

NorthEast Sustainable Energy Association

G338

Applying Swedish Innovations in Residential Construction Systems

Track 1 Homes

Gregory La Vardera

6 March 2014



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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.



Course Description

Applying Swedish Innovations in Residential Construction Systems

Sweden's housing market is dominated by industrial production of energy efficient houses. In this mature market, fabrication techniques, products, and components have all been optimized for efficient factory building, and the off-site process has been leveraged to make energy efficient construction affordable and universal. Because Sweden and the US share a tradition of wood framed housing, their techniques can be readily adopted and suggest a way forward for the North American Housing Industry.



Learning Objectives

After attending this session, participants will...

- ... have a basic understanding of the industrialized construction process in Sweden, and an overview of Swedish Residential Construction Systems.
- ... understand how off-site building supports the construction of affordable high performance wall systems.
- ... have an overview of typical Swedish wall assemblies, and insulation practices.
- ... have learned how to apply the lessons from Swedish Residential Construction Systems to residential construction in the US.



Innovations in Swedish Factory-Built Housing



presented by Scott Hedges and Greg La Vardera

- Precedent of Technology Exchange
- How Swedish houses are built
- Industrial Production Process
- Application to US practices



- Common Natural Resources
- Timber Industry
- Wood Building Tradition
- Similar Development Patterns
- Entering 1970's home building very similar
- Exiting 1970's Sweden deeply reforming
- Establishes Energy Efficient Practices
- Enhanced by Off-Site Building
- Today: High Standards in a Mature Industry



Can our construction industry be influenced by
Sweden?

There is already a history of technology
exchange.

Technology Exchange Precedent



Sweden: Traditional Log House

US: Nothnagle log house c. 1640, Gibbstown, near Swedesboro, New Jersey



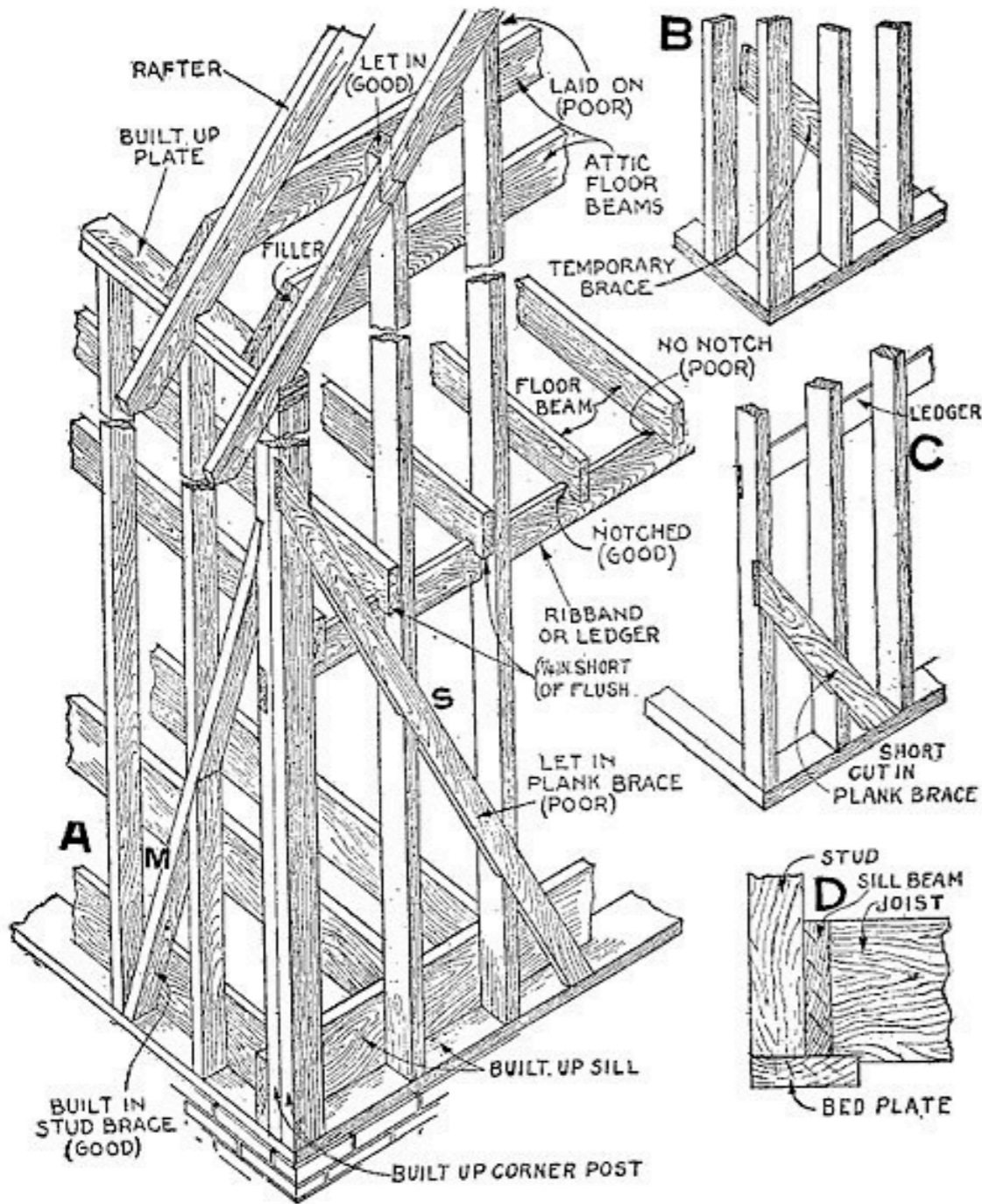
Valley Forge
reconstruction, 1770s



Swedish Family
Minnesota, 1890s

US: Stud Framing

Balloon Framing 1830s - 1940s,
surpassed by Platform Framing



US: Batt Insulation

Fiberglas, Owens-Corning 1938
Patent Application 1953

Patented Mar. 31, 1953

2,633,433

UNITED STATES PATENT OFFICE

2,633,433

INSULATING MATERIAL

Frederick H. Hollenberg, Jr., Wyndmoor, Pa., as-
signor to Baldwin-Hill Company, Trenton, N. J.,
a corporation of New Jersey

No Drawing. Application May 2, 1946,
Serial No. 666,807

11 Claims. (Cl. 117-126)

1 The present invention relates to an inorganic fibre insulating material of unusual and improved properties, and to a wet process of producing the same, and more particularly, it relates to an insulating sheet material which is characterized by its fire-resistance. In addition, the invention relates to an aqueous resinous com-

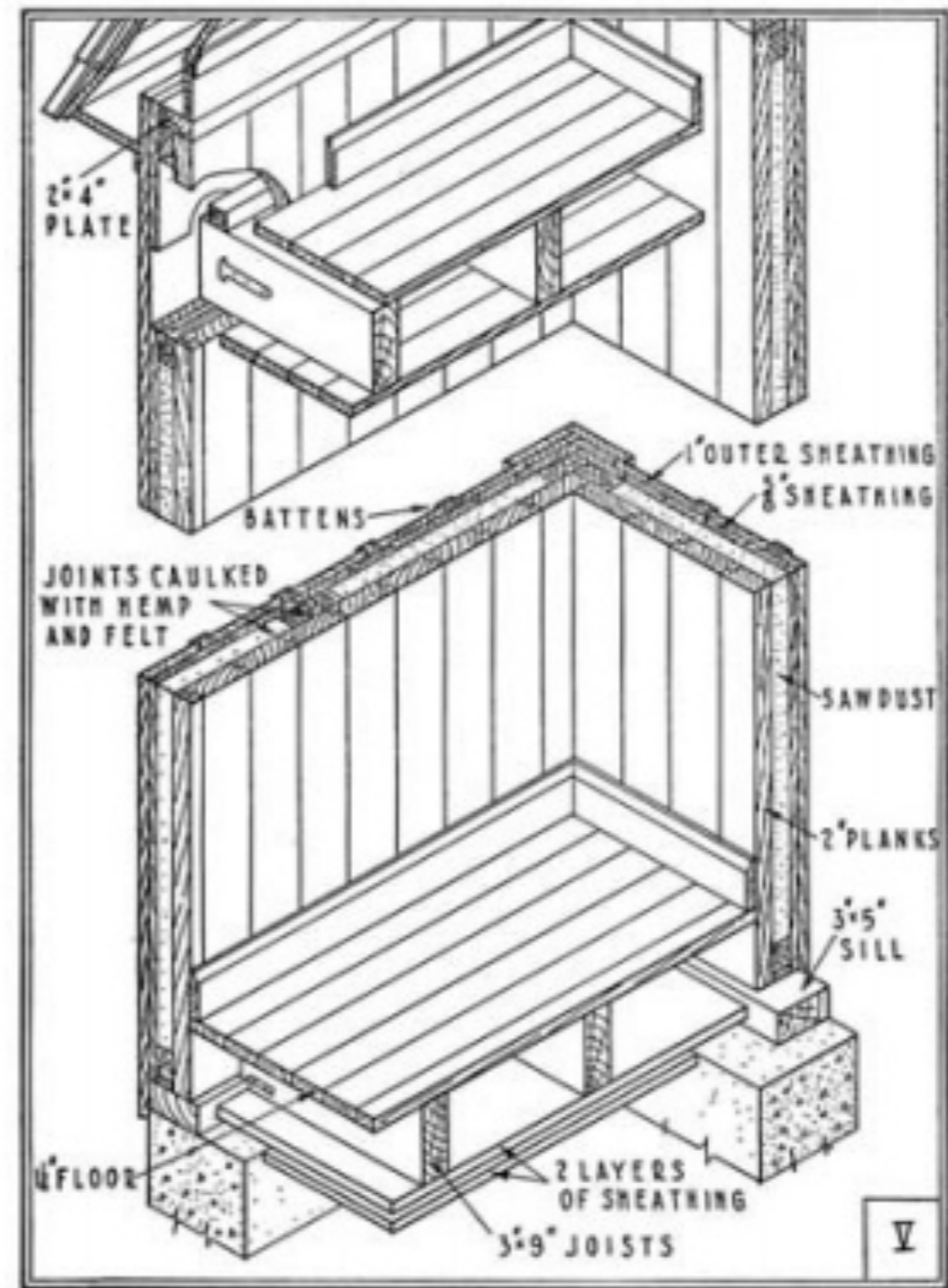
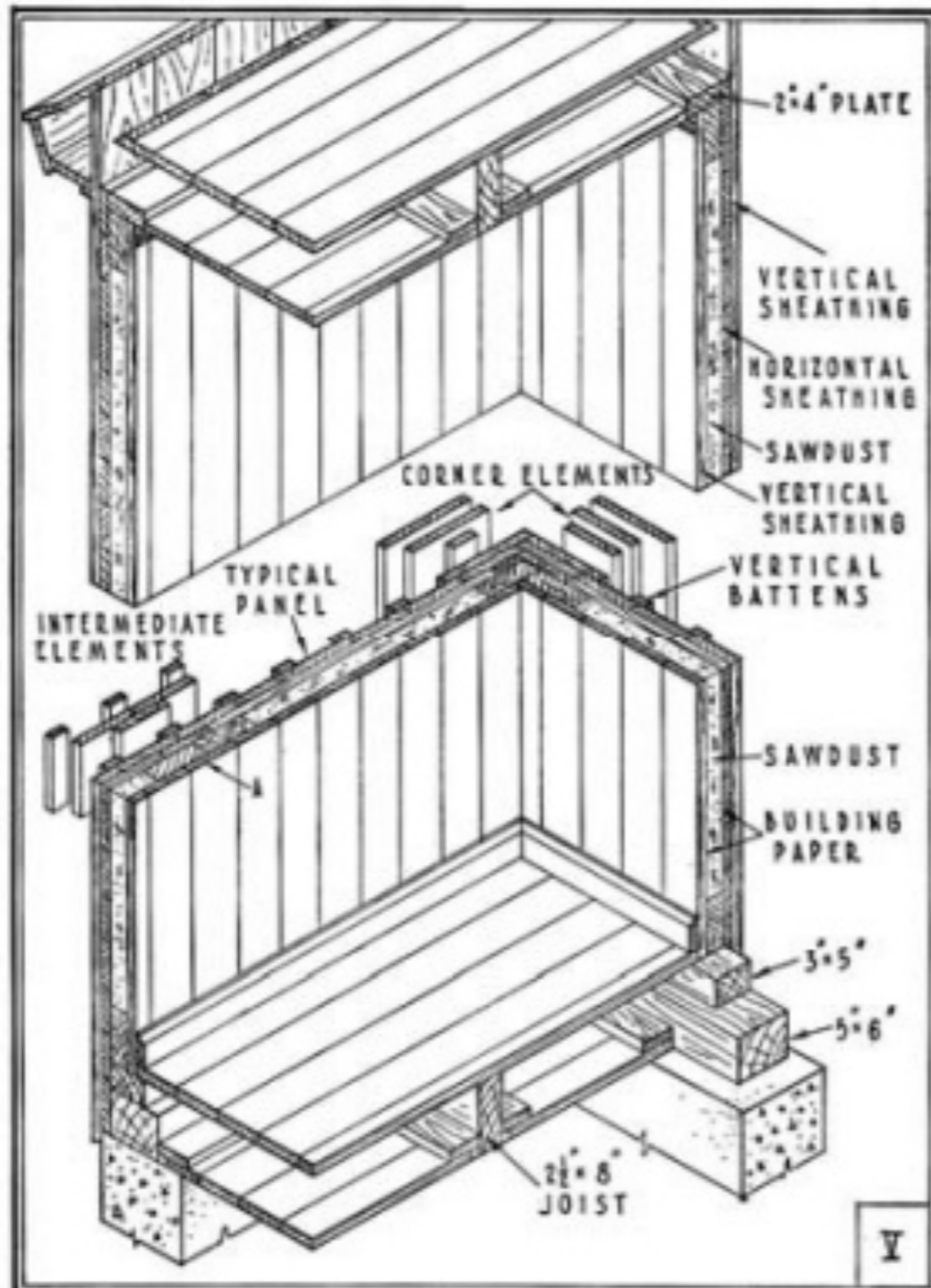
2 center section and the resin may even be substantially confined to the outer sections.

