U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Residential PACE Energy Savings

Lawrence Berkeley National Laboratory

Lisa Schwartz, Energy Efficiency Team Leader, PI

Jeff Deason, Program Manager, Co-PI/Project Manager

jadeason@lbl.gov

Project Summary

Timeline:

Start date: 10/2016

Planned end date: TBD, likely Q1 of FY19

Key Milestones

1. PV Deployment Report; published 4/4/18
2. Energy Impacts Report; estimated Q1 FY19

Budget:

Total Project $ to Date: $390,000

- DOE: $390,000
- Cost Share: In-kind contributions: data from R-PACE providers and utilities/California Energy Commission

Total Project $: $390,000

- DOE: $390,000
- Cost Share: as above

Key Partners:

California Energy Commission	Placer County/mPOWER Program
Renew Financial/California FIRST Program	Ygrene Energy Fund
Sonoma County/ Energy Independence Program	Renovate America/HERO Program

Project Outcome:

Provide clarity on the deployment and energy impacts of residential Property Assessed Clean Energy (PACE) programs, which have not received third party impact evaluation, for states considering adopting such programs.

Fulfill request on preliminary impact evaluation from the California Energy Commission, which seeks to quantify R-PACE contributions to the state's energy savings goals.

Team


Jeff Deason


Sean Murphy


Lisa Schwartz


Chuck Goldman

Jeff Deason, Program Manager: Co-Principal Investigator and project lead on research design/data analysis. Trained in program evaluation and econometrics. Expert on energy efficiency financing programs.

Sean Murphy, Scientific Engineering Associate: Data analysis and management. Skilled in data management, merging, and analysis. Experience working at a utility on energy efficiency programs and usage data.

Lisa Schwartz, Energy Efficiency Team Leader: Principal Investigator and project oversight. Expert on energy efficiency programs, policies, regulation with over 30 years' experience.

Chuck Goldman, Staff Scientist: Research design/oversight. 35 years of energy efficiency research at Berkeley Lab. Expert on many topics including financing, program evaluation.

Challenge

- **DOE has set aggressive residential retrofit goals:** Prove retrofit solutions at scale by upgrading 1 million homes.
- **Financing can help** by overcoming first-cost barriers to efficient technologies.
- **Residential PACE is scaling where other financing programs have not.**

Table 1. Programmatic Efficiency Lending Volumes in 2014

Program Type	Total Loan Volume ($M)	Residential Sector ($M)	Number of Residential Loans
On-bill	$179	$76	9,486
Utility loan (not on-bill)	$202	$196	16,607
PACE	$267	$248	12,061
State Energy Office RLF	$74	$17	1,595
ESPC	$4,101	-	-
Total	**$4,823M**	**$537M**	**39,749**

Source: Deason et al., "Energy Efficiency Program Financing: Where it comes from, where it goes, and how it gets there."

Challenge

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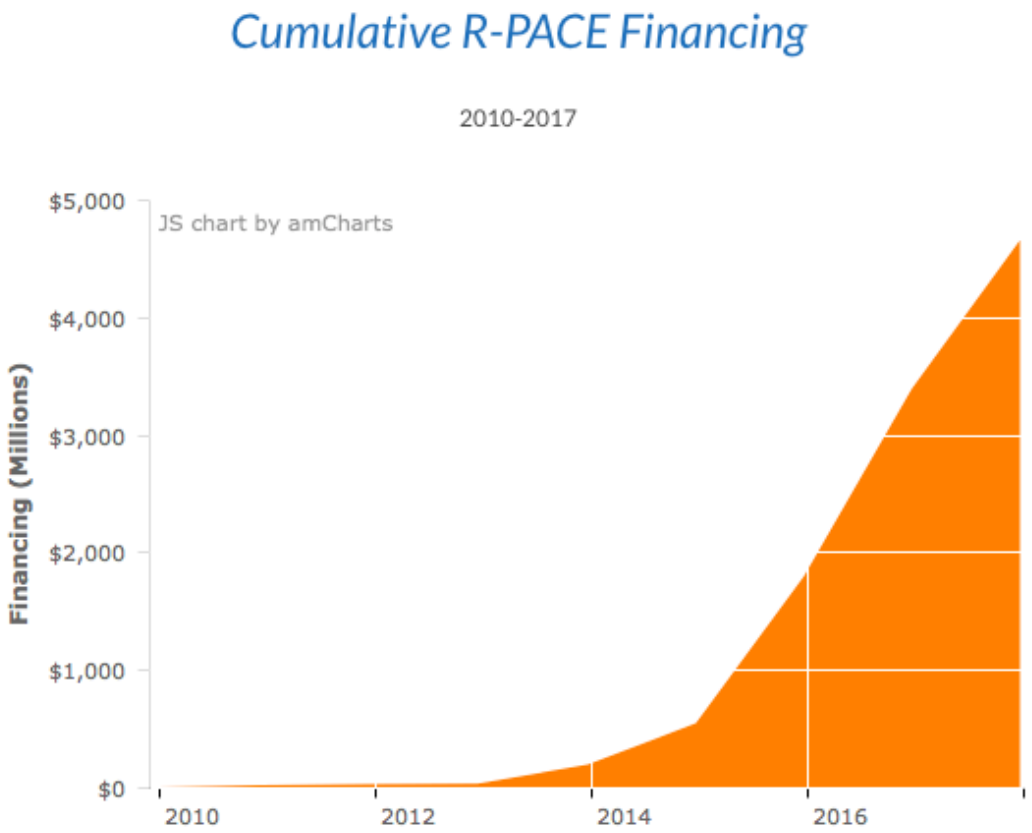


