

Advancing Local Code Enforcement Through Digital Transformation: Lessons from the CODES Digitalization Toolkit

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ABSTRACT

Across the United States, many local building departments, particularly in small or resource-constrained communities, continue to depend on paper-based permitting, inspection, and plan review processes. These manual systems slow project approvals, increase staff workload, and limit the consistency of building and energy code enforcement. As codes become more complex and expectations for community resilience grow, these inefficiencies have increasingly visible consequences. Local governments face mounting pressure to modernize their processes, yet often lack the technical capacity, time, or funding to evaluate and implement digital solutions.

Introduction

Across the United States, communities of all sizes are facing persistent challenges in delivering affordable and efficient housing. Local permitting and approvals processes—essential gateways for construction—often remain slow, inconsistent, or overly complex, creating avoidable delays that compound housing costs and shortages. In small or resource-constrained jurisdictions, these pressures are intensified by continued reliance on paper-based permitting, inspections, and records management. Such manual processes can limit transparency, increase staff workload, and make it difficult to enforce increasingly complex energy and safety codes. As expectations for community resilience grow and catastrophic events become more frequent, the limitations of these outdated systems become even more apparent.

This paper captures findings and recommendations from a project funded under the U.S. Department of Energy’s (DOE) Resilient and Efficient Codes Implementation (RECI) program, which supports states and jurisdictions in improving code compliance, enforcement, and modernization. The Code Official Digitization and Efficiency Support (CODES) initiative was established to provide practical, scalable pathways for jurisdictions seeking to digitize their permitting and inspection operations. A central deliverable of CODES—the Digitalization Toolkit—offers step-by-step guidance, assessment instruments, and case studies tailored to communities at different stages of digital transformation.

Drawing on the design and early application of the Toolkit, this paper identifies strategies that can help small and under-resourced communities overcome staffing, legacy system, and cost barriers. These insights are informed by literature reviews, interviews with code officials, national surveys, and pilot case studies. They are also shaped by recent catastrophic events such as the wildfires in Lahaina, Maui, and Los Angeles which underscored how essential agile,

digitized permitting systems are to post-disaster recovery. Together, this evidence shows how structured road mapping, targeted training, and phased implementation can support digital transformation under everyday conditions while strengthening community resilience in times of crisis.

Background and Motivation

Barriers in Local Code Administration

Despite steady advances in digital government tools, a significant portion of the nation's local building departments, especially in rural areas, still operate with paper forms, hand-written inspection notes, and physical plan sets. Staffing shortages further exacerbate these issues. Small jurisdictions (informally classified in this paper as jurisdictions with population less than 25,000) often rely on a single code official or a small team responsible for multiple roles, making it difficult to evaluate new technologies or pursue modernization initiatives. Legacy systems introduce additional barriers: older permitting databases may be incompatible with new software, or they may lack the security, mobility, and analytical capabilities needed for modern operations. Budget constraints pose another challenge. Many digital systems require upfront investment, ongoing subscription fees, or IT support that small departments cannot sustain. These factors create a cycle where the jurisdictions most in need of digital efficiency are often least able to pursue it.

Increasing Pressures from Disasters

The need for modernization becomes more pronounced after disasters. Events such as the Lahaina and Los Angeles wildfires revealed how quickly traditional, paper-based permitting systems can become overwhelmed when communities must process hundreds or thousands of damage assessments and rebuild applications. Manual workflows hinder coordination among agencies, slow inspections, and delay essential services needed to restore housing and infrastructure. In contrast, digital permitting and mobile inspection tools can streamline data collection, accelerate reviews, and support transparent, real-time communication with residents and contractors.

These events underscore the importance of building departments having resilient and flexible systems in place before an emergency occurs. They also highlight a broader point: the benefits of stronger and more up-to-date codes can only be realized if jurisdictions have the administrative capacity to implement them efficiently, particularly during periods of intense rebuilding demand. This urgency is reinforced by evidence that adopting the latest building code requirements saves an average of \$11 for every \$1 invested while reducing losses from major hazards, strengthening the case for permitting and code administration systems that can carry those requirements into practice under post-disaster conditions (Multi-Hazard Mitigation Council 2019).

