We built that.

Del E. Webb School of Construction

Ira A. Fulton Schools of Engineering, Arizona State University

ROOFING ALLIANCE THE FOUNDATION OF NRCA

Roofing Alliance Faculty Workshop

Roofing and sustainability

Mark S. Graham
National Roofing Contractors Association

Helene Hardy Pierce
Industry Advisor

Cool roofs

Vegetative roofs

Rooftop PV

World Green Building Trends 2021

SmartMarket Report

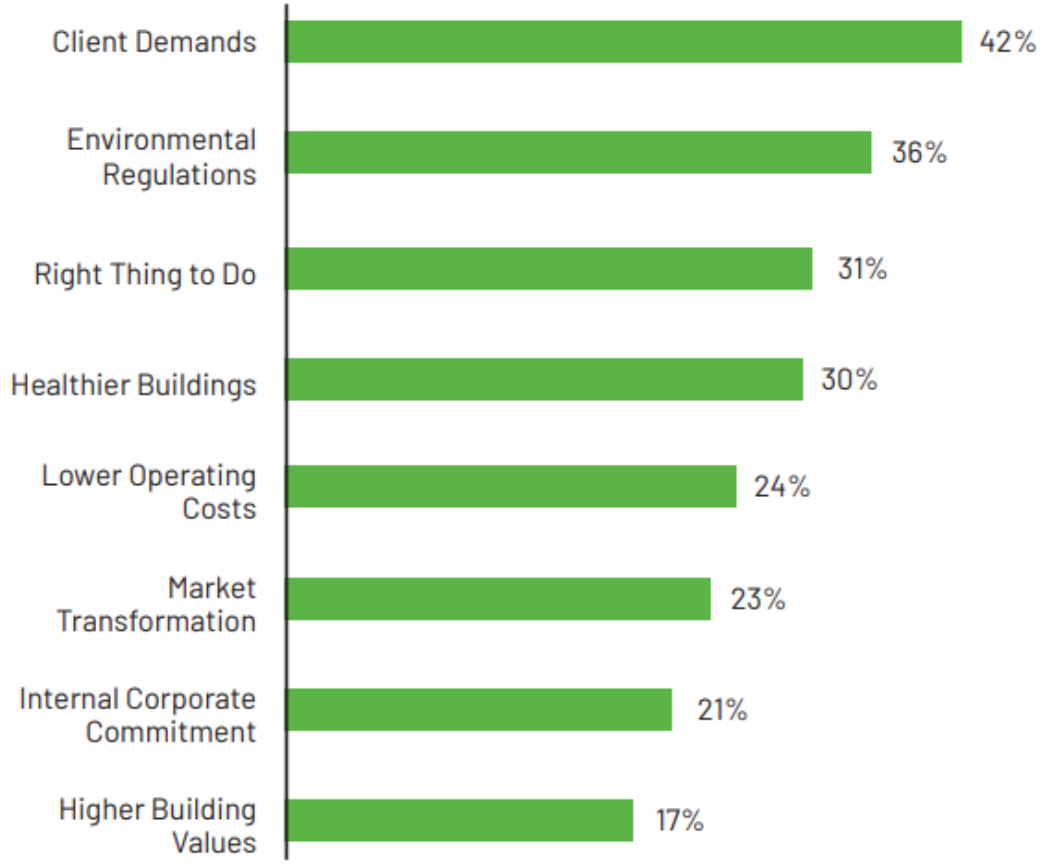
Dodge Construction Network

- Macro Takeaways
- Micro (Product/Granular) Takeaways

Link

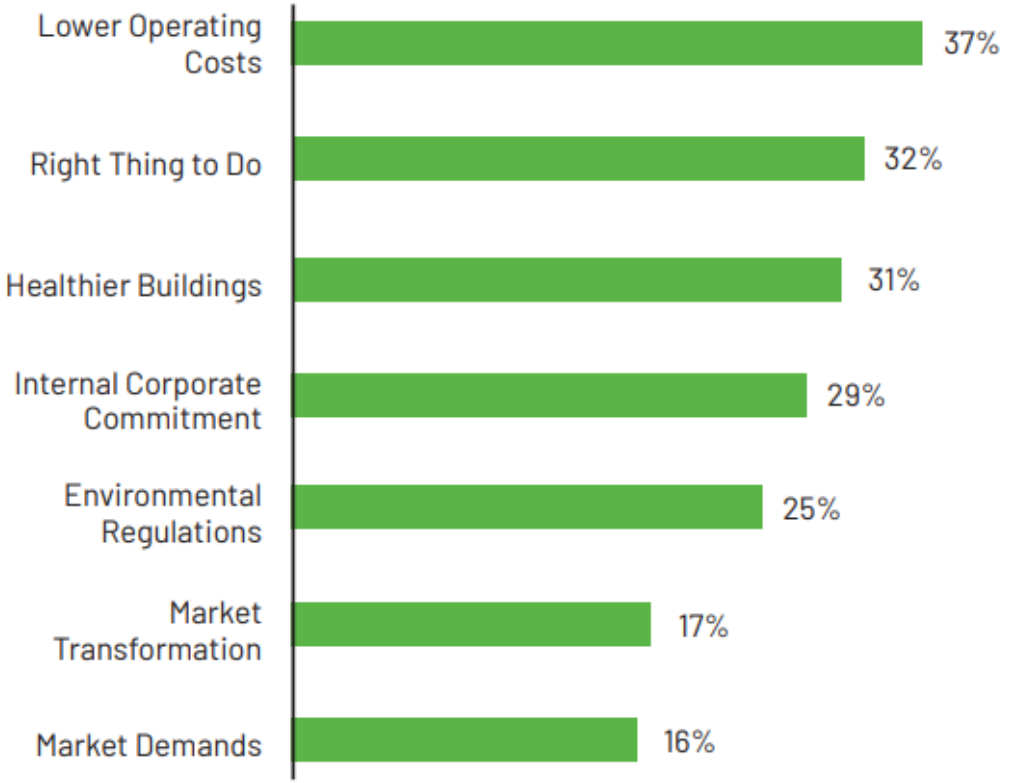
Top Triggers for Green Building (Selected Among the Top Three by Architects, Engineers and Contractors)

Dodge Data & Analytics, 2021



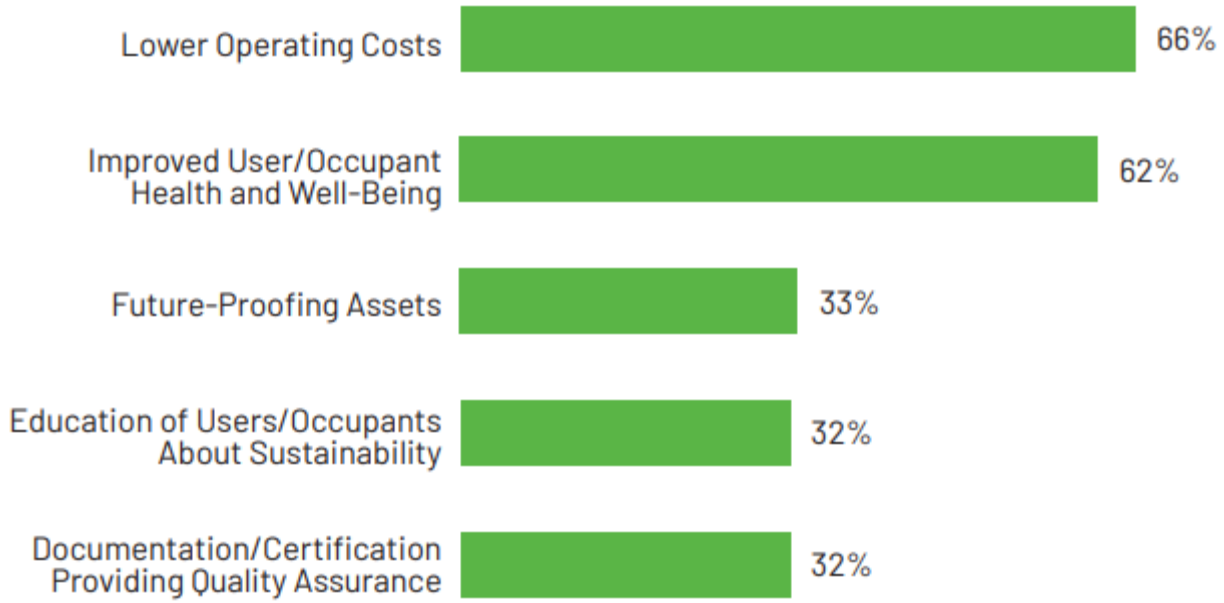
Top Triggers for Green Building (Selected in the Top Three by Owners and Investors)

Dodge Data & Analytics, 2021



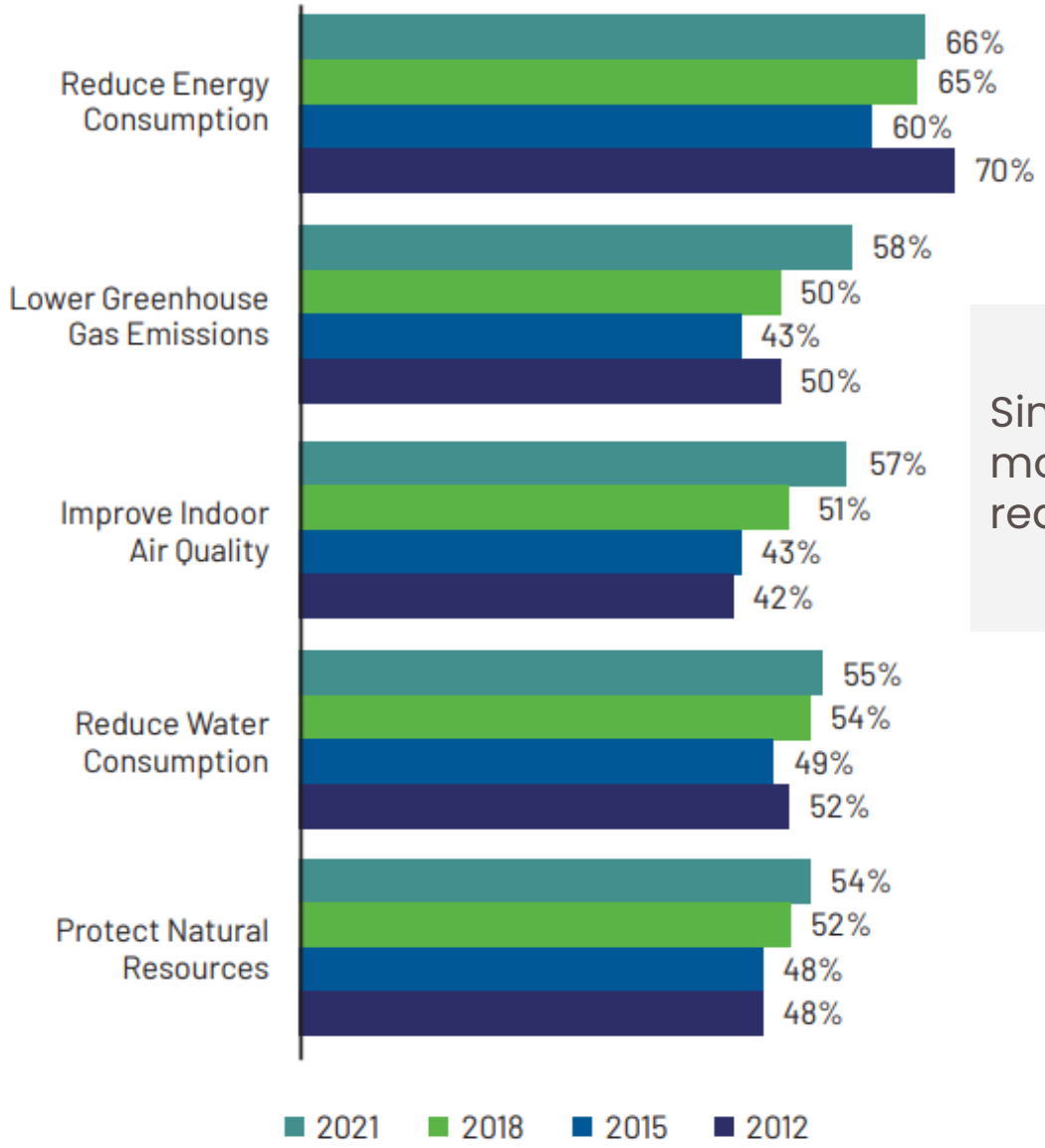
Most Important Business Benefits of Green Building

Dodge Data & Analytics, 2021



Top Environmental Reasons for Building Green (Rated Very Important by Respondents)

Dodge Data & Analytics, 2021

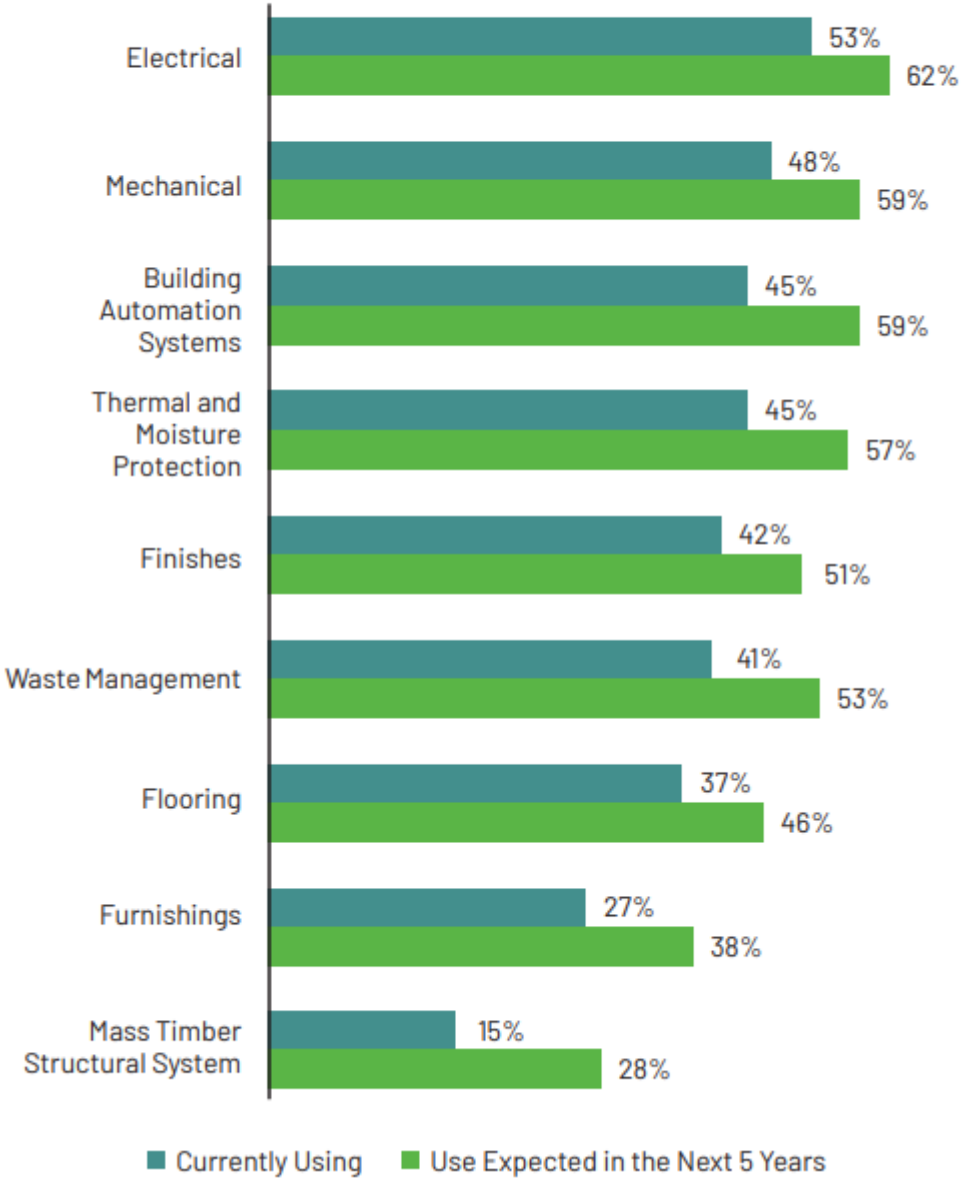


Since 2008, reducing energy consumption is still most frequently selected as a top environmental reason for building green.

