



TEXAS GENERAL LAND OFFICE

“We work to rebuild communities, to put Texans back in their homes, and to help businesses recover after the trauma of disaster.”

George P. Bush

Texas General Land Office Commissioner



INTRODUCTIONS



Findings Report Presentation Agenda

- Introductions
- Meeting Objectives
- Study Approach and Methodology
- Overview of Units Evaluated
- Key Findings and Recommendations
- Obstacles and Pathways for Alternative Housing
- Discussion
- Adjourn



Meeting Objectives

- Describe the Study's purpose and research methodology.
- Identify the types and capabilities of units evaluated.
- Review the Study's key findings and recommendations for Phase II.
- Discuss the obstacles and pathways for the future of alternative housing.



STUDY APPROACH AND METHODOLOGY

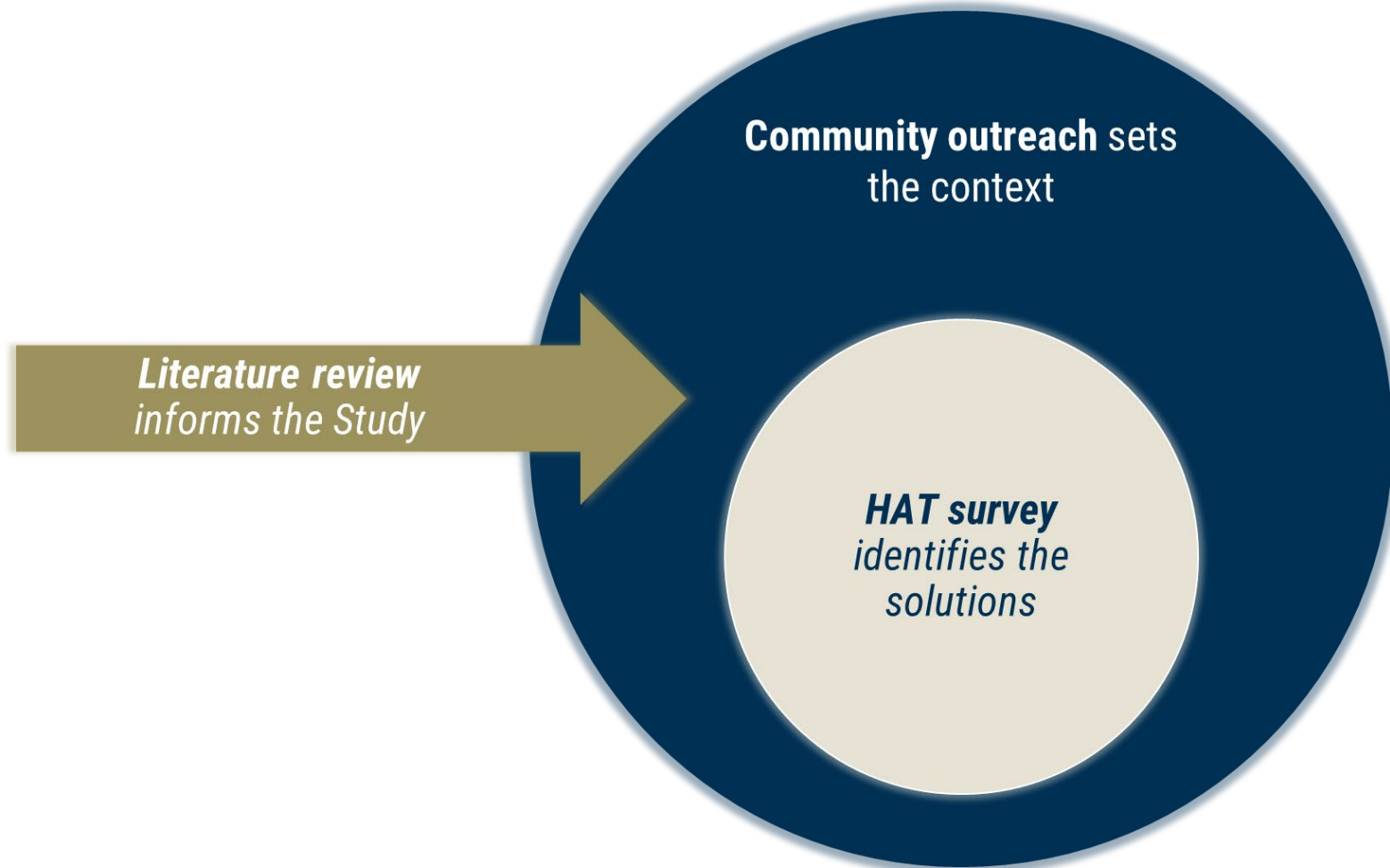
Purpose of Study



- Evaluate **alternative housing** options currently available in the marketplace, focusing on units that can meet needs for both **interim** and **permanent housing**.

Key Metrics: Resiliency, Cost, Timeliness, Livability, and Range of Use

Study Approach





Literature Review Findings

Community-Based Approaches



Active **community engagement** is critical, especially given that the impact of effective housing missions extends to the **survival and long-term recovery** of the community.

Challenges in Previous Pilots and Programs



Pilot programs to boost housing accessibility have historically been encumbered by **technical and project management challenges, supply chain issues**, and a lack of **unit durability**.

Modular Construction



Modular housing construction—using **expedited and less expensive assembly lines**—can be a strategy to combat rising construction costs, if they meet local codes and standards.



Community Outreach Findings

Estimate Cost Holistically



“Are they able to afford the taxes, upkeep, and maintenance? That’s where non-profits and funders struggle, because **we see a lot of repeat survivors with deferred maintenance.**”

Design to Aesthetic Standards



“A lot of this is about aesthetics, particularly if you are talking temporary to permanent. Does this fit into the neighborhood? **Does this look and feel like a real house?**”

