2024 PROJECT PEER REVIEW

U.S. DEPARTMENT OF ENERGY
BUILDING TECHNOLOGIES OFFICE

BTO Peer Review:

South El Monte Autonomous Controls Retrofit

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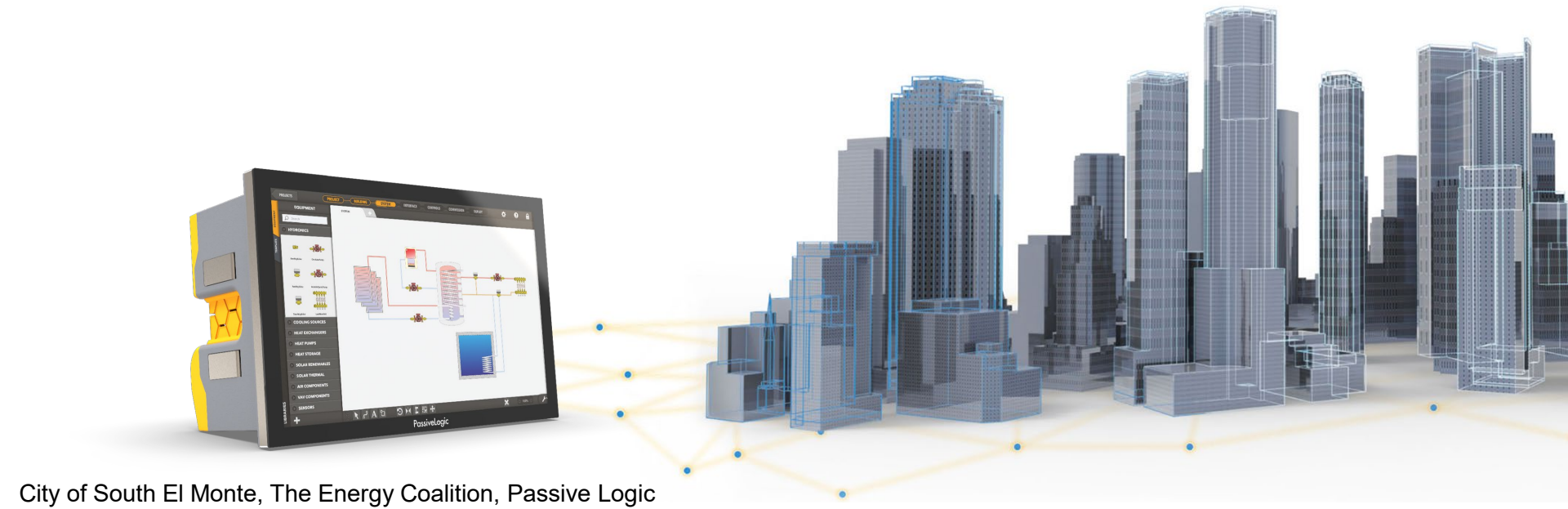

City of South El Monte, The Energy Coalition, Passive Logic
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Award# DE-EE0009466

Project Summary

OBJECTIVE, OUTCOME, & IMPACT

- Demonstrate autonomous building controls and digit twin model function for 3 host buildings
- Develop recommendations to scale this technology
- Leveraging CA ratepayer funds and programs to accelerate deployment of technology

TEAM & PARTNERS

- City of South El Monte (Building Owner/Operator)
- Passive Logic (Technology Innovator)
- The Energy Coalition (Facilitator)

STATS

Performance Period: 07/2021 through 06/2026

DOE Budget: $747,494, Cost Share: $1,010,482

Milestone 1: Installation of equipment and control devices

Milestone 2: Measurement & verification analysis

Milestone 3: Findings Report and Dissemination Plan

Problem

Successful implementation of high-performance control has been shown to reduce HVAC energy use in commercial buildings by 30%. Nationwide deployment would correspond to an absolute reduction of >3% of total U.S. energy consumption.
- United State Department of Energy EERE Website

The Challenge:

- **Control is Hard**: Small labor pool for design/install/programming of controls
- **High-Performance Control is Harder**: Only a subset of that pool can do high performance
- **Control is Expensive**: Today controls are reserved for big budget buildings
- **Control Doesn't Scale**: Today controls are reserved for large buildings

