

A New Playbook for Housing Affordability

Credits: 1.0 AIA/CES LUs, 1.0 PHD credit, 0.10 ICC credit (no HSW)

MASS TIMBER+SM
OFFSITE CONSTRUCTION CONFERENCE

PRODUCED BY



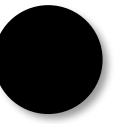
Forest Economic Advisors

Ivan Rupnik, PhD
Founding Partner, MOD X



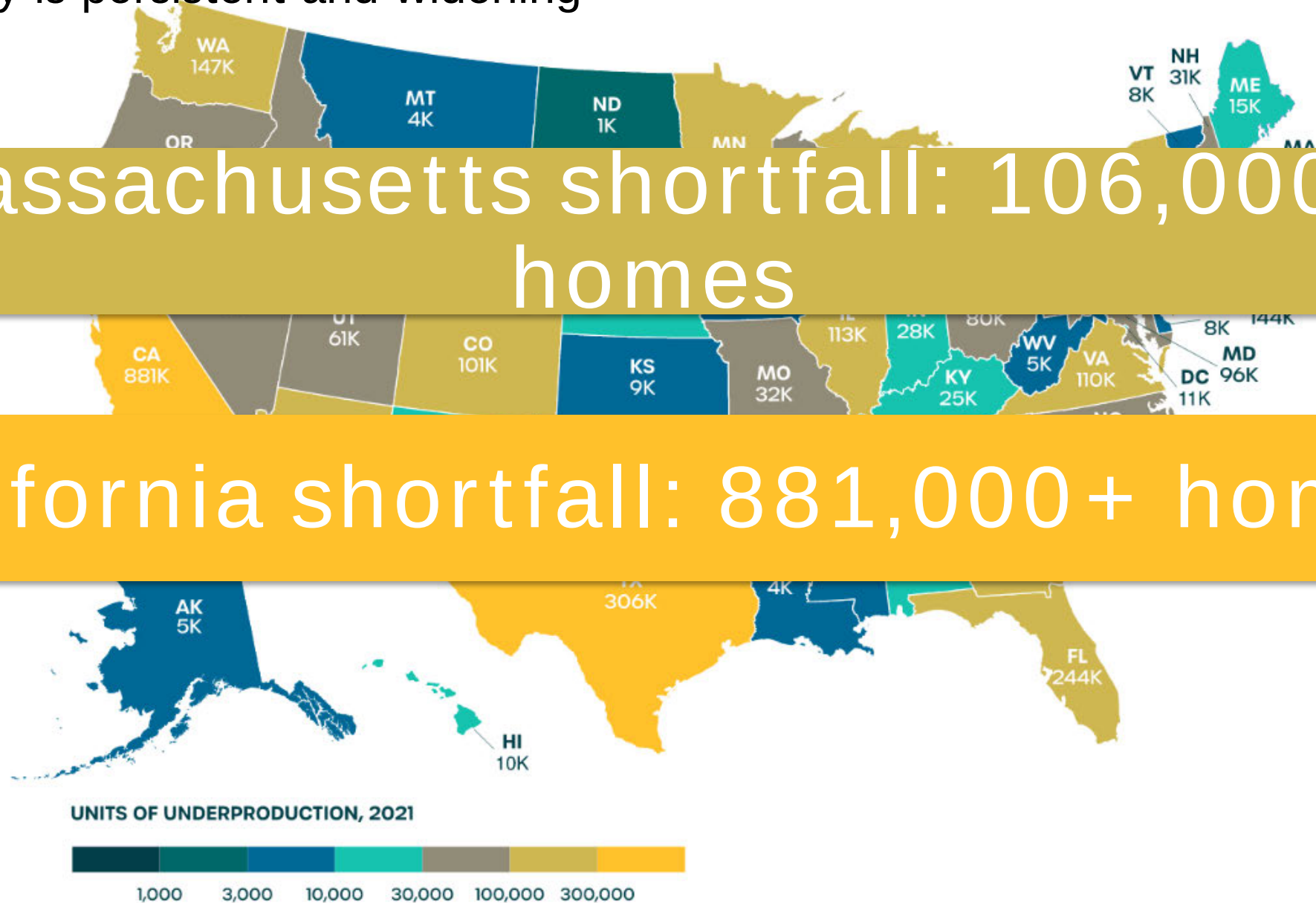
We're In A Housing Crisis, Undersupply Plays a Major Factor

Undersupply is persistent and widening



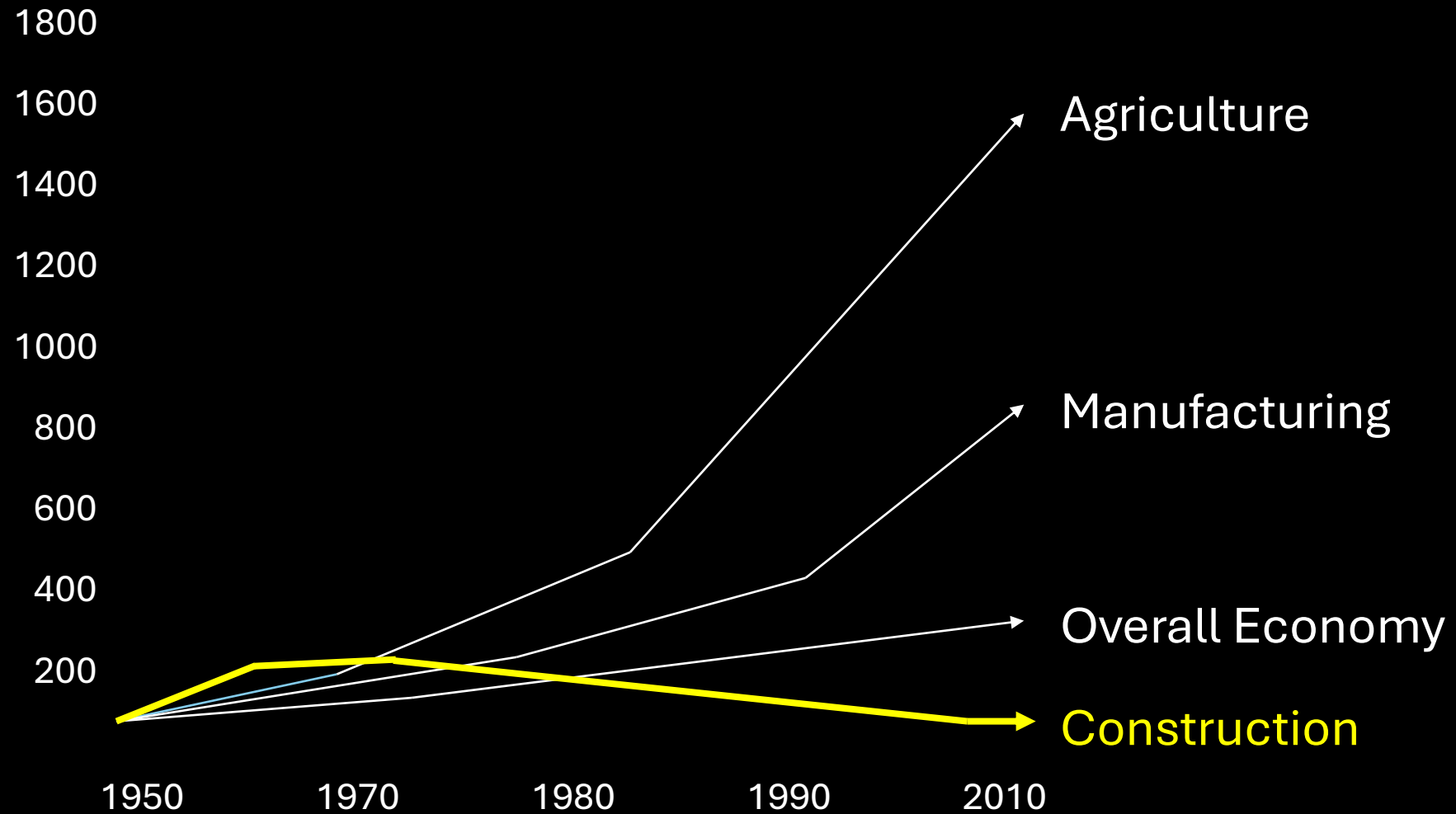
Massachusetts shortfall: 106,000+ homes

California shortfall: 881,000+ homes



Productivity Gap → Undersupply

Construction productivity has stagnated while other sectors improved.



Move to a Manufacturing-Style Production System – and get 10X gains

only with the enablers:
Internal (manufacturing mindset) + External (Regulatory Reform and Demand Aggregation).