The product may be prepared by any process in which a thermosetting resin and bentonite in the presence of an aqueous medium is incorporated in inorganic fibrous material, the fibres of which are interfelted in an aqueous suspension thereof and in which the resin after its associa-

Both transferred to Sweden

Sweden: Cross Layered Solid Wood Walls

and some sawdust fill, common into 1940s



the IBO and Knivsta systems

Burchard, 'Efforts to Modernize Housing Structure', pp 544, 546

off-site factory production already common



Sweden: Standard-Hus

Post WW2 Export of Swedish Factory Houses to UK and Germany



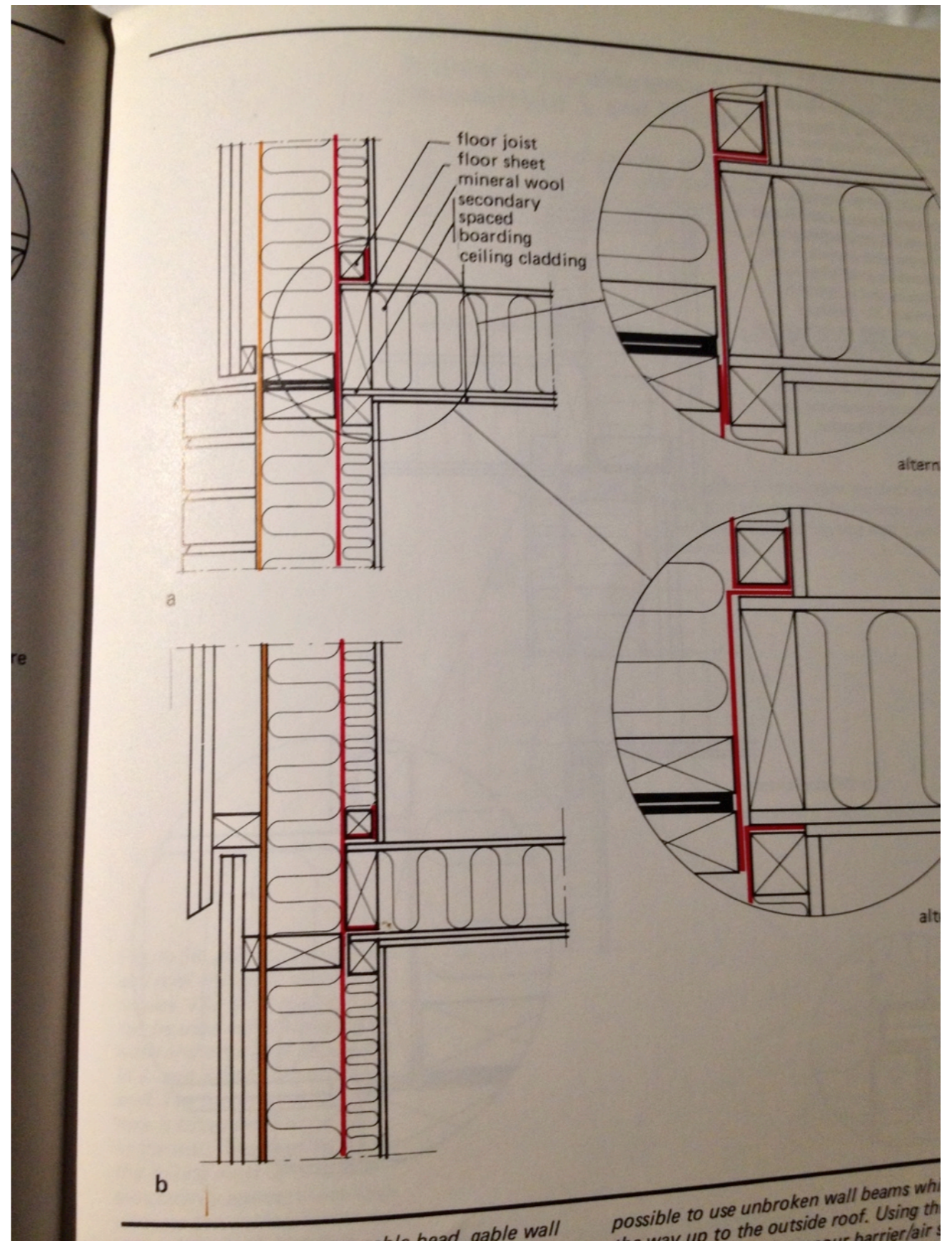
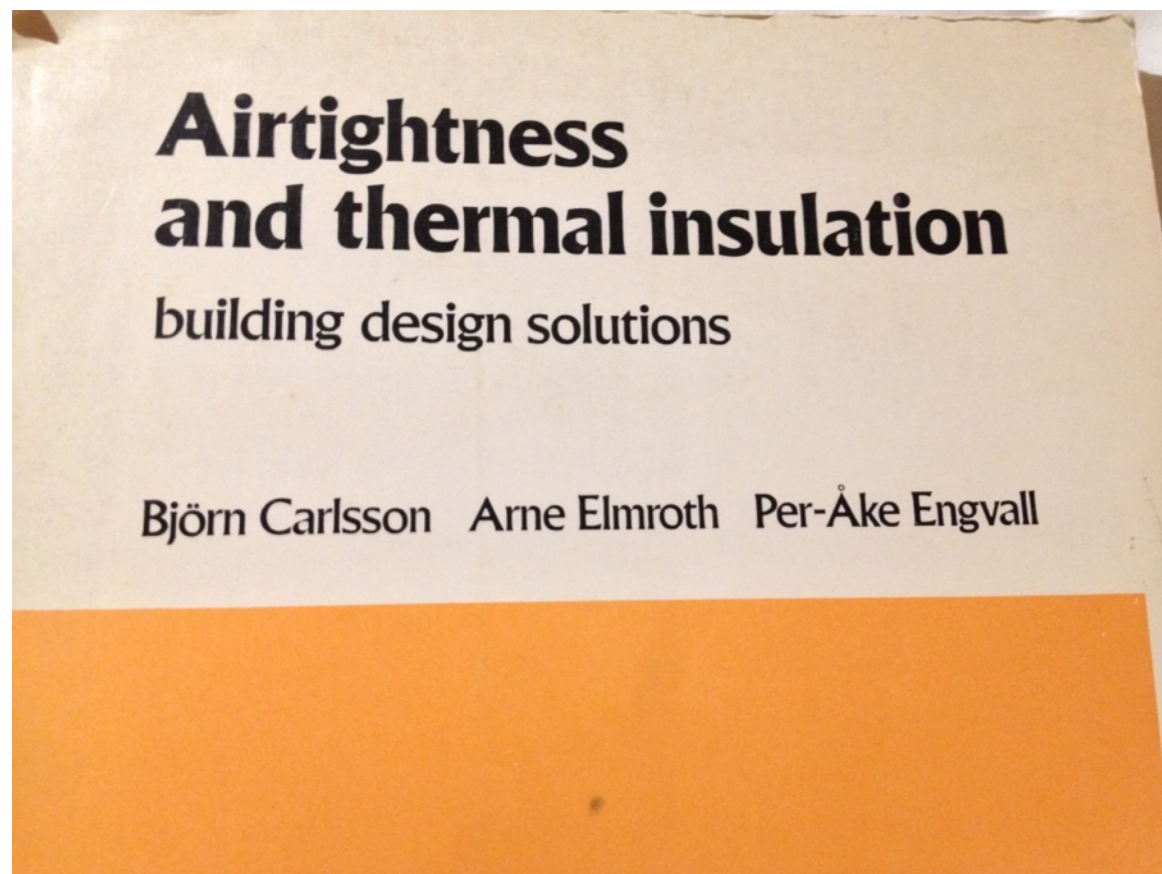
Swedish houses, South Norfolk, UK, 1946



Continues to influence German factory building, but market share only 15% of detached homes

Sweden: investment in building science

high level of cooperation between
industry, academia, and government



late 1970s

Today Passive House Standard roots in Sweden

 **Scott Hedges** @byggghouse · Jul 16
@bruteforceblog @WolfgangFeist why did you go to Lund in 1988?
Details [← Reply](#) [↻ Retweet](#) [★ Favorite](#) [⋮ More](#)

 **Wolfgang Feist** @WolfgangFeist · Jul 20
@byggghouse @bruteforceblog Invited by Prof. Adamson to do joint research on low energy buildings, especially looking on German conditions
Details [← Reply](#) [↻ Retweet](#) [★ Favorite](#) [⋮ More](#)

 **Scott Hedges** @byggghouse · Jul 22
@WolfgangFeist curious, was Sweden ahead or behind FRG in building science at that time. Curious?
Details [← Reply](#) [↻ Retweet](#) [★ Favorite](#) [⋮ More](#)

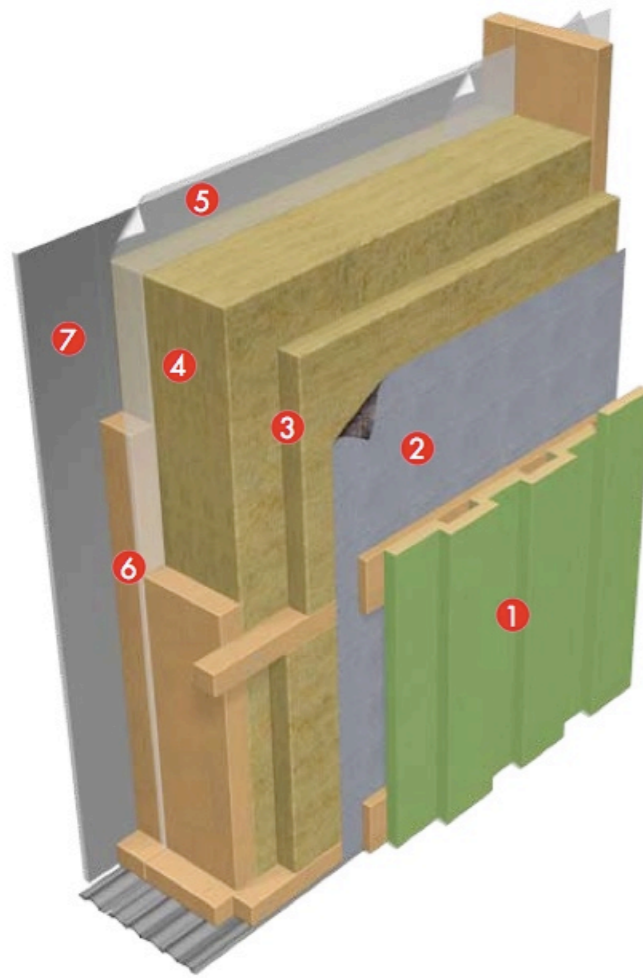
 **Wolfgang Feist**
@WolfgangFeist [⚙](#) [+ Follow](#)

@byggghouse 1988: Sweden was the world leading country in energy efficient construction and Bo Adamson was their BPhys "foreign minister"

