Understanding the Challenges of Financing Modular Construction: A Case Study for Prospective Multifamily Units

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Office of Energy Efficiency & Renewable Energy
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List of Acronyms

ABC	advanced building construction
APR	annual percentage rate
BTO	Building Technologies Office
DOE	U.S. Department of Energy
GC	general contractor
HUD	U.S. Department of Housing and Urban Development
IRA	Inflation Reduction Act
LOI	letter of intent
LTC	loan-to-cost
MBI	Modular Building Institute
MEP	mechanical electrical and plumbing
NREL	National Renewable Energy Laboratory
NZE	net zero energy
O&P	overhead and profit
OEDIT	Office of Economic Development and International Trade
PACE	property assessed clean energy
PMC	permanent modular construction
SF	square feet
WRB	water-resistive barriers

Executive Summary

Compared to traditional site build, modular construction can significantly shorten construction schedules and speed income generation. Modular construction may also reduce construction costs. Yet access to commercial financing remains one of the most significant barriers to modular construction. Materials must be purchased, and production lines reconfigured for each project months ahead of fabrication. Materials alone can be 60% or more of the total cost of production. As a result, manufacturers require large upfront deposits—often 30% or more of the off-site contract. In addition, the capital-intensive nature of modular construction requires frequent progress payments for manufacturers to maintain cash flow. For those lenders willing to fund modular projects, many require the developer to share more of the risk. This may include the developer paying for line reservation fees and material deposits 3–6 months prior to production. Because these are unsecured loans, interest rates may be higher and loan amounts lower. As suppliers, modular manufacturers discourage retainage. Together, these and other factors may contribute to higher equity requirements for the developer—particularly at the beginning of the project.

This report and associated research contribute by comparing risk and possible benefits across site built and modular example project financing models. The University of Nebraska–Lincoln held 10 interviews with modular manufacturers and lenders, and specific detailed projects and cash-flow analysis have been highlighted. From this, two comparisons have been developed to highlight the difference between traditional site building and modular multifamily construction.

The two modeled case studies compared 1) traditional site build to 2) modular and off-site builds for a 200-unit multifamily, multiunit building. The hypothesis of the comparison is that for a large commercial multifamily construction project, using modular and off-site construction can lead to time savings, cost savings, and better standardized build qualities compared to the same building constructed using conventional site-build techniques. Results from this case study suggest developers' equity requirements may be as much as 30% higher for modular construction ($18.2M) compared to site-built construction ($13.6M), particularly at the beginning of the project. For the 200-unit multifamily building, if modular construction is used compared to site build, a 6-month construction time savings is possible (15 months for modular compared to 21 months for site build).

Modular developers are integrating alternative financing approaches and partnering with local lending partners who understand the modular construction and cash flow process—suggesting solutions for the broader industry to scale. State affordable housing agencies are attempting to address some of these barriers with housing innovation funds and loans to create regional solutions. The learnings from this report will be disseminated to members of the advanced building construction (ABC) and broader off-site financing and development communities to provide confidence in the modular construction of multifamily buildings. As part of future research, it is recommended to continue investigation into modular construction for single-family and multifamily communities—e.g., Pinion Park in Colorado—and compare results to multifamily, multiunit buildings and potentially apply the learnings. Further research is also recommended on the development of incentives to create greater standardization and a more favorable market environment for modular construction.

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1 Introduction

The National Renewable Energy Laboratory's (NREL's) Industrialized Construction Innovation team, with partners from the School of Architectural Engineering and Construction at the University of Nebraska, have undertaken this research to enable affordable, net zero energy (NZE) modular multifamily buildings. Prior work has investigated the specific need and plan to increase the "optimal integration of energy efficiency strategies during Industrialized Construction (IC) with little or no additional cost, labor, and production time" (Pless et al. 2022). This report explores specific project financing and cash-flow considerations of modular and off-site construction as a potential and viable way to increase the deployment of industrialized construction practices—mainly by highlighting one case of modular construction compared to one case of site build. To note, NZE buildings are not the focus of this work, but modular and off-site construction can effectively be used as a mechanism for providing cost-effective NZE buildings' envelope and mechanical, electrical, and plumbing (MEP) systems (Pless et al. 2022).

This report seeks to evaluate and educate the broader off-site financing and development community, who struggle to overcome financing barriers that come from a legacy approach set up for on-site construction processes. In addition, this report is aimed at helping the Building Technologies Office (BTO) and researchers further understand the key aspects of the financial benefits and difficulties associated with permanent modular construction (PMC). PMC are units or modules built at a manufacturing or fabrication facility off-site and then delivered prebuilt to site for a permanent foundation (Kamali, Hewage, and Sadiq 2022; MBI 2023).

This work adds to BTO's efforts to help deploy IC practices through the Advanced Building Construction (ABC) Initiative. The BTO mission is to develop, demonstrate, and accelerate the adoption of cost-effective technologies, techniques, tools, and services that enable high-performing, energy-efficient, and demand-flexible residential and commercial buildings in both the new and existing buildings markets, in support of an equitable transition to a decarbonized energy system by 2050, starting with a decarbonized power sector by 2035 (DOE BTO 2023b).

This report includes a case comparison developed by the University of Nebraska–Lincoln. Ten interviews were conducted with modular manufacturers and lenders, and specific detailed projects and cash-flow analysis have been highlighted. From this, a comparative case study has been developed to highlight the difference between traditional site build and modular multifamily construction.

The two cases compared 1) traditional site build to 2) modular off-site builds for a 200-unit multifamily, multiunit building. The hypothesis of the case studies is that for a large commercial multifamily construction project, using modular and off-site construction can lead to time savings, cost savings, and better standardized build qualities compared to the same building constructed using conventional site-build techniques.

1.1 Benefits of Modular, Prefabrication, and Off-Site Construction

IC focuses on using standardization and advanced production processes—which include off-site production, prefabrication, and modular construction—to reduce the costs (both for site construction and off-site assembly) and increase the potential for energy efficiency and decarbonization (NREL 2022). Traditional site-build construction also uses some prebuilt parts/components, where most of the activity in constructing the building is unique to the specifications. Prefabrication and modular construction aim to industrialize significant portions of the construction processes where product and process quality can be more controlled through a repeated process. Modular units and prefabricated panels still require final assembly on-site.

As shown in Figure 1, product innovation (e.g., prefabricated parts and panels off-site) and process innovation (e.g., factory assembly line manufacturing, standardized assemblies, consistent quality control processes, and modular units that can arrive partially prebuilt), can lead to time, cost, and system benefits. Instead of the project being fully built on-site like traditional construction, the project is optimized and maximized with off-site processes and minimized on-site tasks.

