We built that.
Del E. Webb School of Construction
ASU 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 Contrators Association

Helen Hardy Pierce
GAF Materials Corp.

Jason Stanley
IB Roof Systems

1

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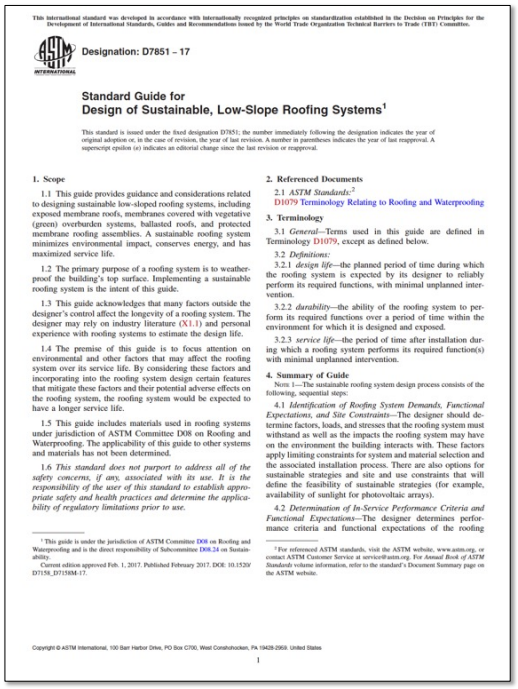

This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade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

[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/D7851_D7851M-17.

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

[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.

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

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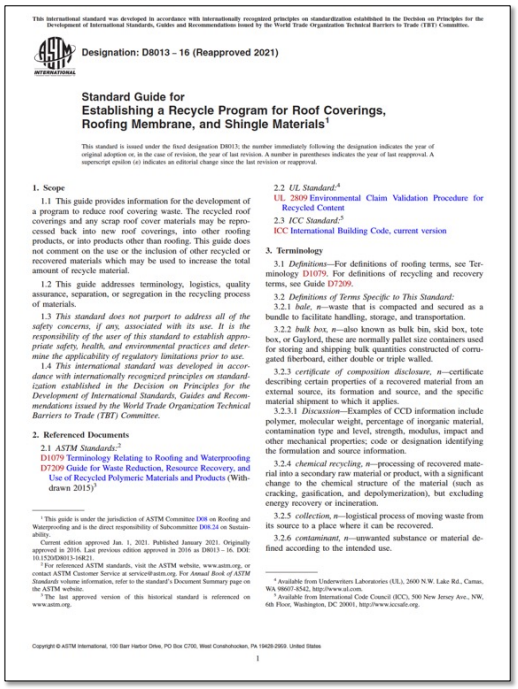

This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade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

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

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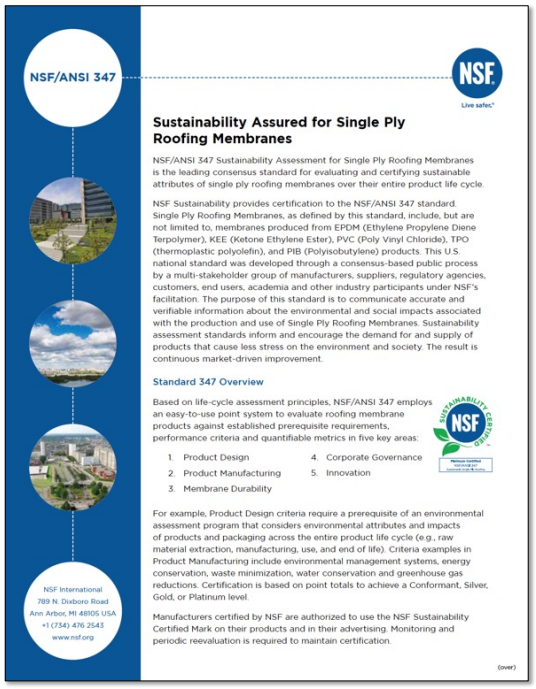
NSF/ANSI 347

NSF

Live safe.