> 60%

Productivity boost
(onsite + offsite)

- Reshape regulation
- Rewire contracts
- Rethink design
- Improve procurement and supply chain
- Improve onsite execution
- Infuse technology and innovation
- Reskill workers

> 1000%

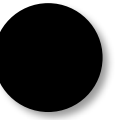
Productivity boost
(offsite)



- Move to a manufacturing style production system

Circa 1916, U.S. Led the Move to a Manufacturing-Style Production System

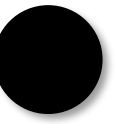
Enabled by softer boundaries between building construction, infrastructure, and manufacturing



USA 1916

Circa 1970: A Peak Year in Offsite Construction Capability in the U.S.

The Sector and Framework Began to Diverge...



USA 1970



Japan 1990



After 1970: Sweden & Japan Scaled — and Built the Rules to Match
They paired technology with enabling frameworks so the gains endured

USA 1970



Sweden, 2000



A black and white photograph of a large-scale industrial building under construction. The building features a prominent balcony with a person standing on it. The image is overlaid with a large quote in white text. In the top right corner, there is a solid black circle.

“... large-scale application of industrialized building systems (was) **not limited by technological, design or cost factors, but only by institutional constraints.**”

HUD, 1968

A New Playbook for Housing Affordability Through Offsite Construction

A Manufacturing Mindset and a Harmonized, Performance-Based Regulatory Framework



MBI 2016-2018

INTERNAL ENABLERS TO ACCELERATION

- Capacity, Capability, Competency (3 C's)
- Data
- Standards
- Partnerships
- > ICC MBI Standards

EXTERNAL ENABLERS TO ACCELERATION

- Regulatory Framework
- Capital, Finance, and Insurance
- Standards and System Performance
- Project Delivery and Contracts
- Labor + Workforce Training and Management
- Business Models and Economic Performance

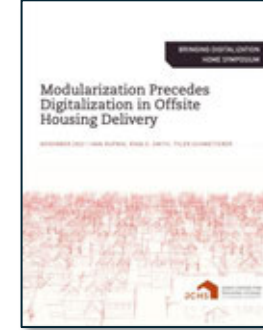


Ivan Rupnik
Ryan E. Smith
Tyler Schmetterer

> Federal Funding for Research



IMTC 2022



Harvard 2022

INTERNAL ENABLER
Manufacturing Mindset



NHCT 2025

EXTERNAL ENABLER
Coordinated Fed. State and Local Action



HUD 2021-2023

EXTERNAL ENABLER

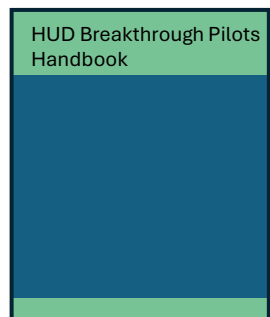
- Demand Aggregation
- Regulatory Reform



HUD 2022-2025

EXTERNAL ENABLER

- Pilot Projects
- Action Plans



HUD 2024-2027



McKinsey 2019

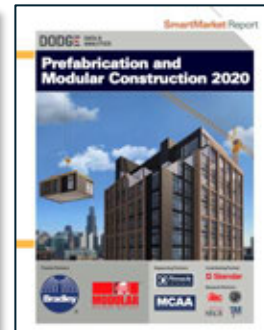
Source: MOD X



AIA 2020



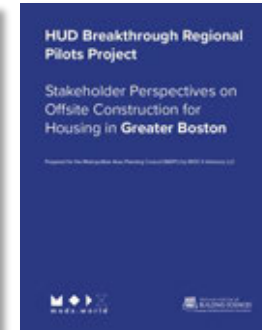
Fannie 2020



Dodge 2020



Action Plans > CA ...



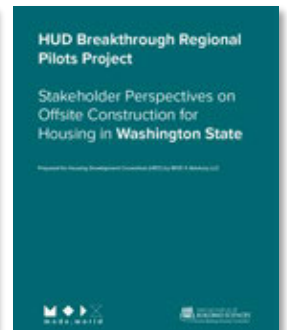
Boston ...



MN ...



UT ...



WA ...

A New Playbook for Housing

Affordability Offsite Construction at Scale

1) REGULATORY REFORM (define & approve)

- Consistent definitions and metrics for offsite construction
- Code reform: fragmentation → harmonization; prescriptive → performance-based specifications
- Performance-based, system-level approvals with recognized verification methods

2) DEMAND AGGREGATION (market pull & finance)

- Standard award criteria across local, state, and federal programs & subsidies
- Coordinated/direct procurement to aggregate demand and stabilize the pipeline
- Finance & insurance acceptance of certified systems (clear, standardized routes)

3) COMPETENCY EDUCATION (use capacity for overall capability)

- Manufacturing mindset: platform + parts; standardized interfaces & repeatable work packages
- Design—bid—**build** → **IPD** for outcome-based delivery
- End-to-end data, QA/QC & traceability (incl. EPDs)

4) Continual Improvement (feedback loop)

Surveillance & performance data update metrics, approvals, and award criteria



The Long *Road to Housing* Affordability: Sweden (E.U.)

Sweden's decades-long shift—now echoed across the EU—shows how to move from fragmented, prescriptive rules to harmonized, performance-based standards.



MOD X

Lindbacks

Construction Revolution

Tener Center

RMI (DOE)

NYT

Synergy Modular

Homes England

Univ. of Tokyo

**Center for
Advanced Timber
Tech**

Performance Supported Wood-Based Construction Reaching New

A 10-story light-wood + mass-timber hybrid, volumetric-modular project



0% → 19%

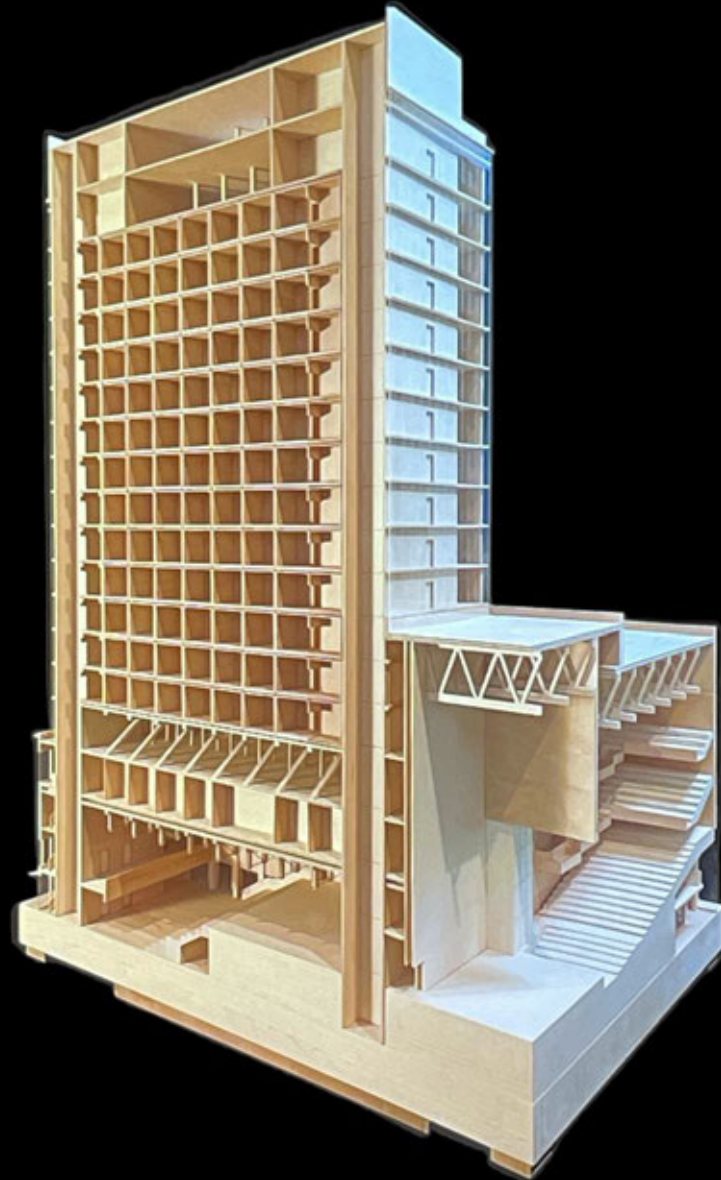
1995 2015

Sector-wide Standardization Supports Collaboration and Innovation

Martinsons + Derome > Wood Hotel



Martinsons + Derome



Martinsons

Same Problems in the 1960s. A Different Choice in Europe.

Facing the U.S.-like fragmentation and prescriptive rules, Europe set a long-term, performance-based regulatory destination—and built toward it.

“The only major divergence from the general trend toward continued expansion of industrialized building (in Europe) is ...Sweden. Here prefabrication rose steadily until 1958 when it reached 7.4% ... after which it declined to 3.2% in 1962. ... The fact **that Sweden is the only highly developed West European country that has not provided special assistance to industrialized housing systems** may be a partial explanation for this fluctuating trend.”

“**Local building codes are frequently written in terms of (prescriptive) specifications rather than performance**, thereby excluding the introduction of new prefabricated materials. In Austria prefabrication has encountered difficulties from the fact that **provincial building regulations**, of which there are **15**, **permit the use of prefabrication only under certain conditions**. Building codes in France have been **less of a problem** since the substitution in 1955 of a **national building code** for various sets of local regulations.”

