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Scaling Up Off-Site Construction in Southern California

Streamlining Production of Affordable and Supportive Housing

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Executive Summary

Off-site—also referred to as industrialized—construction has grown substantially in the U.S. in the last decade. Methods for such construction can range from the use of small kits-of-parts, which seek to simplify on-site assembly with individual manufactured components, to the construction of full volumetric modules in factory facilities that are then transported to project sites. The latter method has been the primary form of modular production in the U.S. to date.

In Southern California, the high and urgent demand for housing—especially for affordable and permanent supportive housing—paired with rising costs and lengthy timelines for delivering new supply, has brought increasing interest in off-site and industrialized construction strategies. For instance, affordable and permanent supportive housing projects using off-site methods in the U.S. have seen relatively consistent reductions in total construction schedule time. Other potential benefits of off-site construction include the potential to reduce project costs, standardize energy efficient design and quality construction, and reduce material waste. The stable schedules and controlled environment of a factory setting can offer a pipeline of stable, safe, and quality employment distinct from on-site opportunities, which helps to diversify the construction workforce and improve working conditions.

This analysis documents the current landscape of off-site construction in Southern California with a focus on multifamily affordable and supportive housing, drawing on dozens of interviews with industry experts to identify barriers and opportunities related to expanding its success and adoption.

Two primary challenges need to be overcome in order to foster robust off-site production capacity:

Establishing a stable workstream:

Factory production requires a stable pipeline of projects and benefits from standardization, which can be difficult to reconcile with the uncertainty of conventional housing development.

Procuring funding for projects and companies using off-site construction:

The unconventional payment schedule and risk profiles of projects using off-site methods can make the coordination and sequencing of traditional funding sources challenging.

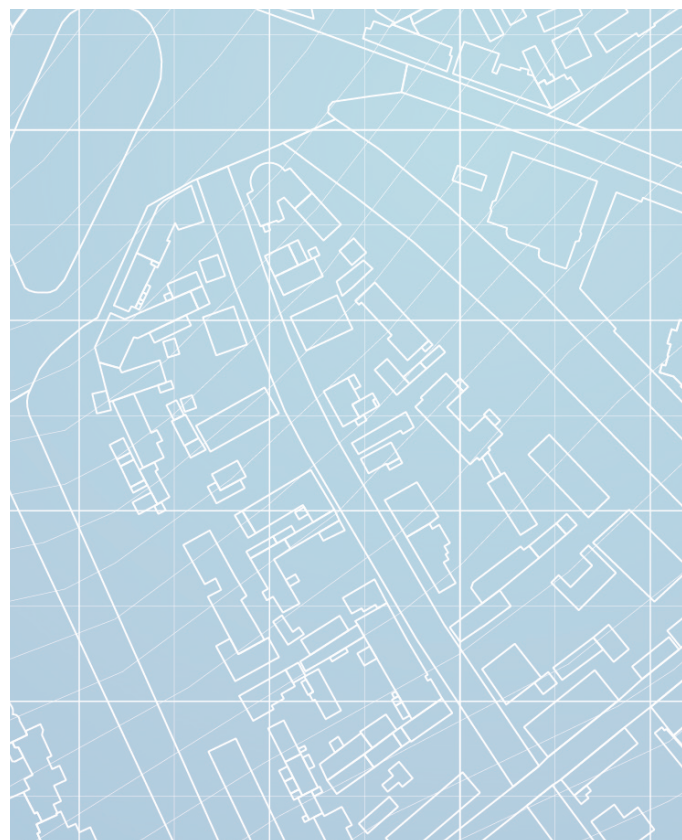
The challenges are not necessarily unique to Southern California, but they have kept the collective production capacity of off-site construction firms in the region at a relatively low level, especially for multifamily housing. Of the few projects completed in the last 10 years using off-site methods, many imported modular units from outside California.

To fulfill and expand the potential of off-site housing production, many housing industry stakeholders have important roles to play:

1. **Off-site producer** can improve consistent delivery on potential benefits to minimize project risk while promoting open learning and sharing of best practices to industry partners.
2. **Housing developers** can prioritize and accommodate off-site construction methods early on in project timelines and engage other industry stakeholders to encourage collective learning about best practices.

3. **Philanthropy and social impact capital** can offer targeted, flexible funding support for affordable housing projects using off-site production, support the workforce development efforts of off-site producers, and help researchers build the evidence base around the cost and benefits of industrialized building methods.
4. **Local government** can reduce uncertainty in permitting and approval processes for affordable housing projects in general, and improve compliance with state inspection for projects using off-site methods in particular.
5. **State government** can simplify and align fragmented funding and programming for affordable housing production in general, and explicitly incentivize projects that can make housing delivery more cost- and time-effective in funding applications.

In Southern California, where off-site construction applications for affordable multifamily housing are still relatively new, early interventions to coordinate action and collaboration among these groups (as well as others in the industry) will be critical to unlock the benefits of innovative construction methods. Catalyzing off-site housing construction *within* Southern California could localize and amplify the benefits of industrialized methods for the region in service of affordable and supportive housing development. The more familiar regional industry stakeholders and local officials become with off-site construction methods, the easier it will be to implement these methods, evaluate their true costs and benefits, and improve and expand their use.



Introduction

The U.S. has seen a recent proliferation of off-site construction strategies and producers in the past decade. In part, this growth has been driven by the promise of faster and more cost-efficient project delivery, especially in California where housing demand and construction costs continue to rise. Policymakers and practitioners in Southern California have been exploring how and where industrialized construction could help the region meet its housing needs, particularly given the ambitious production targets set by the state in the latest Regional Housing Needs Allocation (RHNA), with acute demand for affordable and supportive housing.

This analysis documents the current landscape of off-site construction and capacity in Southern California, and draws on interviews with 45 housing industry stakeholders (e.g., from lending institutions, real estate development, architecture and engineering, general contracting, off-site production, and city and state government) to document lessons learned from early projects, identify challenges in scaling up off-site production, and to highlight opportunities to better support and expand on the adoption of industrialized construction.

This brief provides an overview of anticipated and observed benefits of off-site strategies as well as the present limitations of innovative construction methods. The next section summarizes the state of the housing market as well as the policy and funding landscape for affordable and permanent supportive housing in Southern California, including an overview of prominent existing off-site producers and completed affordable housing projects. The brief then presents remaining challenges to scaling up off-site housing

production, both at the individual project level and at the company level. Finally, the report details specific steps different types of stakeholders can take to help address barriers and capitalize on opportunities and potential benefits related to off-site methods.

Off-Site Construction Background

Concept and Diversity of Off-Site Approaches

Off-site construction comprises a broad range of innovations that seek to improve the productivity and efficiency of construction by moving parts of the process to off-site locations. The controlled environment of a factory allows a company to optimize labor efficiency in the assembly processes while insulating the construction process from adverse weather conditions. The ability to produce substantial portions of a project off-site has the additional advantage of reducing certain high-skilled labor costs in many major metropolitan regions.

While the motivations to use off-site methods tend to be similar, there are generally three major categories of strategic approaches: kit-of-parts, flat-pack, and volumetric modular. Modular, though not representative of the whole of off-site construction, is the most common in the U.S.¹ But each approach has advantages and disadvantages, and Table 1 below compares the three and provides examples of each.

The categorizations above are not necessarily mutually exclusive. Volumetric modular units, which are often referred to as “boxes,” may comprise the cores of a building while the flat-pack system

Table 1. Three Strategic Approaches to Off-Site Construction

	Kit-of-parts	Flat-pack	Volumetric Modular
Description	Individual building components designed and prefabricated to be easily assembled on site	Prefabrication of larger elements like walls and floor systems to be stacked for shipping and connected on site	Full prefabrication of whole units to be shipped and craned into place on site
Common Analogies	LEGO®, K'NEX®	IKEA furniture, folding tables/chairs	Automobiles, meal kits
Advantages	<ul style="list-style-type: none"> • Allows distributed manufacturing in more traditional factory facilities • Lower capital investment required for new physical facilities • High potential for factory automation • Maximizes design flexibility 	<ul style="list-style-type: none"> • Hybrid approach balances productivity gains, capital investment, and design flexibility • Stacking components maximizing shipping efficiency 	<ul style="list-style-type: none"> • Minimizes on-site work required and total construction time • Completely controlled environment allows for full process optimization • Maximizes benefit of standardization
Disadvantages	<ul style="list-style-type: none"> • Requires sophisticated design expertise • Requires software expertise • Requires more coordination between (and increases interdependency on) external manufacturers • Requires full on-site inspection 	<ul style="list-style-type: none"> • Likely requires large upfront investment in physical facilities • Can complicate division between on- and off-site scopes of work for laborers and inspectors • Benefits are muted compared to kit-of-parts or modular approaches 	<ul style="list-style-type: none"> • Requires large upfront investment in physical facilities • Requires sophisticated manufacturing expertise • More strict site constraints • Project delays may necessitate holding area for finished units • Risk of damage during storage and transport • Lower design flexibility
Optimal Project(s)	1-2 story structures with high design variation (e.g. education, small residential)	Flexible across project types	Projects with high repeatability (e.g. multifamily housing, hotels)
Example Companies	Project Frog, OBY House	Cover, Entekra	CRATE, Guerdon, Factory OS

attaches the facade onto the building exterior; wall and floor/ceiling assemblages may be constructed off-site in flat packs while smaller interior fixtures and finishes are shipped as a kit-of-parts and pieced together on-site; the structural steel skeleton of a building may be assembled as a kit-of-parts without any on-site welding, and in a way that allows modular units to slot easily into the framing system without additional framing support. As more competitors enter the off-site construction market, the distinctions between these three approaches—and their respective limitations—may shift or disappear entirely.

