

W H I T E P A P E R

Air Infiltration and the SIP Advantage:

Why SIPs Outperform Conventional Framing, Spray Foam, and Continuous Insulation on Building Airtightness

1. Executive Summary

Building airtightness is among the most consequential — and most underappreciated — factors in a building envelope's real-world energy and comfort performance. Research consistently shows that air leakage accounts for 25–40% of a home's heating and cooling energy loss, exceeding the impact of wall insulation R-value in many climates. Yet most conventional construction methods produce buildings that are far leakier than they need to be — and far leakier than their designers intend.

Structural Insulated Panels (SIPs) address the air infiltration problem at the factory, before installation begins. By integrating structure, insulation, and air control into a single monolithic panel, SIPs eliminate the majority of the seams, penetrations, and material interfaces that are the primary sources of uncontrolled air movement in framed buildings.

This white paper examines the physics of air infiltration, quantifies the performance gap between SIPs and competing construction methods — including spray polyurethane foam (SPF) and continuous exterior insulation (CI) — and addresses two specific failure modes in conventional framing that are rarely resolved even in high-performance construction: air leakage through electrical boxes and the gap formation caused by wood shrinkage as framing members dry in service.

2. Why Airtightness Matters

2.1 The Energy Impact of Air Leakage

Thermal insulation — whether fiberglass batt, spray foam, or rigid board — resists conductive heat transfer through the material itself. But heat also moves by convection, carried by air moving through gaps, seams, and penetrations in the building envelope. These two mechanisms are independent: a wall can have a high nominal R-value and still lose substantial energy to air infiltration if the assembly is not airtight.

The U.S. Department of Energy estimates that air infiltration accounts for 25–40% of the energy used for heating and cooling in a typical American home. In cold climates, the figure can be higher — particularly in buildings with significant stack effect, where pressure differentials driven by temperature differences between inside and outside force air through even small openings at rates that overwhelm the contribution of insulation.

A wall rated R-21 with an air leakage rate of 5 ACH50 will lose more energy through air movement than through conduction — making the nominal R-value largely irrelevant to real-world performance.

2.2 Code Requirements for Airtightness

The 2021 IECC Section R402.4 requires that all buildings be tested for airtightness using a blower door in accordance with ASTM E779 or ASTM E1827. Maximum allowable air leakage rates vary by climate zone:

Zones 1–2	5.0 ACH50	Standard construction
Zones 3–5	3.0 ACH50	Code minimum
Zones 6–8	3.0 ACH50	Code minimum
Energy Star Certified	≤ 2.0–3.0 ACH50	Program dependent
Passive House	≤ 0.6 ACH50	Highest standard

For Climate Zone 5A (Connecticut and much of the Northeast), the code maximum is 3.0 ACH50. SIP construction routinely achieves results far below this threshold without extraordinary effort — often meeting Passive House standards as a baseline.

2.3 Additional Consequences of Air Infiltration

Beyond energy loss, uncontrolled air infiltration carries a cascade of additional consequences that affect building durability, occupant health, and comfort:

- ▶ **Moisture damage:** Air carrying water vapor through the building envelope can deposit that moisture as condensation within wall and roof assemblies, causing mold, rot, and structural deterioration over time.
- ▶ **Comfort:** Drafts, cold spots, and uneven temperatures are primarily caused by air infiltration, not insufficient insulation.
- ▶ **Indoor air quality:** Unfiltered outdoor air brings allergens, pollutants, and humidity into the living space through random gaps rather than through a controlled ventilation system with filtration.
- ▶ **HVAC oversizing:** Tight envelopes allow accurate Manual J load calculations and right-sized equipment. Leaky envelopes force oversized equipment that short-cycles, fails to dehumidify, and wears prematurely.
- ▶ **Acoustics:** Air leakage paths are also sound transmission paths. Airtight envelopes provide significantly better sound attenuation from exterior noise sources.

3. Where Air Leaks in Conventional Framed Buildings

A conventionally framed building is assembled from dozens of different materials joined at hundreds of interfaces. Each interface is a potential air leakage path. Building science research has identified the primary locations:

3.1 The Framing Itself

Wood-framed walls consist of studs, plates, headers, and blocking joined at numerous connections. Every joint between framing members is a potential air path. The wall's sheathing — typically OSB or plywood — spans these members and is itself joined at edges with gaps. Even when a housewrap or building paper is applied, it must be lapped, taped, and sealed at every penetration: windows, doors, outlets, fixtures, and mechanical systems.

