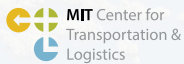


DISASTER HOUSING CONSTRUCTION CHALLENGES IN AMERICA

Exploring the Role of
Factory-Built Housing

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Exploring the Role of Factory-Built Housing

CONTEXT

In April 2017, the MIT Lincoln Laboratory (a federally funded research and development center) initiated a research project titled “Alternatives for FEMA Disaster-Related Housing Assistance.” MIT’s work supports one of the 13 working groups involved with the Federal Emergency Management Agency’s (FEMA) Housing Assistance Initiative. FEMA tasked MIT to provide a comprehensive, systematic analysis of FEMA’s existing housing program and use this analysis to design more survivor-centric and cost-effective methods. This report represents just one piece of the broader MIT research project with FEMA, which involved the following groups:

- MIT Lincoln Laboratory
- MIT Urban Risk Lab
- MIT Digital Structures
- MIT Department of Urban Studies and Planning
- MIT Sloan School of Management
- MIT Center for Transportation & Logistics

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DISCLAIMER

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ABOUT US

The mission of the MIT Humanitarian Supply Chain Lab (HSCL) is to understand and improve the supply chain systems behind public services and private markets to meet human needs.

The HSCL is part of the Massachusetts Institute of Technology (MIT) Center for Transportation & Logistics (CTL). Launched in 1973, the MIT CTL is a solutions-oriented environment where students, faculty, and industry leaders pool their knowledge and experience to advance supply chain education and research. Through the Global Supply Chain and Logistics Excellence (SCALE) Network, CTL maintains an international network of:

- Six centers of excellence
- 80+ researchers and faculty from multiple disciplines
- Over 150 corporate partnerships
- More than 170 master’s students annually
- Over 1,000 alumni worldwide

EXECUTIVE SUMMARY

Disaster housing is a persistent challenge facing America's emergency management community. Reports aggregated by the Department of Homeland Security (DHS) indicate that states and territories have ranked housing as the second-least proficient of 32 core capabilities for preparedness. These same reports identified housing as a national area of preparedness improvement every year since 2012. Amidst this disaster housing environment, America is also facing several non-disaster housing challenges: construction workforce shortages, construction labor productivity stagnation, low levels of housing inventory, and high levels of cost-burdened households.

With a focus on new construction (as opposed to repairs), this report examines the distinction between temporary and permanent housing and explores the potential for factory-built housing to be utilized, at scale, as a regular tool for disaster recovery. For this report, "factory-built housing" is defined to include modular, panelized, and pre-assembled housing construction methods and to exclude both site-built housing and manufactured housing. Wider use of factory-built housing after disasters has the potential to be faster and cheaper, act as a resource after catastrophic events, and help states both address affordable housing challenges as well as improve overall community resiliency.

The speedy provision of post-disaster housing is complicated by the array of ordinances, regulations, and permitting practices that emergency managers navigate after each disaster. The disaster housing tool that the Federal Emergency Management Agency (FEMA) has used most frequently when providing direct housing support is manufactured homes. These homes fall under America's only national pre-emptive code, commonly called the "HUD Code," due to oversight provided by the Department of Housing and Urban Development (HUD). This pre-emptive code assists with FEMA's ability to provide direct housing in communities across the United States by reducing, but not eliminating, regulatory delays to installation of direct temporary housing.

Manufactured homes – though designed to be permanent – are utilized on a temporary basis to provide disaster survivors with direct housing. Manufactured homes are capable of providing housing for a family for more than 50 years, but Congress, via the Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act), requires FEMA's temporary housing assistance to last no longer than 18 months. FEMA's use of manufactured homes comes at an average cost of roughly \$110,000 to \$129,000 each. (See Appendix C for cost estimate information.)

Factory-built homes could potentially become an alternative to manufactured homes, and they have been utilized after disasters in several pilot programs with varying success. Should emergency managers and policymakers want to utilize factory-built homes more frequently after disasters, they must first overcome several significant barriers. Lack of a pre-emptive building code – and the norm of state and local adoption of differing building codes – reduces the ability of emergency managers to develop a uniform inventory of homes deployable to meet disaster needs across the United States. Tabulation of U.S. Census Bureau figures reveals that America currently only produces 3% of its single-family houses as factory-built homes, which limits its staying power as a tool for emergency managers. The historical average of 3% of new single-family homes being factory-built indicates that this industry is not yet widely accepted as an alternative to site-built homes in America. Finally, disaster restrictions distinguishing temporary housing from permanent housing reduce the use of factory-built homes after disasters, even as temporary housing solutions already reach levels of permanency and as some states seek to develop combined solutions for disaster housing and affordable housing.

When provided with flexible federal recovery dollars, states have occasionally leveraged factory-built houses to address combined disaster housing and affordable housing challenges. These flexible dollars, however, do not arrive until long after a disaster occurs – after temporary housing assistance is likely to be discontinued.

For example, after 2008's Hurricane Ike, Congress appropriated roughly \$1.3 billion in flexible housing construction and repair dollars via HUD's Community Development Block Grant Disaster Recovery (CDBG-DR), yet virtually none of these funds were expended until after the 18-month timeline for temporary housing. As CDBG-DR dollars have a goal of targeting unmet long-term recovery needs, a long-term timeline seems appropriate. However, CDBG-DR funds that address unmet permanent housing needs are generally not available until well after FEMA's temporary housing support ends.

A state's desire to deploy disaster housing to meet both disaster and affordable housing needs is incompatible with Congress's emphasis that disaster housing be temporary. The United States emphasizes local primacy where state, local, tribal, and territory officials direct their community's disaster response and recovery efforts. When it comes to disaster housing, however, states have minimal responsibility for direct financial costs. Additionally, state and local governments drive standards amidst a decentralized building code environment.

These overlapping roles and competing perspectives between states, tribes and territories and the federal government highlight a "piecemeal" approach to disaster housing, and effectively excludes factory-built homes as a viable option for post-disaster housing. Should emergency managers and policymakers want to more broadly leverage factory-built housing in their recovery toolkit for future disasters, they will have to address these challenges in a way that also meets the preferences of disaster survivors, the most important decision maker in the recovery process.

Though emergency managers are not primarily tasked with addressing these housing circumstances, improvements in the toolkit of disaster housing options may also help address the broader non-disaster-caused housing challenges in America. Doing so would influence overall community resiliency, an additional goal for emergency managers.

This report concludes with recommendations for emergency managers; housing agencies; policymakers at state, local, tribal, territorial, and federal levels; leaders in the building code community; home construction companies; and others who have a goal of addressing challenges around disaster housing. Recommendations are grouped into three categories and are summarized below:

PROCESS IMPROVEMENT

1. Develop a common process to track the impact that state, local, tribal, and territory rules and ordinances have on implementation speed of post-disaster housing.
2. Develop criteria for when state, local, tribal, and territory officials should enact uniform rebuilding standards and processes across counties, cities, and local municipalities impacted by large disasters.
3. Develop public-private partnerships to more effectively leverage factory-built housing after catastrophic events.

DECISION SUPPORT

4. Create a measurement of the total cost of sheltering and housing services received by a family, during disaster and non-disaster times, provided by all levels of government.
5. Support research on moral hazard and the incentive effects of providing permanent housing in a disaster context.
6. Conduct an assessment of when disaster housing programs defined and intended to be temporary actually achieve levels of permanency.
7. Update analysis of the cost, time, and labor benefits of different housing construction methods.

DIRECTION SETTING

8. Develop a strategy to engage America's shrinking construction workforce in disaster rebuilding.
9. Determine if and how the federal government should provide further support to the factory-built housing industry.
10. Analyze and develop a strategy to consider what place (if any) temporary-to-permanent rebuilding should have in America's emergency management toolkit.
11. Develop a long-term vision on the role emergency management and disaster housing should have in addressing long-term vulnerability reduction and non-disaster affordable housing challenges.

BACKGROUND

Prior to FEMA's creation in 1979, state, local, tribal, and territorial governments led disaster response and recovery. The first major unified piece of disaster legislation, the Federal Disaster Relief Act, positioned the federal government to **“supplement the efforts and available resources of states and local governments”** in “carrying out their responsibilities” over disaster response and recovery.¹ The U.S. Census Bureau has identified more than 89,000 local governments in the United States.² With this level of variety, state and local leaders are more knowledgeable about a community's nuanced needs, resources, and cultures than employees of the federal government could be from hundreds or thousands of miles away.

Contrary to the usual role of state, local, tribal, and territorial governments leading disaster response and recovery, in housing matters, states view the federal government as the leader. In a 2017 survey, 53% of states and territories viewed housing as mostly or entirely a federal responsibility.³ This may be in part because states are not responsible for much of the direct financial costs of disaster housing. For example, **states pay none of the costs related to disaster housing rental and repair programs.**⁴ As the Congressional Research Service noted in 2017, states do not “contribute to the costs of disaster housing through any cost-shares with regard to rental or repair expenditures” and also do not “have any obligation to assist in the physical establishment of temporary manufactured housing communities.” The tension over who is responsible for post-disaster housing is only one facet of housing being **a persistent challenge facing the emergency management community.** Multiple recent reports from the Department of Homeland Security (DHS) have captured the broader extent of the problem:

- States and territories have ranked housing as the second-least proficient of 32 core capabilities for preparedness. (2017 State Preparedness Report)⁵
- Housing is one of the nation's five persistent preparedness challenges. (2018 National Preparedness Report)
- Housing has been identified as a national area of preparedness improvement – every year since 2012. (National Preparedness Reports)

On top of decisions by disaster survivors, key policy choices have driven the evolution of disaster housing programs in the United States. This report examines how, even absent any specific statutory authority referencing types of housing technology, the reliance on the federal government for disaster housing significantly narrows the range of options. This virtually excludes the possibility for modular and panelized houses to be used at scale after disasters.⁶ This report explores the potential for factory-built housing⁷ to play a larger role in America's disaster housing strategy. **While factory-built houses have been utilized after disasters in several pilot programs, they remain largely outside the scope of regularly implemented housing assistance options.**

This report's intended audience is emergency managers; housing agencies; policymakers at local, state, and federal levels; leaders in the building code community; home construction companies; and others who have a goal of addressing challenges around disaster housing. This analysis is grouped around three pillars: current situation, possible future, and obstacles. Recommendations are also included. This report is based on:

- A June 2018 seminar held at the MIT DC office titled “Systems-Built Homes for Use, at Scale, Post-Disaster: A Discussion Hosted by MIT in Washington, DC.” Participants came from across the public and private sectors including federal agencies, state agencies, housing manufacturers, home builders, and housing construction associations.⁸
- An October 2018 presentation and discussion titled “Roundtable: Meeting Post-Disaster Needs with Offsite Construction.” The presentation and discussion took place at the National Association of Home Builders' 2018 Building Systems Housing Summit. Summit participants included housing manufacturers, home builders, and housing construction associations.⁹
- Additional research on disaster housing from July 2017 to July 2019.

KEY TERMINOLOGY

This report focuses on disaster shelter and housing programs in the United States. Emergency managers in the United States view shelter, temporary housing, and permanent housing as distinct terms describing different types of emergency assistance. **Key emergency management terms have been defined in common language in Appendix A.**

This report focuses largely on direct housing, which is a type of disaster housing support provided when survivors are unable to use financial housing assistance (such as rental assistance) to secure temporary housing.

Additionally, **this report draws a distinction between manufactured homes and factory-built homes.** Manufactured homes (also called mobile homes) are governed by a pre-emptive national building code established by HUD, the “HUD Code.”¹⁰ Factory-built homes (also called off-site construction) are built to state and local building codes and standards, but are built in factory conditions away from the job site. Factory-built homes is inclusive of modular, panelized, and pre-assembled housing construction methods. For the purpose of this report, manufactured homes are separate from factory-built homes, despite the fact that manufactured homes are manufactured in a factory.

Finally, **this report has a minimal focus on unique tribal and territorial considerations in disaster housing.** The research focuses on state and local considerations in disaster housing.

WHERE ARE WE NOW?

State-Driven Building Codes, Locally-Driven Zoning Laws and Permitting Requirements

States and localities have the freedom to choose their own building codes based on the laws created by their individual governing bodies. Some states adopt a statewide building code, while other states have building code adoption at the local level. These choices differ broadly from one jurisdiction to another, just as terrain, hazards, and political processes differ. Though 49 states, as well as some territories, use/have adopted the International Residential Code (IRC) from the International Code Council (ICC), there is variation in what year code they require.¹¹ For example, most states build to the 2012 or 2015 IRC standard. Texas, however, builds to the 2000 IRC standard, while Indiana builds to the 2003 IRC standard. To further complicate matters, 11 of these states have adopted the IRC, but not on a statewide basis.¹²

Zoning laws and permitting requirements further determine what kinds of housing is allowed in a community. Zoning is a purely county, city, or municipal affair; therefore, it is not regulated or uniform from state to state. The Houston-Galveston Area Council identified several statutory barriers that slow housing recovery after disasters:¹³

- Masonry requirements
- Garage requirements
- Minimum square footages
- Industrialized housing ordinances
- Zoning ordinances
- Grandfathered properties
- Landscaping requirements
- Unsuitable site conditions
- Permitting requirements
- Code compliance
- Historic districts
- Homeowners associations
- Deed restrictions
- Occupancy standards

As part of the 2016 Hurricane Matthew response in North Carolina, the housing team at FEMA's Joint Field Office sought to get ahead of coordination challenges around local requirements impacting temporary housing. Knowing that "identifying the local governmental requirements was critical to meeting the primary goal of housing disaster survivors, so they can begin their recovery," FEMA and the state worked in partnership with the following groups to gather information about local ordinances, rules, and requirements: University of North Carolina School of Government, North Carolina League of Municipalities, and North Carolina Association of County Commissioners.¹⁴

Though cross-governmental coordination is nothing new for successful disaster response, housing presents unique challenges because of the variety of local requirements. Such requirements include planning for environmental and historic preservation compliance. Infrastructure concerns such as access to utilities and the prevalence of the floodplain add complicating contours to disaster response. **The existence of these statutory barriers puts veto power in the hands of state and local decision makers, who, as described above, do not pay for FEMA's disaster housing programs and have self-reported that they do not think disaster housing is their responsibility.**

“The time savings of constructing modular housing offsite are often negated by the current protracted processes required to rebuild. The current requirements for funding housing recovery, qualifying homeowners, and the various local authorizations required to rebuild are all more significant time constraints to rapid reconstruction than the manner of construction technology employed.”

Houston-Galveston Area Council,
writing about a Rapid Housing Recovery
Pilot Program following Hurricane Ike¹⁵

Reliance on Manufactured Housing in Disaster Relief

FEMA provides an array of programs that support the shelter and housing needs of disaster survivors. See Appendix A for an overview of FEMA’s programs in this area.

FEMA often provides financial housing assistance which helps eligible households pay for repairs or supports monthly rent payments to provide a temporary place to stay. In cases where financial housing assistance would not be sufficient for meeting disaster caused housing needs, FEMA can provide non-financial forms of assistance.

