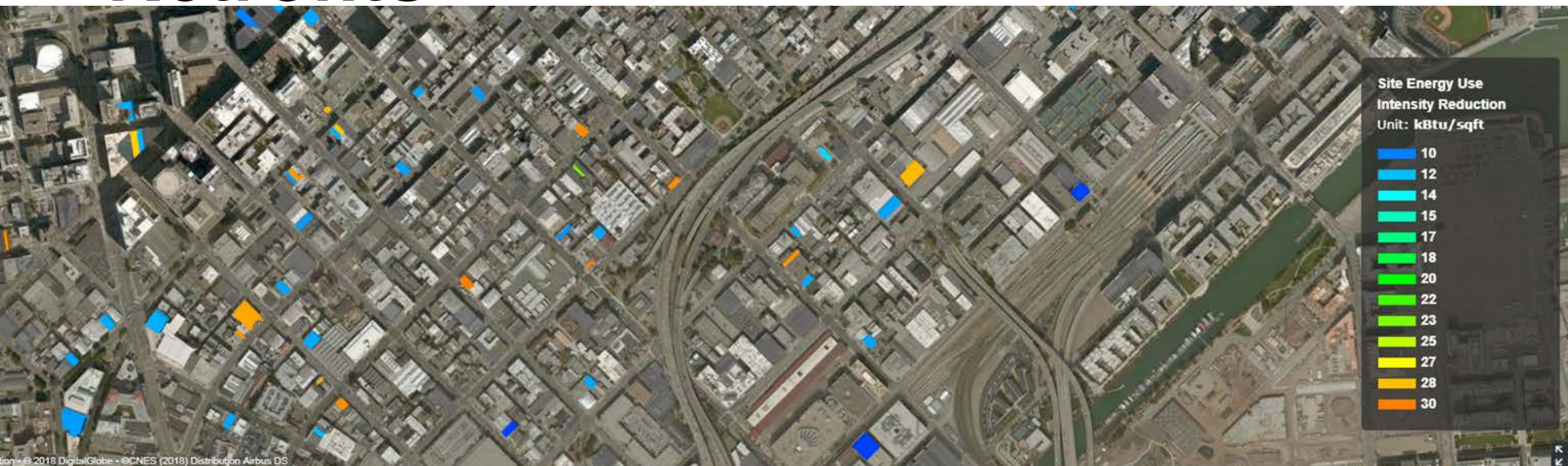


BayREN Integrated Commercial Retrofits



BayREN (ABAG), NREL, LBNL, Open Energy Efficiency, SF Environment

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Co-Presenters: Tianzhen Hong, LBNL; Daniel Macumber, NREL

Project Summary

Timeline:

Start date: 10/1/2016

Planned end date: 3/31/2020

Key Milestones

1. Report on the existing tools, gaps, work plan for integration (FY18Q1)
2. Building energy modeling report (FY18Q2)
3. Webinar to USDOE, Train 20 Energy Watch staff and contractors (FY18Q2)

Budget:

Total Project \$ to Date:

- DOE: \$548,155
- Cost Share: \$685,049

Total Project \$:

- DOE: \$1,398,758
- Cost Share: \$1,424,825

Award: DE-EE0007558

Key Partners:



Project Outcome:

BayREN Integrated Commercial Retrofits (BRICR) aims to enable local-government energy efficiency programs to perform mass assessment, recruit participants, develop retrofits, and measure outcomes in small and medium-sized commercial buildings. BRICR will leverage existing energy efficiency programs to deliver at least 28 enhanced retrofits with financing, rebates, installation quality assurance and measurement of realized energy savings.

Key Partners

SAN FRANCISCO
energy
watch

Strengths

- 12+ years experience with commercial and multifamily energy programs
- Excels engaging hard to reach customers
- Long term relationship with customers and utility (PG&E)
- SME focus supports economic development and sustainability
- City policies and programs support customer recruitment
- Mission-driven

Challenges faced by SF Energy Watch

- Cost effectiveness favors deemed measures; shallow savings
- Existing CRM does not support targeting or analysis
- Limited access to energy usage history
- Limited utilization of financing

BAYREN
Local Governments Empowering Our Communities

The Bay Area Regional Energy Network is a program of the Association of Bay Area Governments, implementing energy programs via collaboration among the 9-counties of the San Francisco Bay Area.

- BayREN Multifamily requires minimum 10% energy savings. In 2017, the program netted 1.6MW & 276,000 therms
- A Business Plan proposal for initiating a BayREN Commercial program was approved by the CPUC in April 2018.