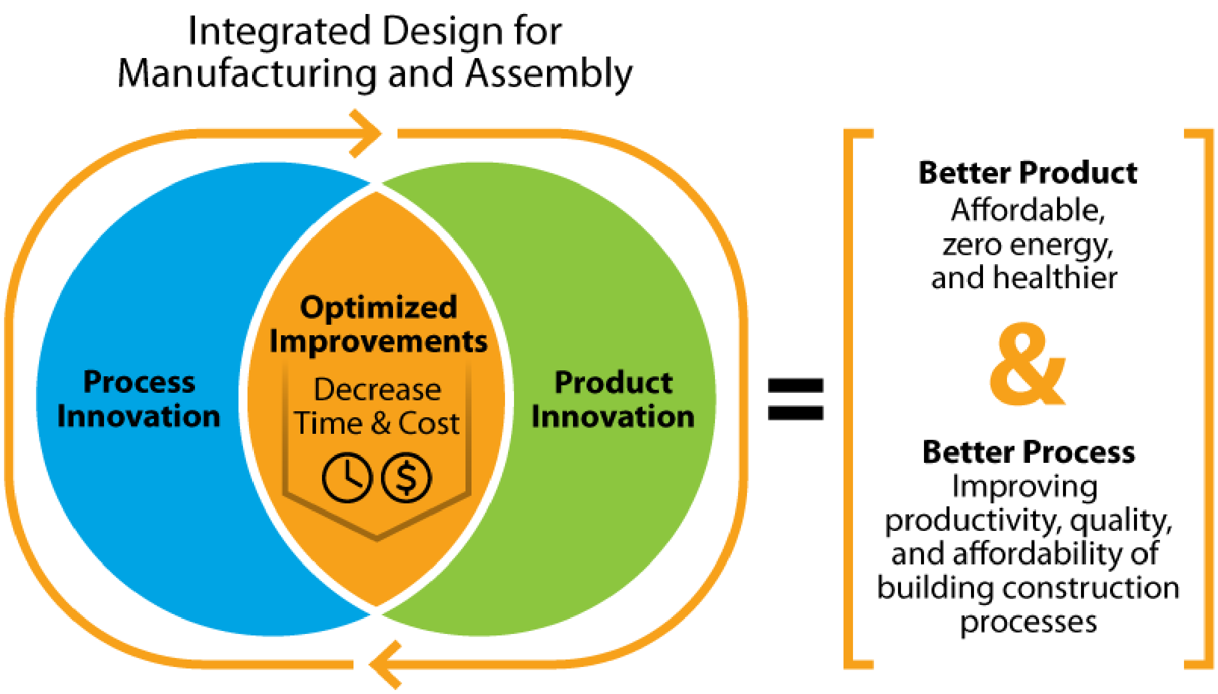

Figure 1. Integrated process and product innovation support the design, development, and delivery of net zero, factory-built buildings

Credit: (NREL 2022)

Key benefits of modular and panelized construction include direct cost savings, for example, where consistent build quality, the elimination of change orders, and finishing can be used in multiple units (MBI 2023). The use of modular construction increases the off-site fabrication and assembly of the modular units, the building affordability, and the costs of construction. When modular construction is implemented well, the traditional construction time for the final building can be reduced potentially 40%—and with a 20% reduction in construction costs (MBI 2023). For example, a 193-unit building with 155 modules was found to have reduced the project timeline from 24 months for a traditional site-build construction approach to 14 months using modular construction (MBI 2023). Modular construction also reduces uncertainty and project overruns (commonly 25%–50%) and can accelerate build times (Bertram et al. 2019).

1.2 Markets

Despite the previously stated benefits, modular construction has been slow to gain market share, especially in the United States. In 2022, the modular construction global market was valued at approximately $103 billion (B), with an expected compound annual growth rate of 5.5% per year from 2023 to 2028 (Bailo 2022).

Post–World War II to rebuild cities, the United States and Europe in the 1940s and 1950s and the United Kingdom (UK) in the 1960s and 1970s experienced periods of need for quick construction and improved social welfare. In those times, modular construction began to grow, but the growth was not sustained. In the United States, as in other parts of the world, the expense of setting up and maintaining the manufacturing facilities, the uneven pipeline of projects, and lack of interest in investing have traditionally been barriers to the continued growth of modular construction (Erlich 2023). This is discussed in more detail in Section 2.

Modular construction has been used in markets globally such as the United States, the UK, Japan, Scandinavia, Germany, and China. Typically modular growth in countries such as the United States, the UK, and Australia has been driven by significant housing supply shortages and the cost and insufficient supply of skilled labor (Bertram et al. 2019). In the UK, there is approximately a 100K per year shortage between the housing units being built (200K/yr) and the demand (300K/yr) of needed housing (Bertram et al. 2019).

In the United States, a significant shortage of residential homes, high construction costs, and the drive for sustainable construction are likely to be important factors for modular construction uptake (Frost & Sullivan 2023). For example, in California, a 3.5 million (M) unit shortage must be closed by 2025 (Bertram et al. 2019). The most populous states in the United States—California, Florida, Texas, and New York—have a total housing shortage of nearly 1.8M units (Summers 2023).

In the United States, with few developers or manufacturers, modular construction has yet to be used to its full potential. In contrast, Scandinavia (e.g., Finland, Norway, and Sweden) has nearly 45% of the housing market constructed off-site because of factors such as the difficulty of building in severe winters and low light (Bertram et al. 2019). Most countries have notably less market penetration for off-site and modular construction. Japan, Germany, and China have 15%, 10%, and 6%, respectively, for off-site and modular construction. The United States has approximately 3% in off-site construction (Bertram et al. 2019).

1.3 Focus Areas

This report focuses on modular construction of commercial multifamily buildings using PMC. For this report, other building types that can use modular construction—e.g., manufactured homes, single-family homes, hospitals, and healthcare and office buildings—are out of scope, though they could have similar benefits such as cost, time, and energy savings.

2 Challenges and Opportunities in Financing Modular Construction

Project developers seek to maximize profit while minimizing investment capital and risk. IC could shorten project schedules, reduce costs, and speed income generation. One of the most significant barriers to industrialized construction for commercial buildings and developers in a nascent area, however, is access to commercial financing (particularly for new entrant developers) aligned with the specific needs and differences that exist in the modular construction delivery process. For modular construction, materials must be purchased, and production lines reconfigured for each project months ahead of fabrication. Materials alone can comprise 60% or more of the total cost of production (MBI 2023). As a result, modular manufacturers/project developers often require large upfront deposits, e.g., 35%–50% of the modular contract (Salama et al. 2020). In addition, the capital-intensive nature of modular construction often requires more frequent progress payments for the manufacturers to maintain a positive cash flow. Combined with off-site progress verification challenges and a track record of financial distress within the modular industry in the UK and the United States (Hanson and Chung 2023; McLennon 2021), many commercial lenders will not fund modular projects.

A recent U.S. Department of Housing and Urban Development (HUD) Off-Site Construction for Housing Research Roadmap identified key knowledge gaps and research needs to overcome the barriers and challenges of off-site construction. Of the six research topics identified, they included Capital, Finance, and Insurance. They identified that "securing capital for off-site construction manufacturing facilities and financing for individual projects is a major obstacle" to the modular industry, primarily because of "a lack of education, knowledge, and awareness within the developer, lending, and insurer communities related to off-site construction" (Smith et al. 2023). This HUD roadmap specifically identified a research subtopic related to documenting and evaluating the developer and lending risk associated with off-site construction in various segments of the housing market. They further recommend future research to "identify financial methods and mechanisms to provide better upfront project finance and insurance bonding for off-site construction." This report and associated research contribute to this area of research interest by comparing risk and possible benefits across site and modular example project financing models.

