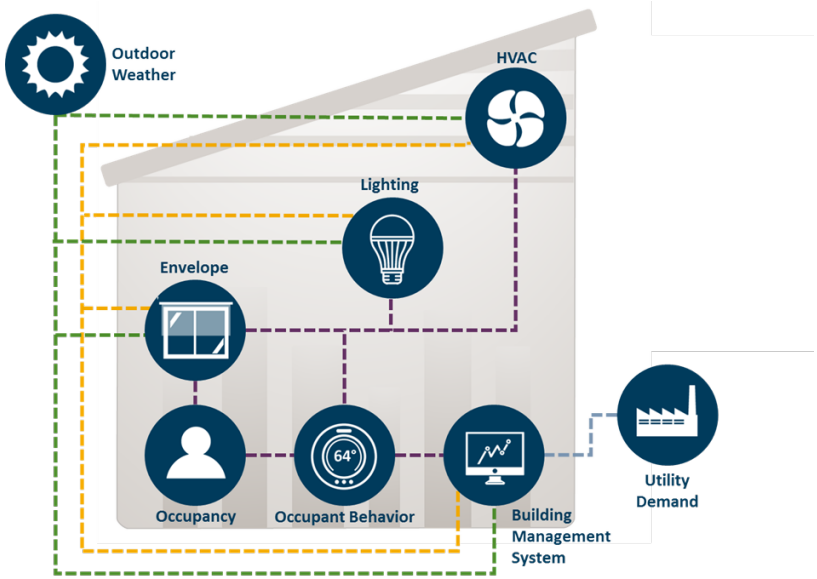
U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Integrated Solutions for Optimized Performance (ISOP)



TRC Energy Services

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Project Summary

Timeline:

Start date: September 1st, 2017

Planned end date: August 31st 2020

Key Milestones

1. MS 1.3: Site Assessment & Selection
2. MS 4.1: Performance Analysis
3. MS 5.4: Utility Program Design

Budget:

Total Project $ to Date:

- DOE: $ 66,780
- Cost Share: $ 20,000 (Estimate)

Total Project $:

- DOE: $699,826
- Cost Share: $709,000

Key Partners:

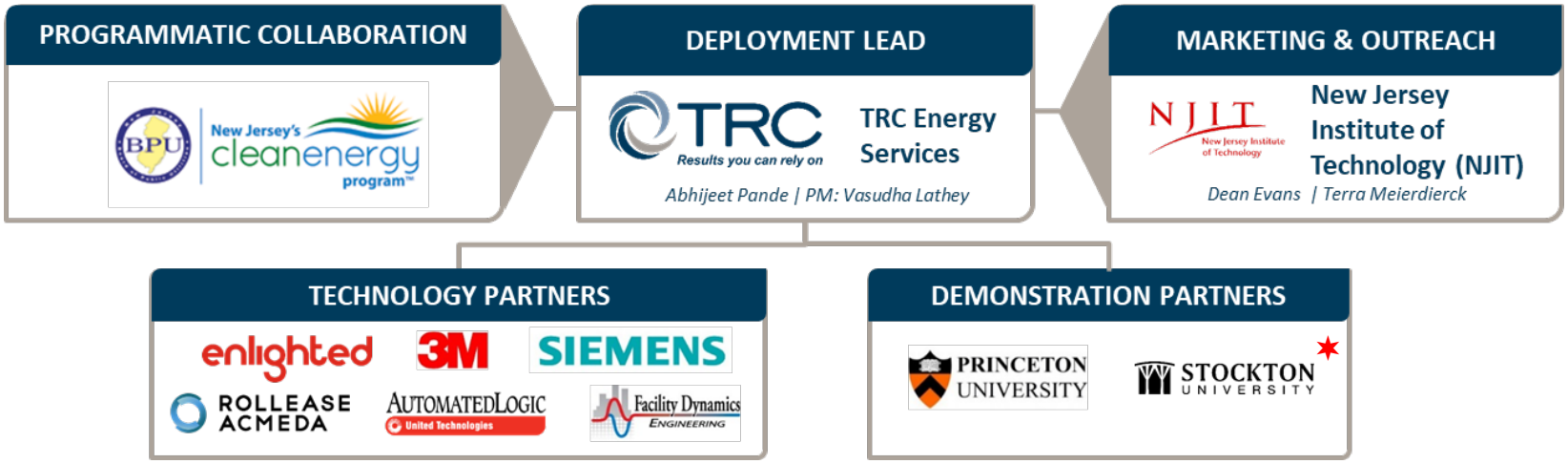
New Jersey Institute of Technology (NJIT)- Marketing and Outreach
Princeton University- Deployment Partner
Stockton University- Deployment Partner
New Jersey Board of Public Utilities- Program

