Statement of Project Objectives
Dane County, Wisconsin
See the Savings: An Advanced Window-Lighting Controls Field Validation

A. Project Objectives

This project seeks field validation of cutting- edge, triple- paned window technology, packaged with more cost-effective lighting and advanced controls, as a cost-effective (at scale) retrofit solution in buildings. Specifically, Dane County and its partners (the Team) aims to achieve 10 percent heating, ventilation, and air-conditioning (HVAC) savings, 60 percent lighting savings, and 20 percent lighting demand response (DR) savings. Scaled to relevant buildings nationally, that could potentially save more than 480 trillion British thermal units (TBtu) in annual savings.

The project will:

- Validate using cutting edge triple paned windows, lighting and lighting controls in about 100,000 square feet (SF) of space in public building space.
- Leverage results from other projects to supplement the data collected from the retrofits described above.
- Model the energy savings of six building types across all U.S. climate zones to prove energy and demand savings potential in additional sectors and locations.
- Work with the local utility and Wisconsin's energy efficiency program to ensure that project results inform their ongoing efforts.
- Create a retrofit standard that will be used on future Team retrofit projects across our combined portfolio of more than 7,500,000 SF of space and that the Team will share with others.
- Disseminate the concept nationwide to drive deployment.

B. Technical Scope Summary

Budget Period 1

The Team will research and finalize the window and control technologies to be used and finalize the field data plan. At the same time, the Team will gather baseline data on current energy usage at the project site. Pre-retrofit measurement and verification (M&V) activities will include establishing a baseline for:

- HVAC electricity and natural gas consumption and demand spanning portions of the cooling and heating seasons
- HVAC building automation system (BAS) points such as space temperature, relative humidity and carbon dioxide levels
- Lighting electricity consumption and demand
- Window and adjacent wall temperatures
- Light level in retrofit spaces
- Occupant satisfaction surveys (thermal and visual comfort, controllability)

Budget Period 1 Go/No-Go Decision Point: At the end of the Budget Period (BP) all pre-retrofit data for both heating and cooling seasons will be collected and submitted for third party review.

Budget Period 2

The Team will oversee the installation of the retrofit package of windows, lighting and lighting controls in the City County Building in Madison, WI. The Team will continue monitoring the post-retrofit system performance.

Budget Period 2 Go/No-Go Decision Point: At the end of the BP window, lighting, and controls retrofit installation will be completed and commissioned. Additionally, all post-retrofit data for both heating and cooling seasons will be collected and submitted for third party review.

Budget Period 3

The team will perform measurement and verification (M&V) on the new installation in order to collect and compare post-installation data to the baseline data.

M&V activities will include:

- HVAC electricity and natural gas consumption and demand spanning portions of the cooling and heating seasons
- HVAC BAS points such as space temperature, relative humidity and carbon dioxide levels
- Lighting electricity consumption and demand
- Window and adjacent wall temperatures, as well as solar radiation
- Light level in retrofit spaces
- Occupant satisfaction surveys (thermal and visual comfort, controllability)
- Documentation of installation challenges and tenant disruption

Following the M&V activities, the Team will:

- Incorporate the technology package into Dane County and the City of Madison's retrofit standards.
- Share the retrofit standards with other entities.
- Model the retrofit package's energy savings and grid flexibility potential for six different building types at various climate zones using Department of Energy's (DOE's) prototype building models.
- Work with the local utility and Wisconsin's energy efficiency program to ensure that project results inform their ongoing efforts.
- Write a comprehensive technical report on the project.
- Host a webinar that showcases the project results.

C. Tasks To Be Performed

The following outlines how project milestones and goals will be accomplished.

Budget Period 1

Task 1. Retrofit Design

Subtask 1.1: Research Window Retrofit Options. The Team will research cutting edge window retrofits, focusing on thin triple pane varieties. The Team has already developed quotes for thin triple pane windows from Alpen.

Milestone 1.1: Define window specifications to be used in bid documents.

