INSTITUTE of Museum and Library SERVICES

Museums for America

Sample Application MA-255900-OMS-24
Project Category: Lifelong Learning

Discovery Museum

Amount awarded by IMLS:	$88,726
Amount of cost share:	$88,876

The Discovery Museum will build a new, permanent exhibit that invites young children to explore the inner workings of a solar cell, a device that converts sunlight into electrical energy. Drawing upon children's curiosity and imagination, the exhibit will inspire visitors to "be" the sun as they playfully work to induce an "electric current." This experience will also connect to the museum's own working solar array, composed of tens of thousands of solar cells that generate enough electricity to power the museum. Museum staff will also design a series of facilitated activities including public programs, interactive experiences for school groups, and a resource guide. As a result, visitors and young learners will expand their understanding of renewable energy sources and learn from action-oriented experiences about mitigating the impacts of climate change.

Attached are the following components excerpted from the original application.

- Narrative
- Schedule of Completion
- Performance Measurement Plan

When preparing an application for the next deadline, be sure to follow the instructions in the most recent Notice of Funding Opportunity for the grant program to which you are applying.

Project Justification

Discovery Museum respectfully requests a Museums for America Grant in the amount of $89,340 to fund a new, permanent exhibit that invites young children and students to explore the inner workings of a solar cell. The exhibit will playfully model how the Museum's own prominent 326kWh solar array (Supportingdoc1), installed in 2022, harnesses energy from the sun to generate electricity—demonstrating one of the many concrete actions people are taking to mitigate the impacts of climate change.

With the climate crisis certain to be among the most profound and pervasive challenges children will face throughout their lifetimes, children's museums, including Discovery Museum, have stepped up individually and collectively to reduce their carbon footprints, educate, advocate, and offer hope.[1] With respect to visitor experiences, however, exhibits designed for early learners about renewable energy technologies are uncommon. Because the underlying science is complex, they are typically geared toward middle schoolers and high school students and often rely on lengthy written or elaborate visual descriptions. Further limiting opportunities for young children to explore these topics is the fact that few states—Massachusetts among them[2]—include substantive climate change content in their elementary curriculum frameworks (Moon, 2022; NCSE, 2020; Von Mering, 2023).

The one-year, *Play Inside a Solar Cell* project will help fill this gap for our annual audience of 190,000 visitors and 11,000 school field trip participants. In addition to its focus on young learners, the exhibit will also take a novel approach to exploring the science content itself. Oftentimes, learning experiences focused on solar electricity are designed to help kids understand what solar energy is (before it reaches a solar panel) and how we use solar electricity once it is generated, both of which are valuable for gaining an understanding of renewable energy. Discovery Museum's exhibit, however, will hone in on what happens in between—inside the solar cell itself—right as the sun's rays hit the silicon layers and induce an electric current. Moreover, the exhibit will introduce young children and students to the mechanics of a sophisticated yet familiar[3] technology without losing sight of our low-tech, play-based, approach to STEM learning, which invites active, open-ended inquiry. In developing the concept for this exhibit, Program Educator Kellie Roach designed a prototype, constructed out of simple materials, and tested it on multiple occasions with visitors during a facilitated program about solar energy (Supportingdoc2). The success of this proof-of-concept prototype encouraged us to move forward with development of an unfacilitated, generation 2 prototype, which we will test with general visitors and school-age students, before producing a final, stand-alone exhibit in the spring of 2025.

To complement the exhibit, we will also build on our extensive experience delivering facilitated, environmental-focused programs to develop, test, and iterate three public programs for families during the grant year. The final of these will be a large-scale event, featuring local scientists and industry experts, where visitors will be able to explore how energy gets to homes and businesses. This programming will help visitors understand the science, technology, and the impact on communities for both renewables as well as fossil fuels. As currently envisioned, the centerpiece of this program will be a 3D printed model city, half of which will be powered by simulated fossil fuels and half by simulated renewable energies, allowing visitors to learn about the infrastructure needed for these energy sources. This program will also include interactive stations exploring solar, wind, water, and hydrogen power. This event and the additional facilitated programs, in combination with the *Play Inside a Solar Cell* exhibit, will offer visitors multiple opportunities to explore what solar and renewable energies are, how they are critical parts of our lives, and what choices they might make to reduce their own environmental impact.

