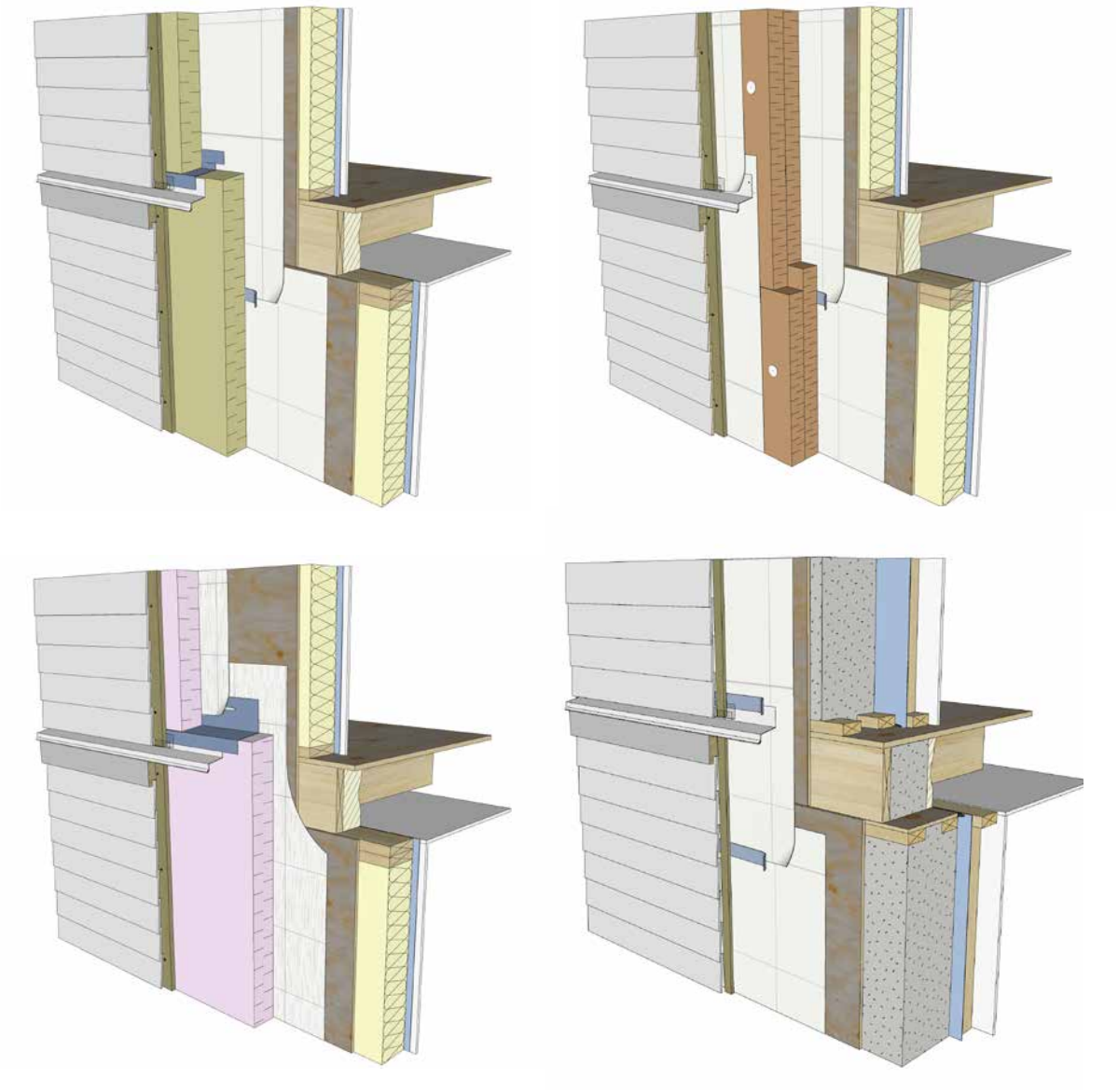
LEEP LOCAL ENERGY EFFICIENCY PARTNERSHIPS NET ZERO ENERGY Wall Assemblies

Introduction: LEEP NZE Wall Guide Series & The Wall Selection Guide



Developed by Natural Resources Canada's
Local Energy Efficiency Partnerships (LEEP) team

LEEP Net Zero Energy Wall Assemblies
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Acknowledgements

The *Local Energy Efficiency Partnerships* (LEEP) team at CanmetENERGY would like to thank the many Canadian builders who have participated in our programs. Builders were contacted by their regional Home Builders Associations and invited to participate in LEEP technical forums and workshops. Their feedback identified the need for this series of guides. Builder groups repeatedly requested technical forums on high-performance above-grade wall assemblies and focused on four commonly used, generic wall assemblies. These wall assemblies were studied by building science experts and manufacturers and were upgraded for energy efficiency and for use in net zero buildings. Response to the resulting presentations has been positive and builders have gone on to trial these wall assemblies.

