Please pick one: A) Develop affordable housing; B) Achieve climate goals; C) Create a Roadmap to meet both goals

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ABSTRACT

Local governments throughout the country have committed to reducing emissions from residential and commercial buildings. Many communities are also confronting growing gaps in affordable housing availability. Beliefs that energy efficient homes cost more to build than conventional homes frequently lead to a perceived conflict between climate goals and housing affordability needs. This research explores strategies that municipalities are pursuing to achieve both sustainability and affordability goals.

Advances in high-performance prefabricated homes present a potential opportunity to achieve both objectives by increasing both availability of affordable housing and improving energy affordability for lower income households. This paper explores the potential of this type of home to pursue both local affordability emissions reduction goals.

This research examines case studies from Cleveland, New York City, Aurora (Illinois), and New York City, where cities and affordable housing organizations are facilitating the construction of highly efficient prefabricated homes to address the dual objectives of 1) adding affordable housing that offers low energy costs for low-income households and 2) aligning development with climate goals.

The research includes interviews with manufactured home producers and City staff to understand whether prefabricated homes can help meet local emission or energy targets, including the Illinois stretch energy code, Enterprise Green Communities criteria, net-zero, and/or elements of PHIUS standards.

The paper uses insights from these diverse perspectives and experiences to establish a roadmap through which local governments can engage with manufactured home producers, adapt zoning guidelines, and take the additional steps needed to enable use of prefabricated efficient housing to increase affordability while decreasing emissions in their communities.

Introduction

This paper explores how local governments and community organizations are using highly energy efficient prefabricated homes to increase supplies of affordable housing that minimizes energy burdens for low- and moderate- income households, while also supporting local climate goals. One such city, Aurora, Illinois, is currently exploring this strategy in an effort to create local jobs, repurpose underutilized lots, and build awareness about Passive House[1] standards and the Illinois Stretch Energy Code. The authors use findings and data from Aurora's work to inform the research in this paper, and use the experiences of Aurora, and other cities, to propose a framework for other municipalities.

[1] Passive House means either the standards of Passive House Institute or Passive House Institute – US (PHIUS)

Prefabricated housing

As used within this paper, the term "prefabricated homes" encompasses units that are built in their entirety at a production facility as modules and are assembled at the permanent location. It also includes homes for which substantial building components, such as wall panels, are built off-site and then assembled at the permanent location. Homes in this category are built to meet a wide range of standards for both construction quality and energy performance. Not included in this category are mobile homes ("manufactured housing"), which are built entirely at an off-site facility and include a permanent chassis that can be used to transport the home.

Approximately one million new single-family homes were completed in the United States in 2025 (Census, 2026a) and an additional 103,000 homes were produced in manufacturing facilities and shipped to home sites (IBTS, 2025). Because federal housing statistics distinguish "manufactured housing" [2] from conventional housing but do not consistently separate site-built homes from prefabricated housing and other forms of factory-built construction, the total market share of off-site residential construction in the United States is difficult to quantify.

The average sale price of a manufactured home in 2025 was $85,160 with an average size of 1,550 sq.ft. (Census, 2026b), whereas the average price of a single-family home during the 12-month period ending September 30, 2025, was $413,650 and the average home size was 2,364 sq.ft. (Census, 2026c). Because production data does not disaggregate quantities and costs for prefabricated homes from site-built homes, the authors were unable to quantitatively compare the current markets for site built versus prefabricated homes. While definitive market-level data is not available, information from producers and general observations confirm that building on-site is the predominant construction technique in the U.S. However, off-site production of high-quality housing units is emerging as an approach for meeting increasing demand for affordable housing.

Off-site construction offers several potential advantages in comparison to on-site construction Gossman (2024), such as:

- Shortened time from site development to occupancy
- Reduced impact of inclement weather on construction timeline and quality
- Improved working conditions for construction staff
- Reduced construction waste
- Less site and community disruption during development

Together, more efficient production processes and potential economies of scale create opportunities for communities to deploy prefabricated energy efficient homes as a scalable strategy for addressing local housing needs.