Disaster-Driven Use Cases

Insights drawn from recent wildfires illustrate how digital tools can accelerate post-disaster operations. Mobile inspection applications allowed officials to capture geotagged damage assessments rapidly, reducing backlogs and enabling faster decisions on building safety and

rebuilding eligibility. Digital permitting portals made it easier to track, manage, and prioritize applications in high-volume situations. For residents, these tools improved transparency by providing real-time updates on review status, requirements, and next steps. These insights emphasize that digitalization is not only a tool for everyday efficiency but also a critical component of disaster preparedness and community resilience.

A recent example from Los Angeles illustrates how digital permitting can support post-disaster rebuilding. According to the City of Los Angeles Bureau of Engineering (2026), the City’s “B” Permit process became fully online in 2019 through ProjectDox, establishing a structured four-phase workflow for application intake, fee processing, design review, and construction coordination. In a post-disaster context, this type of end-to-end electronic permitting system can help jurisdictions manage surges in rebuilding activity more efficiently by enabling remote submittals, supporting digital interagency review, and improving transparency throughout the approval process.

Federal and Programmatic Response

The CODES project recognizes that modernizing code enforcement is a foundational step toward achieving energy efficiency, improving building performance, and supporting community resilience. The CODES initiative was developed to equip jurisdictions, especially those lacking Information Technology (IT) departments and infrastructure administrative capacity, with practical tools and guidance to begin digital transformation. By creating a standardized yet adaptable toolkit, the project aims to help communities chart a clear implementation path, identify achievable milestones, and reduce the uncertainty that often prevents smaller departments from adopting new technologies.

At a federal level, focus has been on how federal levers can help drive system improvements within a building and land use system largely implemented at a state and local level. Rather than treating permitting and inspection systems as purely local operational matters, the federal government has begun to frame these functions as essential infrastructure linked directly to national objectives for housing affordability, consistency in regulatory approaches, and efficiency in approvals processes. This consistent focus demonstrates the nonpartisan nature and benefit of these types of innovations fitting policy priorities across administrations. This policy posture recognizes that many jurisdictions lack the staffing, technical capacity, and resources needed to modernize their own systems, and therefore require structured federal support to overcome longstanding barriers.

It was within this policy environment that Congress—through the Bipartisan Infrastructure Law in 2021—directed the U.S. Department of Energy (DOE) to launch the Resilient and Efficient Codes Implementation (RECI) program. RECI sought to strengthen state and local capacity to improve code compliance, enforcement, and modernization, positioning digital transformation as a necessary component of achieving broader energy and resilience targets.

Under the RECI funding opportunity—and recognizing digitalization as a strategy to advance energy efficiency and resilience goals—the project partners including the International Code Council, Plus Labs, Clarkson University, and Resource Refocus, proposed the Code Official Digitization and Efficiency Support (CODES) initiative, which DOE funded. Federal support enabled the work allowed the project team to support communities that have historically struggled to participate in modernization efforts, particularly small, rural, and

resource-constrained jurisdictions with limited IT capacity. These jurisdictions often face disproportionately high barriers when evaluating or procuring digital tools, and targeted assistance was needed to reduce uncertainty and accelerate readiness.

The central output of CODES, the Digitalization Toolkit, translated policy priorities and on-the-ground needs into a practical, scalable resource. The Toolkit's structure, embedded with step-by-step guidance and assessment tools, was shaped by literature reviews, interviews, national surveys, and pilot case studies. Pilot communities, including rural towns, small cities, and jurisdictions with limited or no IT infrastructure, helped ensure the Toolkit addressed real-world barriers. Their experiences reinforced that modernization requires more than simply recommending software; it means confronting systemic challenges such as staffing shortages, outdated legacy databases, and prohibitive costs. These challenges align with broader federal priorities to streamline permitting and approvals processes—an area where code department digitalization plays an increasingly important role.