In communities with insufficient housing stock, FEMA has the ability to provide Direct Temporary Housing Assistance¹⁶ via Transportable Temporary Housing Units, Multi-Family Lease and Repair and Direct Lease. An MIT analysis of recent disasters requiring a direct housing mission indicates that FEMA primarily provides transportable temporary housing units in the form of manufactured homes and RVs/travel trailers.¹⁷

In response to Hurricanes Katrina and Rita in 2005, FEMA conducted the largest housing operation in the country’s history, primarily through the use of 140,000 RVs/travel trailers. Following these hurricanes, FEMA temporarily stopped using RVs/travel trailers.¹⁸ Manufactured homes are governed by a pre-emptive national building code established by HUD, the “HUD Code”.¹⁹ Additionally:

- In 2006, FEMA’s Joint Housing Solutions Group created a Housing Assessment Tool that included the following two conditions when evaluating viable housing options:²⁰

1. Footprint: Units should be small, capable of HUD certification, and suitable for FEMA community sites or privately-owned sites.
2. Production Lead-Time: Providers must be able to deliver a certain number immediately or within a short time frame to meet FEMA’s operations and performance requirements.

- In 2009, when speaking about manufactured homes, the FEMA Administrator described that:

Traditional temporary housing units are generally able to be procured relatively quickly due to the existing production infrastructure supporting the private market.... Alternative forms of temporary housing units, by comparison, have varying degrees of production capabilities, and have not been previously used for extended periods of occupancy in any substantial quantities. Some forms of alternative housing units pose unique delivery and installation challenges, whereas there is an existing private market for delivery and installation of traditional forms of temporary housing units.²¹

Manufactured homes are capable of providing housing for a family for more than 50 years, but Congress, via the Stafford Act, requires FEMA’s temporary housing assistance to last no longer than 18 months. Deploying a manufactured home to provide 18 months of housing (taking into account resale and reuse) costs roughly \$110,000 to \$129,000.

While manufactured homes are often described as the housing option of last resort, they have effectively become the only option when FEMA needs to provide Direct Temporary Housing Assistance. Manufactured homes are, in effect, the de facto form of FEMA’s Direct Temporary Housing Assistance, even absent any specific statutory authority referencing specific types of housing technology.

This has created a significant mismatch of product performance and product requirement since manufactured homes were not designed as disaster-specific housing, or even as temporary housing. Manufactured homes are capable of providing housing for a family for more than 50 years.²² Congress, via the Stafford Act, requires FEMA's temporary housing assistance to last no longer than 18 months (unless specifically extended).²³ A year-and-a-half after the declaration date of a disaster, the Stafford Act indicates that FEMA should no longer be providing any temporary housing assistance (unless a timeline extension has been granted). Taking into account resale and reuse, the average deployment cost for one manufactured home is \$110,000 to \$129,000. (See Appendix C for information on calculating cost estimates, including figures higher than \$129,000.) FEMA expends significant financial resources to meet its mandate of 18 months of temporary housing assistance (unless specifically extended).

There are three important caveats to note regarding FEMA's reliance on manufactured homes for post-disaster housing:

1. Manufactured housing plays a critical role in the overall housing market as the only non-subsidized form of affordable housing. These homes account for 10% of new homes nationwide, and are especially popular in hurricane-prone Southern states.²⁴ Manufactured housing has a necessary place in the American single-family home construction landscape.
2. It is important to reiterate that in areas with sufficient rental housing options, FEMA would provide financial (rather than direct) housing assistance for the duration of an eligible applicant's 18-month temporary stay. Approximate costs vary widely depending on an area's HUD-determined Fair Market Rent, but they are still well below the cost of using manufactured homes. For example, the 18-month cost of financial housing assistance would be approximately \$20,000 in Tuscaloosa, Alabama, or approximately \$50,000 in Oakland, California.²⁵ As this report will document, there is a persistent affordable housing shortage in America which makes it less and less likely that a community will have sufficient post-disaster rental housing options for survivors.
3. About 10 years after Hurricane Katrina, in 2017, as part of FEMA's Housing Assistance Initiative, FEMA began to once more use RVs/travel trailers (which meet higher standards developed by the RV Industry Association as well as formaldehyde standards developed by the U.S. Environmental Protection Agency²⁶) as transportable temporary housing units. It is too early to measure the

extent to which this additional direct housing option will reduce FEMA's reliance on manufactured homes governed by the HUD code.

Year-Round Nationwide Housing Shortage

Though this report is focused on post-disaster housing, it is important for policymakers to understand broader challenges in the overall United States housing market because disasters exacerbate pre-existing stresses. Restrictions on the disaster housing toolkit limit the options available to respond and ameliorate those stresses post-impact.

Whether through the repair of multi-family housing or the provision of more resilient single-family homes, housing support provided during disaster recovery can provide benefits to a community's housing stock well into the future.

“It is critical to understand the impact that post-disaster housing stock levels have on disaster housing operations. The repair and restoration of housing stocks is one of the most important challenges FEMA and its response and recovery partners face following a catastrophic housing disaster. All other housing decisions and programs hinge on this single variable.”

DHS OIG, OIG-09-111, September 2009³⁰

Outside of disaster recovery, the United States faces ongoing challenges with housing. For example, in its 2018 *The State of the Nation's Housing* report, Harvard University's Joint Center for Housing Studies describes that:²⁷

- Inventories for single-family homes for sale is at its lowest level since the National Association of Realtors began its tracking in 1982.
- About a third of all households in most metros are cost-burdened, defined to be when a household spends more than 30% of its income on housing.
- The national median rent rose 20% faster than overall inflation from 1990 to 2016.
- Inflation-adjusted construction wages and benefits were up 7% from 2001—somewhat less than the 9% increase for all private industry workers.

The slow wage growth is despite there being a record number of job openings in the construction industry. The U.S. Bureau of Labor Statistics estimated a total of 434,000 construction job openings in the United States in April 2019, the highest level recorded since 2000.²⁸

Additionally, the National Low Income Housing Coalition describes in a 2019 report, “The Gap: A Shortage of Affordable Rental Homes,”²⁹ the United States has a shortage of 7 million affordable rental homes for extremely low-income renters. This population group is also particularly vulnerable to the impacts of disasters.

These are just some of the ongoing challenges the United States faces with housing. Though emergency managers are not primarily tasked with addressing these housing circumstances, improvements in the toolkit of disaster housing options may help address the broader non-disaster-caused housing challenges in America. Doing so would influence overall community resiliency, which is in scope for emergency managers.

Limited FEMA Role in Permanent Post-Disaster Housing

The notion of “Building Back Better” refers to the execution of recovery activities in a manner that also mitigates future risk for disaster impacted communities. This approach emerged after the 2004 Indian Ocean tsunami³¹ and was endorsed in 2015 by the UN General Assembly³² as part of the Sendai Framework for Disaster Risk Reduction.³³

In the United States, the National Preparedness Goal and Presidential Policy Directive 8 both describe mitigation as its own mission area, distinct from recovery. However, “Building Back Better” has also started to permeate disaster lexicon in the United States. For example, following Hurricane Maria in 2017, “Building Back Better” was the title of both Puerto Rico’s official Request for Federal Assistance for Disaster Recovery, as well as the electricity sector’s recommendations for the rebuilding of Puerto Rico’s electric grid.³⁴

Within the National Disaster Recovery Framework, recovery is described as “more than the community’s return to pre-disaster circumstances.”³⁵ When it comes to housing, “Building Back Better” represents an improvement in a community’s long-term housing stock (i.e., its permanent housing stock) to achieve a reduction in vulnerability.

Building Back Better can be both bringing existing buildings up to modern construction standards and codes, as well as

decreasing long-term housing needs in a community.

Over time, Congress and federal emergency managers have been part of a slow evolution over the role of federal government in supporting permanent housing specifically in post-disaster settings.³⁶ Despite adopting a hands-off approach in the 1980s, the federal government has increasingly included consideration of permanent housing into its doctrine and programs:

- **In 1988, the Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act)**³⁷ stated that temporary housing assistance is limited to 18 months. Disaster survivors still occupying a government-provided temporary housing unit after 18 months can purchase the housing unit at prices that are fair and equitable when the occupants lack permanent housing.
- **In 2000, the Disaster Mitigation Act**³⁸ authorized permanent housing construction in insular areas outside the continental United States and in other remote locations. Occupants who purchase the government’s temporary housing unit are required to maintain hazard and flood insurance.
- **In 2006, the Alternative Housing Pilot Program (AHPP)** was authorized as a competitive grant program to identify and evaluate better ways to house future disaster victims. As the Department of Homeland Security Office of Inspector General (DHS OIG) describes, Congress created the AHPP “recognizing the extensive housing challenges presented by Hurricane Katrina, as well as limitations within the Stafford Act.”³⁹ Five awards were given to four states (Alabama, Mississippi, Louisiana, and Texas). Each state piloted permanent housing solutions constructed from a range of methods (site-built, modular, panelized, manufactured).⁴⁰
- **In 2006, the Joint Housing Solutions Group (JHSG)** was formed (across FEMA, HUD, and the National Institute of Building Sciences) to evaluate and rate disaster housing options. The options evaluated by the JHSG included modular homes that could transition to permanent housing.⁴¹
- **In 2006, the Post-Katrina Emergency Management Reform Act (PKEMRA)**⁴² amended the Stafford Act so that permanent housing construction would no longer be limited to remote or insular locations.

- **In 2009**, the **National Disaster Housing Strategy** called for the nation to focus on six housing goals, one of which is to “build capabilities to provide a broad range of flexible housing options, including sheltering, interim housing, and permanent housing.” The Strategy identified that one key principle of permanent housing is that “some interim housing solutions can become permanent housing.”⁴³
- **In 2010**, the **National Disaster Housing Task Force** was created as a federal inter-agency coordination structure. One of the Task Force’s purposes is to promote strategic planning across the disaster housing continuum of sheltering, interim housing, and permanent housing.⁴⁴
- **In 2017**, FEMA’s **Housing Assistance Initiative** was created to meet the need for an in-depth, critical look at FEMA’s post-disaster housing strategy. Included among a list of actions is the task to “identify alternative post-disaster housing solutions that leverage [best practices] to provide operational and cost-effective solutions for both temporary and permanent housing.”⁴⁵
- **In 2018**, the **Disaster Recovery Reform Act**⁴⁶ amended the Stafford Act to allow states, tribes, and territories to administer temporary and permanent housing and allowed for more flexibility in FEMA’s Multi-Family Lease and Repair program which completes permanent repairs to a community’s existing housing stock.

While permanent housing is now given a place in the United States’s emergency management doctrine, and while improving a community’s permanent housing stock has the potential to reduce long-term vulnerability, FEMA continues to focus on temporary rather than permanent housing needs. This may be in part due to the fact that FEMA is the Coordinating Agency for Emergency Support Function (ESF) #6 (Mass Care, Emergency Assistance, Temporary Housing, and Human Services) while HUD is the Coordinating Agency for Recovery Support Function (RSF) Housing.

Not only are response-oriented temporary housing and recovery-oriented (permanent) housing coordinated by different federal agencies, but the timelines are also quite separated. For example, FEMA’s temporary housing is meant to be available for no more than 18 months (unless an exception is granted) while HUD’s funding mechanism for recovery-oriented (permanent) housing often takes several years. (See the Extended Timelines for Disaster Recovery section on page 23.)

Congress has limited when FEMA can provide assistance via permanent or semi-permanent housing. FEMA can provide assistance in insular areas outside the continental United States or in other locations where no alternative housing resources are available and where temporary housing assistance is “unavailable, infeasible, or not cost-effective.”⁴⁷

When it comes to shelter and temporary housing, Congress has granted FEMA much broader authorities. The clear distinction in authorities between temporary and permanent housing, however, does not equate to a clear distinction in how survivors utilize temporary and permanent housing programs. **The following are examples of activities defined to be shelter or temporary housing, even as they may reach a level of permanency.** The examples come from the range of FEMA Individual Assistance and Public Assistance programs.

1. Transitional Sheltering Assistance (TSA) provides direct payment to approved hotels and motels for disaster survivors. It is **intended to initially last from 5 days to 2 weeks**, with the goal of moving remaining and returning evacuees out of congregate shelters. After Hurricane Harvey impacted Texas in 2017, congregate shelters had a one-night peak of 28,000 people while the TSA program had a much higher one-night peak of 73,000 people (2.6x). Additionally, **some survivors remained in the TSA program for nearly a year** after the disaster, far surpassing the intended timeframe of this sheltering assistance.⁴⁸
2. The Blue Roof Program is implemented by the U.S. Army Corps of Engineers and provides free installation of fiber-reinforced sheeting to cover damaged residential roofs until arrangements can be made for permanent repairs. These protective measures are **designed to last for 30 days** and are intended to prevent further damage to home contents. Blue Roofs are **sometimes the only type of roof repair houses may have more than a year after a disaster.**⁴⁹
3. Operating as a temporary pilot program since 2012, the Sheltering and Temporary Essential Power (STEP) program has provided free minor repairs to make a home safe, secure, and weatherproof. Essential utilities and plumbing were made safe and operational to meet basic life sustaining needs so that occupants could shelter in place until more permanent repairs could be made.⁵⁰ The intent was to allow homeowners to return to living in their damaged homes while longer-term repairs continue, allowing people to return to work and school in their communities. **Repairs,**

even if not aesthetically pleasing, often become de facto permanent. The New York Times described Hurricane Sandy's version of the STEP program in New York in a September 2014 article by stating, "In less than 100 days, Rapid Repairs restored heat, power and hot water service to more than 11,700 buildings. More than \$640 million was spent, much of it toward repairs with permanent value."⁵¹

4. Manufactured Housing Units are utilized for temporary direct housing missions in communities with low available housing stock. **This assistance is meant to be available for no more than 18 months (unless extended),** yet for survivors unable to make progress towards "permanent housing," these units can be extended longer than 18 months. Survivors can be asked to begin paying nominal monthly rent and utilities. **In some cases, survivors can purchase the FEMA-provided manufactured home outright.**

Across an initial disaster response and a longer-term disaster recovery, there are different times when sheltering, temporary housing, and permanent housing may each be the most effective and cost-effective manner to meet the needs of disaster survivors. And to be clear, the above examples likely represent FEMA's desire to utilize judgment and flexibility to help create tailored disaster-, community-, and survivor-specific approaches to housing recovery. However,

these examples also shed light on ways that hard-and-fast distinctions between temporary and permanent housing may be unrealistic or impractical. The differences between emergency protective measures, sheltering, temporary housing, and permanent housing may be clearly defined within the federal government, but they can also represent bureaucratic distinctions that make the recovery process less straightforward, rather than more.

One consequence of Congress's choice to focus FEMA on temporary housing is that the United States may be missing an opportunity to leverage disaster recovery efforts (led by FEMA or other agencies) to also improve a community's long-term housing stock. Rigid distinctions between temporary and permanent housing may limit America's ability to "Build Back Better."

Outside Perspectives on Distinctions across Sheltering, Temporary Housing, and Permanent Housing

"There is [an] artificial divide between phases in a post-disaster scenario, with the assignment of the term "shelter" to the relief phase and the term "housing" to the recovery or development phase. But in reality, there is no difference between shelter and housing. A shelter is a house and a house is a shelter regardless of the type or style. Although a common distinction is that shelters are built in relief and houses are built in development, in both cases the words carry no indication of quality, standards, type of materials or construction specifications."

Habitat for Humanity, 2016, Pathways to Permanence⁵²

"By focusing excessively on housing that is defined to be temporary, FEMA has ignored construction methods that would meet the criteria of emergency housing, but which happen to not be permanent. ... It is the speed, safety, and cost of disaster housing that is important, not whether the housing is labeled 'temporary' or 'permanent.'"

