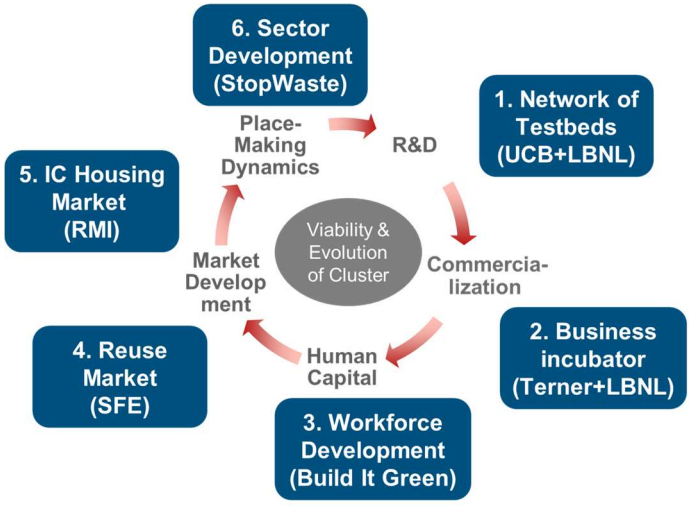
Bay Area Construction Innovation Cluster | Overarching Narrative

The coalition, led by StopWaste (Alameda County Waste Management Authority) and including University of California Berkeley (UCB), Lawrence Berkeley National Laboratory (LBNL), Terner Center and Labs (Terner), Build It Green (BIG), San Francisco Department of the Environment (SFE), Rocky Mountain Institute (RMI), and East Bay Economic Development Alliance (EBEDA), proposes a **Bay Area Construction Innovation Cluster (BACIC)**. BACIC's goal is to transform a risk-averse, fragmented construction sector into an engine for creating diverse, resilient enterprises and jobs throughout the industry while simultaneously alleviating economic inequity. The Bay Area has among the highest income disparities in the nation, with home prices that are up to 15 times per capita income. BACIC proposes six projects to accelerate the adoption of innovation and stimulate circular economic[1] growth.

1. Network of Testbeds. Two pre-eminent research institutions will retool their existing testbeds and create a new fabrication lab (FABLAB) to provide comprehensive structural, environmental, and systems integration testing for new building materials and methods, reducing the barrier for less-capitalized startups to comply with California's stringent building codes and climate goals.



2. Business Incubator. A new Bay Area Builders Lab Incubator (Builders Lab) combines the inclusive entrepreneurship focus of Terner's Housing Lab incubator with the building technology expertise of LBNL's IMPEL+ incubator. Builders Lab will provide startups with access to capital-intensive prototyping equipment and triple-bottom-line business advising while de-risking investment opportunities for investors and funders.

3. Workforce Development. California-based green building non-profit Build It Green will partner with local trades, workforce organizations, educational institutions, manufacturers, and architecture and engineering firms to promote inclusive career pathways in construction-related fields, provide training in new construction methods and emerging technical skills, and support small developers and contractors in equity priority communities.

4. Reuse Market. The City of San Francisco will create the Building Resources Innovation Center (BRIC), a secondary materials market in partnership with CalTrans. Developing the market for high-value building materials extracted from the existing urban environment and creating tools that facilitate match-making of supply and demand will lay the groundwork for future local policies that require building deconstruction over demolition. A satellite reuse market will be located in the East Bay.

[1] Circular economy is a framework that decouples economic growth from resource consumption through efficient use of materials, recirculation, and resource regeneration.

5. Industrialized Construction[2] (IC) Market Development. A global leader in climate action through market transformation, RMI will leverage its role leading the U.S. Department of Energy (DOE)–funded Advanced Building Construction Initiative by demonstrating demand for industrialized construction in the Bay Area. RMI will develop a pipeline of small urban infill projects in partnership with cities, small developers and owners, contractors, IC companies, and financial institutions that will apply the innovations supported by BACIC in real projects.

6. Sector Development. A public agency instrumental to the mainstreaming of green building in California, StopWaste will facilitate cross-sector collaboration, promote the cluster through a Construction Innovation Center, ensure equitable community engagement, and incubate initiatives that regionalize the building materials supply and address systemic barriers.

