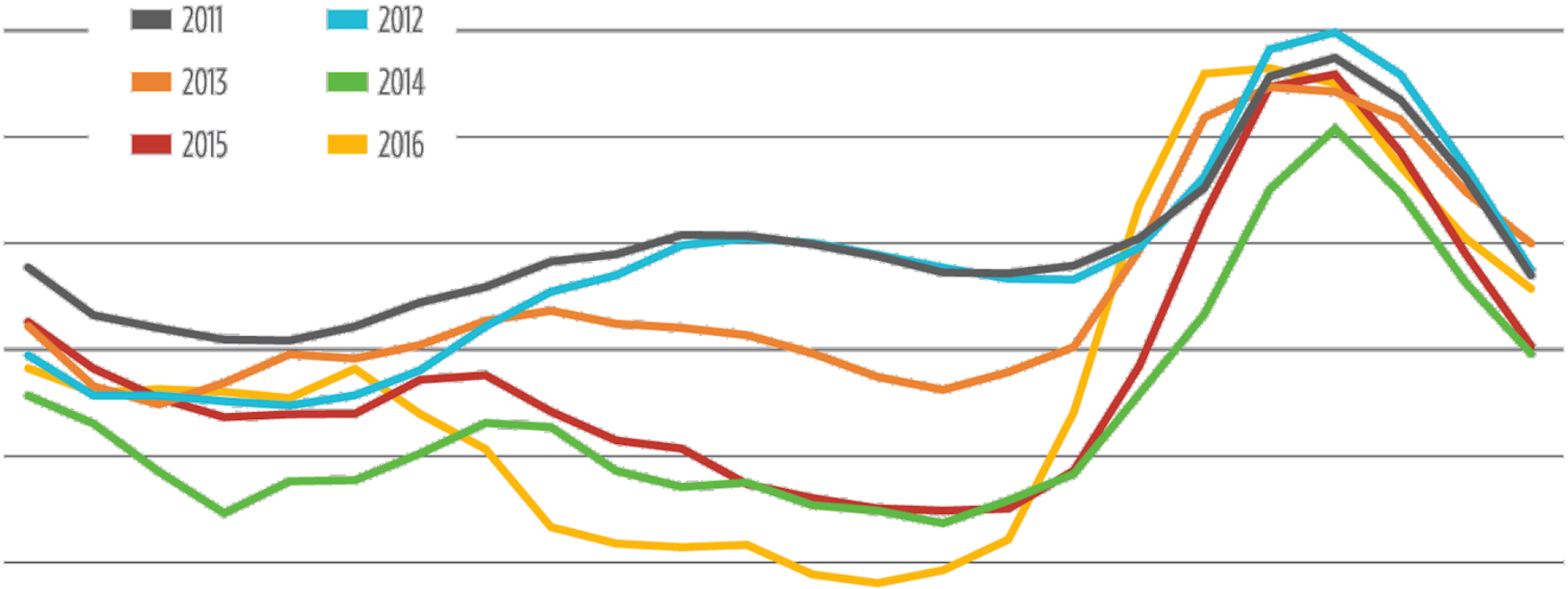
Flexible Demand as a Resource

Efficiency, Demand Response, and Electrification

IEA Global Conference on Energy Efficiency

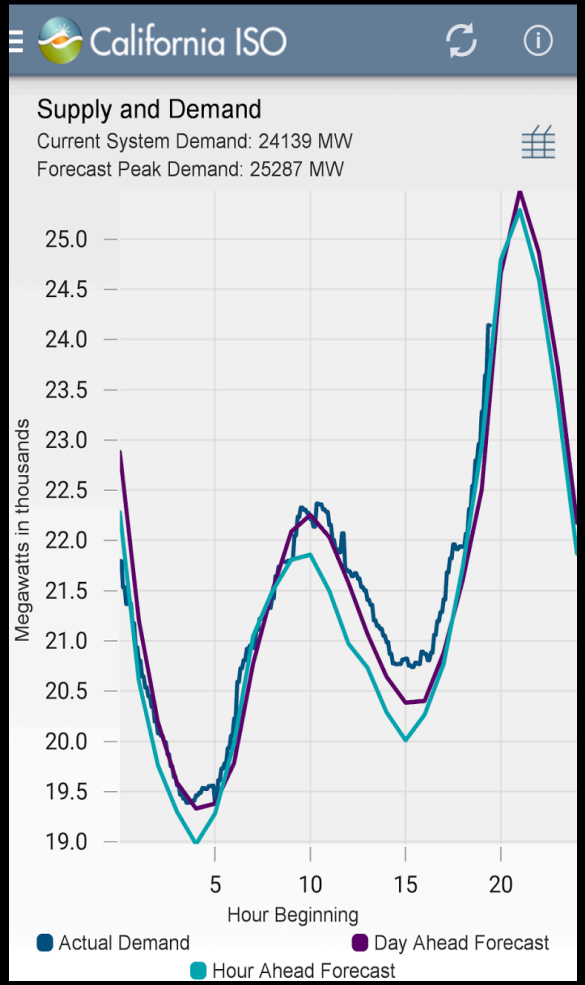
October, 2018

