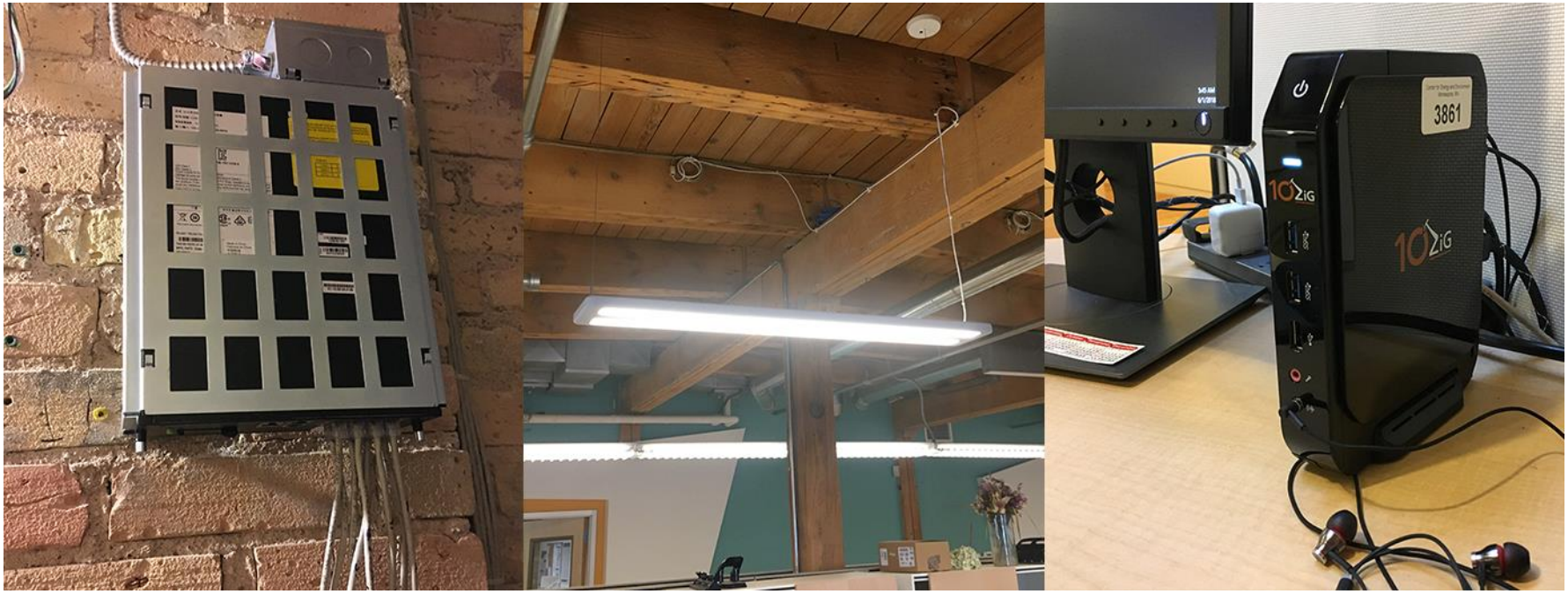
U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

DE-EE0008191: Using Network Switches to Operate and Control Lighting and Plug Loads in Commercial Building Office Spaces



Center for Energy and Environment / Wold Architects and Engineers / LHB / Xcel Energy

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Project Summary - DE-EE0008191

Timeline:

Start date: 10/1/2017

Planned end date: 9/30/2020

Key Milestones

1. IT Survey Report submitted, approved, and published; 6/2018
2. Office site recruited, built-out, monitoring begun; 9/2018
3. School site recruited, built-out, monitoring begun; 3/2019

Budget:

Total Project $ to Date:

- DOE: $95,556
- Cost Share: $96,131

Total Project $:

- DOE: $260,580
- Cost Share: $262,180

Key Partners:

Wold Architects & Engineers
LHB
Xcel Energy
NREL (M&V)

Project Outcome:

This project will demonstrate the energy efficiency opportunities of Power over Ethernet (PoE) technologies at four or more sites. IT network switches will be employed to power and control multiple building systems such as lighting, plug loads, and heating, ventilation, and air-conditioning (HVAC). Technical and market barriers, energy management opportunities, and utility program incentives will also be examined.

