Putting People First:

Improving Vulnerable Roadway Users Safety through Proactive and Predictive Smart City Technologies

2023 Strengthening Mobility and Revolutionizing Transportation (SMART) Program

Project Stage: Stage 1 - Planning and Prototyping
2023 SMART Funds Requested: $1,924,500

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Supporting Information can be found at:
https://www.srfconsulting.com/city-of-madison-smart/

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October 10, 2023

The Honorable Pete Buttigieg
Secretary of Transportation
U.S. Department of Transportation
West Building
Office of the Secretary – Ninth Floor
1200 New Jersey Ave., SE
Washington, DC 20590

Dear Secretary Buttigieg,

I write today to ask for your support of the City of Madison's "Putting People First: Improving Vulnerable Roadway Users Safety through Proactive and Predictive Smart City Technologies" application to the FY 2023 SMART program.

Advances in technology have significantly improved transportation safety. Motor vehicle improvements such as the addition of air bags, backup cameras, emergency braking, and blind spot warning have changed traffic crash outcomes for the better. We believe that technology has the potential to also improve safety for people walking and biking.

The City of Madison saw a large increase in serious and fatal traffic crashes during the pandemic including increases in crashes involving people walking and biking. This is devastating for the victim's families and friends and a call to action for our entire community. The City of Madison is fully committed to changing those statistics and we strongly believe that the project we are proposing for funding through the Strengthening Mobility and Revolutionizing Transportation (SMART) grants is one important component of reaching our Vision Zero goal.

Our project focuses on six intersections along Park Street, which is a key corridor linking the University of Wisconsin and our Beltline. Park Street also includes one of the City's disadvantaged census tracks and one of our most diverse communities, South Madison, a historic African American neighborhood, is known for its ethnic restaurants, grocery stores and other small businesses. South Madison and the UW-Madison are connected by two neighborhoods with a mix of single family and multi-family homes. Park Street is also the home to Madison College, major hospital facilities, a library, a fire station, a police station, a transit hub, numerous community-based organizations, and public low-income housing. All these factors make this corridor one filled with people walking, biking, and taking transit beside and across a major motor vehicle traffic corridor. It also makes it one of our corridors with frequent crashes involving vulnerable users.

Park Street is also home to significant new projects led by members of Madison's Black and Latinx communities. These investments, supported by the City, will bring new customers and residents to the area, exacerbating the need to improve safety for vulnerable users. The time is now to make sure we understand the problems and potential solutions, so that we can implement them as part of South Madison's renaissance.

The City of Madison, in partnership with the University of Wisconsin, Madison College, and the Wisconsin Department of Transportation, is committed to successfully carry out the proposed project. We have a long history of working collaboratively on projects. Along with our private partners, our staff have the experience, knowledge, and capabilities to execute this project and test these technology solutions. Ensuring our streets are safe is imperative and this project focused on detection, prediction of dangerousness and communication of warnings is an important step on our path to meeting our Vision Zero commitment. This project leverages existing local and State investments in Smart City technologies on Park Street, and synergize with potential Small Start federal funding Madison is pursuing for the Bus Rapid Transit project along the corridor. We believe that our project can be a model not just for the City of Madison but also for all other communities over the entire country.

Sincerely,

Satya Rhodes-Conway
Mayor

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KEY INFORMATION TABLE

1	**Project Name**	Putting People First: Improving Vulnerable Roadway Users Safety through Proactive and Predictive Smart City Technologies
2	**Lead Applicant Name**	City of Madison
3	**Lead Applicant Unique Entity Identifier (UEI)**	FS3AZ3FV8JG8
4	**Eligible Entity Type**	B. a political subdivision of a State
5	**Was a similar application submitted for the FY 2022 SMART Grants funding opportunity?**	Yes, Putting People First: Improving Vulnerable Roadway Users Safety through Proactive and Predictive Smart City Technologies, City of Madison
6	**Was a similar application submitted in the past two years, or do you anticipate a similar application will be submitted for funding in the coming year for this project under any other USDOT discretionary grant programs (not including the SMART Grants Program)?**	No
7	**Was federal funding previously received for this project?**	No
8	**What organizations will be considered partners on this project?**	Wisconsin Department of Transportation (WisDOT), University of Wisconsin-Madison Traffic Operation and Safety Laboratory (UW-TOPS Lab), Madison Area Technical College, Giner, Inc.
9	**Is this a collaborative application, with each applicant applying separately?**	No
10	**Brief Project Description**	Building on the City's Vision Zero campaign, Stage 1: Planning and Prototyping Grant funding will be used to implement a strategy to help eliminate all traffic deaths and severe injuries on city-wide roadways, bikeways, and sidewalks. The project will create a safety net of layered sensors and warning systems to improve the vulnerable road user (VRU) safety, through detection, prediction, and communication. Stage 1 implementation will test the effectiveness of the proposed solutions. Potential Stage 2 activities will include deploying this system to other identified segments of the high injury network (HIN) across Madison including the East Washington Avenue and University Avenue corridors.
11	**Primary Project Location**	Madison, Wisconsin
12	**Other Project Location**	N/A
13	**What congressional district(s) is your project located in?**	WI-02
14	**Size of Community Receiving Benefits**	Midsize Community within Madison Area MPO
15	**Is the project located (entirely or partially) in a Disadvantaged Community based on its location in a census tract identified as "disadvantaged" in the Climate and Economic Justice Screening Tool (CEJST)?**	Yes, per the Climate and Economic Justice Screening Tool, the project is located partially in a Disadvantaged Community. It is also located in one of Wisconsin's 120 statewide federal Opportunity Zones, and in a 2022 Choice Neighborhood.
16	**If you responded "Yes" to Question 15, please identify the relevant census tract(s) that contribute to this designation.**	Census tract 55025001401

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KEY INFORMATION TABLE

17	**Project Cost: Amount Requested**	$1,924,500
18	**Project Cost: Total Project Cost**	$1,924,500
19	**Proposed Duration of Stage 1 Project (in months)**	18 months
20	**Primary Technology Area**	D. systems integration;
21	**Secondary Technology Area(s) (if applicable)**	C. intelligent, sensor-based infrastructure;
22	**Does this project relate to traffic or parking enforcement; or license plate reader activities?**	No
23	**Is an exemption, waiver, permit, or special permission required to conduct the proposed project?**	No
24	**Jobs / Workforce Assessment**	The City and its partners, UW-Madison and Madison College, will use the Stage 1 grant to train existing workforce and create a pipeline of developing future workforce opportunities through apprenticeship and internship programs. If funded for a Stage 2 implementation grant, the City would be able to build on the workforce development programs and absorb the trained workers to its workforce. The technologies introduced through the project also increase the quality of the jobs. These jobs are part of the City's collective bargaining associations. Some existing positions will be restructured, and additional training will be provided for the workforce. The workforce development program would also provide opportunities for historically underrepresented groups, in alignment with City of Madison's ongoing initiatives and priorities, especially as Madison College serves a large number of historically underserved population.
25	**Anticipated Stage 1 NEPA Requirements**	Currently, there are no NEPA requirements anticipated in Stage 1 as all work will occur within the existing right-of-way under the City of Madison's jurisdiction.
26	**Anticipated Stage 2 NEPA Requirements**	Currently, there are no NEPA requirements anticipated in Stage 2 as all work will occur within the existing right-of-way under the City of Madison's jurisdiction.