Subtask 1.2: Research Lighting Retrofit Options. The Team will research cutting edge lighting retrofits, focusing on light emitting diode (LED) products with advanced lighting controls. The Team already has experience with many LED light fixture manufacturers and product lines.

Milestone 1.2: Define lighting specifications to be used in bid documents.

Subtask 1.3. Design. The Team will work with designers to finalize the retrofit design, including windows, lighting (where applicable) and lighting controls. The Team will develop control and window specifications to be included in the bid documents.

Milestone 1.3: Complete window and lighting retrofit design. Submit key design documents to DOE.

Subtask 1.4. Bid. Use a competitive procurement process to solicit bids for equipment. Select contractor(s) and define project timeline.

Milestone 1.4: Selected contractor(s) and define retrofit timeline. Notify DOE of selected contractor(s).

Task 2. Pre-Retrofit Measurement and Verification

Subtask 2.1. Plan M&V and install M&V equipment. Based on the retrofit design, M&V Project Partner will prepare an M&V plan for the test site. Once finalized, the Team will procure necessary additional M&V instruments or recalibrate existing instruments. This will occur before M&V equipment setup and installation at the field test site. The Team will additionally confirm or set up trending of relevant BAS points. The measurements will cover the lighting power and HVAC equipment energy as well as comfort-related variables such as space temperature, carbon dioxide, relative humidity and light levels in the spaces.

Milestone 2.1: Create comprehensive M&V plan that is consistent with project goals. Submit to DOE National Lab partner for review.

Subtask 2.2. Pre-Retrofit Monitoring. The M&V Project Partner will monitor the site for six to nine months to determine energy performance, impact on the indoor environment and any other non-energy factors. This six to nine-month span will include portions of the cooling and heating seasons before the retrofit. The Team will administer pre-retrofit occupant and owner satisfaction surveys, for both continuous improvement and dissemination testimonials. The Team will target a minimum of 50% response rate of occupant surveys.

Milestone 2.2.1: Ensure that adequate cooling season pre-retrofit data is being collected. Data will be submitted to DOE National Lab partner for third party review.

Milestone 2.2.2: Ensure that adequate heating season pre-retrofit data is being collected. Data will be submitted to DOE National Lab partner for third party review.

Milestone 2.2.3: Administer pre-retrofit surveys. Data will be submitted to DOE National Lab partner for third party review

Budget Period 1 Go/No-Go Decision Point: At the end of the BP all pre-retrofit data for both heating and cooling seasons will be collected and submitted for third party review.

<u>Budget Period 2</u>

Task 3. Installation and Commissioning

Subtask 3.1. Installation. The Team will oversee installation in their spaces, managing contractors for installation and coordinating with occupants.

Milestone 3.1: Installation complete. Submit installation documentation to DOE National Lab partner for review.

Subtask 3.2. Commissioning. The Team will oversee commissioning to ensure systems are maximizing energy savings, to ensure satisfied occupants and to enhance performance persistence.

Milestone 3.2: Commissioning complete. Submit commissioning report to DOE National Lab partner. DOE invited to tour project site.

Task 4. Post-Retrofit Measurement and Verification

Subtask 4.1. Post-Retrofit Monitoring. The M&V Project Partner will adjust any monitoring to capture the updated system's post-retrofit configuration. The Team will continue monitoring for a similar six-to-nine-month period as was monitored pre-retrofit, including portions of the cooling and heating seasons after the retrofit. The Team will re-administer occupant and owner satisfaction surveys. The Team will target a minimum of 50% response rate of occupant surveys.

Milestone 4.1.1: Ensure that adequate heating season post-retrofit data is being collected. Data will be submitted to National Lab partner for third party review.
Milestone 4.1.2: Administer post-retrofit surveys. Data will be submitted to National Lab partner for third party review
Milestone 4.1.3: Ensure that adequate cooling season post-retrofit data is being collected. Data will be submitted to National Lab partner for third party review.