Research from Oak Ridge National Laboratory found that even in well-constructed framed assemblies, the cumulative effect of these seams and joints produces air leakage rates that would shock most designers. A well-built 2×6 framed wall with OSB sheathing and housewrap, before any interior finish work, typically shows air leakage values of 3–7 ACH50 as a whole-building measure — and that is before the interior trades create additional penetrations.

3.2 Top Plate Air Leakage and Stack Effect

One of the most significant and underappreciated air leakage pathways in framed exterior walls occurs at the ceiling plane — specifically the gap between the drywall and the exterior wall top plate on both sides of the plate. Every framed wall has a top plate, but the imperfect fit of framing lumber, combined with wood shrinkage as framing dries in service, produces gaps of 1/16" to 1/8" or more that run continuously along the top of every exterior wall at the attic floor plane. Research cited in building industry literature documents these gaps leaking approximately 0.5–0.7 CFM per linear foot of wall — an amount that in a typical home is equivalent to leaving a double-hung window open 4 to 5 inches on a cold winter day.

These gaps are powerfully exploited by the stack effect — the thermodynamic phenomenon by which warm, less-dense interior air rises in winter toward the upper portions of the building and exits through any available opening near the roofline. Building Science Corporation describes the mechanism clearly: as heated air escapes through ceiling-plane gaps into the unconditioned attic, a negative pressure is induced in the lower building, drawing cold outside air in through rim joists, sill plates, and lower wall penetrations to replace it. The greater the temperature difference between inside and outside — the delta T — the stronger the driving force. This cycle operates continuously in cold weather, carrying not just air but the heat and moisture it contains into the attic where condensation and structural damage can follow.

These gaps are rarely sealed in conventional construction. Doing so requires access from the attic side after drywall is hung but before attic insulation is placed — a step that adds trade coordination and cost, and is routinely skipped. Energy Vanguard and the Journal of Light Construction have both noted that sealing only attic-plane leakage can cut a home's total air leakage by more than half — confirming how dominant this pathway is in the overall leakage budget of a typical framed building.

3.3 Electrical Boxes and Recessed Fixtures

Electrical outlet boxes, switch boxes, and recessed light fixtures in exterior walls and ceilings represent one of the most persistent and underestimated sources of air infiltration in framed buildings. A conventional electrical box installed in an exterior wall creates multiple air leakage paths:

- ▶ The box itself penetrates the vapor barrier and air barrier at the interior wall surface
- ▶ Wire knockouts in the box — even when partially sealed with the wire grommet — are rarely airtight
- ▶ The gap between the box perimeter and the rough opening in the drywall or wall material
- ▶ The stud cavity behind the box, which connects directly to the rest of the wall cavity and often to the attic or floor system above or below

Research published in the Journal of Light Construction found that a single conventional recessed can light in a ceiling can account for approximately 9 CFM50 of air leakage — enough that four to five fixtures represent a full 1.0 ACH50 of additional air leakage in a typical home. Even "airtight, IC-rated" fixtures performed only marginally better in field testing.

For outlet and switch boxes in exterior walls, studies have measured 1–3 CFM50 per box depending on construction details. A typical home may have 20–40 devices in exterior walls, making the cumulative contribution of electrical boxes a significant fraction of total building air leakage.

Airtight electrical boxes, foam gaskets behind cover plates, and careful sealing of wire penetrations are all required to address this pathway — but each requires additional labor, additional materials, and additional trade coordination on a framed project. The failure rate in conventional construction is high.

3.4 Wood Shrinkage and Long-Term Gap Formation

Perhaps the most underappreciated air leakage mechanism in wood-framed construction is the dimensional change of framing lumber as it dries after installation. Framing lumber is typically installed at a moisture content of 15–19% — significantly above the equilibrium moisture content (EMC) of 7–10% it will eventually reach in a conditioned building. As the wood dries and its moisture content drops toward equilibrium, it shrinks — primarily across the grain.