Meet and Exceed Codes



“We are not in the community rating system, we have adopted no free board, **we have adopted the bare bones requirements—and we’re being asked to waive them and put people in harm’s way.**”

Community Outreach Findings (continued)



Utilize Temporary to Permanent



“...anything that promotes temporary to permanent housing is a **better return on investment** for our state, government, and partners.”

Coordinate with Non-Profits



“As we consider these, I know **there are several non-profits available who can support rebuild after a disaster.**”

Develop Education and Buy-in



“There is **a lot education that needs to happen about modular homes** and the fact that they’re not interchangeable with manufactured homes. In their mind, it’s a trailer.”



HAT Survey Approach

INPUTS

177 questions in 9 categories

Alternative Housing Categories

Codes and Standards

Resilience

Unit Sizes and Amenities

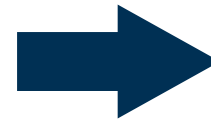
Customizability

Structure Elements

Construction and Site Requirements

Production Capability

Cost and Cost Effectiveness



OUTPUTS

5 primary categories

Resilience

> Flood

> Wind

> Fire

> Energy

Livability

Range of Use

Timeliness

Cost

Vendor Participation



| | | |
|-----------------------------------|----------------------------|--------------------------------|
| 80+ | 34 | 24 |
| Vendors Contacted (Phone / Email) | HAT Surveys Submitted | Participating Vendors |
| 20 | 1 | 1 |
| Comprehensive Datasets Developed | Informational Webinar Held | Informational Website Launched |

Evaluation Methodology



The Study utilized a **hybrid quantitative and qualitative analysis approach** to support consistent scoring and direct comparison of units across metrics (i.e., resilience, cost).

The **quantitative analysis** translated to an automated web-based algorithm that scored units based on HAT survey data.

Vendor Profiles
Findings and Phase II Recommendations

The **qualitative analysis** leveraged expertise to contextualize scores and inform the Study's overall recommendations.



