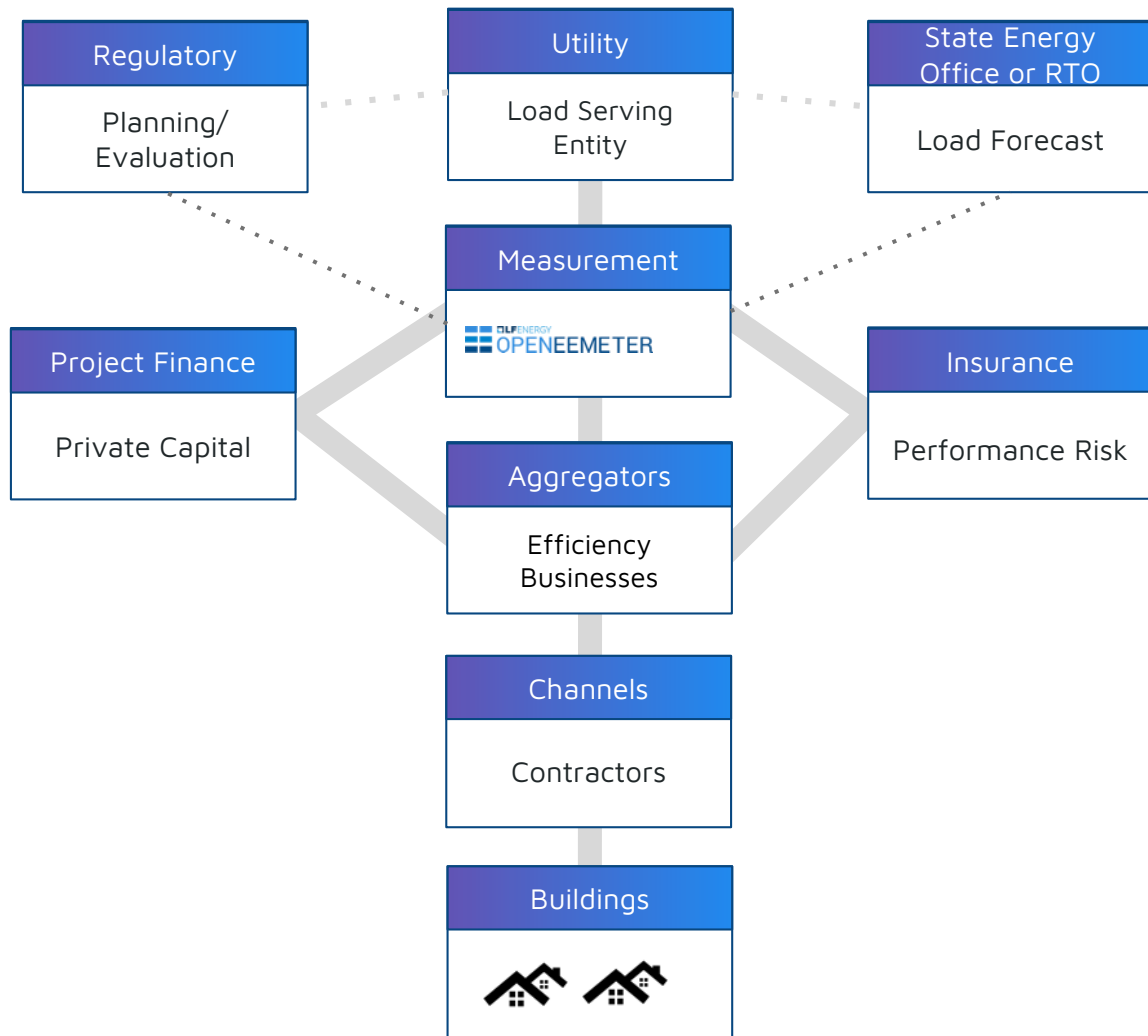
*Energy savings determinations are made using an NMEC approach based on pre and post-intervention **energy usage data observed at the meter***

Pre-Defined & Consistent

*Measurement methods and calculation software are **set before the program starts** (and not subsequently changed) and apply to all sites in a uniform fashion*

Create Performance Accountability

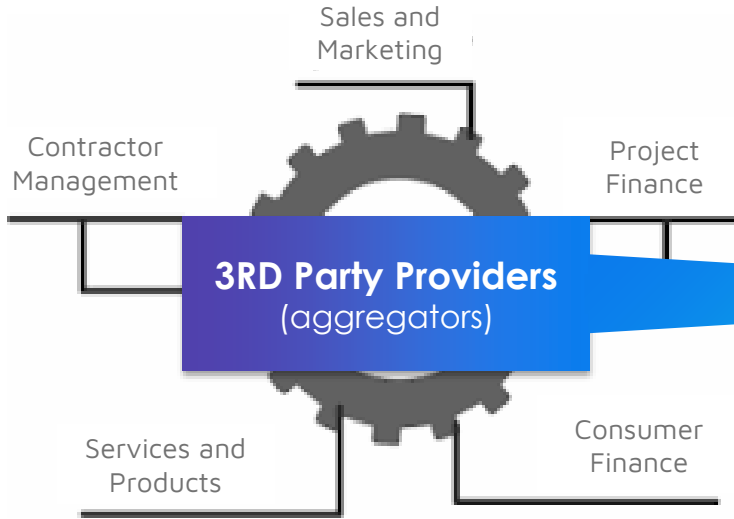
RECURVE



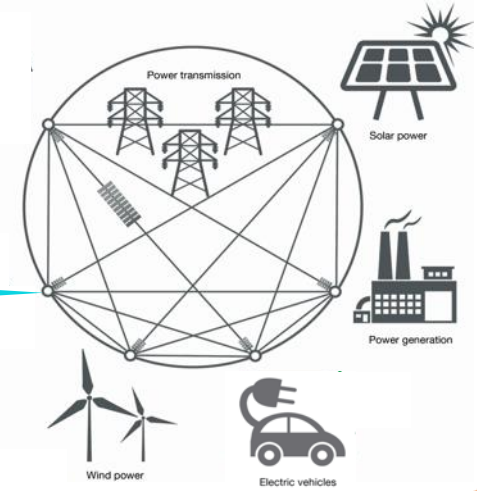
Project Finance: The long-term financing of projects based upon projected cash flows rather than the balance sheets of its sponsors.



