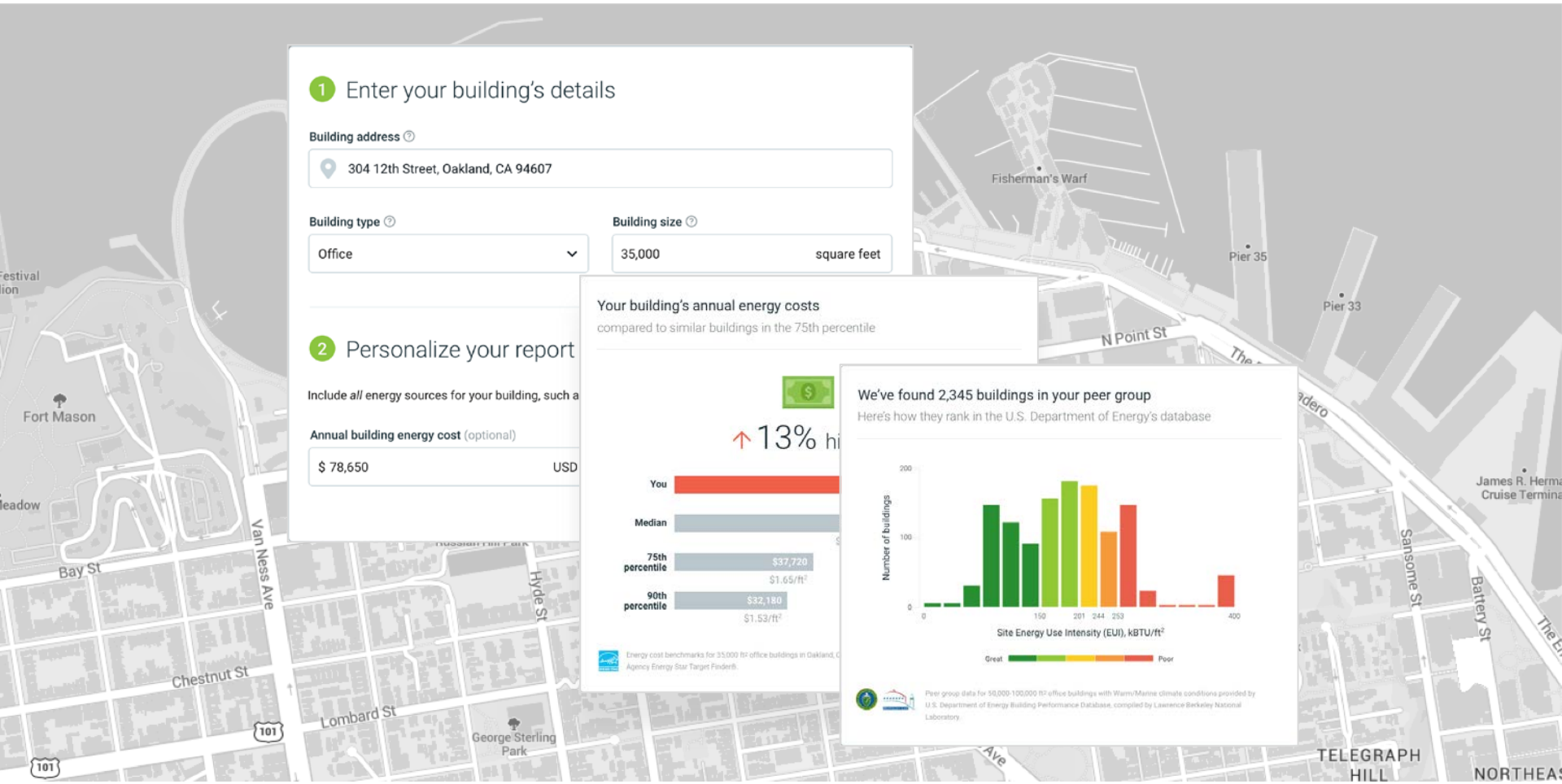
Small Business Vouchers, Lucid

2017 Building Technologies Office Peer Review



U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

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Project Summary

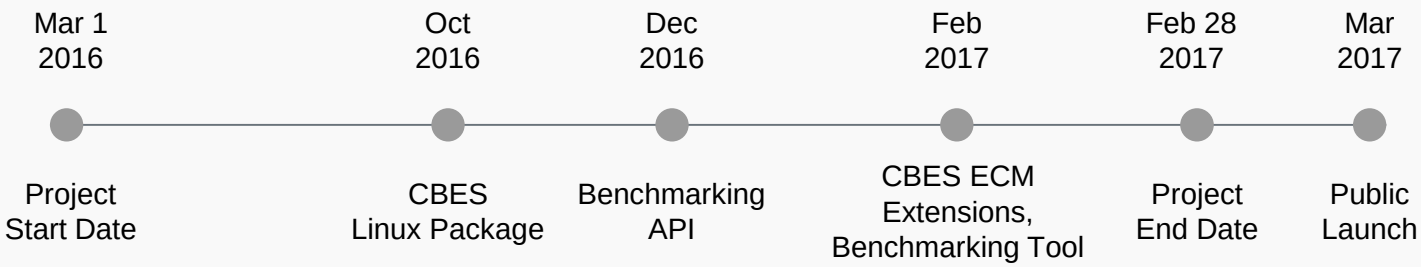
BUDGET Small Business Voucher (SBV) DOE: $200,000 Cost Share: $60,000

TEAM

Lawrence Berkeley National Laboratory (LBNL)
Tianzhen Hong, *Lead Research Scientist*
Yixing Chen, *Assoc. Engineering Developer*
Jessica Granderson, *Deputy of Research*

Lucid, makers of BuildingOS.com
Nathan Gould, *Data Scientist*
Gavin Platt, *Product Designer*
Josh Wentz, *Product Architect*

MILESTONES



OUTCOME

The project succeeded in commercializing key Department of Energy software packages.
1.Free public benchmarking tool: A unique benchmarking tool which leverages the vast building datasets of Energy Star and the DOE Building Performance Database has been created for all of the public.
2.Expansion of CBES to national scope: The project also piloted the integration of LBNL's Commercial Building Energy Saver (CBES) Pro (an API on top of OpenStudio/EnergyPlus) into BuildingOS.com, preparing the platform to use physics-based building energy modeling for retrofit analysis on a scalable cloud infrastructure.

[MYPP Modeling Strategy 3 - Expand partnerships with vendors to create end user applications that use energy modeling. LBNL focused on the engine while Lucid focused on the user interface.]