Project Outcome:

To validate the Integrated Solutions for Optimized Performance (ISOP) package in sites representing 250,000 sq.ft.; and;

To develop technology data and knowledge transfer vehicles to support the roll out of a utility rebate program in New Jersey.

Team



Team Member	Site Selection	Project Design	Tech. Installation	Project Evaluation	Market Transformation
TRC Energy Services	●	●	●	●	●
NJIT		◑	◑	●	●
Demonstration Partners	●	●	●	◑	◑
Technology Partners		◑	●	◑	

● Lead Role ◑ Support Role

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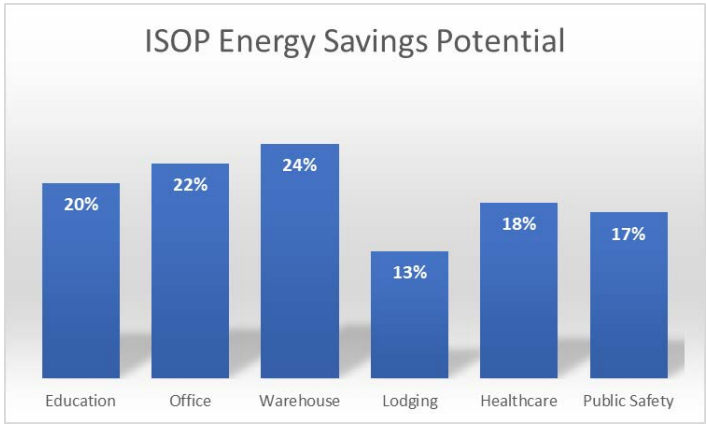
Challenge

Problem Definition:

- Conventional retrofit projects focus on individual technologies and/or products
- Not designed to optimize the building performance as an integrated system- therefore missing deeper energy saving opportunities

Advice:

- Unlocking the potential of deep whole building retrofits by design, deployment, **optimization and assessment** of integrated replicable and standardized packages
- Combine multiple technologies and smart communicating controls to maximize energy efficiency
  - ISOP Package address energy use across multiple building types
  - Impacts end uses that represent >60% of the energy consumption



