REPORT BRIEF

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Chemical and Environmental Justice Impacts in the Life Cycle of Building Insulation

ENERGY EFFICIENCY FOR ALL

energyefficiencyforall.org

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ABOUT ENERGY EFFICIENCY FOR ALL

Energy Efficiency for All unites people from diverse sectors and backgrounds to collectively make affordable multifamily homes energy and water efficient. We do this work so people in underinvested and marginalized communities—particularly Black, Latino, and other communities of color—can equitably benefit from the health, economic, and environmental advantages of energy and water efficiency. Reducing energy and water use in affordable multifamily housing will improve the quality of life for millions, preserve affordable housing across the country, reduce the energy burden on those who feel it most, and cut carbon pollution.

ABOUT HEALTHY BUILDING NETWORK

Since 2000, Healthy Building Network (HBN) has defined the leading edge of healthy building practices that increase transparency in the building products industry, reduce human exposure to hazardous chemicals, and create market incentives for healthier innovations in manufacturing. We are a team of researchers, engineers, scientists, building experts, and educators, and we pursue our mission on three fronts:

1) Research and policy—uncovering cutting-edge information about healthier products and health impacts;

2) Data tools—producing innovative software platforms that ensure product transparency and catalog chemical hazards; and

3) Education and capacity building—fostering others' capabilities to make informed decisions.

As a nonprofit organization, we do work that broadly benefits the public, especially children and the most marginalized communities, who suffer disproportionate health impacts from exposure to toxic chemicals. We work to reduce toxic chemical use, minimize hazards, and eliminate exposure for all.

ACKNOWLEDGMENTS

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HBN HEALTHY BUILDING NETWORK KNOW BETTER

SUMMARY

Photo: Beto Lugo-Martinez/ CleanAirNow

Product manufacturers, policymakers, and professionals in the building industry are paying more attention to the potential health and environmental impacts of building products during installation and use, but there has been less consideration of the important chemical impacts, including contributions to environmental injustice, that may occur during other life cycle stages. To address this issue, we used the principles of green chemistry and environmental justice to develop a framework for understanding some of the important life cycle chemical impacts of products, considering the following criteria: avoid hazardous chemicals, prevent accidents, prevent pollution and waste, implement circularity and reduce end-of-life impacts, abide by environmental regulations, and prevent disproportionate and cumulative impacts.

This brief introduces these criteria for considering chemical and environmental justice impacts in a product's life cycle, highlights findings from case studies on fiberglass and spray foam insulation, and outlines recommended actions for building industry professionals, policymakers, manufacturers, and alternatives assessors.[a,b] Among our key findings:

- The production and disposal of building materials can impact surrounding communities, contributing to environmental injustice.
- Understanding the embodied chemical impacts in the life cycle of building materials, including how they contribute to environmental injustice and cumulative impacts on communities, is necessary to inform safer, more equitable material choices and policies.
- Case studies comparing the primary inputs for spray foam and fiberglass building insulation found a much heavier pollution burden for spray foam, but over their life cycles, both materials impact communities with disproportionate numbers of Black, Indigenous, people of color (BIPOC), and/or low-income residents.
- There are significant opportunities for life cycle improvements through avoiding hazardous chemicals, implementing circularity, and taking other actions stemming from the principles of green chemistry and environmental justice.
- Manufacturers and policymakers should advance transparency about what is in a product, how and where it is made, and the hazardous releases that occur throughout its life cycle.
- Avoiding hazardous chemicals in a product's content can serve as a starting point to help protect not only building occupants and installers, but also others impacted by those hazardous chemicals throughout the supply chain.