We would like to thank RDH Building Science for their work in developing and illustrating the guides, updating them based on broad feedback, and developing the technical presentations for LEEP initiatives that provided the foundation for this work. We would also like to thank Morrison Hershfield for providing a technical and code review.

We want to acknowledge the essential contribution made by our partners and their help in delivering regional and local LEEP initiatives that led to this guide series. These partners include: BC Housing, BC Hydro, FortisBC, BCIT, the Nova Scotia Ministry of Energy and Mines, and Efficiency Nova Scotia. We would particularly like to thank the provincial and local Home Builders Associations that made this possible, including CHBA British Columbia, HAVAN, CHBA Central Okanagan, CHBA Central Interior, CHBA Northern BC, CHBA Vancouver Island, CHBA Kelowna, CHBA Fraser Valley, CHBA New Brunswick, CHBA Nova Scotia, and CHBA Newfoundland.

The LEEP NZE Wall Guide Series was developed by Graham Finch and James Higgins of RDH Building Science. Project management was provided by Clarice Kramer with support from James Glouchkow and Patric Langevin of the NRCan LEEP Team, CanmetENERGY Ottawa. Funding for this work was provided by *Natural Resources Canada* through the *Green Infrastructure Fund*.

Disclaimer

This document does not provide assurances or information related to structural systems, seismic performance, or fire safety. It is intended only as a guide on building enclosure science and wall assembly selection, detailing, materials and performance. The aim of this publication is to provide builders and designers with a framework for making decisions on the type of wall assemblies to use for individual homes and for new communities.

Natural Resources Canada assumes no liability for injury, property damage, or loss resulting from the use of information contained in this publication. This guide is intended to provide information only and does not express views of the Government of Canada nor does it constitute an endorsement of any commercial product, manufacturer or any individual.

Building science, related products, and construction practices change and improve over time, and it is advisable to regularly consult up-to-date technical publications on building science, products, and practices rather than relying solely on this publication. Seek specific information on the use of products, the requirements of good design and construction practices, and requirements of the applicable building codes before undertaking a construction project. Consult the manufacturer's instructions for construction products, and also speak with and retain professional consultants who hold a valid license and have appropriate engineering or architectural qualifications. Work with your municipality or local authority having jurisdiction to ensure compliance with issues of design, zoning and construction practices, including life and fire safety.

The effective R-value ranges and assemblies illustrated in this guide represent potential strategies to reach high-performance targets including the upper tiers of the National Building Code of Canada. As with any performance-based energy target, energy modelling must be used to determine appropriate designs for each individual project. Compliance strategies may be influenced by design choices such as building form, window placement, orientation, mechanical systems, and equipment efficiency.

The information included in these guides is generic in nature and is not tied to any specific voluntary labeling program. Builders and renovators looking to qualify their homes under the Canadian Home Builders' Association (CHBA) *Net Zero Home Labeling Program* must ensure their homes meet all the Technical Requirements of that Program.

LEEP LOCAL ENERGY EFFICIENCY PARTNERSHIPS Net Zero Energy Wall Assemblies Introduction

LEEP Context

The LEEP Team at CanmetENERGY works with groups of builders, through their Home Builders Associations (HBAs). LEEP programs offer opportunities to identify barriers and gaps in technology and to discuss and evaluate Net Zero Energy (NZE) and high-performance home building strategies. Builders use forums and workshops to identify key technology challenges and invite experts and manufacturers to respond by proposing solutions, innovations and direction on how to integrate these ideas into construction practices. Through their HBAs, builders use LEEP to define and solve technology challenges, and to connect with design professionals who can help them deliver the homes of tomorrow. The goal is builder-driven enhancement to local building practices.