Emerging Ideas

The framing above captures a high proportion of the recent growth in off-site and industrialized construction methods. However, other innovative approaches are also rapidly emerging that could have implications for broader adoption of non-traditional construction methods.

The methods presented in Table 1 primarily highlight the physical elements of industrialized construction methods. But innovative approaches to the software behind the building industry are also being developed. One example is the use of parametric modeling and generative design tools, which allows architects and other collaborators to input the physical constraints of a site—such as lot geometry and zoning limitations—into a digital design tool to generate thousands of hypothetical building layouts that optimize for features like in-unit daylighting or energy efficiency. They can then tweak the inputs and outputs of the tool to design by rapid iteration rather than starting from scratch on every project. Advanced design tools and more sophisticated digital modeling could also support more automated assembly.

For instance, a detailed 3D model could integrate well with machine-assisted manufacturing technology and processes in a way that reduces dependency on manual assembly.

Digital design tools could also provide new means of engaging non-professionals in the design and development process. Some firms—including Toronto-based Sidewalk Labs (a subsidiary of Alphabet Inc.) and U.K.-based Bryden Wood—have piloted digital design platforms to accomplish this. By combining their modeling tool with user-friendly interfaces, Bryden Wood hosted a workshop in which primary school students adjusted to a digital model of their school building as a means of brainstorming renovation ideas. Another company in the U.K., WikiHouse, is developing an open-source online tool and building system to share, customize, and order home designs, shipped as building kits, which can then be assembled by unskilled labor with minimal tools required on-site. The entire process is intended to enable individuals to access quality design and construction without involving traditional building industry professionals.

In addition to the growth in digital tools, several firms are exploring the potential to achieve many of the advantages of industrialized construction without the “off”-site component. 3D printing, for example, allows for rapid on-site production of buildings, dramatically reducing the amount of on-site labor required. Companies pursuing this in the U.S. include ICON, Mighty Buildings, and Black Buffalo, with different approaches and market applications. Though the cost implications and feasibility for multistory construction of 3D printing remain unclear, the technology opens new avenues for creative

Table 2. Progress Towards Key Benefits of Off-Site Construction

Benefit	Description	Status/Progress
Time Savings	Parallel work on- and off-site and higher labor productivity in factory environment	<p>Realized</p> <p>The majority of projects expect 10-30 percent reduction in construction schedule (from breaking ground to occupancy). Stakeholders emphasized the importance of designing for off-site methods and involving off-site partners early in the project to maximize time saving benefits.</p>
Worker Safety	Lower risk in factory environment compared to on-site work, especially for fall hazards	<p>Realized, but more evidence needed</p> <p>Stakeholders expressed anecdotal evidence and high degree of confidence in the safer working conditions of off-site facilities, but more comprehensive research is needed to confirm and measure this impact.</p>
Cost Savings	Primarily from time savings (reducing carrying costs and generating revenue sooner), with added benefit from higher labor productivity and material efficiency	<p>Inconsistent but promising</p> <p>Multiple projects did see cost savings, but results have been mixed and detailed comparative analyses are difficult. Most respondents estimated relative parity in the costs of off-site methods and site-built approaches, with others estimating savings in the range of 10-20 percent compared to traditional construction methods. Many emphasized cost saving potential in maximizing repeatability between projects (e.g. via standardized unit designs), but this has not yet been achieved at scale</p>
Construction Quality Improvement	Controlled factory setting allows for consistent QA/QC procedures	<p>Inconsistent but promising</p> <p>Several stakeholders reported improvements in finish details and from improved thermal and sound insulation, due in part to double floor/ceiling height of stacked modules. Early adopters cited quality issues, partially from damage during transport, which required rework and caused project delays. The majority of those interviewed believed that quality would improve as off-site producers gain experience.</p>
Sustainability	Reduced material waste, better insulation, and increased energy efficiency from tighter building envelope	<p>Promising</p> <p>Research suggests off-site methods can reduce material waste and efficiently incorporate sustainable design features, but more long-term studies are needed.³</p>
Economic/ Workforce Development	Ecosystem of high-quality employment opportunities in- and outside the factory	<p>Promising</p> <p>Many stakeholders cited this as an important component and advantage of scaling up off-site methods, especially within regions of high housing demand. This held true among producers planning for in-factory automation.</p>

architectural forms that would be difficult to construct through conventional, manual means.

These and other innovations will likely continue to grow and emerge in step with professional expertise and experimentation across the industry.

Status and Progress of Off-Site Methods in the U.S.

The concepts and motivation behind off-site construction are not new, but the last decade has seen substantial increase in the number of companies pursuing these methods in the U.S., which has led to significant lessons learned.² Beyond time and cost savings, industrialized construction has shown the potential to improve both building quality and safety in the workplace, while reducing the environmental impact of new housing. However, the variation in approaches and priorities among companies and the myriad of context-specific differences across projects and geographies make a summary of collective progress challenging. Table 2 below summarizes the results of dozens of interviews with off-site construction professionals on their view of the industry and its qualitative progress toward realizing the perceived benefits of off-site construction.

The stakeholders interviewed for this report regarded the prevalence and promise of off-site and industrialized construction methods with general optimism. This was true even for those with experience on projects in which none of the purported benefits of off-site methods were realized. They frequently emphasized that lessons were learned “for next time,” and most of the developers interviewed were actively considering off-site methods for future projects.

Limitations

Even with the observed and expected benefits of off-site and industrialized construction techniques, implementation still faces important limitations.

Real estate development is not like an assembly line. The inherently unpredictable nature of the real estate industry in its current form, characterized by complex, fragmented stakeholder networks and a project-focused work cycle that is vulnerable to frequent delays and downtime, is at odds with the continuous workflow of ideal factory production. Taking full advantage of off-site methods will require a cultural shift to embrace new approaches in a broadly risk-averse and conservative industry, potentially creating friction with the entrenched interests of conventional business models and practices. The scale of housing demand—combined with changes to housing development that improve the reliability and consistency of project delivery (such as ministerial approvals and long-term supplier partnerships)—may reduce the impact of this misalignment.

Variable site conditions make full standardization difficult. Housing demand tends to be highest in dense metropolitan areas, where urban infill projects stand to benefit the most from time and cost savings. However, infill locations can also be the sites with complex and unique constraints: lot geometry may be irregular, local zoning codes include maximum height constraints and minimum setbacks that restrict building area, modular methods may require large staging areas for construction cranes, and unpredictable soil conditions can create numerous complications. These constraints restrict the developer’s ability to fully standardize

and replicate designs and procedures across projects, though the limitation is less pronounced for methods that allow for more flexibility and adaptability in design and assembly.

Evolving knowledge and improvements in off-site and industrialized construction techniques may mitigate or address the above shortcomings over time. Even so, the success already exhibited by these methods amidst their recent growth implies that they can be effective tools to increase the supply of housing.

Housing Dynamics in Southern California

Procedural and technological advances have paved the way for the recent growth of off-site construction methods in Southern California. A primary driver of interest in these practices is in the housing affordability crisis decades in the making.

The following section contextualizes the chronic under-supply of housing that has motivated the growth in factory-built housing.

The Need for More Housing

Years of sustained increases in housing demand in Southern California remain unmet by new supply. The effects of this shortage include rising rents and—as wages have failed to keep pace with rising housing costs—increasing rent burdens. In 2019, more than 1.2 million renter households in Southern California (over 40 percent of all renter households in the region) were rent-burdened, meaning they spent at least 30 percent of their income on housing costs, which can make it difficult for households to meet other basic needs such as transportation, food, and health care.⁴

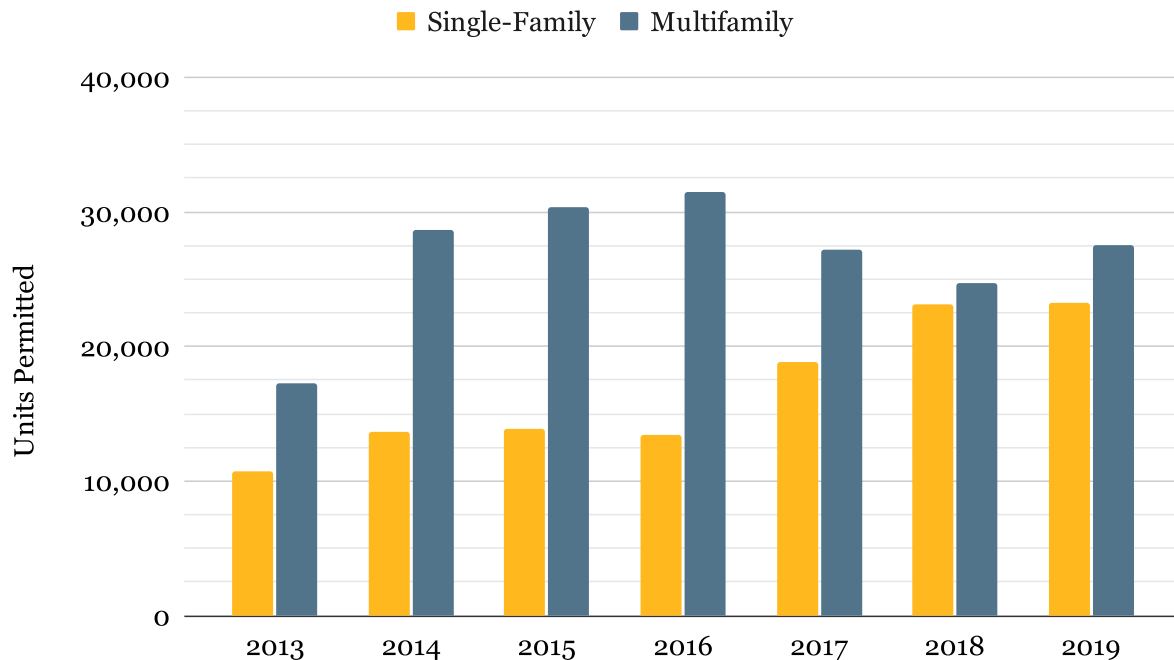
Figure 1 shows the number of renter households broken out by income level,

Figure 1: Number of Tenants Experiencing Rent Burden by Income in Southern California Counties, 2019



Source: American Community Survey 5-year estimates for 2019, Table B25074. Rent-burden refers to households spending more than 30 percent of their income on rent.