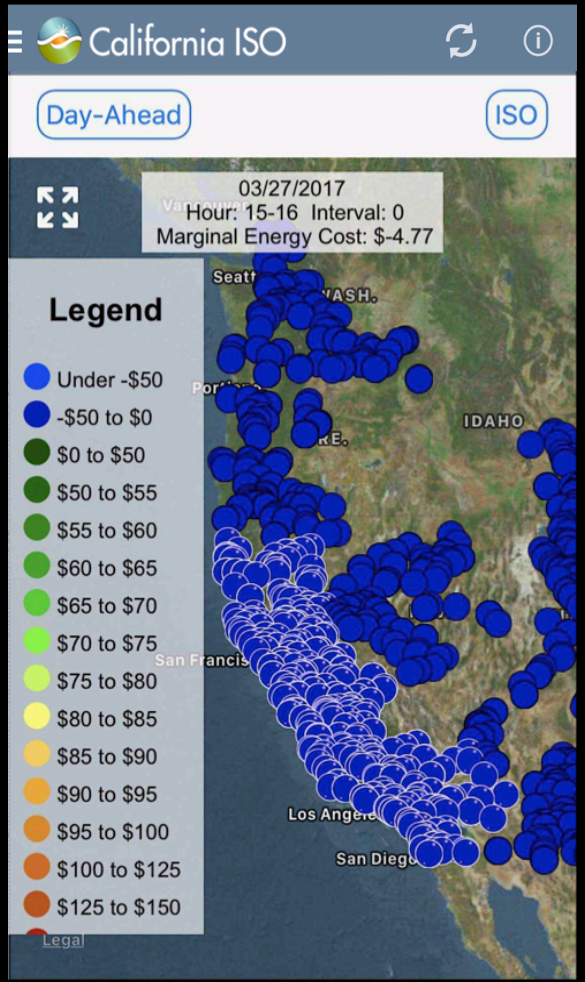
The Big Bad Duck



Four Years Ahead of CAISO Projections

Lots of Renewables but Nobody Buying



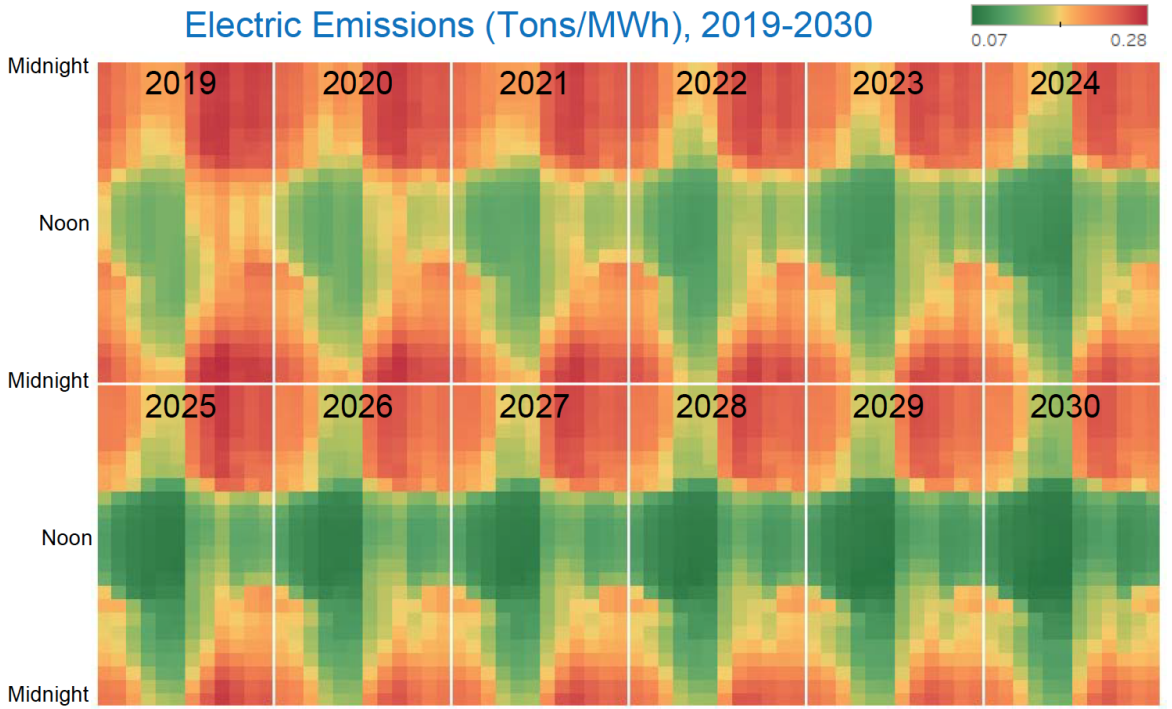


What Is the Problem We Need to Solve?

