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Scalable and Sustainable Hybrid Housing: In-Situ Tunnel Form for Affordable Homes

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Organization Profile

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Practice Details

Country(ies): Türkiye, Afghanistan, Iraq

City(ies): Mersin, Adana, Herat, Baghdad, Kabul

Start Year: 1983 **Ongoing:** Yes **End Year:** N/A

Main Adequate Housing Components:

Housing Thematic Areas:

- Housing Affordability & Financing
- Rental Housing
- Social Housing
- Communal & Self-Build Housing

Relevant SDGs:

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Problem & Context

The global housing crisis is one of today's most urgent urban challenges, with millions still living in unsafe or overcrowded conditions while demand grows rapidly. Traditional construction is too slow, costly, and wasteful to meet this need, and many countries lack policies to adopt faster, industrialized solutions such as hybrid tunnel form, precast, and prefabricated POD systems. Skills gaps, fragmented financing, and weak incentives linking affordability with sustainability further block progress. The environmental toll is severe: beyond cement emissions, conventional methods create hidden costs through waste, rework, transport, and fuel use, multiplying carbon and resource burdens. Our hybrid system minimizes waste, streamlines logistics, and cuts labor, proving that efficiency is the best path to sustainability. Without practical and replicable models, governments and communities cannot deliver housing at the speed, scale, and sustainability the world urgently requires.

Solution Developed

1) How the practice addressed the challenge and target beneficiaries: The practice tackled the shortage of affordable housing with a hybrid model combining in-situ tunnel form structures and on-site precast/POD units. This cut time and costs while improving quality and energy compliance. Beneficiaries include low- and middle-income families needing adequate homes and municipalities/governments seeking scalable delivery.

2) Objectives of the housing practice: Goals were to accelerate housing supply, lower costs, enhance quality control, and ensure sustainability in line with climate targets. It also aimed to empower communities through local jobs, training, and licensing, while minimizing environmental impact by reducing waste, handling, fuel use, and maximizing efficiency.

3) Innovative or unique approaches: The innovation integrates technology, society, and institutions. Technologically, tunnel form shells paired with precast kitchens/bathrooms deliver unmatched speed, quality, and simplicity. Socially, the model builds skilled local capacity. Institutionally, it creates a scalable, adaptable framework for public housing and PPPs worldwide.

Implementation

1) Actions implemented: A hybrid construction model was developed, integrating in-situ tunnel form with on-site production of precast and POD units (kitchens/bathrooms). Standardized housing typologies were created to ensure affordability and energy efficiency. Training and licensing programs were launched to build local workforce capacity, supplier partnerships secured production and delivery, pilot projects validated cost/time/quality benefits, and a digital configurator was initiated for land-use optimization (B2B) and customizable finishes (B2C).

2) Actors involved: Government bodies provided regulatory approval and integration into housing programs. Private sector partners (construction firms, precast/POD manufacturers, engineering companies) led design and assembly. Community groups engaged in feedback and social acceptance. NGOs and international partners contributed technical expertise, advocacy, and visibility.

3) Timeline: The first application of our hybrid approach was the Erciyes Housing Site, delivered between 1983 and 1986, marking the start of this construction model.

4) Resources and partnerships: Financing combined PPP frameworks, municipal housing funds, and private equity. Technical resources included industrialized construction equipment, digital design tools, and QA/QC systems. Partnerships involved authorities, local manufacturers, and training institutions.

Enablers & Obstacles

1) Key drivers and enablers

Political commitment and housing strategy alignment created space for innovation, while community engagement built trust. The hybrid tunnel form with precast and POD units enabled faster, higher-quality, and more affordable housing. Workforce training built sustainable skills, PPP frameworks and private financing provided resources, and regulatory flexibility eased permits and integration.

2) Obstacles and how they were addressed

Resistance to non-traditional methods was overcome with pilot evidence of savings and compliance. Some architects resisted tunnel form due to design limits, but workshops showed adaptability. High upfront investment discouraged adoption, addressed by proving lifecycle efficiency. Workforce shortages were solved through training, supply chain risks with long-term agreements, financing barriers with PPP alignment, and regulatory uncertainty through dialogue with authorities.

Results & Impact

1) Quantitative and qualitative results: Construction time cut by up to 40% versus conventional methods; cost per m² lowered 10–20%, boosting affordability. Defect rates fell nearly 50% thanks to factory-controlled precast/POD production. Units met or exceeded national/EU energy standards, reducing utility costs. Workforce development trained and licensed dozens of local workers in hybrid construction. Resident satisfaction was high, citing improved comfort, safety, and design quality. Case example – Erciyes Project: 548 affordable apartments delivered with the hybrid system, benefiting 548 families with durable, energy-efficient homes.

2) Impacts on low-income households and marginalized groups: Provided affordable housing to families previously priced out of the market; reduced energy/maintenance costs for low-income households; created local jobs and skills pathways for vulnerable groups; aligned with social housing policies to ensure inclusivity.

3) Broader and long-term impacts: Strengthened community stability by reducing reliance on informal housing; stimulated local construction ecosystems through supplier engagement and workforce training; lowered lifecycle emissions via efficient material use and high energy standards; established a scalable, replicable model adaptable worldwide, supporting long-term pipelines and resilience against future crises.

Replication & Scale Up

Beyond the Erciyes Housing Site, similar projects in Adana and Mersin used the hybrid tunnel form and precast–POD system to accelerate large-scale housing delivery. Internationally, it was applied to military housing in Kabul, Herat, and Baghdad, proving versatility across civilian and institutional contexts. Success was enabled by standardized processes, local workforce training, supplier partnerships, and adaptability to regulatory and financing frameworks—demonstrating the model is scalable and transferable globally.

This housing practice can be scaled up through standardized hybrid tunnel form and precast–POD systems adaptable to diverse contexts. Successful replications in Erciyes, Adana, Mersin, and military projects in Kabul, Herat, and Baghdad prove its versatility. Scale-up is enabled by local workforce training, supplier partnerships, PPP financing, and policy integration. By reducing material, transport, and labor waste while ensuring affordability and sustainability, the model can expand from hundreds to thousands of units annually worldwide.

Policy Uptake

This housing practice has informed or been partially integrated into policy discussions, strategies, or pilot-level policy instruments.

The practice has been partially integrated into policy discussions through pilots in Erciyes, Adana, Mersin, and in Kabul, Herat, and Baghdad. These pilots provided concrete evidence of reduced costs, faster delivery, and improved sustainability, which informed local government housing strategies and PPP frameworks. In several cases, municipalities and housing authorities referenced the hybrid approach in planning documents and feasibility studies, signaling its potential for broader adoption.

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Lessons & Takeaways

In hindsight, earlier engagement with regulators would have eased policy integration, while expanding workforce training with digital tools could have improved quality and speed. Stronger systems for monitoring environmental impact would have provided clearer evidence of sustainability gains. Involving financial institutions earlier could have reduced funding delays and accelerated scale-up, showing that innovation must go hand in hand with policy, skills, sustainability tracking, and finance.