[1] We are participating in the IMLS-funded *Caretakers of Wonder* project with 8 other children's museums, led by the Madison Children's Museum, which is developing a framework for children ages 0-8 to educate caregivers on age-appropriate climate change actions and communications.
[2] Climate change is not mentioned in the MA curriculum framework for elementary grades other than the statement "an understanding of climate change is not expected in state assessment." The North American Association of Environmental Education (NAAEE) assessed the inclusion of climate change content in U.S. states' education policy and curriculum standards: Massachusetts, like most states, ranked in the lowest tier, with "very low" inclusion of climate change-related content (NAAEE, 2022). The study did not assess efforts by teachers to go above and beyond.
[3] Massachusetts' per capita distributed (non-utility-scale) solar generation capacity as of 2022 was higher than every state except Hawaii (ILSR, 2023). Rooftop solar panels are common sights for children in this region.

Also during the project year, Discovery Museum school program staff will design an onsite Field Trip orientation activity and follow-up resource guide that introduces and extends the exhibit experience for students and teachers. Discovery Museum is intentional about supporting schoolkids in playing and exploring during their Field Trips: our staff provide pre-visit information to teachers and chaperones and engage every visiting student in a 10- to 20-minute, hands-on orientation activity that helps prime them for their open-ended, playful learning experiences. The new orientation activity will become part of our regular welcome process for most of the 11,000 students and educators who visit Discovery Museum every year. For Field Trip students, who typically fall within the K-4th grade range, the project activities will support children's understanding of key physics concepts taught in the classroom, including energy transfer, energy sources, and forms of energy—all topics explored broadly in 4th grade in Massachusetts. Learning about energy concepts within a real-life context—in this case electricity generation for human use—has also been shown to deepen young students' understanding of the underlying scientific principles (Merritt, 2019; Pliogou, 2017).

The *Play Inside a Solar Cell* project extends Discovery Museum's considerable progress reducing our own carbon footprint and using our sustainability initiatives as learning tools to inform visitors and inspire action (Supportingdoc3). The solar cell exhibit and related programs fit within our larger environmental education framework, designed around the understanding that we cannot expect children to become conscientious environmental stewards without first connecting them to and teaching them about the natural world. Recognizing that this happens progressively and dynamically, we offer a continuum of environmental education experiences, from those that increase families' comfort with being outdoors, to those that deepen children's knowledge about and connection to nature and the environment, and finally to those that build advocacy skills and motivate action. An exhibit that highlights the science behind the Museum's highly visible solar array is the next logical step in our ongoing, comprehensive efforts to equip children with the knowledge, skills, and dispositions they'll need to adapt to a warming planet. The project outcomes are aligned with the Museums for America Lifelong Learning goal and its associated objectives for all-age programs, exhibits, and out-of-school programs, as well as the sustainability goals outlined in Discovery Museum's Strategic Plan.

Thinking holistically, we also remain mindful of the social and emotional impacts of climate change on children. Even though meaningful climate change education is limited in most U.S. elementary schools, young children are still acutely aware of it and experience anxiety and distress because of it (Léger-Goodes, 2022). Helping children to recognize that people are working on solutions, and that they themselves have a role to play, can reduce climate anxiety and build children's hope, efficacy, resilience, and engagement (Sanson, 2018). The solar cell exhibit, along with the working solar array—which generates twice the electricity the Museum uses—will highlight one example of how the world is attempting to adapt to and reduce its reliance on fossil fuels. The public programs will provide opportunities for experiential learning and facilitated conversations about active and potential ways to mitigate climate change. Conveying a hopeful, action-oriented message early also has the potential to inspire attitude and behavior changes over the longer term (Bahri, 2022; Von Borries, 2020). Recent studies have even sought to quantify the substantial role climate education can play in reducing an individuals' carbon emissions over their lifetimes (Cordero, 2020). Climate change education aimed at children has also been shown to inspire adult caretakers, who are also a key audience for the Museum—to adopt more sustainable behaviors (Damerell, 2013; Larsson, 2010).