Challenges

- Small and medium commercial buildings (SMB) comprise 51% of US commercial floor area and 47% of building energy consumption
- Bay Area SMB's do not meet current T24 energy code. 67% were built before 1975 and 27% have not been renovated in at least 15 years
- SMB market is 'hard to reach'
 - Lack of capacity to understand, evaluate, and act on efficiency opportunities
 - Customer focus on short payback
 - Existing programs favor single-measure projects
 - Limited access to low-cost, low-hassle financing
- Limitations on existing energy programs serving SMB:
 - Projects are tracked via CRM, which does not assess efficiency potential
 - Whole-building assessments are a prerequisite for comprehensive retrofits and access to streamlined financing
 - The cost of identifying savings opportunities must be reduced
- Shifting Bay Area local government energy efficiency program landscape
 - East Bay Energy Watch transition from utility partnership to CCA in Q4 2018 may create a gap in service
 - BayREN Commercial Business Plan approved by CPUC 2018 – Good news for BRICR continuity after this project, but does not fit BRICR timeline

Opportunity – Provide a template for other cities with reusable processes, tools, and workflows

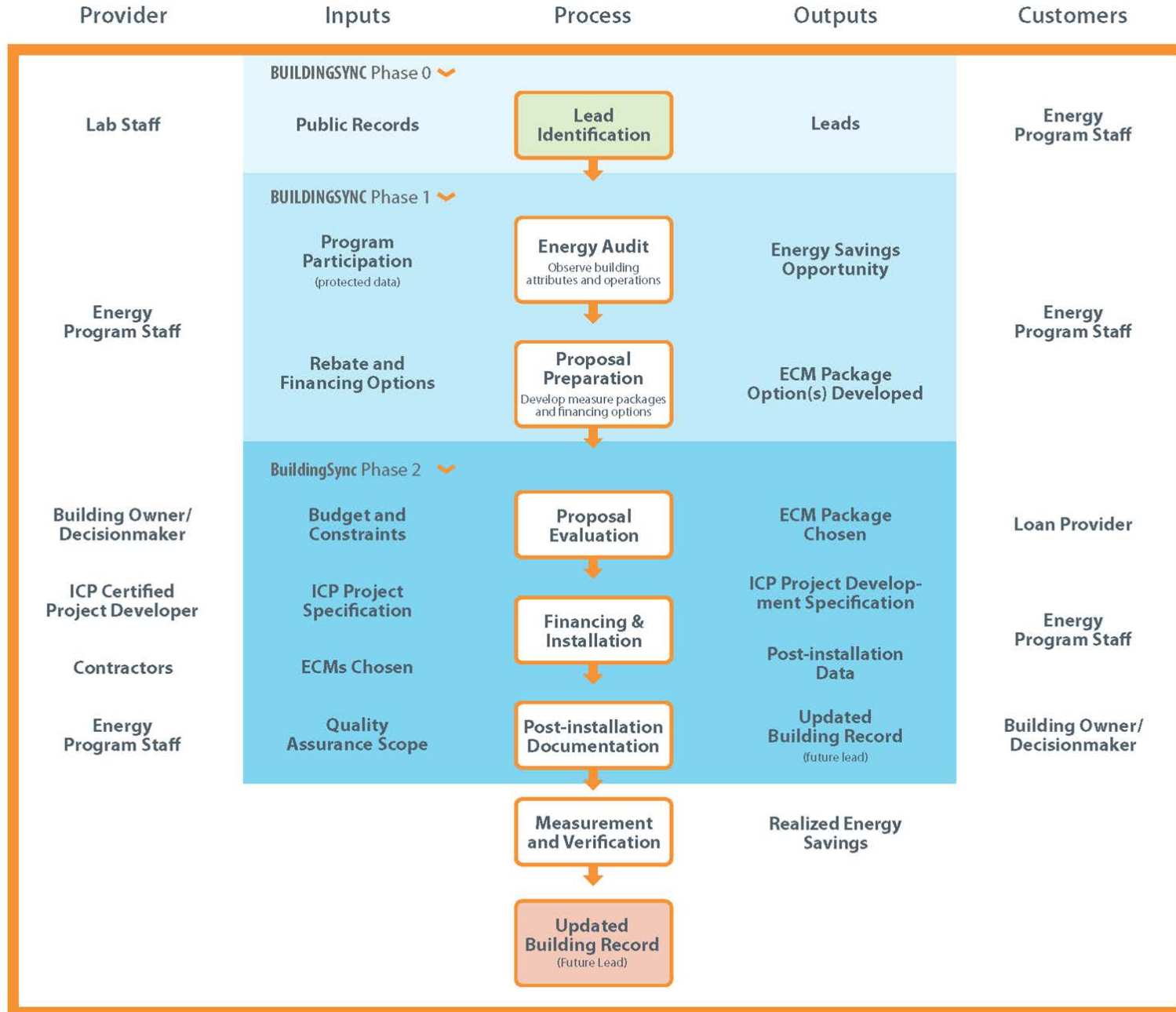
Key Objectives

- Leverage DOE tools including SEED and BEDES to develop an extensible database able to support the 43,255 SMB facilities in the 9-county Bay Area
 - City-scale building energy modeling to identify portfolio potential and target buildings
 - Develop BRICR Targeting and Proposal Tool (TPT) for deep energy retrofit proposals
 - Streamline financing by applying Investor Confidence Project (ICP) protocols
- Utilize public data and inference based on use, scale, construction type, and code vintage to develop a profile of at least 5,000 SMB buildings