HUD 1968

How Performance-Based Frameworks Work

Societal Goals > Performance-based requirements > Industry Independence AND Accountability

2025 > Manufacturing Mindset Expected

(Performance Code Update, Anticipating Eurocode 2.0)

2023 > National Verification of Impact

(Move to manufacturing in industry AND regulation showed consistent results)

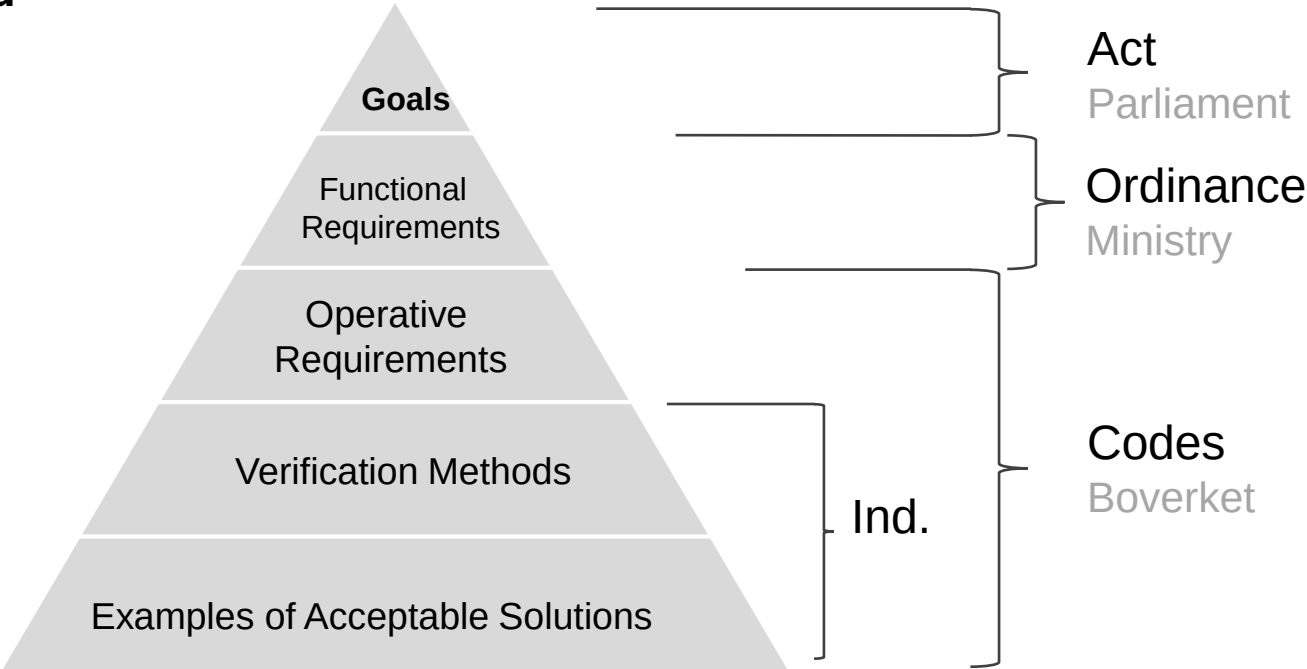
2010 > “State” > “Federal”

(Eurocode + European Building Products)

1995 > Prescriptive to Performance

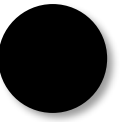
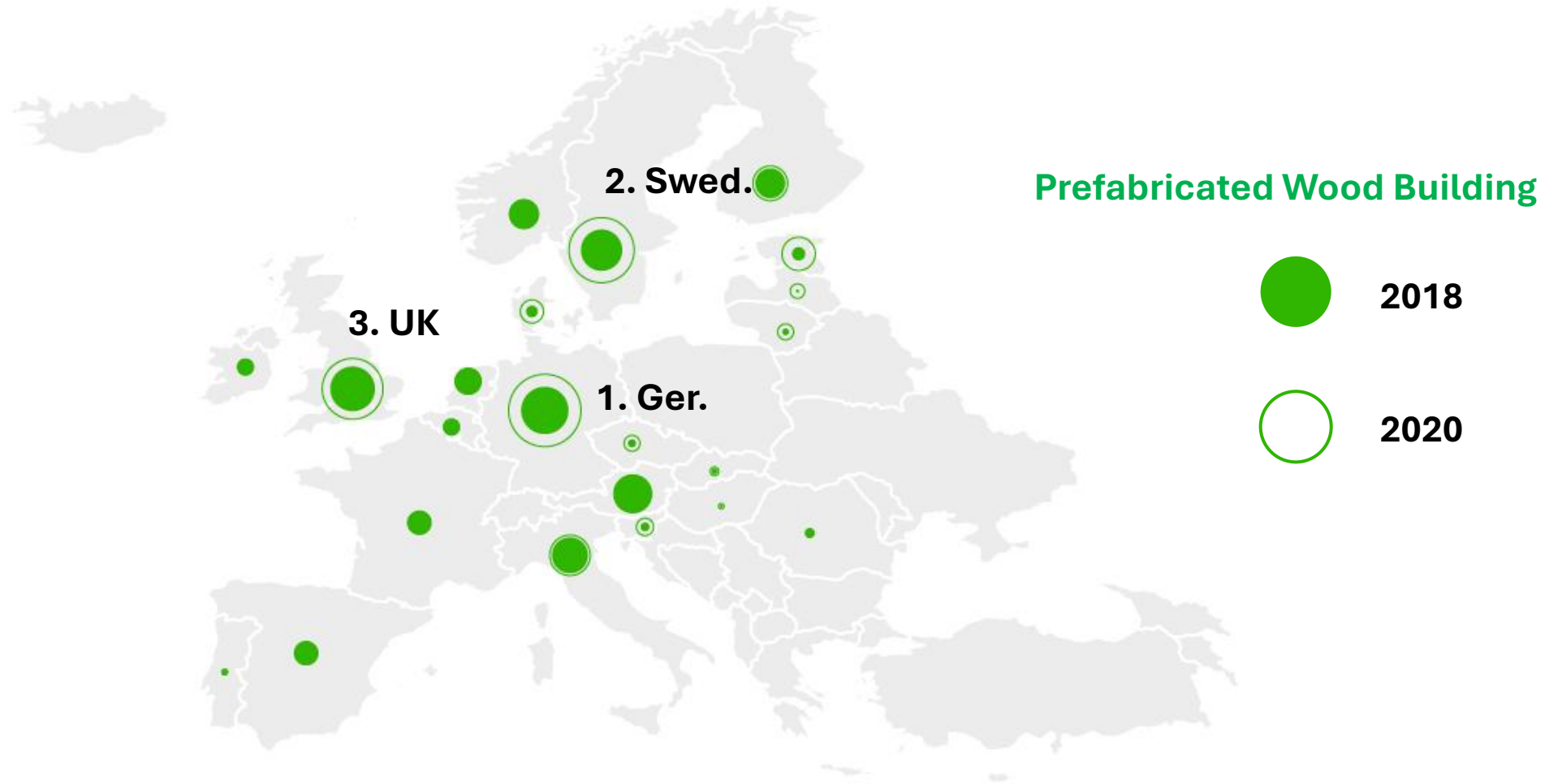
(The Nordic Pyramid)