Key policy changes today . . .



**DEMAND
FLEXIBILITY**



. . . enable a future of
grid integration.

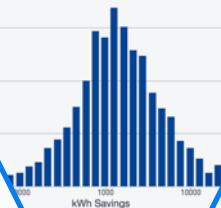


Savings Comfort Health

RECURVE

SHAPE THE FUTURE OF ENERGY

Pay for
Performance



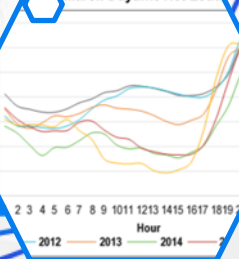
Demand
Flexibility

Procurement

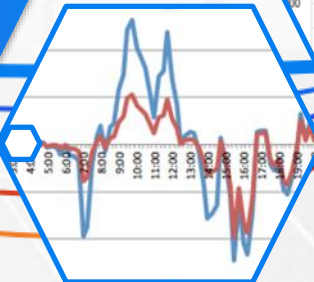


Resource
Curve

March Daytime Net Load



Metered
Flexiwatt



Carmen Best

carmen@recurve.com

References & Resources



CALIFORNIA
ENERGY COMMISSION



CALIFORNIA
DEPARTMENT OF
WATER RESOURCES

California Energy Commission
DRAFT STAFF REPORT

2019 California Energy Efficiency Action Plan

*"With current savings
projections, the state is
missing the 2030 goal in
terms of avoided GHG
emissions." p4*

Gavin Newsom, Governor
August 2019 | CEC-400-2019-010-SD

2019 Energy Efficiency Plan - Doubling Efficiency

- "develop ability to incorporate **aggregations** of energy efficiency and demand response programs into **long term planning**"
- "incorporate **meter-based analysis** into potential studies to identify cost effective savings potential."



The Electricity Journal

Available online 8 August 2019, 106621

In Press, Corrected Proof ?



Decarbonization of electricity requires market-based demand flexibility

Matt Golden ¹ , Adam Scheer, Carmen Best

<https://www.sciencedirect.com/science/article/pii/S1040619019302027>

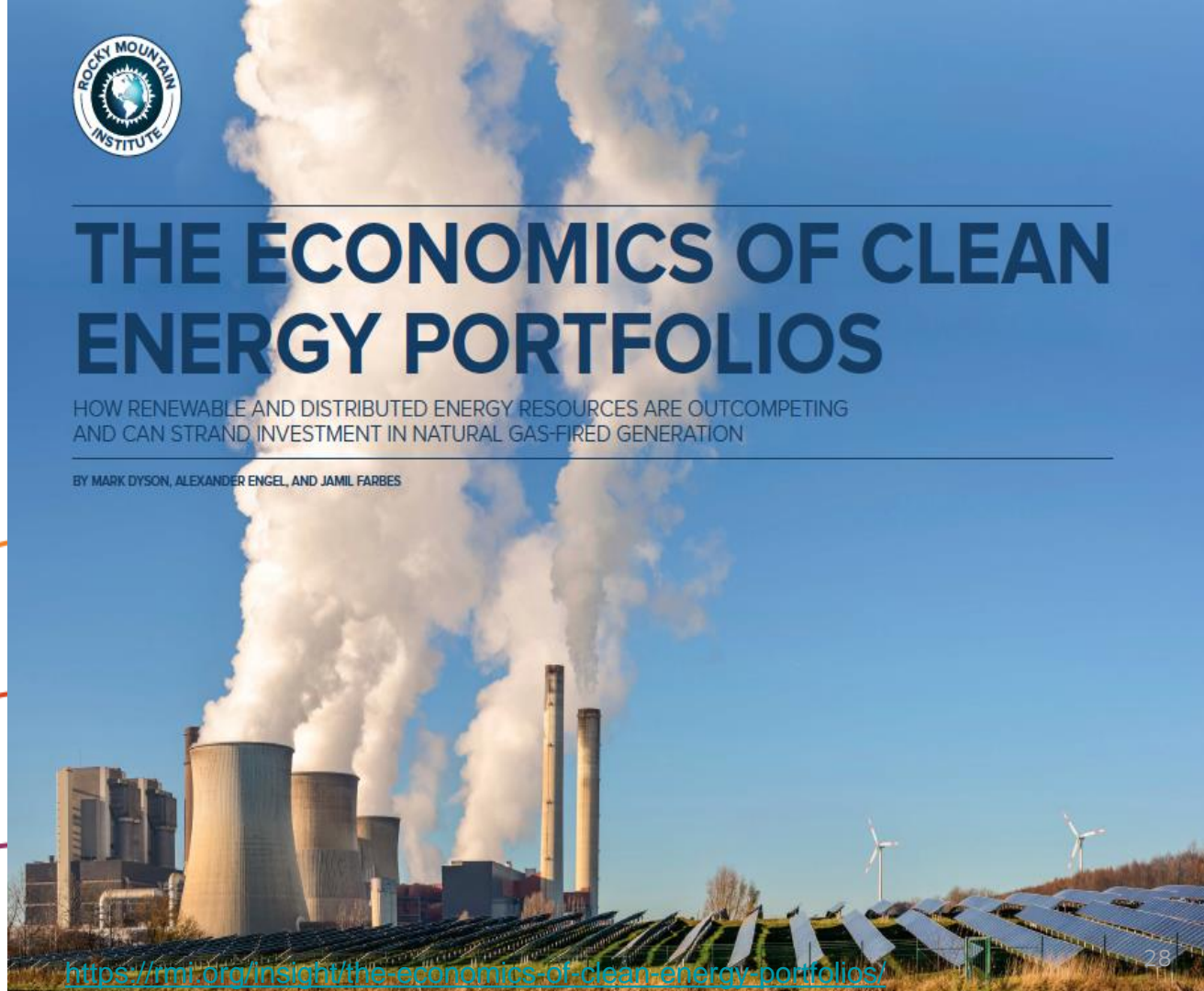
Clean Energy Portfolios Win on Price



THE ECONOMICS OF CLEAN ENERGY PORTFOLIOS

HOW RENEWABLE AND DISTRIBUTED ENERGY RESOURCES ARE OUTCOMPETING
AND CAN STRAND INVESTMENT IN NATURAL GAS-FIRED GENERATION

