Enabling and Sustaining Connected Communities Rooted in Solving Societal Challenges

Carnegie Mellon University

Metro21
SMART CITIES INSTITUTE

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Introduction

Less than ten years ago, the promise of smart cities seemed ripe with opportunities to improve quality of life through technologies like cameras and Internet of Things (IoT) devices with a layer of artificial intelligence (AI) behind them to streamline and optimize operations. Since that time, the shine has worn off and the framing of these issues has also shifted from smart cities to connected communities, as the integration of intelligent technologies is not limited to just cities, but can be used in rural, tribal and remote areas as well. Connected communities technology projects often do not go past the pilot stage; are application and context specific; are not implemented at scale; do not explicitly integrate community input during design, planning or operation; and largely consist of isolated platforms or systems of operation without integration.

To better understand and address these issues, the National Science Foundation (NSF) funded Carnegie Mellon University's Metro21: Smart Cities Institute (Metro21) to host a workshop entitled *Enabling and Sustaining Connected Communities Rooted in Solving Societal Challenges*. The in-person workshop and pre-workshop virtual listening sessions were designed to elicit feedback and suggestions from experts in academia, government, nonprofits, civic organizations, and industry to identify solutions to the significant technical, policy, and socioeconomic challenges to integration and scaling of connected communities technologies. We heard from experts in the following domains: mobility/transportation, energy, climate resilience, ecosystem services and multiple applications. The resultant solutions and suggestions are summarized in the following report. Findings are based on discussions from the two-day workshop, five pre-workshop listening sessions, and three surveys.

WORKSHOP FINDINGS

Workshop input largely applied to three critical roles in connected communities projects:

1. **National Science Foundation** and other funders
2. **Academia** and other research and technology experts, and
3. **Local governments** and other community organizations

We therefore organized input directed to each of these roles. Inputs can largely be categorized under three impact areas:

1. **Putting communities in the lead:** There is a need to better align technology with community needs. This could be addressed by investing in early partnerships between researchers and communities, especially local governments. To support this activity, it's important to have dedicated staff at local governments and universities to facilitate partnerships. It is especially important for communities to be involved in proposing and selecting projects. Guidelines and best practice documents can be created to inform researcher-community partnerships, as well as the inclusion of human-centered design principles to ensure solutions were useful for communities.

2. **Sustaining Innovations:** There are several challenges to sustaining technology deployments beyond initial pilot projects. Funders, researchers, and community partners can invest in evaluating the effectiveness of technologies and improving technical skills and capacity in community organizations to sustain and expand technology deployments.

3. **Integrating and Scaling Successful Technologies in New Communities:** Communities want more (and unbiased) information about technologies that have been tested elsewhere to make decisions about which ones to integrate into their own communities. Building and actively disseminating evidence about the effectiveness of technologies under different circumstances is key to helping communities make informed decisions about which technologies to adopt and thereby scale their impact.

Below, we outline the potential solutions in tables organized by audience/roles (described further in the Workshop Findings section of this report).

PUTTING COMMUNITIES IN THE LEAD

National Science Foundation

1. Compensate researchers, local governments, and community members for early partnership-building and scoping work.
2. Incentivize plans detailing how researchers will work with communities in grant proposals.
3. Fund intermediary facilitators at universities and local governments who can help organize and manage continuous partnerships.
4. Create opportunities for communities to propose problems and set success metrics.
5. Connect communities with researchers doing work that is relevant to their needs.
6. Support the creation of regional innovation plans.
7. Include non-academics in grant review panels.
8. Incentivize multidisciplinary research into connected communities, including social scientists and human-centered design.
9. Provide funding and guidelines to improve communication and trust in communities.
10. Establish guidelines and best practices for connected communities projects.
11. Coordinate with other government agencies to address pressing community needs and amplify efforts.

Academia

1. Build and maintain trusting partnerships.
2. Hire staff to facilitate and sustain trusting community partnerships.
3. Streamline processes for community partnerships.
4. Support grant writing in all departments.
5. Prioritize diversity, equity, inclusion, and accessibility.
6. Compensate community members and government employees for participating in partnerships.
7. Create multidisciplinary teams, including human-centered design and social scientists.
8. Incentivize and reward researchers who invest their time and effort into research with community partners.
9. Create multidisciplinary spaces for connected communities research.
10. Adjust overhead requirements for grants funding community partnerships.

Local Governments

1. Create staff roles that facilitate sustained partnerships with universities.
2. Streamline processes for partnering with universities.
3. Improve contracts with third-party vendors, ensuring data sharing.
4. Ensure equitable and inclusive community involvement.

SUSTAINING INNOVATIONS

National Science Foundation

1. Fund evaluations of connected communities technology.
2. Fund transition of research pilots to integration and scale.
3. Incentivize evaluation and sustainability plans in grant proposals.
4. Support research into technical skills and capacity that community partners need to sustain, integrate, and scale technologies.
5. Fund training programs for technical skills and capacity of community partners.