Some stereotypes equate prefabricated homes with poor construction quality, less desirable units, and poor energy efficiency (NEEP 2022). While these views may reflect segments within this category, a growing number of builders of prefabricated homes are

[2] "Manufactured housing" is defined by the US Census as being built primarily in a factory, constructed on a permanent chassis, transportable in one or more sections, built in compliance with the federal manufactured housing standards administered by the U.S. Department of Housing and Urban Development (HUD), and bearing a HUD certification label. Construction practices and energy efficiency standards for mobile homes are established by HUD, rather than by the local jurisdiction.

producing high-quality and highly efficient units. The Producer Case Studies section of this paper explores examples of high-quality high performance prefabricated homes.

Categories of off-site construction. Our research distinguishes the currently dominant practice of constructing a house at the home's final location ("site-built construction") from off-site construction.

There are multiple sub-categories under the broad classification of off-site construction. Wu and Egelkamp (2021) provide detailed descriptions of three categories of off-site construction, which are summarized below.

- **Precut Dimensional Lumber/Engineered Lumber**. Using detailed design requirements and specialized software, wood and other building materials are precisely cut and organized at an off-site construction facility. The full package of materials for a home is shipped to the site where construction crews assemble the home. This method reduces overall on-site construction time and material waste in comparison to site-built construction but is subject to the same risks of quality control and timeline due to inclement weather as conventional practices.
- **Panelized systems**. Components of a home, such as trusses, floor cassettes, and wall panels are built in their entirety at a manufacturing facility and are shipped to the site. Structural Insulated Panels (SIPs) are an example of a panelized system that can be used to build highly energy efficient homes. Some SIPs also include integral windows.
- **Modular homes.** Sections of a house that include the walls, floor, and ceiling are built at a production facility and are shipped to the site when the foundation and required cranes/equipment are ready to secure the module. Interior finishes may be installed at the production facility or after the modules are secured to the foundation.

Homes that use one of these types of off-site construction are required to meet locally enforced building and energy codes. The research presented in this paper focuses on off-site construction for which energy performance requirements are governed by local energy codes.

Illinois Energy Regulations

In 2021, the State of Illinois passed the Climate and Equitable Jobs Act (CEJA), which enacted multiple new programs and policy tools that are intended to accelerate the state's transition to a clean energy economy built upon a foundation of well-paying new jobs in the clean energy sector (CEJA 2021). The Illinois Stretch Energy Code is one of the new policy mechanisms that CEJA created. The residential and commercial Stretch Energy Codes ("Stretch Codes") are alternatives to the statewide base energy codes that establish the minimum standard for energy performance for new buildings and significant renovations in Illinois.

The Stretch Codes require buildings to achieve higher energy efficiency standards than are required by the statewide base code and add readiness provisions (ex. all-electric ready) that the statewide base code does not require. Municipalities that want to advance energy efficiency within their jurisdictions may choose to adopt the residential and/or commercial Stretch Code. Following adoption, the Stretch Code becomes the new minimum standard for energy performance within that jurisdiction. The Stretch Code is updated at three-year intervals to achieve increasingly advanced targets for energy efficiency and affordability.

Energy codes offer multiple pathways, such as prescriptive compliance and modeled energy performance, through which a design team can demonstrate that a building meets the code's requirements. Both the residential and commercial Stretch Codes add Passive House and Net Zero Energy certification as compliance pathways options that design teams may utilize. Designating Passive House and Net Zero Energy certification as compliance pathways means that a building that achieves one of these certifications and includes the mandatory 'readiness' provisions is by-definition also compliant with the Stretch Code, thus streamlining the process of demonstrating code compliance for these buildings.

As of early 2026, only one municipality, Evanston, has adopted the Stretch Code. Other municipalities in the greater Chicago region are actively considering moving forward with adopting the Stretch Code. However, stakeholders in many of these communities have expressed concerns that meeting the higher standards will increase costs for developing new housing and commercial buildings.

City of Aurora Objectives

Aurora, Illinois is the second-largest city in Illinois and is part of the Chicago metropolitan region. It is located approximately 40 miles west of downtown Chicago. The population, of nearly 200,000 residents, is a diverse and growing community, with more than 40 percent of residents identifying as Hispanic or Latino. Recent Census data shows that it also has a relatively young population and many working families, with a median age of approximately 35 years.

Housing affordability and access are challenges for Aurora's lower-income residents and first-time buyers. Under CEJA, portions of Aurora have been designated as Equity Investment Eligible Communities (EIECs), which are areas prioritized by the State for investments in additional clean energy resources, workforce training, and economic development support. Designation as an EIEC reflects socioeconomic indicators for that community, such as income levels and environmental burdens, which suggest the presence of barriers to economic opportunity in that area.

