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Technology and innovation for cleaner and more productive and competitive production

Statement by

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26th United National Commission on Science and Technology for Development
Two-Minute Overview

Regina Gray
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Good morning (afternoon). I am delighted to join you on behalf of the U.S. Department of Housing and Urban Development's Office of Policy Development and Research.

I am Regina Gray, Director of the Affordable Housing Research and Technology Division in HUD's Office of Policy Development and Research.

Regarding digital and green transformation that coincides with the increasing adoption of green, innovative technologies:

The Department supports efforts to further initiatives that advance technology, including AI, with cost-savings realized through automation, timely and accurate reporting, and that promote equity and effectiveness through renewable energy options for low-income and marginalized communities. These efforts include expanding broadband access to lessen the digital divide, as well as smart technology for tenants, landlords, and assistive technologies to help seniors age in place.

HUD is working with several researchers to understand how housing and building technologies, such as submetering products, battery technology, solar technology and grid management may assist in not only lowering utility costs, but also assisting low- and moderate-income communities with understanding the importance of the impacts on health, safety and the improving the environment. Expanding broadband or internet service will go a long way to ensure that we are reaching the most marginalized segments of our nation, particularly as we continue to work remotely and search for affordable housing and other supportive services. This is a challenge for us, and we look to our international partners for strategies that enhance equity and inclusion in terms of the benefits that the adoption of these technologies will have on marginalized communities. We need to learn more about the use of AI and other emerging green technologies that the panelists mentioned.

Regarding the topics that advance the use of concrete and cross laminated timber, particularly in housing:

Two points worth mentioning here:

First, Concrete 3D printing technology *can produce affordable homes and communities within a short period of time and can handle higher dimensional analytics than conventional building processes. HUD is working with the Home Innovation Research Labs in Upper Marlboro, MD to help identify barriers to the adoption of the technology in construction practices and explore ways to expedite the integration of the technology in residential buildings. The biggest challenge*

here is the facilitation of widespread adoption to the market, increasing awareness and consumer education on the benefits of these sustainable technologies. I will discuss additional technologies later during the interactive event.

Second, Compressed Laminated Timber (CLT) *is a remarkably superior green innovation than natural wood, and is widely used structural materials such as plastics, steel, and alloys. Its stable in the presence of water/moisture. HUD has commissioned several studies testing the performance of this technology in housing construction projects.*

Addressing smart cities and the relationship to urban sustainability (community resilience & energy consumption)

The Department supports the cultivation of smart cities to promote urban sustainability through the accurate, precise, and timely reporting of data for progress on carbon-reduction strategies, especially as urban sprawl continues unabated. Smart cities can also facilitate the implementation of resilient and sustainable practices through enhanced automation, energy efficiency, specialized distribution, more walkable, transit-oriented development and the preservation of greenspace. We need more information on how smart cities achieve these goals without compromising our overarching mission to expand affordable housing options for all Americans—in other words, families should pay a premium to enjoy the benefits of more sustainable neighborhoods or communities. We have an opportunity to learn here.

Data driven approaches (weaving in equity and inclusivity):

The Department continues to improve its understanding and approach to equity and inclusivity through evidenced-based policymaking and data driven approaches, including participant-informed program improvements, policy evaluation to determine impact on housing affordability, and research endeavors to identify bias in regulations and program that exacerbate disparities. Further, the Department recognizes that social equity depends, in large measure, on the quality of data on its constituent communities and how communities have responded to program interventions around sustainability—the focus here must be on addressing the needs of vulnerable communities and special needs populations. We look to our national and international partners to help improve data information and sharing.

Internally, the Department has adopted voluntary self-reported demographic data to reduce potential barriers in hiring, promotion, professional development, and retention practices. Initiatives such as these align with the Biden administration's commitment to expanding Diversity, Equity and Inclusion

Work that HUD is doing around partnerships with others:

HUD continues to improve its partnerships both intra-agency and inter-departmentally, as well as across cities, states, and nations. HUD partners with other agencies such as the U.S. Department of Transportation (DOT) to provide grant opportunities, such as the Reconnecting Communities Pilot Program to address inequities due to past government policies and programs that historically excluded the participation of low-income and communities of color.

