RECURVE

SHAPE THE FUTURE OF ENERGY

California's policies:

Are not aligned to scale.

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There are SO Many Solutions In the Market

Unified Field Theory

=

Common **R**esource **V**aluation **M**ethodology

+

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Normalized **M**etered **E**nergy **C**onsumption

CALTRACK

Technology Agnostic
Change In Consumption

LF ENERGY
OPENEEMETER

Hourly Time of Week &
Temperature Model

OPEN
GRID METER

Stratified comparison groups
net impact to the grid
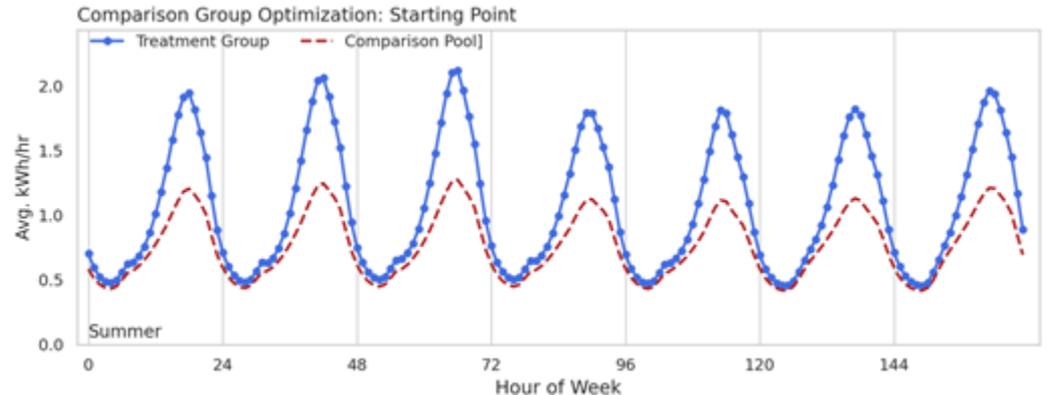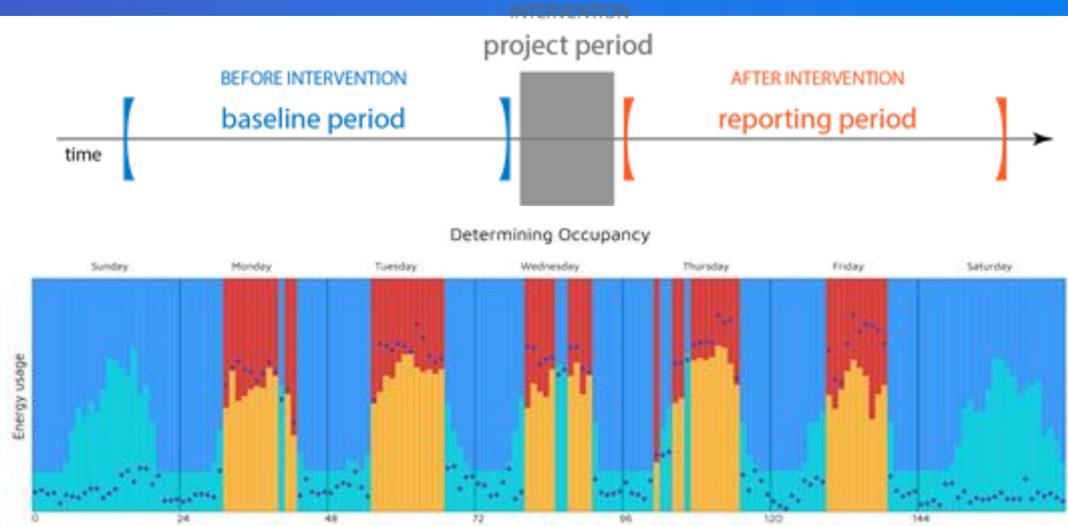
Policy Pathway to Scale Demand Flexibility

