

Reframed Tech Series

Prefabricated panels & deep retrofits



#Reframed

May 13, 2020

Leading Canada's transition to clean energy

The Pembina Institute is a non-profit think-tank that advances a prosperous clean energy future for Canada through credible policy solutions.



Funding partners

Partially funded by / Financé partiellement par



Natural Resources
Canada

Ressources naturelles
Canada

Canada



FEDERATION
OF CANADIAN
MUNICIPALITIES

FÉDÉRATION
CANADIENNE DES
MUNICIPALITÉS

Supporting partners





Reframed Tech Series

Moderator

Betsy Agar

Senior analyst, Pembina Institute

Agenda

1. Introductions
2. Presentations
3. Q&A
4. Upcoming opportunity

Note to attendees

This webinar is being recorded.
The video will be published
online and shared with all
registrants.

Introducing the Reframed Initiative

The Reframed Initiative is working with designers, builders, owners, financiers, and policy-makers to scale up deep retrofits.

Together, we can address the housing crunch and climate emergency.

LEARN MORE: pembina.org/reframed

Deep retrofits are:

- **Healthy:** cleaner air, improved comfort
- **Resilient:** ready for extreme weather and earthquakes
- **Low-carbon:** use renewable energy and carbon smart materials

Let's scale up solutions that:

- Keep rent affordable
- Minimize disruption to tenants
- Return value to owners and investors

New primer

DOWNLOAD:

pembina.org/pub/prefab-panel-retrofits



Prefabricated panels and deep retrofits

Tackling the crises of climate change and affordable housing calls for streamlining and industrializing the process for delivering deep retrofits. Europe is already retrofitting buildings with fully finished panels — complete with windows and integrated mechanical, electrical, and plumbing systems — and North American leaders are quickly making strides with prefabricated panel retrofits.

State of the North American market

In recent years, modular housing and the prefabrication of wall panels for new construction have gained considerable momentum. Building on that experience, innovators are introducing prefabrication to building retrofits. Two examples of fully finished panel designs being implemented are illustrated below. The first is wood-framed with cellulose insulation, chosen to minimize cost and carbon footprint. The second integrates cladding and a weather-resistant barrier with a structural insulated panel (SIP), chosen to minimize weight, plus the foam doubles as the air barrier. Both are installed directly over existing cladding to save time and minimize demolition waste, leaving potentially hazardous materials undisturbed. A "squishy layer" is sometimes added to improve contact with the existing cladding.

The prefabrication sector is beginning to recognize the opportunity existing buildings represent. In the meantime, retrofitters are taking the lead by playing an intermediary fabricator role, starting with basic prefabricated panels and integrating windows, weather-resistant air-barrier (WRB), and cladding — either on-site, immediately prior to installing the panel, or off-site, before delivery. Third-party integrators are launching demonstration projects throughout North America to help transform the retrofit process from stick built (assembled on-site) to fully prefabricated panelization with integrated mechanical, electrical, and plumbing distribution and equipment, as European companies are already doing.

Advantages of prefabrication

Prefabrication shifts the majority of construction off-site to a controlled environment, which can mean:

- Less time on-site and less disruption to occupants
- Lower risk of costly construction delays caused by inclement weather
- Reduced need for lay-down space on-site
- Better co-ordination of subcontractors and the supply chain
- Less demolition and construction waste
- Higher quality construction
- Safer working conditions
- Less demand on an already stretched labour force

Wood-framed panel



- James Hardie siding
- 3/8" rain screen
- Delta Vent S airtight vapour open water-resistant barrier
- 7 1/16" OSB
- 8" of dense packed cellulose insulation
- Original 2x6 wall

Built-up structurally insulated panel (SIP)



- Cladding on strapping
- Weather-resistant air-barrier (WRB)
- Expanded polystyrene (EPS) foam SIP
- Laminated strand lumber top and bottom chords
- Glass fibre "squishy layer"
- Original brick-clad wall



Reframed Tech Series

Panellist

Jeff Armstrong

Principal, Cold Climate Building



Reframed Tech Series

Panellist

David Arnott

Cofounder, TAG Panels

Panellist

Michael Dombowsky

Cofounder and senior vice president
for building technology, Nexii



PEER

Prefabricated Exterior Energy Retrofits



Panelized Retrofits
... some insights

Pembina Webinar

May. 13, 2020

Jeff Armstrong
Cold Climate Building Inc.

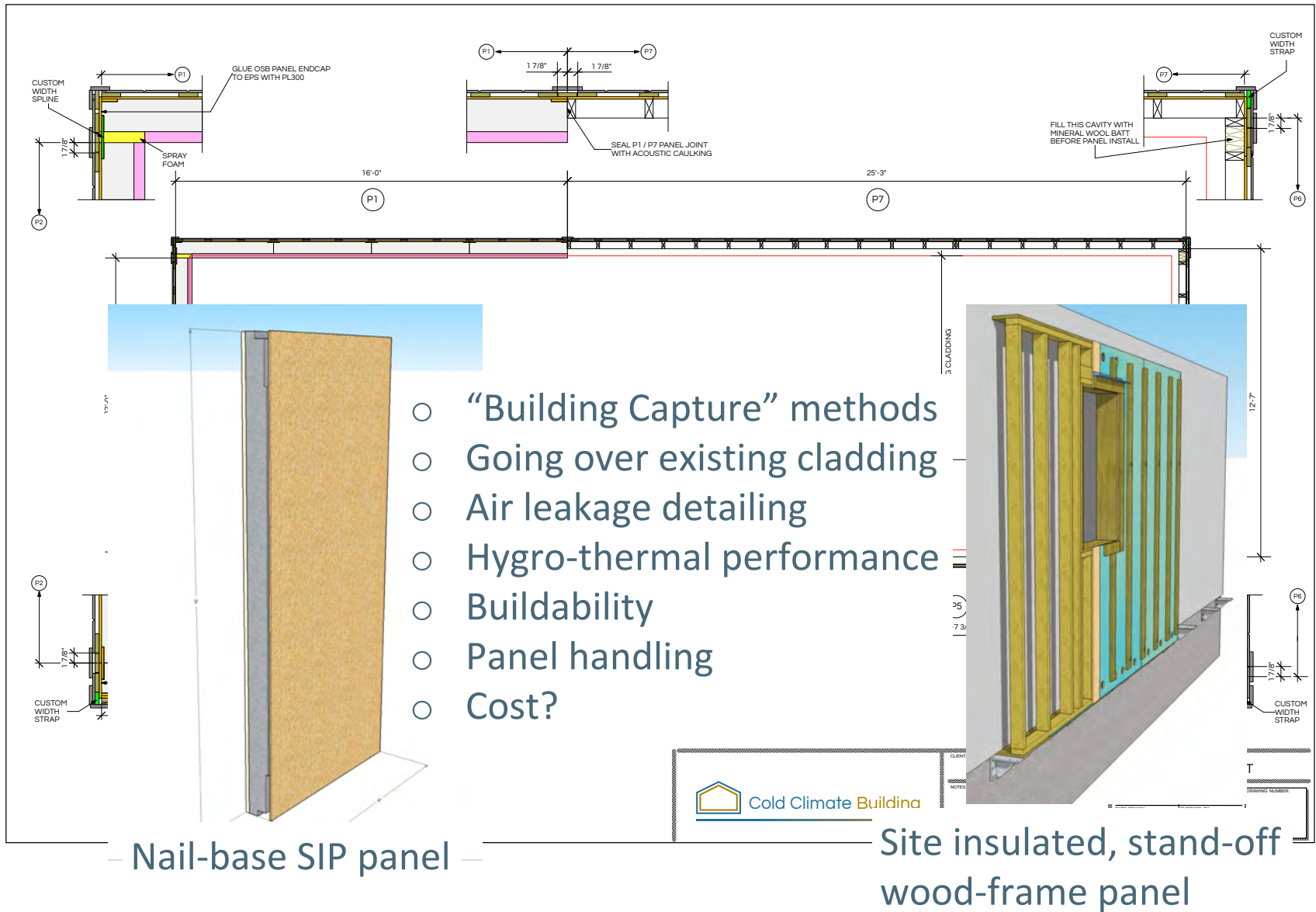


1ST PEER Pilot - 2017

NRCan Research project

- Above grade wall panels







2ND Pilot

- OCH – a forward thinking social housing provider
- “Total cost of building ownership” perspective
- Many poor energy performers (bldgs. over 50 years old)

Building Suitability Checklist

- ✓ Small scale but many similar buildings in the portfolio
- ✓ Simple low-rise form with repetitive window/door pattern
- ✓ Good solar orientation
- ✓ Good machine access



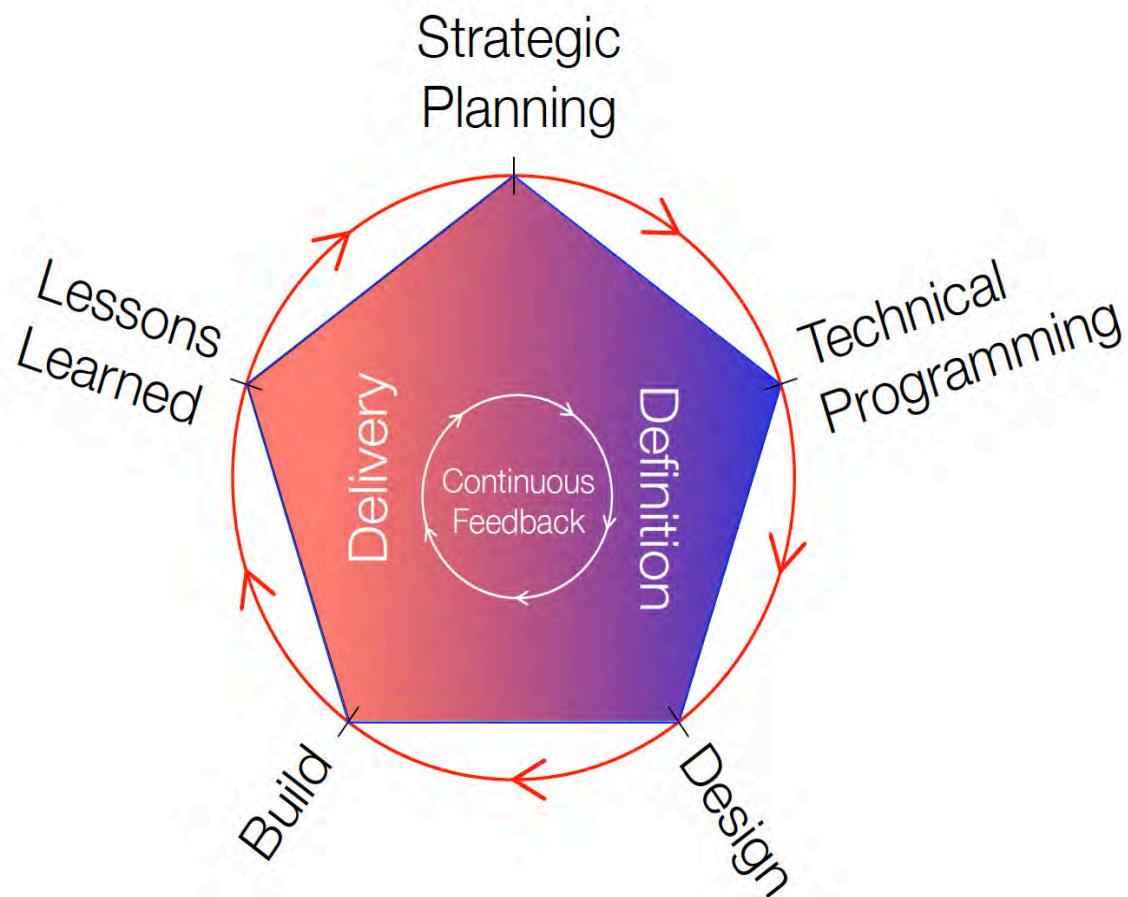
2ND Pilot A Real-world project

- Above grade wall panels
- Below grade walls
- New roof structure
- Building condition assessment
- Fuel switching
- Mechanical upgrade
- Net Zero Energy (Roof-mounted PV)
- Occupants

Phase	Activity	Responsible	Start Date	End Date	Status
Phase 1	Strategic Planning	Strategic Planning Team	2023-01-01	2023-03-31	Completed
Phase 2	Technical Programming	Technical Programming Team	2023-04-01	2023-06-30	In Progress
Phase 3	Design	Design Team	2023-07-01	2023-09-30	Not Started
Phase 4	Build	Build Team	2023-10-01	2023-12-31	Not Started
Phase 5	Delivery	Delivery Team	2024-01-01	2024-03-31	Not Started
Phase 6	Lessons Learned	Lessons Learned Team	2024-04-01	2024-06-30	Not Started

A Unique Type of Project

The Key is Integrated Project Delivery



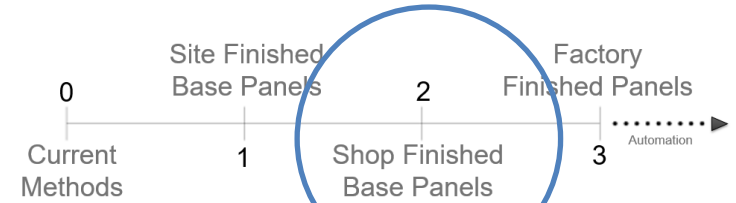
WE SEE A PREFAB CONTINUUM



Industrialization

Market Size & Business Model Certainty

Reduced Costs & Decreasing Occupant Disruption



Simple Panel Shop

- 32' x 32' x 12' high
- Good concrete slab
- Well lit
- 10' x 18' Rolling Table
- Means of hoisting
- Large sliding door



Panel storage & transport



Panel handling at the shop



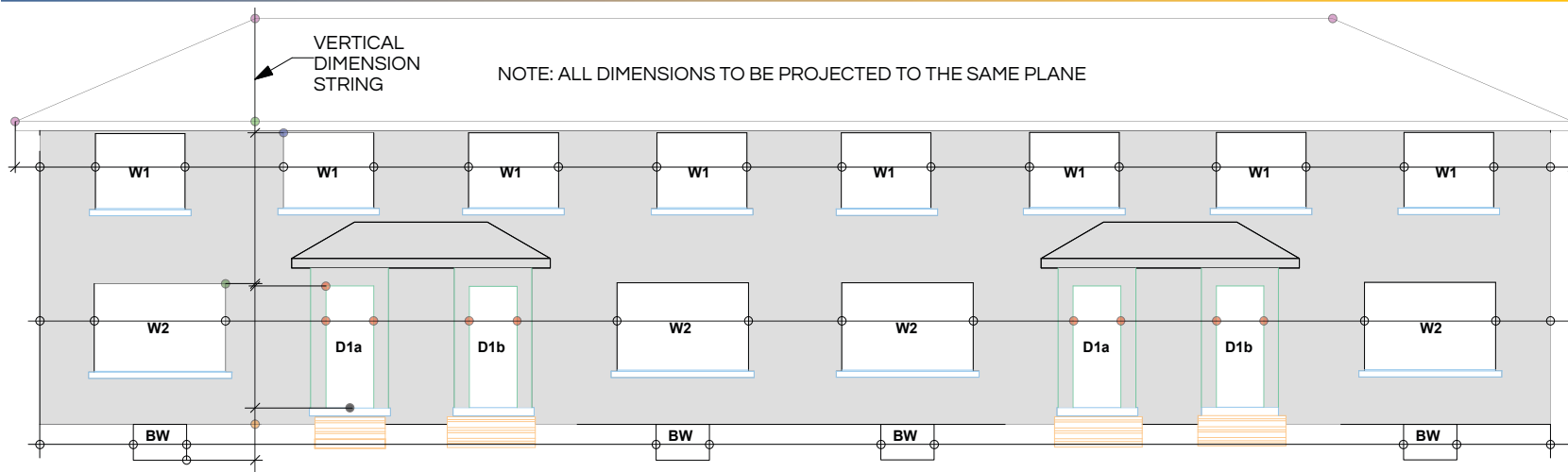
Panel installation on site

Panel Fit Strategy

Is meant to address:

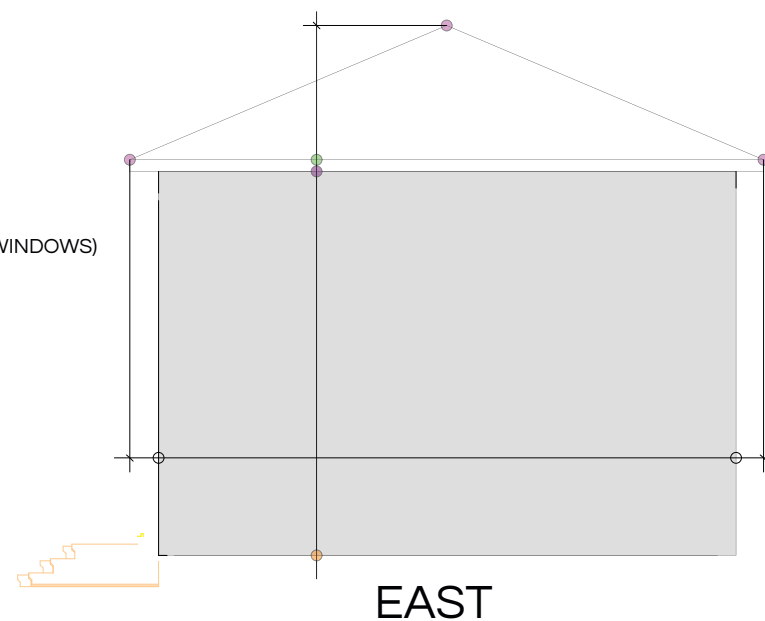
- Dimensional tolerance of base materials
- Panel Creep
- Workmanship tolerances
- Base building anomalies
- Mistaken point-cloud conversion assumptions
- “Building Capture” inaccuracies



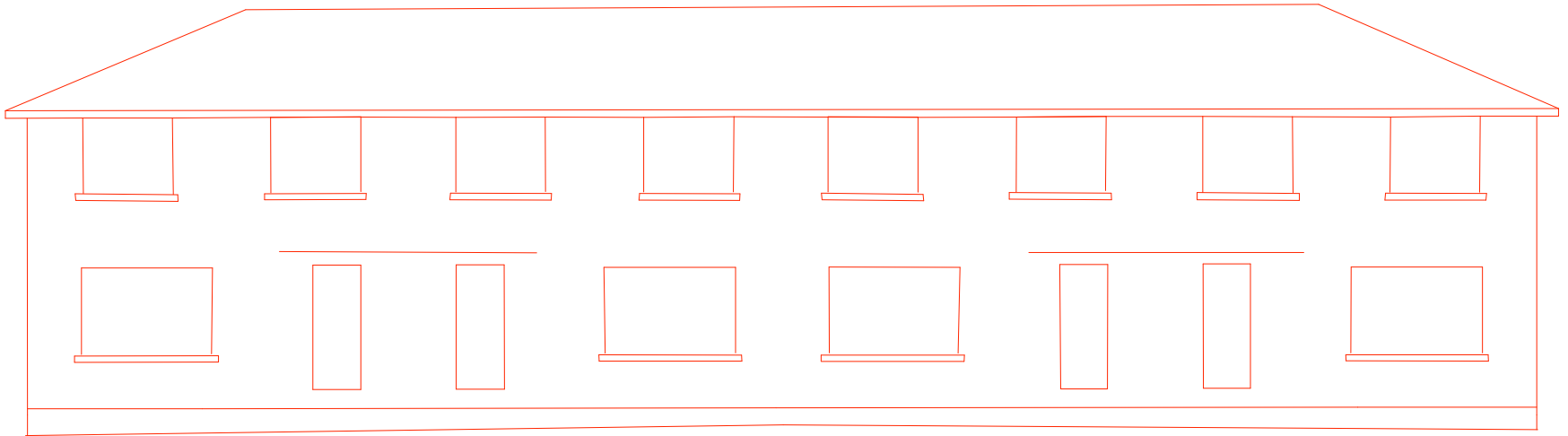


- OUTSIDE CORNERS OF ASPHALT SHINGLES
- OUTSIDE EDGE OF ASPHALT SHINGLES
- BRICK RETURN / TOP OF WINDOW FRAME
- TOP CORNER OF BRICK RETURN
- CORNER FORMED BY DOOR SLAB / DOOR FRAME
- FINISHED FLOOR INSIDE APARTMENT
- BOTTOM EDGE OF FIRST BRICK COURSE
- OUTSIDE CORNER OF BRICK RETURN (PARGING RETURN @ BASEMENT WINDOWS)