National Association of Home Builders, Public Comments on the National Disaster Housing Strategy, 2008; DOCKET ID FEMA-2008-0009⁵³

WHERE COULD WE GO?

Factory-Built Homes Have Cost and Speed Benefits Outside Disaster Settings

In 2017, roughly 87% of single-family homes built in the United States were site-built homes.⁵⁴ The site-built construction method relies on materials and skilled labor available **locally** at the job site. During disaster events with widespread residential damage, houses will be both repaired and rebuilt. Post-disaster construction can be delayed due to several factors: lack of capital, a shortage of skilled workers, licensing rules hindering out of state workers, unavailability of materials, postponed decisions on rebuilding versus relocating, building code restrictions, floodplain considerations, zoning changes, and infrastructure repair challenges.

An alternative to site-built homes is factory-built homes,⁵⁵ which come in various forms, such as pre-assembled components and furnished houses that can be assembled on site. Notably, factory-built homes are constructed in a controlled indoor environment away from their final destination. Factory-built home construction can decrease the demand for local skilled labor and building materials in communities recovering from disasters, further increasing a community's ability to recover. Off-site construction occurs around the world, with many countries utilizing these techniques more than the United States, as outlined in Table 1. These techniques can be utilized even for geographies with a wide range of climate regions like the United States, which may require a larger variety of styles appropriate to local climates.

The National Association of Home Builders (NAHB) Research Center (now known as the Home Innovation Research Labs) has highlighted the benefit of factory-built home construction in decreased labor requirements. The labor cost component of a modular or manufactured home is typically 8 to 12% of the total house construction cost, while the labor cost of a site-built home is upwards of 40 to 60% of the total cost.⁵⁶ These labor savings are helpful, because as noted above, the U.S. Bureau of Labor Statistics estimates a total of 434,000 construction job openings in the United States in April 2019, the highest level recorded since 2000.⁵⁷

Table 1: America Lags Other Countries in Adoption of Prefabricated Techniques

COUNTRY	% of Construction Using Factory-Built Techniques
Sweden ⁶⁰	74–84%
Finland ⁶¹	50%
Singapore ⁶²	40%
China ⁶³	30%
Germany ⁶⁴	20%
Netherlands ⁶⁵	20%
Japan ⁶⁶	15–20%
UK ⁶⁷	7–12% (and 25% target for publicly funded social housing)
USA ⁶⁸	3–13%
Australia ⁶⁹	3–5%

Table 2: Cost Comparisons of Home Construction by Method (in 1998 dollars)

COST CATEGORY	Site-Built	Modular	Manufactured
Construction Costs	\$77,140	\$65,560	\$47,277
Structure	\$71,123	\$59,543	\$41,260
Foundation	\$6,017	\$6,017	\$6,017
Cost per Square Foot	\$38.57	\$32.78	\$23.64
Land Costs	\$35,314	\$35,314	\$35,314
Improved Lot	\$34,113	\$34,113	\$34,113
Site Preparation	\$1,201	\$1,201	\$1,201
Financing Costs	\$2,895	\$1,298	\$610
Construction Financing	\$2,895	\$1,298	—
Inventory Financing	—	—	\$610
TOTAL COST	\$115,349	\$102,172	\$83,151

Additional benefits to off-site construction were identified in a 2011 McGraw-Hill survey of architecture, engineering, and contracting professionals:⁵⁸

- 66% of respondents report that project schedules are decreased—35% by four weeks or more.
- 65% of respondents report that project budgets are decreased—41% by 6% or more.
- 77% of respondents report that construction site waste is decreased—44% by 5% or more.

Though more recent cost comparisons are not available, an NAHB Research Center's 1998 report detailed that site-built homes cost more than both modular and manufactured homes⁵⁹ (See Table 2). It is important to note that estimates of the speed, cost, and waste savings from off-site construction excluded considerations needed for building in a disaster recovery environment (e.g., material shortages as well as increased labor and support costs).

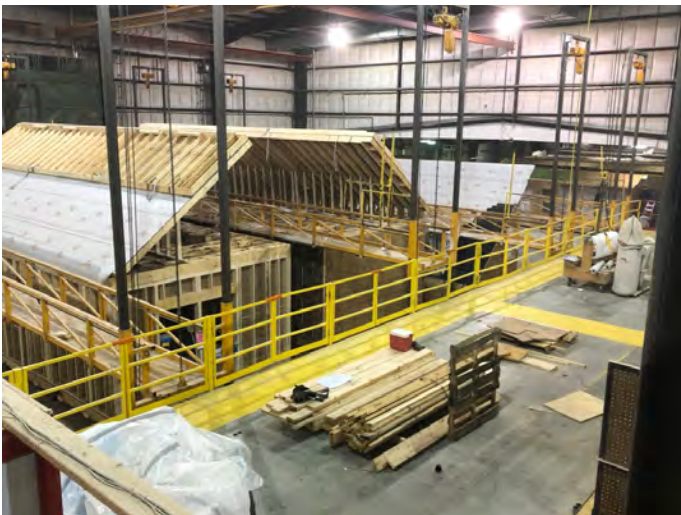


Figure 3: Photos of Production of Factory-Built Housing
Photo credits: NAHB, Ritz-Craft, Cardinal Homes

Pop-Up Factories Could Be a Resource Following Catastrophic Events

Following catastrophic events, when especially high numbers of homes are completely destroyed, new factories can be stood up near disaster-impacted areas to produce modular/panelized/pre-cut homes. These so-called “pop-up factories” can be a previously abandoned, refurbished, or newly constructed factory. Initiating a new factory would require tooling, skilled labor, and most importantly, experienced management. Regional fabrication locations could be pre-identified as possible factories, work areas, or distribution centers to aid in disaster rebuilding.

Disaster impacted communities would benefit from new nearby pop-up factories through reduced transportation time and cost for completed homes. A skilled labor pool could be developed and utilized outside the immediate disaster area, reducing the logistical burdens associated with bringing a trained workforce into a community for disaster recovery purposes. Moreover, home manufacturing could represent an investment in long-term economic development, creation of new readily available employment opportunities, and faster re-establishment of an area’s housing stock.

Several factors would need to be addressed for pop-up factories to become a viable option after catastrophic events. For example:

- Are pop-up factories government-supported, or fully private-sector-led?
- Through what agency (e.g., housing, community development, emergency management) and at what level (e.g., state, local, tribal, territorial, federal) would government support be appropriate and warranted?
- How should pop-up factory facilities be utilized once the demand surge for post-disaster housing has passed?
- What is the best way to leverage the efficiencies of production given the difficulties of managing variation across individual orders and installation?

In preparation for catastrophic events, pop-up factories have the potential to stand alongside policy changes, reciprocity agreements among states, and pre-event contracts—as a multi-pronged approach for disaster housing preparedness.

Factory-built methods are utilized not just for single-family housing, but also for hotels and multi-family housing. For example:

- Founded in 2015, **Katerra**, a manufacturer of cross-laminated timber wall assemblies with headquarters in the United States, has residential products focused on multifamily, senior, student, and single-family housing. Katerra platforms include compliance with 48 states’ building and energy codes.⁷⁰
- In 2017, **Google** began working with Factory OS to construct 300 apartment units in the San Francisco Bay Area using modular construction.⁷¹
- In 2017, **Marriott International** announced intentions to incorporate modular construction in the construction of 50 hotels in North America. As of May 2019, modular construction has been used in hotels in California, Kentucky, North Carolina, Oklahoma, Washington, and Wisconsin.⁷²
- In 2018, Polish manufacturer **Polcom Modular** completed construction on a 21 story hotel in Manhattan, creating the (then) tallest modular hotel in the United States.⁷³
- In 2018, the **New York City Department of Housing Preservation and Development** issued a Request for Proposal for 100% affordable housing that explicitly required modular construction.⁷⁴
- In 2019, **DMD Modular**, also from Poland, plans to finish construction on a 26-story Marriott hotel, also in New York City. This will be the tallest modular hotel in the world.⁷⁵

In these examples, there is one owner, so construction-related decisions are streamlined across multiple units. This benefit is not found in single-family housing.

Opportunity to Leverage Disaster Housing for Affordable Housing Challenges

State, local, tribal, and territorial governments face not only periodic disaster housing challenges, but also year-round affordable housing challenges. Rather than address each of these housing problems individually, states are seeking out ways to address both problems in tandem. In the Commonwealth of Virginia, for example, the Virginia Department of Emergency Management and the Virginia Department of Housing and Community Development are trying to address disaster and non-disaster housing needs with a combined solution. Speaking on **the need for a coordinated approach to address long-term resiliency**, experts from Virginia relayed the following to MIT researchers:

Affordable housing is limited and difficult to attain, even on a blue-sky day. When you consider that the vast majority of individuals in shelters were already living at or below the poverty line when the disaster struck, were transport- and food-insecure, and were living in substandard housing from the outset, the need for affordable housing after an event becomes imminently apparent. Any opportunity to increase affordable housing stock will ultimately benefit communities and disaster survivors.

Virginia Department of Emergency Management

Dawn Brantley, Sheltering Coordinator

Ed Porner, Director, Recovery and Resilience Division

The Virginia Department of Housing and Community Development (DHCD) is concerned that the most vulnerable populations after a disaster are those most in need of permanent housing assistance. Recognizing that FEMA is limited in the resources it can provide and the 18-month restriction on temporary housing, DHCD is interested in how our agency can support new policies **for temporary housing that can transition to permanent**. DHCD believes that identifying an innovative product and process will improve the use of both federal and state funds and most importantly provide affordable permanent housing for vulnerable populations post-disaster.

Virginia Department of Housing and Community Development

Cindy L. Davis, Deputy Director, Division of Building & Fire Regulations

Pamela Kestner, Deputy Director, Housing

Flexible housing recovery funding most often comes in the form of HUD's CDBG-DR program. In cases where CDBG-DR funding allows state and local officials to provide permanent housing to disaster survivors, they frequently turn to factory-built or manufactured homes:

- In areas of the **Lower Rio Grande Valley** impacted by Hurricane Dolly in 2008, a consortium of organizations⁷⁶ created the **RAPIDO** pilot program which implemented a temporary-to-permanent housing method for 20 homes. Panelized modules were constructed nearby and formed a core unit the family would move into, with additional bedrooms added on afterwards. Results of the RAPIDO program included successful expansion past the core unit, which would be used immediately after a disaster. The consortium utilized the same temporary-to-permanent housing method in Houston after Hurricane Harvey in 2017 with 15 homes planned, and funded by non-governmental grants.⁷⁷
- Following Hurricane Ike in 2008, the **Houston-Galveston Area Council**⁷⁸ developed the **Back Home pilot program** designed to “minimize displacement of residents by developing a strategy for the rapid, efficient, large-scale deployment of temporary-to-permanent housing following future natural disasters.” This program led to the construction of 20 modular homes in Harris and Galveston counties.⁷⁹ Six years later, local officials visited the homes to survey damage from Hurricane Harvey in 2017. All units were still occupied and none had any flood damage from Hurricane Harvey.⁸⁰ A central goal of both of these Texas programs was “to test the feasibility of... large-scale production of replacement housing for victims of federally declared natural disasters.”⁸¹
- Following Hurricane Sandy in 2012, the **City of New York** experienced long delays filling unmet housing needs despite receiving federal funds for that purpose.⁸² To improve the speed of the **Build It Back** program, the city leveraged modular homes. The New York Times reported in an October 2017 article that only minimal additional work was required to install these modular homes on appropriate foundations – adding staircases and finishes – making local contractors available for more projects.⁸³

- Following major flooding in **Louisiana** in 2016, the **Restore Louisiana Homeowner Assistance Program** had a policy of replacing, not rehabilitating or repairing, flood-damaged manufactured housing units. The program was meant to serve the long-term housing needs of survivors and to protect against potential environmental health hazards due to water damage.⁸⁴

The temporary-to-permanent examples listed above (RAPIDO and Back Home) identify unique disaster housing approaches championed and explored by specialized organizations. That is because **temporary-to-permanent disaster housing options are generally not supported by the non-disaster market.**

These examples also illustrate that when flexible recovery funding is made available, states often choose to implement permanent housing. Unfortunately, the uncertainty and lengthy timeline for flexible recovery dollars,⁸⁵ and the limitations preventing initial FEMA funds from being used for permanent housing, slow the ability of states to move towards these recovery options. (See the Extended Timelines for Disaster Recovery section on page 23.)

Through the 2018 Disaster Recovery Reform Act, Congress is asking FEMA to develop grant processes so that states can begin to administer federally funded disaster housing programs. However, it is unlikely that states will be able to use this funding for permanent housing in all cases where they want to do so.

State housing programs will need to follow the same restrictions as FEMA. Thus, this funding for states will likely be for temporary housing (as FEMA is mostly restricted by Congress to do now), even if a state wants to do permanent housing to address a community's overall resiliency in addition to immediate response and recovery.

WHAT IS STOPPING US?

America Has One National Pre-Emptive Code

The National Manufactured Housing Construction and Safety Standards Act of 1974 represents the lone nationwide pre-emptive building code. Also known as the “HUD Code,” the legislation and regulation dating from nearly fifty years ago addressed wide disparities in manufactured home construction standards. Then referred to as mobile homes, these structures built in one state could be sold by a retailer in a second state, and installed in a third state, each with different building codes.

To assure the quality, durability, safety, and affordability of manufactured homes across jurisdictions, **Congress created the HUD Code construction and safety standards which preempt state and local laws that are not identical to the federal standards.** Thus, the HUD Code was created to overcome jurisdictional variation when it comes to quality, durability, safety, and affordability. Similarly, FEMA benefits from the HUD Code’s ability to overcome jurisdictional variation when fulfilling direct housing missions. The HUD Code provides a uniform, cross-jurisdictional assurance that FEMA’s direct housing tool will be in compliance with state and local building codes, by pre-empting state and local building codes.

While modular homes face the same challenges of being built in one state, but sometimes utilized in another state, modular homes are produced on demand, which allows manufacturers to know what state and local building codes to utilize during construction.

Forthcoming building code standards that focus on off-site construction should provide more uniformity in state and local choices on building code adoption for future factory-built housing construction. The ICC is on track to develop, propose, and release the following by 2021:⁸⁶

- A standard for the planning, design, fabrication and assembly of off-site construction,
- A standard for the inspection and regulatory compliance of off-site construction, and

- A guideline for the transportation of modular components to the construction site.

Additionally, in March 2019, the ICC released guidelines for safe use of ISO (International Organization for Standardization) intermodal shipping containers repurposed as buildings and building components.⁸⁷ While each of these optional standards is likely to bring more uniformity to state and local building codes, **they do not provide the benefit to federal emergency managers of helping ensure that their direct housing tools will be allowable in all jurisdictions across the United States.**

Pre-emptive standards provide authority to larger jurisdictions to overrule standards enacted by smaller jurisdictions, which can be at odds with the United States’ system of federalism. Along the same lines as a pre-emptive national building code, when discussing local building regulations as a policy barrier to implementation of the Back Home pilot program, the Houston-Galveston Area Council described the following:⁸⁸

If the State of Texas wishes to create a rapid housing program using the Back Home design after a disaster, [state] or municipal ordinances would need to be created to override [local] restrictions. ... [To adopt] the Back Home model as a standard disaster recovery home, they would need to pass laws at the State level to supersede local restrictions to building the [Back Home]. ... Overriding these local controls would be contentious.