WHY

Current and Expected Use of Green Building Products and Systems

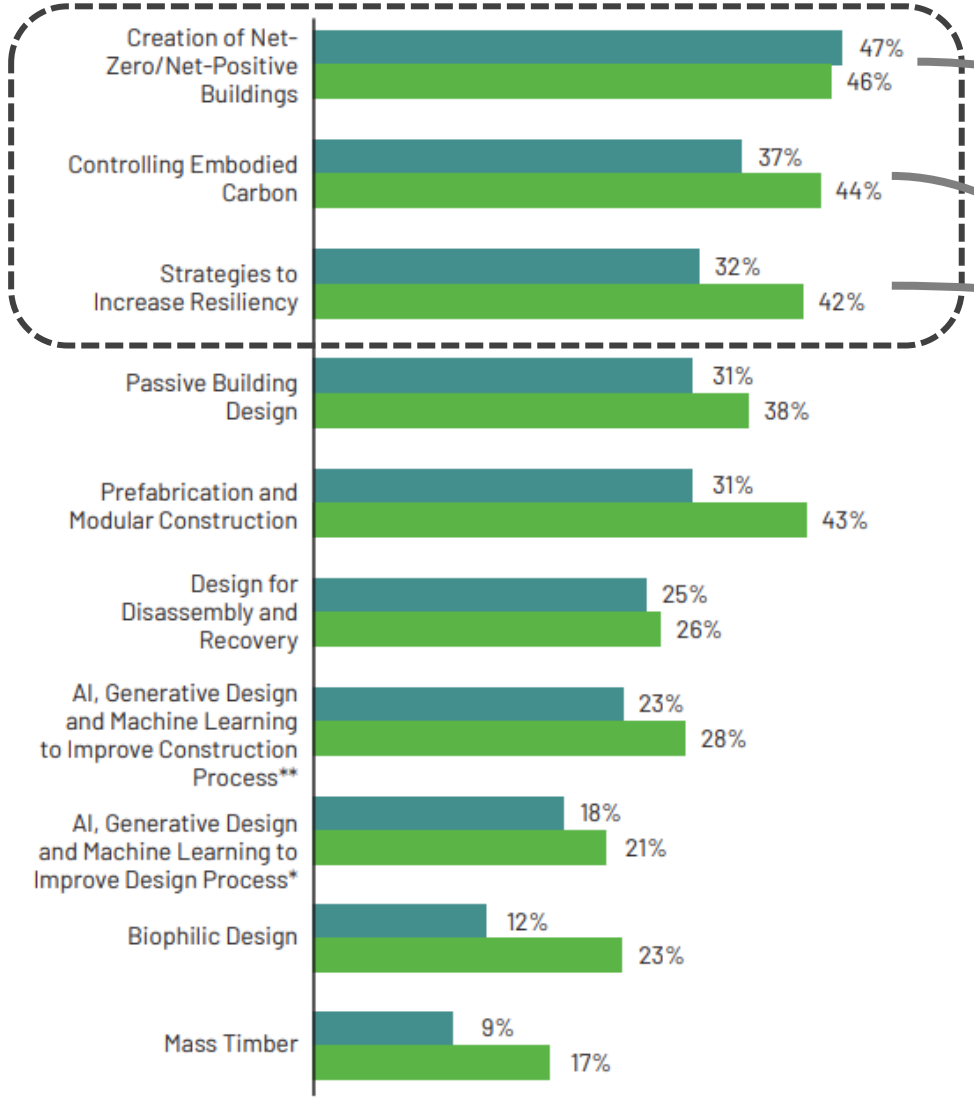
Dodge Data & Analytics, 2021



WHERE

Most Important Approaches to Improve Sustainability in the Design and Construction Industry in the Next 5 Years

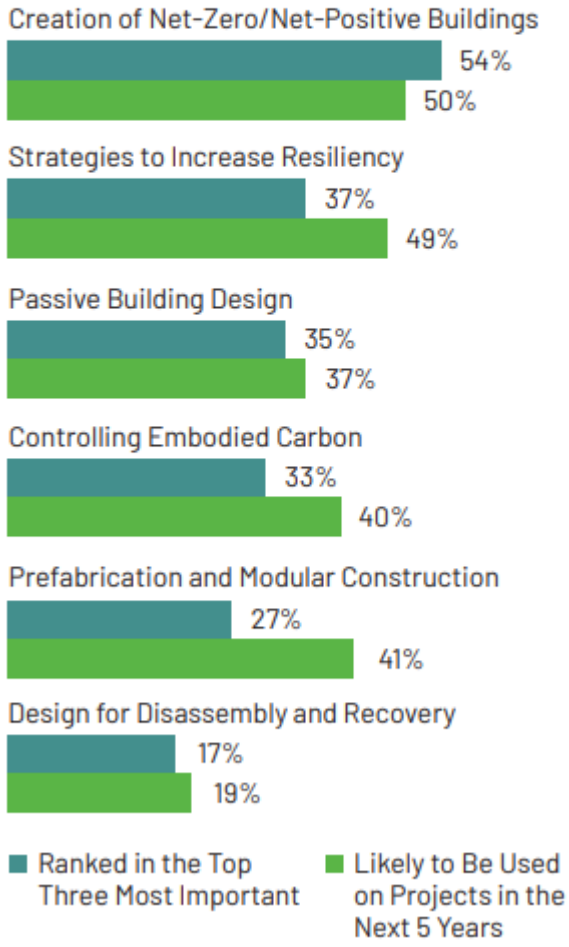
Dodge Data & Analytics, 2021



*According to Architects and Owners
**According to Contractors and Owners

Most Important Approaches to Improve Sustainability (According to Respondents in the US)