Project Summary

Small Business Voucher (SBV) pairs U.S. DOE National Laboratories with small companies

TEAM	Lawrence Berkeley National Laboratory (LBNL) focused on engines	Lucid, makers of BuildingOS.com focused on user interface
Software Tools	Commercial Building Energy Saver (CBES) Retrofit Analysis Software Energy Conservation Measure (ECM) Database OpenStudio EnergyPlus ENERGY STAR TargetFinder™ DOE BUILDINGS PERFORMANCE DATABASE	buildingOS **10,000**+ buildings, **1B**+ ft² across universities, corporations, real estate, government, cities, states **150**+ integrations with building hardware & software systems **700**+ customers primarily building owners & operators

Purpose and Objectives

TARGET MARKET

5.7M commercial buildings comprising **87B** sq.ft.

Accounting for 4.5 trillion BTU per year, 40% of all U.S. emissions of greenhouse gases.
According to Energy Star, commercial buildings waste 30% of that energy.
Audience: Building owners & operators.

PROBLEM STATEMENT

1.Benchmarking Can Be Made Easier. Benchmarking is critical first step to understanding building performance, EE potential, yet Portfolio Manager (PM) can be difficult to access for beginners; BPD offers targeted custom outputs, but not widely integrated with commercial analytics tools.

2.Commercial Analytics Don't Address Retrofits. Ongoing analytics tools enable operational savings of 10%+, yet do not rigorously address retrofit measures.