I. OVERVIEW

The City of Madison, Wisconsin (herein known as the City) requests $1,924,500 in federal discretionary funding through the FY 2023 Strengthening Mobility and Revolutionizing Transportation (SMART) grants program. The federal funding will advance SMART goals of providing a platform for creativity and innovation in transportation planning and advancing smart city initiatives based on Safe System Approach, in Madison.

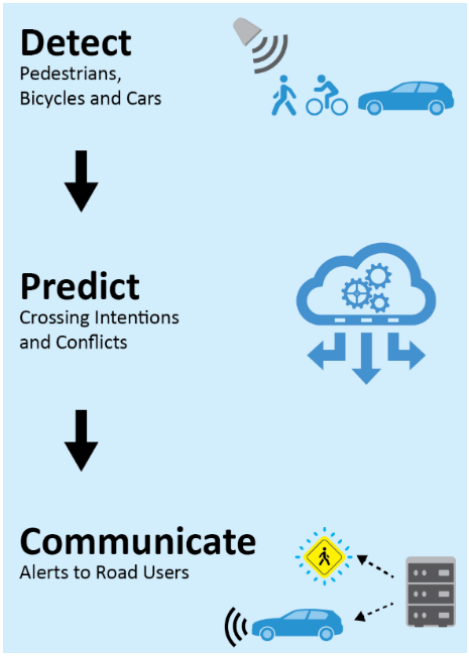
Building on the City's Vision Zero campaign, Stage 1: Planning and Prototyping Grant funding will implement a strategy to eliminate all traffic deaths and severe injuries on city-wide roadways, bikeways, and sidewalks by targeting road user distraction and situational awareness through proactive communications and conflict avoidance technologies. The project leverages existing local and state investments in Smart City Technologies on Madison's Park Street Connected Corridor (PSCC) spurred by the 2015 USDOT Smart City Challenge Grant Application, and synergizes with potential Safe Streets and Roads for All (SS4A) and Small Start bus rapid transit federal funding Madison is pursuing to make other related pedestrian and bicycle focused improvements along the corridor.

Real World Issues and Challenges

Pedestrians and bicyclists are highly vulnerable when involved in traffic crashes due to the lack of protective structures compared to motorists. **There have been 46 pedestrian and bicycle crashes along Park Street in Madison over the last five years.** The combination of high roadway volumes (between 21,000-44,600 vehicles per day), heavy pedestrian traffic, and large University of Wisconsin-Madison student and faculty population (approximately 50,000 in Fall 2022), results in high number of conflicts in this area. Since the pandemic, bicycle and pedestrian related crashes have been increasing with 13 crashes occurring in 2022 alone. The lack of awareness of drivers among vulnerable roadway users (VRUs) is suggested as one of the major contributing factors to crashes.

Proposed Technologies

Considering the existing issues and challenges, the project aims to create a safety net of layered solutions using various sensors and warning systems to improve VRUs safety at signalized intersection, mid-block segments, and unsignalized intersections while focusing on the safety of human life as the proactive and fundamental design principle. Specific solutions are proposed for individual road infrastructure facilities while considering detection capacity, power consumption, communication, and scalability. The three key elements of the project are detection, prediction, and communication:



- **Detection** of road users using sensors including LiDARs and cameras
- **Prediction** of road users' crossing intentions, as well as conflicts between VRUs and vehicles
- **Communication** of proactive warnings to road users via two methods:
  - Infrastructure-based methods:
    - Blank-out warning signs
    - Low-powered electrochromic signs in off-grid locations
    - Rectangular Rapid Flashing Beacons (RRFBs)

- Vehicle-based methods:
  - Connected vehicles with vehicle-to-everything (V2X) technology

The project would be prototyped on two signalized and four unsignalized intersections along the PSCC, which is the first installation of connected vehicle equipment in Wisconsin. In 2015, Smart City Challenge Grant Application brought numerous partners, contributors, and interested stakeholders to the table to identify and research connected vehicle technology and its benefits. In May 2016, Park Street was identified as the technology test area and became the basis for a five-year plan for connected vehicle technology investments. A full timeline of the projects and investments can be found here. In total, 16 milestones, deployments, or projects have occurred on this corridor directly related to the Park Street Connected Corridor.

This Stage 1 grant will conduct an 18-month process to test the flexibility and scalability of the proposed solutions under varying contexts and conditions. Based on the results of the project, the City intends to apply for Stage 2 Implementation grant funding to deploy this system to other identified segments of the high injury network (HIN) across Madison including the East Washington Avenue and University Avenue corridors, the top two roadway segments with the highest concentration of serious pedestrian and bicyclist crashes in Dane County according to historical crashes. The systematic implementation in Stage 2 will demonstrate the current project's ability to scale-up the concept and provide targeted safety measures at intersections and mid-block segments. Further, the project will offer the possibility to implement Safe System Approach solutions based on potential crash risk and not just observed crash history.

The proposed technologies will support City's priority of "*implementing traffic safety measures in a fair and equitable manner to eliminate traffic deaths and serious injuries on City streets*", thereby improving the status quo of the existing transportation system in Madison. Project eligibility is demonstrated through criteria 2 (Connected vehicles), 3 (Intelligent, sensor-based infrastructure), and 4 (Systems integration), as described in the NOFO.