This includes joint initiatives, such as reducing carbon emissions in housing, with U.S. Department of Energy and the U.S. Environmental Protection Agency, and through initiatives, such as disaster mitigation, response, coordinating with agencies, particularly the Federal Emergency Management Administration (FEMA). These partnerships allow HUD to capitalize on a wide range of expertise and experience, while coordinating efforts to provide efficient responses to the American public. I will discuss these partnerships in more detail a little later.

26th United National Commission on Science and Technology for Development
Talking Points

Regina Gray
Director, Affordable Housing Research and Technology Division
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Good afternoon, again. Allow me to elaborate on a few points from the earlier discussion:

Digital and green transformation coinciding with increasing adoption of technologies such as AI and renewable energy:

- *The Department supports efforts to further initiatives that advance technology in housing, including Artificial Intelligence—with cost savings realized through automation, timely and accurate reporting, and that promote equity and effectiveness through the adoption of renewable energy options for low-income and marginalized communities.*

- *An example of some of this work includes a study we funded with Tennessee State University—a designated Historically Black College and University—to understand a relatively new technology: energy-saving batteries that can be installed in cemented walls to monitor energy consumption and retrieve more accurate information regarding usage. The technology utilizes concrete structure testing, efficiency and degenerative testing, temperature and humidity testing, and pilot-scale testing. The data collection, evaluation and redesign will be simultaneously implemented to improve the energy storage performance of rechargeable cement-based batteries in building structures. If successful, the storage capability will allow us to track energy performance over a long period of time, providing an accurate picture of energy savings.*

Topics of advances in the use of concrete and compressed and cross laminated timber:

My office is working with a several research teams that are testing various concrete systems in housing. Please allow me to elaborate on a few of these:

- *First, with respect to 3D Concrete Printing technology, HUD is working with Home Innovation Research Labs located in Upper Marlboro, Maryland to help identify barriers to the adoption of the technology in construction practices and explore ways to expedite the integration of the technology in residential buildings.*
- *The study results show a great potential for the 3D printed technology to significantly improve the home building process based on reduced labor requirements (skill sets and fewer people), exterior wall aesthetics (elimination of 2 x 4 frames for walls), and the best way to show code compliance since the technology is only beginning to be adopted in the building codes. The final report will provide conventional builders with knowledge on how to integrate 3D Concrete Printed walls into their current construction practices, replacing typical wood framing.*

- *Second, there are many different types of concrete forms that we are exploring:*
- *The first one is* **Ultra-High-Performance Concrete** *which is a new concrete technology that mixes steel fibers (that range in strength from polyester to stainless steel) with about 80 percent concrete, resulting in a product with extended usage life; improved durability and resiliency; improved tensile strength and tensile ductility; and reduced maintenance when compared to conventional concrete.*
- *Another is the* **Self-healing Concrete or Bacterial Concrete** *which is produced by directly mixing the concrete with bacteria spores (Bacillus) and calcium, or by encapsulation, whereby the bacteria and calcium lactate in clay pellets are mixed with the concrete.*
- *The material seals cracks in concrete as the bacteria spores germinate in the presence of water or moisture and feed on the embedded calcium lactate, producing limestone as a by-product. The limestone then hardens and seals the crack without any external aide. The process involves the infusion of oxygen in the concrete form to prevent corrosion and improves the durability of steel reinforced concrete.*
- **Graphic concrete technology** *is the printing of a visual idea on a specific membrane (which is disposable and moldable) and transferring it to a precast concrete surface. This new trend in concrete technology allows custom concrete patterned surfaces.*
- And finally, **Insulated concrete forms (or ICF)** *can produce affordable homes and communities within a short period of time and can handle higher dimensional analytics than conventional building processes. HUD has commissioned several studies on the performance of this technology.*
- *ICF technology has been hailed as an alternative to the traditional light-frame construction. The rising cost and the quality of framing lumber make ICF a clear choice for many residential home builders. Its popularity stems from its strong, durable, and energy-efficient wall system for housing. Homeowners appreciate the new ICF technology for its overall comfort and its ability to reduce transmission of "street noise."*
- *A study by NAHB (2001) concluded that it is "generally more economical or practical to consider ICF construction based on the collective benefits".*
- *Despite the advantages of ICF, the decision by the home builders to use the technology depends on several factors, including cost, availability of labor, and familiarity with construction methods. Another emerging barrier to wider adoption of ICF technology is the building code regulatory requirements. Until these requirements are made clearer or eliminated altogether, the continued interest in ICF by home builders could be in doubt. Therefore, there is a critical need to find ways or methods to relax or remove these barriers so that ICF can be widely adopted.*
- *Our long term goal is to find ways to eliminate ICF building code regulatory barriers through policy change recommendations that when implemented, will relax the current code compliance requirements and other barriers to the adoption of ICF technology.*
- *HUD is working with North Carolina Agricultural and Technology State University—a designated Historically Black College and University—to learn more about ICF technology and how we might address the challenges the industry faces with building code compliance.*