1960 > Harmonization: National Code



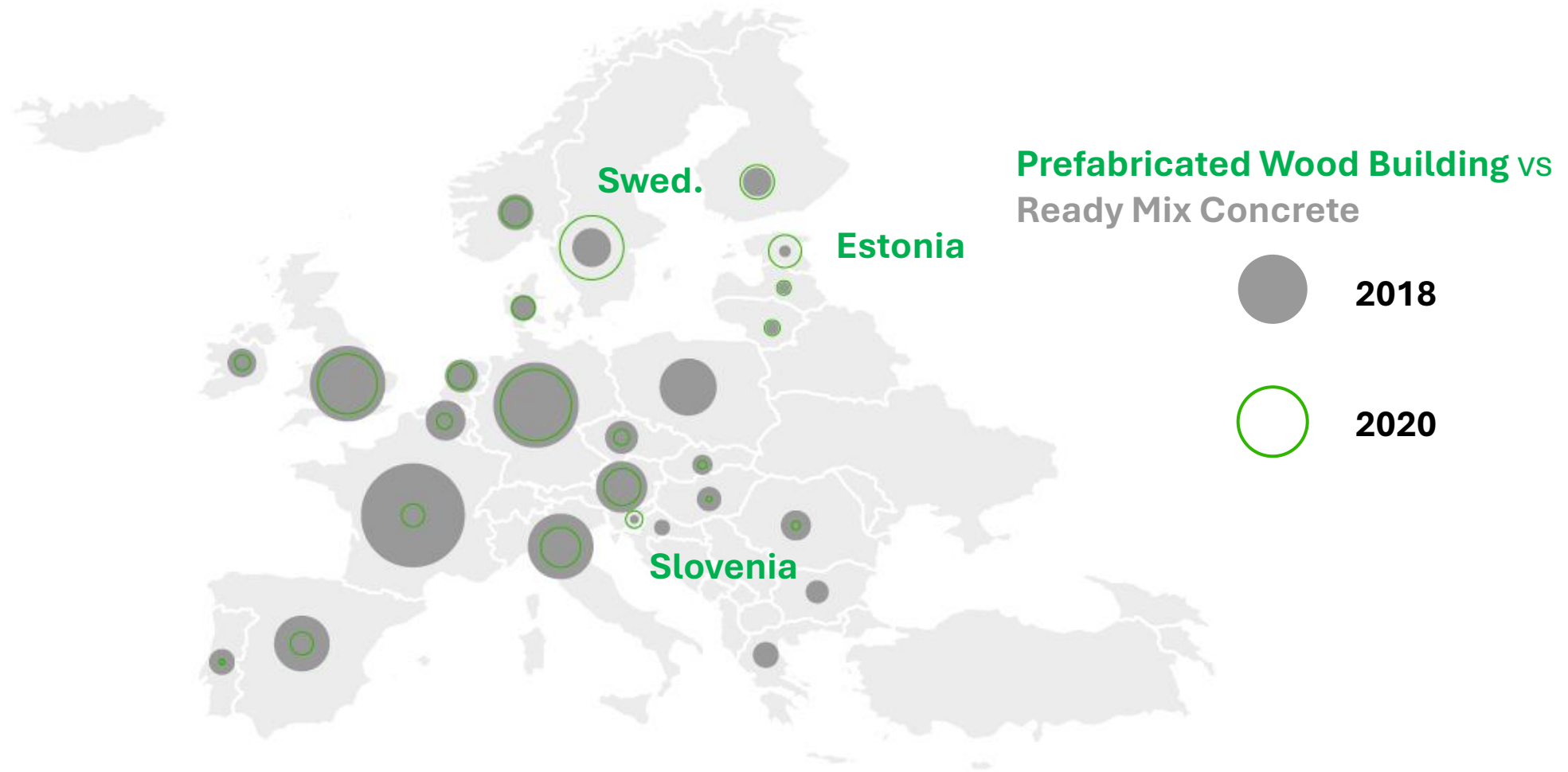
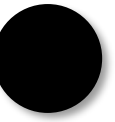
The Impact of a Performance-based Framework on Prefab Wood in the EU

Sweden has the largest domestic **Prefabricated Wood Building** industry in Europe, per capita



Performance Code Levelled the Playing Field Between Wood and Concrete

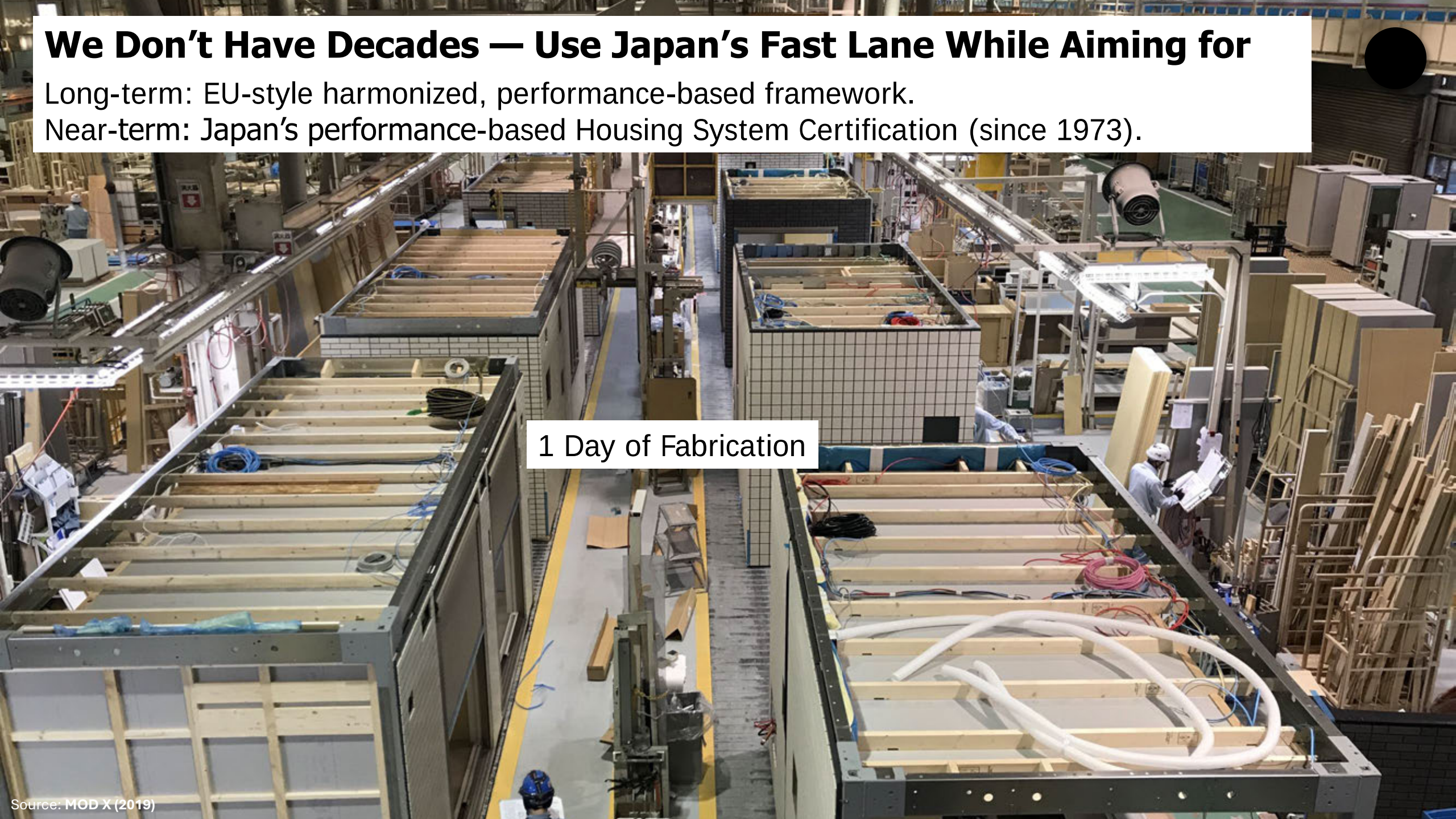
Performance code is helping prefab wood gain share vs. site-poured concrete EU Wide



We Don't Have Decades — Use Japan's Fast Lane While Aiming for

Long-term: EU-style harmonized, performance-based framework.

Near-term: Japan's performance-based Housing System Certification (since 1973).



1 Day of Fabrication

The Fast Lane to Housing Affordability

Performance-based Housing System Certification in Japan

A photograph of a construction or industrial site. In the center, an orange and black forklift is lifting a large, rectangular module covered in silver and green tarps. The module is being loaded onto a flatbed truck. To the right, another similar module is already on a truck. The background shows a building with a corrugated metal roof and some industrial equipment. The ground is paved with orange and white markings.

