Avoiding High-GWP Insulation Materials

NESEA Building Energy Conference

Calculating the Global Warming Potential of Insulation

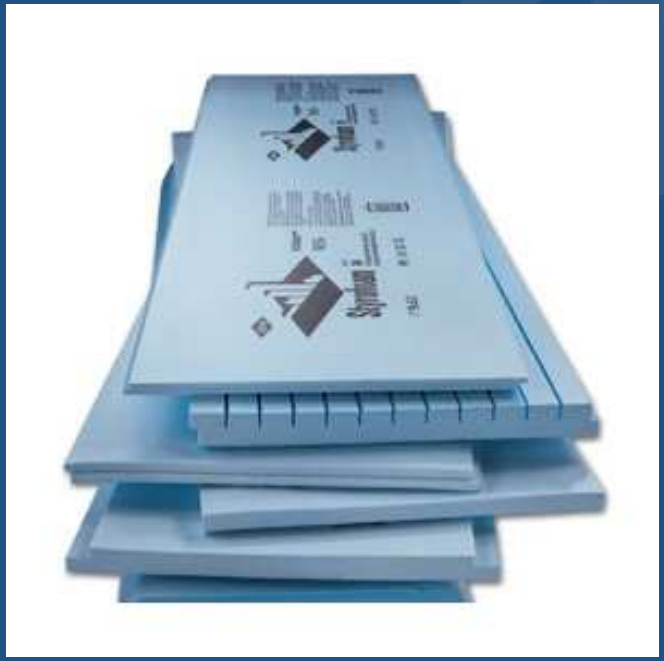
March 10, 2011

Alex Wilson

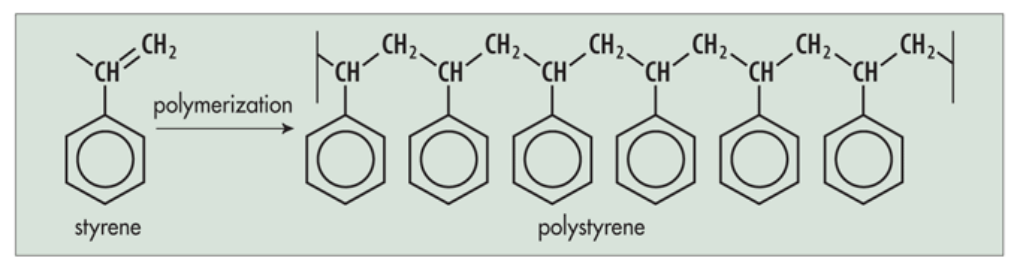
Hudson Passive House
Photo: Jordan Dentz

Concerns about extruded polystyrene

- Two concerns
- The first is that the flame retardant HBCD is used in all polystyrene building insulation
- The second is that XPS is made with HFC blowing agent
- Today, focusing on this second issue



Dow Styrofoam - image from HomeConstruction Improvement.com



Global warming – extruded polystyrene

- Relatively new concern
- Solved the ozone-depletion problem, but new blowing agent has high GWP
- Payback of the "lifetime GWP"
- 65-year payback for the lifetime GWP of the XPS in the house shown here

Net-zero-energy house with 4" XPS wrapped around 2x6 walls with cellulose. Photo: Bensonwood

Issue addressed in June, 2010 issue of Environmental Building News

- Dr. Danny Harvey raised the concern in a 2007 scientific paper
- We examined and updated Harvey's assumptions
- Generating a lot of discussion this week
- With certain types of insulation, more isn't always better

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Avoiding the Global Warming Impact of Insulation

Insulation is key to reducing carbon emissions from buildings. But the blowing agents in extruded polystyrene and spray polyurethane foam offset much of that benefit.

by Alex Wilson

TWO COMMON FOAM INSULATION materials are produced with hydrofluorocarbon (HFC) blowing agents that are potent greenhouse gases—extruded polystyrene (XPS) such as Dow Styrofoam of Owens Corning Foamular, and standard closed-cell spray polyurethane foam (SPF). While all insulation materials reduce greenhouse gas emissions (by saving energy), insulating with thick layers of either of these two particular foams results in very long "payback periods" for the global warming potential of the insulation, thwarting even the best attempts to create carbon-neutral buildings. The bottom line is that designers and builders aiming to minimize the global warming impacts of their buildings should choose fiber insulation (cellulose, fiberglass, or mineral wool) or non-HFC foam insulation.