BY MARK DYSON, ALEXANDER ENGEL, AND JAMIL FARBER



<https://rmi.org/insight/the-economics-of-clean-energy-portfolios/>



Open Source: Opening New Doors for Performance-Based Regulation

Published on July 22, 2019

Carmen Best

Director of Policy & Emerging Markets at Recurve

<https://www.linkedin.com/pulse/open-source-opening-new-doors-performance-based-regulation-best/>



RECURVE

The image shows the cover of a report titled '2035 THE REPORT' by the Goldman School of Public Policy at the University of California Berkeley. The cover features a dark blue vertical band on the left side with the title and date in white and teal text. The background of the entire cover is a photograph of a wind farm with several wind turbines visible against a clear blue sky with some light clouds. The turbines are white and have three blades each. The overall tone is professional and focused on clean energy.

**GOLDMAN SCHOOL
OF
PUBLIC POLICY**
UNIVERSITY OF CALIFORNIA BERKELEY

**20
35**

THE REPORT

JUNE 2020

**PLUMMETING
SOLAR, WIND, AND
BATTERY COSTS CAN
ACCELERATE OUR
CLEAN ELECTRICITY
FUTURE**

"The best way to create value for flexibility is to enhance price signals in the energy markets themselves, to ensure they are rewarding flexible resources."

<https://www.2035report.com/>

Normalized Metered Energy Consumption



California
LEGISLATIVE INFORMATION

SB-350 Clean Energy and Pollution Reduction Act of 2015.

(2015-2016)

*"The energy efficiency savings and demand reduction . . . achieving the targets established pursuant to paragraph (doubling of EE by 2030) **shall** be measured taking into consideration the **overall reduction in normalized metered electricity and natural gas consumption** where these measurement techniques are feasible and cost effective."*

Link: https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160SB350

Normalized Metered Energy Consumption



California
LEGISLATIVE INFORMATION

AB-802 Energy efficiency.(2015-2016)

*" . . . increase the energy efficiency of existing buildings based on **all estimated energy savings and energy usage reductions**, taking into consideration the overall reduction in normalized metered energy consumption as a measure of energy savings. Those programs shall include **energy usage reductions resulting from the adoption of a measure or installation of equipment required for modifications to existing buildings to bring them into conformity with, or exceed, the requirements of Title 24 of the California Code of Regulations . . .**"*

Link: https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160AB802

Normalized Metered Energy Consumption



CPUC Guidelines: *Programs and Projects Using Normalized Metered Energy Consumption (NMEC)*

<https://www.cpuc.ca.gov/General.aspx?id=6442456320>

History of NMEC (An Unauthorized Biography):

Policy References for Normalized Metered Energy Consumption in California - 2018 Update, Published on February 4, 2019

<https://www.linkedin.com/pulse/policy-references-normalized-metered-energy-consumption-carmen-best/>

As California continues the discussions on Normalized Metered Energy Consumption..., Published on February 14, 2018

<https://www.linkedin.com/pulse/california-continues-discussions-normalized-metered-energy-best/>

Rulebook for Programs and Projects Based on Normalized Metered Energy Consumption

Version 2.0

Release Date: 7 January, 2020

*"**Proprietary Methods & Software:** Savings measurement methods and calculation software that is public, and **especially those that are open-source**, benefit from a stakeholder vetting process that allows experts and practitioners to share their knowledge and use updated information to inform savings estimates. The Commission has supported the development of public, open-source processes to develop NMEC methods (e.g. CALTRACK) and encourages stakeholders to engage in these open-source initiatives." p. 18*

RECURVE



Population NMEC M&V Plan & Compliance Checklist



Provided by Recurve Analytics Inc. under a Creative Commons [Attribution 4.0 International License](https://creativecommons.org/licenses/by/4.0/)

Impact Evaluation Specification Comparison Group Methods

- Matching Approach & Criteria
- Statistical Metrics

M&V Protocols and standards . . .



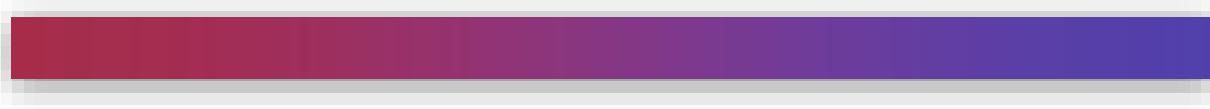
IPMVP Option (C)



ECAM



**Professional
Guidance**



**Reproducible
Execution**

The California Evaluation

Framework
(2004)

Protocols
(2006)

Time of Week
& Temperature
Model



California EM&V Framework
Refresh Needs Assessment

Final Report
October 11, 2017

. . . enable settlement.

