Welcome

Healthier Homes: How to Cost-Effectively Deliver Buyers’ Must-Have Features

HIGH PERFORMANCE HOME SUMMIT 2019

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Welcome

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Wellness Within Your Walls

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Hayward Health Home

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National Association of Home Builders
Learning Objectives

• Explore how to build healthier homes that achieve higher profits and market visibility.

• Assess how to make natural, sustainable, and responsible choices before, during, and after the building process that make healthier homes cost-effective and achievable.

• Mitigate indoor air quality challenges during design

• Examine how to build a home that is both energy-efficient and healthy.
Air Quality is Impactful

When all the doors and windows are closed in your house where does the air you breathe come from?
Air Quality is Impactful

EMOTIONAL CHANGES
• Mood changes, feeling agitated or depressed

COGNITIVE CHANGES
• Frequent headaches
• Foggy thinking, difficulty making decisions
• Sleep disturbance (can’t sleep, can’t wake up)
• Short term memory loss

RESPIRATORY CHANGES
• Sinus congestion
• Coughing or shortness of breath
• Need to increase use of asthma inhaler or other medications

OTHER PHYSICAL ISSUES
• Stomach discomfort
• Muscle and joints hurt, making exercise difficult
• Extreme fatigue, feeling lethargic
• Always feeling sick (too many colds)
• Skin rashes
• Night sweats
• Heart racing or palpitations
Air Quality is Impactful

- There are 130 million homes in America w/ 2.9 living in each
- 46% of the homes have an indoor air quality issue affecting at least 1 family member
- 65,000,000 people
  - suffering
  - missing work
  - missing school
  - visiting emergency rooms
Air Quality is Impactful

Build Using Four Simple Principles of Healthy Homes

I. Continuous Fresh Air
II. Properly Sealed and Insulated
III. Less Toxic Materials
IV. Cleanable Surfaces
# Air Quality is Impactful

## Home Buyer Values That Compete With Granite & Hardwood

<table>
<thead>
<tr>
<th>$ Affordable</th>
<th>$$ Work Force</th>
<th>$$$ Market Rate</th>
<th>$$$$ Luxury</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quiet</td>
<td>Quiet</td>
<td>Quieter, Don’t Feel Allergies</td>
<td>Peacefully Quiet, Don’t Feel Allergies</td>
</tr>
<tr>
<td>Health Savings $$, Energy Savings $$$</td>
<td>Health Savings $$, Energy Savings $$$</td>
<td>Health Savings $$, Energy Savings $$$</td>
<td>Health Savings $$$, Energy Savings $$$</td>
</tr>
</tbody>
</table>