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 International
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Ann Arbor, MI 48105 USA
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www.nsf.org

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

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IgCC®

INTERNATIONAL
GREEN CONSTRUCTION CODE®
A Comprehensive Solution for High-Performance Buildings

A Member of the International Code Family®

2021

POWERED BY
ANSI/ASHRAE/ICC/USGBC/IES 189.1-2020
Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings

ANSI ASHRAE ICC INTERNATIONAL CODE COUNCIL

International Green Construction Code, 2021 Edition

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

Link

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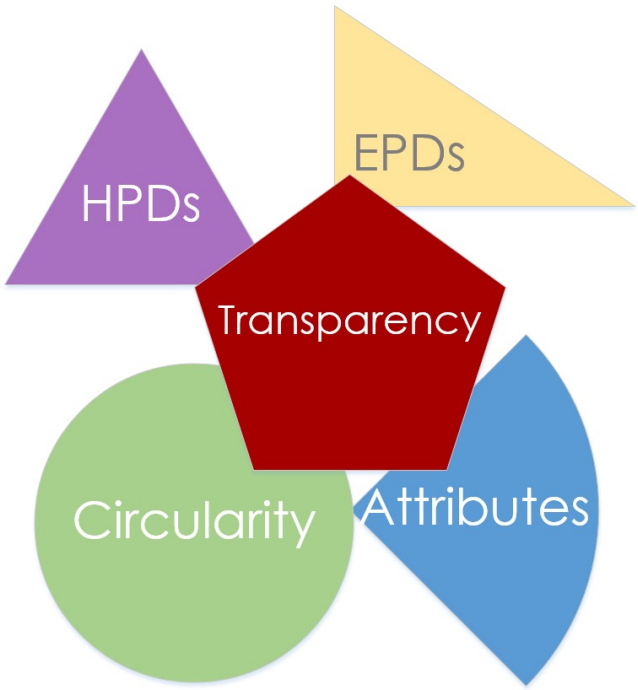
How Roofing Contributes

Certifications & Ratings

7



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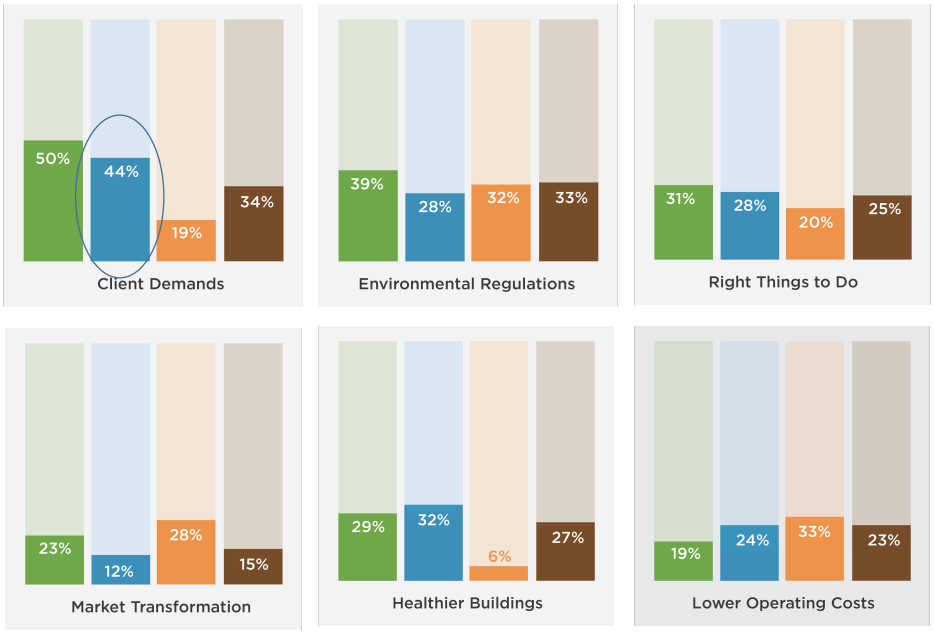
Drivers of the U.S. Green Building Market