Source: PACENation

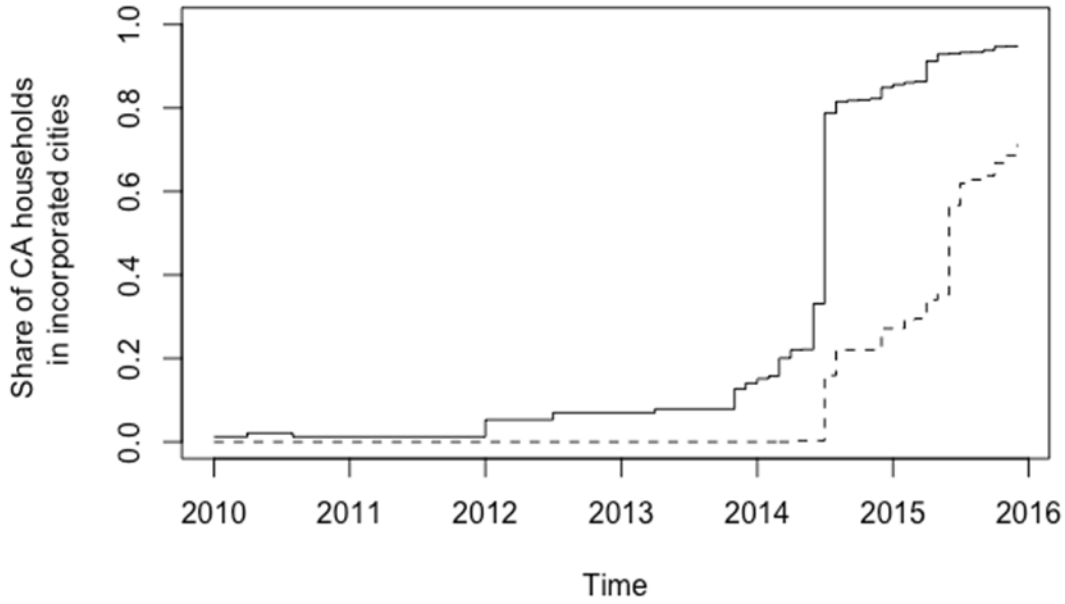
Challenge

- **DOE has set aggressive residential retrofit goals:** Prove retrofit solutions at scale by upgrading 1 million homes.
- **Financing can help** by overcoming first-cost barriers to efficient technologies.
- **Residential PACE is scaling where other financing programs have not.**

- **However, there is little evidence of R-PACE impacts on technology deployment and energy usage.** R-PACE programs are not regulated by public utility commissions and program impacts are not regularly measured.
- **Our project seeks to fill this gap** by answering the following questions:
  - *Are R-PACE programs driving the deployment of energy efficiency and renewable energy technologies that would not otherwise be installed?*
  - *How do R-PACE program participants' energy usage change after project installation?*
- **States are seeking this information.** California seeks to use savings from R-PACE to fulfill its energy efficiency goals, but has no reliable estimates. Other states are considering adopting R-PACE, but are deterred in part by lack of clarity on impacts.