The State of Texas’ Natural Disaster Housing Reconstruction Plan in 2010 further identified the challenges that emerged from local requirements when describing post-Katrina disaster housing in Louisiana and Mississippi:⁸⁹

This idea of “temp-to-perm” disaster housing received much positive attention from state housing and emergency management officials. Local public officials and communities strongly resisted “temp-to-perm.” Ultimately, this resistance created many challenges to realizing the full potential of the [Alternative Housing Pilot Program] projects as long-term recovery solutions.

...

Local officials and the public did not understand that the project was a permanent housing solution. Additionally, a stigma persisted that the AHPP units would lower the property values of the surrounding neighborhood. ...

Due to the overwhelming demands of recovery on local authorities, many officials did not see housing as an immediate priority, instead focusing efforts on restoring the basic infrastructure and economy of the community.

...

Additionally, communities expressed concerns about [these houses] not fitting with the style and size of many neighborhoods. Local officials argued that [these small houses] would do less to restore the tax base than larger, more expensive homes or condos.

Except for the HUD Code, emergency managers and community development managers have no mechanisms that provide the cross-jurisdictional benefits of utilizing a pre-emptive national code for disaster housing purposes.

A Relatively Small Industry Base for Factory-Built Homes

One obstacle preventing wide-scale adoption of factory-built homes for disaster recovery is the limited annual installation of factory-built homes across the United States. As shown in the figures below, **the current industry base for factory-built homes has not been tested to produce at the same scale as disaster recovery.**

Following the August 2016 flooding in Louisiana, FEMA provided approximately 4,500 households with a FEMA-provided temporary transportable housing units.⁹⁰ Given nationwide production and installation of modular and panelized units was 26,000 across all of 2017, a demand of 4,500 units from a single event is a significant demand spike for the industry. As Figure 5 and Figure 6 indicate, output from the factory-built housing industry has remained small relative to site-built homes – both in total units produced and in market share for single-family home construction – since the U.S. Census Bureau began reporting totals in 1992.

This relatively fixed output for factory-built homes has occurred despite stagnant construction productivity (see Appendix B), and despite a multi-year effort by Congress and the emergency management community to build out a suite of innovative housing options (see Where Are We Now? section beginning on page 9).

The impact of this relatively small industry size was described by a county official in Florida when speaking about the need for thousands of homeowners to rebuild or replace their homes following Hurricane Irma in 2017:

There were not enough manufacturers to produce the modular homes that we want for our community. The modular home industry does not have the ability to surge quickly. When you're talking about ordering thousands of houses, even when people have money in their bank account, they're put on a 3-year waiting list. Traditionally, this type of industry cannot accommodate large surges.

Monroe County, Florida

Marty Senterfitt, Deputy Fire Chief/
Director of Emergency Management,
speaking about recovery efforts from
Hurricane Irma in 2017

Table 4: Single-Family Home Construction Totals by Construction Method, 2017⁹¹

2017 Residential 1-Unit Construction Totals		
Site-Built	769,000	87%
Manufactured	92,900	10%
Modular	12,000	1%
Panelized/Pre-Cut	14,000	2%

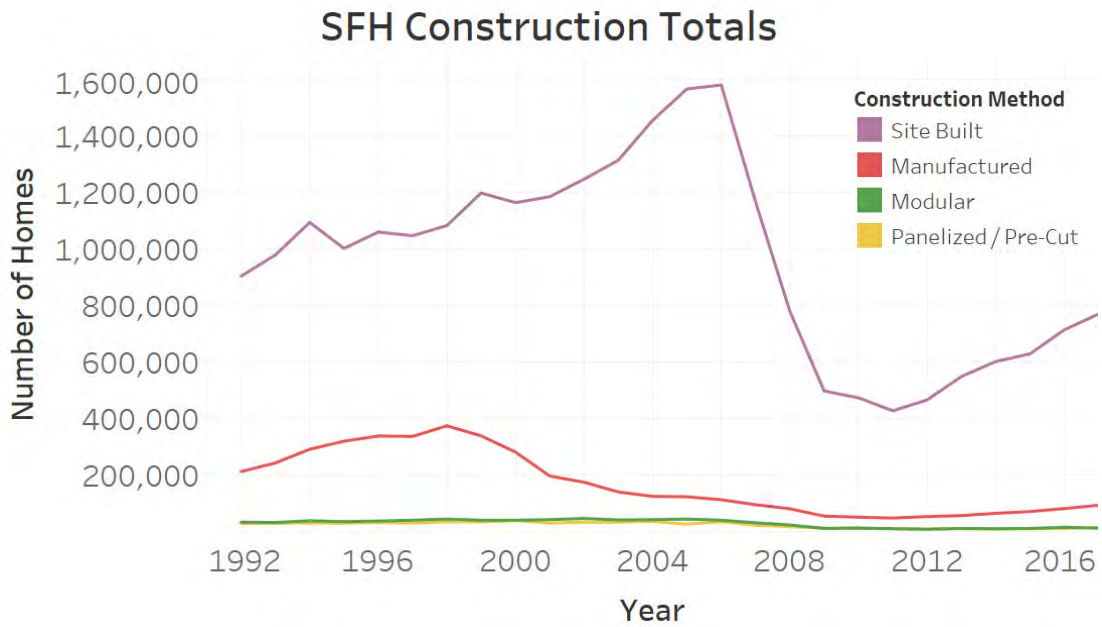


Figure 5: Single-Family Home Construction Totals by Construction Method, 1992–2017⁹²

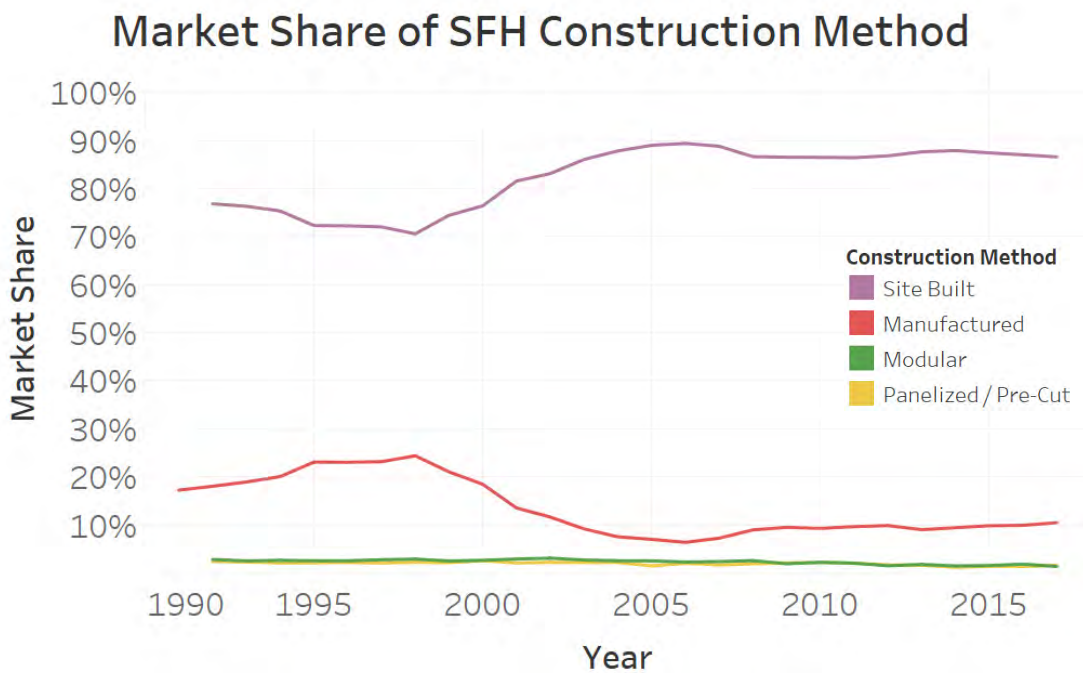


Figure 6: Single-Family Home Market Share by Construction Method, 1992–2017⁹³

Inadequate supply of housing deliveries, like the case in Florida above, can be due to a range of factors such as manufacturer capacity, state-specific manufacturer licensing, or transportation limitations. The need for the United States to be able to draw housing industry capacity to disaster areas is also conveyed as part of the National Disaster Housing Strategy, which identified the following as one of more than a dozen “future directions”:

The housing production system must become capable of producing or rehabilitating enough standard housing units to rehouse populations more quickly following a catastrophic event.⁹⁴

Small industries often lack the surge capacity and standing inventory for catastrophic events. Similarly, smaller-scale manufacturers lack the track record necessary for emergency managers to confidently re-orient their programs around a different product. To regularly and reliably leverage the benefits of factory-built homes during disaster recovery, the industry needs to substantially grow in size, either through normal market changes or government support.

Additional Obstacles to Provision of Post-Disaster Permanent Housing

Extended Timelines for Disaster Recovery

Disaster recovery is a long-term endeavor that takes years. (See Figure 7 below.) In the private market, appropriate insurance and timely payouts are an important driver in the timeline for disaster recovery. Federal financial support for housing comes largely from CDBG-DR special appropriations. These funds are amongst the most flexible of housing assistance dollars and are thus frequently leveraged for permanent housing. The

time from any one disaster event to the ensuing CDBG-DR appropriation often takes several months to more than a year, with uncertainty compounded due to the lack of an ongoing appropriation for CDBG-DR. After an appropriation, states develop action plans to determine how funding should be put to use.⁹⁵ Each of these represents a step in a community’s path towards recovery.

Two events, 2008 Hurricane Ike in Texas and 2016 flooding in Louisiana, each illustrate the extended timelines of HUD housing construction funding. As Figure 8 and Figure 9 show, a very concentrated infusion of federal disaster dollars from FEMA, the Small Business Administration (SBA), and the National Flood Insurance Program (NFIP) goes to meet housing construction and repair needs in the initial days, weeks, and months after a disaster. In that same time frame, homeowners receive funds from their private insurance policies. CDBG-DR dollars, which are meant to provide for unmet housing needs during long-term recovery, come much later.

FEMA dollars shown here represent Repair Assistance, Replacement Assistance, and in the case of Louisiana, the Sheltering and Temporary Essential Power pilot. NFIP dollars shown here represent Property and Increased Cost of Compliance, but exclude Contents. SBA loan dollars shown here represent Home and Personal Property Loans. For 2008 Hurricane Ike in Texas, private insurance totals represent homeowners’ policies only and are based on recurring state insurance commissioner reports that detail claims paid out over time. (Louisiana’s insurance commissioner did not require insurance companies to provide homeowner policy claim data on a regular basis. Additionally, as primarily a flooding event, private homeowners’ insurance payouts were likely minimal.) CDBG-DR dollars shown here represent six

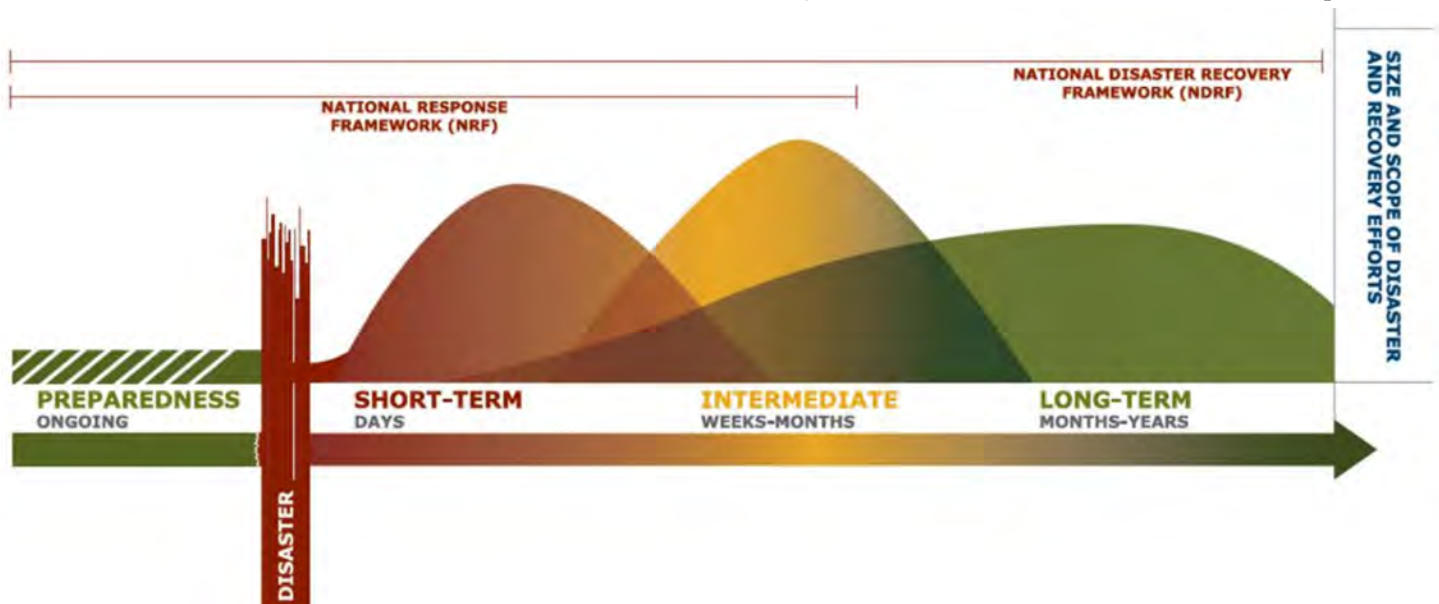


Figure 7: Recovery Continuum⁹⁹

different activity types related to residential housing.⁹⁶ Thus, looking at these dollars attempts to exclude other grants not intended for housing construction and repair purposes.

Funding is affiliated with a calendar year month based as close as possible to when the dollars were available to be spent on housing construction and repair. For instance, all dollars are shown based on when the construction work was done (in the case of FEMA's Sheltering and Temporary Essential Power pilot for Louisiana), when the funds were reported as "disbursed" (in the case of CDBG-DR), or when the check was written (in the case of FEMA Repair Assistance, FEMA Replacement Assistance, SBA, NFIP, and Private Insurance).⁹⁷ These three indicators (work completed, grants disbursed, checks sent) do not conclusively reflect the timing of an increase in demand in a community's construction capacity, but they are the best available proxies for the timing of construction dollars.

For 2008 Hurricane Ike, CDBG-DR dollars totaled \$1.37 billion. These funds were largely unavailable to be spent until several years after the disaster—much longer than FEMA's 18-month restriction on temporary housing. And for 2016 Louisiana Floods, CDBG-DR dollars totaled \$610 million. Only a portion of these dollars was available to be spent in the disaster-impacted community prior to FEMA's 18 month restriction on temporary housing. This 18 month distinction is important because **CDBG-DR funds that address unmet permanent housing needs are generally unavailable to be spent until well after FEMA's temporary housing support ends** (unless granted an extension).

