2024 PROJECT PEER REVIEW

U.S. DEPARTMENT OF ENERGY
BUILDING TECHNOLOGIES OFFICE

See the Savings:

An Advanced Windows, Lighting, Lighting & HVAC Controls Demonstration

Coupling shell and lighting EEMs to maximize cost effectiveness

City-County Building
Madison, Dane County, Wisconsin

See the Savings

slipstream

Pacific Northwest NATIONAL LABORATORY

Dane County, Wisconsin
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FOA # 0002324; Award # DE-EE0009465

Project Summary

OBJECTIVE, OUTCOME, & IMPACT

-Leverage LED lighting & controls upgrade to reduce costs of upgrading roughly 1/3 of facade to triple pane windows in a 70-year old public building.
-Develop new window & lighting control standards for other County and City projects.
-Achieve 10% HVAC savings; 60% lighting savings and 20% peak demand savings in upgraded spaces.

TEAM & PARTNERS

Project Lead: Dane County

- Public Works: *Design & construction management*
- Facilities Management: *BAS integration (with IT), site coordination*
- Energy & Climate Change: *Overall grant management*

Partners:

- City of Madison: *tenant in 40% of facility; integrated lighting and controls into in-suite remodeling*
- Slipstream and PNNL: *M&V*

STATS

Performance Period: 6/2021- 6/2026

DOE Budget: $982k, Cost Share: $2,098k

Milestone 1: Pre-Upgrade M&V and Initial Design

Milestone 2: Final Design & Installation thru 2024

Milestone 3: Post-Upgrade M&V begins 2025

Problem

Average public building is 68 years old with no plans to retire

- Nationally, average age of municipal buildings is 68 years
- Building envelopes drive HVAC expenditures and impact occupant comfort. Window upgrades have 20 year paybacks, so it's hard to justify and often upgrades do not qualify for energy efficiency program incentives
- Additional barriers to action include risk/cost to remediate negative environmental conditions and hazardous construction materials (asbestos, lead, etc.)
- Plus complex internal and external coordination (County leasing space to City government)
- Easiest course of action is inaction
- Packaged solutions could unlock energy savings in Public Assembly, Office, Education, and Healthcare sectors – total potential more than 400 TBtu/year

Alignment & Impact

US-Dane County Climate Goal Alignment

	Reduce greenhouse gas emissions	Power system decarbonization	Energy Justice
US Climate Goals	✓ 50–52% reduction by 2030 vs. 2005 levels ✓ Net zero by 2050	✓ 100% carbon pollution-free electricity by 2035	✓ 40% of benefits from federal climate and clean energy investments flow to disadvantaged communities
Dane County Goals and Achievements	✓ Internal emissions down 60% between 2020-2023 ✓ 2030 goal: facilities-fleet-land operations are carbon neutral	✓ 100% renewable electricity (via local utility partnerships) in 2023	✓ Prioritize equity in all projects

Project Alignment & Impact

Blueprint Alignment

Blueprint Priorities	Increase building energy efficiency	Accelerate onsite emissions reductions	Transform the grid edge at buildings	Minimize building life cycle emissions
Dane County's Project	✓ Cost effective energy efficiency upgrades ✓ Action on long-delayed shell measures	Minimal onsite emissions - mostly district steam and electricity	✓ Connected lighting creates expanded GEB capabilities	✓ Long lifetime fixtures ✓ Upgrades lengthen life of existing building

Alignment & Impact

Impact

BTO funding was an impetus to action

- City and County worked together with Slipstream on proposal
  - Opportunity to think about multiple measures, interactive benefits
  - Funding provided a nudge to action and some timeline pressure
  - When costs increased, County and City committed more funding
- Case study/findings shared via local, national networks
  - Local governments, school districts, universities
  - Energy efficiency professionals
  - Private sector
  - Webinars, presentations, publications by Dane County & Slipstream

Approach

Shortfalls of Current Solutions

Windows matter but are rarely cost effective

- Difficult to justify as stand-alone measure, even when occupants complain about comfort issues
- Strong impetus to delay action

Not addressing drafty windows rationalizes other occupant inefficiencies

- Lack of resolution undermines broader efficiency efforts
  - Why should I turn off equipment when windows are so leaky?