- Health Savings $$
- Energy Savings $$$
# Air Quality is Impactful

## Incremental Costs to Achieve Healthy Homes

Based upon a 2,500 sq. ft. home

<table>
<thead>
<tr>
<th>$ Affordable</th>
<th>$&gt;$ Work Force</th>
<th>$&gt;$$ Market Rate</th>
<th>$&gt;$$$ Luxury</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Sealing</td>
<td>$5k</td>
<td>Air Sealing</td>
<td>Air Sealing</td>
</tr>
<tr>
<td>3 Purifiers</td>
<td>$15k</td>
<td>HRV/ERV</td>
<td>HRV/ERV</td>
</tr>
<tr>
<td>MERV Filter</td>
<td>$.2k</td>
<td>MERV Filter</td>
<td>MERV Filter</td>
</tr>
<tr>
<td>HEPA Vac</td>
<td>$.7k</td>
<td>HEPA Vac</td>
<td>HEPA Vac</td>
</tr>
<tr>
<td>Makeup Air</td>
<td>$2k</td>
<td>Makeup Air</td>
<td>Makeup Air</td>
</tr>
<tr>
<td>ElectCook Top-</td>
<td>$2k</td>
<td>Induction</td>
<td>Induction</td>
</tr>
<tr>
<td>Garage Seal</td>
<td>Garage Seal</td>
<td>$1k</td>
<td>Garage Seal</td>
</tr>
<tr>
<td>Less Toxic</td>
<td>$1k</td>
<td>Less Toxic</td>
<td>Less Toxic</td>
</tr>
<tr>
<td>Dust Protocol</td>
<td>$1k</td>
<td>Dust Protocol</td>
<td>Dust Protocol</td>
</tr>
<tr>
<td>Clean Water</td>
<td>$.1k</td>
<td>Clean Water</td>
<td>Clean Water</td>
</tr>
<tr>
<td>Risk Reduction</td>
<td>$3k</td>
<td>Risk Reduction</td>
<td>Risk Reduction</td>
</tr>
<tr>
<td>Smaller HVAC</td>
<td>$4k</td>
<td>Smaller HVAC</td>
<td>Smaller HVAC</td>
</tr>
<tr>
<td>No Gas Line to Cooktop</td>
<td>$1k</td>
<td>No Gas Line to Cooktop</td>
<td>No Gas Line to Cooktop</td>
</tr>
<tr>
<td>No Penetrations &amp; Bath Fans</td>
<td>$1</td>
<td>No Penetrations &amp; Bath Fans</td>
<td>No Penetrations &amp; Bath Fans</td>
</tr>
<tr>
<td>Fewer Operable Windows</td>
<td>$1k</td>
<td>Fewer Operable Windows</td>
<td>Fewer Operable Windows</td>
</tr>
<tr>
<td>*Energy Calc</td>
<td>$</td>
<td>*Energy Calc</td>
<td>*Energy Calc</td>
</tr>
<tr>
<td>Net Cost</td>
<td>$13k</td>
<td>Net Cost</td>
<td>Net Cost</td>
</tr>
<tr>
<td>Net Cost</td>
<td>$25k</td>
<td>$31k</td>
<td>$40k</td>
</tr>
</tbody>
</table>

**Hayward Score 75**

**Hayward Score 85**

**Hayward Score 90**

**Hayward Score 94**

*Net Cost based upon a 2,500 sq. ft. home.*
Air Quality is Impactful

Fill the House With Continuous Fresh Air

Stop The Sucking
Air Quality is Impactful

The Power of Fresh Air Ventilation

Off for 48 Hours - Ouch
Designing Healthier Homes

Changing your building strategies, one decision at a time results in the domino effect.
Designing Healthier Homes

Holistic Approach

An Interconnected Sum of All the Parts
## Designing Healthier Homes

### The Healthy Living System™: Healthy Home Design + Lifestyle Pathways

<table>
<thead>
<tr>
<th>Clean Air</th>
<th>Clean Water</th>
<th>Natural Light</th>
<th>Chemical Control</th>
<th>Physical Wellness</th>
<th>Spiritual Wellness</th>
<th>Mental Wellness</th>
<th>Conscious Consumption</th>
<th>Food Science</th>
<th>Behavioral Strategies</th>
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</thead>
<tbody>
<tr>
<td>Analyze</td>
<td>Analyze</td>
<td>Expose</td>
<td>Analyze</td>
<td>Educate</td>
<td>Reflect</td>
<td>Educate</td>
<td>Reduce</td>
<td>Educate</td>
<td>Contemplate</td>
</tr>
<tr>
<td>Purify</td>
<td>Purify</td>
<td>Capture</td>
<td>Remove</td>
<td>Motivate</td>
<td>Awaken</td>
<td>Nurture</td>
<td>Reuse</td>
<td>Innovate</td>
<td>Adapt</td>
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<tr>
<td>Breathe</td>
<td>Hydrate</td>
<td>Absorb</td>
<td>Contain</td>
<td>Maintain</td>
<td>Flourish</td>
<td>Thrive</td>
<td>Reinvent</td>
<td>Provision</td>
<td>Maintain</td>
</tr>
</tbody>
</table>
Designing Healthier Homes

Sun Analysis

Start with natural resources. Position your homes correctly on the lot for maximum natural light exposures.
Designing Healthier Homes

Community Analysis

How do communities promote health and wellness?