Figure 2: Permitted Housing Units in Southern California by Building Type, 2013-2019



Source: CA-HCD Open Data Annual Progress Report Dashboard, retrieved 4/26/2021

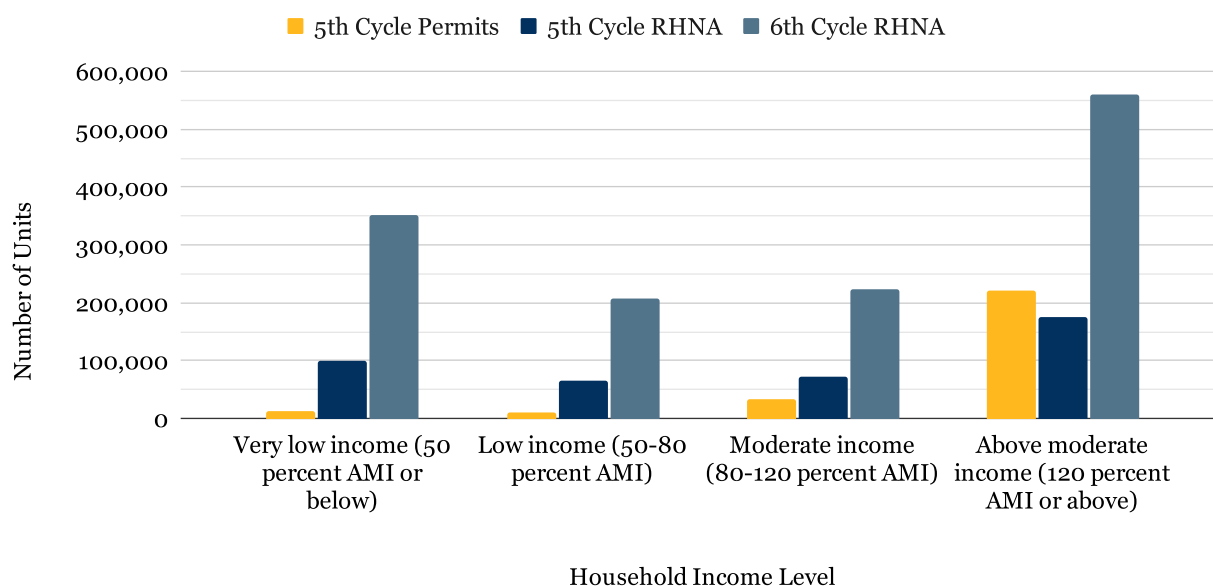
including those who are cost-burdened for the six counties that comprise the region: Imperial, Los Angeles, Orange, Riverside, San Bernardino, and Ventura, as represented by the Southern California Association of Governments (SCAG). Just 14 percent of renters making at least \$75,000 a year face rent burdens compared to 54 percent of renter households earning \$50,000 to \$75,000. Shares climb even higher as incomes diminish, with nearly every renter household earning less than \$10,000 experiencing rent burden.

Amid increasing affordability challenges, the Southern California region has also experienced pronounced increases in homelessness. Despite successful efforts to place more than 22,000 individuals in permanent housing in 2019 in LA County, the number of people experiencing homelessness increased by more than 10 percent in the two most recent point-in-time counts.⁵ In the most recent

count, conducted in 2020 (the 2021 count was canceled due to the ongoing pandemic), more than 85,000 individuals were experiencing homelessness in Southern California, more than half of whom were people of color.⁶ More than two thirds of these individuals captured in the count were unsheltered, meaning not served nightly by local emergency shelters or transitional housing facilities. While emergency shelters and other accommodations have increased in number during the pandemic, the financial impacts of the pandemic have also put many renters at higher risk of experiencing cost burdens and homelessness, especially as federal aid has been slow to roll out and federal and local eviction moratoriums have expired.⁷

Housing production in Southern California, especially housing affordable to low-income households, has continued to fall short of the targets set for the region through California's Regional Housing

Figure 3. Permitted Units in Southern California Against 5th and 6th Cycle RHNA



Source: CA-HCD Open Data Annual Progress Report Dashboard, retrieved 4/26/2021

Needs Allocation (RHNA) process. The 5th RHNA cycle—which ended in October of 2021—called for more than 400,000 units of new housing across Southern California. In the years leading up to the pandemic (the impacts of which on construction are still unclear), only 45,000-50,000 were permitted each year, meaning just two thirds of the region’s target was met by April of 2020 (nearly 90 percent through the current cycle).

The majority of permitted units in Southern California continue to be in multifamily buildings, though the permitting of single-family units grew considerably from 2016 to 2019 (Figure 2). This partially reflects the uptick in construction of accessory dwelling units (ADUs), with more than 7,000 ADUs built in 2019 alone, though the specific methods for calculating how ADUs contribute towards RHNA totals vary across jurisdictions. The growth of ADUs is likely to continue due to statewide legislation passed in 2020 that allows ADUs by-right in all single-family

lots, regardless of existing local zoning restrictions.⁸ However, while there is early evidence suggesting that ADUs provide more naturally affordable units than traditional single-family development, ADU growth alone would not be sufficient to overcome the region’s supply deficit. Expanding multifamily housing development will remain critical, especially given the more ambitious targets set in the 6th RHNA cycle.⁹

The 6th RHNA cycle increases the eight-year goal for Southern California to more than 1.3 million total units from 2021 to 2029, or more than triple the previous cycle’s target. Meeting that goal will require an average production rate of over 167,000 units per year, a 329 percent increase from the number of permits issued in 2019. The new targets will be challenging to attain without intervention and innovation in the policies, funding mechanisms, and methods of delivery to increase housing supply.

For a detailed overview of the current policy and funding landscape that shapes affordable housing production in California—and which impacts decision making around off-site methods and the extent to which their benefits are realized—see the appendix.

Off-Site Construction in Southern California

Southern California's off-site housing construction industry is growing but still relatively new. The following sections provide a high-level overview of modular housing projects completed and in the development pipeline in Southern California as well as the existing factory-built housing firms and their collective production capacity. A brief assessment of the early experiences and lessons from these projects follows, drawing on practitioner feedback gathered during interviews.

Company Scan

Off-site housing production in Southern California is less common than in Northern California. Table 3 highlights and compares the strategic approach and order of magnitude of completed units for the existing companies located in the region.

Of the three producers listed with completed multifamily projects, only USModular, Inc. and CRATE have experience with affordable or permanent supportive housing projects. Both USModular, Inc. and Silver Creek specialize in single-family homes, but shifted their process in recent years to be able to build modular multifamily projects. Several of the firms prioritizing the single-family

housing and ADU market have the stated capacity for multifamily projects as well, but it is unclear if they will make use of that capacity given the strength of the single-family home market in Southern California (as shown in Figure 2).

Each company's production depends on a variety of factors and can be difficult to quantify, but the firms in Southern California have a combined capacity to construct several hundred housing units per year across all segments. In addition, extensive capacity exists in firms located outside of the region. The following section provides examples of projects that have been completed in Southern California that have drawn on that extra-regional capacity, by transporting units built elsewhere in the U.S. and abroad.

Off-Site Construction Adoption and Outlook

A scan of off-site housing production in the region and dozens of stakeholder interviews yielded the following findings about the current state of the industry in Southern California.

Only a few *completed* affordable housing projects have used off-site construction methods in Southern California. The first was a 100-unit permanent supportive housing project—Star Apartments—developed by Skid Row Housing Trust in 2013. They partnered with Idaho-based Guerdon Modular for the units. Due to inexperience with alternative delivery methods and an unclear division of work between the modular producer and general contractor, the project experienced project delays and respective cost increases. The challenges

Table 3: Overview of Off-Site Housing Producers for Southern California

Company	Factory Location (County)	Approach	Units Built in Southern California
Multifamily Market			
CRATE	Carson (LA County)	Modular	100+
Silver Creek	Perris (Riverside)	Modular	100+
Single-Family and ADU Market			
Cutting Edge Homes	El Cajon (San Diego)	Modular	20+
Ma Williams	Hemet (Riverside)	Modular	
Plant Prefab	Rialto (San Bernardino)	Modular	10+
Cover	Los Angeles	Modular	Under 10
Proto Homes	Los Angeles	Kit of parts	Under 10
Both Markets			
US Modular, Inc.	Redlands (San Bernardino)	Modular	200+

Information sourced from publicly available data on company websites

and lessons from the development left some stakeholders in the Southern California housing field averse to pursuing off-site projects in the immediate aftermath. However, off-site production seems to have recovered in recent years with at least a dozen modular multifamily projects completed or planned in the region. Stakeholders reported that, due to high housing demand and high prevailing wages, there is a high concentration of projects in the County of Los Angeles compared to other jurisdictions in Southern California.