Financing traditional construction projects through short-term construction loans is well understood and does not require upfront capital to effectively build a factory where the modules are preassembled (Salama et al. 2020). A key issue with modular and panelized construction is the need to first build an off-site construction facility, which can cost up to $100M for large facilities and $50M for smaller facilities (Salama et al. 2020). This type of upfront investment in setting up the facility means the building cost must be amortized over multiple projects, over multiple years—not just recouped after the first project. As such, significant upfront investment is needed to build a facility, and a pipeline of projects is needed to ensure the manufacturing facility costs are amortized (Bertram et al. 2019). As part of this risk, a lack of standardization between module manufacturers and fragmented supply chains also means different projects can be made and sourced with different materials and build qualities (Bertram et al. 2019).

For financing institutions interested in backing modular commercial projects, the key challenge lies in the mismatch between providing the finances to the manufacturer to produce units and the collateral by which the loan is secured. The majority of the collateral in modular construction is effectively off-site, and modular construction developers can produce 70%–90% of the total building off-site (McShanog 2022). To produce the modules, upfront raw materials and the manufacturing facility are needed. Materials associated with the modules are owned by the manufacturer until they leave the factory and are installed at the site. Because the market for modular construction is still early, many banks are inexperienced with modular construction lending and provide funding only as a percentage of the construction completed after modules are assembled and installed on-site as real property (Salama et al. 2020). Because of the immaturity of the modular construction market, project and module developers may face higher interest rates—especially from inexperienced banks and lenders—either because of higher perceptions of risk or the storage risk once the modules are completed (Bertram et al. 2019).

3 Data Collection for Case Studies

The comparative cases highlight the key finance and cash-flow requirements of traditional site-built construction to modular construction. Specifically, a cash deployment schedule has been developed comparing site-built multifamily construction to modular multifamily construction from the perspective of the developer. For the case studies, finance and cash-flow data were first collected from factory visits and interviews with seven multifamily modular manufacturers. Together, these manufacturers have completed more than 50 commercial multifamily projects since 2015, each averaging approximately 150,000 gross square feet (SF) in floor area. Financial data from a subset of these projects were also collected from interviews with three commercial lenders specializing in modular financing. A cash deployment schedule was then developed comparing site-built construction to modular construction using control budgets and construction schedules from two 200-unit case study multifamily projects. These comparative cases are presented in Section 4.

Summary data from interviews with seven modular manufacturers and three lenders is provided in Table 1. Manufacturers included a combination of modular suppliers (four), suppliers acting as prime or general contractors (three), and/or suppliers acting as "turnkey" design-build developers (two). Manufacturers were primarily producers of volumetric modular units for multifamily construction. Most manufacturers used machine-assisted manual assembly, producing two to three modules per day complete with interior finishes and exterior water resistive barriers (WRB). One manufacturer used semiautomated assembly, producing three to five modules per day. Module construction costs range from $100 to $180/SF and $5,000–10,000 per module for transportation and placement on-site. Combined with on-site construction, total project construction costs were generally 5%–10% less than site-built construction (range -20% to +10%). Site schedules for construction average 11 months (range 7–15 months), approximately 30% faster than site-built construction (range -20% to -50%) (Grosskopf 2023; Bertram et al. 2019).

Table 1. Industrialized Construction Finance, Cash-Flow, and Production Metrics Taken From Interviews

Delivery Method	Supplier Only (4); Supplier-General Contractor (GC) (3); Developer-Supplier-GC (2)
Product type	Volumetric (6)
Project type	Affordable (49%); market rate (26%); hospitality (21%); other (4%)
Automation	Fully automated (0); Semiautomated (1); Manual, machine-assisted (6)
Productivity	2–5 module completions per day
Module cost	$100–180/SF ($130 average); +$5,000–10,000/module for transport and crane set
Site schedule	7–15 months (11 average)
Cap rates	4%–6% (4.5 average)
Financing	0.65–0.70 loan-to-cost Interest only financing: 12–18 months typically with 6-month lease-up
Equity	20%–30% Spent initially (land acquisition, design, permitting, modular deposits)
Interest rates	≥9% blended; unsecured (industrialized construction work) underwritten against developer credit
Draw schedule with assumptions (xx%)	Letter of intent: 5% deposit Material: 25% deposit Online: 30% deposit Offline: 35% deposit Set: 5% deposit
Retention	None (supplier, not subcontractor); note: only for the off-site portion of the project
Biling cycle	Every 15–30 days
Contract	Fixed price; 3–6 months prior to production

Generally, for some lenders who consider the off-site portion of a project unsecured, loan-to-cost (LTC) ratios for modular projects were on average 5%–10% lower than those for comparable site-built projects. As a result, financing available for modular projects was lower, requiring more equity investment from the developer. Often, the unsecured portion of the construction loan covering the modular work was underwritten against the developer's credit, resulting in higher interest rates. A letter of intent (LOI) and a nonrefundable deposit of 5% of the modular contract is usually required 6 months ahead of production. A 25% (or greater) material deposit is usually required 3 months ahead of production. Often, both line reservation and material deposits are paid by the developer before project financing is available.

Once modular production begins, usually in parallel with on-site earthwork and foundations, volumetric modules progress through two to three factory workstations per day and are completed from start to finish in approximately 10–15 days. Most manufacturers using machine-assisted manual assembly to produce 2–3 finished modules per day or 40 modules per month on average. An “online” fee of 30%–35% is charged for each module start and an “offline” fee of 30%–35% is charged for each module completion. Manufacturers generally invoice for module starts and completions every 15–30 days. Because the developer pays a draw inspection fee to the lender, more frequent billing is discouraged. The final 5%–10% of the IC contract is usually billed following module transport and placement on-site, if module transportation and placement are included in the industrialized construction scope. As suppliers and not subcontractors, manufacturers typically limit or discourage retainage on progress payments.

An advantage of modular construction is the ability to “lock in” a firm, fixed-price contract for the off-site portion of work 3–6 months prior to the start of construction. For most projects, the IC portion of work is approximately 40%–60% of the total project construction cost (Bertram et al. 2019). As a result, manufacturers most often have owner-direct contracts with the developer. Though this form of delivery bypasses the general contractor’s markup on the off-site work, the developer assumes more risk and must play a greater role in project coordination.

4 Case Studies

This section highlights case studies for multifamily commercial buildings and the difference in project financing for off-site and site-built cases. To provide context and comparison, a traditional site-built case for a commercial building is highlighted. These cases were chosen because of their similarity in size (e.g., 200 units) and the data gathered and cost model analysis that shows the differences in the cash-flow schedule and financing between the two cases. The analysis does not consider land acquisition, design and other preconstruction fees, or postconstruction costs, which are likely to be similar for both site-built and modular.

4.1 Traditional Site Built

The site-built case study (Figure 2) is a 200-unit multifamily building under construction in Seattle, Washington. The building consists of 6 stories of Type-III residential over 1 story of Type-I commercial (podium). Table 2 highlights the construction cost at modeled completion (2023) as $45M, and the construction duration is 21 months.