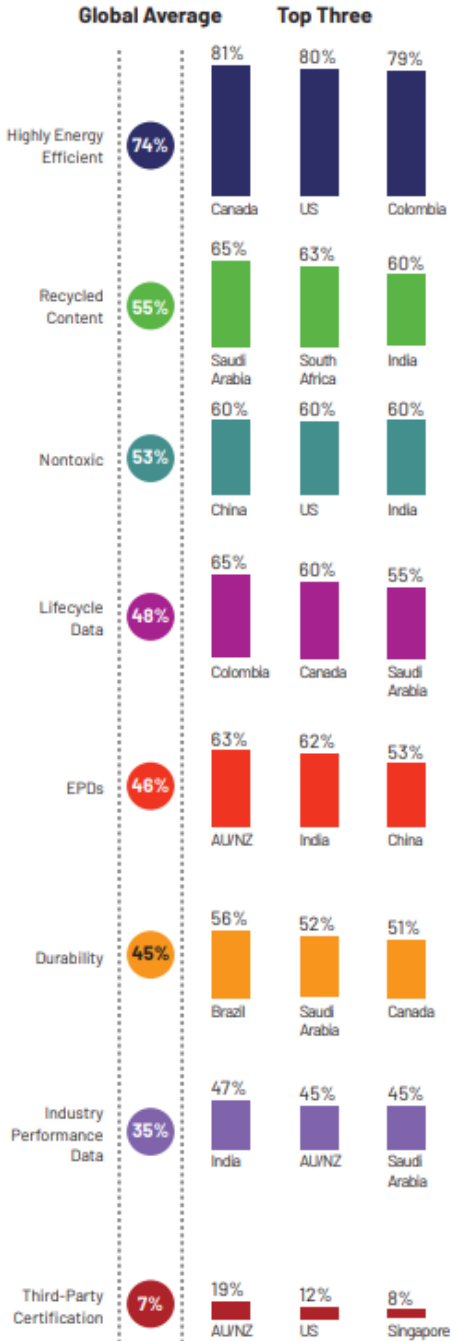
Dodge Data & Analytics, 2021

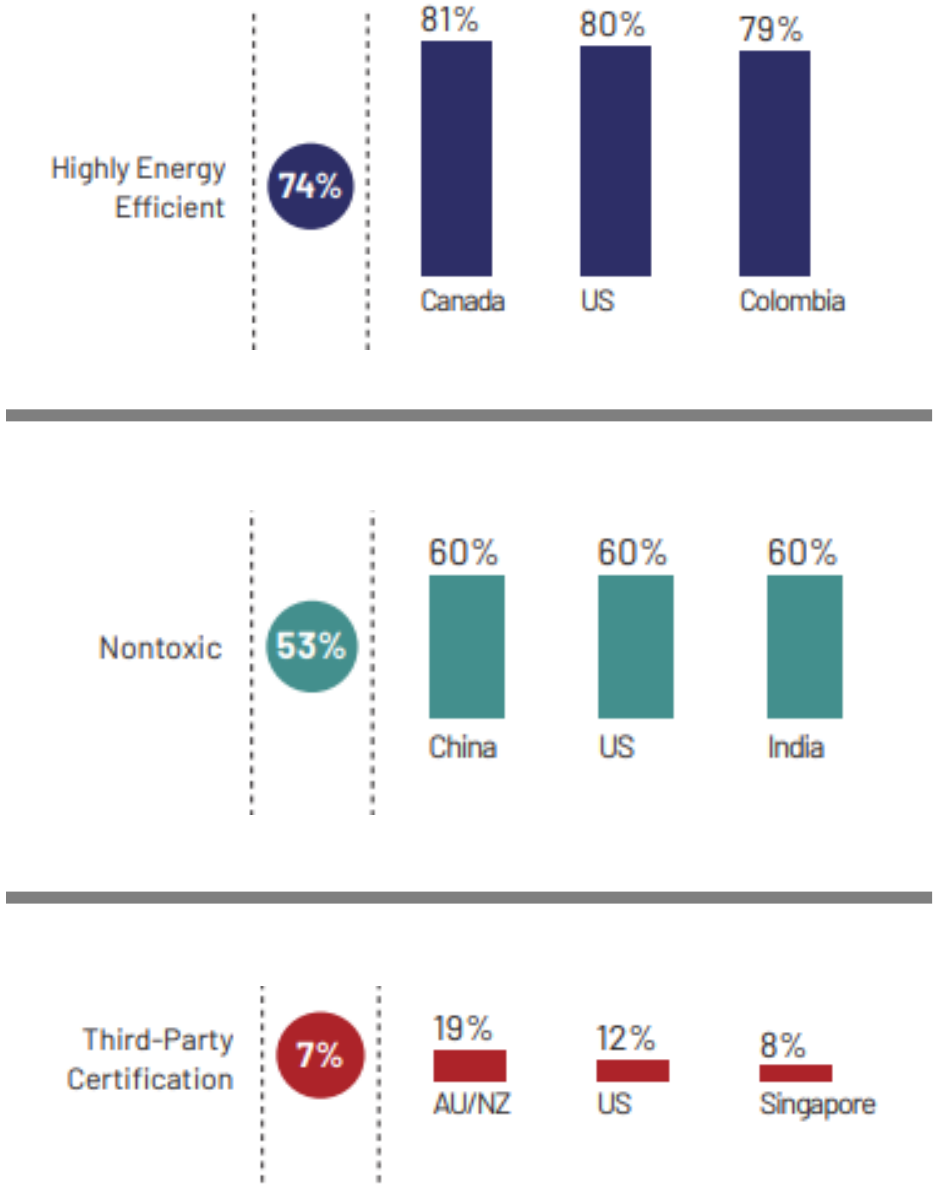


HOW

Criteria Used to Identify Green Products

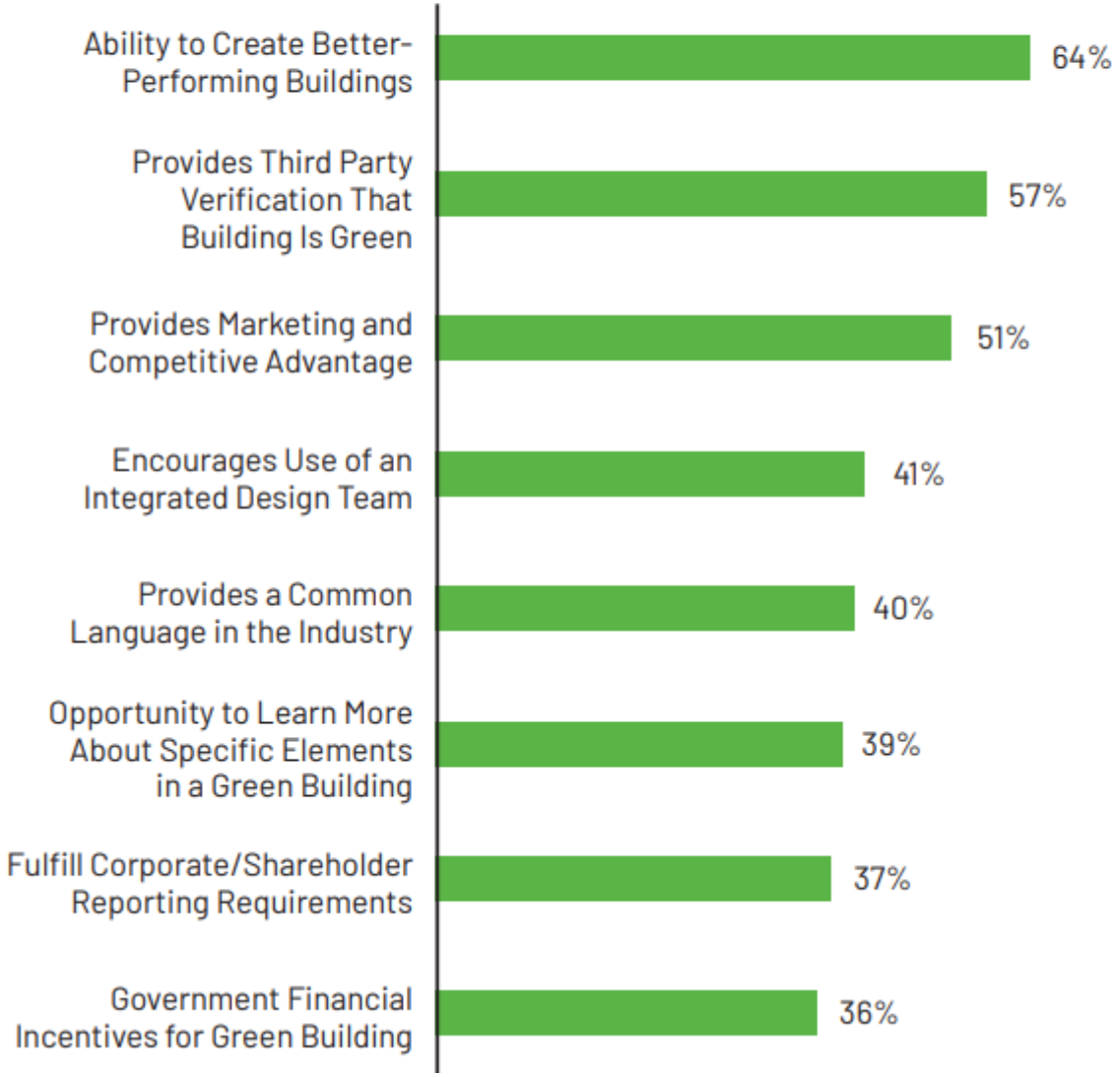
Dodge Data & Analytics, 2021





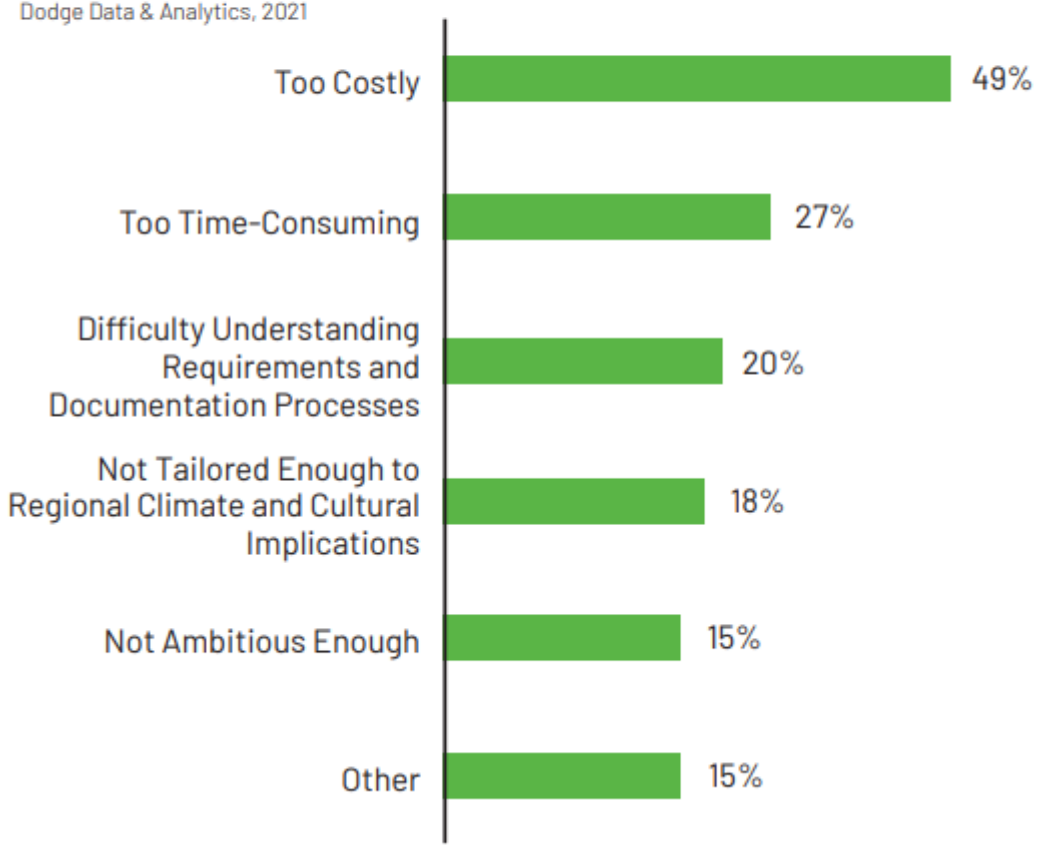
Benefits of Using a Rating System (Percentage Selecting Each Among Their Top 3)

Dodge Data & Analytics, 2021



Factors That Influence the Decision to Not Use a Rating System for a Green Project (Percentage Selecting Each Among Their Top 3)

Dodge Data & Analytics, 2021



Environmental, Social and Governance (ESG)

A definition…

sustainability: "…to create and maintain conditions under which humans and nature can exist in productive harmony, that permit fulfilling the social, economic and other requirements of present and future generations."

--National Environmental Policy Act of 1969

Documentation of sustainability

product category rule (PCR): "…a set of specific rules, requirements and guidelines for developing environmental declarations for one or more products that can fulfill equivalent functions."

CAN/CSA ISO 14025-07 (R2022), "Environmental Labels and Declarations –Type III Environmental Declarations–Principles and Procedures"

PCRs determine what information should be gathered and how that information should be evaluated for an environmental declaration.

ASTM International has published the following PCR.

- PCR for Asphalt Shingles, Built-up Asphalt Membrane Roofing and Modified Bituminous Membrane Roofing
- PCR for Clay Brick, Clay Brick Pavers, and Structural Clay Tile
- PCR for Construction Aggregates: Natural Aggregate, Crushed Concrete, and Iron/Steel Furnace Slag
- PCR for Decorative Overlays for Use on Composite Wood Panels
- PCR for Expanded Shale, Clay, and Slate Lightweight Aggregate
- PCR for Glass Mat Gypsum Panels
- PCR for Interior Architectural Wood Door Leaves
- PCR for Manufactured Concrete and Concrete Masonry Products
- PCR for North American Pressure-Treated Wood Products
- PCR for Portland, Blended Hydraulic, Masonry, Mortar, and Plastic Stucco Cements
- PCR for Power-Operated Pedestrian Doors and Revolving Doors
- PCR for Precast Concrete
- PCR for Segmental Concrete Paving Products
- PCR for Single Ply Roofing Membrane
- PCR for Slag Cement
- PCR for Spray-applied Fire-Resistive Materials (SFRM)
- PCR for Water-Resistive and Air Barriers

Link

PRODUCT CATEGORY RULES FOR PREPARING
AN ENVIRONMENTAL PRODUCT DECLARATION
FOR PRODUCT GROUP

1.1 | GOAL AND SCOPE

This PCR document specifies rules, requirements, and guidelines for developing EPDs for Asphalt Shingles and Bituminous Membrane Roofing and underlying requirements of related Life Cycle Analysis (LCAs). These PCR are valid for, and provide requirements for, both Business-to-Business (BtoB) and Business-to-Consumer (BtoC) EPDs. An EPD prepared under these PCR will present data that has been aggregated over some or all of the following phases of the life cycle depending on whether the EPD is BtoB or BtoC:

- raw materials acquisition,
- manufacturing,
- transportation,
- installation,
- use and maintenance, and
- disposal/reuse/recycling.

A reference service life (RSL) shall be stated in a BtoC EPD to take account of the maintenance and replacement impacts over an assumed building service life. A RSL shall be stated for a BtoB EPD if a use phase scenario is included in the EPD. A RSL must be based on a verifiable performance history as per Section 6.2.

Link

6.0 Requirements for the Underlying LCA

The underlying LCA shall be conducted in accordance with ISO 14040 and ISO 14044.

6.1 | FUNCTIONAL AND DECLARED UNIT

The functional unit of a product provides the quantitative normalization for comparing products of equivalent function (functional unit) or equivalent specification. A functional unit is defined for EPDs covering the complete cradle-to grave life cycle or the cradle-to-gate life cycle with a use stage scenario.

A declared unit is defined for EPDs covering only the cradle-to-gate or cradle-to-gate plus end-of-life stages (see Section 6.2). If the intended use of the EPD is for comparison purposes between different building products, the entire life cycle shall be included, including the use and end-of-life stages. In such situations the functional unit shall be used as the reference, not the declared unit.

For Asphalt Shingles and Bituminous Membrane Roofing, the declared unit shall be 1 m^2 [10.8 ft^2]. A weighted average thickness or other applicable aspects of the product shall be stated when the EPD deals with a generic or representative product group with different thicknesses. The weights shall reflect the relative production volumes for the relevant materials.

The functional unit shall be 100 m^2 [1076.4 ft^2] of constructed area using the product, including all layers required to achieve the expected performance. Explanation of the selected functional unit shall be stated clearly, including the reference service life, installation methods and all ancillary materials such as ballasting, fasteners and adhesives.

The reference service life shall refer to the declared technical and functional quality of the product in the building. It shall be established in accordance with the ISO 15686-1, -2, -7, and -8 standards.

6.2 | SYSTEM BOUNDARIES

Figure 1 shows the life-cycle stages and individual modules that shall be included within the LCA system boundary, depending on whether the EPD is BtoB or BtoC.

FIGURE 1 Life-Cycle Stages and Modules

PRODUCT STAGE			CONSTRUCTION PROCESS STAGE		USE STAGE							END OF LIFE STAGE			
al		ng		ess		e		t	nt	ergy	ater	ion		sing	

11.0 Content of the EPD

The following demonstration of verification shall be completed and included with the EPD. Note that third-party verification is optional for BtoB EPDs, but mandatory for BtoC EPDs.

Demonstration of Verification
PCR review, was conducted by: < name and organization of the chair, and information on how to contact the chair through the programme operator >
Independent verification of the declaration and data, according to ISO 14025: internal external
(Where appropriate [a]) Third party verifier: <name of third party verifier>
Optional for business to business communication, mandatory for business to consumer communication.

All Type III environmental declarations in a product category shall follow the format and include the parameters as identified in this PCR. The following general information shall be declared in the EPD:

Name and address of the manufacturer(s);

- Product identification by name (including, for example, production code) and a simple visual representation of the product;
- Description of the building product's use and the functional or declared unit of the product to which the data relates;
- Description of the application (installation) of the building product where relevant;
- Detailed list of the substances, by weight, that make up the building product;
- Data from LCA or LCI or information modules as per ISO 14025, clause 7.2.2;
- Additional environmental information (see Section 9);
- Statement of whether the EPD is cradle to gate or cradle to grave;
- Statement that EPDs from different programs (using different PCR) may not be comparable;
- Statement that the EPD represents an average performance in cases where an EPD declares an average performance for a number of products, with the standard deviation of the product's performance with respect to the average stated;

environmental product declaration (EPD): provide quantifiable environmental data to compare products that fulfill the same function.

To create comparable EPDs, organizations must follow the rules and guidelines called for in an associated PCR. EPDs created under different PCRs generally are not comparable.

Published Environmental Product Declarations

An Environmental Product Declaration (EPD) provides quantifiable environmental data to compare products that fulfill the same function. In order to create comparable EPDs, they must follow the rules and guidelines called for in the associated PCR.

- Athena Sustainable Materials Institute (Athena) EPD Calculator for Concrete
- Cement Sustainability Initiative (CSI) EPD Generator for Cement and Concrete
- Climate Earth CarbonCLARITY EPD Generator - Concrete Masonry
- Climate Earth CarbonCLARITY™ EN 15804 EPD Generator-Concrete
- Climate Earth Enterprise (CEE) EPD Generator for Ready Mix Concrete
- DEP du SOPRA-XPS - panneau isolant en polystyrène extrudé de SOPREMA (Version française)
- EPD Optimization Credit for USG Mars Healthcare (80.35) Acoustical Ceiling Panels
- EPD Optimization Credit for USG Mars Healthcare High NRC (80.40) Acoustical Ceiling Panels
- EPD Optimization Credit for USG Mars Healthcare High NRC (85.35) Acoustical Ceiling Panels
- EPD Optimization Credit for USG Mars Healthcare High NRC (90.30) Acoustical Ceiling Panels
- EPD Optimization Credit for USG Mars High NRC (80.35) Acoustical Ceiling Panels
- EPD Optimization Credit for USG Mars High NRC (80.40) Acoustical Ceiling Panels
- EPD Optimization Credit for USG Mars High NRC (85.35) Acoustical Ceiling Panels
- EPD Optimization Credit for USG Mars High NRC (90.30) Acoustical Ceiling Panels
- EPD Optimization Credit for USG Sheetrock Brand EcoSmart Mold Tough Firecode X
- EPD for 711 Materials (EPDs are generated using an enterprise software tool)

Link

ENVIRONMENTAL PRODUCT DECLARATION

ASPHALT SHINGLE ROOFING SYSTEM

INSTALLATION: FASTENED

Steep-slope roofing system installed with fasteners and consisting of asphalt shingl underlayment, leak barrier, starter strip, and hip and ridge components.

ATLAS

GAF

OWENS CORNING

TAMKO BUILDING PRODUCTS LLC

certainteed SAINT-GOBAIN

IKO

PABCO Roofing Products

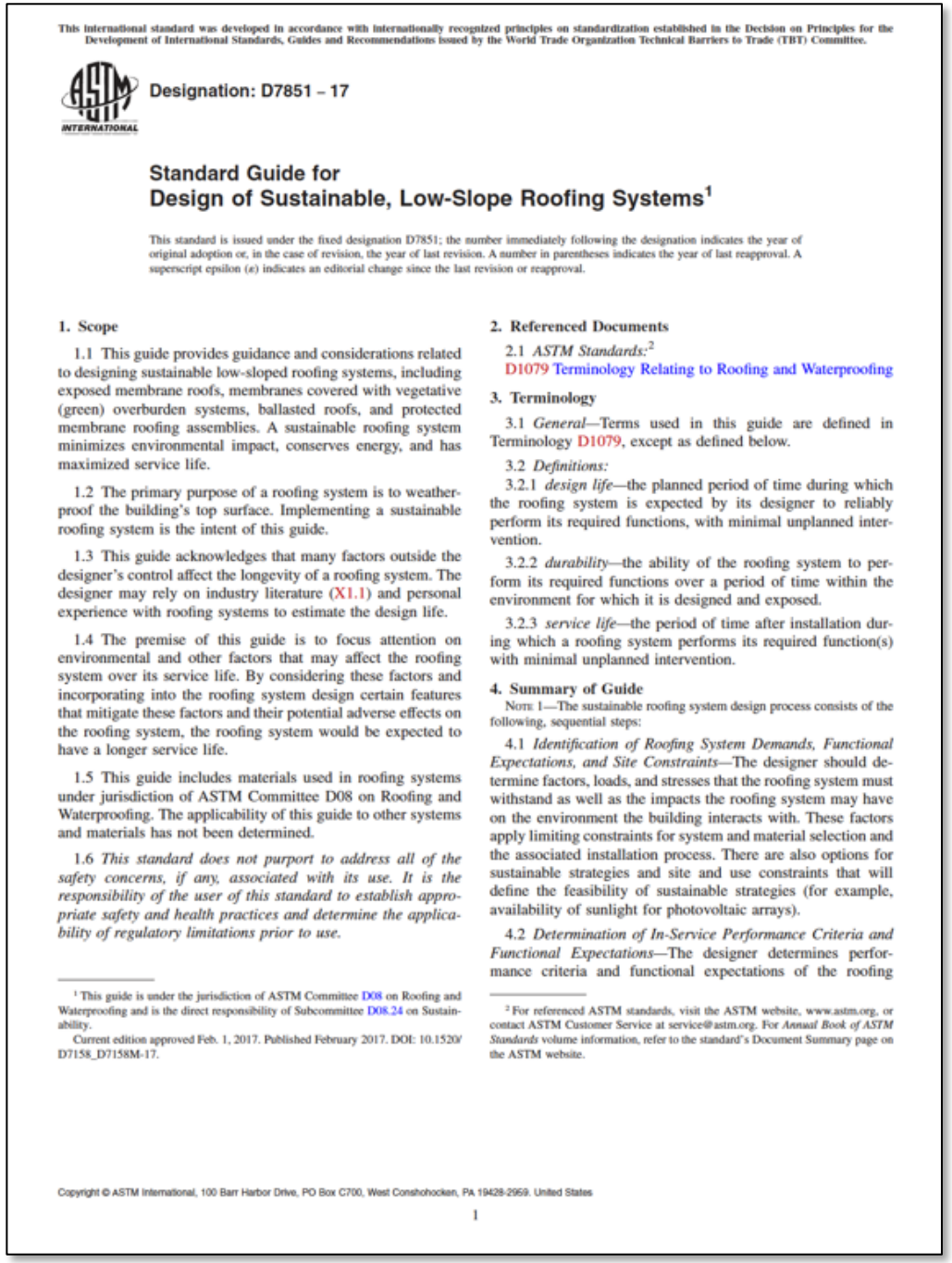
ASPHALT ROOFING MANUFACTURERS ASSOCIATION

The Asphalt Roofing Manufacturers Association (ARMA) is a trade association representing North America's asphalt roofing manufacturing companies and their raw material suppliers. The association includes the majority of North American manufacturers of asphalt shingles and asphalt low slope roof membrane systems. Information that ARMA gathers on modern asphalt roofing materials and practices is provided to building and code officials, as well as regulatory agencies and allied trade groups. Committed to advances in the asphalt roofing industry, ARMA is proud of the role it plays in promoting asphalt roofing to those in the building industry and to the public.