Southern California has limited but growing local capacity for off-site multifamily housing production. Within the state, most off-site producers are located or have prioritized development in Northern rather than Southern California. As a result of this dearth of factories and producers in the region, several of the completed and planned housing projects to adopt industrialized construction methods in Southern California have outsourced the off-site components from outside of the region. Three

affordable and supportive housing projects used refurbished shipping container modules from CRATE, based in Carson, CA, and another project sourced units from USModular, Inc., based in Redlands, CA. But the other off-site projects in the region—at least two completed and at least a dozen under development—used modules from Northern California, Idaho, and China. The Skid Row Housing Trust project used modules from Guerdon in Idaho,¹⁰ and Hope on Alvarado, developed by Aedis Real Estate Group, used modules from China.¹¹ Aedis has two other projects under development intending to use Chinese modular producers as well. Factory OS, with a factory in Vallejo, has four confirmed projects in Southern California for Abode Communities, Mercy Housing, and LA Family Housing, with over 300 combined units and upwards of several hundred more in the pipeline. Lastly, Daylight Communities Development has three modular projects in partnership with Idaho-based IndieDwell, the same state in which The Pacific Companies produces its own modules.

Two of the local off-site producers announced plans to expand their capacity and capabilities: CRATE plans to be able to fabricate steel frame modules in addition to refurbished shipping containers, while Plant Prefab plans to incorporate two additional factory facilities into its Southern California portfolio in the next two years, with the latter focused on enabling enhanced automation.¹²

Early use of off-site methods in Southern California have favored modular approaches. Providers and developers reported being motivated by maximizing the potential optimization and productivity gains from fully volumetric modular strategies. The nearby

Port of Los Angeles and Port of Long Beach have allowed developers to access the existing manufacturing sophistication and capacity of international producers. Few established producers utilize kit-of-parts or flat-pack approaches to serve the multifamily housing market in the U.S., limiting their adoption by affordable housing developers.

Completed projects report faster delivery and marginal cost savings.

Though it is difficult to generalize results for a small number of affordable housing projects using off-site methods, at least four built since 2018 claimed 10-30 percent reductions in their construction schedules. In line with the status of the industrialized construction market at large, some projects reported cost savings due both to the time savings as well as in material and labor efficiency. Several stakeholders said that they expect cost savings will be more regularly achievable as adoption—as well as familiarity and experience with off-site technologies and processes—grows.

Several affordable housing developers reported that they are increasingly considering and pursuing off-site methods. Many affordable and supportive housing developers operating in Southern California—including but not limited to Abode Communities, Skid Row Housing Trust, Daylight Communities Development, Flyaway Homes, and The Pacific Companies—have at least 2,000 units in their combined Southern California pipeline, nearly half of which are being planned for off-site, modular production.¹³ While plans may change as development progresses, the explicit intentions to use off-site construction for their projects seems emblematic of the general optimism among stakeholders interviewed.

Challenges, Opportunities, and Roles to Play

In the U.S. in general and Southern California in particular, off-site construction has a number of challenges to achieve the scale and the full potential benefits of alternative delivery methods. Table 4 summarizes the remaining barriers by the scale of the challenge in approximate order of descending importance.

Many of the barriers are not exclusive to projects utilizing industrialized methods. Uncertainty created by fragmented processes and stakeholder relationships can disrupt any housing project (affordable or otherwise). But these challenges create additional stress for those using off-site factory production that relies on predictable timelines for construction and delivery. Consistent success with off-site methods will depend on overcoming the challenges listed below.

Establishing a stable workstream emerged in interviews as the most important challenge to off-site construction. A stable workstream was identified by stakeholders as a broad obstacle from which most other challenges flow. Real estate development does not conform to the type of standardization that typifies most factory production, making a stable workstream one of the most intractable of the four challenges listed. But changes to housing development *can* make the process more predictable and consistent.

Change requires looking beyond the scope of individual projects and outside the control of an individual company. It demands a concerted and coordinated effort from the broad ecosystem of stakeholders in the delivery of affordable and supportive housing. An initial framework for strategic interventions, categorized by challenge area and stakeholder group, is provided in Table 5 below. It is not an all-inclusive list of stakeholders nor of potential interventions; instead it highlights those organizations with distinct and significant roles to play in the catalyzation of off-site construction for affordable housing. This overview is followed by a series of more specific suggestions for each stakeholder group.



Table 4. Challenges to Off-Site Construction

Challenge	Project Level	Company Level	Policy Level
Stable Work-stream	<ul style="list-style-type: none"> • Unpredictable on-site timelines • Right-sizing project scale to realize benefits of standardization and repeatability • Minimizing change orders to design 	<ul style="list-style-type: none"> • Minimizing domino effect of delays • Securing strong project pipeline • Achieving repeatability across projects 	<ul style="list-style-type: none"> • Uncertainty in entitlement, permitting, and approval processes
Funding	<ul style="list-style-type: none"> • Upfront deposit required to start production • Stringent bonding/insurance requirements 	<ul style="list-style-type: none"> • Startup capital for facilities investment • Covering operational costs • Satisfying conventional lender requirements for liquidity and cash flow 	<ul style="list-style-type: none"> • Misaligned funding source and program requirements • Coordinating multiple funding sources
Workforce Development	<ul style="list-style-type: none"> • On-site assembly may require specialized labor • Reduced scope of work for on-site trades 	<ul style="list-style-type: none"> • Minimizing factory down-time • Relationships with local construction trades 	
Education and Experience	<ul style="list-style-type: none"> • Stakeholders unfamiliar with off-site delivery methods 	<ul style="list-style-type: none"> • Establishing developer relationships in early project phases • Achieving potential benefits <i>consistently</i> 	<ul style="list-style-type: none"> • Unclear division between local and state review and inspection

Table 5. Opportunities and Roles to Play in Off-Site Construction

Challenge	Off-Site Producers	Housing Developers	Philanthropy and Social Impact Capital	Local Government	State Government
Stable Workstream	Establish strong pipeline, improve performance and maximize repeatability within and across projects	Prioritize off-site methods early in project and minimize changes after design completion	Consider offering funding backstop for off-site projects in case of delays	Minimize time required and uncertainty in entitlement, permitting, and inspection processes	Improve clarity and compliance between state and local scopes of review for off-site projects
Funding	Reduce costs and minimize risk of off-site production methods	Work with lenders to align funds with unique nature of off-site construction financing	Encourage innovative approaches with flexible financing support	Reduce and/or align regulations attached to different housing funds	Reduce and/or align regulations attached to different housing funds
Workforce and Economic Development	Pursue opportunities to maximize quality of employment	Consider local off-site production when feasible	Coordinate and foster collaboration between existing W/ED programs and off-site methods	Consider utilizing W/ED funds to support and expand local off-site production capacity	Consider utilizing W/ED funds to support skills training for off-site production
Education and Experience	Openly engage external stakeholders to promote cross-sector learning	Consider long-term, multi-project partnerships with other stakeholders	Foster collaboration and promote knowledge sharing for best practices	Improve compliance with state guidance on reduced local review scope for off-site projects	Continue outreach and improve clarity on local review scope for off-site projects

OFF-SITE PRODUCERS

Stable Workstream

For industrialized construction manufacturers, industry experts reported that securing 1-2 years of work in a factory's pipeline is an important goal, both to stabilize production and to earn the confidence of external partners. Companies can deploy several strategies to generate a consistent stream of demand.

Minimize downtime in factory operations. This is one of the most important elements for off-site construction firms (with their own factory facilities). Shutting down a factory even for a short period—due to gaps of work between projects or delays in on-site work—can debilitate a company through the loss of specialized labor and the need to re-hire (or re-train new) employees after restarting the factory. Risk management practices such as including buffer time in schedule estimation must be balanced in tandem with the need to “keep the lights on.” Activities like organizing cross-training (between different assembly tasks) for in-factory labor and conducting new unit and assembly prototyping can fill what would otherwise be gaps in production.

Create and enforce reliable quality assurance and quality control mechanisms in factory production and on-site coordination. Industrialized methods enable consistent, stringent internal mechanisms for ensuring in-factory components are built to a high minimum standard. Rigorous standard practices should further ensure the adequate protection of modules or components to avoid damage during transport to project sites, as well as after modules are

installed but interiors may be vulnerable to weather damage. In the short-term, it minimizes any repairs and re-work required after units are assembled on-site, as well as related project delays. The long-term benefits include reinforcing trust in individual companies and off-site methods overall by improving as-built construction quality. This improves both public and professional perception of off-site construction.

Generate separate plans for local and state review scopes. California's Department of Housing and Community Development (HCD) conducts in-factory inspections for housing units produced off-site—including outside of the state—to ensure they meet building codes and quality standards while being assembled. This eliminates the need for on-site inspections that would otherwise undo work completed in the factory, such as opening up sealed walls to confirm insulation installation. In collaboration with the project architects, off-site producers should separate the scopes for in-factory (state) and on-site (local) design review and inspection by creating two separate plans for each, visibly “greying out” out-of-scope elements. This can minimize confusion and delays in the respective permitting processes and clarify the differences in scope for other project team members as well. For example, general contractors (that are responsible for planning on-site activities) would benefit from having a firm understanding of where the factory scope ends and the on-site work begins in the construction plans.