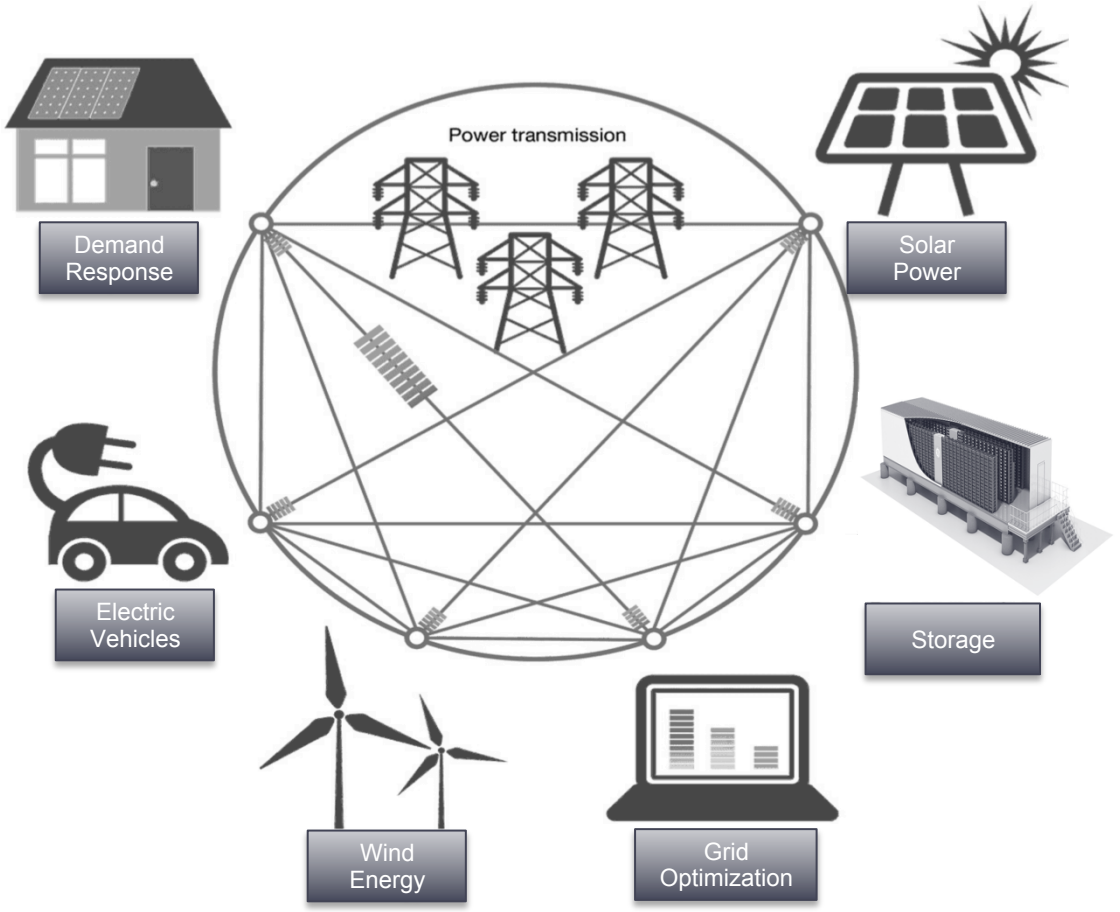
CALIFORNIA ENERGY COMMISSION

Electricity CO_2 Intensity

Electric Emissions (Tons/MWh), 2019-2030



Fitting Energy Efficiency into Distributed Energy Resource Markets



OPEN

CALTRACK

- Standard Calculation Methods for Energy Efficiency and Electrification
- Monthly, Daily, and Hourly
- Public 60 Stakeholders Empirical Process
- www.CalTRACK.org

OPEN METER

- Python CalTRACK Engine
- Open Source Apache 2.0
- Available Without Restriction
- How It Works: https://goo.gl/mhny2s
- Code Repo: https://goo.gl/qFdW4P

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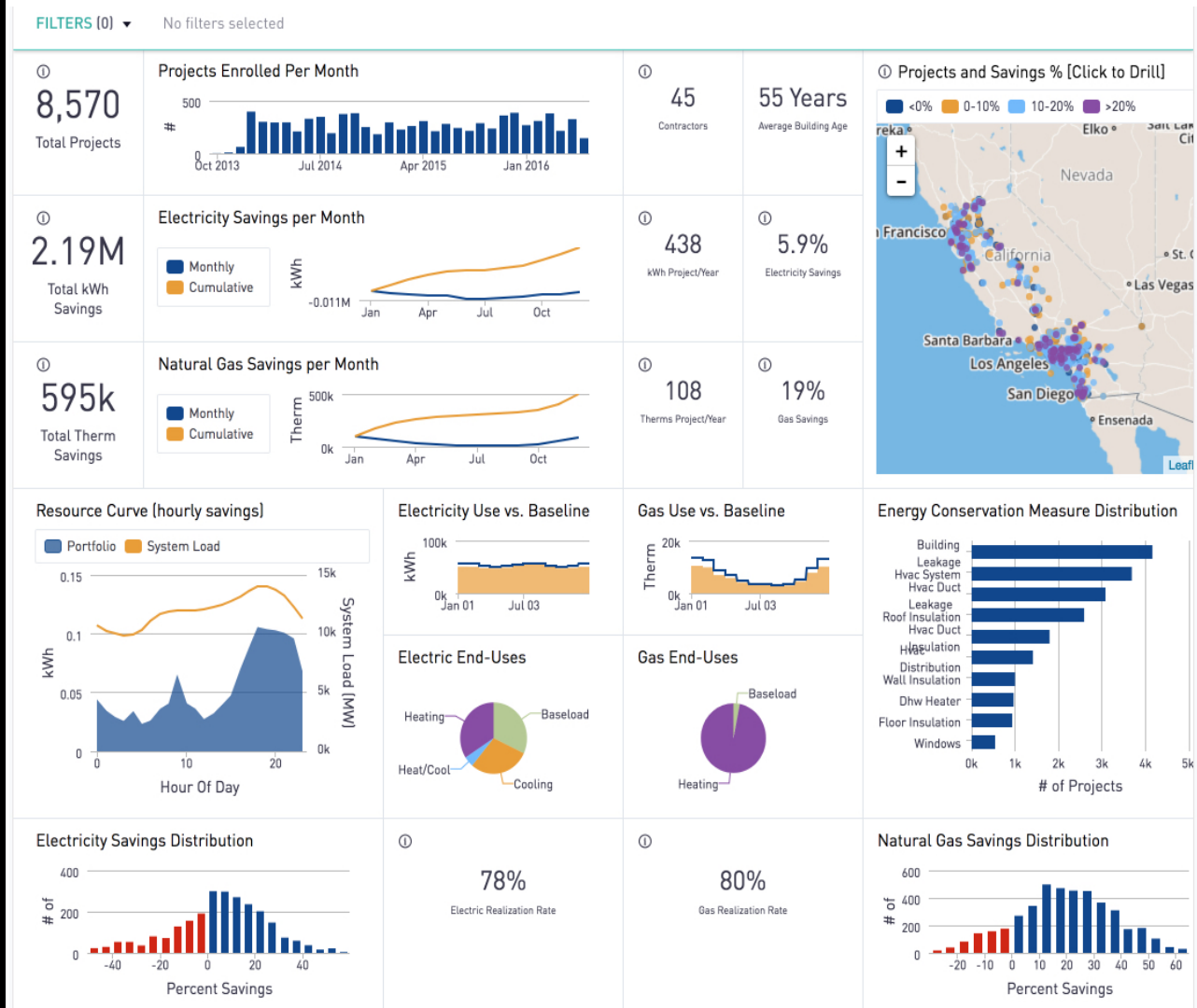
Track Efficiency Impacts in Real-Time