3.Lack of Commercialization. Building software companies have yet to commercialize benchmarking and retrofit analytics on a broad scale.

PROJECT OUTPUTS

1.Free public benchmarking tool integrating Energy Star Portfolio Manager and BPD

2.Expansion of CBES to national scope, and infrastructure to integrate model-based retrofit and ECM engine into BuildingOS.com

IMPACT

1.Benchmarking made more accessible and more targeted. Benchmarked buildings save 2%.

2.Retrofit assessment paired with operational analytics accessible to building owners to enable comprehensive capital efficiency improvements on the order of 15-50%.

Approach

MUTUAL MISSION

Reduce the energy use of buildings on a broad scale.

	WHY	WHAT	WHERE	HOW
BARRIERS	Why do I care?	What can I do?	Where should I focus?	How can I do it?
ANSWERS	MONEY Save money. Lots of money.	TRACK your data.	COMPARE across your portfolio. Submeter each building.	IMPLEMENT ECMs that work for your building profile.
	Benchmarking via Energy Star + BPD	BuildingOS.com	BuildingOS.com	Energy Conservation Measures via CBES OpenStudio/EnergyPlus

Approach

APPROACH

•LBNL provided Lucid detailed understanding of DOE tool architecture, APIs, ECMs, facility types, characteristics, underlying analysis in CBES, PM, and BPD

•LBNL provided Lucid design guidance and technical assistance to integrate desired benchmarking and ECM analysis capabilities into BuildingOS.com (coding examples, testing and verification process, user presentation).

•Lucid leveraged Energy Star Target Finder & DOE BPD to create a public benchmarking web tool

•LBNL expanded CBES functionality for applicability beyond CA climates and measures.

KEY ISSUES

•Architecture: Ensuring compatibility with cloud-based SaaS infrastructure

•User Experience: Ability for users to understand the information and transform the information into actions

DISTINCTIVE CHARACTERISTICS

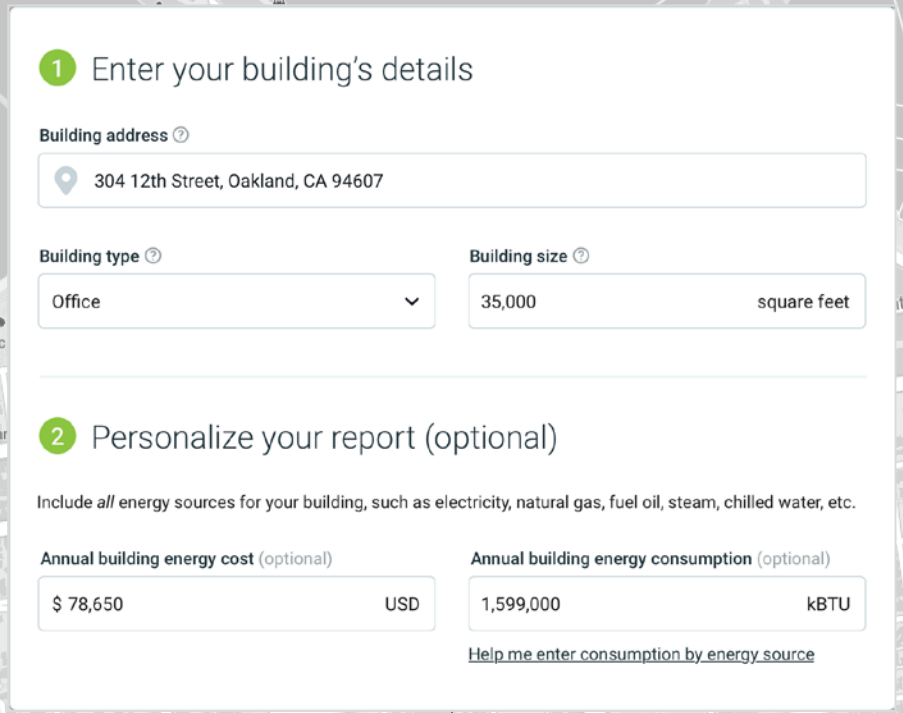
•Small Business Vouchers Pilot Program provided industry access to Laboratory expertise, supports lab-to-market technology and knowledge transfer.