Communities create inclusive environments, make opportunities for connections, provide exposure to nature, promote physical activities, and inspire fellowship.

Outcomes:
- Reduces stress
- Lessen likelihood of depression
- Decreases risk of Cardiovascular Disease
- Helps decrease likelihood of Respiratory Illness
- Reduced chances of Environmental Cancers
Plant trees early to mitigate job site eye pollution, remove CO2 from the environment, and create early interest in what is coming.
Designing Healthier Homes

World Health Organization (WHO) Housing + Health Guidelines Report 2018 Identifies the Following as Health Disrupters:

- Room Crowding- More than 3 occupants in a room
- Poor Insulation
- Poor Ventilation
- Poor Air Quality/Unsafe Air Supply
- Low indoor Temperatures
- High indoor Temperatures
- Water Vapor/Dampness/Mold
- Inadequate hydration/Unsafe water supply
- Noise
- Chemicals of Concern
Determining Health Outcomes

It’s NOT your genetic code...

it’s your zip code!

Source: https://www.cdc.gov/nchhstp/socialdeterminants/faq.html

>5% Genetics/biology

~20% Lifestyle/behavior

~20% Medical care

~55% Physical & social environment
Determining Health Outcomes
Our Built Environment

COMMON HOUSEHOLD CHEMICALS AND TOXINS*

KIDNEY DISEASE
ASTHMA
DEVELOPMENTAL DISABILITIES
BIRTH DEFECTS
HORMONE DISRUPTION
LIVER DISEASE
ADHD
CANCER

TOXIC HOME
Our Built Environment

- Tobacco smoke
- Biological contaminants
- Combustion by-products
- Household products
- Toxic materials
- Radon
- Safety & security
- Diet & Exercise

Cancer • Heart Disease • Respiratory Illness
Respiratory Illness • Lung Disease • Stress
Cancer • Respiratory Illness • Lung Disease
Cancer • Respiratory Illness • Diseases (neurological)
Cancer • Respiratory Illness • Diseases (neurological)
Cancer
Stress
Cancer • Heart Disease • Respiratory Illness
Avoid Chemicals of Concern

- Nonylphenol Ethoxylates (NPE)
- Phthalates
- Antimicrobials
- Flame Retardants
- Perfluorinated Chemicals (PFC)
Avoid Chemicals of Concern

- Asbestos
- Antimicrobials
- Bromine (fire retardant)
- Cadmium
- Chlorinated Polyethylene & Chlorosulfonated Polyethylene
- Chlorofluorocarbons (CFCs)
- Chloroprene (Neoprene)
- Formaldehyde (added)
- Halogenated Flame Retardants
- Hydro Chlorofluorocarbons (HCFCs)
- Lead
- Mercury
- Petrochemical Fertilizers & Pesticides
- Phthalates
- Polyvinyl Chloride (PVC)
- Nonylphenol Ethoxylates (NPE)
- Toluene
- Wood treatments with Creosote, Arsenic or Pentachlorophenol
Building Materials
## Building Materials