Approach: PV deployment

- **Question:** *Are R-PACE programs driving the deployment of energy efficiency and renewable energy technologies that would not otherwise be installed?*
- **Method: Fixed effects panel regression analysis**, exploiting city-level differences in program start dates to estimate the impact of R-PACE on deployment of residential solar PV in California cities.



Growth in the share of California households in incorporated cities with an R-PACE program, 2010-2015. Solid line indicates share of households served by at least one program; dashed line indicates share of households served by multiple programs.

- **Data:** PV deployment by date and jurisdiction (Berkeley Lab); program start dates by city (R-PACE programs); control data including electricity prices, solar incentives, economic and demographic data

Approach: Energy usage

- **Question:** *How do R-PACE program participants' energy usage change after project installation?*
- **Dataset**, all at the household level:
  - PACE assessment data (addresses, dates)
  - Energy usage data
  - Measures installed by category
- **Method: Analyze household measured energy usage data for R-PACE customers to estimate impact of R-PACE projects.** Analysis will cover ~ 50,000 households that participated in R-PACE programs. Methods may include:
  - *Princeton Scorekeeping Method (PRISM)*, a weather-normalized comparison of energy usage before and after the project, conducted for each household – as implemented by software developed to assess pay-for-performance utility programs in California
  - *Fixed effects panel regression*, exploiting differences in R-PACE project timing among households, implicitly using past/future R-PACE participants as controls
  - *Comparison with usage in non-R-PACE households*, as data will allow
- **We will report impacts for different categories of measures**, e.g.:
  - efficiency vs. solar PV
  - HVAC vs. insulation vs. appliances vs. doors and windows

Impact

PV Deployment:

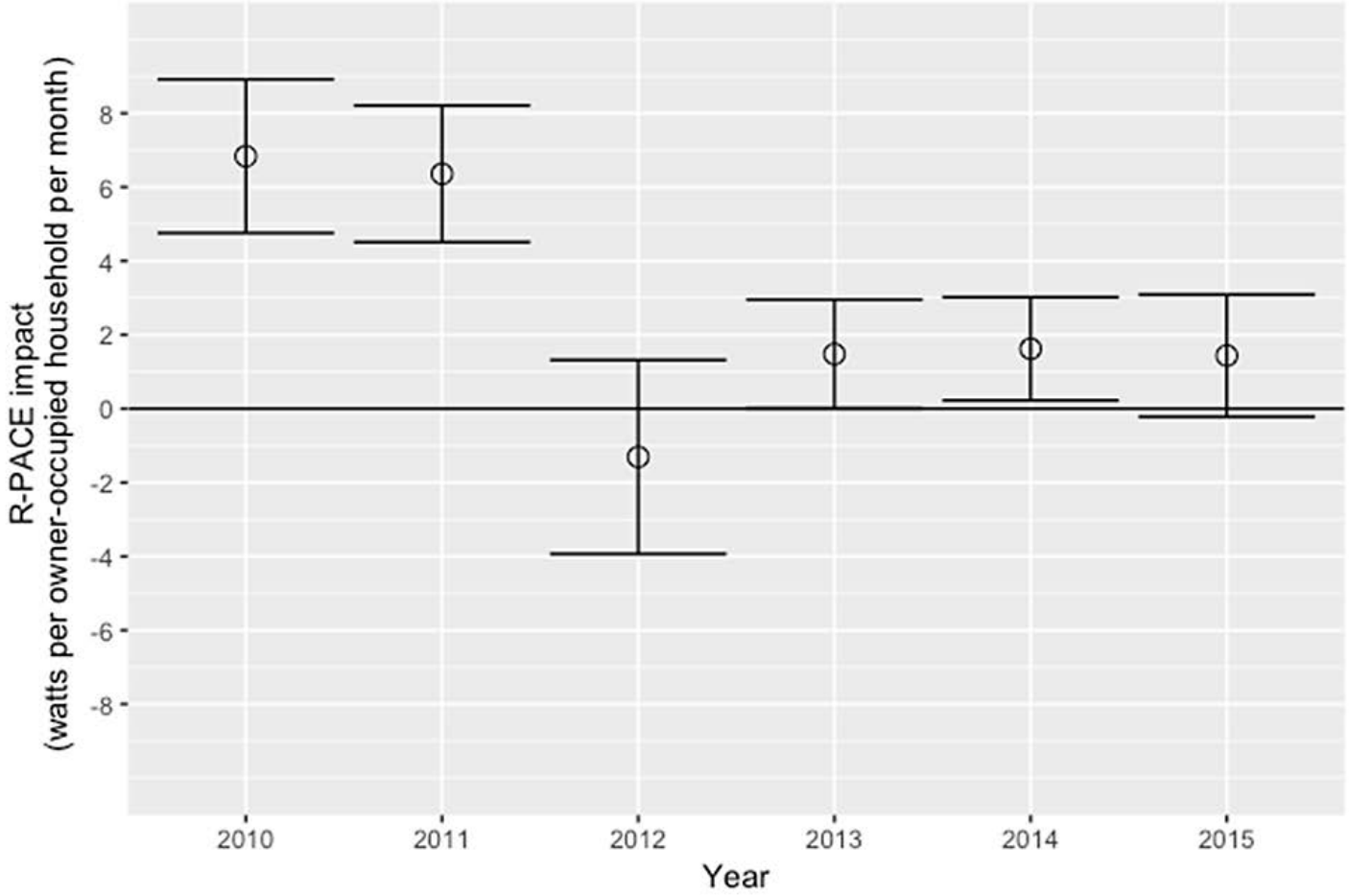
- While prior research has estimated impacts of early, regional R-PACE programs, ours demonstrates their impact in years more akin to today's PV financing market:
  - Large, statewide R-PACE programs administered and capitalized by private companies
  - Many competitive financing products for PV (power purchase agreements, leases, loans)
- Results demonstrate whether R-PACE is driving additional deployment or simply financing projects that would have been deployed regardless

