Introductory Brief #1

Level Setting on Offsite Construction

Key Concepts and Regional Context for Greater Boston

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The purpose of this paper is to provide level setting information on the topic of offsite construction broadly and within the Greater Boston Region. Developed to support MAPC's PRO Housing grant initiative, it provides key definitions, outlines common systems and regulatory structures, and summarizes the current state of the sector locally.

What is Offsite Construction?

Offsite construction is "the process of planning, designing, fabricating, transporting, and assembling building elements in a factory setting for rapid onsite assembly to a greater degree of finish than in traditional piecemeal onsite construction."[1] The goal of this approach is to utilize the benefits of a factory environment to produce standardized building components that are assembled at construction sites. This definition of offsite construction is subject to evolution and change; it is still an emerging practice in the United States and not a fully established industry.

Offsite construction encompasses a wide range of building materials, project scales, and integrated systems. Materials commonly used in offsite methods include light wood framing, steel, mass timber, and concrete, each selected based on structural performance, cost, and transportation logistics. These materials support varying degrees of prefabrication, from simple kit-of-parts assemblies to highly integrated volumetric modules (see below for more detail). Offsite construction methods vary by the degree of prefabrication, complexity, and factory integration. The most commonly used systems include:

1. 1D Kit-of-Parts Systems
    - Prefabricated elements, such as log cabin kits, precut wood kits, and metal building systems are prepared for easy installation on site.
2. 2D Panel Systems
    - Open panels: Wall, floor, and roof elements.
    - Closed panels: Include additional features like insulation, windows, doors, electric, plumbing, or cladding.
    - Require special handling during transportation and installation.

[1] *HUD Research Roadmap*

3. 3D Volumetric Systems
    - Three-dimensional units that are completed between 50% and 90% in the manufacturing facility.
    - This is the highest degree of prefabrication and has the most pre-installed building systems.
    - Requires special transportation and installation logistics due to size.
    - Can be constructed with light wood frames, steel, or mass timber
4. HUD Code Housing / Manufactured Housing / Mobile Homes[2] (*Distinct from Offsite Housing*)
    - Built to the federal HUD Code (24 CFR Part 3280), not to local or state building codes.
    - Undergo factory inspections and testing under HUD standards; local code inspections occur only for installation (e.g., anchoring, foundation).
    - Designed primarily for single-family use, often in mobile home parks or rural areas.
    - Typically treated as personal property (not real estate) unless permanently affixed and titled.

Note: For the purposes of the grant work, the terms 'offsite constructed homes' or 'offsite housing' will be used to refer to housing units built to local and state building codes in a factory setting, typically involving 2D panelized or 3D volumetric systems. This *does not* include HUD Code manufactured homes (commonly referred to as mobile homes), which are regulated under a separate federal code and have distinct construction, financing, and regulatory characteristics.

Offsite Housing Delivery Process

Offsite construction can operate on multiple scales, spanning from individual housing units to larger multifamily and mixed-use developments. The factory-based construction enables the integration of multiple building systems, including mechanical, electrical, plumbing, and insulation. The majority of this work happens prior to site delivery, improving efficiency and quality while reducing waste and construction time. However, it also integrates both offsite (factory-based) and onsite (field-based) workstreams. Typical procedural stages[3] include:

- Design & Engineering
    - Architects and engineers use offsite housing-specific design tools or BIM (Building Information Modeling).
    - Coordination ensures modules meet code and logistics requirements.
- Permitting & Approvals
    - Plans submitted for third-party or local authority review.