Standard Weights & Measures

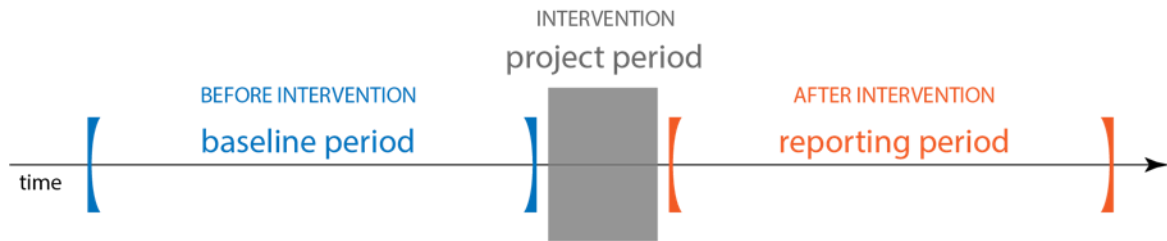


- Standard M&V Calculation Methods
- Monthly, Daily, and Hourly
- Public Stakeholders Empirical Process
- www.CalTRACK.org

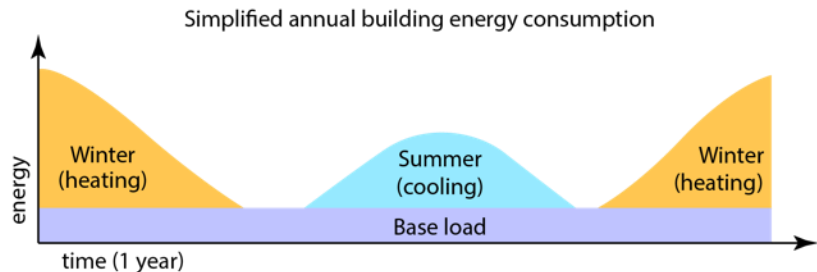


- Python CalTRACK Engine
- Open Source [Apache 2.0](https://www.apache.org/licenses/LICENSE-2.0)
- How It Works: <https://goo.gl/mhny2s>
- Code Repo: <https://goo.gl/qFdW4P>
- Overview:
<https://www.lfenergy.org/projects/open-eemeter/>

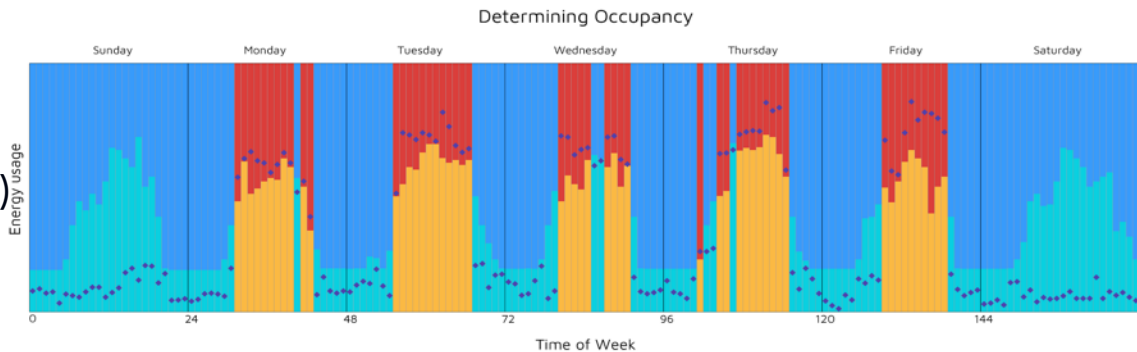
Technology Agnostic Change In Consumption



CalTRACK Monthly Model



CalTRACK Hourly Time of Week Temperature (TOWT) Model



RECURVE

Policy Pathways to Meter-Based Pay-for-Performance

Carmen Best, Recurve, Berkeley, CA

Megan Fisher, NYSERDA, New York, NY¹

Mark Wyman, Energy Trust of Oregon, Portland, OR

International Energy Program Evaluation Conference 2019

Abstract: https://www.iepec.org/wp-content/uploads/2019/02/abstracts_presentations_best.pdf

Paper:

https://www.iepec.org/2019_proceedings/#/paper/event-data/044-pdf

Three Generic Categories of Adoption

Market Focus

Large scale pilot with focus on market development

New York: *Business Energy Pro, a Pay-for-Performance initiative*

Executive direction for grid level improvements, coupled with State Authority leadership

Scaled Pilots & 3P

Large scale pilots and third-party procurements

California: *Pacific Gas & Electric Residential Pay-for-Performance, and Third-party Solicitations*

Legislation, regulatory authorization, and utility administrator leadership

Contractor Focus

Step-wise testing with contractors delivering existing programs

Oregon: *Energy Trust Pay-for-Performance Pilot*

Third-party administrator initiative coupled with Governors executive order

Pacific Gas and Electric Company Pay for Performance Programs & Grid Resource Program Procurement

Ben Brown

NARUC Webinar on Meter-Based Efficiency

June 18th, 2020

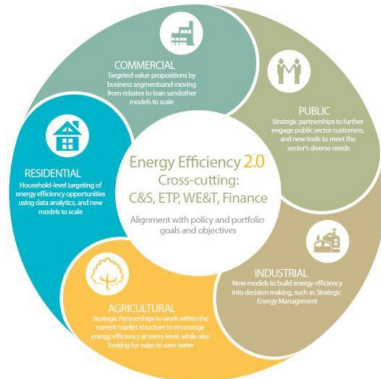


Together, Building
a Better California

Energy Efficiency in California

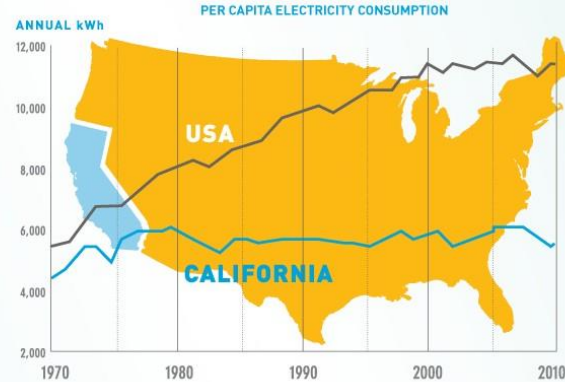
History

- Began in the 1970s
- Building and appliance Code drove savings
- Decoupling introduced – utility profits not tied to revenue
- Shareholder incentive introduced



Why Energy Efficiency Matters

Since 1970, California's energy use has remained flat while per capita consumption throughout the rest of the country has doubled. California's energy efficiency has helped the state avoid building at least 30 large power plants.