"The more insulation the better" is a common refrain in the green building industry. *EBN* has long advocated very high levels of insulation, particularly in residential and small commercial buildings, which are skin-dominated. At the furthest end of the spectrum is the Passive House movement (see *EBN* Apr. 2010), where it is not uncommon to provide R-50 under a floor slab, R-60 in the walls, and as much as R-100 in the attic. High levels of insulation are seen as a key strategy for achieving net-zero-energy and carbon-neutral performance—the latter meaning that the building will have no net contribution to climate change.

How we achieve high levels of insulation is a very significant issue, however. We rarely pay attention to the fact that insulation materials themselves contribute to greenhouse gas emissions and global warming. This happens in two ways: through the embodied energy of the insulation (the energy use and greenhouse gas emissions that result from manufacturing

(continued on p. 9)

Photo: Benson Wood

Unaware of the recently reported GWP implications of certain foam insulation materials, builder Todd Benson specified four inches of extruded polystyrene over 2x6 studs insulated with dense-pack cellulose in this net-zero-energy home.

In This Issue

Quote of the month:

"Specifying a high-GWP insulation completely defeats the point of using it."

– Scott Shell, FAIA of EHDD Architecture commenting on new information on the global warming potential of insulation materials (page 12)

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ODP and GWP of Blowing Agents

Type of Insulation	Blowing Agent	Atmospheric lifetime (yr)	ODP[1]	GWP[2]
Polyisocyanurate				
Original	CFC-11	45	1	4,750
2nd Generation	HCFC-141b	9.3	0.11	725
3rd Generation	Pentane, cyclopentane	A few days	0	7[3]
Spray Polyurethane				
Original	CFC-11	45	1	4,750
2nd Generation	HCFC-141b	9.3	0.11	725
3rd Generation	HFC-245fa	7.2	0	1,030
3rd Generation	CO_2	variable	0	1
Extruded Polystyrene (XPS)				
Original	CFC-12	100	1	10,900
2nd Generation	HCFC-142b	17.9	0.065	2,310
3rd Generation	HFC-134a[4]	13.8	0	1,430

Charts from Environmental Building News, June, 2010

Alternatives to XPS: Polyisocyanurate

Fine Homebuilding photo

- Blowing agent has a GWP of 7 instead of over 1,400
- Chlorinated rather than brominated flame retardant
- It may be possible to meet codes without any flame retardant
- Thermoset plastic rather than thermo-plastic

Polyisocyanurate roof insulation

John Straube photo

- Most appropriate above-grade
- Occasionally used for foundations
- Highest R-value of any common insulation material
- Possible to superinsulate without a lot of added weight

Alternatives to XPS – *Expanded* polystyrene

Photo: John Straube

- Negligible GWP (pentane as blowing agent)
- Higher-density EPS for below-grade
- This is PolyForm's tongue & groove EPS insulation
- R-10 for 2.5" thickness
- Cost-competitive with XPS

Expanded polystyrene – for below-grade

Photo: John Straube

Alternatives to XPS: rigid mineral wool

Rockwool International

- Growing interest in rigid mineral wool
- Zero GWP – no blowing agent
- No flame retardant
- Totally fire-safe
- Inert
- Superb drainage below-grade
- Resistant to termites
- High recycled content
- Contains phenolic binder, but very low emissions

Thermafiber Mineral Wool

Thermafiber rigid mineral wool insulation products

www.thermafiber.com

Rigid mineral wool – below-grade?

Toprock installation in British Columbia - Photo: Roxul

- Roxul Toprock
- Mainly used for roofs, but recent test applications beneath slabs
- Should be cost-competitive with XPS
- Not widely available for residential use

www.roxul.us

Rigid mineral wool – below-grade?

Photo: Roxul

Alternatives to XPS: Foamglas

- Cellular glass – has been made since 1937 (not marketed as a building insulation in U.S. until now)
- 100% inorganic
- Noncombustible without flame retardants
- CO_2 as fills the cells, not HFC (GWP of 1 vs. 1,400)
- 2-1/2 times as expensive as XPS
- Not stocked, but made in the U.S. and can be shipped anywhere