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[2] *This type will not be included in our grant work. We will be focusing on 2D, 3D.*
[3] *Modular Building Institute's article* *"Inside the Modular Building Process"*

    - Approval can occur faster in jurisdictions familiar with offsite residential construction.
- Factory Fabrication
    - Modules are constructed indoors in a controlled environment.
    - Structural, MEP systems, insulation, and interior finishes completed here.
    - Certified Third-Party Inspection Agencies (TPIAs) conduct inspections during production to ensure compliance with state building codes and approved manufacturing plans.
- Transportation
    - Modules are wrapped and shipped via truck/trailer.
    - Route planning and permitting for oversized loads is critical.
- Site Preparation
    - Foundations, utility stubs, and grading done concurrently with factory work.
- Installation & Assembly
    - Modules craned into place and locked together on-site.
    - Structural and weatherproofing tie-ins completed.
- Utility Hookups & Finishing
    - Electrical, plumbing, HVAC connections finalized.
    - Minimal site-built work such as stairs or roof caps added.
- Final Inspections
    - Comprehensive review for code compliance.
    - Includes fire safety, accessibility, energy, and structural checks.
- Occupancy
    - Certificate of Occupancy issued.
    - Project handed over to owner or operator.

Regulatory Framework

Offsite constructed homes in the United States are primarily regulated by state and local building codes, rather than a single national standard. Unlike mobile homes, which must comply with the HUD Code, offsite housing is constructed to meet the same building codes as site-built homes, typically based on the International Residential Code (IRC) or International Building Code (IBC).

State Level: In Massachusetts, at the state level, offsite construction is governed by the Manufactured Building Program, as outlined in 780 CMR 110.R3[4] of the Massachusetts State Building Code. This regulation covers the design, manufacture, transportation, and installation of offsite housing within the state. Manufacturers are required to have their building systems and compliance assurance programs approved by the Board of Building Regulations and Standards

[4] 780 CMR 110.R3 *available at* https://www.mass.gov/info-details/manufactured-building-program.

(BBRS). Each offsite housing unit must bear a certification label indicating compliance with state regulations. Manufacturers must engage BBRS-approved TPIAs to inspect and certify offsite housing units during production.

Local Level: While the BBRS oversees the manufacturing process, local building officials are responsible for inspecting site-specific elements such as foundations and utility connections. Local agencies ensure that the installation complies with zoning ordinances and local building codes.

Key Barriers to Offsite Construction:

There are currently several key barriers that inhibit the implementation and growth of the offsite construction industry. Major challenges include the following:

1. **Regulatory Framework**[5]
    - Local authorities being unfamiliar with offsite systems and methods.
    - A misalignment between building code and the innovations made with offsite construction.
    - Inconsistencies from state to state (or even municipality to municipality) between inspection standards.
    - Offsite construction spans across multiple code sections, and there is ambiguity around responsibilities for fire safety systems, egress, and energy code compliance when integrating modules onsite.
    - Varying transportation regulations.
    - Even though modules are inspected in-state, local inspectors often require re-inspection of offsite constructed components which can create confusion, delays, and legal risk. E.g. Electrical or fire system components sealed into offsite housing units needing to be reopened for additional inspection by some local inspectors.
2. **Standards and Performance**
    - Differing terminologies are common across the industry.
    - Varying testing and certification processes hinder innovation.
    - Supply chain disruptions and material quality issues.
3. **Capital, Finance, and Insurance**
    - Difficulties securing capital for manufacturing facilities.
    - Challenges with obtaining financing and insurance for projects.

[5] *Offsite is regulated at state as well as local levels. In MA the state level licensing and permitting is done by State Board of Building Regulations & Standards (BBRS) which plays a key role in setting and enforcing the statewide building code, and it is housed within the Office of Public Safety and Inspections (OPSI), which is part of the Executive Office of Public Safety and Security (EOPSS).*

- Conflicting timelines and structure between factory production and construction loans.

