Modular Construction for Multifamily Affordable Housing

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Acknowledgments

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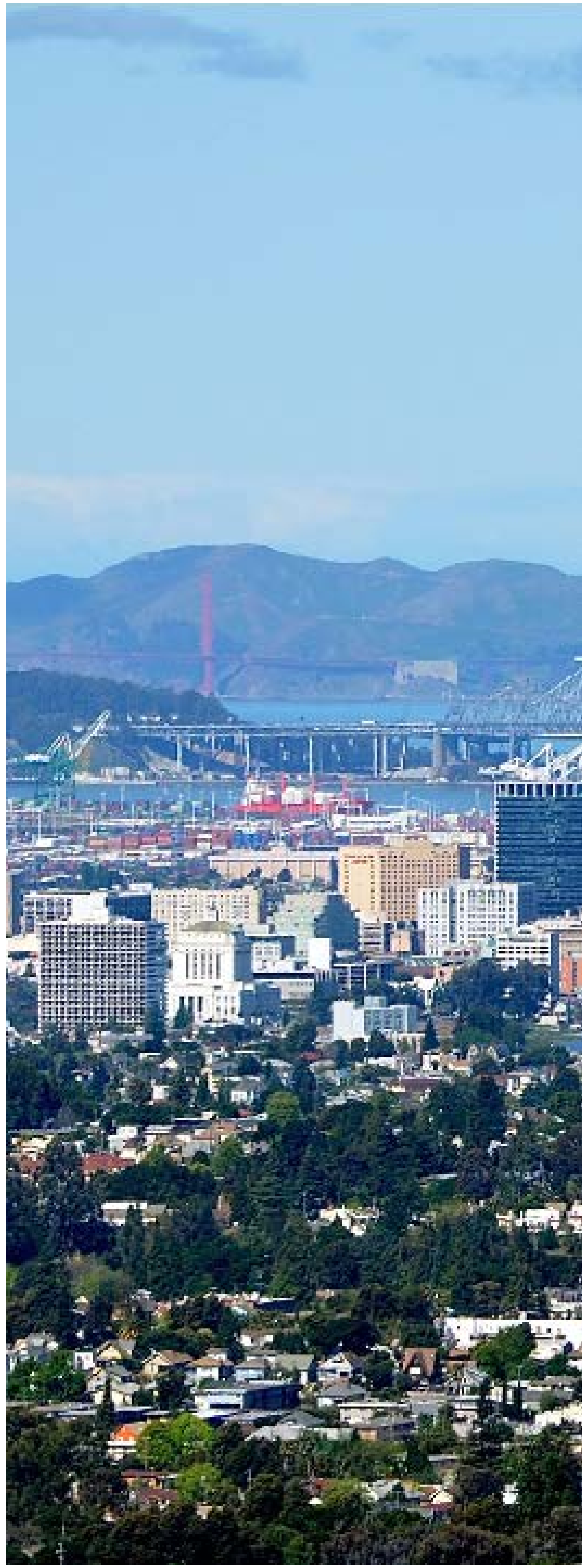


EXECUTIVE SUMMARY

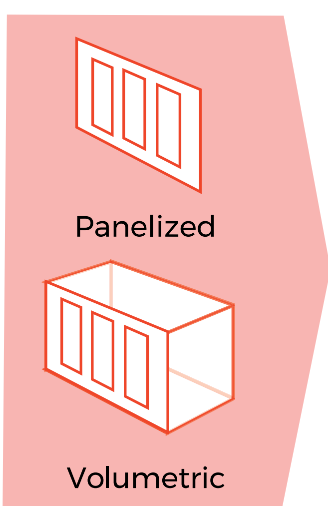
Modular multifamily housing construction can increase the development of healthy affordable housing by saving significant cost, time, and resources. This nacent market also bears risks for developers that limit it's growth and penetration. Public and private entities can assist the Factory-Built Housing sector to help project teams and development agencies realize its vast potential.

INTRODUCTION

Modular and Factory Built Housing (FBH) is a promising trend in the building design and construction market. It is embedded in a broader practice of modular construction, which employs some degree of repetition in the construction process. FBH applies modular methods to residential projects by preassembling repeated modules off-site. The degree to which the modules are fully finished off-site varies, but they may be two-dimensional wall assemblies ("panelized" modules) or three dimensional spaces ("volumetric" modules, see below illustration). Building significant sections off-site allows FBH to achieve cost and time savings, along with a range of other advantages.

FBH is a nascent sector that has been tested only on a small percentage of construction projects, leaving manufacturers, contractors, developers, customers, lenders, and policymakers with questions about how this industry will work and what it needs in order to scale up.

This report focuses on the application of FBH and its ramifications for below market multifamily housing in the San Francisco Bay Area. In this region, a massive demand for housing and skyrocketing construction costs have added to a housing crisis that is severe not only for low income residents, but for middle income brackets as well. The specific concentration of our study is new housing development that is developed with the use of public funding and is in turn price controlled based on resident income.



FINDINGS

Drawing on literature review, case studies, expert interviews, and an industry focus group, this research focuses on the current FBH market in the Bay Area to reveal the challenges and ways forward for scaling the market. Specifically, the report describes a range of FBH manufacturing methods, summarizes recent industry developments, collects generalized advantages and disadvantages, elevates best practices, and provides ways forward for industry stakeholders. The report finds promising benefits that could make FBH a solution for many communities. There are also various risks in this immature market to be understood, managed, and mitigated. Specifically, conclusions include:

COST AND TIME SAVINGS:

- Manufacturers report cost savings of 20% and time savings of 40-50%. Saving on construction materials cost, on-site labor, and abated interest motivate the anticipation of the building technology. However, these savings are not without risk. While perceived risk is exaggerated, risk nonetheless exists. (Read More)

OTHER ADVANTAGES:

- Beyond cost, FBH provides the advantage of reduced wasted materials, construction safety and predictability, assembly line quality control, and reduced strain on site neighborhood. (Read More)

LIMITATIONS AND RISKS:

- FBH has technical limitations due to site size, shape, and context, economic limitations of the immature business model, and social limitations related to stigma and labor politics. (Read More)

BROWNFIELDS:

- FBH does not require additional environmental remediation, nor does FBH impact the way environmental remediation would be carried out. Therefore, FBH is at least as appropriate for brownfield sites as conventional site-built construction, and likely would provide developers new sites for consideration by virtue of its lower costs. (Read More)

FINANCING

FBH departs from conventional site-built construction practices, therefore financing projects raises several constraints:

CHALLENGES

- **Challenge 1:** There is a shift in payment schedule for a developer to pay for materials and labor during the construction process. FBH requires a substantial amount more capital earlier on in the process than site built construction, which is typically paid in arrears. This shifts can be particularly challenging for affordable housing developers because of their reliance on public grants, bonds, and lender financing.
- **Challenge 2**: The lack of market maturity for manufacturers drives uncertainty in supplier prices and schedules, and these inconsistencies are passed on to developers, further complicating FBH financing.

WAYS FORWARD

» **Way Forward 1:** To help facilitate development of more robust manufacturer markets, lenders could employ digital materials tracking, and statewide agencies such as the California Housing Finance Agency (CalHFA) could implement new financial tools for affordable FBH.

» **Way Forward 2**: Until the FBH product market is more mature, developers could partner with a factory from the inception of the project to provide both parties a more certain window for schedule and price.

» **Financing Opportunity**: To help facilitate development of more robust manufacturer market and smooth out the uneven pipeline of demand, large developers with the ability to self-finance could invest in a stock of modules that could be used across their project types.

» **Financing Opportunity**: To maintain long term affordability, Community Land Trusts (CLT) can provide an equitable opportunity for remediation, redevelopment, and cooperative governance. In this model, the CLT owns the land beneath the housing unit, and caps the price at which unit can be sold based on Area Median Income. FBH makes cash-poor CLTs more viable and align with community development corporations.

CODES AND PERMITTING

Compliance with Department of Buildings permits and building codes also changes for FBH. Rather than the entire building falling under the local jurisdiction’s authority, all modules must also be reviewed separately by the California Department of Housing and Community Development (HCD).

CHALLENGES

- **Challenge 1**: Unlike conventional site-built projects, navigating requirements for multi-jurisdictional codes is cumbersome and time consuming, especially for project teams with limited experience.
- **Challenge 2**: Lack of consistency in local jurisdictions' approach to code review and compliance. Some local agencies prefer to examine the modules again after the state examines them, and are particularly concerned with fire proofing and plumbing.
- **Challenge 3**: The already lengthy permitting process may be compounded by complications in FBH permitting. Scheduling delays limit the cost savings benefit of FBH deployment.

WAYS FORWARD

» **Way Forward 1**: HCD could normalize the permitting process by developing standards prescribing the necessary components for FBH. This guidance may be modeled on the CA Division of the State Architect’s (DSA) statewide standards.

» **Way Forward 2**: Senate Bill 35 addresses permitting streamlining for jurisdictions that have not met a local benchmark. Municipal governments may consider investigating addition actions to fast-track the permitting process, and engage the FBH community on further development.

BACKGROUND

The housing crisis in the Bay Area and in many other metropolitan areas is worsening while conventional construction costs are growing. Affordable multifamily housing is in especially high demand, and could be built on sites in need of remediation.

HOUSING CRISIS AND CONSTRUCTION COSTS

In recent years, growth in the Bay Area has left a housing crisis that will require many solutions. The challenge is symptomatic of global trends related to affordability, urbanization and densification, but Bay Area cost of living has grown more quickly than almost anywhere. In fact, the San Jose and San Francisco metro areas have the highest and second highest household incomes needed to buy a median priced home in the country.[1] A consequence of consistent population growth, constrained housing supply, and the skyrocketing cost of building new homes, the crisis constrains low, middle, and even upper middle income earners.[2]

Though more housing stock is needed, the conventional site-built construction industry has not been able to meet the demand. The second least digitalized sector in the national economy, the construction sector has not been disrupted in the way so many other sectors have.[3] In its current state, the construction industry is not alleviating the housing crisis, instead it is underperforming on meeting project schedules and budget limits, leaving wide gaps in the housing stock.