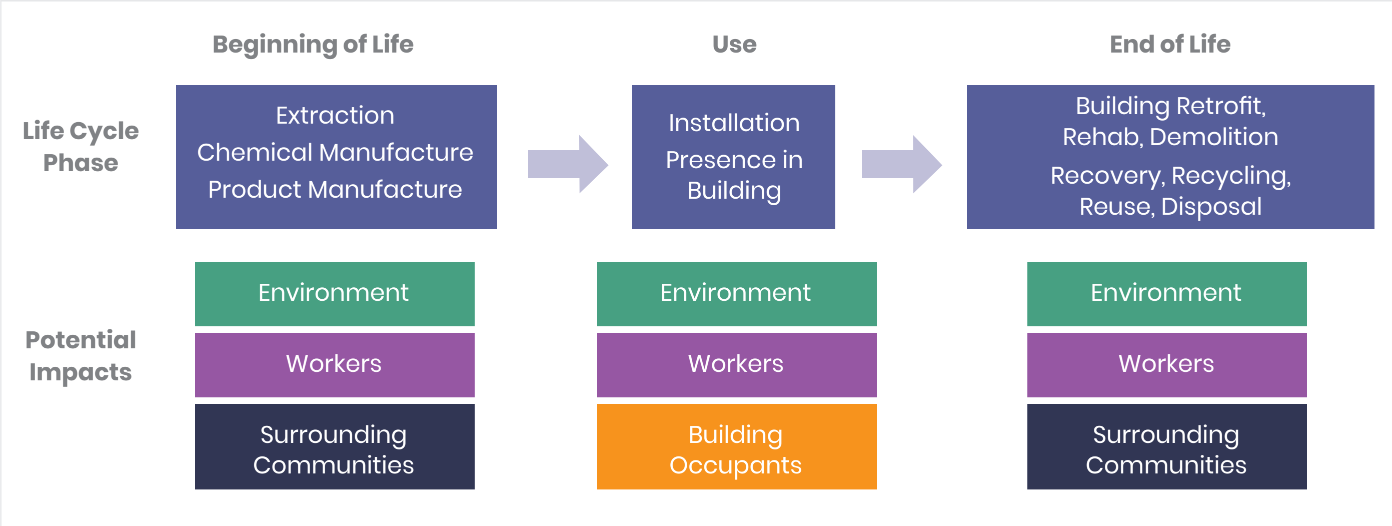
[a] Full case studies are available here: https://healthybuilding.net/reports.
[b] Alternatives assessment (or analysis) is a comprehensive approach to identifying safer chemicals, materials, and processes.

Background

Often, when people think about a "green" building, energy efficiency is what comes to mind. For decades the sustainable building sector has focused mostly on considerations that bring financial benefits to building owners and developers. Thus, the major factors driving building material choices have been energy performance and cost.[1] More recently, materials' life cycle greenhouse gas emissions (also called embodied carbon), which are relevant to buildings' contribution to climate change, have also become a focus. Often overlooked but equally important are the human and environmental health impacts of hazardous chemicals in a product's life cycle (Figure 1).

Hazardous chemicals can impact communities near manufacturing or disposal sites; workers who make, install, or dispose of materials; building occupants; and the broader environment. They can also contribute to environmental injustices (see breakout box, "Environmental Justice and Building Materials"). To truly create an equitable and sustainable built environment, we must not perpetuate these impacts. Climate solutions, such as building insulation, should advance the well-being of all communities, not just those that are privileged in society. Buildings and products shouldn't be considered "green" unless they are green for all.

Figure 1. Simplified building materials life cycle and potential impacts of hazardous chemicals at each stage



Climate solutions, such as building insulation, should advance the well-being of all communities. Buildings and products shouldn't be considered "green" unless they are green for all.

In our prior research, we identified fiberglass as a preferred insulation material and spray foam as having significant chemical concerns.

Figure 2. Case study criteria for assessing health and environmental justice impacts based on selected green chemistry and environmental justice principles

Framework

To expand understanding of products' life cycle health and environmental justice impacts, we started with the principles of green chemistry and environmental justice and developed a framework that includes the six major criteria outlined in Figure 2.[2]

Applying the Framework: Insulation Case Studies

Using this framework, we examined two widely used insulation materials: fiberglass and spray polyurethane foam (SPF) insulation. We chose insulation because it is a critical element of almost all new construction and many energy efficiency upgrades; it helps provide a comfortable indoor environment and reduce energy use in buildings but can also introduce hazardous chemicals. In our prior research focused on use-phase chemical impacts, we identified fiberglass as a preferred insulation material and spray foam as having significant chemical concerns. We chose these materials for additional research because one is among the best in class and one is worst in class. For more information on the hazards associated with a range of insulation materials, see Healthy Building Network's website.[c] The goal of this new work was to add to our understanding of the life cycle impacts.

[c] https://healthybuilding.net/products/7-insulation

Environmental Justice and Building Materials

Have you ever thought about where the materials in buildings come from, who makes them, and how the chemicals used in manufacturing impact these workers and people who live nearby? What about when a building is rehabilitated or torn down and demolition materials are disposed of—where do the materials go and who is impacted by this disposal? These questions are important because the production and disposal of building materials can contribute to environmental injustice.