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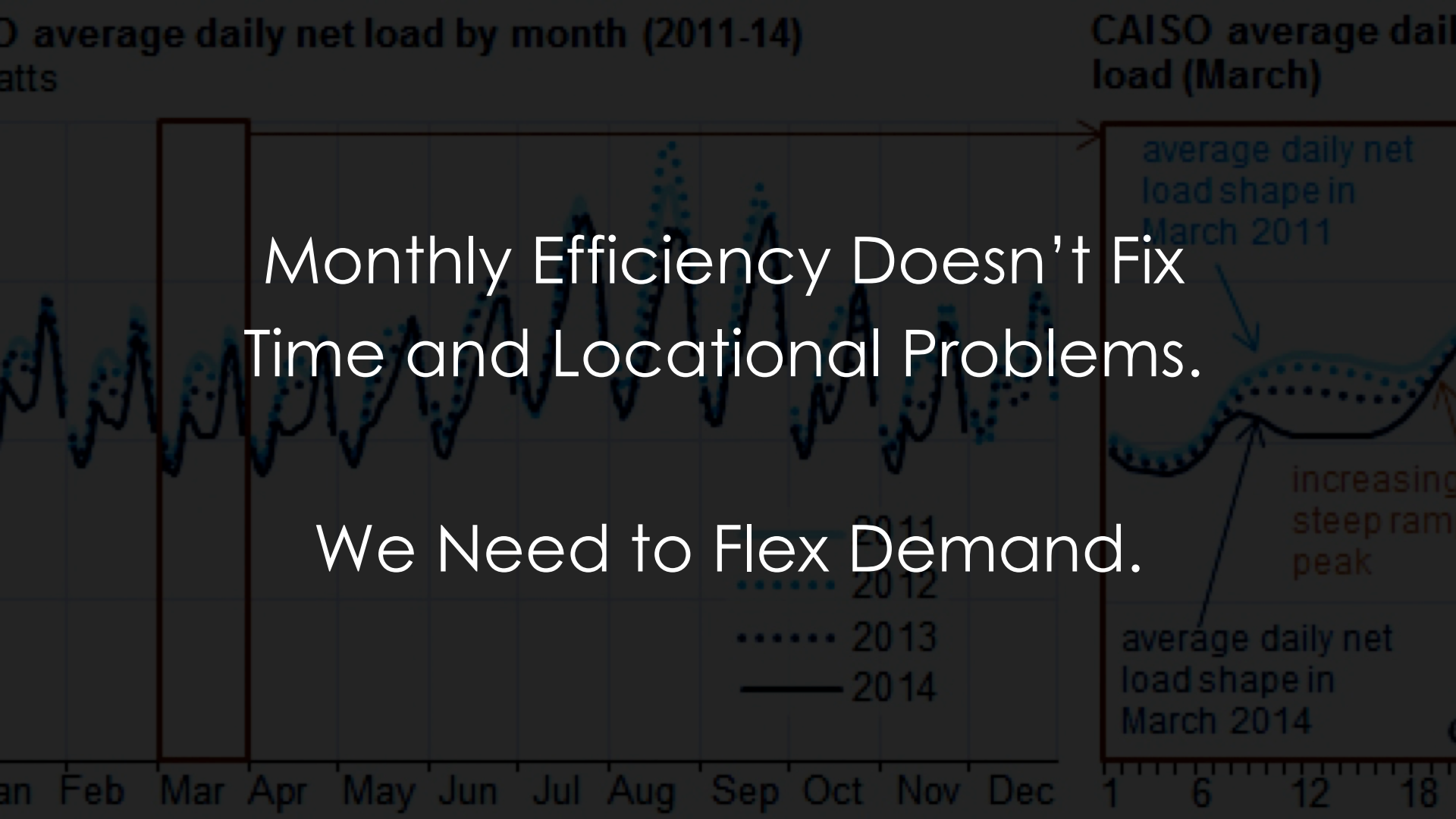

Monthly Efficiency Doesn't Fix Time and Locational Problems.

We Need to Flex Demand.

Calculating Real Avoided Costs

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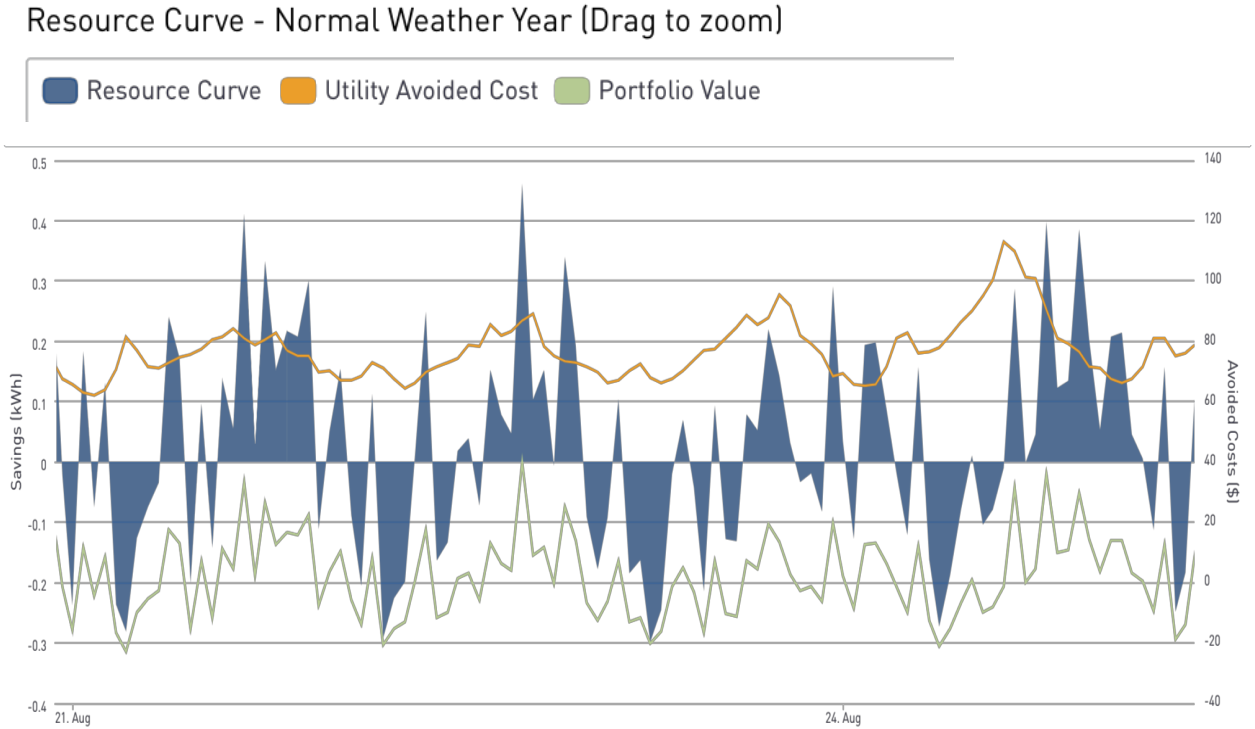
$50.8k	218k	$101.55
Portfolio Normal Year Avoided Costs	Portfolio Normal Year kWh Savings	Normal Year Avoided Costs Per Participant