Aurora's demographic diversity and socioeconomic range highlight the need for housing strategies that expand access to affordable, high-quality, and energy-efficient homes while supporting long-term sustainability goals. The City's current administration is strongly focusing on implementing the strategies that were established in its 2019 Sustainability Plan, and believes that the City can simultaneously improve environmental performance, economic opportunity, and quality of life for residents. To do this, the City of Aurora is working to implement a housing strategy that incorporates prefabricated construction, high-performance energy standards, and creative land use solutions to expand attainable homeownership opportunities. There are seven objectives in this initiative.

1. Demonstrate the feasibility of factory-built and modular homes as a cost-effective housing solution.
    a. How: Aurora will construct 1-2 new prefabricated energy-efficient homes that will serve as proof-of-concept projects. Qualitative and quantitative cost data from these developments will be monitored and analyzed to show how modular housing can expand supply while maintaining neighborhood character.
2. Train and educate stakeholders, such as developers, affordable housing advocates, and residents about the Illinois Stretch Code and Passive House standard.

    a. How: The City received a grant to support the adoption of the Illinois Stretch Code, which it will use to provide education and training to the industry. The demonstration home(s) will also provide hands-on experience during and after construction of the demonstration homes to the industry and general public.
3. Reduce residential energy costs through high-performance building standards.
    a. How: Due to their very low energy consumption, houses that achieve Passive House certification reduce utility costs for residents and allow the occupants to repurpose money that would otherwise be paid for electricity and natural gas service toward essential household expenses, such as mortgage payments. Supporting installation of prefabricated homes that meet Passive House certification would also align with Aurora's intention to adopt the Illinois Stretch Energy Code because certification would streamline verification of compliance with the stretch code for these homes.
4. Utilize nonconforming parcels to expand the supply of small-scale infill housing.
    a. How: The City identified hundreds of parcels that, due to small lot sizes or unconventional shapes, are not viable for use as standard site-built homes, but on which a small, affordable prefabricated home could be installed. The City is formulating a new zoning overlay district that would enable small prefabricated homes to be added at these locations.
5. Attract a prefabricated housing manufacturer to Aurora to reduce construction and transportation costs and to provide jobs for a local clean energy workforce.
    a. How: Aurora's location within the Chicago metropolitan region, strong transportation infrastructure, and available industrial land make it well positioned to support this type of manufacturing activity.
6. Fulfill goals in the 2019 Sustainability Plan.
    a. How: This initiative aligns with objectives that are identified in the climate change, community development and land use, energy efficiency, environmental justice, and community resilience sections of the Sustainability Plan.
7. Leverage partnerships and create support programs and financing to scale up the effort.
    a. How: The Aurora Housing Authority, Habitat for Humanity, and the Neighbor Project are local affordable housing developers and potential project partners. Aurora is considering developing incentives for high-performance homes, such as offering revolving loan programs, expedited permitting, and alignment with utility rebate programs.

Methods

This paper explores the potential for prefabricated homes to be deployed in communities to 1) address existing shortfalls in affordable housing; 2) create new local living wage construction and manufacturing jobs and 3) support community wide energy and emissions reduction goals. We consider three questions:

1. Is support for deployment of prefabricated homes a viable strategy through which local governments and housing organizations can increase the supply of affordable housing?
2. How can local governments and community organizations support the development and installation of prefabricated homes to cost-efficiently meet energy efficiency and emissions reduction goals, such as implementation of the Illinois Stretch Energy Code?

3. Is support for deployment of prefabricated homes an effective strategy for local governments and community organizations to increase the supply of local living wage construction and manufacturing jobs?

To investigate these questions, this paper offers primarily qualitative findings and discussion, as well as some quantitative analysis. We summarize how three communities are incorporating prefabricated housing into affordable housing and climate initiatives and describe the approaches to housing production that several leading manufacturers are delivering. We also explore existing research comparing production and deployment costs and outcomes for prefabricated homes generally and for high-performance prefabricated homes specifically. From these case studies, we highlight available data on actual costs, energy performance, and job creation resulting from these initiatives. To guide a roadmap for other communities, we offer two metrics that offer holistic assessments of the affordability, sustainability, and emissions impacts of different affordable housing strategies. We then apply data from the literature review and manufacturers to compare types of site-built and off-site built housing.