The results of this project will be used by staff to inform future exhibit and program development aligned with the Museum's sustainability goals. *Play Inside a Solar Cell* will also provide a model for other informal learning centers seeking to create active, open-ended experiences that introduce early learners to complex STEM topics. We will share the results of this project through our professional networks, including at the New England Museum Association annual conference after the grant year concludes.

Project Work Plan

During this one-year project, we will engage an exhibit designer/fabricator in developing an approximately 8' by 4' unfacilitated exhibit for the Museum floor based on a staff-designed, proof-of-concept prototype, tested successfully

with visitors during facilitated programs in 2022. Observations of more than 100 visitors yielded promising results. Children of varied ages enjoyed actively engaging with the materials, both independently and cooperatively, and were observed to remember and use key vocabulary, like "electron" and "photon," during their play. Visitors also related the exhibit to the Museum's solar array and asked follow-up questions based on their observations. Adults found the content meaningful, with one parent stating: "This is a great demonstration. We have solar panels at our house, and I could never understand how they worked." The most difficult aspect of this project will likely be developing a reset mechanism for the exhibit that allows visitors to explore independently. We are mitigating this risk by working with an experienced exhibit designer who is enthusiastic about the project; developing a thorough evaluation plan; and testing a prototype with visitors over a period of 6 to 8 weeks. Another challenge will be to convey the science concepts effectively to a young audience. Our Educator Advisory Council will support this aspect of our project. We also have a phased evaluation plan to ensure we are revising our plans in response to observations and interviews with visitors.

Project Team

Brindha Muniappan, Senior Director of the Museum Experience, will direct the project, which will take place over one year. She successfully led the recent development of another Discovery Museum exhibit on the topic of Cause and Effect, taking the project from a rough "proof-of-concept," through a prototyping phase with an exhibit fabricator and external evaluator, to final design and installation. *Play Inside a Solar Cell* project team members include:

- *Program Team*: Educator Kellie Roche (designer of the initial prototype) and Paul Fenton, Director of Environmental and Outdoor Education, will develop three facilitated public programs that highlight and supplement the learning objectives of the solar cell exhibit. Liz Leahey, Director of STEAM Education, will also participate in this project by developing exhibit labels and text.

- *School Program Team*: Jill Foster, Director of School and Group Programs; Kathie Watt, Assistant Director of School and Group Programs; Jennie Yoo, Field Trip Manager; and Lucy Indge, School Programs Marketing Assistant, will develop, test, and revise a School Field Trip orientation activity about solar cells. School program staff will also develop a 2-4 page follow-up resource guide for students and teachers, which will include a summary of exhibit content, suggested prompts for class discussion and reflection, and follow-up activities for home or the classroom for further exploration of solar energy concepts. School program staff will also participate in evaluation activities during this project.

- *Marketing Team*: Ann Sgarzi, Director of Marketing, and Jill Jacques, Marketing Manager, will produce exhibit graphics and signs, layout and print resource guides, add exhibit-related content to the Museum website, and add exhibit-specific questions and track responses to our follow-up surveys for visitors.

- *Explorers:* Six floor staff will assist in Field Trip orientation sessions and two will participate in exhibit evaluation.

- *Facilities staff*: Mark Cooper, Director of Facilities and Exhibit Maintenance, will assist with exhibit installation.

- *Consultants*: Exhibit designer/fabricator Blake Wigdahl and evaluator Betsy Loring will participate as contractors on this project (see Supportingdoc4 and Supportingdoc5 for their scopes of work).

- *Advisors:* We will seek feedback at appropriate points during the project from members of several of the Museum's standing volunteer advisory groups (Supportingdoc6) including the Science and Technology Advisory Council, an Educator Advisory Council, which is being formed to bring together informal and formal educators to share innovative ideas to support the Museum's school outreach programs, a Sustainability Advisory Committee, and an ad hoc group of accessibility advisors. Other networks through which we will seek feedback include the children's museums participating in *Caretakers of Wonder*; New England Museum Association's

Environment and Climate Community of Practice, co-founded by our own Director of Environmental and Outdoor Education; and the Gulf of Maine's Learning Ecosystems Northeast (LENE) project, of which we are participants (Supportingdoc7 includes letters of support from some of these partners).