Reserve a holding area near project sites or at the factory for completed modules/components. As one interviewee described, reserving such an area ensures that “factory products have some-

where to go”, rather than halting production if the project site is not prepared to receive and install the components.

Consider offering standardized products to increase repetition between projects. Investing the upfront time and effort into a unit or units designed intentionally for efficient factory production allows an off-site manufacturer to optimize their market fit. It also improves the consistency of quality design and construction. Offering ready-to-deliver units for small project types such as ADUs might help fill gaps in the production pipeline and avoid shutdowns in factory production. In a multifamily market, standardized unit (or even full building) layouts could minimize the lead time on projects by streamlining design and permitting without compromising on design and build quality

Pursue long-term partnerships with external stakeholders. Upstream, this could include suppliers of raw materials or even products like pre-packaged bathroom “pods” that are designed specifically to integrate with factory production. The need for continuous resource flow in off-site methods incentivizes long-term contracts, potentially reducing material costs while prioritizing consistent performance (like timely delivery of high-quality materials) beyond the scope of an individual project. Downstream, multi-project agreements with housing developers could similarly incentivize collaboration while establishing a steady pipeline of work for off-site producers. Bundling projects together also helps achieve the benefits of scale often required for modular methods to deliver time and cost savings.

Target multiple markets to insulate against downturns. Targeting markets can be challenging because factory production processes often cater to specific unit or product types. But taking advantage of markets that require overlapping factory capabilities can be beneficial. For instance, a facility able to produce large, single-unit modules for multifamily buildings may also be able to serve commercial hotel projects as well as single-family housing markets. Smaller projects like single-family homes and ADUs could make use of production gaps in between (or in the buffer time of) more substantial projects. Some industry experts interviewed also mentioned the potential value modular methods could offer in producing rapidly deployable, permanent replacements to disaster response shelters. The alternative product lines can help maintain factory production if larger projects are delayed by on-site factors or if they produce ahead of schedule, leaving additional time before the next project begins. Focusing on relationships with affordable and supportive housing developers can help as well, but a factory competent in multiple markets will be even more secure in the event of a downturn in one or more market segments.

Consider a distributed manufacturing (e.g. kit-of-parts) approach to minimize risk and sensitivity to delays. For new firms pursuing off-site methods, procuring and holding large assets such as factory facilities for modular production increases the amount of startup capital required and risk involved. Pursuing more component-based offerings such as a kit-of-parts or a panelized flat-pack approach could be more appropriate for smaller projects and make it easier to find and use existing manufacturing capacity. While this comes with its own challenges, it reduces the company’s

operating and holding costs and thus its sensitivity to short-term project delays, effectively lowering the critical dependency on a stable workstream altogether.

Funding

Prioritize the reduction in the cost of constructing housing. Off-site construction can succeed without necessarily reducing the cost of building. But lowering per-unit costs could make project financing for affordable housing easier by lowering the amount needed to deliver housing in the first place. Through the time savings of parallel on- and off-site workflows, as well as higher labor and material efficiency, industrialized construction methods could lower the cost of new housing construction by 5 to 20 percent according to industry experts. More significant reductions depend on maximizing replicability across projects, such as through standardized unit or building layouts. However, off-site producers must choose to pass construction cost savings through to their clients. If achieved, off-site methods could effectively stretch housing funds by producing more units for the same amount of public subsidy.

Standardize insurance and bonding policies to satisfy conventional lenders. Bonding requirements from traditional lending institutions can be difficult for new off-site manufacturing companies to meet, but obstacles can be mitigated by firms that standardize their insurance policies to functionally fulfill the policies of existing funding sources. Furthermore, based on the likely lower risks of injury both for factory laborers as well as for on-site laborers that spend less time on an active site, industrialized housing producers could pursue reduced project insurance premiums to decrease costs.

Workforce Development

Industrialized construction firms can not only benefit from enhancing their appeal and capacity as a workforce development catalyst, but they can also serve their own need for more workers at an industry-wide scale. A survey of modular industry practitioners conducted by researchers at the University of Missouri in 2020 found that the most impactful risk factor for modular construction projects was the “shortage of skilled and experienced laborers”.¹⁴ This was reported among fifty predefined risk factors to have the *most* influence on schedule and cost performance for projects. Off-site producers that prioritize workforce development can help catalyze the growth of a dynamic network of supportive industry knowledge and labor in Southern California.

Ensure fair wages and reasonable benefits to employees. At a basic level, this includes benefits like medical and dental coverage, vacation, sick, parental leave, and regular incremental pay increases. But off-site firms can adopt less common practices for the construction industry, like offering on-site child-care services and optional meals. These elements can improve the appeal of off-site production to prospective employees and reinforce the reciprocal benefit they receive from staying at and growing within the company.

Partner with building trades and other labor organizations. Many of the skills required for high-quality factory production are shared with the building industry at large. One interviewee encouraged off-site producers to “tap into the recruitment and training capacity offered by very established building trades.” The segmented repetition offered by factory processes can even integrate with a labor

union's existing training regimen for apprentices who seek to gain condensed experience in a variety of common construction tasks and tools. Whether individual laborers prefer in-factory work or move on to more advanced on-site tasks, off-site producers can collaborate with labor organizations rather than compete with them to expand the breadth and quality of employment in the construction industry more broadly.

Partner with organizations that support workforce development for underrepresented demographics.

Organizations that focus on hiring opportunities for individuals who are formerly incarcerated, community-focused groups that support historically underserved neighborhoods with high BIPOC populations, and programs that aim to expand female representation in male-dominated fields are potential partners in diversifying the off-site industry workforce. Even without these partnerships and goals made explicit, several interviewees believed anecdotally that off-site housing production in the U.S. is already attracting more diversity in the workforce. One respondent cited this as true “both in the office and on the factory floor.” Industrialized housing manufacturers should expand on this momentum to take advantage of existing pipelines of capable employees, thus reducing the resources they need for hiring and outreach while unlocking the potential to pursue workforce development funding reserved for disadvantaged groups. Managing the installation of components or modules on-site is one piece of the off-site workflow that lends itself to small crews, which are more likely than large firms to be led by individuals from underrepresented demographics and to meet local hiring requirements that are often attached to projects receiving public subsidy.

Offer cross-training and skills development for employees in advanced construction technology and processes. Even for relatively simple factory facilities, there are considerable opportunities for exposure to and training in digital software tools, advanced manufacturing operations in technical and managerial capacities, and other modern skills. More advanced factories equipped with robotics and automation do not eliminate the need for labor, but instead demand a differently skilled labor force to operate and maintain those machines. The range of industrialized methods applied to the construction industry can serve as a productive stepping stone for employees seeking upward professional mobility in a variety of pathways.

Education and Experience

Proactively engage with external stakeholders. This should not only apply to immediate clients like developers. Manufacturers could also pursue outreach and education in the form of regular public tours inviting architects, general contractors, union representatives, local planning and building department staff, researchers, and even other off-site producers. Efforts to broadly improve familiarity and comfort with off-site construction methods can dispel misconceptions and increase confidence in innovative approaches.

Encourage research and case studies. Open calls for research collaborations on the measurable impacts of off-site methods can proliferate collective learning and knowledge sharing to the benefit of the entire industry. The more certainty around alternative delivery methods (even if empirical project outcomes fall short of best-case scenario potential), the more confidence and comfort investors and other critical stakeholders will have in providing support.

Pursue long-term partnerships with other stakeholder groups. Strategic partnerships can promote stability in project team workflows and ensure information feedback loops continuously improve project practices and outcomes. Partnerships can happen upstream of factory production through supply chain relationships as well as downstream through housing developers, architects, and general contractors. Establishing best practices for off-site construction with a trusted core team is likely easier than starting anew for each project. Similar benefits could be achieved by vertically integrating business functions, such as maintaining self-developing capabilities as well as factory production; however, this requires a higher degree of consolidation of technical expertise (which can be difficult for a new firm).

Prioritize continuous process improvement into business and factory operations. One of the key advantages to off-site methods is the ability to embed the lessons learned from each project into the factory production itself. Industrialized housing manufacturers can maximize the feedback loops between each phase of development (such as design, assembly, installation, and occupancy) to continuously improve on outcomes. Each iterative standardized unit layout, for example, can be refined and improved upon from project to project, and the benefits of each improvement can be passed forward. In this way, the layered institutional knowledge of an experienced off-site production firm is built into the process, rather than only the individuals and projects themselves.

Consider partnerships with labor unions and other organizations to improve industry outreach and support scaling. Feedback from local professionals suggests that, though friction between building trades, affordable housing developers, and industrialized construction firms does occur, such friction has not been a significant problem in Southern California. The lack of evidence of friction may be because of the low prevalence of off-site methods in the region so far. The building trades unions as well as organizations such as community colleges offer resources and capacity to promote skills development for off-site housing producers that pursue partnerships in earnest. The carpenters union, for example, has a large training facility in Las Vegas for factory-based construction activities. Firms able to utilize this skilled labor pipeline can minimize the challenges of training in-factory and in-office labor.

DEVELOPERS

Stable Workstream

Though housing developers are not in direct control of factory production, they play an important role in ensuring a stable workstream for off-site manufacturers. Developers depend upon this stability to reap the benefits to their project(s).