A Module Every 3 Minutes

The Fast Lane to Housing Affordability

Performance-based Housing System Certification in Japan

1 Day of Assembly



The Fast Lane to Housing Affordability

Performance-based Housing System Certification in Japan

10-30 Days of Onsite Work

The Fast Lane to Housing Affordability

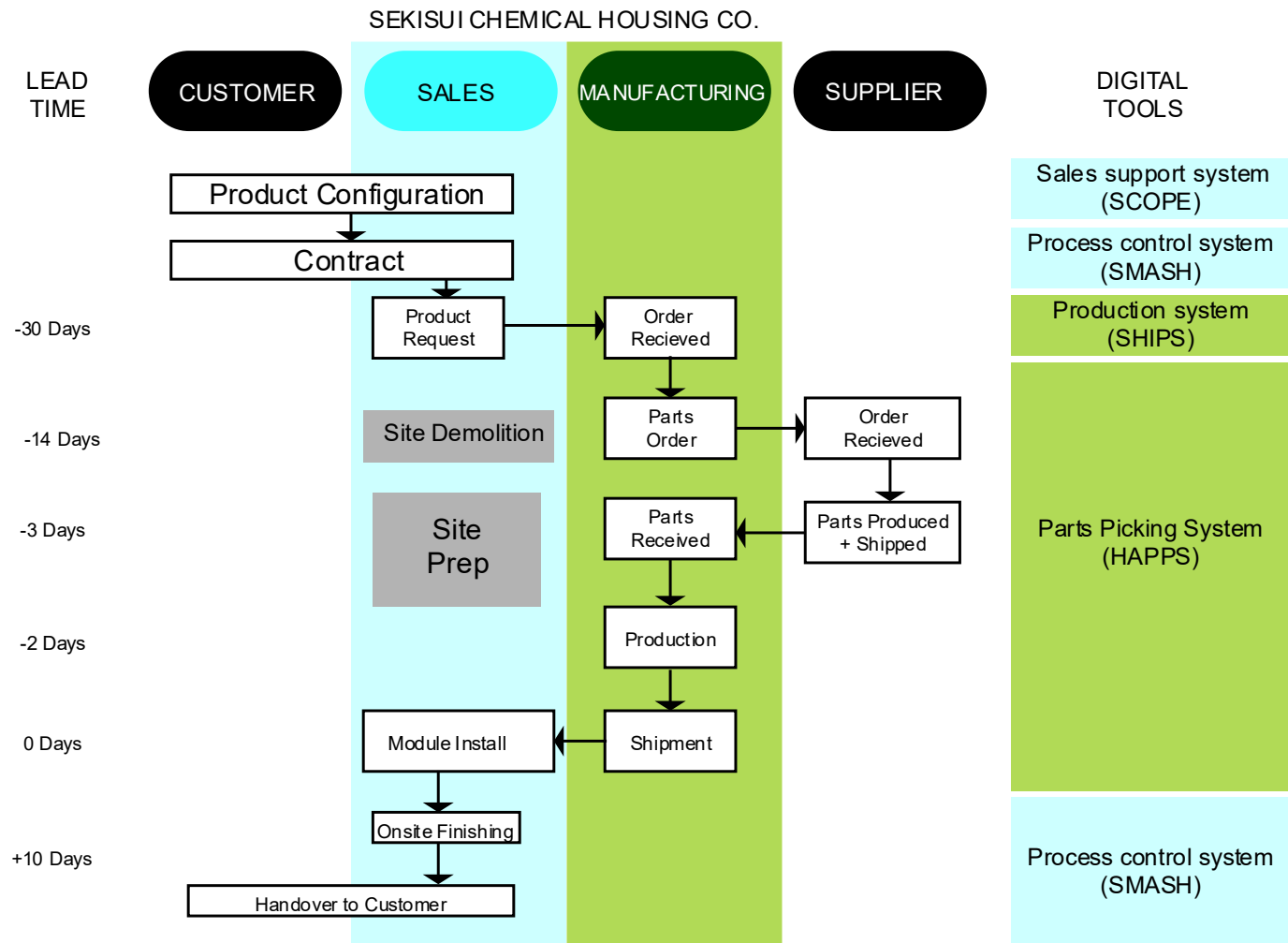
Performance-based Housing System Certification in Japan

Level of Completion



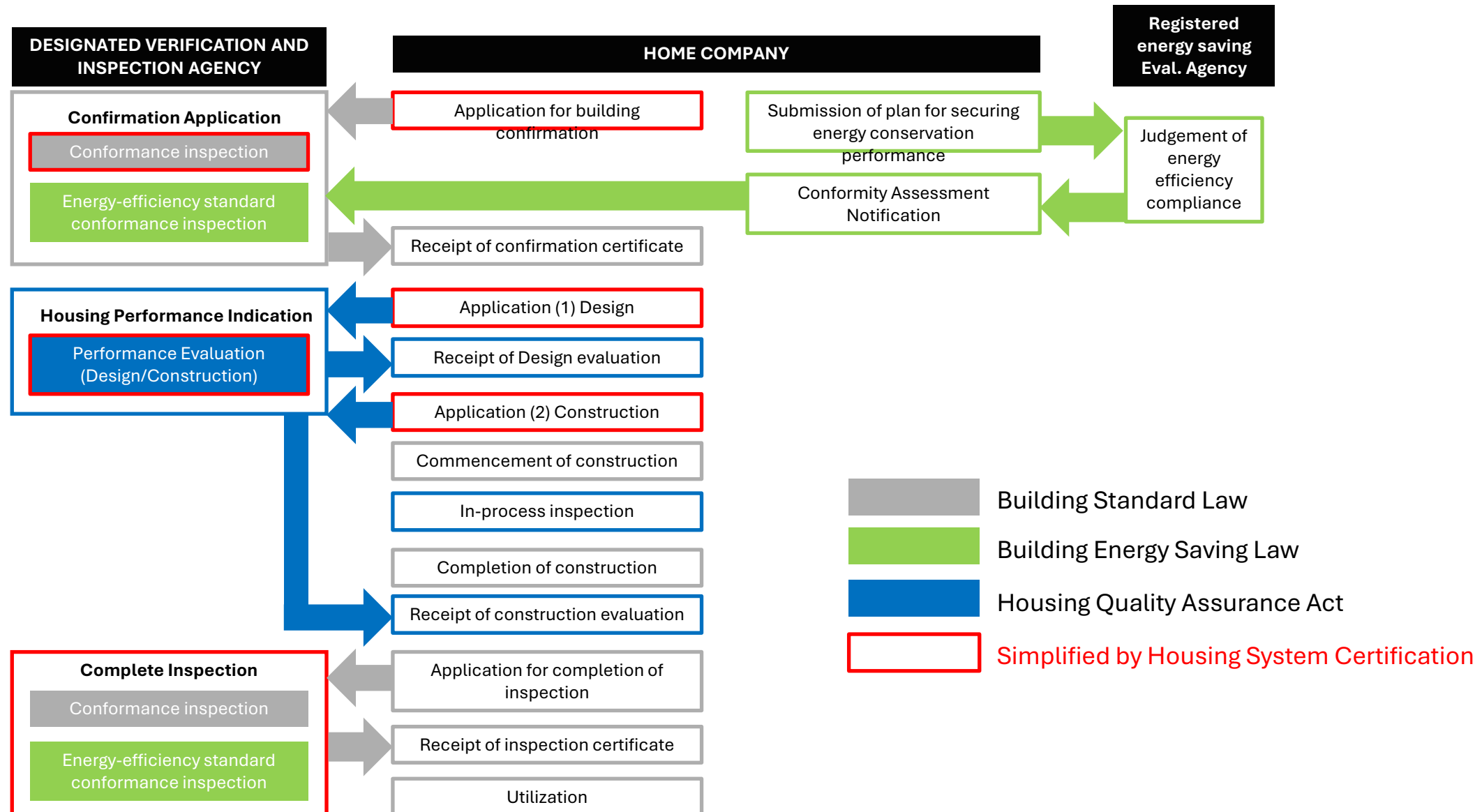
Japan's Housing System Certification Program

Enables a uniquely configured home (or homes) in 40–60 days.



Japan's Housing System Certification

Equally rigorous—but faster—because inspectors verify company-specific, performance-derived specs.



Japan's Housing System Certification

Not a "preapproved" design but a configurable system of preapproved assemblies and relationships