Team:

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Challenge

1. The commercial sector consumes 37% of the total US electricity use and lighting, computers, office equipment, and HVAC comprise 43% of the commercial sector electricity use.
2. PoE devices are already ubiquitous in the commercial sector in the form of phones, Wi-Fi access points, and security cameras.

	PoE	PoE+	UPoE	PoE++
Launched	2000	2008	2011	2018
Max power	15.4W	30W	60W	90W
Avail power	12.95W	25.50W	51W	71.3W

3. With increasing power capabilities, more and more devices such as LED lights, computers, and HVAC controllers are available as PoE systems.
4. Savings potential (100%adoption): LED lighting/controls - 750 TBtu/yr; plug load control - 28% savings; occupancy-based control of VAVs – 18% savings.
5. Beyond manufacturers' claims, their energy benefits and the ramifications to building systems and operations still need to be understood.

Challenge

1. How do these technologies perform in different use cases?
2. What energy and non-energy benefits do they provide?
3. What are the operational and maintenance requirements and what is the impact on building staff?
4. How can PoE systems be integrated with other building systems?
5. What are the barriers and limitations to adoption?
6. What program incentives exist or could be adopted?

Approach

- Demonstrate and evaluate the operation of PoE technologies at four or more sites, with two sites in Budget Period One and two or more sites in Budget Period 2.
- Work with NREL as the third party evaluator to compare the performance of the PoE technologies against current technologies and practices.
- Work with site staff to document O&M practices and needs.



Impact

Competitive Advantages:

- Low-voltage DC allows installation cost savings and device location flexibility.
- Power and data over the same cable connection permits individual network control.
- Sensors can be integrated within devices and systems.
- Open software allows communication with other building systems.
- Port level power monitoring is provided by the network management software (submetering).

Impact

1. Field evaluation of a number of PoE use cases (e.g., lighting, plug loads, and HVAC.)
2. Assessment of O&M requirements for PoE adoption - Information Technology (IT) vs. Operations Technology (OT).
3. Demonstration of the integration of PoE systems with other building systems.
4. Demonstration of a low voltage DC distribution system in commercial buildings.
5. Exploration of a roadmap for on-going development and adoption of Intelligent Building systems.

Progress

Task	Task Name	Budget Period 1																	
		1			2			3			4			5			6		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1.0	Technology and Program Development Overview																		
2.0	Field demonstrations																		
3.0	Site Instrumentation and Baselining																		
	Decision Point																G/NG		
4.0	Field demonstration																		
5.0	Site Monitoring & Savings Analysis																		
6.0	Final Reporting																		

1. Published IT Survey
2. Published Technical Overview
3. Recruited, Instrumented, and Monitoring Office Site with PoE Lights, Thin Clients, and All-in-One Computer
4. Recruited, Instrumented, and Monitoring School District Sites with PoE Lights and Thin Client (Classroom and Administrative Office)