II. PROJECT LOCATION

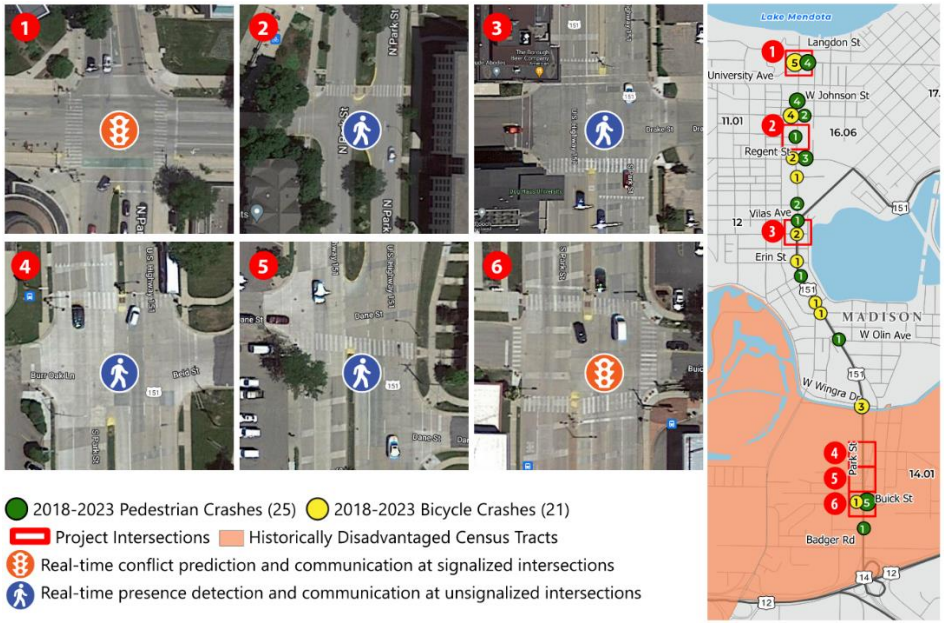


Figure 1. Project Locations

The Project is in Madison, Wisconsin in an urban area with a population of 269,840, per the 2020 Census-designated urban areas definition. It is the capital city of Wisconsin and the county seat for Dane County. Madison is designated as a mid-sized city and is a part of the Greater Madison Metropolitan Planning Organization (MPO). As the regional center for employment, education, and health care, Madison streets serve nearly three quarter million residents and visitors daily. Park Street is one of seven north/south principal arterial roadways in the city connecting users to downtown Madison to the north and the beltline (US 12/14/18/151 carrying 138,000 vehicles per day) to the south.

The project lies partially in a disadvantaged community as three of the six project intersections are within census tract 55025001401 (14.01) and is adjacent to tract 55025001402 (14.02). Based on the Climate and Economic Justice Screening Tool (CEJST), both tracts 14.01 and 14.02 are designated as disadvantaged in Transportation and/or Water and Wastewater categories.

III. COMMUNITY IMPACT

The project will provide direct and indirect safety improvements to the disadvantaged communities in census tracts identified above. Approximately 12,600 residents are located within the census tracts highlighted in Figure 1. The southern one-third of the PSCC is identified as disadvantaged by the CEJST, the northern one-third of the PSCC is located on the University of Wisconsin-Madison campus (census tracts 11.01 and 12). Census tracts 11.01 and 16.06 have zero-vehicle household rates of 59.5 percent and 43.7 percent respectively, indicating that populations in this area are dependent on walking, biking, or using transit to access their everyday essentials (attending class, work, shopping etc.), and depend on reliable and safe infrastructure to cross busy roadways. Moreover, according to the 2020 Biennial Transportation Survey Report, 69 percent of the UW-Madison students indicate walking or bicycling as their travel mode to Campus. These technologies will be deployed directly to this area along Park Street.

The South Madison Neighborhood Plan indicates that 32.9 percent of residents in the southern one-third of the corridor identified as Latino or Hispanic (nearly 4.9 times higher than the city-wide average). Engagement activities will focus on involving these and other underrepresented populations at all phases of the project. To proactively address potential residents' concerns about privacy, the project will work to assure and protect data privacy issues to all users.

IV. TECHNICAL MERIT OVERVIEW

Identification and Understanding of Problem to Be Solved

Nationally, the pedestrian fatality rate has increased by about 46 percent from 2011 to 2020, and pedestrian-involved crashes have become more deadly and frequent. A total of 6,516 pedestrian fatalities occurred on the roadways in the US in 2020, which represents a 3.9 percent increase from the number in 2019. **Improving the safety of vulnerable roadway users has become an urgent need for all cities in the US, including Madison.**

On Park Street between August 2018 – July 2023, there were 25 pedestrian crashes and 21 bicycle crashes, resulting in eight incapacitating and 23 non-incapacitating injuries. Crash reports shows that the majority of drivers stated that they did not see the VRUs before making the turning movements while some VRUs indicated that they thought drivers were going to stop. Of the 25 pedestrian crashes, 15 occurred while vehicles were making turning maneuvers. Similar patterns were also found in bicyclist crashes. Overall, road users are not able to predict the movements of others, especially under complicated traffic conditions, which ultimately causes crashes.

Two major contributing factors can be summarized from these crashes:

- The lack of ability to detect road users, and
- The lack of ability to predict movements or intentions of road users

Appropriateness of Proposed Solution

Considering the existing contributing factors to VRU-related crashes, the City and its partners propose a real-time, proactive traffic safety solution to improve VRUs safety at intersections and mid-block segments.

The proposed solution has three major components: detection, prediction, and communication. **None of the system subcomponents need additional waivers or permits to be deployed as part of the project.**

- The **detection** component utilizes different sensors including LiDARs and cameras to detect VRUs. The team has reached out to multiple vendors who provide off-the-shelf sensors. For example, one of the vendors provides an artificial intelligence (AI) based traffic detection solution based on LiDAR technology, which contains one LiDAR, one edge computing unit, and one Power over Ethernet (PoE) box. The sensors can be attached to a traffic pole, and the power to a network of sensors can be provided by the local traffic cabinet. Further, the team will assemble low-cost open-sourced sensors and compare the performance of all these sensors under various conditions and contexts to decide the optimal configurations of sensors.
- The **prediction** component predicts the crossing intentions and movements of road users so that conflict between the VRUs and vehicles can be predicted. For example, using data obtained through the **detection** component, trajectories of VRUs are used to predict their crossing intentions, and trajectories of vehicles are used to predict their movements. The conflicts will then be identified based on the predicted intentions and movements of the road users.
- The **communication** component takes care of the communication between sensors, roadside units (RSU), drivers, and VRUs. For example, at a signalized intersection, the warning information generated by the prediction component can be transmitted to connected vehicles by the RSU through infrastructure-to-vehicle (I2V) communication. To warn other vehicles, it will be transmitted to the blackout sign through infrastructure-to-infrastructure (I2I) communication.

Figure 2 shows a depiction of the system across the varying contexts to be studied in this project.