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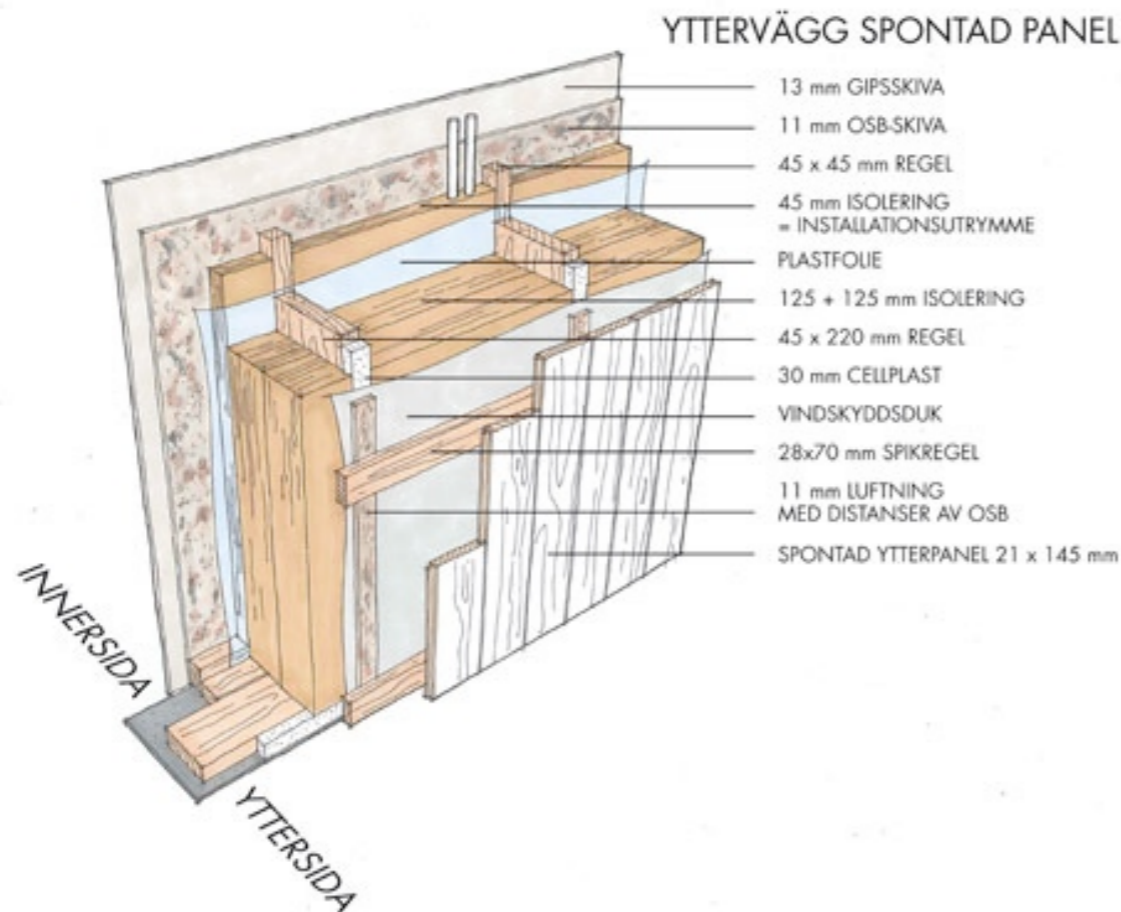
3:16 PM - 23 Jul 2013

Sweden Today: Standard stud framing, improved performance through layering and updates to platform framing conventions. High-Value Assemblies.



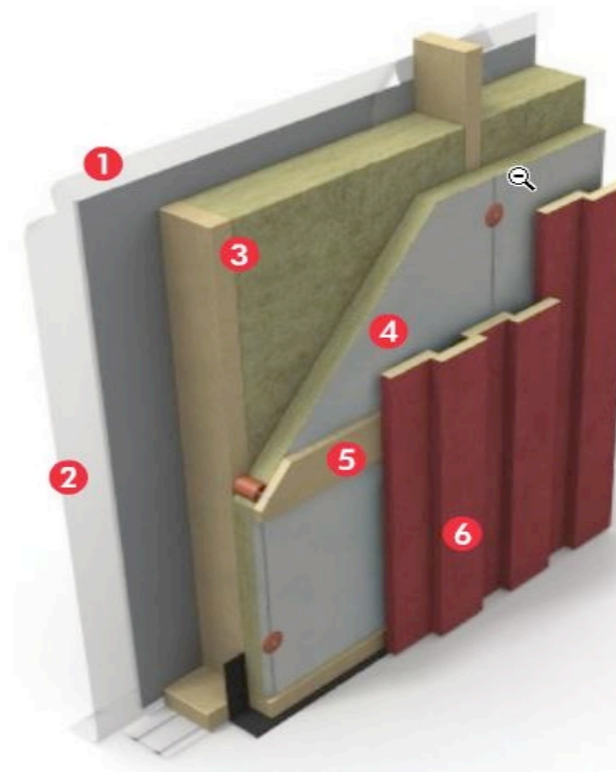
Vägg för lägenegihus

- 1 Träpanel.
 - 2 PAROC XMV 080, Vindtät.
 - 3 Korslagd regelstomme med 45 mm isolering, PAROC UNS 37z, Väggb-/Bjälklagsskiva Trä.
 - 4 Bärande stomme med mellanliggande isolering 170 mm, PAROC UNS 37z, Väggb-/Bjälklagsskiva Trä.
 - 5 PAROC XMW 001, Plastfolie.
 - 6 Installationsskikt med 70 mm isolering, PAROC UNS 37z, Väggb-/Bjälklagsskiva Trä.
 - 7 Gipsskiva.
- U-värde: 0,16 W/m² C



YTTERVÄGG SPONTAD PANEL

- 13 mm GIPSSKIVA
- 11 mm OSB-SKIVA
- 45 x 45 mm REGEL
- 45 mm ISOLERING = INSTALLATIONSUTRYMME
- PLASTFOLIE
- 125 + 125 mm ISOLERING
- 45 x 220 mm REGEL
- 30 mm CELLPLAST
- VIINDSKYDDSDUK
- 28x70 mm SPIKREGEL
- 11 mm LUFTNING MED DISTANSER AV OSB
- SPONTAD YTTERPANEL 21 x 145 mm



- 1 Internal facing
- 2 Air and vapor barrier
- 3 Wooden stud 50 mm x thickness, c 600, and PAROC UNS 37
- 4 PAROC WAS 25t ≥ 30 mm or PAROC WAS 35t ≥ 30 mm
- 5 Nail batten + ventilation gap ≥ 20mm
- 6 Wooden panel

How does Sweden produce high-value wall systems affordably?

Industrial Production Methods for Off-Site Construction.

How Swedish houses are built



video - not included in PDF file

















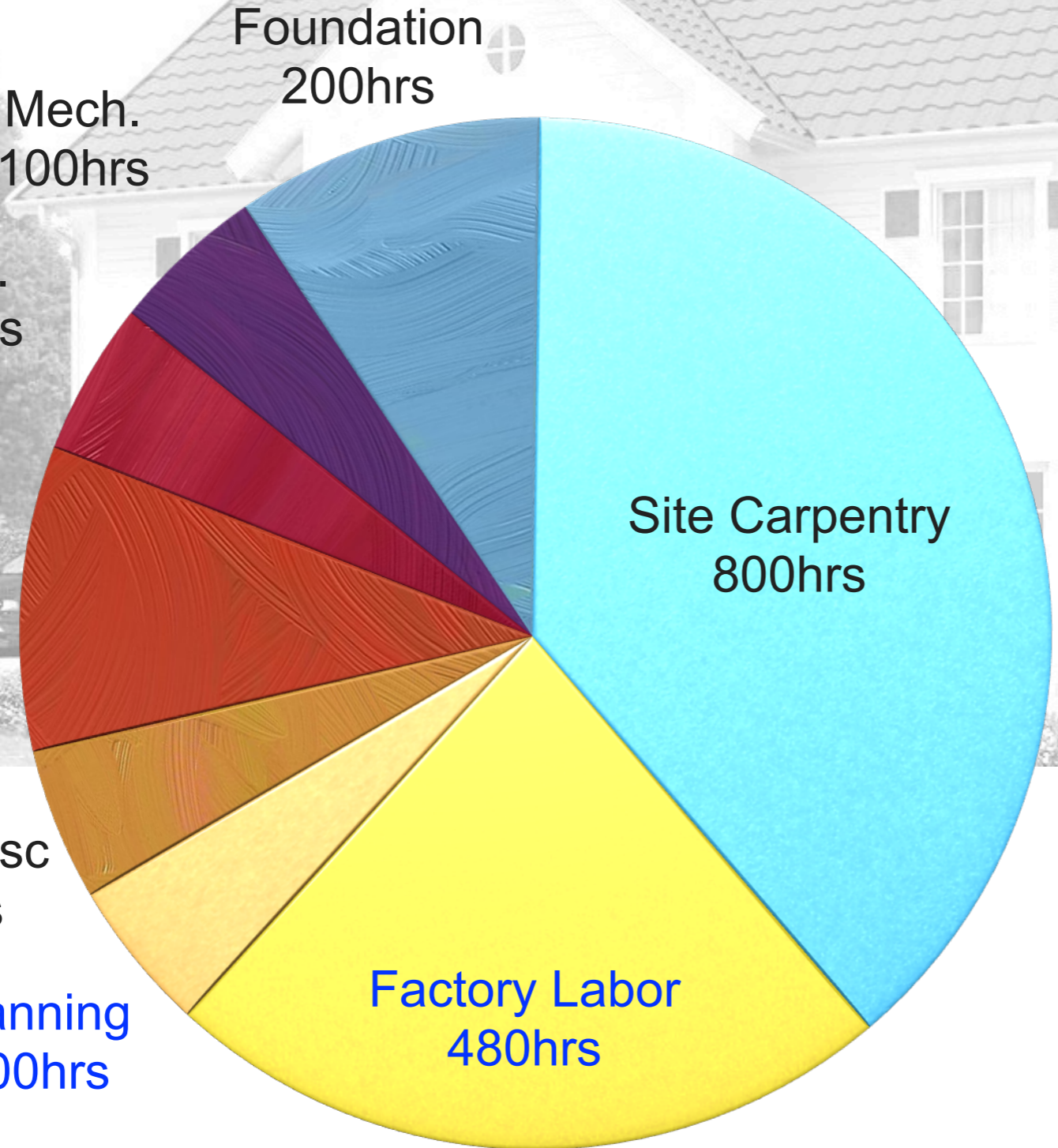
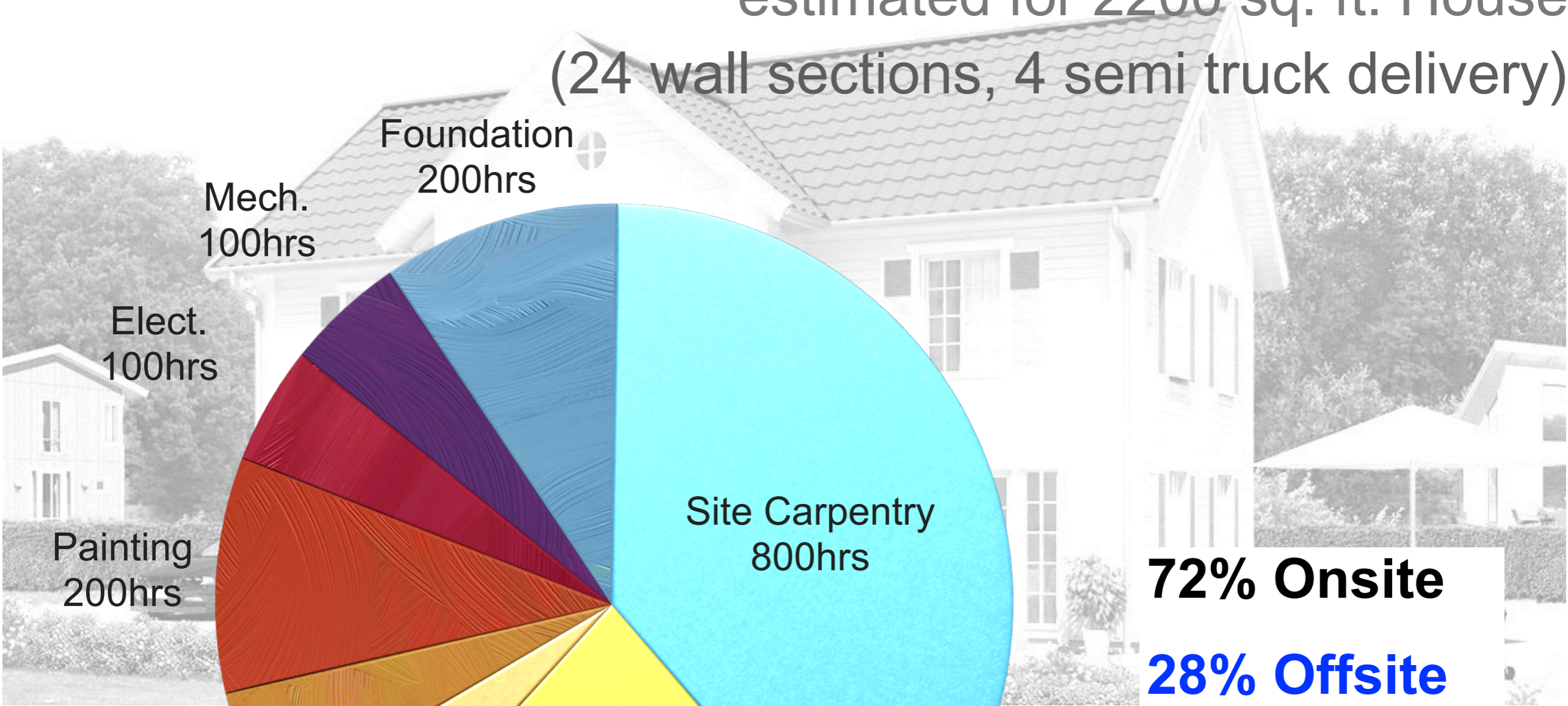






Distribution of Labor

estimated for 2200 sq. ft. House
(24 wall sections, 4 semi truck delivery)



72% Onsite
28% Offsite

**Estimated
Total Labor:
2080 hours**

Industrial Production Process



Panel or Modular?

