October 8, 2010

Mr. Alex Wilson
Executive Director
Environmental Building News
Building Green, LLC
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Brattleboro, VT 05301

VIA E-MAIL: alex@buildinggreen.com

Dear Mr. Wilson,

Subject: Avoiding the Global Warming Impact of Insulation

The Canadian Plastics Industry Association (CPIA) is the voice of the Canadian Plastics Industry, a sophisticated, multi-faceted sector encompassing plastic products manufacturing, machinery, moulds, and resins. CPIA prides itself on communicating the facts behind plastics' manufacturing and use from the economical, social and environmental perspectives.

We believe that industry should demonstrate to the public that it is taking a leadership role in encouraging environmentally and economically sustainable end-of-life plastics management. We also believe that the media and technical writers have a responsibility to communicate accurate and pertinent information regarding the sustainable and proper use of plastic products.

Several of our members and some non-members have brought to our attention your online article "Avoiding the Global Warming Impact of Insulation", published in June 2010 on the Building Green website. This article inaccurately targets the high global warming potential (GWP) of blowing agents used by closed-cell spray polyurethane foam (SPF) and extruded polystyrene (XPS) relative to other insulation products and provides insulation material recommendations based on flawed analyses. CPIA believes the assumptions, analyses and statements are inaccurate and potentially damaging to the SPF and XPS industries.

Environmental impact is always considered when formulating new or existing insulation products and is a factor that should be a part of the selection of components for building design. However, environmental impact must be determined using established analytical methods and industry accepted standards. CPIA believes that the analyses used in the EBN article need refinement in several areas to accurately characterize and compare the environmental impact of the different insulation products. Specifically, the analysis is lacking in the following six areas and needs to be re-evaluated:

1. Blowing agent use and emissions assumptions;
2. Embodied GWP assumptions may be incomplete or inaccurate;
3. Use of SPF or XPS as a secondary or additional insulation over a baseline R-value represents an unfair and inaccurate depiction of the value of these insulation products;
4. GWP impact of fourth-generation blowing agents not fully reported;
5. Additional energy savings from reduced air leakage and elimination of thermal bridges; and
6. Significant condensation potential in assemblies that can reduce the durability of the building envelope and lead to health issues arising from aspects such as mold growth, etc…

Regarding each of these topics, our concerns are detailed in the attached document along with suggested improvements to provide for a science-based discussion of this topic. Following your review of this information we request that you immediately update and re-publish the referenced article to correct these inaccuracies by using the new information provided in this letter.

Failing this, our industry will publish our own peer-reviewed technical article in recognized industrial publications, this time ensuring the presented data is accurate and science-based.

One of CPIA's mandates is to provide unbiased information, outreach and education regarding the safe use and proper application of all foamed plastic insulation and building products. We would be glad to speak with you to discuss our concerns and answer any questions you may have. Please feel free to call us at any time.

Sincerely,

Marion Axmith
Director General

Detailed Discussion

Below is a detailed discussion addressing each of CPIA's 5 concerns with the referenced article "Avoiding the Global Warming Impact on Insulation" as published in the Environmental Building News, June 1, 2010.

1. **Blowing agent use and emissions assumptions**

In the case closed-cell SPF, the HFC−245fa blowing agent was mistakenly assumed to be two times higher than is actually used in practice. The Harvey paper assumes that HFC blowing agents comprise 12wt% of closed-cell SPF. The fact is blowing agents make up about 12% of the B-side (polyol) component. When SPF is manufactured on the jobsite, it is combined with an equal amount of A-side (MDI) to create the finished foam. This 1:1 field mixture of the A-side and B-side reduces the amount of blowing agent by a factor of two, so the blowing agent is approximately 6% of the weight of the finished foam, not 12% assumed by the Harvey study. The analysis should be re-done considering this information, or the payback term should be reduced by a factor of at least two.

The current blowing agent used in the production of XPS insulations in North-America are HFCs, predominantly HFC-134a, a highly efficient insulating gas with a long residence time within the foam substrate. This blowing agent has an approximately 35% lower GWP than its predecessor (HCFC-142b) and also has a lower permeability coefficient in polystyrene resulting in a reduced blowing agent loss rate from the foam (8). Numbers in the article were inaccurate as to how much HFC 134a is used in the product itself. Compared to its previous HCFC-based blowing agent technology, one XPS manufacturer has halved the GHG emissions from its production of XPS Insulation in North America, and eliminated any ozone depleting compounds. Unfortunately, as admitted in the article, you the author were not privy to that information. HFC-134a is a non-flammable, non-VOC substance with zero ozone-depleting potential, which are also key benefits to the overall environmental health and safety of our product chemistry that were completely overlooked in the EBN article.