Autonomous Model-Based Control as a Solution:

- **Simplified (Programming Free) Workflow**: Draw your system, get controls, reduce labor by 90%
- **Autonomous Controls:** High performance, self-commissioning, flexib and edge based
- **Scalable Pricing:** Enables scaling down opening up new market segments

Alignment and Impact

Project Goals, Deliverables and Impact

Project Goals and Deliverables

- **Deliverable to South El Monte:** 30% Savings on energy cost
  - Autonomous Controls
  - Replacement of gas-fired RTUs with high efficiency heat pump RTUs
  - LED Lighting Retrofit
- **Deliverable to DOE:** Findings Summary and Recommendations for Replication
  - M&V to validate savings
  - Develop recommendations on scaling to other public agencies
  - Develop strategies to utilize public agency ratepayer programs

Impact for South El Monte

- Reduced operational costs
- Increased capital for community investment
- Highlight South El Monte as model for energy efficient municipalities

Alignment and Impact

National Climate Goal Alignment

Greenhouse Gas Emission Reduction	**Increased Building Efficiency** ❑ High Performance Controls ❑ Continuous commissioning and FDD ❑ Heat pumps and LEDs
Power System Decarbonization	**Grid Flexibility via Demand Response and Communication** ❑ Demand response ❑ HVAC controls as edge compute/integration platform ❑ Predictive controls allow for power generation planning ❑ Enabling buildings as batteries
Energy Justice	**Democratization of controls** ❑ Enabling broader pool of installers ❑ Scaling to small projects and small budgets

Alignment and Impact

Blueprint Alignment

Increase Building Energy Efficiency	❑ High-performance controls ❑ Continuous commissioning and FDD ❑ Heat pumps and LEDs
Accelerate Onsite Emissions Reduction	❑ Converting Gas to Heat Pumps
Transform Grid Edge at Buildings	❑ Enabling grid interactive buildings ❑ HVAC controls as edge compute/integration platform
Minimize Lifecycle Emissions	❑ LED Longevity (compared to incandescent or fluorescent)
Prioritize Equity	❑ Eliminate technical and capital barrier to entry for controls contractors (Democratization of controls)
Prioritize Affordability	❑ Scalable pricing model
Prioritize Resilience	❑ HVAC controls as edge compute/integration platform

Approach

Project Approach

Monitoring

- Power monitoring
- Environmental monitoring
- 6-month minimum baselining period

Building Retrofit

- Lighting retrofit (LEDs, occupancy monitoring, daylight sensors)
- HVAC retrofit
  - **Original Scope**: Like-for-like replacement of 9 of the gas-fired RTUs
  - **Updated Scope**: replace 100% of gas-fired RTUs with heat pumps (additional cost covered by City)
- **Additional Scope**: Heat pump water heaters (additional cost covered grant through SoCalREN)
- 6-month minimum re-baselining period with new equipment (before controls enabled)

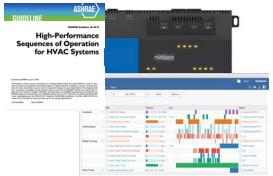
Autonomous Controls Installation and Commissioning