Figure 2. Site-built case study project in Seattle, Washington

Photo credit: Kevin Grosskopf

Table 2. Traditional Site-Build Project Characteristics

2023	Seattle, Washington
Site-built	General contractor
200 units	7 Stories (6/1)
$45M	21 months

Using control budgets and construction schedules provided by the general contractor (GC), a cost-loaded schedule and project cash-flow curve were developed. The cost-loaded schedule (Figure 3) identifies each major construction activity, when each activity occurs, the duration of each activity, and the cost of each activity as a percentage of the total construction cost. From this information, the value of work completed each 30-day "draw" period can be determined. The value of work completed in each 30-day draw period approximates what the developer can expect to pay the GC and its subcontractors and suppliers each month. As shown in Figure 4, construction costs for the site-built project average approximately \$2.0M/month and can well exceed \$3.0M/month.

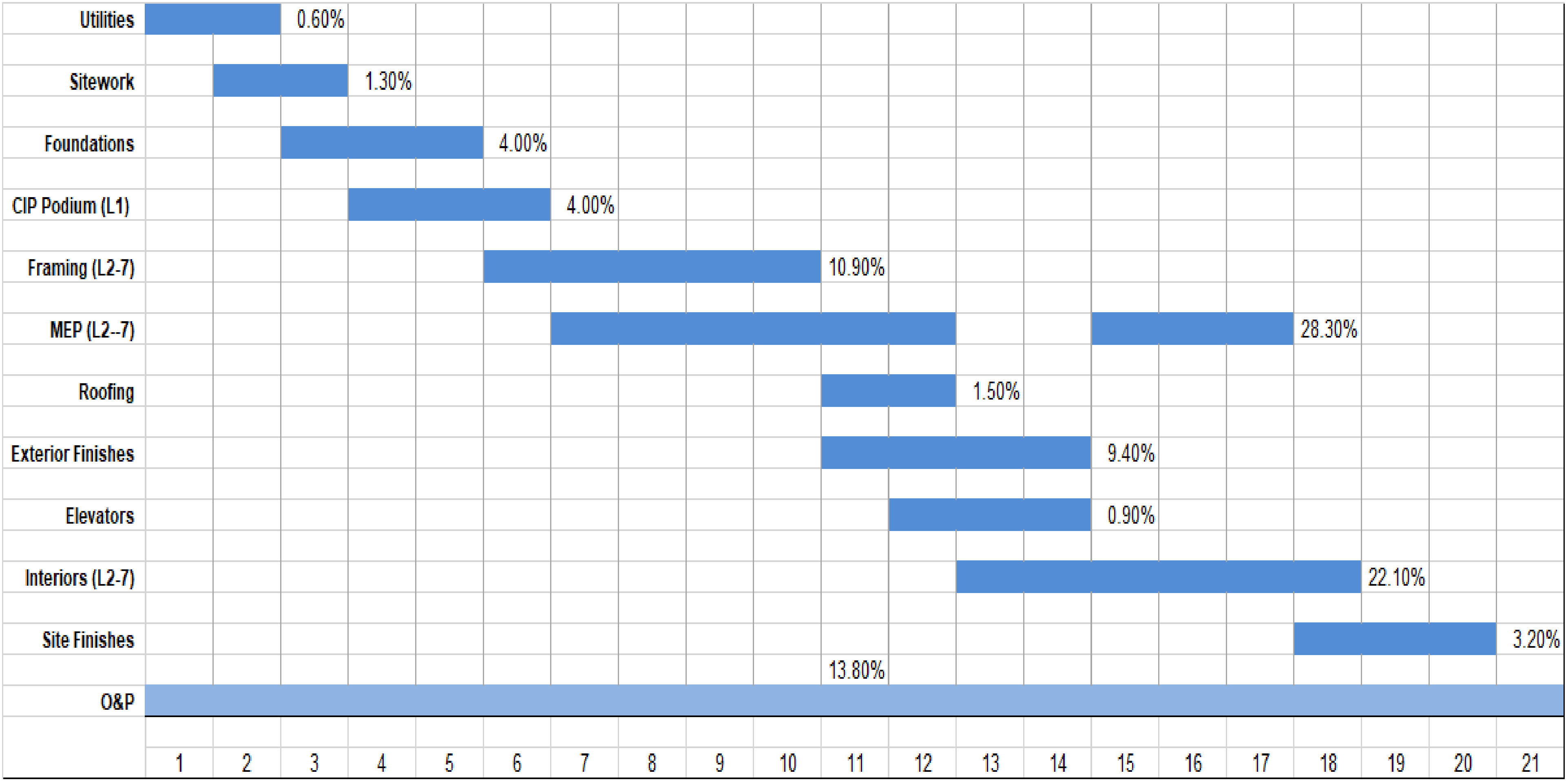

Figure 3. Cost-loaded schedule, site built

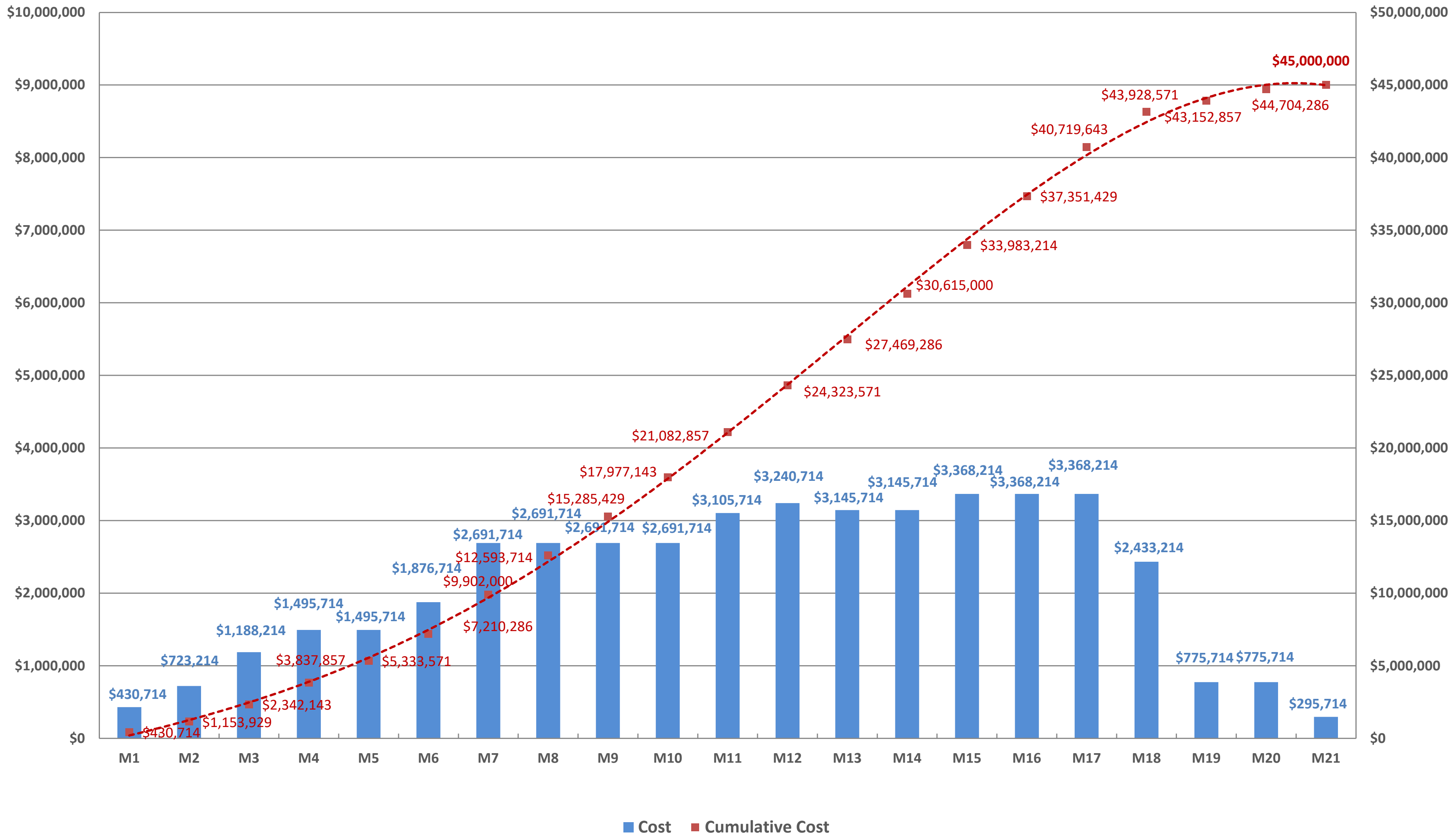

Figure 4. Project cash-flow curve, site built

To absorb such a cash-flow liability during construction, developers often secure commercial financing. Financing typically covers 70%–80% of the construction cost. For this site-built project, a 75% LTC ratio provides approximately $33.8M in financing for a $45.0M project. Loan proceeds are released after all the developer's equity funds have been used or as a percentage of the value of work completed each month as verified by lender draw inspections. As loan funds are released, the developer incurs interest costs on the cumulative amount of funds borrowed during the project, which can be either paid in cash each month (e.g., "interest carry") or paid from an interest reserve.