The Potential for Construction Sector Innovation

An industry ripe for transformation. With catalytic investment from BBBRC, BACIC is united by a vision for modernizing the Bay Area construction sector in a way that builds economic, social, and environmental resilience. Industry profit margins are low and construction defect liability risks are high, which disincentivizes investment in innovation. Builders use stick-built construction methods that have changed little since the mid-20th century. The industry has chronically failed to keep up with the demand for housing, and the COVID-19 pandemic has exacerbated its vulnerability to market disruptions, particularly worker shortages, supply chain disruptions, and rising material costs. BACIC targets the following technological innovations:

The Bay Area Comprehensive Economic Development Strategy (CEDS) cites the shortage of housing as one of the main barriers to equitable economic development. BACIC's projects support the CEDS priorities of housing production and affordability; the Bay Area's innovation and entrepreneurship ecosystems; and the Production, Goods Movement and Repair Clusters.

Design & process innovation. The construction industry in the U.S. has decreased in productivity over the past half century, whereas nations like China, Japan, and Sweden have invested in IC and advanced building construction. IC produces housing in a more controlled environment with higher precision, increased efficiency, and reduced cost through economies of scale and standardization. It facilitates the adoption of net-zero carbon green building systems. Modularizing components enables rapid on-site deployment and future retrofit and recovery, yielding additional cost, resource, and GHG emissions savings. BACIC will encourage modular and panelized systems and "kit-of-parts" business models, which are gaps in the U.S. market.

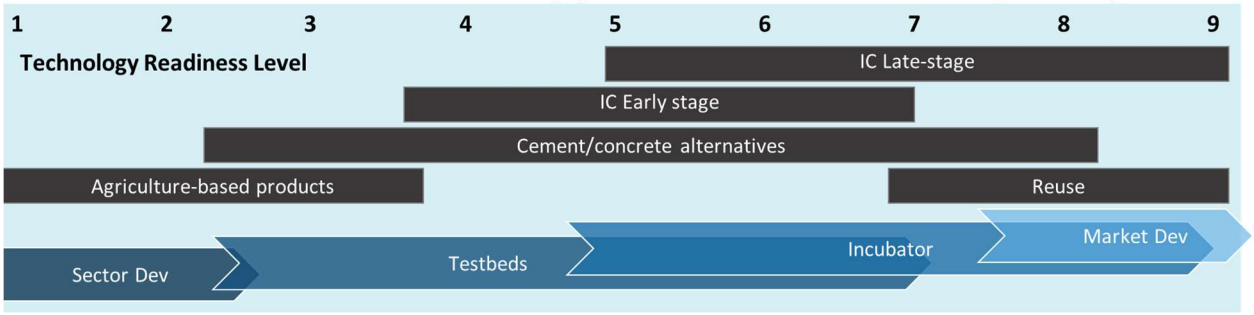
Product innovation. BACIC has identified key opportunities to regionalize supply chains to retain or regain manufacturing while increasing reliable availability of materials for construction companies. Northern California ports currently import $1.3 billion of building materials - 50% from Asia and 30% from Europe.

- **Cement and concrete** contribute over $500 million to the Bay Area's gross regional product (GRP), but the region's sources of natural aggregate are depleted, and its cement plants have closed. Innovations in alternative cementitious materials (some of which can be made with

[2] Industrialized construction aims to adapt principles, processes, and technologies from the manufacturing industry to holistically improve building construction and performance. It commonly involves prefabrication, digitization, standardization, and more integrated project management.

circular materials like recycled glass and rice husk ash), carbon-sequestering inputs, and recycled aggregates rebuild opportunities for regional supplies while ensuring the industry complies with California's climate regulations.

- **Agricultural byproducts** can be recovered to produce building materials. This is a growing industry segment in Europe and California is well positioned to supply its own biogenic materials. Its agricultural base generates 1-2 million tons of straw byproduct from rice and grains annually, which can be used in medium-density fiberboard and insulative panels. The 4+ million tons of wood biomass, including forest thinning to mitigate wildfires, have similar applications or can be used in the growing mass timber market. This rural-urban connection would stimulate new revenue for distressed agricultural communities, diversify crops vulnerable to climate change, and restore soil carbon through climate-beneficial agriculture.
- **Urban reuse** derives value from materials exiting the built environment as "waste" following deconstruction or demolition, minimally processed, and recirculated as high-value products.