- *With respect to timber or wood systems,* **Compressed or Cross Laminated Timber (CLT)** *is produced by the partial removal of lignin and hemicellulose through boiling in sodium hydroxide and sodium sulfite solution, then hot pressing at 100 degrees Celsius. This treatment results in the collapse of the cell walls and a densified wood reduced to about 20% of its original size. It's strong and tough, yet lightweight and holds promise as a low-cost armor and ballistic energy absorption.*
- *The mechanical properties of the densified wood are not only remarkably superior to those of natural wood, but also exceed those of many widely used structural materials such as plastics, steel, and alloys. Its stable in the presence of water or moisture. HUD has commissioned several studies testing the performance of this technology in housing construction projects, most notably with the University of Florida-Gainesville. We are nearing the end of the study and should have results later this year.*

Smart cities as it relates to urban sustainability (community resilience & energy consumption)

- *The Department supports the cultivation of smart cities to promote urban sustainability through accurate, precise, and timely reporting of data for progress on carbon-reduction strategies adopted by state and local communities, especially as urban sprawl continues unabated.*

- *HUD researchers would like to explore how the uptake of smart technologies utilized in smart cities can help address sustainability problems in urban environments attributed to rapid urbanization. We would like to learn more about what these emerging smart technologies are and whether they've been successful. We want to hear about strategies that optimize pedestrian-friendly mobility and reduce greenhouse gases emissions in cities, conserve natural resources and make better decisions about where to direct growth or development.*

- *We realize that to be successful requires engaging community residents; it also requires sustained commitment from public and private stakeholders.*

- *We are currently working with a few graduate students to learn more about smart city designation, but more importantly, to understand the technological innovations that have worked to advance sustainable goals. We know of a few cities, for example, that have addressed energy grid challenges following a natural disaster event.*

- *We are also aware of alternative sources of energy and renewable energy technologies, including solar, hydroponics and wind, which are prominent in states like California and Washington. But we need to understand what works and what does not—especially in terms of both cost-effective measures to reduce carbon, but also whether or not these strategies help achieve the national goal to reduce energy consumption by 40% by the year 2030.*

- *The international community might help us in two ways: (1) understanding the smart city concept and the metrics involved in determining how a smart city is designated; and (2)*

understanding the innovative interventions that are effective and can be replicated in similar contexts.

Data driven approaches (weaving in equity and inclusivity):

- *The Department continues to improve its understanding and approach to equity and inclusivity through evidenced based policymaking and data driven approaches, including participant informed program improvements, exploring the socioeconomic determinants of health, safety and wellness; policy evaluation to determine impact on housing affordability, and research endeavors to identify bias in regulations and or exploitative actions the further exacerbating disparities. Further, the Department recognizes that social equity depends, in large measure, on the quality of data on its constituent communities.*

- *Some of our research activities include exploring strategies that prepare and protect communities of color and other marginalized communities when a disaster threatens the infrastructure and human life. Typically these communities are most harmed.*

- *Our strategies would center on protecting community assets (e.g., housing, infrastructure), removing locally unwanted land uses (Brownfields remediation), and conducting health impact assessments before and after these events to understand how resident health outcomes are impacted—this includes the damage to water and air supply; it includes noise abatements; the power grid; toxic spills; and indoor air quality. Community residents themselves must be engaged in all aspects of community planning and preparedness—and leaders must demonstrate a shared commitment to reducing environmental racism and enhancing justice.*