Resource Integration

Accountability Mechanisms

Meter-Based
Quantification

Track Meter-based Impacts

Performance
Payment

Competitive
Procurement

Review Past Performance

Treatment of Participant Costs

AMI and
Data Access

Calibrating the Avoided Cost
Calculator & other value signals

6
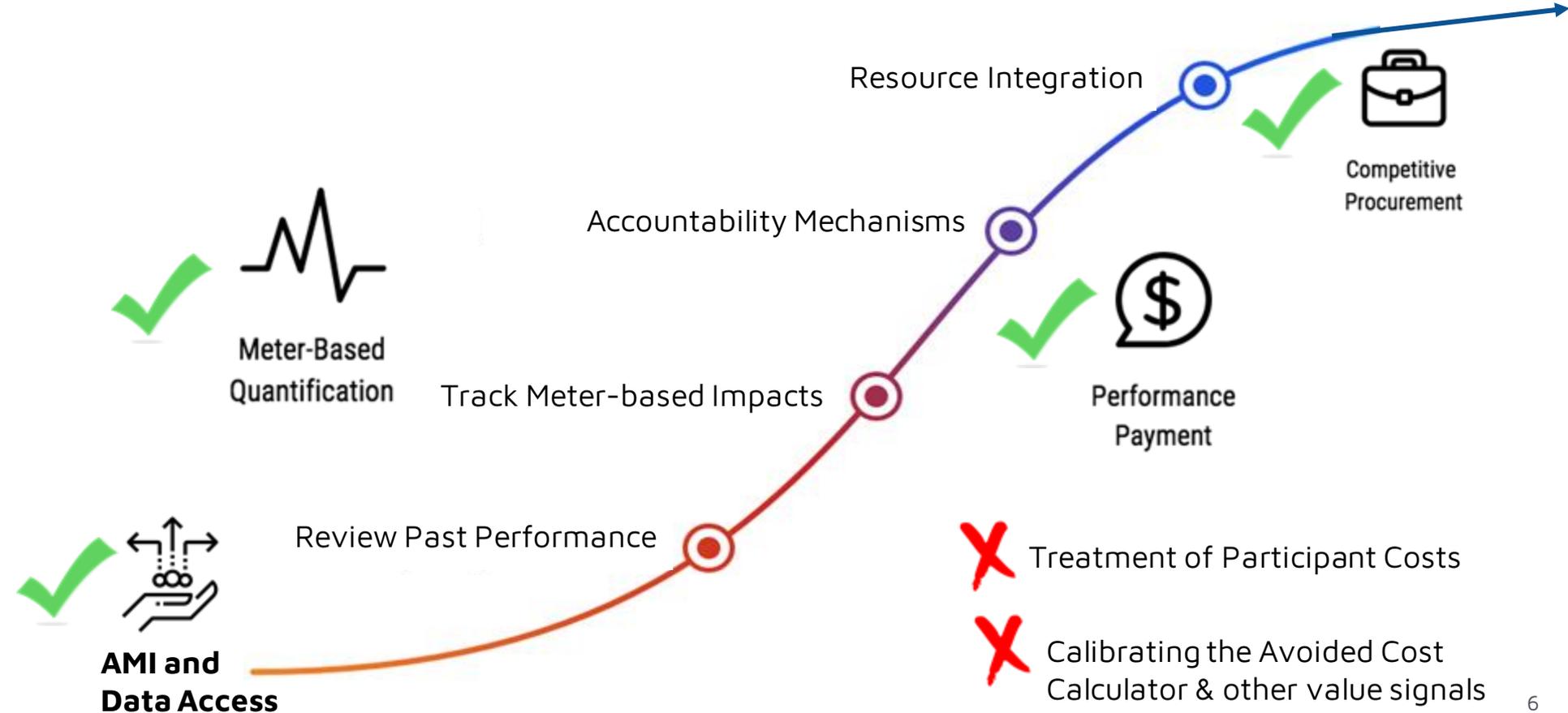
Markets for Demand Flexibility

- **Load Shifting**
  (e.g., Storage, DR)

- **Load Shaping**
  (e.g., EE, Solar)

- **Load Balancing**
  (e.g., EVs, Heat Pumps)

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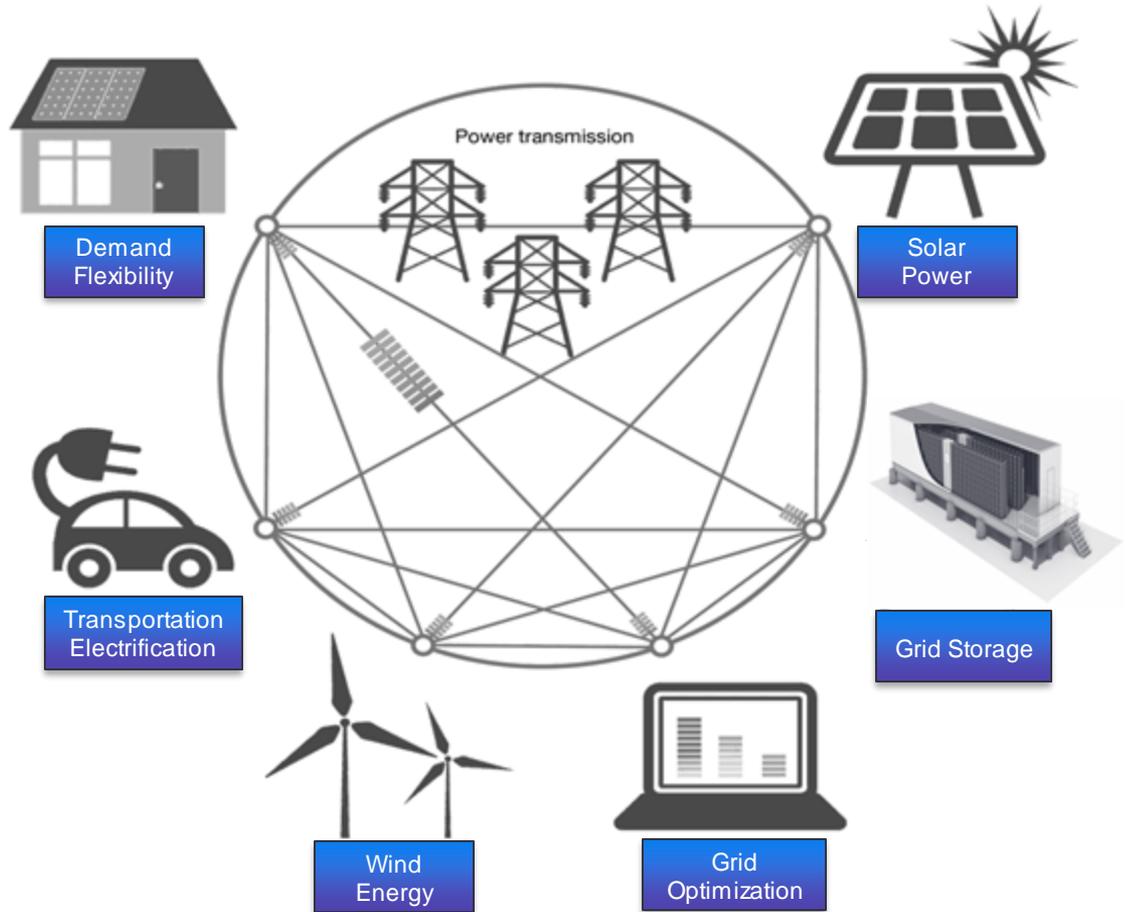
Recurve Platform:

Execution of meter-based calculations at scale

Scaleable
Parallelized architecture utilizing on demand disposable cloud resources

Automated
Automatically run complex ETL and metering calculations in real time

Verifiable
CalTRACK compliant using openEEmeter

Secure
Isolated platform nodes with permissioned user access

Transparent
Auditable record down to the meter
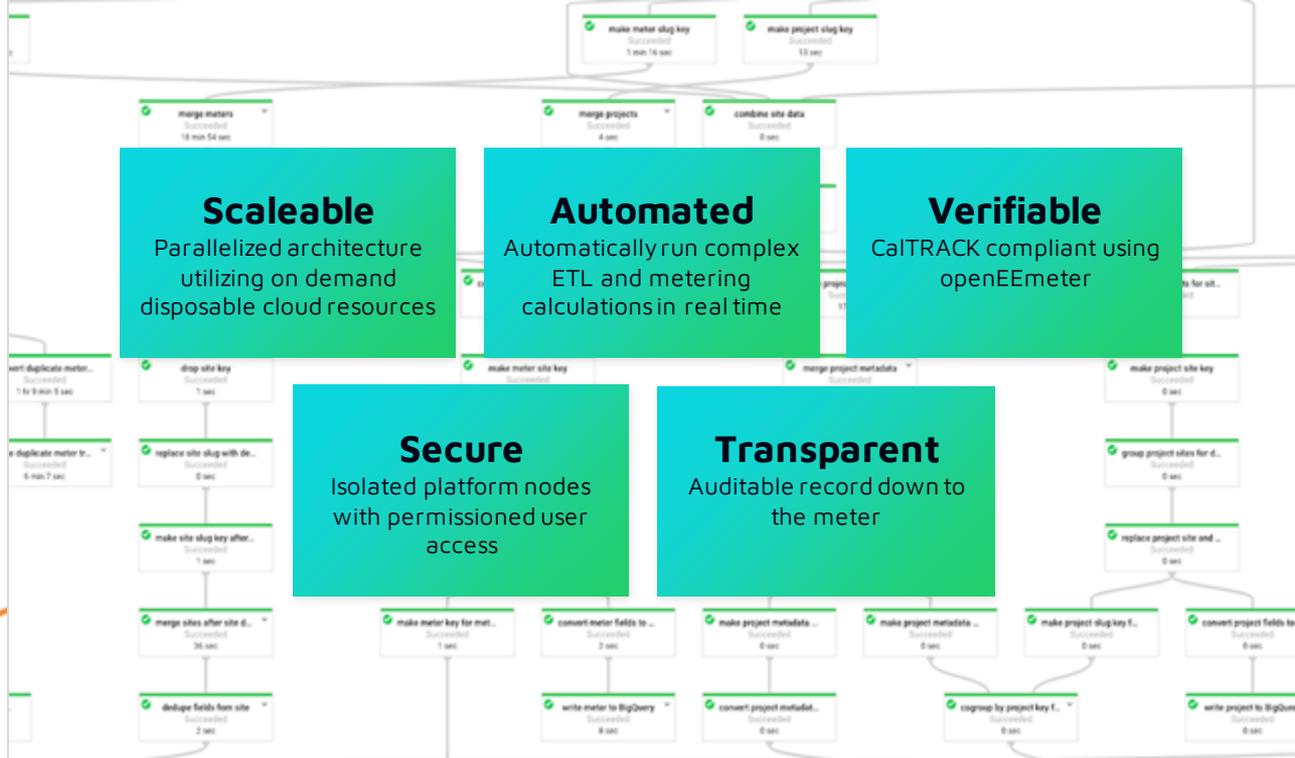
Computing savings once for 1,000,000 meters...

≈ 3,472 Days

Using a local computer

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

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MAKING VALUE VISIBLE

Accessibility of Cost Effectiveness
& Other Price Signals

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FLEXVALUE ~ Purpose

- **Simplify** and bring **transparency** to valuation - amplify the value signal.

- Expand **functionality**: to enable innovative program design
    - Integrated programs
    - Pay on measured value

- Open governance model = Tools to foster smart policy and align decisions in the field

Value shouldn't hidden in a black box inside an DSM bubble

What Do I **Need** to Know to Calculate Cost Effectiveness?