Terms In US:

Modular = any Off-Site?

PreFab = any factory made component?

Panels, Panelized = any pre-assembly?

Clarity

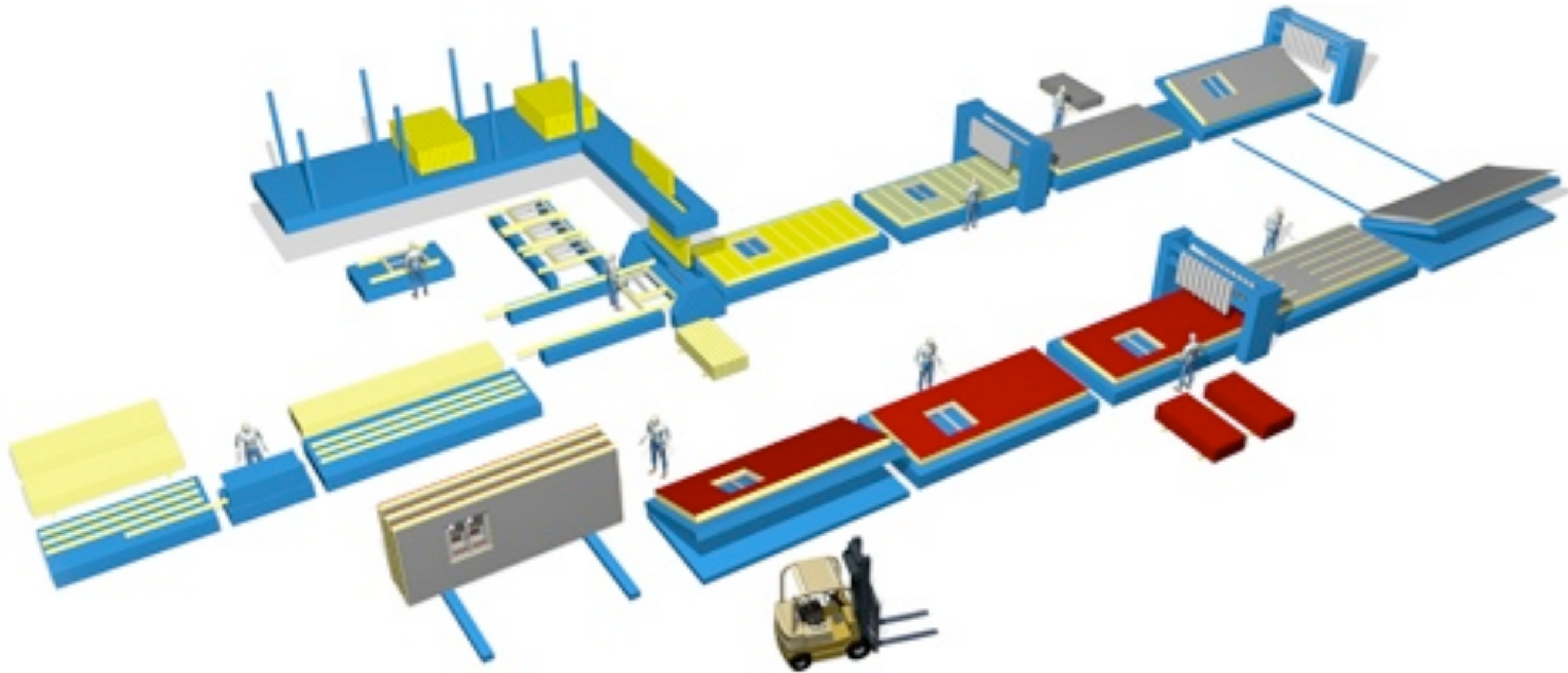
Be aware that these terms are used to mean multiple things in the US.

Sweden: Assembly & Elements

Concepts of
assembly & elements
inform the vocabulary

Monteringsfärdiga	=	Finished Assembly
Elementbyggande	=	Element Building
Väggelement	=	Wall Elements
Volumelement	=	Volume Elements
Lössvirke	=	Loose Work
Montagehus	=	assembled house

Standard Wall Element Process



Source: Randek, Falkenberg, Sweden

manual line



Scalable, Flexible workstation



automated line

Significant *process* differences between factory assembly and site building

Walls - built on the flat



Sequence critical layering has low premium

Work is not done from ladders





Walls flipped to work both sides

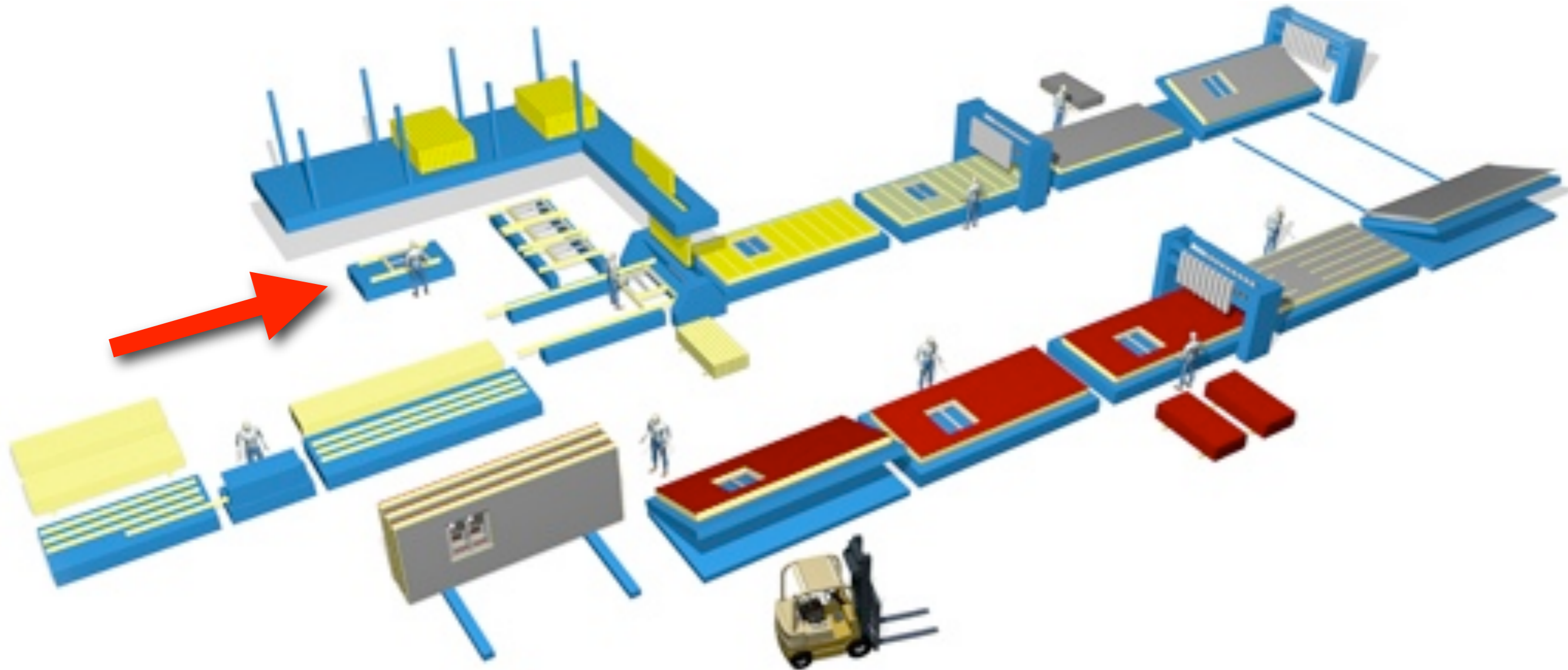
Industrial Production



Window installation complete. Wall has yet to be framed.



window & door sub-assembly workstation



Redesign of building components



Components - electrical

Components - plumbing



insulation practices - stone wool batts

stone wool batts
≠
fiberglass batts

higher density, higher R-values,
different physical properties,
no learning curve