Top Triggers Driving Future Building Activity in North America

Dodge Data & Analytics, 2018



Source: Dodge Data & Analytics, World Green Building Trends market report, 2018

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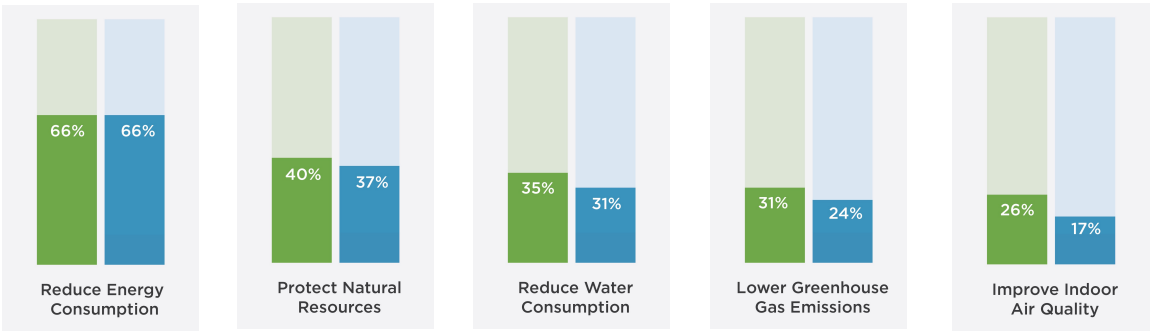
How Roofing Helps Achieve Green Building Energy Goals

Top Environmental Reasons for Building Green

(Ranked Among the Top Two Reasons by Those Who Consider it Important)

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



Source: Dodge Data & Analytics, World Green Building Trends market report, 2018

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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

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Major Options

- IgCC
- ASHRAE 189.1
- LEED
- Green Globes
- Living Building Challenge

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Major Options

- IgCC
- ASHRAE 189.1

Model Codes

- LEED
- Green Globes
- Living Building Challenge

Rating/Certification Systems

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Rating/Certification Systems

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

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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	Gold	Silver	Certified
80+ points earned	60-79 points earned	50-59 points earned	40-49 points earned

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How/Where Roofing Contributes in this space

LEED® 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

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Green Globes

The certification program for commercial buildings provided by the Green Building Initiative (GBI)

Adapted in the US from Green Globes, a Canadian web-based tool with BREEAM Canada origins

Program is based on *ANSI/GBI -01-2019,* American National Standard *Green Globes Assessment Protocol for Commercial Buildings*

GBI also the provider for the Guiding Principles Compliance and third-party assessment program for federal building sustainability requirements

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How/Where Roofing Contributes in this space

GREEN GLOBES® – NC v2013

Site	Materials and Resources	Energy		Indoor Environment
3.2.2.4	**3.5.1.2**	**3.3.4.1**	**3.3.9.1**	**3.7.2.1**
Heat Island Effect	Prescriptive Path for Building Core & Shell (e.g., EPDs)	Thermal Resistance	On-Site Renewable Energy	Volatile Organic Compounds (VOCs)
	Path B			

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Living Building Challenge

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

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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

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And a Funny Thing Happens

When You Consider "Roofing as a System"…

LIVING BUILDING CHALLENGE						
	Materials Petal					
EPDM THERMOSET MEMBRANE ROOFING	Net Positive Waste					
	Water Petal	Health + Happiness Petal	Materials Petal			
THERMAL INSULATION	Net Positive Water	Healthy Interior Performance	Responsible Materials	Red List	Responsible Sourcing	Living Economy Sourcing
	Place Petal	Water Petal	Health + Happiness Petal	Beauty Petal		
VEGETATED ROOF SYSTEMS	Urban Agriculture	Net Positive Water	Access To Nature	Education + Inspiration		

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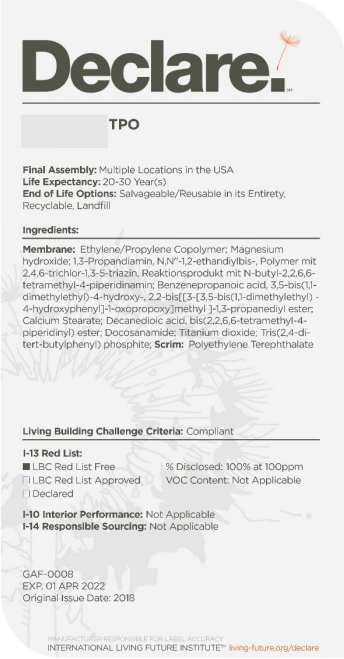
Living Building Challenge Declare.

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



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-Propanediamin, 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
□ I Declared

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

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

GAF-0008
EXP. 01 APR 2022
Original Issue Date: 2018

INTERNATIONAL LIVING FUTURE INSTITUTE™ living-future.org/declare

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Living Building Challenge Declare.