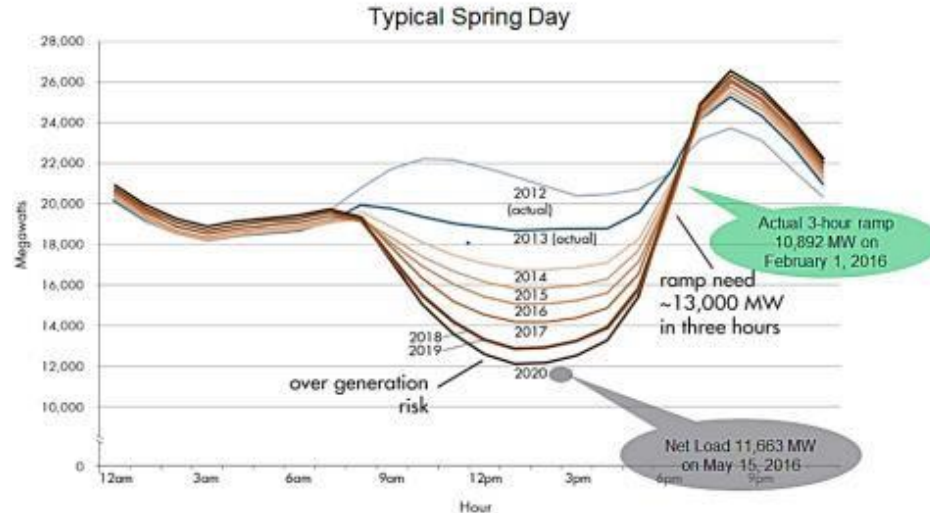


Currently

- \$1 Billion/year in ratepayer funded EE
- Cost effective savings are mandated
- Huge variety of programs, channels and offerings

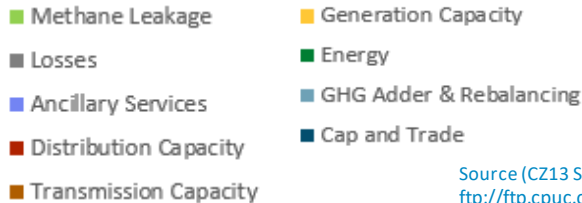
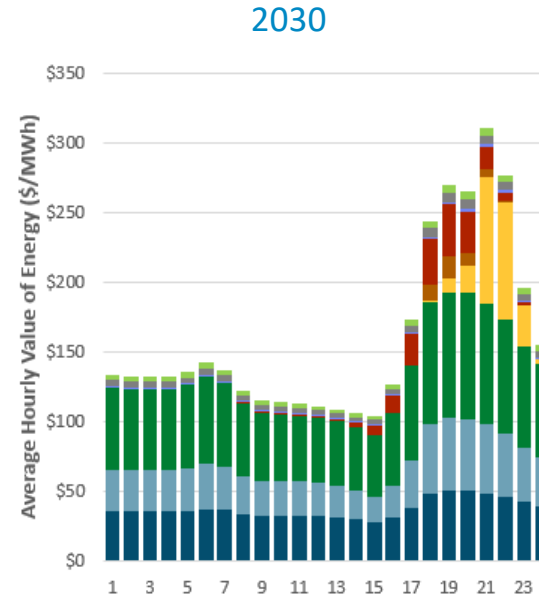
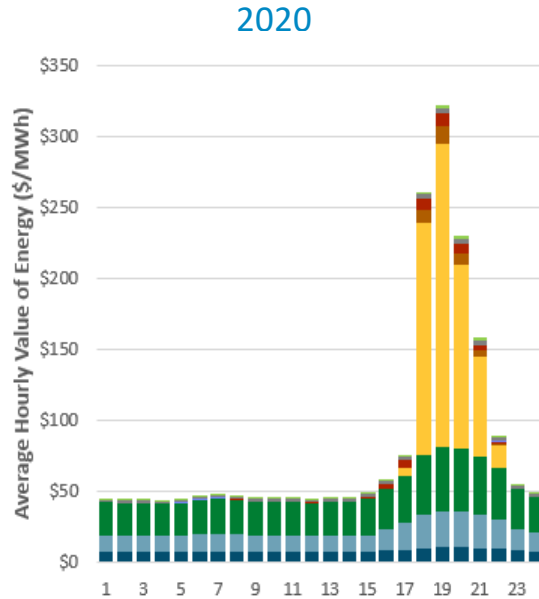
California Duck Curve

Figure 2: The duck curve shows steep ramping needs and overgeneration risk



Source: https://www.caiso.com/Documents/FlexibleResourcesHelpRenewables_FastFacts.pdf

Hourly Value of Energy (Electric)



Source (CZ13 Shown):
ftp://ftp.cpuc.ca.gov/gopher-data/energy_division/EnergyEfficiency/CostEffectiveness/2020%20ACC%20Electric%20Model%20v1b.xlsx

California (CA) Senate Bill 350

- Doubles energy efficiency goals in existing buildings by 2030
- Calls out behavioral savings opportunities

CA Assembly Bill (AB) 802

- Allows “existing conditions” baselines
- Prioritizes weather normalized, “meter-based” savings

CA AB 793

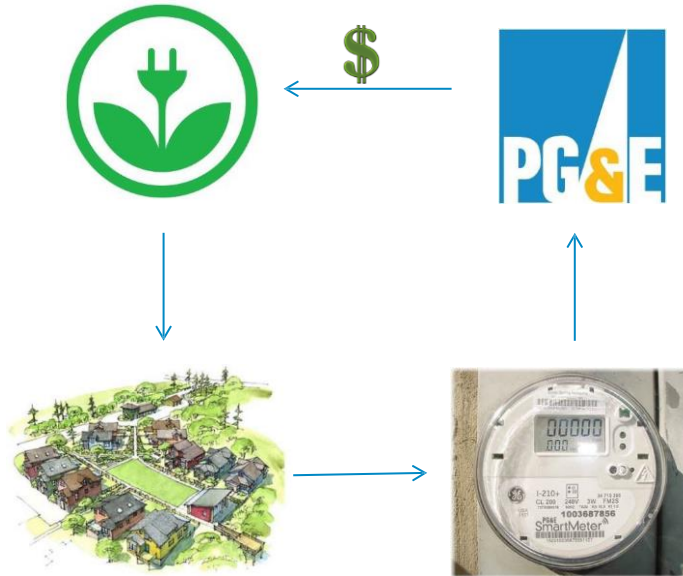
- Requires that real time energy usage data is made available to customers
- Requires utilities to incentivize energy management technologies