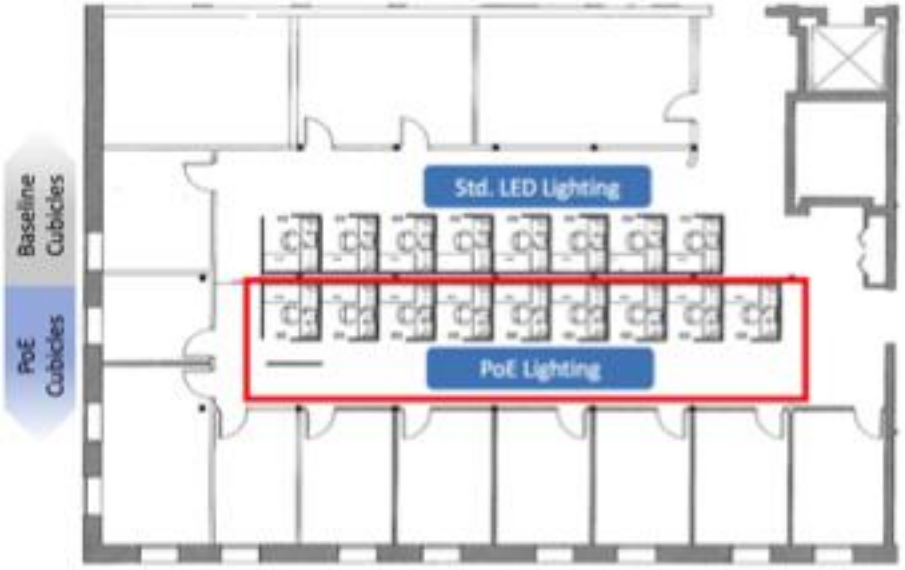
Progress

Key Outcomes

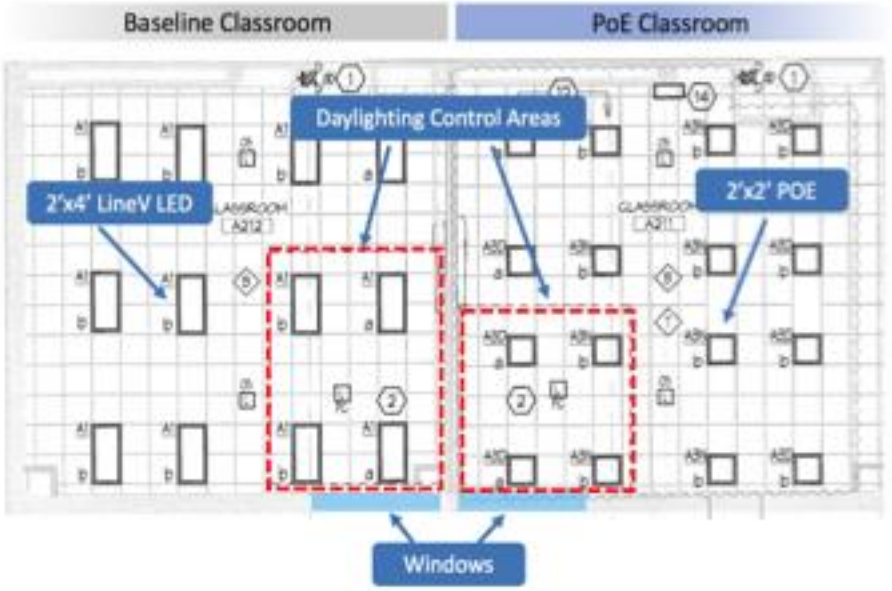
- The PoE lights are a form of network controlled lighting with individual control capable for each light.
- Network switch management software allows power monitoring of each port (and therefore each connected device).
- Each network connected device remains on standby when off. Standby power load also includes the network switch.