<table>
<thead>
<tr>
<th>Assembly</th>
<th>Component</th>
<th>Location</th>
<th>Occupant Exposure</th>
<th>Materials to Avoid</th>
<th>Concerns</th>
<th>Alternatives</th>
<th>Brand</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Foundation</strong></td>
<td>Concrete</td>
<td>Exterior</td>
<td>Negligible</td>
<td></td>
<td>Cement: CO2 &amp; heavy metal emissions, airborne pollution, quarrying</td>
<td>Superior Wall (extruded polystyrene foam insulation)</td>
<td></td>
</tr>
<tr>
<td>Waterproofing</td>
<td>Exterior</td>
<td>Negligible</td>
<td></td>
<td></td>
<td>Styrene-butadiene (possible carcinogen)</td>
<td>Drainage Boards/Mats</td>
<td></td>
</tr>
<tr>
<td><strong>Drainage Mat</strong></td>
<td>Exterior</td>
<td>Negligible</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PVC Drainage</td>
<td>Exterior</td>
<td>Negligible</td>
<td>Polyvinyl Chloride (PVC)</td>
<td>Manufacturing Concerns</td>
<td></td>
<td></td>
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<tr>
<td><strong>Masonry</strong></td>
<td>Exterior</td>
<td>Negligible</td>
<td></td>
<td></td>
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<tr>
<td><strong>Slab Insulation</strong></td>
<td>Interior</td>
<td>Negligible</td>
<td>EPS, XPS, Polyiso</td>
<td>(MDI) methylene diphenyl diisocyanate</td>
<td>Cellular Glass Insulation</td>
<td>FoamGlas</td>
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</tr>
<tr>
<td><strong>BG Walls</strong></td>
<td>Studs</td>
<td>Interior</td>
<td>Moderate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insulation</td>
<td>Interior</td>
<td>Moderate</td>
<td>Spray Foam Insulation</td>
<td>Isocyanates, MDI, polyols (catalysts)</td>
<td>mineral wool</td>
<td></td>
<td></td>
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<tr>
<td>Drywall</td>
<td>Interior</td>
<td>Certain</td>
<td>paper faced</td>
<td>mold/moisture</td>
<td>paper-less board</td>
<td>Dense Shield</td>
<td></td>
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<tr>
<td><strong>Drywall Sealant</strong></td>
<td>Interior</td>
<td>Certain</td>
<td></td>
<td>toluene diisocyanates (TDIs)</td>
<td>California Air Resources Board (CARB) compliant</td>
<td></td>
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<tr>
<td>Assembly</td>
<td>Component</td>
<td>Location</td>
<td>Occupant Exposure</td>
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<td>Brand</td>
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<td>--------------------------------------------</td>
<td>-------------------------------------------------------------------------------</td>
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<tr>
<td>Floor</td>
<td>Floor Joists</td>
<td>Interior</td>
<td>Moderate</td>
<td></td>
<td>Urea Formaldehyde Binders</td>
<td>Methal diisocyanate (MDT), Phenol-resorcinol Formaldehyde HPVA compliant (meets CARB)</td>
<td>Timberstrand</td>
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<td></td>
<td>Floor sheathing</td>
<td>Interior</td>
<td>Moderate</td>
<td>OSB</td>
<td>Formaldehyde</td>
<td>California Air</td>
<td>Plywood, AdvanTech</td>
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<td>AG Walls</td>
<td>Subfloor Sealant</td>
<td>Interior</td>
<td>Certain</td>
<td></td>
<td>toluene diisocyanates (TDIs)</td>
<td>Resources Board (CARB) compliant blown</td>
<td>Armstrong</td>
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<td></td>
<td>Rim Joist Insulation</td>
<td>Interior</td>
<td>Moderate</td>
<td>Spray Foam Insulation</td>
<td>methylene diphenyl diisocyanate; polyols (catalysts)</td>
<td>fiberglass w/ low VOC sealant blown</td>
<td>Johns Manville, Knauf</td>
</tr>
<tr>
<td></td>
<td>Cavity Insulation</td>
<td>Interior</td>
<td>Moderate</td>
<td>Spray Foam Insulation</td>
<td>Isocyanates, MDI, polyols (catalysts)</td>
<td>fiberglass w/ low VOC sealant</td>
<td>Johns Manville, Knauf</td>
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<tr>
<td></td>
<td>Continuous Insulation</td>
<td>Exterior</td>
<td>Negligible</td>
<td>EPS, XPS, Polyiso</td>
<td>MDI</td>
<td>mineral wool</td>
<td>Insulated ZIPS</td>
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<td></td>
<td>Sheathing/Air Barrier</td>
<td>Exterior</td>
<td>Negligible</td>
<td>Particle Board</td>
<td>Binders</td>
<td>Hardwood sheathing paper-less</td>
<td>ZIPS</td>
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<td>Certain</td>
<td>paper faced</td>
<td>mold/moisture</td>
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<td>Component</td>
<td>Location</td>
<td>Occupant Exposure</td>
<td>Materials to Avoid</td>
<td>Concerns</td>
<td>Alternatives</td>
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<tr>
<td>Roof</td>
<td>Rafters</td>
<td>Interior</td>
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<td></td>
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<td>Sheathing</td>
<td>Exterior</td>
<td>Negligible</td>
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<td>Cavity Insulation</td>
<td>Interior</td>
<td>Moderate</td>
<td>Spray Foam Insulation</td>
<td>Isocyanates, (DMI) methylene diphenyl diisocyanate; polyols (catalysts)</td>
<td>blown fiberglass w/ low VOC sealant</td>
<td>ZIPS</td>
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<td>Exterior</td>
<td>Negligible</td>
<td>EPS, XPS, Polyiso</td>
<td>MDI</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Ice &amp; Water Shield</td>
<td>Exterior</td>
<td>Negligible</td>
<td>Petroleum, Asphalt</td>
<td>polynuclear aromatic compounds (PACs) Possible Carcinogen</td>
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<td></td>
<td>Roofing</td>
<td>Exterior</td>
<td>Negligible</td>
<td>Asphalt</td>
<td>PACs</td>
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<tr>
<td></td>
<td>Penetration Sealant</td>
<td>Exterior</td>
<td>Moderate</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>DHW</td>
<td>Pipe</td>
<td>Interior</td>
<td>Certain</td>
<td>ethyltertbutyl ether (ETBE)</td>
<td></td>
<td>NSF’s Standard 61 tested PEX low VOC Armacell</td>
<td>Armacell</td>
</tr>
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<td>Insulation</td>
<td>Interior</td>
<td>Moderate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Building Materials