CA Public Utilities Commission Decision 16-08-019

- Requires utilities to procure third party designed and implemented energy efficiency programs

Pay for Performance Program Model

Implementer/Aggregator





PG&E's Residential Pay for Performance (Res. P4P) Programs

Unparalleled flexibility to pursue a range of improvements and activities over time to achieve residents' savings goals

Retrofit

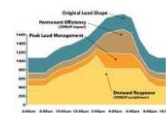
- Whole House
- HVAC
- Lighting
- Outdoor/Pool Deck

Operational

- Smart Thermostats
- Home Energy Management Systems
- Smart Appliances

Behavioral

- Homeowner Incentives
- Demand Response
- Other specially designed programs



Res. P4P Experience (so far)

Successful Solicitations

- We competitively procured four program contracts with three different implementers
- All contracts are entirely performance based using CalTRACK methods
- Two contracts contain variable pricing allowing us to value program energy savings in close alignment with real energy costs

Innovative Implementation

- Programs largely include behavioral and operational interventions to drive savings
- Customers are provided a strategic energy partner
- Implementers use data driven feedback to inform future program interventions

Challenges

- Incorporate behind the meter solar PV, battery storage, electric vehicle charging
- Implementer cash flow challenges
- Ensuring program participant and data integrity
- Develop benefit and cost reporting structure able to accommodate new program model

Next Steps

- Application in other program models and sectors (commercial retrofits and financing programs)
- Develop track record to allow for accuracy in forecasting
- Incorporate wider range of distributed energy resources (DERs)
- Incorporate more dynamic pricing into future contracts

Program Goals

- Demonstrate program is a sustainable model for EE program portfolios
- Create a supportive data ecosystem
- Allow EE to emerge as a reliable grid resource



EE as a Grid Resource

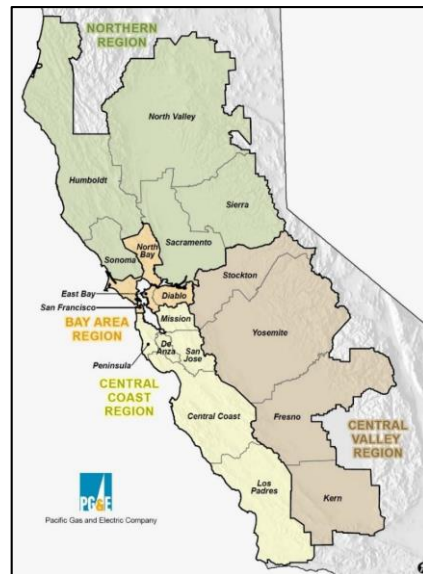
- PG&E invited Bidders to submit program designs that could demonstrate the capability of EE as a Distributed Energy Resource (DER).
- DERs must meet the same technical and operating standards as the rest of the distribution system such that when DERs are interconnected, they do not impact the safety and reliability of the grid.
- For EE, this requires a program that can deliver verifiable energy savings at:
 - Specific locations
 - Predictable times
 - Predictable levels (magnitude)
 - Acceptable levels of availability and assurance
- Grid Resource program proposals must target the right customers with the right measures at the right time and at the right locations such that the energy savings generated by the program naturally align to the specific locational and temporal needs of the grid.



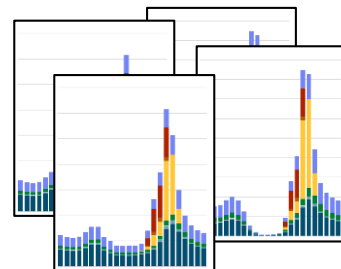
EE as a Grid Resource

- PG&E's objective for Grid Resource programs in this RFP is to identify innovative EE program designs that demonstrate EE can provide energy savings with the level of precision and confidence equivalent to other DER technologies.
- There are two requirements for a program to be considered as a Grid Resource program in the RFP
 - Grid Resource programs require a **meter-based approach and support near real-time Embedded M&V** to deliver verified energy savings and/or capacity reductions that can be substantiated, commercially transacted and settled to terms on par with other DER technologies.
 - Grid Resource Programs must be informed by both **customer data and grid data** to create a program design that can target customers in a region with the right measures, so the energy savings produced coincides when they are most needed by the grid which varies by the time of day, the time of year, and geographic location.
- At this stage, such program structures will not need to defer distribution capital investments or relieve grid constraints, avoiding the risk to system reliability and the associated punitive commercial terms that follow.
- It is PG&E's expectation that some or all of these Grid Resource programs will, at some point in the future, serve these grid resource roles.

- The dynamic interplay between weather patterns (coast, valley, mountain), development (urban, suburban, rural), and other regional factors (commercial / industrial activity and customer adoption of rooftop solar) coalesce and create distinct variations in grid needs across the various Distribution Planning Regions.
- This analysis is depicted as a simple delivery window for each DRP and can be seen in Figure 5.6 – PG&E DPR Savings Delivery Windows.
- For each DP Region, energy savings delivered during the time frames indicated in green are designated as preferred. Energy savings delivered outside of these timeframes are also accepted.