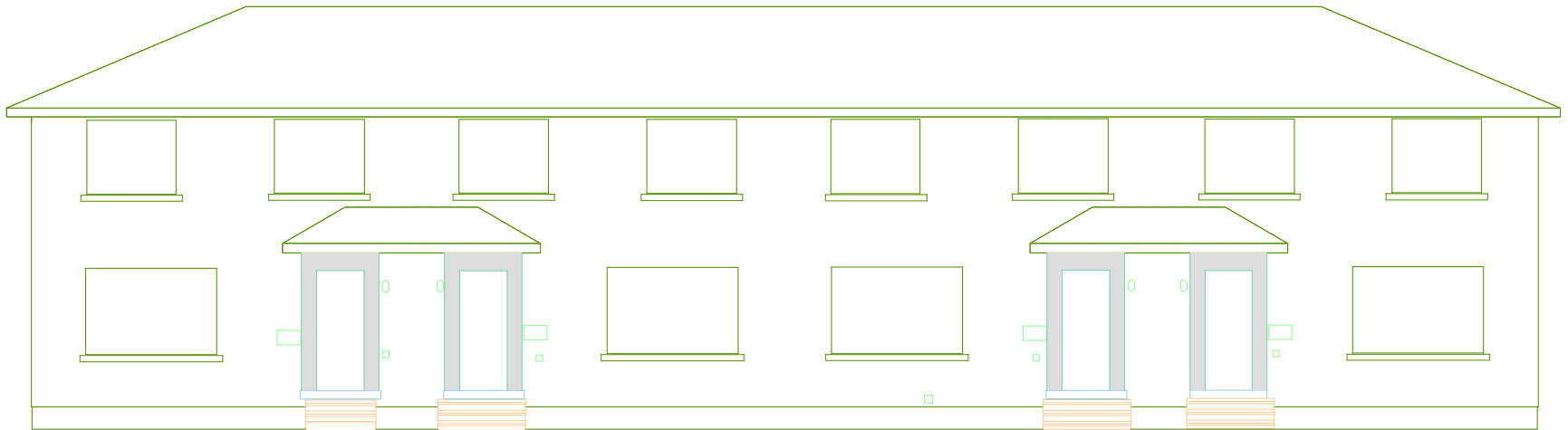
Survey Points



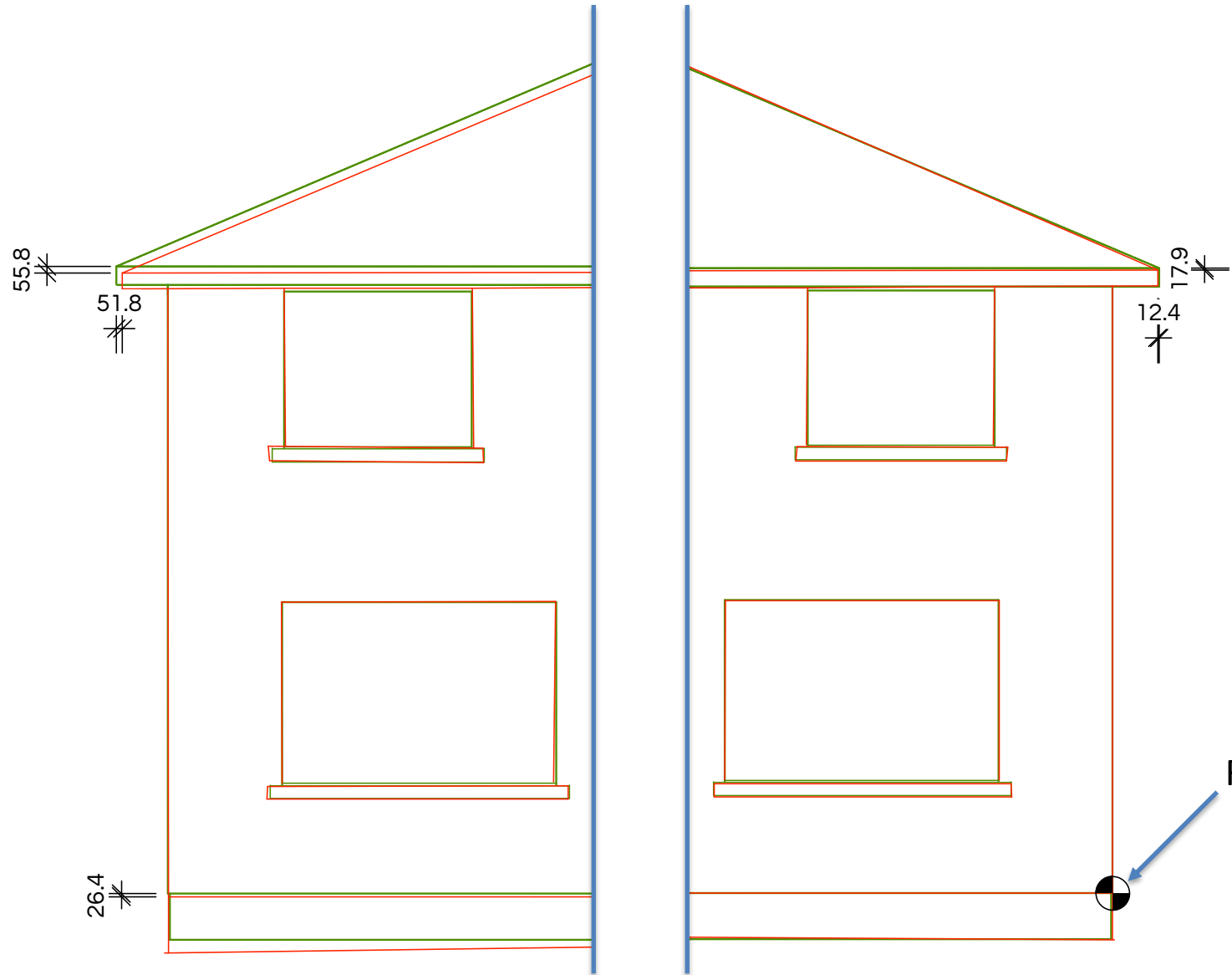


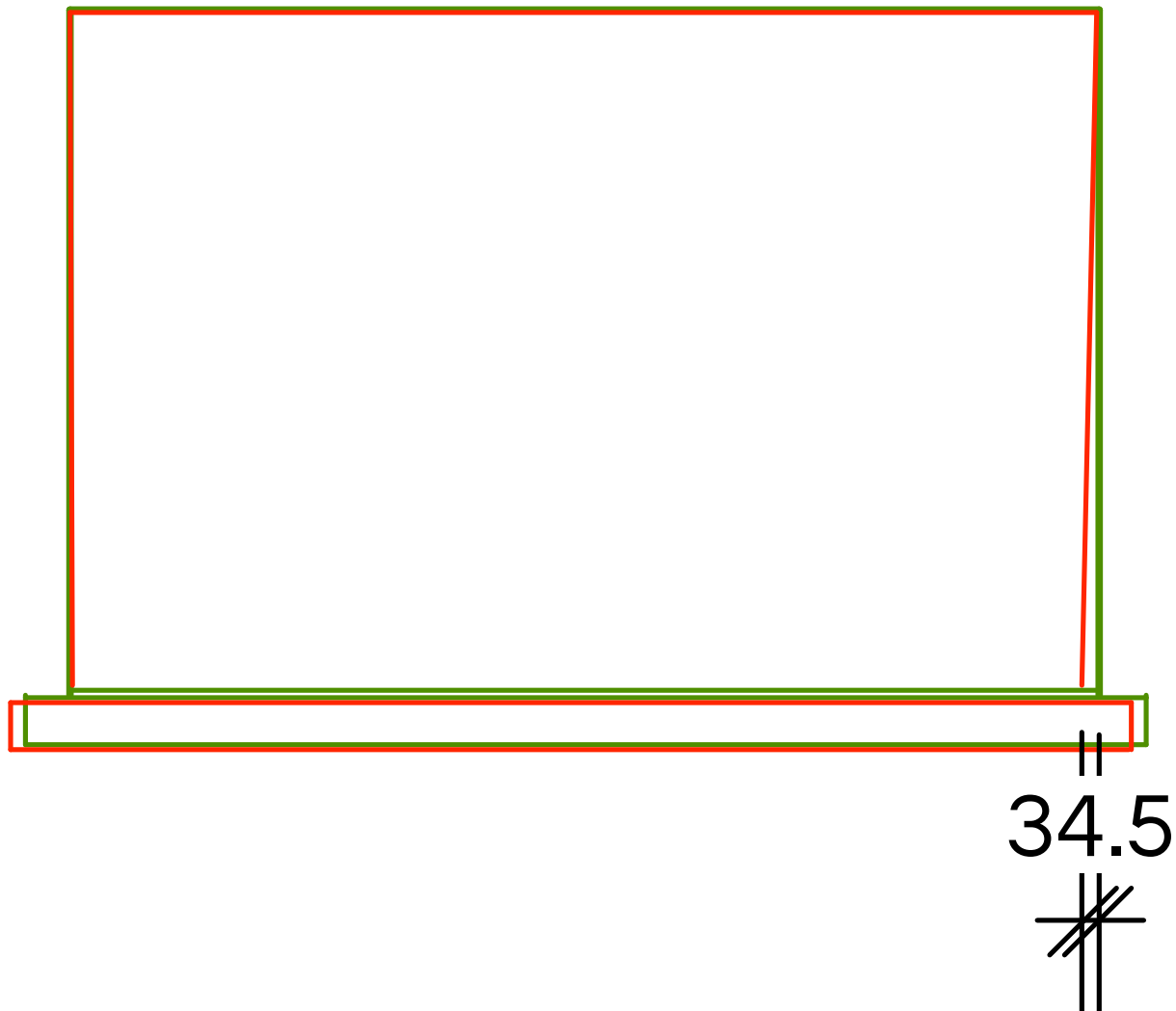


Survey Points

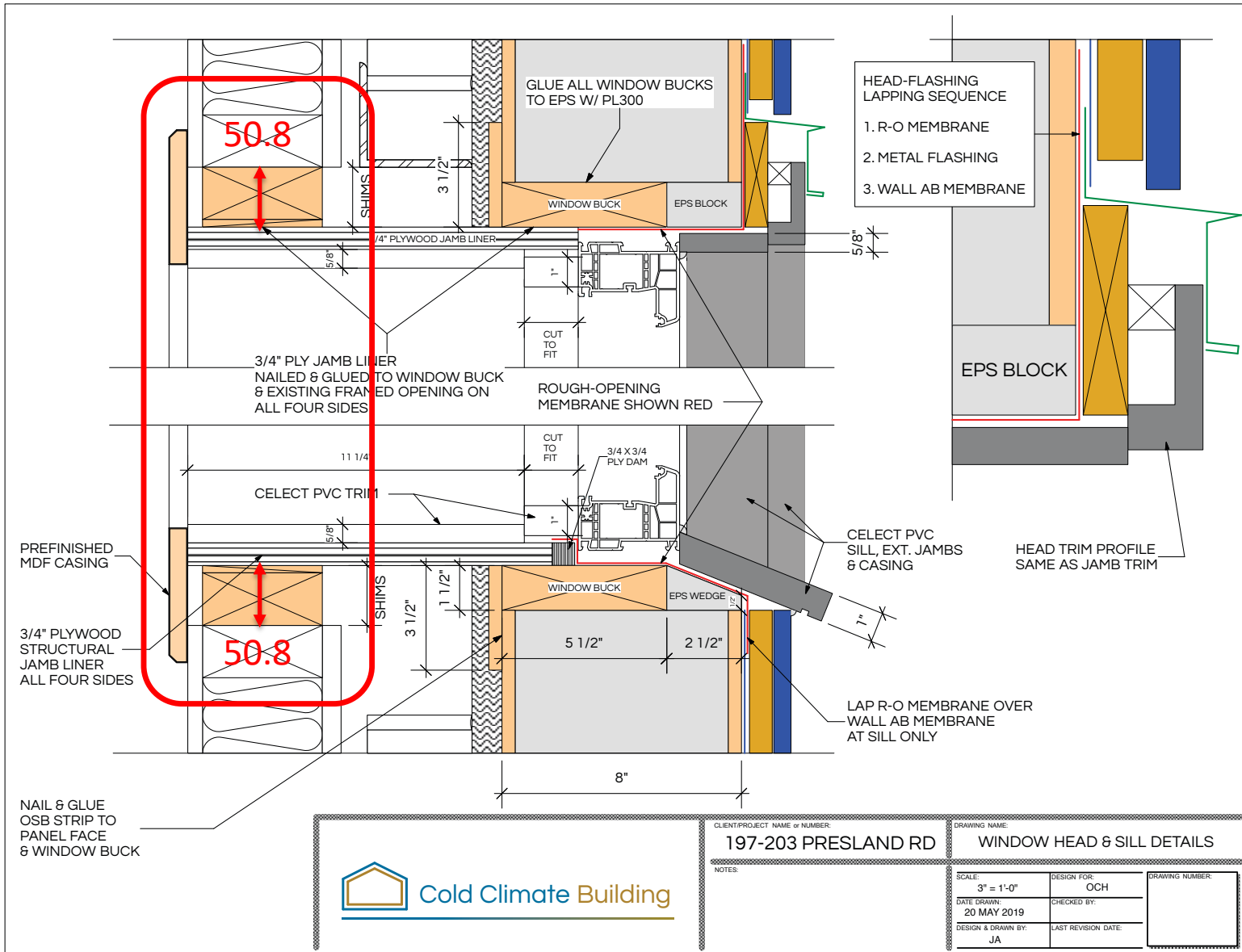


Laser Scan

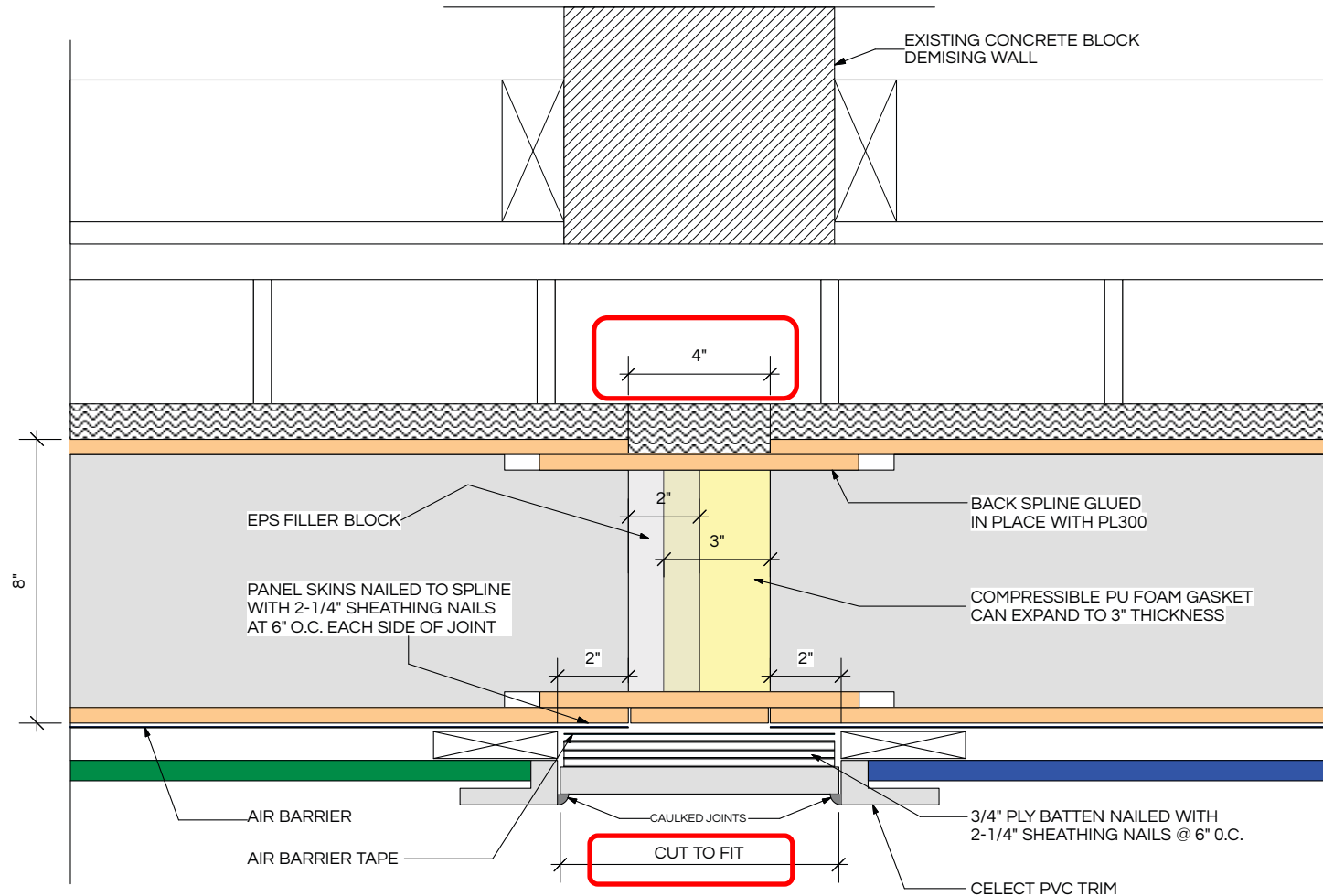




Panel Fit Strategy



Panel Fit Strategy



NOTE:
ALL SIP PANELS TO BE
INSULSPAN STRUCTURAL
INSULATED PANEL:
CCMC 13016-R



Cold Climate Building

CLIENT/PROJECT NAME or NUMBER:

197-203 PRESLAND RD

NOTES:

DRAWING NAME:

VERTICAL PANEL JOINT

SCALE:
3" = 1'-0"

DESIGN FOR:
OCH

DRAWING NUMBER:

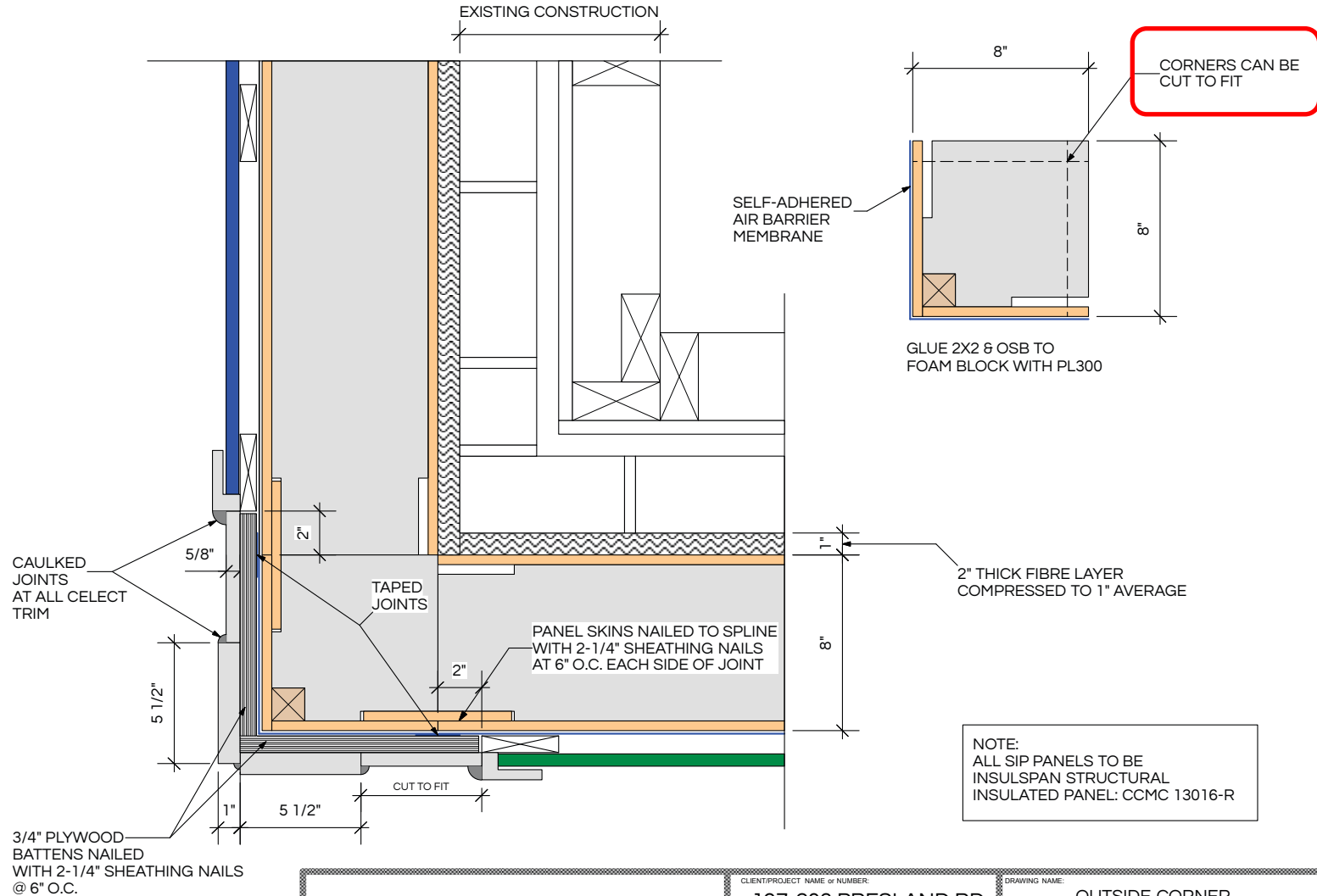
DATE DRAWN:
30 MAY 2019

CHECKED BY:

DESIGN & DRAWN BY:
JA

LAST REVISION DATE:

Panel Fit Strategy



Cold Climate Building

CLIENT/PROJECT NAME or NUMBER:

197-203 PRESLAND RD

DRAWING NAME:

OUTSIDE CORNER

NOTES:

SCALE:

2" = 1'-0"

DESIGN FOR:

OCH

DATE DRAWN:

20 MAY 2019

CHECKED BY:

JA

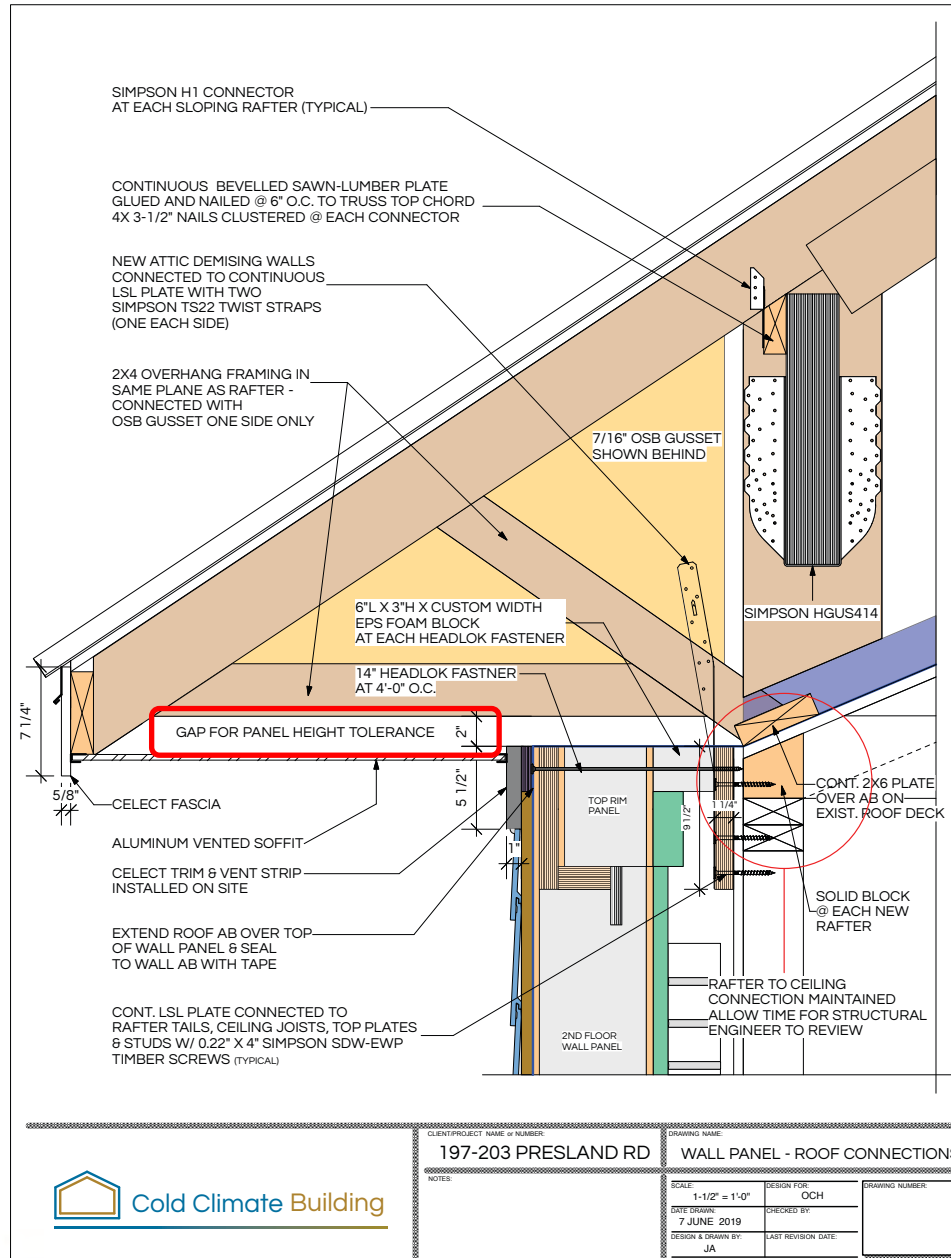
LAST REVISION DATE:

DRAWING NUMBER:

CanmetENERGY

Leadership in ecoInnovation

Panel Fit Strategy



PEER

Prefabricated Exterior Energy Retrofits



Panelized Retrofits
... some insights

Questions?

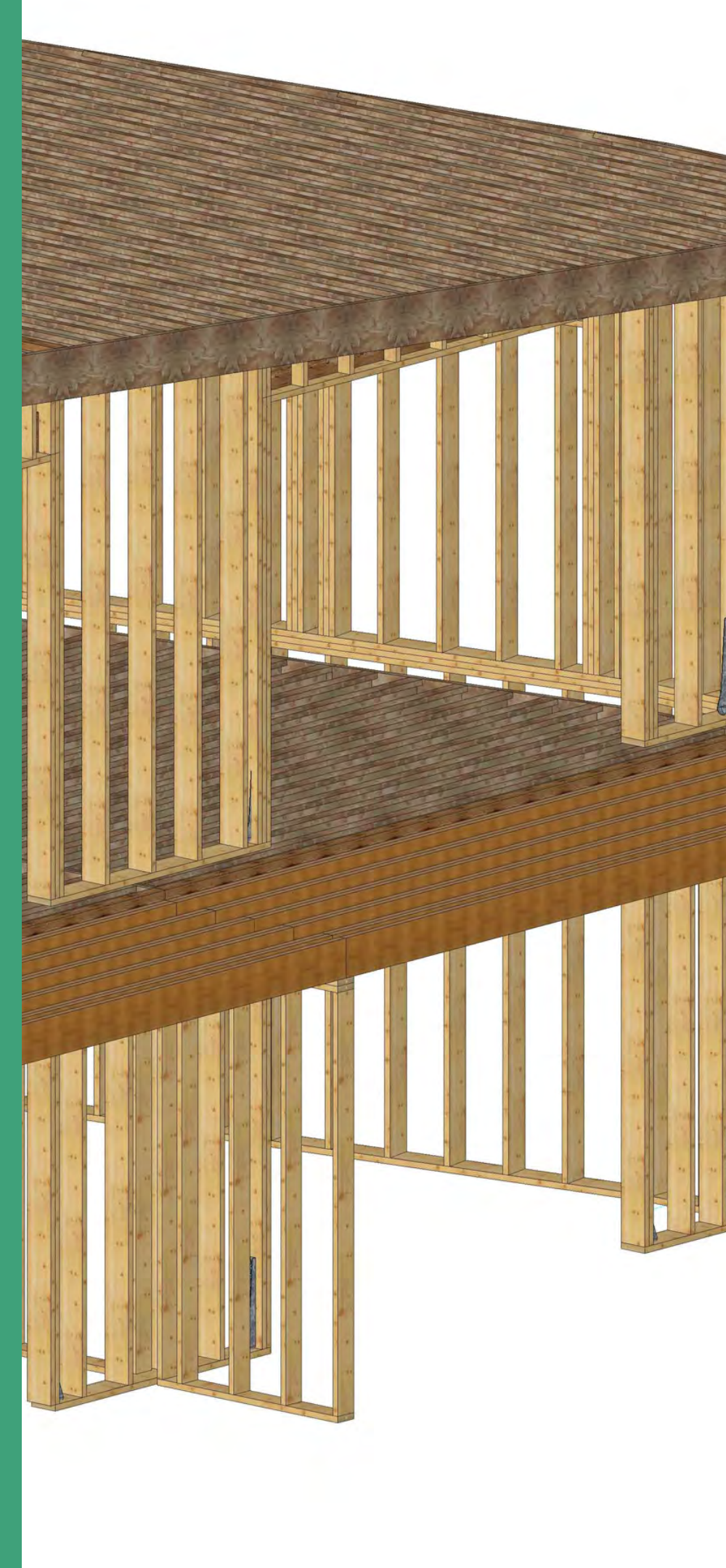
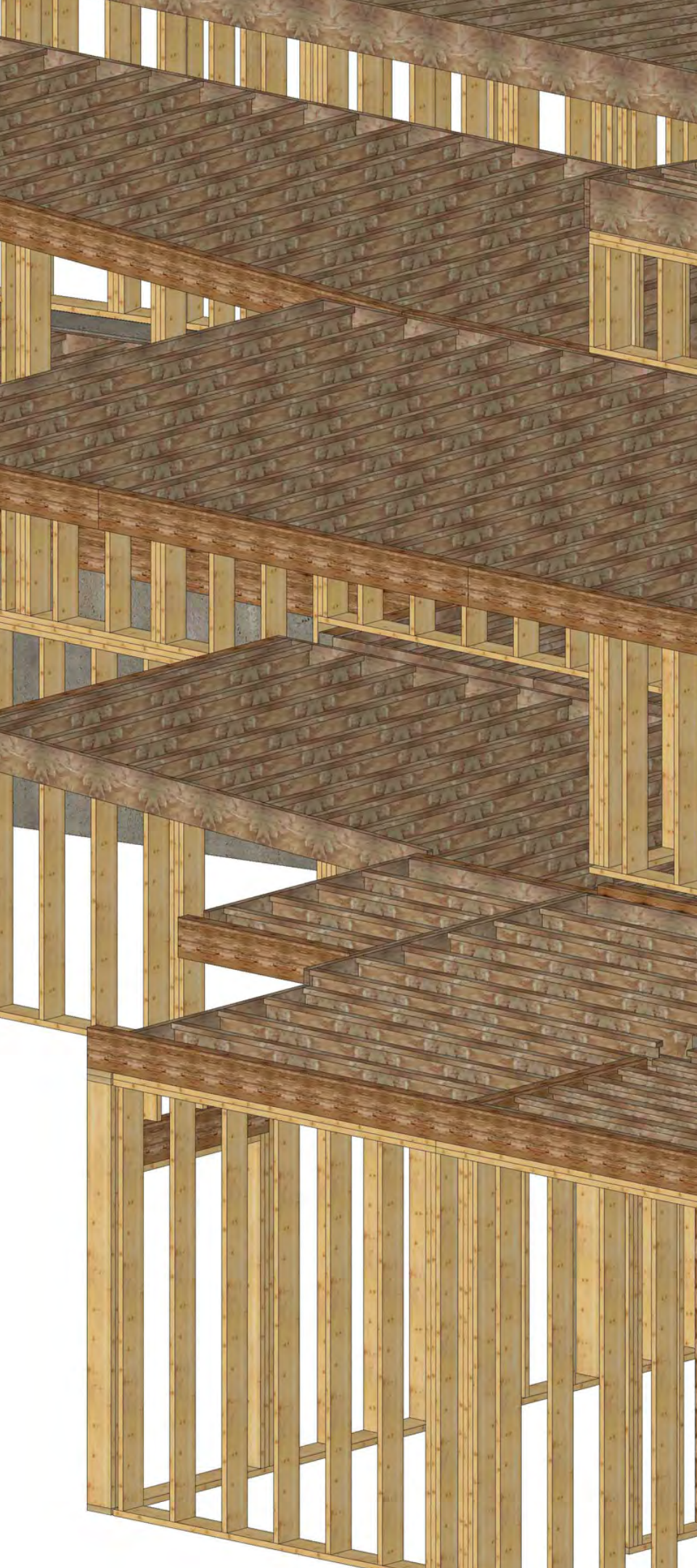
jeff@coldclimatebuilding.ca