Project Activities

Throughout the project year, key team members and external consultants will meet biweekly to carry out project activities. Progress will also be tracked through an established internal meeting schedule, which includes monthly meetings with the Museum finance team to ensure expenses and contributions of staff time are within budget; biweekly exhibits team meetings; weekly school program staff meetings; and biweekly Museum experience staff meetings.

Design Development Phase (September 2024 – March 2025):

- *Concept development (September – November 2024)*: The exhibit design consultant and the Museum project team will review the proof-of-concept prototype and visitor feedback and refine the exhibit concept. Process Curiosity will create conceptual renderings, layout, exhibit description, and prototype.

- *Consult with school partners (October – November 2024)*: School program staff will convene a meeting of the Educator Advisory Council to explore what, if any, climate change or sustainability-related content teachers are using in their classrooms. While it is not included in the state's curriculum framework, individual teachers may use or be aware of outside resources. The group will explore ideas for activities that connect to this content or brainstorm new ideas.

- *Consult with accessibility advisors (October – November 2024)*: We will share preliminary design plans with our standing group of accessibility advisors, as well as consult with Process Curiosity's Universal Design experts to ensure we are fully considering opportunities to remove potential barriers to access.

- *Develop, test, revise, deliver, and evaluate related facilitated public program #1 (October 2024 – January 2025)*

- *Develop exhibit label text (November 2024)*: Director of STEAM Education, Liz Leahey, who has created exhibit labels for many of Discovery Museum's newest exhibits, will draft text to accompany the exhibit prototype.

- *School group curriculum development (November 2024 – January 2025)*: School program staff will work internally to design and test several Field Trip orientation activities. During the prototype testing period, they will pilot an activity or activities with four Field Trip groups. They will collect teacher feedback and informally observe students interacting with the exhibit.

- *Develop, test, revise, deliver, and evaluate related facilitated public program #2 (December 2024 – March 2025)*

- *Prototype testing (December 2024 – January 2025)*: The exhibit prototype with be tested over 6 to 8 weeks with Museum visitors and school groups. For comparison, 28,000 visitors and 1,300 Field Trip participants visited the Museum during this same time period—which includes the busy winter school vacation week—in December 2022 and January 2023. The external evaluator will oversee data collection with an additional 16 hours of observations and interviews performed by staff Explorers.

- *Formative evaluation (December 2024 – January 2025)*: Consultant Betsy Loring of ExpLoring Exhibits & Engagement will design a formative evaluation tool (observations and interviews) to assess the functionality of the exhibit and its reset mechanism; assess whether the exhibit provides a meaningful experience for both school and family groups; and determine what instructional text or illustrations would support visitors in

operating the exhibit and understanding key concepts. The evaluator will train Museum team and two Explorers (floor staff) on best practices for conducting observations of visitors and using the evaluation tool.

- *Graphic direction (January 2025):* Discovery Museum marketing team will design exhibit-specific graphics for use on our website, exhibit guides (available in every gallery), and in school program materials.

Final Design (January – February 2025):

- *Refine exhibit design (January – February 2025)*: Project team will finalize the design based on formative evaluation results. Fabricator will develop a digital model, identify materials and finishes, and generate a detailed exhibit design package.

- *Finalize exhibit text (February 2025):* Liz Leahey and Museum team will finalize exhibit label based on formative evaluation results.

- *Finalize Field Trip Activity and follow-up guide (February 2025 – April 2025)*: School program staff will refine final activity and assemble 12 activity kit boxes, each containing materials for a group of students to explore together. School program staff will also develop a follow-up activity guide during this time with support from the marketing staff, who will layout and print the packets.

Fabrication and installation (February – June 2025):

- *Fabrication of exhibit components by external fabricator (February – April 2025)*

- *Graphics production (March – April 2025)*: Marketing team will produce the exhibit sign and labels.

- *Develop, test, revise, deliver, and evaluate large-scale facilitated public program #3 (March – June 2025):* Program staff will develop the large-scale event building on facilitated programs already produced, collaborating with content advisors, and identifying local organizations that are involved with energy generation and delivery.