DPR Energy Savings Delivery Windows																							
Bay Area Region																							
Central Coast Region																							
Central Valley Region																							
Northern Region																							
Hour Beginning	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22



Thank You

Ben Brown

Ben.Brown@pge.com





Mark Wyman
Pay For Performance
June 2020 Update

About us

Independent
nonprofit

Serving 1.6 million customers of
Portland General Electric,
Pacific Power, NW Natural,
Cascade Natural Gas and Avista

Providing access
to affordable
energy

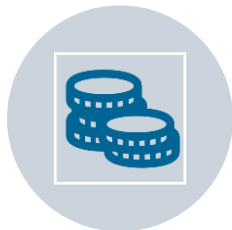
Generating
homegrown,
renewable power

Building a
stronger Oregon
and SW
Washington

Oregon Residential Pay For Performance (P4P) Design Principles



SAVINGS
CALCULATED OFF
12 MONTHS
WEATHER
NORMALIZED
BASELINE AND 12
MONTHS POST-
TREATMENT USAGE
DATA



USE CALTRACK AS
THE FOUNDATION
FOR SAVINGS
METHODOLOGY,
IMPLEMENTED
THROUGH OPEN EE
PLATFORM



SAVINGS ARE
MEASURE-
AGNOSTIC

Pilot overview



2 year limited deployment

Three aggregators
Portfolios based on dominant treatment type



Layered onto deemed savings

performance above deemed assumptions
Lifetime value established by deemed weighted average



1 year performance period

Two enrollment periods per year
Comparison group analysis nets exogenous change

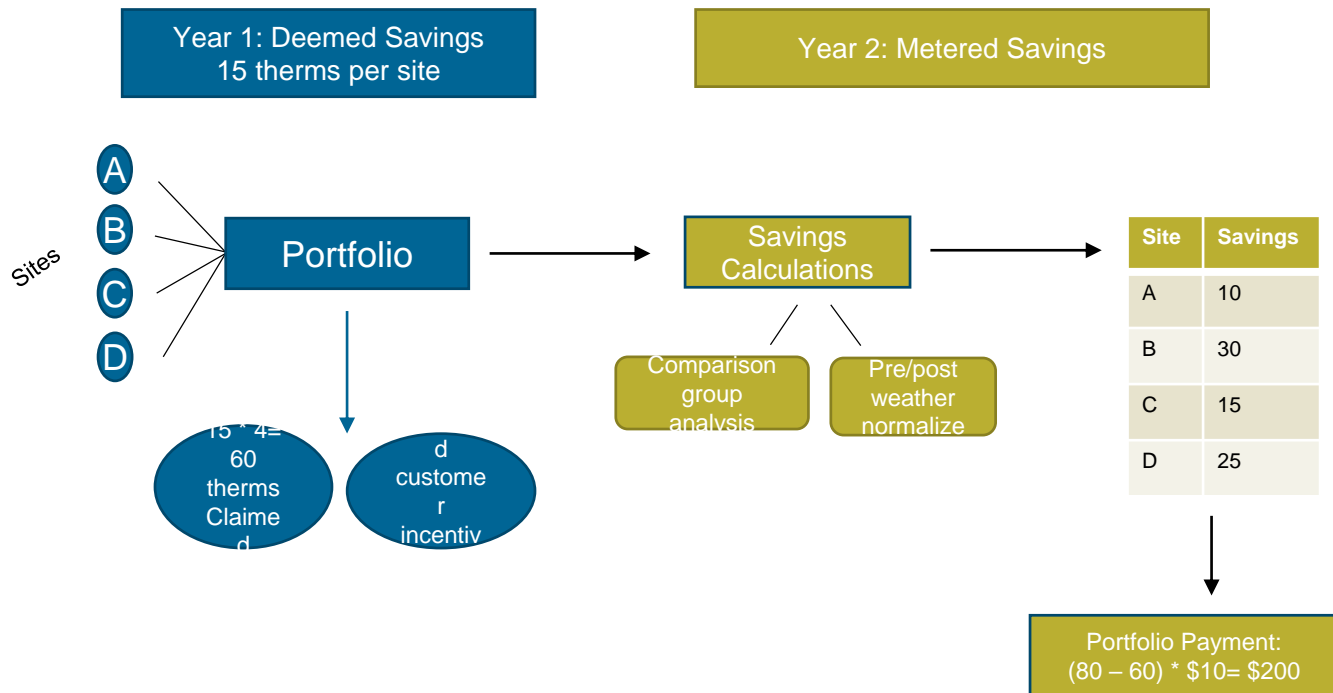


Contractor-facing market test

Three contractors act as aggregators of projects
Contractors have access to performance dashboards