Academia

1. Research, develop, and offer training programs to increase institutional capacity of community organizations and municipal governments.
2. Research and develop legal and policy guidelines for successful technology deployments.

Local Governments

1. Identify and invest in areas necessary to sustain and scale connected communities technology.
2. Update laws and policies to support new technologies.
3. Actively foster a culture that is open to data and innovation.
4. Work with private entities to align their interests with innovation.

INTEGRATING AND SCALING SUCCESSFUL TECHNOLOGIES IN NEW COMMUNITIES

National Science Foundation

1. Create a public portal where people can learn about the results of NSF-funded projects.
2. Support research into the factors that impact technology's success, including meta-analyses and comparative studies.
3. Support research into organizational behavior.
4. Support research into particularly challenging contexts.
5. Fund development of conferences and journals where researchers can present and publish social impact research.
6. Support networks and events that connect communities with technology solutions.

Academia

1. Publicize applied research.
2. Publish results of unsuccessful projects.
3. Conduct research into the conditions that lead to successful projects.

Local Governments

1. Commit to publication of research in your communities.
2. Commit resources to investigating public innovations

Conclusion and Next Steps

The workshop and listening sessions highlighted potential solutions to challenges integrating and scaling connected communities technologies. This report provides a potential path forward to funders, researchers, and community leaders to more effectively collaborate to achieve the promise of connected communities technologies. We encourage wide distribution of the findings of this report and hope that NSF will support turning these ideas into actions and invest in the promise of connected communities.

In the full report, we go into greater detail about background, methods, and findings of the workshop and listening sessions. We also provide detailed notes from the workshop and listening sessions in a Technical Appendix accompanying the report.

Enabling and Sustaining Connected Communities Rooted in Solving Societal Challenges

FULL REPORT

Project Background

Less than ten years ago, the promise of smart cities seemed ripe with opportunities to improve quality of life through technologies like cameras and Internet of Things (IoT) sensors with a layer of artificial intelligence (AI) to streamline and optimize operations. Since that time, the shine has worn off and the focus has also shifted from smart cities to connected communities. Smart cities technology projects often do not go past the pilot stage, are application and context specific, are not implemented at scale, do not explicitly integrate community input, and largely consist of isolated platforms or systems of operation without integration. They often ignore, only to realize later, issues of privacy, security, accessibility, and public acceptance of such technologies. Communities are suspicious of technology deployments (i.e., "techlash"), municipalities are cash-strapped and face challenges to build back better after the COVID-19 pandemic, and industry partners are wary of jumping back into a market often estimated to be worth billions of dollars.

To better understand and address these issues, the National Science Foundation asked Carnegie Mellon University's Metro21: Smart Cities Institute (Metro21) to host the Enabling and *Sustaining Connected Communities Rooted in Solving Societal Challenges workshop*. The in-person workshop and pre-workshop virtual listening sessions brought together experts from academia, government, nonprofits, industry, and civic organizations to identify solutions to the significant technical, policy, and socioeconomic challenges to integrating and scaling connected communities technologies. We were intentional in our desire to include a diversity of perspectives and backgrounds, and heard from experts in the following domains: mobility/transportation, energy, climate resilience, ecosystem services and multiple applications.

In this report, we share input from workshop participants about how organizations, including local government, academia, and funders like the National Science Foundation, can help integrate and scale connected communities technologies. These findings include ways these organizations can ensure that technologies are matched to community needs, sustained beyond initial pilots, and adopted and expanded to new communities. They include ideas about how to support early research scoping community needs, develop guidelines and best practices for university-community partnerships, evaluate the conditions that lead to successful technology deployments, foster multidisciplinary research, build community capacity for sustaining and expanding technology, and disseminate learnings from projects. It is our hope that these findings can pave a path forward for integrating technology into communities in ways that improve people's lives.

Background and role of National Science Foundation

The workshop was funded and supported by the U.S. National Science Foundation's Directorate for Technology, Innovation, and Partnerships (TIP). The National Science Foundation (NSF) is an independent federal agency established by Congress to advance the progress of science and engineering, chiefly by making grants that fund research and education by scientists and engineers. TIP advances user-inspired and translational research in all fields of science and engineering, giving rise to new industries and engaging all Americans, regardless of background or location, in the pursuit of new, high-wage jobs in science, technology, engineering, and math (STEM). Members from NSF also attended the workshop as observers and provided valuable feedback on the design of the workshop, listening sessions, and final report.

Background and role of Metro21: Smart Cities Institute

Metro21: Smart Cities Institute is an interdisciplinary research and implementation center at Carnegie Mellon University (CMU) that works with metropolitan and rural communities to tackle some of their most pressing real-world challenges. Led by Director Raj Rajkumar and Executive Director Karen Lightman, Metro21 connects municipal and equity partners with CMU researchers to deploy innovative technology solutions to solve real-world problems identified by the community. With colleagues Burcu Akinci, Mario Bergés, and Katherine Flanigan from CMU's Department of Civil and Environmental Engineering, Metro21 planned and led the *Enabling and Sustaining Connected Communities Rooted in Solving Social Challenges* workshop and listening sessions. Metro21 has significant experience working with community partners to design and deploy connected communities technology projects and leading workshops to inform work on such projects.