Costs

- Admin Costs
- Measure Costs
- Incentive

Program

- Electric Savings
- Electric Load Shape
- Gas Savings
- Gas Savings Profile
- Net to Gross
- EUL

Benefits

- Hourly electric avoided costs for duration of EUL
- Monthly gas avoided costs for duration of EUL
- Discount Rate

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nesp

National Standard Practice Manual (NSPM) for DERs

Commission Approved:
Electric Avoided Costs by Component
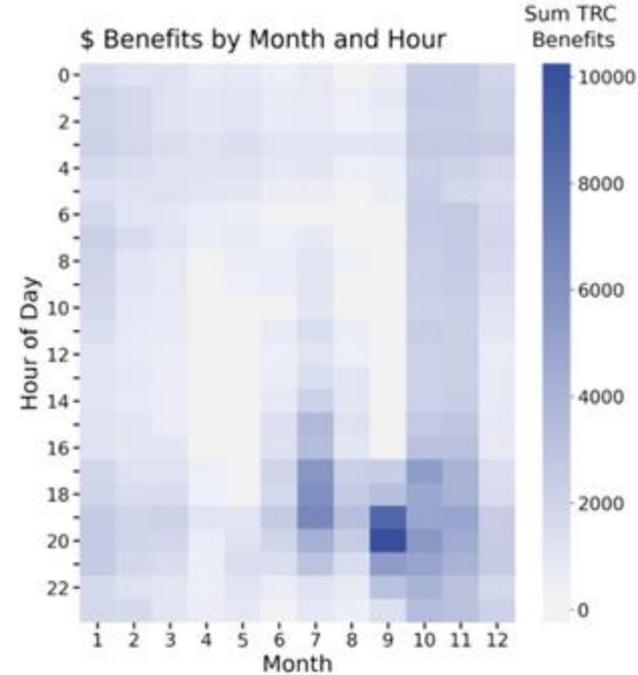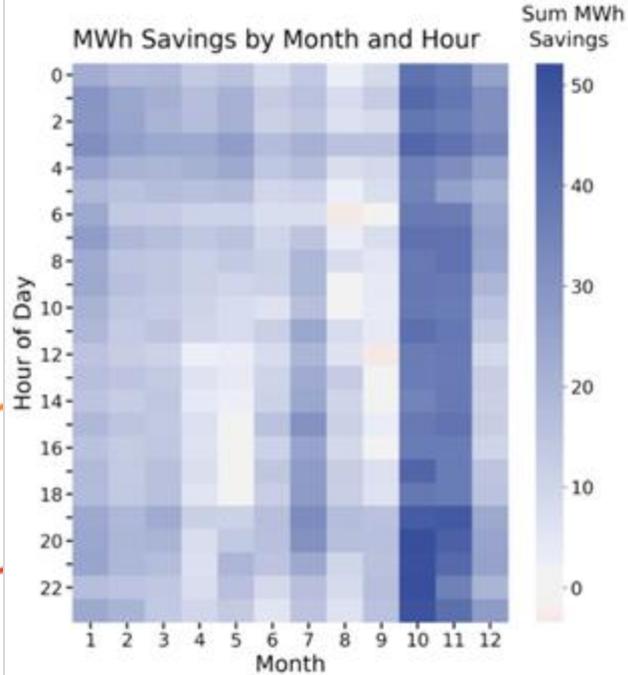
Market **accessible** to optimize projects, programs, portfolios
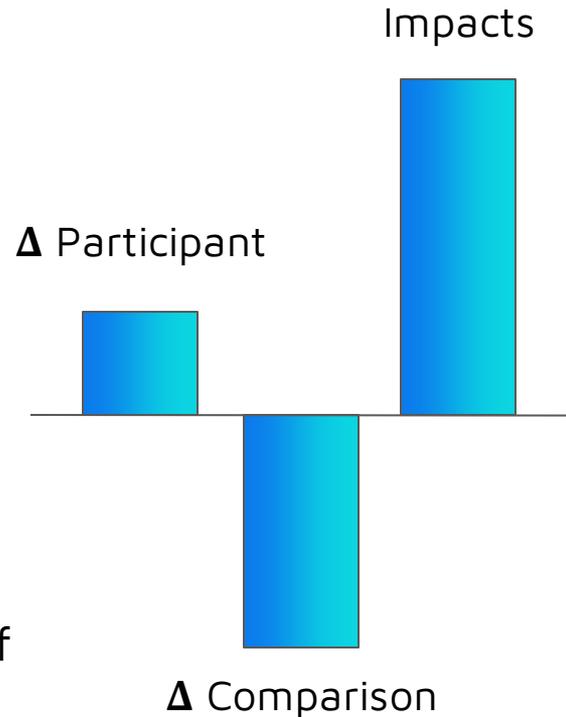
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STANDARD WEIGHTS & MEASURES

Understanding Performance

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How it works:

➢ **EEmeter** generates revenue-grade hourly baselines for all meters on the grid (treated and untreated)

➢ **GRIDmeter** generates a comparison group that matches the **entire distribution** of participating customers at an **hourly** level to quantify the difference = savings impact.

➢ **Energy Differential Privacy (EDP)** injects random noise into datasets to rigorously protect the privacy of individual customers.
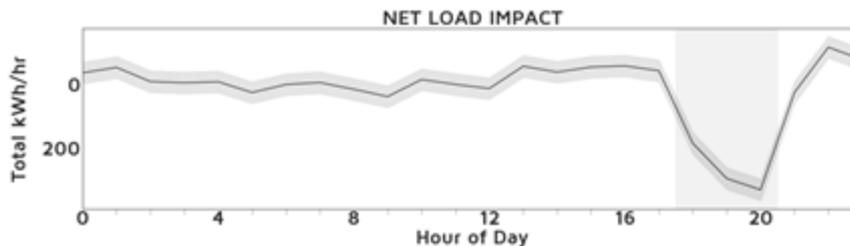
Impacts