Subtask 4.2. Demand Response Testing. The Team will prepare field test plans. The test plan will focus on instigating different levels and durations of DR events to the lighting system and measuring power impacts during and after the events to see if any "rebounding effect" will occur. The demand profile during the DR events will be compared to demand profiles during periods without DR events. The Team will also conduct occupant surveys for visual comfort and tolerance levels during DR events. The Team will target a minimum of 50% response rate of occupant surveys.

Milestone 4.2.1: Demand response data collection complete. Data will be submitted to National Lab partner for third party review.
Milestone 4.2.2: Administer DR surveys. Data will be submitted to DOE National Lab partner for third party review

Subtask 4.3. Data Analysis. The Team will condition the gathered data, filtering for outliers and data gaps. The Team will use weather normalization to map both the pre- and post-retrofit data onto a Typical Meteorological Year. The Team will compare pre- and post-retrofit estimates to calculate energy and demand impacts. The Team will quantify DR demand impacts and also analyze annual energy savings on a time dependent basis, including marginal costs and emissions to understand the retrofit's grid-interactive efficient buildings (GEB) impact. The Team will calculate the project's cost effectiveness using the actual project costs. At the end of the post-retrofit monitoring period, the M&V equipment will be uninstalled from the field test sites. We will additionally pull in results from other research projects that have established components of the technology package. These projects will include, among others:

- LED retrofits with Advanced Lighting Controls
  - Department of Defense Environmental Security Technology Certification Program (DoD ESTCP)
    - Lighting Retrofit: LED Fixtures and Controls for Advanced Holistic Lighting Solutions
    - Validating the Digital Lumens LED Lighting Control Retrofit
    - Intelligent Building Management with Holistic Digital Lighting
  - DOE
    - Lighting Technology Energy Solutions Program,
  - General Service Administration
    - Evaluation of Advanced Lighting Control Systems in a Working Office Environment
- Integrating Lighting and HVAC Controls
  - DoD ESTCP
    - Integrated Controls Package for High Performance Interior Retrofit,
  - ESTCP
    - Intelligent Building Management with Holistic Digital Lighting
  - National Grid
    - Comprehensive Networked Lighting Controls
- Lighting Demand Response
  - DOE
    - Technology analysis and validation of integrating connected lighting, automated shades, and intelligent energy storage to provide grid-interactive flexible building loads,

Milestone 4.3: Quality control data from M&V equipment, BAS trends, and occupant comfort surveys. DOE reviews data set.

Budget Period 2 Go/No-Go Decision Point: At the end of the BP, window, lighting, and controls retrofit installation will be completed and commissioned. Additionally, all post-retrofit data for both heating and cooling seasons will be collected and submitted for third party review.

Budget Period 3

Subtask 4.4. Building Energy Modeling. The Team will expand our analysis beyond the project site using the U.S DOE's prototype building models. The Team will adjust the prototype building models to incorporate the retrofit package (Window U-Value and Solar Heat Gain Coefficient, Lighting Power Density, and Controls). This analysis will include the most applicable building types (Education, Healthcare, Lodging, Office, Public Assembly, and Multifamily) for this technology package. It additionally will include all major U.S. climate zones. Through this expanded analysis, the Team will quantify the technology package's impact on energy and demand impact in a wide range of applications.

Milestone 4.4: Develop building energy models. DOE reviews energy model files.

Task 5. Reporting and Dissemination

Subtask 5.1. Final technical report. The Team will prepare a comprehensive final technical report describing the project, field test site, field test results, and technical analysis results.

Milestone 5.1: Finalize project technical report. DOE reviews technical report.