ARMA's vision and mission is to be an association committed to the long-term sustainability of the asphalt roofing industry and to advocate and advance the interests of the asphalt roofing industry by leveraging the collective expertise of its members.

UL CERTIFIED ENVIRONMENTAL PRODUCT DECLARATION UL.COM/EPD

Link



This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

Designation: D7851 – 17

Standard Guide for Design of Sustainable, Low-Slope Roofing Systems[1]

This standard is issued under the fixed designation D7851; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This guide provides guidance and considerations related to designing sustainable low-sloped roofing systems, including exposed membrane roofs, membranes covered with vegetative (green) overburden systems, ballasted roofs, and protected membrane roofing assemblies. A sustainable roofing system minimizes environmental impact, conserves energy, and has maximized service life.

1.2 The primary purpose of a roofing system is to weather-proof the building's top surface. Implementing a sustainable roofing system is the intent of this guide.

1.3 This guide acknowledges that many factors outside the designer's control affect the longevity of a roofing system. The designer may rely on industry literature (X1.1) and personal experience with roofing systems to estimate the design life.

1.4 The premise of this guide is to focus attention on environmental and other factors that may affect the roofing system over its service life. By considering these factors and incorporating into the roofing system design certain features that mitigate these factors and their potential adverse effects on the roofing system, the roofing system would be expected to have a longer service life.

1.5 This guide includes materials used in roofing systems under jurisdiction of ASTM Committee D08 on Roofing and Waterproofing. The applicability of this guide to other systems and materials has not been determined.

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D1079 Terminology Relating to Roofing and Waterproofing

3. Terminology

3.1 *General*—Terms used in this guide are defined in Terminology D1079, except as defined below.

3.2 *Definitions:*

3.2.1 *design life*—the planned period of time during which the roofing system is expected by its designer to reliably perform its required functions, with minimal unplanned intervention.

3.2.2 *durability*—the ability of the roofing system to perform its required functions over a period of time within the environment for which it is designed and exposed.

3.2.3 *service life*—the period of time after installation during which a roofing system performs its required function(s) with minimal unplanned intervention.

4. Summary of Guide

NOTE 1—The sustainable roofing system design process consists of the following, sequential steps:

4.1 *Identification of Roofing System Demands, Functional Expectations, and Site Constraints*—The designer should determine factors, loads, and stresses that the roofing system must withstand as well as the impacts the roofing system may have on the environment the building interacts with. These factors apply limiting constraints for system and material selection and the associated installation process. There are also options for sustainable strategies and site and use constraints that will define the feasibility of sustainable strategies (for example, availability of sunlight for photovoltaic arrays).

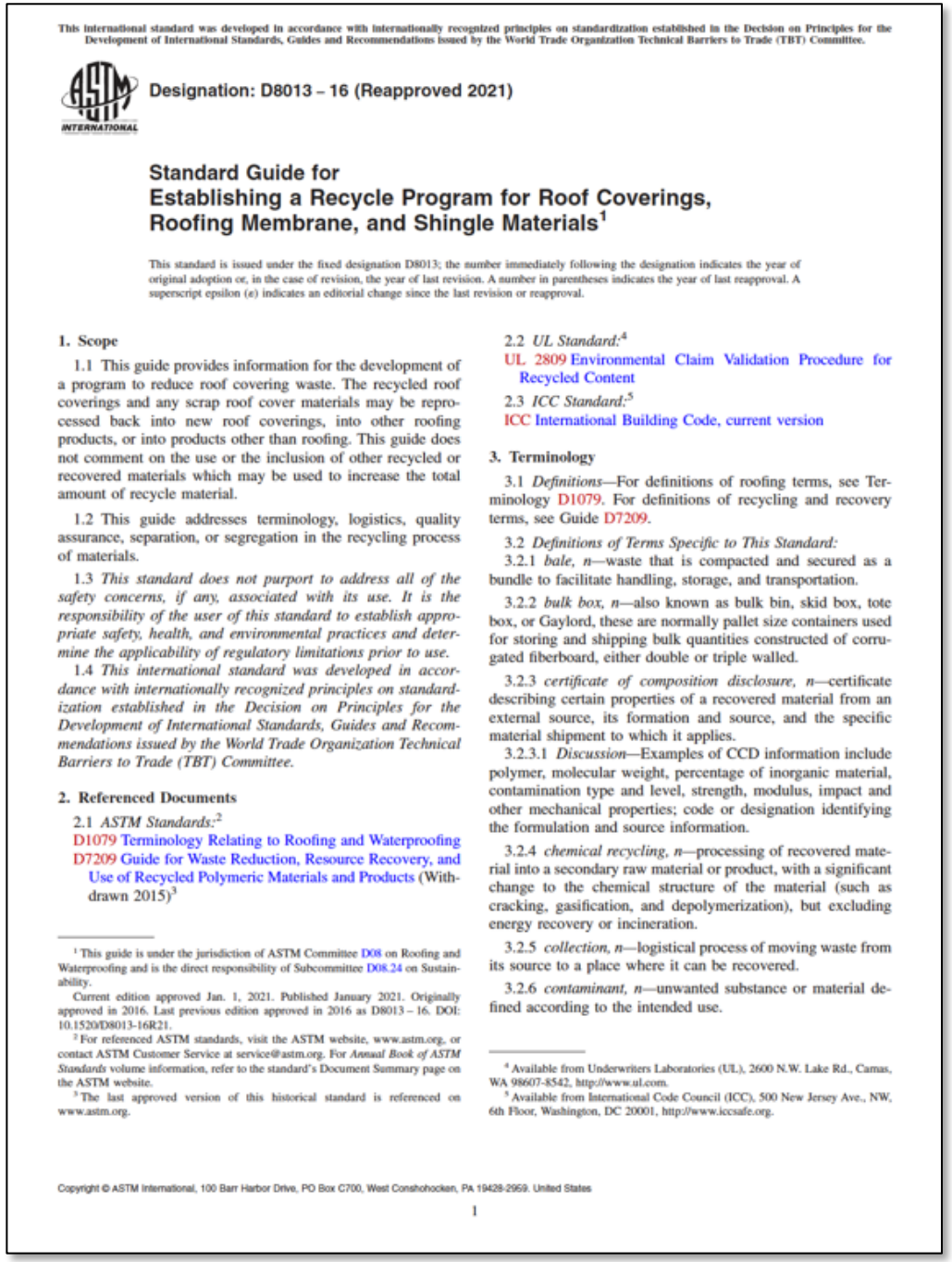
4.2 *Determination of In-Service Performance Criteria and Functional Expectations*—The designer determines performance criteria and functional expectations of the roofing

[1] This guide is under the jurisdiction of ASTM Committee D08 on Roofing and Waterproofing and is the direct responsibility of Subcommittee D08.24 on Sustainability.

Current edition approved Feb. 1, 2017. Published February 2017. DOI: 10.1520/D7158_D7158M-17.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

ASTM D7852, "Standard Guide for Design of Sustainable, Low Slope Roofing Systems"



This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

Designation: D8013 – 16 (Reapproved 2021)

Standard Guide for Establishing a Recycle Program for Roof Coverings, Roofing Membrane, and Shingle Materials[1]

This standard is issued under the fixed designation D8013; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This guide provides information for the development of a program to reduce roof covering waste. The recycled roof coverings and any scrap roof cover materials may be reprocessed back into new roof coverings, into other roofing products, or into products other than roofing. This guide does not comment on the use or the inclusion of other recycled or recovered materials which may be used to increase the total amount of recycle material.

1.2 This guide addresses terminology, logistics, quality assurance, separation, or segregation in the recycling process of materials.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D1079 Terminology Relating to Roofing and Waterproofing

D7209 Guide for Waste Reduction, Resource Recovery, and Use of Recycled Polymeric Materials and Products (Withdrawn 2015)[3]

2.2 *UL Standard:*[4]

UL 2809 Environmental Claim Validation Procedure for Recycled Content

2.3 *ICC Standard:*[5]

ICC International Building Code, current version

3. Terminology

3.1 *Definitions*—For definitions of roofing terms, see Terminology D1079. For definitions of recycling and recovery terms, see Guide D7209.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *bale, n*—waste that is compacted and secured as a bundle to facilitate handling, storage, and transportation.

3.2.2 *bulk box, n*—also known as bulk bin, skid box, tote box, or Gaylord, these are normally pallet size containers used for storing and shipping bulk quantities constructed of corrugated fiberboard, either double or triple walled.

3.2.3 *certificate of composition disclosure, n*—certificate describing certain properties of a recovered material from an external source, its formation and source, and the specific material shipment to which it applies.

3.2.3.1 *Discussion*—Examples of CCD information include polymer, molecular weight, percentage of inorganic material, contamination type and level, strength, modulus, impact and other mechanical properties; code or designation identifying the formulation and source information.

3.2.4 *chemical recycling, n*—processing of recovered material into a secondary raw material or product, with a significant change to the chemical structure of the material (such as cracking, gasification, and depolymerization), but excluding energy recovery or incineration.

3.2.5 *collection, n*—logistical process of moving waste from its source to a place where it can be recovered.

3.2.6 *contaminant, n*—unwanted substance or material defined according to the intended use.

[1] This guide is under the jurisdiction of ASTM Committee D08 on Roofing and Waterproofing and is the direct responsibility of Subcommittee D08.24 on Sustainability.

Current edition approved Jan. 1, 2021. Published January 2021. Originally approved in 2016. Last previous edition approved in 2016 as D8013 – 16. DOI: 10.1520/D8013-16R21.

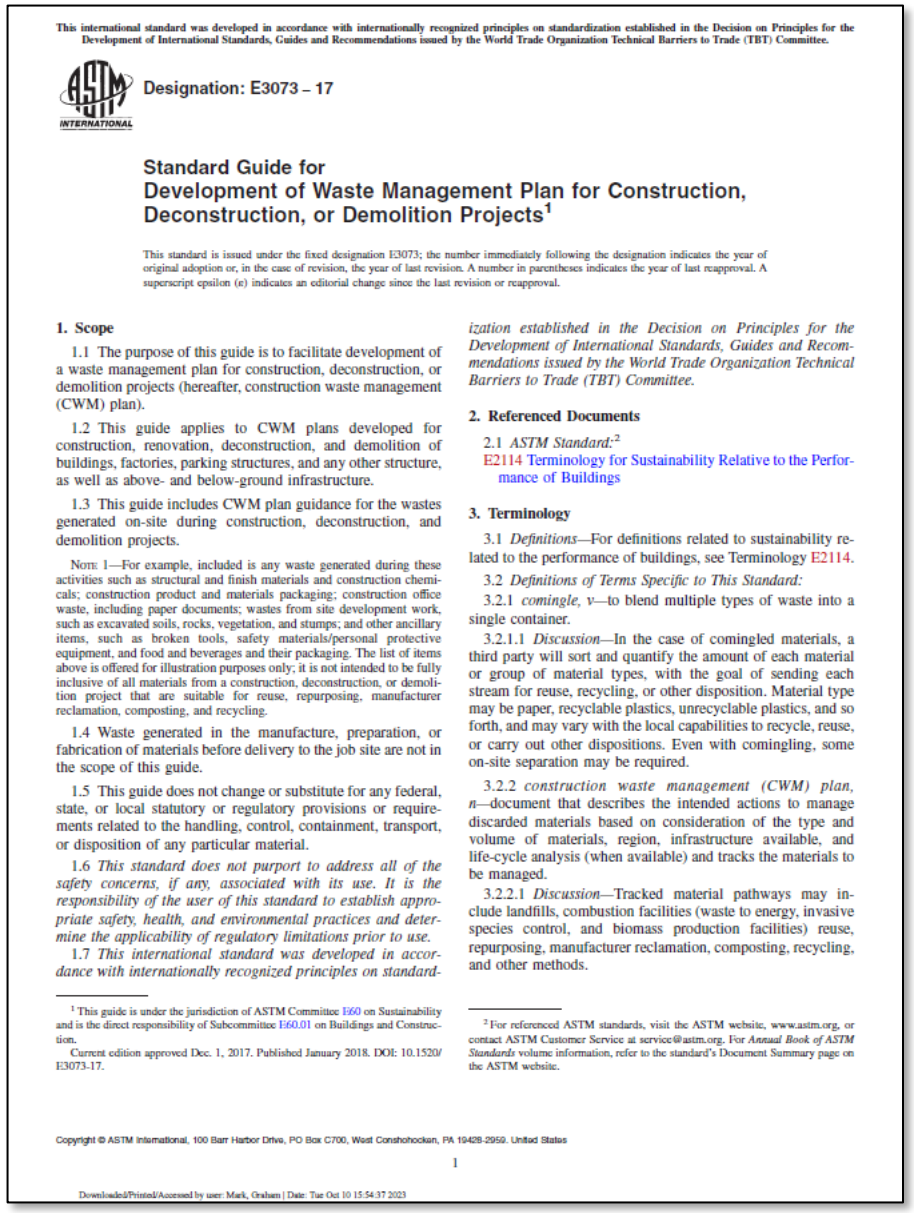
[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] The last approved version of this historical standard is referenced on www.astm.org.

[4] Available from Underwriters Laboratories (UL), 2600 N.W. Lake Rd., Camas, WA 98607-8542, http://www.ul.com.

[5] Available from International Code Council (ICC), 500 New Jersey Ave., NW, 6th Floor, Washington, DC 20001, http://www.iccsafe.org.

ASTM D8013, “Standard Guide for Establishing a Recycle Program for Roof Coverings, Roof Membrane and Shingle Materials”



This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

Designation: E3073 – 17

Standard Guide for Development of Waste Management Plan for Construction, Deconstruction, or Demolition Projects[1]

This standard is issued under the fixed designation E3073; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 The purpose of this guide is to facilitate development of a waste management plan for construction, deconstruction, or demolition projects (hereafter, construction waste management (CWM) plan).