Environmental injustice or environmental racism refers to the fact that pollution and its resultant harmful health impacts fall disproportionately on BIPOC communities. Decades of systemic racism and racist policies such as redlining have resulted in a greater concentration of pollution sources, polluting industries, and contaminated sites in BIPOC communities.[3] These same populations, moreover, do not benefit equally from policies and investments that improve community health, such as green infrastructure upgrades or programs to strengthen climate resilience. And often, the communities located near chemical plants, manufacturing facilities, and disposal sites, including those related to building materials, are disproportionately composed of BIPOC and other populations, such as low-income people, who have been and continue to be excluded from power, processes, and decisions that affect them. The environmental justice movement has worked for decades to reduce environmental, health, economic, and racial disparities for impacted communities.[4]

Those facing environmental injustice often suffer from multiple sources of pollution in addition to other stressors, such as poverty and racial discrimination.[5] U.S. policies have largely failed to evaluate, mitigate, or prevent these *cumulative impacts* resulting from a combination of stressors over time. A community experiencing cumulative impacts may be identified as an overburdened, disadvantaged, or environmental justice community in local, state, or federal policies.

Including life cycle chemical impacts in building material selection and advancing policies to reduce and eliminate these impacts can help to lessen environmental injustices and improve equity.

Highlights From the Case Studies

Below we outline some potential chemical and environmental justice impacts throughout the life cycle of products, according to the framework described above, with specific examples from the insulation case studies. We investigated the manufacture and disposal in the United States of the primary component of spray foam insulation (isocyanates) and the primary component of fiberglass insulation (glass fibers).[d]

Avoid Hazardous Chemicals

Hazardous chemicals can contribute to the development of diseases such as cancer and asthma, disrupt human reproductive systems, and negatively impact children's health. Chemicals that are volatile, reactive, or flammable can present immediate dangers and increase the potential for incidents that can harm workers and surrounding communities.

We identified the manufacturing inputs for each material (glass fibers used in fiberglass and isocyanates used in SPF) and the associated human health and physical hazards.

As shown in Table 1, more hazardous, reactive, flammable, and volatile inputs are used to make isocyanates than are used to make glass fibers. In addition, isocyanates are themselves respiratory sensitizers, which means that exposure can result in lung irritation or sensitization such that future exposure to small quantities can trigger asthma, inflammation, or other allergic reactions in the respiratory system. The type of glass fibers used in fiberglass insulation are not considered hazardous but can cause temporary eye, skin, and lung irritation.

Prevent Accidents

Nonroutine events like equipment failures or weather-related incidents (e.g., hurricanes, extreme temperatures) can lead to greater impacts on workers and communities and can disrupt daily life for residents. For example, hurricanes and the resultant flooding and power outages have caused fires and additional hazardous releases from industrial facilities.[6]

We searched for government and media reports of worker injuries and community impacts due to incidents at manufacturing and supply chain facilities. We did not find any incidents related to glass fiber manufacturing, but we did find multiple reports of worker injuries and other incidents related to isocyanate manufacturing. For example, between 2016 and 2020, one isocyanate facility had three separate incidents during which it released phosgene, an acutely toxic input chemical, injuring workers and requiring community shelter-in-place orders.[7] The most dependable way to prevent incidents is to use safer chemicals.

> "We worry about an explosion all the time in that area. You just have to pray that it never happens."
>
> —Christine Bennett, resident near a high-risk facility[8]

Prevent Pollution and Waste

During manufacturing, hazardous chemical waste can be released as pollution to the air or water, or collected and disposed of. Communities surrounding facilities where hazardous chemicals are released or disposed

Table 1. Analysis of inputs with respect to the criterion "avoid hazardous chemicals"

Manufacturing inputs	Isocyanates	Glass fibers
Type of inputs	Primarily fossil fuel–based	Primarily recycled glass and mineral-based
Inputs hazardous to human health	>90%	~35%
Highly reactive or flammable inputs	50%	<10%
Volatile inputs	>90%	0%

[d] Isocyanates make up about 50 percent of spray polyurethane foam insulation, and glass fibers make up about 85–98 percent of residential fiberglass batt or blown-in insulation.

of (either at the manufacturing site itself or at other disposal facilities) are impacted.

We analyzed data from the U.S. Environmental Protection Agency (EPA) on waste and releases from isocyanate and glass fiber facilities.[e] Results for the two materials are not directly comparable because there was not enough publicly available information to calculate the amount of waste or releases for a given output of insulation. However, greater amounts of hazardous releases, regardless of production volume of insulation, can still translate to greater overall impacts on surrounding communities and the environment.