Federal support also played a key role in shaping the Toolkit's design principles. DOE emphasized the need for standardization, interoperability, and scalability, ensuring that jurisdictions at different starting points could adopt digital tools incrementally rather than through disruptive, all at once transitions. The Toolkit's modular structure, user friendliness and adaptability mirrored these national priorities, offering clear pathways for communities beginning with fully paper-based workflows as well as those already using partial digital systems.

Finally, recent disaster experiences, particularly the wildfires in Lahaina and Los Angeles, reinforced a central tenet to code department modernization: that digital permitting, mobile inspections, and real-time data sharing are essential components of disaster preparedness and continuity of operations. The integration of resilience considerations into the Toolkit was not incidental, it was a direct response to the recognition that traditional manual systems collapse under post disaster demand, and that federal guidance must help communities build flexible, future ready infrastructure before crisis strikes.

Development of the CODES Digitalization Toolkit

Methods and Inputs

The CODES team conducted a literature review of the adoption of digital processes for building code reviews and code compliance verification by examining existing digital permitting platforms, building code solutions, and digitalization implementation challenges and best practices from prior modernization efforts. A [national survey](#) distributed to ICC's network of code officials gathered data on the prevalence of digital tools, common barriers, and readiness levels. Additionally, a virtual stakeholder engagement event brought together over 85 individuals from the code enforcement and AEC industries to discuss digitalization, code compliance challenges, and skills and training needs. Following this broader survey and stakeholder engagement event, the team followed up with 12 code officials across a variety of jurisdictions to gain insight into the challenges and opportunities related to digitalization that their building code departments face.

CODES Toolkit Structure and Components

The CODES Digitalization Toolkit is developed from the results of the literature review, stakeholder survey, engagement event, and interviews and is designed to provide guidance for jurisdictions seeking to digitalize their building/code departments. The Toolkit is made up of six components listed below.

Digitization Roadmap. This provides [step-by-step](#) guidance for different digitalization pathways based on jurisdiction needs.

Gap analysis. This highlights over 40 common gaps in the adoption of digital tools and processes that jurisdictions at different stages of digitalization face and provides recommendations to overcome each. Common gaps at the Digitization stage include scoping the appropriate data storage system type and size, historical paper-based data digitization requirements, budget management, applications and form conversion needs, legal barriers, and lack of digital infrastructure. Some of the Essential Digitalization gaps include integrating digital tools into the permitting process, overcoming the cultural shift within departments, timing of software implementation, integration and coordination, need for internal technical support, post-implementation vendor support, code resource alignment, and staff training. Advanced Digitalization gaps include integration with existing digital systems, navigating rapidly evolving technology, and workforce training and support. Some Aspirational Digitalization gaps include a lack of remote virtual inspection standards and best practices, the potential to over rely on technology, and the current limitations of artificial intelligence-supported tools.

Pilot community implementation case studies. A series of case studies summarizes four completed pilot projects, highlighting the pre-implementation conditions and post-implementation outcomes for each partner jurisdiction. The team engaged four small, resource-constrained jurisdictions to implement the toolkit. Table 1 lists characteristics of the pilot communities. These pilot communities include rural towns, small cities, and communities with limited cellular and broadband access. Pre-implementation surveys with the code officials from these pilot communities identified common pain points, highlighted successful workarounds, and helped refine the toolkit to be scalable, accessible, and sensitive to local contexts.