The shrinkage of a single 2×6 stud across its width can be 3/16" to 1/4" or more as it dries from installation moisture content to equilibrium. Multiplied across an entire wall of studs, plates, headers, and blocking, this shrinkage creates a network of new gaps at every wood-to-wood connection and every location where an air-sealing material was bonded to wood. These gaps form after the building is complete and often after it has been inspected and certified.

This is a critical limitation of spray foam as an air-sealing strategy in framed walls. Closed-cell spray polyurethane foam achieves excellent adhesion to wood at installation — but as the wood shrinks away from the cured foam, gaps open at the perimeter of the foam application. Research published in *Construction Specifier* has documented these shrinkage-induced cracks and separations as a primary failure mode for spray foam as an air barrier component. The magazine noted that these gaps are especially problematic precisely because the foam is intended to be the air barrier — meaning any breach directly compromises the building's airtightness.

Even properly applied, cured, and undisturbed closed-cell spray foam can exhibit shrinkage of its own — up to roughly 10% according to some manufacturer testing data — particularly when applied in thick single-pass applications or under marginal temperature and humidity conditions. A study by the Thermal Metric project found closed-cell spray foam showing significant shrinkage in one of nine framing bays under laboratory conditions — a failure rate that would be deeply concerning in field applications where quality control is less rigorous.

Spray foam also has a fundamental limitation that exists entirely independent of foam shrinkage: it only seals areas where it is actually applied. The Thermal Metric laboratory study — the same research that documented foam shrinkage in framing bays — explicitly noted that "significant leakage paths often remain at wood-to-wood connections" even after spray foam installation. This is not a workmanship failure. It is a structural limitation of the approach.

Every framed wall contains dozens of wood-to-wood interfaces: studs bearing on bottom plates, top plates bearing on studs, double top plates stacked face-to-face, built-up headers composed of multiple members, rim boards bearing on sill plates, and trimmers alongside king studs at openings. At the time of framing, these members are in contact and the interface appears tight. Spray foam fills the stud-bay cavities but does not penetrate these wood-to-wood interfaces — there is no cavity to fill. As the lumber dries from installation moisture content toward equilibrium, each member shrinks independently across its grain. The WoodWorks Council and IIBEC both document cross-grain shrinkage of approximately 6% from green condition to equilibrium — applied to a 2×6 plate (5.5" face width), that represents over 5/16" of shrinkage per member. A double top plate, each course shrinking independently, can open a continuous gap along its full length that runs the entire perimeter of the building. Stud-to-plate bearing surfaces separate. Built-up header members pull apart at their interfaces. These are not random isolated gaps — they are systematic, predictable, and geometrically continuous through the framing.

The result is two distinct and additive failure modes in spray-foamed framed walls: gaps that open where the foam separates from shrinking wood, and gaps at wood-to-wood interfaces that the foam never sealed in the first place. Both are inevitable consequences of building with dimensional lumber that dries after installation. Neither failure mode exists in SIP construction, where the air barrier is a factory-bonded foam-to-OSB assembly with no wood-to-wood interfaces within the insulation plane.

Air-sealing strategies in framed buildings depend on materials bonded to wood. Wood moves. Over time, the building itself opens the gaps that were sealed during construction — and creates new ones at wood-to-wood interfaces that were never sealed at all.

3.5 Rim Joists — A Documented Air Leakage and Thermal Problem

The rim joist — the framing member that caps the floor joist system at the perimeter of the building — is consistently identified in building science research as one of the highest-priority air leakage locations in conventionally framed construction, alongside attic penetrations. The ICC's Building Air Tightness Technical Note explicitly lists rim joist areas among the locations requiring priority attention in any air-sealing program.

The rim joist problem is both a thermal and an air leakage issue. Thermally, the rim joist is often the least insulated portion of the above-grade building envelope, with fiberglass batt stuffed into joist bays providing negligible air resistance despite its insulation value. As an air barrier, the rim joist assembly is exceptionally complex: the sill plate, rim joist board, subfloor sheathing, foundation wall, and individual floor joists all converge at this location, creating a three-dimensional geometry with numerous cracks and gaps. Building Science Corporation's Info-408, which specifically addresses rim joist air sealing, states directly: "This area is problematic for several reasons. First, several framing components need to be connected with sealant as air barrier components; this application is quite workmanship-sensitive."