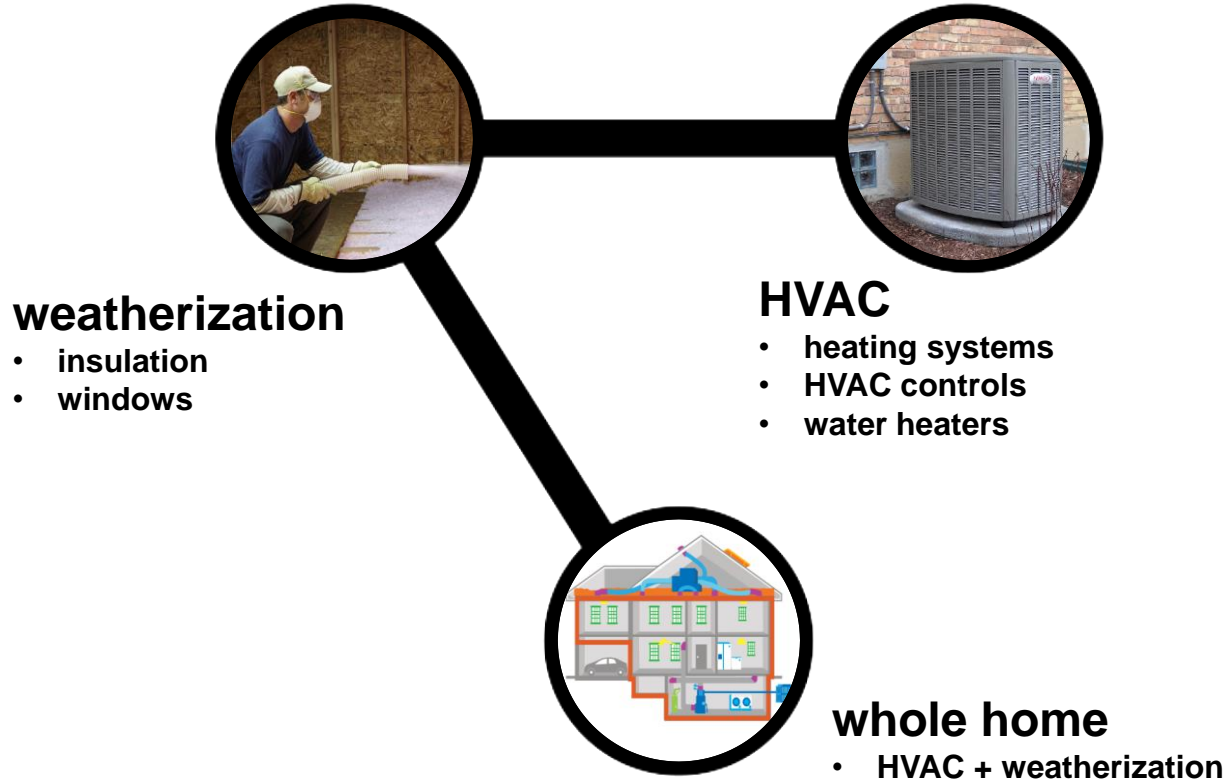
Sample Portfolio Life Cycle

Example: deemed savings 15 therms per treatment, savings above deemed priced at \$10/therm

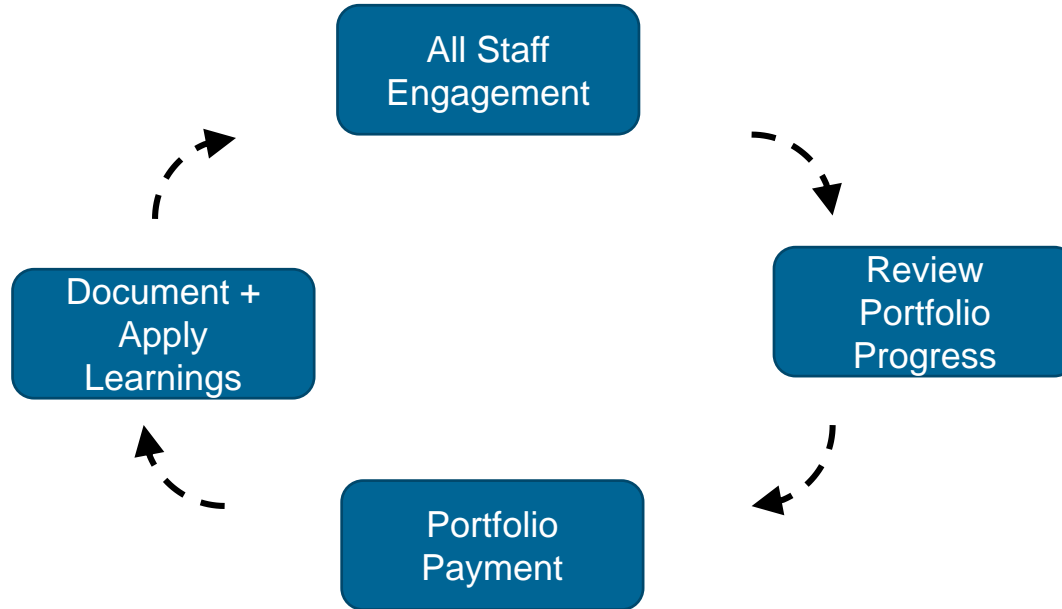


Pay for Performance Portfolio Types

Priority Measures



Aggregator Engagement



Research Questions

- 1) Do P4P designs enable better targeting of interventions with variable outcomes?
- 2) Do P4P designs improve measure cost effectiveness?
- 3) Do P4P designs create new participation opportunities for lagging markets?
- 4) Is the market ready for a “pure” P4P approach with no guaranteed (deemed) incentives?
- 5) How persistent are the energy savings from P4P?





Limits and Exclusions

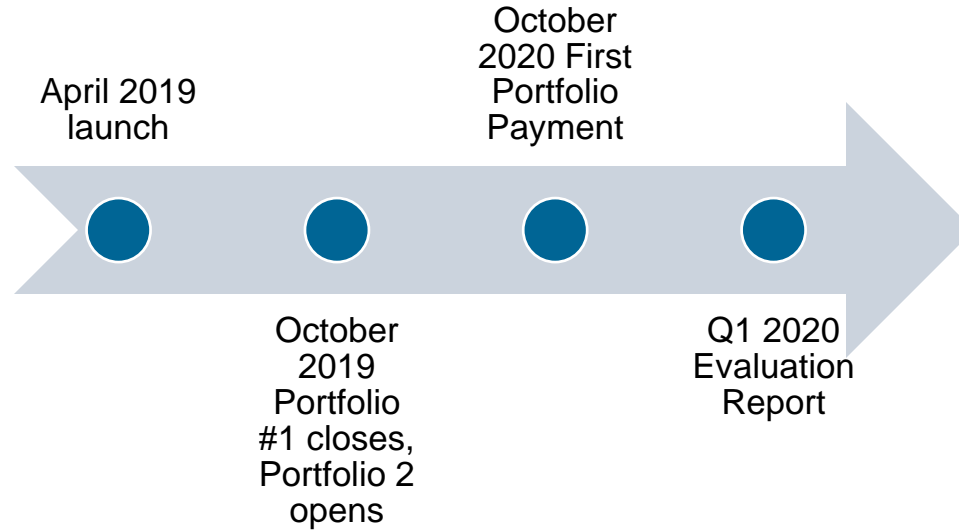
- Sites with solar
- Missing meter data
- Fuel switching
- “Synthetic baselining” or non-routine adjustments

Risks, Unknowns and Considerations

- Monthly billing data quality
- Account changeovers
- Non-routine events
- Measures with market baselines
- Forecasting yield



Pilot Milestones





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QUESTIONS?

1. Use the Question box
2. Direct your question to Panelist by name





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