Design for off-site production from the start. Even before choosing to utilize off-site methods with certainty, a developer could instruct the architect to design the project with off-site production in mind. For modular approaches, this typically entails designing the building as a composition of modules according to the maximum physical dimensions determined either by factory limitations or shipping constraints. For kit-of-parts or flat-pack producers, the overall project design may have less geometric constraints, but the approach may depend on software tools used by the manufacturing partner to translate between design and factory plans. In all cases, starting with the intent to develop using off-site methods allows developers to take advantage of the potential benefits of doing so if they follow through, while retaining the option to revert to conventional, stick-built construction methods with minimal negative impact. Changing the intended construction method in the *reverse* order, however (from conventional, stick-built methods to off-site), is more difficult.

Engage off-site producers early in the project(s). In addition to designing for off-site methods more broadly, involving an industrialized manufacturing partner early is key. The earlier an off-site

producer can be engaged—including before entitlements, in some cases—the sooner their facility-specific capabilities and constraints can inform the project scope, design, and delivery phasing. That information allows project teams to anticipate any potential complications and prepare for them before they cause costly design changes or project delays.

Prioritize site selection for off-site methods and eligibility for streamlined permitting and approval processes. When possible, optimizing site choice based on simple metrics like amenable (i.e. rectangular) site geometry, level ground, and ample construction staging area can make off-site methods—especially modular—more feasible by default. Furthermore, looking for sites eligible for streamlined approval processes (such as those fitting Los Angeles’s transit-oriented Measure JJJ criteria) can amplify the potential time and cost benefits available via industrialized construction.

Lock in design decisions early and minimize change orders. Changes to the design can affect the expected schedule and cost estimates on any project, but they are especially detrimental to projects utilizing factory construction. Every unanticipated alteration reduces the ability of off-site manufacturers to meet original performance metrics. In some cases, alterations can be addressed by strict developer discipline, but many design changes may come as an outcome of local inspections. Though the latter changes are not directly in control of the project team, developers should be sure to involve the local government authorities early on and before design completion, in order to minimize changes in later project phases.

Use standardized unit layouts and minimize layout variety. The less variation in design and assembly between units and projects, the better the likely performance benefits achievable by industrialized methods. This is particularly salient for project types that offer consistency and self-containment between individual units, such as predominantly studio-based permanent supportive housing projects. Developers that anchor their projects and business models to the capabilities of off-site housing producers can maximize the positive outcomes.

Partner with off-site producers (and other project team members) for multiple projects. Bundling multiple projects together can help developers that target multifamily projects (especially those under 100 units) meet the unit scale at which off-site methods offer the most benefit. Such arrangements can also help team members become more familiar and comfortable with off-site methods. The collective commitment to positive outcomes over multiple projects can foster cooperation and allow the core team (of individuals and companies) to build competency, learn from early mistakes, and take advantage of that learning in subsequent efforts. This could lead to faster and more reliable fulfillment of the potential benefits of off-site construction than approaching each project—and project *team*—from scratch.

Funding

Be flexible with upfront deposit requirements. Developers could work with lending partners (including public sources like local jurisdictions) to expand the list of eligible uses of funds to include upfront deposits for off-site construction.

This may be more feasible for affordable and supportive housing developers that have long-standing relationships, trust, and shared values with lenders who are more willing to be flexible on lending constraints. Developers could also provide temporary gap financing using their own reserves to move projects forward before substituting for traditional lending options, though this does introduce risk to the developer.

Workforce Development

Utilize local off-site producers when and where feasible. This is dependent on the existence and timely availability of local factory-built housing capacity, which is currently somewhat limited in Southern California. Even when there is capacity, the timeline of a specific housing project may not align with the opening of the local factory—especially if the project is relying on the simultaneous alignment of multiple disparate funding sources (which is more common for publicly subsidized projects). When possible, however, taking advantage of nearby production can ensure the positive potential workforce development benefits of off-site methods accrue locally. Additionally, it increases the likelihood that the extended partnerships supporting that local production—including that which is potentially provided by on-site installation crews, transportation of building components, and other services—foster a self-reinforcing network of quality employment in the region. Doing so also offers an opportunity for architects, contractors, and even local government officials to visit the factory and increase the collective familiarity and trust in off-site construction processes.

Education and Experience

Conduct thorough public outreach and education early and throughout projects. Projects using off-site production minimize local disruption and noise pollution due to the reduced time of on-site activities compared to those built with conventional means. However, fears of rapid neighborhood change, combined with misconceptions surrounding off-site methods and affordable housing can add friction to projects if developers do not proactively engage the public throughout the development process. It is important to note that this does not entail local control, especially for projects eligible for streamlined procedures (which is increasingly the case for affordable housing projects). But establishing and continuing informative and constructive conversation with existing residents could nonetheless mitigate local resistance to development, particularly when on-site activities proceed quickly for projects using modular methods.

PHILANTHROPY AND SOCIAL IMPACT CAPITAL

Stable Workstream

Offer revolving capital support for off-site producers serving affordable and supportive housing markets.

While there are practical reasons for off-site producers to focus on affordable housing (such as high demand, sensitivity to time and cost, and potential for standardization), several off-site manufacturers like CRATE and Factory OS also have strong, value-based leadership that specifically seek out these projects and partners. Philanthropic organizations could further incentivize a commitment to affordable and supportive housing projects by offering funding for firms that prioritize non-market-rate housing. At the project level, offering rapidly deployable funding for affordable housing projects utilizing off-site methods could provide gap financing or address misalignment in the timing between project financing sources. This could get projects off the ground that would otherwise be delayed or infeasible, helping to accelerate pre-construction timelines and catalyze full-scale factory production.

Funding

Provide flexible capital to accelerate projects utilizing off-site approaches. Philanthropic organizations may be better positioned to provide gap financing. Tipping Point and the San Francisco Housing Accelerator Fund played an important role in providing the short-term financing for the 833 Bryant Street development to move forward

before traditional financing pathways (like the Low-Income Housing Tax Credit) were procured. In that specific case, the philanthropic funds allowed the permanent supportive housing project to be delivered without any upfront public subsidy. Corporate funds committed to affordable housing procurement—such as those from Apple, Google, or Facebook—could similarly stimulate industrialized housing production by reserving a portion of their funds as patient capital for projects utilizing off-site methods.

Encourage and incentivize off-site construction methods in housing grant applications. For programs supporting individual housing projects or initiatives, or for those granting organizational support more broadly, social impact capital can call for industrialized and other innovative construction methods. Even without citing off-site production explicitly, funding could specify scoring criteria for applicants that minimize the cost and time of housing development while improving design and build quality using innovative delivery methods. Such criteria would favor projects using industrialized construction only if they promote the values and outcomes shared by the funding organization.

Workforce Development

Coordinate existing programs and organizations to maximize the workforce and community benefits of off-site construction. Industrialized housing facilities *can* serve as important centers for well-paying work that provide employment opportunities for local residents, but they would benefit greatly from the aid and guidance of long-standing and ongoing efforts to support local communities. For example, new housing production facilities could partner with established

groups that help at-risk youth, previously unhoused individuals, or veterans connect to nearby jobs. Several such organizations combined their efforts with the City of Los Angeles through a program called Los Angeles Regional Initiative for Social Enterprise (LA:RISE), which connects formerly incarcerated and previously unhoused individuals to work in the area. Another organization, Emerson Collective, is partnering with Los Angeles County to grow and train the local workforce for energy efficiency retrofits. Collaborations like this directed towards off-site housing facilities can help them integrate and grow with their immediate surroundings as an anchor of stable, quality employment.

Directly fund workforce development benefits for off-site construction firms. Philanthropic organizations could perhaps support benefits like on-site childcare in factory facilities for manufacturers that adopt shared values and a vision to serve affordable and supportive housing markets, specifically. They could also offer backstop funding (e.g. a low-interest loan to cover paid time off for employees) so that a temporary, unexpected factory shutdown does not risk the employment status of factory workers.

Education and Experience

Create a stakeholder network and knowledge hub to foster cross-sector relationships and coordinate broader public education and outreach efforts. Philanthropic and social impact organizations may be the most well-positioned and neutral entities to facilitate industry-wide knowledge sharing and collaboration around off-site construction methods. Housing industry social events and regional networking conferences can provide the foundation for productive relationship-building around alternative approaches to housing delivery and construction.

LOCAL GOVERNMENT

Stable Workstream

Any intervention the local government makes to increase the certainty and repeatability in housing development processes—from entitlements to permit reviews and inspections, for example—will especially benefit projects using off-site construction. Industrialized construction can simultaneously provide reciprocal benefit to local governments by reducing the scope and complexity of their review processes. The mutual benefits can serve to reinforce certainty and minimize the time required for housing development, providing indirect stability to the continuous flow of factory-built housing production.

Simplify and streamline permitting and approval processes. Independent of construction methods, the complexity and unpredictability in housing permitting and approval was repeatedly cited as a barrier to rapid, cost-effective housing development. Fair and consistent enforcement of planning and building code requirements across multi-agency review procedures would increase certainty for housing developers (and their project partners) and minimize the staff time required for each project—especially if it avoids multiple re-submissions. The increased predictability would reduce the risk of delays related to permitting, which in turn would make off-site production more effective. More ambitious streamlining could expand the criteria for affordable and supportive housing projects eligible to forego CEQA and other discretionary review processes.

Offer pre-approved unit plans. This is especially feasible for small and simple project types such as single-family homes or ADUs. Providing even a small selection of detailed design specifications that comply with all necessary planning and building code requirements (such as electrical and plumbing, structural framing, and fire protection measures) can help standardize quality local design while “minimizing the guesswork” for project teams, as one interviewee described. It would also enable off-site manufacturers to optimize their factory workflow to accommodate assembly for the pre-approved units. While modular units would be inspected and approved by HCD, pre-approved plans would add clarity for projects using any off-site strategies. It would also clarify any locally-specific design requirements such as minimum floor areas or spacing requirements within units, which some practitioners said were challenging to foresee and implement. In addition, if a local government provides access to pre-approved unit plans, off-site producers may more readily pursue projects in that jurisdiction due to the relative certainty in the permitting and review process. This approach could be especially beneficial for smaller jurisdictions with limited staff capacity.