Affordable housing is in particularly short supply. Over 97 percent of Californian cities have not met their Regional Housing Needs Allocation (RHNA) targets.[4] In the Bay Area, cities permitted less than a third of moderate-, low-, and very low-income housing needed between 2007 and 2014.[5] According to California's Legislative Analyst, the state must produce about 180,000 units of housing a year to keep up with growth in demand. Historically, the market has produced around half that figure.[6]

A principal factor limiting production is cost. With construction costs around $330/sf, San Francisco is approaching the most expensive city to in the world for new construction.[7] For affordable housing, the cost of building an affordable project increased 60% in the last decade and a half.[8] This market—struggling to modernize, underbuilding, with costs growing and demand increasing—is in need of a new solutions.

Factory Built Housing (FBH) can facilitate more houses for lower costs, along with a variety of other benefits. Beyond cost, FBH provides the advantage of reduced wasted materials, construction safety and predictability, assembly line quality control, and reduced strain on site neighborhood. On the other hand, FBH has technical limitations due to site size, shape, and context, economic limitations of the immature business model, and social limitations related to stigma and labor politics.

FACTORY BUILT HOUSING ON BROWNFIELDS

Factory Built Housing has potential to align with the goals of the Environmental Protection Agency's (EPA) Brownfields and Land Revitalization Program. The program focuses on brownfields, defined as real property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant. EPA encourages communities to assess, cleanup and redevelop land for reuse for recreation, green space, industrial, commercial, and residential use. In an effort to alleviate the housing crisis in the Bay Area, the EPA has investigated FBH construction to determine its feasibility as a brownfield redevelopment solution.

Of particular interest are infill sites, which are often convenient locations for people to live, work, and play. Brownfields are often located in the urban core, so prioritizing their redevelopment enables infill as well as Transit Oriented Development (TOD). TOD is the practice of siting higher density commercial and residential projects along accessible transit, which facilitates housing that has convenient access to services and employment. If sited on a brownfield with TOD, projects not only reduce the emissions required for transportation, but also remediate the environmental contamination present.

Brownfield sites are underutilized, but not overlooked. The Sustainable Communities Protection Act of 2008 instructs each of California's Metropolitan Planning Organizations to formulate a strategy on how to imagine communities through more integrated land use practices. Prioritizing brownfields along with TOD is one possible method of doing so.

By including FBH into conversations about integrated housing strategies, local and regional planners may have another synergistic opportunity. At present, most FBH developers who build on urban sites already commonly develop sites in need of environmental remediation. FBH interfaces with the ground in the same way as conventional housing, so developing either on a brownfield would be congruent. Therefore, FBH on brownfields could be an opportunity to lower the cost and reduce the impact of TOD on brownfield sites. While the extra remediation costs are a disincentive, the savings incurred by FBH technology may offset the cost of cleanup, making brownfield sites eligible for use in affordable or below market rate housing development. This report further explores the FBH possibilities for affordable multifamily housing on brownfield sites.

PRESENT MARKET

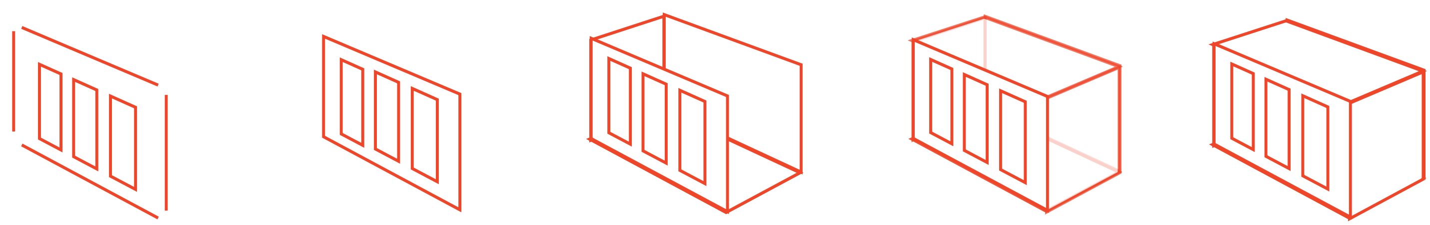
EARLY DEVELOPMENT OF FACTORY BUILT HOUSING

Building construction has always had some measure of prefabrication. However, the current state of the FBH has transformed quite recently. While the level of interest in the process is growing quickly, the number of multifamily FBH manufacturers nationwide is low. These factories build projects for multifamily uses, specialty multifamily such as student housing, assisted living, supportive housing, and the hospitality industry.

With Guerdon Modular Building, FBH emerged in the western US in 2001 and to the San Francisco metro area in 2012. Within three years, others acted on the promise of FBH and there was a cohort of four firms building in the metro area (ZETA Design + Build, RAD Urban, and Panoramic Interests) three of which exist today (see Appendix I, Case Study 1, and Case Study 2). In late 2018, another manufacturer (Factory OS) is expected to come online in the region. Because each successful project increases the demand, current expectations are that factories will grow in size and number for the foreseeable future.

FACTORY BUILT HOUSING TYPOLOGIES

In the Bay Area market and elsewhere, companies have answered the demand for Factory Built Homes in diverging ways. The FBH market exists on a spectrum of five typologies from low off-site work at one end, to high off-site work on the other (See below illustration.)



Typology 1: Components

On the side of the spectrum with low on-site work, Typology 1 includes many conventional site-built structures. As long as contractors install some prefabricated product such as roofing, flooring, or glazing systems, projects are Typology 1.

Typology 2: Panelized

Projects in the Panelized Typology are approximately 60% complete off-site and use non-volumetric modules such as floors, roofs, and interior and exterior walls. One prominent company operating in Typology 2 is Katerra, which began production at their Phoenix factory in 2017 and expects their Spokane factory to be operational in 2018. Broad Sustainable Buildings (See Case Study 3) also delivers components to site in two dimensional assemblies.

Typology 3: Hybrid

Hybrid projects are a mix of Typology 2 and Typology 4. Projects in the hybrid typology are made up volumetric modules but are not fully enclosed. Manufacturers may have eliminated interior walls or ceiling to eliminate superfluous panels, such as RAD Urban (See Case Study 1).

Typology 4: Volumetric

This typology defines the most common projects—three-dimensional modules 80% to 90% complete off-site. Modules arrive on-site without interior or exterior finishes. A wide array of companies operates in this space, with both traditional enterprises and innovators.

Typology 5: Complete

Projects in this typology are also delivered to site as a volumetric module, though in this case the modules are almost complete (90 to 95%) when they arrive on site. These projects require virtually no on-site construction before occupancy. Panoramic Interest's MicroPADs, for example, arrive on-site approximately 95% complete, with fixtures, finishes, a curtain rod and toilet paper holder (See Case Study 2).

Figure 1: Site Assembly

ADVANTAGES

Factory Built Housing offers developers cost savings and a condensed construction timeline as well as a variety of further benefits to occupants and thier communities.

COST SAVINGS

Cost savings are a central draw to FBH. Reported cost reductions vary from project to project, but most have demonstrated savings around 20%, with expected savings of much more as the market matures. McGraw Hill Construction's study conducted in 2011 found that 65% of projects had cost savings, but just five percent of projects had savings over 20%. In its thorough 2017 analysis of the Bay Area FBH market, the Terner Center for Housing Innovation demonstrated reductions in construction costs due to FBH were 20% for the mainstream FBH market.[10] Though projects have not demonstrated them yet, industry experts David Baker Architects and Rick Holliday expect hot markets like San Francisco to attain 20% to 50%[11]

Holliday Development's 5830 Third St., containing 136 units, was the largest FBH project at the time it was completed in 2016. Holliday demonstrated a 20% cost savings over conventional construction. Lowney Architects priced a project in 2017 for a 96 unit supportive housing project in San Francisco. The firm asked for a site built price and a factory built price, and the factory price was 15% less.

Broad Sustainable Buildings (BSB) reports higher savings.[12] In its T30 high rise, BSB saw around 30% savings, at $93/SF as compared to $[13]0/SF for the average traditional Chinese high rise. Three years later, the cost per square foot fell to $65, or 50% savings. In BSB's case, the manufacturing efficiencies allow for far reduced labor costs, safer and healthier working conditions, and rigorous quality control.

Generally, savings predominantly come from on-site labor which are less specialized and more efficient in an assembly line setting, with less travel and weather related delay.

Second, the economies of scale of material stock also achieve cost reductions because orders can be placed for higher volumes of material, and cut out subcontractor overhead. As the costs of conventional site-built construction continue to move skyward, the cost savings possible with FBH will be more and more appealing.

These FBH projects have achieved significant cost and time savings, which drive the interest in moving away from conventional business models. However, experienced companies are quick to emphasize that converting to off-site manufacturing is not in itself the differentiating factor. With unforeseen difficulties, FBH construction can move from a cost saving method to a neutral or cost adding endeavor. To be successful, companies need a streamlined manufacturing process and to troubleshoot the bugs that come with a business model overhaul.

TIME SAVINGS

Time savings are another crucial factor, and are intimately intertwined with cost savings. Project teams report 40% to 50% reduced timeline. As shown in Figure 2, for both conventional site-built and FBH construction tracks, the initial planning phases from schematic design to permits and approvals are the same. During site development and foundation phase, the manufacturing facility builds the modules while the site is being prepared. When the site is ready for installation, site work can occur in just days to months, rather than months to years. The time saved also becomes a financial boon, as there is a faster return for equity as rental revenue. Furthermore, with greater time savings there is less interest on construction loans, so developers can pay back debt more quickly.