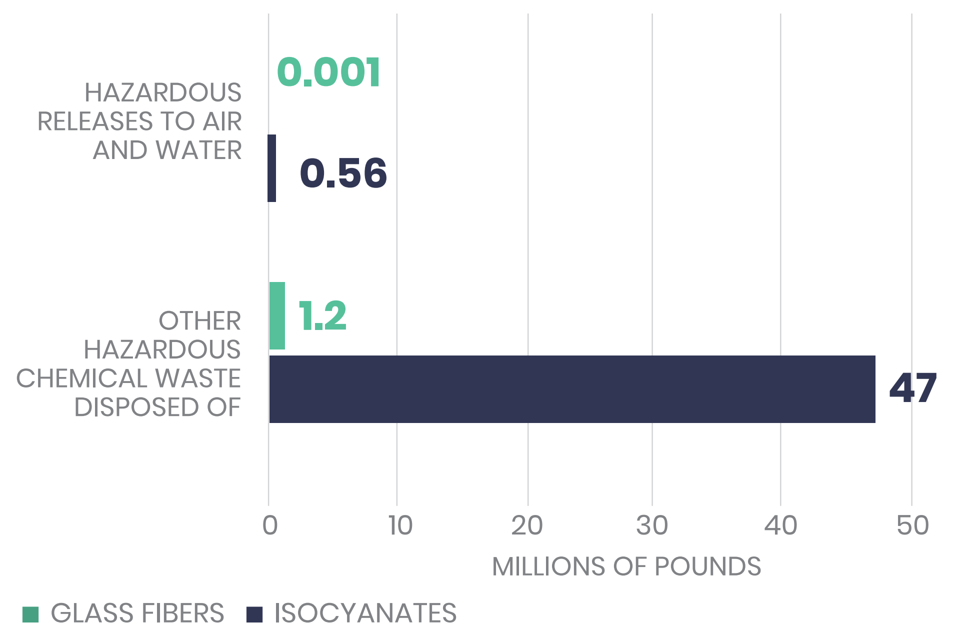
Manufacturing of isocyanates released a much larger amount of hazardous chemicals to the air and water and generated far more overall waste than did glass fiber manufacturing (Figure 3). While comparatively smaller in the amount of waste, the manufacturing of glass fibers still released compounds of major concern such as lead, a toxic metal for which there is no safe level of exposure for children.[9]

Abide by Environmental Regulations

While much more needs to be done from a regulatory perspective to safeguard communities, workers, and the environment, adherence to current regulations can provide some protection from dangerous pollution and chemicals. Noncompliance can be discovered only by inspections and enforcement, but the EPA lacks resources to inspect every facility.[10] Therefore, periods without violations may simply reflect a lack of inspection and do not necessarily mean a facility is in compliance.

We analyzed EPA data on regulatory compliance for each isocyanate and glass fiber facility and found that many exhibited regular noncompliance and had significant violations.[f] For example, 2 of the 4 isocyanate facilities (50 percent) and 3 of the 22 glass fiber facilities (14 percent) had significant violations for all 12 quarters of the past three years at the time of our research. Irregularly enforced and consistently violated regulations fail to protect all individuals equally from toxic chemicals and violate people's fundamental right to clean air, water, and land.

FIGURE 3. Average annual hazardous isocyanate– or glass fiber–related chemicals released to air and water or disposed of as waste for the facilities studied, 2015–2019



[e] In the case studies, we identified 22 facilities in 21 cities making glass fibers for residential batt and loose fill fiberglass insulation and 4 facilities in 3 cities making isocyanates used in spray foam insulation. We analyzed waste and releases from these facilities using the EPA's Toxics Release Inventory (TRI). TRI requires self-reporting from manufacturers on waste and releases of some specific hazardous chemicals. We focused our analysis on chemicals tied to isocyanate and glass fiber production specifically. Isocyanates are used in the manufacture of many other products, including polyisocyanurate insulation, so not all of the reported releases were tied to spray foam insulation. For more details and limitations to this analysis, see the full reports.

[f] Violations are reported quarterly. Data for isocyanates facilities were current as of May 2021; data for glass fiber facilities were current as of July 2022.

Two of the 4 isocyanate facilities (50 percent) and 3 of the 22 glass fiber facilities (14 percent) had significant violations for all 12 quarters of the past three years.

Prevent Disproportionate Impacts

As discussed earlier, in the United States, communities of color and low-income communities are disproportionately affected by environmental pollutants.[11] We analyzed facility locations and community demographics to identify localized environmental justice impacts and found that both isocyanate and glass fiber production can contribute to such disproportionate impacts.

Isocyanate manufacturing uses and releases hazardous chemicals, as noted above. All four isocyanate facilities in the United States are sited in places that are disproportionately Black, Latino, and/or American Indian/ Alaska Native. As for glass fiber manufacturing facilities, the majority are located in or near communities with a percentage of people of color and/or low income greater than in the United States overall. Nine glass fiber facilities had at least one significant violation of EPA regulations in the past 12 quarters. Seven of these are located in communities disproportionately made up of people of color, low-income populations, and/or those who are linguistically isolated, and three have disproportionately high percentages of all three of these populations (Table 2).[g, 12] Two are in Kansas City, Kansas, within about half a mile of each other. The percentage of Black people in the community surrounding these Kansas City facilities is more than twice that of the United States overall, and the percentage of Latino people is 1.5 times that of the nation as a whole.