- *In January of 2021, President Biden made a commitment to ensuring that 40 percent of certain federal investments related to climate and the environment benefit disadvantaged communities through the Justice40 Initiative. Much of the work that we are undertaking under HUD's Climate Action Plan, for example, aligns with the administration's goals.*

- *Internally, the Department has adopted the utilization of employee voluntary self-reported demographic data to reduce potential barriers in hiring, promotion, professional development, and retention practices. This activity is just one example of our work that also builds on the administration's commitment to expanding Diversity, Equity and Inclusion goals.*

Work that HUD is doing around partnerships with others:

- *HUD continues to improve its partnerships both intra-agency and inter-departmental—and across cities, states, and nations. HUD partners with other agencies, such as the U.S. Department of Transportation (DOT) to provide grant opportunities, such as the Reconnecting Communities Pilot Program that addresses present and past inequities in the delivery of federal investments in transportation and infrastructure projects—connecting communities historically excluded from the benefits of these programs.*

- *Another example includes joint initiatives, such as energy-efficiency in public housing with the U.S. Department of Energy and the U.S. Environmental Protection Agency, and through initiatives, such as disaster mitigation and response in coordination with the Federal Emergency Management Administration (FEMA).*

- *These partnerships allow HUD to capitalize on a wide range of expertise and experience, while coordinating efforts to provide efficient responses to the American public.*

- *We continue our alliances with these agencies and others to address sustainability goals: (a) transit-oriented development and Electric Vehicle initiatives with U.S. DOT; (b) reducing carbon emissions in housing with both U.S. DOE and EPA; (c) addressing food insecurity with the U.S. Department of Agriculture; and (d) data and information sharing on the impacts of health and housing with the U.S. Department of Health and Human Services.*

- *And we will continue to work with our international partners to fulfill our collective commitment to achieving sustainability goals through advancements in science and innovative technologies.*

Resources:

1. PD&R's Research Learning Agenda: https://www.huduser.gov/portal/about/pdr_learningagenda.html
2. HUD's Strategic Plan: FY 2022-2026 HUD Strategic Plan | HUD.gov / U.S. Department of Housing and Urban Development (HUD)
3. PD&R's Offsite Construction Roadmap: https://www.huduser.gov/portal/publications/Offsite-Construction-for-Housing-Research-Roadmap.html
4. PD&R@50 Short History: PD&R@50: A Short History of PD&R | HUD USER
5. PD&R@50 Series, "The Prequel of HHFA/HUD research before 1973." Article by Kent Watkins: https://www.huduser.gov/portal/pdredge/pdr-edge-pdrat50-032123.html
6. Innovative Housing Showcase website: Innovative Housing Showcase | HUD.gov / U.S. Department of Housing and Urban Development (HUD)
7. Innovation in Affordable Housing Student Design and Planning Competition, register here: Innovation in Affordable Housing Student Design and Planning Competition (huduser.gov)
8. Cityscape symposium on Housing Technologies: https://www.huduser.gov/portal/periodicals/cityscape/vol25num1/guest.pdf

Forthcoming reports:

Site Planning Guidebook for Disaster Preparedness
Designing for Natural Hazards
Testing Cross Laminated Timber Systems in Housing
Advanced Modular Systems in Multifamily Housing
Overcoming Barriers to the Adoption of Innovative Technologies
3D Concrete Printing Components for Walls and Windows
3D Concrete Printing in Affordable Housing
Rammed Earth as Alternative Energy Renewable
Capital Needs Assessment in Public Housing
Factory-Built Housing Market Analysis

The following are relevant studies underway that have been funded by HUD's Office of Policy Development and Research:

Project 1 - Enable 3D Printed Concrete Single-/Multi-Family Housing Technologies
Project 2 - Out of plane and Axial Hazard-Agnostic Design of 3DPC Walls to Enable Hazard Resilient

Study Objective: To remove regulatory barriers impeding the adoption of 3D printed concrete housing. The object of project 1 is to remove barriers by building a rational design procedure for 3D printed residential construction. The object of project 2 is to enable concrete 3D printing of low-rise single-family and multi-family buildings building on knowledge developed through project 1.