- Identify top 500 sites for marketing based on cost effective efficiency potential
- Complete enhanced retrofits to at least 28 buildings
- Measure and verify realized energy savings in SMB sector via OpenEE meter
- Provide a template for other US cities and regions

BRICR Energy Program Process (Human view)

Mapped a comprehensive process. Local government energy efficiency programs provide sales, technical assistance, and process management

Software facilitates workflow partly performed by humans



Software Components



Building Sync

BRICR tailors BuildingSync XML schema data requirements based on availability:

Phase 0 – Simplest model

Informed by public records, prototypes and (if available) retrofit history. Useful for analyzing regional efficiency potential and prioritizing leads.

Phase 1 - More detail, more ECMs available to user

Information from site visits and building staff interviews inform model for proposal development, incentive eligibility, and identifying financing.

Phase 2 – Maximum detail supported by BRICR

Acquiring project financing, documenting ECM installation and M&V



CBES

Commercial Building Energy Saver (CBES) is a modeling tool with California-specific data



Measure Scenario N

OpenStudio quickly develops and manipulates EnergyPlus models



Audit Template

Audit Template is a feature of the Asset Score tool that collects, stores and reports audit data



BRICR Gem

BRICR Gem - **New** open source Ruby library developed for this project:

- Translates CBES GeoJSON to BuildingSync
- Translates BuildingSync to OpenStudio Models
- Translates simulation results back to BuildingSync



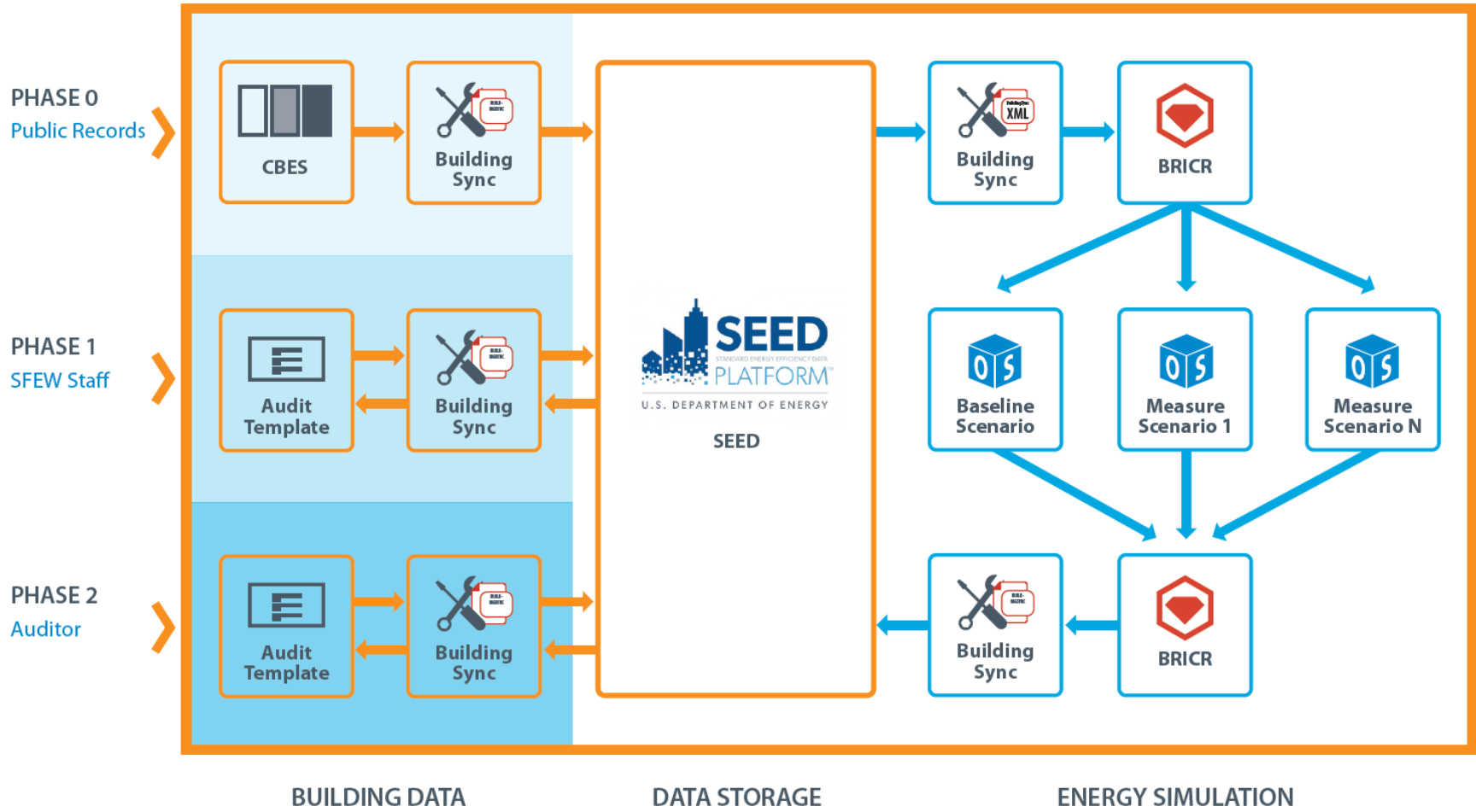
Standard Energy Efficiency Data Platform™ (SEED) manages building data