Δ Participant

Δ Comparison
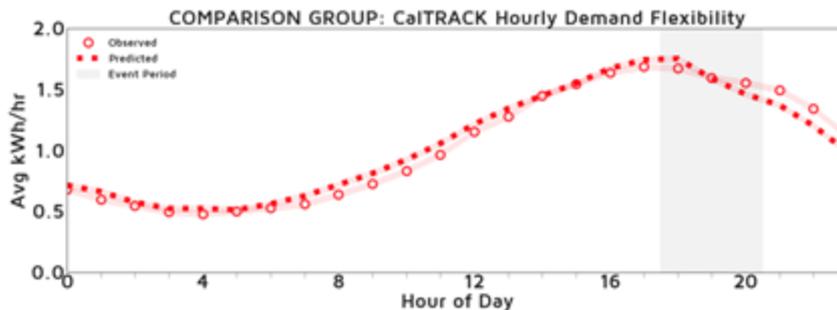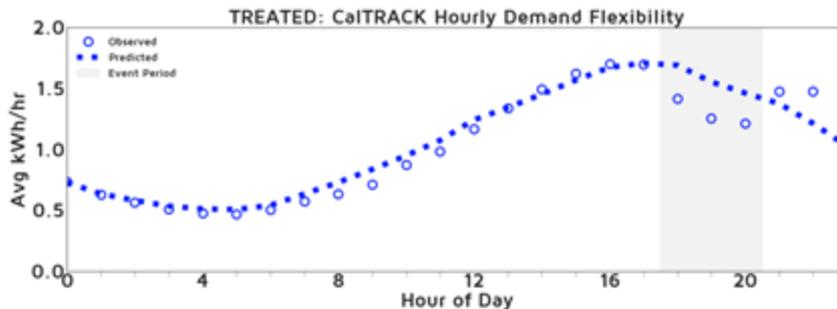
In Practice:

A robust framework for measuring DR impacts

Open source, transparent methods that are ready for deployment

TREATMENT GROUP:

-17.5%
Event Demand Reduction

CALTRACK

OPENEEMETER

COMPARISON GROUP:

1.8% ±0.5%
Event Demand Reduction

OPEN GRIDMETER

ENERGY DIFFERENTIAL PRIVACY

NET IMPACT:

-19.3% ±0.5%
Event Demand Reduction

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Promote event based and long term impacts and attribute impacts to EE and/or DR

Measurement Period

EE Savings = EE Counterfactual - DR Baseline

DR Savings = DR Baseline - Observed

Event

EE Savings

DR Savings

Demand (MW)

— Observed

--- EE Counterfactual

▪ ▪ DR Baseline

Hour of Day
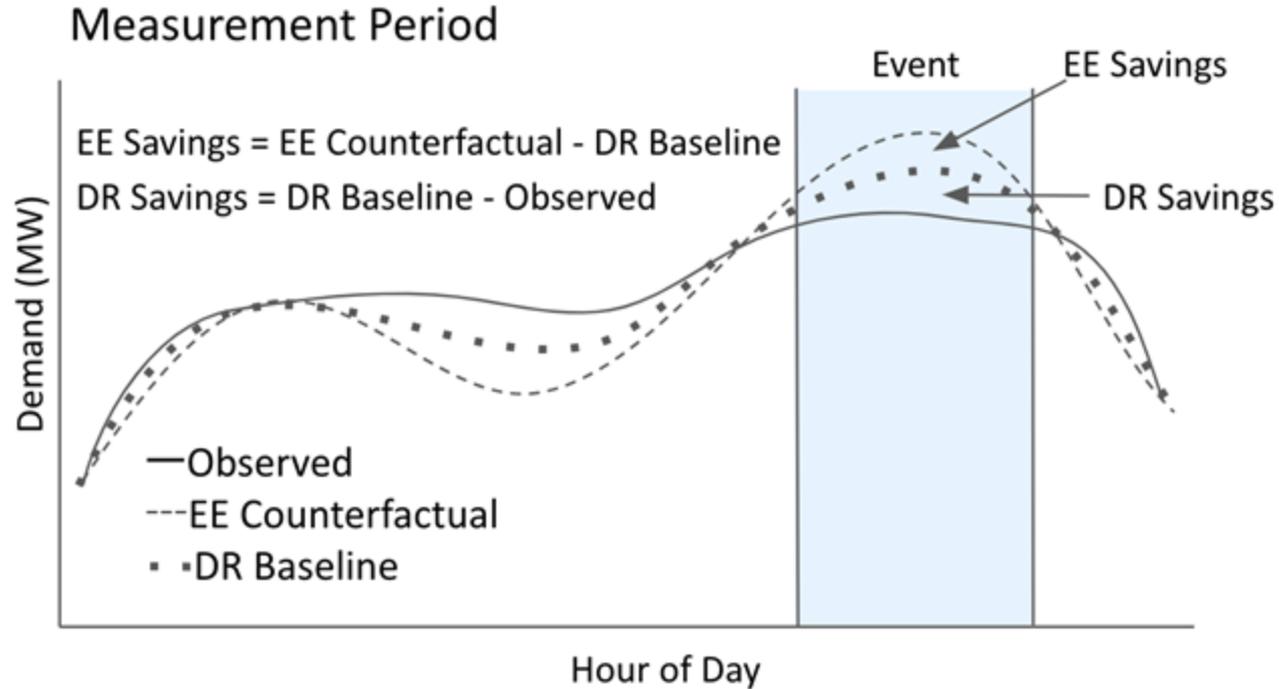
*Long term: add any DER. Break down the silos!