Case Studies

The research compiled profiles of the costs and energy efficiency levels or certifications of models of efficient prefabricated housing units. It also explored the use of this category of efficient prefabricated housing by communities to increase local affordable housing.

Producer Case Studies

Our research found an array of sizes and specialty areas for companies that are producing and promoting high efficiency prefabricated houses. Table 1 shows a selection of these companies.

Table 1. Examples of high-performance prefabricated housing providers

Company	Manufacturing location	Production category	Energy performance
CABN	Ottawa, Canada	Pre-cut components	Net zero-ready
Clayton Homes	LaPorte, IN	Modular	HUD standards equivalent to 2021 IECC with option to improve to ENERGY STAR or ZERH standard.
EkoBuilt	Ottawa, Canada	Panelized walls and building components	Passive House and/or Department of Energy ZERH[3]
Mighty Small Homes	Louisville, KY	SIP and pre-assembled building components	Department of Energy ZERH
YardHomesMN	New Brighton, MN	SIP and pre-assembled building components	Department of Energy ZERH

[3] To achieve U.S. Department of Energy Zero Energy Ready Homes (ZERH) certification, the unit must meet high energy efficiency and indoor air quality standards, while also including renewable energy readiness

Table 2 presents key metrics for sample models produced by these manufacturers. Data shown in the table offers information about a single home model and layout; however, all manufacturers shown produce multiple models of efficient prefabricated homes, with ranges of sizes and corresponding costs. The examples shown are for models that may be relevant for local governments focused on increasing availability of affordable housing. Following the tables, we describe some of the homes produced by these companies in greater detail.

Table 2. Key metrics of sample prefabricated home manufacturers and models

Company	Size (sq. ft.)	Cost[4]	Site labor requirement
CABN	540 – 2,500	Variable	Site preparation and foundation Non-specialized labor for assembly Finishing
Clayton Homes CrossMod	1,600	$208,000 - $304,000	Non-specialized labor for assembly
EkoBuilt	1,320	$326,000	EkoBuilt site supervisor Non-specialized labor for assembly
Mighty Small Homes	1,200	$279,000 - $349,000	Mechanicals Interior finishes
YardHomesMN	<1,000	$160,000	Assembly Installation of interior finishes

YardhomesMN. The researchers interviewed Nichol Dehmer (2026), the founder and CEO of YardhomesMN to understand the production, efficiency, and costs of the company's models.

YardhomesMN uses SIPs in its off-site production of homes that are smaller than 1,000 square feet, and which it describes as "tiny homes." The company produces the panels and other structural elements of the home at its manufacturing facility in New Brighton, Minnesota and ships the components to the home site, where they are assembled.

Preparing a YardhomesMN unit for occupancy requires less than a week to assemble and achieve weather-tightness. After completing the exterior shell, building trades professionals install electrical, water, and mechanical systems, as well as interior finishes per the selections of the homebuyer. No specialized prefabricated homes construction skills are required for the on-site assembly and finishing for these homes.

The company states that its homes meet ENERGY STAR standards and that it conducts two blower door tests during the construction and assembly processes to ensure proper air sealing in the unit. Together, the high R-values of the SIP panels and the focus on air tightness enable the company's CityCabn models to earn a HERS score of 44.

Costs for the home components that the company produces start at approximately $160,000, but costs may be reduced to approximately $125,000 if five or more units will be shipped to the same development site. The company tracks the costs of the production materials that it uses and compares its costs to site-built construction costs. While YardhomesMN previously found that materials for stick-built homes were less expensive, due to recent

[4] Several manufacturers indicated that reduced costs may be possible through purchasing economies of scale.

significant increases in the costs of lumber and other conventional construction materials, it finds that it achieves net cost savings by using SIP construction rather than conventional materials. The costs shown in Table 2 do not include shipping, assembly, mechanical systems, or interior finishes.

EkoBuilt. EkoBuilt focuses its value proposition to customers on the energy performance of its units, as well as on the large number of models and floor plans that it offers. By using off-site construction, it has worked to achieve pre-certification of certain models as meeting Passive House and/or Net Zero-ready standards. These models offer very low energy costs and generate minimal GHG emissions. Homes are also constructed to be solar-ready so that homebuyers can add on-site renewable energy systems to achieve net-zero or net-negative energy performance. EkoBuilt ships a set of wall panels, pre-built roof systems, windows/doors, and certain interior components required for assembly to customers. An EkoBuilt staff person supervises the on-site assembly of the home and assures that the remainder of the building components that are installed comply with the design intent and will support achievement of Passive House or Net Zero-ready standards.