As CDBG-DR dollars have a goal of targeting unmet long-term recovery needs, a longer timeline seems appropriate. However, this extended timeline for CDBG-DR funding has two additional consequences:

1. State, local, tribal, and territorial governments tend to lack quick access to these most flexible of federal disaster housing dollars. This limits the ability of recipients of CDBG-DR funding from using that money to provide permanent housing during the response phase of a disaster, should they wish to do so.
2. Disaster survivors may experience a gap in housing support between when FEMA's temporary housing support ends (usually 18 months after disaster declaration, unless extended) and when recipient agencies can leverage CDBG-DR funding for remaining unmet housing needs.

It is important to note the role of private homeowners' insurance in the course of a community's recovery. Figure 10 and Figure 11 illustrate the relative size of the various funding mechanisms for housing construction and repair that are available after a disaster. For both disasters, CDBG-DR funding was approximately 15% of total estimated funding for housing construction and repair.

Figure 10 also indicates that **for Hurricane Ike in Texas in 2008, nearly 60% of all funds destined for housing construction and repair came from private homeowners' insurance policies.** These insurance funds are meant to cover home damage from wind or other non-flood risks. Figure 11 lacks similar figures because Louisiana's insurance commissioner did not require insurance companies to regularly report on homeowner policy claim data after this disaster. Further, because the 2016 disaster in Louisiana was a flood, private homeowners' insurance payouts were likely minimal because flood coverage is provided by NFIP.

To be clear, faster allocation and spending of housing recovery dollars does not automatically lead to better recovery outcomes. Additionally, long-term programs initiated early in a recovery will have ongoing expenses that may not be reflected in quarterly grant reports. Despite all of this, the extended timeline for delivery of flexible CDBG-DR housing recovery dollars into an impacted community is significant. **While CDBG-DR funds frequently provide for permanent housing options, it can take several years for funds to be allocated to the need and expended. Extended timelines for disaster recovery – as well as for federal funds supporting permanent rebuilding – are the norm, not the exception.**

Following their Rapid Housing Recovery Pilot Program after Hurricane Ike, the Houston-Galveston Area Council said the following with regard to delays in home construction:

The delay between the declaration of a disaster and authorization of spending by Congress to the time that builders are funded to construct homes is far greater than any time savings that modular technologies can provide.⁹⁸

Thus, it is important to consider the role that different home construction technologies can play in more effective residential rebuilding. **Additionally, it is important to consider the role that Congress plays in determining the timeline for CDBG-DR's flexible housing dollars.** Note that concerns about government-caused delays would be decreased if more property owners had insurance at appropriate levels.

Hurricane Ike Housing Construction Funding - Monthly

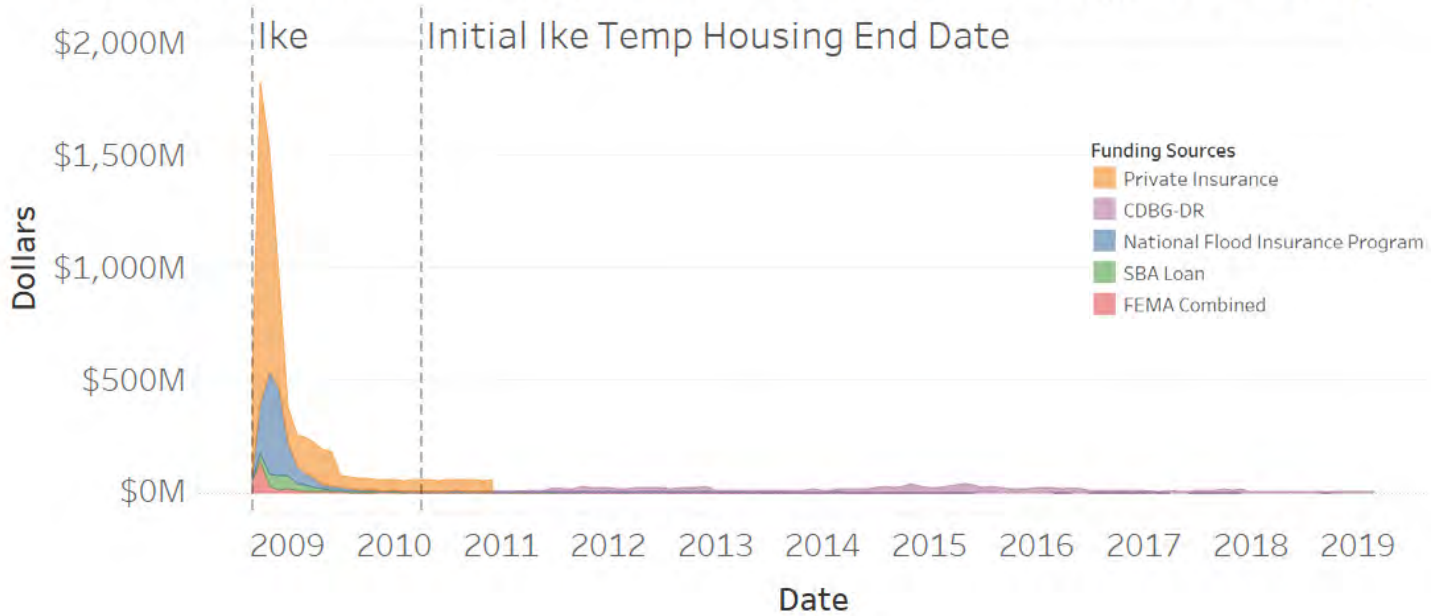


Figure 8: 2008 Hurricane Ike Construction and Repair Funding by Source Over Time

Louisiana Floods Housing Construction Funding - Monthly

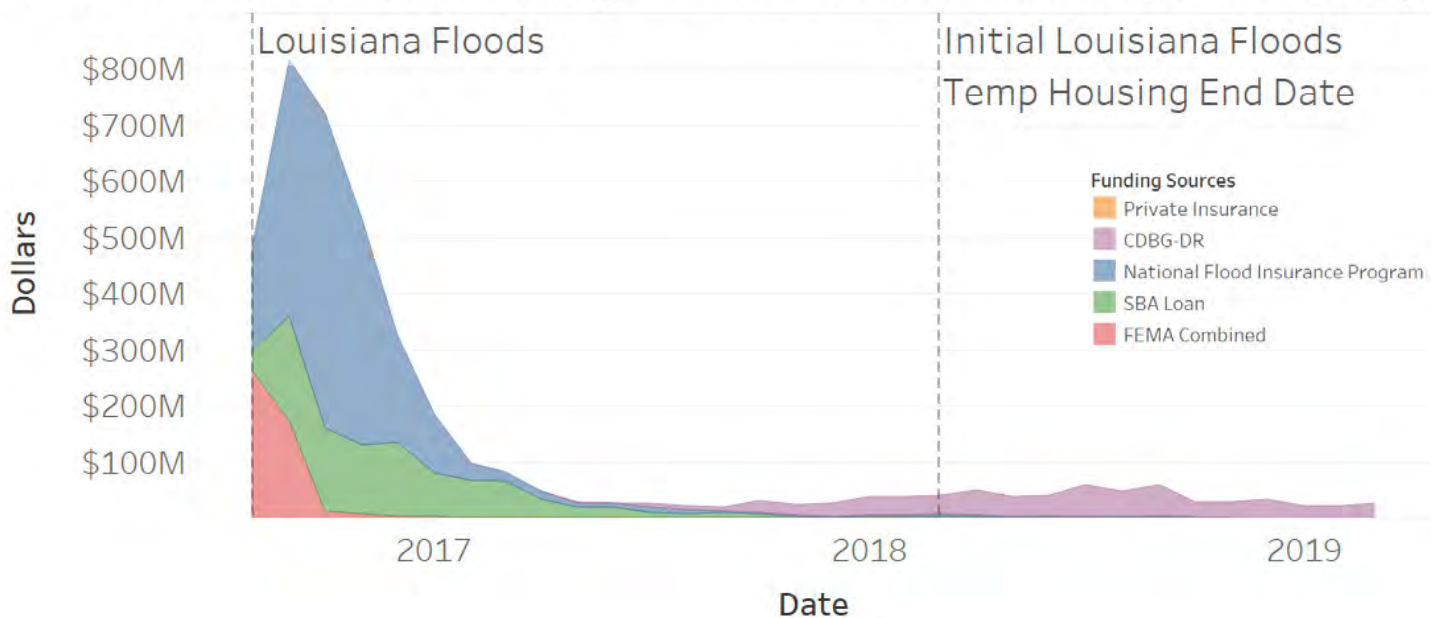


Figure 9: 2016 Louisiana Floods Housing Construction and Repair Funding by Source Over Time

Hurricane Ike - Housing Construction and Repair Funding

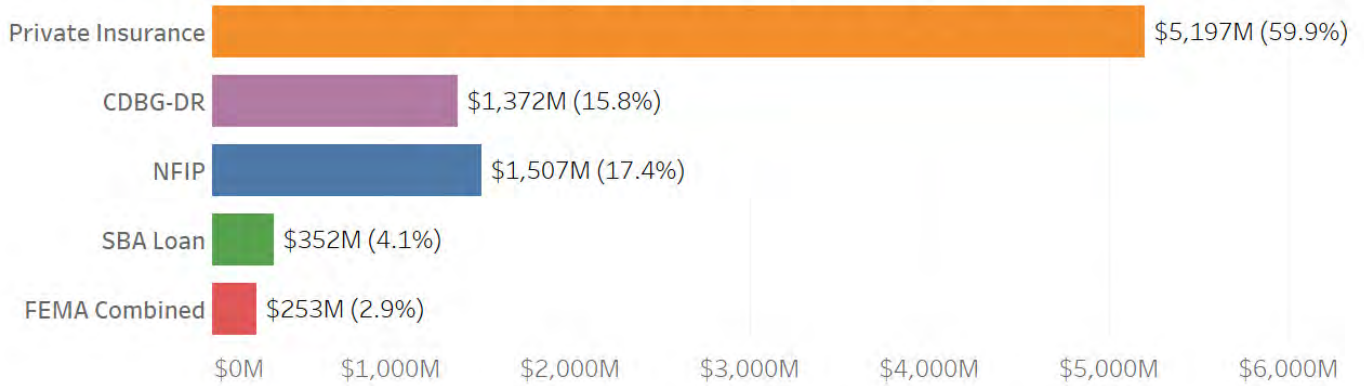


Figure 10: 2008 Hurricane Ike Housing Construction and Repair Funding Totals by Source

Louisiana Floods - Housing Construction and Repair Funding

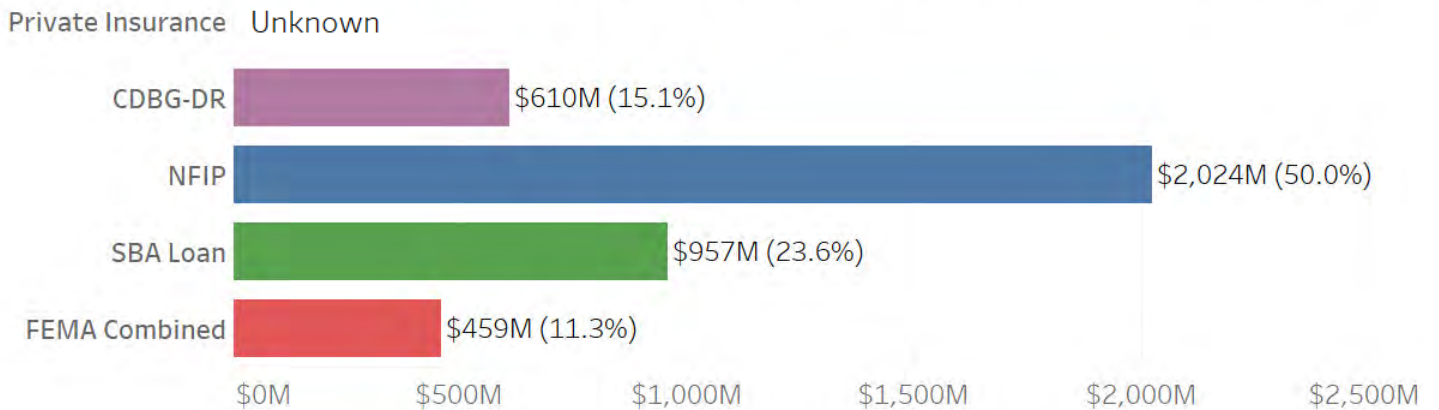


Figure 11: 2016 Louisiana Floods Housing Construction and Repair Funding Totals by Source

Moral Hazard

Moral hazard is the idea that policies or decisions may create incentives for undesirable behavior. Moral hazard occurs when someone takes additional risks because the cost of those risks is borne by another party. Most moral hazard discussions about the role of government assistance after disasters focus on whether government disaster aid reduces insurance uptake.¹⁰⁰ FEMA's NFIP publicly reports on policy and claim statistics,¹⁰¹ and academic literature has thoroughly explored the incentive effects flood insurance has on rebuilding decisions.

There has been no significant research on the incentive effects of providing government funded permanent housing to disaster survivors in the United States. As academics, policymakers, and practitioners examine the question of moral hazard when it comes to permanent disaster housing, they will have to evaluate a number of tradeoffs, both known and unknown. Some of the known factors to be studied include the potential benefits in disaster recovery outcomes, the impact of permanent housing on long-term vulnerability, and any cost savings achieved by providing permanent rather than temporary housing. In short, **reasonable concerns exist about the incentive effects associated with providing permanent housing to the segment of homeowners who may be uninsured or underinsured.**¹⁰²

Lack of Appropriate Data to Measure Cost-Effectiveness

In 2017, a report from the National Institute of Building Sciences, calculated there to be a \$6 benefit for each \$1 invested in a specific subset of federal agency grant programs.¹⁰³ This oft-cited study focuses exclusively on federal agency grant program dollars spent on mitigation and does not draw conclusions on the return on response and recovery programs.

We recognize disaster management as a cycle inclusive of prevention, protection, mitigation, response, and recovery. Disaster aid programs are frequently evaluated on a cost-effectiveness basis, though this is not the overriding goal of disaster aid programs. **Yet there are no cost-effectiveness calculations measuring the impact that additional housing investments in the response and recovery phase may have on future disaster expenses.**¹⁰⁴

One criterion for designing disaster assistance programs, identified by Government Accountability Office (GAO) in 1980, described that:

No individual or group of individuals should be able to improve on their pre-disaster state as a result of disaster assistance unless such an improvement would result in less cost to the Government in future disasters.¹⁰⁵

When it comes to housing assistance, FEMA has no standing metric to measure the total cost of shelter and housing for a single household, across all sheltering and housing programs. Further still, disaster housing programs and affordable housing programs are intrinsically siloed across multiple federal agencies which prevents policymakers from determining the long-term cost effectiveness of providing permanent housing to disaster survivors to meet both disaster housing and affordable housing challenges.