OpenEEMeter calculates realized energy savings

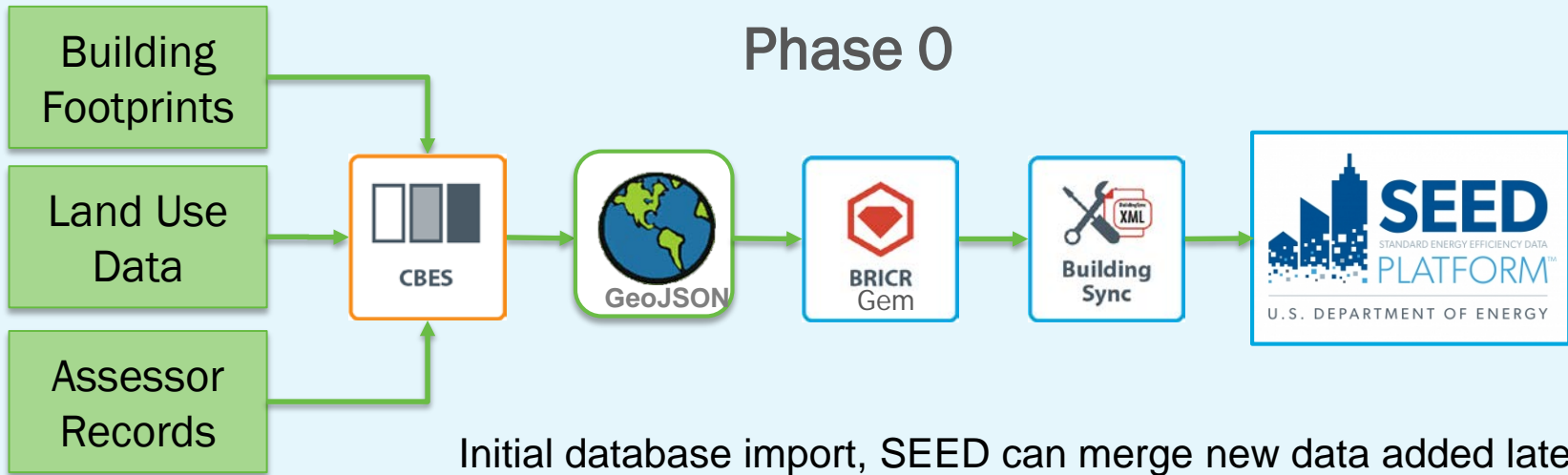
BRICR Software Architecture

Targeting and Proposal Tool (TPT)