Prevent Cumulative Impacts

While the impacts of specific processes discussed above are important to consider, it is also imperative to understand the total, *cumulative impacts* experienced by communities, as mentioned above. High concentrations of industrial facilities, contaminated sites, and other sources of pollutants near homes can all contribute to cumulative impacts.

We reviewed EPA data on additional hazardous chemical releases from the glass fiber and isocyanate facilities (from other processes) and on all hazardous chemical releases reportable to the EPA in the cities where those facilities are located.

Table 2. Demographic information about residents within three miles of glass fiber manufacturing facilities with significant EPA violations, compared with the United States overall

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	Kansas City, KS	Waxahachie, TX	Santa Clara, CA	Albion, MI	Lanett, AL	Inwood, WV	Kansas City, KS	Chowchilla, CA	Richmond, IN	U.S. overall
People of color	63%	28%	68%	38%	52%	16%	65%	72%	18%	39%
Low-income	52%	24%	18%	57%	50%	26%	53%	43%	46%	33%
Linguistically isolated	9%	2%	9%	0%	1%	0%	10%	8%	1%	4%
Number of Quarters with Significant Violations	5 of 12	4 of 12	12 of 12	10 of 12	1 of 12	12 of 12	9 of 12	12 of 12	5 of 12	

Gray highlights indicate where the percentage of specific populations in the three-mile radius is greater than in the nation as a whole.

g Definitions are based on the EPA's EJScreen. Low-income population is the "population in households where the household income is less than or equal to twice the federal 'poverty level.' " People of color are individuals "who list their racial status as a race other than white alone and/or list their ethnicity as Hispanic or Latino." Linguistically isolated populations are people living in "a household in which all members age 14 years and over speak a non-English language and also speak English less than 'very well' (have difficulty with English)."

The four isocyanate manufacturing facilities are located in three cities: two in Geismar, Louisiana, and one each in Baytown, Texas, and Freeport, Texas. Figure 4 illustrates how the releases from these facilities contribute to cumulative hazardous chemical releases in the surrounding communities. Compared with glass fiber manufacturing, the isocyanate facilities are located in cities with much greater total hazardous releases, but both contribute to cumulative impacts.

Geismar has many other industrial facilities besides the two isocyanate manufacturing plants. Combined, these facilities reported releasing more than 15 million pounds of hazardous chemicals in 2019 alone (Figure 4), and EPA data for the past 10 years show an upward trend in the quantity of hazardous releases reported in Geismar.

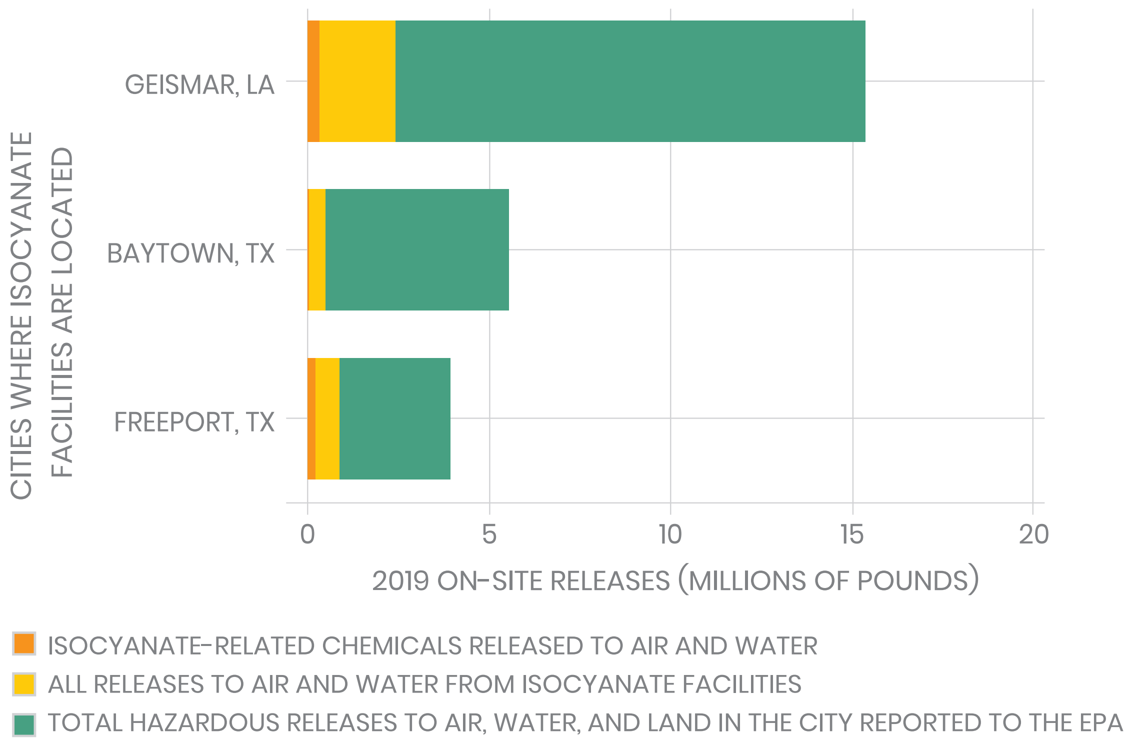
Geismar is part of the area along the Mississippi River between New Orleans and Baton Rouge known as "Death Alley" (or "Cancer Alley") because of the concentration of industrial activity and the associated elevated health risks and deaths.[13] The proportion of Black residents in the community around its isocyanate facilities is more than 2.5 times the proportion of Black residents in the United States overall.