Energy Usage:

- First independent third-party assessment of the *gross* energy usage impacts of these very large programs (over 200,000 participating households, and $4.9 billion in capital to date)
- Provide a starting point for quantifying R-PACE program impacts for state energy goals (e.g., SB 350 in California)
- Paired with deployment impacts, can begin to think about *net* program impacts
- Large-scale analysis with on-site results regarding impacts by measure category may have broad relevance beyond R-PACE and financing programs

Progress: PV deployment

Report released 4/4/18. Findings: R-PACE programs appear to be driving PV deployment even in later years of our dataset (2010-2015), though effects are largest in early years.



Sample 1: ~ 102 large CA cities, richer control variables

Progress: PV deployment

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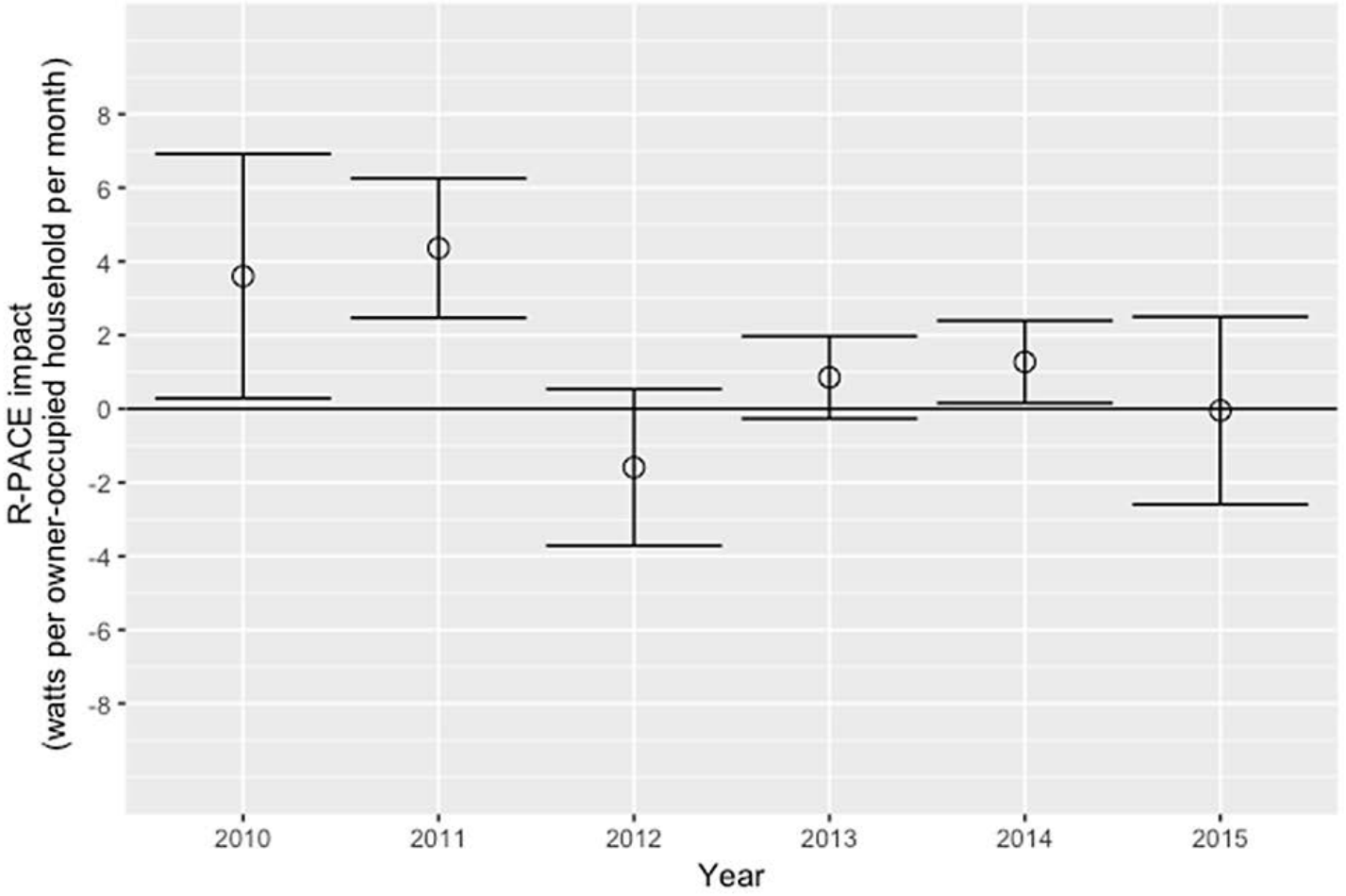