Photo: Pittsburgh Corning

Foamglas

www.foamglas.us

Photo: Pittsburgh Corning

Foamglas - properties

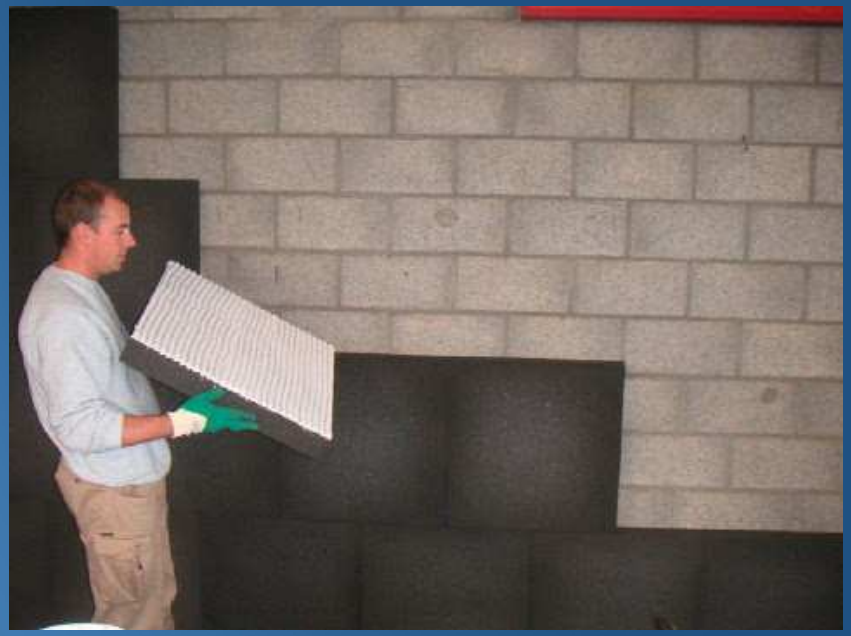


Photo: Foamglas

From Environmental Building News

Physical Properties	I-P Units	SI (metric)
Moisture absorption (% by vol.)[1]	0.2%	0.2%
Water vapor permeability	0.00	0.00
Acid resistance	Impervious to common acids except hydrofluoric acid	
Capilarity	None	None
Combustibility	Noncombustible	
Compressive strength	90 psi	600 kPA
Density (average)	7.5 /b/ft3	120 kg/m3
Dimensional stability	Does not shrink, swell, or warp	
Coef. of linear expansion (25°C)	5.0 x 10^{-6}/°F	9.0 x 10^{-6}/°K
Maximum service temperature	+900°F	480°C
Melting point	1,832°F	>1,000°C
Modulus of Elasticity (approx)	1.3 x 10^{5} psi	900 MPa
Specific heat	0.20 Btu/lb°F	0.84 kJ/kg·°K
Thermal conductivity	Btu/hr·ft^2·°F 0.29 @ 75°F 0.28 @50°F	W/mK 0.039 @ 0°C 0.040 @ 10°C
Thermal resistance	R-3.44/inch	RSI-0.26/cm

1. The only retained moisture is that adhering to surface cells after immersion.
2. Wet-cup method, procedure B Data from Pittsburgh Corning.