Place-sourced innovation. Last year's high-profile bankruptcy of Silicon Valley startup Katerra, which spent $2 billion in 6 years, demonstrates that access to financial capital may not be the limiting factor in adoption of innovation. Katerra's aim of reinventing architecture and construction through modular design, prefabrication, and supply-chain integration resonates with BACIC, but we will advance a more thoughtful approach. BACIC will support a diverse set of entrepreneurs with access to open-source tools and expertise, educate industry stakeholders that lack familiarity with new technologies, and empower equity priority communities to shape their own neighborhoods. Katerra sought to overcome the inefficiencies of design and construction through vertical integration, but ended up bringing the industry's fragmentation in-house. BACIC's goal is to develop the capacity for collaboration within the existing Bay Area industry, and ultimately, shift the culture from prioritizing short-term profit to investing in long-term well-being of workers and communities. Anchored by local governments, academia and non-profits, we provide the long view necessary to realize regional transformation.

Leveraging complementary initiatives. BACIC's innovations will leverage investments being made by its members and partners. Our UC Berkeley team includes one of the nation's foremost experts in IC, and the university is hiring additional IC faculty. Major foundations, the California Energy Commission and the DOE have prioritized funding for IC technology deployment (see letters of support). In California, Assembly Bill 262, Senate Bill 596, and active bills like Assembly Bill 2446 and Senate Bill 1297 will push the industry towards new sources of low-carbon building materials. At the regional level, SF Environment and StopWaste are employing circular economy strategies to derive greater value from existing resources, build resilient supply chains, and manufacture high-value products from the region's waste streams. BACIC's coalition members and partners participate in national—and international—networks of academia, government, and industry. Our proposed projects have national relevance, because the construction industry, while necessarily place-based, exists in every region.

Timeline and Metrics of Success

Coordinated implementation timeline. After set-up time for projects in the first year, project operations will run approximately 24 months before transitioning to other funding sources. By this time, BACIC plans to establish itself as a hub for construction innovation in the region.

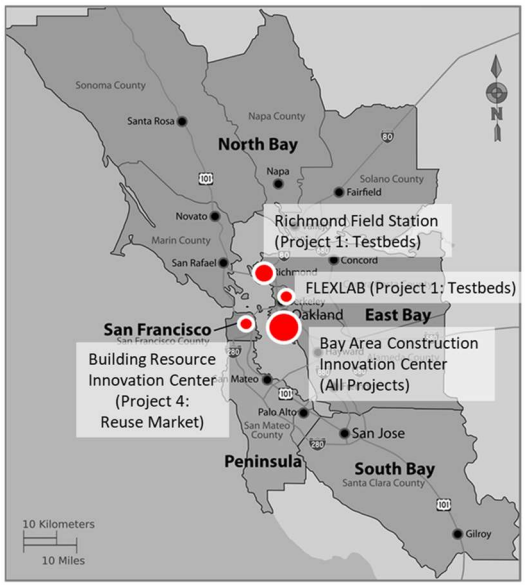
Metrics of success: BACIC's aim is to stimulate economic growth in ways that strengthen the region's ability to handle economic, environmental and social disruption. Outcomes sought are:

- **Increased number of "resilient" jobs in** IC and low-carbon building design and manufacturing, community-based development, agricultural waste products, deconstruction, or as contractors and construction entrepreneurs or reskilled construction workers.
- **Increased number of housing units produced:** Productivity gains that lower the cost of construction. Meeting demand for housing so that everyone can remain in the Bay Area.
- **Increased levels of follow-on investment:** De-risk IC and low-carbon building design, drive process and product innovation to attract capital for BACIC priority businesses.
- **Increased workforce diversity:** Construction-related fields reflect the region's diversity, by creating inclusive pathways for youth, women, and BIPOC.
- **Growth of circular economic businesses:** Revenue growth from targeted innovations, material expenditures shifted from imports to regional producers.