Calculating Real Carbon Reductions

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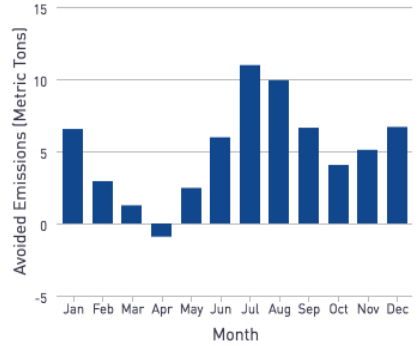
FILTERS (1) ▾ **Portfolio** Weatherization

45	0.207	0.09	436
Portfolio Avoided GHG Emissions [Metric Tons]	Avoided Emissions Factor [Metric Tons/MWh Saved]	Participant Avoided GHG Emissions [Metric Tons]	Participant Normal Year kWh Savings

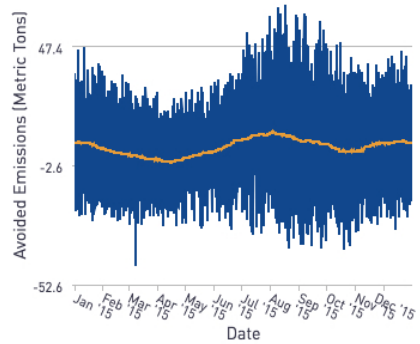
Avoided Electric GHG Emissions (Kilograms Carbon)

HOUR	1	2	3	4	5	6	7	8	9	10	11	12
1	14.1	8.3	-1.4	-6.4	1.0	8.8	14.6	10.1	0.4	2.8	1.2	5.3
2	4.2	7.5	-1.5	-5.1	1.8	5.8	11.1	6.9	-9.1	-3.3	4.2	9.9
3	5.5	4.8	2.3	-3.6	-0.4	0.6	4.1	2.9	-3.0	-2.8	5.5	2.5
4	8.0	6.8	0.9	-0.8	-3.6	2.5	1.9	3.3	-3.1	-3.9	0.2	6.6
5	8.0	8.7	1.2	-0.8	-0.6	1.8	0.2	3.3	2.8	-0.9	1.8	8.4
6	3.8	1.0	2.9	-4.1	0.7	0.9	-1.6	-6.9	-0.1	0.5	3.5	3.5
7	3.3	1.8	-0.2	2.1	0.6	0.0	2.7	-2.8	-4.9	-0.4	5.2	3.7
8	5.5	4.1	3.0	2.5	1.8	2.5	1.1	-3.3	3.8	-0.6	2.0	6.9
9	10.7	5.2	3.1	1.6	3.9	1.8	-0.7	-1.3	0.8	7.4	4.5	7.4
10	10.9	3.6	5.3	3.6	-0.2	0.9	3.5	10.2	9.7	8.6	13.3	9.7
11	8.5	0.0	2.2	-1.7	1.0	-0.4	-1.9	-3.6	0.6	1.4	1.5	9.1
12	3.6	0.2	1.3	0.2	-3.2	-1.5	0.2	-3.3	-2.6	2.7	2.7	5.0
13	2.7	-1.9	-2.8	-4.2	-1.1	-1.4	1.6	0.8	-2.9	-3.5	-1.0	-2.8
14	-0.3	-2.3	-3.1	-3.2	0.4	2.4	4.9	0.3	-0.7	-2.9	-2.8	1.1
15	0.0	-0.6	-3.1	-1.6	3.1	3.5	2.9	3.6	-1.9	-0.6	0.4	2.7
16	1.4	-6.0	-4.6	-3.9	2.7	4.6	12.6	9.0	3.3	-0.6	0.2	3.6
17	3.6	-4.1	-4.4	-4.5	1.3	7.3	16.4	19.9	9.8	8.7	8.1	10.9
18	4.4	3.2	1.7	0.0	2.7	12.5	17.5	20.6	18.4	13.6	6.6	9.5
19	2.2	4.2	3.0	1.9	7.3	13.6	25.8	29.2	26.1	19.8	11.3	11.1
20	11.0	3.7	2.3	4.6	9.2	22.5	26.3	27.1	22.3	12.6	8.9	7.3
21	9.2	9.0	4.0	1.2	7.5	15.2	30.4	26.1	26.8	11.7	18.3	6.3
22	15.0	6.0	7.5	1.4	10.2	17.3	31.8	31.6	21.4	14.1	7.8	10.1
23	8.6	2.2	6.9	0.4	8.1	14.3	30.1	36.4	26.2	9.2	14.2	15.2
24	13.2	5.1	3.6	-1.7	4.9	7.8	27.7	18.0	15.2	3.6	4.9	7.4

Avoided GHG Emissions By Month (Metric Tons)



Hourly Avoided GHG [Drag to Zoom]