Workforce Development

Many completed and expected housing projects are taking advantage of off-site construction capacity located outside the region and state, so catalyzing production *within* the region could expand adoption and localize the workforce and economic development benefits. To support and grow the local capacity for factory-built housing, city governments in Southern California should maximize the workforce development potential of industrialized building methods

Utilize existing workforce and economic development funds and efforts to support off-site construction methods. Jurisdictions large enough to administer Community Development Block Grants (CDBG), a federal funding program could deploy these funds directly to encourage skills training in industrialized production methods. This would take advantage of the high-quality job growth made available through factory-built housing methods to ensure Southern California residents can benefit from increased local housing production. LA:RISE offers an exemplary local model to support similar efforts via the centralized coordinating power of city governments.

Revisit local hiring requirements to consider impact on projects utilizing off-site methods. For projects utilizing public subsidy, some local jurisdictions include requirements on the use of local construction labor. It can be unclear if and how these apply to the off-site scopes of work for projects using factory production, and added guidance would reduce uncertainty in project development while ensuring projects still meet the intent of legislation or policy. Extending these criteria to factory facilities within the region could further support and incentivize local housing production over imported modules.

Education and Experience

Follow HCD's guidelines on limited local review scope for projects using off-site methods. State inspection includes any scope of work inside the factory, including many facilities outside of the state and country. This allows state-certified officials to review plans for factory-built housing and inspect units during the assembly process, approving

components completed before the modules leave the factory, such as insulation or structural framing. Units can then be transported to and installed on-site without needing to be opened up for local inspectors, saving time and simplifying the logistics of on-site work. However, industry experts reported that local officials still occasionally insist on conducting a full on-site inspection, delaying progress for redundant review. Local governments should familiarize those responsible for plan check and inspection—services which may be contracted out to 3rd parties—with the division of work set forth by HCD for factory-built housing. This minimizes delays to projects while reducing the local jurisdiction's own time and resources dedicated to reviewing and inspecting individual housing projects.

Improve staff retention. Several interviewees reported that high turnover in local government staffing exacerbated existing issues with unclear scopes of review in planning and inspection for projects using off-site construction projects. Thus, pursuing strategies to improve retention of planning and building department staff could preserve the institutional knowledge retention across projects, preserving the benefits of streamlined review for projects using off-site production.

STATE GOVERNMENT

Stable Workstream

Consider and coordinate more regional housing program initiatives. The state of California could help in better aligning housing funding programs by encouraging and incentivizing the priorities and eligibility criteria across local jurisdictions. This could be in the form of grants provided to large counties such as Los Angeles (or regional governing entities like SCAG) to research and propose criteria that combine the goals of local programs into an overarching housing program. Though difficult to craft, a unified regional housing policy framework could dramatically simplify the process of sourcing funding for affordable and supportive housing developers (and other housing industry stakeholders) that pursue work in multiple jurisdictions in Southern California. Policies that make it easier for off-site construction firms to pursue housing projects across a broader region would encourage them to scale up their production capacity to meet the magnitude of regional demand.

Workforce Development

Utilize existing workforce and economic development funds and efforts to support off-site construction methods. The state's jurisdiction covers localities too small to administer their own CDBG funds. This includes most peri-urban areas (i.e., the transition zones between urban areas, land use patterns, and rural environments) where land value is relatively low compared to dense urban cores, and in which businesses that require large physical footprints—like factories

dedicated to housing production—may be more feasible as a result. State intervention to support off-site construction-based skills and workforce development in these areas could be crucial to catalyze factory-built housing efforts to expand construction capacity for housing.

Encourage and coordinate more regional workforce and economic development program criteria. Coordination of state programs—perhaps through SCAG and other regional governing bodies—can increase and improve the incentives for cross-jurisdictional collaboration. As it stands, local governments seeking to spur workforce and economic development confine their efforts to their rigid jurisdictional boundaries. From a single city's perspective, a nearby program (or factory facility) with scope and impact in an adjacent city is as ineligible for support and funding as one in another country. Similarly, several interview respondents reported that the expected commercial tax revenue from a new business can prompt a strategic redrawing of electoral districts even within the same jurisdiction so as to incorporate the commercial footprint of a new company. This parochial view and application of development can be counterproductive to the intent behind related programs, and state leadership toward the regionalization of economic and workforce development programming could help coordinate and spread the benefits. Such a shift would increase the appeal of regionally-oriented off-site production of housing, which could provide crucial housing supply—which transcends individual jurisdictional boundaries—in an efficient and cost-effective manner to the benefit of multiple jurisdictions.

Catalyze opportunities for building trades organizations to integrate with and support off-site construction methods. Recent, renewed debates about state level legislation on housing and labor requirements underscore that the interests and influence of construction labor unions span wider than the scope of local jurisdictions.¹⁵ While off-site construction may insulate affordable housing projects from high labor costs in dense urban areas, use of the approach may simultaneously alienate one or more of the construction trades in the process. There are opportunities for collaboration to address the complex tension between building trades, affordable housing developers, and off-site producers. A factory's controlled environment, with regimented tasks that are more ergonomically optimized, allows for individual construction activities to be completed across a wider range of physical ability than on-site work. Several off-site producers reported that their in-factory labor has a significantly higher prevalence of historically underrepresented demographics in construction, including women and people of color, than is characteristic of on-site workers. As the building trades face challenges related to aging workforce and diversity in recruitment, this synergy could be a boon for both factory production and the construction industry more broadly. Organizations representing the construction trades, meanwhile, could apply existing institutional partnerships and training capacity to facilitate workforce development through industrialized construction at scale. Factory OS and the Carpenters Union stand out as an example of a proactive partnership with mutual benefit. But state leadership and guidance would greatly help in fostering collaboration.

Education and Experience

Improve clarity and outreach on local versus state review scopes for off-site construction projects. HCD already provides guidelines on the division of work between state versus local review and inspection for housing projects utilizing factory production. But it should continue and expand communication and cooperation with local jurisdictions to ensure the division of labor is maintained. The simplest version of this could be a series of webinars for local building inspectors and other staff to attend, in which HCD presents the most important details of state-certified factory unit inspection and answers any questions that come up. A potential (resource-intensive) supplement to the webinars could be in-person workshops in which HCD facilitates one or more tours of actual off-site housing production facilities for local government officials and staff. This more involved activity would likely do more to engage and educate local officials with the state-level inspection process. But it would also make them more familiar and comfortable with the process and quality control of a factory setting, and perhaps even more willing to comply with the lack of local review for factory-built units as a result.

STATE AND LOCAL GOVERNMENT

The following recommendations reflect the mutual responsibilities of both local and state governments to reduce uncertainty in affordable housing development.

Simplify and align project eligibility criteria from different policies and funding sources. Different programs to support affordable and supportive housing development often have varying requirements. Attempting to combine multiple public funding sources on a single project can be complicated at best, and conflicting at worst. Affordable housing developers may have to choose between building more housing or meeting the multiple program criteria for a single project, which may introduce risk, complexity, and administrative burden.¹⁶ Such requirements can include different proportions and limitations for specific tenant incomes or demographic factors, prevailing wages that can increase on-site labor costs and administrative burden, and restrictions on eligible uses of funds (such as not being applicable for a factory's up-front deposit). As one industry professional reported, these requirements could mean "potentially sacrificing valuable units for the sake of convenience" by choosing to build smaller projects and avoiding layered requirements from multiple funding sources. By extension, the fragmentation of funding and rules associated with affordable and supportive housing projects makes it difficult for an off-site housing manufacturer to align multiple projects in a continuous pipeline of factory production.

Encourage and incentivize innovative approaches in funding program applications. Similar to the recommendations for philanthropic grants included

above, state and local governments should consider including scoring criteria that incentivize approaches that reduce the time and cost required for housing delivery (or even call for the utilization of industrialized methods explicitly) in funding program applications. For example, the City of Milwaukee recently sent out a public request for information about a potential public private partnership for factory-built housing.¹⁷ While exploratory, this is an example of how jurisdictions could help move the field toward more industrialized construction.

Remove per project maximum funding caps on state funding sources and consider per unit maximums instead. If public subsidy programs could fully fund large affordable and supportive housing projects, developers would be less likely to need to combine multiple funding sources and thus face increased project complexity. Funding caps placed on a per unit basis would simultaneously remove the disincentive for large projects while keeping developers focused on cost savings and containment. The change would affect affordable housing development at large, but also specifically help off-site housing producers take advantage of consistent project finance mechanisms and reporting requirements across projects.

Consider the use of public land for off-site construction of affordable housing. State and local governments could enable and prioritize affordable and supportive housing development on its own land assets, specifically targeting sites suitable for off-site methods. Basic criteria for this could prioritize lots with rectangular geometry and sufficient staging area for a construction crane to install volumetric modules.

Other Stakeholders

Several additional entities not shown in Table 5 can influence off-site construction success and adoption as well. In particular, architects and general contractors can serve as advocates of off-site methods and accelerate their successful implementation. However, they can also create friction and negate the potential benefits offered, especially cost savings. Yet, because their impact is most often felt on a project basis, their roles touch less on the systemic challenges facing off-site construction of affordable housing. The feedback and cooperation of architects and general contractors is paramount in ongoing conversations about accelerating off-site construction adoption and unlocking its benefits.