Measurement & Verification and Reporting

Replication, Dissemination and Ratepayer Program Assessment

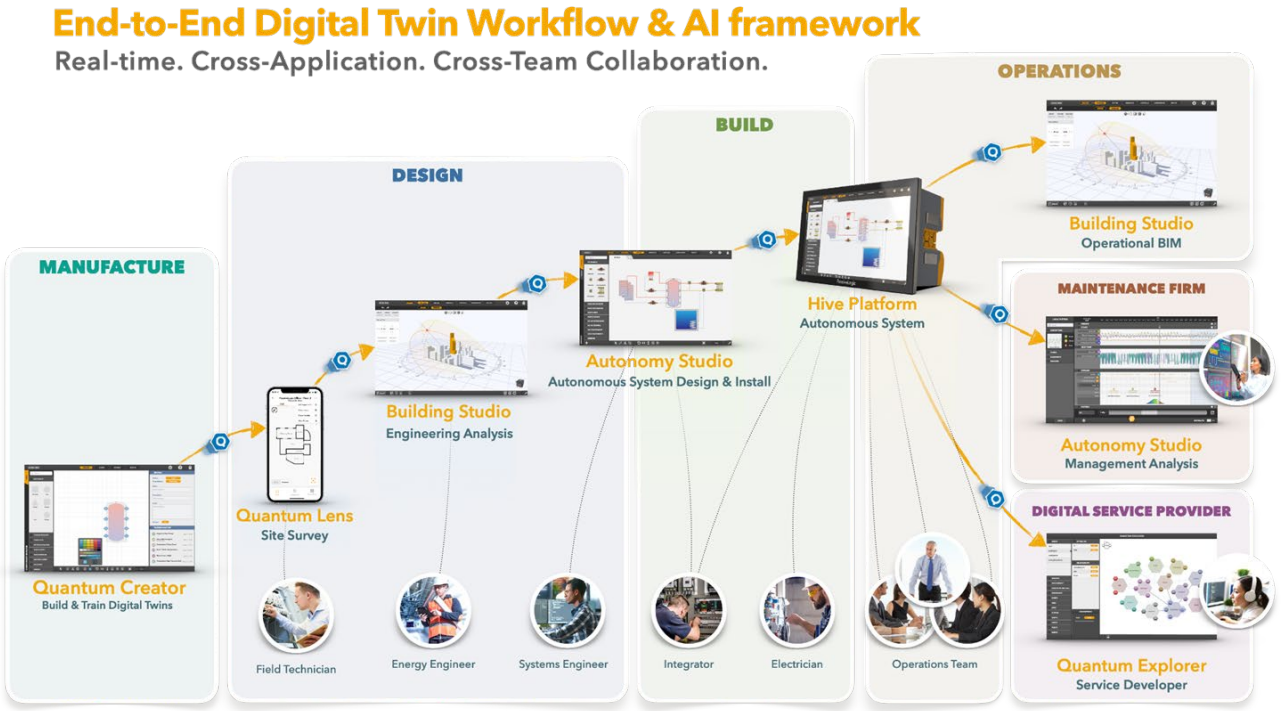
Approach:

Current State of Building Controls

	Thermostat	Web Enabled Thermostat	Configurable Controllers	Building Automation System	High Performance BAS
					
Affordability	✓	✓	!	!	✗
Scalability	✓	✓	✓	✗	✗
Ease of Install	✓	✓	!	✗	✗
Meets DOE Goals	✗	✗	✗	!	✓/!

Approach

PassiveLogic and Autonomous Control



- Integrated workflow
- Code free tooling
- Model based control
- Continuous model tuning
- Continuous Cx / FDD
- Operational BIM

Affordability	✓
Scalability	✓
Ease of Install	✓
DOE Goals	✓

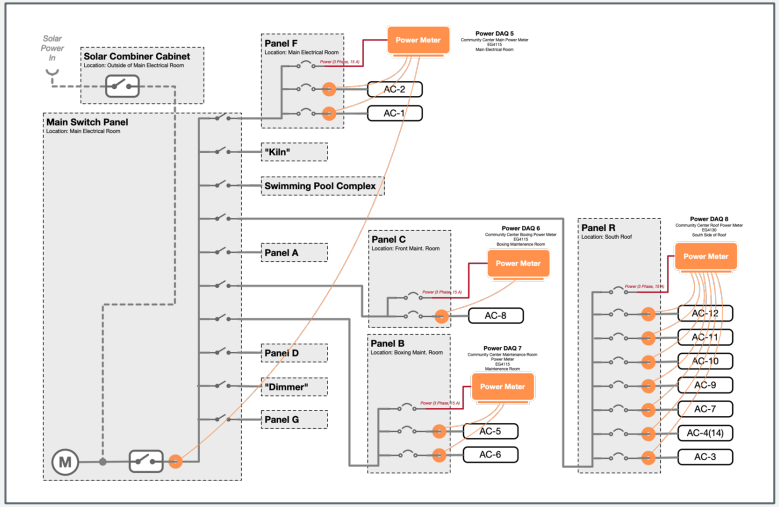
Approach

Power / Energy Reduction Validation

- Monitoring building main power (after solar) and each RTU at each building via eGauge4015 and eGauge4030
- Connected via web API and stored in Cloud DB
- Establishing 3 power profiles
  a. Before Lighting/HVAC Retrofit (~2 years)
  b. After Lighting/HVAC Retrofit (≤6 months)
  c. After PassiveLogic Installation (≤6 months)
- Energy savings at each step will be validated via weather normalized energy analysis using power meter data.