- ***Subtask 5.2. Dissemination.*** In order to reach as wide an audience as possible, the Team will prepare a webinar and case study. The Team will market the webinar and distribute the final report and case study using our comprehensive contact database of energy efficiency industry stakeholders. The Team will leverage strategic partnerships with more than 100 organizations including United States Green Building Council, American Society of Heating, Refrigeration, and Air-Conditioning Engineers and American Institute of Architects who have agreed to share reports, messages and training opportunities with their membership lists and other contact databases. The Team will have focused follow-up conversations with at least three public building owners that are interested in the package, meeting with them to describe and promote the technology package. In addition, the Team will pursue opportunities for the project to be used as a case study, public tour or other educational opportunities and in these cases key sustainability features can also be highlighted. The team will work with the local utility and Wisconsin's energy efficiency program to ensure that project results inform their ongoing efforts.
  Milestone 5.2.1: Develop webinar slide deck. DOE reviews.
  Milestone 5.2.2: Complete a case study document, including quantified cost and performance effects. DOE reviews case study.
  Milestone 5.2.3: Direct outreach to 3 public building owners, broad communication to utility audience. DOE invited to meetings.

Subtask 5.3. Standard Development. The Team will update existing Project Partner design standard to include these advanced strategies for future projects. Design standards are provided to project teams at the start of new projects - they include contractual requirements and deliverables in one document and a separate document broken down by division of work that outlines our basis of design/starting point. This document includes window and lighting requirements. Successful strategies from this research project will be incorporated into these documents. The Team will share the design standard with other local governments in Wisconsin through our network; the Team will also share the standard with the University of Wisconsin and with State of Wisconsin officials.

Milestone 5.3: Update design standard. Submit to DOE for review.

Task 6. Project Management

Subtask 6.1. Project management. See "Project Management" section below.

Subtask 6.2. Provide long term data. Provide DOE with project data for up to 5 years beyond the project period of performance. This data includes utility bills, BAS trended data and whole building interval power data.

Milestone 6.2: Provide utility and energy usage data. Data will be submitted to National Lab partner for third party review.

End of Project Goal

The end of project SMART goal is that field validation of the technology package is complete. The retrofit will reduce HVAC energy consumption by 10% and lighting energy consumption by 60%. It will show a peak load reduction of 20% and demand response reduction of 20% of

lighting power. Occupant satisfaction, as measured on a Likert scale, will increase. The simple payback for the project will be less than 10 years.

D. Project Management and Reporting

Reports and other deliverables will be provided in accordance with the Federal Assistance Reporting Checklist following the instructions included therein.

Additional deliverables as indicated in the task/subtask descriptions include the following:

1. *Subtask 1.3 – Key design drawings*
2. *Subtask 2.1 – M&V plan*
3. *Subtask 2.2 – Pre-retrofit data*
4. *Subtask 3.1 – Installation documentation*
5. *Subtask 3.2 – Commissioning report*
6. *Subtask 4.1 – Post-retrofit data*
7. *Subtask 4.2 – Demand response data*
8. *Subtask 4.4 – Energy models*
9. *Subtask 5.1 – Final report*
10. *Subtask 5.2 – Webinar slide deck and case study document*
11. *Subtask 5.3 – Design standard*
12. *Subtask 6.1* - Quarterly project reports, financial reports, and participation and reporting at the annual Building Technologies Office peer-review conference