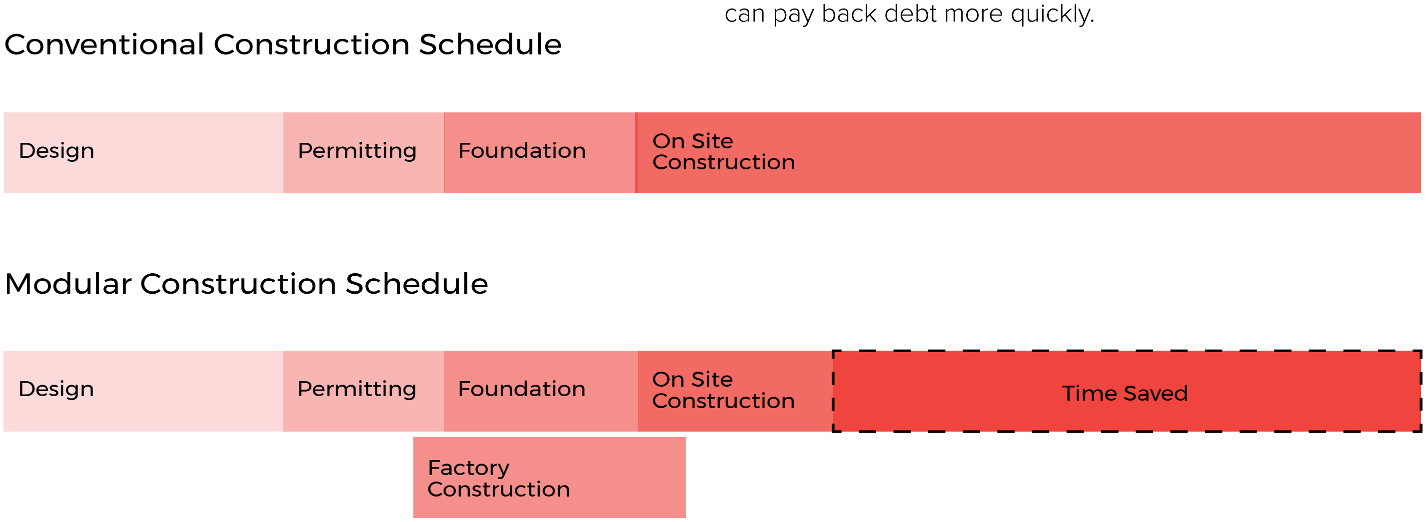


Figure 2: Process Comparison

The Union Flats transit hub in Union City offers a Bay Area time savings case study. The brownfield site was remediated by the local utility and sold to the city, who contracted a team of private developers, nonprofit developers, and architects to design and build multiple projects on site. David Baker Architects (DBA) worked with Guerdon Modular Buildings to produce 408 modules and create 243 apartments on site. After the 650-mile long transportation of the modules, the construction costs were about even. However, the modules could be installed at a rate of 12 per day, so the installation took about a month and a half, with total time savings of 9 months. This schedule shifting allowed indirect costs savings on construction loan interest, as well as extra rental revenue from earlier leasing.[13]

MANUFACTURING AND CONSTRUCTION RESOURCE REDUCTION:

FBH holds promise for sustainability and health outcomes, both demonstrated and expected. Health and sustainability impacts are not a central focus for manufacturers, but the efficiencies of the manufacturing process help facilitate them. Material efficiency and waste reduction is a primary component of environmental savings. In conventional site-built construction, material waste is generated and must be hauled off-site for sorting and processing. Overall, waste reduction is reduced from 10 to 15% in a conventional project to 5% with FBH.[14] This is replicated in two of our case studies: Broad Sustainable Building reports just 1% waste (See Case Study 3) and RAD Urban reports 4% waste (See Case Study 1).

With FBH, a few important differences allow manufacturers to lighten their waste stream. First, FBH is a more controlled environment where raw materials are kept in controlled states. With less material in transit and transition on a project site, there are fewer instances of accidents, spills, damage, and other raw material waste. Second, the use of Building Information Modeling (BIM) allows for automated production of prefabricated components. By sharing detailed 3D models between designers and contractors, contractors have a precise plan to reduce material scrap. Third, by delivering assemblies in panels or modules, the MEP systems are often built in and do not require extra components to snake around structure or drywall. For example, the Sutter Castro Valley Medical Center uses BIM enabled prefabrication for 18% cost reduction of the mechanical budget and 50% cost reduction for drywall.[15]

On the other hand, FBH projects do add more framing materials because most module designs duplicate interior walls and add double floor-ceilings. Most FBH designs use this technique to frame the volumetric mod and reinforce it for transportation. Modules without ceilings or walls are used in a few cases (See Case Study 1) but the majority of manufacturers cap each module. This translates to approximately 30% more wood and composite wood use[16] and approximately 8% higher total materials use.[17] However, because the conventional site-built method produces around 2.5 times more construction waste, this more than offsets the extra materials. With the material that is wasted, there is also the issue of transporting, recycling, and repurposing it. In a factory, some materials waste can also be processed on-site, where scraps and fibers can be ground and reused in the same facility.

In terms of environmental quality, FBH does decrease dust and noise on-site, but there are no studies indicating a variation of site pollution, Volatile Organic Compounds (VOCs), or other environmental quality issues.[18] However, during the construction process, off-site manufacturing does not rely on portable generators which are loud, have a higher CO2e/KWh rate, and emit more particulates than the grid in general.

Integrative design process is one potentially positive unintended consequence of the FBH manufacturing process. This methodology encourages the design team to meet early in the process for a comprehensive and multidisciplinary examination of the project. The method is successful only when many parties—owner, architect, civil engineers, MEP engineers, landscape architect, building maintenance and users—come to the table before major design decisions have been made. For example, examining indoor/outdoor water use and storm water as part of the same system, the team can identify opportunities for synergy before other design decisions are set. While a FBH project might not have all the same stakeholders around the table, the manufacturing process necessitates decisions about building layout, massing, site orientation, structure, and systems to occur early on to allow time for manufacturing.

RAD Urban is one manufacturer who accomplishes this by virtue of being vertically integrated. When the engineers, designers, and construction teams work together, they can more easily find efficiencies and synergies across disciplines. For others, using an integrative design process is an opportunity for sustainability as the FBH markets matures. To accomplish this, projects pursuing a LEED green building certification could pursue the Integrative Design Credit. For projects not pursuing a certification through LEED, the owner or architect could initiate the schematic design as early as feasible, and invite the project team to a planning charrette where they can all discuss the project goals and make recommendations for possible resource synergies.

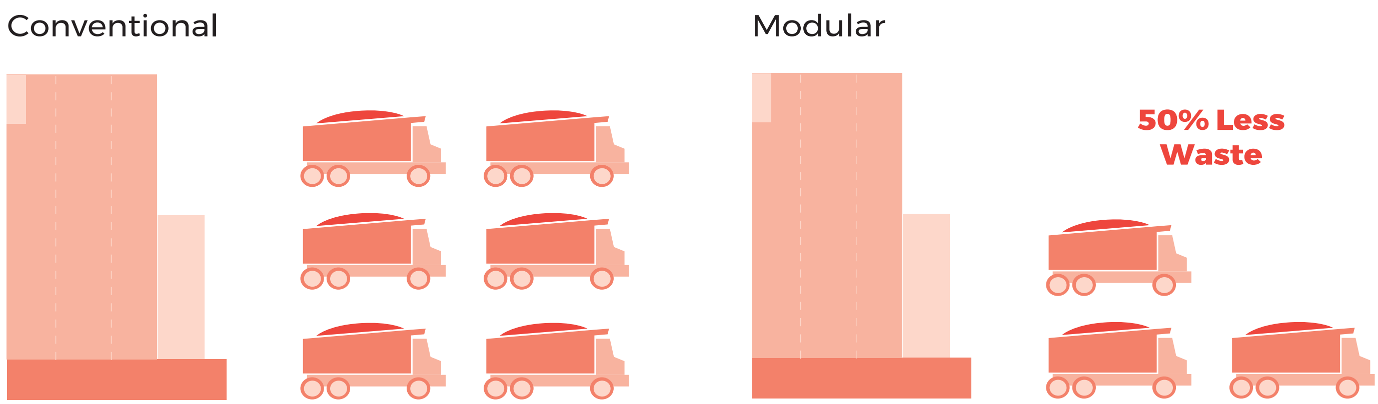


Figure 3 Waste Comparison

BUILDING OPERATIONS RESOURCE REDUCTION:

Greenhouse gas emissions associated with building operation far exceeds the GHG impact of materials transportation, construction and end of life processing of the building. However, as buildings become more efficient, and the utility grid becomes less carbon intensive, the manufacturing phase and end of life phase of the building's lifespan has a greater share of the building's net impact. There is no robust research comparing FBH and conventional site-built energy use or GHG impact. Some producers, however, claim off-site manufacturing can develop components with more precision resulting in tighter envelopes and reduced thermal bridges, further reducing operational energy use (for example, Broad Sustainable Buildings in Case Study 3).

Additionally, with prefabricated buildings, architectural decision making can use more time, effort and money to achieve energy efficient and resource efficient results because those results are amortized over multiple projects rather than just one. Even small variations from the baseline can become quite significant with many units on multiple projects.

LIFE CYCLE IMPACT REDUCTION:

Contrary to commonly held public notion, most FBH units are not built for relocation after their initial installation. Therefore, wood-framed FBH has very similar end of life impacts as a conventional site-built project. Steel-framed FBH, on the other hand, has a higher potential for life cycle impact reduction. Steel FBH units are typically joined together with bolts and rivets which can be disassembled. Rather than mortar or concrete, steel FBH units are likely to be recycled at higher rates. Those FBH projects that are built for relocation in another location achieve a lower impact, as the embodied energy in the building can be repurposed again.