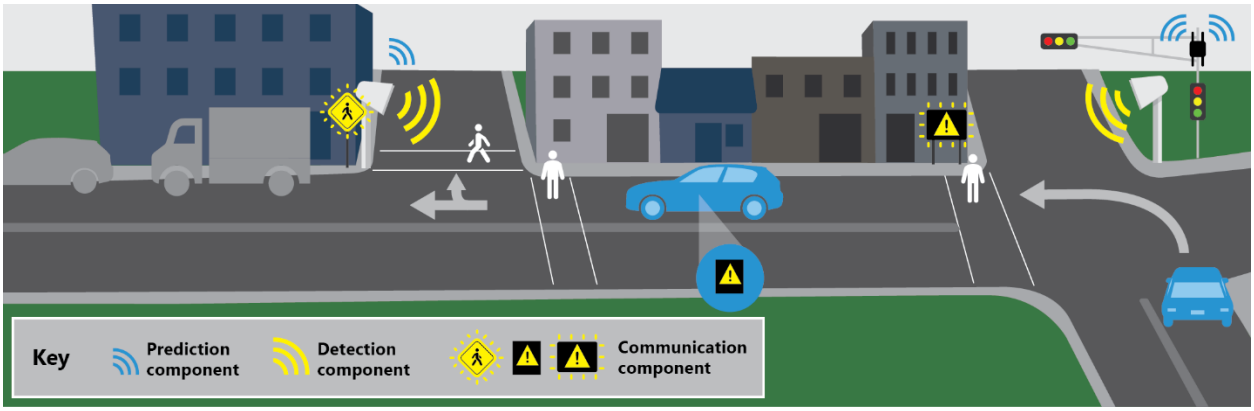


Figure 2. System Overview

Existing studies provide a strong foundation to develop algorithms that detect road users using various sensors, such as cameras, LiDARs, and other sensors. Moreover, the proposed system and predictive models are scalable and easily adaptable to other locations. Lastly, the project team has successfully deployed multiple roadside units on Park Street, which can serve as an excellent testbed for field testing and comparing different technologies.

External Project Challenges and the Status Quo:

In addition to the high frequency of vehicle and VRU conflicts, there are several external challenges present of the corridor, including:

- Limited detection (especially for VRUs like pedestrians and bicyclists)
- Limited communication between VRUs, infrastructure, and vehicles

Unfortunately, the current status quo fails to address these challenges in the following ways:

- Dynamic signs are difficult to scale to off-grid location

- Many traffic signal infrastructure solutions are vendor specific and are not easily configured at other locations
- Static or passive traffic signs and markings convey regulations or warnings that do not vary based on when those rules are needed or conditions are prevalent
- State-of-the-art advanced analytics usually is deployed as decision support systems that may improve traffic engineers' diagnosis of safety issues, but does not expand the available treatments to reduce those issues

While the combination of system technologies is novel, the individual subsystems are based on proven approaches. The resulting system is expected to be highly reliable and provide warnings to the public that would otherwise not be possible. The additional situational awareness by and of VRUs can be reasonably expected to provide safety benefits to all roadway users in the proposed urban area. The proposed solution is appropriate for the location's population density and existing transportation system as it will test varying intersection configurations and traffic patterns.

Expected Benefits

This system showcases several distinct, innovative approaches that go beyond the capabilities of existing VRU detection and warning deployments and are in alignment with USDOT and SMART Grant Program priorities.

Equity and Access

- The system is highly adaptable and can be applied to numerous contexts, impacts a wide base of users, and advances data, technology, and applications to provide significant benefits.
- Low-cost readily available sensors improve system scalability. Additionally, low power needs to ensure that the system is accessible for all communities and minimizes energy and climate impacts.

Enhanced Safety through Layered Warnings

- Using multiple technologies such as on-board units and roadside signs will increase the chances of more road users receiving the warning in time to avoid conflicts.
- Conditionally active warning signing will reduce "exposure fatigue" and increase the attentiveness of roadway users to potential conflicts.
- Other future applications such as winter weather advisories and real-time dynamic lane control could also be enabled through the low-cost conditional static signs.

Systems Integration

- Real-time conflict prediction and communication at intersections and mid-block segments will promote the connectivity of infrastructure, drivers, VRUs, and the broader traveling public.

Partnerships

- The project team consists of several partners from public and private sectors which will contribute to the economic competitiveness of the investments. Additionally, the project also creates a channel for workforce development through apprenticeship and internships offered by the City, Madison College, and University of Wisconsin-Madison.

Performance Measures for Stage 1

- The accuracy, efficiency, and scalability of the system will be evaluated. Specifically, accuracy refers to the accuracy of detecting road users, as well as predicting conflicts. Efficiency refers to the communication between sensors, vehicles, infrastructure, and cloud. Scalability refers to the requirements in terms of power, network, and cost.

V. PROJECT READINESS OVERVIEW

Feasibility of Workplan

The proposed technologies can be prototyped and executed as soon as the grant funds are obligated. The sensors used are commercially available products that do not require additional exemptions, waivers, permits, or special permissions. The project team has interviewed eleven candidate vendors, including five based on video cameras, three based on LiDARs, and two based on multi-modal sensors, with email questionnaires and web meetings. A subset of candidate vendors has been identified to provide products with desired functions, such as VRU tracking, traffic conflict prediction, integration with warning systems, and within the desired cost range. This preparation has validated the feasibility and affordability of the proposed system and paved the way for prototype development.

The work plan represents a methodical approach to creating and deploying the project in an 18-month schedule. Each of the four tasks listed below provides the foundation for the next, with the result of a clearly defined, tested, and evaluated prototype system. Additionally, workforce development will occur concurrently to use training and education programs for meeting future workforce capacity needs. The project tasks will be:

Planning and Design (3 months) – The project team will engage with project partners and stakeholders for listening sessions and design consultations. During monthly stakeholder meetings, the final site selections will be made, a review of legal and regulatory impacts will be completed, and a "beta test" group will be identified for initial system evaluations.

Development (5 months) – Based on input from the first task, system components will be procured, and predictive models will be configured for the PSCC. Initial system integration will be completed and validated with a lab-based bench test. The bench tests will be followed by closed course testing and a test deployment at one site along the PSCC.

Field Testing (8 months) – Once the system is successfully tested it will be deployed at identified locations along the corridor. Each of the system's conflict detection and warning functions will be tested by using different configurations of system components. Taken collectively, this will allow the team to understand how different environmental factors and different experimental setups affect the performance of the system. The eight-month duration will allow data collection in various weather conditions and precipitation types. During the test period, extensive data will be collected for evaluation purposes.

Evaluation and Reporting (2 months) – Using an evaluation process created in the Planning and Design task, data collected from field tests will be used to determine the accuracy, efficiency, and scalability of the system. The final report will describe the system's overall availability ("uptime"), significant component failures or maintenance practices, and activation records. Multiple accuracy measures will be compared to assess the system's overall impact on VRU conflicts and ultimately crashes. Ground truth crossing data validation will be conducted using human annotation of video data using equipment and processes used in previous studies.