2. **Embodied GWP assumptions may be incomplete or inaccurate**

The embodied GWP reported by ICE for the different insulation products in Table 2 of the article may not be accurate or complete and may not follow standard practice. It is important to compare the environmental impact of different materials only when they have undergone a thorough life cycle assessment (LCA) or life-cycle inventory (LCI).

For all insulation products and other building products there are established LCA protocols that must be followed (per ISO 14040/14025) for the results to be meaningful and comparable. These ISO (International Standards Organization) standards include life-cycle assessment standard ISO14044:2006. Their use is essential in putting together a GHG study. These ISO protocols define the boundary for the LCA, such as cradle-to-grave or cradle-to-gate, and include all aspects of producing the product such as the environmental impact of raw material extraction, transportation and processing, as well as production of the final product. In addition, these protocols establish a functional unit for each product and require an independent review by industry experts.

It is not clear from Table 2 in the EBN article or from the analysis in the Harvey paper that the applicable ISO standards were consistently followed for every material in SPF and XPS insulation products. If these standards were not followed, then their environmental impacts cannot be compared to other insulation products.

The SPF industry, through SPFA and an independent service provider, is undertaking an industry-wide cradle-to-grave LCA to incorporate not only the embodied energy required to make, transport and install SPF, but to also consider the building energy saved during the use phase and proper disposal of the product. We believe that the results will show the GWP impact of energy saved will be 30 to 100 times that of the GWP impact to manufacture SPF. When completed within the next 12-18 months, the SPF industry LCA should provide thorough evidence to challenge many of the statements and conclusion in this article. A summary example of an LCA for the embodied energy of several insulation materials, including SPF made with HCFC-141b blowing agent, is contained in reference (1). This work, using the ISO protocol, should be included or referenced in the article

The XPS insulation industry has also conducted LCA in accordance to the applicable ISO standards. The embodied energies also confirm extremely favorable GWP impact of energy saved versus energy used to manufacture, transport the XPS insulation (5) (6).

3. **<u>Use of SPF or XPS as a secondary or additional insulation over a baseline R-value represents an unfair and inaccurate depiction of the value of these insulation products</u>**

Considering SPF or XPS insulations only as a secondary or additional insulation can unfairly position them at a disadvantage in the analysis by dramatically reducing energy savings and increasing the payback period for these products.

The relationship between conductive energy loss of a building and its envelope R-value is inherently non-linear, as shown in Figure 1. In this example contained in Figure 1, it is assumed that the un-insulated wall has an R-value of R1. At this R-value, the energy loss of the wall is assumed to be 100%. If a continuous R13 primary insulation is added, the energy loss from the insulated wall will be reduced by about 86% of its un-insulated value. If an additional R6 of ‘secondary’ insulation is added to the wall with R13 of primary insulation, an additional 4% energy savings will be realized.