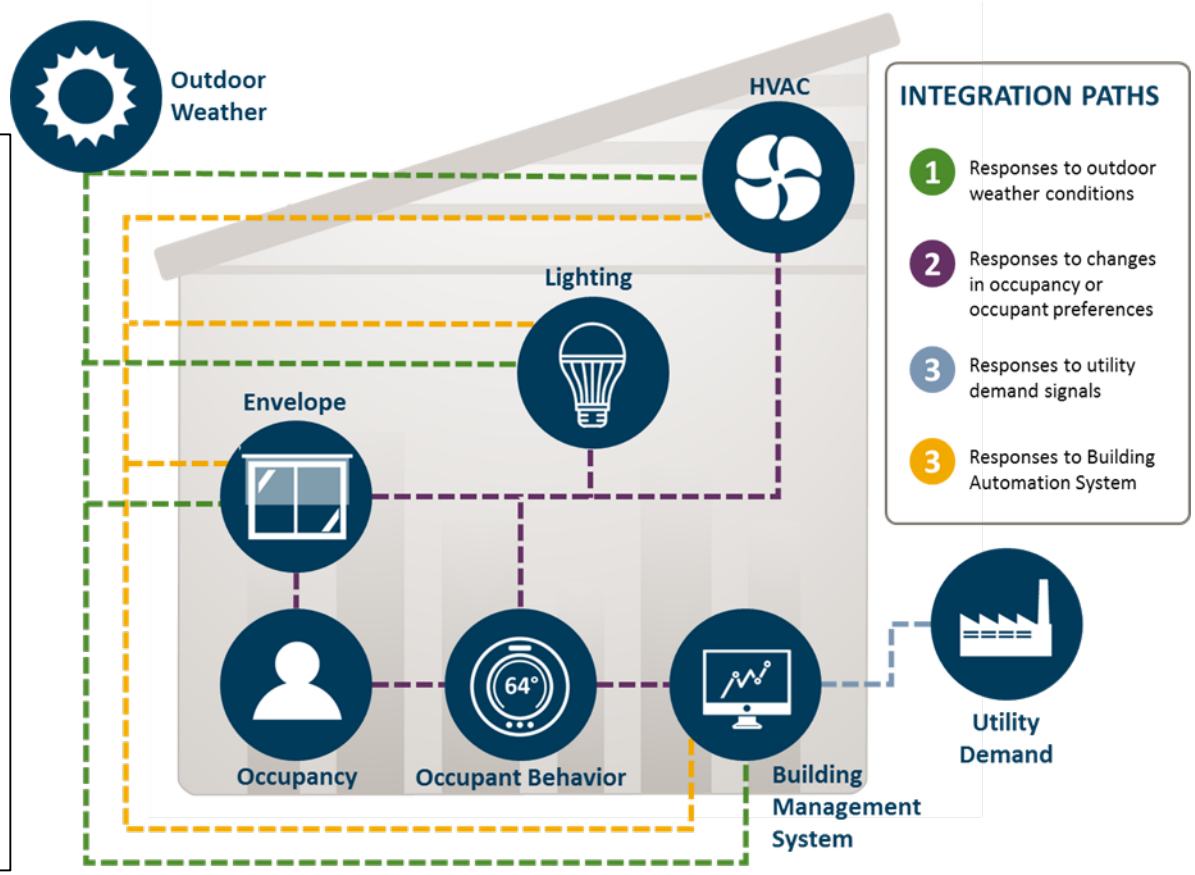
Approach: The Solution

I. Advanced lighting & controls

II. Daylight harvesting through automated self-powered shades and window films

III. HVAC controls upgrade and advanced controls sequences (ASHRAE Guideline 36)

IV. Fault detection and diagnostics (FDD) and continuous commissioning (Cx) using advanced analytics



Integrated Solutions for Optimized Performance (ISOP)

Each demonstration site will integrate at least two measures and validate savings through measurement and verification (M&V) 2.0 protocols.

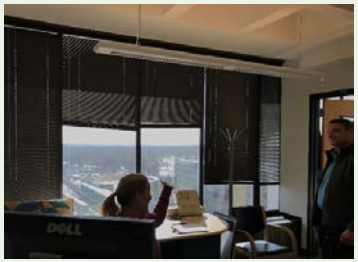
Approach (Contd.) – Technology Innovation

	CURRENT MARKET STATE	PROPOSED INNOVATION
Lighting	Increasing adoption of LED's but lost saving opportunities due to lack of integration with other building systems	**Enlighted** combines the advanced LED' and aggressive controls strategies integrated with the HVAC operations
Daylight	Not typically a focus of existing building retrofits and rarely integrated with HVAC	Integration of **Rollease** shades and **3M** window films with lighting and HVAC provides an easy and cost-effective method of optimizing daylighting and energy use with minimal operational disruptions.
HVAC	Lack of standardized control sequences results in software, hardware, and human error deficiencies that result in energy wastage.	**ASHRAE GDL36** offers standardization of controls sequences based on industry best practices that reduce cost and operational errors
CCx & FDD	Rarely used in buildings	Sophisticated analytical techniques analyze building operations, diagnose and prioritize system faults for efficient decision-making.
M&V 2.0	Limited market availability	Automated **M&V 2.0** will streamline the savings estimation process, provide continuous feedback for operational efficiency, and provide performance validation results for future utility program