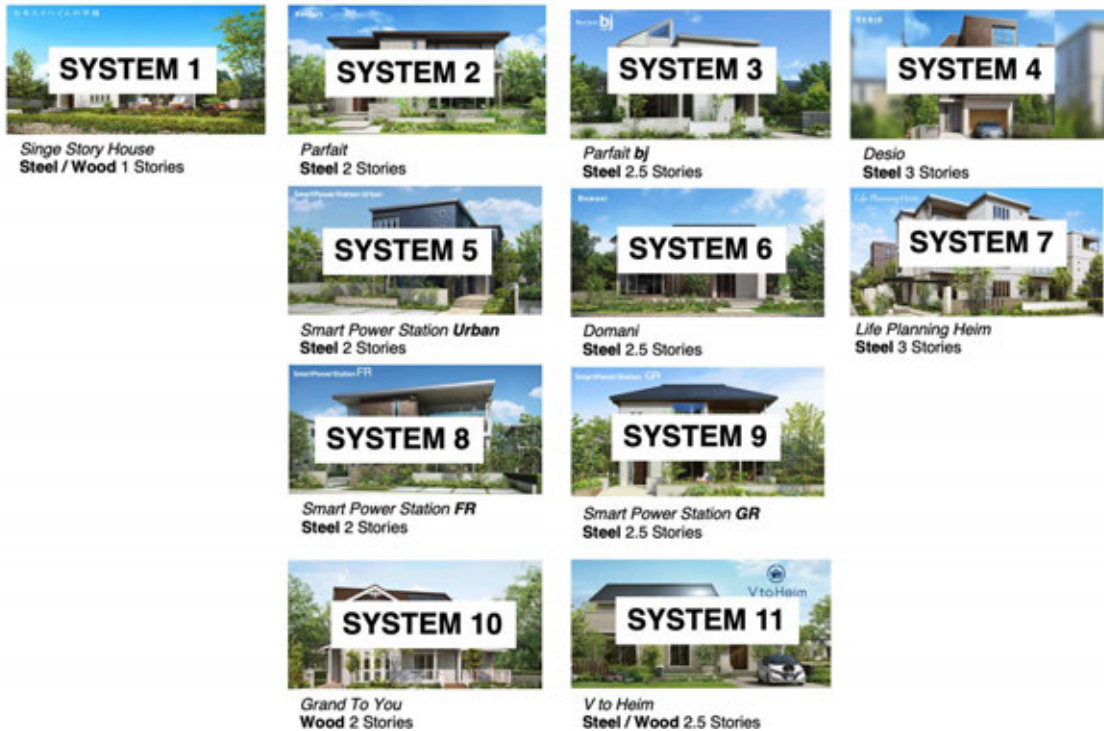
Case Study: Sekisui Heim

14,000 homes a year, nearly half "unique" but based on a system

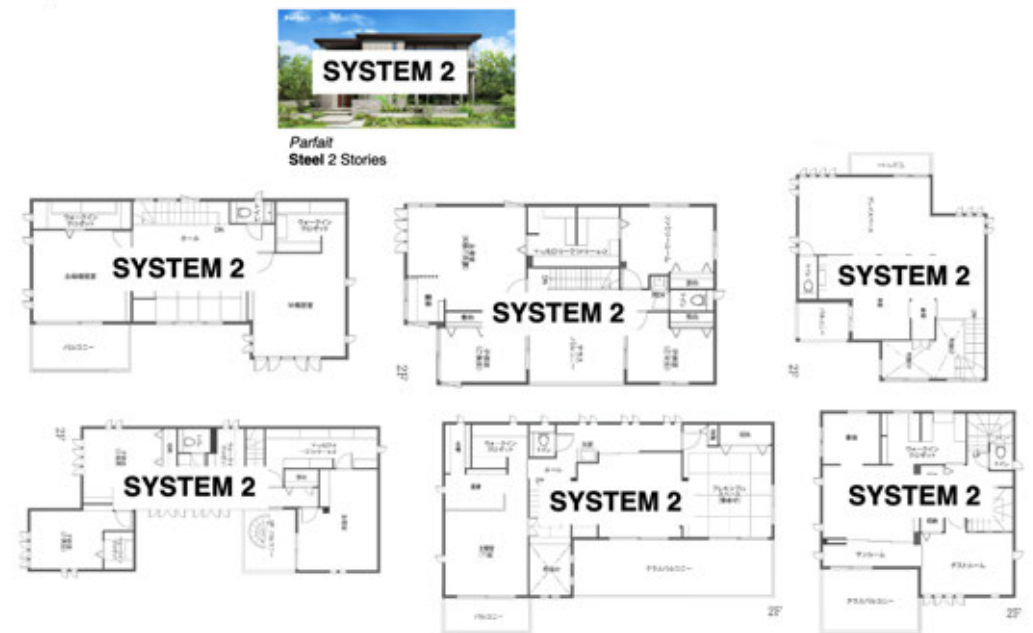
60,000 certified components

90 housing system certifications on file

Different Certified Systems



Variants of the Same System



Japan's Housing System Certification

Directly and Indirectly Supports Innovation Across the Sector > Offsite and "Onsite"

Housing Business

"Prefabricate House"

1D Kit of Parts (Complete House)



Timber and Building Materials Business

"Conventional House"

1D Kit of Parts, Fasteners, Software



Japan's Housing System Certification

Aligned with Japan's FHA Equivalent – the JHF – Certification Aligned With Mortgage Rate Reductions Related to Japan's Evolving Societal Goals



As a national policy implementation agency and public financial institution, JHF grapples with various societal issues related to housing while taking into account policy issues such as the eight goals (**Goals**) of the Basic Plans for Housing established by the government.



Lifestyle changes and diversification

Goal 1 Realize housing compatible with a new normal and advancements in digital transformation (DX)



Declining birthrate and aging population

Goal 3 Develop housing conducive to raising children

Goal 4 Develop communities where diverse generations support one another and the elderly can live with peace of mind and in good health

Goal 5 Establish a safety net function whereby people requiring special assistance in securing housing can live with peace of mind



Advancement of climate change

Goal 6 Establish a housing circulation system and formulate high-quality housing stock aimed at a decarbonized society



Housing stock surplus and underdeveloped secondary market

Goal 7 Promote appropriate management, demolition and utilization of vacant homes in an integrated manner based on vacancy situation

Goal 8 Develop a housing industry that enriches the convenience and abundance of residents' lives



Increased frequency and severity of natural disasters

Goal 2 Develop safe housing and residential areas, and secure homes for people affected by disasters, in a new stage where disasters occur more frequently and cause greater damages

Housing System Certification — An American Idea, Perfected in

First tested in the U.S. (late-1960s/early-1970s) and studied in 1972 by the "Uchida Mission."

The Uchida Mission

Editor's Note: October 17, 1971 and November 4, 1971 bracketed thousands of miles of intensive travel by plane and bus by 47 members of a Japanese study team and one HUD official. During a 20-day nationwide working tour organized by HUD's Office of International Affairs, the Fourth Housing Industry Study Team was led by Morris Cohen, Director of Education and Training in the Office of International Affairs. Mr. Cohen, an indefatigable traveler and amateur diarist, kept a voluminous log of the cross-country trek. What follows is a condensation of his full account.

On October 17, 47 members of a Japanese housing study team arrived at San Francisco on the first leg of a nationwide tour of U.S. industrialized housing developments. HUD's Office of International Affairs planned the professional and technical aspects of the visit as part of its international cooperative program.

The Fourth Housing Industry Study Mission was headed by Genko Uchida, of the Uchida Consulting Firm, Tokyo. The group included three Japanese government officials and representatives of 37 businesses and organizations and was self-financed. Altogether, the group visited 10 housing sites and developments and six housing factories in 10 states during the 20 days it spent in this country. The group also visited two new communities and the Industrialized Building Exposition and Congress (INBEX) where they saw over 350 exhibits of materials, equipment, and systems.

In San Francisco, the "Uchida Mission," armed with cameras, notebooks, a barrage of questions, and unlimited enthusiasm, opened the study tour with a visit to the new community of Foster City where Mayor Wayne McFadden explained the background and future plans for the community. Then the group inspected two

new housing developments being built by Kaufman and Broad and L.B. Nelson, before heading across the Bay to see two other housing developments, the Mission Bay Mobile Homes Park and then the Golden Gate urban renewal area in downtown San Francisco.

The second day found the group in Seattle where E.K. Muller of the Boeing Company welcomed them and gave the background on Operation

BREAKTHROUGH. Another highlight was a guided tour through the St. Regis housing factory in Tacoma, which produces wood modular homes.

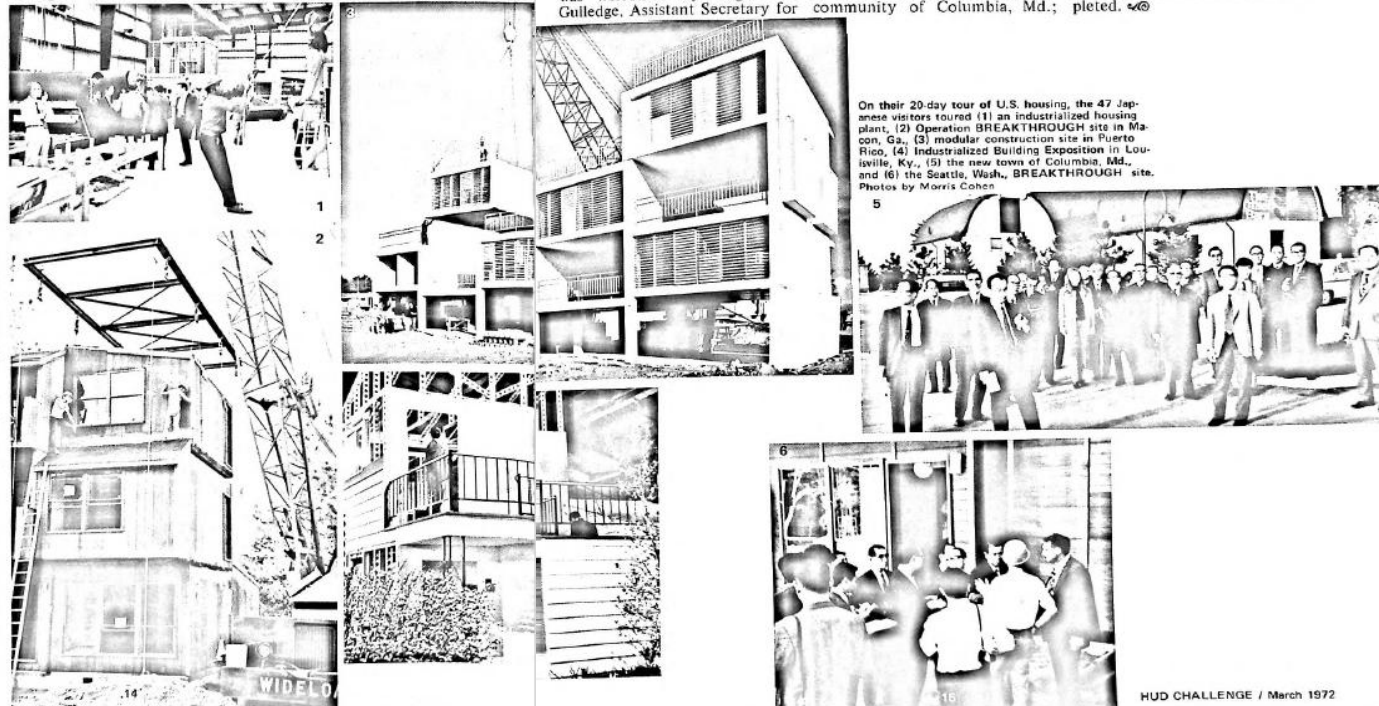
Kalamazoo, Mich., was the next stop. Here, the group was "greatly impressed" with the 166 structures already erected on the BREAKTHROUGH site, reflecting a wide range of building materials and designs. The group traveled by bus to the Guerdon factory at Elkhart, Indiana, to see how Pacemaker Mobile Homes are built. On succeeding days, the study mission visited the Boston area (San Vel Concrete Corporation,