Because materials are wasted less and recycled more, se, a life cycle analysis assessment shows 5% lower life cycle energy consumption and 3% reduction in GHG emissions.[19] Other studies come to different conclusions[20], including one that shows the only significant deviation in total carbon dioxide emissions is the category of worker transportation. In general, the studies examined indicate FBH is less carbon intensive, but their disagreement on key issues indicates more research is needed.

QUALITY CONTROL:

Outside of cost and time, FBH provides a quality control benefit to developers, project teams, and occupants over conventional construction. Increase quality control comes from building components that are completed, inspected, and sealed in one facility that builds them repeatedly to exact specifications. Because assembly line technology is at the center of the process, the results are more efficient and precise. For example, tracking deliveries, installations, and general material flows can be more organized and digitized in a factory setting, reducing the risk of lost and damaged materials. The precision can reduce the energy consumption of the building through thermal bridges, and is also a boon for durability, liability, and safety.

EMPLOYEE SAFETY:

Employee safety improves in FBH projects, with 80% lower reported accident rates than site intensive construction.[21] There are several reasons why factories are less dangerous than on-site work, and costly in terms of worker's compensation. First, factories are a more controlled environment in which to use construction tools. Additionally, outsourcing manufacturing off-site reduces the need for heavy machinery on site after the Site Preparation is complete. Some manufacturers design their workflow so workers avoid ladder work as much as possible, or install preattached protective barriers to modules to further reduce injuries and accidents.

LESS HEAVY EQUIPMENT USE:

Another benefit to moving heavy machinery off-site is the reduction in space, volume and exhaust associated with these activities. Less heavy equipment is a welcome reprieve for neighborhoods near construction sites. There are also fewer days with parking challenges and fewer days of truck deliveries. While the volume of material arriving on site remains high, the number of trips it takes to deliver is diminished up to 70%, reducing noise, traffic, dust and disruption for the neighborhood.[22]

ENHANCED ACOUSTICS:

In completed FBH structures, acoustics generally improve. This is due primarily to the double floor-ceiling that most FBH systems employ, but also to the precision of manufacturing. While it is a trade-off for material use as mentioned above, it is particularly helpful for the building use types that are already a good fit for FBH: hospitality, multifamily, and supportive housing.

DIVERSIFIED LABOR FORCE:

With this disruption in the construction sectors, there are numerous uncertainties about the consequences to the existing labor force, detailed below. One positive outcome is the opening up the labor force to nontraditional construction workers, which is beneficial to both workers and employers. In Katerra's Phoenix factory, for example, women make up 40% of the workforce compared to 9% in the industry more broadly. Although factory pay is lower, income can be more consistent due to fewer delays. Additionally, employees retain the same job site, and the predictability that comes with it.

LIMITATIONS AND RISKS

Factory Built Housing has been demonstrated successfully, albeit sparsely. Public skepticism, labor issues, manufacturing constraints and siting challenges are today's biggest challenges to further deployment of FBH.

PIPELINE INCONSISTENCY:

In FBH factories, a consistent business pipeline is essential. All workers are on one payroll, so if there is a slowdown, all the workers are effected at once rather than being diffused across trades. In order to diversify against the cyclical nature of the building industry, manufacturers need a range of product pipelines: student housing, hospitality, multifamily rental, multifamily owner occupied, assisted living and more.

As mentioned above, many FBH units have both a floor and a ceiling, which gives multiple floor projects added materials. This additional height can impact height limits present in certain zoning areas. In the costly affordable housing market, developers must include more units to be profitable, and height limits can decrease the likelihood that projects contain enough units to be financially feasible.

SKEPTICISM OF NEW TECHNOLOGY:

Inertia and skepticism about new technologies and untried methods is another barrier facing the FBH industry. This is true for consumers whose understanding of prefabricated housing is limited to single family home relocatable units (i.e. “mobile homes”), but also by developers and financial backers avoiding risk (See Financing). However, the stigma appears to be perceived and not experienced; according to HUD, occupants of FBH structures do not perceive the quality to be diminished.[23] Therefore, while stigma is a barrier for consumers generally, that stigma diminishes for occupants who have personally experienced the product.

TRANSPORTATION COMPLICATIONS:

Some FBH projects have experienced modules damaged by inclement weather during transit to site or when placed on-site without necessary protection. Another limitation related to transportation is the size requirements for shipping, rail, and trucking. Unlike materials in the conventional site-built process, modules are required to have an escort on highways, with the widest FBH requiring double escorts. This narrows the range of distance modules can travel expediently, safely, and inexpensively.

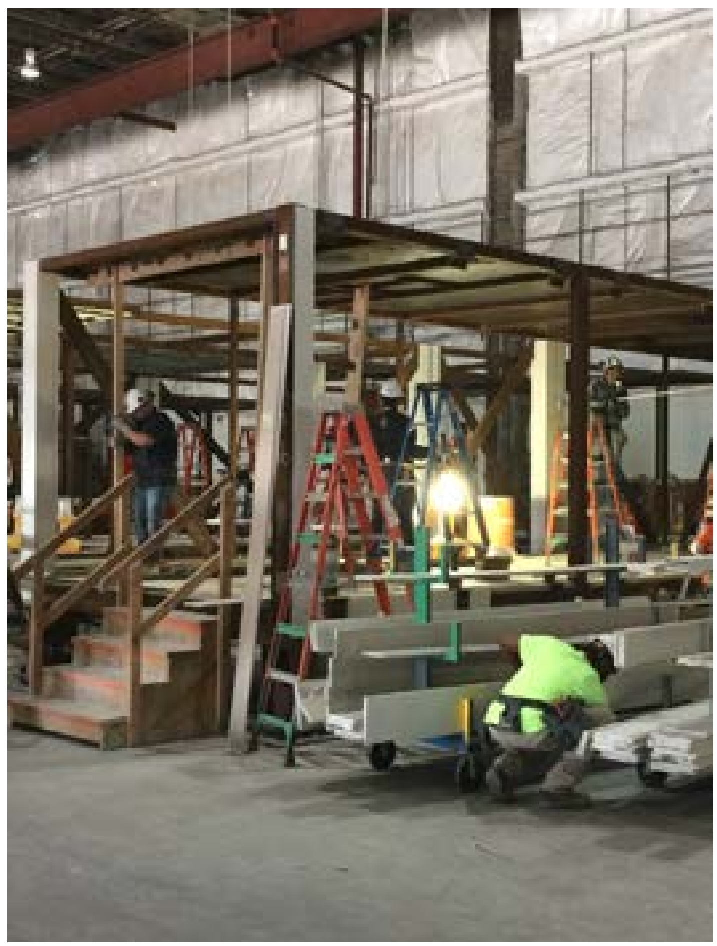
TECHNICAL CHALLENGES

Due to the repeated size and shape of modules, irregular site shapes can be a challenge for design teams. A triangular site might demand some units be asymmetrical, which necessitates deviations from standard FBH construction which could increase cost. Sites must also contain enough space for a staging area. A sloped site may be inhibitive, as it constrains the safe storage and expedient assembly of modules.

ORGANIZED LABOR:

Some organized labor has opposed FBH on the grounds that it is a net loss of union labor and decreases access to construction jobs in communities near sites. For this reason, FBH housing can be imperiled politically. In general, factories are not often unionized, although in the Bay Area both RAD Urban and Factory OS are unionized with the Carpenter’s Union Local 22. In both cases, the management did not resist unionization and the parties have carried out productive negotiations. ZETA Design + Build was also unionized before it went out of business.

In the case of the Carpenter's Union Local 22, union leadership hopes to evolve with the industry, and sees FBH as a promising part of the industy's future. The Carpenter's are one united union at the factory but have different specialties. Other trade unions in the region find fault with this appraoch, noting there could be quality control impacts. For example, some worry the members of the Carpenter's Union can't gaurentee the same quality of work on some tasks that invidual trades unions can. Thus far, the Carpenter's have not experienced issues of this nature, though more research is needed to maintain the both project quality and labor rights are upheld by FBH manufacturers.



FINANCING

In today's nascent industry, Factory Built Housing creates challenges for the traditional models of financing multifamily developments.

The following are two barriers Factory Built Housing faces and corresponding course to move beyond those challenges. Below these are two financing problems FBH has the opportunity to solve due to its lower cost.

CHALLENGE 1: UPFRONT CAPITAL

With FBH projects, there are two challenges traditional construction lenders aren't conditioned to deal with. First, a significant concentration of payment occurs up front. Manufacturers need capital upfront to begin their design, order supplies, and initiate manufacturing. Therefore they might require a significant deposit of 50% of the module cost, or might even require them to be paid upfront in full. If factories do not receive capital in time, they risk missing payments to their suppliers and staff. As a result, developers need financing earlier in the project but consolidating that capital early in the project proves difficult.

Second, construction lenders are conditioned to operating by loaning monthly "draws" as a percentage of work complete. With FBH the percentage of work complete is much harder to determine on site, because so much of the work is occurring in the factory, which lenders don't usually assess.

WAYS FORWARD: UPFRONT CAPITAL

To help ameliorate this issue, the Terner Center for Housing Innovation at UC Berkeley recommends affordable construction loans from lenders who ideally develop digital tracking of material flows, employ inspectors to assess percent complete, and lend based on the manufacturing facility's overall capitalization.[24] These processes would give lenders new to the sector more exposure, while minimizing their risk. California Housing Finance Agency (Cal HFA) is a possible avenue for funding as it already works statewide to distribute affordable housing financing and could implement new financial tools for affordable FBH.

There is no single uniform process for securing upfront capital, either from public or private entities. At least a few public sector sources have financed FBH thus far: New York City Affordable Housing Bonds, federal Housing and Urban Development agency and Federal Home Loan Bank. Panoramic Interests (See Case Study 2) has proposed an assortment of models for public private partnership, including a 99-year lease to Panoramic for a structure built over an existing parking lot, and a turnkey product to be sold outright to the city. Moving forward, agencies could take the lead to make funds available within the time restraints of FBH projects.