Workforce Development (concurrent) – The City and its partners, UW-Madison and Madison College, will create opportunities to train existing staff on Smart City Technologies as well as create a pipeline of developing future workforce opportunities through the use of apprenticeship and internship programs. The educational partners will be offering courses for students geared towards learning the skills required on the job. Additionally, the City will hire interns to work alongside City engineering team and apprentices to assist field technicians, with the potential to absorb the trained workers within its workforce. The workforce development program would also provide opportunities for historically underrepresented groups, in alignment with City of Madison's ongoing initiatives and priorities.

Community Engagement and Partnerships

Community-centered Approach – In 2013, the City launched the Racial Equity and Social Justice Initiative that focuses on eliminating racial and social inequities in municipal government by implementing equity strategies that influence City policies and budgets, City operations and the community. The City has made big strides in improving equitable investment in underserved communities in Madison to prevent pedestrian, bicycle, and vehicle fatalities and serious injuries. Moving forward, the City proposes to implement, as part of this project, enhanced community outreach and engagement activities with consultant support to better integrate equitable community feedback in the decision-making process. These engagement activities will include:

- Engaging partners in listening sessions at multiple sites on the corridor
- Monthly stakeholder meetings
- Development of beta testing stakeholder group

Committed and Sustainable Partnerships – The project partners represent various sectors including governmental agencies, industry, and academia. The partners have a long history of efficient and productive collaboration that maximizes the value of budget resources. Additionally, through these relationships, the City as the applicant understands the legal and policy requirements needed for deploying equipment and reporting requirements. The Letters of Commitment are available here.

Leadership and Qualifications

The City of Madison team, led by Dr. Yang Tao will lead the project and assist the project partners with system integration with existing City infrastructure. The Madison team has a long history of leading successful projects related to VRU safety with the University of Wisconsin Traffic Operations and Safety (TOPS) Laboratory and Wisconsin Department of Transportation (WisDOT), such as the recent development of the City's High Injury Network. The City has also applied for the SS4A grant with a particular emphasis on VRU safety including on South Park Street, and for the Small Start funding to implement bus rapid transit with pedestrian/bicycle improvements along the corridor.

The TOPS Lab team, led by Dr. David Noyce will perform system development and prototyping. The TOPS Lab, part of the College of Engineering at the University of Wisconsin-Madison, is a nationally recognized research organization with a mission to improve traffic operations and safety through research, partnership, service, and training. Researchers at the TOPS Lab have conducted various studies focused on detecting road users using different sensors and predicting road users' movements and conflicts, which will be utilized as a solid foundation for developing the proposed solutions.

The Madison College team, led by Dr. Kevin Mirus will lead the workforce development program to prepare apprentices and interns that can be successfully integrated into the project. As the community college, Madison College provides open access to quality higher education and prepares its diverse communities to earn an associate degree, technical diploma, or certificate in more than 180 programs.

The Giner Inc. consultant team, led by Dr. Avni Argun will lead the development of a dynamically switching, electrochromic traffic sign prototype that will provide high optical contrast between its clear (see through) and dark (opaque) states. Giner has a successful history of developing novel prototypes using electrochromic technology, including SBIR funded projects by NASA and the Air Force (AFWERX) to build and test next generation eyewear and visual devices.

APPENDIX 1 - RESUMES

City of Madison

Yang Tao, Ph.D., P.E. is the City Traffic Engineer and the agency head of the City of Madison's Traffic Engineering Division, which has over 140 employees and is responsible for the City's pedestrian, bicycle, and motor vehicle transportation systems. Dr. Tao has also been overseeing Madison's Smart Cities and Vision Zero Initiatives, and has been working with various City agencies, universities, and a consortium of other public and private entities in envisioning and building a next- generation people and data centered, safe, efficient, equitable and climate- friendly transportation system for Madison. He obtained his Ph.D. degree in Civil Engineering from the University of Wisconsin-Madison with a minor degree in Business. Dr. Tao has also played leadership roles in the transportation profession both locally and nationally, and served on many national committees on Bicycle Transportation, Intelligent Transportation Systems, Smart Communities and Automated Transportation. Dr. Tao was named the 2018 Transportation Professional of the Year by the Institute of Transportation Engineers Midwestern District.

Jerry Schippa, P.E. is a Traffic Engineer with the City of Madison Traffic Engineering department where he works on development and design of traffic signals, street lighting, and infrastructure necessary for fiber optic networks. Jerry has previously worked on initiatives such as adaptive traffic signal control systems, traffic signal request analysis, and various construction and reconstruction projects over the past eight years with the City of Madison. In addition to that, he is developing the first transit signal priority system with Madison Metro along with reconfiguring traffic signals along the 15-mile stretch of the East-West Bus Rapid Transit line which involves center running buses on many of the arterials in the city. He received his B.S. in Civil Engineering from Michigan Technological University in 2010 and has been working with the city since 2015.

Renee Callaway is the City of Madison Pedestrian and Bicycle Administrator where she manages pedestrian and bicycle planning efforts, safety programs, and the school crossing guard program. She also co-leads the City's Vision Zero and Complete Green Streets initiatives. She has previously worked at the Wisconsin Department of Transportation as the Safe Routes to School Coordinator and at the University of Wisconsin-Madison as the Pedestrian and Bicycle Coordinator. She received her M.S. in Continuing and Vocational Education from the University of Wisconsin.

University of Wisconsin - Madison

David Noyce, Ph.D., P.E. has over 39 years of experience in transportation engineering including state government, private consulting, and academia. He has held positions at the University of Massachusetts-Amherst, Texas A&M University, the Illinois Department of Transportation, and several US civil engineering consulting firms. Dr. Noyce currently serves as the Executive Associate Dean of the UW-Madison College of Engineering and as the Director of the Traffic Operations and Safety (TOPS) Laboratory at UW-Madison. The TOPS Laboratory has over 40 research professionals conducting research in the areas of traffic safety, traffic operations, information technology, freight operations, ITS, CAV, and product development. Dr. Noyce also leads the Wisconsin Driving Simulator Laboratory and directs the UW-Madison partnership in the SAFER-SIM University Transportation Center (UTC).

Pei Li, Ph.D. is a Scientist at the Department of Civil and Environmental Engineering, University of Wisconsin-Madison. Prior to that, he was a Postdoctoral Research Fellow at the University of Michigan Transportation Research Institute. He received his Ph.D. in Civil Engineering from the University of Central

Florida in 2021. He has extensive research experience in proactive traffic safety, vulnerable road user safety, trajectory prediction, and artificial intelligence. He has participated in the development of a proactive traffic safety system that won the 1st prize of the USDOT Solving for Safety Visualization Challenge.

Andrew McFadden, P.E. is a researcher at the Department of Civil and Environmental Engineering, University of Wisconsin-Madison and a member of the Wisconsin Transportation Information Center. He has broad experience working for multiple state and local transportation agencies. He worked on the development and implementation of City of Denver's Vision Zero Action Plan and has experience analyzing VRU crashes and installing a broad range of engineering countermeasures.