•Integration of federally-funded tools & capabilities into commercial software offering to enhance the state of the technology.

Accomplishments

Free easy-to-use public benchmarking web tool to motivate the ‘why’ to act

Benchmark My Building web form:



3 INPUTS 1) Type, 2) Size, 3) Location

2 ENGINES

15+ OUTPUTS in REST JSON

Benchmarking API

Energy Star Target Finder | DOE Building Performance Database | +

Benchmarking API

Future Potential: Asset Score, BOMA

WHY | WHAT | WHERE | HOW

Accomplishments

Median Benchmarks

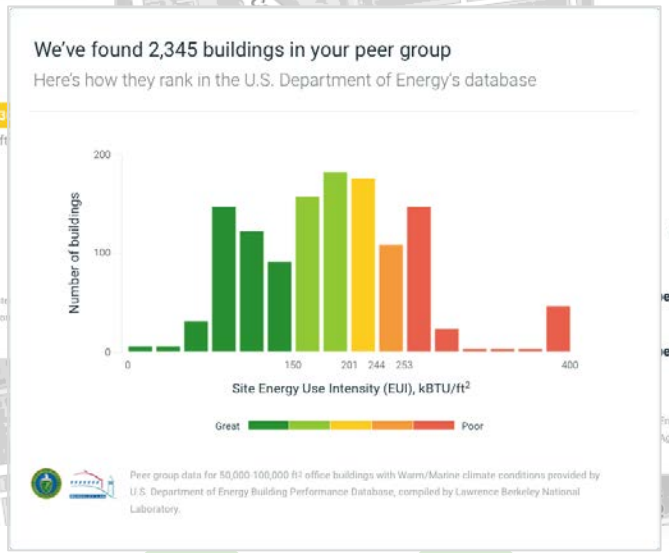
from 3 inputs, type, size, location

data-driven OUTPUTS

7k buildings from CBECS representative of 57M

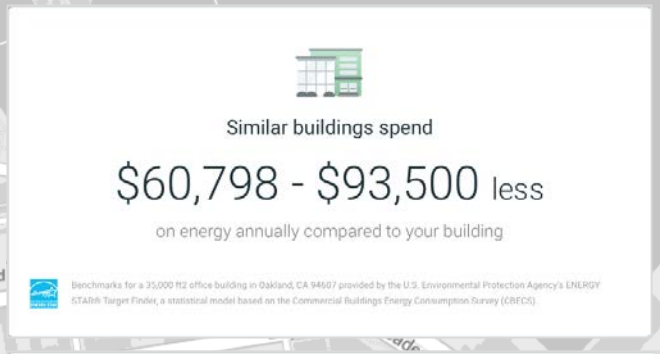
DOE BUILDINGS PERFORMANCE DATABASE

200k+ commercial buildings of metered & utility data



Personalized Benchmarks

from all 5 inputs, annual cost & consumption



1. Bridges gap between finance & engineering
2. Transfers Data: Owner > City > DOE > BenchmarkMyBuilding Tool

WHY | WHAT | WHERE | HOW

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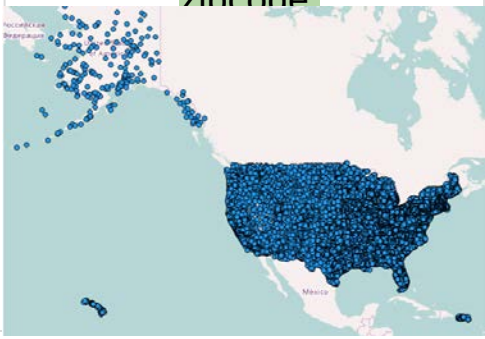
10,000+ buildings across nation & world track their data with BuildingOS.com