1.2 This guide applies to CWM plans developed for construction, renovation, deconstruction, and demolition of buildings, factories, parking structures, and any other structure, as well as above- and below-ground infrastructure.

1.3 This guide includes CWM plan guidance for the wastes generated on-site during construction, deconstruction, and demolition projects.

NOTE 1—For example, included is any waste generated during these activities such as structural and finish materials and construction chemicals; construction product and materials packaging; construction office waste, including paper documents; wastes from site development work, such as excavated soils, rocks, vegetation, and stumps; and other ancillary items, such as broken tools, safety materials/personal protective equipment, and food and beverages and their packaging. The list of items above is offered for illustration purposes only; it is not intended to be fully inclusive of all materials from a construction, deconstruction, or demolition project that are suitable for reuse, repurposing, manufacturer reclamation, composting, and recycling.

1.4 Waste generated in the manufacture, preparation, or fabrication of materials before delivery to the job site are not in the scope of this guide.

1.5 This guide does not change or substitute for any federal, state, or local statutory or regulatory provisions or requirements related to the handling, control, containment, transport, or disposition of any particular material.

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.7 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standard:*[2]

E2114 Terminology for Sustainability Relative to the Performance of Buildings

3. Terminology

3.1 *Definitions*—For definitions related to sustainability related to the performance of buildings, see Terminology E2114.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *comingle, v*—to blend multiple types of waste into a single container.

3.2.1.1 *Discussion*—In the case of comingled materials, a third party will sort and quantify the amount of each material or group of material types, with the goal of sending each stream for reuse, recycling, or other disposition. Material type may be paper, recyclable plastics, unrecyclable plastics, and so forth, and may vary with the local capabilities to recycle, reuse, or carry out other dispositions. Even with comingling, some on-site separation may be required.

3.2.2 *construction waste management (CWM) plan, n*—document that describes the intended actions to manage discarded materials based on consideration of the type and volume of materials, region, infrastructure available, and life-cycle analysis (when available) and tracks the materials to be managed.

3.2.2.1 *Discussion*—Tracked material pathways may include landfills, combustion facilities (waste to energy, invasive species control, and biomass production facilities) reuse, repurposing, manufacturer reclamation, composting, recycling, and other methods.

[1] This guide is under the jurisdiction of ASTM Committee E60 on Sustainability and is the direct responsibility of Subcommittee E60.01 on Buildings and Construction.

Current edition approved Dec. 1, 2017. Published January 2018. DOI: 10.1520/E3073-17.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

ASTM E3073, “Standard Guide for Development of Waste Management Plan for Construction, Deconstruction, or Demolition Projects”

NSF/ANSI 347

NSF International
789 N. Dixboro Road
Ann Arbor, MI 48105 USA
+1 (734) 476 2543
www.nsf.org

Live safer.®

Sustainability Assured for Single Ply Roofing Membranes

NSF/ANSI 347 Sustainability Assessment for Single Ply Roofing Membranes is the leading consensus standard for evaluating and certifying sustainable attributes of single ply roofing membranes over their entire product life cycle.

NSF Sustainability provides certification to the NSF/ANSI 347 standard. Single Ply Roofing Membranes, as defined by this standard, include, but are not limited to, membranes produced from EPDM (Ethylene Propylene Diene Terpolymer), KEE (Ketone Ethylene Ester), PVC (Poly Vinyl Chloride), TPO (thermoplastic polyolefin), and PIB (Polyisobutylene) products. This U.S. national standard was developed through a consensus-based public process by a multi-stakeholder group of manufacturers, suppliers, regulatory agencies, customers, end users, academia and other industry participants under NSF's facilitation. The purpose of this standard is to communicate accurate and verifiable information about the environmental and social impacts associated with the production and use of Single Ply Roofing Membranes. Sustainability assessment standards inform and encourage the demand for and supply of products that cause less stress on the environment and society. The result is continuous market-driven improvement.

Standard 347 Overview

Based on life-cycle assessment principles, NSF/ANSI 347 employs an easy-to-use point system to evaluate roofing membrane products against established prerequisite requirements, performance criteria and quantifiable metrics in five key areas:

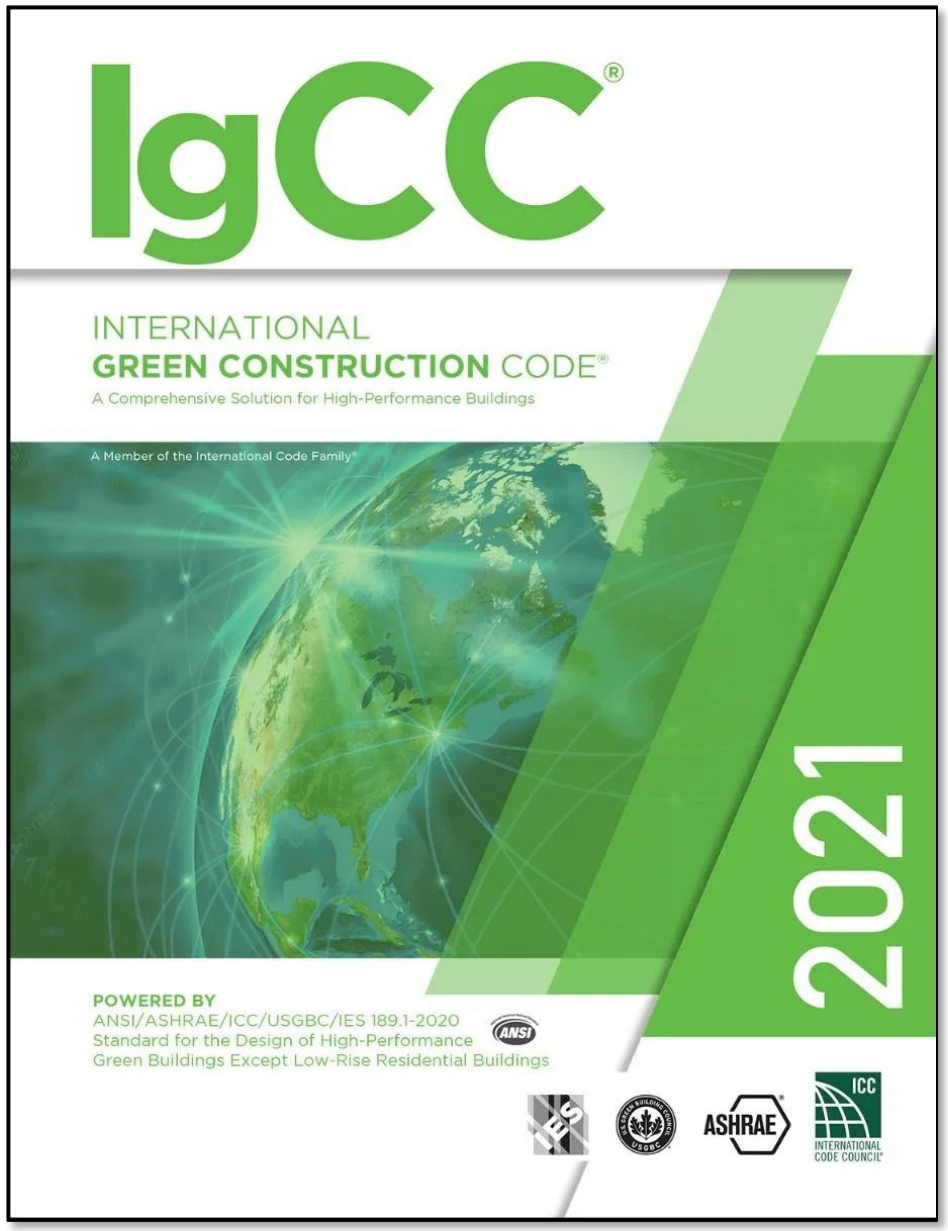
1. Product Design
2. Product Manufacturing
3. Membrane Durability
4. Corporate Governance
5. Innovation

For example, Product Design criteria require a prerequisite of an environmental assessment program that considers environmental attributes and impacts of products and packaging across the entire product life cycle (e.g., raw material extraction, manufacturing, use, and end of life). Criteria examples in Product Manufacturing include environmental management systems, energy conservation, waste minimization, water conservation and greenhouse gas reductions. Certification is based on point totals to achieve a Conformant, Silver, Gold, or Platinum level.

Manufacturers certified by NSF are authorized to use the NSF Sustainability Certified Mark on their products and in their advertising. Monitoring and periodic reevaluation is required to maintain certification.

(over)

NSF/ANSI 347, “Sustainability Assessment for Single Ply Roof Membranes”



International Green Construction Code, 2021 Edition

--ANSI/ASHRAE/ICC/USGBC/IES 189.1-2020

Link

EPD directories

ASTM: Link

ARMA (asphalt roofing): Link

PIMA (polyisocyanurate insulation): Link

Sustainable Minds Transparency Catalog: Link

Ecomedes: Link

UL Spot: Link

RESEARCH+TECH

Sustainable thinking

The roofing industry has made significant progress in sustainability

by Mark S. Graham

The issue of sustainability in the construction industry, including the roofing industry, comes up frequently in conversations among building owners, designers, manufacturers, distributors, contractors, and representatives from standards-setting organizations and regulatory and code groups. Sustainability is an important issue, and the roofing industry has put forth several efforts to address it.

What is sustainability?

The concept of sustainability is not new. The National Environmental Policy Act of 1969 committed the U.S. to sustainability, declaring it a national policy "to create and maintain conditions under which humans and nature can exist in productive harmony, that permit fulfilling the social, economic and other requirements of present and future generations."

In the years since, the public's interest in sustainability has broadened. In addition, sustainability practitioners are becoming more ambitious in their sustainability efforts and are sharing best practices to ensure the greatest environmental, economic and social impact.

Professional Roofing

June 2023

Link

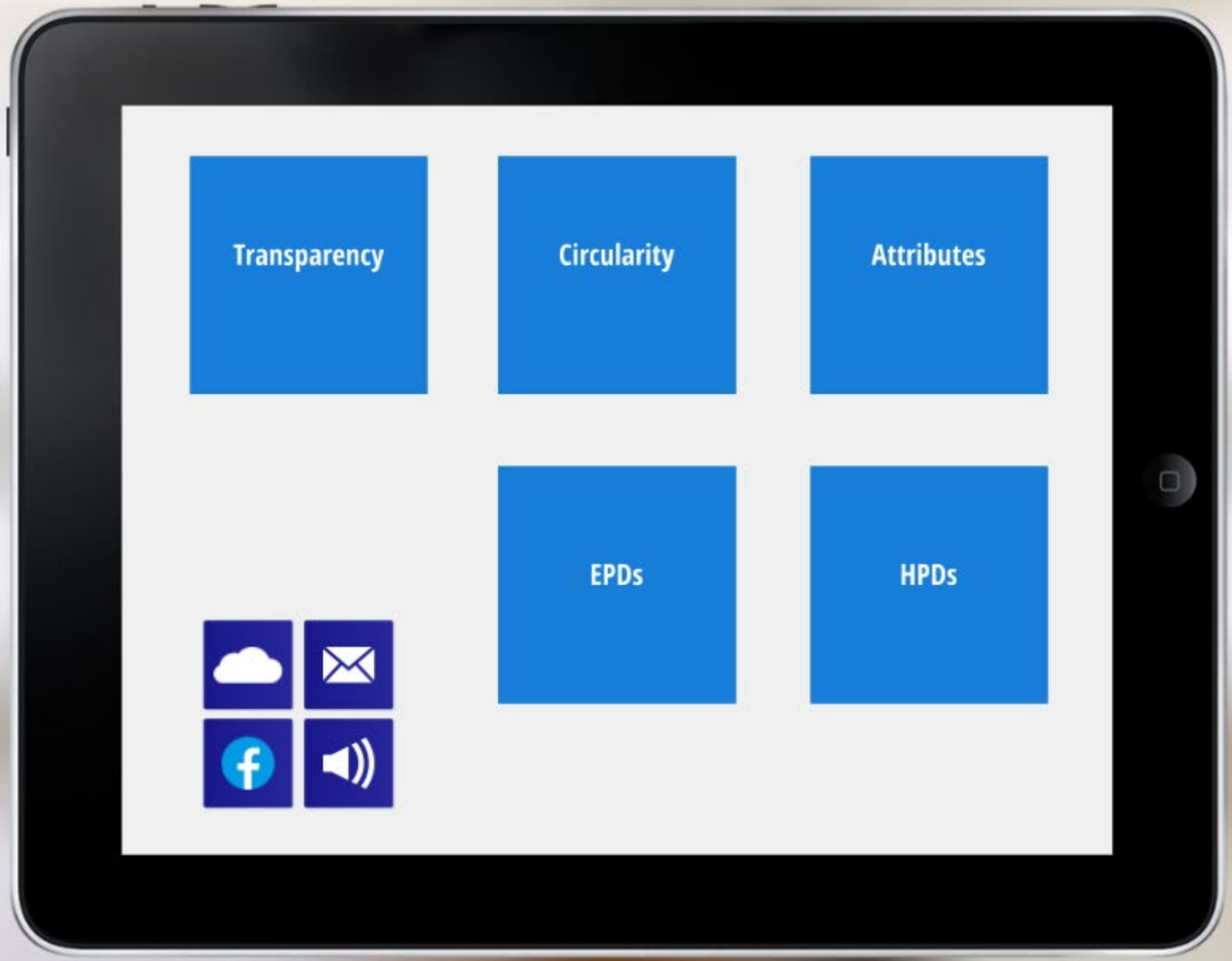
One last definition…

green washing:

How Roofing Contributes

"About 8 billion people currently live on Earth and product garbage daily….it is imperative that we consider how to reduce waste to conserve space for materials that cannot be reused or recycled. Considering the toxins and diseases that can be emitted as waste breaks down, ***it is important the roofing industry increases the use of recyclable and sustainably sourced materials.***"

Justin Brown, NSF



ROOFING CONTRIBUTIONS

Roofing
Certifications & Ratings

Certification evaluates raw materials, chemical composition, manufacturing processes, recyclability/disposal, etc.

Green Building Standards

"American communities have more options than ever for encouraging greener building and development. Many organizations have developed model codes or rating systems that communities can use to develop green building programs or revise building ordinances."