The Need

There is a need for fundamental change in wall design and construction. Canadian builders are moving beyond typical wood-framing practices to wall assemblies that reach higher levels of performance. LEEP technical forums have been delivered in many locations across Canada. Regional LEEP builder-groups have consistently identified high-performance walls as a key technological challenge. They have requested information on:

- Increased effective R-values; continuous insulation and reduced thermal bridging
- Continuous air barrier and airtight building enclosures; improved thermal performance, reduced heating and cooling loads, reduced risk of condensation within wall cavities
- Water-protection systems; reduced risk of bulk water intrusion from rain, snow and wind, reliable water-shedding details
- Effective vapour barrier; reduced risk of trapping moisture within the wall assembly, assurance that double vapour barriers are not created

There is great diversity in Canadian light wood construction. Wall details and assembly types vary by region and climate zone. Local construction practices can also vary, along with access to reliable technical information and training. Coordination with trades and consultants is critical when introducing new technology and this should not be overlooked. It is our hope that by providing these guidelines for wall assemblies with construction details, we will help builders select, plan and construct robust wall assemblies with success. Project-specific details should always be developed to account for the unique conditions of each project.

We see the LEEP NZE Wall Guides not as the end goal, but as part of the foundation for a new generation of high-performance housing.

Documents in This Series

Further to the guidance presented in the wall guides, Appendix A and B present guidance on material and product selection for each assembly. The following is a list of the documents in the NRCan LEEP Net Zero Energy Wall Assembly Technical Guide series:

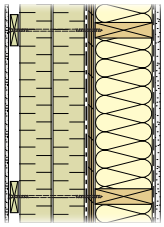
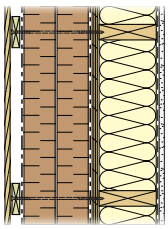
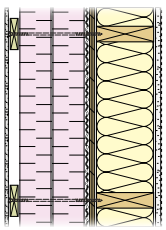
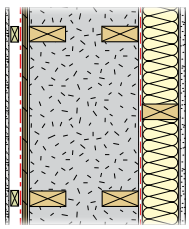
YOU ARE HERE

- **Introduction**: LEEP NZE Wall Guide Series & The Wall Selection Guide
- **Wall #1** Split-Wall: Vapour Permeable Exterior Insulation
- **Wall #2** Split-Wall: Wood Fibre Exterior Insulation
- **Wall #3** Split-Wall: Low-Permeance Exterior Insulation
- **Wall #4** Double Stud Wall with Interior Service Wall
- **Appendix A:** Building Material and Product Selection Guide
- **Appendix B:** Selection Process for Exterior Insulation in Split-Walls

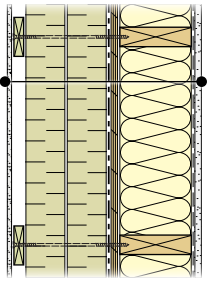
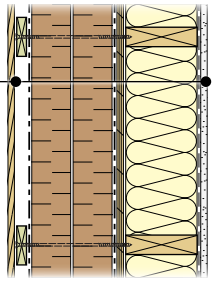
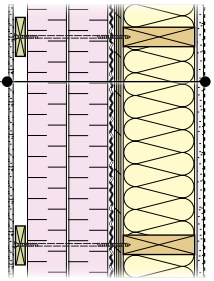
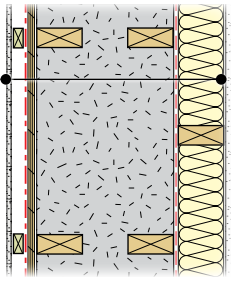
This guide-series examines four generic above grade wall assemblies. Builders, from different regions in Canada, repeatedly selected these common wall types in LEEP workshops and asked for technical guidance on modifications and performance upgrades.

Wall Selection Guide: Quick Reference Decision Matrix

The four wall assembly guides presented in this series offer a variety of construction approaches to achieve energy efficient assemblies as part of a net zero energy project. Each assembly has it's own unique benefits and drawbacks and therefore must be carefully selected and implemented. This quick reference guide and decision matrix (see next pages) provides an overview of each wall assembly and guidance on the deciding factors that may impact selection.