Workshop Design

The goal of the workshop and preceding listening sessions was to elicit input from participants on potential solutions to pressing challenges facing the integration and scaling of connected communities technologies. To accomplish this, the project team first organized a series of listening sessions aimed at highlighting the diverse array of challenges facing connected communities projects and some of the solutions participants had developed. Based on that feedback, the project team then designed a workshop aimed at generating potential solutions to those challenges. During the workshop, the project team also asked participants to respond to three surveys that were used to inform the findings of this report.

Pre-Workshop Listening Sessions

To better understand the challenges facing connected communities technology projects, the project team held a series of five listening sessions around key topic areas including climate resilience, ecosystem services, energy, mobility and transportation, and multiple applications. The goal of these sessions was to generate honest feedback about challenges facing practitioners from government, industry, and academia in the process of deploying, sustaining, and scaling connected communities projects. Listening sessions were moderated discussions attended by practitioners from local government, nonprofits, consulting, industry, and academia. Sessions were held and recorded via video conference (for internal use only) and a scribe took notes.

Moderated listening sessions lasted 90 minutes and were guided by high-level questions to generate open discussion and feedback about challenges in connected communities projects. The following questions were used to guide discussion:

- **Future plans:** What are your actual or intended plans for the future relative to this topic of smart cities deployment? What are the challenges that you face and what could NSF do to help address them?
- **Cybersecurity and privacy:** How do you plan to address cybersecurity and privacy issues related to this topic of smart city deployment? What are the challenges and barriers? What do you need to address them (policy, technology, funding)?
- **Data management:** How do you plan to address issues related to data management that enables transparency while still preserving privacy? What are the challenges and barriers? What do you need to address them (policy, technology, funding)?
- **Co-creation and community engagement:** How do you co-create with communities (community, city government, developer/owner, and technology providers) to ensure that smart city technologies are equitably deployed?

Anonymized notes from the listening sessions can be found in the Technical Appendix accompanying this report.

In-Person Workshop

A two-day in-person workshop was scheduled, organized, and designed to get feedback from practitioners in government, nonprofits, industry, and academia about possible solutions to challenges facing connected communities projects. Notes from the listening sessions were synthesized into four themes that guided the workshop discussion:
- Enabling connected communities beyond pilot projects
- Matching community needs with technology solutions
- Designing, deploying, monitoring, and evaluating technology to ensure effectiveness, efficiency, and equity
- Managing, sharing, and analyzing data to enhance communities quality of life and protect privacy

42 people attended the workshop: 9 from local governments; 12 from federal government; 13 from universities; and 8 from nonprofits, industry, and consulting. Attendees came from all over the United States and represented urban, suburban, rural, and tribal communities. Federal government attendees represented a variety of agencies including the National Science Foundation, US Department of Agriculture, US Department of Transportation, US Department of Housing and Urban Development, and the White House Office of Science, Technology and Policy.

The workshop was organized to encourage broad and diverse feedback. Each theme was first introduced in a general session via a 20-minute moderated roundtable featuring two practitioners with experience implementing connected communities projects. Each general session was followed by a breakout session during which each participant joined a breakout group of about 10 people. Each breakout group engaged in a moderated discussion that was recorded in notes by a scribe. The first 45 minutes of each breakout session were devoted to open discussion framed by guiding questions. These questions vary by topic and are available in the Technical Appendix.

After 45 minutes of open discussion, moderators guided their breakout groups to spend 20 minutes developing potential solutions to the challenges they discussed. These were also recorded by the scribe and then shared with the full group of attendees in a 20-minute general session. With regard to each theme, participants were asked for their input on how NSF could support work related to the theme, what transformative and incremental research gaps needed to be filled, and who should be involved in work related to the theme and what their role should be. To encourage creativity and diversity of opinion in breakout sessions, attendees were reassigned to different breakout groups on the second day of the workshop.

After discussing the four themes following the format described above, participants were invited to rejoin their breakout groups at the end of the two-day workshop to choose their highest-priority input from the workshop. Attendees were asked to answer the following questions:

- What input do you have for NSF to support integration and scaling of connected communities technology?
- What are the transformative and incremental research gaps that need to be filled to integrate and scale connected communities technology?
- Who should be involved in integrating and scaling connected communities technology and what should their role be?

Responses to these questions were reported out in a final general session and recorded. Notes from workshop and listening sessions were used to inform the findings of this report. Participants of the workshop were also asked to complete a pre-survey before the workshop, a survey after the first day of the workshop, and a final survey at the end of the workshop, which also informed this report. Anonymized notes from the workshop and listening sessions can be found in the Technical Appendix.