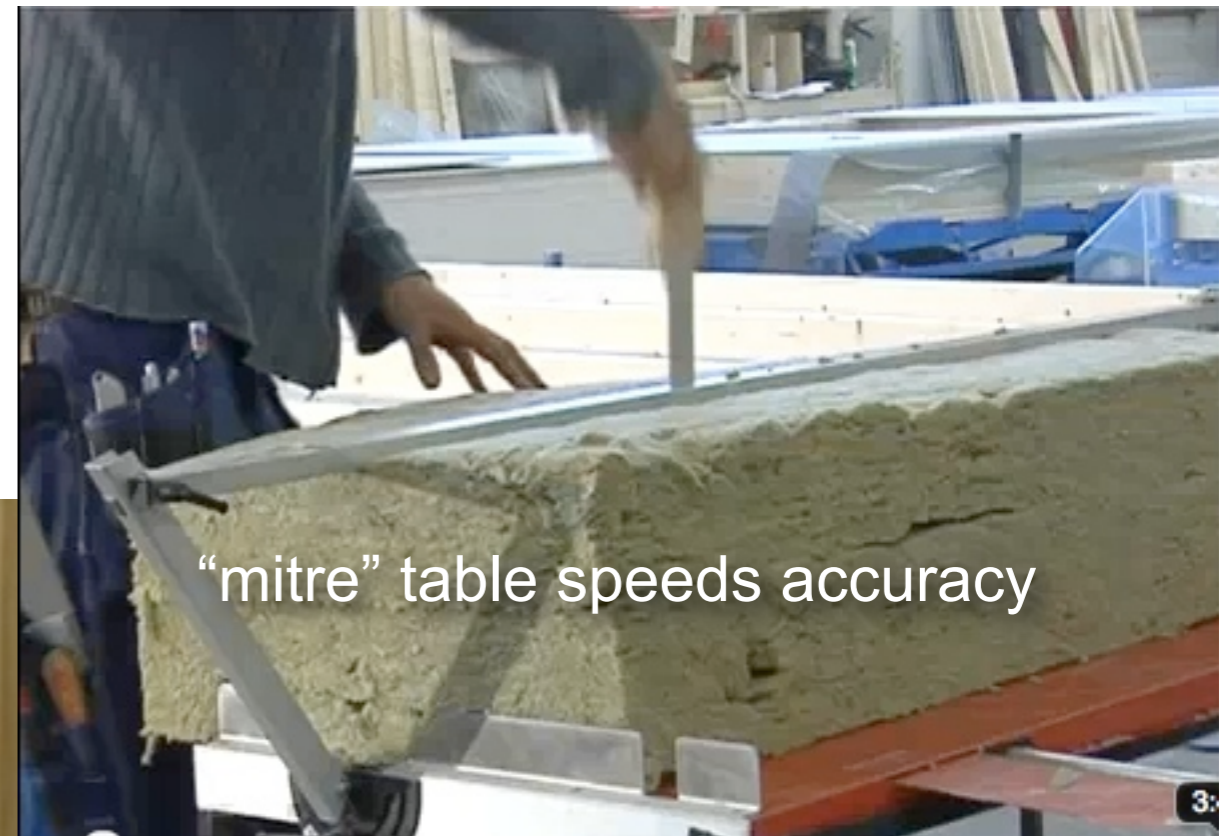


insulation practices - stone wool batts

easy to cut accurately, faster to do proper install



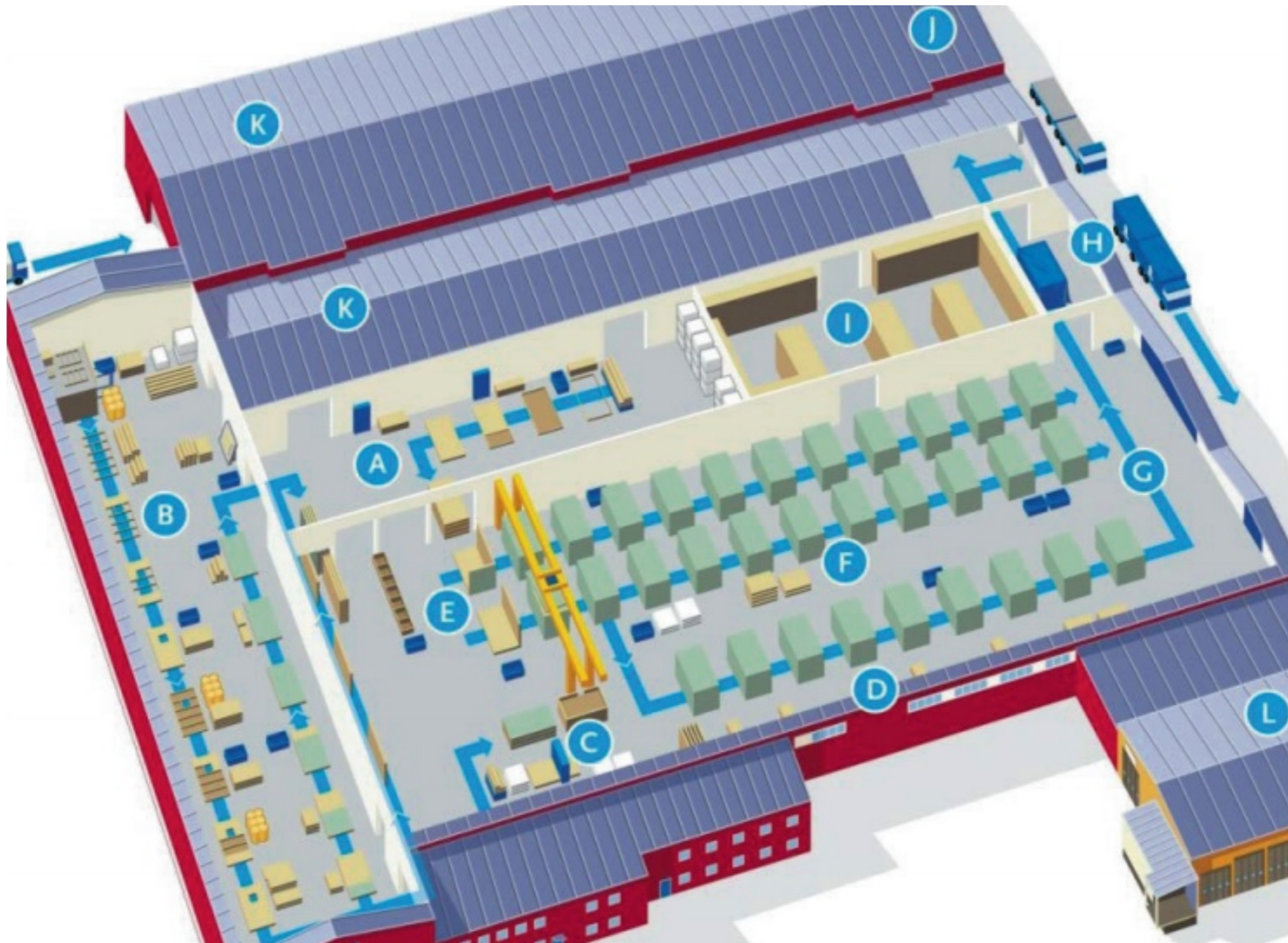
cut with large bread knife



No new sub contractors,
no new material suppliers,
time is predictable,
pricing is predictable.

Easy to adopt.

Volume Wall Element Process







Swedish housing industry

Approx. 15% of apartments now supplied via highly industrialized wood construction (up from 0% in 1994)



Wall elements used in conjunction with precast systems - podium building



continuing innovation & improvement:
an active priority of government, academia and industry



Highly competitive & customer focused housing industry with international markets



Focus on quality, energy performance,
and affordability



Broad offerings in wide range of styles with high quality marketing materials.

Swedish Factory House Week
In support of our *PreFab is Dead* blog post series we will be posting images of Swedish factory houses for the next week or so. Just a taste of what any home buyer can pick from any ole' day in Sweden. Today Eksjöhus.

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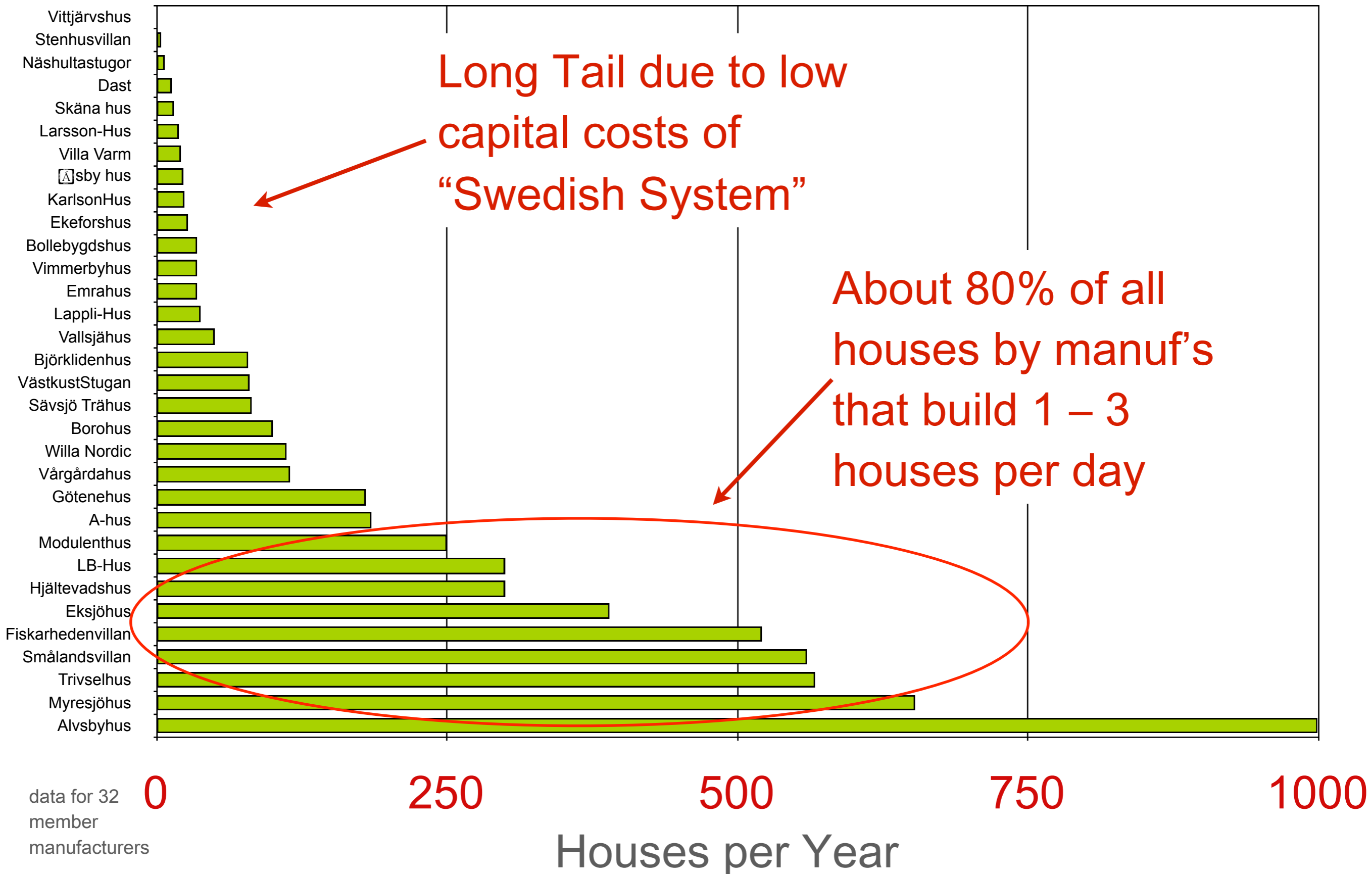
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SÄLJSTART 2011

Strong focus on customer value. Factories face the customer, site installers are subs.

House Starts by Company



Comparison of Conventional Production Building with Swedish Factory Building

Primary Forest Resources

- Trees
- Sawing
- Drying

Non Forest Building Materials

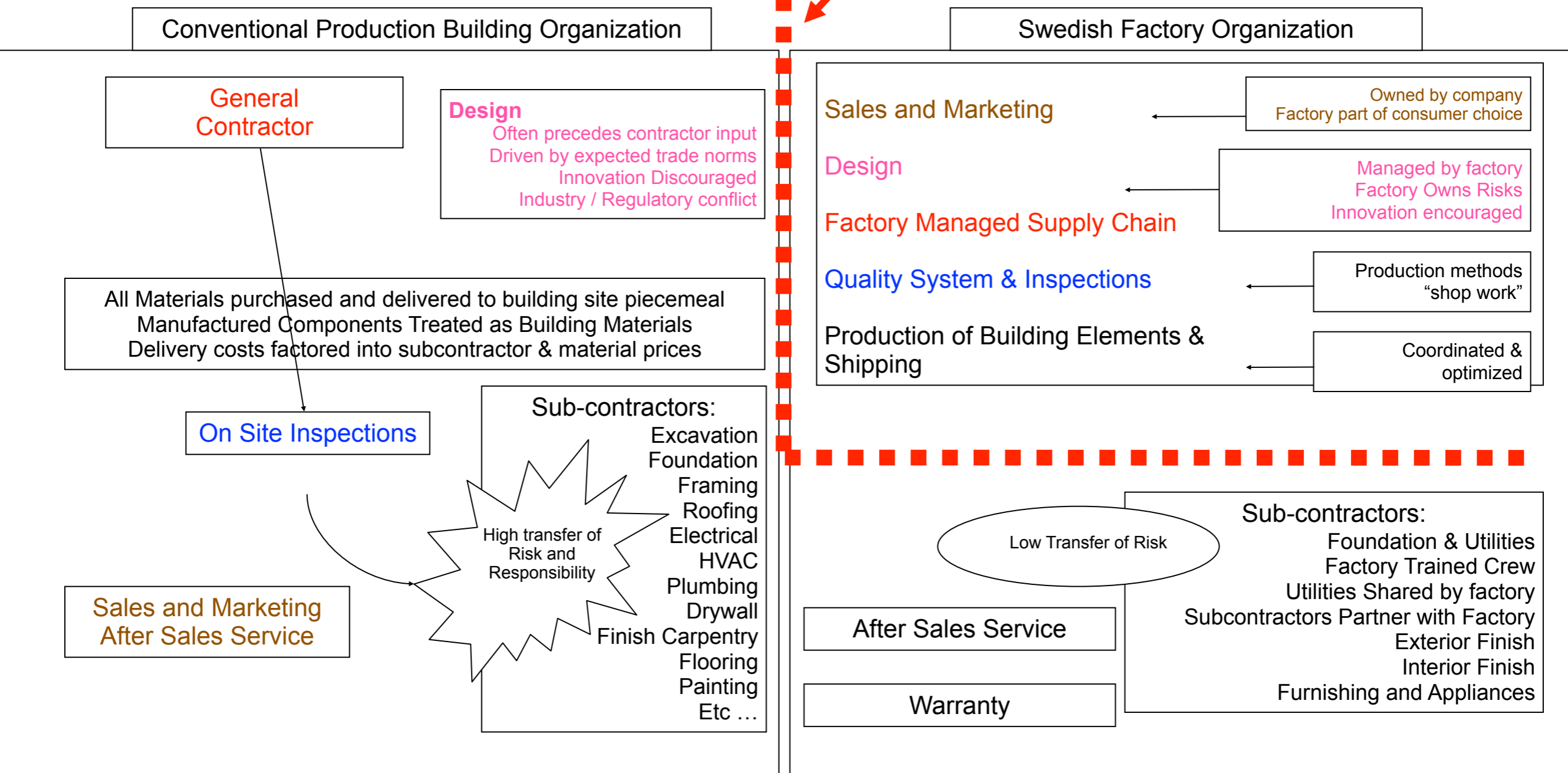
- Gypsum
- Concrete
- Metal Flashing & Roofing

Manufactured Building Components

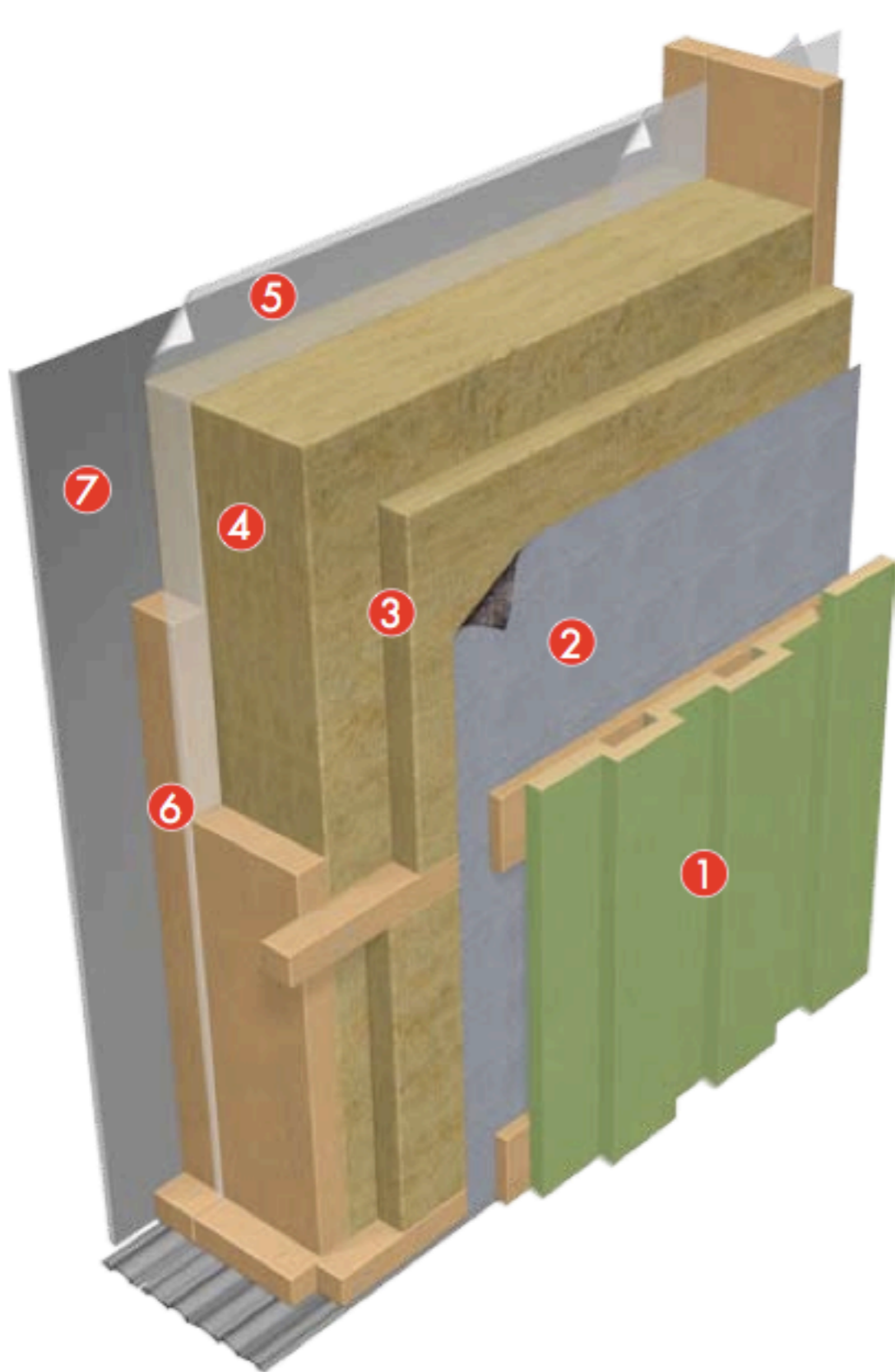
- Cabinetry
- Windows & Doors
- Mechanicals & Electricals