Where Do We Go From Here?

While both spray foam and fiberglass insulation materials impacted communities that are disproportionately BIPOC and/or low income, fiberglass performed far better for the criteria we analyzed. We advise choosing fiberglass or other insulation materials with fewer hazardous chemicals (see breakout box, "Healthy Building Network's Product Guidance"), implementing the following recommendations that are relevant to you to reduce impacts on communities, and supporting those who are pushing for changes to ensure they have healthy places to live, learn, work, and play.

Embodied chemical and environmental justice impacts should be key considerations in decision making for all building materials. Including these considerations in climate and energy solutions can ensure they do no harm and benefit all. The framework we've developed can be applied to any other chemical or material to identify opportunities to reduce impacts or to compare materials.

FIGURE 4. Isocyanate–related releases to air and water, all releases from isocyanate facilities to air and water, and all releases in the cities where isocyanates are produced



Policymakers, manufacturers, building industry professionals, alternatives assessors, and others all have a role and a responsibility to support work toward a more equitable and sustainable built environment. Our recommendations follow.

For Policymakers:

- Increase facility inspections, penalties for violations, and enforcement of corrective actions.[14]
- Strengthen the Risk Management Plan (RMP) Rule to increase information and protections for people who live and work near high-risk chemical facilities.[15]
- Implement mandates on emissions reduction.[16]
- Increase safe recovery, reuse, and recycling of products without hazardous content through incentives and mandates.[h,17]
- Adopt policies centered on hazard avoidance.
- Adopt policies that account for cumulative impacts in permitting and re-permitting decisions and meaningfully involve impacted communities in decision making.
- Support transparency about material content, emissions, and location of manufacture.

For Manufacturers:

- Formulate products with contents that are known to be safe.
- Reduce waste and releases beyond regulatory requirements by optimizing process efficiency and using safer inputs.
- Design products to safely feed back into the same material production cycle, reducing demand for new raw materials and resources.
- Invest in infrastructure to recover materials at their end of use.
- Avoid expanding or building new facilities that will increase hazardous chemical releases in already disproportionately impacted communities.
- Assess and improve social equity impacts of products and in organizations.[18]
- Provide full disclosure about material content, emissions, and location of manufacture.
- For fiberglass and spray foam manufacturers, see the full case studies for additional, specific recommendations.[i]

For Building Industry Professionals:

- Avoid spray polyurethane foam insulation whenever possible.
- Avoid hazardous chemicals in a product's content as a starting point to help protect not only building occupants and installers, but also others impacted by those hazardous chemicals throughout the supply chain.
- Use Healthy Building Network's product guidance for a range of categories to choose products with fewer chemical impacts.[j] See breakout box, below, for insulation guidance.
- Demand transparency about what is in a product, how and where it is made, and the hazardous releases that occur throughout its life cycle.
- Work with standards organizations, like the Health Product Declaration Collaborative, to incorporate comprehensive reporting on chemical hazards, location information, and environmental justice considerations.

For Alternatives Assessors:[19]

- Consider life cycle environmental justice impacts in problem formulation and scoping.
- Use publicly available information to understand localized life cycle impacts.
- Incorporate principles of environmental justice in values that guide alternatives assessment decisions.
- Inform more equitable decisions by understanding disproportionate and cumulative impacts of alternatives.

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[h] Does not include "chemical recycling." See cited source for more information.
[i] Full case studies are available here: https://healthybuilding.net/reports.
[j] https://healthybuilding.net/products.