As identified above, moral hazard is an important consideration when developing disaster programs. In some cases, and after broadening the scope of measurement to more than just a single disaster event, FEMA has determined it makes sense to provide a permanent support to disaster survivors to achieve cost effectiveness and to reduce the impact of moral hazard. Looking across flooding events, FEMA has identified Repetitive Loss Properties and Severe Repetitive Loss Properties as households who receive recurring rebuilding assistance from the National Flood Insurance Program. The ability to get recurring assistance essentially encourages NFIP policyholders to maintain residency in flood prone areas by alleviating the disincentive associated with disaster risk. To reduce long-term costs, FEMA has prioritized these properties for buyouts which reduces a community's overall risk. **This calculation relies on the ability of FEMA to identify repeat recipients of disaster assistance across flood events, something that is not possible across the entire spectrum of government-supported housing programs.**

By looking outside the scope of a single disaster, **the same approach can be applied to disaster and affordable housing assistance provided not just by the federal government, but also by state, local, tribal and territorial governments.** It will be extremely challenging to develop an accurate and accepted cost calculation for disaster and affordable housing assistance across multiple levels of government over time. **Having such a metric – across different disaster housing programs, different disasters, and even non-disaster housing challenges – will allow policymakers to determine what housing programs across the combined disaster and affordable housing space are most appropriate and cost-effective.**

Over time, restrictions have been eased allowing for rebuilding beyond just a community or household's pre-disaster state. For example, the National Disaster Recovery Framework in 2011 described recovery as "more than the community's return to pre-disaster circumstances." Similarly, the National Mitigation Framework from 2013 identified the following as a critical task for long-term vulnerability reduction: "Capitalize on opportunities during the recovery building process to further reduce vulnerability."¹⁰⁶

At a census tract level, the U.S. Centers for Disease Control and Prevention (CDC) maintain a social vulnerability index cataloging how factors including poverty, lack of access to transportation, and crowded housing may weaken a community's ability to prevent human suffering and financial loss in a disaster.¹⁰⁷ Measures of vulnerability are at the community level over time while FEMA housing programs are tracked at the applicant (household) level for individual disasters. This is one example of a mismatch further complicating the ability to evaluate cost-effectiveness against vulnerability reduction. An additional complication is that those survivors who may be most in need of permanent housing support may also face additional social and economic challenges that impact long-term vulnerability but are unrelated to housing. Many survivors in greatest need of permanent housing were among the community's most vulnerable well before the disaster.

FEMA's disaster housing programs have the potential – beyond assisting disaster survivors – to partially address the nation's affordable housing and long-term vulnerability challenges. One policy calculation that needs to take place is a determination of whether the cost to provide increased permanent housing outweighs the costs avoided from providing ongoing temporary housing, combined with the reduction in vulnerability that permanent housing may cause. **Policymakers will have to shift their fundamental understanding of disaster housing, affordable housing, and long-term vulnerability to calculate figures that would drive a holistic approach to housing cost-effectiveness.**

Should modified disaster housing programs be determined to be beneficial for meeting affordable housing and long-term vulnerability challenges, policymakers would also have to determine whether and how disaster housing programs should be adjusted to also meet the preferences of disaster survivors, the most important decision maker in the recovery process.

RECOMMENDATIONS

This report's intended audience is emergency managers; community planners; housing agencies; policymakers at local, state, tribal, territorial, and federal levels; leaders in the building code community; home construction companies; and others who have a goal of addressing challenges around disaster housing. The following recommendations were written with those stakeholders in mind. The recommendations were developed to:

- better address the challenges faced by disaster housing,
- leverage the potential of factory-built housing at scale,
- approach the nation's affordable housing challenges from a new direction, and
- produce better disaster recovery outcomes for all Americans.

Recommendations are grouped into three categories: Process Improvement, Decision Support, and Direction Setting.

PROCESS IMPROVEMENT

1. Code compliance, zoning ordinances, and permitting requirements are often cited as drivers in the timing and success of post-disaster temporary housing. FEMA and states should develop a common process to quantify and track the impact that specific state, county, city, or municipal rules and ordinances have on implementation speed of post-disaster housing. This information should drive long-term process improvement.
2. The National Governors Association, and associations representing state and local government officials, should collaboratively develop criteria for when governors and state legislatures should leverage existing or new authorities to enact uniform rebuilding standards and processes across counties, cities, and local municipalities impacted by statewide disasters – for the purpose of speeding disaster rebuilding.
3. FEMA and states should develop public-private partnerships to leverage “pop-up housing factories” following catastrophic events.

DECISION SUPPORT

4. FEMA and HUD should work with others to develop a measurement of the total cost of sheltering and housing services – across both disaster housing and affordable housing programs – for a given family. This holistic metric should cut across different disaster housing programs, different disasters, and even non-disaster housing programs, and should include services provided by all levels of government. This metric should inform policymakers' evaluations around cost-effectiveness of disaster rebuilding programs.
5. FEMA and HUD should support research on moral hazard and the incentive effects of providing permanent housing to disaster survivors.
6. FEMA should conduct an assessment of when disaster housing programs defined and intended to be temporary achieve levels of permanency. How often, under what conditions, and for what demographics does this occur? HUD, GAO, and the Department of Homeland Security Office of Inspector General (DHS OIG) should make themselves available to support this effort. This assessment should inform policymakers' future decisions around disaster housing programs in America.
7. HUD should update its analysis of the cost and labor benefits of factory-built building types. Specific interest should be paid to construction labor shortages in post-disaster settings. The most recent standardized comparison was funded by HUD and conducted by the NAHB Research Center in 1998.¹⁰⁸

DIRECTION SETTING

8. The Department of Labor and FEMA should develop and integrate a strategy around engaging the construction workforce in disaster rebuilding – and this should take into account the workforce gap in America’s construction industry.
9. Congress should identify if and how the factory-built housing industry should be further supported due to this industry’s small market share, the nation’s ongoing housing shortage, and the broader stagnation in construction labor productivity.
10. Emergency managers and housing officials, from the local, state, and federal levels, should develop a strategy to consider what place (if any) formalized temporary-to-permanent rebuilding should have in America’s emergency management toolkit. This group should evaluate how current regulations defining temporary and permanent housing impact the viability of this disaster housing method.
11. Congress, the National Governors Association, and associations representing state and local government officials, should develop a long-term vision on how best to leverage emergency management and disaster housing to address long-term vulnerability reduction and year-round affordable housing challenges.

NECESSARY AREAS OF FURTHER DISASTER RESEARCH

This report has focused on the residential construction market and the role that factory-built houses, at scale, can play in achieving faster disaster recovery. A single method of building construction is by no means a panacea for the complexities and challenges in disaster housing specifically, or disaster recovery broadly. A number of key drivers in disaster housing success in America are left unaddressed by looking exclusively at construction methods for single-family houses.

For example:

1. Multi-family housing, which is also used frequently by low-income communities.
2. Housing accessibility for people with disabilities or other access and functional needs.
3. Disaster survivors who are housing-insecure, or may have been experiencing homelessness before the disaster.
4. Programs supporting disaster repairs, not just new construction.
5. Programs supporting renters, not just homeowners.
6. A survivor's ease or difficulty of navigating government disaster housing programs.
7. Strategies to improve code adoption, code enforcement, code modernization, and disaster-specific waivers.
8. Strategies to decrease the extent that households are uninsured or underinsured.
9. The impact of land use, zoning, and floodplain determinations on future disaster housing challenges.
10. The unique nature of housing regulations that may exist in federally recognized tribal lands or territories.
11. The impact of climate change on future disaster housing challenges.
12. The role that managed retreat may play in mitigating the impact of future disasters.
13. What role the government might play in providing relocation support rather than rebuilding support, and how local primacy may impact rebuilding decisions.

While unable to address these topics in depth here, the authors wish to note the importance of these housing-related challenges. This list is not simply included as an afterthought; these topics deserve further research, dialogue, attention, and solutions.

A. Overview of FEMA's Shelter and Housing Programs

FEMA has a variety of programs that assist disaster survivors with shelter and housing needs. This appendix attempts to summarize FEMA's various shelter- and housing-related terms in common language. The examples come from the range of FEMA Individual Assistance and Public Assistance programs.

1. Emergency Protective Measures (related to private housing property)

- Emergency work to protect public health and safety and to eliminate or lessen immediate threats of significant additional damage to improved public or private property through measures which are cost-effective. For example:
 - Pumping of flooded basements
 - Repair of residential electrical meters to reduce the number of survivors needing shelter
 - Fiber-reinforced plastic sheeting to cover damaged residential roofs (Blue Roof)

2. Sheltering

- Providing a safe, sanitary, and secure place for evacuees and disaster survivors to stay while displaced from their homes
- There are practical distinctions between evacuation shelters, short-term shelters, and long-term shelters. There are also congregate shelters (e.g., school gymnasiums) and non-congregate shelters (e.g., hotel rooms through Transitional Sheltering Assistance).

3. Financial Housing Assistance

- Funds provided to eligible applicants for temporary lodging expenses, rental of temporary housing, or repair or replacement of a damaged primary residence

4. Direct Temporary Housing Assistance

- Housing provided to eligible applicants when they are unable to use financial housing assistance (rental assistance) to secure temporary housing. Can come in two forms:
 - Temporary Housing Units through Multi-Family Lease and Repair or Direct Lease
 - Transportable Temporary Housing Units through the placement of Manufactured Housing Units (MHU) and/or recreational vehicles (RVs) placed on private, commercial, or group sites.

5. Permanent Housing Construction

- Permanent repairs or new construction when both Financial Housing Assistance (rental assistance) and Direct Temporary Housing Assistance are not feasible, available, or cost-effective (such as insular areas).

6. Semi-Permanent Housing Construction

- Very similar to permanent housing construction, rarely referenced with this term
- Semi-permanent has an added definition of “housing designed and constructed with finishes, material, and systems selected for moderate (or better) energy efficiency, maintenance, and life cycle cost, and with a life expectancy of more than 5 years but less than 25 years.”¹⁰⁹

Readers seeking comprehensive language, including nuanced regulator and policy terms, should look to the following sources:

- FEMA's Individual Assistance Program and Policy Guide¹¹⁰
- FEMA's Public Assistance Program and Policy Guide¹¹¹
- Title 44, Code of Federal Regulations
- Stafford Act, as amended

B. Trends with Residential Construction in America

Two important trends within America's residential construction market include stagnant labor productivity and a domination of site-built homes.

Globally, there is a stagnation in construction sector labor productivity. As Figure 12 illustrates, growth in labor productivity for the construction sector lags behind that of both manufacturing and the total economy:

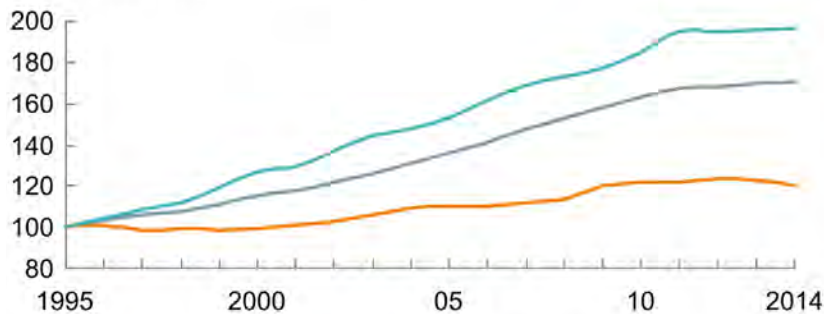
Globally, labor-productivity growth lags behind that of manufacturing and the total economy

Global productivity growth trends¹

Construction Total economy Manufacturing

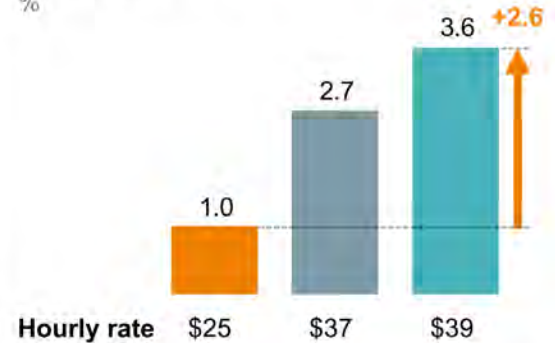
Real gross value added per hour worked by persons engaged, 2005 \$

Index: 100 = 1995



Compound annual growth rate, 1995–2014

%

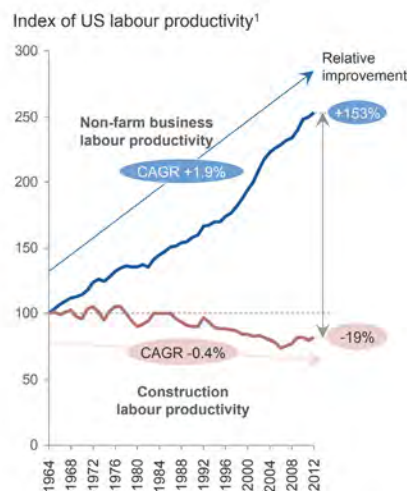


¹ Based on a sample of 41 countries that generate 96% of global GDP.

SOURCE: OECD; WIOD; GGCD-10, World Bank; BEA; BLS; national statistical agencies of Turkey, Malaysia, and Singapore; Rosstat; McKinsey Global Institute analysis

Figure 12: Global Construction Labor Productivity Trends¹¹²

Looking just at the United States, Figure 13 shows that construction labor productivity has decreased since the 1960s, while non-farm labor productivity has steadily improved.



¹ Peer set based on US companies with Engineering, Construction and Services-related Standard Industrial Classification codes. Financials are inflation-adjusted and indexed to 1964; output per working hours.

CAGR = compound average growth rate

Source: Global Vantage; Compustat; Bloomberg; www.aecbytes.com/viewpoint/2013/issue_67.html; www.nber.org/papers/w1555.pdf; S&P Capital IQ; BCG ValueScience Center; World Economic Forum

Figure 13: U.S. Construction Labor Productivity Trends, 1964–2012¹¹³

And looking at new housing construction in the United States specifically, labor productivity for single-family housing has remained at about the same level for the last 30 years. Additionally, labor productivity for multi-family new housing construction has drastically exceeded that of single-family new housing construction. See Figure 14 to see housing labor productivity trends since 1987.

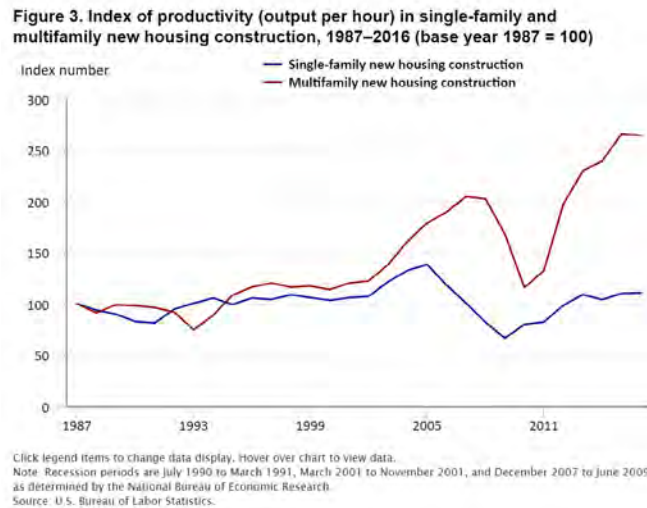


Figure 14: Labor Productivity in Single-Family Home Construction Has Lagged Labor Productivity in Multi-Family New Housing Construction¹¹⁴

A key driver in labor productivity of single-family homes is the construction method. As discussed above, site-built homes – constructed on site through sequential fabrication and assembly of products, materials and systems into finished homes by skilled tradesmen and general laborers¹¹⁵ – represent the majority of single-family home construction in the United States. In 2017, site-built homes represented 87% of single-family homes built in the United States. And from 2003 to 2017, site-built homes represented an average of 90.4% of the U.S.’s single-family home construction market.¹¹⁶

Site-built construction represents the tried-and-true method of new home construction in the United States. Further use of the automated home construction methods found in factory-built housing construction has the potential to drastically close the labor-productivity gap facing America’s housing construction workers.