Project 1: Currently 3D printed concrete housing is hindered by two barriers, 1) 3D printed homes are not approved for use in seismic regions of the U.S., except through a direct approval by local building officials and local jurisdictions, which constitutes a time consuming and expensive process 2) the approval processes often result in overly conservative designs, which add unnecessary costs to 3D printed structures reducing their competitiveness and further hindering their implementation**.** This project will remove these barriers by developing a procedure, validated via a comprehensive collapse assessment methodology. Providing coding agencies with design procedures for adoption by local jurisdictions and national-level provisions and design codes, with the support of a stakeholder-based Peer Review panel.

Project 2: The goal of this project is to enable concrete 3D printing of low-rise single-family and multifamily buildings (up to three stories); thus, providing faster and more affordable housing that is also resilient to natural and climate hazards. This project will build the knowledge base gained under project 1 to remove a regulatory barrier to this type of construction through a systematic research program. The design will produce a hazard-agnostic, material-agnostic design methodology for the out-of-plane and axial compressive response of 3DPC walls, which control the structural stability and performance of 3DPC housing.

Methodology: Print and test 3DCP walls.
Grantee: Texas A&M University
Current Status: Project 1: Analysis walls via stress test, **Project 2**: data collection

Assessment of Barriers to Adoption of Insulating Concrete Form Technology in Residential Housing

Study Objective: This project will provide statistical information on the status of ICF usage among home builders; assess the extent to which building code regulations impede the wider adoption of ICF technology in the home building industry; and recommend how building code regulatory barriers and other constraints impeding the adoption of ICFs can be eliminated.

The project involves the collection of national survey data on the use and perceptions of Insulated Concrete Forms (ICFs) among home builders, code officials, and manufacturers to assess the Barriers to Adoption of Insulating Concrete Form Technology in Residential Housing. This research is focused on relaxing the current code regulations and other barriers to the adoption of Insulated Concrete Form (ICF) technology.

Insulating concrete form (ICF) technology has been hailed as an alternative to the traditional light-frame construction. The rising cost and the quality of framing lumber make ICF a clear choice for many residential home builders. Its popularity stems from its strong, durable, and energy-efficient wall system for housing. Homeowners appreciate the new ICF technology for its overall comfort and its ability to reduce transmission of "street noise." A study by NAHB (2001) concluded that it is "generally more economical or practical to consider ICF construction based on the collective benefits". Despite the advantages of ICF, the decision by the home builders to use the technology depends on several factors, including cost, availability of labor, and familiarity with construction methods. Another emerging barrier to wider adoption of ICF technology is the building code regulatory requirements. Until these regulations are eliminated, the continued interest in ICF by home builders could be in doubt. Therefore, there is a critical need to find ways or methods to relax or remove these barriers so that ICF can be widely adopted.

Our long-term goal is to find ways to eliminate ICF building code regulatory barriers through policy change recommendations that when implemented, will relax the current code regulations and other barriers to the adoption of ICF technology. We are well prepared to undertake this research project due to our collective research experiences and performance with HUD HBCU grants. We propose the following specific objectives: (1) Provide statistical information on the status of ICF usage among home builders; (2) Assess the extent to which building code regulations impede the wider adoption of ICF technology in the home building industry; (3) Recommend how building code regulatory barriers and other constraints impeding the adoption of Insulating Concrete Forms can be eliminated.

At the completion of the study, it is our expectation that we will understand which parts of the building code regulations hinder the wider adoption of ICF technology so that we can offer the solution to eliminate the barriers.

Advanced Modular Housing Design

Study Objective: To design post-disaster housing using advanced modular building methods.

U.S. housing industry faces at least three key challenges: resiliency, sustainability, and affordability. Resiliency is a community's ability to minimize damage and recover quickly, sustainability is the ability to minimize the impact on the environment through material selection and energy efficiency and affordability is a measure of its cost and the purchaser's monetary ability. These challenges are exacerbated by natural disasters, such as major storm events that have heightened the risk of destruction to property and other infrastructure in U.S. coastal communities. Tragically, in some instances, storms have caused near-permanent damage to communities, including extreme shortages of housing stock.