New simulation cycle triggered whenever data is updated in SEED

Records Import and Editing



Phases 1 and 2



Facility Description

Building Characteristics

Gross Floor Area 10000

Spaces Excluded from Gross Floor Area

Conditioned Floor Area, Heated Only 0

Conditioned Floor Area, Cooled Only 0

Conditioned Floor Area, Heated and Cooled 10000

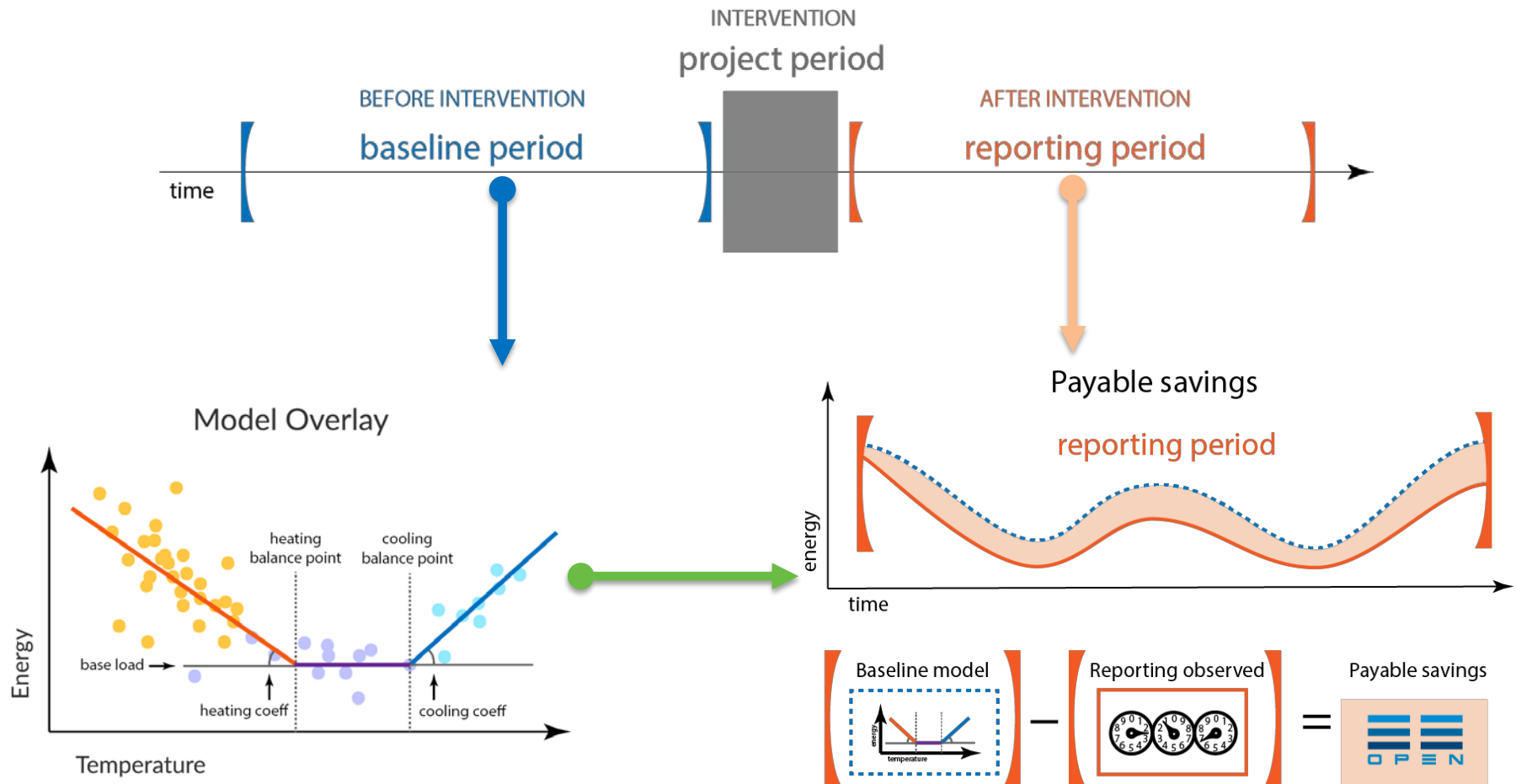


- SEED imports/exports BuildingSync to Audit Template
- Audit Template used to edit audit data

M&V: Open Energy Efficiency Meter



Open-source SaaS platform calculates site-based, weather-normalized energy savings from existing conditions baseline using utility meter data