The company offers models that are intended to serve multiple market segments, which include applications for small floor plans and multi-unit models that would be well-positioned to be placed on non-conforming urban in-fill lots. Its shared living space models may also align with focuses on increasing housing density in some communities. Most units are produced in panel segments in Ottawa and are then shipped to home sites for assembly, installation of electrical and mechanical systems, and interior finishes (EkoBuilt 2025).

Unit costs vary among models and customization options. One example of a home that could align with affordability and sustainability goals of communities, while also fitting well into unconventional sites is a 1,320 square foot unit. The cost for the shell only for this model is approximately $171,000 and the total installed cost with foundation is approximately $326,000.

Clayton Homes. Clayton Homes, the largest mobile home manufactured housing producer in the U.S. has been working to expand the high-energy-performance prefabricated construction market. Clayton Homes focuses on affordable and mid-tier market segments, with their typical products meeting HUD standards for energy efficiency but demonstrating higher quality than the lowest-cost mobile homes. Clayton built over 142,000 ENERGY STAR homes from 2005-2023. A company representative stated, “ENERGY STAR® estimates the 30,244 certified homes Clayton Home Building Group built in 2022 will save Clayton homeowners $8.89 million in annual utility bills [and contribute to] over 43,000 metric tons of carbon dioxide emissions avoided at respective power grids.” (Clayton 2023). Clayton Homes now produces two options that offer improved quality and the energy performance in comparison to their typical models: “E-Built” and “CrossMod™.”

Clayton launched their new line of “E-Built” homes in July 2023. E-Built models are manufactured to meet the U.S. Department of Energy’s Zero Energy Ready Home™ performance standards through improvements or modernization in HVAC, insulation, and envelope airtightness over their typical units. The price range for E-built models ranges from $65 to $95 per square foot for the factory components and between $100 to $150 per square foot when including delivery, site prep, utility hook-ups, and foundation aspects.

In 2020, Clayton Homes released ten floor plans for CrossMod™ models that range in quality, affordability, and energy-efficiency (Clayton 2020). The CrossMod™ concept was introduced in 2016 by the Modular Housing Institute (MHI) with the intention to bridge the gap

between affordable manufactured housing and site-built construction (MHI 2023). CrossMod™ homes may include site-built aspects that differ from typical manufactured housing options, such as permanent foundations, higher roof pitches, interior drywall and smooth ceilings, site-built style exterior finishes, and energy-efficient features. Scaled off-site production reduces costs and site-built finishes support market acceptance.

Market research found that approximately 46 percent of consumers would consider purchasing a CrossMod™ home compared to nine percent of consumers who would consider a traditional manufactured home (MHInsider 2024).

Prices for CrossMod™ models range from $90 to $130 per square foot for the factory components and between $130 to $190 per square foot when including delivery, site prep, utility hook-ups, and foundation aspects. For one of the 1,600 sq. ft. floor plans, estimated total costs range from $208,000 to $304,000.

Community Development Case Studies

We examine how three communities are currently leveraging efficient prefabricated homes to address energy and affordable housing objectives.

Cleveland, Ohio. The City of Cleveland identifies buildings and housing as a priority for reducing community-wide greenhouse gas emissions and improving community resilience. In its Climate Action Plan and Sustainable Cleveland initiative (Cleveland, 2025), the City prioritizes new construction and rehabilitation that improves energy performance, reduces utility costs, and expands affordable housing access. To advance these goals, Cleveland supports initiatives that emphasize energy-efficient modular and prefabricated housing, like the Habitat for Humanity modular housing program.

The Greater Cleveland Habitat Modular Homes program (Greater 2024) helps Greater Cleveland Habitat for Humanity meet its goal of producing 400 new affordable homes in the Cleveland area. The project broke ground in late 2024 and planned to build 19 1,350 sq. ft. modular homes in three neighborhoods that year. The project utilized funding from Cuyahoga Land Bank and the American Rescue Plan Act (ARPA) through the Cleveland City Council.