- U.S. EPA

Major Options

- IgCC
- ASHRAE 189.1
- LEED
- Living Building Challenge
- WELL Building Standard

Major Options

- IgCC
- ASHRAE 189.1

Model Codes

- LEED
- Living Building Challenge
- WELL Building Standard

Rating/Certification Systems

Rating/Certification Systems

- Generally voluntary
- New construction/existing buildings/additions
- All three generally include:
  - sustainable sites
  - energy efficiency
  - water efficiency
  - materials and resource use
  - indoor environmental quality

LEED Leadership in Energy and Environmental Design

To achieve LEED certification, a project earns points by adhering to prerequisites and credits that address carbon, energy, water, waste, transportation, materials, health and indoor environmental quality

More than 100,000 buildings participating today

Platinum

80+ points earned

Gold

60-79 points earned

Silver

50-59 points earned

Certified

40-49 points earned

How/Where Roofing Contributes in this space

LEED
LEADERSHIP IN ENERGY AND ENVIRONMENTAL DESIGN

LEED®1 v4 FOR BUILDING DESIGN AND CONSTRUCTION: NEW CONSTRUCTION

Sustainable Sites	Energy and Atmosphere		Materials and Resources				Indoor Environmental Quality
SSc5	**EAp2/EAc2**	**EAc5**	**MRc2**	**MRc3**	**MRc4**	**MRp2/MRc5**	**EQc2**
Heat Island Reduction	Min/Optimize Energy Performance	Renewable Energy Production	BPDO – Environmental Product Declarations (EPDs)	BPDO – Sourcing of Raw Materials (e.g., recycled content)	BPDO – Material Ingredients (e.g., HPDs)	Construction & Demo Waste Planning/ Management	Low-Emitting Materials
Opt 1 & 2			Option 1	Option 2	Option 1	Opt 1 & 2	Opt 1 & 2

Living Building Challenge

One of a series of certifications offered by the International Living Futures Institute

How/Where Roofing Contributes in this space

LIVING BUILDING CHALLENGE™ v3.1

LIVING BUILDING CHALLENGE

Health and Happiness Petal	Materials Petal			
I08	**I10**	**I12**	**I13**	**I14**
Healthy Interior Environment (CDPH SM v1.1-2010)	Red List (Red List Free; VOCs; Disclosure)	Responsible Industry (Declare)	Living Economy Sourcing (Distance & Declare)	Net Positive Waste

And a Funny Thing Happens

When You Consider "Roofing as a System"…

LIVING BUILDING CHALLENGE

	Materials Petal
	Net Positive Waste
EPDM THERMOSET MEMBRANE ROOFING	

	Water Petal	**Health + Happiness Petal**	**Materials Petal**			
	Net Positive Water	Healthy Interior Performance	Responsible Materials	Red List	Responsible Sourcing	Living Economy Sourcing
THERMAL INSULATION						

	Place Petal	**Water Petal**	**Health + Happiness Petal**	**Beauty Petal**
	Urban Agriculture	Net Positive Water	Access To Nature	Education + Inspiration
VEGETATED ROOF SYSTEMS				

Living Building Challenge Declare.

Nutrition labels for safe products

Declare is a platform to share and find healthy building products. Manufacturers voluntarily disclose product information on easy-to-read Declare labels, which are accessible on a free database

Nutrition Facts

about 42 servings per container

Serving size **1/4 cup (27g)**

Amount per serving

Calories **130**

	% Daily Value*
Total Fat 5g	**6%**
Saturated Fat 1.5g	**8%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 90mg	**4%**
Total Carbohydrate 20g	**7%**
Dietary Fiber less than 1g	**2%**
Total Sugars 11g	
Includes 11g Added Sugars	**22%**
Protein 1g	
Vitamin D 0mcg	0%
Calcium 10mg	0%
Iron 1.1mg	6%
Potassium 40mg	0%

* The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

Living Building Challenge Declare.

Nutrition labels for safe products

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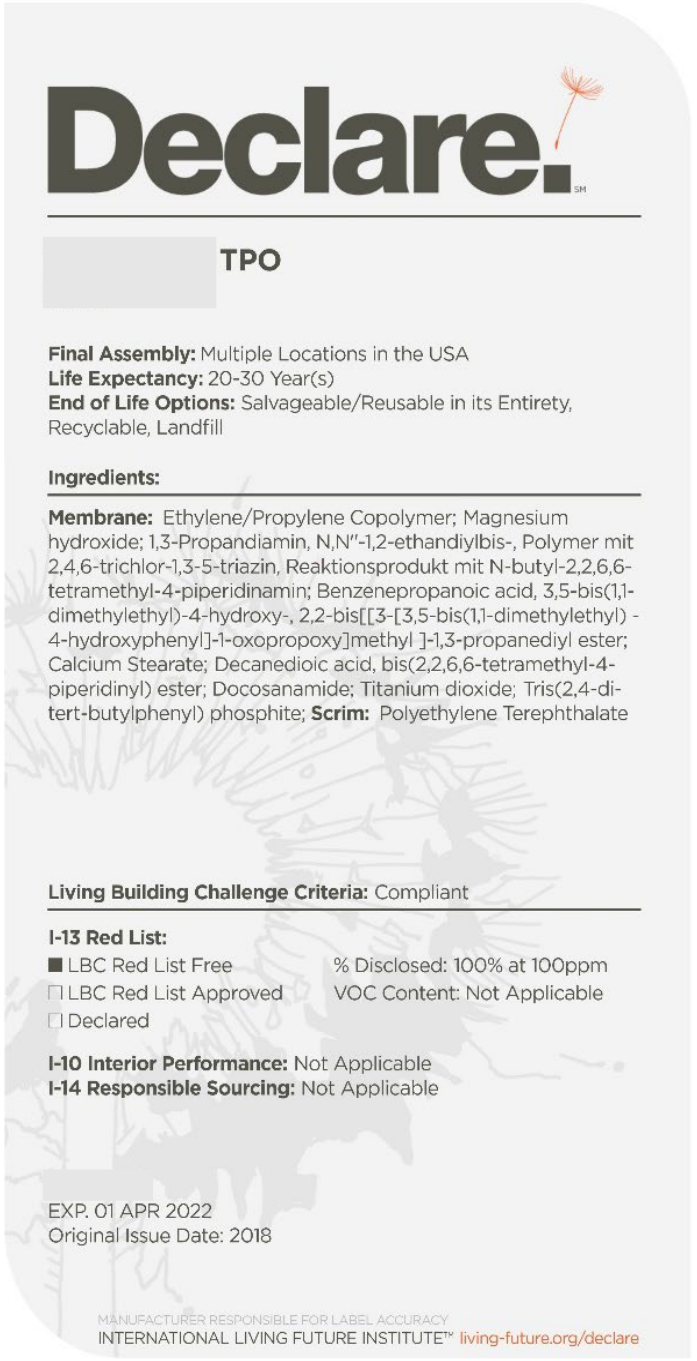
Cholesterol 0mg	**0%**
Sodium 90mg	**4%**
Total Carbohydrate 20g	**7%**
Dietary Fiber less than 1g	**2%**
Total Sugars 11g	
Includes 11g Added Sugars	**22%**
Protein 1g	
Vitamin D 0mcg	0%
Calcium 10mg	0%
Iron 1.1mg	6%
Potassium 40mg	0%

* The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.



Declare.

TPO

Final Assembly: Multiple Locations in the USA
Life Expectancy: 20-30 Year(s)
End of Life Options: Salvageable/Reusable in its Entirety, Recyclable, Landfill

Ingredients:

Membrane: Ethylene/Propylene Copolymer; Magnesium hydroxide; 1,3-Propandiamin, N,N''-1,2-ethandiylbis-, Polymer mit 2,4,6-trichlor-1,3-5-triazin, Reaktionsprodukt mit N-butyl-2,2,6,6-tetramethyl-4-piperidinamin; Benzenepropanoic acid, 3,5-bis(1,1-dimethylethyl)-4-hydroxy-, 2,2-bis[[3-[3,5-bis(1,1-dimethylethyl) -4-hydroxyphenyl]-1-oxopropoxy]methyl]-1,3-propanediyl ester; Calcium Stearate; Decanedioic acid, bis(2,2,6,6-tetramethyl-4-piperidinyl) ester; Docosanamide; Titanium dioxide; Tris(2,4-di-tert-butylphenyl) phosphite; **Scrim:** Polyethylene Terephthalate

Living Building Challenge Criteria: Compliant

I-13 Red List:
■ LBC Red List Free
☐ LBC Red List Approved
☐ Declared

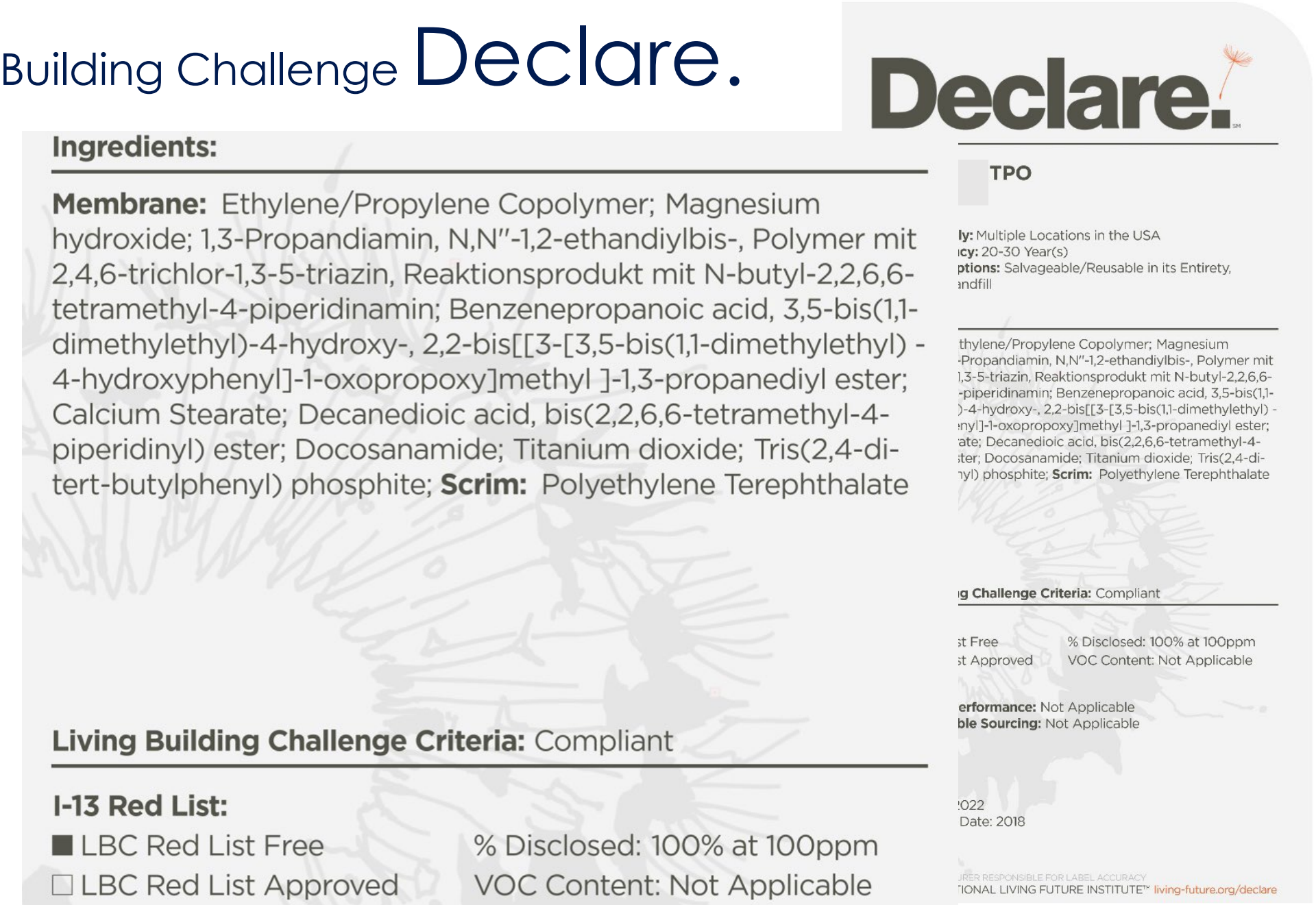
% Disclosed: 100% at 100ppm
VOC Content: Not Applicable

I-10 Interior Performance: Not Applicable
I-14 Responsible Sourcing: Not Applicable

EXP. 01 APR 2022
Original Issue Date: 2018

MANUFACTURER RESPONSIBLE FOR LABEL ACCURACY
INTERNATIONAL LIVING FUTURE INSTITUTE™ living-future.org/declare

Living Building Challenge Declare.



Declare.

TPO

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st Free
st Approved

% Disclosed: 100% at 100ppm
VOC Content: Not Applicable

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ble Sourcing: Not Applicable

'022
Date: 2018

URER RESPONSIBLE FOR LABEL ACCURACY
TIONAL LIVING FUTURE INSTITUTE™ living-future.org/declare

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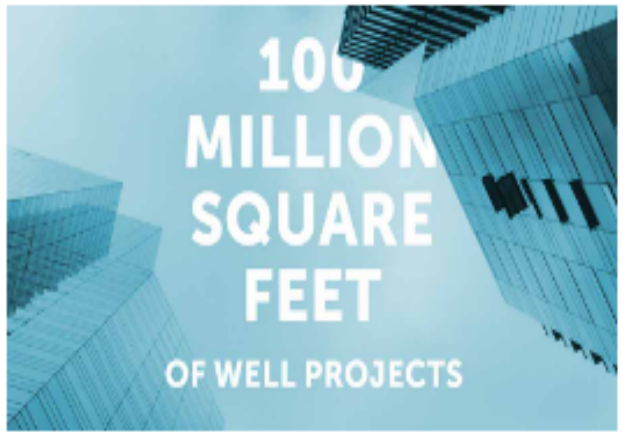
Living Building Challenge Criteria: Compliant

I-13 Red List:

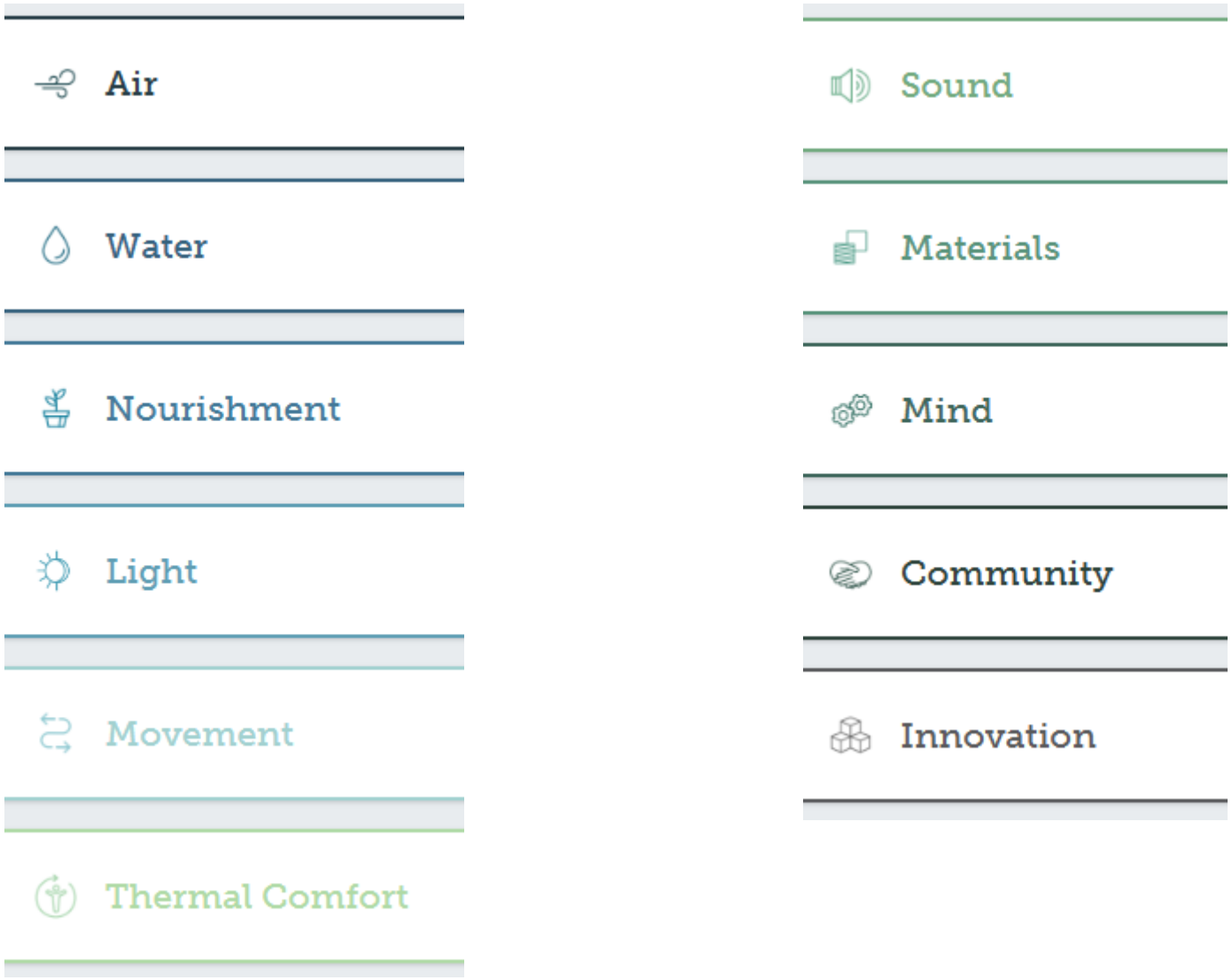
- ■ LBC Red List Free
- ☐ LBC Red List Approved
- ☐ Declared

% Disclosed: 100% at 100ppm
VOC Content: Not Applicable



The International WELL Building Institute (IWBI) is a public benefit corporation whose mission is to improve human health and well-being in buildings and communities across the world through its WELL Building Standard (WELL).