CHALLENGE 2: PRICING UNCERTAINTY

For developers to pay upfront, they need to know the cost well in advance. However, the unit costs are notoriously ambiguous. Because the FBH sector is immature, manufacturers don't reliably know their costs, and in turn change their prices as needed. If their suppliers underperform, the factory is impacted as well. For example, curtain wall materials have been a particularly unreliable, but the manufacturers products are contingent on this resource. This uncertainty is unnerving for developers, who need to trust the stability of the manufacturer and plan for the amount of capital they need.

This pricing uncertainty of FBH compounds an existing problem in affordable housing financing. Affordable housing financing takes a number of years to secure. Because construction costs are rising so dramatically, the costs rise while finance is being secured. After the affordable housing developer has secured the financing needed, the next bid may be much higher and the developer must seek incremental financing. With costs rising as fast as they have in the Bay Area, the East Bay Asian Local Development Commission (EBALDC) went through several rounds of this challenge. In the years of searching for financing, the cost of a building system rose over 50%. If FBH has even less established prices than conventional site-built, this financing quagmire could worsen.

WAYS FORWARD: PRICING UNCERTAINTY

To avoid pricing instability as much as possible, developers could partner with the factory and proceed with them through the financing and design process. If developers partner with a factory and manage the process together, manufacturers can be more accommodating with cost estimates and delivery timing. While it is a challenge for manufacturers to confirm whether they can take on a new project in the future, if developers can agree to a certain time span, then manufacturers can provide more certain pricing and delivery estimate. For example, if a developer agrees to initiate manufacture within a nine-month window, the factory can lock in the price and book the assembly line for that period.

Another proposed strategy that moves towards minimizing pricing uncertainty is to encourage large affordable housing developers who can self-finance to pursue FBH. Because these developers like Eden and BRIDGE can provide their own capital, they are much less at risk from costs jumping by 50% than smaller affordable developers would be. This way large developers can prove the concept and lay the groundwork for others to follow.

FINANCING OPPORTUNITIES FOR FBH

While some financing problems are the result of FBH operational differences, FBH also has the opportunity to solve existing financing problems. As detailed above, its lower cost and time savings provide positive financial benefits to developers who can develop more units in less time for less money. These cost and time savings make projects that were not appealing to developers in conventional site-built construction more feasible.

Vacant Lots in Need of Remediation

Brownfield sites in need of environmental remediation are an example of the type of project FBH could make financially viable. The cost of remediation varies greatly depending on the type and extent of contamination. For more expensive sites where the developer would directly or indirectly bear the cost of cleanup, developers could consider FBH to make up the difference. These sites might be particularly attractive for redevelopment but have been passed over by other developers who couldn't find a feasible financial pathway.

Outside of cost, there are no substantial differences between conventional site-built and FBH on a brownfield. FBH is at least as promising as conventional site-built with no additional risks. The projects would be required to follow the same standards. Both would interface with the ground in the same way, and could be sited to be impervious to contaminated soil.

For a few reasons, FBH could indeed be more suitable for brownfield redevelopment than conventional site-built construction. By virtue of having higher tolerances and tighter envelopes, sites undergoing risk-based cleanup may require less extensive remediation though this would be a question for environmental regulators to determine. With Type 1 construction, FBH is substantially lighter weight and could therefore in theory be sited on poorly consolidated soil, further extending the site FBH might work for. In terms of air pollution, FBH projects may be able to afford higher quality MEP systems or HEPA filters.

FHB HOUSING RESOURCE

In the second quater of 2018, affordable housing developer MERCY housing is publishing a handbook for FBH development. This handbook will contains a side-by-side comparisons of FBH and conventional construction, calculate costs, and issue recommendations for pursing FHB.

Long Term Affordability

By virtue of being less expensive, modular also has the opportunity to address other challenges. One challenge communities face that is not addressed by conventional site-built affordable housing is ensuring truly and permanently affordable units. For many occupants of affordable housing, the market will continue to drive prices higher, pressuring occupants and threatening displacement.

Community Land Trusts address this problem by creating community wealth through public-private partnership. Public and private funds can leverage the initial purchase of properties. Then through a "ground lease," individuals and families under a given Area Median Income buy the structure of a home, while the land is separated and owned by the community board. Homeowners obtain a traditional mortgage and begin paying down the cost of the unit, building equity over time. The local board assists owners and implements a resale formula employed when any owner sells their property. Rather than selling it for as high as the market can bear, the formula estimates a sum affordable to someone with the target AMI, plus a credit to the seller for improvements made to the home. Unlike the roughly 50% of first-time, low-income home buyers who revert to the rental market within five years, nearly 90% of first-time, low-income residents of CTL properties remained in their home for five years or purchased another home with the equity they built.[25]

The crucial barrier to initiating CLTs is the upfront cost to buy properties outright. With FBH, CLTs with limited funds are more likely to be able to raise the capital and purchase these properties. As CLTs are focused in urban areas and interested in less costly redevelopment options, brownfields could be a natural fit. Redeveloping infill sites with CLTs turns this land into productive use again.

CLTs built as FBH also share alignment with Community Development Corporations and other advocates for infill development, transit oriented development, and equity. CDCs are also frequently built into the governing process; traditional CLT utilize three-part boards made up of CLT residents, community residents, and public stakeholders including community developers. This pathway encourages the investment of other community based resources such as recreational space, community gardens, commercial space, health clinics, and more. At present, the Oakland Community Land Trust and the other network of the Bay Area Consortium of Land Trusts are seeking partnerships.[26]

CLTs make efficient use of public subsidies, because the value of the subsidies stay with the unit indefinitely. They provide residents power to participate in the development, and remain in control of the land even as prices increase around them. This creates permanent affordability and protects again involuntary displacement. With a dedicated bond in a city's capital, budget, CLTs can begin environmental remediation and redevelopment of new homes on vacant lots as well as purchasing existing housing units.

BUILDING CODES AND PERMITS

For project teams with limited experience in Factory Built Housing, navigating the code and permit requirements can be burdensome. Standaization of approval process from public agencies will reduce the barrier to entry for affordable housing projects using FBH.

There are a few challenges to navigate when submitting for permits and code compliance on a FBH project. The following is a characterization of what processes are different from conventional site-built design and construction and course of action to meet those challenges.

Challenge 1: Determining Building Code Applicability

The US Department of Housing and Urban Development distinguishes between mobile homes and FBH. Whereas mobile homes must be constructed on a permanent chassis and are subject to other federal oversite, all FBH including converted shipping containers, instead fall under the same building codes as the state, local, or regional where they are sited.[27]

Unlike conventional site-built housing, the California Department of Housing and Community Development (HCD) administers the construction and remodeling of FBH in California.[28] Consequently, HCD has jurisdiction over all modules, both in the factory and on-site. HCD manages inspections through a third party. This HCD appointed reviewer approves only the factory-built portion of the project.

On the other hand, all site-built work—the foundation, the podium, the roof, stairs and the exterior building skin—fall outside of state jurisdiction and are approved by local agencies. Once the entitlement process is complete, two separate permit sets must be submitted to the state and city. For developers and project teams with limited experience in FBH, the process of submitting these separate building code compliance packages can be unclear.

In addition to compliance with the standard local building codes, new development projects in Oakland must meet the CA Green Building Code, known as Cal Green, conform to Oakland's Green Building Ordinance and obtain Green Point Rated (GPR) or LEED certification. The GPR or LEED certification processes follow design and construction.

Way Forward 1: Determining Building Code Applicability

Lowney Architecture in Oakland has submitted a range of FBH designs for approval, and has developed a process chart that describes permitting steps and jurisdictions (See Appendix II). Alongside the chart is a narrative describing an overview of the permit approvals process, consultants involved as well as recommendations for navigating the dual permit process. As part of Lowney's process, they produce two permit sets, one for the state and one for the local government. By highlighting only the pertinent details for the given agency, and graying the inapplicable information, the process helps ensure reviewers can see what they are looking for. An example of these drawings is provided in the Appendix III. For a complete matrix of FBH code applicability, see Appendix IV.

New projects can better avoid challenges by meeting with the architect, contractor, manufacturer and HCD reviewer at inception to ensure all codes and requirements are understood as well as using one architect and consultant team for both scopes of work (site and factory).

Finally, another way forward is for a HCD to distribute explicit standards or a checklist outlining the required compliance documentation for HCD and for local jurisdictions. This checklist would assist project teams in submitting codes, especially those that are navigating FBH codes for the first time. As a model, the Department of the State Architect (DSA) uses a similar checklist to show what exactly is needed for compliance.

Challenge 2: Inconsistent Administration of the Code

Because local governments have different priorities and outlooks, local agencies have different conventions for enforcing code. Because FBH are sited within their jurisdiction, some agents want to double-check modules that arrive in their jurisdiction after being approved by the state. Agents in some districts lack trust in HCD's third-party reviews, and may ask to review certain components of the modules.

Way Forward 2: Inconsistent Administration of the Code

Developers could review what aspects of the building fall in each agency's jurisdiction, and also be prepared for double inspections. Project teams can expect local jurisdictions to be more stringent when it comes to fire proofing and plumbing, and should be prepared to demonstrate compliance through a secondary inspection for these systems.

Challenge 3: Streamlined Permitting Approvals

Some blame a burdensome permitting and environmental approvals process for blocking development that could address the scarcity of affordable housing in the region. This challenge is not unique to FBH, but another example of an existing problem compounded by FBH. Permitting approvals can be lengthy and onerous. For conventional site-built projects, permits are often delayed by the bureaucratic process and slow the project schedule. More specifically, many developers feel environmental quality review required by the California Environmental Quality Act (CEQA) is a major source of unnecessary delays.