Stack effect makes the first-floor rim joist particularly vulnerable. In winter, the negative pressure induced at the lower building by warm air escaping through the ceiling plane draws cold outside air in through precisely the locations where the foundation meets the wood framing — the sill plate-to-foundation connection, the gaps between individual joists and the rim board, and the corners where the subfloor meets the rim assembly. Builder Online's infrared camera studies have captured this cold air infiltration vividly, showing it traveling several feet up the inside face of exterior walls from the rim joist zone.

Spray foam applied to the interior of the rim joist cavity is the current best-practice solution for framed construction — blower door testing before and after rim joist spray foam application typically shows 15–25% reductions in total building air leakage, confirming this is a significant contributor. However, spray foam at the rim joist is subject to the same long-term gap formation described in section 3.4: as the sill plate, rim board, and floor joists dry and shrink after construction, the cured foam can separate from the wood at its bonded perimeter, reopening the very leakage paths it was intended to seal. The complexity and workmanship-sensitivity of this assembly means reliable, durable air sealing of framed rim joists is genuinely difficult to achieve consistently.

Building science research consistently identifies rim joist areas as among the highest-priority air leakage locations in framed buildings — a complex three-dimensional assembly where multiple framing members converge, stack effect draws cold air inward, and durable air sealing is genuinely difficult to achieve.

3.6 Continuous Insulation — Better, But Not a Complete Solution

Exterior continuous insulation (CI) — rigid foam board applied to the exterior face of the framing — addresses thermal bridging through framing members and can also contribute to air barrier continuity when properly taped and detailed. It represents a meaningful improvement over cavity insulation alone.

However, CI does not eliminate the fundamental air leakage pathways of framed construction. The interior of the wall cavity is still framed, still has the ceiling-plane top-plate gaps described in section 3.2, still contains electrical boxes, and still relies on wood-to-wood connections that are subject to shrinkage. The CI layer must also be lapped, taped, and sealed at every penetration — a field operation that is highly workmanship-dependent and subject to the same gap-formation concerns as any other field-applied air barrier.

Building science research consistently shows that CI assemblies targeting ≤ 3.0 ACH50 require meticulous multi-trade coordination, pre-drywall blower door testing, and remediation of identified leaks — a process that adds cost and schedule time to every project. The target is achievable, but not easily or consistently.

4. The SIP Air Barrier System

4.1 How SIPs Control Air Infiltration

A Structural Insulated Panel is a factory-manufactured assembly: two structural OSB facings bonded under controlled conditions to a continuous foam core — EPS, GPS, or polyurethane. The foam core is a solid, impermeable material. Air does not move through it. The OSB facings, bonded directly to the foam under factory pressure, create a panel that is itself an air barrier — not just an insulation layer.

When SIP panels are joined at the field, the connections are made with surface splines, block splines, or cam-lock systems, and all joints are sealed with SIP manufacturer-specified sealant or tape. The result is a building envelope with a small number of defined, accessible, fully sealed joints — rather than the hundreds of random gaps present in framed construction.

Crucially, SIP construction eliminates the primary internal air pathways of framed buildings:

- ▶ No stud-bay cavities behind the wall surface — the foam core is continuous and solid from interior OSB to exterior OSB, so even a gap at the drywall-to-top-plate interface at the ceiling plane connects to solid foam, not to an attic-communicating cavity
- ▶ Significantly fewer wood-to-wood framing interfaces than conventional construction — and where they do occur, such as inlet nailers, top plates, and spline connections, they are sealed with manufacturer-specified sealant as a standard installation step. Applying equivalent sealing to the much larger number of wood-to-wood connections in a conventionally framed wall would materially increase both labor and sealant material costs
- ▶ No sheathing seams at 16" or 24" intervals through the insulation plane
- ▶ Electrical wiring is run through factory-pre-bored horizontal chases within the foam core, eliminating the open stud-bay pathways that make framed-wall electrical penetrations a significant leakage source

It is worth noting that SIP walls do have top plates — typically dimensional lumber inlet nailers embedded in the foam core with a load-bearing plate above, per standard SIP industry practice. The critical distinction from framed construction is not the absence of a top plate but the absence of any cavity behind it. In a framed wall, a gap at the drywall-to-top-plate interface opens into an interconnected stud-bay system that communicates with the attic above — the leakage pathway described in section 3.2. In a SIP wall, the same gap — if present — opens into the face of a solid foam core. The pathway that drives stack-effect air loss in framed buildings simply does not exist in SIP construction.