Research Questions: Through collaborative research, the following two research questions were addressed:

- *How do we design and manufacture modular housing to help mitigate the impacts of climate change and reduce operational costs through hyper energy efficiency, the incorporation of renewable energy generation and storage systems, and other measures to make housing more sustainable?*
- *How can we maintain affordability while providing people with housing that can withstand increasingly frequent and damaging natural disasters?*

Methodology: This was a collaborative effort with four working teams: the *architecture team,* designed housing to improve resiliency, enhance energy efficiency, and increase affordability. The *energy team* developed whole-building energy models to estimate building energy use. Energy simulation model analysis included various energy efficiency measures (EEMs) to minimize monthly energy cost. The *life-cycle cost team* analyzed the initial cost, simple payback period, and life-cycle costs over a 30-year period of the building, site improvement, and EEMs, including renewable energy systems. Finally, the *affordability team* integrated the affordable housing context and the post-disaster recovery environment into the project. The project also involved organizing two workshops centered on post-disaster housing through AMH research and inviting industry leaders (modular home manufacturers, mechanical system and smart control device manufacturers) and other participants from the insurance and finance industry to attend.

Grantee: University of Florida
Current Status: Will be published late April.

Development of Rechargeable Cement-based Batteries to Store Energy in Building Structures

Study Objective: The goal of this study is to develop rechargeable cement-based batteries to store energy in building structures, which can be applied in new apartment buildings or concrete slabs of new single family houses.

This study will produce relevant results for mechanical, efficiency, and degenerative performance of rechargeable cement-based batteries. The safety test and life cycle assessment will provide the results of safety and long-term performance of the rechargeable cement-based battery. The pilot-scale study will provide knowledge and data on the behaviors of rechargeable cement-based batteries in real building structures. The outcomes of this study will greatly advance the knowledge regarding rechargeable cement-based batteries and contribute to the pool of data that is necessary for governmental agencies to make scientifically sound decisions. The cement-based battery technology using large building structures as sources to store energy offers a solution to enhance energy flexibility, access to low-cost energy, and improve the built environment, especially for the built environment and energy independence of underrepresented neighborhoods.

Research Objectives:

1. Design and optimize a rechargeable cement-based battery to power home devices;
2. Test the mechanical properties of concrete structures after cycles of charging and discharging;
3. Test the efficiency and degenerative performance of a rechargeable cement-based battery;
4. Conduct safety testing and life cycle assessment of the battery;
5. Conduct pilot-scale testing in a real building.

Educational Contribution:
The implementation of this research project will enhance science and engineering education at one of the largest HBCU (Tennessee State University) and broaden the participation of underrepresented groups. This project will create opportunities for African American undergraduate and graduate students at TSU to participate in scientific research.

Current Status: (*3/28/2023)*
Tennessee State University will present a project update to HUD in April 2023, and is currently developing and testing the efficiency and degenerative performance of the battery (objective 3).

Period of Performance: 36 months
Grantee: Tennessee State University
Current Status: testing of materials for installation.
Next: development of models for pilot testing

Capital Needs Assessment of Public Housing

Study Objective: The main objective of this study is to: identify policy solutions to address public housing capital needs and determine the capital needs of HUD's public housing portfolio and value of existing HUD data in estimating public housing capital needs.

The research team shall rely on secondary data sources including, but not limited to, HUD administrative data to complete this task. The researchers shall also collect data regarding current Public Housing Agencies (PHAs) methods of assessing capital needs using a survey in addition to other research methods. The research team shall compare capital needs assessment (CNA) methods and resulting estimations, and present policy solutions to meet identified needs. The team shall be responsible for developing and implementing a research design to meet these requirements.

Research Questions:

1. What are the capital needs of PHAs?
   1.1 What are the most effective methods to estimate the capital needs of PHAs, other than an expensive third-party inspection of a very large representative sample of housing units?
   1.2 What is the value of existing HUD data to estimate the capital needs of PHAs?

2. How are PHAs currently estimating their capital needs?
   2.1 Which of these methods can be considered best practice?
   2.2 What proportion of PHAs seem to be using best practice in estimating capital needs?

3. Apart from inadequate funding, do PHAs believe there are statutory or regulatory barriers to meeting their capital needs? If so, which barriers are frequently mentioned? (Question 4 will use data from the survey instrument identified in Question 2).

Current Status: (*3/28/2023)*
OMB has received the final version of all survey instruments for approval. Contract extended 6 months from October 2023. Data collection via survey instrument occurring asap.