mark.carver@canada.ca

daniel_dicaire@och.ca



**PREFABRICATED, SUSTAINABLE
BUILDING PANELS**



TODAY'S PRESENTATION

THREE MAIN POINTS

- What are TAG Panels?
- What are the materials & embodied carbon in TAG Panels?
- How can prefabrication benefit New Builds & Retrofits?





FOUNDERS

DAVID ARNOTT - CO FOUNDER

Registered Architect in B.C. & Alberta.
Certified Passive House Designer

BRIAN GAVAN - CO FOUNDER

Contractor

BEN TOWSEY - CO FOUNDER

Registered Engineer in B.C.



TEAM

BRIAN - construction
TRIXTON - construction
JOEL - construction
DANIEL - modeler
GABRIEL - modeler
STEPHAN - production manager
SIMON - operations manager





FUTURE USE

ASK OURSELVES.

ARE WE BUILDING A BETTER SYSTEM?

IF WE ARE REPLACING AN ENVELOPE WITH A marginally BETTER SYSTEM..

ARE WE IN DANGER OF REPEATING OUR MISTAKES?

R-WHAT?

1930'S



1980'S



2000'S



R-WOAH?

1930'S



1980'S



2000'S



ALL THREE BUILDINGS SOMEWHERE BETWEEN **R2** AND **R3.5**

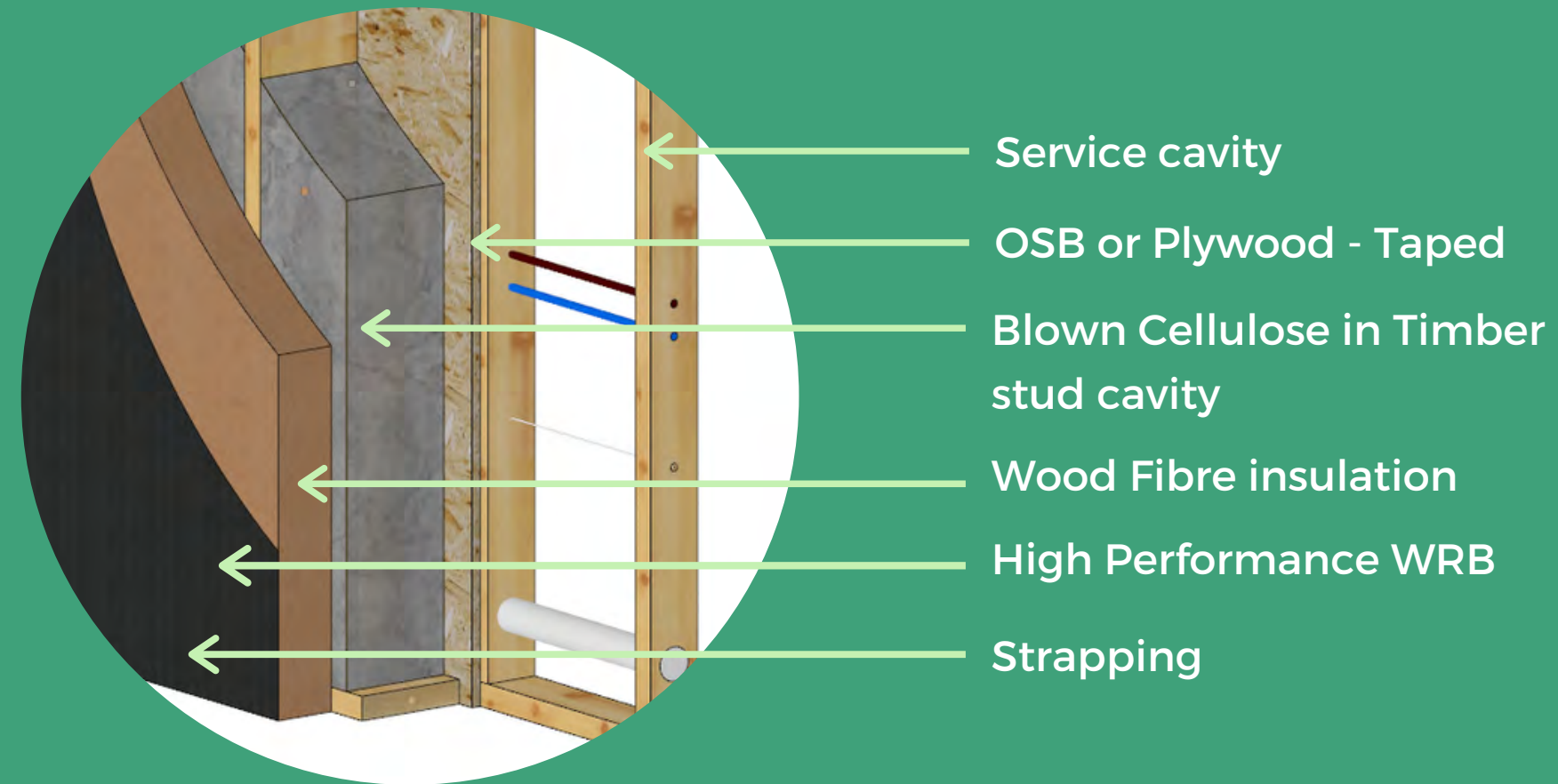


WHAT ARE TAG PANELS?

**PREFABRICATED, SUSTAINABLE BUILDING PANELS.
ENABLING CLIENTS TO MEET HIGH PERFORMANCE BUILDING GOALS.**

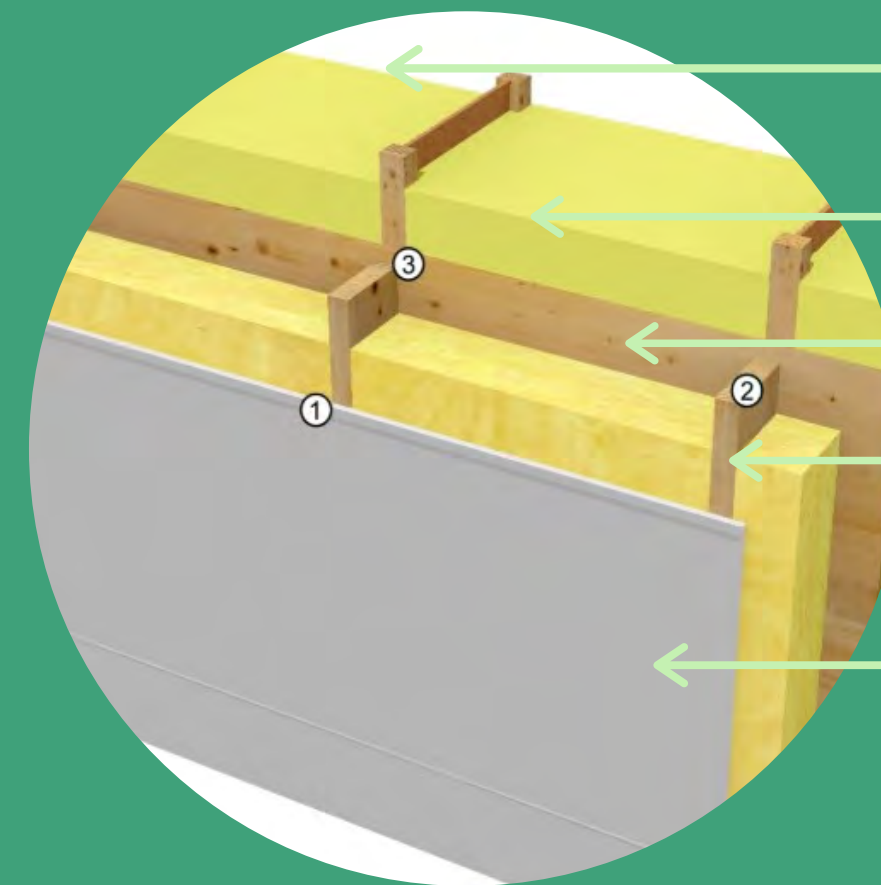
BUILD UP

We created three "typical" wall assemblies to cater for Step 1, Step 3/4 and Step 5 / Passive.
However our walls are customised depending on client and code requirements.



ALT. BUILD UPS

As the system is customisable, we have created other wall, floor and roof assemblies to work with clients required RSI values and site conditions..



High Performance WRB & Strapping

Larsen Truss (TJI System) with blown cellulose.