The SIP panel is also dimensionally stable. EPS, GPS, and polyurethane foams do not shrink, settle, or change dimension in response to moisture or temperature within normal building service conditions. The air seals established at panel joints do not open over time due to material movement.

4.2 Electrical Boxes in SIP Construction

In SIP construction, the standard approach for electrical devices in exterior walls is to route wiring through factory-pre-bored horizontal chases in the foam core — typically horizontally at plug height and switch height, and vertically at 4' on center, as specified. Outlet and switch boxes are recessed into the interior OSB facing only, not through the full panel depth. The box does not penetrate to the exterior foam or OSB.

This detail is fundamentally different from framed construction in two important ways. First, the box does not create a penetration through the air barrier — the exterior OSB and foam behind the box

remain intact. Second, there is no open stud cavity behind the box connecting to the attic or floor system. The foam core directly behind the electrical box is continuous and uninterrupted.

The result is that electrical boxes in SIP walls contribute negligible air leakage compared to their framed-wall counterparts. The primary sealing task — ensuring the box perimeter is airtight at the drywall — is the same in both systems, but in SIP construction there is no connected cavity behind the box to leak through even if the box perimeter is imperfect.

In a SIP wall, an imperfectly sealed electrical box leaks into a blind pocket of foam. In a framed wall, an imperfectly sealed electrical box leaks into a connected cavity system that may extend from the foundation to the attic.

4.3 Long-Term Stability

Because SIP air seals are made at panel joints between rigid, dimensionally stable foam and OSB — rather than between cured foam and shrinking wood — the performance of a SIP building's air barrier does not degrade as the structure dries and settles in service. Field blower door tests conducted on SIP buildings years after construction consistently confirm airtightness values close to those measured at initial completion.

This stands in contrast to framed buildings, where progressive wood shrinkage and the aging of caulks, tapes, and housewrap adhesives typically cause airtightness to worsen over time. Energy audits of existing framed homes commonly reveal air leakage pathways that were not present at construction — gaps that opened as the building settled, dried, and cycled through temperature and humidity changes over successive seasons.

4.4 Rim Joists in SIP Construction

The rim joist air leakage problem described in section 3.5 is one of the most difficult challenges in framed construction — and one that standard SIP construction methods address not by better sealing, but by fundamentally changing the assembly geometry.

In the SIP industry-standard wrapped floor assembly used at the first floor, the SIP wall panel runs continuously on the exterior of the floor framing system. The rim joist, rather than being an exterior-facing element exposed to the weather and subject to stack-effect-driven air infiltration, is repositioned entirely to the interior side of the SIP wall. The continuous foam core of the SIP provides the air barrier and insulation at this level — not a spray-foamed assembly of multiple framing components. The complex three-dimensional interface that makes framed rim joist sealing so difficult is simply not present.

At upper-floor assemblies, the standard SIP industry approach uses top-mount joist hangers fastened to the top plate of the first-floor SIP wall, with floor joists hanging inside the building envelope and the subfloor extending to the exterior face of the SIP wall above. Again, the rim joist becomes an interior structural member, not an exterior air and thermal leakage path. The SIP wall runs continuously past the floor framing on the exterior, maintaining an unbroken insulation and air barrier plane from foundation to roof.

The result is that the entire category of rim joist air leakage — extensively documented as one of the most difficult problems to reliably solve in framed construction, subject to workmanship variation, wood shrinkage, and stack-effect pressure — is structurally eliminated in standard SIP construction. This is not an air-sealing solution; it is an assembly solution that removes the problem rather than attempting to seal around it.

In standard SIP wrapped-floor construction, the rim joist is moved from the exterior to the interior of the building envelope. The air sealing problem disappears because the vulnerable assembly is no longer exposed.

5. The Research: SIP vs. Conventional Framing

5.1 Oak Ridge National Laboratory Studies

The most cited body of research on SIP airtightness comes from Oak Ridge National Laboratory (ORNL), which conducted controlled side-by-side comparisons of SIP and conventionally framed rooms and buildings over multiple studies.