C. Cost of FEMA Manufactured Homes

There is no single dollar figure consistently referenced to describe the cost to FEMA for a manufactured home. In some ways, trying to identify a single cost for the use of a manufactured home in a disaster setting is similar to identifying a single cost for rebuilding a damaged home after a disaster. There are many options and circumstances which determine total cost. All of this adds to the complexity of identifying the cost of using a manufactured home in a disaster setting.

GAO, DHS OIG, and FEMA have documented a wide range of costs for manufactured homes. Figures go from \$17,558 to \$229,000 and describe housing unit costs for disasters as far back as Katrina; for both RVs/travel trailers and manufactured homes; in private, group, and commercial sites; with or without tank pump systems; purchased off the lot or from manufacturers. This range in dollar values illustrates the difficulty in using a single dollar value to estimate cost of a housing unit. Additionally, the choice of what dollar figure to attribute to the cost of a manufactured home has an extremely significant impact on the results of any analysis.

Figure 15 documents the range of cost figures cited in reports from GAO and DHS OIG. The table also includes figures from FEMA. Figure 16 documents those same cost figures graphically, highlighting the site type as well as the unit type.

Attempting to take into account some of those difficulties, the authors sought out a standardized cost estimation method. Appendix I of the DHS Acquisition Instruction/Guidebook #102-01-001 is titled “Life Cycle Cost Estimates (LCCE), Independent Cost Estimates (ICE) and Cost Estimating Baseline Documents (CEBD).” This document, written in 2011 by DHS’s Cost Analysis Division, provides guidance to DHS units on creation of Lifecycle Cost Estimates.

The authors utilized the December 2017 MHU Lifecycle Cost Estimate from FEMA’s Logistics Management Directorate (LMD). The authors took the estimated total program cost over a period of 13 fiscal years and divided that by the estimated total deployments over that same period. FEMA LMD’s Lifecycle Cost Estimate accounted for the overall MHU program (not just a single unit’s deployment). This includes long-term storage costs for approximately 2,000 units, resale value, repeated unit use, tank and pump systems, group sites, commercial site expansion, haul and install, living kits, maintenance, transportation, deactivation, and other costs. This resulted in a simplified point estimate of \$110,000 per transportable temporary housing unit.

It is important to recognize that the simplified point estimate of \$110,000 is exceeded by three estimates developed by FEMA in 2017: \$129,198; \$148,998; and \$202,007. Again, specific figures depend on the circumstances of the disaster activation. Given the estimates FEMA created in 2017, the authors understand that the \$110,000 figure is likely an underestimate. **Leveraging the standardized methodology to calculate the Lifecycle Cost Estimates as well as FEMA’s 2017 estimates, the authors chose to use \$110,000 to \$129,000.**

Table 15: Summary of Past References to the Cost of Temporary Transportable Housing Units

Cost	Unit Type	Purchase Source	Site Type	Data Source
\$17,558	Trailer	Manufacturer	Private Site	DHS OIG-08-93 (9/2008)
\$26,558	Trailer	Off the Lot	Private Site	DHS OIG-08-93 (9/2008)
\$29,348	Trailer	Manufacturer	Commercial Site	DHS OIG-08-93 (9/2008)
\$30,000	Trailer	Manufacturer	Private Site	GAO-08-106 (11/2007)
\$38,348	Trailer	Off the Lot	Commercial Site	DHS OIG-08-93 (9/2008)
\$43,455	MHU	Manufacturer	Private Site	DHS OIG-08-93 (9/2008)
\$51,455	MHU	Off the Lot	Private Site	DHS OIG-08-93 (9/2008)
\$60,000	MHU	Manufacturer	Private Site	DHS OIG-13-102 (6/2013)
\$61,970	MHU	Manufacturer	Commercial Site	DHS OIG-08-93 (9/2008)
\$69,000	Trailer	Manufacturer	Group Site	GAO-08-106 (11/2007)
\$69,970	MHU	Manufacturer	Commercial Site	DHS OIG-08-93 (9/2008)
\$74,948	Trailer	Manufacturer	Group Site	DHS OIG-08-93 (9/2008)
\$79,000	MHU	Manufacturer	Commercial Site	DHS OIG-13-102 (6/2013)
\$83,000	Trailer	Manufacturer	Group Site	GAO-08-106 (11/2007)
\$83,938	Trailer	Off the Lot	Group Site	DHS OIG-08-93 (9/2008)
\$105,770	MHU	Manufacturer	Group Site	DHS OIG-08-93 (9/2008)
\$113,770	MHU	Manufacturer	Commercial Site	DHS OIG-08-93 (9/2008)
\$115,000	MHU	Manufacturer	Group Site	DHS OIG-13-102 (6/2013)
\$126,000	Trailer	Manufacturer	Commercial Site	GAO-08-106 (11/2007)
\$129,198	MHU	Manufacturer	Private Site	Prepared for DR4277 Congressional Testimony (4/5/2017)
\$148,998	MHU	Manufacturer	Commercial Site	Prepared for DR4277 Congressional Testimony (4/5/2017)
\$202,007	MHU	Manufacturer	Group Site	DR4332 Housing Option Analysis (9/15/2017)
\$229,000	MHU	Manufacturer	Group Site	GAO-08-106 (11/2007)



Figure 16: Graphical Summary of Past References to the Cost of Temporary Transportable Housing Units

Note: Dollars have not been adjusted for inflation.

Sources: DHS OIG-08-93, GAO-08-106, DHS OIG-13-102, and FEMA

Endnotes

1. Federal Disaster Relief Act, Public Law 81-875. <https://www.loc.gov/law/help/statutes-at-large/81st-congress/session-2/c81s2ch1125.pdf>, https://training.fema.gov/emiweb/downloads/is7unit_3.pdf
2. 2012 Census of Governments, U.S. Census Bureau, <https://www.census.gov/newsroom/releases/archives/governments/cb12-161.html>
3. This is up from 41% in 2014. 2018 National Preparedness Report.
4. Congressional Research Service Report R44619, August 31, 2017, “FEMA Disaster Housing: The Individuals and Households Program—Implementation and Potential Issues for Congress” Page 16: “[The] actual role that states play in disaster housing, as administered by FEMA in the disaster recovery process, is quite limited. Not only do states not contribute to the costs of disaster housing through any cost-shares with regard to rental or repair expenditures, they also do not have any obligation to assist in the physical establishment of temporary manufactured housing communities.” <https://crsreports.congress.gov/product/pdf/R/R44619> Note that both TSA and the STEP pilot are defined to be Public Assistance (rather than Individual Assistance). States and territories generally pay a cost-share for Public Assistance programs.
5. 2018 National Preparedness Report, p. 34, <https://www.fema.gov/media-library/assets/documents/170861>
6. States have begun to take an administration and implementation role on federal direct housing missions. On September 22, 2017, an inter-governmental service agreement was signed by FEMA and the State of Texas allowing the Texas General Land Office to implement direct housing after Hurricane Harvey. The Disaster Recovery Reform Act of 2018 also provides mechanisms to further empower states to implement federal disaster housing programs. However, state implementation of federal direct housing programs are still constrained by federal disaster housing policies and tools.
7. In this report, the term “factory-built housing” is used to include modular, panelized, and pre-assembled housing construction methods. This excludes both site-built housing and manufactured housing. As the focus of this report is on post-disaster housing, and because construction labor is usually highly demanded after a disaster, this definition was created to encompass the housing methods with decreased labor requirements for final construction/installation on-site. The provision of manufactured housing is contrasted with the provision of permanent housing, so even though manufactured homes are built in factories, they are excluded from this definition of “factory-built housing.” Dual code housing options (i.e., meeting HUD code as a manufactured house and other building codes as a modular house) are excluded from this analysis because of their relatively small portion of the housing market. Other reports offer unique definitions for “factory-built housing” including these reports from HUD’s Partnership for Advancing Technology in Housing, which each use a different definition for factory-built housing: Factory-Built Housing Roadmap, January 2006; and A Community Guide to Factory-Built Housing, September 2001.
8. Seminar was conducted under Chatham House Rule. All participants are anonymous to give an unfiltered and objective view/opinion on the use of factory-built homes during disasters.
9. The NAHB provided no financial compensation for participation in this summit. MIT speakers received free admission to the two-day meeting but paid their own travel costs. The NAHB provided no financial support for the research or work in this report.
10. The National Manufactured Housing Construction and Safety Standards Act of 1974. The HUD code governs construction, as well as installation of manufactured homes. FEMA stopped using RVs/travel trailers in 2007 and park models in 2012. https://www.oig.dhs.gov/assets/Mgmt/2013/OIG_13-102_Jun13.pdf
11. <https://www.iccsafe.org/codes-tech-support/codes/2018-i-codes/irc/>
12. <https://www.iccsafe.org/wp-content/uploads/Master-I-Code-Adoption-Chart-july-update.pdf> Accessed 4/16/2019.
13. <http://www.h-gac.com/community-and-environmental-planning-publications/documents/Back-Home-Rapid-Housing-Recovery-Pilot-Program-Report.pdf>
14. Author interview with Abraham Gunn (FEMA) on 4/9/2019.
15. <http://www.h-gac.com/community-and-environmental-planning-publications/documents/Back-Home-Rapid-Housing-Recovery-Pilot-Program-Report.pdf>
16. For disasters receiving a Major Disaster Declaration, FEMA may provide housing assistance as part of its Individuals and Households Program in counties designated to receive Individual Assistance. FEMA would provide Direct Housing Assistance in cases where Financial Housing Assistance would have a limited effect due to a lack of housing stock in a community. <https://www.fema.gov/individual-assistance-program-and-policy-guide>

17. An analysis of recent major disasters showed that transportable housing units were utilized several orders of magnitude higher than other direct housing types. Analysis included 2016 Louisiana Floods (DR-4277), 2017 Harvey Texas (DR-4332), 2008 Ike Texas (DR-1791), 2017 California Wildfires (DR-4344), 2017 Irma Florida (DR-4337), and 2015 Matthew North Carolina (DR-4285). Some of these disasters did not include activation of Direct Lease or Multi-Family Lease and Repair programs which further indicates the tendency to rely on transportable housing units, and the recency in which the programs have been created or expanded. It is important to note that for the majority of disasters, temporary housing is accessible via vacant apartments, extended stay hotels, etc. Thus, the vast majority of disasters, and the majority of presidentially declared disasters, do not require transportable housing units. But when they are used, they can be used in large numbers for entire communities.
18. FEMA stopped using RVs/travel trailers in 2007 and park models in 2012. https://www.oig.dhs.gov/assets/Mgmt/2013/OIG_13-102_Jun13.pdf
19. The National Manufactured Housing Construction and Safety Standards Act of 1974. The HUD code governs construction as well as installation of manufactured homes.
20. https://www.fema.gov/media-library-data/20130726-1819-25045-9288/ndhs_core.pdf, p. 66
21. Answers attributed to then-FEMA Administrator Craig Fugate, in response to written questions, following a July 8, 2009 hearing of the House Committee on Homeland Security titled “FEMA Housing: An Examination Of Current Problems And Innovative Solutions.” <https://www.govinfo.gov/content/pkg/CHRG-111hhr52955/pdf/CHRG-111hhr52955.pdf>
22. A 1998 report sponsored by the Manufactured Housing Institute estimated the life expectancy of a manufactured home to be 57.5 years. Meeks, Carol B. 1998. *Manufactured Housing Life*. Arlington, Va.: Manufactured Housing Institute.
23. The 18-month time period starts on the federal disaster declaration date. This time period can be extended on a case by cases basis past 18 months. The time requirement for non-permanent direct housing assistance is not limited to manufactured homes, but to other types of direct housing assistance as well – such as Direct Lease.
24. Analysis in the “What Is Stopping Us?” section beginning on page 20 shows market share totals for new single-family home construction. Manufactured housing is prevalent primarily in the South, where some 58% of the 6.6 million units nationwide are located.
25. Costs were estimated based on HUD Fair Market Rents for 2BR and 3BR units in Tuscaloosa County and Alameda County. In each county, these two prices were averaged, received a 10% administrative surcharge, and were multiplied across 18 months. This replicates one method that FEMA uses internally when evaluating housing costs.
26. <https://www.epa.gov/formaldehyde/formaldehyde-emission-standards-composite-wood-products>
27. Inventories measured by months of supply and millions of units. A household is cost-burdened if it spends more than 30% of its income on housing. *The State of the Nation’s Housing 2018*, Joint Center for Housing Studies of Harvard University. <http://www.jchs.harvard.edu/state-nations-housing-2018>
28. Bureau of Labor Statistics’s (BLS) Job Openings and Labor Turnover Survey (JOLTS).
29. <https://reports.nlihc.org/gap/about>
30. https://www.oig.dhs.gov/assets/Mgmt/OIG_09-111_Sep09.pdf
31. <https://www.wcdr.org/uploads/Reconstructing-after-disasters-Build-back-better.pdf>
32. The UN General Assembly has formally defined “Build Back Better” as: “The use of the recovery, rehabilitation and reconstruction phases after a disaster to increase the resilience of nations and communities through integrating disaster risk reduction measures into the restoration of physical infrastructure and societal systems, and into the revitalization of livelihoods, economies, and the environment.” UN General Assembly, December 1, 2016. Report of the open-ended intergovernmental expert working group on indicators and terminology relating to disaster risk reduction. A/71/644. <https://undocs.org/A/71/644>
33. The Sendai Framework was adopted by UN Member States on March 18, 2015, at the Third UN World Conference on Disaster Risk Reduction in Sendai City, Miyagi Prefecture, Japan.
34. https://www.governor.ny.gov/sites/governor.ny.gov/files/atoms/files/PRERWG_Report_PR_Grid_Resiliency_Report.pdf, https://www.governor.ny.gov/sites/governor.ny.gov/files/atoms/files/Build_Back_Better_PR.pdf
35. <https://www.fema.gov/national-disaster-recovery-framework>, NDRF 2nd ed., p. 55
36. In this report, “permanent housing construction” is used to be inclusive of both permanent and semi-permanent construction.
37. Public Law 100-707