Approach

Relevant sectors

Older public sector buildings

- Local governments
- School districts
- Universities, hospitals

Aging private sector facilities

- Office buildings

Approach

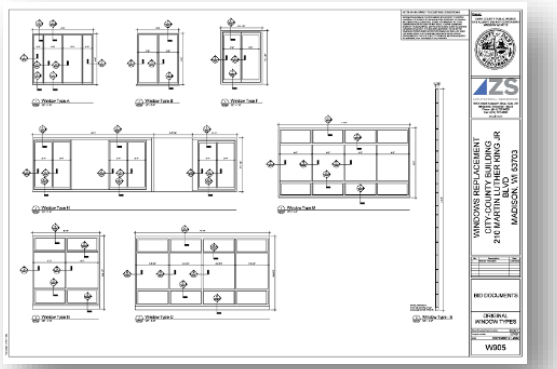
Novelty in Approach

Coupling windows with lighting and BAS controls

- Combined EEMs means windows are more cost effective
- It also increases project complexity

Tackling a portion of the building

- Demonstrate efficacy of replacements
- Makes enormous project a little less overwhelming



- Still, scale is significant – affects 16 departments
  - 174 windows in 7 different styles

Approach

Sharing Results

Via our networks

- Local governments and school districts in Wisconsin (Dane Co)
  - Sustainable Leaders Collaborative
  - Wisconsin Local Government Climate Coalition
- Energy efficiency professionals nationally (Slipstream)
- Wisconsin's Focus on Energy program (both)

More broadly

- At least one national webinar
- Present at national conferences (e.g. ACEEE Summer Study)
- Published case study

Progress and Future Work

Major Accomplishments

- ✓ Baseline data monitoring
- ✓ Baseline occupant surveys
- ✓ Windows and lighting/controls design
- Window installation ~ 90% complete as of October 2024
- Lighting and controls installation ~ 40% complete
- Post-installation M&V in 2025
- Final reporting, sharing 2026

Progress and Future Work

Future Work

Scaling this Solution

- A lot of unrealized potential savings
- Public facilities need financial & technical help
  - Support for EEMs with 10+ year paybacks
  - Nudge to address complicated upgrades
- Area for more DOE investment

Progress and Future Work

Lessons Learned

Choosing a Window Solution

- Initially open to multiple window solutions
- Team preferred thin-triple pane
- Reality shifted us to triple pane
  - Some windows too large for thin-triple; warranty concerns
  - Chose triple pane with equivalent performance metrics
    - Details at Slide #26

Progress and Future Work

Lessons Learned

	Federal	Dane Co	Total
Original Budget	$ 982k	$ 555k	$ 1,537k
Updated Budget	$ 982k	$1,818k	$ 2,800k

Project Momentum Prevails

- Anticipated budget challenges
  - Created alternate bids to maximize our ability to get as much as possible for budget available
- County leadership opted to fund all identified upgrades
  - Added $1.3M to budget from County and City
- Reflects momentum project generated
- Now more impetus to replace remaining windows

Progress and Future Work

Lessons Learned

Replacing Old Windows: Never Boring

- Installation critical; set specific installation parameters
  - Design team verified contractor performance
- Found unanticipated variations in original windows
  - Hollow spots where solid frame should be
  - Missing anchor points
  - Past water damage, plaster unstable (top)
  - Steel bars in way of installation (bottom)
- Requires real-time adjustments to installation protocol
  - Goal to maintain energy efficiency benefits
- *These are the surprises staff wondered about at the start*

Progress and Future Work

Lessons Learned

Lighting and Controls

- Required agreement on a control system between County and City
  - Met jointly with multiple vendors to identify a system that accommodated everyone's priorities
  - Site visits to other customer installations with similar challenges
- Integrate into County IT systems
  - Security concerns associated with any third-party system
  - City and County operate on separate data networks
- Consistent City and County systems likely to be beneficial for other joint controls projects in the future

Progress and Future Work

Lessons Learned

Thinking about M&V Process and Timing

- Typically we do projects and move on
  - M&V not part of local government projects
  - Might verify via ENERGY STAR Portfolio Manager
- This time, with BTO, pre- and post-M&V
  - Summer (June-August) and winter (December-February)
- So timing matters – have to capture summer/winter
  - Anxious about missing winter 2024-25 for post-M&V
  - Winters shorter, more erratic

Thank you

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Reference Slides

Include the following slides in the version you submit (excluded from your total slide count).