If, for example, the developer's cash-flow requirement for work completed in Month 12 is $3.2M, or 7.2% of construction cost, the developer may request disbursement of 7.2% of the construction loan, or $2.4M. Given the *total* value of work completed by the end of Month 12 is $24.3M, or 54.1% of construction costs, the developer may have requested disbursement of 54.1% of the construction loan, or $18.2M, by the end of Month 12. As a result, the developer may incur an interest expense of roughly $121.6K for the cumulative amount of funds borrowed by the end of Month 12 (8% annual percentage rate [APR]). To note, developers often withhold retainage on contractor payments until the project is substantially complete. Retainage amounts may vary but are typically 5%–10% of the construction contract. Considering only these factors, the developer's net cash flow for Month 12 is summarized in Table 3.

Table 3. Developer's Month 12 Example of Net Cash Flows in the Traditional Site-Built Case

Item	Value ($)	Comment and Calculation
Cost	-$3,240,714	7.2% of $45.0M construction cost
Loan disbursement	+$2,430,536	7.2% of $33.8M construction loan
Interest carry	-$121,618	0.67% simple interest (8%/12) of $18.2M loan disbursements to date
Retainage	+$324,071	10% of contractor payments
Developer net cash flow	-$607,725	

The developer's monthly and cumulative cash-flow requirements for the $45.0M, 21-month site-built project are shown in Figure 5. The developer's equity requirement for construction is approximately $13.6M. Roughly $4.8M (35%) of this equity is deferred until the end of the project in the form of released retainage. Total interest carry during the project is $2.3M.

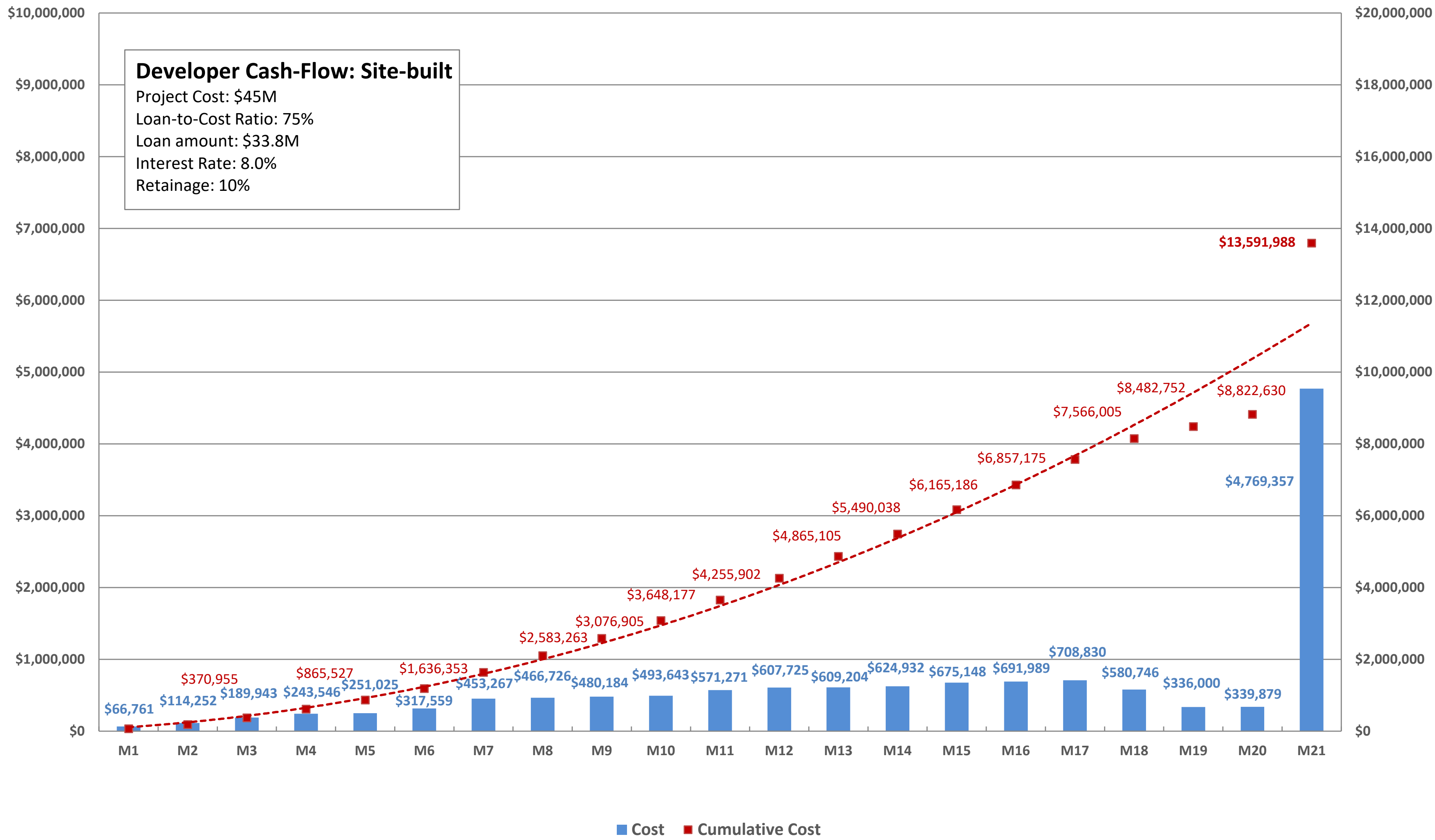

Figure 5. Developer cash-flow curve, site-built

4.2 Modular Construction

The modular case study is a 200-unit multifamily building under construction in Minneapolis, Minnesota (see Figure 6). The building consists of 5 stories of Type-III residential over 1 story of Type-I commercial (podium). The construction cost at modeled completion (2023) is approximately $45M, and the construction duration is 15 months. Table 6 lists the 200-unit modular project characteristics.