***Feedback received:** Expert Panel – Modifications should be steps towards energy efficiency, green energy projects, accessibility improvements, and consideration of infrastructure for improvement of broadband internet – (what are common building aspects among PHAs to be considered re internet provision?).

Start Date: Q4, 2021
Period of Performance: 24 months
Contractor: Econometrica (Research firm)
Current Status: Administration of survey

Measurement of Broadband Access in HUD-Assisted Buildings

Study Objective: To determine current broadband connectivity and performance in public housing and for properties participating in Section 8 Project-Based Rental Assistance (PBRA) programs.

This investigation will employ a mixed methods approach to determine current connectivity rates, internet speeds, resident satisfaction, and the potential for expanding broadband access at recommended connectivity speeds for HUD public and assisted households. It shall provide feedback to Departmental officials on the needs and experiences of residents as well as public housing administrators and operators of project-based housing. These recommendations are meant to inform future broadband initiatives and implementation efforts.

Research Questions

1. What is the current internet connectivity of public housing and for Section 8 Project-Based Program?
    i. What are the current download and upload speeds, given the current infrastructure and available network speeds per household and per user?
2. What are the current internet capacities of HUD-assisted households identified above?
    i. What are the potential download and upload speeds given current infrastructure and available network speeds per household and per user?
3. What are the estimated costs for HUD-assisted properties in the programs identified above to provide internet access at a minimum speed of 25/3 Mbps per household, and 10/2 Mbps for each potential user simultaneously?
4. How satisfied are HUD-assisted households in the programs identified above in the programs identified above with current internet access?
    i. How satisfied are portfolio managers with access to, and pricing of, connectivity?
5. What barriers or challenges should be considered when improving and expanding internet access for HUD-assisted households in the programs identified above?

Major Deliverables:

1) Research Design, Data Collection, Data Analysis Plan (RDDCAP)
2) Interim Briefing (at 12 months)
3) Final Briefing (at 24 months)

*Each deliverable is accompanied by a presentation and discussion.

Current Status: Awaiting solicitation release
Start Date: Fall 2023
Period of Performance: 24 months
Contractor: TBD

Overcoming Barriers to Innovation in the Home Building Industry

Study objective: Identify current barriers to building technology innovation in home building.

This effort is a follow up to a 2005 HUD study of the same name. During the current effort, HUD sponsored a series of working groups to explore the current landscape of innovation in housing technology and process, to identify barriers that continue to thwart innovation, and to explore opportunities for collaboration and future research. A major focus was to identify strategies that are already working and opportunities to disseminate those strategies.

The concluding report, "Overcoming Barriers to Innovation in the Home Building Industry," contributes to the discussion on what we have learned over past decades and where we can go from here to continue to innovate in the home building industry. This report provides a literature review and summarizes research findings about four key barriers to innovation: education—the lack of sufficient technical information, training, and instruction from product innovators; risk—potential to experience losses when adopting new products and practices; industry fragmentation—the diffusion and complexity of the homebuilding industry; and, behavioral factors and biases—thought processes that lead housing market participants to resist innovations that would be in their best interest.

The report also summarizes panel discussions on these topics with leaders and experts from government, architecture, research, and housing development fields.

The report offers ideas and examples, drawn from the literature review and panel discussions, that could help tackle three big challenges:

- How to support continuing education for workers in the homebuilding industry to facilitate the adoption of new technologies;
- How local stakeholders can work together to remove zoning and land use barriers to building more energy efficient and affordable housing where it is needed most; and,
- How to reduce financial risk for builders and homeowners, while also educating both groups on the benefits of new technologies for improving energy efficiency and long-term affordability.

Research Question: What are the current barriers to the adoption of building technology in the United States?

Status: Final report is in Departmental clearance

Modern Rammed Earth House: History, Construction and Monitoring

Study objective: Demonstrate that stabilized rammed earth can be used to build resilient, modern housing even in harsh environments.

Rammed earth is a construction technique in which subsoil1 is compressed within a vertical formwork to form the walls (generally, exterior) of a building. The subsoil is added layer by layer, rather than all at once. These layers are called "lifts". Compacting each lift ensures even compression across the entire wall section. In modern use, rammed earth is typically stabilized with a stabilizing agent—Portland cement being the most common. This technique is called stabilized rammed earth.