Because FBH permits may be subject to incremental discretion, this can further compound the protracted permitting procedure. This can be problematic for FBH development in particular, as manufacturers are locked into a schedule early on. If their entitlement or permit is delayed, the project falls behind at a crucial phase.

Way Forward 3: Streamlined Approvals

During the 2016 and 2017 California legislative session, lawmakers aimed to streamline the permitting process as one means of addressing the underbuilding occurring during the housing crisis. One bill lawmakers passed eliminates CEQA requirements for certain developments. Senate Bill 35 allows for “by right”, or streamlined, approval process for infill developments in local districts that have not met their regional housing goals. The “by-right” process allows for a different approval track that avoids public hearings, administrative review, and CEQA review.[29] The statehouse passed Senate Bill 35 alongside Senate Bill 2, a fee on real estate development to support affordable housing, Senate Bill 3, a $4 billion housing bond, and twelve other housing-related bills.

For local governments, there is still remaining uncertainty about how these laws will impact their jurisdictions. The law is triggered for cities that do not meet their Regional Housing Needs Assessment goals. According to HCD, over 97 percent of California jurisdictions do not meet their Regional Housing Needs Assessments and are subject to the law.[30] The law requires further local action to facilitate its implementation, and it is likely that local governments will need to further investigate what is required for their locality.

There is disagreement over whether SB 35 will meaningfully address the permitting difficulties enough to impact the housing crisis. On one hand, the real estate community still sees far too many barriers to expedited permitting that remain unaddressed in the legislation. On the other hand, some social justice advocates find the bill removes one of the few tools they have to slow development they worry will cause displacement in their community. Local governments may consider evaluating how to remove barriers to permitting affordable housing, whether it is "by-right" or otherwise.

NEXT STEPS

Barriers to using FBH for affordable multifamily projects can be addressed to enable faster, healthier, and more sustaianble housing develoment within priority development zones.

Deploying FBH is an opportunity to reduce the cost and lower the impact of affordable multifamily development in the Bay Area. Though there is still uncertainty in the market, a number of the current challenges will diminish as more projects are built with FBH. With foresight, and perhaps most importantly with practice, the various risks can be understood, managed, and mitigated. Project teams, local planners, construction lenders, investors, and policymakers could consider the following:

» The Department of Housing and Community Development could publish explicit standards outlining the code submittal requirements for FBH. Similar to standards published by the Department of the State Architect, this may clarify the complex process and help resolve confusion for inexperienced project teams.

» Traditional construction lenders have little understanding of how best to lend for FBH. As lenders develop expertise, Cal HFA is one statewide agency that could help provide a possible avenue for securing upfront capital for FBH projects.

» Large affordable housing developers are primed to pursue FBH for their developments. Some such as BRIDGE and MERCY have already expressed interest and built projects. By virtue of their ability to self-finance, large affordable housing developers can avoid some of the pitfalls like price escalation smaller affordable developers encounter. Additionally, by placing large, repeatable orders with manufacturers, they lay the groundwork for a more robust market, where manufactures have more certainty about their suppliers, prices, and product.

» Explore synergies between siting multifamily affordable housing FBH on brownfields, in priority development areas, and near transit nodes. Local and regional planners can employ this as a method of compliance for the Sustainable Communities Protection Act and best practices in urban planning more generally.

» Local governments could explore streamlining the CEQA process. For the vast majority that have not met their Regional Housing Needs Assessment goals, local jurisdictions can evaluate how this process will be facilitated by recent state legislation.

» More research is needed on health, sustainability, and labor implications of modular housing. While cost and schedule savings are more robust, detailed analysis on life cycle impacts, longitudinal operational energy use, quality assurance, and impacts on local labor are more uncertain.

In the appendices below are further resources for use by project teams, developers, planners, policymakers, and other stakeholders. Appendix I features a matrix of global FBH firms along with three lessons from project case studies: limiting excess materials, developing more standardized modular units, and choreographing process efficiency. Appendix II provides more information for building code and permitting questions, and Appendix III demonstrates one possible practice for clarifying code submittals. Appendix IV is a chart of which codes apply to various project types. Finally, Appendix V is a visualization of ways forward suggested by participants of the Focus Group.

APPENDICES

APPENDIX I

BEST PRACTICES: CASE STUDIES

To understand the range of manufacturers in the space, this report reviews nine domestic and international FBH manufacturers. In Figure 4, key details are provided for each. Below are three notable case studies that demonstrate high performance in three distinct areas. First, RAD Urban has limited excess materials and weight to build lighter with less. Second, Panoramic Interests has developed a standardized unit that is the same from project to project. Third, Broad Sustainable Buildings has pioneered standardization and coordination to achieve rapid construction speed.

COMPANY	ATTRIBUTES							
	Typologies	Year Founded	% Off-Site Work	Height (Stories)	Design Location	Manufacture Location	Construction Type	Built Affordable to Date
Panoramic Interests	4 and 5	1990	very high	4-11 with plans for 25	Bay Area	China	Type 1 and 2	Yes
Lindbacks	4 and 5	1942	very high	2 to 8	Sweden	Sweden	Type 2 and 3	Yes
Tempo Housing	4 and 5	2002	very high	2 to 6	Netherlands	China	Type 1 and 2	Yes
Guerden	4	2001	moderate	2 to 6	Idaho	Idaho	Type 2 and 3	Yes
Factory OS*	4	2017	moderate	N/A	Bay Area	Bay Area	N/A	N/A
ZETA Design + Build†	4	2009	moderate	2 to 6	Sacramento	Sacramento	Type 2 and 4	Yes
Full Stack	4	2008	moderate	up to 32	Bay Area	Bay Area	Type 1	Yes
RAD Urban	3	2009	very high	3-6 with plans for 29	Bay Area	Bay Area	Type 1 and 2	No
Broad Sustainable Buildings	2	2009	very high	30 to 57	China	US, Europe and China	Type1	No
Katerra	2	2015	moderate	2 to 6	Seattle	Spokane, Phoenix	Type 2 and 3	No

* Expected late 2018
† No longer exists

Figure 4: Building System Attributes

Appendix 1 features a matrix of global FBH firms. They are sorted by typology, and vary in percent of off-site work, height, and construction type.

RAD URBAN

RAD Urban is an all residential vertically integrated FBH design, developer and manufacturer. Their focus is on urban infill, grounded by the philosophy that urban living provides economic opportunity, lower resource consumption, and higher quality of life. RAD Urban's vision is to iteratively refine its FBH product towards projects that are lighter, faster and more effective than conventional site-built construction. Eventually RAD Urban envisions scaling its projects such that its high rises are the cheapest on the market, adding housing stock and discouraging the economic forces that encourage cheap but resource intensive suburban sprawl. RAD is moving towards higher Type I construction; they are beginning a 29-story tower which will be among the tallest FBH structures in the country.

To do this RAD Urban has identified inefficiencies in conventional site-built construction and minimized them. From its earliest projects, RAD Urban has avoided superfluous materials and focused on lighter weight materials that bear heavier loads. They have relied on steel rather than lumber, which eliminates the need for double interior walls and double floor-ceilings which most FBH relies on. Consequently, RAD Urban's projects weigh around 1/3 of an equivalent structure. Because product weight is a correlated to the volume of resources necessary to extract, fabricate, and transport it, the impact is likely significantly below buildings with more mass.

Another lesson from RAD Urban is the level of integration of their project team. In traditional projects, subcontractors and consultants are contracted to deliver one piece of the total project scope. When something goes awry, this arrangement encourages self protection over collaboration. In contrast,. RAD Urban restructured the project team such that the design, engineering, and fabrication occurred under one roof. Knowing that mistakes would happen during innovation, RAD Urban bet that it's integrated team would be able to fix it more efficiently than the conventional contractors.

PANORAMIC INTERESTS

Unlike most other FBH firms, Panoramic Interests has developed a standardized unit that is the same from project to project. Most FBH manufacturers build custom modules specific to the project. Panoramic has developed the MicroPAD, an eye-catching FBH unit that functions as the central building block of Panoramic's homeless housing strategy, which is the basic unit for their FBH projects.