Table 1. Pilot community characteristics

Population	# of Parcels	# of Staff	# of Permits / Year	Existing Permitting System	Goals of Pilot
Westfield, NY					
1,000 – 5,000	1,780	1 part-time code official	175 ±	Mix	Times savings
Geddes, NY					
10,001 – 25,000	5,200	1 code official, 1 clerk	100 ±	Digital	Cost saving, switch from another vendor

Lock Haven, PA					
5,001 – 10,000	_*	1 code official, 1 city planner, 1 project manager	25-75 residential (3 rd party handles commercial permits)	Paper Based	Eliminate paper, expedite process, in field data entry
Potsdam, NY					
5,001 – 10,000	_*	_*	_*	_*	_*

*Community did not report as of writing this draft

Digital platform summaries. The team evaluated existing digital platforms and vendor solutions currently available to jurisdictions. These summaries provide an overview of each digital tool, including its features, applicable building types, relevance to energy code compliance, and common users.

Staff training materials and micro-credentialing courses. Training courses were developed to educate staff on the gaps and barriers to digitalization and help bridge the transition to updated processes. Following in-person delivery, these micro-credentials are designed to be offered online to support personnel involved in the digitalization of building code enforcement.

The micro-credential sequence offered contains the following three modules:

1. **Building Code Digitalization 101** - 21st Century Building Code Enforcement: This course would provide a comprehensive overview and review of the nature of building codes, their application, and the digitalization of enforcement. This course will also introduce the RECI-CODES developed “CODES Digitalization Roadmap”.
2. **Building Code Digitalization 201** - Use of ICC Tools: Municipality: As a mechanism to show how digitalization is accomplished for code enforcement, this course would use the ICC developed platform of Municipality as an arch-type and model for how digitalized code enforcement can be actualized.
3. **Building Code Digitalization 202** – Local Government Processes in a Digitalized Environment: To support municipalities and their personnel on the pathway to digitalization, this course would train individuals on how to move from paper-based code enforcement and inter-office exchanges to digitalized efforts.

Implementation template documents. The toolkit also includes samples of typical RFP language, stakeholder outreach materials, and training that jurisdictions can reference when preparing to advertise for digital solutions from vendors, as well as providing information for the community with changes to jurisdictional processes.

Early Application and Lessons Learned

Implementation Findings in Small and Resource-Constrained Jurisdictions

One of the challenging aspects of tool implementation for permitting and code purposes is that there is no one-size-fits-all approach, regardless of jurisdiction size. Larger jurisdictions may

have the resources to customize the available tools and strategies for digitalization to meet their needs, but smaller and resource-constrained jurisdictions often are at the mercy of the pre-set abilities of the tools used, assuming they can even acquire the funding and staff training necessary to implement the tools.

The key lesson for these jurisdictions is the importance of planning and realistic expectations. If a jurisdiction is mostly operating from paper storage, switching to a digital permitting and storage system can cost valuable budget without increasing efficiency, if implemented without an intentional plan in place. Small pilot communities saw benefits from digital tools by reducing the number of documents required for permitting. Additionally, more advanced tools that require significant technical support from the software company should be evaluated. Small pilot communities have not been able to use the full capabilities of the software because the in-house technical expertise does not exist, and in some cases technical support from the software company can be scaled back or eliminated. Depending on the fate of the company, this results in leaving the jurisdiction with the challenging decision of continuing to use a tool without any support, starting over with new software or reverting to a previous system of storage and organization.

In general, jurisdictions are most successful in transitioning to digital storage, data entry, or more advanced tools when the primary users actively support the change, rather than when it is imposed top-down without consulting staff.

Addressing Staffing Limitations

Pilot communities noted that limited staff time made it difficult to pursue system-wide overhauls. Incremental approaches such as digitizing a single workflow (e.g., inspection scheduling) before tackling full permitting system replacement proved more feasible. Simplifying workflows, reducing paper handling, and using shared regional platforms also helped reduce staff burden. Peer exchange networks were especially valuable, allowing smaller departments to learn from similar jurisdictions' experiences.

Overcoming Legacy System Challenges

Many communities were constrained by outdated databases or partially digitized systems that lacked mobile functionality. Successful strategies included adopting cloud-based permitting tools that could integrate with or gradually replace existing systems, as well as prioritizing data inventory and cleaning early in the process. Establishing data governance practices, such as standardizing file naming or documenting key fields, helped jurisdictions transition more smoothly.