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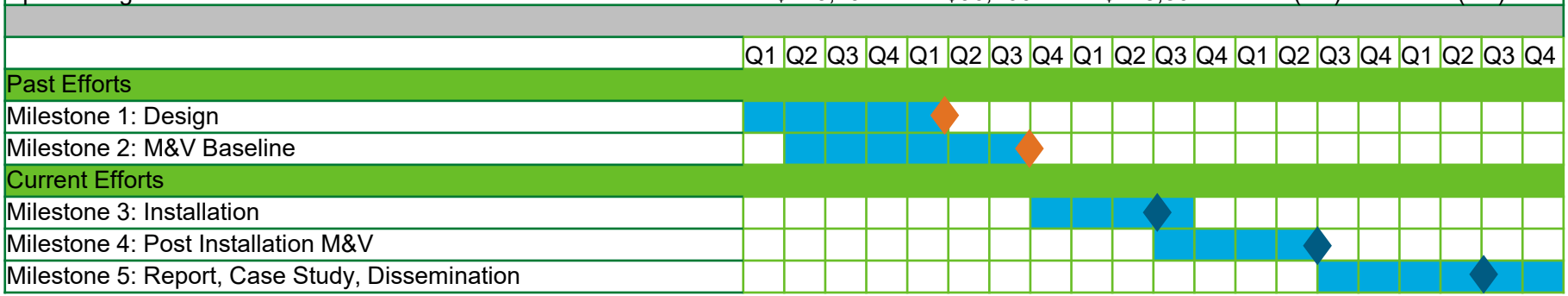
Project Execution

	June 2021-May 2022	June 2022 - May 2023	June 2023 - May 2024	June 2024 - May 2025	June 2025-May 2026
Planned Budget	$105,153	$ 1,371,060	$60,791		
Spent Budget	$173,791	$96,700	$775,801	$1,703,618 (est)	$50,000 (est)



- *Design process longer for project involving windows and lighting/controls*
- *High installation cost required additional County and City funding of $1.3M*

Team

Kathy Kuntz

Director

Dane Co Office of Energy & Climate Change

Amanda DePagter

Director

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Scott Carlson

Project Engineer

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Valora Gutierrez

Energy Specialist

Dane Co Office of Energy & Climate Change

Jon Evans

Building Design Project Manager

City of Madison

Scott Schuetter

Principle Engineer

Slipstream

Michael Myer

Researcher

PNNL

National Energy Savings Potential

- Estimated national energy savings is 416 TBtu/yr.
- Based on CBECS data at 100% penetration.

Estimated National Energy Savings (Tbtu/yr)					
Percent savings by end use	11%	11%	11%	69%	
Building Type	Heating	Cooling	Ventilation	Lighting	Total
Education	32.9	10.0	7.5	53.8	104.2
Health care	23.1	8.7	9.0	42.1	82.9
Office	33.6	13.0	23.5	102.1	172.2
Public assembly	20.8	9.5	2.6	24.2	57.1
Total	**110.4**	**41.2**	**42.6**	**222.2**	**416.4**

Window Specifications

DOE Recommended Performance Specs	Final Window Performance Specs
Glazing requirements at center of glass	
U-value – less than or equal to 0.13	0.12
Solar Heat Gain Coefficient – maximum 0.36	0.32
Visible Transmittance – minimum 0.57	0.52
Whole window requirements	
U-value – less than or equal to 0.19	0.19
Solar Heat Gain Coefficient – maximum 0.32	0.276
Condensation Resistance Factor – minimum 64	CRF of 68 frame and 80 glass
Visible Light Transmittance – minimum 0.46	0.44