Conclusion

Off-site and industrialized construction is an emerging strategy to reduce the time and cost of housing delivery alongside other benefits to the quality and performance of housing. These innovative methods, which depend on predictability and consistency, underscore the need to simplify and improve the policies and processes that support housing development more generally, particularly in the affordable and supportive segments. But there are also several steps stakeholders involved in the housing industry can take to realize the full range of potential benefits and support the adoption and growth of off-site methods. This report presents a preliminary, guiding framework for the different roles to be played to support factory-built housing production in Southern California. Though the suggestions are divided by stakeholder and opportunity area, the scale and urgency of the housing shortage demands sustained, concerted efforts across all of the institutions involved in housing procurement. Thus, these recommendations—and off-site construction as a whole—should be seen as part of important, ongoing conversations to improve and expand housing production in Southern California.



Appendix

The Need for More Housing

Table A1: 5th RHNA Cycle Progress for Southern California Six-County Region

Income level	5th Cycle RHNA	Percent of RHNA Total	5th Cycle Permits	Percent of Total Permitted	Percent Attained
Very low income (50 percent AMI or below)	100,586	24%	13,011	5%	13%
Low income (50-80 percent AMI)	64,918	16%	9,936	4%	15%
Moderate income (80-120 percent AMI)	72,021	17%	32,305	12%	45%
Above moderate income (120 percent AMI or above)	174,429	42%	221,397	80%	127%
Total	411,954	100%	276,649	100%	67%

The Policy and Funding Landscape for Affordable and Supportive Housing Development

The challenges of scaling up off-site construction for affordable and supportive housing development in Southern California must be understood within the context of the fragmented landscape for securing planning approvals and project funding.¹⁸ The following section provides an overview of some of the prominent levers used to encourage and support affordable housing development in California.

Streamlined Planning Approvals

Affordable and supportive housing projects can often bypass onerous and lengthy local permitting and approval processes. For instance, SB 35, which was passed in 2017, allows most affordable housing projects that conform to local zoning to qualify for streamlined, typically staff level, ministerial planning approval.¹⁹ In 2019, two more policies—AB 2162 and AB 101—expanded the ministerial approval eligibility of all supportive housing and shelter projects meeting specified criteria in areas zoned for multifamily housing in the local jurisdiction.

Statewide legislation that went into effect in 2020 allows by-right development of ADUs on all lots in California that can physically accommodate them. From the 2021 legisla-

tive session, SB 9 will extend this by allowing homeowners to split their lot into two and construct two units on each, effectively allowing fourplexes on single-family lots around the state. A Turner Center analysis found that SB 9 would enable the financial feasibility of over 700,000 new homes in California.²⁰

Density bonuses are another key tool to facilitate affordable housing. In addition to the state level density bonus, a number of local jurisdictions have passed their own versions that vary in both the depth and breadth of the requirement: the bonuses can increase the allowable residential density of a given lot by 50 to 100 percent or more depending on the number and degree of affordability.

At the local level, transit-oriented development (TOD)—which concentrates housing within a certain radius of major transit hubs—is another criterion targeted by some streamlining policies. For example, the City of Los Angeles’ passed Measure JJJ (2016), is an example of a locally-enacted program that incentivizes for affordable housing projects near transit that meet certain labor hiring requirements.²¹ An analysis of Measure JJJ’s impact conducted by researchers at the University of Southern California in 2021 found that it resulted in 4,100 additional units since implementation, compared to roughly 500 units they attribute to the longer-standing density bonus ordinances.²² Other local governments such as LA County expand the eligibility criteria of state legislation for housing projects within unincorporated LA County, allowing ministerial approval for residential and mixed use projects on commercially zoned sites.²³

Public Funding

A variety of funding sources at multiple levels of government are designed to support affordable and supportive housing projects. The majority of production-focused funding is for individual projects meeting certain criteria (e.g., serving specific vulnerable demographics such as seniors or military veterans). The funding available for each program varies from year to year, and the limited allocation requires many of them to be competitive, meaning that developers must apply and be scored against other projects based on a performance rubric. Notices of funding availability and successive rounds of applications and awards notifications are staggered throughout the year. The resulting uncertainty for winning funding and the variability of total funds available each year is a problem that HCD acknowledged in its statewide housing assessment in 2018.²⁴

The largest production-oriented program is the federal LIHTC program, which was established in 1986 to provide incentives to private developers and investors (in the form of a dollar-for-dollar reduction in their federal tax liability) to produce affordable housing. Administered by states and, in the case of the City of Los Angeles, the local LIHTC-allocating agency, LIHTC has a broad range of applications in that it can be used for new construction or rehabilitation, and to fund housing for different kinds of target populations, including seniors, residents with special needs, and families with children. However, not all eligible applicants receive funding, and those that do often have to layer multiple additional funding sources in addition to LIHTC.²⁵

The State has been dedicating more funding toward affordable housing in recent years. The total amount of state funding put towards housing and homelessness in the June 2021 state budget is \$22 billion, with over \$3 billion dedicated to new housing production.²⁶

In addition, more localities are themselves dedicating funding toward housing needs. Additional funds are sourced at the local level directly through in-lieu fees (a component of inclusionary zoning ordinance) and ballot measures, though the latter tend to be one-time injections rather than ongoing funds. The City of LA, for example, passed Proposition HHH in 2016, creating \$1.2 billion for permanent supportive housing, with the goal of constructing 10,000 units over ten years. But higher-than-anticipated development costs have limited the projected unit count from these funds to roughly 7,305 units, two thirds of which have not yet begun construction, and more than one half of which will not open until 2023. The variance in per-unit cost performance across projects—including several utilizing off-site construction—may offer key insights for strategies to improve delivery in future projects.²⁷

The tenant-based federal Housing Choice Voucher (HCV) program provides rental subsidies to low income households renting private-market housing by covering the difference between what they can afford to pay (i.e., 30 percent of their gross income) and the fair market rent established by their local housing authority. Local housing authorities can also reserve a certain percentage of vouchers for housing projects (meaning the subsidies are tied to a unit instead of a tenant), which provides an operating subsidy to housing developments that allows them to reach deeper levels of affordability than possible through production subsidies (e.g., LIHTC) alone. Limited voucher availability has added uncertainty to projects seeking this funding. However, proposals such as the Build Back Better plan at the federal level, would offer significant expansions to the federal voucher program which could increase the ability of renters to access those resources as well as affordable developers to secure project-based vouchers.

Another avenue for public funding is through utilization of public land to support housing development, an opportunity driven by California state legislation in 2019.²⁸ Because so much of the cost of development is attributed to the high cost of land in dense metropolitan areas of high housing demand, this lowers the up-front cost to affordable housing developers, as well as reduce the need for nonprofit developers to compete with private developers (and capital) in the open market for desirable lots with high development potential.

Private and Philanthropic Efforts

Outside of conventional lending institutions, private corporations in California—notably the big tech firms, Apple, Google, Facebook—have announced large funding pools in recent years to fund affordable and supportive housing efforts. The announcements from those three firms alone amount to \$4.5 billion. While details remain uncertain, many of these companies (and others) have an established presence in Southern California and may intend to dedicate a portion of those funds to their satellite offices there. These funds may provide more flexible and innovative funding pools and mechanisms for expanding and improving housing development, broadly.

For example, a supportive housing project at 833 Bryant Street in San Francisco, used a privately-funded revolving loan fund to seed the project and move ahead in the development phase before the conventional public subsidy sources could be approved and deployed. This allowed the project to capitalize on efforts to streamline permitting and construction timelines with ministerial approval and off-site construction, effectively shortening the construction period and lowering project costs relative to other supportive projects in the city. Though this is only one project in San Francisco, a collaborative partnership between several housing organizations recently announced a similar initiative in Southern California. California Community Foundation administers a \$5 million revolving construction loan fund (funded through Prop HHH) to support a partnership between three local developers, Abode Communities, LA Family Housing, and Mercy Housing. The fund intends to streamline financing in early project phases so projects using off-site methods can move forward without delays caused by waiting on more long-term financing. This will be integrated with the organizations' other projects and efforts utilizing funding from Prop HHH, and combine other strategies to establish more efficient ways of delivering supportive housing.²⁹

Prop HHH itself was passed in part due to funding and support from other regional philanthropic organizations, including United Way of Greater Los Angeles and the Hilton Foundation. Additionally, through donations and leveraging public funds, United Way has procured more than \$1 billion for homeless and permanent supportive housing services since 2011.³⁰ The Hilton Foundation performs similar fundraising, with over \$120 million raised since 2012—serving more than 35,000 individuals—and a goal of raising \$190 million more in the next five years for placing unhoused individuals into permanent supportive housing.³¹ They also helped fund an initiative called RETHINK Housing that combines multiple strategies to reduce the time and cost required to deliver affordable and supportive housing.³² The development model incorporates several procedural improvements to simplify and streamline housing delivery, many of which align with the goals and potential advantages of off-site construction methods.

The array of policy and funding mechanisms to support and steward affordable and supportive housing in Southern California is broad but complex. Navigating this landscape can be difficult even for conventional development and construction models, and weaving in the novel features required of a project using off-site methods can add one more layer of complication. Despite this, many of the existing efforts could benefit from the advantages offered by industrialized construction practices if they can thoughtfully adapt to the nuance of the new approaches.

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