Figure 6. 200-unit commercial modular multifamily building in Minneapolis, Minnesota (Rise Modular project) for case study

Photo credit: ProSet Inc.

Table 4. Modular Building Project Characteristics

2023	Minneapolis, Minnesota
Volumetric modular	Manufacturer/GC
200 units (160 modules)	6 stories (5/1)
$45M	15 months

Like the site-built case study, a cost-loaded schedule and project cash-flow curve were developed for the modular case study. Overall, the off-site scope for 200 residential units on Floors 2–6 was approximately 60% of the total construction cost ($27.0M).

As shown in Figure 7, the timing, duration, and cost of on-site construction activities were similar in the modular case study to those same activities in the site-built case study. Exceptions include MEP systems and interior finishes. Because MEP systems and interior finishes for residential units were completed off-site in the factory, on-site scopes for MEP systems and interior finishes were largely reduced to common areas and corridors. Lobbies, offices, retail, and other common areas were located on the site-built ground floor. Residential corridors in modular units were unfinished in the factory to allow MEP connections on-site. Overhead and profit (O&P) was also reduced in part because of a 6-month shorter construction schedule and subsequent reductions in jobsite overhead (e.g., "general conditions"). O&P was also reduced because of the consolidation of the GC and subcontractor markups in a single modular contract with few (if any) allowances for change orders or contingency.

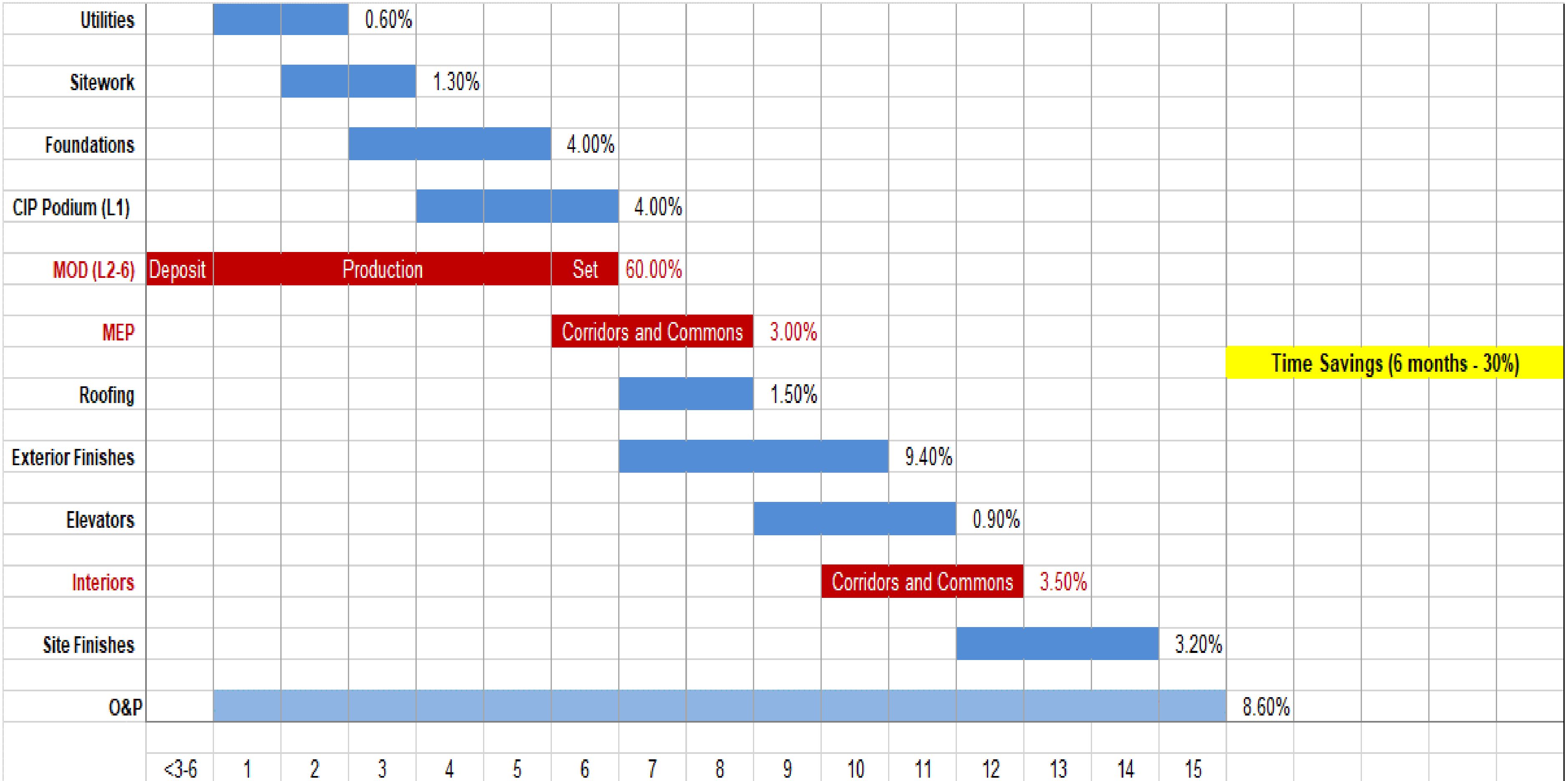

Figure 7. Cost-loaded schedule, modular

As shown in Figure 8, construction costs for the modular project are roughly the same as for the site-built project ($45.0M). However, the modular project requires a line reservation fee and material deposit of 30% of the modular contract ($8.1M) often paid by the developer 3–6 months in advance of production. Once production begins, ~160 modules are fabricated off-site to provide 200 residential units, corridors, stairwells, and utility spaces. A single module can be completed from start to finish in 2 weeks. The average cost per module is ~$168,750 ($27.0M ÷160 modules). Table 5 shows the off-site module production and how many modules are "offline" and "online."