Description of Region Served

The San Francisco Bay Area is home to a diverse population of 7.7 million across its nine counties. Black, indigenous, and people of color (BIPOC) make up 61% of the population. High- and low-wage job growth outpaced middle-wage job increases since 1990. EBEDA's East Bay Forward report found that the construction and manufacturing sectors offer high potential for filling this gap. Yet there is a shortage of labor to fill the current demand for construction workers. BACIC's programming targets historically excluded communities who struggle in this context of economic bifurcation, where top incomes are 12 times higher than the lowest. Recent studies have identified 160 thousand construction workers among essential workers that have suffered disproportionately from COVID-19 impacts.

The Bay Area's key assets include world-class research institutions, progressive local governments, leading environmental and social justice non-profits, robust professional associations, the highest concentration of venture capital in the world, and innovative CleanTech

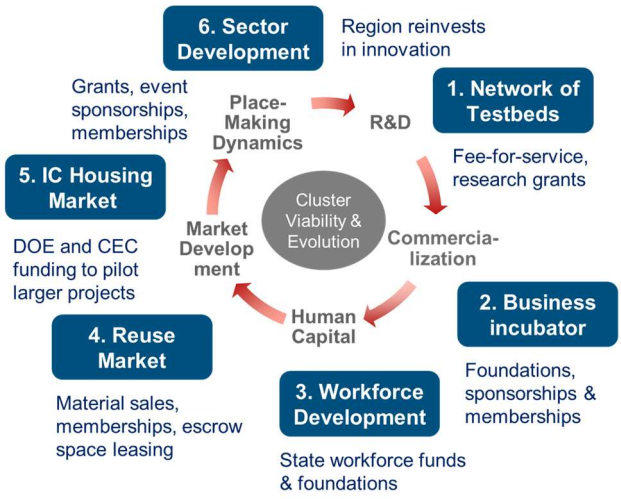


startups. BACIC comprises a cross-section of these assets clustered in the three core Bay Area counties: Alameda, Contra Costa, and San Francisco. The projects will coalesce at the former Alameda Naval Base, where we propose a Construction Innovation Center. Ideally situated in the heart of the Bay Area, this site will host the FABLAB (Project 1), incubator (Project 2), on-site education (Project 3), a material reuse market (Project 4b), and a showroom and networking space for industry professionals and community organizations (Projects 5 and 6).

The businesses and communities served are located across the nine-county Bay Area: Alameda (FIPS: 06001), Contra Costa (06013), Marin (06041), Napa (06055), San Francisco (06075), San Mateo (06081), Santa Clara (06085), Solano (06095), Sonoma (06097), and Congressional Districts 2, 3, 5, 11-19. The businesses are primarily in NAICS codes 236: Construction of Buildings, 328: Specialty Trade Contractors, and 32-33: Manufacturing.[3]

Regional Growth Cluster Sustainability: Financial Viability and Network Governance

The goal of the cluster is not only to advance specific innovations and entrepreneurs, but to build a long-term innovation ecosystem within the construction industry. The BBBRC investment will target high-impact activities that are feasible in two years and set us up for transformative long-term impacts by attracting follow-on investments and addressing systemic barriers. Each project lead has a proven track record of securing foundation, industry, and government funding, or running existing programs with sustainable operating revenue. BACIC consulted over a hundred industry stakeholders to identify market gaps and is confident in its ability to attract follow-on investment. As evidenced in letters of support from state and federal agencies, the innovations that we are pursuing align with their policy and funding priorities.



[3] NAICS codes 32-33 include 321992 and 332311 for prefabricated wood and metal buildings; 321 Wood Products, 327: Mineral Products, and 332: Metal Products. Additional sectors served include NAICS codes 5413: Architectural, Engineering, and Related Services; 531: Real Estate; 4233: Construction Material Wholesalers, 4441: Building Material Dealers, 113: Forestry and 115: Support Activities for Agriculture and Forestry.

As described in Project 6 Sector Development, BACIC's network governance structure is designed to ensure effective tactical coordination and strategic alignment of projects by Coalition Members, while simultaneously engaging with key stakeholders. BACIC will engage partners representing all **five forms of capital** needed for sustainable development. The Bay Area has access to significant financial capital, but it is concentrated in inequitable ways. This is evident in speculative real estate boom and bust cycles, which result in decreasing local ownership of property and increasing levels of housing insecurity. The sector's labor supply never fully recovered from the exodus of construction workers during the 2008 recession. By growing multiple forms of wealth and cultivating mutually beneficial relationships among stakeholders, we can tap into the region's potential.