Workshop Findings

To identify and inform solutions to common challenges to integrating and scaling of connected communities technology, we combined feedback from participants at the two-day workshop with input from pre-workshop listening sessions and surveys collected during the workshop. The workshop, listening sessions, and surveys were designed to foster and elicit diverse, creative ideas that could solve challenges, not just identify them.

Findings from the workshop can be broadly organized under three impact areas: 1) The need to put **communities in the lead** of connected communities projects; 2) The need to **sustain innovations beyond pilot projects**; and 3) The need to **scale and integrate tested pilots** to other communities.

While there are a number of roles in connected communities projects, the inputs from the workshop and listening sessions largely pertained to three actors:

1. **NSF and other funders:** NSF and funders play a key role in providing the resources necessary to support, sustain, integrate, and scale connected communities technologies. Funders like NSF are also well-positioned to create incentives for researchers and community organizations to tackle projects in ways that promote the sustainability and scalability of connected communities projects. While workshop participants largely directed their input towards NSF, much of the input is also relevant to other national and local funders.

2. **Academia and other researchers:** Researchers in and out of academia play an important role developing, deploying, and testing technologies that can benefit communities. They are key partners to community leaders, like local governments, in the effort to modernize infrastructure and integrate technology. In academia - and in particular, the staff - play a key role in building shared spaces for researchers and creating incentives for them to engage in research with communities. While workshop participants largely directed their input towards academic support staff and researchers, much of the input is also relevant to non-academic researchers who want to work with communities.

3. **Local government and other community leaders:** Community leaders, especially local government, play an important role in planning, deploying, monitoring, and sustaining connected communities technologies. They often play an important role identifying problems, connecting researchers with local communities, and integrating and scaling successful technologies after initial pilot projects. Workshop participants largely directed their recommendations to local governments, who often play a large role in this work, but much of the input is also relevant to other community leaders and organizations.

In what follows, we present our findings for each impact area and describe the role of each of these major actors in enabling and sustaining connected communities.

Putting Communities in the Lead

A major theme that emerged in the workshop and listening sessions was the need to align technology with communities' needs. An important way of doing this is putting communities in a position to articulate their needs to researchers, and researchers in a position to design technologies to meet those needs. NSF, academia, and local governments all play a role in ensuring that technology deployments address high-priority community needs.

National Science Foundation

NSF can help align technology development and deployment with community needs by incentivizing and compensating researchers and community members for participating in projects. NSF is well-positioned to support efforts to connect communities with researchers who can help them meet important needs by funding facilitators and creating opportunities for partnership building.

1. Compensate researchers, local governments, and community members for early partnership-building and scoping work.
   Often when researchers invest effort into early partnership building and project scoping with communities that effort is not compensated by funding grants. Furthermore, local governments and community members who contribute to this early work are often not compensated for their time and effort. NSF could encourage and enable partnership building and project scoping by funding early exploratory work to learn about community needs, including compensation for researchers as well as local government workers and community partners
   .

2. Incentivize plans detailing how researchers will work with communities in grant proposals.
   NSF could incentivize partnerships between researchers and community partners by rewarding researchers who provide long-term partnerships and detailed plans for how they will work with communities to address community priority areas around needs and innovations. NSF could develop a rubric for assessing grant applications based on the quality of authentic collaborative partnerships and partnership plans.

3. Fund intermediary facilitators at universities and local governments who can help organize and manage continuous partnerships.
   Researchers, government workers, and staff at community organizations have limited time to dedicate to building and maintaining research partnerships. NSF could encourage university-community partnerships by funding facilitators at universities and community organizations, like local governments, whose role it would be to actively build and sustain long-term partnerships. These roles should be filled by experienced professionals with sufficient technical knowledge to match community needs with technology solutions and an ability to navigate university and government administration to implement projects.

4. Create opportunities for communities to propose problems and set success metrics.
The creation of a platform where community organizations could share local challenges to solve with research and innovation can help with the co-creation process. Researchers could search the platform for problems, propose solutions, and get matched to community partners. This platform could be created or funded by NSF. A national organization that convenes researchers and communities around innovation could play a key role in coordinating or developing such a platform.

5. Connect communities with researchers doing relevant work.
NSF could provide additional assistance helping or funding an organization to help communities connect with researchers who are doing work that could benefit them. There are already national organizations that specialize in matching researchers with communities. By providing such organizations with additional resources, NSF could foster greater collaboration between researchers and communities on technology projects across the nation.

6. Support the creation of regional innovation plans. In many cases, municipalities and regions lack an established innovation or modernization plan to guide technological development. NSF is encouraged to support opportunities for local and regional governing bodies, research institutions, and other stakeholders to gather to share ideas, set goals, and establish plans and strategies for modernization.