OSB or Plywood Taped

Timber stud structural wall & service cavity

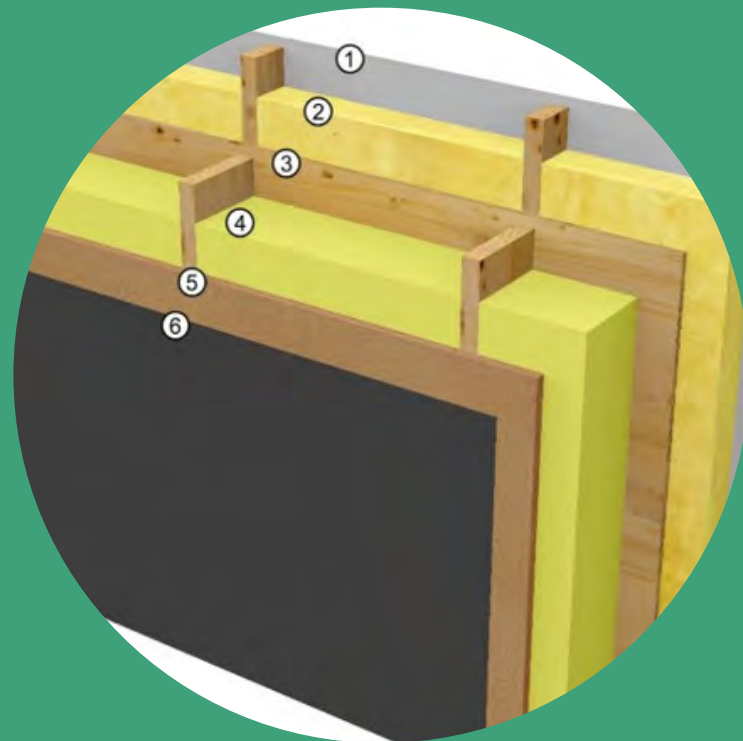
Drywall

OPERATION





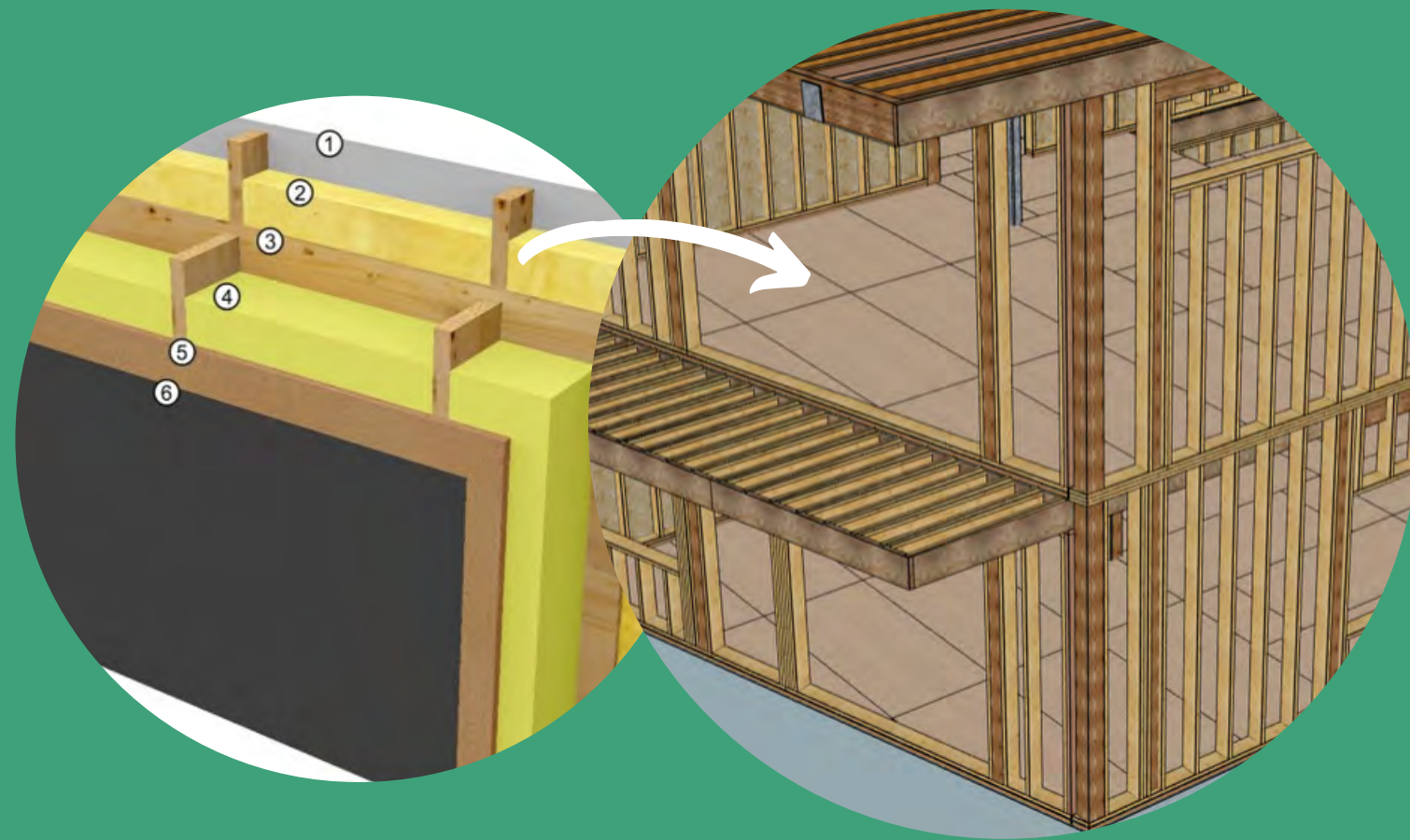
PROCESS



1

Needs

PROCESS



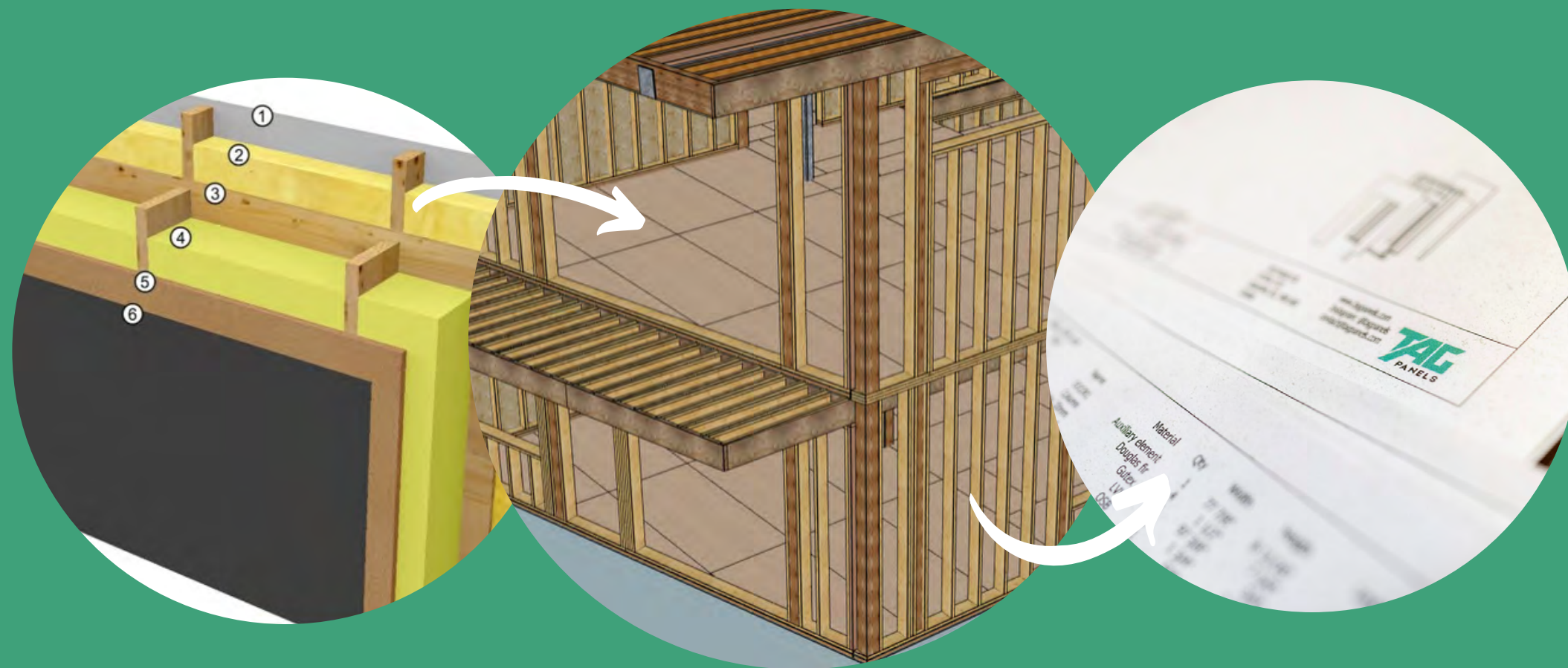
1

Needs

2

Modelling

PROCESS

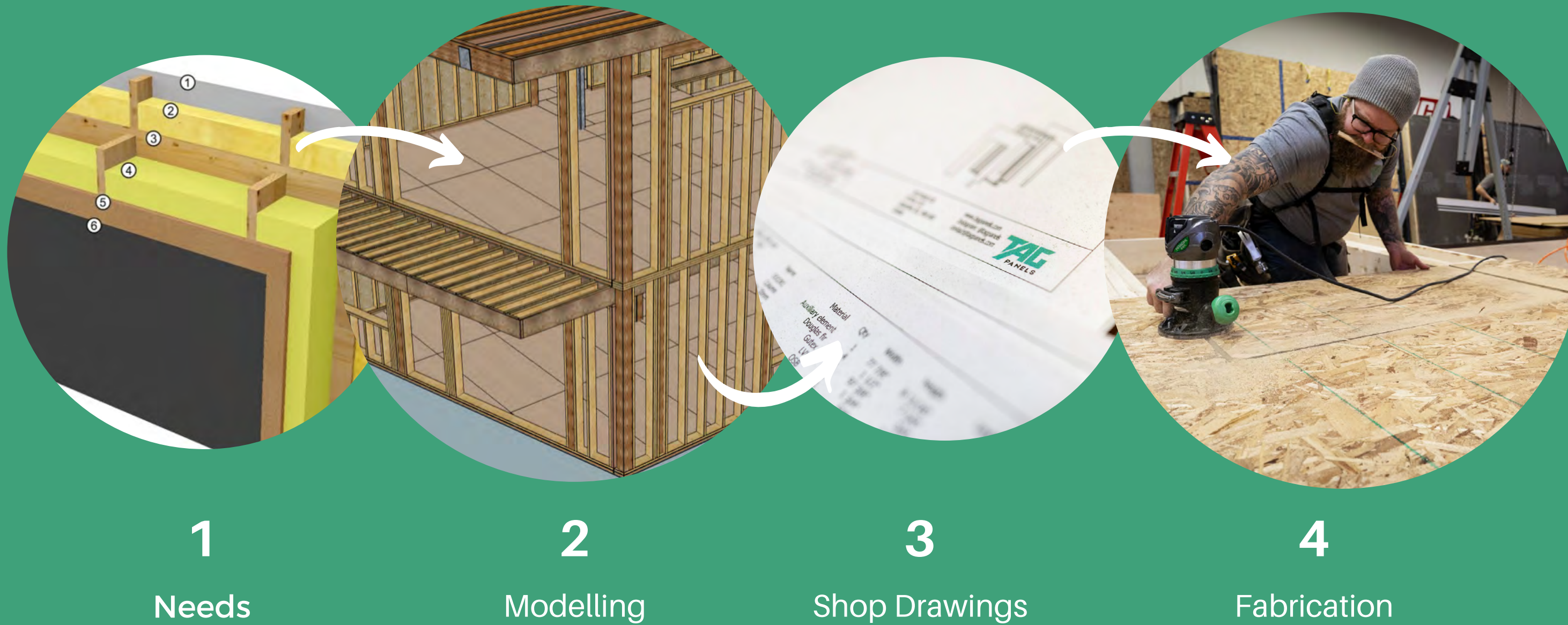


1
Needs

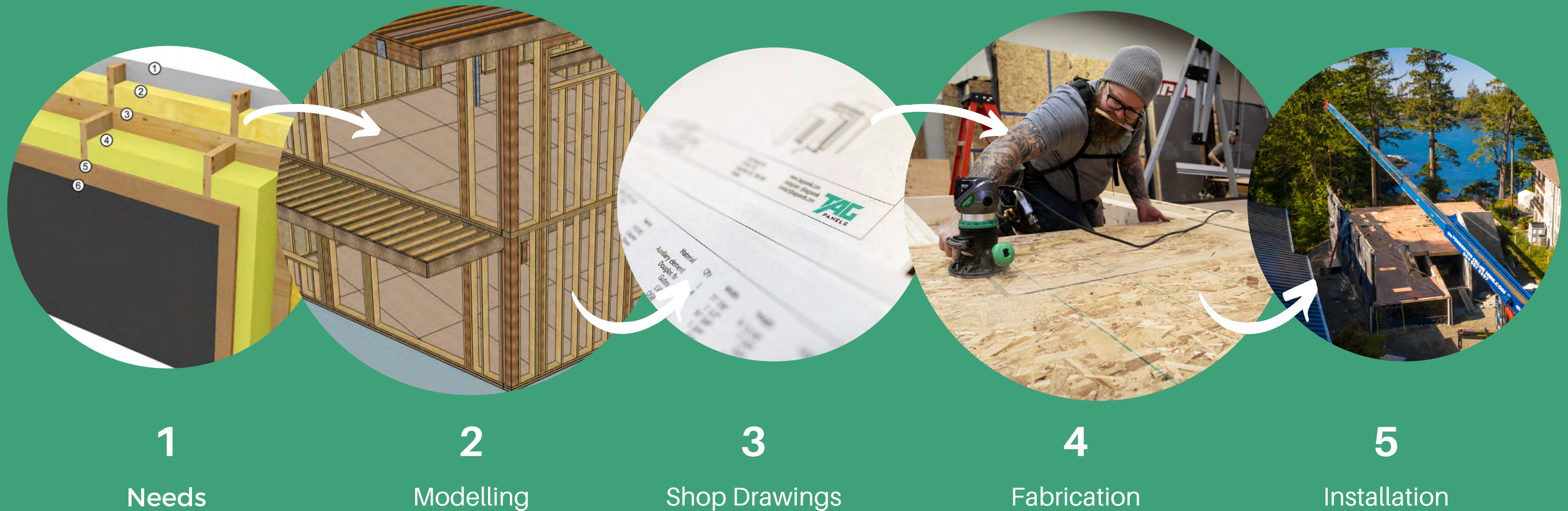
2
Modelling

3
Shop Drawings

PROCESS



PROCESS





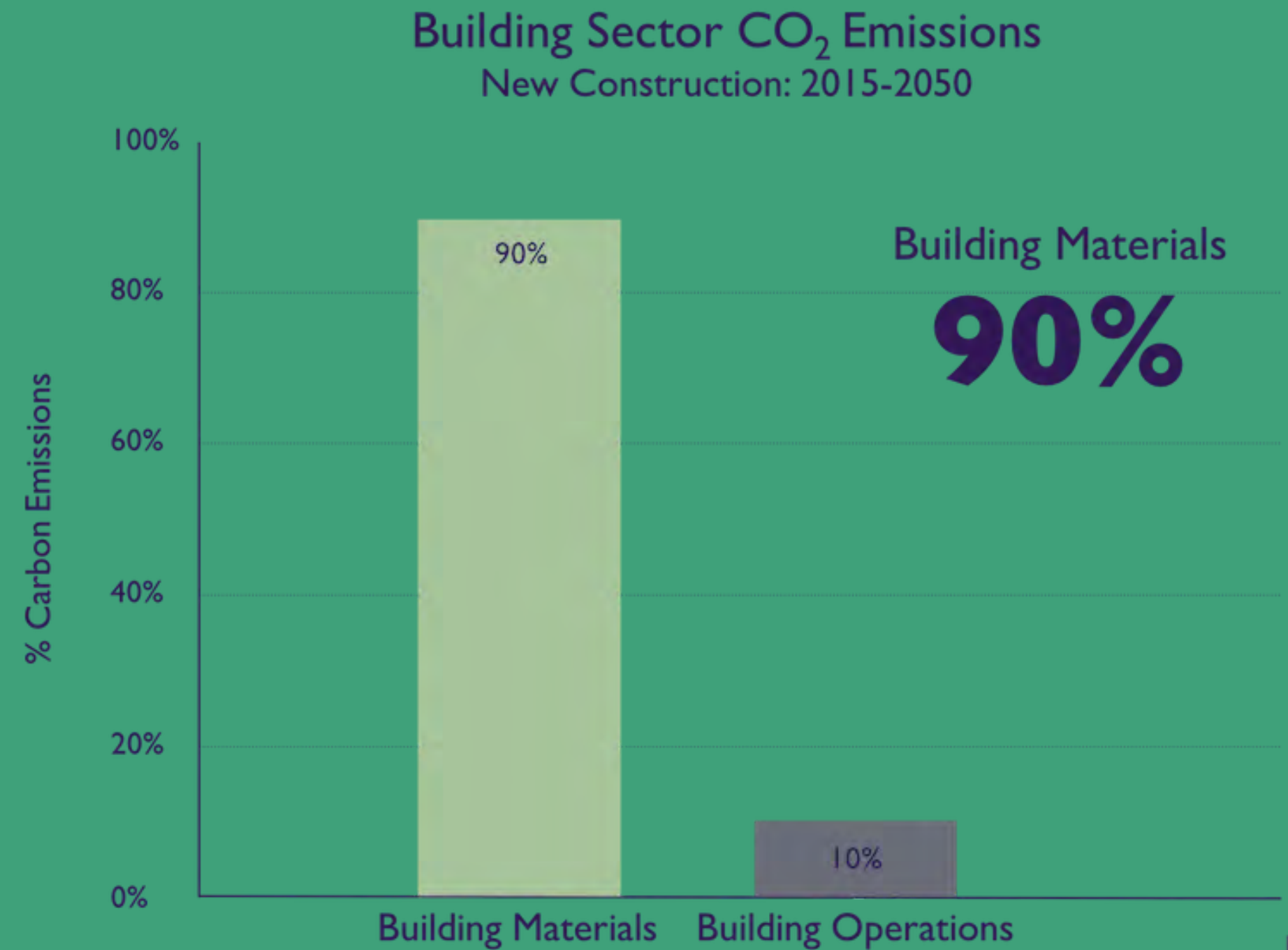
MATERIALS & CARBON

SUSTAINABLE, BREATHABLE PANELS MARRY THE BENEFITS OF PRE FABRICATION WITH LOWER EMBODIED CARBON & LOWER LIFECYCLE COSTS.

CARBON CAPTURE

There is a growing awareness that high-performance, and energy savings, can't be "at any cost".

Building materials play an outsized role in the CO₂ emissions of a building.



Source: ©2018 2030, Inc. / Architecture 2030. All Rights Reserved.
Data Source: EIA (2011), Richard Stein, CBECS (2003), McKinsey Global Institute



MATERIALS

Inside a prefabricated wall, when used as either new build or retrofit. Materials used, and the carbon they emit play a huge role for future use and re-use of buildings.



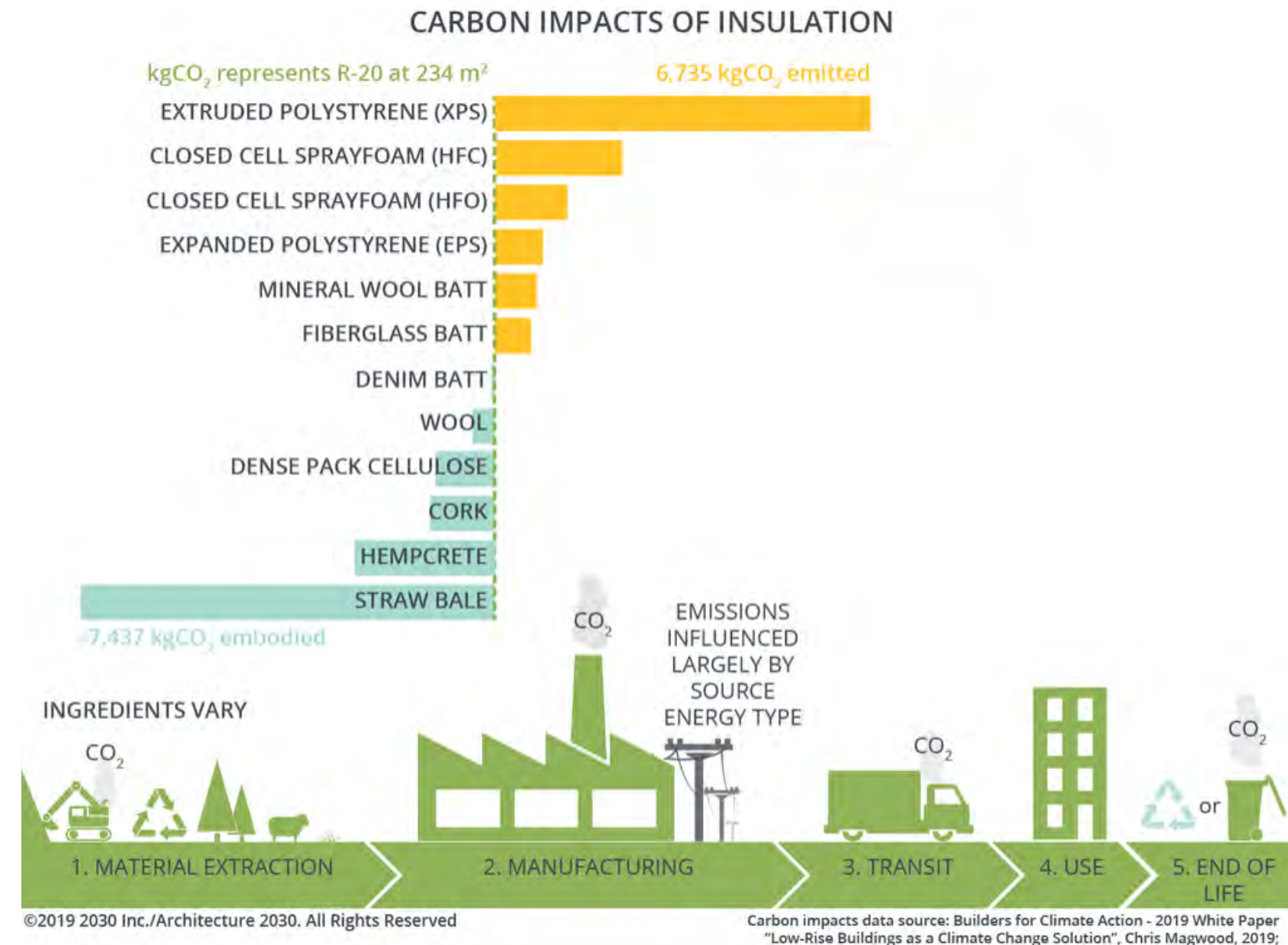
Wood fibre



Harvested timber



Cellulose (recycled)



AIR BARRIER

Keeping a house or retrofit air tight is essential in keeping users running costs low, and ensuring comfort.