RESOURCE CURVE

Time And Locational Savings

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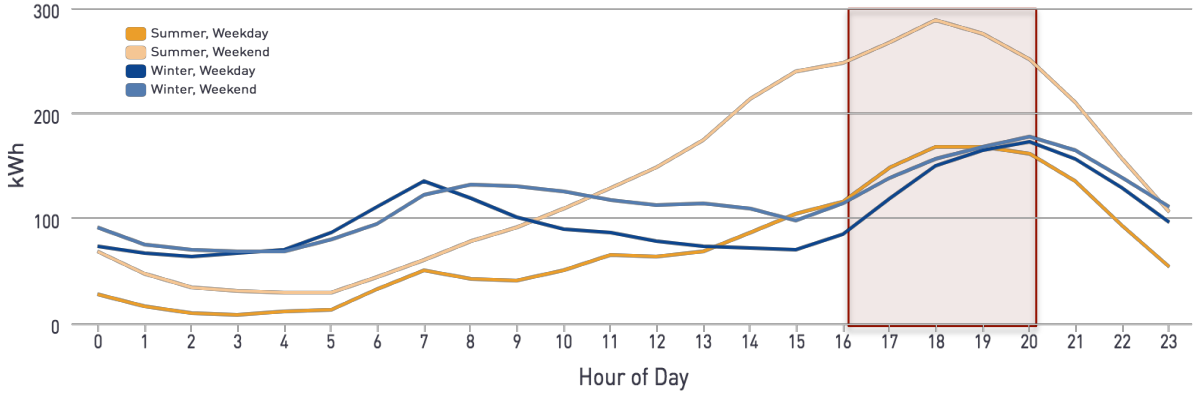
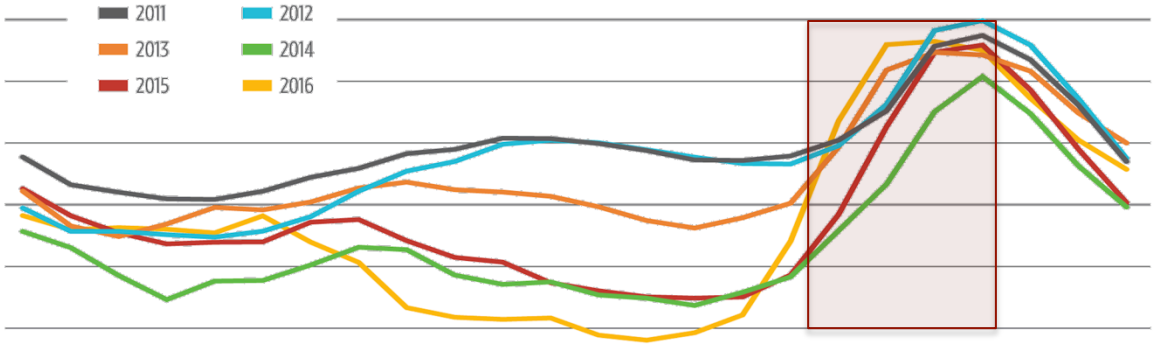
Resource Curve

Resource Curve by Season and Weekend/Weekday



Duck Curve



Case Study: PG&E Residential P4P

Develop models for taking Res EE to scale by enticing more private capital

Achieve Data Driven M&V by measuring "at the meter"*

Pay for measured savings performance from retrofits and BROs

Develop a program that can successfully transition to grid-tied procurement

* Weather-normalized

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

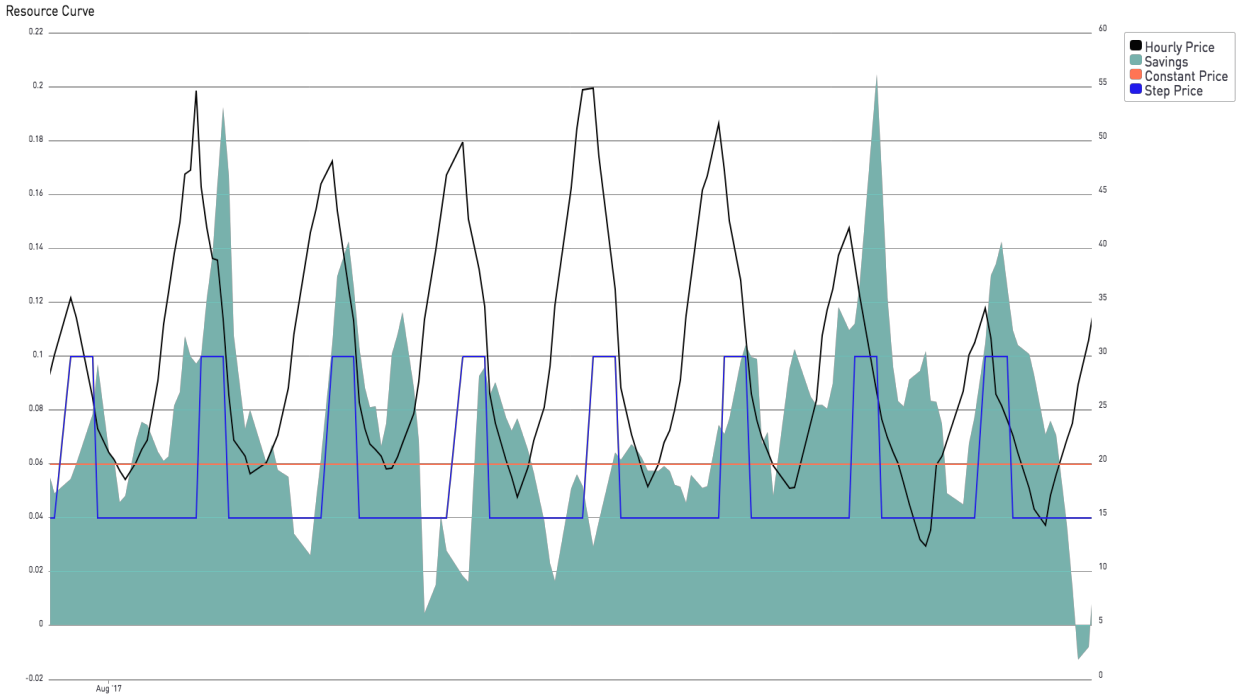
Retrofit
- Whole House
- HVAC
- Lighting
- Outdoor/Pool Deck

Operational
- Smart Thermostats
- Home Energy Management Systems
- Smart Appliances

Behavioral
- Homeowner Incentives
- Demand Response
- Other specially designed programs