OVERVIEW OF UNITS EVALUATED



Disruptors in the Housing Market

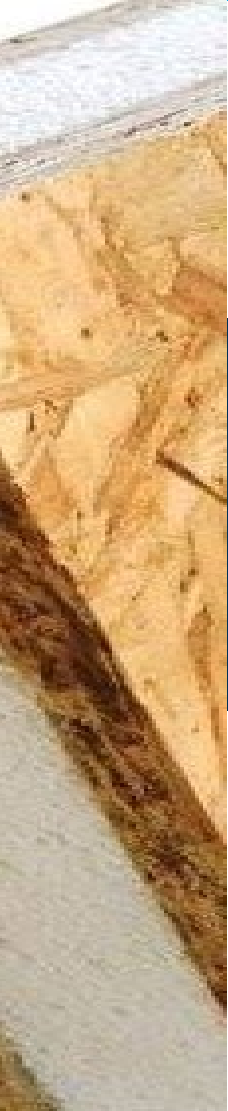
Technology to enable rapid deployments that serve survivors quickly

Cost effective solutions with community buy-in

Long-term resilient housing that will withstand future natural hazards

Emerging alternative housing technologies are potential disruptors in the market to addressing challenges for short- and long-term housing deployments.

Rapidly Deployable Technology



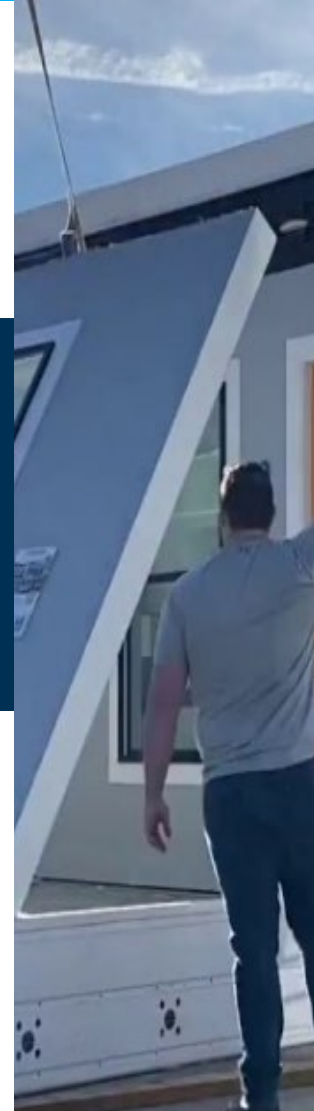
Structural insulated panels (SIPs)



Off-grid capable



Flatpack for transport



Unfold for installation

Resilient Housing Technology



**Flood damage-
resistant
materials**

**Ability to
elevate**



**Built to
exceed codes**



**Metal framing
systems with
strong load
paths**

Categorization of Housing Solutions



1

3D Printed Homes

2

Log Kit Homes

1

Traditional Kit Homes

4

Modular Foldable Units

7

Modular Panelized Units

5

Modular Prefabricated Units

4

Shipping Containers

3D Printed Housing



ICON | Texas

- Vulcan printer used for construction
- Main construction material is a proprietary concrete termed “magma”
- Wood framed roofing, plumbing, and electrical systems installed after unit has been printed



Modular Foldable Units



A-FOLD Houses | Italy **Boxabl** | Nevada
Forts USA | Florida **SO?** | Turkey



- Built from SIPs constructed in a prefabricated shell
- Use a crane to “unfold” on-site in a construction process that takes 1-2 days
- Can stack and connect to become larger homes



Modular Panelized Units



AbleNook | Florida **Gravity Architects** | California
Hex House | Minnesota **Horizon North** | Canada
Kiro Action | Texas **LiV-Connected** | New York
RAPIDO | Texas

- Constructed with prefabricated SIPs that connect on-site in different configurations
- Configurations can expand and connect for a range of use purposes

Modular Prefabricated Units



Connect Homes | California

Core Housing Solutions | Florida **Dweller** | Oregon

Haus.me | Nevada **M-Rad** | California

- Units are almost entirely prefabricated in factory
- Distinct from manufactured housing units and travel trailers in their use of more resilient building materials and designs
- Include capabilities for rapidly deployable shelter

Shipping Containers



Falcon Structures | Manor, TX

indieDwell | Boise, ID

Urban Rigger | Denmark

- Built using a shipping container as the base structure
- Can stack and connect for different home sizes
- Can include aesthetic changes on the exterior to meet community expectations