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Recurve is implementing comparison group methods for CAISO

California ISO

April 9, 2021

The CAISO has contracted with Recurve to evaluate the impacts of demand response during the events of summer 2020 using their open-source comparison group methodology. The data pipelines established for this study will be applicable to further expansion of DR impact analysis in 2021. Recurve will also provide a point-by-point review of the control group method currently approved by FERC for the CAISO DR Tariff.

The purpose of this analysis is to:

- Understand and operationalize the baseline and comparison group methods in relation to existing guidance and practice;

- Understand barriers to data access and identify a viable path to overcome them;

- Understand the 2020 heat storm events based on the baseline and comparison group methods implemented by Recurve to inform and support decision making; and

- Understand impacts of demand response events in 2021 and operationalize methods at scale.

As a result of this effort, the CAISO hopes a DR provider or resource(s) can use this methodology as a performance methodology for settlement of market dispatches in summer 2021, conditional to the methodology's compliance with the CAISO tariff. Following this, the CAISO hopes the methodology will be applied broadly amongst the DR community to measure performance.

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Lauren Carr

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RECURVE

BUILDING MARKET OPPORTUNITIES

Keeping Value Front and Center

RECURVE

FLEXmarket

MCE EBCE Providers

Demand FLEXmarket

MCE | My community. My choice.

Commercial Lighting Value

1 MWh = $76.25

Electric Avoided Costs By Hour of Day

Legend: Methane Leakage — Ghg Adder Rebalancing — Cap and Trade — Distribution — Transmission — Capacity — Ancillary Services — Losses — Energy

Avoided Cost [$/MWh]

Hour of Day

MCE Commercial Efficiency Market

Enabling Innovative Business Models and Customer Choice

Rather than develop a typical energy efficiency program with prescriptive saving measures and a lot of paperwork, MCE's Commercial Efficiency Market will directly subsidize Energy Efficiency and Demand Flexibility projects implemented by approved Demand FLEXmarket aggregators.

MCE's approach uses actual, metered savings from projects to determine payments to aggregators based on the hourly avoided cost value of their projects net of program and customer costs. In turn, aggregators will be motivated to maximize grid and customer outcomes, and can use this new cash flow to develop

Grid-Responsive Peak FLEXmarket

Delivering Peak Reductions To Improve Grid-Reliability, Decrease GHGs, and Help Customers Lower Energy Costs

MCE is pleased to announce the launch of the Peak Demand FLEXmarket, a first-of-its-kind pilot marketplace platform aimed at shifting energy use throughout our service area away from times of extreme demand.

The Demand FLEXmarket provides tools to measure hourly reductions in energy use that will allow MCE to
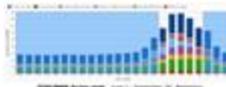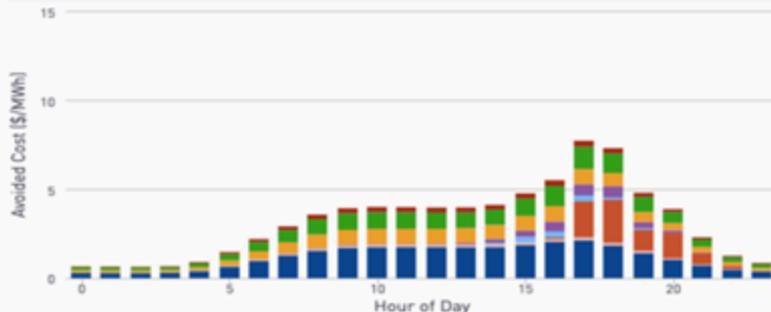
Peak Price Signal (click to enlarge)

Designed to Bridge Customer & Grid Value

DEMAND FLEXMARKET

Utility

Procures
Cost Effective
Avoided Cost

↔ Marketplace Contract

Recurve

RE

Provides
Neutral Market
Platform

↔ Flexibility Purchase Agreements

Aggregators

lime · TakeOff · GreenSync · SUNVERGE
Innowatts · enervee · G Nest · kW · CLEAResult
ohmconnect · TESLA · V · opusone
leap. · EnergyHub
AutoGrid · uplight · ecobee
bidgely · ICF · LA · WILLDAN
piclo · CPower · PACKETIZED · sunrun · enel x

Paid for cost effective hourly
grid value based on
metered performance

Platform as a Service: Providing Utilities With Cost-Effective Load Shaping Via VPP Aggregators

A Platform for Market Innovation

BlocPower
Increase your building's profitability with a modern heating and cooling system.

BRIGHT POWER
Bright Power
Bright Power is the premier provider of energy and water management services.

CARBON LIGHTHOUSE
Carbon Lighthouse
Cut Energy at a Portfolio Scale. Because one building at a time doesn't cut it.

elevation — Elevation Home Energy Solutions
We are on a mission to Elevate the Home Energy Experience.

EVERWATT — EverWatt
Stop wasting money on old lighting.

Halco
Halco is a leading residential and commercial energy services provider in NY

CH:Energy
CH Energy
CH Energy is an expert in providing a turnkey energy solution.

CLEAResult®
CLEAResult
We make energy efficiency smarter, faster, and more accessible for everyone.

Conectric IoT
Conectric IoT
Operational Asset Risk Management.

JouleSmart™
Joule Smart
Joule Smart will save you time, money, and give you peace-of-mind.

leap.
Leap
Leap is a marketplace for grid services, to help balance the grid.