Inputs used by both kinds of building organizations are produced by Industry

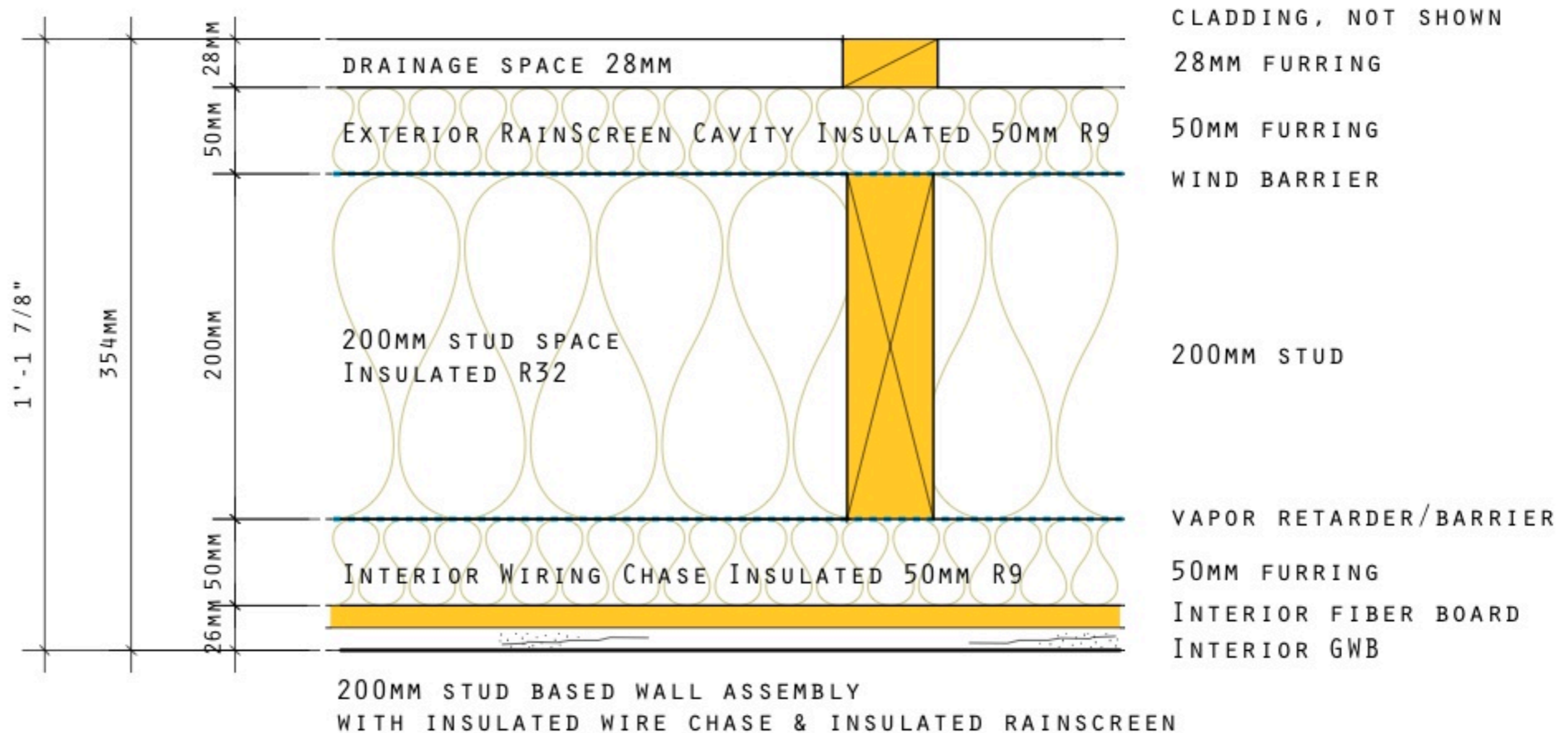
“Demarcation of Industrial Organization”
Moving this line is both a technical and organizational challenge.