Managing Cost Barriers

Smaller jurisdictions often operate under constrained budgets, and software procurement can be a significant hurdle. The most successful pilot communities pursued phased implementation, beginning with low-cost tools or modules and building toward more comprehensive systems. Others leveraged regional partnerships or state-level programs that subsidized digital systems.

Subscription-based or cloud-hosted solutions offered lower upfront costs and reduced the need for long-term IT support.

Recommendations for Scaling Digital Enforcement

Structured Roadmap Approaches

Communities benefit from having a clear, structured plan to guide digital transformation, especially for code enforcement. Developing a roadmap helps departments, and the broader municipality, identify immediate priorities, anticipate operational impacts, sequence investments, and build internal support. Establishing short-, medium-, and long-term goals allows jurisdictions to move forward steadily even with limited resources. Having a code digitalization roadmap also ensures that personnel have a common understanding of not just what needs to be accomplished, but why it is important.

Tailored Training and Change Management

While having a roadmap is useful to guide the process, adopting new digital systems requires building staff knowledge and skills. This necessitates training that is tailored to varying technical skill levels and familiarity of working in a digitalized environment. Ideally training is integrated into daily tasks rather than presented as additional work. Best practices in change management indicate that engaging staff early, communicating benefits, and piloting new tools with small teams can reduce resistance and improve uptake (Chibogwu, et al, 2025). This is especially true for those teams that are resource constrained, have positions with numerous roles and responsibilities that are often across various domains of knowledge and require extensive cross-departmental coordination to accomplish even rudimentary functions. Training that enables the team to learn the new processes together, with a set of tailorable learning modules that allow for varied rates and modes of learning, enables longer term likelihood of the change being successful (Lick, 2006).

Training Quality and Micro-Credentials

A key part of this journey that should be considered is the nature of the training modalities, the quality of the training tools used, and the ability to ensure that those taking part are indeed learning what is needed to enable the planned changes. A recently established mechanism for this kind of training is micro-credentials. Micro-credentials are short courses or other training that results in a verifiable claim of learning, skills development or experience (Kiishkila, et al, 2023). To accomplish the training needed towards digitalization of code enforcement, a set of potential micro-credentials has been developed as indicated in Figure 2.