Progress

Center for Energy & Environment



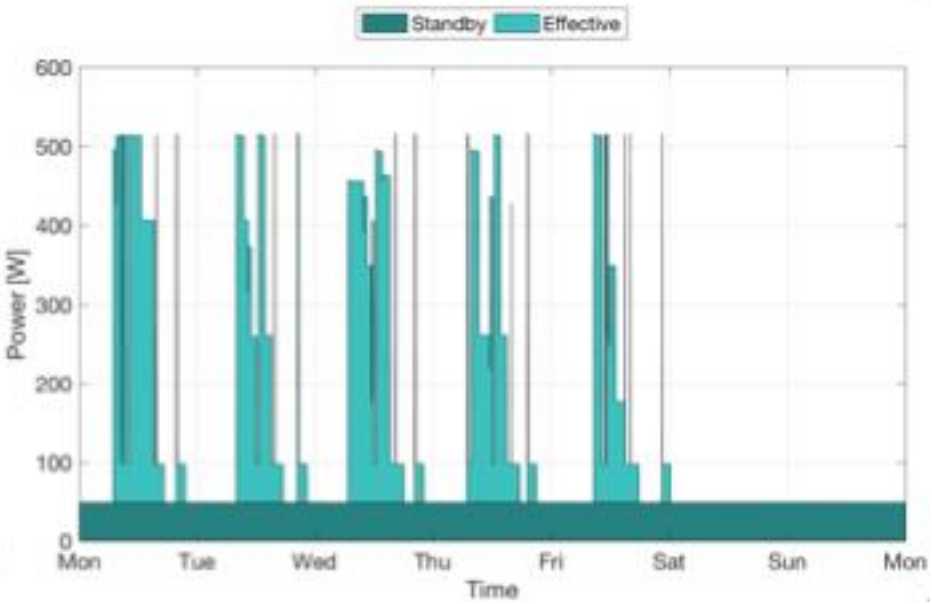
Edina Public School



Progress – Preliminary Results

PoE vs. Line Voltage

Standby Power for PoE

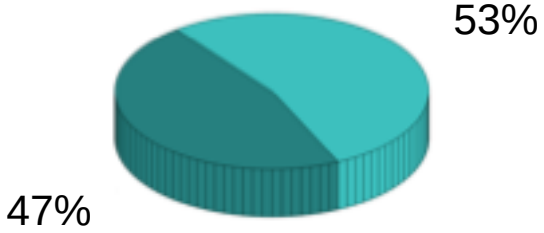


Standby Power

PoE = 49 W vs LineV = 3 W

15W + 33 W + 1W = 49W

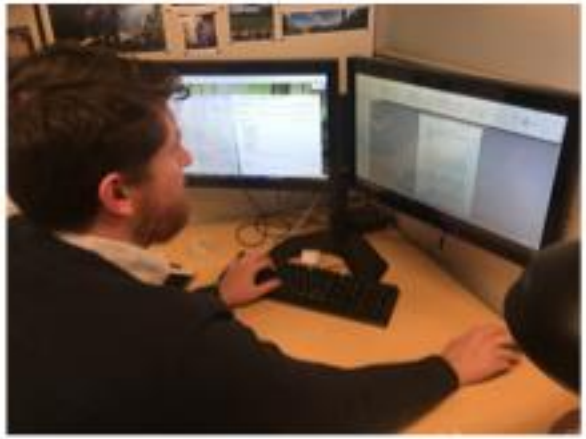
Network Switch | 8 Nodes (3W-5W) | Sensor



Progress

Key Outcomes

- Network controls add a level of complexity that requires dedicated staff time for maintaining the system (e.g., firmware updates).
- PoE thin clients and computers are a seamless conversion but PoE monitors would be a useful addition with the thin clients.
- Networked PoE features may not be justified in some applications (like common areas such as classrooms).



Stakeholder Engagement

1. **Technical Advisory Group** – DOE, NREL, LBNL, GSA, MN DER, Xcel, GRE, Cisco, CBRE, EMerge Alliance
2. **Stakeholder Survey** – 46 responses
    1. IT Staff - 16
    2. Facilities – 13
    3. Building Owner/Property Mgr - 3
3. **Manufacturers**
    1. Lights – Philips, Cree, Igor, NuLEDs, GENISYS
    2. Computers – 10Zig, Thin Labs
    3. HVAC – Delta Controls, LG
4. **Associations**
    1. Building Intelligence Group - Twin Cities (BIG-TC)
    2. Cresa PoE Advisory Board

Remaining Project Work

Task	Task Name	Budget Period 2																
		7			8			9			10			11			12		
		19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
1.0	Technology and Program Development Overview																		
2.0	Field demonstrations																		
3.0	Site Instrumentation and Baselining																		
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4.0	Field demonstration																		
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6.0	Final Reporting																		

1. Continue monitoring and analysis of initial two sites.
2. Demonstrate and evaluate the operation of PoE technologies at two or more additional sites.
3. Investigate system integration of PoE technologies with building operations at additional sites, where possible.