Concepts of WELL v2



CONCEPTS / MATERIALS / FEATURE X07 OPTIMIZATION

Materials Transparency

Promote material transparency across building material and product supply chain.

OVERVIEW | ALTERNATIVES 2 | FAQ 0 | VERIFICATION

SUMMARY

This WELL feature requires the compilation and availability of product descriptions, with ingredients evaluated and disclosed through transparency programs

Read more

REQUIREMENTS WELL

Part 1

Select Products With Disclosed Ingredients (1 Point)

For All Spaces

For at least 25 distinct, permanently installed products (including flooring, insulation, wet-applied products, ceiling and wall assemblies and systems), furnitu floor lamps, ingredients are disclosed by the manufacturer, a disclosure organization or a third party through one of the following:

a. A Declare label, operated by the International Living Future Institute.[3]

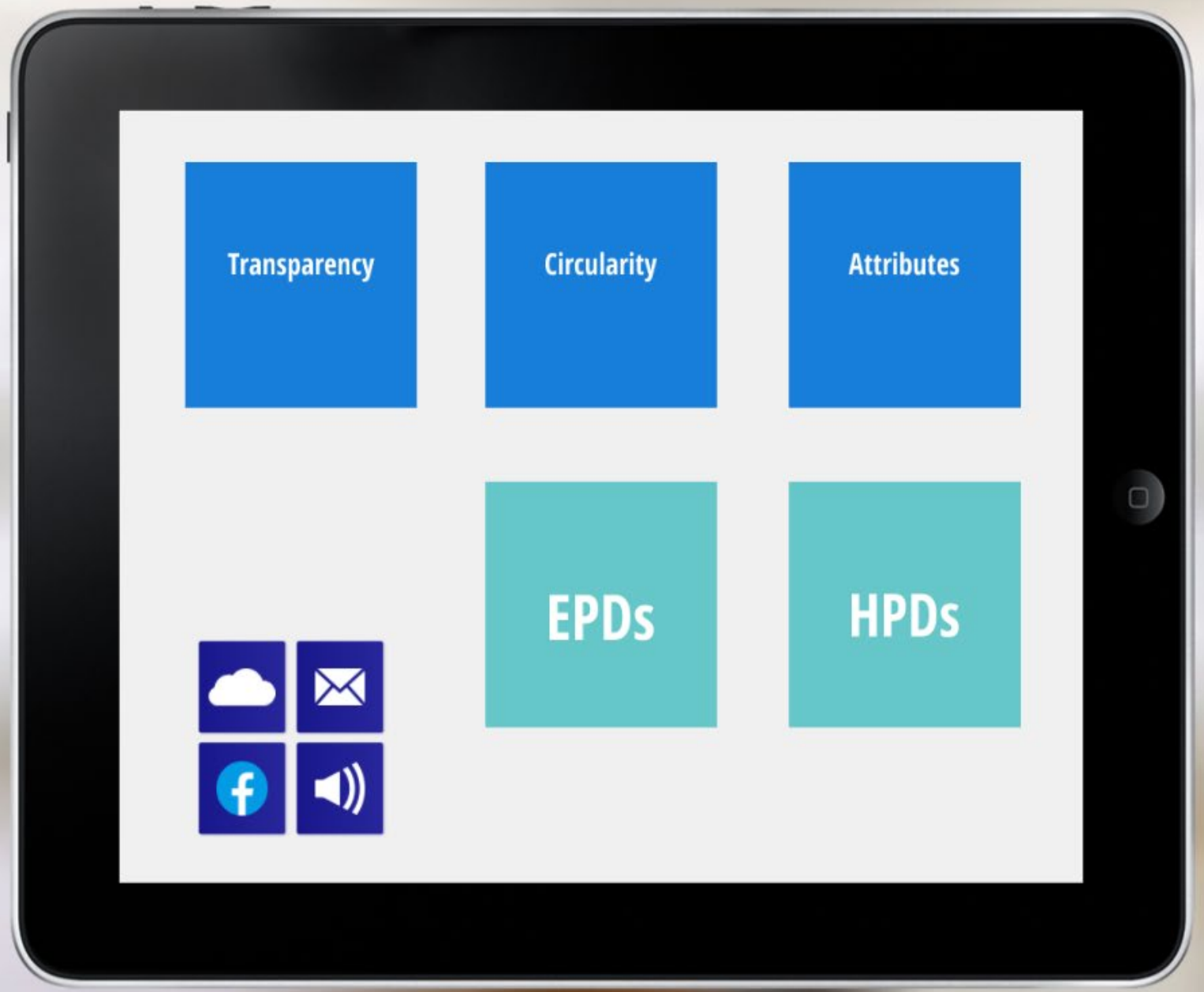
b. A Health Product Declaration (HPD) published in the HPD Public Repository, operated by the Health Product Declaration Collaborative.[4]

c. A Cradle-to-Cradle Certified™ product, or a product with a Material Health Certificate from the Cradle to Cradle Products Innovation Institute.[5]

d. A Product Lens Certification™, operated by UL.[6]

e. A Product Health Declaration, operated by Global Green Tag.[7]

f. A BIFMA Level scorecard compliant with BIFMA e3-2019 standard that demonstrates achievement of 4 points or more in credits 7.5.1.1, 7.5.2.2, or achie



ROOFING CONTRIBUTIONS

EPDs in the Roofing Industry

Industry Associations such as ARMA, SPRI, and PIMA have collaborated with manufactures to create industry wide EPDs.

ENVIRONMENTAL PRODUCT DECLARATION

SBS-MODIFIED BITUMEN ROOFING MEMBRANE

INSTALLATION: COLD ADHESIVE

Low-slope roofing membrane installed using low-VOC adhesive and consisting of a SBS-modified bitumen cap sheet and base sheet.

ASPHALT ROOFING MANUFACTURERS ASSOCIATION

The Asphalt Roofing Manufacturers Association (ARMA) is a trade association representing North America's asphalt roofing manufacturing companies and their raw material suppliers. The association includes the majority of North American manufacturers of asphalt shingles and asphalt low slope roof membrane systems. Information that ARMA gathers on modern asphalt roofing materials and practices is provided to building and code officials, as well as regulatory agencies and allied trade groups. Committed to advances in the asphalt roofing industry, ARMA is proud of the role it plays in promoting asphalt roofing to those in the building industry and to the public.

ARMA's vision and mission is to be an association committed to the long-term sustainability of the asphalt roofing industry and to advocate and advance the interests of the asphalt roofing industry by leveraging the collective expertise of its members.

UL CERTIFIED ENVIRONMENTAL PRODUCT DECLARATION UL.COM/EPD

Polyiso Roof Insulation Boards

For more than 30 years, the Polyisocyanurate Insulation Manufacturers Association (PIMA) has served as the voice of the North American rigid polyiso industry, and as a proactive advocate for safe, cost-effective, sustainable, and energy-efficient high-performance building construction. PIMA is one of the foremost industry advocates for building energy-efficiency practices and policies.

PIMA membership includes manufacturers of polyiso insulation products, raw material suppliers to the industry, and businesses that provide third-party testing services to manufacturers. PIMA members produce the majority of polyiso used in commercial roof and wall applications, and residential, institutional and industrial construction throughout the United States and Canada. PIMA represents the rigid polyiso industry in the development of product technical standards, certification programs, and energy efficiency advocacy.

As a leading advocate for building energy efficiency, PIMA has received many environmental awards, including the U.S. Environmental Protection Agency's Climate Protection Award in 2007 for the Association's leadership in promoting energy efficiency and climate protection. The U.S. EPA also awarded PIMA the Stratospheric Ozone Protection Award in 2002 for leadership in the CFC phase-out in polyiso insulation and in recognition of exceptional contributions to global environmental protection.

Date of Issue: November 4, 2020
Period of Validity: 5 years
Declaration Number: EPD10465

NSF Certified Environmental Product Declaration www.nsf.org

ENVIRONMENTAL PRODUCT DECLARATION

TPO MEMBRANE

SINGLE PLY ROOFING MEMBRANE
INSTALLATION: MECHANICALLY FASTENED

Singly ply, TPO membrane mechanically fastened and representative of 45, 60, and 80 mil thicknesses

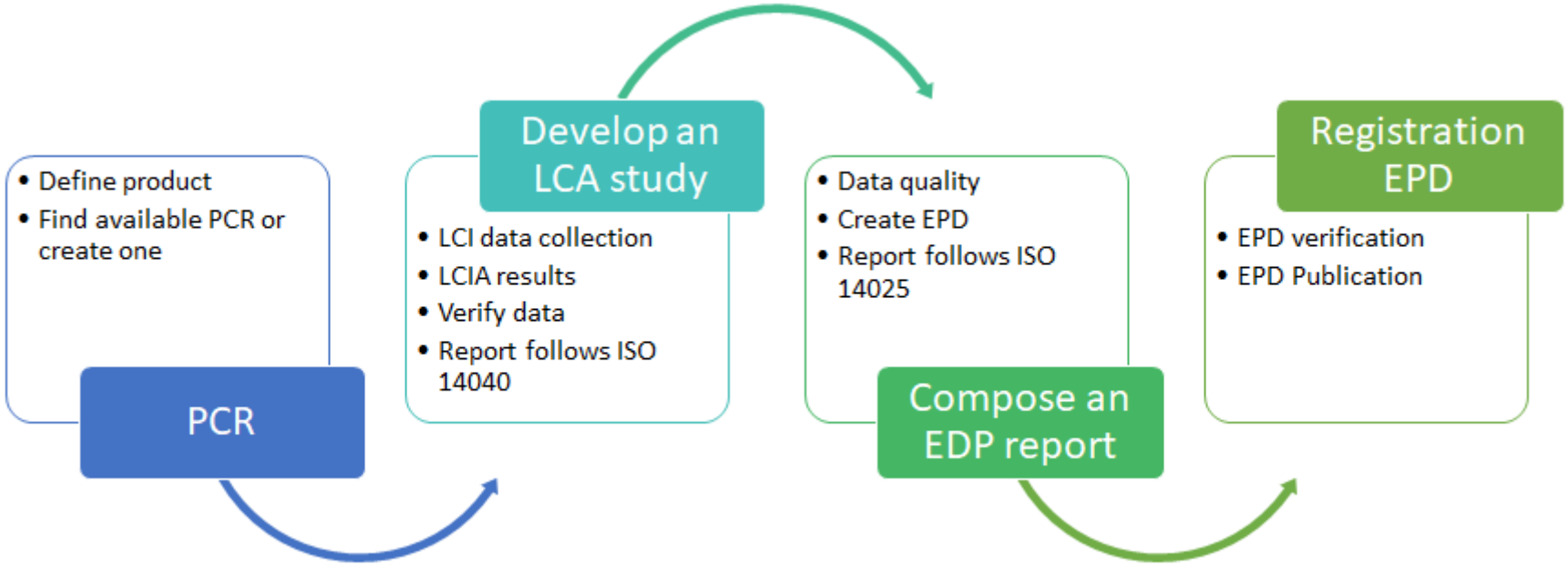
SPRI SINGLE PLY ROOFING INDUSTRY

SPRI is the recognized technical and statistical authority on the Single Ply Roofing Industry. SPRI provides the best forum for its members to collectively focus their industry expertise and efforts on critical industry issues. By acting as a trade organization, as opposed to each member working individually, the group can effectively improve product quality, installation techniques, workforce training and other issues common to the industry. This approach enables every SPRI member to operate more effectively in the commercial roofing marketplace.

SPRI represents sheet membrane and related component suppliers in the commercial roofing industry. Since 1981, SPRI has been an excellent resource for building owners, architects, engineers, specifiers, contractors and maintenance personnel, providing objective information about commercial roofing components and systems.

UL CERTIFIED ENVIRONMENTAL PRODUCT DECLARATION

What are the steps to produce an EPD



PCRs are the product category-specific requirements to prepare for an LCA

Life Cycle Analysis (LCA) collects data and prepares the results to publish in the Environmental Product Declaration.

Environmental Product Declarations (EPD), consistent with international standards ISO 14025 and ISO 14044 is then prepared for review. Once reviewed, it can be registered and published

EPD in simple terms

A comprehensive report that provides the life cycle story of a product.

Harvesting raw materials
Refining
Shipping
Manufacturing
Distribution
Installation
End of life events (i.e. upcycle, recycle or landfill)

EPD Information

ENVIRONMENTAL PRODUCT DECLARATION

According to ISO 14025 and ISO 21930:2017

NON-REINFORCED EPDM MEMBRANE

SINGLE PLY ROOFING INDUSTRY (SPRI)

About SPRI

SPRI is the recognized technical and statistical authority on the Single Ply Roofing Industry. SPRI provides the best forum for its members to collectively focus their industry expertise and efforts on critical industry issues. By acting as a trade organization, as opposed to each member working individually, the group can effectively improve product quality, installation techniques, workforce training and other issues common to the industry. This approach enables every SPRI member to operate more effectively in the commercial roofing marketplace.