Log Kit Homes



EcoHouseMart | New York

Allwood Industrials | Florida

- Constructed from a spruce lumber
- Logs use an interlocking tongue and groove technology
- Units are designed as a single building system

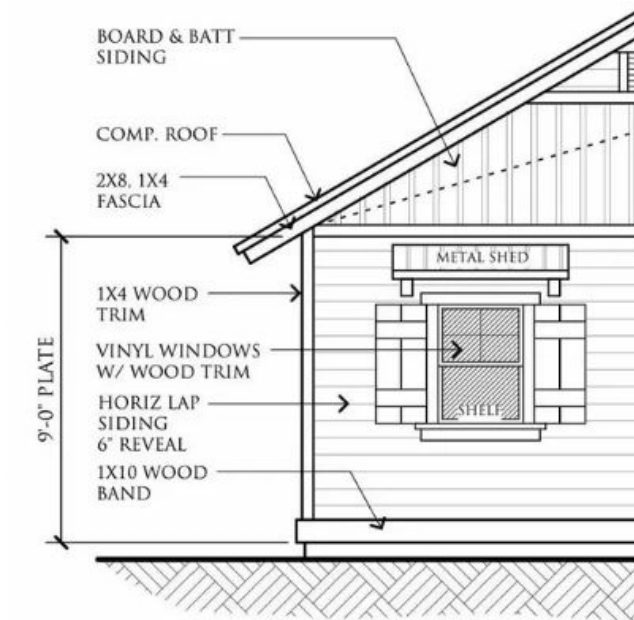


Traditional Kit Homes



Sunshine Home Kits | Oregon

- Concept like the Sears Homes sold in the 1900s
- Mobilizes an assembly line system through use of corporate partnerships (e.g., Home Depot, Lowes)
- Streamlines procurement and production supply chains through standardized models





KEY FINDINGS AND RECOMMENDATIONS

Resilience



Flood Resilience



Hardened, flood damage-resistant exteriors and framing systems that are easy to elevate

Wind Resilience



Constructed with strong exterior shells designed to meet wind speeds per Texas Windstorm Insurance Association

Fire Resilience



Capable of attaining 1.5 to 2+ hour fire ratings and constructed with fire-resistant materials (e.g., steel, cement board)

Energy Resilience



Compliant with green building standards and off-grid capable



Overall Unit Capabilities

Livability



Flexibility to customize the interior and exterior, meet local architectural standards, and provide a comfortable living space

Range of Use



Capable of supporting temporary-to-permanent needs, single or multi-family use purposes, and adapt to specific environments

Timeliness



Able to flatpack for expedited transportation and quickly install for rapid use purposes

Cost

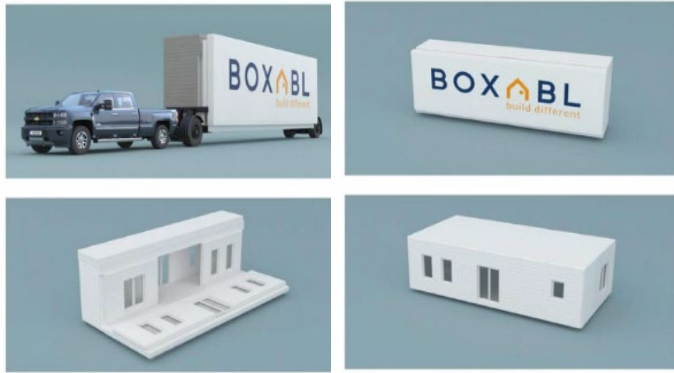


Cost-efficiency as indicated by the purchase price, projected lifespan, haul and install, long-term maintenance, and resilience

Phase II Testing Recommendations

The Study identified four vendors that presented the most viable solutions for use in the State of Texas.

BOXABL



ICON



INDIEDWELL



LIV-CONNECTED



Obstacles and Pathways for Alternative Housing



**Manufacturing
Solutions at Scale**

**Programmatic and
Contractual
Infrastructure**

**Changes to the
Stafford Act**

GLO is well-positioned to take on these obstacles and define the pathway to successful alternative housing deployments.



DISCUSSION



ADJOURN