Xiaopeng (Shaw) Li, Ph.D. is currently a Professor in the Department of Civil and Environmental Engineering and an affiliate in the Department of Electrical and Computer Engineering at the University of Wisconsin-Madison (UW-Madison). Prior to joining UW-Madison, he was a faculty member at the University of South Florida, and he served as the director of one USDOT national university transportation center, National Institute for Congestion Reduction (NICR). He established the Connected and Automated Transportation Systems Lab that developed a multi-scale CAV testbed including multiple full-scale and reduced-scale CAVs and associated system units. He was the holder of the Susan A. Bracken Faculty Fellowship and the Vasant Surti Fellowship at USF. He is a recipient of a National Science Foundation (NSF) CAREER award. He is a senior member of IEEE. He has served as the PI or a co-PI for a number of federal (NSF, USDOT, USDOE), local (e.g., state DOTs, UTCs, I-4 Corridor Program), and industry grants. He has published over 100 peer-reviewed journal papers. His major research interests include automated vehicle traffic control and connected & interdependent infrastructure systems). He received a B.S. degree (2006) in civil engineering from Tsinghua University, China, an M.S. degree (2007), and a Ph.D. (2011) degree in civil engineering along with an M.S. degree (2010) in applied mathematics from the University of Illinois at Urban-Champaign, USA.

Sikai Chen, Ph.D. is an Assistant Professor at the Department of Civil and Environmental Engineering, University of Wisconsin-Madison. Prior to that, he was a Visiting Assistant Professor at the Lyles School of Civil Engineering at Purdue University, and Visiting Researcher at the Robotics Institute, School of Computer Science at Carnegie Mellon University. He received his Ph.D. in Civil Engineering focusing on Computational Science & Engineering from Purdue University in August 2019. Dr. Chen's research interests span both theoretical and applied aspects of artificial intelligence, data science, and robotics, all of which are applicable to connected and autonomous vehicles, transportation and infrastructure systems, human factors, smart cities, and cloud/fog/edge computing for large-scale network modeling and simulation. His Ph.D. dissertation, "Safety Implications of Roadway Design and Management: New Evidence and Insights in The Traditional and Emerging (Autonomous Vehicle) Operating Environments", received the 2019 best civil engineering dissertation award from Purdue University and the 2019 Milton Pikarsky Memorial Award (a national prize for best Ph.D. dissertation) from the Council of University Transportation Centers. In addition, he is a member of ASCE national committees on Connected & Autonomous Vehicle Impacts, and Economics & Finance.

Madison College

Kevin Mirus, Ph.D. is Dean for the School of Engineering, Science, and Mathematics (ESM) at Madison Area Technical College (MATC). The School of ESM houses five applied engineering departments (Civil, Electrical, Electro-Mechanical, HVAC, and Mechanical Design), one transfer engineering department, six additional transfer STEM departments (Biology, Chemistry, Computer Science, Mathematics, Physical Sciences, and Physical Education) and a STEM Center devoted to supporting STEM students. Housing all this programming under one roof provides a one-stop shop for access to STEM students and faculty for this grant. Previous to his Dean role at MATC, Dr. Mirus was STEM Center Director, STEM Academy Co-Director, Associate Dean for the School of Art & Sciences, Mathematics Department Chair, and a Mathematics Instructor. His Ph.D. is in experimental plasma physics from UW-Madison. A consistent theme throughout his career at MATC has been collaboration with external stakeholders on curriculum and programming. Dr. Mirus was on the STEM Academy design and implementation team, which included several high school administrators and faculty. The STEM Academy is a dual enrollment program that provides high school students the opportunity to pursue an Associate of Science on MATC's campus in their last two years of high school. To date, the STEM Academy has graduated 347 scholars with an average GPA of 3.5, 99 earned degrees, and an average of 53.4 college credits. The students were 60% female, 51% low income, 55% first gen, and 67% students of color. Dr. Mirus also helped design and implement ESM's transfer STEM internship program, which will be a likely source of interns for this grant. Finally, Dr. Mirus is a co-PI on a Howard Hughes Medical Institute (HHMI) Inclusive Excellence grant, which is working toward providing access to freshman- and sophomore-level classes to any student in the Wisconsin Technical College System in preparation for junior-level coursework in a variety of STEM majors in the University of Wisconsin System.

Randy Way, MS is the Associate Dean in the School of Engineering, Science, and Mathematics at Madison College. Serving over 6,000 unduplicated students annually, the school represents a major pathway from regional high schools to the workforce and institutions of higher education. Capitalizing on its institution's unique mission, the school serves the dual roles of preparing engineering technicians directly for the workforce and providing transfer pathways into the full breadth of STEM degrees at baccalaureate degree granting institutions. Associate Dean Way earned his master's degree in Career and Technical Education from Stout Polytechnic University and is currently pursuing a PhD in Educational Leadership and Policy Analysis at the University of Wisconsin – Madison. His duties to the school include budget planning and oversight, operations management, and program development and evaluation.

GINER, INC.

Avni Argun, Ph.D., Vice President of Advanced Materials received his Ph.D. from University of Florida, where he studied the patterning and electro-optical characterization of conducting polymers for electrochromic devices. During his postdoctoral work at MIT, he developed LbL assembly techniques for fabrication of electrochromic polymer layers as well as ionically and electronically conducting membranes. Joining Giner in 2010, he has worked on programs developing electrochromic devices, electrochemical sensors, and multifunctional coatings. Dr. Argun has over 20 years of experience in electrochemical systems and has authored over 20 research articles on electrochemical device technologies including electrochromic device prototyping, fuel cells, and biosensors. Dr. Argun is also the PI for Giner's NASA program that aims to develop tintable helmet bubbles for the next generation spacesuits.

Andrew Weber, Senior Project Scientist received his M.S. in Chemistry from Tufts University where he worked extensively in the analytical and electrochemical fields. His research there required adapting standard

benchtop electrochemical techniques for remote in situ environmental analysis. This necessitated development and fabrication of systems to withstand particularly harsh environments. Since joining Giner, Inc. in 2017, he has developed several devices using his expertise in electrochemical techniques and fabricated color changing electro-optical devices utilizing electrochromic polymers. Mr. Weber's experience in building and testing such devices will be beneficial in developing the electrochromic devices proposed in this program.

David Markham, Senior Mechanical Engineer received his M.S. in Mechanical Engineering from the University of Central Florida in 2017. After obtaining his master's, he worked at Raytheon where he designed and developed a test stand for a phase change heat exchanger. This included building the LabVIEW software and designing the fluid circuits. Since joining Giner, Inc. in 2019, he has designed stack hardware for several high pressure electrolyzer programs. He has extensive experience in building and designing test stands. He also has experience in automated spray processing of polymers, which will be used to coat the proposed prototypes.