NRM — National Resource Management
If your business relies on refrigeration systems, NRM has a way to help you.

DIVIDEND
Dividend Finance
A smarter, faster way to finance home improvements and commercial upgrades

ecobee
ecobee
A smart home technology helping customers maintain comfort and cost savings

EcoGreen Solutions
EcoGreen Solutions
We help companies save energy and cut costs.

Northern Pacific Power Systems
Premier Energy Solutions for the North Bay Area in California

OhmConnect
OhmConnect
Use energy when it's cleanest and earn rewards for saving when it's dirty.

PACKETIZED ENERGY
Packetized Energy
Packetized Energy makes electricity flexible.

Ecology Action
Ecology Action is creating a thriving environment and low-carbon economy.

edgewise energy
Edgewise Energy
Helping property owners to improve resiliency, sustainability, and profit.

ELECTRUM
Formerly PickMySolar
Electrum
Electrum provides a home electrification concierge marketplace

Sealed
Sealed
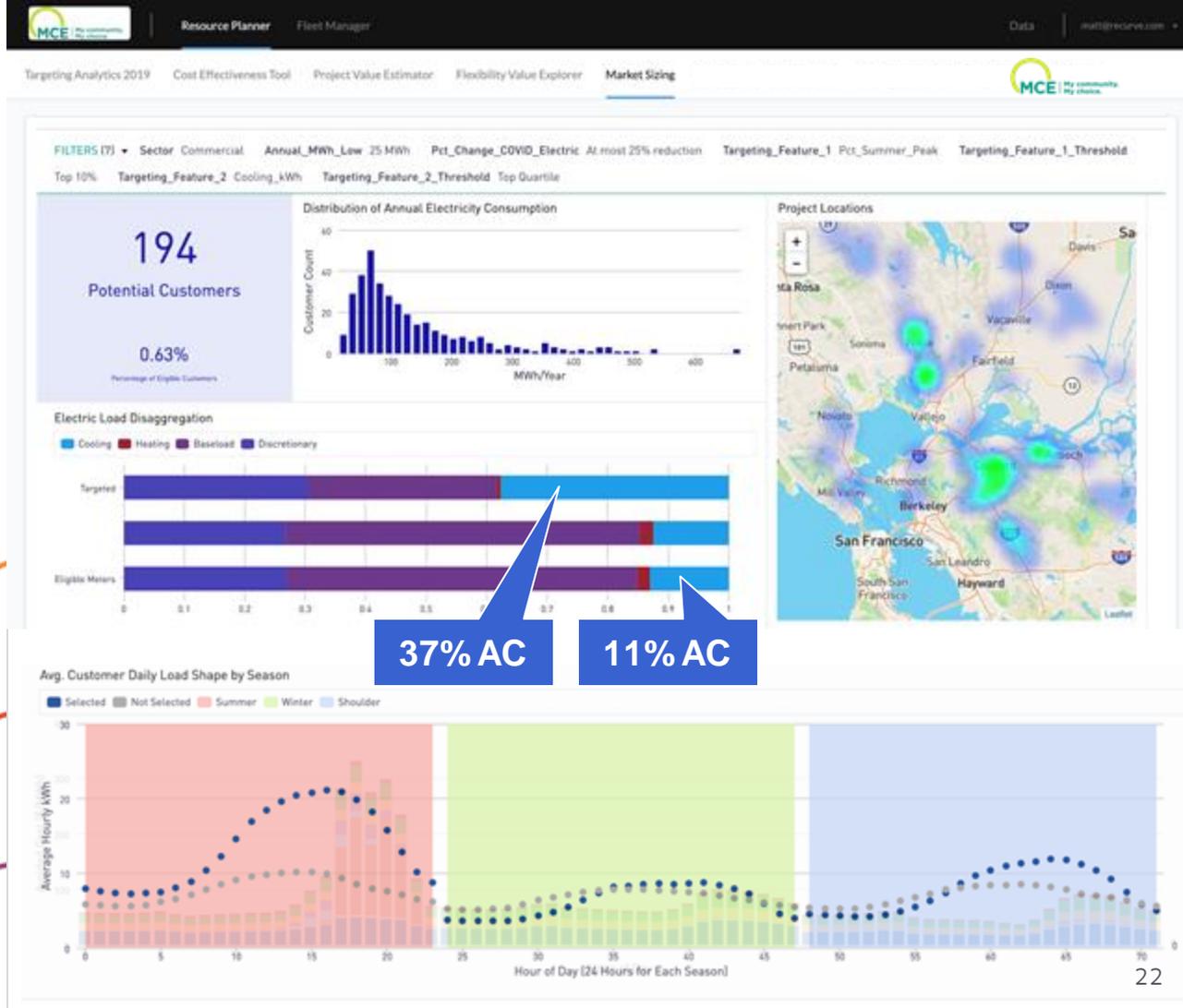Stress-free home upgrades? With Sealed, they're not just a fantasy.

swell
Swell Energy
Swell Energy is an energy and smart grid solutions provider.

voltus
Voltus
Better Energy, More Cash.