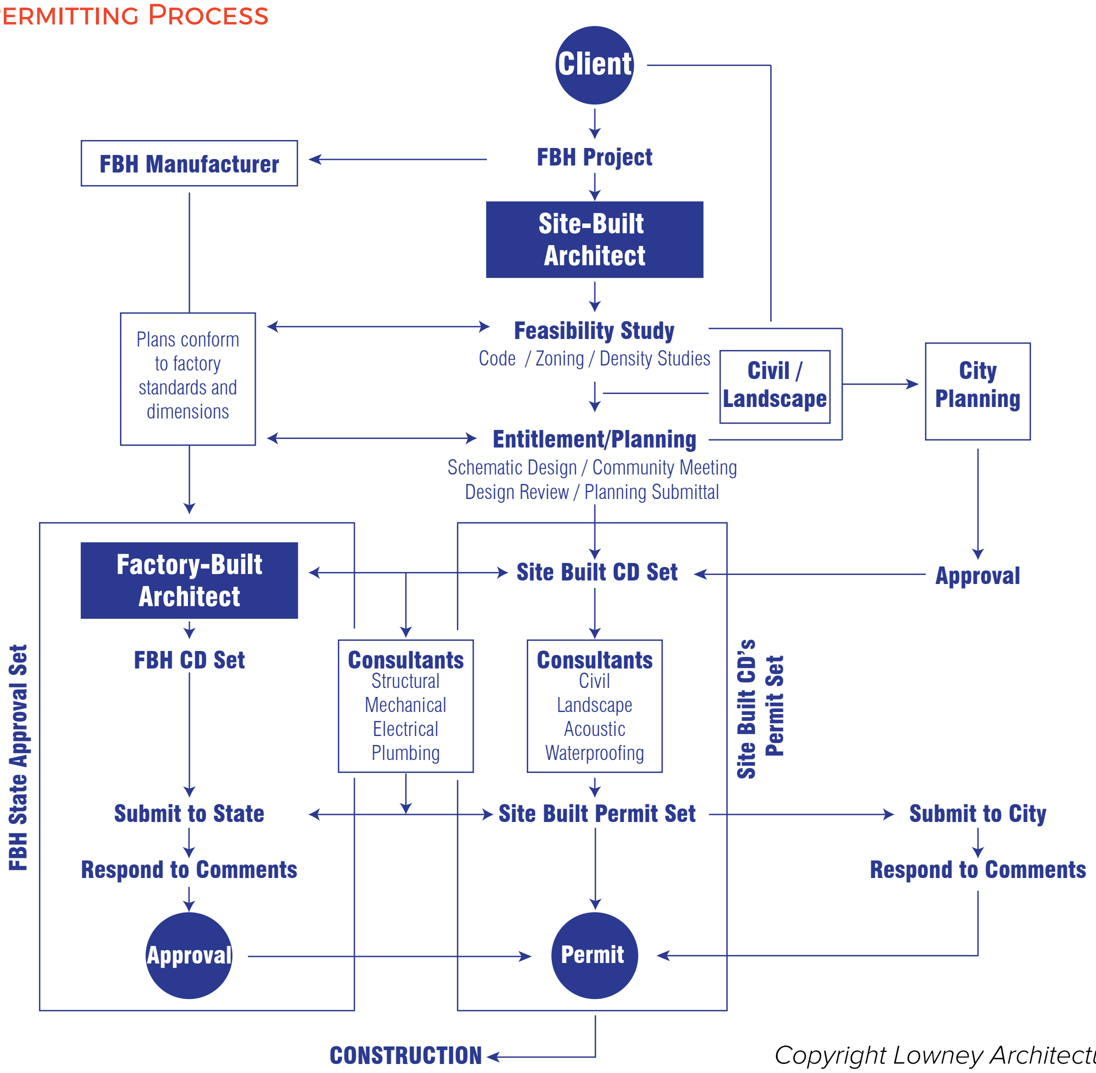
Not all development projects Panoramic pursues are FBH, but they have used the MicroPAD both in past projects and plan to use it for future ones. Many of the projects on their "CITYSPACES" line feature the MicroPAD, which are steel bodied units that come in three sizes—one person, two-person and four-person. These projects fit into the Typology 5: Complete on the Off-site Spectrum (See Figure 1), as they arrive on site with shower, countertop, and appliances built in—even a curtain rod and a toilet paper holder. The units are self-contained with seven foot windows, fabricated, inspected, and tested off site transported on ship, train, and truck. Panoramic prioritizes energy efficiency in all of their properties, and designed the MicroPAD to perform highly in this regard. Singles are one room dormitories with nine foot ceilings, flood and fire protected, meet ADA accessibility requirements, and can be relocated if necessary. As the FBH matures, there will likely be much greater unit standardization, similar to the MicroPAD.

BROAD SUSTAINABLE BUILDINGS

Broad Sustainable Buildings (BSB) is an ambitious firm headquartered in China notable for their speed and coordination. The company got the attention of the construction industry when it completed a thirty-story T30 tower in 15 days. Since then, BSB has differentiated itself through meticulous standardization which allows for expedited coordination of each stage of the manufacturing and assembly process. BSB projects have a standardized floor plate comprised of module segments. Using lean manufacturing principles, the floors and ceilings are built in sections with preinstalled ducts for HVAC, waste, hot and cold water. Packaged together, one truck carries everything needed to assemble two modules including columns, tools, bolts, ducts, and panels. As loads arrive on site they are towed as an entire package. Upon placement in their destination, packages are snapped in place and affixed together in a series of brief and standardized tasks by a small team. The role of on-site workers is primarily to connect columns, panels, piping and wiring to attach the new segment to existing segments. The result of this fastidious procedure is rapid speed; Mini Sky City, BSBs tallest tower to date at 57 floors, rose at a rate of three floors per day. BSB is seeking permission to build a 2,749-foot super tall building dubbed Sky City, planned to be the tallest skyscraper in the world. Beyond the height and speed, BSB's most valuable contribution may be its process rather than its product. The precision and organization of its manufacturing provides a replicable cast study for all projects considering FBH construction.

APPENDIX II

Modular Permitting Process



DESCRIPTION OF MODULAR WORK PROCESS

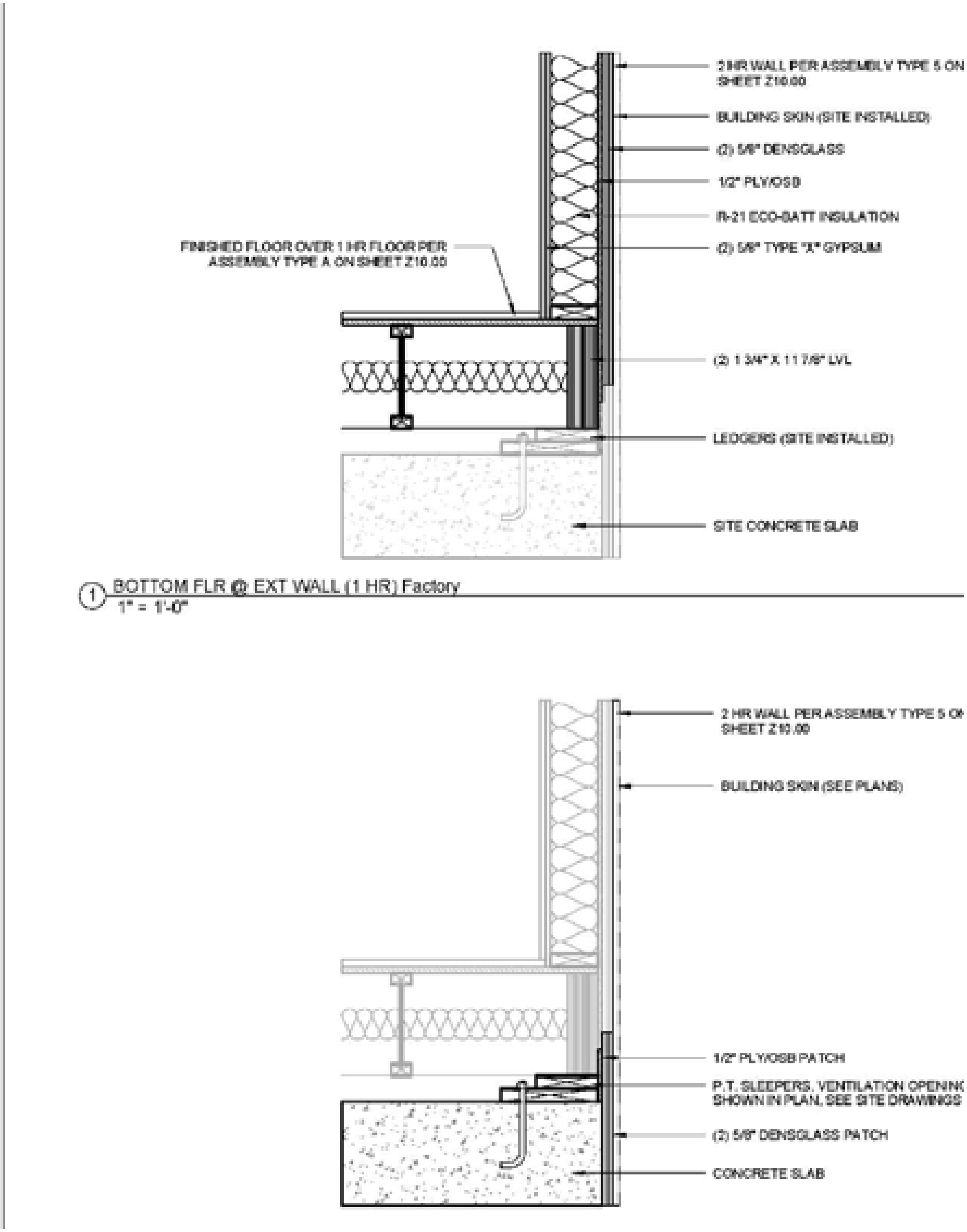
When incorporating Factory Built Housing technology into a project, the front end approval process is split between the State and Local Municipality. This dual process for approvals slightly increases the scope of work for Architecture and Engineering services. This increase in upfront work is offset by the 40 - 50% time savings on the construction schedule. We recommend when the client starts a project and is considering utilizing factory built housing, they engage a factory, an experienced architect, and a contractor. This will ensure project plans conform to the design parameters of the factory and that estimations are more accurate.

Above we have outlined the approval process and work flow for a typical project. We also indicate the consultant teams required to complete the work. The Factory preference is to work with experienced architecture and engineering consultants to streamline the production of CD's and state approval process. Clients on occasion have selected to work with other architects and engineering teams for the site work. This process, while workable, is not ideal and requires additional steps in coordination and will lengthen the schedule for the CD and approval phases. The preferred method is to work with one architect and consultant team for both scopes of work.

When starting a project in the entitlement phase, it is critical that the plan layout and building height conform to the parameters of the factory built housing (FBH). Once these items are resolved, the coordination with site work to complete entitlement work can be completed. Following the entitlement phase, the dual CD phase begins. In this phase, two sets of CD's are created: one set of CD's is for the factory-approved components by the State department of Housing and Community Development; and one set of CD's is for all the site work to be approved by the local municipality. These sets are created in tandem, and typically submitted to the separate review agencies around the same time. State approval is typically required before the local permit can be issued.

APPENDIX III

Section



The above diagram demonstrates one possible practice for project teams to clarify code submittals for public agencies. By greying out the aspects not relevant to reviewers, architects help reviewers to see the components they need to inspect, while providing the context of how each system fits together.