Accomplishments

Commercial Building Energy Saver (CBES) Pro
expanded coverage for national scope

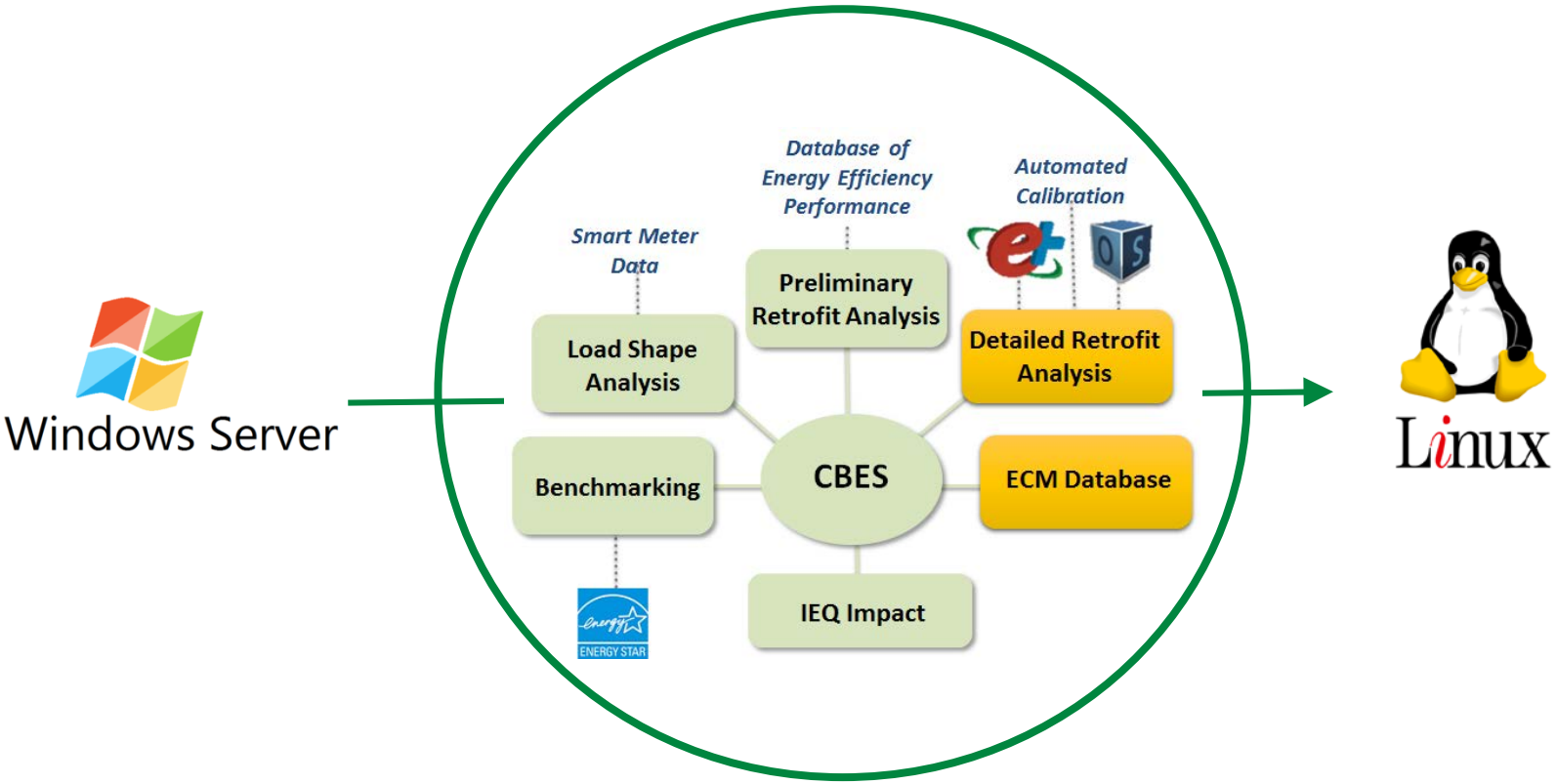
BUILDING TYPES & ECMs		CLIMATE ZONES	
BEFORE SBV	*AFTER SBV*	*BEFORE SBV*	*AFTER SBV*
Small Office Medium Office	Small Office Medium Office Large Office, 6 new ECMs (chillers, cooling towers, pumps, AHU fans, VAV boxes, air-side economizer)	10 ASHRAE climate zones Based on 15 U.S. city weather files	All 16 ASHRAE Climate Zones Based on 861 U.S. location weather files Accessed via U.S. zipcode
Small Retail Medium Retail	Small Retail Medium Retail		
Mixed-use (office and retail)	Mixed-use (office and retail)		