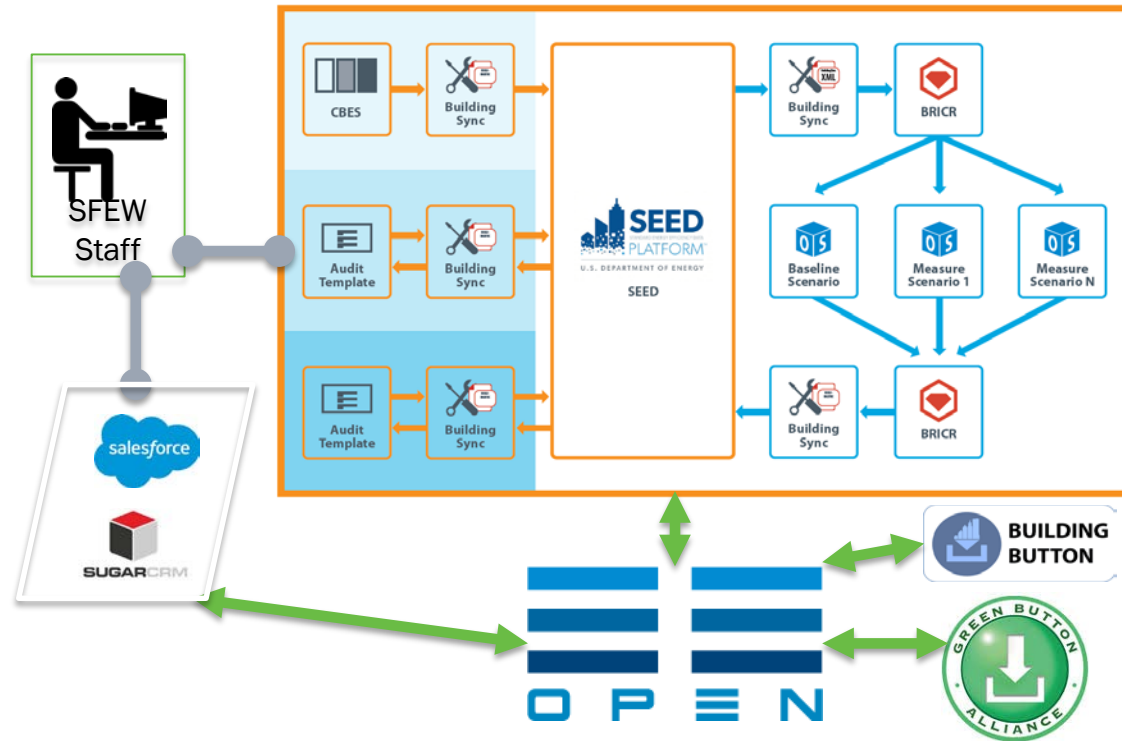
BRICR Software Review

BRICR combines DOE projects to solve real-world problems

- SEED, Audit Template, BuildingSync, OpenStudio

New open source BRICR Gem

- Translates CBES GeoJSON to BuildingSync
- Translates BuildingSync to OpenStudio
- Translates simulation results to BuildingSync



Challenges integrating software & data tools with processes and constraints of an existing EE program

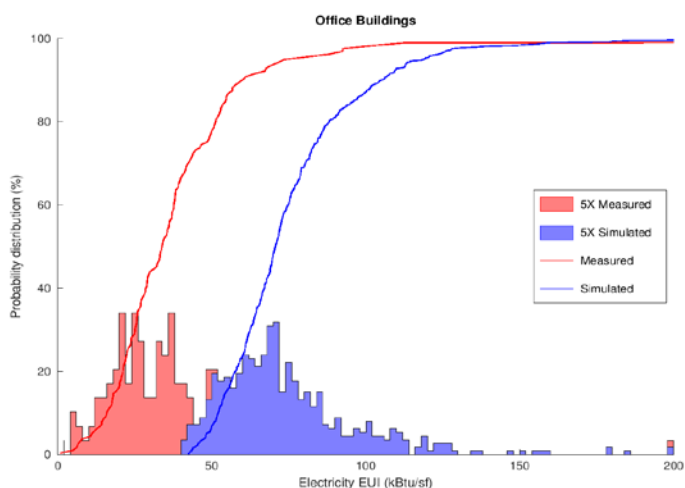
- Defining exact specifications for interoperability
- Integrating with other data sources and tools

Significant progress

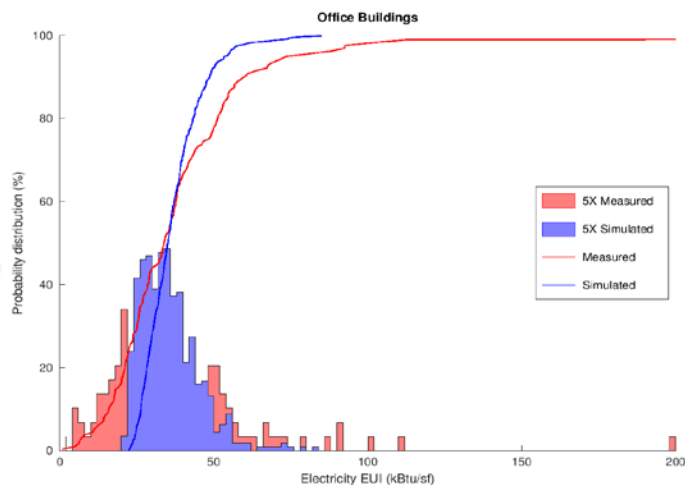
- Continued need for iteration
- Energy programs are complex; expectation management is critical

BRICR Phase 0 Calibration and Benchmarking

Portfolio model calibration technique led to fixes to California Title 24 prototype models, e.g., LPD, HVAC system type, and elevators.