In the landmark ORNL/SIPA study (Christian and Petrie, 2002), two identical test rooms were constructed under laboratory conditions — one with 4" EPS SIP walls and ceiling, one with 2×6 framing, OSB sheathing, fiberglass batt insulation, and drywall. Both rooms included a window, a door, factory-routed electrical wiring chases, and outlet boxes. Under blower door testing, the SIP room was measured to be 15 times more airtight than the framed room.

In field studies of completed SIP homes in a residential subdivision, ORNL measured natural air change rates as low as 0.03 ACH under normal atmospheric conditions — compared to 0.20 to 0.25 ACH for conventionally framed homes of similar size in the same subdivision. This represents a 7–8 fold improvement in actual infiltration performance under real-world conditions.

"When it comes to stopping air infiltration and exfiltration, a properly sealed SIP building is almost 15 times better than the competition." — Bill Wachtler, Executive Director, Structural Insulated Panel Association (SIPA), citing ORNL research

5.2 Field Blower Door Performance Data

Blower door testing data from completed SIP buildings across multiple studies and building programs consistently confirms the ORNL laboratory findings:

Conventional framing + fiberglass batt	5–10 ACH50	Unmodified baseline
Conventional framing + spray foam (ccSPF)	2–5 ACH50	Highly workmanship-dependent
Conventional framing + exterior CI + careful sealing	2–4 ACH50	Requires multi-trade coordination
ZIP System sheathing with taped seams	2–4 ACH50	Better than housewrap; still field-dependent
SIP construction — standard installation	1–2 ACH50	Typical well-installed SIP building
SIP construction — high-performance detailing	0.5–1.0 ACH50	Passive House range; routinely achievable
ORNL SIP research room (controlled)	~0.03 ACH natural	15× more airtight than framed baseline

It is important to note that the spray foam and CI figures above represent best-case outcomes under attentive field supervision. Production-quality construction — where multiple subcontractors, variable weather, and schedule pressure are factors — typically produces results at the higher end of the ranges shown, often exceeding 5 ACH50 for spray foam applications and 4+ ACH50 for CI systems.

5.3 Energy Star and Code Recognition

The consistently superior airtightness of SIP construction has been recognized by the EPA's Energy Star program: SIP homes are permitted to waive the required blower door test for Energy Star

certification, because field data shows SIP buildings routinely exceed the program's airtightness requirements without specific air-sealing efforts beyond standard SIP joint sealing.

The 2024 IECC sets a maximum of 2.5–4.0 ACH50 for most climate zones. SIP construction meets or beats this threshold as a matter of standard practice, while conventional framed construction typically requires specific air-sealing programs, inspections, and often remediation to achieve the same result.

6. Downstream Benefits of SIP Airtightness

6.1 Energy Savings

The direct energy saving from reduced air infiltration in SIP buildings is substantial. SIPA life cycle analysis data shows SIP homes saving up to 45% more CO₂ over their lifespans compared to equivalent stick-framed construction, with a 5.1-year energy payback and 3.8-year greenhouse gas payback period. A significant portion of these savings is attributable to reduced air infiltration rather than insulation R-value alone.

6.2 Right-Sized HVAC Equipment

Manual J heating and cooling load calculations depend critically on accurate air leakage inputs. A SIP building with measured airtightness of 1.0–1.5 ACH50 will have a dramatically lower calculated infiltration load than an equivalent framed building at 4–5 ACH50. This translates directly to smaller, less expensive HVAC equipment — typically one to two equipment sizes smaller than a comparable framed home.

Right-sized equipment also runs longer cycles, which improves dehumidification, maintains more consistent temperatures, reduces compressor wear, and extends equipment life. The HVAC savings from a tight SIP envelope can offset a meaningful fraction of any cost premium for SIP construction.

6.3 Moisture Management and Durability

Infiltrating air carries moisture. In cold climates, warm interior air moving outward through the building envelope deposits moisture as it cools, creating condensation within wall and roof assemblies. This is a primary cause of mold, rot, and structural deterioration in framed buildings.