model-driven OUTPUTS

Accomplishments

Commercial Building Energy Saver (CBES) Pro ported from Windows to Linux, laying the foundation to scale code into a cloud server infrastructure.



HOW can I reduce energy? Implement Energy Conservation measures custom tailored to your building profile via CBES/OpenStudio/EnergyPlus. Accomplishment: Expanded coverage + scaled codebase. There's always more to do.

Accomplishments

ACCOMPLISHMENTS

1. Integration of the Energy Star + DOE BPD into a unique free building report which bridges gap between finance and engineering

2. Simplifying accessibility to, and usability of Energy Star Portfolio Manager / Target Finder information

3. Expansion of CBES to cover all US climate zones and Large Office building type.

4. Piloting CBES Pro API integration with BuildingOS.com, platform for 10k+ buildings

MARKET IMPACT

1. Save time: building operators currently have to spend time and resources to broaden any benchmark data outside of the standard Energy Star score

2. Accelerate ECM projects: leverage energy modeling to provide building operators with an incentive and business case to drive new projects

3. Direct technology transfer for use in **1 Billion** sq.ft. of commercial building space through Lucid's current customer base

Project Integration and Collaboration

PROJECT CONTENTS WILL BE RELEASED TO THE:

- Public: for anyone to use the benchmarking tool
- 10,000+ buildings, 1B+ ft^2, 700+ building owners/operator customers: for all of Lucid's current and prospective customers

COMMUNICATIONS

- JAN 2017: Anonymous user test conducted with building operators
- MAR 30, 2017 at 11am PST: Launch webinar for public benchmarking tool
- APR 2017: Campaign to cities with benchmarking ordinances
- MAY 2017: Better Buildings Summit
- FUTURE: Conferences: ACEE, ASHRAE, etc

INTEGRATION

PARTNERS

Small Business Vouchers Pilot U.S. DEPARTMENT OF ENERGY | BERKELEY LAB | lucid | U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Next Steps and Future Plans

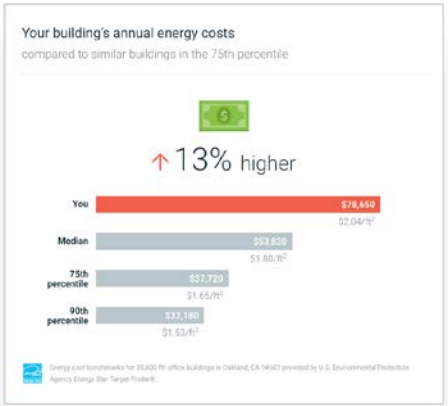
BenchmarkMyBuilding.com

NEXT STEPS

- **BenchmarkMyBuilding.com** launches as of today, Mar 16, 2017
- Launch Webinar, Thu, Mar 30, 2017 at 11am PST
- Socialize **BenchmarkMyBuilding.com** with cities with benchmarking ordinances

FUTURE PLANS

- A proposal was submitted to the Technology Commercialization Fund (TCF) to fully implement and demonstrate the CBES Pro API integration with BuildingOS for retrofit analysis.