- Global Warming Potential (GWP)
- Embodied Carbon
- Life Cycle Analysis (LCA)
• Closed Cell Foam in 2010 had a GWP of about 1,000

• Today some blowing agents have GWP as low as 1

• R410a GWP is 2088

• CO$_2$ is 1
Building Materials

Embodied Carbon
Manufacture, transport and installation of construction materials

Operational Carbon
Building Energy Consumption
Building Materials

R20 Foundation Wall Insulation CO2e

XPS                  | 8980
EPS                  | 839
ccSPF, HFC BA        | 2264
ccSPF, HFO BA        | 1286
Mineral Board        | 801
Hempcrete            | -3805
Vacuum Panels        | 3822
Aerogel              | 5571

Embodied CO2e, kg
Building Materials

Plant Based Carbon Storing Building Materials
Building Science Basics

Air Barrier Drawing Set

Air Barrier Installed
Building Science Basics

Air Sealing Design

Air Sealing Construction
Building Science Basics
Building Science Basics

Radon Mitigation Plans
<table>
<thead>
<tr>
<th></th>
<th>Cuts</th>
<th>Over</th>
<th>Material</th>
<th>Description</th>
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<tbody>
<tr>
<td>14</td>
<td>90-95%</td>
<td>&gt;98%</td>
<td>Most Tobacco Smoke</td>
<td>Smoking Lounges</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Box Filter - Rigid Style Cartridge Filters 6 to 12&quot; deep may use lofited or paper media.</td>
</tr>
<tr>
<td>13</td>
<td>89-90%</td>
<td>&gt;98%</td>
<td>Proplet Nuclei (Sneeze)</td>
<td>Superior Commercial Buildings</td>
</tr>
<tr>
<td>12</td>
<td>70-75%</td>
<td>&gt;95%</td>
<td>1.0-3.0 pm Particle Size Legionella</td>
<td>Superior Residential</td>
</tr>
<tr>
<td>11</td>
<td>60-65%</td>
<td>&gt;95%</td>
<td>Humidifier Dust Lead Dust</td>
<td>Better Commercial Buildings</td>
</tr>
<tr>
<td>10</td>
<td>50-55%</td>
<td>&gt;95%</td>
<td>Milled Flour</td>
<td>Hospital Laboratories</td>
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<tr>
<td>9</td>
<td>40-45%</td>
<td>&gt;90%</td>
<td>Auto Emissions Welding Fumes</td>
<td></td>
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<tr>
<td>8</td>
<td>30-35%</td>
<td>&gt;90%</td>
<td>3.0-10.0 pm Particle Size</td>
<td>Commercial Buildings</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Pleated Filters - Disposable, extended surface area, thick with cotton-polyester blend media</td>
</tr>
</tbody>
</table>
HVAC