Sample 2: ~ 412 CA cities, all sizes, fewer control variables

Progress: PV deployment

- Impacts averaged across dataset (2010-2015):

Sample	Impact of R-PACE where present (watts per owner-occupied household driven by R-PACE)	Impact of R-PACE where present (% of capacity driven by R-PACE)	Estimate of total systems installed due to R-PACE
Large cities with annual demographic data	1.1	12%	12,000
All cities, no annual demographic data	0.6	7%	9,500

- Share of PACE-financed PV associated with program presence: ~100% large cities; ~55% all cities (with large confidence intervals)

Progress: Energy usage

Early/early-mid stage – gathering data

Assessment data:

- Have dates, assessment amounts, and addresses for ~ 90,000 R-PACE households in California

Measures data from R-PACE programs:

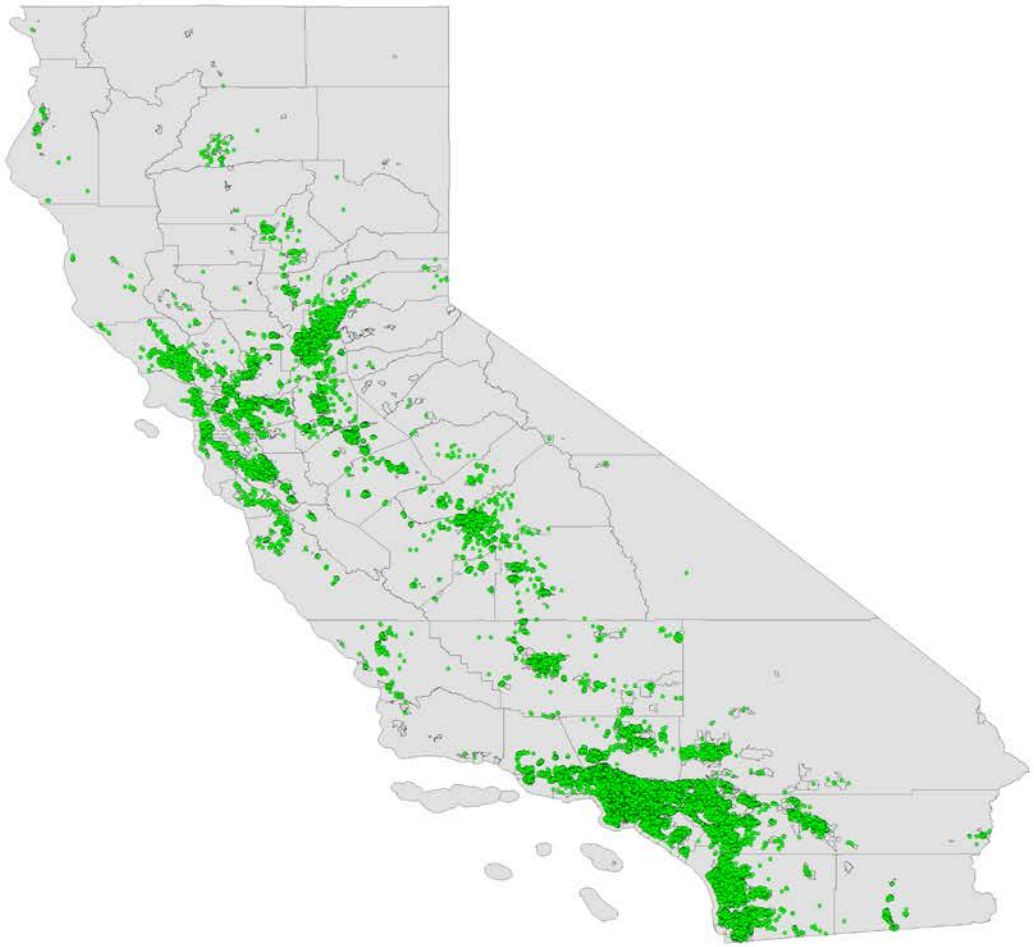
- Secured household-level measures data from one R-PACE program
- Signed non-disclosure agreements with two R-PACE programs; data on the way
- Still working to access data from two programs