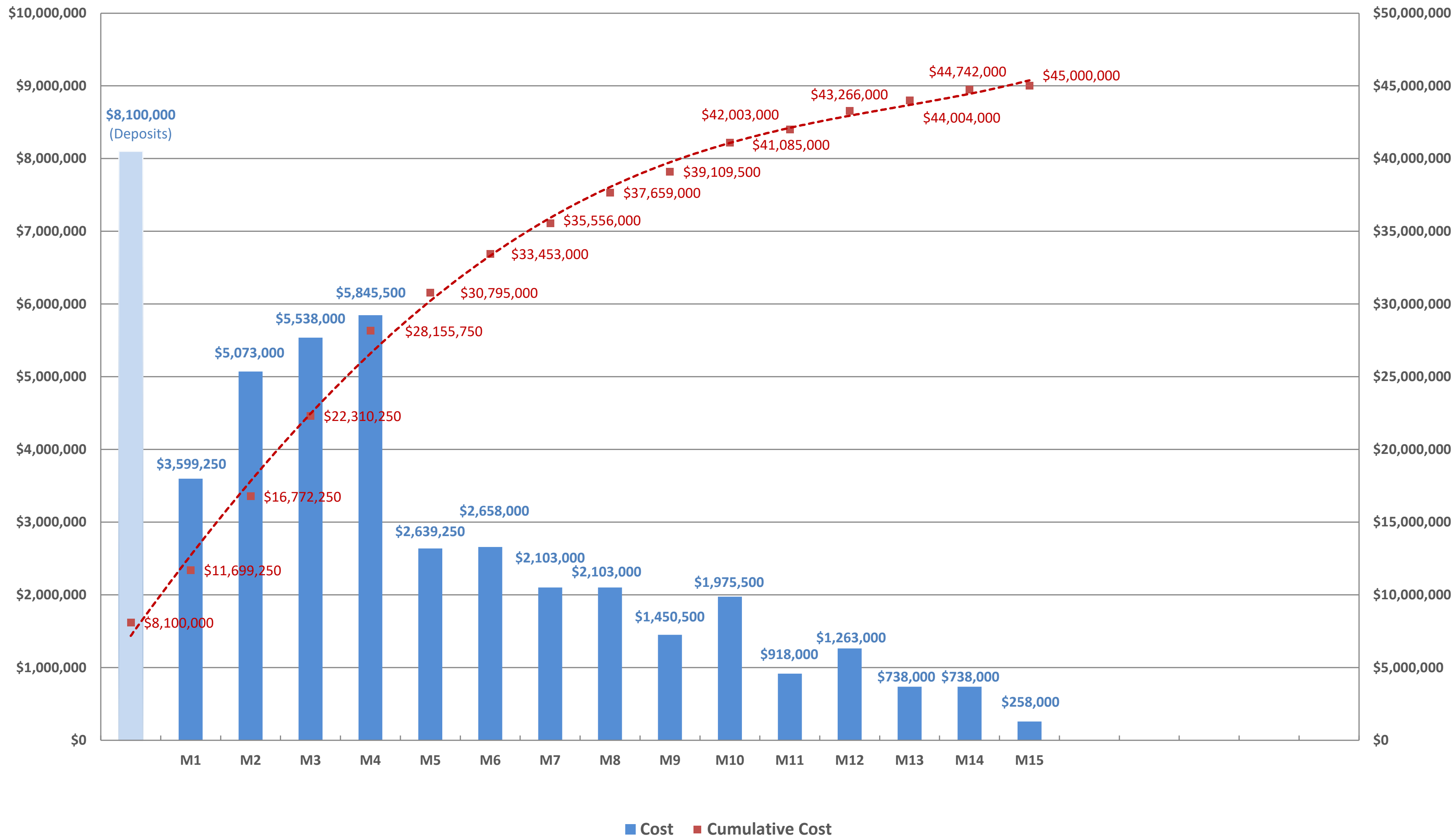

Figure 8. Project cash-flow curve, modular

Table 5. Monthly Online and Offline Module Production

	Month 1	Month 2	Month 3	Month 4	Month 5
Online	40 modules	40 modules	40 modules	40 modules	
Offline	20 modules	40 modules	40 modules	40 modules	20 modules

The modular manufacturer assesses an "online" fee of 30% for each module start and an "offline" fee of 35% for each module finish. For 40 modules started and completed in Month 4, for example, the manufacturer will invoice the developer ~$4.4M, as shown in Table 6. Combined with $1.5M of work performed on-site in Month 4, the total cost of work in Month 4 is $5.9M.

Table 6. Month 4 Manufacturer Invoicing for the Online and Offline Modules

Month 4	Value ($)	Comment and Calculation
40 modules online	+$2,025,000	40 modules x $168,750 per module x 30%
40 modules offline	+$2,362,500	40 modules x $168,750 per module x 35%
Total	+$4,387,500	

For this modular project, a 65% LTC ratio provides approximately $29.3M in financing for a $45.0M project. For this example, the LTC ratio is lower than the site-built project because the lender considers the off-site portion of work to be "unsecured" until the modules are delivered to the construction site and set. The unsecured portion of the construction loan covering the off-site work is underwritten against the developer's credit, resulting in a higher interest rate (9.5% APR). As a result, the developer must contribute more equity to pay for a greater share of the work and higher interest carry during construction. In addition, the developer may not be able to withhold retainage on payments to the modular manufacturer. Considering only these factors, the developer's net cash flow for Month 4 is summarized in Table 7.

Table 7. Developer's Month 4 Example of Net Cash Flows in the Module Case

Item	Value ($)	Comment and Calculation
Cost	-$5,845,500	15.8% of $36.9M construction costs *after* deposits
Loan disbursement	+$4,633,628	15.8% of $29.3M construction loan
Interest carry	-$125,858	0.79% simple interest (9.5%/12) of $15.9M loan disbursements to date
Retainage	+$145,800	10% of on-site contractor payments only
Developer net cash flow	-$1,191,930	

The developer's monthly and cumulative cash-flow requirements for the $45.0M, 15-month modular project are shown in Figure 9. The developer's equity requirement for construction is approximately $18.2M. A total of $8.1M, or ~40% of this equity, is required 3–6 months prior to construction for line reservation fees and material deposits. Total interest carry during the project is $2.4M, roughly the same as for the site-built project despite a 6-month shorter construction schedule. In contrast to the site-built project having more evenly distributed construction costs over a longer period, the modular project requires large loan disbursements early in the project to cover the cost of both on- and off-site work occurring simultaneously.