Good Filtration Because it’s Not Just Dirt

Average Concentration of Chemicals in Dust (NG/G)
Air Quality is Impactful

Cost-Effective Healthy Homes
Air Quality is Impactful

Cost Effective Healthy Homes
Air Quality is Impactful

The impact of green buildings on cognitive function

24 Participants
6 Days
2 Tests

Participants experienced significantly better cognitive function.

The Total Indoor Environmental Quality Lab is housed at Syracuse Center of Excellence. The lab was used to simulate conditions observed in different office environments.

Based on the following cognitive function domains:
- Basic activity level
- Applied activity level
- Focused activity level
- Task orientation
- Crisis response
- Information seeking
- Information usage
- Breadth of approach
- Strategy

https://green.harvard.edu/tools-resources/research-highlight/impact-green-buildings-cognitive-function
Air Quality is Impactful


Building Environment

Blue Enriched Light
-Enhances dayglow
-Improves sleep quality

Melatonin
-Enhances sleep quality

Sleep Quality Scores
25% Higher in high-performing, green-certified buildings

Overall Well-being

In addition, 26% Higher Cognitive Function Scores in high-performing, green-certified buildings

https://naturalleader.com/thecogfxstudy/study-2/
EPDs Enable Embodied Carbon Transparency

Environmental Product Declarations

Nutrition Facts

EPD Results are like MPG
- Estimates based on standard assumptions (PCR)
- Known variability
- Directionally accurate
More Solutions

EC3: Embodied Carbon Calculator for Construction
More Solutions

Point of Service Water System
More Solutions

Personal Filtration
More Solutions

Clothing Refresher
More Solutions

Largest Database of Health/Housing

Over 53,000 people across the US have scored their homes

Hayward Score has Largest Database of Health/Housing Related Information

Slide credit: Hayward Score, www.haywardscore.com
More Solutions

Data Collected by Hayward Score

Structural
- Heating/Cooling
- Crawlspace
- Basement/Attic
- Garage
- Remodeling/Retrofit
- Carpet
- Fireplace
- Cladding

Conditions
- Age
- Maintenance
- Dampness
- Pests
- Leaks
- Mold
- Odor
- Dust

Symptoms/Triggers
- Respiratory
- Non-respiratory
- Event Triggers
- Severity
- Feel Better when Leave

Location
- Climate
- Proximity to Pollutants
- Sun/Shade

Behaviors
- Cooking
- Bathing
- Vacuuming
- Pets
- Pest Treatment
- Chemical Storage

Deep Understanding of Home

Slide credit: Hayward Score, www.haywardscore.com
Resources

http://www.c2ccertified.org/products/registry

https://access.living-future.org/

https://hpdrepository.hpd-collaborative.org/Pages/Results.aspx

https://www.greenscreenchemicals.org/

https://materialspalette.org/

https://buildingclean.org/building/products/flooring


https://www.haywardscore.com/
Questions???

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Thank you!

Join the conversation - #EEBASummit2019

Save the dates for next year:

HIGH PERFORMANCE HOME SUMMIT 2020

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