Energy usage data: Working on several fronts to gain access

- All four large CA investor-owned utilities (under provisions of California Public Utilities Commission decision on data access)
- California Energy Commission
- Partnership with UC Berkeley

Progress: Energy usage

Locations of R-PACE households



Stakeholder Engagement

R-PACE programs

- Substantial ongoing engagement
  - Data provision for studies
  - Reviewed PV study and issued press releases
  - Invited presentation at PACENation Summit

State and local government

- Presented R-PACE overview information and/or study findings in a number of forums
- Will feature study findings in DOE-convened state R-PACE working group
- California Energy Commission an ongoing strategic partner and central audience for results

Remaining Project Work

PV deployment:

- Will continue dissemination activities
- Could consider updating analysis to cover additional years as data become available, but this is not in scope of existing project

Energy usage:

- Secure energy usage data
- Secure measures data from additional programs
- Perform analysis
- Develop technical report
- Disseminate findings

Thank You

Lawrence Berkeley National Laboratory
Jeff Deason, Program Manager
jadeason@lbl.gov

REFERENCE SLIDES

Project Budget

Project Budget: $390,000 ($30,000 FY16, $360,000 FY17)
Variances: None to date
Cost to Date: $350,000
Additional Funding: None

Budget History					
9/2016 – FY 2017 (past)		FY 2018 (current)		FY 2019 (planned)	
DOE	Cost-share	DOE	Cost-share	DOE	Cost-share
$390,000		$0		$0	

Project Plan and Schedule

Project Schedule													
Project Start: September 2016	Completed Work												
Projected End: TBD, likely Q1 FY19	Active Task (in progress work)												
	Milestone/Deliverable (Originally Planned)												
	Milestone/Deliverable (Actual)												
	FY2017				FY2018				FY2019				
Task	Q1 (Oct-Dec)	Q2 (Jan-Mar)	Q3 (Apr-Jun)	Q4 (Jul-Sep)	Q1 (Oct-Dec)	Q2 (Jan-Mar)	Q3 (Apr-Jun)	Q4 (Jul-Sep)	Q1 (Oct-Dec)	Q2 (Jan-Mar)	Q3 (Apr-Jun)	Q4 (Jul-Sep)	
Past Work													
Q1 Milestone: Memo on data availability	◆												
Q2 Milestone: Progress report		◆											
Q3 Milestone: Progress report			◆										
Q4 Milestone: Written progress report				◆									
Q1 Milestone: Draft of PV deployment report					◆	◆							
Q1 Milestone: Progress report					◆								
Q1 Milestone: Final PV deployment report					◆	◆							
Q2 Milestone: Progress report						◆							
Current/Future Work													
Q3 Milestone: Draft of energy savings report													
Q4 Milestone: Finel energy savings report													