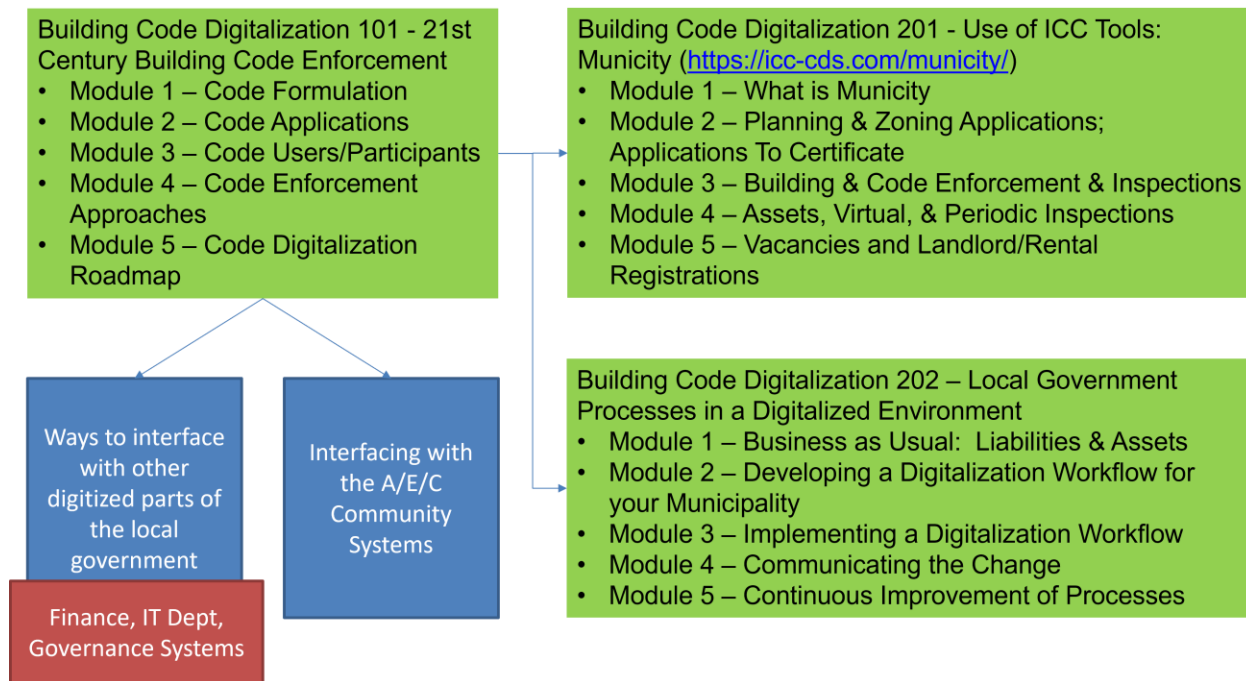


Figure 2. Planned Micro-credential Development and Topics towards Digitalization

Incremental and Flexible Implementation Pathways

Jurisdictions do not have the luxury to stop their day-to-day operations in order to make the needed changes in how they operate. Metaphorically, they are constantly flying the plane at the same time they are maintaining and improving the plane. This requires implementation of change to be both flexible, but also incremental in nature; this is no less true for code enforcement digitalization. Roadmaps and training only can get you so far, in other words, if they don't build upon these considerations. Flexible pathways acknowledge that jurisdictions differ in size, resources, and technical capacity. Incremental implementation allows departments to adopt digital tools in manageable steps, celebrate early wins, and build momentum. Communities should prioritize digitalization efforts that deliver the greatest immediate benefits (such as online permit submissions or mobile inspections) while planning for long-term system integration (through adoption of integrated digital workflows, accounting management, and other inter-related operations within the jurisdiction). Often, timelines present false expectations, but having a robust understanding of the implementation steps and phases enables concerted efforts on the part of the municipality staff to be accomplished in time, while also being held accountable to condition-based milestones to ensure the transformation comes to culmination.

Future Directions for Digital Code Administration

Integration of Emerging Technologies

The maturation of digital tools is reshaping core functions of code administration, from plan review to inspections and compliance monitoring. Three complementary technology areas—AI-assisted plan review, remote virtual inspections (RVI), and automated compliance tracking and analytics—are emerging as practical, near-term pathways to improve consistency, speed, and transparency in local code enforcement.

Artificial intelligence (AI) is beginning to augment plan review by screening submittals for completeness, surfacing potential inconsistencies across sheets, and cross-referencing provisions to applicable code sections. These functions can shorten cycle times while improving consistency in smaller departments with limited staff capacity. Realizing these benefits require risk aware governance; the NIST AI Risk Management Framework (AI RMF 1.0) and its Generative AI Profile offer sector agnostic controls for transparency, accountability, security, and bias management that public agencies can adopt or crosswalk into procurement and QA processes.

Virtual and remote inspections now provide practical complements to field visits. ICC's Recommended Practices for Remote Virtual Inspections (RVI), (ICC, 2020) set out program design, documentation, and record-keeping steps jurisdictions can implement to reduce travel time, maintain service levels, and support continuity during emergencies. Evidence from the pandemic period indicates many visual inspections can be conducted remotely when structured guidance and communication protocols are in place.

Automated compliance tracking and analytics enable departments to move from reactive case management to proactive risk management. Public sector energy code analytics work—e.g., PNNL's Energy Code Field Study Data analysis methods for code compliance datasets (Huckett, 2023)—demonstrates how structured data and dashboards can reveal recurrent issues, target technical assistance, and support performance-based pathways.