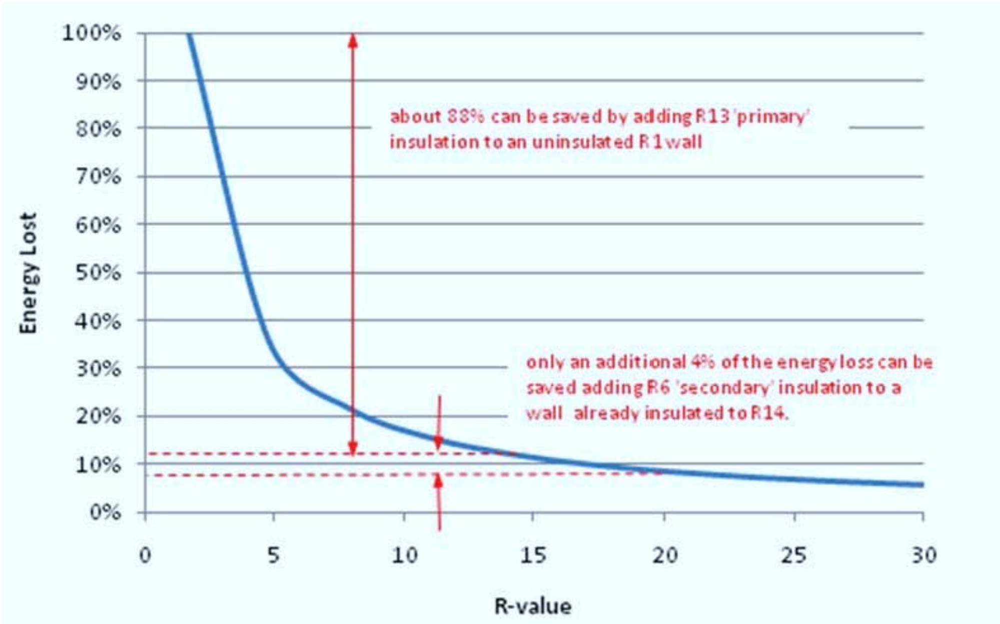

FIGURE 1 – Energy Lost versus R-value

In the Harvey paper it was assumed that a fibrous insulation was the primary insulation, and that foam plastic was the secondary insulation. This assumption greatly reduces any energy savings benefit from the foam plastic. If R6 of foam plastics was considered as the primary insulation, and a fibrous R13 was considered as a secondary insulation, the R6 foam plastic would be credited with about 75% of the savings and the R13 fibrous insulation with about 17%. The assumption of primary versus secondary position can have a significant effect on the energy savings used to calculate payback in this paper.

In the illustrative example above, R6 of foam plastics as a secondary insulation accounts for only 4% of additional energy savings. If the R6 foam plastic were considered as the primary insulation, it would account for 75% of the energy savings. The benefit of foamed plastics is decreased nearly twenty-fold when considered as a secondary insulation instead of a primary insulation.

Moreover, foam plastics are routinely used as the only insulation in many buildings. For example, XPS insulated sheathing and SPF are used as an external continuous insulation over masonry or framed walls and low-sloped roofs. SPF is often used as the cavity insulation in many framed structures. Externally-applied SPF and XPS in combination with fibrous insulations in framed wall constructions also provide a more thermally efficient wall assembly by reducing thermal bridging from the framing members. In the case of steel stud framing the external use of XPS or SPF provides even more efficiency.

To make the analysis valid the methodology MUST consider all valid insulation scenarios and not the single case (Boston) used in the Harvey publication. The analysis of GWP from achieved savings has to consider climate, construction type, how much

SPF or XPS insulation is used in various climate and construction types and the base insulation used. This has been the methodology used in 2 studies carried out by the XPS manufacturers (5), (6). The end results from these studies demonstrated GWH (savings) / GWH (emissions) ratios from 8 to 170. These are extremely attractive ratios. Another study (7) also concluded that for every unit of CO^2 used to make rigid foam insulation more than 233 units of CO^2 are saved. These factors, among others, have allowed one XPS manufacturer to receive Cradle-to-Cradle® silver certification by MBDC (McDonough Braungart Design Chemistry). Cradle-to-Cradle is a leading product certification program recognized by many government agencies and environmental organizations, such as the U.S. EPA and U.S. Green Building Council.

Another point to be addressed in the EBN article's analysis, or lack thereof, is the fact that Canadian climate conditions over time are typically more severe than Boston's. This significantly increases the insulation scenarios predicted heating savings further driving the CO^2 savings up and reducing "payback".

4. GWP impact of fourth-generation blowing agents not fully reported

Fourth-generation blowing agents for SPF, with significant reductions in GWP are not fully reported. During the past two decades, blowing agent manufacturers worked diligently to reduce the environmental impact of these chemicals with regard to ozone depletion potential and global warming potential. A brief summary of this development is provided in Table 1 of this paper. These fourth-generation blowing agents were not included in Table 1 of the EBN article, and should be added in fairness to address the future of these materials. In fact three major chemical companies have recently announced the impending launch of fourth generation of SPF blowing agents to occur within the next 1-2 years (2),(3),(4). We believe this continuing evolution of SPF blowing agents should be considered and discussed for completeness.