4. **Project Delivery and Contracts**
    - Traditional contracts are not always aligned with offsite methods.
    - There is a need for earlier decisions in project timelines.
    - Documentation challenges for describing factory vs. site scope
5. **Labor and Workforce**
    - Required training for both factory and onsite workers.
    - Concerns about the displacement of union labor.
    - Workforce recruitment and training.
6. **Business Models and Economic Performance**
    - There is a need for better data collection and performance metrics.
    - Business models must adapt to as supply chain evolves or shifts.
    - Questions surrounding vertical integration and customer-based approaches.
7. **Public Perception and Need for Education**
    - A basic misunderstanding of offsite construction, especially offsite housing, continues to hinder its broader acceptance and implementation.
    - Conflated with HUD-code manufactured housing or mobile homes, which are subject to entirely different standards.
8. **Lack of Sustained, Aggregated Demand**
    - Manufacturers require predictable volume of projects to operate viably. Absence of a coordinated, multi-year project pipeline that is critical to production lines.
    - The current offsite construction landscape in the Greater Boston region is nascent, with no single large-scale manufacturing facility to support the demand for new housing units.

Growing Momentum - State and Regional Alignment

There is growing momentum to advance offsite construction as a strategy to address the housing crisis across Massachusetts. At the local level, cities like Boston are actively exploring offsite residential construction solutions through pilots and industry engagement. Regionally, MAPC and its municipal partners are working to build a coordinated pipeline of projects that could support in-state manufacturing. At the state level, recent policy reports and initiatives from the Healey-Driscoll Administration and EOHLC highlight a commitment to innovation in construction as part of broader efforts to unlock housing production. This momentum is not limited to Massachusetts—neighboring states like Vermont are also exploring offsite construction to meet their housing, workforce, and climate goals. Together, these efforts signal growing alignment across local, regional, and state actors in New England to scale offsite housing as a core part of the housing solution.

Progress on the Local Level: Boston's Housing Innovation Lab RFI

Boston's Housing Innovation Lab (iLab) has helped catalyze local interest in offsite housing through its recent Request for Information (RFI), which drew responses from eleven modular and panelized construction firms. Of those, nine are based in New England or along the East Coast, signaling strong regional interest. Several companies—including Reframe Systems (Somerville/Andover), Greenstaxx (Cambridge), and Quartz Properties (Newton)—have a local footprint in Massachusetts, and at least one respondent, RCM Modulaire, has already completed offsite housing projects in Boston.

Momentum at the State Level

The Commonwealth's Unlocking Housing Production Commission issued several detailed recommendations for addressing Massachusetts' housing crisis. The report outlines strategies to accelerate housing production by leveraging innovative construction methods, policy support, and public-private collaboration. Offsite construction is highlighted as a key solution to unlock housing production by increasing efficiency, reducing costs, and addressing labor shortages. The report emphasizes its potential to deliver high-quality, lower-carbon homes more quickly when paired with supportive regulatory and financial frameworks. Read the full report here.

The state of Offsite Construction in Vermont:

The report *Opportunities to Utilize Off-Site Construction to Meet Vermont's Housing, Workforce, and Climate Goals*, explores how Vermont can leverage off-site construction methods to address its acute housing shortage, workforce development needs, and climate objectives. Vermont is actively incorporating off-site construction to build more homes faster and more affordably. The state is home to offsite construction factories like Huntington Homes and is exploring reopening the former Skyline plant in Fair Haven. Vermont has supported projects such as the Mobile Home Infill Program and bulk purchasing efforts to deploy offsite and manufactured homes. These initiatives aim to lower housing costs, reduce reliance on scarce skilled labor, and promote energy-efficient, climate-resilient construction.

MOD X HUD Grant: Northeast Regional Action Plan:

The MOD X regional action plan focuses on educating stakeholders, establishing consistent implementation protocols, and creating a unified approach that can be adapted to diverse local contexts while maintaining core principles. By developing shared resources, technical guidelines, and policy frameworks, the plan aims to overcome traditional barriers to offsite construction adoption, ultimately accelerating the transition toward more efficient, sustainable, and cost-effective building practices throughout the region.