Power Metering Design & Visualization

Community Center



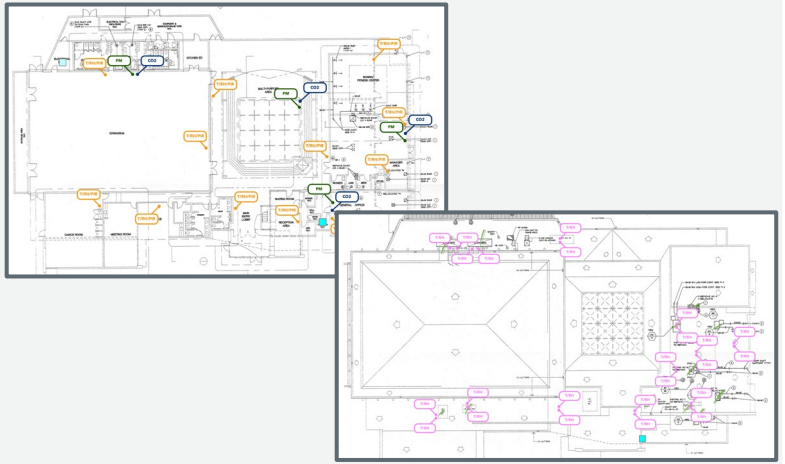
Approach

Comfort / Environmental Validation

- 102 sensors are gathering 232 metrics across the 3 buildings
- HVAC Monitoring:
  a. RTU Supply Air Temperature and RH
  b. RTU Return Air Temperature and RH
- Indoor Monitoring:
  a. Temperature
  b. Relative Humidity (RH)
  c. CO_2
  d. PM
  e. Occupancy
- Monnit Battery Power 900MHz Solution Selected
- Connected via web API and stored in Cloud DB
- This data will be used to analyze comfort before and after the updates.

Sensor Design & Visualization

Community Center



Progress

Project Overview

1	Finalize Design	DONE
2	Equipment Procurement	DONE
3	System Installation	In Progress
4	Commissioning	In Progress
5	Launch Digital Twin Model Control Strategies	On Track*
6	Measurement & Verification	On Track*
7	Perform Analysis	On Track*
8	Dissemination Plan	On Track*

**On Track means that we are meeting the newly established timelines based on approved project extensions*

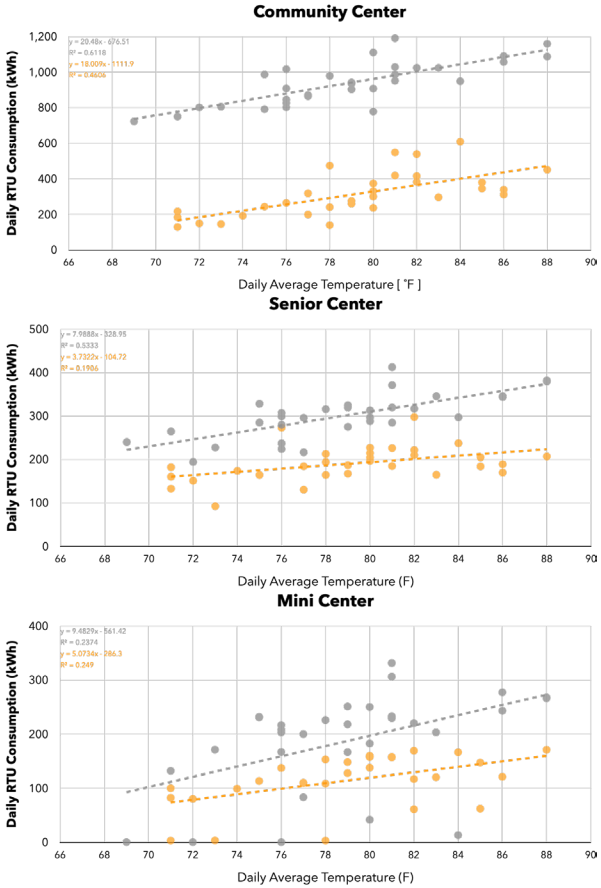
Progress

HVAC/Lighting Accomplishments, Milestones and Findings

- As of June 2024 HVAC and lighting upgrade EEMs are **COMPLETE**
  a. 26 Gas fired RTUs (~170 tons total nominal capacity) removed
  b. Replaced with high efficiency heat pumps