APPENDIX 2 - SUMMARY BUDGET NARRATIVE

The City of Madison is requesting $1,924,500 for the Stage 1 SMART Grant project. This funding will be divided between subconsultants and the procurement of equipment for the prototype deployments. An approximate project cost per task is provided below in Table A.2-1.

Task Description	Total
Task 1: Planning and Design	$70,000
Task 2: Development	$710,000
Task 3: Field Testing	$954,500
Task 4: Evaluation and Reporting	$80,000
Task 5: Workforce Development	$110,000
Project Total	$1,924,500

Table A.2-1. City of Madison Stage 1 SMART Grant Budget per Task

Based on the relevant context for each location, different technologies will be deployed at different locations along the corridor, as shown in Figure 1 of the project narrative. An estimate of the planned costs for each of the prototypes is included in Table A.2-2.

ID	Name	Personnel	Fringe Benefits	Travel	Equipment	Supplies	Contractual	Construction	Total
1	Real-time conflict prediction and communication at signalized intersections	$50,000	$14,000	$2,000	$240,000	$5,000	$572,250	$0	$883,250
2	Real-time presence detection and communication at unsignalized intersections	$34,000	$8,000	$2,000	$220,000	$5,000	$772,250	$0	$1,041,250

Table A.2-2. City of Madison Stage 1 SMART Grant Budget by Application and Category

Personnel and Fringe Benefits

All City of Madison personnel and fringe benefit costs are directly proportional to the planned hours needed for each prototype. Eligible project personnel include traffic engineers, traffic signal technicians, and IT staff.

Travel

The City has budgeted for two in-person meetings in Washington, D.C. to aid in information sharing.

Equipment

The equipment for each prototype will initially be procured, assembled, and tested by the UW-TOPS and Giner Inc. teams in lab and test environments. Once a functioning prototype is developed, it will be tested

on the Park Street corridor. After initial field testing is complete in task 2, the City will procure equipment to develop additional prototypes along the corridor that will be assembled and tested by the team in task 3.

Contractual

Contractual costs include equipment and staff for four subconsultants:

- UW TOPS Lab
  - Development and testing of all prototypes.
  - Data and performance reporting of all prototypes.
- Giner Inc.
  - Development and testing of electrochromic film to be used in prototype #2.
- Madison Area Technical College
  - Workforce development
- Engagement Consultant
  - Ensure continuous community engagement for all prototypes during the project.
  - Develop the training needed to support the scaling of prototypes.
  - Identify the steps needed to ensure the prototypes can create high-quality jobs.
  - This consultant has not been selected and these services will be solicited in accordance with Federal regulations if this application is awarded grant funding.
- Signal Vendor/Contractor
  - Configuration and delivery of traffic signal equipment needed for prototypes #1.
  - This vendor/contractor has not been selected and these services will be solicited in accordance with Federal regulations if this application is awarded grant funding.

APPENDIX 3 – LETTERS OF COMMITTMENT

Wisconsin Department of Transportation
Office of the Secretary
4822 Madison Yards Way, S903
Madison, WI 53705

Governor Tony Evers
Secretary Craig Thompson
wisconsindot.gov
Telephone: (608) 266-1114
FAX: (608) 266-9912
Email: sec.exec@dot.wi.gov

September 21, 2023

The Honorable Pete Buttigieg
Office of the Secretary of Transportation
U.S. Department of Transportation (DOT)
1200 New Jersey Avenue, SE
Washington, DC 20590

RE: Letter of Commitment for FY 2023 SMART Grant Program: City of Madison

Dear Secretary Buttigieg:

I am writing on behalf of the Wisconsin Department of Transportation (WisDOT), which is responsible for planning, building, and maintaining Wisconsin's highways. Park Street in Madison, which is included in this proposal, is partially part of the US 151 system. The City of Madison and WisDOT have joint jurisdiction over Park Street from Regent Street to US 12. We commit to working with the City of Madison on their project – Putting People First: Improving Vulnerable Roadway Users Safety through Proactive and Predictive Smart City Technologies.

To support the project and its partners, the Wisconsin Department of Transportation commits to the following:

- Providing technical assistance and advice to the project team as a key stakeholder to improve the project's outcomes and the likelihood of successfully scaling the project's applications to other roadways in Madison and Wisconsin.
- Modifying policy, if needed and appropriate, to allow the prototyping of the project's applications on public highways in Wisconsin.
- Provide independent evaluation of the long-term benefits of the project applications.

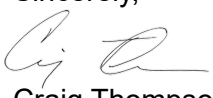
This commitment is new, specific, and measurable in the following ways:

- As the entity responsible for Wisconsin highways, including US 151, WisDOT has a key stake in ensuring the project's applications are appropriate and successful in reducing the chance of traffic conflicts for vulnerable road users on the State's public roadways.
- WisDOT has been a partner on the Park Street Smart Corridor since its creation in 2018. This project will revitalize the corridor with new technologies and applications that will both showcase emerging connected vehicle technologies and focus on solving a current issue that is at the heart of the Department's mission to develop a safe and efficient transportation system.
- The Department will reduce barriers for experimentation and scaling these technologies to make the most and fastest use of their application in the State.

I support the City of Madison's application for the funding of Putting People First: Improving Vulnerable Roadway Users Safety through Proactive and Predictive Smart City Technologies

project and look forward to the infrastructure investment in our region through the Bipartisan Infrastructure Law. Please give this FY 2023 SMART Discretionary Grant proposal your full consideration and if I can answer any questions, please do not hesitate to contact me. I may be reached at 608-266-1114 or DOTExec@dot.wi.gov.

Sincerely,



Craig Thompson
Secretary

WISCONSIN TRAFFIC OPERATIONS & SAFETY LABORATORY
UNIVERSITY OF WISCONSIN-MADISON
Department of Civil and Environmental Engineering

1203 Engineering Hall
1415 Engineering Drive
Madison, WI 53706 danoyce@wisc.edu

October 9, 2023
Pete Buttigieg
United States Secretary of Transportation
U.S. Department of Transportation
1200 New Jersey Ave, SE
Washington, DC 20590

RE: Letter of Commitment for the 2023 SMART Grant Program: City of Madison

Dear Secretary Buttigieg:
I am writing on behalf of the University of Wisconsin – Madison Traffic Operations and Safety (TOPS) Laboratory which is a key stakeholder in the Park Street corridor project. We commit to working with the City of Madison on their project – Putting People First: Improving Vulnerable Roadway Users Safety through Proactive and Predictive Smart City Technologies.
To support the project and its partners, the University of Wisconsin – Madison TOPS lab commits to the following:

- Work closely with City of Madison staff and other partners to engage residents along the corridor to improve the outcomes of the project and ensure its efforts are equitable beneficial to all roadway users on the corridor.
- Provide technical assistance to the project team to improve the project's outcomes and the likelihood of successfully scaling the project's applications to other roadways in Madison and Wisconsin.