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SPRI
SINGLE PLY ROOFING INDUSTRY

Issue Date: 21-07-2022

Valid Until: 21-07-2027

Declaration Number: ASTM-EPD335

Product

Industry EPD

EPD Information

SPRI
SINGLE PLY ROOFING INDUSTRY

According to ISO 14025 and ISO 21930:2017

ENVIRONMENTAL PRODUCT DECLARATION
TPO Single Ply Roofing Membrane

DECLARATION INFORMATION

Declaration	
Program Operator: ASTM International **Company:** Single Ply Roofing Industry 465 Waverley Oaks Road, Suite 421 Waltham, MA 02452 Tel: (781) 647-7026 Email: info@spri.org	ASTM INTERNATIONAL **www.astm.org**
Product Information	**Validity / Applicability**
Product Name: TPO Single Ply Roofing Membrane	**Period of Validity:** This declaration is valid for a period of 5 years from the date of publication.
Product Definition: Thermoplastic Polyolefin (TPO) Single Ply Roofing Membrane	
Declaration Type: Business-to-business (B2B)	**Geographic Scope:** North America
PCR Reference: • Core PCR: ISO 21930:2017 (ISO, 2017) • Sub-category PCR: Product Category Rules for Single Ply Roofing Membranes (ASTM International, 2019)	**PCR Review was conducted by:** • Thomas P. Gloria, Ph.D., Industrial Ecology Consultants • Bill Stough, Sustainable Research Group • Jack Geibig, EcoForm
Product Application and/or Characteristics	
Single ply, TPO roofing membrane installed and representative of 45, 60 and 80 mil thicknesses are used as a roofing protective layer for building applications.	
Content of the Declaration	
• Product definition and physical building-related data • Details of raw materials and material origin • Description of how the product is manufactured • Life Cycle Assessment results	
Verification	
Independent verification of the declaration and data, according to ISO 21930:2017 and ISO 14025:2006	☐ internal ☒external
This declaration and the rules on which this EPD is based have been examined by an independent verifier in accordance with ISO 14025.	
Limitations *The environmental impact results of TPO products in this document are based on a declared unit and therefore do not provide sufficient information to establish comparisons. The results shall not be used for comparisons without knowledge of how the physical properties of the TPO product impact the precise function at the construction level. The environmental impact results shall be converted to a functional unit basis before any comparison is attempted. Environmental declarations from different programs (ISO 14025) may not be comparable.*	

Content of Declaration

- Product definition and physical building-related data
- Details of raw materials and material origin
- Description of how the product is manufactured
- Life Cycle Assessment results
- Additional environmental information

EPD Information

SPRI
SINGLE PLY ROOFING INDUSTRY

According to ISO 14025 and ISO 21930:2017

ENVIRONMENTAL PRODUCT DECLARATION
TPO Single Ply Roofing Membrane

GENERAL INFORMATION

DESCRIPTION OF COMPANY/ORGANIZATION

The following SPRI members provided data for the product under study:

CARLISLE CONSTRUCTION MATERIALS

Carlisle Construction Materials
1285 Ritner Hwy
Carlisle, PA 17013
www.carlisleconstructionmaterials.com

JM Johns Manville

Johns Manville
P. O. Box 5108717
17th Street
Denver, CO 80217-5108
www.jm.com

HOLCIM

Holcim Building Envelope
26 Century Blvd., Suite 205
Nashville, TN 37214
www.holcimbe.com/en

IKO®

IKO Industries Inc.
6 Denny Road, Suite 200
Wilmington, DE 19809
www.iko.com/na

Manufactures that participated in supplying data for EPD

PRODUCT DESCRIPTION

The product system evaluated in this report is an installed single ply TPO roofing membrane at the finished nominal thicknesses produced by SPRI members. See Table 1 for membrane specification and standard.

Table 1 Membrane specification and standard

Roof System	Roofing System Component	Thickness and Reference Weights	Standard
Thermoplastic Polyolefin (TPO)	Membrane	45 mils: 1.15 kg/m^2 60 mils: 1.48 kg/m^2 80 mils: 2.02 kg/m^2	ASTM D6878

PRODUCT AVERAGE

The production data used in this EPD was collected for the year 2019 for six production sites. For the seventh production site, primary data was collected for four months beginning December 2021 to March 2022 and extrapolated for a year. An exception was from one of the participating companies that provided data for the year 2021/2022 collected over 4 months and extrapolated to the full year. The company stated that 2021/2022 data was selected as they only recently started TPO

EPD Information

SPRI
SINGLE PLY ROOFING INDUSTRY

ENVIRONMENTAL PRODUCT DECLARATION
TPO Single Ply Roofing Membrane

According to ISO 14025 and ISO 21930:2017

METHODOLOGICAL FRAMEWORK

DECLARED UNIT

The declared unit is 1 m^2 of single ply roofing membrane for a stated product thickness. Environmental performance results therefore represent the industry average production of 1 m^2 of TPO membranes. The reference service life is not specified. Because the use stage is not included in the system boundary, no reference service life needs to be defined for the analysis.

SYSTEM BOUNDARY

System boundaries are summarized in Figure 2 for the analysis scope of "cradle-to-gate". Excluded modules are indicated by "MND" or "module not declared". As is typical of works of life cycle assessment, the construction and maintenance of capital equipment, such as production equipment in the manufacturing stage, are not included in the system, nor are human labor and employee commute. The use stage is also outside the scope of this study.

PRODUCT STAGE			CONSTRUCT-ION PROCESS STAGE		USE STAGE							END OF LIFE STAGE				BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARY
Raw material supply	Transport	Manufacturing	Transport from the gate to site	Assembly/Install	Use	Maintenance	Repair	Replacement	Refurbishment	Building Operational Energy Use During Product Use	Building Operational Water Use During Product Use	Deconstruction	Transport	Waste processing	Disposal	Reuse, Recovery, Recycling Potential
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND

Figure 3 Life cycle stages included in system boundary

CUT-OFF RULES

Per the PCR, the cut-off criteria for flows to be considered within each system boundary are as follows:

- Mass: If a flow is less than 1% of the cumulative mass of the model flows, it may be excluded, provided its environmental relevance is minor, based on a sensitivity analysis.
- Energy: If a flow is less than 1% of the cumulative energy of the system model, it may be excluded, provided its environmental relevance is minor, based on a sensitivity analysis.
- Environmental relevance: If a flow meets the above two criteria but is determined to contribute 2% or more to the

Cradle-to-gate
- Raw material supply
- Transport
- Manufacturing

EPD Information

SPRI
SINGLE PLY ROOFING INDUSTRY

According to ISO 14025 and ISO 21930:2017

ENVIRONMENTAL PRODUCT DECLARATION
TPO Single Ply Roofing Membrane

ESTIMATES AND ASSUMPTIONS

In cases where no matching life cycle inventories were available to represent a flow, proxy data were applied b
conservative assumptions regarding environmental impacts.

LIFE CYCLE ASSESSMENT RESULTS

The environmental impacts associated with the TPO roofing membrane is presented below in Table 3 for the pro
stage (A1-A3). The life cycle impact assessment results, listed in Table 3 are calculated according to TRACI 2.1 in
with the exception of Global Warming Potential (caulcated according to IPCC AR5 indicators), in accordance with ISO
2017.

Table 3: Environmental impact indicators for 1m² of TPO Single Ply Roofing Membrane

Indicator	A1	A2	A3	Total
Global Warming Potential [kg CO_2 eq.]				
TPO 45 mils	2.73E+00	4.75E-02	2.47E-01	3.02E+00
TPO 60 mils	3.52E+00	6.20E-02	3.22E-01	3.90E+00
TPO 80 mils	4.98E+00	8.71E-02	4.54E-01	5.51E+00
Ozone Depletion Potential [kg CFC-11 eq.]				
TPO 45 mils	9.08E-15	8.72E-18	1.10E-12	1.11E-12
TPO 60 mils	1.16E-14	1.14E-17	1.41E-12	1.42E-12
TPO 80 mils	1.65E-14	1.60E-17	1.99E-12	2.00E-12
Acidification Potential [kg SO_2 eq.]				
TPO 45 mils	5.80E-03	3.89E-04	4.06E-04	6.60E-03
TPO 60 mils	7.50E-03	5.09E-04	5.29E-04	8.54E-03
TPO 80 mils	1.06E-02	7.15E-04	7.45E-04	1.21E-02
Eutrophication Potential [kg N eq.]				
TPO 45 mils	1.02E-03	3.19E-05	5.91E-05	1.12E-03
TPO 60 mils	1.33E-03	4.17E-05	7.65E-05	1.45E-03
TPO 80 mils	1.89E-03	5.86E-05	1.08E-04	2.06E-03
Smog Formation Potential [kg O_3 eq.]				
TPO 45 mils	9.08E-15	8.72E-18	1.10E-12	1.11E-12
TPO 60 mils	1.53E-01	1.72E-02	9.54E-03	1.79E-01
TPO 80 mils	2.15E-01	2.42E-02	1.34E-02	2.53E-01

PRODUCT STAGE			CONSTRUCT-ON PROCESS STAGE		USE STAGE							END OF LIFE STAGE				BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARY
Raw material supply	Transport	Manufacturing	Transport from gate to site	Assembly/Install	Use	Maintenance	Repair	Replacement	Refurbishment	Building Operational Energy Use During Product Use	Building Operational Water Use During Product Use	Deconstruction	Transport	Waste processing	Disposal	Reuse, Recovery, Recycling Potential
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND

Figure 2 Life cycle stages included in system boundary

- LCA Results for stages A1-A3
- With total LCA for the Product Stage.

Utilizing EPDs

- Transparency data on products
- Product comparisons
- Select the product that aligns with the goals and objectives that the system is being designed for.
  - Examples:
    - Is the goal to have a more renewable product
    - Is the goal to have the lowest global warming potential?

Nutrition Facts

about 42 servings per container

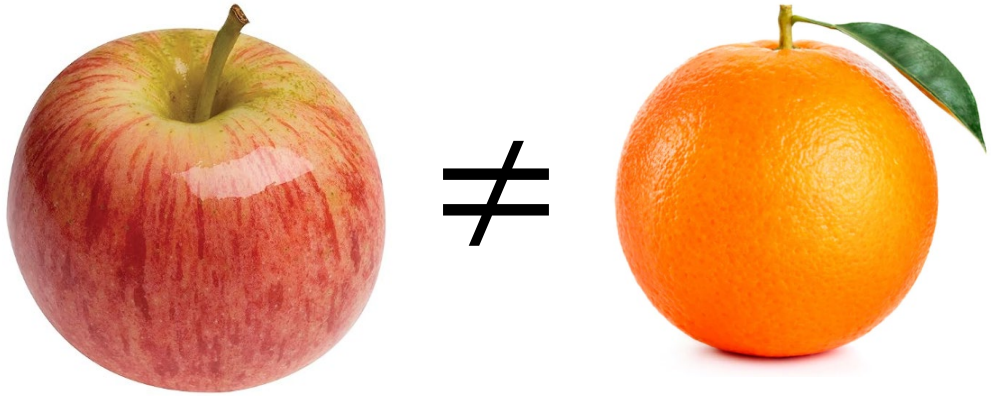
Serving size **1/4 cup (27g)**

Amount per serving

Calories **130**

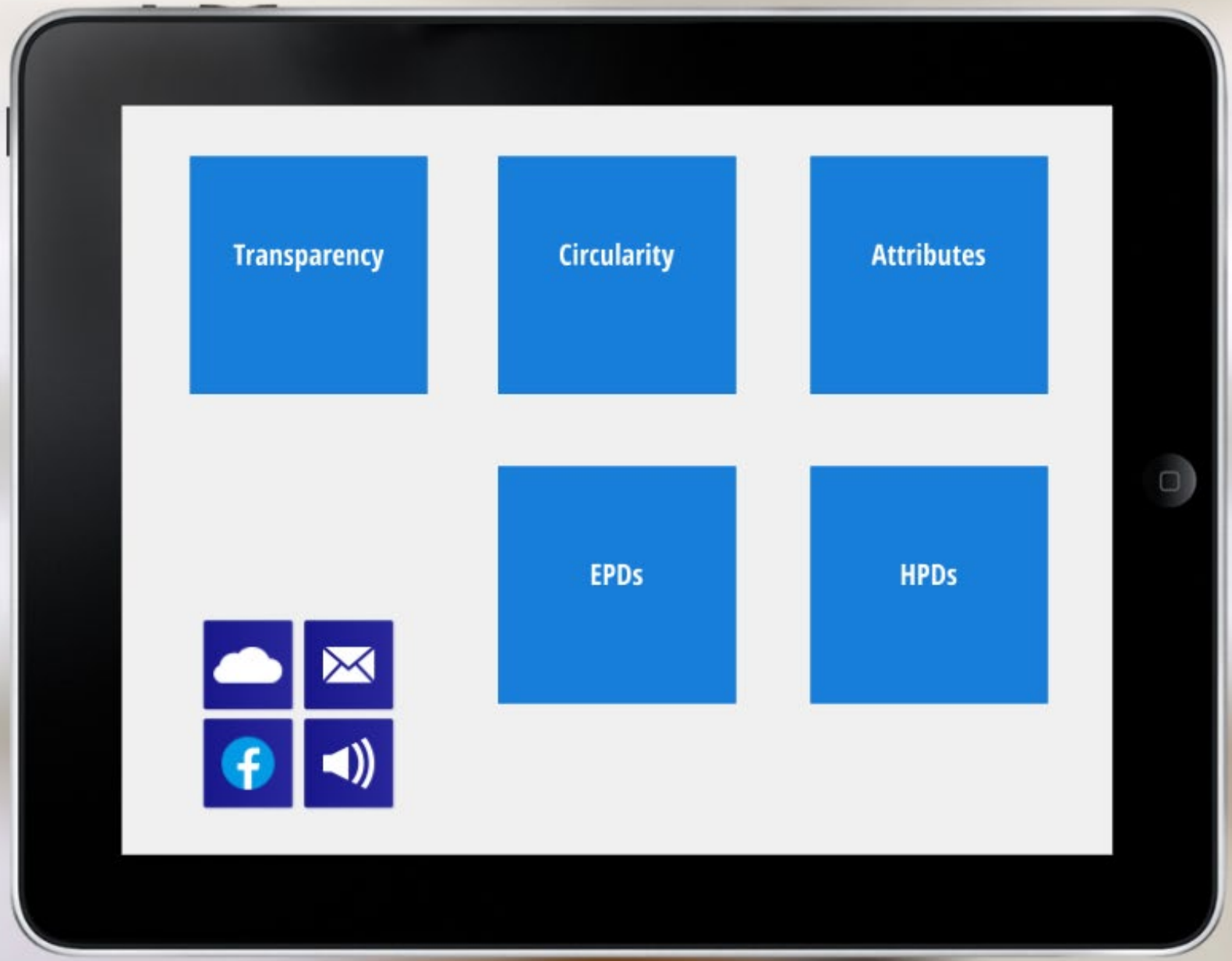
	% Daily Value*
Total Fat 5g	**6%**
Saturated Fat 1.5g	**8%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 90mg	**4%**
Total Carbohydrate 20g	**7%**
Dietary Fiber less than 1g	**2%**
Total Sugars 11g	
Includes 11g Added Sugars	**22%**
Protein 1g	
Vitamin D 0mcg	0%
Calcium 10mg	0%
Iron 1.1mg	6%
Potassium 40mg	0%

* The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.



Some Comparison Considerations:

3rd Party Certified
Industry or Site Specific
System Boundaries
Units of Measure



ROOFING CONTRIBUTIONS

Sustainable Practices

- Sourcing of raw materials
- Improved manufacturing: reduction in water & energy use as well as waste reduction
- Improved thermal efficiency
- Resilient design
- Local/regional sourcing of materials

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