- Change in HVAC energy usage (PRELIMINARY):
  a. Community Center: **-68.3% (?!?) - ONLY 1 MONTH OF DATA - VERIFYING**
  b. Senior Center **-36.7%**
  c. Mini Center: **-29.6%**
  d. Project: **-56.3%**
- Discussion
  a. Lighting upgrade is not visible in power data (likely due to changes in occupancy)
  b. HVAC Improvement is great!
  c. Too great…
  d. Energy decrease has **NOT** been corroborated with billing.
  e. Energy decrease has **NOT** been aligned with occupancy/usage
  f. Savings are in the right direction, but more analysis is needed

Weather Normalized
Average Daily Electrical Usage
Pre / Post HVAC Upgrade



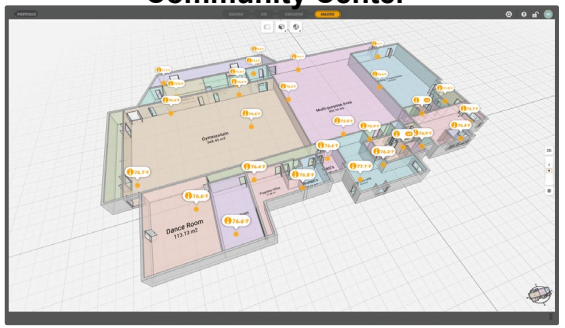
Analysis Period:
Pre Upgrade = Aug 2023
Post Upgrade = Aug 2024

Progress

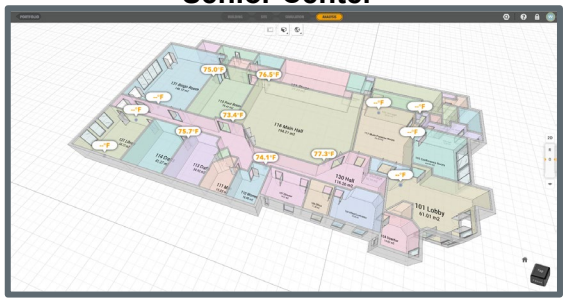
Controls Installs Accomplishments and Milestones

- PassiveLogic Controls installation is **IN PROGRESS**
- As of October 2024:
  - Electrical subcontractor has completed all wiring
  - Hives (PassiveLogic controllers) have been installed in all 3 buildings
  - Sense Nanos (PassiveLogic sensors) have been installed in all 3 buildings
- Digital twins have been created for all buildings
- Data is being gathered for digital twin tuning

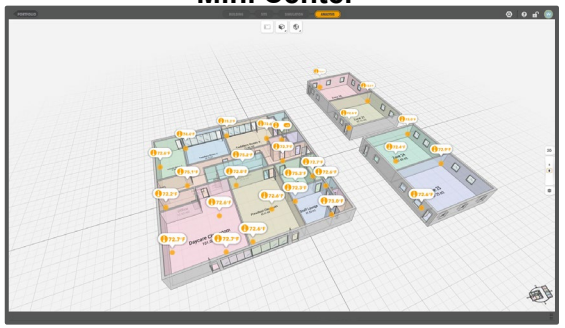
Community Center



Senior Center



Mini Center



Progress

Issues, Lessons and Solutions

Issue	Lesson Learned	Solution
Long Lead Times	❑ Avoid pandemics…	❑ Applied for project extension
Inflation	❑ DOE Budget is fixed	❑ City budget flexibility
Scope Increase	❑ DOE Budget is fixed ❑ Scope creep is a thing… and sometimes that's OK… sometimes	❑ City budget flexibility ❑ Ratepay programs (SoCalREN)
Personnel Turnover	❑ The project is the people ❑ Progress/momentum can be lost with people	❑ Increased meeting frequency to get back on track ❑ Get the right people in the right places
Technology Development Delays	❑ Product development is hard	❑ PassiveLogic self installing ❑ Using a RS-485/IP Router ❑ Considering reducing scope