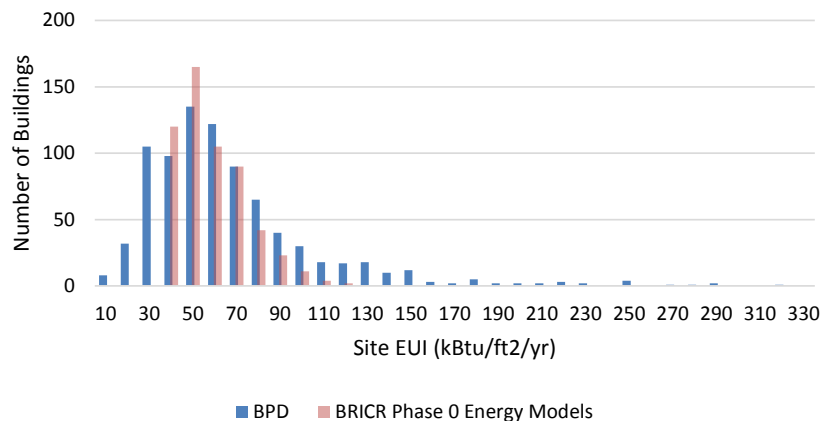


Before Calibration



After Calibration

Office Building Energy Histogram



EUI distribution of Phase 0 baseline models is a good match to BPD data

BPD buildings with recent retrofits correspond to Phase 0 buildings with relatively low energy consumption

ECM Options Available to User Increase as Detail Increases

- Simulation results from applying 29 ECMs to 1699 SMBs
- Top measures:
 - ✓ Ground source heat pump or VRF
 - ✓ LED lighting
 - ✓ Daylighting controls
 - ✓ Windows
 - ✓ EnergyStar appliances

BuildingSync Measure	Average Energy Savings			Phase
	Total Energy	Electricity	Natural Gas	
LED lighting	16.2%	27.9%	-15.3%	0
ENERGY STAR appliances	8.7%	13.3%	-6.2%	
Replace burner	3.3%	0.0%	11.7%	
Upgrade package units	3.2%	4.4%	0.0%	
Air sealing	3.0%	0.2%	10.5%	
Daylight controls	12.5%	19.2%	-5.3%	1
Operating protocols, calibration and sequencing	5.9%	2.7%	15.4%	
Wall insulation	4.2%	1.6%	11.5%	
Plug load controls	4.0%	6.4%	-3.0%	
Upgrade gas water heater	2.8%	0.0%	10.6%	
Window film	2.8%	5.6%	-4.9%	
Occupancy sensors	1.4%	2.3%	-1.0%	
Roof insulation	1.2%	0.3%	4.3%	
Insulate thermal bypasses	1.1%	0.4%	3.0%	
Ceiling insulation	0.5%	0.1%	1.9%	
Ground coupled heat pump	23.6%	19.9%	24.4%	2
PZHP HVAC	14.6%	7.3%	37.5%	
VRF HVAC	11.5%	3.9%	22.7%	
Replace windows	9.0%	11.6%	3.0%	
Demand Controlled Ventilation	5.0%	-2.2%	22.3%	
High efficiency fan	4.6%	9.2%	-8.0%	
Repair economizer	3.6%	6.5%	-4.6%	
Replace boiler	3.0%	0.0%	13.1%	
Recirculating pumps	2.7%	0.0%	10.0%	
Pipe insulation	2.6%	0.0%	9.8%	
Ventilation fans	2.4%	4.8%	-4.1%	
High efficiency ice/refrigeration equipment	1.0%	1.6%	-0.7%	
Low-flow faucets and showerheads	0.5%	0.0%	2.2%	
Energy recovery	0.1%	0.3%	-0.5%	