Wall Assembly Summary	
 Wall #1	This above-grade wall assembly consists of multiple layers of rigid or semi-rigid insulation placed on the exterior of a conventional insulated wood-frame wall assembly. High effective R-values are achieved by using layers of continuous vapour permeable insulation outside of the structural framing and low-conductivity cladding attachments, in combination with insulation in the stud space. The air barrier and water-resistive barrier are provided by the sealed exterior sheathing membrane.
 Wall #2	This above-grade wall assembly consists of multiple layers of rigid or semi-rigid wood fibre insulation placed on the exterior of a conventional insulated wood-frame wall assembly. High effective R-values are achieved by using layers of continuous vapour permeable insulation outside of the structural framing and low-conductivity cladding attachments, in combination with insulation in the stud space. In most cases, cladding can be supported by strapping fastened with screws through rigid insulation.
 Wall #3	This above-grade wall assembly consists of multiple layers of rigid foam insulation placed on the exterior of an insulated wood-frame wall assembly with a dimpled/drained exterior sheathing membrane (or conventional sheathing membrane if drainage medium or grooved insulation is used). High effective R-values are achieved by using layers of continuous low-permeance insulation outside of the structural framing and low-conductivity cladding attachments, in combination with insulation in the stud space.
 Wall #4	This above-grade wall assembly consists of a deep stud cavity created by an additional framed wall inside a conventional wood-frame wall. High effective R-values are achieved by filling the increased stud cavity depth with blown-in insulation. The water-resistive barrier is provided by the sealed exterior sheathing membrane, and the air barrier is provided by the interior sealed membrane or rigid board (exterior of an interior service wall) combined with the sealed exterior sheathing membrane.

Wall Assembly Selection Decision Matrix

Comparison Legend	**Wall #1** Split-Wall: Vapour Permeable Exterior Insulation	**Wall #2** Split-Wall: Wood Fibre Exterior Insulation	**Wall #3** Split-Wall: Low-Permeance Exterior Insulation	**Wall #4** Double Stud Wall with Interior Service Wall
✔ Good performance and potentially optimized for given category ✔ Typically good performance but not necessarily optimized for given category ✔ Acceptable performance but not optimized for given category; requires careful attention during application	**Exterior** Cladding Strapping + screws through ins. Rainscreen cavity Thick rigid insulation Sheathing membrane Exterior sheathing Stud framing Batt insulation Vapour Control Layer Finished gypsum board **Interior** 	**Exterior** Cladding Strapping + screws through ins. Rainscreen cavity Sheet membrane Wood fibre insulation Sheathing membrane Exterior sheathing Stud framing Batt insulation Vapour Control Layer Finished gypsum board **Interior** 	**Exterior** Cladding Strapping + screws through ins. Rainscreen cavity Thick rigid low-perm insulation Drained sheathing membrane Exterior sheathing Stud framing Batt insulation Finished gypsum board Vapour retarder paint **Interior** 	**Exterior** Cladding Furring/rainscreen cavity Sheathing membrane Exterior sheathing Double stud framing Blown-in dense-pack insulation Polyethylene 2x4 framed service cavity Finished gypsum board **Interior** 
Category	**Discussion/Comparison**			
Thermal Performance Versus Thickness	✔ • High R-values possible with moderate thickness • Uses continuous thermally efficient moderate R-value per inch exterior insulation	✔ • High R-values possible with moderate thickness • Uses continuous thermally efficient moderate R-value per inch exterior insulation	✔ • High R-values possible with least overall thickness • Uses continuous thermally efficient high R-value per inch foam exterior insulation	✔ • Moderate to high R-values possible with significant thickness • Relies on low R-value per inch thermally bridged interior insulation within framing
Constructability	✔ • Backup wall structure uses conventional framing practices • Relies on fully sealed exterior air barrier sheathing membrane • Requires careful installation of the exterior insulation layer	✔ • Backup wall structure uses conventional framing • Requires careful installation of the air barrier sheathing membrane at the sheathing • Additional membrane layer over the exterior insulation prior to strapping install • Simplified detailing at openings by using window bucks	✔ • Backup wall structure uses conventional framing practices • Relies on fully sealed exterior air barrier sheathing membrane with built-in/ dedicated carefully detailed drainage plane • Requires careful installation of the exterior insulation layer	✔ • Backup wall structure uses two rows of conventional framing spaced apart with top/ bottom plates • Relies on fully sealed interior and exterior air barrier • Uses mostly conventional exterior rainscreen, cladding, and trim approaches
Cost Premium (at same thermal and airtightness performance)	✔ • Highest estimated relative cost increase over conventional 2x6 wall • Exterior insulation and cladding attached with unconventional systems • Unconventional exterior detailing to accommodate exterior insulation	✔ • Second highest estimated relative cost increase over conventional 2x6 wall • Exterior insulation and cladding attached with unconventional systems • Additional membrane layer for water-resistive barrier over the wood fibre • Potentially conventional exterior detailing at face of exterior insulation	✔ • Moderate estimated relative cost increase over conventional 2x6 wall • Exterior insulation and cladding attached with unconventional systems • Unconventional exterior detailing to accommodate exterior insulation	✔ • Lowest estimated relative cost increase over conventional 2x6 wall • Additional framing and stud cavity insulation the primary driver in cost increase • Interior service cavity results in further cost increase likely in line with other walls