Approach (Contd.) : Problem Solving

Key Project Tasks	Challenges- Current and/or Anticipated	TRC Problem Solving Approach
Site Selection	• Lack of availability or access of sites appropriate for ISOP technologies	• Detailed site selection criteria and pre-selection during proposal stage
Project Design	• **Data Availability:** Lack of data needed for project design and/or access to data • **Technological:** Incompatibility between existing technology and ISOP solutions • **Funding:** Meeting cost effectiveness criteria of demo institutions • **Procurement:** Lack of ability of demo sites to sole-source technology vendors	• TRC leveraging relationship with demo sites, technology solutions (SharePoint) and contributing cost share- building auditing • TRC included preliminary technology screening in the site selection criteria • TRC will leverage the NJ utility rebate and incentive programs to meet cost effectiveness • TRC will help building owners make the case for exceptions
Technology Installation	• **Installation schedule** not aligned with DOE project schedule • **Technology Integration**: Lack of adequate integration and communication between technologies	• TRC will work with building owners and technology vendors to develop installation and procurement schedule • TRC will work with the technology team to integrate technologies and commission the building
Project Evaluation	• **Building Access:** Inadequate access for pre and post retrofit evaluation • **Inadequate existing metering:** Inadequate sub metering infrastructure for measure level analysis • **Other concurrent projects**: Might impact ISOP results	• TRC ensured adequate building and data access during the site selection stage • TRC has some funds budgeted for sub-metering • TRC worked with building owners to identify sites that do not have any other planned retrofits during the demo timeframe • TRC will develop an MOU which details building owner responsibilities and alerting TRC to any operational or building modifications during the project timeline.
Market Transformation	• **Scalability:** No plan for scaling up project success to other parts of the industry	• TRC project approach includes scalability of project success i) across campus, and ii) across the building sector through a utility program

Demonstration Sites

Building Name	Characteristics	Proposed ISOP Package
Stockton: Bldg 30 ✶   	1972 Vintage: 130,000 Sq. Ft.; 2 Stories Offices, Classrooms -24 Hour occupancy Singe pane glazing with exterior metal shades & interior blinds T8 lighting with limited LEDs with basic occupancy controls Packaged rooftop constant volume mutizone AC units and perimeter radiators. Trane BAS system.	Rollease Automated Shades 3M Window Film Advanced LED fixtures and TLED retrofits Advanced Lighting Control Systems HVAC Retrocommissioning (RCx)
Princeton: New South   	1965 Vintage 53,227 Sq.. Ft. 7 Stories Offices, Conference rooms - 8 am – 6 pm occupancy Core and shell served with different HVAC systems 3 Air handling units and perimeter fan coil units. A VAV unit serves lower 3 floors and core of floors 2-6. 100% OA systems serves the fan coils and a separate unit serves the 7th floor Single pane glazing with interior manually operated blinds- Glare problems Lighting mostly upgraded to LEDs	Rollease Automated Shades 3M Window Films Lighting Controls Upgrades HVAC RCX

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Demonstration Sites (Contd.)

Building Name	Characteristics	Proposed ISOP Package
Princeton: Friend Center   	2001 Vintage 65,729 sq. ft. 2 Stories Classrooms and library- Occupied 8 am – 10 pm Double pane curtain glazing with interior manually operated wood blinds LED lighting with Lutron Quantum ALCS (Not fully operational due to lack of controls and sensors) VAV reheat system with a several AHUs, and a mix of standard VAV boxes and parallel fan powered boxes. Outdated Siemens BAS. HVAC served by campus chilled water and steam.	Lighting Controls and sensor to upgrade to ALCS operations 3M Window Film Automated interior shades ASHRAE GDL 36
Princeton: Computer Science   	1989 Vintage 53,030 sq. ft. 4 Stories Offices, Classrooms, Data Centers Double pane windows with some interior shades Retrofitted TLED lighting with Lutron Grafik Eye in some rooms Multizone VAV systems. Data centers cooled by computer room air conditioning (CRAC) systems	3M window films Automated interior shades ALCS upgrade ASHRAE GDL 36/RCx