WHY

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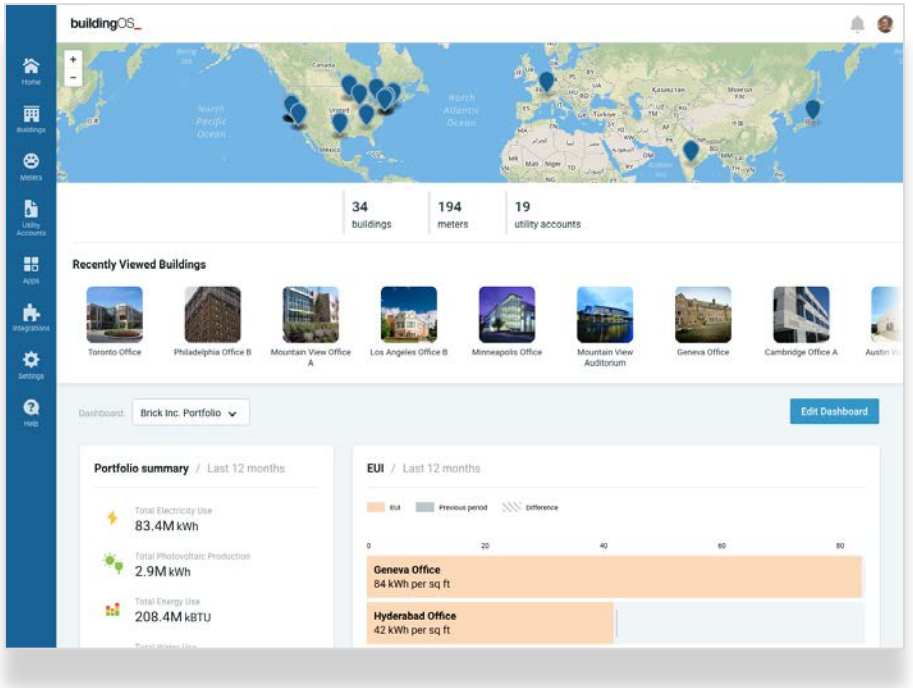
Next Steps and Future Plans

lucid	**User Interface** model-based retrofits via CBES / ECM database		○
	Engine	Production-Grade Integration	○
		Piloted Integration	✓
		Port to Linux	✓
lucid	**Servers** cloud infrastructure		✓

FUTURE PLANS / HOW can I save?

- User Interface Design for ECM Prioritization of savings opportunities across an entire portfolio
- Production-Grade Integration of CBES/OpenStudio/EnergyPlus into BuildingOS.com
- Auto-Calibrate Models against monthly & real-time data