The construction sector is beset with conflicting interests: developers vs. neighborhoods, designers vs. builders, construction vs. manufacturing, owners vs. tenants, affordability vs. environment. We identified initial strategies to overcome these perceived tradeoffs in the design of our proposed projects, but far more is needed to address systemic barriers and inequities. Leveraging its reputation as a well-respected and neutral convener in the residential building industry, Build It Green will steward an intersectional housing network. In addition to facilitating networking and cross-sector learning opportunities, BIG will provide a collaborative space for participants to set aside their familiar roles, affiliations, and agendas and think about what is best for the system as a whole.

Detailed Overview of Private-Sector Engagement

BACIC's primary private sector partners are the entrepreneurs introducing new industrial construction and regionalized supply chain materials into the market. Additional partners include the landscape of companies in development, construction, and design that drive the demand for these innovations. Finally, we seek to leverage resources from philanthropic and financial institutions for long-term sector growth.

Sector Role	Firm names (project #)	Commitments made
Prefab manufacturers	Factory OS (1,2,3)	IC Working Group
	Mighty Buildings (1,2,3,5)	IC Working Group
	Entekra (1,2,3,5,6)	IC Working Group
	Lada Cube (1,2,5,6)	IC Working Group
	J.E. Dunn	IC Working Group
	Kit Switch, SATPAL (1,2)	Incubator candidates
Product manufacturers	DuPont (1,3)	Product donations, hiring commitment
	NRMCA (1,2)	Advisor, Connection to concrete suppliers

	Central Concrete (1,2)	Industry advisor, in-kind testing
	CalPortland (1)	Lab testing, product donation, labor
	LumenCache (1)	Product discounts; CEO & technician time
	ABB (1)	RobotStudio software network license
	Brimstone Energy (1)	Sample materials; CEO in-kind labor
	MCSC Global (1)	In-kind labor for smart building advising
	Blue Planet (1,2)	Product donations
	Okomworks, Tec MGO, Verdant Structural (1,2)	Incubator candidates
	Armstrong, Interface, Tarkett, USG, CARE (4)	Extended Producer Responsibility pilot
Large Portfolio Owners 	All for Reuse Alliance (4)	Commitment to use BRIC for sourcing
	Google (4)	Cash donation; participation in BRIC
	Lendlease (4)	Participation in BRIC
	Jones Lang LaSalle Inc. (4)	Participation in BRIC
Builders, Contractors, Developers 	Bay Area Sustainable Construction Leaders (All)	In-kind labor
	BCCI Construction (4)	In-kind labor; participation in BRIC
	Charles Pankow Builders (4)	Cash donation; participation in BRIC
	GCI General Contractors (4)	Cash donation; participation in BRIC
	Madrone Construction Resources (4)	Cash donation; participation in BRIC
	No. California Land Trust (5,6)	Participation in technical assistance
	Swinerton Construction (3)	Cash donation
Design firms 	Gensler (4)	Cash donation; participation in BRIC
	Natoma Architects (1, 2)	In-kind labor for advising
	AIA Chapters (5, 6)	Networking for startups; project pipeline
Philanthropy and Finance 	ClimateWorks Foundation (1)	$500,000 cash donation for testbeds
	Vectors Capital (1)	In-kind labor and investment commitment
	ADL Ventures (2)	In-kind labor and investment commitment
	Multiple lending institutions (5)	Financial Institutions working group

Labor, Community, and Environmental Engagement

The innovations proposed by BACIC promise significant increases in productivity and environmental performance, but this potential cannot be realized without engaging labor, community, and environmental groups. In particular, prefab methods of construction require workers to use skills that cross different building trades and introduce a "manufacturing" mindset. As described in Project 6, BACIC will work proactively with unions and employers.