Foamglas – Brattleboro, Vermont installation

Photo: Mindel & Morse Builders

Foamglas – bitumen-faced ReadyBoard

Photo: Pittsburgh Corning

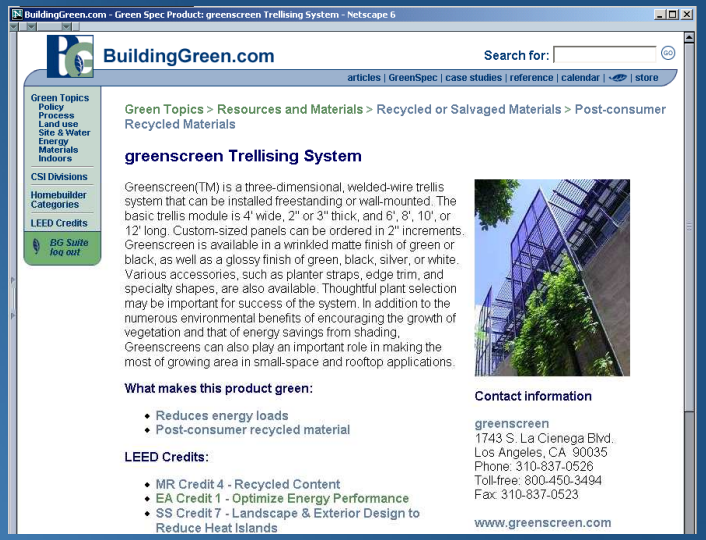
2030 Challenge for Products

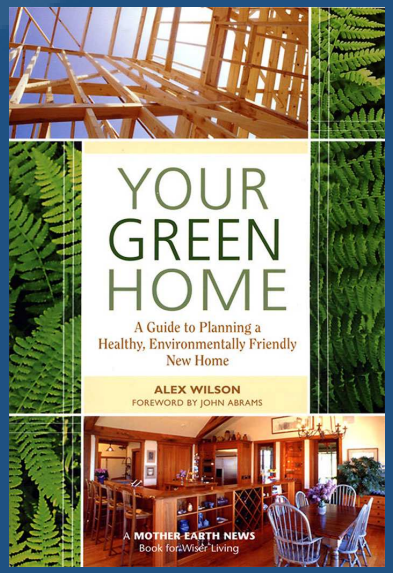
- Goal to reduce the embodied carbon of building materials 50% by 2030
- Rolled out on Valentine's Day by Ed Mazria and Architecture 2030
- BuildingGreen is partnering with Architecture 2030 on metrics and product listings

Discussion Questions

- How significant a concern is all this?
- Would you specify or use an XPS insulation material that had less than R-5 per inch?
- Would you spend more for something like Foamglas?

Resources from BuildingGreen





For information, visit www.BuildingGreen.com or call 800-861-0954

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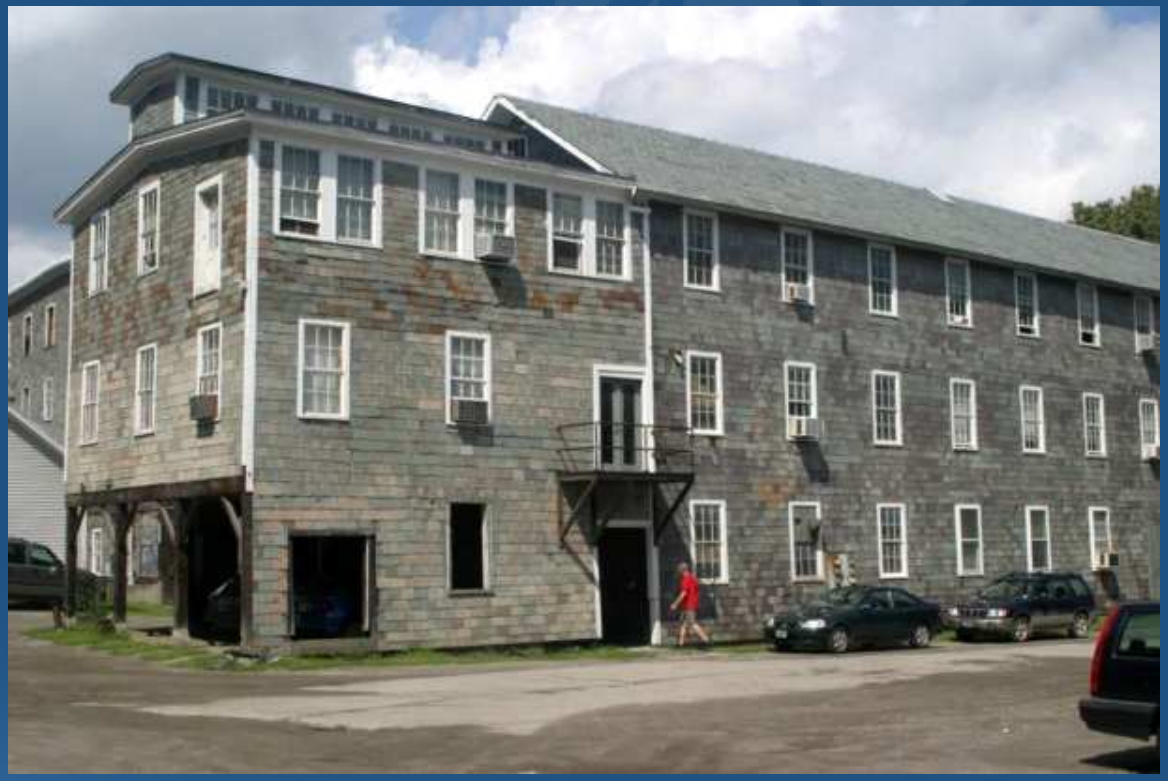

BuildingGreen offices in the old Estey Organ Factory, Brattleboro

Thank you!

Old Lyme, Connecticut - Alex Wilson photo