Over the past quarter century, rammed earth construction has received renewed attention due to its desirable, green characteristics. The North American Rammed Earth Building Association (NAREBA) and other green advocates have led the movement for increased attention. This interest led to a standardization effort for the use of rammed earth and other earthen wall construction techniques the civil engineering community uses. In 2010, the American Society for Testing and Materials International (ASTM) created the Standard Guide for Design of Earthen Wall Building Systems, which "provides guidance for earthen building systems, also called earthen construction, and addresses both technical requirements and considerations for sustainable development."

In 2016, HUD supported the construction of a stabilized rammed earth home by the Aleutian Housing Authority (AHA) in Butte, Alaska. AHA was interested in demonstrating a stabilized rammed earth (SRE) affordable home because of their desire to produce the most energy efficient and healthiest homes possible at the lowest possible cost.

West Virginia University (WVU) has been evaluating the performance of the AHA SIRE home since its construction. The evaluation includes testing of the wall system for its structural properties in a mechanical properties laboratory at WVU and monitoring its energy use, thermal performance, living comfort, and durability at the Butte, Alaska site.

Research question: Can stabilized rammed earth be used to build a resilient, modern home?

Status: Final report that represents the entire project is being edited.

Designing for Natural Hazards: A Resilience Guide for Builders & Developers

Study objective: Develop a set of practical, actionable guidelines for builders and developers to design and construct residential buildings, neighborhoods, and accessory structures that improve resilience.

The *Designing for Natural Hazards: A Resilience Guide for Builders & Developers* series was developed with a technical advisory group that included subject matter experts from a wide range of industry stakeholders. The experts were tasked with identifying above-code construction techniques to improve the resilience of residential buildings. A consensus process was used with the goal of creating a set of practical, actionable guidelines for builders and developers. The guidelines are intended for new construction and major reconstruction efforts after natural disasters, especially where entire communities need to be rebuilt.

The technical advisory group recognized that when natural disasters occur, certain damage is more likely than other types of damage. To address this challenge, the technical advisory group recommended a mitigation strategy that prioritizes high-frequency damage over damage that rarely occurs—based on post-disaster damage assessment reports. This novel approach to disaster mitigation encourages improving those parts of the building that typically get damaged first. This approach allows for the impact of disaster mitigation grants to be maximized in terms of preventing future damage to homes.

The resilience guides are an excellent addition to HUD's PD&R Disaster Recovery Took Kit. These guides should be updated periodically based on post-disaster damage assessment data—from future natural disasters. The resilience guides will be valuable resources to builders and developers seeking to incorporate resilience in housing.

Research Question: What are the practical building technologies that can be used to make housing more resilient to natural hazards?

Status: Final report is in Departmental clearance

Community Resilience Planning for Disaster Recovery

Study Objective: To develop case studies based on the application of the NIST guidance and associated tools that will be shared with community planners, community stakeholders, HUD grant managers, and researchers as guidance on who to create comprehensive resilience plans.

Through HUD programs, such as Community Development Block Grant (CDBG), CDBG Disaster Recovery (CDBG-DR) and CDBG Mitigation (CDBG-MIT), HUD provides a financial and technical foundation for communities around the country that seek to reduce the effects of natural hazard events. HUD's goal is to demonstrate approaches for improving community resilience and disaster recovery through comprehensive planning and other long-range plans. NIST's Community Resilience Program provides science-based tools to help communities make effective decisions that improve the resilience of their communities and built environment.

This project will demonstrate approaches for improving communities' comprehensive planning towards community resilience and disaster recovery and through characterization of how specific projects improve or advance resilience. Three communities will be selected for case studies.

The Contractor works with each of the three communities to discuss the key aspects of their comprehensive community plans with a focus on community resilience and how to incorporate the NIST Guide and associated tools into their long-range planning process. The final case studies are based on the application of the NIST guidance and associated tools and will include information from the community about successes and lessons learned from the collaborative efforts.

Methodology: One-on-one meetings with stakeholders from each community, to establish their goals and help communities as they develop their comprehensive resilience plans.

Contractor: Applied Research Associates (ARA), Inc.

Current Status: Data collection and one-on-one engagement with communities