38. Public Law 106-390
39. DHS OIG 08-93
40. Public Law 109-234. https://www.fema.gov/pdf/about/programs/ahpp/ahpp_pamphlet.pdf
41. <https://www.fema.gov/news-release/2008/02/29/fema-evaluating-non-traditional-alternatives-trailers/mobile-homes-future>, https://www.fema.gov/media-library-data/20130726-1819-25045-9288/ndhs_core.pdf
42. Public Law 109-295
43. https://www.fema.gov/media-library-data/20130726-1819-25045-9288/ndhs_core.pdf
44. NDHTF membership is composed of federal agency partners, including the Federal Emergency Management Agency (FEMA), Department of Housing and Urban Development (HUD), U.S. Access Board, Department of Homeland Security (DHS), Department of Justice (DOJ), Department of the Interior (DOI), Environmental Protection Agency (EPA), General Services Administration (GSA), Department of Health and Human Services (HHS), National Council on Disability (NCD), Small Business Administration (SBA), U.S. Army Corps of Engineers (USACE), U.S. Department of Agriculture (USDA) and the Department of Veterans Affairs (VA). <https://www.fema.gov/ar/media-library/assets/documents/25783>
45. April 11, 2017 memo from FEMA's Acting Administrator Robert Fenton
46. Part of the Federal Aviation Administration Reauthorization Act of 2018. Public Law 115-254.
47. IAPPG <https://www.fema.gov/media-library-data/1551713430046-1abf12182d2d5e622d16acbb37c4d163/IAPPG.pdf> , 42 U.S.C. § 5174(c)(4) and 44 C.F.R. § 206.117(b)(4).
48. FEMA's Individual Assistance Program and Policy Guide (IAPPG) in March 2019 describes that TSA policy changes are forthcoming. MIT's description of the TSA program may be inconsistent with future TSA policy changes not found in the IAPPG. To calculate nightly population count for the TSA program, MIT used data provided by FEMA's Recovery Analytics Division as of 12/7/2018. A one night peak of 73,462 individuals was calculated by MIT for Hurricane Harvey on 9/23/2017. This includes all TSA entries with a bill start date prior to or including 9/23/2017 and a bill end date later than or including 9/24/2017. A total of 24,972 registrant numbers met this criteria and household composition for these registrant numbers was used to determine a total of 73,462 individuals. Note that a total of 185 registrants were listed more than once. Duplicate entries were not removed. MIT's estimate of 73,000 differs from a one night peak of 69,187 individuals reported for 9/24/2017 in the "TSA Daily Summary Report" also generated by FEMA's Recovery Analytics Division. For other disaster events, TSA totals were not significantly above peak shelter population totals. For example, Louisiana 4277 had a shelter peak at approximately 10,500 and a TSA peak at approximately 10,000. Ike 1791 had a shelter peak at approximately 31,600 and a TSA peak at approximately 32,100. California Wildfire 4344 had a shelter peak at approximately 4,300 and a TSA peak at 735. Florida Irma 4337 had a shelter peak at approximately 190,000 and a TSA peak at approximately 28,000.
49. <https://www.fema.gov/news-release/2017/09/17/4337/frequently-asked-questions-about-operation-blue-roof>, <https://www.pbs.org/wgbh/frontline/article/after-maria-thousands-on-puerto-rico-waited-months-for-a-plastic-roof/>, <https://www.apnews.com/a99551194b144db490b25c7f0e6d46fd>
50. https://www.fema.gov/media-library-data/20130726-1858-25045-8258/step_pilot_program_final_111612.pdf
51. <https://www.nytimes.com/2014/09/05/nyregion/after-hurricane-sandy-a-rebuilding-program-is-hindered-by-its-own-construction.html?module=inline>
52. <https://www.habitat.org/sites/default/files/pathways-to-permanence.pdf>
53. <https://www.regulations.gov/document?D=FEMA-2008-0009-0040>
54. Analysis in the "What Is Stopping Us?" section beginning on page 20 shows market share totals for new single-family home construction.
55. As described above, "factory-built homes" includes modular, panelized, and pre-cut homes while excluding manufactured homes as a separate category due to its orientation around HUD code.
56. "Factory and Site-Built Housing—A Comparison for the 21st Century," NAHB Research Center, 1998. <https://www.huduser.gov/Publications/pdf/factory.pdf>
57. Bureau of Labor Statistics' (BLS) Job Openings and Labor Turnover Survey (JOLTS).

58. McGraw-Hill SmartMarket Report. Prefabrication and Modularization: Increasing Productivity in the Construction Industry. 2011. <https://www.nist.gov/sites/default/files/documents/el/economics/Prefabrication-Modularization-in-the-Construction-Industry-SMR-2011R.pdf> This was sponsored in part by the U.S. Department of Commerce National Institute for Standards and Technology, the Modular Building Institute, and the National Institute of Building Sciences.
59. "Factory and Site-Built Housing—A Comparison for the 21st Century," NAHB Research Center, 1998.
60. <http://www.globalconstructionreview.com/trends/why-sweden-beats-world-h8an0ds-4d2own0-6p4r2e0f8ab/>, <https://theconversation.com/building-a-housing-industry-from-the-relics-of-a-car-industry-23195>
61. <https://theconversation.com/building-a-housing-industry-from-the-relics-of-a-car-industry-23195>
62. https://www.bca.gov.sg/Newsroom/pr10032014_BCA.html, <https://www.mnd.gov.sg/newsroom/speeches/view/budget-2018-speech-by-2m-desmond-lee-transforming-our-built-environment>
63. http://english.gov.cn/policies/latest_releases/2016/09/30/content_281475455281032.htm
64. <https://www.forbes.com/sites/sherikoones/2019/02/04/prefab-101-defining-the-many-forms-of-factory-built-homes/#75d0bbf15bd0>
65. <https://www.forbes.com/sites/sherikoones/2019/02/04/prefab-101-defining-the-many-forms-of-factory-built-homes/#75d0bbf15bd0>, <https://www.forbes.com/sites/sherikoones/2019/02/18/extraordinary-prefab-houses-around-the-world/#218b5b154386>
66. <https://www.forbes.com/sites/sherikoones/2019/02/04/prefab-101-defining-the-many-forms-of-factory-built-homes/#75d0bbf15bd0>, <https://www.forbes.com/sites/sherikoones/2019/02/18/extraordinary-prefab-houses-around-the-world/#218b5b154386>
67. <https://www.gov.uk/government/publications/technology-and-skills-in-the-construction-industry> UKCES, (2013). Technology and skills in the construction industry. UKCES, London; https://web.ornl.gov/sci/buildings/conf-archive/2004%20B9%20papers/174_Gorgolewski.pdf
68. See section titled "A Relatively Small Industry Base for Factory-Built Homes" on page 21 for a description of how this number was calculated. Three percent excludes manufactured homes while 13% includes them.
69. <http://dx.doi.org/10.5130/AJCEB.v16i2.4741>, https://eprints.qut.edu.au/81178/1/QUT-Housing-Project-Industry-Paper-3-web-final_D788.pdf
70. <https://katerra.com/en.html>, https://katerra.com/content/dam/katerra/www/en_us/assets/white-paper/Building%20Platforms-Print-v7_no%20crop.pdf
71. <https://www.wsj.com/articles/google-bets-on-modular-homes-to-fill-housing-demand-1497448838>
72. <https://news.marriott.com/2017/05/marriott-international-expands-modular-construction-initiative/>, <https://www.prnewswire.com/news-releases/worlds-tallest-modular-hotel-set-to-rise-in-new-york-city-this-fall-highlighting-marriott-internationals-vision-to-disrupt-the-way-buildings-get-built-300834707.html>
73. <https://www.constructiondive.com/news/21-story-modular-hotel-opened-in-nyc-said-to-be-tallest-in-us/541044/>, <https://archpaper.com/2018/12/citizenm-new-york-bowery-hotel-modular-construction/#gallery-0-slide-0>
74. <https://therealdeal.com/2018/05/24/city-issues-first-affordable-housing-rfp-requiring-modular-construction/>
75. <https://www.prnewswire.com/news-releases/worlds-tallest-modular-hotel-set-to-rise-in-new-york-city-this-fall-highlighting-marriott-internationals-vision-to-disrupt-the-way-buildings-get-built-300834707.html>
76. Community Development Corporation of Brownsville; buildingcommunityWORKSHOP; La Union del Pueblo Entero; A Resource In Serving Equality; Hazard Reduction & Recovery Center, Texas A&M University; and Texas Low Income Housing Information Service
77. <http://www.bcworkshop.org/posts/expanding-rapido-for-gulf-coast-recovery>
78. Along with Tegrity Homes, Home Innovation Research Labs, and Architend.
79. <http://www.h-gac.com/community/publications/documents/Back-Home-Rapid-Housing-Recovery-Pilot-Program-Report.pdf>

80. The H-GAC's Back Home Rapid Housing Recovery Pilot Program experienced delays in standing up permanent housing quickly after Ike. Many of the homes were completed in 2011, 3 years after Ike made landfall. Per interview with Josh Owens from H-GAC on 2/23/2018.
81. <https://capitol.texas.gov/tlodocs/81R/billtext/html/HB02450F.HTM>
82. <https://www.nytimes.com/2014/09/05/nyregion/after-hurricane-sandy-a-rebuilding-program-is-hindered-by-its-own-construction.html>
83. <https://www.nytimes.com/2017/10/22/nyregion/hurricane-sandy-modular-homes.html>
84. <http://restore.la.gov/homeowner-assistance-program/>
85. https://www.urban.org/sites/default/files/publication/98463/the_evidence_base_on_how_cdbg-dr_works_for_state_and_local_stakeholders_0.pdf
86. <https://www.iccsafe.org/building-safety-journal/bsj-technical/icc-joins-modular-building-revolution/> These standards would achieve a goal similar to that of the Interstate Industrialized Buildings Commission (IIBC). The IIBC was created in 1992 when the states of Minnesota, New Jersey, and Rhode Island enacted the Interstate Compact for Industrialized/Modular Buildings. In 2011, North Dakota joined the commission and Wisconsin created a separate agreement with Minnesota to allow modular homes manufactured in Minnesota to be sited in Wisconsin. Separate from the IIBC, Idaho has created interstate agreements related to the manufacture and location of modular structures. Idaho has entered into agreements with Oregon, Washington, Montana, Colorado and Nevada.
87. <https://www.iccsafe.org/building-safety-journal/bsj-hits/icc-releases-repurposed-shipping-containers-guideline/>
88. <http://www.h-gac.com/community-and-environmental-planning-publications/documents/Back-Home-Rapid-Housing-Recovery-Pilot-Program-Report.pdf>
89. Report titled "Natural Disaster Housing Reconstruction Plan" was submitted to the state of Texas's "Natural Disaster Housing Reconstruction Advisory Committee" on November 30, 2010 as required by Texas HB 2450, 81st Legislative Session. <http://www.h-gac.com/community-and-environmental-planning-publications/documents/natural-disaster-housing-reconstruction-plan.pdf>
90. <https://www.fema.gov/news-release/2018/02/28/fema-housing-program-changes-underway-deadline-extended-through-may-15>
91. U.S. Census Bureau, Survey of Construction and Manufactured Housing Survey. Totals for modular and panelized homes were not tracked prior to 1992. Not captured is the fact that there have been significant fluctuations in nationwide construction totals over this time period. A small market share for modular and panelized homes held true both in both high building years (ex – 2005 and 2006 each had more than 1.7M in single-family home construction) and low building years (2009-2012 each had less than 600K in single-family home construction).
92. U.S. Census Bureau, Survey of Construction and Manufactured Housing Survey.
93. U.S. Census Bureau, Survey of Construction and Manufactured Housing Survey.
94. National Disaster Housing Strategy
95. https://www.urban.org/sites/default/files/publication/98463/the_evidence_base_on_how_cdbg-dr_works_for_state_and_local_stakeholders_0.pdf
96. CDBG-DR funds are categorized by HUD into activity types. Six activity types were included, all of which relate to housing: Acquisition - buyout of residential properties; Affordable Rental Housing; Homeownership Assistance to low- and moderate-income; Rehabilitation/reconstruction of residential structures; Relocation payments and assistance; Rental Assistance (waiver only). These housing-related activity types likely include some amount of non-construction related support.
97. Dollars are grouped by calendar month spent. So "Ike" date does not represent declaration date of 9/13/2008, but start of that month at 9/1/2008. And "Ike Temp Housing Ends" does not represent declaration + 18 months (3/13/2010). But end of that month (3/31/2010). Similarly, "Louisiana Floods" represents 8/1/2016 rather than the declaration date of 8/14/2016, and "Louisiana Floods Temp Housing Ends" represents 2/28/2018 rather than 2/14/2016. A combined CDBG-DR appropriation was made available for Hurricanes Dolly and Ike. Recognizing all of these dollars as being for residential construction for Hurricane Ike will overestimate the amount of CDBG-DR dollars for Hurricane Ike, and will underestimate the amount of time the dollars took to get spent (because Hurricane Dolly dollars would likely have been spent, on average, earlier than Hurricane Ike dollars). The "Temp Housing Ends" dated do not account for temporary extensions which may have occurred.

98. <http://www.h-gac.com/community-and-environmental-planning-publications/documents/Back-Home-Rapid-Housing-Recovery-Pilot-Program-Report.pdf>
99. National Disaster Recovery Framework, p. 5
100. http://opim.wharton.upenn.edu/risk/library/WRCib2015a_FederalDisasterAssistance.pdf, http://www.independent.org/pdf/tir/tir_15_04_2_shughart.pdf, <https://hbr.org/2012/11/the-problem-with-fema-no-one-is-talking-about>, https://hazards.colorado.edu/uploads/observer/2013/may13_observerweb.pdf
101. <https://www.fema.gov/policy-claim-statistics-flood-insurance> <https://fas.org/sgp/crs/misc/RL32972.pdf>
102. A 2013 report by Marshall & Swift/Boeckh reports that 60% of homes in the U.S. were undervalued in the eyes of their insurance company by an average of 17%. <https://www.prnewswire.com/news-releases/insurance-industrys-property-undervaluation-issue-continues-to-improve-according-to-marshall-swiftboeckh-218715371.html>
103. The Natural Hazard Mitigation Saves: 2017 Interim Report
104. The National Institute of Building Sciences may include information on the value of retrofitting in future reports.
105. GAO Report PAD-80-39 dated July 16, 1980 titled “Federal Disaster Assistance: What Should The Policy Be?” <https://www.gao.gov/products/PAD-80-39>
106. https://www.fema.gov/media-library-data/20130726-1914-25045-9956/final_national_mitigation_framework_20130501.pdf
107. <https://svi.cdc.gov/>
108. “Factory and Site-Built Housing—A Comparison for the 21st Century,” NAHB Research Center, 1998. <https://www.huduser.gov/Publications/pdf/factory.pdf>
109. 44 C.F.R. § 206.117(b)(4)
110. <https://www.fema.gov/individual-assistance-program-and-policy-guide>
111. <https://www.fema.gov/media-library/assets/documents/111781>
112. <https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/reinventing-construction-through-a-productivity-revolution>, p. 32.
113. http://www3.weforum.org/docs/WEF_Shaping_the_Future_of_Construction_full_report_.pdf
114. <https://www.bls.gov/opub/mlr/2018/article/pdf/measuring-productivity-growth-in-construction.pdf>
115. <https://www.huduser.gov/Publications/pdf/factory.pdf> PDF Page 18. Document Page number 3.
116. For the purposes of this report, construction totals from the U.S. Census Bureau Survey of Construction and the U.S. Census Bureau Manufactured Housing Survey have been combined. With a focus on the role that modular, panelized, and manufactured homes play in the larger single-family home market, these two data sources are combined to create a new total of single-family homes built each year. To calculate totals of site-built homes, modular homes, and panelized homes, the U.S. Census Bureau Survey of Construction was utilized. Specifically, the Microdata files were used to make annual totals of “WEIGHT” by “MFGS” category. MFGS is defined as “Construction Method” in: https://www.census.gov/construction/chars/pdf/socmicro_info.pdf To calculate totals of Manufactured homes, the U.S. Census Bureau Manufactured Housing Survey was used. There was an attempt to use the Public Use Files, but those only exist for 2014-2017. Instead, the “shipment” totals found at <https://www.census.gov/data/tables/time-series/econ/mhs/shipments.html> were used. Specifically, the “Annual Shipments to states” files were used because those numbers were not rounded (unlike the monthly nationwide totals).



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