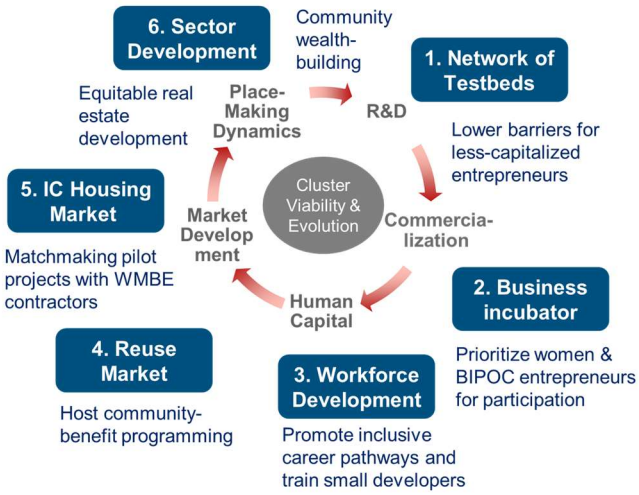
Sector Role	Organization name (project #)	Commitments made
Labor 	Construction Workforce Trades Initiative (3, 6)	IC Working Group; Workforce development partner
	Northern California Carpenters Union (3, 6)	IC Working Group, Advising on wrap-around services
Education 	Rising Sun Ctr. for Opportunity (3)	Workforce development partner
	Emerald Cities Collaborative (3)	Workforce development partner
	Brightline Defense Project (4)	Youth workforce dev. partner
	Mission Hiring Hall (3, 4)	Workforce dev. partner; BRIC
	UCB Terner Center (1,2,5,6)	In-kind labor
Community 	Multiple Bay Area cities (5, 6)	Local Government Working Group
	Bay Area Council (1,2)	Access to housing committees
	California Forward (3)	Workforce development partner
	The Reuse People (4)	Reuse market partner
Environment 	Bay Area Deconstruction WG (4)	Industry promotion
	Chico State University (6)	Sector development partner
	Calif. Straw Building Assn. (6)	Sector development partner
	Growers, aggregators and agricultural producers (6)	Material Suppliers and Producers Working Group

Ensuring Cluster Benefits are Experienced Equitably

"The rampant displacement seen today in the San Francisco Bay Area is built upon a history of exclusion and dispossession, centered on race, and driven by the logic of capitalism. This history established massive inequities in who owned land, who had access to financing, and who held political power, all of which determined—and still remain at the root of deciding—who can call the Bay Area home." Othering & Belonging Institute, 2019

Despite its progressive reputation, the City of Berkeley was the first city in the nation to adopt exclusionary single-family zoning in 1916. A century later, the Bay Area is at the forefront of

repairing these harms. The enactment of California Senate Bills 9 and 10 on January 1, 2022, essentially eliminates exclusionary single-family zoning by allowing most single-family homes to add up to three additional housing units. BACIC has chosen to focus its initial testbed, incubator, workforce, and IC market development programming on small infill projects, because of this new opportunity to provide "missing middle" housing within existing neighborhoods. Small infill projects are also more likely to support socially integrated neighborhoods and to help communities retain residents that might otherwise be displaced in the Bay Area's overheated housing market, and create inclusive entrepreneurship opportunities. BACIC will address the technology, process, and financing barriers to building 1–4-unit projects, while training small WMBE developers and contractors.