Regional Momentum: MAPC's HUD PRO Housing Grant

The Biden-Harris Administration and U.S. Department of Housing and Urban Development (HUD) awarded the Metropolitan Area Planning Council (MAPC) $3 million to explore innovative ways to build and install offsite constructed housing in the Greater Boston region through the Pathways to Removing Obstacles to Affordable Housing (PRO Housing) grant. The grant, which is now underway aims to create a regional strategy for expanding offsite construction to accelerate housing production while creating good jobs in the region. The grant will also fund the solicitation for a new manufacturing facility (or facilities) to effectively scale the use of offsite construction as a method of developing housing faster and more efficiently in Greater Boston. Building on foundational research from Boston's Housing Innovation Lab and HUD, the initiative is now underway and guided by a series of targeted working groups focused on regulatory, workforce, pipeline, and facility siting challenges. MAPC has been engaging with municipalities from the Metro Mayors Coalition (MMC) Housing Taskforce, along with state agencies, regional entities working on housing and workforce development and subject matter experts to create the regional strategy. This white paper serves as a level-setting resource for working group and advisory committee members, offering shared definitions and context to inform collective action and upcoming decisions, including the development of a solicitation for one or more facilities to support the offsite construction ecosystem in the Greater Boston region.

Preliminary Research Findings from PRO Housing Grant Work

Massachusetts has the demand, but not the offsite construction capacity.
Offsite construction is actively used across Massachusetts for residential, educational, and healthcare projects. Despite this demand, most offsite housing units are manufactured out-of-state, in places like Maine, New Hampshire, Pennsylvania, New Jersey, and Canada. While a few Massachusetts-based firms such as Reframe Systems (Andover) and Greenstaxx (Cambridge) are innovating in the field, the state lacks mid-sized to large-scale offsite construction facilities. This gap is unusual for the Northeast and represents a critical missing link in the local housing supply chain. Expanding in-state manufacturing could reduce vehicle miles traveled (VMT), lower shipping costs, and generate high-quality jobs within the Commonwealth.

Offsite construction enables industrialization of housing delivery and relies on a broad network of interdependent stakeholders.
The strength of the offsite construction approach lies in applying core manufacturing principles to the construction industry—industrializing the building process to scale housing production. It involves shifting substantial portions of the building process from the job site to a controlled factory setting, improving speed, quality, and cost control. The realm of stakeholders includes manufacturers, architects, developers, general contractors, inspectors (State via third party and local), transport & logistics firms, lenders & insurers, subsidizing agencies, regulators, local planning boards, and more.

A regional, ecosystem-focused approach is necessary to overcome barriers to offsite construction.

Preliminary research underscores the need for a regional strategy to support offsite construction in Greater Boston. Two of the largest barriers to broader adoption are the absence of a local manufacturing facility and the lack of a sustainable, aggregated development pipeline to support such a facility. Addressing these challenges individually at the municipal level is not feasible. A coordinated, cross-jurisdictional effort is essential to de-risk offsite housing adoption, signal long-term viability to the market, and set a precedent for scalable, equitable offsite housing production.

Demand aggregation is key to supporting a manufacturing facility.

The term demand aggregation refers to the coordinated effort to generate a pipeline of offsite construction housing projects large enough to support a manufacturing facility during its initial years of operation. Preliminary research suggests that this pipeline must total at least 1,000 housing units per year for a minimum of three years to make facility operations viable. Further research is needed to identify the optimal scale and configuration of manufacturing capacity appropriate for the Greater Boston region and Massachusetts more broadly.

Offsite construction presents both opportunities and tensions for labor.

Offsite housing sits at the intersection of construction and manufacturing, and it is critical to recognize this distinction. Jobs in offsite construction can offer more predictable hours, fixed work locations, reduced seasonal volatility, and greater access to wraparound supports. These conditions can create new opportunities for underrepresented workers, including women and people of color, who have historically faced barriers to entry in the building trades. Labor and workforce concerns remain a significant barrier to offsite housing adoption, particularly fears that offsite construction could displace traditional union jobs. To address these concerns while building market familiarity, early offsite housing efforts can strategically focus on smaller-scale infill development, such as triple-decker style multifamily housing on underutilized parcels and Accessory Dwelling Units (ADUs) on small lots. These projects are less likely to compete with large union-built developments and can demonstrate offsite construction's value in complementing, rather than replacing, traditional construction.