Years	Generation	SPF Blowing Agent (USA)	ODP	GWP
1960s -1993	1	CFC-11	1.0	4750
1993 - 2003	2	HCFC-141b	0.12	760
2003 - present	3	HFC-245fa	0	1020
2012 and beyond	4	HFO/HFE	0	6 to 15

Table 1: Environmental Impact (GWP and ODP) of closed-cell SPF insulation Blowing Agents

The XPS insulations' migration to HFC-134a as the blowing agent has reduced the GWP while maintaining the insulation's thermal and physical properties. Continuing research to improve XPS insulation products is of course always ongoing.

Blowing agent	GWP100
CO2	1
CH4	21
HFC-152a	124
N2O	310
HFC-134a	1300
HCFC-142b	2000

5. **Additional energy savings from reduced air leakage & elimination of thermal bridges**

The U.S. Department of Energy states air leakage can account for 20-40% of a buildings heating and cooling costs. In the EBN article and the Harvey publication, the effects of energy loss from air leakage were ignored. Foam plastics are air-impermeable and therefore minimize air leakage and convection effects. Further, most foam plastics are moisture resistant, not degraded or otherwise compromised by moisture infiltration.

Continuous layer application of either XPS or SPF can reduce air leakage through the building envelope. This reduces the energy required to heat and cool the infiltrating air. These potential savings were not considered when evaluating the savings GHP in the EBN article.

Use of XPS rigid insulating sheathing as a replacement for conventional non-insulating sheathings like OSB or plywood in residential construction has been shown to not only increase the effective thermal resistance of the wall but has also resulted in as much as a 40% reduction in air leakage rate through the insulated walls. Replacing fibrous insulation in the cavity with SPF and keeping insulating sheathings on the exterior further reduces the potential for air leakage.

The continuous application of SPF to a wall surface also accounts for significant air sealing benefits. In these types of applications the EBN analysis should have considered SPF to have an additional 20-40% energy savings. Also not considered is that SPF around windows and doors can provide a complete air barrier system for most buildings.

Meeting more stringent insulation levels in wood-framed walls can be achieved by using deeper framing, thicker fibrous insulation in walls that are sheathed with conventional wood-based sheathings (ie: OSB). The use of rigid XPS or ISO insulating sheathings with or without SPF in the frame cavities allows meeting those same stringent insulation levels without the additional framing, fiber insulation and non-insulating sheathing. These are significant GWP savings when one considers the embodied energies of these three components. Also consider that the sheathing and framing are taken from a source (trees) that contributes to reducing GHG production. This has not been considered in the analysis for this EBN article.

6. **Significant condensation potential in assemblies**

Steel or wood-framed wall assemblies with little or no exterior continuous insulation in the form of rigid XPS foam sheathing or SPF are subject to colder conditions in the outer regions of the wall cavity during the colder times of year. As a result the potential for concealed condensation is greatly increased. This condensation can lead to reduced durability of the framed wall by creating conditions favourable to wood rotting and corrosion. These potential moist conditions in the wall can also lead to potential health issues such as mold growth. The same concerns apply to block/concrete walls that have little or no externally-applied continuous insulation. The layers of SPF or XPS insulating sheathing keep wall cavities and interior surface temperatures of block/concrete walls significantly warmer decreasing the potential for rotting, corrosion and mold growth. These insulation applications further provide significant resistance to outward leakage of warm, humid air during the heating season. This further reduces the potential for concealed condensation and the inherent problems associated with it.

Summary

If the issues above are properly addressed as part of a comprehensive science-based product analysis we believe that the payback term for SPF and XPS insulation will be dramatically reduced as demonstrated below.

SPF:

The correct blowing agent content, use as the primary insulation and the additional estimated air leakage savings can reduce the present 36-year payback by using the following factors :
Amount of HFC-245fa blowing agent 0.5 factor
Secondary vs. primary insulation (4% savings to 75% savings = 19x) 0.05 factor
Air sealing properties included (30% average savings) 0.70 factor

36 year payback (1" of SPF) x 0.5 x 0.05 x 0.70 = **0.63 years actual payback**.

XPS:

Studies and information (5), (6) and (7) using the proper protocols for LCA and actual data on climate, building type, insulation requirements and actual insulation volumes used confirmed that the payback for these products is not 36 to 46 years but **actually 0.5 to 3.3 years.**

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References

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5 Energy and Environmental Benefits of Extruded Polystyrene Foam and Fiberglass Insulation Products in US Residential and Commercial Buildings – Merle F.McBride, PhD, Owens-Corning 4-27-2004

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