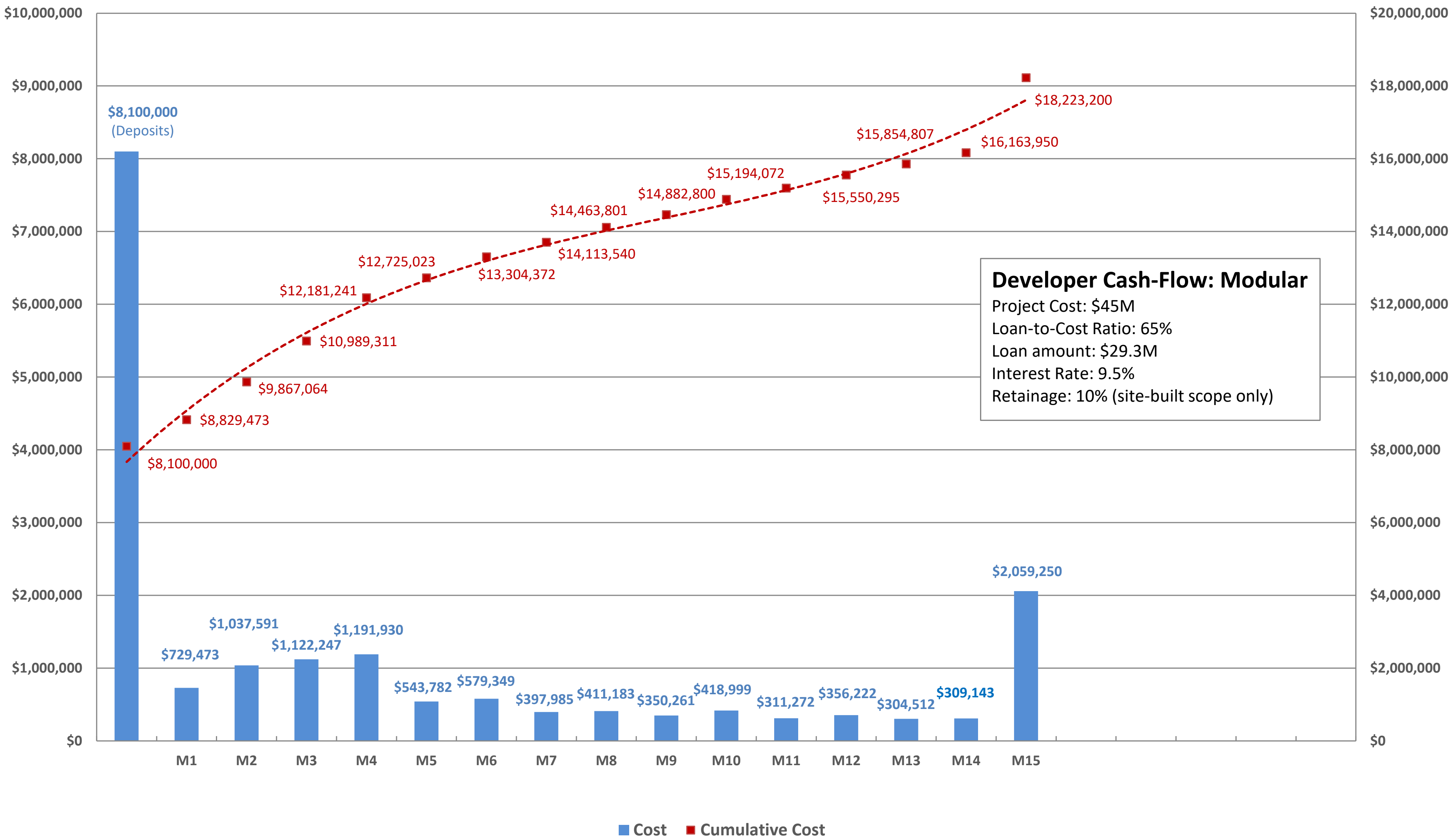

Figure 9. Developer cash-flow curve, modular

5 Lessons Learned and Risk Mitigation

Current modular developers have engaged their own financing partners, created processes that seem to work for their projects, and addressed the barriers identified in this report to make their projects financially workable. Committed modular developers have formed local partnerships with lenders experienced in modular project financing, but this is more of a nonstandard or newer approach. Though this demonstrates the modular financing barriers are solvable, an industrywide solution is still needed to scale modular development. The HUD Off-site Construction Roadmap provides a related recommendation to address this (Smith et al. 2023): "Partner with Fannie Mae and Freddie Mac to develop a bridge-funding vehicle for off-site construction early-stage finance for factory deposits, and design documentation assistance associated with off-site construction."

Developers addressing the barriers identified in this report may seek alternative funding opportunities to diversify their sources—for example, exploring ways to use tax credits for energy efficiency and on-site renewables available through the Inflation Reduction Act (IRA) bills. Specifically, modular developers are including the IRA tax credits for designing to the Zero Energy Ready Homes program (DOE BTO 2023c; 2023d). The property assessed clean energy (PACE) financing program may also be available and can provide alternative financing solutions in new construction (DOE State and Local Solution Center 2023). With the release of the IRA, the question arises whether the IRA benefits and supports the development and deployment of modular and off-site construction. Though specific state and local level incentives—including HUD loan guarantees—are outside the scope of this report (DOE HUD 2023; Preferred Homes 2023), some federal incentives are worth mentioning.

For commercial buildings developed using modular construction as a pathway to high-performance buildings (Pless et al. 2022), developers could take advantage of IRA initiatives, including the following (Tienken 2023):

- Updated 179D, commercial buildings energy efficiency tax deduction. This now offers tax deductions to new commercial building owners and designers of buildings, where they meet energy; heating, ventilation, and air conditioning; or lighting savings compared to reference buildings (DOE BTO 2023a).
- The tax deduction levels increase to $.50 per SF for energy savings of 25% and to $1 per SF for energy savings of 50% or greater (Tienken 2023).
- As state housing agencies struggle to increase the supply of affordable housing options across the United States, they are looking to align their housing innovation funds to address these financing barriers. A recent example in Colorado awarded a total of $38 million to local modular developers and factory team, with loan terms below market with interest rates ranging from 1.5% to 1.75%. The funding includes loans made possible through the Innovative Housing Incentive Program and the Proposition 123 Affordable Housing Financing Fund (OEDIT 2024a; 2024b). Using modular construction as a pathway to high-performance buildings, "[b]oth programs offer low-cost financing options for innovative housing manufacturing facilities, including panelized, tiny homes, kit homes, and off-site 3D-printed homes" (Vederra 2024; Smith et al. 2023; Preferred Homes 2023).

6 Conclusions and Next Steps

Results from this case study suggest developers' equity requirements may be as much as 30% higher for modular construction ($18.2M) than those for site-built construction ($13.6M), particularly at the beginning of a project. Factors that contribute to higher equity requirements include modular fees and deposits as early as 6 months prior to production that may not be covered under the construction loan. As suppliers, modular manufacturers discourage retainage, creating an additional cash-flow burden on the developer.

Modular construction, however, has consistently shown the ability to shorten construction schedules (e.g., 6-month time saving) and speed income generation. To a lesser extent, modular construction may also reduce overall construction costs and create a safer, more efficient development process less susceptible to weather delays, labor shortages, and other on-site conditions. Of note, the analysis herein does not consider land acquisition, design and other preconstruction fees, or postconstruction costs that are likely to be similar for both site-built and modular construction. Highly variable site-specific costs such as site staging, storage, and street closures are also not considered in this analysis.

Leading modular developers are integrating alternative financing approaches and partnering with local lending partners that understand the modular construction and cash flow process, suggesting solutions for the broader industry to scale. State affordable housing agencies are attempting to address some of these barriers with housing innovation funds and loans to create regional solutions. The learnings from this report will be disseminated to members of the ABC—and broader off-site financing and development communities—to help provide confidence in modular construction for multifamily units. As part of future research, it is recommended to continue investigation into modular construction for single-family and multifamily communities—e.g., Pinion Park in Colorado (Rural Homes 2022)—and compare to multifamily, multiunit buildings and potentially apply the learnings. Further research is also recommended on the development of incentives to create greater standardization and a more favorable market environment for modular construction. Finally, collecting data from case study projects to illustrate the comparison in change orders, cost overruns, or the use of contingency funds between off-site and site-built projects is recommended to increase familiarity with off-site construction processes in the lending community.

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