Littleton, and Fountainhead Apartments, Westboro); New York City (Shelley Systems); King of Prussia, Pa. (General Electric's module manufacturing facility); and Philadelphia, Pa. (Society Hill and Independence Hall urban renewal areas). Also, Macon, Ga. (Herciform Homes at the BREAKTHROUGH site); Perry, Ga. (Systems Structures, Ltd.); Orlando, Fla. (DISNEY-WORLD); San Juan, Puerto Rico (Shelley Systems operations); Louisville, Ky. (INBEX); and Washington, D.C. In Washington, the group was welcomed by Eugene A. Guldge, Assistant Secretary for

Housing Production and Mortgage Credit, and Dale E. Barnes, Director of International Affairs. Discussions were conducted by Alfred A. Perry, Director, Operation BREAKTHROUGH; David C. Moore, Director, Special Projects; and Charles J. Orlebeke, Deputy Under Secretary for Policy Analysis and Program Evaluation. Their Washington activities also included a visit to the National Bureau of Standards to observe testing of BREAKTHROUGH modules; inspection of HRW Systems housing factory in Edmonston, Md.; the new community of Columbia, Md.;

and a farewell reception at the Mayflower Hotel.

On November 4, Mr. Cohen said "Mata Aimasho" (until we meet again) to the group at Baltimore's Friendship Airport. Some members went directly to Europe, a few to other U.S. cities, but most departed for Honolulu—where they toured local housing developments—before heading for Tokyo and home. Before leaving, the group members expressed their satisfaction with their program and their determination to organize another study tour to see Operation BREAKTHROUGH completed. ☺



Housing System Certification — Advocated by Congress (1966–1974)

Congress identified institutional barriers and called for a national standards/evaluation function.

1966 — Advisory Commission on Intergovernmental Relations

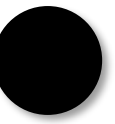
“U.S. **building regulation** has placed **unjustified burdens on the technology and economics of building**,” limiting the “**full economic range of housing**.”

1968 — Housing and Urban Development Act (Operation Breakthrough)

HUD shall assess “the **effect which local housing codes and zoning regulations** have, or would have if applicable, **on the cost per dwelling unit**” of innovative housing construction.

1974 — Housing and Community Development Act

“... the absence of an authoritative national source ... on ... nationally acceptable standards ... is an obstacle that **imposes severe burdens and leads to missed innovation**. Model codes alone won’t fix updating difficulties and local inconsistencies; non-uniform provisions increase costs ... therefore, **a single authoritative nationally recognized institution to evaluate new technology is needed to speed acceptance at all levels**. Congress declares the need for an authoritative nongovernmental instrument — the **National Institute of Building Sciences (NIBS)**”



Housing System Certification... falls within NIBS's statutory mandate

Congress created NIBS as an authoritative nongovernmental body for standards and evaluation.

“NIBS shall exercise its functions and responsibilities in four areas relating to building regulations:

(A) Develop, **promulgate, and maintain nationally recognized performance criteria, standards, and test/evaluation methods**— suitable for adoption by building officials — including for building systems, subsystems, components, products, and materials.

(B) Evaluate and prequalify existing and new building technology.

(C) Conduct needed investigations in support of (A) and (B).

(D) Assemble, store, and disseminate technical data and related information.”

U.S. Congress, Housing and Community Development Act of 1974

We've Done This in Other Sectors — U.S. Automotive

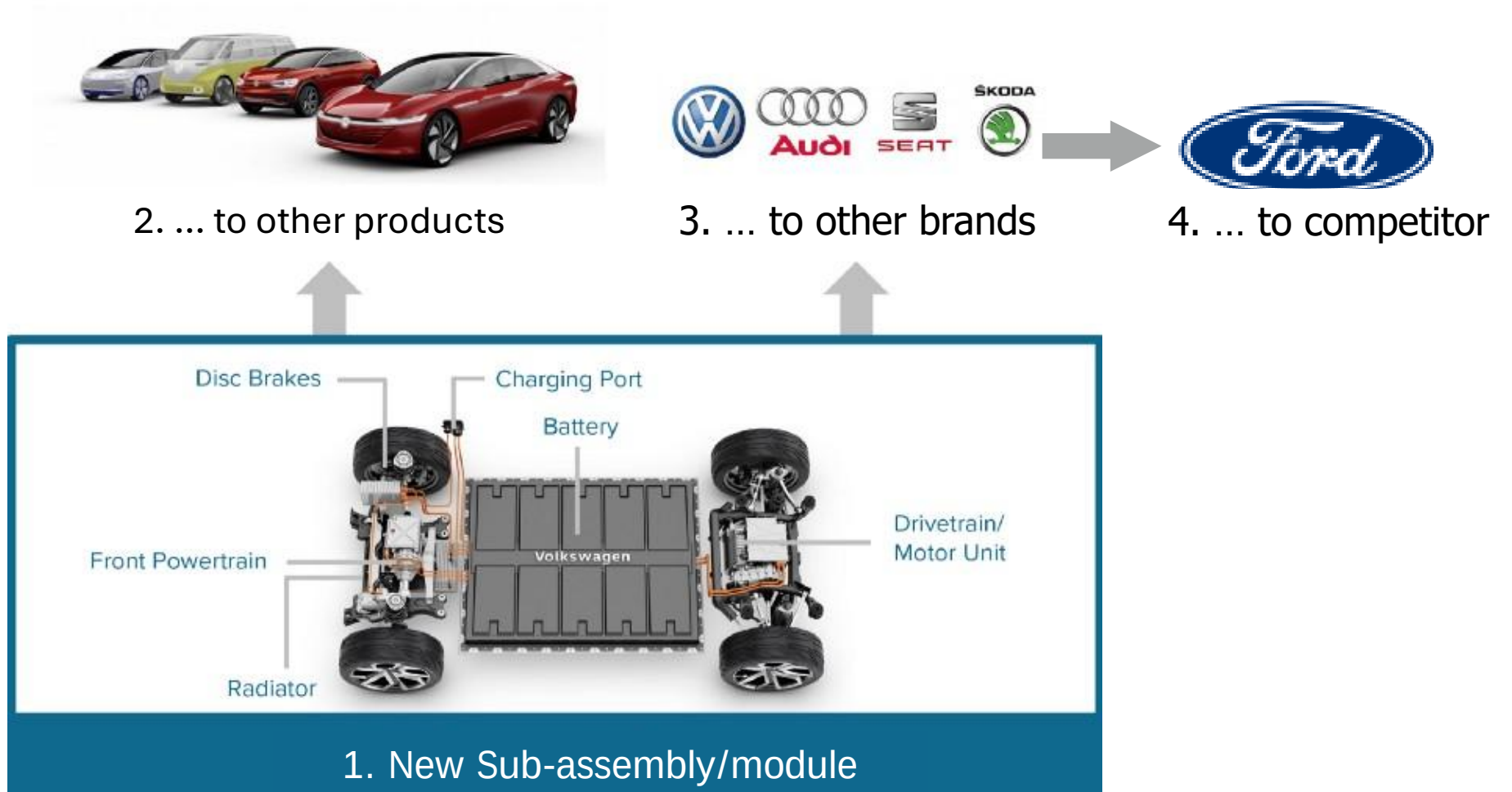


From Prescriptive and Fragmented to Performance-based and Harmonized (Internationally)

	Regulatory Framework	Key Attributes	Scale
1900s–1930s <i>Trigger</i>	Prescriptive, Fragmented <i>Global Recession + World War II</i>	Lighting, noise, roadworthiness	City/State
1950s–1960s <i>Trigger</i>	Prescriptive, Harmonized <i>Energy Crisis, Globalization</i>	Safety features, design specs	Federal (emerging)
1970s–1990s <i>Trigger</i>	Performance-Based Standards, Harmonized <i>Increasing Global Competitiveness</i>	Safety, emissions, crash testing	Federal/National
2000s–Today	Performance-based System-Level Certification, Internationally Harmonized	Integrated systems, software, global standards	Global/Federal

Sector Wide Standardization Supports Innovation and Affordability

Volkswagen Group > Ford (Competitor)



"VW MEB platform illustration (example of platform → multiple models)".