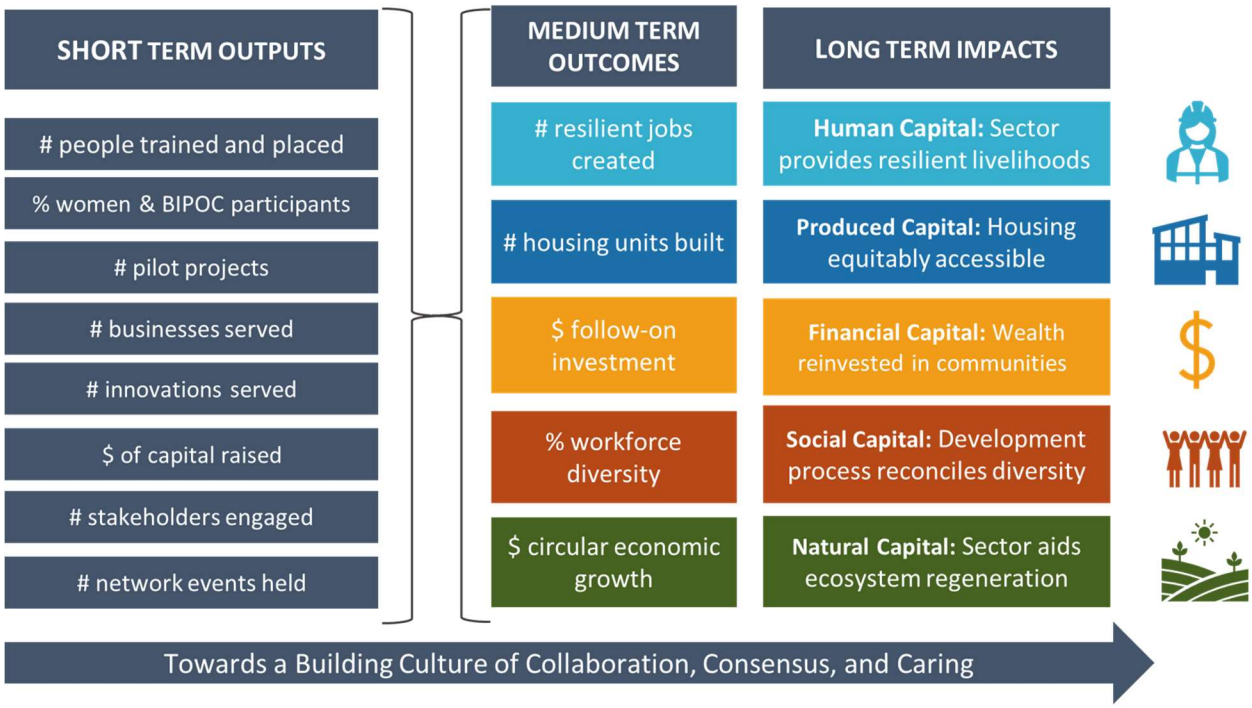


BACIC's primary goals are to create more equitable access to the sector's products (housing) and to diversify the sector's jobs and workforce to be more representative of the Bay Area's population, particularly BIPOC and women. With a focus on creating an "infrastructure commons" and open-source tools, the testbeds will enable a more diverse set of innovators to validate their products, preparing them to participate in the Bay Area Builders Lab, which prioritizes enrollment of women and BIPOC entrepreneurs. BACIC's workforce program includes a non-degree pathway into higher-paying architecture, engineering, and manufacturing jobs, offering training in new tools that firms will be adopting to meet state and local requirements for low-carbon materials and building design.

Our short-term interventions will focus on serving historically excluded populations and deliver community serving co-benefits, while we simultaneously work on the longer-term culture shift needed to address systemic inequities. We will measure our outcomes by the participation of women and BIPOC in the construction sector in high-quality jobs and as entrepreneurs in new product manufacturing, design and real estate development.

Expected Outcomes

BACIC will evaluate its progress in all five capitals necessary for sustainable development. As discussed earlier, if financial growth comes at the expense of other forms of capital, the sector's productivity and health will eventually decline. As a nascent cluster, we will initially measure how well we support target innovations and equity priority communities, and later, the growth of circular economic businesses, workforce diversity, and resilient jobs. The graphic below illustrates how the project outputs and outcomes relate to the long-term industry transformation we seek. Detailed metrics are included in the respective component project narratives.



Work conducted in Phase 1

- Clarified cluster's unifying vision, solidified project details, secured match funding and partnership commitments (as detailed in Private Sector Participation)
- Eliminated potential construction activity from testbeds and focused on equipment only
- Chose an initial focus on smaller infill projects for rapid deployment and iteration, rather than go too big, too fast with IC construction methods.
- Developed short-and long-term strategy for engaging local labor unions based on lessons learned from conflicts over the introduction of IC in other regions of the country
- Shifted focus of workforce programs to build on existing programs and serving historically excluded communities based on input from employers and workforce orgs
- Engaged equity organizations in program design and project implementation roles
- Limited direct program services to the 9-county Bay Area region for most project synergy
- Added Project 6: Sector Development for governance and to incubate future initiatives
- Terner Labs, a non-profit arm of UC Berkeley's Terner Center for Housing Innovation will lead Project 2: Incubator, and RMI will lead Project 5: IC Market Development
- Clarified economic development goals alongside housing and environment objectives
- Evolved SF reuse market as an adaptable installation, designed for disassembly and reassembly in other locations to optimize access and streamline environmental reviews
- Developed network governance structure for long-term sustainability and accountability
- Pursued two sites for the co-location of FABLAB and Incubator and scoped a Construction Innovation Center with satellite reuse market in Alameda