SIP buildings are not immune to moisture challenges — panel joints must be carefully sealed to prevent air movement that could carry moisture to the OSB facings — but the elimination of ceiling-plane cavity pathways, stack-effect-driven rim joist infiltration, and framing shrinkage gaps removes the most common moisture transport routes found in framed buildings. Properly installed SIP buildings have demonstrated exceptional long-term durability in cold and mixed-humid climates.

6.4 Indoor Air Quality

In a tight SIP building, air exchange occurs through controlled mechanical ventilation — typically an Energy Recovery Ventilator (ERV) or Heat Recovery Ventilator (HRV) — rather than through random gaps in the envelope. This means incoming air is filtered, conditioned, and distributed intentionally rather than entering through electrical boxes, wall cavities, and attic bypasses.

Occupants of tight buildings report improved air quality, reduced allergen infiltration, and better humidity control. The HVAC system can be right-sized for ventilation needs rather than also compensating for uncontrolled infiltration.

6.5 Acoustic Performance

Air leakage paths are also sound transmission paths. The continuous foam core of a SIP panel and the airtight panel joints provide meaningful attenuation of exterior sound transmission — traffic noise, aircraft, and outdoor mechanical equipment — in addition to the thermal benefits. This acoustic benefit is an often-overlooked quality-of-life advantage of SIP construction, particularly in suburban and urban locations.

7. The Necessary Complement: Mechanical Ventilation

A tightly built SIP home requires mechanical ventilation. ASHRAE 62.2 and the IRC mandate ventilation rates that ensure occupant health and control indoor pollutant concentrations. In a leaky framed home, much of this ventilation happens accidentally through air infiltration — with all of the energy, comfort, and air quality penalties that entails. In a tight SIP home, ventilation is intentional and controlled.

The standard solution is an ERV or HRV, which brings fresh outdoor air into the building while capturing 70–85% of the heat (and in the case of an ERV, moisture) from the outgoing stale air. This controlled ventilation approach:

- ▶ Eliminates unfiltered infiltration of outdoor allergens and pollutants
- ▶ Recovers 70–85% of the energy that would otherwise be lost to ventilation
- ▶ Provides consistent, measurable fresh air distribution throughout the home
- ▶ Allows the designer to specify the exact ventilation rate rather than relying on random leakage

The incremental cost of an ERV or HRV — typically \$1,500–\$4,000 installed — is offset by reduced HVAC equipment costs from right-sizing, lower operating costs from heat recovery, and improved occupant health and comfort over the building's life.

8. Conclusion

Air infiltration is not a secondary building science concern — it is among the primary drivers of real-world energy performance, occupant comfort, building durability, and indoor air quality. Conventional framed construction, even when enhanced with spray foam or continuous exterior insulation, struggles to achieve consistent, durable airtightness because its fundamental assembly method produces buildings with hundreds of random leakage pathways that are difficult to seal, subject to quality control variation, and vulnerable to deterioration as wood shrinks and materials age.

SIP construction solves the air infiltration problem at the assembly level, before installation begins. The factory-manufactured monolithic panel — with its continuous foam core, bonded OSB facings, and sealed panel joints — eliminates the stud-bay pathways, top-plate bypasses, wood-shrinkage gaps, and electrical box penetrations that are the primary leakage sources in framed buildings. The result is consistently demonstrated in field blower door testing: SIP buildings routinely achieve 0.5–2.0 ACH50, while framed buildings — even well-built ones with spray foam — typically land at 2–7 ACH50.

This performance advantage is not theoretical. It is measurable, repeatable, and recognized by code bodies, energy efficiency programs, and the research community. For designers, builders, and owners committed to durable, comfortable, energy-efficient construction, SIPs offer a compelling and well-documented path to airtightness that conventional framing cannot reliably match.

NorthEast SIPs is an independent SIP dealer providing a comprehensive array of services through NorthEast SIPs and its manufacturing partners related to designing and building with SIPs. NorthEast SIPs works closely with its clients to help them achieve their goals with independent advice and guidance throughout the design and building process. Services available to clients include: architectural design services, preliminary SIP-related engineering review, engineering and SIP fabrication, SIP delivery, structural framing takeoffs and material

delivery, and on-site SIP installation consulting. To discuss your project and how SIPs can contribute to building an efficient and comfortable residential or commercial structure, please reach out to Trevor Huffard, President of NorthEast SIPs, at trevor@nesips.com or 203-293-5404.

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