APPENDIX IV

CODE MATRIX

STATE OF CALIFORNIA

DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT
DIVISION OF CODES AND STANDARDS

MANUFACTURED AND FACTORY BUILT HOUSING PROGRAMS – CODE MATRIX

HCD MH 605 (Rev 03/2014)

• **Unit Type** • **Definition**	• **Authority** • **Construction Standards**	• **Accessibility**	• **Fire Sprinkler System**
• **CM** • HSC 18001.8	• HSC 18028 • CCR T25, 2013 CBSC *(Effective 01.01.2014)* [1,2]	• CCR T24, CBSC Chap *11B*	• Authority – HSC 18015 • Construction Stds – CCR T25, 2013 CBSC
• **FBH** • HSC 19971	• HSC Div 13, Part 6 • CCR T25, 2013 CBSC[2]	• CCR T24, CBSC Chap 2 & 11A[3] or 11B *(Privately or publicly funded)*	• Authority – HSC 18015 • Construction Stds – CCR T25, 2013 CBSC
• **MFMH** • HSC 18008.7	• HSC 18008.7 • 24 CFR MHCSS, Part 3280	• CBC, Part 2, Chaps 11A or 11B *(Privately or publicly funded)*. See CBC, Part 2, Chap 1 for application and scoping.	• Authority – HSC 18015 • Construction Stds – CCR T25, Chap 3, Art 2.5; NFPA 13D 2010 *(Only when required by ordinance – See Below)*
• **SPCM** • HSC 18012.5	• HSC 18028 • CCR T25, Chap 3, Subchp 2, Art 1, 3.5, HSC Div 104, Part 7, Chap 4, Art 12 *(Food preparation units)*	• CCR T24, CBSC Chap 11B *(SPCM's as module of a permanent building and/or for public use)*	• N/A • Exception: HSC 18029.4 *(SPCM's as a module of a permanent building)* • Exception, Construction Stds – CCR T25, 2013 CBSC
• **MH** • 24CFR MHCSS T24, Sec 3280.2	• 24CFR MHCSS T42, Chap 70 • New construction: 24CFR MHCSS, Chap XX, Part 3280. Alterations & conversions: HSC 18029, 4050(b) & (c)		• Authority – HSC 18015 • Construction Stds – CCR T25, Chap 3, Art 2.5; NFPA 13D 2010 *(Only when required by ordinance – See Below)*
• **MH / FS Systems** – Private Property			• Valid local ordinance required • Design / Installation Stds established by HCD
• **MH / FS Systems** – Mobilehome Parks			• FS not required in HCD jurisdiction parks • FS in parks under LEA – Only when required by local ordinance

Acronym Key – Unit Type	Acronym Key – Laws and Regulations	Acronym Key – Codes
CM – Commercial Modular FBH – Factory-built Housing FS – Fire Sprinkler Systems MH – Manufactured Home MFMH – Multifamily Manufactured Housing SPCM – Special Purpose Commercial Modular	CCR – California Code of Regulations 24CFR – Title 24, Code of Federal Regulations HSC – (California) Health and Safety Code MHCSS – (HUD) Manufactured Housing Construction and Safety Standards	CBC – California Building Code CBSC – California Building Standards Code LEA – Local Enforcement Agency MHCSS – (HUD) Manufactured Housing Construction and Safety Standards NFPA – National Fire Protection Association

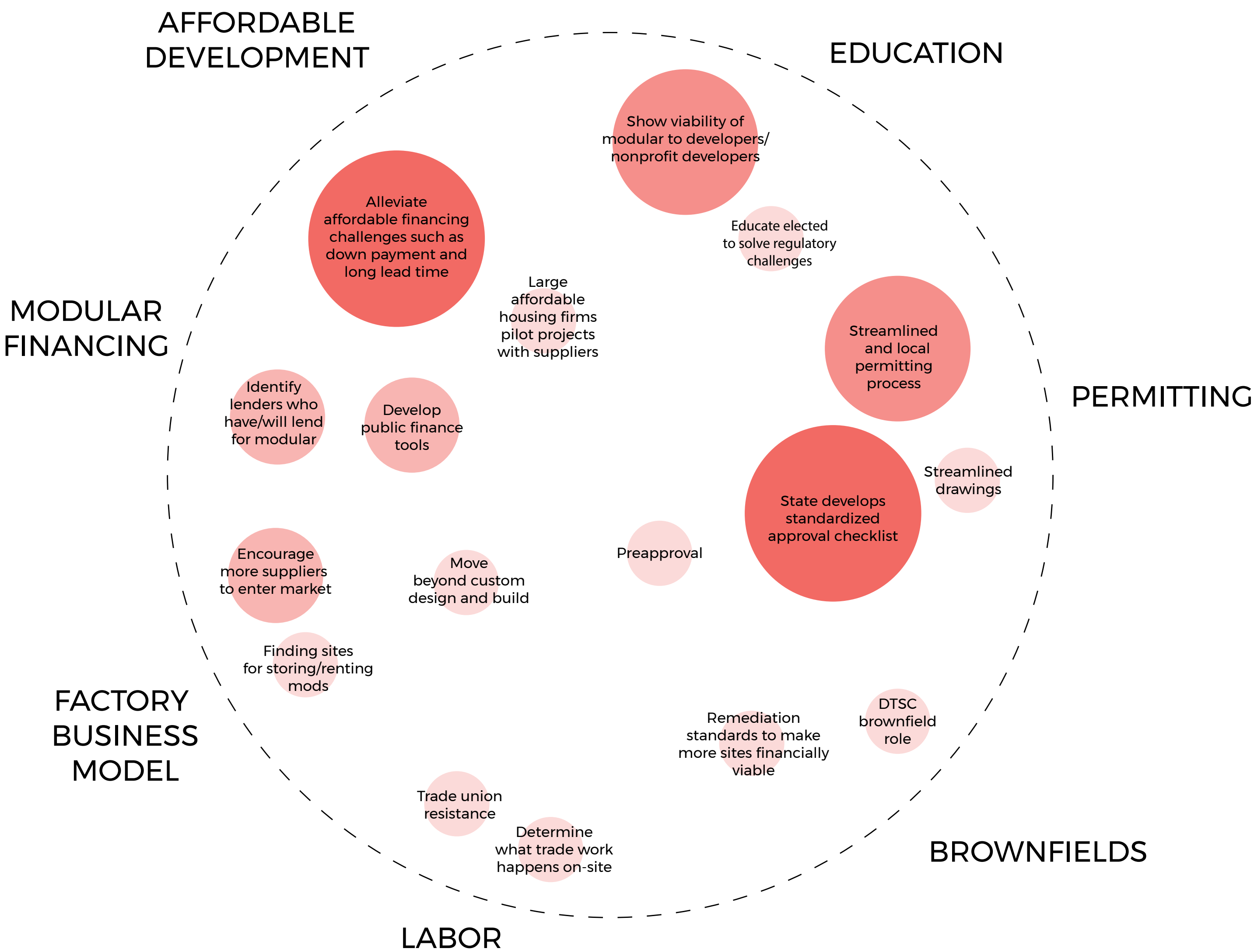
[1, 2] Includes Part 2 – CA Building Code; Part 2.5 – CA Residential Code; Part 3 – CA Electrical Code; Part 4 – CA Mechanical Code; Part 5 – CA Plumbing Code; Part 6 – CA Energy Code; and, Part 11 – CAL Green Code. *Part 6 – CA Energy Code, and affected Energy portions (only) of CAL Green Code, Part 11 effective 07.01.14.*

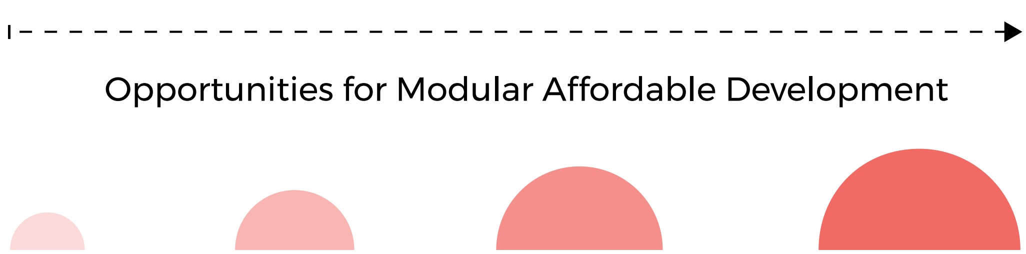
[3] Chap 1, Sec 108 for application of these standards for covered multi-family dwelling units; Chap 1, Sec 108 for public accommodation buildings *("covered" under disability/accessibility requirements of Chapter 11A).*

The above chart indicates which codes apply to various project types.

APPENDIX V

Lessons From Focus Group





During the Focus Group, participants were asked to consider the top three opportunities that would support the FBH market. Their responses are mapped here in this visualization. The size of the bubble indicates the number of participants who concurred

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ABOUT WSP

WSP USA, formerly WSP I Parsons Brinckerhoff, is the U.S. operating company of one of the world's leading engineering and professional services firms—WSP. Dedicated to serving local communities, we are engineers, planners, technical experts, strategic advisors and construction management professionals. WSP USA designs lasting solutions in the buildings, transportation, energy, water and environment sectors. With nearly 7,000 people in 100 offices across the U.S., we partner with our clients to help communities prosper.

ABOUT BUILT ECOLOGY

Built Ecology is an integrated national practice within WSP that is dedicated to the goal of creating a sustainable built environment. Our team of professionals brings strategic thinking, industry leadership and technical depth in collaboration with WSP's building, transportation, and environmental engineering and infrastructure capabilities. We support WSP's cross-sector sustainability initiatives, helping to position WSP as a leader in the field, driving sustainability into all aspects of the company's work and internal operations.

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