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

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- ☐ LBC Red List Approved
- ☐ Declared

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VOC Content: Not Applicable

Declare.

TPO

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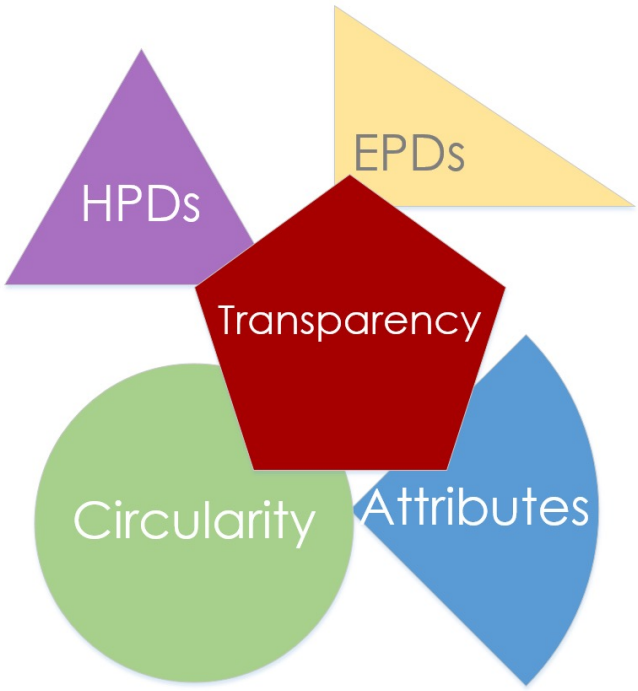

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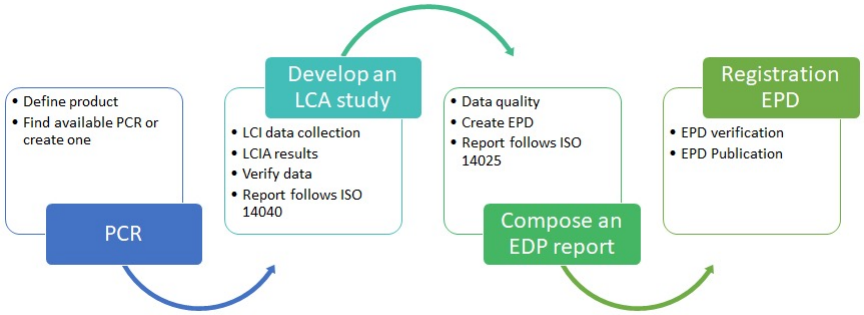
What are the steps to produce an EPD



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

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EPD in simple terms

An EPD gives the company the amount of carbon and carbon equivalencies that is embodied in their product, from:

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

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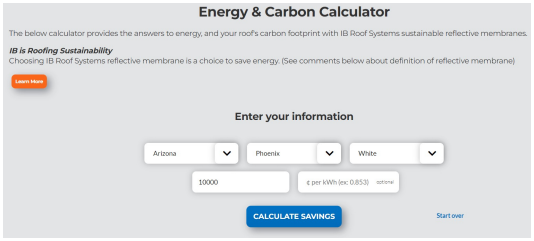
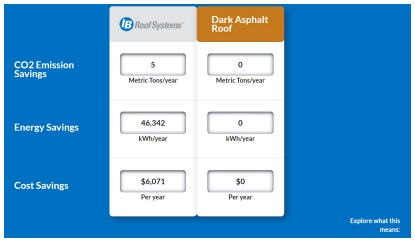
Manufacturers can utilize the information in the EPD to develop tools to show the environmental benefits of utilizing their products. In this case showing energy savings and its results calculated in environmental terms





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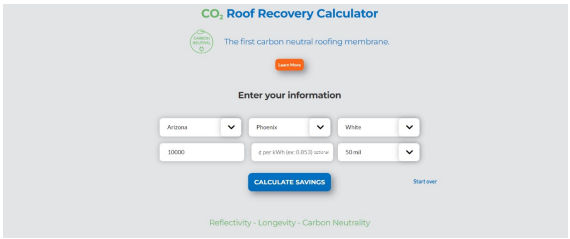
Going one step further the EPD can be utilized to show if or when the product would be carbon-neutral or carbon-negative. In one case during a products warranted lifetime it will become carbon-neutral in less than 4 months and will have more than 14 years of carbon-negativity.



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