Healthy Building Network's Product Guidance

Healthy Building Network uses a simplified color spectrum (red to orange to yellow to green) to rank different product types within various building product categories on the basis of the chemicals used in their manufacturing and associated health hazards. Products in green categories are the best options currently available, whereas products at the bottom of the spectrum, in red, should be avoided. See Healthy Building Network's website for up-to-date guidance on insulation and other product categories.[k]

Here is some general guidance to use when choosing insulation materials:

- Give preference to fiberglass, formaldehyde-free mineral wool, or cellulose insulation.
- If board insulation is required, opt for expanded cork, halogen-free polyisocyanurate, or rigid mineral wool insulation.
- Avoid foam insulation, whether board or spray applied, whenever possible.
- Use mechanical installation methods, such as fasteners, to avoid unnecessary use of adhesives.
- Choose products with full disclosure of content through Health Product Declarations (HPDs).

- Expanded Cork
- Blown-In Fiberglass (Loose Fill, Dense Pack, and Spray-Applied)
- Kraft-Faced and Unfaced Fiberglass Batts
- Formaldehyde-Free Mineral Wool Batts
- Halogen-Free Polyisocyanurate
- Unfaced Cellulose/Cotton Batts
- Blown-In Cellulose (Loose Fill, Dense Pack, and Wet Blown)
- PSK or FSK-Faced Fiberglass Batts or Blankets
- Mineral Wool Batts and Boards
- Fiberglass Board
- Expanded Polystyrene (EPS)
- Polyisocyanurate
- Traditional Expanded Polystyrene (EPS)
- Extruded Polystyrene (XPS)
- Traditional Extruded Polystyrene (XPS)
- Spray Polyurethane Foam (SPF)

[k] https://healthybuilding.net/products

Endnotes

1 NAACP, "NAACP Guidelines for Equitable Community Involvement," May 2021, https://drive.google.com/file/d/1ReSm3NDsH5thjNnOZn7VW9RBiOkjQHTk/view.

2 Delegates to the First National People of Color Environmental Leadership Summit, "Principles of Environmental Justice," https://www.ejnet.org/ej/principles.html (accessed November 8, 2021). American Chemical Society, "12 Principles of Green Chemistry," https://www.acs.org/content/acs/en/greenchemistry/principles/12-principles-of-green-chemistry.html (accessed May 4, 2021). Our framework was also informed by the Louisville Charter for Safer Chemicals. The Louisville Charter has been endorsed by more than 100 organizations representing environmental justice and grassroots communities; environmental and health nonprofits; and leaders in the medical, public health, business, science, and research communities. It is meant to serve as a shared road map for transforming the chemical industry so that it is no longer a source of greenhouse gas emissions and toxic harm. For more information, see Coming Clean, "The Louisville Charter for Safer Chemicals," https://comingcleaninc.org/louisville-charter/endorse (accessed August 16, 2022).

3 Robert D. Bullard et al., *Toxic Wastes and Race at Twenty: 1987–2007*, United Church of Christ, March 2007, https://www.nrdc.org/sites/default/files/toxic-wastes-and-race-at-twenty-1987-2007.pdf. Kelly Hilovsky, Kenneth Lim, and Tia Taylor Williams, *Creating the Healthiest Nation: Health and Housing Equity*, American Public Health Association, May 2020, https://www.apha.org/-/media/files/pdf/topics/equity/health_and_housing_equity.ashx.

4 Robert D. Bullard, Glenn S. Johnson, and Angel O. Torres, *Environmental Health and Racial Equity in the United States* (Washington, D.C.: APHA Press, 2011), https://doi.org/10.2105/9780875530079.

5 G. M. Solomon et al., "Cumulative Environmental Impacts: Science and Policy to Protect Communities," *Annual Review of Public Health* 37, no. 1 (March 2016): 83–96, https://doi.org/10.1146/annurev-publhealth-032315-021807. Yukyan Lam et al., "Toxic Air Pollution in the Houston Ship Channel: Disparities Show Urgent Need for Environmental Justice," Natural Resources Defense Council and Texas Environmental Justice Advocacy Services, August 31, 2021, https://www.nrdc.org/resources/toxic-air-pollution-houston-ship-channel-disparities-show-urgent-need-environmental.

6 John Schwartz and Hiroko Tabuchi, "When Hurricanes Lead to Industrial Fires, Minority Neighborhoods Can Take a Hit," *New York Times*, August 27, 2020, https://www.nytimes.com/2020/08/27/climate/hurricane-laura-fire-pollution.html. Sara Sneath, " 'Ticking Time Bombs': Residents Kept in the Dark About Risks to La.'s Chemical Plants During Storms," WWNO News, December 7, 2020, https://www.wwno.org/post/ticking-time-bombs-residents-kept-dark-about-risks-las-chemical-plants-during-storms.