Remaining Project Work

Future work:

1. Continued assessment of PoE technologies and building system integration.
2. Deployment of PoE with Intelligent Building approaches.
3. Integration with DC generation/battery storage.
4. Demonstration of DC-powered building.

Thank You

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REFERENCE SLIDES

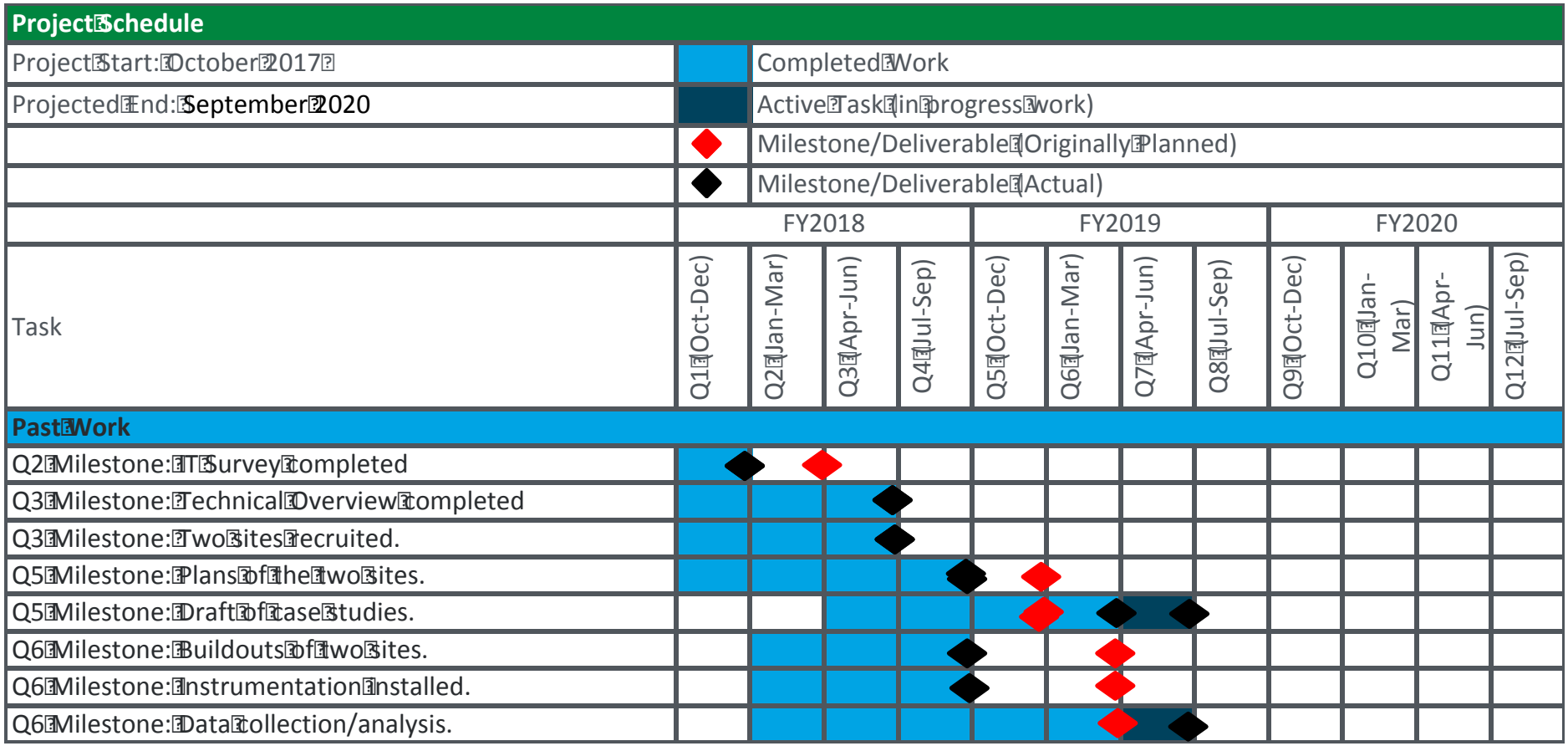
Project Budget

Project Budget: **$522,760** (DOE: $260,580, Cost Share: $262,180)
Variances:
Cost to Date: **$191,687** (DOE: $95,556, Cost Share: $96,131)
Additional Funding: **$104,975** as part of cast share from the Minnesota Department of Commerce Division of Energy Resources Conservation and Applied Research and Development Program