Cleveland is also implementing a 5,000 affordable homes initiative that further advances deployment of prefabricated homes. The $100 million effort provides financing for developers who are constructing or rehabilitating homes for low- and moderate-income residents through a program called the Cleveland Housing Investment Fund (Kurtz 2025). As part of the initiative, the City released a request for proposal through which four finalists manufactured at least one prototype prefabricated home (Gideon 2025). The six homes in the pilot were constructed in partnership with Habitat for Humanity. A second, larger “market pilot” was expected to launch in early 2026, and will deploy 20 homes in two additional neighborhoods. Following this pilot, the city plans to reuse thousands of vacant lots across Cleveland and will redevelop a former General Electric site in Collinwood as an off-site housing factory.

City of Milwaukee. As described in “Single Family Off-Site Construction” (Wu and Egelkamp, 2021) the City of Milwaukee released a request for information for off-site construction producers to develop production facilities in the city. These factories would leverage increased consistency of construction and economies of scale to produce affordable single-family homes that achieve Passive House design and construction standards at a price point that is affordable for low- and moderate-income households. The initiative will require that the local

manufacturing facility commit to paying living wages and/or to use union labor, thereby supporting broader economic development objectives. The planning process for the initiative is ongoing in response to changes in available funding.

New York City Habitat for Humanity. Habitat for Humanity NYC completed a modular home development project in April 2024. The homes were designed and constructed based on Enterprise Green Communities criteria and included elements of Passive House construction. These construction techniques ensure that the households will continue to benefit from energy affordability throughout the years that they own the home. The HFH chapter further ensured long-term affordability of these homes by installing the houses at sites owned by a land trust.

Findings and Discussion

The literature review and case studies of manufacturers found that high-performance prefabricated homes are available and can be produced at similar or lower costs than site-built homes. The combination of energy affordability and lower purchase costs suggests that these homes can achieve both affordability and climate objectives. The case studies of local governments offer examples of how municipalities are exploring and applying this strategy to re-write conventional wisdom and show that communities do not need to choose between meeting affordability and emissions-reduction goals. Aurora is applying insights from prefabricated home manufacturers and other communities to inform its path toward meeting its affordability and sustainability goals. Together, information from producers and municipal case studies inform a roadmap that can guide the use of high-performance prefabricated homes by local governments to advance affordability and sustainability goals.

Cost

As shown in Table 3 prefabricated homes can offer lower production costs, even inclusive of shipping and installation costs, than comparably sized and finished site-built homes. Models offered by EkoBuilt, and other manufacturers, that meet Passive House, Net Zero, or other high-performance standards demonstrate that deploying prefabricated homes in a community can align with local sustainable development initiatives.

Table 3. Comparison of costs and energy performance of housing production methods

Housing type	Factory construction cost ($/sq ft)	Installed cost ($/sq ft)	Energy performance
Site-built single-family home	Not applicable	$150–$300+	Code minimum (varies by jurisdiction)
Manufactured housing	$55–$90	$85–$150	HUD standard
CrossMod homes	$90–$130	$130–$190	Enhanced manufactured housing standards
High-performance manufactured homes (EkoBuilt)	$65–$95	$100–$150	DOE Zero Energy Ready Home
Passive House prefab homes (EkoBuilt example)	$130–$250	$200–$400	Passive House/Net Zero-ready

Source: NAHB 2024; MHInsider 2024; Clayton 2020; Clayton Home Building Group 2023; PHIUS 2022; MEEA and NEEP 2021.

While designation of housing as "affordable" is typically based on purchase or development costs, other factors also affect actual affordability for occupants. In addition to interest and insurance expenses, energy costs influence ongoing affordability of housing throughout the lifetime of the home. Improving efficiency and meeting Passive House or Net Zero standards supports both energy affordability and housing affordability. To help local leaders select strategies to most cost-effectively advance affordability and sustainability, we propose applying two metrics that incorporate effects of a pathway on ongoing housing costs, GHG emissions, and local economic development to evaluate potential affordable housing strategies.

$$Metric\ 1: Household\ Affordability = \frac{[PITI + Average\ monthly\ utilities]}{Sq.Ft.}$$

$$Metric\ 2: Sustainable\ Development = Local\ economic\ development\ benefit\ x\ \frac{GHG\ emissions}{sq.ft.}$$

In Metric 1, PITI equals principal payments, interest expenses, property taxes, and insurance. This metric connects energy expenses with house payments to capture the total monthly cost of housing relative to the size of the home. Metric 2 addresses the potential for the addition of affordable housing to support local economic development and emission reductions simultaneously. For example, prefabricated housing manufactured locally may generate manufacturing employment, tax generation, and economic activity while also reducing building-related greenhouse gas emissions. **Error! Reference source not found.** provides a comparison that includes affordability, economic, and sustainability metrics. The table shows that all types of off-site construction offer affordability and emissions benefits when compared to site built homes, with Passive House pre-fabricated homes boasting the lowest emissions level. High performance and Passive House pre-fabricated homes also offer the greatest potential for sustainable development.