In pilots, starting with one workflow (e.g., inspection scheduling) before larger system replacement proved more realistic; mobile functionality and cloud services supported field operations; and subscription models lowered upfront costs.

Finally, disaster use cases reinforce the value of these tools. Mobile inspection applications enabling geotagged assessments and remote review can accelerate post event triage; this operational logic mirrors broader emergency management practice in FEMA's updated Preliminary Damage Assessment guidance (FEMA, 2025) and related remote/virtual inspection modalities.

Designing “Future-Ready” Systems

Sustained modernization depends on systems that are scalable, interoperable, and secure, with resilience and continuity designed in from the outset.

Interoperability and Information Management

Jurisdictions should prefer open standards and documented APIs to avoid vendor lock-in and support phased integration across permitting, GIS, finance, and assessor systems. In the built environment domain, building SMART's Industry Foundation Classes (IFC, ISO 16739) and the ISO 19650 series provide widely recognized schemas and process guidance for structuring, exchanging, and governing building information throughout the asset lifecycle—principles that translate directly to digital plan review and records management.

Cybersecurity and Data Governance

Because permitting systems handle sensitive plan sets and personally identifiable information, cybersecurity must be embedded as a programmatic function. NIST's Cybersecurity Framework (CSF) 2.0—with its added Govern function and supply chain emphasis—offers a

scalable, outcome-based structure for policy, roles, risk assessment, identity and access management, detection, response, and recovery that is suitable for jurisdictions of any size. Complementary CISA/NSA cloud security guides and continuity resources provide practical mitigations for identity, key management, logging, and configuration baselines.

Continuity of Operations and Resilience

To maintain service during disasters or disruptions, implementations should include cloud backups, offline capable mobile workflows, cross region redundancy, and role based remote access—aligned with FEMA’s Continuity Guidance Circular and CISA continuity practices. These measures parallel findings from the CODES pilots on the importance of mobile functionality and flexible deployment options for small teams.

Phased Procurement and Program Alignment

DOE’s RECI initiative highlights that modernization is most effective when paired with training, technical assistance, and flexible funding that allow jurisdictions to sequence investments and de-risk adoption. This aligns with pilot findings that incremental pathways and shared regional solutions can mitigate capacity constraints.

Conclusion

Digital transformation represents a pivotal opportunity for local building departments to improve efficiency, strengthen code compliance, and enhance community resilience. The development and early application of the CODES Digitalization Toolkit demonstrate that practical and scalable pathways exist—even for small and resource constrained jurisdictions—to modernize permitting and inspection functions. Structured road mapping, targeted training, incremental implementation, and thoughtful integration of emerging technologies enable jurisdictions to build more agile, transparent, and responsive systems that better meet the needs of residents, builders, and partner agencies.

As communities face increasing demands—from evolving energy codes to climate driven disasters—the urgency of adopting future ready digital systems continues to grow. The lessons from this project point to clear, actionable next steps for stakeholders at all levels:

- **Jurisdictions should assess their current permitting and inspection processes, identify priority gaps, and use the CODES Toolkit to develop both short- and long-term digitalization roadmaps.** This structured approach helps ensure that limited resources are deployed strategically and that modernization efforts align with operational realities rather than aspirational timelines.
- **Federal partners—including Congress, DOE, FEMA, and HUD—should identify and expand strategies that help jurisdictions advance digital permitting, inspection, and code enforcement systems.** These may include flexible funding mechanisms, technical assistance, standards development, and efforts to streamline permitting processes nationally. Federal support remains essential for reducing barriers faced by small and under resourced communities.
- **Comprehensive impact data is still forthcoming, additional case studies and empirical data should be collected and shared.** Documenting outcomes will help refine

the Toolkit, strengthen future implementation guidance, and broaden the evidence base for digital transformation in code enforcement.

By supporting jurisdictions in their digital evolution and continuing to build a national ecosystem that encourages modernization, programs like RECI and initiatives like CODES can play a transformative role in shaping safer, more resilient, and more efficient built environments.

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