7. Include non-academics in grant review panels.
Local governments and community organizations are well-positioned to ensure that funded projects are aligned with community needs and can play an important role on funding review panels for grants, especially for connected communities projects. While NSF currently includes non-academics on review panels, it is not always clear to review panelists how their feedback is incorporated into decision-making. NSF could more actively communicate the inclusion of non-academic reviewers on panels more broadly and ensure that panelists are aware of how their input affects final decisions.

8. **Incentivize multidisciplinary research into connected communities, including social scientists and human-centered design.**
NSF is encouraged to incentivize multidisciplinary research, especially the inclusion of social scientists and design researchers as co-investigators on connected communities projects. Specifically, design experts bring valuable knowledge about co-creation and can help ensure that technology is designed for community use; and social scientists know methods for evaluating the impacts of technology on social outcomes. NSF could more explicitly reward the inclusion of co-investigators from diverse research backgrounds to encourage academic research that is more collaborative and less siloed.

9. **Provide funding and guidelines to improve communication and trust in communities.**
Trust can be lost when researchers and practitioners do not communicate effectively and proactively with communities about technology and its expected benefits. Communities should be consulted with and informed before, during, and after technology pilots (in an evaluation). It is also important that communities understand that pilots are often iterative and that pilot technologies may not be those that are ultimately adopted and scaled. NSF can support this by funding proactive communication and training for researchers about best practices for communicating with communities.

10. **Establish guidelines and best practices for connected communities projects.**
The lack of clear guidelines and best practices for university-community partnerships and connected communities research is a challenge. Researching and establishing guidelines and best practices could help achieve stronger, more effective university-community partnerships for connected communities projects. Some areas where guidelines and best practices are most needed include:

   a. Co-creation and community-created success metrics
   b. Risk-assessment to help determine costs and benefits of deployments
   c. Technical and organizational readiness
   d. Data management, sharing, and interoperability
   e. Multidisciplinary evaluation
   f. Diversity, equity, inclusion, and accessibility (DEIA)

11. **Coordinate with other government agencies to address pressing community needs and amplify effort.**
Numerous federal government agencies, including USDA and HUD, have a local presence that connects them with community needs. Furthermore, federal agencies like NIH pursue research in fields adjacent to NSF, including public health. NSF is encouraged to actively coordinate with other federal agencies to identify and address

Academia

In order to enable the integration and scaling of connected communities technology projects, it is important for academic institutions to actively build and sustain partnerships with local governments and other community organizations. Universities can do this by supporting and rewarding researchers for working with community partners. Universities can take actions that are both incremental, small steps towards better community partnerships and large, transformative steps.

Incremental

1. **Build and maintain trusting partnerships.**
   To build and maintain trust, researchers and universities are encouraged to regularly collaborate with communities to provide transparency and accountability when projects do and do not provide the expected benefits. Researchers should actively communicate to communities about how technology can improve quality of life and prepare communities for technology rollouts. It is also important to set clear expectations and roles for both academic researchers and community partners in the project. In particular, pilot projects are often iterative and the final technology that is implemented may not always be the one that was originally created and tested.

2. **Hire staff to facilitate and sustain community partnerships.**
   Universities need to invest in staff roles that build and facilitate partnerships with local governments and other community partners to ensure consistency of engagement and build and maintain trust. Nonprofit organizations that convene academic-community partnerships could play a key role helping universities scope these roles.

3. **Streamline processes for community partnerships.**
   Universities can do a better job of setting up processes that streamline partnerships, including processes for approving and managing sponsored projects, data-use agreements, and ethics reviews. Universities should update contracting and other requirements to facilitate partnerships and find ways to embed faculty and staff within local governments and other community organizations to facilitate access to data systems. Likewise, universities can collaborate more efficiently by making these processes repeatable so researchers are not "reinventing the wheel" with each new partnership.

4. **Support grant writing in all departments.**
   Universities can provide grant writing training and support to all departments, including social science and design, which are integral to the successful deployment and evaluation of technology solutions.

5. **Prioritize diversity, equity, inclusion, and accessibility.**
   To ensure that connected communities technology projects lessen racial and other social disparities, researchers need to incorporate diversity, equity, inclusion and accessibility goals. In the same vein, researchers must strive to ensure that their designated community partners are representative of the diversity of the community they represent.

6. Compensate community members and government employees for participating in partnerships.
Researchers should make sure that community members are compensated for the time they devote to partnerships and co-creation. This includes staff at local governments (when allowable - as some government agencies do not allow compensation) and community organizations, as well as community members who participate in co-creation events. For co-creation events, compensation can be monetary, but can also include necessities like childcare, food, and transportation to the event. Researchers must budget sufficient grant funding to cover the costs of local governments and other community partners participating in projects and co-creation.

7. Create multidisciplinary research teams, including human-centered design and social scientists.
Researchers are encouraged to create multidisciplinary research teams for connected communities projects. In addition to technology experts, research teams should include experts in human-centered design, to increase the usability and accessibility of technology for communities, and social scientists, to inform how technology pilots are evaluated.