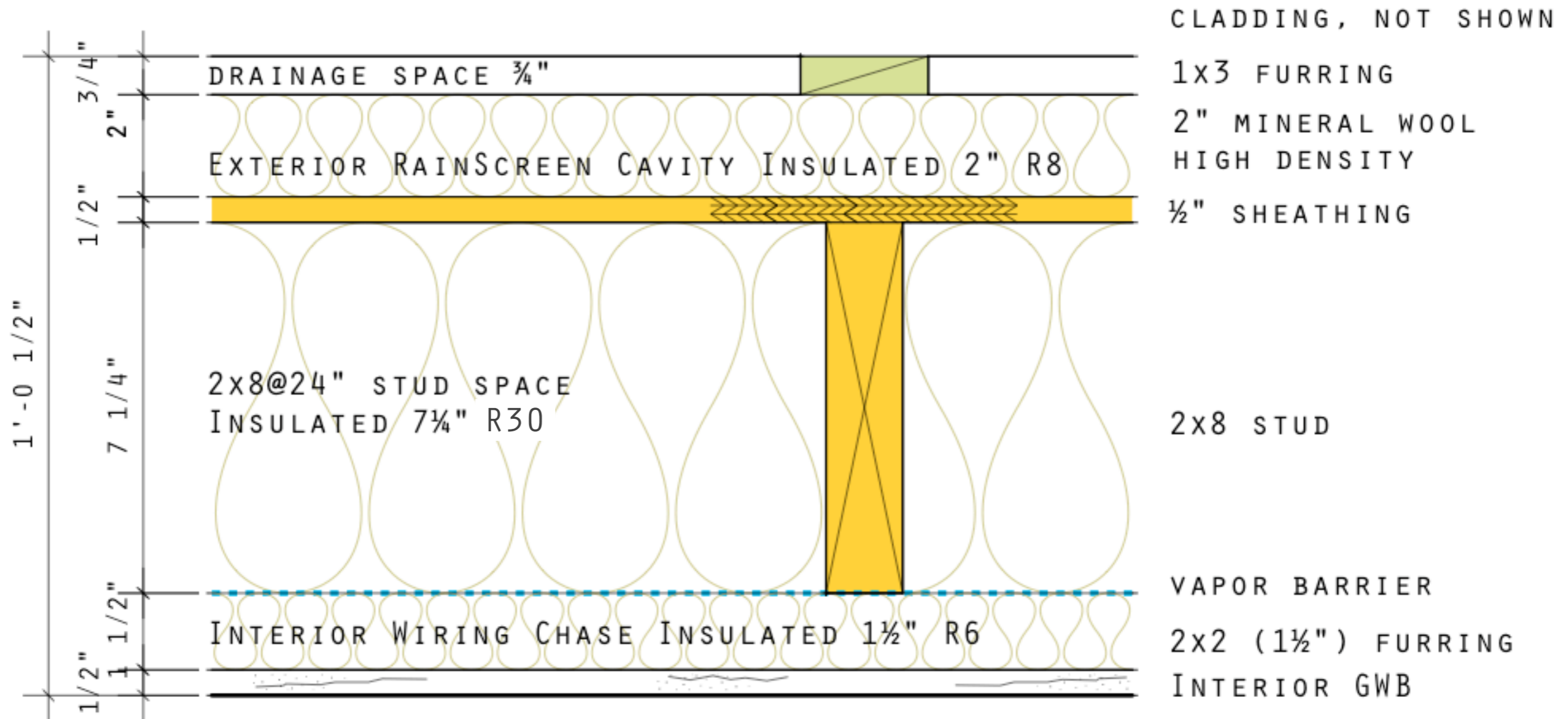
Application to US practices



Typical Swedish Wall

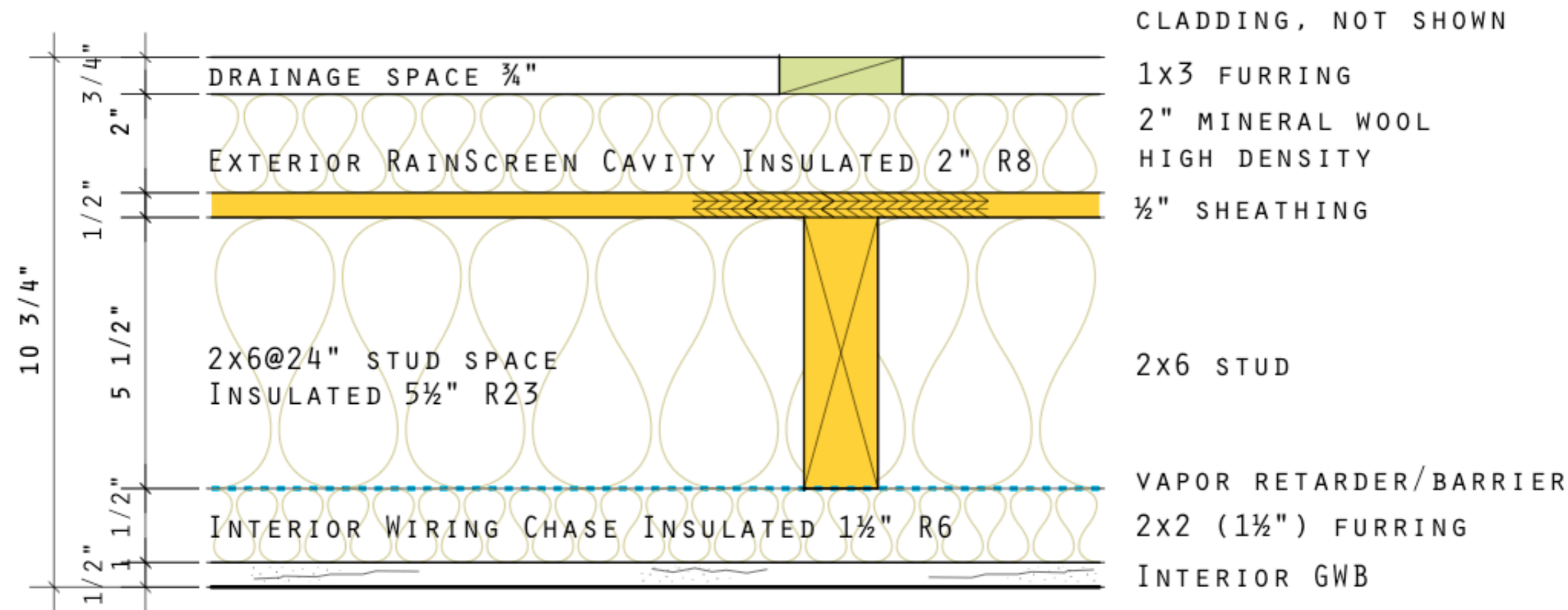


USA New Wall 2x8



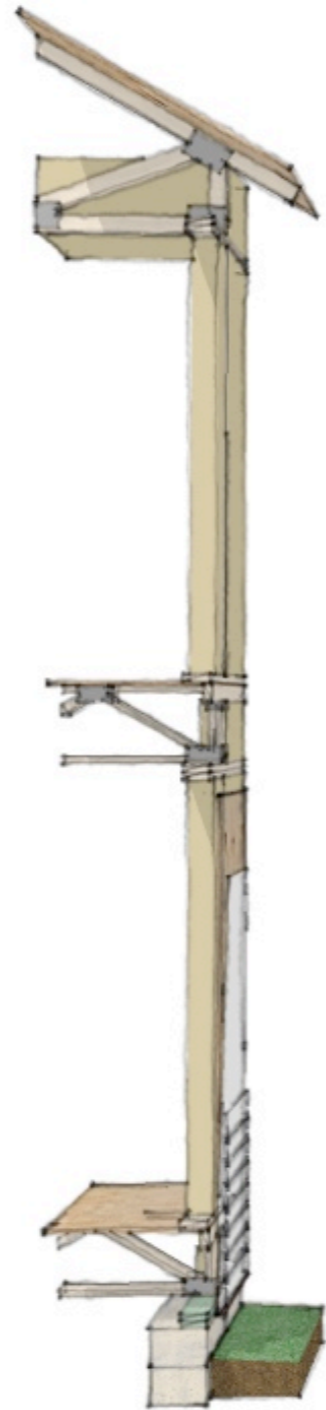
2x8 BASED WALL ASSEMBLY
WITH INSULATED WIRE CHASE & INSULATED RAINSCREEN

USA New Wall 2x6

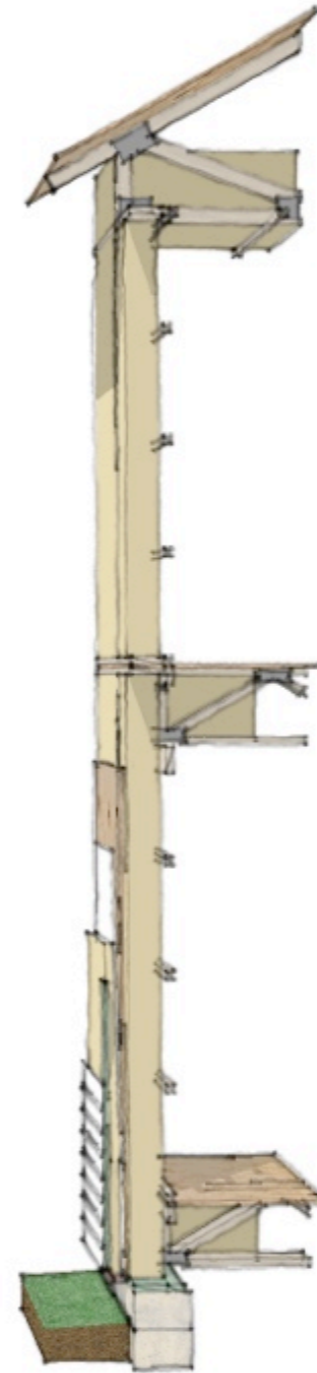


2x6 BASED WALL ASSEMBLY
WITH INSULATED WIRE CHASE & INSULATED RAINSCREEN

Platform Framing Innovations

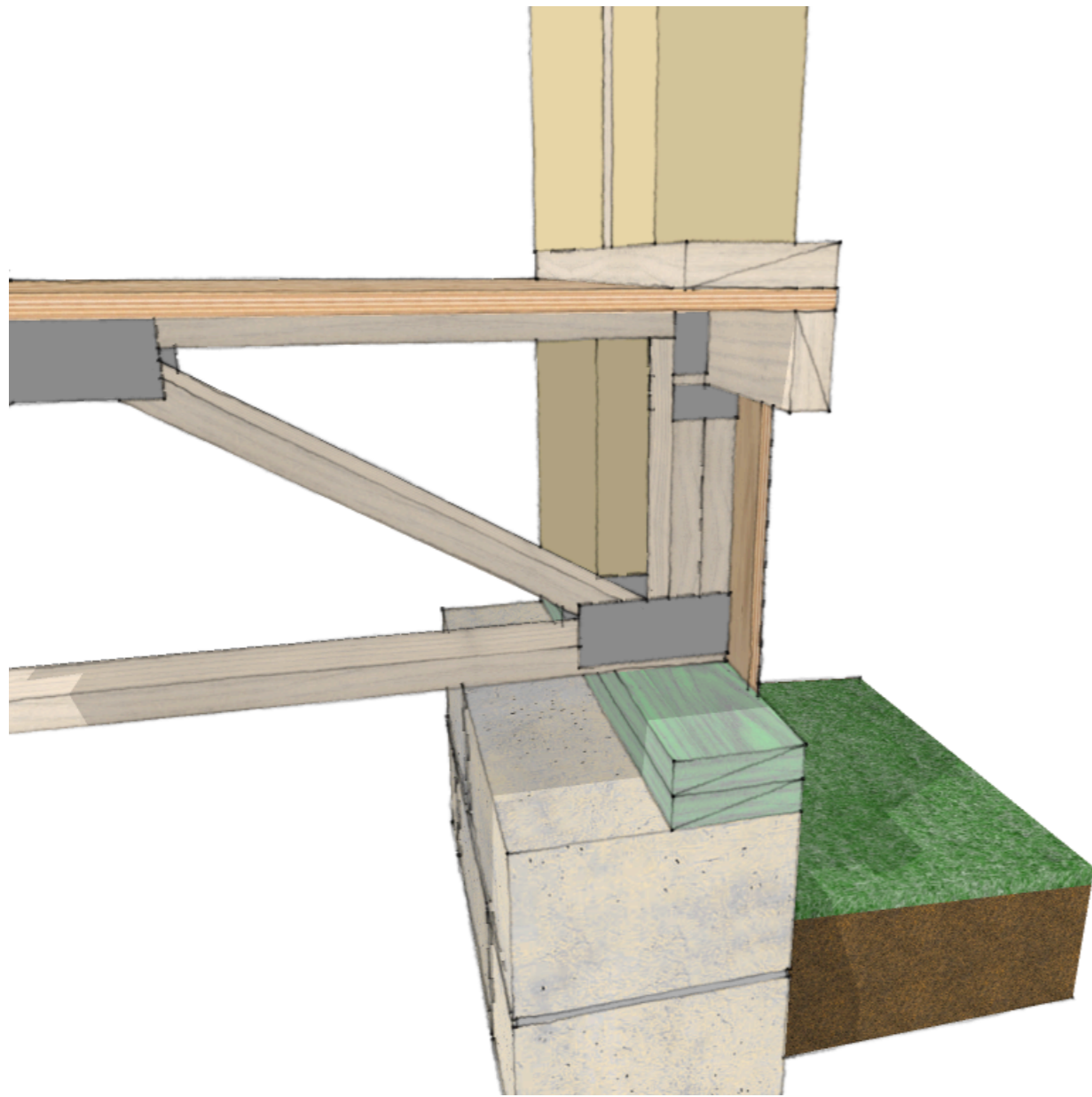


Western Platform Framing

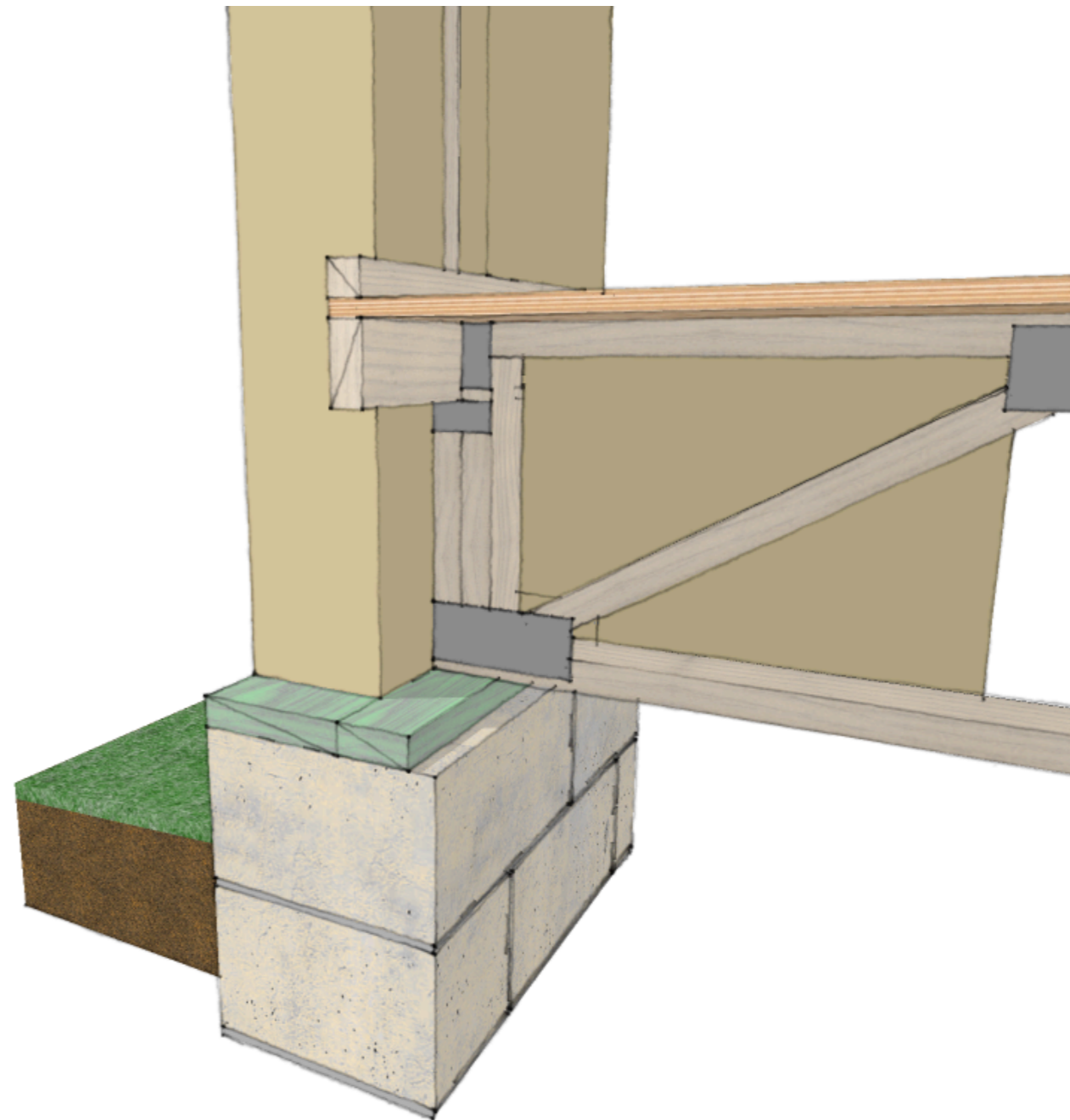


Swedish Platform Framing

Ground Floor Condition

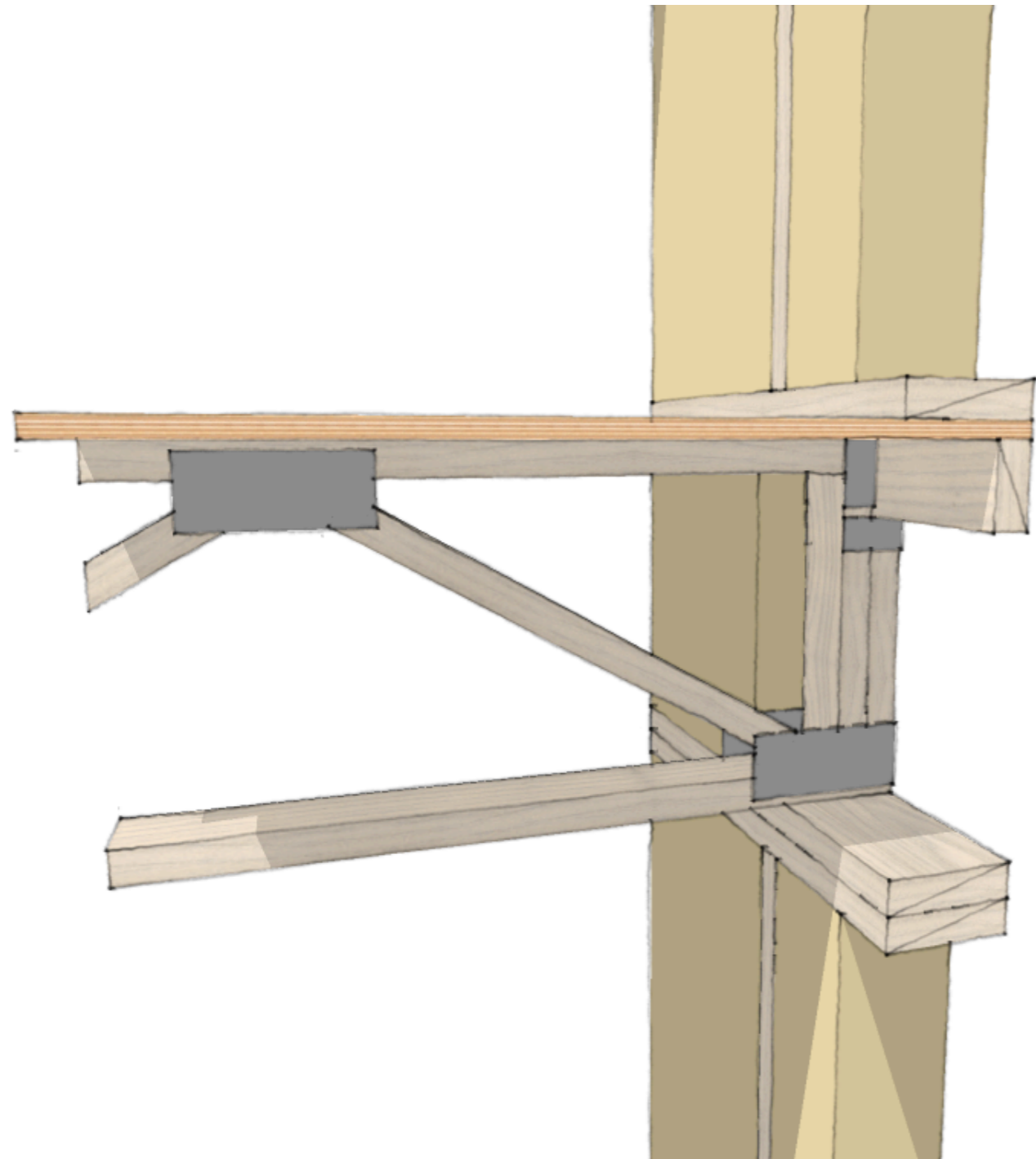


Western Platform Framing

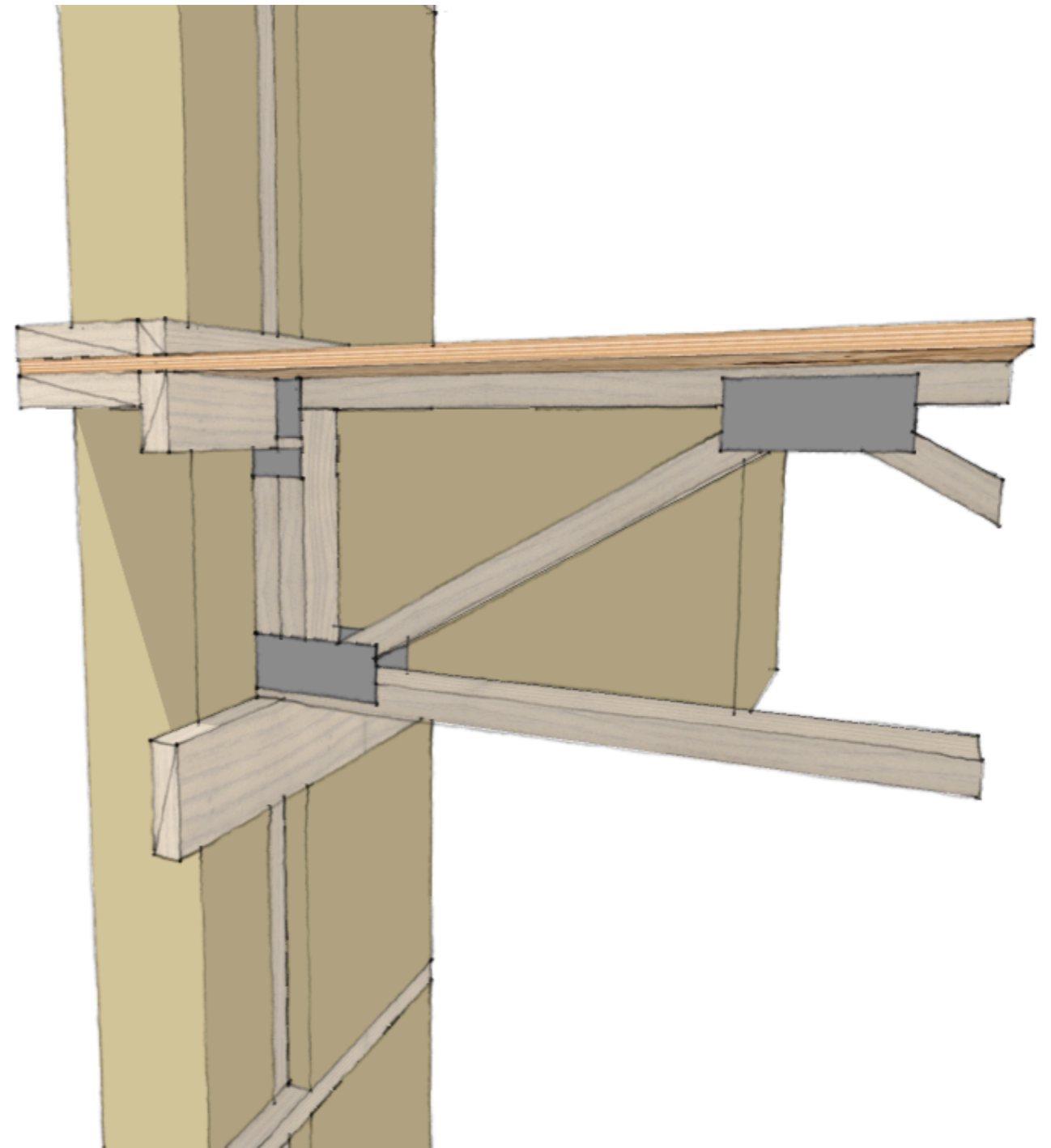


Swedish Platform Framing

Second Floor Condition