- *Explorer staff training (April 2025):* School program team will train six Explorers to implement the new orientation activity for visiting school children.

- *Updates to website and visitor surveys (April – May 2025)*: Marketing team will add new solar cell exhibit and related programs to Museum's website and add relevant questions about engagement with the exhibit to the Museum's existing visitor survey.

- *Exhibit installation and opening (May 2025):* Exhibit fabricator with support from the Museum facilities team will install exhibit on Museum floor.

- *Pilot school program (May – June 2025):* Field Trip orientation activities will be piloted with 8 additional school groups. Participating schools will be selected in order to ensure we include a broad range of grade levels in the prototyping process. We will waive Field Trip fees for these groups in consideration of the additional time they will spend providing program feedback. A typical school group has between 30 and 65 participants.

Post-opening (May – August 2025):

- *Remedial evaluation of exhibit (May 2025)*: The external evaluator and staff will assess whether any operational issues remain and identify corrective steps. Text, graphics, program materials, and school resources will also be assessed to determine whether final revisions are needed.

- *School Program evaluation (May – June 2025):* External evaluator with support from Museum Explorers will observe school groups to assess whether the orientation activity and accompanying resource packet engage students and prompt them to interact with the solar panel exbibit. Evaluation will also assess whether student discussions demonstrate understanding of key concepts and whether teachers find the ties to curriculum valuable. The external evaluator will also develop a teacher feedback form for all teachers participating in pilot school visits (2-6 teachers per field trip) to assess the impact of the exhibits and resources. Staff explorers will conduct three days of observations. The evaluator will summarize recommendations for modifications to the orientation program and resource packet.

- School program modifications *(July – August 2025)*

- *Summative evaluation (July – August 2025):* External evaluator will oversee interviews and observations of visitor interactions to assess if we achieved our intended outcomes, including whether visitors understood key concepts and expressed an interest in learning more about renewable energy, climate change, or related topics.

Project Results

Project outputs will include the new *Play Inside a Solar Cell* exhibit, with graphics and explanatory signage; a set of three facilitated public programs that complement exhibit content; a new Field Trip orientation activity about solar cells; and a follow-up activity guide for continued exploration in the classroom and at home, all of which will become integral parts of our environmental education program beyond the project period. This project will also generate actionable data about the questions, curiosities, and interests that the exhibit and new programs provoke in visitors, students, and teachers that will guide the planning of future learning experiences. Staff will also gain experience in translating technical content to an audience of early learners, which will support future program development.

For visitors and school groups:

As with all Discovery Museum learning experiences, *Play Inside a Solar Cell* and related programs will offer opportunities for children of different ages to practice STEM skills, such as observing, predicting, problem solving, and describing, and for adults to guide their children's exploration and facilitate conversation about the content. With respect to exhibit-specific outcomes, we see this project as achieving the following:

Knowledge: Through their interaction with the solar cell exhibit and related programming, children, adult caretakers, and school group participants will increase their understanding (to different degrees depending on age) of the following key science concepts:

- A solar cell transforms energy from the sun into electricity we can use to power our lives;
- Inside a solar cell, photons from the sun "knock" electrons out of place, creating an electric current;
- Inside a solar cell, when electrons are knocked into "holes" or photons fall through other layers, this can negatively influence the efficiency of the cell.
- A solar array, like the one on the Discovery Museum grounds, is made up of tens of thousands of solar cells like the single one modeled by the exhibit;
- Solar energy is a renewable resource. Generating more of our electricity from the sun is one way people are working to mitigate the impacts of climate change;
- Solar energy is just one form of energy we use to generate electricity. We also harness energy from wind, water, hydrogen, fossil fuels, and other sources.

Attitudes: The exhibit and related programs will lead to increased curiosity among visitors and school program participants about renewable energy sources, climate change, and related topics, as well as an increased awareness of

the impacts of human energy consumption. Children will also feel hopeful about society's intentions to address the impacts of climate change and feel empowered to participate in that effort and share their knowledge with others.

Behaviors: Visitors and school group participants will think about how their own actions impact the environment, take steps (big or small) to reduce their or their families' environmental impact, and advocate for change. Teachers will also integrate exhibit and program content into their curriculum using our follow-up activity guides.