Transformational

8. Incentivize and reward researchers who invest their time and effort into research with community partners.
Universities could do more to incentivize and reward researchers for investing their effort into research with community partners. Universities could offer internal grants and awards to researchers who work with community partners and do more to highlight and celebrate their accomplishments. Research with community partners often requires long-term investment of time and effort in partnerships and co-creation, and applied research is not always treated the same as more traditional academic research in academic publications. Universities can adjust tenure requirements and reward academic researchers who dedicate their effort to applied research with community impact to encourage and reward this work.

9. Create multidisciplinary spaces for connected communities research.
Academic researchers working on connected communities research are often siloed in their own departments. To address this issue, one suggestion is to have more interdisciplinary shared space to encourage collaborative, multidisciplinary connected communities research. Such spaces could include shared physical office space, as well as centers, events, and forums.

10. Adjust overhead requirements for grants funding community partnerships.
Though this is not seen as an easy lift, universities are encouraged to adjust overhead requirements for grants funding projects with community partners. Lower university overhead rates would allow larger portions of grants to go towards compensating community partners for effort they put into projects. Universities could accomplish this by scaling down the overhead they require for portions of grants that compensate community partners. Universities could also dedicate a portion of overhead from projects funding community partnerships to maintaining staff roles dedicated to facilitating those partnerships.

Local Governments

Local governments also play an important role in deploying, evaluating, sustaining, and scaling connected communities projects. Local governments need capacity and resources to manage partnerships; collect, manage, and share data; engage communities; and sustain and scale projects beyond initial pilots.

1. **Create staff roles that facilitate partnerships with universities.**
   Like universities, local governments need staff roles that are dedicated to building and maintaining partnerships with universities and other research partners. These staff should be knowledgeable in local government processes, priorities, and capacity, as well as the requirements of technical projects. Local governments require resources to sustain such roles and should be compensated by grants from funders like NSF.

2. **Streamline processes for partnering with universities.**
   To better collaborate with university partners, local governments can streamline processes required for connected communities project partnerships with universities, including processes for accepting grant funding, procurement, data sharing, and other project agreements. Local governments should also explore ways to give research partners access to their data and technical systems, including sandbox environments or embedding researchers in government agencies as fellows or volunteers.

3. **Improve contracts with third-party vendors, ensuring data-sharing.**
   Local governments are often limited by third party agreements when attempting to collect, integrate, and share data. To address this issue, local governments can review and update agreements with third-party data and technology vendors to ensure they can access, integrate, and share data that is generated by those vendors. They can also update their policies with respect to third-party data and technology procurements to ensure that they have access to data generated by that technology and that the data can be integrated with other data and shared.

4. **Ensure equitable and inclusive community involvement.**
   To enable equitable and inclusive community engagement, local governments can ensure that participation in connected communities projects is diverse and inclusive and that the goals of those projects are consistent with increasing equity and reducing racial and other social disparities.

5. **Help research partners communicate proactively and build trust with communities.**
   Local governments play a critical role in coordinating projects with the community. Local governments are often closer to the community than researchers, and can provide important context, as well as help arranging opportunities for communication and co-creation. Local governments should work with research partners to actively communicate projects with communities and ensure that a diverse set of voices is heard. Local governments should also ensure transparency and that trust is built and maintained over the course of the project.

Sustaining Innovations

Another theme that emerged is the need to sustain innovations beyond early pilot projects and the even more critical need for evaluating technology deployments to determine which technologies should be sustained and scaled. Local governments and other community partners need the resources and capacity necessary to maintain and expand successful technologies beyond pilots.

National Science Foundation

To help sustain technology beyond pilot projects, NSF can reward research that evaluates the impact of technology to assess whether it should be sustained and scaled. NSF can also structure grants to provide resources to local governments and other community organizations to integrate and scale effective technology.

1. **Fund evaluations of connected communities technology.**
    Evaluating connected communities technology is key to identifying which technologies communities should sustain, integrate, and scale. Social scientists, in particular, are adept at designing and implementing these kinds of evaluations in community settings. To incentivize multidisciplinary teams, NSF can require or reward the inclusion of researchers from other disciplines, including social science, as primary investigators.

2. **Fund transition of research pilots to integration and scale.**
    Grants do not always include funding for integrating and scaling technologies into local operations when the initial deployment proves successful. Frequently, after pilots, communities are left searching for resources to sustain and expand the use of beneficial technologies. To encourage transition to the next phase of development, NSF could structure grants to include funding for integration and scaling of technologies after successful pilots.

3. **Incentivize evaluation and sustainability plans in grant proposals.**
    In order to decide which technologies to integrate and scale, it is necessary to know whether those technologies have the desired impact on community needs. Furthermore, if technologies prove impactful, communities will need resources to integrate and scale those technologies. NSF could encourage evaluation, integration, and scaling of connected communities technologies by requiring or rewarding investigators for including evaluation and sustainability plans in their grant proposals. NSF could also structure grants to support integration and scale of successful technologies past pilot projects.