Table 4. Comparison of ownership expenses and economic benefits of different housing production methods

Housing type	Monthly PITI	Monthly utilities	Home size (sq ft)	Est. GHG emissions (kg CO_2/sq. ft. /year)	Metric 1: Affordability ($/sq. ft./month)	Metric 2: Sustainable Development indicator
Conventional site-built home	$2,200	$250	2,000	8–10	1.23	Low
Manufactured home	$1,200	$180	1,400	7–9	0.99	Moderate
High-performance prefab (EkoBuilt)	$1,350	$110	1,400	4–6	1.04	High
Passive House prefab (EkoBuilt)	$1,600	$60	1,400	1–2	1.19	Very high

Source: DOE 2023; PHIUS 2022; NAHB 2024; MHInsider 2024.

Opportunities to implement prefabricated efficient housing

We identified four primary opportunities for communities by applying insights gained from producers of prefabricated homes and from local governments.

1. **Affordability through economies of scale**. Manufacturing processes can achieve significant cost savings when increasing the scale of production of a product. While larger developers may achieve limited per-unit cost savings as the scale of a development increases, there are fewer opportunities for economies of scale by increasing production of site-built homes than there is through off-site construction. The potential economies of scale through off-site production could be valuable in affordably reducing this shortfall.
2. **Standardize production.** Completing construction processes in a controlled and standardized environment mitigate risks from factors that could reduce the quality or efficiency of the home, such as exposure to inclement weather and inconsistent workmanship.
3. **Precertification for (Stretch) code compliance**. Plan reviews and inspections needed to confirm compliance with building energy codes require time and effort by municipal staff and by developers. Additionally, as energy codes advance, municipal building officials may have concerns about their ability to effectively enforce these codes. Homes that are built off-site can be pre-certified as meeting third-party high-performance standards. Pre-certifying housing to these standards fast-tracks verification of compliance with advanced

energy codes, such as the Illinois Stretch Code, which specifically identifies Passive House certification as a means of confirming compliance with the Stretch Code.

4. **Localized manufacturing**. The cost of transporting pre-built home components from a production facility to a building site adds to the total purchase cost of a prefabricated home. Longer distances from production to installation increase costs and compromise affordability for the homebuyer. The case studies for Milwaukee and Aurora reveal strategies that municipalities are using to attract producers of prefabricated homes to establish production facilities in their communities and to commit that the facilities will provide high-quality stable jobs to residents. These strategies can both reduce transportation costs, thereby promoting affordability, and foster broader economic development by securing high-quality jobs for community members.

While high performance prefabricated homes present opportunities for communities, we also identified key challenges to the implementation and scaling of this strategy.

Key challenges

1. **Variable affordability**. Variability in designs and the significant cost impacts of required site preparation, transporting building systems, and installing mechanical systems and interior finishes made it challenging to determine the most cost-effective production method. While some producers can deliver affordable high performance prefabricated homes, there is insufficient data to determine whether off-site construction is consistently the lowest cost means of producing energy efficient housing.
2. **Localizing production**. Engaging a manufacturer to build a local production facility could increase housing affordability and support local economic development. However, it is unclear whether this strategy can be scaled nationally and attracting producers may be particularly challenging for smaller communities where a manufacturer may see insufficient business opportunities. Additionally, securing a local investment by a producer will require a considerable time for municipal staff.
3. **Perceptions of prefabricated homes**. While some research has shown that public perceptions of factory-built homes is improving, historical associations of this type of housing with poor quality have contributed to generally negative perceptions of this category of home. Consequently, communities seeking to deploy high quality efficient prefabricated homes to increase the supply of energy efficient affordable housing may face headwinds in gaining approval of these plans.