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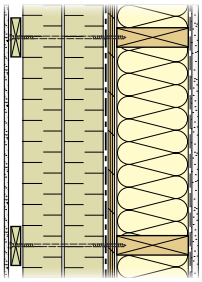
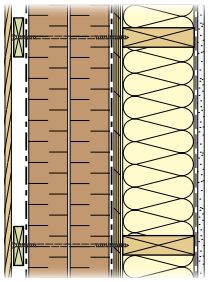
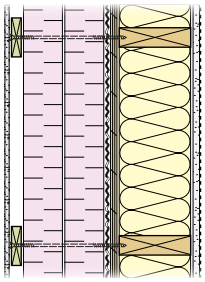
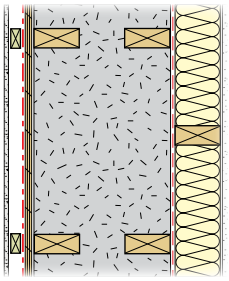
Wall Assembly Selection Decision Matrix Continued				
	 **Wall #1** Split-Wall: Vapour Permeable Exterior Insulation	 **Wall #2** Split-Wall: Wood Fibre Exterior Insulation	 **Wall #3** Split-Wall: Low-Permeance Exterior Insulation	 **Wall #4** Double Stud Wall with Interior Service Wall
Category	Discussion/Comparison			
Condensation Risk & Vapour Management	• Low risk of sheathing condensation due to exterior insulation • Vapour permeable exterior insulation allows for outward drying if needed	• Low risk of sheathing condensation due to exterior insulation • Vapour permeable exterior insulation allows for outward drying if needed	• Low risk of sheathing condensation due to exterior insulation • **Low permeance exterior insulation can trap outward-flowing vapour** • Uses semi-permeable interior vapour control to avoid trapping inward-flowing vapour	• High risk of sheathing condensation due to thick interior insulation • Requires interior air barrier to reduce risk of airflow into and through assembly and potentially need for service wall to reduce penetrations • Vapour permeable exterior layers allow for outward drying if needed
Liquid Moisture Management	• Excellent moisture management due to secondary drainage plan at face of exterior insulation combined with protected sheathing membrane • Permeable porous ext. insulation allows liquid moisture to escape	• WRB membrane at the face of the wood fibre insulation provides proven conventional moisture management from drained and ventilated rainscreen cavity behind cladding	• Secondary drainage plane at face of exterior insulation combined with protected drained sheathing membrane • Low permeance non-porous ext. insulation relies on dimpled/drained WRB or dedicated drainage plane and consistent drainage to exterior	• Proven conventional moisture management from drained and ventilated rainscreen cavity behind cladding
Airtightness	• Variety of high-performance exterior air barrier approaches available • All require careful sealing at joints and penetrations	• Variety of high-performance exterior air barrier approaches available • All require careful sealing at joints and penetrations including at window and door bucks and transitions to WRB	• Variety of high-performance exterior air barrier approaches available if separate drainage layer used • Baseline dimpled sheathing membrane relies on careful sealant installation to achieve airtightness	• Variety of high-performance interior and exterior air barrier approaches available • Interior air barrier behind service cavity combined with exterior air barrier can achieve very high levels of airtightness
Adaptability & "Future-Proofing"	• Can perform in a variety of exposure conditions • Wide selection of materials and components available • Highly adaptable to required airtightness and insulation levels • Likely provides best exterior fire protection	• Can perform in a variety of exposure conditions • Wood fibre insulation is typically considered "lower carbon" compared to other insulation types • Highly adaptable to required airtightness and insulation levels	• Can perform in a variety of exposure conditions • Combustibility of exterior insulation must be considered • Wide selection of materials and components available • Highly adaptable to required airtightness and insulation levels	• Can perform in a variety of exposure conditions • Vapour flow and condensation in cold climates must be considered • May be difficult to adapt to higher R-values due to substantial wall thickness

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LEEP Technology Guides and Tools available online. Search "NRCan LEEP".