HOW

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Reference Slides

Project Budget

Variances: None

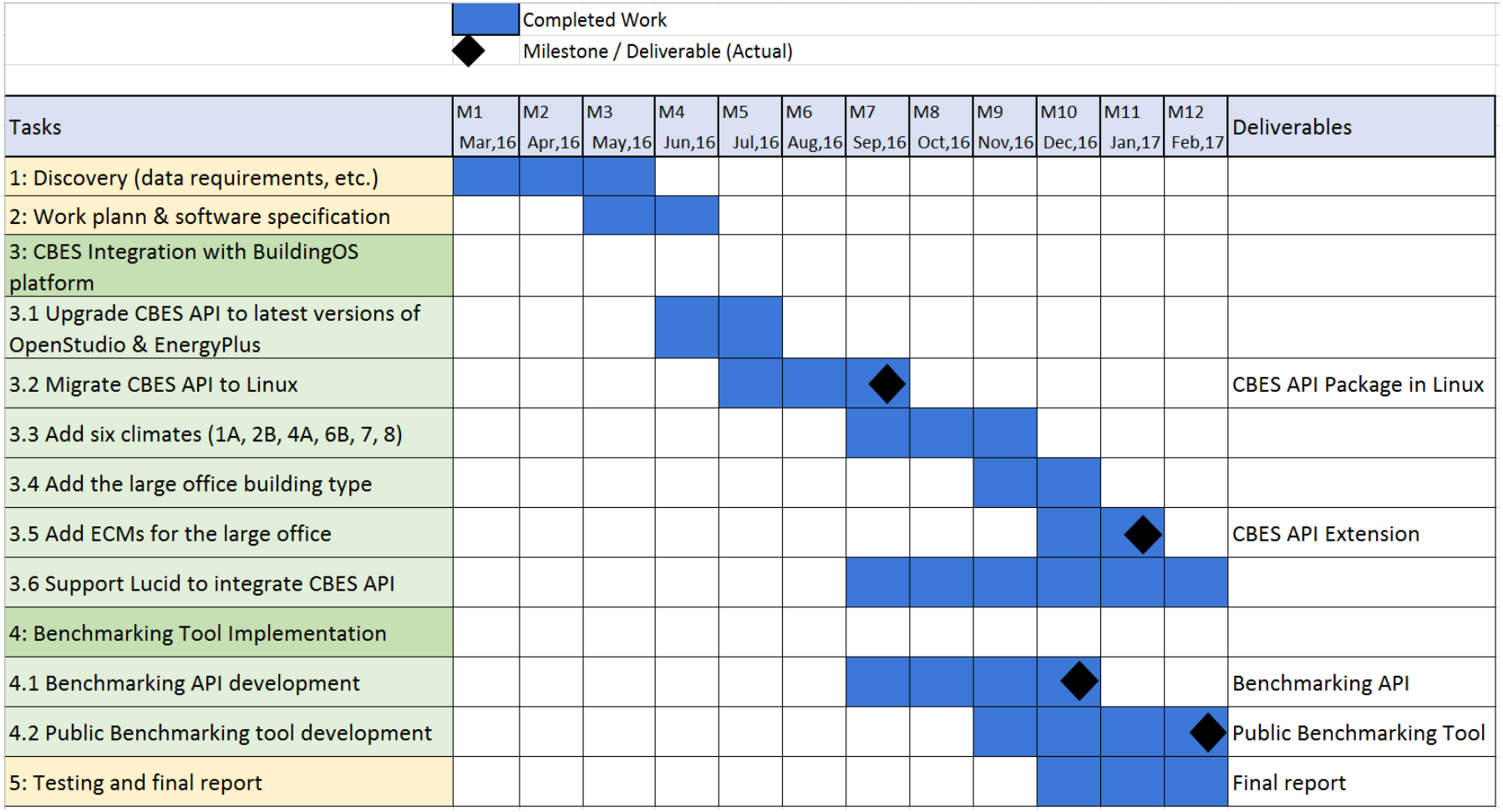
Cost to Date: DOE $200,000 + Lucid in-kind $60,000

Additional Funding: N/A

Budget History					
FY 2016 (past)		FY 2017 (current)		FY 2018	
DOE	Cost-share	DOE	Cost-share	DOE	Cost-share
$200,000	$60,000	$0	$0	N/A	N/A

Project Plan and Schedule

- Initiation date: March 1, 2016
- Completion date: February 28, 2017



Tasks	M1 Mar,16	M2 Apr,16	M3 May,16	M4 Jun,16	M5 Jul,16	M6 Aug,16	M7 Sep,16	M8 Oct,16	M9 Nov,16	M10 Dec,16	M11 Jan,17	M12 Feb,17	Deliverables
1: Discovery (data requirements, etc.)													
2: Work plann & software specification													
3: CBES Integration with BuildingOS platform													
3.1 Upgrade CBES API to latest versions of OpenStudio & EnergyPlus													
3.2 Migrate CBES API to Linux													CBES API Package in Linux
3.3 Add six climates (1A, 2B, 4A, 6B, 7, 8)													
3.4 Add the large office building type													
3.5 Add ECMs for the large office													CBES API Extension
3.6 Support Lucid to integrate CBES API													
4: Benchmarking Tool Implementation													
4.1 Benchmarking API development													Benchmarking API
4.2 Public Benchmarking tool development													Public Benchmarking Tool
5: Testing and final report													Final report