A replicable model for local governments and affordable housing providers

The City of Aurora's initiative offers an opportunity to translate the research from this paper into replicable steps that other communities may follow:

1. **Educate stakeholders**. Community members, City staff, Aurora's housing authority, and developers working in Aurora have interests in housing affordability, sustainability, and local economic development. City staff meet with stakeholders and hold public meetings and other events to continue to educate the community about the initiative.
2. **Establish policy alignment between housing and climate goals.** Aurora's 2019 Sustainability Plan identifies energy efficiency, climate mitigation, and equitable community development as priority goals. CEJA identifies portions of Aurora as EIECs.

The Illinois Stretch Code advances CEJA goals and offers a Passive House option for compliance. Aurora's prefabricated homes initiative supports all of these policies**.**

3. **Identify housing needs and opportunities for infill development.** Aurora is identifying nonconforming parcels that present opportunities for small-scale infill development using compact prefabricated homes and has been working with local affordable housing developers on housing needs. Aurora has reached out to manufacturers to assess feasibility.
4. **Identify manufacturers and demonstrate feasibility through pilot projects.** Aurora plans to use an RFI or RFP process for demonstration homes that showcase high-performance energy standards (like Passive House and Illinois Stretch Code) through factory-built construction. It also helps with providing industry training and increasing public acceptance of prefab through demonstration. Aurora can use the information from Tables 1, 2, and 3 to establish cost ranges and understand potential savings.
5. **Assess costs, potential savings, and support needs.** Aurora can use the RFI and RFP process to refine costs and create support programs as needed. Aurora can work with lenders and utilities to align incentives and financing mechanisms like revolving loans and other support programs. Metrics 1 and 2 can help financers understand other ways to evaluate potential developments.
6. **Align building codes and certification pathways.** Learning from the demonstration projects, Aurora will consider adoption of the Stretch Code (of which Passive House and Net Zero Energy certification can serve as compliance pathways) and will consider incentives for developers willing to integrate high-performance prefabricated housing into their projects. Aurora will also work with manufacturers to pre-certify their products, decreasing permitting time.
7. **Build partnerships to support deployment**. Aurora will encourage the Aurora Housing Authority, Habitat for Humanity, and the Neighbor Project to utilize lessons learned, participate in demonstration projects, and incorporate high-performance prefab into their affordable housing projects. Aurora will also develop support that builds upon existing utility and state programs.
8. **Encourage local manufacturing and workforce development.** Aurora will conduct a market study to understand the potential for bringing a local manufacturer to Aurora to reduce transportation costs, increase production capacity, and create local clean-energy jobs. Aurora will also require hiring of workers from the CEJA workforce development hub into a certain percentage of future projects.
9. **Measure outcomes and refine the strategy**. At various points, Aurora will track metrics (like energy bills and housing prices) to evaluate success and guide program expansion, including incorporation of Metrics 1 and 2 into financing programs.

Conclusions

The metrics and comparisons presented above suggest that high-performance prefabricated housing strategies may offer pathways for communities that are looking to address barriers to achieving climate goals, rising energy costs, and accessibility of affordable housing. While some upfront construction costs for high energy performance may exceed those of conventional construction, the lower long-term energy costs and benefits of factory production present an opportunity to create total housing costs that are competitive over the lifetime of the home.

Localizing production and deployment of prefabricated homes that meet high standards for energy performance may offer a strategic opportunity for communities to effectively balance

their needs to increase the supply of affordable housing in the community with their stated objectives of reducing community-wide energy use and GHG emissions from buildings. Well-established and emerging companies are manufacturing homes that meet high standards, such as Passive House pre-certification. Local governments and community organizations are seeking to achieve affordability and sustainability goals by leveraging this type of housing.

This housing strategy offers attractive opportunities for communities, including increasing affordability by accessing economies of scale of production; standardizing production to ensure quality and efficiency; using precertification to third-party standards to streamline compliance and reduce time burdens on developers and municipal staff; and localizing manufacturing to foster local economic development. However, there are also challenges to deploying this strategy, which include challenges in ensuring affordability; obstacles to attracting local production; and poor public perception of off-site produced homes.

This research engaged producers and leading communities to gain insights on the strategies described in this paper, yet more research and in-field deployment of efficient and affordable prefabricated homes is needed to further test and refine recommendations for implementation by other communities and accelerate the deployment of this solution to address affordability and emissions reduction challenges nationally.

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AI-assisted tools used: ChatGPT.
Used for: Identifying and clarifying sources.
Extent: light editing.
Human review: The authors reviewed and verified all content, calculations, and citations.

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