Future Work

Project Execution

- **Controls Finalization**
  - Complete wiring and installation
  - Connect to RTUs via BACnet for monitoring
  - Take over control of RTUs via BACnet (after the re-baselining period has ended)

- **Measurement, Verification and Reporting**
  - Continue gathering data through post-controls-retrofit period
  - Analyze data and calculate savings
  - Report on above

- **PassiveLogic Commercialization Plan** (More on this on reference slide if desired)
  - Soft Roll Out - REIT Partnerships / Self Installing
  - Technology Partnerships - Select US MSIs
  - General Release - North America VARs and MSI

- **Public Agency Scaling and Ratepayer Programs** (More on this on future slides)

Future Work

Public Agency Scaling and Ratepayer Programs

- **Public Agency Scaling:**
  - Leverage the California Technical Forum (CalTF)
  - Active participation in CalTF to refine and align methodologies with statewide protocols.
  - Utilize CalTF to ensure the consistency and accuracy of energy savings estimates for control measures.
  - Engage in CalTF discussions to support the scalability of energy efficiency measures (EEMs) across public agencies.

- **Utilizing Ratepayer Programs**
  - Integrate the approach into ratepayer-funded initiatives to scale EE efforts.
  - Example: SoCal Regional Energy Network (SoCalREN) Public Sector Programs.
    - SoCalREN helps small commercial buildings in public agencies implement EEMs through tailored solutions and technical assistance.

Thank you

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The Energy Coalition
Passive Logic

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PassiveLogic®

the Energy Coalition

Reference Slides

Project Execution

Federal Fiscal Year	FY2021		FY2022			FY2023				FY2024				FY2025				FY2026			
Federal Quarter	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Total
Project Budget Period	Budget Period 1													Budget Period 2				Budget Period 3			
Project Quarter	Q1	Q2	Q3	Q4						Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12				
Planned Federal Budget	$487,396									$156,998				$103,100							$747,494
Planned Cost Share	$242,381									$84,327				$77,942							$404,650
Planned Total	$729,777									$241,325				$181,042							$1,152,144
Actual Federal Budget	$654,969									$85,343				$7,182							$747,494
Actual Cost Share	$832,766									$99,228				$78,488							$1,010,482
Actual Total	$1,487,735									$184,571				$85,670							$1,757,976

Past Work

		Project Quarter	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20
1.1.1	Update EEMs	Start Date of Quarter	Jul 2021	Oct 2021	Jan 2022	Apr 2022	Jul 2022	Oct 2022	Jan 2023	Apr 2023	Jul 2023	Oct 2023	Jan 2024	Apr 2024	Jul 2024	Oct 2024	Jan 2025	Apr 2025	Jul 2025	Oct 2025	Jan 2026	Apr 2026
1.2.1	Develop Survey																					
1.2.2	Receive Survey Responses																					
1.3.1	Draft Project Deisgn																					
1.3.2	Finalize Project Design																					
1.4.1	Create M&V Plan																					
1.5.1	Install DAQ System																					
2.1	Release RFP																					
2.2	Procurement Complete																					
3.1	Complete Installation																					
3.1.1	Contractor Selected																					
3.2.1	Update DAQ System																					

Current / Future Work

4.1	Commission System																					
4.2	EEM Installation Inspection																					
4.3	Hive Commissioning Assistance																					
5.1	Launch Autonomous Control																					
6.1	Digital Twin Calibration																					
6.1.1	M&V Check 1																					
6.1.2	M&V Check 2																					
6.1.3	M&V Check 3																					
7.1	M&V Complete																					
7.1.1	Savings Calculations																					
7.1.2	Final Report Submitted																					
8.1	Publish Paper																					

COVID disruptions, personnel turnover and inflation cost increases caused major early delays

Go/No Go 1

Go/No Go 2

◆ Actual Date
◆ Original Date

Team

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Project Manager

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Administration
Oversight