4. **Support research into technical skills and capacity community partners need to sustain, integrate, and scale technologies.**
    Local governments and other community partners do not always have the human or technical capacity to sustain and scale technology beyond what was done in initial pilots. NSF could fund research into the institutional capacity necessary for local governments and community partners to successfully sustain and expand technology beyond pilots and how best to build that capacity.

5. **Fund training programs for technical skills and capacity of community partners.**
    There is a need to fund programs that would train staff at local governments and other community partners in technical skills that would allow them to sustain and scale technology beyond initial pilot projects.

Academia

Universities are an important space for collaborative research and education. As educators, universities are well-positioned to help local governments develop the capacity to sustain, integrate, and scale connected communities technologies. To address this issue, universities and researchers can develop training programs to upskill staff in local governments and other community organizations to support technology deployments.

1. **Research, develop, and offer training programs to increase institutional capacity of community organizations.**
   Local governments and other community organizations often do not have the technical skills and capacity required to sustain and scale successful connected communities technology. There is a need to understand institutional capacity gaps in local governments and community organizations and universities are encouraged to develop and offer training programs to fill them.

2. **Research and develop legal and policy guidelines for successful technology deployments.**
   In addition to the technical skills required to sustain connected communities technologies, there are legal and policy factors that impact successful deployment and scaling of these technologies. Researchers can encourage adoption and scaling of these technologies by researching and establishing legal and policy guidelines and best practices that support technology deployments and sharing them with government and community partners.

Local Governments

When pilots end, local governments are often responsible for sustaining and scaling technology deployments. Given this potential opportunity, local governments should identify growth areas and build the technical capacity and skilled workforce necessary to sustain technology beyond pilots. Local governments can also create policy environments and cultures that are more conducive to integrating technology into regular operations, so that this transition is anticipated and staff are more prepared for it.

1. **Identify and invest in areas necessary to sustain and scale connected communities technology.**
    Many local governments lack the technical skill and capacity to sustain and scale connected communities technology after pilots. For connected communities projects to be successful, local governments must find resources to invest in developing the skills and technical capacity required to support these technologies, including local, state, federal, and private funding.

2. **Update laws and policies to support new technologies**
    Currently, many local governments have laws and policies that are not conducive to technology innovation. Local governments are encouraged to adopt laws and policies that facilitate procurement and integration of new technologies.

3. **Actively foster a culture that is open to data and innovation.**
    Local governments are not always open to data and technological innovation yet there is a need to improve best practices around data (storage, ownership/stewardship, sharing). This hesitancy on behalf of local government can be related to several factors, including aversion to the risk of new technologies, lack of understanding of the benefits of those technologies, and concerns that government workers may be displaced by new technology. Government leaders could take a more proactive role in fostering a culture that is open to data and innovation by finding ways to mitigate risk through funding and partnerships, upskilling workers to understand and leverage new technology, and fostering an environment of trust ensuring government workers that their jobs will be enhanced, not replaced, by new technology. Local governments should work with researchers and entities like NSF to adopt guidelines and best practices for data management, sharing, and interoperability.

4. **Work with private entities to align their interests with innovation.**
    Private entities like utility companies, developers, and landlords often play an important role in the integration of connected communities technologies into built environments. For technology deployments to succeed, these private actors must be open to updating and integrating technology into infrastructure they own, like power grids or buildings. And at the same time, local governments are encouraged to work with these private entities to ensure their interests are aligned with innovation.

Integrating and Scaling Successful Technologies into New Communities

A goal of connected communities research is to scale the impact of beneficial technologies by integrating them into other communities. However, communities often do not adopt successful technologies because they do not have enough information about those technologies and their benefits. NSF, academic researchers, and community partners can do more to share information about technologies that do (and do not) successfully improve outcomes in communities.

National Science Foundation

NSF plays a key role in the development and dissemination of evidence that can help communities make informed choices about what technologies to adopt. To further encourage this, NSF can provide funding for research into the factors that contribute to successful technology deployments and to actively disseminate the results of both successful and unsuccessful deployments to local governments and other community leaders.

1. **Create a public portal where communities can learn about the result of NSF-funded projects.**
    A portal that provides community leaders an opportunity to learn about both successful and unsuccessful connected communities projects can help them make informed decisions about what technologies to adopt. It is important that such a portal is open access and that information is presented in an accessible way that will enable policymakers, who may lack a technical background, to understand the information and use it to make decisions. Nonprofit organizations could play a key role in coordinating or developing work on the portal. NSF's Smart and Connected Communities website has valuable content but requires more exposure, sorting capabilities, and dissemination to be effective.