This commitment is new, specific, and measurable in the following ways:

- UW TOPS Lab has been a partner on the Park Street Smart Corridor since its creation. This project will revitalize the corridor with new technologies and applications that will both showcase emerging connected vehicle technologies and focus on solving an important and timely issue for the University's students and employees and community at large.
- This project engages a cross-discipline collection of faculty and staff to provide complementary solutions to address this complex issue.
- The project team will engage our University partners as key stakeholders on the corridor to aid in the development and testing of the team's applications.

Please give this 2023 SMART Discretionary Grant proposal your full consideration and if I can answer any questions, please do not hesitate to contact me. I may be reached at (608) 265-1882 or danoyce@wisc.edu.

Sincerely,

David A. Noyce, Ph.D., P.E., F. ASCE, F.ITE
Arthur F. Hawnn Professor, Department of Civil and Environmental Engineering
Executive Associate Dean, College of Engineering
Director, Traffic Operations and Safety Laboratory

Kevin Mirus, Dean
School of Engineering, Science, and Mathematics
Madison Area Technical College
1701 Wright Street
Madison, WI 53704
kmirus@madisoncollege.edu

Wednesday September 27, 2023

Pete Buttigieg
United States Secretary of Transportation
U.S. Department of Transportation
1200 New Jersey Ave, SE
Washington, DC 20590

RE: Letter of Commitment for the 2023 SMART Grant Program: City of Madison

Dear Secretary Buttigieg,

I am writing on behalf of the School of Engineering, Science, and Mathematics at Madison Area Technical College, which is a key stakeholder in the Park Street corridor project. We commit to working with the City of Madison on their project – Putting People First: Improving Vulnerable Roadway Users Safety through Proactive and Predictive Smart City Technologies.

To support the project and its partners, Madison Area Technical College commits to the following:

- Provide access to a broad group of internship- and research-interested students from programs including Electro-Mechanical Technology, Electrical Engineering, Computer Science, Information Technology, and University Transfer Engineering.
- Provide technical training to city staff and students on sensor equipment installation and maintenance.

This commitment is new, specific, and measurable in the following ways:

- This project engages a cross-disciplinary collection of faculty and staff from both the University of Wisconsin and Madison Area Technical College to enrich the education of our students and prepare our regional workforce for upcoming opportunities.
- This project will enhance technological innovations as well as how cities and colleges can most effectively work together to train and retrain staff on projects that help improve safety in our community.

Please give this 2023 SMART Discretionary Grant proposal your full consideration and if I can answer any questions, please do not hesitate to contact me. I may be reached at (608) 246-6478 or kmirus@madisoncollege.edu.

MADISON AREA TECHNICAL COLLEGE
SCHOOL OF ENGINEERING, SCIENCE AND MATHEMATICS

Sincerely,

Kevin A. Mirus

Kevin A. Mirus, Ph.D.
Dean, School of Engineering, Science, and Mathematics
Madison Area Technical College

October 3, 2023

Avni Argun, Ph.D.
CTO, Giner Labs
89 Rumford Avenue
Newton, MA 02466-1311

Dear Secretary Buttigieg,

I am writing on behalf of Giner, Inc. (Giner) to indicate our enthusiasm and interest in this Strengthening Mobility and Revolutionizing Transportation (SMART) grant application to develop a new dynamic electrochromic display device technology to improve traffic safety.

Giner is a Boston-based research and development firm committed to developing and commercializing cutting-edge electrochemical technologies. We leverage our 50 years of experience in applied electrochemistry and electrochemical engineering to produce great ideas and exciting products. We commit to working with the City of Madison on this project.

Giner has a successful track record of developing novel prototypes using electrochromic technology. Previously we have been awarded SBIR funding by NASA and the Air Force (AFWERX) to build and test next generation eyewear and visual devices. The program goals required uniquely shaped substrates that rapidly alter their opacity to provide maximum visibility in a wide range of ambient light conditions. The electrochromic laminates developed at Giner are solution processible so adapting them for new form factors or applications is straightforward. Additionally, we utilize a robotic spraying process that insures uniform coverage on the desired substrate.

To support the project and its partners, Giner commits to the following:

> **Development of a dynamically switching, electrochromic traffic sign prototype that will provide high optical contrast between its clear (see through) and dark (opaque) states.** We will demonstrate the feasibility of a device assembly that can be integrated into existing traffic signs to provide high dark-to-clear optical contrast, continuously variable operation, rapid switching, zero power use at any state (long optical memory), and low power requirements for each switch.

This commitment is new, specific, and measurable with the following operational requirements:

- Clear to dark electrochromic device on a polymer substrate in an outline of 6” x 10”. Several clear plastic substrates will be utilized including PET and polycarbonate
- >55% of transmittance change between on and off states in the visible spectrum.

- Full electro-optical characterization of the prototype devices.
- Outdoor operational capability and a wide range of operational temperatures ranging from -20 °C to 45 °C.
- Cycling capability of over 10,000 cycles.
- Rapid switching (<3 seconds).
- Fail safe operation to accommodate power loss to the device

Giner has extensive experience in designing, fabricating, and testing prototypes:

> **Giner will leverage our state-of-the-art electrochromic R&D facilities to accomplish the goals outlined above.** Our facilities contain dedicated fabrication and assembly areas as well as a rapid prototyping lab with 3D printers, capable of extrusion and UV curing print processes, and CNC instrumentation. We have developed a custom UV/Vis spectroscopy test stand to measure the optical performance, both absorbance and transmission, of our uniquely shaped electrochromic devices during switching. In addition, Giner's analytical potentiostats are capable of testing the electrochemical function of the devices and record the resulting data. We also have temperature controlled ovens, humidity saturators, and vacuum/pressure chambers to simulate environmental conditions that the prototype is eventually expected to encounter.

We are pleased to participate on this application and excited to work together with the proposing team. We are confident that we can utilize our prior experience in electrochromic technologies to explore the feasibility of dynamically switching traffic signs with the specifications detailed above.

Upon funding of this effort, Giner will perform the activities listed above under a contract at a total cost of $197,374 for 18 months. In addition to this letter of commitment, we are also providing you with budget information and key personnel biographies. Please do not hesitate to contact me if you have any questions.

Sincerely,

Avni Argun, Ph.D.
CTO

Giner, Inc.
89 Rumford Avenue • Newton, MA 02466-1311
Main: 781-529-0500 • Fax: 781-893-6470 www.ginerinc.com