Impact

- This funding fills a gap that cannot be provided by the private sector, which must create proprietary tools to recoup investment and meet profit goals
- The new open-source BRICR targeting and proposal tool builds upon existing DOE tools to allow ABAG and other governments to identify the energy efficiency potential in region-wide SMBs, and deliver technical assistance at reduced cost and potentially at a larger scale.
- Initial assessment of ECMs found energy savings potential of up to 25%.
- Integration from mass building-scale analysis, retrofit implementation, and M&V enable Plan-Do-Act energy management cycle for local government
- Project informing design of upcoming energy efficiency program serving the nine Bay Area counties (BayREN Commercial)
- Dissemination of the tools, workflows, and knowledge gained beyond the nine Bay Area counties

Stakeholder Engagement



Operational

- Project is currently in an early stage
- Technical team benefits from extensive interaction with San Francisco Energy Watch
- Coordinating tasks, datasets, and outreach with benchmarking and audit program; improves ability to leverage San Francisco mandatory audits as on-ramp for retrofits
- Interviews and input from financing providers

Promotion and Feedback

- Paper submitted to 2018 ACEEE Summer Study
- Poster and panel at SimBuild 2017
- Presentation at Internet of Things 2018

Key Accomplishments

Year 1

- San Francisco commercial building stock data integration
- Identification of Phase 0 target buildings in San Francisco
 - ABAG gathering data for additional counties
- Prototype energy models developed
 - Aligned with CA Title 24 standards
 - Title 24 standards added to OpenStudio Standards GEM
- BRICR tool development in progress
- Recovered from 6 month delay in project start due to incapacitation of original PI and local government contracting challenges

Years 2 and 3 (upcoming)

- Complete working version of BRICR Targeting and Proposal Tool (TPT)
- Implementation and support of TPT
- Develop 28+ Deep Energy Retrofits
- Initiate Measurement and Verification
- Expand Outreach to Support Scaling Up

Thank You

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REFERENCE SLIDES

Project Budget

Project Budget: \$1.4M Federal + \$1.4M Cost Share = \$2.8M Total

Variances:

- Low initial spending due to incapacitation of original PI and local government contracting delays. Received 6 month no-cost extension.
- \$175k cost share commitment fell through; replaced by \$346k commitment from Wells Fargo Innovation Incubator

Cost to Date: Federal share 39% expended

Additional Funding: Cost share supplied by SF Energy Watch, Wells Fargo Innovation Incubator (NREL), California Energy Commission (LBL)

Budget History

10/1/2016 – 3/30/2018 (past)		4/1/2018 – 3/30/2020 (planned)	
DOE	Cost-share	DOE	Cost-share
\$548,155	\$685,049	\$850,603	\$739,779

Project Plan and Schedule

BRICR Project Schedule	Budget period 1						Budget period 2				Budget period 3			
	2016	2017				2018		2018		2019		2019		2020
	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1
PROJECT PERIOD - OCT 2016 TO MAR 2020														
Task 1.0 Project Communications														
Task 2.0: Develop Data														
Milestone 2 Report describing the existing tools, gaps, workplan for for single tool, use cases, minimum data requirements, and EM&V plan														
Task 3.0: Develop Modeling Tool														
Milestone 3 Memo to DOE describing completion of tool, integration of constituents, configuration for EM&V, API connections established, incorporation of emerging technology ECMs and proposal editing capability														
Task 4.0 Perform Energy Modeling														
Milestone 4 Provide USDOE a copy of the subdivided list of prospects by county. Initial energy modeling for targeting complete, prospects disseminated to local government programs														
Task 5.0 Develop BRICR Targeting and Proposal Tool (TPT)														
Milestone 5 Webinar to USDOE showing TPT is ready for implementation, and on-line access is provided to USDOE.														
Go/No-Go														
Task 6.0 Implementation of TPT														
Milestone 6 At least 20 Energy Watch staff and contractors have been trained on the TPT in two trainings														
Task 7.0 Deep Energy Retrofits														
Milestone 7 Documentation of 28 signed retrofit project agreements is presented to DOE with report summarizing retrofits completed to date														
Go/No-Go														
Task 8.0 Evaluation, Measurement, and Verification														
Milestone 8 EM&V Results presented to CPUC staff, and project partners have requested ratepayer support for program continuity. A one page summary of the outcome of the CPUC meeting is provided to USDOE.														
Task 9.0 Scaling Up														
Milestone 9 Provide the document on the national strategy to USDOE														
Task 10 Reporting														
Milestone 10 Provide USDOE with final Report, Presentation, and Brochure														

Future Software Opportunities

Currently beyond project scope:

- Better handling of sub-building project details (tenant and account level)
 - UBID may play a role
- Inclusion of detailed audit data into model predictions
 - Phase 2, ASHRAE Level 2 audit data to improve models
- Building-level calibration of baseline and energy savings estimates
- Additional prototypes to improve SMB coverage
- Additional ECMs to address broader opportunities