Multiple Air Barriers give the best chance of achieving this, whilst moving plumbing / electrical to the interior of the air barriers reduces penetrations.



Wood fibre



Taped OSB & Plywood



High Performance
Exterior Membranes





VAPOUR DIFFUSION

An effective air barrier is paramount. However, an assemblies ability to be vapour "open", can help with swings in moisture, as well as drying assemblies to the interior or exterior.



Wood fibre



Cellulose (recycled)



High Performance
Exterior Membranes



HOW PREFAB BENEFITS

WHETHER NEW BUILD OR RETROFIT, PREFABRICATION HAS MULTIPLE BENEFITS TO A PROJECT, WHETHER CLIENT, CONTRACTOR, OWNER OR END USER.

PREFABRICATED PANELS

THE FIVE BIGGEST BENEFITS TO THE SYSTEM AS WE SEE IT



Building your investment within a climate controlled production facility. Systems that build upon known construction. Reduction in on-site trades. Ownership of the envelope.

PREFABRICATED PANELS

THE FIVE BIGGEST BENEFITS TO THE SYSTEM AS WE SEE IT



Building your investment within a climate controlled production facility. Systems that build upon known construction. Reduction in on-site trades. Ownership of the envelope.



Conflict resolution at an early stage. Having your entire structure modeled and built within the panels. Window openings pre-flashed. Ordering of windows early in construction.

PREFABRICATED PANELS

THE FIVE BIGGEST BENEFITS TO THE SYSTEM AS WE SEE IT



Building your investment within a climate controlled production facility. Systems that build upon known construction. Reduction in on-site trades. Ownership of the envelope.



Conflict resolution at an early stage. Having your entire structure modeled and built within the panels. Window openings pre-flashed. Ordering of windows early in construction.



Fixed price. Cost uncertainty can be removed from one of the largest line items in any budget.

PREFABRICATED PANELS

THE FIVE BIGGEST BENEFITS TO THE SYSTEM AS WE SEE IT



Building your investment within a climate controlled production facility. Systems that build upon known construction. Reduction in on-site trades. Ownership of the envelope.



Conflict resolution at an early stage. Having your entire structure modeled and built within the panels. Window openings pre-flashed. Ordering of windows early in construction.



Fixed price. Cost uncertainty can be removed from one of the largest line items in any budget.



Time. Panels are built while foundations are being formed or demolition underway. Lockup can be achieved faster. Benefits sites with tight construction windows.

PREFABRICATED PANELS

THE FIVE BIGGEST BENEFITS TO THE SYSTEM AS WE SEE IT



Building your investment within a climate controlled production facility. Systems that build upon known construction. Reduction in on-site trades. Ownership of the envelope.



Conflict resolution at an early stage. Having your entire structure modeled and built within the panels. Window openings pre-flashed. Ordering of windows early in construction.



Fixed price. Cost uncertainty can be removed from one of the largest line items in any budget.



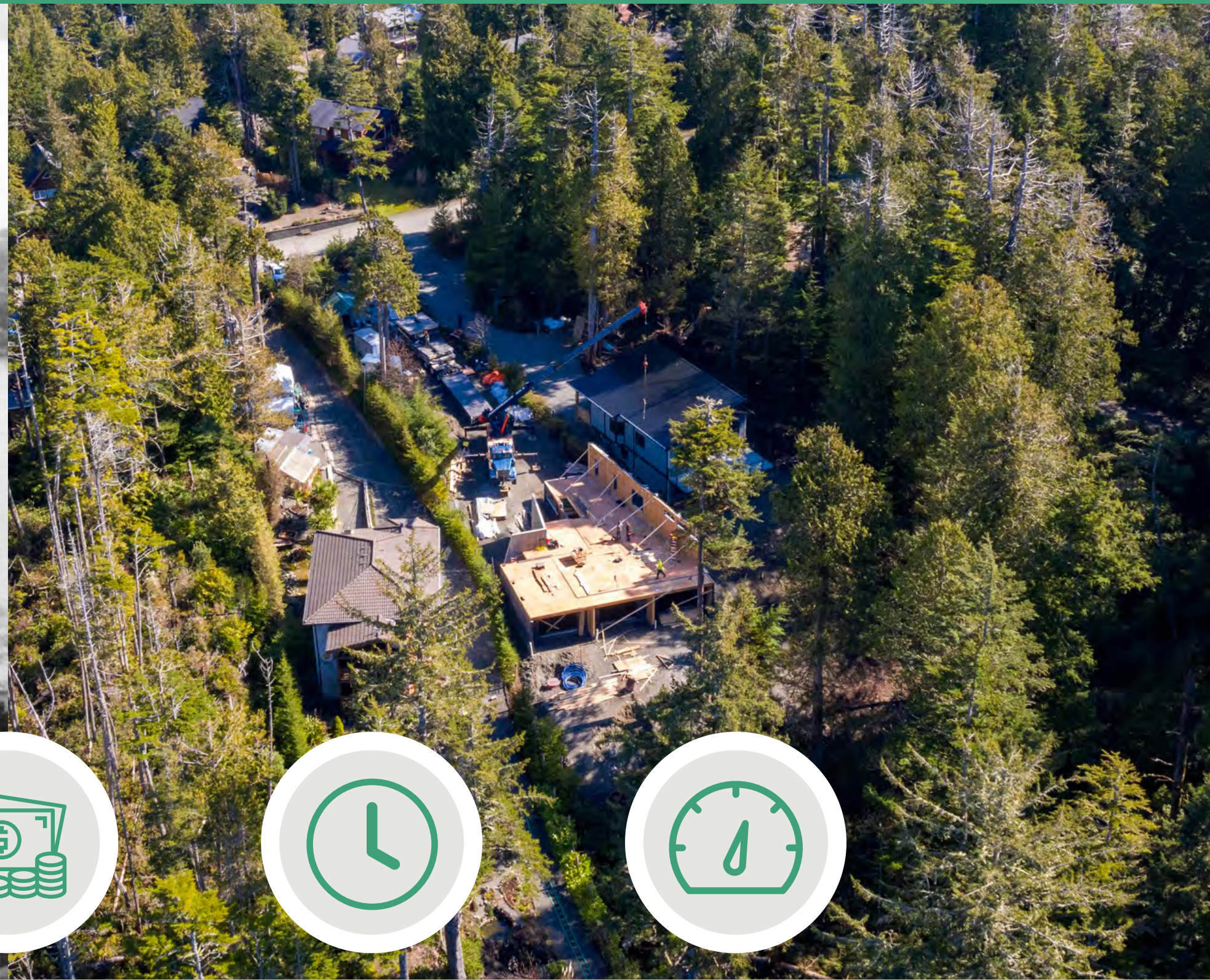
Time. Panels are built while foundations are being formed or demolition underway. Lockup can be achieved faster. Benefits sites with tight construction windows.



Performance. Achieve levels of air tightness and insulation values without taking chances or headaches. Vapour open assemblies allow building to dry inward or outward.

RETROFIT

NEW BUILD



SUMMARY

THREE POINTS

- What are TAG Panels?
 - Prefabricated, sustainable, vapour open - high performance building panels.
- What are the materials & embodied carbon in TAG Panels?
 - A mixture of timber, wood fibre, cellulose and high performance membranes, helping reduce embodied carbon.
- How can prefabrication benefit New Builds & Retrofits?
 - Controlling building conditions, removing conflicts, providing a fixed price, reducing on-site time and helping to achieve significant performance over traditional systems.





**PREFABRICATED, SUSTAINABLE
BUILDING PANELS**

WWW.TAGPANELS.COM

CONTACT@TAGPANELS.COM

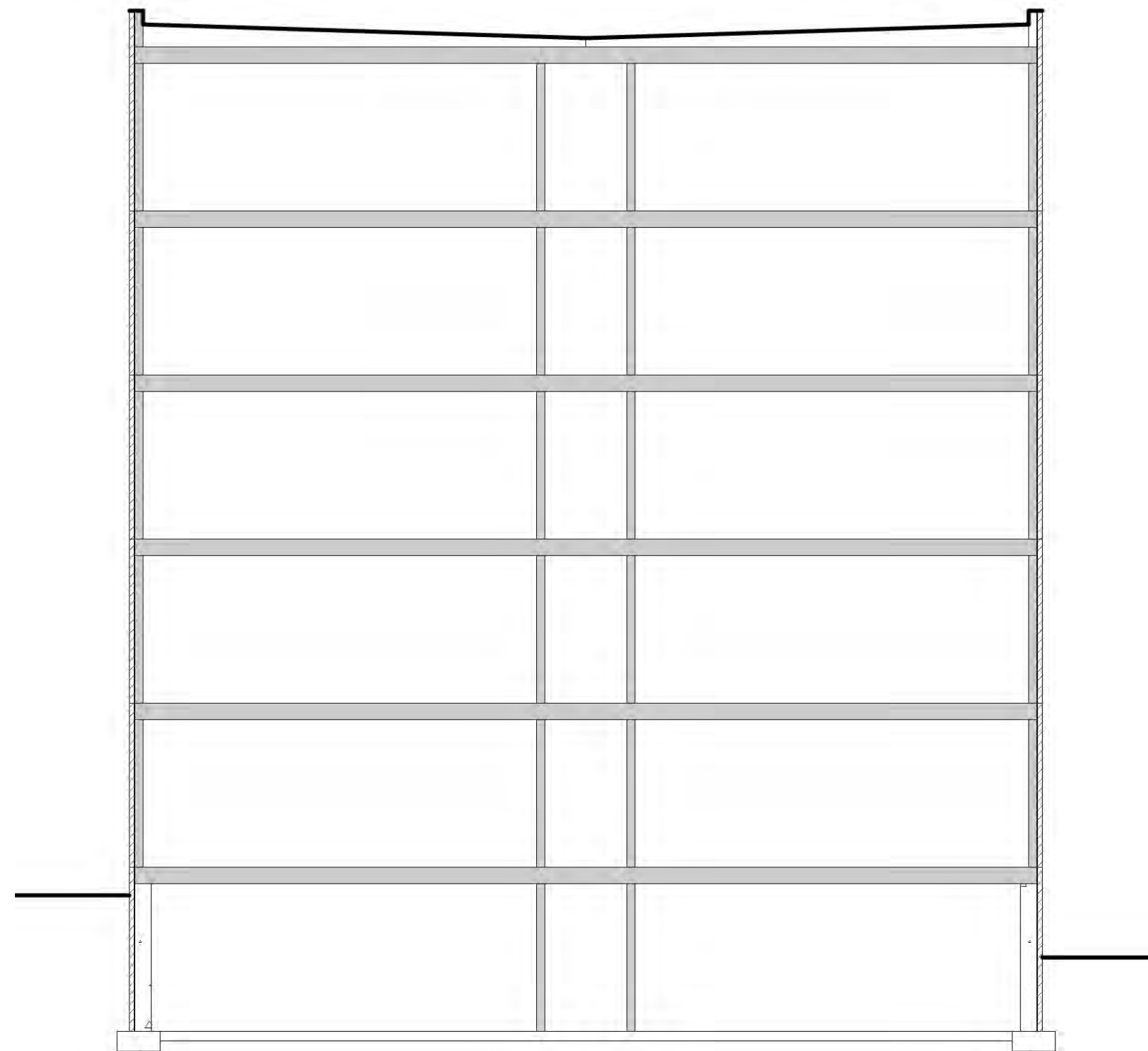


NEX II

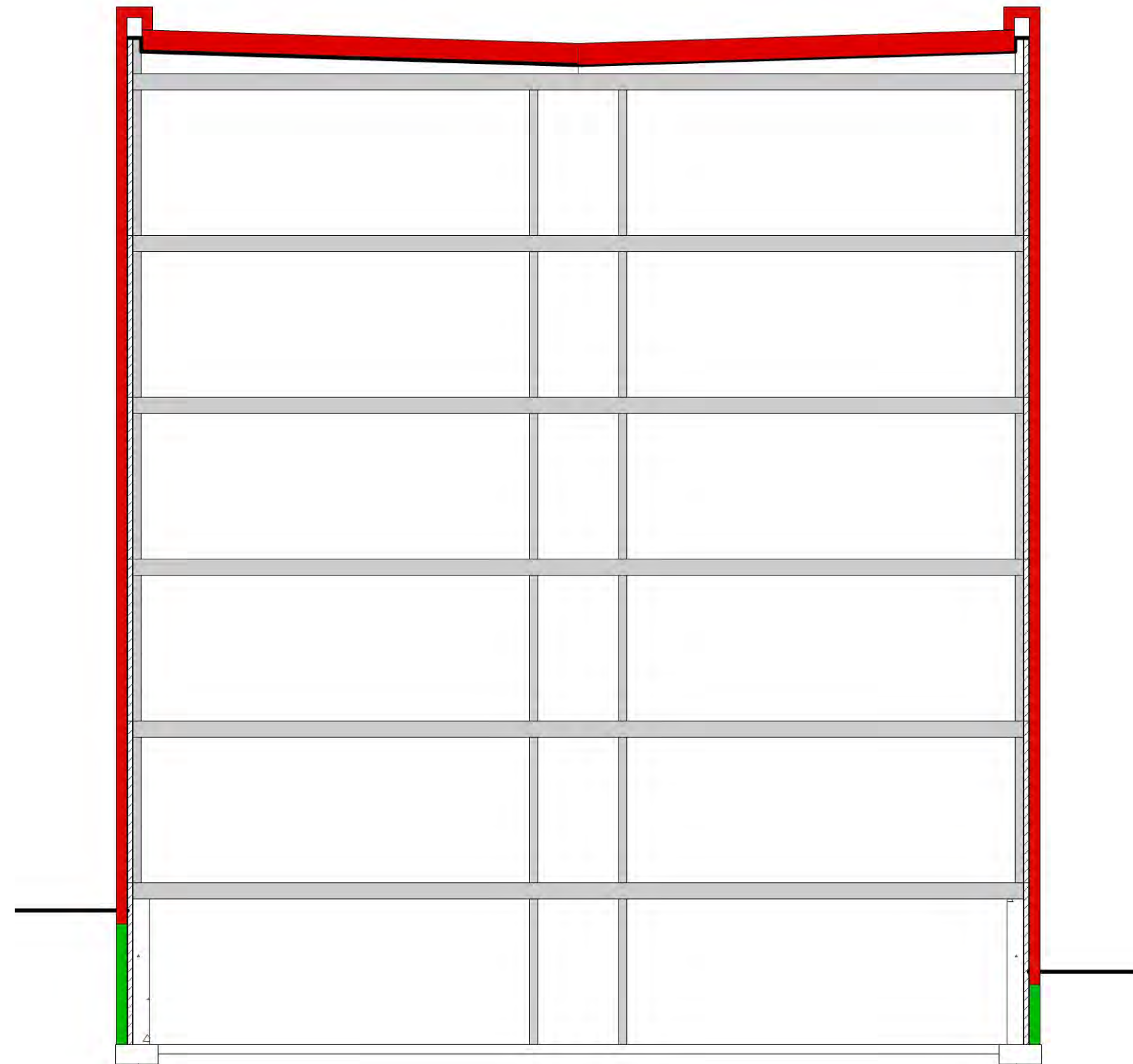
RETROFIT BUILDING SOLUTION

Change the blueprint. Change the planet.