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Project Activities	2024				2025							
	Sept	Oct	Nov	Dec	Jan	Feb	March	April	May	June	July	August
Design development												
Project kick off meeting with Museum team, evaluator, Process Curiosity team												
Bi-weekly meetings with project team												
Concept development by fabricator												
Consult with Educator Advisory Council												
Consultation with accessibility experts, UD staff												
Develop, test, revise, deliver, and evaluate related facilitated public program #1												
Develop exhibit label text												
School group activity development and piloting with four Field Trip groups												
Develop, test, revise, deliver, and evaluate related facilitated public program #2												
Test enhanced prototype and text with visitors, student groups, teachers												
Formative evaluation of prototype, with training for staff evaluators												
Determine graphic design direction												
Final Design												
Refine details, drawings, confirm materials/finishes												
Finalize exhibit text												
Finalize Field Trip activity and follow-up guide												
Fabrication and Installation												
Fabrication of exhibit components												
Graphics production												
Develop, test, revise, deliver, and evaluate large-scale facilitated public program #3												
Explorer staff training with orientation materials												
Updates to Museum website and visitor surveys												
In-museum installation & exhibit opening												
Pilot school orientation program with 8 groups												
Post-Opening												
Remedial evaluation of exhibit												
Evaluation of school orientation program												
School program modifications												
Summative evaluation												

Applicant Name: Discovery Museum
Project Title: Play Inside a Solar Cell

Performance Measure	**Data We Will Collect** (e.g., counts, costs, weights, volumes, temperatures, percentages, hours, observations, opinions, feelings)	**Source of Our Data** (e.g., members of the target group, project staff, stakeholders, internal/ external documents, recording devices, databases)	**Method We Will Use** (e.g., survey, questionnaire, interview, focus group, informal discussion, observation, assessment, document analysis)	**Schedule** (e.g., daily, weekly, monthly, quarterly, annually, beginning/end)
Effectiveness: The extent to which activities contribute to achieving the intended results	• During the project year, external evaluation consultant will report on formative evaluation (observations and interviews) and compare results against our intended outcomes. • Once during the project year, external evaluation consultant will report on summative evaluation (surveys and interviews) and compare results against intended outcomes. • Following exhibit installation, external evaluation consultant will report on remedial evaluation (observations and interviews) and compare against intended results. • Following exhibit installation, Museum staff will review post-visitation surveys from visitors and assess satisfaction with the solar panel exhibit (specific exhibit-related questions will be added to the established tool and implemented as we typically do). • During the project year, external exhibit evaluator will report on education program evaluation (observations and teacher feedback forms) and compare results against intended outcomes. • At three points during the project year, the Museum's program team will assess the outcomes of pilot public programs through observations, surveys, or interviews and compare against intended results.			

Efficiency: How well resources (e.g., funds, expertise, time) are used and costs are minimized while generating maximum value for the target group	• Each month during the project year, we will tabulate the number of hours staff members and external consultants have contributed to this project to assess whether time spent aligns with the project plan. • Weekly during evaluation periods, we will confer with external evaluator and Museum staff involved in performing observations and administering visitor surveys to ensure they are obtaining sufficient counts for data validity, to assess inter-rater reliability, and to iterate evaluation tools as needed. • Bi-weekly following exhibit installation, we will confer with internal facilities team and fabricator to ensure exhibit remediation is occurring in accordance with the results of the remedial evaluation.
Quality: How well the activities meet the requirements and expectations of the target group	• Periodically during design and prototype testing phases, we will confer with education, accessibility, and science advisors to assess whether the exhibit and related text align with their respective expertise. • Following exhibit installation, we will gather opinions via questionnaire from educators with visiting school groups about whether the solar panel exhibit and related orientation activity met expectations and ultimately delivered a meaningful educational experience to their constituents.
Timeliness: The extent to which each task/activity is completed within the proposed timeframe	• Bi-weekly during the project period, the Project Director will compare program staff progress against Schedule of Completion. • Every week during school program staff meetings, the Director of School and Group programs will compare staff progress against Schedule of Completion. • Every two weeks during internal exhibit staff meetings, the Project Director will compare staff progress against Schedule of Completion.