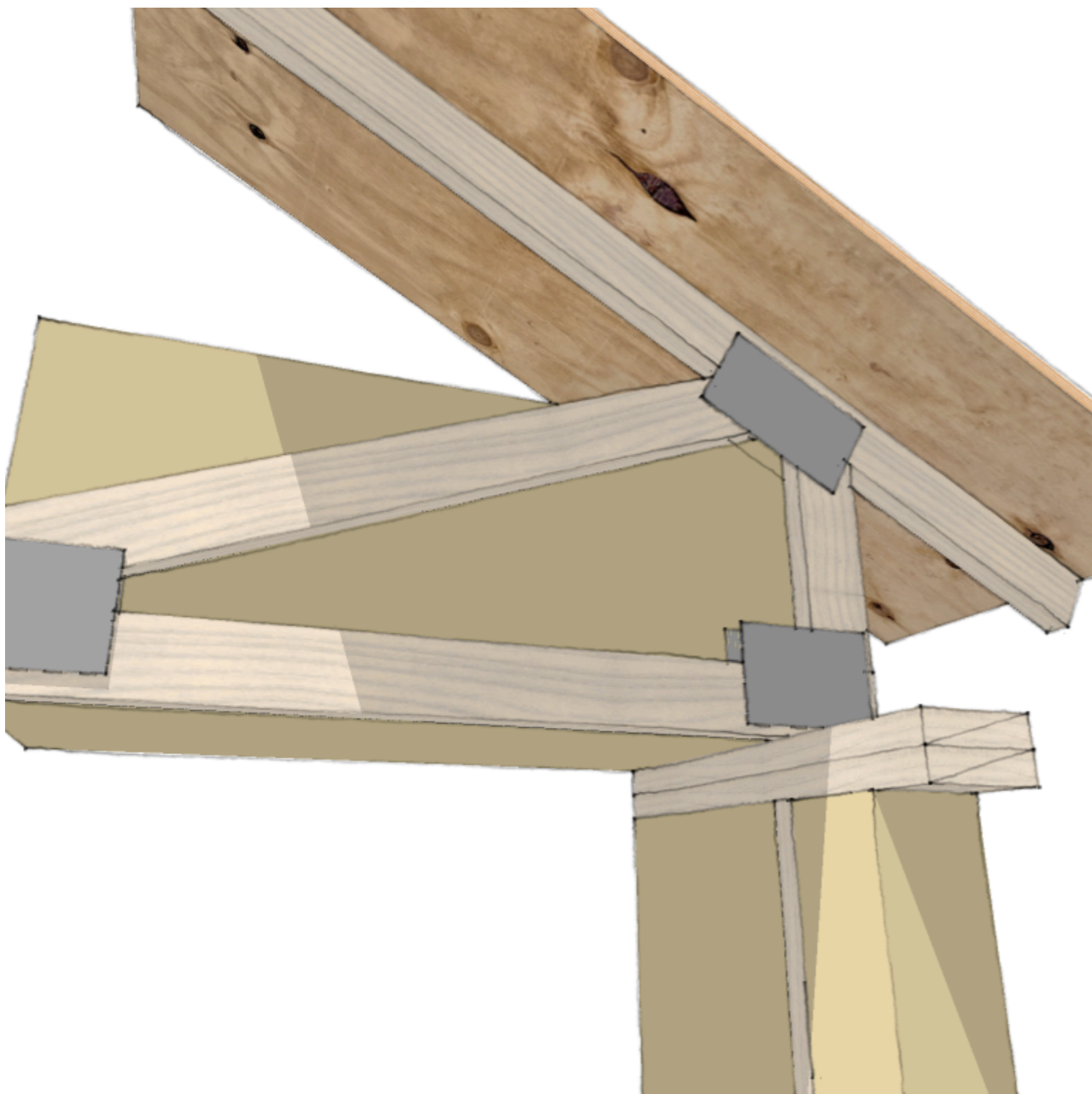


Western Platform Framing

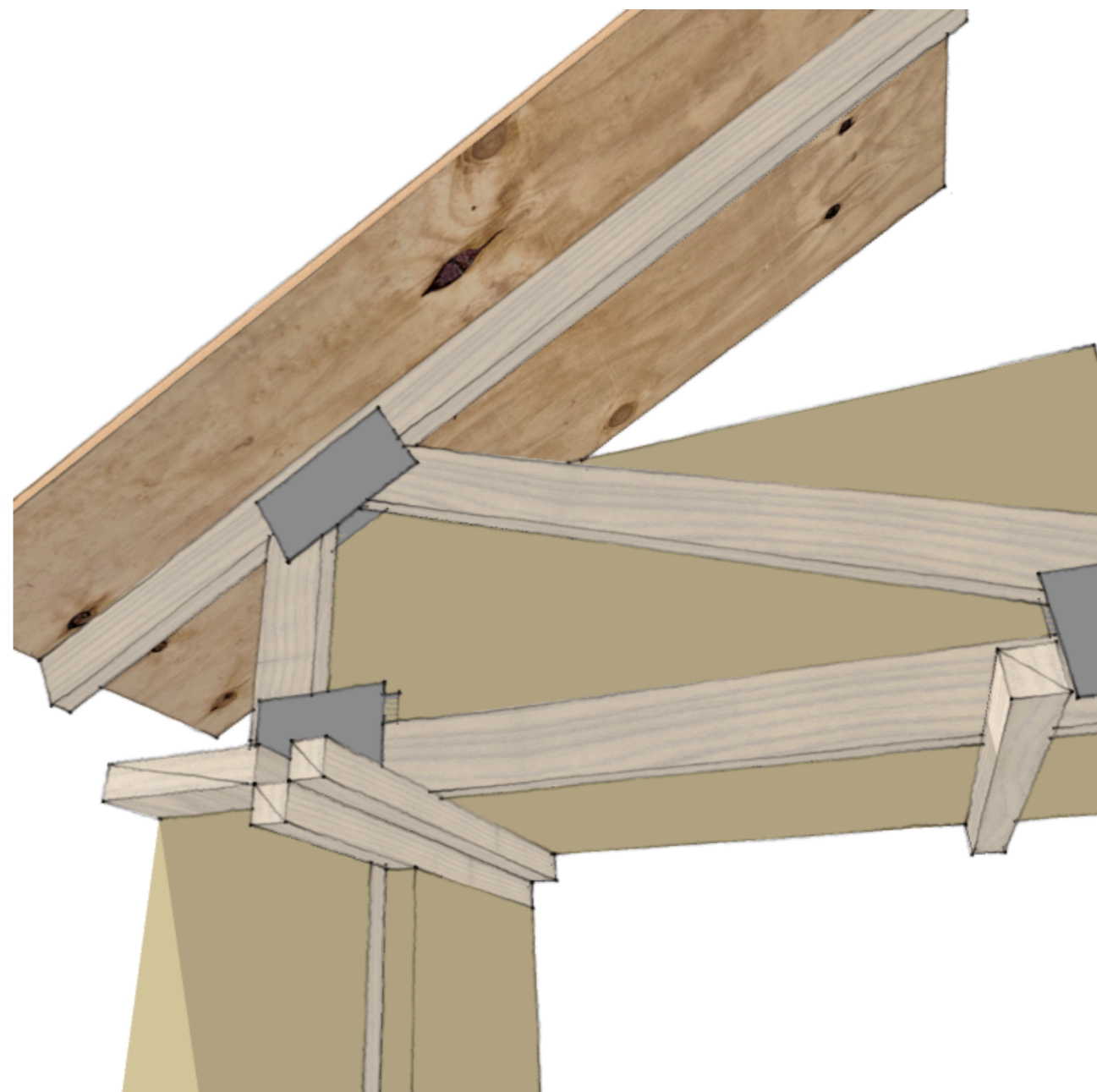


Swedish Platform Framing

Roof Condition



Western Platform Framing



Swedish Platform Framing

Comparisons

- Sweden: 173,732 sq miles
- California: 163,696 sq miles

- Sweden Population: 9.517 million (2012)
- New Jersey Population: 8.865 million (2012)

On a regional basis we clearly have the population density to support an industry like this. Emerging demand for energy efficient housing will be driven by maximizing consumer value.

This concludes The American Institute of Architects
Continuing Education Systems Course



LA VARDERA
architecture design

Gregory La Vardera
Architect

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