THE RETROFIT SOLUTION

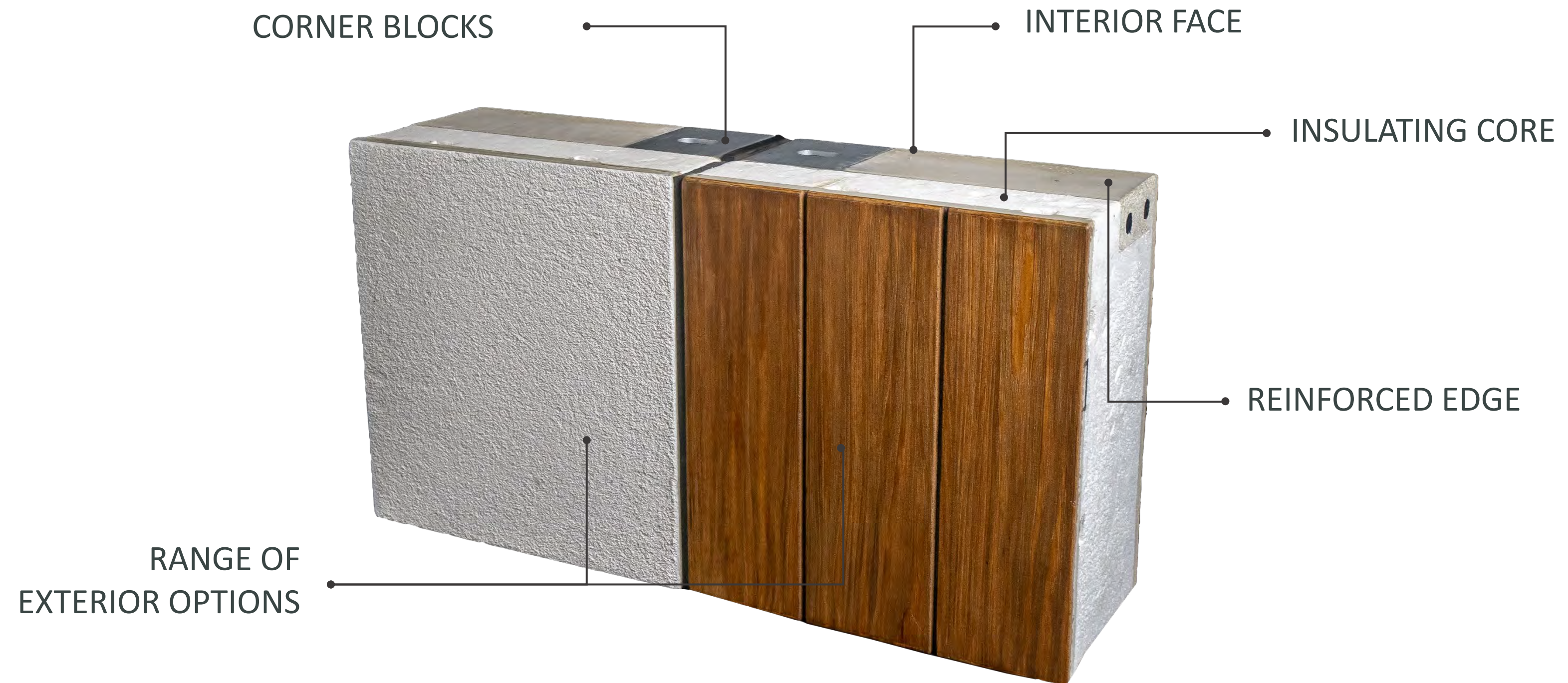


THE RETROFIT SOLUTION



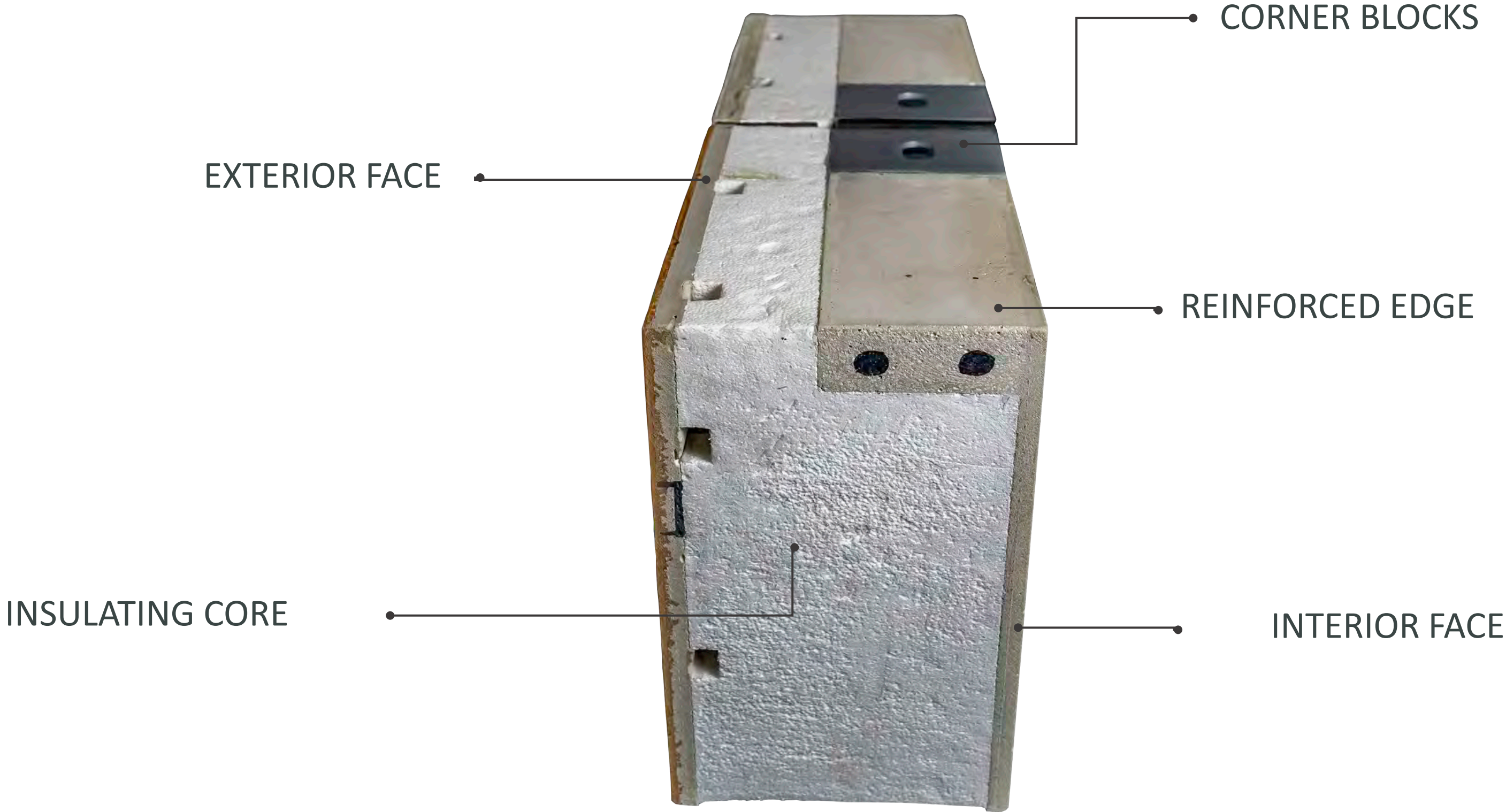
Like a Museum, the existing building is encapsulated in a highly controlled environment

BUILDING TECHNOLOGY



Patent pending, proprietary, lightweight, ultra high-performance composite with an insulating core

BUILDING TECHNOLOGY



AIR TIGHT &
ENERGY
EFFICIENT

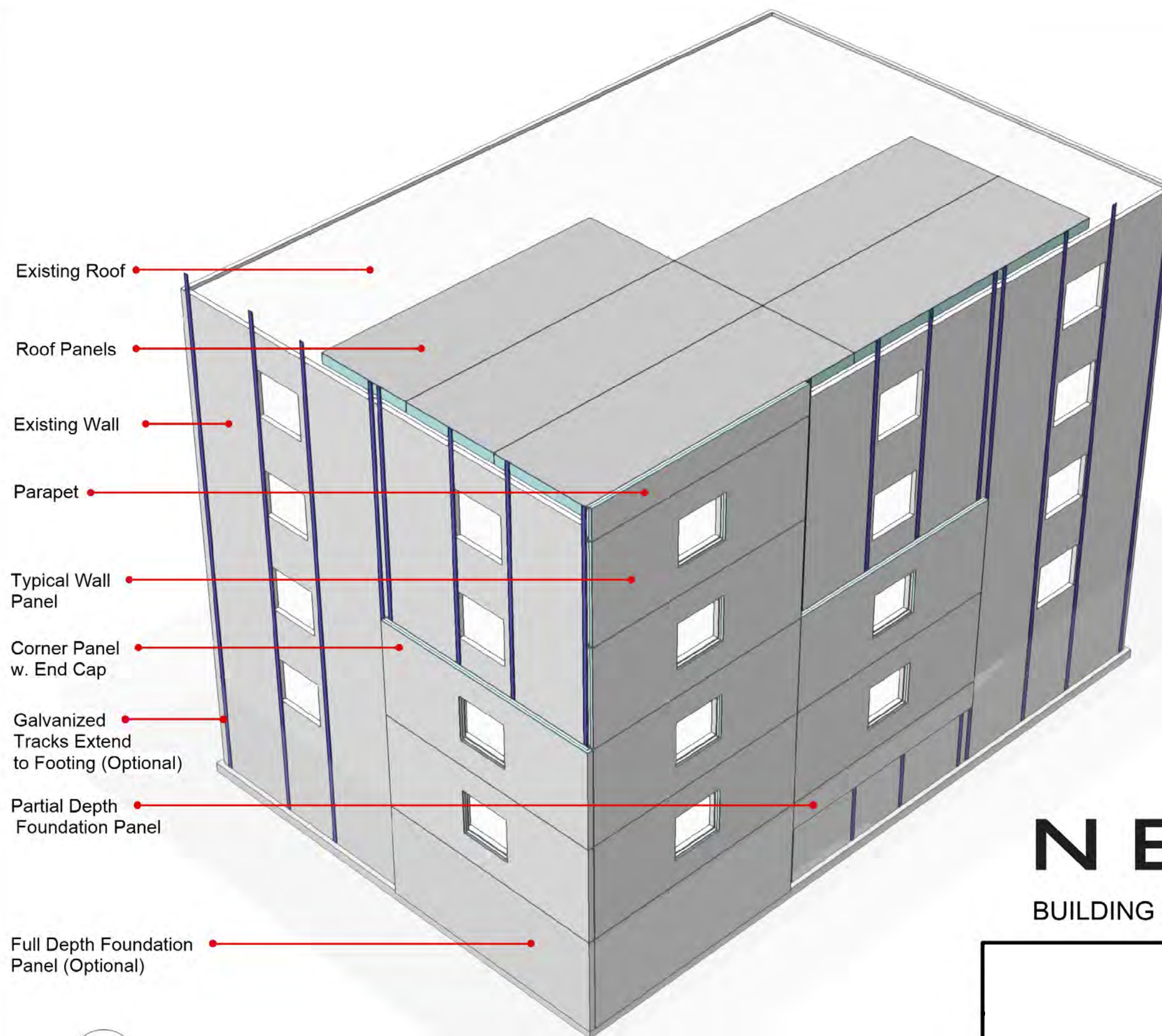


RETROFIT



COMMERCIAL EXAMPLE





NEXII
BUILDING SOLUTIONS INC.

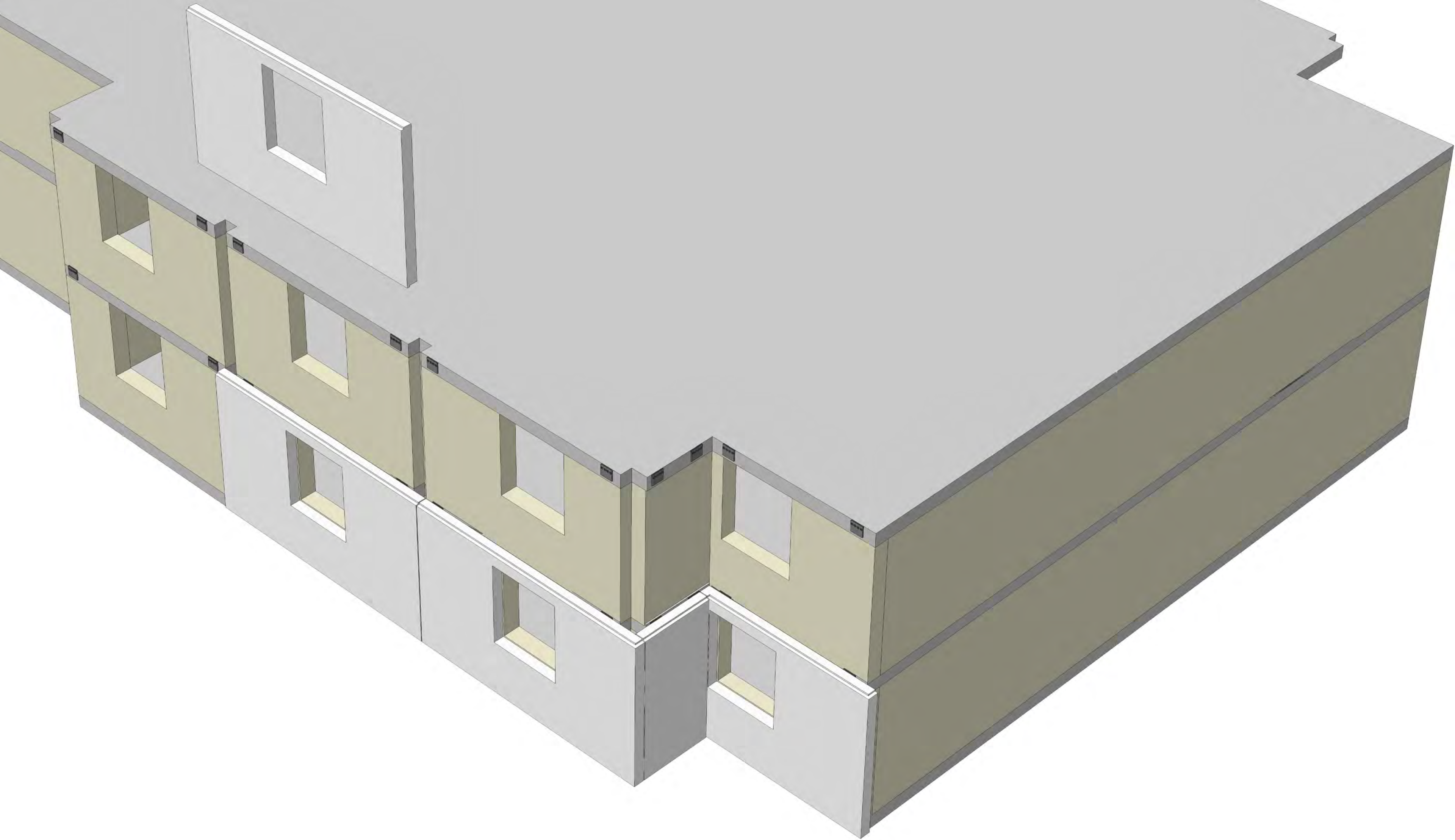
1 Retrofit System Parts

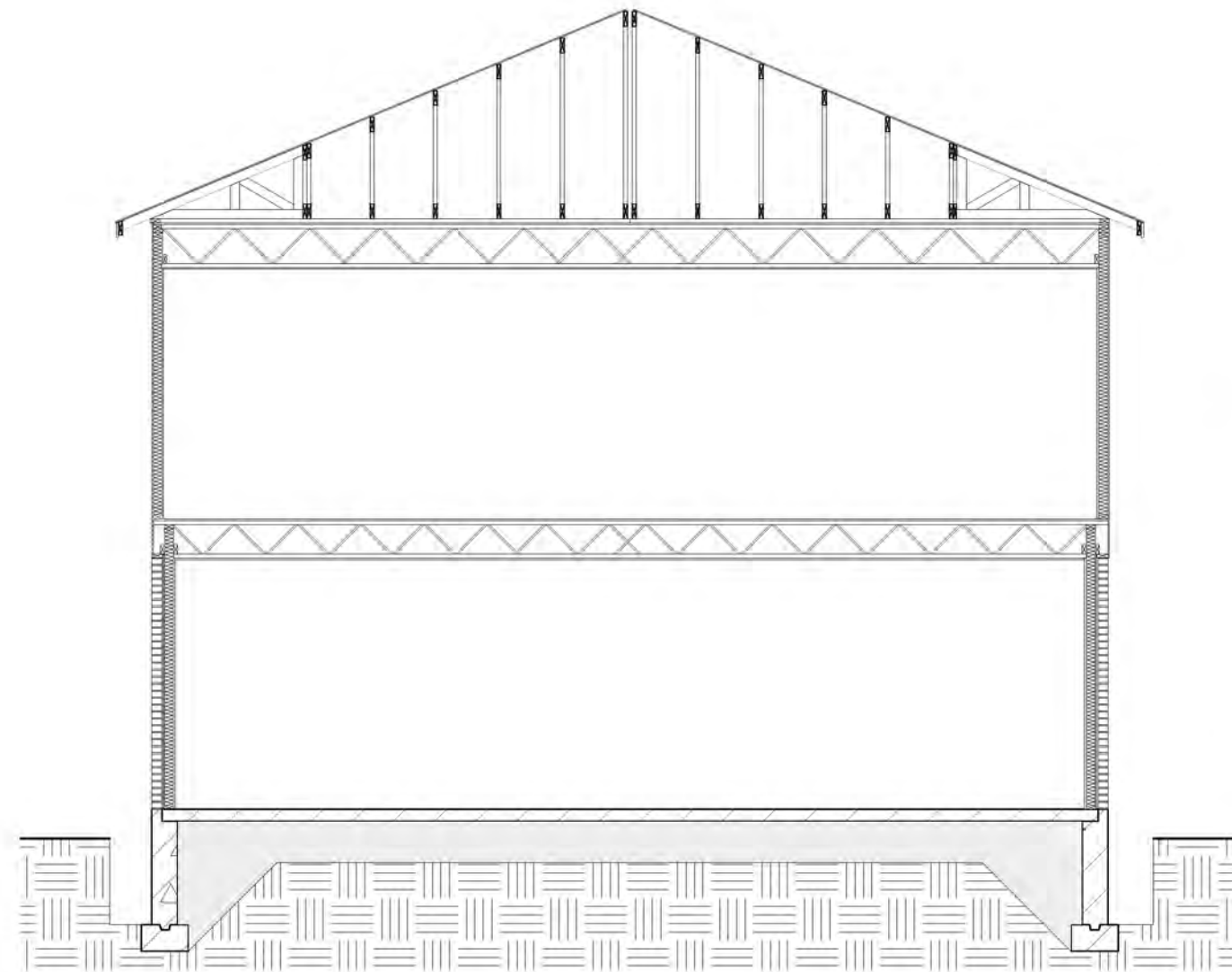
Sheet Number	Cover Page	Sheet Title	Perspective
--------------	------------	-------------	-------------