2. **Support research into the factors that impact technology's success, including meta-analyses and comparative studies.**
    The success of technology deployments may hinge on existing physical and digital infrastructure, social and economic factors in communities, and the legal and policy environment. Research that compares the success of technology deployments in different environments could help local governments and other organizations understand what might be effective in their communities. Such analyses could include literature reviews or meta-analyses of existing research, or comparative studies based on deployment of the same technology in multiple communities.

3. Support research into organizational behavior.
   There is a need for more research into organizational behavior, including the structures and coalitions that enable successful projects in local governments and communities. Buy-in from private sector actors, like utility companies, developers, and landlords, is also necessary to incorporate new technologies into the built environment. Understanding the conditions under which such actors incorporate these technologies into infrastructure they own could help more communities successfully adopt them.

4. Support research into particularly challenging contexts.
   Deploying new technologies in some communities can be more challenging than in others. In particular, remote rural and tribal communities often face distinct challenges integrating new technologies, often due to unique geographical, infrastructure, and policy hurdles. Tribal communities especially have struggled with the limitations of outdated federal and state policies that restrict their ability to adopt and integrate new technology. Further, tribal areas often do not have research universities in local colleges. NSF can play a critical role supporting research into technology adoption and integration in tribal communities and to help foster stronger local research capacity in those communities.

5. Fund the development of conferences and journals where researchers can present and publish research with a social impact.
   Funding the creation of conferences and journals for connected communities technology research could help motivate and reward researchers and encourage collaboration. Academic researchers must publish and present research at conferences to achieve promotion and tenure. Conferences and journals establish an academic literature to which researchers can contribute and from which they can learn. To the extent that journals and conferences are open to research from a variety of disciplines, they can also encourage multidisciplinary research

6. Support networks and events that connect communities with technology solutions.
   Policymakers are often unaware of technology solutions that could address pressing problems in their communities. NSF can help support networks and fund events that connect community leaders with researchers and technologists. There are excellent examples of national organizations convening municipal governments with academic researchers to take successful pilot projects and deploy them in their communities.

Academia

Academia plays an important role in conducting and publishing research that informs the decisions of policymakers. In particular, academic researchers are well-positioned to investigate the factors that impact success of connected communities technologies in different settings. This research can help policymakers make informed decisions about which technologies to test in their own communities. Key to providing this valuable information is publishing and publicizing the results of both successful and unsuccessful connected communities projects.

1. Conduct research into the conditions that lead to successful projects.
   For communities to know which technologies to adopt, it is important for them to understand the conditions under which technologies are effective. To help understand which technologies might work best in different communities, it is important for researchers to investigate the factors that may impact the effectiveness of technologies. This can be done through comparative studies of the same technology across different communities. As more results and data are published from connected communities research, it will also be important for researchers to complete literature reviews and meta-analyses that can help inform the discipline and the communities adopting these technologies.

2. Publish the results of unsuccessful projects.
   In academia, there is often more incentive to publish and publicize the results of successful technology projects than there is to publish those that did not deliver expected benefits. Researchers are encouraged to publish the results of unsuccessful projects so that communities and other researchers can learn about what did not work.

3. Publicize applied research.
   Researchers can also publicize the results of their research beyond academic publications in order that non-technical audiences can access their learnings.

Local Governments

Local governments are often the prime decisionmakers when it comes to which technologies are tested, integrated, and scaled in their communities. It is important for local governments to dedicate staff time to investigating technologies that have been evaluated in other jurisdictions and to publish and publicize the results of technologies they try in their own communities. Local governments committed to research and evidence can fuel the impact and spread of valuable technologies.

1. Commit to the publication of research in your communities
   Local governments are often risk-averse and may be concerned about the political repercussions if they acknowledge a project did not generate the expected benefits. However, if they choose to see that experience as a learning opportunity, local governments can commit to publishing the results of connected communities projects, even if they do not produce anticipated benefits. In addition to creating transparency, it also helps other communities make informed decisions.

2. Commit resources to investigating public innovations.
   Similarly, local governments can commit staff time to learning about research on connected communities projects in other jurisdictions. This would be a good role for staff who are committed to building and managing research partnerships and technology adoption.

Conclusions

New intelligent technologies promise great benefits for society that can be harnessed to improve quality of life in our communities. Those benefits should extend to people throughout the United States, including those in urban, rural, and tribal communities and those who live in communities that have been historically disadvantaged. However, there are significant challenges to effectively integrating technology into our communities and scaling it in a way that benefits everyone in them.

The goal of this workshop was to spotlight potential solutions to these challenges. The findings in this report provide a potential path forward to NSF, academia, and local governments to more effectively collaborate to achieve the promise of connected communities technologies. However, it will be up to these parties to act on this input; this workshop is not an end to the conversation. It will be up to NSF, universities, researchers, and local governments to figure out how to put into practice the ideas in this report. Further development of these ideas will benefit from collaborative effort by people working in each of these domains, co-creatively and inclusively. We encourage NSF to support further work to develop these ideas into action and to invest in the promise of connected communities.