Impact

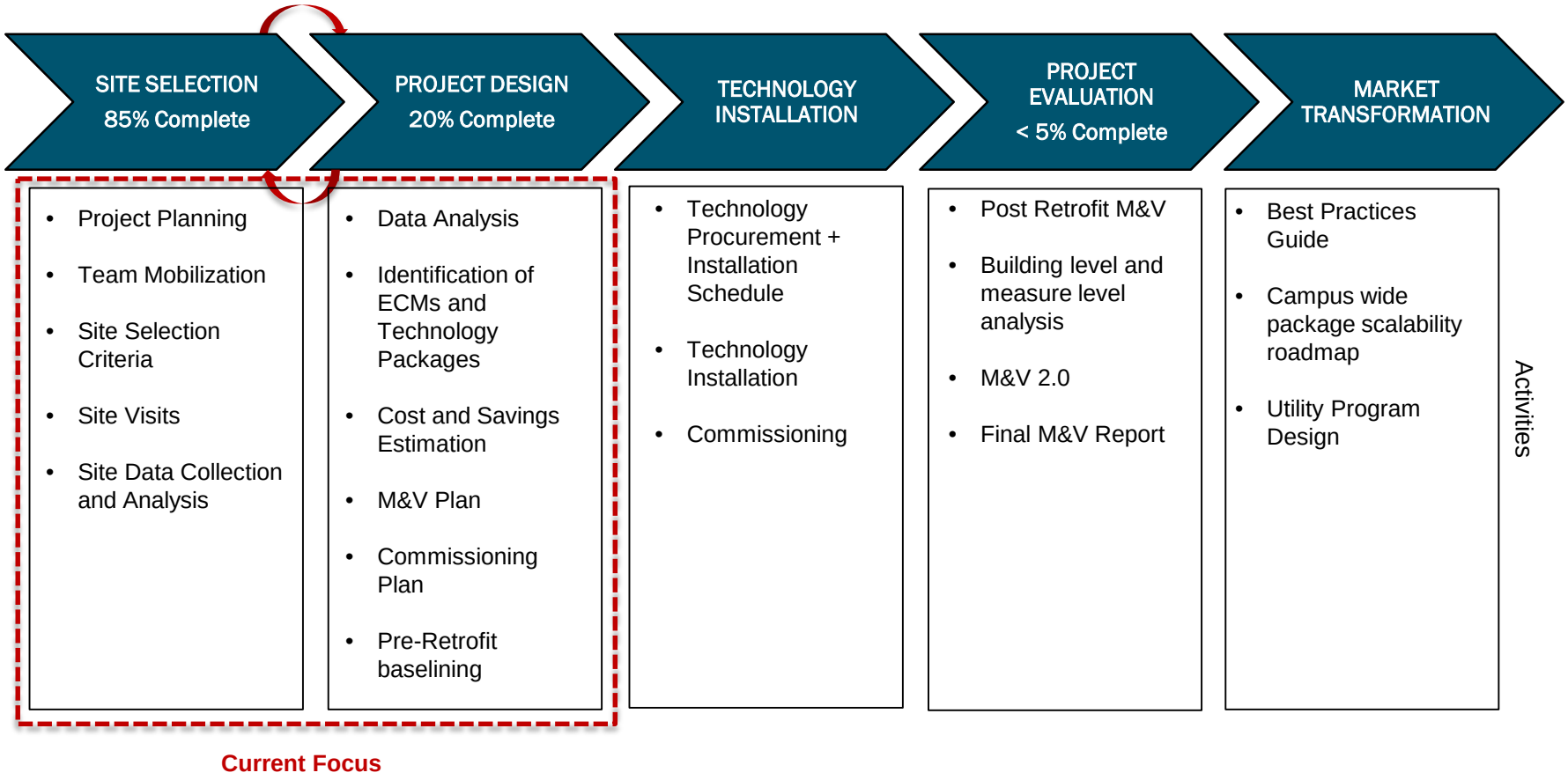
- Integrated ISOP package is estimated to save a total of 765 TBtu/Yr of energy reduction nationwide
  - 60% lighting energy
  - 25-30% HVAC
  - 10% plug load energy

- Project is expected to result in energy and cost savings and the following non-energy, benefits
  - Improved indoor lighting and visual quality
  - Improved thermal comfort
  - Health and wellness benefits
  - Increased productivity

- Project successes, outcomes and lessons learned will inform the design of utility incentive program focused on deploying pre-packaged integrated efficiency solutions

Progress

Early Stage Project: Month 7 /36



Progress (Contd.)- Site Data Collection

	Architectural	Electrical & Lighting	Mechanical	Operational Schedule	Energy Bills	Old Audit Reports
Stockton- Building 30 ✶	●	◔	◔	○	◑	○
Princeton- New South	●	◑	◑	◔	◑	◑
Princeton- Friend Center	●	◑	◑	◔	◑	◑
Princeton-Computer Science	●	◑	◑	◔	◑	◑

4 Data Available | 2 Partial Data Available | 1 Limited Data Available | 0 Not Available

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Progress (Contd.)- Measure Assessment