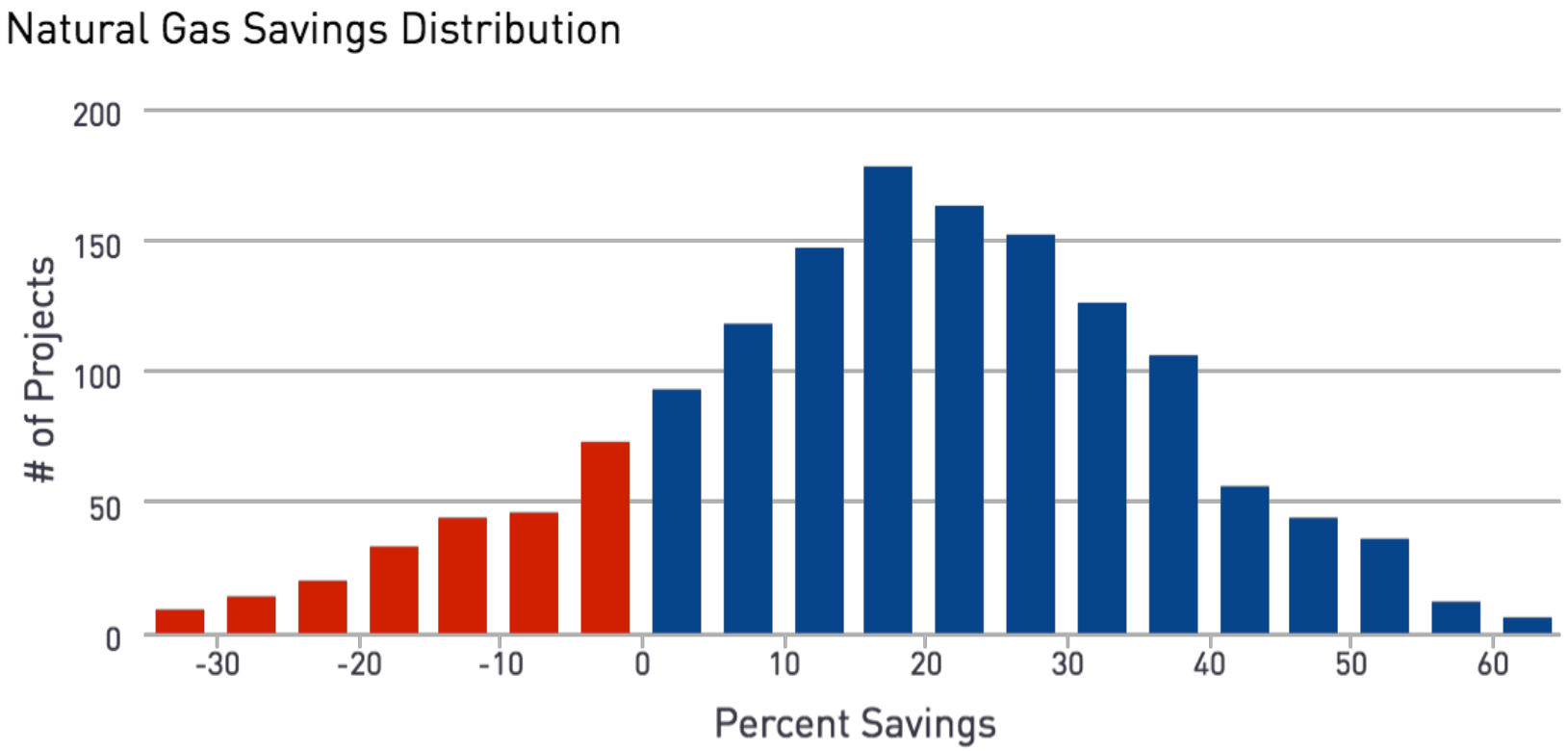
- Performance payments made monthly based on OpenEE Platform running CalTRACK 2.0
- Four (4) Aggregators with varied business models (2 underway, 2 in contracting)
- $25M total payments based on kWh & Resource Curve (time based savings)