Eva White - Boston

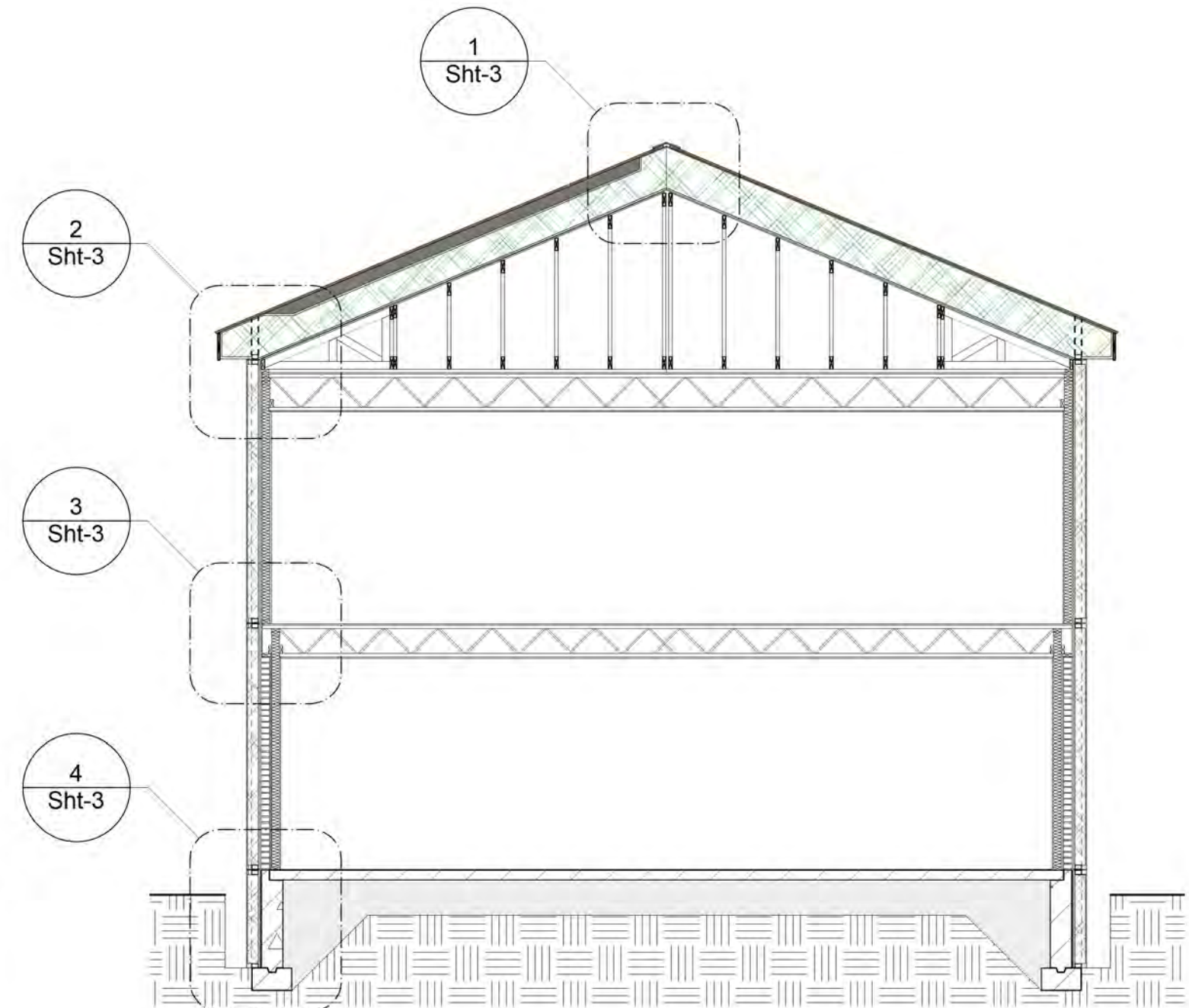








1 **Base Building Section**
Scale: 3/16" = 1'-0"



2 **Building Section with Panels**
Scale: 3/16" = 1'-0"

NEXII
BUILDING SOLUTIONS INC.

Sheet Number	Sheet Title
Sht-2	Building Sections

T H E D E S I G N P R O C E S S

S t a g e 1 - S c h e m a t i c D e s i g n

1. 3D Survey of Building Elevations & Roof
2. Schematic Design of Panels on the Building
(Driven from the Architectural Drawings)
3. Review of the Schematic Panel Design with the Architect
4. Engineering of the Track & Panels System
5. Shop Drawings for Tracks & Panels



P R O J E C T T I M E L I N E

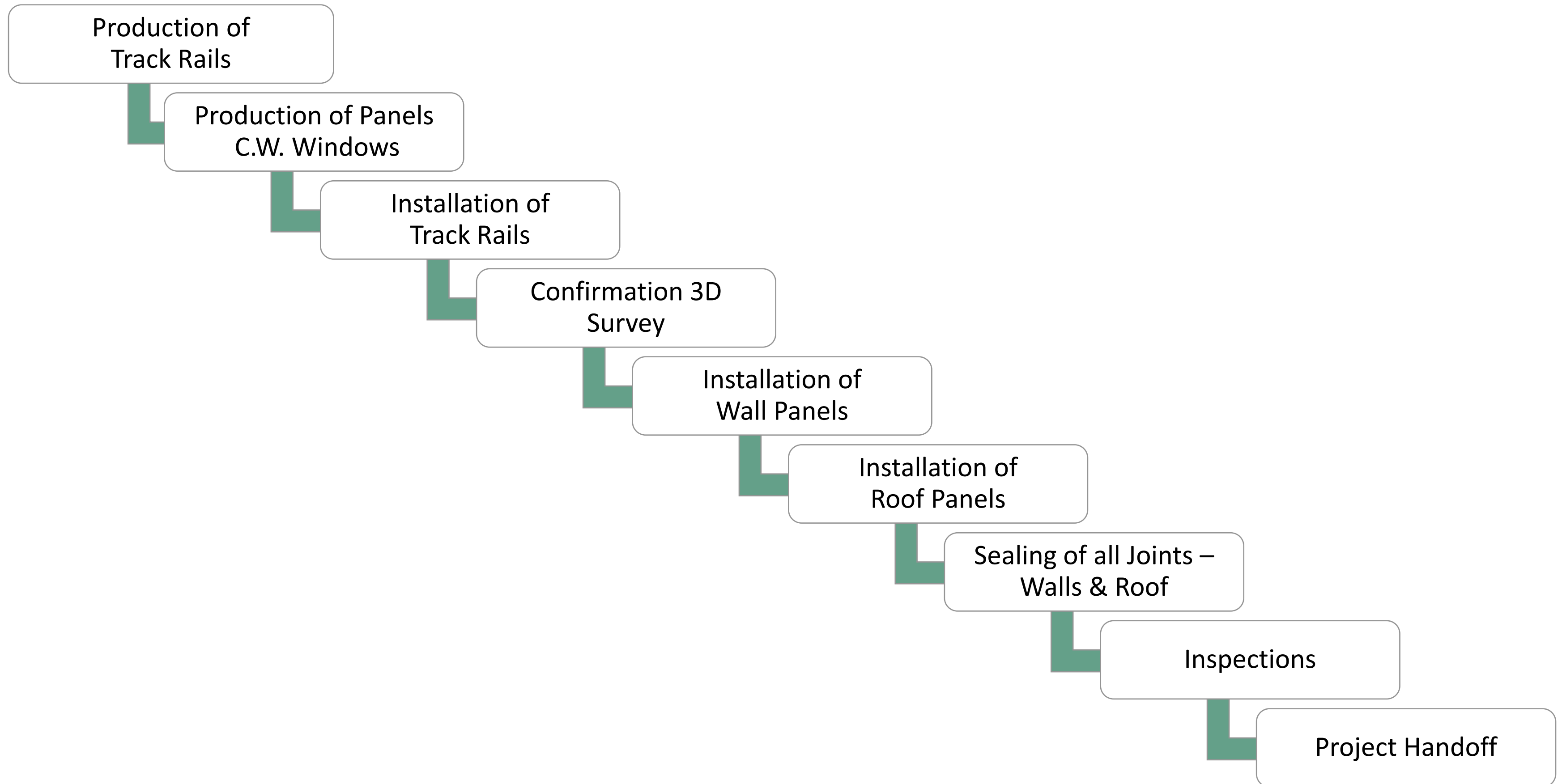
- 12 - 24 Weeks in Planning
- 4 Weeks in Production
- 2 Weeks for Installation of Panels
- 2 Weeks to Complete Seals

Nexii does not do the interior millwork around the windows or interior renovations.

Installation of the panels is done by Nexii Certified Installers.



PROJECT DELIVERY



DESIGN CONSTRAINTS

- **Horizontal Panels**
 - 10' Tall x 24' Long
- **Roof Panels**
 - 10' Wide x 24' Long
- **Wall Panel Weight**
 - 10 PSF w. GPS Insulative Core
 - Windows are Included in the Panel Weight
- **Wall R-Value**
 - R-5 per Inch of GPS
- **Roof R-Value**
 - R-4 per inch of EPS
 - 12" Typical = R48

17



Challenges to Retrofitting Existing Buildings

- Floor to Floor and Suite to Suite
 - Fire
 - Smoke
 - Sound
 - Air Quality
 - Smell / Odours
- Existing Window Shapes
- Doors in Corners – Reducing Size
- Balconies
- Roof Projections / Overhangs

Design Targets

- Passive House Standard for Insulation & Air Tightness
- Net Zero and Net Positive Ready

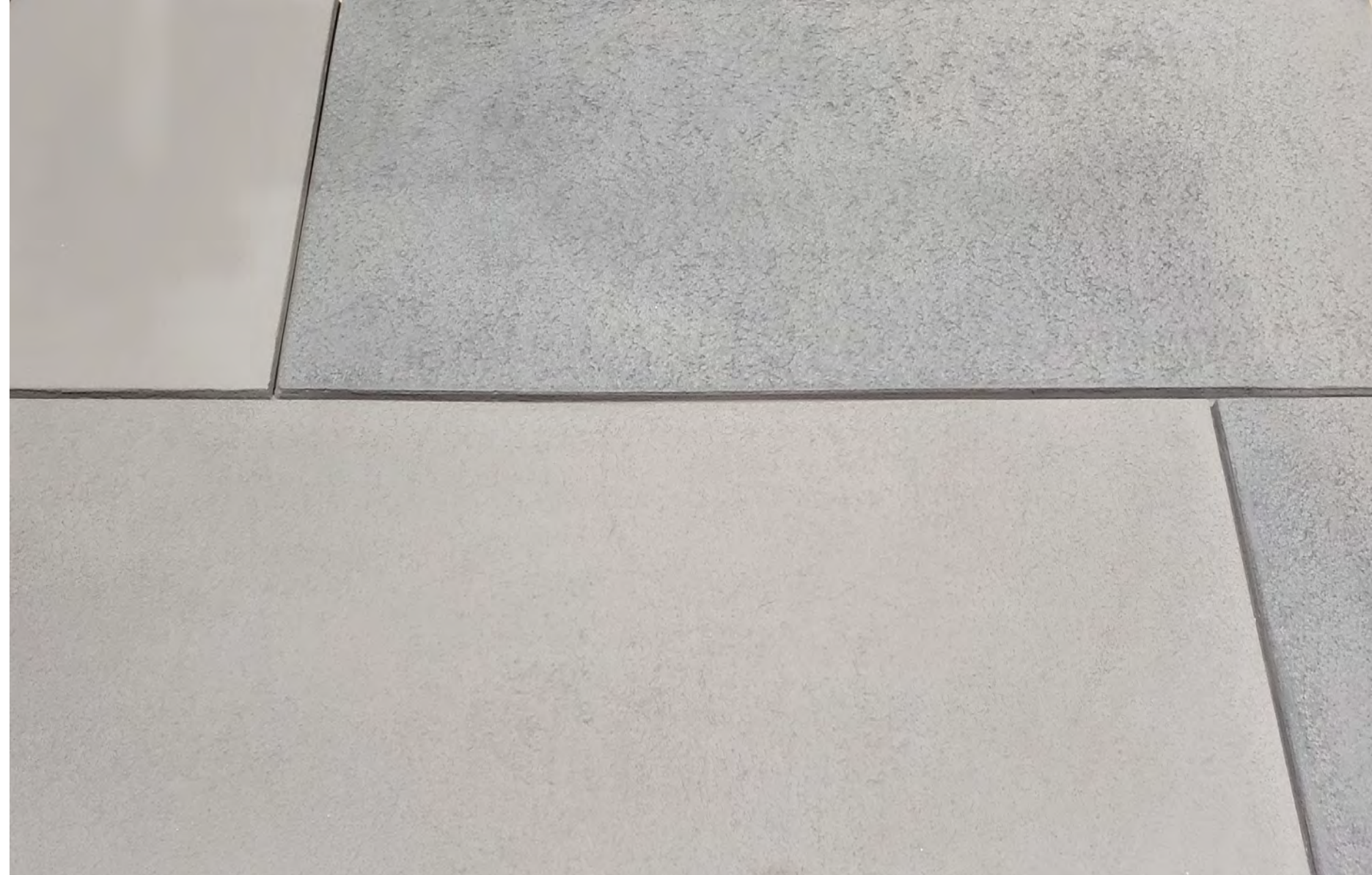
Pricing

\$40 – \$50 Per Sq.Ft. of Wall Area

Potential of \$30 With Scale



EXTERIOR FINISHES



EXTERIOR FINISHES



Questions?

www.nexii.com

FINANCING
CONSTRAINTS

BUILDING
STOCK

DESIGN
&
CONSTRUCTION

CODE &
PERMITTING

3/0
Energy Conservation
& SEISMIC
Retrofit Compliance

Poll

3/0
Seeing examples
that work abroad

3/0
Recognition that
the current model
isn't working at
the political
level. Young
people are joining

GOALS

What:

Net-zero Carbon retrofits delivered
at scale across Canada, driving carbon
neutrality in the residential market
by 2050.

W: Engage & coordinate the market
on an industrialized turnkey
retrofit process

Questions

Upcoming Reframed Lab

- Request for proposals expected in summer 2020
- Multi-disciplinary teams will design solutions for low-rise residential buildings in B.C.'s Lower Mainland or Victoria area
- Six-month exploration lab with support from climate, energy, and health experts

REGISTER YOUR INTEREST: pembina.org/reframed

Integrated design teams

- Architects
- Building science, electrical, mechanical, and structural engineers
- Contractors, builders, and retrofitters
- Manufacturers, fabricators, and suppliers
- Modeling and data capture specialists
- Monitoring and control equipment specialists

REGISTER YOUR INTEREST: pembina.org/reframed

Solutions of particular interest

- Prefabricated exterior wall and roof panels
- High-efficiency and low-carbon mechanical systems
- Roofing solutions that integrate on-site renewable electricity
- Storage and/or thermal generation
- Seismic upgrades
- Climate adaptation measures
- System controls and performance monitoring

REGISTER YOUR INTEREST:
pembina.org/reframed

Reframed Tech Series

Upcoming
Event

Heat pumps & deep retrofits

May 27, 2020



JOIN THE WEBINAR: pembina.org/ReframedTechSeries

#Reframed

PEMBINA
institute

Contact us

reframed@pembina.org

pembina.org/reframed

Register as a solution provider. Sign up for updates.

#Reframed