ISOP Technology	Assessment criteria	Stockton Bldg.30 ✶	Princeton New South	Princeton Friend Center	Princeton Computer Science
3M Window Films	Solar heat/loss problems Glare problems Thermal discomfort- especially in the perimeter zone	●	●	◑	◑
Automated Window Shades		●	●	●	●
Advanced Lighting Control Systems	Need for lighting upgrades Variable occupancy and potential for control savings Lack or and/or limited controls Existing electrical wiring is viable for controls upgrades	●	◑	●	●
ASHRAE GDL 36	Availability of system types and controls covered by GDL36- Multizone VAV reheat systems with DDC controls to the zone	○	○	●	◑
HVAC Controls Upgrades	Existing thermal comfort issues HVAC operations not optimized for efficiency Lack of ability to integrate with other systems	●	●	●	●

4 Viable Solution | 2 Potentially Viable | 0 Not Viable

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Stakeholder Engagement & Collaboration

- **Utility Partner Engagement:**
  - New Jersey Board of Public Utilities (NJBPU) brief on project initiation
  - NJBPU incentive programs identified to support DOE ISOP demonstrations

- **BTO Peer Group Engagement:**
  - Seventhwave
  - LBNL
  - NREL

- **Coordination with other research efforts:**
  - Cross-cutting collaboration with similar CEC EPIC projects
  - ASHRAE GDL 36 project database in development

- **Industry and Market Engagement:**
  - Technology partners webinar
  - Other technology partners engagement- Lutron
  - HVAC industry engagement for GDL 36

Remaining Project Work

Project Next Steps: (2018 Q2)

- Project scoping and analysis
- Project design
- Technology specifications developed
- M&V site visits and plan

2018 Q3 Plan:

- Technology procurement and installation schedule
- Technology installations
- Pre-retrofit baselining completed

2018 Q4 Plan:

- Completion of technology installation
- Begin post-retrofit savings assessment

Year 2 & 3 Plan:

- Project Evaluation
- Market Transformation

Thank You

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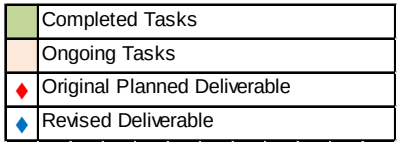
REFERENCE SLIDES

Project Budget

Project Budget: Federal : $ 699,826 ; Cost Share: 709,000
Variances: NA
Cost to Date: Federal 9.5%; Cost Share 2.8%
Additional Funding: NA

FY 2018 (current)		FY 2019 – FY 2020 (planned)	
DOE	Cost-share	DOE	Cost-share
$ 161, 984	$ 165,000	$ 537,842	$ 544,000

Project Plan and Schedule



Major Task Schedule		Budget Period 1											Budget Period 2												Budget Period 3											
Phase	**SOPOTask #**	Oct-17	Nov-17	Dec-17	Jan-18	Feb-18	Mar-18	Apr-18	May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19	Feb-19	Mar-19	Apr-19	May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20	Feb-20	Mar-20	Apr-20	May-20	Jun-20	Jul-20	Aug-20
1. Project Selection	1.1: Project Team Planning Meeting			♦																															
	1.2 Site Selection Critiera, Site Visits and Data Collection							♦																											
	1.3 Site Assessment and Selection							♦				♦																							
2. Project Design	2.1 Identifiy Technology Packages								♦			♦																							
	2.2 Savings Analysis of Proposed Packages										♦	♦																							
	2.3 Technology Procurement and Installation Schedule											♦																							
	2.4 ISOP Tecnology Procurement											♦	♦																						
	2.5 Development of a Draft M&V Plan											♦																							
3A. Field Demonstration Initiation	3.1A Field Demonstration Initiation												♦																						
	3.2A Building Commissioning Plan												♦																						
	3.3 A Performance Measurement Plan											♦																							
3B. Field Demonstration Completation	3 B Field Demonstration Completion																♦			♦			♦												
4. Performance Analysis	4.1 A Begin Continuous Performance Measurement																♦			♦			♦												
	4.2 Annual Site Performance Measurement																							♦											
	4.3 Comprehensive Technology Package Impact Analysis																									♦									
																														♦					
5. Best Practices Guide and Program Development	5.1 Final Verification Report																														♦				
	5.2 Best Practices Guide																																♦		
	5.3 Package Roadmaps																																♦		
	5.4 Utility Program Design																																		♦