Milestone Summary Table							
Recipient Name:			Dane County				
Project Title:			See the Savings: An Advanced Window-Lighting Controls Field Validation				
Task Num	**Task or Subtask Title**	**Milestone Type**	**Milestone Number***	**Milestone Description**	**Milestone Verification Process**	**Anticipated Date**	**Anticipated Quarter**
1.1	Research Window Options	Milestone	1.1	Define window specifications to be used in bid documents.	Submit window specification to DOE.	7/2021	1
1.2	Research Lighting Options	Milestone	1.2	Define lighting specifications to be used in bid documents.	Submit lighting specification to DOE.	7/2021	1
1.3	Design	Milestone	1.3	Complete window and lighting retrofit design.	Submit key design drawings to DOE.	10/2021	2
1.4	Bid	Milestone	1.4	Select contractor and define retrofit timeline.	Notify DOE of contractor selection.	1/2022	3
2.1	Plan M&V and Install M&V Equipment	Milestone	2.1	Create comprehensive M&V plan that is consistent with our project plans.	Submit to DOE for review.	7/2021	1
2.2	Pre-Retrofit Monitoring	Milestone	2.2.1	Ensure that adequate cooling season pre-retrofit data is being collected.	Data will be submitted to National Lab partner for third party review	10/2021	2
2.2	Pre-Retrofit Monitoring	Milestone	2.2.2	Ensure that adequate heating season pre-retrofit data is being collected.	Data will be submitted to National Lab partner for third party review	1/2023	3
2.2	Pre-Retrofit Monitoring	Milestone	2.2.3	Administer pre-retrofit surveys.	Data will be submitted to National Lab partner for third party review	4/2022	4
[redacted]		Go/No-Go	BP1	All pre-retrofit data for both heating and cooling seasons will be collected and submitted for third party review	Data will be submitted to National Lab partner for third party review	4/2022	4
3.1	Installation	Milestone	3.1	Installation complete.	Submit installation documentation to DOE.	7/2022	5

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Task Num	**Task or Subtask Title**	**Milestone Type**	**Milestone Number***	**Milestone Description**	**Milestone Verification Process**	**Anticipated Date**	**Anticipated Quarter**
3.2	Commissioning	Milestone	3.2	Commissioning complete.	Submit commissioning report to DOE. DOE invited to tour site.	10/2022	6
4.1	Post-Retrofit Monitoring	Milestone	4.1.1	Ensure that adequate heating season post-retrofit data is being collected.	Data will be submitted to National Lab partner for third party review.	1/2023	7
4.1	Post-Retrofit Monitoring	Milestone	4.1.2	Administer post-retrofit surveys.	Data will be submitted to National Lab partner for third party review	4/2023	8
4.1	Post-Retrofit Monitoring	Milestone	4.1.3	Ensure that adequate cooling season post-retrofit data is being collected.	Data will be submitted to National Lab partner for third party review	7/2023	9
4.2	Demand Response Testing	Milestone	4.2.1	Demand response data collection complete.	Data will be submitted to National Lab partner for third party review	7/2023	9
4.2	Demand Response Testing	Milestone	4.2.2	Administer DR surveys	Data will be submitted to National Lab partner for third party review	7/2023	9
4.3	Data Analysis	Milestone	4.3	Quality control data from M&V equipment, BAS trends, and occupant comfort surveys.	DOE reviews data set.	10/2023	10
[redacted]		Go/No-Go	BP2	Retrofit installation will be completed and commissioned. Additionally, all post-retrofit data for both heating and cooling seasons will be collected	Data will be submitted to National Lab partner for third party review	10/2023	10

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Task Num	**Task or Subtask Title**	**Milestone Type**	**Milestone Number***	**Milestone Description**	**Milestone Verification Process**	**Anticipated Date**	**Anticipated Quarter**
				and submitted for third party review.			
4.4	Building Energy Modeling	Milestone	4.4	Develop building energy models	DOE reviews energy model files.	12/2023	11
5.1	Final Technical Report	Milestone	5.1	Finalize project technical report.	DOE reviews technical report.	3/2024	12
5.2	Dissemination	Milestone	5.2.1	Webinar slide deck.	DOE reviews slide deck.	4/2024	12
5.2	Dissemination	Milestone	5.2.2	Complete a case study document, including quantified cost and performance effects.	DOE reviews case study.	4/2024	12
5.2	Dissemination	Milestone	5.2.3	Direct outreach to 3 public building owners, broad communication to utility audience.	DOE invited to meetings.	4/2024	12
5.3	Standard Development	Milestone	5.3	Update design standard	DOE reviews.	4/2024	12
6.2	Project Management	Milestone	6.2	Provide longterm data.	Data will be submitted to National Lab partner for third party review.	When requested	When requested