Budget History					
FY 2018 (past)		FY 2019 (current)		FY 2020 – 9/30/2020 (planned)	
DOE	Cost-share	DOE	Cost-share	DOE	Cost-share
$59,898	$59,946	$100,341	$101,117	$100,341	$101,117

Project Plan and Schedule

- Three year project that started Oct 2017 & planned to be completed Sep 2020.
- IT Survey and Technical Overview complete.
- Recruitment and build outs at two sites completed and data being collected.
- Data analysis underway and case studies being written,
- First go/no-go decision point: one site completed, one site underway by Mar 2019.



Project Plan and Schedule

- Budget Period 2 starts Apr 2019 & project end date Sep 2020
- Complete two demonstration sites in Minnesota & possibility of other sites.
- Utility Rollout Plan originally scheduled for BP1, extended to BP2 in order to account for project results and recommendations.
- Final report and webinar to be completed by Sep 2020.

Project Schedule

Project Start: October 2017
Projected End: September 2020

Completed Work
Active Task (in progress work)
Milestone/Deliverable (Actual)

Task	FY2018 Q1 (Oct-Dec)	FY2018 Q2 (Jan-Mar)	FY2018 Q3 (Apr-Jun)	FY2018 Q4 (Jul-Sep)	FY2019 Q5 (Oct-Dec)	FY2019 Q6 (Jan-Mar)	FY2019 Q7 (Apr-Jun)	FY2019 Q8 (Jul-Sep)	FY2020 Q9 (Oct-Dec)	FY2020 Q10 (Jan-Mar)	FY2020 Q11 (Apr-Jun)	FY2020 Q12 (Jul-Sep)
Current/Future Work												
Q7 Milestone: Two or more sites recruited..							◆					
Q9 Milestone: Plans of the two+ sites.									◆			
Q9 Milestone: Draft of case studies.									◆			
Q10 Milestone: Buildouts of two+ sites.										◆		
Q10 Milestone: Report and Rollout Plan.										◆		
Q10 Milestone: Instrumentation installed.										◆		
Q11 Milestone: Data collection/analysis.											◆	
Q11 Milestone: Instrumentation removed.											◆	
Q12 Milestone: Final Report/webinar.												◆

Progress

Go / No Go	Actual Accomplishment
Published survey of IT technicians and staff to understand interest and ability from this workforce to	The survey was performed and completed with the report of the results posted on the CEE website:https://www.mncee.org/resources/projects/power-over-ethernet.
Documented commitments from two demonstration sites	Both sites have signed Participation Agreement forms and fully executed AMAs.
Design and construction plans are completed and permitted at two sites.	• The design and construction plans were completed for both sites. • The CEE office remodel did not require a building permit. • The necessary permits were obtained for the building construction work at the Edina Public Middle School.
1. One buildout will be complete 2. Second site buildout underway	1. CEE office remodel with PoE LED lighting completed in the Spring of 2018. 2. The Edina classroom construction was completed during the summer of 2018 with the classrooms ready for the beginning

Preliminary Results - Office

Lights:

	2x4 T8	2x4 LED (AC)	2x4 LED (PoE)
Load per fixture (W)	58	26	25
Load per cubicle (W)	94	42	45
Savings per fixture	56%	2%	
Savings per Cubicle	73%	40%	

Thin Clients:

	HP AC	10zig AC	10zig PoE
Average Load (W)	10.9	6.0	3.3
Average savings	70%	45%	