7 Sneath, " 'Ticking Time Bombs.' "

8 Ibid.

9 Centers for Disease Control and Prevention, "Factsheet: Lead," November 2009, https://www.cdc.gov/biomonitoring/lead_factsheet.html.

10 Kathlene Butler et al., *Resource Constraints, Leadership Decisions, and Workforce Culture Led to a Decline in Federal Enforcement*," U.S. Environmental Protection Agency (hereinafter EPA), May 13, 2021, https://www.epa.gov/sites/default/files/2021-05/documents/_epaoig_20210513-21-p-0132_0.pdf.

11 Michelle L. Bell and Keita Ebisu, "Environmental Inequality in Exposures to Airborne Particulate Matter Components in the United States," *Environmental Health Perspectives* 120, no. 12 (December 1, 2012): 1699–1704, https://doi.org/10.1289/ehp.1205201. Michael Gochfeld and Joanna Burger, "Disproportionate Exposures in Environmental Justice and Other Populations: The Importance of Outliers," *American Journal of Public Health* 101, no. Suppl 1 (December 2011): S53–63, https://doi.org/10.2105/AJPH.2011.300121. EPA, *Environmental Equity: Reducing Risk for All Communities; Volume 1: Workgroup Report to the Administrator*, June 1992, https://www.epa.gov/sites/production/files/2015-02/documents/reducing_risk_com_vol1.pdf.

12 EPA, "Overview of Demographic Indicators in EJScreen," March 5, 2021, https://www.epa.gov/ejscreen/overview-demographic-indicators-ejscreen.

13 Tristan Baurick, Lylla Younes, and Joan Meiners, "Welcome to 'Cancer Alley,' Where Toxic Air Is About to Get Worse," *ProPublica*, October 30, 2019, https://www.propublica.org/article/welcome-to-cancer-alley-where-toxic-air-is-about-to-get-worse?token=6gUgP8I5cJIpT-zNaKZUM1en4qd5mMoT. James Pasley, "Inside Louisiana's Horrifying 'Cancer Alley,' an 85-Mile Stretch of Pollution and Environmental Racism That's Now Dealing With Some of the Highest Coronavirus Death Rates in the Country," *Business Insider*, April 9, 2020, https://www.businessinsider.com/louisiana-cancer-alley-photos-oil-refineries-chemicals-pollution-2019-11. Forensic Architecture, "Environmental Racism in Death Alley, Louisiana: Phase I Investigative Report," July 4, 2021, https://forensic-architecture.org/investigation/environmental-racism-in-death-alley-louisiana. Coalition Against Death Alley, "Coalition Against Death Alley," https://www.enddeathalley.org (accessed July 25, 2022).

14 Lawrence E. Starfield, letter to Office of Enforcement and Compliance Assurance Office Directors and Deputies, Enforcement and Compliance Assurance Directors and Deputies, and Regional Counsels and Deputies, "Strengthening Enforcement in Communities With Environmental Justice Concerns," EPA, April 30, 2021, https://www.epa.gov/sites/default/files/2021-04/documents/strengtheningenforcementincommunitieswithejconcerns.pdf.

15 Environmental Justice Health Alliance for Chemical Policy Reform et al., comments submitted to EPA in response to "Accidental Release Prevention Requirements: Risk Management Programs Under the Clean Air Act; Notice of Virtual Public Listening Sessions," July 31, 2021, https://www.regulations.gov/comment/EPA-HQ-OLEM-2021-0312-0149.

16 Nicky Sheats, "Achieving Emissions Reductions for Environmental Justice Communities Through Climate Change Mitigation Policy," *William & Mary Environmental Law and Policy Review* 41, no. 2 (February 2017): 27, https://scholarship.law.wm.edu/cgi/viewcontent.cgi?article=1674&context=wmelpr.

17 Veena Singla and Tessa Wardle, "Recycling Lies: 'Chemical Recycling' of Plastic Is Just Greenwashing Incineration," NRDC, February 2022, https://www.nrdc.org/resources/recycling-lies-chemical-recycling-plastic-just-greenwashing-incineration.

18 Companies can use the Social Life Cycle Assessment methodology developed by the United Nations Environment Programme or a similar analysis. Life Cycle Initiative, "Social Life Cycle Assessment (S-LCA)," https://www.lifecycleinitiative.org/starting-life-cycle-thinking/life-cycle-approaches/social-lca/ (accessed April 6, 2022).

19 National Research Council, *A Framework to Guide Selection of Chemical Alternatives* (Washington, D.C.: The National Academies Press, 2014), https://doi.org/10.17226/18872.