Resource Planning:

Find customers with the greatest potential and worth the most to the grid
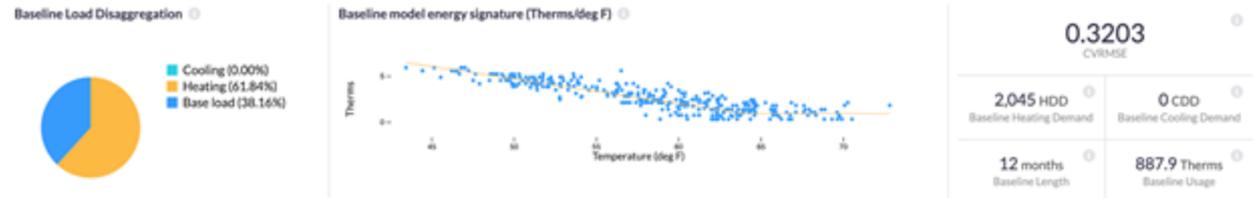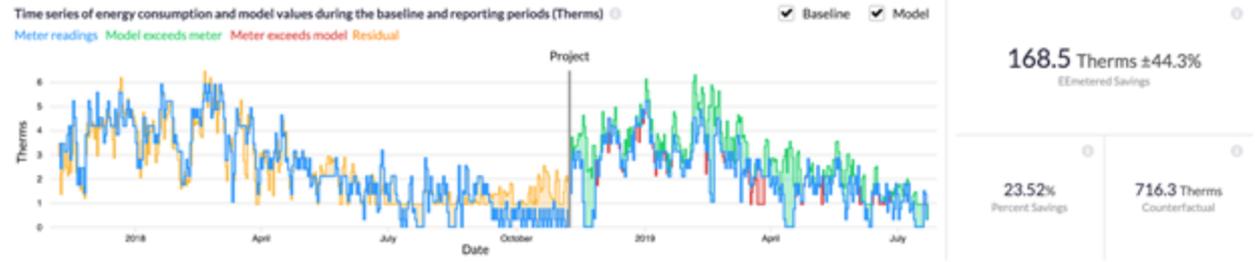

37% AC   11% AC

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Fleet Management:

Track, Manage, and Integrate Behind the Meter Demand Flexibility

Track and Optimize Virtual Power Plants

Automated Site Level Hourly M&V

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Accountability

Ledger:

Auditable System of Record for Demand Flexibility Transactions

Demand Flexibility System of Record for:

RECURVE

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Key policy changes today . . .

Sales and Marketing

Contractor Management

3RD Party Providers
(aggregators)

Project Finance

DEMAND FLEXIBILITY

Services and Products

Consumer Finance

BUSINESS MODELS
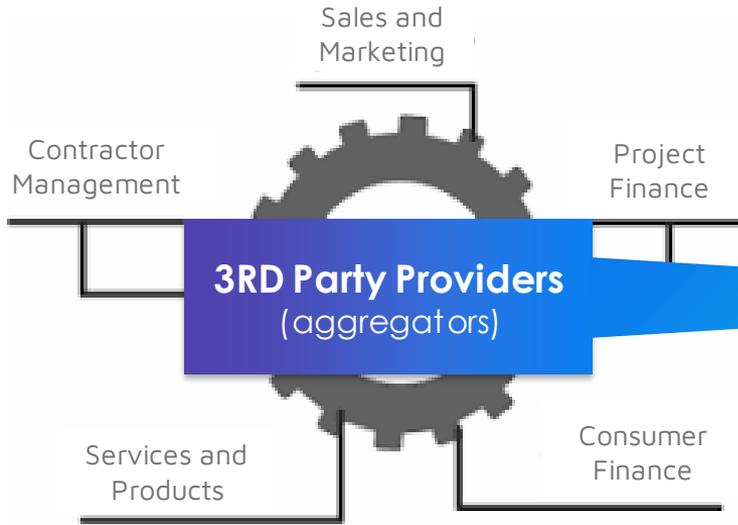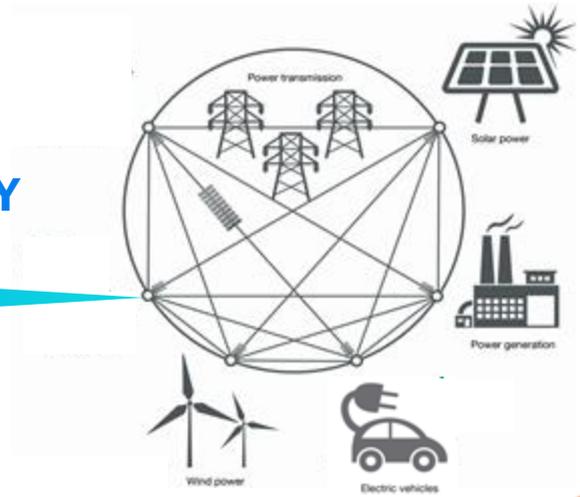
. . . enable a future of grid integration.

Savings   Comfort   Health

RECURVE

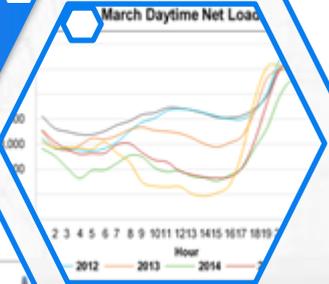SHAPE THE FUTURE OF ENERGY

Procurement

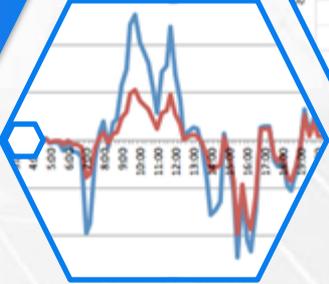Pay for Performance

Demand Flexibility

Resource Curve

Metered Flexiwatt

Carmen Best

carmen@recurve.com