Sending the Right Price Signal

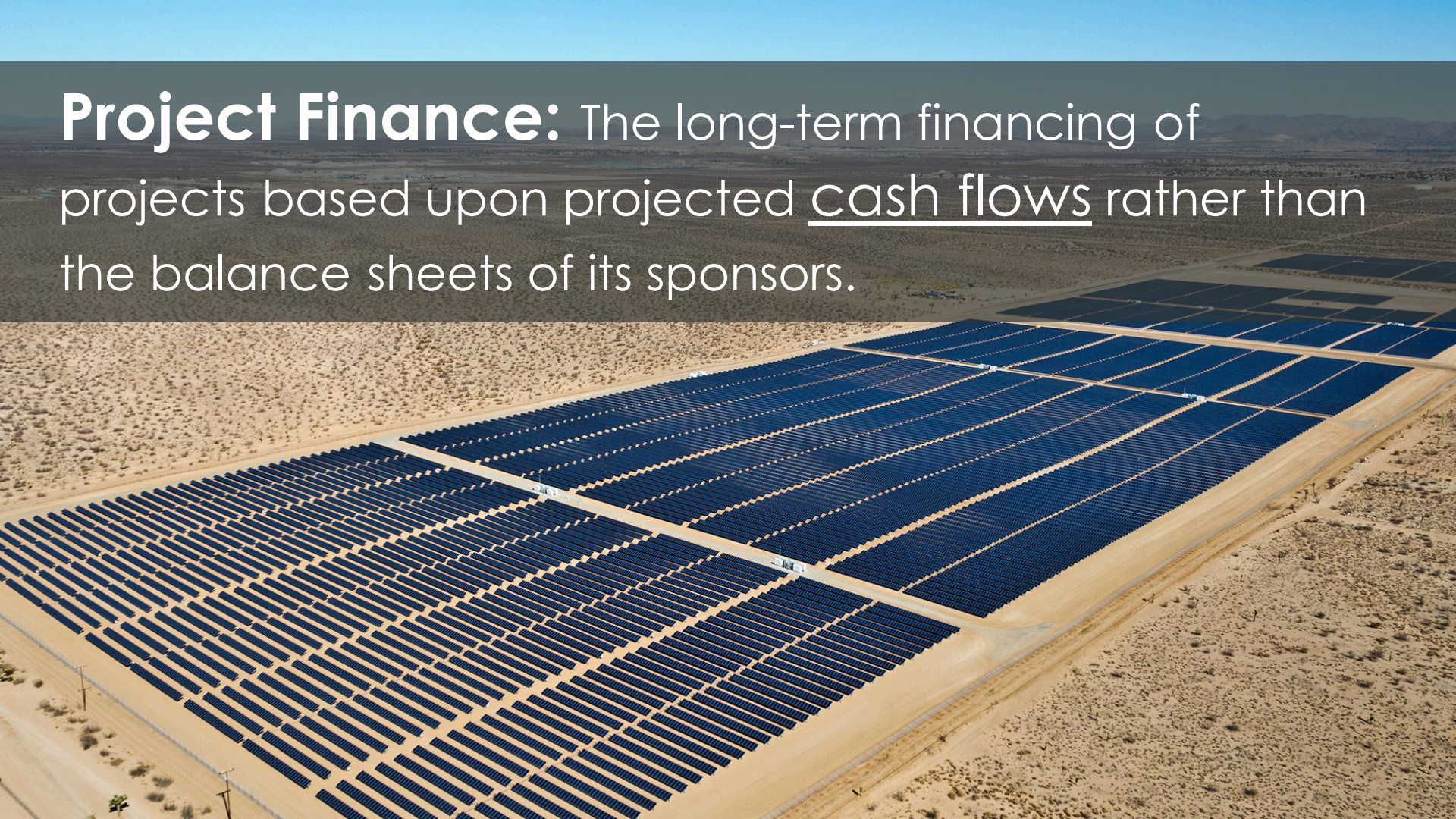


- PG&E Residential Pay-for-Performance Program
- kWh rate + 3x Kicker for savings from 4pm to 8pm
- Payments based on CalTRACK / OpenEEmeter

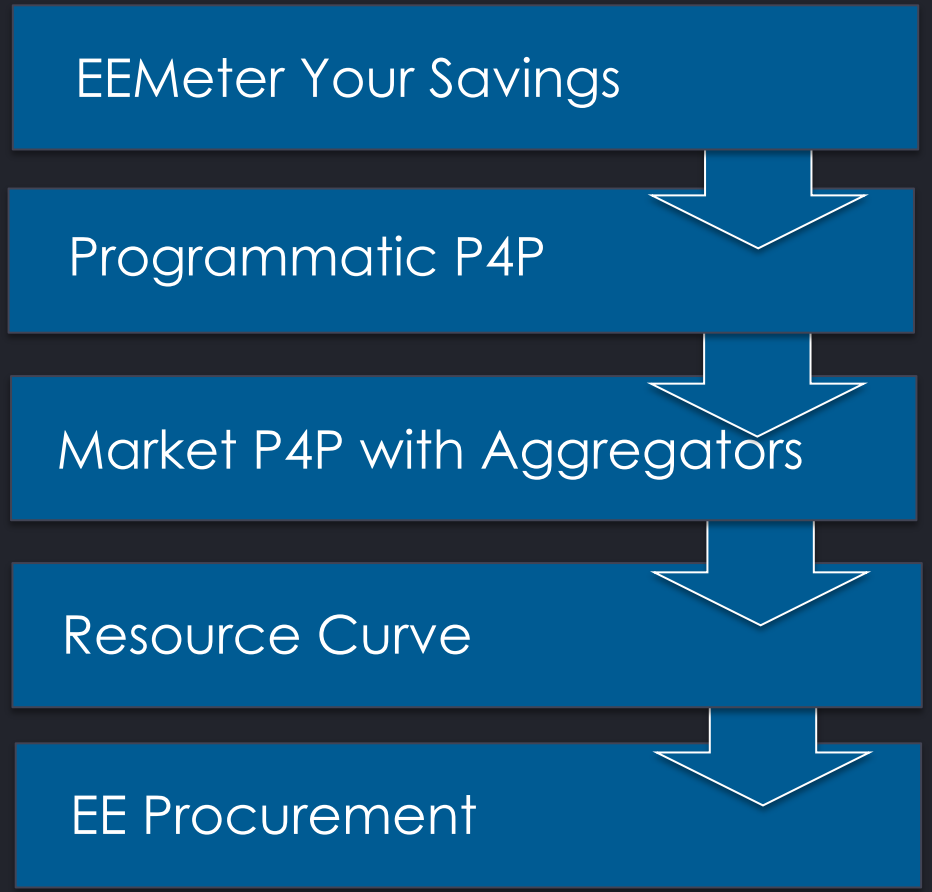
Efficiency Risk is Manageable as a Portfolio

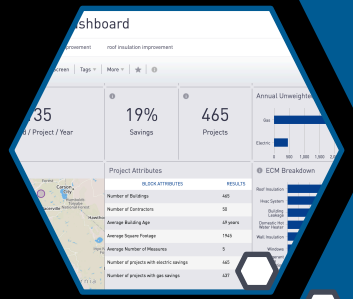


Project Finance: The long-term financing of projects based upon projected cash flows rather than the balance sheets of its sponsors.

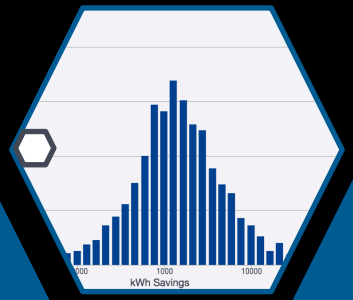


Roadmap To Flexible Demand Markets



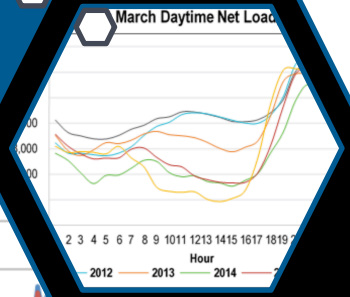


Pay for Performance

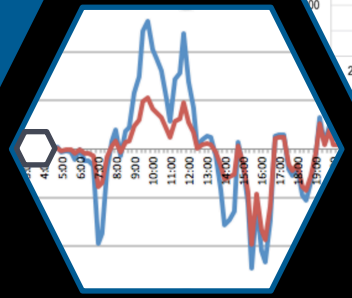


Procurement

Demand Flexibility



Resource Curve



OpenEEmeter

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