Sector Wide Standardization Supports Innovation and Affordability

Mercer > Green Canopy NODE



The Factory (and Construction Site) as Laboratory

Taylor, the Gilbreths, and Gantt argued for company-led, evidence-based standards that can be rapidly referenced by regulatory frameworks and ultimately raise the level of an entire sector

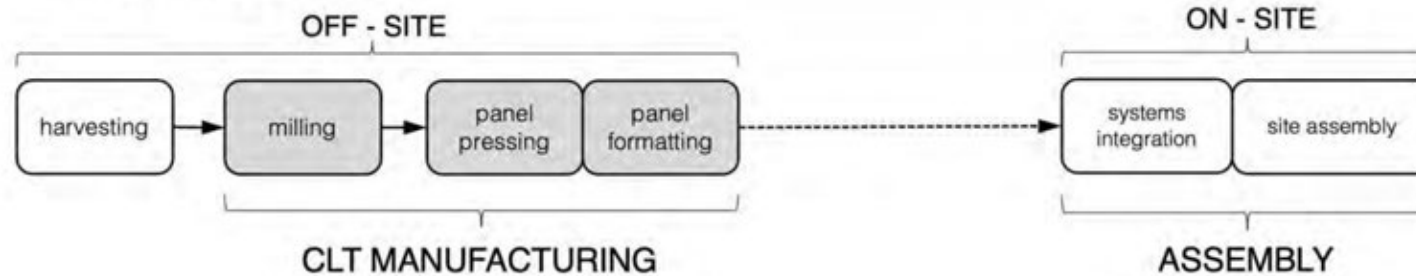


Certification-ready Companies Exist in the U.S. (Many Are in This Mass Timber Systems



Mass Timber: Evolving From Building Products to Configurable Products vs. Systems

MASS TIMBER PRODUCTS



MASS TIMBER SYSTEMS

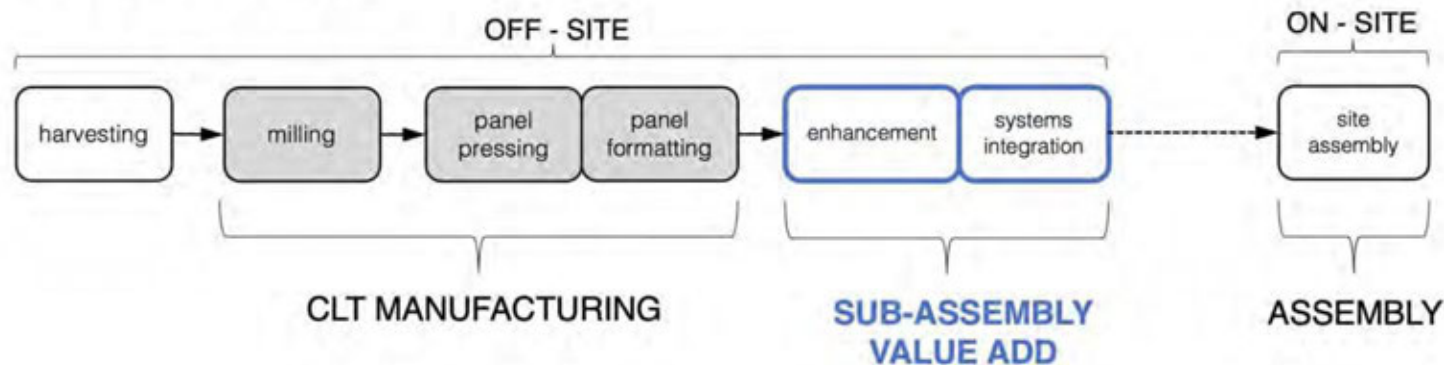


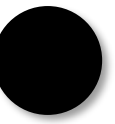
FIGURE 2.2: MASS TIMBER SUPPLY CHAIN RELATIONSHIPS IDENTIFYING OFF-SITE VALUE-ADD MANUFACTURING AND ON-SITE ASSEMBLY

Source: Adapted from T. Beyreuther, *Mass Timber Systems*

Certification-ready Companies Exist in the U.S. (Many Are in This IDCUBED



Innovative Companies as Innovation, Standardization and IDCUBED



Innovative Companies as Innovation, Standardization and Reframe Systems

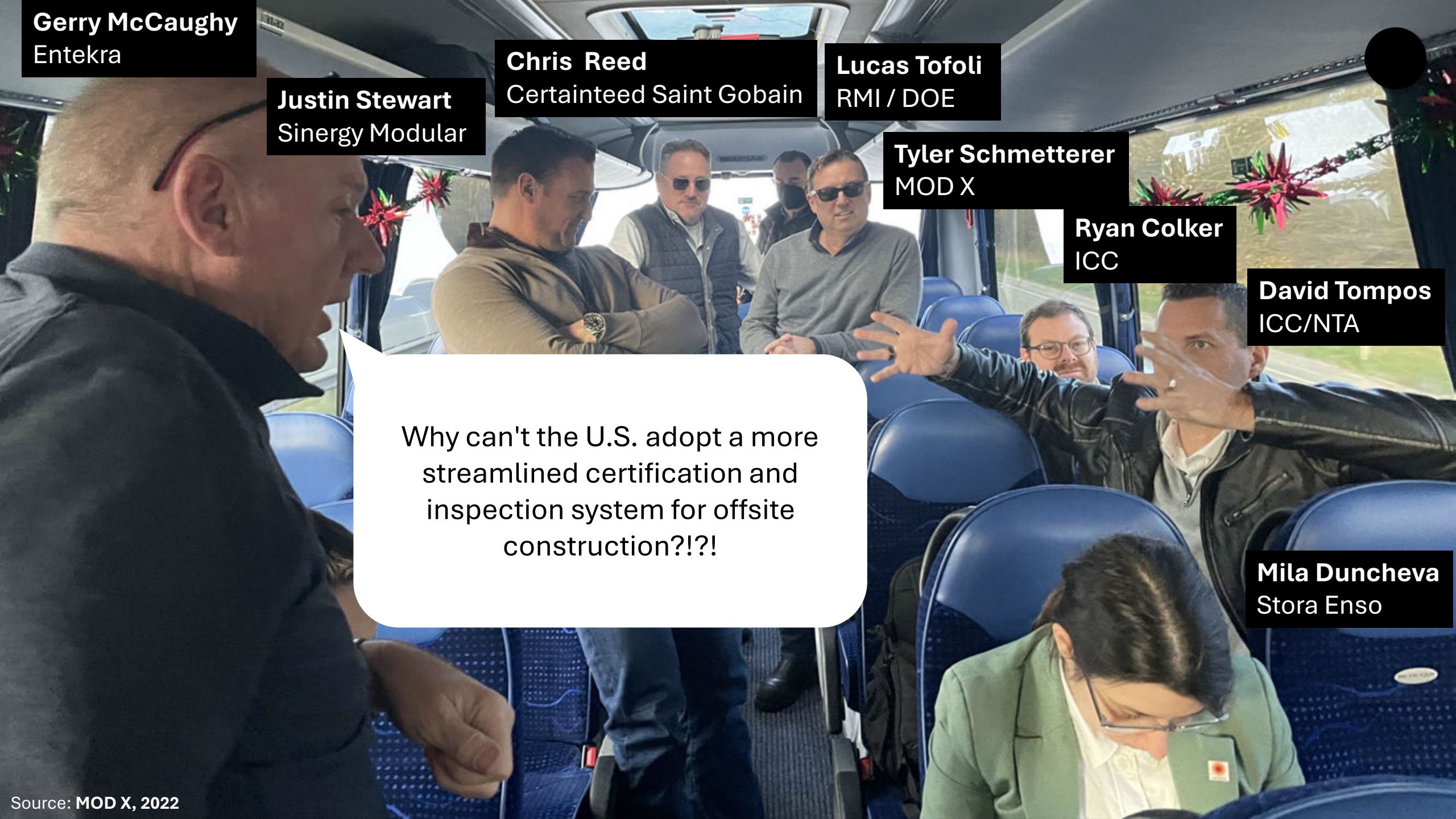


Innovative Companies as Innovation, Standardization and Reframe Systems



Innovative Companies as Innovation, Standardization and Reframe Systems





Gerry McCaughy
Entekra

Justin Stewart
Sinergy Modular

Chris Reed
Certainteed Saint Gobain

Lucas Tofoli
RMI / DOE

Tyler Schmetterer
MOD X

Ryan Colker
ICC

David Tompos
ICC/NTA

Why can't the U.S. adopt a more
streamlined certification and
inspection system for offsite
construction?!?!

Mila Duncheva
Stora Enso



Standardization | Innovation
Affordability | Societal Goals

Standardization → **Innovation** → Affordability + Goals

